MITSUBISHI FUSO

Service Manual

2002 - 2004

Choose a model:

FE FG FH FK FM

FE.FG

SERVICE MANUAL
2002 Model

FOREWORD

This Service Manual contains maintenance and repair methods for the Mitsubishi Fuso Truck FE, FG Series. Read this manual carefully as an aid in providing correct, efficient maintenance. Please note that the information and specifications contained within this manual may change without notice. This is due to product modifications and contined vehicle improvements that are made throughout the model years. Should you encounter any discrepancy in the information provided, please do not hesitate to contact your nearest Mitsubishi Fuso Dealer or Mitsubishi Fuso Truck of America, Inc.

April 2001

HOME

GROUP INDEX

HOW TO READ THIS MANUAL
GENERAL 00
MAINTENANCE SCHEDULE 01
ENGINE
< 4M5 > 11A
< 4D3 > 11B
LUBRICATION
< 4M5 > 12A
< 4D3 > 12B
FUEL AND ENGINE CONTROL
< 4M5 > 13A
< 4D3 > 13B
ELECTRONICALLY CONTROLLED FUEL SYSTEM
< 4M5 > 13EA
< 4D3 > 13EB
COOLING
< 4M5 > 14A
< 4D3 > 14B
INTAKE AND EXHAUST
< 4M5 > 15A
< 4D3 > 15B
CLUTCH 21
MANUAL TRANSMISSION 22
AUTOMATIC TRANSMISSION 23
TRANSFER 24
PROPELLER SHAFT 25
FRONT AXLE
< FE > 26A
< FG > 26B
REAR AXLE 27
WHEEL AND TIRE 31
FRONT SUSPENSION 33
REAR SUSPENSION 34
BRAKE 35A
ANTI-LOCK BRAKE SYSTEM 35E
PARKING BRAKE 36
STEERING 37
FRAME 41
CAB 42
ELECTRICAL 54
AIR-CONDITIONER 55A
HEATER 55B

MITSUBISHI
FUSO

How to Read this Manual

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-H

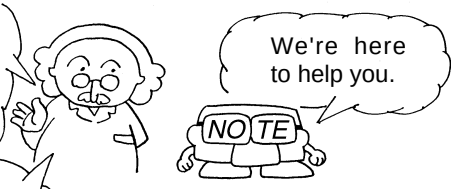
INDEX

HOW THIS MANUAL IS STRUCTURED 2

TERMS 15

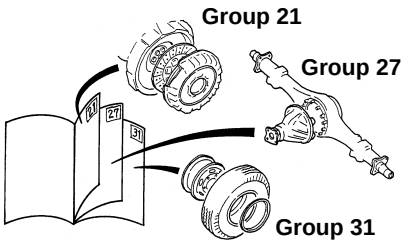
HOW THIS MANUAL IS STRUCTURED

I'm here to explain how to use this manual. To get the most out of your manual, follow along carefully and read all the notes given by my assistant.

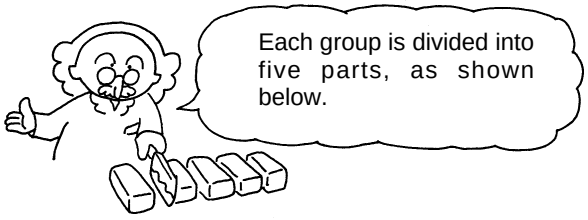


23929

This manual is divided into groups, with one group for each main area of the vehicle.
By way of example, let's look at Group 21, which covers the clutch.



23915



23916

Specifications
Specifications, oil quantities, and other information pertaining to system components.

Structure and Operation
Information on the structure and operation of the overall system and its components.

Troubleshooting
An item-by-item guide to fault symptoms and their probable causes.

On-Vehicle Inspection and Adjustment
Instructions for on-vehicle inspection and adjustment operations.

Service Instructions
(See the next and subsequent pages.)

INDEX

SPECIFICATIONS .....

STRUCTURE AND OPERATION .....

TROUBLESHOOTING .....

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Clutch Fluid Replacement and Air Bleeding .....
2. Inspection of Clutch Booster Functionality .....
3. Clutch Pedal Play .....

CLUTCH PEDAL .....

CLUTCH MASTER CYLINDER .....

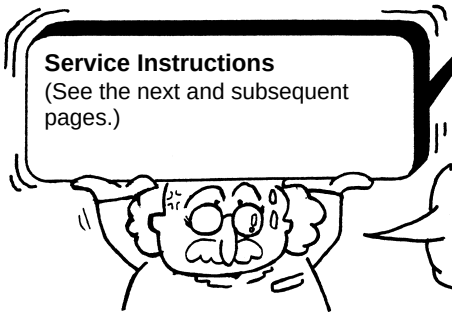
CLUTCH BOOSTER AND CLUTCH MASTER CYLINDER .....

CLUTCH POWER CYLINDER .....

CLUTCH-PROPER .....

CLUTCH HOUSING .....

CLUTCH DISC WEAR INDICATOR SWITCH .....



The service instructions are the most important parts of this manual. Starting on the next page, you'll learn more about them.

23917

Service procedures

1

INDEX

SPECIFICATIONS .....

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Clutch Fluid Replacement and Air Bleeding .....
2. Inspection of Clutch Booster Functionality .....
3. Clutch Pedal Play .....

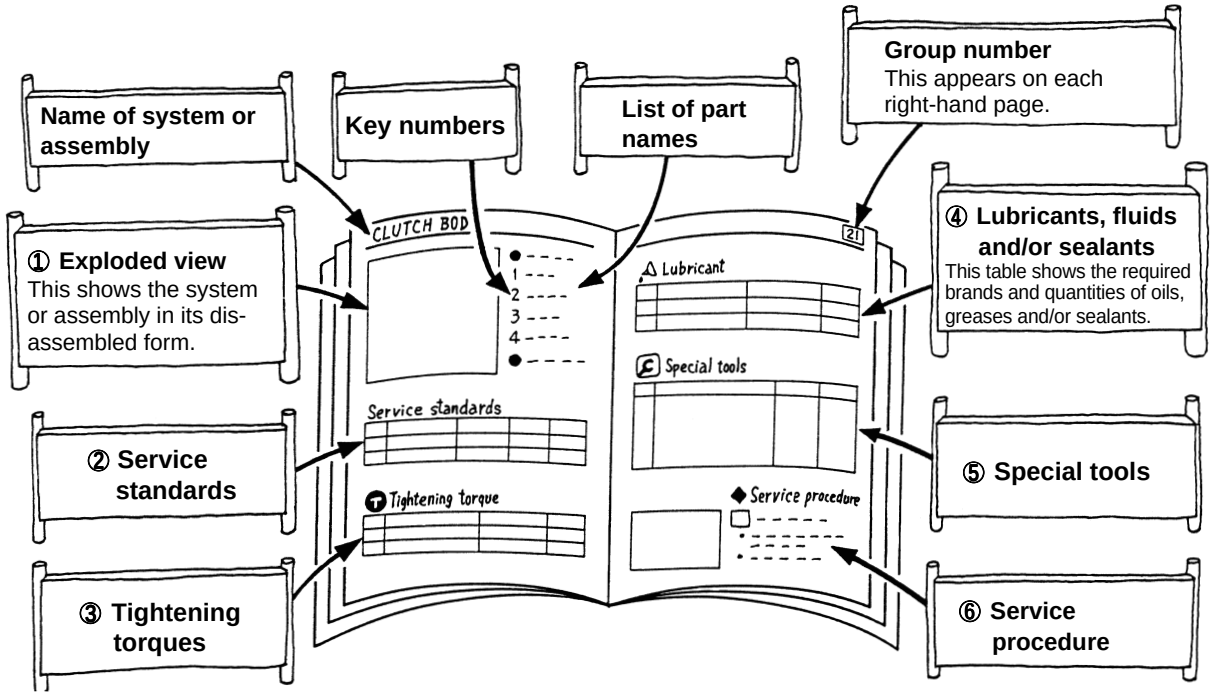
CLUTCH PEDAL .....
CLUTCH MASTER CYLINDER .....
CLUTCH BOOSTER AND CLUTCH MASTER CYLINDER .....
CLUTCH POWER CYLINDER .....
CLUTCH-PROPER .....
CLUTCH HOUSING .....

23918

2

The service instructions consist of the parts shown below. Starting on page 7, these parts are described in detail in order of the circled numbers.

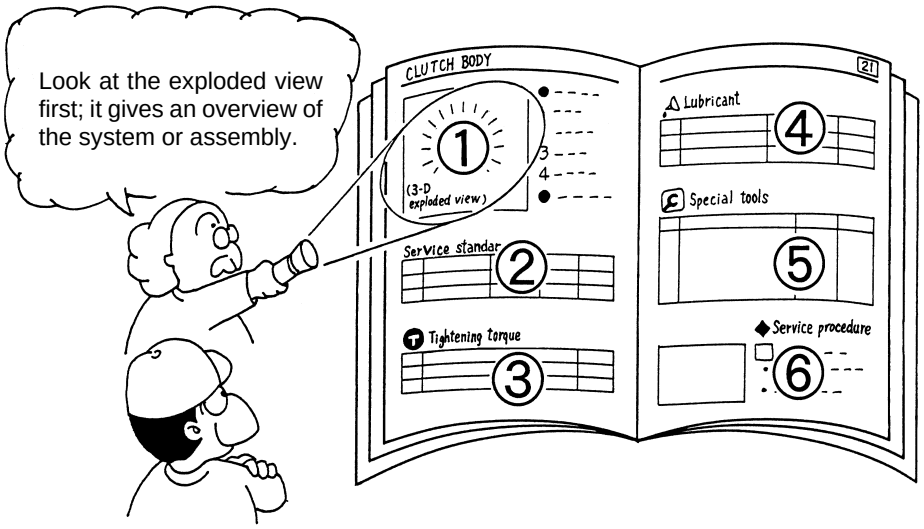
20244



26310

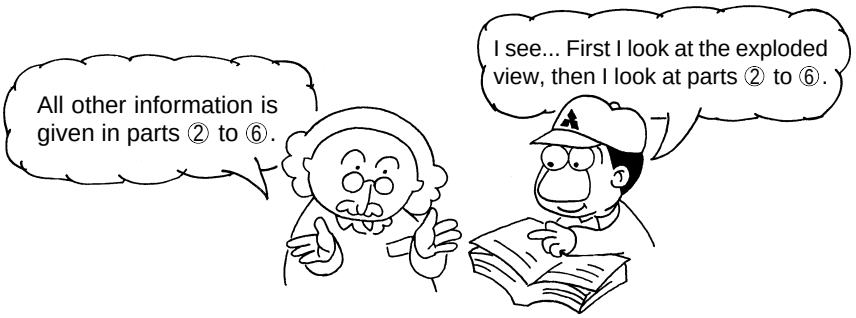
HOW THIS MANUAL IS STRUCTURED

3



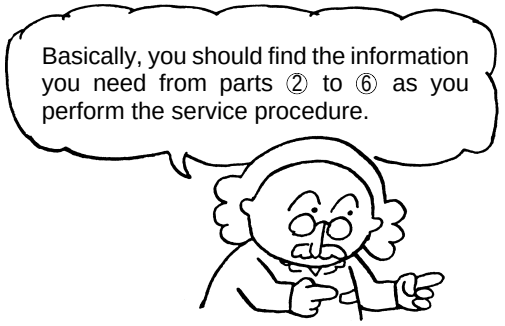
26311

4

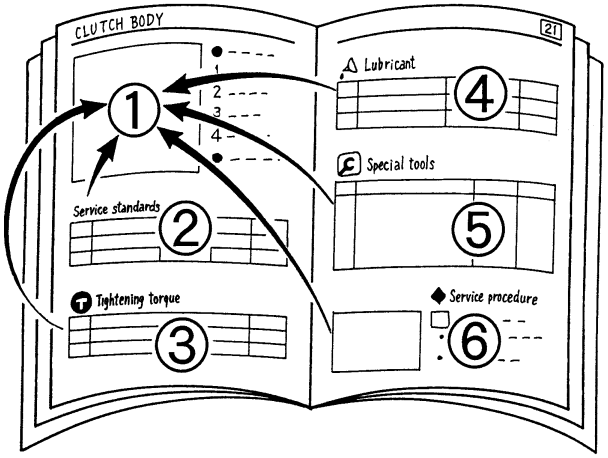


23921

5



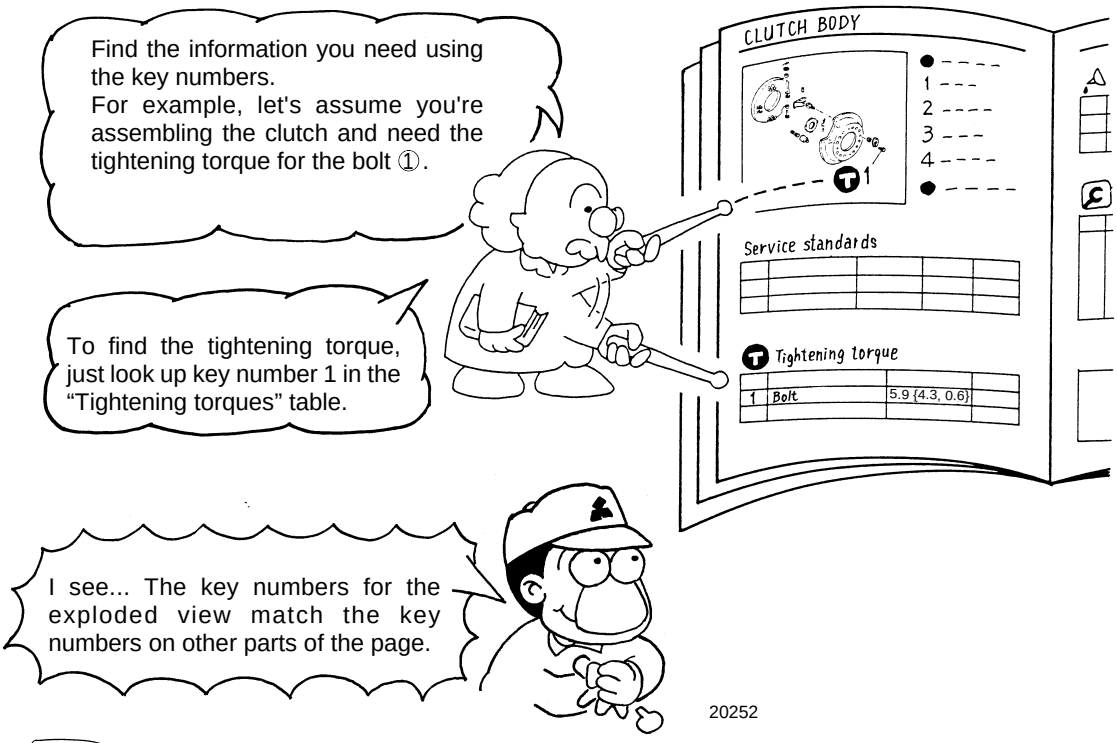
20245



26312

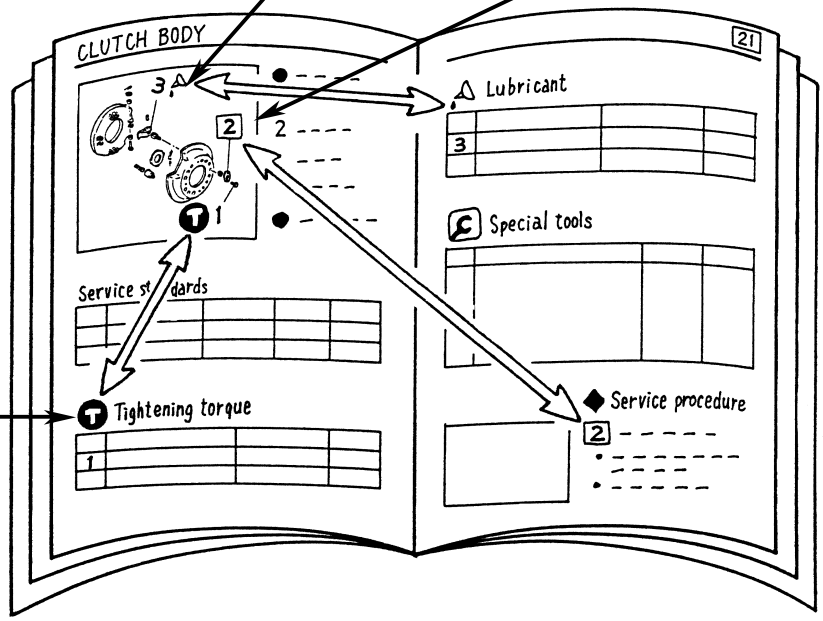
23922

6



NOTE

To help you find information quickly:
Tightening torques are marked with T.
Lubricants, fluids and sealants are marked with △.
And every key number that appears in the service procedure is enclosed with a square.



HOW THIS MANUAL IS STRUCTURED

① Exploded view

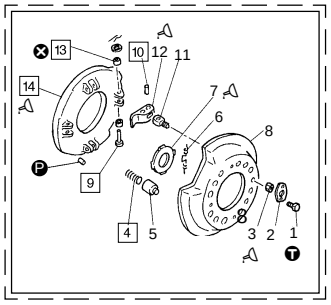
1

Explanatory notes for the exploded view are given below. Explanatory notes for the parts list are given on the facing page.

23925

CLUTCH-PROPER <C5>

Pressure Plate-and-Lever Assembly



● **Pre-disassembly operations**
P21 - 44

• **Disassembly sequence**

1	Bolt
2	Lock plate
3	Support nut
4	Pressure spring
5	Pressure spring cap
6	Return spring
7	Release lever plate
8	Clutch cover
9	Release lever pin
10	Support lever pin
11	Support lever
12	Release lever
13	Bushing
14	Pressure plate

Ⓟ Positioning pin
⊗ : Non-reusable part

NOTE
Do not remove the bushing 13 unless it is defective.

● **Assembly sequence**
Reverse the order of disassembly.
Repair kit : Clutch release
Lever kit

● **Post-assembly Inspection and adjustment**
P21 - 44

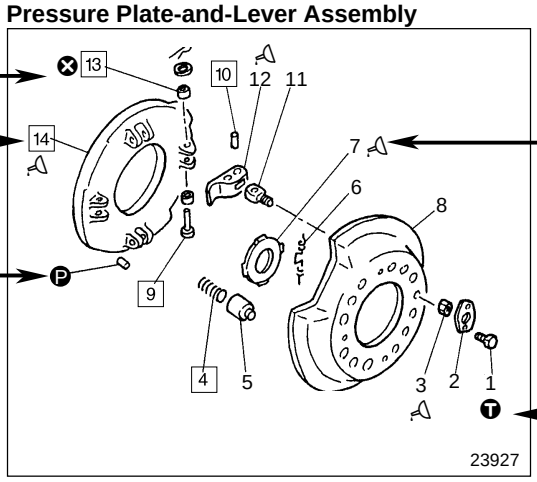
23926

NOTE
This mark indicates a part that cannot be reused.

NOTE
The key number enclosed with a square indicates that the part is mentioned in the service procedure.

NOTE
Ⓟ: Indicates positioning pin.

Pressure Plate-and-Lever Assembly



23927

NOTE
This mark indicates that lubricant or sealant must be applied to the part.

NOTE
This mark indicates that a tightening torque is specified for the part.

So parts without Ⓣ marks don't have specified tightening torques ?

No, they don't. But every bolt and nut must be tightened to a standard torque. A Ⓣ mark shows either that the part must be tightened to a torque other than the standard torque or that the standard torque cannot be determined from the part's shape or markings.
Standard tightening torques are explained at the bottom of the next page.

23928

2

NOTE
The key numbers are given here.

● **Pre-disassembly operations**
P21 - 44

NOTE
This shows that certain operations must be performed before disassembly.

● **Disassembly sequence**
1 Bolt
2 Lock plate
3 Support nut
4 Pressure spring
5 Pressure spring cap
6 Return spring
7 Release lever plate
8 Clutch cover
9 Release lever pin
10 Support lever pin
11 Support lever
12 Release lever
13 Bushing
14 Pressure plate

⊗ : Non-reusable part

NOTE
The names of parts are given here.

NOTE
Links to reference information are given as follows:
- P21 - 44
  Refer to the indicated page of the same group.
- Gr 42
  Refer to the indicated group in another manual.

NOTE
The key numbers show the disassembly sequence.

NOTE
Do not remove bushing 13 unless it is faulty.

● **Assembly sequence**
Follow the disassembly sequence in reverse.
Repair kit : Clutch Release Lever kit

● **Post-assembly inspection and adjustment**
P21 - 44

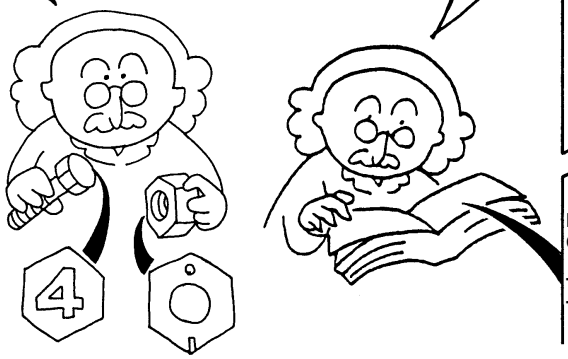
NOTE
This shows that certain operations must be performed after assembly.

NOTE
The name of the specified repair kit (if any) is given here.

NOTE
The assembly sequence is given here. Assembly is usually performed in the opposite order to disassembly. If the assembly sequence is otherwise specified, it is given in terms of key numbers like this:
● **Assembly sequence**
14→12→10→13→11.....

Now let's look at standard tightening torques. Normally, bolts and nuts have numbers or markings to show their material strength.

Tightening torques for bolts and nuts with such numbers and markings are shown in the Table of Standard Tightening Torques that appears in group 00.



INDEX

ENGINE NUMBER AND NUMBER PLATE .....

PRECAUTIONS FOR MAINTENANCE OPERATIONS .....

TABLE OF STANDARD TIGHTENING TORQUES .....

23930

HOW THIS MANUAL IS STRUCTURED

② Service standards

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
4	Pressure spring	Installed load (Installed length 49.1 {1.93})	885 N {200 lbf, 90.2 kgf}	750 N {170 lbf,76.7 kgf}	Replace
		Squareness	2.9 {0.11} or less	5.0 {0.20}	Replace
7	Release lever plate height		53.8±0.7 {2.12±0.028}	Relative difference 0.5 {0.020} maximum	Adjust
10, 13	Clearance between release lever pin and bushing		[10 {0.39}] 0.02 to 0.11 {0.00079 to 0.0043}	0.4 {0.016}	Replace
14	Pressure plate	Thickness	23.6±0.1 {0.93±0.0039}	21 {0.83}	Replace
		Flatness	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Strap bolt hole I.D.	10.2 to 10.25 {0.40 to 0.40}	10.5 {0.41}	Replace

NOTE

Number(s) in this column match the key number(s) on the exploded view ①.

③ Tightening torques

Tightening torque

Unit : N·m {ft.lbs, kgf.m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	5.9 to 7.8 {4.3 to 5.8, 0.6 to 0.8}	—

NOTE

Number(s) in this column match the key number(s) on the exploded view ①.

NOTE

If oil or grease must be applied to threads before tightening, the word "Wet" appears in this column.

	Remarks
	Wet

④ Lubricants, fluids and/or sealants

Lubricant

Location	Points of application	Specified lubricant	Quantity
3	Threads and spherical surface of support nut	Anti-seizure compound	As required
7, 12	Sliding surfaces of release lever plate and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
11, 12	Sliding surfaces of support lever and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
11, 14	Sliding surfaces of support lever and pressure plate	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

NOTE

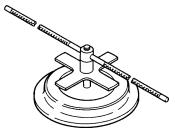
Number(s) in this column match the key number(s) on the exploded view ①.

NOTE

The specified types/brand are shown here.

⑤ Special tools

Special tools Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Clutch Installer  01277	MH061051	Removal and installation of clutch cover

NOTE
Number(s) in this column match the key number(s) on the exploded view ①.
For any special tool that is not a Mitsubishi genuine part, no illustration is shown; only the part number is given, as shown below.

Special tools

Location	Tool name and shape	Part No.	Application
21	Insertion Tool	*910-24461	Installation of O-ring
32	Retainer	*910-24590	Retention of primary piston

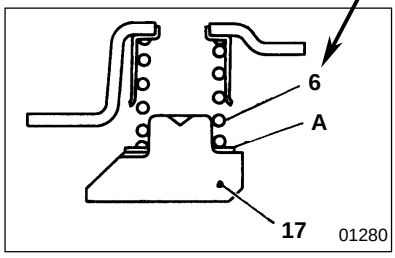
* BOSCH BRAKING SYSTEMS Co. Ltd. product number

⑥ Service procedure

1

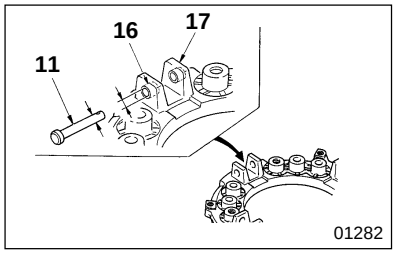
NOTE
Number(s) is this column match the key number(s) exploded view ①.

NOTE
The service procedure gives instructions in order of key numbers.



6 **Installation of pressure spring**
If the pressure plate **17** has been reqround, insert between the pressure plate and pressure spring **6** an adjusting washer **A** whose thickness matches that of the ground off material.

Regrind amount	Thickness and number of washer(s)
Less than 1 mm {0.039 in.}	Not required
1 mm {0.039 in.} (or more) to less than 2 mm {0.079 in.}	1.2 mm {0.047 in.} x 1
2 mm {0.079 in.} (or more) to less than 3 mm {0.12 in.}	1.2 mm {0.047 in.} x 2 or 2.3 mm {0.091 in.} x 1



11 16 **Clearance between release lever pin and bushing**
If the measurement exceeds the specified limit, replace the defective part(s).

NOTE
Perform this check with the bushing 16 press-fitted into the pressure plate 17.

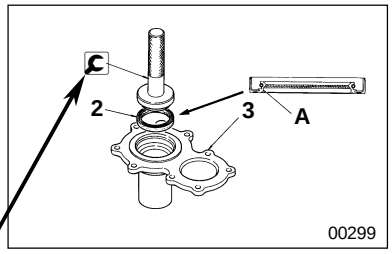
2

Service procedures contain a variety of symbols and other indications. Let's look at some examples.

23931

Key number

[Example 1: Special tools]



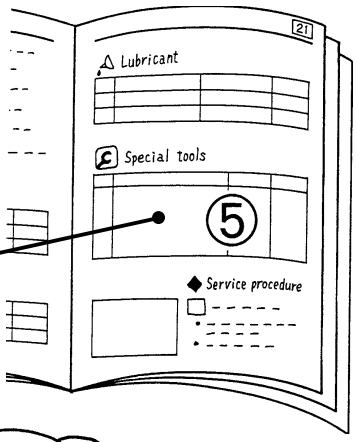
2 Installation of oil seal

- Apply grease to the lip **A** of the oil seal **2**.
- Using the Oil Seal Installer, fit the oil seal **2** into the front bearing retainer **3**. Make sure the oil seal is aligned as illustrated.

Name of special tool

Every special tool is indicated by a symbol. The text of the service procedure also includes the special tool's name. To see the part number and shape of a special tool, find the tool's key number and name in the "Special tools" table ⑤.

23932



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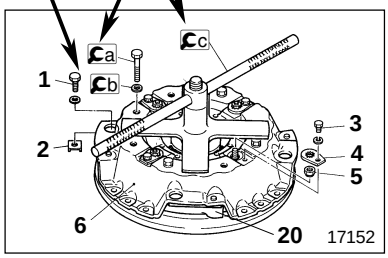
If more than one special tool is used, the symbols are supplemented by letters (for example, a, b and c) to enable cross-referencing between the exploded view and service procedure.

20277



6 Removal and installation of clutch cover

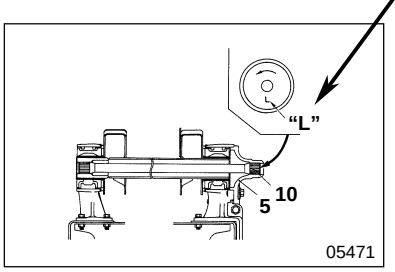
[Removal]

- Compress the pressure spring **8** using the c Clutch Installer, then remove the a Stopper Bolt, b Washer, strap bolt **1**, washer **2**, bolt **3**, lock plate **4** and support nut **5**.
- Gradually loosen the c Clutch Installer until the pressure spring **8** is ineffective, then remove the clutch cover **6**.

3

[Example 2: Identification or mating marks]

NOTE Any mark on an actual part is given in quotation marks " " in the service procedure.

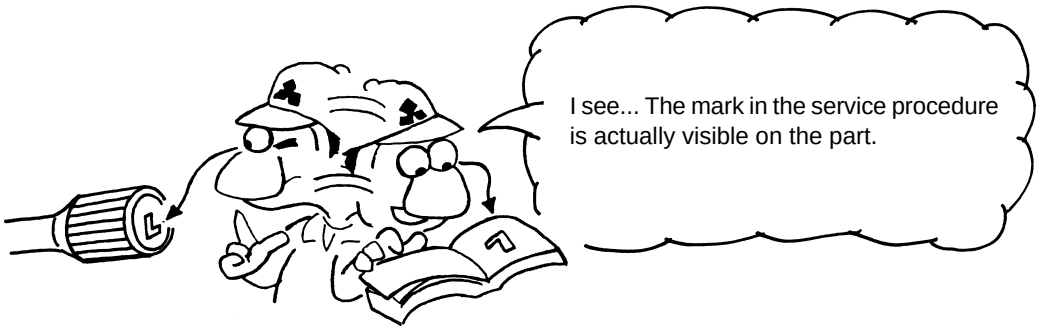


10 Installation of torsion bar

Fit the torsion bar **10** such that the "**L**" identification mark is on the side of the anchor lever **5**.

CAUTION ⚠

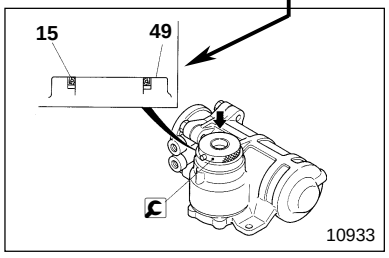
Make sure the torsion bar 10 aligned as specified. If the torsion bar is installed the wrong way around, the torsion direction will be reversed, resulting in damage.



4

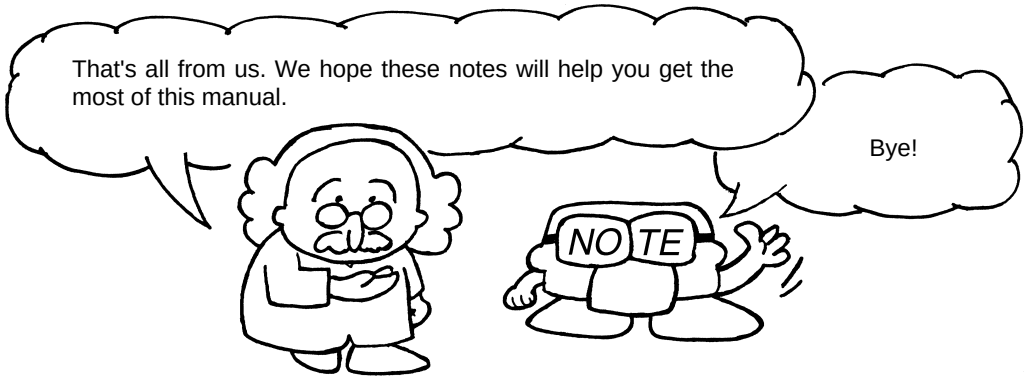
[Example 3 : Alignment of parts]

NOTE All illustrations show the correct alignment/direction of parts relative to each other. Provided the alignment/direction is shown clearly in the exploded view ①, no further explanation is given in the text of the service procedure.

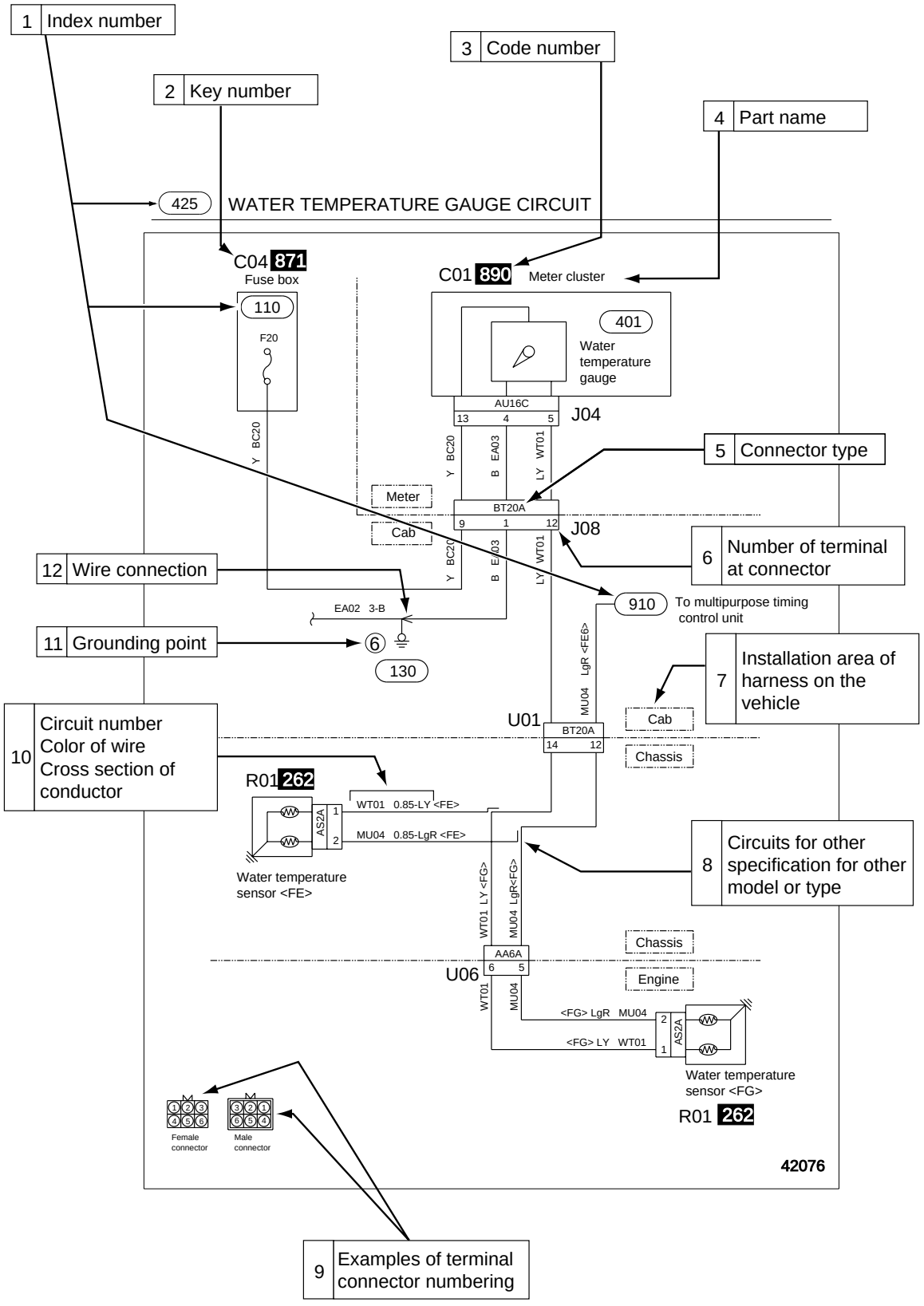


15 Installation of oil seal

Fit the oil seal **15** into the body **49,** making sure it is aligned as illustrated.



HOW TO READ CIRCUITS (GROUP 54)



Ⓟ 43351

1 Index number: (110)

Each circuit has its own Index number respectively and has three digits ((110)).
How to read index number

- By proper using of the index number, it is possible to locate right place immediately since the circuit drawing of this manual book are classified as function by function. (including “Power Circuit” (110) and “Ground Circuit” (130) .)
- How to check the location of circuit drawing in each part
  The circuit drawing which can not be diagramed in one page due to its complicated structure (such as meter cluster and electronic control unit etc.), has its remarked index number to be connected to other circuit drawing. ((401) , (910) , etc.)

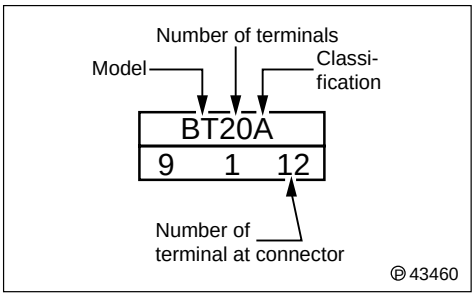
2 Key number: A01~
Key number is the number to indicate the installation position of the parts, and is shown by A01 ~ Z.
The details of the installation position are described in GROUP 10 .

3 Code number: **001** ~
Code number is the number to indicate the one portion of the parts to be checked and has three digits (**001**).
The details of the parts to be checked are described in GROUP 11 .

4 Part name

5 Connector type
Connectors are shown by □ without mentioning Male or Female and in the box it is described model of connector, number of terminals and its classification, etc.
Table of connectors is described in GROUP 14.

6 Number of terminal at connector
Terminal numbers of connector are shown by figures in the box.

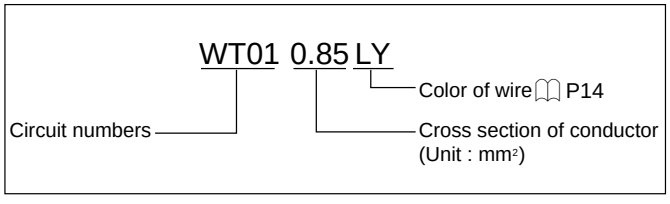


7 Installation area of harness on the vehicle
The location and boundary of the harnesses in the vehicle are shown in the each circuit drawing and it may help to check mounting position of connectors.

8 Circuits for other specification for other model or type

9 Examples of terminal connector numbering
As it is shown, for female connectors, with placing the lock upward then starting to put numbers from the upper left. And when it is male connector, put numbers from the upper right, also with placing the lock upward.

10 Circuit number, color of wire, and cross section of conductor are shown in circuit drawings.



Except for 0.5mm², Wire thickness is described in the circuit drawing. The reason why only wire thickness, 0.5 mm² is not described in the drawings is 0.5mm² is so common and so that the circuit drawing can be seen more easily.
(Examples) 0.5mm²: Y
0.85mm²: 0.85 — LY
3mm²: 3 — B

11 Grounding point
The actual locations of grounding points on the vehicle are shown. Refer to (130) for detailed information.

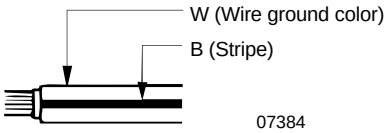
12 Wire connection
When the wires are connected into one point of the harnesses, the circuit drawing shows “Arrow mark”.

CAUTION !
Be careful that direction of the arrow does not show the direction of the electric current flow.

HOW THIS MANUAL IS STRUCTURED

● Wire Colors

Example: WB means a wire whose ground color is white and whose stripe is black.

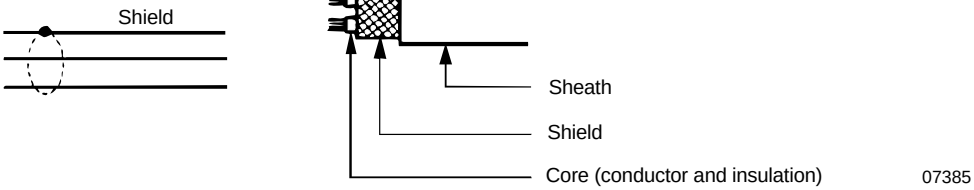


Wire ground color		Wire ground color + Stripe									
W	White	WR	White red	WB	White black	WL	White blue	WG	White green		
B	Black	BW	Black white	BY	Black yellow	BR	Black red				
R	Red	RW	Red white	RB	Red black	RY	Red yellow	RG	Red green	RL	Red blue
Y	Yellow	YR	Yellow red	YB	Yellow black	YG	Yellow green	YL	Yellow blue	YW	Yellow white
G	Green	GW	Green white	GR	Green red	GY	Green yellow	GB	Green black	GL	Green blue
Br	Brown	BrW	Brown white								
L	Blue	LW	Blue white	LR	Blue red	LY	Blue yellow	LB	Blue black	LO	Blue orange
Lg	Yellow green	LgR	Yellow green red	LgY	Yellow green yellow	LgB	Yellow green black	LgW	Yellow green white		
O	Orange										
P	Pink	PB	Pink black								

● Shield Wire

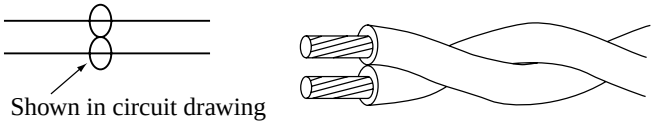
A shield wire is clearly identified as follows:

Example



● Twist wire

Twist wires are made by twisting the core of wires by the constant pitch.
Example:



The terms in this manual are defined as follows.

● This service manual contains important cautionary instructions and supplementary information under the following four headings which identify the nature of the instructions and information:

DANGER⚠ ——— Precautions that should be taken in handling potentially dangerous substances such as battery fluid and coolant additives.

WARNING⚠ ——— Precautionary instructions, which, if not observed, could result in serious injury or death.

CAUTION⚠ ——— Precautionary instructions, which, if not observed, could result in damage to or destruction of equipment or parts.

NOTE Suggestions or supplementary information for more efficient use of equipment or a better understanding.

● **Front and rear**

The terms “front” is the fan side and “rear” the flywheels side of the engine.

● **Left and right**

The terms “right” and “left” shall be used to indicate the side as viewed from the flywheel side of the engine.

● **Terms of service standards**

(1) Standard value

Standard value dimensions in designs indicating: the design dimensions of individual parts, the standard clearance between two parts when assembled, and the standard value for an assembly part, as the case may be.
The figure in [ ] is the basic diameter.

(2) Limit

When the value of a part exceeds this, it is no longer serviceable in respect of performance and strength and must be replaced or repaired.

● **Tightening torque**

Appropriate tightening torque has particular importance in respect of performance. Accordingly, tightening torque is specified in locations that are to be tightened.
Where there is no specified figure for tightening torque, follow the table covering standard tightening torques.
When the item is to be tightened in a “wet” state, wet is indicated. Where there is no indication, read it as dry, and tighten at specified torque.

MITSUBISHI
FUSO

Group 00

General

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-00

INDEX

MODEL CODING SYSTEM 00- 2

POWER TRAIN TABLE 00- 3

CHASSIS NUMBER AND ENGINE NUMBER 00- 4

POWER TRAIN LABEL 00- 4

VEHICLE IDENTIFICATION NUMBER 00- 5

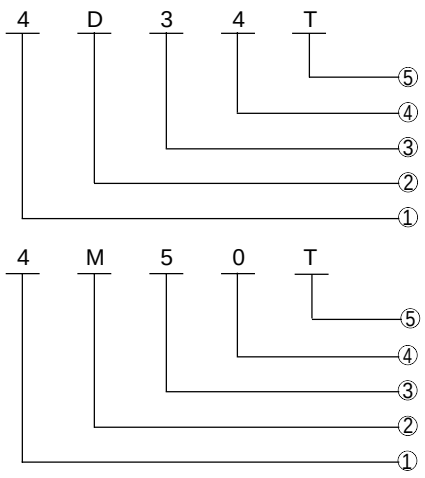
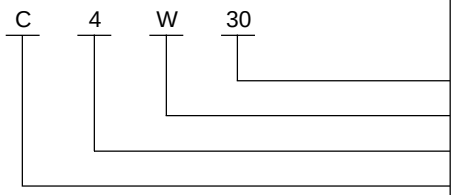
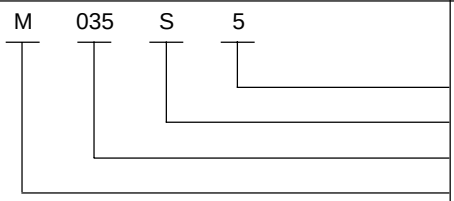
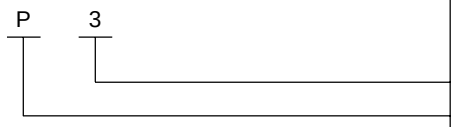
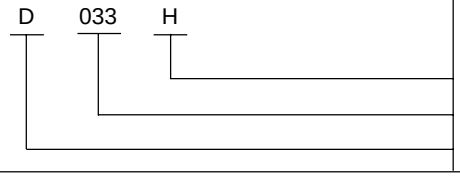
PRECAUTIONS FOR MAINTENANCE OPERATION 00- 6

TABLE OF STANDARD TIGHTENING TORQUES 00- 18

CONNECTOR CONFIGURATION CHART 00- 22

MODEL CODING SYSTEM

Equipment Model

Equipment name	Model description	Code description
Engine		① No. of cylinders (4 : Four cylinders) ② Stands for diesel engine ③ Series number ④ Version number ⑤ With turbocharger
Clutch		Disk outer diameter Facing material (W : Woven) Loading capacity of major type (tonnage) Stands for clutch
Transmission		No. of forward speeds Meshing (S : Synchromesh A : Automatic) Loading capacity of major type (tonnage) Stands for transmission
Propeller shaft		Loading capacity of major type (tonnage) Stands for propeller shaft
Reduction and differential		Teeth shape (H : hypiod gear) Loading capacity of major type (tonnage) Stands for reduction and differential

POWER TRAIN TABLE

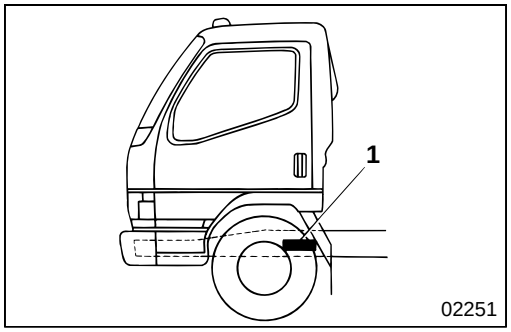
Model	Engine model	Clutch model	Transmission model	Propeller shaft	Rear axle model	Final reduction and gear ratio
FE639 G.V.W. 5445 kg {12000 lb}	4D34T3 145 HP/2900 rpm 275 ft.lbs/1600 rpm (SAE, Gross)	C4W30	M035S5 5.380/0.722	P3	R033T	D033H 5.714
		Torque converter	M035A4 3.018/0.703			
FE639 G.V.W. 6125 kg {13500 lb}	4D34T3 145 HP/2900 rpm 275 ft.lbs/1600 rpm (SAE, Gross)	C4W30	M035S5 5.380/0.722	P3	R033T	D033H 5.714
		Torque converter	M035A4 3.018/0.703			
FE640 G.V.W. 6575 kg {14500 lb}	4M50T2 175 HP/2700 rpm 347 ft.lbs/1800 rpm (SAE, Gross)	Torque converter	M035A4 3.018/0.703	P3	R033T	D033H 5.285
FE649 G.V.W. 6375 kg {14050 lb}	4D34T3 145 HP/2900 rpm 275 ft.lbs/1600 rpm (SAE, Gross)	Torque converter	M035A4 3.018/0.703	P3	R033T	D033H 5.714
FE649 G.V.W. 6575 kg {14500 lb}	4D34T3 145 HP/2900 rpm 275 ft.lbs/1600 rpm (SAE, Gross)	C4W30	M035S5 5.380/0.722	P3	R033T	D033H 5.714
FG639 G.V.W. 5445 kg {12000 lb}	4D34T3 145 HP/2900 rpm 275 (253:*b) ft.lbs/1600 rpm (SAE, Gross)	Torque converter	M035A4+TF3 3.018/0.765	P2 (Front) P3 (Rear)	R033T	D1H modified 5.714 (Front) D033H 5.714 (Rear)
FG649 G.V.W. 6375 kg {14050 lb}	4D34T3 145 HP/2900 rpm 275 (253:*a) ft.lbs/1600 rpm (SAE, Gross)	C4W30	M035S5+TF3 5.380/0.722	P2 (Front) P3 (Rear)	R033T	D1H modified 5.714 (Front) D033H 5.714 (Rear)

*a: Torque cut when 1st/reverse is selected
*b: Torque cut when 4WD/Low is selected

CHASSIS NUMBER AND ENGINE NUMBER/POWER TRAIN LABEL

CHASSIS NUMBER AND ENGINE NUMBER

The serial numbers for chassis and engines are assigned to the respective vehicles and engines in manufacturing sequence: every vehicle and engine has its own numbers. These numbers are required for registration and incidental inspection of the vehicle. Please do not fail to mention these numbers to the dealers when ordering spare parts.

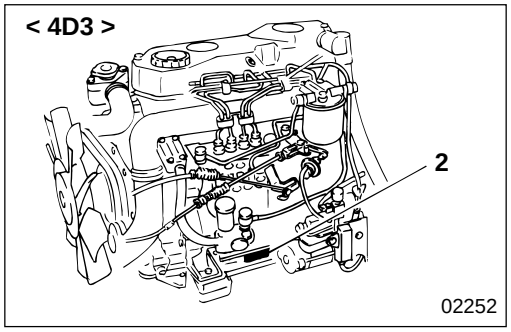


Chassis number

Chassis number **1** is punch-marked on the frame by the left-side front wheel.

Example : FE639C-□□□□□□

- FE639C: Vehicle model
- □□□□□□: Chassis number

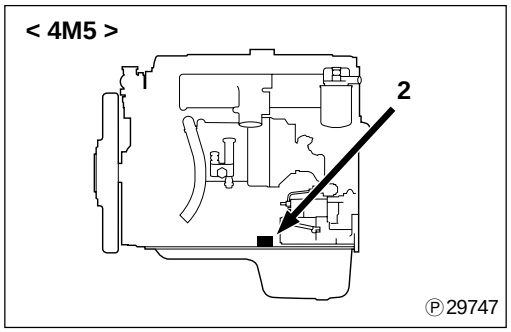


Engine number

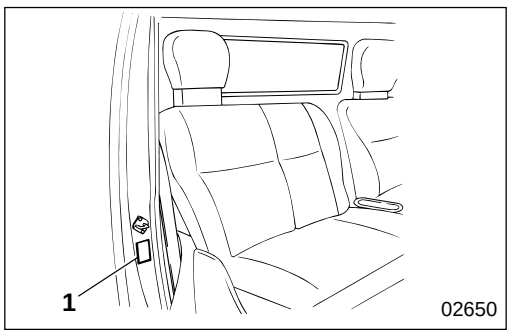
Engine number **2** is punch-marked on the left side of the crankcase.

Example : 4D34-□□□□□□

- 4D34: Engine model
- □□□□□□: Engine number

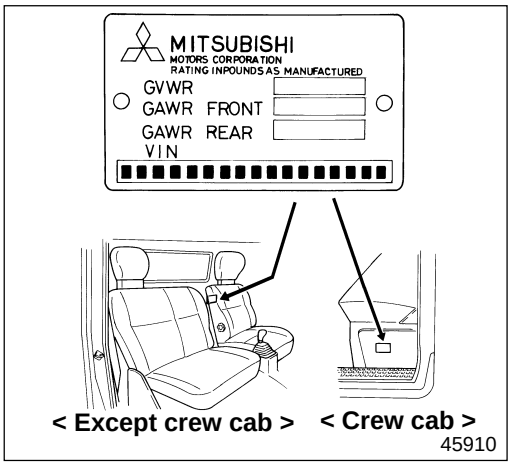


POWER TRAIN LABEL

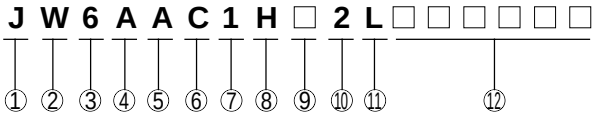


Power train label **1** located in the position illustrated indicates the vehicle model, chassis number and information relevant to the vehicle's power - train components.

VEHICLE IDENTIFICATION NUMBER



The vehicle identification number is punch-marked on the plate, which is attached in the position as illustrated.
The vehicle identification number consists of a 17-digit set of alphanumeric characters. Each digit represents the following specifications.



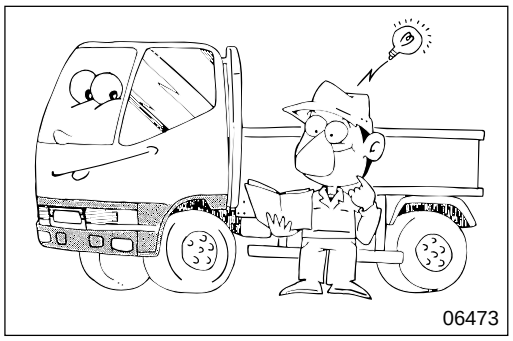
①	Country	J: Japan
②	Make	W: Mitsubishi Fuso
③	Vehicle type	6: Incomplete Vehicle
		7: Truck
④	Gross vehicle weight/Brake system	A: 10001 to 14000 lbs/Hydraulic
		B: 14001 to 16000 lbs/Hydraulic
⑤	Line	A: FE639
		B: FE649
		G: FG639
		H: FE640
		K: FE640□W
		L: FG649
⑥	Series (Wheelbase)	C: 2.6 to 2.98 m {8.53 to 9.48 ft.}
		E: 3.2 to 3.49 m {10.49 to 11.44 ft.}
		F: 3.5 to 3.79 m {11.48 to 12.43 ft.}
		H: 4.1 to 4.39 m {13.45 to 14.40 ft.}
⑦	Cab chassis type	1: Chassis cab
		3: Mixer
⑧	Engine	H: 3.907 ℓ Diesel turbocharged and charge air cooled
		S: 4.899 ℓ Diesel turbocharged and charge air cooled
⑨	Check digit	
⑩	Model year	2: 2002
⑪	Plant	K: Kawasaki-1
		L: Kawasaki-2
		M: Kawasaki-3
⑫	Plant sequential number	

PRECAUTIONS FOR MAINTENANCE OPERATION

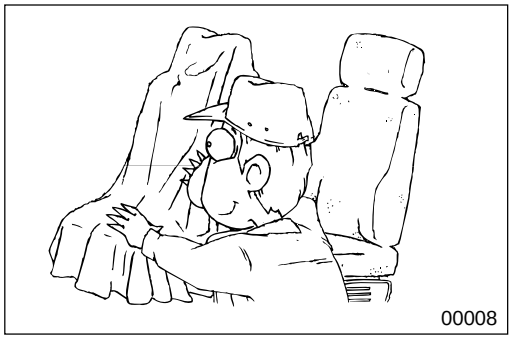
DANGER ⚠

This product contains or emits chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

In order to determine the condition of the vehicle adequately, keep records of the accumulated mileage, operating condition, what the customer's complaint is, and other information that may be necessary. Prepare steps to be taken to perform efficient maintenance procedures.

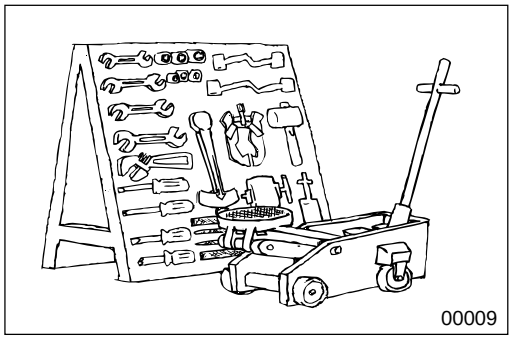

06473

Determine where the fault exists and check for the cause to see whether removal or disassembly of the part is necessary. Then follow the procedure specified by this manual.


00008

Perform maintenance work on level ground.
Prepare the following.

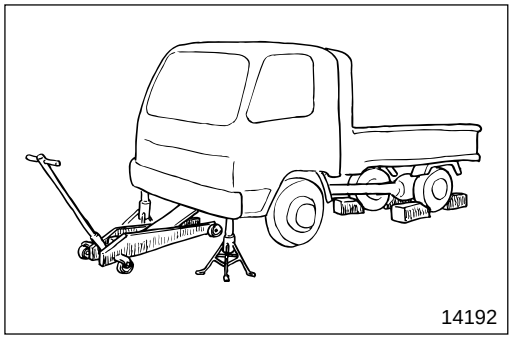
- To prevent the seats, upholstery, floor and bodywork from being spoiled or scratched, cover with workshop sheet cover(s).


00009

- Prepare general and special tools necessary for the maintenance work.

WARNING ⚠

Do not attempt to use tools other than special tools where use of special tools is specified in this manual. This will avoid injury or damage.

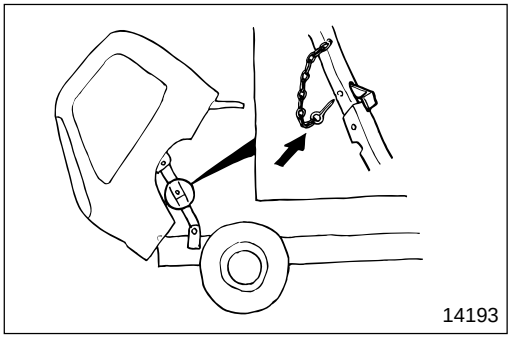

14192

When jacking up the vehicle to work under the vehicle, carry out the following preparatory work:

- Chock the wheels on both sides.
- Jack up the vehicle using a garage jack.
- Support the frame on rigid jack stands.

WARNING ⚠

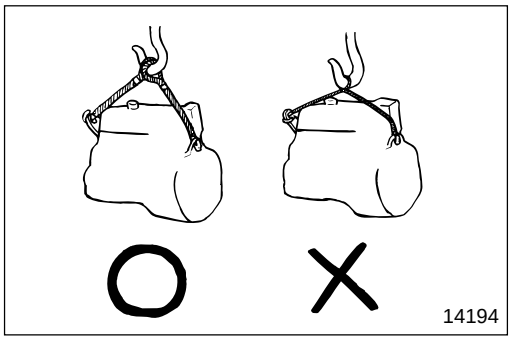
- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid jack stands.**
- **Leave the garage jack and rigid jack stands in place until the entire operation is completed. Never remove them during the operation.**


14193

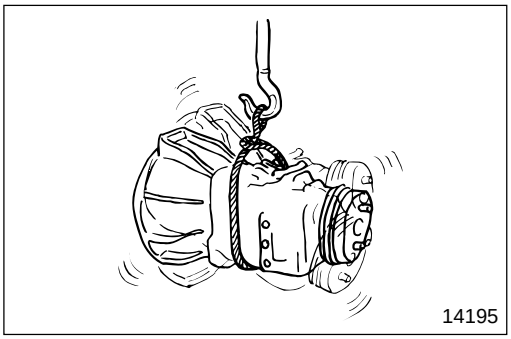
When tilting the cab, be sure to insert the safety pin into the cab stay so that the cab stay remains locked and is not released when the cab is tilted.

Pay special attention to safety when removing or installing heavy items such as engines, transmissions and axles.

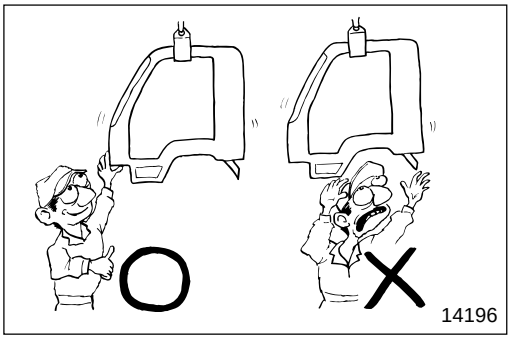
When lifting up heavy items using cables, pay special attention to the following points:


14194

- Check the mass of the item to be lifted and use a cable capable of lifting that mass.

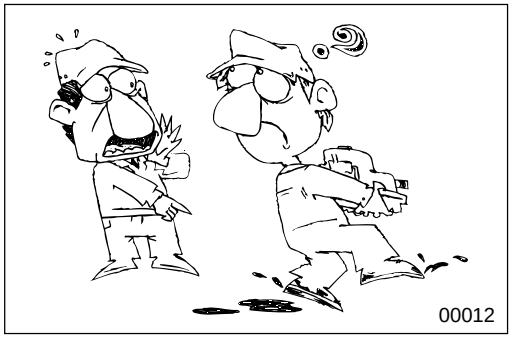

14195

- If you do not have the specified lifting hanger, secure the item using cable taking the point-of-balance of the item into consideration.

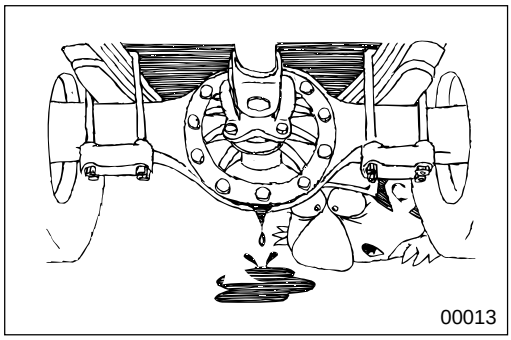

14196

- You must work in a position where you will not be injured even if the cable comes undone and the lifted item falls.

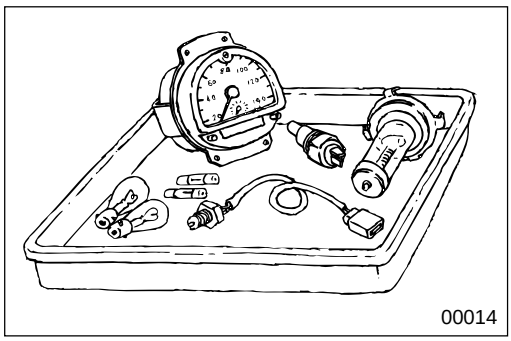
PRECAUTIONS FOR MAINTENANCE OPERATION



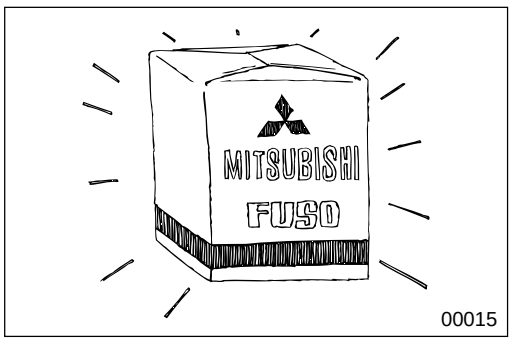
Be particularly careful not to work in shoes that have oily soles and are slippery. When working as a team of two or more, arrange signals in advance and keep confirming safety. Be careful not to accidentally bump switches or levers.



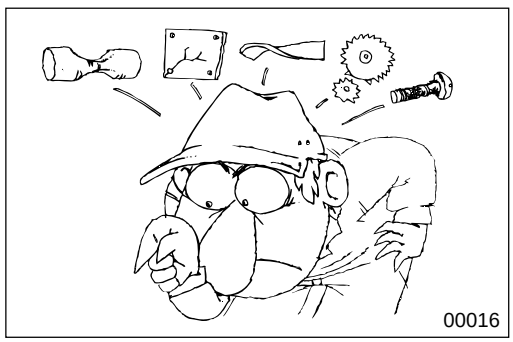
Check for oil leakage before cleaning the area having the fault otherwise you might miss detecting the leakage.



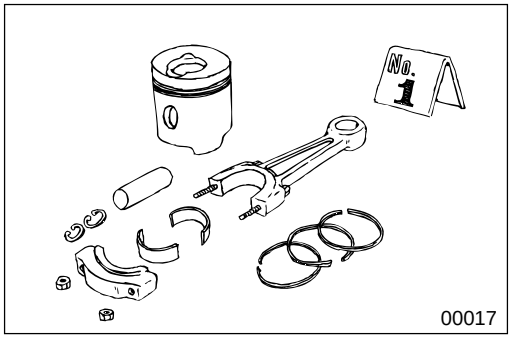
Prepare replacement part(s) beforehand.



Replace oil seals, packing, O-rings and other rubber parts; gaskets and split pins with new parts whenever any of them has been removed. Use only genuine MITSUBISHI replacement parts.



On disassembly, visually inspect all parts for wear and tear, cracks, damage, deformation, degradation, rust, corrosion, smoothness in rotation, fatigue, clogging and any other possible defect.

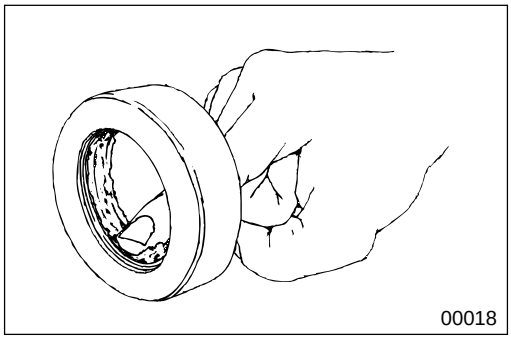


00017

Put alignment marks on part combinations before disassembly and arrange the disassembled parts neatly. This will help avoid mismating of the parts later.
Put the alignment marks, punch marks, etc. where performance and appearance will not be affected.
Cover the area left open after removal of parts to keep it free from dust.

CAUTION⚠

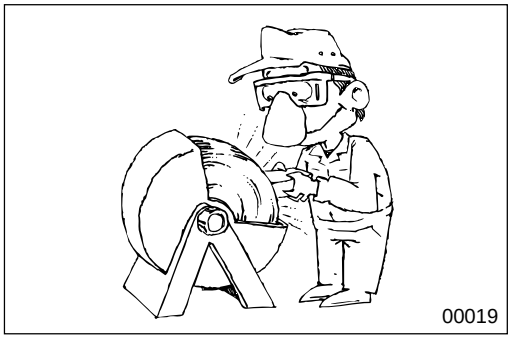
- **Take care to avoid mixing up numerous parts, similar parts, left and right, etc.**
- **Keep new parts for replacement and original (removed) parts separate.**


00018

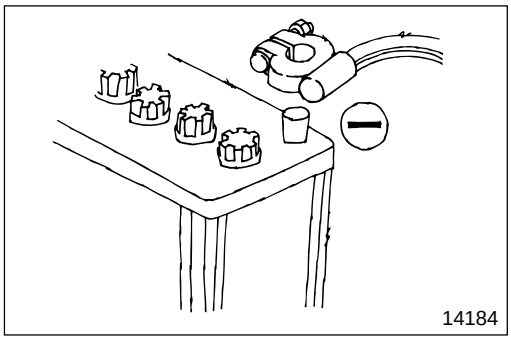
Apply the specified oil or grease to U-packings, oil seals, dust seals and bearings during assembly.
Use only the specified oil, grease, etc. for lubricant, remove the excess immediately after application with a clean rag, etc.

CAUTION⚠

When the specified lubricant, fluid and sealant is not available, you may use an equivalent.


00019

Wear goggles when using a grinder or welder. Pay full attention to safety by wearing gloves when necessary. Watch out for sharp edges, etc. that might injure your hands or fingers.

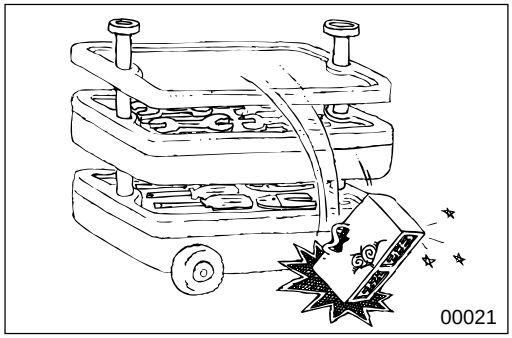

14184

Before carrying out maintenance work on the electric system, disconnect the negative terminal from the batteries to prevent them from short-circuiting.

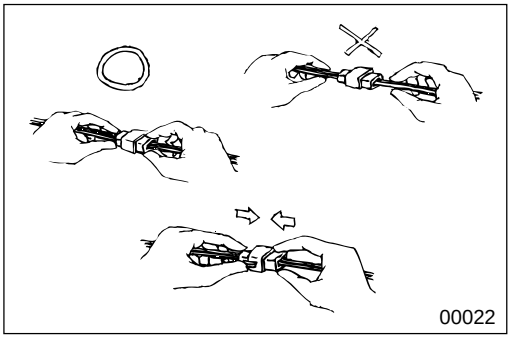
CAUTION⚠

Be sure to turn starter and lighting switches, etc. off before disconnecting or connecting battery terminals, because the semiconductors can become damaged.

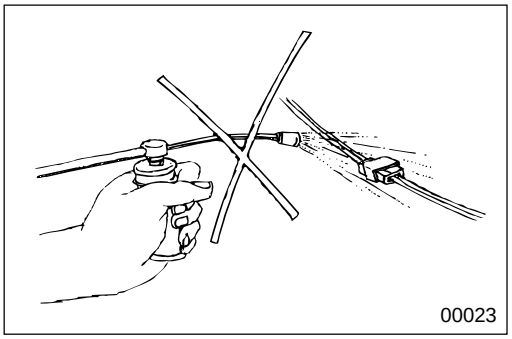
PRECAUTIONS FOR MAINTENANCE OPERATION



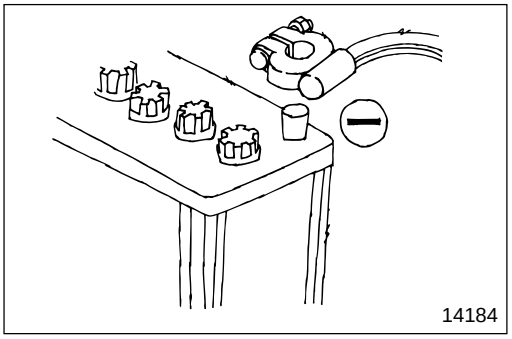
Take care when handling sensors, relays, etc. which are vulnerable to shock and heat. Do not attempt to remove the cover from, or apply paint to, the electronic control unit.



Pull the connector, and not the harness lead, to separate connectors. To separate a lock-type connector, first push toward arrow mark. To reconnect a lock-type connector, press the separated parts until they click together.



When washing the vehicle, cover the electric system parts and instruments with waterproof material beforehand (Cover with vinyl sheet or the like). Keep water away from harness wire connectors and sensors. If any of them should get wet, wipe them off immediately.



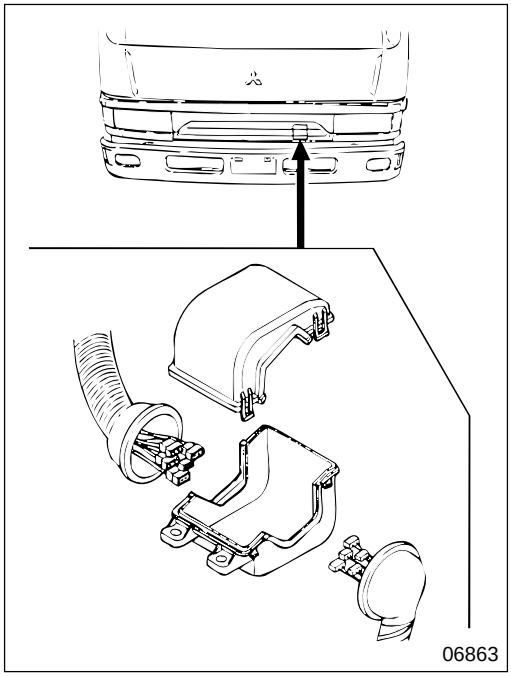
When using an electric welder, such electronic parts that are directly connected to the batteries might be damaged due to the flow of current from the welder that flows through the negative circuit. Parts that have switches might be subject to the same danger if the switches are left on. Therefore, do not fail to observe the following.

A : Welder

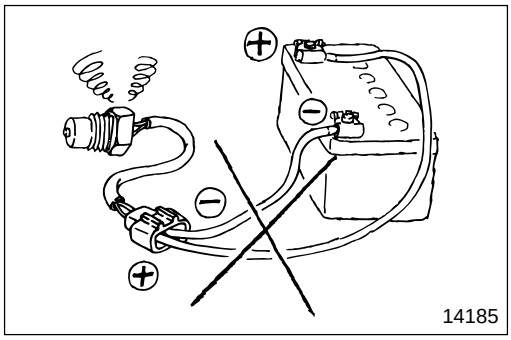
B : Connect the negative terminal of the welder as near as possible to the area that is to be welded.

C : Disconnect the negative cable at the batteries.

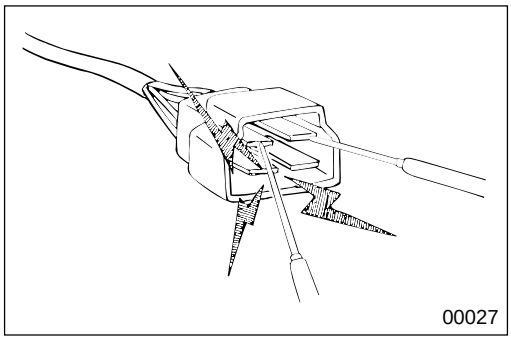
Gr 54 (130)



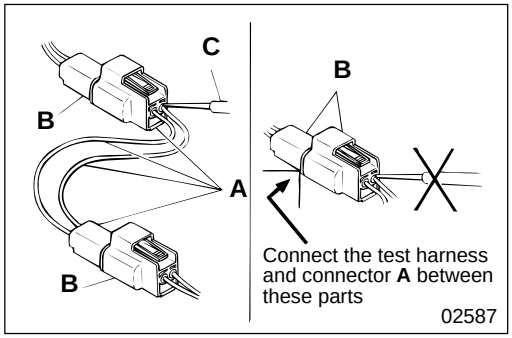
- Disconnect the negative terminals of batteries.
- Disconnect connections between the cab harness wires and the chassis harness wires.



To apply voltage for testing, check that the positive and negative cables are connected properly, then increase voltage gradually from 0 volt. Do not apply voltage higher than the specified value.
In particular, pay close attention to the electronic control unit and sensors, since they are not always fed by battery voltage.



When using testers or the like for continuity tests, be careful not to allow test probes to touch the wrong terminals.



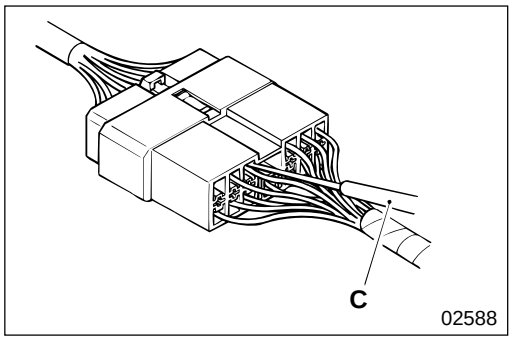
Measurement procedures using connectors

- **Test with connectors engaged (continuity through circuit obtained)**

  < Waterproof connector >

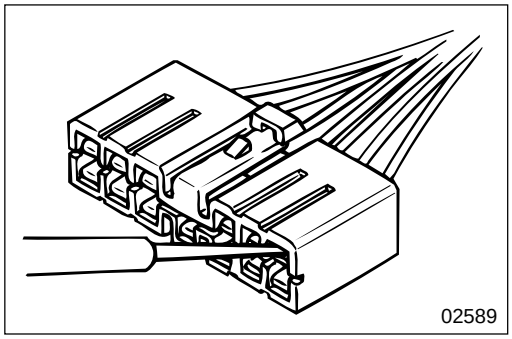
  Prepare a test harness and connectors **A**, then connect if between the two parts of harness **B** that is to be tested. Check the circuit by touching test probe **C** to the test connector.

  Never insert the test probe from the harness side of the waterproof connection, or waterproof performance might be diminished causing corrosion of the connector.



< Non-waterproof connector >

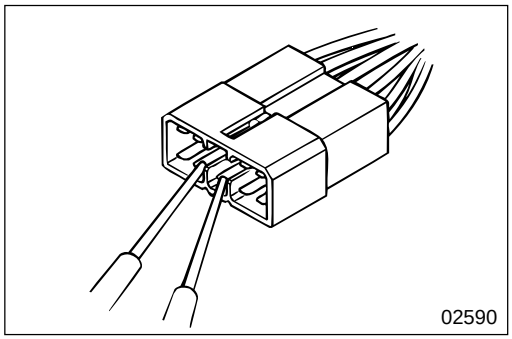
Insert test probe **C** from the harness side of the connector. Where control units, etc. have connectors that are too small to accept the test probe, do not force the test probe into them.



- **Test with connectors disengaged**

  Using female pins

  Insert a test probe into a terminal. However, do not force the probe into the terminal, or it will cause a poor contact.

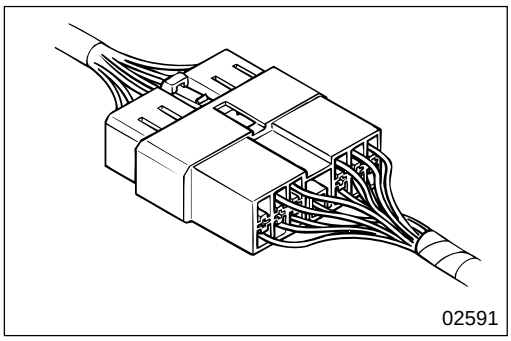


Using male pins

Touch the pins directly using test probes.

CAUTION⚠

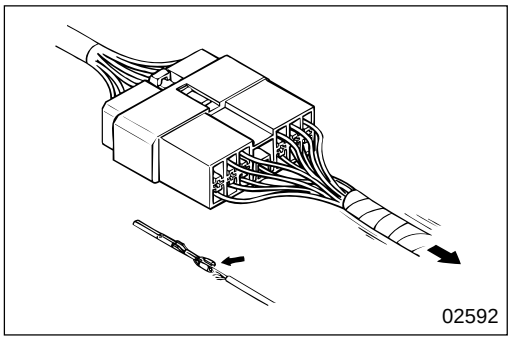
Be sure that you do not short circuit the connector pins when you use the test probe because this could damage the internal circuit of the electronic control unit.



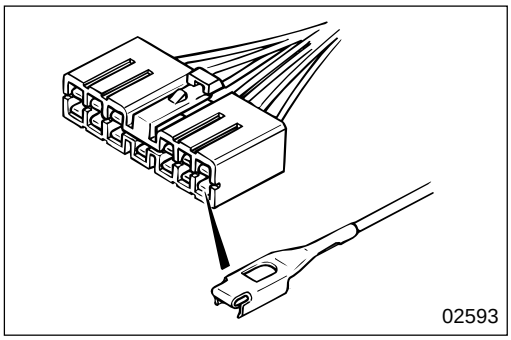
Connector inspection procedures

- **Visual inspection**

  Check for loose connection and poor engagement.

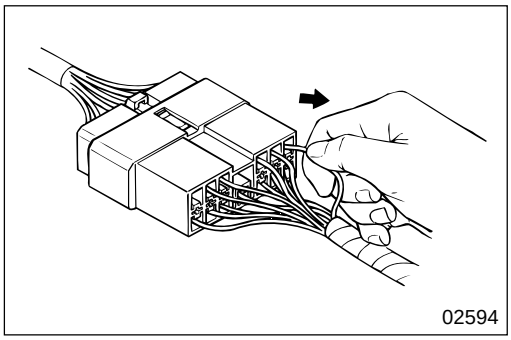


Check if harnesses are broken by pulling gently around the terminals.



Check for a decrease in contact pressure between the male and female terminals.

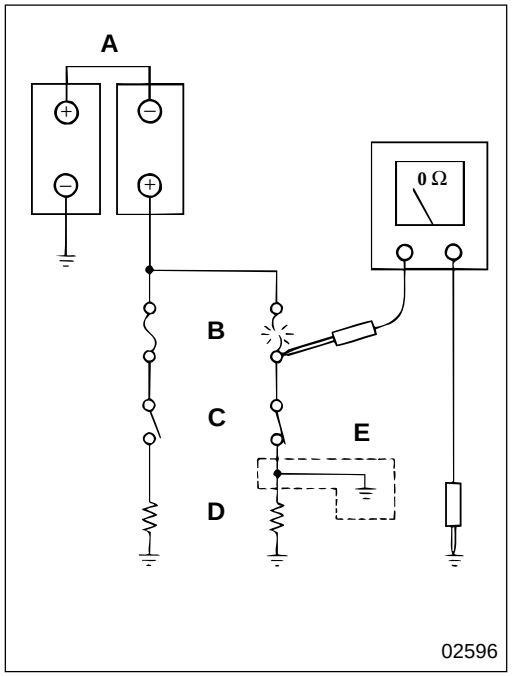
Check for poor contact caused by connector pins having fallen out, rusted terminals or foreign particles.



- **Connector pin fall out inspection**

  Damaged connector pin stoppers can cause poor engagement of the terminals (male and female pins) even if the connector body is secured, and might cause some pins to fall out. Check if the pins have fallen out from the connector by pulling each harness wire gently.

PRECAUTIONS FOR MAINTENANCE OPERATION



Inspection procedures for blown out fuses

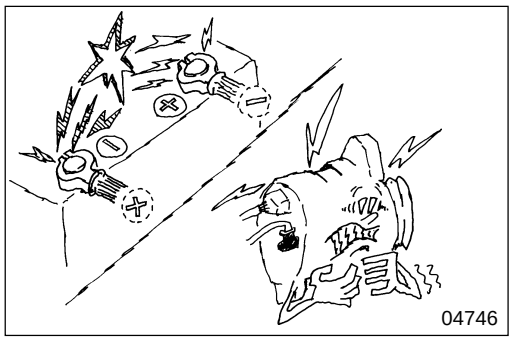
Remove fuse **B** and measure resistance between the loaded side of the fuse and ground.

Turn on all circuit switches (connected to the fuse). If the resistance value reading is approximately 0 Ω, a short has occurred between the switch and the loaded point. A value of other than zero may indicate that the fuse was blown by a temporary short but the short is no longer present.

The major causes of a short circuit are as follows:

- Harness stuck under the vehicle mounted body.
- Harness sheath damaged by friction or heat.
- Water in connectors or circuits.
- Mistakes (accidental short circuits)

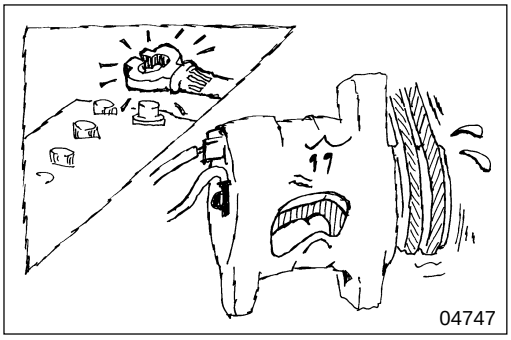
A : Battery
B : Fuse
C : Loaded switch
D : Load
E : Short circuit



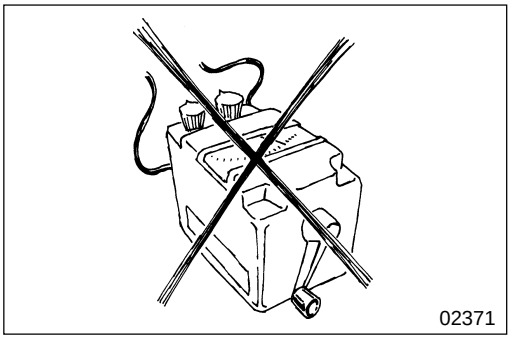
Precautions for handling alternator

When servicing alternators, pay attention to the following :

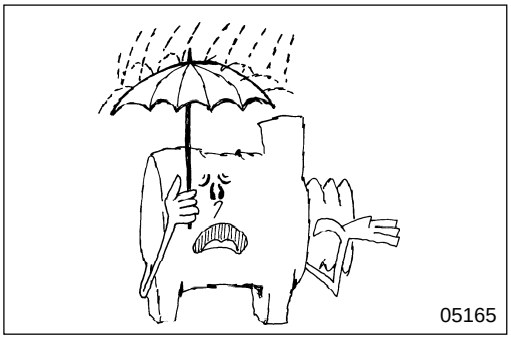
- Do not connect the alternator with battery polarities reversed.
  If the alternator is connected with reversed polarities, a large current flow from the battery to the alternator occurs, and the diode or regulator might be damaged.



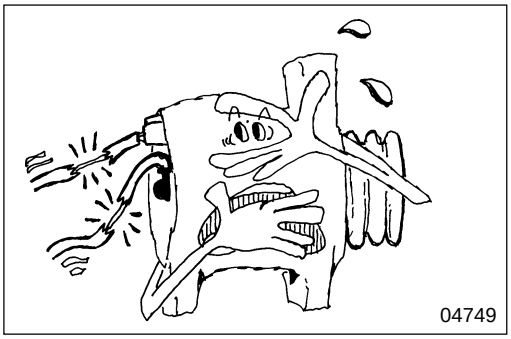
- While the engine is running, do not remove the battery terminals. If the battery terminals are removed at that time, a surge voltage is generated and the diode or regulator might be weakened.



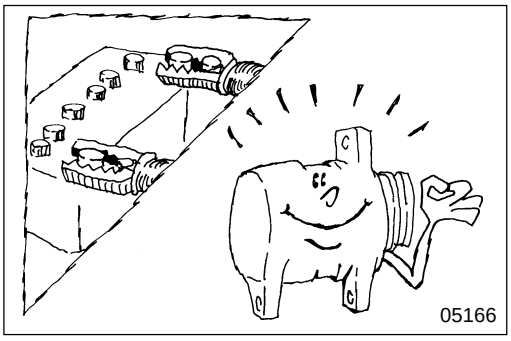
- Do not use a high-voltage tester such as a megger for inspection.
  If a high-voltage tester is used, the diode or regulator might be destroyed.



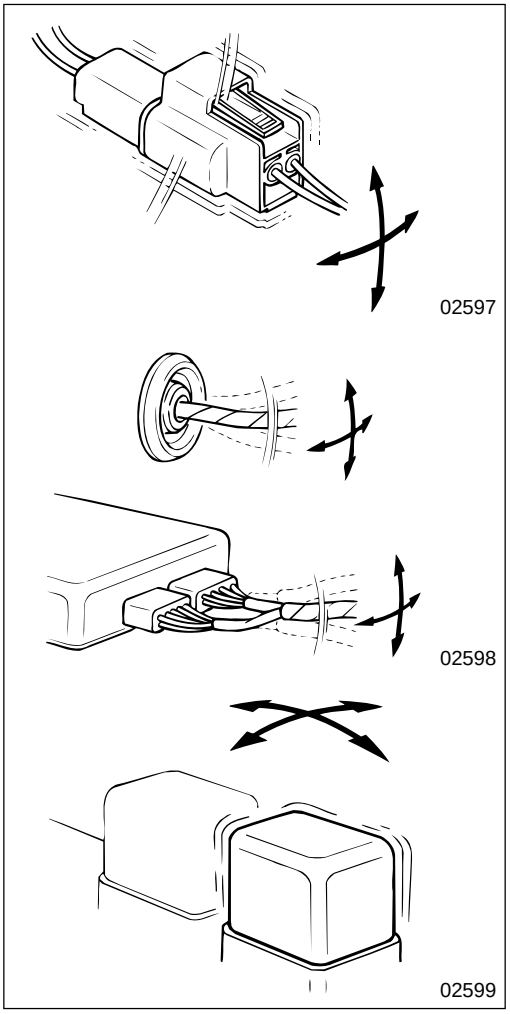
- Do not splash water over the alternator.
  If water is directly splashed over the alternator, individual components will be short-circuited and might be destroyed.



- Do not short-circuit terminal B and terminal L while running the alternator.
  If the terminals are short-circuited while the alternator is running, the diode trio might be destroyed.



- Disconnect the battery terminals before quick-charging the battery. Quick-charging without disconnecting the battery terminals might damage the diode or regulator.



Measures for temporary faults

Temporary faults often occur under certain conditions. So identifying those conditions helps to find possible causes. To find the conditions under which temporary faults occurred, you need to reproduce the faults after interviewing customers in detail about actual driving conditions, weather, frequency of occurence and fault phenomena.
Then determine if the faults were caused by vibration, temperature or other possible elements depending on the actual conditions identified. If vibration is suspected as a possible cause, inspect individual connectors as follows to check if the fault will occur:

- Shake the connector gently in all four directions of the arrows as illustrated.
- Shake the wiring harness gently in all four directions of the arrows as illustrated.
- Wiggle each sensor or piece of equipment by hand.
- Gently shake the wiring harnesses near movable parts such as suspensions.

The inspection subjects include possible causes related to the diagnosis code outputs and faults, as well as the connectors and other parts in the inspection procedure.

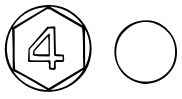
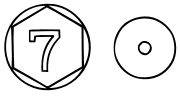
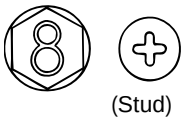
M E M O

TABLE OF STANDARD TIGHTENING TORQUES

- Use specified bolts and nuts and tighten them at specified torques according to the following table, unless otherwise specified.
- Threads and contact seats shall be dry.
- Where there is difference in strength classification between the nut and bolt (or stud bolt), the torque specified for the bolt shall apply.

Hex-head Bolt and Stud Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Repre-sentation / Diameter symbol	 (Stud)		 (Stud)		 (Stud)	
M 5	2 to 3 {1.4 to 2.2, 0.2 to 0.3}	—	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	5 to 7 {3.6 to 5.1, 0.5 to 0.7}	—
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	7 to 11 {5.1 to 8.0, 0.7 to 1.1}	—	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—
M 8	9 to 14 {6.5 to 10.0, 0.9 to 1.4}	—	17 to 26 {12 to 19, 1.7 to 2.6}	—	20 to 29 {14 to 22, 2.0 to 3.0}	—
M 10	19 to 28 {14 to 20, 1.9 to 2.8}	18 to 26 {13 to 20,1.8 to 2.7}	36 to 52 {25 to 40, 3.5 to 5.5}	33 to 49 {25 to 36, 3.5 to 5.0}	45 to 60 {33 to 43, 4.5 to 6.0}	41 to 59 {31 to 50, 4.3 to 6.9}
M 12	35 to 50 {25 to 36, 3.4 to 5.0}	31 to 46 {22 to 34, 3.1 to 4.7}	70 to 95 {51 to 69, 7.0 to 9.5}	65 to 85 {47 to 61, 6.5 to 8.5}	85 to 110 {61 to 80, 8.5 to 11}	75 to 100 {54 to 72, 7.5 to 10}
M 14	60 to 85 {43 to 61, 6.0 to 8.5}	55 to 75 {40 to 54, 5.5 to 7.5}	120 to 160 {87 to 115, 12 to 16}	110 to 140 {80 to 100, 11 to 14}	130 to 180 {94 to 130, 13 to 18}	120 to 160 {87 to 120, 12 to 17}
M 16	90 to 130 {69 to 94, 9.5 to 13}	90 to 120 {65 to 87, 9.0 to 12}	180 to 240 {130 to 175, 18 to 24}	160 to 220 {115 to 160, 16 to 22}	200 to 270 {145 to 195, 20 to 27}	190 to 260 {135 to 190, 19 to 26}
M 18	140 to 190 {100 to 135, 14 to 19}	120 to 160 {87 to 115, 12 to 16}	260 to 340 {180 to 255, 25 to 35}	220 to 290 {160 to 215, 22 to 30}	290 to 390 {215 to 290, 30 to 40}	260 to 340 {190 to 255, 26 to 35}
M 20	190 to 260 {135 to 190, 19 to 26}	170 to 230 {120 to 165, 17 to 23}	350 to 470 {260 to 345, 36 to 48}	320 to 420 {230 to 310, 32 to 43}	410 to 550 {295 to 405, 41 to 56}	370 to 490 {265 to 360, 37 to 50}
M 22	260 to 340 {190 to 255, 26 to 35}	230 to 300 {165 to 225, 23 to 31}	470 to 640 {345 to 470, 48 to 65}	430 to 570 {310 to 420, 43 to 58}	550 to 740 {405 to 540, 56 to 75}	490 to 670 {360 to 490, 50 to 68}
M 24	340 to 450 {255 to 330, 34 to 46}	290 to 390 {210 to 290, 29 to 40}	630 to 840 {455 to 620, 63 to 86}	540 to 730 {395 to 535, 55 to 74}	730 to 980 {535 to 725, 74 to 100}	630 to 840 {460 to 620, 64 to 86}

Hex-head Flange Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Repre-sentation / Diameter symbol						
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—	9 to 14 {6.5 to 10, 0.9 to 1.4}	—
M 8	10 to 15 {7.0 to 11, 1.0 to 1.5}	—	19 to 28 {14 to 20, 1.9 to 2.8}	—	22 to 32 {16 to 24, 2.2 to 3.3}	—
M 10	21 to 30 {15 to 22, 2.1 to 3.1}	20 to 28 {14 to 21, 1.9 to 2.9}	39 to 58 {28 to 43, 3.9 to 6.0}	37 to 53 {26 to 39, 3.6 to 5.4}	50 to 65 {36 to 47, 5.0 to 6.5}	45 to 65 {33 to 47, 4.5 to 6.5}
M 12	38 to 54 {27 to 40, 3.8 to 5.5}	35 to 51 {25 to 38, 3.4 to 5.2}	80 to 110 {58 to 80, 8.0 to 11}	70 to 95 {51 to 69, 7.0 to 9.5}	90 to 120 {65 to 87, 9.0 to 12}	85 to 110 {61 to 80, 8.5 to 11}

Hex-head Nut

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		6 T	
Representation / Diameter symbol				
	Standard screw	Coarse screw	Standard screw	Coarse screw
M 5	2 to 3 {1.4 to 2.2, 0.2 to 0.3}	—	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	7 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
M 8	9 to 14 {6.5 to 10, 0.9 to 1.4}	—	17 to 26 {12 to 19, 1.7 to 2.6}	—
M 10	19 to 28 {14 to 20, 1.9 to 2.8}	18 to 26 {13 to 20, 1.8 to 2.7}	36 to 52 {25 to 40, 3.5 to 5.5}	33 to 49 {25 to 36, 3.5 to 5.0}
M 12	35 to 50 {25 to 36, 3.4 to 5.0}	31 to 46 {22 to 34, 3.1 to 4.7}	70 to 95 {51 to 69, 7.0 to 9.5}	65 to 85 {47 to 61, 6.5 to 8.5}
M 14	60 to 85 {43 to 61, 6.0 to 8.5}	55 to 75 {40 to 54, 5.5 to 7.5}	120 to 160 {87 to 115, 12 to 16}	110 to 140 {80 to 100, 11 to 14}
M 16	90 to 130 {69 to 94, 9.5 to 13}	90 to 120 {65 to 87, 9.0 to 12}	180 to 240 {130 to 175, 18 to 24}	160 to 220 {115 to 160, 16 to 22}
M 18	140 to 190 {100 to 135, 14 to 19}	20 to 160 {87 to 115, 12 to 16}	260 to 340 {180 to 255, 25 to 35}	220 to 290 {160 to 215, 22 to 30}
M 20	190 to 260 {135 to 190, 19 to 26}	170 to 230 {120 to 165, 17 to 23}	350 to 470 {260 to 345, 36 to 48}	320 to 420 {230 to 310, 32 to 43}
M 22	260 to 340 {190 to 255, 26 to 35}	230 to 300 {165 to 225, 23 to 31}	470 to 640 {345 to 470, 48 to 65}	430 to 570 {310 to 420, 43 to 58}
M 24	340 to 450 {255 to 330, 34 to 46}	290 to 390 {210 to 290, 29 to 40}	630 to 840 {455 to 620, 63 to 86}	540 to 730 {395 to 535, 55 to 74}

Hex-head Flange Nut

Unit : N·m {ft.lbs, kgf·m}

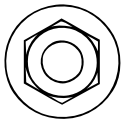
Strength classification	4 T	
Representation / Diameter symbol		
	Standard screw	Coarse screw
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
M 8	10 to 15 {7.0 to 11, 1.0 to 1.5}	—
M 10	21 to 30 {15 to 22, 2.1 to 3.1}	20 to 28 {14 to 21, 1.9 to 2.9}
M 12	38 to 54 {27 to 40, 3.8 to 5.5}	35 to 51 {25 to 38, 3.4 to 5.2}

TABLE OF STANDARD TIGHTENING TORQUES

Tightening torque for flair nut for general purpose

Unit : N·m {ft.lbs, kgf·m}

Pipe diameter	ø4.76 mm {0.19 in.}	ø6.35 mm {0.25 in.}	ø8 mm {0.31 in.}	ø10 mm {0.39 in.}	ø12 mm {0.47 in.}	ø15 mm {0.59 in.}
Tightening torque	17 {12, 1.7}	25 {19, 2.6}	39 {29, 4.0}	59 {43, 6.0}	88 {65, 9.0}	98 {72, 10.0}

Tightening torque for air piping nylon tube for general purpose {DIN type}

Unit : N·m {ft.lbs, kgf·m}

Standard diameter	6×1 mm {0.24×0.039 in.}	10×1.25 mm {0.39×0.049 in.}	12×1.5 mm {0.47×0.059 in.}	15×1.5 mm {0.59×0.059 in.}
Tightening torque	$20^{+5.9}_{-0}$ $\left\{14^{+4.3}_{-0},\ 2.0^{+0.6}_{-0}\right\}$	$29^{+9.8}_{-0}$ $\left\{22^{+7.2}_{-0},\ 3.0^{+1.0}_{-0}\right\}$	$49^{+9.8}_{-0}$ $\left\{36^{+7.2}_{-0},\ 5.0^{+1.0}_{-0}\right\}$	$54^{+4.9}_{-0}$ $\left\{40^{+7.2}_{-0},\ 5.5^{+0.5}_{-0}\right\}$

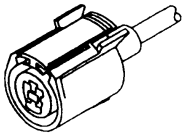
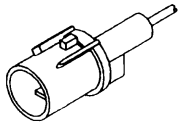
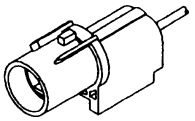
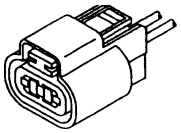
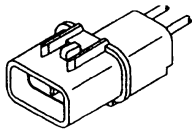
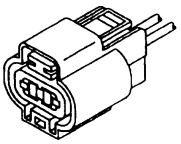
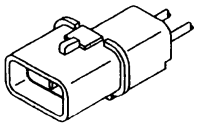
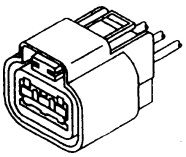
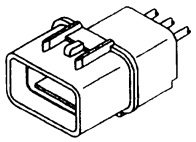
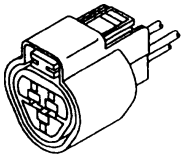
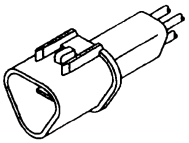
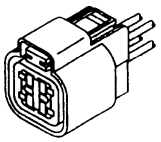
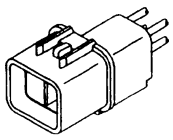
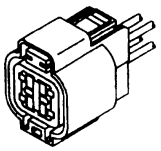
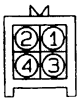
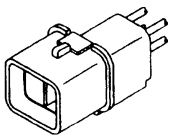
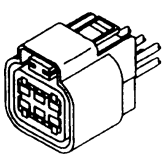
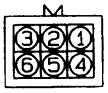
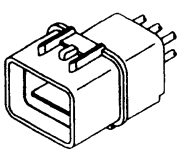
Tightening torque for air piping nylon tube for general purpose {SAE type}

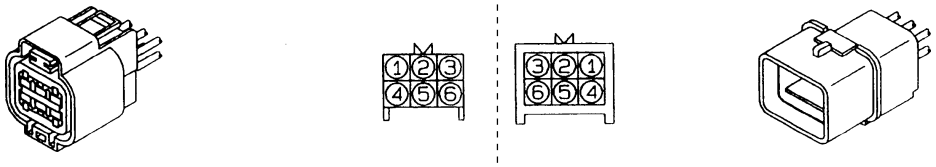
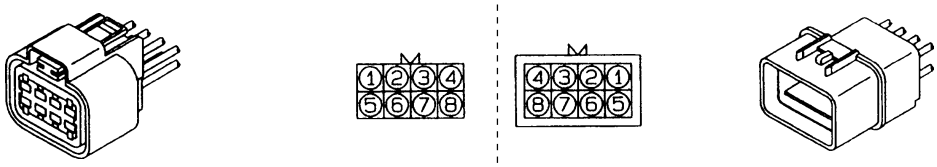
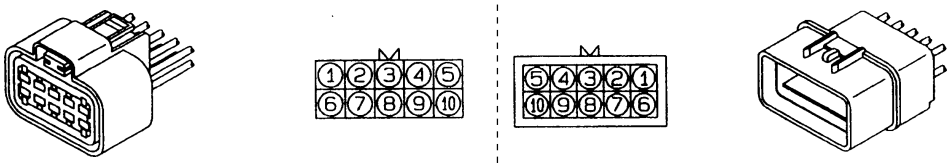
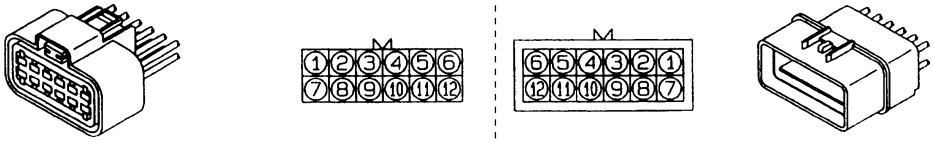
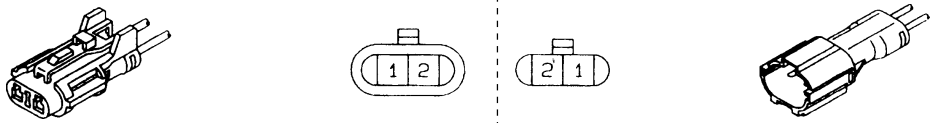
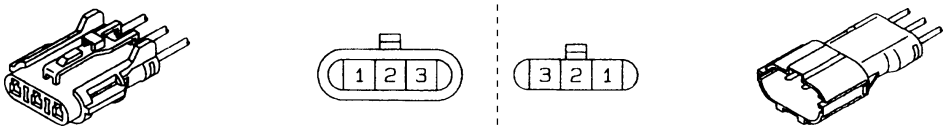
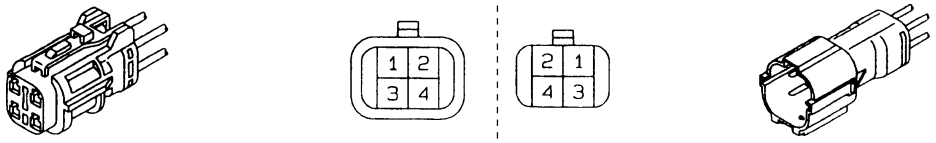
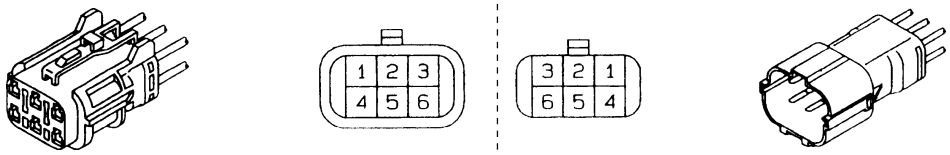
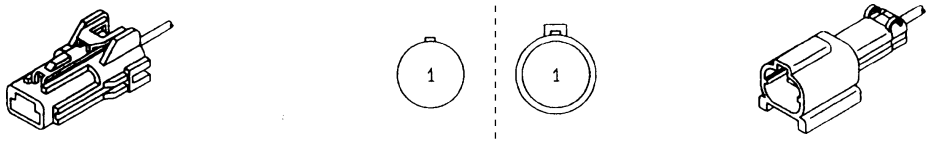
Unit : N·m {ft.lbs, kgf·m}

Standard diameter	1/4 in.	3/8 in.	1/2 in.	5/8 in.
Tightening torque	$13^{+3.9}_{-0}$ $\left\{9.4^{+2.9}_{-0},\ 1.3^{+0.4}_{-0}\right\}$	$29^{+4.9}_{-0}$ $\left\{22^{+3.6}_{-0},\ 3.0^{+0.5}_{-0}\right\}$	$49^{+4.9}_{-0}$ $\left\{36^{+3.6}_{-0},\ 5.0^{+0.5}_{-0}\right\}$	$64^{+4.9}_{-0}$ $\left\{47^{+3.6}_{-0},\ 6.5^{+0.5}_{-0}\right\}$

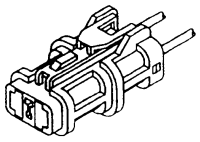
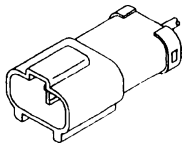
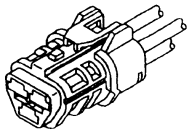
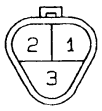
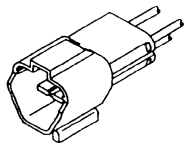
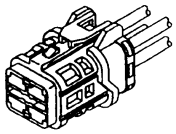
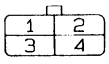
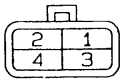
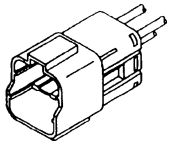
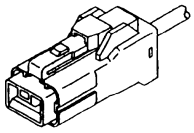
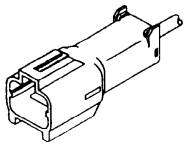
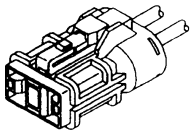
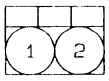
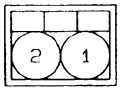
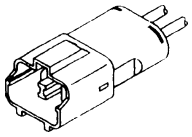
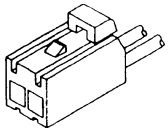
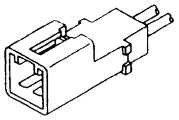
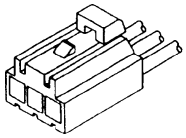
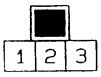
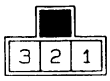
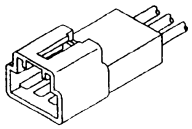
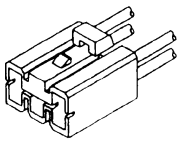
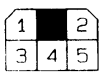
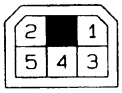
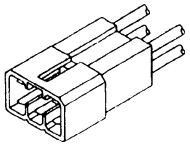
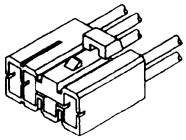
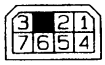
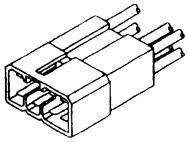
M E M O

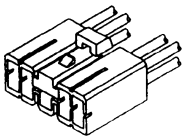
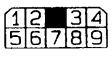
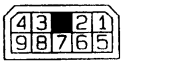
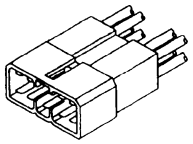
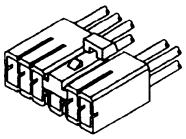
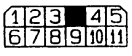
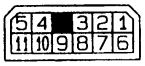
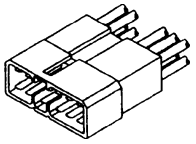
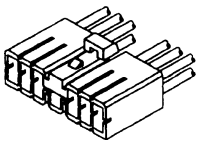
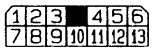
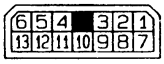
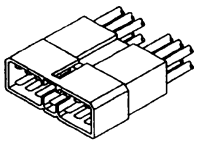
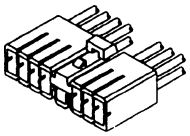
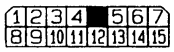
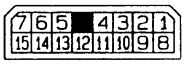
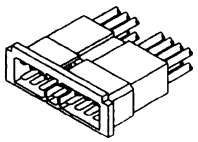
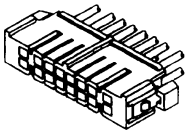
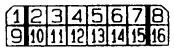
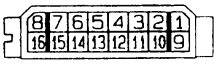
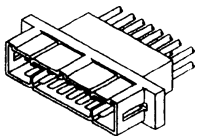
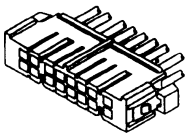
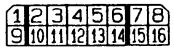
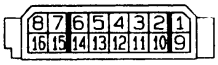
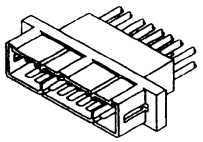
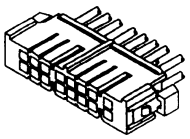
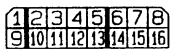
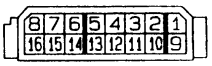
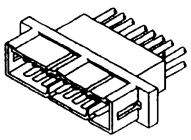
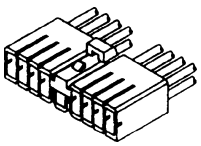
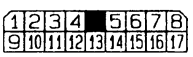
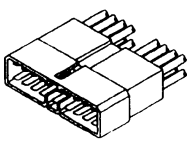
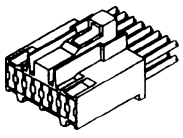
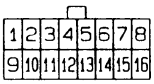
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AA	AA 1 A				
					
	AA 2 A				
	AA 2 B				
	AA 3 A				
	AA 3 B				
	AA 4 A				
	AA 4 B				
	AA 6 A				

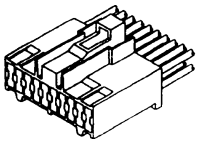
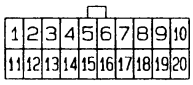
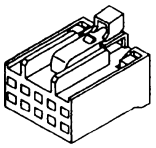
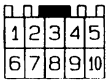
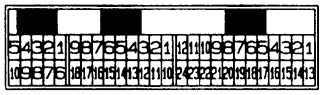
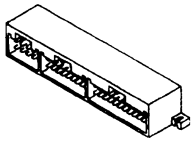
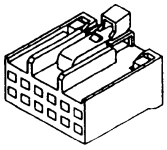
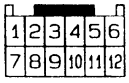
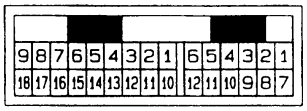
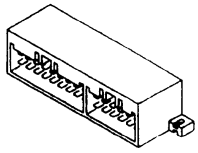
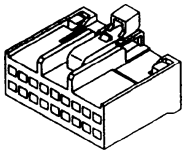
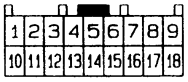
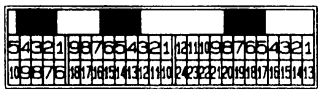
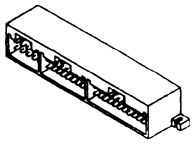
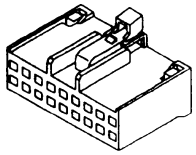
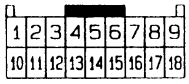
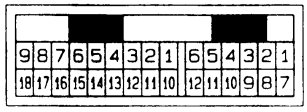
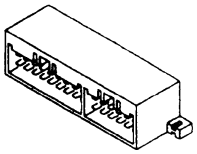
Model (Number shows number of pins)		Connection
AA	AA 6 B	
	AA 8 A	
	AA10A	
	AA12A	
AB	AB 2 A	
	AB 3 A	
	AB 4 A	
	AB 6 A	
AC	AC 1 A	

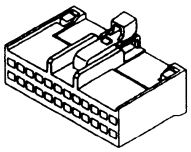
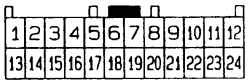
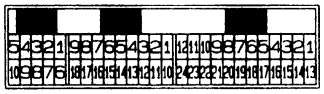
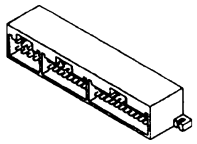
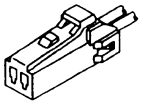
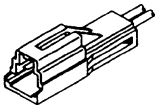
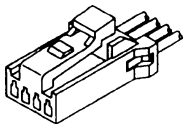
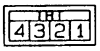
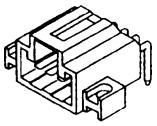
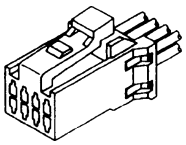
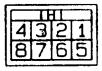
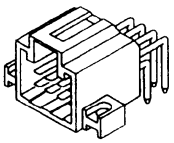
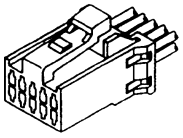
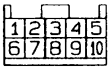
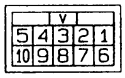
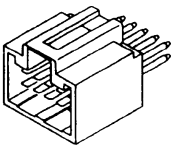
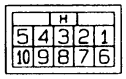
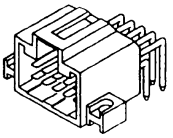
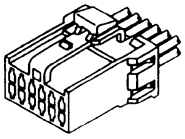
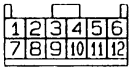
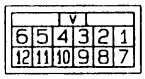
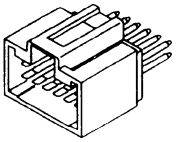
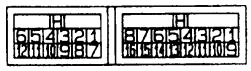
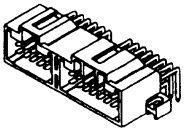
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AC	AC 2 A				
	AC 3 A				
	AC 4 A				
AD	AD 1 A				
	AD 2 A				
AE	AE 2 A				
	AE 3 A				
	AE 5 A				
	AE 7 A				

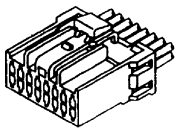
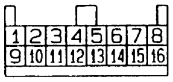
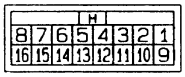
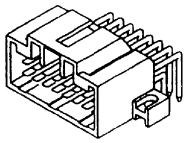
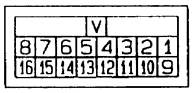
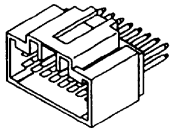
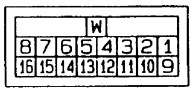
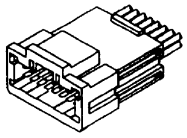
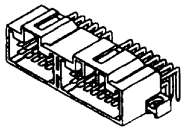
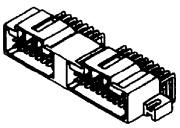
Model (Number shows number of pins)		Connection			
AE	AE 9 A				
	AE11A				
	AE13A				
	AE15A				
	AE16A (White, Gray, Black)				
	AE16B (Green)				
	AE16C (Blue)				
	AE17A				
AG	AG16A				

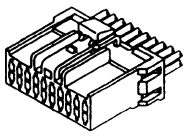
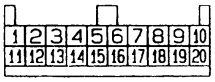
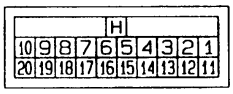
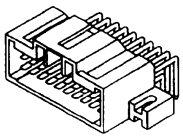
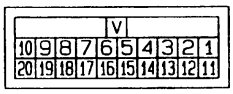
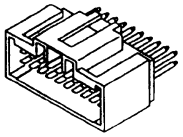
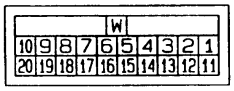
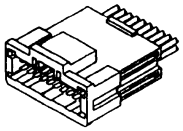
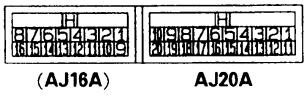
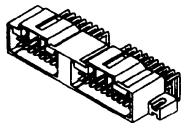
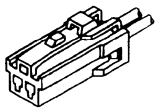
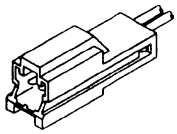
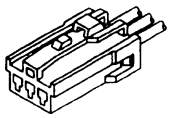
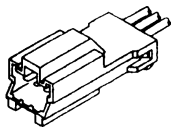
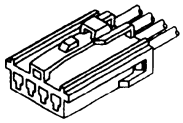
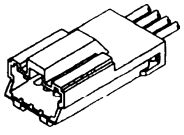
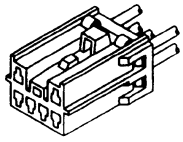
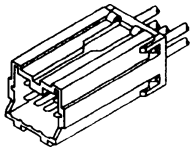
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AG	AG20A	 
AH	AH10A	   AH10A (AH18A) (AH24A) 
	AH12A	   (AH18A) AH12A 
	AH18A	   (AH10A) AH18A AH24A 
	AH18B	   AH18A (AH12A) 

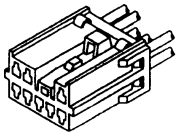
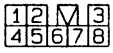
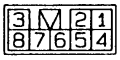
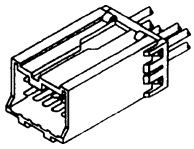
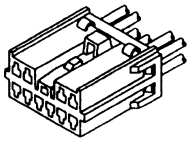
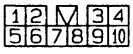
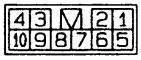
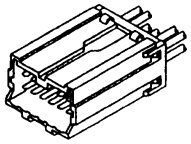
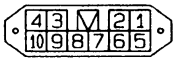
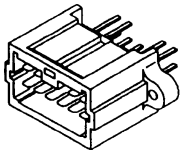
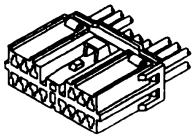
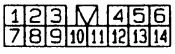
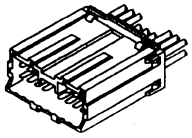
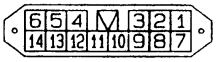
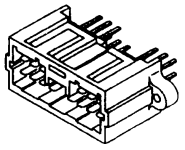
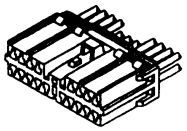
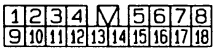
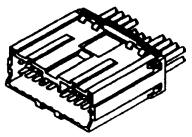
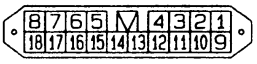
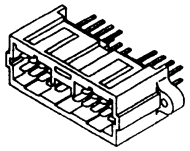
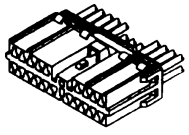
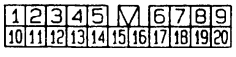
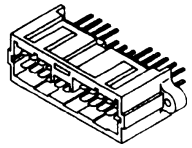
Model (Number shows number of pins)		Connection
AH	AH24A	   (AH10A) (AH18A) AH24A 
AJ	AJ 2 A	 
	AJ 4 A	  
	AJ 8 A	  
	AJ10A	     
	AJ12A	     AJ12 (AJ16) 

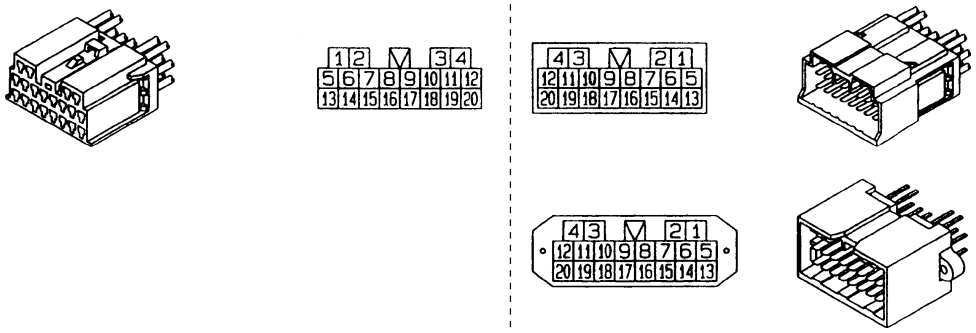
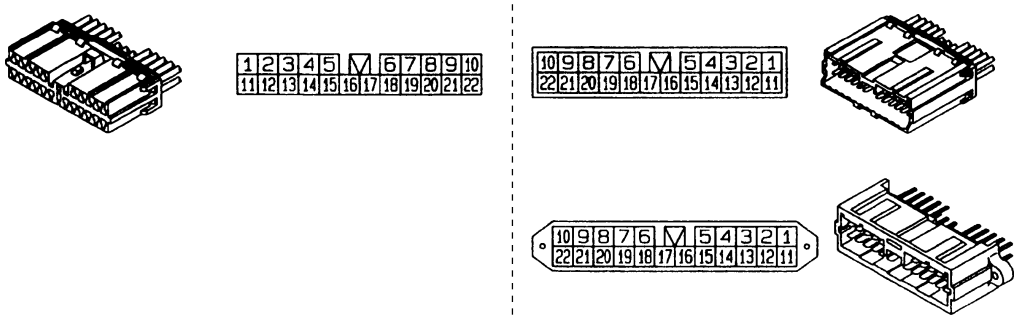
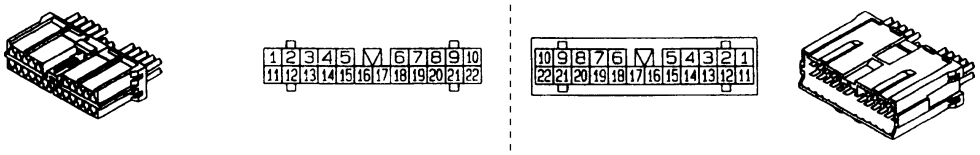
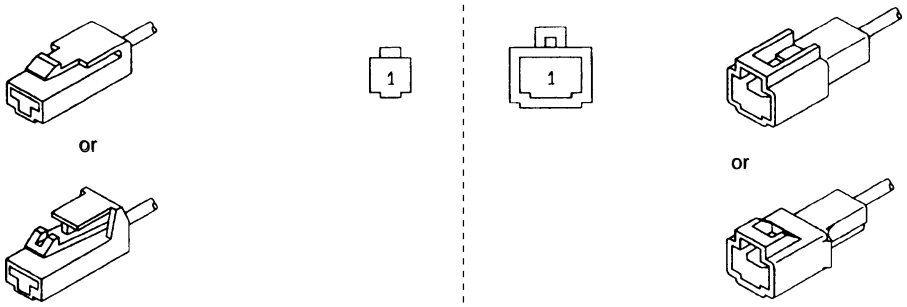
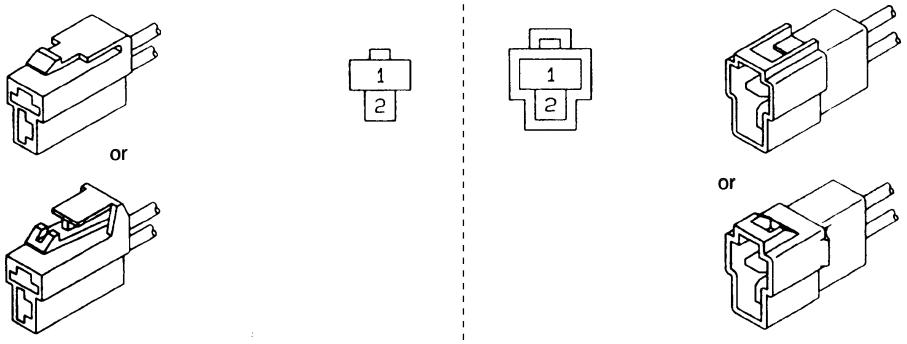
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AJ	AJ16A	        (AJ12A) AJ16A  AJ16A (AJ20A) 

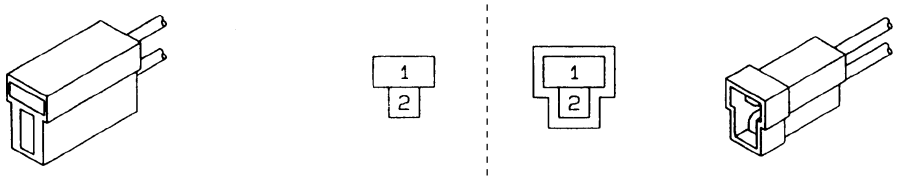
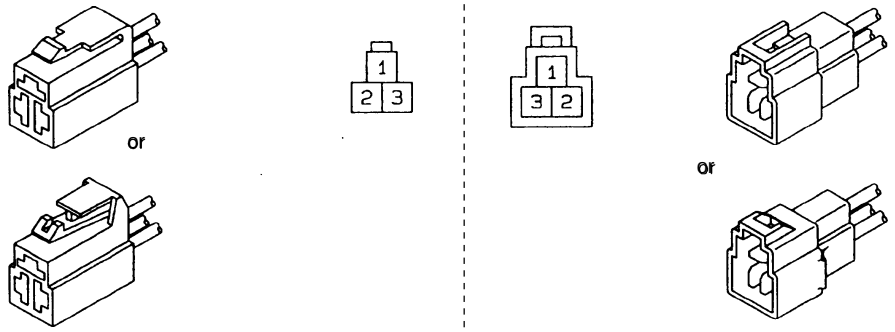
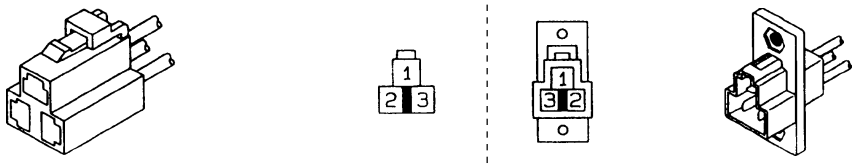
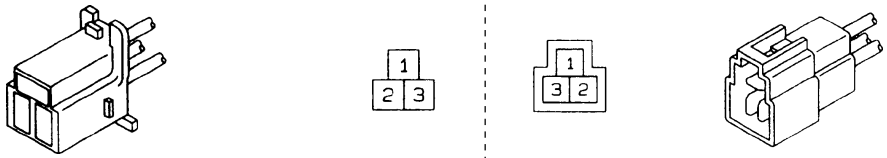
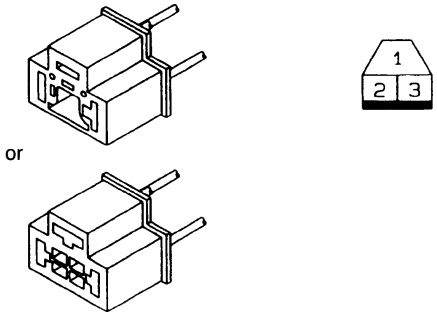
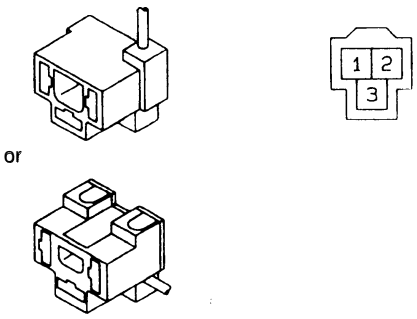
Model (Number shows number of pins)		Connection
AJ	AJ20A	         (AJ16A) AJ20A 
AK	AK 2 A	 
	AK 3 A	 
	AK 4 A	 
	AK 6 A	 

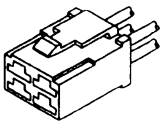
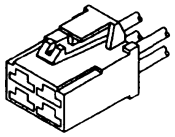
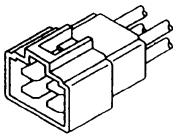
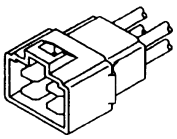
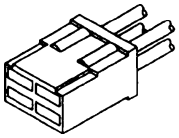
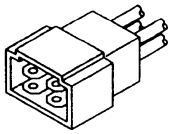
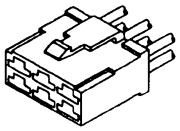
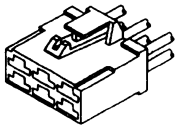
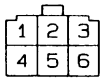
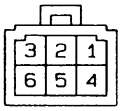
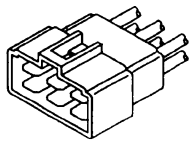
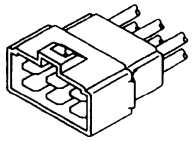
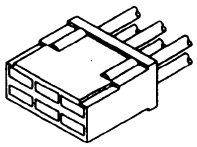
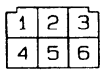
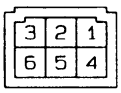
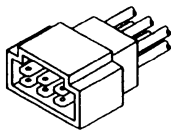
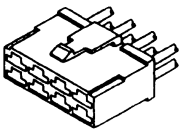
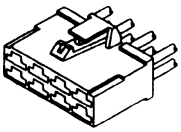
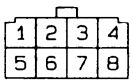
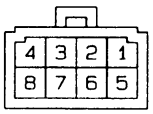
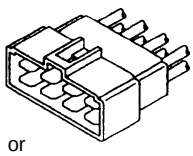
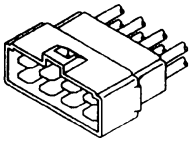
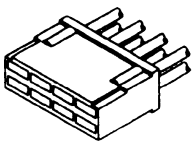
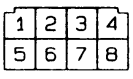
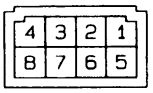
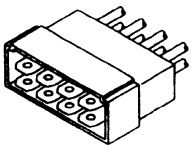
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AK	AK 8 A	   
	AK10A	     
	AK14A	    
	AK18A	    
	AK20A	  

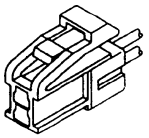
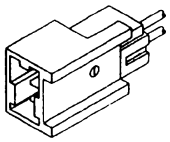
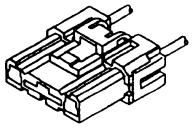
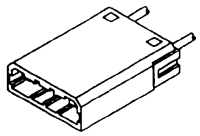
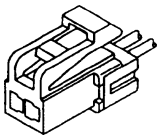
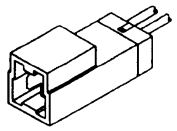
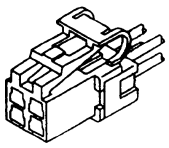
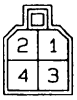
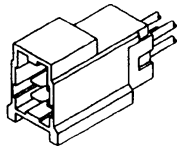
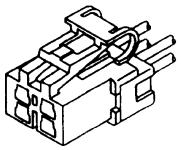
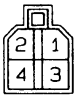
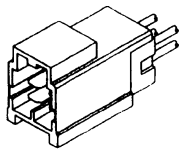
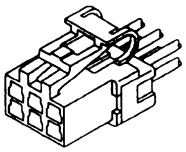
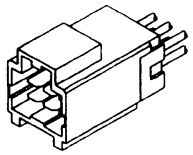
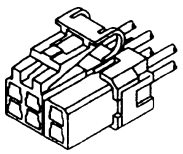
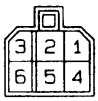
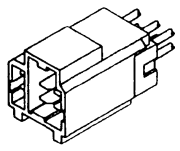
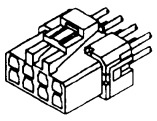
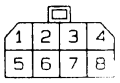
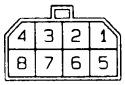
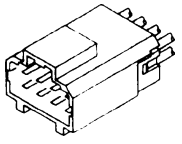
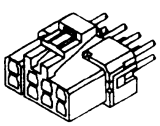
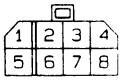
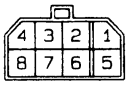
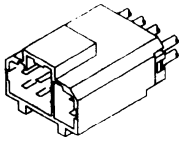
Model (Number shows number of pins)		Connection
AK	AK20B	
	AK22A	
	AK22B	
AL	AL 1 A	
	AL 2 A	

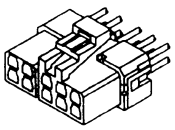
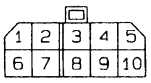
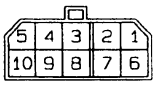
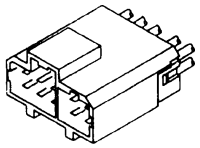
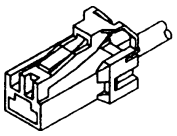
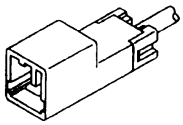
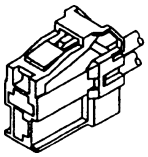
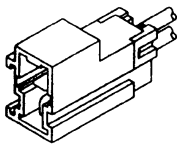
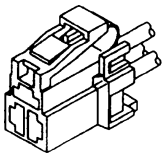
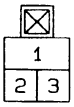
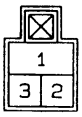
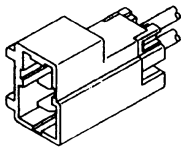
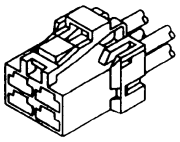
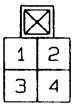
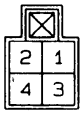
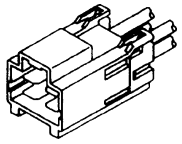
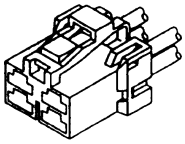
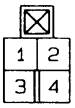
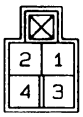
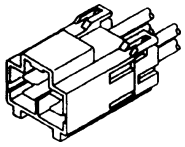
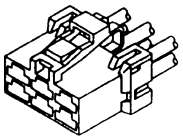
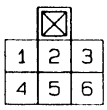
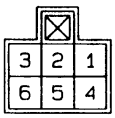
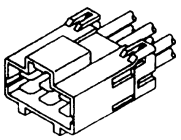
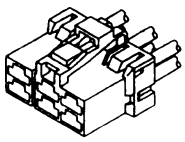
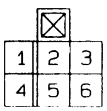
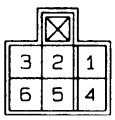
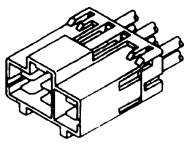
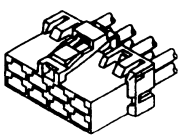
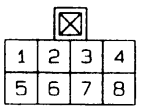
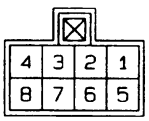
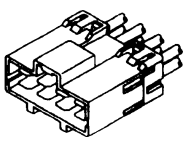
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AL	AL 2 B	
	AL 3 A	
	AL 3 B	
	AL 3 C	
	AL 3 D	
	AL 3 E	

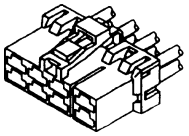
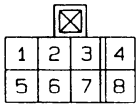
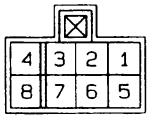
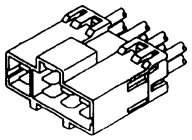
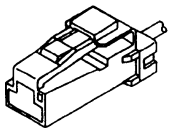
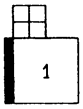
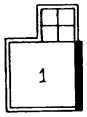
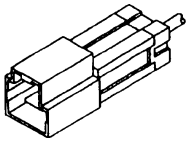
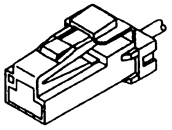
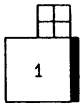
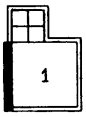
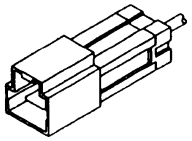
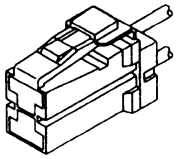
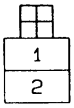
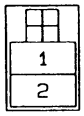
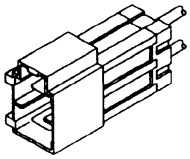
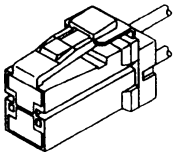
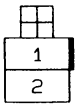
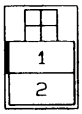
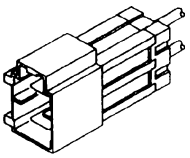
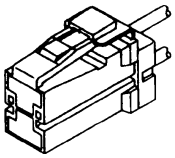
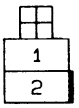
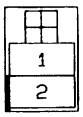
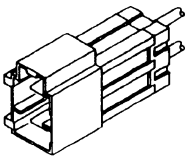
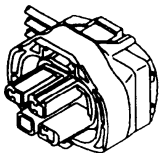
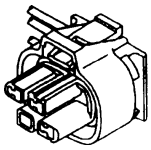
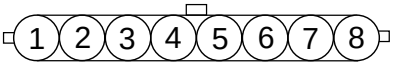
Model (Number shows number of pins)		Connection			
AL	AL 4 A	 or 			 or 
	AL 4 B				
	AL 6 A	 or 			 or 
	AL 6 B				
	AL 8 A	 or 			 or 
	AL 8 B				

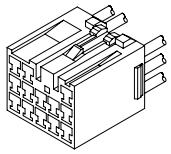
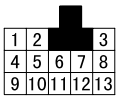
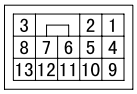
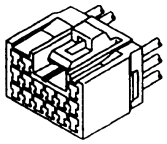
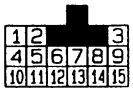
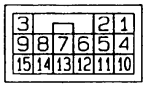
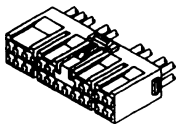
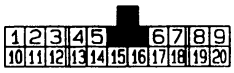
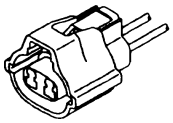
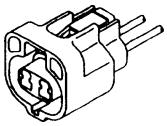
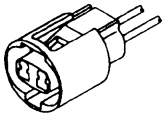
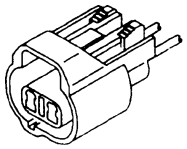
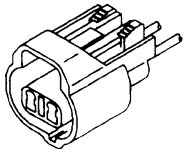
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AM	AM 2 A				
	AM 2 B				
	AM 2 C				
	AM 4 A				
	AM 4 B				
	AM 6 A				
	AM 6 B				
	AM 8 A				
	AM 8 B				

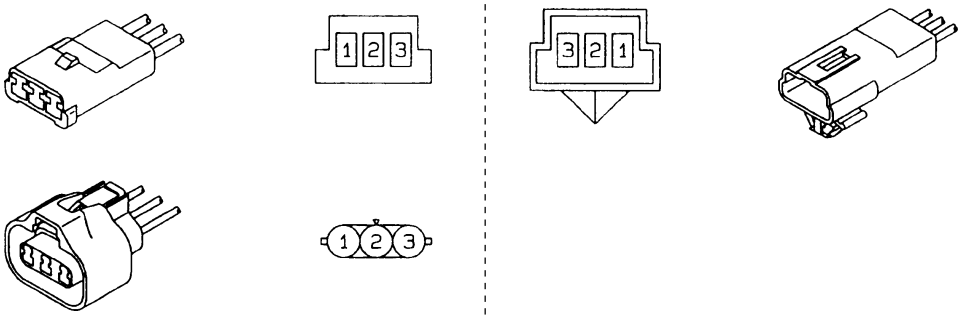
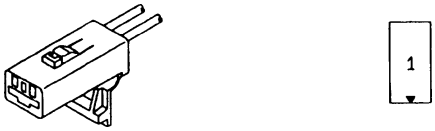
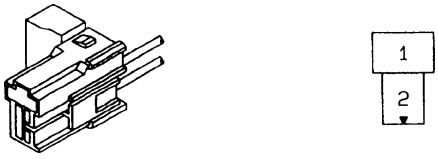
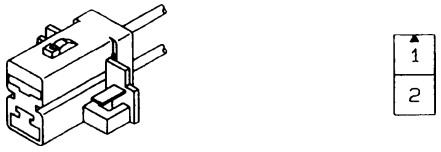
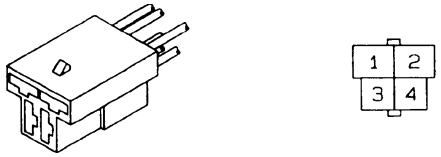
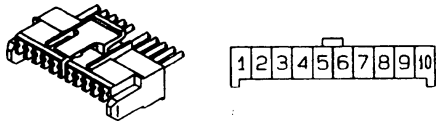
Model (Number shows number of pins)		Connection			
AM	AM10A				
AN	AN 1 A				
	AN 2 A				
	AN 3 A				
	AN 4 A				
	AN 4 B				
	AN 6 A				
	AN 6 B				
	AN 8 A				

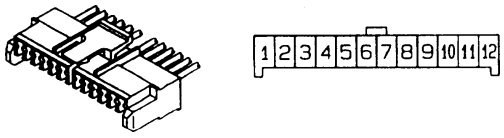
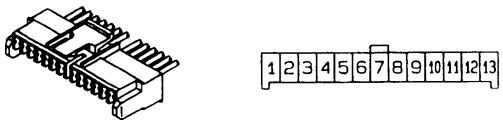
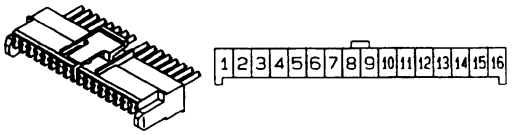
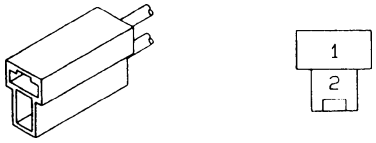
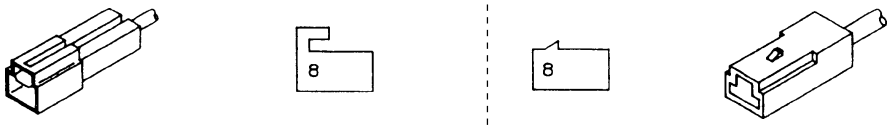
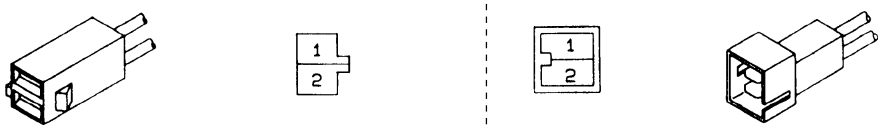
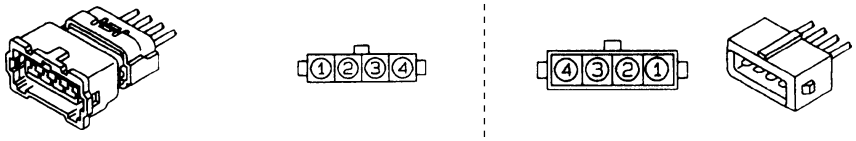
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AN	AN 8 B				
AP	AP 1 A				
	AP 1 B				
	AP 2 A				
	AP 2 B				
	AP 2 C				
AQ	AQ 3 A				
	AQ 3 B				
	AQ 8 A				

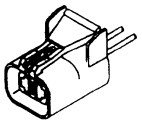
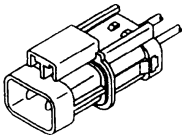
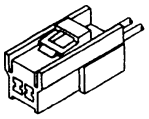
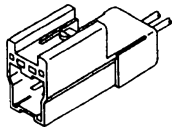
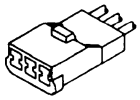
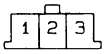
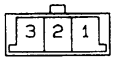
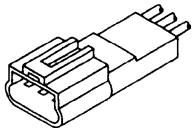
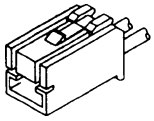
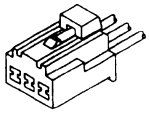
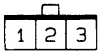
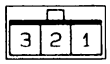
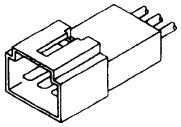
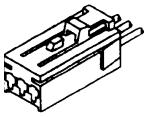
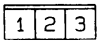
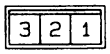
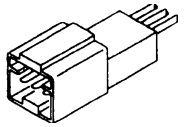
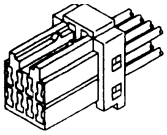
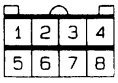
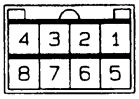
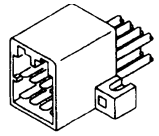
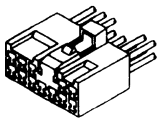
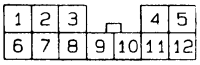
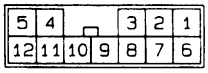
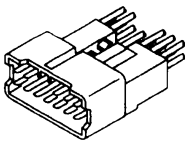
Model (Number shows number of pins)		Connection	
AQ	AQ13A	 	
	AQ15A	 	
	AQ20A	 	
AR	AR 2 A		
	AR 2 B		
	AR 2 C		
	AR 2 D		
	AR 2 E		
	AR 2 F		

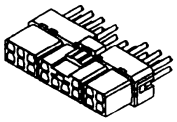
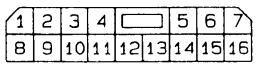
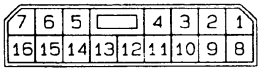
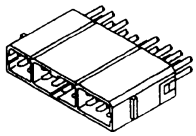
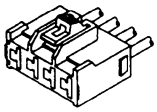
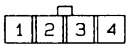
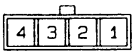
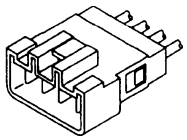
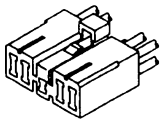
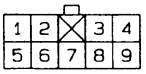
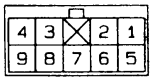
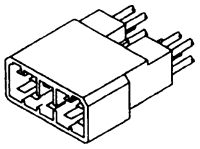
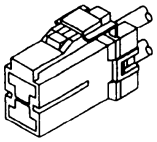
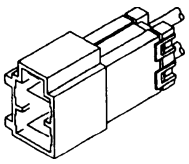
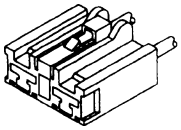
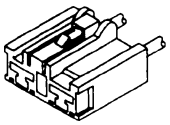
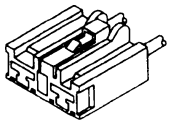
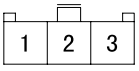
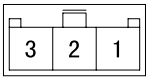
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AR	AR 3 A	
AS	AS 1 A	
	AS 2 A	
	AS 2 B	
AT	AT 4 A	
AU	AU 6 A	
	AU 8 A	
	AU10A	

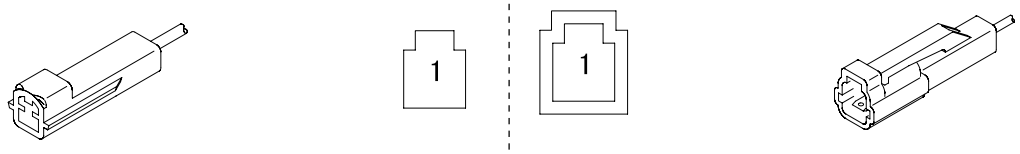
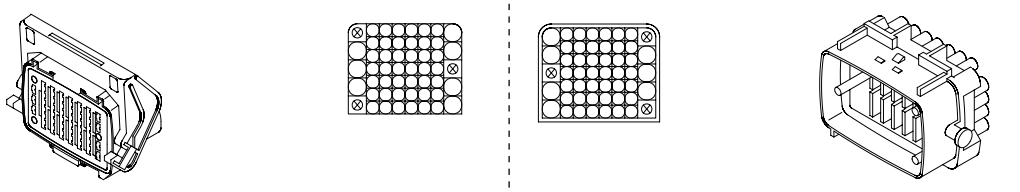
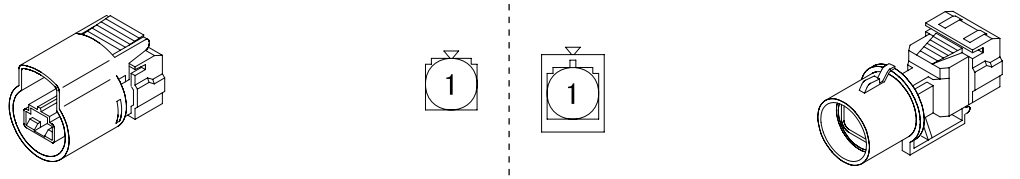
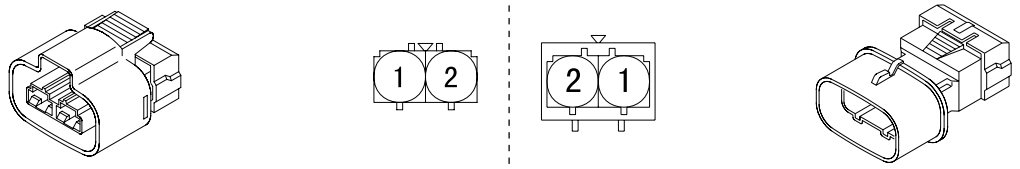
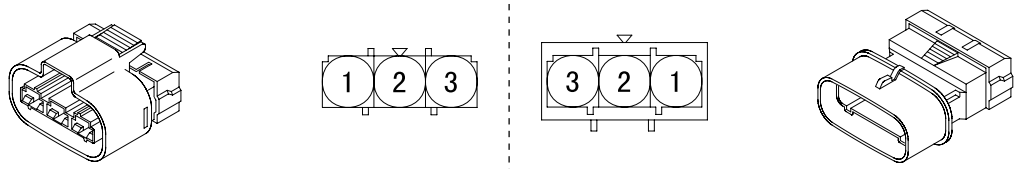
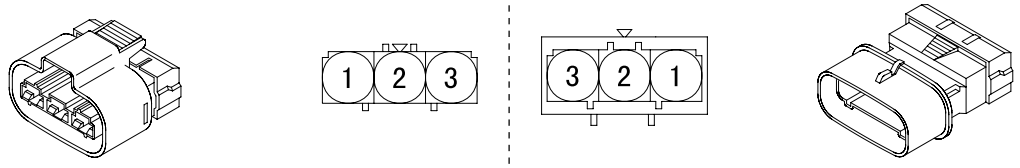
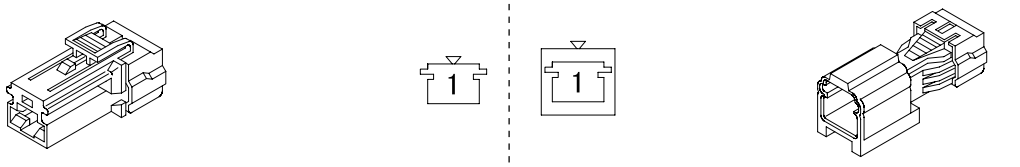
Model (Number shows number of pins)		Connection
AU	AU12A	
	AU13A	
	AU16C	
AV	AV 1 A	
	AV 2 A	
AW	AW 1 A	
	AW 1 B	
	AW 2 A	
AX	AX 4 A	

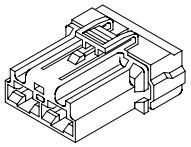
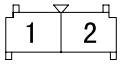
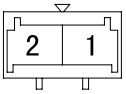
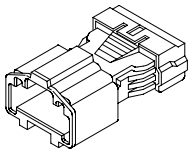
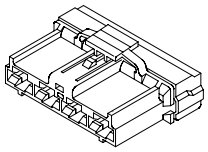
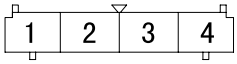
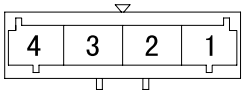
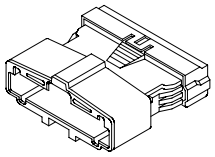
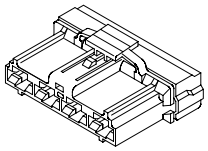
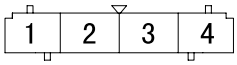
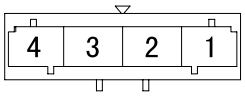
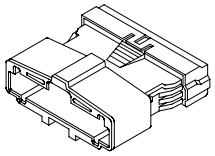
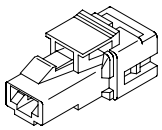
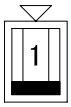
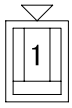
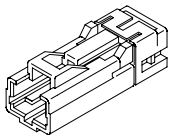
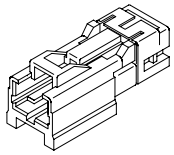
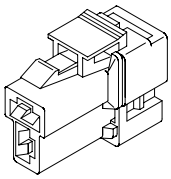
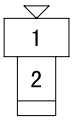
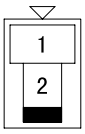
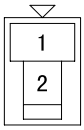
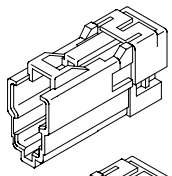
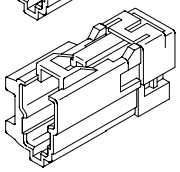
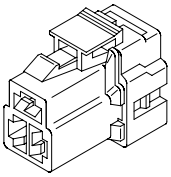
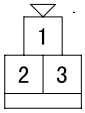
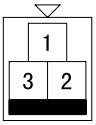
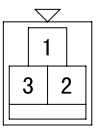
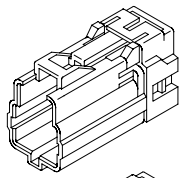
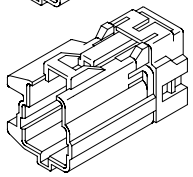
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AY	AY 2 A				
AZ	AZ 2 A				
BA	BA 3 A				
BB	BB 2 A				
	BB 3 A				
BC	BC 3 A				
BD	BD 8 A				
BE	BE 6 A				
BF	BF12A				

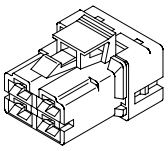
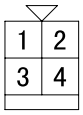
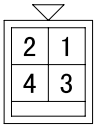
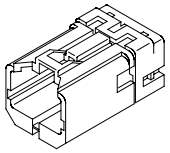
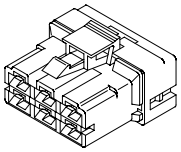
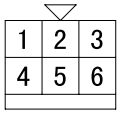
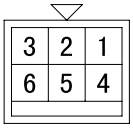
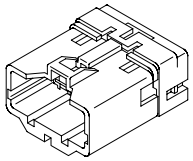
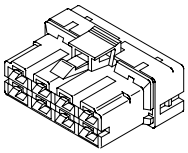
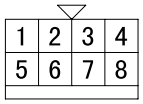
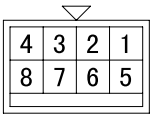
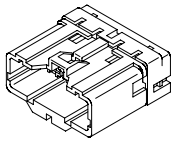
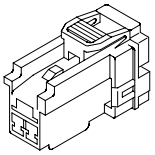
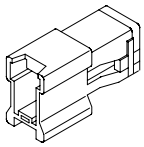
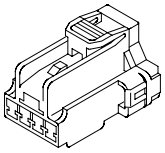
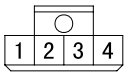
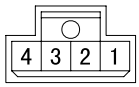
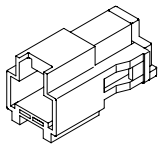
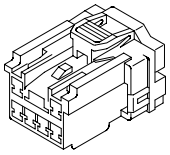
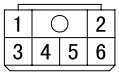
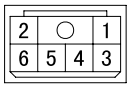
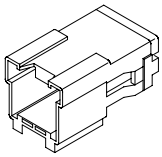
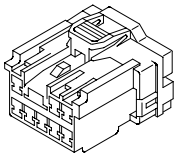
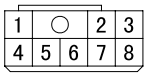
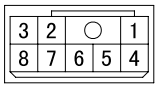
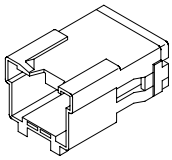
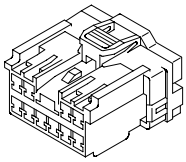
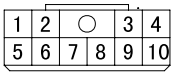
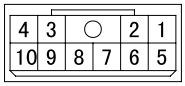
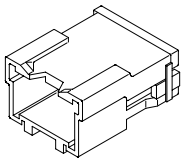
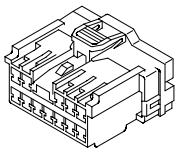
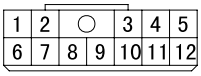
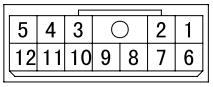
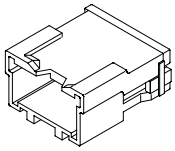
Model (Number shows number of pins)		Connection			
BG	BG16A				
BH	BH 4 A				
BJ	BJ 9 A				
BL	BL 2 A				
BM	BM 2 A				
	BM 2 B				
	BM 2 C				
	BM 3 A				

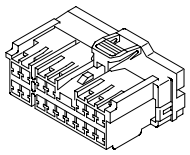
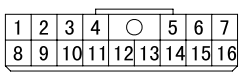
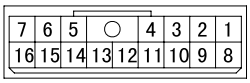
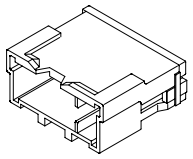
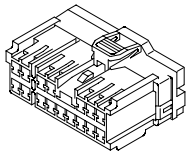
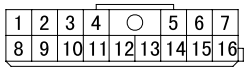
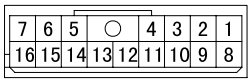
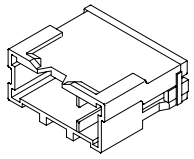
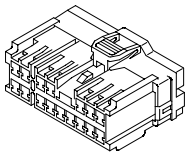
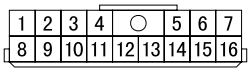
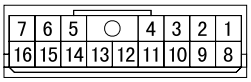
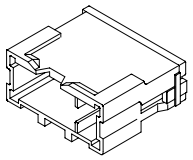
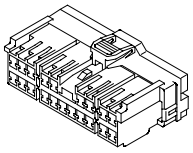
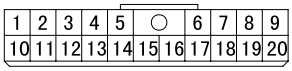
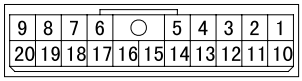
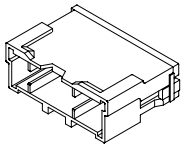
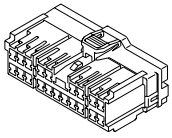
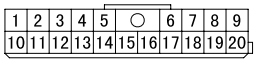
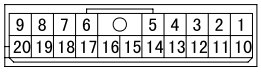
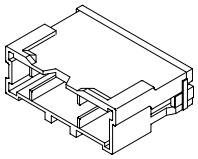
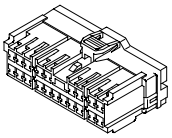
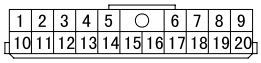
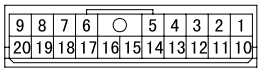
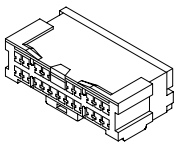
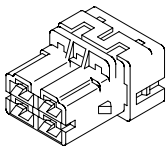
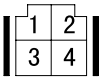
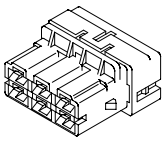
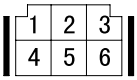
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
BN	BN 1 A	
BP	BP49A	
BQ	BQ 1 A	
	BQ 2 A	
	BQ 3 A	
	BQ 3 B	
BR	BR 1 A	

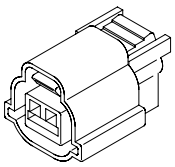
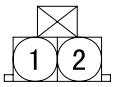
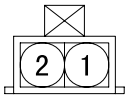
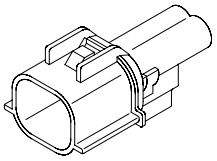
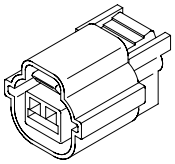
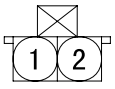
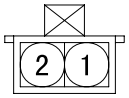
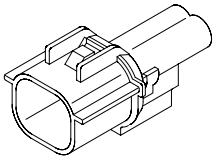
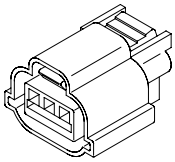
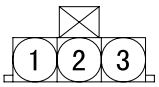
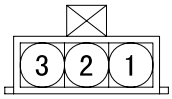
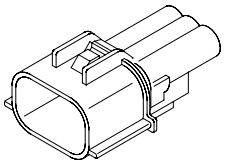
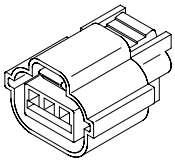
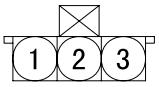
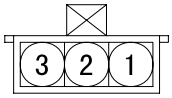
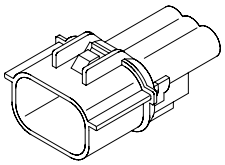
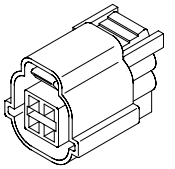
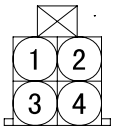
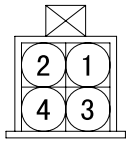
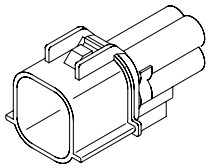
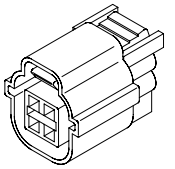
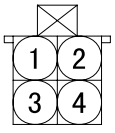
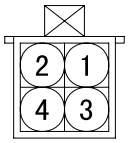
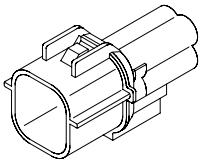
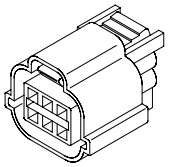
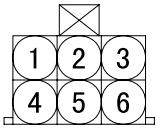
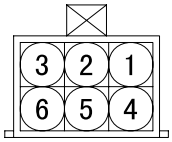
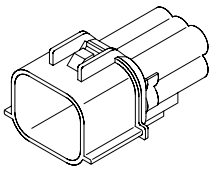
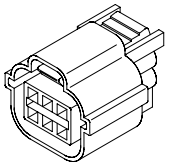
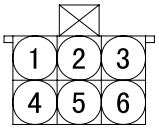
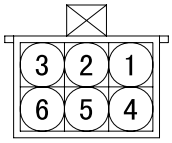
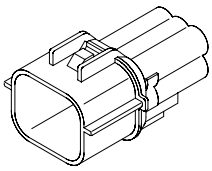
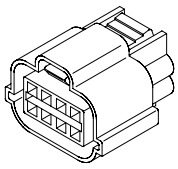
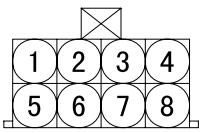
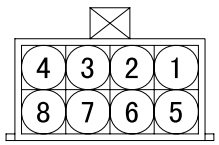
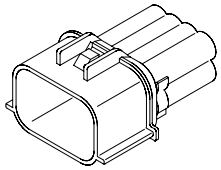
Model (Number shows number of pins)		Connection			
BR	BR 2 A				
	BR 4 A (Glay)				
	BR 4 B (Black)				
BS	BS 1 A			 	 
	BS 2 A			 	 
	BS 3 A			 	 

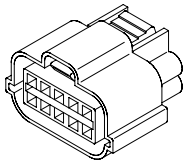
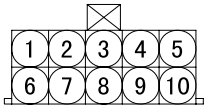
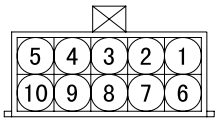
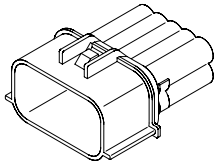
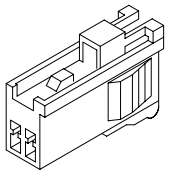
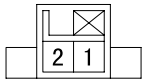
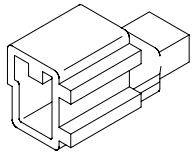
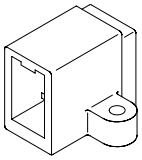
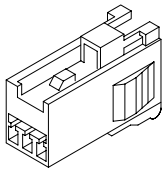
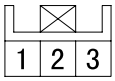
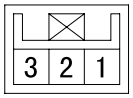
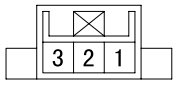
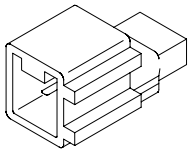
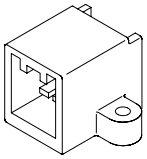
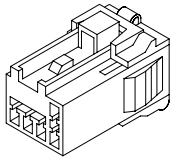
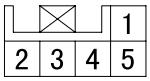
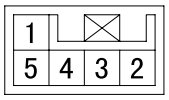
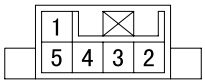
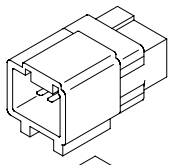
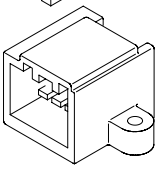
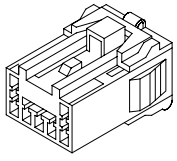
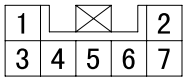
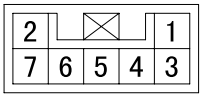
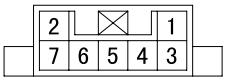
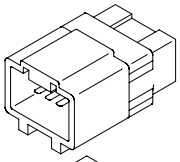
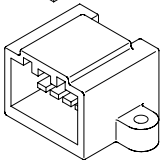
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BS	BS 4 A				
	BS 6 A				
	BS 8 A				
BT	BT 2 A				
	BT 4 A				
	BT 6 A				
	BT 8 A				
	BT10A				
	BT 12 A				

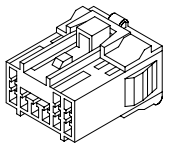
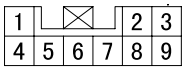
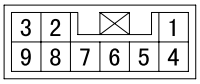
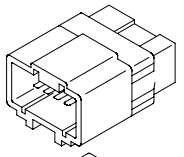
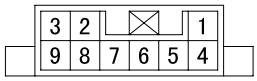
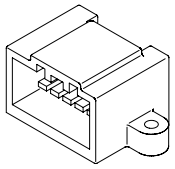
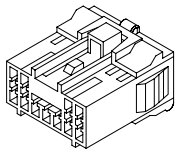
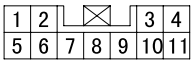
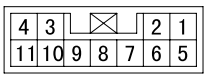
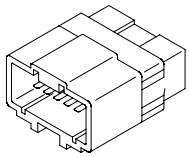
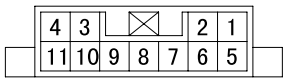
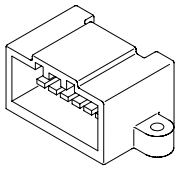
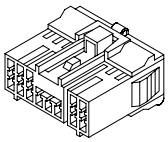
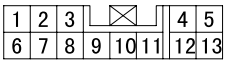
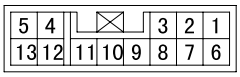
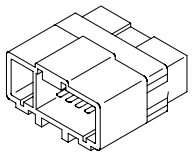
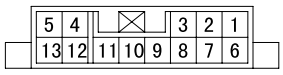
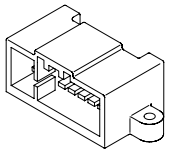
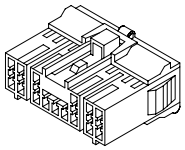
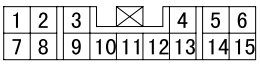
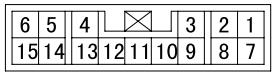
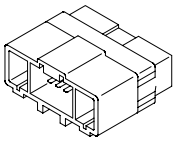
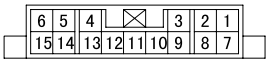
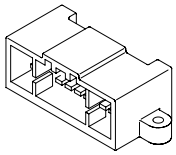
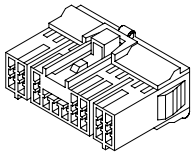
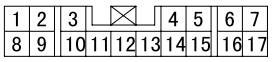
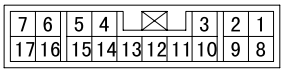
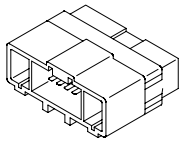
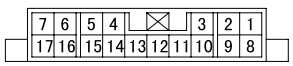
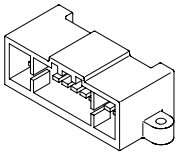
Model (Number shows number of pins)		Connection			
BT	BT16A				
	BT16B				
	BT16C				
	BT20A				
	BT20B				
	BT20C				
BU	BU 4 A				
	BU 6 A				

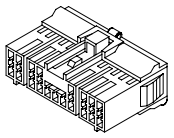
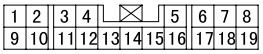
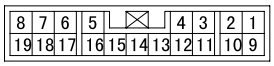
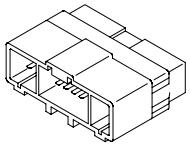
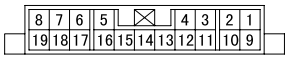
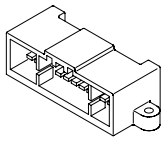
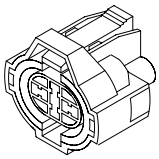
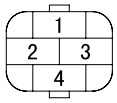
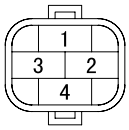
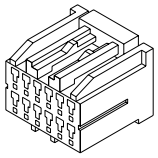
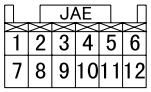
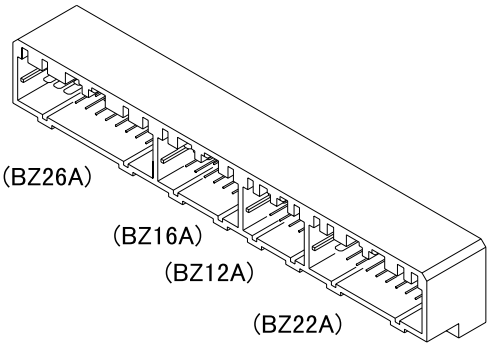
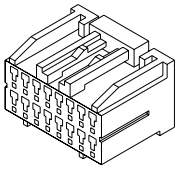
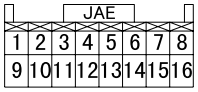
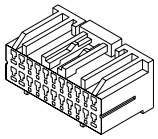
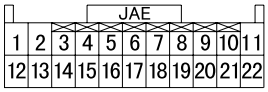
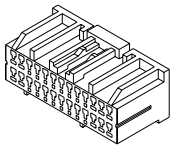
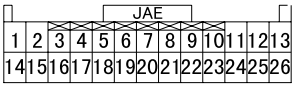
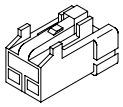
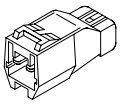
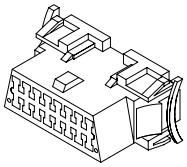
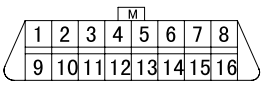
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BW	BW 2 A				
	BW 2 B				
	BW 3 A				
	BW 3 B				
	BW 4 A				
	BW 4 B				
	BW 6 A				
	BW 6 B				
	BW 8 A				

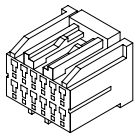
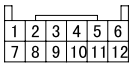
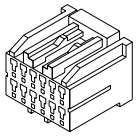
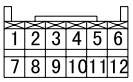
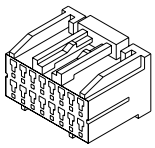
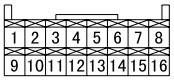
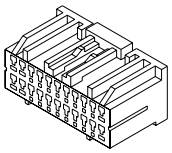
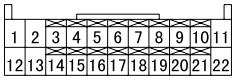
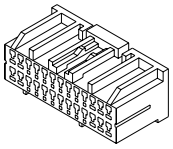
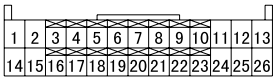
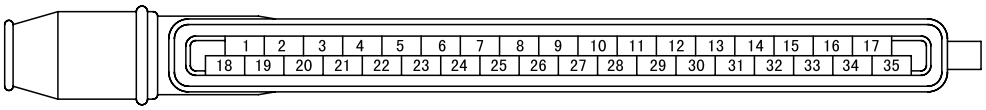
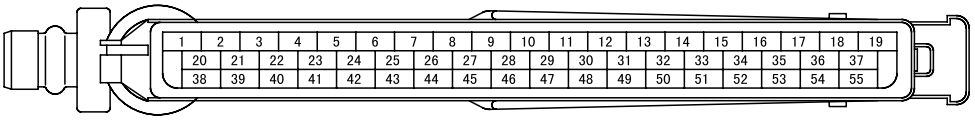
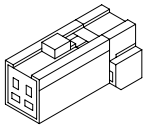
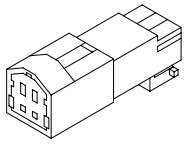
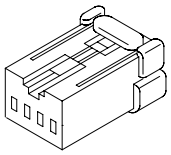
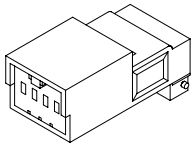
Model (Number shows number of pins)		Connection			
BW	BW10A				
BX	BX 2 A			 	 
	BX 3 A			 	 
	BX 5 A			 	 
	BX 7 A			 	 

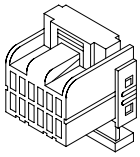
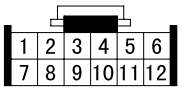
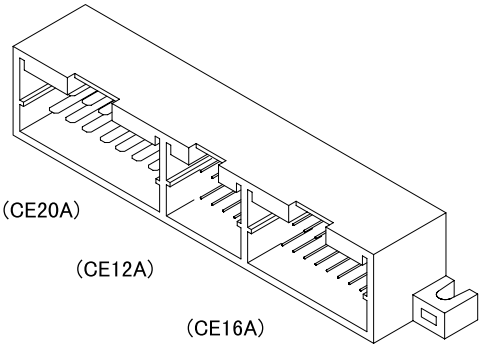
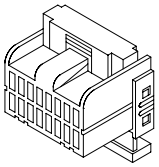
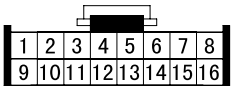
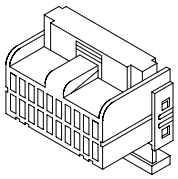
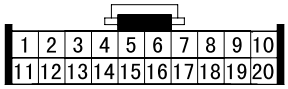
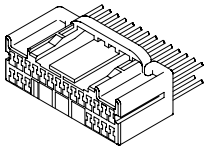
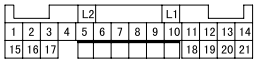
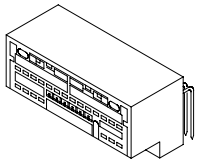
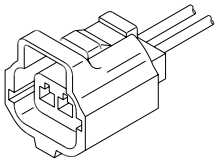
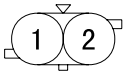
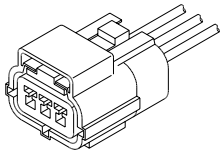
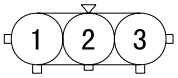
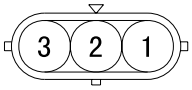
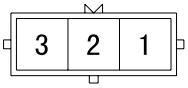
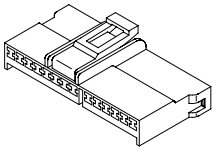
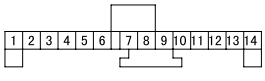
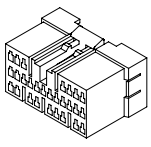
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BX	BX 9 A				
					
	BX11A				
					
	BX13A				
					
	BX15A				
					
	BX17A				
					

Model (Number shows number of pins)		Connection	
BX	BX19A	 	   
BY	BY 4 A	 	
BZ	BZ12A	 	 (BZ26A) (BZ16A) (BZ12A) (BZ22A)
	BZ16A	 	
	BZ22A	 	
	BZ26A	 	
CA	CA 2 A		
CB	CB16A	 	

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CC	CC12A	 
	CC12B	 
	CC16A	 
	CC22A	 
	CC26A	 
CD	CD35A	
	CD55A	
CE	CE 2 A	 
	CE 4 A	 

Model (Number shows number of pins)		Connection	
CE	CE12A	 	CE48A 
	CE16A	 	
	CE20A	 	
CF	CF21A	 	
CH	CH 2 A	 	
	CH 3 A	 	
CK	CK 3 A		
CL	CL14A	 	
CM	CM28A		

CONNECTOR CONFIGURATION CHART

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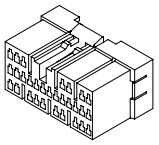
<tr><td rowspan="2">CM</td><td>CM30A</td><td> 
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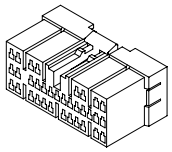
<tr><td>CM35A</td><td> 
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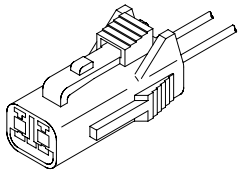
<tr><td rowspan="2">CN</td><td>CN 2 A</td><td> 
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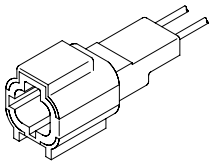
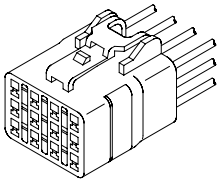
 </td></tr>
<tr><td>CN12A</td><td> 
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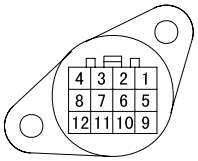
</table></td><td> 
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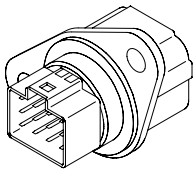
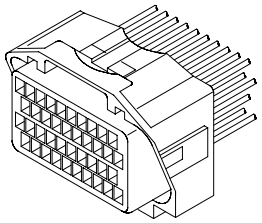
 </td></tr>
<tr><td rowspan="2">CP</td><td>CP40A</td><td> 
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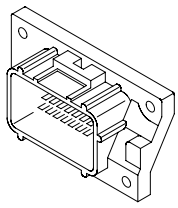
</table></td><td> 
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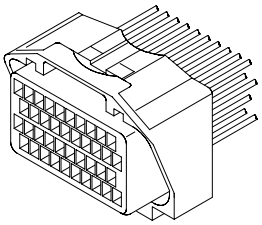
<tr><td>CP40B</td><td> 
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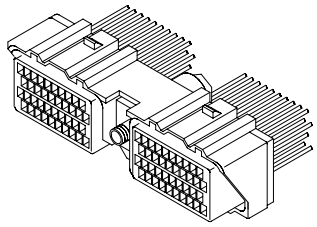
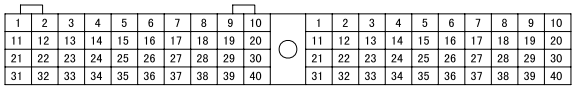
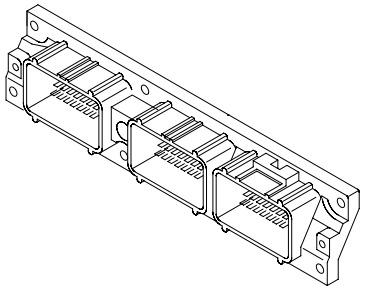
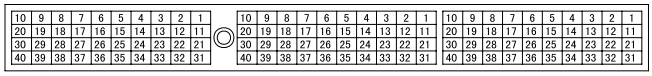
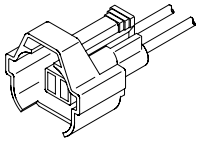
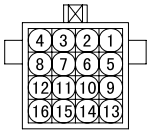
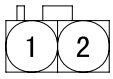
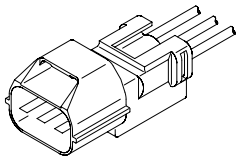
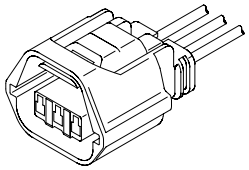
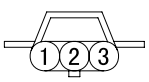
Model (Number shows number of pins)		Connection
CP	CP80A	  1 2 3 4 5 6 7 8 9 10 / 11 12 13 14 15 16 17 18 19 20 / 21 22 23 24 25 26 27 28 29 30 / 31 32 33 34 35 36 37 38 39 40 ○ 1 2 3 4 5 6 7 8 9 10 / 11 12 13 14 15 16 17 18 19 20 / 21 22 23 24 25 26 27 28 29 30 / 31 32 33 34 35 36 37 38 39 40
	CP40B CP80A	  10 9 8 7 6 5 4 3 2 1 / 20 19 18 17 16 15 14 13 12 11 / 30 29 28 27 26 25 24 23 22 21 / 40 39 38 37 36 35 34 33 32 31 ◎ 10 9 8 7 6 5 4 3 2 1 / 20 19 18 17 16 15 14 13 12 11 / 30 29 28 27 26 25 24 23 22 21 / 40 39 38 37 36 35 34 33 32 31 10 9 8 7 6 5 4 3 2 1 / 20 19 18 17 16 15 14 13 12 11 / 30 29 28 27 26 25 24 23 22 21 / 40 39 38 37 36 35 34 33 32 31 (CP80A) (CP40B)
CQ	CQ 2 A	
CR	CR16A	 4 3 2 1 / 8 7 6 5 / 12 11 10 9 / 16 15 14 13
CS	CS 2 A	 1 2
CT	CT 3 A	 3 2 1 
	CT 3 B	  1 2 3 3 2 1

CONNECTOR CONFIGURATION CHART

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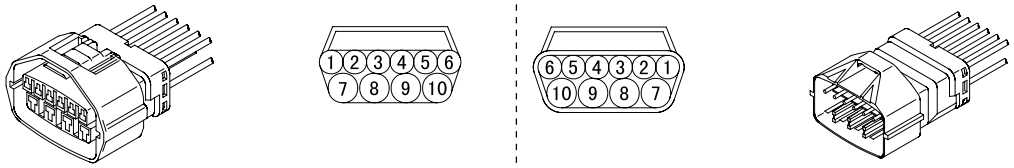
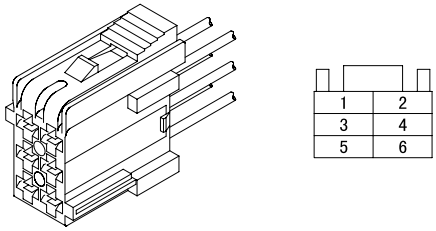
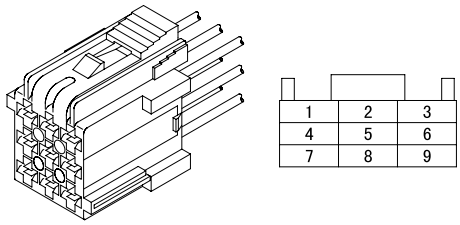
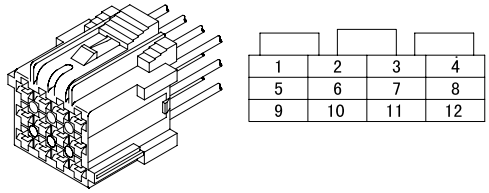
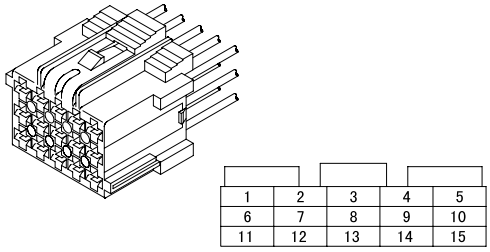
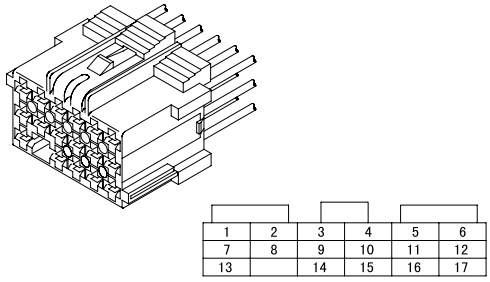
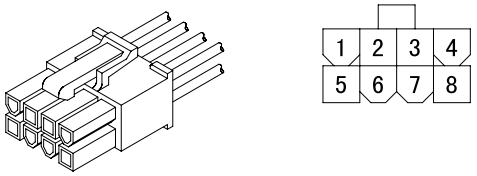
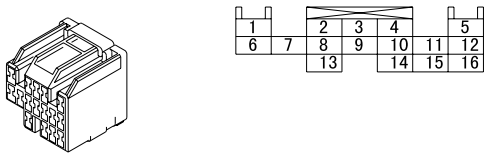
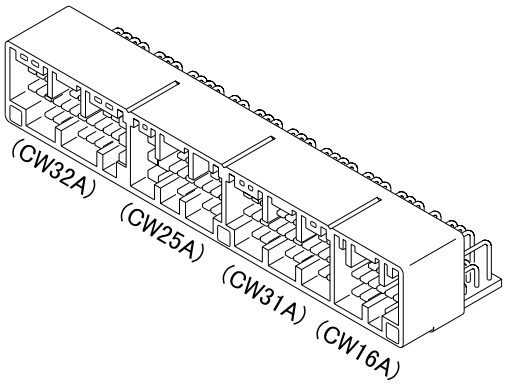
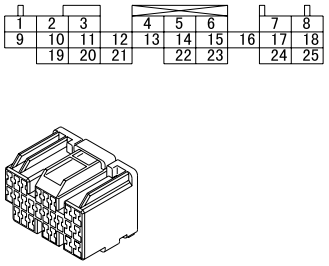
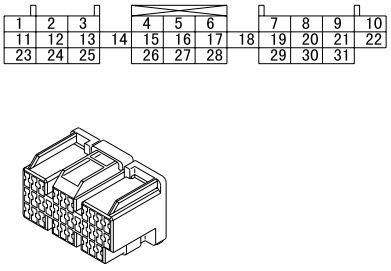
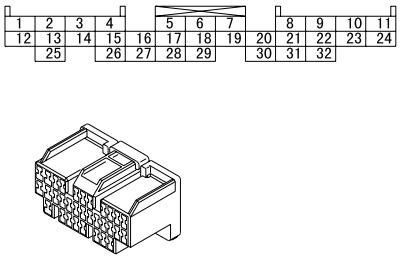
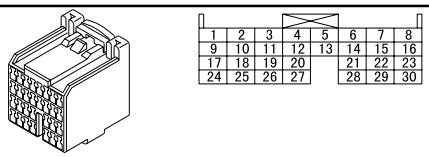
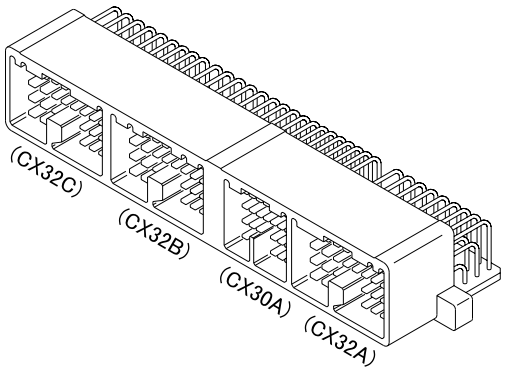
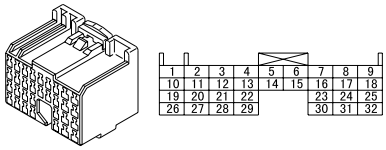
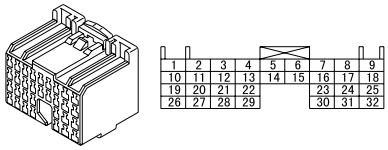
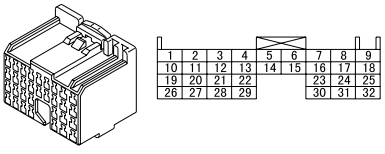
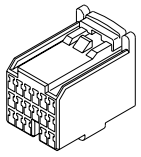
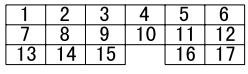
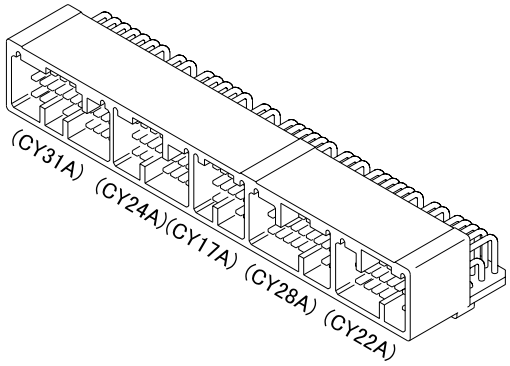
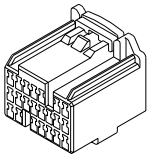
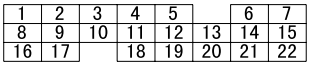
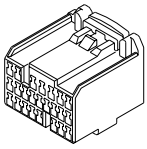
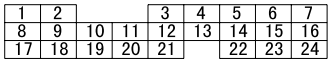
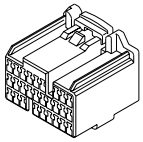
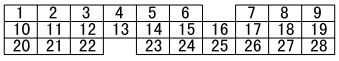
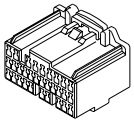
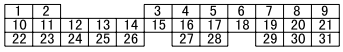
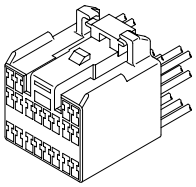
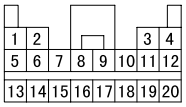
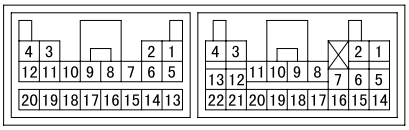
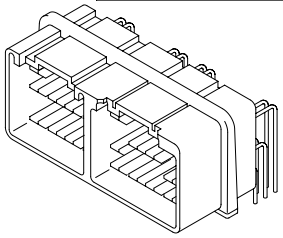
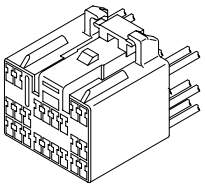
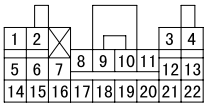
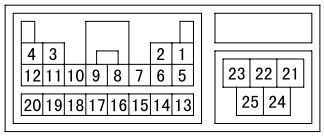
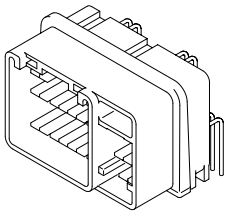
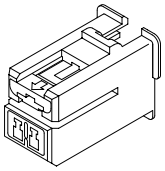
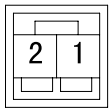
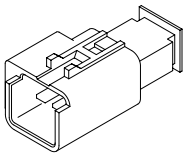
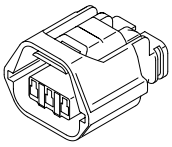
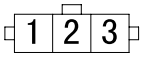
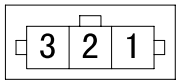
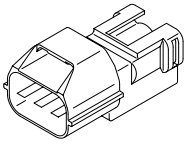
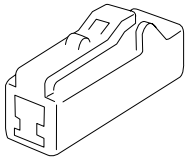
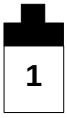
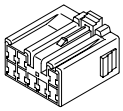
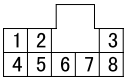
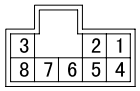
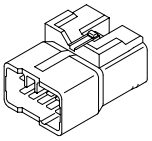
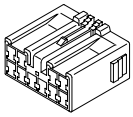
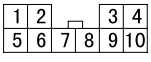
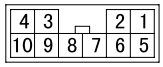
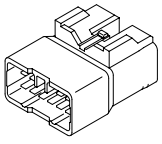
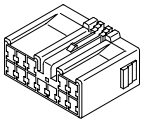
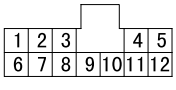
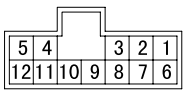
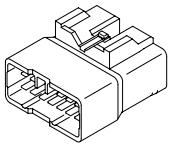
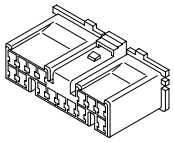
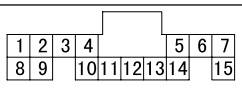
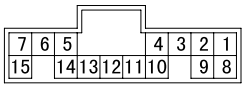
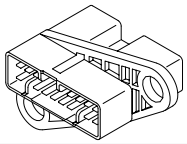
CT	CT10A	
CU	CU 6 A	
	CU 9 A	
	CU12A	
	CU15A	
	CU17A	
CV	CV 8 A	

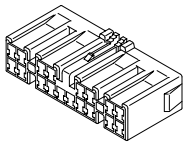
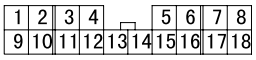
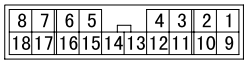
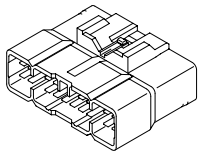
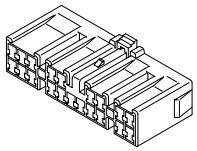
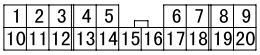
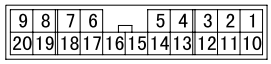
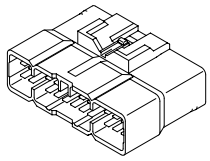
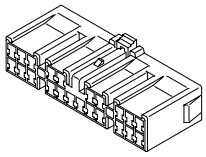
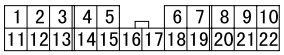
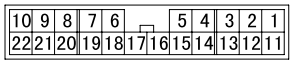
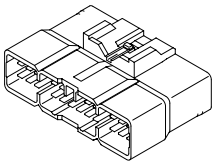
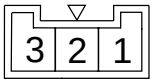
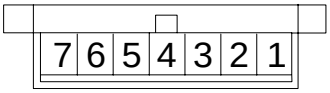
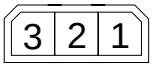
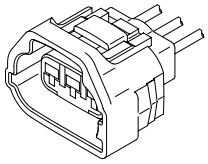
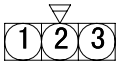
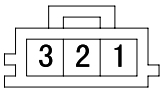
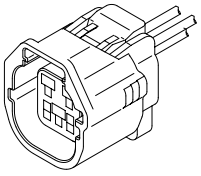
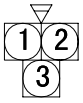
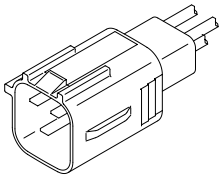
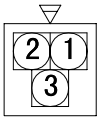
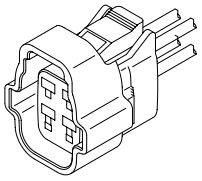
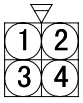
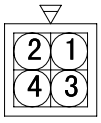
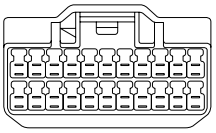
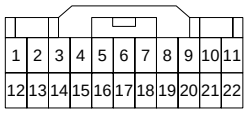
Model (Number shows number of pins)		Connection
CW	CW16A	 
	CW25A	
	CW31A	
	CW32A	
CX	CX30A	 
	CX32A	
	CX32B	
	CX32C	

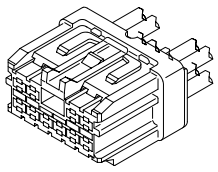
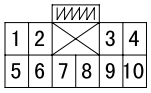
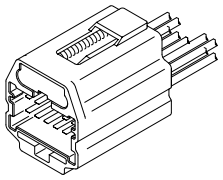
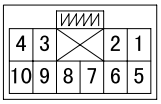
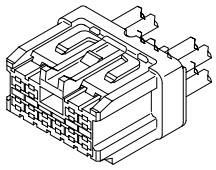
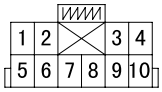
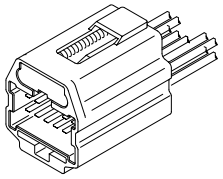
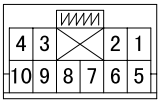
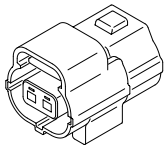
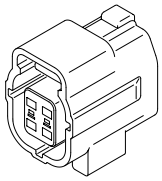
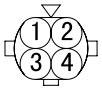
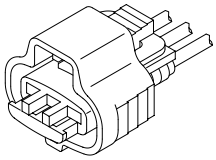
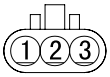
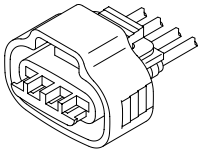
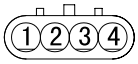
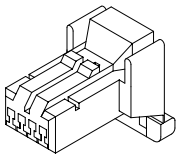
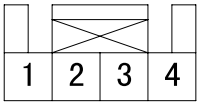
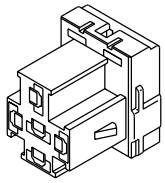
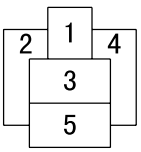
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CY	CY17A	  
	CY22A	 
	CY24A	 
	CY28A	 
	CY31A	 
DA	DA20A	   
	DA22A	 

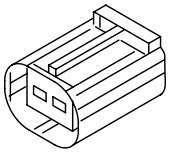
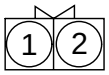
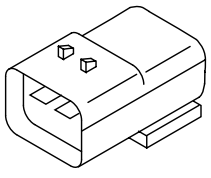
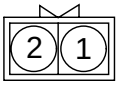
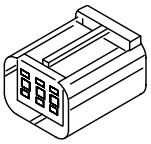
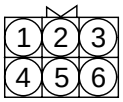
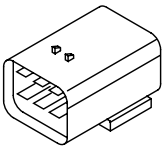
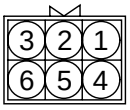
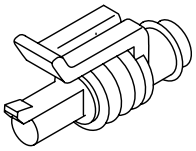
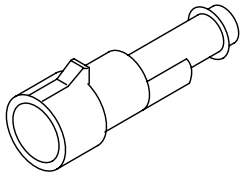
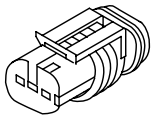
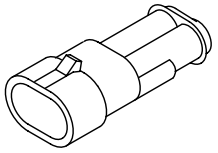
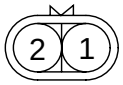
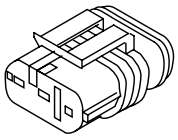
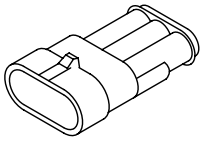
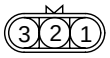
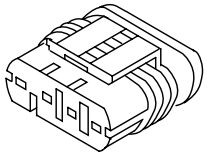
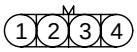
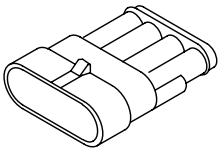
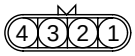
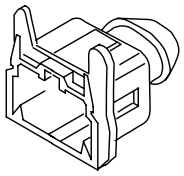
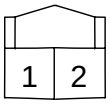
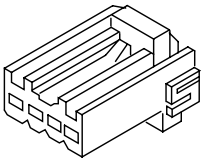
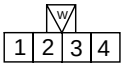
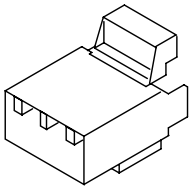
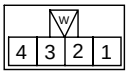
Model (Number shows number of pins)		Connection
DA	DA25A	 
DB	DB 2 A	  
DC	DC 3 A	   
DD	DD 1 A	 
	DD 8 A	   
	DD10A	   
	DD12A	   
	DD15A	   

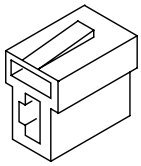
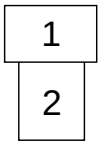
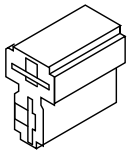
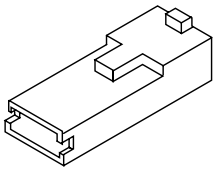
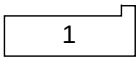
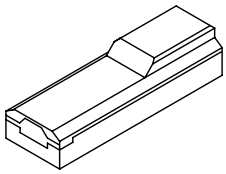
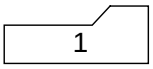
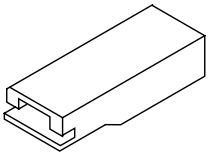
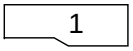
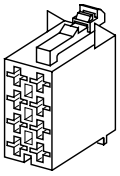
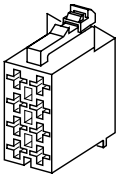
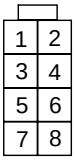
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
DD	DD18A	   
	DD20A	   
	DD22A	   
DE	DE 3 A	
	DE 7 A	
DF	DF 3 A	
DG	DG 3 A	  
	DG 3 B	   
	DG 4 A	  
DH	DH22A	 

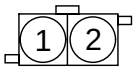
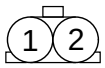
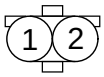
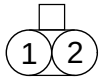
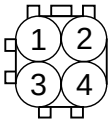
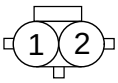
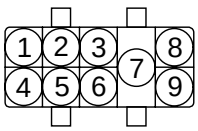
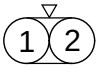
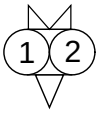
Model (Number shows number of pins)		Connection			
DJ	DJ10A				
	DJ10B				
DK	DK 2 A				
	DK 4 A				
DM	DM 3 A				
	DM 4 A				
DN	DN 4 A				
DP	DP 5 A				

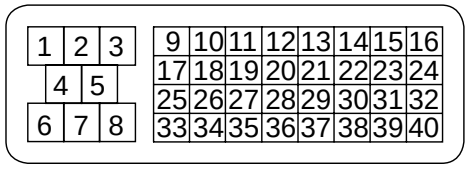
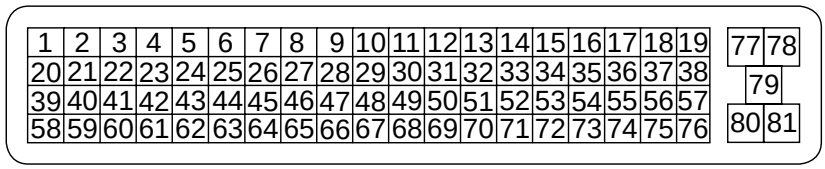
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection	
DS	DS 2 A	 	 
	DS 6 A	 	 
DT	DT 1 A		
	DT 2 A		 
	DT 3 A		 
	DT 4 A	 	 
DU	DU 2 A	 	
DV	DV 4 A	 	 

Model (Number shows number of pins)		Connection
DW	DW 2 A	 
DX	DX 2 A	
DY	DY 2 A	 
	DY 2 B	 
DZ	DZ 1 A	 
EA	EA 8 A	
	EA 8 B	
EB	EB 8 A	

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
EC	EC 2 A	
ED	ED 2 A	
EE	EE 2 A	
EF	EF 2 A	
EG	EG 4 A	
EH	EH 2 A	
EJ	EJ 9 A	
EK	EK 2 A	
EL	EL 2 A	

Model (Number shows number of pins)		Connection
EM	EM40A	
	EM81A	

MITSUBISHI
FUSO

Group 01
Maintenance Schedule

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-01

INDEX

HOW TO READ THE MAINTENANCE SCHEDULE TABLES 01- 2

MAINTENANCE SCHEDULE TABLES 01- 4

MAINTENANCE OPERATIONS

- Replacement of Oil Filter 01- 6
- Replacement of Fuel Filter 01- 8
- Draining of Water Separator Condensation 01- 10
- Cleaning of Fuel Feed Pump Gauze Filter < 4D3 > 01- 10
- Bleeding of Air from Fuel Line 01- 11
- Adjustment of V-Ribbed Belt or V-Belt Tension 01- 12
- Cleaning and Replacement of Air Cleaner Element 01- 16
- Inspection of Clutch Pedal Free Play 01- 17
- Tire 01- 18
- Inspection of Brake Lining Thickness < Drum Brake Only > 01- 23
- Battery 01- 23
- Fuse 01- 26

LUBRICATION TABLES 01- 28

LUBRICATION

- Engine Oil 01- 30
- Manual Transmission Gear Oil 01- 32
- Automatic Transmission Fluid 01- 34
- Transfer Gear Oil < FG Model Only > 01- 36
- Front Axle Gear Oil < FG Model Only > and Rear Axle Gear Oil 01- 37
- Power Steering Fluid 01- 38
- Brake Fluid 01- 40
- Greasing Various Areas of Chassis 01- 46

HOW TO READ THE MAINTENANCE SCHEDULE TABLES

Example Table :

Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance (1)		Time of inspection and maintenance (2)								Working procedures (3)	Remarks (4)
		New vehicle at 4000 km/ 2500 miles	Inspection interval: Every 10000 km/ 6000 miles	Every 20000 km/ 12000 miles	Every 30000 km/ 18000 miles	Every 40000 km/ 24000 miles	Every 50000 km/ 30000 miles	Every 90000 km/ 54000 miles	Every 250000 km/ 150000 miles		
ENGINE											
1	Manifold bolts torque	×					×			Check inlet and exhaust manifold nuts for looseness	Gr 15A, B
2	Ⓔ Check and adjust valve clearance	×					×			Check valve clearance with feeler gauge	Gr 11A, B
3	Ⓔ Oil filter replacement	×	Every 10000 km/6000 miles or 12 months							Replace oil filter	Gr 12A, B
4	Ⓔ Injection nozzle Ⓝ							×	×	Check and clean injection nozzle	Gr 13A, B
5	Ⓔ Fuel Injection timing Ⓝ							×		Check fuel injection timing	Gr 13A, B
6	Ⓔ		Every 40000 km/24000 miles or 24 months							Clean gauze filter inside co	
					km/12000 miles or 12 months					Re	

(1) This column contains the maintenance and inspection items.
(2) The periods between inspection and service are based on the assumption that the vehicle will be driven approximately 60000 kilometers (36000 miles) per year.
Inspections which must be made are indicated by an "×" or by the appropriate period between servicing.
(3) This column provides a simplified explanation of the operational procedures involved for each inspection or maintenance item.
(4) The Gr. No. refers to the "group number" in this Service Manual. For visual checks and simple inspections, see the sections labelled "Working Procedures".

M E M O

MAINTENANCE SCHEDULE TABLES

Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance		Time of inspection and maintenance								Working procedures	Remarks
		New vehicle at 4000 km/ 2500 miles	Inspection interval: Every 10000 km/ 6000 miles	Every 20000 km/ 12000 miles	Every 30000 km/ 18000 miles	Every 40000 km/ 24000 miles	Every 50000 km/ 30000 miles	Every 90000 km/ 54000 miles	Every 250000 km/ 150000 miles		
ENGINE											
1	Manifold bolts and nuts torque						×			Check inlet and exhaust manifold bolts and nuts for looseness	Gr 15A, B
2	Ⓔ Check and adjust valve clearance	×					×			Check valve clearance with feeler gauge	Gr 11A, B
3	Ⓔ Oil filter replacement		Every 10000 km/6000 miles or 12 months							Replace oil filter	P01-6
4	Ⓔ Injection nozzle Ⓝ							×	×	Check and clean injection nozzle	Gr 13A, B
5	Ⓔ Fuel Injection timing Ⓝ							×		Check fuel injection timing	Gr 13B
6	Ⓔ Fuel feed pump filter		Every 40000 km/24000 miles or 24 months							Clean gauze filter inside connector	P01-10
7	Ⓔ Fuel filter replacement		Every 20000 km/12000 miles or 12 months							Replace fuel filter	P01-8
8	Ⓔ Fuel line		Every 20000 km/12000 miles or 12 months							Inspect fuel tank, cap and lines for damage and leakage	Gr 13A, B
9	Ⓔ V-ribbed belts or V-belts tension and Ⓝ damage		Every 10000 km/6000 miles or 12 months							Inspect V-ribbed belt or V-belts for cracks, wear and tension	P01-12
10	Ⓔ Cooling system			×						Check radiator and radiator cap for sealing performance and mounting condition. Inspect hoses for looseness, deterioration, damage causing leakage. Remove dust and foreign deposits from radiator and intercooler front	Gr 14A, B
11	Coolant replacement		Every 24 months							Replace coolant	Gr 14A, B
12	Ⓔ Turbocharger rotor play								×	Check turbocharger rotor play	Gr 15A, B
13	Air cleaner element		Every 5000 km/3000 miles							Clean air cleaner element by blowing clean compressed air	P01-16
14	Ⓔ Air cleaner element Ⓝ replacement					×				Replace air cleaner element	Gr 15A, B
15	Ⓔ Exhaust system Ⓝ			×						Inspect exhaust system for damage, corrosion and loose connection causing leakage	Gr 15A, B
POWER TRAIN											
16	Clutch pedal and clutch disc		×							Check pedal for free play	P01-17
	wear									Check disc wear	Gr 21
17	Propeller shaft flange torque and universal joint looseness		×							Check flange yoke bolts for looseness and universal joint for play	Gr 25
18	Propeller shaft center bearing						×			Check center bearing for wear, damage and play	Gr 25

Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance		Time of inspection and maintenance								Working procedures	Remarks
			Inspection interval								
		New vehicle at 4000 km/ 2500 miles	Every 10000 km/ 6000 miles	Every 20000 km/ 12000 miles	Every 30000 km/ 18000 miles	Every 40000 km/ 24000 miles	Every 50000 km/ 30000 miles	Every 90000 km/ 54000 miles	Every 250000 km/ 150000 miles		
FRONT AND REAR AXLE											
19	Wheel hub bearing				×					Check wheel hub bearing for play	Gr 26A, 26B, 27
20	Wheel hub bearing hub seals replacement				×					When wheel hub bearing grease is replaced, also replace wheel hub bearing hub seals	Gr 26A, 26B, 27
21	Wheel and tire		×							Check disc wheel for corrosion, deformation and cracks. Measure inflation pressure with tire gauge. Check tire tread and side wall for cracks and damage. Measure tire tread groove depth to make sure it is deep enough. Check tire tread for uneven wear, stepped wear and other abnormal wear.	P01-18
22	Retightening wheel nuts	×	×							Check wheel nuts for looseness. Check at the first 50 to 100 km/30 to 60 miles after changing a wheel	P01-18
SUSPENSION SYSTEM											
23	Retightening U-bolts	×		×						Check U-bolt nuts for looseness. Check at the first 1000 km/600 miles after removing and retightening U-bolt nuts	Gr 33, 34
BRAKING SYSTEM											
24	Disc brake pad and disc		×							Check disc brake pad and disc for damage and wear	Gr 35A
25	Brake lining		×							Check lining for wear through inspection hole	P01-23
26	Brake drum				×					Disassemble and check drum for wear, cracks and damage	Gr 35A
27	Looseness, play and damage of brake system parts		×							Inspect brake lines and hoses for looseness, play and damage. Inspect wheel cylinder and brake master cylinder for looseness, play and damage	Gr 35A
STEERING SYSTEM											
28	Steering system		×							Check steering system for looseness, steering wheel play and operating condition. Inspect for oil leaks, booster and oil pump function	Gr 37

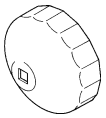
Replacement of Oil Filter
< 4M5 >

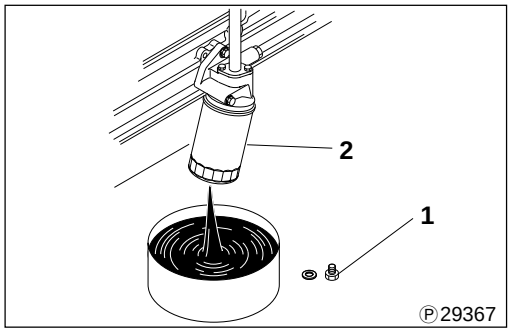
Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Oil filter	Engine oil (API CD or higher)	Approximately 1 L {1.1 qts}

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
2	Oil Filter Element Socket  08550	OBTAIN LOCALLY	Oil filter removal
	Oil Filter Wrench ø107 to 120 {ø4.21 to 4.72} 01503	OBTAIN LOCALLY	



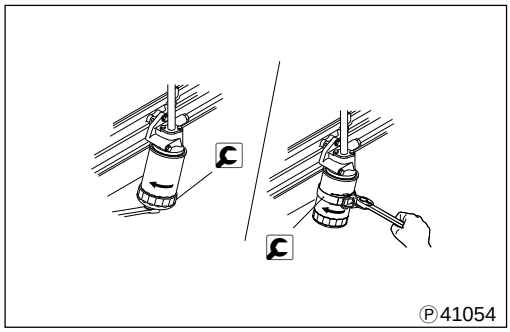
Ⓟ29367

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire or accident.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

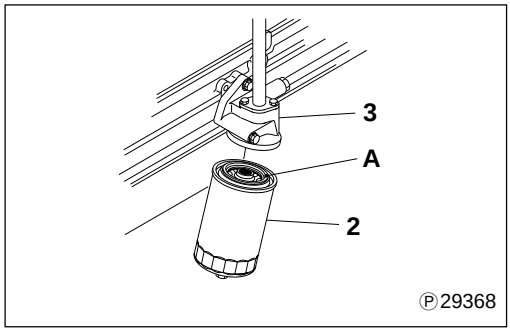
CAUTION ⚠

When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.


Ⓟ41054

Loosen oil filter drain plug **1** to drain the engine oil from inside the filter **2**.
[Removal]

: Oil Filter Element Socket or Filter Wrench



Ⓟ29368

[Installation]

- Clean the surface of oil filter head **3** to which oil filter **2** is fitted.
- Apply a thin coat of engine oil to the gasket **A** of oil filter **2**.
- Screw oil filter **2** into oil filter head **3** by hand until gasket **A** contacts the oil filter head. Then, tighten oil filter **2** further by giving it a 3/4 turn.
- After installing the oil filter, start the engine and check gasket **A** for oil leakage.
- Stop engine, check dipstick to see if the engine oil level is in the specified range.

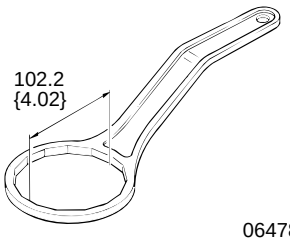
< 4D3 >

Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Inside oil filter	Engine oil	Approximately 1 L {1.1 qts}
	Gasket area of oil filter with thin application	Engine oil	As required

Special tools

Unit : mm {in.}

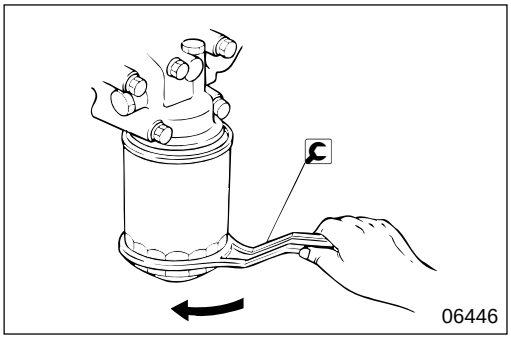
Location	Tool name and shape	Part No.	Application
2	Oil filter wrench  06478	MH061587 (Obtain Locally)	Removal of oil filter

WARNING

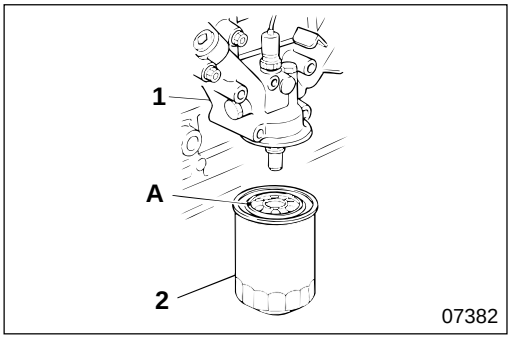
- **Wipe up any spilled engine oil since it may cause a fire or accident.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

CAUTION

- **When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.**



[Removal]

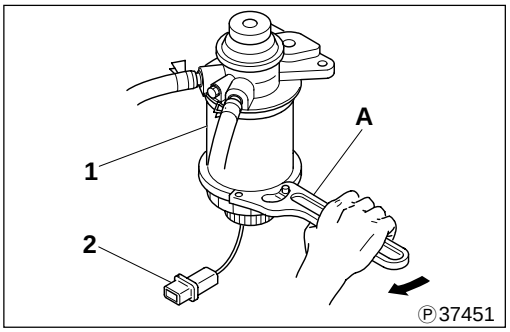


[Installation]

- Clean the surface of oil cooler body **1** that makes contact with oil filter **2**.
- Apply engine oil thinly and evenly to gasket area **A** of oil filter **2**.
- Screw oil filter **2** into oil cooler body **1** until gasket area **A** sits on the body. From this position, tighten further by rotating by 3/4 turn.
- After installation, run the engine and check that there is no oil leakage from gasket area **A**.
- Check the oil making sure it is within the specified range.

Replacement of Fuel Filter
< 4M5 >
Lubricant

Location	Parts to be tightened	Specified lubricant	Quantity
3	Gasket for fuel filter cartridge	Engine oil	As required



[Removal]

A: Filter Wrench
(Commercially available one: For filter diameter of approx. 90 mm {3.54 in.})

WARNING
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To minimize the risk of fire, wipe up any spilled fuel.**

CAUTION
- **The water level sensor 2 may be reused if it functions properly.**

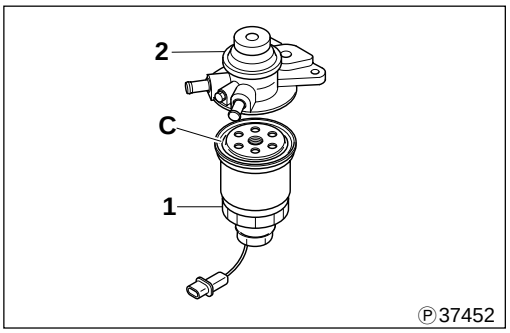
[Installation]

WARNING

Use of an unsuitable fuel filter cartridge 1 can lead to fuel leaks and fires. Be sure to use a genuine filter.

CAUTION

To prevent injection failures, keep dust and dirt out of the fuel filter cartridge 1 and the fuel pipe.



- To fit the fuel filter cartridge **1**, turn it until the gasket **C** touches seal surface of the fuel filter head **2**. Be sure to turn the filter by hand clockwise.
  Then, tighten the filter by 3/4 turn.
- After fitting the filter, start the engine and check that no fuel leakage occurs.
- Bleed all air out of the fuel system. P01-11

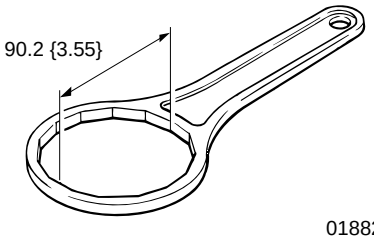
< 4D3 >

Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Gasket contact surfaces of fuel filter and fuel filter head	Engine oil	As required

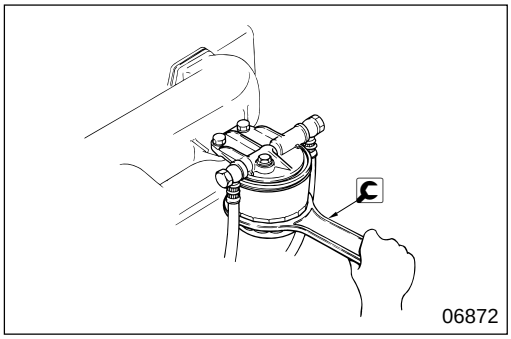
Special tools

Unit : mm {in.}

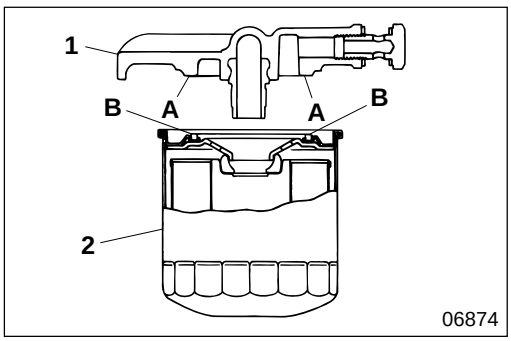
Location	Tool name and shape	Part No.	Application
2	Filter wrench  01882	MH061509 (Obtain Locally)	Removal of fuel filter

WARNING

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any diesel fuel that has been spilled because it can cause a fire.**
- **Do not use an unsuitable filter because it can cause a fire.**



[Removal]



[Installation]

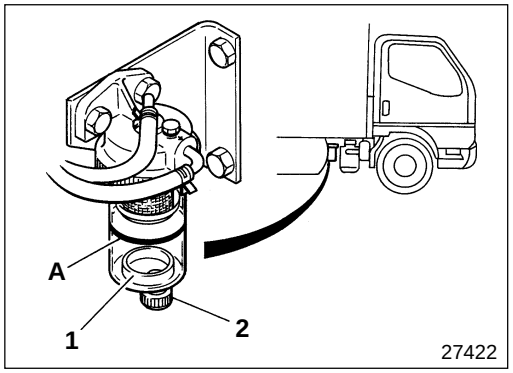
- Install by tightening three quarters to one full turn after contact surface **A** of fuel filter head **1** makes contact with gasket **B** of fuel filter **2**. Be sure to tighten by hand.
- After installation, bleed air from fuel system, run the engine and check for fuel leakage.

Draining of Water Separator Condensation

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Drain plug	3 to 4 {2.2 to 2.9, 0.3 to 0.4}	—



Visually inspect the water separator before driving.
When level ring **1** reaches red line **A**, drain the condensation as follows:

- Loosen drain plug **2** and drain out the condensation.
- When level ring **1** has dropped to the bottom, tighten drain plug **2**.
- Carefully wipe the water separator and the surrounding area.
- Check for fuel leakage.

Cleaning of Fuel Feed Pump Gauze Filter < 4D3 >

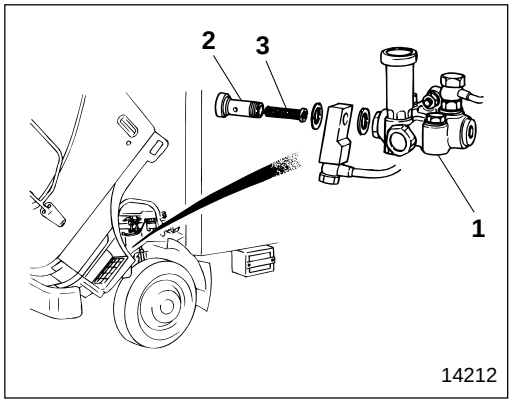
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Eye bolt	25 to 29 {18 to 22, 2.5 to 3}	—

WARNING⚠

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any diesel fuel that has been spilled because it can cause a fire.**



- Remove eye bolt **2** on the inlet side of fuel feed pump **1**.
- Remove gauze filter **3** from eye bolt **2**.
- Clean gauze filter **3** with diesel fuel.
- Follow the removal sequence in reverse and reinstall gauze filter **3**. Install eye bolt **2** in the fuel feed pump.
- Bleed the air from the fuel line.
- Start the engine and check for fuel leakage.

Bleeding of Air from Fuel Line

Tightening torque

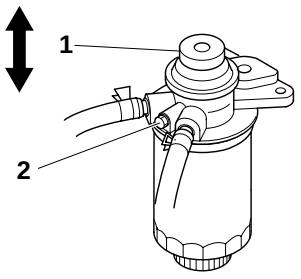
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
2	Air vent plug	4M5	6±1 {4.3±0.7, 0.6±0.1}	—
		4D3	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—

WARNING

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **Be sure to wipe up all spilled fuel as it could cause a fire.**

< 4M5 >



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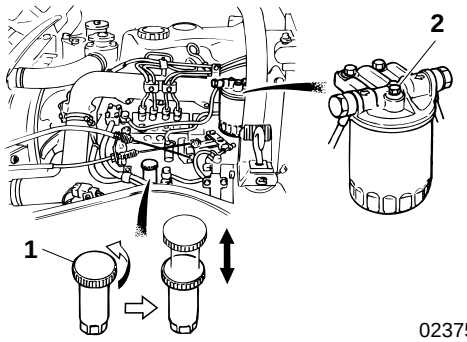
< 4D3 >



02375

- Loosen the fuel filter air vent plug **2**.
- Operate the priming pump **1** to pump up fuel.
- Continue to pump fuel until no air bubbles are found in the fuel flowing out from the air vent plug **2**.
- After ascertaining that air bubbles have completely disappeared, tighten the air vent plug **2** securely.
- Operate the priming pump **1** further until it feels heavy.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

Adjustment of V-Ribbed Belt or V-Belt Tension

Newly installed V-ribbed belt or V-belts can stretch during their initial running-in period. To prevent this from becoming a problem, run the engine for several minutes after installing the V-ribbed belt or V-belt, then readjust. Perform this cycle several times.

WARNING⚠

You must take special precautions to prevent the engine from rotating while a V-ribbed belt or V-belt is being inspected or adjusted.

CAUTION⚠

- **Make sure that you turn off the engine before attempting to inspect or adjust the V-ribbed belt or V-belts.**
- **Make sure that you fasten all bolts and nuts securely after adjusting the V-ribbed belt or V-belts. Remember that too much tension can damage the V-ribbed belt or V-belts and bearings.**
- **Make sure V-ribbed or V-belts remain clean and free of oil and grease or they may slip which will reduce service life.**

Service standards

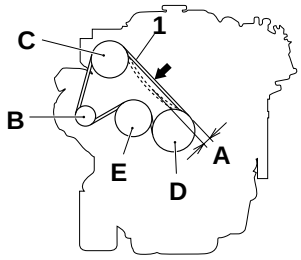
Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1	V-ribbed belt tension < 4M5 >	When belt is new	9 to 11 {0.35 to 0.43}	—	Adjust
		When belt in use is re-tensioned	11 to 13 {0.43 to 0.51}	—	
2	V-belt tension < 4M5 (With refrigerator) >		6 to 8 {0.24 to 0.31]	—	Adjust
3	V-belt tension < 4D3 (Air-conditioner) >		16 to 20 {0.63 to 0.79}	—	Adjust
4	V-belt tension < 4D3 (Fan) >		12 to 16 {0.47 to 0.63}	—	Adjust

Special tools

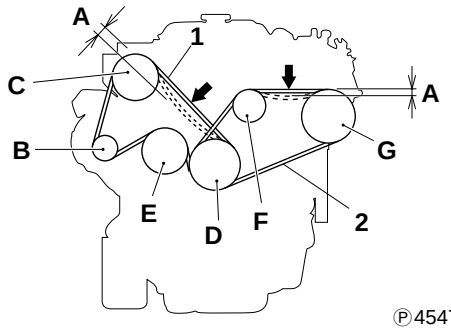
Location	Tool name and shape	Part No.	Application
1, 2, 3, 4	Belt tension gauge 03612	MH062345 (Obtain Locally)	Measurement of tension of V-ribbed belt or V-belt

< 4M5 (Without refrigeration compressor) >



Ⓟ29774

< 4M5 (With refrigeration compressor) >



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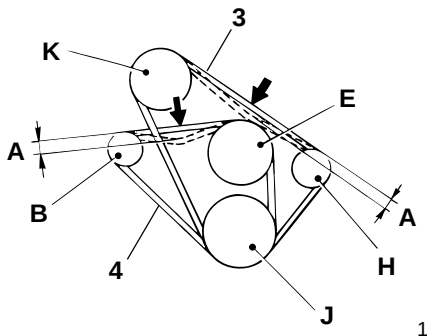
< 4D3 >



11518

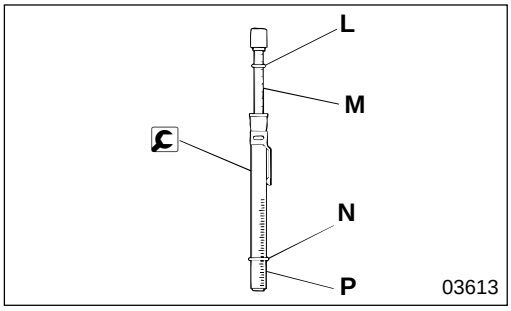
[Inspection]

NOTE

Before checking for tension, crank the engine one turn or more using normal engine rotation.

Apply force of approximately 98 N {22 lbf, 10 kgf} to the span center of the V-belt **2**, **3**, **4** or V-ribbed belt **1** and measure the extent of belt deflection **A**.

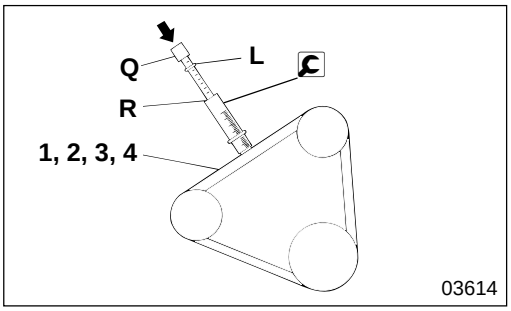
- **B** : Alternator pulley
- **C** : Air-conditioner compressor pulley or tension pulley
- **D** : Fan pulley
- **E** : Water pump pulley
- **F** : Tension pulley
- **G** : Compressor pulley - auxillary refrigeration compressor
- **H** : Tension pulley
- **J** : Crankshaft pulley
- **K** : AC compressor pulley



03613

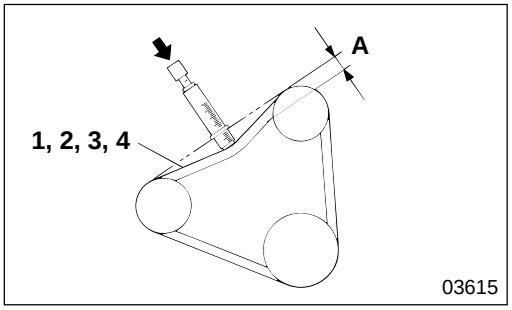
Use of belt tension gauge

- Set the upper O-ring **L** of the Belt Tension Gauge to a push load of 98 N {22 lbf, 10 kgt} on scale **M**.
- Set the lower O-ring **N** of the Belt Tension Gauge to the belt's specified maximum deflection value on scale **P**.
- Refer to Service Standards 🕮 P01-12



03614

- Apply the Belt Tension Gauge to the center of V-ribbed belt **1** or V-belt **2**, **3**, **4** and push **Q** until the upper O-ring **L** reaches the flange **R**.



- Measure the deflection **A** of the V-ribbed belt **1** or V-belt **2**, **3**, **4**. If the measurement does not comply with the standard value, adjust the tension in accordance with the following procedure.

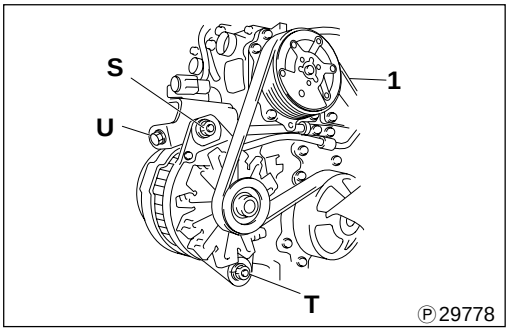
[Adjustment]

CAUTION ⚠

- **Excessive tension in the V-ribbed belt 1 or V-belt 2, 3, 4 may damage the belt and related bearings.**
- **Keep the V-ribbed belt 1 or V-belt 2, 3, 4 free of oil. If the belt becomes oily, it may slip, resulting in overheating of the engine and insufficient charging of the battery.**

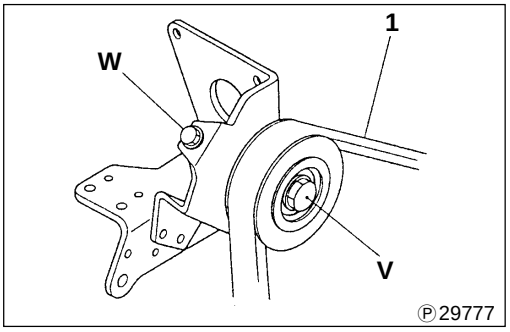
< 4M5 >

(1) V-ribbed belt



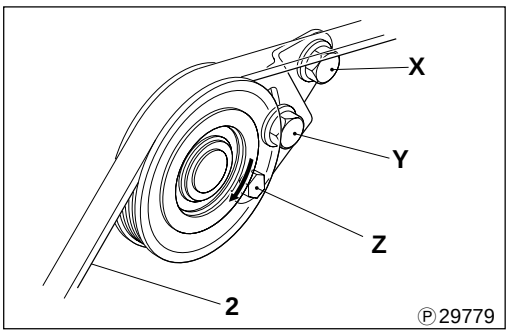
< With air-conditioner >

- Loosen the alternator mounting nuts **S** and **T**, then adjust the tension of the V-ribbed belt **1** using the adjustment bolt **U**.
- When the adjustment is completed, securely tighten the nuts **S** and **T**.



< Without air-conditioner >

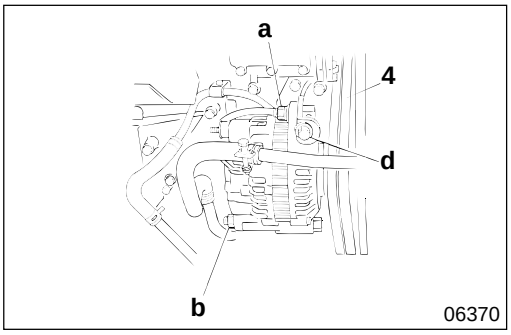
- Loosen the tension pully mounting sleeve **V** and adjust the tension of the V-ribbed belt **1** using the adjusting bolt **W**.
- After the adjustment, tighten the sleeve **V** securely.



(2) V-belt < With refrigerator >

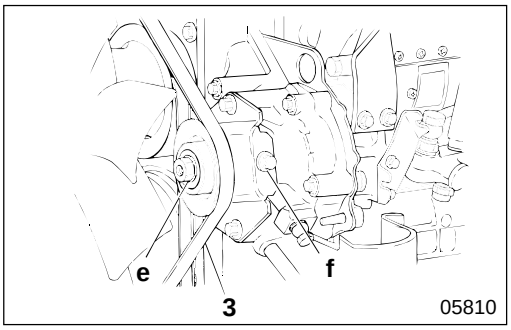
- Loosen bolt **X** first, then loosen bolt **Y**.
- Adjust the tension of V-belt **5** by turning bar **Z** with a closed-end wrench.
- After adjustment, tighten bolt **Y**, then tighten bolt **X** firmly.

< 4D3 >



(1) For fan

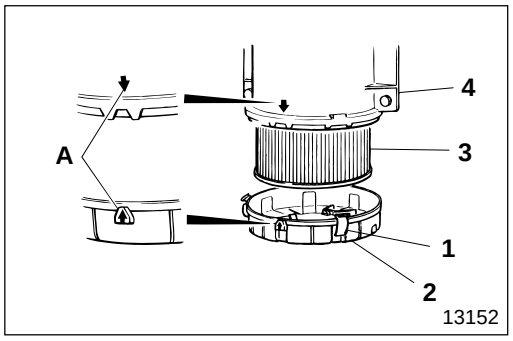
- Loosen the alternator mounting bolts **a** and **b**, then adjust the tension of the V-belt **4** using the adjustment bolt **d**.
- When the adjustment is completed, securely tighten the bolts **a** and **b**.



(2) For air-conditioner

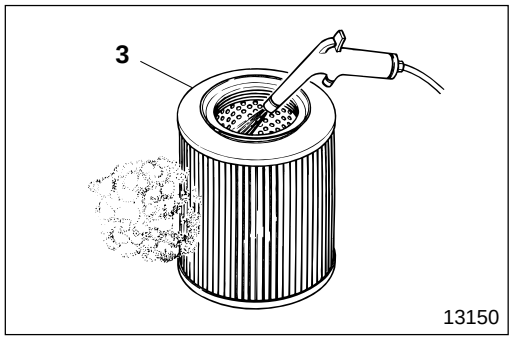
- Loosen the alternator mounting nut **e**, then adjust the tension of V-belt **3** using the adjustment bolt **f**.
- When the adjustment is completed, securely tighten the nut **e**.

Cleaning and Replacement of Air Cleaner Element



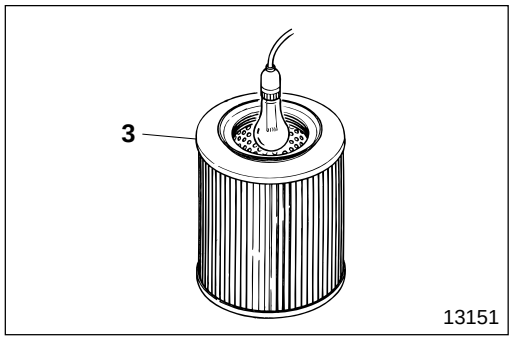
[Removal]
- Unfasten clamp **1** and remove air cleaner cap **2**.
- Remove air cleaner element **3**.

[Installation]
- Install by aligning alignment marks **A** of air cleaner cap case **4** and air cleaner cap **2**.



[Cleaning]
- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **3** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of air cleaner element **3** evenly.

CAUTION⚠
- **Do not tap or hit air cleaner element 3 to remove dust.**
- **Do not blow compressed air through air cleaner element 3 from the outside.**



[Inspection]
- Illuminate the inside of air cleaner element **3**.
- If parts of the filter paper are torn or thin, or if the sealing area of the upper surface of air cleaner element **3** is damaged, replace the air cleaner element.

NOTE

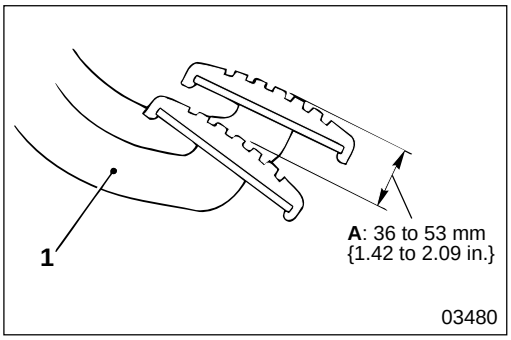
If the dust on air cleaner element 3 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.

Inspection of Clutch Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Clutch pedal free play	36 to 53 {1.42 to 2.09}	—	Adjust or replace



[Inspection]
Push clutch pedal **1** with your hand and measure the amount of movement **A** (free play) until you meet resistance. If the measured value does not conform to the standard value, adjust stroke of clutch power cylinder push rod or replace the clutch disc.

[Clutch operation]
- Check for unusual noises when clutch pedal **1** is pressed while the engine is idling, and also for abnormally hard/stiff clutch operation. Also check to be certain that it is not difficult to shift the vehicle into first and reverse gears.
- Gradually release clutch pedal **1** to set the vehicle in motion.
  Check to be sure there is no slippage, and that the clutch engages smoothly.

Tire

Service standards

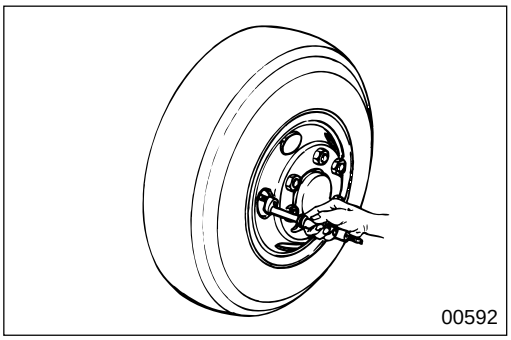
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Depth of tire tread grooves	—	1.6 {0.063}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Wheel nut	490±49 {360±36, 50±5}	—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Air pressure

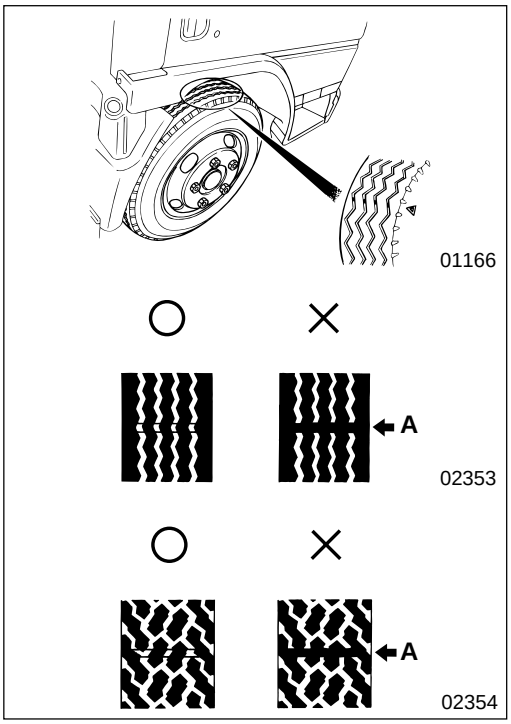
Tire air pressure should be checked before the vehicle is driven, while the tires are still cool.

Item / Vehicle model	Tire size	Air pressure kPa {psi, kgf/cm²}	
		Front	Rear
FE639 (GVWR : 11600 lb, 5260 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}
FE639 (GVWR : 13500 lb, 6120 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}
FE64□ (GVWR : 14500 lb, 6580 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}
FE649 (GVWR : 14050 lb, 6375 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}
FG639 (GVWR : 12000 lb, 5445 kg)	7.50R16(E)	550 {80, 5.50}	550 {80, 5.50}
FG649 (GVWR : 14050 lb, 6375 kg)	235/85R16(E)	550 {80, 5.50}	550 {80, 5.50}

GVWR : Gross vehicle weight rating

CAUTION

- **Make certain that there is no difference in the air pressure between the inner and outer rear tires.**
- **Make certain you use valve caps on the air valves.**
- **It is not necessary to increase the air pressure for high-speed driving.**



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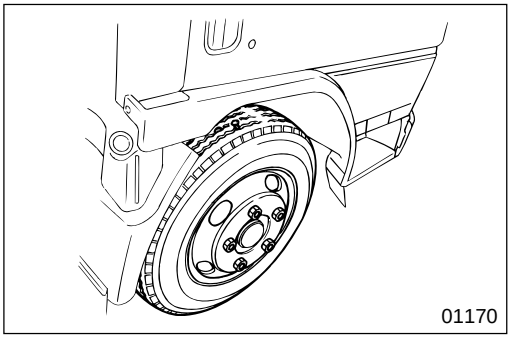
Checking tread depth

- Check all around the tire treads to make sure that the depth of the tread grooves is above the wear limit.
- If the tread grooves are not deep enough, slip sign **A** appears at the position of the ⚠ mark, where the tread groove has worn away.

WARNING

If the depth of the tread grooves is not adequate, the tires will slip on wet roads and present a hazard. Such tires are also extremely dangerous because they are more susceptible to hydroplaning when the vehicle is running at high speeds in the rain. Such tires must be replaced with new ones as soon as possible.


01170

Checking for cracks, damage, and objects embedded in the treads

- Check the tire treads and walls for cracks and damage.
- Check tire treads for uneven wear or other abnormal wear.
- Check if metal objects or nails have penetrated the tires.
- Check for stones embedded between double tires.

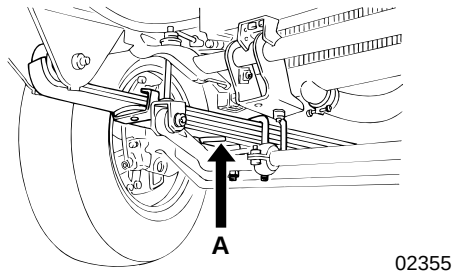
WARNING⚠

Badly damaged or worn tires are extremely dangerous, because they can be punctured more easily when the vehicle is running, they must be replaced with new ones as soon as possible.

Removing tires

- Jacking up point
  - For FE front wheels : Point **A** under the leaf spring in front of the front axle
  - For FG front wheels : Point **A** under the front axle housing
  - For rear wheels : Point **B** under the rear axle housing

< FE Front wheel >



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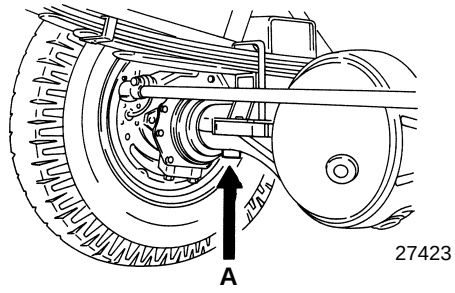
< FG Front wheel >



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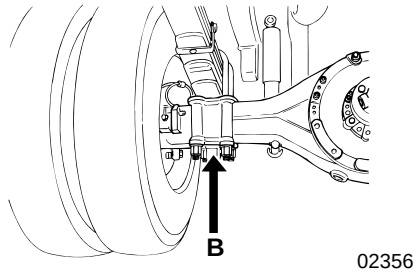
< Rear wheel >



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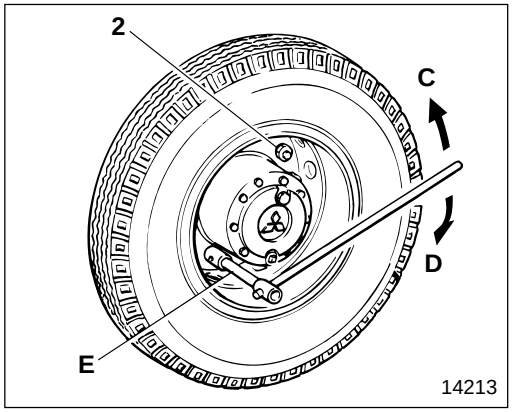
WARNING⚠

- **The jack should be placed on flat, solid ground, and should not be used to raise the vehicle higher than necessary.**
- **Do not use the jack at vehicle locations other than those illustrated.**
- **Keep in mind the danger of a slipping jack. Never crawl under the vehicle while the jack is in use or rock the vehicle. Also, do not start the engine while the vehicle is jacked up.**
- **To increase safety, use rigid racks for the vehicle when it is necessary to leave it jacked up for long periods.**
- **Chock both the tire to be removed and the tire diagonally opposite to it so that they will not rotate when you are removing the tire.**



- Loosen wheel nuts **2** slightly. The wheel nuts for right tires **C** have right-hand threads "**R**", and the wheel nuts for left tires **D** have left-hand threads "**L**".

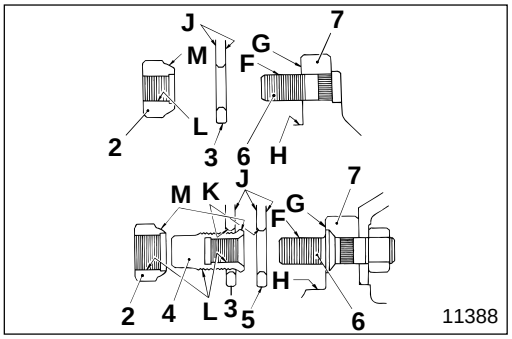
WARNING

Make certain that wheel nut wrench E is fully engaged, all the way to the back of nuts 2. If it is not, it could slip.

CAUTION

Only loosen wheel nuts 2 slightly. Do not remove them.

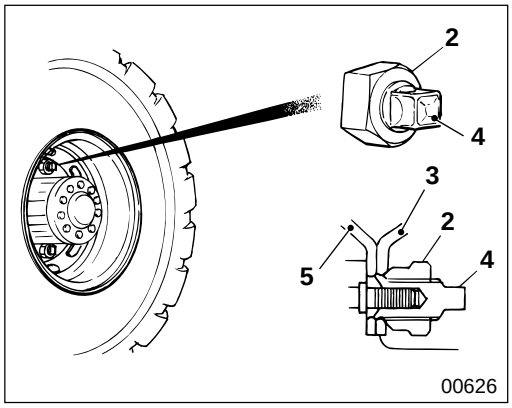
- Jack up the vehicle carefully, until the tire is slightly off the ground. Remove wheel nuts **2**, then remove the tire.
- When working on the double tires at the rear of the vehicle, first remove the outside tire, then lower the vehicle and loosen the nuts on the inside tire. After doing this, jack the vehicle back up and remove the tire.



Mounting tires

To prevent wheel nuts **2**, **4** and hub bolt **6** from becoming loose and to prevent mounted parts (tire assemblies **3**, **5** and hub **7**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:

F : Hub bolt thread area
G : Wheel mounting surface of hub
H : Wheel alignment area of hub
J : Disc wheel mating surface
K : Disc wheel nut mounting surface
L : Wheel nut thread area
M : Wheel nut spherical area



- Install the dual rear tires as follows:
  - After mounting inner tire **5** and fully tightening inner wheel nuts **4**, jack the vehicle up and mount on outer tire **3**, then tighten outer wheel nuts **2**.
  - Even if only outside tire **3** is to be changed, do not mount it until inner wheel nuts **4** have been fastened at the specified torque.
  - Slide the air valves on the inside and outside tires down when mounting the tires.

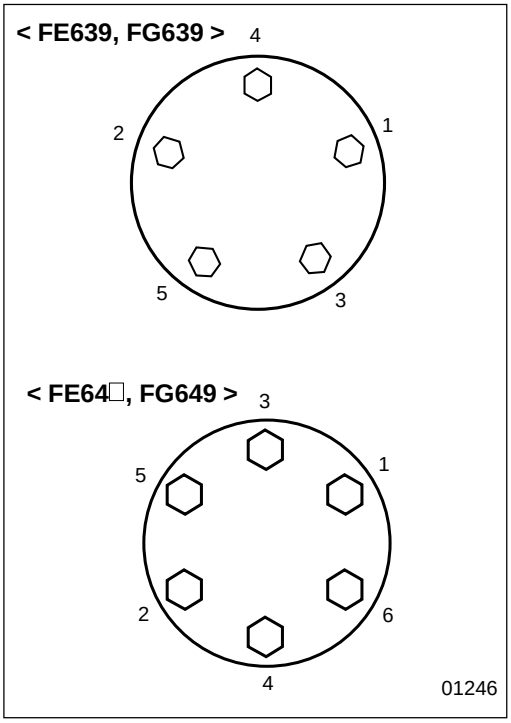
WARNING

If the threads are scored, or the disc wheel is deformed or cracked, change bolts 6, nuts 2, 4 and disc. Driving the truck before correcting such problems can cause the tire in question to come loose, which could be the source of major accidents.

CAUTION

Check hub bolt 6 threads carefully for damage before putting the tire on.

- Place the tapered end of wheel nuts **2**, **4** towards the disc wheel and fasten temporarily. Center so that there is no eccentricity between bolts **6** and the disc wheel bolt holes.
- Lower the vehicle.



- Tighten the nuts in the order as illustrated, tightening each nut two or three times. To finish, tighten each nut at the specified torque.

WARNING

- **Always use the specified torque when tightening the wheel nuts. If the wheel nuts are not tightened properly, the wheels could come loose while the vehicle is being driven, which could result in life threatening accidents or the truck being disabled.**
- **Do not coat the threads with grease when tightening the nuts. This could result in over-tightening force, which could be dangerous.**

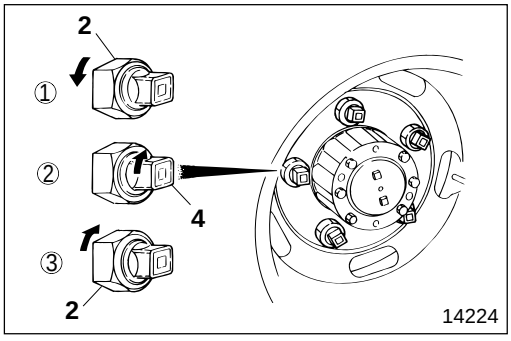
CAUTION

Over-tightening the wheel nuts can damage them.

Checking the wheel nuts for looseness

The wheel nuts should be checked for looseness every 10000 km (6000 miles). All nuts should be tightened at the specified torque.

- Check the double rear tires for looseness as follows:



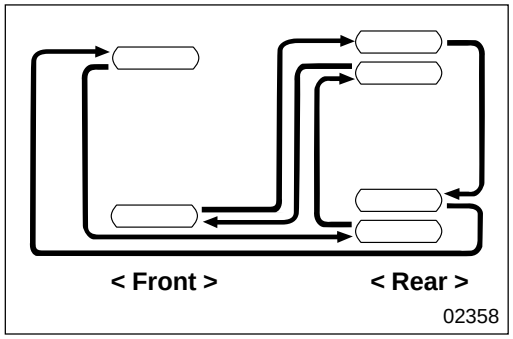
① Loosen outer wheel nuts **2**.
② Tighten inner wheel nuts **4** at specified torque.
③ Tighten outer wheel nuts **2** at specified torque.

CAUTION

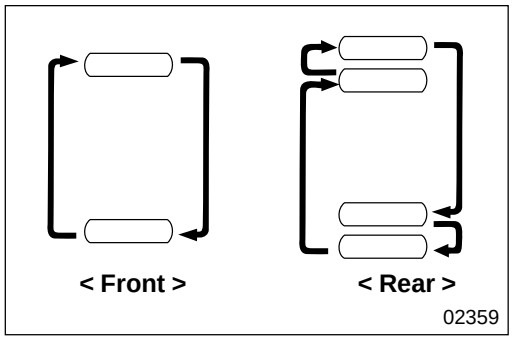
If outer wheel nuts 2 are tightened without first being loosened, it might not be possible to tighten them at the specified torque.

Tire rotation

Tires wear differently, according to the location where they are mounted. To make this wear uniform and prolong the life of your tires, they should be rotated every 10000 km (6000 miles) in the rotation order shown below:



- When the tread patterns for all tires are identical:



- When the tread patterns are different for the front and rear tires:

CAUTION⚠

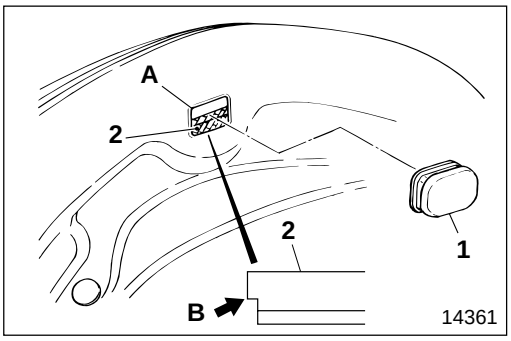
- **Always adjust air pressure after running-in new tires.**
- **When using tires of different tread patterns, use rib-type patterns for the front tires and traction type patterns for the rear tires.**
- **Avoid using both radial and biased tires on the same vehicle.**

Inspection of Brake Lining Thickness < Drum Brake Only >

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Thickness of brake lining	—	4 {0.16} (Side shoulder means wear limit)	Replace



NOTE

Be sure to inspect at two points for each wheel per side.

- Remove cover **1** from the packing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall cover **1**.

Battery

DANGER⚠

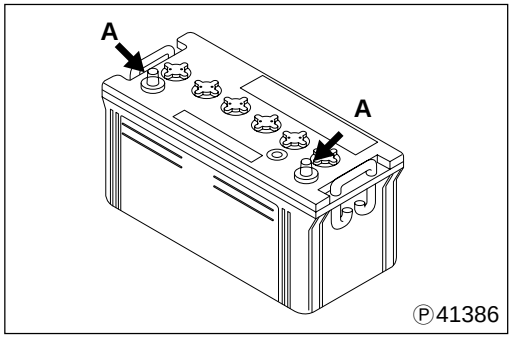
- **Since flammable hydrogen gas is generated by the battery, be sure to obey the following warnings :**
- **Do not short-circuit the ⊕ and ⊖ terminals on the battery.**
- **Keep sparks and lit cigarettes away from the battery.**
- **Do not wear metal objects on your arms and lean over the battery.**
- **Because the battery electrolyte is diluted sulfuric acid and is corrosive, when handling the battery wear safety glasses and rubber gloves to protect the eyes and hands.**
- **Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.**

WARNING⚠

To prevent a short-circuit be sure that the disconnected battery cables do not accidentally touch the battery terminals.

CAUTION⚠

- **Make sure that you disconnect the battery cable ⊖ first when you disconnect the battery cables.**
- **Make sure that all electrical switches of the vehicle are OFF before connecting the battery cables.**
- **Make sure that you connect the positive battery cables ⊕ before you connect the negative battery cable ⊖.**

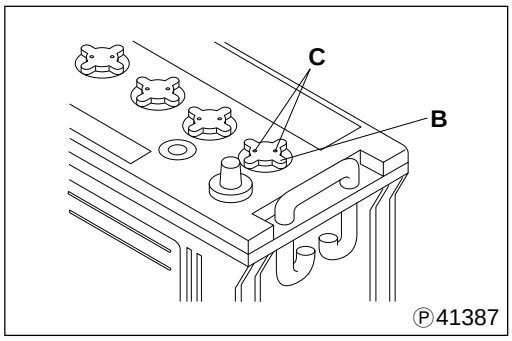


Visual inspection

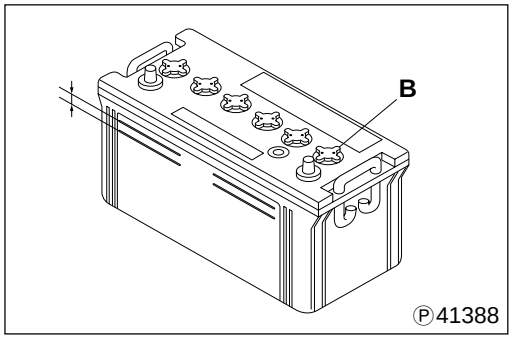
- If terminal **A** is corroded, scrub the corrosion off of it using a wire brush.
- If cracks or defects are found on battery **7**, replace it because the cracks or defects can cause liquid spills.

CAUTION⚠

Be sure to apply grease to the ⊕ side of terminal A because it is easily corroded.

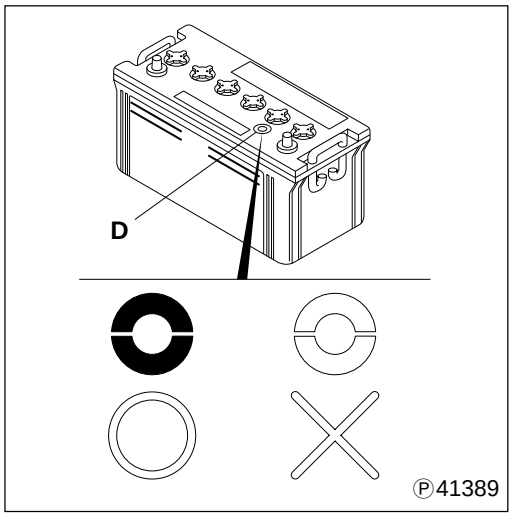


- If the air bleed hole **C** of vent plug **B** is clogged, clean the hole.



Inspection of fluid level

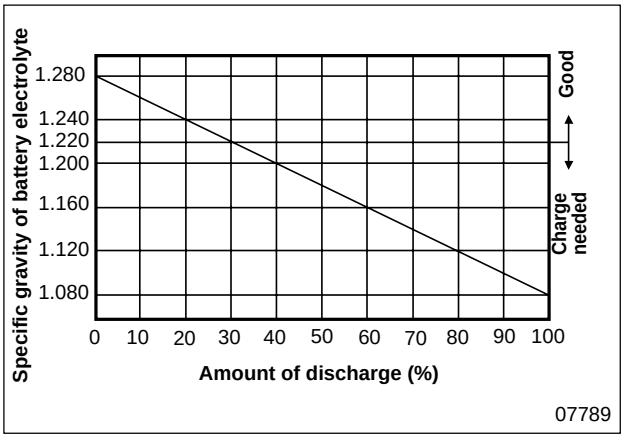
- Confirm that the level of battery electrolyte is between the UPPER and LOWER LEVEL lines.
- If the level is below the LOWER LEVEL line, remove the vent plug **B** and replenish with distilled water or battery fluid to the UPPER LEVEL.



Specific gravity measurement

You can tell the specific gravity of the battery electrolyte by the color shown in indicator **D**.

Blue : Good
White : Charge or replace



Charging

- Although, as a rule, charging of the battery should be done with the battery removed from the vehicle, if you have to charge the battery while it is in the vehicle, make sure that you stop the engine and disconnect the battery cable ⊖.
- Remove vent plug **B** before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	Value of 5-hour rating capacity / 10	*Amount of discharge (Ah) / Charge current (A) ×1.2(to 1.5)	45 {113}
Quick charge	Value of 5-hour rating capacity / 1.5	0.5	55 {131}

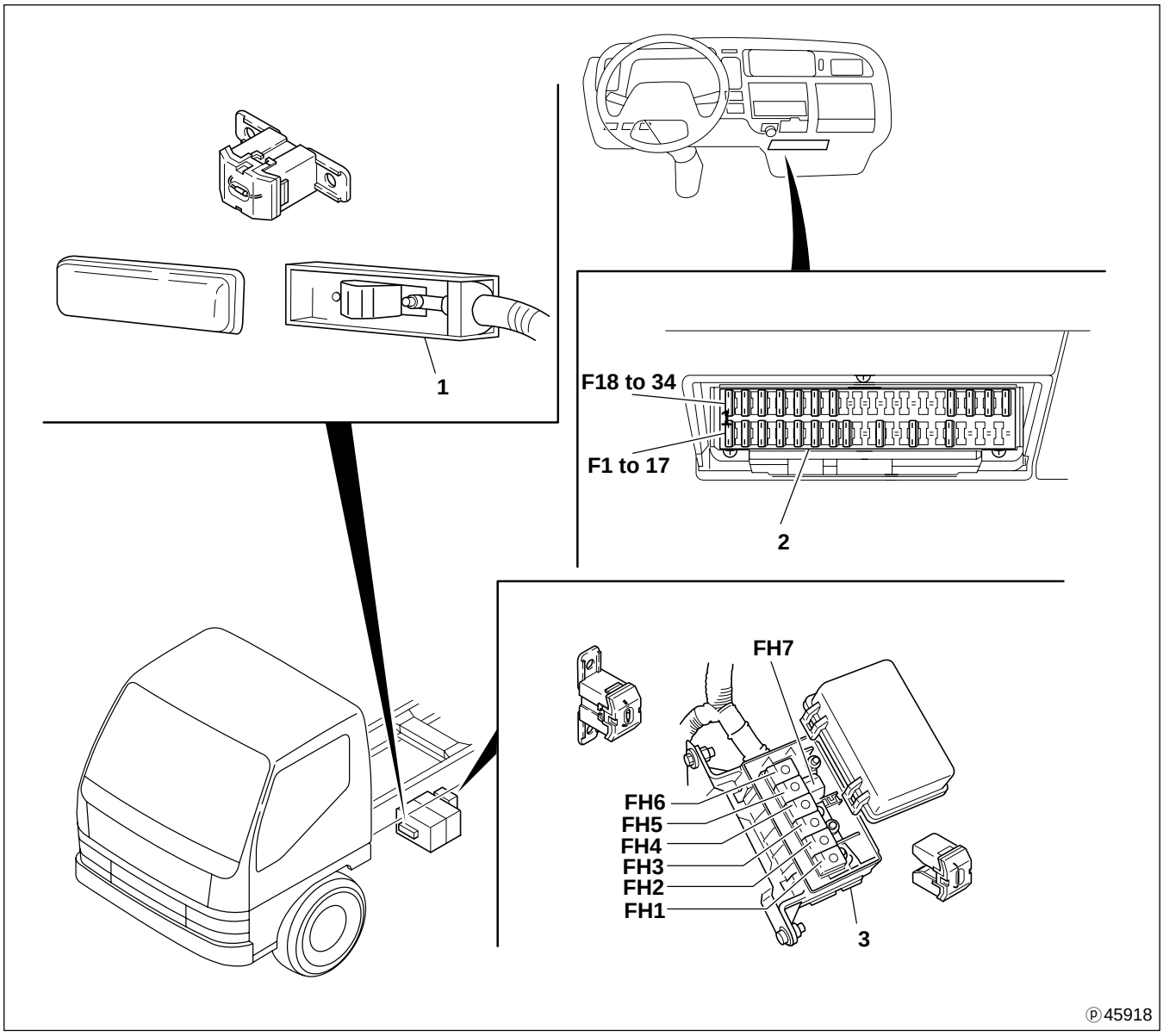
*Amount of discharge (Ah)=5-hour rating capacity (Ah)× Amount of discharge (%) / 100

- Use the graph shown on the left to calculate the amount of discharge (%).
- If electrolyte level is low add distilled water to raise level.
- The specific gravity of fully-charged battery electrolyte is 1.280 with the temperature at 20°C {68°F}.

DANGER⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **Keep unprotected lights away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it may explode.**
- **After charging the battery, tighten vent plug B, wash away sulfuric acid from the battery using water, and dry the surface.**
- **Be sure to check the electrolyte level before charging the battery. Charging with the electrolyte level below the lower limit (LOWER LEVEL) can cause premature deterioration, heat generation and explosion of the battery.**

Fuse



1 Main high-current fuse box
2 Fuse box
3 High-current fuse box

CAUTION

- **If a fuse blows, make sure you identify and remedy the cause, then replace the fuse.**
- **Make sure that you replace the fuse with one having the same rating.**
- **Make sure that you remove the ⊖ terminal of the battery cable before removing high-current fuses FH1 to 7.**

Main high-current fuse box

Fuse No.	Main load	Capacity
—	Alternator	100 A

High-current fuse box

Fuse No.	Main load	Capacity
FH1	Fuse box (F1 to F4)	50 A
FH2	Fuse box (F5 to F8, F10, F11)	50 A
FH3	ABS	40 A
FH4	ABS	30 A
FH5	Starter switch (Terminal B)	50 A
FH6	Fuse box (F31 to F34)	50 A
FH7	Alternator	100 A

Fuse box

Fuse No.	Main load	Capacity
F1	Headlamp, LH	15 A
F2	Headlamp, RH	15 A
F3	Stop lamp, horn	15 A
F4	Turn signal lamp	15 A
F5	Engine electronic control unit	20 A
F6	Cab lamp	10 A
F7	Reserve power (BATT)	10 A
F8	Power window	25 A
F9	—	—
F10	A/T	15 A
F11	A/T	20 A
F12	—	—
F13	* Cigarette lighter	15 A
F14	Radio	10 A
F15	Reserve power (ACC)	10 A
F16	—	—
F17	Mirror heater	10 A

Fuse No.	Main load		Capacity
F18	Starter		10 A
F19	Backup lamp		10 A
F20	Meter cluster, DRL		10 A
F21	Wiper		10 A
F22	Reserve power (MAIN)		10 A
F23	A/T	4D3	15 A
		4M5	10 A
F24	A/T (4D3)		10 A
F25	Engine Control (ACT)		10 A
F26	—		—
F27	Exhaust brake		10 A
F28	Engine electronic control unit		10 A
F29	ABS		10 A
F30	Mirror heater		10 A
F31	—		—
F32	Air conditioner		15 A
F33	Blower fan		25 A
F34	Tail lamp		20 A

ABS : Anti-lock brake system
A/T : Automatic transmission
DRL : Daytime running light

* : Fuses are provided for these pieces of equipment only where they are installed.

LUBRICATION TABLES

	Items	Time of inspection and maintenance						Lubricant specifications	Remarks
			Inspection interval						
		New vehicle at 4000 km/ 2500 miles	Every 10000 km/ 6000 miles	Every 20000 km/ 12000 miles	Every 30000 km/ 18000 miles	Every 40000 km/ 24000 miles	Every 50000 km/ 30000 miles		
1	Engine oil replacement	×	×					Engine oil API classification, CD, CD/SF, CE, CE/SF or CF-4 Over 30°C {86°F} SAE 40 40 to –5°C {104 to 23°F} SAE 30 15 to –15°C {59 to 5°F) SAE 20W-20 Over –15°C {5°F} SAE 15W-40 Below 0°C {32°F} SAE 10W-30	🕮 P01-30
2	Manual transmission oil level		×					Engine oil Long period of high-speed driving API classificationCC SAE 30 or SAE 40 Gear oil API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region)	🕮 P01-32
	Manual transmission oil replacement	×			×				
3	Automatic transmission fluid level		×					Automatic transmission fluid (DEXRON III type) Carry out the first inspection for new vehicles at 10000 km/6000 miles	🕮 P01-34
	Automatic transmission fluid replacement					×			
4	Transfer gear oil level < FG Model only >		×					Gear oil API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region) Engine oil Long period of high-speed driving API classification CC SAE 30 or SAE 40	🕮 P01-36
	Transfer gear oil replacement < FG Model only >	×			×				
5	Rear axle housing gear oil level		×					Gear oil API classification GL-5 Below 40°C {104°F} SAE 90 Over 40°C {104°F} SAE 140 Use SAE 140 when operating vehicle at high load, such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more < Limited slip differential only > Limited slip differential oil API classification GL-5 SAE 90	🕮 P01-37
	Rear axle housing gear oil replacement	×			×				
6	Front axle housing gear oil level < FG Model only >		×					Gear oil API classification GL-5 Below 40°C {104°F} SAE 90 Over 40°C {104°F} SAE 140 Use SAE 140 when operating vehicle at high load, such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more	🕮 P01-37
	Front axle housing gear oil replacement < FG Model only >	×			×				
7	Hub bearing grease and oil seal replacement				×			Wheel bearing grease [NLGI No.2 (Li soap)]	🗀 Gr 26A, 26B, 27
8	Front axle birfield joint grease replacement < FG Model only >				×			Wheel bearing grease [NLGI No.2 (Li soap)]	🕮 P01-46
9	Front axle kingpin bearing grease replacement < FG Model only >				×			Wheel bearing grease [NLGI No.2 (Li soap)]	🕮 P01-46

Ⓔ : Exhaust emission items

Items			Time of inspection and maintenance						Lubricant specifications	Remarks
			New vehicle at 4000 km/ 2500 miles	Inspection interval						
				Every 10000 km/ 6000 miles	Every 20000 km/ 12000 miles	Every 30000 km/ 18000 miles	Every 40000 km/ 24000 miles	Every 50000 km/ 30000 miles		
10	Front axle steering knuckle grease replacement < FG Model only >					×			Wheel bearing grease [NLGI No.2 (Li soap)]	🕮 P01-46
11	Brake fluid replacement							×	Brake fluid (SAE J1703f or FMVSS No. 116 DOT3)	🕮 P01-40
12	Power steering fluid level			×					Automatic transmission fluid (DEXRON, DEXRON II or DEXRON III type)	🕮 P01-38
	Power steering fluid replacement							×		
13	Lubrication of propeller shaft	Center bearing						×	Bearing grease [NLGI No.3 (Li soap)]	🕮 P01-46
		Universal joint, slip joint Double cardin joint < FG Model only >		×					Wheel bearing grease [NLGI No.2 (Li soap)]	🕮 P01-46
		Double cardan joint < FG (Manual Transmission) >		×						
14	Lubrication of rear suspension spring pin			×					Chassis grease [NLGI No.1 (Li soap)]	🕮 P01-46
15	Lubrication of kingpins			×					Chassis grease [NLGI No.1 (Li soap)]	🕮 P01-46
16	Lubrication of steering linkage ball joint			×					Chassis grease [NLGI No.1 (Li soap)]	🕮 P01-46
17	Lubrication of door hinge			×					Chassis grease [NLGI No.1 (Li soap)]	🕮 P01-46
18	Lubrication of anchor hook			×					Chassis grease [NLGI No.1 (Li soap)]	🕮 P01-46

LUBRICATION

Engine Oil

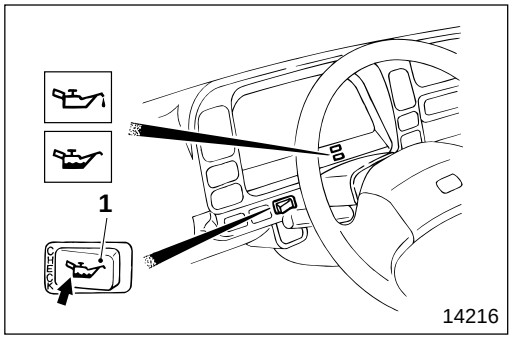
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Oil pan drain plug	34 to 39 {25 to 29, 3.5 to 4.0}	4D3
		34.3 to 43.1 {25 to 32, 3.5 to 4.4}	4M5
5	Oil filter drain plug	9.8±1.96 {7.2±1.4, 1.0±0.2}	4M5

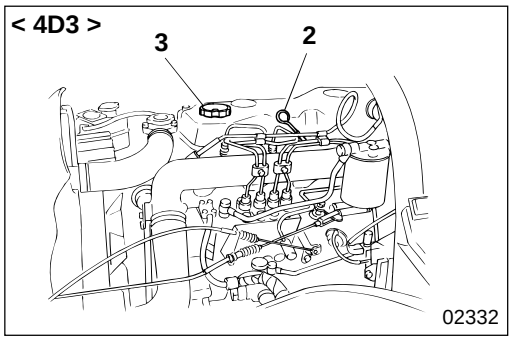
Lubricant

Point of application	Specified lubricant	Quantity	Remarks
Oil pan	Engine oil (API CD or higher)	Approximately 8 L {8.5 qts}	4D3
		Approximately 9 L {9.5 qts}	4M5
Oil filter		Approximately 1 L {1.1 qts}	4M5

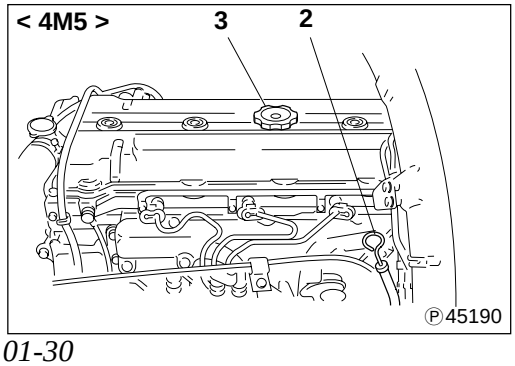


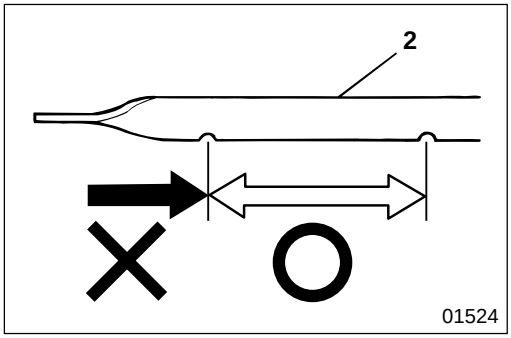
[Inspection]
There are two methods for inspecting the engine oil level; using oil level check switch **1**, and using dipstick **2**. Inspection using the oil level check switch is a simple inspection method. For a more accurate inspection use the dipstick.

- Inspection using oil level check switch **1** (simple inspection)
  - Press oil level check switch **1** before starting the engine. Check the oil level using the illuminated lamp.
    lamp (green) : Correct oil level
    lamp (red) : Low oil level
  - If the level is low, fill to correct level.

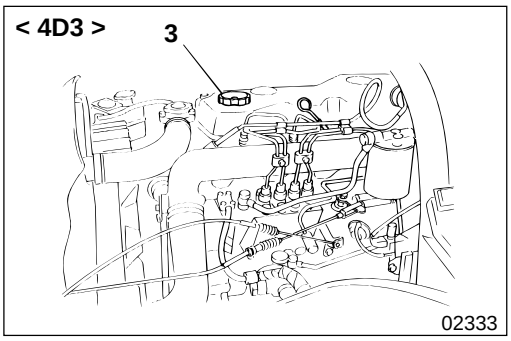


- Inspection using dipstick **2**
  - Tilt the cab.
  - Pull out dipstick **2**, wipe off the oil with a cloth.
  - Reinsert dipstick **2**, then pull it out carefully.
  - Oil level is correct if there is oil sticking to the dipstick between the two notches.
  - If the level is low, fill to correct level.





[Replenishment]
- Clean the area surrounding oil filler cap **3** and prevent dust from entering through the filler.
- Remove oil filler cap **3** and top up with engine oil.
- Wait five minutes before re-checking the oil level.
- Replace filler cap **3**.

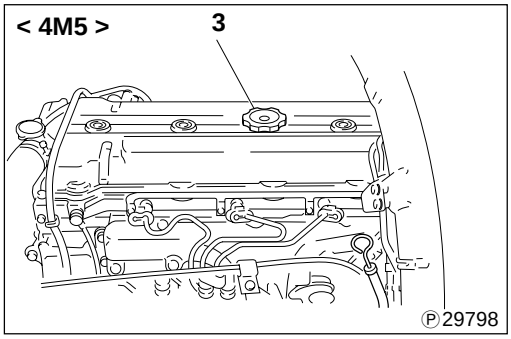


WARNING⚠

Wipe up any spilled engine oil since it can cause a fire.
Do not touch oil when the engine is hot since it can inflict severe burns.

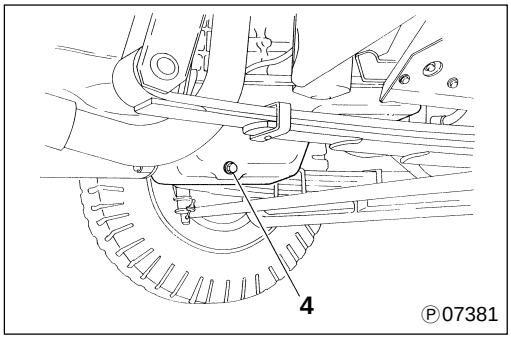
CAUTION⚠

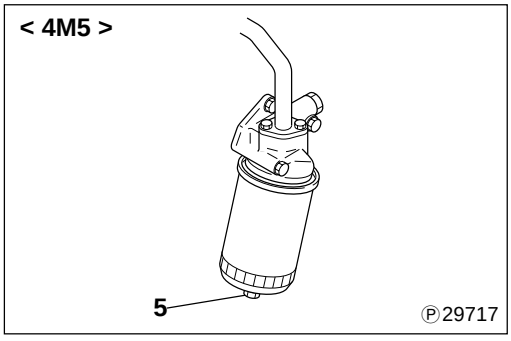
When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.



[Draining]
- Warm up the engine, then remove oil fill cap **3**.
- Remove oil pan drain plug **4** and oil filter drain plug **5**. Allow engine oil to drain.

[Filling]
Tighten oil pan drain plug **4** and oil filter drain plug **5** to their specified torques. Then, add new engine oil to the specified level.





Manual Transmission Gear Oil

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

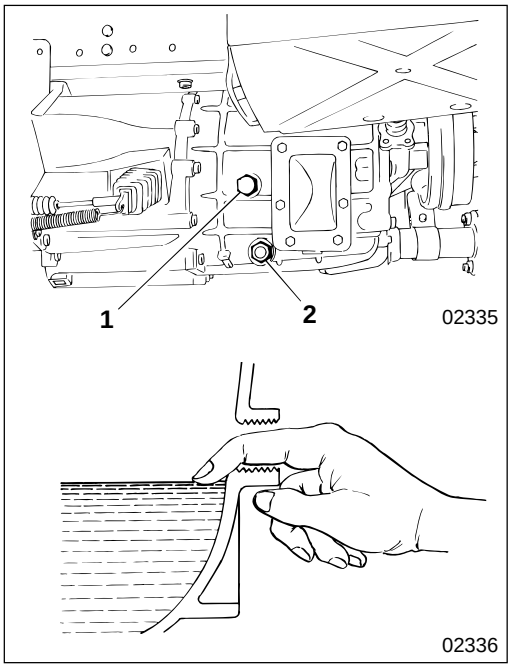
Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	69±15 {51±11, 7±1.5}	—
2	Drain plug	69±15 {51±11, 7±1.5}	—

Sealant

Location	Points of application	Specified sealant	Quantity
1	Thread area of inspection plug	THREEBOND 1105D	As required
2	Thread area of drain plug	THREEBOND 1105D	As required

WARNING

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.



[Inspection and replenishment]

- Remove inspection plug **1** and check whether the oil level is up to the edge of the entrance.
- If the level is low, add oil through the inspection plug hole until the level comes up to the edge of the entrance.

[Replacement]

- Drain the oil after removing inspection plug **1** and drain plug **2**.
- Remove any metal particles sticking to the magnetic part of drain plug **2** before reinstalling the plug.
- Add oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Reinstall inspection plug **1**.

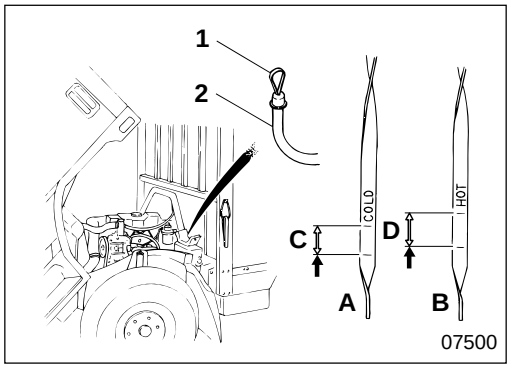
M E M O

Automatic Transmission Fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain plug	29 to 39 {22 to 29, 3 to 4}	—



[Inspection and replenishment]

- Park the vehicle on level ground, make sure that the parking brake is fully activated and chock the wheels to keep them from rolling.
- Start the engine and let it idle. To fill the hydraulic circuit with automatic transmission fluid, slowly shift the range selector lever once through the P to L ranges and finally shift into the N range.
- While the engine is still idling, pull out dipstick **1** and wipe off the fluid sticking to it. Reinsert the dipstick, then pull it out again and check the fluid level.
- If the fluid level is inspected right after the engine is started and the fluid temperature is still low (40±15°C {104±27°F}) the level should be within area **C** marked COLD on dipstick **1** as illustrated in **A**.
- If the fluid level is inspected after the vehicle has been driven and the fluid temperature is high (65±15°C {149±27°F}) the level should be within area **D** marked HOT on dipstick **1** as illustrated in **B**.

WARNING ⚠

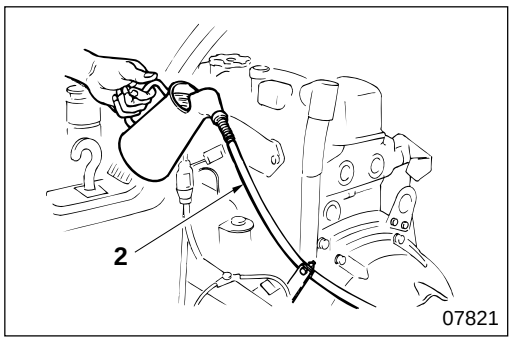
Take care during the inspection because the engine will be running. Take sufficient care to avoid burns or injuries resulting from contact with moving parts.

CAUTION ⚠

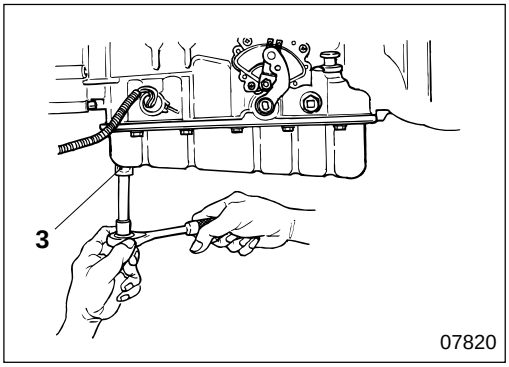
Be sure to wipe off the dust from the safety cap and the upper part of filler tube 2 before you pull out dipstick 1.

NOTE

- **Make sure the vehicle is parked on level ground when you are checking the fluid level.**
- **Make sure the range selector lever is in the N range and the engine is idling when you are checking the fluid level. When the engine is at standstill, the fluid level appears higher than it actually is.**
- **To ensure the fluid is correct, reinspect the fluid level after an actual drive.**



- If the fluid level is low, top it up to the specified level by supplying automatic transmission fluid (DEXRON III type) through filler tube **2**.



[Replacement]

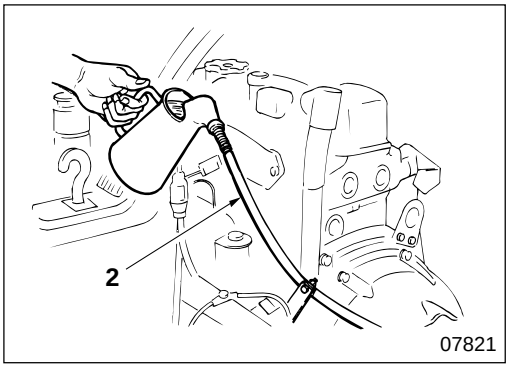
- Place a container under the oil pan, remove drain plug **3** in the front of the oil pan and drain the fluid.

WARNING

Take care because the automatic transmission fluid temperature immediately after the engine has stopped is very high. To avoid scalds, wait until a safe temperature has been reached before draining the fluid.

NOTE

- **The fluid will drain faster if the engine is first run to raise the fluid temperature.**
- **The fluid cannot be drained from the hydraulic circuit, the torque converter or the oil cooler.**



- Reinstall the gasket, and oil pan drain plug **3**.
- Add automatic transmission fluid (DEXRON III type) through filler tube **2**.

CAUTION

Make sure that dirt and foreign particles do not become mixed in with the fluid when it is added.

- Shift the range selector lever into the N range, start the engine and let it idle for at least two minutes.
- After shifting the lever through all ranges once, shift it back into N.

CAUTION

To prevent burning out the interior of the automatic transmission assembly, make sure that the engine is not allowed to race when you do the above.

- Add fluid until the fluid level is at the lower limit of the specified area on dipstick **1**. Next, check the fluid level to make sure it is within the specified limit when engine and transmission reach normal operating temperatures.

NOTE

- **Determining the fluid level immediately after supplying the fluid might be difficult due to the fluid stuck in the inside of the filler tube. Therefore, check the fluid level a few times between intervals.**
- **If the fluid is overfilled, it will overflow and can be mistaken for leakage.**
- **Let the engine idle and, while paying attention to the fluid level, pour in the fluid slowly.**

Transfer Gear Oil < FG Model only >

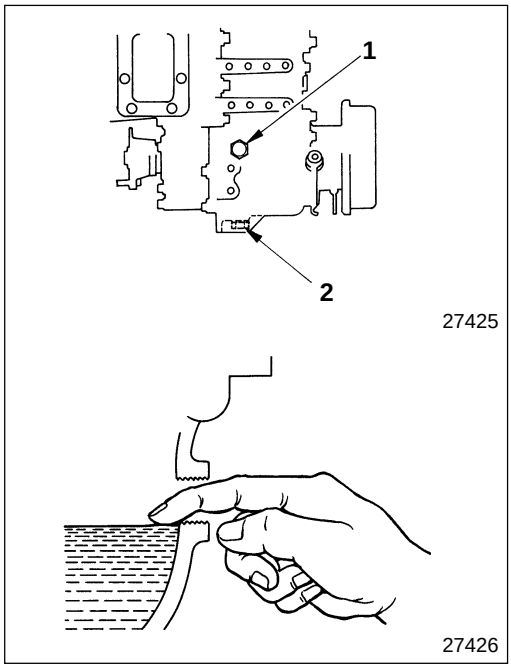
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	69±15 {51±11, 7±1.5}	—
2	Drain plug	69±15 {51±11, 7±1.5}	—

Sealant

Location	Points of application	Specified sealant	Quantity
1	Thread area of inspection plug	THREEBOND 1105D	As required
2	Thread area of drain plug	THREEBOND 1105D	As required



[Inspection and replenishment]

WARNING

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

- Remove inspection plug **1**, check the oil level and make sure it is up to the edge of the entrance.
- If the oil level is low, add oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Insert inspection plug **1**.

[Replacement]

- Drain the oil after removing inspection plug **1** and drain plug **2**.
- Remove any metal particles sticking to the magnetic part of drain plug **2** before reinstalling the plug.
- Supply oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Reinstall inspection plug **1**.

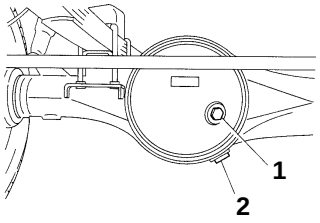
Front Axle Gear Oil < FG Model only > and Rear Axle Gear Oil

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

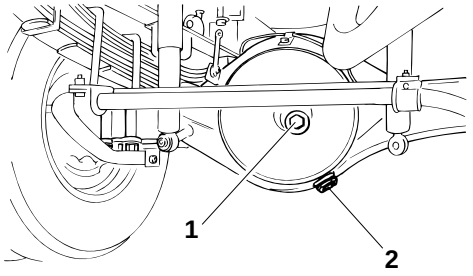
Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	98 to 115 {72 to 87, 10 to 12}	—
2	Drain plug	98 to 115 {72 to 87, 10 to 12}	—

< FG (Front axle) >



< Rear axle >

27424



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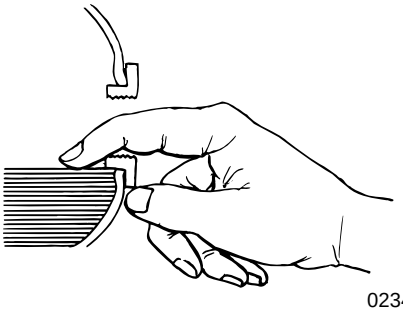


02340

[Inspection and replenishment]

WARNING

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

- Remove inspection plug **1**, check the oil level and make sure it is up to the edge of the entrance.
- If the oil level is low, add oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Insert inspection plug **1**.

[Replacement]

- Drain the oil after removing inspection plug **1** and drain plug **2**.
- Remove any metal particles sticking to the magnetic part of drain plug **2** before reinstalling the plug.
- Supply oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Reinstall inspection plug **1**.

NOTE

- **Some FG models may be equipped with an optional limited slip differential which requires special purpose gear oil.**

Power Steering Fluid

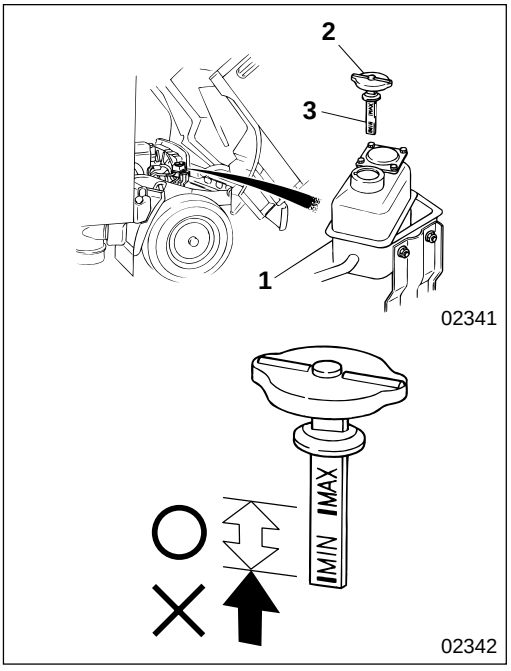
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Pressure tube	29 to 39 {22 to 29, 3 to 4}	—
5	Return tube	39 to 49 {29 to 36, 4 to 5}	—

Fluid

Location	Points of application	Specified fluid	Quantity
1	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Between MIN and MAX on filler cap dipstick



[Inspection and replenishment]

- Straighten the front wheels and stop the engine.
- Tilt the cab.
- Remove filler cap **2** of power steering oil tank **1** by turning the filler cap counterclockwise.
- Wipe off the fluid sticking to dipstick **3** on filler cap **2**. Replace the filler cap.

NOTE

Check the fluid level without screwing on filler cap 2.

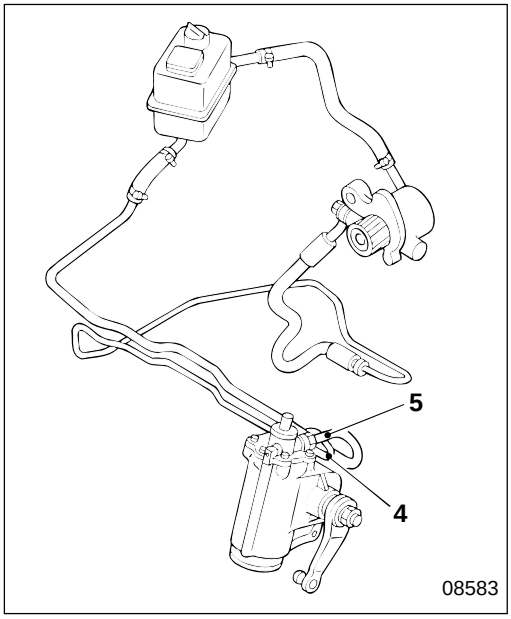
- Carefully lift up filler cap **2** and check the fluid sticking to dipstick **3** to make sure that the fluid is at a point between the “MAX” and “MIN” levels. If the fluid position does not reach the “MIN” level, add fluid.
- After inspection install filler cap **2** by turning it clockwise.

WARNING⚠

Close filler cap 2 firmly; otherwise the fluid may leak and could catch fire. Also wipe up spilled fluid.

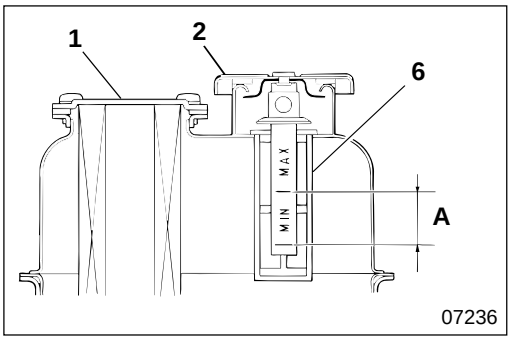
CAUTION⚠

If the fluid level is far below the recommended range, the fluid may be leaking.



[Replacement]

- Drainage
  - Jack up the front wheels.
  - Release pressure tube **4** and return tube **5** connected to the power steering gear box.
  - Turn the steering wheel fully left and right repeatedly, and drain the fluid from the power steering gear box.
  - After draining the fluid, tighten pressure tube **4** and return tube **5** at specified torque.



[Fluid supply]

- Pour fluid into power steering oil tank **1** up to the inner port of strainer **6**.
- With the engine stopped, jack up the front wheels and turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.

NOTE

Check the fluid level without screwing on filler cap 2.

- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times to raise the fluid temperature to approximately 60 to 80°C {140 to 176°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise, bleeding is completed.
- When bleeding is finished, check fluid level of power steering oil tank **1**, and pipe and hose connections for fluid leakage.

LUBRICATION

Brake Fluid

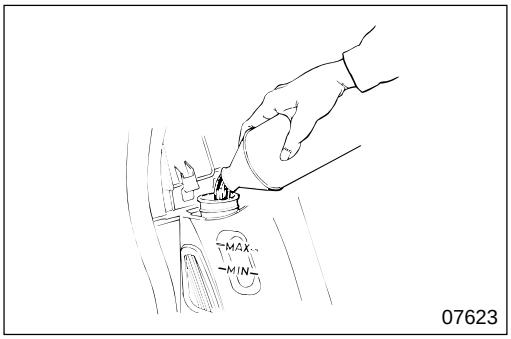
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Air bleeder	Front disc brake < FE >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Front wheel cylinder < FG >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Rear wheel cylinder < FE639, FG639 >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Rear disc brake < FE640, FE649, FG649 >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—

Fluid

Location	Points of application	Specified fluid	Quantity
—	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required



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WARNING

- **The clutch fluid system and the brake fluid system use the fluid tank in common. Therefore, replacement and air bleeding of the clutch fluid must be carried out simultaneously with that of the brake fluid. Gr 21**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in ineffective clutch and brake operations.**
- **If you use a container for adding brake fluid, keep it solely for that purpose.**

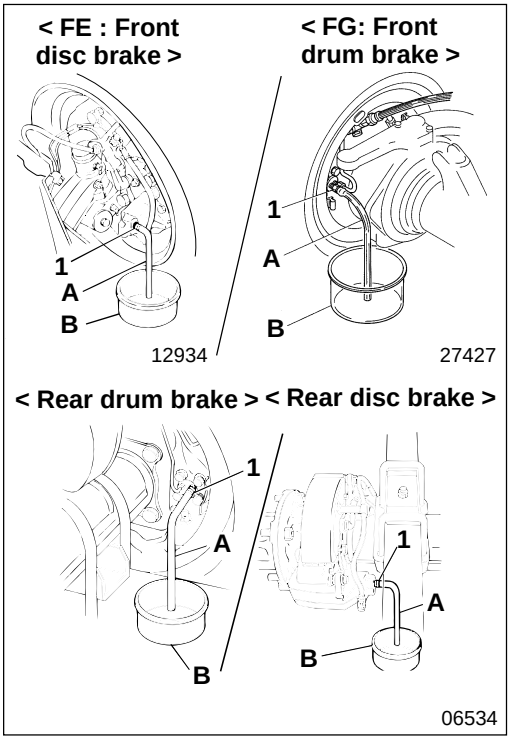
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately, and wash area, if you splash it on the paintwork.**

NOTE

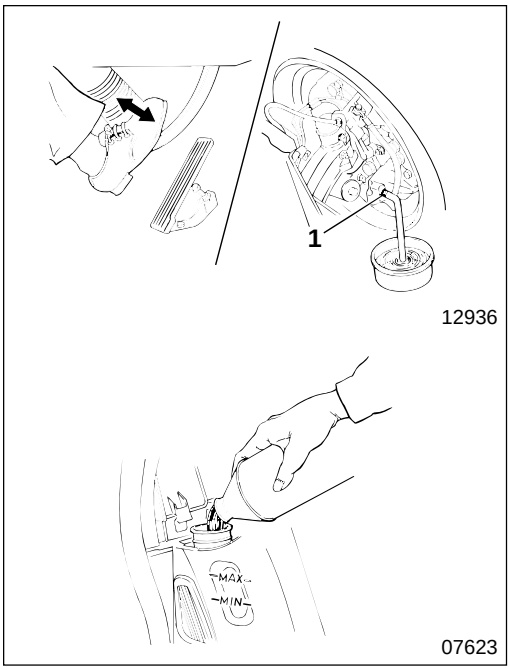
Supply brake fluid to maintain the “MAX” level of the fluid tank always.

[Inspection and replenishment]
Inspect the level of the brake fluid in the fluid tank. It should be between the “MAX” and “MIN” levels. If it is below the “MIN” level, lift up the lid and remove the cap from the fluid tank, then add specified brake fluid until the level reaches the “MAX” level. Do not fill above the “MAX” level.



[Replacement]

- Start the engine and let it idle until you complete brake fluid replacement.
- Attach vinyl pipe **A** to the front disc brake < FE >, the front drum brake < FG >, the rear drum brake < FE639, FG639 >, the rear disc brake < FE64□ >
- Place the free end of vinyl pipe **A** into container **B**.

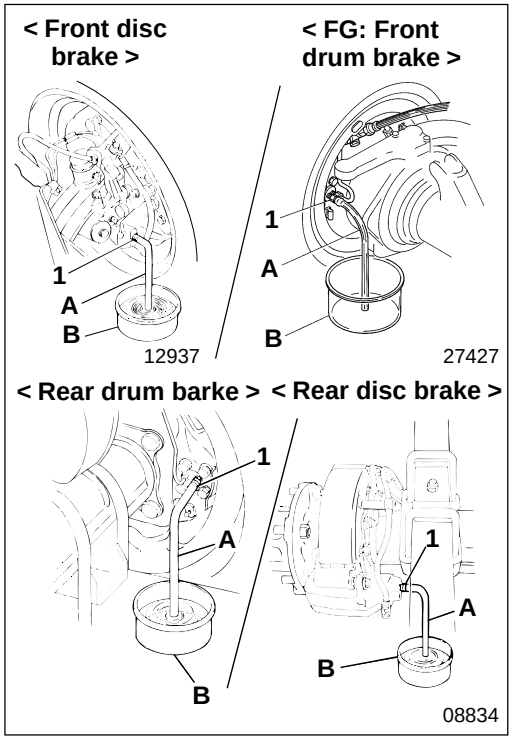


- Loosen air bleeders **1** and depress the brake pedal several times to drain brake fluid completely.
- Maintaining a supply of new brake fluid up to the “MAX” level of the fluid tank, depress the brake pedal repeatedly until the old brake fluid of the brake system is replaced with new fluid. After you complete the work, tighten each air bleeder **1** at specified torque.

NOTE

You can tell when the brake fluid has been completely replaced because the fluid coming out will be a different color.

- Carry out air bleeding of the brake system.



[Air bleeding]

- Start the engine and let it idle until you complete air bleeding of the brake system.
- Attach vinyl pipe **A** to the front disc brake < FE >, the front drum brake < FG >, the rear drum brake < FE639, FG639 >, the rear disc brake < FE64□ >.
- Place the free end of vinyl pipe **A** into container **B**, then bleed air from the brake system as follows:

< Front brake system >

FG639

Drum brake, RH
↓
Drum brake, LH

FE639, FE64□

Disc brake, RH
↓
Disc brake, LH

< Rear brake system >

FE639, FG639

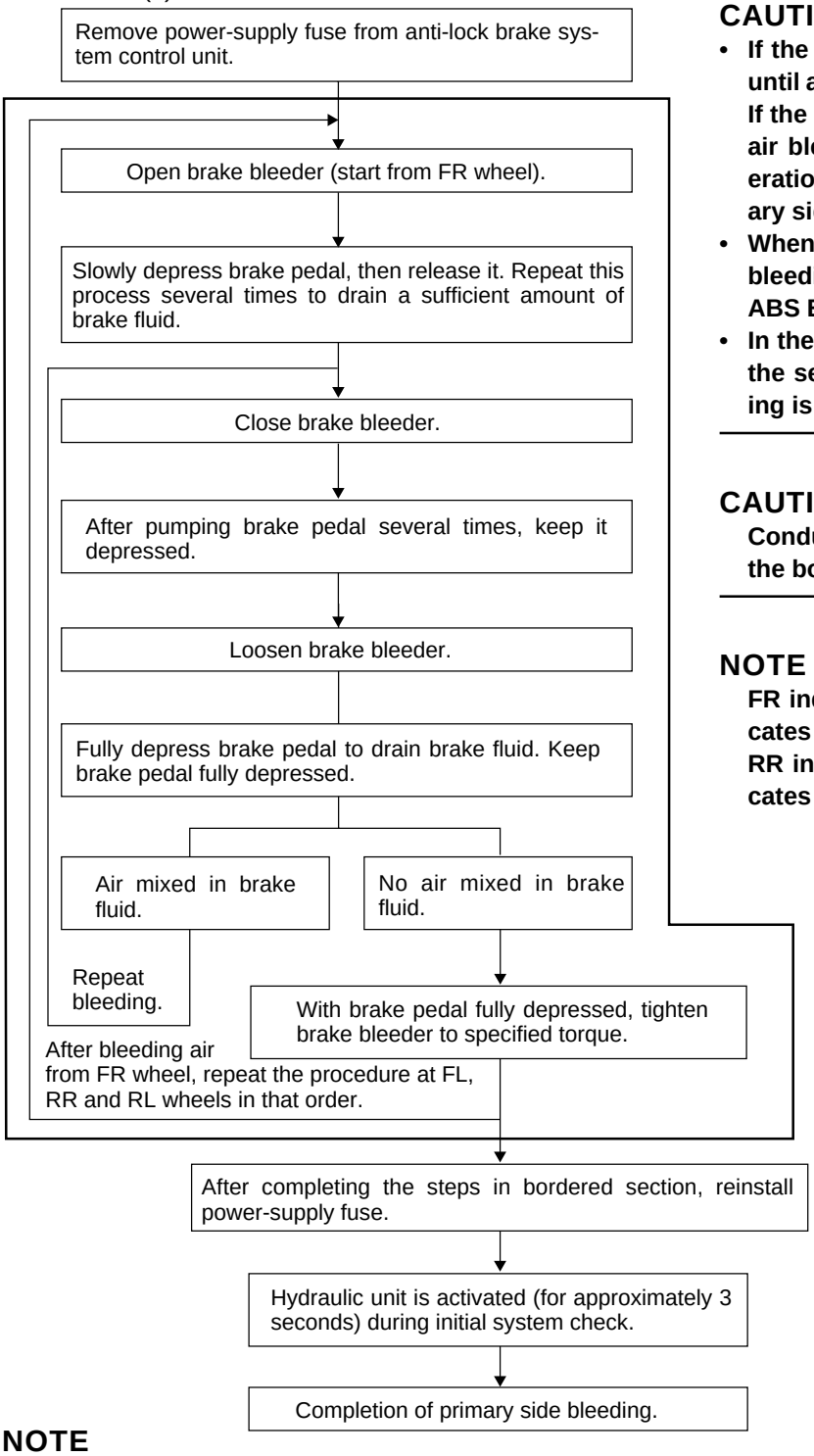
Drum brake, RH
↓
Drum brake, LH

FE64□

Disc brake, RH
↓
Disc brake, LH

(1) Air bleeding during regular maintenance, and hydraulic unit replacement

When air bleeding is conducted during regular maintenance or when the ABS hydraulic unit is replaced, brake fluid flows into the secondary side (operating circuit) of the ABS hydraulic unit. Therefore, bleed the primary side (normal circuit) by following the procedures below. In the event air enters the secondary side, bleed air by following the procedures described in (2).



CAUTION⚠

- **If the battery is disconnected, do not reconnect until air bleeding of the primary side is complete. If the battery is reconnected before primary side air bleeding is complete, the system check operation is activated and air can enter the secondary side.**
- **When the battery must be connected prior to air bleeding, remove the power-supply fuse for the ABS ECU.**
- **In the event air enters the secondary side, bleed the secondary side after primary side air bleeding is complete.**

CAUTION⚠

Conduct the air bleeding operation described in the bordered section at every wheel.

NOTE

FR indicates front-axle right wheel, and FL indicates front-axle left wheel.
RR indicates rear-axle right wheel, and RL indicates rear-axle left wheel.

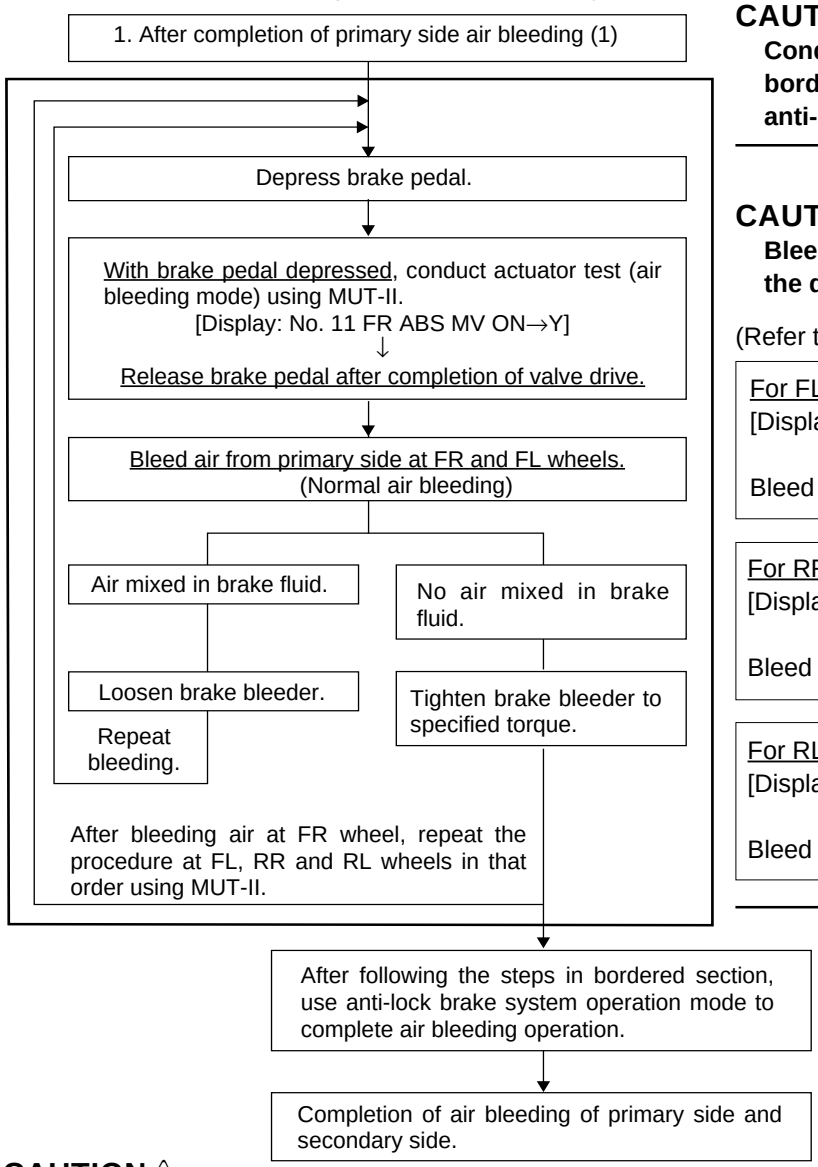
NOTE

- **The primary side (normal circuit) is a hydraulic circuit formed when the system is in non-operation.**
- **The secondary side (operating circuit) is a hydraulic circuit which connects with the primary side only when the system is in operation (when the system is in non-operation, the secondary side is disconnected from the primary side).**

(2) Air bleeding of secondary side

If the system starts operating before air bleeding of the primary side is complete, air can enter the secondary side. In the event the system accidentally starts before the completion of primary side air bleeding, follow the procedures below to bleed air. If air enters the secondary side, air flows into the primary side when the system starts, and this can extend the brake pedal stroke.
During air bleeding, use the MUT-II to conduct an actuator test (anti-lock brake system operation mode) at all wheels.

Use the MUT-II when bleeding air from the secondary side.



CAUTION⚠

Conduct air bleeding operation described in the bordered section at every wheel by using the anti-lock brake system operation mode.

CAUTION⚠

Bleed air from wheels other than FR according to the directions below.

(Refer to NOTE below)

For FL wheel
[Display: No. 12 FL ABS MV ON→Y]
↓
Bleed air from primary side at FR and FL wheels.

For RR wheel
[Display: No. 13 RR ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

For RL wheel
[Display: No. 14 RL ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

CAUTION⚠

- **Avoid continuous execution of the actuator test (anti-lock brake system drive) using the MUT-II; otherwise, excessive heating of the anti-lock brake system motor, valve and other parts can cause hydraulic unit damage.**
- **Do not conduct the actuator test with the MUT-II while bleeding air from the primary side; otherwise, air can enter the secondary side from the primary side.**
- **When mixing of air was found after air bleeding is conducted to correct an excessive brake pedal stroke, bleed air from the secondary side, too.**

NOTE

- **For the MUT-II operation for the actuator test during air bleeding, refer to section 4.**
- **If a drive operation is conducted for the FR and RL wheels at one time using the MUT-II, subsequent air bleeding of the primary side conducted at each wheel will not remove air from the secondary side.**

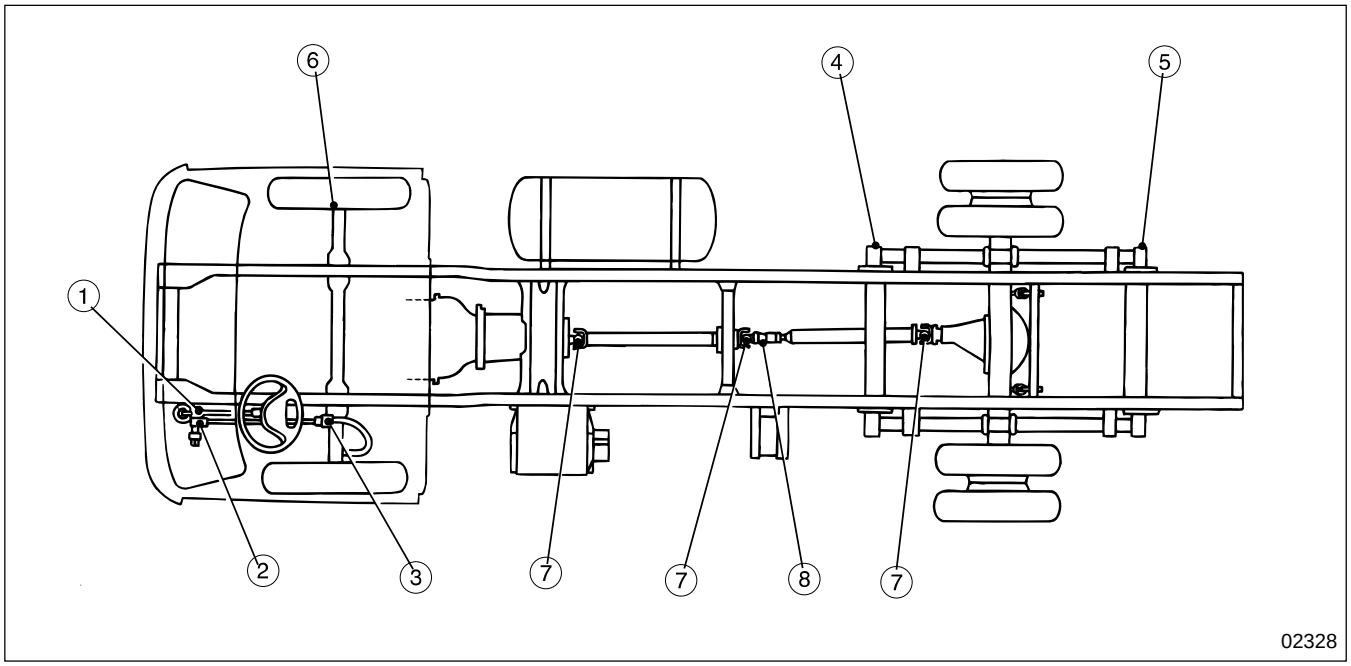
M E M O

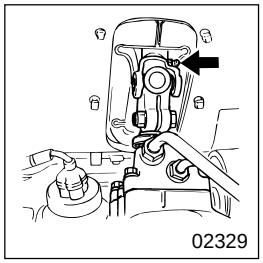
LUBRICATION

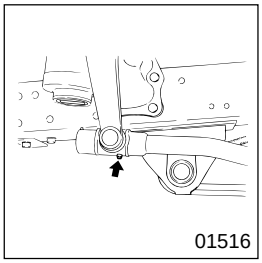
Greasing Various Areas of Chassis

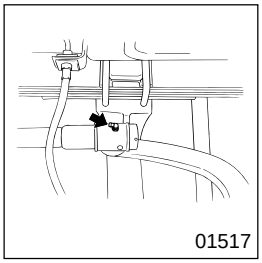
Carefully clean away all dust and dirt from the grease nipples, and use the specified type of grease. The areas to be greased are shown in the following illustration.

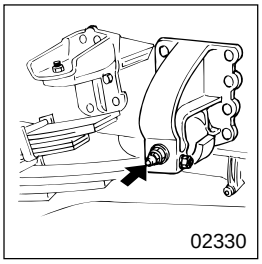
< FE >

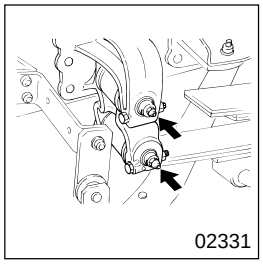


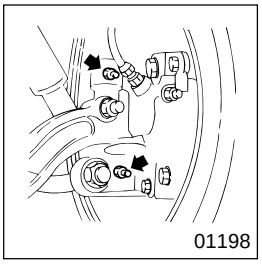
① 

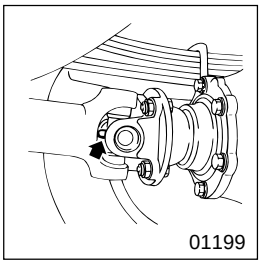
② 

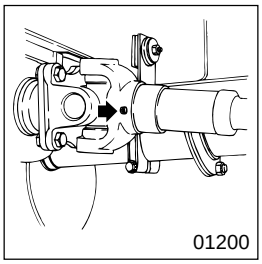
③ 

④ 

⑤ 

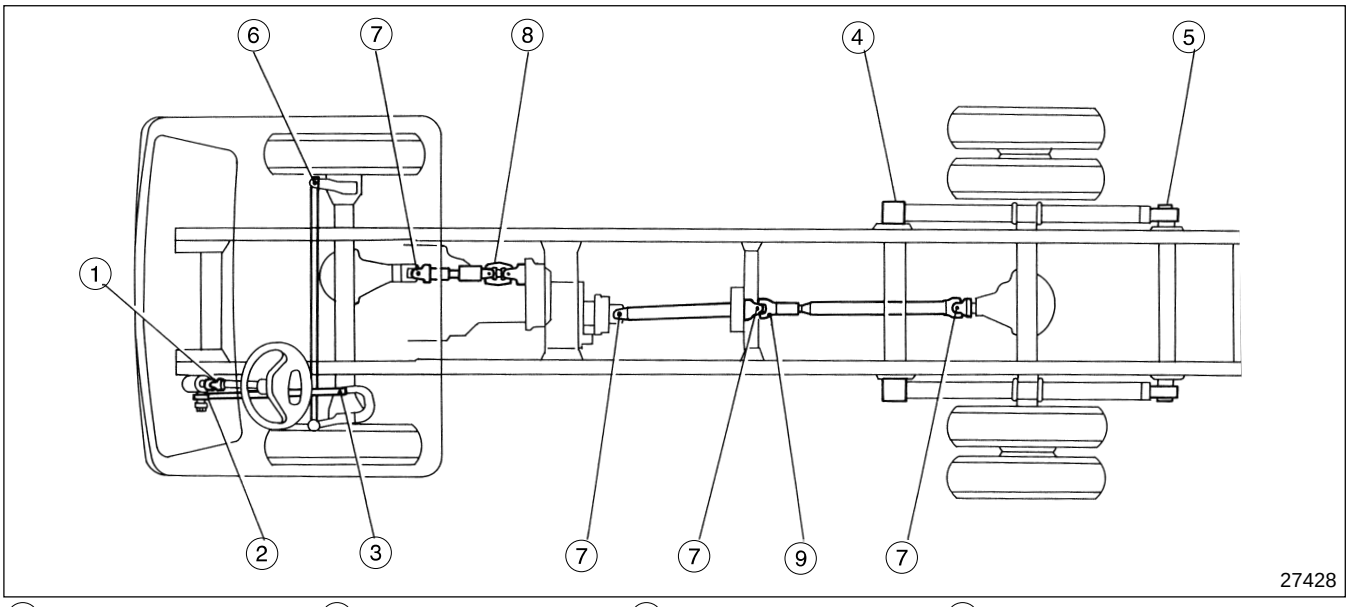
⑥ 

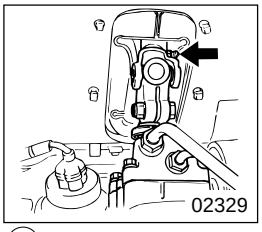
⑦ 

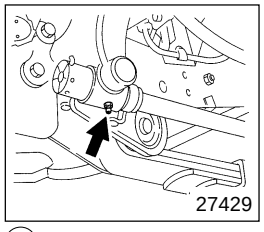
⑧ 

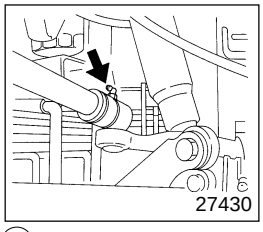
① Steering shaft
② Drag link front
③ Drag link rear
④ Rear spring pin front (left and right, 2 points)
⑤ Rear spring pin rear (left and right, 4 points)
⑥ Kingpin bearing (left and right, 4 points)
⑦ Propeller shaft universal joint's-all
⑧ Propeller shaft slip joint

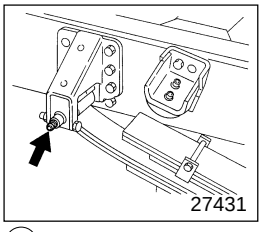
< FG >

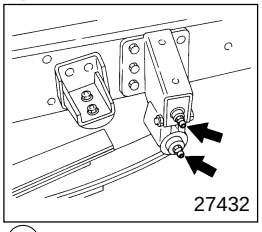


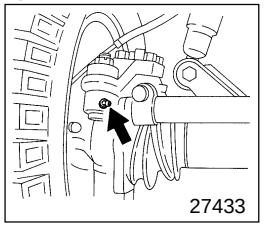
① 

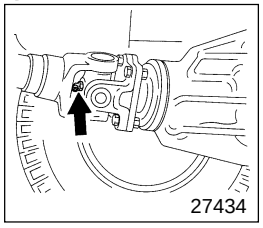
② 

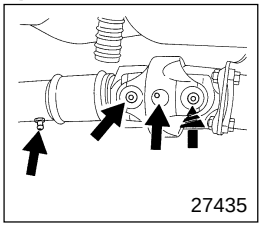
③ 

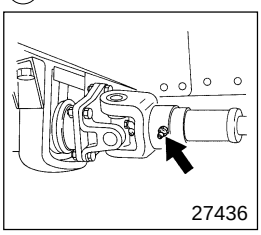
④ 

⑤ 

⑥ 

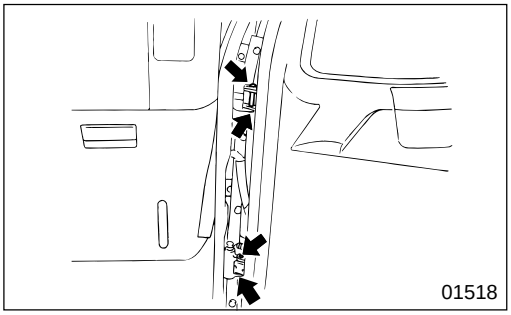
⑦ 

⑧ 

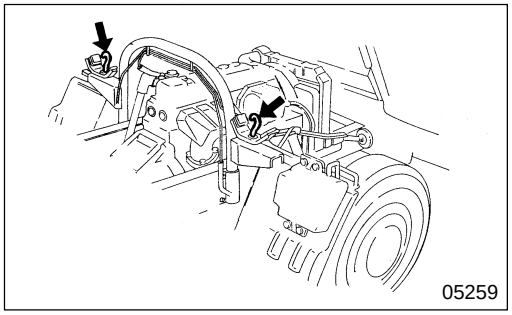
⑨ 

① Steering shaft
② Drag link front
③ Drag link rear
④ Rear spring pin front (left and right, 2 points)
⑤ Rear spring pin rear (left and right, 4 points)
⑥ Tie rod end
⑦ Propeller shaft universal joint's-all
⑧ Double cardin joint, propeller shaft slip joint, propeller shaft universal joint
⑨ Propeller shaft slip joint

● **Door hinge**



● **Anchor hook**



MITSUBISHI
FUSO

Group 11A

Engine

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-11A

INDEX

SPECIFICATIONS 11A- 2

STRUCTURE AND OPERATION 11A- 4

TROUBLESHOOTING 11A-14

ON-VEHICLE INSPECTION AND ADJUSTMENT 11A-16

REMOVAL AND INSTALLATION OF ENGINE 11A-20

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS 11A-24

CYLINDER HEAD AND VALVE MECHANISM 11A-38

FRONT CASE 11A-52

TIMING GEARS AND BALANCE SHAFTS 11A-56

PISTONS, CONNECTING RODS AND CYLINDER LINERS 11A-64

FLYWHEEL 11A-76

CRANKSHAFT AND CRANKCASE 11A-80

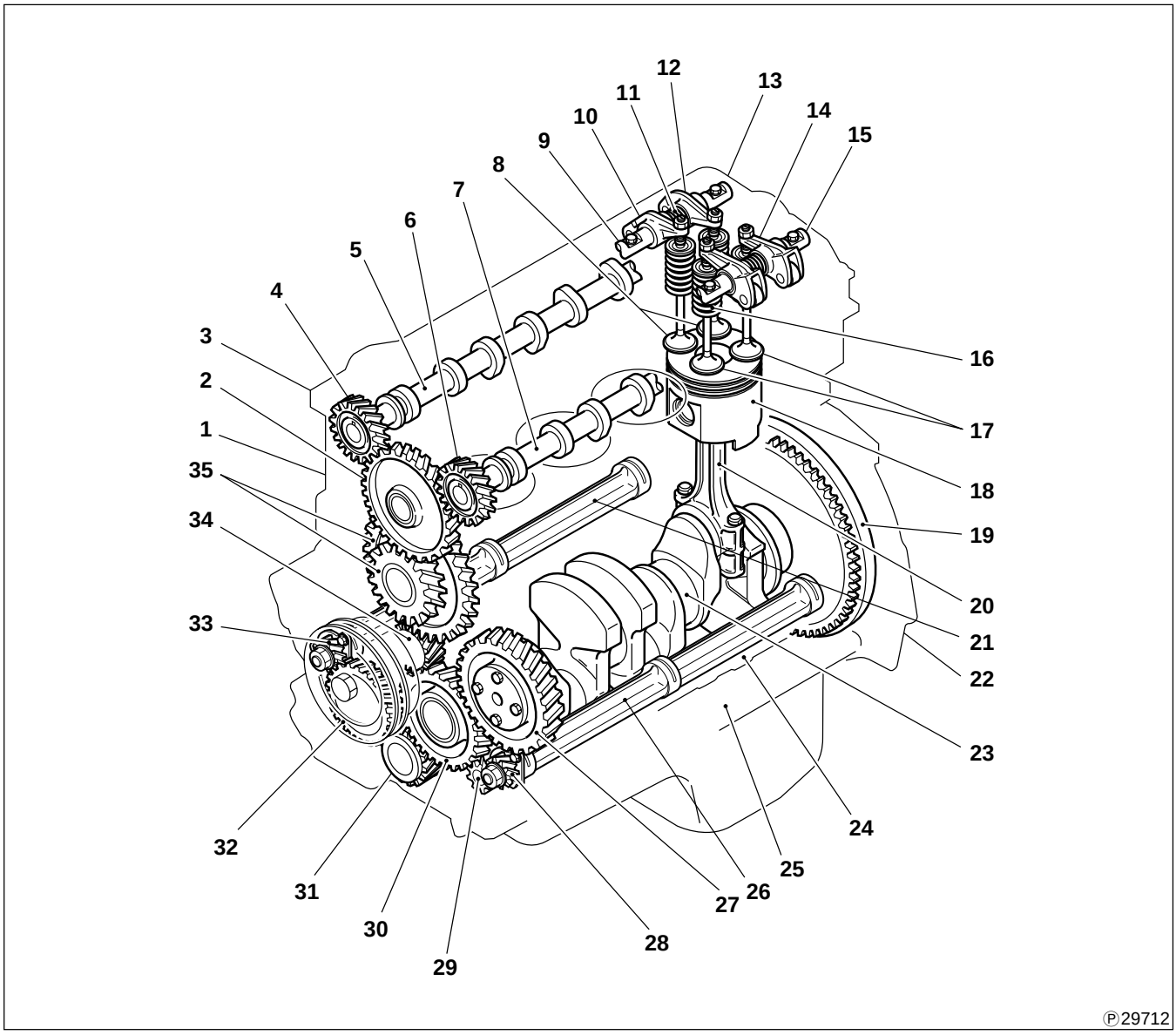
BALANCE SHAFT BUSHINGS 11A-88

SPECIFICATIONS

Item	Specifications
Engine model	4M50T2
Type	4-cylinder, in-line, water-cooled, 4-cycle diesel
Combustion chamber type	Direct injection
Valve mechanism	Double overhead camshaft
Max. power output HP/rpm (SAE Gross)	175/2700
Max. torque lbf.ft/rpm (SAE Gross)	347/1800
Cylinder bore × stroke mm {in.}	ϕ 114 × 120 {4.49 × 4.72}
Total displacement ℓ (cu. in.)	4.899 (299)
Compression ratio	17.5

MEMO

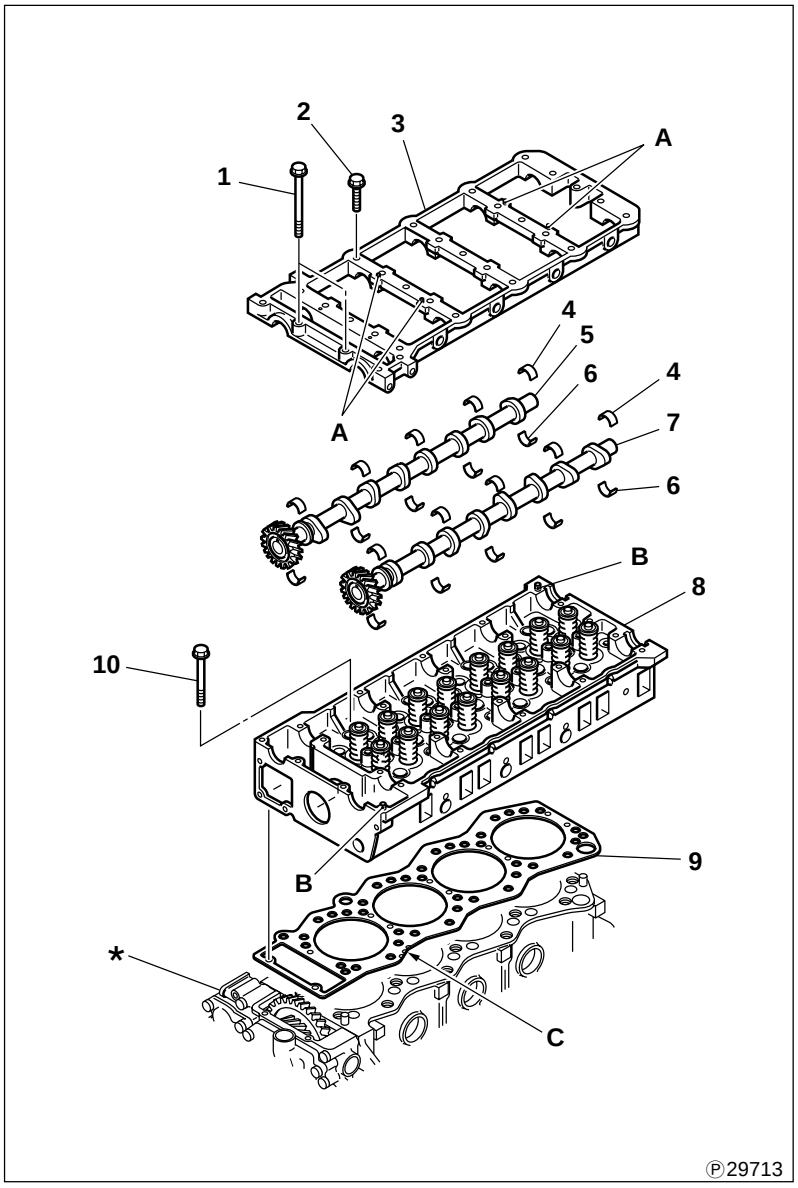
Engine-proper



1 Cylinder head
2 Head idler gear
3 Camshaft frame
4 Camshaft gear (Exhaust side)
5 Exhaust camshaft
6 Camshaft gear (Inlet side)
7 Inlet camshaft
8 Exhaust valve
9 Exhaust rocker shaft
10 Short rocker
11 Rocker shaft spring
12 Long rocker
13 Rocker cover
14 Short rocker
15 Inlet rocker shaft
16 Valve spring
17 Inlet valve
18 Piston
19 Flywheel
20 Connecting rod
21 Balance shaft RH
22 Rear plate
23 Crankshaft
24 Upper crankcase
25 Lower crankcase
26 Balance shaft LH
27 Injection pump gear
28 Balance shaft gear LH
29 Vacuum pump gear
30 No. 1 idler gear
31 Crankshaft gear
32 Oil pump gear
33 Balance shaft gear RH
34 Fan shaft assembly
35 Idler gear assembly

The 4M50T2 engine is of the double overhead camshaft (DOHC) type. The valve mechanism and timing gear arrangement is illustrated above.

Cylinder Head, Cylinder Head Gasket, Camshaft and Camshaft Frame

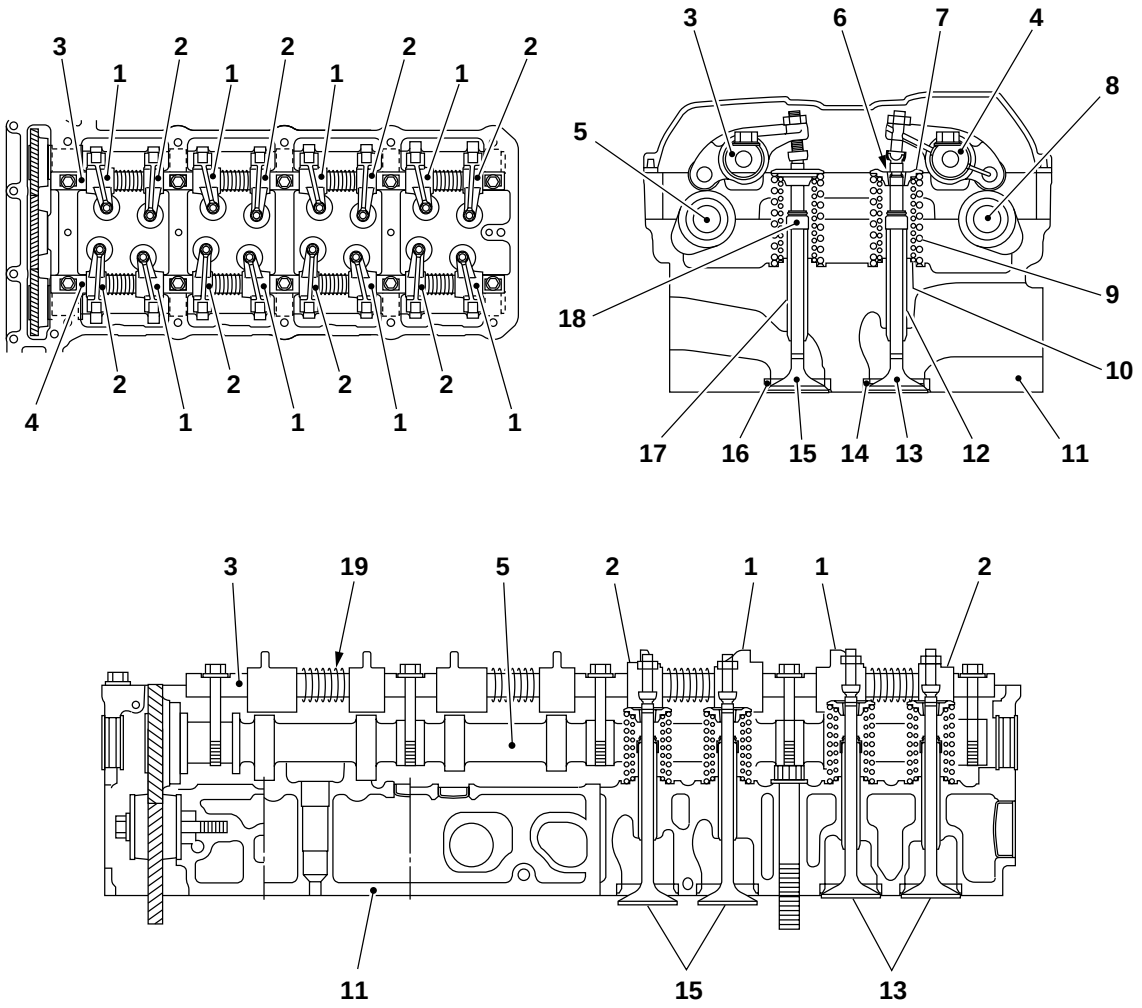


1 Bolt (× 2)
2 Bolt (× 13)
3 Camshaft frame
4 Camshaft bearing (Upper)
5 Exhaust camshaft
6 Camshaft bearing (Lower)
7 Inlet camshaft
8 Cylinder head
9 Cylinder head gasket
10 Cylinder head bolt

A : Locating pin
B : Locating pin
C : Notched portion
*** :** Front

- The camshafts **5** and **7** have their journals supported by the cylinder head **8**, and are held down from above by the camshaft frame **3**.
- The camshaft bearings **4** and **6**, both upper and lower, are identical parts. When they are reassembled, however, be sure to reinstall them in their original positions, as they were before disassembly.
- The exhaust camshaft **5** and the inlet camshaft **7** have the same gears but use different cams. Use care not to confuse them at reassembly.
- As for the cylinder head gasket **9**, select and use one of proper thickness suitable for the projection of the piston. The thickness of gaskets is identifiable by a difference in the shape of the notched portion **C**.
- The bolts **2** (× 13) are threaded into the cylinder head **8**, whereas the bolts **1** (× 2) are threaded into the front case *****.

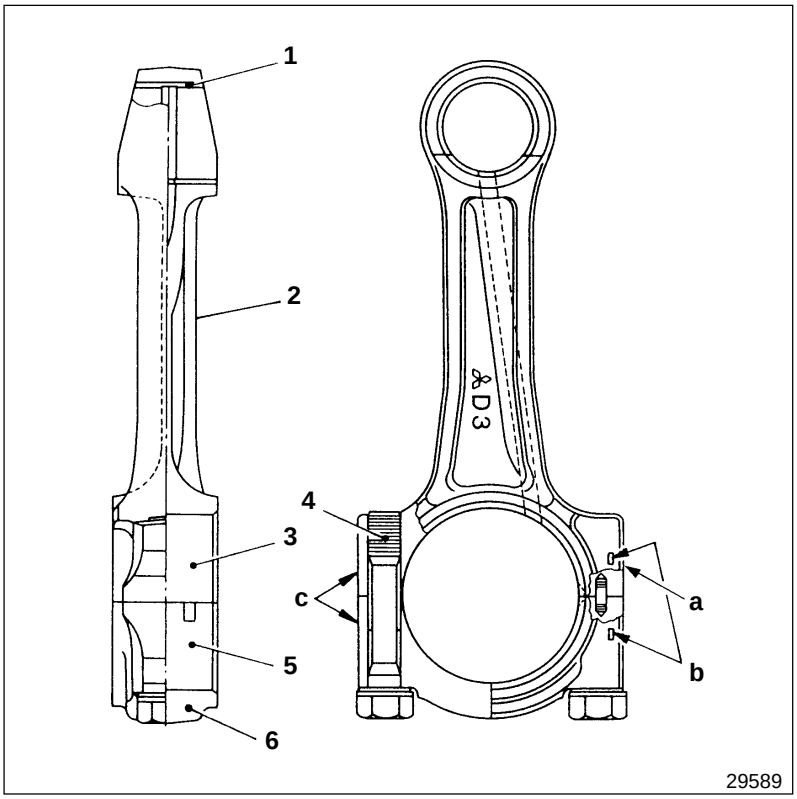
Valve Mechanism



1 Short rocker
2 Long rocker
3 Exhaust rocker shaft
4 Inlet rocker shaft
5 Exhaust camshaft
6 Valve collet (keepers)
7 Upper valve spring retainer
8 Inlet camshaft
9 Outer valve spring
10 Inner valve spring
11 Cylinder head
12 Inlet valve guide
13 Inlet valve
14 Inlet valve seat
15 Exhaust valve
16 Exhaust valve seat
17 Exhaust valve guide
18 Valve stem seal
19 Rocker shaft spring

- The rockers come in two types; short rockers **1** and long rockers **2**, and are mounted in different directions as illustrated.
- The valve springs include the outer springs **9** and inner springs **10**. A pair of outer and inner springs are used for each valve.

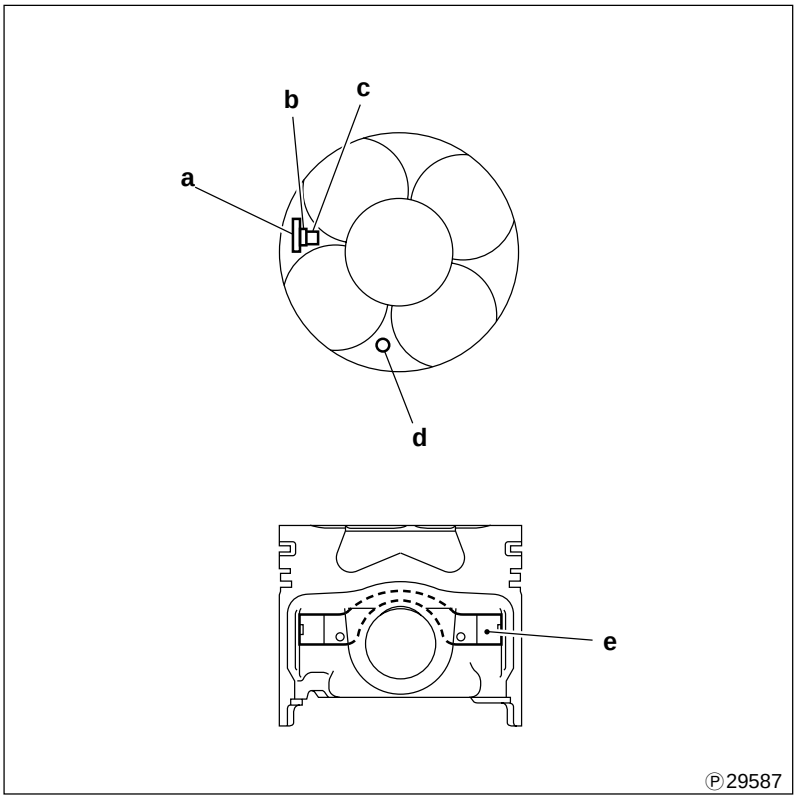
Connecting Rods



1 Connecting rod bushing
2 Connecting rod
3 Upper connecting rod bearing
4 Connecting rod bolt
5 Lower connecting rod bearing
6 Connecting rod cap

***a :** Weight mark stamp
"A" to "G"
(where "A" indicates the maximum connecting rod weight.)
***b :** Alignment mark
***c :** Alignment mark

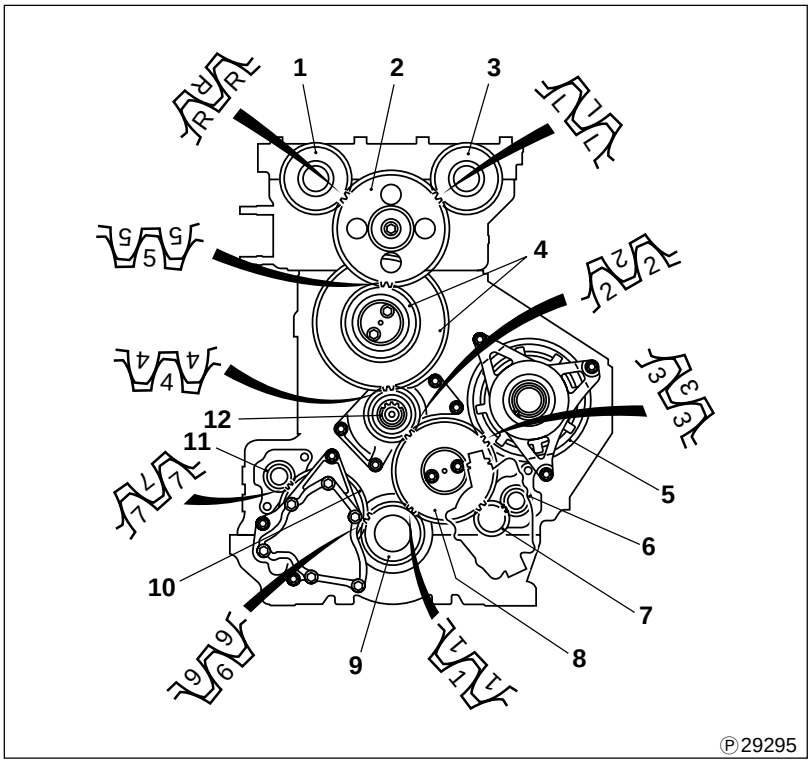
Pistons



a : Part number
b : Weight mark
c : Size mark
"**A**", "**B**"
Pistons marked "**B**" are larger than those marked "**A**" at the outside diameter.
d : Front mark
Indicated by "○".
e : Strut

- Pistons to be used can be selected by matching the size mark of the piston with that of the cylinder liner. 📖 P11A-11
- The piston is made of special aluminum alloy. Its total height is relatively low and both end faces of the piston in the direction of the piston pin are concaved for weight reduction.
- The piston is an autothermic piston reinforced with strut **e**.

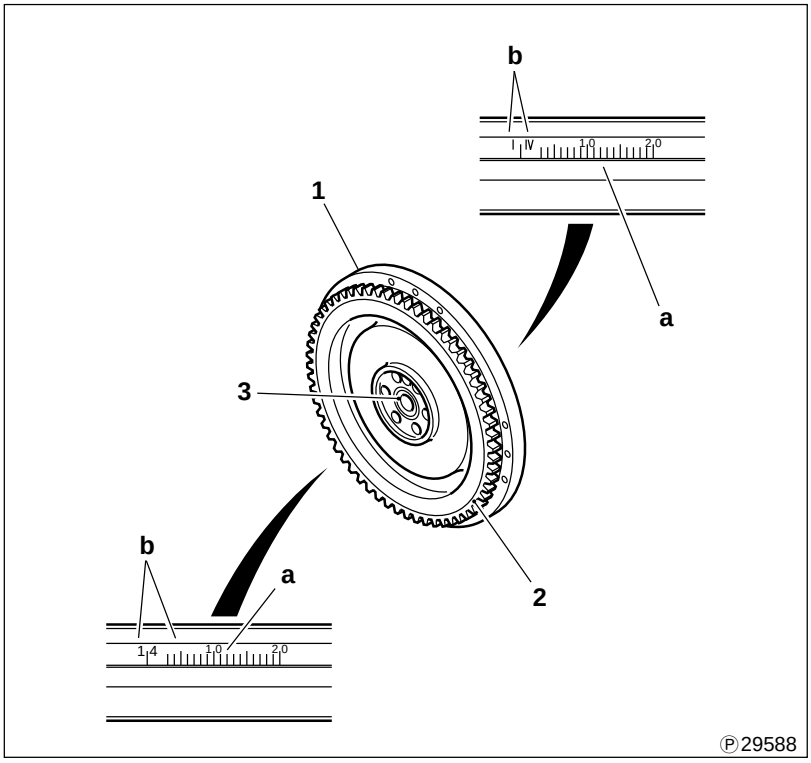
Timing Gears



1 Camshaft gear(exhaust) RH (32)
2 Head idler gear (54)
3 Camshaft gear (intake) LH (32)
4 Idler gear (63, 36)
5 Injection pump gear (56)
6 Balance shaft gear LH (14)
7 Vacuum pump gear (15)
8 No. 1 idler gear (49)
9 Crankshaft gear (28)
10 Oil pump gear (41)
11 Balance shaft gear RH (14)
12 Fan shaft (25)
Number of teeth shown in parentheses

Each of the timing gears (except the vacuum pump gear) has alignment marks to ensure correct assembly.

Refer to 🕮 P11A-63 for balance shaft positioning.

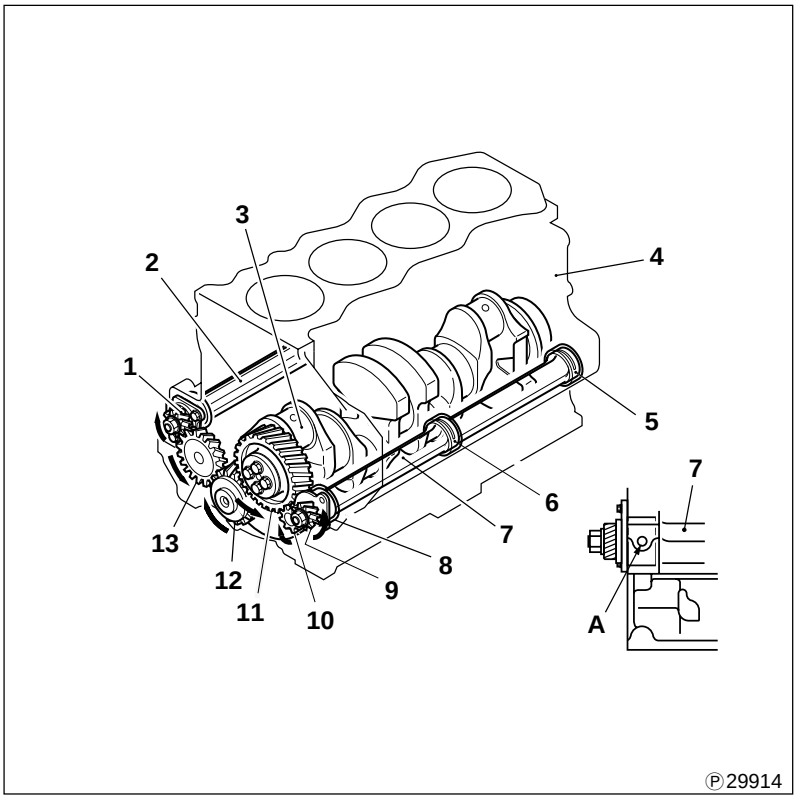


Flywheel

1 Flywheel
2 Ring gear
3 Pilot bearing

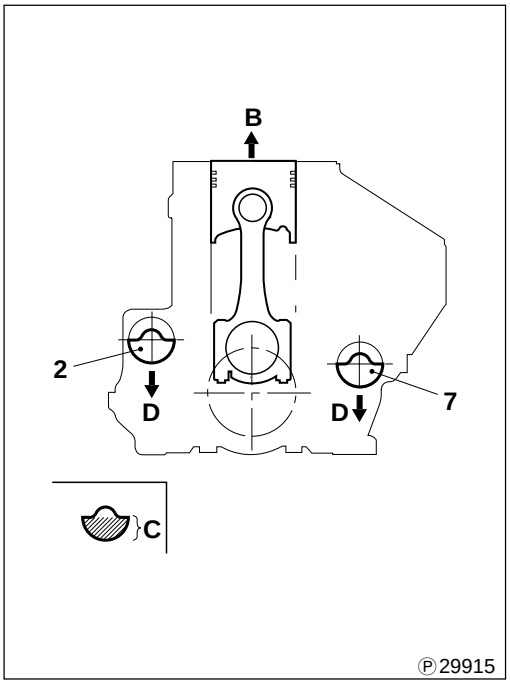
a : Angle scale
b : Cylinder No. (“1 4”, “I IV”)

Balance Shaft



1 Balance shaft gear RH
2 Balance shaft RH
3 Crankshaft
4 Upper crankcase
5 No. 3 balance shaft bushing
6 No. 2 balance shaft bushing
7 Balance shaft LH
8 No. 1 balance shaft bushing
9 Balance shaft gear LH
10 Vacuum pump gear
11 No. 1 idler gear
12 Crankshaft gear
13 Oil pump gear

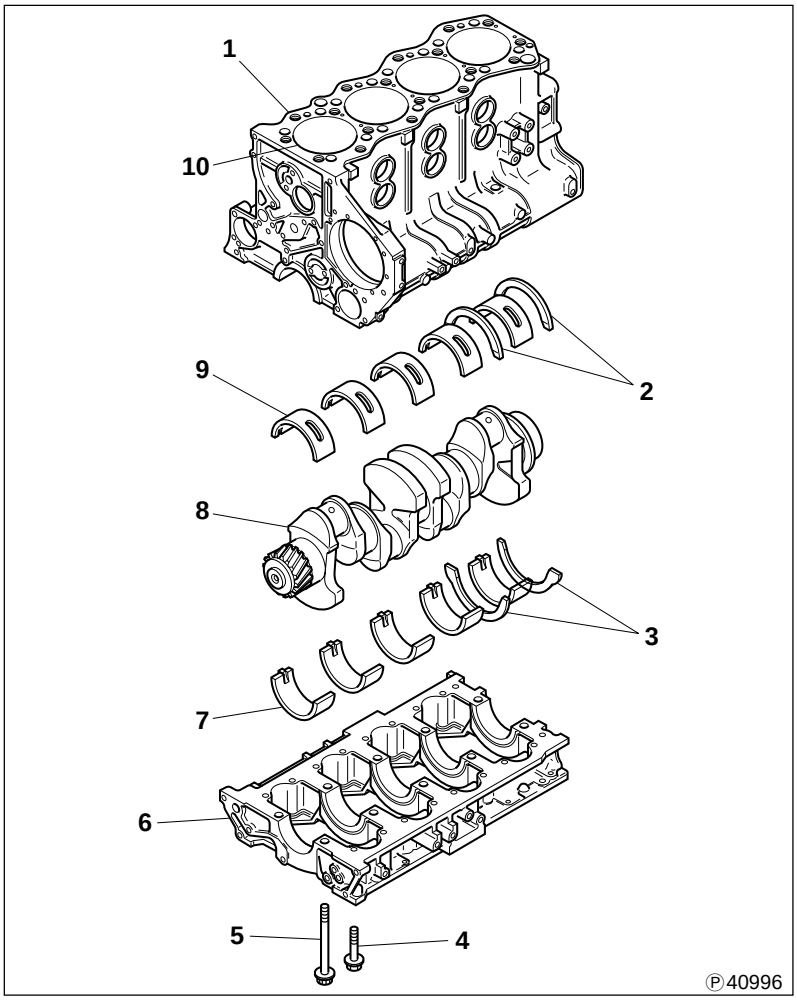
- The balance shafts RH **2** and LH **7** are mounted in the upper crankcase **4** with the crankshaft **3** sandwiched in between, and serve to reduce the engine vibration caused by rotation of the crankshaft.
- Both balance shafts RH **2** and LH **7** are supported by the three balance shaft bushings **5**, **6** and **8** mounted in upper crankcase **4** and driven by the timing gears (🕮 P11A-8).
- The balance shaft LH **7** is provided with a positioning hole **A** to ensure correct assembly. 🕮 P11A-63



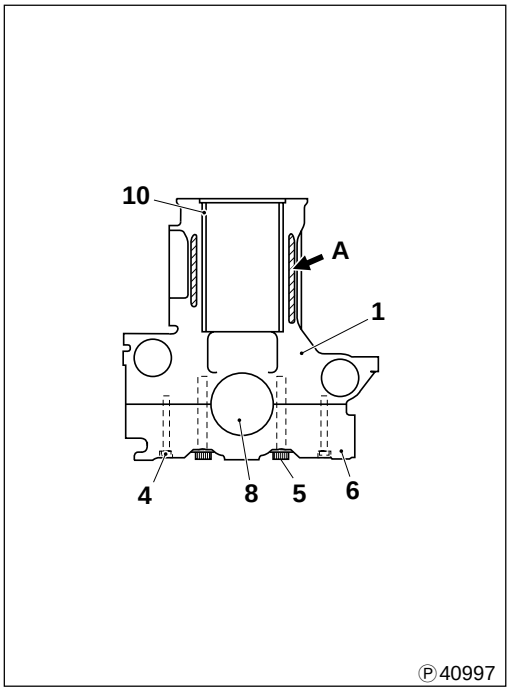
● **Reduction of vertical vibration (Secondary components)**

- The reciprocating motion of the piston produces inertial force **B**, the source of vertical vibration, at the top and bottom dead centers of the piston.
- The balance shafts RH **2** and LH **7** rotate in such a way that at the top and bottom dead centers of the piston, the semi-circular weight portion **C** will always be placed opposite to the piston head in terms of top or bottom position.
- As a result, at the top and bottom dead centers of the piston, both balance shafts RH **2** and LH **7** produce equal centrifugal force **D** to offset inertial force **B** of the piston, thereby reducing vertical vibration.
- In addition, in the medium and high engine speed ranges, the crankshaft rotation moments (secondary components) are also reduced by the balance shafts.

Crankcase and Main Bearings

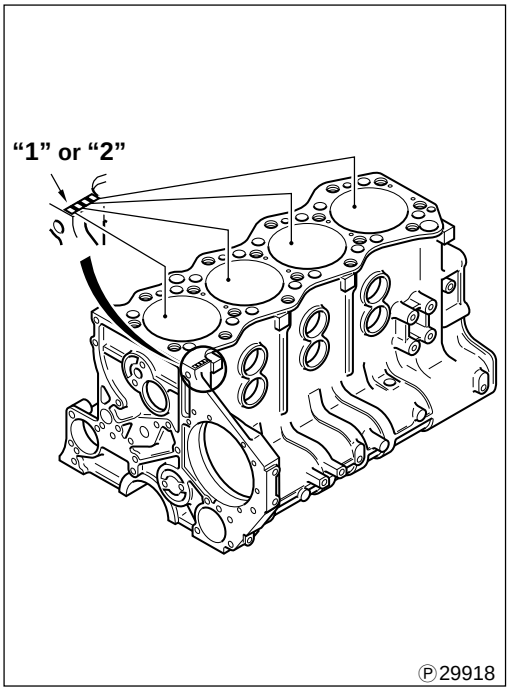


1 Upper crankcase
2 Upper thrust plate
3 Lower thrust plate
4 Bolt
5 Main cap bolt
6 Lower crankcase
7 Lower main bearing
8 Crankshaft
9 Upper main bearing
10 Cylinder liner

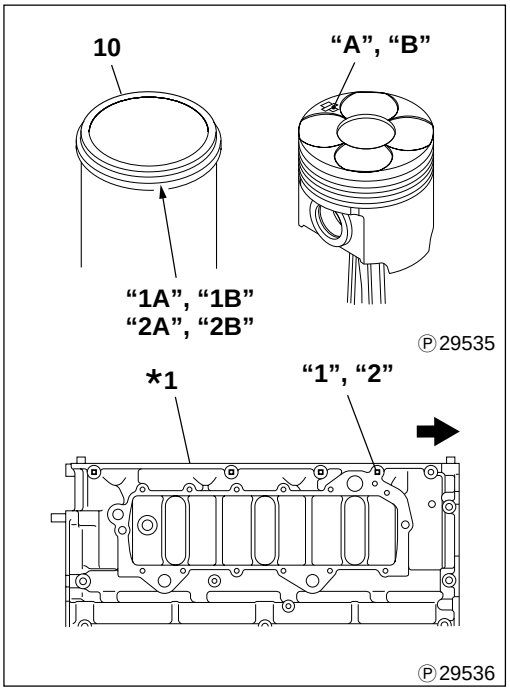


● **Crankcase**

- The crankcase is composed of two parts; upper crankcase **1** and lower crankcase **6**, which are coupled together with crankshaft **8** in between.
- The upper crankcase **1** has four cylinder bores provided into which cylinder liners **10** are fitted.
- Water jacket **A** is provided around the cylinders to cool down the cylinder liners **10**.
- The bolts **4** used to couple the upper crankcase **1** and the lower crankcase **6** and the main cap bolts **5** require the specified procedure to be followed when tightened. P11A-83

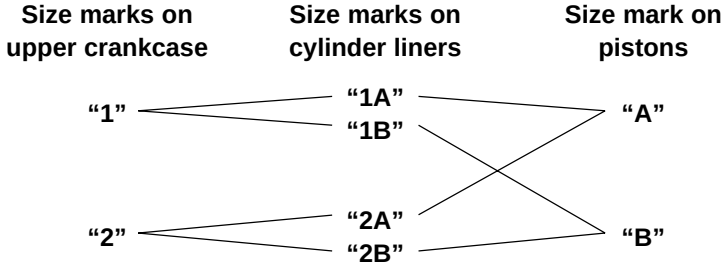


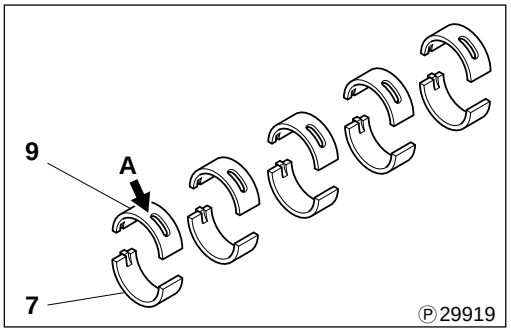
- Size mark "**1**" or "**2**" is stamped on the upper crankcase **1** for selective fitting of pistons in the crankcase.
- The size marks for the four cylinders are collectively stamped at a single location, and indicate the sizes of the respective cylinder liners as illustrated. P11A-7



● **Cylinder liner**

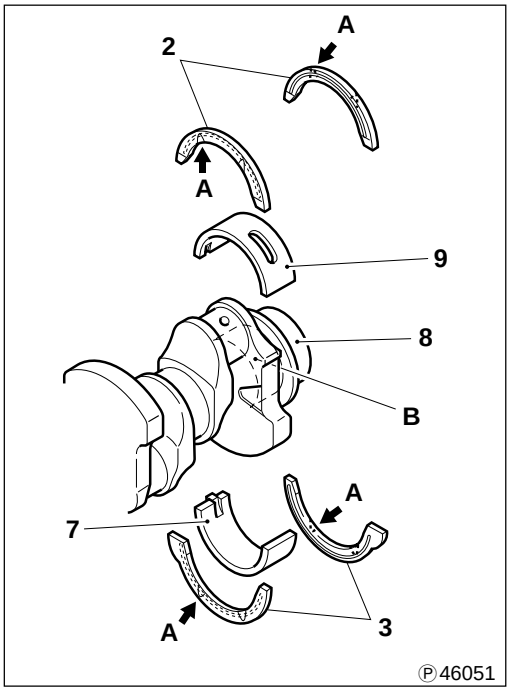
- Select a cylinder liner **10** which has the same size mark as those stamped on the upper crankcase ***1** the piston.
- The size marks on the upper crankcase ***1** are arranged in the order of No. **1**, **2**, **3** and **4** cylinders starting from the engine front **C**.





● **Main bearings**

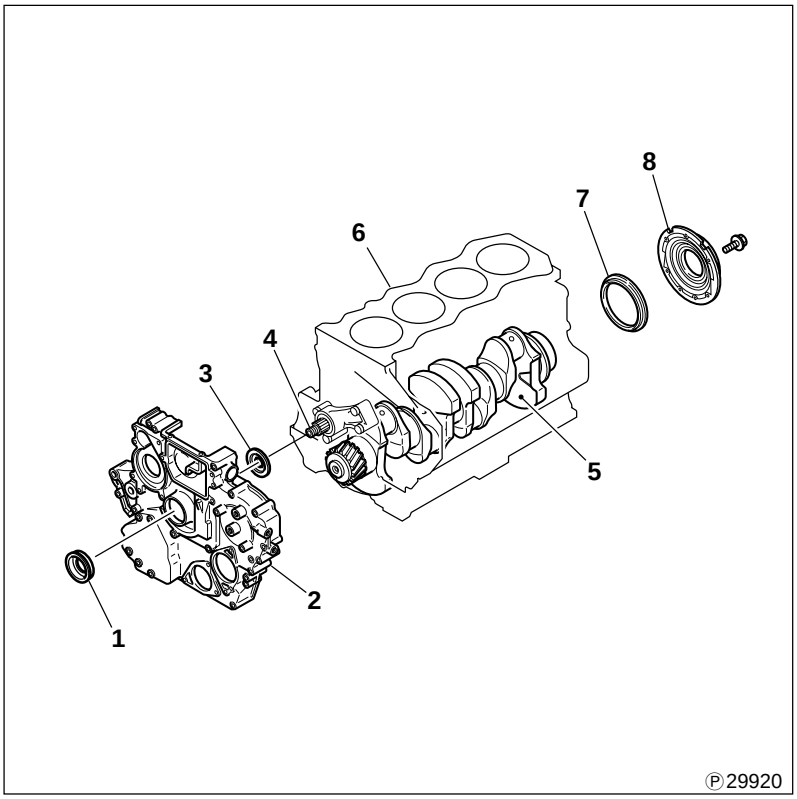
The upper main bearing **9** has an oil hole **A** through which engine oil is supplied to the journal of the crankshaft **8**.



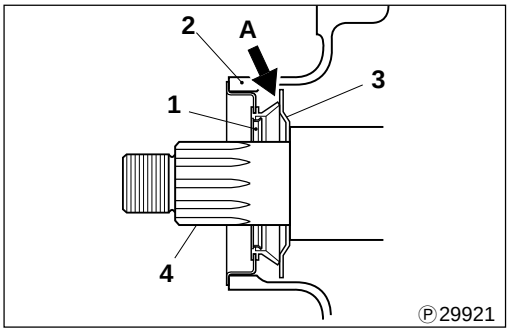
● **Thrust plates**

- The thrust plates include upper thrust plates **2** and lower thrust plates **3**. They are mounted at both ends of the upper main bearing **9** and the lower main bearing **7** at the rearmost portion of the crankshaft **8**.
- The thrust plates to be used should have a proper thickness suitable to maintain the end play specification of the crankshaft **8**.
  Each thrust plate has an oil groove in two places to assure its smooth sliding on the journal **B** of the crankshaft **8**.

Oil Seals

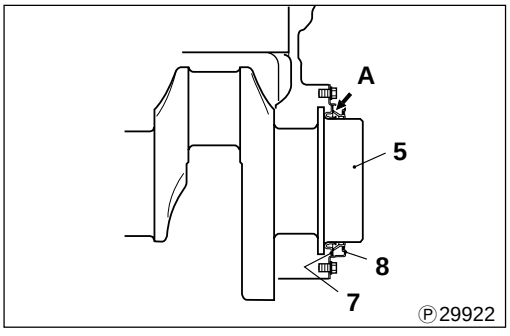


1 Front oil seal
2 Front case
3 Front oil seal slinger
4 Fan shaft
5 Crankshaft
6 Crankcase
7 Rear oil seal slinger
8 Rear oil seal



● **Front Oil Seal**

- The front oil seal **1** is mounted in the front case **2**. Its lip **A** is in contact with the front oil seal slinger **3** for sealing.
- The front oil seal slinger **3** is fitted on the fan shaft **4**.



● **Rear Oil Seal**

- The rear oil seal **8** is mounted to the crankcase **6**. Its lip **A** is in contact with the rear oil seal slinger **7** for sealing.
- The rear oil seal slinger **7** is press-fitted on the rear end of the crankshaft **5**.

Possible Causes \ Symptoms		Low power output	Abnormal engine noise	Remarks
Cylinder head and valve mechanism	Incorrect valve clearance	×	×	
	Defective cylinder head gasket	×	×	
	Worn valve and valve seat, and deposited carbon	×	×	
	Weakened valve spring	×	×	
	Defective rocker shaft and bracket		×	
	Poor lubrication of rocker shaft bracket		×	
Timing gears	Incorrect backlash in timing gears		×	
	Poor lubrication of timing gear peripheries and idler shafts		×	
Camshaft	Excessive end play in camshaft		×	
	Worn camshaft		×	
Pistons and connecting rods	Worn/damaged piston ring groove(s)	×	×	
	Worn/damaged piston ring(s)	×	×	
	Worn piston pin and connecting rod small end bushing		×	
Crankshaft	Excessive end play in crankshaft		×	
	Incorrectly fitted fan pulley		×	
	Worn/damaged crankshaft pin and connecting rod bearing		×	
	Worn/damaged crankshaft journal and main bearing		×	
Fuel	Defective bearing in injection pump bearing housing		×	
	Faulty injection nozzle spray condition	×	×	Gr 13A
	Incorrect injection timing	×	×	Gr 13A
	Air trapped in fuel system	×		Gr 13A
Cooling	Defective cooling system	×		Gr 14A
	Loose/damaged V belt		×	
Intake and exhaust	Clogged air cleaner	×	×	Gr 15A
	Clogged muffler	×	×	
Incorrect oil viscosity		×		
Improper fuel		×		
Incorrectly fitted piping, hose, etc.			×	
Defective/incorrectly fitted auxiliaries like injection pump and alternator			×	

MEMO

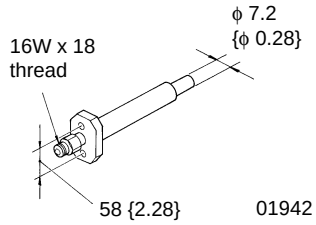
ON-VEHICLE INSPECTION AND ADJUSTMENT

Measuring Compression Pressure
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Compression pressure	Each cylinder (at 200 rpm)	2550kPa {370 psi, 26 kgf/cm²}	1960 kPa {285 psi, 20 kgf/cm²}	Inspect
		Cylinder-to-cylinder pressure difference	–	0.4 kPa {57 psi, 4 kgf/cm²}	Inspect

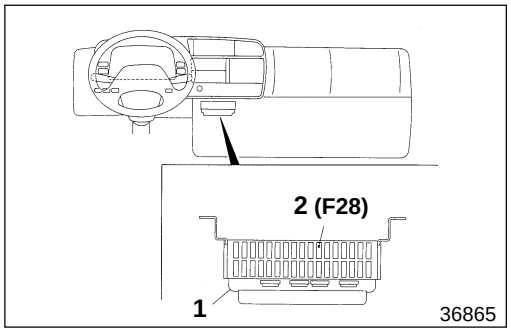
Special tools

Unit: mm {in.}

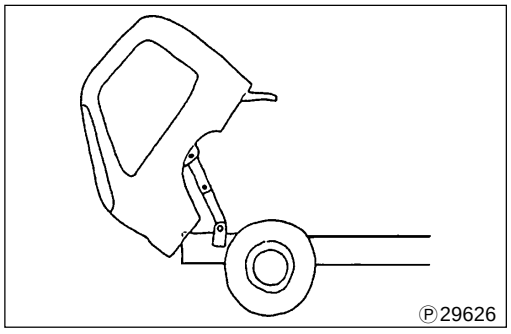
Location	Tool name and shape	Part No.	Application
–	Compression Gauge Adapter 	MH063434	Measuring compression pressure

A drop in compression pressure should be used as a guide in determining a time to overhaul the engine.
Measure the compression pressure at regular intervals, and keep track of its transition which will provide a useful tool for troubleshooting. On a new vehicle, or for a while after replacement of parts with new ones, the compression pressure will be somewhat higher, depending on the break-in condition of piston rings, valve seats, etc., but will return to normal as the parts wear down.

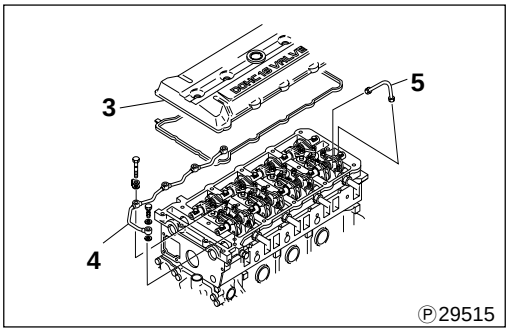
- Prior to an inspection, check to ensure that the engine oil, starter and battery are in normal condition.
- Place the vehicle in the following condition.
  - Warm up the engine until the coolant temperature reaches approx. 75 to 85 °C {167 to 185 °F}.
  - Turn off the lights and auxiliaries.
  - Place the transmission in neutral.
  - Place the steering wheel in the straight-ahead position.



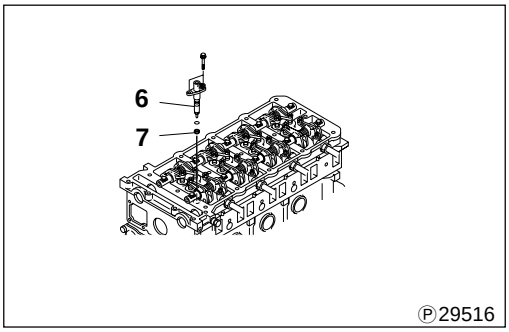
- Remove the fuel cut motor fuse **2** from the fuse box **1** in the cab to make sure that the fuel is not injected when the engine is cranked by the starter.



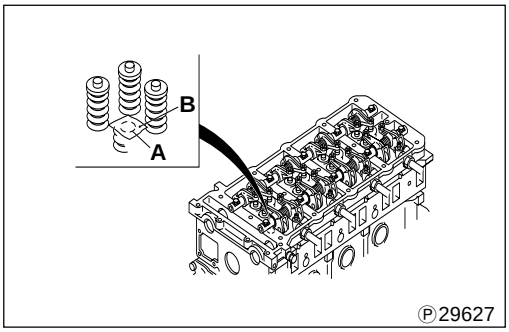
- Tilt the cab.



- Remove the rocker cover **3**, fuel leak-off pipe **4** and injection pipe **5**.
  P11A-24



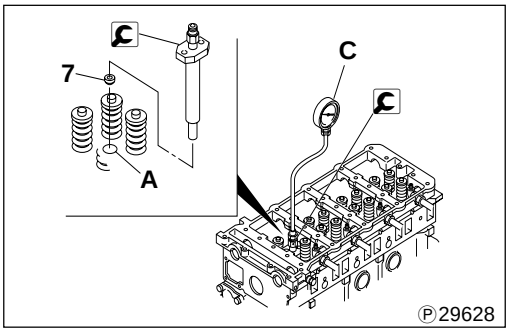
- Remove all glow plugs.
  P11A-38



- Cover the glow plug mounting holes with pieces of waste cloth **B**. After cranking the engine by the starter, check to ensure that no foreign substances are deposited on the waste cloth.

WARNING ⚠

If there is a crack in any of the cylinders, some of the coolant, engine oil, fuel, etc. will enter the cylinder through the crack. If the engine is cranked in such a condition, these substances heated to high temperatures will blow out from glow plug holes A and can be very dangerous. When the engine is cranked, therefore, stay away from the glow plug holes.



- Fit the glow plug adapter for the 🔧 Compression Gauge onto the glow plug mounting hole **A** and mount the compression gauge **C**.
- Crank the engine and measure the compression pressure.
- On all of the cylinders, measure the compression pressure and determine the pressure difference between cylinders.
- If any compression pressure or cylinder-to-cylinder pressure difference is out of the limits, pour in a small amount of engine oil into glow plug mounting hole **A** and check by measuring the compression pressure again.
  - If the compression pressure increases:
    Worn/damaged piston rings and cylinder inner surfaces are suspected.
  - If the compression pressure remains unchanged:
    A seized valve, incorrectly seated valve or defective cylinder head gasket is suspected.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspecting and Adjusting Valve Clearances

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
–	Valve clearance (when cold)	Inlet	0.4 {0.016}	–	Adjust
		Exhaust	0.5 {0.020}	–	Adjust

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (adjusting screw tightening)	11.2 {8.25, 1.14}	–

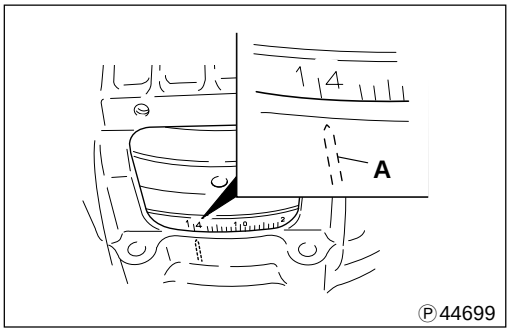
Special tools

Location	Tool name and shape	Part No.	Application
–	Cranking handle Ⓟ45041	MH063568 < without refrigerator > MH063569 < with refrigerator >	Turning fan pulley

Valve clearances should be checked and adjusted as follows while the engine is cold.

[Inspection]

- Tilt the cab.
- Remove the rocker cover. P11A-24
- To place the piston No. 1 or No. 4 at the top dead center on the compression stroke, crank the engine until the pointer **A** in the converter housing (on automatic transmission) inspection window is aligned with the mark between "**1** and **4**" inscribed in the flywheel.

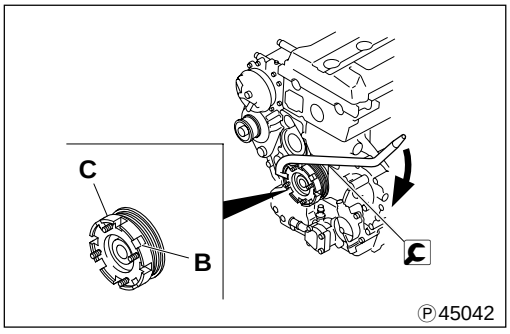


Ⓟ44699

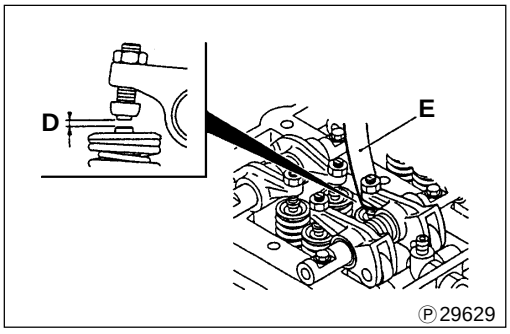
NOTE

Find the cylinder where the rocker arms for both the inlet and exhaust valves can be pushed down. The piston of the cylinder is at the top dead center (TDC) on the compression stroke.

- Use the cranking handle to crank the engine: set it in the groove **B** located on the outer circumference of the fan pulley **C** to turn the crank shaft.



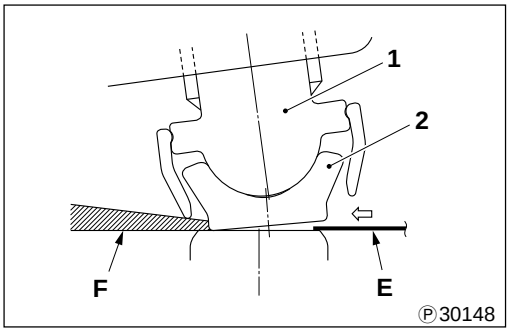
Ⓟ45042



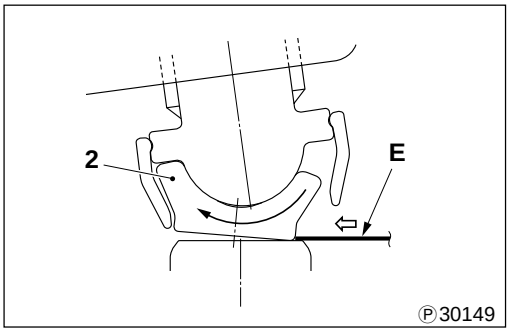
Ⓟ29629

- With the piston No. 1 or No. 4 at the top dead center (TDC) on the compression stroke, measure the valve clearance **D** at the valves marked × in the following table.

Cylinder No.	1		2		3		4	
Valve arrangement	IN	EXH	IN	EXH	IN	EXH	IN	EXH
Piston No. 1 at TDC on compression stroke	×	×	×	–	–	×	–	–
Piston No. 4 at TDC on compression stroke	–	–	–	×	×	–	×	×



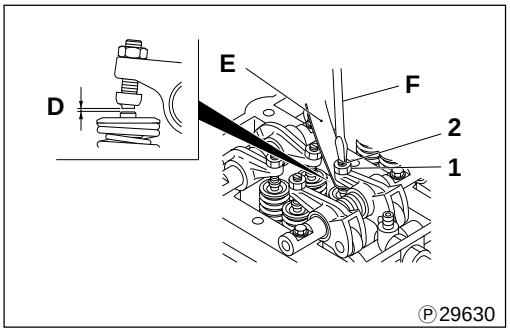
- When measuring the clearances, push the pad **2** of the adjusting screw **1** with the tip of a plain screwdriver **F** or something else from opposite the side where the feeler gauge **E** is to be inserted to open a gap as illustrated, then insert the feeler gauge in the gap.



- If an attempt is made to insert a feeler gauge **E** without opening a gap, the pad will be tilted as illustrated, making it impossible to insert the feeler gauge.

NOTE

- **The feeler gauge E must have a slight drag when taking a measurement.**
- **If the feeler gauge moves without any resistance, the measurement is incorrect (too loose).**

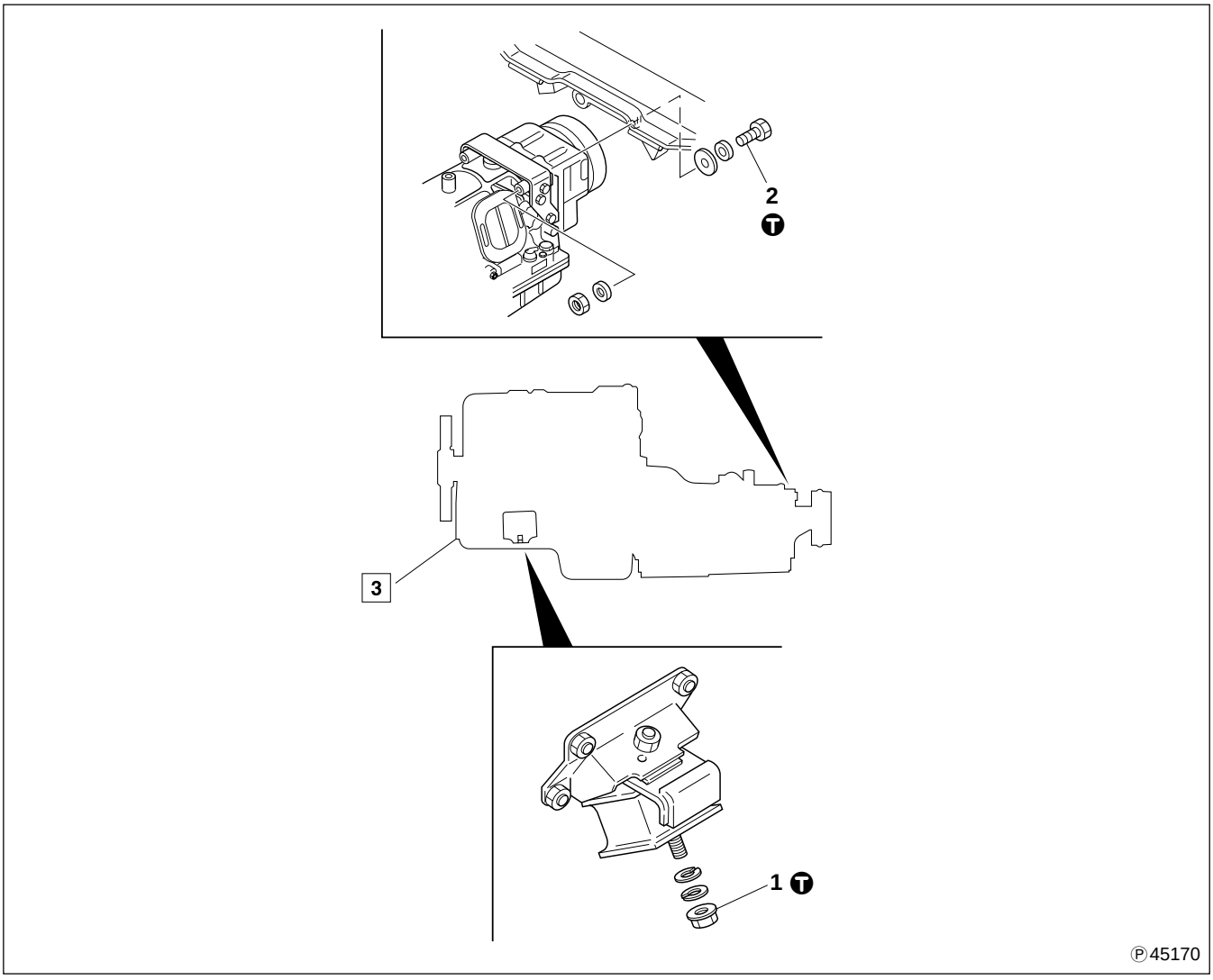


- If the reading is out of specification, adjust by the following procedures.

[Adjustment]

- To adjust the valve clearance **D**, loosen the lock nut **1** and rotate the adjusting screw **2** to adjust the clearance to the extent that the feeler gauge **E** is somewhat hard to move.
- After the adjustment, hold the adjusting screw **2** in position with a screwdriver **F** and tighten the lock nut **1** to the specified torque.
  Thereafter, re-check the valve clearance **D** with the feeler gauge **E**.

REMOVAL AND INSTALLATION OF ENGINE



● **Removal Squence**

1 Nut
2 Bolt
3 Engine and automatic transmission assembly

WARNING ⚠

When lifting the engine and automatic transmission assembly 3, be sure to use a lifting gear or engine hoist capable of lifting an engine of 3.9 to 4.7 kN {880 to 1060 lbs, 400 to 480 kg}

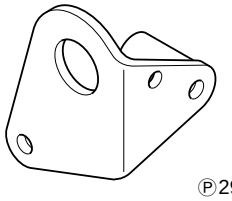
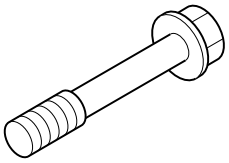
● **Intallation sequence**

Follow the removal sequence in reverse.

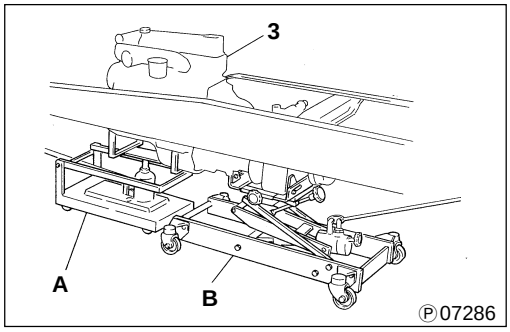
T Tightening torque Unit: N·m{ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (For attaching front mounting)	69 to 99 {51 to 65, 7 to 9}	–
2	Bolt (For attaching rear mounting)	83 to 105 {61 to 80, 8.5 to 11.0}	–

Special tools

Location	Tool name and shape	Part No.	Application
4	Engine front hanger < Tilt cab >  Ⓟ29983	MH062781	Removal and installation of engine
4	Flange bolt < Tilt cab >  Ⓟ29984	MF140234 MF140235	Mounting of hanger

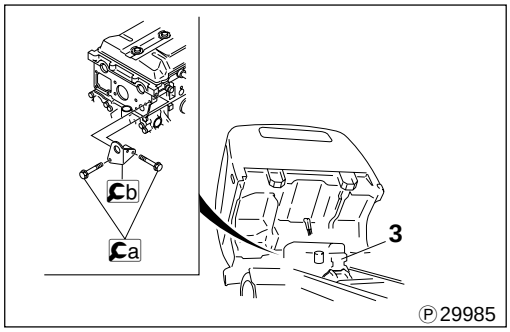
◆ Service procedure



Ⓟ07286

● **Preparatory operation for removal < Fixed cab >**

- Support engine and transmission assembly **3** on engine lifter **A** and transmission jack **B**.
- Make sure that all wiring and hoses are disconnected.



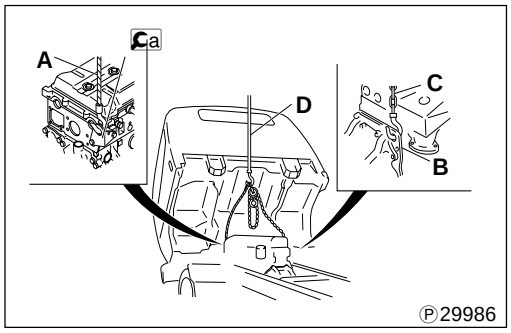
Ⓟ29985

3 **Removal of engine and transmission assembly**

< Tilt cab >

Using a flange bolts, install b engine front hanger to engine and automatic transmission assembly **3**.

REMOVAL AND INSTALLATION OF ENGINE

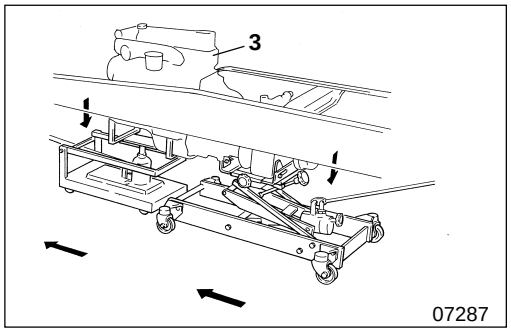


- Attach wire rope **A** to Ca engine front hanger, and chain block **C** to rear plate **B**. Use crane **D** to make the ropes taut.

WARNING ⚠

To lift engine and automatic transmission assembly 3, use hanging hardware suitable for hoisting an engine weighing 3.9 to 4.7 kN {880 to 1060 lbs, 400 to 480 kg}.

- Make sure that all wiring harnesses and pipes are disconnected.
- Slowly lift engine and automatic transmission assembly **3**, making sure that the assembly does not contact the frame or cab.

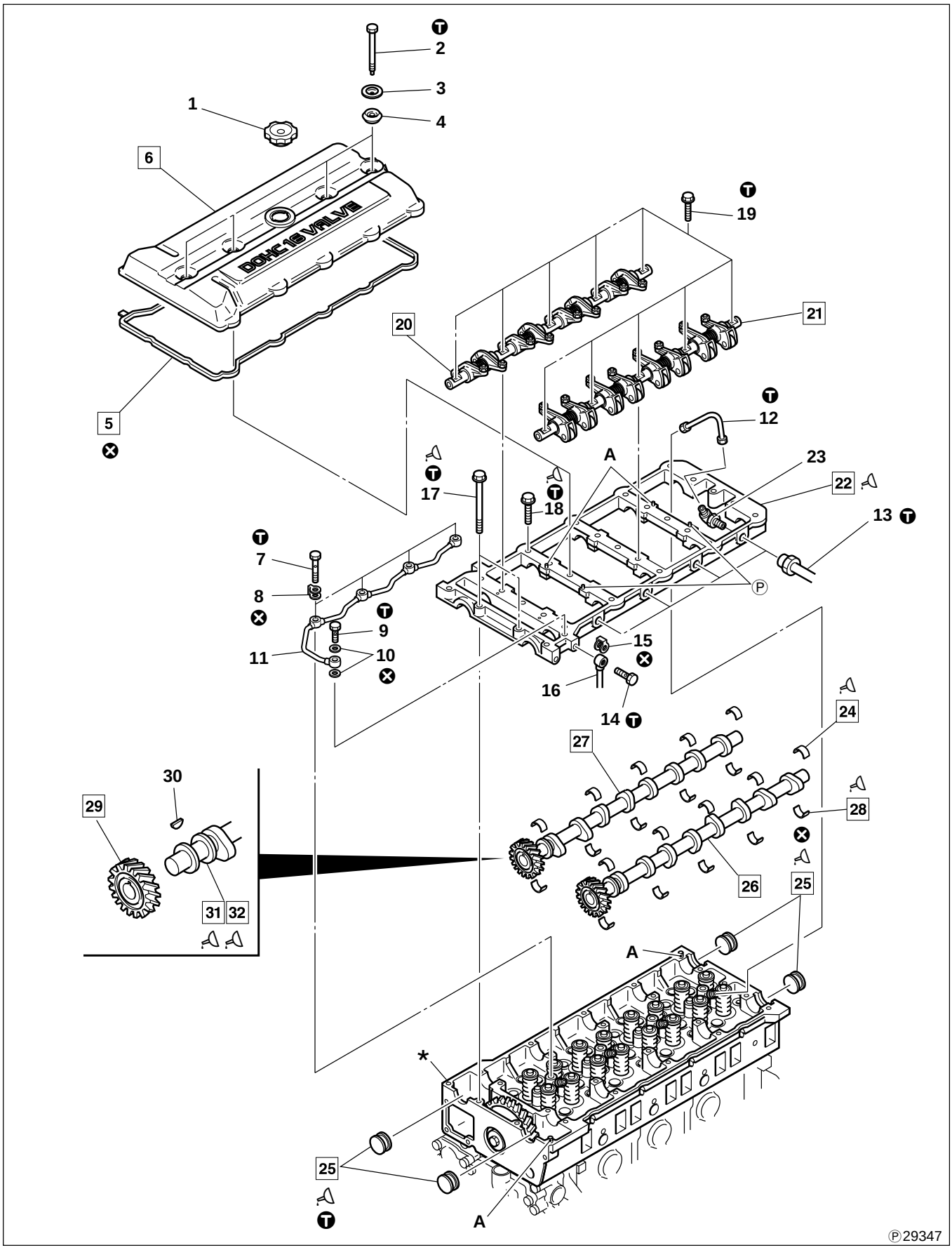


< Fixed cab >

- Lower engine and transmission assembly **3** to fullest extent keeping it horizontal.
- Lift the vehicle using a jack, and move engine and transmission assembly **3** forward.

MEMO

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS



● **Pre-disassembly inspection**

P11A-27

● **Pre-disassembly work**

Some work is necessary before disassembly. P11A-27

● **Disassembly sequence**

1 Oil filler cap
2 Bolt
3 Plate
4 Rubber grommet
5 Rocker cover gasket
6 Rocker cover
7 Eye bolt
8 Gasket
9 Eye bolt
10 Gasket
11 Fuel leak-off pipe
12 Injection pipe
Gr 13A
13 Injection pipe
Gr 13A
14 Eye bolt
15 Gasket
16 Fuel return pipe
Gr13A
17 Bolt (× 2)
18 Bolt (× 13)
19 Bolt (× 10)
20 Exhaust rocker shaft assembly
P11A-34
21 Inlet rocker shaft assembly
P11A-34
22 Camshaft frame
23 Injection pipe connector
24 Camshaft bearing (upper)
25 Packing
26 Inlet camshaft assembly
27 Exhaust camshaft assembly
28 Camshaft bearing (lower)
29 Camshaft gear
30 Key
31 Inlet camshaft
32 Exhaust camshaft

***** : Cylinder head assembly
P11A-38
Ⓟ : Locating pin
⊗ : Non-reusable part

NOTE

- **Avoid removing the camshaft gear 29 unless something wrong is evident.**
- **The camshaft frame 22 and the cylinder head assembly * have been machined jointly when manufactured. It is impossible to replace only either of the parts. Be sure not to change the combination.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
–	Backlash	Between head idler gear assembly and camshaft gear	0.09 to 0.12 {0.0035 to 0.0047}	0.3 {0.012}	Replace
		Between head idler gear assembly and idler gear assembly	0.11 to 0.14 {0.0043 to 0.0055}	0.3 {0.012}	
	End play	Camshaft assembly	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Check all the parts.
		Head idler gear assembly	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	
24, 28	Camshaft bearing free span		–	35.5 {1.39} or more	Replace

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
26	Inlet camshaft	Cam lift	For long rocker	7.157 {0.281}	7.107 {0.297}	Lobe height: 42.157 {1.66} Base circle diameter: 35 {1.38}
			For short rocker	9.202 {0.36}	9.152 {0.36}	Lobe height: 44.201 {1.74} Base circle diameter: 35 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace
		Journal oil clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.0063}	Replace
27	Exhaust camshaft	Cam lift	For long rocker	7.217 {0.284}	7.167 {0.282}	Lobe height: 42.217 {1.66} Base circle diameter: 35 {1.38}
			For short rocker	9.279 {0.365}	9.229 {0.363}	Lobe height: 44.279 {1.74} Base circle diameter: 35 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace
		Journal oil clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.0063}	Replace
29, 31, 32	Camshaft gear and camshaft interference			[30 {1.18}] 0.007 to 0.041 {0.00028 to 0.00160}	–	Replace

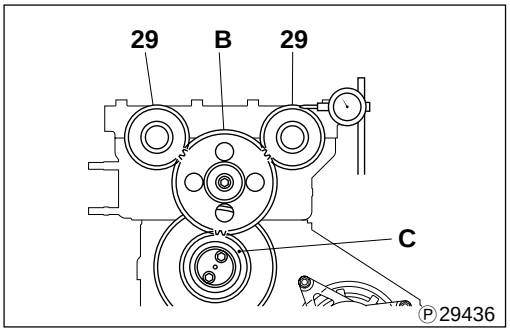
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (mounting rocker cover)	2.0 {14.0, 0.2}	–
7, 9	Eye bolt (mounting fuel leak-off pipe)	20.6 {15.0, 2.1}	
12, 13	Injection pipe	38.2 {28, 3.9}	–
14	Eye bolt (mounting fuel return pipe)	20.6 {15.0, 2.1}	–
17	Bolt (mounting camshaft frame)	23.5 {17.0, 2.4}	Wet
18	Bolt (mounting camshaft frame)	27.5 {20.0, 2.8}	Wet
19	Bolt (mounting rocker shaft assembly)	27.5 {20.0, 2.8}	Wet

Lubricant and sealant

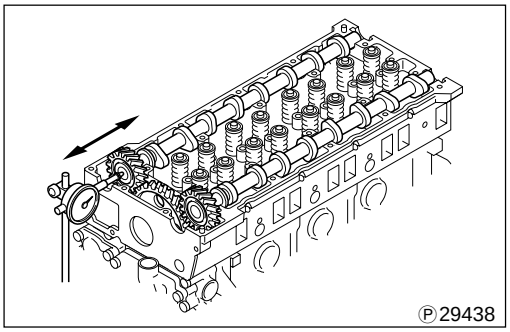
Location	Points of application	Specified lubricant and/or sealant	Quantity
17, 18	Bolt threads and seating surface	Engine oil	As required
22	Surface of camshaft frame which makes contact with cylinder head	THREEBOND 1207C or D	As required
24, 28	Inside surface of camshaft bearing	Engine oil	As required
25	Circumference of packing	THREEBOND 1207C or D	As required
31, 32	Journal and cam portions of camshaft	Engine oil	As required



● **Pre-disassembly inspection**

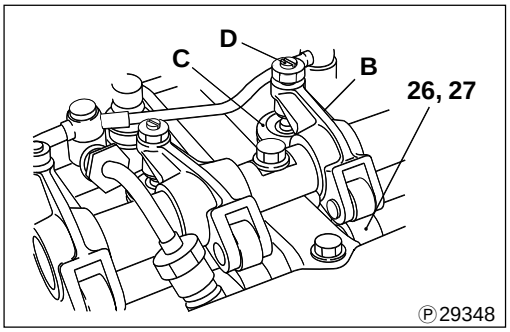
(1) Backlash between head idler gear B and camshaft gear 29 and idler gear assembly C

On a pair of gears, measure backlash at more than three positions. If the reading is more than the limit, replace defective parts.



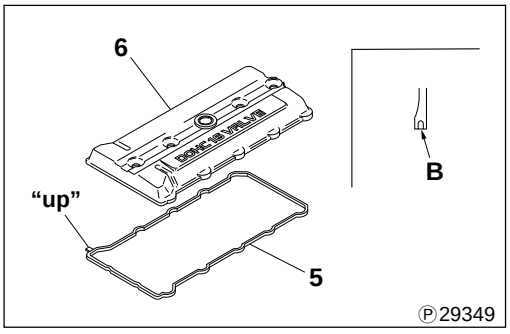
(2) End play of camshaft

If the reading is more than the limit, replace defective parts.



● **Pre-disassembly work**

If the rocker **B** forced up by the camshaft **26** or **27** is pressing the valve spring **C** down, loosen the adjusting screw **D** of the rocker to set the valve spring free.



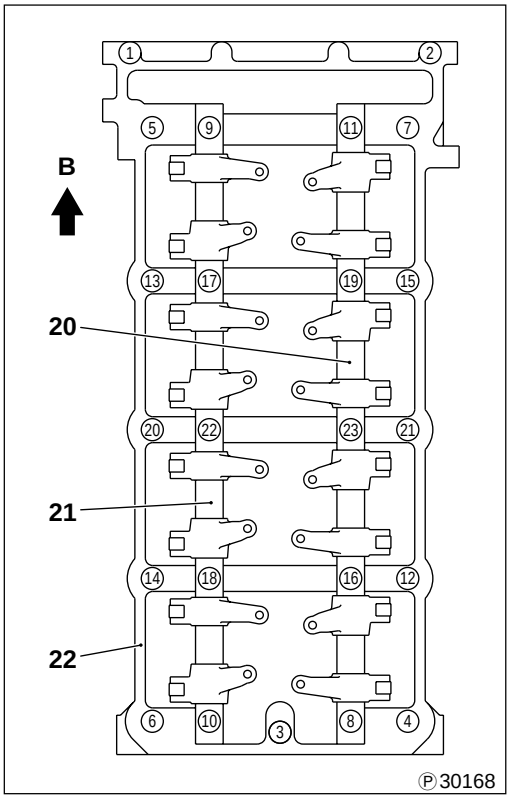
◆ Service procedure

5 **6** **Installation of rocker cover and rocker cover gasket**

- Before installing the rocker cover **6**, remove oil and other deposits thoroughly from the gasket groove **B**.
- Face the rocker cover gasket **5** as illustrated when it is installed on the rocker cover **6**.

CAUTION ⚠

Make sure that the rocker cover gasket 5 is not twisted when installed.

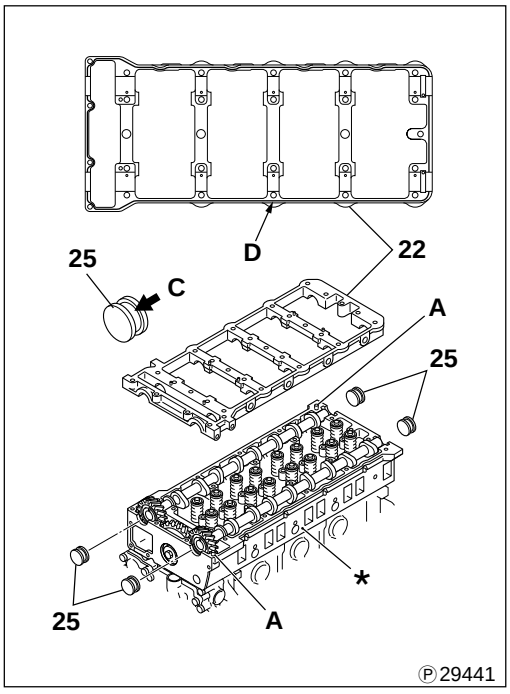


20 to **22** , **25** **Rocker shaft assemblies, camshaft frame and packing**

[Removal]

Loosen the bolts **18** and **19** (① through ㉓) one after another, a small amount at a time, in the numbered sequence shown in the illustration. Then remove the rocker shaft assemblies **20** and **21** and the camshaft frame **22**.

B : Front of engine



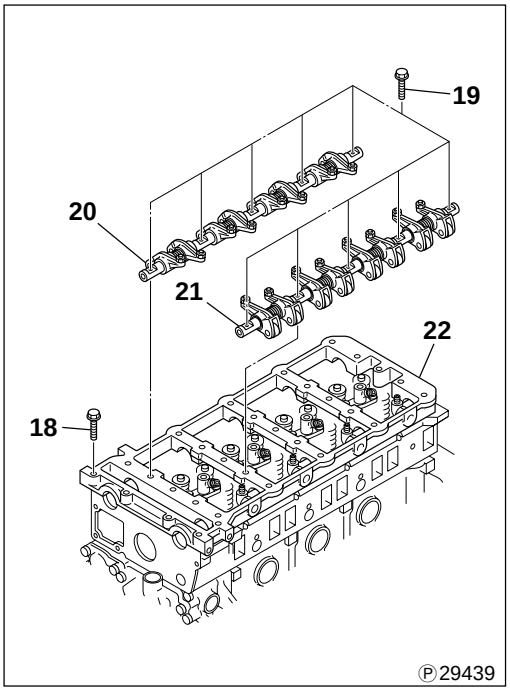
[Installation]

- Apply an even bead of sealant (ϕ 2 ± 1 mm {ϕ 0.079 ± 0.039}) without any break to all around the illustrated portion **C** of the four packings **25**.
- Apply an even bead of sealant (ϕ 1 mm {0.039}) without any break on the circumference **D** of the camshaft frame **22**.
- After the sealant application, install the camshaft frame **22** and the packings **25** on the cylinder head assembly * in less than three minutes.

CAUTION ⚠

- **Check to ensure that the sealant application surfaces C and D are clean and free from any oil or other deposits.**
- **When installing the parts, make sure that the sealant is not forced out of position.**
- **Do not start the engine in less than an hour after installation.**

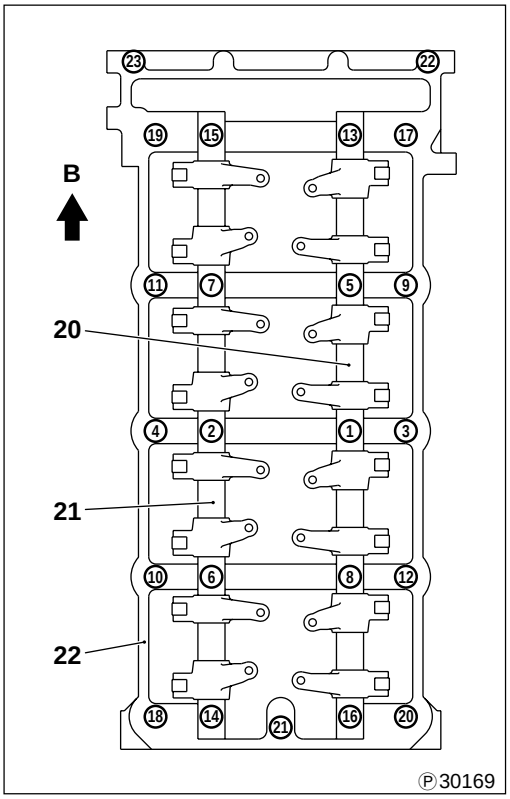
A : Locating pin



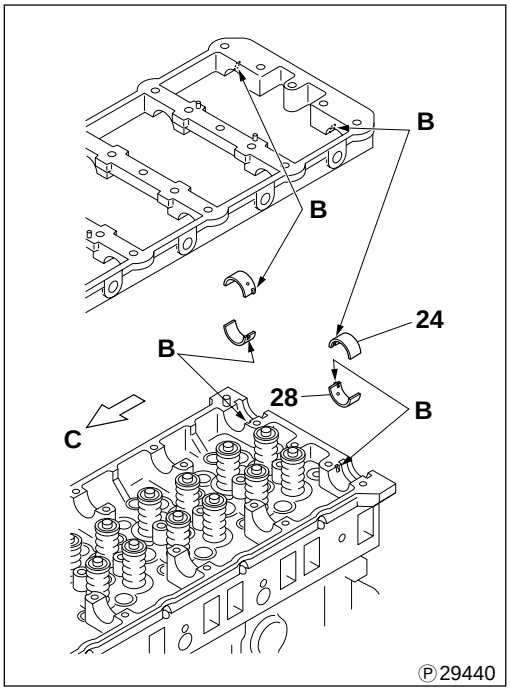
- The bolts **18** (× 13) and **19** (× 10) must be tightened in the following sequence. Therefore, secure the rocker shaft assemblies **20** and **21** together with the camshaft frame **22**.

CAUTION ⚠

When the bolts 18 and 19 were loosened or removed after installation, be sure to re-apply sealant.



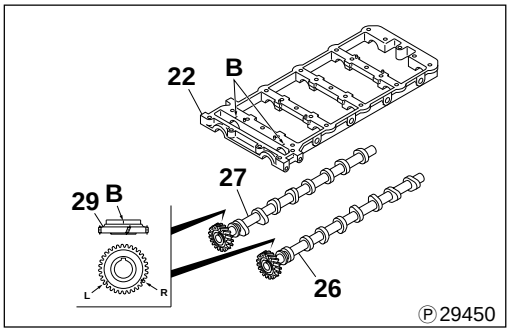
- Tighten the bolts **18** and **19** (① through ㉓) to the specified torque in the numbered sequence shown in the illustration.



24 **28** **Installation of camshaft bearings**

Be sure to fit the lugs **B** of the camshaft bearings **24** and **28** in the mating notches.

C : Front of engine

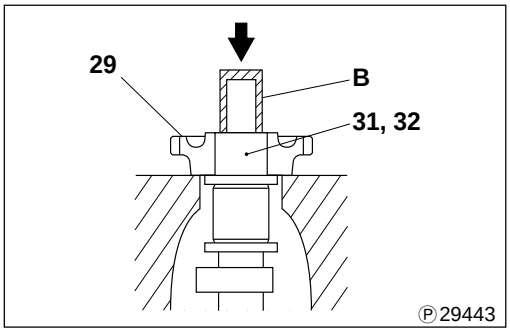


26 **27** **Installation of camshaft assemblies**

- Place the piston of No. 1 cylinder at the top dead center on the compression stroke.
- Install the camshaft assemblies **26** and **27** with the alignment marks **B** on the camshaft gear **29** and on the camshaft frame **22** in alignment.

NOTE

The alignment marks "L" and "R" on the camshaft gear 29 and those on the head idler gears need not always be in alignment, because the alignment mark of the head idler gears, depending on their mounted condition, does not always match that of the camshaft gear.



29 **Camshaft gear**

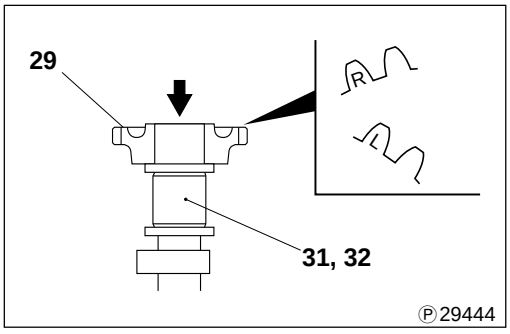
[Removal]

Remove the camshaft gear **29** by pressing the camshaft end with a press.

B : Removal block

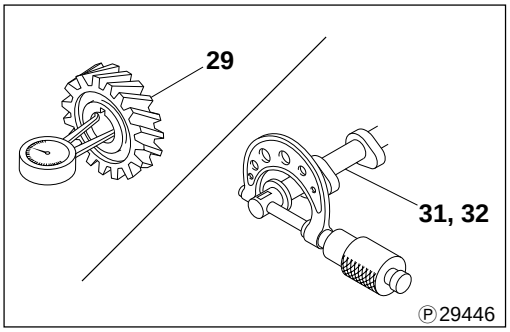
CAUTION ⚠

Never strike the camshaft gear 29 with a hammer to remove it. Be sure to use a press or a similar tool.



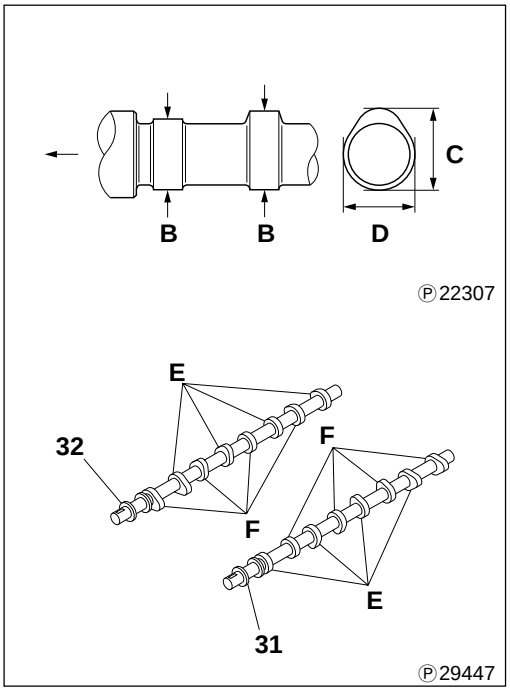
[Installation]

- Heat the camshaft gear **29** to 150 °C {302°F} by a piston heater or a similar tool and install it with the alignment mark "R" or "L" directed as shown.
- Install the camshaft gear **29** such that it is held tightly against the camshaft **31** or **32**.



29 31 32 Camshaft gear and camshaft interference

If the reading is out of the standard values, replace defective parts.



31 32 Inspection of camshafts

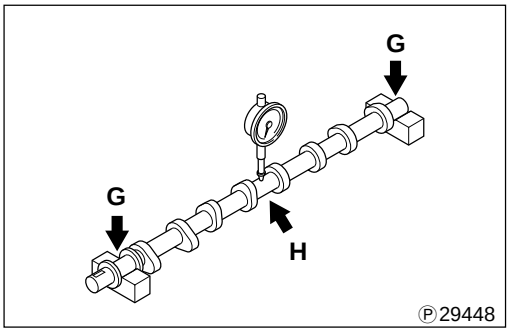
(1) Cam lift (Difference between lobe height and base circle diameter)

If the reading is less than the limit, replace the camshafts **31** and **32**.

B : Measuring position
C : Cam lobe height
D : Base circle diameter
E : Long rocker side cam
F : Short rocker side cam

NOTE

The cam dimensions are different between the long rocker side cams E and the short rocker side cams F.

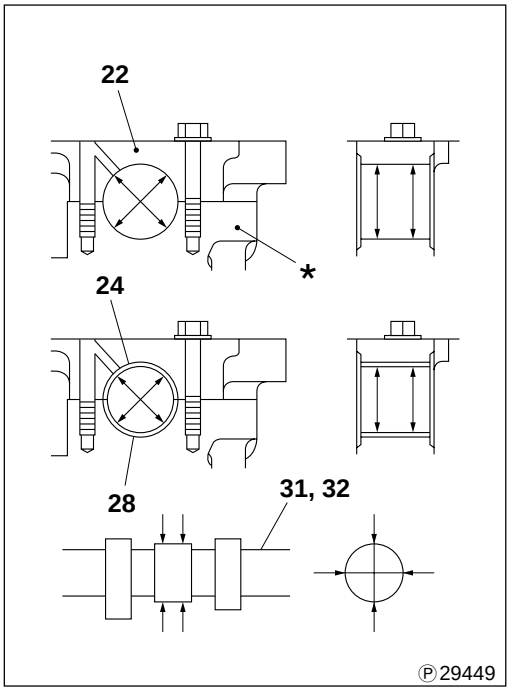


(2) Bend

Measure the bend of the camshafts **31** and **32** at the journal **H** with the journals **G** supported. If the reading is in excess of the limit, replace the camshaft.

NOTE

The bend of the camshafts 31 and 32 is one half of the reading of the dial indicator taken after turning the camshaft through a rotation.



(3) Oil clearance between journals and bearings

Measure the oil clearance. If the reading is in excess of the limit, replace defective parts.

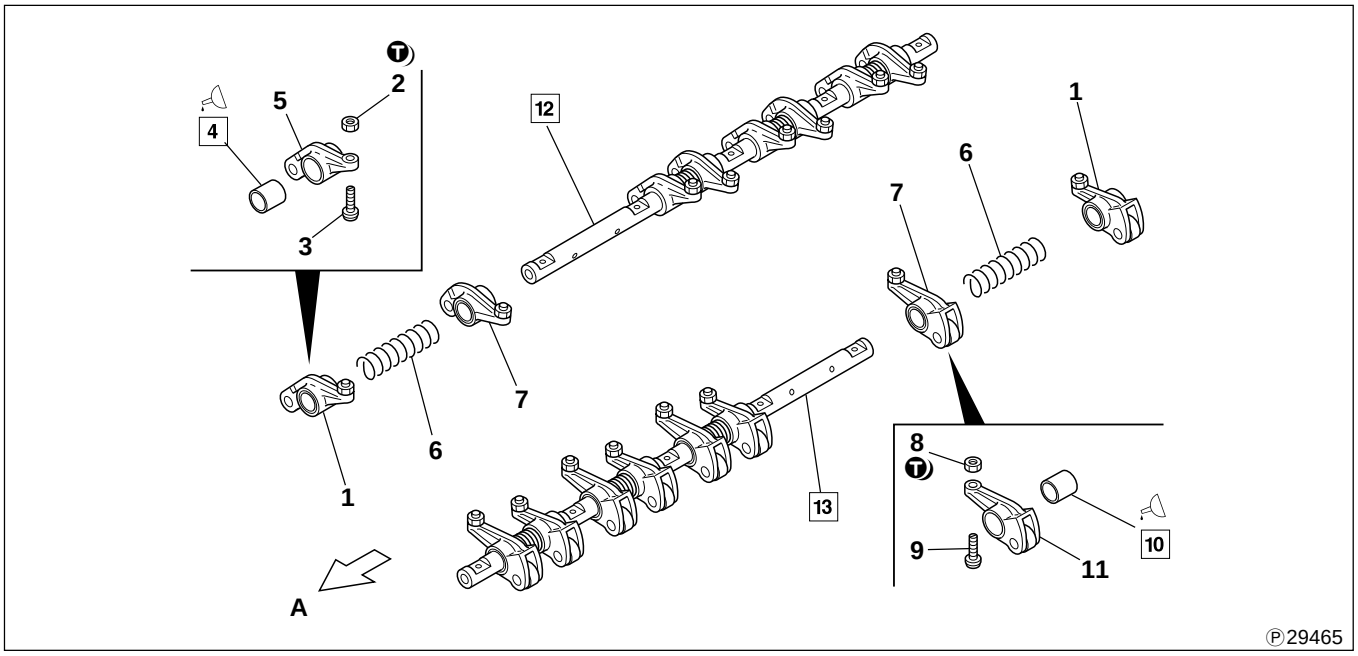
CAUTION ⚠

If a camshaft bearing 24 or 28 is to be replaced, make sure that both upper and lower halves are simultaneously replaced as a pair.

MEMO

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS

Rocker Shaft and Rocker Assembly



● Disassembly sequence

1 Short rocker assembly
2 Lock nut
3 Adjusting screw
4 Rocker bushing
5 Short rocker
6 Rocker shaft spring
7 Long rocker assembly
8 Lock nut
9 Adjusting screw
10 Rocker bushing
11 Long rocker
12 Exhaust rocker shaft
13 Inlet rocker shaft

A : Front of engine

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

The rockers come in two types; short rocker assembly 1 and long rocker assembly 7. Note the difference in mounting sequence between the inlet and exhaust rocker shafts.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1, 7	Radial play of rocker assembly rollers	0.038 to 0.100 {0.0014 to 0.0039}	–	Replace
4, 10, 12, 13	Clearance between rocker bushing and rocker shaft	[22 {0.87}] 0.01 to 0.08 {0.0039 to 0.0031}	0.12 {0.0047}	Replace

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

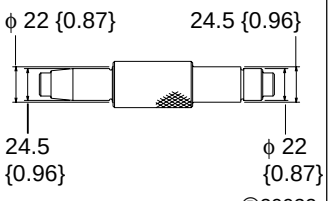
Location	Parts to be tightened	Tightening torque	Remarks
2, 8	Lock nut (securing adjusting screw)	11.2 {8.24, 1.14}	

Lubricant

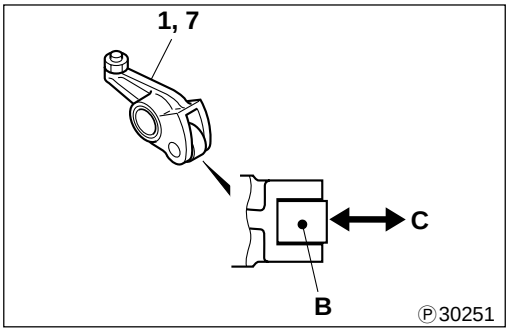
Location	Points of application	Specified lubricant	Quantity
4, 10	Inside of rocker bushing	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4, 10	Rocker Bushing Puller 	Use Equivalent	Installation and removal of rocker bushing

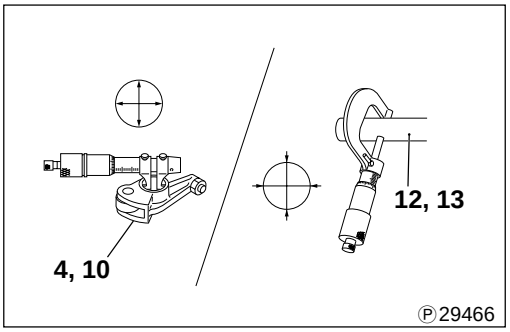
◆ Service procedure



1 **7** **Inspection of rocker assemblies**

If the play **C** of the roller **B** of the rocker assembly **1** or **7** are out of the standard values, replace the assembly.

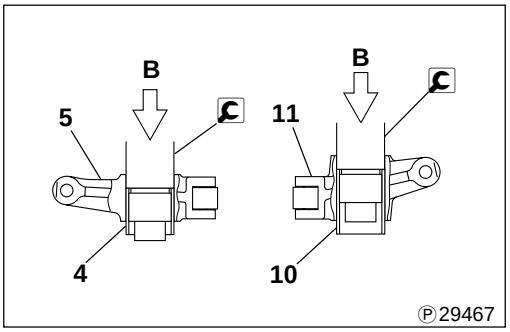
C : Radial play



4 **10** **12** **13** **Rocker bushing and rocker shaft**

[Inspection]

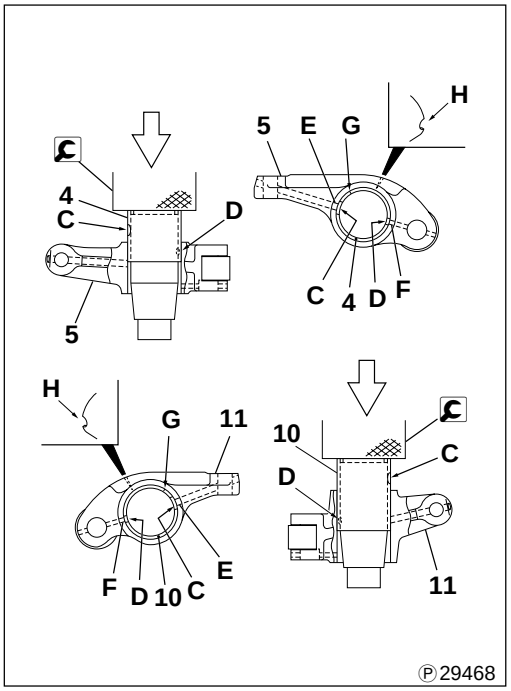
If the clearance is in excess of the limit, replace defective parts.



Rocker bushing

[Removal]

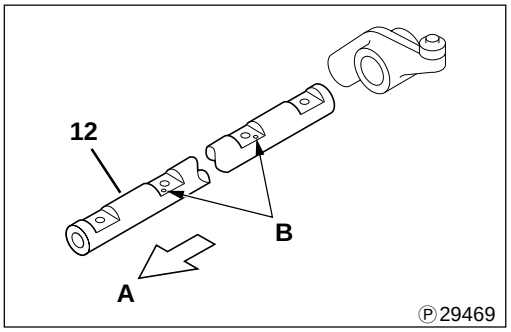
: Rocker Bushing Puller
B : Press



[Installation]

Install the rocker bushings **4** and **10** on the rockers **5** and **11** in the illustrated direction.

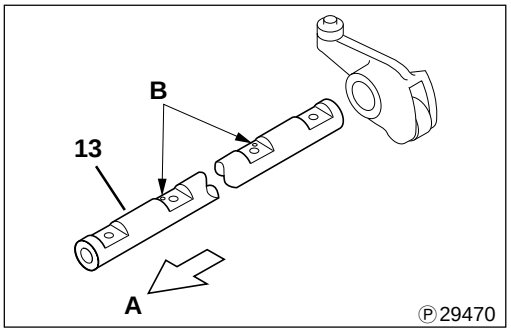
- **: Rocker Bushing Puller
- **C :** Rocker bushing oil hole
- **D :** Rocker bushing oil hole
- **E :** Rocker oil hole
- **F :** Rocker oil hole
- **G :** Rocker bushing clinch (seam)
- **H :** Rocker bushing notch (rear side)



12 Installation of exhaust rocker shaft

Install the exhaust rocker shaft **12** in the illustrated direction.

- **A :** Front of engine
- **B :** Camshaft frame locating pin mounting hole



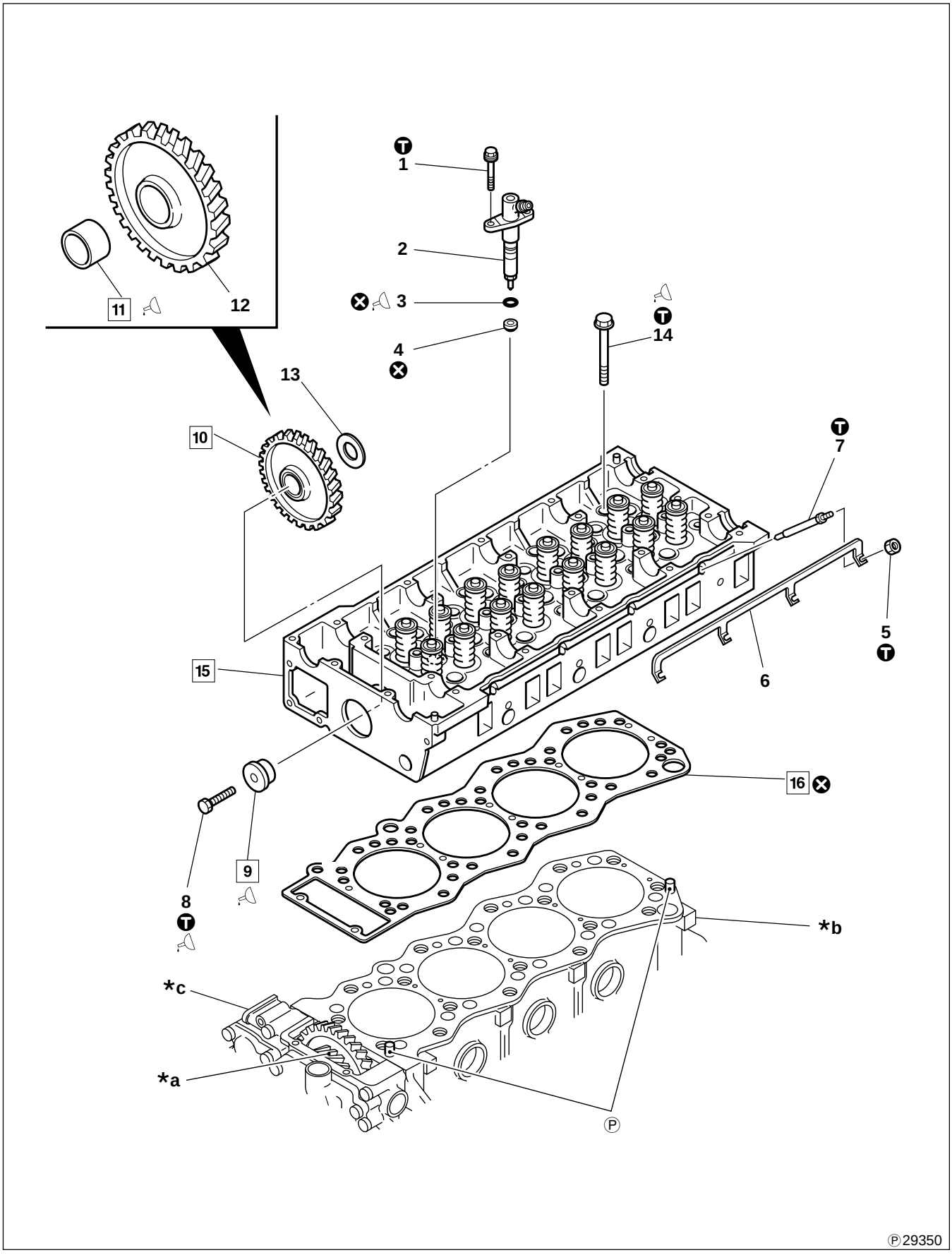
13 Installation of inlet rocker shaft

Install the inlet rocker shaft **13** in the illustrated direction.

- **A :** Front of engine
- **B :** Camshaft frame locating pin mounting hole

MEMO

CYLINDER HEAD AND VALVE MECHANISM



● **Pre-disassembly inspection**

P11A-40

● **Disassembly sequence**

1 Bolt
2 Injection nozzle Gr13A
3 O-ring
4 Nozzle tip gasket
5 Nut
6 Connecting plate
7 Glow plug
8 Bolt
9 Head idler shaft
10 Head idler gear assembly
11 Head idler gear bushing
12 Head idler gear
13 Thrust plate
14 Cylinder head bolt
15 Cylinder head assembly
P11A-44
16 Cylinder head gaskect

***a:** Idler gear assembly
P11A-56
***b:** Upper crankcase
P11A-80
***c:** Front case assembly
P11A-52

Ⓟ : Locating pin
⊗ : Non-reusable part

CAUTION ⚠

The cylinder head bolts 13, 14 utilize the torque-turn tightening method. Any cylinder head bolt that has apparently been tightened three times already must be replaced with a new one. **P11A-41**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
9, 11	Head idler shaft and head idler gear bushing clearance	[32 {1.26}] 0.01 to 0.05 {0.00039 to 0.002}	0.1 {0.0039}	Replace

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

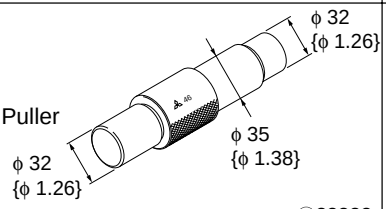
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (injection nozzle installation)	14.7 {11, 1.5}	–
5	Nut (connection plate installation)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	–
7	Glow plug	22.6 {17, 2.3}	–
8	Bolt (Head idler shaft installation)	44.1 {33, 4.5}	Wet
14	Cylinder head bolt	147 {110, 15} + 90°	Wet

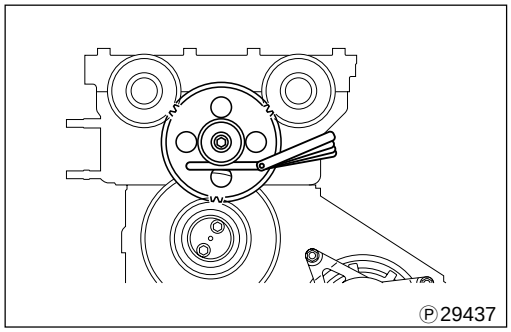
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	O-ring	Engine oil	As required
8	Thread and bearing surface of bolt	Engine oil	As required
9	Outer surface of head idler shaft	Engine oil	As required
***c**	Upper surface of joint section between front case assembly and crankcase assembly and cylinder head gasket contacting surface	Threebond 1211	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
11	Idler Gear Bushing Puller  Ⓟ22322	MH061779 (Obtain Locally)	Removal and installation of idler gear bushing

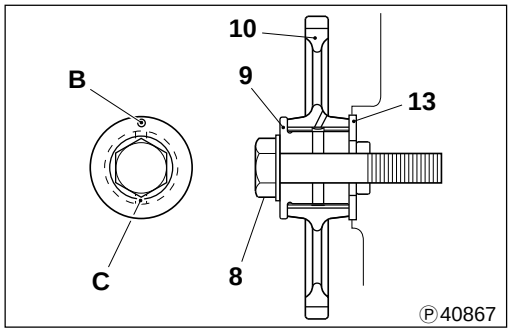

Ⓟ29437

◆ Service procedure

● **Pre-disassembly inspection**

End play of head idler gear assembly

If any measurement exceeds the specified limit, replace the defective part(s).



Ⓟ40867

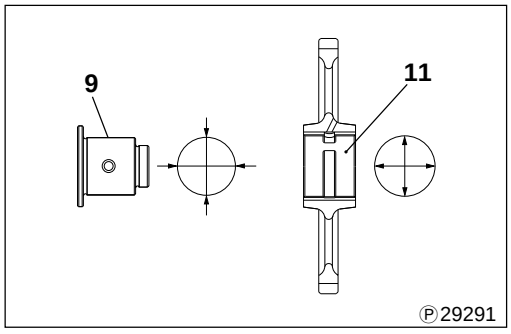
9 **Installing head idler shaft**

Install the head idler shaft **9** as illustrated.

B : Depression
C : Oil hole

CAUTION ⚠

Don't forget to install the thrust plate 13.

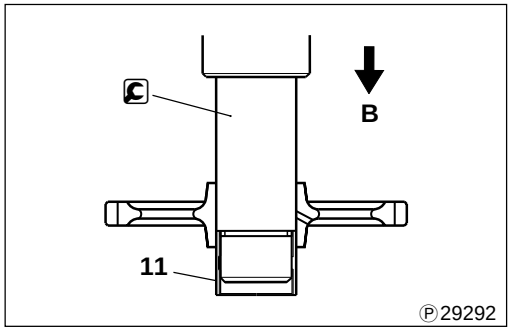


Ⓟ29291

9 **11** **Head idler shaft and head idler gear bushing**

[Inspection]

If the clearance exceeds the specified limit, replace the defective part(s).

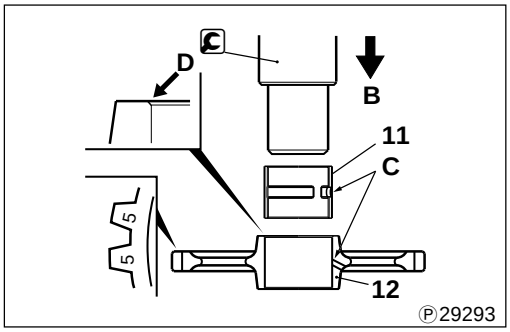


Ⓟ29292

Head idler gear bushing

[Removal]

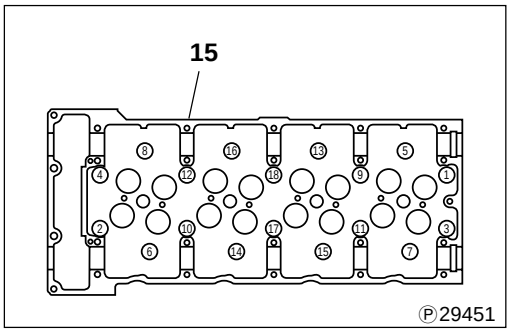
B : Press
Special tool : Idler Gear Bush Puller



[Installation]

- Fit the idler gear bushing **11** in the head idler gear **12** in the illustrated direction so that the oil holes **C** may be aligned with each other when press-fitted.
- Using the C Idler Gear Bush Puller, press the bushing into the head idler gear **12** until its end face becomes flush with the chamfered end **D** of the gear.

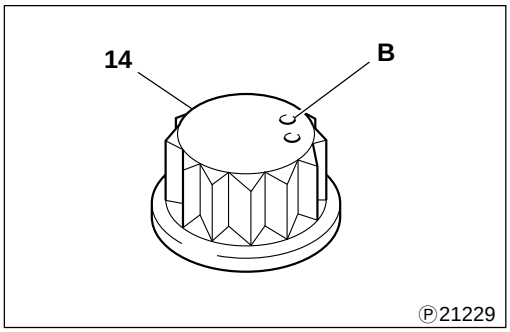
  B : Press
- After press-fitting, measure the clearance again. If the measurement is below the specified limit, ream the head idler gear bushing **11** to the standard value.



15 Cylinder head assembly

[Removal]

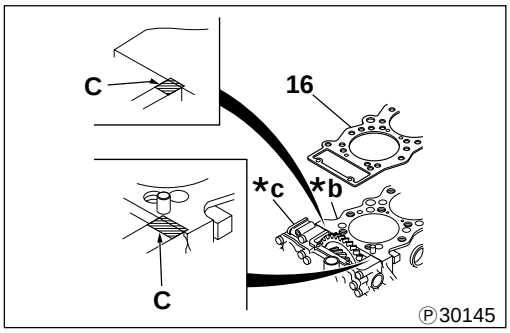
Loosen and remove the cylinder head bolts **14** in the sequence shown (① to ㉒). Each cylinder head bolt should be loosened a little at a time.



[Fitting]

CAUTION ⚠

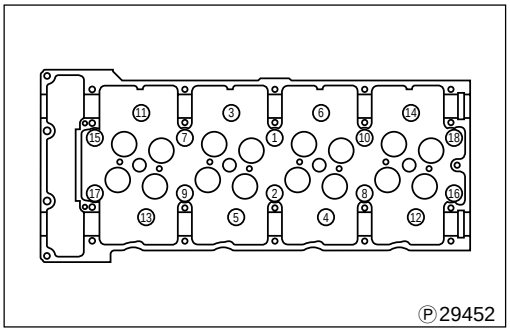
- **Before fitting any cylinder head bolt 14, check the punch marks B on its head. Do not use bolt if there are more than two punch marks.**
- **The punch marks indicate the number of times each bolt has been tightened using the torque-turn tightening method. Any bolt that already has three punch marks must be replaced.**



- Select an appropriate cylinder head gasket **16**. 📖 P11A-42
- Apply a coat of specified sealant to the upper surface **C** of the joint section between the frontcase assembly ***c** and the crankcase assembly ***b**.
- Within 3 minutes after the sealant application, install the cylinder head assembly to the crankcase assembly ***b** together with the cylinder head gasket **16**.

CAUTION ⚠

- **Check to ensure that the sealant application surface C is clean and free of oil and other foreign matter.**
- **During installation of the cylinder head assembly, use care to ensure that the sealant is kept in place.**
- **Do not start the engine for at least 1 hour after the cylinder head assembly is installed.**
- **Whenever the cylinder head bolt 14 is loosened or removed after the cylinder head assembly has been installed, always apply a fresh coat of specified lubricant.**

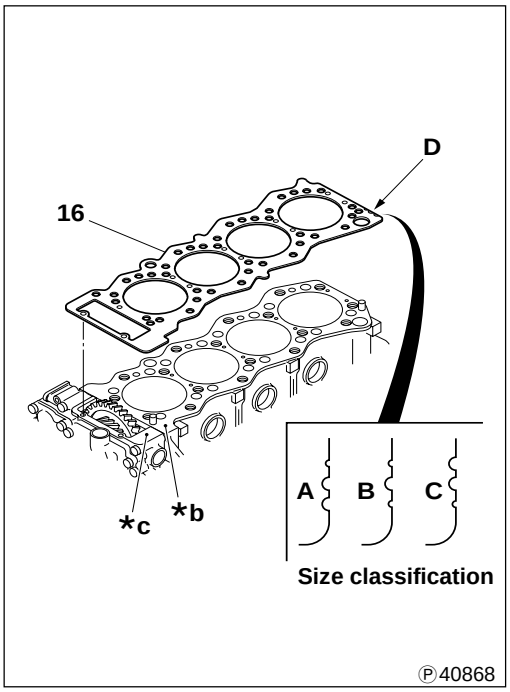


Ⓟ29452

- Tighten the cylinder head bolts **14** (① through ⑱) to a torque of 145 N·m {110 ft.lbs, 15 kgf·m}(wet) in the sequence shown.
  After tightening,give the bolts an additional 90 degree turn in the sequence of the numbers shown.
- After tightening the cylinder head bolts **14** using the torque-turn tightening method, make a punch mark on the head of each one to indicate the times of use.

CAUTION ⚠

Since the cylinder head bolts utilize the torque-turn tightening method, they must not be tightened further after the angular tightening procedure has been performed.



Ⓟ40868

16 Cylinder head gasket

[Removal]

CAUTION ⚠

Be careful not to scratch cylinder head assembly 15, the crankcase assembly *b and the front case assembly *c when removing cylinder head gasket 16.

[Installation]

Cylinder head gasket **16** installed must be the one which can accommodate the piston projection. Select such a gasket as follows:

- Measure the piston projection at each cylinder. 🕮 P11A-66
- Select a cylinder head gasket **16** appropriate for the piston projection average value from the following table.
- If any of the piston projection measurements is more than 0.05 mm {0.002 in.} larger than the average value, then use the gasket one rank higher than that rank (**A** → **B**, **B** → **C**).

Unit: mm {in.}

Average value of piston projection	Cylinder head gasket	
	Size classification	Thickness when tightening
–0.088 to –0.027 {–0.0034 to 0.0106}	A	0.75 ± 0.03 {0.029 ± 0.0012}
–0.027 to –0.033 {–0.0106 to 0.0129}	B	0.80 ± 0.03 {0.031 ± 0.0012}
–0.035 to –0.094 {–0.0129 to 0.0370}	C	0.85 ± 0.03 {0.033 ± 0.0012}

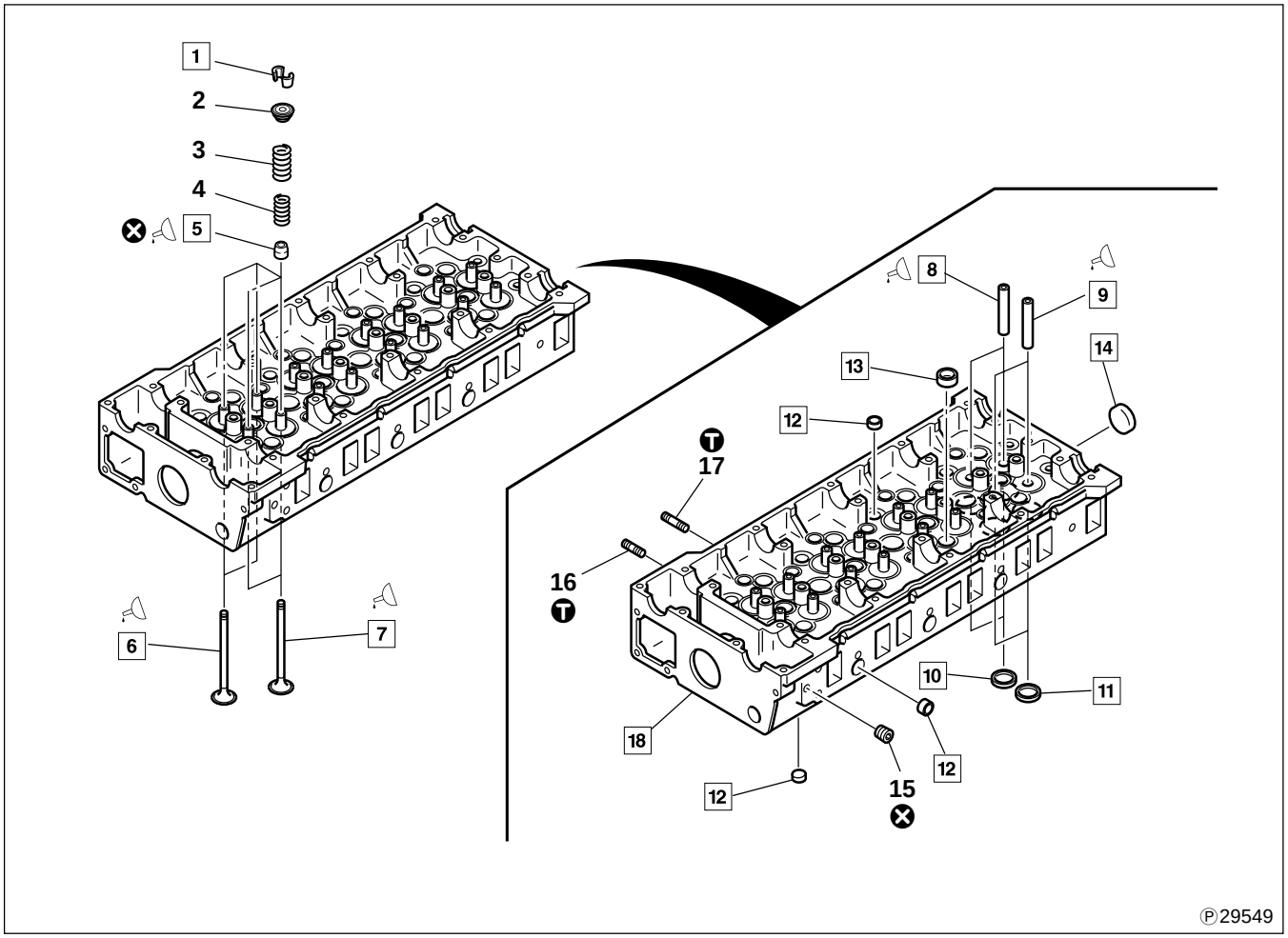
- The classification (size) of the cylinder head gasket **16** can be known from the shape of the notches **D** cut in the gasket edge.
- Install the cylinder head gasket **16** on the crankcase ***b** in the direction as illustrated.

  E : Part number

MEMO

CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head Assembly



● **Disassembly sequence**

1 Valve collets
2 Upper retainer
3 Outer valve spring
4 Inner valve spring
5 Valve stem seal
6 Exhaust valve
7 Inlet valve
8 Exhaust valve guide
9 Inlet valve guide
10 Exhaust valve seat
11 Inlet valve seat
12 Sealing cup plug (22 mm {ϕ 0.87 in.})
13 Sealing cup plug (30 mm {ϕ 1.18 in.})
14 Sealing cup plug (40 mm {ϕ 1.57 in.})
15 Taper plug
16 Stud (short)
17 Stud (long)
18 Cylinder head

⊗ **:** Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Any valve stem seal 5 removed from an exhaust valve 6 or inlet valve 7 must be replaced.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
3	Outer valve spring	Free length	87.8 {3.45}	–	Replace
		Installed load (at 57 {2.24} installed length)	360N {36.7 kgf}	–	Replace
		Squareness	–	2.5 {0.098}	Replace
4	Inner valve spring	Free length	78.8 {3.10}	–	Replace
		Installed load (at 52.3 {2.05} installed length)	168N {17.1 kgf}	–	Replace
		Squareness	–	2.5 {0.098}	Replace
6	Exhaust valve	Stem outside diameter	$\phi 8\ ^{-0.060}_{-0.075}$ {$\phi 0.31\ ^{-0.0024}_{-0.0029}$}	–	Replace
		Sinkage from cylinder head bottom surface	0.2 ± 0.25 {0.0079 ± 0.00098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45°	–	Correct
6, 8	Exhaust valve stem-to-valve guide clearance		[8 {0.31}]0.07 to 0.10 {0.0028 to 0.0039}	0.2 {0.0079}	Replace
7	Inlet valve	Stem outside diameter	$\phi 8\ ^{-0.025}_{-0.040}$ {$\phi 0.31\ ^{-0.00098}_{-0.00160}$}	–	Replace
		Sinkage from cylinder head bottom surface	0.2 ± 0.25 {0.0079 ± 0.00098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45°	–	Correct
7, 9	Inlet valve stem-to-valve guide clearance		[8 {0.31}] 0.03 to 0.06 {0.0012 to 0.0024}	0.2 {0.0079}	Replace
10	Exhaust valve seat width		2.5 ± 0.2 {0.098 ± 0.0079}	3.5 {0.13}	Correct or replace
11	Inlet valve seat width		2 ± 0.2 {0.079 ± 0.0079}	2.8 {0.11}	Correct or replace
18	Cylinder head	Bottom surface distortion	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Height from top to bottom surface	107 ± 0.5 {4.21 ± 0.02}	106.5 {4.19}	Replace

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

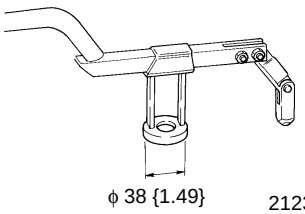
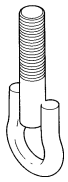
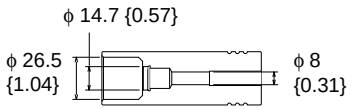
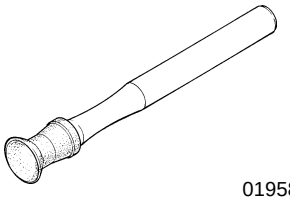
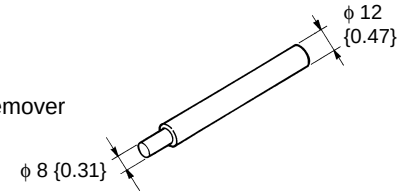
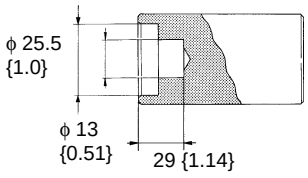
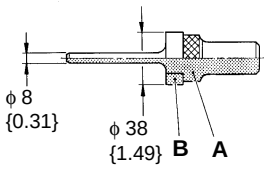
Location	Parts to be tightened	Tightening torque	Remarks
15	Taper plug	14 {10, 1.4}	–
16, 17	Stud	20 {14, 2.0}	–

Lubricant and/or sealant

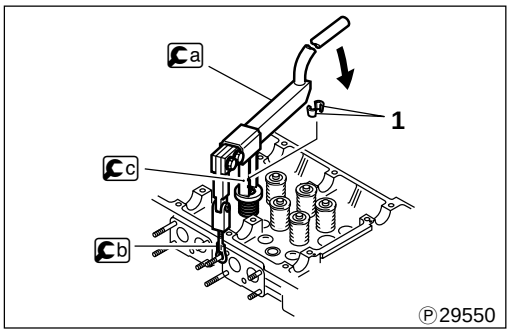
Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Lip of valve stem seal	Engine oil	As required
6,7	Valve stem	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
1	A: Valve Lifter B: Valve Lifter Seat 	Obtain Locally	Removing and installing valve cotters
	Valve Lifter Hook 	Use Equivalent	
5	Valve Stem Seal Installer 	Use Equivalent	Installing valve stem seals
6, 7	Valve Lapper 	Obtain Locally	Lapping inlet and exhaust valves and valve seats
8, 9	Valve Guide Remover 	Obtain Locally	Removing valve guides
	Valve Guide Installer 	MH063604	Installing valve guides
10, 11	**A**: Caulking Tool Body **B**: Caulking Ring 	Use Equivalent	Installing inlet and exhaust valve seats

◆ Service procedures



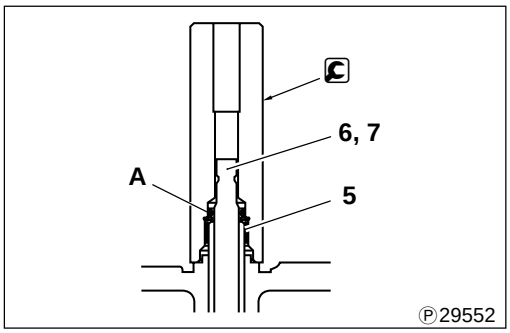
1 Valve keepers

[Removal]

To remove the valve keepers **1**, use the a Valve Lifter, b Valve Lifter Hook and c Valve Lifter Seat to evenly compress the valve springs **3**, **4**.

[Installation]

To install valve keepers, follow the removal instructions in reverse.

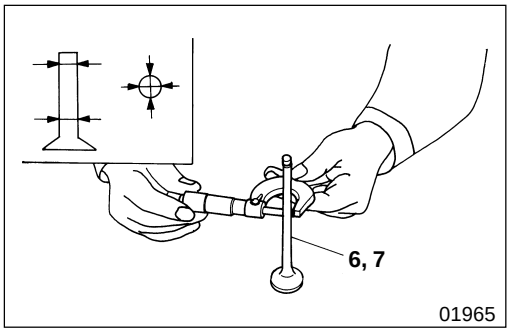


5 Installing valve stem seals

- Apply engine oil to the lip **A** of the valve stem seal **5**.
- Install the valve stem seal **5** using the Valve Stem Seal Installer.
- Strike the Valve Stem Installer until it sits snugly on the cylinder head **18**.

CAUTION ⚠

After installing the valve stem seal 5, check that its spring area is neither deformed nor damaged.



6 7 Inlet and exhaust valves

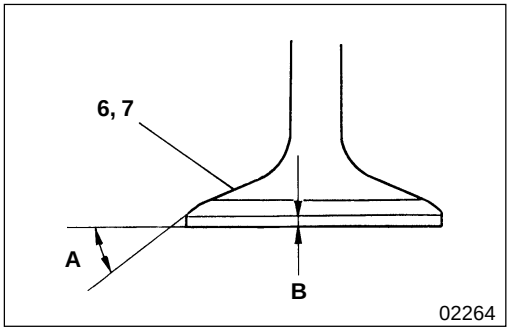
[Inspection]

(1) Valve stem outside diameter

Replace the valve **6**, **7** if its stem's outside diameter is below specification or severely worn.

CAUTION ⚠

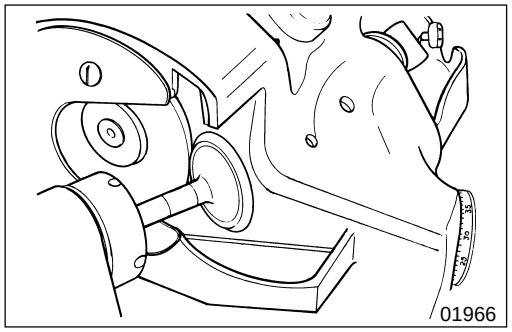
Whenever a valve 6, 7 is replaced, be sure to lap the valve and valve seat 10, 11. P11A-49



(2) Valve seat angle and valve margin

Reface or replace the valve **6**, **7** if the valve seat angle or valve margin exceeds the specified limits.

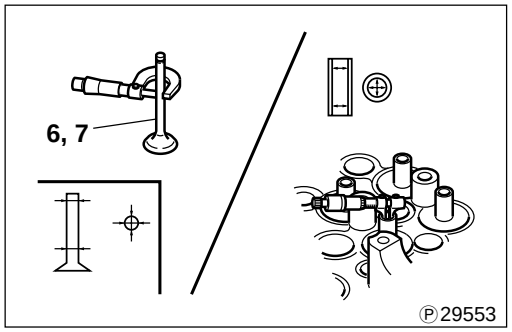
A : Valve seat angle
B : Valve margin



[Refacing]

NOTE

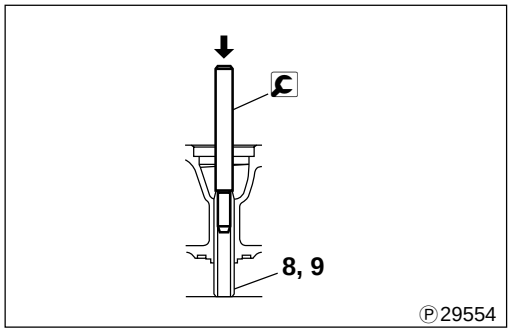
- **Keep grinding to a minimum.**
- **If the valve margin is below specification after grinding, replace the valve 6, 7.**
- **After grinding, be sure to lap the valve 6, 7 and valve seat 10, 11.** **P11A-45**



6 to 9 Valve and valve guides

[Inspection]

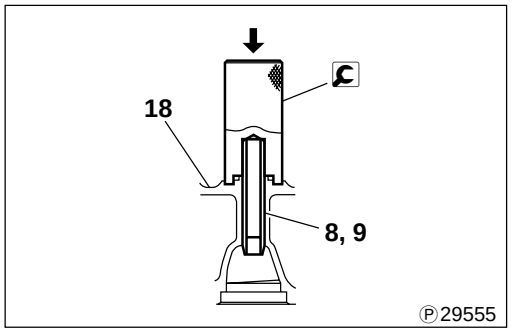
If any clearance exceeds the specified limit, replace the defective part(s).



Valve guides

[Removal]

: Valve Guide Remover

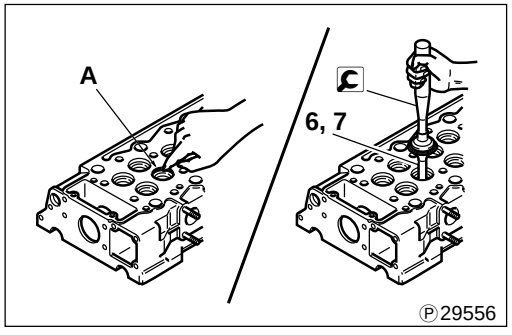


[Installation]

Using the Valve Guide Installer, install the valve guide **8**, **9** until the tool sits snugly on the cylinder head **18**.

CAUTION

- **The valve guides 8, 9 must be pressed in to the specified depth.Be sure to use the Valve Guide Installer for this operation.**
- **Exhaust valve guides 8 are longer than inlet valve guides 9.Be sure to install the correct type of guide in each location.**



6 7 10 11 Valves and valve seats

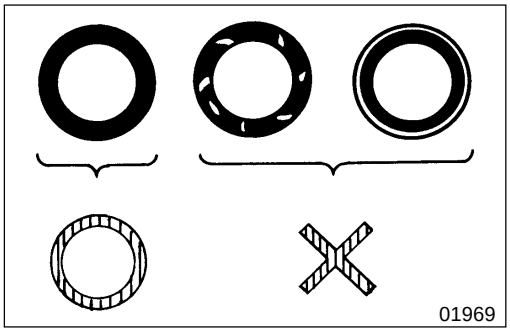
[Inspection]

- Apply an even coat of prussian blue to the valve seat **10**, **11** surface **A** that makes contact with the valve **6**, **7**.
- Strike the valve **6**, **7** against the valve seat **10**, **11** once. Do not rotate the valve during this operation.

: Valve Lapper

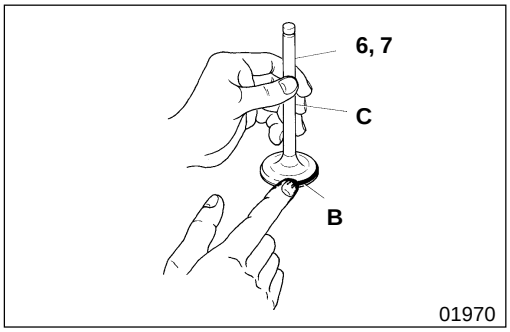
NOTE

Carry out these inspections after inspecting the valves 6, 7 and valve guides 10, 11.



- If the prussian blue deposited on the valve **6**, **7** indicates a poor contact pattern, rectify the contact pattern as follows:

Contact	Corrective action
Minor defect	Lapping
Serious defect	Reface or replace valve and valve seat



[Lapping]

Lap the valve in accordance with the following procedure:

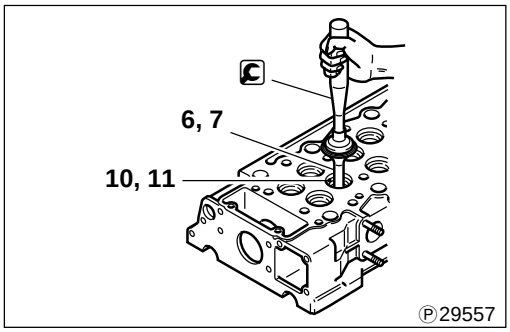
- Apply a thin, even coat of lapping compound to the surface **B** of the valve **6**, **7** that makes contact with valve seat **10**, **11**.

CAUTION ⚠

- **Ensure that no compound adheres to the stem C of the valve 6, 7.**

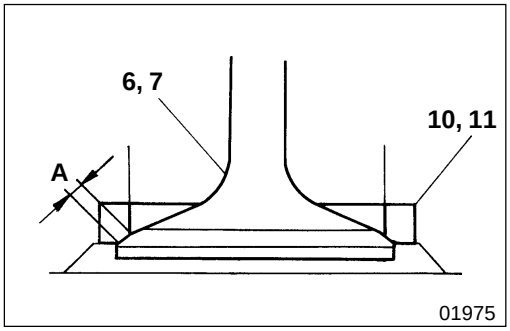
NOTE:

- **Start with intermediate-grit compound (120 to 150 grit) and finish with fine-grit compound (200 grit or more).**
- **The addition of a small amount of engine oil makes lapping compound easier to apply.**



- Strike the valve **6**, **7** against the valve seat **10**, **11** while turning it little by little.

  : Valve Lapper
- Wash away the compound with cleaning fluid.
- Apply engine oil to the contact surfaces of the valve seat **10**, **11** and rub it in so that the contact surfaces are lubricated and mate together snugly.
- Inspect the contact pattern of the valve **6**, **7** and valve seat **10**, **11** once more.
- If the contact pattern is still defective, replace the valve seat **10**, **11**.



10 **11** **Valve seats**

[Inspection]

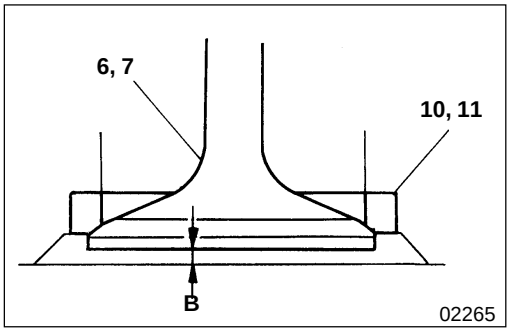
(1) Valve seat width

If the measurement exceeds the specified limit, rectify or replace the valve seat **10**, **11**.

A : Valve seat width

NOTE

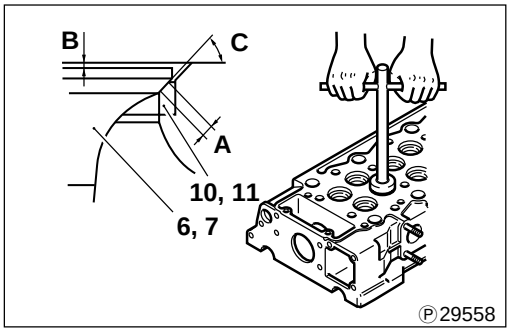
Whenever a valve seat 10, 11 is rectified or replaced, be sure to lap the valve seat and valve 6, 7.



(2) Valve sinkage from cylinder head bottom surface

If any measurement exceeds the specified limit, rectify or replace the defective part(s).

B : Valve sinkage



[Grinding]

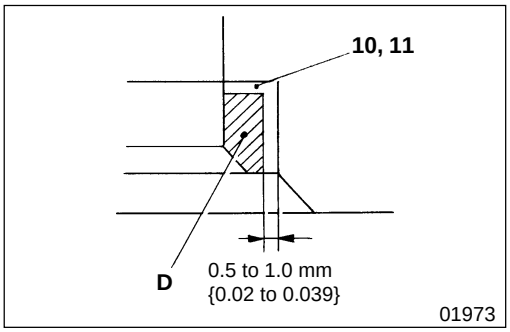
- Grind the valve seat **10**, **11** using a valve seat cutter or valve seat grinder.
- Use a 15° or 75° cutter to achieve the specified valve seat width **A** of the valve **6**, **7**.
- After grinding, put some sandpaper of around #400 grade between the cutter and valve seat and grind the valve seat lightly.

C : Valve seat angle

CAUTION ⚠

Ensure that grinding does not cause the sinkage B of the valve 6, 7 to exceed the specified limit.

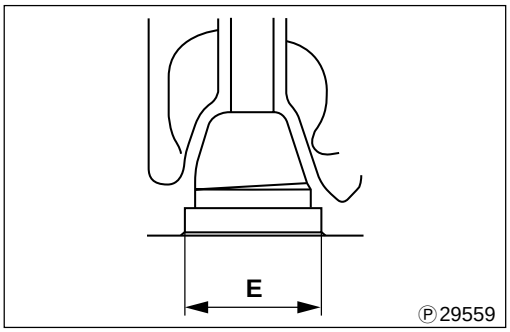
- After grinding, lap the valve **6**, **7** and valve seat **10**, **11**.
🕮 P11A-49



[Removal]

Valve seats **10**, **11** are installed by expansion fitting. To remove a valve seat, grind the inside surface to reduce its thickness, then remove the valve seat at room temperature.

D : Material to be ground

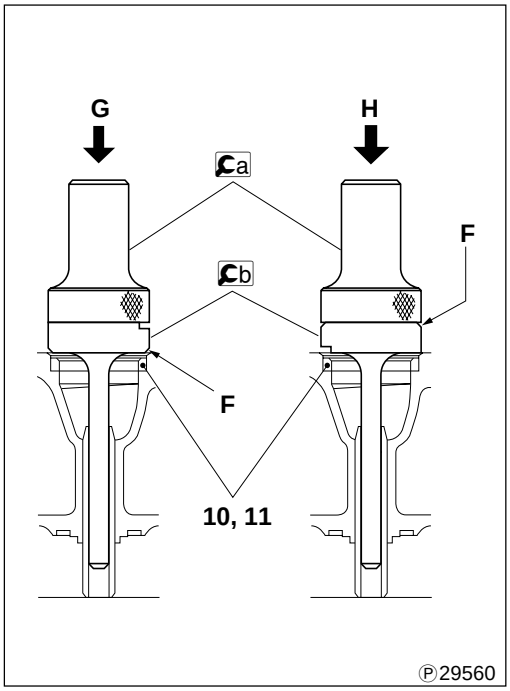


[Installation]

- Check that the valve seat hole diameter **E** in the cylinder head **18** conforms with the value shown below.

Unit: mm {in.}

	Hole diameter
Valve seat hole: **E**	$38\ ^{+0.025}_{0}$ {$1.49\ ^{+0.00098}_{0}$}



- Cool the valve seat **10**, **11** by immersing it in liquid nitrogen.
- Install the valve seat **10**, **11** in the cylinder head **18** using the a Caulking Tool Body and the b Caulking Ring.

CAUTION ⚠

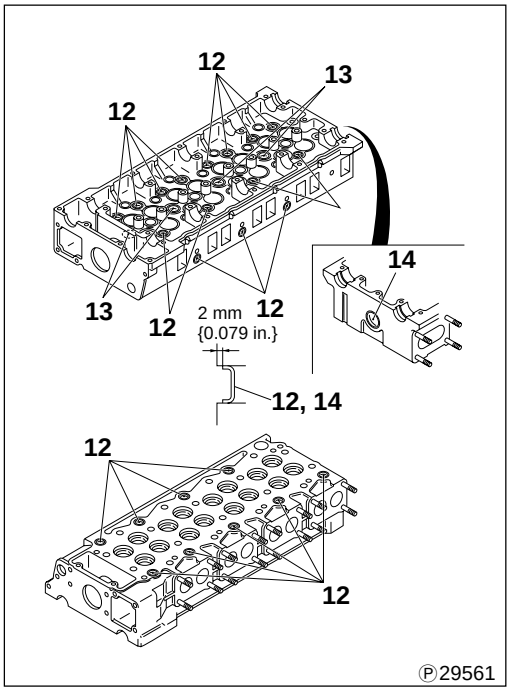
- **For installation, the chamfered side F of the b Caulking Ring must be against the valve seat 10, 11.**

G : Configuration for installation

- Invert the b Caulking Ring such that its chamfered side **F** is against the a Caulking Tool Body, then caulk the valve seat **10**, **11**.

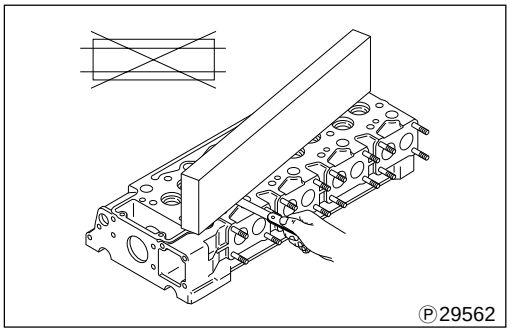
H : Configuration for caulking

- After installing the valve seat **10**, **11**, lap the valve seat and valve **6**, **7**. P11A-49



12 to 14 Installing sealing cup plugs

Drive the sealing cups **12** to **14** in the cylinder head **18** until the specified depth is reached.



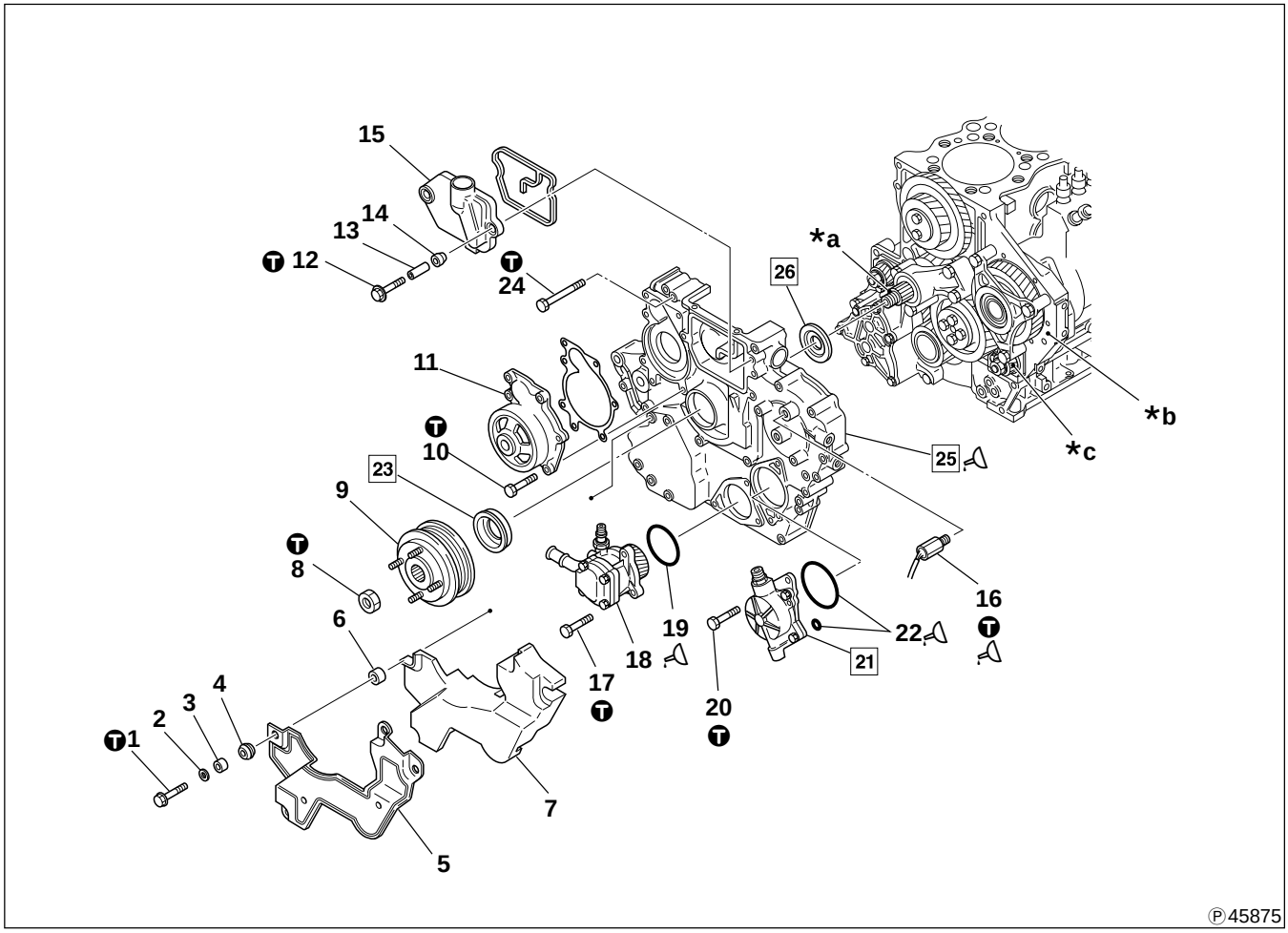
18 Inspecting cylinder head

Measure the extent of distortion in the cylinder head **18** bottom surface. If the degree of distortion exceeds the specified limit, rectify the distortion with a surface grinder.

CAUTION ⚠

Ensure that grinding does not cause the cylinder head 18 top surface-to-bottom surface distance to fall below the specified limit.

FRONT CASE



● **Disassembly sequence**

1 Bolt
2 Washer
3 Spacer
4 Insulator
5 Front case cover
6 Spacer
7 Front case rubber insulation
8 Nut
9 Fan pulley
10 Bolt
11 Water pump assembly
Gr 14A
12 Bolt
13 Spacer
14 Rubber
15 Breather cover
16 Engine speed sensor
Gr 54
17 Bolt
18 Power steering oil pump assembly
Gr 37
19 O-ring
20 Bolt
21 Vacuum pump assembly
Gr 35A
22 O-ring
23 Front oil seal
24 Bolt
25 Front case
26 Front oil seal slinger

***a:** Fan shaft assembly
P11A-56
***b:** Upper crankcase
P11A-80
***c:** Balance shaft assembly LH
P11A-56
⊗: Non-reusable part

CAUTION ⚠

- **When the vacuum pump assembly 21 is removed, be sure to follow the specified procedure. Blind removal will result in failure of the assembly being positioned with the balance shaft assembly LH *c.**
- **Do not remove the front oil seal 23 unless something wrong is evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

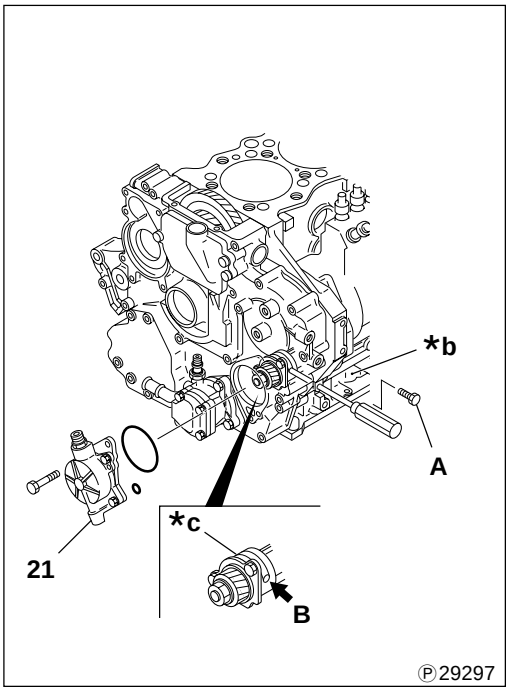
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (mounting front case cover)	2.9 to 3.9 {2.2 to 2.9, 0.3 to 0.4}	–
8	Nut (mounting fan pulley)	196.1 {145, 20.0}	–
10	Bolt (mounting water pump assembly)	23.5 {17, 2.4}	–
12	Bolt (mounting breather cover)	2.9 {2.2, 0.3}	–
16	Engine speed sensor	29.4 {22, 3.0}	–
17	Bolt (mounting power steering oil pump assembly)	23.5 {17, 2.4}	–
20	Bolt (mounting vacuum pump assembly)	23.5 {17, 2.4}	–
24	Bolt (mounting front case)	23.5 {17, 2.4}	–

Lubricant and sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
16	Threaded portion of engine speed sensor	THREEBOND 1104J	As required
19, 22	All around O-ring	Engine oil	As required
23	Lip of front oil seal	Engine oil	As required
25	Front case mounting surface	THREEBOND 1207C or D	As required



◆ Service procedure

21 Installation of vacuum pump assembly

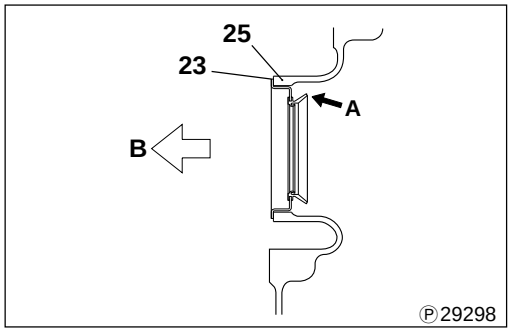
The vacuum pump assembly **21** serves also to position the balance shaft assembly LH ***c**. For this reason, before the assembly is installed, the balance shaft assembly must be kept in the right position by the following procedure.

- Place the piston of cylinder No. 1 at the top dead center on the compression stroke.
- Remove plug **A** from the upper crankcase ***b**.
- Insert a screwdriver into the hole from which the plug **A** was removed until it slightly touches the balance shaft assembly LH ***c**.

CAUTION ⚠

Be sure not to force the screwdriver in, as there is danger of damage to the No. 1 journal of the balance shaft assembly LH *c.

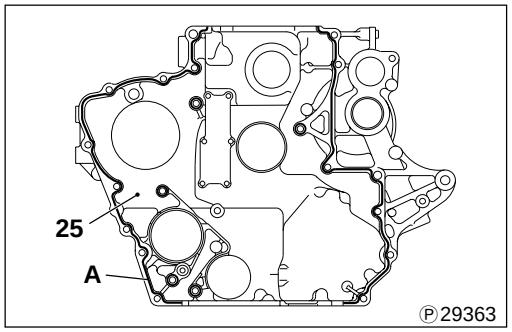
- Slowly rotate the balance shaft assembly LH ***c** to align the tip of the screwdriver with the shaft support hole **B** in the No. 1 journal of the balance shaft.
- Supporting the balance shaft by inserting the screwdriver in the hole, install the vacuum pump assembly **21**.
- After the installation, remove the screwdriver.



23 **Installation of front oil seal**

Install the front oil seal **23** on the front case **25** in the illustrated direction after applying engine oil to the lip **A**.

B : Front of vehicle

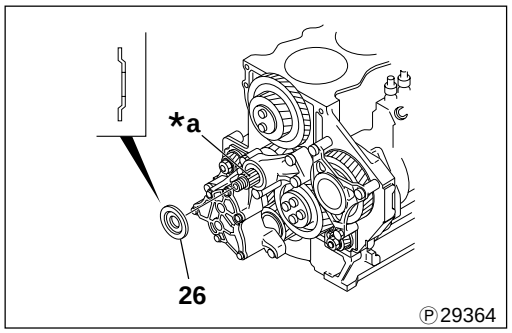


25 **Installation of front case**

- Apply sealant **A** evenly without any break to the mounting surface of the front case **25** as shown. (Approximately ϕ 1 mm {ϕ 0.0393})
- After application of sealant **A**, install the front case **25** in less than three minutes.

CAUTION ⚠

- **Check to ensure that the sealant application surface is clean and free from any oil and other deposits.**
- **When installing the parts, make sure that the sealant is not forced out of position.**
- **Do not start the engine less than an hour after installation.**
- **If the mounting bolts were loosened or removed after installation of the front case 25, be sure to re-apply sealant A.**

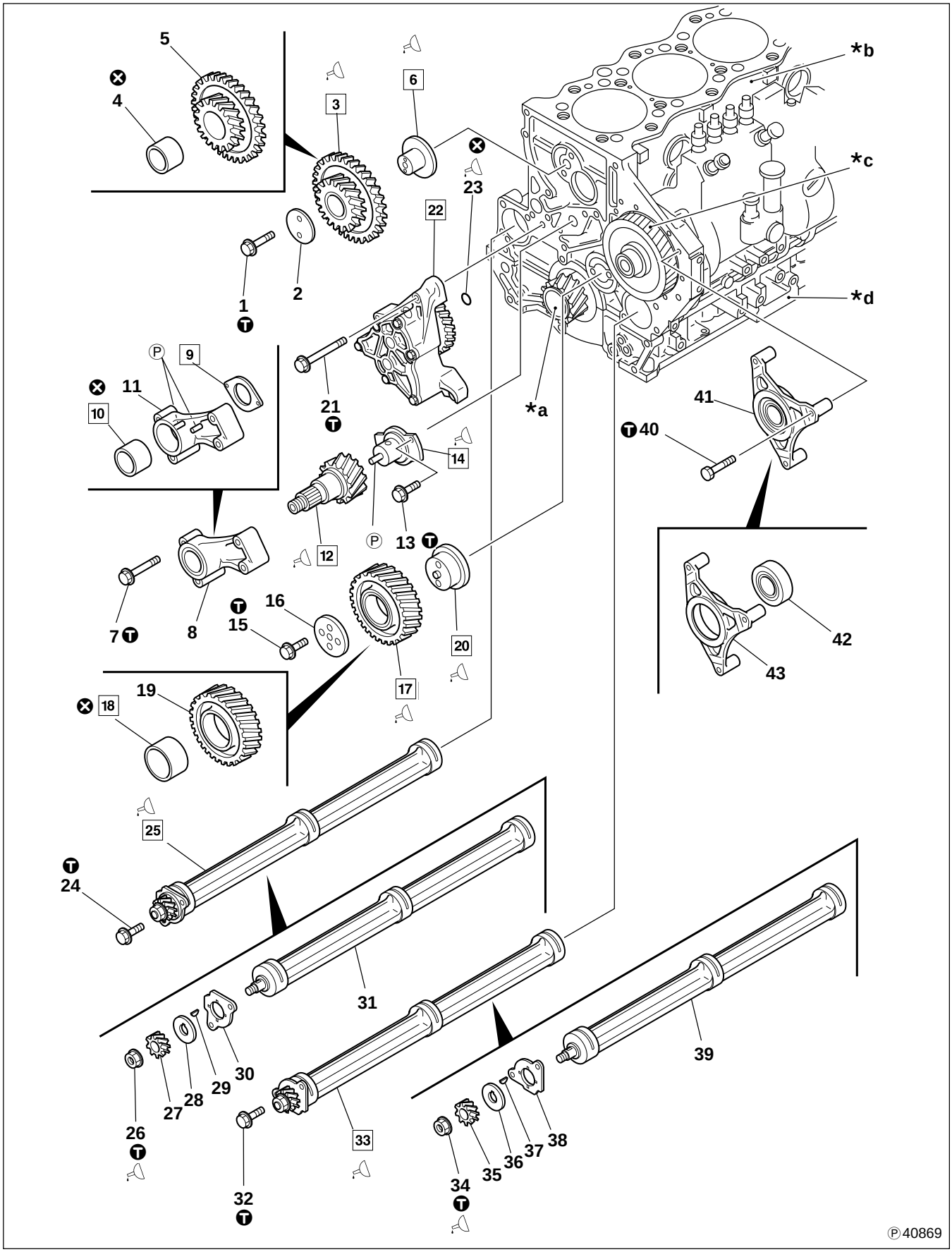


26 **Installation of front oil seal slinger**

Install the front oil seal slinger **26** on the fan shaft assembly ***a** in the illustrated direction.

MEMO

TIMING GEARS AND BALANCE SHAFTS



● **Pre-disassembly inspection**

P11A-59

● **Disassembly sequence**

1 Bolt
2 Thrust plate
3 Idler gear assembly
4 Idler gear bushing
5 Idler gear
6 Idler shaft
7 Bolt
8 Fan shaft case assembly
9 Thrust plate
10 Fan shaft case bushing
11 Fan shaft case
12 Fan shaft assembly
13 Bolt
14 Fan gear shaft
15 Bolt
16 Thrust plate
17 No. 1 idler gear assembly
18 No. 1 idler gear bushing
19 No. 1 idler gear
20 No. 1 idler shaft
21 Bolt
22 Oil pump assembly
Gr 12A
23 O-ring
24 Bolt
25 Balance shaft assembly RH
26 Nut
27 Balance shaft gear RH
28 Thrust spacer
29 Key
30 Thrust plate
31 Balance shaft RH
32 Bolt
33 Balance shaft assembly LH
34 Nut
35 Balance shaft gear LH
36 Thrust spacer
37 Key
38 Thrust plate
39 Balance shaft LH
40 Bolt
41 Injection pump bearing housing assembly
42 Bearing
43 Injection pump bearing housing

***a :** Crankshaft gear P11A-80
***b :** Upper crankcase P11A-80
***c :** Injection pump gear Gr 13A
***d :** Lower crankcase P11A-80

Ⓟ **:** Locating pin
⊗ **:** Non-reusable part

CAUTION ⚠

For details on the balance shaft removal and installation procedures, refer to P11A-88.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

TIMING GEARS AND BALANCE SHAFTS

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
–	Backlash between gears	Idler gear assembly and fan shaft assembly	0.09 to 0.13 {0.0035 to 0.0051}	0.3 {0.012}	Replace
		Fan shaft assembly and No. 1 idler gear assembly	0.06 to 0.10 {0.0024 to 0.0039}	0.3 {0.012}	
		No. 1 idler gear assembly and crankshaft gear	0.11 to 0.13 {0.0043 to 0.0051}	0.3 {0.012}	
		No. 1 idler gear assembly and injection pump gear	0.09 to 0.12 {0.0035 to 0.0047}	0.3 {0.012}	
		Crankshaft gear and oil pump gear	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	
		Balance shaft gear RH and oil pump gear	0.19 to 0.22 {0.0075 to 0.0087}	0.3 {0.012}	
–	End play of each gear and shaft	Idler gear assembly	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Replace
		Fan shaft assembly	0.07 to 0.19 {0.0028 to 0.0075}	0.3 {0.012}	
		No. 1 idler gear assembly	0.15 to 0.25 {0.0059 to 0.0098}	0.3 {0.012}	
		Balance shaft RH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
		Balance shaft LH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
4, 6	Clearance between idler gear bushing and idler shaft		[51 {2.0}] 0.02 to 0.06 {0.00079 to 0.0024}	0.1 {0.0039}	Replace
10, 12	Clearance between fan shaft case bushing and fan shaft assembly		[41 {1.61}] 0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
12, 14	Clearance between fan shaft assembly and fan gear shaft		[36 {1.41}] 0.01 to 0.05 {0.00039 to 0.0020}	0.1 {0.0039}	Replace
18, 20	Clearance between No. 1 idler gear bushing and No. 1 idler shaft		[59 {2.32}] 0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
25	Bend of balance shaft assembly RH		0.025 {0.00098}	0.05 {0.002}	Replace
33	Bend of balance shaft assembly LH		0.025 {0.00098}	0.05 {0.002}	Replace

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

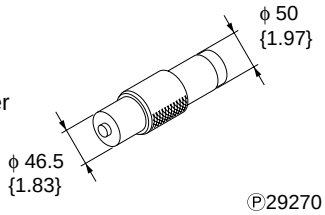
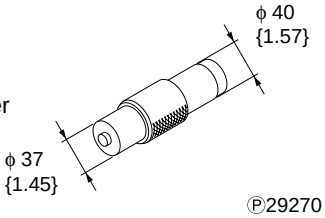
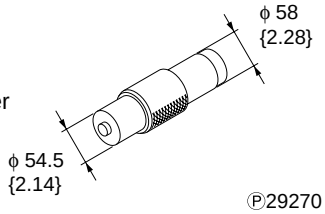
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (mounting idler shaft)	23.5 {17, 2.4}	–
7	Bolt (mounting fan shaft case assembly)	23.5 {17, 2.4}	–
13	Bolt (mounting fan gear shaft)	23.5 {17, 2.4}	–
15	Bolt (mounting No. 1 idler shaft)	53.9 {40, 5.5}	–
21	Bolt (mounting oil pump assembly)	27.4 {20, 2.8}	–
24	Bolt (mounting balance shaft assembly RH)	23.5 {17, 2.4}	–
26	Nut (mounting balance shaft gear RH)	96.1 {71, 9.8}	Wet
32	Bolt (mounting balance shaft assembly LH)	23.5 {17, 2.4}	–
34	Nut (mounting balance shaft gear LH)	96.1 {71, 9.8}	Wet
40	Bolt (mounting injection pump bearing housing assembly)	27.4 {20, 2.8}	–

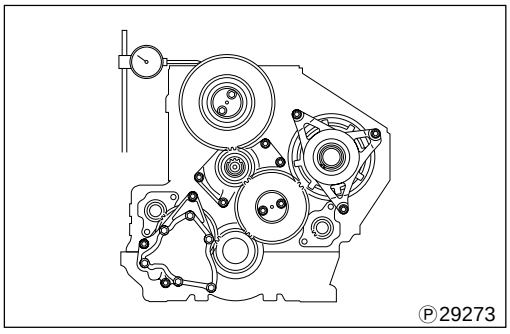
Lubricant

Location	Points of application	Specified lubricant	Quantity
3, 17	Inside surface of bushing of each gear	Engine oil	As required
6, 12, 14, 20	Outside circumference of each shaft	Engine oil	As required
23	All around O-ring	Engine oil	As required
25, 33	Journal portions of balance shaft	Engine oil	As required
26, 34	Threaded portion of nut	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4	Idler Gear Bushing Puller 	Use Equivalent	Installation and removal of idler gear bushing
10	Idler Gear Bushing Puller 	Use Equivalent	Installation and removal of fan shaft case bushing
18	Idler Gear Bushing Puller 	Use Equivalent	Installation and removal of No. 1 idler gear bushing

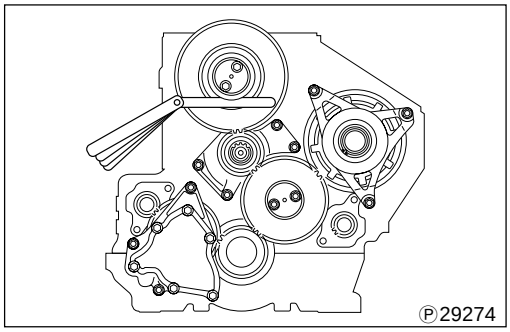


◆ Service procedure

● **Pre-disassembly inspection**

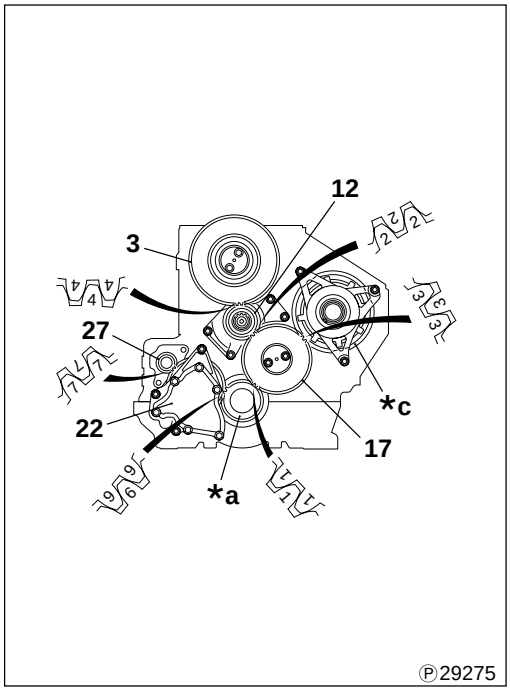
(1) Backlash between gears

On a pair of gears, measure backlash at more than three positions. If the reading is more than the limit, replace defective parts.



(2) End play of each gear and shaft

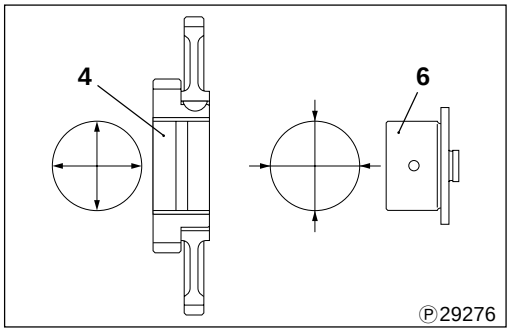
If the reading is more than the limit, replace defective parts.



3 12 17 22 Installation of timing gears

Install the timing gears in the following sequence.

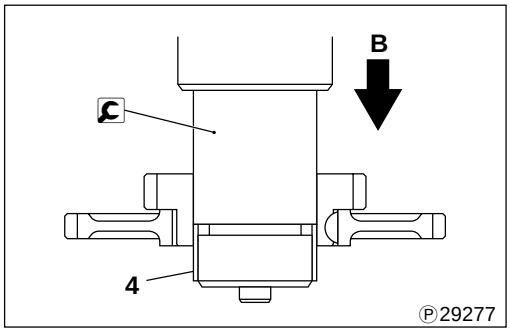
- Place the piston of No. 1 cylinder at the top dead center to position the crankshaft gear ***a**.
- Install the gear of the oil pump assembly **22** while aligning the alignment marks "**6**" and "**7**" with those on the crankshaft gear ***a** and balance shaft gear RH **27**, respectively.
- Install No. 1 idler gear assembly **17** while aligning the alignment marks "**1**" and "**3**" with those on the crankshaft gear ***a** and injection pump gear ***c**, respectively.
- Install the fan shaft assembly **12** while aligning the alignment mark "**2**" with that of No. 1 idler gear assembly **17**.
- Install the idler gear assembly **3** while aligning the alignment mark "**4**" with that of the fan shaft assembly **12**.



4 6 Idler gear bushing and idler shaft

[Inspection]

If the reading is more than the limit, replace defective parts.

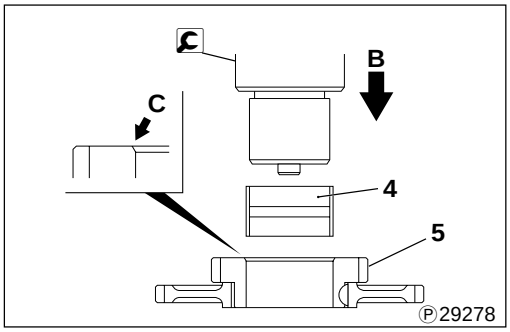


Idler gear bushing

[Removal]

B : Press

**: Idler Gear Bushing Puller

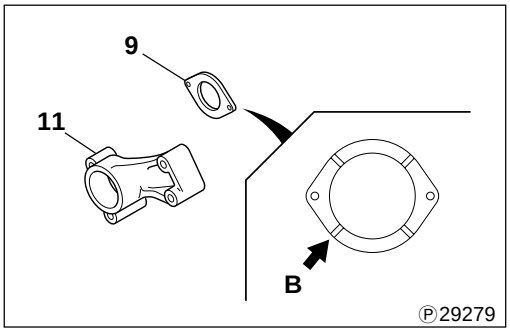


[Installation]

- Face the idler gear **5** in the illustrated direction. Using 🔧 Idler Gear Bushing Puller, press-fit the idler gear bushing **4** into the idler gear up to the chamfered portion **C**.

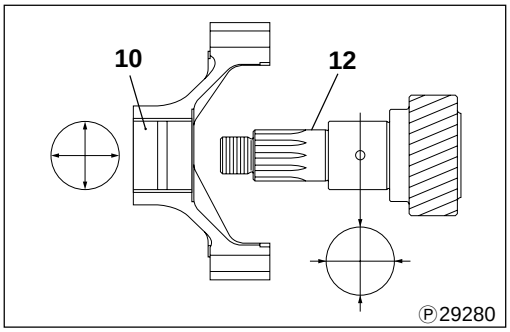
  B : Press

- After press-fitting the bushing, re-measure the clearance. If the reading is less than the standard limits, ream the idler gear bushing **4** until the clearance falls within the standard limits.



9 **Installation of thrust plate**

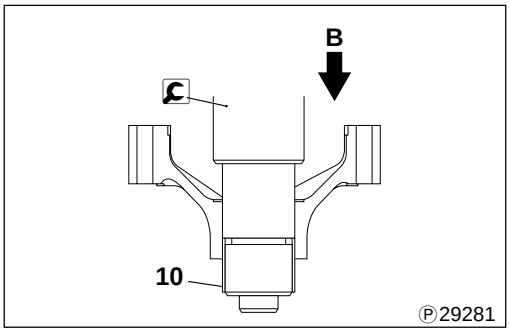
Install the thrust plate **9** with that side which does not have oil grooves **B** toward the fan shaft case **11**.



10 **12** **Fan shaft case bushing and fan shaft assembly**

[Inspection]

If the clearance is more than the limit, replace defective parts.

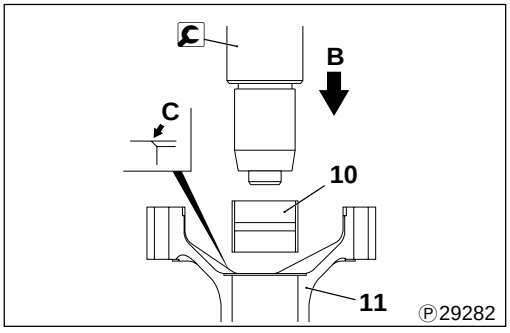


Fan shaft case bushing

[Removal]

B : Press

🔧 **:** Idler Gear Bushing Puller

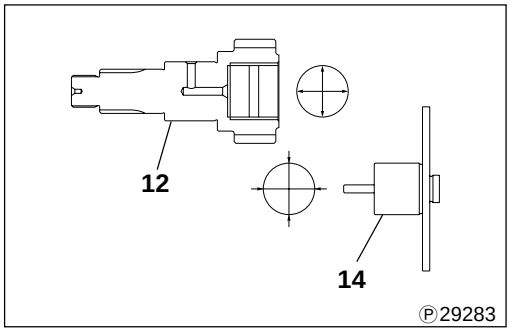


[Installation]

- Face the fan shaft case in the illustrated direction. Using 🔧 Idler Gear Bushing Installer, press-fit the fan shaft case bushing up to the chamfered portion **C** of the fan shaft case.

  B : Press

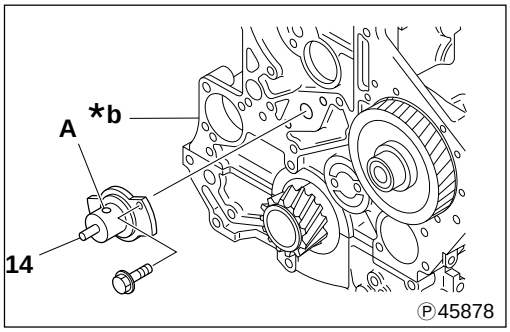
- After press-fitting the bushing, re-measure the clearance. If the reading is less than the standard limits, ream the fan shaft case bushing **10** until the clearance falls within the standard limits.



12 **14** **Fan shaft assembly and fan gear shaft**

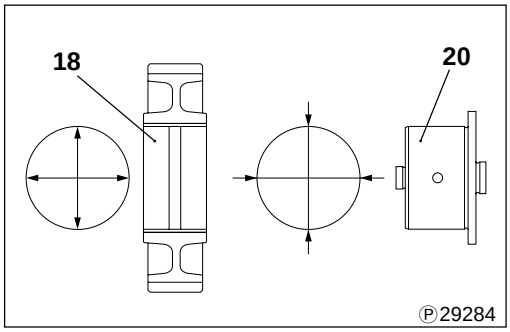
[Inspection]

If the clearance is more than the limit, replace defective parts.



14 **Installation of fan gear shaft**

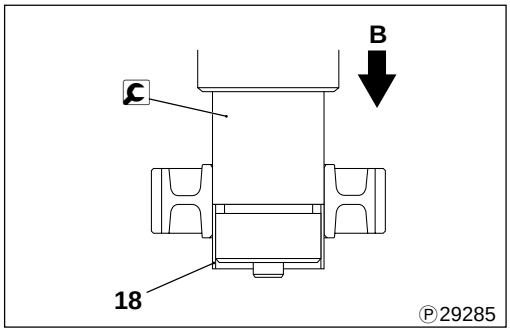
With oil hole **A** in fan gear shaft **14** facing up, install the fan gear shaft to upper crankcase ***b**.



18 **20** **No. 1 idler gear bushing and No. 1 idler shaft**

[Inspection]

If the clearance is more than the limit, replace defective parts.

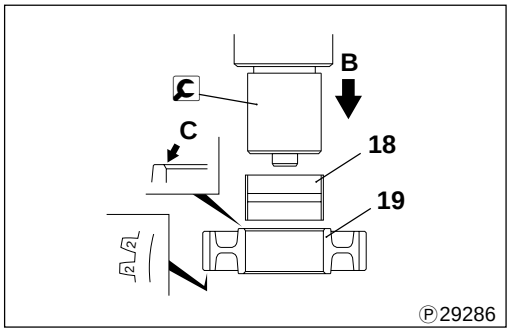


Idler gear bushing

[Removal]

B : Press

: Idler Gear Bushing Installer

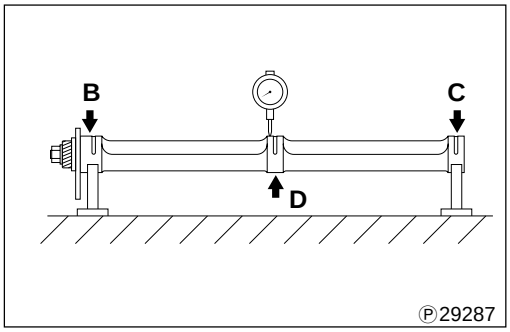


[Installation]

- Face the No. 1 idler gear **19** in the illustrated direction. Using Idler Gear Bushing Installer, press-fit the idler gear bushing up to the chamfered portion **C** of the No. 1 idler gear.

  B : Press

- After press-fitting the bushing, re-measure the clearance. If the reading is less than the standard limits, ream the No. 1 idler gear bushing **18** until the clearance falls within the standard limits.



25 **33** **Balance shaft assembly**

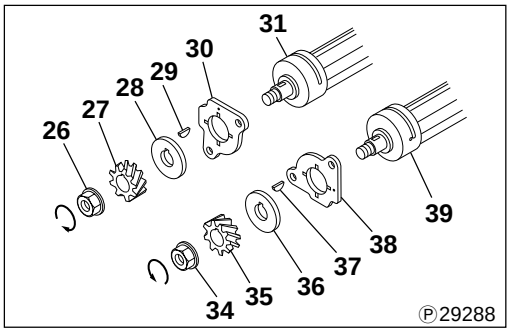
[Inspection]

- Check the balance shaft assemblies RH **25** and LH **33** for bend.
- Measure the balance shaft bend at No. 2 journal **D** while supporting the shaft at No. 1 journal **B** and No. 3 journal **C**.

NOTE

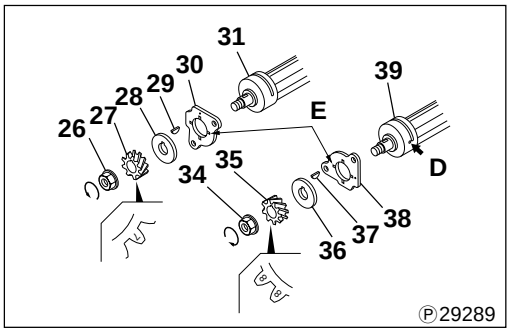
The bend of the balance shaft assemblies RH 25 and LH 33 is one half of the reading of the dial indicator taken after turning the balance shaft assembly through a rotation.

- If the reading exceeds the limit, disassemble the balance shaft assembly RH **25**, LH **33**, and replace the balance shaft RH **31**, LH **39**.



[Disassembly]

- The nut **26** of the balance shaft RH **31** and the nut **34** of the balance shaft LH **39** are different in the thread cutting direction.
- Remove the nut **26** by turning counter-clockwise. Remove the nut **34** by turning clockwise.



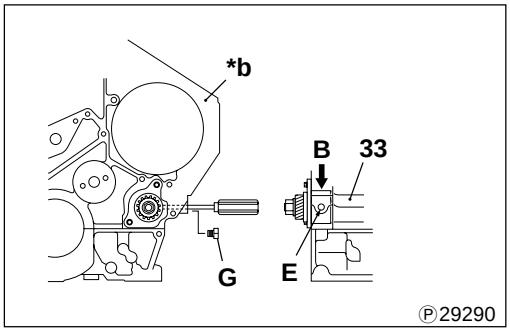
[Assembly]

- Of the balance shaft RH **31** and LH **39**, one with a shaft support hole **D** (ϕ 5 mm {ϕ 0.2 in.}) in No. 1 journal is the balance shaft LH **39**.
- Install the thrust plates **30** and **38** in the illustrated direction.

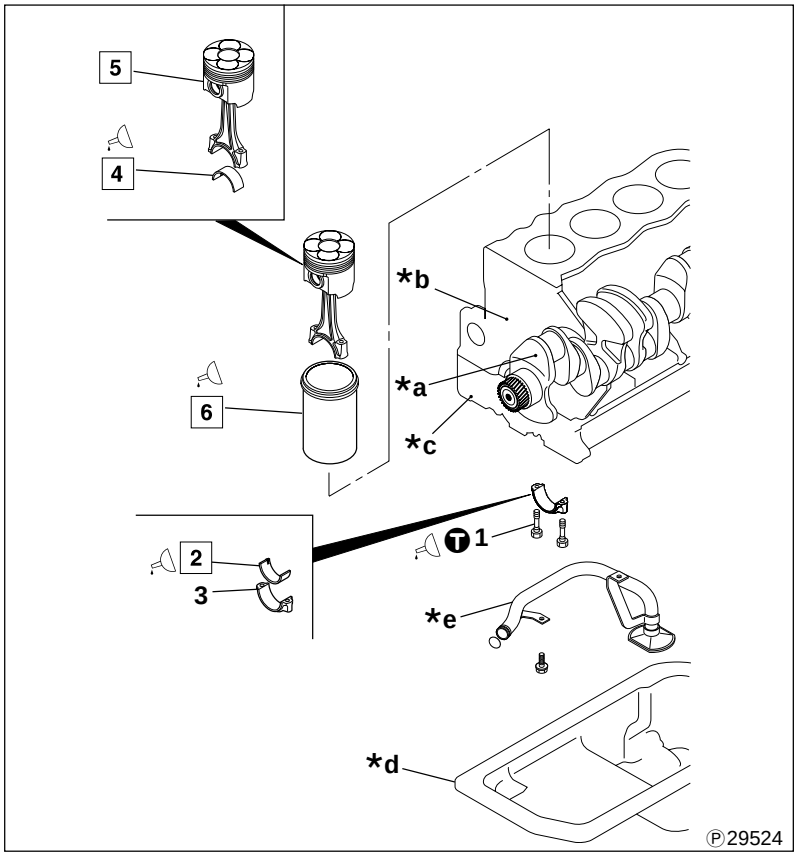
  E : Oil groove
- Install the balance shaft gears RH **27** and LH **35** in the illustrated direction.
- Install the nut **26** by turning clockwise. Install the nut **34** by turning counter-clockwise.

[Installation]

- The installation position of the balance shaft assembly RH **25** is determined by the gears being put in mesh when the oil pump assembly **22** is installed. P11A-60
- The balance shaft assembly LH **33** is not brought in mesh with any gear until when the vacuum pump assembly is installed with the front case attached. Therefore, the following steps must be performed before installation.
  - Remove the plug **G** from the upper crankcase ***b**.
  - Insert a screwdriver in the hole from which the plug **G** was removed and into the shaft support hole **E** (ϕ 5 mm {ϕ 0.2 in.}) provided in the No. 1 journal **B** of the balance shaft assembly LH **33** to support the balance shaft assembly.
  - Align the alignment marks of all the timing gears. P11A-60
  - By so doing, the balance shaft assembly LH **33** can be positioned. Keep it in position until the vacuum pump assembly is installed (P11A-53).



PISTONS, CONNECTING RODS AND CYLINDER LINERS



● **Pre-disassembly inspection**

P11A-65

● **Removal sequence**

1 Bolt
2 Lower connecting rod bearing
3 Connecting rod cap
4 Upper connecting rod bearing
5 Piston and connecting rod assembly P11A-71
6 Cylinder liner
***a :** Crankshaft assembly P11A-80
***b :** Upper crankcase P11A-80
***c :** Lower crankcase P11A-80
***d :** Oil pan Gr 12A
***e :** Oil strainer Gr 12A

NOTE

Since the bolts 1 (for installing connecting rod cap 3) utilize the torque-turn tightening method, they must not be removed unless it is absolutely necessary.

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
–	Piston protrusion		–0.09 to 0.09 {–0.0035 to 0.0035}	–	Inspect each location
	Connecting rod end play		0.15 to 0.45 {0.0039 to 0.018}	0.6 {0.024}	Replace
2, 4	Connecting rod bearing	Oil clearance	[65 {2.56}] 0.04 to 0.09 {0.0016 to 0.0035}	0.2 {0.0079}	Replace
		Span when free	–	Less than 69.5 {2.73}	
5, 6	Piston and connecting rod assembly-to-cylinder Liner clearance		[114 {4.49}] 0.135 to 0.155 {0.0053 to 0.0061}	–	Replace
6	Cylinder liner	Flange projection	0.01 to 0.07 {0.00039 to 0.0028}	–	Replace
		Inside diameter	ϕ 114 to 114.02 {ϕ 4.4881 to 4.4889}	ϕ 114.25 {ϕ 4.498}	Replace
		Cylindricity	0.03 {0.0012} or less	–	Replace
		Difference in cylinder liner flange projection from adjacent cylinders	0.04 {0.0016} or less	–	Replace

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

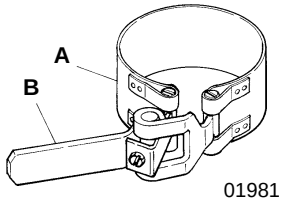
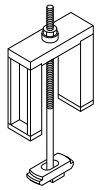
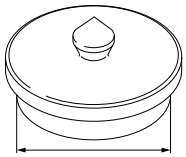
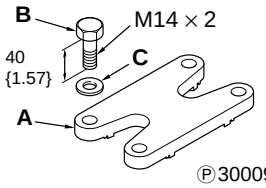
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (connecting rod cap installation)	29 {22, 3} +90°	Wet

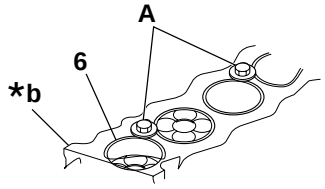
Lubricant

Location	Points of application	Specified lubricant	Quantity
1	Bolt threads	Engine oil	As required
2, 4	Connecting rod bearing inside surface	Engine oil	As required
6	Portions of cylinder liner held by upper crankcase	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
5	**A**: Piston Guide Clamp **B**: Piston Guide Lever  01981	**A**: MH063432 **B**: MH061658 (Obtain Locally)	Installing piston and connecting rod assembly
6	Cylinder Liner Extractor  Ⓟ30008	MH062537 (Obtain Locally)	Removing cylinder liners
	Cylinder Liner Installer  Ⓟ30010	MH063606 (Obtain Locally)	Installing cylinder liners
	A: Adapter **B**: Bolt **C**: Washer  Ⓟ30009	**A**: MH063433 **B**: MF130625 **C**: MH005012 (Obtain Locally)	Measuring cylinder liner flange projection amount and their difference from adjacent cylinders.



Ⓟ29525

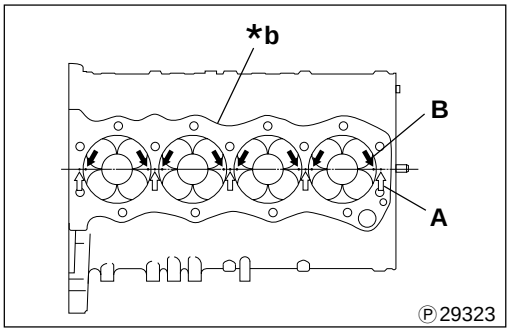
◆ Service procedure

● **Pre-disassembly inspection**

CAUTION ⚠

The cylinder liners 6 may be forced out if the upper crankcase *b is turned over or if the crankshaft assembly *a is rotated with the pistons inserted. Before beginning with inspection procedures, be sure to hold each cylinder liner at its flange section using a washer A or a similar tool.

PISTONS, CONNECTING RODS AND CYLINDER LINERS



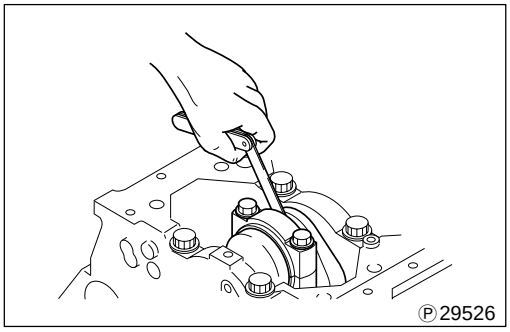
(1) Piston protrusion from crankcase top surface

NOTE

The piston protrusion affects engine performance and must therefore be checked.

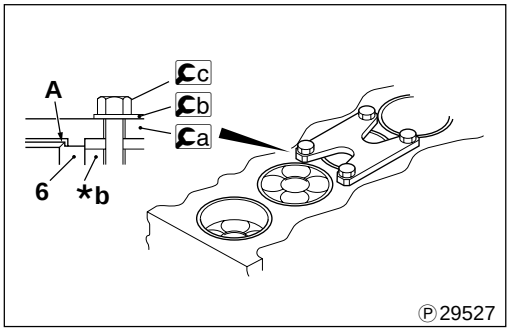
- Set the piston at top dead center.
- Make standard points **A** (five points) on upper crankcase assembly ***b** the 0 (zero) point and measure any protrusion relative to this point.
- Measure at four points on each piston at the nearest standard point from the zero point and produce the average value.

  B : Measurement point (16 points)
- If the average value is out of specification, check the clearances between all relevant parts.



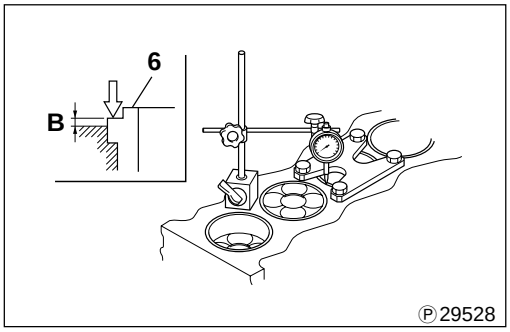
(2) Connecting rod end play

- Measure the end play every connecting rod.
- If any measurement exceeds the specified limit, replace the defective part (s).



(3) Cylinder liner flange protrusion amount and its difference between adjacent cylinders.

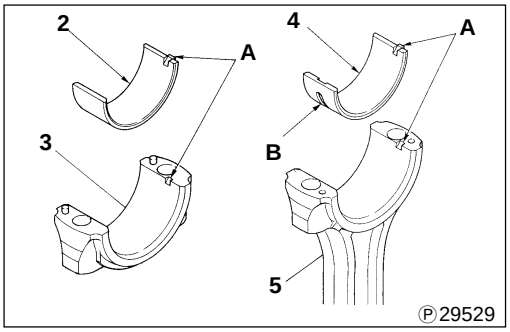
- Install the a Adapter on the upper crankcase in such a way that it may not ride on the flange **A** of the cylinder liner **6** and secure it by tightening the b Washer and c Bolt to a torque of 49 N·m {36 ft.lbs, 5 kgf·m}.



- Measure the protrusion amount **B** of flange of the cylinder liners **6**.
- If the measurement is out of specification, replace the defective part(s).
- Calculate the differences of the protrusion amounts between adjacent cylinders. If any difference is out of specification, check the mounting condition of the liners and replace the defective part(s).

CAUTION ⚠

If the cylinder liner 6 flange protrusion is insufficient, bearing pressure on the cylinder head gasket will be too low in the region of the bore, possibly causing gas to leak.



2 4 Connecting rod bearings

[Installation]

Fit the lower connecting rod bearing **2** into the connecting rod cap **3**, and fit the upper connecting rod bearing **4** into the piston and connecting rod assembly **5.** Make sure the lugs **A** on the bearings are fitted into their respective grooves.

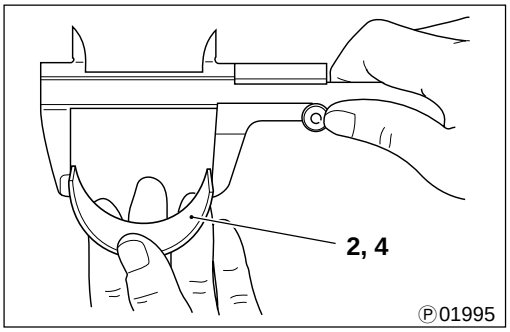
CAUTION ⚠

The upper connecting rod bearing 4 has an oil hole B. The lower connecting rod bearing 2 has no oil hole. Take care not to confuse the upper and lower parts.

[Inspection]

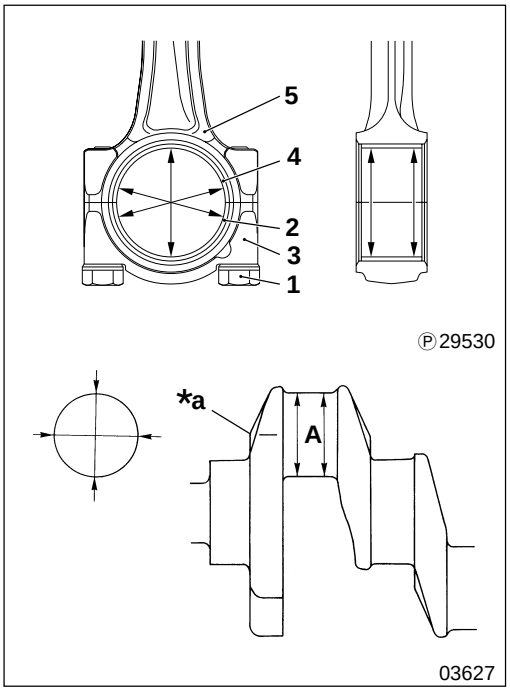
CAUTION ⚠

- **Do not attempt to manually expand a connecting rod bearing 2, 4 if its span is insufficient.**
- **Upper and lower connecting rod bearing 2,4 must be replaced as a set.**



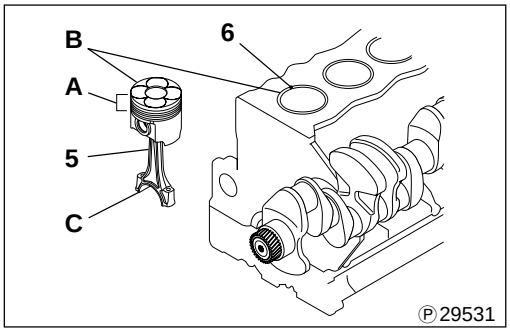
(1) Span when free

If the span is less than the specified requirement, replace the upper and lower connecting rod bearings **2**, **4** as a set.



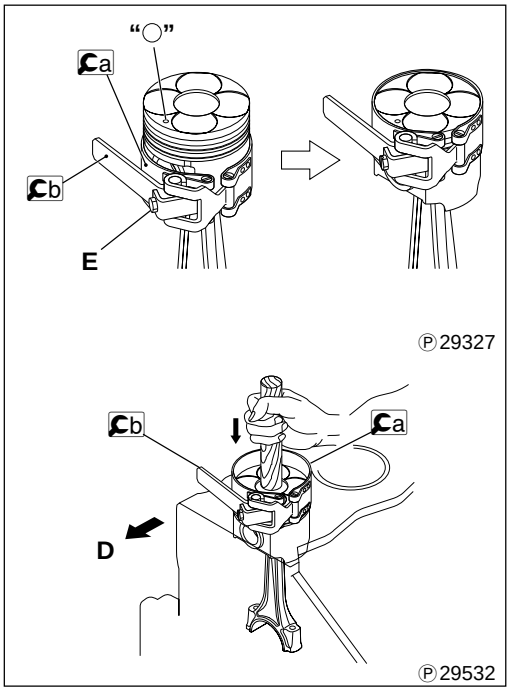
(2) Connecting rod bearing-to-crankshaft pin clearance (oil clearance)

- Fit the lower connecting rod bearing **2** into the connecting rod cap **3**, and fit the upper connecting rod bearing **4** into the piston and connecting rod assembly **5**. Then, tighten the bolts **1** to the specified torque.
- Measure the inside diameter of the connecting rod bearings **2**, **4** and the outside diameter of the crankshaft ***a** pin **A**. If the clearance exceeds the specified limit, replace the defective part(s).
- If the connecting rod bearing **2**, **4** have to be changed to undersized ones, adjust crankshaft ***a** pin outer diameter **A** in accordance with the specified procedure to fit the undersized dimensions. 🕮 P11A-86



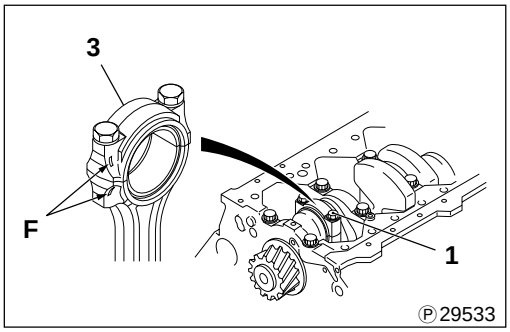
5 Installing piston and connecting rod assembly

- Ensure the gaps of the piston rings **A** remain in their correct positions. 🕮 P11A-74
- Check that the size marks **B** on the piston and cylinder liner are the same. 🕮 P11A-69
- Use care to prevent the connecting rod **C** from damaging the cylinder liner **6** and crankshaft pin.



- With the piston's front mark "○" facing the front of the engine **D**, carefully insert the piston and connecting rod assembly into the cylinder liner.
- Using the bolt **E** of the ⓑb Piston Guide Lever, adjust the inside diameter of the ⓐa Piston Guide Clamp such that it matches the piston's outside diameter.
- After adjustment, remove it from the piston and smear engine oil over the following items**:**
  - Outside of piston
  - Inside of the ⓐa Piston Guide Clamp
  - Inside of the cylinder liner

- Install piston and connecting rod assembly by tapping top of piston with wooden dowel.

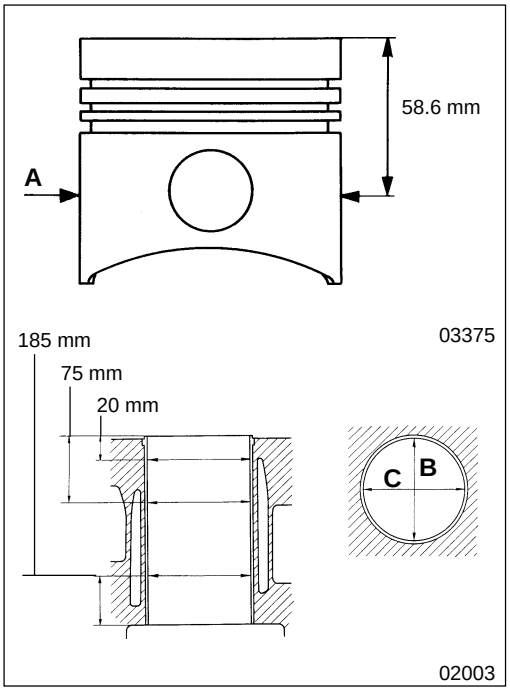


- With the piston installed, align the mating marks **F** on the connecting rod and connecting rod cap **3** and tighten the bolts **1** to the specification.
- Tighten bolts **1** alternately in the following manner.
  - First tighten to a torque of 29 N·m {22 ft.lbs, 3 kgf·m}.
  - Then tighten further 90° ± 5°.

NOTE

After installation of connecting rod cap 3, inspect the following points:

- **End play of the connecting rod: 🕮 P11A-66**
- **Piston Protrusion: 🕮 P11A-66**



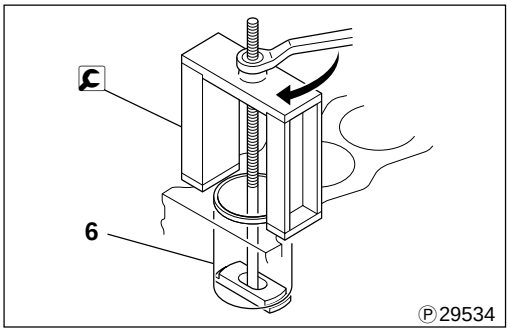
5 **6** **Piston-and-connecting rod assembly and cylinder liners**

[Inspection]

- Take measurements to determine the clearance between the piston and cylinder liner **6**.

  A : Outside diameter measurement position of piston
  B : Direction of crankshaft axis
  C : Perpendicular to crankshaft axis

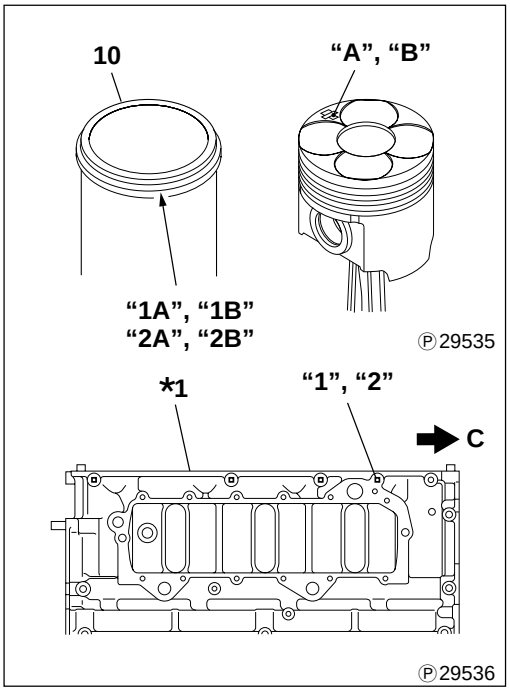
- If the clearance is out of specification, replace the defective part(s).



Cylinder liners

[Removal]

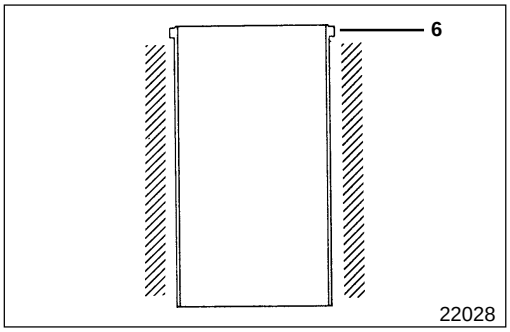
: Cylinder Liner Extractor



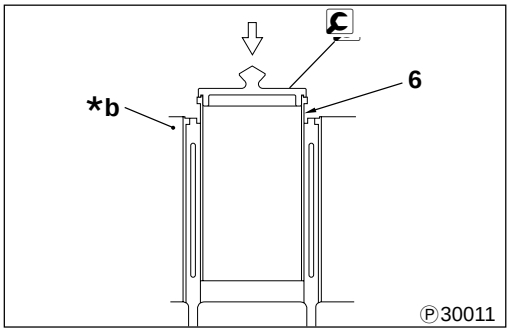
[Installation]

- Select a cylinder liner **6** which has the same size mark as those stamped on the upper crankcase ***b** and the piston.
- The size marks on the upper crankcase ***b** are arranged in the order of No. **1**, **2**, **3** and **4** cylinders starting from the engine front **C**.

Size marks on upper crankcase	Size marks on cylinder liners	Size mark on pistons
"1"	"1A"	"A"
	"1B"	
"2"	"2A"	"B"
	"2B"	



- Apply engine oil to the indicated ▨ parts of the cylinder liner **6**.

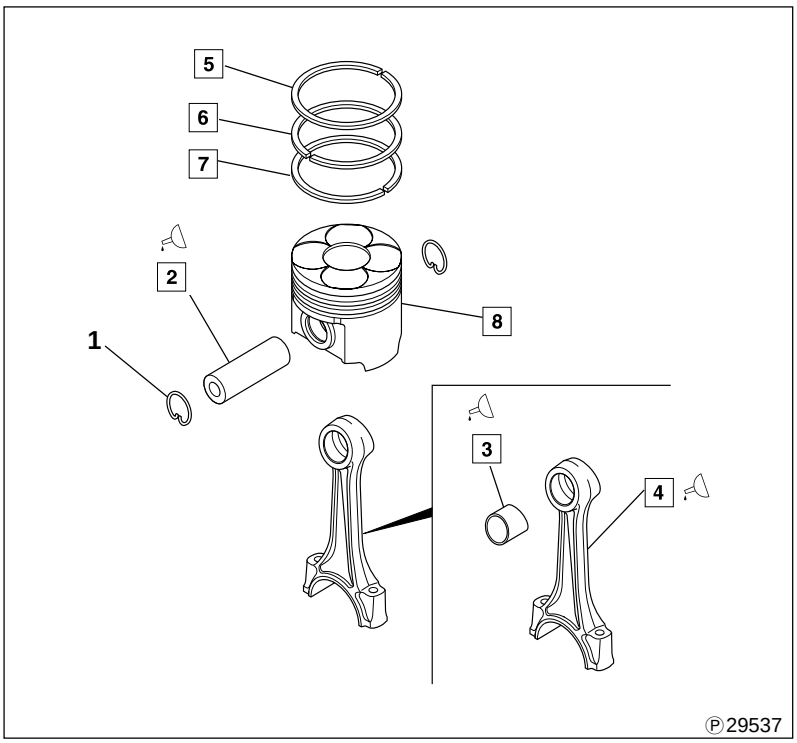


- Using the Cylinder Liner Installer, gently tap down the cylinder liner **6** until it is snugly seated on the upper crankcase ***b**.

CAUTION ⚠

The cylinder liner 6 is thin in wall thickness.
Use utmost care when handling it.

Piston and Connecting Rod Assembly



● **Disassembly sequence**

1 Snap ring
2 Piston pin
3 Connecting rod bushing
4 Connecting rod
5 1st compression ring
6 2nd compression ring
7 Oil ring
8 Piston

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

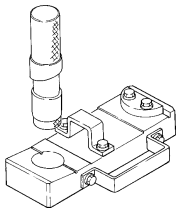
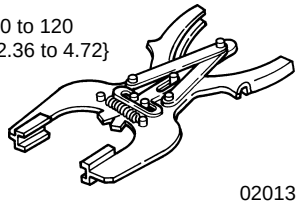
Location	Maintenance item		Standard value	Limit	Remedy
2, 3	Piston pin-to-connecting red small end bushing clearance		[36 {1.42}] 0.03 to 0.04 {0.0012 to 0.0016}	0.1 {0.0039}	Replace
2, 8	Piston pin-to-piston clearance		[36 {1.42}] 0.007 to 0.021 {0.00028 to 0.00083}	0.05 {0.002}	Replace
4	Connecting rod bend		–	0.05 {0.002}	Replace
	Connecting rod twist		–	0.1 {0.0039}	Replace
5 to 7	Piston ring end gap	1st compression ring	0.3 to 0.45 {0.012 to 0.018}	1.5 {0.059}	Replace
		2nd compression ring	0.4 to 0.55 {0.016 to 0.022]	1.5 {0.059}	
		Oil ring	0.3 to 0.5 {0.012 to 0.02}	1.5 {0.059}	
5 to 8	Piston ring-to-piston ring groove clearance	1st compression ring	0.02 to 0.10 {0.00079 to 0.0039}	0.2 {0.0079}	Replace
		2nd compression ring	0.07 to 0.10 {0.0028 to 0.0039}	0.15 {0.0059}	
		Oil ring	0.03 to 0.06 {0.0012 to 0.0024}	0.15 {0.0059}	

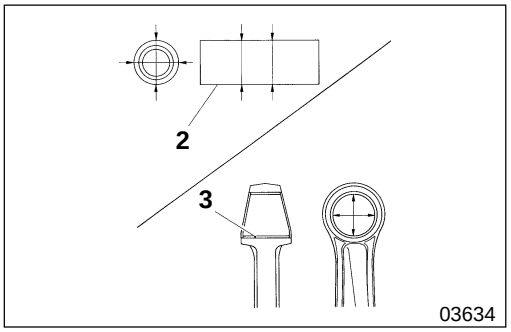
Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Piston pin outer surface	Engine oil	As required
3	Connecting rod bushing outer surface	Engine oil	As required
4	Bushing installation surface of connecting rod	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
3	Connecting Rod Bushing Puller Kit  02015	Use Locally Manufactured Equivalent	Removing and installing connecting rod bushings
5 to 7	Piton Ring Tool  02013	Obtain Locally	Removing and installing rings



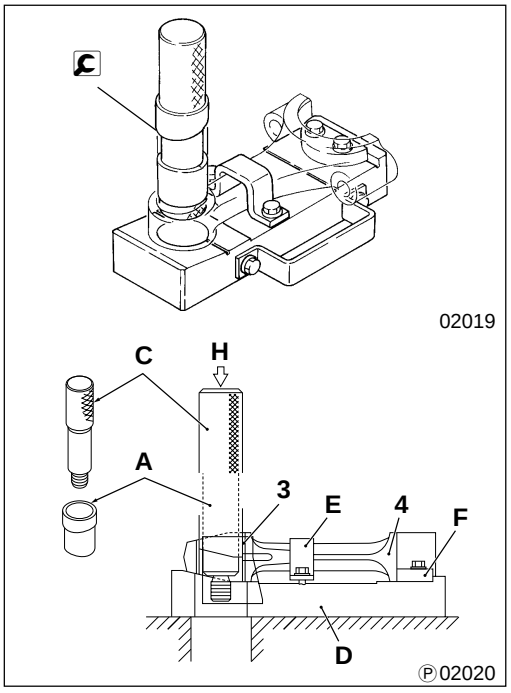
03634

◆ Service procedure

2 **3** **Piston pin and connecting rod**

[Inspection]

If the clearance exceeds the specified limit, replace the defective part(s).



02019
Ⓟ02020

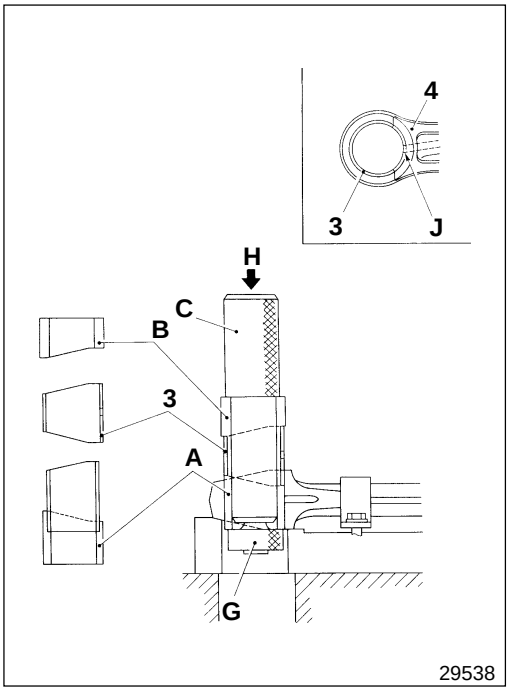
Connecting rod bushing

Replace the connecting rod bushing **3** using the Connecting Rod Bushing Puller Kit.
(Components of the Connecting Rod Bushing Puller Kit)

- **A :** Collar
- **B :** Collar
- **C :** Puller
- **D :** Base
- **E :** Bracket
- **F :** Plate
- **G :** Nut

[Removal]

- Remove the upper bearing (if fitted) from the big end of the connecting rod **4**.
- Mount the connecting rod **4** on the base **D** and lock it in position with the bracket **E** and place **F**.
- Fit the Collar **A** over the Puller **C** in the direction shown. Then, slowly apply pressure of approximately 49 kN (11020 lbf, 5,000 kgf) **H** until the connecting rod bushing **3** is pressed out.

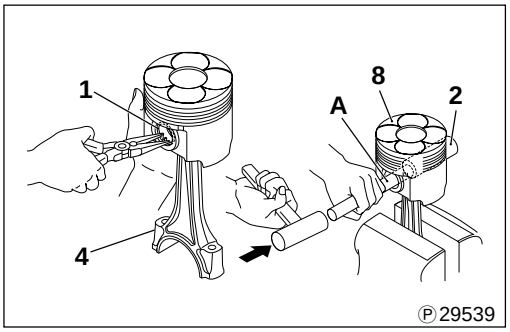


[Installation]

- Apply engine oil to the small end of the connecting rod **4** and to the outer surface of the connecting rod bushing **3**.
- Fit the Collar **B** over the Puller **C**, position the connecting rod bushing **3** and the Collar **A**, and lock this arrangement together with the Nut **G**.
- Align the oil holes **J** in the connecting rod bushing **3** and in the small end of the connecting rod **4**. Then, use a press to slowly apply pressure of approximately 49 kN (11020 lbf, 5,000 kgf) **H** until the bushing is pressed into place.
- After press-fitting the connecting rod bushing **3**, ream it to achieve the specified normal clearance between the bushing and piston pin **2**.

NOTE

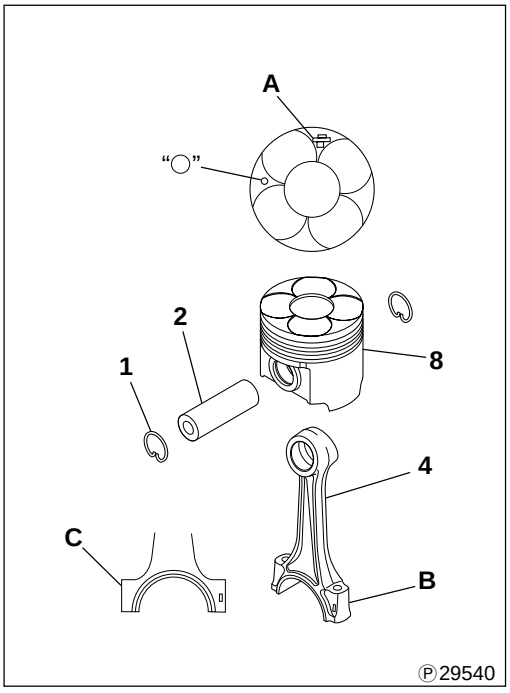
After reaming the connecting rod bushing 3, insert the piston pin 2 and check that it turns smoothly and without play.



2 | 4 | 8 Piston Pin, connecting rod, and piston.

[Removal]

- Removal the snap ring **1** and tap out the piston pin **2** using a rod **A** and hammer.
- If the piston pin **2** is difficult to remove, heat the piston **8** in hot water or using a piston heater.

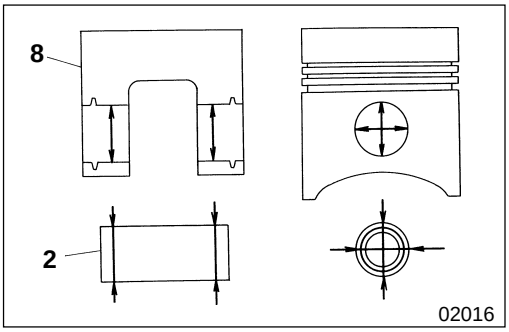


[Installation]

- Apply engine oil to the piston pin **2**. With the connecting rod **4** and piston **8** and aligned as illustrated, insert the piston pin to hold these components together.
  - **A :** Weight mark
  - **B :** Weight mark (**A** through **G**: "**A**" stands for the largest weight)
  - **C :** Alignment mark for connecting rod cap
  - "○"**:** Front mark
- If the piston pin **2** is difficult to insert, heat the piston pin **8** in hot water or use a piston heater.

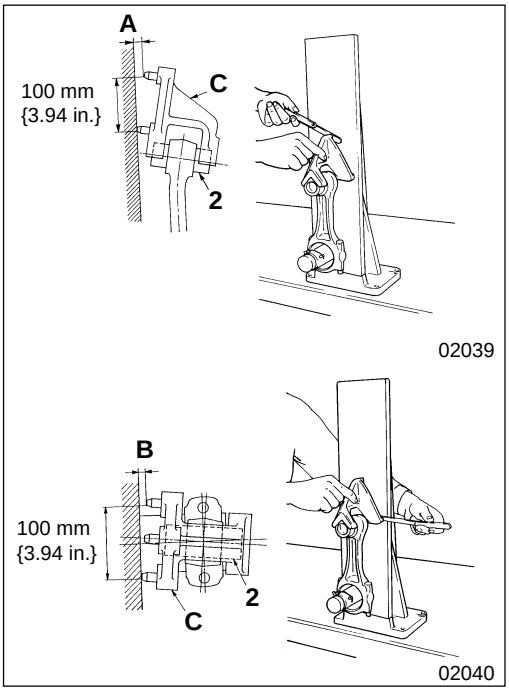
CAUTION ⚠

- **Make sure that all pistons have the same weight mark.**
- **The connecting rods must all have the same weight mark.**
- **After inserting the pin 2, check that it turns smoothly and without play.**



2 **8** **Piston pin-to-piston clearance**

If the clearance exceeds the specified limit, replace the defective part(s).



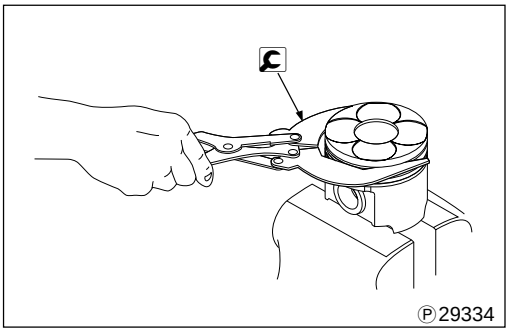
4 **Connecting rod bend and twist**

- Fit the connecting rod bushing **3** and piston pin **2** in their respective positions of the connecting rod **4**.
- Measure the extent of bending **A** and twisting **B** in the connecting rod **4**. If either measurement exceeds the specified limit, replace the connecting rod.

  C : Connecting rod aligner (Measurement device)

NOTE

- **Before mounting the connecting rod 4 on the connecting rod aligner C, install the upper and lower connecting rod bearings in their respective positions.** **P11A-67**
- **Measurements must be made with the connecting rod cap mounting bolts tightened to the specification.** **P11A-67**

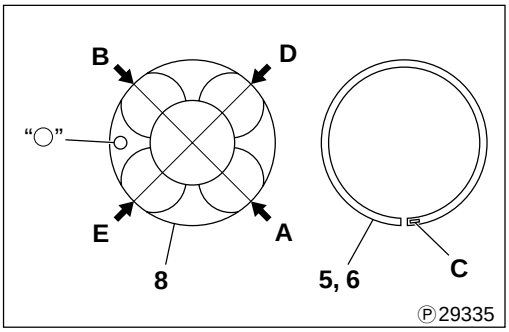


5 **to** **8** **Piston rings and piston**

Piston rings

[Removal]

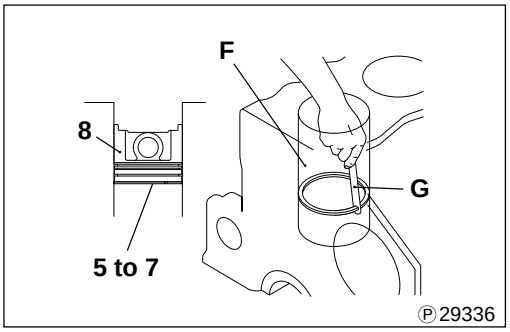
C **:** Piston Ring Tool



[Installation]

- Fit the oil ring onto the piston **8** with its gap **A** and the expander spring end joint **B** in the position illustrated.
- Fit the piston ring **5**, **6** onto the piston **8** such that the manufacturer's marks **C** near the gaps face upward.
- Align the gaps **D**, **E** of the piston ring **5**, **6** as illustrated.

  D **:** 1st compression ring gap
  E **:** 2nd compression ring gap
  "○" **:** Front mark



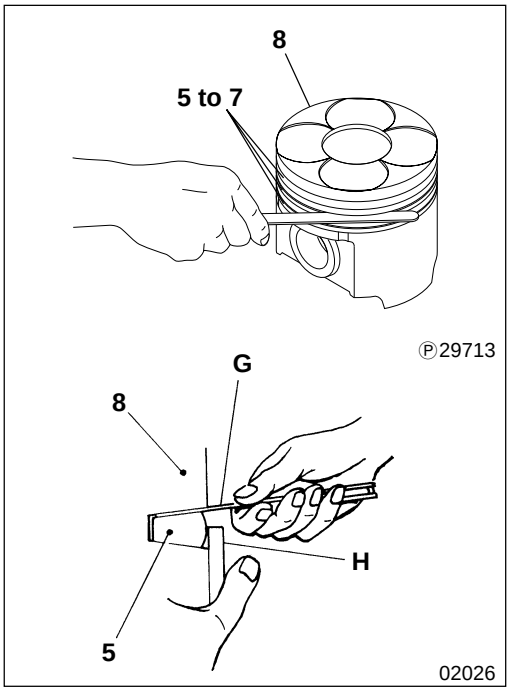
[Inspection]

(1) Piston ring end gap

- Using the crown of a piston **8**, push the piston ring **5**, **6** or **7** horizontally into a cylinder liner **F** in the upper crankcase for measurement.
- Taking care not to move the piston ring **5**, **6** or **7**, measure the end gap using a thickness gauge **G**. Replace all the rings of piston if any gap exceeds the specified limit.

NOTE

- **To keep the piston ring 5, 6 or 7 horizontal, be sure to insert them into the cylinder liner F using a piston 8.**
- **Push the piston ring 5, 6 or 7 down to the bottom of cylinder liner F; the bottom should be less worn than the top.**
- **Piston rings 5, 6 or 7 must be replaced as a set. Never replace piston rings individually.**



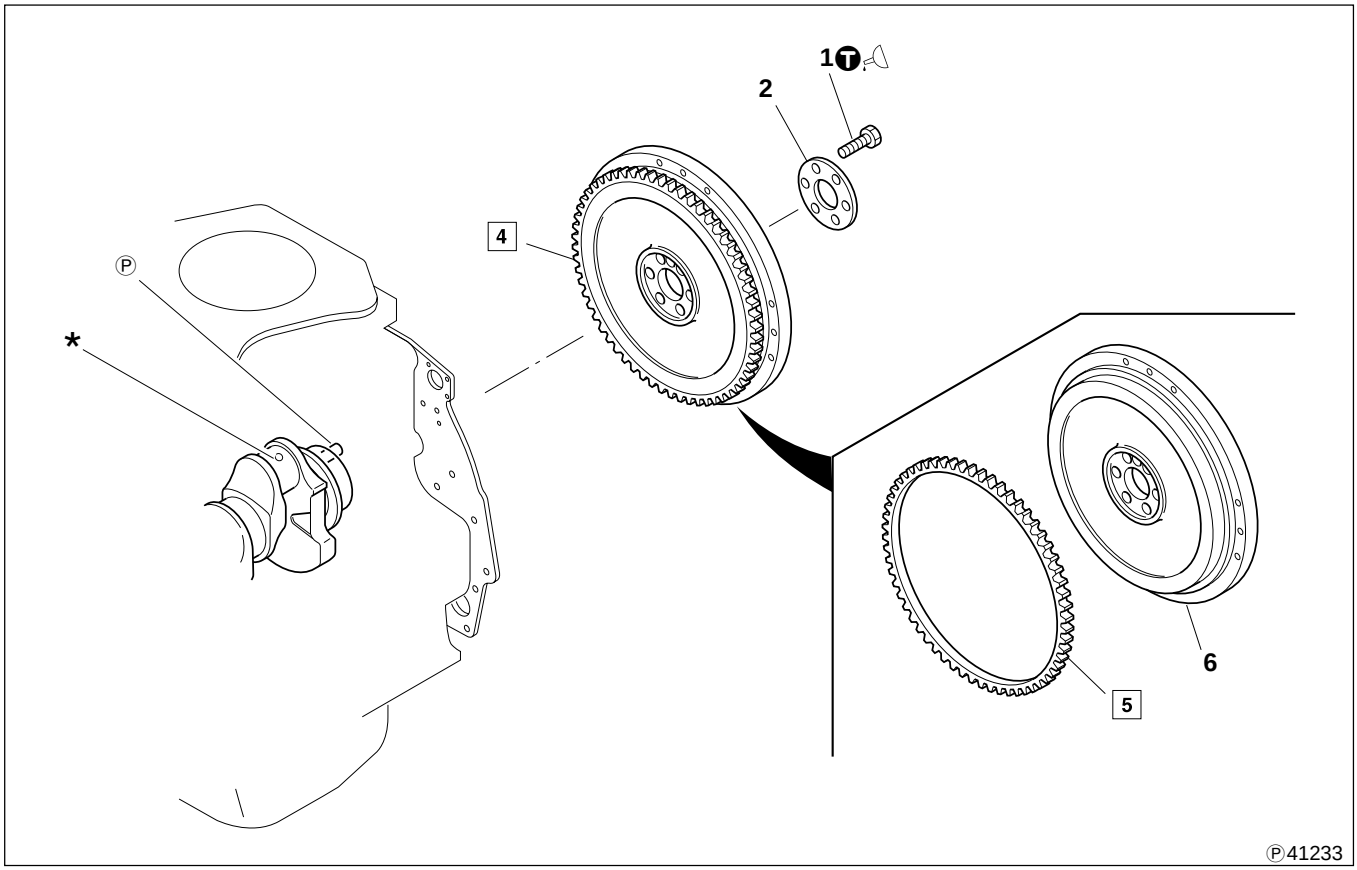
(2) Piston ring-to-piston ring groove clearance

- If any measurement exceeds the specified limit, replace the defective part(s).
- Measure the 1st compression ring **5** clearance with a thickness gauge **G** while pressing the ring against the piston **8** with a straight edge **H**.

NOTE

- **Remove any carbon deposits from the ring groove of the piston 8 and measure the clearance around the piston's entire periphery.**
- **Piston ring 5, 6, 7 must be replaced as a set. Never replace piston rings individually.**

FLYWHEEL



● **Disassembly sequence**

1 Bolt
2 Plate
3 Pilot bearing
4 Flywheel assembly
5 Ring gear
6 Flywheel
***** : Crankshaft assembly P11A-80
Ⓟ : Locating pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the mounting surface of the flywheel assembly 4 is free from any foreign substances, oil and detrimental flaws.**
- **After installing flywheel assembly 4, check for runout.**

NOTE

- **Do not remove the pilot bearing 3 or ring gear 5 unless an abnormality is evident.**

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

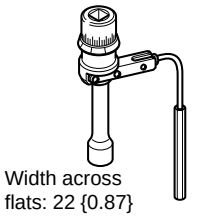
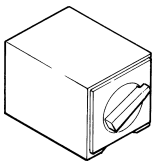
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (flywheel assembly installation)	39.0 {29.0, 4.0} +40°	Wet

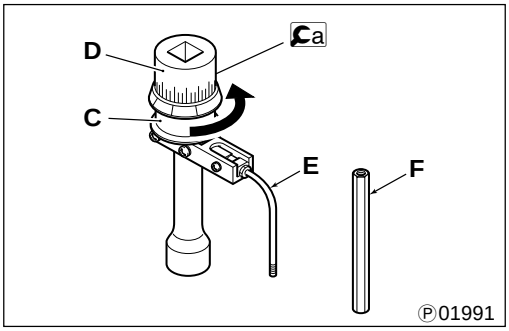
Lubricant

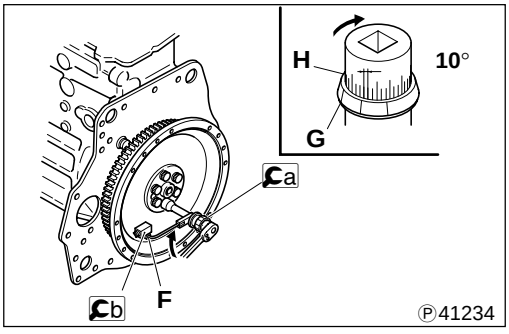
Location	Points of application	Specified lubricant	Quantity
1	Bolt threads	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4	Socket Wrench  Width across flats: 22 {0.87} Ⓟ01984	Obtain Locally	Installation of flywheel
	Magnet Base  00471	Obtain Locally	





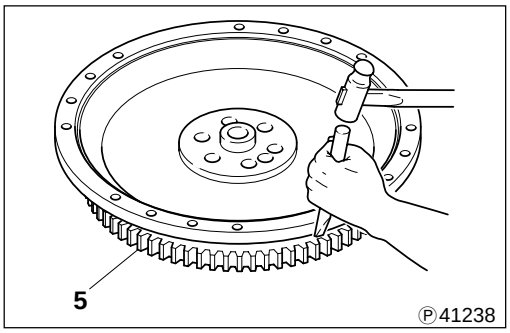
◆ Service procedure

5 Installation of flywheel assembly

- Tighten the bolts **1** to the specified torque (39.0 N·m {29 ft.lbs, 4.0 kgf·m}. After that, turn the bolts further in accordance with the following procedure.
- Turn the holder **C** of the Ca Socket Wrench counterclockwise to the tension the built-in spring.

  D : Socket
  E : Rod
  F : Rod (extension)

- Fit the Cb Magnet Base on the flywheel at a position where it can come in contact with the Rod **F** (for extension) as shown in the illustration.
- Set the rod **F** (for extension) such that it may be pressed against the Cb Magnet Base by the spring force.
- Align any inscribed line **G** on the holder **C** with any inscribed line **H** on the socket **D**. (Use this point as reference 0° position.)
- From the above reference position, turn the socket **D** clockwise by 40° to tighten the bolt to the proper specification.



5 Ring gear

[Inspection]

Inspect ring gear **5** for damage and abnormal wear. If any defect is evident, the ring gear must be replaced.

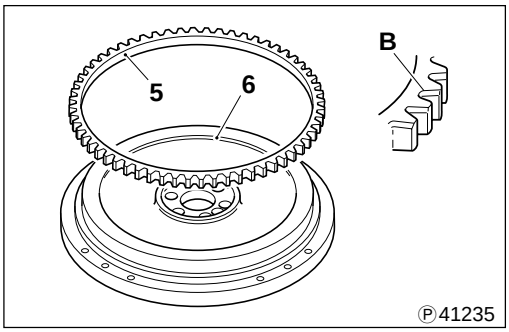
[Removal]

Heat the ring gear **5** evenly with an acetylene torch or the like.

WARNING ⚠

Be careful not to get burned.

- Remove the ring gear **5** from the flywheel by tapping around its entire periphery.



[Installation]

Using an acetylene torch or the like, heat the ring gear **5** to approximately 100 °C {212 °F} for **3** minutes.

WARNING ⚠

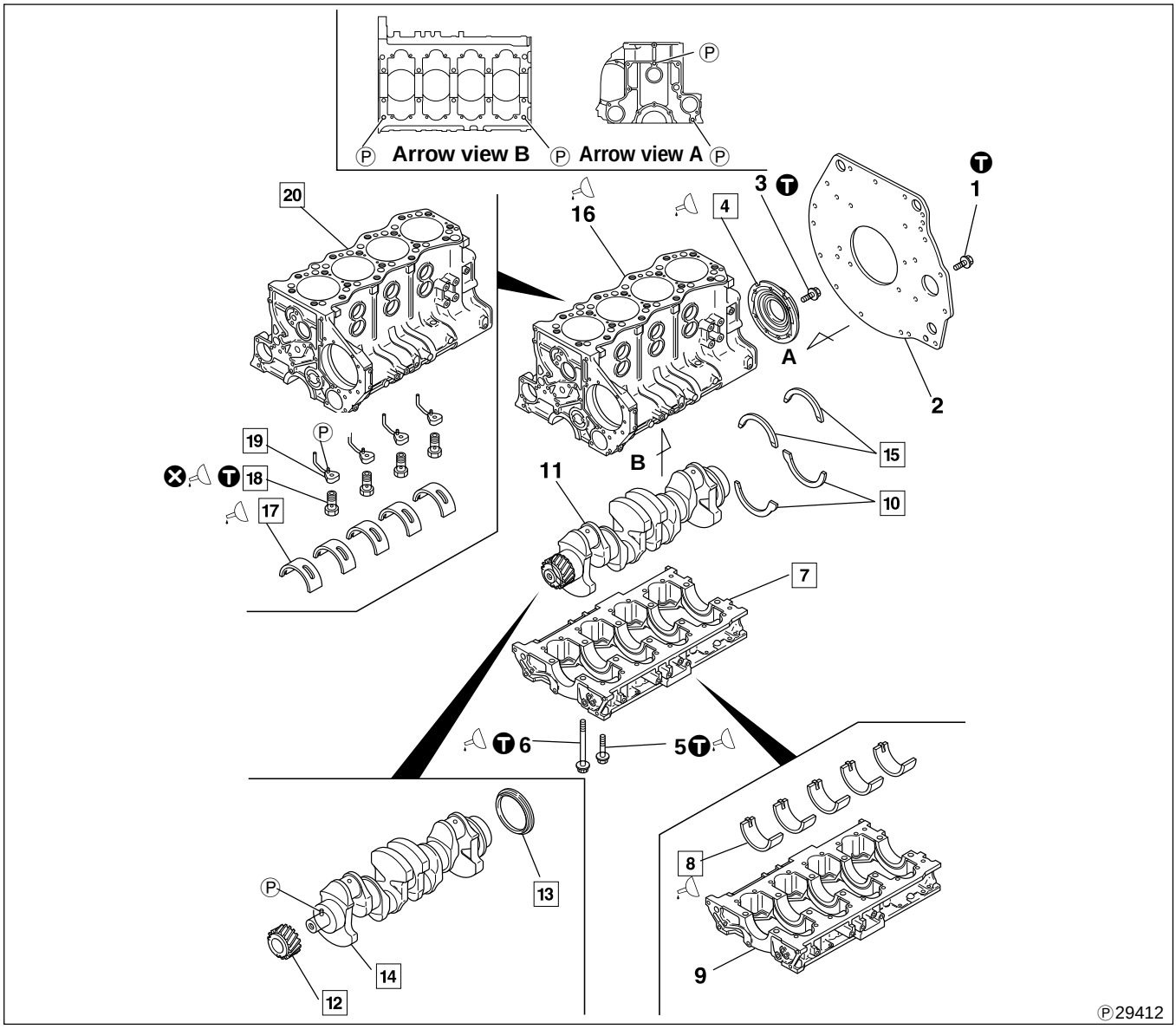
Be careful not to get burned.

- Fit the ring gear **5** with the non-chamfered side of its teeth toward the flywheel **6**.

  B : Chamfered side of ring gear **5**.

MEMO

CRANKSHAFT AND CRANKCASE



● **Pre-disassembly inspection**

P11A-82

● **Disassembly sequence**

1 Bolt
2 Rear plate
3 Bolt
4 Rear oil seal
5 Bolt
6 Main cap bolt
7 Lower crankcase assembly
8 Lower main bearing
9 Lower crankcase
10 Lower thrust plate
11 Crankshaft assembly
***12** Crankshaft gear
***13** Rear oil seal slinger
14 Crankshaft
15 Upper thrust plate
16 Upper crankcase assembly
17 Upper main bearing
***18** Check valve
19 Oil jet
20 Upper crankcase

Ⓟ **:** Locating pin
⊗ **:** Non-reusable part

NOTE

- **Do not remove parts marked * unless defects are evident.**
- **The lower crankcase 9 and upper crankcase 20 have been machined in a pair. Therefore, replacing either one of the pair is not allowed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **If the main cap bolt shows evidence of having been tightened three times, replace it. 🕮 P11A-83**
- **Do not overtighten the check valve 18. If the tightening torque exceeds the specified one, the check valve may malfunction, resulting in damage to the engine.**

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
–	Crankshaft end play			0.10 to 0.28 {0.0039 to 0.0110}	0.4 {0.016}	Replace thrust plate
8, 17	Main bearing	Oil clearance	No. 1, 2, 4, 5	[86 {3.385}] 0.04 to 0.11 {0.0016 to 0.0043}	0.15 {0.0059}	Replace
			No. 3	[86 {3.385}] 0.06 to 0.13 {0.0024 to 0.0051}		
		Span when free		–	Less than 91.5 {3.60}	Replace
14	Crankshaft	Bend		0.02 {0.00079} or less	0.05 {0.002}	Correct or replace
		Pin and journal	Roundness	0.01 {0.00039} or less	0.03 {0.0012}	Correct or replace
			Cylindricity	0.06 {0.00024} or less	–	Correct or replace
20	Distortion of upper crankcase top surface			0.07 {0.0028} or less	0.2 {0.0079}	Replace

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

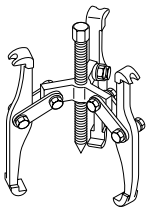
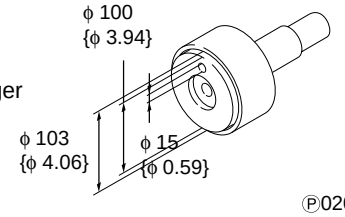
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (rear plate installation)	63,7 {47, 6.5}	—
3	Bolt (rear oil seal installation)	9.8 {7.2, 1.0}	—
5	Bolt (lower crankcase installation)	23.5 {17, 2.4}	Wet
6	Main cap bolt (lower crankcase installation)	49 {36, 5.0} + 90°	• Wet • Reusable 3 times
18	Check valve	29.4 {22, 3.0}	Wet

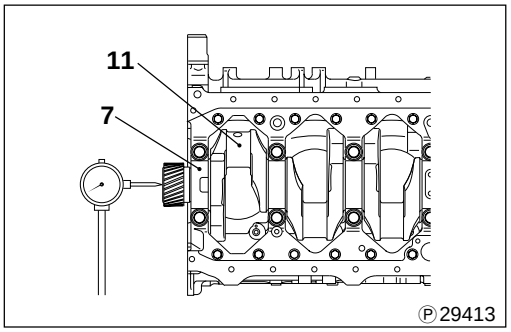
Lubricant and sealant

Location	Points of application	Specified lubricant/sealant	Quantity
4	Rear oil seal lip	Engine oil	As required
	Upper and lower crankcase contracting surface of rear oil seal	Threebond 1207	As required
5, 6	Bolt threads and seating surface	Engine oil	As required
8, 17	Main bearing inside surfaces	Engine oil	As required
16	Lower crankcase attaching surface of upper crankcase	Threebond 1207	As required
18	Check valve threads	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
12	Gear Puller  Ⓟ02065	Obtain Locally	Removing crankshaft gear
13	Rear Oil Seal Slinger Installer  Ⓟ02051	MH061470A	Installing rear oil seal slinger

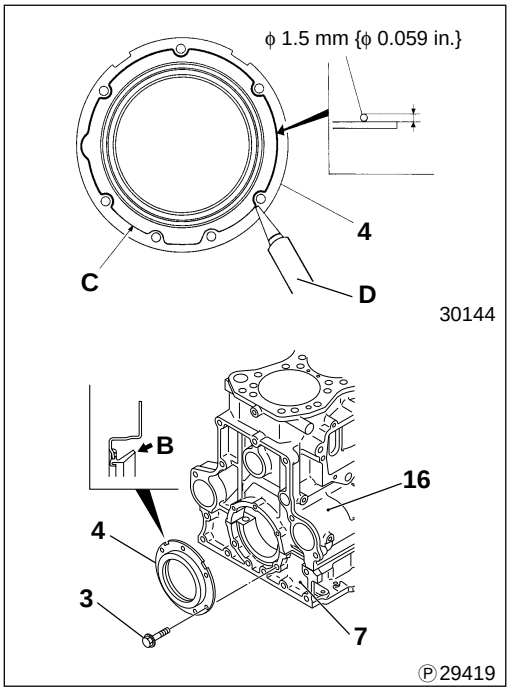


Ⓟ29413

◆ Service procedure

● **Pre-disassembly inspection**
Crankshaft end play

- Before removing the lower crankcase assembly **7**, measure the extent of crankshaft end play.
- If the measurement exceeds the specified limit, replace the thrust plates with oversize ones. P11A-85



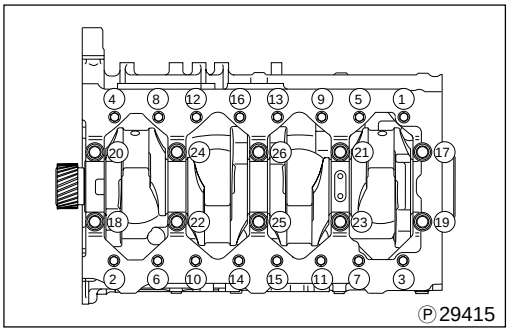
Ⓟ29419

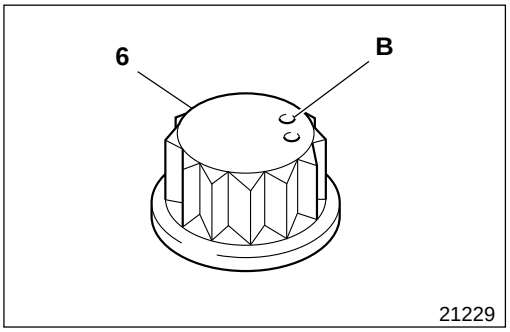
4 **Mounting of rear oil seal**

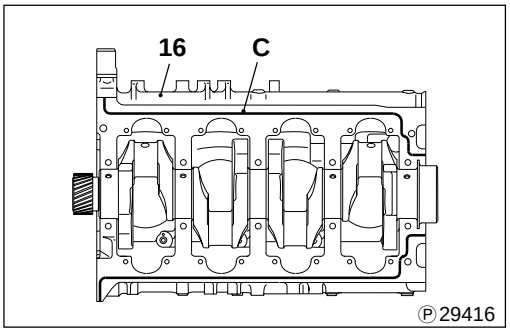
- Apply engine oil to lips **B** of rear oil seal **4**.
- Apply sealant **D** along black line **C** stamped on the rear oil seal **4** evenly without break. (ϕ 1.5 mm {ϕ 0.059 in.})
- After applying sealant **D**, install the rear oil seal **4** between the lower crankcase assembly **7** and upper crankcase assembly **16** within three minutes.

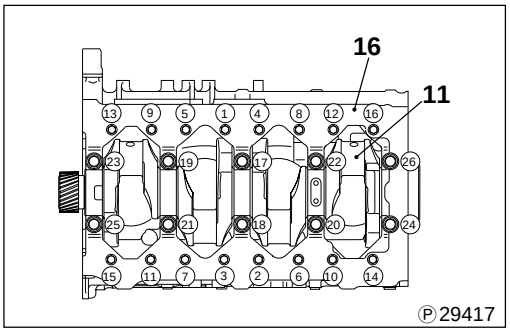
CAUTION ⚠

- **Make sure that the sealant application surfaces are clean and free from grease and oil.**
- **Use care not to let the applied sealant slip out of place during installation.**
- **After fitting rear oil seal, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant D whenever mounting bolts 3 of rear oil seal have been loosened.**









7 Lower crankcase assembly

- ① – ⑯ : Bolt **5**
- ⑰ – ㉖ : Main cap bolt **6**

[Removal]

- Gradually loosen the bolts **5** in the sequence of numbers ① – ⑯ shown in the illustration.
- Then, gradually loosen the main cap bolts **6** in the sequence of numbers ⑰ – ㉖ shown, and remove.

[Installation]

CAUTION ⚠

- **Before installing the lower crankcase assembly check the head of the main cap bolt 6 for punch marks B.**
- **The number of punch marks corresponds to the number of times the bolt has been tightened using torque-turn method (bolts with two or less punch marks are reusable). If there are three, replace the main cap bolt.**

- Apply ϕ 2 mm {ϕ 0.079 in.} thick bead of specified sealant **C** to the fitting surface of the upper crankcase assembly **16** as shown.
- After applying sealant **C**, install the lower crankcase assembly **7** to the upper crankcase assembly **16** within three minutes and secure with the main cap bolts **6** and the bolts **5** as follows:

CAUTION ⚠

- **Make sure that the sealant application surfaces are clean and free from grease and oil.**
- **Use care not to let the applied sealant C slip out of place during installation.**

- Apply a thin coat of engine oil to the threaded part and seating surface of each main cap bolt **6**, then tighten the bolts to a torque of 49 N·m {36 ft.lbs, 5.0 kgf·m} in the sequence of the numbers shown (⑰ – ㉖)
- After tightening, give the bolts an additional 90° turn in the same sequence.
- Following the main cap bolts **6**, tighten the bolts **5** to the specified torque in the sequence of the numbers shown (① – ⑯).

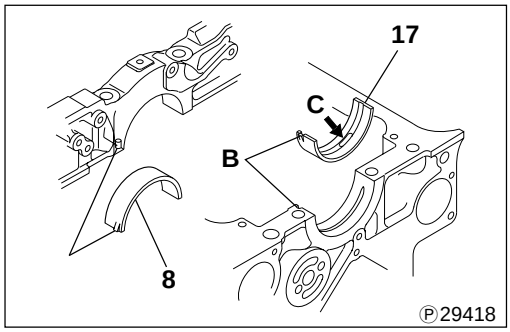
CAUTION ⚠

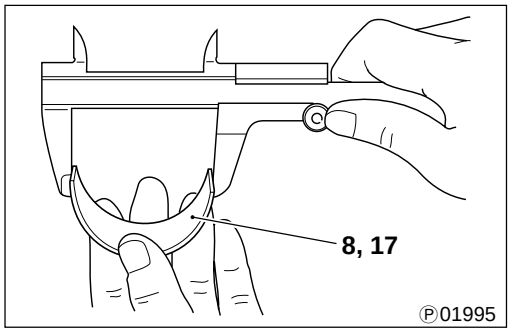
- **After installation, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant C whenever the bolts 5 or the main cap bolts 6 have been loosened.**

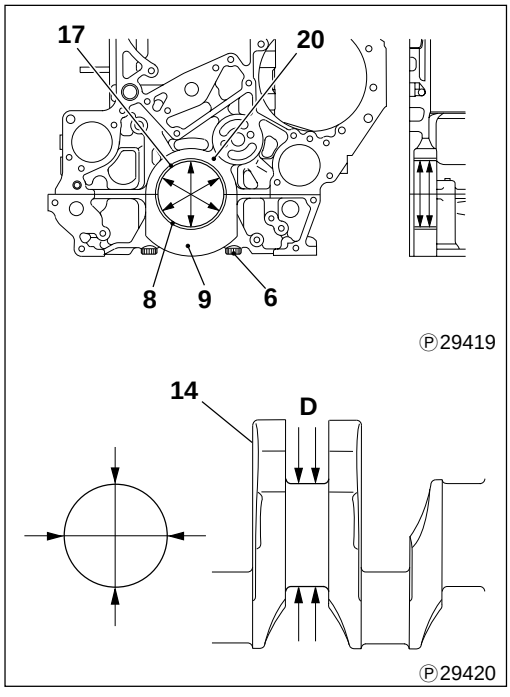
- After tightening the main cap bolts **6** using the torque-turn tightening method, make a punch mark on the head of each one to indicate the number of times used.

NOTE

Since bolts 1 utilize the torque-turn tightening method, they must not be tightened further after this procedure.







- After installing the lower crankcase assembly, check the following:
  - Smooth rotation of crankshaft assembly **11**
  - End play of the crankshaft assembly **11** P11A-82

8 **17** **Main bearings**

[Installation]

Install the main bearings **8**, **17** such that their lugs **B** fit into the corresponding grooves.

CAUTION ⚠

The upper main bearing 17 has an oil hole C. The lower main bearing 8 has no oil hole. Take care not to confuse the upper and lower parts.

[Inspection]

CAUTION ⚠

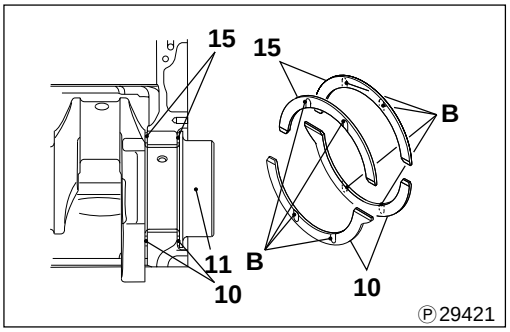
- **Do not attempt to manually expand either bearing 8, 17 if its span is insufficient.**
- **Upper and lower bearings 8, 17 must be replaced as a set.**

(1) Span when free

If either bearing's span when free exceeds the specified limit, the bearings **8**, **17** must be replaced.

(2) Main bearing-to-crankshaft clearance

- Fit the upper main bearing **17** into the upper crankcase **20** and the lower main bearing **8** into the lower crankcase **9**. Then, tighten the main cap bolts **6** to their specified torque (49 N·m {36 ft.lbs, 5.0 kgf·m}).
- Measure the internal diameters of the main bearings **8**, **17** and the journal outside diameter **D** of the crankshaft **14**. If the clearance exceeds the specified limit, replace the defective part(s).

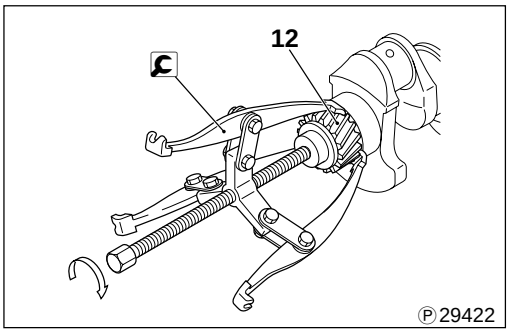


10 **15** **Thrust plate**

Install the thrust plates **10**, **15** to the crankshaft assembly **11** at No. 5 journal only. Install all halves of the thrust plates with the oil groove **B** oriented outward.

NOTE

If any oversize thrust plates are to be used, be sure to use an upper thrust plate 15 and lower thrust plate 10 of the same size at one side. However, using the same size upper (or lower) thrust bearings on both sides is not necessary.
Available oversize: 0.15, 0.30, 0.45 mm {0.0059, 0.012, 0.018 in.}



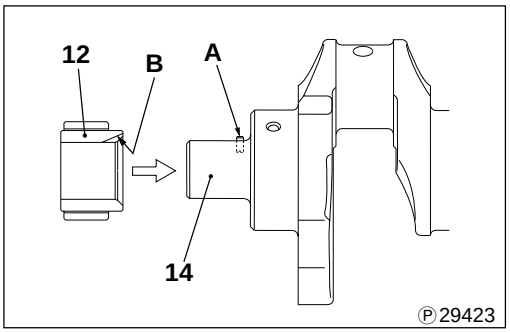
12 **Crankshaft gear**

[Removal]

: Gear Puller

CAUTION ⚠

Do not tap off the crankshaft gear 12 since this could damage it.



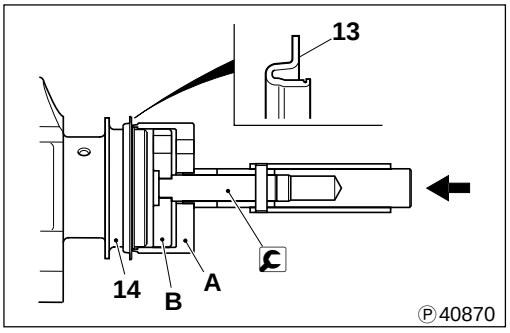
[Installation]

- Using a piston heater or the like, heat the crankshaft gear **12** to a temperature of approximately 150 °C {302 °F}.

WARNING ⚠

Be careful not to get burned.

- Align the location pin **A** on the crankshaft **14** with the notch **B** in the crankshaft gear **12**. Then, drive the gear into position by striking its end face with a plastic mallet.



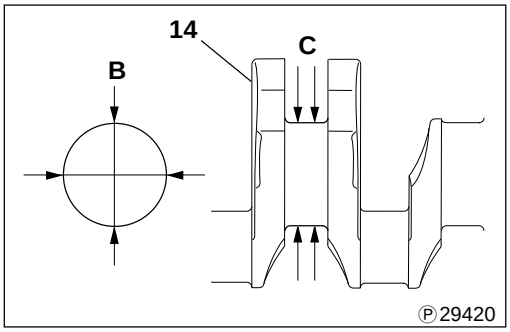
13 **Rear oil seal slinger**

[Removal]

Taking care not to damage the crankshaft **14**, split the oil seal slinger using a chisel or the like.

[Installation]

With the rear oil seal slinger **13** directed as illustrated, drive it onto the crankshaft using the Rear Oil Slinger Installer until the tools end face **A** is pressed firmly against the guide **B**.



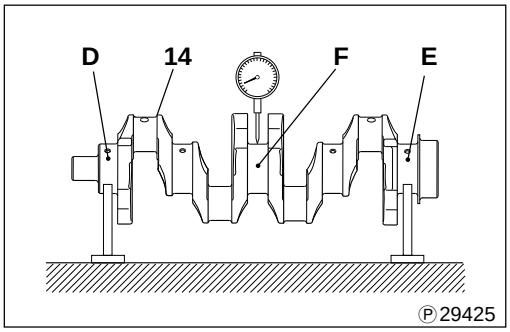
14 Crankshaft

[Inspection]

(1) Roundness and cylindricity of crankshaft journal and pin

If either measurement exceeds the specified limit, grind it to undersize or replace the crankshaft **14**.

B : Roundness
C : Cylindricity

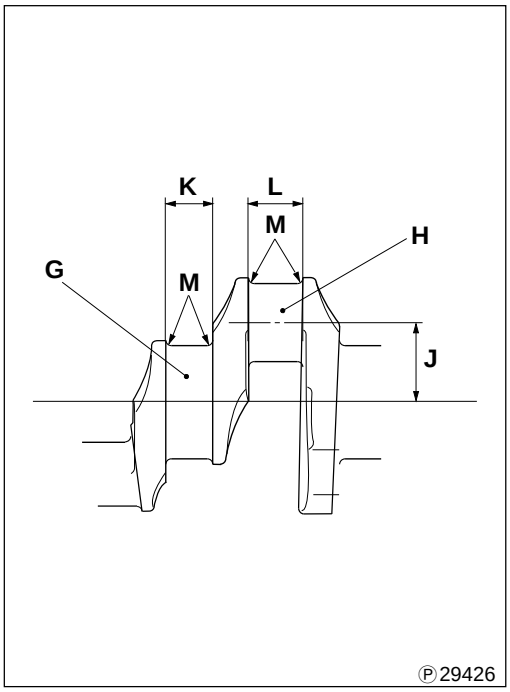


(2) Bend

- Support the crankshaft **14** at its No. 1 journal **D** and No. 5 journal **E**. Measure the extent of bending in the crankshaft at the center of the No. 3 journal **F**.
- If the measurement exceeds the specified limit, replace the crankshaft **14**.

NOTE

Turn the crankshaft 14 through one revolution. One-half of the dial indicator reading represents the extent of bending.



[Rectification]

NOTE

If the crankshaft 14 is rectified by grinding, the main bearings 8, 17 must be replaced with undersized ones.
Available undersizes: 0.25 mm, 0.50 mm 0.75 mm, 1.00 mm {0.0098, 0.02, 0.03, 0.039 in.}

- Grind such that the center-to-center distance **J** between the journal **G** and pin **H** never be changed.

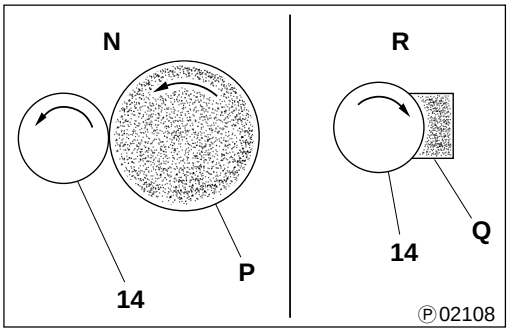
  J : 60 ± 0.05 mm {2.36 ± 0.002 in.}
- Grind such that the journal width **K** and pin width **L** do not change.

  K : 33.5 mm {1.32 in.} (No. 1 journal)
  35 mm {1.38 in.} (No. 2 to No. 4 journals)
  $35^{+0.039}_{0}$ mm {$1.38^{+0.0015}_{0}$ in.} (No. 5 journal)
  L : $41^{+0.2}_{0}$ mm {$1.61^{+0.0079}_{0}$ in.}
- Finish the corner fillet smoothly and to the specified radius M.

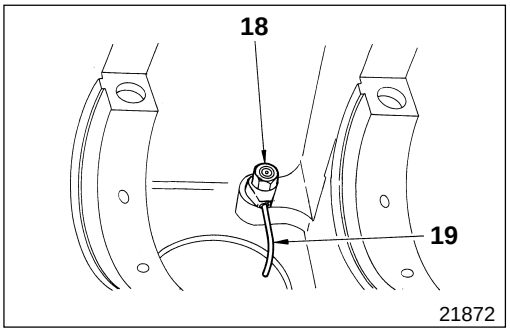
  M : 5 mm {0.2 in.}
- Carry out a magnetic inspection to check for cracks caused by grinding. Also, check that the Shore hardness of the surface has not dropped below Hs 75.

Crankshaft undersize dimensions Unit: mm {in.}

		Degree of undersize			
		0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finished journal diameter	No. 1, 2, 4, 5	85.68 to 85.70 {3.373 to 3.374}	85.43 to 85.45 {3.363 to 3.364}	85.18 to 85.20 {3.353 to 3.354}	84.93 to 84.95 {3.343 to 3.344}
	No. 3	85.66 to 85.68 {3.372 to 3.373}	85.41 to 85.43 {3.362 to 3.363}	85.16 to 85.18 {3.352 to 3.353}	84.91 to 84.93 {3.342 to 3.343}
Finished pin diameter		64.69 to 64.71 {2.546 to 2.547}	64.44 to 64.46 {2.537 to 2.5378}	64.19 to 64.21 {2.527 to 2.528}	63.94 to 63.96 {2.517 to 2.518}
Roundness		0.01 {0.00039} or less			
Cylindricity		0.006 {0.00024} or less			



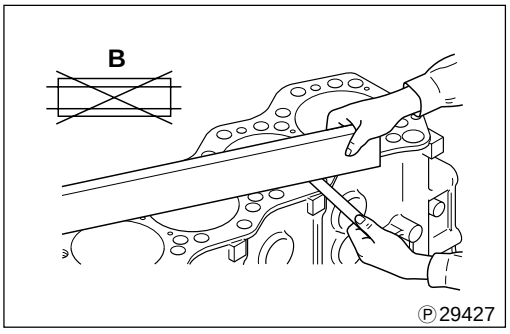
- When grinding **N**, turn the crankshaft **14** counter-clockwise as viewed from its front end. The grinder **P** should rotate in the same direction.
- When finishing **R** the crankshaft **14** with whetstone or sandpaper **Q**, rotate the crankshaft clockwise.



18 **19** **Installation of check valve and oil jet**

CAUTION ⚠

Do not overtighten the check valve 18. If the tightening torque exceeds the specified one, the check valve may malfunction, resulting in seizure of the engine.



20 **Inspecting upper crankshaft**

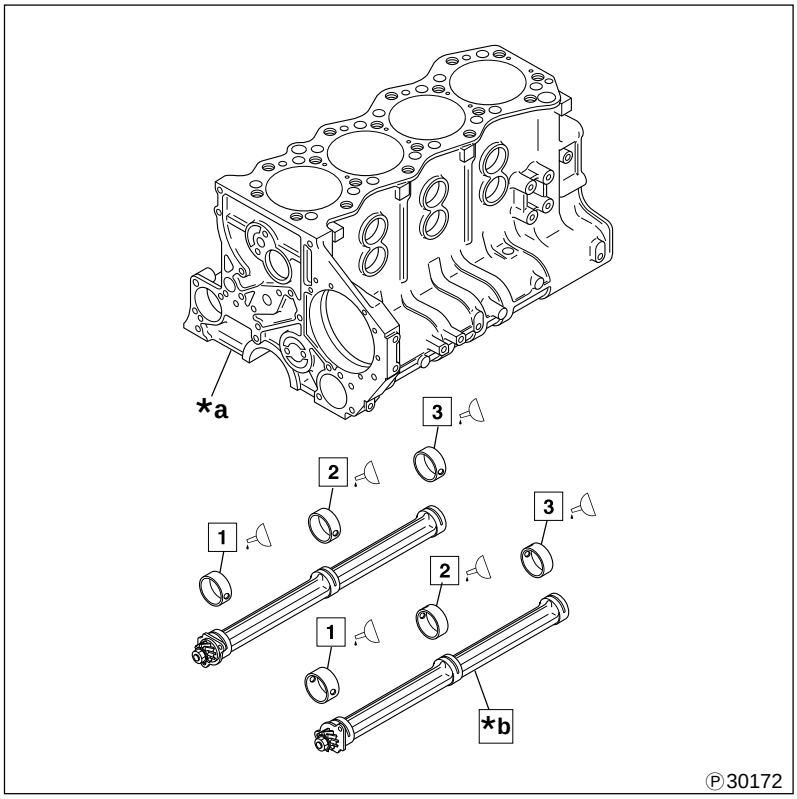
- Measure the upper surface distortion of the upper crankcase **20**.
- If distortion exceeds the specified limit, correct it with a surface grinder.

B : Measurement positions

CAUTION ⚠

When grinding the crankcase 20, take care that the piston protrusions stay within specification.

BALANCE SHAFT BUSHINGS



● **Disassembly sequence**

1 No. 1 balance shaft bushing
2 No. 2 balance shaft bushing
3 No. 3 balance shaft bushing

***a** : Upper crankcase 🕮 P11A-80
***b** : Balance shaft 🕮 P11A-56

CAUTION ⚠

Do not remove the balance shaft bushings 1 through 3 unless something wrong is evident.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

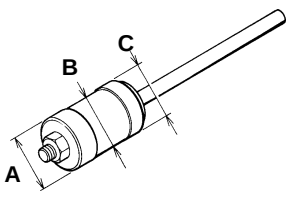
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
***b, 1 to 3**	Clearance between balance shaft and balance shaft bushing	No. 1 journal	[51.5 {2.027}] 0.055 to 0.099 {0.0021 to 0.0039}	0.15 {0.0059}	Replace
		No. 2 journal	[51 {2.0}] 0.075 to 0.119 {0.0029 to 0.0046}		
		No. 3 journal	[50.5 {1.98}] 0.055 to 0.099 {0.0021 to 0.0039}		

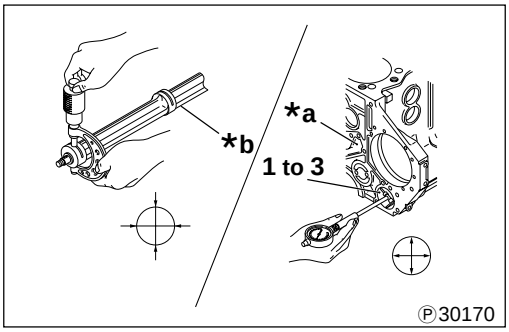
Lubricant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1 to 3	Inside surface of balance shaft bushing	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
1 to 3	Balance shaft bushing installer and extractor Dimensions A and C / Dimension B No. 1: ϕ 55.25 {ϕ 2.175} / ϕ 51.5 {ϕ 2.027} No. 2: ϕ 55 {ϕ 2.165} / ϕ 51 {ϕ 2.007} No. 3: ϕ 55.75 {ϕ 2.155} / ϕ 50.5 {ϕ 1.988}  02083	MH062782 (Obtain Locally)	Installation and removal of balance shaft bushing



◆ Service procedure

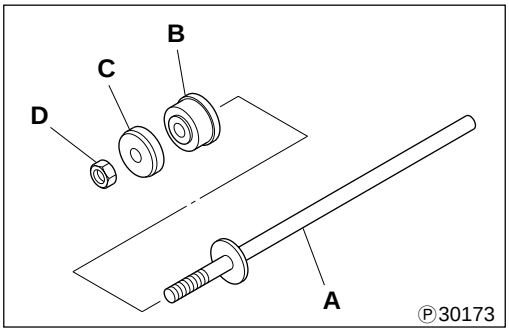
[*b] [1] to [3] Balance shaft and balance shaft bushing

[Inspection]

If the clearance is more than the limit, replace defective parts.

NOTE

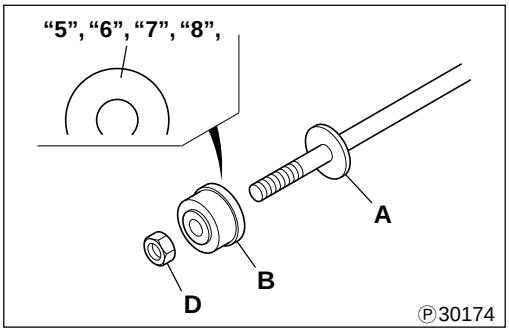
Measure the inner diameter of the balance shaft bushings 1 through 3 with the bushings installed on the upper crankcase *a.



Balance shaft bushing

Use the [C] Balance Shaft Bushing Installer & Extractor to replace the balance shaft bushings **1** through **3**.
(Components of [C] Balance Shaft Bushing Installer & Extractor)

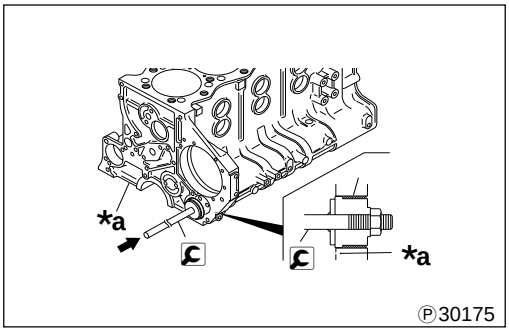
A : Rod
B : Adapter
C : Guide piece
D : Nut



[Removal]

- Drive out the balance shaft bushings **1** to **3** using the [C] Balance Shaft Bushing Installer & Extractor consisting of the adapter **B** appropriate to each bushing secured on rod **A** with nut **D**.

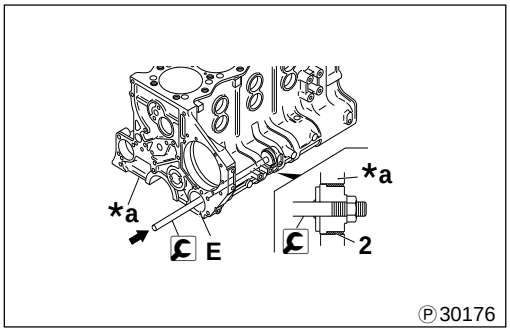
Balance shaft bushing		Identification mark of adapter **B**
No. 1	Left	5
	Right	6
No. 2		7
No. 3		8



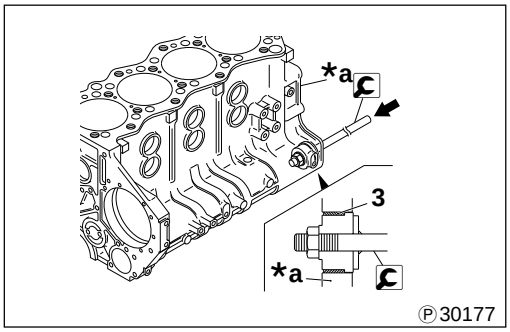
- Remove the No. 1 balance shaft bushing **1** from the front side of the upper crankcase ***a**.

[C] **:** Balance Shaft Bushing Installer & Extractor

BALANCE SHAFT BUSHINGS

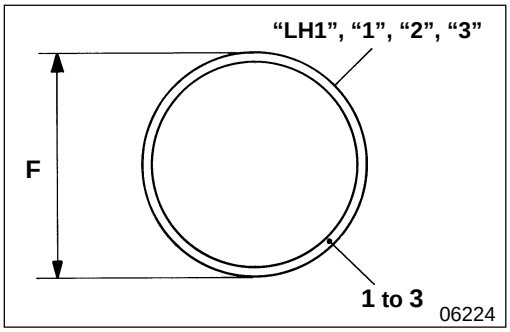


- Remove the No. 2 balance shaft bushing **2** from the upper crankcase ***a** by inserting the 🔧 Balance Shaft Bushing Installer & Extractor through the hole **E** from which the No. 1 balance shaft bushing was removed.



- Remove the No. 3 balance shaft bushing **3** from the rear side of the upper crankcase ***a**.

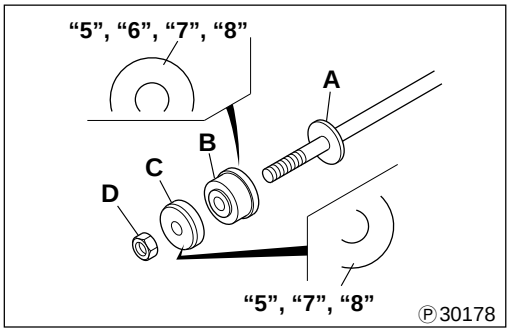
  🔧 **:** Balance Shaft Bushing Installer & Extractor



[Installation]

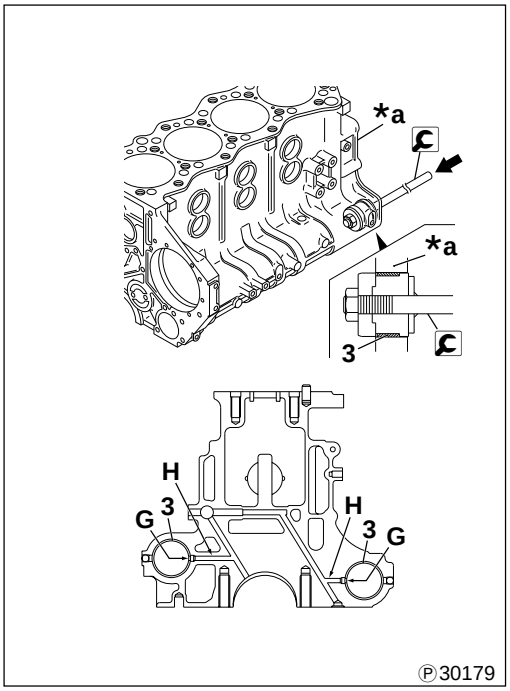
- Identify balance shaft bushings **1** through **3** by the marks "1", "2", "3" or "LH1" stamped on each bushing.
  If the mark on a bushing is unclear, identify the bushing by measuring the outside diameter **F** of the bushing.

Balance shaft bushing (from front of engine)		Mark	Outside diameter (mm {in.})
No. 1	Left (two oil holes)	LH1	ϕ 55.25 {ϕ 2.175}
	Right (one oil hole)	1	
No. 2		2	ϕ 55 {ϕ 2.165}
No. 3		3	ϕ 54.75 {ϕ 2.155}

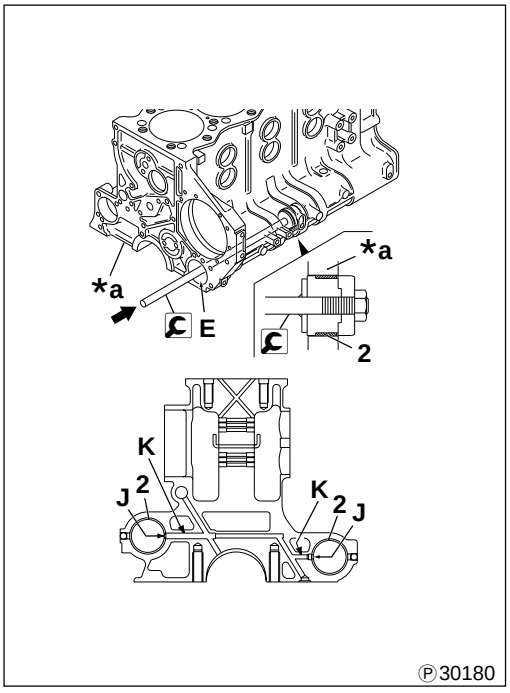


- Drive the balance shaft bushings **1** through **3** in position by hammering on the 🔧 Balance Shaft Bushing Installer & Extractor consisting of the adapter **B** and guide piece **C** appropriate to each bushing secured on the rod **A** with nut **D**.

Balance shaft bushing		Identification mark of adapter **B**	Identification mark of guide piece **C**
No. 1	Left	5	5
	Right	6	
No. 2		7	7
No. 3		8	8

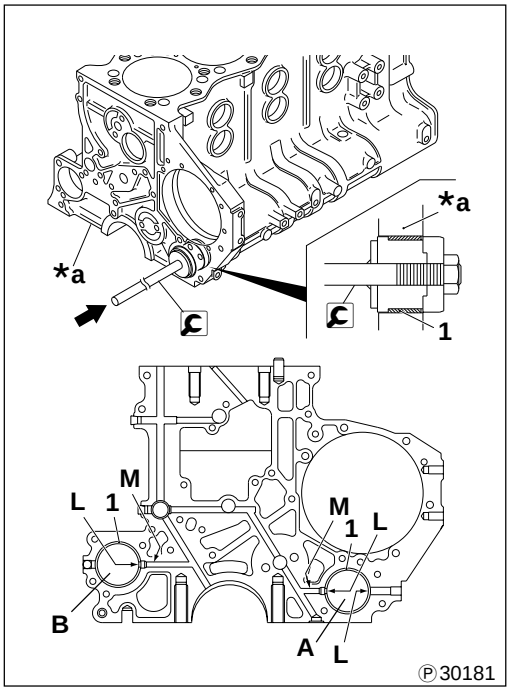


- Install the No. 3 balance shaft bushing **3** from the rear side of the upper crankcase ***a**.
  In this case, make sure that the oil hole **G** in the bushing matches the oil passage **H** in the crankcase.
  : Balance Shaft Bushing Installer & Extractor



- Install the No. 2 balance shaft **2** by inserting the Balance Shaft Bushing Installer & Extractor through the No. 1 balance shaft bushing mounting hole **E** of the upper crankcase ***a**.
  In this case, make sure that the oil hole **J** in the bushing matches the oil passage **K** in the crankcase.
  : Balance Shaft Bushing Installer & Extractor

BALANCE SHAFT BUSHINGS



- Install the No. 1 balance shaft bushing **1** from the front side of the upper crankcase ***a**.
  In this case, make sure that the oil hole **L** in the bushing matches the oil passage **M** in the crankcase.

  : Balance Shaft Bushing Installer & Extractor

CAUTION ⚠

- **The No. 1 balance bushings 1 include the right and left ones which are different from each other. Use care to prevent confusion when installing them.**
  The left one A has two oil holes L, whereas the right one B has one oil hole L.
- **Before installing No. 1 balance bushing 1, check to ensure that No. 2 balance shaft bushing 2 has been installed.**

MITSUBISHI
FUSO

Group 11B
Engine

< 4D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-11B

INDEX

SPECIFICATIONS 11B- 2

STRUCTURE AND OPERATION 11B- 3

TROUBLESHOOTING 11B- 6

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE
- Inspection of Engine Compression 11B- 7
- Inspection and Adjustment of Valve Clearance 11B- 9

REMOVAL AND INSTALLATION OF ENGINE 11B-12

CYLINDER HEAD AND VALVE MECHANISM 11B-16

TIMING GEAR 11B-30

CAMSHAFT 11B-34

PISTON, CONNECTING ROD AND CYLINDER SLEEVE 11B-40

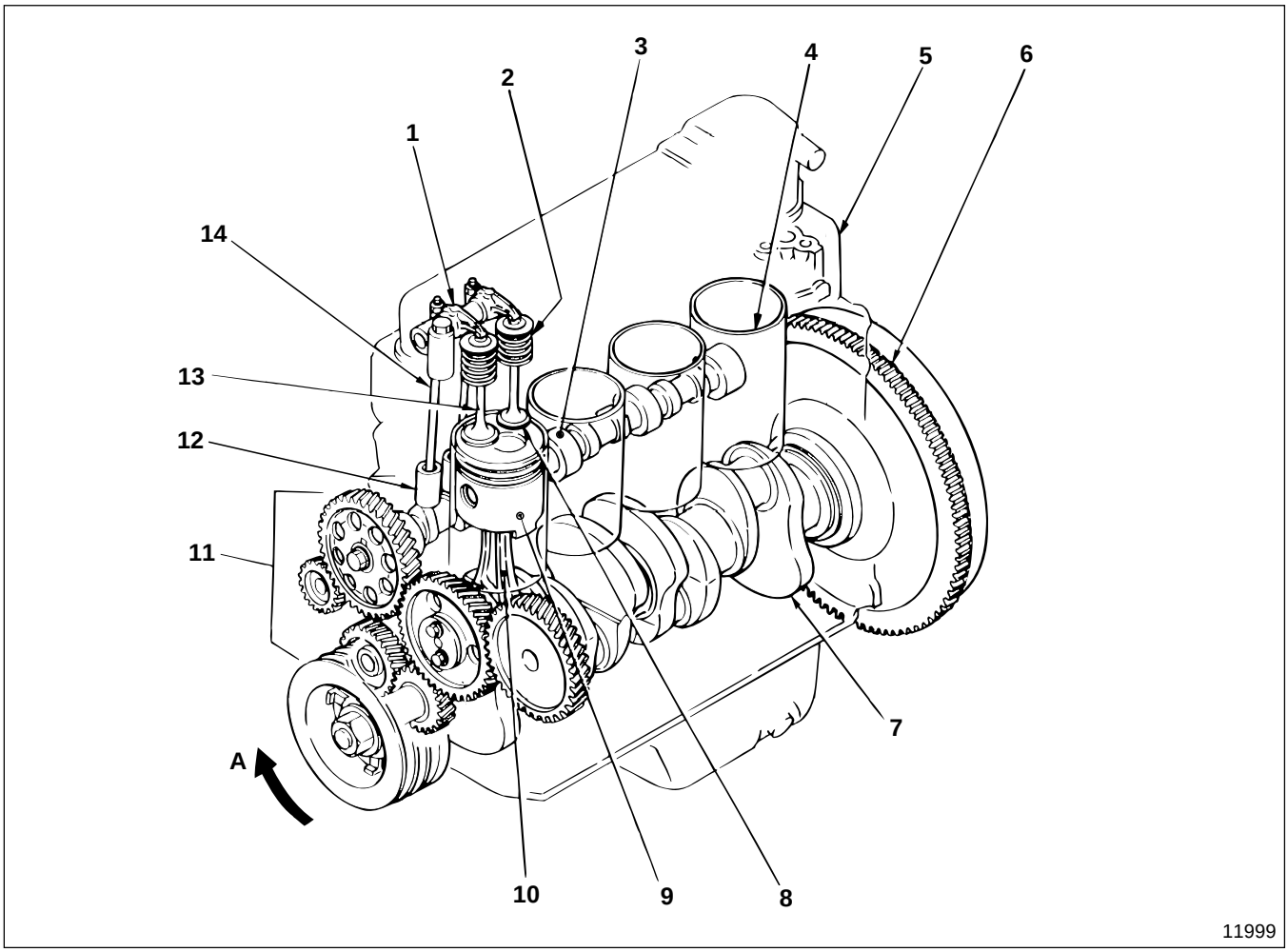
FLYWHEEL
< WITHOUT FLYWHEEL POWER TAKE-OFF > 11B-54
< WITH FLYWHEEL POWER TAKE-OFF > 11B-58

CRANKSHAFT AND CRANKCASE 11B-66

SPECIFICATIONS

Item	Specifications
Engine model	4D34T3
Type	4-cylinder in-line, water-cooled 4-cycle diesel
Combustion chamber type	Direct injection type
Valve mechanism	Overhead valve (OHV) type
Maximum output HP/rpm (SAE Gross)	145/2900
Maximum torque lbf.ft/rpm (SAE Gross)	275/1600
Bore×stroke mm {in.}	ø104×115 {4.09×4.53}
Total displacement cm^3 {cu. in.}	3907 {240}
Compression ratio	17.5

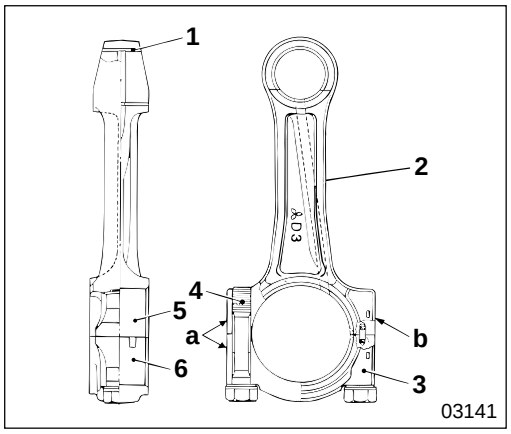
Engine Body



1 Rocker arm
2 Valve spring
3 Camshaft
4 Cylinder sleeve
5 Cylinder head
6 Flywheel
7 Crankshaft
8 Exhaust valve
9 Piston
10 Connecting rod
11 Timing gear
12 Tappet
13 Inlet valve
14 Push rod

A : Direction of rotation

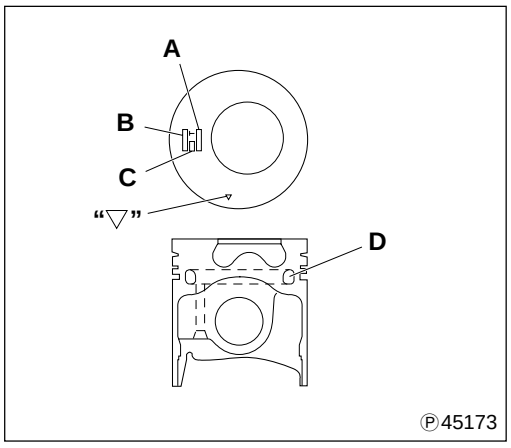
Connecting Rod



1 Connecting rod bushing
2 Connecting rod
3 Connecting rod cap
4 Connecting rod bolt
5 Upper connecting rod bearing
6 Lower connecting rod bearing

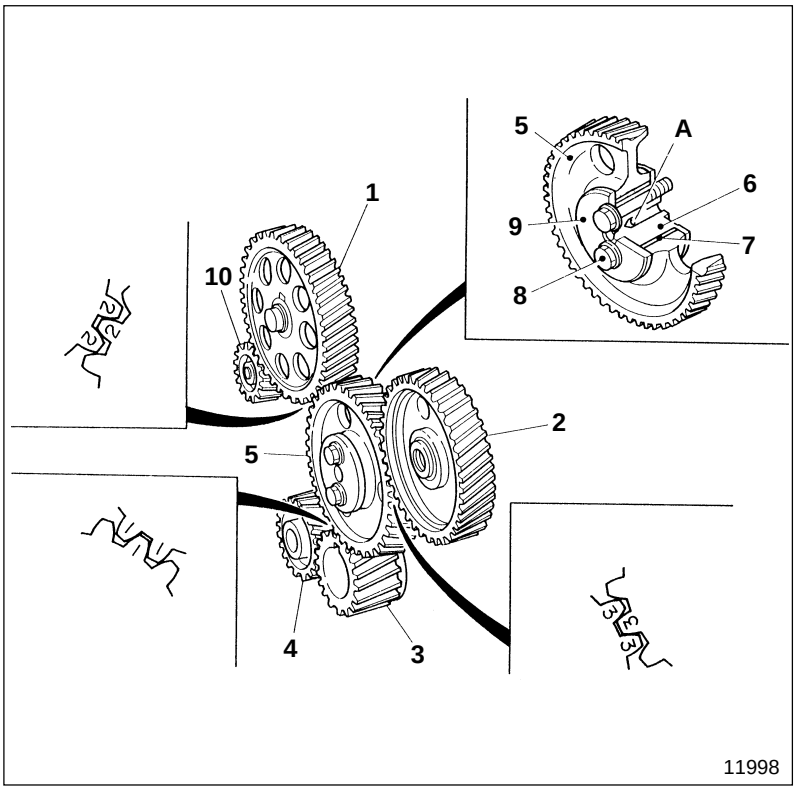
a : Alignment mark
b : Mass mark (weight)
(“A” through “G”)
“A” : Maximum connecting rod mass (weight)

Piston



A : Part Number
B : Mass mark
C : Oversize mark “0.50” to “1.00”
D : Cooling cavity
▽ : Front mark

Timing Gear



1 Camshaft gear
2 Injection pump gear
3 Crankshaft gear
4 Oil pump gear
5 Idler gear
6 Idler shaft
7 Idler bushing
8 Bolt
9 Thrust plate
10 Power steering oil pump gear

A : Oil hole

Alignment marks "**1**", "**2**", "**3**" are punch-marked on each timing gear to ensure proper engagement of the gears at installation.

TROUBLESHOOTING

Symptoms / Possible causes	Decrease of power	Engine noise abnormal	Remarks
Oil viscosity unsuitable	○		Gr 12B
Fuel incorrect or unsuitable	○		
Valve clearance faulty	○	○	
Head gasket faulty	○	○	
Valve and valve seat worn, and carbon deposits	○	○	
Valve spring fatigued	○	○	
Piston ring worn or damaged	○	○	
Piston ring grooves worn or damaged	○	○	
Injection timing faulty	○	○	Gr 13B, Gr 13EB
Injection pump malfunctioning	○	○	Gr 13B, Gr 13EB
Cooling system malfunctioning	○		Gr 14B
Injection nozzle malfunctioning	○	○	Gr 13B
Fuel system sucking air	○		Gr 13B
Air cleaner mesh clogged	○		Gr 15B
Muffler clogged	○		Gr 15B
Pipe and hose installation faulty		○	
Ancillary equipment (injection pump, alternator, etc.) or installation faulty		○	Gr 13B Gr 54
V-belt loose or damaged		○	Gr 14B
Crankshaft pulley mounted incorrectly		○	
Air cleaner or muffler malfunctioning		○	Gr 15B
Rocker shaft and bracket faulty		○	
Rocker shaft bracket lubrication faulty		○	
Timing gear backlash faulty		○	
Timing gear system and idler shaft lubrication faulty		○	
Connecting rod small end bushing worn and piston pin worn		○	
Crankshaft pin and big end bearing of connecting rod worn or damaged		○	
Crankshaft journal and main bearing worn or damaged		○	
Crankshaft and camshaft end play excessive		○	
Tappet and camshaft worn		○	

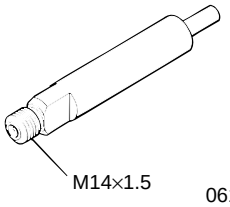
Inspection of Engine Compression

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Engine Compression	Each cylinder (200 rpm)	2550 kPa {370 psi, 26 kgf/cm^2}	1960 kPa {285 psi, 20 kg/cm^2}	Inspect
		Pressure difference between each cylinder	—	within 390 kPa {57 psi, 4 kgf/cm^2}	Inspect

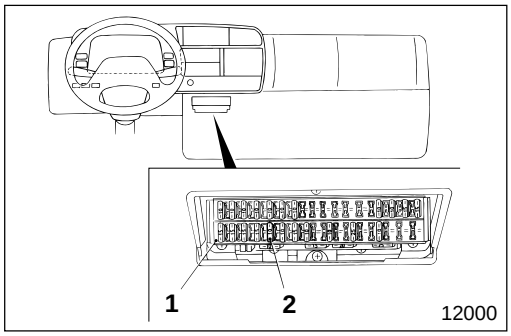
Special tools

Unit : mm {in.}

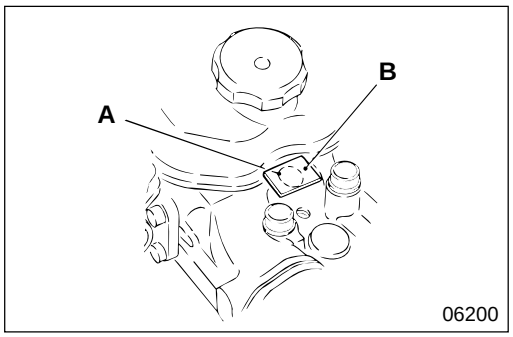
Location	Tool name and shape	Part No.	Application
—	Compression gauge adapter  06197	MH061460	Measurement of engine compression

The decrease of engine compression is a signal that it is time to overhaul the engine. It is strongly recommended that this item is inspected periodically and that you record the history of deterioration in engine performance as this will help you to diagnose causes of future irregularities.
When the vehicle is still new or immediately after installation of new parts, there may be a slight increase in engine compression, but normal performance will be restored soon.

- Before inspection make sure that engine oil, starter and battery are in normal condition.
- Before inspecting the vehicle do the following:
  - Run the engine to bring the temperature of the coolant up to approximately 75 to 85°C {167 to 185°F}.
  - Turn all the lights and accessory equipment OFF.
  - Put transmission in neutral. (P range for automatic transmission)
  - Set the steering wheel at center and straight position.



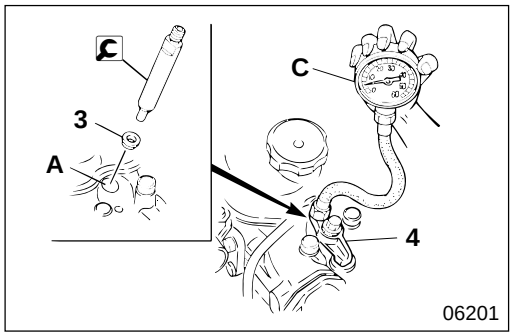
- Remove fuse **2** for the fuel-cut motor/engine ECU from fuse box **1** inside the cab to prevent the fuel from being injected when the engine is cranked by the starter.



- Remove all the injection nozzles. Gr 13B
- Check that no foreign particles are sticking to waste cloth **B** covering injection nozzle mounting hole **A** after cranking the engine.

WARNING

You must stay clear of injection nozzle mounting hole A when you crank the engine during this inspection. Assume that all cylinders have cracked, and that coolant, engine oil, fuel, etc. have seeped into the cylinder chambers. If this is the state when the engine is cranked, there is an extreme danger of these substances being injected out of the injection nozzle mounting hole at high temperature.



- Mount gasket **3** and compression gauge adaptor in injection nozzle mounting hole **A** and fasten them with nozzle bridge **4**, then mount compression gauge **C**.
- Measure engine compression while cranking the engine.
- Measure engine compression of cylinders and calculate the difference among the cylinders.
- If the engine compression and pressure difference between each cylinder deviate from the limit, reinspect by pouring a small amount of engine oil into injection nozzle mounting hole **A**.
  - When pressure is high : It is likely that either wear or damage of the slide-contact area of both the piston ring and the cylinder inner surface has taken place.
  - When pressure is low : It is likely that burning of the valve, faulty contact of valve surfaces and/or faults in the cylinder head gasket have developed.

Inspection and Adjustment of Valve Clearance

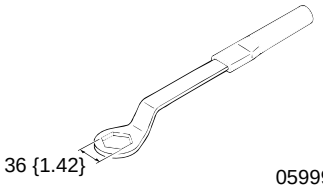
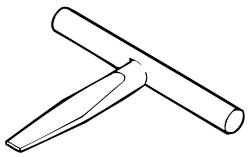
Service standards

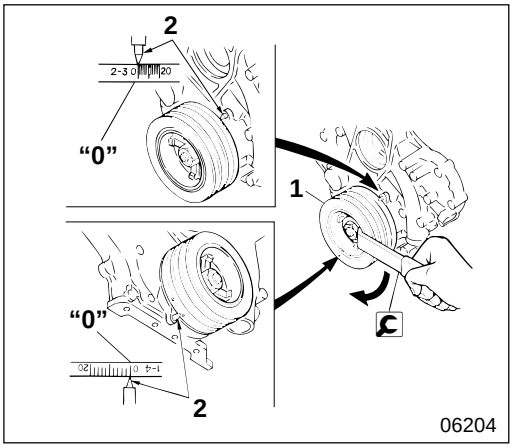
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Valve clearance (When engine is cold)	0.4 {0.016}	—	Adjust

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Cranking handle  05999	MH061289 (Obtain Locally)	Cranking of engine
—	Flat-blade screwdriver  06000	MH060008 (Obtain Locally)	Valve clearance adjustment (Used for an installed engine)



06204

Inspect and adjust the valve clearance while the engine is cold in the following way.

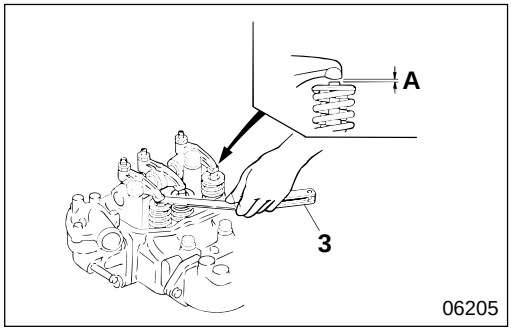
[Inspection]

- Crank the engine to move No.1 or No.4 piston to top dead center. Do this by turning crankshaft pulley **1** clockwise using cranking handle to align stamped mark "**0**" on the crankshaft pulley with pointer **2**.

NOTE

- **The cylinder whose push rod is not pushing up the inlet/outlet rocker is the one whose piston is at top dead center.**
- **There are two pointers 2. Use any one of the two pointers to align the stamped mark of crankshaft pulley 1 in the position as illustrated.**

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE



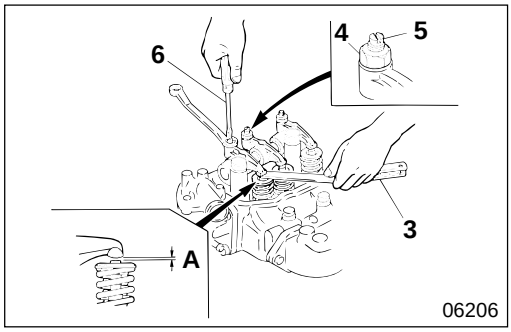
- Measure valve clearance **A** when either No.1 or No.4 piston is at top dead center in accordance with the following tabulated sequence of each valve.

Cylinder No.	1		2		3		4	
Valve arrangement	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust
No.1 piston at top dead center	○	○	○	—	—	○	—	—
No.4 piston at top dead center	—	—	—	○	○	—	○	○

NOTE

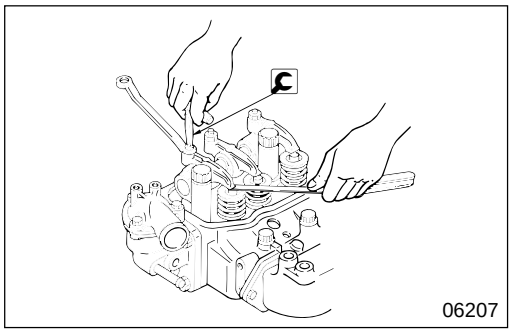
Be sure when taking measurements using feeler gauge 3 that some resistance is felt when inserting the gauge. If the gauge can be inserted freely without any resistance, an accurate measurement has not been obtained.

- If the measured value deviates from the limit, adjust as follows:



[Adjustment]

- Adjust valve clearance **A** so that feeler gauge **3** encounters some resistance when it is inserted. Do this by loosening lock nut **4** and turning adjusting screw **5**.
- After adjusting, hold adjusting screw **5** using screwdriver **6** and tighten lock nut **4**. Reinspect valve clearance **A** using feeler gauge **3**.



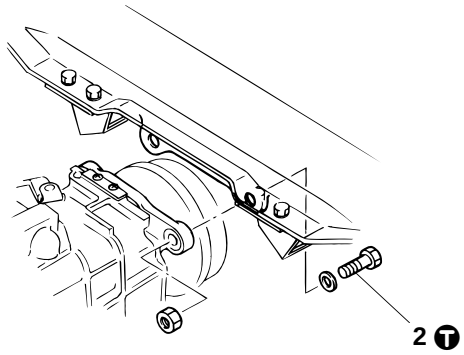
- When turning adjusting screw **5** on an engine that is installed, using a flat-blade screwdriver will make the work easier.

M E M O

REMOVAL AND INSTALLATION OF ENGINE

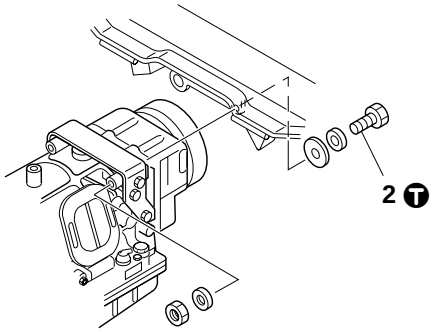
< FE >

< Manual transmission >



07344

< Automatic transmission >



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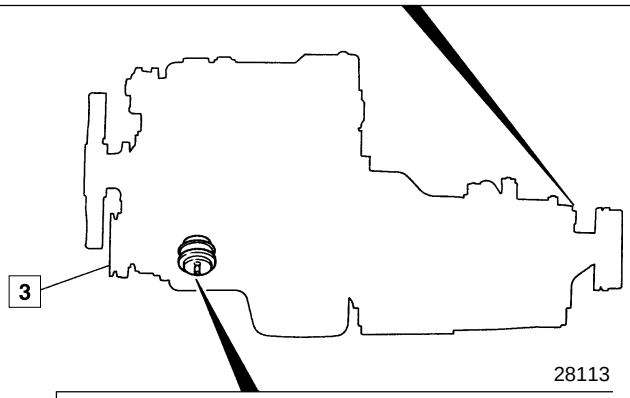

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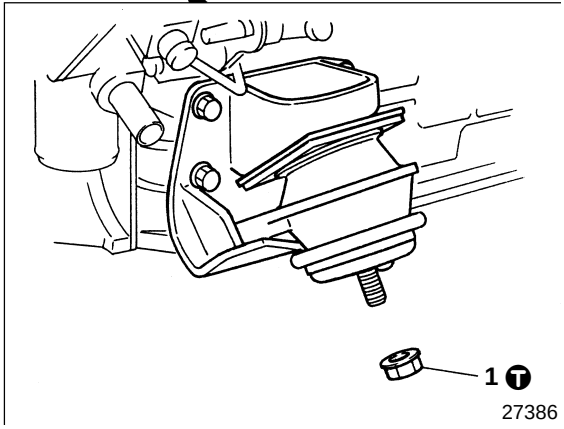


27386

● **Removal sequence**

1 Nut
2 Bolt
3 Engine and transmission assembly

WARNING ⚠

When you lift engine and transmission assembly 3 you must use lifting gear that is strong enough to lift the mass of the engine and transmission assembly (480 to 560 kg {1060 to 1230 lb}).

● **Installation sequence**

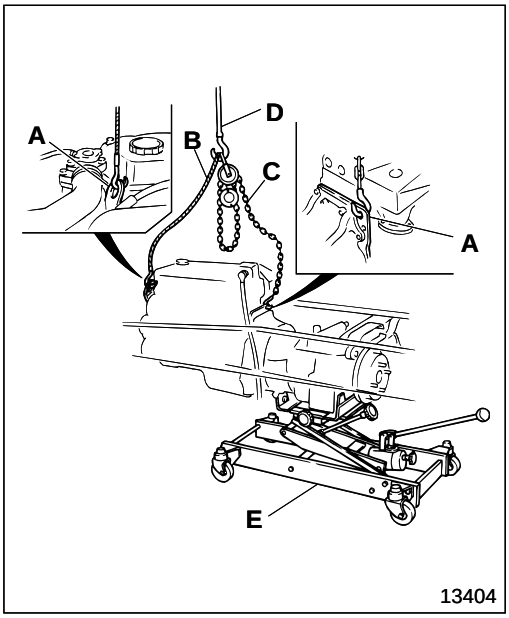
Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

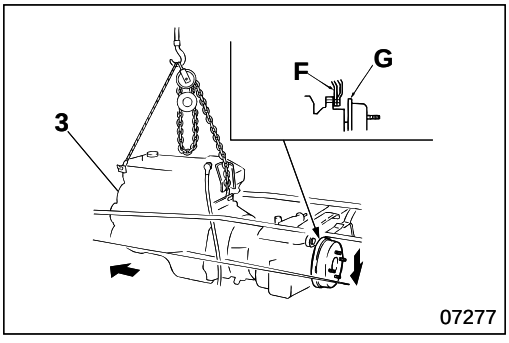
Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Front mounting installation)		68 to 88 {50 to 65, 6.9 to 9.0}	—
2	Bolt (Rear mounting installation)	Manual transmission	125 to 175 {94 to 130, 13 to 18}	—
		Automatic transmission	83 to 105 {61 to 80, 8.5 to 11.0}	—

◆ Service procedure

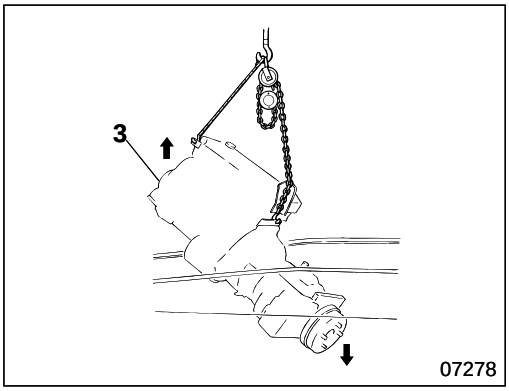


3 Removal of engine and transmission assembly

- Hook cable **B** and chain block **C** to two hangers **A** on the engine and transmission assembly and lift the engine using crane **D** until the lifting gear becomes taut.
- Support the transmission using transmission jack **E**.
- Make sure that wiring and hoses are disconnected.



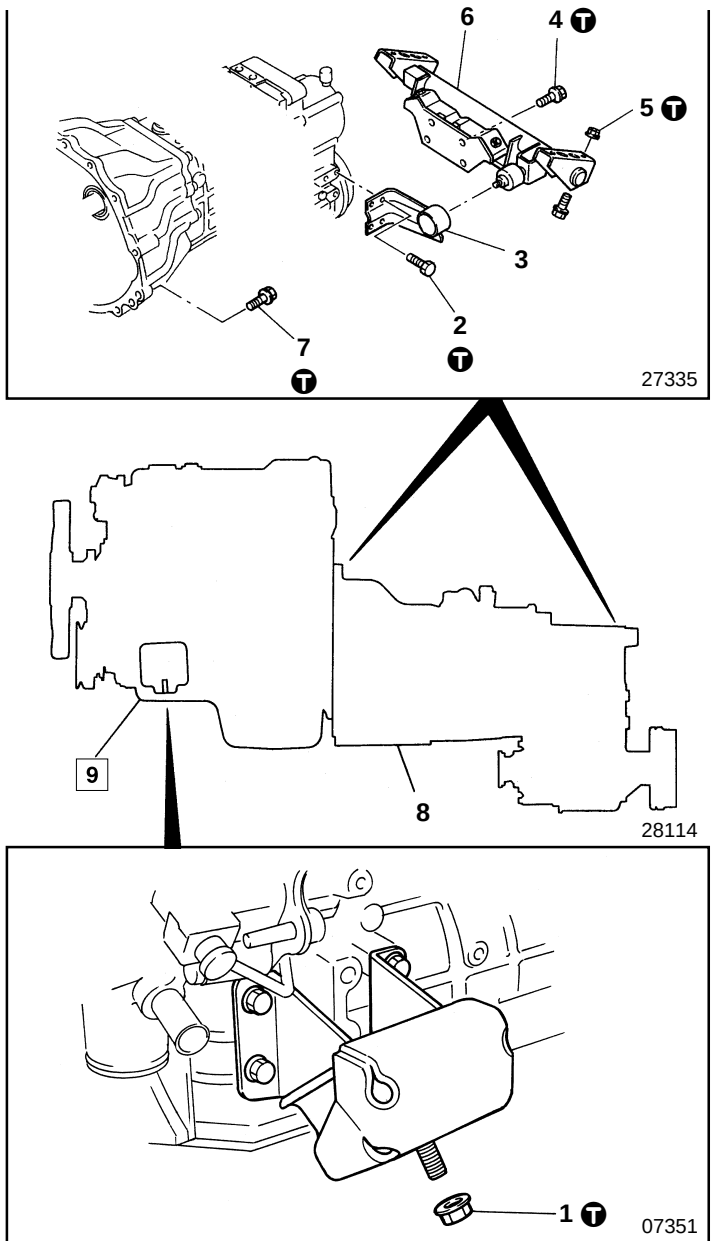
- Lower the transmission carefully so that transmission back plate **G** does not hit engine rear support **F** then move engine and transmission assembly **3** forward.



- Lift engine and transmission assembly **3** carefully adjusting the lifting angle. As the transmission appears from the front of the rear body turn the transmission 90° clockwise and place it down on the right side carefully so that it does not hit the frame or cab.

REMOVAL AND INSTALLATION OF ENGINE

< FG >



● **Removal sequence**

1 Nut
2 Bolt
3 Roll stopper
4 Bolt
5 Nut
6 Rear engine support bracket
7 Bolt
8 Transmission and transfer assembly Gr 22
9 Engine assembly

WARNING

- **Take care not to allow engine assembly 9 to hit the cab and rear body when lifting the engine.**
- **Be sure to use lifting gear or an engine hoist that is capable of lifting engine assembly 9 weighing 380 kg {840 lb}.**

● **Installation sequence**

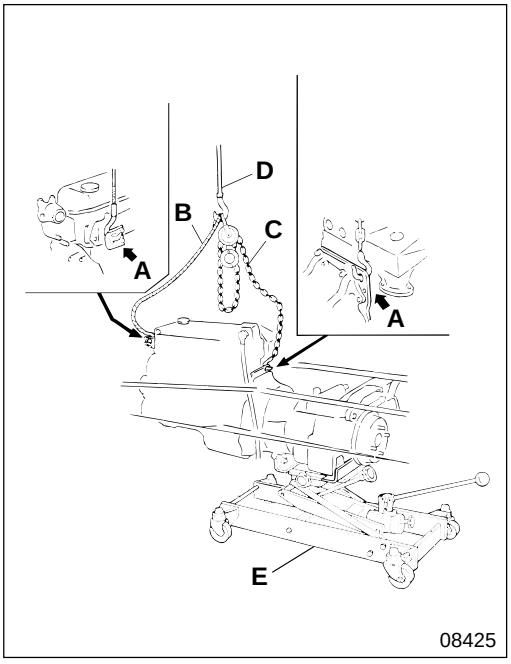
Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

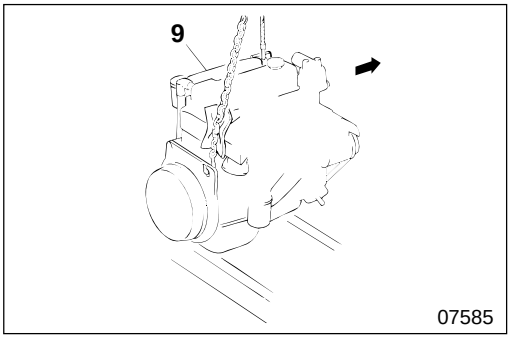
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Front mounting installation)	68 to 88 {50 to 65, 6.9 to 9.0}	—
2	Bolt (Roll stopper bracket mounting)	44 to 64 {33 to 47, 4.5 to 6.5}	—
4	Bolt (Rear mounting installation)	44 to 64 {33 to 47, 4.5 to 6.5}	—
5	Nut (Rear engine support bracket mounting)	98 to 115 {72 to 87, 10 to 12}	—
7	Bolt (Transmission and transfer assembly mounting)	47 {35, 4.8}	M10×1.25
		82 {61, 8.4}	M12×1.75

◆ Service procedure



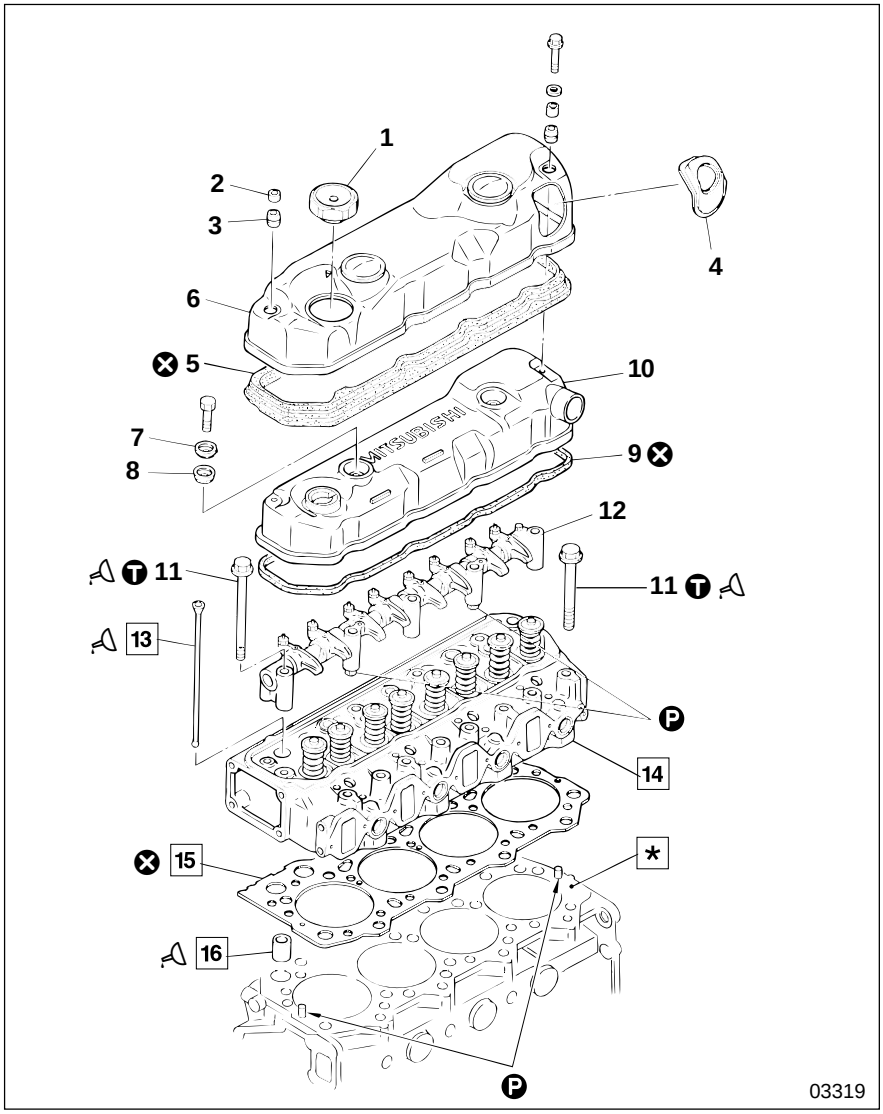
9 **Preparatory operations for removal**

- Hook cable **B** and chain block **C** to two hangers **A** on the engine assembly and lift the engine using crane **D** until the lifting gear become taunt.
- Support the transmission using transmission jack **E**.
- Make sure that the wiring and hoses are disconnected.



Lift engine assembly **9** carefully and slowly, and turn the engine 90° clockwise when the lower part of engine appears above the frame.

CYLINDER HEAD AND VALVE MECHANISM



● **Disassembly sequence**

1 Oil filler cap
2 Spacer
3 Insulator
4 Breather grommet
5 Rocker cover insullator
6 Outer rocker cover
7 Washer
8 Insulator
9 Inner rocker cover gasket
10 Inner rocker cover
11 Cylinder head bolt
12 Rocker and bracket assembly 🕮 P11B-20
13 Push rod
14 Cylinder head and valve assembly 🕮 P11B-22
15 Cylinder head gasket
16 Tappet

***** : Crankcase 🕮 P11B-66
P : Positioning pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
13	Push rod deflection	—	0.4 {0.016}	Replace
16, *	Clearance between tappet and crankcase tappet hole	[28] 0.05 to 0.09 {[1.10] 0.0020 to 0.0035}	0.2 {0.0079}	Replace

Ⓣ Tightening torque

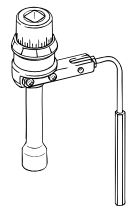
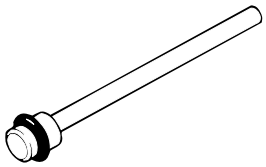
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
11	Cylinder head bolt	145 {110, 15}+90°	Wet Reuse up to three times

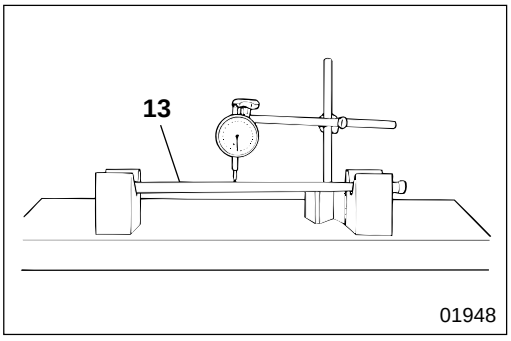
Lubricant

Location	Points of application	Kinds	Quantity
11	Thread area of cylinder head bolt	Engine oil	As required
13	Both ends of push rod	Engine oil	As required
16	Outer periphery of tappet	Engine oil	As required

Special tools

Location	Tool name and shape	Part No.	Application
14	Socket wrench  01984	MH061560	Installation of cylinder head and valve assembly
16	Tappet extractor  03320	MH063329 (Obtain Locally)	Removal of tappet

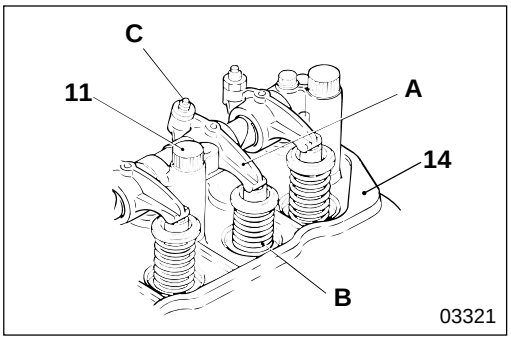
◆ Service procedure



01948

13 **Push rod deflection**

If the measured value is higher than the limit, replace push rod **13**.

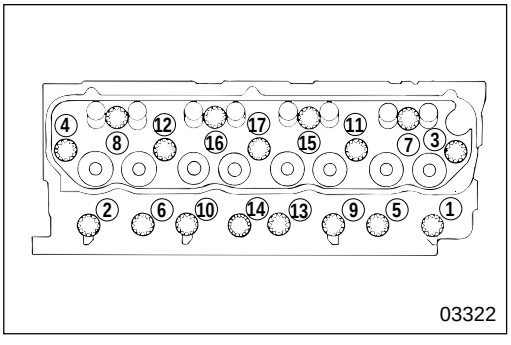


03321

14 **Cylinder head and valve assembly**

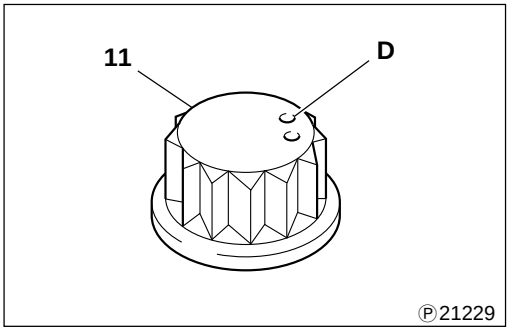
[Removal]

- Before undoing cylinder head bolts **11**, first loosen adjusting screw **C** of rocker **A** that pushes down valve spring **B**.



03322

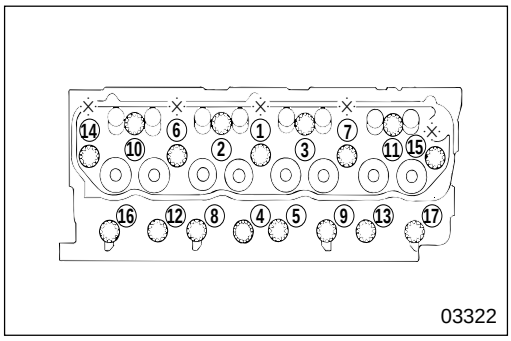
- First loosen cylinder head bolts **11** in the numbered order as illustrated, then remove them.



[Installation]

CAUTION ⚠

- **Before fitting any cylinder head bolt 11, check the punch marks D on its head. Do not use bolt if there are more than two punch marks.**
- **The punch marks indicate the number of times each bolt has been tightened using the torque-turn tightening method. Any bolt that already has three punch marks must be replaced.**

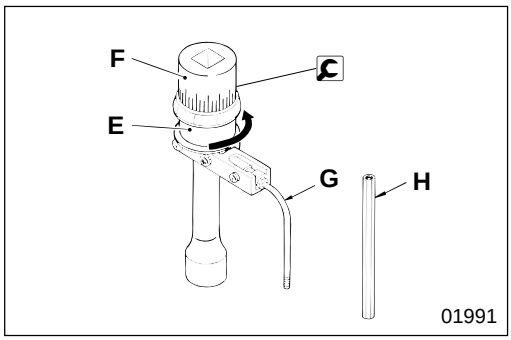


- Center punch the heads of cylinder head bolts **11** before installation.

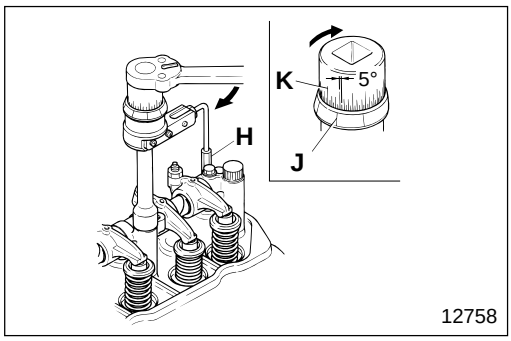
CAUTION ⚠

If there are already three center-punch marks, replace the cylinder head bolt with a new one.

- After tightening cylinder head bolts **11** at specified torque in the numbered order as illustrated, tighten further as follows:
  ·※· : Tightened simultaneously with rocker and bracket assembly



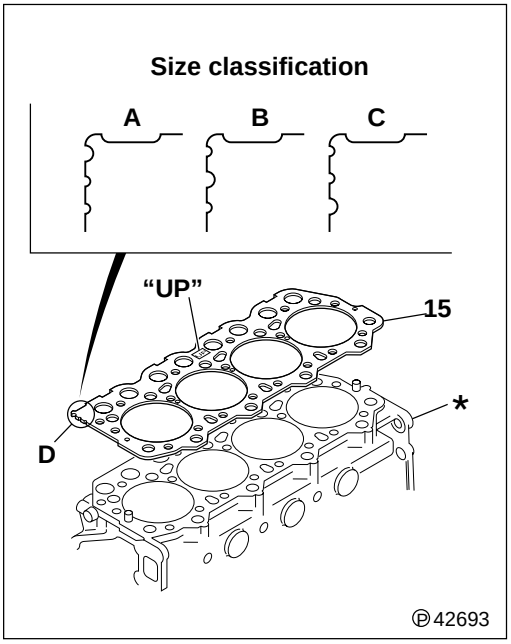
- Turn 🔧 socket wrench holder **E** counterclockwise and keep the spring in the wrench compressed.
  F : Socket
  G : Rod
  H : Rod (for extension)



- Set 🔧 socket wrench holder **E** so that the twisting force of the spring presses rod **H** (for connection) against adjacent parts such as, rocker shaft bracket or the injection pipe.
- Select a scale that is convenient for reading graduation **J** on holder **E**.
- Tighten further by turning socket **F** clockwise by 90° (setting is in 5° increments), referring to graduation **K** on the selected scale.

CAUTION ⚠

Do not retighten after the bolts are tightend to specified torque and angle, since the bolts are provided with a torque-turn tightening system.



15 **Cylinder head gasket**

[Removal]

CAUTION⚠

Be careful not to scratch the cylinder head or crankcase * when removing cylinder head gasket 15.

[Installation]

- Install cylinder head gasket **15** to crankcase * in the direction as shown.
- Measure the piston protrusion value of each cylinder before installing cylinder head gasket. Then, select the cylinder head gasket **15** with thickness corresponding to its average piston protrusion value from the table below.
  Measurement of piston protrusion: 🕮 P11B-42
- If there is any one cylinder which has a piston protrusion value of 0.05mm {0.0020 in.} or more, compared with the average piston protrusion value, use the gasket with one-rank-up thickness (A→B, B→C).

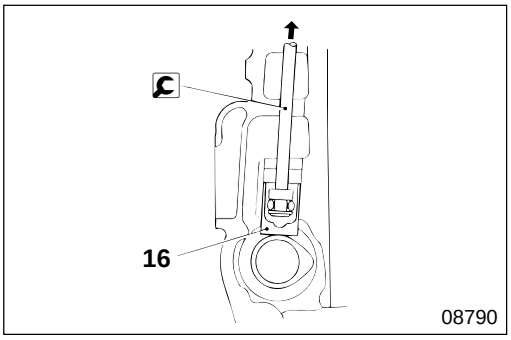
Unit: mm {in.}

Average protrusion value of piston	Size classification of cylinder head gasket
0.466 to 0.526 {0.018 to 0.021}	A
0.526 to 0.588 {0.021 to 0.023}	B
0.588 to 0.648 {0.023 to 0.026}	C

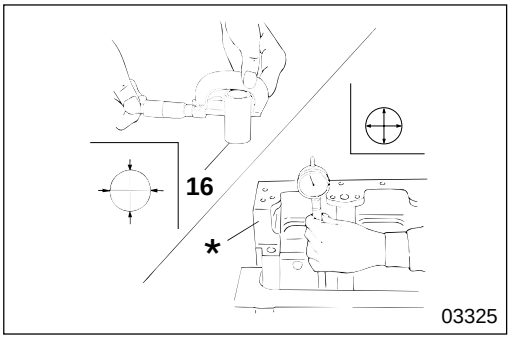
- Identify the kind of cylinder head gasket **15** (engine model and size classification) is based on the notched part **D**.

CAUTION⚠

When changing piston, connecting rod, etc., make sure to measure the protrusion value of piston because it varies.



16 **Removal of tappet**

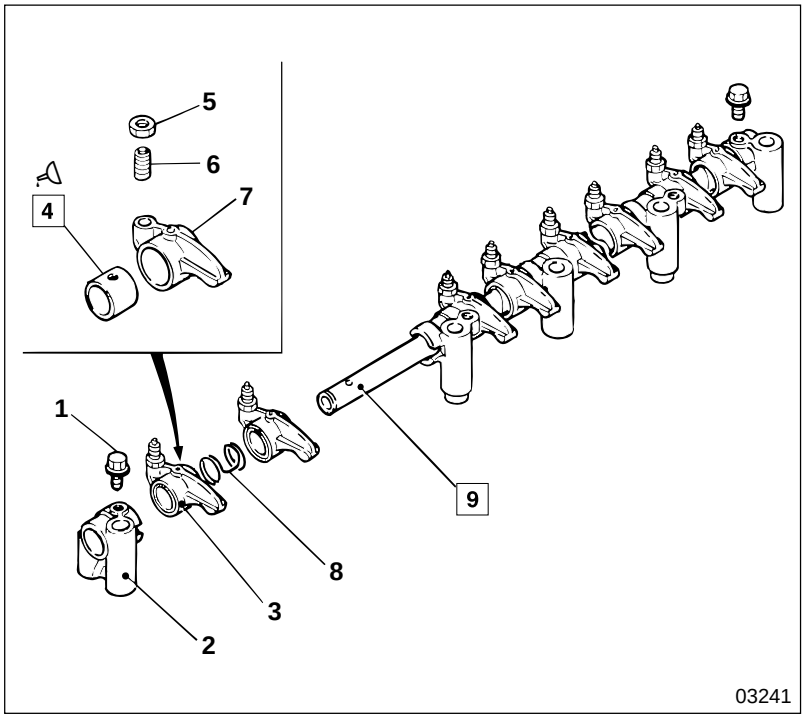


16 ***** **Clearance between tappet and crankcase tappet hole**

If the measured value is higher than the limit, replace the faulty parts.

CYLINDER HEAD AND VALVE MECHANISM

Rocker and Bracket Assembly



● **Disassembly sequence**

1 Set bolt
2 Rocker shaft bracket
3 Rocker assembly
4 Rocker bushing
5 Lock nut
6 Adjusting screw
7 Rocker
8 Rocker shaft spring
9 Rocker shaft

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

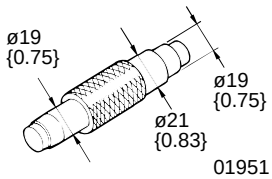
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
4, 9	Clearance between rocker bushing and rocker shaft	[19] 0.06 to 0.11 {[0.75] 0.0024 to 0.0043}	0.2 {0.0079}	Replace

Lubricant

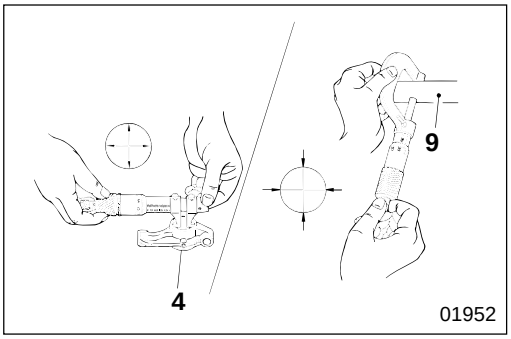
Location	Points of application	Kinds	Quantity
4	Inner surface of rocker bushing	Engine oil	As required

Special tools

Unit : mm {in.}

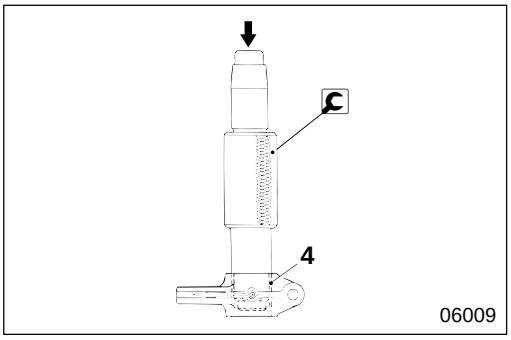
Location	Tool name and shape	Part No.	Application
4	Rocker bushing puller 	MH061378 (Obtain Locally)	Removal and installation of rocker bushing

◆ Service procedure



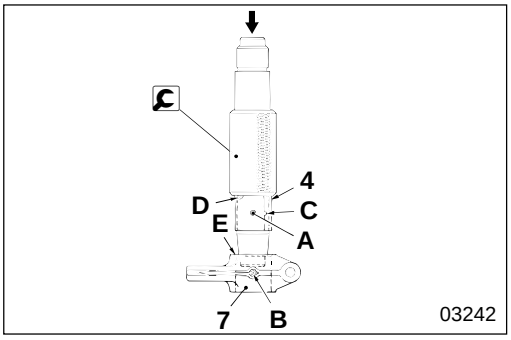
4 **9** **Rocker bushing and rocker shaft**

[Inspection]
If the clearance is higher than the limit, replace the faulty parts.



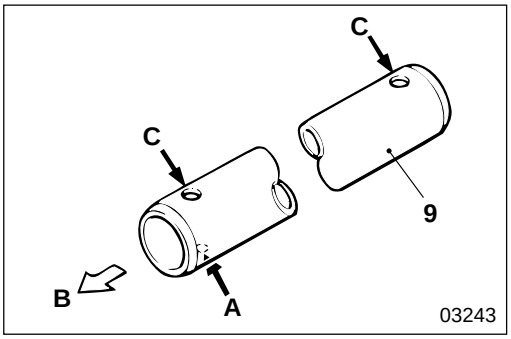
Rocker bushing

[Removal]



[Press-fitting]

- Align oil hole **A** of rocker bushing **4** with oil hole **B** of rocker **7**.
- Position clinch **C** and split **D** of rocker bushing **4** in the direction as illustrated.
- Press-fit rocker bushing **4** from chamfered side **E** of rocker **7**.



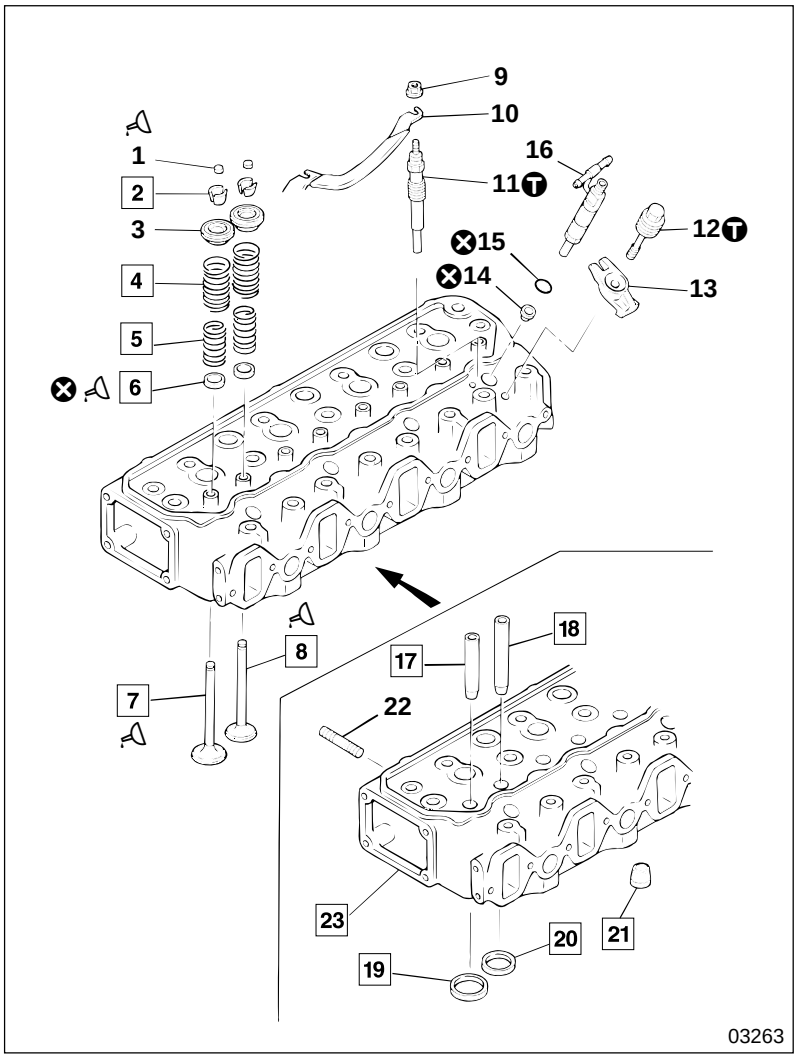
9 **Installation of rocker shaft**

When installing rocker shaft **9**, bring oil passage hole for lubrication **A** to front side **B**.

C : Fixing hole of the set bolt.

CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head and Valve Assembly



● **Disassembly sequence**

1 Valve cap
2 Valve cotter (keeper)
3 Upper retainer
4 Outer valve spring
5 Inner valve spring
6 Valve stem seal
7 Inlet valve
8 Exhaust valve
9 Nut
10 Connecting plate
11 Glow plug Gr 54
12 Bolt
13 Nozzle bridge
14 Nozzle tip gasket
15 O-ring
16 Injection nozzle Gr 13B
17 Inlet valve guide
18 Exhaust valve guide
19 Inlet valve seat
20 Exhaust valve seat
21 Water director
22 Stud
23 Cylinder head

⊗ : Non-reusable parts

CAUTION

Be careful of the protrusion of glow plug 11 and injection nozzle 16 from the bottom surface of cylinder head 23.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

When inlet valve 7 and exhaust valve 8 have been removed, replace valve stem seal 6.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
4	Outer valve spring	Without load	66.1 {2.60}	63.0 {2.48}	Replace
		Installed load (Installed length 47.25 {1.86})	273±14 N {62±3.1 lbf, 27.9±1.4 kgf}	230 N {52 lbf, 23.7 kgf}	Replace
		Tilt	—	2.5 {0.098}	Replace
5	Inner valve spring	Without load	60.0 {2.36}	57.0 {2.24}	Replace
		Installed load (Installed length 40.3 {1.59})	119±5.9 N {27±1.3 lbf, 12.1±0.6 kgf}	101 N {18 lbf, 10.3 kgf}	Replace
		Tilt	—	2.5 {0.098}	Replace
7	Inlet valve	Stem diameter	8.96 to 8.97 {0.3527 to 0.3531}	8.85 {0.348}	Replace
		Valve recess from the cylinder head bottom surface	0.75 to 1.25 {0.030 to 0.049}	1.5 {0.059}	Inspect each part
		Valve margin	1.5 {0.059}	1.2 {0.047}	Replace
		Valve seat angle	45°±15'	—	Correct or replace
7, 17	Clearance between inlet valve stem and inlet valve guide		[9] 0.04 to 0.06 {[0.35] 0.0016 to 0.0024}	0.15 {0.0059}	Replace
8	Exhaust valve	Outer diameter of stem	8.93 to 8.94 {0.3515 to 0.3519}	8.85 {0.348}	Replace
		Valve recess from the cylinder head bottom surface	0.95 to 1.45 {0.037 to 0.057}	1.7 {0.067}	Inspect each part
		Valve margin	1.5 {0.059}	1.2 {0.047}	Replace
		Valve seat angle	45°±15'	—	Correct or replace
8, 18	Clearance between exhaust valve stem and exhaust valve guide		[9] 0.07 to 0.1 {[0.35] 0.0028 to 0.0039}	0.2 {0.0079}	Replace
19	Seat width of inlet valve seat		2±0.2 {0.079±0.0079}	2.8 {0.11}	Correct or replace
20	Seat width of exhaust valve seat		2±0.2 {0.079±0.0079}	2.8 {0.11}	Correct or replace
23	Cylinder head	Distortion of bottom	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Height from top to bottom	95±0.1 {3.74±0.0039}	94.6 {3.72}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

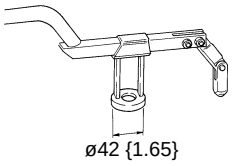
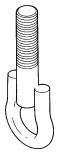
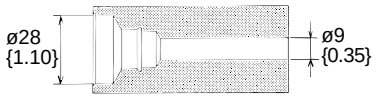
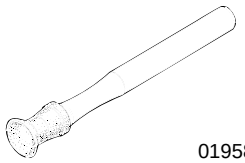
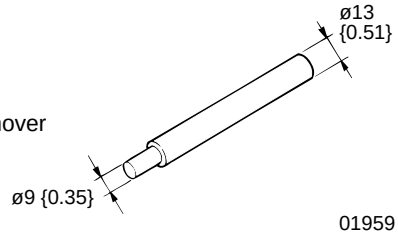
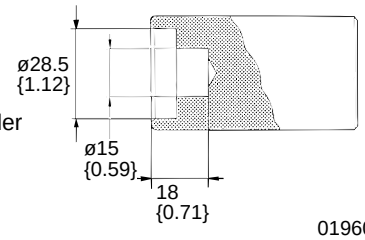
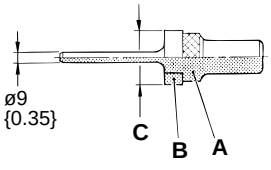
Location	Parts to be tightened	Tightening torque	Remarks
11	Glow plug	15 to 20 {11 to 14, 1.5 to 2.0}	—
12	Bolt (Nozzle bridge mounting)	25 {18, 2.5}	—

Lubricant

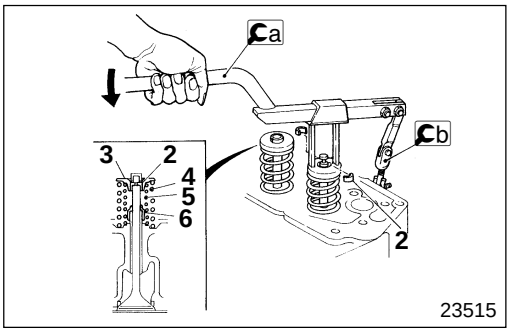
Location	Points of application	Kinds	Quantity
1	Slide contact areas of valve cap and rocker	Engine oil	As required
6	Lip of valve stem seal	Engine oil	As required
7, 8	Valve stem	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Valve lifter  21239	MH061668 (Obtain Locally)	Removal and installation of valve cotter
	Valve lifter hook  21240	MH061679 (Obtain Locally)	
6	Valve stem seal installer  01957	MH061293	Installation of valve stem
7, 8	Valve lapper  01958	30091-07500 (Obtain Locally)	Fitting of valve and valve guide
17, 18	Valve guide remover  01959	MH061066	Removal of valve guide
	Valve guide installer  01960	MH061998	Press-fitting of valve guide
19, 20	**A** : Caulking tool body **B** : Caulking ring **C** dimension: Inlet ø47.6 {1.87}; Exhaust ø40.6 {1.60}  01961	**A** : MH061067 **B** : MH061275 (Inlet) MH061069 (Exhaust)	Press-fitting of valve seat

◆ Service procedure

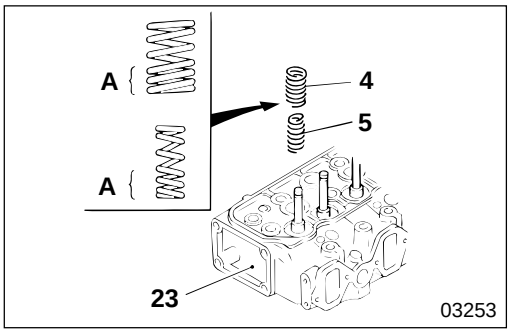


2 **Valve cotter (keepers)**

[Removal]
Remove valve cotter (keepers) **2** making sure that valve springs **4**, **5** are squarely and evenly pressed down by a valve lifter and b valve lifter hook.

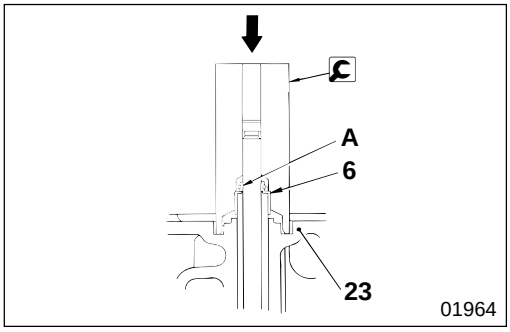
[Installation]
Follow the removal procedure in reverse.

CAUTION
Be sure not to press down on valve springs 4, 5 too hard because this would cause upper retainer 3 to contact valve stem seal 6 and damage it.



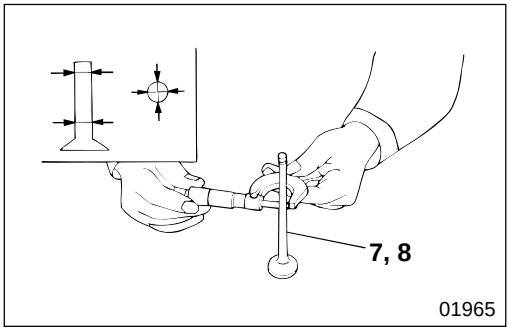
4 **5** **Installation of outer and inner valve springs**

Install outer springs **4** and inner springs **5** in cylinder head **23** in the direction as illustrated.
A : Closely wound area



6 **Installation of valve stem seal**

- Apply engine oil to lip **A** of valve stem seal **6**.
- Tap down valve stem seal installer until it hits cylinder head **23**.



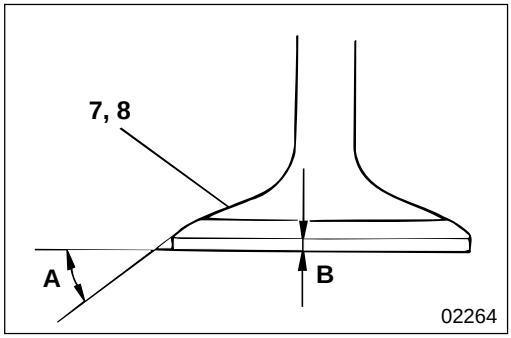
7 **8** **Inlet valve and exhaust valve**

[Inspection]

(1) Inspection of stems

If the measured value is lower than the limit or in the case of excessive wear, replace valves **7**, **8**.

CAUTION
Be sure to lap valve seats 19, 20 when valves 7, 8 are replaced with new ones. **P11B-27**

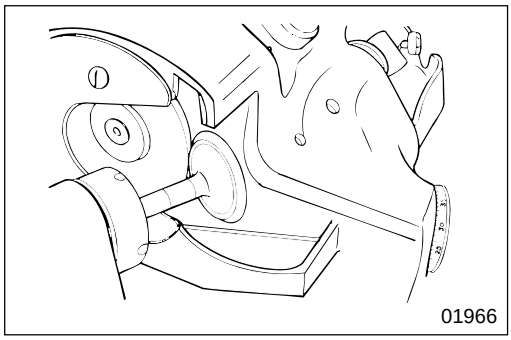


(2) Valve seat angle and valve margin

If the measured value is higher than the limit, replace valves **7**, **8**.

A : Valve seat angle

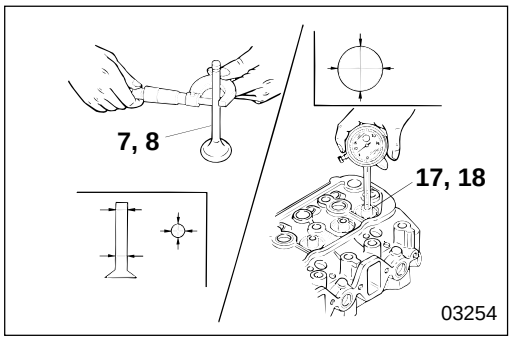
B : Valve margin



[Valve Grinding]

NOTE

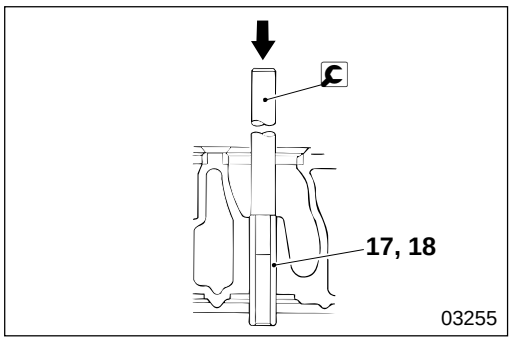
- **Be sure to keep the grinding work as light as possible.**
- **Be sure to replace valves 7, 8 after grinding if valve margin deviates from the limit.**
- **Be sure to lap valve 7, 8 and valve seats 19, 20 after grinding.** **P11-27**



7 **8** **17** **18** **Valve and valve guide**

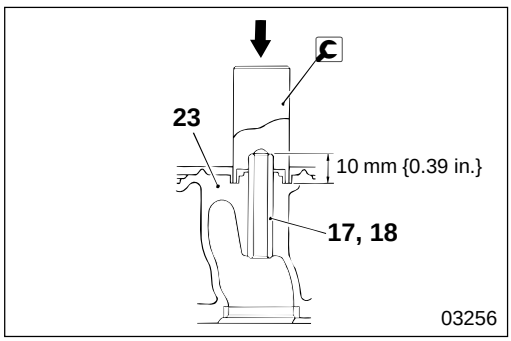
[Inspection]

When the clearance is higher than the limit, replace the faulty parts.



Valve guide

[Removal]

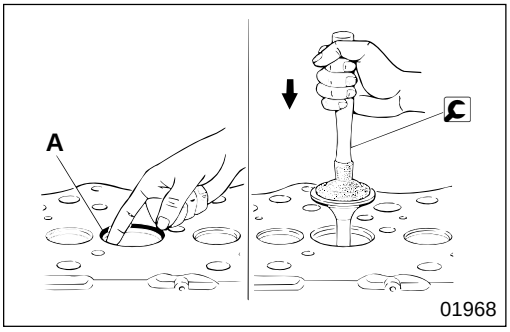


[Installation]

- Tap down valve guides **17**, **18** with 09916-58210 valve guide installer until it hits cylinder head **23**.

CAUTION

- **The length of fit of valve guides 17, 18 is standardized. Be sure to use 09916-58210 valve guide installer.**
- **Be sure to distinguish between valve guides 17, 18. Exhaust valve guide 18 is longer.**



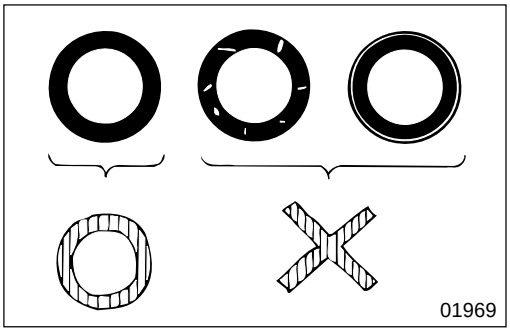
7 **8** **19** **20** **Valve and valve seat**

[Inspection]

- Apply red lead evenly to entire surface **A** of valve seats **19**, **20** that contact valves **7**, **8**.
- Fit valves **7**, **8** to valve seats **19**, **20** and tap once without rotating.

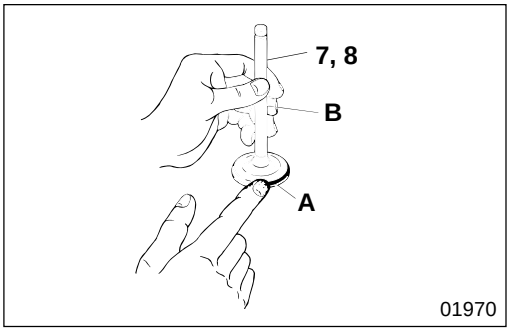
NOTE

Be sure to carry out inspection under the condition that valves 7, 8 and all parts of valve guides 17, 18 are normal.



- Check how much red lead has transferred to valves **7**, **8** to determine the contact of the valve and the seat. According to the degree of abnormality, take proper measures to correct it.

Contact conditions	Correction measures
Minor fault	Valve lapping
Major fault	Repair of valve and seat or replacement of both



[Correction]

Valve lapping is done in the following manner:

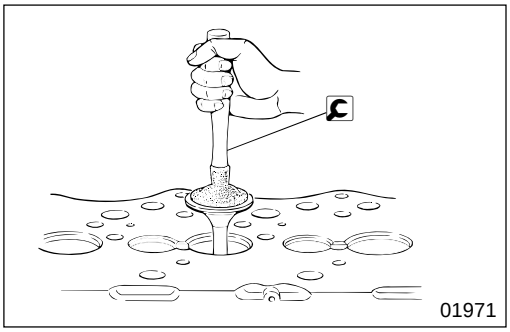
- Apply valve lapping compound thinly to contact surface **A** of valves **7**,**8** with valve seats **19**, **20**.

CAUTION

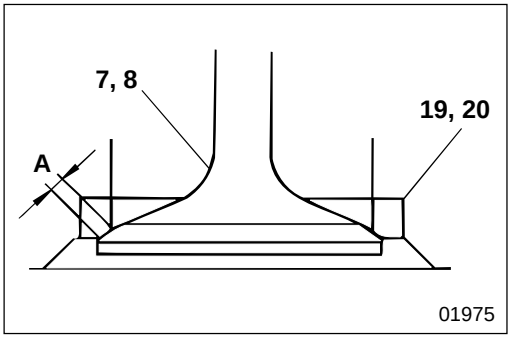
Take care not to smear stems B of valves 7, 8 with the compound.

NOTE

- **Start with medium grit compound (120 to 150 grit) and for finishing up, use finer grit (200 grit or finer).**
- **Mixing with a small amount of engine oil will make the compound consistent and make even application easier.**



- Tap valves **7**, **8** against valve seats **19**, **20** several times while rotating the valves slightly at each strike.
- Clean off the compound with gas oil.
- Apply engine oil to contact surface **A** of valve seats **19**, **20** and smooth the surface.
- Check the contact of valves **7**, **8** and valve seats **19**, **20**.
- If contact does not take place completely around the seat, replace valve seats **19**, **20**.



19 **20** **Valve seat**

[Inspection]

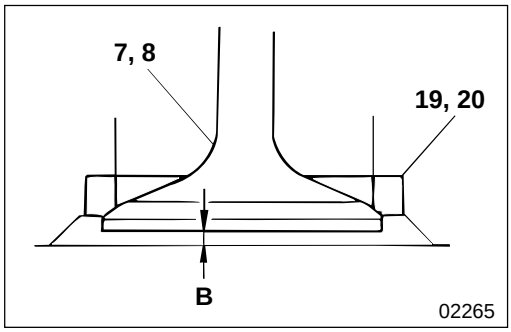
(1) Valve seat width

If the measured value is higher than the limit, replace valve seats **19**, **20**.

A : Valve seat width

NOTE

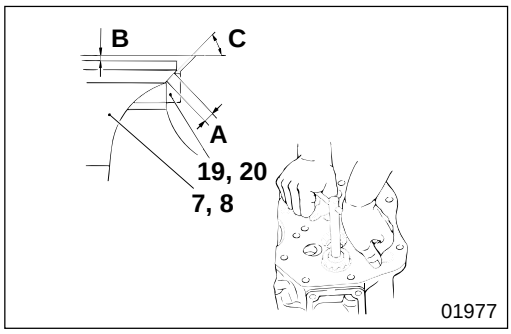
Be sure to lap and fit valves 7, 8 and valve seats 19, 20 after correction or replacement.



(2) Extent of valve recess from the bottom surface of cylinder head

If the measured value is higher than the limit, correct or replace the faulty parts.

B : Extent of valve recess



[Valve Seat Grinding]

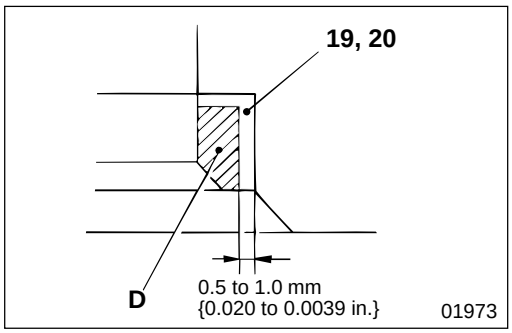
- Grind valve seats **19**, **20** using valve seat cutter or valve seat grinder.
- After grinding, do another light abrasion using 400 grit emery paper placed between the cutter and the seat.
- Adjust the seat width **A** of valves **7**, **8** using 15° or 75° cutter to make seat width conform to the standard value.

C : Valve seat angle

CAUTION ⚠

Be sure that as a result of grinding, recess B of valves 7, 8 does not become higher than the limit.

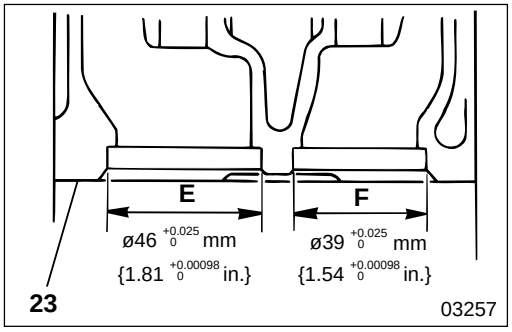
- After valve seat grinding is done, be sure to carry out lapping and fitting of valves **7**, **8** and valve seats **19**, **20**.



[Removal]

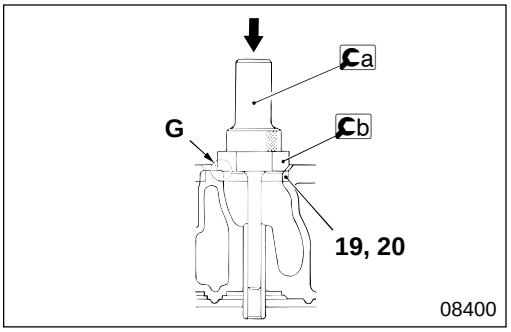
- Valve seats **19**, **20** have been set in by the cooling-off-process, and have to be thinned by grinding off the inner side for removal under normal temperature.

D : Part to be ground



[Installation]

- Make sure that the diameter of valve seat hole of cylinder head **23** conforms to the standard value.
  E : Inlet valve seat hole diameter
  F : Exhaust valve seat hole diameter

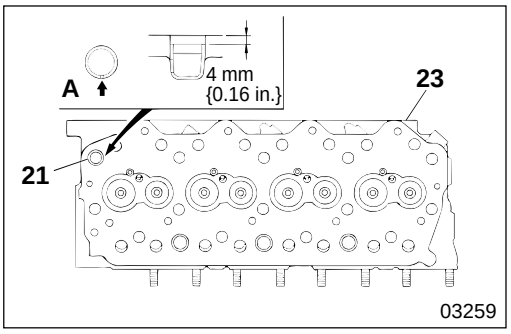


- Immerse valve seats **19**, **20** in liquid nitrogen and cool them substantially. Press-fit into the cylinder head using Ca caulking tool body and Cb caulking rings inlet and exhaust.

CAUTION

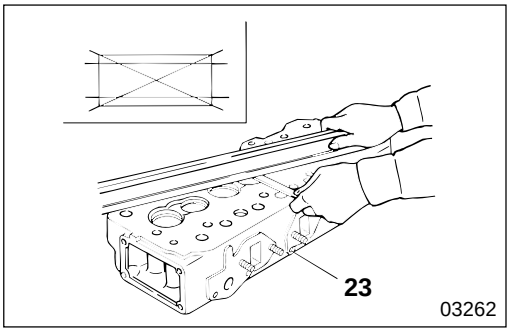
Be sure, when press-fitting, to place the chamfered side G of Cb caulking rings inlet and exhaust against valve seats 19, 20.

- After installation of valve seats **19**, **20**, lapp-in until they contact valves **7**, **8** smoothly.



21 Installation of water director

- With indent **A** set in the direction as illustrated, press-fit water director **21** into cylinder head **23** to the specified depth.



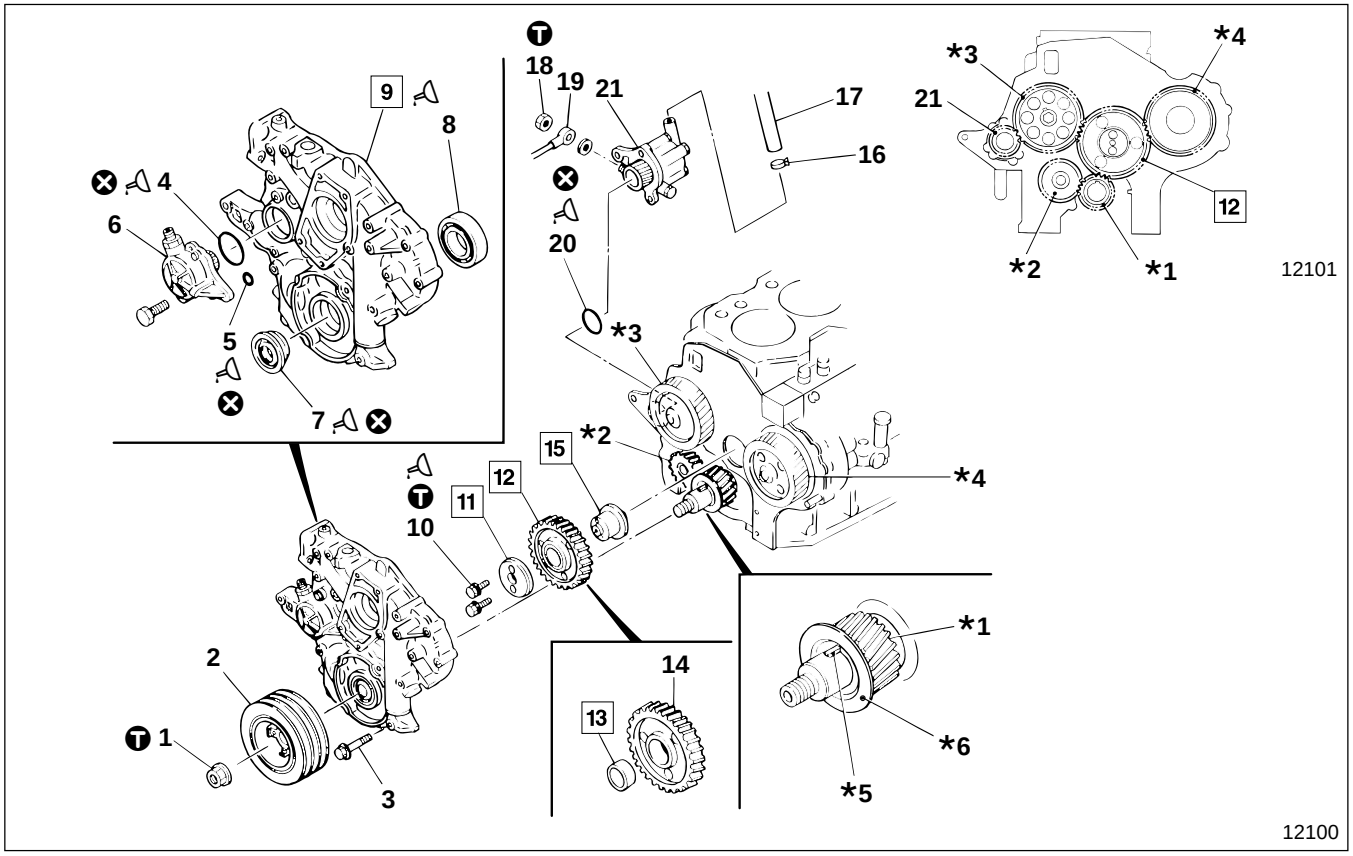
23 Inspection of cylinder head

Measure the extent of distortion of the bottom of cylinder head **23**, and if the measured value is higher than the standard value, grind using a surface grinder.

CAUTION

Be sure to keep the amount of grinding within the limit of the height of cylinder head 23.

TIMING GEAR



● **Inspection before disassembly**

P11B-32

● **Disassembly sequence**

1 Nut
2 Crankshaft pulley
3 Bolt
4 O-ring
5 O-ring
6 Vacuum pump assembly Gr 35A
7 Front oil seal
8 Bearing
9 Timing gear case
10 Bolt
11 Thrust plate
12 Idler gear assembly
13 Idler gear bushing
14 Idler gear
15 Idler shaft
16 Clamp
17 Rubber hose Gr 37
18 Nut
19 Pressure hose Gr 37
20 O-ring
21 Power steering oil pump Gr 37

***1** : Crankshaft gear P11B-66
***2** : Oil pump gear Gr 12B
***3** : Camshaft gear P11B-34
***4** : Injection pump gear Gr 13B
***5** : Key P11B-66
***6** : Front oil seal slinger P11B-66

⊗ : Non-reusable parts

NOTE

Do not remove front oil seal 7 and bearing 8 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

Be sure to install key *5 when installing crankshaft pulley 2.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
—	Backlash of gears	Idler gear assembly and crankshaft gear	0.07 to 0.15 {0.0028 to 0.0059}	0.3 {0.012}	Replace
		Idler gear assembly and camshaft gear	0.07 to 0.17 {0.0028 to 0.0067}	0.3 {0.012}	
		Idler gear assembly and injection pump gear	0.07 to 0.17 {0.0028 to 0.0067}	0.3 {0.012}	
		Crankshaft gear and oil pump gear	0.10 to 0.18 {0.0039 to 0.0071}	0.3 {0.012}	
		Camshaft gear and power steering oil pump gear	0.08 to 0.16 {0.0031 to 0.0063}	0.3 {0.012}	
—	End play of idler gear		0.05 to 0.15 {0.0020 to 0.0059}	0.3 {0.012}	Inspect
13, 15	Clearance between idler gear bushing and idler shaft		[45] 0.03 to 0.06 {[1.77] 0.0012 to 0.0024}	0.1 {0.0039}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

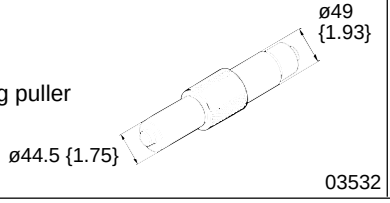
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Crankshaft pulley mounting)	590 {435, 60}	—
10	Bolt (Thrust plate mounting)	24 {17, 2.4}	—
18	Nut (Pressure hose mounting)	29 to 39 {22 to 29, 3 to 4}	—

Lubricant and sealant

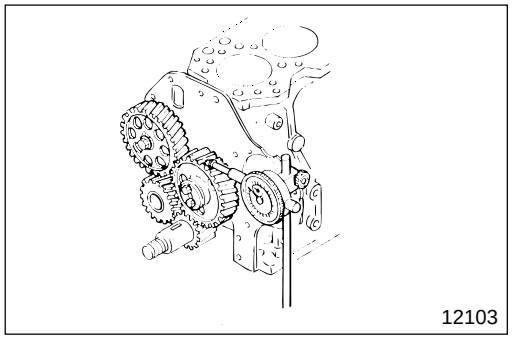
Location	Points of application	Kinds	Quantity
4, 5, 20	Entire body of O-ring	Engine oil	As required
7	Front oil seal lip	Engine oil	As required
9	Mounting surface of timing gear case	THREEBOND 1207C	As required
10	Thread area of bolt	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
13	Idler gear bushing puller 	MH062224	Removal and installation of idler gear bushing

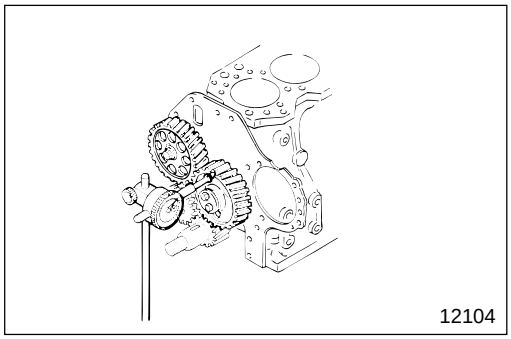
◆ Service procedure



● **Inspection before disassembly**

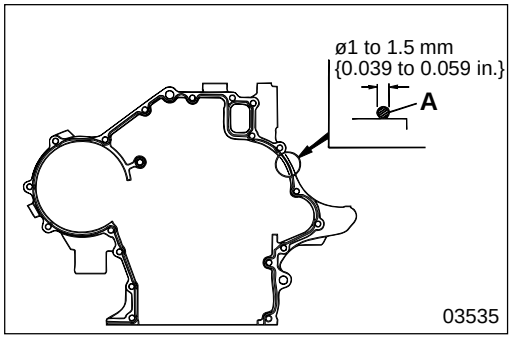
(1) Backlash of each gear

Measure three or more locations on the pairing gears and if the measurements are higher than the limit, replace the faulty parts.



(2) End play of idler gear

If the measured value is higher than the limit, replace the faulty parts.

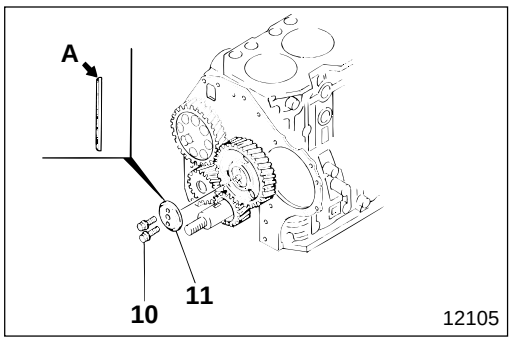


9 Installation of timing gear case

Apply sealant **A** to the mounting surface of timing gear case **9** evenly without break. After applying sealant, within three minutes, mount to the front plate.

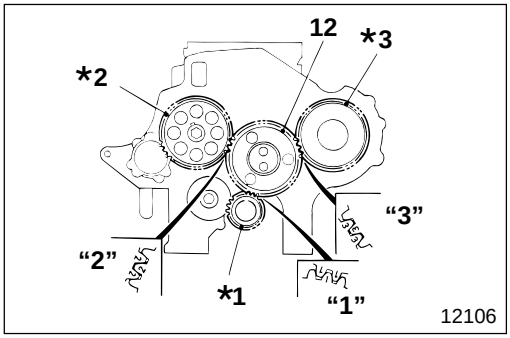
CAUTION ⚠

- **Be sure to clean and wipe off oily substances from the surface where sealant A is to be applied.**
- **Make sure that sealant A is not transferred to other areas while the mounting work is being done.**
- **Be sure to reapply sealant A if the bolts are loosened or removed by any cause whatsoever after mounting.**
- **Do not start the engine within an hour of mounting.**



11 Installation of thrust plate

A : Chamfered side (facing forward)



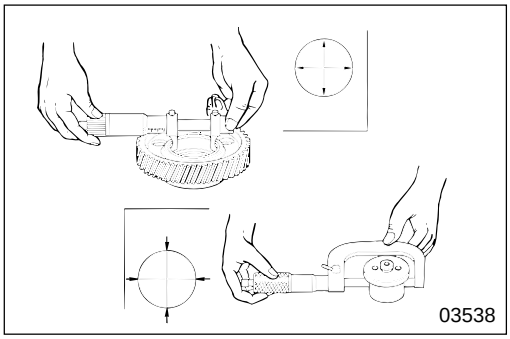
12 **Installation of idler gear assembly**

Install idler gear assembly **12** by matching alignment marks **"1"**, **"2"**, **"3"** on the gears that engage with those on the assembly.

- ***1** : Crankshaft gear
- ***2** : Camshaft gear
- ***3** : Injection pump gear

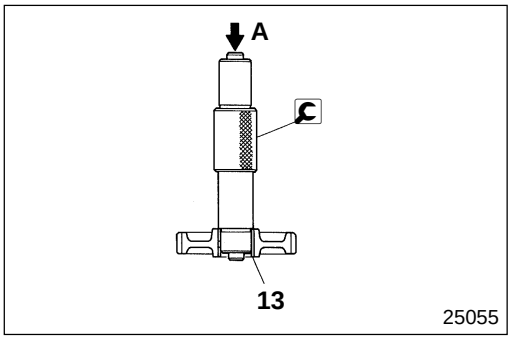
NOTE

When aligning each gear with its alignment mark, make sure that pistons No.1, 4 are at top dead center.



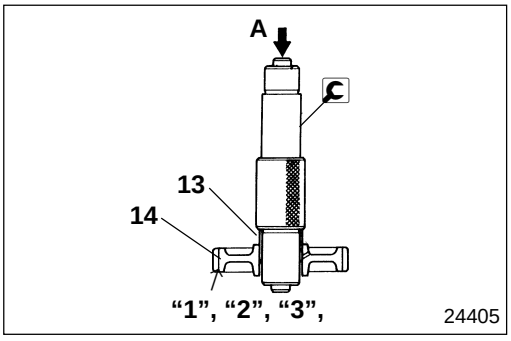
13 **15** **Idler gear bushing and idler shaft**

[Inspection]
If the clearance is higher than the limit, replace the faulty parts.



Idler gear bushing

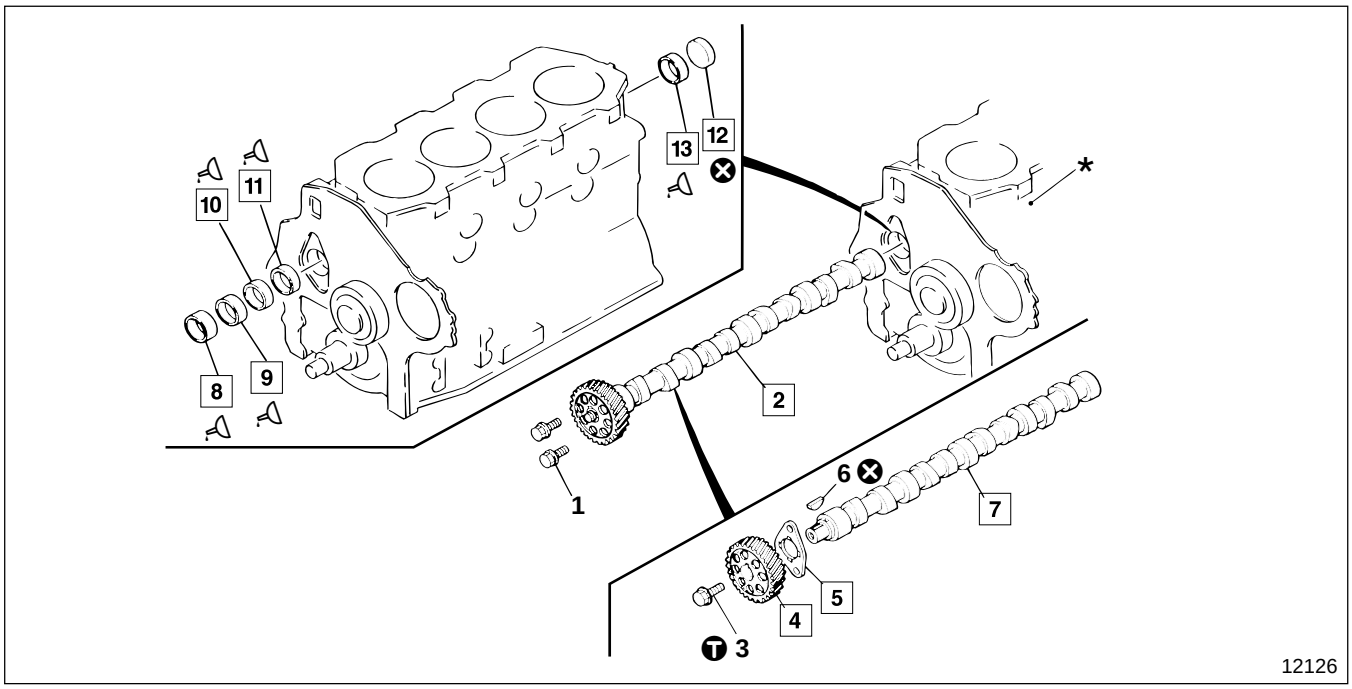
[Removal]
A : Press



[Press-fitting]

- Press-fit idler gear bushing **13** from chamfered side **B** of idler gear **14** and align oil holes **C** of the idler gear and the bushing.
- After press-fitting, finish the fitting by bringing the clearance between idler gear bushing **13** and the idler shaft to the standard value.

CAMSHAFT



● **Disassembly sequence**

1 Bolt
2 Camshaft assembly
3 Bolt
4 Camshaft gear
5 Thrust plate
6 Key
7 Camshaft
8 No.1 camshaft bushing
9 No.2 camshaft bushing
10 No.3 camshaft bushing
11 No.4 camshaft bushing
12 Sealing cap
13 No.5 camshaft bushing

***** : Crankcase 🕮 P11B-66
⊗ : Non-reusable parts

NOTE

Do not remove camshaft gear 4 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
—	End play of camshaft assembly			0.05 to 0.22 {0.0020 to 0.0087}	0.3 {0.012}	Replace
4, 7	Interference of camshaft gear and camshaft			[30] 0.03 to 0.02 {[1.2] 0.0012 to 0.0028}	—	Reuse up to three times
7	Camshaft	Difference between long and short diameters	Inlet	7.195±0.05 {0.28±0.0020}	6.70 {0.26}	Replace: Long diameter 47.105 {1.85} Short diameter 39.910 {1.57}
			Exhaust	7.321±0.05 {0.29±0.0020}	6.82 {0.27}	Replace: Long diameter 46.979 {1.84} Short diameter 39.658 {1.56}
		Bend		0.02 {0.00079} or less	0.05 {0.0020}	Replace
7 to 11, 13	Clearance between camshaft and camshaft bushing		No.1 to No.4	[54.5] 0.04 to 0.09 {[2.15] 0.0016 to 0.0035}	0.15 {0.0059}	Repair or replace
			No.5	[53] 0.04 to 0.09 {[2.09] 0.0016 to 0.0035}	0.15 {0.0059}	

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

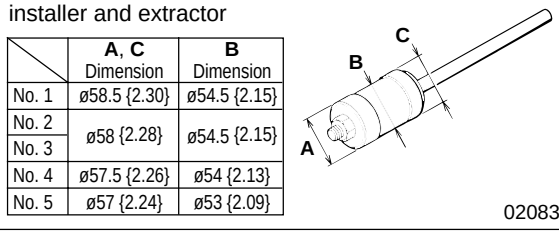
Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt	34 to 39 {25 to 29, 3.5 to 4.0}	—

Lubricant

Location	Points of application	Kinds	Quantity
8 to 11, 13	Inner surface of camshaft bushing	Engine oil	As required

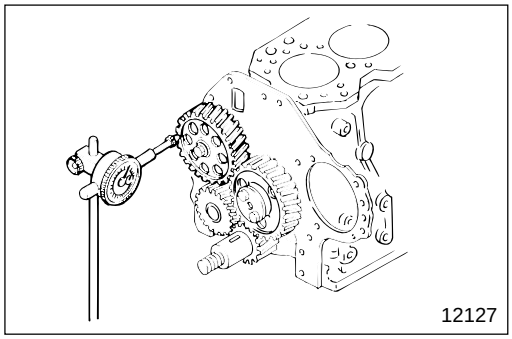
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8 to 11, 13	Camshaft bushing installer and extractor  02083	MH061276 (Obtain Locally)	Removal and press-fitting of camshaft bushing

	A, **C** Dimension	**B** Dimension
No. 1	ø58.5 {2.30}	ø54.5 {2.15}
No. 2	ø58 {2.28}	ø54.5 {2.15}
No. 3		
No. 4	ø57.5 {2.26}	ø54 {2.13}
No. 5	ø57 {2.24}	ø53 {2.09}

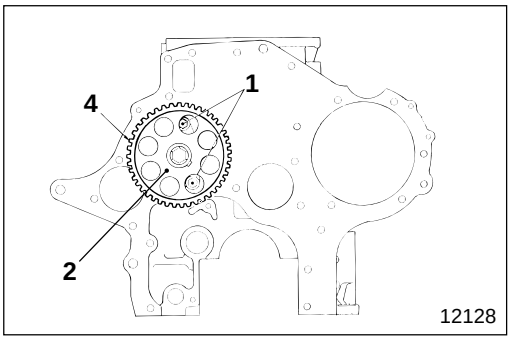
◆ Service procedure


12127

● Inspection before disassembly

Camshaft end play

If the measured value is higher than the limit, replace the faulty parts.



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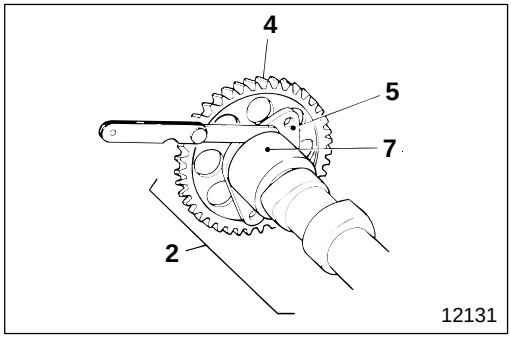
2 **Camshaft assembly**

[Removal]

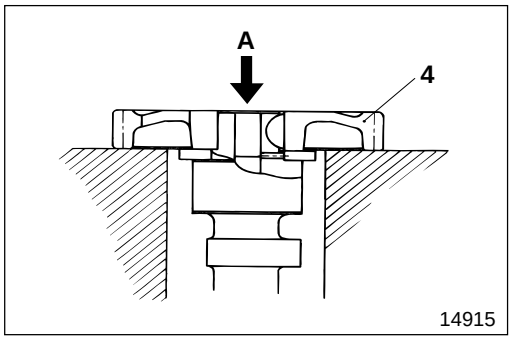
Remove camshaft assembly **2** by undoing bolts **1** through the holes in camshaft gear **4**.

CAUTION⚠

Be careful not to damage the camshaft bushings when you remove camshaft assembly 2.

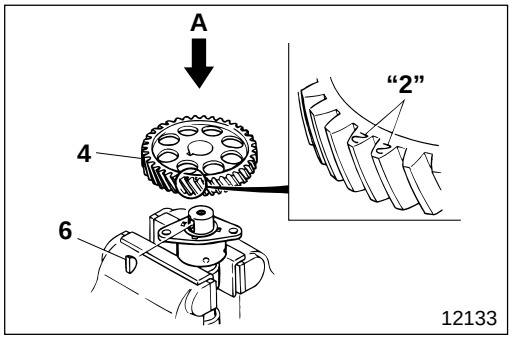


[Installation]
- Before installing camshaft assembly **2**, measure the end play between thrust plate **5** and camshaft **7**.
- If the measured value is higher than the limit, replace thrust plate **5**.
- Install the camshaft assembly by matching the alignment mark on camshaft gear **4** with the alignment mark on the idler gear. P11B-33

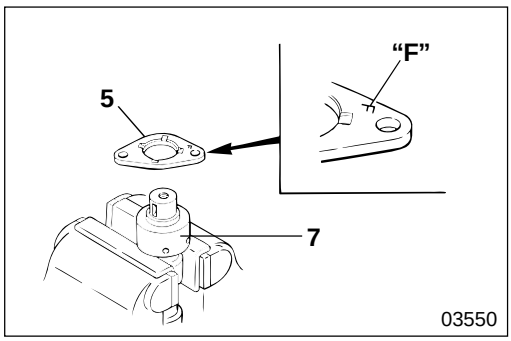


4 **Camshaft gear**

[Removal]
A : Press

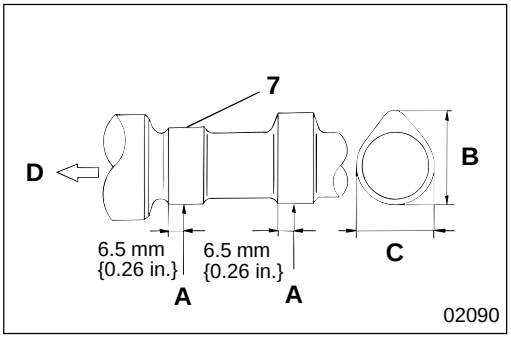


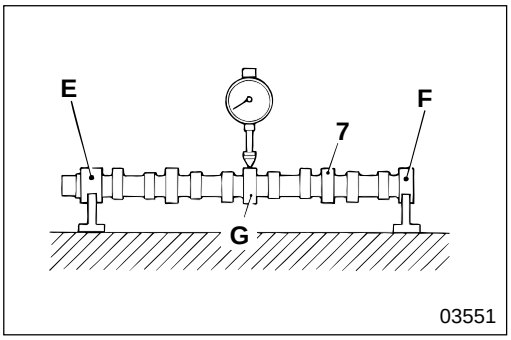
[Installation]
- Install camshaft gear **4** onto camshaft **7** in the direction as illustrated.
  A : Press
- Be sure to install key **6** prior to gear installation.

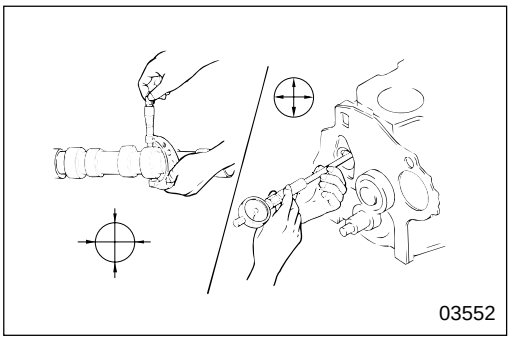


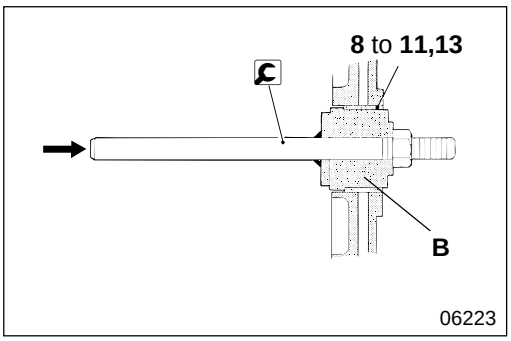
5 **Installation of thrust plate**

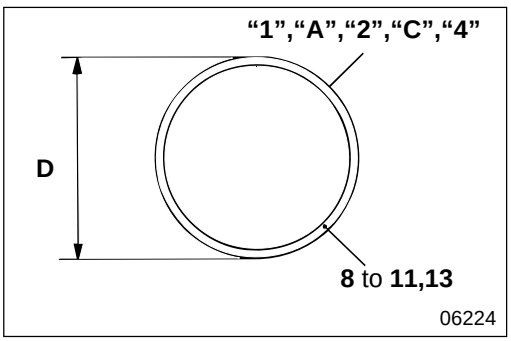
- Install thrust plate **5** onto camshaft **7** in the direction as illustrated.











7 **Inspection of camshaft**

(1) Difference between long diameter and short diameter

If the measured value is lower than the limit, replace camshaft **7**.

NOTE

Measure at point A, as illustrated, because the cam is tapered.

B : Long diameter
C : Short diameter
D : Front of the engine

(2) Degree of bend

To measure bend, support camshaft **7** at area **E** of No.1 journal, and area **F** of No.5 journal. Then, measure the amount of bend at area **G** of No.3 journal. If the measured values are higher than the limit, replace the camshaft.

NOTE

Degree of bend of camshaft 9 is half of the indicated value of the gauge after rotating the shaft 360°.

7 **to** **11** **13** **Camshaft and camshaft bushing**

[Inspection]
If the clearance is greater than the limit, replace the faulty parts.

NOTE

Measure bushings 8 to 11, 13 mounted in the crankcase.

Camshaft bushing

[Removal]
Remove camshaft bushings by using 🔧 camshaft bushing installer and extractor which has adapter **B** set by each bushing No.

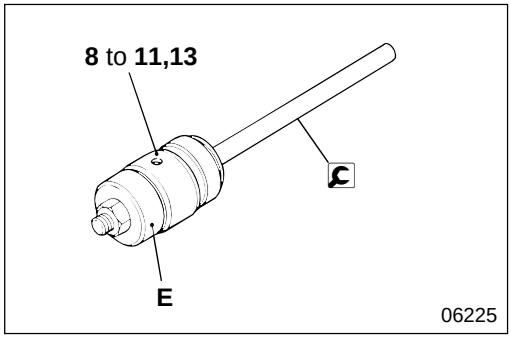
NOTE

Remove No.1 to 4 camshaft bushings 8 to 11 from the front of the engine, and No. 5 camshaft bushing 13 from the rear of the engine by pushing 🔧 camshaft bushing installer and extractor.

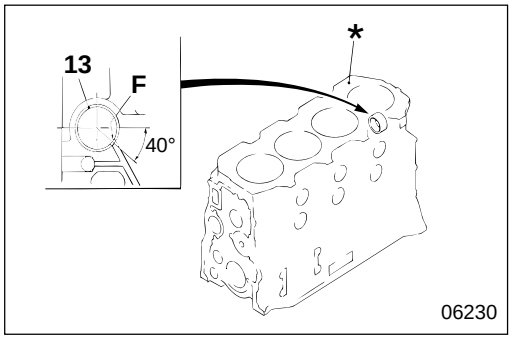
[Press-fitting]

- Identify, by referring to the table below, No.1 to No.5 camshaft bushings by noting marks **"1"**, **"A"**, **"2"**, **"C"**, **"4"** on camshaft bushings **8** to **11**, **13**. If you cannot identify the mark, measure outer diameter **D** of the bushing and refer to the table below.

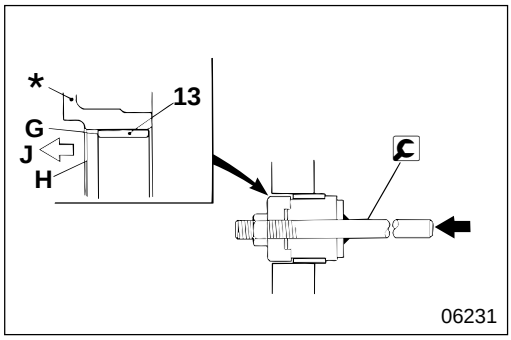
Bushing No. (from the front of the engine)		Mark	Outer diameter D (mm {in.})
No.1	8	1	ø58.50 {2.30}
No.2	9	A	ø58.25 {2.29}
No.3	10	2	ø58.06 {2.28}
No.4	11	C	ø57.75 {2.27}
No.5	13	4	ø57.06 {2.25}



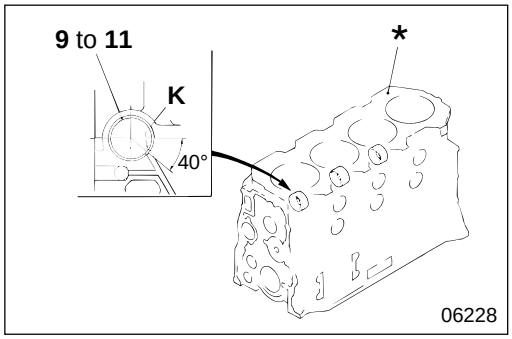
- For press-fitting, mount guide **E** to camshaft bushing installer and extractor.
- Install camshaft bushings **8** to **11** and **13** in descending order, from No.5 to No.1.
- Install No.5 camshaft bushing **13** from the rear end of the engine, and No.4 to No.1 camshaft bushings **8** to **11** from the front end of the engine.



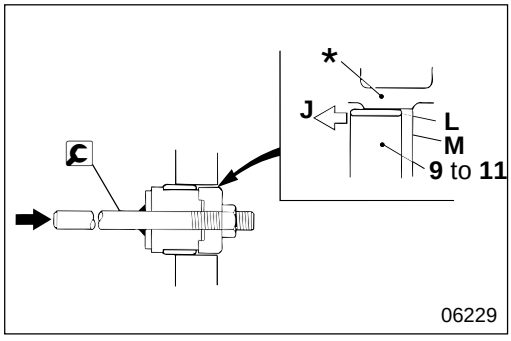
- Align oil hole **F** of No.5 camshaft bushing **13** in the direction as illustrated.



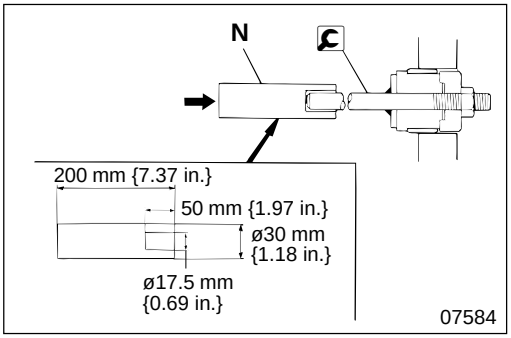
- Press in until surface **G** of No. 5 camshaft bushing **13** is flush with chamfered part **H** of crankcase *.
  J : Front of the engine



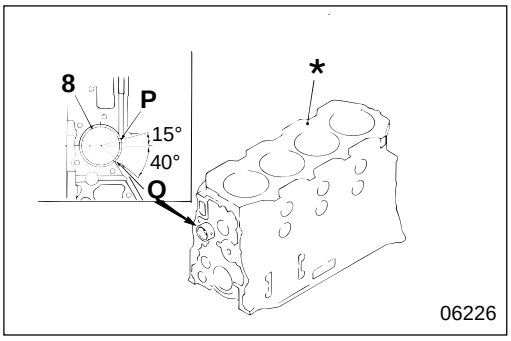
- Align oil hole **K**, of No.2 to No.4 camshaft bushings **9** to **11**, in the direction as illustrated, and press-fit in the order of No. 4, 3, 2.



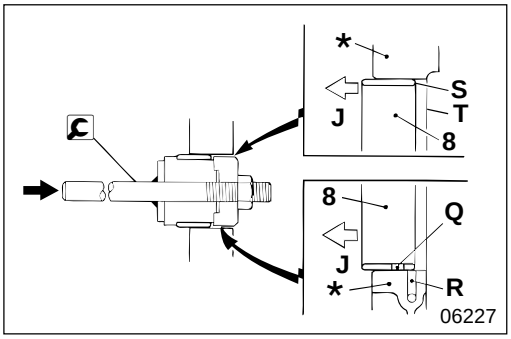
- Press in until surface **L** of No.2 to No.4 camshaft bushings **9** to **11** is flush with surface **M** of crankcase *.
  J : Front of the engine



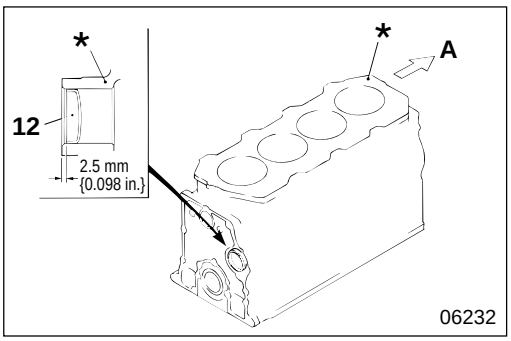
- For press-fitting of No.4 camshaft bushing **11**, use tool **N** as illustrated.



- Align oil holes **P**, **Q** of No.1 camshaft bushing **8** in the direction as illustrated.
  L : ø3 mm {0.11 in.}
  M : ø8 mm {0.31 in.}
  ***** : Crankcase



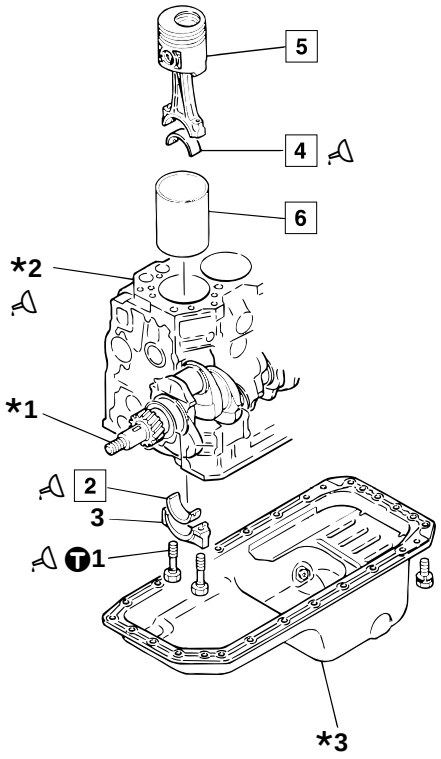
- Align oil hole **Q** of No.1 camshaft bushing **8** with oil hole **R** of crankcase ***** and press in until camshaft bushing surface **S** is flush with crankcase surface **T**.
  J : Front of the engine



12 **Installation of sealing cap**

Press-fit sealing cap **12** into crankcase ***** to the specified depth.
A : Front of the engine

PISTON, CONNECTING ROD AND CYLINDER SLEEVE



03373

● **Disassembly sequence**

1 Bolt
2 Lower connecting rod bearing
3 Connecting rod cap
4 Upper connecting rod bearing
5 Piston and connecting rod assembly
📖 P11B-48
6 Cylinder sleeve

***1** : Crankshaft 📖 P11B-66
***2** : Crankcase 📖 P11B-66
***3** : Oil pan Gr 12B

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
—	Extent of piston protrusion		0.47 to 0.64 {0.019 to 0.025}	—	Inspect
—	End play of connecting rod		0.15 to 0.45 {0.0059 to 0.018}	0.6 {0.024}	Inspect
2, 4	Connecting rod bearing	Oil clearance	[65] 0.04 to 0.09 {[2.56] 0.0016 to 0.0035}	0.2 {0.0079}	Replace
		Expansion	—	Less than 69.5 {2.74}	
5, 6	Clearance between piston and connecting rod assembly and cylinder sleeve		[104] 0.07 to 0.11 {[4.094] 0.0028 to 0.0043}	—	Adjust or replace with oversizes
6	Cylinder sleeve	Inner diameter	104 to 104.03 {4.094 to 4.095}	104.25 {4.10}	Adjust or replace with oversizes
		Circular accuracy	0.01 {0.00039} or less	—	
		Cylindrical accuracy	0.03 {0.0012} or less	—	
6, *2	Interference between cylinder sleeve and crankcase	Standard	0.17 to 0.23 {0.0067 to 0.0091}	—	Replace with oversizes
		Oversize	0.19 to 0.21 {0.0075 to 0.0083}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt	30 {22, 3}+90°±5°	Wet

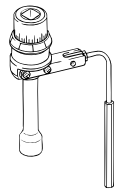
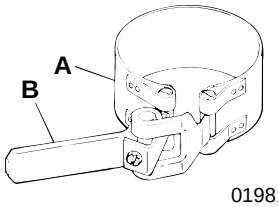
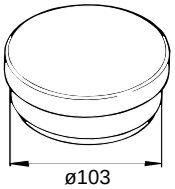
Lubricant

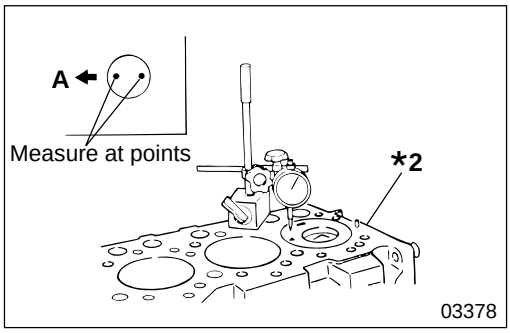
Location	Points of application	Kinds	Quantity
1	Thread area of bolt	Engine oil	As required
2, 4	Inner surface of bearing	Engine oil	As required
***2**	Sleeve hole of crankcase	Spindle oil (ISO VG 32)	As required

PISTON, CONNECTING ROD AND CYLINDER SLEEVE

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Socket wrench  01984	MH061560 (Obtain Locally)	Installation of piston and connecting rod assembly
	A : Piston guide clamp **B** : Piston guide lever  01981	**A** : MH061890 **B** : MH061658 (Obtain Locally)	
6	Cylinder sleeve installer  ø103 {4.06} 03377	MH062228	Installation of cylinder sleeve



03378

◆ Service procedure

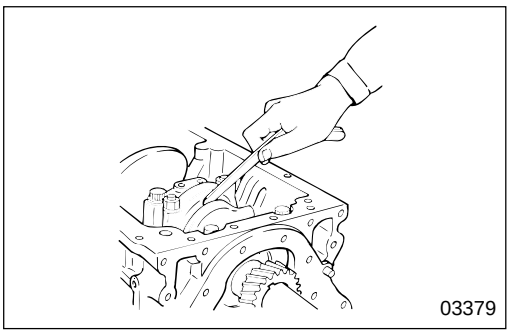
● **Inspection before disassembly**

(1) Extent of piston protrusion from the upper surface of crankcase *2

NOTE

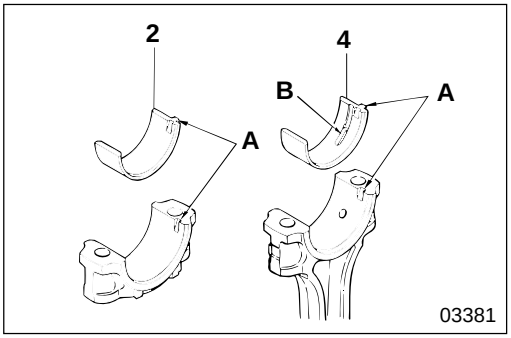
Always inspect the extent of piston protrusion because it affects the engine performance greatly.

- Measure piston protrusion at two points on the top of the piston, and produce the average value.
  A : Front of the engine
- If the average valve deviates from the limit, inspect clearance of the related parts.


03379

(2) End play of connecting rod

- Measure the end play of each connecting rod.
- If the measured value is higher than the limit, replace the faulty parts.



2 **4** **Connecting rod bearing**

[Installation]
Install connecting rod bearings **2**, **4** by matching lugs **A** to the connecting rods.

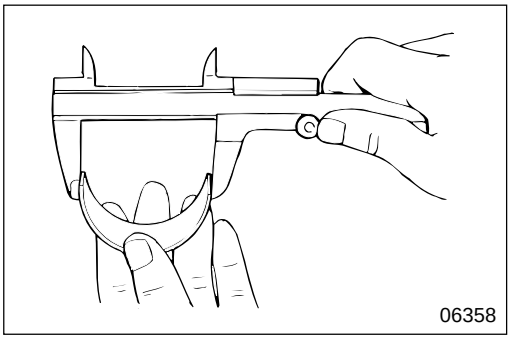
CAUTION

Be sure to distinguish between upper and lower connecting rod bearings 2, 4. The upper bearing has oil opening B while the lower bearing has no oil opening.

[Inspection]

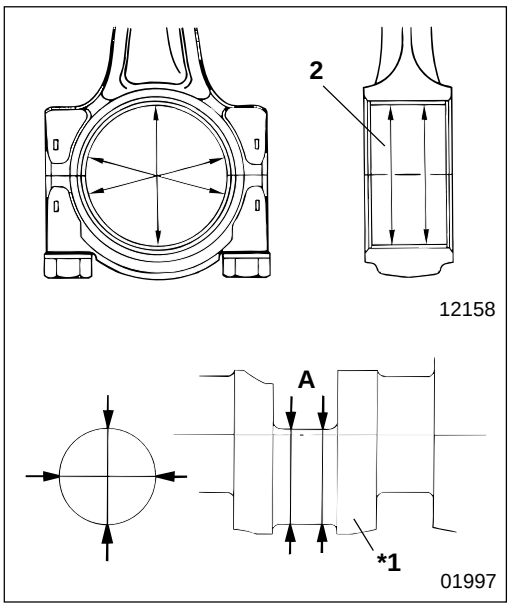
CAUTION

- **Do not forcibly open or expand connecting rod bearings 2, 4.**
- **When either upper or lower connecting rod bearings 2, 4 needs replacing, replace as a set.**



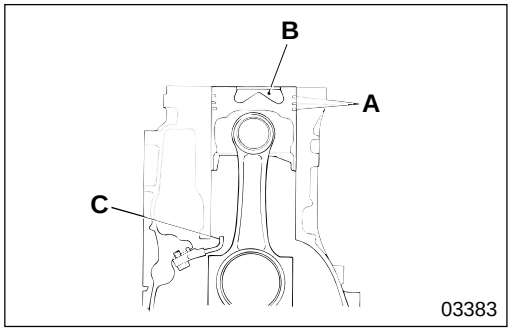
(1) Expansion at free state

If the measured value is lower than the limit, replace connecting rod bearings **2**, **4**.



(2) Clearance between connecting rod bearing and crankshaft (Oil clearance)

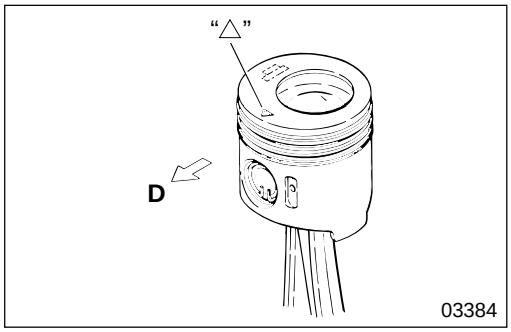
If the measured value is higher than the limit, replace the faulty parts. When replacing connecting rod bearings **2**, **4** with undersized ones, correct pin outer diameter **A** of crankshaft ***1** to the specified undersize. P11B-71



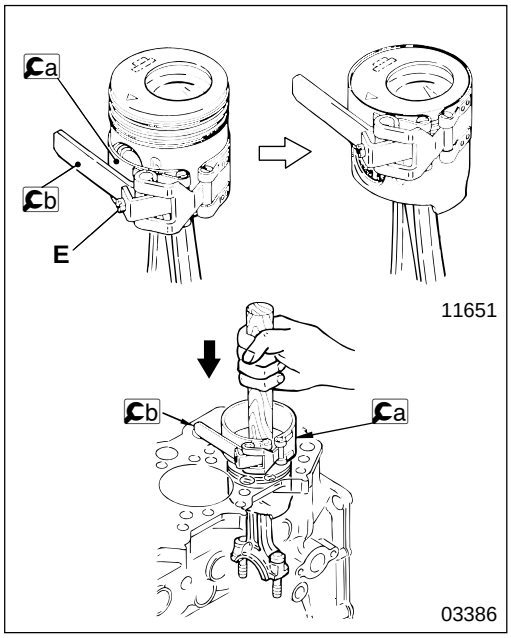
5 **Installation of piston and connecting rod assembly**

CAUTION

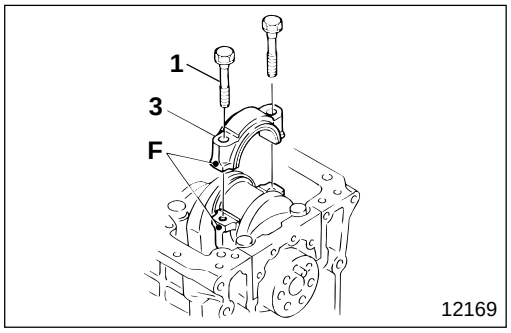
- **Be sure to fit piston ring A in the correct position.**
  P11B-48
- **Be careful not to scratch or damage head B of the piston (a part of the combustion chamber).**
- **Make sure that the connecting rod does not hit oil jet C.**



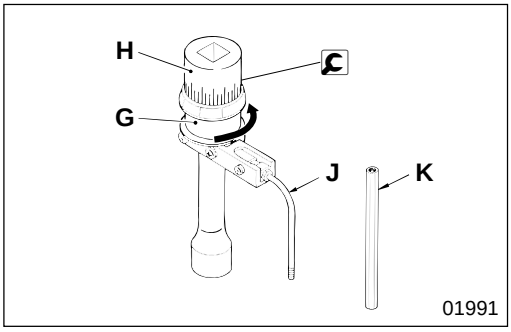
- Install piston front mark "△" directed towards the front of the engine using the following procedure.
  D : Front of the engine



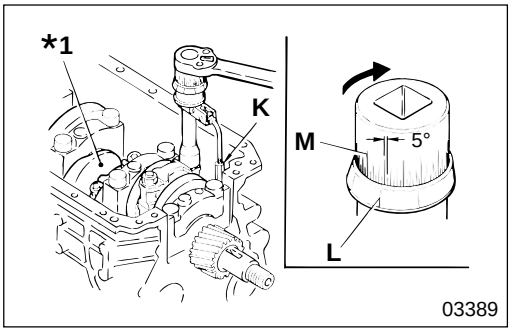
- Match the inner diameter of a piston guide clamp to the outer diameter of the piston skirt by turning adjusting bolt **E** of b piston guide lever.
- After adjusting, set a piston guide clamp and b piston guide lever at the top of the piston so that the clamp is flush with the top of the piston.
- Insert piston into cylinder linner and tap into place using a wooden dowel.



- After the piston is inserted, align alignment marks **F** on the connecting rod with the alignment marks on connecting rod cap **3** and tighten bolt **1** at specified torque. Then tighten the bolt further as follows:



- Turn socket wrench holder **G** counterclockwise and keep the spring in the wrench compressed.
  H : Socket
  J : Rod
  K : Rod (for extension)

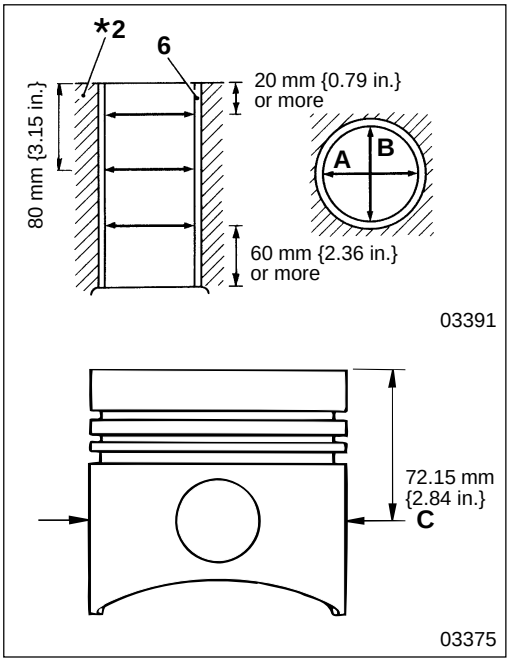


- Set socket wrench holder **G** so that the twisting force of the spring presses rod **K** (for connection) against crankshaft ***1**.
- Select a scale that is convenient for reading graduation **L** on holder **G** side.
- Tighten further by turning socket **H** clockwise by 90° (setting is in 5° increments), referring to graduation **M** on the selected scale.

NOTE

After installation of connecting rod cap 3, inspect the following points :

- **End play of the connecting rod : 🕮 P11B-42**
- **Piston protrusion : 🕮 P11B-42**



5 **6** **Piston and connecting rod assembly and cylinder sleeve**

[Inspection]

- Measure the clearance between the inner diameter of cylinder sleeve **6** and outer diameter of the piston part of piston and connection rod assembly **5**.
  A : Measuring point on the crankcase (in direction of the crankcase axis)
  B : Measuring point on the crankcase (vertical to the crankcase axis)
  C : Measuring point on the piston outer diameter (vertical to the piston pin hole)
- If the measured value is higher than the standard value, correct according to one of the following methods, depending on the condition of the parts.

CAUTION ⚠

Even if only one cylinder is faulty, correct all the cylinders to oversized ones of the same size.

  - Replacing the piston with an oversized one
  - Replacing cylinder sleeve **6**
- After determining the proper method of correction, correct by following one of the procedures described below.

[Correction]

Piston

< When replacing the pistons with an oversized ones >

Amount of oversize : 0.5, 1.0 mm {0.020, 0.039 in.}

- Measure the outer diameter **C** of the oversize piston to be used.
- Bore each cylinders so that the clearance between the piston and the cylinder sleeves conform to the standard value.

CAUTION

To prevent deformation as a result of the rise in temperature during boring, bore the cylinders in the following order.
No. 2 → No. 4 → No. 1→ No. 3

Dimension after boring finish (tolerance ±0.005mm {0.0002 in.})=
oversize piston outer dimension **C** + clearance between piston and cylinder - 0.02 mm {0.0008 in.}
(measured value) (service standards mean value) (honing extent)

- Boring is followed by honing to obtain the proper dimensions (tolerance ±0.005mm {0.0002 in.}).

Dimension after final finish (tolerance ±0.005mm {0.0002 in.})=
oversize piston outer dimension **C** + clearance between piston and cylinder
(measured value) (service standards mean value)

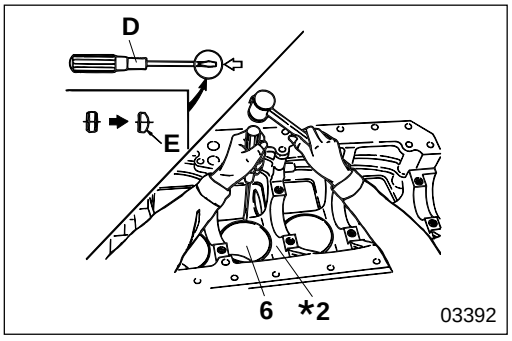
NOTE

- **Honing finished surface coarseness : 3.2 μm {1.26 × 10^{-4} in.} or less**
- **Honing cross-hatching angle : 15 to 25° (half angle)**
- **Cylinder bore squareness : 0.05 mm {0.002 in.}**

- Check the clearance between the piston and the cylinder.

NOTE

Piston rings must be replaced with the corresponding oversized ones.



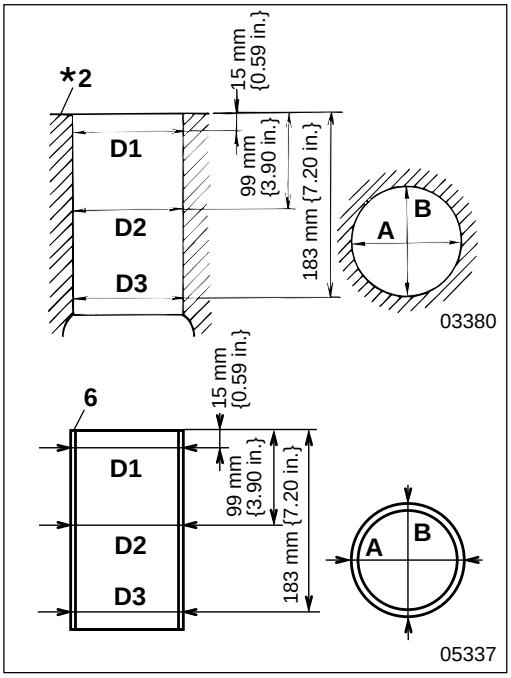
Cylinder sleeve

[Removal]

- Mount a boring machine on crankcase ***2** and center. Centering must be done at the lower part of cylinder sleeve **6** which is less unevenly worn.
- Bore until the thickness of cylinder sleeve **6** is approximately 0.5 mm {0.020 in.}.
- Insert tool **D** (a modified screwdriver) between crankcase ***2** and cylinder sleeve **6**, break the sleeve by tapping it gently, then remove.

CAUTION

Make sure when inserting tool D that round part E is facing crankcase *2.



[Installation]

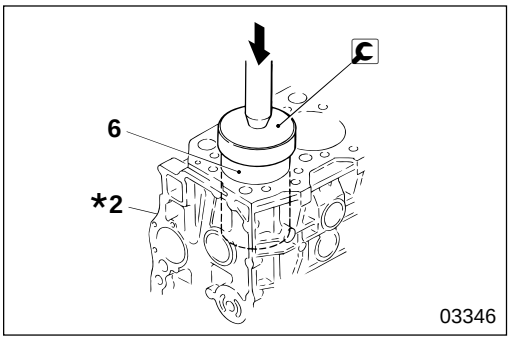
- Inspect sleeve hole of crankcase ***2** before installing cylinder sleeve **6**. If there are irregularities, such as defects or insufficient interference, correct them by boring.

NOTE

- **Pull out cylinder sleeve 6 of all cylinders and bore the sleeve holes perfectly round when you bore the sleeve holes of crankcase *2.**
- **Apply spindle oil (ISO VG 32) when you push cylinder sleeve 6 into the sleeve hole of crankcase *2.**

Inspection of interference must be carried out as follows.

- Measure the inner diameter of the sleeve hole of crankcase ***2** and the outer diameter of cylinder sleeve **6** at the specified positions illustrated.
- Take the average value at the top, middle and bottom (**D1**, **D2**, **D3**) and across the diameter (**A**, **B**). If the interference is lower than the limit, bore the sleeve hole of crankcase ***2** oversize.



< If interference fit is sufficient >

- Press-fit cylinder sleeve **6** into crankcase ***2** from the chamfered end using [C] cylinder sleeve installer.

NOTE

Align the top of cylinder sleeve 6 with the top of crankcase *2 when press-fitting.

- After press-fitting, make the inner diameter of cylinder sleeve **6** conform to the standard value by honing the block surface.

< If interference fit is insufficient >

- Prepare cylinder sleeve **6** which is 0.5 mm {0.020 in.} oversize in diameter.
- Hone crankcase ***2**, making the clearance between the outer diameter of cylinder sleeve **6** and the sleeve hole of crankcase ***2** conform to the standard value.
- Press-fit cylinder sleeve **6** into crankcase ***2** from the chamfered end using [C] cylinder sleeve installer.

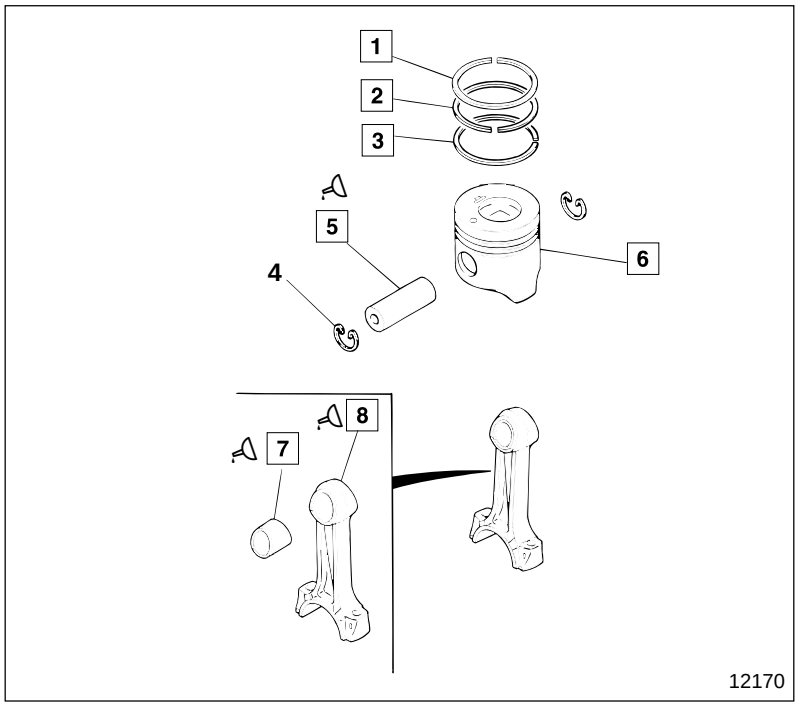
NOTE

Align the upper face of cylinder sleeve 6 with the upper face of crankcase *2 when press-fitting.

- After press-fitting, make the inner diameter of cylinder sleeve **6** conform to the standard value by honing, and or boring, the installed sleeve.

PISTON, CONNECTING ROD AND CYLINDER SLEEVE

Piston and Connecting Rod Assembly



● **Disassembly sequence**

1 1st compression ring
2 2nd compression ring
3 Oil ring
4 Snap ring
5 Piston pin
6 Piston
7 Connecting rod bushing
8 Connecting rod

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

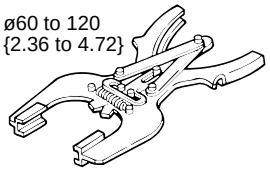
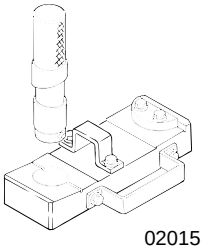
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 3	Deviation of piston ring fitted position	1st compression ring	0.3 to 0.45 {0.012 to 0.018}	1.5 {0.059}	Replace
		2nd compression ring	0.4 to 0.55 {0.016 to 0.022}		
		Oil ring	0.25 to 0.45 {0.0098 to 0.018}		
1 to 3, 6	Clearance between piston ring and piston ring groove	1st compression ring	0.03 to 0.08 {0.0012 to 0.0031}	0.2 {0.0079}	Replace
		2nd compression ring	0.05 to 0.08 {0.0020 to 0.0031}	0.15 {0.0059}	
		Oil ring	0.03 to 0.06 {0.0012 to 0.0024}		
5, 7	Clearance between piston pin and connecting rod bushing		[36] 0.03 to 0.04 {[1.42] 0.0012 to 0.0016}	0.1 {0.0039}	Replace
5, 6	Clearance between piston and piston pin		[36] 0.007 to 0.021 {[1.42] 0.00028 to 0.00083}	0.05 {0.0020}	Replace
8	Connecting rod	Bend	—	0.05 {0.0020}	Repair or replace
		Twist	—	0.1 {0.0039}	

Lubricant

Location	Points of application	Kinds	Quantity
5	Exterior of piston pin	Engine oil	As required
7	Exterior of connecting rod bushing	Engine oil	As required
8	Bushing attachment area of connecting rod	Engine oil	As required

Special tools

Unit : mm {in.}

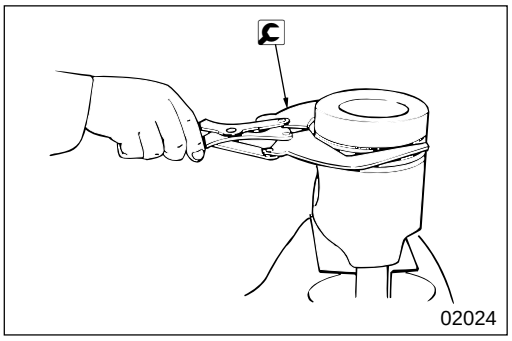
Location	Tool name and shape	Part No.	Application
1 to 3	Piston ring tool  02013	MH060014 (Obtain Locally)	Removal and installation of piston ring
7	Connecting rod bushing puller kit  02015	MH062225 (Obtain Locally)	Removal and installation of connecting rod bushing

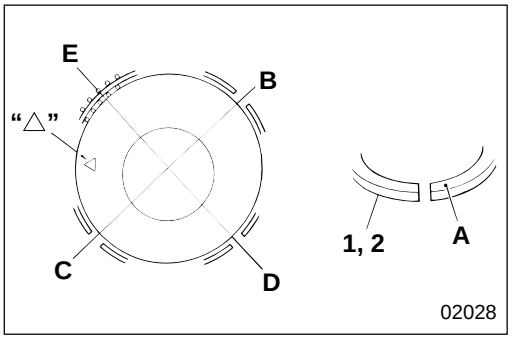
◆ Service procedure

1 to **3** , **6** **Piston ring and piston**

Piston ring

[Removal]


02024



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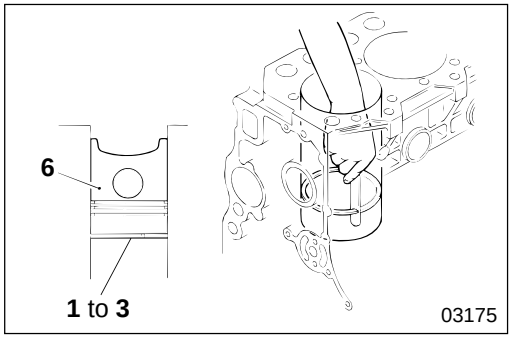
[Installation]

- Install oil ring **3** so that split **D** and the butting joint of expander spring **E** come to the points as illustrated.
- Compression rings **1** and **2** have a manufacturer's mark **A** at the split, and installation should be made with the mark outward.
  B : The split of the 1st compression ring
  C : The split of the 2nd compression ring
  D : Oil ring slit
  E : Oil ring expander spring butt joint
  △ : Front mark of piston

PISTON, CONNECTING ROD AND CYLINDER SLEEVE



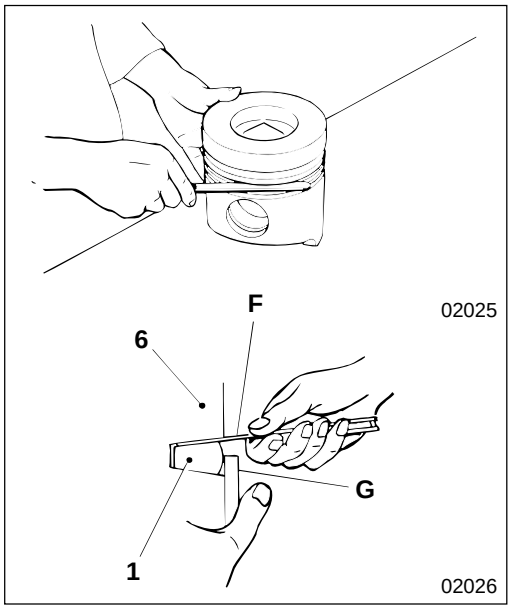
[Inspection]

(1) Clearance of piston ring slit

- Install piston rings **1** to **3** into the crankcase cylinder sleeve using the head of piston **6** to level the piston ring.
- Measure the clearance of the piston ring split while keeping them level and stationary. If the measured value is higher than the limit, replace the piston ring.

NOTE

- **Use piston 6 to ensure that piston rings 1 to 3 are kept level when inserting them into the crankcase cylinder sleeve.**
- **Insert piston rings 1 to 3 into the lower part of the crankcase cylinder sleeve, where the area is less worn, when measuring clearance of piston ring split 1 to 3.**
- **Exchange the whole set of piston rings 1 to 3 as a set if any of the rings is faulty.**

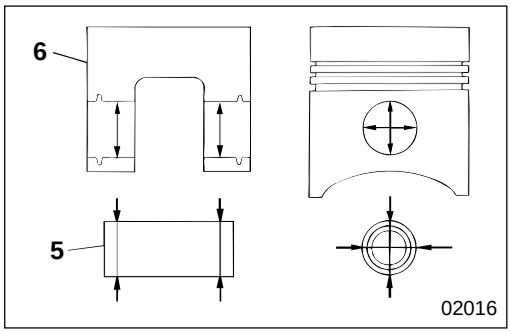


(2) Clearance between piston ring and ring groove

- If the measured value is higher than the limit, replace the faulty parts.
- Measure using feeler gauge **F**, by pressing 1st compression ring **1** against piston **6** with straight edge **G**.

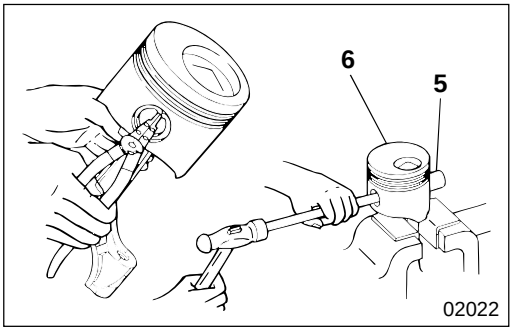
NOTE

- **Measurement has to be conducted around the whole periphery of piston 6 after removing carbon deposits.**
- **Be sure to exchange the whole set of piston rings 1 to 3 as a set if any of the rings is faulty.**



5 6 Clearance between piston pin and piston

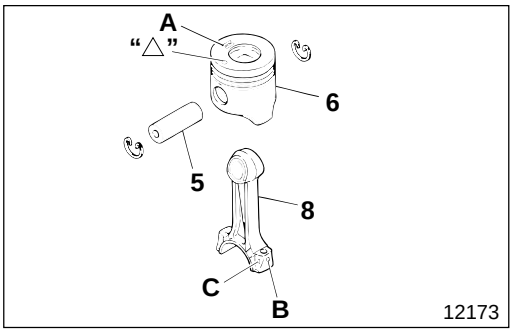
If the clearance is higher than the limit, replace the faulty parts.



5 6 8 Piston pin and connecting rod and piston

[Disassembly]

- Drift out piston pin **5** using a rod.
- When removal of piston pin **5** is difficult, warm piston **6** using a piston heater or hot water.



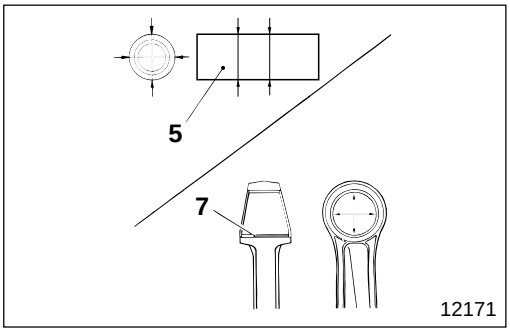
[Installation]

- Apply engine oil to piston pin **5** and assemble connecting rod **1** and piston **6** in the direction as illustrated.
  A : Piston mass (Mass of piston is marked)
  B : Connecting rod mass mark (Alphabetical: A, B, C, D, E, F, G)
  C : Mounting base of connecting rod cap
  △ : Front mark

- When piston pin **5** insertion is difficult, warm piston **6** using a piston heater or hot water.

CAUTION⚠

- **Make sure that the total mass error of all pistons 6 in one engine is 10 g {0.35 oz.} or less.**
- **Be sure to install connecting rods 8, to be used in one engine, that have identical mass mark B.**
- **Be sure that after inserting piston pin 5 the connecting rod operates smoothly without excessive play.**

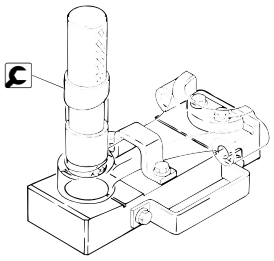


5 7 Piston pin and connecting rod bushing

[Inspection]

If the clearances are higher than the limit, replace the faulty parts.

PISTON, CONNECTING ROD AND CYLINDER SLEEVE



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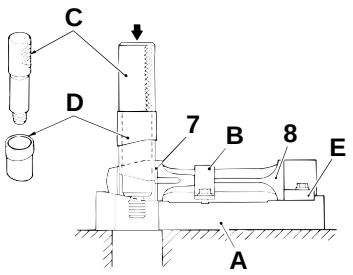


02020

Connecting rod bushing

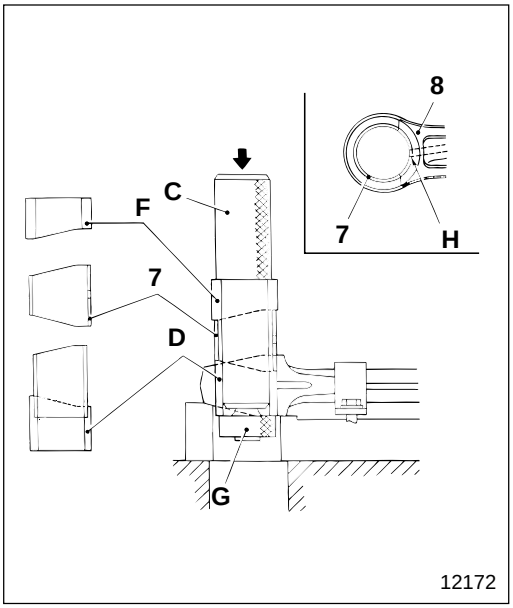
Use 🔧 connecting rod bushing puller kit to replace connecting rod bushing **7**.

(Components of 🔧 connecting rod bushing puller kit)

A : Base **B** : Bracket **C** : Puller **D** : Collar
E : Plate **F** : Collar **G** : Nut

[Pulling-out]

- Remove upper connecting rod bearing from the big end of connecting rod **8**.
- Place connecting rod **8** on base **A** and fix it to the base at two points, bracket **B** and plate **E**.
- Fit collar **D** in puller **C** in the direction as illustrated, and pull out connecting rod bushing **7** with a gradual load of approximately 49 kN {11020 lbf, 5000 kgf}.



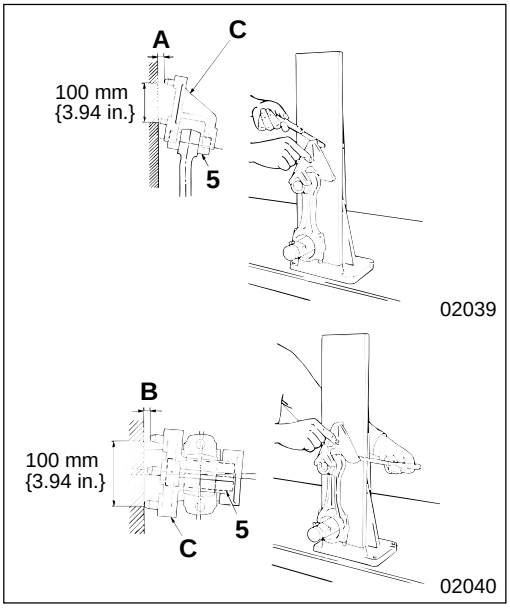
12172

[Press-fitting]

- Apply engine oil to the exterior peripheral area of connecting rod bushing **7** and the inner area of the bushing fitting ring of connecting rod **8**.
- Fit collar **F**, connecting rod bushing **7** and collar **D** in puller **C** in the arrangement and direction as illustrated and mount them with nut **G**.
- Align oiling holes **H** of connecting rod bushing **7** and connecting rod **8**, and gradually press in the bushing with approximately 49 kN {11023 lbf, 5000 kgf} load.
- After press-fitting, ream connecting rod bushing **7** to make its clearance with piston pin **5** conform to the standard value.

NOTE

After press-fitting bushing 7, insert piston pin 5 and make sure that the rod moves smoothly without any excessive play.



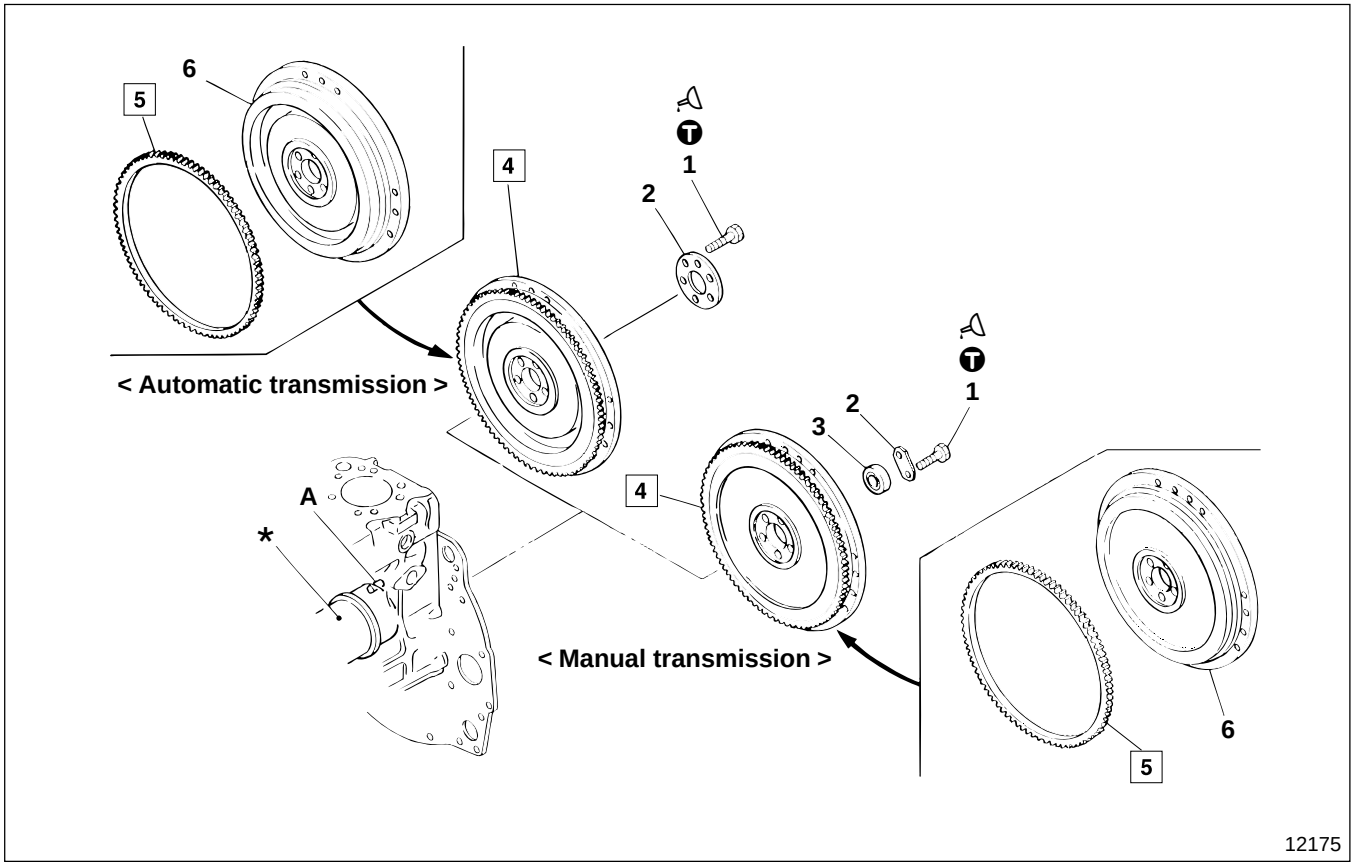
8 **Degree of bend or distortion of connecting rod**

- Mount connecting rod bushing **7** and piston pin **5** to connecting rod **8**.
- Measure degree of bend **A** and distortion **B** of connecting rod **8**. If the measured value is higher than the limit, repair or replace the connecting rod.
  C : Connecting rod aligner (Measuring instrument)

NOTE

- **When making measurements by mounting connecting rod 1 to connecting rod aligner C, make sure that the upper connecting rod bearing and the lower connecting rod bearing are mounted on the rod.**
- **Mount the connecting rod cap by tightening the bolt at specified torque.** 🕮 **P11B-44**

FLYWHEEL < WITHOUT FLYWHEEL POWER TAKE-OFF >



● **Disassembly sequence**

1 Bolt
2 Plate < Manual transmission >
Wear plate < Automatic transmission >
3 Bearing < Manual transmission >
4 Flywheel assembly
5 Ring gear
6 Flywheel

***** : Crankshaft assembly
🕮 P11B-66
A : Positioning pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Be sure to check wobble of flywheel 6 after installing flywheel assembly 4. 🕮 **P11B-55**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
4	Flywheel assembly < Manual transmission >	Height from bolt mounting surface to friction surface	24.5 {0.96}	23.5 {0.93}	Repair or replace
		Distortion of friction surface	0.05 {0.0020} or less	0.2 {0.0079}	
		Wobble of friction surface	—	0.2 {0.0079}	

Ⓣ Tightening torque

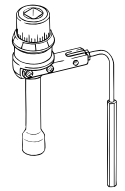
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Flywheel mounting)	39 {29, 4}+40°±5°	Wet

Lubricant

Location	Points of application	Kinds	Quantity
1	Thread area of bolt	Engine oil	As required

Special tools

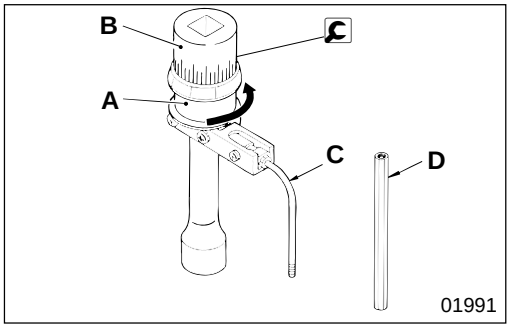
Location	Tool name and shape	Part No.	Application
4	Socket wrench  01984	MH062183	Installation of flywheel assembly
	Magnetic base < Manual transmission > 00471	MH062356	Installation of flywheel assembly < Manual transmission >

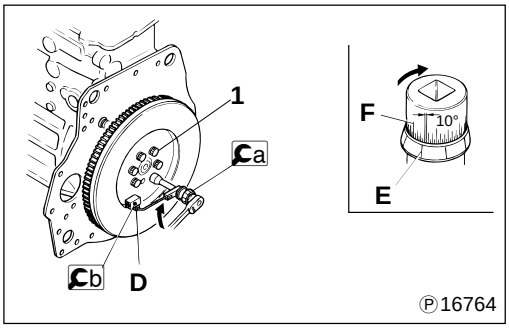
◆ Service procedure

4 Flywheel assembly

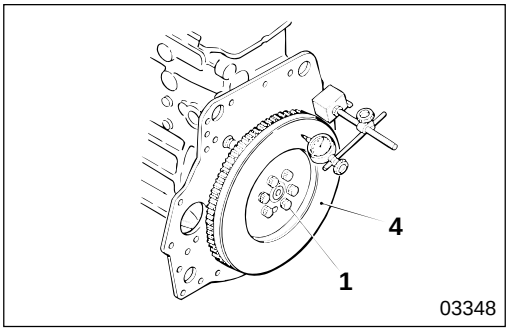
[Installation]

- After tightening bolt **1** at specified torque, tighten further as follows:
- Turn [c] socket wrench holder **A** counterclockwise and keep the spring in the wrench compressed.
  B : Socket
  C : Rod
  D : Rod (for connection)





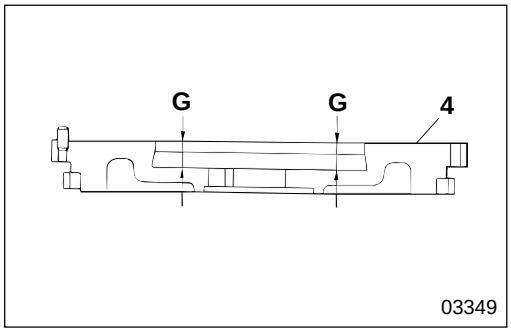
- Set [a] socket wrench holder **A** so that the repercussive force of its spring presses rod **D** (for connection) against [b] magnetic base
- Select a scale that is convenient for reading graduation **E** on holder **A** side.
- Tighten further by turning the socket clockwise by 40° ±5° (setting is in 10° increments) referring to graduation **F** on the selected scale.



[Inspection]
< Manual transmission >

(1) Wobble

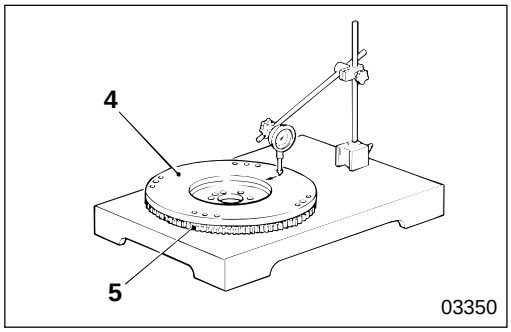
If the measured value is higher than the limit, check the fastening of bolt **1**, the attachment surface of crankshaft assembly, and depending on the condition found, either repair or replace flywheel assembly **4**.



(2) Height of friction surfaces

If the measured value is lower than the limit, repair or replace flywheel assembly **4**.

G : Height from bolt mounting surface to friction surface

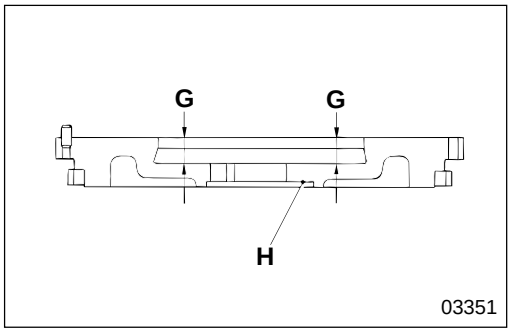


(3) Distortion of friction surface

If the measured value is lower than the limit, repair or replace flywheel assembly **4**.

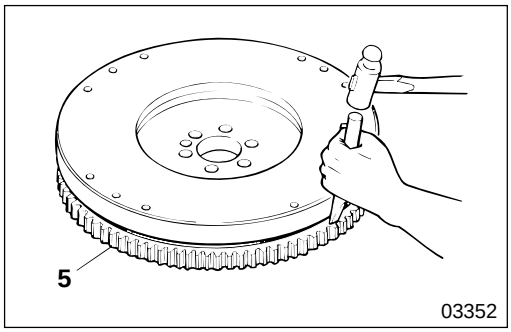
NOTE

If any fault is found in ring gear 5, replace it first, then begin the inspection.



[Correction]

Make sure when grinding the friction surfaces for correction, that height **G** is not lower than the limit while maintaining the degree of parallel with surface **H** within 0.1 mm {0.0039 in.}.



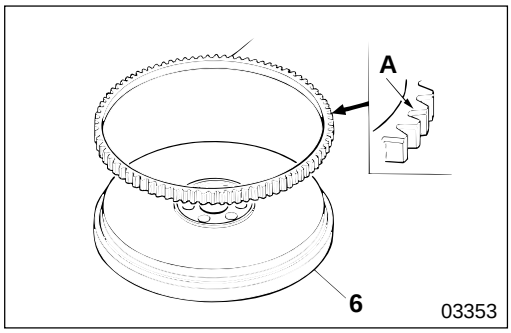
5 Ring gear

[Inspection]

Check and see if there is any damage, wear or other fault, and if any fault is found, replace ring gear **5**.

[Removal]

- Heat up ring gear **5** evenly using an acetylene torch.
- Hammer the outer edge of ring gear **5** evenly until it drops off.



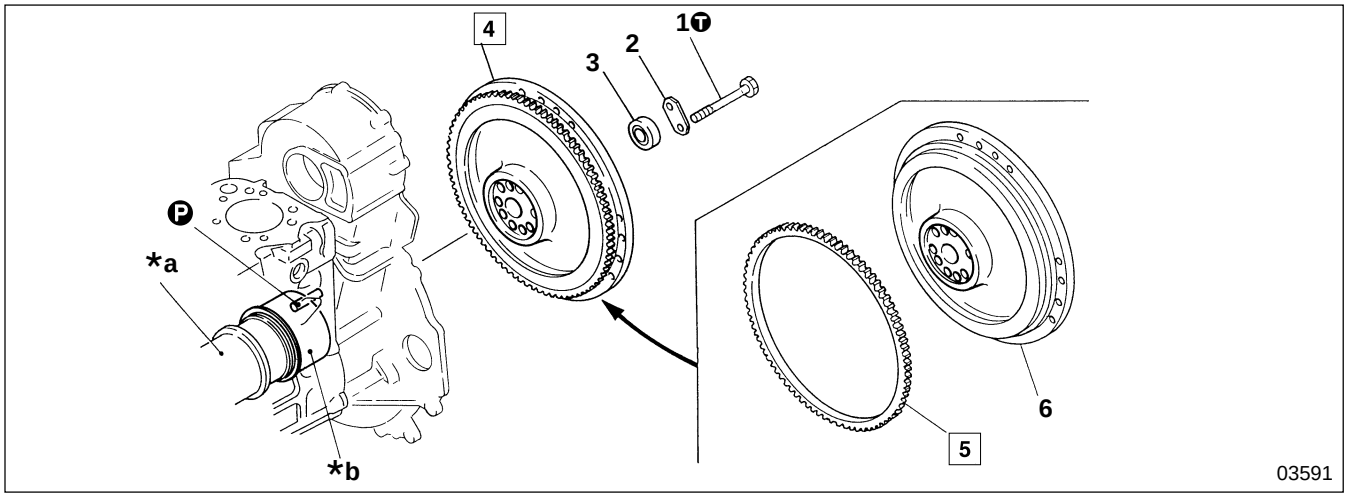
[Installation]

- Heat up ring gear **5** using a piston heater to approximately 100°C {212°F} for three minutes.
- With the side of the chamfered teeth of ring gear **5** facing you, mount it on flywheel **6**.

  A : Chamfered ring gear side

M E M O

FLYWHEEL < WITH FLYWHEEL POWER TAKE-OFF >



● **Disassembly sequence**

1 Bolt
2 Plate
3 Bearing
4 Flywheel assembly
5 Ring gear
6 Flywheel

***a:** Crankshaft Gr 11B
***b:** Crankshaft power take-off pulley P11B-62
P: Location Pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

After the flywheel assembly 4 is installed, be sure to check the flywheel 6 for runout.

Service standards

Unit: mm (in.)

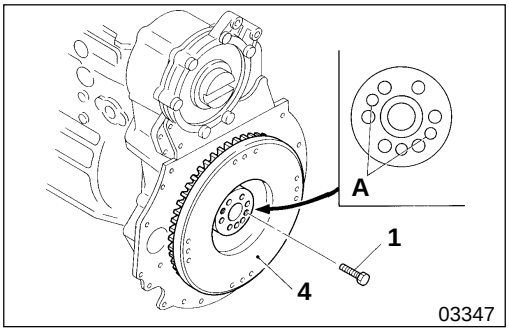
Location	Maintenance item		Standard value	Limit	Remedy
4	Flywheel assembly	Height of friction surface	25 (0.98)	24 (0.94)	Correct or replace
		Friction surface distortion	0.05 or less (0.0020)	0.2 (0.0079)	Correct or replace
		Friction surface runout (when fitted)	—	0.2	Correct or replace

T Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (flywheel assembly installation)	120 {90, 12.5}	M12 bolt
		175 {130, 18.0}	M14 bolt

◆ Service procedure



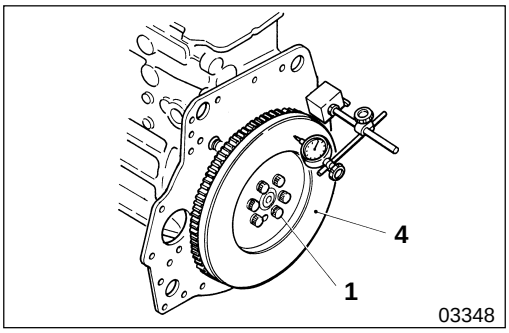
4 Flywheel assembly

[Removal]

- To remove the flywheel assembly **4**, screw the mounting bolts **1** into the removal holes **A**.
- Loosen the bolt of the tensioner pulley assembly to remove the tension from the belt. P11B-64

[Installation]

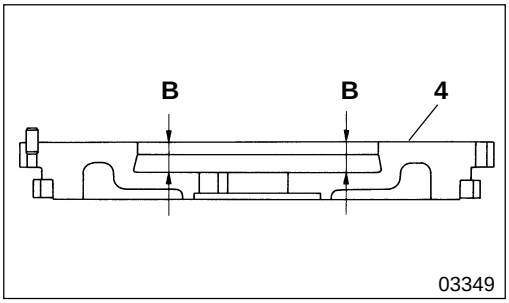
Adjust the belt tension after installing the flywheel assembly **4**.
P11B-62



[Inspection]

(1) Runout

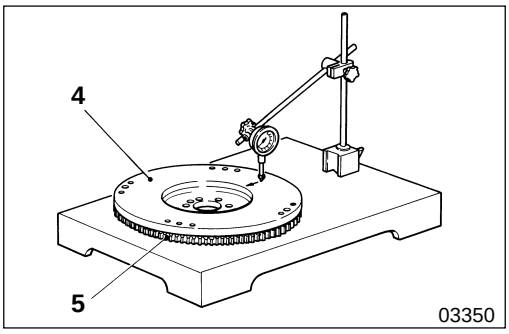
If runout exceeds the specified limit, check that the bolts **1** are tightened correctly and inspect the surface in contact with the crankshaft ***1**. Then, rectify or replace the flywheel assembly **4** as required.



(2) Height of friction surface

If the measurement is below the specified value, replace the flywheel assembly **4**.

B: Height of friction surface

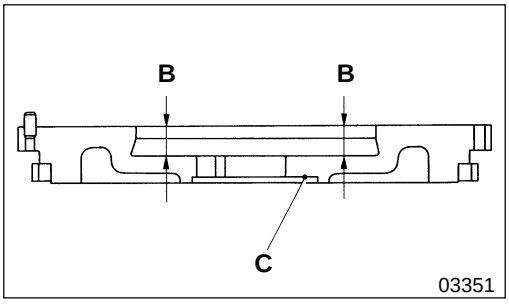


(3) Distortion of friction surface

If distortion exceeds the specified limit, rectify or replace the flywheel assembly **4**.

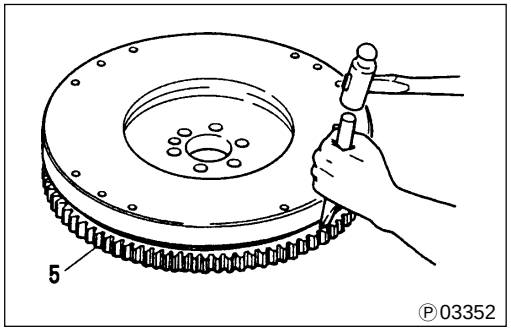
CAUTION ⚠

If any abnormality is evident on the ring gear 5, replace the ring gear before making inspections.



[Rectification]

Grind the friction surface such that its height **B** remains greater than the specified minimum. The friction surface must remain parallel with surface **C** with a tolerance of 0.1 mm {0.0039 in.}.



5 **Ring gear**

[Inspection]

Check the ring gear **5** for damage and abnormal wear, and replace the ring gear if it is faulty.

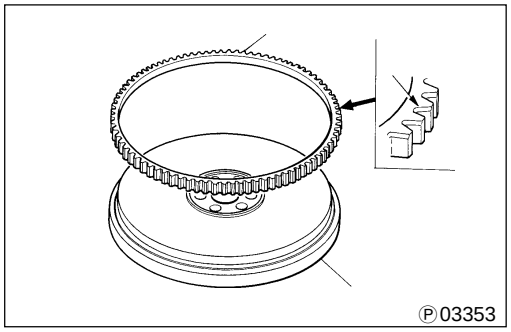
[Removal]

- Heat the ring gear **5** evenly.

WARNING ⚠

Be careful not to get burned.

- Remove the ring gear **5** from the flywheel by tapping around its entire periphery.



[Installation]

- Using a piston heater or the like, heat the ring gear **5** to approximately 100°C {212°F} for 3 minutes.

WARNING ⚠

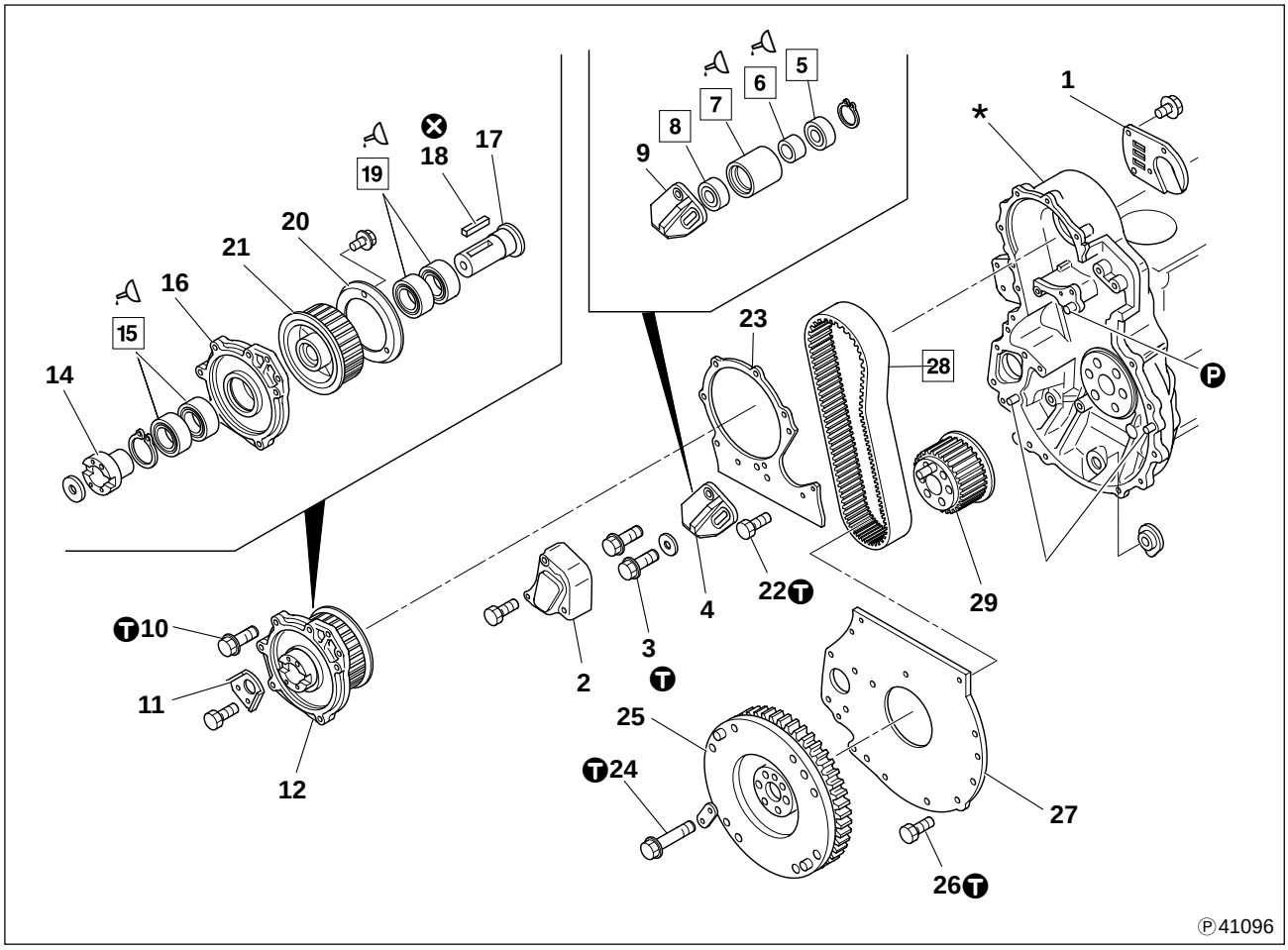
Be careful not to get burned.

- Fit the ring gear **5** with the non-chamfered side of its teeth toward the flywheel **6**.

  A : Chamfered side of ring gear

M E M O

FLYWHEEL < WITH FLYWHEEL POWER TAKE-OFF >



● **Disassembly sequence**

1 Bearing cover
2 Tension pulley cover
3 Bolt
4 Tension pulley assembly
5 Bearing
6 Spacer
7 Tension pulley
8 Bearing
9 Tension lever
10 Bolt
11 Hanger plate
12 Power take-off pulley assembly
13 Washer
14 Power take-off joint
15 Bearing
16 Bearing case
17 Power take-off shaft
18 Key
19 Bearing
20 Pulley flange
21 Power take-off pulley
22 Bolt
23 Cover plate
24 Bolt
25 Flywheel assembly P11B-58
26 Bolt
27 Cover plate
28 Belt
29 Crankshaft power take-off pulley

***** : Flywheel housing P11B-66
P : Location pin
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torques

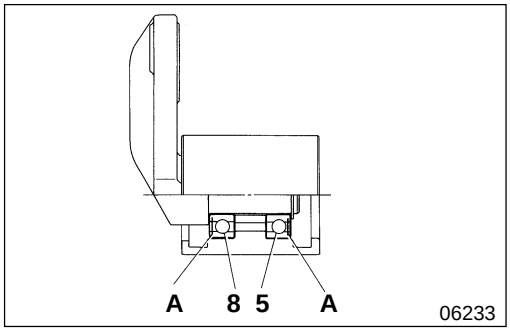
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (for mounting tension pulley assembly)	82 {61, 8.4}	—
10	Bolt (for mounting power take-off pulley assembly)	44 {33, 4.5}	—
22	Bolt (for mounting cover plate)	54 {40, 5.5}	—
24	Bolt (for mounting flywheel assembly and power take-off pulley)	175 {130, 18.0}	M14
26	Bolt (for mounting cover plate)	55 {41, 5.6}	—

Lubricant

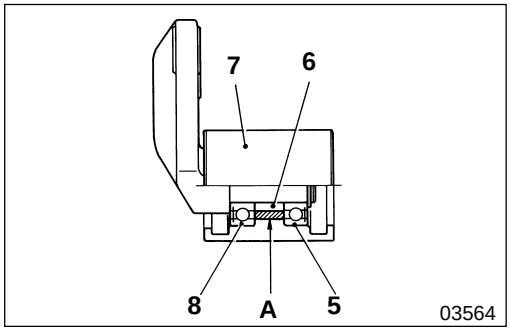
Location	Points of application	Specified lubricant	Quantity
6, 7	Between spacer and tension pulley	Templex N-3	5 to 8g {0.18 to 0.28 oz}
15	Between bearings	Templex N-3	5 to 8g {0.18 to 0.28 oz}
19	Between bearings	Templex N-3	7 to 10g {0.25 to 0.35 oz}

◆ Service procedure



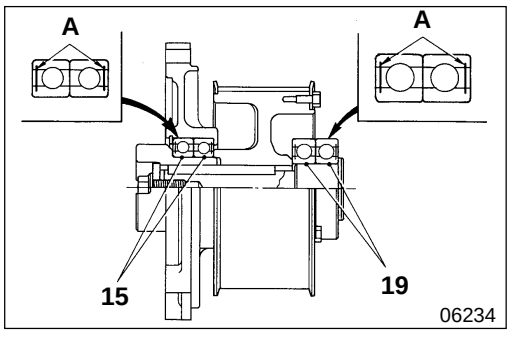
5 **8** **Installation of bearings**

Install the bearings with the sealing portion **A** directed as shown.



6 **7** **Packing grease between spacer and tension pulley**

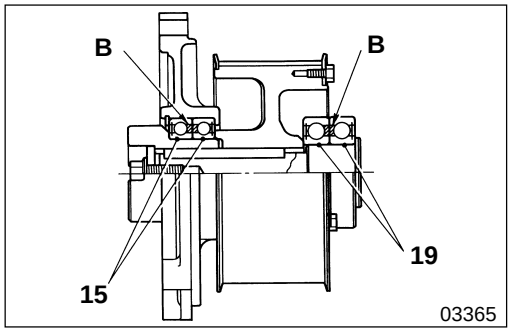
Pack a specified amount of grease in the illustrated section **A**.



15 **19** **Bearings**

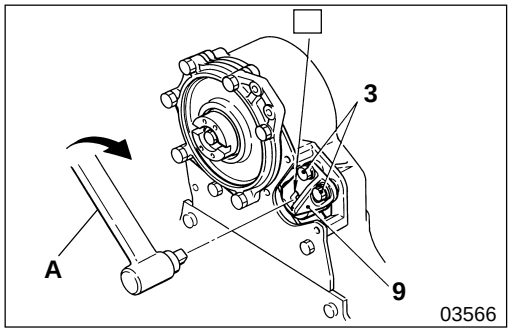
[Installation]

Install the bearings with the sealing section **A** directed as shown.



[Grease packing]

Pack a specified amount of grease in the illustrated section **B**.

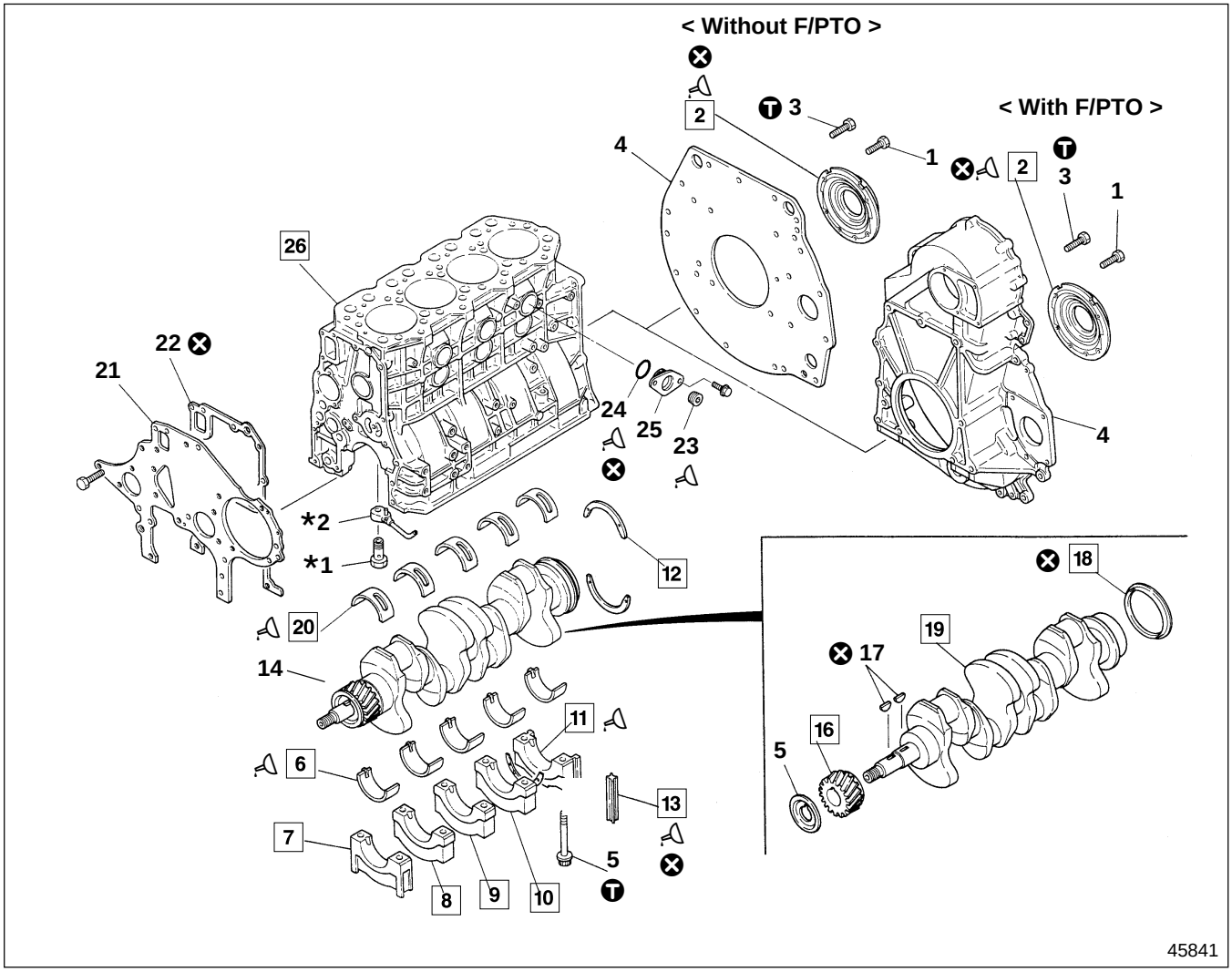


28 **Adjustment of belt tension**

- Loosen the bolt **3** of the tension lever **9**.
- Attach a torque wrench **A** to the □ section of the tension lever **9**.
- Apply a torque of 9.8 N·m {7.2 ft.lbs, 1.0 kgf·m} to the torque wrench **A** in the arrowed direction. Keeping this condition, tighten the bolt **3** to the specified torque.

M E M O

CRANKSHAFT AND CRANKCASE



● **Inspection before disassembly**

P11B-68

● **Disassembly sequence**

1 Bolt
2 Rear oil seal
3 Bolt
4 Rear plate < Without F/PTO >
Flywheel housing < With F/PTO >
5 Bolt
6 Lower main bearing
7 No.1 main bearing cap
8 No.2 main bearing cap
9 No.3 main bearing cap
10 No.4 main bearing cap
11 Rear main bearing cap
12 Thrust plate
13 Side seal
14 Crankshaft assembly
15 Front oil seal slinger
16 Crankshaft gear
17 Key
18 Rear oil seal slinger
19 Crankshaft
20 Upper main bearing
21 Front plate
22 Gasket
23 Taper plug
24 O-ring
25 Block heater adaptor
26 Crankcase

***1** : Check valve Gr 12B
***2** : Oil jet Gr 12B
⊗ : Non-reusable parts
F/PTO : Flywheel power take-off

NOTE

Do not remove crankshaft gear 16, rear oil seal slinger 18 check valve *1 and oil jet *2 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
—	Crankshaft end play			0.10 to 0.26 {0.0039 to 0.010}	0.4 {0.016}	Inspect
6, 20	Main bearing	Oil clearance	No.1, 2, 4, 5	[78] 0.04 to 0.09 {[3.07] 0.0016 to 0.0035}	0.15 {0.0059}	Replace
			No.3	[78] 0.06 to 0.12 {[3.07] 0.0024 to 0.0047}		
		Expansion at free state		—	less than 82.5 {3.25}	Replace
19	Crankshaft	Degree of bend		0.02 {0.00079} or less	0.05 {0.0020}	Replace
		Pin and journal	Circular accuracy	0.01 {0.00039} or less	0.03 {0.0012}	Repair or replace
			Cylindrical accuracy	0.006 {0.00024} or less	—	Repair or replace
26	Crankcase top surface distortion			0.07 {0.0028} or less	0.2 {0.0079}	Repair or replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

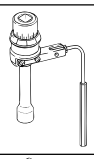
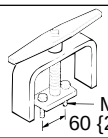
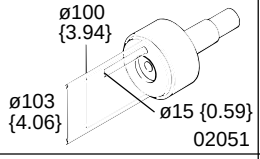
Location	Parts to be tightened		Tightening torque	Remarks
3	Bolt	Rear plate mounting	64 {47, 6.5}	—
		Flywheel housing mounting	55 {41, 5.6}	
5	Bolt (Main bearing cap mounting)		59 {43, 6}+90°	Wet,Reuse up to three times

Lubricant and sealant

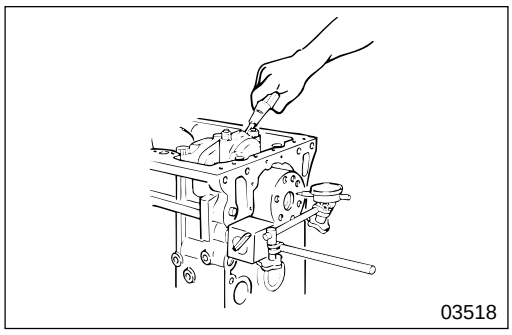
Location	Points of application	Kinds	Quantity
2	Rear oil seal lip	Engine oil	As required
	Rear oil seal mounting surface to crankcase	THREEBOND 1207C	As required
6, 20	Interior of main bearing	Engine oil	As required
11	Pack side seal driving groove of rear main bearing	THREEBOND 1207C	As required
13	Side seal tip and groove	THREEBOND 1207C	As required
23	Thread area of taper plug	THREEBOND 2410	As required
24	O-ring	Soapy water	As required

Special tools

Unit : mm {in.}

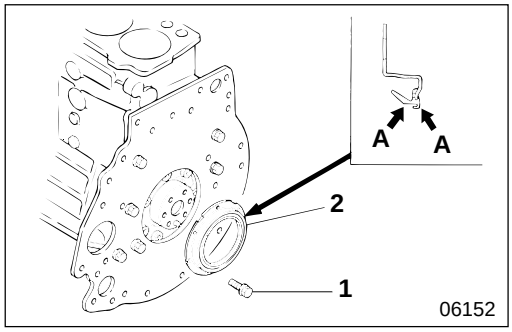
Location	Tool name and shape	Part No.	Application
7 to 11	Socket wrench  01984	MH061560 (Obtain Locally)	Installation of main bearing cap
11	Bearing cap extractor  03516	MH061083 (Obtain Locally)	Removal of rear main bearing cap
15	Rear oil seal slinger installer  02051	MH062677	Installation of rear oil seal slinger
16	Gear puller 02065	MH061326 (Obtain Locally)	Removal of crankshaft gear

◆ Service procedure



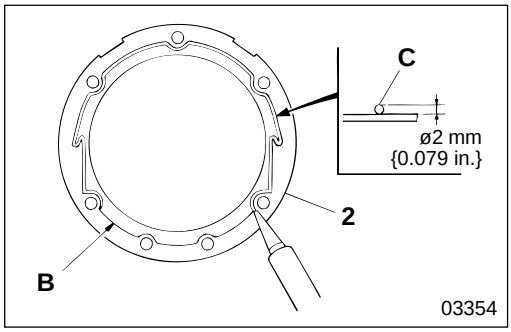
● **Inspection before disassembly**

Crankshaft assembly end play
If the measured value is higher than the limit, replace thrust plates **12** with oversized ones. 🕮 P11B-70
< Available oversize ones >
+0.15, +0.30, +0.45 mm
{+0.0059, +0.012, +0.018 in.}



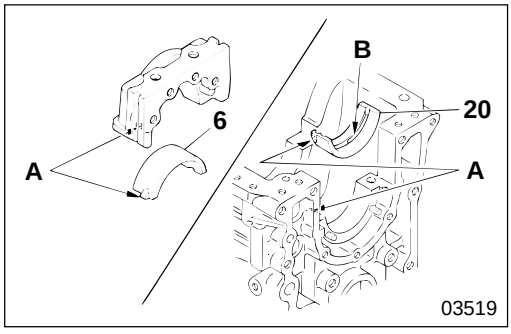
2 **Mounting of rear oil seal**

- Apply engine oil to lip area **A** of rear oil seal **2**.



- Apply sealant **C** along line **B** on rear oil seal **2** evenly without break.
- After applying sealant **C**, within three minutes, mount rear oil seal **2**.

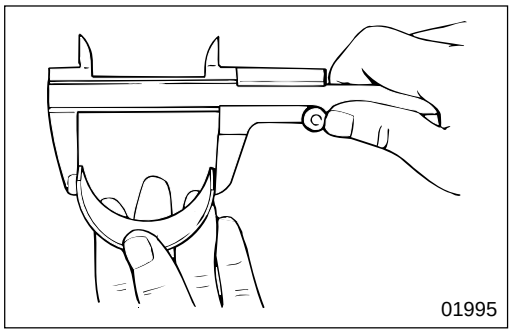
CAUTION⚠
- **Do not start the engine within an hour of mounting rear oil seal 2.**
- **Be sure to reapply sealant C if bolts 1 (for mounting rear oil seal 2) are loosened or removed by any cause whatsoever after mounting.**



6 **20** **Main bearing**

[Installation]
When installing main bearings **6**, **20**, align lugs **A**.

CAUTION⚠
Be sure to distinguish between main bearings 6, 20. The upper bearing has oil opening B while the lower bearing has no oil opening.

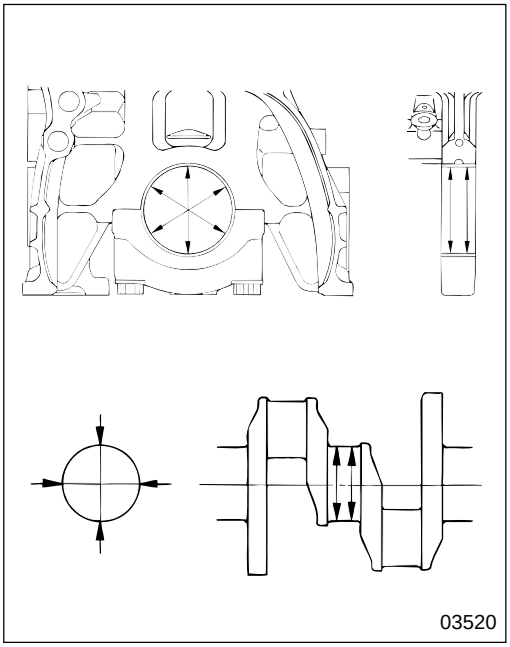


[Inspection]

CAUTION⚠
- **Do not forcibly expand main bearings 6, 20.**
- **Be sure to replace both upper and lower main bearings 6, 20 as a pair when replacement is necessary.**

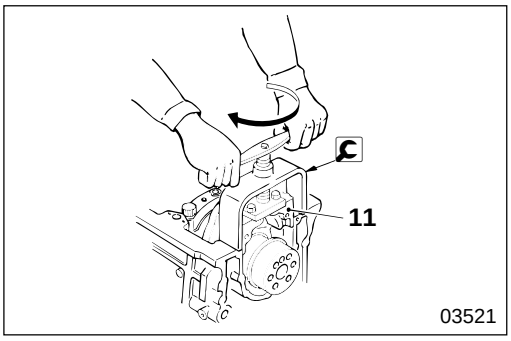
(1) Expansion at free state

If the measured value is lower than the limit, replace main bearings **6**, **20**.



(2) Clearance between main bearing and crankshaft

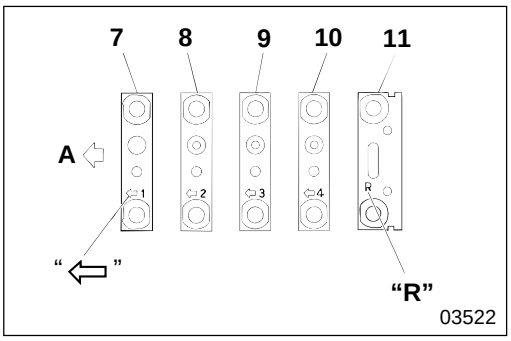
If the measured value is lower than the limit, replace faulty parts.



7 to 11 Main bearing cap

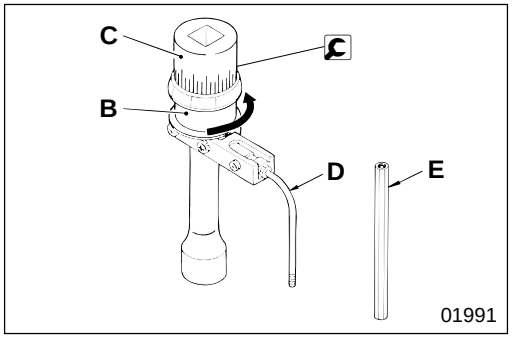
[Removal]

Use C bearing cap extractor to remove rear main bearing cap **11** because side seal **13** is installed between crankcase **23** and the rear main bearing.



[Installation]

- Install main bearing caps **7** to **11** in the direction as illustrated.
  A : Front of engine

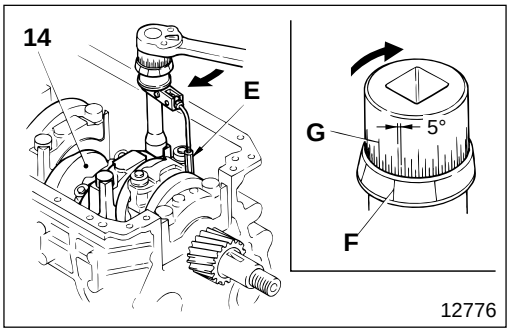


- Center punch the head of bolt **5** before installation.

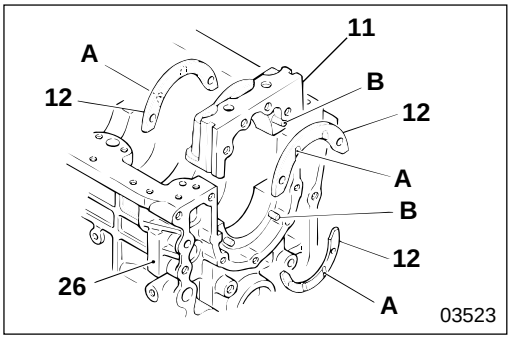
CAUTION⚠

If there are already three center-punch marks, replace the bolt with a new one.

- After tightening main bearing cap bolt **5** at specified torque, tighten further as follows:
- Turn 🔧 socket wrench holder **B** counterclockwise and keep the spring in the wrench compressed.
  C : Socket
  D : Rod
  E : Rod (for connection)



- Set 🔧 socket wrench holder **B** so that the repercussive force of the spring presses rod **E** (for connection) against crankshaft assembly **14**.
- Select a scale that is convenient for reading graduation **F** on holder **B**.
- Tighten further by turning socket **C** clockwise by 90° (setting is in 5° increments), referring to graduation **G** on the selected scale.
- After installation, check the following points :
  - Crankshaft assembly **14** can be rotated easily by hand.
  - The end play of crankshaft assembly **14**. 📖 P11B-69

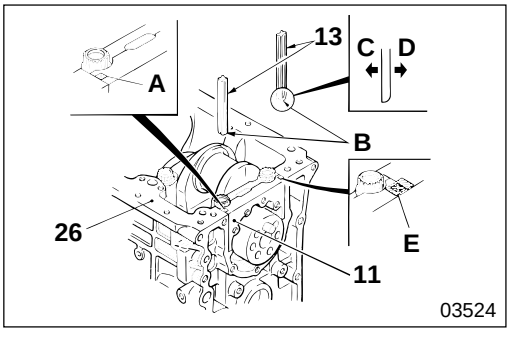


12 Installation of thrust plate

Install thrust plates **12** on both ends of rear main bearing **11** and the rear end of crankcase **26** in the direction as illustrated.
A : Oil groove
B : Positioning pin

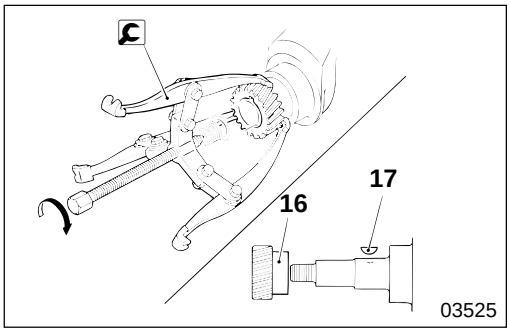
CAUTION⚠

When installing oversized thrust plates 12, mount them on the front and rear of rear main bearing cap 11. It is not necessary that the thrust plates used are all of the same size, but use the same-size-combination of thrust plates for mounting on the rear of crankcase 26 and on the rear of the rear bearing cap.
Available oversize : 0.15, 0.30, 0.45 mm { 0.0059, 0.012, 0.018 in. }



13 Installation of side seal

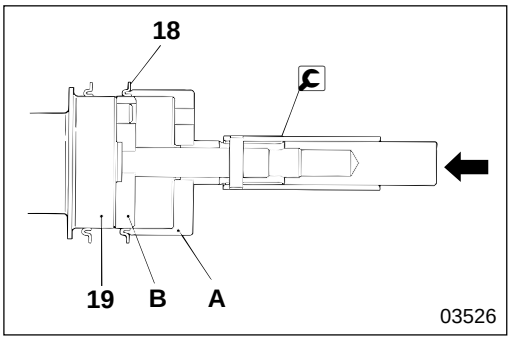
- Supply sealant in side seal mounting groove **A** of rear main bearing cap **11**.
- Apply sealant at end **B** of side seal **13**.
- Press in side seal **13** between rear main bearing cap **11** and crankcase **26** in the direction as illustrated.
  C : Rear main bearing cap side
  D : Crankcase side
- After pressing in, apply sealant to side seal mounting **E** of rear main bearing cap **11**.



16 Crankshaft gear

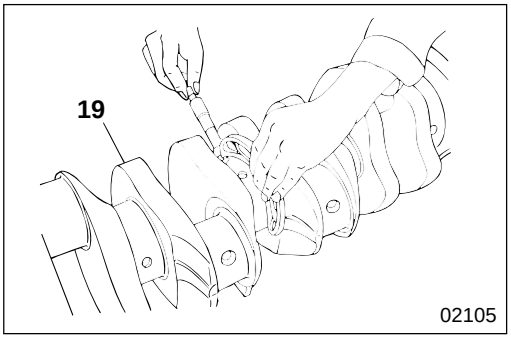
[Removal]
Never remove crankshaft gear **16** by striking, hitting or hammering it.

[Installation]
Before installing heat up crankshaft gear **16** using a piston heater or similar device to approximately 100°C {212°F}.



18 Installation of rear oil seal slinger

Install rear oil seal slinger **18** using oil seal slinger installer. Strike installer **A** until it hits guide **B** positively.

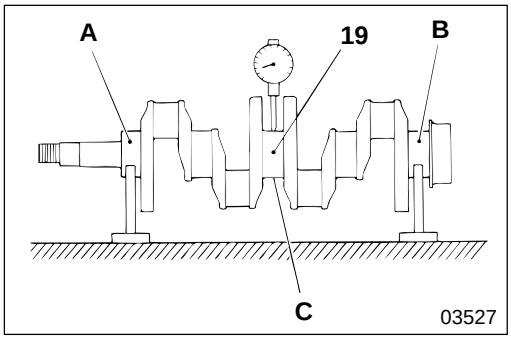


19 Crankshaft

[Inspection]

(1) Cylindrical and circular accuracy of the journal and the pin

If the measured value is higher than the limit, grind and correct crankshaft **19** to convert it to the undersize specifications or replace it.

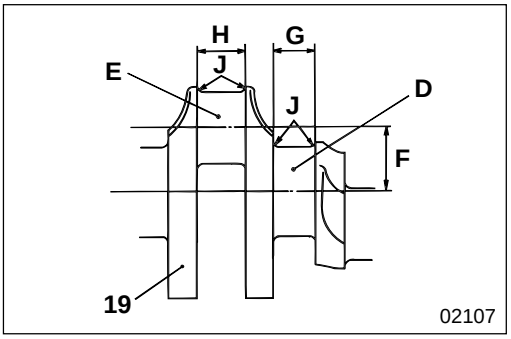


(2) Degree of bend

The degree of bend of crankshaft **19** is measured at No.3 journal **C** by supporting No.1 journal **A** and No.5 journal **B.** If the measured value is higher than the limit, replace the crankshaft.

NOTE

The degree of bend of crankshaft 19 is half of the indicated value of the gauge after rotating the shaft 360°.



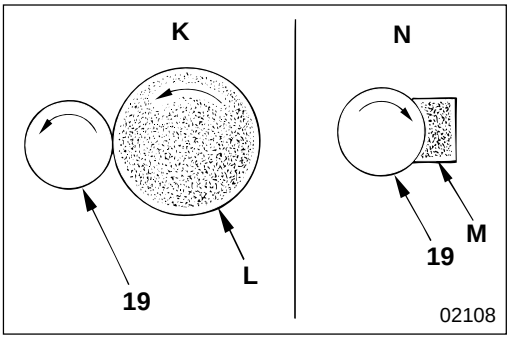
[Correction]

NOTE

Be sure to replace main bearings 6, 20 with those that meet the undersize specifications after crankshaft 19 is corrected by grinding.

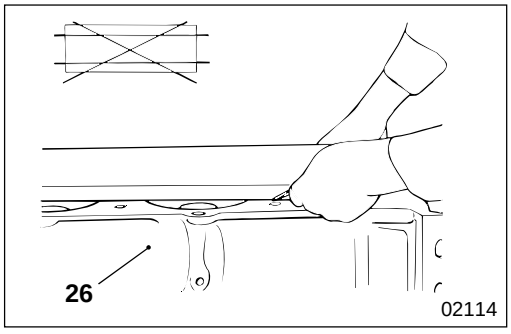
- Set **F**, distance between the center line of the journal **D** and that of the pin **E**, constant.
  F : 57.5±0.05 mm {2.26±0.0020 in.}
- Set the width of journal **G** and pin **H** so they are constant.
  G : 35 mm {1.38 in.} (32 mm {1.26 in.} for No.1 journal)
  H : $41\ ^{+0.2}_{0}$ mm
  $\{1.61\ ^{+0.0079}_{0}$ in.}

- Finish the fillet **J** smoothly.
  J : R4±0.2 mm {0.0079 in.}
- Check and confirm that there has been no cracking caused by grinding using the magnetic particle inspection method (Magnafluxing). Also make sure the surface hardness has not deteriorated (Shore hardness to be maintained at not less than Hs 75).
- When grinding **K**, set crankshaft **19** and grinder **L** so that they both rotate counterclockwise as viewed from the front of the crankshaft.
- To finish grinding **M** using a grindstone or emery paper **N,** rotate crankshaft **19** clockwise.



Undersize specifications of crankshaft Unit : mm {in.}

		Undersize scales			
		0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finish outer diameter of journal	No.1, 2, 4, 5 journals	77.68 to 77.70 {3.058 to 3.059}	77.43 to 77.45 {3.048 to 3.049}	77.18 to 77.20 {3.038 to 3.039}	76.93 to 76.95 {3.028 to 3.029}
	No.3 journal	77.66 to 77.68 {3.057 to 3.058}	77.41 to 77.43 {3.047 to 3.048}	77.16 to 77.18 {3.037 to 3.038}	76.91 to 76.93 {3.027 to 3.028}
Finish outer diameter of pin		59.695 to 59.715 {2.3501 to 2.3509}	59.445 to 59.465 {2.340 to 2.341}	59.195 to 59.215 {2.33 to 2.331}	58.945 to 58.965 {2.320 to 2.321}
Circular accuracy		0.01 {0.00039} or less			
Cylindrical accuracy		0.006 {0.00024} or less			



26 **Crankcase top surface distortion**

If the measured value is higher than the limit, grind and correct using a surface grinder.

A : Lines to be measured

CAUTION⚠

When grinding crankcase 26 be sure that the extent of piston protrusion does not deviate from the standard value.
Piston protrusion : 🕮 P11B-42

MITSUBISHI
FUSO

Group 12A
Lubrication

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-12A

INDEX

SPECIFICATIONS 12A- 2

STRUCTURE AND OPERATION 12A- 4

TROUBLESHOOTING 12A-13

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Oil Filter Replacement 12A-14
- Engine Oil Replacement 12A-15
- Oil Pressure Measurement 12A-16

OIL PAN, OIL STRAINER AND OIL JET 12A-18

OIL PUMP 12A-20

OIL FILTER 12A-24

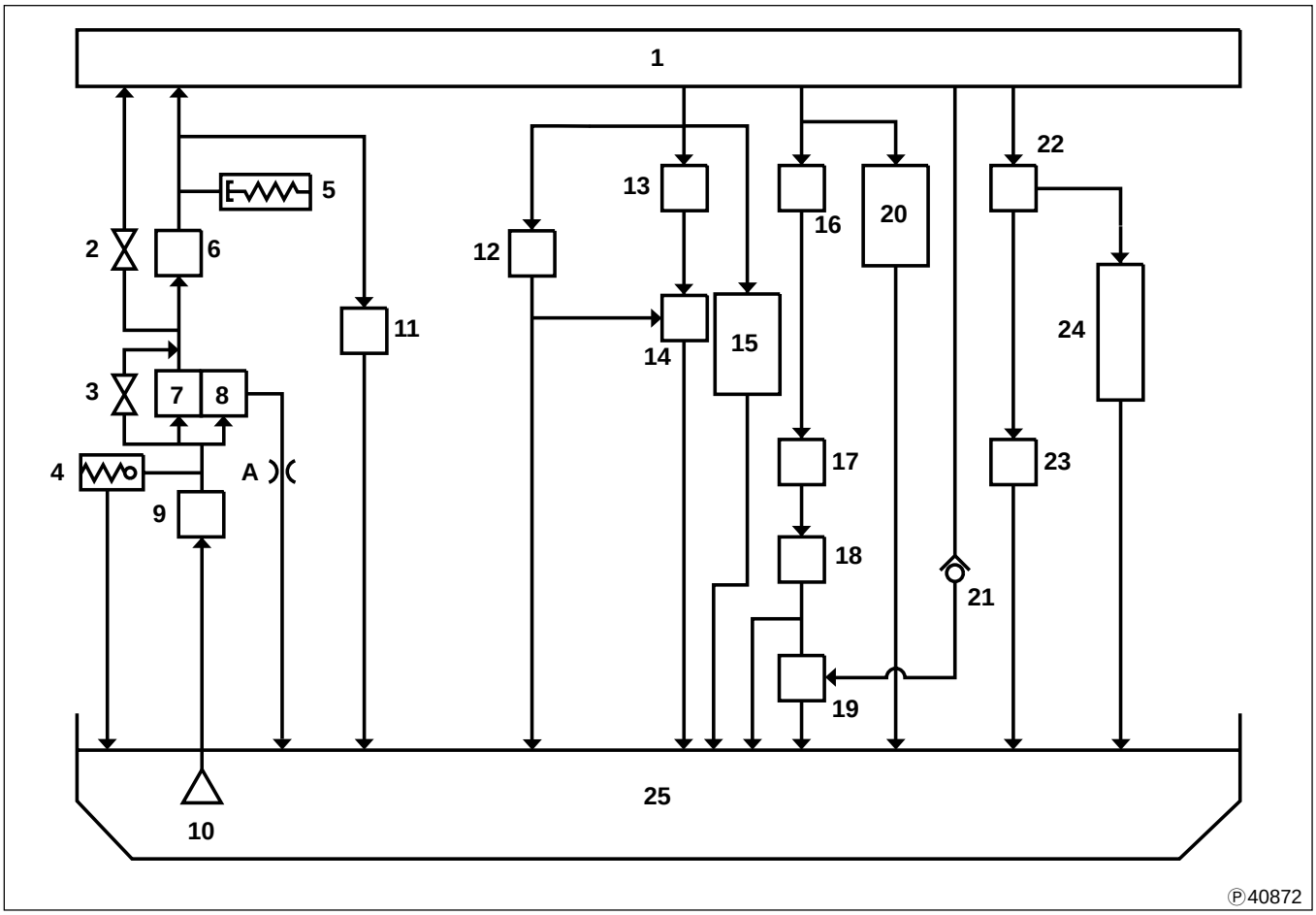
OIL COOLER 12A-26

SPECIFICATIONS

Item			Specifications
Mode of lubrication			Oil pump type
Oil filter type			Paper-filter, spin-on type
Oil cooler type			Shell and plate type (multi-plate type)
Engine oil	Grade		API CD or higher
	Oil quantity	Oil pan	Approximately 9 L {9.5 qts}
		Oil filter	Approximately 1 L {1.1 qts}

M E M O

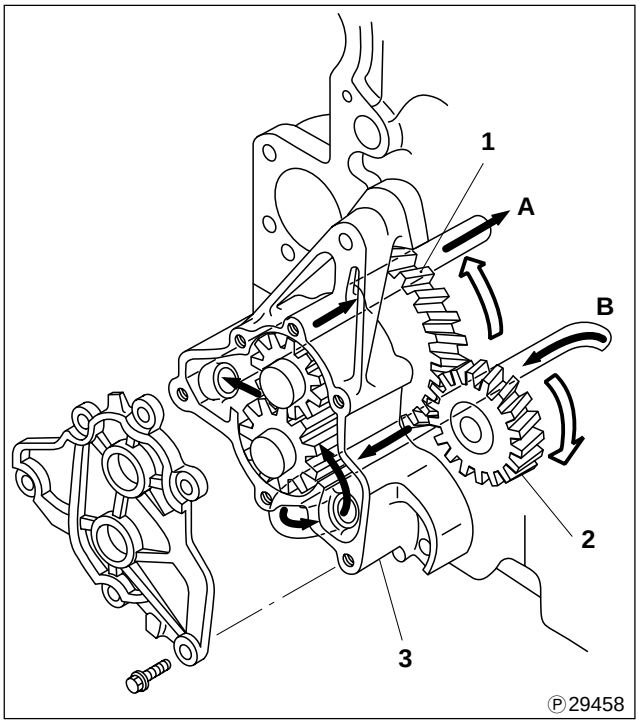
Lubrication System (Oil Flow)



1 Main oil gallery
2 Bypass valve
3 Bypass valve
4 Relief valve
5 Engine oil pressure switch
6 Oil cooler
7 Full-flow oil filter
8 Bypass oil filter
9 Oil pump
10 Oil strainer
11 Turbocharger
12 Vacuum pump
13 Idler bushing
14 Timing gear
15 Balancer bushing LH
16 Crankshaft main bearing
17 Connecting rod bearing
18 Connecting rod bushing
19 Piston
20 Balancer bushing RH
21 Oil jet check valve
22 Rocker bushing
23 Camshaft bushing
24 Rocker roller
25 Oil pan

A : Orifice

Oil Pump

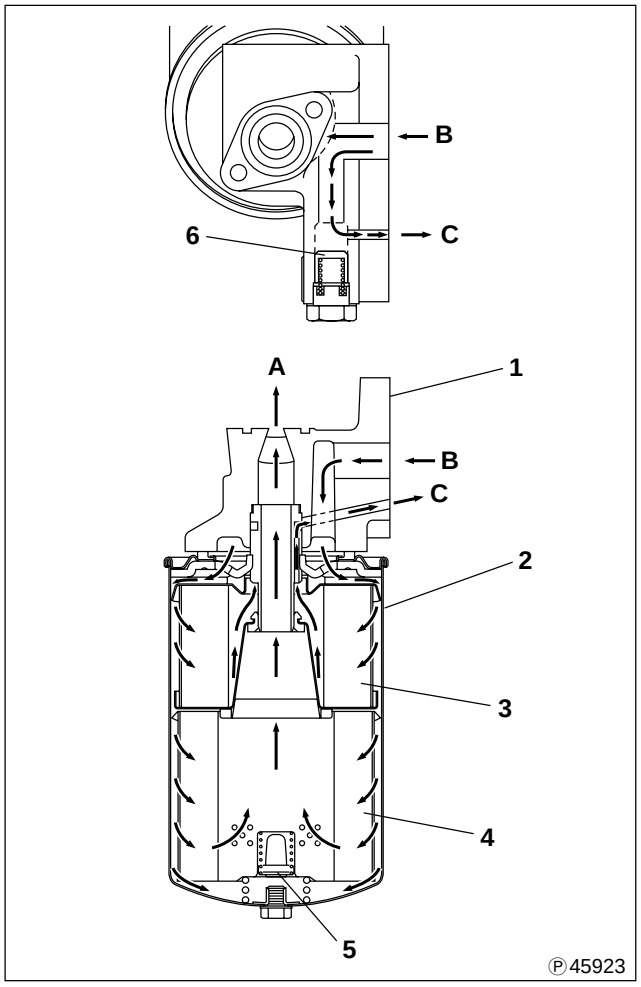


1 Oil pump gear
2 Crankshaft gear
3 Oil pump

A : To oil filter
B : From oil strainer

Oil pump **3** is a gear type. It is driven by rotation of the crankshaft via crankshaft gear **2** and oil pump gear **1**.

Oil Filter

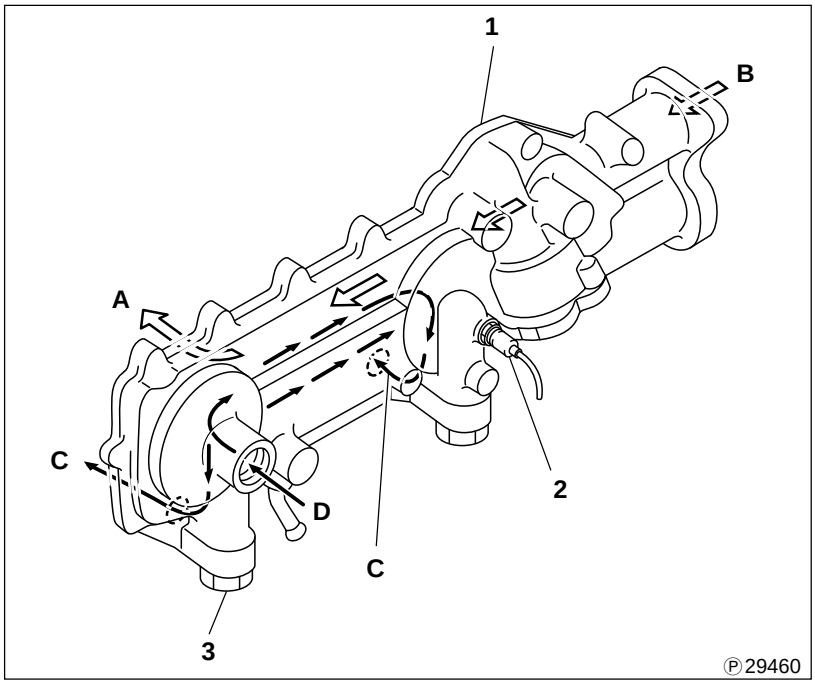


1 Oil filter head
2 Oil filter
3 Bypass filter
4 Full-flow filter
5 Bypass valve
6 Regulator valve

A : To oil cooler
B : From oil pump
C : To oil pan

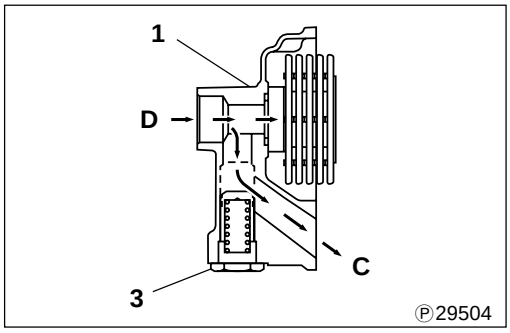
- The oil filter is a spin-on filter-paper type incorporating a bypass filter **3** and a full-flow filter **4**.
  A bypass valve **5** is fitted at the bottom of the filter assembly. If the elements become clogged, the bypass valve opens and allows oil to flow to oil cooler without passing through the elements. This operation prevents seizure of the engine.
- When the pressure of oil going to the main oil gallery exceeds a specified level, regulator valve **6** opens, allowing some of the engine oil to return to the oil pan. The oil pressure is thus constantly regulated.

Oil Cooler



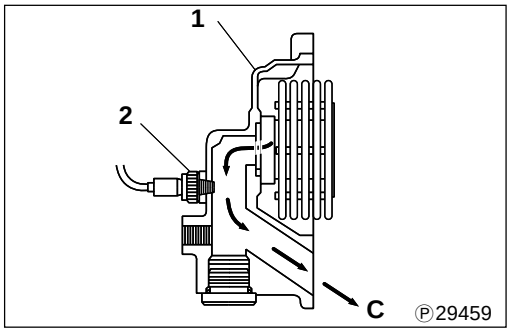
1 Oil cooler
2 Engine oil pressure switch
3 Bypass valve

A : Coolant outlet
B : Coolant inlet
C : To main oil gallery
D : From oil filter



● **Bypass valve**

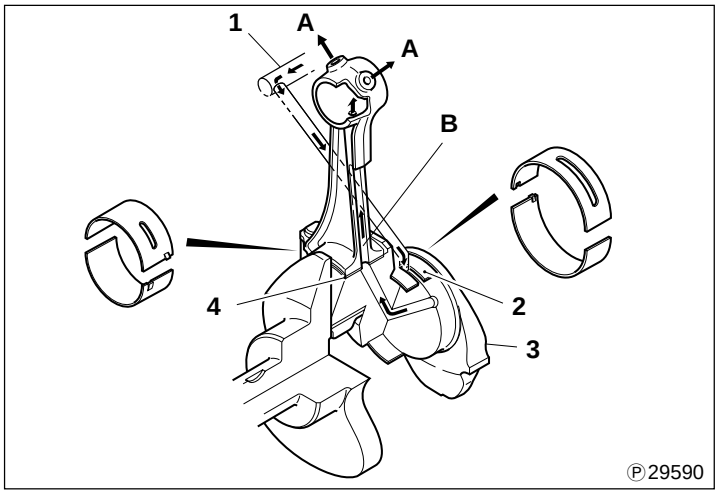
When the oil's viscosity is high at low temperatures or when oil cooler **1** element is clogged and resists the oil's flow, bypass valve **3** opens, thus allowing engine oil to flow to main oil gallery without passing through the cooler.



● **Oil pressure switch**

If the pressure of oil fed to main oil gallery drops below the specified level, electric contacts close inside engine oil pressure switch **2**. As a result, a warning lamp illuminates in the meter cluster to alert the driver.

Lubrication of Related Parts

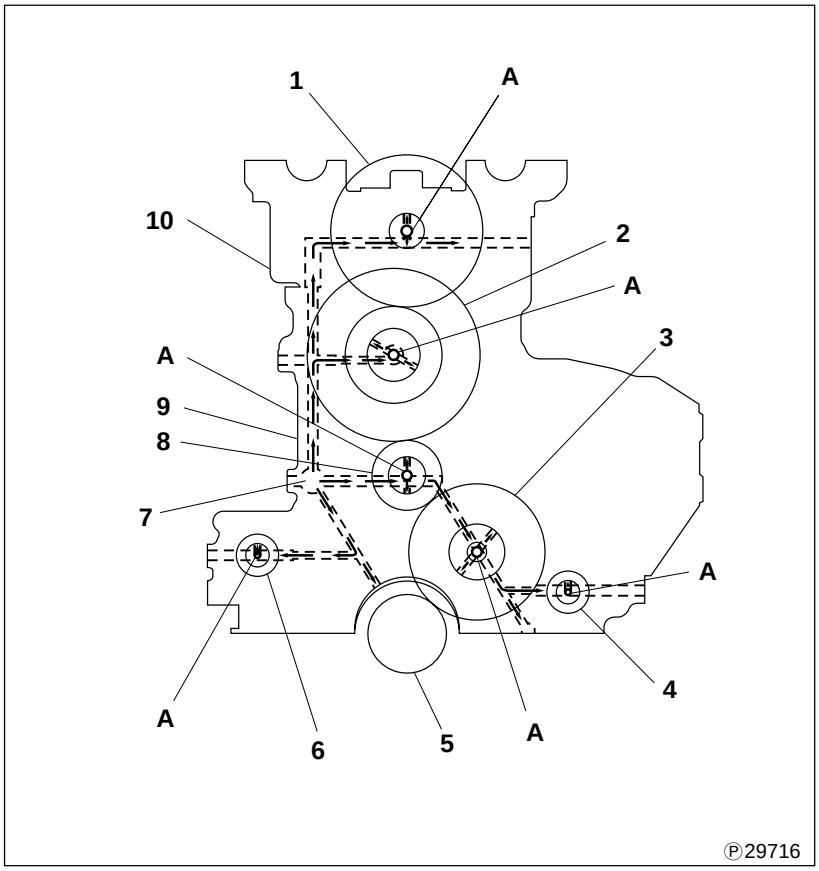


● **Main bearing and connecting rod bearing**

1 Main oil gallery
2 Main bearing
3 Crankshaft
4 Connecting rod bearing

A : Oil jet
B : Connecting rod oil passage

Oil supplied via the oil passage in the crankshaft flows through oil passage **B** in the connecting rod to lubricate the connecting rod's small end. The oil then sprays out from oil jet **A** at the top of the connecting rod to cool the piston.

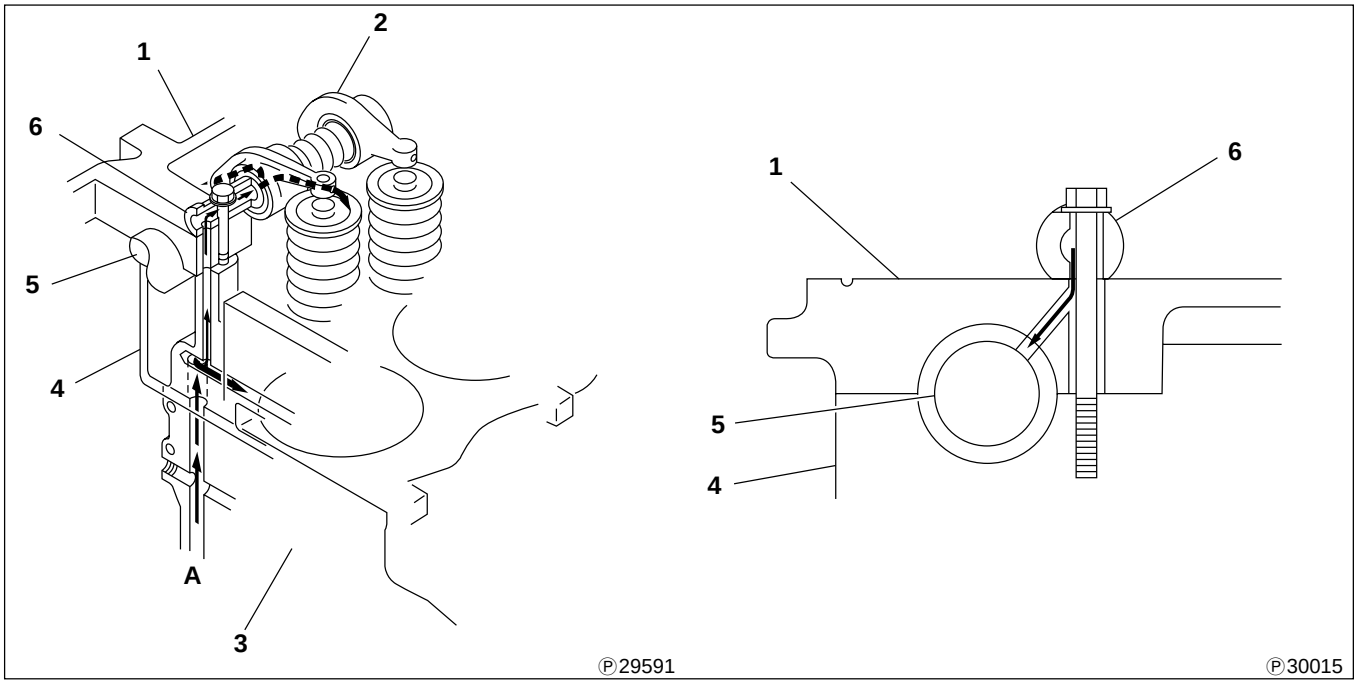


● **Timing gear**

1 Head idler gear
2 Idler gear A, B
3 Idler gear No.1
4 Balanceshaft gear LH
5 Crankshaft gear
6 Balanceshaft gear RH
7 Main oil gallery
8 Fan shaft assembly
9 Upper crankcase
10 Cylinder head

A : Oil hole

Engine oil from main oil gallery **7** passes through upper crankcase **9** and cylinder head **10** to lubricate the journals of the gears. The oil that has lubricated head idler gear **1** sprays out of oil hole in the gear boss and returns to the oil pan through inside the front case while lubricating the gears.

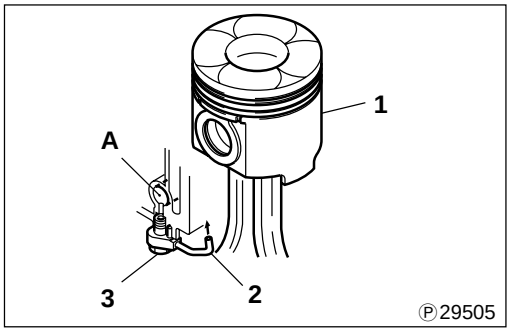


● **Valve mechanism**

1 Camshaft frame
2 Rocker arm
3 Upper crankcase
4 Cylinder head
5 Camshaft
6 Rocker shaft

A : From main oil gallery

Engine oil from main oil gallery **A** passes through upper crankcase **3**, cylinder head **4** and camshaft frame **1** to rocker shaft **6**. Then, the oil flows through the oil passage of rocker shaft and returns to the oil pan while lubricating rocker arm **2** and camshaft **5**.

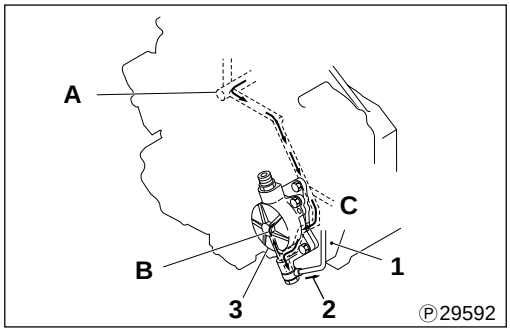


● **Oil jet**

1 Piston
2 Oil jet
3 Check valve

A : Main oil gallery

An oil jet **2** is fitted in the lower part of the main oil gallery **A** for each cylinder. These oil jets cool the pistons **1** by injecting oil into them. Each oil jet is fitted with check valve **3** that opens and closes at specified oil pressure levels. At low engine speeds, these check valves close to maintain the required volume of oil in the lubrication system and prevent reductions in oil pressure.



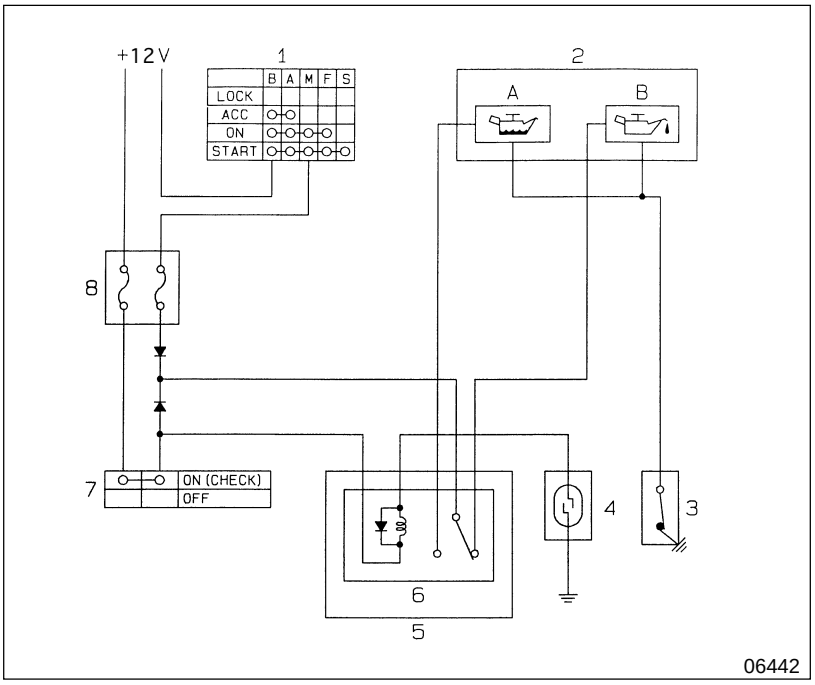
● **Vacuum pump**

1 Front case
2 Oil pipe
3 Vacuum pump

A : Main oil gallery
B : To front case
C : To automatic timer

Engine oil delivered from main oil gallery **A** flows to vacuum pump **3** where it branches into two flows; one is, after lubricating the vanes, discharged into front case **1** from the air vent hole and returns to the oil pan. The other passes through oil pipe **2** to lubricate various parts of the automatic timer and then returns to the oil pan.

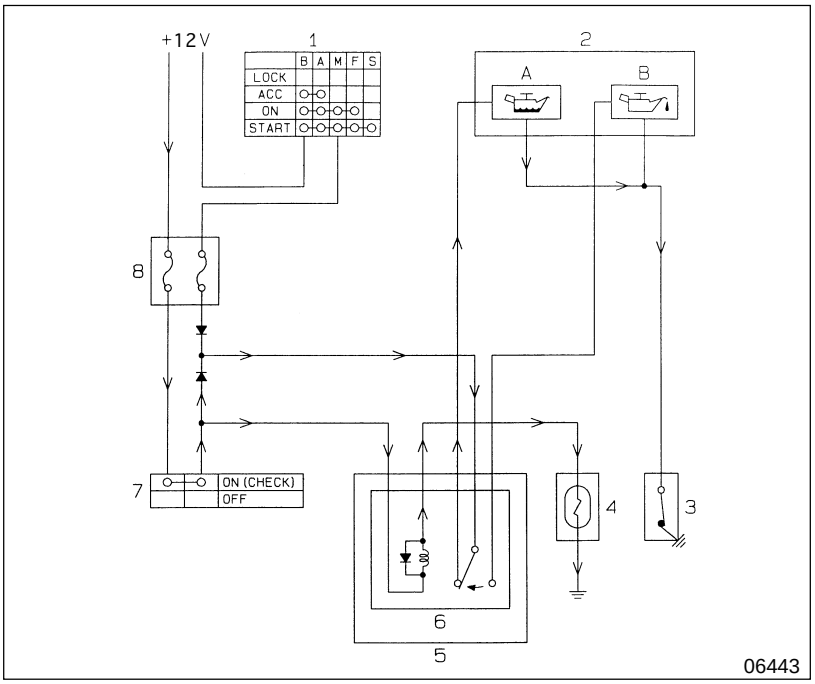
Lubrication System Monitoring Circuit



1 Starter switch
2 Meter cluster
3 Oil pressure switch
4 Oil level sensor
5 Relay box
6 Oil level relay
7 Oil level check switch
8 Fuse box

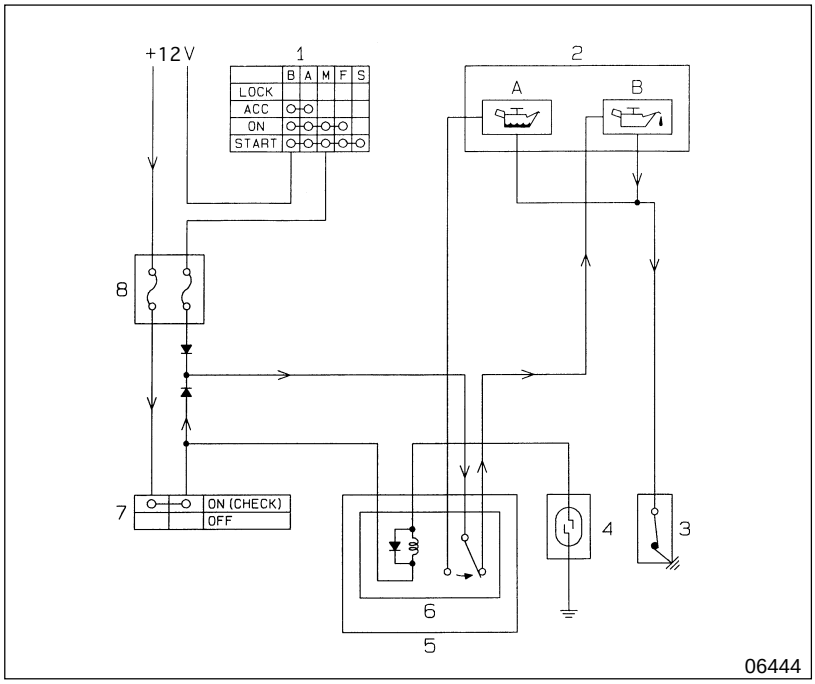
A : Oil level indicator lamp (green)
B : Low oil warning lamp (red)

This circuit monitors the lubrication system by detecting the pressure and level of engine oil.



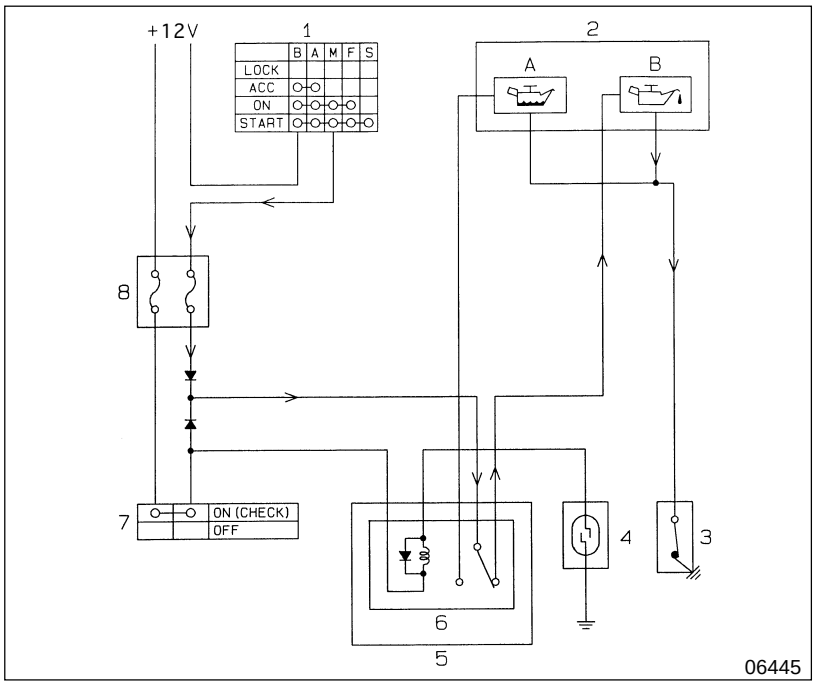
● Oil level normal (oil level sensor ON)
When oil level check switch **7** is turned ON while the engine is not running (oil pressure switch **3** ON), oil level sensor **4** is grounded and therefore oil level relay **6** is energized. This allows current to flow through the route given below and turn on oil level indicator lamp **A**. (green)

Fuse box **8** → oil level check switch **7** → relay box **5**
→ oil level relay **6** → oil level sensor **4** → ground
→ meter cluster **2** → oil level indicator lamp **A**
→ oil pressure switch **3** → ground



● Oil level low (oil level sensor OFF)
Even when oil level check switch **7** is turned ON while the engine is not running (oil pressure switch **3**: ON), oil level relay **6** is not energized because oil level sensor **4** is off. This causes the current to flow through the route given below and turn on oil pressure warning lamp **B**. (red)

Fuse box **8** → oil level switch **7** → Relay box **5** → oil level relay **6** → meter cluster **2** → oil pressure warning lamp **B** → oil pressure switch **3** → ground



● Oil pressure abnormal (oil pressure switch ON)
The oil pressure drops while the engine is running oil pressure switch **3** turns ON. As a result, current flows through the route given below to turn on oil pressure warning lamp **B**. When oil pressure is normal, oil pressure switch **3** remains off and no current flow to illuminate lamp **B.** (red)

Starter switch **1** → fuse box **8** → relay box **5** → oil level relay **6** → meter cluster **2** → oil pressure warning lamp **B** → oil pressure switch **3** → ground

Possible causes \ Symptoms		Engine hard to start	Overheating	Low oil pressure	Excessive oil consumption (oil leakage)	Remarks
Oil cooler	Oil cooler element installed poorly		×	×	×	
	Gasket defective		×	×	×	
	O-ring defective		×	×	×	
	Oil cooler element clogged		×	×		
	Oil cooler element damaged		×	×	×	
	Fatigue in bypass valve spring		×			
Oil pump	Oil pump malfunctioning		×	×		
	Interference between oil pump gear and oil pump case or cover	×		×		
Oil filter	Oil filter fitted poorly				×	
	Element clogged		×	×		
	Gasket defective			×	×	
Fatigue in regulator valve spring				×		
Oil strainer installed poorly, clogged			×	×		
Front case installed poorly					×	Gr 11A
Fan shaft front oil seal defective					×	Gr 11A
Crankshaft rear oil seal defective					×	Gr 11A
Piston cooling oil jet(s) defective			×			
Oil working its way up into combustion chamber(s)					×	
Oil working its way down into combustion chamber(s)					×	
Oil viscosity too high		×				
Unsuitable of quality			×		×	
Deterioration in oil			×		×	
Fuel mixed with oil			×		×	

ON-VEHICLE INSPECTION AND ADJUSTMENT

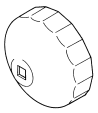
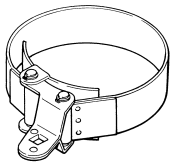
Oil Filter Replacement

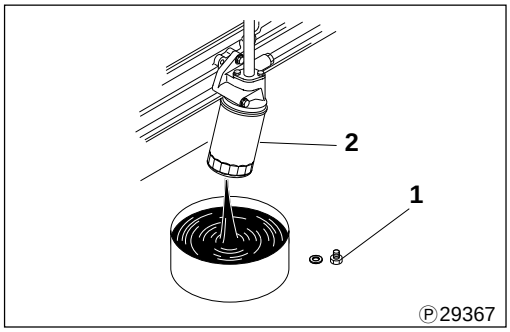
Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Oil filter	Engine oil (API CD or higher)	Approximately 1 L {1.1 gts}

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
—	Oil Filter Element Socket  08550	MH061566	Oil filter removal
	Oil Filter Wrench  ø107 to 120 {ø4.21 to 4.72} 01503	MH063200	



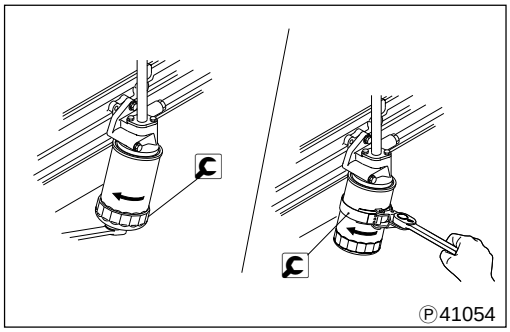
Ⓟ29367

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

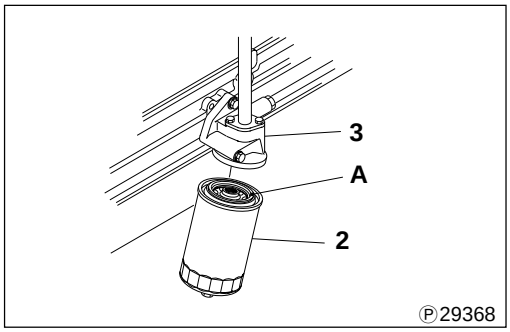
CAUTION ⚠

When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.


Ⓟ41054

Loosen oil filter drain plug **1** to drain the engine oil from inside the filter **2**.
[Removal]

: Oil Filter Element Socket or Filter Wrench



Ⓟ29368

[Installation]

- Clean the surface of oil filter head **3** to which oil filter **2** is fitted.
- Apply a thin coat of engine oil to the gasket A of oil filter **2**.
- Screw oil filter **2** onto oil filter head **3** by hand until gasket **A** contacts the oil filter head. Then, tighten oil filter **2** further by giving it an additional 3/4 turn.
- After installing the oil filter, start the engine and check gasket **A** for oil leakage.
- Check to see if the engine oil level is in the specified range.

Engine Oil Replacement

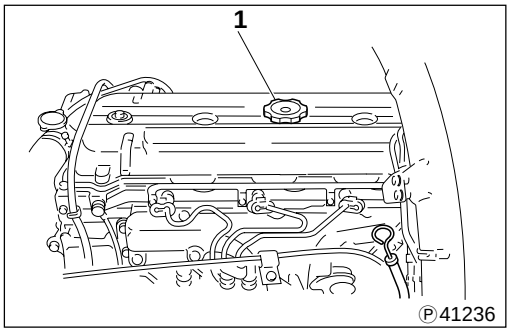
Tightening torques

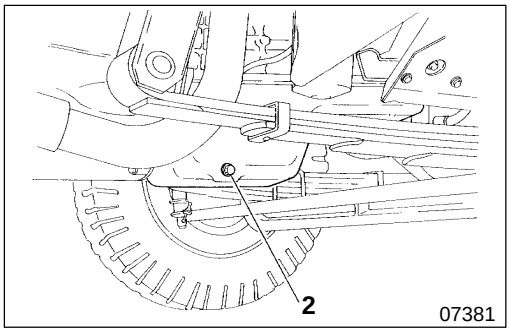
Unit: N·m {ft.lbs, kgf·m}

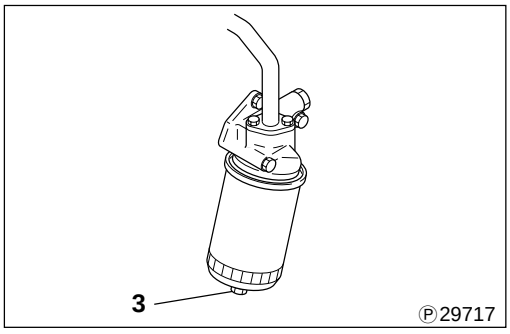
Location	Parts to be tightened	Tightening torque	Remarks
2	Oil pan drain plug	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	—
3	Oil filter drain plug	9.8±1.96 {7.2±1.4, 1.0±0.2}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
—	Oil pan	Engine oil (API CD or higher)	Approximately 9 L {9.5 qts}
—	Oil filter	Engine oil (API CD or higher)	Approximately 1 L {1.1 qts}







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When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.

[Draining]

- Warm up the engine, then remove oil filler cap **1**.
- Remove oil pan drain plug **2** and oil filter drain plug **3**. Then, drain the engine oil.

[Filling]

Tighten oil pan drain plug **2** and oil filter drain plug **3** to their specified torques. Then, add new engine oil to the specified level.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Oil Pressure Measurement
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Oil pressure (at oil temperature of 158 to 194°F, 70 to 90°C)	At no-load minimum speed	145 kPa {21 psi, 1.5kgf/cm^2}	49 kPa {7.1 psi, 0.5 kgf/cm^2}	Check
		At no-load maximum speed	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm^2}	195 kPa {28 psi, 2 kgf/cm^2}	

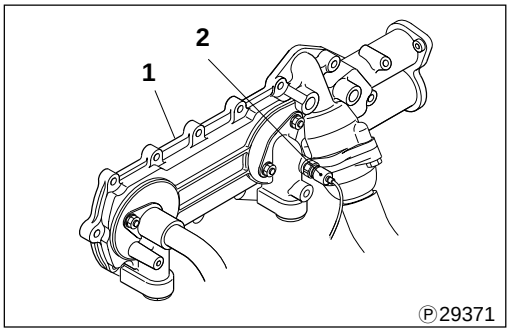
Tightening torque

Unit: N·m {ft.lbs, kgf·m}

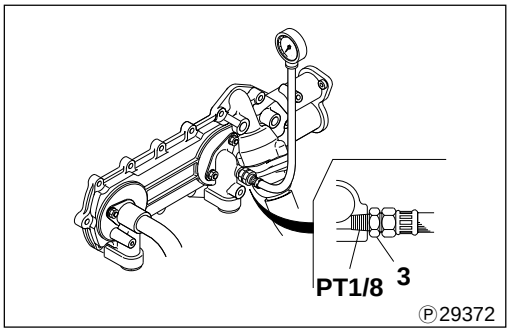
Location	Parts to be tightened	Tightening torque	Remarks
2	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11.0, 0.8 to 1.5}	Check with engine cold

Sealant

Location	Point of application	Specified sealant	Quantity
2	Threaded part of engine oil pressure switch	Teflon tape	3 and half turns



- Remove engine oil pressure switch **2** from oil cooler **1**.



- Fit adapter **3** into the engine oil pressure switch **2** mounting hole, then fit the oil pressure gauge onto the adapter.
- Warm up the engine until the oil temperature reaches 158 to 194°F (70 to 90°C).
- Measure the oil pressure at idle speed and at no-load maximum speed. If the measured values are below the specified standard values, overhaul the lubrication system.
- After taking measurements, install oil pressure switch **2** and tighten it to the specified torque.

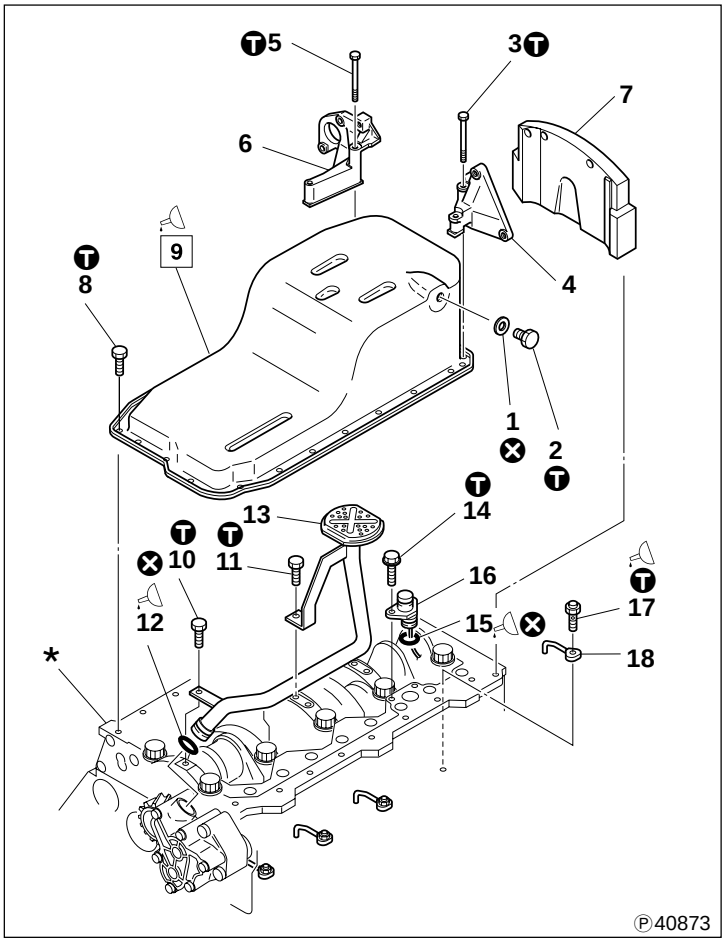
CAUTION ⚠

Oil pressure switch 2 must be fitted when the engine is cold.

Inspection of oil pressure switch
Gr 54

M E M O

OIL PAN, OIL STRAINER AND OIL JET



● **Disassembly sequence**

1 Gasket
2 Oil drain plug
3 Bolt
4 Stiffner RH
5 Bolt
6 Stiffner LH
7 Rubber spacer
8 Bolt
9 Oil pan
10 Bolt
11 Bolt
12 O-ring
13 Oil strainer
14 Bolt
15 O-ring
16 Engine oil level sensor Gr 54
17 Check valve
18 Oil jet

***** : Crankcase Gr 11A
⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Do not tighten check valve 17 in excess of the specified torque. Excessive tightness can cause defective operation, resulting in damage to the engine.

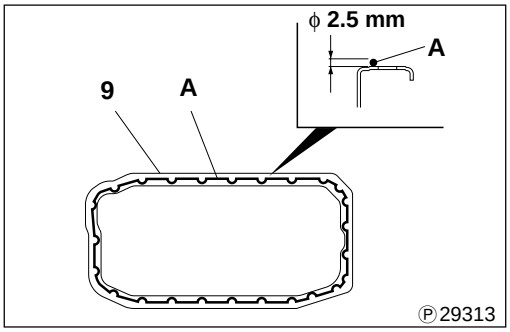
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Oil drain	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	—
3	Bolt (spacer stay RH mounting)	23.5 {17.3, 2.4}	—
5	Bolt (spacer stay LH mounting)	23.5 {17.3, 2.4}	—
8	Bolt (oil pan mounting)	23.5 {17.3, 2.4}	—
10	Bolt (oil strainer mounting)	23.5 {17.3, 2.4}	—
11	Bolt (oil strainer mounting)	23.5 {17.3, 2.4}	—
14	Bolt (engine oil level sensor mounting)	23.5 {17.3, 2.4}	—
17	Check valve	29.4 {22, 3.0}	Wet

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Crankcase mounting surface of oil pan	Threebond 1207C	As required
12, 15	Entire circumference of O-ring	Engine oil	As required
17	Threads of check valve	Engine oil	As required



◆ Service procedure

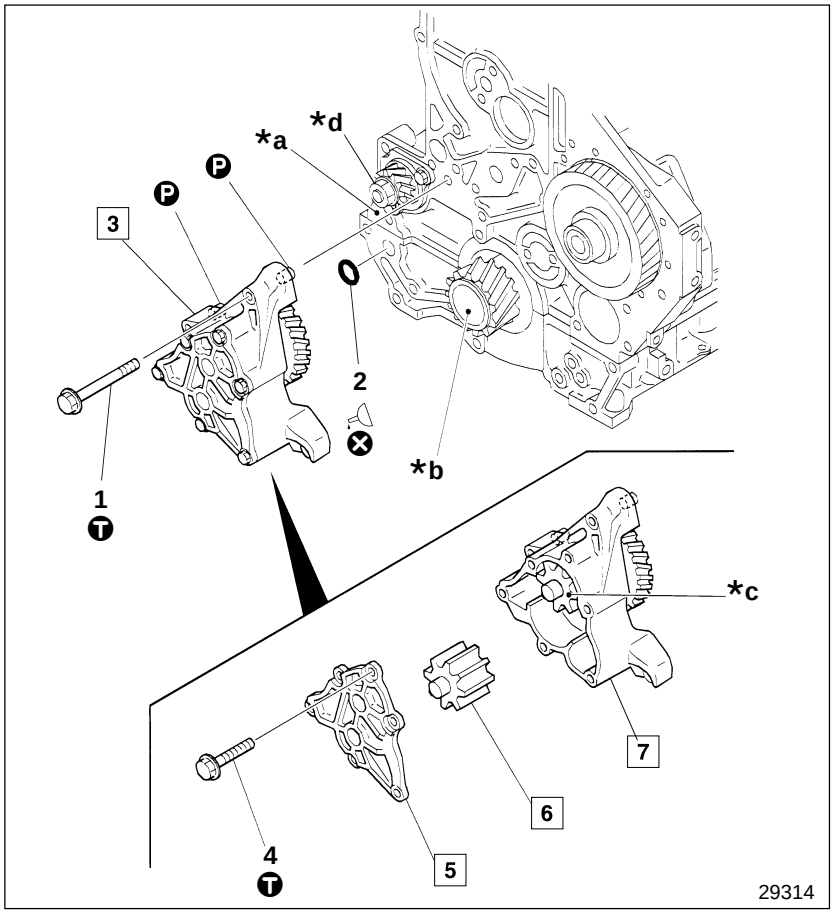
9 **Fitting oil pan**

- Apply sealant **A** to the mounting surface of oil pan **9** as illustrated. Apply the sealant evenly and without breaks.
- Within three minutes of applying sealant **A**, fit oil pan **9** onto the crankcase*.

CAUTION ⚠

- **Clean the oil pan mounting surface and ensure it is free of oily substances before applying sealant.**
- **Carefully mount oil pan exactly in the correct position. Ensure that sealant A does not spread to other areas.**
- **After fitting oil pan 9, wait at least one hour before starting the engine.**
- **Reapply sealant A to the oil pan mounting surface whenever the mounting bolts 8 of oil pan 9 have been loosened.**

OIL PUMP



● **Disassembly sequence**

1 Bolt
2 O-ring
3 Oil pump assembly
4 Bolt
5 Oil pump cover
6 Driven gear assembly
7 Oil pump case assembly

***a :** Crankcase Gr 11A
***b :** Crankshaft gear
***c :** Drive gear
***d :** Balanceshaft gear RH
P : Locating pin (Bushing)
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in[ ])	Limit	Remedy
—	Backlash between oil pump gear and crankshaft gear Gr 11A	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	Replace
—	Backlash between oil pump gear and balanceshaft gear Gr 11A	0.19 to 0.22 {0.0075 to 0.0087}	0.3 {0.012}	Replace
5, 6, 7	Clearance between gear shaft and oil pump case and cover	[20 {0.79}] 0.04 to 0.075 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
5, *C	Clearance between gear shaft and oil pump cover	[20 {0.79}] 0.04 to 0.075 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
6, 7, *C	Difference between height of each gear and depth of oil pump case	0.040 to 0.094 {0.0016 to 0.0035}	0.15 {0.0059}	Replace
	Clearance between tooth tips of each gear and oil pump case	0.13 to 0.22 {0.0051 to 0.0087}	0.23 {0.0091}	Replace

T Tightening torques

Unit: N·m {ft.lbs, kgf·m}

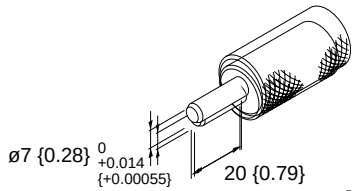
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (oil pump assembly mounting)	27.4 {20, 2.8}	—
4	Bolt (oil pump cover mounting)	8.2±2.46 {5.8±1.8, 0.8±0.25}	—

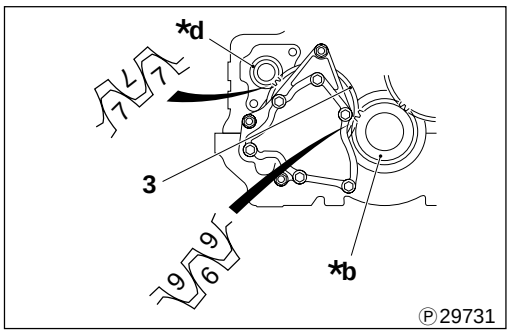
Sealant

Location	Points of application	Specified sealant	Quantity
—	Oil pump gears	Engine oil	As required
2	Entire circumference of O-ring	Engine oil	As required

Special tools

Unit: mm {in.}

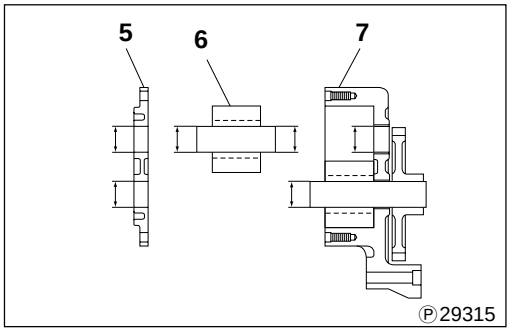
Location	Tool name and shape	Part No.	Application
5	Pump Cover Pin 	MH063431 (Obtain Locally)	Oil pump cover installation



◆ Service procedure

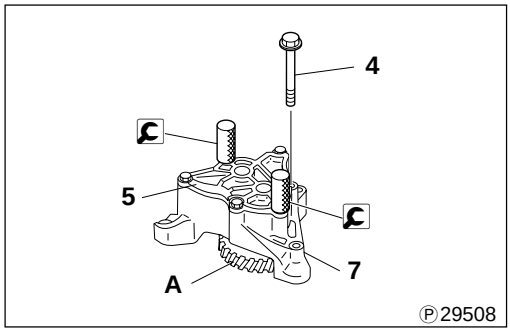
3 Installation of oil pump assembly

- With No. 1 cylinder set at its top dead center, position crankshaft gear ***b**.
- Install oil pump assembly **3** while meshing its gear with crankshaft gear ***b** and balance shaft gear RH ***d** at the match marks "**6**" and "**7**" as shown.



5 to 7 Inspection of oil pump cover, driven gear assembly and oil pump case assembly

Measure the clearance between each gear shaft and oil pump case assembly **7** or cover **5**. Replace the oil pump assembly if any measurement is out of specification.

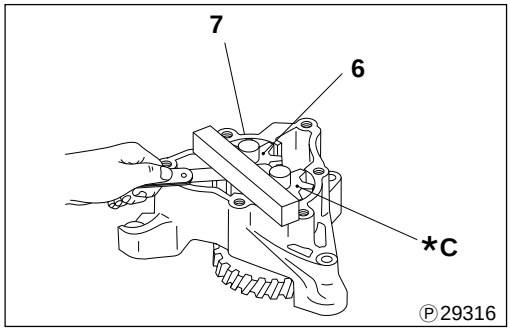


5 **7** **Installation of oil pump cover and oil pump case assembly**

- Position oil pump cover **5** on oil pump case assembly **7** using two 🔧 Pump Cover Pins.
- Fit bolt **4** and tighten it to the specified torque.
- Remove 🔧 Pump Cover Pins, then fit other bolts **4** and tighten them to the specified torque.

CAUTION ⚠

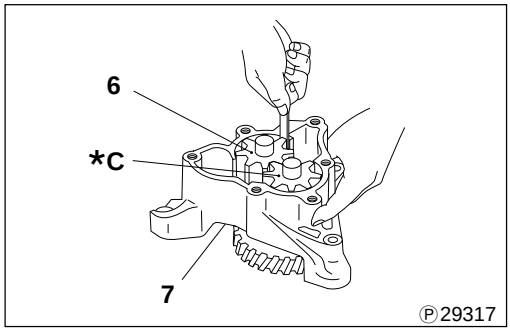
- **Before assembly, apply engine oil to various parts. Pour approximately 5 cm³ {0.3 Cu.in.} of engine oil into the assembly from the oil outlet before installing to the engine.**
- **After assembly, turn the oil pump gear A by hand and check that it rotates smoothly. If the gear does not rotate smoothly, disassemble and reassemble the components.**



6 **7** **Inspection of driven gear assembly and oil pump case assembly**

(1) Differences between gear heights and oil pump case depth

Replace the oil pump assembly if the measurement is out of specification.

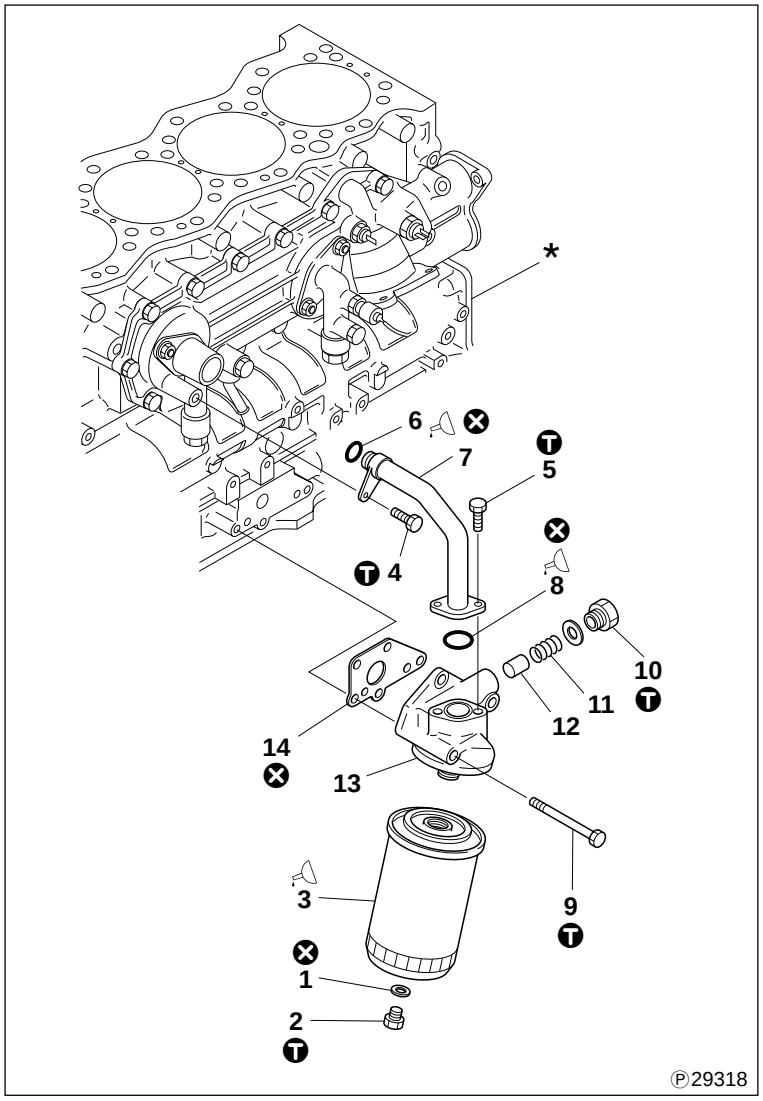


(2) Clearance between gear teeth tip and oil pump case

Replace the oil pump assembly if the measurement is out of specification.

M E M O

OIL FILTER



● **Disassembly sequence**

1 Gasket
2 Oil drain plug
3 Oil filter 📖 P12A-14
4 Bolt
5 Bolt
6 O-ring
7 Oil pipe
8 O-ring
9 Bolt
10 Plug
11 Spring
12 Regulator valve
13 Oil filter head
14 Gasket

***** : Crankcase 📖 Gr 11A
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

CAUTION ⚠

- **When pouring oil into the engine, take care not to spill any on the V-ribbed belts. Contact with oil could make the V-ribbed belts slip, rendering the cooling system less effective.**
- **Install gasket 14 in the correct direction. If installed in wrong direction, it blocks oil hole.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
12	Regulator valve opening pressure	$600\ ^{+100}_{0}$ kPa {$85\ ^{+14.2}_{0}$ psi, $6\ ^{+1}_{0}$ kgf/cm^2}	—	Replace spring

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

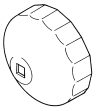
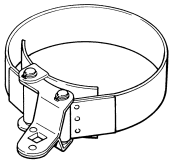
Location	Parts to be tightened	Tightening torque	Remarks
2	Oil drain plug	9.8±1.96 {7.2±1.4, 1.0±0.2}	—
4	Bolt (Oil pipe mounting)	9.8 {7.2, 1.0}	—
5	Bolt (Oil pipe mounting)	23.5 {17, 2.4}	—
9	Bolt (Oil filter head mounting)	44.1 {33, 4.5}	—
10	Plug (Regulator valve mounting)	60 {43, 6.0}	—

Lubricant

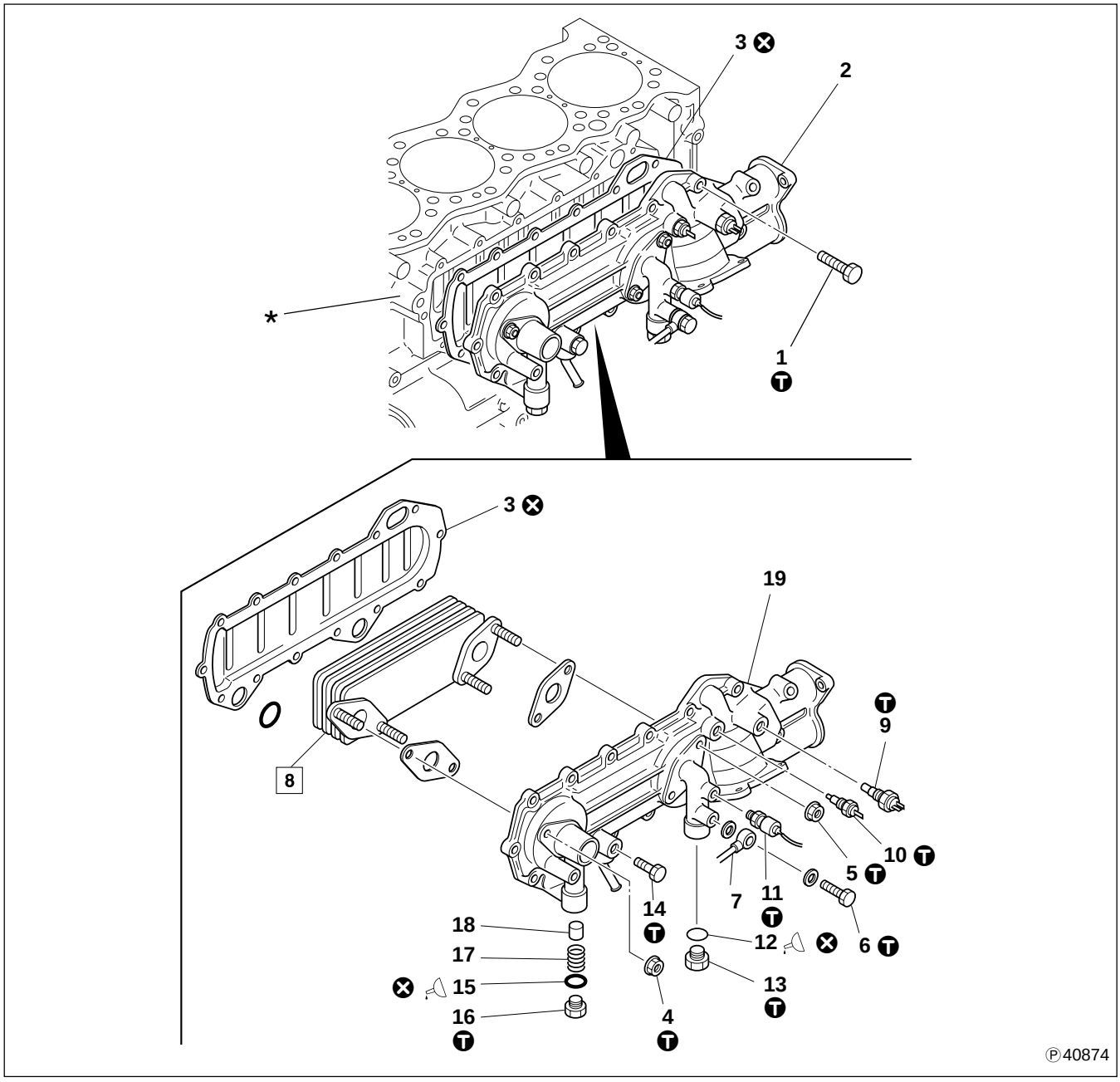
Location	Points of application	Specified lubricant	Quantity
3	Gasket of oil filter	Engine oil	As required
6, 8	Entire circumference of O-ring	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
3	Oil Filter Element Socket  08550	Obtain Locally	Oil filter removal
	Filter Wrench  ø107 to 120 {4.21 to 4.72} 01503	Obtain Locally	

OIL COOLER



● **Disassembly sequence**

1 Bolt
2 Oil cooler assembly
3 Gasket
4 Nut
5 Nut
6 Eyebolt
7 Oil pipe
8 Oil cooler element
9 Coolant temperature sensor (for engine control)
Gr 54
10 Coolant temperature sensor (for MUTIC)
Gr 54
11 Engine oil pressure switch
Gr 54
12 O-ring
13 Plug
14 Water drain valve
15 O-ring
16 Plug
17 Spring
18 Bypass valve
19 Oil cooler body

***** : Crankcase Gr 11A
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
8	Oil cooler element air leakage (air pressure of 980 kPa {140 psi, 10 kgf/cm^2} for 15 seconds)	0 cm^3 {0 Cu.in.}	—	Replace
18	Bypass valve opening pressure	390 kPa {57 psi, 4 kgf/cm^2}	—	Replace spring

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Oil cooler assembly mounting)	23.5 {17, 2.4}	—
4	Nut (Oil cooler element mounting)	24.5±5 {18±3.6, 2.5±0.5}	—
5	Nut (Oil cooler element mounting)	24.5±5 {18±3.6, 2.5±0.5}	—
6	Eyebolt (Oil pipe mounting)	21.6 {16, 2.2}	—
9	Coolant temperature sensor	34.3 {25, 3.5}	—
10	Coolant temperature sensor	34.3 {25, 3.5}	—
11	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11.0, 0.8 to 1.5}	—
13	Plug	34.5±5 {25±3.6, 3.5±0.5}	—
14	Water drain valve	19.5 to 29.5 {14 to 22, 2.0 to 3.0}	—
16	Plug	34.3±4.9 {25±3.6, 3.5±0.5}	—

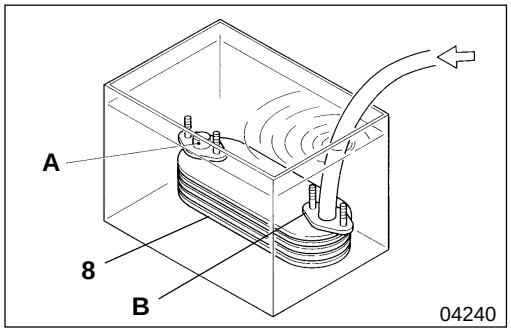
Lubricant

Location	Points of application	Specified lubricant	Quantity
12, 15	Entire circumference of O-ring	Engine oil	As required

◆ Service procedure

● Cleaning

- Check whether carbon deposits or sludge have accumulated in the oil passage of oil cooler element **8** or in the oil cooler's bypass arrangement. Remove any deposits with cleaning solvent.
- Clean out any water scale or deposits that have accumulated in the oil cooler element **8** or oil cooler body **19**.



8 **Inspection of oil cooler element**

- Plug outlet **A** of oil cooler element **8** and connect a hose to the oil inlet **B**. Then, immerse the oil cooler element in a tank of water.
- Apply an air pressure of 980 kPa {140 psi, 10 kgf/cm^2} via the hose and check that no air leaks from the oil cooler element **8**.
- If any air leaks, replace the oil cooler element **8**.

MITSUBISHI
FUSO

Group 12B
Lubrication

< 4D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-12B

INDEX

SPECIFICATIONS 12B- 2

STRUCTURE AND OPERATION 12B- 3

TROUBLESHOOTING 12B-10

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

- **Replacement of Oil Filter 12B-11**
- **Replacement of Engine Oil 12B-12**
- **Measurement of Oil Pressure 12B-13**

OIL PAN, OIL STRAINER AND OIL JET 12B-14

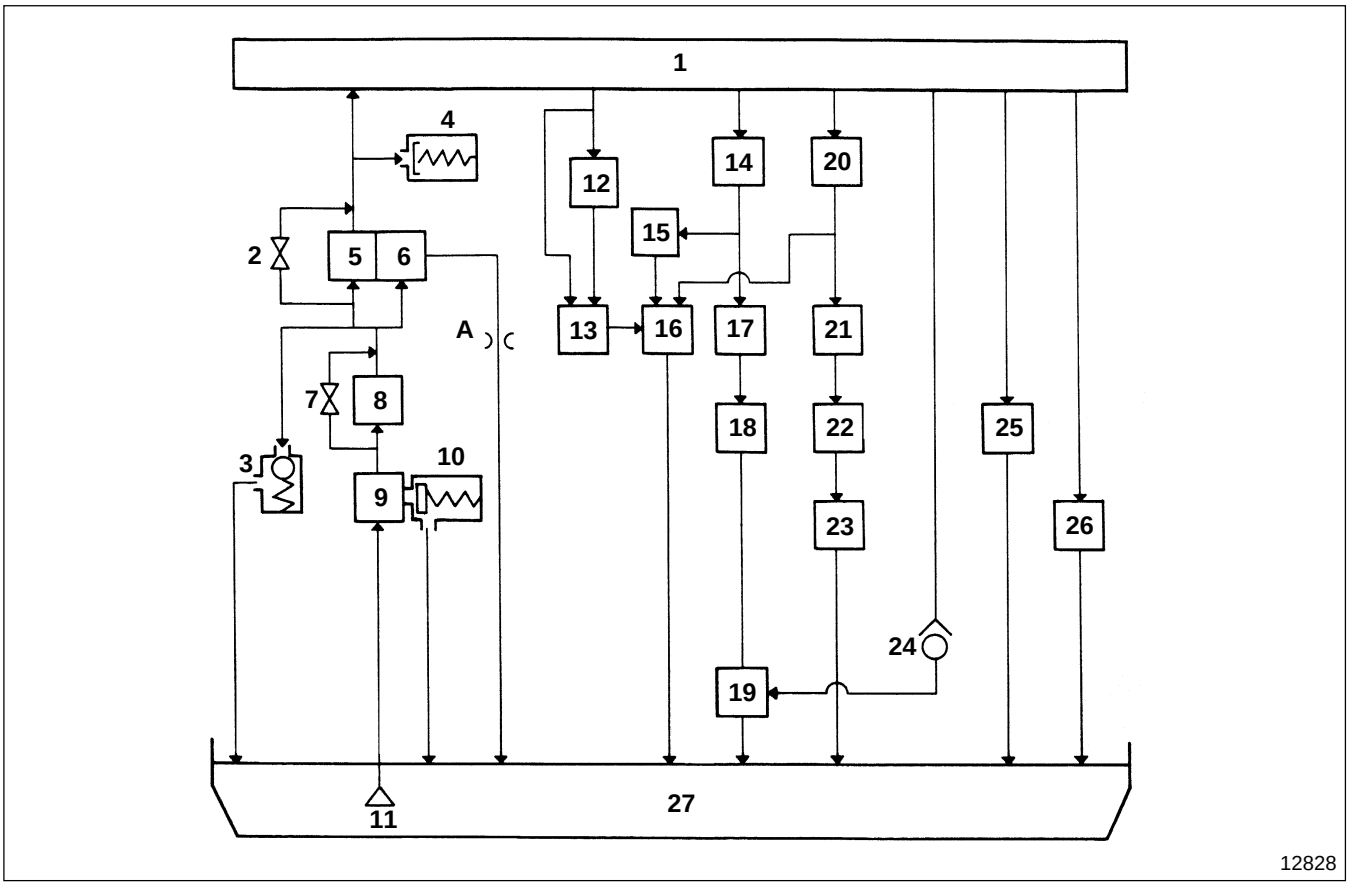
OIL PUMP 12B-16

OIL COOLER AND OIL FILTER 12B-20

SPECIFICATIONS

Item			Specifications
Mode of lubrication			Oil pump type
Oil filter type			Spin-on filter paper type
Oil cooler type			Shell and plate type (Multiple-plate type)
Engine oil	Grade		Grade CD or above as per API classification
	Quantity of oil L {qts}	Oil pan	Approximately 8 {8.5}
		Oil filter	Approximately 1 {1.1}

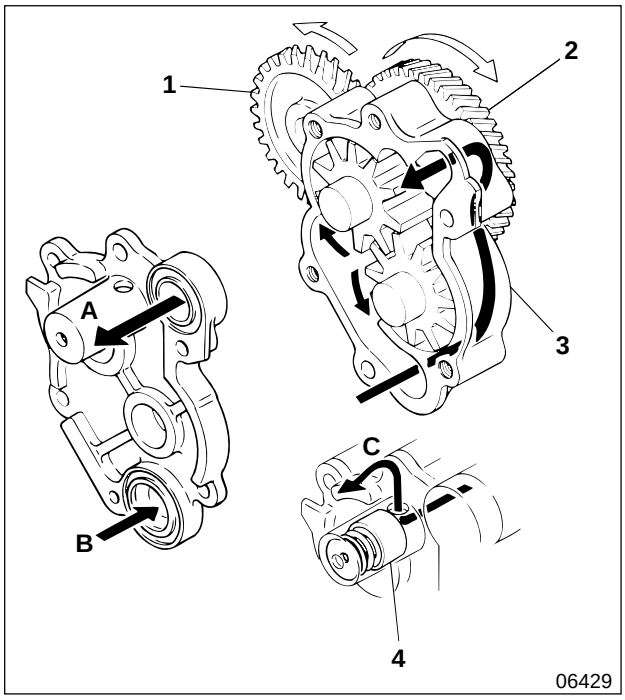
Lubrication System (Flow of Oil)



1 Main oil gallery
2 Bypass valve (Built-in within oil filter)
3 Regulator valve
4 Engine oil pressure switch
5 Full-flow filter element
6 Bypass filter element
7 Bypass valve
8 Oil cooler
9 Oil pump
10 Relief valve (Built-in within oil pump)
11 Oil strainer
12 Injection pump
13 Injection pump gear
14 Crankshaft main bearing
15 Idler bushing
16 Timing gear
17 Connecting rod bearing
18 Connecting rod bushing
19 Piston
20 Camshaft bushing
21 Rocker bushing
22 Push rod
23 Tappet
24 Check valve for oil jet
25 Turbocharger
26 Vacuum pump
27 Oil pan

A : Orifice

Oil Pump

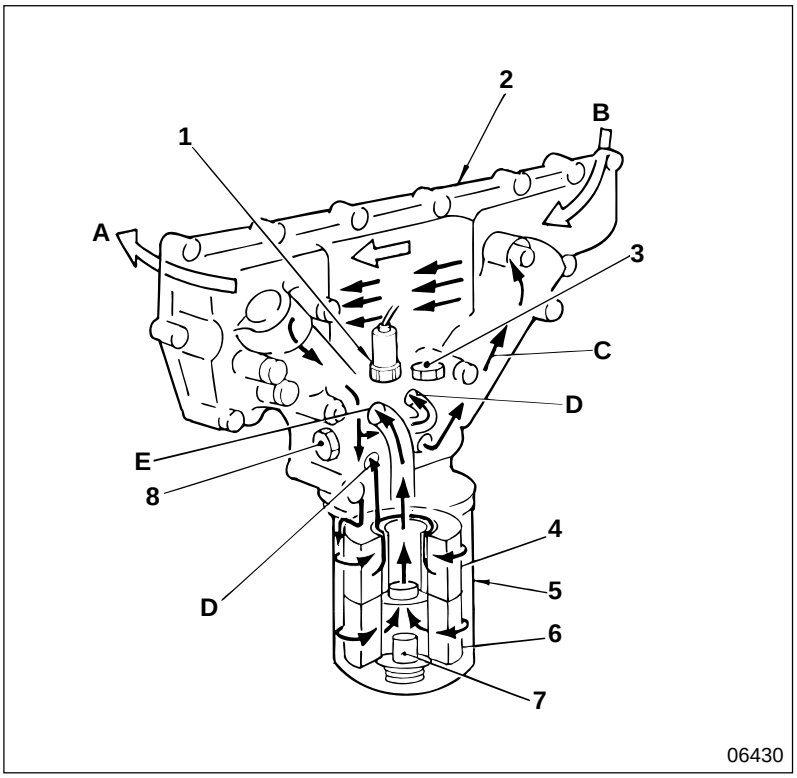


1 Crankshaft gear
2 Oil pump gear
3 Oil pump
4 Relief valve

A : To oil cooler
B : From oil strainer
C : To oil pan

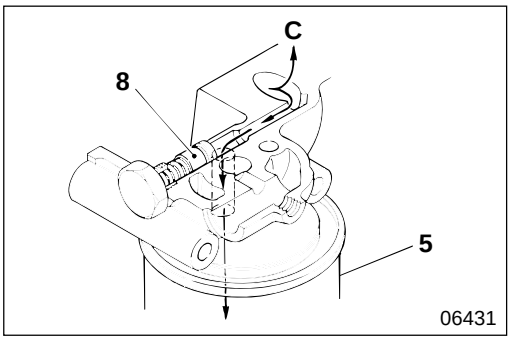
Oil pump **3** is a gear type, driven by rotation of the crankshaft transmitted by crankshaft gear **1** that engages oil pump gear **2**. Relief valve **4** is installed on the oil pump and when the oil pump discharge pressure becomes higher than the standard pressure level, part of the engine oil is returned to the oil pan by relief action of the valve, protecting the lubricating system from damage caused by excessive oil pressure.

Oil Cooler and Oil Filter



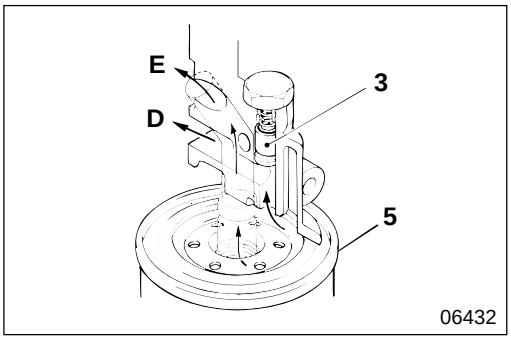
1 Engine oil pressure switch
2 Oil cooler
3 Regulator valve
4 Bypass filter element
5 Oil filter
6 Full-flow filter element
7 Bypass valve
8 Bypass valve

A : Coolant exit port
B : Coolant entry port
C : To oil cooler
D : To oil pan
E : To main oil gallery



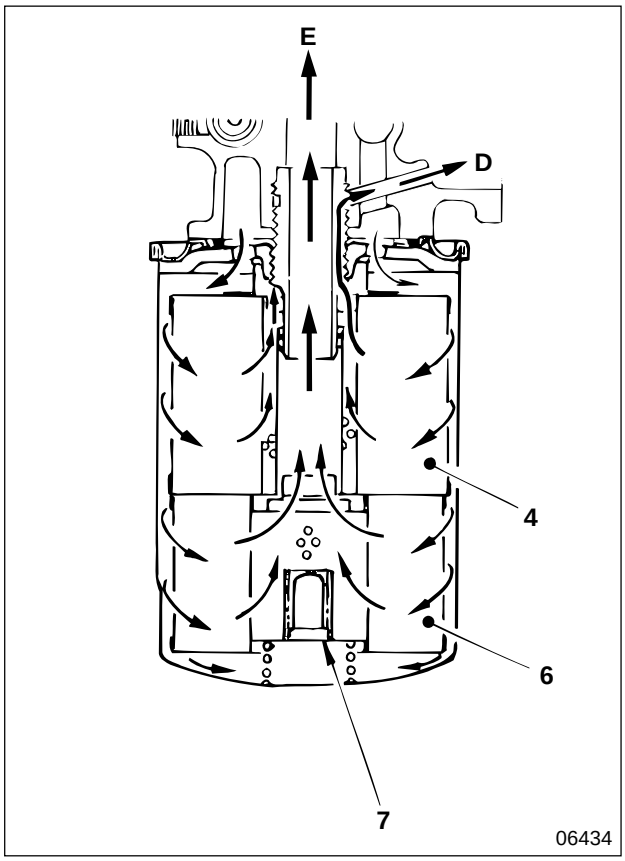
● **Operation of bypass valve**

When the viscosity of the engine oil is high at low temperatures, or when oil cooler **2** element is clogged, flow resistance is high, and if this happens, bypass valve **8** opens to let the engine oil return directly to oil filter **5** without going through the oil cooler.



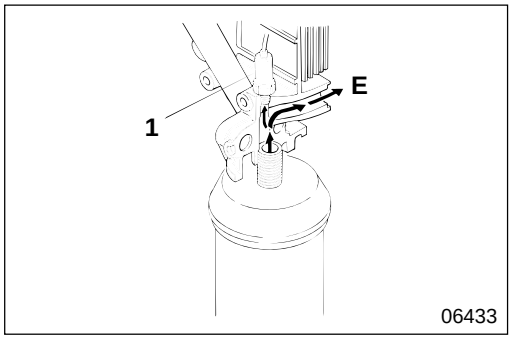
● **Operation of regulator valve**

When the oil pressure in the main oil gallery becomes higher than standard, regulator valve **3** opens to let part of the oil return to oil pan **D**, thereby regulating the oil pressure.



● **Oil filter element**

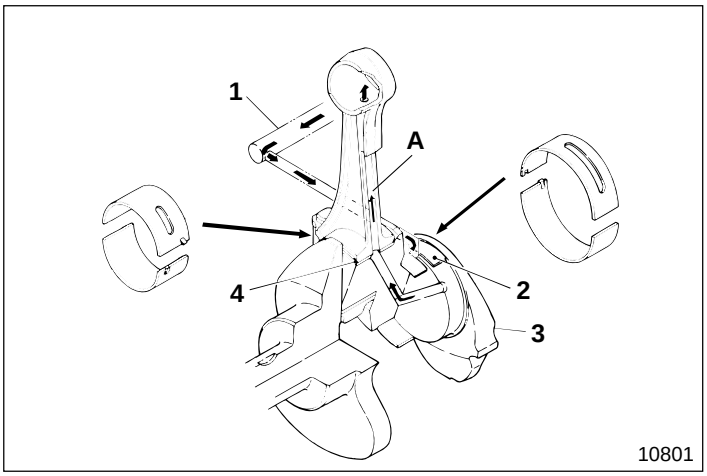
This oil filter uses a spin-on, filter paper type element, that integrates full-flow filter element **6** and bypass filter element **4**. When the filter element is clogged, bypass valve **7**, installed at the base of the filter, opens to let the oil bypass the element and flow directly to main oil gallery **E**, preventing engine seizure.



● **Operation of engine oil pressure switch**

When oil pressure to main oil gallery **E** becomes lower than standard, the built-in electric contact point of engine oil pressure switch **1** closes to light the warning lamp in the meter cluster, warning the driver that the oil pressure is abnormal.

Lubrication of Related Parts



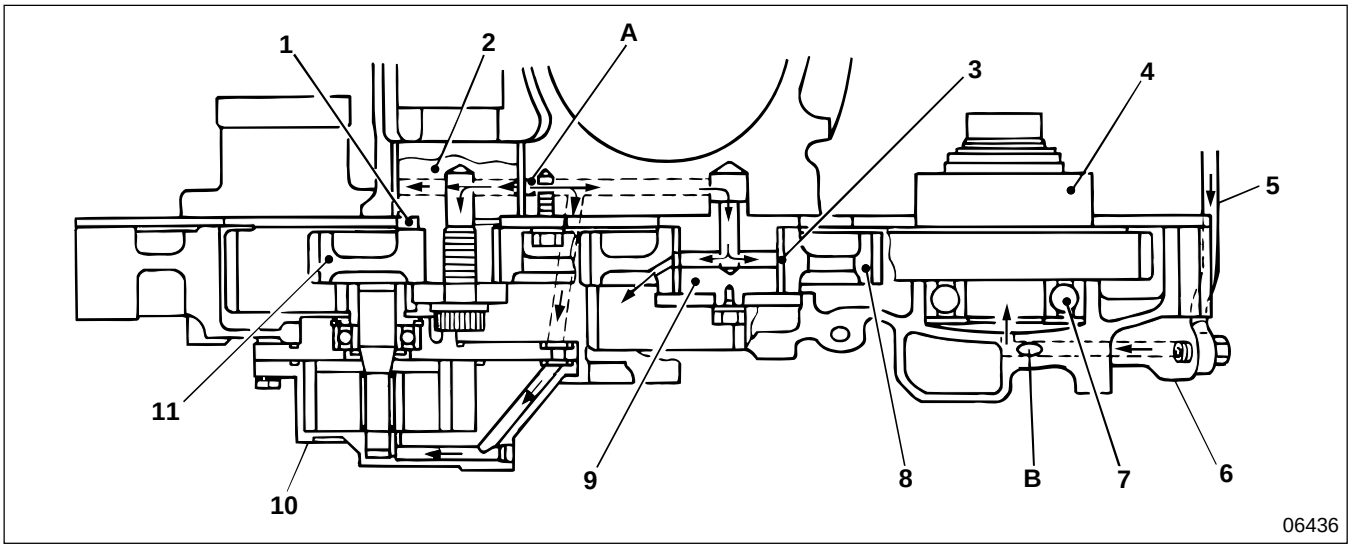
● **Main bearing and connecting rod bearing**

1 Main oil gallery
2 Main bearing
3 Crankshaft
4 Connecting rod bearing

A : Connecting rod oil passage

Engine oil supplied through the oil passage drilled in the crankshaft flows through connecting rod oil passage **A** to lubricate the small end of the connecting rod.

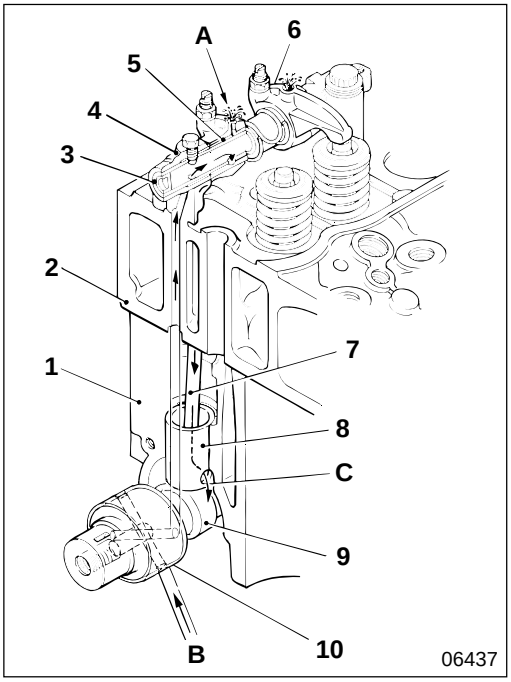
● **Timing gear**



1 Thrust plate
2 Camshaft
3 Idler gear bushing
4 Injection pump gear
5 Oil pipe
6 Timing gear case
7 Bearing
8 Idler gear
9 Idler shaft
10 Vacuum pump
11 Camshaft gear

A : From main oil gallery
B : Oil jet (for forced lubrication of automatic timer)

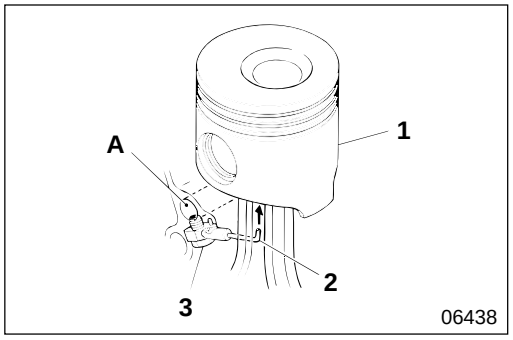
Engine oil from main oil gallery **A** flows through the inside of camshaft **2** and idler shaft **9** and lubricates each gear along the way including vacuum pump **10**.



● **Valve mechanism**

1 Crankcase
2 Cylinder head
3 Rocker shaft
4 Rocker shaft bracket
5 Rocker bushing
6 Rocker
7 Push rod
8 Tappet
9 Camshaft
10 No. 1 camshaft bushing

A : Rocker oil hole
B : From main oil gallery
C : To oil pan

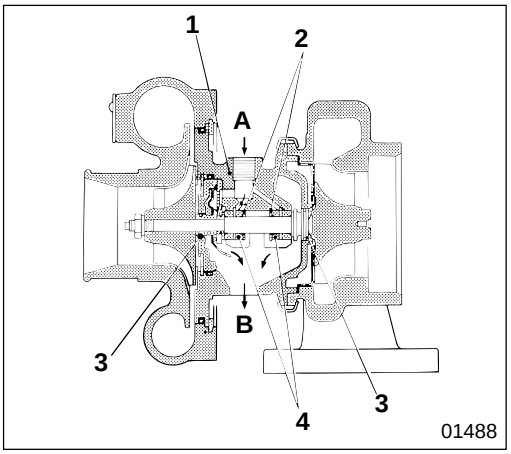


● **Oil jet**

1 Piston
2 Oil jet
3 Check valve

A : Main oil gallery

An oil jet **2** is installed, in the lower part of main oil gallery **A**, for each cylinder and cools piston **1** by injecting engine oil toward the inside of the piston. The oil jet is fitted with check valve 3 which operates at specific oil pressure levels. This check valve remains closed at low engine speed to ensure sufficient oil supply to internal engine parts and to prevent the oil pressure from decreasing.

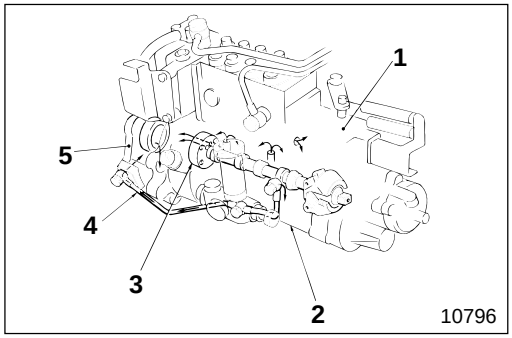


● **Turbocharger**

1 Bearing housing
2 Snap ring
3 Sealing ring
4 Bearing

A : From main oil gallery
B : To oil pan

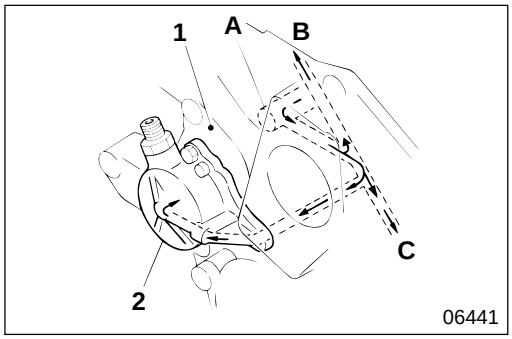
Engine oil is delivered from the main oil gallery to bearing housing **1** through the oil pipe to lubricate bearing **4**. Sealing ring **3** installed at both ends of the turbine wheel shaft works as an oil seal.



● **Injection pump**

1 Governor
2 Injection pump
3 Bearing cover
4 Oil pipe
5 Timing gear case

Engine oil that has lubricated injection pump **2** and governor **1** returns to the oil pan through the oil passage of bearing cover **3**.



● **Vacuum pump**

1 Timing gear case
2 Vacuum pump

A : Main oil gallery
B : To camshaft
C : To crankshaft

Engine oil is delivered from main oil gallery **A** to vacuum pump **2** through the oil passage of timing gear case **1** to lubricate the vanes. Then, the oil is discharged to the timing gear case returning to the oil pan.

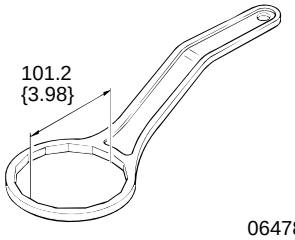
TROUBLESHOOTING

Possible causes / Symptoms		Engine hard to start	Overheating	Oil pressure low	Oil consumption excessive (Oil leakage)	Remarks
Oil cooler	Oil cooler element installation faulty		○	○	○	
	Gasket faulty		○	○	○	
	O-ring faulty		○	○	○	
	Oil cooler element clogged		○	○		
	Oil cooler element damaged		○	○	○	
	Bypass valve spring fatigued		○			
	Regulator valve spring fatigued			○		
Oil pump	Malfunctioning		○	○		
	Oil pump gear interfering with oil pump case or cover	○		○		
	Relief valve spring fatigued			○		
Oil filter	Installation faulty				○	
	Element clogged		○	○		
	Gasket faulty			○		
Oil strainer installation faulty or clogged			○	○		
Crankshaft front oil seal faulty					○	Gr 11B
Crankshaft rear oil seal faulty					○	Gr 11B
Timing gear case installation faulty					○	Gr 11B
Oil jet for piston cooling faulty			○			
Oil working its way up into combustion chamber					○	
Oil working its way down into combustion chamber					○	
Oil viscosity too high		○				
Oil quality unsuitable			○			
Oil deteriorated			○			
Fuel mixed with oil			○			

Replacement of Oil Filter

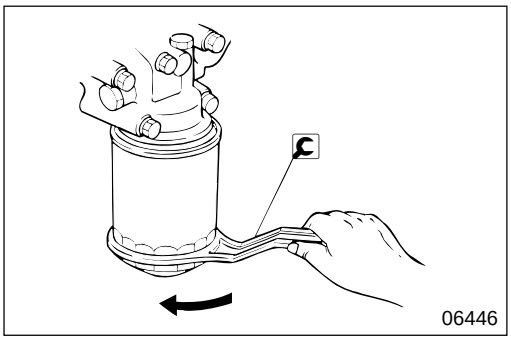
Special tools

Unit : mm {in.}

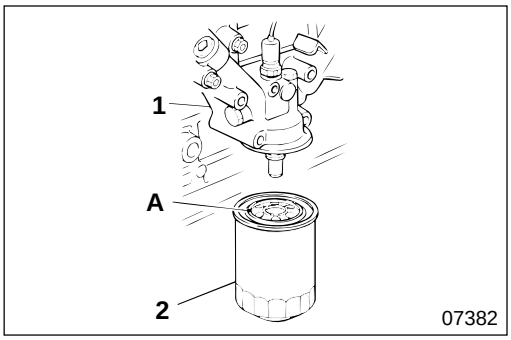
Location	Tool name and shape	Part No.	Application
2	Oil filter wrench  06478	MH061587 (Obtain Locally)	Removal of oil filter

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**
- **When replacing oil filter 2, take care not to spill oil on the V-belt.**



[Removal]



[Installation]

- Clean the surface of oil cooler body **1** that makes contact with oil filter **2**.
- Apply engine oil thinly and evenly to gasket area **A** of oil filter **2**.
- Screw on oil filter **2** to oil cooler body **1** until gasket area **A** sits on the body. From this position, tighten further by rotating by three quarters of a turn.
- After installation, run the engine and check that there is no oil leakage from gasket area **A**.
- Check the oil level and if it is low, fill to correct level.

Replacement of Engine Oil

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

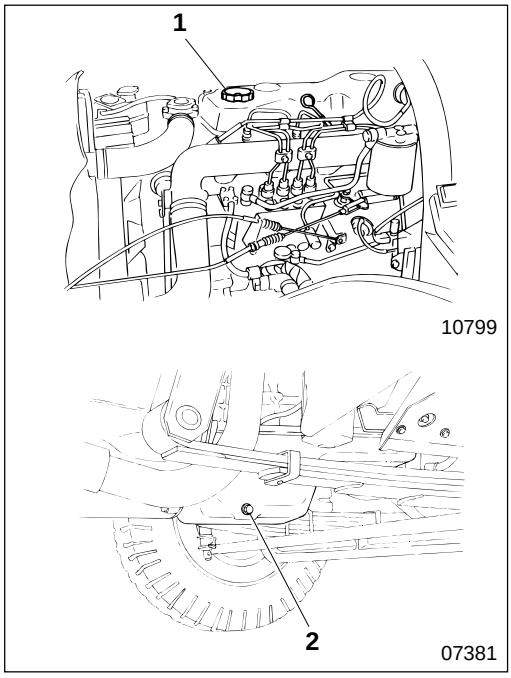
Location	Parts to be tightened	Tightening torque	Remarks
2	Oil drain plug	34 to 39 {25 to 29, 3.5 to 4.0}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	Oil pan	Engine oil (Grade CD or above as per API Classification)	Approximately 8 L {8.5 qts}
—	Oil filter	Engine oil (Grade CD or above as per API Classification)	Approximately 1 L {1.1 qts}

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**
- **When replacing oil, take care not to spill oil on the V-belt.**



[Draining]
After warming-up the engine, remove oil filler cap **1** and remove drain plug **2** of the oil pan and drain the engine oil.

[Refilling]
Tighten drain plug **2** of the oil pan at specified torque and fill with the specified quantity of engine oil.

Measurement of Oil Pressure

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Oil pressure (Oil temperature 70 to 90°C {158 to 194°F})	At no-load minimum revolution	145 kPa {21 psi, 1.5 kgf/cm²}	49 kPa {7.1 psi, 0.5 kgf/cm²}	Inspect
		At no-load maximum revolution	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm²}	195 kPa {28 psi, 2 kgf/cm²}	

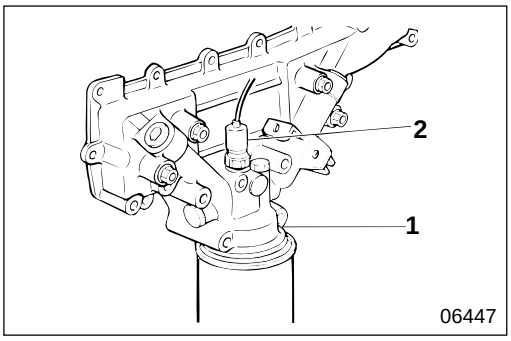
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

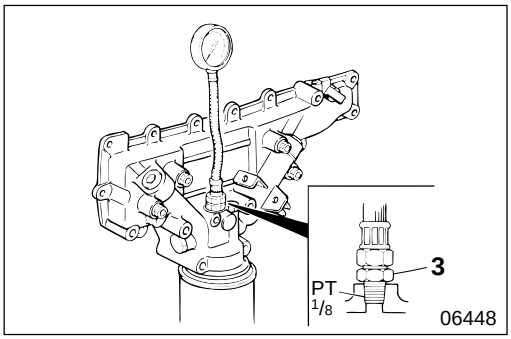
Location	Parts to be tightened	Tightening torque	Remarks
2	Engine oil pressure switch	7.8 to 15 {5.8 to 11, 0.8 to 1.5}	When engine is cold

Sealant

Location	Points of application	Kinds	Quantity
2	Thread area of engine oil pressure switch	Teflon tape	3 1/2 turns



- Remove engine oil pressure switch **2** from oil cooler **1**.
- Mount the oil pressure gauge after installing adaptor **3** onto oil cooler **1**.
- Warm up the engine until the oil temperature reaches 70 to 90°C {158 to 194°F}.
- Measure oil pressure at no-load minimum revolution and at no-load maximum revolution. If the measured values are lower than the limit, overhaul the lubricating system.



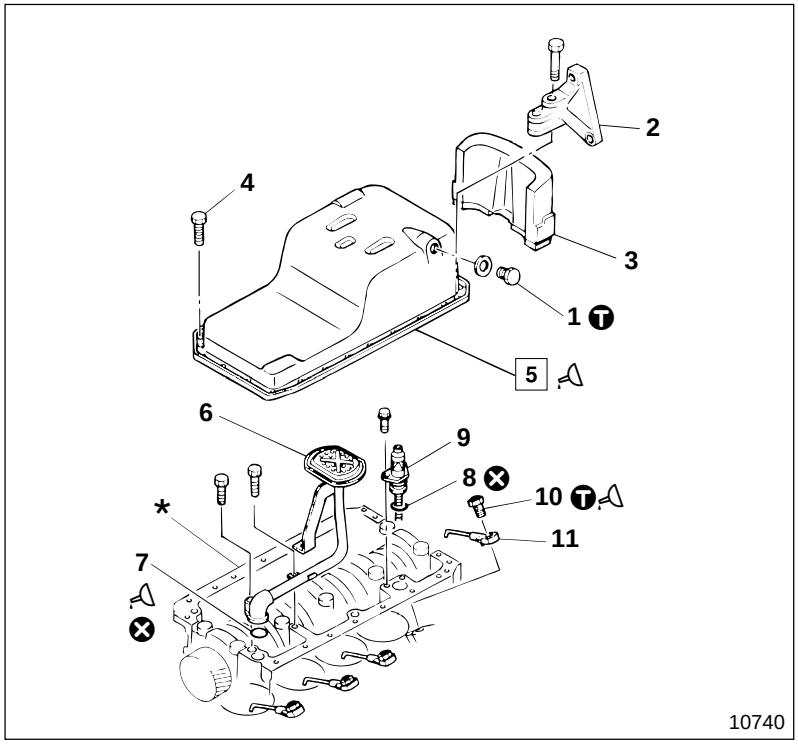
- After measurement, install engine oil pressure switch **2** and tighten at specified torque.

CAUTION

Make sure you install engine oil pressure switch 2 when the engine is cold.

Inspection of engine oil pressure switch
Gr 54

OIL PAN, OIL STRAINER AND OIL JET



● **Disassembly sequence**

1 Drain plug
2 Stiffener
3 Rubber spacer
4 Bolt
5 Oil pan
6 Oil strainer
7 O-ring
8 O-ring
9 Engine oil level sensor Gr 54
10 Check valve
11 Oil jet

* : Crankcase
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

Make sure that you do not tighten check valve 10 higher than the specified torque. Overtightening will cause damage to the check valve, resulting in serious overheating damage to the engine.

T Tightening torque

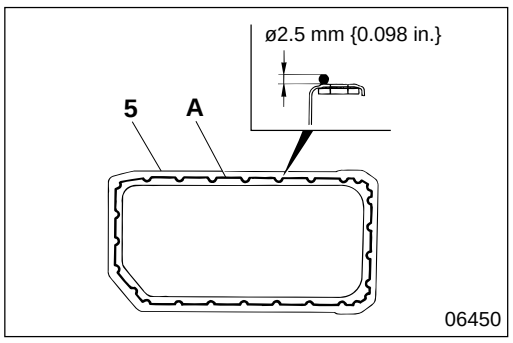
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	34 to 39 {25 to 29, 3.5 to 4.0}	—
10	Check valve	29 {22, 3}	Wet

Lubricant and sealant

Location	Points of application	Kinds	Quantity
5	Oil pan to crankcase connecting surface	THREEBOND 1207C	As required
7	Body of O-ring	Engine oil	As required
10	Thread area of check valve	Engine oil	As required

◆ Service procedure



5 **Installation of oil pan**

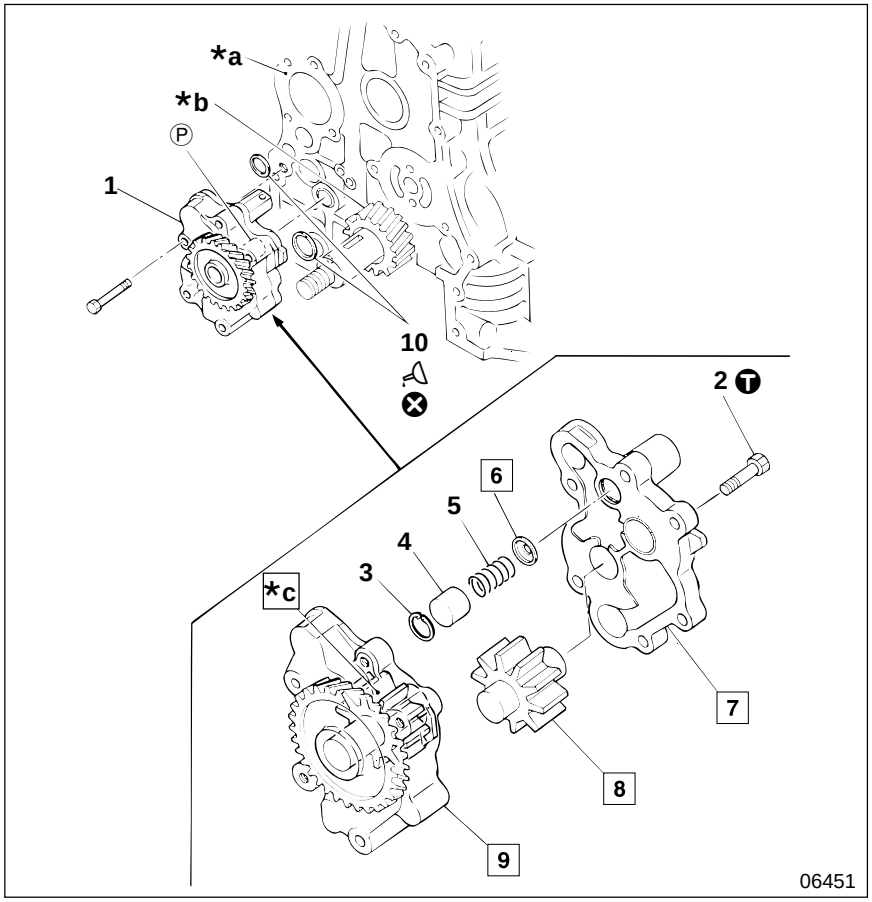
- Apply sealant **A** to lower connecting surface of oil pan **5** as illustrated evenly without break.
- After applying sealant **A**, within three minutes, mount oil pan **5** to crankcase *.

CAUTION

- **Be sure to clean and wipe off oily substances from the surface where sealant A is to be applied.**
- **Make sure that sealant A is not transferred to other areas while the mounting work is being done.**
- **Do not start the engine within an hour of mounting oil pan 5.**
- **Be sure to reapply sealant A if bolts 4 (for mounting oil pan 5) are loosened or removed by any cause whatsoever after mounting.**

M E M O

OIL PUMP



● **Disassembly sequence**

1 Oil pump assembly
2 Bolt
3 Snap ring
4 Relief valve
5 Spring
6 Seat
7 Oil pump cover
8 Driven gear assembly
9 Oil pump case assembly
10 O-ring

***a** : Crankcase Gr 11B
***b** : Crankshaft gear
***c** : Drive gear

Ⓟ : Positioning pin (Bushing)
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
—	Backlash between oil pump gear and crankshaft gear Gr 11B	0.10 to 0.18 {0.0039 to 0.0071}	0.3 {0.012}	Replace
4	Relief valve opening pressure	1080±98 kPa {155±14 psi, 11±1.0 kgf/cm^2}	—	—
5	Relief valve spring load (Installed length : 33.4 {1.31})	215±11 N {49±2.4 lbf, 22.1±1.1 kgf}	—	Replace
7, 8, 9	Clearance between gear shaft and oil pump case and oil pump cover	[20 {0.79}] 0.04 to 0.07 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
7, *c	Clearance between gear shaft and oil pump cover	[20 {0.79}] 0.04 to 0.07 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
8, 9, *c	Difference between height of each gear and depth of oil pump case	0.01 to 0.07 {0.00039 to 0.0028}	0.18 {0.0071}	Replace
	Clearance between tooth tip of each gear and oil pump case	0.10 to 0.19 {0.0039 to 0.0075}	0.2 {0.0079}	Replace

ⓣ Tightening torque

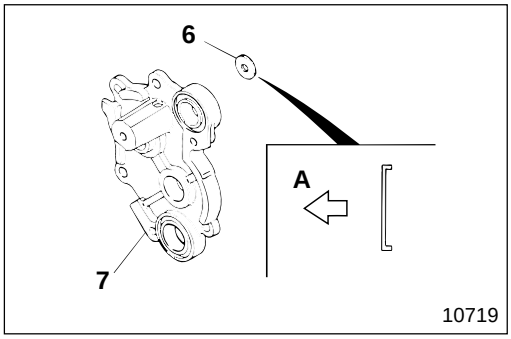
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Oil pump cover mounting)	9.8±2.0 {7.2±1.4, 1.0±0.2}	—

Lubricant

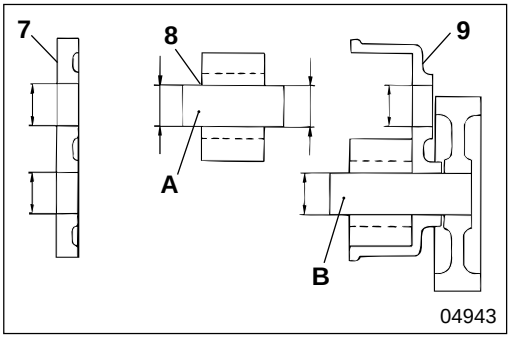
Location	Points of application	Kinds	Quantity
10	Body of O-ring	Engine oil	As required

◆ Service procedure



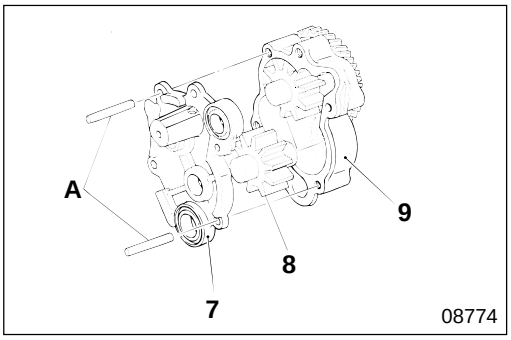
6 **Installation of seat**

A : Oil pump cover side



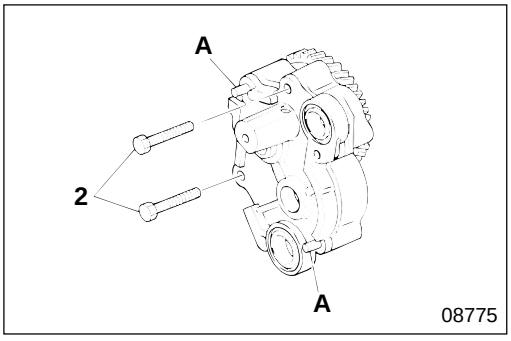
7 **to** **9** **Inspection of oil pump cover, driven gear assembly, and gear and case assembly**

- Measure the clearance between oil pump cover **7** and driven gear shaft **A**, and the clearance between oil pump gear case assembly **9** and the driven gear shaft.
  Measure the clearance between the oil pump cover and drive gear shaft **B**.
- If the measured values are higher than the limit, replace the faulty parts.

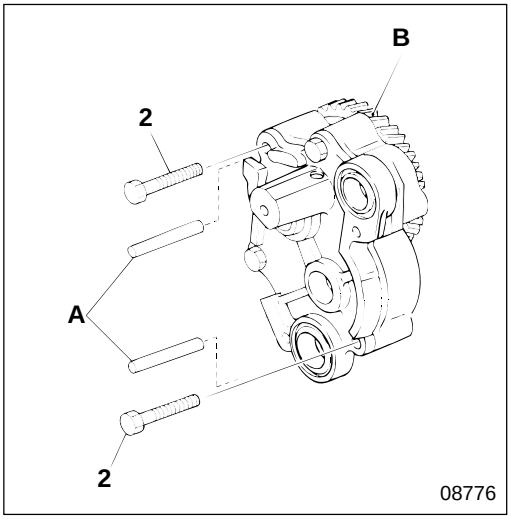


7 **9** **Installation of oil pump cover and oil pump case assembly**

- Prepare two pins **A** of 9 mm {0.35 in.} in outer diameter and position oil pump cover **7** and oil pump case assembly **9** as illustrated.



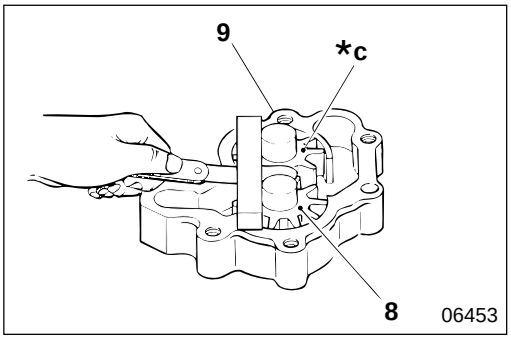
- Tighten the illustrated bolts **2** at specified torque.



- Remove pins **A**, replacing them with bolts **2** and tighten at specified torque.

NOTE

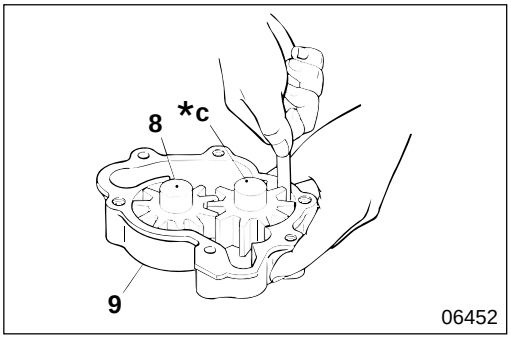
Confirm smooth movement by rotating oil pump gear B by hand. If it catches, disassemble and reassemble it.



8 9 *c Inspection of driven gear assembly, and oil pump case assembly

(1) Difference between height of each gear and depth of oil pump case

If the measured value is higher than the limit, replace the faulty parts.

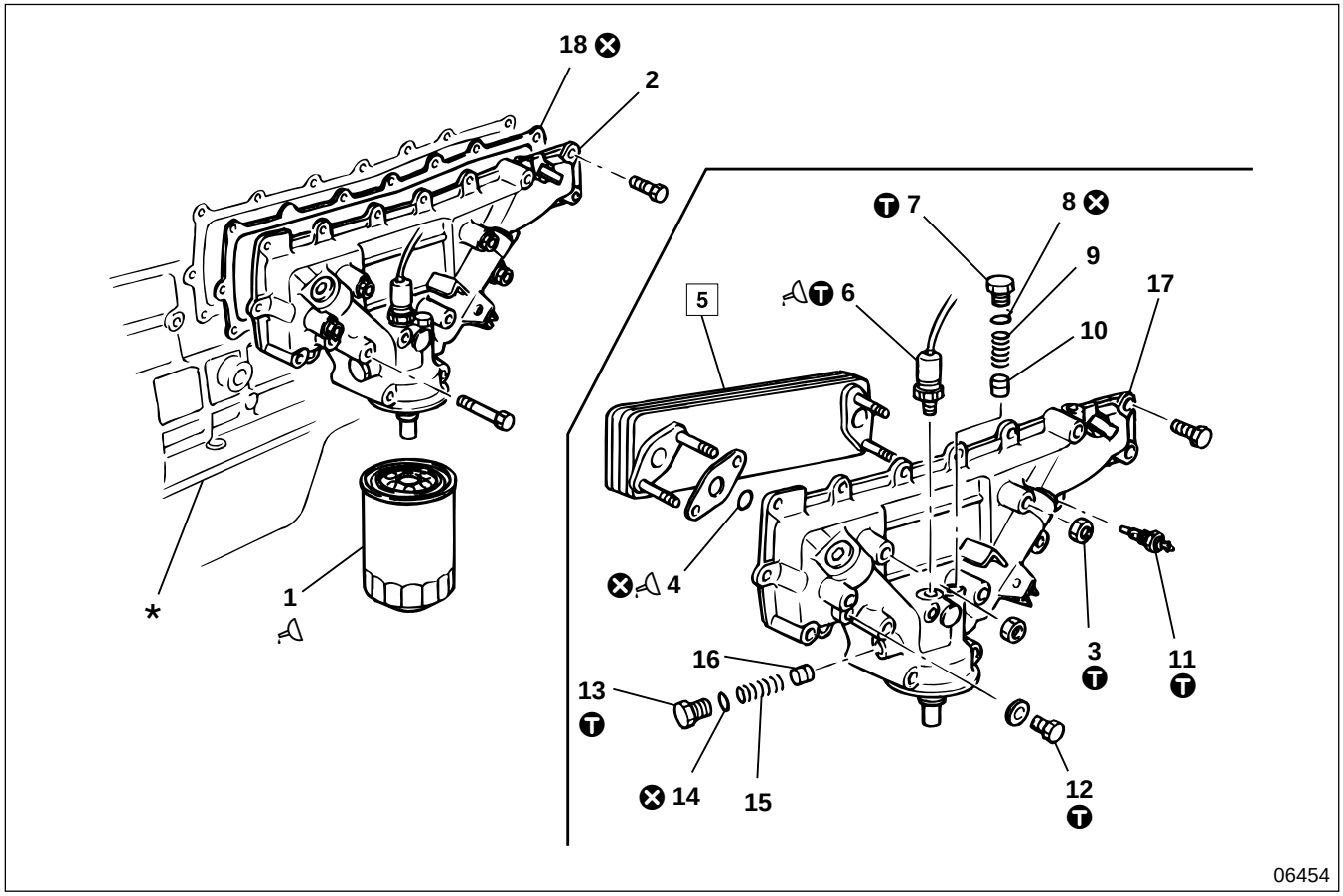


(2) Clearance between tooth tip and oil pump case

If the measured value is higher than the limit, replace the faulty parts.

M E M O

OIL COOLER AND OIL FILTER



● **Disassembly sequence**

1 Oil filter P12B-11
2 Oil cooler assembly
3 Nut
4 O-ring
5 Oil cooler element
6 Engine oil pressure switch Gr 54
7 Plug
8 O-ring
9 Spring
10 Regulator valve
11 Thermostat switch Gr 54
12 Drain plug
13 Plug
14 O-ring
15 Spring
16 Bypass valve
17 Oil cooler body
18 Gasket

* : Crankcase assembly Gr 11B
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
5	Oil cooler element air leakage (Air pressure 980 kPa {140 psi, 10 kgf/cm²}, 15 seconds)	0 cm³ {0 cu. in.}	—	Replace
10	Regulator valve opening pressure	590±29 kPa {85±4.3 psi, 6.0±0.3 kgf/cm²}	—	Replace
16	Bypass valve opening pressure	390±29 kPa {57±4.3 psi, 4.0±0.3 kgf/cm²}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (Oil cooler element mounting)	19.5±5 {14±3.6, 2.0±0.5}	—
6	Engine oil pressure switch	7.8 to 15 {5.8 to 11, 0.8 to 1.5}	—
7	Plug (Regulator valve spring mounting)	19.5±5 {14±3.6, 2.0±0.5}	—
11	Thermostat switch	34±5 {25±3.6, 3.5±0.5}	—
12	Drain plug (Oil cooler)	34 {25, 3.5}	—
13	Plug (Bypass valve spring mounting)	19.5±5 {14±3.6, 2.0±0.5}	—

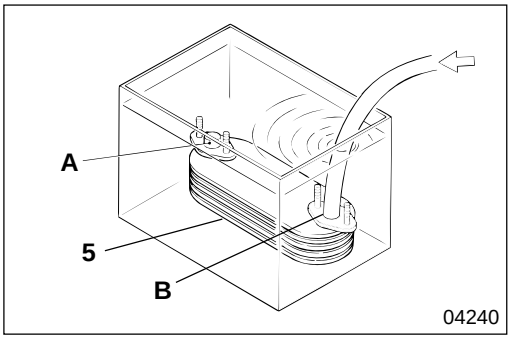
Lubricant and sealant

Location	Points of application	Kinds	Quantity
1	Gasket area of oil filter with thin application P12-13	Engine oil	As required
4	Body of O-ring	Engine oil	As required
6	Thread area of engine oil pressure switch	Teflon tape	3 1/2 turns

◆ Service procedure

● Cleaning

- Check and see if any carbon deposits or sludge have developed in the oil passage of oil cooler element **5** or its bypass. Clean any deposits off thoroughly with cleaning solvent.
- Also clean any water scale or fur found in oil cooler element **5** or oil cooler body **17**.



5 Inspection of oil cooler element

- Immerse oil cooler element **5** in a water tank after plugging exit port **A** and connecting the hose to engine oil entry port **B**.
- Apply air pressure of 980 kPa {140 psi, 10 kgf/cm²} via the hose and see if there is any air leakage from any part of oil cooler element **5**.
- If you see any leakage, replace oil cooler element **5**.

MITSUBISHI
FUSO

Group 13A
Fuel and Engine Control

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-13A

INDEX

SPECIFICATIONS 13A- 2

STRUCTURE AND OPERATION
- **1. Fuel System (Fuel flow) 13A- 3**
- **2. Engine Control 13A- 4**
- **3. Fuel Filter 13A- 5**

ON-VEHICLE INSPECTION AND ADJUSTMENT
- **1. Checking Minimum and Maximum No-Load Speeds 13A- 6**
- **2. Bleeding Air from Fuel System 13A- 7**
- **3. Replacing Fuel Filter 13A- 7**

ENGINE CONTROL 13A-10

FUEL TANK 13A-14

FUEL FILTER 13A-15

INJECTION PUMP 13A-16

INJECTION NOZZLE 13A-20

For system control of the electronically controlled injection pump, refer to Group 13EA Electronically Controlled Fuel System.

SPECIFICATIONS

Injection Pump Assembly

Item		Specification
Manufacturer		DENSO
Model		V4
Type		Distributor type electronically controlled pump
Spill valve solenoid		Electronically controlled
Timer	Control	High-pressure chamber control
	Drive	Timer controlled valve (TCV)
Feed pump type		Vane

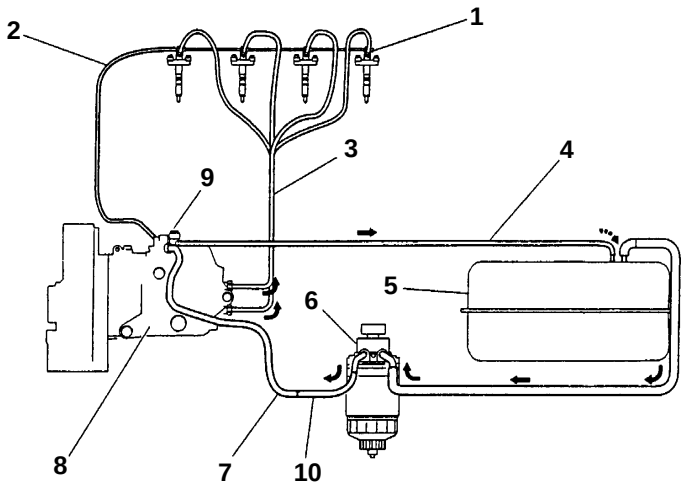
Injection Nozzle Assembly

Item	Specification
Manufacturer	DENSO
Type	Hole-type (2-spring)
No. of holes	6
Hole diameter mm {in.}	ϕ 0.20 {0.0079}

Fuel Filter

Item	Specification
Fuel filter type	Spin-on type (paper filter)
Water level alarm	Provided
Priming pump	Provided

1. Fuel System (Fuel flow)

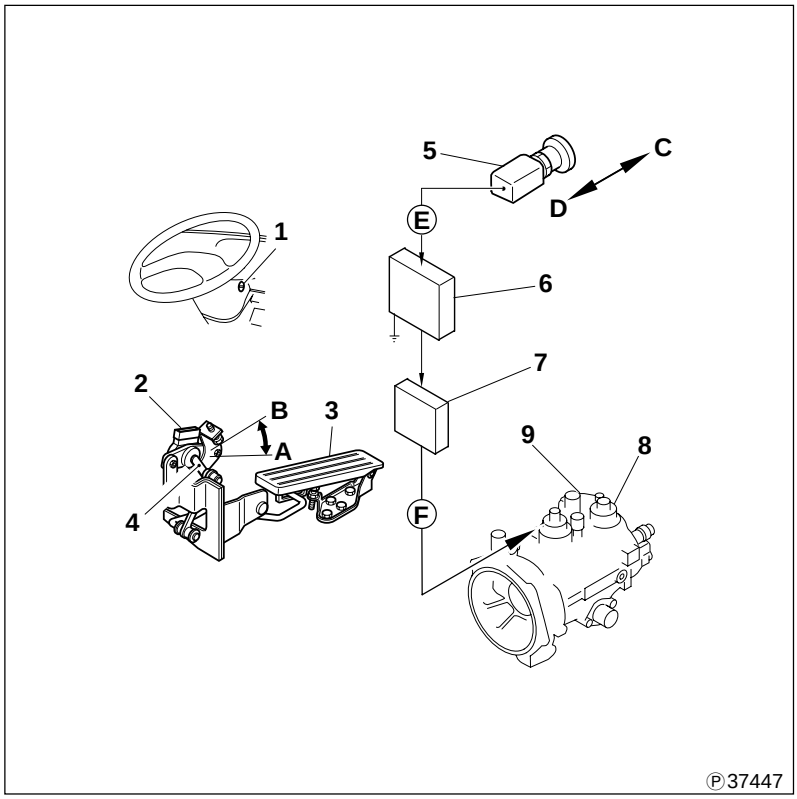


Ⓟ37446

1 Injection nozzle
2 Fuel leak-off pipe
3 Injection pipe
4 Fuel return pipe
5 Fuel tank
6 Fuel filter
7 Fuel suction pipe
8 V4 injection pump
9 Overflow valve
10 Fuel hose

- Fuel from the fuel tank **5** is drawn up by the feed pump, which is driven by the V4 injection pump **8**. Then, the fuel is delivered into the V4 injection pump through the fuel filter **6**.
- After filtration, the fuel is fed to the V4 injection pump **8**. From there, it is fed under high pressure to the injection nozzles **1**. The injection nozzles spray the fuel into the combustion chambers.
- Excess fuel from the injection nozzles **1** returns to the fuel tank **5** by way of the fuel leak-off pipe **2**.
- If the fuel pressure in the V4 injection pump **8** exceeds a preset level, the overflow valve **9** opens to allow excess fuel to return from the fuel return pipe **4** to the fuel tank **5**.

2. Engine Control



1 Starter switch
2 Accelerator position sensor & accelerator switch assembly
3 Accelerator pedal
4 Lever
5 Emergency engine stop switch
6 Engine control unit
7 Drive Unit
8 Spill valve
9 V4 injection pump assembly

A : Idling position
B : Full-load position
C : Engine stopping position
D : Engine starting position
E : Fuel cut signal
F : Power supply

● **Accelerator position sensor & accelerator switch unit**

The accelerator position sensor & accelerator switch unit **2** consists of an accelerator position sensor and a built-in accelerator switch.

- The accelerator switch responds to the foot pressure acting upon the accelerator pedal **3**.
- The accelerator position sensor detects the movement of the accelerator pedal **3** and outputs an electric signal to the engine control unit **6**. The lever **4** is constantly pulled by the return spring toward the idling position **A**.

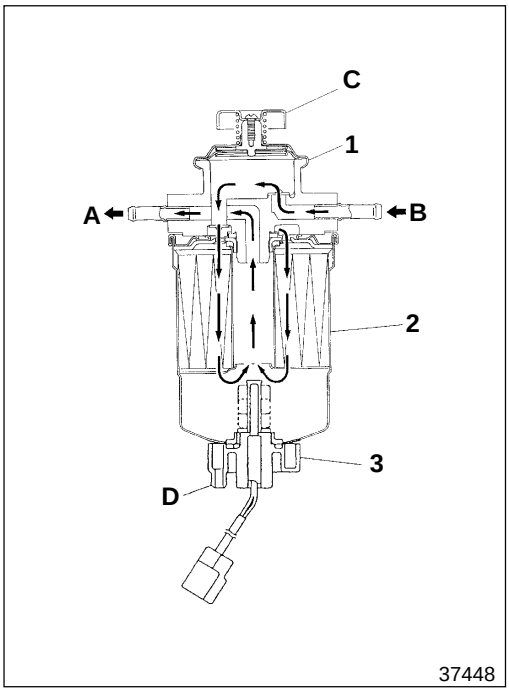
● **Emergency engine stop switch**

The emergency engine stop switch **5** is used to stop the engine when the starter switch **1** placed in the ACC position fails to do it due to a system failure or for some other reason. If the switch is pulled into the engine stopping position **C**, a fuel cut signal **F** is sent to the engine control unit **6**, which in turn terminates power **F** to the spill valve **8** of the V4 injection pump assembly **9** to stop the engine.

CAUTION ⚠

When restarting an engine stopped by means of the emergency engine stop switch 5, set the starter switch 1 to the ACC or LOCK position beforehand to initialize the engine control unit 6.

3. Fuel Filter



1 Fuel filter head
2 Fuel filter cartridge
3 Water level sensor

A : To injection pump
B : From fuel tank
C : Priming pump
D : Drain port

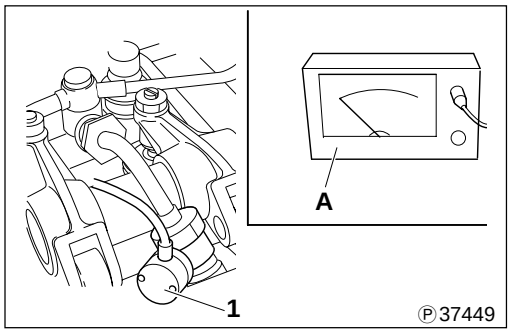
The fuel filter cartridge **2** serves also as a water separator, it separates water from fuel as well as removes impurities. Separated water is collected in the lower part of the filter. The filter is provided with a water level sensor **3**. When water is collected to a certain level, this sensor turns on the warning lamp in the meter cluster.
Collected water can be drained away through the drain port **D** by loosening the water level sensor **3**. The fuel filter head **1** is equipped with a priming pump **C** for bleeding the fuel system.

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Checking Minimum and Maximum No-Load Speeds

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	No-load minimum speed (Idling speed)	650±25 rpm	–	Check
–	No-load maximum speed (W.O.T)	3400±50 rpm	–	Check



● **No-load minimum speed**

Prepare the vehicle for inspection as follows.

- Engine coolant temperature: 176 to 203°F {80 to 95°C}
- Lamps and electrical equipment: Off
- A/T: “P” range
- Steering wheel: Neutral position
- Connect a tachometer **A** to the injection nozzle **1** or the injection pipe.

NOTE

Before connecting the tachometer A to the injection pipe, undo all clamps from the pipe.

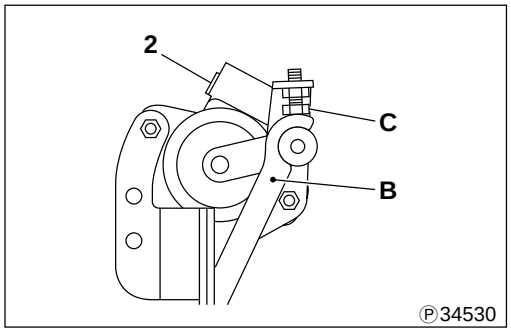
- Check that the minimum speed meets the standard value when the accelerator pedal is free of foot pressure.
- If the reading deviates from the standard value, check the accelerator position sensor & accelerator switch unit **2** for malfunction. Gr 13EA
- If the accelerator position sensor & accelerator switch unit **2** is found normal, check the fuel system diagnosis code, injection pump and ECU. Gr 13EA

● **No-load maximum speed**

- Connect a tachometer **A** to the injection nozzle **1** or the injection pipe.

NOTE

Before connecting the tachometer A to the injection pipe, undo all clamps from the pipe.



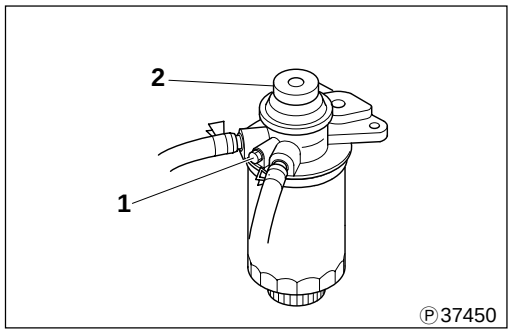
- Check that the maximum speed meets the standard value when the lever **B** of the accelerator position sensor & accelerator switch unit **2** is in contact with the full load stopper bolt **C**.
- If the reading deviates from the standard value, check the accelerator position sensor & accelerator switch unit **2** for malfunction. Gr 13EA
- If the accelerator position sensor & accelerator switch unit **2** is found normal, check the fuel system diagnosis code, injection pump and ECU. Gr 13EA

2. Bleeding Air from Fuel System

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Air vent plug	6±1 {4.3±0.7, 0.6±0.1}	–



- Loosen the fuel filter air vent plug **1**.
- Operate the priming pump **2** to pump up fuel.
- Continue to pump fuel until no air bubbles are found in the fuel flowing out from the air vent plug **1**.
- After ascertaining that air bubbles have completely disappeared, tighten the air vent plug **1** securely.
- Operate the priming pump **2** further until it becomes hard to push.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

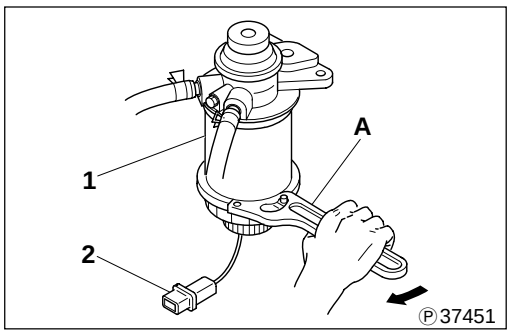
WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**

3. Replacing Fuel Filter

Lubricant

Location	Point of application	Specified lubricant	Quantity
1	Gasket for fuel filter cartridge	Engine oil	As required



[Removal]

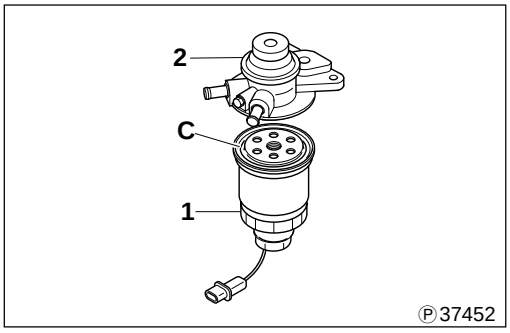
A: Filter Wrench
(Commercially available one: For filter diameter of approx. 90 mm {3.54 in.})

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To minimize the risk of fire, wipe up any spilled fuel.**

CAUTION ⚠

- **The water level sensor 2 may be reused if it properly functions.**



[Installation]

WARNING ⚠

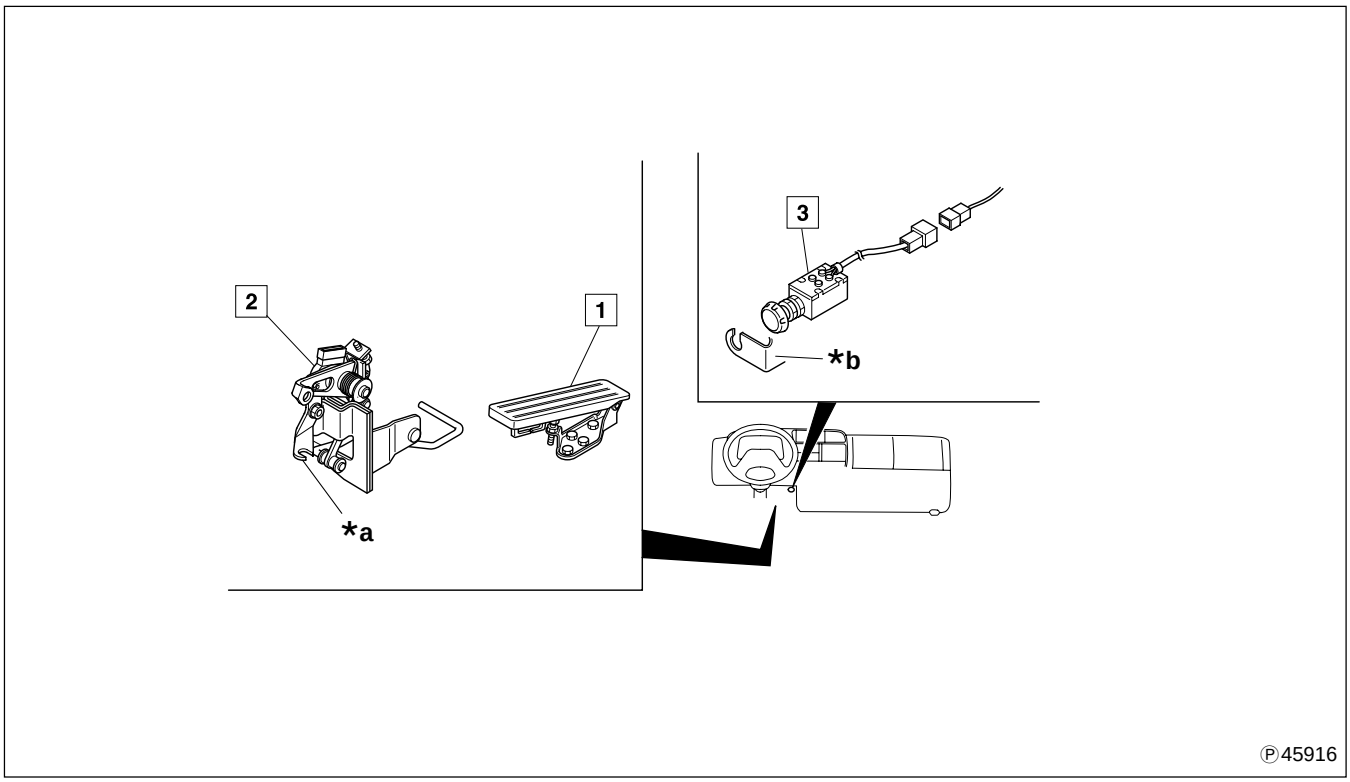
Use of an unsuitable fuel filter cartridge 1 can lead to fuel leaks and fires. Be sure to use a genuine filter.

CAUTION ⚠

To prevent injection failures, keep dust and dirt out of the fuel filter cartridge 1 and the fuel pipe.

- To install the fuel filter cartridge **1**, turn it until the gasket **C** touches seal surface of the fuel filter head **2**. Be sure to turn the filter by hand clockwise.
  Then, tighten the filter by an additional 3/4 turn.
- Bleed all air out of the fuel system. 🕮 P13A-7
- After fitting the filter, start the engine and check that no fuel leakage occurs.

M E M O



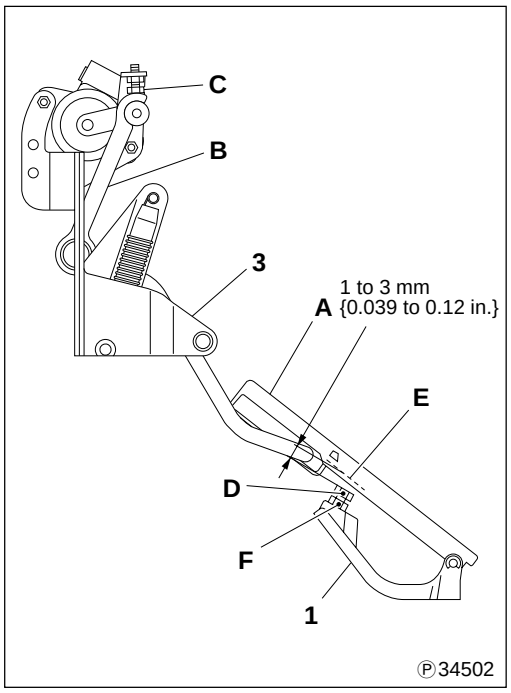
● **Removal sequence**

1 Accelerator pedal assembly 🕮 P13A-12
2 Accelerator pedal position sensor assembly 🕮 P13A-13
3 Emergency engine stop switch Gr 13EA

***a :** Lever and bracket assembly
***b :** Bracket

● **Installation sequence**

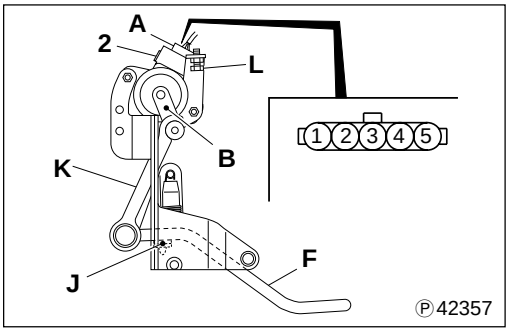
Follow the removal sequence in reverse.



◆ Service procedure

1 **Installation of accelerator pedal assembly**

- Fit the accelerator pedal assembly **1** onto the accelerator pedal position sensor assembly **3**.
- Depress the accelerator pedal **A** until the accelerator control extension **B** touches the stopper bolt **C** of the accelerator pedal position sensor assembly **3**.
- Check that the clearance between the stopper bolt **D** and the stopper bolt contact surface **E** of the accelerator pedal **A** is as shown in the illustration.
- Adjust the stopper bolt **D**, if necessary, to achieve the illustrated clearance. Lock the stopper bolt with the nut **F** after adjustment.



2 **Inspect the accelerator pedal position sensor**

[Inspection]

- Set the starter switch to ON.
- Measure the output voltage of the accelerator position sensor **2** from the back side of harness connector **A** according to the following table.

		Accelerator Position Sensor I		Accelerator Position Sensor II		Accelerator Switch	
		②	①	②	⑤	②	③
Lever **B** position		⊕	⊖	⊕	⊖	⊕	⊖
Standard value	Idling position **C**	0.85±0.1 V		0.85±0.1 V		4V or more	
	Accelerator operating position **D**	1.0±0.24 V		1.0±0.24 V		1V or less	
	Full load position **E**	4.0±0.1 V		4.0±0.1 V			

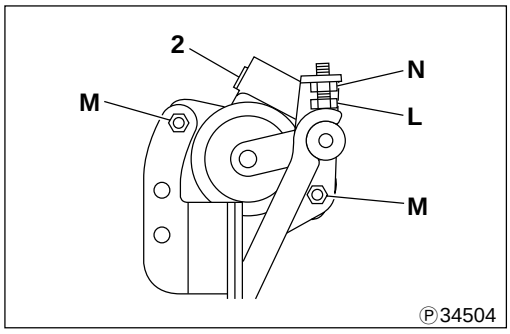
◯——◯ : There must be continuity between the pins.
⊕——⊖ : Polarity when voltage is measured.

C : Where accelerator control arm **F** is in contact with stopper **J**.

D : Where voltage across pins ② and ③ is reduced to 1V or less by slowly depressing the accelerator pedal.

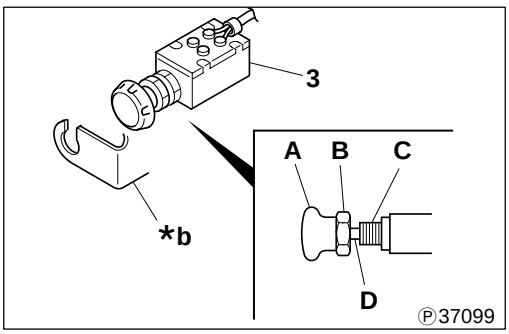
E : Where accelerator control extension **K** is in contact with stopper bolt **L**.

- If the output voltage is out of the standard value range, adjust by the following procedures.



[Adjustment]

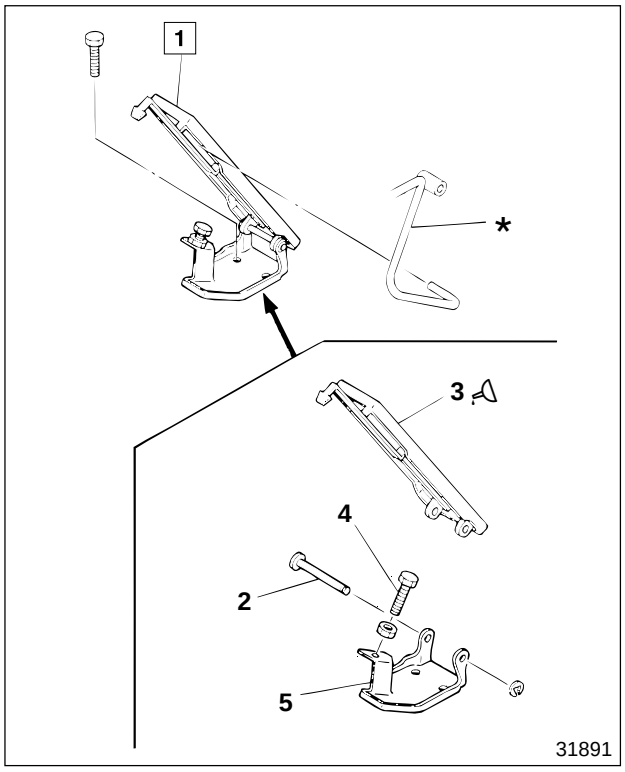
- Adjust the output voltage at the idling position **C** by loosening the screws **M** and moving the accelerator position sensor **2**.
  After the adjustment, retighten the screws.
- Adjust the output voltage at the full load position **E** by loosening the nut **N** and adjusting the stopper bolt **L**.
  After the adjustment, lock the bolt with the nut.



3 **Installation of emergency engine stop switch**

- Pull the knob **A** of the emergency engine stop switch **3** into the OFF position. Loosen the nut **B** to remove from the threaded end **C** of the switch.
- Set the shaft **D** in the bracket ***b**.
- Position the shaft **D** properly in the hole of the bracket ***b** and tighten the nut **B**.

Accelerator Pedal Assembly



● **Disassembly sequence**

1 Accelerator pedal assembly
2 Clevis pin
3 Accelerator pedal
4 Stopper bolt
5 Accelerator pedal bracket

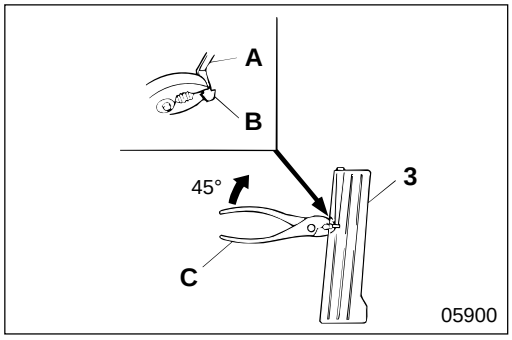
* : Accelerator pedal position sensor assembly P13A-13

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Kinds	Quantity
3	Slide-contacting surfaces of accelerator pedal and bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required



◆ Service procedure

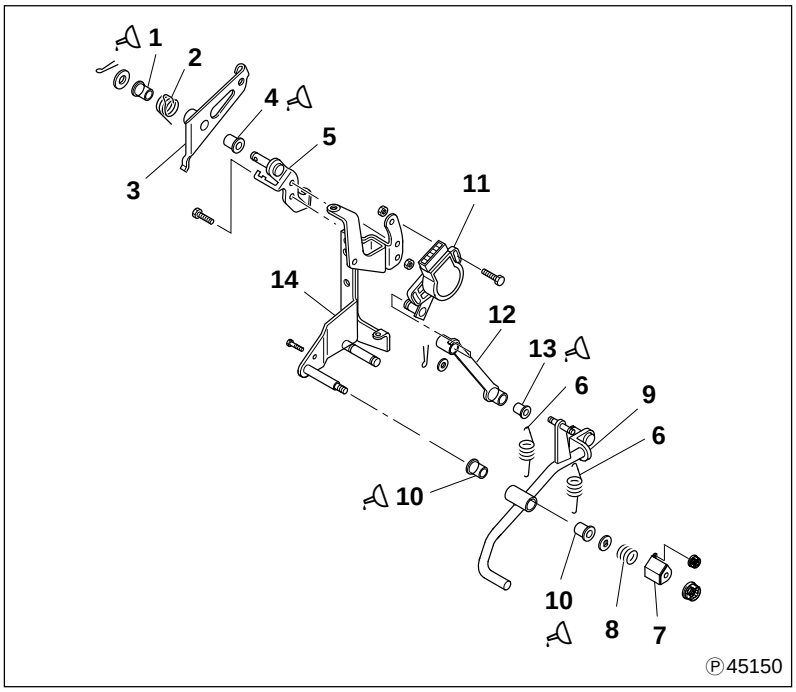
1 **Removal of accelerator pedal assembly**

Pinch hook **B** of stopper **A** of accelerator pedal **3** using pliers **C** and rotating approximately 45° pull out the stopper towards the front of the vehicle.

CAUTION

Take care not to damage stopper A itself during removal, do not pull it out too forcibly.

Accelerator Pedal Position Sensor Assembly



● **Removal sequence**

1 Bushing < Mixer >
2 Spring < Mixer >
3 Lever assembly < Mixer >
4 Bushing < Mixer >
5 Bracket assembly < Mixer >
6 Return spring
7 Shaft cover
8 Spring
9 Accelerator control arm
10 Bushing
11 Throttle position sensor
12 Accelerator control extension
13 Bushing
14 Bracket

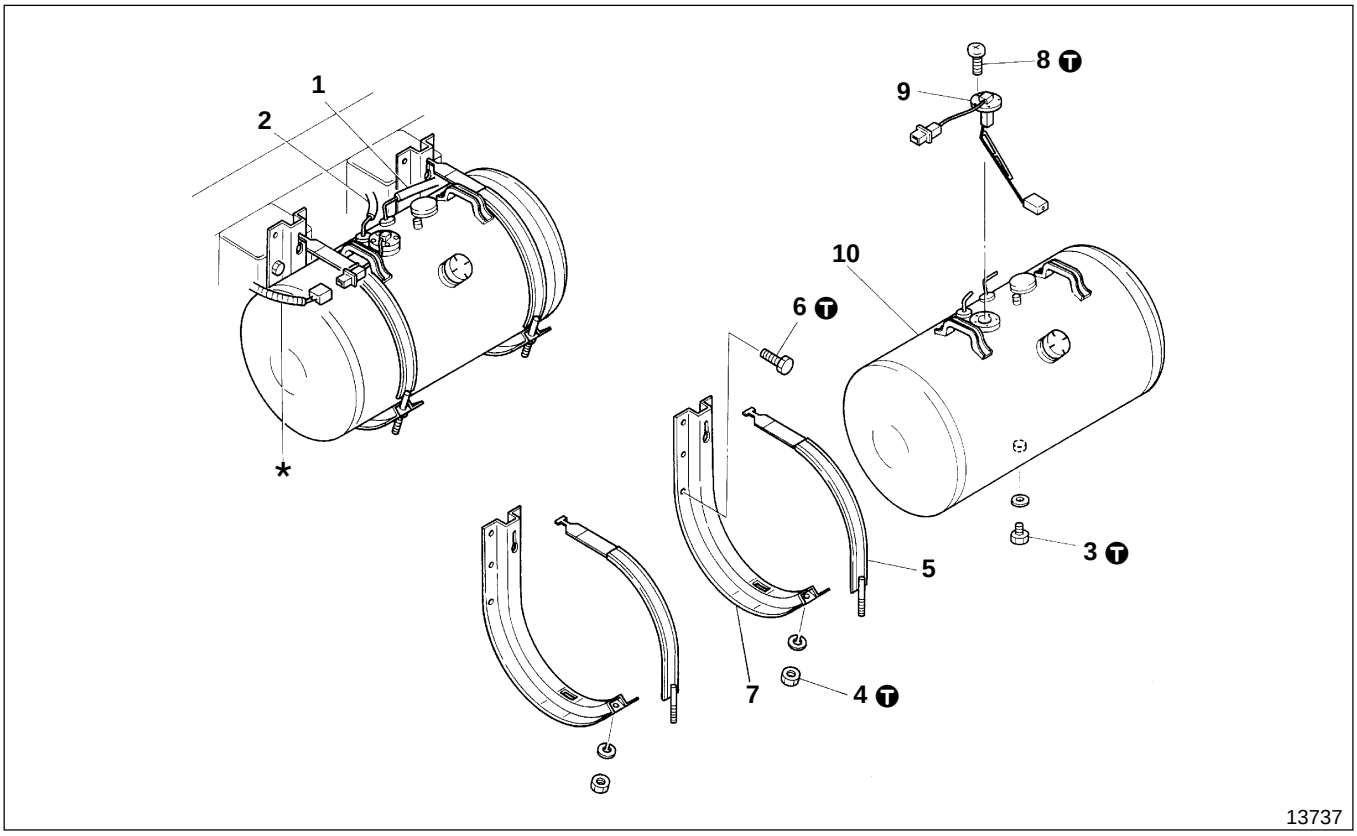
● **Installation sequence**

Follow the removal sequence in reverse.

Lubricant

Location	Points of application	Specified Lubricant	Quantity
1, 4, 10, 13	Slide-contacting surfaces of bushing and support assembly	Chassis grease [NLGI No.1 (Ca soap)]	As required

FUEL TANK



● **Work before removal**

WARNING ⚠

- **Keep unprotected lights away because of the risk of explosion.**
- **Wipe up any spilled fuel because it can cause a fire.**

NOTE

Drain fuel before working on the job.

● **Removal sequence**

1 Suction hose
2 Return hose
3 Drain plug
4 Nut
5 Fuel tank band
6 Bolt
7 Fuel tank bracket
8 Screw
9 Fuel gauge unit Gr 54
10 Fuel tank
***** : Chassis harness Gr 54

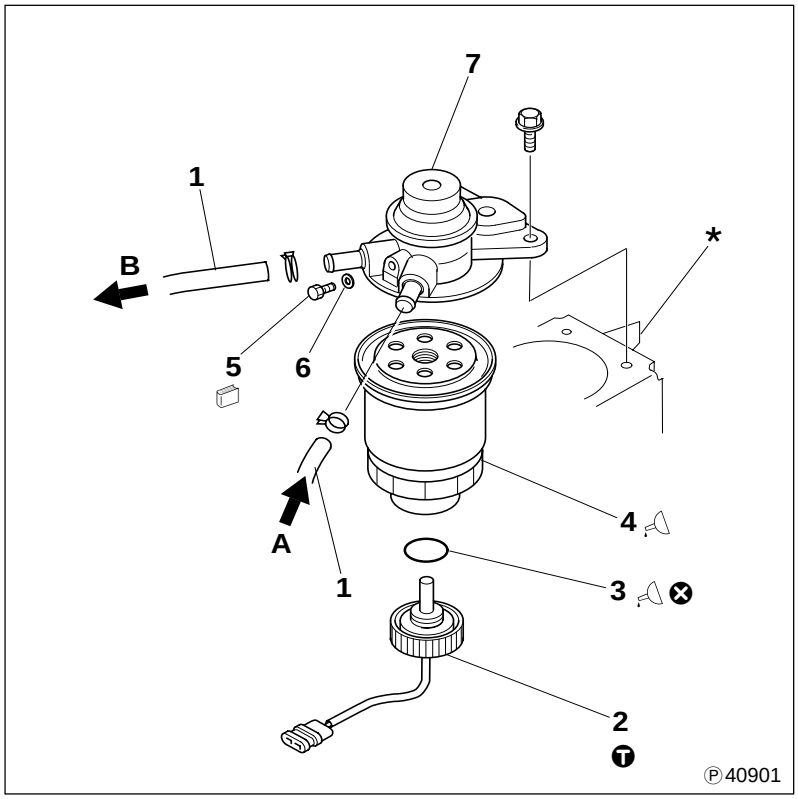
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain plug	59 to 98 {43 to 72, 6 to 10}	–
4	Nut (Fuel tank band mounting)	5.9 to 9.8 {4.3 to 7.2, 0.6 to 1.0}	–
6	Bolt (Fuel tank bracket mounting)	59 to 78 {43 to 58, 6 to 8}	–
8	Screw (Fuel gauge unit mounting)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	–



● **Disassembly sequence**

1 Fuel hose
2 Water level sensor Gr 54
3 O-ring
4 Fuel filter cartridge P13A-7
5 Air vent plug
6 Gasket
7 Fuel filter head

A : From fuel tank
B : To injection pump
*** :** Bracket
⊗**:** Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

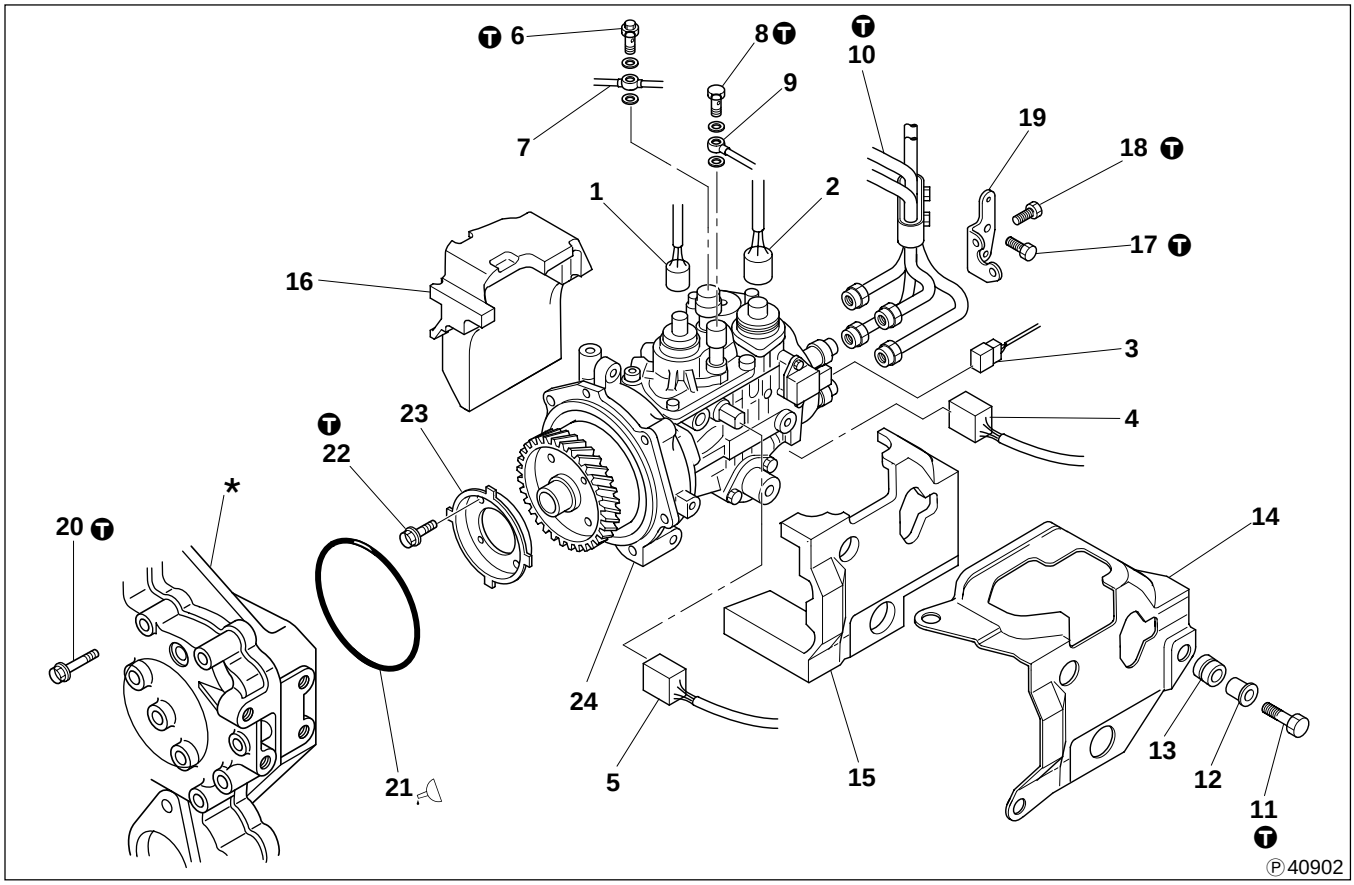
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Water level sensor	2.5±0.5 {1.81±0.36, 0.25±0.05}	–
5	Air vent plug	6±1 {4.3±0.7, 0.6±0.1}	–

Lubricant

Location	Points of application	Specified sealant	Quantity
3	O-ring	Engine oil	As required
4	Fuel filter cartridge gasket (surface in contact with fuel filter head)	Engine oil	As required

INJECTION PUMP



● **Disassembly sequence**

1 Harness connector (Engine speed sensor)
2 Harness connector (Spill valve)
3 Harness connector (Injection control ROM)
4 Harness connector (Timer control valve)
5 Harness connector (Fuel temperature sensor)
6 Overflow valve
7 Fuel return pipe
8 Eyebolt
9 Fuel suction pipe
10 Injection pipe
11 Bolt
12 Spacer
13 Insulator
14 Injection pump cover
15 Injection pump sound insulation
16 Rubber spacer
17 Bolt
18 Bolt
19 Pump bracket
20 Bolt
21 O-ring
22 Bolt
23 Sensor plate
24 Injection pump assembly

***** : Front case assembly Gr 11A
: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

- **For maintenance of the injection pump assembly 24, please contact a Denso service station.**
- **Dirt particles in the injection pump assembly 24 can seriously detract from engine performance. To prevent enter of dirt, cover all pipes, hoses and other parts after removal.**

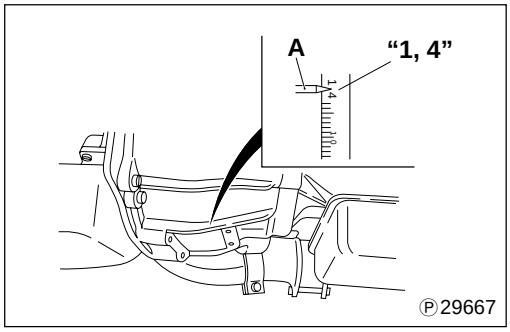
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Overflow valve (fuel return pipe mounting)	19.6 to 29.5 {14 to 22, 2 to 3}	–
8	Eyebolt (fuel suction pipe mounting)	19.6 to 29.5 {14 to 22, 2 to 3}	–
10	Injection pipe (union nut mounting)	38.2 {28, 3.9}	–
11	Bolt (injection pump cover mounting)	9.8 {7.2, 1}	–
17	Bolt (pump bracket mounting)	44.1 {33, 4.5}	–
18	Bolt (injection pump assembly mounting)	47.0 {35, 4.8}	–
20	Bolt (injection pump assembly mounting)	23.5 {17, 2.4}	–
22	Bolt (sensor plate mounting)	4.9 {3.6, 0.5}	–

Lubricant

Location	Points of application	Specified lubricant	Quantity
21	O-ring	Engine oil	As required



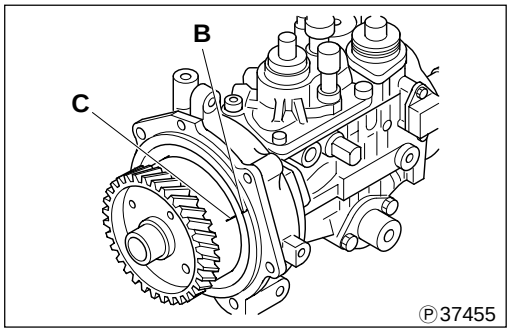
◆ Service procedure

24 Installation of injection pump assembly

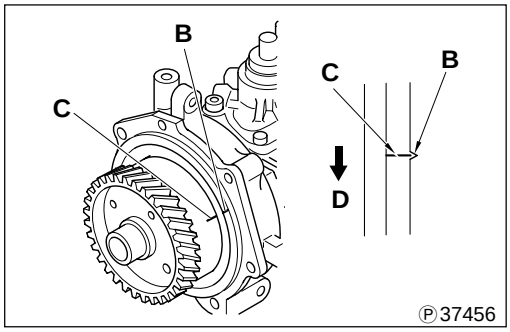
- Crank the engine clockwise to bring the cylinder No. 1 piston to the top dead center of compression stroke; align the pointer **A** in the torque converter housing inspection opening with the inscribed mark between "**1**" and "**4**" on the flywheel.
- Check that the rocker arms of both inlet and exhaust valves of the cylinder No. 1 move.
- If the rocker arms still hold the valves down, give the engine another turn.

NOTE

There are two kinds of marks inscribed in the flywheel, "I" and "IV" and "1" and "4". Do not confuse.



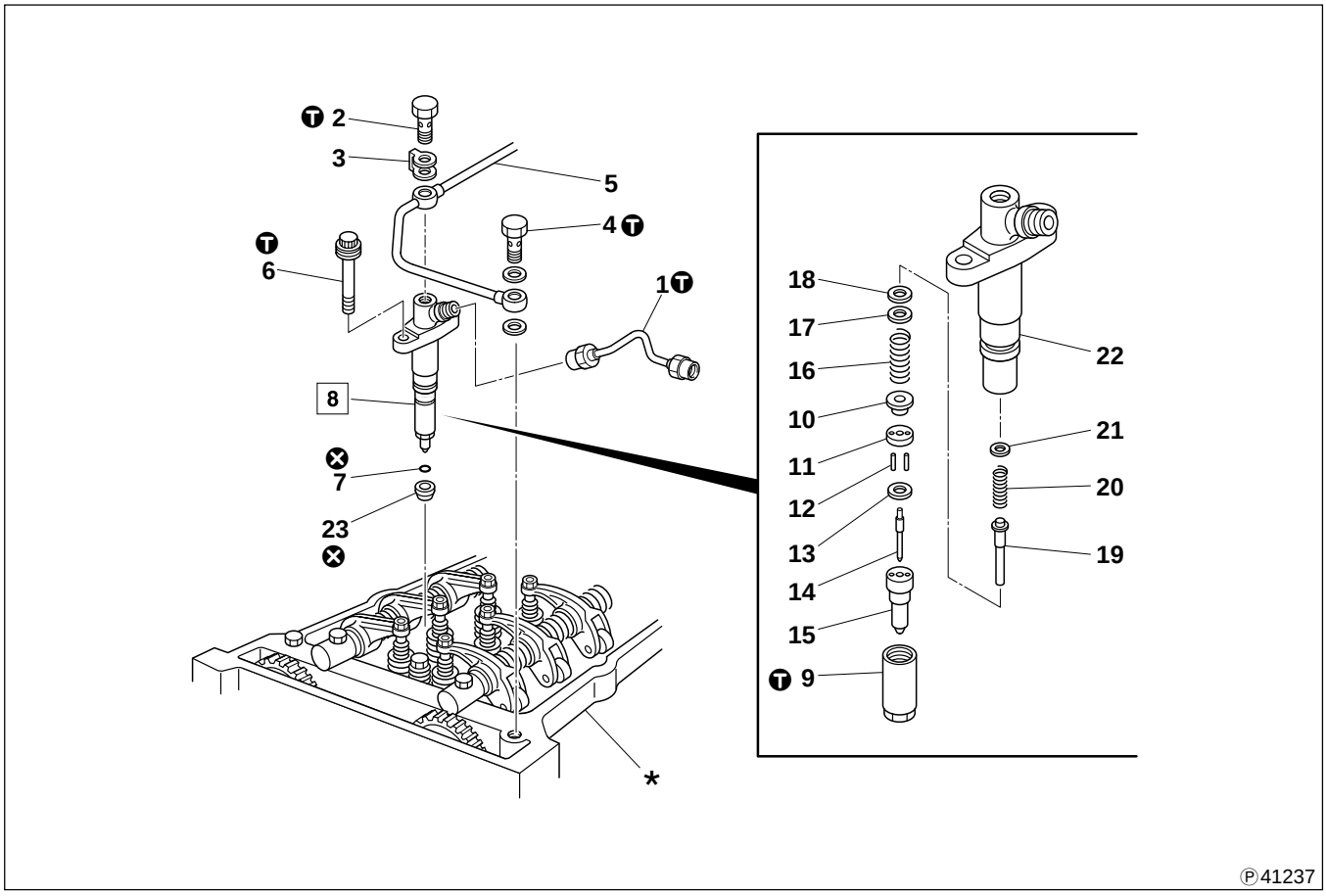
- Align the notch **B** in the flange plate with the inscribed mark **C** on the injection pump gear.



- Ascertaining the alignment between notch **B** and inscribed mark **C**, push in the injection pump assembly to install in position. At this time, the inscribed mark moves in the direction **D**.

M E M O

INJECTION NOZZLE



● **Disassembly sequence**

1. Injection pipe
2. Eyebolt
3. Gasket
4. Eyebolt
5. Leak-off pipe
6. Bolt
7. O-ring
8. Injection nozzle assembly
9. Retaining nut
10. Spring seat (for adjustment of pre-lift)
11. Tip packing
12. Straight pin
13. Washer (for adjustment of needle valve lift)
14. Needle valve
15. Nozzle
16. 2nd pressure spring
17. Adjusting shim (for adjustment of 2nd valve opening pressure)
18. Spring seat
19. Pressure pin
20. 1st pressure spring
21. Adjusting shim (for adjustment of 1st valve opening pressure)
22. Nozzle holder
23. Nozzle gasket

*: Cylinder head Gr 11A
⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

- **Take care not to touch the sliding part of the needle valve 14. It could be scratched or corroded in the worst case, resulting in the loss of airtightness between the valve and the nozzle 15.**
- **Under no circumstances change the needle valve 14 and nozzle 15 combination as they are matched.**
- **Dirt particles can seriously detract from engine performance. To prevent ingress of dirt, cover parts to which the injection nozzle assemblies 8 were fitted after removal.**

NOTE

Clean off any carbon deposits before disassembling, reassembling or adjusting the injection nozzle assembly 8. Before disassembly, check the pressure and shape of the spray and inspect the assembly for fuel leads. If no abnormality is apparent, do not commence disassembly.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
8	Injection nozzle assembly injection pressure (valve opening pressure)	1st valve opening pressure	$16.18\,^{+0.98}_{0}$ MPa $\{2346\,^{+142}_{0}$ psi, $165\,^{+10}_{0}$ kgf/cm$^2\}$	–	Adjust
		2nd valve opening pressure	20.10±0.49 MPa {2915±71 psi, 205±5 kgf/cm^2}	–	
–	Prelift		0.08±0.01mm {0.0031}	–	Adjust
–	Needle valve lift		$0.25\,^{+0.03}_{-0.02}$ $\{0.0098\,^{+0.0012}_{-0.00079}\}$	–	Adjust

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Union nut (injection pipe mounting)	38.2 {28, 3.9}	–
2	Eyebolt (leak-off pipe (nozzle side) mounting)	29.4 {22, 3.0}	–
4	Eyebolt (leak-off pipe (head side) mounting)	20.6 {15, 2.1}	–
6	Bolt (injection nozzle assembly mounting)	14.7 {11, 1.5}	–
9	Retaining nut	25 to 34 {18 to 25, 2.5 to 3.5}	–

Special tool

Location	Tool name	Part No.	Application
–	Nozzle Cleaning Tool	***105789-0010**	Cleaning injection nozzle assemblies
–	Tool Set	*95093-00040	Disassembly, assembly and adjustment of injection nozzle
–	*1 Attachment Measure	*95093-10300	Measurement of prelift
–	*1 Base	*95093-10230	Assembly of injection nozzle
–	Master Spring Seat	*95093-10330	Adjustment of 2nd valve opening pressure

***** : BOSCH AUTOMOTIVE SYSTEMS product number
* : DENSO product number
*1 : Component of Tool Set (95093-00040)

◆ Service procedure

● Inspection before disassembly

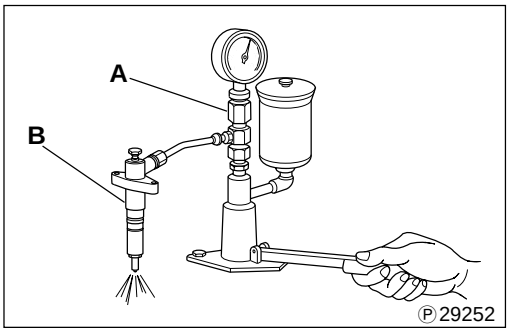
Fit the injection nozzle assembly **8** onto the nozzle tester **A** ready for inspection.

WARNING ⚠

Do not touch the spray that comes out of the nozzle.

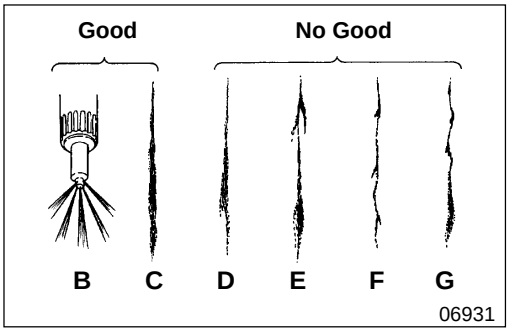
NOTE

Before commencing inspection, operate the lever on the nozzle tester A two or three times to bleed all air out of the arrangement.



(1) Checking valve opening pressure

- Push down the lever on the nozzle tester **A** at a rate of 1 to 2 seconds per stroke. The pressure gauge reading will gradually rise, then the needle will suddenly deflect. Note the pressure when the needle starts to deflect.
- If the measurement is out of specification, disassemble the nozzle, clean it and make adjustments by changing the shims **17**, **21**.
- If the measurement is still out of specification after adjustment, replace the injection nozzle assembly **8**.

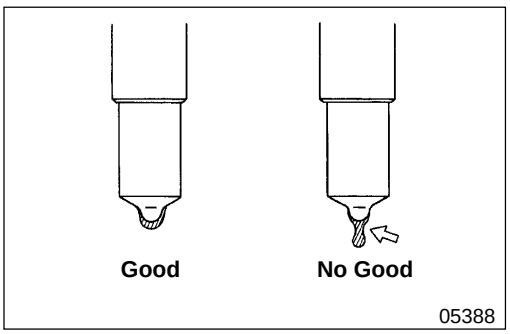


(2) Inspecting spray condition

- Pump the lever on the nozzle tester **A** at a rate of about 1 to 2 strokes per second and maintain a continuous spray.

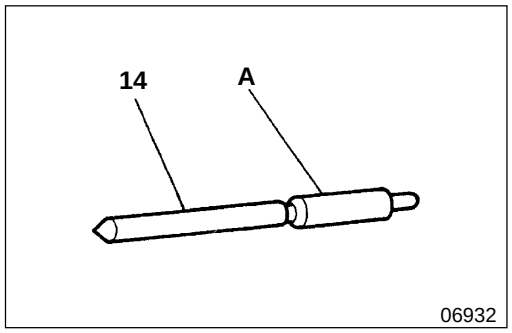
  B : Even spray from all five injection orifices (Good)
  C : Even and symmetrical spray (Good)
  D : Asymmetrical spray (No Good)
  E : Branched spray (No Good)
  F : Thin spray (No Good)
  G : Irregular spray (No Good)

- If the spray is unsatisfactory, disassemble and clean the injection nozzle assembly **8**, then inspect the spray again. If the spray is still unsatisfactory, replace the injection nozzle assembly.
- Check that no fuel drips from the nozzle after the spray is complete.



(3) Inspecting for oil-tightness and leaks

- Slowly increase the nozzle pressure to the pressure below the specified 1st valve opening pressure by 1.96 MPa {285 lbf/in^2, 20 kgf/cm^2}. Maintain this pressure for 10 seconds and check that no fuel drips from the end of the nozzle.
- If the injection nozzle assembly **8** appears defective, disassemble and clean it, then inspect it again. If the injection nozzle assembly still appears defective, it must be replaced.

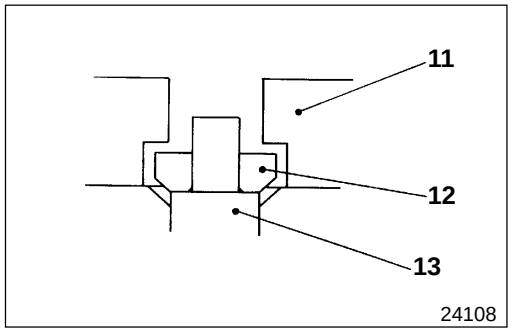


8 **Injection nozzle assembly**

[Disassembly]

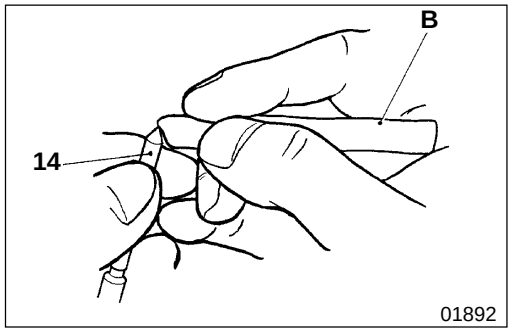
CAUTION ⚠

- **Never touch the sliding part A of the needle valve 14.**
- **Never change the needle valve 14 and nozzle 15 combination as they are a matched set.**



[Assembly]

Assemble the tip packing **11** and the washer **12** (for adjustment of needle valve lift) in the illustrated directions.



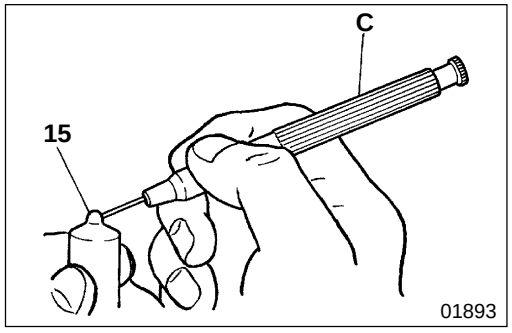
[Cleaning]

Wash the needle valve **14** and nozzle **15** in diesel fuel, then use the Cleaning Tool to remove any carbon deposits in accordance with the following procedure.

- Remove carbon from the end of the needle valve **14** using the Cleaning Bar **B** of the Cleaning Tool.

CAUTION ⚠

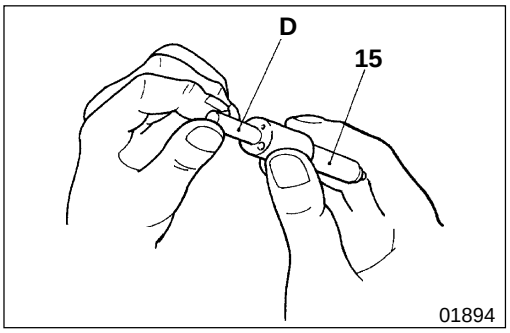
Do not use a wire brush or any hard metallic object for cleaning.

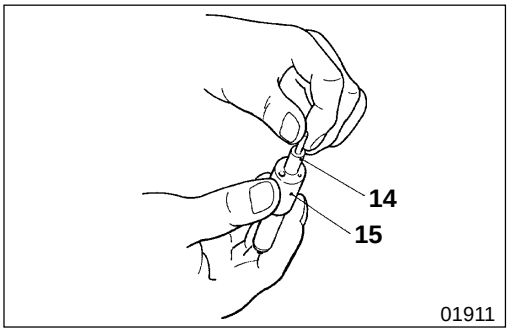


- Remove carbon from the injection orifice of the nozzle **15** using the Cleaning Needle **C** of the Cleaning Tool. Insert the Cleaning Needle and rotate it to remove carbon.

  Cleaning needle diameter: 0.20 mm {0.0079 in.} or smaller

INJECTION NOZZLE





- Clean the seat of the nozzle **15** using the Cleaning Scraper **D** of the Cleaning Tool.
- To remove burned and hardened carbon, use a carbon remover tool.

[Inspection]

- Wash the needle valve **14** and nozzle **15** in diesel fuel, then fit them together.
- Pull up the needle valve **14** by approximately 1/3 of its entire stroke, then check that it drops under its own weight. Repeat this test several times, turning the needle valve each time.
- If the needle valve **14** does not drop as required, wash it in diesel fuel and carry out this test again. If the needle valve is still defective, replace the needle valve and nozzle **15** as a set.

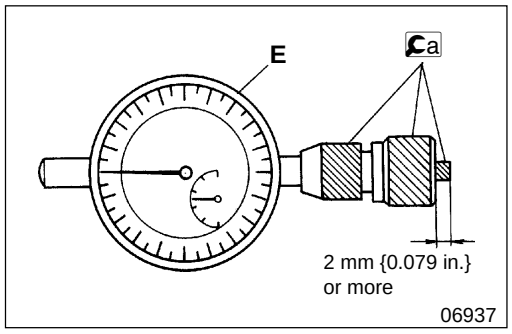
[Adjustment]

During reassembly, make adjustments in the sequence shown below.

CAUTION

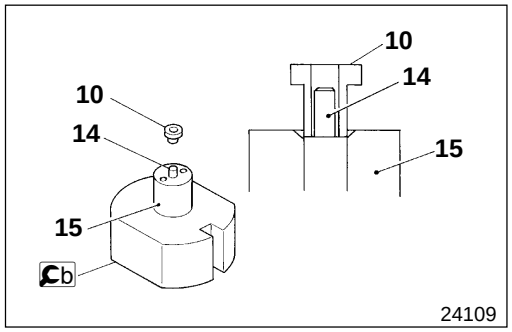
- **Before making adjustments, wash all parts in diesel fuel and ensure that they are free of dirt and other foreign material.**
- **Do not touch the sliding surfaces of the needle valve 14.**

- Check needle valve full lift
- Check prelift
- Adjust 2nd valve opening pressure
- Adjust 1st valve opening pressure

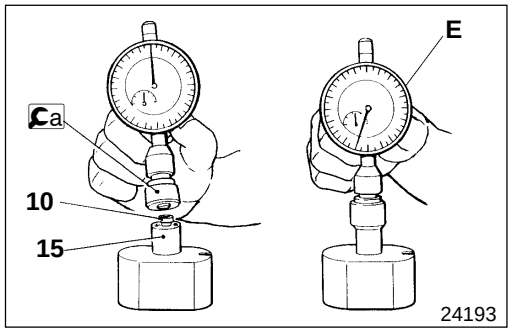


● **Checking needle valve full lift**

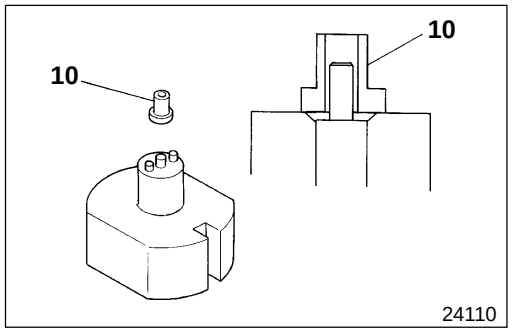
- Set the a Attachment Measure to a dial gauge **E**.



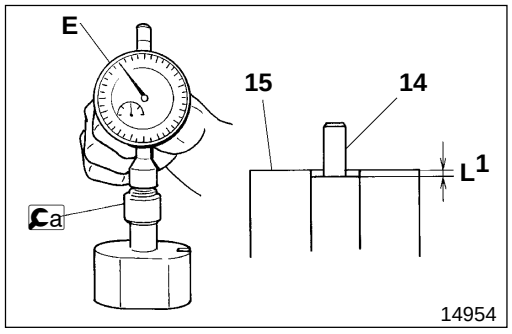
- Mount the nozzle **15** on the b base, with the needle valve **14** and spring seat **10** (for adjustment of pre-lift) fitted to the nozzle in that order.



- Fit the a Attachment Measure onto the nozzle **15**.
- Zero the dial gauge **E**.

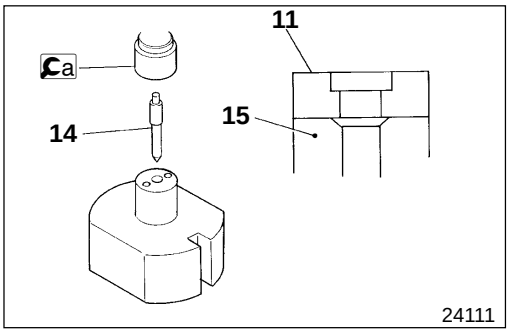


- Remove the a Attachment Measure. Remove the spring seat **10** (for adjustment of pre-lift) and refit it to the nozzle upside down.

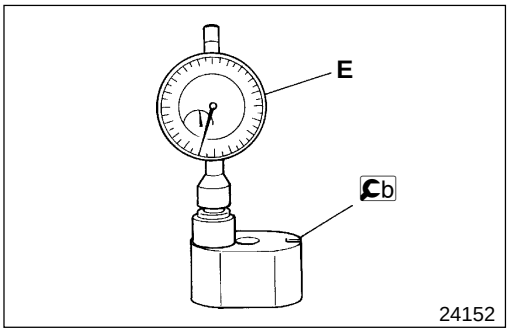


- Fit the a Attachment onto the nozzle **15** again, and read the dial gauge **E**. The reading should be the illustrated dimension L^1.

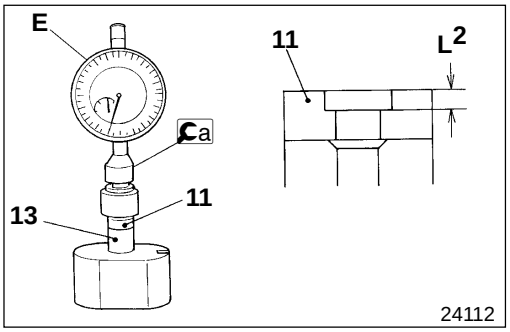
INJECTION NOZZLE



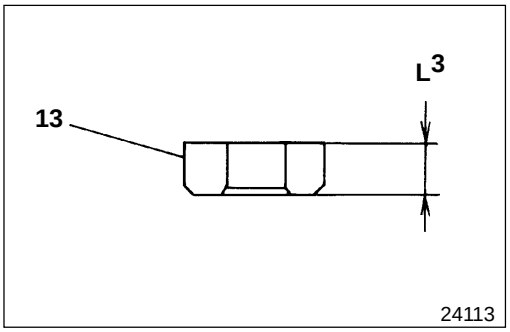
- Remove the a Attachment Measure and the needle valve **14**. Fit the tip packing **11** to the nozzle **15** as shown.



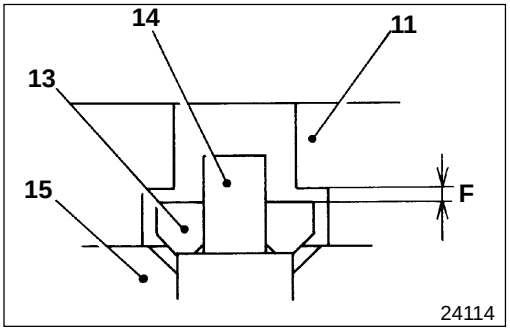
- Zero the dial gauge **E** on the b base.



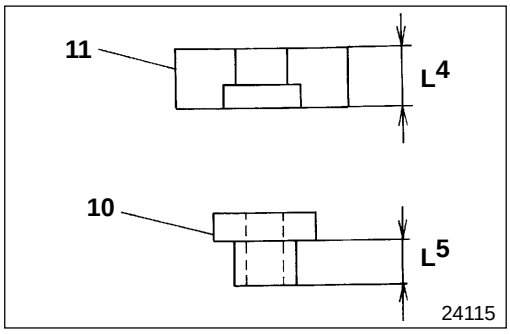
- Fit the a Attachment Measure to the tip packing **11**, and read the dial gauge **E**.
  The reading should be the illustrated dimension L^2.



- Measure the thickness L^3 of the washer **13** (for adjustment of needle valve lift).

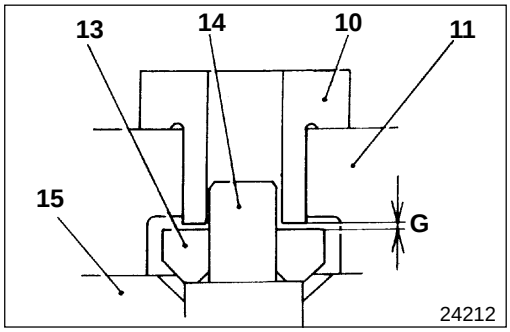


- Calculate the maximum lift **F** of the needle valve **14** from the measurements L^1, L^2 and L^3 as follows.
  Maximum lift **F** = $L^1 + L^2 - L^3$
- If the calculated value is out of specification, make the necessary adjustment by changing the washer **13** (for adjustment of needle valve lift).
  Washers **13** are available in the following thicknesses (L^3):
  2.40, 2.425, 2.45, 2.475, 2.50 mm {0.094, 0.095, 0.096, 0.097, 0.098 in.} (5 sizes)

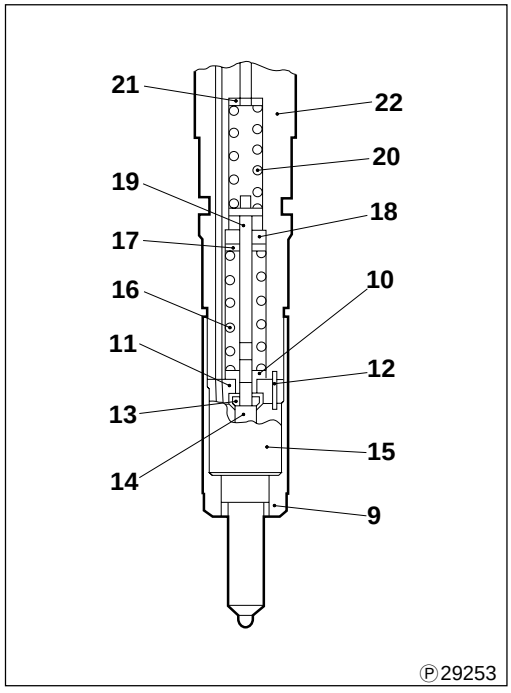


● **Adjusting pre-lift**

- Measure the thickness L^4 of the tip packing **11**.
- Measure the thickness L^5 of the spring seat **10 (**for adjustment of pre-lift).



- Calculate the pre-lift **G** from the measurements L^1, L^3, L^4 and L^5 as follows.
  Pre-lift **G** = $L^4 - L^5 - L^3 + L^1$
- If the calculated value is out of specification, make the necessary adjustment by changing the spring seat **10** (for adjustment of pre-lift).
  Spring seats **10** are available in the following thicknesses (L^5):
  2.59 to 2.80 mm {0.101 to 0.110 in.} (22 sizes at steps of 0.01 mm {0.00039 in.})



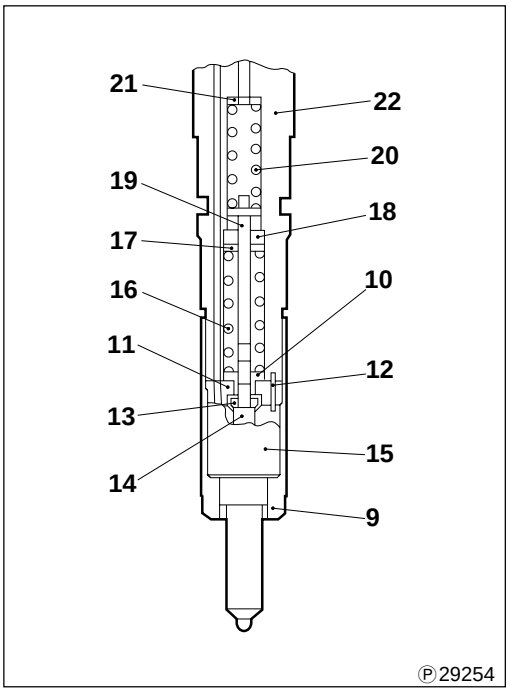
● **Adjusting 2nd valve opening pressure**

- Assemble parts to the nozzle holder **22** as shown. Fit the SC Master Spring Seat in the place of the spring seat **10** (for adjustment of pre-lift).
- Tighten the retaining nut **9** to the specified torque.
- Fit the nozzle assembly onto the nozzle tester and measure the 2nd valve opening pressure.

CAUTION ⚠

Never touch the spray that comes out of the nozzle.

- If the reading is out of specification, make the necessary adjustment by changing the adjusting shim **17** (for adjustment of 2nd valve opening pressure). Adjusting shims **17** are available in the following thicknesses.
  0.70 to 2.15 mm {0.028 to 0.085 in.} (30 sizes at steps of 0.05 mm {0.002 in.})
  0.975 to 1.775 mm {0.038 to 0.070 in.} (17 sizes at steps of 0.05 mm {0.002 in.})
- A difference of 0.025 mm {0.00098 in.} in the thickness of the adjustment shim **17** changes the 2nd valve opening pressure by 345 kPa {50 psi, 3.5 kgf/cm^2}.



● **Adjusting 1st valve opening pressure**

- Assemble parts to the nozzle holder **22** as shown.
- Tighten the retaining nut **9** to the specified torque.
- Fit the nozzle assembly onto the nozzle tester and measure the 1st valve opening pressure.

CAUTION ⚠

Never touch the spray that comes out of the nozzle.

- If the reading is out of specification, make the necessary adjustment by changing the adjusting shim **21** (for adjustment of 1st valve opening pressure).

  Adjusting shims **21** are available in the following thicknesses:
  0.8 to 2.0, 2.05, 2.075 to 2.2 mm {0.031 to 0.079, 0.080, 0.081 to 0.087 in.} (56 sizes at steps of 0.025 mm {0.00098 in.})
  A difference of 0.025 mm {0.00098 in. } in the thickness of the adjusting shim **21** changes the 1st valve opening pressure by 345 kPa {20 psi, 3.5 kgf/cm^2}.

MITSUBISHI
FUSO

Group 13B
Fuel and Engine Control

< 4D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-13B

INDEX

SPECIFICATIONS 13B-2

STRUCTURE AND OPERATION 13B-3

TROUBLESHOOTING 13B-8

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Checking and Adjusting Injection Timing 13B-10
- Bleeding Air from Fuel System 13B-12
- Cleaning Gauze Filter 13B-12
- Replacing Fuel Filter 13B-13

ENGINE CONTROL 13B-14

FUEL TANK 13B-20

FUEL FILTER 13B-21

WATER SEPARATOR 13B-22

INJECTION PUMP 13B-24

INJECTION NOZZLE 13B-28

SPECIFICATIONS

Injection Pump

Item	Specifications
Manufacturer	BOSCH AUTOMOTIVE SYSTEMS
Body model	MD-TICS (Pre-stroke control type)
Governor type	RED-III Electronic control governor
Feed pump model	KD

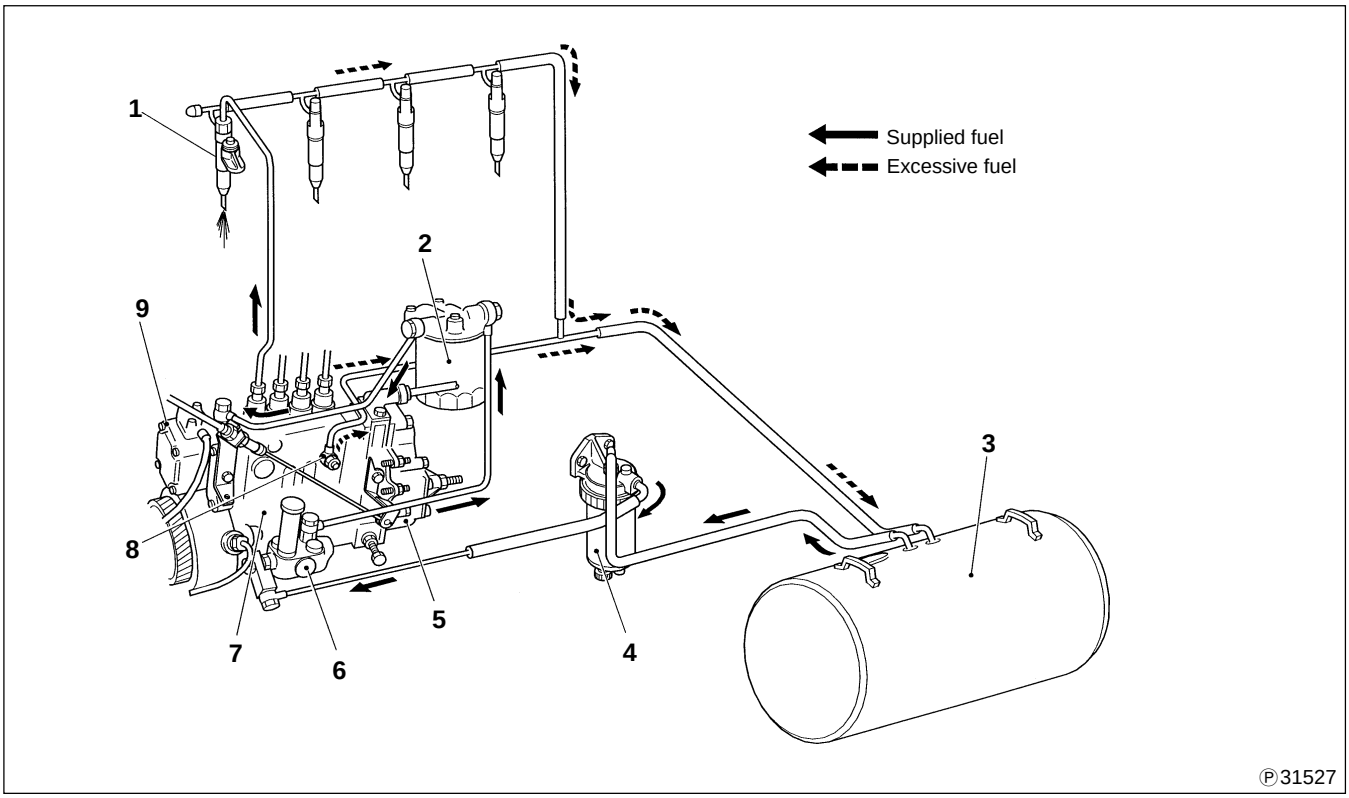
Injection Nozzle

Item	Specifications
Manufacturer	BOSCH AUTOMOTIVE SYSTEMS
Model and type	DLLA hole type 1-spring nozzle
Nozzle orifice quantity	5
Orifice diameter mm {in.}	ϕ 0.25 {0.0098}

Fuel Filter Type

Item	Specifications
Filter type	Spin-on type

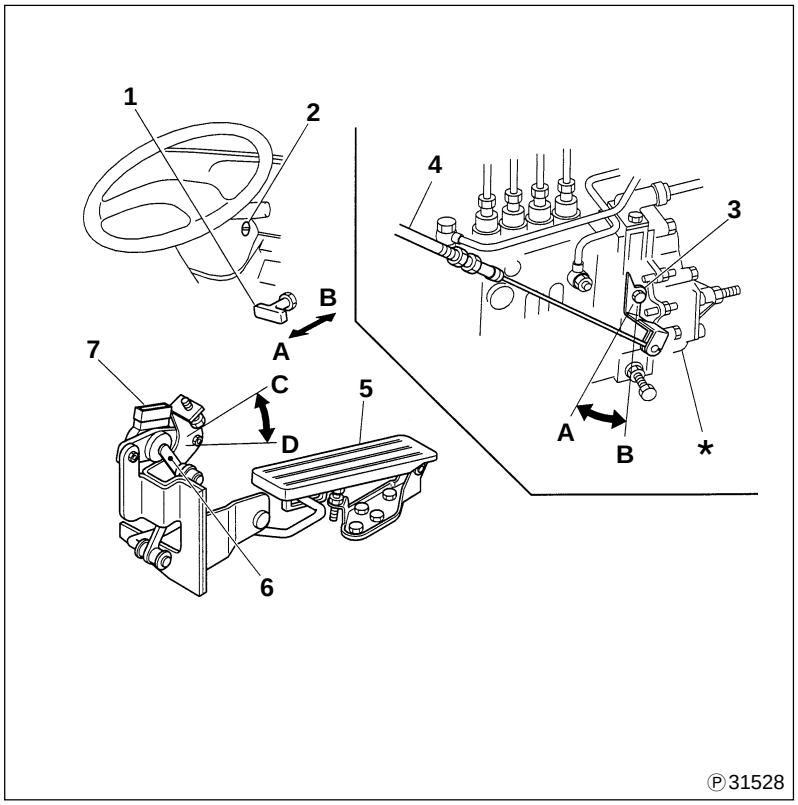
Fuel System (Flow of Fuel)



1 Injection nozzle
2 Fuel filter
3 Fuel tank
4 Water separator
5 Electronic governor
6 Feed pump
7 Injection pump
8 Overflow valve
9 Pre-stroke actuator

Fuel in fuel tank **3** is sucked up by feed pump **6** which is driven by the cam action of injection pump **7** and is filtered through fuel filter **2** which removes dirt and other foreign particles.
Filtered fuel is sent to the injection pump where the fuel pressure is boosted and injected through injection nozzle **1** into the combustion chamber.
When fuel pressure is higher than the specified value, overflow valve **8** opens to let the fuel return to the fuel tank.

Engine Control



1 Emergency engine stop handle
2 Starter switch
3 Engine stop lever
4 Engine stop cable
5 Accelerator pedal assembly
6 Lever
7 Accelerator pedal position sensor

*: Electric governor

A : Engine-stop position
B : Engine start-up position
C : Full-load position
D : Idling position

● **Accelerator switch**

The accelerator switch is integrated in the accelerator pedal position sensor **7**. It detects the pressing of accelerator pedal assembly **5**.

● **Accelerator pedal position sensor**

Accelerator pedal position sensor **7** detects the movement of the accelerator pedal assembly **5,** and sends an electric signal to the electronic governor control unit. Lever **6** of the accelerator pedal position sensor is constantly pulled by the return spring towards idle position **D**.

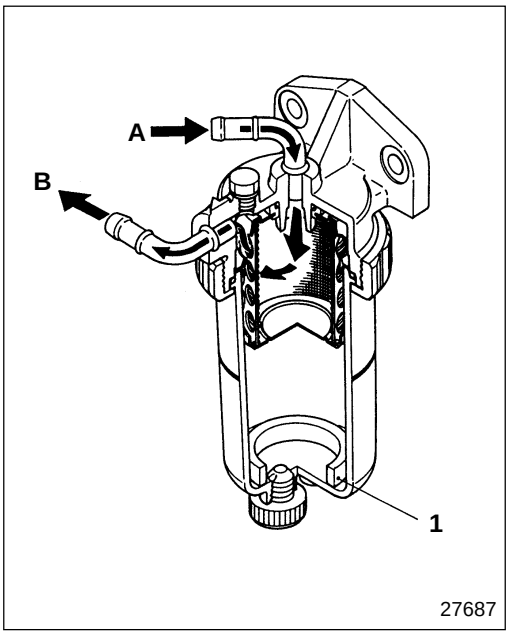
● **Emergency engine stop button**

In normal condition, turn starter switch **2** to the ACC position to electrically shut down the engine operation.
In the case the engine does not stop when the starter switch is turned to the ACC position due to malfunction of the electronic governor system or some other cause, stop the engine by pulling emergency engine stop handle **1** to move stop lever **3** of electronic governor * to engine-stop position **A**.

CAUTION⚠

When the engine is stopped by pulling engine stop handle 1, set starter switch 2 to the ACC or LOCK position to reset the control unit computer.
Restarting the engine without resetting the computer results in unstable engine speed control.

Water Separator

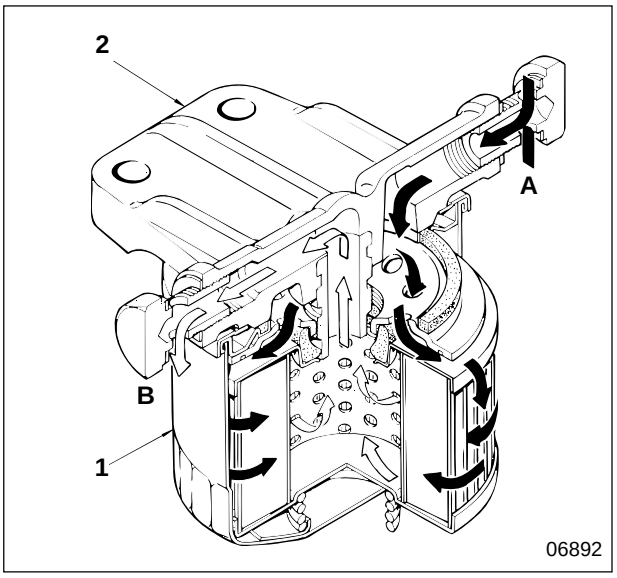


1 Water level ring

A : From fuel tank
B : To feed pump

The water separator is installed between the fuel tank and the feed pump. Any water present in the fuel is separated by the baffle plate and the screen assembly.

Fuel Filter

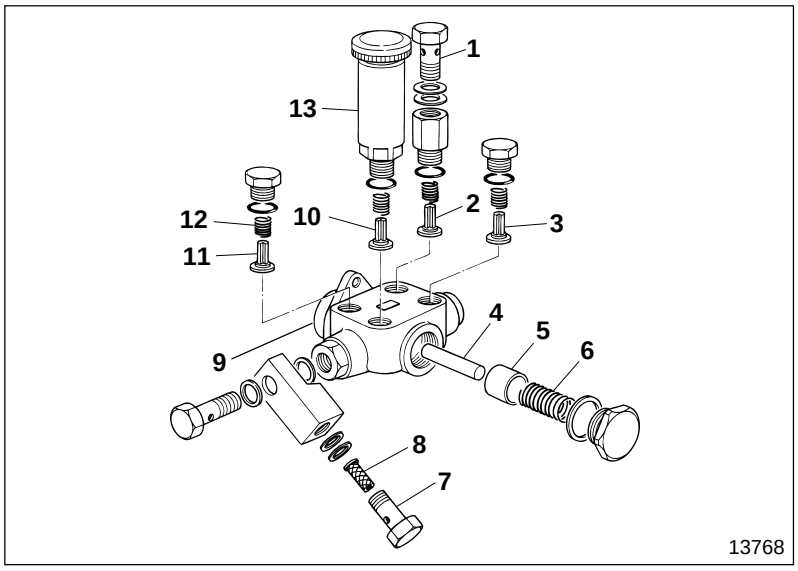


1 Fuel filter
2 Fuel filter head

A : From feed pump
B : To injection pump

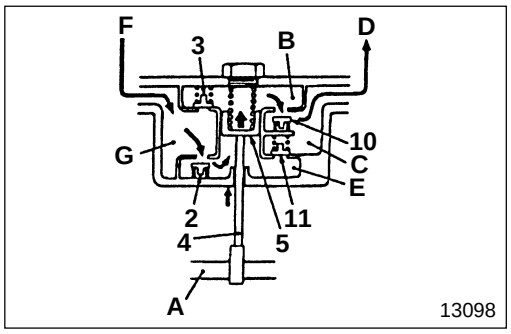
Pressurized fuel is delivered from the feed pump of the injection pump to the fuel filter which separates water from the fuel. Dirt and other foreign particles are removed from the fuel by fuel filter **1**.

Feed Pump

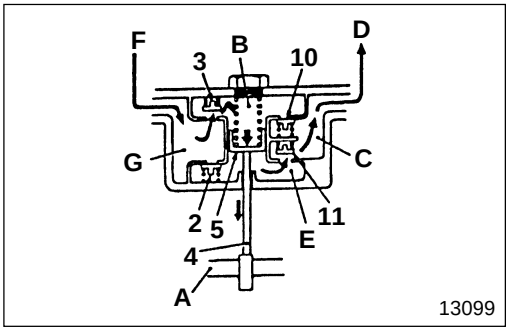


1 Eye bolt at fuel outlet
2 Check valve
3 Check valve
4 Push rod
5 Piston
6 Piston spring
7 Eye bolt at fuel inlet
8 Gauze filter
9 Feed pump housing
10 Check valve
11 Check valve
12 Check valve spring
13 Priming pump

- The feed pump is a double-action type pump which, with four check valves operating, sucks and discharges fuel during both strokes of pistons **5**.
- Push rod **4** makes contact with the injection pump camshaft directly, moving piston **5**.
- Priming pump **13** can be manually operated, when the injection pump is not operating, to suck up fuel and thus can be used for air bleeding.
- Gauze filter **8** eliminates large foreign particles from the fuel sucked up from the fuel tank to prevent clogging of the feed pump. This gauze filter must be cleaned with diesel fuel periodically.

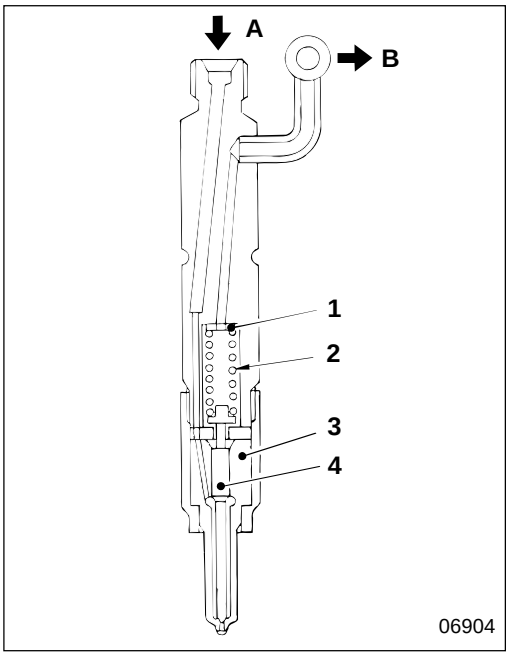


The rotation of injection pump camshaft **A**, pushes up push rod **4** and piston **5**, and the pressure in inner chamber **B** increases. This closes check valve **3**, and check valve **10** opens to let the fuel in inner chamber **B** flow through outer chamber **C** to fuel filter **D**.
When the pressure in inner chamber **E** decreases, check valve **11** closes, and check valve **2** opens to let fuel flow from fuel tank **F** through outer chamber **G** to inner chamber **E**.



When injection pump camshaft **A** rotates further, it pushes down push rod **4** and piston **5**, and the pressure in inner chamber **E** increases. This closes check valve **2**, and check valve **11** opens to let the fuel in inner chamber **E** flow through outer chamber **C** to fuel filter **D**.
When the pressure in inner chamber **B** decreases, check valve **10** closes, and check valve **3** opens to let fuel from fuel tank **F** flow through outer chamber **G** to inner chamber **B**.

Injection Nozzle



1 Washer
2 Spring
3 Nozzle tip
4 Needle valve

A : From injection pump
B : To fuel tank

- As the pressure of the fuel delivered from the injection pump overcomes the repercussive force of spring **2**, needle valve **4** is pushed up to allow the fuel to spray out the opening at the tip of the nozzle.
- Injection pressure can be adjusted by increasing or decreasing the number of washers **1**.

Possible causes \ Symptoms		Engine will not start	Engine difficult to start	Engine knocks	Unstable engine output	Insufficient engine output	Engine maximum speed too high	Unstable engine idling	Engine stops soon after starting	Engine does not reach maximum speed	Engine will not stop	Accelerator pedal too stiff	Defective fuel supply	Warning lamp illuminates	Remarks
Defective pre-stroke injection pump system														○	
Injection pump proper	Defective injection pump proper	○	○	○	○	○	○	○	○	○	○				*
	Defective mounting (poorly adjusted injection timing)		○		○	○		○							
	Defective overflow valve operation	○	○			○		○					○		
Defective pre-stroke actuator				○	○	○		○							
Fuel feed pump	Gauze filter clogged	○	○			○		○	○				○		
	Check valve not operating	○											○		
	Sticky piston	○											○		
	Sticky push rod	○											○		
	Defective check valve operation	○	○		○			○					○		
	Piston worn		○		○			○					○		
Defective governor				○	○	○	○	○	○	○	○				*
Injection nozzles	Sticky needle valve	○													
	Valve opening pressure too low	○								○					
	Blocked injection orifice	○		○		○		○		○					
	Poor airtightness in nozzle	○		○		○		○		○					
	Valve opening pressure too high			○											
	Broken spring				○	○									
	Defective sliding action in needle valve				○										
	Defective valve opening pressure				○										
	Weakness/deterioration in spring							○							
Fuel filter	Clogged filter	○			○			○	○						
Fuel tank empty		○													
Fuel pipes blocked and/or fuel leaking from connections		○													
Air or water in fuel system		○			○			○	○						
Low-quality fuel in use			○	○		○		○							

* : Must be serviced by BOSCH AUTOMOTIVE SYSTEMS service station.

Possible causes \ Symptoms		Engine will not start	Engine difficult to start	Engine knocks	Unstable engine output	Insufficient engine output	Engine maximum speed too high	Unstable engine idling	Engine stops soon after starting	Engine does not reach maximum speed	Engine will not stop	Accelerator pedal too stiff	Defective fuel supply	Warning lamp illuminates	Remarks
Engine control	Incorrect accelerator pedal stopper bolt adjustment					○				○					
	Rusted accelerator pedal arm											○			
	Defective accelerator pedal position sensor													○	
Cracked fuel pipe													○		
Leaky fuel tank													○		
Incorrect oil viscosity			○												Gr 12B
Incorrect valve clearance			○					○							Gr 11B
Defective cylinder head gasket			○					○							Gr 11B
Wear and/or carbon deposits on valve and valve seat			○					○							Gr 11B
Weakness/deterioration in valve spring			○					○							Gr 11B
Worn/damaged piston ring(s)			○					○							Gr 11B
Worn/damaged piston ring groove(s)			○					○							Gr 11B
Worn piston and cylinder liner			○												Gr 11B
Cooling system malfunctioning			○					○							Gr 14B
Defective starter switch			○												Gr 54

ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspection and Adjustment of Fuel Injection Timing

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Fuel injection timing (BTDC)	3°±0.5°	—	Adjust

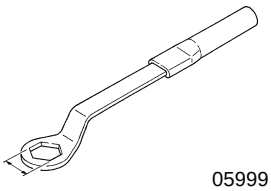
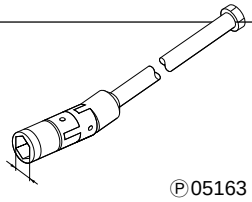
Tightening torque

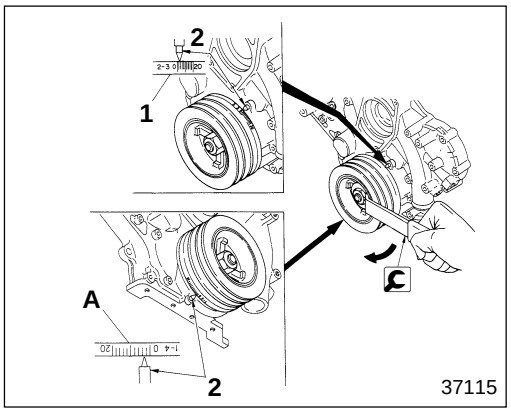
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Engine speed sensor	44 to 54 {33 to 40, 4.5 to 5.5}	—
4, 5	Injection pump mounting nut	29 to 39 {22 to 29, 3.0 to 4.0}	—

Special tools

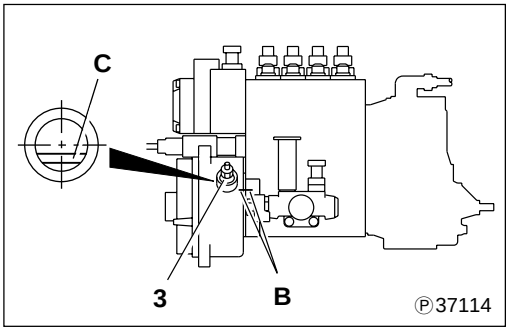
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Cranking handle Width across flats: 36 {1.42}  05999	MH061289 (Obtain Locally)	To crank engine
4, 5	Universal extension Width across flats: 14 {0.55}  Ⓟ05163	MH061099 (Obtain Locally)	For inspection and adjustment of fuel injection timing

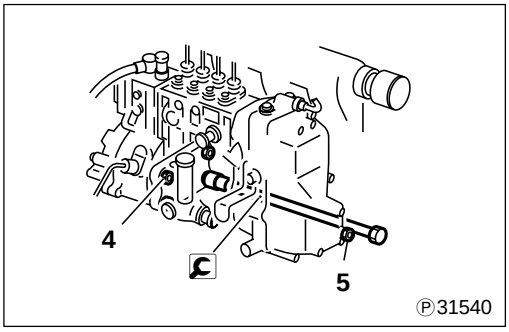


[Inspection]

- Bring the piston in engine cylinder No. 1 to the top dead center in compression stroke by turning crankshaft pulley **1** clockwise with cranking handle and aligning pointer **2** on the timing gear case with the specified fuel injection timing mark on stamped scale **A** on the crankshaft pulley.

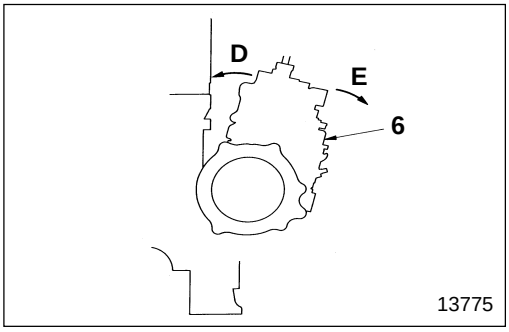


- Make sure that stamped line **B** on the injection pump is aligned with the stamped line on the timer case.
- Remove engine speed sensor **3**.
- Fuel injection timing is normal if internal engine speed pulser protrusion **C** is located at the center of the lower side of the engine speed sensor **3** mounting hole (drilled hole).
- If protrusion **C** is not positioned as described above, follow the procedure below to adjust.



[Adjustment]

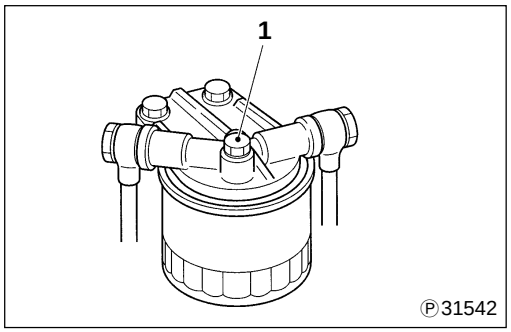
- Loosen injection pump mounting nuts **4** and **5**.
  4 : Nut (4 locations; flange section)
  5 : Nut (1 location)
  : Universal extension



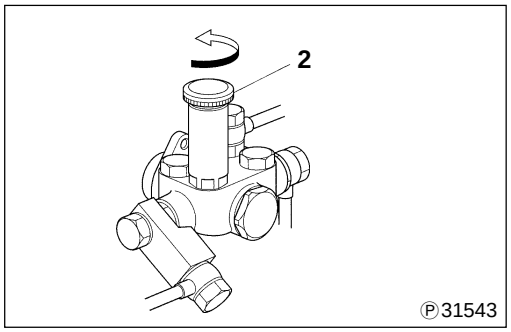
- If the fuel injection timing is retarded, tilt injection pump **6** toward crankcase side **D**.
- If the fuel injection timing is advanced, tilt injection pump **6** toward side **E** opposite to the crankcase.

ON-VEHICLE INSPECTION AND ADJUSTMENT

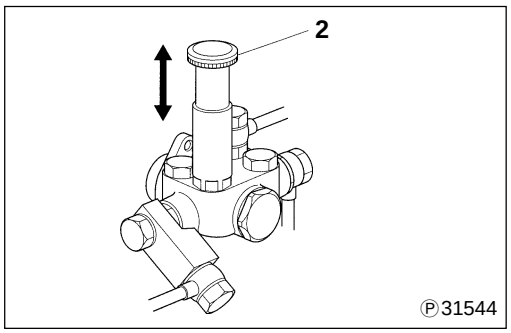
Bleeding Air from Fuel System



- Loosen the fuel filter air plug **1**.



- Turn the priming pump knob **2** counterclockwise until it pops up.
- Move the priming pump knob **2** up and down to feed fuel through the fuel filter.
- When fuel emerging from the fuel filter air plug **1** no longer contains air bubbles, tighten the air plug securely.

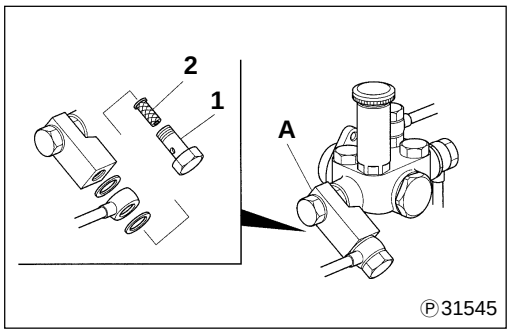


- Move the priming pump knob **2** up and down five or six more times. Then, press the knob down and screw it clockwise to lock it in position.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

WARNING

- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**

Cleaning Gauze Filter



- Remove the eyebolt **1** from the suction port side **A** of the fuel feed pump.
- Remove the gauze filter **2** from the eyebolt **1**.
- Clean the gauze filter **2** in diesel fuel.
- Refit the gauze filter **2** and eyebolt **1** in the opposite order to that in which they were removed.
- Bleed all air out of the fuel system.
- Start the engine and check that no fuel leakage occurs.

WARNING

- **To minimize the risk of fire, wipe up any spilled fuel.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After refitting the gauze filter, check that no fuel leakage occurs.**

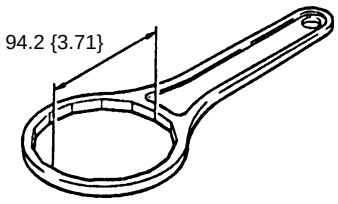
Replacing Fuel Filter

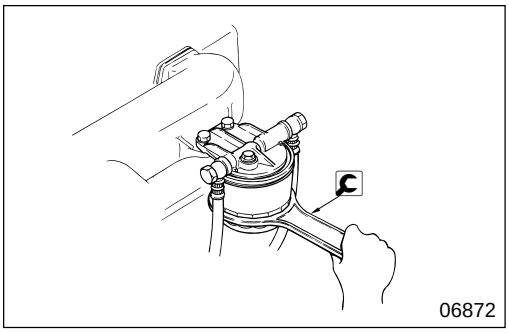
Lubricant

Location	Points of application	Specified lubricant	Quantity
1	Gasket between fuel filter and fuel filter head	Engine oil	As required

Special tool

Unit : mm {in}

Location	Tool name and shape	Part No.	Application
1	Filter wrench  01882	MH061572 (Obtain Locally)	Fuel filter removal


06872

[Removal]

: Filter Wrench

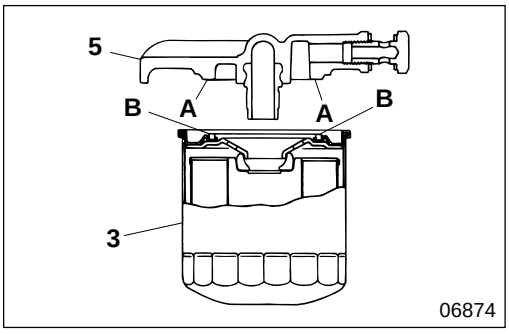
WARNING

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To minimize the risk of fire, wipe up any spilled fuel.**

[Installation]

WARNING

Use of an unsuitable fuel filter 1 can lead to fuel leaks and fires. Be sure to use a genuine filter.

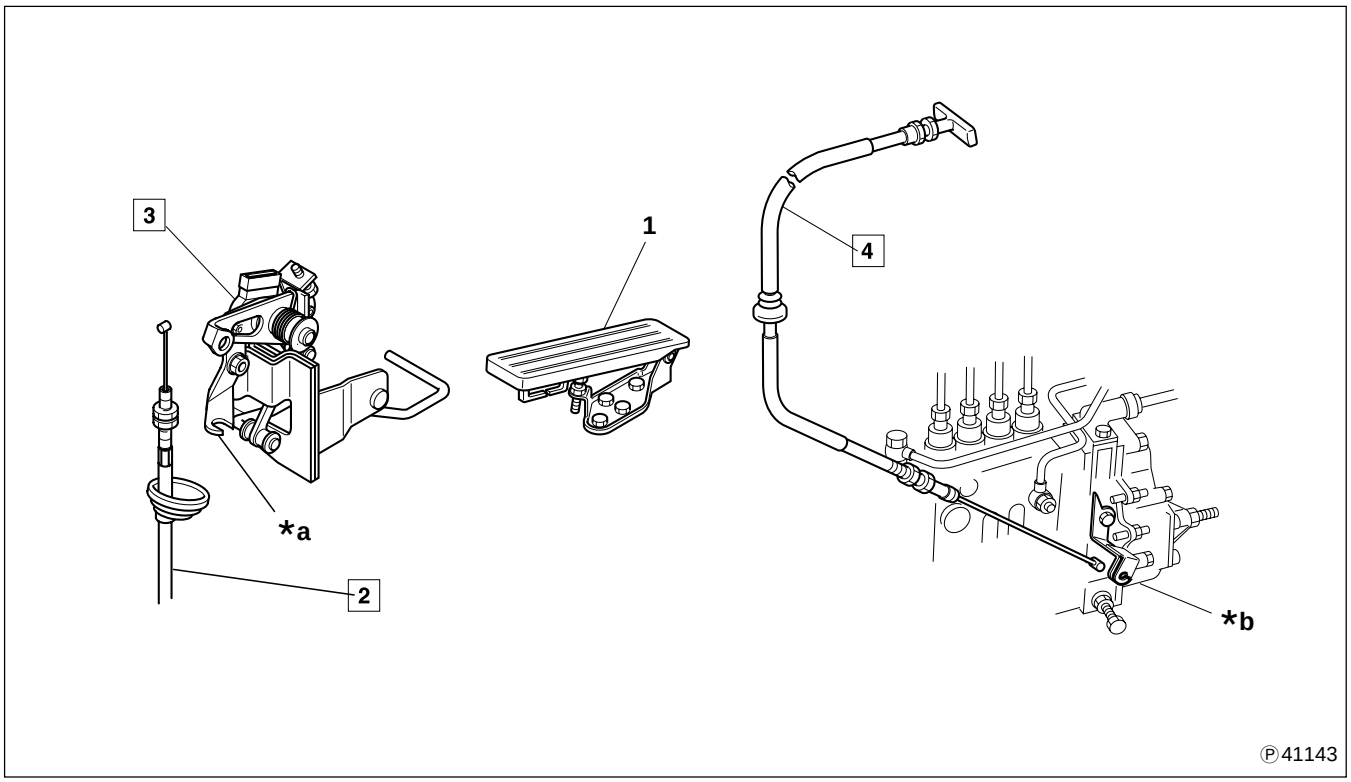


06874

- To install the fuel filter **3**, turn it until the gasket **B** touches surface **A** of the fuel filter head **5**. Then, tighten the filter by 1 to $1\frac{1}{8}$ turn. Be sure to turn the filter by hand.
- Bleed all air out of the fuel system. P13B-12

WARNING

After fitting the fuel filter 3, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.



● **Removal sequence**

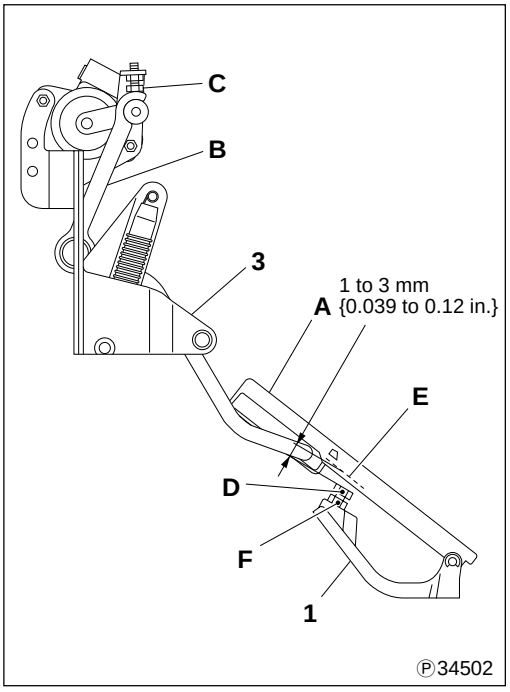
1 Accelerator pedal assembly 🕮 P13B-18
2 Engine control cable < Mixer >
3 Accelerator pedal position sensor assembly 🕮 P13B-19
4 Emergency engine stop cable

***a :** Lever and bracket assembly
***b :** Injection pump assembly

● **Installation sequence**

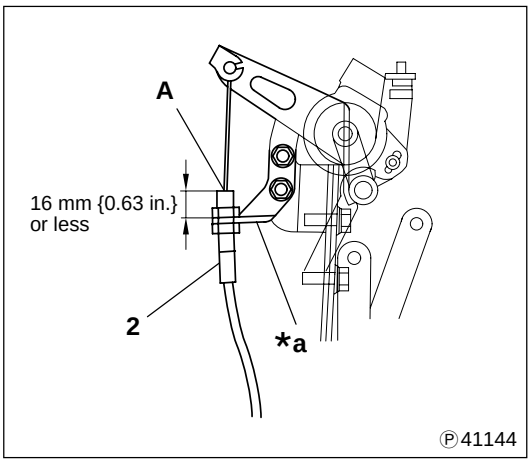
Follow the removal sequence in reverse.

◆ Service procedure



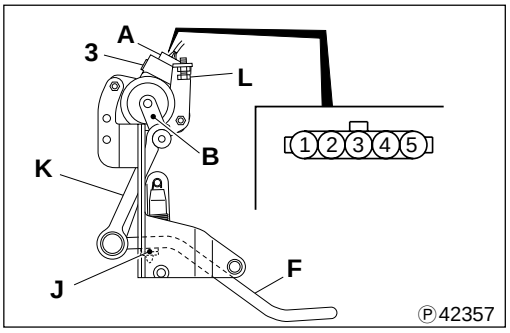
1 Installation of accelerator pedal assembly

- Fit the accelerator pedal assembly **1** onto the accelerator pedal position sensor assembly **3**.
- Depress the accelerator pedal **A** until the accelerator control extension **B** touches the stopper bolt **C** of the accelerator pedal position sensor assembly **3**.
- Check that the clearance between the stopper bolt **D** and the stopper bolt contact surface **E** of the accelerator pedal **A** is as shown in the illustration.
- Adjust the stopper bolt **D**, if necessary, to achieve the illustrated clearance. Lock the stopper bolt with the nut **F** after adjustment.



2 Installation of engine control cable (mixer)

Adjust the threaded section **A** of the engine control cable **2** to the dimension shown in the illustration and connect the cable to the lever & bracket assembly ***a**.



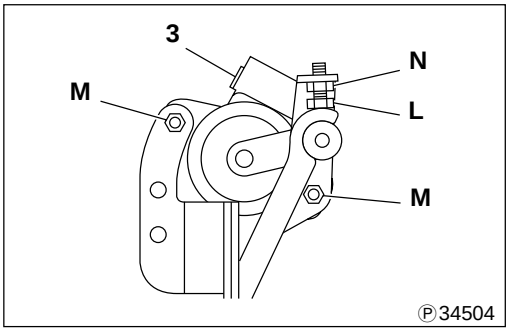
3 **Inspect the accelerator pedal position sensor**

[Inspection]
- Set the starter switch to ON.
- Measure the output voltage of the accelerator position sensor **3** from the back side of harness connector **A** according to the following table.

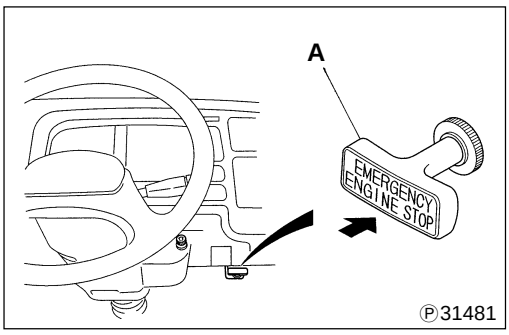
Lever **B** position		Accelerator Position Sensor I		Accelerator Position Sensor II		Accelerator Switch	
		②	①	②	⑤	②	③
		⊕	⊖	⊕	⊖	⊕	⊖
Standard value	Idling position **C**	0.85±0.1 V		0.85±0.1 V		4V or more	
	Accelerator switch operating position **D**	1.0±0.24 V		1.0±0.24 V		1V or less	
	Full load position **E**	4.0±0.1 V		4.0±0.1 V			

○——○ : There must be continuity between the pins.
⊕ , ⊖ : Polarity when voltage is measured
C: Where accelerator control arm **F** is in contact with stopper **J**
D: Where voltage across pins ② and ③ is reduced to 1V or less by slowly depressing the accelerator pedal
E: Where accelerator control extension **K** is in contact with stopper bolt **L**

- If the output voltage is out of the standard value range, adjust by the following procedures.

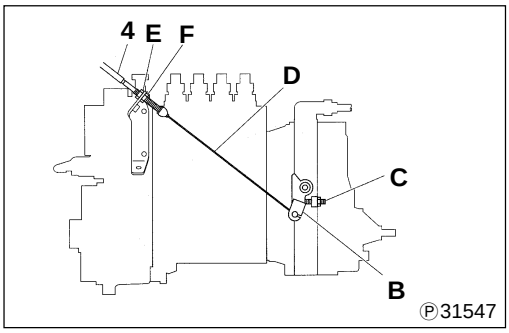


[Adjustment]
- Adjust the output voltage at the idling position **C** by loosening the screw **M** and moving the accelerator position sensor **3**.
  After the adjustment, retighten the screws.
- Adjust the output voltage at the full load position **E** by loosening the nut **N** and adjusting the stopper bolt **L**.
  After the adjustment, lock the bolt with the nut.



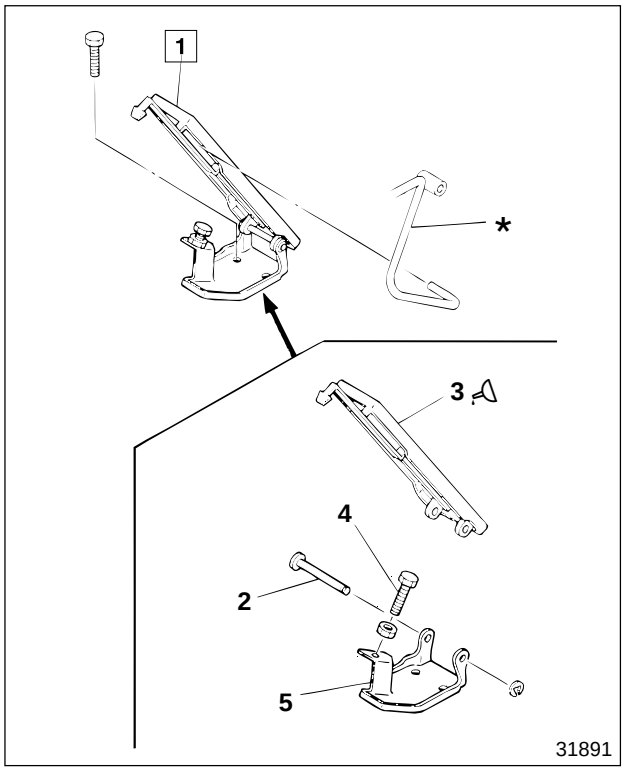
4 **Installation of the emergency engine stop cable**

- Mount stop button **A** on emergency engine stop cable **4** and press the button firmly in position.



- With stop lever **B** of the governor contacting stopper bolt **C**, adjust nut **E** so that inner cable **D** of emergency stop cable **4** is taught. Then, tighten nut **F** to secure it in place.
- After installation, start the engine. Pull the stop cable button to make sure that engine stops operating.

Accelerator Pedal Assembly



● **Disassembly sequence**

1 Accelerator pedal assembly
2 Clevis pin
3 Accelerator pedal
4 Stopper bolt
5 Accelerator pedal bracket

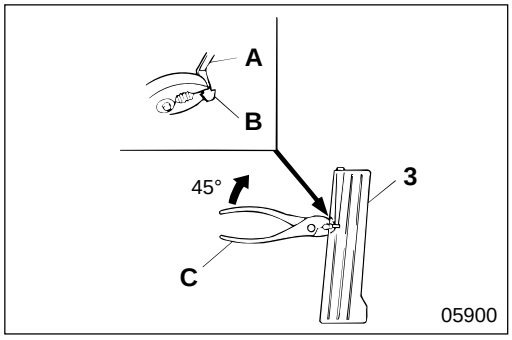
***** : Accelerator pedal position sensor assembly P13B-19

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Kinds	Quantity
3	Slide-contacting surfaces of accelerator pedal and bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required



◆ Service procedure

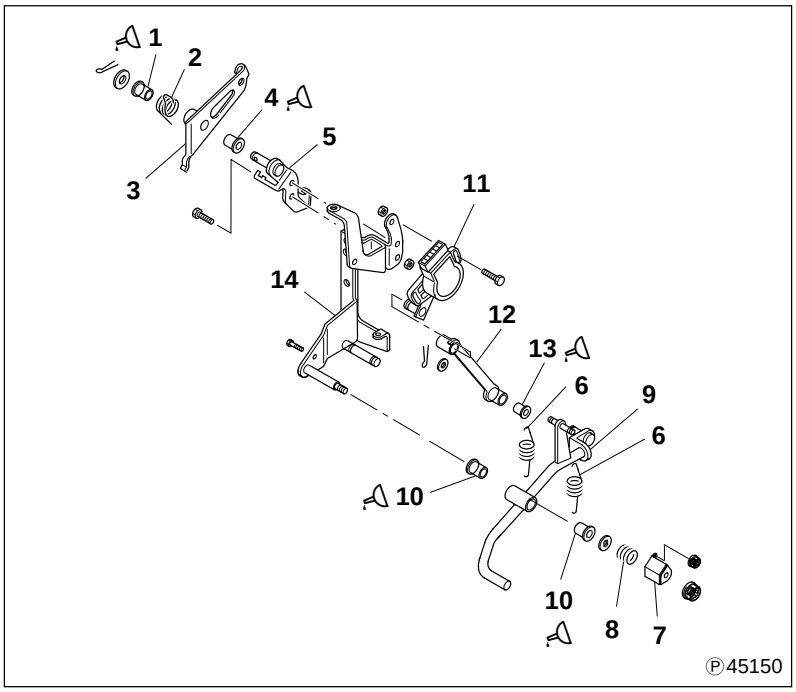
1 **Removal of accelerator pedal assembly**

Pinch hook **B** of stopper **A** of accelerator pedal **3** using pliers **C** and rotating approximately 45° pull out the stopper towards the front of the vehicle.

CAUTION⚠

Take care not to damage stopper A itself during removal, do not pull it out too forcibly.

Accelerator Position Sensor Assembly



● **Removal sequence**

1 Bushing < Mixer >
2 Spring < Mixer >
3 Lever assembly < Mixer >
4 Bushing < Mixer >
5 Bracket assembly < Mixer >
6 Return spring
7 Shaft cover
8 Spring
9 Accelerator control arm
10 Bushing
11 Throttle position sensor
12 Accelerator control extension
13 Bushing
14 Bracket

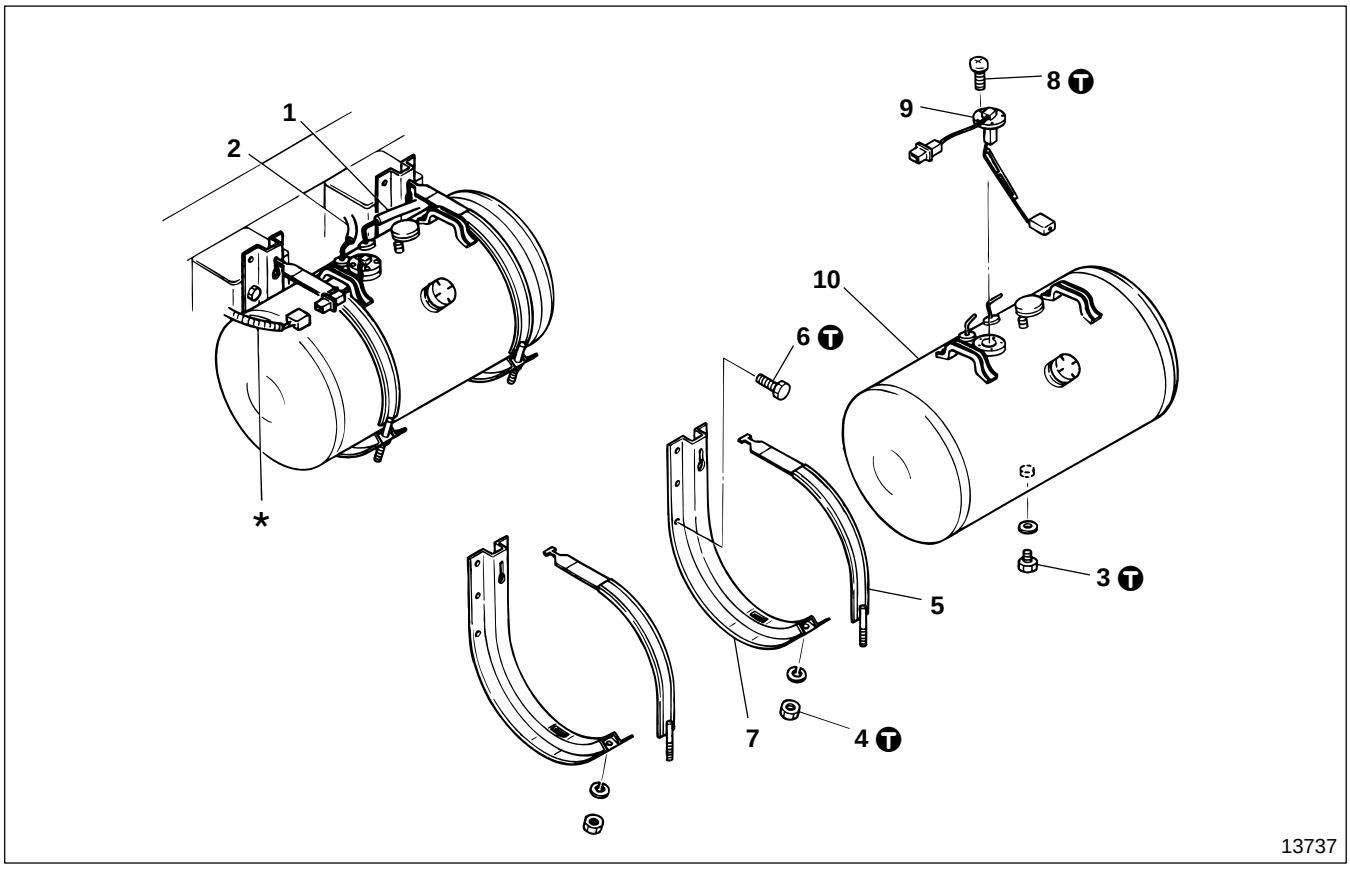
● **Installation sequence**

Follow the removal sequence in reverse.

Lubricant

Location	Points of application	Specified Lubricant	Quantity
1, 4, 10, 13	Slide-contacting surfaces of bushing and support assembly	Chassis grease [NLGI No.1 (Ca soap)]	As required

FUEL TANK



● **Work before removal**

WARNING ⚠

- **Keep naked lights away because of the risk of explosion.**
- **Wipe up any spilled fuel beacuase it can cause a fire.**

NOTE

Drain fuel before working on the job.

● **Removal sequence**

1 Suction hose
2 Return hose
3 Drain plug
4 Nut
5 Fuel tank band
6 Bolt
7 Fuel tank bracket
8 Screw
9 Fuel gauge unit Gr 54
10 Fuel tank
*: Chassis harness Gr 54

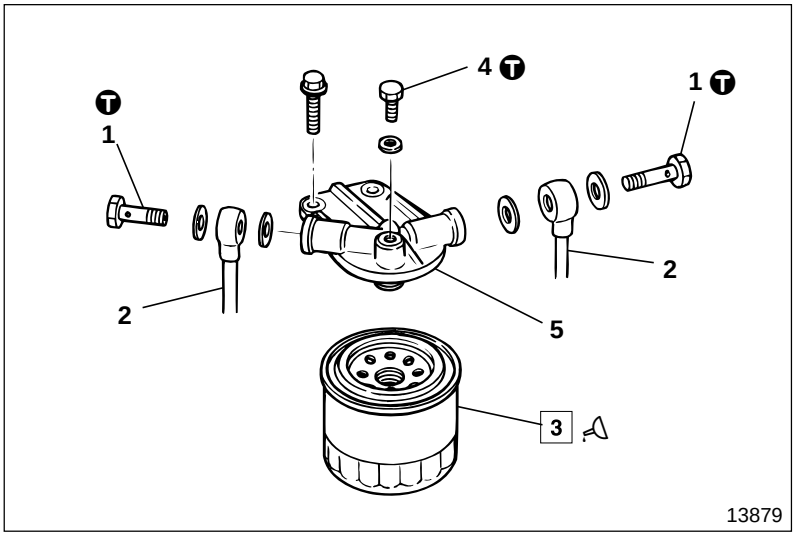
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain plug	59 to 98 {43 to 72, 6 to 10}	—
4	Nut (Fuel tank band mounting)	5.9 to 9.8 {4.3 to 7.2, 0.6 to 1.0}	—
6	Bolt (Fuel tank bracket mounting)	59 to 78 {43 to 58, 6 to 8}	—
8	Screw (Fuel gauge sending unit mounting)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	—



● **Disassembly sequence**

1 Eye bolt
2 Fuel feed pipe
3 Fuel filter
4 Air vent plug
5 Fuel filter head

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

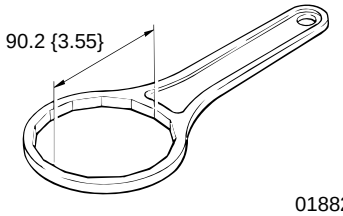
Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt	25 to 34 {18 to 25, 2.5 to 3.5}	—
4	Air vent plug	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—

Lubricant

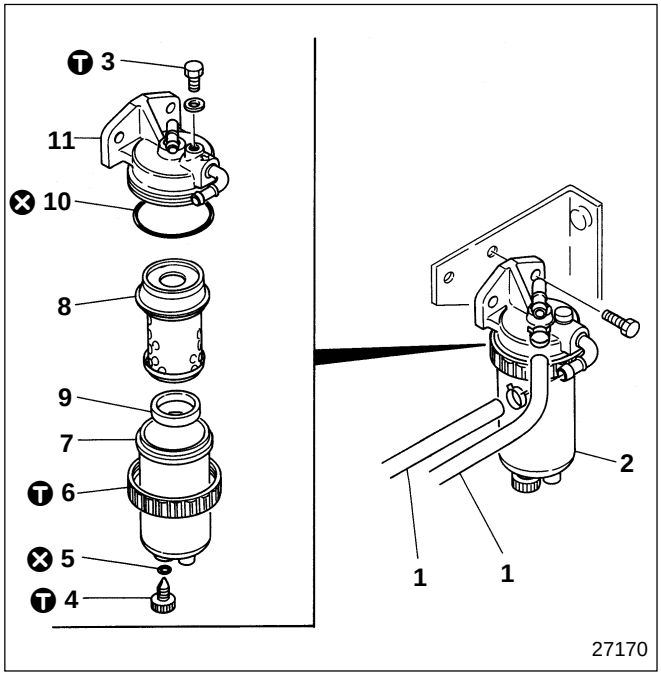
Location	Points of application	Specified Lubricant	Quantity
3	Gasket contact surfaces of fuel filter and fuel filter head	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Filter wrench  01882	MH061509 (Obtain Locally)	Removal of fuel filter

WATER SEPARATOR



● **Disassembly sequence**

1 Fuel hose
2 Water separator assembly
3 Air vent plug
4 Drain plug
5 O-ring
6 Ring nut
7 Case
8 Screen assembly
9 Water level ring
10 O-ring
11 Head

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Operations after assembly**

Bleed all air out of the fuel system. 📖 P13B-12

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After assembling the water separator, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.**

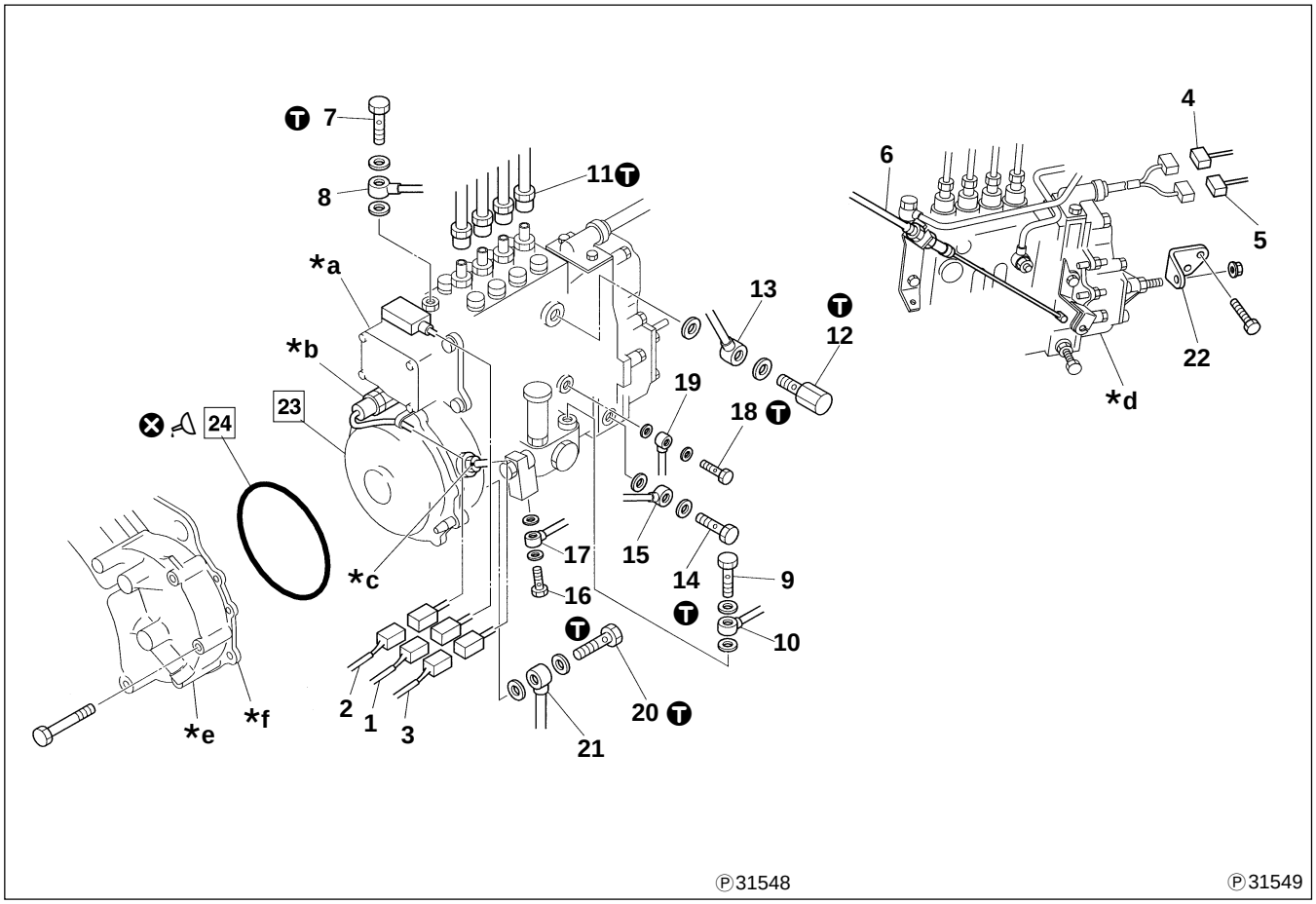
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Air vent plug	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—
4	Drain plug	3 to 4 {2.2 to 2.9, 0.3 to 0.4}	—
6	Ring nut	23 to 27 {17 to 20, 2.3 to 2.8}	—

M E M O

INJECTION PUMP



● **Removal sequence**

1 Harness (6 pins)
2 Harness (4 pins)
3 Harness (3 pins)
4 Harness (10 pins)
5 Harness (3 pins)
6 Engine stop cable 🕮 P13B-17
7 Eye bolt
8 Fuel feed pipe
9 Eye bolt
10 Fuel feed pipe
11 Injection pipe
12 Overflow valve
13 Fuel return pipe
14 Eye bolt
15 Oil pipe
16 Eye bolt
17 Fuel suction pipe
18 Eye bolt
19 Oil pipe
20 Eye bolt
21 Oil pipe
22 Pump stay
23 Injection pump assembly
24 O-ring

***a** : Pre-stroke actuator Gr 13EB
***b** : Sub-control rod position sensor Gr 13EB
***c** : Engine speed sensor Gr 13EB
***d** : Electronic governor Gr 13EB
***e** : Timing gear case Gr 11B
***f** : Front plate Gr 11B
⊗ : Non-reusable parts

WARNING⚠

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any spilled fuel because it can cause a fire.**

CAUTION⚠

- **Be sure to protect all openings by covering them after removal of hoses and pipes because the engine performance is adversely affected if dirt and foreign particles enter injection pump assembly 23.**
- **Do not hold the control lever when lifting injection pump assembly 23. Also, do not remove the control lever because removal of the lever might cause poor performance of the pump.**

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

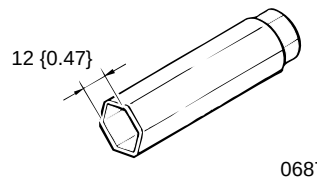
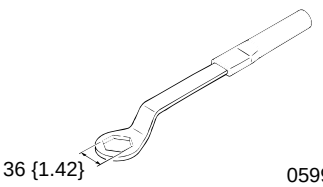
Location	Parts to be tightened	Tightening torque	Remarks
6	Eye bolt (Fuel feed pipe mounting)	25 to 29 {18 to 22, 2.5 to 3}	—
9	Eye bolt (Fuel feed pipe mounting)	25 to 29 {18 to 22, 2.5 to 3}	—
11	Injection pipe (Union nut fastening)	29 to 49 {22 to 36, 3 to 5}	—
12	Overflow valve	25 to 29 {18 to 22, 2.5 to 3}	—
14	Eye bolt (Oil pipe mounting)	9.8 to 13 {7.2 to 9.4, 1 to 1.3}	—
16	Eye bolt (Fuel suction pipe mounting)	25 to 29 {18 to 22, 2.5 to 3}	—
18	Eye bolt (Oil pipe mounting)	20 to 29 {14 to 22, 2 to 3}	—
20	Eye bolt (Oil pipe mounting)	20 to 29 {14 to 22, 2 to 3}	—

Lubricant

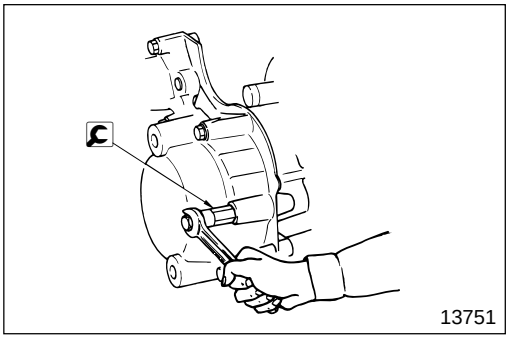
Location	Points of application	Specified Lubricant	Quantity
24	Entire body of O-ring	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
23	Socket wrench  06876	31391-14100 (Obtain Locally)	Removal and installation of injection pump assembly
—	Cranking handle  05999	MH061289 (Obtain Locally)	Cranking of engine

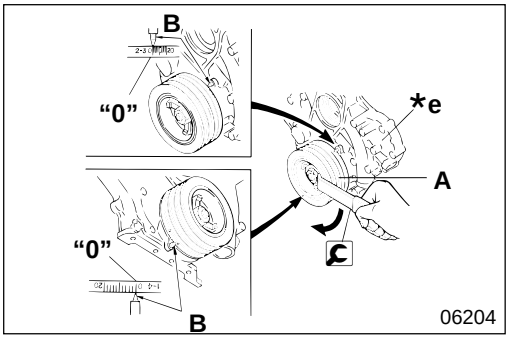
◆ Service procedure



23 **Injection pump assembly**

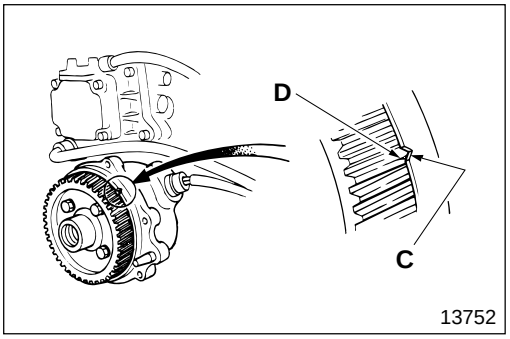
[Removal]

- Refer to Removal sequence on page 13B-62.

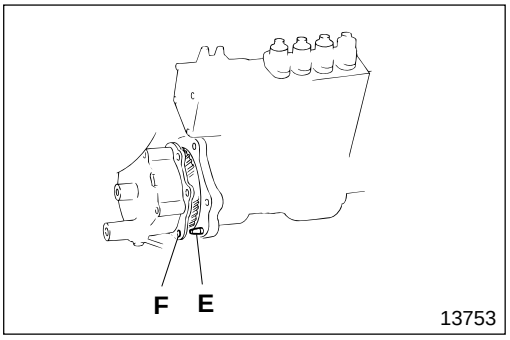


[Installation]

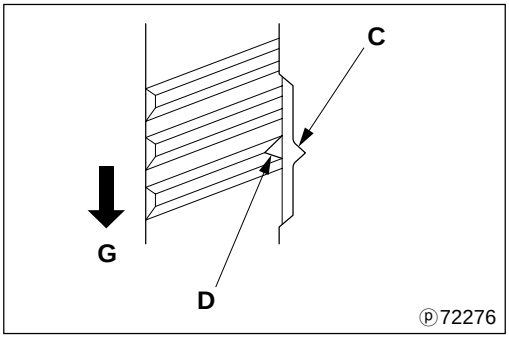
- To bring No. 1 cylinder piston to top dead center in the compression cycle, align pointer **B** of timing gear case ***e** with indent mark "**0**" on crankshaft pulley **A** by turning the crankshaft pulley clockwise using cranking handle. At this point, make sure that the intake and exhaust valves of No.1 cylinder are not depressed by the push rod. If they are depressed, make another full rotation of the crankshaft pulley.



- Align indent **C** on the timer case with indent **D** on the injection pump gear.

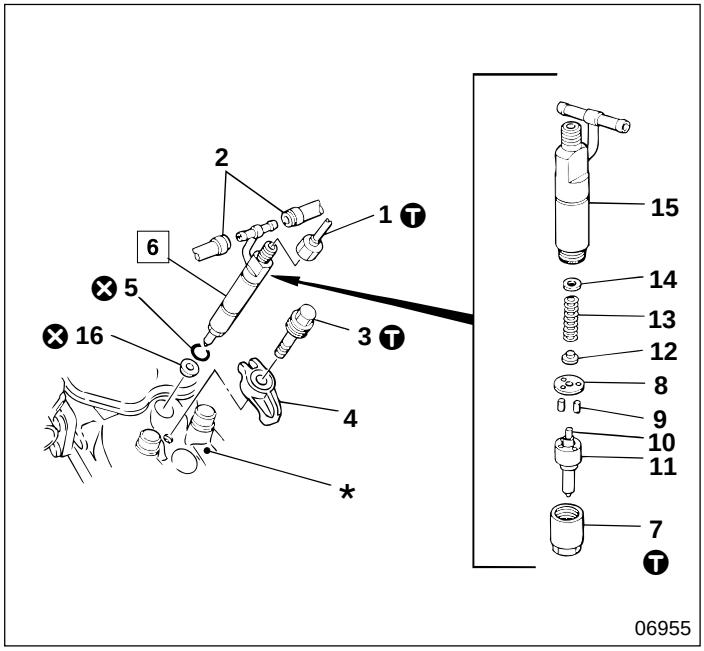


- By aligning guide bar **E** of the timer case with guide hole **F** of the front plate, push in the idler gear up to a fraction of an inch short of engaging the injection pump gear.



- Making sure that alignment mark **C** on the timer case aligns with indent **D** on the injection pump gear, push in the injection pump assembly.
  As this installation is taking place, the indent tooth **D** will turn in direction **G**.

INJECTION NOZZLE



● **Inspection before disassembly**

P13B-29

● **Disassembly sequence**

1 Injection pipe
2 Leak-off pipe
3 Bolt
4 Bridge
5 O-ring
6 Injection nozzle assembly
7 Retaining nut
8 Tip packing
9 Straight pin
10 Needle valve
11 Nozzle
12 Pressure pin
13 Spring
14 Adjusting shim
15 Nozzle holder
16 Nozzle gasket

* : Cylinder head Gr 11B
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

Wipe up any spilled fuel because it can cause a fire.

CAUTION

- **Be sure not to touch the slide-contact area of needle valve 10 because any scratches or corrosion might spoil the airtightness of nozzle 11. It must be handled with utmost care.**
- **Never change the combination of needle valve 10 and nozzle 11 as they are a matched set.**
- **Be sure to protect all openings by covering them after removal of hoses and pipes because the engine performance is adversely affected if dirt and foreign particles enter injection nozzle assembly 6.**

NOTE

Remove carbon deposits and clean injection nozzle assembly 6 before working on it, then test the injection pressure and jet spray condition, and check for fuel leakage before disassembly. If no fault is found, do not disassemble.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
6	Valve opening pressure	21.6 MPa {3130 psi, 220 kgf/cm^2}	—	Adjust

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Union nut (Injection pipe mounting)	25 {18, 2.5}	—
3	Bolt (Bridge mounting)	25 {18, 2.5}	—
7	Retaining nut	34 to 44 {25 to 33, 3.4 to 4.5}	—

Special tools

Location	Tool name and shape	Part No.	Application
—	Nozzle cleaning tool	★105789-0010	Cleaning of injection nozzle assembly

★ BOSCH AUTOMOTIVE SYSTEMS code number

◆ Service procedure

● Inspection before disassembly

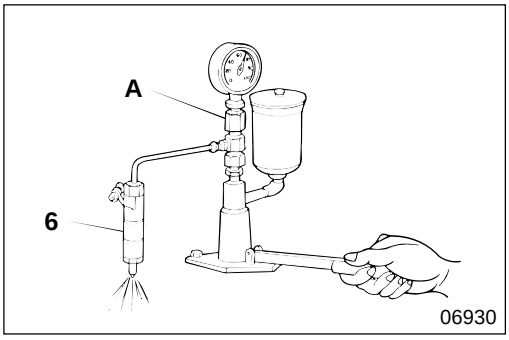
Attach injection nozzle assembly **6** to nozzle tester **A**, and conduct the following inspection.

WARNING⚠

Never touch the spray from nozzle 11 or let your hands get too close to the spray point during the test.

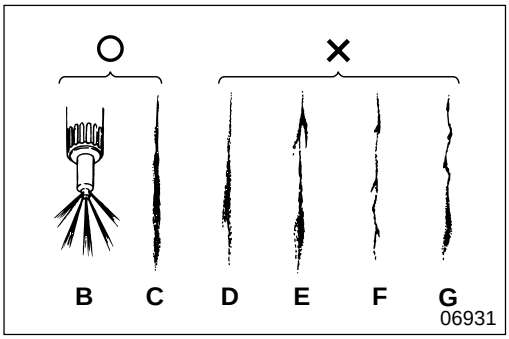
NOTE

Before inspection, bleed the air out in a couple of bursts by pumping nozzle tester A lever.



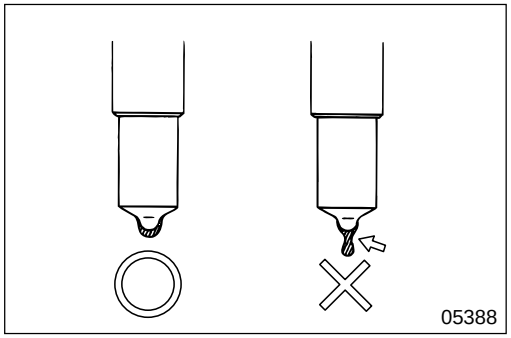
(1) Valve opening pressure

- Raise the pressure of nozzle tester **A** by operating the lever, and measure the pressure that the gauge registers when the pressure is released which will be observed by the sudden movement of the gauge indicator.
- If the measured value deviates from the standard value, disassemble the nozzle and clean, and adjust it using adjusting shims **14**.
- Variation of 0.05 mm {0.0020 in.} thickness in adjusting shims **14** causes a difference of 735 kPa {105 psi, 7.5 kgf/cm^2} of pressure, for example, to alter the pressure for 98 kPa {14 psi, 1 kgf/cm^2}, a thickness of 0.0067 mm {0.00026 in.} is required.
- If the performance cannot reach the standard value even after adjustment, replace injection nozzle assembly **6**.



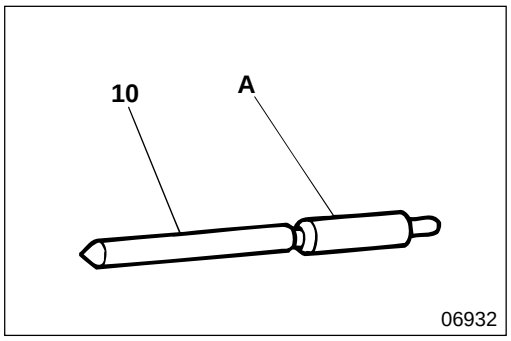
(2) Spray condition

- Test injection spray condition by quick lever actions of nozzle tester **A**, 4 to 6 actions per second.
  - **B** : Even spray from all five orifices (Good)
  - **C** : Even and symmetrical spray (Good)
  - **D** : Asymmetrical spray (Faulty)
  - **E** : Spray direction deviates from the nozzle axis line (Faulty)
  - **F** : Thin and insufficient spray (Faulty)
  - **G** : Irregular spray (Faulty)
- If faulty spray cannot be corrected, disassemble injection nozzle assembly **6** and clean every part and repeat the test.
  If faulty spray still occurs after repeating test, replace the injection nozzle assembly.
- Make sure that there is no post-spray dripping after injection.



(3) Fuel air tightness and leakage at related contact points

- Maintain interior pressure of nozzle at 1960 kPa {285 psi, 20 kgf/cm^2} lower than the valve opening pressure, and check and see if any fuel seeps out of the nozzle tip within 10 seconds.
- If any fault is found, disassemble injection nozzle assembly **6** and clean every part and repeat the test. If any fault is still found, replace the injection nozzle assembly.

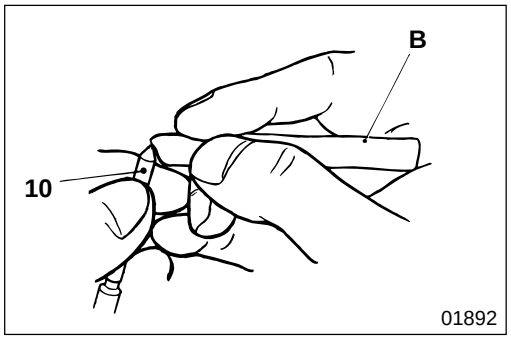


6 Injection nozzle assembly

[Disassembly]

CAUTION

- **Be sure not to touch sliding part A of needle valve 10 with your hands.**
- **Never change the combination of removed needle valve 10 and nozzle 11 as they are a matched set.**



[Cleaning]

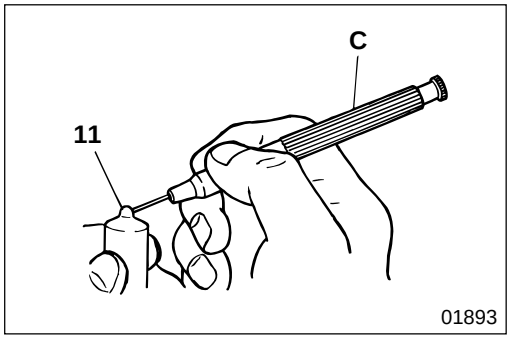
Clean needle valve **10** and nozzle **11** with gas oil (cleaning solvent).

Remove carbon deposits with cleaning tool in the following manner:

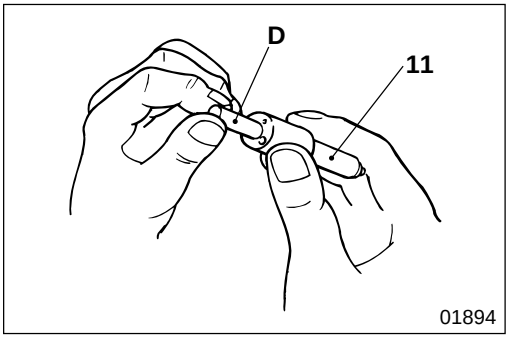
- Clean needle valve **10** by removing carbon deposits from its tip using cleaning bar **B** of cleaning tool.

CAUTION

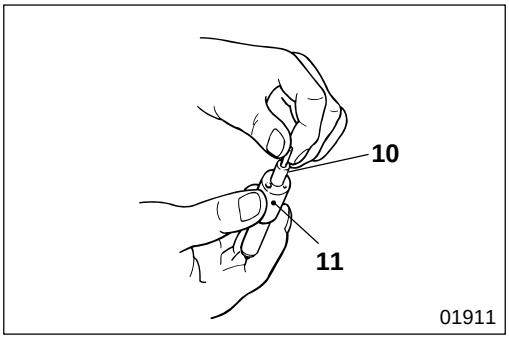
Never use a wire brush or hard steel for cleaning.



- To clean nozzle **11**, remove carbon deposits from the orifices of the nozzle using needle cleaner **C** of cleaning tool, by inserting it into the orifices and turning it.
  Needle cleaner diameter : ø0.25 mm {0.0098 in.} or less



- Clean the seat of nozzle **11** using cleaning needle **D** of [tool] cleaning tool.
- Use a carbon remover tool to remove burnt-on carbon deposits.



[Inspection]

- Immerse needle valve **10** and nozzle **11** in gas oil (cleaning solvent) and clean them thoroughly.
- Check and see if needle value **10** drops by its own weight into the nozzle from the position where a third of its length is pulled out. (Repeat this several times rotating the needle valve.)
- If needle valve **10** does not drop smoothly, repeat cleaning and repeat the test. If any fault is still found, replace both the needle valve and nozzle **11** together as a set.

MITSUBISHI
FUSO

Group 13EA

Electronically Controlled Fuel System

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWSE0101-13EA

INDEX

SPECIFICATIONS 13EA- 2

STRUCTURE AND OPERATION
1. General 13EA- 3
2. Electronic Control System 13EA- 5
3. Pin Configuration of Engine Electronic Control Unit 13EA- 9

TROUBLESHOOTING
1. Inspection Procedures 13EA-14
2. Connection of Multi-Use Tester II 13EA-16
3. Reading and Erasing Diagnostic Trouble Codes 13EA-17
4. Diagnostic Trouble Codes and Check Items 13EA-19
5. Service Data of Multi-Use Tester II 13EA-28
6. Actuator Test by Mutil-Use Tester II 13EA-30
7. Checks at Connector of Electronic Control Unit 13EA-32
8. Checks on Intermittent Troubles 13EA-35

INSPECTION OF ELECTRICAL EQUIPMENT 13EA-36

LOCATIONS OF PARTS 13EA-44

ELECTRICAL WIRING DIAGRAM 13EA-49

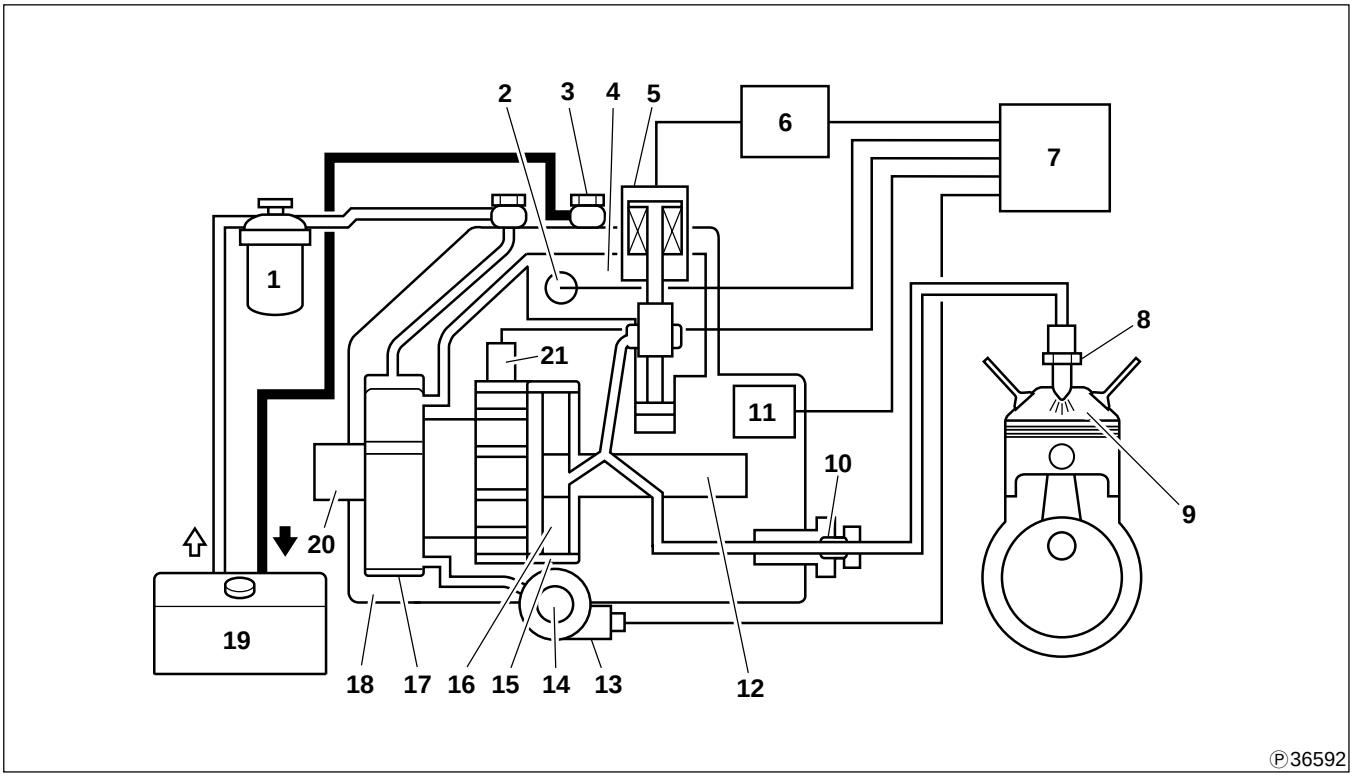
SPECIFICATIONS

Item			Specification
Injection pump assembly	Manufacturer		DENSO
	Model		V4
	Type		Distribution type electronically controlled pump
	Spill valve (Solenoid valve)		Electronically controlled type
	Timer	Control scheme	High pressure chamber control
		Drive method	Timer control valve (TCV)
	Overflow valve	Valve opening pressure kPa (psi, kgf/cm^2)	343 {49.8, 3.5}
	Feed pump	Type	Vane type
		Theoretical delivery rate cc {cu.in.}	6.4 {0.39} (per rotation)
	Fuel temperature sensor		Provided
	Engine speed sensor		Provided
Engine control unit	Manufacturer		DENSO
	Rated voltage V		12
Electrical drive unit	Manufacturer		DENSO
	Rated voltage V		12

1. GENERAL

The V4 system adopts a distribution type injection pump, which features small size and light weight and yet high speed, as well as an electronic control unit which controls the fuel injection rate, fuel injection timing, etc., thereby operating the engine in an optimum condition.

Theory of Operation

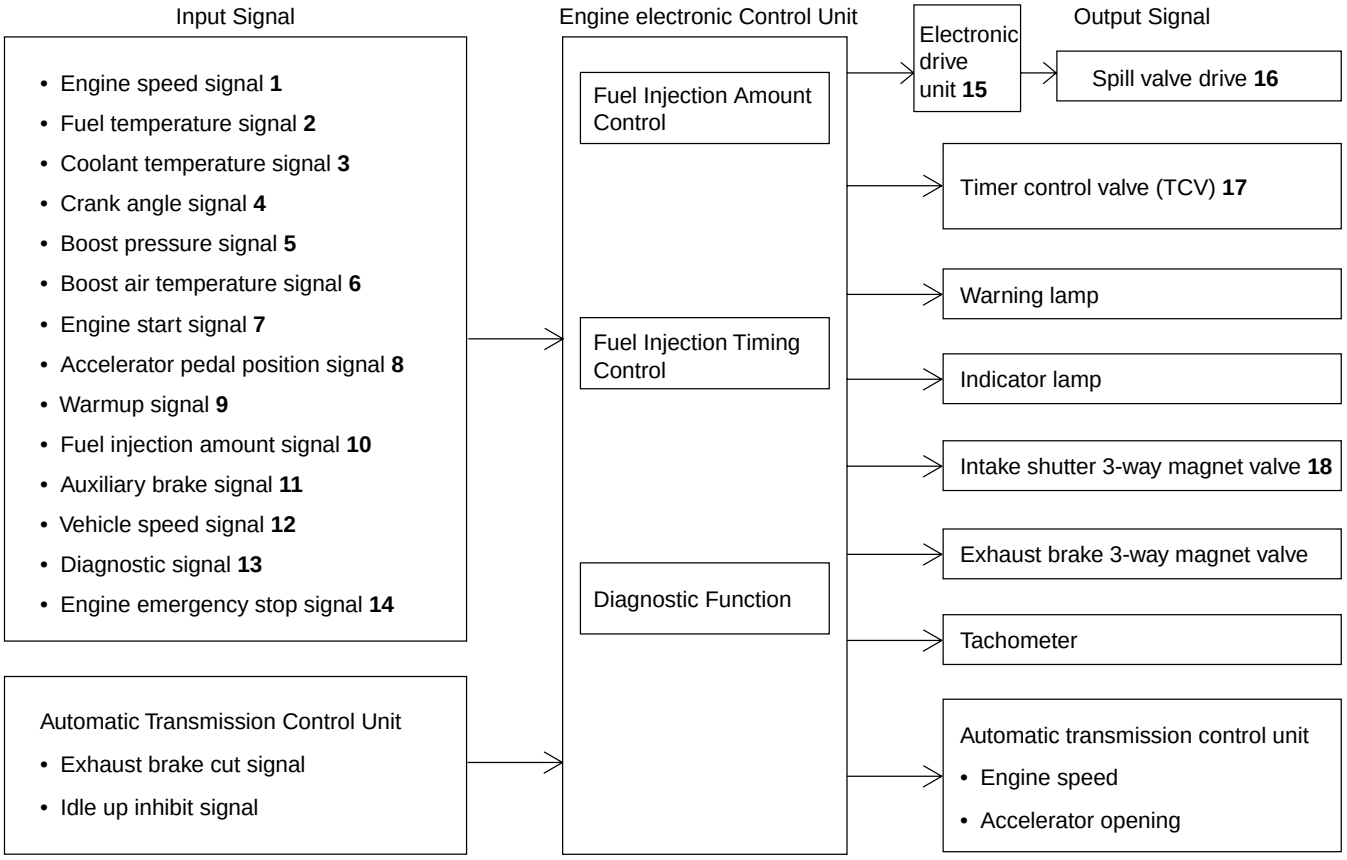


1 Fuel filter
2 Fuel temperature sensor
3 Overflow valve
4 Pump chamber
5 Spill valve
6 Electronic drive unit
7 Engine electronic control unit
8 Injection nozzle
9 Fuel chamber
10 Delivery valve
11 Injection rate adjusting read-only memory
12 Rotor
13 Timer control valve
14 Timer piston
15 Inner cam
16 Plunger
17 Feed pump
18 Injection pump proper
19 Fuel tank
20 Drive shaft
21 Engine speed sensor

- The feed pump **17** in the injection pump proper **18** pumps up the fuel from the fuel tank **19**, keeping the inside of the injection pump full of the fuel at all times.
- The rotor **12** rotates in the inner cam **15**.
- The electrical drive unit **6** converts the spill valve **5** drive signal delivered from the engine electronic control unit **7** into a high voltage signal to enhance the responsiveness of the spill valve **5**.
- The fuel injection rate is increased or reduced by adjusting the opening time of the spill valve **5**.
- When the spill valve **5** is opened, the inside of the rotor **12** is filled with the fuel.
- After it has been filled, the spill valve **5** closes to confine the fuel in the rotor **12**. In this condition, as the drive shaft **20** rotates, the fuel is pressurized by the inner cam **15** and plunger **16** and fed through the delivery valve **10** to the injection nozzle **8** from which it is injected.
- Then the spill valve **5** opens, and a resultant decline in the fuel pressure in the rotor **12** causes the delivery valve **10** to close, thereby bringing the fuel injection to an end.
- The overflow valve **3** returns the fuel to the fuel tank **19** when the fuel pressure in the injection pump exceeds a predetermined value.
- The fuel injection timing is controlled by the timer control valve **13** which controls the fuel pressure acting on the timer piston **14**.
- The timer control valve **13** is activated by commands from the engine electronic control unit **7**.

2. ELECTRONIC CONTROL SYSTEM

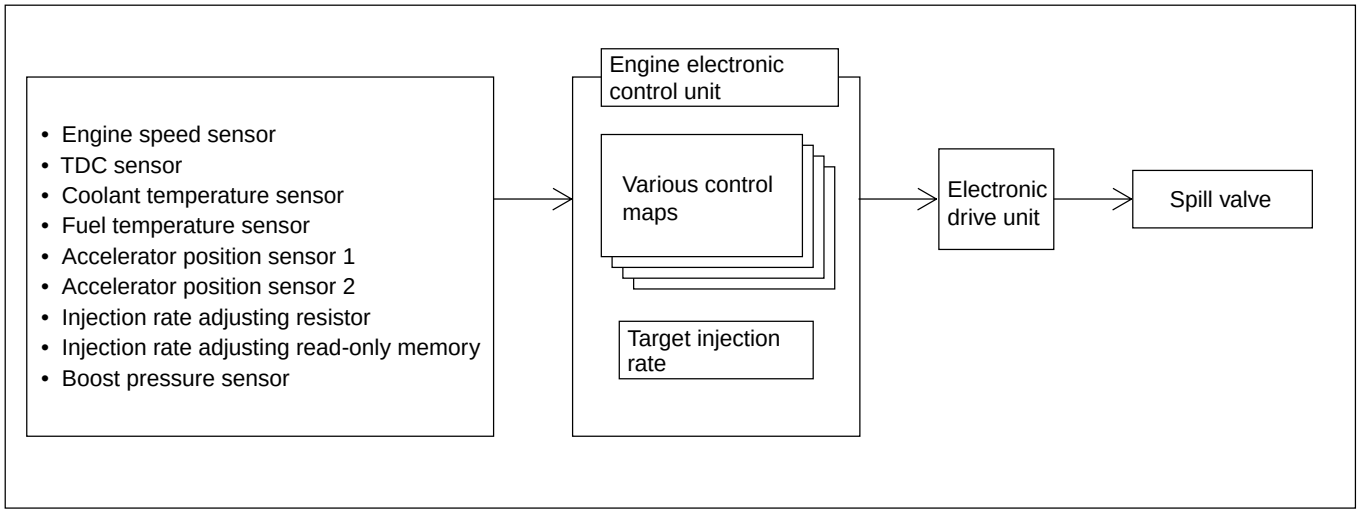
2.1 System Block Diagram



	Information Signal	Part Names	Major Function or Operation
1	Engine speed signal	Engine speed sensor	Detection of engine speed
2	Fuel temperature signal	Fuel temperature sensor	Detection of fuel temperature
3	Coolant temperature signal	Coolant temperature sensor	Detection of coolant temperature
4	Crank angle signal	TDC sensor	Detection of crank angle signal
5	Boost pressure signal	Boost pressure sensor	Detection of boost pressure
6	Boost air temperature signal	Boost air temperature sensor	Detection of boost air temperature
7	Engine start signal	Starter switch	Recognition of engine start when starter switch is placed at START position
8	Accelerator depressed signal	Accelerator position sensor	Detection of amount that accelerator pedal has been depressed
		Accelerator switch	Detection of released/depressed accelerator pedal
9	Warmup accelerating signal	Idle control variable resistor	Acceleration of warmup
		Cold start switch	
10	Fuel injection amount adjustment signal	Injection amount adjusting ROM	Adjustment of fuel injection amount
11	Auxiliary brake signal	Exhaust brake switch	Control of auxiliary brake
		Exhaust brake cut relay	
12	Vehicle speed signal	Vehicle speed sensor	Detection of vehicle speed

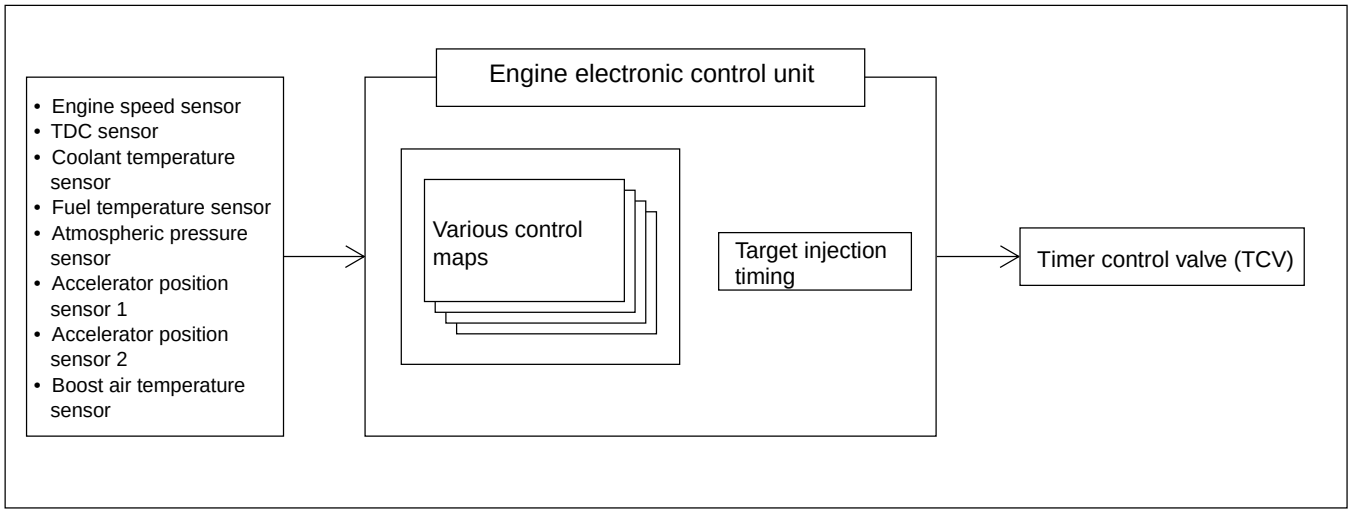
	Information Signal	Part Names	Major Function or Operation
13	Diagnostic signal	Diagnosis switch	Transmission of diagnosis signal
		Memory clear switch	Erasure of diagnostic trouble code Transmission of past diagnostic trouble code
14	Engine emergency stop signal	Emergency engine stop switch	Emergency shutdown of engine
15	–	Electronic drive unit	Assurance of high voltage for high speed drive of spill valve
16	–	Spill valve	Control of fuel injection amount and injection rate
17	Timer control valve operation signal	Timer control valve	Operation of timer piston
18	–	Intake shutter 3-way magnet valve	Operation of intake shutter 3-way magnet valve

2.2 Fuel Injection Rate Control



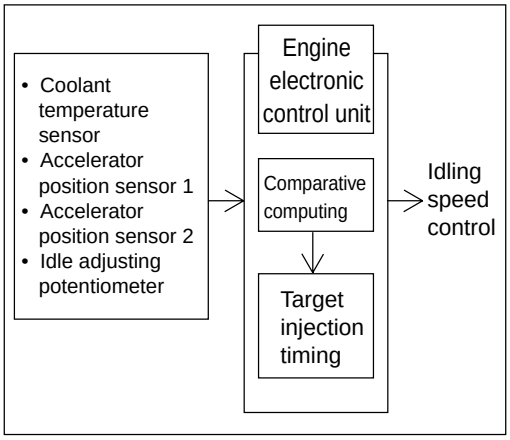
- During operation of the engine, the engine electronic control unit (ECU) processes the individual information signals according to the control maps to select an appropriate injection mode from among the “basic”, “maximum” and “minimum”.
- After selection of the injection mode, the ECU calculates the minimum value to ensure that the maximum injection rate is not exceeded and determines the target injection rate.
- Once the target injection rate has been determined, the engine electronic control unit outputs a signal to drive the spill valve.
- The signal to drive the spill valve is passed through the electronic drive unit so that its responsiveness for high speed driving will be enhanced.
- The electronic drive unit immediately converts the signal voltage delivered from the engine electronic control unit to a high voltage.

2.3 Fuel Injection Timing Control



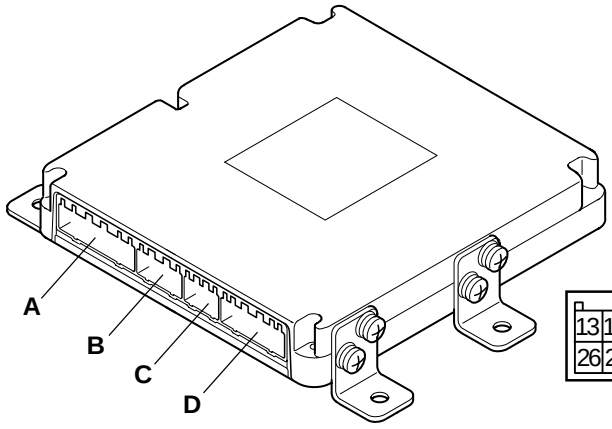
- During operation of the engine, the engine electronic control unit (ECU) processes the individual information signals according to the control maps to calculate the target injection timing, and drives the timer control valve (TCV) in such a way that the real timing computed on the basis of the engine speed sensor and TDC sensor will match the target timing.
- Controls at the time of an engine start are achieved by the start compensation map contained in each control map.

2.4 Warmup Accelerating Function



The warmup accelerating function varies the idling speed according to the engine coolant temperature to accelerate warmup. The function includes the automatic and manual modes. Either of the modes can be selected by pushing/pulling the idle adjusting potentiometer.

3. PIN CONFIGURATION OF ENGINE ELECTRONIC CONTROL UNIT



C: CC12B

6	5	4	3	2	1
12	11	10	9	8	7

D: CC22A

11	10	9	8	7	6	5	4	3	2	1
22	21	20	19	18	17	16	15	14	13	12

A: CC26A

13	12	11	10	9	8	7	6	5	4	3	2	1
26	25	24	23	22	21	20	19	18	17	16	15	14

B: CC16A

8	7	6	5	4	3	2	1
16	15	14	13	12	11	10	9

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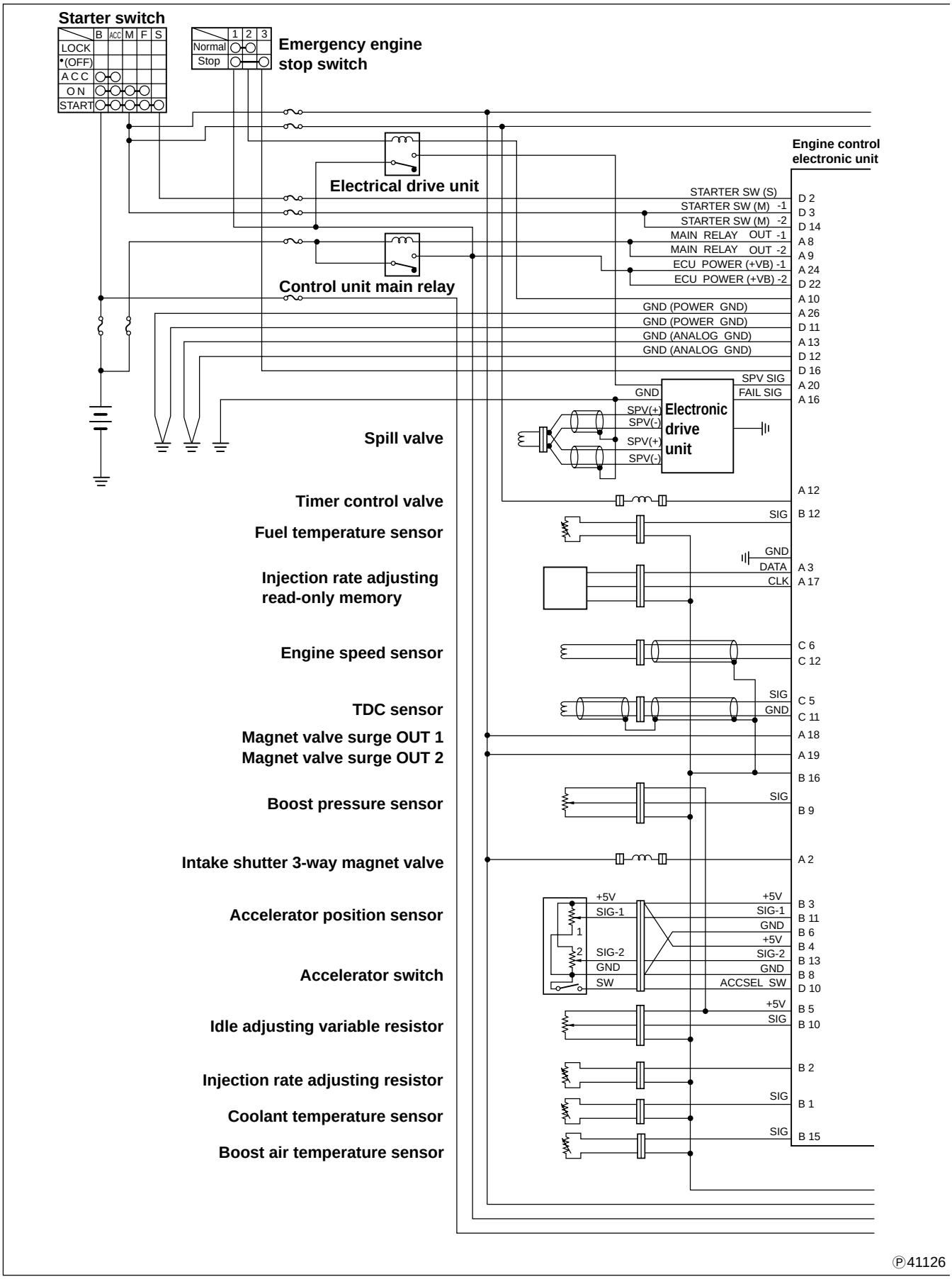
Connector A: CC26A	
Pin No.	Connected to
1	–
2	Intake silencer 3-way magnet valve
3	Injection rate read-only memory
4	–
5	–
6	PMW acceleration OUT (signal)
7	Vehicle speed sensor (signal)
8	Engine control electronic unit main relay 1
9	Engine control electronic unit main relay 2
10	Electronic drive unit relay
11	–
12	Timer control valve
13	Ground (ANALOG)
14	–
15	–
16	Electronic drive unit (FAIL signal)
17	Injection rate adjusting read-only memory (CLK)
18	Magnet valve surge OUT 1
19	Magnet valve surge OUT 2
20	Electronic drive unit (Spill valve signal)
21	Warning lamp (Red)
22	Warning lamp (Amber)
23	–
24	Engine electronic control unit POWER-1
25	Exhaust brake
26	Ground (POWER)

Connector B: CC16A	
Pin No.	Connected to
1	Coolant temperature sensor
2	Injection rate adjusting resistor (signal)
3	Accelerator position sensor 1 (+5V)
4	Accelerator position sensor 2 (+5V)
5	Sensor power supply (+5V)
6	Accelerator position sensor (Ground-1)
7	–
8	Accelerator position sensor (Ground-2)
9	Boost pressure sensor (signal)
10	Idle adjusting potentiometer (signal)
11	Accelerator position sensor 1 (signal)
12	Fuel temperature sensor (signal)
13	Accelerator position sensor 2 (signal)
14	–
15	Boost air temperature sensor
16	Sensor ground

Connector C: CC12B	
Pin No.	Connected to
1	–
2	–
3	–
4	Engine speed OUT (signal)
5	TDC sensor (signal)
6	Engine speed sensor (signal)
7	–
8	Idle up cancel
9	–
10	Tachometer output (signal)
11	TDC sensor (ground)
12	Engine speed sensor (ground)

Connector D: CC22A	
Pin No.	Connected to
1	–
2	Starter switch (S terminal)
3	Starter switch (M terminal-1)
4	–
5	Multi-Use Tester (DTC)
6	–
7	–
8	–
9	Diagnosis switch
10	Accelerator switch
11	Ground (POWER)
12	Ground (ANALOG)
13	Multi-Use Tester (K-LINE)
14	Starter switch (M terminal-2)
15	Memory clear switch
16	Emergency engine stop switch
17	Auxiliary brake cut relay (for automatic transmission)
18	–
19	Cold start switch
20	Cooler switch
21	Exhaust brake switch
22	Engine electronic control unit POWER-2

M E M O


Starter switch
B ACC M F S
LOCK
•(OFF)
A C C
O N
START
1 2 3
Normal
Stop
Emergency engine stop switch
Electrical drive unit
Control unit main relay
Engine control electronic unit
STARTER SW (S) D 2
STARTER SW (M) -1 D 3
STARTER SW (M) -2 D 14
MAIN RELAY OUT -1 A 8
MAIN RELAY OUT -2 A 9
ECU POWER (+VB) -1 A 24
ECU POWER (+VB) -2 D 22
GND (POWER GND) A 10
GND (POWER GND) A 26
GND (ANALOG GND) D 11
GND (ANALOG GND) A 13
D 12
D 16
SPV SIG A 20
FAIL SIG A 16
GND
SPV(+)
SPV(-)
SPV(+)
SPV(-)
Electronic drive unit
Spill valve
Timer control valve A 12
Fuel temperature sensor SIG B 12
GND
DATA A 3
CLK A 17
Injection rate adjusting read-only memory
Engine speed sensor C 6
C 12
TDC sensor SIG C 5
GND C 11
Magnet valve surge OUT 1 A 18
Magnet valve surge OUT 2 A 19
B 16
Boost pressure sensor SIG B 9
Intake shutter 3-way magnet valve A 2
+5V
SIG-1
1
2
SIG-2
GND
SW
Accelerator position sensor
Accelerator switch
+5V B 3
SIG-1 B 11
GND B 6
+5V B 4
SIG-2 B 13
GND B 8
ACCSEL SW D 10
Idle adjusting variable resistor +5V B 5
SIG B 10
Injection rate adjusting resistor B 2
Coolant temperature sensor SIG B 1
Boost air temperature sensor SIG B 15

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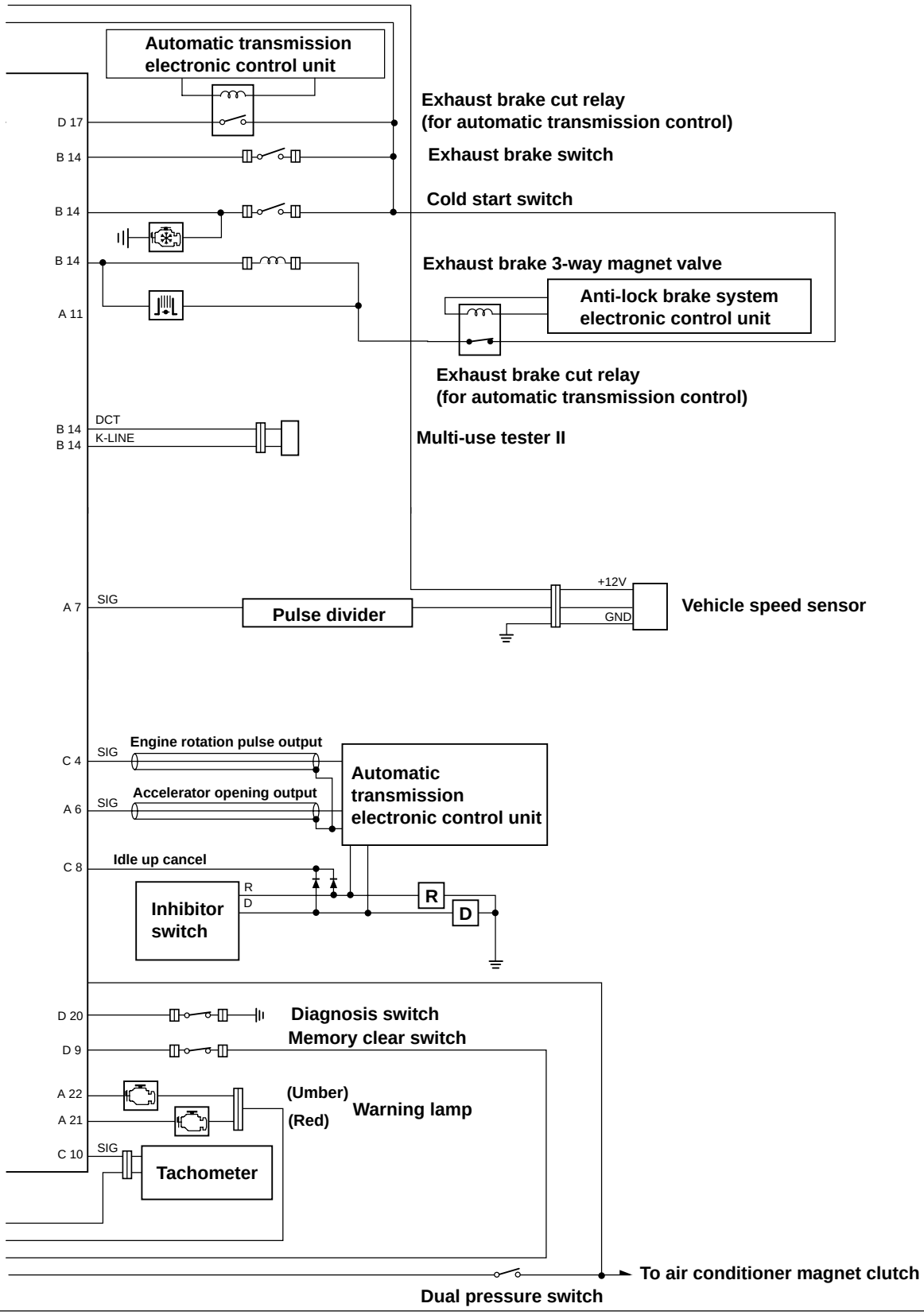
Automatic transmission electronic control unit
D 17
Exhaust brake cut relay (for automatic transmission control)
B 14
Exhaust brake switch
B 14
Cold start switch
B 14
Exhaust brake 3-way magnet valve
A 11
Anti-lock brake system electronic control unit
Exhaust brake cut relay (for automatic transmission control)
B 14
DCT
K-LINE
B 14
Multi-use tester II
A 7
SIG
Pulse divider
+12V
GND
Vehicle speed sensor
C 4
SIG
Engine rotation pulse output
A 6
SIG
Accelerator opening output
Automatic transmission electronic control unit
C 8
Idle up cancel
Inhibitor switch
R
D
R
D
D 20
Diagnosis switch
D 9
Memory clear switch
A 22
(Umber)
A 21
(Red)
Warning lamp
C 10
SIG
Tachometer
To air conditioner magnet clutch
Dual pressure switch

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TROUBLESHOOTING

1. INSPECTION PROCEDURES

Diagnostic Function

- Whenever the starter switch is placed at ON, the diagnostic function is activated to check all the sensors, etc. If any of them is found faulty, the warning lamp in the meter cluster is lit to alert the driver. At the same time, the fault location is stored in memory, and the system enters the backup mode.

Warning Lamp Indications

	(Red)	(Amber)
Safety-critical error (Vehicle must not be driven)	ON	OFF
Non-safety-critical error (Vehicle can be driven despite poor control feeling)	OFF	ON

- The stored fault location can be read as a diagnostic trouble code by the Multi-Use Tester II or the diagnosis switch.

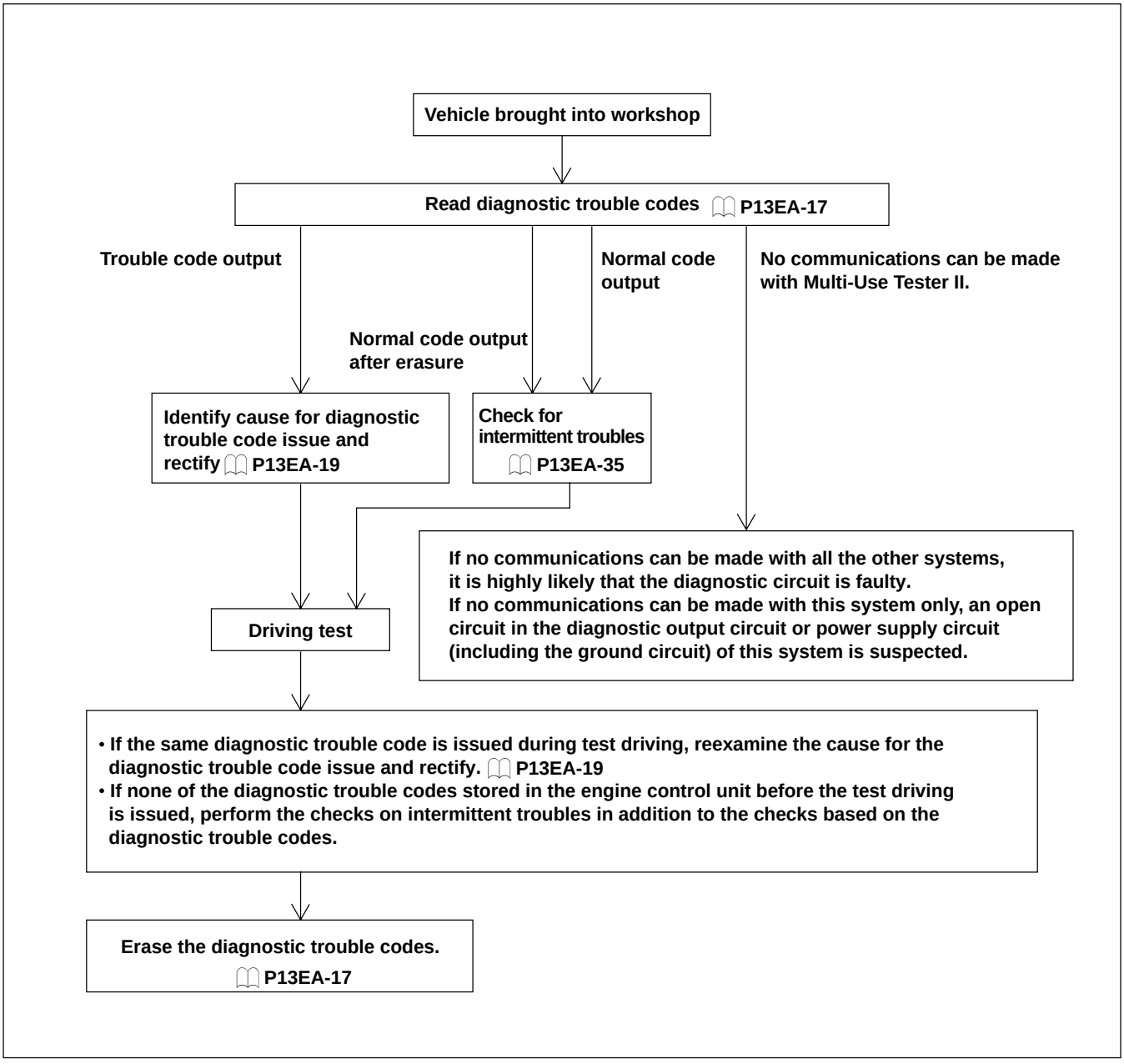
CAUTION ⚠

- **Check to ensure that the battery voltage is within the specified range.**
- **Check all the harness and device connectors for looseness. Always remove a connector at least 20 seconds after placing the starter switch at the LOCK position.**
- **Do not forget to clear the diagnostic trouble code by the Multi-Use Tester II or memory clear switch after a fault has been rectified.**
- **As a rule, inspection operations should be performed with the starter switch at the LOCK position. Some checks, however, may have to be made with the starter switch at the ON position. In such a case, use care to make sure that no short circuit develops between pins of the connectors or with the body.**
- **The resistance value of each component is affected by the temperature and the accuracy of the tester. The reading, therefore, does not always fall within the standard limits. Note that the check values shown in the text are the values obtained at normal temperature (10 to 35°C {58 to 95°F}).**
- **Whether or not the system automatically returns to normal from the backup mode after a fault has been removed depends on the diagnostic trouble code (fault location). When the system returns to normal, the warning lamp will be OFF.**
- **Even when the fault has been removed and the system has been automatically returned to the normal mode, the diagnostic trouble code of the fault remains stored in the engine control unit.**
- **When a fault occurs at a point where the system is not automatically reset, perform the memory clear procedure to let the system exit from the backup mode. 🕮 P13EA-17**

Inspection Flowchart

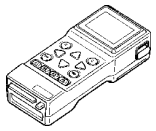
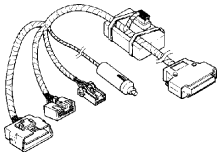
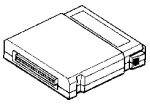
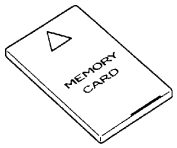
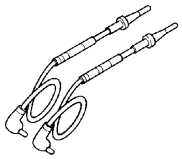
The system inspection can be performed effectively by use of the Multi-Use Tester II. The types of system inspections may be broadly divided as shown below in accordance with the trouble symptoms and diagnostic trouble code outputs.

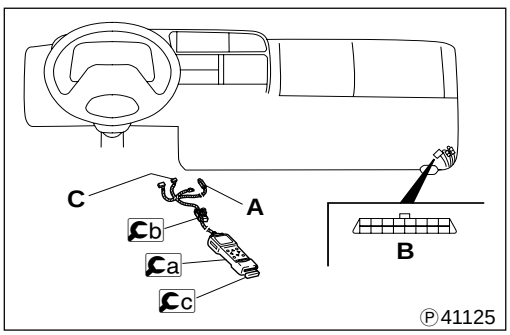
- Inspections based on diagnostic trouble codes stored in the engine electronic control unit
- Inspections of intermittent troubles



2. CONNECTION OF MULTI-USE TESTER II

Special Tools

Location	Name and Shape of Special Tool	Part No.	Application
–	Multi-Use Tester II  19492	MB991496	Inspection of system
–	Multi-Use Tester II harness (for communications)  19141	MK327601	To supply power to Multi-Use Tester II proper and communicate with vehicle side electrical devices
–	Read-only memory pack (MRT-E8.1)  19493	MH063580	Data for inspection and control of engine control unit
–	Memory card (set in Multi-Use Tester II proper)  20538	MB991500	To write data
–	Multi-Use Tester II harness  20536	MB991499	To use Multi-Use Tester II as a circuit tester



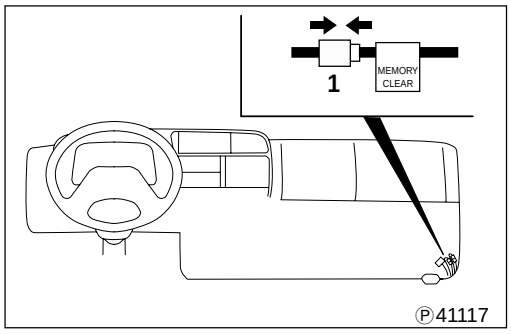
- Place the starter switch at the LOCK position.
- Connect the a Multi-Use Tester II harness to b Multi-Use Tester II and insert the c read-only memory in the tester.
- Connect the connector **A** to the cigar lighter socket.
- Connect the Multi-Use Tester II connector **C** (16 pins) to the data link connector **B** (16 pins).

NOTE

For the operating procedures for the Multi-Use Tester II, refer to the instruction manual for the Multi-Use Tester II.

3. READING AND ERASING DIAGNOSTIC TROUBLE CODES

Two types of methods are available for reading or erasing a diagnostic trouble code; one using the Multi-Use Tester II and one using the vehicle side diagnostic functions.

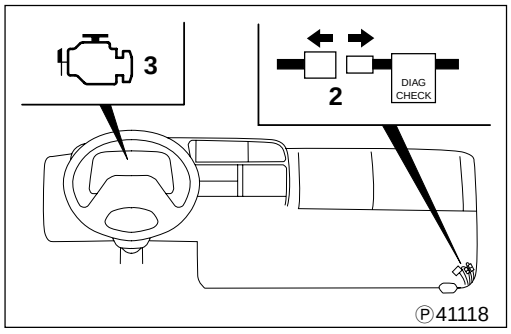


(1) Method using Multi-Use Tester II

● **Current Diagnostic Trouble Code**
- Check to see that the memory clear switch **1** is connected.
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to read the current diagnostic trouble code and determine the fault location.

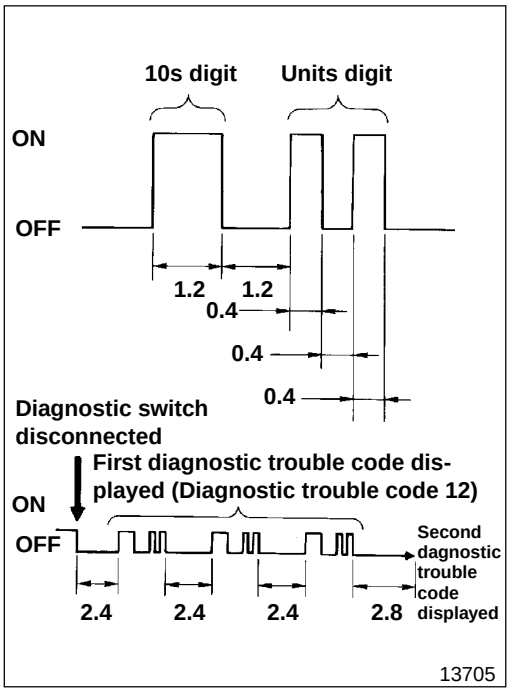
● **Past Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the memory clear switch **1**.
- Operate the Multi-Use Tester II to read the past registered diagnostic trouble codes and determine the fault location.

● **Erasing Diagnostic Trouble Codes**
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to erase all of the diagnostic trouble codes stored in the engine electronic control unit.



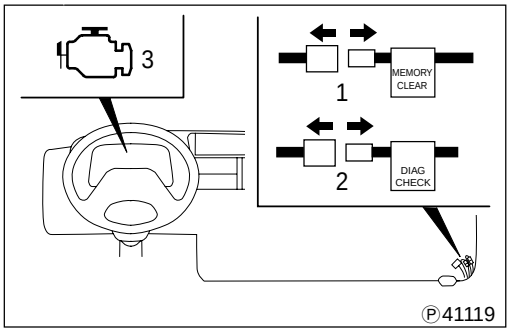
(2) Method Not Using Multi-Use Tester II (Method Using Diagnostic Switch and Memory Clear Switch)

● **Current Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the diagnostic switch **2**.
- The diagnostic trouble code is displayed by flashes of the warning lamp **3**.



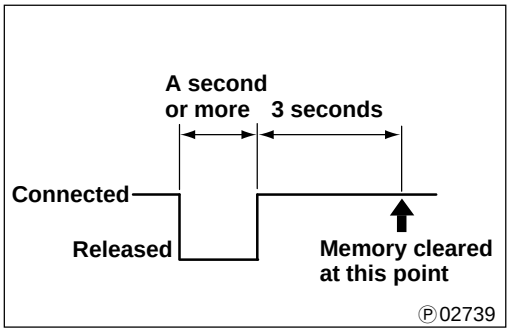
● **Reading Diagnostic Trouble Code**

- Diagnostic trouble codes are indicated by the number of times the warning lamp **3** flashes and their duration.
  - The flashing intervals also differ between the 10s digit and units digit.
  - 10s digit: 1.2 second interval
  - Units digit: 0.4 second interval
  - Each diagnostic trouble code is displayed from the 10s digit followed by the units digit. As for a code which has no 10s digit, units digit only is displayed.
- Each diagnostic trouble code is displayed three times in succession.
- If there is no more code stored, the sequence is then repeated from the beginning with each code indicated three times.
- When the diagnostic switch **2** is connected, the engine electronic control unit will immediately stop displaying codes.



● **Past Diagnostic Trouble Codes**

- After reading the current diagnostic trouble codes (with the diagnostic switch **2** disconnected), disconnect the memory clear switch **1**. Then the warning lamp **3** will restart flashing.
- This time, the warning lamp displays the past diagnostic trouble codes. Determine the fault locations based on the indicated codes.



● **Erasing Diagnostic Trouble Codes**

Disconnect the memory clear switch **1** and the diagnostic switch **2** then reconnect them. Then all the diagnostic trouble codes stored in the engine electronic control unit will be cleared.

CAUTION ⚠

- **If the contents of memory are not to be cleared after display of the stored codes, set the starter switch to OFF with the memory clear switch 1 disconnected. Thereafter, connect the memory clear switch.**
- **When you change the combination of the injection pump and engine electronic control unit, you must rewrite the pump data stored in the engine electronic control unit. For this purpose, be sure to perform the diagnostic trouble code erasing procedure.**
- **Whenever the engine electronic control unit has been replaced with a new one, be sure to erase the diagnostic trouble codes by disconnecting the memory clear switch 1 and diagnostic switch 2 after connecting all the connectors. Upon completing the procedure, confirm that no diagnostic trouble codes is stored.**

4. DIAGNOSTIC TROUBLE CODES AND CHECK ITEMS

4.1 Diagnostic Trouble Code List

Multi-Use Tester II Screen Display		Where Described
Diagnostic Trouble Code	Message	
06	EDU/SPV	🕮 P13EA-19
07	OVER REV	🕮 P13EA-20
14	TDC SNSR	
15	NE SNSR	
16	ACCEL SNSR-2	🕮 P13EA-21
19	AIR PRES SNSR	
21	WTR TEMP SNSR	
23	TCV	🕮 P13EA-22
24	ACCEL SNSR-1	
25	SPEED SNSR	🕮 P13EA-23
26	PUMP ROM	
27	SILENCER M/V	

Multi-Use Tester II Screen Display		Where Described
Diagnostic Trouble Code	Message	
31	IDL VOLUME	🕮 P13EA-24
32	BOOST PRES	
33	ECU SYSTEM	
34	Q RESISTOR	🕮 P13EA-25
41	FUEL TEMP	
44	BOOST TEMP	
45	FUEL CUT SW	🕮 P13EA-26
46	EDU RELAY	
65	ACCEL SW	🕮 P13EA-27
66	STARTER SW (S)	

4.2 Diagnostic Trouble Code Issued Conditions and Check Items

Perform service procedures taking the diagnostic trouble code issued conditions and the probable causes into consideration.

06 EDU/SPV		
Code issued condition [Reset condition]	Diagnostic trouble code **06** is intended for checking the electronic drive unit and spill valve for anything abnormal. The code is issued when the FAIL signal is not input the specified number of consecutive times from the electronic drive unit to the electronic control unit despite the fact that the battery voltage is normal, the engine is running at a speed higher than the idling speed, and the electrical drive unit is outputting the spill valve drive signal. [Starter switch OFF]	
Action taken by electronic control unit	Engine stopped	
Warning lamp illuminated	(Red)	
Probable cause and check item	• Open or short circuit between electronic control unit and electronic drive unit,or between electronic drive unit and spill valve • Faulty electronic drive unit • Faulty spill valve	• Check on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 83: Spill valve operation check • Test the actuator by the Multi-Use Tester II. 🕮 P13EA-30 No. 9B: Spill valve operation check • Check the electronic drive unit (Ask your DENSO service station to do the job.) • Check the spill valve. 🕮 P13EA-36: Inspection of Electrical Devices **536** • Check the circuit between the electronic control unit and electronic drive unit or the circuit between the electronic drive unit and spill valve. 🕮 P13EA-49: Electrical wiring Diagram

07 OVER REV		
Code issued condition [Reset condition]	Diagnostic trouble code **07** is intended for checking whether the engine speed has reached an overspeed. When the engine speed reaches an overspeed, the code is issued. (When the engine speed decreases to fall within the normal range, a reset is made.)	
Action taken by electronic control unit	Spill valve operation stopped	
Warning lamp illuminated	None	
Probable cause and check item	• Faulty spill valve of injection pump assembly • Overrevved engine during driving downhill • Faulty electronic control unit	Check the injection pump assembly (Ask your DENSO service station to do the job.)

14 TDC SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **14** is intended for checking the TDC sensor operation. It is issued when the TDC sensor signal is not input to the electronic control unit the specified number of consecutive times while the engine is running. [When normal TDC sensor signal input is restored, the system is reset.]	
Action taken by electronic control unit	Injection timing feedback control stopped and open-loop control executed	
Warning lamp illuminated	(Amber)	
Probable cause and check item	• Open or short circuit between control unit and TDC sensor • Faulty TDC sensor • Faulty electronic control unit	• Perform checks at electronic control unit connector. 🕮P13EA-32 **01**: Measure resistance of TDC sensor. • Check TDC sensor. 🕮 P13EA-36: Inspection of Electronic Devices **316** • Check circuit between electronic control unit and TDC sensor. 🕮 P13EA-49: Electrical Writing Diagram

15 NE SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **15** is issued when the signal from the engine speed sensor is not input the specified number of times to the electronic control unit while the engine is in operation. [When the signal from the engine speed sensor returns to normal, a reset is made.]	
Action taken by electronic control unit	Synchronous control of spill valve with timer control valve interrupted	
Warning lamp illuminated	(Red)	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and engine speed sensor • Faulty engine speed sensor • Gap of engine speed sensor maladjusted • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮P13EA-28 No. 01: Measure engine speed. • Perform checks at control electronic unit connector. 🕮P13EA-32 **02**: Measure resistance of engine speed sensor. • Check engine speed sensor. 🕮 P13EA-36: Inspection of Electrical Devices **263** • Check circuit between electronic control unit and engine speed sensor. 🕮P13EA-49: Electrical Wiring Diagram

16 ACCEL SNSR-2		
Code issued condition [Reset condition]	Diagnostic trouble code **16** is intended for checking the accelerator position sensor 2 for an abnormal voltage. The code is issued when the voltage of the accelerator position sensor 2 is out of the specified limits. When diagnostic trouble code **24** is also registered, the portion between the accelerator position sensors is faulty. [When the voltage of the accelerator position sensor 2 falls within the specified limits, a reset is made.]	
Action taken by electronic control unit	①: Ordinary controls are made by using only accelerator position sensor 1 ②: When accelerator position sensor 1 is also faulty, controls are made on the assumption that the pedal is depressed 30% when accelerator switch is OFF and 0% when accelerator switch is ON.	
Warning lamp illuminated	①: None ②: (Amber)	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and accelerator position sensor 2 Faulty accelerator position sensor 2 • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 0B: Accelerator pedal opening measurement. No. 0C: Measurement of accelerator position sensor output voltage. • Perform checks at electronic control unit connector. 🕮 P13EA-32 **03**: Measurement of accelerator position sensor 2 output voltage • Check accelerator position sensor 2. 🕮 P13EA-36: Inspection of Electrical Devices **324** • Check circuit between electronic control unit and accelerator position sensor 2. 🕮 P13EA-49: Electrical Wiring Diagram

19 AIR PRES SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **19** is intended for checking the atmospheric pressure sensor (built into the electronic control unit) for anything abnormal. The code is issued when a voltage signal from the atmospheric pressure sensor is out of the specified limits. [When the output voltage of the atmospheric pressure sensor falls within the specified range, a reset is made.]	
Action taken by electronic control unit	Controls achieved on the assumption that atmospheric pressure is 100 kPa {29.9 in. Hg, 760 mmHg}.	
Warning lamp illuminated	None	–
Probable cause and check item	• Faulty atmospheric pressure sensor (built into control unit) Faulty electronic control unit	Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 14: Atmospheric pressure measurement.

21 WTR TEMP SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **21** is intended for checking for open or short circuit in the harness of the coolant temperature sensor or anything abnormal in coolant temperature sensor. The code is issued when the output voltage from the coolant temperature sensor is out of the specified limits. [When the output voltage of the coolant temperature sensor falls within the specified range, a reset is made.]	
Action taken by electronic control unit	Controls achieved on the assumption that the coolant temperature is 80°C {178°F}	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harness between electronic control unit and coolant temperature sensor • Faulty coolant temperature sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 10: Engine coolant temperature measurement • Check coolant temperature sensor. 🕮 P13EA-36: Inspection of Electrical Devices **262** • Check circuit between electronic control unit and coolant temperature sensor. 🕮 P13EA-49: Electrical Wiring Diagram

23 TCV		
Code issued condition [Reset condition]	Diagnostic trouble code **23** is intended for checking the harness of the timer control valve for open or short circuit and checking the timer control valve for anomalies. The code is issued when the real advance angle position of the timer continues to be out of the specified limits under the condition that fuel injection timing feedback control is in progress after completion of engine warmup. [When the advance angle re-enters the specified range with the engine at a speed of less than 1200 rpm, a reset is made.]	
Action taken by electronic control unit	Controls are made on the assumption that the coolant temperature is 20°C {-4°F} when the engine is started, and 120°C {248°F} during operation.	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harness between electronic control unit and timer control valve • Faulty timer control valve • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 09: Timer advance angle measurement • Check timer control valve. 🕮 P13EA-36: Inspection of Electrical Devices **584** • Check circuit between electronic control unit and timer control valve. 🕮 P13EA-49: Electrical Wiring Diagram

24 ACCEL SNSR-1		
Code issued condition [Reset condition]	Diagnostic trouble code **24** is intended for checking the accelerator position sensor 1 for abnormal voltage. The code is issued when the output voltage of the accelerator position sensor 1 is out of the specified limits. When diagnostic trouble code 16 is also registered, the portion between the accelerator position sensors is faulty. [When the output voltage of the accelerator position sensor 1 re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	①: Ordinary controls are continued by using only the accelerator position sensor 2. ②: When accelerator position sensor 2 is also faulty, controls are made on the assumption that the pedal is depressed 30% when accelerator switch is OFF and 0% when accelerator switch is ON.	
Warning lamp illuminated	①: None ②: (Amber)	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and accelerator position sensor 1 • Faulty accelerator position sensor 1 • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 0B: Accelerator pedal opening measurement No. 0C: Measurement of accelerator position sensor output voltage. • Perform checks at electronic control unit connector. 🕮 P13EA-32 **04**: Measurement of accelerator position sensor 1 output voltage • Check accelerator position sensor 1. 🕮 P13EA-36: Inspection of Electrical Devices **324** • Check circuit between electronic control unit and accelerator position sensor 1. 🕮 P13EA-49: Electrical Wiring Diagram

25 SPEED SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **25** is intended for checking the harness of the vehicle speed sensor for open/short circuit and checking the vehicle speed sensor for abnormalities. The code is issued when there are no pulse inputs from the vehicle speed sensor to the electronic control unit in the specified time duration. [When a pulse is input, a reset is made.]	
Action taken by electronic control unit	ISC (Idle Speed Control) disabled	
Warning lamp illuminated	None	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and vehicle speed sensor • Faulty vehicle speed sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 0D: Vehicle speed measurement. • Perform checks at electronic control unit connector. 🕮P13EA-32 **05**: Measurement of vehicle speed signal voltage. • Check vehicle speed sensor. 🕮P13EA-36: Inspection of Electrical Devices **265** • Check circuit between electronic control unit and vehicle speed sensor. 🕮P13EA-49: Electrical Wiring Deagram

26 PUMP ROM		
Code issued condition [Reset condition]	Diagnostic trouble code **26** is intended for checking for an error in the loaded pump read-only memory data necessary for control of the injection rate. The code is issued when any of the following situations occurs. Loaded read-only memory has unmatched data. • Read-only memory data cannot be read. • Loaded data exceeds the upper limit of correction. • There is a mismatch between control unit backup data and loaded data. [No automatic reset takes place.]	
Action taken by electronic control unit	Initial values used	
Warning lamp illuminated	None –	
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and injection rate and adjusting read-only memory • Faulty injection rate adjusting read-only memory • Faulty electronic control unit	• Check injection rate adjusting read-only memory. (Ask your DENSO service station to do the job.) • Check circuit between electronic control unit and injection rate adjusting read-only memory. 🕮P13EA-49: Electrical Wiring Diagram

27 SILENCER M/V		
Code issued condition [Reset condition]	Diagnostic trouble code **27** is intended for checking the harness of the intake silencer 3-way magnet valve for open/short circuit. [No automatic reset takes place.]	
Action taken by electronic control unit	Intake silencer control disabled	
Warning lamp illuminated	(Amber)	
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and injection rate and adjusting read-only memory • Faulty intake silencer 3-way magnet valve • Faulty electronic control unit	• Check intake silencer 3-way magnet valve. P13EA-36: Inspection of Electrical Devices **565** • Check circuit between electronic control unit and intake silencer 3-way magnet valve. P13EA-49: Electrical Wiring Diagram

31 IDL VOLUME		
Code issued condition [Reset condition]	Diagnostic trouble code **31** is intended for checking the harness of the idle adjusting potentiometer for open or short circuit and checking the idle adjusting potentiometer for abnormalities. The code is issued when the voltage of the idle adjusting potentiometer continues to be out of the specified limits for the predetermined period of time. [When the voltage of the idle adjusting variable resistor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Operation mode fixed to auto idle	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and idle adjusting potentiometer • Faulty idle adjusting potentiometer • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 0E: Measurement of idle adjusting variable resistor voltage. • Perform checks at electronic control unit connector. 🕮 P13EA-32 **06**: Measurement of idle adjusting variable resistor output voltage. • Check idle adjusting potentiometer. 🕮 P13EA-36: Inspection of Electrical Devices **157** • Check circuit between electronic control unit and idle adjusting potentiometer. 🕮 P13EA-49: Electrical Wiring Diagram

32 BOOST PRES		
Code issued condition [Reset condition]	Diagnostic trouble code **32** is intended for checking the harness of the boost pressure sensor for open or short circuit and checking the boost pressure sensor for abnormalities. The code is issued when the output voltage of the boost pressure sensor continues to be out of the specified limits for the predetermined period of time. [When the voltage of the boost pressure sensor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Controls are made on the assumption that the boost pressure is 100 kPa {29.9 in. Hg, 760 mmHg}	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and boost pressure sensor • Faulty boost pressure sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 15: Boost pressure measurement • Check boost pressure sensor. 🕮 P13EA-36: Inspection of Electrical Devices **318** • Check circuit between electronic control unit and boost pressure sensor. 🕮 P13EA-49: Electrical Wiring Diagram

33 ECU SYSTEM		
Code issued condition [Reset condition]	Diagnostic trouble code **33** is issued in the following cases. ① : A/D converter out of order [When A/D converter returns to normal, a reset is made.] ② : Mutual monitoring error, interruption processing error [When starter switch is turned OFF, a reset is made.]	
Action taken by electronic control unit	① : All Fail Safe functions against a faulty A/D input are activated. ② : Engine stopped	
Warning lamp illuminated	① : None ② : (Amber)	
Probable cause and check item	Faulty electronic control unit	–

34 Q RESISTOR		
Code issued condition [Reset condition]	Diagnostic trouble code **34** is intended for checking the harness of the injection rate adjusting resistor for open or short circuit and checking the injection rate adjusting resistor for abnormalities. The code is issued when the output voltage of the injection rate adjusting resistor continues to be out of the specified limits for the predetermined period of time. [When the voltage of the injection rate adjusting resistor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	The injection rate correction value is fixed to No. 1 value.	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and boost air temperature sensor • Faulty injection rate adjusting resistor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 13: Resistor No. check of injection rate adjusting resistor. • Check circuit between electronic control unit and injection rate adjusting resistor. 🕮 P13EA-49: Electrical Wiring Diagram

41 FUEL TEMP		
Code issued condition [Reset condition]	Diagnostic trouble code **41** is intended for checking the harness of the fuel temperature sensor for open or short circuit and checking fuel temperature sensor for abnormalities. The code is issued when the output voltage of the fuel temperature sensor continues to be out of the specified limits for the predetermined period of time. [When the voltage of the fuel temperature sensor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Control is made on the assumption that fuel temperature is 40°C {104°F}	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and boost air temperature sensor • Faulty fuel temperature sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 11: Fuel temperature measure. • Perform checks at electronic control unit connector. 🕮 P13EA-32 **12** : Measurement of fuel temperature sensor resistance. • Check fuel temperature sensor. 🕮 P13EA-36: Inspection of Electrical Devices **323** • Check circuit between electronic control unit and fuel temperature sensor. 🕮 P13EA-49: Electrical Wiring Diagram

44 BOOST TEMP		
Code issued condition [Reset condition]	Diagnostic trouble code **44** is intended for checking the harness of the boost air temperature sensor for open or short circuit and checking the boost air temperature sensor for abnormalities. [When the voltage of the boost air temperature sensor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Control is made on the assumption that boost air temperature is 80°C {176°F}	
Warning lamp illunimated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and boost air temperature sensor • Faulty boost air temperature sensor • Faulty electronic control unit	• Check boost air temperature sensor. 🕮 P13EA-36 **303** : Inspection of Electrical Devices • Check circuit between electronic control unit and boost air temperature sensor. 🕮 P13EA-49: Electrical Wiring Diagram

45 FUEL CUT SW		
Code issued condition [Reset condition]	Diagnostic trouble code **45** is intended for checking the harness of the emergency engine stop switch for open or short circuit and checking the emergency engine stop switch for abnormalities. The code is issued when a fault is detected in the circuit with both emergency engine stop switch and starter switch at the ON position (without starting the engine). [When the emergency engine stop switch is set to OFF, a reset is made.]	
Action taken by electronic control unit	Engine start inhibited	
Warning lamp illuminated	(Red)	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and emergency engine stop switch • Faulty emergency engine stop switch • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 📖 P13EA-28 No. 42: Operation check of emergency engine stop switch. • Perform checks at electronic control unit connector. 📖 P13EA-32 **11**: Measurement of emergency engine stop switch operating voltage. • Check emergency engine stop switch. 📖 P13EA-36: Inspection of Electrical Devices **156** • Check circuit between electronic control unit and emergency engine stop switch. 📖 P13EA-49: Electrical Wiring Diagram

46 EDU RELAY		
Code issued condition [Reset condition]	Diagnostic trouble code **46** is issued in the following cases. ①: Electronic driveunit relay is not ON with electronic drive unit relay ON command issued. [When the electronic drive unit relay is not ON with the electronic drive unit relay ON command, and the voltage exceeds 16V, a reset is made.] ②: Electronic drive unit relay is not OFF with electronic drive unit relay OFF command issued. [Electronic drive unit relay is turned OFF with the electronic drive unit relay OFF command, and the voltage exceeds 16V, a reset is made.]	
Action taken by electronic control unit	①: Electronic drive unit relay OFF ②: Ordinary controls continued	
Warning lamp illuminated	①: (Amber) ②: None	
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and electronic drive unit. • Faulty electronic drive unit relay	• Check electronic drive unit relay. 📖 P13EA-36: Inspection of Electrical Devices **228** • Check circuit between electronic control unit and electronic drive unit relay. 📖 P13EA-49: Electrical Wiring Diagram

65 ACCEL SW		
Code issued condition [Reset condition]	Diagnostic trouble code **65** is intended for checking the harness of the accelerator switch for open or short circuit and checking the accelerator switch for abnormalities. The code is issued when the accelerator position sensor 1 or 2 shows an opening of more than 20% with the accelerator switch ON. [If the accelerator switch turns OFF when the accelerator position sensor shows an opening of more than 20%, a reset is made.]	
Action taken by electronic control unit	Ordinary controls continued	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and accelerator switch • Faulty accelerator switch • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 43: Check of accelerator switch operating signal. Perform checks at electronic control unit connector. 🕮 P13EA-32 **09** : Measurement of accelerator switch operating voltage. Check accelerator switch. 🕮 P13EA-36: Inspection of Electrical Devices **324** Check circuit between electronic control unit and accelerator switch. 🕮 P13EA-49: Electrical Wiring Diagram

66 STARTER SW (S)		
Code issued condition [Reset condition]	Diagnostic trouble code **66** is intended for checking the harness of the starter switch for open or short circuit and checking the starter switch for abnormalities. The code is issued when a start signal is input with the engine running at a speed higher than the specified speed. [When the start signal is no longer input, a reset is made.]	
Action taken by electronic control unit	Ordinary controls continued	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and accelerator switch • Faulty starter switch • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 41: Start signal ON/OFF check. • Perform checks at electronic control unit connector. 🕮 P13EA-32 **13**: Measurement of starter switch signal voltage. • Check starter switch. 🕮 P13EA-36: Inspection of Electrical Devices **002** • Check circuit between electronic control unit and starter switch. 🕮 P13EA-49: Electrical Wiring Diagram

5. SERVICE DATA OF MULTI-USE TESTER II

Screen Display of Multi-Use Tester II			Condition When Checking	Judging Criteria
No.	Item Name	Data		
1	ENGINE SPEED	■■■■. rpm	Racing (Engine running)	Synchronized with tachometer
3	INJ VOL	■■■. ■ %	Starter switch ON	0 %
9	TCV ANG DIFF	■■■. ■ deg	Warm engine running at idle	0 deg
0B	ACCEL (%)	■■■. ■ %	Accelerator pedal released	0 %
			Slowly depressed	Slowly increased
			Accelerator pedal fully depressed	100 %
0C	ACCEL (V)	■. ■■■ V	Accelerator pedal slowly depressed from released position	0.85 to 4.15 V
0D	VEHICLE SPEED	■■■. ■ MPH	During driving	Synchronized with speedometer
0E	IDL VOL SNSR	■. ■■■ V	Slow to fast	2.6 to 1.2 V
10	WATER TEMP	■■■. ■ °F	Engine cold	Equivalent to atmospheric temperature
			Engine warmup in progress	Slowly increased
			Engine stopped after warmup	Slowly decreased
11	FUEL TEMP	■■■. ■ °F	Engine cold	Equivalent to atmospheric temperature
			Engine warmup in progress	Slowly increased
			Engine stopped after warmup	Slowly decreased
13	Q RESISTOR	■■■■	–	Matches No. marked on injection rate adjusting resistor.
14	AIR PRESS	■■■■. mmHg	Altitude 0 m	13.5 mmHg
			Altitude 600 m	12.7 mmHg
			Altitude 1200 m	11.7 mmHg
15	BOOST PRESS	■■■■. mmHg	Engine speed 3400 rpm	260 mmHg
16	BATT VOLTAGE	■■. ■■ V	Starter switch ON	Matches battery voltage.
17	PTO-ACCEL (%)	■■■. ■ %	When PTO is used (MIN-MAX)	0 to 100 %
18	PTO-ACCEL (V)	■. ■■■ V	When PTO is used (MIN-MAX)	1 to 3.0 V
19	PTO RESISTOR	■■■■	–	Matches No. marked on power take-off resistor.
41	START SIG	ON/OFF	Engine cranked by starter switch	ON
			Starter switch at any other position than S	OFF
42	FUEL CUT SW	ON/OFF	Switch ON	ON
			Switch OFF	OFF
43	ACCEL SW	ON/OFF	Accelerator pedal depressed	ON
			Accelerator pedal released	OFF
44	A/C SW	ON/OFF	When air conditioner compressor is in operation	ON
			When air conditioner compressor is idle	OFF
45	COLD START SW	ON/OFF	Warming switch ON	ON
			Warming switch OFF	OFF

Screen Display of Multi-Use Tester II			Condition When Checking	Judging Criteria
No.	Item Name	Data		
46	DIAGNOSIS SW	ON/OFF	Diagnostic switch ON (Connected)	OFF
			Diagnostic switch OFF (Open)	ON
47	MEMORY CLEAR	ON/OFF	Memory clear switch ON (Connected)	OFF
			Memory clear switch OFF (Open)	ON
51	EXH.BRAKE SW	ON/OFF	Exhaust brake switch ON (when exhaust brake is active)	ON
			Exhaust brake switch OFF (when exhaust brake is inactive)	OFF
53	NEUTRAL SW	ON/OFF	Transmission at neutral	ON
			Transmission at any other position than neutral	OFF
55	IDL-UP CANCEL	ON/OFF	Automatic transmission select lever at R, D, 2 or L	ON
			At any other position than mentioned above	OFF
61	SILENCER M/V	ON/OFF	At idling	ON
			At 2500 rpm	OFF
71	EXH. BRAKE M/V	ON/OFF	When exhaust brake is active	ON
			When exhaust brake is inactive	OFF
73	DIAG LAMP (RED)	ON/OFF	Starter switch ON (engine not made to start)	ON
			No error generated after engine has started	OFF
74	DIAG LAMP (AMBER)	ON/OFF	Starter switch ON (engine not made to start)	ON
			No error generated after engine has started	OFF
83	SPV	ON/OFF	When engine is running	ON (ON → OFF repeated)
			When engine is stationary	OFF

6. ACTUATOR TEST BY MULTI-USE TESTER II

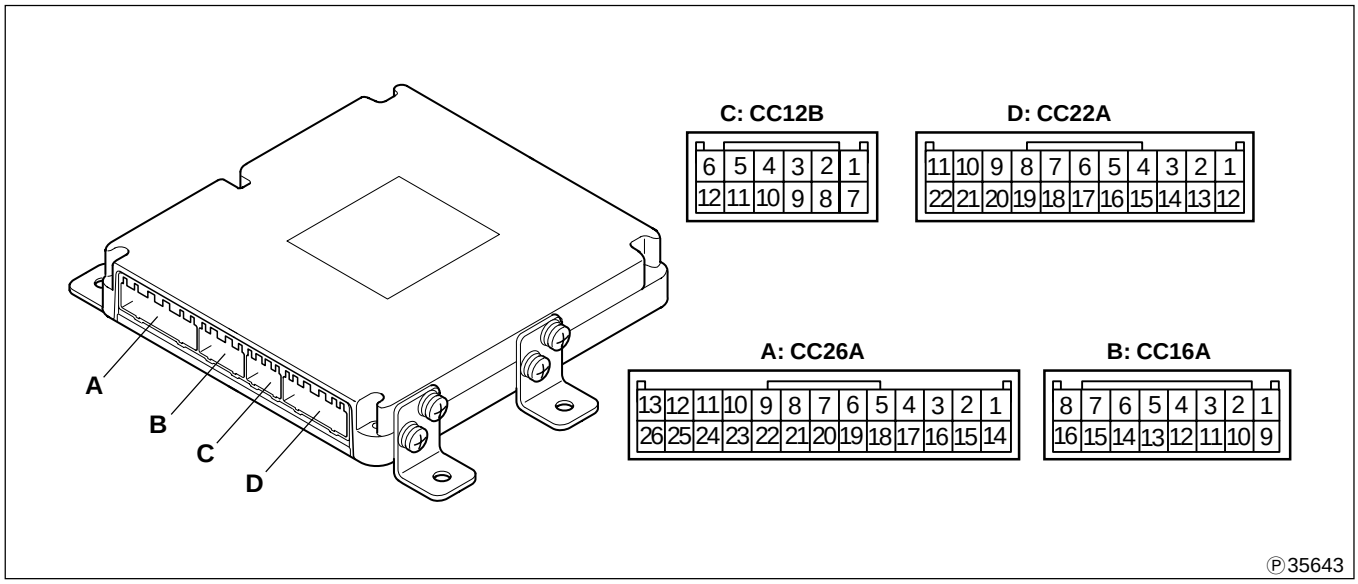
Screen Display of Multi-Use Tester II		Operation Check Procedures
No.	Item Name	
9B	SPV	Operating sound of solenoid valve
9C	TCV-OFF	No operating sound of solenoid valve
9D	TCV-ON	Operating sound of solenoid valve
91	SILENCER M/V	ON/OFF sound of magnetic valve
94	EXH. BRAKE M.V	ON/OFF sound of magnetic valve
97	DIAG LAMP (RED)	ON/OFF state of warning lamp (Red)
98	DIAG LAMP (AMBER)	Operating state of warning lamp (Amber)
99	A/C SIG	High idling speed
9A	IDL-UP CANCEL	Low idling speed

MEMO

7. CHECKS AT CONNECTOR OF ELECTRONIC CONTROL UNIT

This method of checks is useful for checking whether all the signals of the electronic control unit are transmitted without any error through the vehicle side harness and connector.
The numbers in the table correspond to the call numbers used in “4. DIAGNOSTIC TROUBLE CODES AND CHECK ITEMS” for referencing this section.

Pin Configuration of Electronic Control Unit



No.	Item	Reference Page
01	Resistance of TDC sensor	📖 P13EA-33
02	Resistance of engine speed sensor	
03	Output voltage of accelerator position sensor 1	
04	Output voltage of accelerator position sensor 2	
05	Signal voltage of vehicle speed sensor	
06	Output voltage of idle adjusting potentiometer	📖 P13EA-34
09	Voltage of accelerator switch	
11	Voltage of emergency engine stop switch	
12	Resistance of fuel temperature sensor	
13	Voltage of starter switch (start signal)	

Checking Procedures

CAUTION ⚠

Each item is checked by one of two methods; one by disconnecting the connectors and one by leaving the connectors connected.

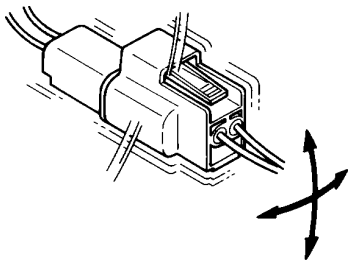
Pay heed to the following points.

- **Be sure not to touch any other pin than the one to be checked.**
  Especially, use utmost care that a short circuit is never produced between pins by the tester.
- **All the illustrations of the connectors in the table show the connectors on the electronic control unit side. Be careful not to confuse the pins with those to be checked.**

Check Item	Checking Procedure
01 Resistance of TDC sensor	[Conditions] • Starter switch OFF • Disconnect connector and make checks at vehicle side harness connector (25°C {77°F}). [Judging Criteria] Between pins: C⑤ – C⑪ 1.5 ± 0.2 kΩ
02 Resistance of engine speed sensor	[Conditions] • Starter switch OFF • Disconnect connector and make checks at vehicle side harness connector. [Judging Criteria] Between pins: C⑥ – C⑫ 230 ± 25 Ω
03 Output voltage of accelerator position sensor 2	[Conditions] • Starter switch OFF • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): B⑬ – B⑧ • When accelerator pedal is released: 0.85V • When accelerator pedal is depressed: 4.15V
04 Output voltage of accelerator position sensor 1	[Conditions] • Starter switch OFF • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): B⑪ – B⑥ • When accelerator pedal is released: 0.85V • When accelerator pedal is depressed: 4.15V
05 Signal voltage of vehicle speed sensor	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of vehicle side connector). • Using chassis dynamometer or something else, slowly rotate wheels. [Judging Criteria] Between pins (⊕ — ⊖): A ⑰ – A ⑬ • Hi: Approx. 8V • Lo: 0.5V or less

Check Item	Checking Procedure
06 Output voltage of idle adjusting potentiometer	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): C⑤ – C⑩ • When knob is pulled: Approx. 1 to 3V • When knob is pushed all the way: Approx. 3.6 to 4.3V
09 Voltage of accelerator switch	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): D⑩ – B⑧ • When accelerator pedal is depressed: 0V • When accelerator pedal is released: 5V
11 Voltage of emergency engine stop switch	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): D⑫ – D⑯ • Switch at stop position: 0V • Switch at normal position: 12V
12 Resistance of fuel temperature sensor	[Conditions] • Starter switch OFF • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins: B⑫ – B⑯ 2.5 ± 1.0 kΩ
13 Voltage of starter switch (starter signal)	[Conditions] • Leave vehicle side harness connected (make checks from back side of connector). • Starter switch (S position) [Judging Criteria] Between pins (⊕ — ⊖): D② – D⑪ 12V

8. CHECKS ON INTERMITTENT TROUBLES



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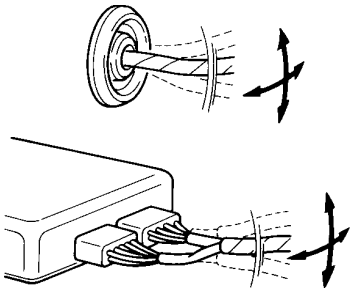

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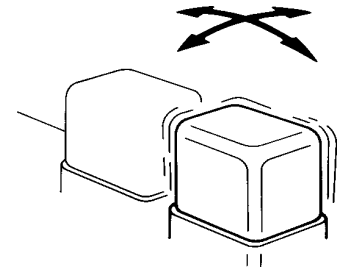


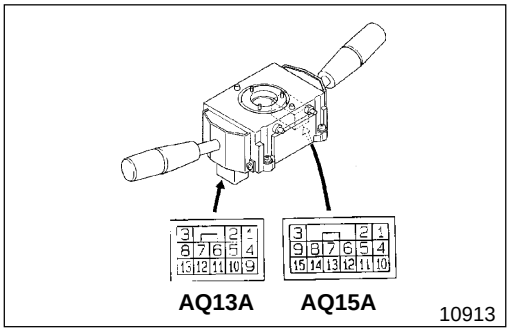
02599

A intermittent trouble often occurs in a specific condition. Therefore, pinpointing the condition will make it easy to estimate the cause. To pinpoint the condition for a intermittent trouble, ask the customer in detail about the driving condition when the trouble occurs, weather, occurrence frequency and symptoms, and reproduce the symptoms of the trouble.
Depending on the condition where the trouble occurs, determine whether the cause of the trouble is vibration, temperature or any other factor.
If the probable cause is vibration, perform the following checks on the relevant connectors harnesses, etc. and check whether the symptoms of the trouble are reproduced.

- Lightly move the connector up and down and to the right and left.
- Lightly move the harness up and down and to the right and left.
- Lightly shake the sensors and other devices by hand.
- Lightly shake the wiring harness located in the moving components such as the suspension.

The connectors and other parts to be checked are identifiable from the descriptions in the Probable Causes or the Checking Procedures for the displayed diagnostic trouble code.

INSPECTION OF ELECTRICAL EQUIPMENT



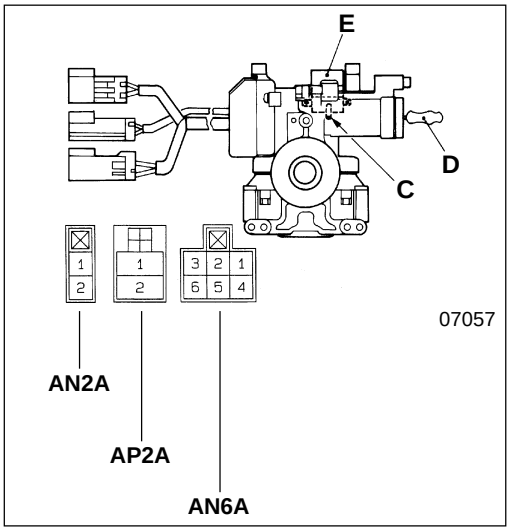
001 Checking Combination Switch

- Perform continuity checks according to the following table.
  AQ15A Connector Connection Table

		⑤	⑥
Exhaust brake switch	OFF		
	ON	○——○	

○——○ : There must be continuity between the pins.

- If there is anything wrong, replace the switch.



002 Checking Starter Switch

- Perform continuity checks according to the following table.
- If there is anything wrong, replace the starter switch. Gr 37

(1) Continuity Check

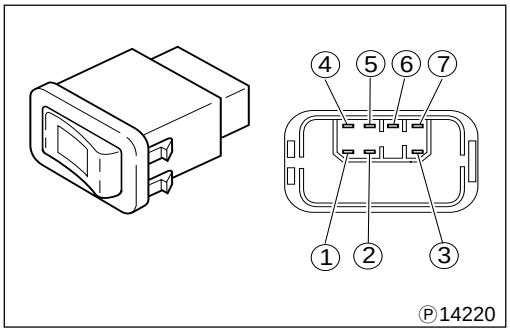
		AP2A		AN6A				
		②	①	③	④	②	⑥	⑤
LOCK	Key not in position							
	Key in position						○——○	
• (OFF)							○——○	
ACC		○——○					○——○	
ON		○——○		○——○			○——○	
START		○——○		○——○		○	○——○	
		B	M	A	F/M	S	K1	K2

○——○ : There must be continuity between the pins.

(2) Checking Key Interlock Solenoid

	AN2A		LOCK	ACC	ON	START	Remarks
	①	②					
Rotating range of key **D**	⊕——⊖			←——		——→	Plunger **C** is locked and key **D** cannot be removed.
			←——			——→	Plunger **C** is free and key **D** can be removed.

⊕——⊖ : Apply voltage across these pins.
DC 12V
E: Key interlock solenoid



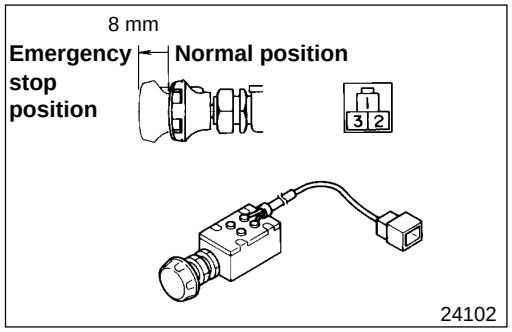
014 Checking Cold Start Switch

- Perform continuity checks according to the following table.

	①	⑤
ON	○——○	
OFF		

○——○ : There must be continuity between the pins.

- If there is anything wrong, replace the switch.



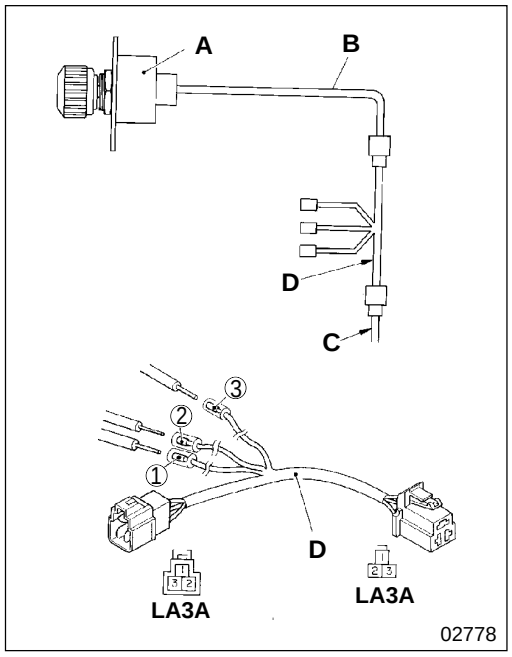
156 Checking Emergency Engine Stop Switch

- Perform continuity checks according to the following table.

	①	②	③
Normal position	○—○		
Emergency stop position	○		○

○—○ : There must be continuity between the pins.

- If there is anything wrong, replace the switch.
  Gr 13A

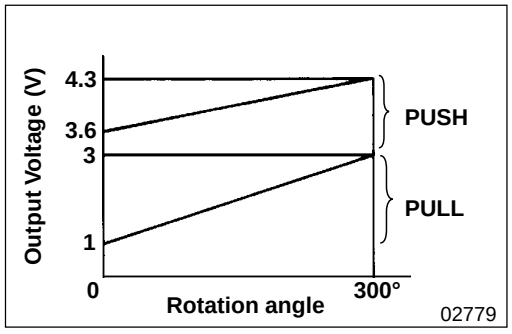


157 Checking Idle Adjusting Potentiometer

- Disconnect the harness **B** of the idle adjusting variable resistor **A** from the vehicle side harness **C**, and connect the inspection harness **D** between them.
- Set starter switch to ON.
- Measure the output voltage of the idle adjusting variable resistor **A** according to the following table.

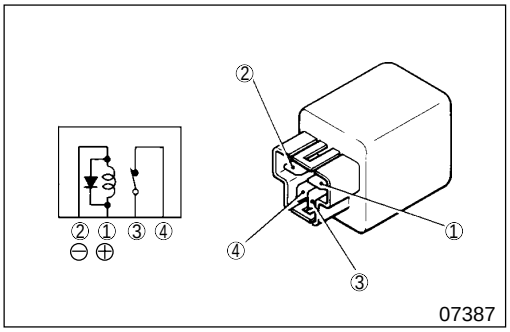
	②	③		
Standard value	⊖	⊕	Output voltage PULL (Knob in pulled position)	1 to 3 V
			Output voltage PUSH (Knob in pushed position)	3.6 to 4.3 V

- If the reading is out of the standard value range, replace the idle adjusting potentiometer **A**.



Output Characteristics

INSPECTION OF ELECTRICAL EQUIPMENT



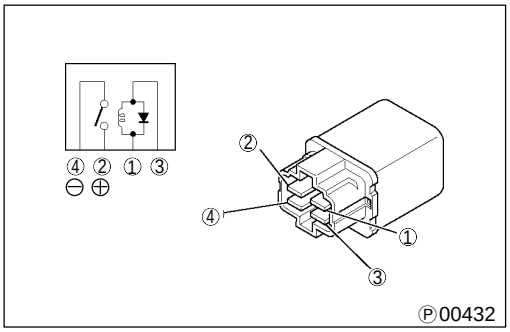
180 Checking Relay (Normally closed type 4-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④
When not energized	○	○	○	○
When energized	⊕	⊖	◌	◌

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12 V DC across these pins.
◌·····◌ : Continuity between these pins must be lost.

- If there is anything wrong, replace the relay.



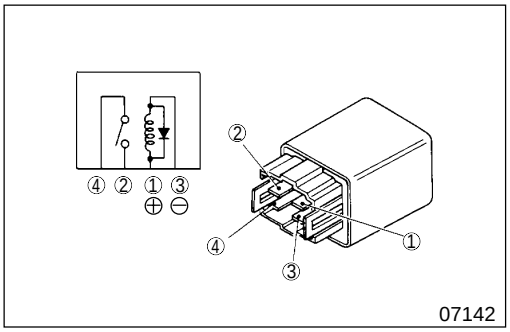
181 Checking Relay (Normally open type 4-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④
When not energized	○		○	
When energized	⊕	○	⊖	○

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12V DC across these pins.

- If there is anything wrong, replace the relay.



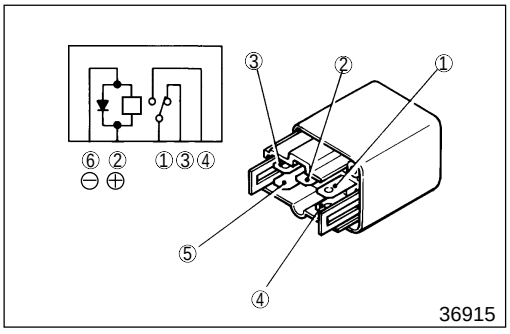
185 Checking Relay (Normally open type 4-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④
When not energized	○		○	
When energized	⊕	○	⊖	○

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12V DC across these pins.

- If there is anything wrong, replace the relay.



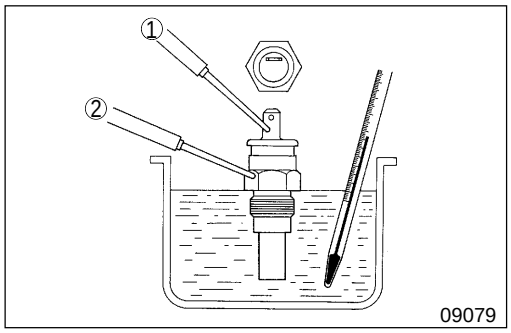
228 Checking Relay (Normally open type 6-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④	⑥
When not energized	○	○	○		○
When energized	○	⊕		○	⊖

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12 V DC across these pins.

- If there is anything wrong, replace the relay.



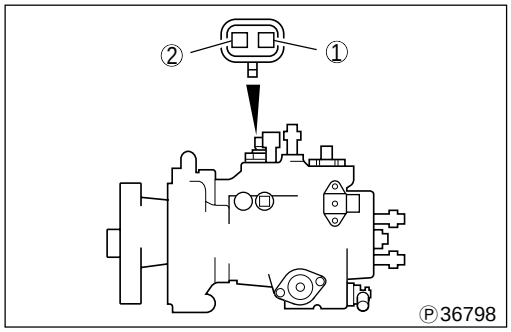
262 **Checking Coolant Temperature Sensor**

- Put the coolant temperature sensor in a container filled with engine oil.
- Heat the engine oil to various specified temperatures while stirring the engine oil.
- Measure the resistance value between pins ① and ② (body).

Standard value	0°C {32°F}	(8.62 kΩ)
	20°C {68°F}	(3.25 kΩ)
	40°C {104°F}	(1.5 kΩ)
	60°C {140°F}	620 ± 62 Ω

Reference value in parentheses

- If the reading is out of the standard value, replace the coolant temperature sensor. Gr14A

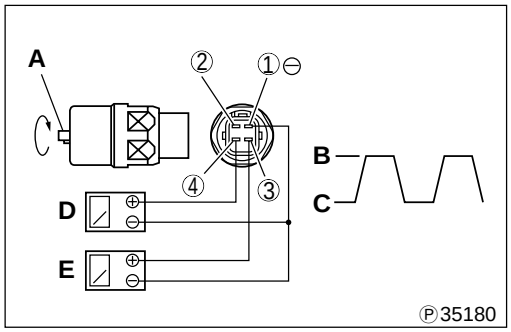


263 **Checking Engine Speed Sensor**

- Measure the resistance value between pins ① and ②.

Standard value (at 20°C {68°F})	230 ± 25 Ω

- If the reading is out of the standard value range, replace the engine speed sensor. Ask your DENSO service station to replace it.



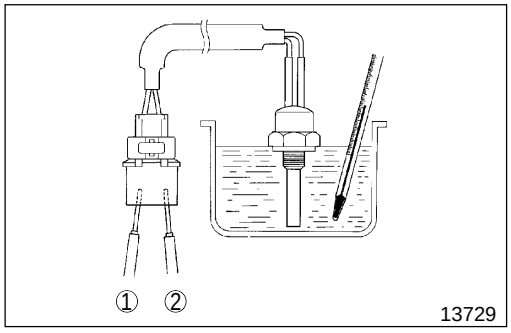
265 **Checking Vehicle Speed Sensor**

- Slowly rotate portion **A** of the vehicle speed sensor with a voltage of 12V DC applied across pins ① and ③.
- Measure the maximum value (high pulse voltage **B**) and minimum value (low pulse voltage **C**) of the voltage generated across the pins ① and ②.

D: Tester (to check 25 pulses)

Standard value	Low pulse	0.5 V or less
	High pulse	8 ± 1 V

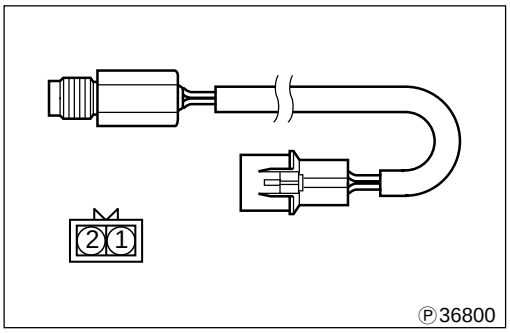
- If the reading is out of the standard value, replace the vehicle speed sensor.



304 **Checking Boost Air Temperature Sensor**

- Place the boost air temperature sensor in a container of water.
- Raise the water temperature to the specified values and stir.
- Measure the resistance between pins ① and ②.
- If the measured value deviates from the standard value, replace the boost air temperature sensor. Gr 15A

Standard value	0°C {32°F}	5880 ± 588 Ω
	20°C {68°F}	2450 ± 245 Ω
	80°C {176°F}	322 ± 48 Ω



316 Checking TDC Sensor

- Measure the resistance between pins ① and ②.

Standard value (at 25°C {77°F})	1.5 ± 0.2 kΩ

- If the reading is out of the standard value, replace the TDC sensor.

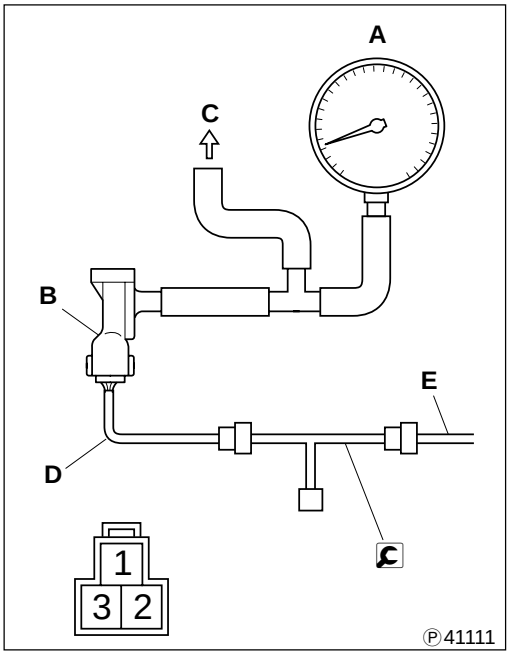
318 Checking Boost Pressure Sensor

< Checking by use of Multi-Use Tester II >

P13EA-28

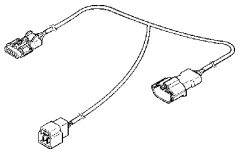
NOTE

The boost pressure checking conditions differ between when the boost pressure is checked by use of the Multi-Use Tester II and when it is checked without use of the Multi- Use Tester II. So the standard values also differ.



< Checking without use of Multi-Use Tester II >

- Disconnect the harness **D** of the boost pressure sensor from the chassis side harness **E** and connect the C inspection harness between them.

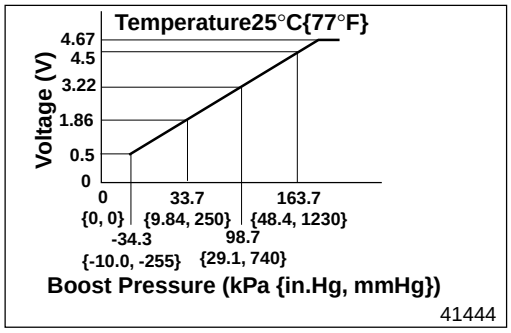
Too Name and Shape	Part No.
Inspection Harness  02806	MC854336 (Obtain Locally)

- Mount pressure gauge **A** for measurement of the boost pressure.
  C: To inlet manifold
- Set the starter switch to ON.
- Measure the output voltage of the boost pressure sensor **B** according to the following table.

Item	Connector Pin		
	① Power (+)	② GND (-)	③ Output (+)
Power voltage	○	○	
* Output voltage (Refer to the output characteristics shown.)		○	○

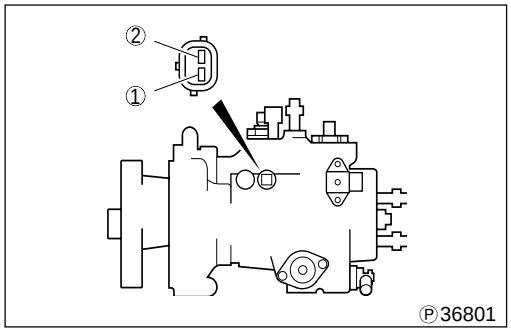
*: Start the engine before measurement.

Output Characteristics



Standard Value	② - ③	5 V
	① - ②	0.5 V/–34.3 kPa {–10.0 in. Hg, –255 mmHg}
		1.86 V/33.7 kPa {9.84 in. Hg, 250 mmHg}
		3.22 V/98.7 kPa {29.1 in. Hg, 740 mmHg}
		4.5 V/163.7 kPa {48.4 in. Hg, 1230 mmHg}

- If the results of the above mentioned checks show any deviation from the standard values, replace the boost pressure sensor **B**.

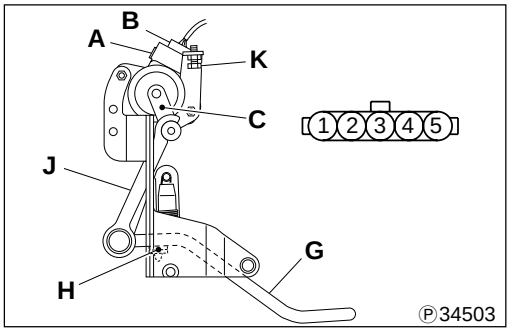


323 Checking Fuel Temperature Sensor

- Measure the resistance between pins ① and ②

Standard value (at 20°C {68°F})	2.5 ± 1.0 kΩ

- If the reading is out of the standard value range, replace the fuel temperature sensor. Ask your DENSO service station to replace it.



324 Checking Accelerator Position Sensor

[Inspection]

- Set the starter switch to ON.
- Measure the output voltage of the accelerator position sensor **A** from the back side of harness connector **B** according to the following table.

Lever **C** position		Accelerator Position Sensor 1		Accelerator Position Sensor 2		Accelerator Switch	
		②	①	②	⑤	②	③
		⊕	⊖	⊕	⊖	⊕	⊖
Standard value	Idling position **D**	0.85 ± 0.1 V		0.85 ± 0.1 V		4V or more	
	Accelerator switch operating position **E**	1.0 ± 0.24 V		1.0 ± 0.24 V		1V or less	
	Full load position **F**	4.0 ± 0.1 V		4.0 ± 0.1 V			

○——○ : There must be continuity between the pins.

⊕ , ⊖ : Polarity when voltage is measured

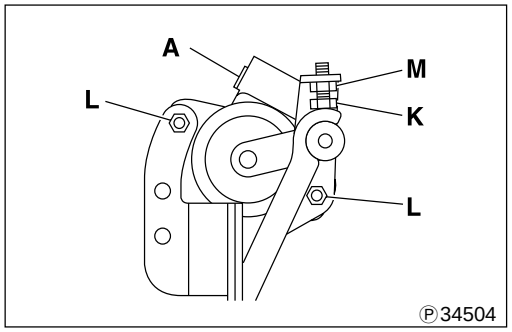
D: Where accelerator control arm **G** is in contact with stopper **H**

E: Where voltage across pins ② and ③ is reduced to 1V or less by slowly depressing the accelerator pedal

F: Where accelerator control extension **J** is in contact with stopper bolt **K** (fully depressed).

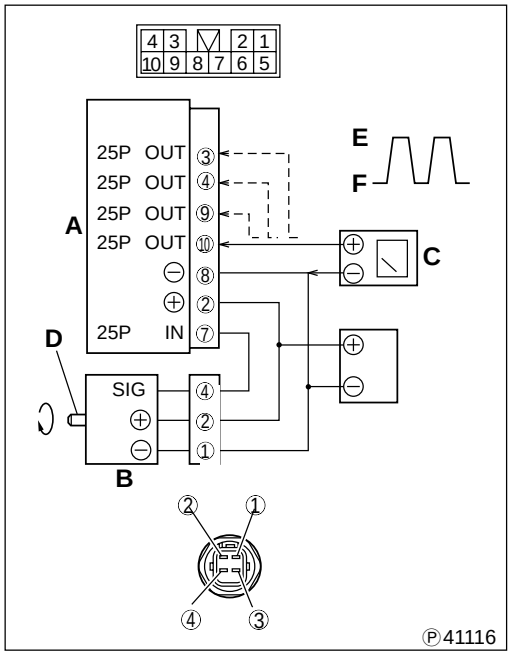
- If the output voltage is out of the standard value range, adjust by the following procedures.

INSPECTION OF ELECTRICAL EQUIPMENT



[Adjustment]

- Adjust the output voltage at the idling position **D** by loosening the screw **L** and moving the accelerator position sensor **A**.
  After the adjustment, retighten the screw.
- Adjust the output voltage at the full load position **F** by loosening the nut **M** and adjusting the stopper bolt **K**.
  After the adjustment, lock the bolt with the nut.

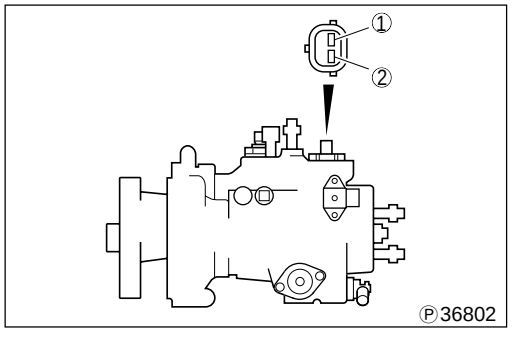


351 Checking Pulse Divider

- Wire the pulse divider **A** as shown.
  B: Vehicle speed sensor (Use 25-pulse pins.)
  C: Tester
- Slowly rotate the shaft **D** of the vehicle speed sensor **B** by hand and measure the maximum value (high pulse voltage **E**) and the minimum value (low pulse voltage **F**) of the voltage generated across each of the output pins (③, ④, ⑨, ⑩) and pin ⑧ of the pulse divider **A**.

Standard value	Low pulse voltage **F**	0.5V or less
	High pulse voltage **E**	8 ± 1 V

- If the reading is out of the standard value, replace the pulse divider **A**.

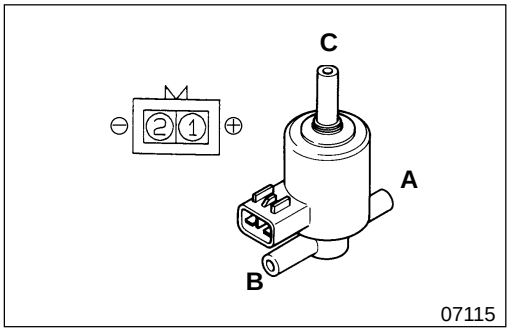


536 Checking Spill Valve

- Measure the resistance between pins ① and ②.

Standard value (at 20°C {68°F})	1.5 ± 0.5 Ω

- If the reading is out of the standard value range, replace the spill valve. Ask your DENSO service station to replace it.



565 Checking 3-Way Magnet Valve

Perform the following checks. If there is anything wrong, replace the 3-way magnet valve.

(1) Operation Check

- Apply DC voltage across pins ① and ② and slowly increase, beginning at 0V.
- Measure the voltage at the time when the 3-way magnet valve is operated.
  (Determine whether the magnet valve is ON or OFF on the basis of its operating sound.)

Standard value (Lowest operating voltage)	11 V or more

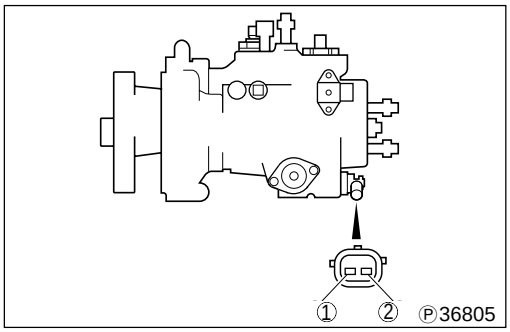
(2) Continuity and Air Tightness Checks

Perform continuity checks according to the following table.

	Input Port **A**	Output Port **B**	Exhaust Port **C**
ON	○———	——○	
OFF		○———	——○

○——○ : There must be continuity between the pins.

Negative pressure at the time of check: 100 kPa {30 in.Hg, 750 mmHg}



584 Checking Timer Control Valve

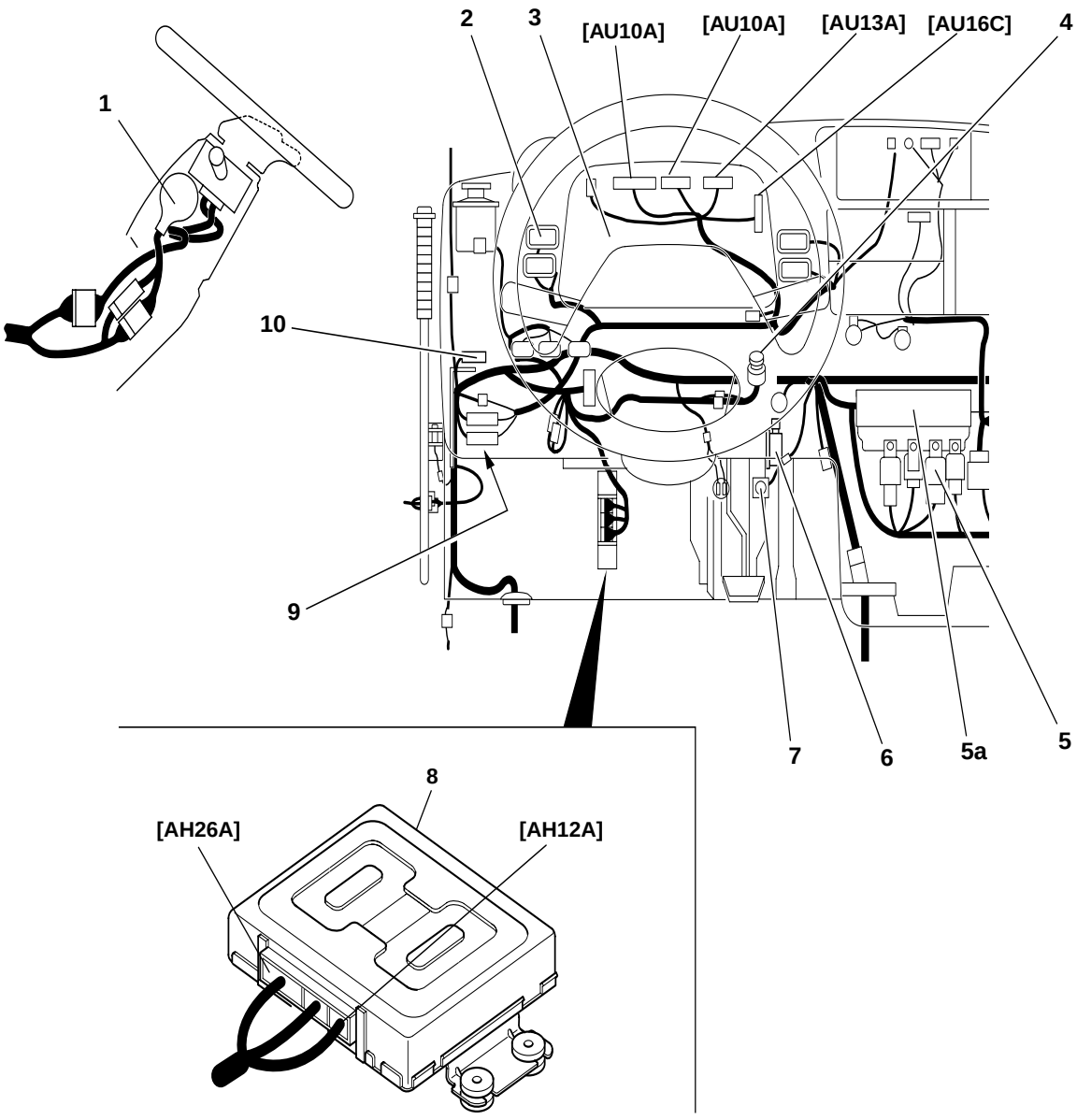
- Measure the resistance between pins ① and ②.

Standard value (at 20°C {68°F})	11.3 ± 3 Ω

- If the reading is out of the standard value range, replace the timer control valve. Ask your DENSO service station to replace it.

LOCATIONS OF PARTS

1 to 10

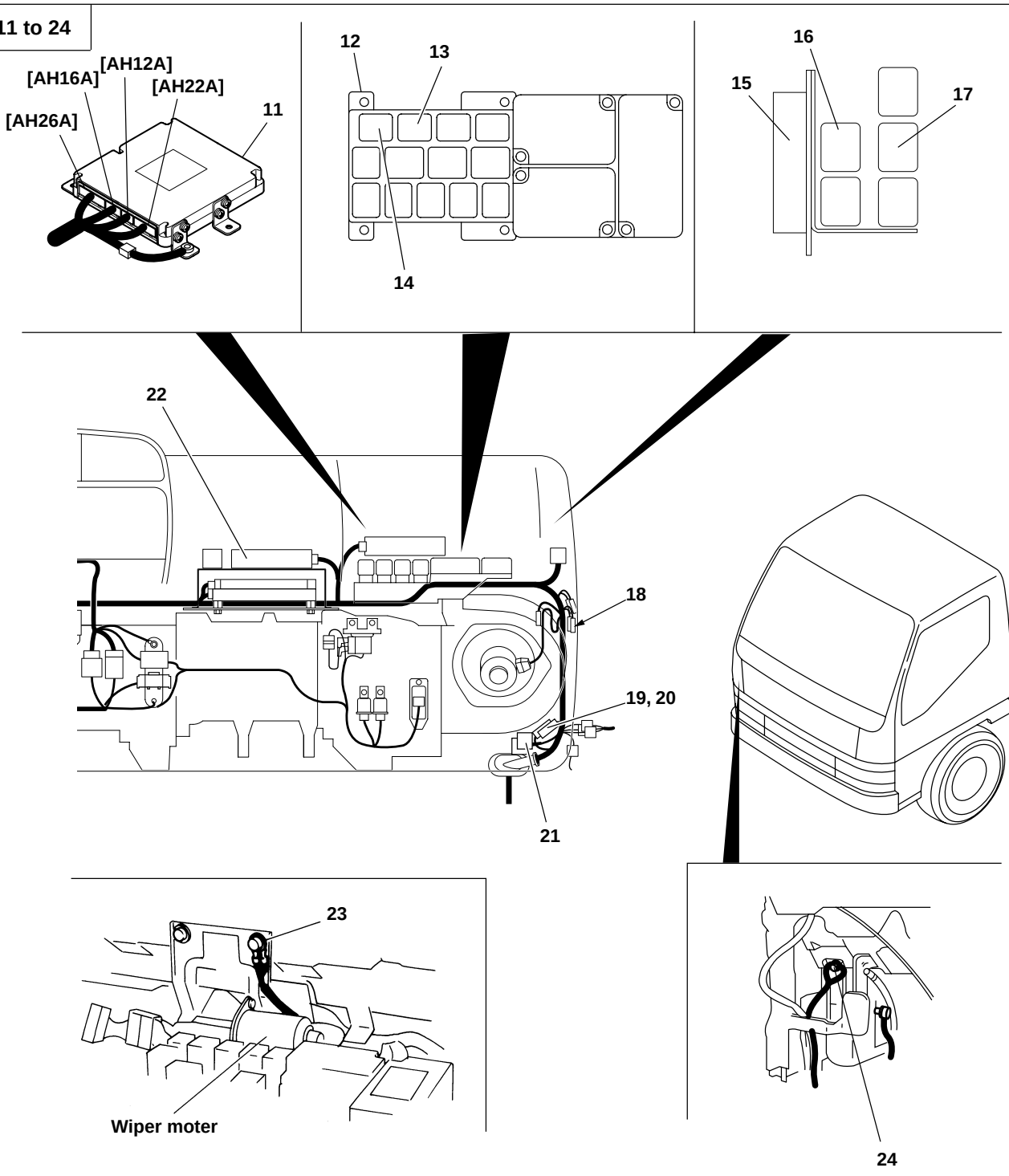


1 Starter switch
2 Warming switch
3 Meter cluster
4 Idling speed adjustment potentiometer
5 Safety relay
5a Fuse box
6 Accelerator pedal position sensor
7 Emergency engine stop switch
8 Automatic transmission electronic control unit
9 Connection of cab harness and meter harness
10 Fuel injection rate adjustment resistor

Indicate by connector type [ ]

Ⓟ45357

11 to 24



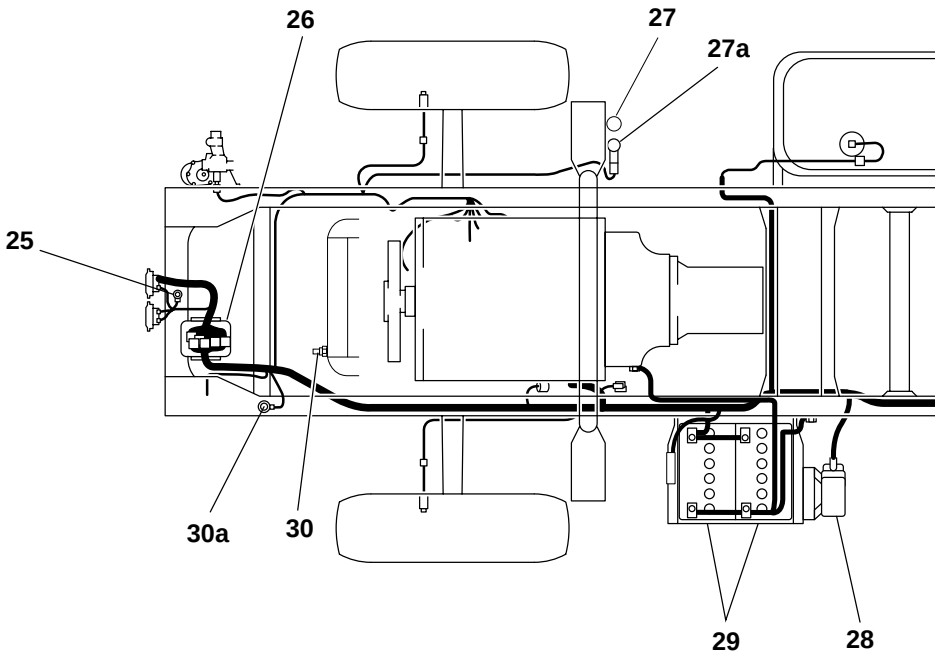
11 Engine electronic control unit
17 Relay box
18 Exhaust brake cut relay (A/T)
14 Exhaust brake cut relay(ABS)
15 Electronic drive unit
16 Electronic drive unit relay
17 Electronic control unit main relay
18 Diode
19 Diagnosis switch
20 Memory clear switch
21 Multi-use tester-II connector
22 Pulse divider
23 Cab ground
24 Cab ground

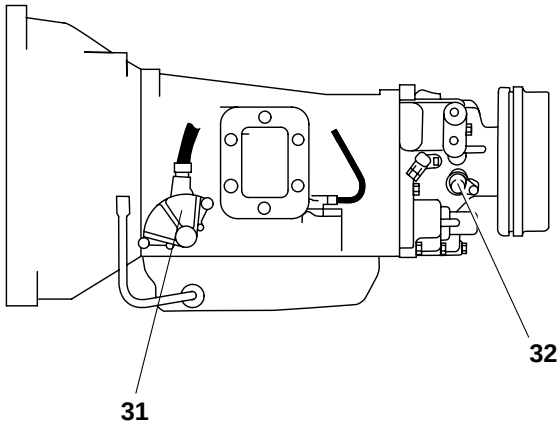
A/T : Automatic transmission
ABS : Anti-lock brake system

Indicate by connector type [ ]

Ⓟ45358

25 to 32



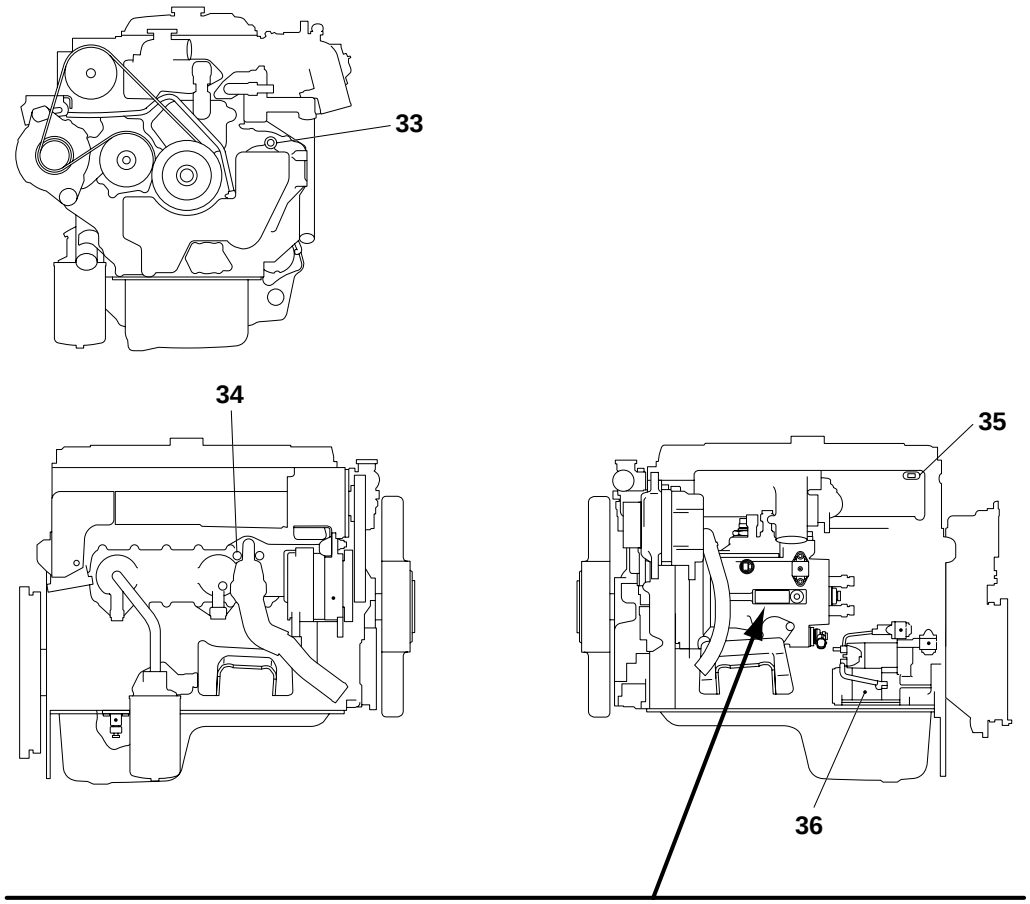


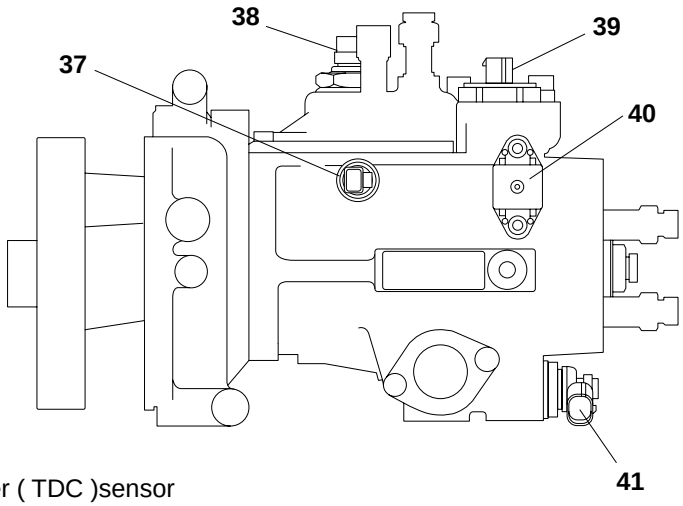
25 Ground
26 connected of cab harness and harness
27 Intake silenser 3-way magnetic valve
27a Exhaust brake 3-way magnetic valve
28 High current Fuse box
29 battery
30 Boost temperature sensor
30a Chassis ground
31 Inhibitor switch
32 Vehicle speed sensor

Indicate by connector type [ ]

Ⓟ45359

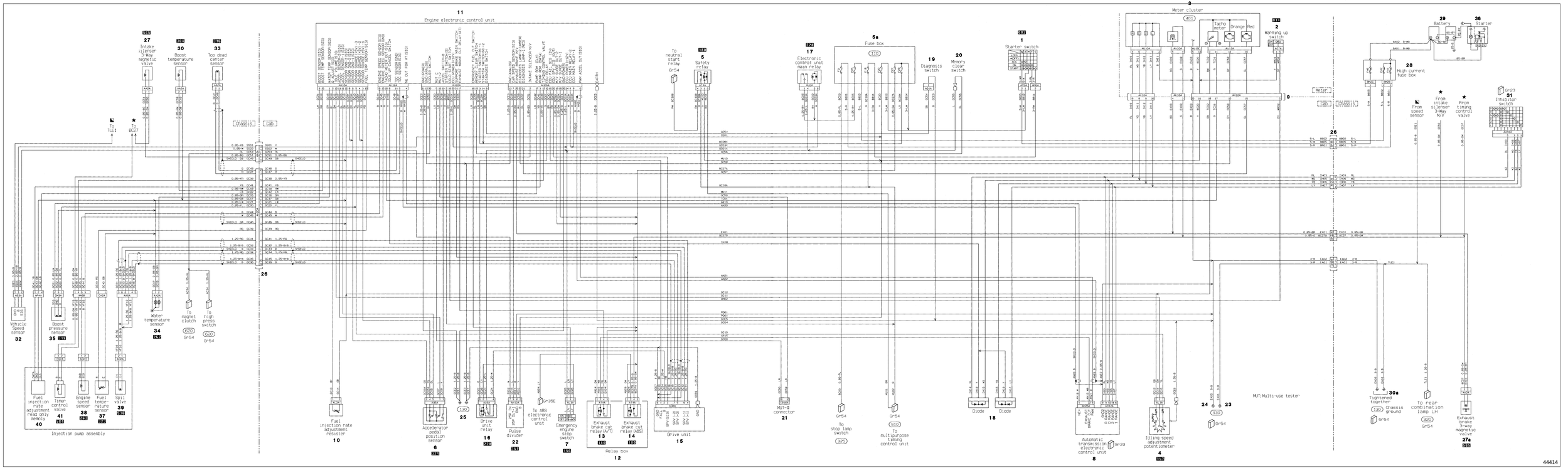
33 to 41





33 Top dead center (TDC)sensor
34 Water tenperature sensor
35 Boost pressure sensor
36 Starter
37 Fuel tenperature sensor
38 Engine speed sensor
39 Spill valve
40 Fuel injection rate adjusting read only memory
41 Timer control valve

Ⓟ45371


11
Engine electronic control unit
27
Intake silencer 3-Way magnetic valve
30
Boost temperature sensor
33
Top dead center sensor
32
Vehicle Speed sensor
35
Boost pressure sensor
34
Water temperature sensor
Fuel injection rate adjustment resistor
40
Inter control valve
41
Engine speed sensor
38
Fuel temperature sensor
37
Spill valve
39
Injection pump assembly
10
Fuel injection rate adjustment resistor
6
Accelerator pedal position sensor
16
Drive unit relay
22
Pulse divider
25
To ABS electronic control unit
Emergency engine stop switch
12
Relay box
13
Exhaust brake cut relay (A/T)
14
Exhaust brake cut relay (ABS)
15
Drive unit
To neutral start relay
5
Safety relay
17
Electronic control unit main relay
5a
Fuse box
19
Diagnosis switch
20
Memory clear switch
1
Starter switch
21
MUT-II connector
To stop lamp switch
To multipurpose timing control unit
18
Diode
Diode
3
Meter cluster
Tacho meter
Orange
Red
2
Warming up switch
9
Meter
8
Automatic transmission electronic control unit
4
Idling speed adjustment potentiometer
24
23
MUT: Multi-use tester
29
Battery
36
Starter
28
High current fuse box
From speed sensor
From intake silencer 3-Way M/V
From timing control valve
31
Inhibitor switch
26
30a
Tightened together
Chassis ground
To rear combination lamp LH
Exhaust brake 3-way magnetic valve
27a
To TLE1
To BC27
To magnet clutch
To high press switch
Water temperature sensor
Fuel injection rate adjustment resistor
Accelerator pedal position sensor
Drive unit relay
Pulse divider
To ABS electronic control unit
Emergency engine stop switch
Exhaust brake cut relay (A/T)
Exhaust brake cut relay (ABS)
Drive unit
To stop lamp switch
To multipurpose timing control unit
Diode
Diode
Automatic transmission electronic control unit
Idling speed adjustment potentiometer
MUT: Multi-use tester
To rear combination lamp LH
Exhaust brake 3-way magnetic valve
44414

MITSUBISHI
FUSO

Group 13EB

Electronically Controlled Fuel System

< 4D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWSE0101-13EB

INDEX

STRUCTURE AND OPERATION 13EB- 2

TROUBLESHOOTING

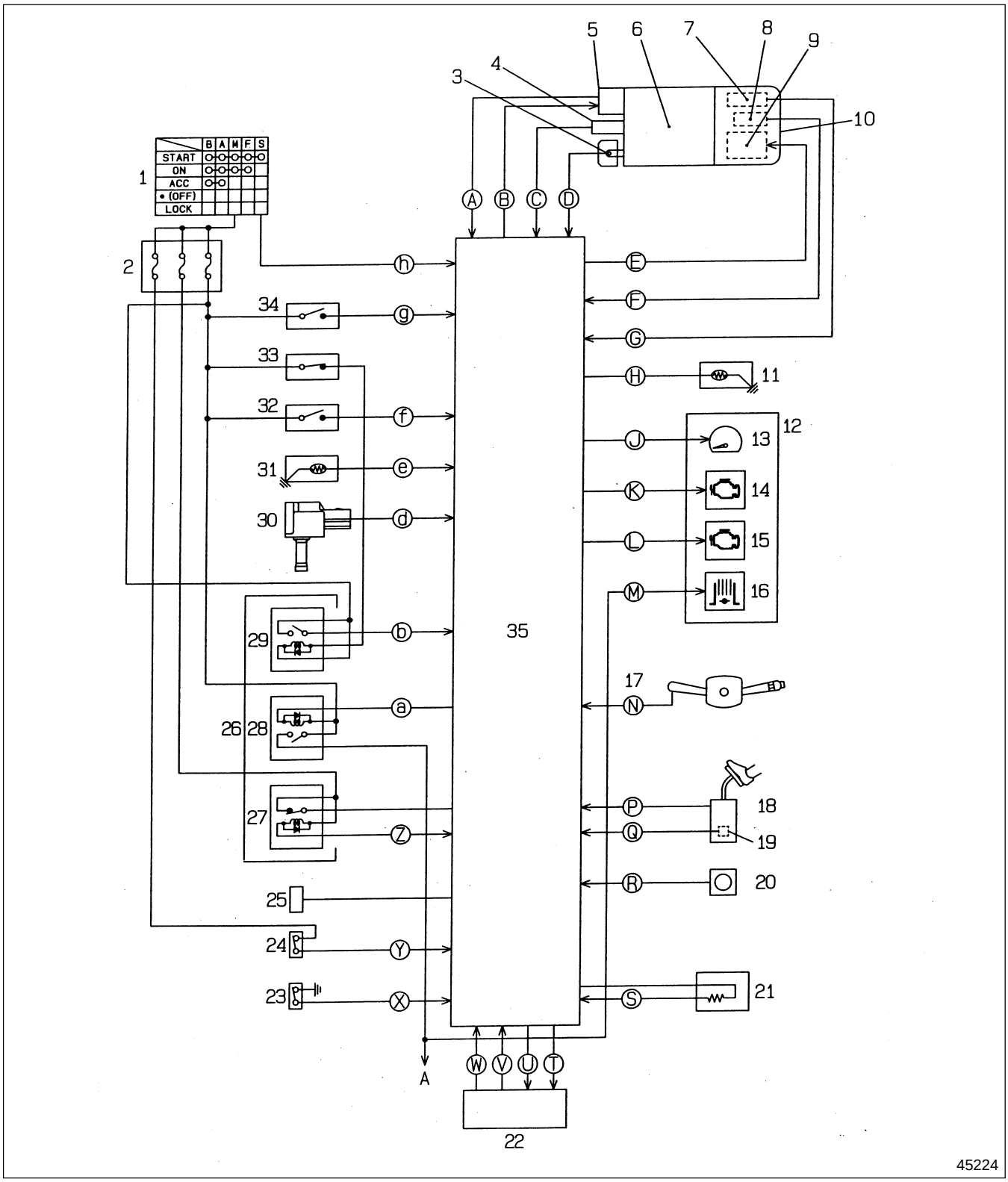
1. Inspection Procedures 13EB-20
2. Connection of Multi-Use Tester II 13EB-22
3. Reading and Erasing Diagnostic Trouble Codes 13EB-23
4. Diagnostic Trouble Codes and Check Items 13EB-25
5. Service Data of Multi-Use Tester II 13EB-30

INSPECTION OF ELECTRICAL EQUIPMENT 13EB-31

LOCATIONS OF PARTS 13EB-40

ELECTRICAL WIRING DIAGRAM 13EB-41

Configuration of Electronic Governor and Pre-stroke Control Injection Pump System



A : To exhaust brake 3-way magnetic valve Gr 54

Part		Main function/operation	Data signal
1	Starter switch	Sensing of start signal	ⓗ : Start signal
2	Fuse box	—	—
3	Engine speed sensor	Sensing of engine speed	Ⓓ : Engine speed signal
4	Sub control rack position sensor	Sensing of control rack position	Ⓒ : Control rack position signal (backup)
5	Pre-stroke actuator • Pre-stroke position sensor • Drive unit	— —	Ⓐ : Pre-stroke position signal Ⓑ : Actuator drive signal
6	Pre-stroke control type injection pump	Alteration of pre-stroke (advancement of fuel injection timing)	—
7	Control rack position sensor	Sensing of control rack position	Ⓖ : Control rack position signal
8	Backup engine speed sensor	Sensing of engine speed	Ⓕ : Engine speed signal (backup)
9	Linear DC motor	Activation of rack	Ⓔ : Linear DC motor drive signal
10	Electronic governor	—	—
11	Boost temperature sensor	Detection of engine intake air temperature	Ⓗ : Boost temperature signal
12	Meter cluster	—	—
13	Tachometer	—	Ⓙ : Tachometer drive signal
14	Warning lamp (Amber)	Indication of system faults and diagnosis codes	Ⓚ : Lamp illumination signal
15	Warning lamp (Red)		Ⓛ : Lamp illumination signal
16	Indicator lamp (Exhaust brake)	—	Ⓜ : Lamp illumination signal
17	Auxiliary brake switch (Manual)	ON/OFF switching of Exhaust brake	Ⓝ : Exhaust brake ON signal
18	Accelerator pedal position sensor	Sensing of accelerator pedal depression amount	Ⓟ : Accelerator pedal position signal
19	Accelerator pedal switch	Turns OFF when accelerator pedal is depressed	Ⓠ : Accelerator pedal depression signal
20	Idling speed adjustment potentiometer	Shortening of warmup time	Ⓡ : Warmup time shortening signal
21	Fuel injection rate adjustment resistor	Correction of fuel injection rate	Ⓢ : Injection volume correction signal
22	Automatic transmission control unit	Automatic transmission control	Ⓣ : Accelerator position signal Ⓤ : Engine speed signal
23	Diagnosis switch	Generation of diagnosis codes	Ⓧ : Diagnosis code signal
24	Memory clear switch	Eraser of diagnosis codes	Ⓨ : Diagnosis code eraser signal
25	Multi-Use Tester-II connector (16 pin)	Connection of Multi-Use Tester-II	—
26	Relay box	—	—
27	Pre-stroke cut relay	Closes contacts upon plunger pre-stroke operation	Ⓩ : Pre-stroke operation signal
28	Exhaust brake relay	Closes contacts upon exhaust brake operation	ⓐ : Exhaust brake operation signal
29	Transmission neutral relay	Contact closed when transmission is in neutral	ⓑ : Transmission neutral signal
30	Boost pressure sensor	Sensing of boost pressure	ⓓ : Boost pressure signal
31	Coolant temperature sensor	Sensing of engine coolant temperature	ⓔ : Coolant temperature signal
32	Clutch pedal switch (Manual)	Turns OFF when clutch pedal is depressed	ⓕ : Clutch pedal depression signal
33	Transmission neutral switch	Turns OFF when transmission neutral is selected	—
34	Warming switch	Shortening of warmup time	ⓖ : Warmup time shortening signal
35	Engine control unit	Control of overall system	—

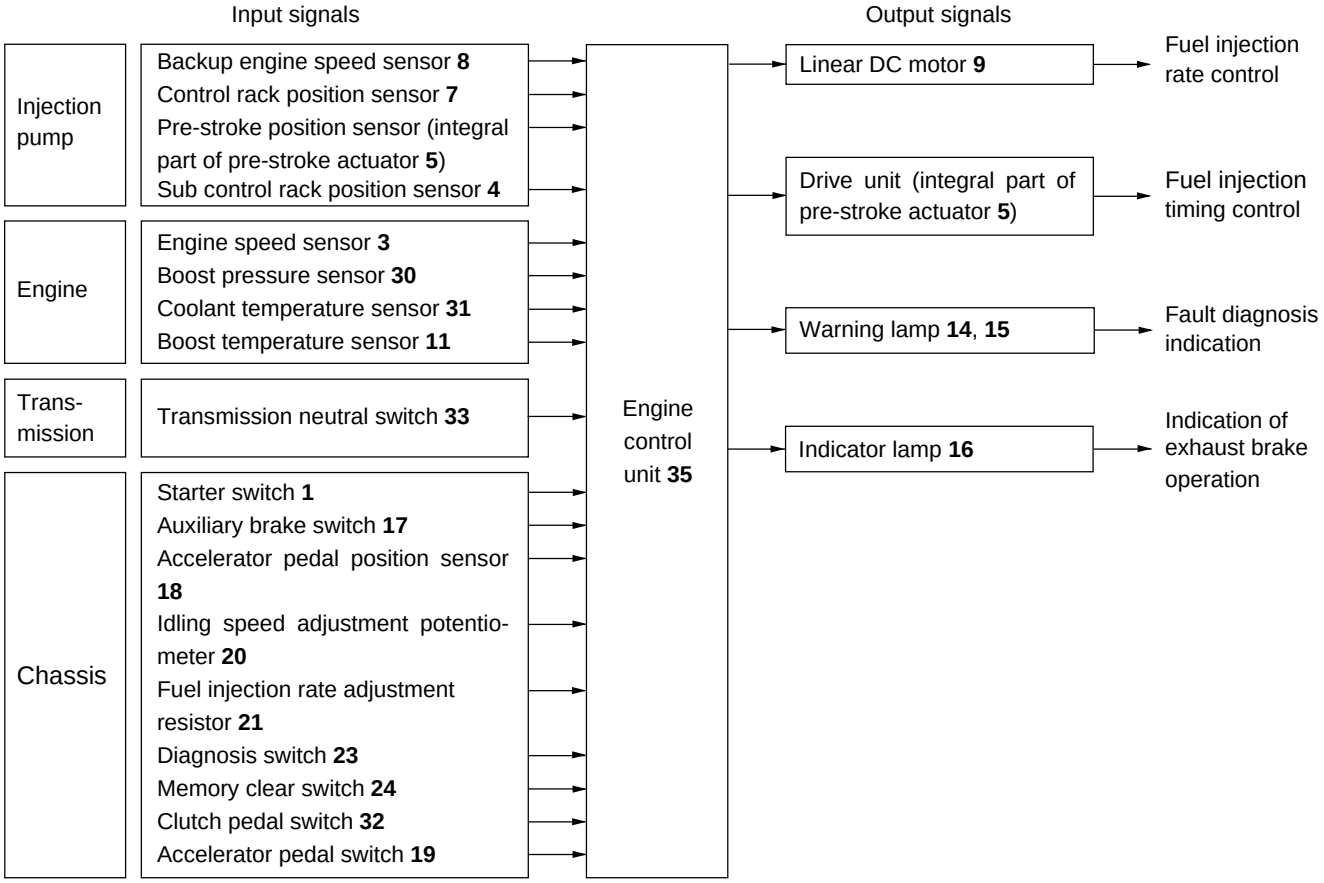
- The electronic governor and pre-stroke control injection pump system combines an electronic governor **10** with an injection pump **6** that has an electronically controlled pre-stroke adjustment feature.
- The injection pump's plunger lift speed varies in accordance with the engine speed, causing concomitant variations in the injection pipe pressure.
- Variations in the injection pipe pressure make it difficult to achieve an optimum spray from the injection nozzles and the optimum air/fuel mixture.
- To compensate for changes in the injection pipe pressure, the injection pump plunger pre-stroke is increased at low and mid- range speeds, thus ensuring that fuel injection takes place late in the cam lift, when plunger movement is relatively fast.
- At high speeds, the plunger pre-stroke is decreased, thus ensuring that fuel injection takes place in early in the cam lift, when plunger movement is relatively slow. Excessive increases in injection pipe pressure are thus prevented.
- By adjusting the plunger pre-stroke in this manner, the pre-stroke control injection pump **6** ensures that the spray and air/ fuel mixture are always optimally suited to combustion.
- The overall benefits are higher engine torque and cleaner exhaust emissions than are possible with a conventional injection pump.
- Control operations are performed by the engine control unit **35**, which receives data from sensors on the engine and other vehicle components, processes them, and issues appropriate drive signals to the pre-stroke actuator **5** (located at the rear of the injection pump) and to the linear DC motor **9** (located inside the electronic governor).

The system's control functions (including auxiliary functions) are shown in the following table.

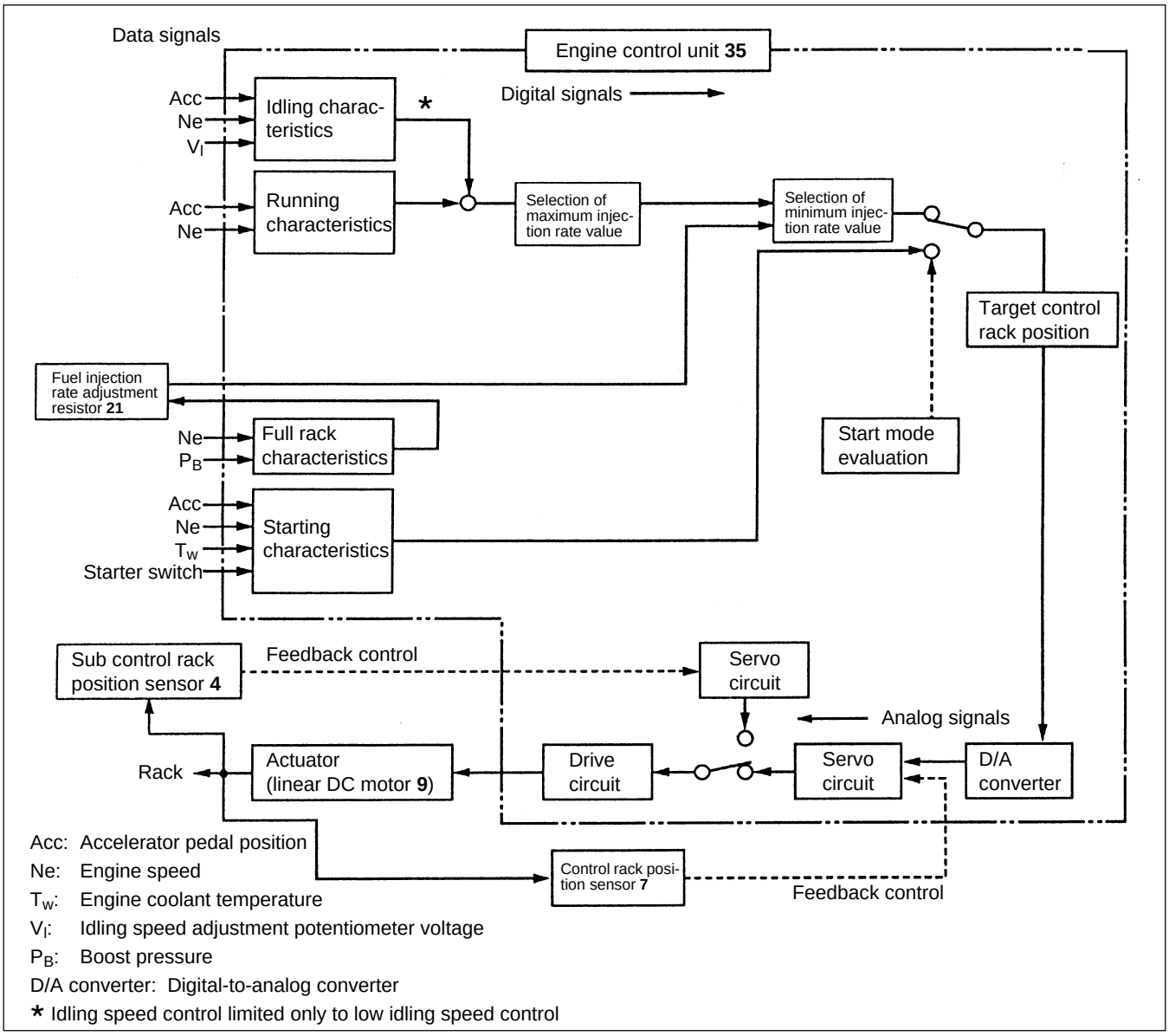
Item	Operation	Data source	
		Sensor(s)	Data signal(s)
Fuel injection rate control	The fuel injection rate is optimized to match engine operating conditions. 🕮 P13EB-6	3, 7, 18, 19, 21, 28	Ⓓ, Ⓖ, Ⓟ, Ⓠ, Ⓢ, ⓑ
Pre-stroke control	The timing sleeve position is altered, thereby changing the pre-stroke and advancing the fuel injection timing. 🕮 P13EB-7	3, 5, 18, 31	Ⓓ, Ⓐ, Ⓑ, Ⓟ, ⓔ
* Control rack preliminary operation	In cold weather and other conditions that are unfavorable for engine startup, the control rod is caused to move slightly in the fuel increase direction, thus enhancing startabilily. This operation takes place when the starter switch is turned ON.	1, 18, 19, 31	ⓗ, Ⓟ, Ⓠ, ⓔ
* Warmup time shortening function	In cold weather, the engine's idling speed is increased to shorten the time required for warmup. 🕮 P13EB-8	18, 19, 20	Ⓟ, Ⓠ, Ⓡ
* Overrun prevention function	In the event of an abnormal increase in engine speed, the control rack is pulled in the fuel decrease direction to prevent the engine from overrunning.	3	Ⓓ
* Emergency vehicle operation function (used in event of control rack position sensor fault)	In the event of a fault in the control rack position sensor **7**, the control rack position is sensed by the sub control rack position sensor **4**. If both rack position sensors develop faults, thus preventing detection of the rack position and optimization of the fuel injection rate, the fuel injection rate is controlled in accordance with engine speed signals only. 🕮 P13EB-10	3, 4, 7	Ⓓ, Ⓒ, Ⓖ
* Auxiliary brake control function	The auxiliary braking devices (exhaust brake) are controlled by the engine control unit **35**. (In a conventional system, the auxiliary braking devices are controlled by switches, relays, and dedicated controllers.) 🕮 P13EB-11	3, 16, 18, 19, 29, 32, 33	Ⓓ, Ⓜ, Ⓟ, Ⓠ, ⓑ, ⓕ
* Fault diagnosis function	The status of each system sensor is monitored continuously during engine operation. In the event of a fault, a warning lamp is illuminated to alert the driver and data related to the fault are stored in memory. 🕮 P13EB-	ALL	ALL
* Fail-safe function	In the event of a fault, a backup mode is selected and remedial action is taken in accordance with the type of fault. 🕮 P13EB-	ALL	ALL
* Reverse engine operation prevention function	In the event of reverse engine operation, the control rack is pulled in the fuel decrease direction to stop the engine.	3	Ⓓ

* : Auxiliary function

System Block Diagram



● Fuel Injection Rate Control



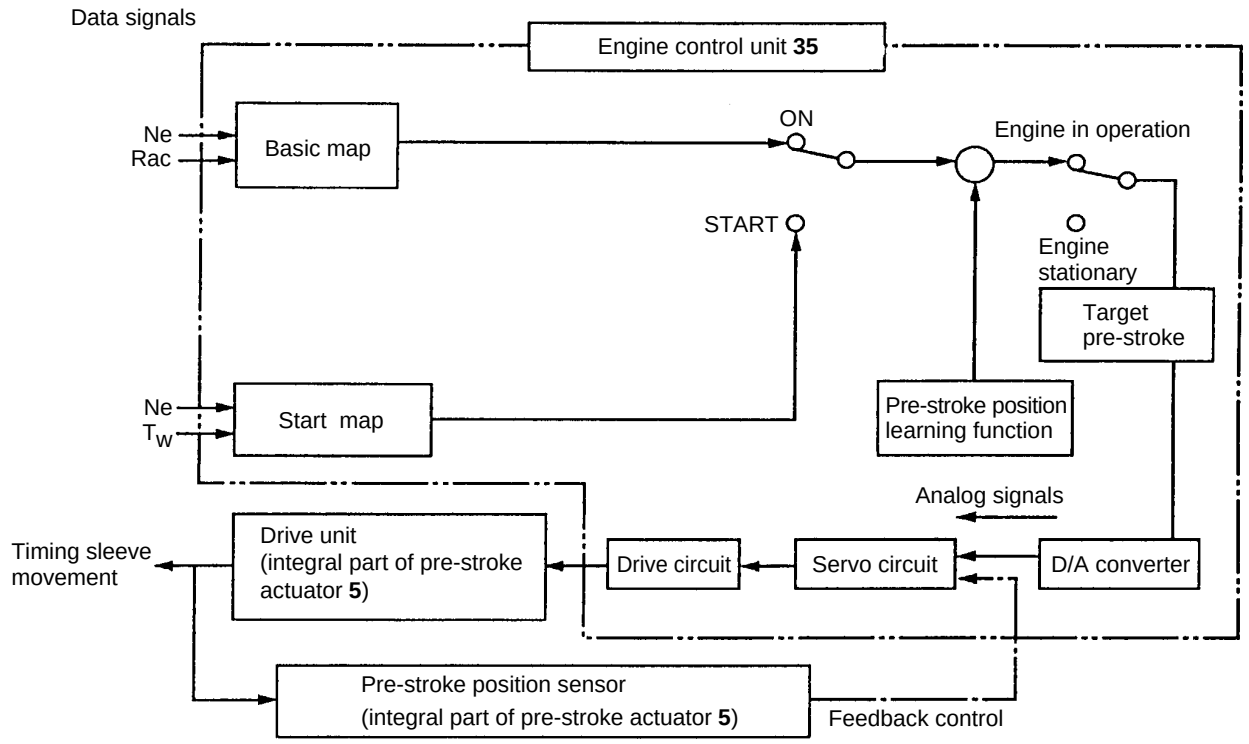
Operation of engine control unit 35

- During engine operation, control is effected in accordance with the idling characteristics and running characteristics. The maximum fuel injection rate value is selected in accordance with the output signals.
- After this selection, the control unit calculates and determines the minimum injection rate to prevent the injection rate selected in accordance with the full rack characteristics from exceeding the maximum injection rate. The target control rack position is thus determined. (During engine startup, control is effected in accordance with the starting characteristics, with the target rack position determined directly in accordance with the data signals.)
- The determined control rack position signal is converted into a continuous analog signal. By way of the servo circuit and drive circuit, the signal is applied to the linear DC motor **9**, which moves the rack.

Operation of control rack position sensor 7

- The control rack position sensor **7** monitors the operation of the linear DC motor **9**. In accordance with the position of the control rack, the sensor determines whether the linear DC motor is operating in accordance with the target, and it transmits feedback signals to the engine control unit **35**.
- In accordance with the feedback signals, the engine control unit **35** calculates the actual control rack position. If the actual position differs from the target, the control unit issues a correction command.
- Through repetition of this process, the system ensures that the control rack position complies with the target at all times.

● Pre-stroke control



Rac: Control rack position
Ne: Engine speed
T_W: Engine coolant temperature
D/A converter: Digital-to-analog converter

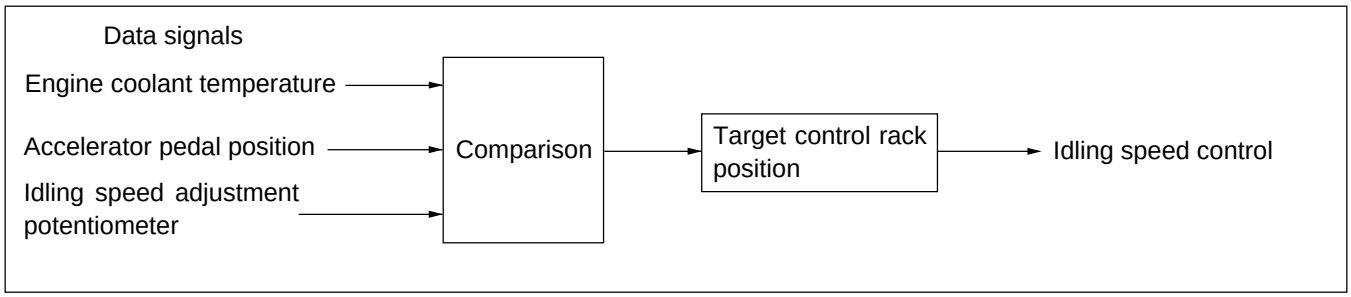
Operation of engine control unit 35

- During engine operation, control is effected in accordance with the basic map.
- The pre-stroke position learning function compensates for pre-stroke position sensor adjustment errors and other injection pump errors using the pre-stroke position sensor output voltage, thereby enabling determination of the target pre-stroke.
- The determined target pre-stroke value is converted into a continuous analog signal. By way of the servo circuit and drive circuit, the signal is applied to the drive unit. The drive unit moves the timing sleeve to alter the pre-stroke.
- During engine startup, control is effected in accordance with the start map.

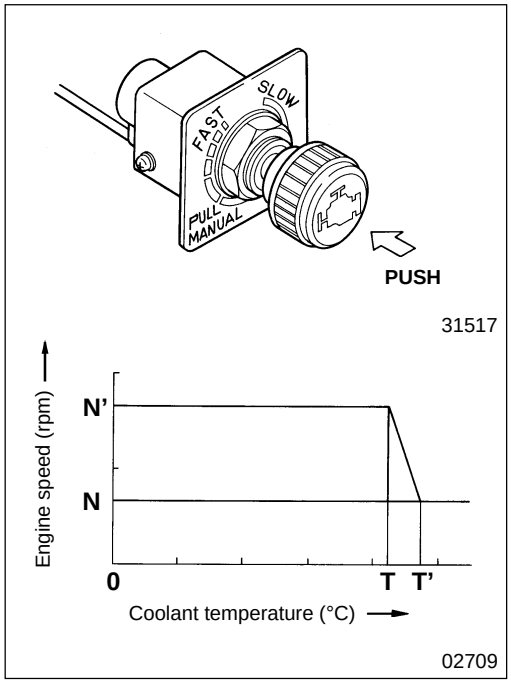
Operation of pre-stroke position sensor (integral part of pre-stroke actuator 5)

- The pre-stroke position sensor monitors the operation of the drive unit. In accordance with the position of the timing sleeve, the sensor determines whether pre-stroke control is being performed in accordance with the target, and it transmits feedback signals to the engine control unit **35**.
- In accordance with the feedback signals, the engine control unit **35** calculates the actual timing sleeve position. If the actual position differs from the target, the control unit issues a correction command.
- Through repetition of this process, the system ensures that the timing sleeve position complies with the target at all times. The appropriate pre-stroke is achieved as a result.

● Warmup time shortening function

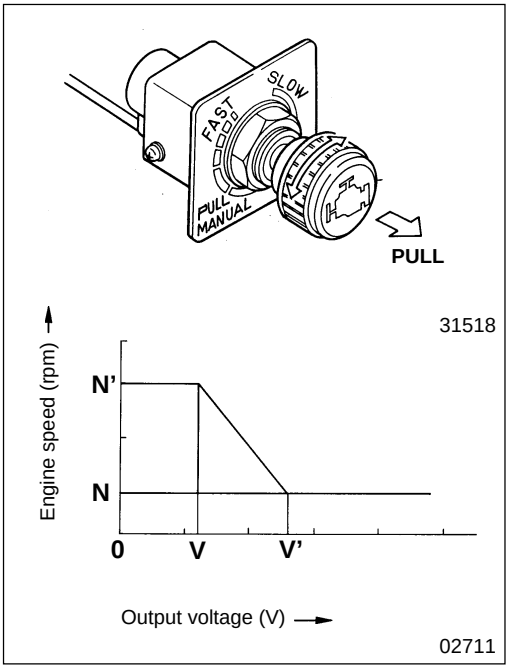


The warmup time shortening function increases the engine's idling speed in accordance with the coolant temperature, thereby shortening the time required for the engine to warm up. Control is effected automatically or manually in accordance with the position of the idling speed adjustment potentiometer **20**. Automatic control is selected by pushing the potentiometer, and manual control is selected by pulling it.



Automatic control (Potentiometer pushed)

- Automatic control is selected when the idling speed adjustment potentiometer **20** is pushed.
- When the coolant temperature is low, the engine's idling speed is automatically increased to shorten the time required for warmup.
- If the coolant temperature increases from **T** to **T'** (see the graph), the engine speed is decreased from **N'** to **N**, thus returning to its standard idling level.



Manual control (Potentiometer pulled)

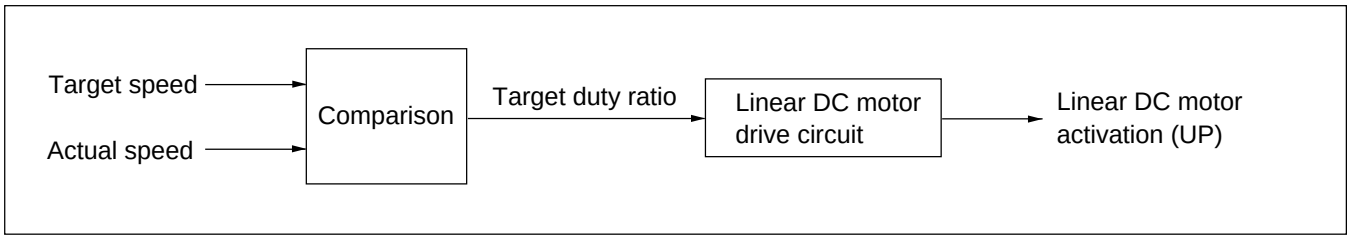
- When the idling speed adjustment potentiometer **20** is pulled, the automatic mechanism is deselected. The driver can then adjust the idling speed as desired by rotating the potentiometer. (Rotation of the potentiometer causes the potentiometer's output voltage to change accordingly.)
- With the output voltage between **0** and **V**, the engine speed stays at the **N** to **N'** level.
- If the output voltage is increased from **V** to **V'** (see the graph), the engine speed decreases from **N'** until it reaches its standard idling level **N**.

● Emergency vehicle operation function (Used in event of control rack position sensor fault)

Fault in Control rack position sensor 7

In the event of a fault in the control rack position sensor **7**, detection of the control rack position is performed using the sub control rack position sensor **4**. This enables more-or-less normal vehicle operation.

Fault in control rack position sensor 7 and sub control rack position sensor 4



In the event of faults in both the control rack position sensor **7** and sub control rack position sensor **4**, the position of the rack, which is controlled by the linear DC motor **9**, cannot be sensed directly. The fuel injection rate cannot be controlled normally with the engine in this condition. As an emergency measure, therefore, control operations are performed in accordance with engine speed data signals only. For this function, target engine speeds for given degrees of accelerator pedal depression are pre-programmed into the engine control unit **35**. Control is effected as follows:

- The target engine speed is compared with the actual engine speed (this is indicated by the engine speed sensor **3**).
- The target duty ratio is determined in accordance with the result of the comparison. In accordance with the target duty ratio, a drive signal is transmitted to the UP-side (speed increasing side) circuit to effect control over the engine speed. If the target engine speed exceeds the actual engine speed or vice versa, the UP-side circuit's ON time period is altered such that the target engine speed is maintained.

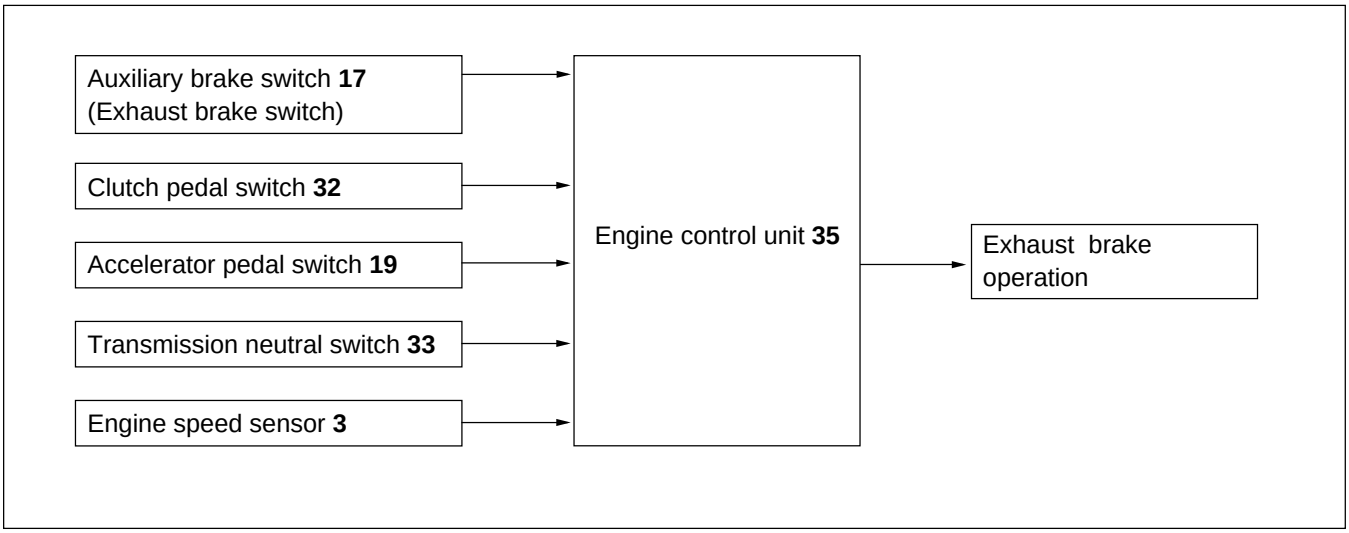
The target duty ratio is the ratio of the time periods during which the linear DC motor's UP-side and DOWN-side (speed decreasing side) circuits are energized. It is calculated as follows:

$$\text{Duty ratio} = \frac{\text{UP-side circuit ON time period}}{\text{UP-side circuit ON time period + DOWN-side circuit ON time period}} \times 100\%$$

CAUTION ⚠

When this function is activated, the warning lamp 14, 15 flashes to indicate that the engine must be inspected immediately. 🕮 **P13EB-20**

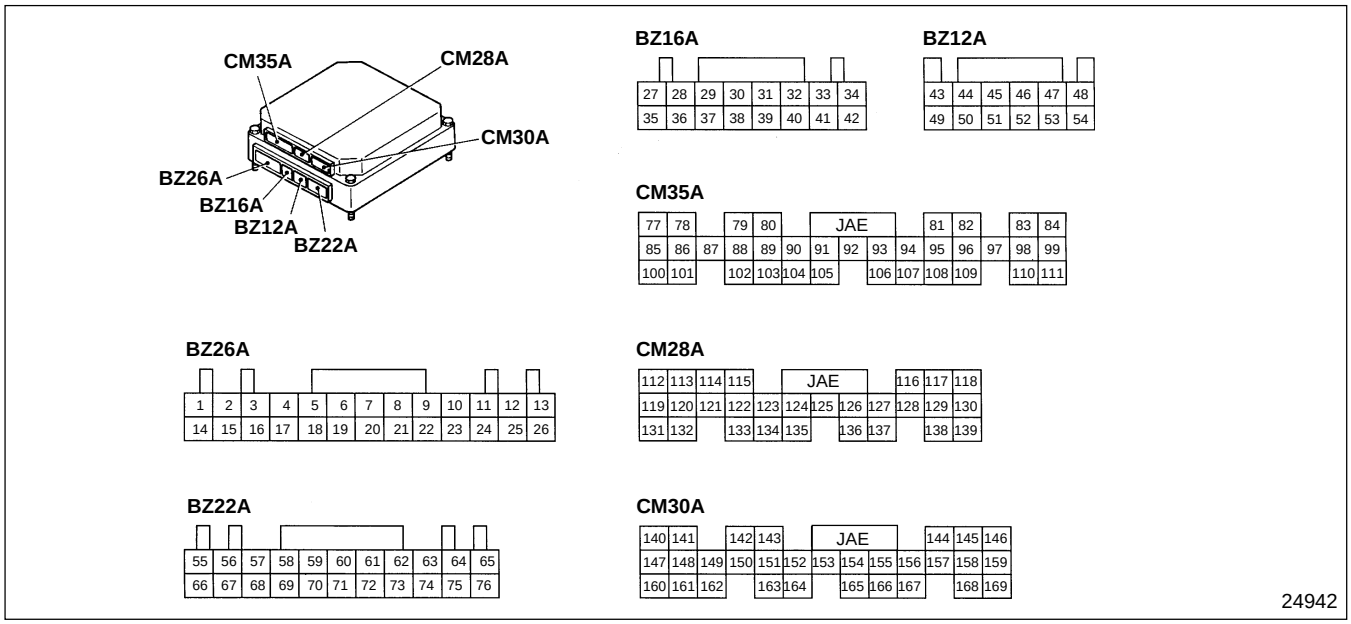
● Auxiliary brake control function



The auxiliary brake control function acts upon the auxiliary braking devices, i.e., the exhaust brake, when the following conditions are satisfied:

- Clutch pedal switch **32**: OFF (clutch pedal released)
- Accelerator pedal switch **19**: ON (accelerator pedal released)
- Transmission neutral switch **33**: ON (transmission not in neutral)

Electronic Governor Control Unit



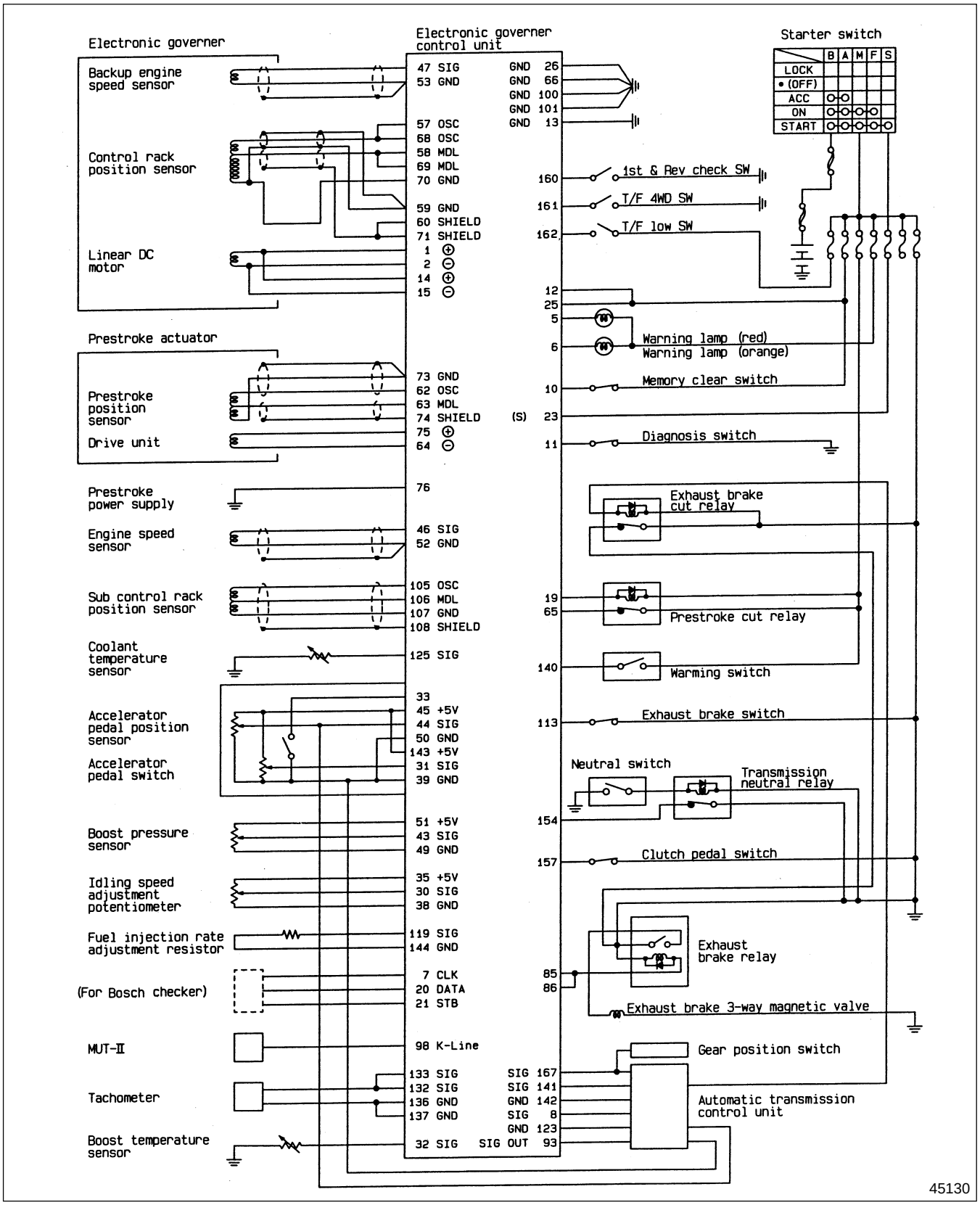
Connector	Terminal	Connected to		Connector	Terminal	Connected to		Connector	Terminal	Connected to	
BZ 26A	1	Linear DC motor	⊕	BZ 26A	19	Pre-stroke cut relay		BZ 16A	37	—	
	2		⊖		20	DDS-3	(DATA)		38	Idling speed adjustment potentiometer (GND)	
	3	—			21		(STB)		39	Accelerator pedal position sensor II (GND)	
	4				22	—			40	—	
	5	Warning lamp	(Red)		23	Start signal			41		
	6		(Amber)		24	—			42		
	7	DDS-3 (CLK)			25	Control unit power supply (starter switch terminal M)		BZ 12A	43	Boost pressure sensor (SIG)	
	8	Automatic transmission control unit (SIG)			26	Control unit GND			44	Accelerator pedal position sensor I	(SIG)
	9	—		BZ 16A	27	—			45		(+5V)
	10	Memory clear switch			28				46	Engine speed sensor (SIG)	
	11	Diagnosis switch			29				47	Backup engine speed sensor (SIG)	
	12	Control unit power supply (starter switch terminal M)			30	Idling speed adjustment potentiometer (SIG)			48	—	
	13	Control unit GND (analog GND)			31	Accelerator pedal position sensor II (SIG)			49	Boost pressure sensor (GND)	
	14	Linear DC motor	⊕		32	Boost temperature sensor (SIG)			50	Accelerator pedal position sensor I (GND)	
	15		⊖		33	Accelerator pedal switch			51	Boost pressure sensor (+5V)	
	16	—			34	—			52	Engine speed sensor (GND)	
	17				35	Idling speed adjustment potentiometer (+5V)			53	Backup engine speed sensor (GND)	
	18				36	—			54	—	

Connector	Terminal	Connected to	
BZ 22A	55	—	
	56		
	57	Control rack position sensor	(OSC)
	58		(MDL)
	59		(GND)
	60		(SHIELD)
	61	—	
	62	Pre-stroke position sensor	(OSC)
	63		(MDL)
	64	Pre-stroke actuator ⊖	
	65	Pre-stroke cut relay (+12V)	
	66	Control unit GND	
	67	—	
	68	Control rack position sensor	(OSC)
	69		(MDL)
	70		(GND)
	71		(SHIELD)
	72	—	
	73	Pre-stroke position sensor	(GND)
	74		(SHIELD)
	75	Pre-stroke actuator ⊕	
	76	Pre-stroke power supply (GND)	
CM 35A	77	—	
	78		
	79		
	80		
	81		
	82		
	83		
	84		
	85	Exhaust brake relay	
	86		
	87	—	
	88		
	89		
	90		
	91		
	92		
	93	Automatic transmission control unit	

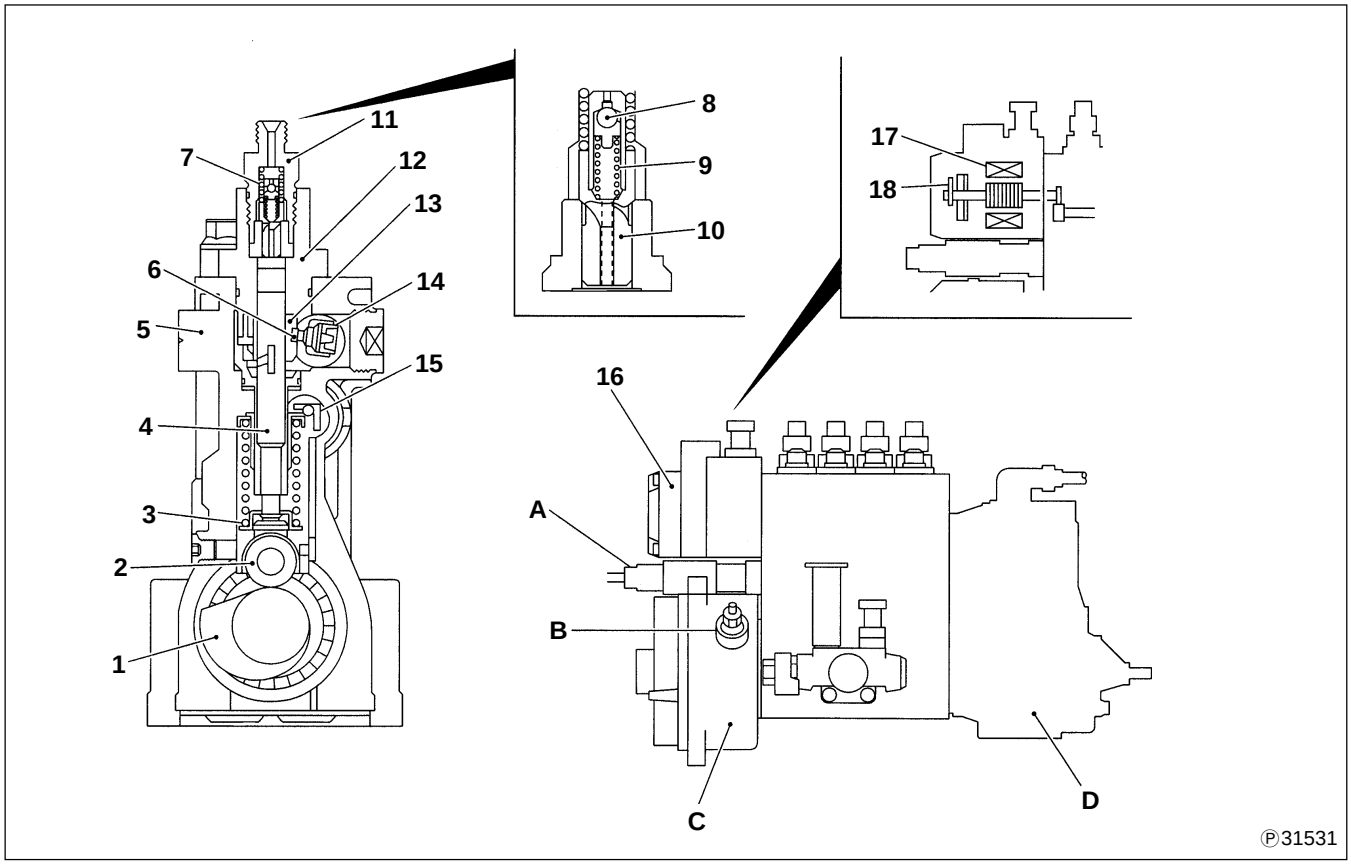
Connector	Terminal	Connected to	
CM 35A	94	—	
	95		
	96		
	97		
	98	Multi-Use Tester-II (K-line)	
	99	—	
	100	Control unit GND (power GND)	
	101		
	102	—	
	103		
	104		
	105	Sub control rack position sensor	(OSC)
	106		(MDL)
	107		(GND)
	108		(SHIELD)
	109	—	
	110		
	111		
CM 28A	112	—	
	113	Exhaust brake switch	
	114	—	
	115		
	116		
	117		
	118		
	119	Fuel injection rate adjustment resistor (SIG)	
	120	—	
	121		
	122		
	123	Automatic transmission control unit (GND)	
	124	—	
	125	Coolant temperature sensor (SIG)	
	126	—	
	127		
	128		
	129		
	130		
	131		

Connector	Terminal	Connected to	
CM 28A	132	Tachometer output	(SIG)
	133		(SIG)
	134	—	
	135		
	136	Tachometer output	(GND)
	137		(GND)
	138	—	
	139		
CM 30A	140	Warming switch	
	141	Automatic transmission control unit (SIG)	
	142	Automatic transmission control unit (GND)	
	143	Accelerator pedal position sensor II (+5V)	
	144	Fuel injection rate adjustment resistor (GND)	
	145	—	
	146		
	147		
	148		
	149		
	150		
	151		
	152		
	153		
	154	Transmission neutral relay	
	155	—	
	156		
	157	Clutch pedal switch	
	158		
	159		
	160	First/ reverse check switch	
	161	Transfer four-wheel drive switch	
	162	Transfer low switch	
	163	—	
	164		
	165		
	166		
	167	Idle up prohibit switch	
	168	—	
	169		

Electronic governor control unit



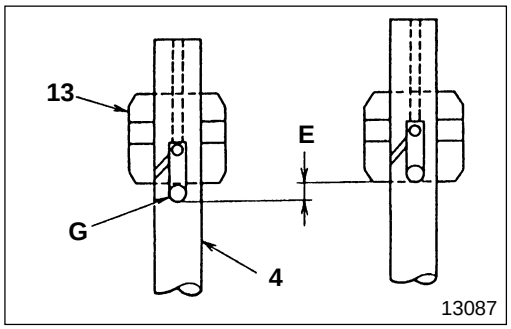
Pre-stroke Control Injection Pump Unit



1 Camshaft
2 Tappet
3 Plunger spring
4 Plunger
5 Pump housing
6 Pin
7 Delivery valve spring
8 Ball
9 Spring
10 Delivery valve
11 Delivery valve holder
12 Plunger barrel
13 Timing sleeve
14 Timing rod
15 Control rod
16 Pre-stroke actuator
17 Drive unit
18 Pre-stroke position sensor

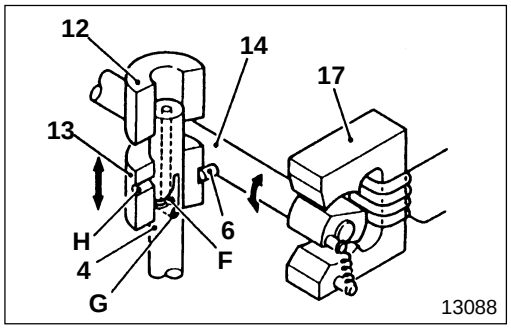
A : Sub-control rod position sensor
B : Engine speed sensor
C : Mechanical timer
D : Electronic governor

- The injection pump is provided with a mechanism that enables variation of the plunger pre-stroke.
- Variation of the plunger pre-stroke enables the creation of air/fuel mixture and spray conditions that are optimally suited to combustion. The overall benefits are higher engine torque and cleaner exhaust emissions than are possible with a conventional injection pump.



Pre-stroke

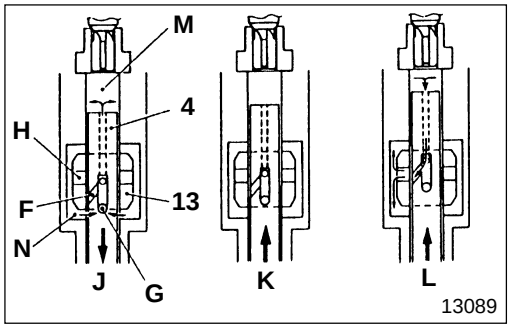
The term “pre-stroke” refers to the stroke dimension **E** of a plunger **4** from the plunger’s bottom dead center position to the point at which its fuel inlet hole **G** is closed by the timing sleeve **13** and fuel feed begins. This stroke dimension is constant in a conventional injection pump.



Variable pre-stroke mechanism

F : Lead
G : Inlet hole
H : Outlet hole

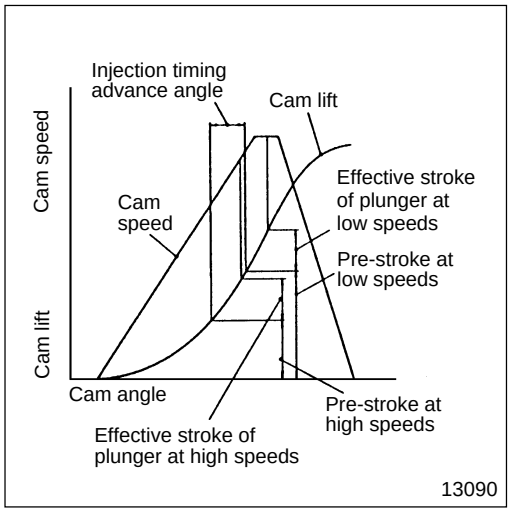
- In contrast to the fixed plunger barrel arrangement of a conventional injection pump, each plunger barrel **12** in the pre-stroke control type injection pump incorporates a vertically moveable timing sleeve **13**.
- Movement of the timing sleeve is effected by the timing rod **14**, pin **6**, and drive unit **17**.
- When the drive unit **17** rotates the timing rod **14**, the pin **6** moves the timing sleeve **13** up or down accordingly.
- Since the timing sleeve **13** incorporates a fuel outlet hole **H**, the pre-stroke changes in accordance with the movement of the timing sleeve.



Fuel feed action

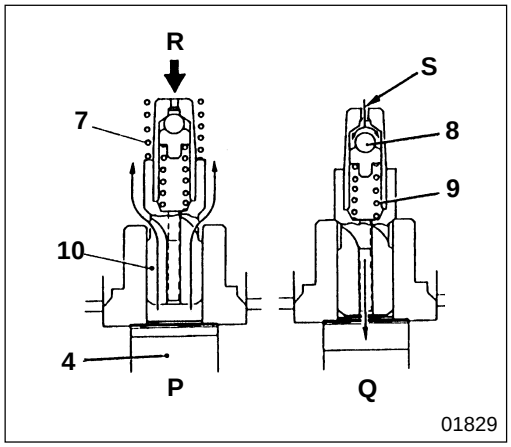
J : Fuel intake
K : Start of pressurization
L : End of pressure feed

- As the plunger **4**, moves downward from its top dead center position and its inlet hole **G** opens, fuel flows into the pressure chamber **M** owing to the vacuum created by the plunger’s downward movement and the fuel pressure produced by the feed pump.
- When the plunger **4** moves upward but its lift dimension is still small, the fuel in the pressure chamber **M** escapes into the sump **N** through the inlet hole **G** in the plunger. Thus, the pressure in the pressure chamber does not increase.
- As the plunger **4** moves further upward and the inlet hole **G** is closed by the timing sleeve **13**, the fuel starts to be pressurized. The pressure increases as the plunger moves upward, and the injection pump starts to feed the pressurized fuel to each injector.
- When the lead **F** in the plunger **4** becomes aligned with the outlet hole **H** in the timing sleeve **13**, the fuel in the pressure chamber **M** returns to the sump **N**, thus completing the pressure feed cycle.
- Adjustment of the injected fuel volume is achieved by rotation of the plunger **4**, which alters the position of the outlet hole **H** in the timing sleeve **13** relative to the lead **F** at the plunger.



Fuel injection timing and fuel injection characteristics

- Changes in the position of the timing sleeve **13** cause multiple changes in the pre-stroke, which in turn alter the fuel injection timing.
- A decrease in the pre-stroke causes the fuel inlet hole **G** in the plunger **4** to close earlier such that the fuel injection timing is advanced.
- This arrangement provides highly responsive control over the injection timing and thus enhances the engine's cold startability.

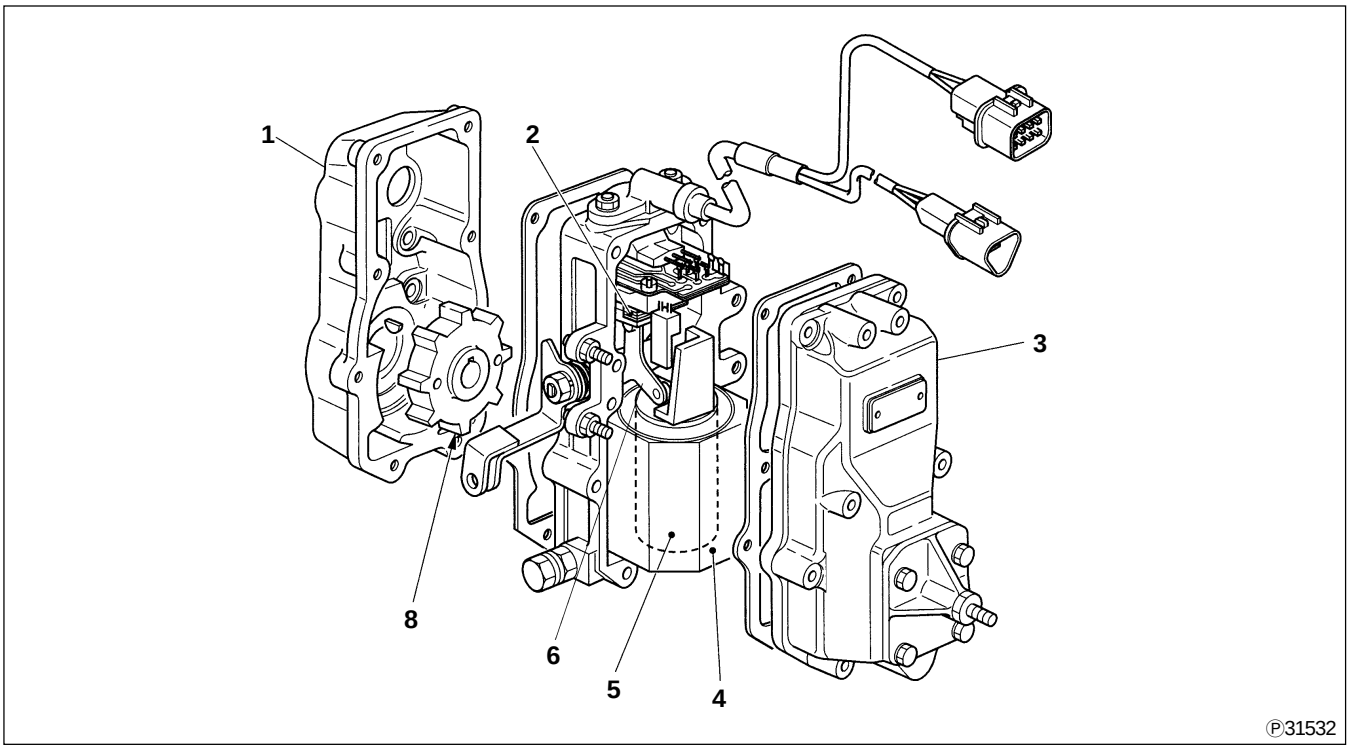


Delivery valve

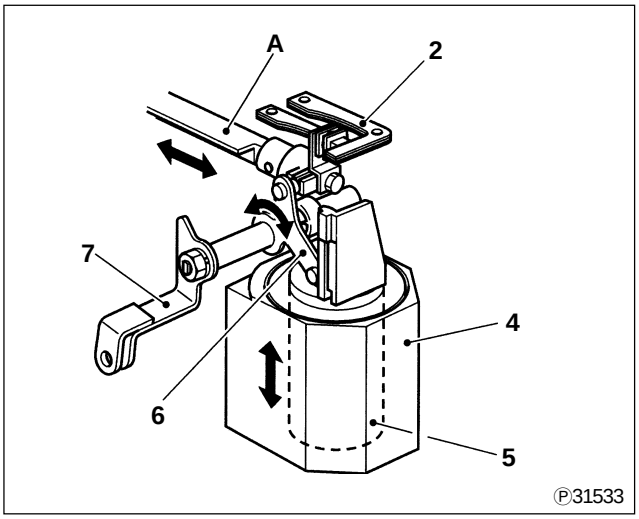
P : Start of pressure feed
Q : End of pressure feed

- The delivery valve **10** keeps constant the residual pressure **R** in the injection pipe at all engine speeds. This operation prevents the generation of bubbles in the fuel (this is known as "cavitation") and thus enables fuel injection at a high pressure.
- When the plunger **4** moves upward and the pressure of the fuel pushed by the plunger overcomes the residual pressure **R** in the injection pipe and the preset force of the delivery valve spring **7**, the delivery valve is pushed upward and delivery of the pressurized fuel begins.
- As soon as fuel delivery is complete, the fuel in the injection pipe rapidly returns to the plunger side and the delivery valve closes.
- Surplus fuel slowly returns through the orifice **S**, thus reducing the pressure in the injection pipe.
- When the preset force of the spring **9** in the delivery valve **10** is exactly offset by the pressure in the injection pipe, the ball **8** closes the orifice **S**, thus ensuring that the residual pressure **R** in the injection pipe remains constant.

Electronic Governor



1 Housing
2 Control rack position sensor
3 Cover
4 Coil assembly
5 Linear DC motor
6 Link
7 Emergency engine stop lever
8 Sensing gear



● Linear DC motor

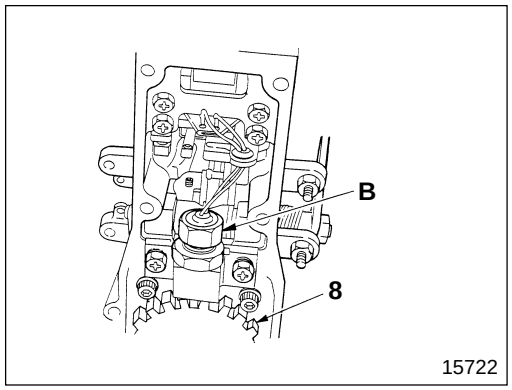
The linear DC motor **5** moves the coil assembly **4** vertically in accordance with signals from the electronic governor control unit. Via the link **6**, this movement is transmitted to the control rack **A**, which moves longitudinally to increase and decrease the fuel quantity.

● Control rack position sensor

The control rack position sensor **2** senses whether the control rack **A** is moved to the correct position by the linear DC motor **5**. In the event of a discrepancy between the actual control rack position and the target control rack position (this is determined by the electronic governor control unit), the control unit instructs the linear DC motor to perform a corrective movement.

● **Emergency engine stop lever**

The emergency engine stop lever **7** is connected to the link **6**. Via a cable, it enables the link to be moved from the driver's seat. In the event of a system fault that prevents the engine from being stopped normally, operation of the emergency engine stop lever forces the control rack **A** to move to the position at which fuel injection is terminated. This operation takes place irrespective of the position of the linear DC motor **5**.



● **Backup engine speed sensor**

The backup engine speed sensor **B** is fitted inside the governor. It converts the rotation speed of the sensing gear **8** into electric signals and feeds the signals to the electronic governor control unit to provide an indication of the engine speed.

TROUBLESHOOTING

1. INSPECTION PROCEDURES

Diagnostic Function

- Whenever the starter switch is placed at ON, the diagnostic function is activated to check all the sensors, etc. If any of them is found faulty, the warning lamp in the meter cluster is lit to alert the driver. At the same time, the fault location is stored in memory, and the system enters the backup mode.

Warning Lamp Indications

	(Red)	(Amber)
Safety-critical error (Vehicle must not be driven)	ON	OFF
Non-safety-critical error (Vehicle can be driven despite poor control feeling)	OFF	ON

- The stored fault location can be read as a diagnostic trouble code by the Multi-Use Tester II or the diagnosis switch.

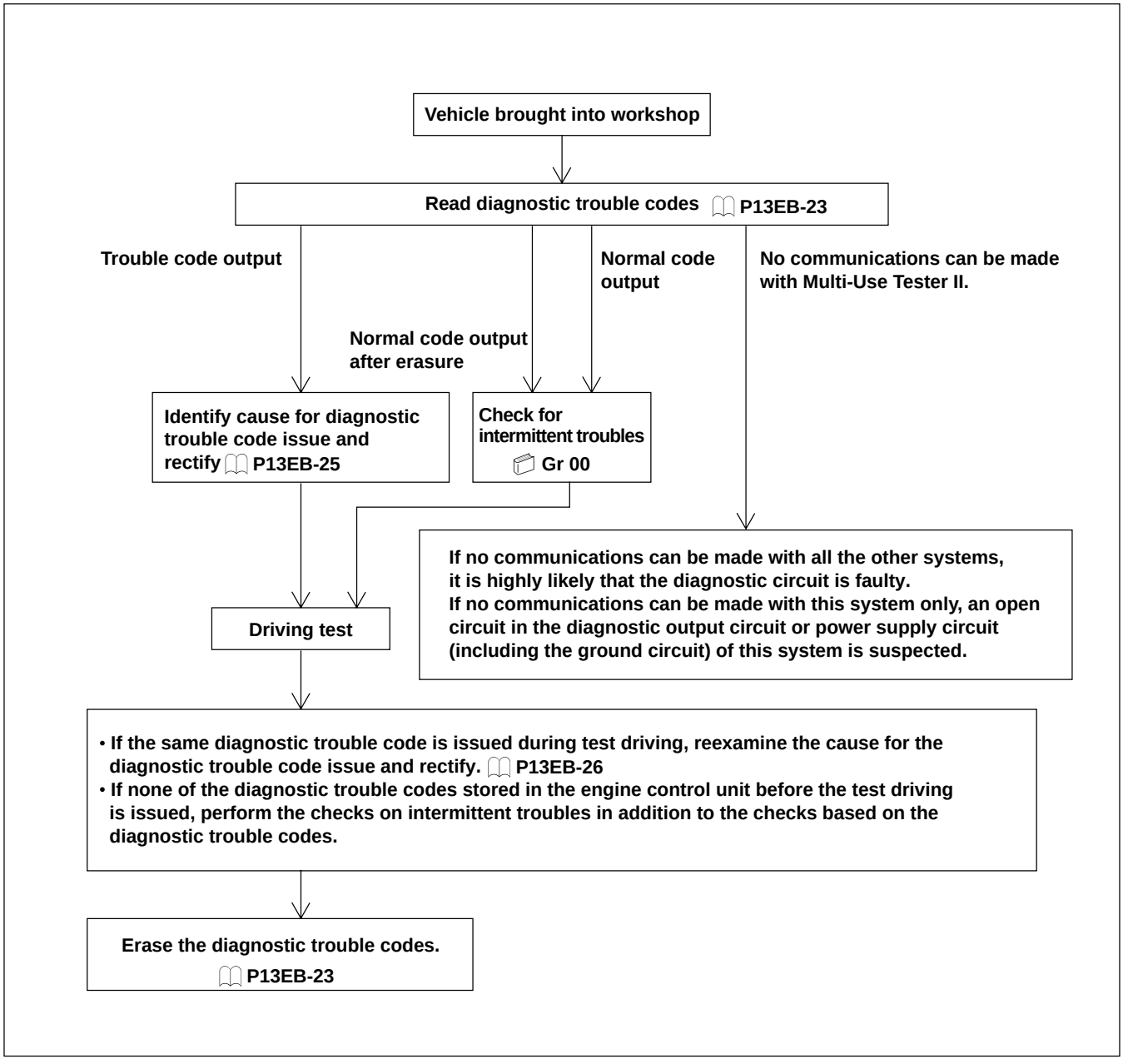
CAUTION ⚠

- **Check to ensure that the battery voltage is within the specified range.**
- **Check all the harness and device connectors for looseness. Always remove a connector at least 20 seconds after placing the starter switch at the LOCK position.**
- **Do not forget to clear the diagnostic trouble code by the Multi-Use Tester II or memory clear switch after a fault has been rectified.**
- **As a rule, inspection operations should be performed with the starter switch at the LOCK position. Some checks, however, may have to be made with the starter switch at the ON position. In such a case, use care to make sure that no short circuit develops between pins of the connectors or with the body.**
- **The resistance value of each component is affected by the temperature and the accuracy of the tester. The reading, therefore, does not always fall within the standard limits. Note that the check values shown in the text are the values obtained at normal temperature (10 to 35°C {58 to 95°F}).**
- **Whether or not the system automatically returns to normal from the backup mode after a fault has been removed depends on the diagnostic trouble code (fault location). When the system returns to normal, the warning lamp will be OFF.**
- **Even when the fault has been removed and the system has been automatically returned to the normal mode, the diagnostic trouble code of the fault remains stored in the engine control unit.**
- **When a fault occurs at a point where the system is not automatically reset, perform the memory clear procedure to let the system exit from the backup mode. 🕮 P13EB-25**

Inspection Flowchart

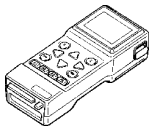
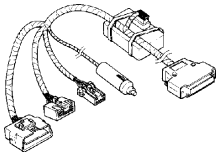
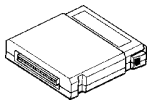
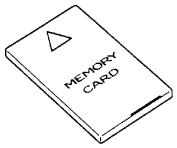
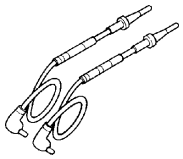
The system inspection can be performed effectively by use of the Multi-Use Tester II. The types of system inspections may be broadly divided as shown below in accordance with the trouble symptoms and diagnostic trouble code outputs.

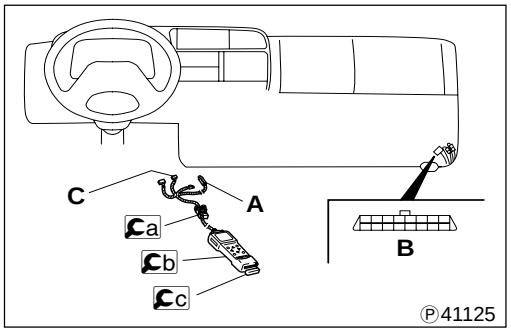
- Inspections based on diagnostic trouble codes stored in the engine control unit
- Inspections of intermittent troubles



2. CONNECTION OF MULTI-USE TESTER II

Special Tools

Location	Name and Shape of Special Tool	Part No.	Application
–	Multi-Use Tester II  19492	MB991496	Inspection of system
–	Multi-Use Tester II harness (for communications)  19141	MK327601	To supply power to Multi-Use Tester II proper and communicate with vehicle side electrical devices
–	Read-only memory pack (MRT-E8.1)  19493	MH063580	Data for inspection and control of engine control unit
–	Memory card (set in Multi-Use Tester II proper)  20538	MB991500	To write data
–	Multi-Use Tester II harness  20536	MB991499	To use Multi-Use Tester II as a circuit tester



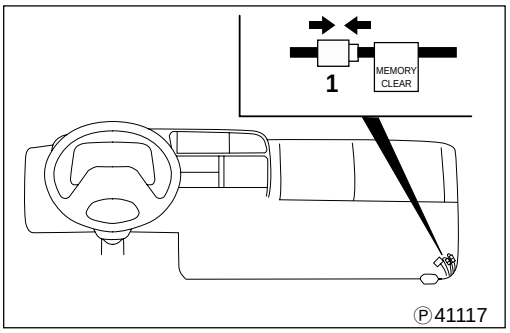
- Place the starter switch at the LOCK position.
- Connect the a Multi-Use Tester II harness to b Multi-Use Tester II and insert the c read-only memory in the tester.
- Connect the connector **A** to the cigar lighter socket.
- Connect the Multi-Use Tester II connector **C** (16 pins) to the data link connector **B** (16 pins).

NOTE

For the operating procedures for the Multi-Use Tester II, refer to the instruction manual for the Multi-Use Tester II.

3. READING AND ERASING DIAGNOSTIC TROUBLE CODES

Two types of methods are available for reading or erasing a diagnostic trouble code; one using the Multi-Use Tester II and one using the vehicle side diagnostic functions.

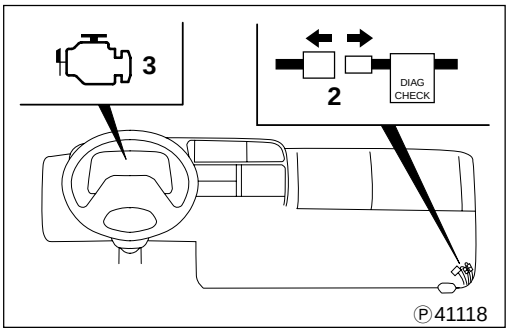


(1) Method using Multi-Use Tester II

● **Current Diagnostic Trouble Code**
- Check to see that the memory clear switch **1** is connected.
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to read the current diagnostic trouble code and determine the fault location.

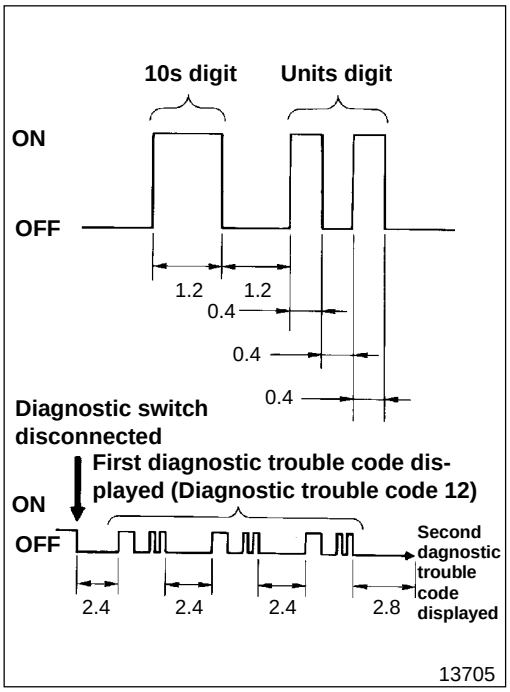
● **Past Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the memory clear switch **1**.
- Operate the Multi-Use Tester II to read the past registered diagnostic trouble codes and determine the fault location.

● **Erasing Diagnostic Trouble Codes**
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to erase all of the diagnostic trouble codes stored in the engine control unit.



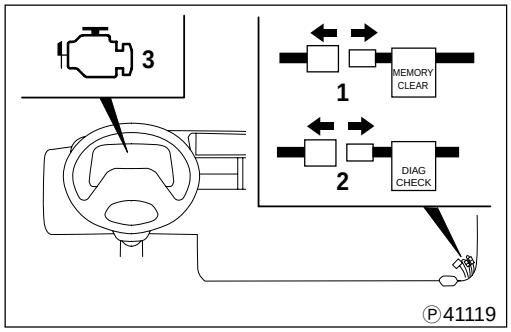
(2) Method Not Using Multi-Use Tester II (Method Using Diagnostic Switch and Memory Clear Switch)

● **Current Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the diagnostic switch **2**.
- The diagnostic trouble code is displayed by flashes of the red warning lamp **3**.



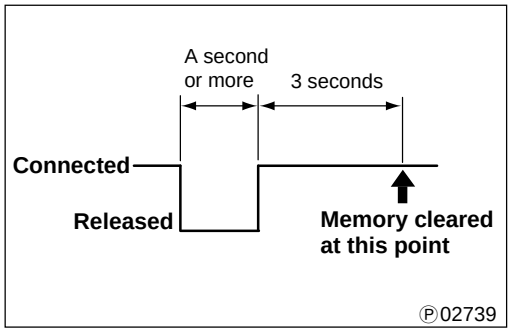
● **Reading Diagnostic Trouble Code**

- Diagnostic trouble codes are indicated by the number of times the red warning lamp **3** flashes and their duration.
  - The flashing intervals also differ between the 10s digit and the units digit.
  - 10s digit: 1.2 second interval
  - Units digit: 0.4 second interval
  - Each diagnostic trouble code is displayed from the 10s digit followed by the units digit. As for a code which has no 10s digit, the units digit only is displayed.
- Each diagnostic trouble code is displayed three times in succession.
- If there is no additional codes stored, the sequence is then repeated from the beginning with each code indicated three times.
- When the diagnostic switch **2** is connected, the engine control unit will immediately stop displaying codes.



● **Past Diagnostic Trouble Codes**

- After reading the current diagnostic trouble codes (with the diagnostic switch **2** disconnected), disconnect the memory clear switch **1**. Then the warning lamp **3** will restart flashing.
- This time, the warning lamp displays the past diagnostic trouble codes. Determine the fault locations based on the indicated codes.



● **Erasing Diagnostic Trouble Codes**

Disconnect the memory clear switch **1** and the diagnostic switch **2** then reconnect them. Then all the diagnostic trouble codes stored in the engine control unit will be cleared.

CAUTION ⚠

- **If the contents of memory are not to be cleared after display of the stored codes, set the starter switch to OFF with the memory clear switch 1 disconnected. Thereafter, connect the memory clear switch.**
- **When you change the combination of the injection pump and engine control unit, you must rewrite the pump data stored in the engine control unit. For this purpose, be sure to perform the diagnostic trouble code erasing procedure.**
- **Whenever the engine control unit has been replaced with a new one, be sure to erase the diagnostic trouble codes by disconnecting the memory clear switch 1 and diagnostic switch 2 after connecting all the connectors. Upon completing the procedure, confirm that no diagnostic trouble codes is stored.**

4. DIAGNOSTIC TROUBLE AND CHECK ITEMS

Diagnosis code	Fault location	Warning lamp	Electronic control unit countermeasure(s) in the case of failure (back-up mode)	Drive ability
01	Normal	—	—	○
03	Pre-stroke actuator learning function	Amber	Provides control with “0” as correction value.	○
06	Sub-control rack position sensor	Amber	Normal control using the main control rack position sensor	○
11	Governor servo	Red	*1 Engine stopped by the pull-down function.	×
12	Pre-stroke servo	Amber	Pre-stroke control stop engine revolution speed limit (approximately 1800 rpm)	△
13	Pre-stroke sensor	Amber	Pre-stroke control stop engine revolution speed limit (approximately 1800 rpm)	△
14	Back-up engine speed sensor	Amber	Control using the main engine speed sensor	○
15	Engine speed sensor	Amber	Calculate the engine revolution speed from the pulse count of the back-up engine speed sensor.	○
14+15	Both the back-up engine sensor and the main engine speed sensors are faulty upon start-up.	Red	Can not start the engine.	×
16	Accelerator pedal position sensor II	Amber	Control using the accelerator pedal sensor I	○
21	Water temperature sensor	Amber	Set the water temperature to 80 °C {176°F}.	○
22	Control rack position sensor	Amber	Switch to the sub-control rack position sensor control.	△
24	Accelerator pedal position sensor I	Amber	Control using the accelerator pedal position sensor II.	○
24+16	Both accelerator pedal position sensor I and accelerator pedal position sensor II are faulty	Red	Set the maximum accelerator depression angle to 30 degrees even if the accelerator pedal is depressed.	△
31	Idling adjustment volume	Amber	Set to auto idling.	○
32	Boost pressure sensor	Amber	Set the boost pressure to 0 kpa {0 mmHg, 0 in. Hg}.	△*2
33	RAM (ECU internal memory circuit)	Red	Do not start the engine.	×
41	Boost temperature sensor	Amber	Normal control assuming the boost temperature is 80 °C {176 °F}.	○
45	Reverse engine operation	Amber	*1 Engine stopped by the pull-down function.	×*2
65	Accelerator switch	Amber	Limited accelerator depressing angle (Approximately 30%)	○

*1 : The pull-down function indicates the rack pull-back action. In the event of an engine over-run or severe accident, the rack is pulled back immediately to the no-injection direction in order to protect the engine.

*2 : Driveable if the starter switch is turned OFF once and then restarted again.

○ : Driveable
△ : Back-up mode driving possible
× : Undriveable

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
03	Indicates that pre-stroke learning function has not been executed.	Faulty timing rod, timing sleeve or other parts in the injection pump assembly.	Repair or replace the injection pump assembly. *
		Faulty adjusment or pre-stroke position sensor	Repair or replace the injection pump assembly. *
		Faulty engine control unit	Replace the engine control unit
06	Displayed if the output voltage of the control rack position sensor is less than 0.06 V or more than 3.5 V.	Open or short in harness wire or poor connector contact between the sub-control rack position sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open, short, or poor connector contact in the sub-control rack position sensor	Inspect the sub-control rack position sensor 🕮 P13EB-35
		Faulty engine control unit	Replace the engine control unit
11	Displayed if the difference between the target control rackposition and the actual control rack position is ± 1mm {0.039 in.}.	Open or short in harness wire or poor connector contact between the linear DC motor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open or shorted wire in the linear DC motor connector	Inspect the linear DC motor 🕮 P13EB-32
		Poor adjustment of the emergency engine stop cable (The lever is pulled in the stop direction)	Inspect the emergency engine stop button 🕮 P13EB-31
		Faulty injection pump assembly rack movement or poor governor actuator link	Repair or replace the injection pump assembly. *
		Faulty engine control unit	Replace the engine control unit
12	Displayed if the difference between the target timing rod angle and the actual timing rod angle is ± 2°.	Open or short in harness wire or poor connector contact between the pre-stroke actuator, pre-stroke cut relay, and engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open or shorted wire in the pre-stroke cut relay	Inspect the pre-stroke cut relay 🕮 P13EB-34
		Faulty pre-stroke actuator	Repair or replace the injection pump assembly. *
		Faulty timing rod, timing sleeve, etc. in the injection pump assembly	Repair or replace the injection pump assembly. *
		Faulty engine control unit	Replace the engine control unit

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
13	Displayed if the output voltage of the pre-stroke position sensor is less than 0.9 V or more than 3.4 V.	Open or short in harness wire or poor connector contact between the pre-stroke position sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open or shorted pre-stroke position sensor coil	Inspect the pre-stroke actuator 🕮 P13EB-32
		Faulty engine control unit	Replace the engine control unit
14	Displayed if the pulse count of the back-up engine speed sensor is less than that of the main engine speed sensor.	Open or short in harness wire or poor connector contact between the back-up engine speed sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Faulty back-up engine speed sensor	Repair or replace the injection pump assembly. *
		Faulty engine control unit	Replace the engine control unit
15	Displayed if the pulse count of the main engine speed sensor is less than that of the back-up engine speed sensor.	Open or short in harness wire or poor connector contact between the speed sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open or shorted wire or improperly assembled coil in the engine speed sensor main unit	Inspect the engine speed sensor main unit 🕮 P13EB-33
		Faulty engine control unit	Replace the engine control unit
16	Displayed if the output voltage of the accelerator pedal position sensor is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the accelerator pedal position sensor II and the engine control unit	• Inspect the accelerator position sensor using Multi-Use Tester-II 🕮 P13EB-30 • Inspect the harness and the connector 🕮 P13EB-41
		Internal malfunction or faulty adjustment of the lever portion of the accelerator pedal position sensor II	• Inspect the accelerator pedal position sensor 🕮 P13EB-30 • Inspect the accelerator pedal position sensor using Multi-Use Tester-II 🕮 P13EB-30
		Faulty engine control unit	Replace the engine control unit
21	—	Open or short in harness wire or poor connector contact between the coolant temperature sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Faulty coolant temperature sensor	• Inspect the coolant temperature sensor 🕮 P13EB-35 • Inspect the coolant temperature sensor using Multi-Use Tester-II 🕮 P13EB-30
		Faulty engine control unit	Replace the engine control unit

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
22	Displayed if the output voltage of the control rack position sensor I is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the control rack position sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open or shorted wire in the coil or poor control rack position sensor contact	• Inspect the control rack position sensor 🕮 P13EB-32 • Inspect the control rack position sensor using Multi-Use Tester-II 🕮 P13EB-30
		Faulty movement of the injection pump assembly control hook or poor governor actuator link.	Repair or replace the injection pump assembly. *
		Faulty engine control unit	Replace the engine control unit
24	Displayed if the output voltage of the accelerator pedal position sensor I is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the accelerator pedal position sensor and the engine control unit	• Inspect the accelerator position sensor using Multi-Use Tester-II 🕮 P13EB-30 • Inspect the harness and the connector 🕮 P13EB-41
		Internal malfunction or poor adjustment of the accelerator pedal position sensor I lever	• Inspect the accelerator position sensor I 🕮 P13EB-30
		Faulty engine control unit	Replace the engine control unit
31	Displayed if the output voltage of the idling adjustment volume is less than 0.6 V or mor than 4.6 V.	Stuck idling speed adjustment potentio-meter knob (between PUSH and PULL)	Reset the knob to PUSH or PULL
		Open or short in harness wire or poor connector contact between the idling speed adjustment potentiometer and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open wire in the switch portion of the idling speed adjustment potentiometer or faulty internal movement	Inspect the idling speed adjustment potentiometer 🕮 P13EB-34
		Faulty engine control unit	Replace the engine control unit
32	Displayed if the output voltage of the boost pressure sensor is less than 0.5 V or more than 4.8 V.	Open or short in harness wire or poor connector contact between the boost pressure sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Internal malfunction of boost pressure sensor	• Inspect the boost pressure sensor using Multi-Use Tester-II 🕮 P13EB-30 • Inspect the boost pressure sensor 🕮 P13EB-36
		Clogged boost hose or faulty assembly	Inspect the boost hose
		Faulty engine control unit	Replace the engine control unit

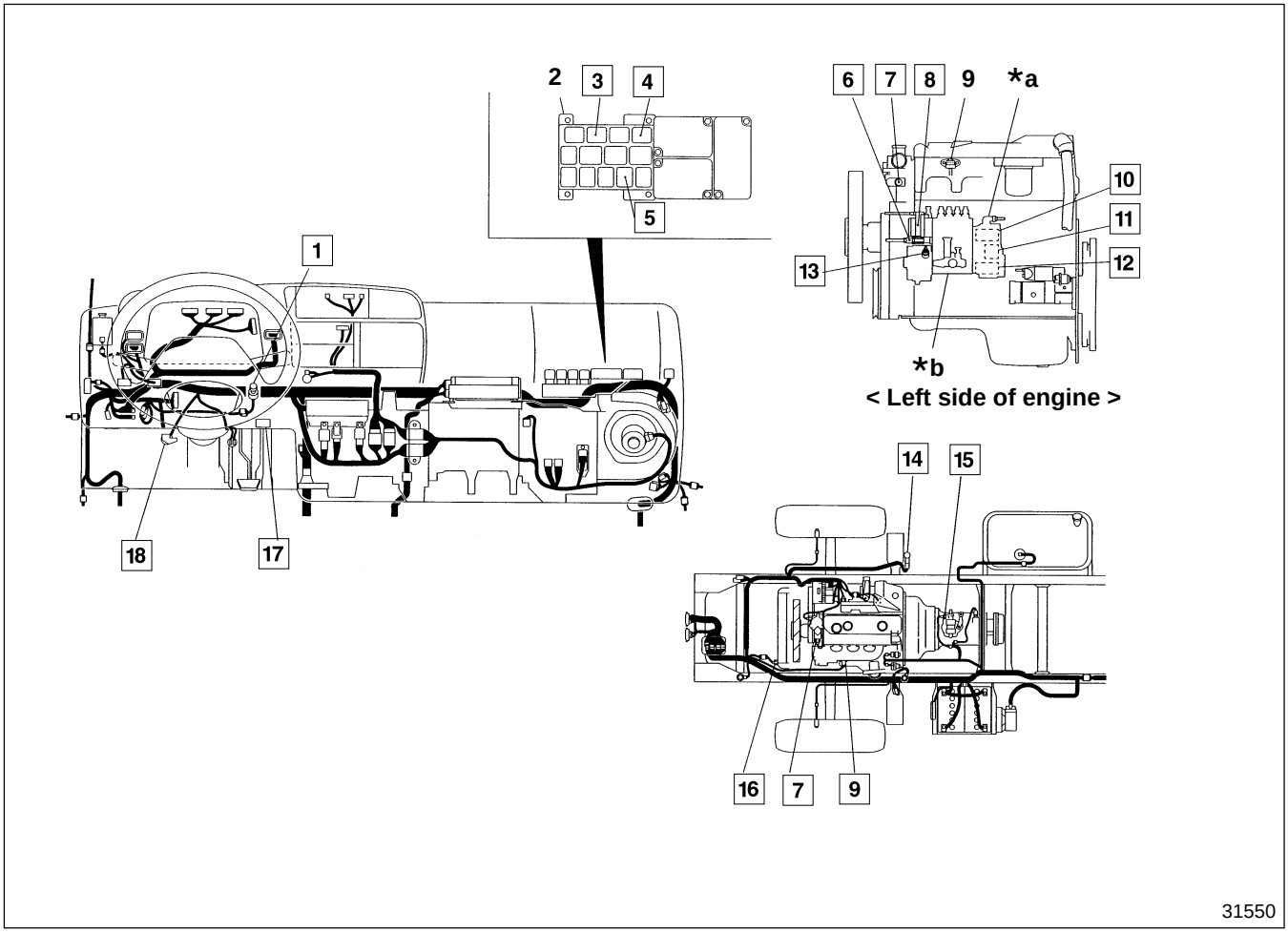
*: Contact your MFTA representative for current injection pumprepair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
33	Displayed if the engine control unit is faulty.	Faulty engine control main unit	In order to reset the engine control unit, temporarily turn the starter switch OFF and erase the diagnostic codes by opening the memory clear switch 🕮 P13EB-24 Replace the engine control unit if the diagnostic codes persist after performing the above procedure
41	Displayed if the output voltage of the boost temperature sensor is more than 4.9 V.	Open or short in harness wire and poor connector contact between the boost temperature sensor and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open or shorted wire or poor assembly of the boost temperature sensor coil	• Inspect the boost temperature sensor 🕮 P13EB-37 • Inspect the boost temperature sensor using Multi-Use Tester-II 🕮 P13EB-30
		Faulty engine control unit	Replace the engine control unit
45	—	Faulty phase of engine speed sensor and backup engine speed sensor	• Inspect the engine speed sensor 🕮 P13EB-33 • Repair or replace the injection pump assembly. *
65	Faulty accelerator switch	Open or short in harness wire or poor connector contact between the accelerator switch and the engine control unit	Inspect the harness and the connector 🕮 P13EB-41
		Open or shorted wire in the accelerator switch	Inspect the accelerator switch (Accelerator switch is built in the accelerator pedal position switch.) 🕮 P13EB-31
		Faulty engine control unit	Replace the engine control unit

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

5. Service of Multi-Use Tester II

Multi-Use Tester-II display			Inspection procedure	
No.	Data signal	Type of data	Inspection condition	Evaluation criterion
11	ENGINE SPEED	▮▮▮▮. rpm	Gradual acceleration (during engine operation)	Synchronization with tachometer
12	TARGET RACK	▮▮.▮▮ mm	Starter switch ON	3 mm
13	REAL RACK	▮▮.▮▮ mm	Starter switch ON	3 mm
14	ACCEL. VOLT	▮.▮▮▮ V	Accelerator pedal gradually depressed from throttle-fully-closed to throttle-fully-open position	1 to 3 V
15	WATER TEMP	▮▮▮.▮ °F	Engine cold Engine warming up Engine stopped after warmup	Same as ambient temperature Gradual increase Gradual decrease
16	BOOST PRESS	▮▮▮▮. mmHg	Engine running at high idling speed	270 mmHg or higher
17	PS ANG. DIFF.	▮▮.▮▮ deg	400 < Ne ≦ 2,000 Ne: Engine speed	–5.5° or greater 5.5° or smaller
18	SUPPLY VOLT	▮▮.▮▮ V	Starter switch ON	7 to 14 V
19	ACCEL. STROKE	▮▮▮.▮ %	Throttle completely closed Pedal gradually depressed Throttle completely open	0 % Gradual increase 100 %
20	BOOST TEMP	▮▮▮.▮ °F	Engine cold Engine warming up Engine stopped after warmup	Same as ambient temperature Gradual increase Gradual decrease
21	START SIG	ON/OFF	Engine cranked using starter switch	ON
33	ACCEL. SW	ON/OFF	Accelerator pedal depressed	OFF
34	DIAGNOSIS SW	ON/OFF	Diagnosis switch turned ON/OFF	ON/OFF
35	DIAG. RESET SW	ON/OFF	Memory clear switch turned ON/OFF	ON/OFF
37	CLUTCH SW	ON/OFF	Clutch pedal depressed	ON
38	NEUTRAL SW	ON/OFF	Transmission in neutral	OFF
42	EXH. BRAKE SW	ON/OFF	Switch ON	ON
51	A/C SW	ON/OFF	Air conditioner switch turned ON or OFF	ON/OFF
61	EXH. BRAKE SIG	ON/OFF	Exhaust brake operating	ON
75	IDLE UP CNCL	ON/OFF	Idle up prohibited (other than N range)	ON



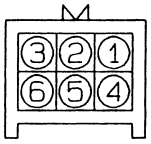
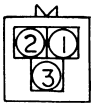
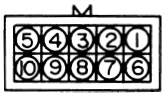
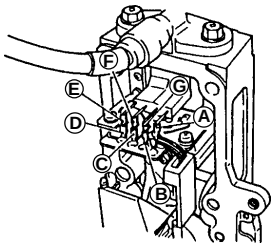
1 Idling speed adjustment potentiometer
2 Relay box
3 Exhaust brake cut relay < A/T >
Transmission neutral relay < M/T >
4 Pre-stroke cut relay
5 Exhaust brake relay < M/T >
6 Sub control rack position sensor
7 Engine coolant temperature sensor
8 Pre-stroke actuator
9 Boost pressure sensor
10 Control rack position sensor
11 Backup engine speed sensor
12 Linear DC motor
13 Engine speed sensor
14 Exhaust brake 3-way magnetic valve
15 Transmission neutral switch < M/T >
16 Boost temperature sensor
17 Emergency engine stop button
18 Clutch pedal switch
19 Fuel injection rate adjustment resistor

***a** : Electronic governor
***b** : Injection pump
M/T : Manual transmission
A/T : Automatic transmission

INSPECTION OF ELECTRICAL EQUIPMENT

Service standards

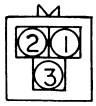
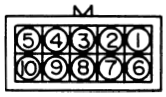
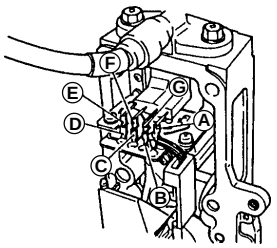
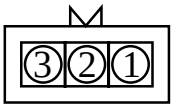
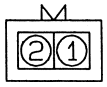
Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
1	Output voltage of idling speed adjustment potentiometer 16184	② – ③	Knob pulled	1 to 3 V	—	Replace
			Knob pushed	3.6 to 4.3 V	—	
6	Resistances of sub control rack position sensor 13725		① – ④	92.5 to 101.5 Ω	—	Repair or replace the injection pump assembly. *
			① – ③	92.5 to 101.5 Ω	—	
			③ – ④	185 to 203 Ω	—	
7	Engine coolant temperature sensor	Between terminal and body	20°C {68°F}	(3.25 kΩ)	—	Replace
			40°C {104°F}	(1.5 kΩ)	—	
			60°C {140°F}	(620±62 Ω)	—	
8	Resistance of pre-stroke actuator (measured at connector)  13714		② – ③	5.5 to 6.1Ω	—	Repair or replace the injection pump assembly. *
			① – ③	11.0 to 12.2 Ω	—	
			① – ②	5.5 to 6.1Ω	—	
			④ – ⑤	0.9 to 1.3 Ω		
10	Resistances of control rack position sensor	< Connector: 3 pin >  16165	③(3 pin) – ④(10 pin)	31.5 to 36.5 Ω	—	Repair or replace the injection pump assembly. *
			③(10 pin) – ④(10 pin)			
			Ⓖ – Ⓒ			
		< Connector: 10 pin >  16160	③(3 pin) – ⑨(10 pin)	18.0 to 21.0 Ω	—	
			③(10 pin) – ⑨(10 pin)			
		< Governor actuator >  24816	Ⓖ – Ⓕ			
			④(10 pin) – ⑨(10 pin)	13.5 to 15.5 Ω	—	
			Ⓒ – Ⓕ			

The values in ( ) are reference values

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
12	Resistances of linear DC motor	< Connector: 3 pin >  16165 ② (3 pin) – ① (3 pin) < Connector: 10 pin >  16160 ② (3 pin) – ② (10 pin) ① (10 pin) – ② (10 pin) < Governor actuator >  24816 ① (10 pin) – ① (3 pin) Ⓐ – Ⓑ	9.0 to 9.8 Ω	—	Repair or replace the injection pump assembly. *
13	Resistance of engine speed sensor (at 25°C {77°F})	 14013 ① – ②	2.1 to 2.5 Ω	—	Replace
14	Minimum operating voltage of 3-way magnetic valve	 14318	11 V or more	—	Replace
16	Resistance valve of boost temperature sensor	0°C {32°F}	5880±588 Ω	—	Replace
		20°C {68°F}	2455±245 Ω	—	
		80°C {176°F}	322±32 Ω	—	

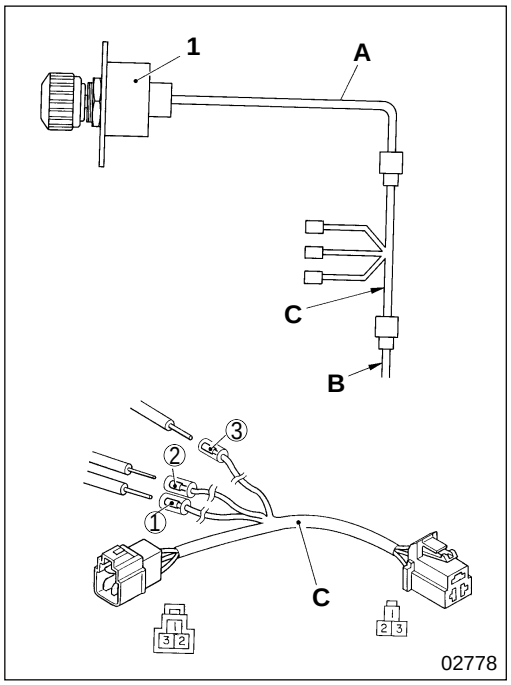
*: Contact your MFTA representative for current injection pump repair and replacement procedures.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Coolant temperature sensor	34 ± 6.9 {25±5, 3.5±0.7}	—
13	Lock nut of engine speed sensor	24 to 35 {17 to 26, 2.4 to 3.6}	—

◆ Service procedure

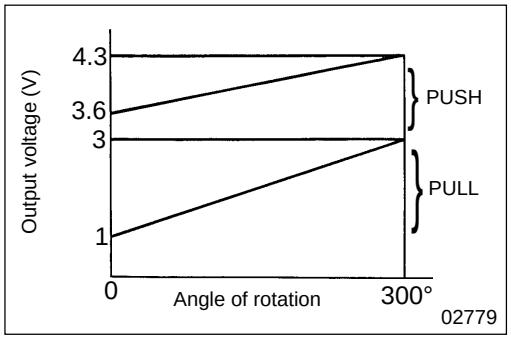


1 **Inspection of idling speed adjustment potentiometer**

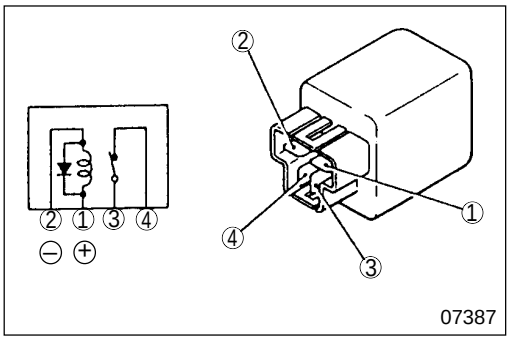
- Disconnect the harness **A** of the idling speed adjustment potentiometer **1** from the cab-side harness **B**. Then, connect an inspection harness **C** between harnesses **A** and **B**. (The inspection harness must be made specially for this procedure.)
- Turn the starter switch to the ON position.
- Check the output voltages of the idling speed adjustment potentiometer **1** in accordance with the following table.

Item	Connector terminal		
	Accelerator pedal position sensor inspection harness		
	①: Power supply (+)	②: GND (–)	③: Output(+)
Output voltage with knob pulled	1.0 - 3.0	⊖	⊕
Output voltage with knob pushed	3.6 - 4.3		

Output characteristics



- If the output voltages are out of specification, replace the idling speed adjustment potentiometer **1.**



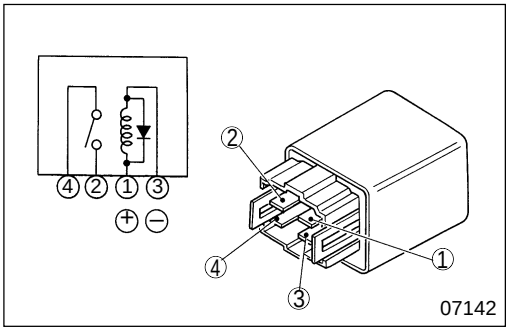
3 **4** **Inspection of pre-stroke cut relay and exhaust brake cut relay (normally-closed type with 4-pin connector)**

- Perform continuity checks in accordance with the following table.

	①	②	③	④
Not energized	○——○		○——○	
Energized	⊕——⊖		〔⊢ - - - - ⊣〕	

○——○ : Continuity exists between terminals.
⊕——⊖ : Terminals across which 12 V DC is applied.
〔⊢ - - - ⊣〕 : Continuity no longer exists between terminals.

- Replace the relay if any abnormality is evident.



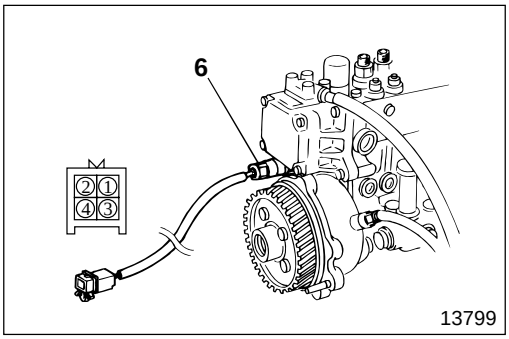
5 Inspection of exhaust brake relay (Open type 4 pin)

- Follow the table below to inspect continuity :

	①	②	③	④
No current	○		○	
Current	⊕		⊖	○

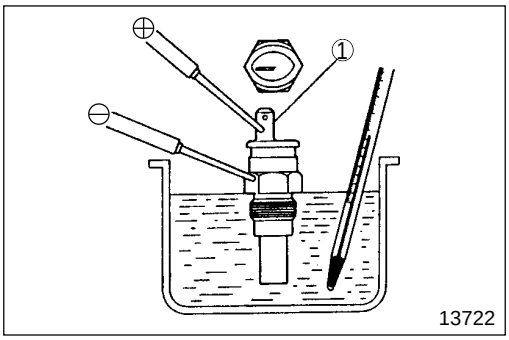
○—○ : There is continuity between terminal ○ and ○.
⊕—⊖ : Indicates that **12** volts DC is applied to the line between the terminals.

- If any fault is found, replace the relay.



6 Inspection of sub control rack position sensor

- Measure the resistances between the following terminals : ① and ④ ; ① and ③ ; ③ and ④.
- If any resistance is out of specification, replace the sub control rack position sensor **6**.
- Have replacement performed by the nearest MFTA Dealer.



7 Inspection of engine water temperature sensor

- Put the engine water temperature sensor **7** in a container of engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil to ensure that it heats up evenly.
- At each of the specified temperatures, measure the resistance between the terminal ① and body of the engine water temperature sensor **7**.
- If the measurements are out of specification, replace the engine water temperature sensor.

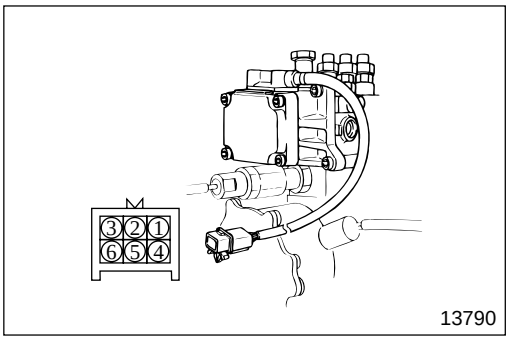
Item			Standard value (reference values)	Limit	Remedy
Engine coolant temperature sensor	Between Terminal and body	20°C {68°F}	(3.25 k) ohms	—	Replace
		40°C {104°F}	(1.5k) ohms	—	
		60°C {140°F}	(650±62k) ohms	—	

8 Inspection of pre-stroke actuator

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA Dealer.

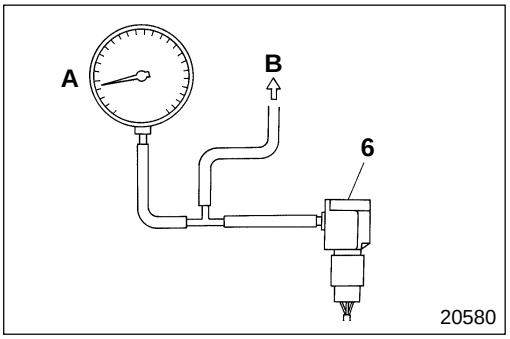
CAUTION ⚠

The pre-stroke actuator 8 must be inspected when the engine is cold.



(1) Measurements on connectors

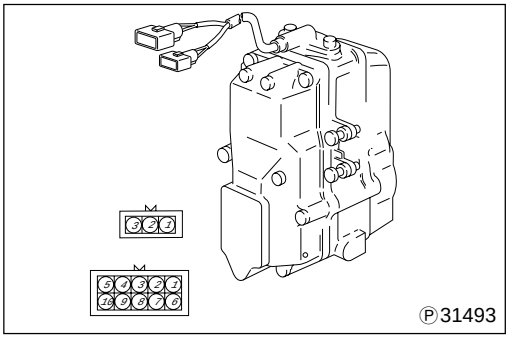
Measure the resistance between terminals ② and ③; ① and ③; ① and ②; ④ and ⑤.



9 Inspection of boost pressure sensor

- Mount pressure gauge **A** for boost pressure measurement as shown in the diagram.
- Connect the Multi-Use Tester-II . 📖 P13EB-22.
- Set the Multi-Use Tester-II for boost pressure measurement
- Start the engine. Compare the value displayed on the Multi-Use Tester-II and the value indicated by pressure gauge **A**. If the values are different, replace boost pressure sensor **9**.

  B : To inlet manifold.

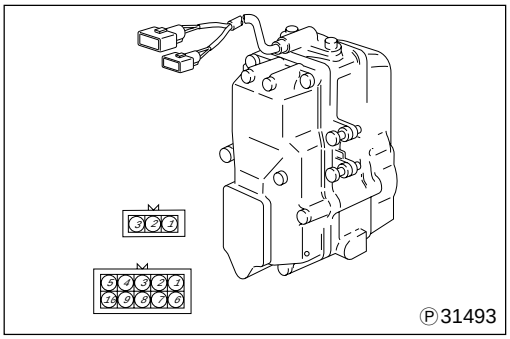


10 Inspection of control rack position sensor

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA.

● **Measurements on connectors**

Measure resistances between terminals as specified in the standard table.

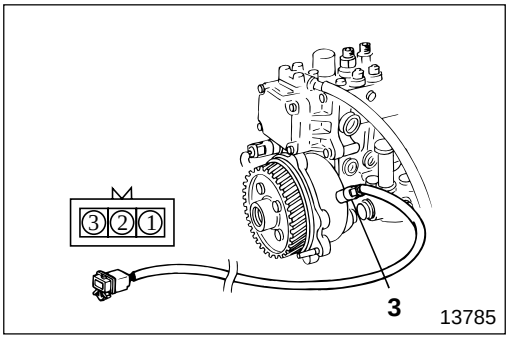


12 Inspection of linear DC motor

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA Dealer.

(1) Measurements on connectors

Measure resistances between terminals as specified in the standard table.



13 Engine speed sensor

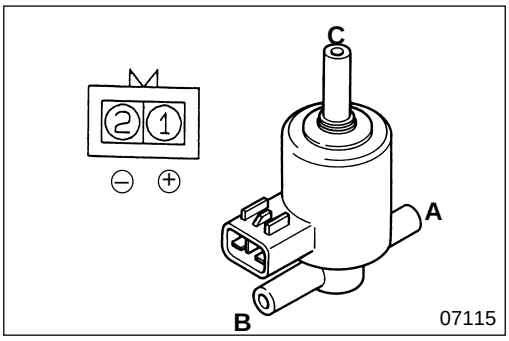
[Inspection]

(1) Main unit

- Measure the resistance between terminals ① and ②.
- If the measured value deviates from the standard value, replace engine speed sensor **13**.

CAUTION

Be sure to check the tightening torque of engine speed sensor 13. If the tightening torque is insufficient, the sensor may not output a signal.



14 Inspection of 3-way magnetic valve

Carry out the following inspection. If any fault is found, replace 3-way magnetic valves **14** :

Air circuit table (There is air continuity between terminals ○ and ○.)

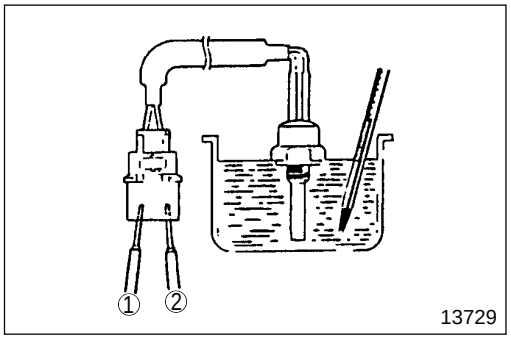
	Input port A	Output port B	Exhaust port C
ON	○	○	
OFF		○	○

(1) Operation inspection

- Apply voltage between terminals ① and ②, increasing gradually from 0 volt.
- Measure voltage (minimum operating voltage) when magnetic valves **14** starts operating. (You can tell if the magnetic valves are ON or OFF by listening for an operating sound.)

(2) Airtightness inspection

- When magnetic valve is ON :
  - Close output port **B.**
  - Apply 12 volts DC between terminals ① and ②.
  - Make sure that there is no air suction from exhaust port **C** when negative pressure (–100 kPa {–30 in.Hg, –750 mmHg}) is applied to input port **A**.
- When magnetic valve is OFF :
  - Close exhaust port **C**.
  - Make sure that there is no air suction from output port **B** when negative pressure (–100 kPa {–30 in.Hg, –750 mmHg}) is applied to input port **A**.



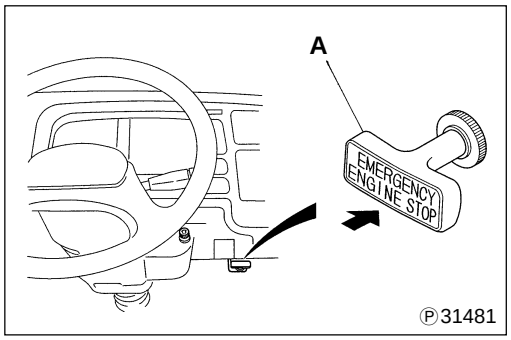
16 Inspection of boost temperature sensor

- Place boost temperature sensor **16** in a container of water.
- Raise the water temperature to the specified values and stir.
- Measure the resistance between terminals ① and ②.

Item	Standard value	Limit	Remedy
0°C {32°F}	5880±588 ohms	—	
20°C {68°F}	2455±245 ohms	—	Replace
80°C {176°F}	322±32 ohms	—	

- If the measured value deviates from the standard value, replace boost temperature sensor. Gr 15A, B

INSPECTION OF ELECTRICAL EQUIPMENT

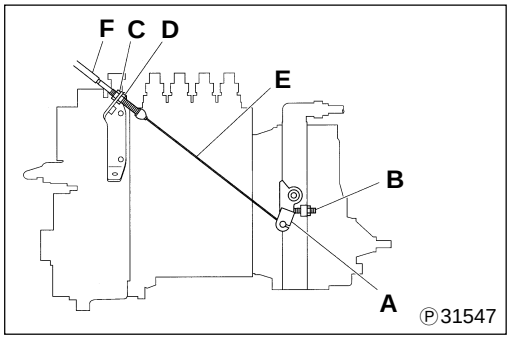


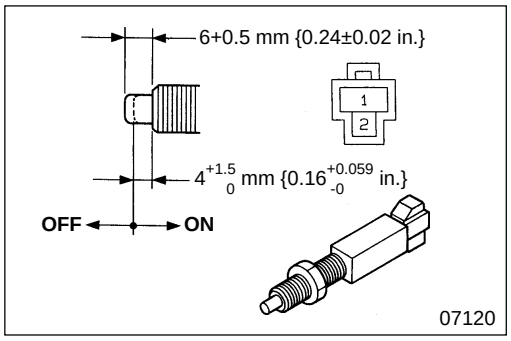
17 **Inspection of emergency engine stop button**

- Push emergency engine stop button **17** in all the way.
- In this step, make sure that stop lever **A** of the governor is in contact with stopper bolt **B**.
- If the stop lever does not contact the stopper bolt, turn nut **C** until they contact, and tighten nut **D** to secure it in place.
- Inner wire **E** of stop cable **F** should be taut. If not, make adjustment.

CAUTION ⚠

Be careful not to make the tension of inner wire E too high, since excess tension prevents stop lever A from fully contacting stopper bolt B.





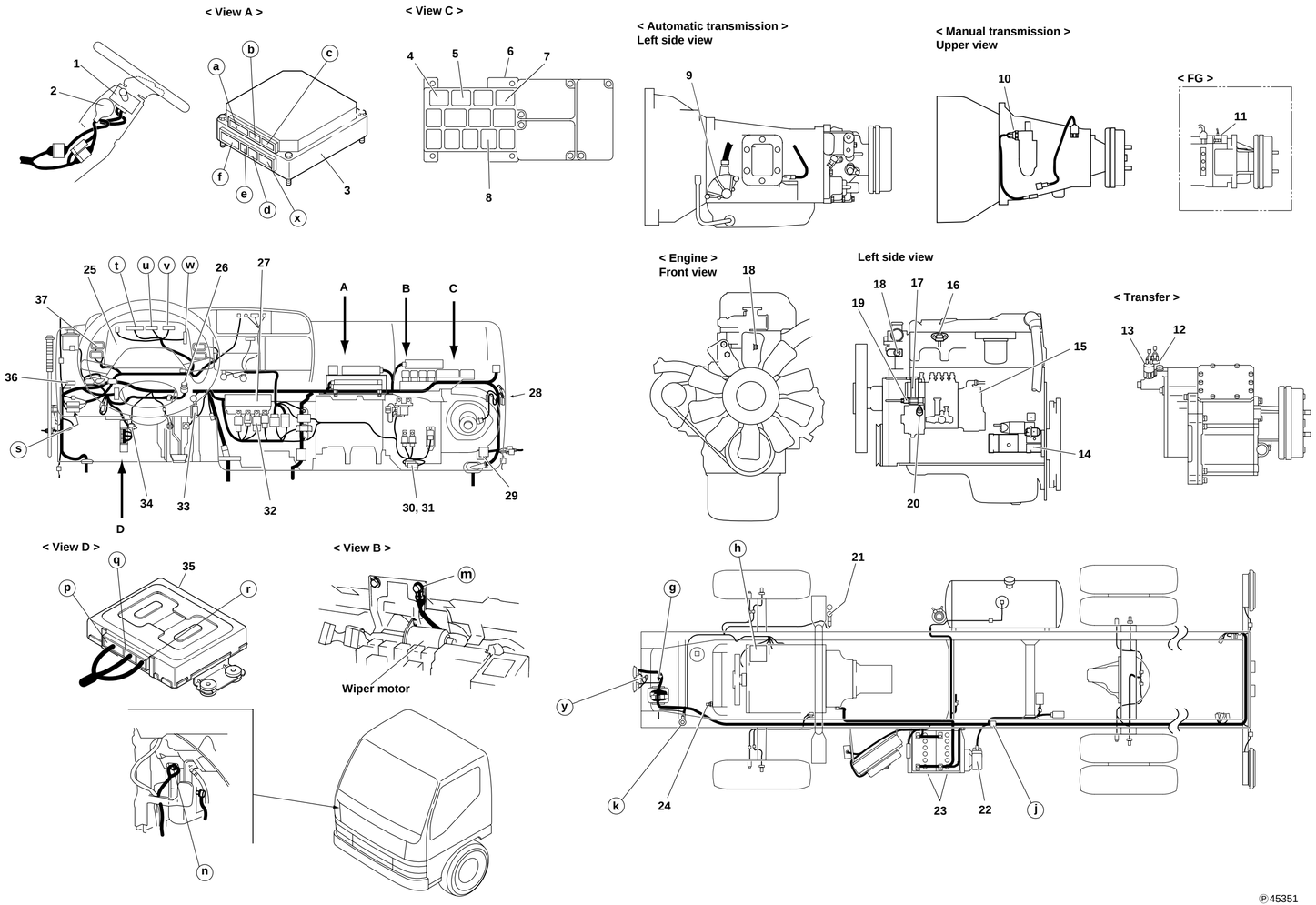
18 **Inspection of clutch switch**

- Follow the table below to inspect continuity:

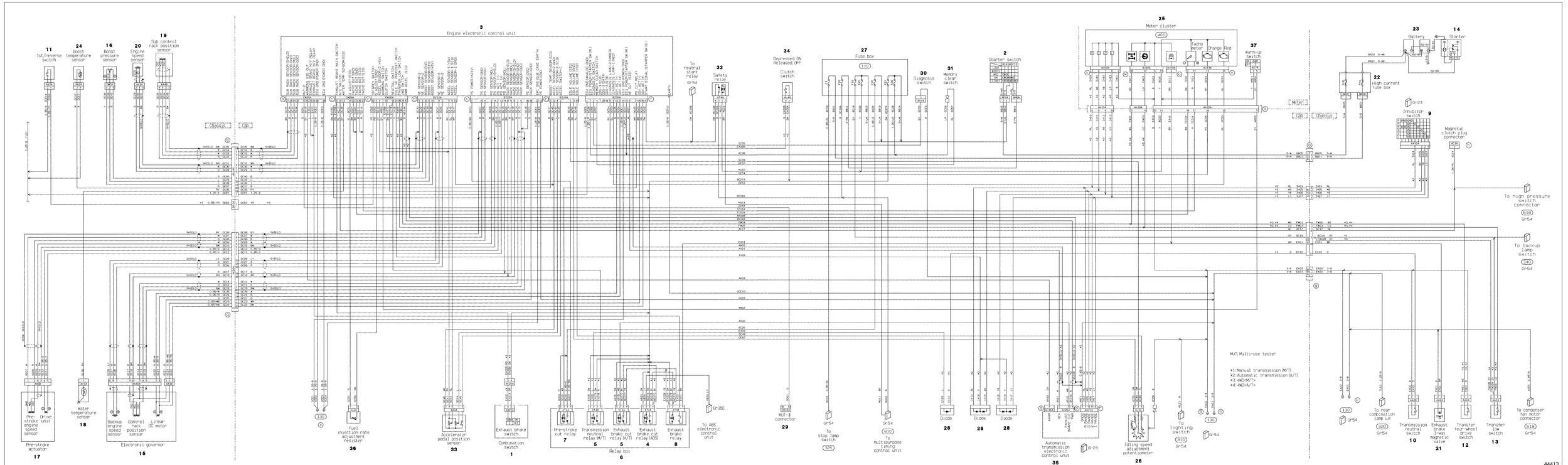
	①	②
OFF		
ON	○	○

○——○ : There is continuity between terminals ○ and ○.

- If any fault is found, replace clutch switch **18**. Gr 21



1 Combination switch
2 Starter switch
3 Engine control unit
4 Exhaust brake cut relay (ABS)
Exhaust brake cut relay (A/T)
5 Transmission neutral relay (M/T)
6 Relay box
7 Pre-stroke cut relay
8 Exhaust brake relay
9 Inhibitor switch
10 Transmission neutral switch
11 1st/reverse switch
12 Transfer 4-wheel drive switch
13 Transfer low switch
14 Starter
15 Electronic governor
16 Boost pressure sensor
17 Pre-stroke actuator
18 Water temperature sensor
19 Sub control rack position sensor
20 Engine speed sensor
21 Exhaust brake 3-way magnetic valve
22 High current fuse box
23 Battery
24 Boost temperature sensor
25 Meter cluster
26 Idling speed adjustment potentiometer
27 Fuse box
28 Diode unit
29 Multi-use tester II connector
30 Diagnosis switch
31 Memory clear switch
32 Safety relay
33 Accelerator pedal position sensor
34 Clutch switch
35 Automatic transmission electronic control unit
36 Fuel injection rate adjustment resister
37 Warm-up switch


3
Engine electronic control unit
11
1st/reverse switch
24
Boost temperature sensor
16
Boost pressure sensor
20
Engine speed sensor
19
Sub control rack position sensor
32
Safety relay
34
Depressed: ON
Released: OFF
Clutch switch
27
Fuse box
30
Diagnosis switch
31
Memory clear switch
2
Starter switch
25
Meter cluster
Tacho meter
Orange
Red
37
Warm-up switch
23
Battery
14
Starter
22
High current fuse box
Inhibitor switch
9
Magnetic clutch plug connector
To high pressure switch connector
To backup lamp switch
To neutral start relay
Pre-stroke actuator
17
Water temperature sensor
18
Electronic governor
15
Backup engine speed sensor
Control rack position sensor
Linear DC motor
Fuel injection rate adjustment resistor
36
Accelerator pedal position sensor
33
Exhaust brake switch
Combination switch
1
Relay box
6
Pre-stroke cut relay
7
Transmission neutral relay (M/T)
5
Exhaust brake cut relay (A/T)
Exhaust brake cut relay (ABS)
4
Exhaust brake relay
8
To ABS electronic control unit
MUT-II connector
29
To stop lamp switch
To multipurpose timing control unit
Diode
28
Diode
28
Diode
28
Automatic transmission electronic control unit
35
Idling speed adjustment potentiometer
26
To lighting switch
To rear combination lamp LH
Transmission neutral switch
10
Exhaust brake 3-way magnetic valve
21
Transfer four-wheel drive switch
12
Transfer low switch
13
To condenser fan motor connector
MUT: Multi-use tester
*1: Manual transmission (M/T)
*2: Automatic transmission (A/T)
*3: 4WD<M/T>
*4: 4WD<A/T>

44413

MITSUBISHI
FUSO

Group 14A
Cooling

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-14A

INDEX

SPECIFICATIONS 14A- 2

STRUCTURE AND OPERATION 14A- 2

TROUBLESHOOTING 14A- 4

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Replacing Coolant and Cleaning Cooling System 14A- 6
- Air Bleeding of Cooling System 14A- 8
- Gas Leak Testing 14A- 8

RADIATOR 14A-10

COOLING FAN, V-RIBBED BELT, V-BELT AND WATER PUMP 14A-18

WATER HOSE & PIPE 14A-22

THERMOSTAT 14A-24

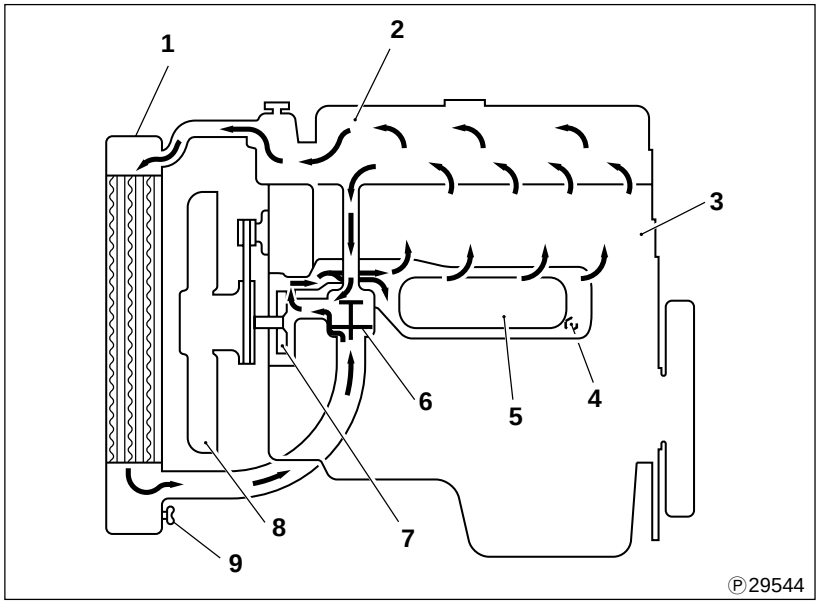
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item	Specifications
Kind of cooling system	Forced water circulation system
Water pump type	Belt-driven involute type
Thermostat type	Wax-pellet, bottom bypass type (with jiggling valve)
Automatic cooling fan coupling type	Continuous control type
Radiator type	Tube and corrugated fin type
Coolant capacity L {qts}	13 {13.7}

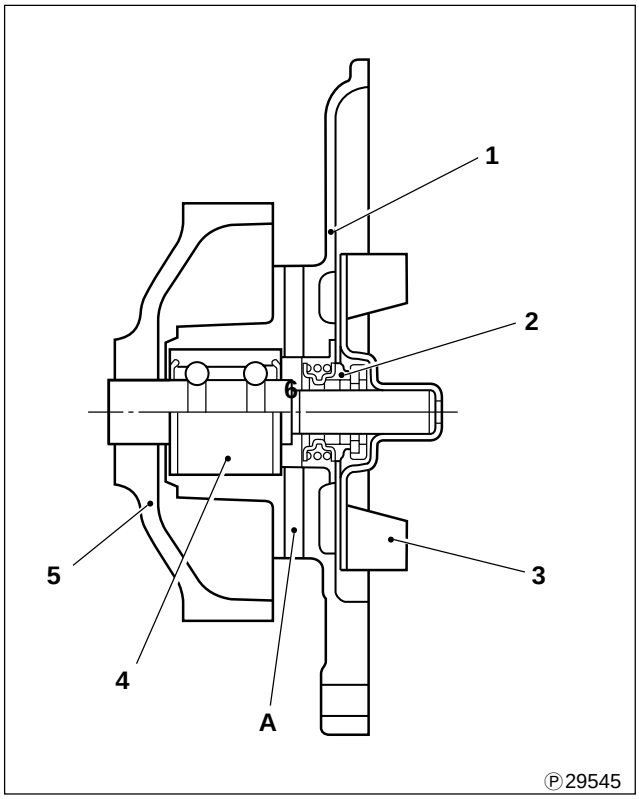
STRUCTURE AND OPERATION

Cooling System (Flow to Coolant)



1 Radiator
2 Cylinder head
3 Crankcase
4 Crankcase drain cock
5 Oil cooler
6 Thermostat
7 Water pump
8 Cooling fan
9 Radiator drain cock

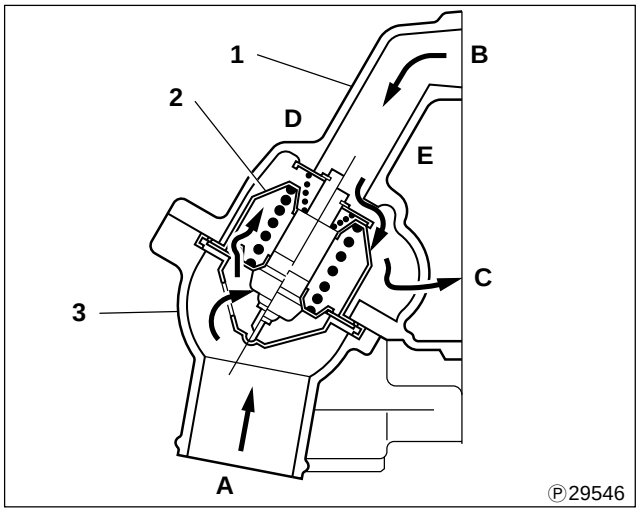
Water Pump



1 Case
2 Unit seal
3 Impeller
4 Unit bearing
5 Pulley

A: Drain hole

Thermostat



1 Oil cooler
2 Thermostat
3 Thermostat cover

A : From radiator
B : From cylinder head
C : To water pump
D : With high coolant temperature
E : With low coolant temperature

Thermostat **2** is a bottom bypass type that uses wax-charged pellets as its regulating element. As the wax changes from solid to liquid in with temperature increases, the total wax volume changes. As a result, the position of the valve, changed by the coolant temperature, regulates the flow of coolant from the radiator and cylinder head (by-pass side) before entering the engine to control the coolant temperature (inlet control type).

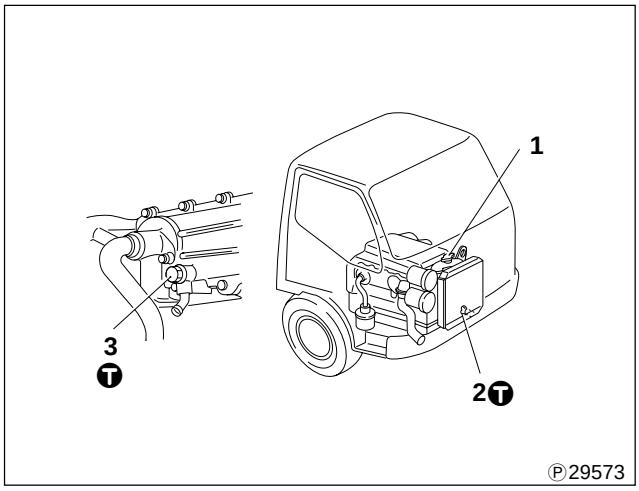
TROUBLESHOOTING

Possible causes \ Symptoms		Overheating (insufficient cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Remarks
V-ribbed belt or V-belt	Loose or damaged	×		×		
	Excessive tension			×		
	Oil on belt	×				
Water pump	Water pump fitted poorly	×		×	×	
	Unit bearing defective	×		×		
	Impeller defective	×		×		
	Unit seal defective	×			×	
	Loose fit between unit bearing and flange and/or impeller	×		×		
Thermostat	Case fitted poorly	×			×	
	Valve opening temperature too high; valve remains closed	×				
	Valve opening temperature too low; valve remains open		×			
Radiator	Space between core and fins clogged	×				
	Core cracked and/or soldered joints separated	×			×	
Cooling fan	Fan shroud fitted poorly	×		×		
Automatic cooling fan coupling	Bearing defective	×		×		
	Bimetal damaged	×				
	Bimetal contaminated with foreign particles	×	×			
	Silicone oil leaking	×		×		
Oil cooler	Oil cooler fitted poorly	×			×	Gr 12A
	Gasket defective	×			×	
Cylinder head	Cylinder head fitted poorly	×			×	Gr 11A
	Gasket defective	×			×	
Coolant quantity insufficient		×				
Coolant passages dirty and/or clogged		×				
Hoses fitted poorly		×			×	
Ambient temperature extremely low			×			

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

Replacing Coolant and Cleaning Cooling System



1 Pressure cap
2 Drain cock
3 Water drain plug

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Drain cock	2 {14.5, 0.2}	—
3	Water drain plug	24.5±4.9 {18.1±3.6, 2.5±0.5}	—

Using the radiator for extended periods without cleaning the cooling system will cause overheating since rust and scale will accumulate. The cooling system must be cleaned periodically.

● **Draining the coolant**

Before draining the coolant, loosen the pressure cap **1** to reduce the pressure in the cooling system.

WARNING ⚠

- **To avoid being scalded, make sure the coolant has cooled sufficiently before loosening the pressure cap 1.**
- **Unless care is taken, opening the pressure cap 1 when the coolant is hot can cause the coolant to spray out. Cover the pressure cap with a cloth, and loosen the cap slowly to bleed off the pressure before opening it fully.**

● **Cleaning procedure**

- Run the engine and keep the coolant at a temperature of approximately 90°C {194°F} such that the thermostat valves remain open and the coolant circulates continuously in the radiator.
- To increase the coolant temperature quickly, cover the front of the radiator with cardboard or a similar material.
- If cleaning is carried out after a large amount of rust has accumulated, the radiator may start to leak. Carefully examine the radiator for leaks after cleaning the cooling system.
- Soft water to be used should have the following properties.

CAUTION ⚠

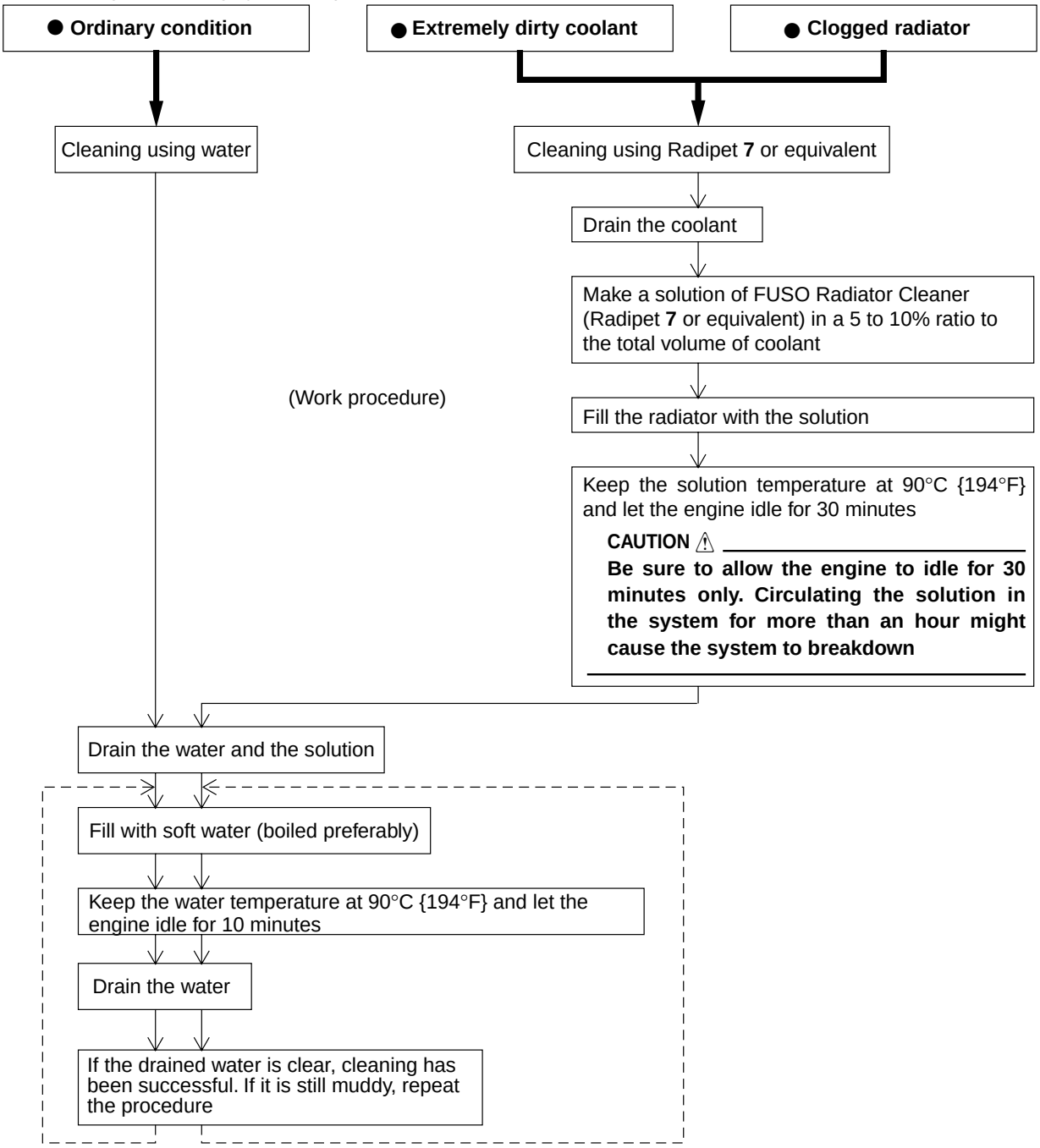
Do not use hard water as it causes scale and rust.

Required properties of soft water

Total hardness	300 ppm or less
Sulfate SO_4^-	100 ppm or less
Chloride Cl^-	100 ppm or less

Total dissolved solids	500 ppm or less
pH	6 to 8

Method of cleaning the cooling system depends on its condition.



DANGER ⚠

If FUSO DIESEL LONG LIFE COOLANT solution gets in your eyes accidentally, you must immediately rinse your eyes with large amounts of water, and be sure to consult a doctor.

WARNING ⚠

FUSO DIESEL LONG LIFE COOLANT is inflammable. Do not put it near unprotected lights.

NOTE

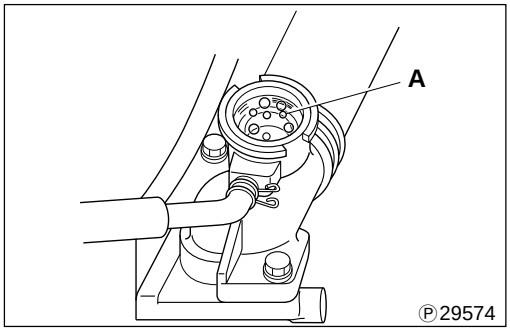
- **After cleaning with solution, fill with coolant as quickly as possible.**
- **To prevent freezing of the coolant and corrosion of the cooling system, use specified coolant solution of FUSO DIESEL LONG LIFE COOLANT. (See the Owner's Handbook for use of these materials.)**

Air Bleeding of Cooling System

- Remove the pressure cap. Then, introduce cooling water little by little up to the water outlet pipe neck. Do not pour water up to the outlet port brim, otherwise water would overflow out of the outlet port after the engine is started as water will expand due to temperature rise.
- With the pressure cap removed, run the engine at idle. While keeping temperature at 90°C {194°F}, bleed the cooling system completely.
- After bleeding the cooling system of air, add coolant to the water outlet pipe and reservoir tank as required.

Gas Leak Testing

The presence of air or exhaust gas in the coolant increases corrosion and rust in the cooling system. Check for air or exhaust gas in the coolant using the following procedure.



- Open the pressure cap.

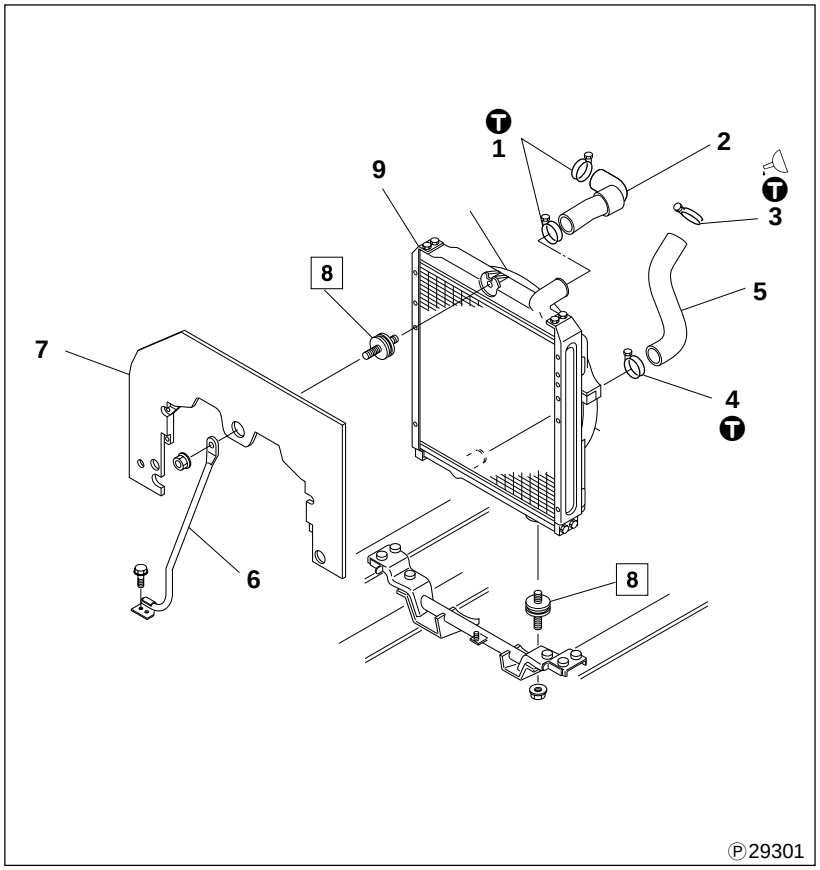
WARNING ⚠

Make sure the coolant is cool before loosening the pressure cap. If the coolant is hot, it may spray out.

- Run the engine and let the coolant temperature reach approximately 90°C {194°F}.
- If bubbles **A** appear continuously, there is air or exhaust gas in the coolant.
- If the coolant contains air, the cylinder head bolts, water pump mounting bolt, or hose connections may be loose. Alternatively, the hoses may be damaged.
- If the coolant contains exhaust gas, it is possible that the cylinder head gasket is damaged or that the cylinder head is cracked.

M E M O

RADIATOR



● **Disassembly sequence**

1 Clamp
2 Upper hose
3 Clamp
4 Clamp
5 Lower hose
6 Radiator support
7 Baffle plate
8 Support cushion
9 Radiator assembly P14A-12

● **Assembly sequence**

Follow the disassembly sequence in reverse.

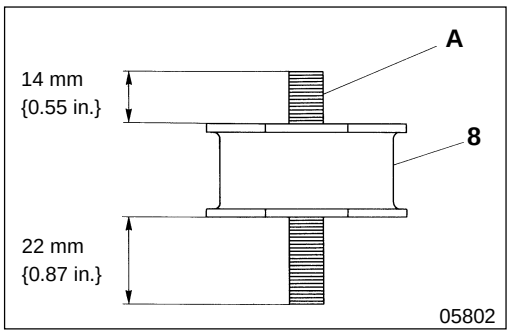
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 4	Clamp	3 to 4.5 {2.2 to 3.3, 0.3 to 0.45}	—
3	Clamp	1.5 to 2 {1.1 to 1.4, 0.15 to 0.2}	Wet

Lubricant

Location	Points of application	Specified lubricant	Quantity
3	Threads of clamp	Engine oil	As required



◆ Service procedure

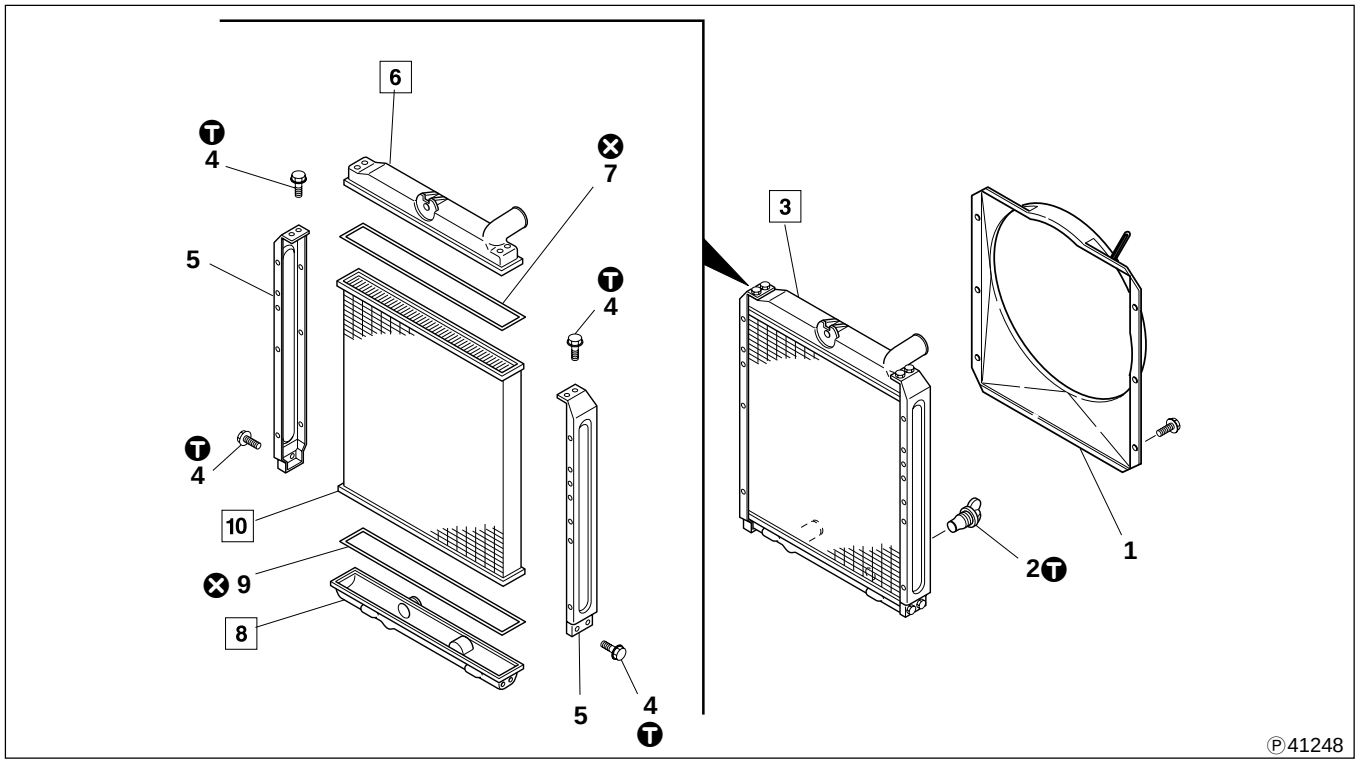
8 Support cushion

Install the support cushion **8** with its shorter threaded part **A** on the radiator side.

M E M O

RADIATOR

Radiator Assembly



● **Disassembly sequence**

1 Radiator shroud
2 Drain cock
3 Radiator assembly
4 Bolt
5 Side member
6 Upper tank
7 O-ring
8 Lower tank
9 O-ring
10 Core

⊗ **:** Non-reusable part

CAUTION ⚠

- **Do not disassemble the radiator assembly 3 unless defects are evident.**
- **The upper tank 6 and lower tank 8 are made of plastic and could crack if subjected to undue shock. Handle them with care.**
- **Replace the core 10 if the clinching tabs that hold the upper tank 6 or lower tank 8 have two paint marks, showing that the tabs have been bent back twice.** 🕮 **P14A-13**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
3	Radiator air leakage (with air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2})	0 cm^3 {0 cu.in.}	—	Rectify or replace

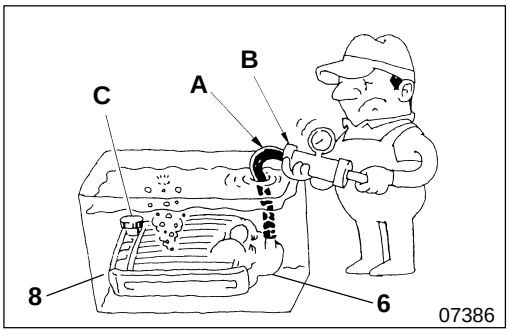
Tightening torque

Unit: N m {ft.lbs, kg fm}

Location	Parts to be tightened	Tightening torque	Remarks
2	Drain cock	2 {1.4, 0.2}	—
4	Bolt (side member mounting)	13 {9.4, 1.3}	—

Special tool

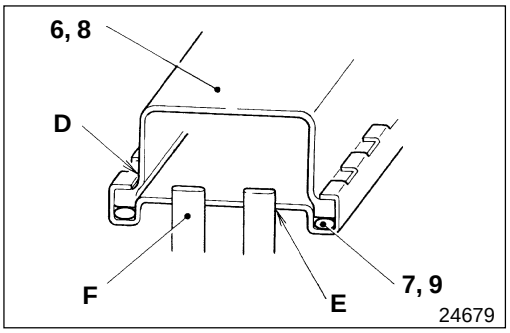
Location	Tool name and shape	Part No.	Application
6, 8	Lock & Break Tool	Obtain locally or use sublet repair	Upper tank, lower tank removal



◆ Service procedure

3 Radiator inspection

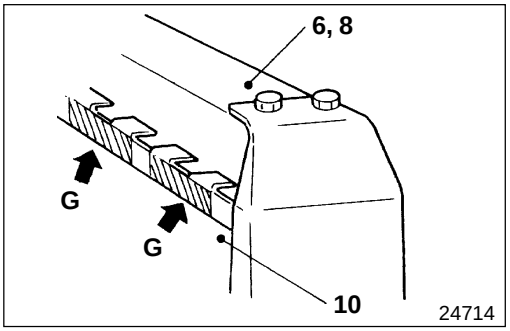
- Fit a hose **A**, and radiator cap tester **B** onto the radiator upper tank **6**.
- Fit a plug **C** onto the radiator lower tank **8**, then immerse the radiator in a tank of water.
- Using the radiator cap tester **B**, apply the specified air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2}, and check for air leakage.
- If air leakage is apparent, repair or replace the radiator assembly **3**.



- Replace the following parts according to the leaking locations.

Leaking location	Part to replace
Tank root **D**	O-ring **7** or **9**
Tank **6**	Tank **6**, O-ring **7**
Tank **8**	Tank **8**, O-ring **9**
Tube fitted area **E**	Core **10**, O-ring **7**, **9**
	* Tube **F** (TIG welded), O-ring **7**, **9**
Tube **F**	Core **10**, O-ring **7**, **9**

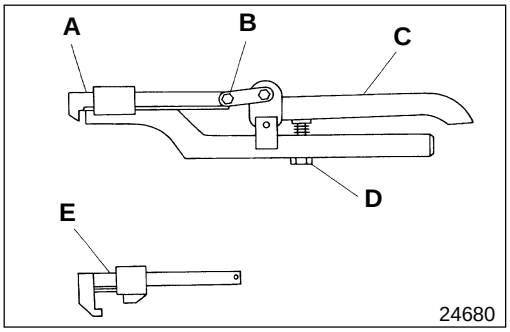
*: When repaired



CAUTION ⚠

Replace the core 10 if its clinching tabs that hold the upper tank 6 or lower tank 8 have two paint marks G, evidence of the tabs having been bent back twice.

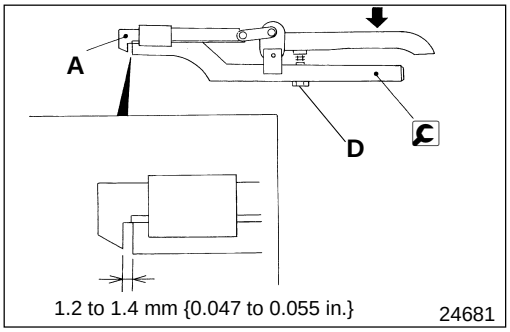
The tabs are provided with one paint mark each time they are bent back. Count the paint marks on each of upper and lower tabs separately.



6 **8** **Upper tank and lower tank**

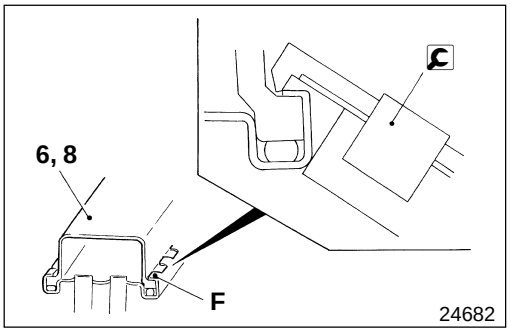
Remove and reinstall the tanks using the Lock and Break Tool.

A : Attachment (for tank removal)
B : Attachment locking bolt
C : Slide handle
D : Stopper/adjuster bolt
E : Attachment (for tank installation)

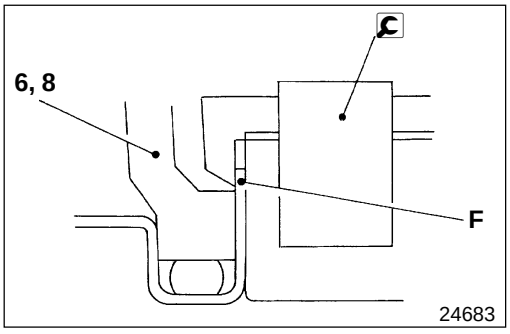


[Removal]

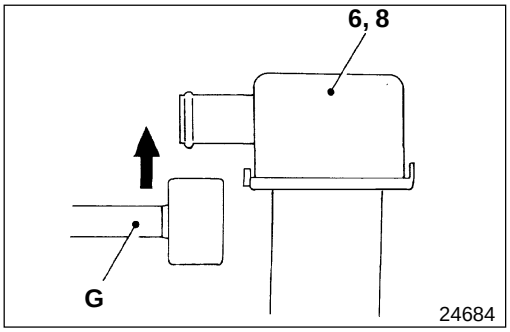
- Fit attachment **A** onto the end of the Lock and Break Tool, set it to the illustrated dimension and lock it in position with the stopper/adjuster bolt **D**.



- Using the Lock and Break Tool, bend up the tabs **F** of the core **10** that hold the tank **6**, **8**.
- Straighten the tabs **F** completely as shown by gripping the Lock and Break Tool.

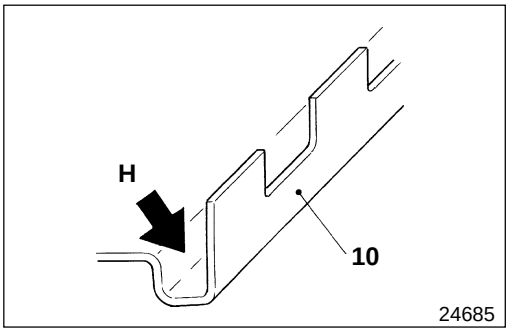


- After straightening all the tabs **F**, grasp the inlet or outlet pipe and remove the tank **6**, **8**.
- If the tank **6**, **8** is difficult to remove, tap it with a rubber or plastic hammer **G**.



CAUTION ⚠

The tanks 6 and 8 are made of plastic and may crack if subjected to undue shock. Handle them with care.

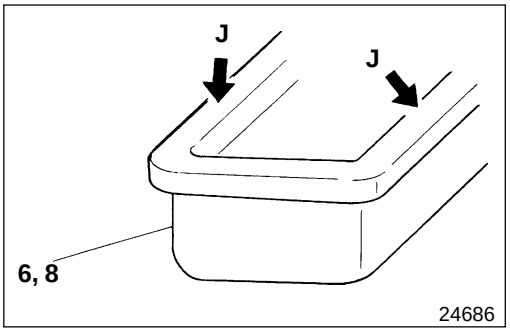


[Inspection]

- Check the tank mounting channels **H** of the core **10** for foreign matters.
- If foreign matter is stuck inside the mounting channels, rub them away with sandpaper (approximately #1000) or blow them out with compressed air.

CAUTION ⚠

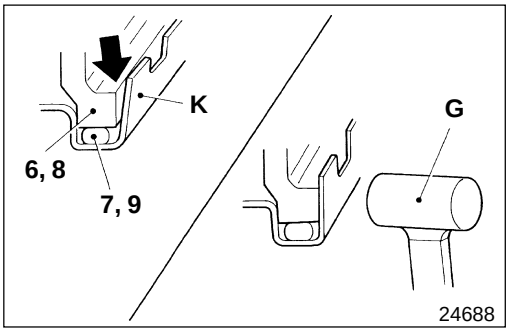
If any foreign matter (even a single hair) remains when the O-ring 7, 9 and tank 6, 8 are fitted, leakage can occur. Carefully inspect and clean each tank mounting channel H entirely.



- Clean the core contacting surface **J** of the tank **6**, **8** and inspect it for damage. Replace the tank if any defect is evident.

CAUTION ⚠

Perform procedure with bare hands to prevent foreign matter from sticking to the surface J.

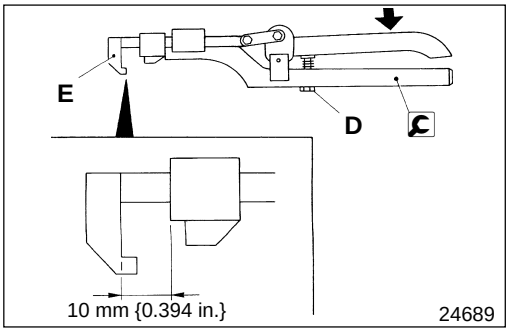


[Installation]

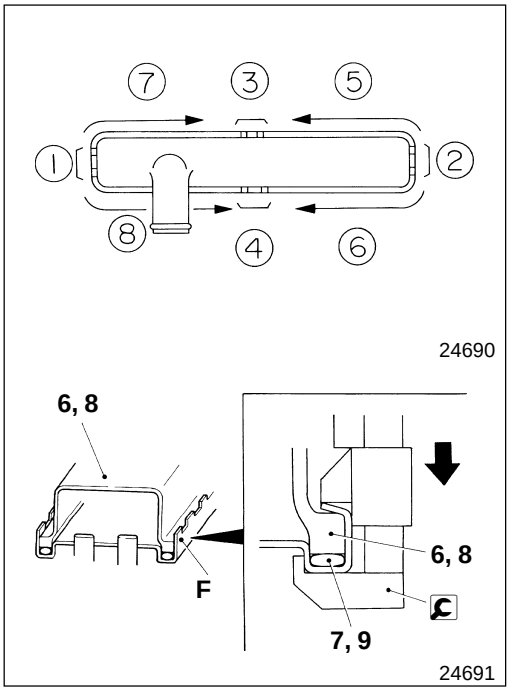
- Install the tank **6**, **8** in position. Check that the sub-plate **K** of the core is in close contact with the tank. If there is any space, tap the sub-plate lightly with a rubber or plastic hammer to eliminate space.

CAUTION ⚠

Handle the parts with bare hands to prevent foreign matter from sticking to the O-ring 7, 9 and tank 6, 8.



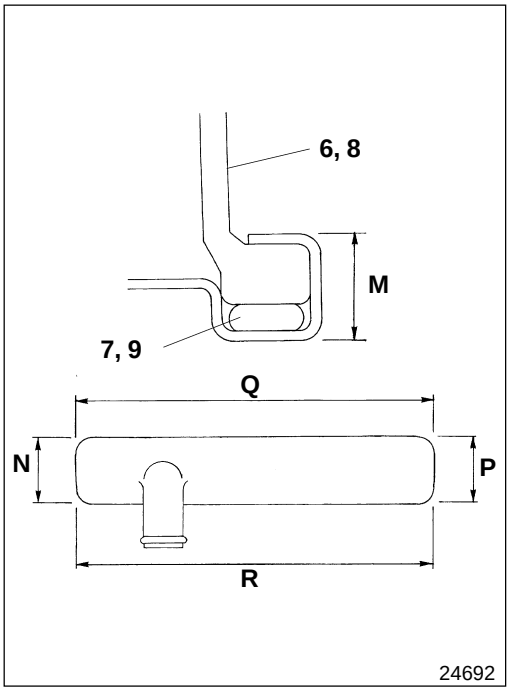
- Fit attachment **E** onto the end of the Lock and Break Tool, set it to the illustrated dimension and lock it in position with the stopper/adjuster bolt **D**.



- Clinch the tabs **F** of the core **10** to hold the tank **6**, **8** in the illustrated order.
  ① to ④ : Two center tabs on each side
  ⑤ to ⑧ : Remaining tabs in illustrated sequence
  : Lock and Break Tool (with attachment **E**)

NOTE

The sides ① and ② do not allow the Lock and Break Tool to be used for clinching. Clinch these sides using a pair of pliers with tape wrapped around its jaws.

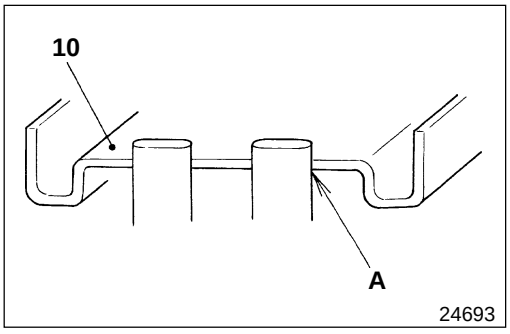


- Check that the tabs have been clinched to the following dimensions.
  M : 14.65 to 15.05 mm {0.576 to 0.592 in.} (Sides **N** and **P**)
  10.05 to 10.45 mm {0.395 to 0.411 in.} (Sides **Q** and **R**)

- Check for leaks. P14A-13
- Provide a paint mark to the sub-plate **K** of the core **10** to indicate that the tabs have been bent up and then down.

NOTE

Provide one paint mark after each removal of the tank.



11 Core

If water leaks from the tube fitted area **A**, replace the core **10** or repair it by the following method.

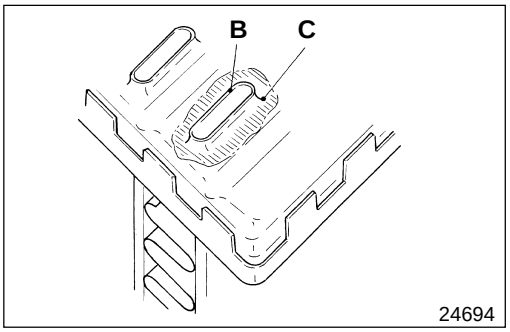
[Repair]

NOTE

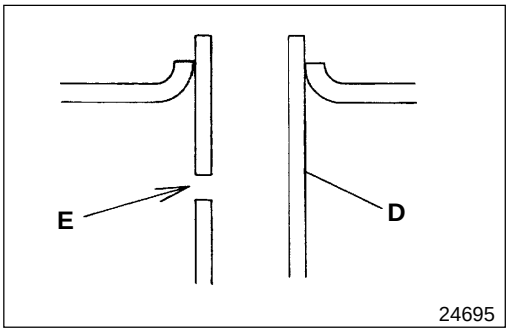
Repair is carried out by tungsten inert gas arc (TIG) welding, which requires the skill of a trained welder.

WARNING ⚠

To avoid danger, dry the core 10 completely before welding.



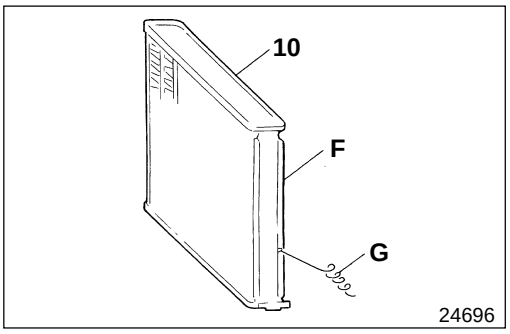
- Clean both edges **B** of the leaky tube and their surroundings **C** using a stainless steel wire brush. Scrub the surface until it glistens with exposed aluminum.



- Since both ends of the tube are covered with weld metal, make a small hole **E** in the tube **D** to allow air venting.

NOTE

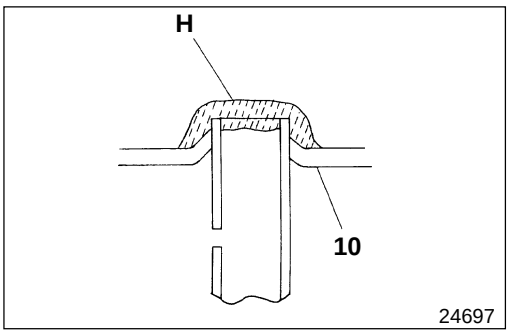
Absence of the small hole E causes escaping air to produce small pin holes in the weld.



- Connect a grounding wire **G** from the support **F** of the core **10** to an appropriate object.

CAUTION ⚠

Improper connection of the grounding wire G causes a short circuit during welding work and the core could be fused at the welded portion.

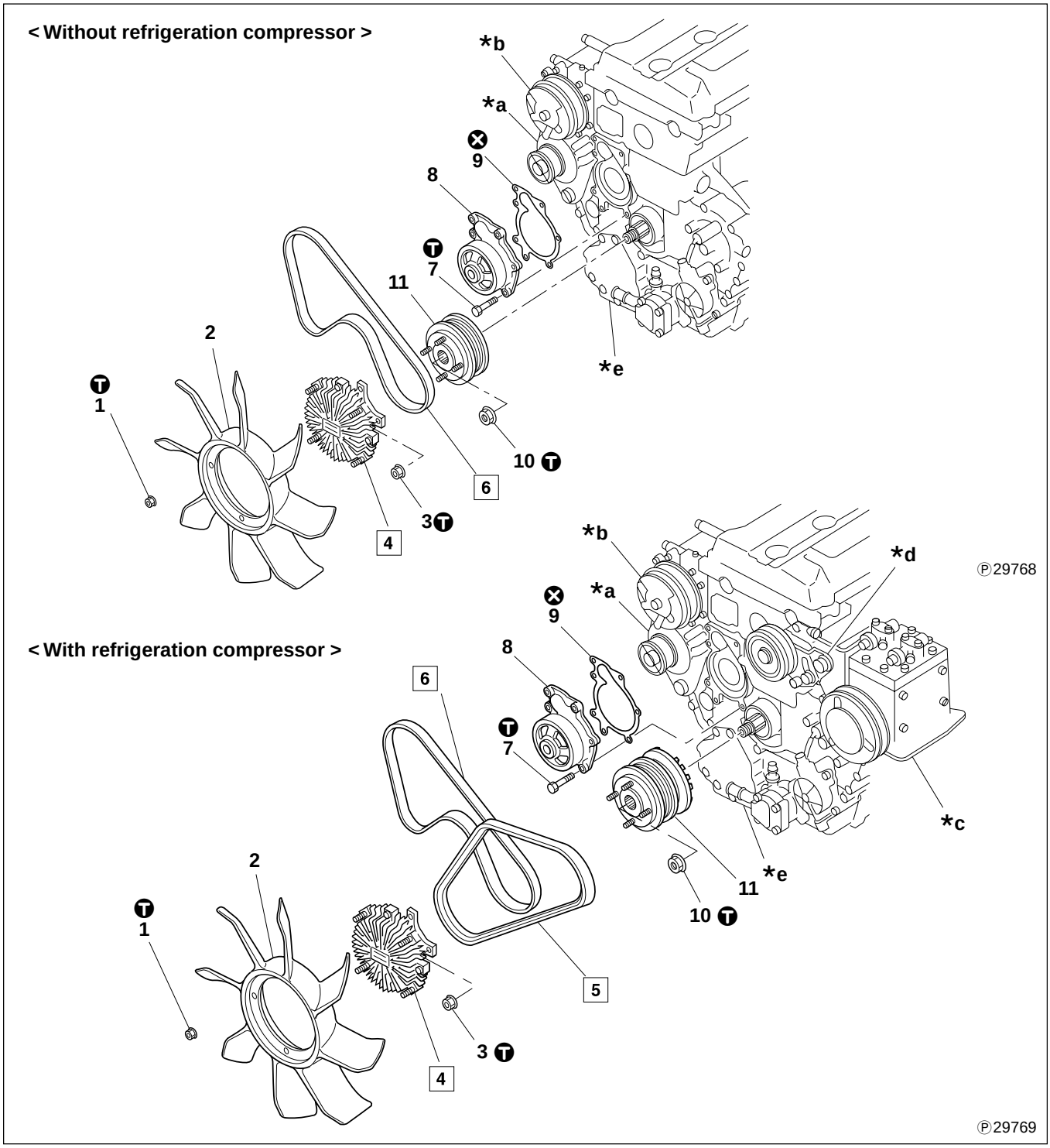


- Cover both ends of the tube with welding metal.
  H : Tungsten inert gas arc weld (TIG)
  Welding conditions:
  Welding rod: A4043 (approximately ϕ 2 mm {ϕ 0.0079 in.} in diameter)
  Welding current: 80A AC
- After welding, check for the following defects. Rectify the weld or replace the core **10** if any of the defects is evident.
  - Undercut
  - Bead crack
  - Crack in base metal

CAUTION ⚠

Weld with sufficient care. Poor welding may cause leakage to reoccur.

COOLING FAN, V-RIBBED BELT, V-BELT AND WATER PUMP



● **Disassembly sequence**

1 Nut
2 Cooling fan
3 Nut
4 Automatic cooling fan coupling
5 V-belt
< Refrigerator-equipped unit >
6 V-ribbed belt (for water pump)
7 Bolt
8 Water pump assembly
9 Gasket
10 Nut
11 Fan pulley

***a :** Altenator Gr 54
***b :** Compressor < with air-conditioner >
or tension pulley < without air-conditioner >
***c :** Compressor < Refrigerator-equipped unit >
***d :** Tension pulley < Refrigerator-equipped unit >
***e :** Front case Gr 11A
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standard

Unit: mm {in.}

Location	Maintenance item		Standard Value	Limit	Remedy
5	V-ribbed belt tension (for refrigerator)		6 to 8 {0.24 to 0.31}	—	Adjust
6	V-ribbed belt tension (for water pump)	When belt is new	9 to 11 {0.35 to 0.43}	—	Adjust
		When belt in use is re-tensioned	11 to 13 {0.43 to 0.51}	—	

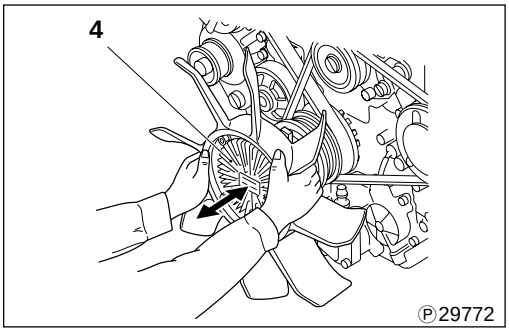
Tightening torque

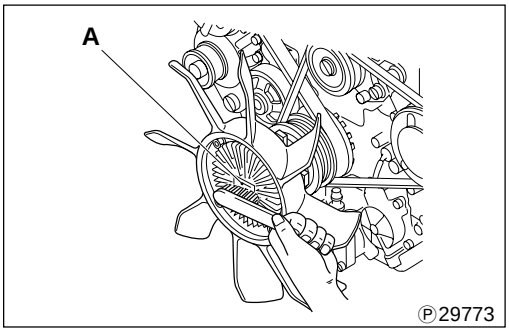
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (cooling fan mounting)	4.9 {3.6, 0.5}	—
3	Nut (for automatic cool fan coupling mounting)	12.7 {9.4, 1.3}	—
7	Bolt (for water pump assembly mounting)	23.5 {17.4, 2.4}	—
10	Nut (for fan pulley mounting)	196.1 {145, 20}	—

Special tools

Location	Tool name and shape	Part No.	Application
5, 6	Belt Tension Gauge 03612	Obtain Locally	V-belt and V-ribbed belt tension measurement





◆ Service Procedure

4 Automatic cooling fan coupling

[Inspection]

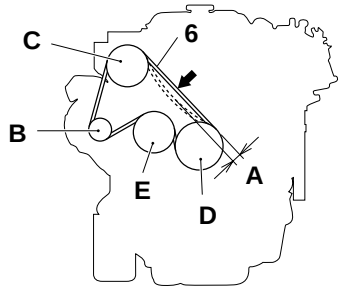
Inspect the automatic cooling fan coupling **4** in accordance with the following procedure. If any defect is apparent, replace the unit.

- Check for leakage of oil from the coupling body.
- Rotate the automatic cooling fan coupling **4** by hand and check for irregular movement or abnormal noise caused by a defect in the bearing.
- Check for excessive axial play in the automatic cooling fan coupling **4** when the engine is cool.

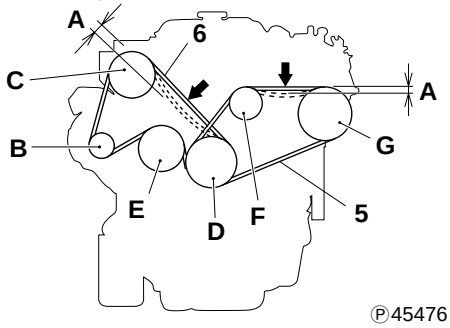
[Cleaning]

If any foreign particles have adhered to the bimetal **A**, brush them off gently.

< Without refrigerator >



< With refrigerator >



5 **6** **V-belt and V-ribbed belt tension**

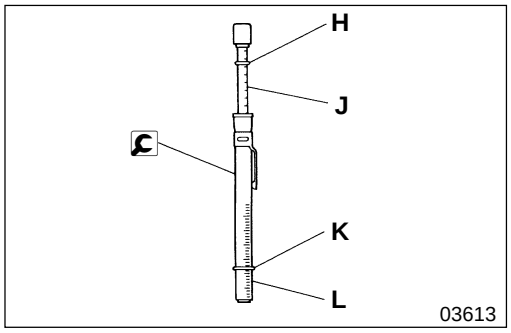
[Inspection]

NOTE

Before checking for tension, crank the engine one turn or more clockwise.

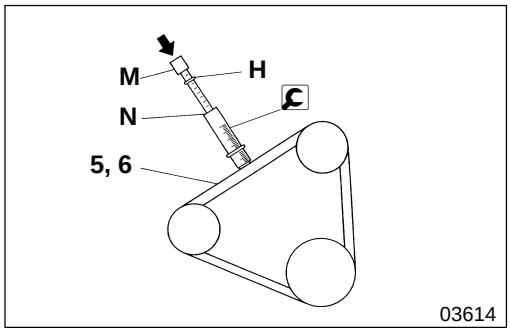
Apply force of approximately 98 N {22 lbf, 10 kgf} to the span center of the V-belt **5** and V-ribbed belt **6**, and measure the extent of belt deflection **A**.

B : Alternator pulley
C : Air conditioner compressor pulley or tention pulley
D : Fan pulley
E : Water pump pulley
F : Tension pulley < Refrigerator-equipped unit >
G : Compressor pulley < Refrigerator-equipped unit >

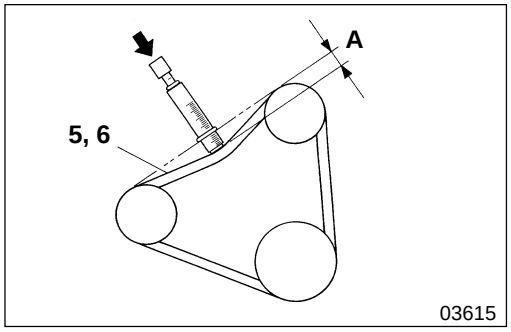


● **Use of belt tension gauge**

- Set the upper O-ring **H** of the 🔧 Belt Tension Gauge to a push load of 98 N {22 lbf, 10 kgf} on scale **J**.
- Set the lower O-RING **K** of the 🔧 Belt Tension Gauge to the belt's specified maximum deflection value on scale **L**.



- Apply the 🔧 Belt Tension Gauge to the center of the V-belt **5** and V-ribbed belt **6** and push **M** until the upper O-ring **H** reaches the flange **N**.

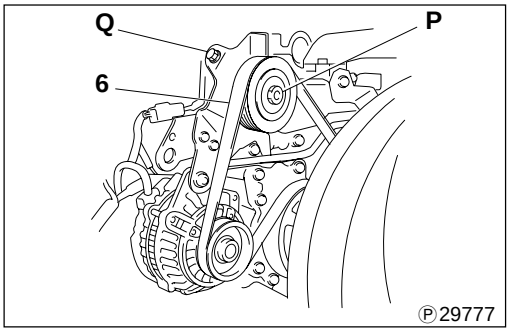


- Measure the deflection **A** of the V-belt **5** and V-ribbed belt **6**. If the measurement does not comply with the standard value, adjust the tension in accordance with the following procedure.

[Adjustment]

CAUTION ⚠

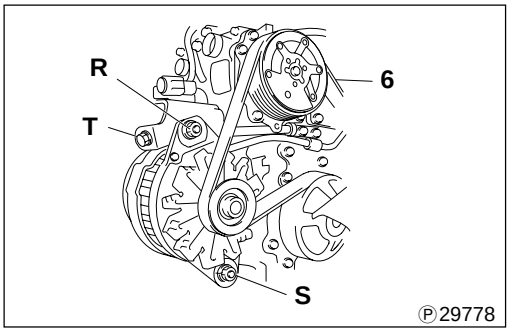
- **Excessive tension in the V-belt 5 or V-ribbed belt 6 may damage the belt and related bearings.**
- **Keep the V-belt 5 or V-ribbed belt 6 free of oil. If the belt becomes oily, it may slip, resulting in overheating of the engine and insufficient charging of the battery.**



(1) V-ribbed belt

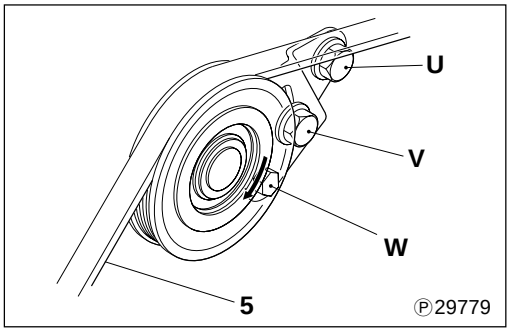
< Without air-conditioner >

- Loosen the tensioner pulley mounting sleeve **P**, then adjust the tension of the V-ribbed belt **6** using the adjustment bolt **Q**.
- When the adjustment is completed, securely tighten the sleeve **P**.



< With air-conditioner >

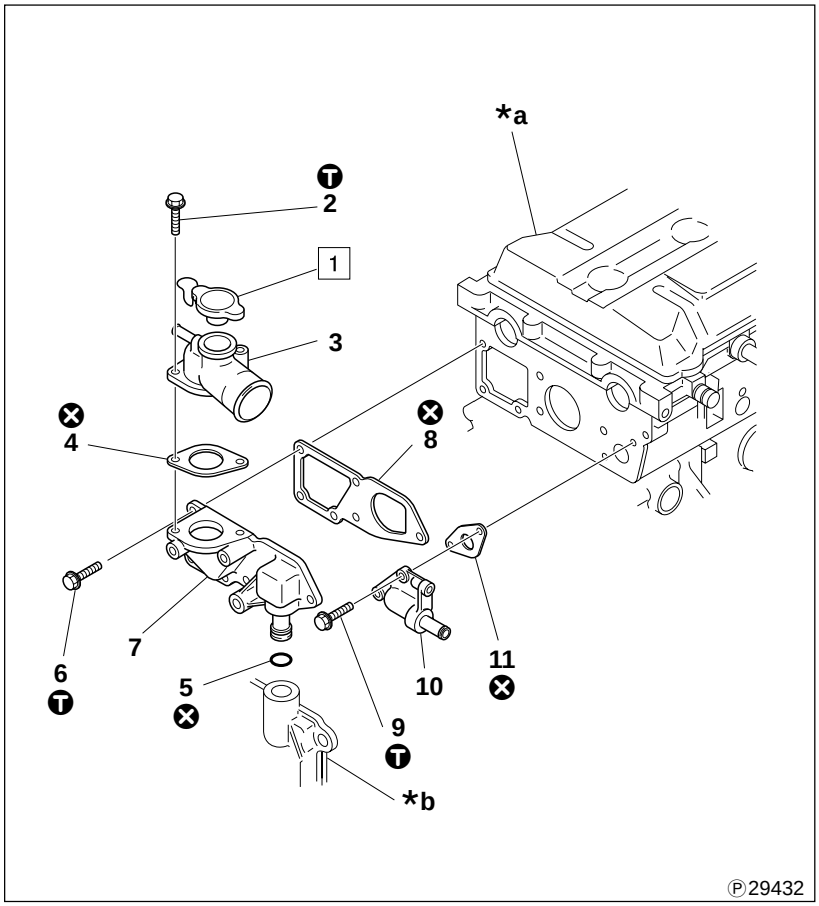
- Loosen the alternator mounting nuts **R** and **S**, then adjust the tension of the V-ribbed belt **6** using the adjustment bolt **T**.
- When the adjustment is completed, securely tighten the nuts **R** and **S**.



(2) V-belt < With refrigerator >

- Loosen bolt **U** before loosening bolt **V**.
- Using a box-end wrench on bar **W**, adjust the tension of the V-ribbed belt **5**.
- After adjustment, tighten bolt **V**, then tighten bolt **U** firmly.

WATER HOSE & PIPE



● **Disassembly sequence**

1 Pressure cap
2 Bolt
3 Water outlet pipe
4 Gasket
5 O-ring
6 Bolt
7 Water outlet case
8 Gasket
9 Bolt
10 Heater hose elbow
11 Gasket

***a :** Cylinder head Gr 11A
***b :** Breather cover Gr 11A
⊗ **:** Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

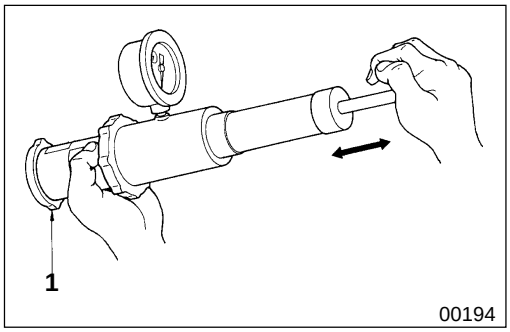
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Valve opening pressure of pressure cap	90±15 kPa {12.8±2.2 psi, 0.9 ±0.15 kgf/cm^2}	—	Replace

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (for water outlet pipe mounting)	23.5 {17.4, 2.4}	—
6	Bolt (for water outlet case mounting)	23.5 {17.4, 2.4}	—
9	Bolt (for heater elbow mounting)	23.5 {17.4, 2.4}	—

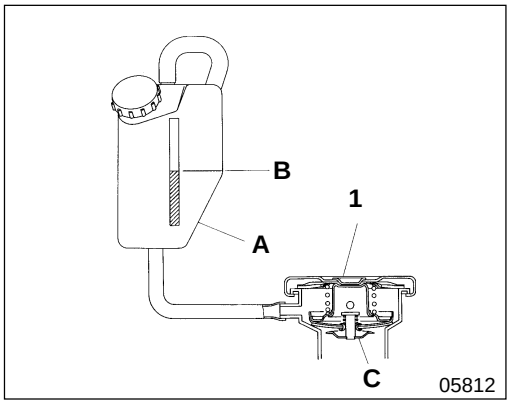


◆ Service procedure

1 Pressure cap inspection

(1) Pressure valve opening pressure

If the gauge reading deviates from the standard value, replace the pressure cap **1**.



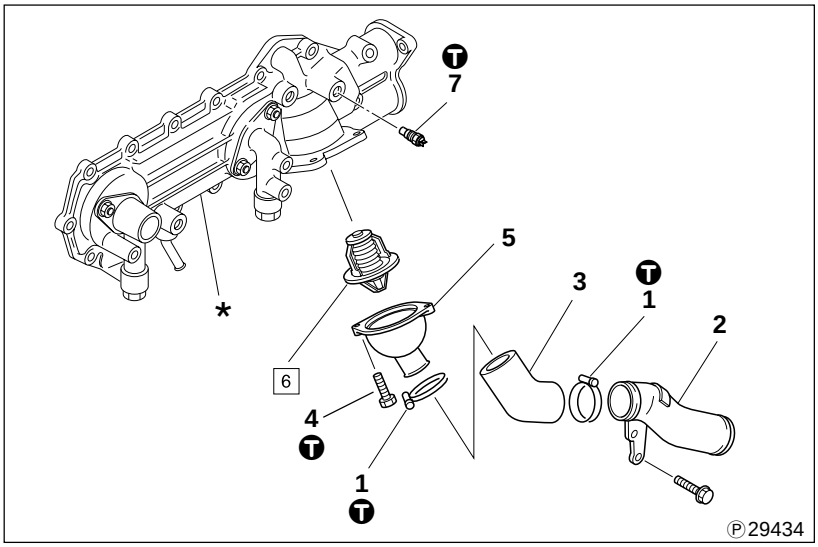
(2) Vent valve inspection

- Observe the water level **B** in the reservoir tank **A**.
- Run the engine at a high speed. Stop the engine when a small amount of coolant has overflowed into the reservoir tank **A**.
- Wait for a while in this condition. When the coolant returns to the ambient temperature, check to see if the water level in the reservoir tank **A** has returned to the level at which it was observed before the engine was started.
- If the water level has not dropped, the vent valve **C** is faulty. Replace the pressure cap **1**.

NOTE

If the pressure cap 1 is removed before the coolant temperature drops to the ambient temperature, the vacuum in the radiator is lost, preventing the coolant from returning to the radiator.

THERMOSTAT



● **Disassembly sequence**

1 Clamp
2 Water pipe
3 Rubber hose
4 Bolt
5 Thermostat cover
6 Thermostat
7 Water temperature sensor
Gr 54

***:** Oil cooler Gr 12A

● **Assembly sequence**

Follow the disassembly sequence in reverse.

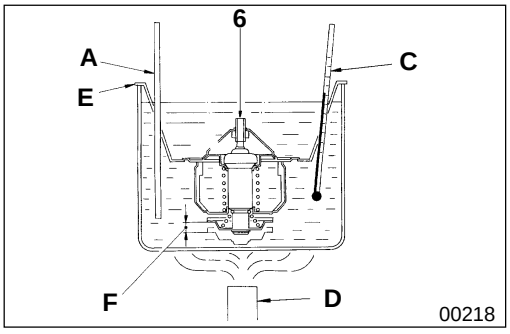
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
6	Thermostat	Valve opening temperature	76.5±2°C {170±36°F}	—	—
		Valve lift/temperature	10 mm or more/90° {194°F}	—	—

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Clamp	3.3 to 4.5 {2.46 to 3.33, 0.34 to 0.46}	—
4	Bolt (for thermostat cover mounting)	23.5 {17.4, 2.4}	—
7	Water temperature sensor	22.6 {16.6, 2.3}	—



◆ Service procedure

6 Thermostat

[Inspection]

Place the thermostat in a container of water. Then, carry out the following inspection procedure while stirring the water with a rod **A** to ensure that it is heated evenly. If the measurements do not comply with the standard values, replace the thermostat **6**.

(1) Valve opening temperature

- Support the thermostat **6** with wire **E** to keep it away from the heat source **D**.
- Gradually heat the water until it reaches the valve opening temperature.
- Maintain this temperature for approx five minutes and check that the valve **B** is open.
- When the water temperature drops below 65 °C {149 °F}, check the the valve **B** is completely closed.

C: Thermometer

(2) Valve lift

Heat the water to slightly higher than the valve opening temperature. With the valve **B** fully open, maintain this water temperature for five minutes. Measure the extent of valve lift **F**.

M E M O

MITSUBISHI
FUSO

Group 14B
Cooling

< 4D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-14B

INDEX

SPECIFICATIONS 14B- 2

STRUCTURE AND OPERATION 14B- 2

TROUBLESHOOTING 14B- 4

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

- Replacing Coolant and Cleaning Cooling System 14B- 6
- Air Bleeding of Cooling System 14B- 8
- Gas Leakage Test 14B- 8

RADIATOR 14B-10

COOLING FAN AND V-BELT 14B-12

WATER PUMP 14B-16

THERMOSTAT 14B-18

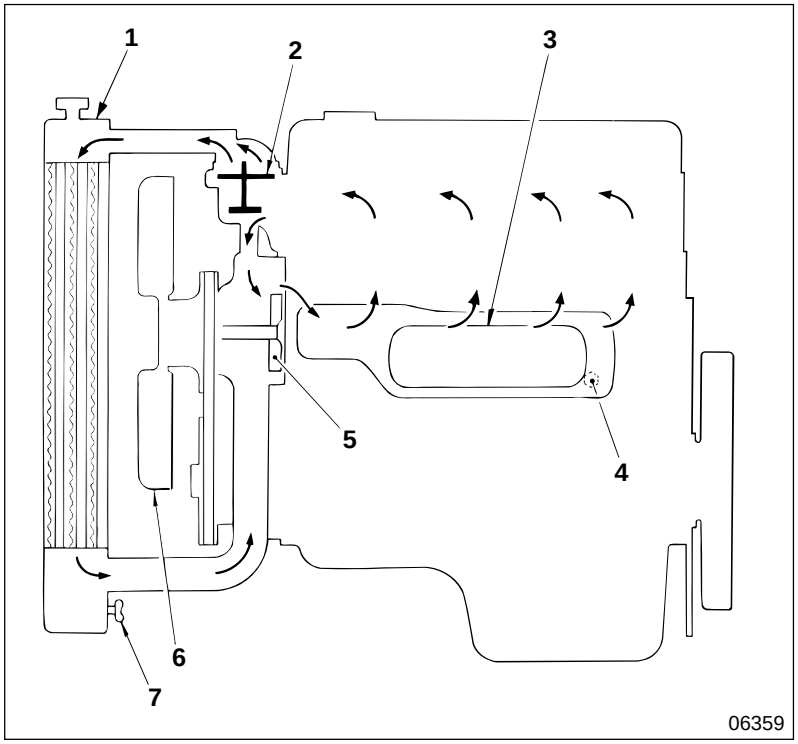
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item	Specifications
Kind of cooling system	Forced water circulation system
Water pump type	Belt-driven involute type
Thermostat type	Wax-pellet, bottom bypass type (with jiggling valve)
Automatic cooling fan coupling type	Continuous control type
Radiator type	Tube and corrugated fin type
Coolant capacity L {qts}	13 {14}

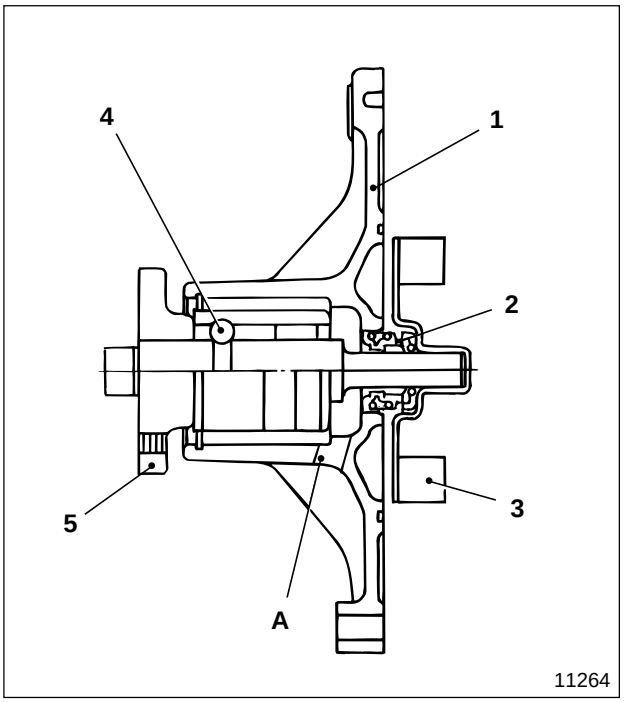
STRUCTURE AND OPERATION

Cooling System (Flow of Coolant)



1 Radiator
2 Thermostat
3 Oil cooler
4 Crankcase drain plug
5 Water pump
6 Cooling fan
7 Radiator drain cock

Water Pump

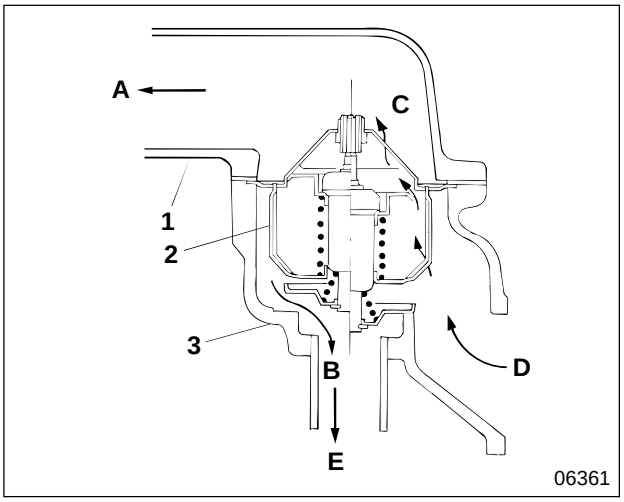


1 Case
2 Unit seal
3 Impeller
4 Ball bearing
5 Flange

A : Drain hole

The water pump is provided with a drain hole **A** to prevent the ingress of coolant to the ball bearing **4** when the unit seal **2** is damaged.

Thermostat



1 Thermostat cover
2 Thermostat
3 Thermostat case

A : To radiator
B : When low coolant temperature
C : When high coolant temperature
D : From cylinder head
E : To water pump

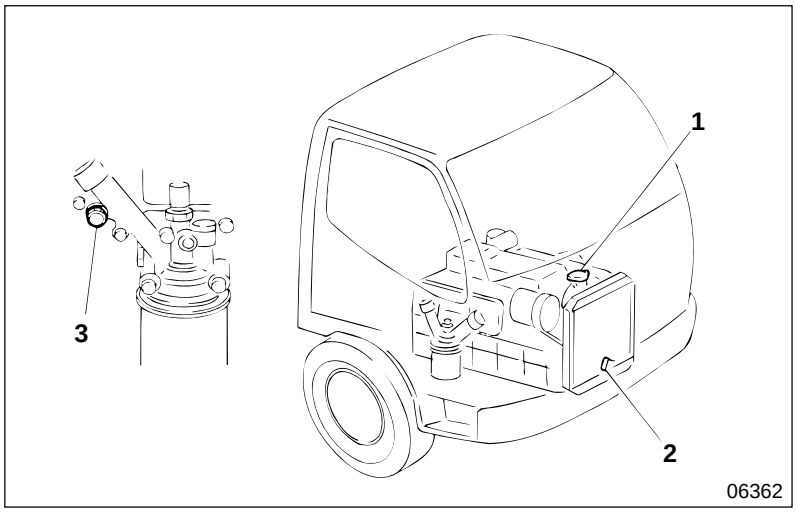
Thermostat **2** is a bottom bypass type that uses wax pellets as its regulating element. As the wax changes its form from solid to liquid according to changes in temperature, the volume of the wax changes. Therefore, the position of the valve, changed by the coolant temperature, regulates the flow of the coolant to the radiator and water pump (bypass side) and controls the coolant temperature.

TROUBLESHOOTING

Possible causes / Symptoms		Overheating (Low cooling effect)	Overcooling	Noise occurs	Coolant loss excessive	Remarks
V-belt	Loose or damaged	○		○		
	Tension excessive			○		
	Oily	○				
Water pump	Water pump installation faulty	○		○	○	
	Unit bearing faulty	○		○		
	Impeller faulty	○		○		
	Unit seal faulty	○			○	
	Unit bearing-to-flange and to-impeller fitting loose	○		○		
Thermostat	Case installation faulty	○			○	
	Gasket faulty	○			○	
	Valve opening temperature too high, valve remains closed	○				
	Valve opening temperature too low, valve remains open		○			
	Water leaking from water temperture sensor	○			○	
Radiator	Space between core and fins clogged	○				
	Core cracked or soldered area separated	○			○	
	Pressure cap airtightness poor	○				
	Water level sensor leaking water	○			○	
Automatic cooling fan coupling	Bearing faulty	○		○		
	Bimetal damaged	○				
	Bimetal contaminated with foreign particles	○	○			
	Silicon oil leaking	○		○		
Oil cooler	Oil cooler installation faulty	○			○	Gr 12B
	Gasket faulty	○			○	Gr 12B
Cylinder head	Cylinder head installation faulty	○			○	Gr 11B
	Gasket faulty	○			○	Gr 11B
Coolant quantity insufficient		○				
Coolant passage clogged		○				
Water hose installation faulty		○			○	
Exterior temperature extremely cold			○			

M E M O

Replacing Coolant and Cleaning Cooling System



1 Pressure cap
2 Radiator drain plug
3 Crankcase drain plug

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Crankcase drain plug	34 to 39 {25 to 29, 3.5 to 4.0}	—

Using the radiator for a long period of time without cleaning it will cause overheating because rust and scale deposits will accumulate inside the cooling system. Periodical cleaning is recommended.

● **Draining coolant**

First loosen pressure cap **1,** to lower the pressure in the cooling system, before draining coolant.

WARNING

- **You must make sure that the engine coolant is cold before draining it so as not to scald yourself.**
- **It is dangerous to open pressure cap 1, when the coolant temperature is high, without taking due care because the hot water would spray out. Be sure to cover the pressure cap with a cloth and loosen slowly to bleed the pressure before opening fully.**

● **Cleaning procedure**

- Keep the coolant temperature at approximately 90°C {194°F} so that the thermostat valve remains open and the coolant continues to circulate in the radiator.
- For the sake of convenience you can raise the coolant temperature quickly by covering the front of the radiator with corrugated cardboard or something similar.
- Soft water to be used should have the following properties.

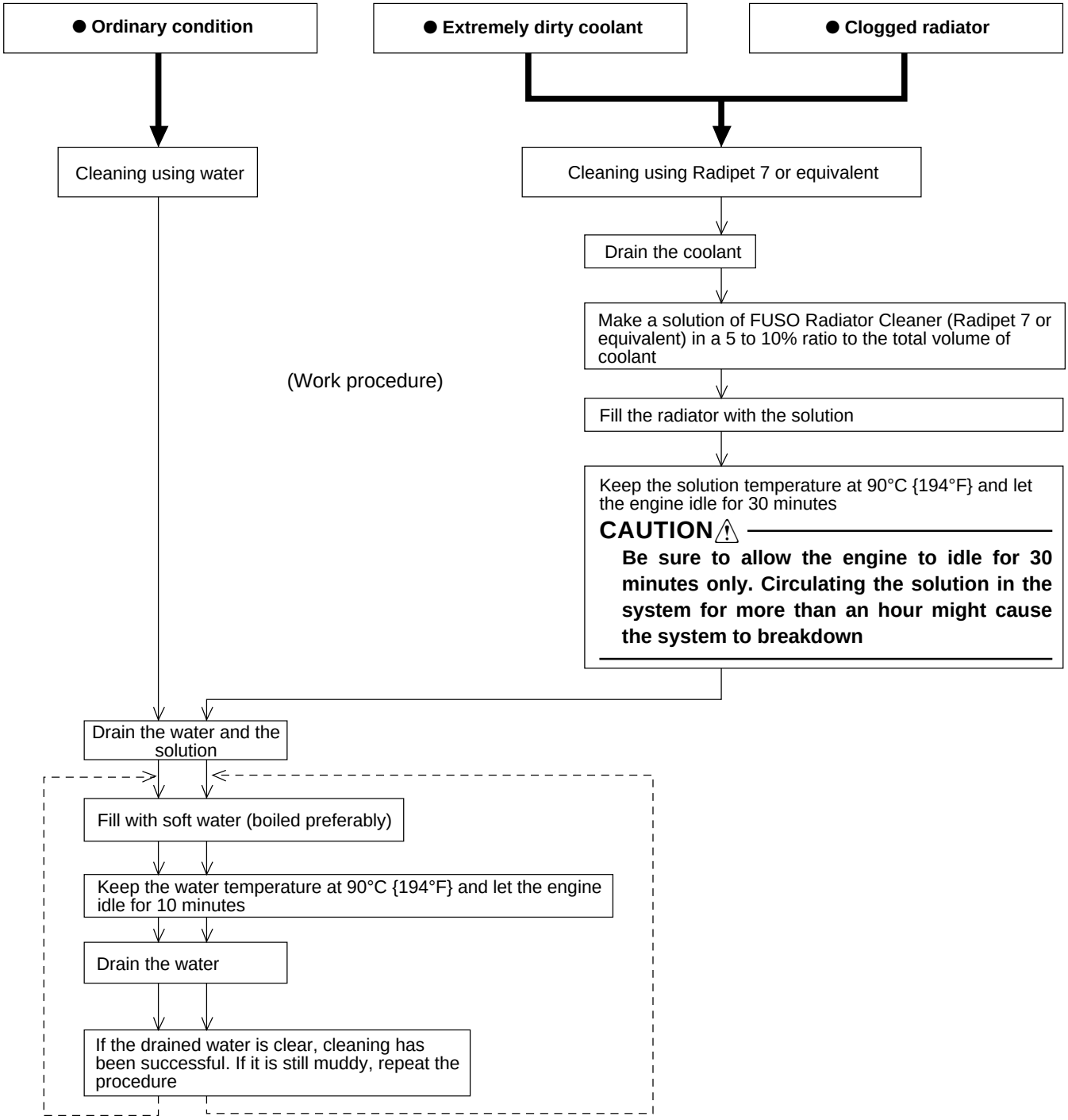
CAUTION

Do not use hard water as it causes scale and rust.

Required properties of soft water

Total hardness	300 ppm or less	Total dissolved solids	500 ppm or less
Sulfate SO_4^-	100 ppm or less	pH	6 to 8
Chloride Cl^-	100 ppm or less		

Method of cleaning the cooling system depends on its condition.



DANGER

If FUSO DIESEL LONG LIFE COOLANT solution gets in your eyes accidentally, you must immediately rinse your eyes with copious amounts of water, and be sure to consult a doctor.

WARNING

FUSO DIESEL LONG LIFE COOLANT is inflammable. Do not put it near naked lights.

NOTE

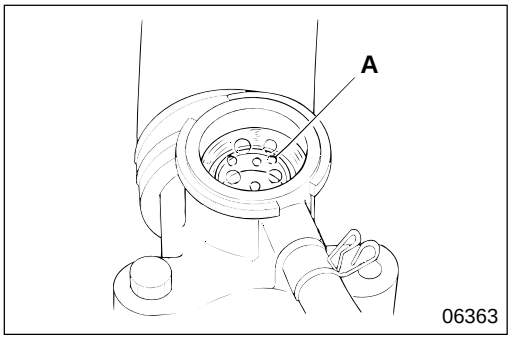
- **After cleaning with solution, fill with coolant as quickly as possible.**
- **To prevent freezing of the coolant and corrosion of the cooling system, use specified coolant solution of FUSO DIESEL LONG LIFE COOLANT. (See the Owner's Handbook for use of these materials.)**

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

Air Bleeding of Cooling System

- Remove the pressure cap and keep the coolant temperature at 90°C {194°F} while letting the engine idle and bleed the air out completely. Keep the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- After completing adequate air bleeding of the cooling system, refill coolant sufficiently enough for the radiator and the reservoir tank.

Gas Leakage Test



Air or exhaust gas in the coolant increases corrosion and rusting in the system. Therefore, carry out the following test:

- Remove the pressure cap.

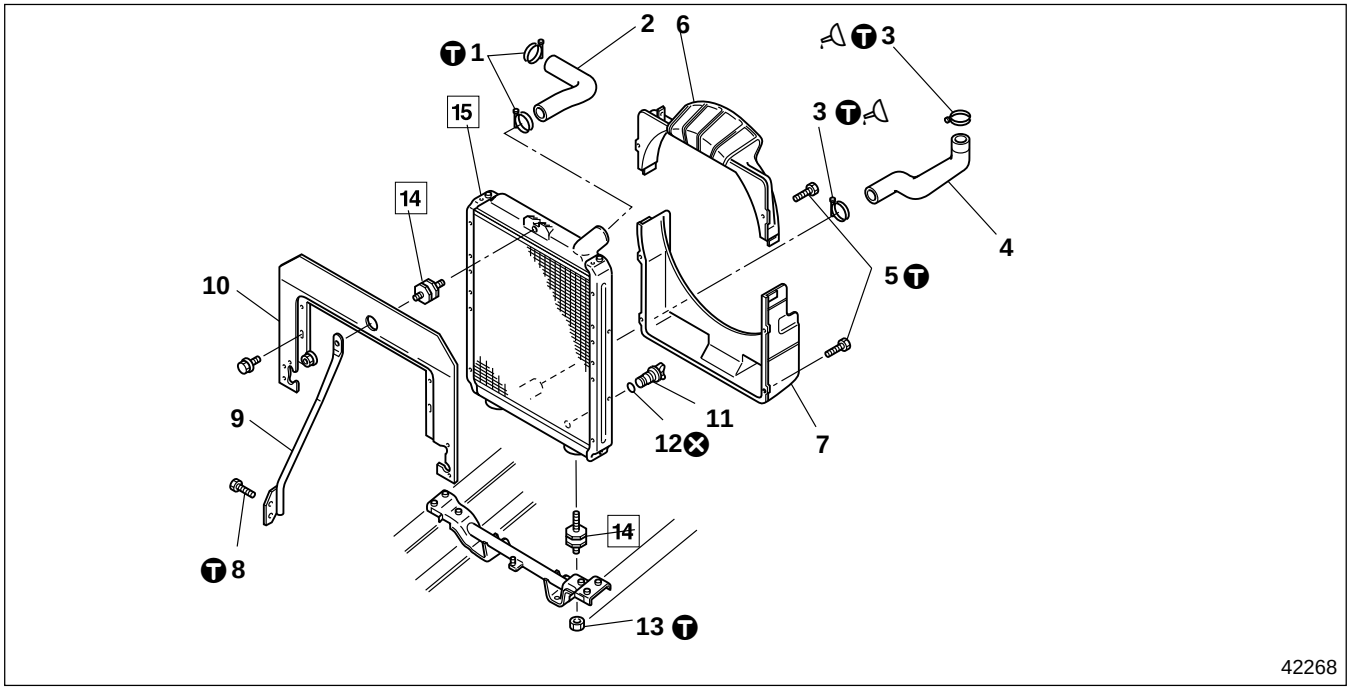
WARNING⚠

Be sure that the coolant temperature is low enough so that hot coolant does not spout out when you loosen the pressure cap.

- Run the engine to bring the coolant temperature to approximately 90°C {194°F}.
- If air bubbles **A** continuously rise from the coolant, it is an indication that air or exhaust gas has gotten into the coolant.
- If it is air, it is possible that the cylinder head bolts, the water pump mounting bolts or the hose connections are loose, or that the hose is damaged.
- If it is exhaust gas, it is possible that the cylinder head gaskets are damaged, or that the cylinder head is cracked.

M E M O

RADIATOR



● **Disassembly sequence**

1 Hose clamp
2 Inlet hose
3 Hose clamp
4 Outlet hose
5 Bolt
6 Upper radiator shroud
7 Lower radiator shroud
8 Bolt
9 Radiator support
10 Baffle plate
11 Radiator drain plug
12 O-ring
13 Nut
14 Support cushion
15 Radiator

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy and remarks
15	Radiator air leakage (Air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2})	0 cm^3 {0 cu. in.}	—	Correct or replace

Ⓣ Tightening torque

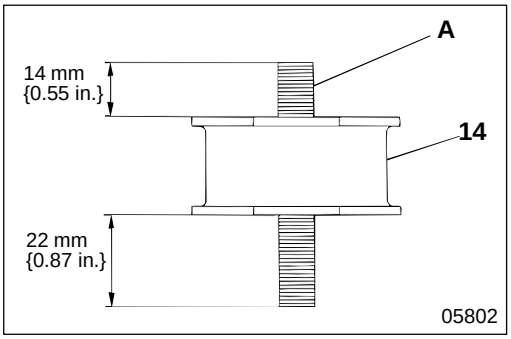
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Hose clamp		3 to 4.4 {2.2 to 3.3, 0.3 to 0.45}	—
3	Hose clamp	Radiator side	3 to 4.4 {2.2 to 3.3, 0.3 to 0.45}	—
		Engine side	1.5 to 2.0 {1.1 to 1.4, 0.15 to 0.2}	Wet
5	Bolt (Upper and lower radiator shroud mounting)		5 to 7 {3.6 to 5.1, 0.5 to 0.7}	—
8	Bolt (Radiator support mounting)		12 to 15 {8.7 to 11, 1.2 to 1.5}	—
13	Nut (Support cushion mounting)		12 to 15 {8.7 to 11, 1.2 to 1.5}	—

Lubricant

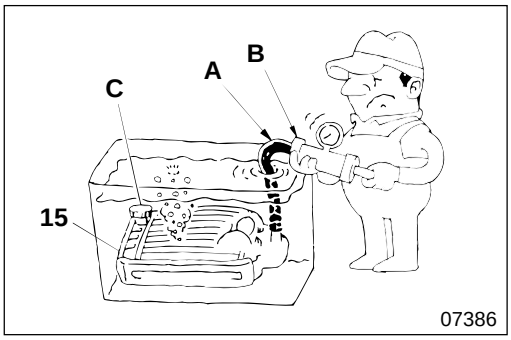
Location	Points of application	Kinds	Quantity
3	Thread area of bolt	Engine oil	As required

◆ Service procedure



14 **Support cushion**

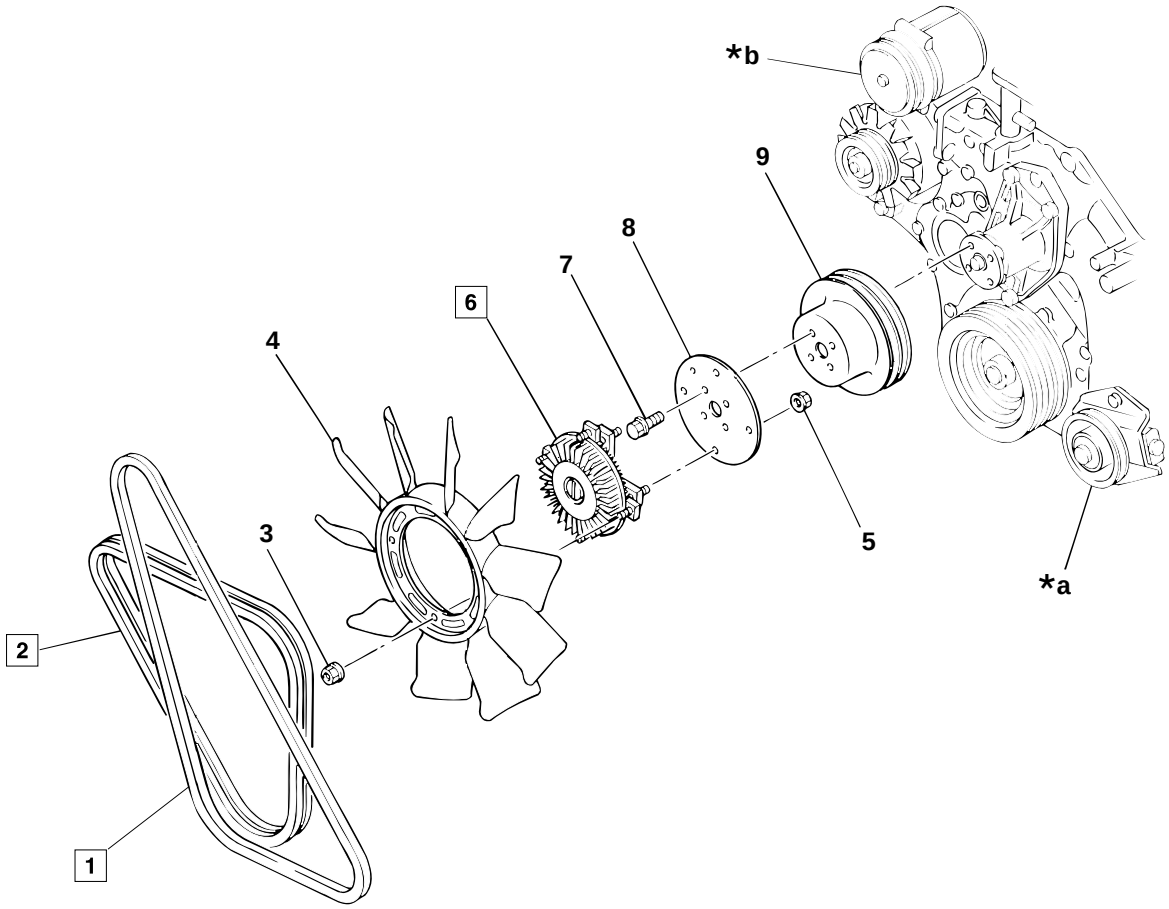
Place support cushion **14** so that thread part **A** (shorter than the other side) comes to the radiator side for mounting.



15 **Inspection of radiator**

- Install radiator cap tester **B** by connecting hose **A** to the radiator inlet hole.
- Plug any other openings **C** with plugs, and immerse the radiator in a water tank.
- Apply specified air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2} using cap tester **B**, and check if there is any air leakage.
- If you find air leakage, correct or replace radiator **15**.

COOLING FAN AND V-BELT



● **Disassembly sequence**

1 V-belt (Compressor)
2 V-belt (Fan)
3 Nut
4 Cooling fan
5 Nut
6 Automatic cooling fan coupling
7 Bolt
8 Coupling plate
9 Water pump pulley

***a** : Tension pulley Gr 54
***b** : Cooler compressor Gr 54

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

- **Be sure to replace automatic cooling fan coupling 6 as an assembly if it is faulty because it is a unit construction.**
- **Be sure to replace V-belts 2 as a set to maintain even tension between them.**

Service standards

Unit : mm {in.}

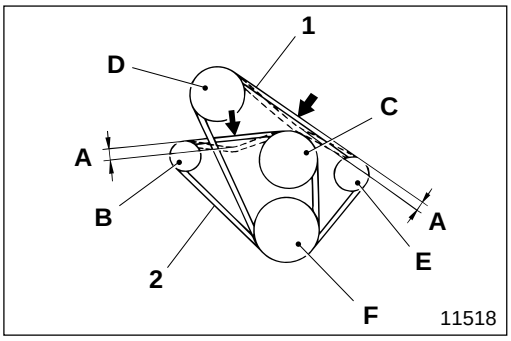
Location	Maintenance item	Standard value	Limit	Remedy
1	V-belt tension (Air-conditioner)	16 to 20 {0.63 to 0.79}	—	Adjust
2	V-belt tension (Fan)	12 to 16 {0.47 to 0.63}	—	Adjust

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1, 2	Belt tension gauge 03612	MH062345	Measurement of tension of V-belt

◆ Service procedure

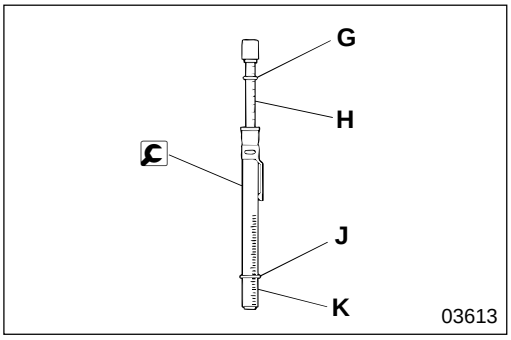


1 **2** **V-belt**

[Inspection]

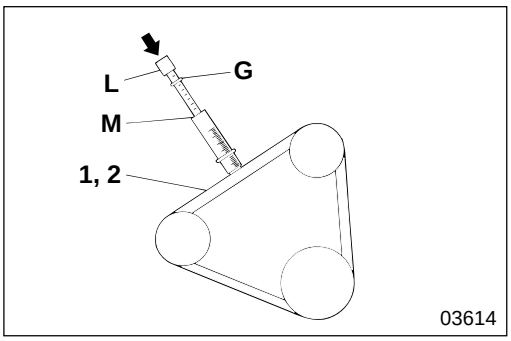
Measure the extent of flex **A** when the center of V-belts **1**, **2** as illustrated is depressed with a force of 98 N {72 lbf, 10 kgf}.

B : Alternator pulley
C : Water pump pulley
D : Cooler compressor pulley (Air-conditioner)
E : Tension pulley
F : Crankshaft pulley

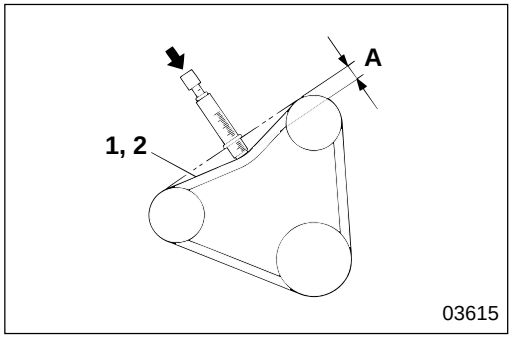


● **Use of special tool belt tension gauge**

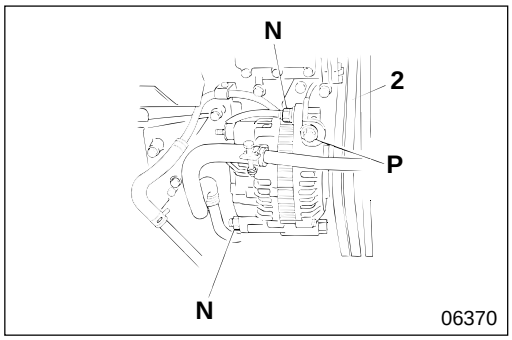
- Set upper O-ring G of belt tension gauge to 98 N {72 lbf, 10 kgf} (push load) on graduation **H**.
- Set lower O-ring **J** of belt tension gauge to graduation **K** (maximum flex of belt).



- Place belt tension gauge at the center of V-belts **1**, **2** perpendicularly as illustrated and push top **L** all the way down until upper O-ring **G** hits upper edge **M**.



- Measure the extent of flex **A** of V-belts **1**, **2** at this point, and if the measured value deviates from the standard value, adjust as follows.



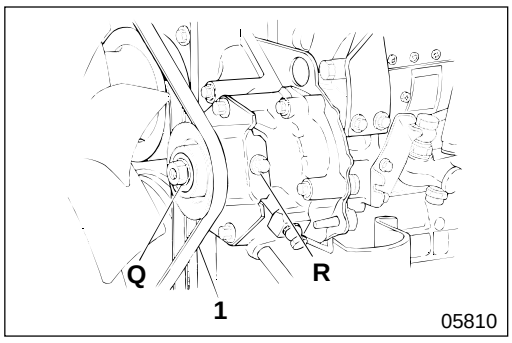
[Adjustment]

(1) Adjustment of V-belt tension for fan

- Loosen alternator mounting bolts **N** (two places), and adjust the tension of V-belts **2** by moving adjusting bolt **P**.
- After adjustment, tighten the bolts and nuts securely.

CAUTION⚠

- **Bear in mind that excessive tension of V-belts 2 might damage the belts and bearings that engage with the V-belts.**
- **Be sure to replace V-belts 2 as a matched set to maintain even tension between them.**
- **Be careful not to let oil stick to V-belts 2, if oil gets onto the belts, it causes slipping, resulting in overheating and insufficient battery charging.**

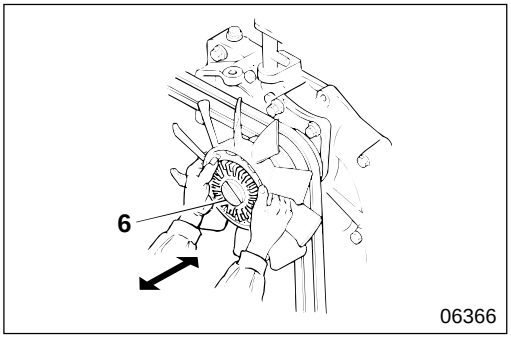


(2) Adjustment of V-belt tension for air-conditioner

- Loosen tension pulley mounting nut **Q**, and adjust the tension of V-belt **1** by adjusting bolt **R**.
- After adjustment, tighten the bolts and nuts securely.

CAUTION⚠

- **Bear in mind that excessive tension of V-belt 1 might damage the belt and bearings that engage with the V-belt.**
- **Be careful not to let oil stick to V-belt 1, if oil gets onto the belt, it causes slipping, resulting in poor performance of the air-conditioner.**

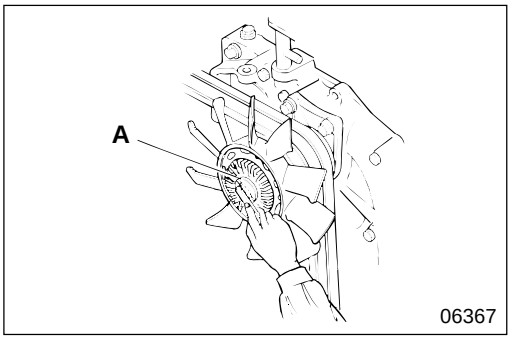


6 Automatic cooling fan coupling

[Inspection]

Carry out the following inspection of automatic cooling fan coupling **6** and if any fault is found, replace the unit.

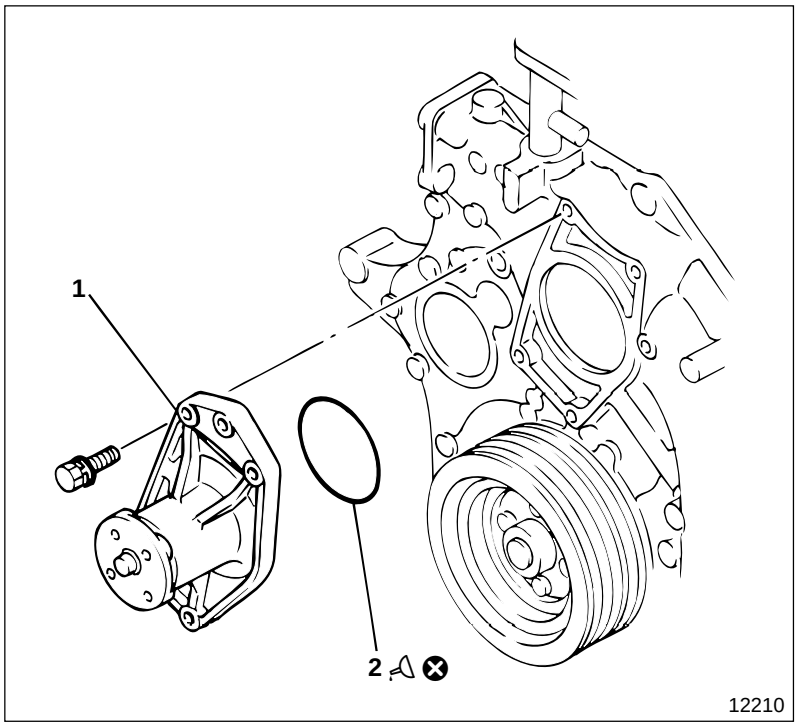
- Check for any leakage of lubricating oil sealed in the coupling body.
- Rotate automatic cooling fan coupling **6** by hand, and check for any irregularity in rotation related to the coupling bearing or any abnormal noise.
- Check for any excessive play of automatic cooling fan coupling **6** in the axial direction when the engine is cool.



[Cleaning]

- If there are any foreign particles sticking to bimetal **A**, remove them by brushing lightly.

WATER PUMP



● **Removal sequence**

1 Water pump assembly
2 O-ring

⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

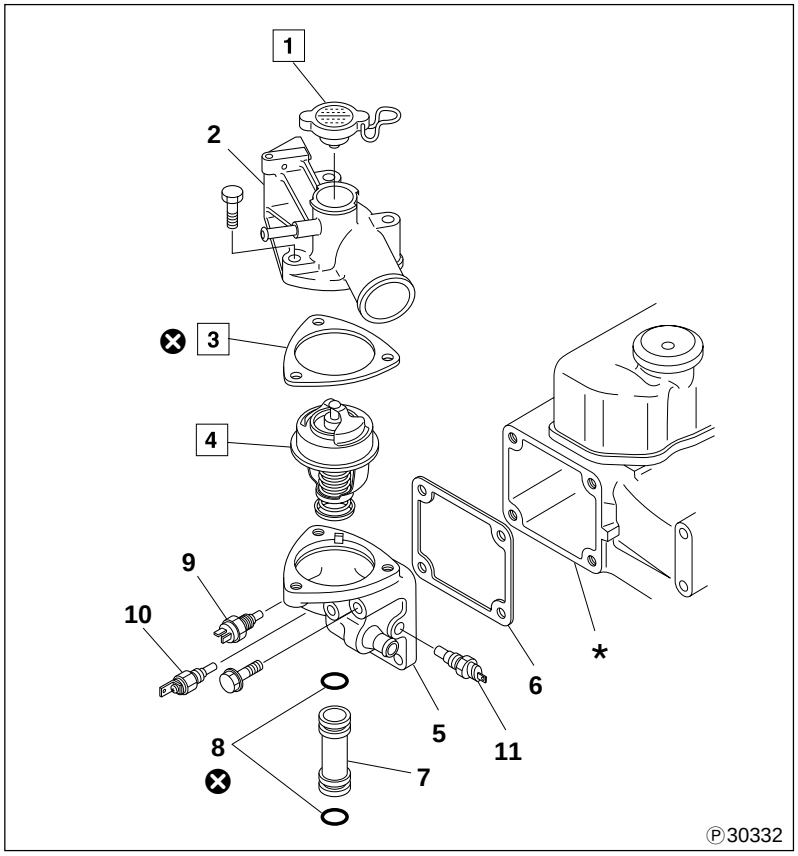
- **Be sure to replace water pump assembly 1 as an assembly if it is faulty because it is a unit construction.**
- **Never apply engine oil to the O-ring because it will cause the O-ring to swell.**

Lubricant

Location	Points of application	Kinds	Quantity
2	Periphery of O-ring	Soapy water	As required

M E M O

THERMOSTAT



● **Disassembly sequence**

1 Pressure cap
2 Thermostat cover
3 Thermostat cover gasket
4 Thermostat
5 Thermostat case
6 Thermostat case gasket
7 Bypass pipe
8 O-ring
9 Water temperature sensor (Water temperature gauge and multi-purpose timing control unit) Gr 54
10 Overheating switch Gr 54
11 Water temperature sensor (Engine control) Gr 54

* : Cylinder head
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Be sure to apply soapy water to O-ring 8 for easier fitting. Never use engine oil because it will cause the O-ring to swell.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy and remarks
1	Pressure cap valve opening pressure		88±15 kPa {13±2.1 psi, 0.9±0.15 kgf/cm²}	—	Replace
4	Thermostat	Valve opening temperature	82±2°C {180±36°F}	—	Replace
		Extent of valve lift (95°C {203°F})	10 {0.39} or more	—	Replace

Tightening torque

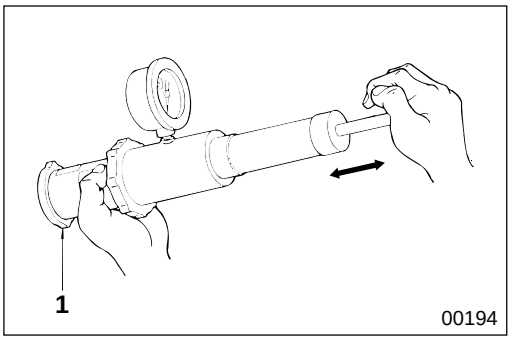
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
9	Water temperature sensor	34±6.9 {25±5.1, 3.5±0.7}	—
10	Overheating switch	27 to 41 {20 to 30, 2.8 to 4.2}	—
11	Water temperature sensor	34±6.9 {25±5.1, 3.5±0.7}	—

Lubricant

Location	Points of application	Kinds	Quantity
8	O-ring	Soapy water	As required

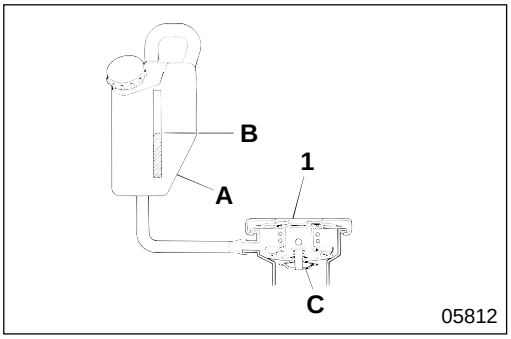
◆ Service procedure



1 Inspection of pressure cap

(1) Pressure valve opening pressure

If the measured value deviates from the standard value, replace pressure cap **1**.

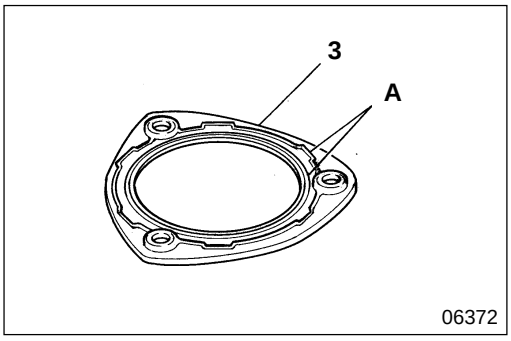


(2) Inspection of vent valve

- Take note of the liquid level **B** of reservoir tank **A** beforehand.
- Run the engine at a high revolution and before the overflow reaches the capacity of tank **A** stop the engine.
- Leave things for a while. Check the time it takes for the coolant temperature to return to the ambient temperature, and check whether the coolant level in tank **A** is the same as before running the engine.
- If the coolant level has not returned to the level before running the engine, it means vent valve **C** is faulty, therefore replace pressure cap **1**.

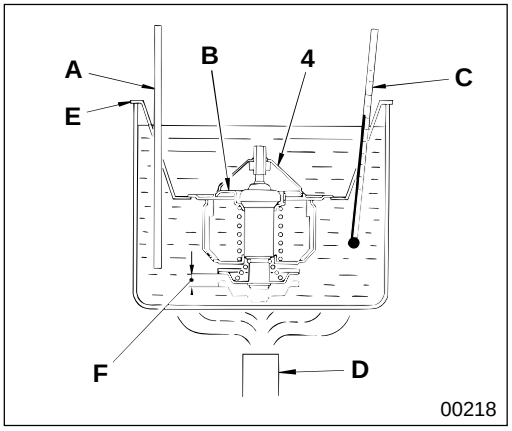
NOTE

Do not remove pressure cap 1 before the coolant temperature falls to the atmospheric temperature. If you do that the coolant will not return to radiator because negative pressure in the radiator is lost.



3 Mounting of thermostat cover gasket

When mounting thermostat cover gasket **3,** face sealant applied surface **A** to thermostat case **5** and mout it to the case.



4 Thermostat

[Inspection]
Stir the water using stick **A** to maintain an even water temperature in the container, then carry out the following tests. If the measured value deviates from the standard value, replace thermostat **4**.

(1) Valve opening temperature

- Hold thermostat **4** with wire **E** so as not to get the thermostat too close to heat **D**.
- Heat the water gradually to raise the temperature to the valve opening temperature.
- Maintain this temperature for five minutes and make sure that valve **B** has opened.
- Make sure that valve **B** has closed when the water temperature has dropped to 65°C {149°F}.

C : Water thermometer

(2) Extent of valve lift

Measure valve lift **F**, while maintaining the water temperature a little higher than the valve opening temperature, with valve **B** fully open for five minutes.

MITSUBISHI
FUSO

Group 15A
Intake and Exhaust

< 4M5 >

Table of Contents

BACK

HOME

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Pub No. TWSE0101-15A

INDEX

SPECIFICATIONS / STRUCTURE AND OPERATION 15A- 2
1. Air Cleaner 15A- 2
2. Turbocharger Assembly 15A- 3

TROUBLESHOOTING 15A- 4

ON-VEHICLE INSPECTION AND ADJUSTMENT
Measurement of Turbocharger Boost Pressure 15A- 5

AIR DUCT AND AIR CLEANER
< EXCEPT CREW CAB > 15A- 8
< CREW CAB > 15A-12

TURBOCHARGER 15A-15

INTERCOOLER 15A-20

INTAKE MANIFOLD 15A-22

EXHAUST MANIFOLD 15A-24

EXHAUST PIPE AND MUFFLER 15A-26

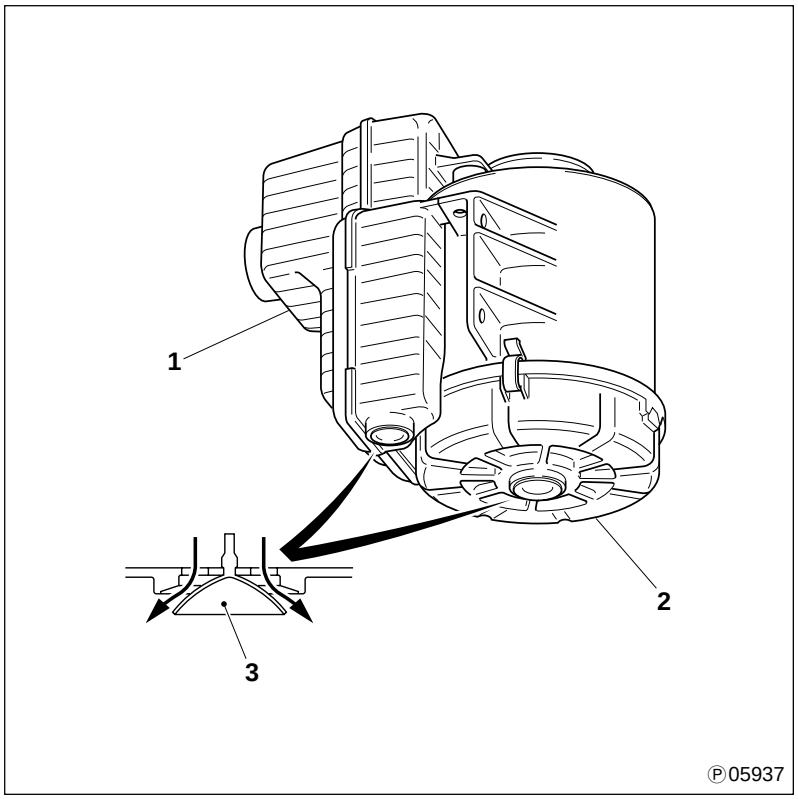
SPECIFICATIONS / STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Air cleaner element		Cyclone paper filter type
Turbocharger	Model	TD05
	Manufacturer	Mitsubishi Heavy Industries
Intercooler type		Tube and corrugated fin (air cooled)

STRUCTURE AND OPERATION

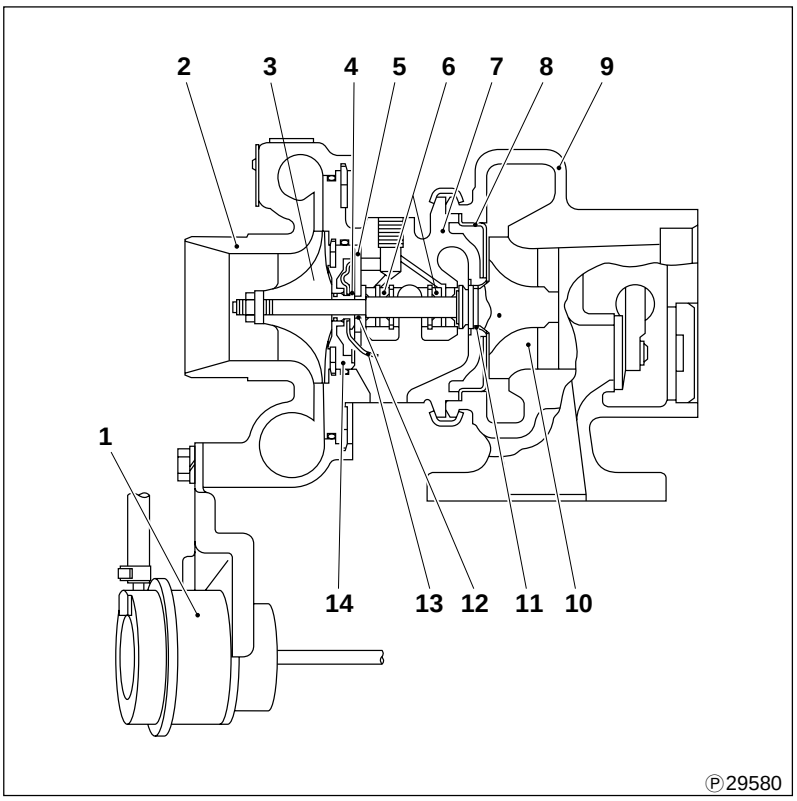
1. Air Cleaner



1 Air box
2 Air cleaner assembly
3 Unloader valve

- The air cleaner assembly **2** utilizes a single element.
- The air box **1** and the air cleaner assembly **2** incorporate an unloader valve **3**.
- The unloader valve vibrates due to a vacuum fluctuation when the engine speed drops below a predetermined level, automatically discharging accumulated water and dust.

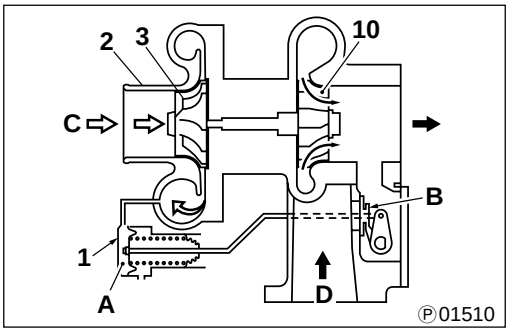
2. Turbocharger Assembly



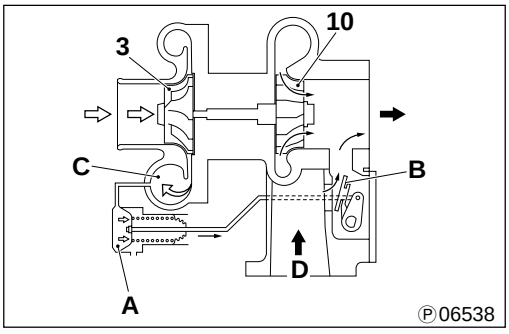
1 Actuator
2 Compressor cover
3 Compressor wheel
4 Thrust sleeve
5 Thrust bearing
6 Bearing
7 Bearing housing
8 Turbine back plate
9 Turbine housing
10 Shaft and turbine wheel
11 Piston ring
12 Thrust ring
13 Oil deflector
14 Insert

● **Waste gate mechanism**

- The waste gate mechanism has an actuator assembly **1** to let extra exhaust gas escape. By so doing, the boost pressure is properly controlled to prevent the turbine wheel from overrunning and prevent an excessive pressure in the intake manifold.
- The boost pressure is led from compressor cover **2** through a rubber hose to chamber **A** of actuator assembly **1**. When the boost pressure **C** that acts on chamber **A** is below the setting, the actuator assembly does not operate, and the waste gate valve remains closed, and exhaust gas **D** is blown against turbine wheel **10**.



- When the boost pressure that acts on chamber **A** exceeds the setting, the waste gate valve is opened. As a result, the amount of exhaust gas blown against turbine wheel **10** decreases, the rotating speed of compressor wheel **3** also decreases, and the boost pressure falls.



TROUBLESHOOTING

Possible causes \ Symptoms			Engine hard to start	Black exhaust gas	White exhaust gas	Insufficient engine output	Excessive oil consumption	Strange sound or vibration in intake and exhaust system	Remarks
Clogged air cleaner element			×	×		×			
Deformed front pipe, muffler, tail pipe								×	
Improperly mounted front pipe, muffler, tail pipe								×	
Incorrect valve clearance				×					Gr 11A
Defective head gasket				×					Gr 11A
Worn valve and valve seat and deposited carbon				×					Gr 11A
Sagging valve spring				×					Gr 11A
Worn or damaged piston ring					×		×		Gr 11A
Worn or damaged piston ring groove of piston					×		×		Gr 11A
Malfunctioning cooling equipment				×		×			Gr 14A
Excessive engine oil					×				Gr 12A
Seizure of major moving parts				×					Gr 11A
Turbo-charger	Cartridge assembly	Defective bearing		×		×		×	
		Carbon deposited on shaft and turbine wheel		×		×			
		Shaft and turbine wheel interfering with turbine back plate		×		×			
		Shaft and turbine wheel interfering with turbine housing		×		×			
		Bent shaft and turbine wheel		×		×		×	
		Damaged shaft and turbine wheel		×		×		×	
		Compressor wheel interfering with compressor housing		×		×			
		Thrust sleeve and thrust bearing seizure		×		×		×	
		Damaged compressor wheel		×		×		×	
		Oil leaks due to worn piston ring and insert			×		×		
		Improperly mounted piston ring					×		
		Unsmooth sliding of internal parts due to clogged lubrication oil pipe and eyebolt		×		×			
		Damaged oil seals due to clogged oil return pipe			×		×		
	Improperly mounted compressor housing			×		×	×	×	
	Improperly mounted turbine housing					×		×	
Intercooler	Foreign substances deposited on intercooler front core					×			

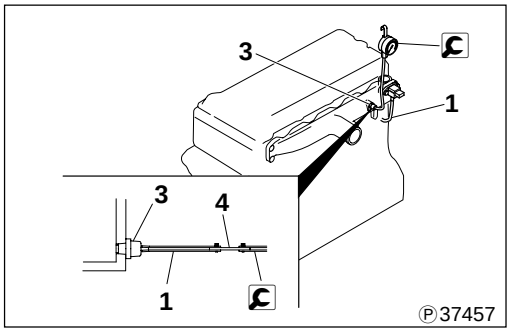
1. Measurement of Turbocharger Boost Pressure

Service standards

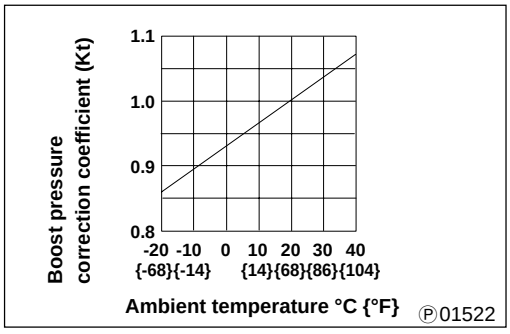
Location	Maintenance item	Standard value	Limit	Remedy
–	Boost pressure (at ambient temperature of 20°C {68°F} and atmospheric pressure of 100 kPa {29.9 in.Hg, 760 mmHg})	–	34.7 kPa {10.2 in.Hg, 260 mmHg}/ 3750 rpm 136 kPa {10.2+29.9 in.Hg, 260+760 mmHg} when measured by MUT	Inspect/ adjust

Special tool

Location	Tool name and shape	Part No.	Application
—	Boost pressure gauge Ⓟ01524	MH061366	Measurement of boost pressure



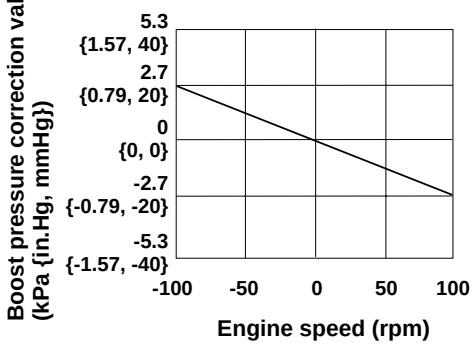
- Before measuring the boost pressure, clean or replace the air cleaner element.
- Disconnect the vacuum hose **1** at the boost pressure sensor **2** side.
- Connect the pipe **4** (MH062049 [component part of MH062047]) between the vacuum hose **1** fitted to the gas filter assembly **3** and the Boost Pressure Gauge.
- Warm up the engine, then measure the boost pressure at the engine's maximum speed. At the same time, measure the engine speed and ambient temperature.



- Correct the measurement to determine the boost pressure under standard conditions. (The boost pressure varies in accordance with the ambient temperature and engine speed.)

  [Correction for ambient temperature]

  From the graph, determine the boost pressure correction coefficient Kt for the ambient temperature.



(Differece between the median of the no-load maximum engine speed and the actual engine speed used for boost pressure measurement)

Ⓟ06165

[Correction for engine speed]

From the engine speed during boost pressure measurement, subtract the median of the maximum idling speed. From the result, determine the boost pressure correction value (**Pa**) in accordance with the graph.

Median**:** 3,750 rpm

[Calculation of corrected boost pressure]

If the measured boost pressure is **P**, the corrected boost pressure **Pb** is determined as follows**:**

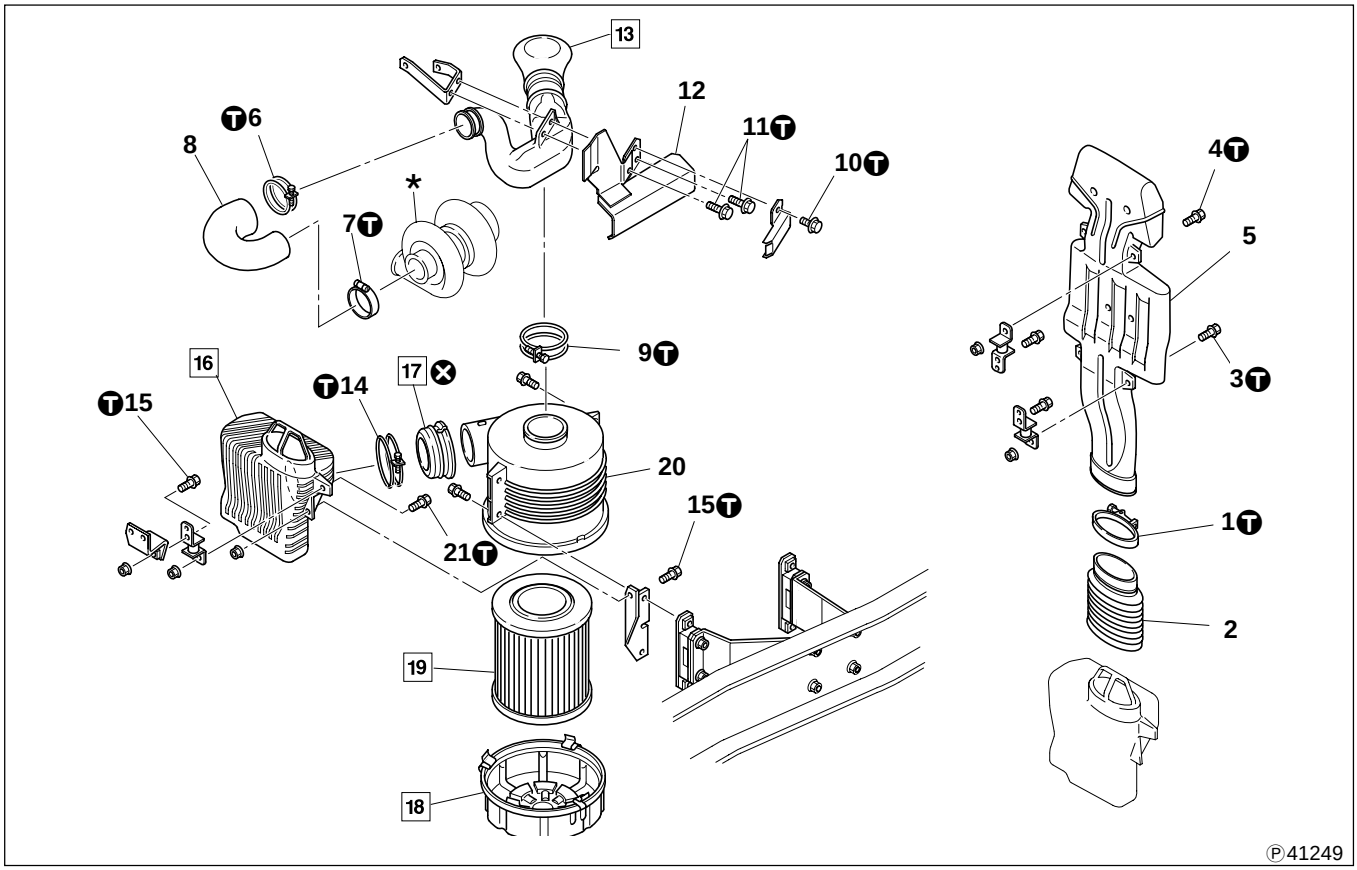
Pb = KtP + Pa

Pb : Corrected boost pressure
P : Measured boost pressure
Kt : Boost pressure correction coefficient for ambient temperature
Pa : Boost pressure correction value

If **Pb** is out of specification, the turbocharger must be inspected and adjusted.

M E M O

AIR DUCT AND AIR CLEANER < EXCEPT CREW CAB >



● **Disassembly sequence**

1 Clamp
2 Connector
3 Bolt
4 Bolt
5 Air inlet duct
6 Clamp
7 Clamp
8 Air hose
9 Clamp
10 Bolt
11 Bolt
12 Bracket
13 Air duct
14 Clamp
15 Bolt
16 Air box
17 Rubber seal
18 Air cleaner cap
19 Air cleaner element
20 Air cleaner case
21 Bolt

***** : Turbocharger P15A-15
T : Non-reusable parts

● **Assembly sequence**

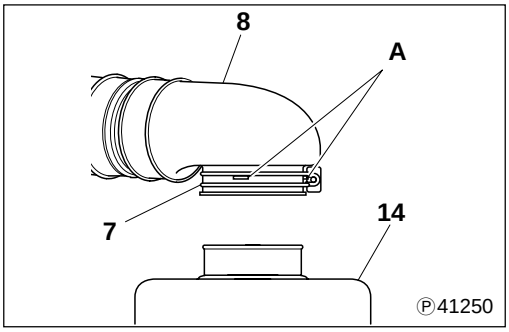
Follow the disassembly sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

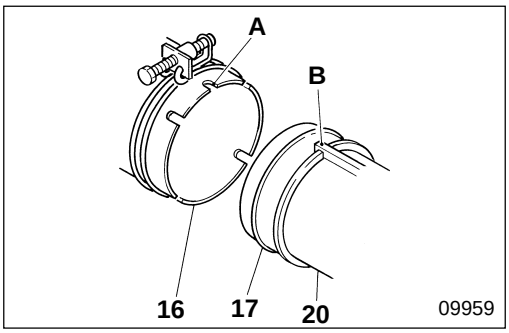
Location	Parts to be tightened	Tightening torque	Remarks
1, 6, 7, 9, 14	Clamp	2.9 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–
3, 4	Bolt (air inlet duct mounting)	4 to 6 {2.9 to 3.6, 0.4 to 0.5}	–
10, 11	Bolt (air duct bracket mounting)	12 to 15 {8.7 to 11.0, 1.2 to 1.5}	–
15	Bolt (air box bracket mounting)	4 to 6 {2.9 to 3.6, 0.4 to 0.5}	–
21	Bolt (air box mounting)	12 to 15 {8.7 to 11.0, 1.2 to 1.5}	–

◆ Service procedure



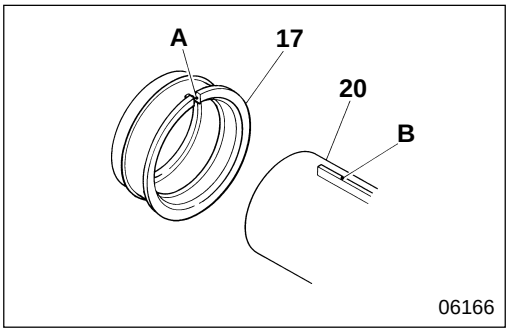
13 Installation of air duct

- Fit clamp **7** over protrusions **A** of air duct **8**.
- Push air duct **8** in until it hits air cleaner case **14**.



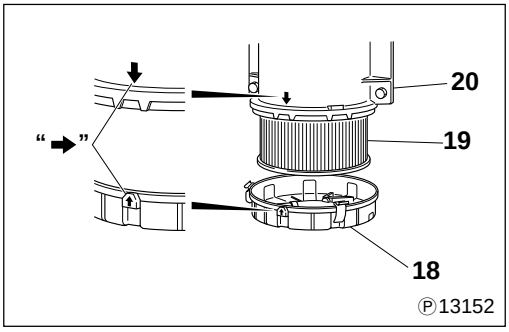
16 Installation of air box

Align slit **A** of air box **16** with key **B** of air cleaner case **14**.



17 Installation of rubber seal

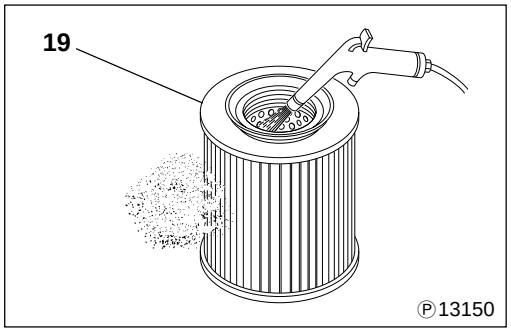
Align slit **A** of rubber seal **17** with key **B** of air cleaner case **20**.



18 Installation of air cleaner cap

➡ **:** Alignment mark

AIR DUCT AND AIR CLEANER < EXCEPT CREW CAB >



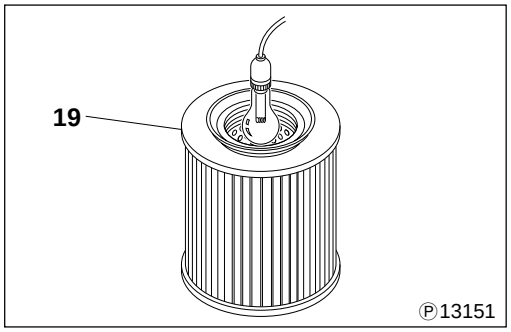
19 **Air cleaner element**

[Cleaning]

- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **19** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of air cleaner element **19** evenly.

CAUTION ⚠

- **Do not tap or hit air cleaner element 19 to remove dust.**
- **Do not blow compressed air through air cleaner element 19 from the outside.**



[Inspection]

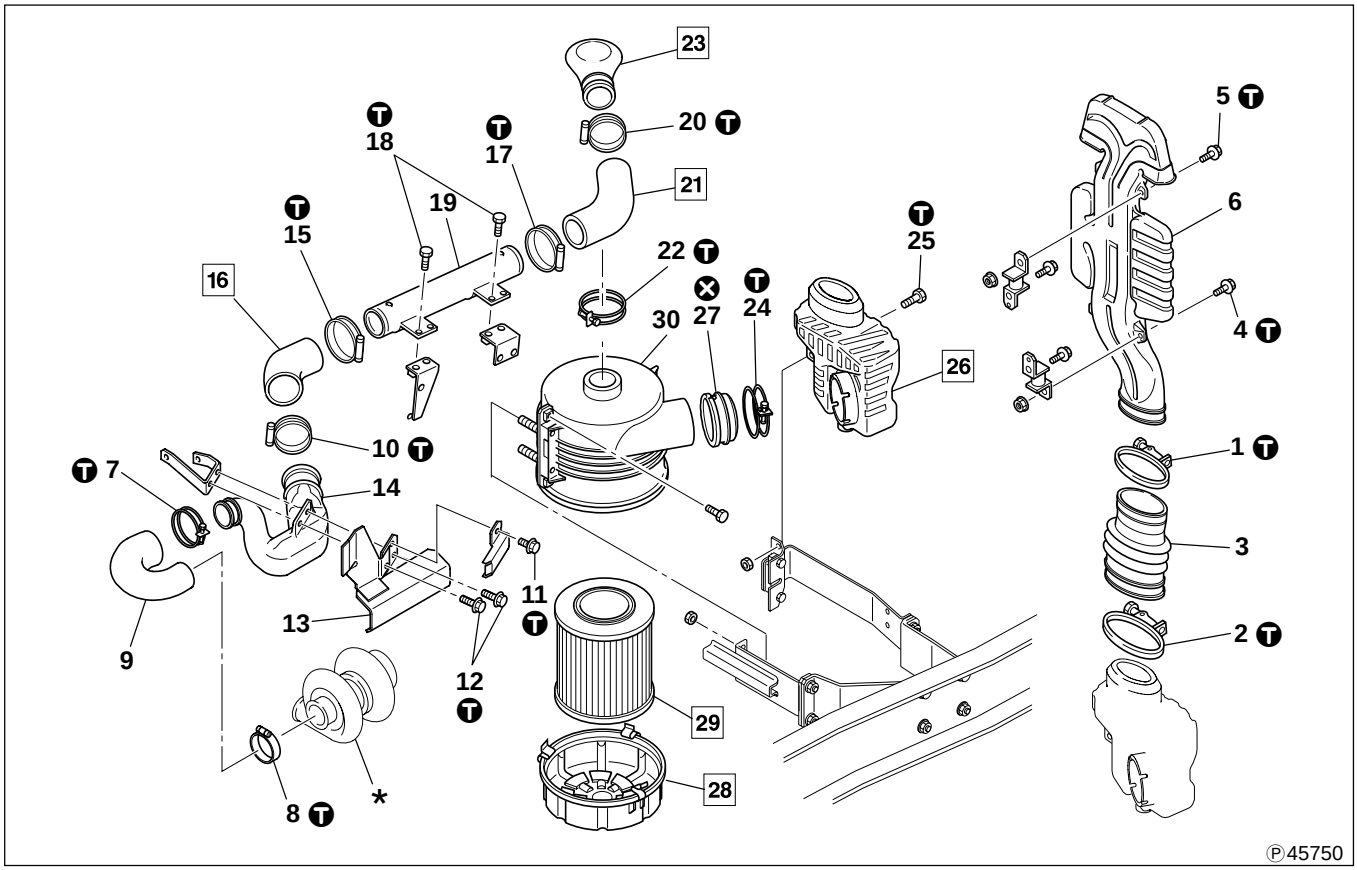
- Illuminate the inside of air cleaner element **19**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of air cleaner element **19** is damaged, replace the air cleaner element.

NOTE

If the dust on air cleaner element 19 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.

M E M O

AIR DUCT AND AIR CLEANER < CREW CAB >



● **Disassembly sequence**

1 Clamp
2 Clamp
3 Connector
4 Bolt
5 Bolt
6 Air inlet duct
7 Clamp
8 Clamp
9 Air hose
10 Clamp
11 Bolt
12 Bolt
13 Bracket
14 Air duct
15 Clamp
16 Connector
17 Clamp
18 Bolt
19 Air inlet pipe
20 Clamp
21 Connector
22 Clamp
23 Air duct
24 Clamp
25 Bolt
26 Air box
27 Rubber seal
28 Air cleaner cap
29 Air cleaner element
30 Air cleaner case

***** : Turbocharger 📖 P15A-15
T : Non-reusable parts

● **Assembly sequence**

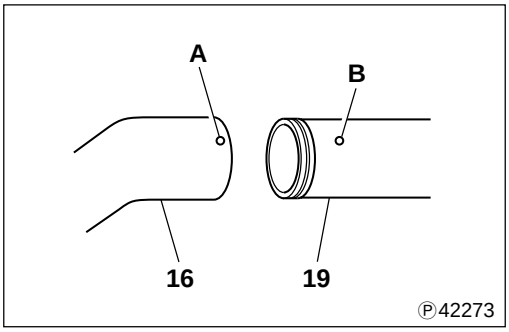
Follow the disassembly sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

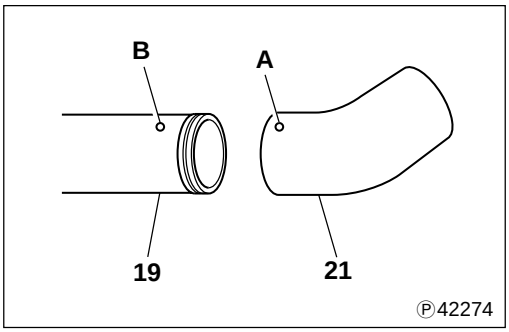
Location	Parts to be tightened	Tightening torque	Remarks
1, 2, 7, 8, 10, 15, 17, 20, 22, 24	Clamp	3.0 to 3.5 {2.2 to 2.5, 0.3 to 0.35}	–
4, 5	Bolt (air inlet duct mounting)	4 to 6 {2.9 to 3.6, 0.4 to 0.5}	–
11, 12	Bolt (air duct bracket mounting)	12 to 15 {8.7 to 11.0, 1.2 to 1.5}	–
18	Bolt (air inlet pipe mounting)	12 to 15 {8.7 to 11.0, 1.2 to 1.5}	–
25	Bolt (air box mounting)	12 to 15 {8.7 to 11.0, 1.2 to 1.5}	–

◆ Service procedure



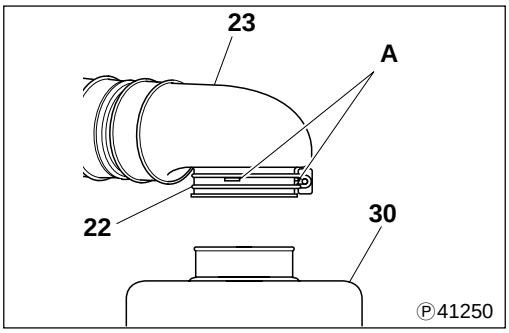
16 Installation of connector

Align painted mark **A** on connector **16** with protrusion **B** on air inlet pipe **19**, and push in the connector.
A : White paint mark



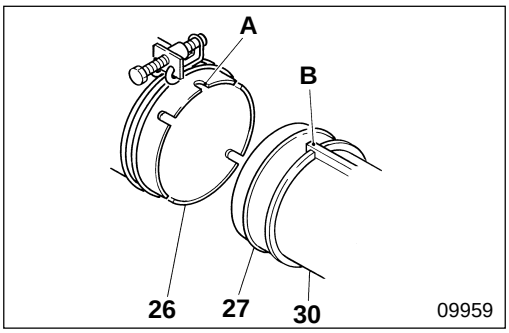
21 Installation of connector

Align painted mark **A** on connector **21** with protrusion **B** on air inlet pipe **19**, and push in the connector.
A : White paint mark



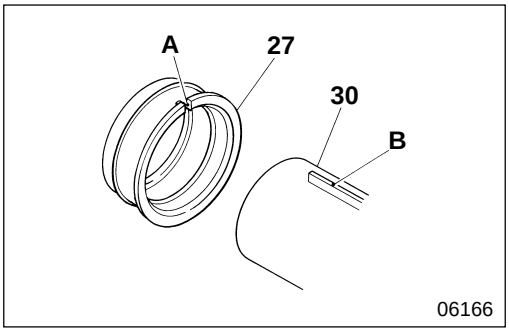
23 Installation of air duct

- Fit clamp **22** over protrusion **A** of air duct **23**.
- Push air duct **23** in until it hits air cleaner case **30**.



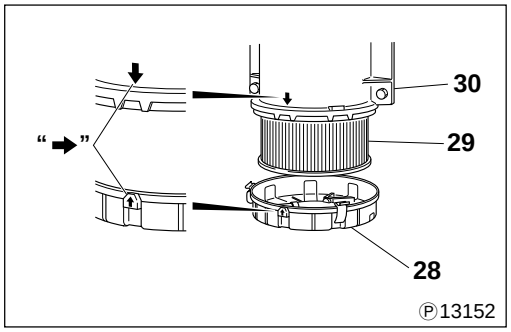
26 Installation of air box

Align slit **A** of air box **26** with key **B** of air cleaner case **30**.



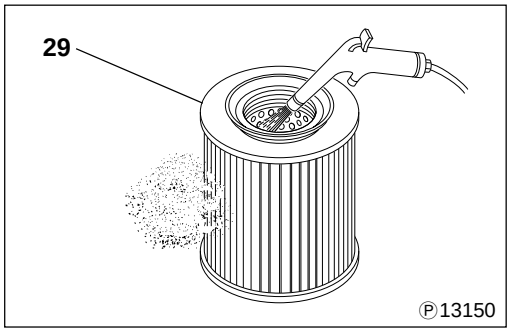
27 Installation of rubber seal

Align slit **A** of rubber seal **27** with key **B** of air cleaner case **30**.



28 **Installation of air cleaner cap**

➡ **:** Alignment mark



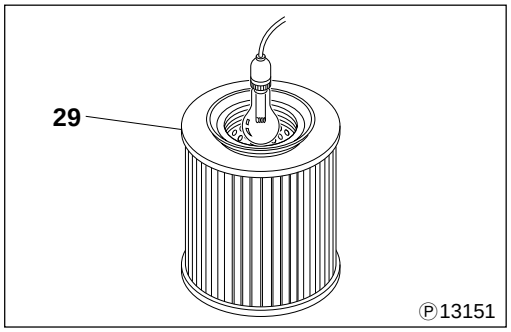
29 **Air cleaner element**

[Cleaning]

- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **29** from the inside.
- When using compressed air, move the blower’s nozzle up and down along the pleats of air cleaner element **29** evenly.

CAUTION ⚠

- **Do not tap or hit air cleaner element 29 to remove dust.**
- **Do not blow compressed air through air cleaner element 29 from the outside.**

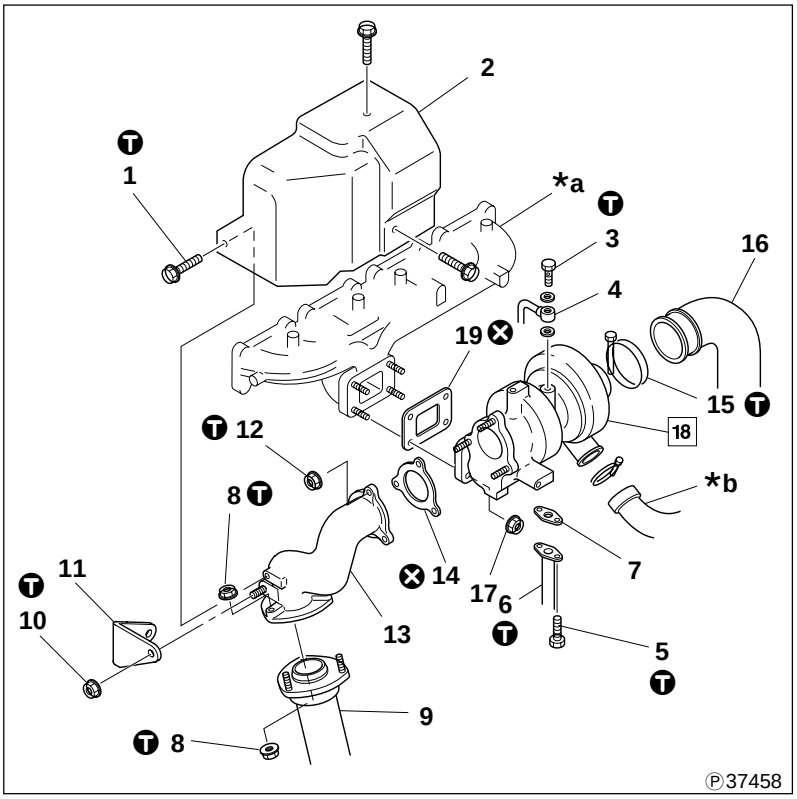


[Inspection]

- Illuminate the inside of air cleaner element **29**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of air cleaner element **29** is damaged, replace the air cleaner element.

NOTE

If the dust on air cleaner element 29 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.



● **Disassembly sequence**

1 Bolt
2 Insulator
3 Eyebolt
4 Oil pipe
5 Bolt
6 Oil return pipe
7 Gasket
8 Nut
9 Front pipe
10 Nut
11 Exhaust pipe stay
12 Nut
13 Exhaust pipe
14 Coupler gasket
15 Clamp
16 Air inlet hose
17 Nut
18 Turbocharger assembly 📖 P15A-17
19 Gasket

***a:** Exhaust manifold 📖 P15A-24
***b:** Rubber hose 📖 P15A-20
⊗ **:** Non-reusable part

● **Reassembly sequence**

Follow the disassembly sequence in reverse.

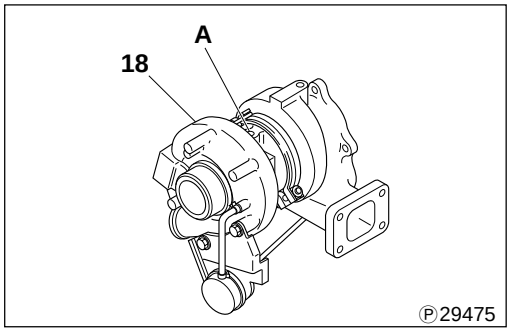
Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (for insulator mounting)	11.8 {8.7, 1.2}	–
3	Eyebolt (for oil pipe mounting)	23.5 {17, 2.4}	–
5	Bolt (for oil return pipe mounting)	4.9 {3.6, 0.5}	–
8	Nut (front pipe mounting)	20 to 25 {14 to 18, 2 to 2.5}	–
10, 12, 17	Nut (for exhaust pipe stay, exhaust pipe, turbocharger assembly mounting)	41.2 {30, 4.2}	–
15	Clamp	8.8 ± 0.98 {5.8 ± 0.7, 0.9 ± 0.1}	–

Lubricant

Location	Points of application	Specified lubricant	Quantity
18	Turbocharger assembly oil hole (supply at time of installation)	Engine oil	As required

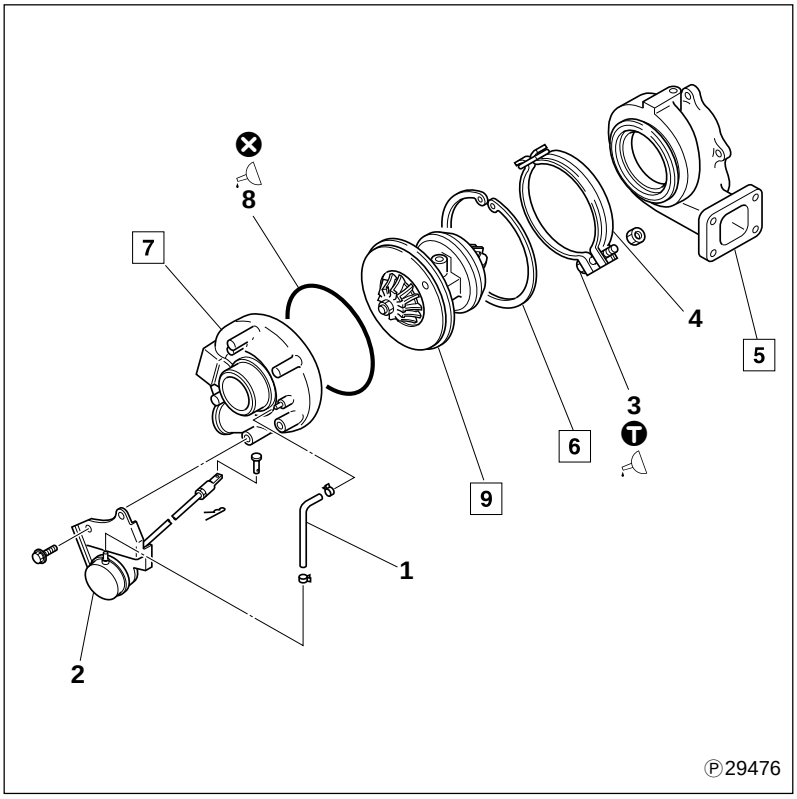


◆ Service procedure

18 **Installation of turbocharger assembly**

Before installing the turbocharger assembly **18**, pour engine oil into the oil hole **A** to ensure smooth operation of the internal parts.

Turbocharger assembly



● **Operation before disassembly**
P15A-18

● **Disassembly sequence**

1 Hose
2 Actuator
3 Bolt
4 Coupling
5 Turbine housing
6 Snap ring
7 Compressor cover
8 O-ring
9 Cartridge assembly

⊗ **:** Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**
P15A-18

NOTE

Cartridge assembly 9 cannot be disassembled. Replace the entire assembly if the turbine wheel or compressor wheel becomes damaged or if the assembly does not rotate smoothly or is otherwise defective.

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
9	Cartridge assembly	Axial play in shaft		0.05 to 0.09 {0.0020 to 0.0035}	0.1 {0.0039}	Replace
		Play at right angle to axial direction	Turbine wheel side	0.40 to 0.53 {0.016 to 0.021}	0.58 {0.023}	Replace
			Compressor wheel side	0.55 to 0.66 {0.022 to 0.026}	0.72 {0.028}	

Ⓣ Tightening torque

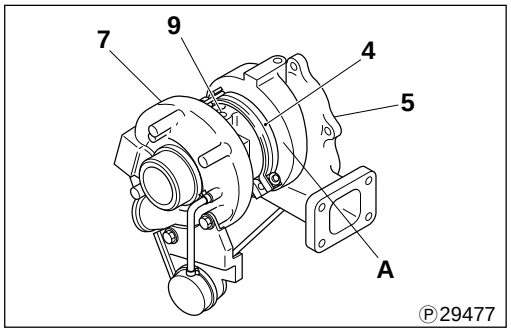
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Coupling securing)	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	Wet

Lubricant and sealant

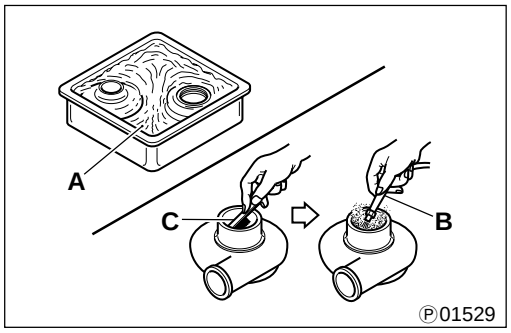
Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Threads of bolt	Molybdenum disulfide grease	As required
8	Entire periphery of O-ring	Engine oil	As required

◆ Service procedure



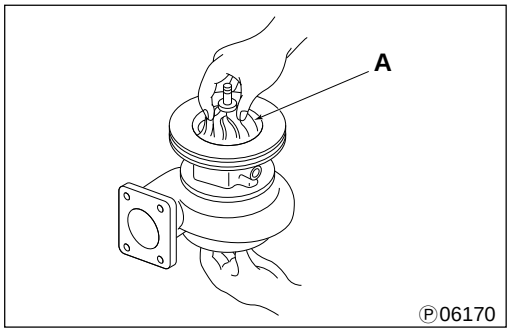
● **Operations before disassembly**

Make alignment marks **A** on the coupling **4**, turbine housing **5**, compressor cover **7**, and cartridge assembly **9**.



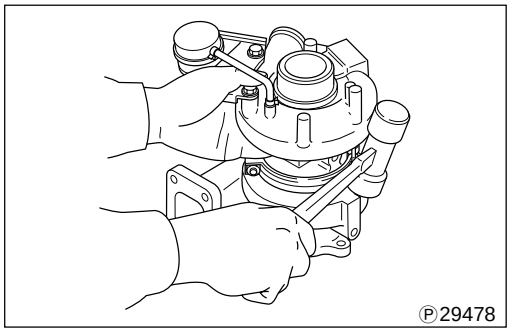
● **Cleaning after disassembly**

- Visually check the disassembled parts for scorches, abrasion, and other marks that may be difficult to see after cleaning. Replace any part that appears defective.
- Immerse the disassembled parts in a non-flammable solvent **A** and remove the parts from the solvent and blow them dry with compressed air **B**. Before this procedure, remove adhering matter if any using a plastic scraper on a wire brush **C**.
- Immerse the parts in the solvent **A** again.
- Blow the parts dry with compressed air **B**.



● **Inspection after assembly**

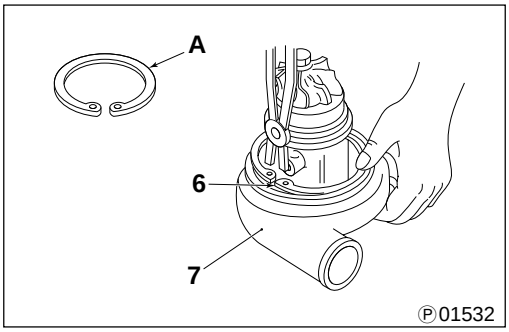
Manually rotate the wheel **A** of the cartridge assembly **9** to check that it turns smoothly.



5 **Removal of turbine housing**

CAUTION ⚠

- **While using care to prevent damage to the turbine housing, lightly strike its entire circumference with a rubber hammer or similar tool.**
- **Since the blades of the turbine wheel are easily bent, use care to make sure that they do not hit turbine housing 5.**

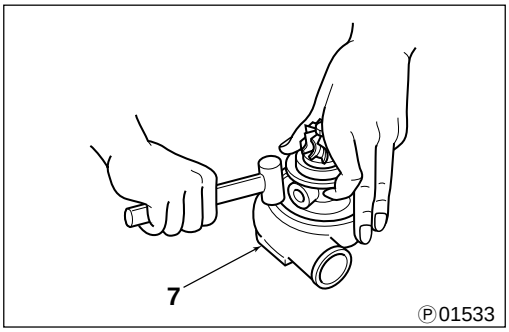


6 Installing snap ring

- Fit snap ring **6** onto compressor cover **7** with its tapered surface **A** facing upward.

WARNING ⚠

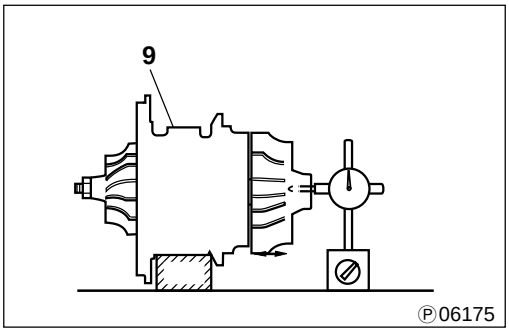
When fitting snap ring 6, hold it down to prevent it from flying off.



7 Removal of compressor cover

CAUTION ⚠

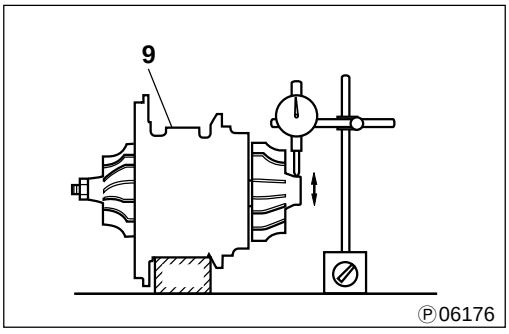
- **While using care to prevent damage to compressor cover 7, lightly strike its entire circumference with a rubber hammer or similar tool.**
- **Since the blades of the compressor wheel are easily bent, use care to make sure that they do not hit the compressor cover.**



9 Inspection of cartridge assembly

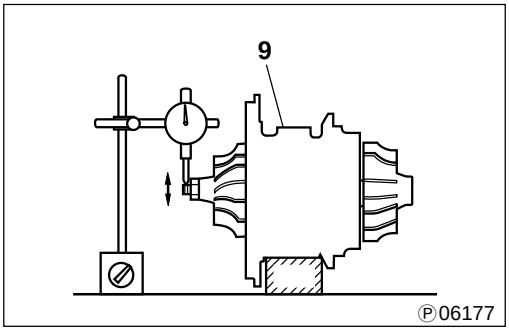
(1) Axial play in shaft and turbine wheel assembly

If the measurement exceeds the specified limit, replace cartridge assembly **9**.



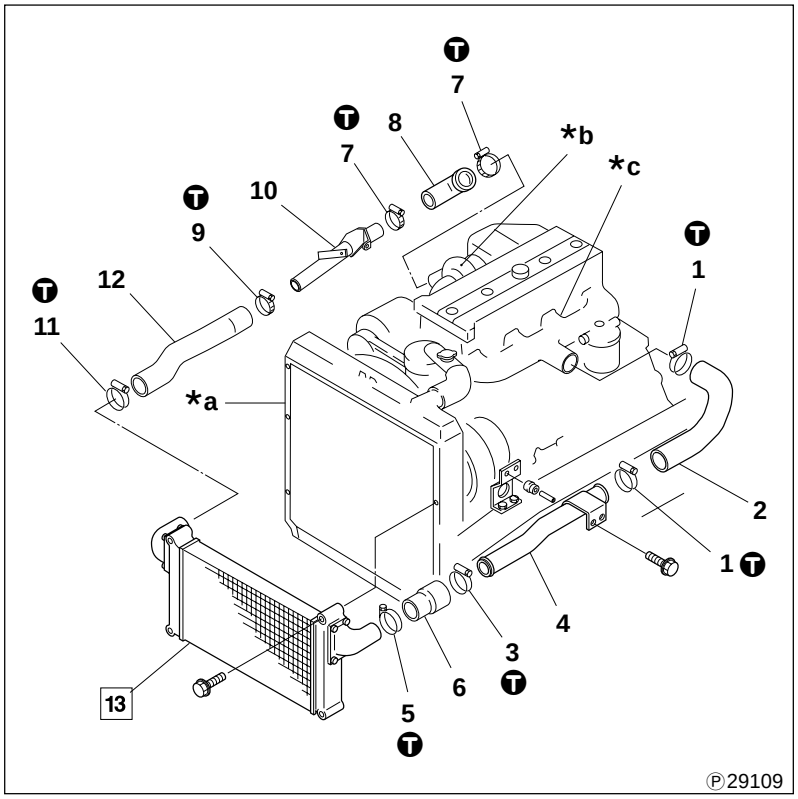
(2) Play at right angle to shaft direction in shaft and turbine wheel assembly

- Play on turbine wheel side
  If the measurement exceeds the specified limit, replace cartridge assembly **9**.



- Play on compressor wheel side
  If the measurement exceeds the specified limit, replace cartridge assembly **9**.

INTERCOOLER



● **Disassembly sequence**

1 Clamp
2 Air inlet hose
3 Clamp
4 Air inlet pipe
5 Clamp
6 Air inlet hose
7 Clamp
8 Rubber hose
9 Clamp
10 Air inlet pipe
11 Clamp
12 Air inlet hose
13 Intercooler

***a :** Radiator Gr 14A
***b :** Intake manifold P15A-22
***c :** Turbocharger assembly P15A-15

● **Reassembly sequence**

Follow the disassembly sequence in reverse.

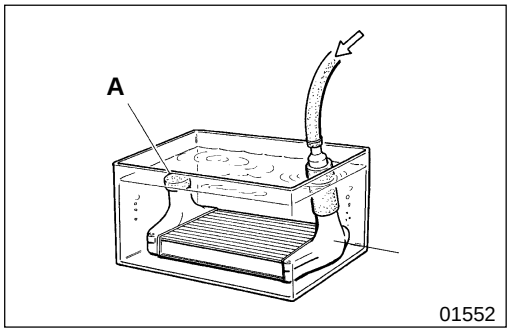
Service standard

Location	Maintenance item	Standard value	Limit	Remedy
13	Intercooler air leakage (at air pressure of 150 kPa {21 psi, 1.5 kgf/cm²})	0 cm³ {0 cu.in.}	–	Replace

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5, 9, 11	Clamp	2.9 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–
7	Clamp	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	–



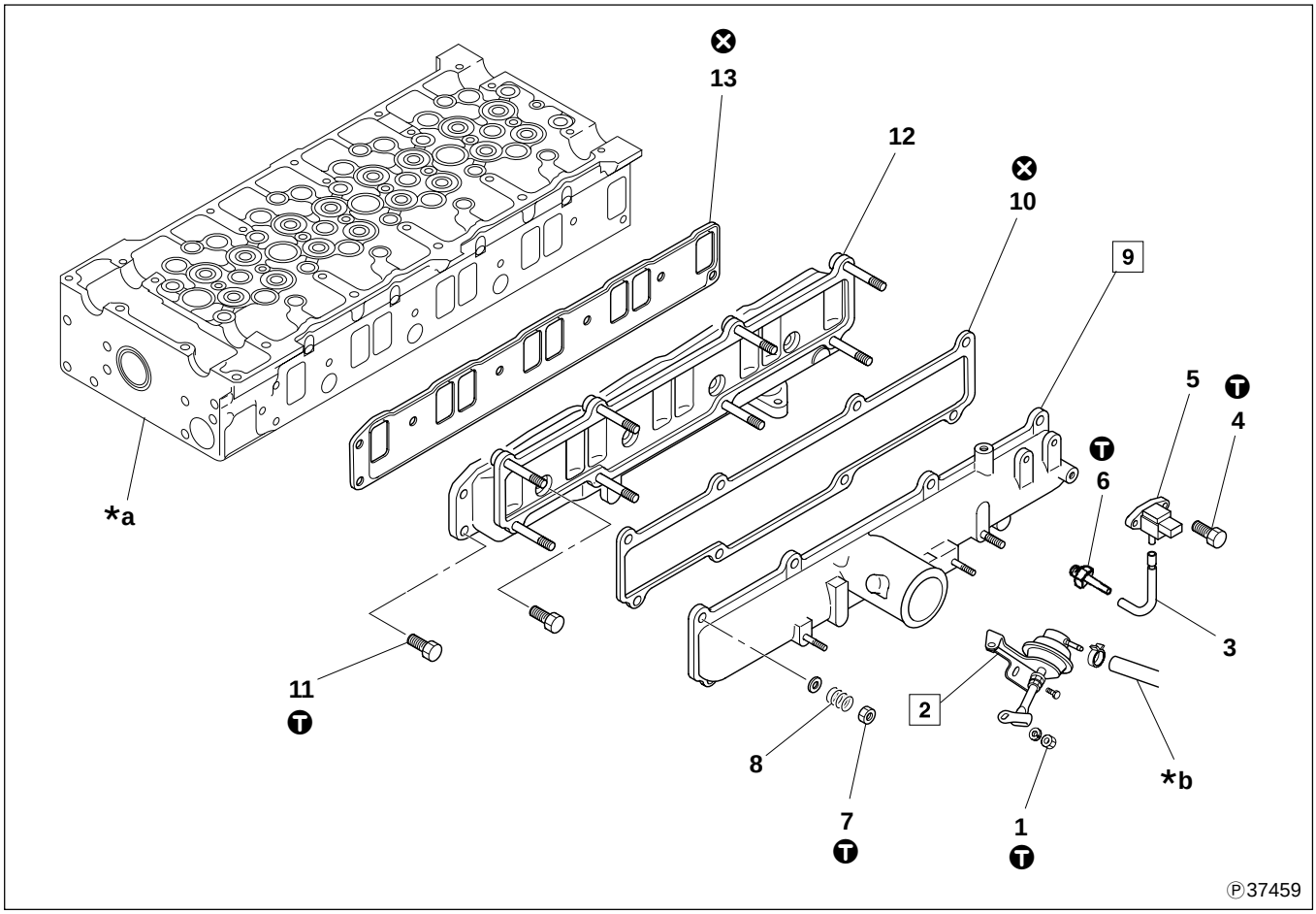
◆ Service procedure

13 **Inspection of intercooler**

Fit a cap over one of the air ports **A** on the intercooler **13**, connect a hose to the other port, and immerse the intercooler in a tank of water. Then, apply the specified air pressure (150 kPa {21 psi, 1.5 kgf/cm²}) via the hose and check for air leakage.
If leakage is apparent, replace the intercooler **13**.

M E M O

INTAKE MANIFOLD



● **Disassembly sequence**

1 Nut
2 Actuator assembly
3 Pressure hose
4 Bolt
5 Boost pressure sensor
6 Pressure hose fitting
7 Nut
8 Spring
9 Intake manifold B
10 Gasket B
11 Bolt
12 Intake manifold A
13 Gasket A

***a:** Cylinder head Gr 11A
***b:** Vacuum hose
⊗ : Non-reusable part

● **Reassembly sequence**

Follow the disassembly sequence in reverse.

Service standards

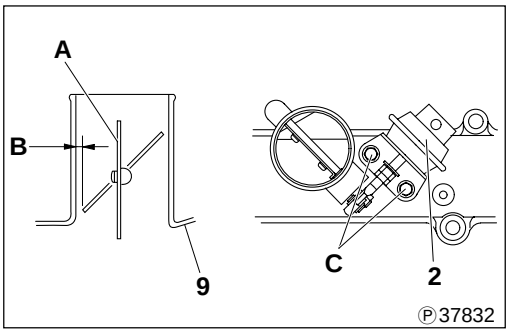
Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2, 9	Butterfly valve intake manifold clearance	Clearance B	$4.0^{+0.5}_{0}$ {$0.16^{+0.02}_{0}$ }	–	Replace

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (actuator assembly mounting)	8 {5.8, 0.8}	–
4	Bolt (boost pressure sensor mounting)	4.9 {3.6, 0.5}	–
6	Pressure hose fitting	14.7 to 19.6 {11.0 to 14.0, 1.5 to 2.0}	–
7	Nut (intake manifold B mounting)	10.8 {8.0, 1.1}	–
11	Bolt (intake manifold A mounting)	44.1 {33.0, 4.5}	–

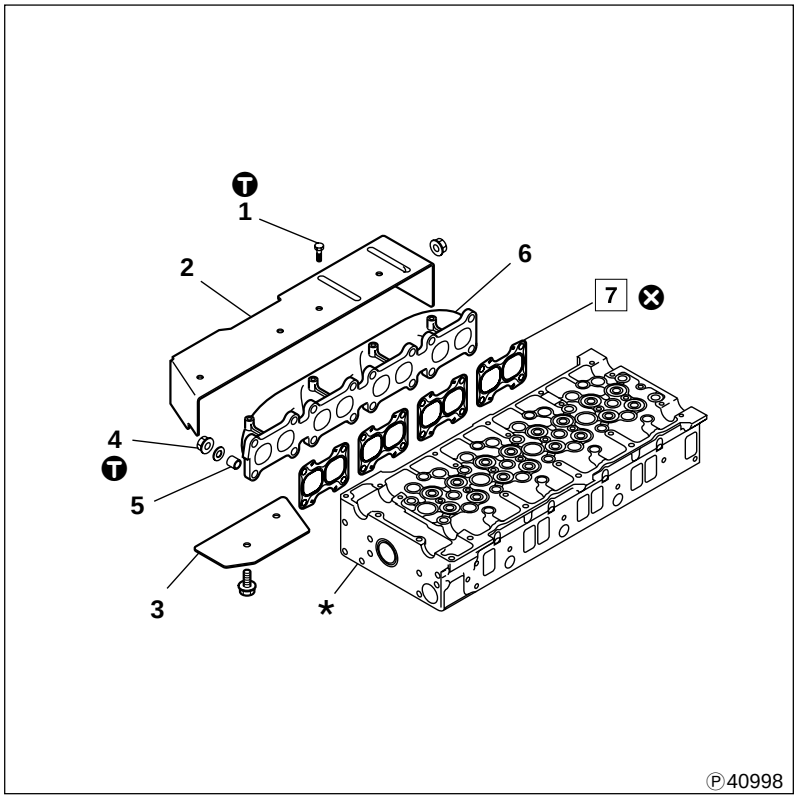


◆ Service procedure

2 **9** **Clearance between butterfly valve and intake manifold B**

Apply a vacuum of more than 67 kPa {19.7 in.Hg, 500 mmHg} to the actuator assembly **2** to bring the double nut into contact with its bracket. While keeping this condition, adjust the clearance **B** between the butterfly valve **A** and the intake manifold B **9** for the specified standard value using the oblong holes **C** in the actuator assembly bracket.

EXHAUST MANIFOLD



● **Disassembly sequence**

1 Bolt
2 Insulator
3 Lower insulator
4 Nut
5 Spacer
6 Exhaust manifold
7 Gasket

*** :** Cylinder head Gr 11A
⊗ : Non-reusable part

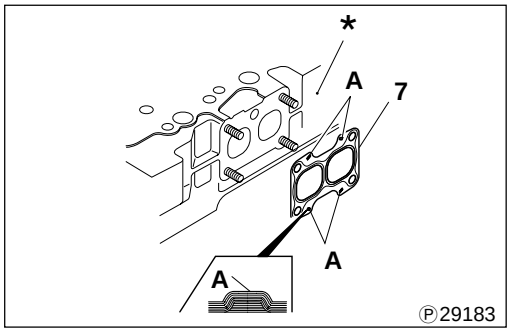
● **Reassembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (insulator manifold mounting)	18.0 {13.0, 1.8}	–
4	Nut (exhaust manifold mounting)	41.2 {30.0, 4.2}	–



◆ Service procedure

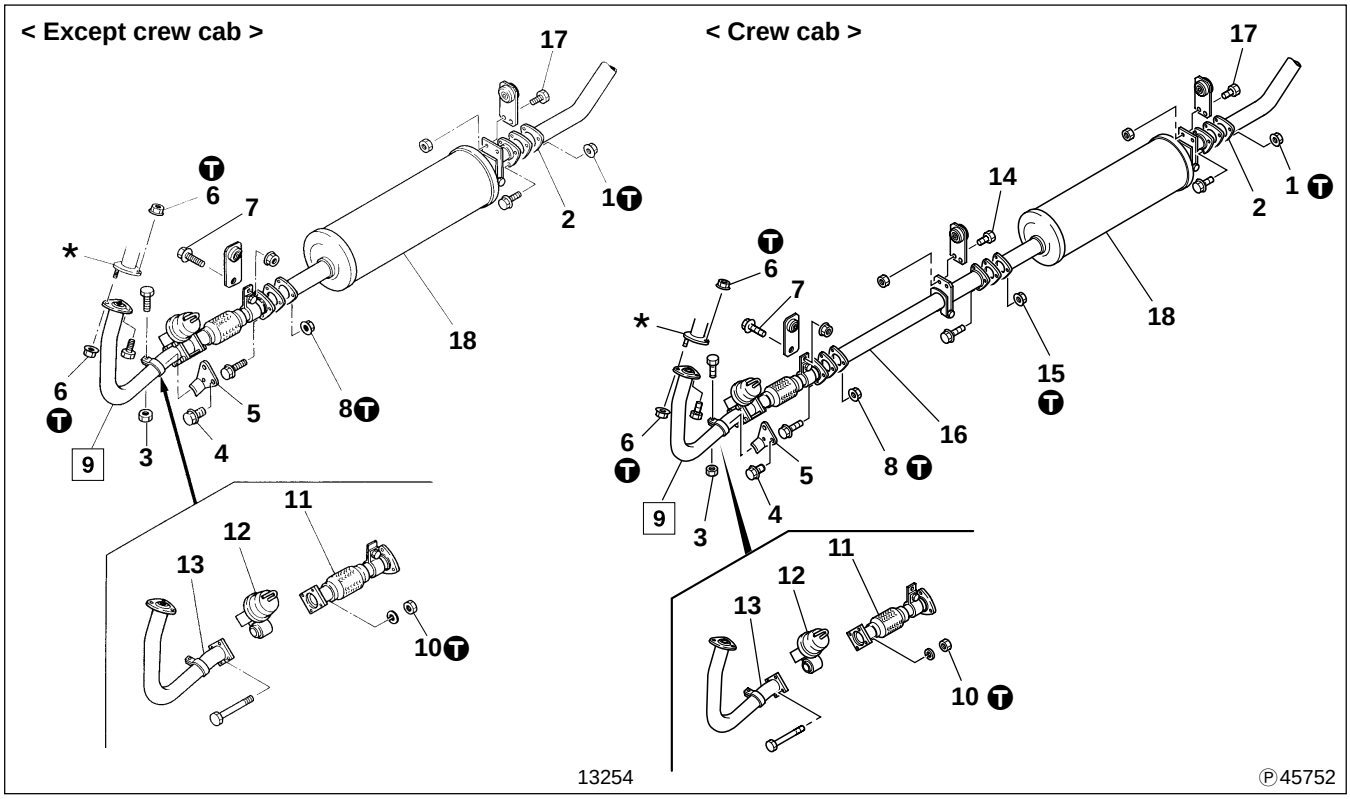
7 Installation of gasket

Fit the gasket **7** with the side having projections **A** facing the cylinder head *****.

A : Projections

M E M O

EXHAUST PIPE AND MUFFLER



● **Disassembly sequence**

1 Nut
2 Tail pipe
3 Nut
4 Bolt
5 Exhaust pipe bracket
6 Nut
7 Bolt
8 Nut
9 Front pipe assembly
10 Nut
11 Front pipe
12 Exhaust brake unit Gr 35A
13 Front pipe
14 Bolt < Crew cab >
15 Nut < Crew cab >
16 Center pipe < Crew cab >
17 Bolt
18 Muffler catalytic converter assembly

***** : Exhaust manifold

● **Assembly sequence**

Follow the disassembly sequence in reverse.

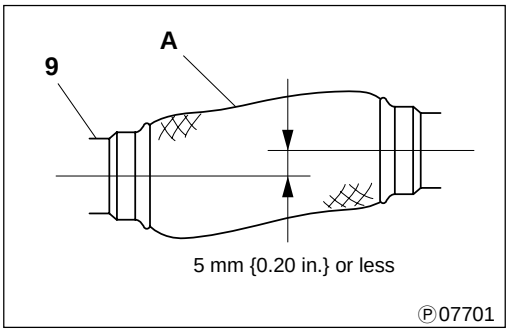
WARNING ⚠

- **Never hit or kick muffler 18, or the catalyst in the muffler will be damaged.**
- **A small amount of water sometimes collects inside muffler 18. Never touch this water, if you do by mistake, wash it off immediately with clean water.**

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 8, 15	Nut (Tail pipe, center pipe and muffler mounting)	26 to 33 {20 to 25, 2.7 to 3.4}	–
6	Nut (Front pipe assembly mounting)	20 to 25 {14 to 18, 2.0 to 2.5}	–
10	Nut (Exhaust brake unit mounting)	27 {20, 2.75}	–



◆ Service procedure

9 Installation of front pipe assembly

Install front pipe assembly **9** so that the offset tolerance in the vertical and horizontal sections between the front and back of bellows **A** conforms to the specified value.

CAUTION ⚠

Be sure when installing front pipe assembly 9, that bellows A are not bent or stretched, since the bellows are designed to reduce the external noise of the vehicle but not to absorb dimensional errors in the installation of pipes.

MITSUBISHI
FUSO

Group 15B

Intake and Exhaust

< 4D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-15B

INDEX

SPECIFICATIONS 15B- 2

STRUCTURE AND OPERATION 15B- 2

TROUBLESHOOTING 15B- 5

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

- Measurement of Turbo Boost Pressure 15B- 6

AIR DUCT AND AIR CLEANER 15B- 8

TURBOCHARGER 15B-12

INTERCOOLER 15B-18

INTAKE MANIFOLD 15B-20

EXHAUST MANIFOLD 15B-22

EXHAUST PIPE AND MUFFLER 15B-24

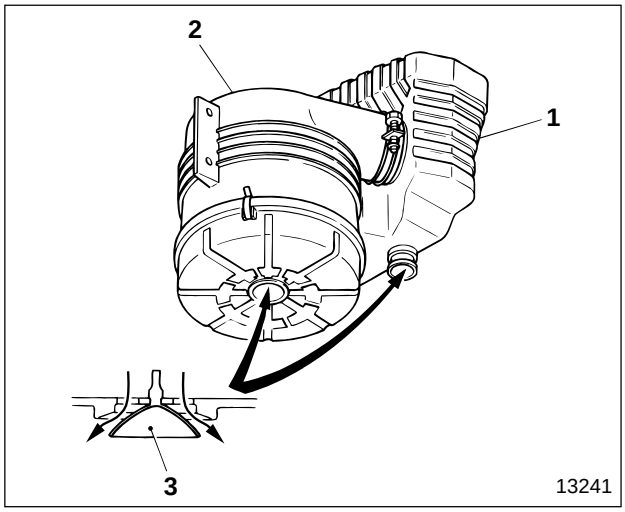
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Items		Specifications
Air cleaner element		Cyclone paper filter type
Turbocharger	Model	TD05
	Manufacturer	MITSUBISHI HEAVY INDUSTRIES
Intercooler type		Air-cooled, tube and corrugated fin type

STRUCTURE AND OPERATION

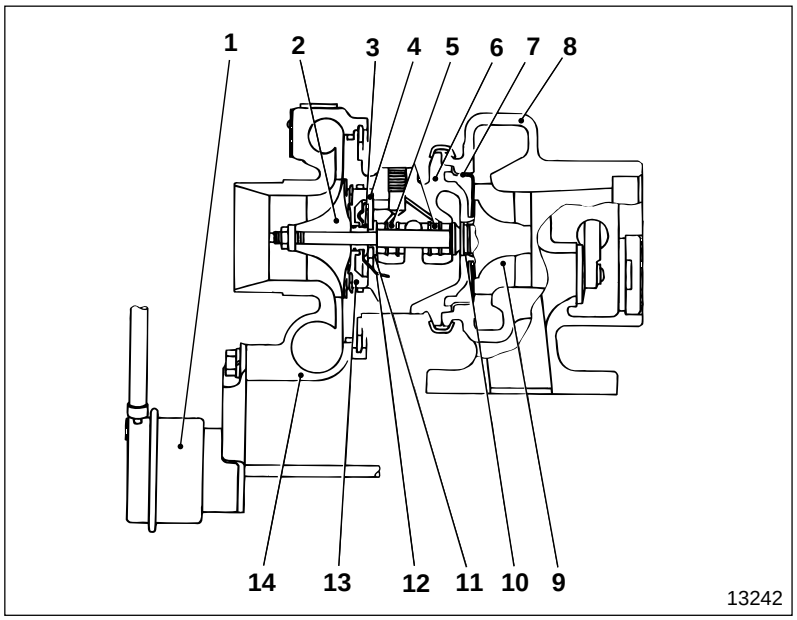
Air Cleaner



1 Air box
2 Air cleaner assembly
3 Unloader valve

- Air cleaner assembly **2** uses a single element.
- Air box **1** and air cleaner assembly **2** are fitted with unloader valve **3**. Water, dust and dirt that collect in the unit are automatically vented by vibration caused by the change of negative pressure when the engine revolution falls below the specified revolution.

Turbocharger

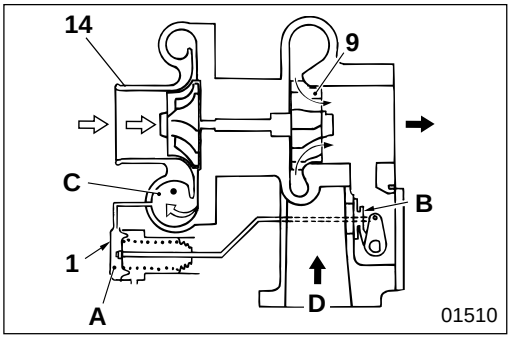


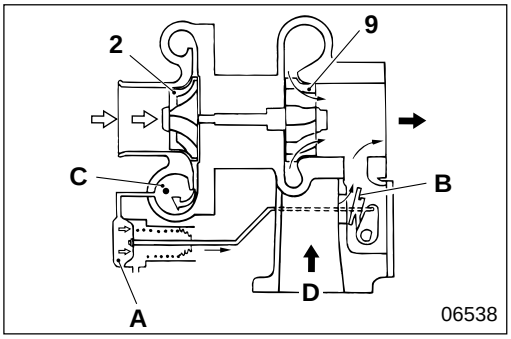
1 Actuator
2 Compressor wheel
3 Thrust sleeve
4 Thrust bearing
5 Bearing
6 Bearing housing
7 Turbine backplate
8 Turbine housing
9 Shaft and turbine wheel
10 Piston ring
11 Thrust ring
12 Oil deflector
13 Inserter
14 Compressor cover

2 to **13** : Cartridge assembly

Waste gate mechanism

- The waste gate mechanism relieves the boost pressure of excess exhaust gas using actuator **1**. This controls the boost pressure appropriately and prevents the turbocharger from overrunning, and prevents excessive pressure in the intake manifold.
- The boost pressure is fed into chamber **A** of actuator **1** from compressor cover **14** via a rubber hose. When boost pressure **C**, acting on the chamber, is lower than the preset value, the actuator does not operate and waste gate valve **B** remains closed, therefore exhaust gas **D** is blown against shaft and turbine wheel **9**.

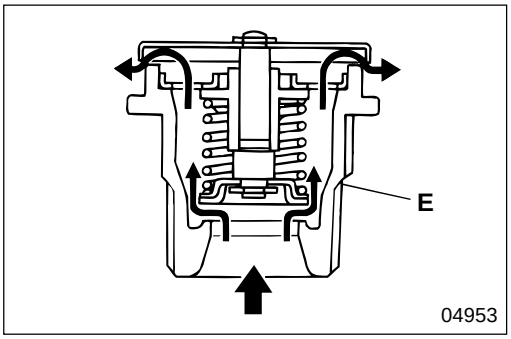




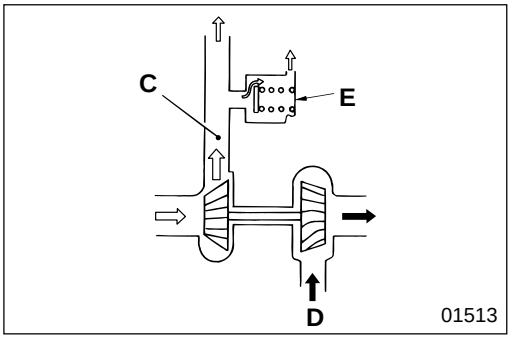
- As the boost pressure acting on chamber **A** increases to become higher than the preset value, waste gate valve **B** is opened and the exhaust gas blown against shaft and turbine wheel **9** decreases. Therefore the rotation of compressor wheel **2** decreases, causing the boost pressure to decrease.

Operation of over-boost valve

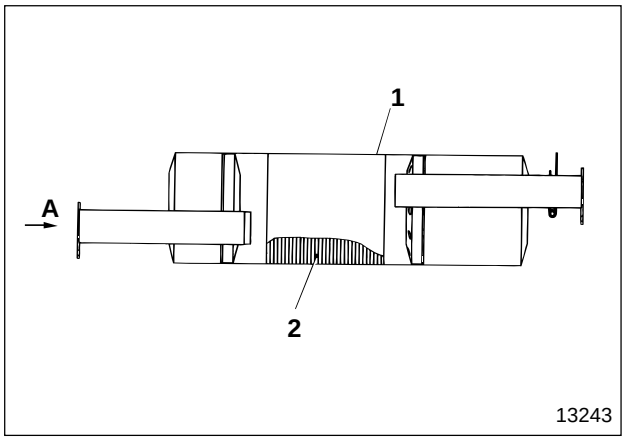
- Over-boost valve **E** operates when the boost pressure increases abnormally because of faulty operation of the waste gate mechanism.



- If boost pressure **C** of over-boost valve **E** increases to become higher than the preset value, the excessive boost pressure is discharged into the atmosphere, protecting the engine from excessive boost pressure. When the valve is operating, a pipe-blowing sound is generated.



Muffler



1 Muffler
2 Catalytic converter

A : Exhaust gas intake

Converter **2** is built into muffler **1** to decrease the amount of particulate matter (PM) in the exhaust gas.

Possible causes \ Symptoms			Engine hard to start	Exhaust gas dark	Exhaust gas whitish	Engine output insufficient	Oil consumption excessive	Noise and vibration in intake/exhaust systems	Remarks
Air cleaner	Air cleaner element clogged		○	○		○			
Turbocharger	Cartridge assembly	Bearing faulty		○		○		○	
		Carbon deposits on shaft and turbine wheel		○		○			
		Shaft and turbine wheel interfering with turbine backplate		○		○			
		Shaft and turbine wheel interfering with turbine housing		○		○			
		Shaft and turbine wheel bent		○		○		○	
		Shaft and turbine wheel broken		○		○		○	
		Compressor wheel interfering with compressor housing		○		○			
		Thrust sleeve and thrust bearing seized		○		○		○	
		Compressor wheel broken		○		○		○	
		Engine oil leaking because piston ring and inserter worn			○		○		
		Piston rings installation faulty					○		
		Parts not sliding smoothly because oil lubrication pipe and eye bolt clogged		○		○			
		Oil seals damaged because oil return pipe clogged			○		○		
	Compressor housing installation faulty			○		○	○	○	
	Turbine housing installation faulty					○		○	
Intercooler	Foreign particles on intercooler front core					○			
Actuator	Butterfly valve does not open			○	○	○			
	Butterfly valve opening and closing adjusted incorrectly			○	○	○			
Front pipe, muffler and tail pipe deformed								○	
Front pipe, muffler and tail pipe installation faulty								○	
Valve clearance faulty				○					Gr 11B
Head gasket faulty				○					Gr 11B
Valve and valve seat worn and carbon deposits				○					Gr 11B
Valve spring fatigued				○					Gr 11B
Piston ring worn and damaged					○		○		Gr 11B
Piston ring groove worn and damaged					○		○		Gr 11B
Cooling system malfunctioning				○					Gr 14B
Engine oil excessive					○				Gr 12B
Main moving parts seized				○					Gr 11B
Fuel injection quantity uneven or excessive				○					Gr 13B

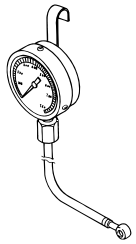
INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

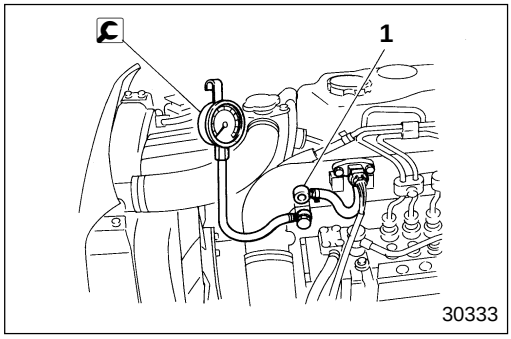
Measurement of Turbo Boost Pressure

Service standards

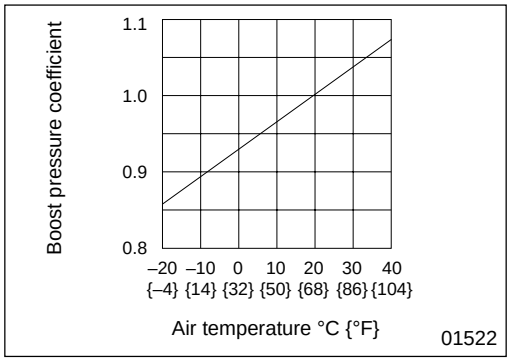
Location	Maintenance item	Standard value	Limit	Remedy
—	Boost pressure (Air temperature 20°C {68°F}, Atmospheric pressure 100 kPa {29.9 in. Hg, 760 mmHg})	—	36 kPa {10.6 in. Hg, 270 mmHg}/ 3700 rpm	Inspect and adjust

Special tools

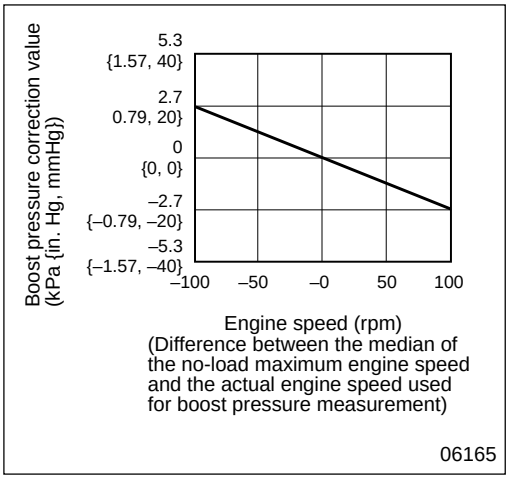
Location	Tool name and shape	Part No.	Application
—	Boost pressure gauge  01524	MH061366	Measurement of turbo boost pressure



- Before measuring the turbo boost pressure, clean or replace the air cleaner element.
- Remove boost pressure sensor hose **1** and attach boost pressure gauge.
- After warming up the engine, measure the boost pressure at the no-load maximum engine speed. Also measure the engine speed and the air temperature.



- Correct the boost pressure at standard conditions. (Since the boost pressure varies depending on the air temperature and engine speed.)
  [Correction for air temperature]
  Identify boost pressure coefficient depending on the air temperature from the graph.



[Correction for engine speed]
Subtract the engine speed actually used for measuring the boost pressure from the median of the no-load maximum engine speed. Identify the boost pressure correction value (**Pa**) according to the graph.
Median value : 3700 rpm

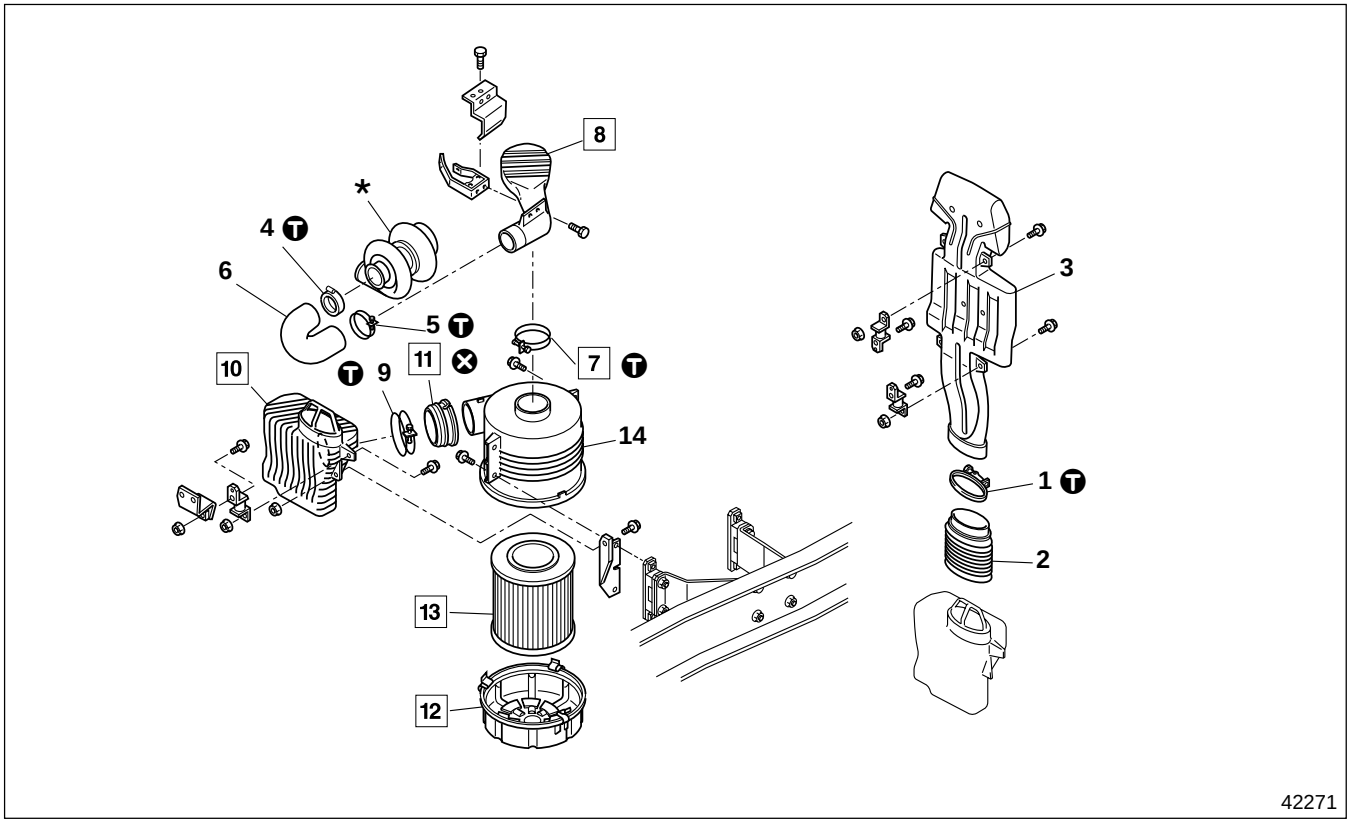
[Calculation of corrected boost pressure]
Given the measured boost pressure to be **P**, corrected boost pressure **Pb** can be calculated from the following equation:

Pb = ktP + Pa

- **Pb** : Corrected boost pressure
- **P** : Measured boost pressure
- **kt** : Boost pressure correcting coefficient depending on air temperature
- **Pa** : Boost pressure correction value

If **Pb** is lower than the limit, the turbocharger must be inspected and adjusted.

AIR DUCT AND AIR CLEANER



● **Disassembly sequence**

1 Clamp
2 Connector
3 Air inlet duct
4 Clamp
5 Clamp
6 Air hose
7 Clamp
8 Air duct
9 Clamp
10 Air box
11 Rubber seal
12 Air cleaner cap
13 Air cleaner element
14 Air cleaner case

*: Turbocharger 📖 P15B-12
⊗: Non-reusable parts

● **Assembly sequence**

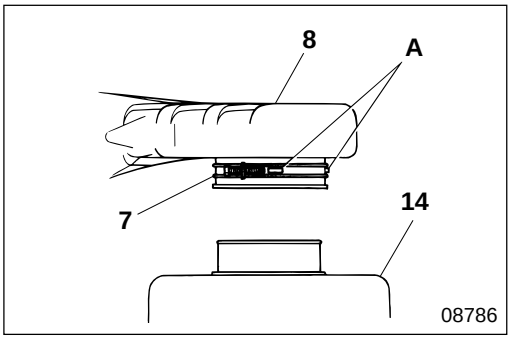
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

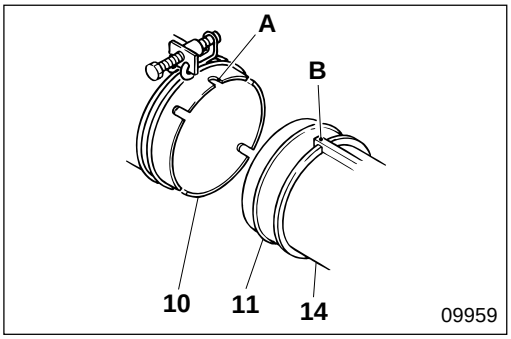
Location	Parts to be tightened	Tightening torque	Remarks
1, 4, 5, 7, 9	Clamp	2.9 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	—

◆ Service procedure



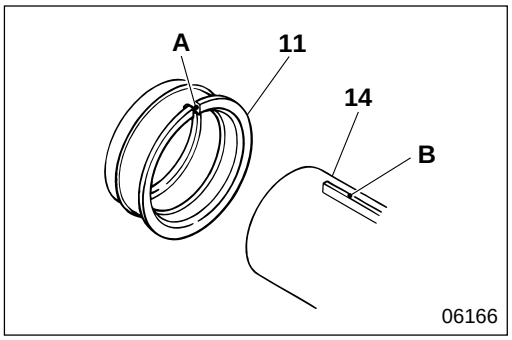
7 **8** **Installation of air duct**

- Fit clamp **7** over protrusions **A** of air duct **8**.
- Push air duct **8** in until it hits air cleaner case **14**.



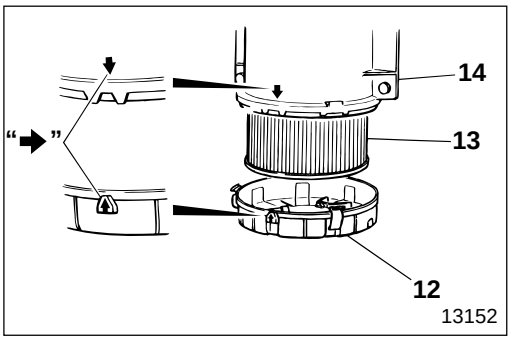
10 **Installation of air box**

Align slit **A** of air box **10** with key **B** of air cleaner case **14**.



11 **Installation of rubber seal**

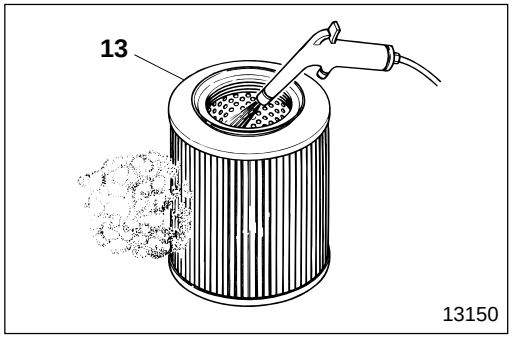
Align slit **A** of rubber seal **11** with key **B** of air cleaner case **14**.



12 **Installation of air cleaner cap**

➡ : Alignment mark

AIR DUCT AND AIR CLEANER



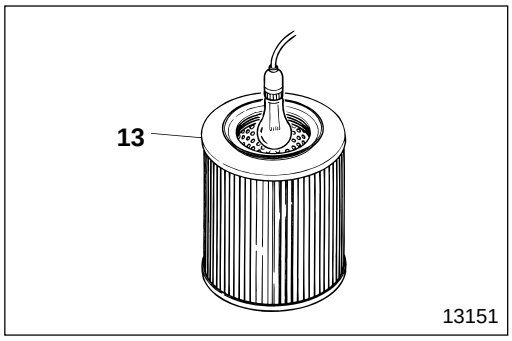
13 **Air cleaner element**

[Cleaning]

- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **13** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of air cleaner element **13** evenly.

CAUTION⚠

- **Do not tap or hit air cleaner element 13 to remove dust.**
- **Do not blow compressed air through air cleaner element 13 from the outside.**



[Inspection]

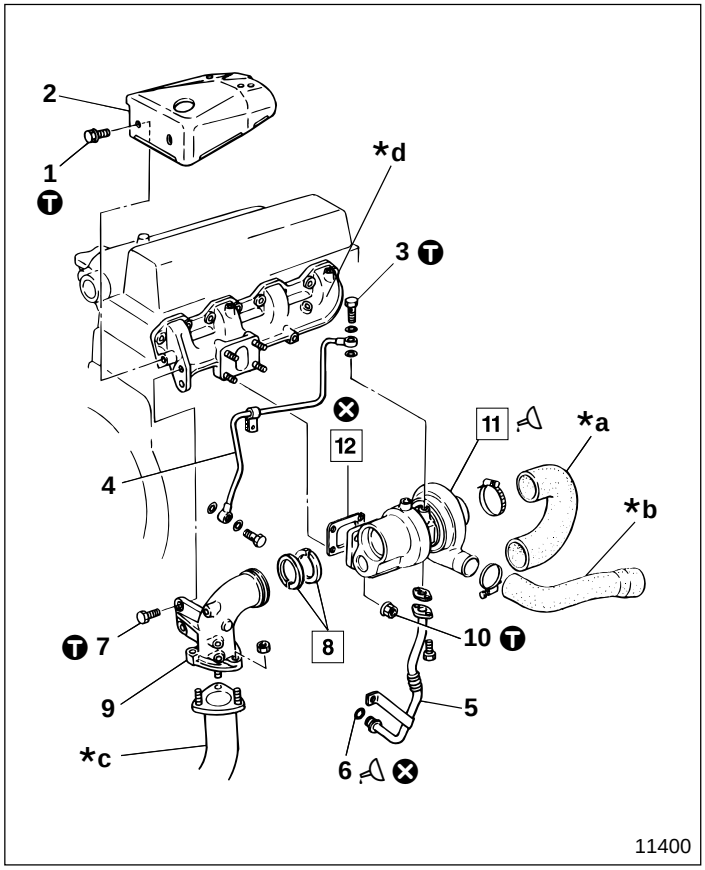
- Illuminate the inside of air cleaner element **13**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of air cleaner element **13** is damaged, replace the air cleaner element.

NOTE

If the dust on air cleaner element 13 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.

M E M O

TURBOCHARGER



● **Removal sequence**

1 Bolt
2 Insulator
3 Eye bolt
4 Oil pipe
5 Oil return pipe
6 O-ring
7 Bolt
8 Seal ring
9 Exhaust pipe connector
10 Nut
11 Turbocharger assembly 🕮 P15B-14
12 Gasket

***a** : Air hose 🕮 P15B-8
***b** : Air inlet hose 🕮 P15B-18
***c** : Front pipe 🕮 P15B-24
***d** : Exhaust manifold 🕮 P15B-22
⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

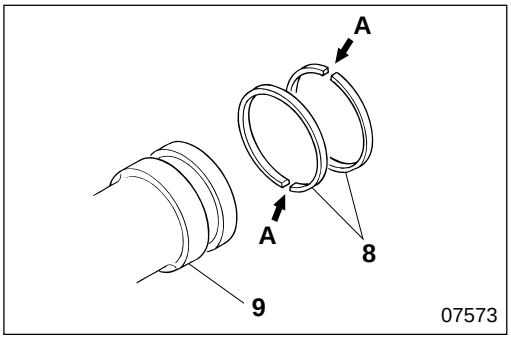
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Insulator mounting)	12 {8.7, 1.2}	—
3	Eye bolt	17 to 23 {12 to 17, 1.7 to 2.3}	—
7	Bolt (Exhaust pipe mounting)	41 to 54 {30 to 40, 4.2 to 5.5}	—
10	Nut (Turbocharger assembly mounting)	41 to 54 {30 to 40, 4.2 to 5.5}	—

Lubricant

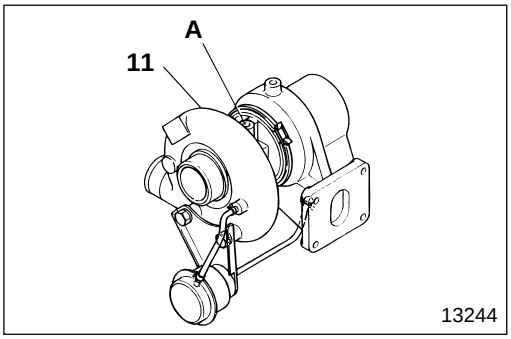
Location	Points of application	Kinds	Quantity
6	O-ring	Engine oil	As required
11	Supply when installing turbocharger assembly	Engine oil	As required

◆ Service procedure



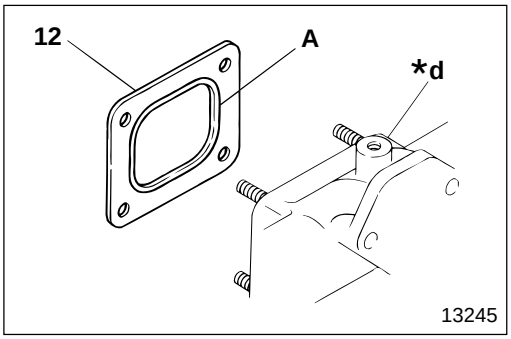
8 **Installation of seal ring**

Offset splits **A** of seal rings **8** at 180°.



11 **Installation of turbocharger assembly**

When installing turbocharger assembly **11**, supply engine oil via oil port **A** as required to ensure that parts move smoothly.



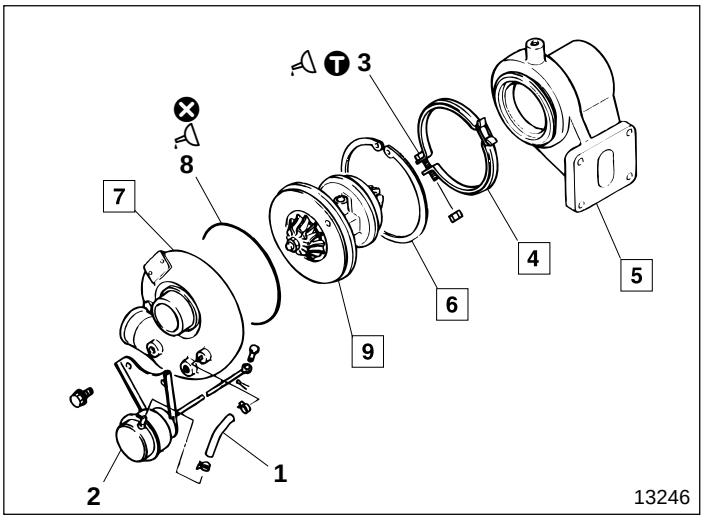
12 **Installation of gasket**

Install gasket **12** to exhaust manifold ***d** in the direction as illustrated.

A : Grommet lip

TURBOCHARGER

Turbocharger Assembly



● **Work before disassembly**

P15B-15

● **Disassembly sequence**

1 Hose
2 Actuator
3 Bolt
4 Coupling
5 Turbine housing
6 Snap ring
7 Compressor cover
8 O-ring
9 Cartridge assembly

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

P15B-15

NOTE

Since cartridge assembly 9 is a unit construction, if the turbine wheel or the compressor wheel is damaged, or the cartridge assembly does not revolve smoothly, or any other fault is found, replace the assembly as a unit.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
9	Cartridge assembly	Play in the shaft direction		0.05 to 0.09 {0.0020 to 0.0035}	0.1 {0.0039}	Replace
		Play at right angles to the shaft	Turbine wheel side	0.40 to 0.53 {0.016 to 0.021}	0.58 {0.023}	Replace
			Compressor wheel side	0.55 to 0.66 {0.022 to 0.026}	0.72 {0.028}	Replace

Ⓣ Tightening torque

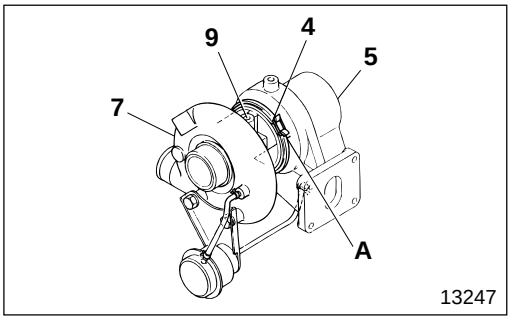
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Coupling mounting)	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	—

Lubricant

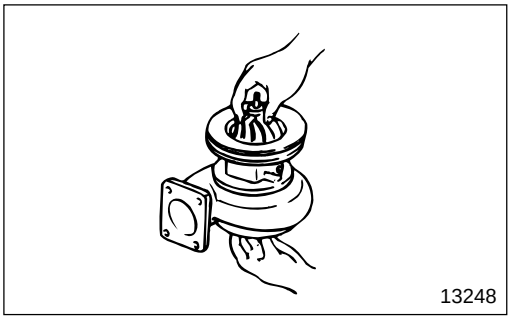
Location	Points of application	Kinds	Quantity
3	Thread area of bolt	Molybdenum disulfide grease	As required
8	Periphery of O-ring	Engine oil	As required

◆ Service procedure



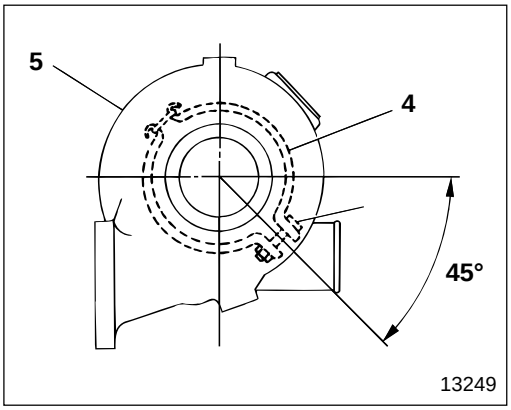
● Work before disassembly

Put alignment marks **A** on coupling **4**, turbine housing **5**, compressor cover **7** and cartridge assembly **9**.



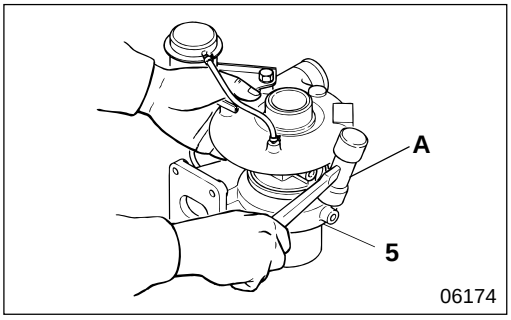
● Inspection after assembly

Turn the turbine wheel and the compressor wheel of cartridge assembly **9** to make sure that they turn smoothly.



4 Installation of coupling

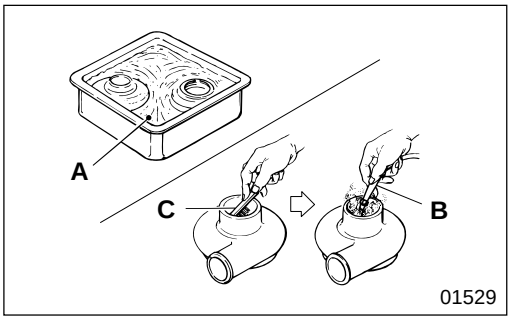
Install coupling **4** onto turbine housing **5** in the direction as illustrated.



5 Removal of turbine housing

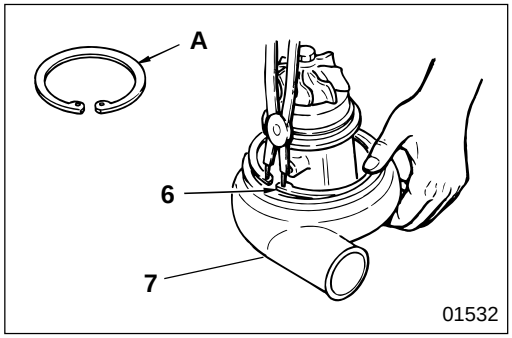
CAUTION ⚠

- **When removing turbine housing 5, tap all around the circumference lightly using rubber-headed hammer A so as not to damage the turbine housing.**
- **Do not hit the turbine wheel near turbine housing 5, since the blade of the turbine wheel can be easily bent.**



5 7 Cleaning of turbine housing and compressor cover

- Visually inspect related parts before cleaning to check if there are any burns or scratches as these would not be seen after cleaning. If any fault is found, replace the faulty parts.
- Remove any foreign particles before cleaning by scraping them off using plastic scraper or bristle-headed brush **C**. Immerse the disassembled parts in nonflammable solvent **A** (DAIDO KAGAKU KOGYO DAICLEANER T-30), then take them out and blow compressed air **B** on them.

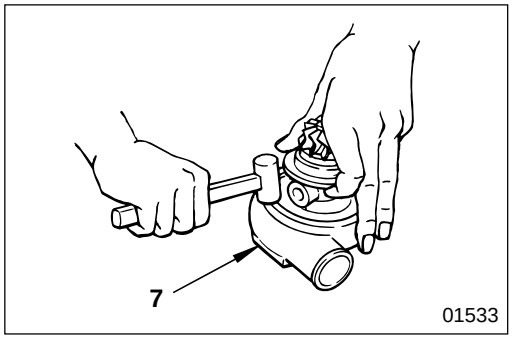


6 **Installation of snap ring**

Install snap ring **6** into compressor cover **7** with taper surface **A** upward.

WARNING

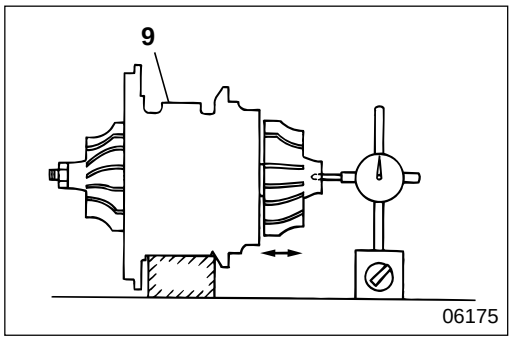
Use your hand to hold snap ring 6 in place to prevent it from springing out.



7 **Removal of compressor cover**

CAUTION

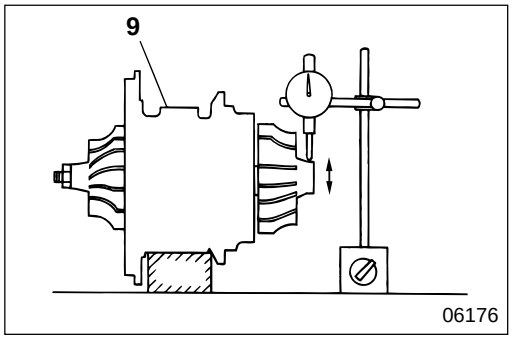
- **When removing compressor cover 7, tap all around the circumference lightly so as not to damage the compressor cover.**
- **Avoid hitting the compressor wheel near compressor cover 7, since the blade of the compressor wheel can be easily bent.**



9 **Inspection of cartridge assembly**

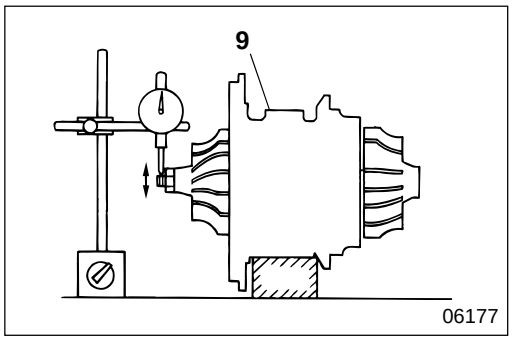
(1) Play in the shaft direction of the shaft and turbine wheel assembly

If the measured value deviates from the standard value, replace cartridge assembly **9**.



(2) Play at right angles to the shaft of the shaft and turbine wheel assembly

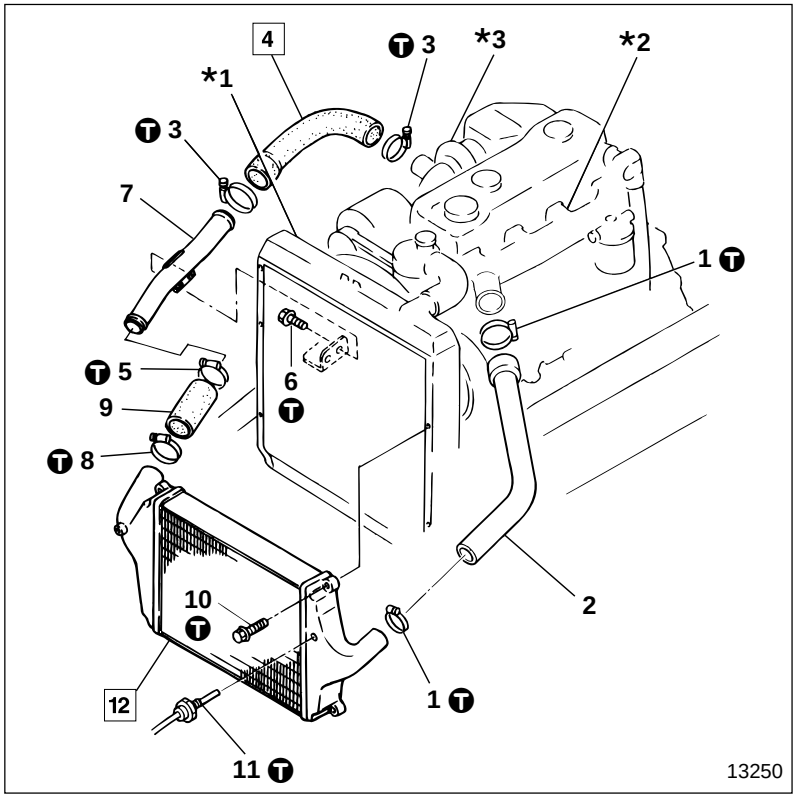
- Play on turbine wheel side
  If the measured value is higher than the limit, replace cartridge assembly **9**.



- Play on compressor wheel side
  If measured value is higher than the limit, replace cartridge assembly **9**.

M E M O

INTERCOOLER



● **Disassembly sequence**

1 Clamp
2 Air inlet hose
3 Clamp
4 Air inlet hose
5 Clamp
6 Bolt
7 Air inlet pipe
8 Clamp
9 Air inlet hose
10 Bolt
11 Boost air temperature sensor
Gr 13EB
12 Intercooler

***1** : Radiator Gr 14B
***2** : Exhaust manifold P15B-22
***3** : Turbocharger P15B-12

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

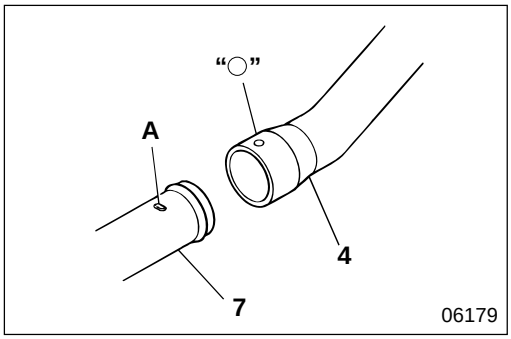
Location	Maintenance item	Standard value	Limit	Remedy
12	Air leakage from intercooler (Air pressure : 150 kPa {21 psi, 1.5 kgf/cm^2})	0 cm^3 {0 cu. in.}	—	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

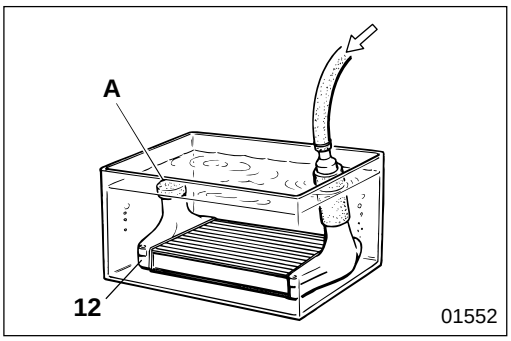
Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5, 8	Clamp (Air inlet hose mounting)	2.9 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	—
6	Bolt (Air inlet pipe mounting)	12 to 15 {8.7 to 11, 1.2 to 1.5}	—
10	Bolt (Intercooler mounting)	12 to 15 {8.7 to 11, 1.2 to 1.5}	—
11	Boost air temperature sensor	14.7±2 {11±1.4, 1.5±0.2}	—

◆ Service procedure



4 **Installation of air inlet hose**

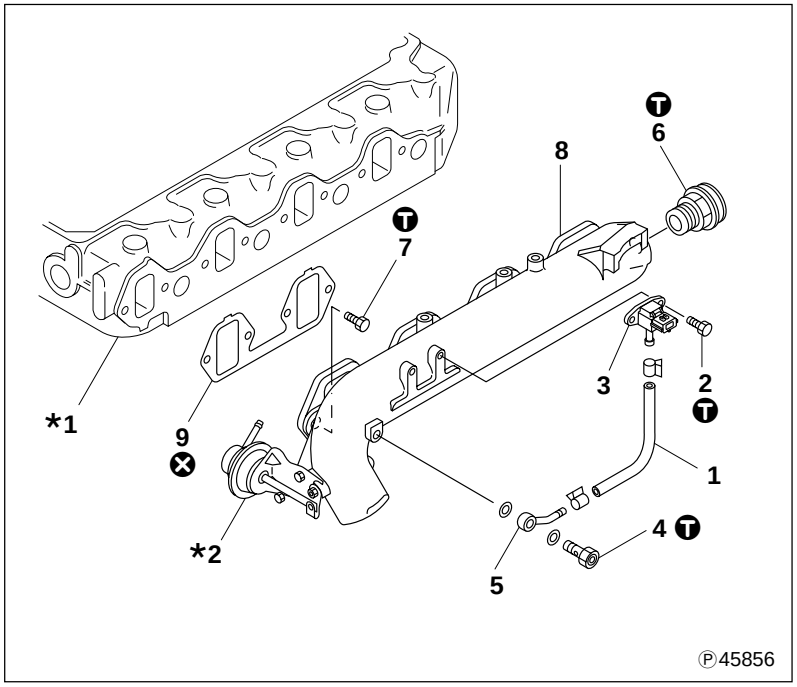
Align alignment mark "○" of air inlet hose **4** with padded part **A** of air inlet pipe **7**.



12 **Inspection of intercooler**

- Fit plug **A** on one of the air inlets of intercooler **12** and close the hole on the boost air temperature sensor, while connecting the hose to the other. Then, immerse the entire body of the intercooler in the water and apply the specified air pressure from the hose side (150 kPa {21 psi, 1.5 kgf/cm^2}) to check for air leakage.
- If any leakage is found, replace intercooler **12**.

INTAKE MANIFOLD



● **Disassembly sequence**

1 Vacuum hose
2 Bolt
3 Boost pressure sensor Gr 13EB
4 Bolt
5 Joint pipe
6 Over-boost valve
7 Bolt
8 Intake manifold assembly
9 Gasket

***1** : Cylinder head Gr 11B
***2** : Actuator assembly Gr 35A
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

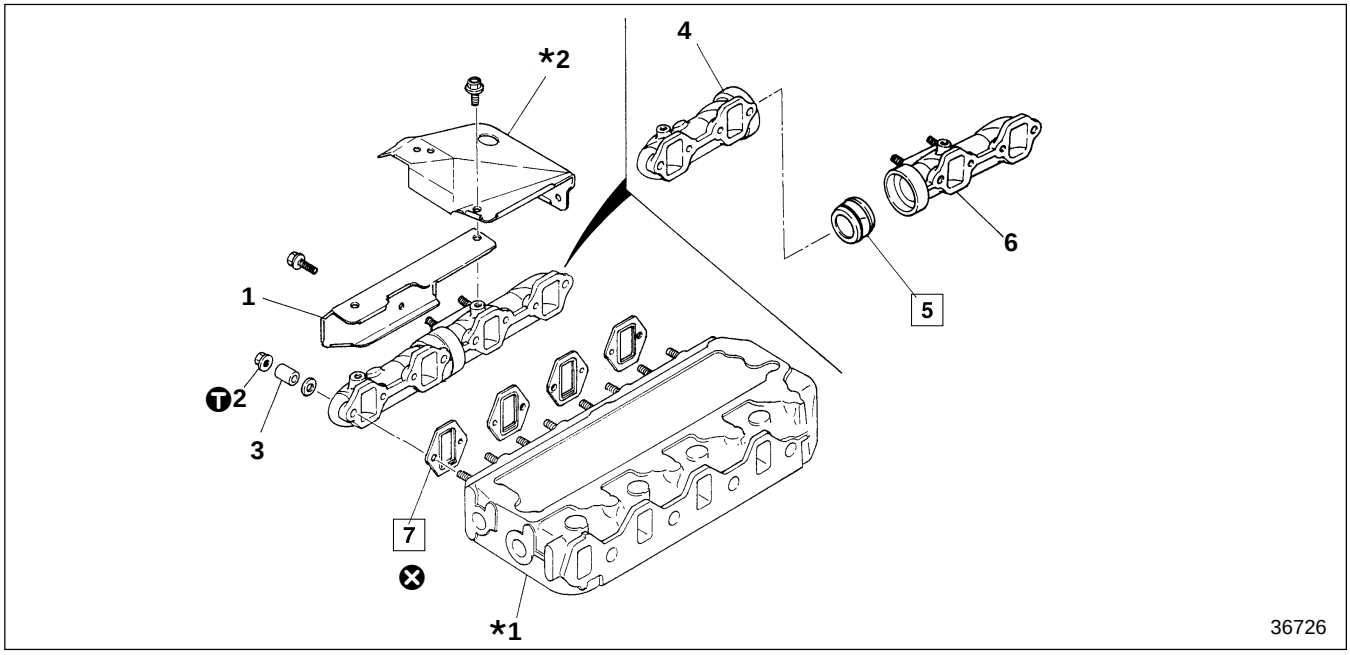
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Boost pressure sensor mounting)	4.9 {3.6, 0.5}	—
4	Bolt (Joint pipe mounting)	17 {12, 1.7}	—
6	Over-boost valve	31 {23, 3.2}	—
7	Bolt (Intake manifold assembly mounting)	16 to 24 {12 to 17, 1.6 to 2.4}	—

M E M O

EXHAUST MANIFOLD



● **Disassembly sequence**

1 Insulator
2 Nut
3 Distance spacer
4 Front exhaust manifold
5 Joint
6 Rear exhaust manifold
7 Gasket

***1** : Cylinder head Gr 11B
***2** : Insulator P15B-12
⊗ : Non-reusable parts

● **Assembly sequence**

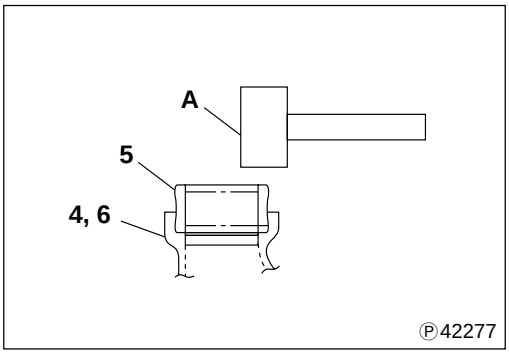
Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

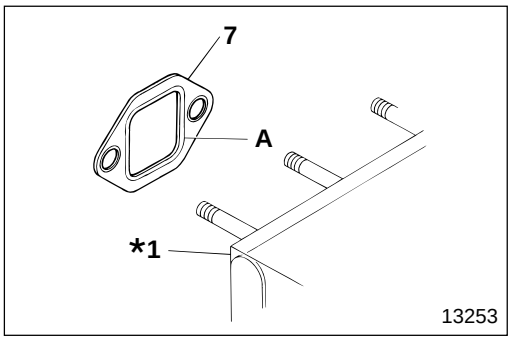
Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Front exhaust manifold and rear exhaust manifold mounting)	41 to 54 {30 to 40, 4.2 to 5.5}	—

◆ Service procedure



5 **Installation of joint**

A : Plastic hammer

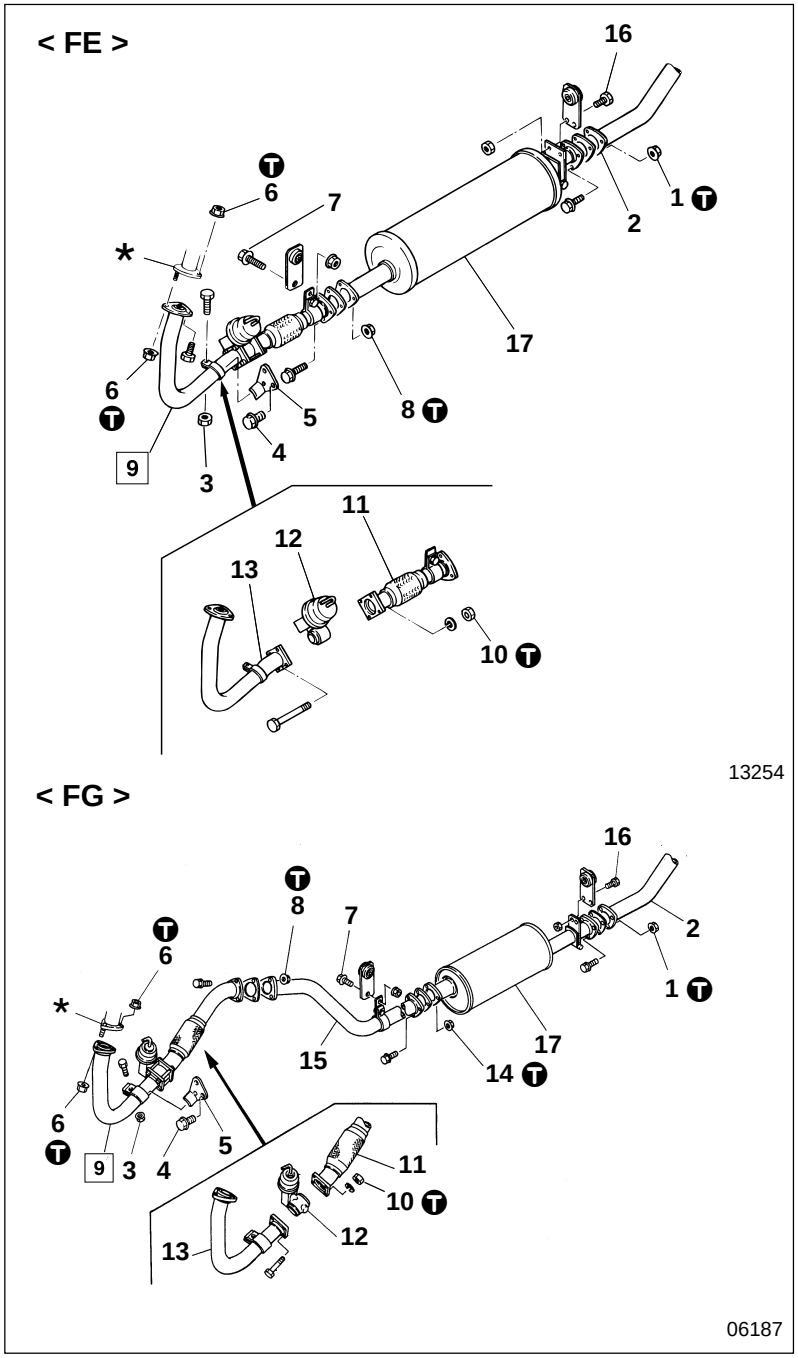


7 **Installation of gasket**

Install gasket **7** on cylinder head ***1** in the direction as illustrated.

A : Grommet lip

EXHAUST PIPE AND MUFFLER



● **Disassembly sequence**

1 Nut
2 Tail pipe
3 Nut
4 Bolt
5 Exhaust pipe bracket
6 Nut
7 Bolt
8 Nut
9 Front pipe assembly
10 Nut
11 Front pipe
12 Exhaust brake unit Gr 35A
13 Front pipe
14 Nut < FG >
16 Center pipe < FG >
16 Bolt
17 Muffler catalytic converter assembly

* : Exhaust manifold P15B-22

● **Assembly sequence**

Follow the disassembly sequence in reverse.

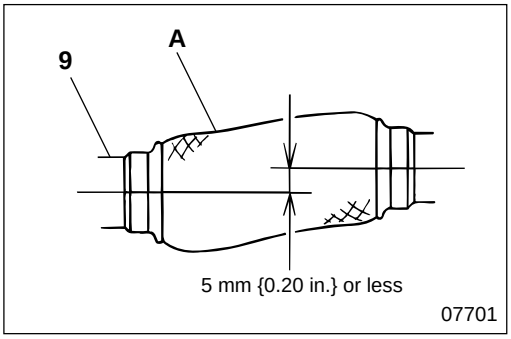
WARNING

- **Never hit or kick muffler 17, or the catalyzer in the muffler will be damaged.**
- **A small amount of water sometimes collects inside muffler 17. Never touch this water, if you do by mistake, wash it off immediately with clean water.**

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 8, 14	Nut (Tail pipe, center pipe and muffler mounting)	26 to 33 {20 to 25, 2.7 to 3.4}	—
6	Nut (Front pipe assembly mounting)	20 to 25 {14 to 18, 2.0 to 2.5}	—
10	Nut (Exhaust brake unit mounting)	27 {20, 2.75}	—



◆ Service procedure

9 **Installation of front pipe assembly**

Install front pipe assembly **9** so that the offset tolerance in the vertical and horizontal sections between the front and back of bellows **A** conforms to the specified value.

CAUTION

Be sure when installing front pipe assembly 9, that bellows A are not bent or stretched, since the bellows are designed to reduce the external noise of the vehicle but not to absorb dimensional errors in the installation of pipes.

MITSUBISHI
FUSO

Group 21
Clutch

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-21

INDEX

SPECIFICATIONS 21- 2

STRUCTURE AND OPERATION 21- 2

TROUBLESHOOTING 21- 5

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

- Clutch Fluid (Brake Fluid) Replacement and Air Bleeding 21- 6
- Clutch Pedal Free Play 21- 8

CLUTCH PEDAL 21-10

CLUTCH MASTER CYLINDER 21-12

CLUTCH POWER CYLINDER 21-14

WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY 21-16

CLUTCH BODY 21-18

CLUTCH CONTROL 21-22

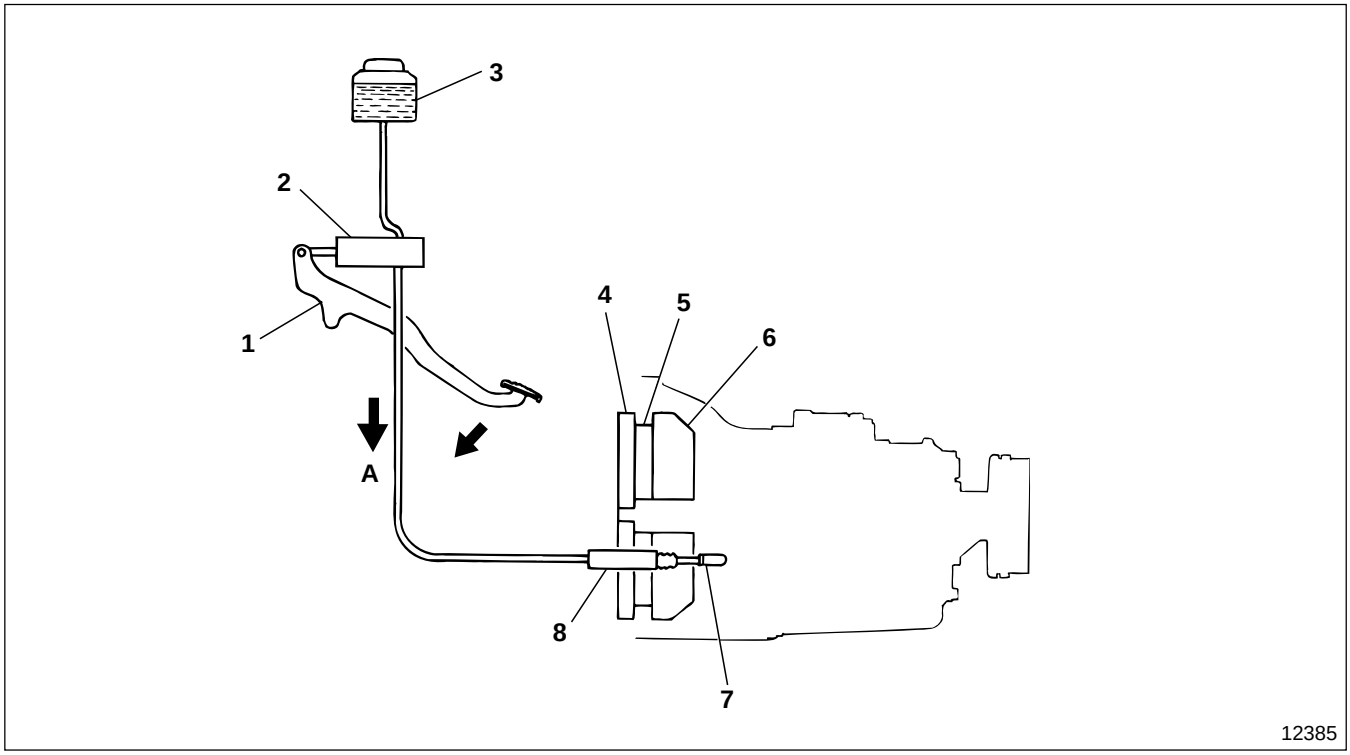
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Clutch	Model	C4W30
Drive type		Strap drive
Clutch disc	Type	Dry, single plate type
Pressure plate	Type	Diaphragm spring type
Control type		Hydraulic pressure type
Clutch master cylinder	Manufacturer	NISSIN KOGYO
Clutch power cylinder	Manufacturer	NISSIN KOGYO

STRUCTURE AND OPERATION

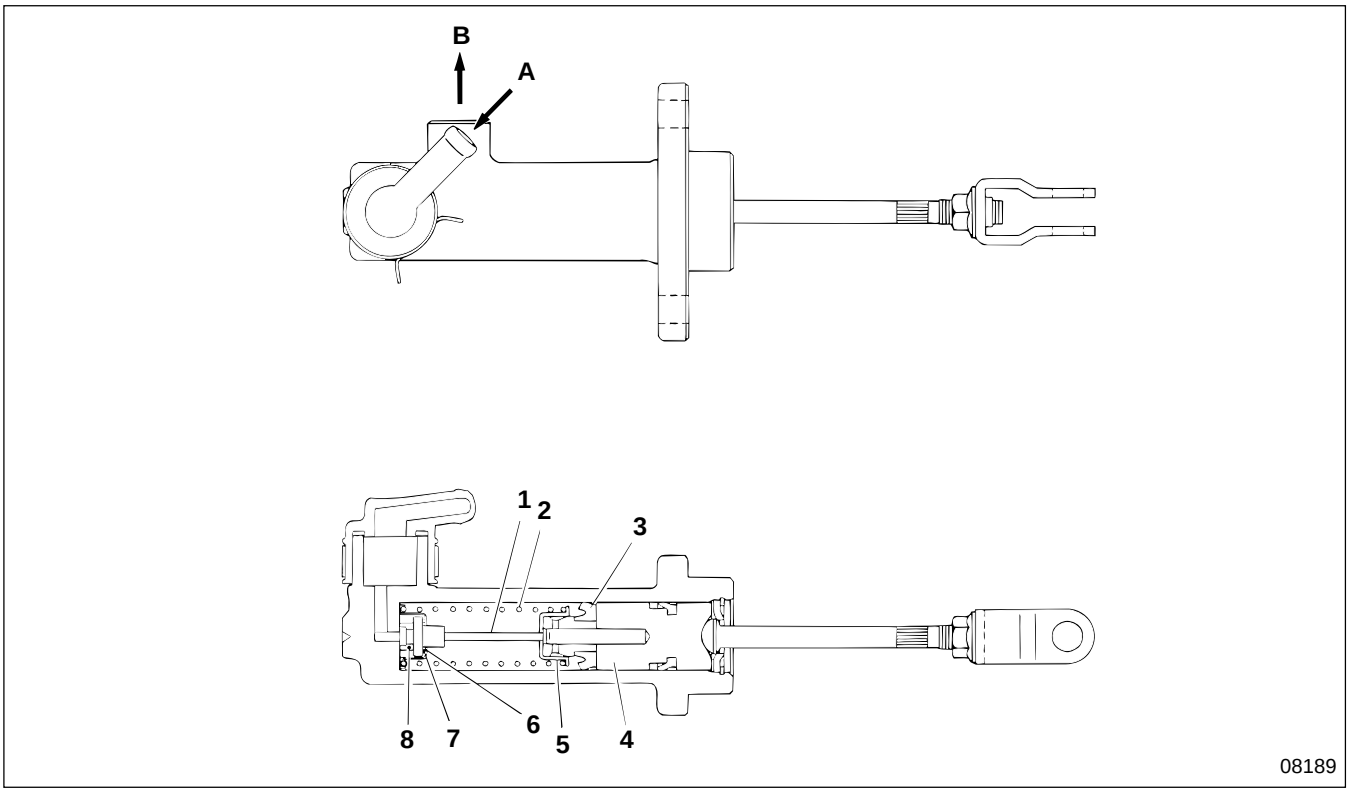
Clutch Control



1 Clutch pedal
2 Clutch master cylinder
3 Fluid tank
4 Flywheel
5 Clutch disc
6 Clutch cover assembly
7 Push rod
8 Clutch power cylinder

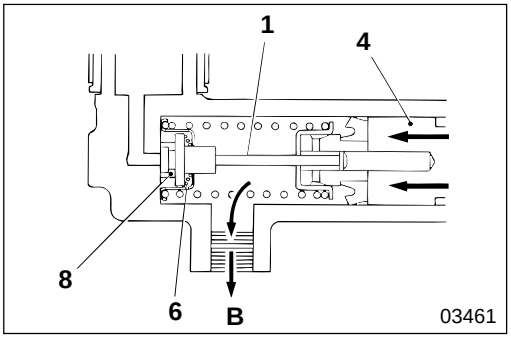
A : Hydraulic pressure

Clutch Master Cylinder



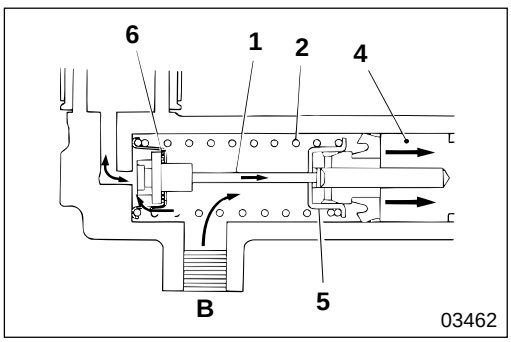
1 Valve stem
2 Return spring
3 Pressure cup
4 Piston
5 Spring seat
6 Valve spring
7 Valve case
8 Valve seal

A : From fluid tank
B : To clutch power cylinder (hydraulic pressure)



When clutch pedal is depressed

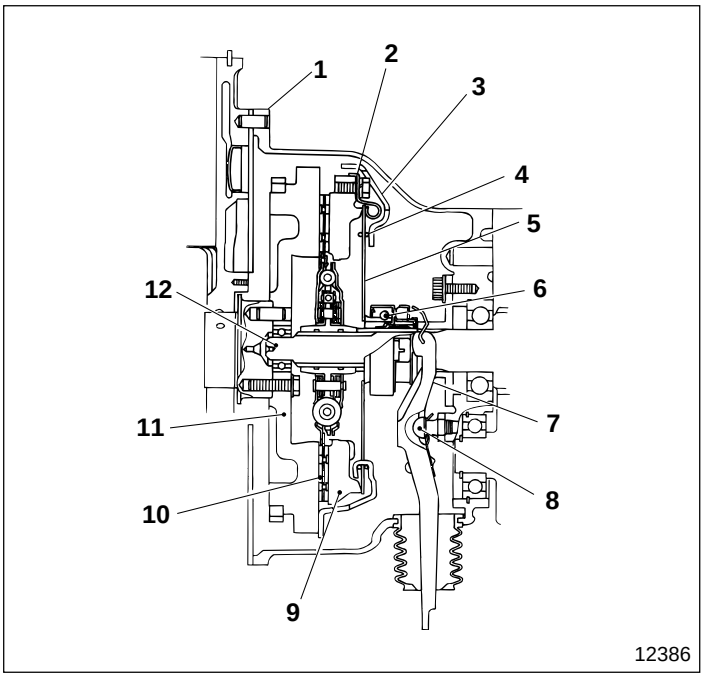
- As piston **4** is pressed in the direction as illustrated, valve spring **6** of valve stem **1** forces down valve seal **8** to close the fluid tank port.
- Then, the hydraulic pressure in the master cylinder increases to transmit hydraulic pressure **B** to the power cylinder.



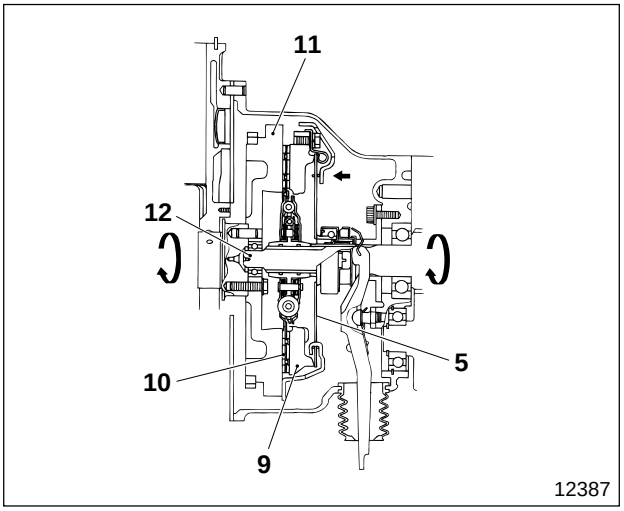
When clutch pedal is released

- As the clutch pedal is released, hydraulic pressure **B** from the power cylinder and return spring **2** push back piston **4**.
- At the same time, valve stem **1** is retracted by spring seat **5** and compresses valve spring **6** to open the fluid tank port.
- Thus released, hydraulic pressure **B** in the master cylinder returns piston **4** to its original position.

Clutch Body

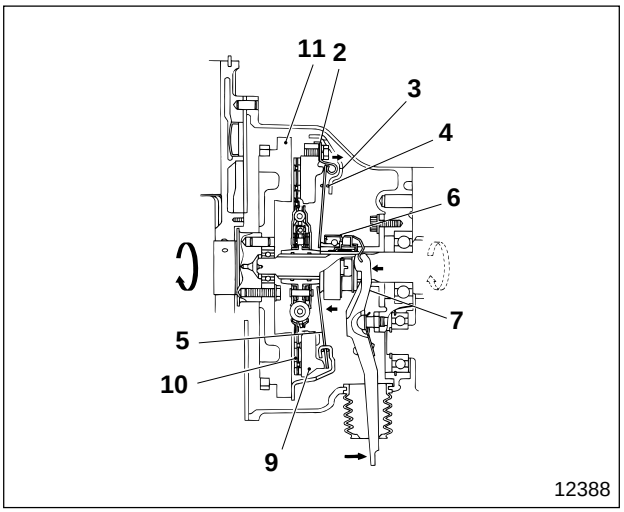


1 Clutch housing
2 Strap plate
3 Clutch cover
4 Pivot ring
5 Diaphragm spring
6 Clutch release bearing
7 Clutch release rocker arm
8 Rocker arm pivot
9 Pressure plate
10 Clutch disc
11 Flywheel
12 Drive pinion



When clutch pedal is released

- Pressure plate **9**, activated by diaphragm spring **5**, forces clutch disc **10** against flywheel **11**.
- Clutch disc **10** forced against flywheel **11** runs together with the flywheel and transmits power from the engine to transmission drive pinion **12**.



When clutch pedal is depressed

- Hydraulic pressure generated within the clutch master cylinder activates the power cylinder. This pushes out clutch release bearing **6** via clutch release rocker arm **7** to compress diaphragm spring **5**. The diaphragm spring supported by pivot ring **4** retracts pressure plate **9**, which is connected to clutch cover **3** via the strap plate **2**. The resulting clearance between clutch disc **10** and flywheel **11** cuts off the transmission of engine power.

Possible causes \ Symptoms		Clutch disengaged but drags	Clutch slips	Clutch does not engage smoothly	Clutch makes noise on disengagement	Clutch makes noise on engagement	Judder when vehicle starting	Clutch pedal hard to depress	Remarks
Clutch cover assembly	Diaphragm spring heights uneven	○	○	○			○		
	Pressure plate warped or faulty	○	○	○			○		
	Diaphragm spring fatigued		○	○		○			
	Rivets loose						○		
	Strap plate bent				○				
Clutch disc	Disc deformed	○		○			○		
	Disc rivets loose			○			○		
	Disc torsion spring fatigued or fractured		○	○	○	○	○		
	Spline worn	○			○	○	○		
	Spline rusted	○		○					
	Facing worn		○					○	
	Facing surface hardened		○	○			○		
	Facing oily or greasy		○	○			○		
Clutch pedal	Pedal free play inadequate		○						
	Pedal free play excessive	○							
	Pedal stroke inadequate	○							
	Return spring fatigued		○	○					
	Pedal friction surfaces faulty			○			○	○	
Clutch master cylinder	Piston and piston cup sliding movement faulty	○	○	○				○	
	Spring fatigued	○	○	○					
	Brake fluid port clogged	○	○	○					
Clutch power cylinder	Piston and piston cup sliding movement faulty	○	○	○					
	Spring fatigued	○	○	○					
	Brake fluid port clogged	○	○	○					
Clutch control	Release bearing faulty	○			○		○		
Transmission drive pinion spline worn		○				○			Gr 22
Engine idling speed too slow		○				○			Gr 13B
Engine mounting fatigued		○					○		Gr 11B
Flywheel warped, deformed or stepped wear		○	○	○			○		Gr 11B
Flywheel pilot bearing faulty		○			○				Gr 11B
Air mixed in clutch hydraulic system		○							
Clutch hydraulic system leaking		○							

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

Clutch Fluid (Brake Fluid) Replacement and Air Bleeding

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bleeder screw	10.8 to 14.7 {8 to 11, 1.1 to 1.5}	—

Fluid

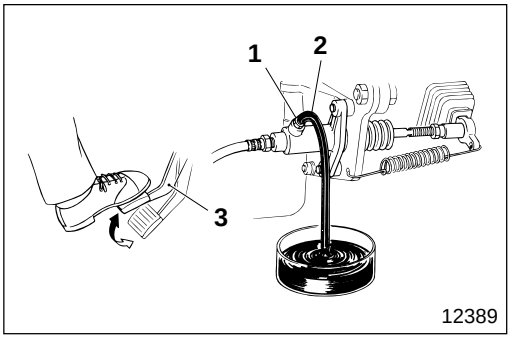
Location	Points of application	Kinds	Quantity
3	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

WARNING

- **The clutch fluid system and the brake fluid system use the fluid tank in common. Therefore, replacement the clutch fluid must be carried out simultaneously with that of the brake fluid. Gr 35A**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in faulty clutch and brake operations.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**

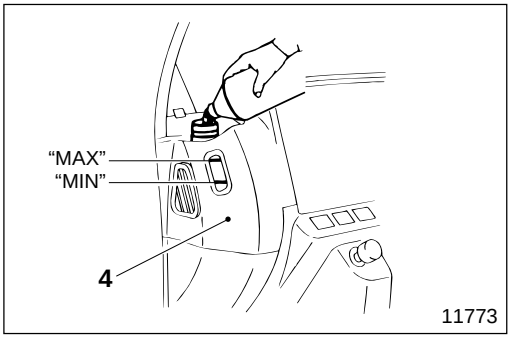
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

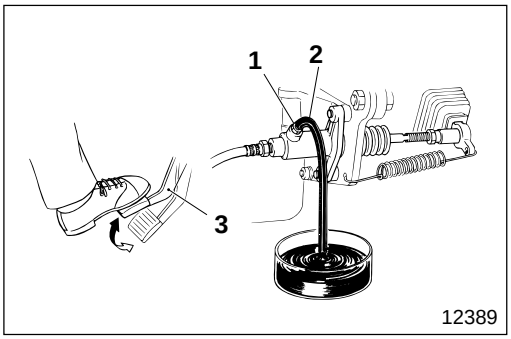


(1) Replacement of brake fluid

- Attach vinyl pipe **2** to bleeder screw **1** of the clutch power cylinder.
- Loosen bleeder screw **1** and depress clutch pedal **3** several times to drain brake fluid completely.



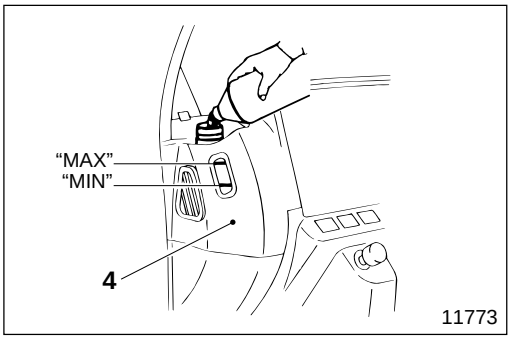
- Supply new brake fluid to the "MAX" level of fluid tank **4**. Depress clutch pedal **3** repeatedly until the old brake fluid discharged from vinyl pipe **2** is replaced by the new brake fluid.



(2) Air bleeding of clutch system

NOTE

Carry out this operation maintaining the brake fluid level in fluid tank 4 between "MAX" and "MIN".



- Attach vinyl pipe **2** to bleeder screw **1** of the clutch power cylinder as in the replacement procedure.
- Fill fluid tank **4** with brake fluid, and loosen bleeder screw **1** of the clutch power cylinder, then depress clutch pedal **3** continuously.
- Keep depressing clutch pedal **3**, and tighten bleeder screw **1** when air is bled completely.
- Depress clutch pedal **3** several times again, then keep it depressed at its fullest extent.
- With the clutch pedal depressed, loosen bleeder screw **1** to drain brake fluid containing air. Release the pedal after tightening the bleeder screw.
- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten bleeder screw **1** at specified torque.
- Check that brake fluid is at the "MAX" level of fluid tank **4**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **3** depressed.

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

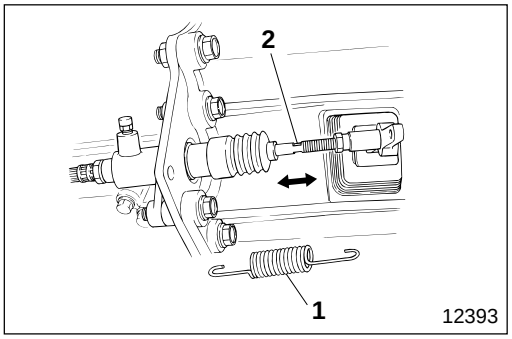
Clutch Pedal Free Play

Service standards

Unit : mm {in.}

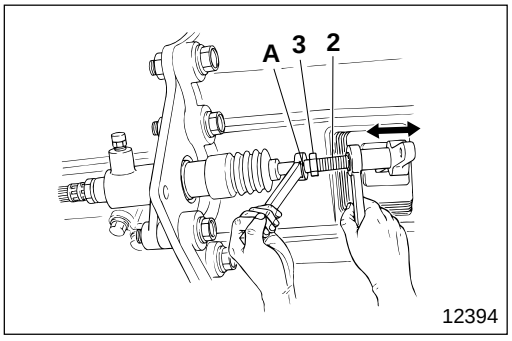
Location	Maintenance item	Standard value	Limit	Remedy
2	Push rod stroke	4 {0.16}	—	Adjust or replace
6	Clutch pedal free play	36 to 53 {1.42 to 2.09}	—	Adjust or replace

Inspect and adjust the free play of the clutch pedal, by noting the stroke of the clutch power cylinder push rod, after the clutch pedal has been correctly adjusted.



[Inspection]

- Bleed air from the clutch system P21-7
- Adjust the clutch pedal P21-11
- Disconnect return spring **1** and check the free play of push rod **2** by hand. If the measured value deviates from the standard value, adjust as follows:

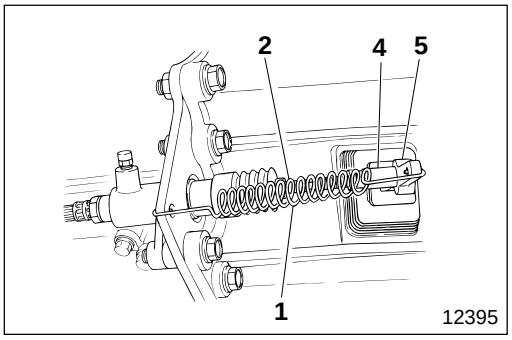


[Adjustment]

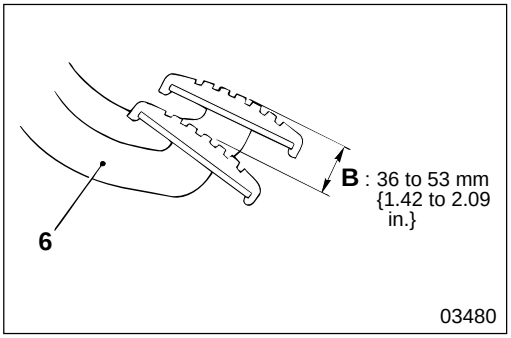
- Loosen nut **3** and turn flat parts **A** of push rod **2** to extend push rod until it stops.
- Then, return flat parts **A** of push rod **2** by the following value and retighten nut **3**.

  Amount of return : Approximately three and one fifth of a turn

- If push rod **2** cannot be returned by the above amount, the clutch disc is worn beyond the limit and needs replacing.

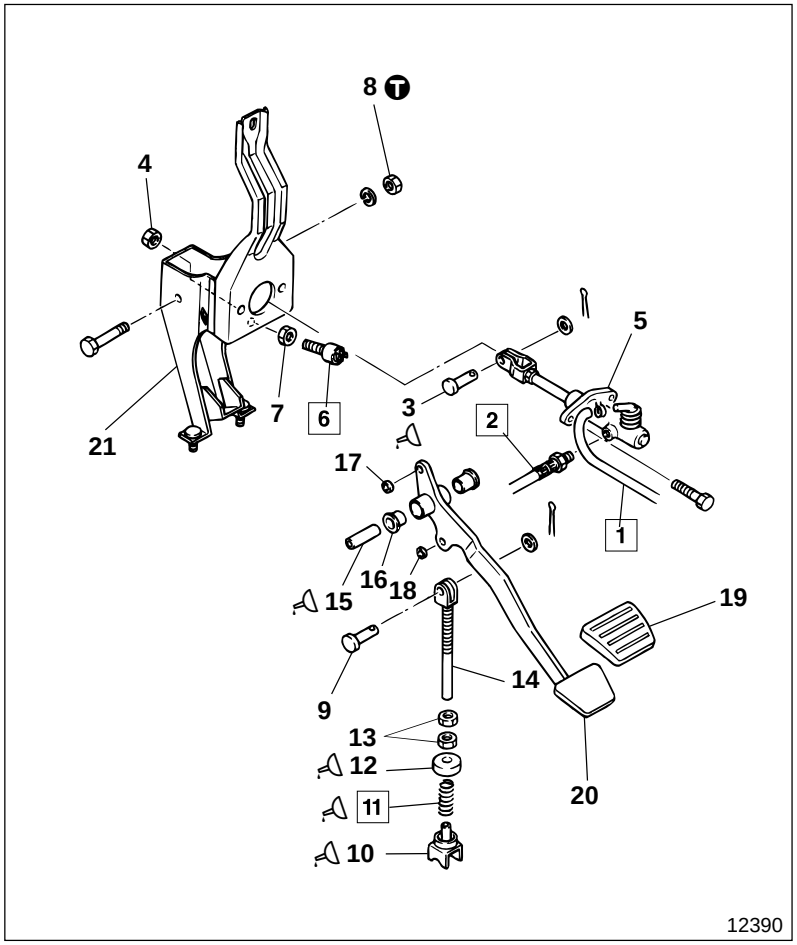


- Install return spring **1**, and check that there is no space between push rod cap **4** and clutch release rocker arm **5** by moving push rod **2**.



[Confirmation]
Push clutch pedal **6** with your hand until you feel a resistance and measure free play **B**.
If the measured value deviates from the standard value, readjust or replace the clutch disc.

CLUTCH PEDAL



● **Disassembly sequence**

1 Fluid hose
2 Fluid hose
3 Clevis pin
4 Nut
5 Clutch master cylinder P21-12
6 Clutch switch Gr 54
7 Lock nut
8 Nut
9 Clevis pin
10 Spring holder
11 Return spring
12 Plate
13 Nut
14 Spring assist rod
15 Collar
16 Bushing
17 Bushing
18 Bushing
19 Pedal pad
20 Clutch pedal
21 Clutch pedal support

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly**

P21-11

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
11	Installed load of return spring (Installed length 37 {1.46})	185 N {41 lbf, 18.7 kgf}	165 N {37 lbf, 16.8 kgf}	Replace
15, 16	Clearance between collar and bushing	[14] 0.02 to 0.26 {[0.55] 0.00079 to 0.010}	0.3 {0.012}	Replace

Tightening torque

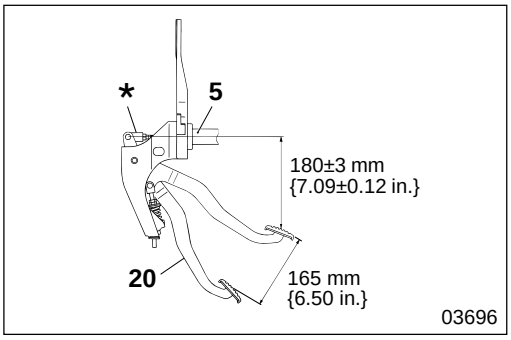
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Nut (Clutch pedal mounting)	16.7 to 25.5 {12 to 19, 1.7 to 2.6}	—

Lubricant

Location	Points of application	Kinds	Quantity
3	Clevis pin	Chassis grease [NLGI No.1 (Ca soap)]	As required
10 to 12	Friction surfaces of spring holder, return spring and plate	Chassis grease [NLGI No.1 (Ca soap)]	As required
15	External surface of collar	Chassis grease [NLGI No.1 (Ca soap)]	As required

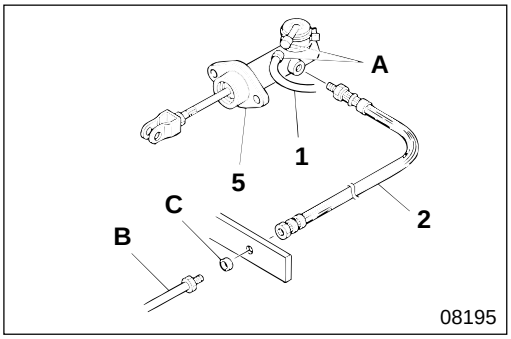
◆ Service procedure



● Adjustment after assembly

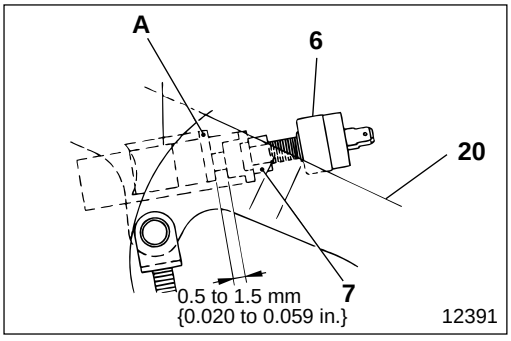
Adjustment of clutch pedal

Adjust clevis * of clutch master cylinder **5** so that clutch pedal **20** is installed as illustrated. 🕮 P21-13



1 **2** **Removal and installation of fluid hose**

- Remove fluid hose **1** from the fluid tank and clutch master cylinder **5**, and fit stopper **A** after draining is completed.
- Remove fluid hose **2** from clutch master cylinder **5** after removing pipe **B** from the cab, then fit stopper **C** to pipe **B**.
- After installation, bleed the system. 🕮 P21-7

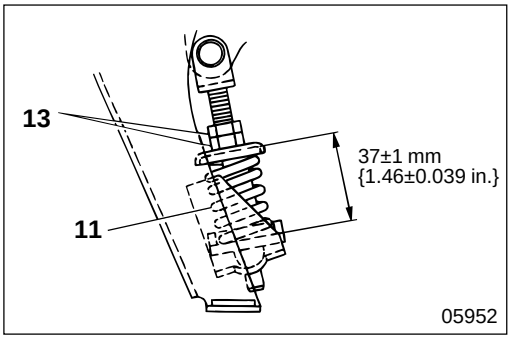


6 **Installation of clutch switch**

After adjusting clutch pedal **20**, adjust the clearance between the thread end of clutch switch **6** and pedal stopper **A** so that it is within the standard value, and tighten lock nut **7**.

CAUTION⚠

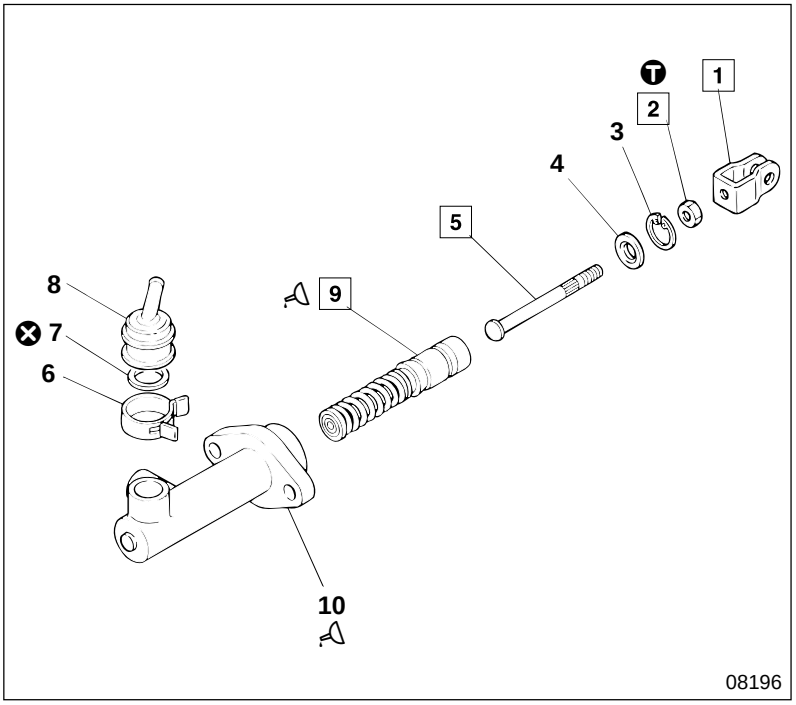
Do not allow the thread end of clutch switch 6 to come into contact with pedal stopper A of clutch pedal 20 because this will cause the clutch to slip.



11 **Adjustment of return spring installation length**

Adjust return spring **11** to the installed length as illustrated using lock nut **13**.

CLUTCH MASTER CYLINDER



● **Disassembly sequence**

1 Clevis
2 Lock nut
3 Retaining ring
4 Stop plate
5 Push rod
6 Clip
7 Packing
8 Union collar
9 Piston assembly
10 Cylinder body

⊗ : Non-reusable parts

● **Assembly sequence**

8 → **7** → **10** → **6** → **9** → **5** → **4** → **3** → **2** → **1**

Repair kit : Clutch master cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
9, 10	Clearance between piston assembly and cylinder body	[22.22] 0.02 to 0.10 {[0.87] 0.00079 to 0.0039}	0.2 {0.0079}	—

Ⓣ Tightening torque

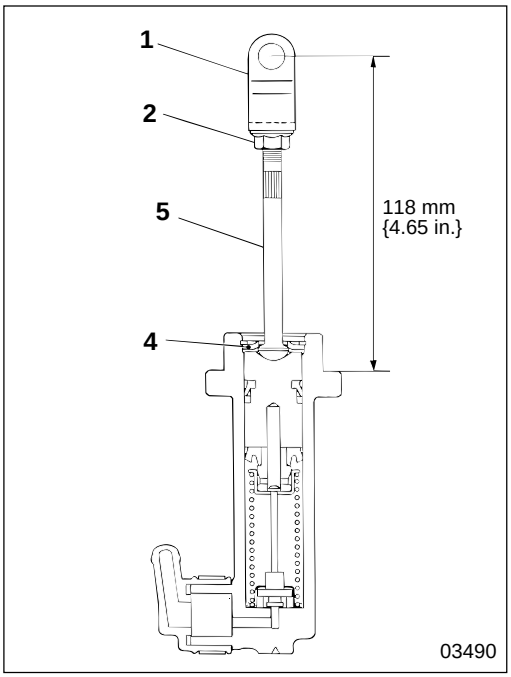
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (Push rod mounting)	19 to 27 {14 to 20, 1.9 to 2.8}	—

Lubricant

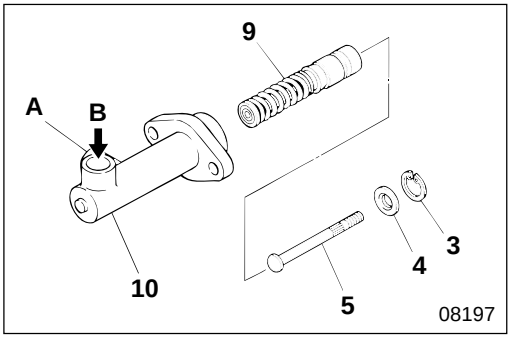
Location	Points of application	Kinds	Quantity
9, 10	Friction surfaces of piston assembly and cylinder body	Rubber grease	0.2 to 0.3 g {0.0071 to 0.011 oz}

◆ Service procedure



1 **2** **5** **Adjustment of push rod length**

- If the length, as illustrated, deviates from the specified value, loosen nut **2**, and adjust the length of push rod **5** by turning clevis **1**.
- Measure the length while push rod **5** is touching stop plate **4**.
- After adjustment, tighten nut **2** at specified torque.



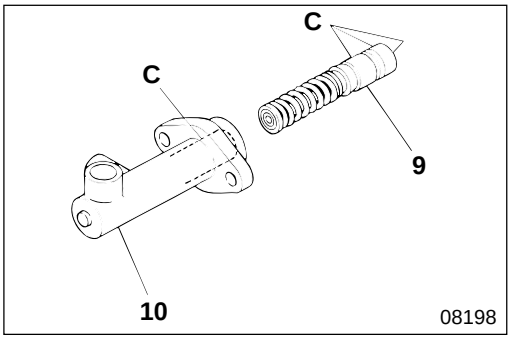
9 **Piston assembly**

[Removal]

- Remove retaining ring **3**, stop plate **4** and push rod **5**.
- Block port **A** of cylinder body **10**, and apply compressed air from **B** as illustrated to remove piston assembly **9**.

WARNING⚠

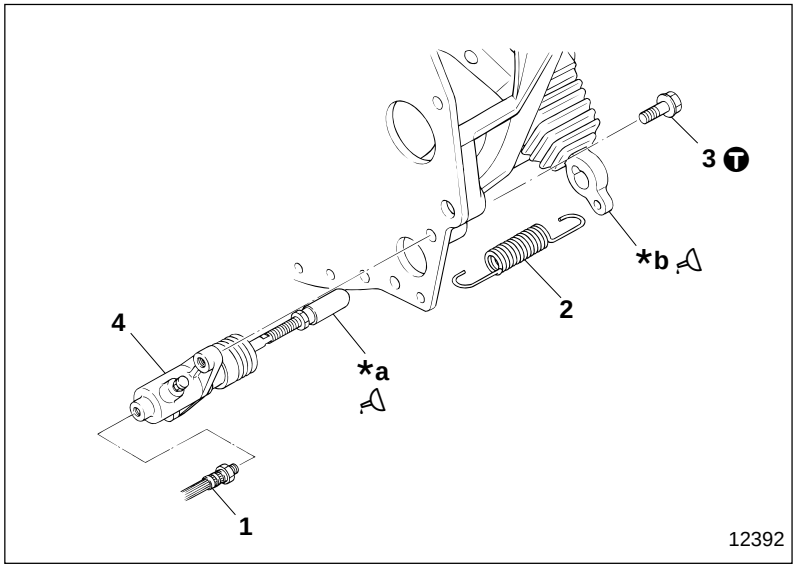
You must apply compressed air gradually when you remove piston assembly 9. If you applied compressed air strongly at one time, the piston assembly would be violently ejected.



[Installation]

Before installing the assembly, apply rubber grease to friction surface **C** of piston assembly **9** and cylinder body **10**.

CLUTCH POWER CYLINDER



● **Removal sequence**

1 Fluid hose
2 Return spring
3 Bolt
4 Clutch power cylinder assembly
P21-15

***a** : Push rod cap
***b** : Clutch release rocker arm

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

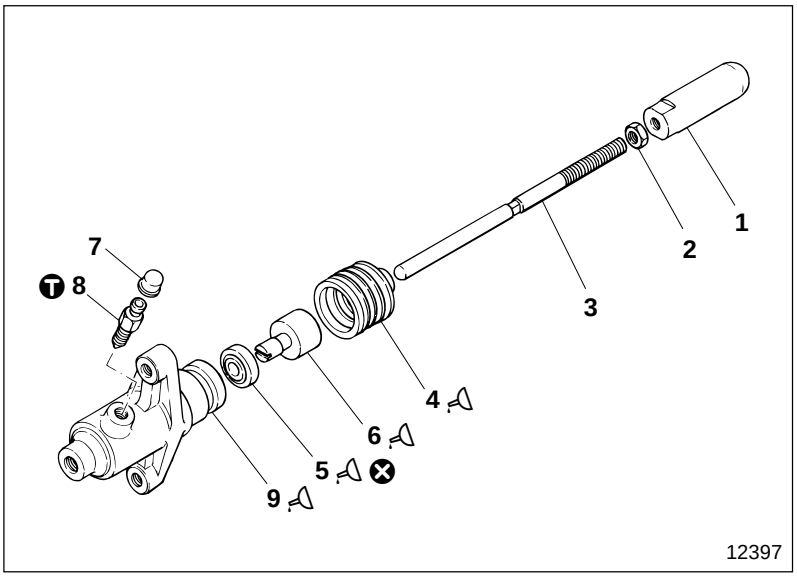
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Clutch power cylinder mounting)	38 to 59 {28 to 43, 3.9 to 6.0}	—

Lubricant

Location	Points of application	Kinds	Quantity
***a, *b**	Contact areas of push rod cap edge and clutch release rocker arm	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Clutch Power Cylinder Assembly



● **Disassembly sequence**

1 Push rod cap
2 Lock nut
3 Push rod
4 Dust cover
5 Piston cup
6 Piston
7 Bleeder cap
8 Bleeder screw
9 Cylinder body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Power cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6, 9	Clearance between piston and cylinder body	[20.64] 0.02 to 0.11 {[0.81] 0.00079 to 0.0043}	0.2 {0.0079}	Replace

Ⓣ Tightening torque

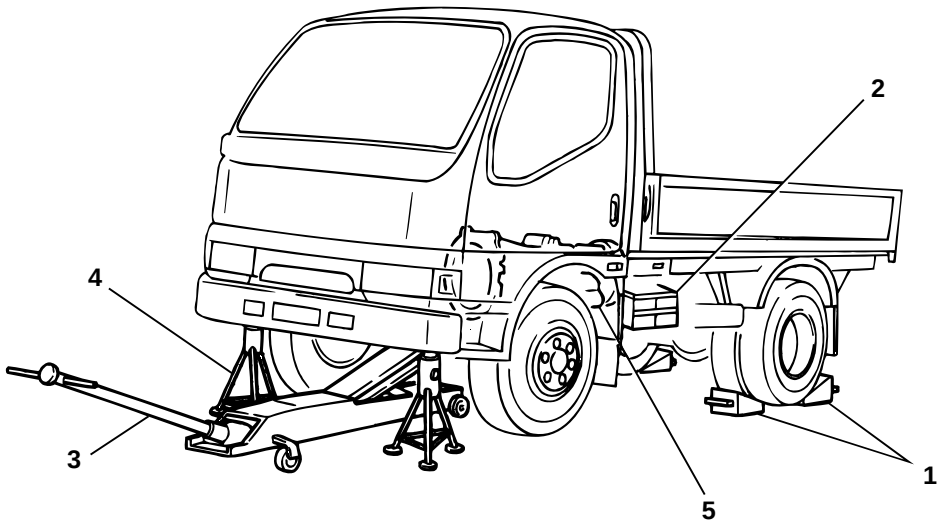
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Bleeder screw	10.8 to 14.7 {8 to 11, 1.1 to 1.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
4	Engagement part of cylinder body	Rubber grease	As required
5, 6, 9	The area extending approximately 15 mm {0.59 in.} from the end surface of cylinder body	Rubber grease	As required
	Piston, piston cup (installation point) and internal surface of cylinder body	Rubber grease	As required

WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY



14121

● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the front axle using a garage jack.
4 Support the front frame on rigid jack stands.
5 Remove the transmission. Gr 22

WARNING⚠

- **Since the parking brake will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid jack stands.**
- **Leave the garage jack and rigid jack stands in place until the entire operation is completed. Never remove them during the operation.**

CAUTION⚠

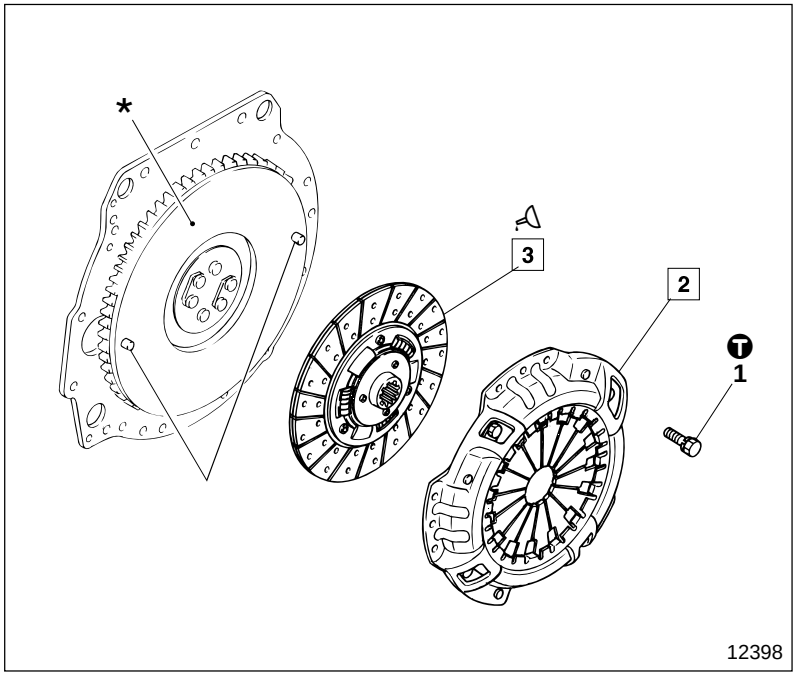
Keep the transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

CLUTCH BODY



● **Removal sequence**

1 Bolt
2 Clutch cover assembly
3 Clutch disc

***** : Flywheel Gr 11B
: Positioning pins (two points)

WARNING

Be careful when you handle pressure plate and lever assembly 2 because it is rather heavy.

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Be careful not to get oily substances on clutch disc 3 surfaces because this will cause the clutch to slip.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2	Flatness of pressure plate		0.05 {0.0020} or less	0.2 {0.0079}	—
	Friction surface of pressure plate (Measured at specified positions)		5.5 {0.22}	4.5 {0.18}	Replace
	Clearance between diaphragm spring and pivot ring		—	Play	Replace
	Finger heights of diaphragm spring uneven		1.0 {0.039} or less	1.3 {0.051}	Correct
3	Clutch disc	Radial runout	1.0 {0.039} or less	1.5 {0.059}	Replace
		Lateral runout	1.0 {0.039} or less	1.5 {0.059}	Replace
		Play in rotation of spline	0.05 to 0.23 {0.0020 to 0.0091}	0.5 {0.020}	Replace
		Depth from facing surface to rivet	1.8 to 2.4 {0.071 to 0.094}	0.2 {0.0079}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

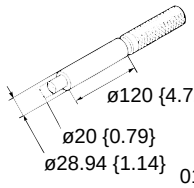
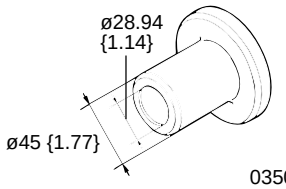
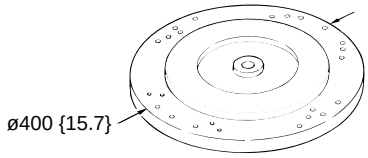
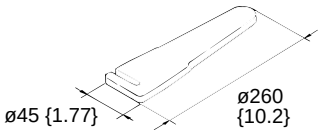
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Clutch cover assembly mounting)	32 to 49 {24 to 36, 3.3 to 5.0}	—

Lubricant

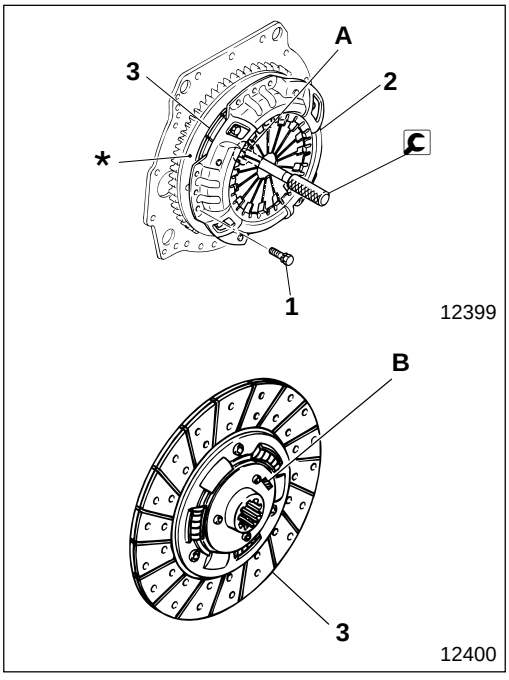
Location	Points of application	Kinds	Quantity
3	Spline of clutch disc	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	3.2 to 4.2 g {0.11 to 0.15 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2, 3	Clutch alignment arbor 	MH061387	Holding of clutch disc
	Sleeve 	MH061425	Inspection of installed height of diaphragm spring
	Plate 	MH061424	Adjustment of diaphragm spring
	Adjust wrench 	MH061426	Adjustment of diaphragm spring

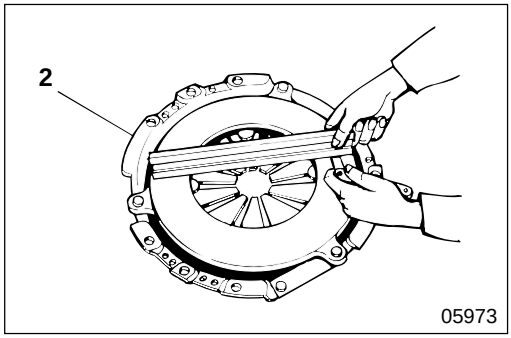
◆ Service procedure



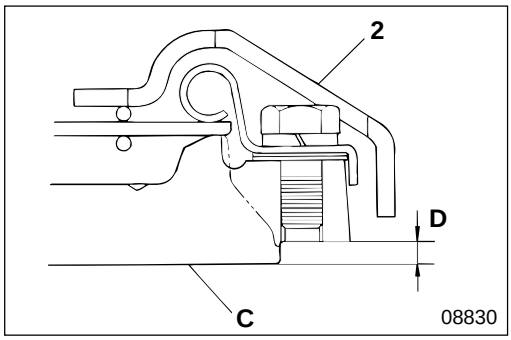
2 Clutch cover assembly

[Removal]

- Insert clutch alignment arbor into pilot bearing **A** on flywheel * to hold clutch disc **3**, and remove clutch cover assembly **2**.
- For installation, follow the removal sequence in reverse.
- Install clutch disc **3** so that part No. B is visible.
- Tighten bolts **1** gradually, in diagonal order, to specified torque.

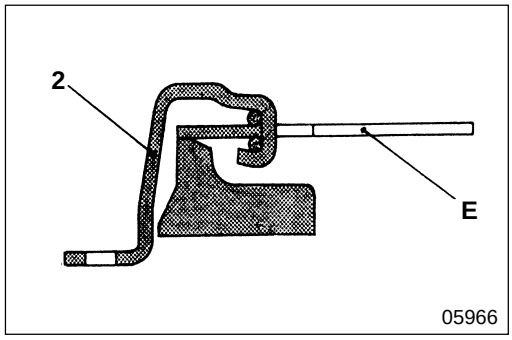


[Flatness of pressure plate]
If the measured value is higher than the limit, replace clutch cover assembly **2**.

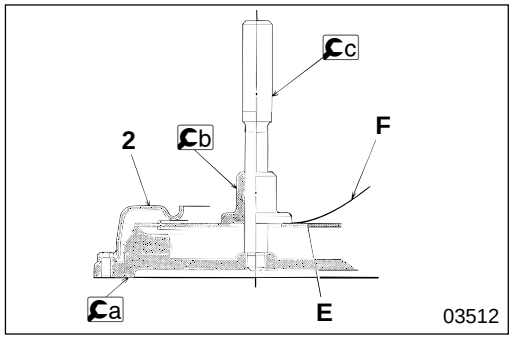


[Friction surface of pressure plate]
Measure pressure plate friction surface **C** at specified position **D** (measuring position of friction surface must be within the maximum and minimum diameters), and if the measured value is lower than the limit, replace clutch cover assembly **2**.

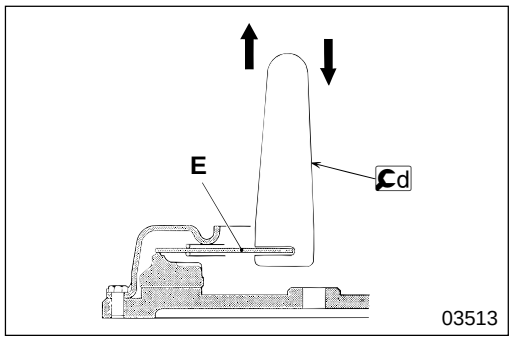
Maximum diameter	298 mm {11.7 in.}
Minimum diameter	192 mm {7.56 in.}



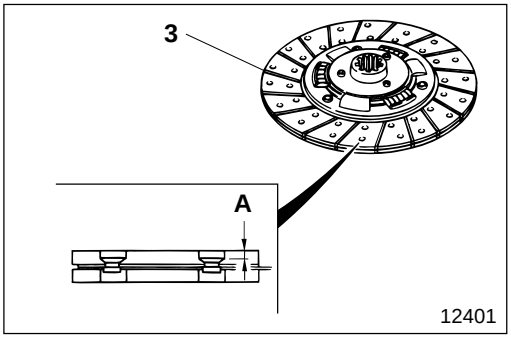
[Inspection]
- Check for play in diaphragm spring **E**.
- If there is play, replace clutch cover assembly **2**.



[Inspection of installation height]
- Place a plate on a surface plate and install clutch cover assembly **2**.
- Install b sleeve and c clutch alignment arbor, measure finger heights of diaphragm spring **E** to see if they are uneven, using feeler gauge **F**. If the measured value is higher than the limit, correct the heights.



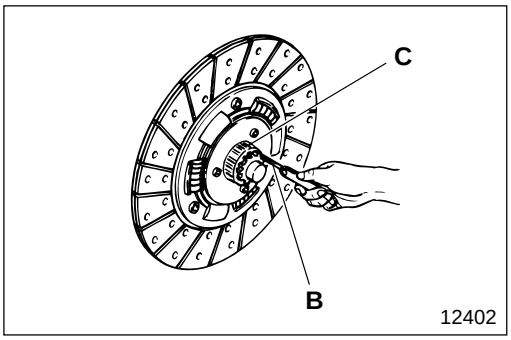
[Correction]
- Correct uneven finger heights of diaphragm spring **E** using d adjusting wrench.



3 Clutch disc

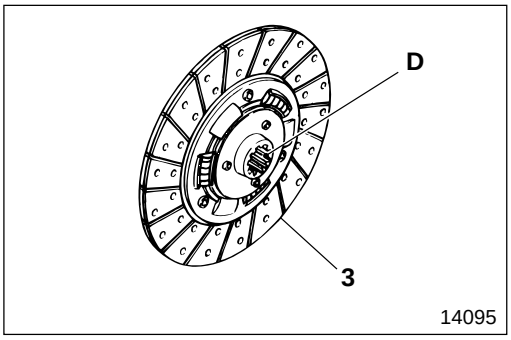
(1) Height of facing

Measure dimension **A** of clutch disc **3**. If the measured value is lower than the limit, replace the clutch disc.



(2) Play in direction of revolution

- Reshape feeler gauge **B** for insertion into drive pinion spline **C**, and measure play. If the measured value is higher than the limit, replace clutch disc **3** or the drive pinion.
- Carry out the same measurement on new clutch disc **3**. If the measured value is higher than the limit, replace the drive pinion.



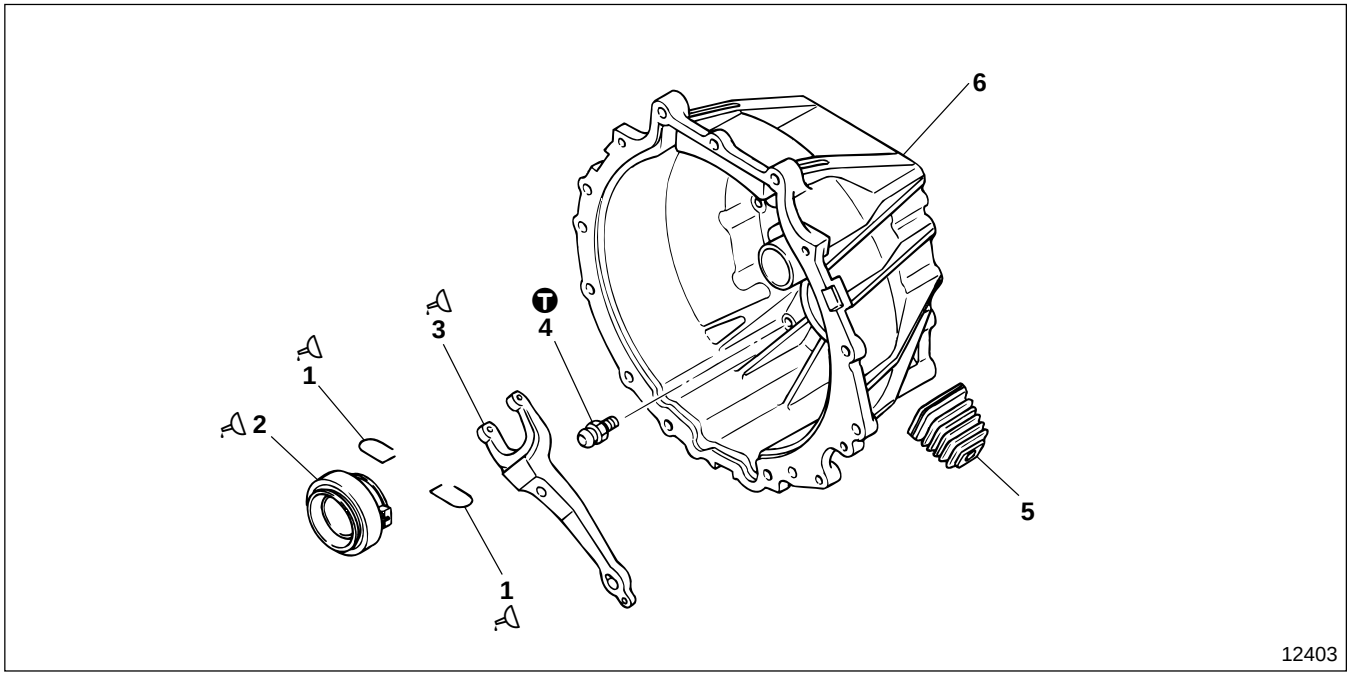
(3) Applying grease

Apply grease evenly to spline **D** entire tooth surface of clutch disc **3**. Apply grease to the grease groove of the spline up to its large diameter.

CAUTION ⚠

Be careful not to apply too much grease because excessive grease causes grease leakage from spline D and can cause the clutch to slip.

CLUTCH CONTROL



● **Disassembly sequence**

1 Retaining spring
2 Clutch release bearing
3 Clutch release rocker arm
4 Rocker arm pivot
5 Clutch rocker arm cover
6 Clutch housing

NOTE

Do not remove rocker arm pivot 4 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Rocker arm pivot	57 {42, 5.8}	—

Lubricant

Location	Points of application	Kinds	Quantity
1 to 3	Friction surfaces of retaining spring, clutch release bearing, and clutch release rocker arm	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

MITSUBISHI
FUSO

Group 22
Manual Transmission

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-22

INDEX

SPECIFICATIONS 22- 2

STRUCTURE AND OPERATION 22- 2

TROUBLESHOOTING 22- 5

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22- 7

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22- 8

GEAR SHIFTER UPPER 22-10

REAR COVER AND REVERSE IDLER GEAR 22-16

TRANSMISSION BODY 22-20

DRIVE PINION ASSEMBLY 22-28

MAINSHAFT ASSEMBLY 22-30

COUNTERSHAFT ASSEMBLY 22-36

TRANSMISSION CONTROL 22-40

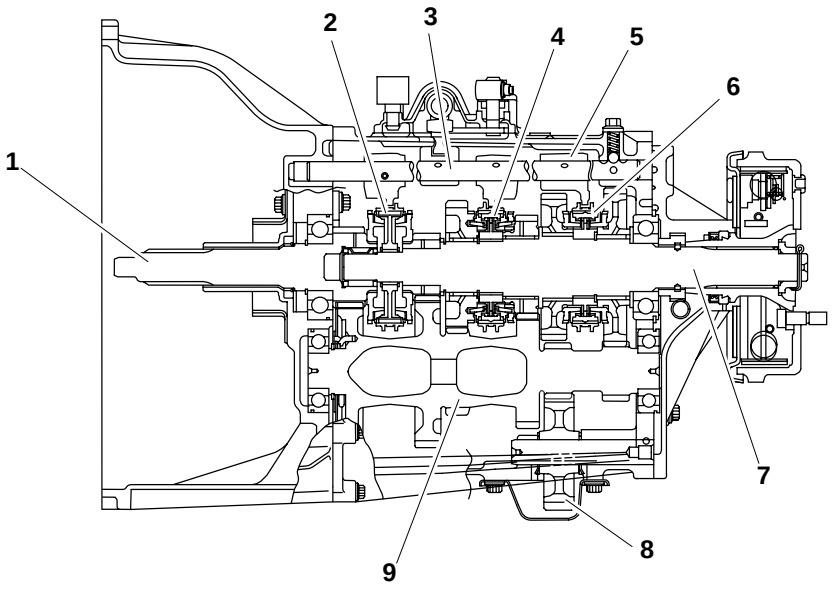
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Mode of control		Floor shift remote control
Transmission model		M035S5
Gear ratio	1st	5.380
	2nd	3.028
	3rd	1.700
	4th	1.000
	5th	0.722
	Reverse	5.380
Oil capacity	L {qts}	Approximately 3.7 {3.9}
Mass	kg {lb}	Approximately 83 {183}

STRUCTURE AND OPERATION

Transmission Assembly

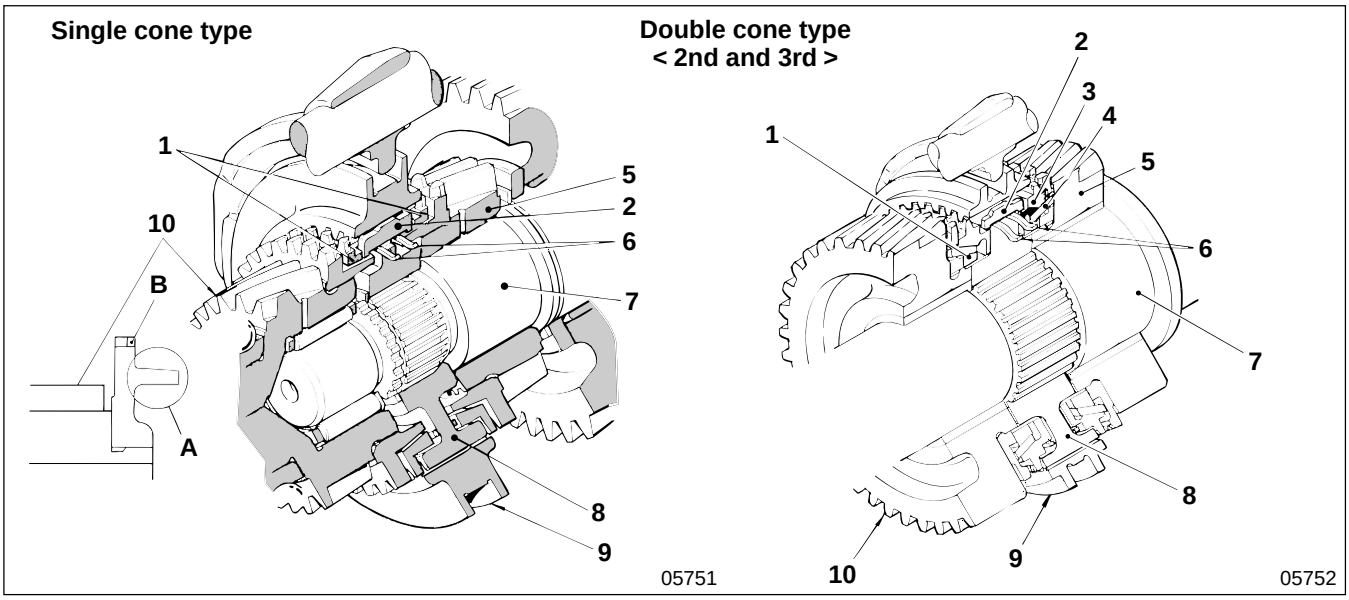


Ⓟ45171

1 Drive pinion
2 4th and 5th synchronizer assembly
3 Shift rail
4 2nd and 3rd synchronizer assembly
5 Shift fork
6 1st and reverse constant-mesh assembly
7 Main shaft
8 Reverse idler gear
9 Countershaft

The transmission changes revolution and torque generated by the engine into those that match the vehicle's power requirement (driving force). Revolution and torque are increased or decreased by making a selection from several sets of engaged gears. The transmission uses an interlock mechanism to avoid double engagement and the non-backlash mechanism reduces the idling noise of the transmission when the engine is idling.

Synchromesh Mechanism



1 Synchronizer ring (Single cone type)
Inner synchronizer ring (Double cone type)
2 Shifting key
3 Outer synchronizer ring (Double cone type)
4 Center cone (Double cone type)
5 Overdrive gear (Single cone type)
3rd gear (Double cone type)
6 Shifting key spring
7 Mainshaft
8 Synchronizer hub
9 Synchronizer sleeve
10 Drive pinion (Single cone type)
2nd gear (Double cone type)

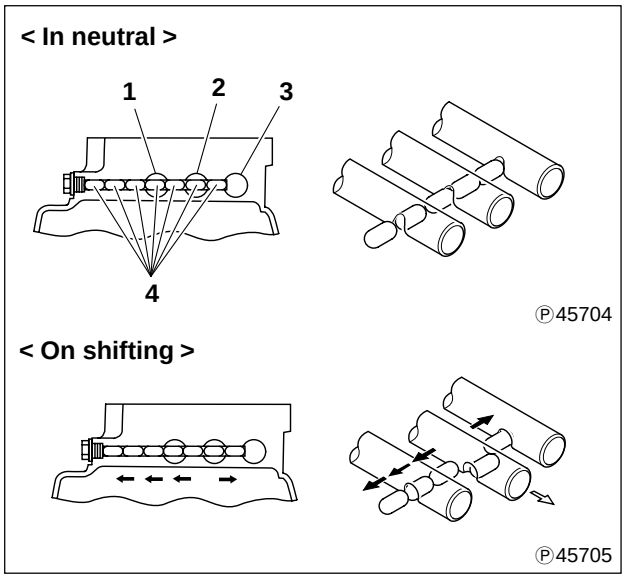
A : Taper cone
B : Dog clutch

The synchromesh mechanism synchronizes the rotating speed of mainshaft **7** and associated synchronizer hub **8** with the rotating speed of the gears to be selected when shifting gear.

Single cone type
In this cone type, gear taper cone **A** acts as a cone clutch for synchronization with synchronizer ring **1**. So the rotating speed of the gear to be synchronized with synchronizer hub **8** gradually changes to the matching speed. When synchronizer sleeve **9** moves into the appropriate position efficiently through this process and engages with the synchronizer hub and dog clutch **B** of the gear to be selected, gear shift is completed.

Double cone type < only for 2nd and 3rd gear >
In this cone type, unlike the single cone type, inner synchronizer ring **1**, center cone **4** and outer synchronizer ring **3** are used instead of just the synchronizer ring. The center cone is between the inner synchronizer ring and the outer synchronizer ring and reduces synchronizing time through more efficient operation of the cone clutch.

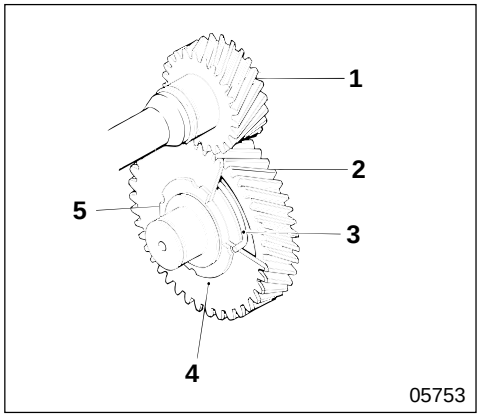
Interlock Mechanism



1 4th and 5th shift rail
2 2nd and 3rd shift rail
3 1st and reverse shift rail
4 Interlock pin

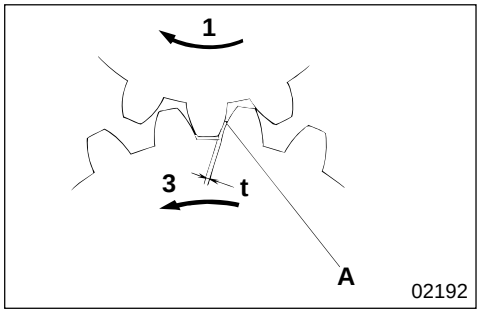
The interlock mechanism is designed to avoid double engagement of gears. When 2nd and 3rd shift rail **2** is shifted, interlock pins other than interlock pin **4** in the 2nd and 3rd shift rail are pushed by the 2nd and 3rd shift rail to lock other shift rails.

* Non-Backlash Mechanism

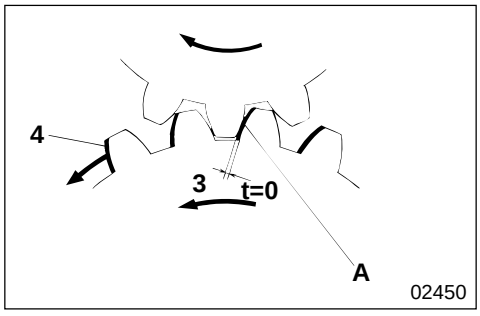


1 Drive pinion
2 Countershaft constant mesh gear
*** 3** Sub-gear spring
*** 4** Sub-gear
*** 5** Sub-gear plate

Sub-gear spring **3** is between sub-gear **4** and countershaft constant mesh gear **2**. The sub-gear is engaged with drive pinion **1** together with countershaft constant mesh gear, being turned in the contracting direction of the sub-gear spring.



The revolution of drive pinion **1** varies in accordance to the engine revolution when idling.
Without a non-backlash mechanism, backlash **t** at point **A** would vary between zero to the maximum, causing a gear grinding noise.



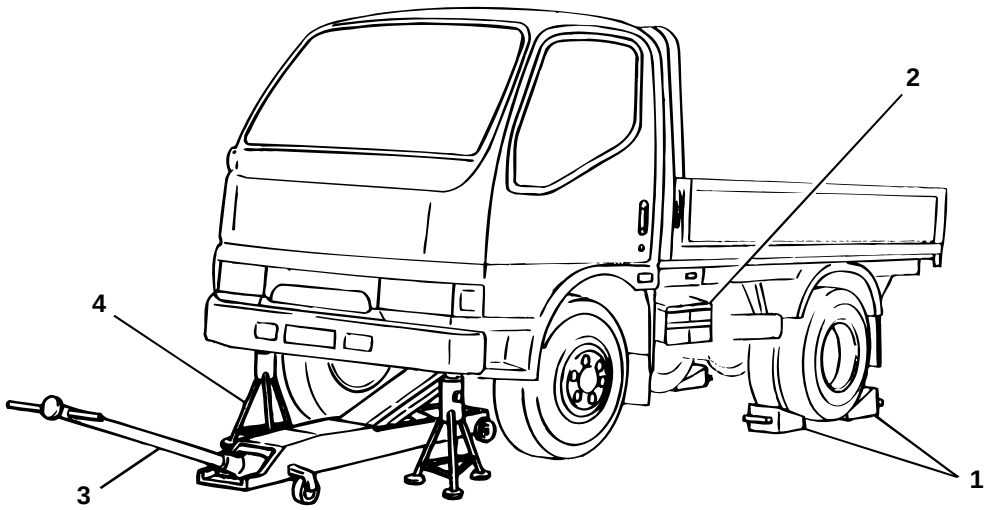
With a non-backlash mechanism, sub-gear **4** maintains backlash **t** at zero at point **A** regardless of change in revolution caused by the engine, eliminating gear grinding noise, resulting in a reduction of idling noise.

*** NOTE: Not used on products for U.S.A.**

Possible causes \ Symptoms		Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise while cruising	Noise when changing gear	Remarks
Transmission body faulty	Mainshaft rear lock nut loose	○	○				
	Mainshaft thrust washer worn	○	○				
	Mainshaft bearing worn or damaged	○	○				
	Synchronizer ring and synchronizer sleeve spline worn	○					
	Synchronizer ring and gears taper cone area worn		○				
	Mainshaft pilot bearing worn or damaged			○	○		
	Drive pinion bearing worn or damaged			○			
	Non-backlash mechanism faulty			○			
	Countershaft bearing worn or damaged			○			
	Needle bearings of gears worn or damaged			○	○		
	Reverse idler gear and power take-off idler gear backlash excessive			○			
	Mainshaft and countershaft bearings worn or damaged				○		
	Mainshaft and countershaft gears backlash excessive				○		
	Splines of gears worn					○	
	Gears damaged				○		
	Gear oil insufficient				○		
Control mechanisms faulty	Control cable joint play	○	○				
	Control rod joint lubricated insufficiently		○				
	Bushings worn	○	○				
	Control rod length adjusted incorrectly		○				
	Control rod bent	○					
	Set board assembly bushings worn	○					
	Shift rail steel ball and groove worn	○					
	Shift rail poppet spring fatigued or fractured	○					
	Shift rail friction movement faulty		○				
	Shift fork claw worn		○				
	Shift fork bent		○				

TROUBLESHOOTING

Possible causes / Symptoms			Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise while cruising	Noise when changing gear	Remarks
Clutch faulty	Clutch engagement poor			○			○	Gr 21
	Clutch pedal play adjusted incorrectly		○					
Synchronizer faulty	Single cone type	Contacting surfaces of synchronizer ring and gear assembly taper cone worn		○			○	
	Double cone type	Contacting surfaces of synchronizer inner and outer rings and center cone worn		○			○	
	Shifting key worn						○	
	Shifting key spring deteriorated or damaged						○	
	Synchronizer sleeve worn or damaged					○	○	



14096

● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect negative battery cable. Gr 54
3 Jack up the front axle on a garage jack.
4 Support the front frame on rigid stands.

WARNING⚠

- **Since the parking brake will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid stands.**
- **Leave the garage jack and rigid stands in place until the entire operation is completed. Never remove them during the operation.**

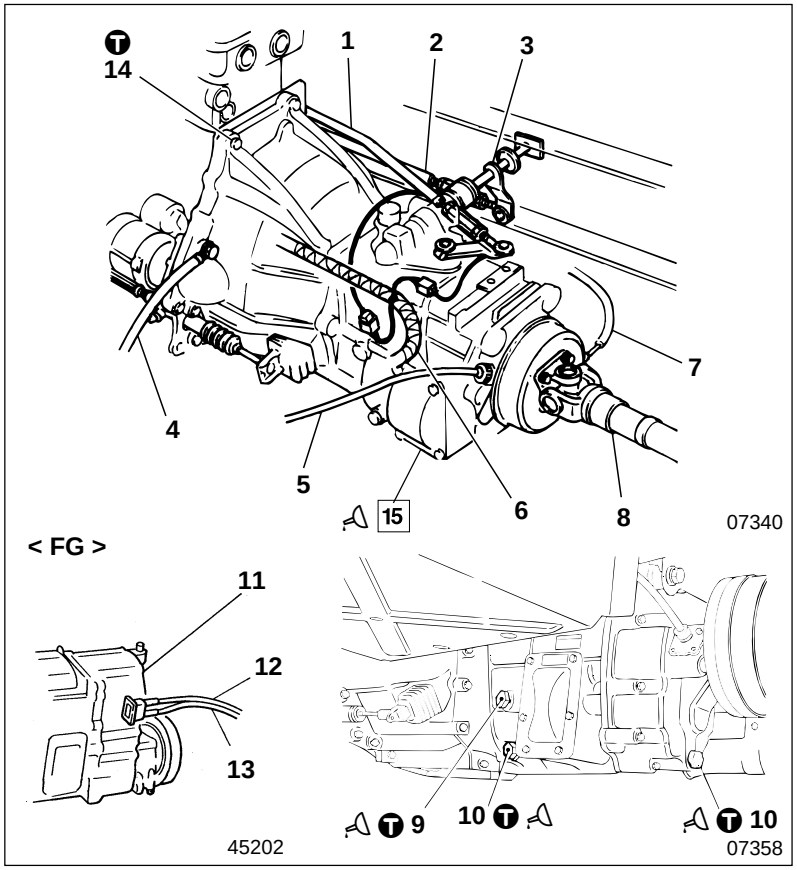
CAUTION⚠

Keep the transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



● **Removal sequence**

1 Selector rod P22-40
2 Shift rod P22-40
3 Cross shaft P22-52
4 Harness (Ground)
5 Speedometer cable
6 Chassis harness
7 Parking brake Gr 36
8 Propeller shaft Gr 25
9 Inspection plug
10 Drain plug
11 Transfer Gr 24
12 HIGH/LOW control cable < FG >
13 2H/4H control cable < FG >
14 Bolt
15 Transmission assembly

WARNING

The engine is hot immediately after it has stopped, so take care not to burn yourself.

NOTE

After removing propeller shaft 8, tie it to the frame at the height of installation assembly using a piece of rope, etc.

● **Installation sequence**

Follow the removal sequence in reverse.

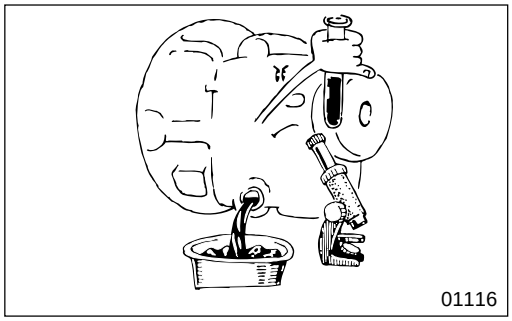
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
9	Inspection plug	69±15 {51±11, 7±1.5}	—
10	Drain plug	69±15 {51±11, 7±1.5}	—
14	Bolt (Transmission assembly mounting)	47 {35, 4.8}	M10×1.25
		82 {61, 8.4}	M12×1.25

Lubricant and sealant

Location	Points of application	Kinds	Quantity
9	Thread area of inspection plug	THREEBOND 1105D	As required
10	Thread area of drain plug	THREEBOND 1105D	As required
15	Spline of drive pinion	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

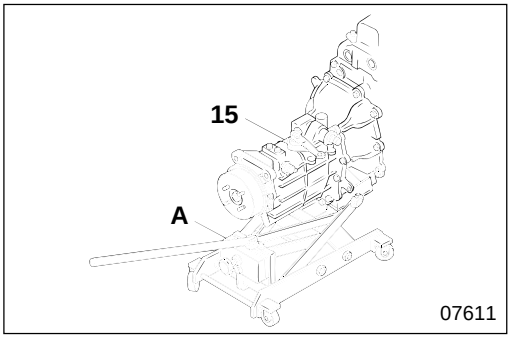


◆ Service procedure

● **Replacement of oil**

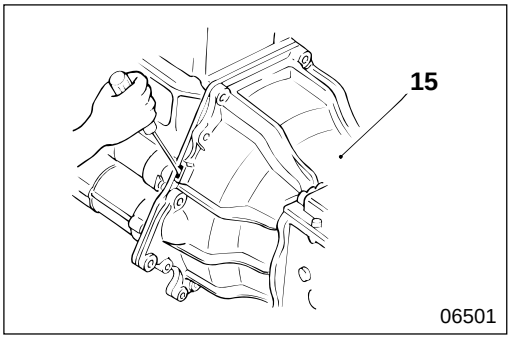
[Draining]
- When draining oil, check the quantity and quality of oil, especially for small pieces of metal and metal dust.
- Clean drain plug **10** before reinstalling it because it is magnetic.

[Filling]
- Check that drain plug **10** is tightened in the transmission case at specified torque.
- Pour in gear oil until the oil overflows from the inspection hole. (For oil quantity, see specifications.)



15 **Transmission assembly**

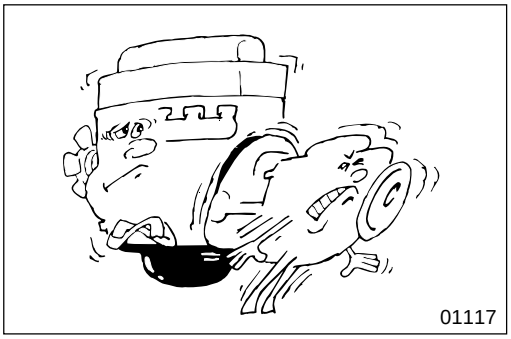
[Supporting transmission]
Support transmission assembly **15** on transmission jack **A**.



[Removal]
- Insert a screwdriver into the three removal grooves to remove transmission assembly **15** from the engine.

CAUTION

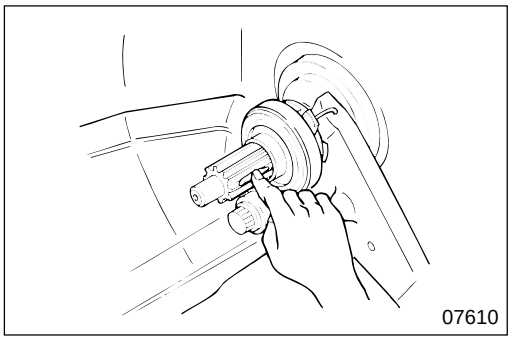
Make sure that you remove hoses and cables correctly during service operations.



- Move transmission assembly **15** backward until the spline of the drive pinion is detached from the clutch.

CAUTION

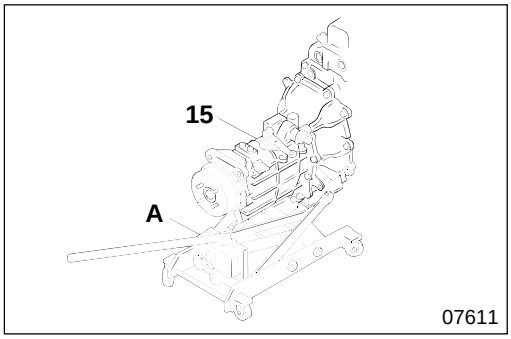
Make sure that you pull transmission assembly 15 out in a straight line. If you seesaw the transmission assembly violently, you will damage the spline that connects the drive pinion and the clutch.



[Installation]
- Check the spline of the drive pinion for rust. If rust is found, remove it using a wire brush.
- Rub grease onto the friction surfaces of the drive pinion using your hand.

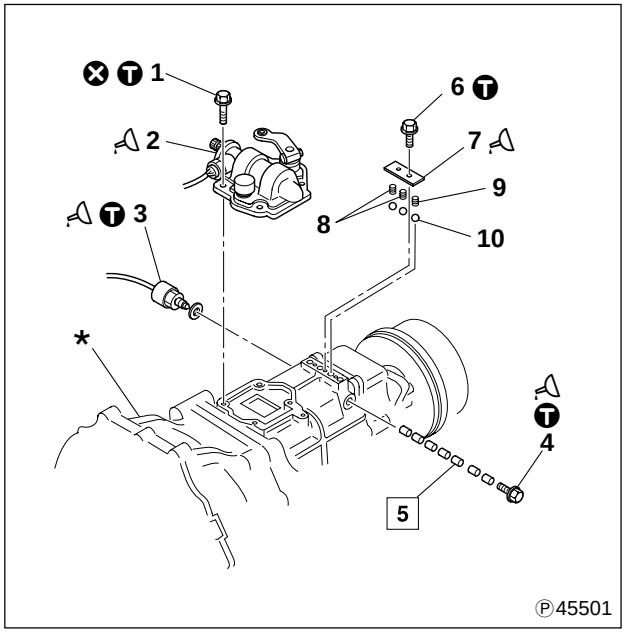
CAUTION

Make sure that you apply only the necessary amount of grease because too much grease could drip and cause clutch slippage.



- Support transmission assembly **15** on transmission jack **A**, and insert the transmission assembly into the pilot bearing of the flywheel paying attention to the drive pinion spline.
- Tighten bolt **14** at specified torque to mount transmission assembly **15** to the engine.

GEAR SHIFTER UPPER



● **Disassembly sequence**

1 Bolt
2 Gear shifter upper assembly
3 Backup lamp switch
4 Screw plug
5 Interlock pins
6 Bolt
7 Poppet spring plate
8 Poppet springs < without 4th and 5th >
9 Poppet springs < 4th and 5th >
10 Steel balls

* : Transmission body
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
8	Poppet spring free length < without 4th and 5th >	22.85 {0.90}	22.00 {0.87}	Replace
9	Poppet spring free length < 4th and 5th >	24.96 {0.98}	24.00 {0.94}	Replace Color coding: Blue

Ⓣ Tightening torque

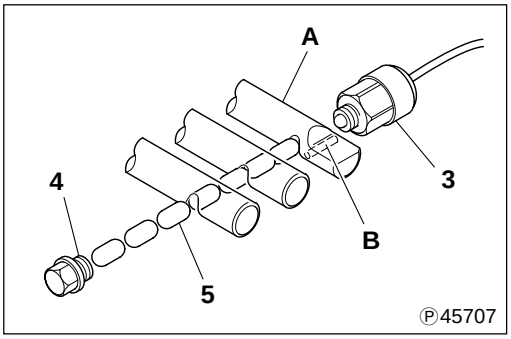
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Gear shifter upper assembly mounting)	24 {17, 2.4}	—
3	Backup lamp switch	29 to 39 {22 to 29, 3 to 4}	—
4	Screw plug	37 {27, 3.8}	—
6	Bolt (Poppet spring plate mounting)	24 {17, 2.4}	—

Sealant

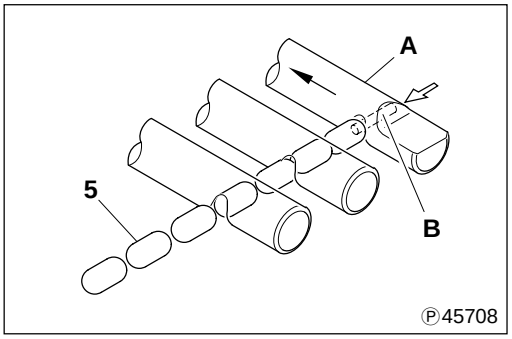
Location	Points of application	Kinds	Quantity
2	Contact surface of transmission case	THREEBOND 1104J	As required
3	Thread area of backup lamp switch	THREEBOND 1215	As required
4	Thread area of screw plug	THREEBOND 1215	As required
7	Contact surface of transmission case	THREEBOND 1215	As required

◆ Service procedure



5 **Removal of interlock pin**

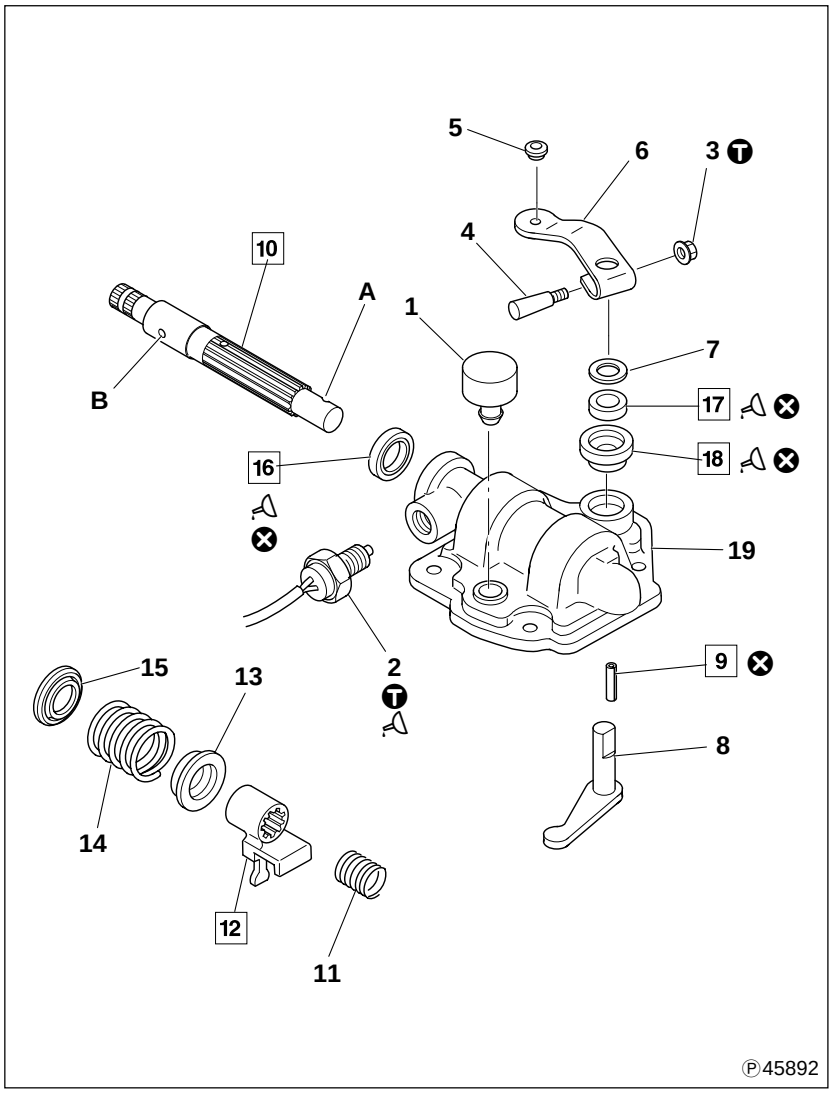
- 1st and reverse shift rail **A** is provided with hole **B** (ø3 mm {0.12 in.}) for the removal of interlock pin **5**.



- When 1st and reverse shift rail **A** is shifted into reverse, hole **B** for removal of the interlock pin aligns with the interlock pin holes of the other shift rails, backup lamp switch **3** installation hole and screw plug **4** hole.
- Remove interlock pin **5** from back-up lamp switch **3** installation hole side using a wire.

GEAR SHIFTER UPPER

Gear Shifter Upper Assembly



● **Disassembly sequence**

1 Air breather
2 Neutral switch Gr 54
3 Nut
4 Lock pin
5 Bushing
6 Gear selector lever
7 Washer
8 Gear selector lever
9 Spring pin
10 Torsion shaft
11 4th and 5th return spring
12 Gear shift slide lever
13 Spring retainer
14 1st and reverse return spring
15 Spring retainer
16 Oil seal
17 Oil seal
18 Bushing
19 Selector lever case

A : Notch for spring pin
B : Recess for interlock switch
⊗ : Non-reusable parts

NOTE

Do not remove bushing 18 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Make sure that you turn gear selector lever 8 while assembling it to prevent damage to the lip area of oil seal 17.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
11	4th and 5th return spring free length	40.05 {1.58}	38.05 {1.50}	Replace
14	1st and reverse return spring free length	39.9 {1.57}	37.9 {1.49}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

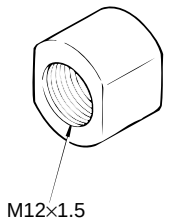
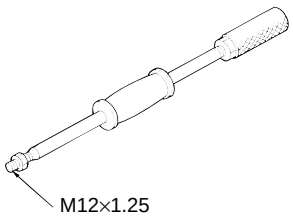
Location	Parts to be tightened	Tightening torque	Remarks
2	Neutral switch	49±2.9 {36±2.2, 5±0.3}	—
3	Nut (Lock pin mounting)	6.9 {5.1, 0.7}	—

Lubricant and sealant

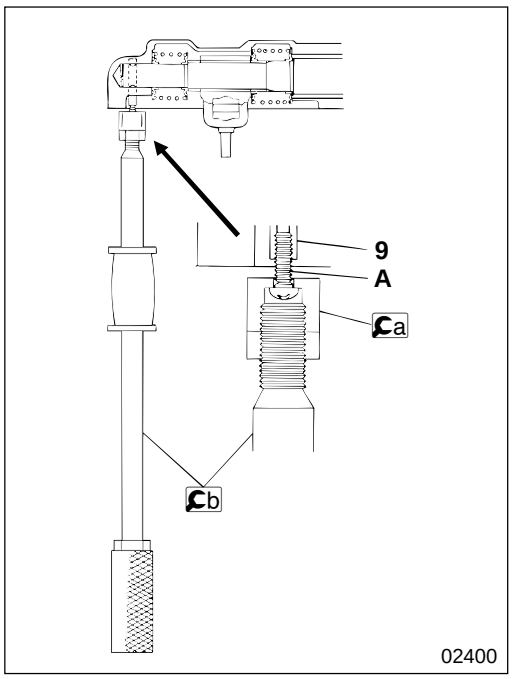
Location	Points of application	Kinds	Quantity
2	Thread area of neutral switch	THREEBOND 1104J	As required
16	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Inner surface of gear selector lever shaft bushing and its friction surface	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Contact surfaces between bushing outer surface and selector lever case	THREEBOND 1104J	As required

Special tools

Unit : mm {in.}

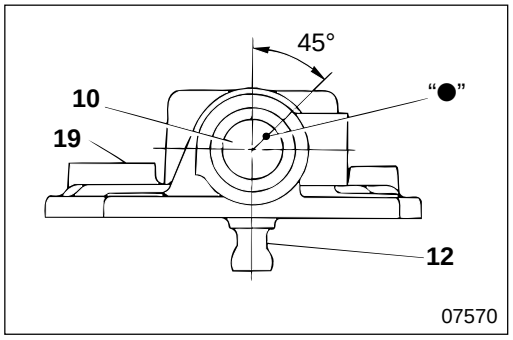
Location	Tool name and shape	Part No.	Application
9	Spring pin puller  02399	MH062445 (Obtain Locally)	Removal of spring pin
	Reverse shaft puller  02118	03726-82000	

◆ Service procedure



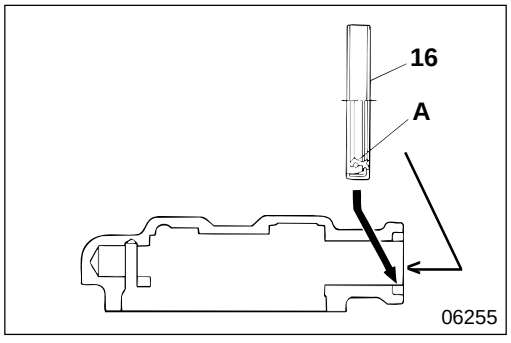
9 **Removal of spring pin**

- Tap spring pin **9** using an M4 tap.
- Attach a spring pin puller with an M4 screw **A** of appropriate length, and pull out spring pin **9** using b reverse shaft puller.



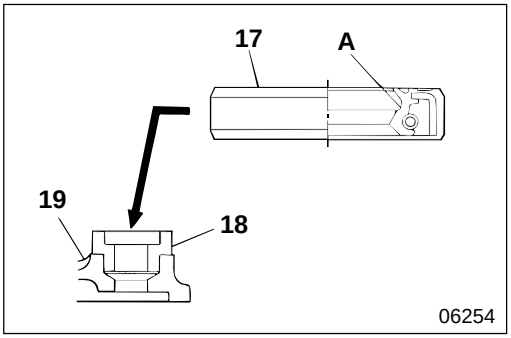
10 **12** **Installation of torsion shaft and gear shift slide lever**

When you install torsion shaft **10**, position punch mark "●" on the tip of the torsion shaft end and gear shift slide lever **12** as illustrated.



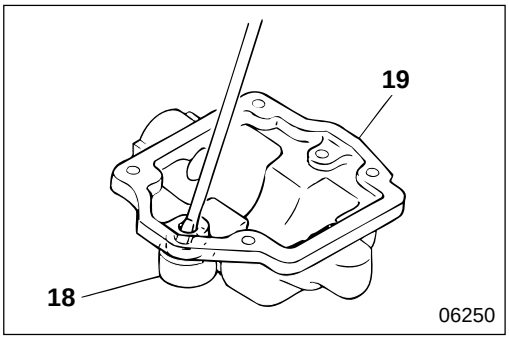
16 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **16**, and press-fit evenly in the direction as illustrated.



17 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **17** with bushing **18** press-fitted onto selector lever case **19**, and press-fit evenly in the direction as illustrated.

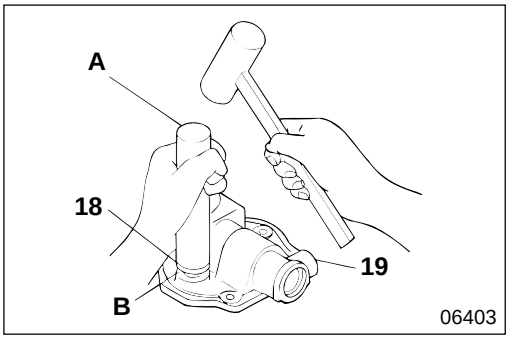


18 **Bushing**

[Removal]
Bushing **18** is press-fitted onto selector lever case **19**. For replacement, remove using a screwdriver.

CAUTION

Be careful not to damage selector lever case 19.

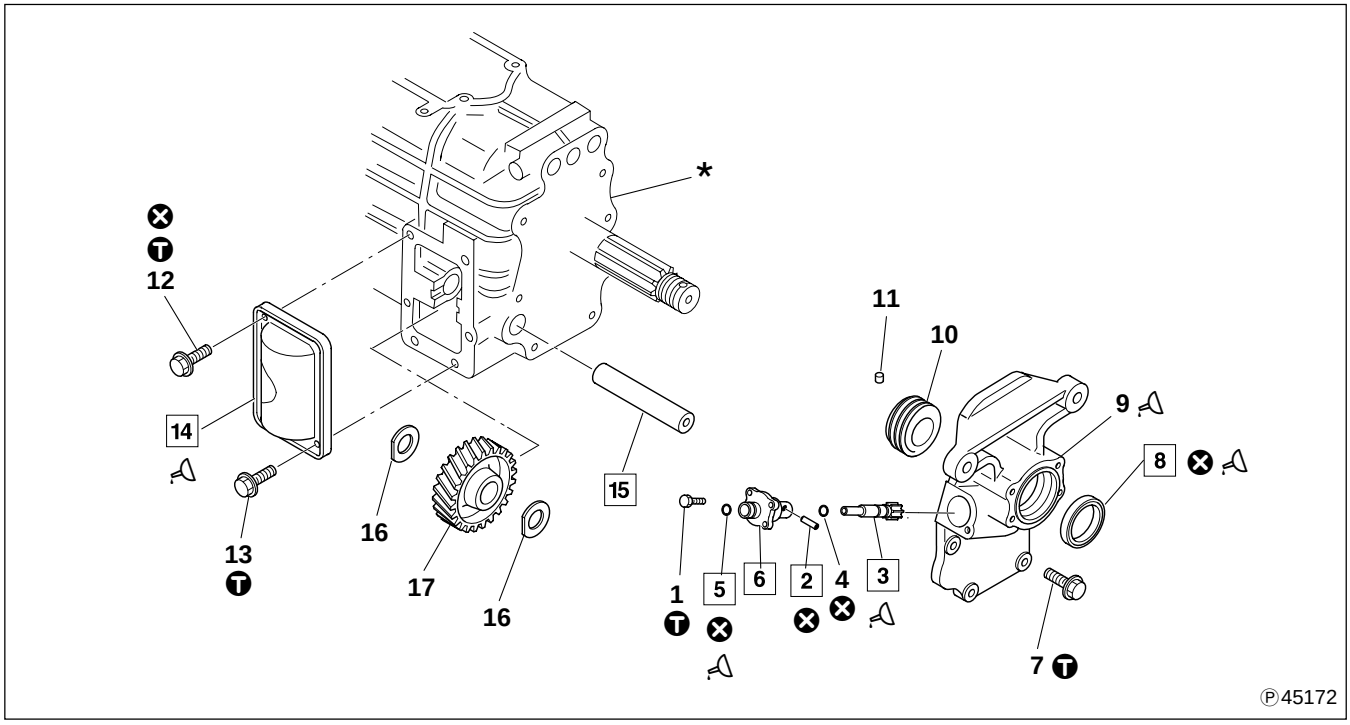


[Press-fitting]
Clean the inner surface of selector lever case **19**, and drive bushing **18** evenly into the case using bar **A** (approximately ø30 mm {1.18 in.}) taking care not to damage the case.
After press-fitting, apply sealant to bushing outer side **B**.

CAUTION

Make sure that you prevent sealant from sticking to the inner surface of bushing 18.

REAR COVER AND REVERSE IDLER GEAR



● **Disassembly sequence**

1 Bolt < FE >
2 Spring pin < FE >
3 Speedometer gear < FE >
4 O-ring < FE >
5 Oil seal < FE >
6 Speedometer gear bushing < FE >
7 Bolt < FE >
8 Oil seal < FE >
9 Rear cover < FE >
10 Speedometer worm < FE >
11 Pin < FE >
12 Bolt (Upper: 2)
13 Bolt (Lower: 4)
14 Reverse idler gear cover
15 Reverse idler gear shaft
16 Side washer
17 Side washer
18 Reverse idler gear

* : Transmission body
⊗ : Non-reusable parts

As for FG refer to Gr 24

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3, 6	Clearance between speedometer gear and speedometer gear bushing	[12] 0.04 to 0.09 {[0.47] 0.016 to 0.0035}	0.15 {0.0059}	Replace
15, 17	Clearance between reverse idler gear shaft and reverse idler gear	[24] 0.05 to 0.08 {[0.94] 0.0020 to 0.0031}	0.20 {0.0079}	—
17	End play of reverse idler gear	0.26 to 0.64 {0.010 to 0.025}	0.9 {0.035}	Replace side washer

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

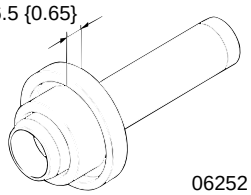
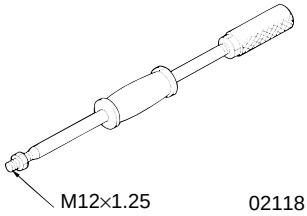
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Speedometer gear bushing mounting)	24 {17, 2.4}	—
7	Bolt (Rear cover mounting)	44 {33, 4.5}	—
12, 13	Bolt (Reverse idler gear cover mounting)	44 {33, 4.5}	—

Lubricant and sealant

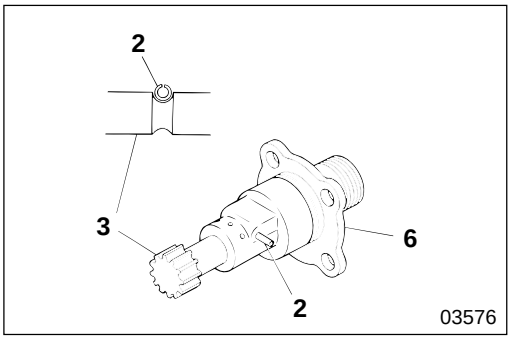
Location	Points of application	Kinds	Quantity
3	Friction surfaces of speedometer gear and speedometer gear bushing	Molybdenum disulfide base grease	As required
5	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
8	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Contact surfaces between rear cover and transmission case	THREEBOND 1215	As required
14	Reverse idler gear cover mounting face	LOCTITE 5999	As required

Special tools

Unit : mm {in.}

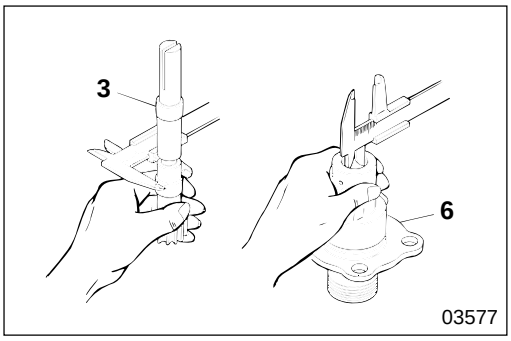
Location	Tool name and shape	Part No.	Application
8	Oil seal installer 	MH062691	Installation of rear cover oil seal
15	Reverse shaft puller 	03726-82000	Removal of reverse idler gear shaft

◆ Service procedure



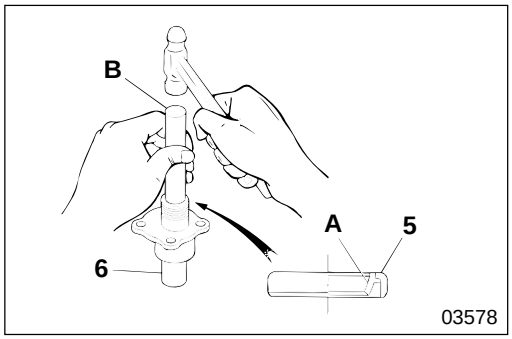
2 **Driving-in spring pin**

Drive spring pin **2** into speedometer gear bushing **6** with the opening in the opposite direction to speedometer gear **3**, as illustrated.



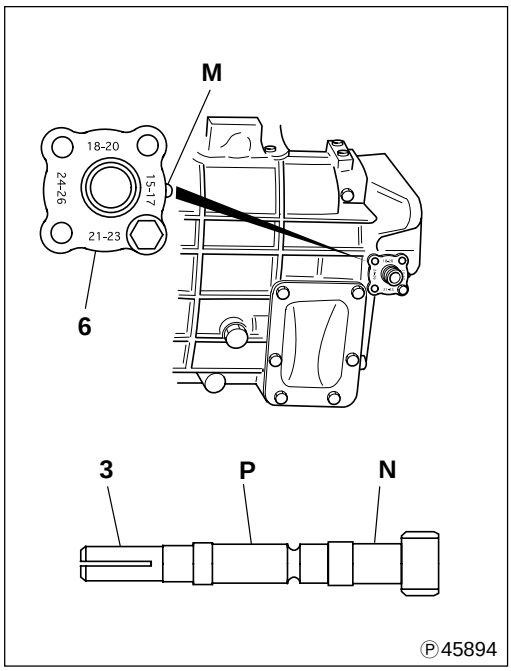
3 **6** **Clearance between speedometer gear and speedometer gear bushing**

If the clearance is higher than the limit, replace faulty parts.



5 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **5**, and drive oil seal evenly into speedometer gear bushing **6** in the direction as illustrated using bar **B** (approximately ø14 mm {0.55 in.}).



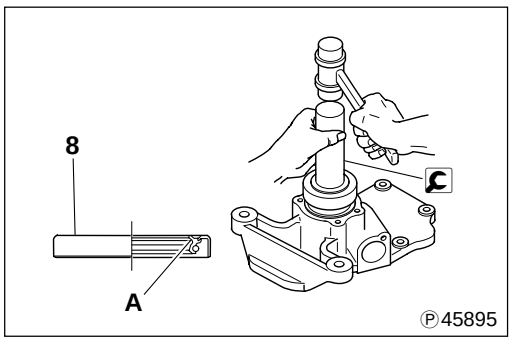
6 **Installation of speedometer gear bushing**

Due to its eccentric center arrangement, speedometer gear bushing **6** allows replacement of speedometer gear **3** with gears having a different number of teeth by changing only the installation direction, the worm gear does not have to be changed.

When installing the bushing, align stamped number, identical to the number of speedometer gear teeth, with alignment mark **M**.

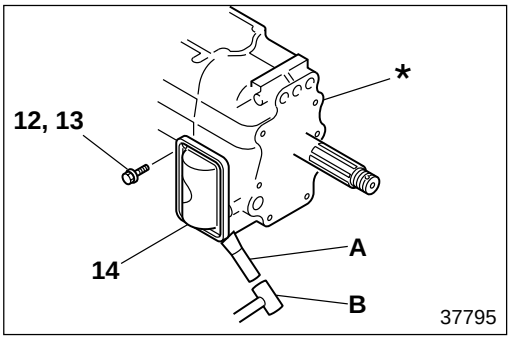
The identification mark is stamped on points **N** or **P**. The following table shows the relationship between the identification marks and the number of speedometer gear teeth:

Identification mark	A	B	C	D	E	F	G	H	I	J	K	L
Number of teeth	15	16	17	18	19	20	21	22	23	24	25	26
Gear ratio	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2



8 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **8**, and press-fit it.



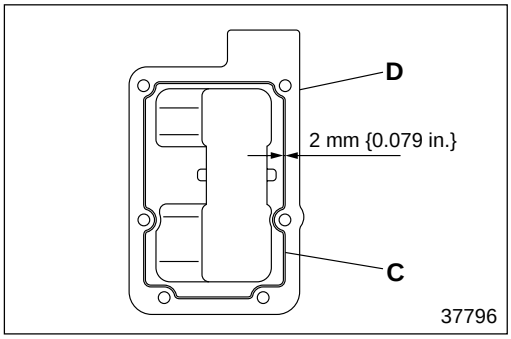
13 **Reverse idler gear cover**

[Removal]

- After removing bolt **12**, **13** insert scraper **A** between transmission body * from the lower right or left of reverse idler gear cover **14**. Use a plastic hammer **B**, if necessary.

- With the scraper **A** inserted, push forward the scraper clockwise and counterclockwise to the upper part of reverse idler gear cover **14** along the flange of the cover, then removing the cover.

- Be sure to get rid of all the sealant adhered to reverse idler gear cover **14** and the flange surface of the transmission body *, by using the scraper **A**.



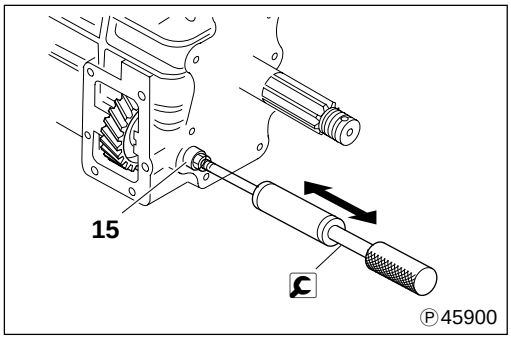
[Installation]

- Apply the sealant **C** on the installation surface **D** of reverse idler gear cover **14** (either transmission body or cover) smoothly and continuously by using a special nozzle (nozzle diameter ø2 mm {0.079}).

- After applying the sealant **C**, assemble reverse idler gear cover **14** within five minutes, and tighten it with the specified torque using bolts.

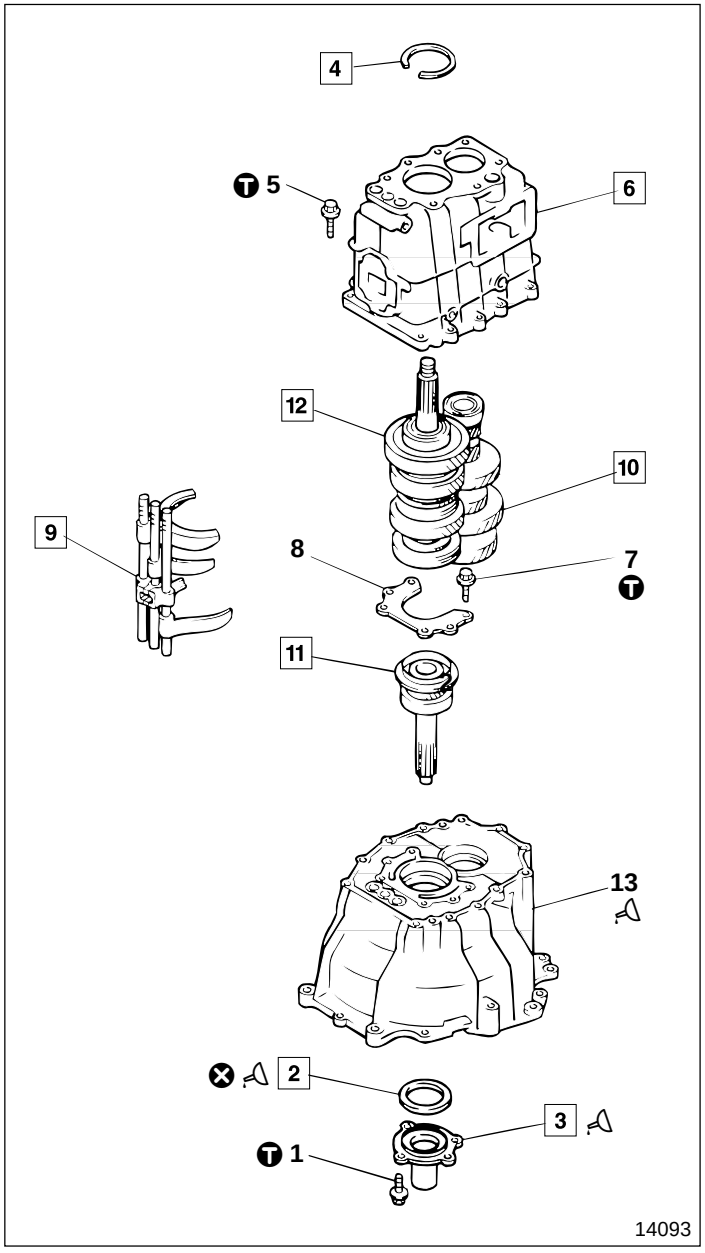
CAUTION⚠

- **Clean all the parts beforehand when applying sealant C.**
- **When using the sealant C, do not apply it uniformly and flatly to whole surface since it will become hard to remove due to its strong bonding power.**
- **Wait at least thirty (30) minutes after assembling for sealant to dry prior to adding oil.**



15 **Removal of reverse idler gear shaft**

TRANSMISSION BODY



● **Disassembly sequence**

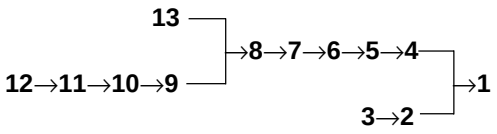
1 Bolt
2 Oil seal
3 Front bearing retainer
4 Snap ring
5 Bolt
6 Transmission case
7 Bolt
8 Bearing retainer
9 Shift rail and shift fork P22-26
10 Countershaft assembly P22-36
11 Drive pinion assembly P22-28
12 Mainshaft assembly P22-30
13 Clutch housing

⊗ : Non-reusable parts

NOTE

- **After removing parts 1 to 3, disassemble the transmission assembly with clutch housing 13 placed stably on a flat surface.**
- **Remove parts 9 to 12 as a group. Note that shift rail and shift fork 9 can be disassembled on their own when parts 9 to 12 are not disassembled. P22-26**

● **Assembly sequence**



Tightening torque

Unit : N·m {ft.lbs, kgf·m}

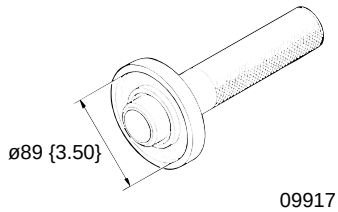
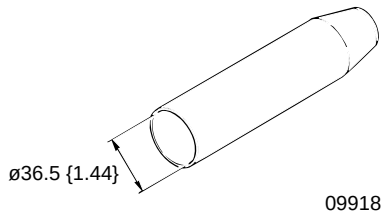
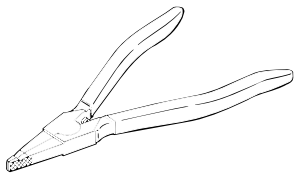
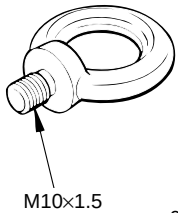
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front bearing retainer mounting)	44 {33, 4.5}	—
5	Bolt (Transmission case mounting)	54 {40, 5.5}	—
7	Bolt (Bearing retainer mounting)	44 {33, 4.5}	—

Lubricant and sealant

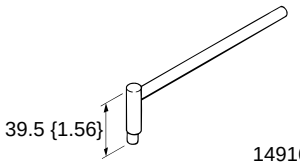
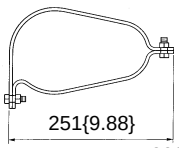
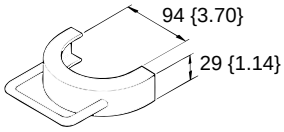
Location	Points of application	Kinds	Quantity
2	Front bearing retainer oil seal lip area	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
3	Contact surfaces between front bearing retainer and clutch housing assembly	THREEBOND 1215	As required
13	Contact surfaces between clutch housing assembly and transmission case	THREEBOND 1215	As required

Special tools

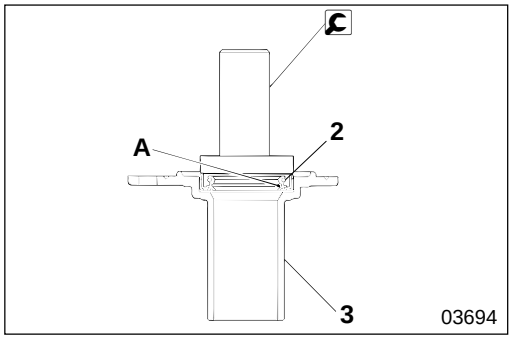
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Oil seal installer  09917	MH062714	Installation of front bearing retainer oil seal
2, 3	Oil seal guide  09918	MH063322	Protection of front bearing retainer oil seal
4	Snap ring expander  01137	MH061268 (Obtain Locally)	Removal and installation of snap ring
6	Eye bolt  01140	MH062340	Lifting up transmission case

Unit : mm {in.}

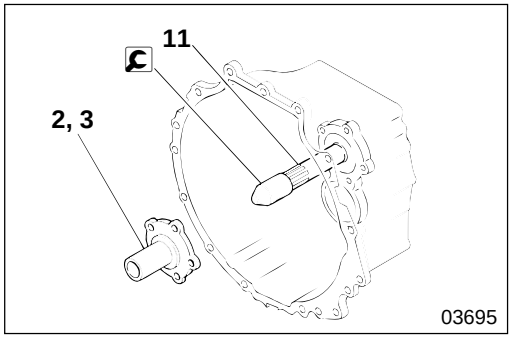
Location	Tool name and shape	Part No.	Application
10	Set pin 	MH063385 (Not Required for USA)	Removal of countershaft assembly (for holding sub-gear)
10, 11, 12	Steel lifting band 	MH063410	Removal and installation of countershaft assembly, drive pinion assembly and mainshaft assembly
	Eye nut	MH063308	
11, 12	Synchro guard 	MH063318 N / A	Prevention of synchronizer sticking when driving-in mainshaft

◆ Service procedure



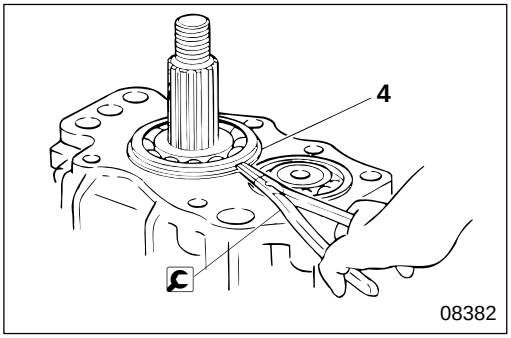
2 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **2**, and press-fit into front bearing retainer **3**.

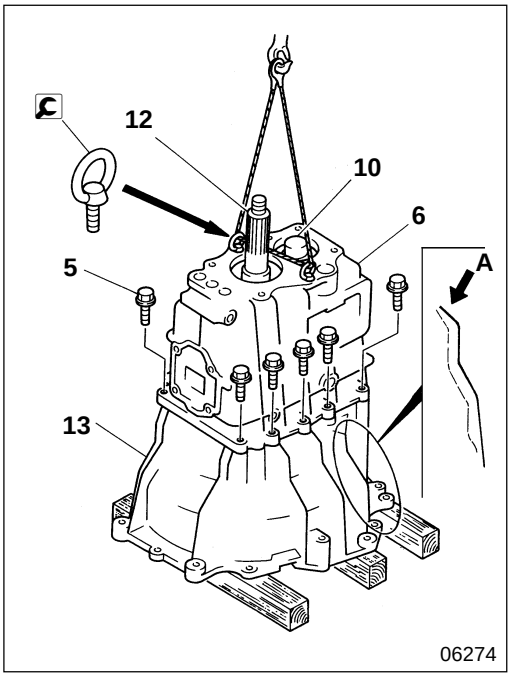


3 **Installation of front bearing retainer**

Install oil seal guide onto drive pinion **11** to protect oil seal **2** installed on front bearing retainer **3**. Then install the front bearing retainer.



4 Removal and installation of snap ring

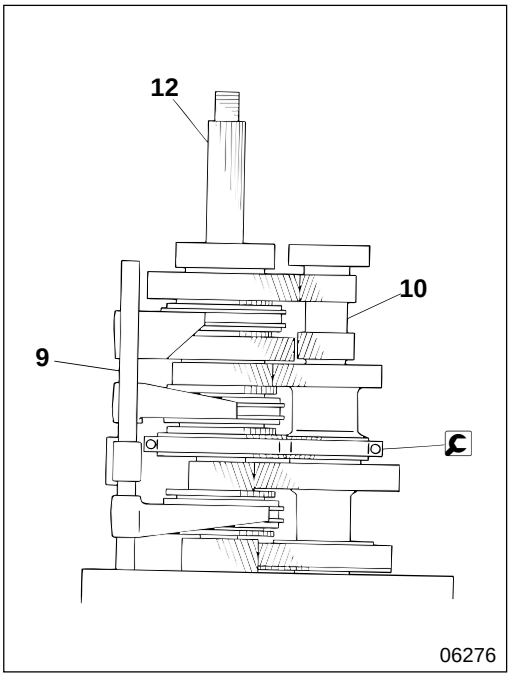


6 Removal of transmission case

- Remove the main shaft and countershaft rear bearings. P22-36
- Install eye bolts to transmission case **6**, and attach wires to prepare for lifting by a crane.
- Remove bolts **5**. Then lift transmission case **6** with a crane, while using a wooden or plastic hammer to tap rear rib section **A** on clutch housing **13**, main shaft assembly **12**, and the rear section of counter shaft assembly **10**.

CAUTION

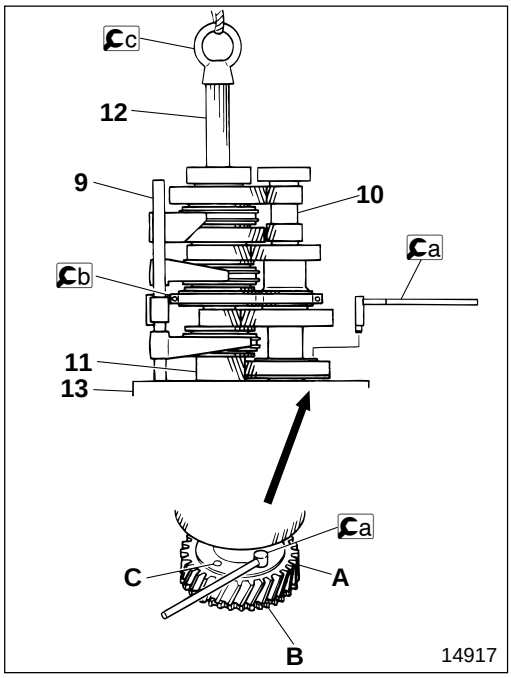
Be sure to tap the clutch housing only at rib section A, as indicated in the diagram. Tapping other parts with a hammer can damage the clutch housing.



- After removing transmission case **6**, fit the 2nd gear using steel lifting band to ensure safety.

CAUTION

Be sure to tighten steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening could damage the gears, etc.



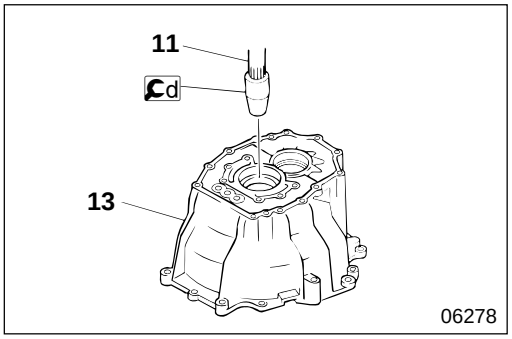
9 to 12 Removal and installation of shift rail and shift fork, countershaft assembly, drive pinion assembly and mainshaft assembly

[Removal]

- When removing or installing shift rail and shift fork **9**, countershaft assembly **10**, drive pinion assembly **11** and mainshaft assembly **12**, handle them as a group.
- After removing the case, install c eye bolt on mainshaft assembly **12** with b steel lifting band fitted so that the whole assembly can be lifted up.
- Fix shift rail and shift fork **9** to mainshaft assembly **12** using rubber bands.
- Remove the bearing retainer bolts **8** and retainer **7**.
- Attach wooden blocks to clutch housing **13**. Then lift the whole assembly (with drive pinion assembly **11**) up with a crane to remove them. During hoisting, hit the assembly using a mallet.

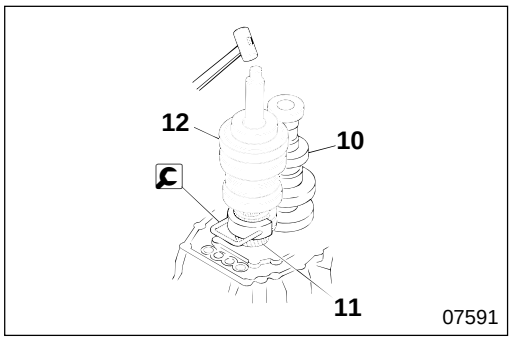
CAUTION

- **Be sure to tighten b steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.**
- **Be sure that you support mainshaft assembly 12, etc. with your hand when lifting them because if the mainshaft assembly and countershaft assembly 10 become detached, drive pinion assembly 11 would fall.**



[Installation]

- Follow the removal sequence in reverse.
- Before installing parts, install d oil seal guide onto drive pinion **11** to prevent damage to oil seal **2** of front bearing retainer **3**.



- To drive-in drive pinion **11**, mainshaft assembly **12** and countershaft assembly **10**, attach synchro guard which prevents the drive pinion and the mainshaft synchronizer sticking during installation.

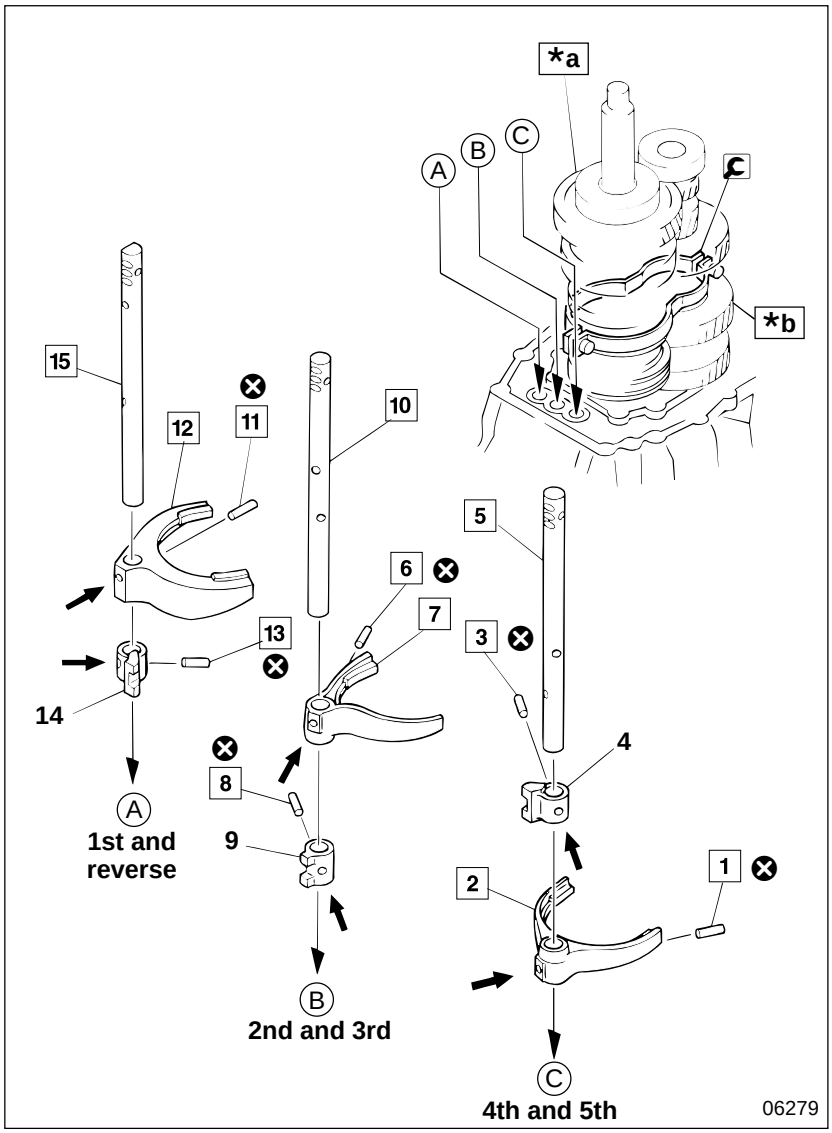
NOTE

Remember to remove all special tools after use.

M E M O

TRANSMISSION BODY

Shift Rail and Shift Fork



The arrows indicate spring pin withdrawal and driving-in directions.

● **Disassembly sequence**

(For disassembling shift rail and shift fork only)

1 Spring pin
2 4th and 5th shift fork
3 Spring pin
4 4th and 5th shift rail jaw
5 4th and 5th shift rail
6 Spring pin
7 2nd and 3rd shift fork
8 Spring pin
9 2nd and 3rd shift rail jaw
10 2nd and 3rd shift rail
11 Spring pin
12 1st and reverse shift fork
13 Spring pin
14 1st and reverse shift rail jaw
15 1st and reverse shift rail

***a** : Mainshaft assembly
***b** : Countershaft assembly
⊗ : Non-reusable parts

● **Assembly sequence**

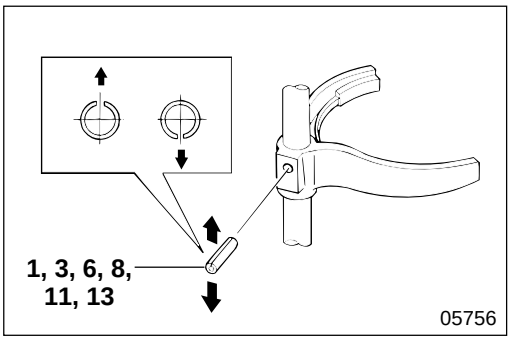
Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2, 7, 12	Shift fork claw tilt	0.1 {0.0039} or less	0.2 {0.0079}	Replace
2, 7, 12, *a	Clearance between shift fork and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
5, 10, 15	Deflection of shift rail	0.04 {0.0016} or less	0.05 {0.0020}	Correct or replace

◆ Service procedure

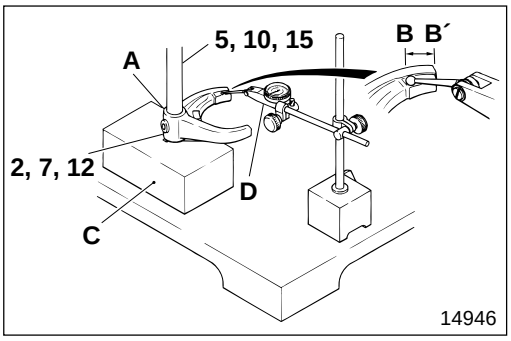


1 **3** **6** **8** **11** **13** **Driving-in spring pin**

For installation of spring pins **1**, **3**, **6**, **8**, **11**, **13**, position the openings in the direction of the shift rail axes.

CAUTION

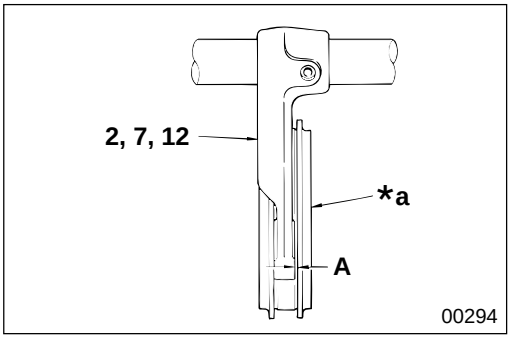
- **Be careful when driving in spring pins 1, 3, 6, 8, 11, 13, that you do not subject shift rails 5, 10, 15 to excessive strain, because this would cause faults such as bent shift rails.**
- **Make sure you do not drive in spring pins 1, 3, 6, 8, 11, 13 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.**



2 **7** **12** **Tilt of shift fork claw**

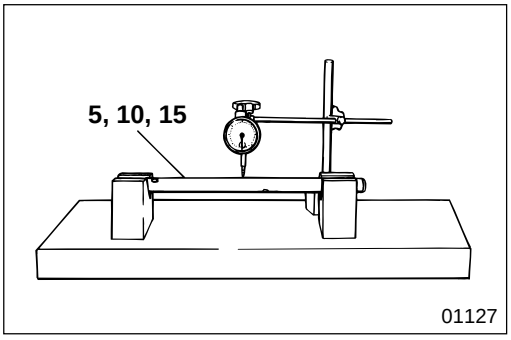
- Measure the tilt (difference between **B** and **B´**) of claw **B-B´** against hole **A** of shift rails **5**, **10**, **15** of shift forks **2**, **7**, **12** with the shift rails upright.
- If the tilt is higher than the limit, replace shift forks **2**, **7**, or **12**.

C : V-block
D : Dial gauge



2 **7** **12** ***a** **Clearance between gear shift fork and mainshaft synchronizer sleeve**

If the measured value for clearance **A** is higher than the limit, replace faulty parts.



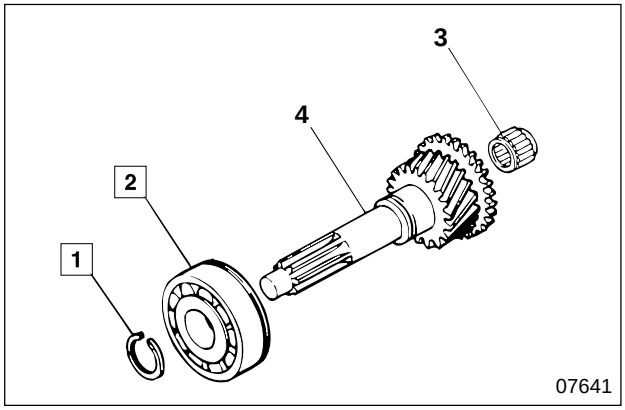
5 **10** **15** **Deflection of shift rail**

If the measured value is higher than the limit, correct or replace shift rails **5**, **10**, **15**.

NOTE

To measure the deflection of shift rails 5, 10, 15, turn them one full revolution and read the dial gauge indicator. The deflection is one half of the indicated value.

DRIVE PINION ASSEMBLY



● **Disassembly sequence**

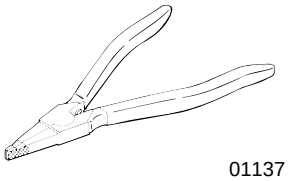
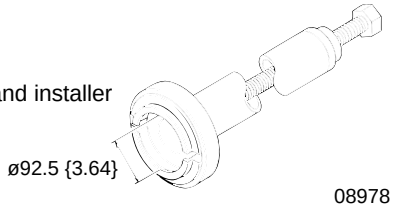
1 Snap ring
2 Drive pinion bearing
3 Pilot bearing
4 Drive pinion

● **Assembly sequence**

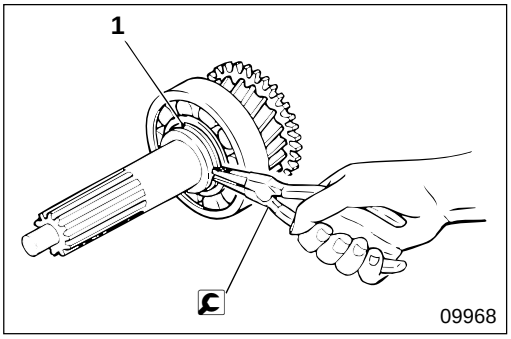
Follow the disassembly sequence in reverse.

Special tools

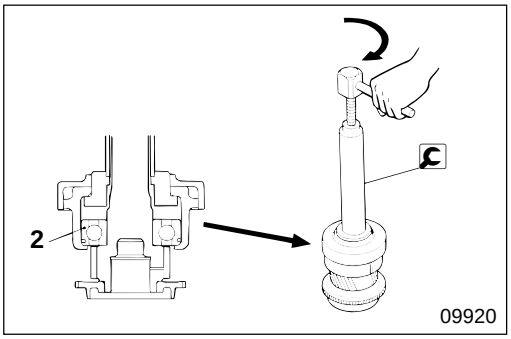
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  01137	MH061268 (Obtain Locally)	Removal and installation of snap ring
2	Bearing puller and installer  08978	MH062697	Removal and installation of drive pinion bearing

◆ Service procedure

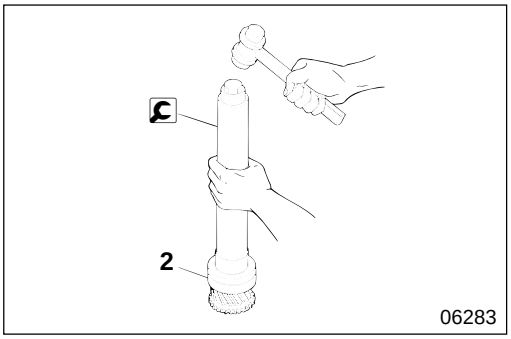


1 **Removal and installation of snap ring**



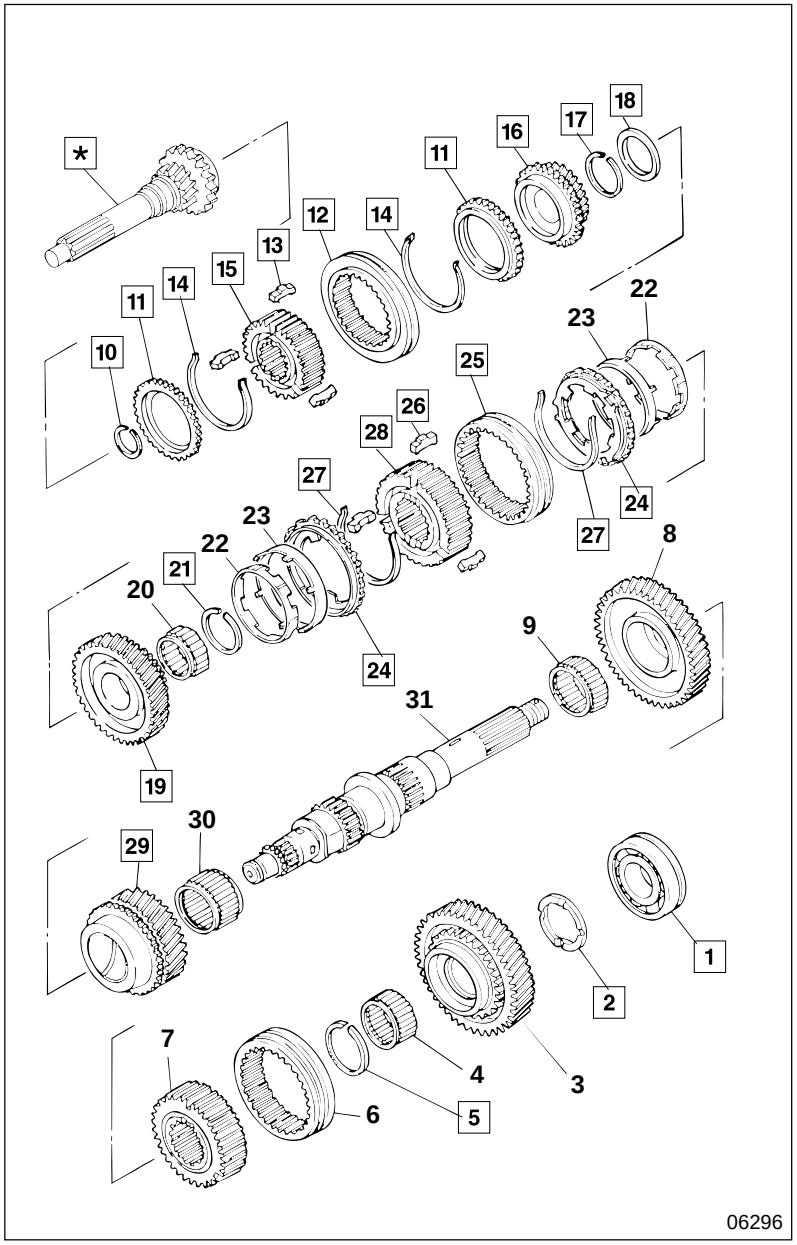
2 **Drive pinion bearing**

[Removal]



[Installation]
Press-fit drive pinion bearing **2** with its snap ring groove facing the gear side.

MAINSHAFT ASSEMBLY



● **Work before disassembly**

P22-32

● **Disassembly sequence**

1 Bearing
2 1st gear thrust washer
3 1st gear assembly
4 Needle bearing
5 Snap ring
6 Synchronizer sleeve
7 Synchronizer hub
8 Reverse gear assembly
9 Needle bearing
10 Snap ring
11 Synchronizer ring
12 Synchronizer sleeve
13 Shifting key
14 Shifting key springs
15 Synchronizer hub
16 5th gear assembly
17 Snap ring
18 2nd gear thrust washer
19 2nd gear assembly
20 Needle bearing
21 Snap ring
22 Synchronizer inner rings
23 Synchronizer center cone
24 Synchronizer outer rings
25 Synchronizer sleeve
26 Shifting key
27 Shifting key springs
28 Synchronizer hub
29 3rd gear assembly
30 Needle bearing
31 Mainshaft

***** : Drive pinion

● **Assembly sequence**

31→30→29
28→25→26→27→24→23→22 **→21→20→19→18→17→16**
15→12→13→14→11 **→10→9→8→7→6→5→4→3→2→1**

Service standards

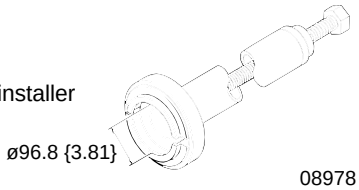
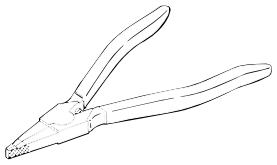
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
3	End play of 1st gear assembly	0.15 to 0.46 {0.0059 to 0.018}	0.70 {0.028}	Replace
3, 4, 31	Play in the diameter direction after assembling 1st gear assembly	0.02 to 0.06 {0.00079 to 0.0024}	0.12 {0.0047}	Replace
8	End play of reverse gear assembly	0.15 to 0.46 {0.0059 to 0.018}	0.70 {0.028}	Replace
8, 9, 31	Play in the diameter direction after assembling reverse gear assembly	0.04 to 0.08 {0.0016 to 0.0031}	0.12 {0.0047}	Replace
11, 13	Clearance between synchronizer ring keyway and shifting key	3.5 to 3.7 {0.14 to 0.15}	4.50 {0.18}	Replace
11, 16	Clearance between synchronizer ring and 5th gear assembly	1.13 to 1.37 {0.044 to 0.054}	0.20 {0.0079}	Replace
11, *	Clearance between synchronizer ring and drive pinion	1.13 to 1.37 {0.044 to 0.054}	0.20 {0.0079}	Replace
13, 15	Clearance between shifting key and synchronizer hub keyway	0.05 to 0.20 {0.0020 to 0.0079}	0.50 {0.020}	Replace
16	End play of 5th gear assembly	0.20 to 0.56 {0.0079 to 0.022}	0.80 {0.031}	Replace
16, 31	Play in the diameter direction after assembling 5th gear assembly	0.05 to 0.09 {0.0020 to 0.0035}	0.20 {0.0079}	Replace
19	End play of 2nd gear assembly	0.15 to 0.61 {0.0059 to 0.024}	0.80 {0.031}	Replace
19, 20, 31	Play in the diameter direction after assembling 2nd gear assembly	0.02 to 0.05 {0.00079 to 0.0020}	0.12 {0.0047}	Replace
19, 24	Clearance between 2nd gear assembly and synchronizer outer ring	1.23 to 1.47 {0.048 to 0.058}	0.95 {0.037}	Replace
24, 26	Clearance between synchronizer outer ring keyway and shifting key	4.7 to 5.0 {0.19 to 0.20}	5.70 {0.22}	Replace
24, 29	Clearance between synchronizer outer ring and 3rd gear assembly	1.23 to 1.47 {0.48 to 0.058}	0.95 {0.037}	Replace
26, 28	Clearance between shifting key and synchronizer hub keyway	0.05 to 0.20 {0.0020 to 0.0079}	0.50 {0.020}	Replace
29	End play of 3rd gear assembly	0.15 to 0.46 {0.0059 to 0.018}	0.70 {0.028}	Replace
29, 30, 31	Play in the diameter direction after assembling 3rd gear assembly	0.02 to 0.06 {0.00079 to 0.0024}	0.12 {0.0047}	Replace

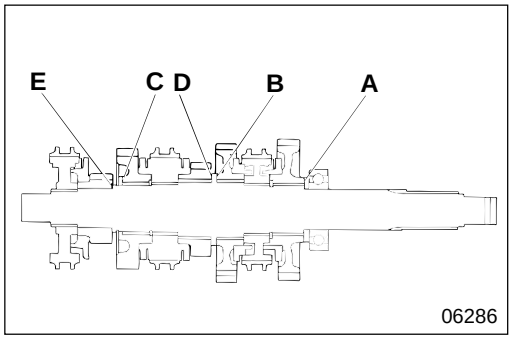
MAINSHAFT ASSEMBLY

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Bearing puller and installer  08978	MH062697	Removal and installation of mainshaft rear bearing
5, 10, 17, 21	Snap ring expander  01137	MH061268 (Obtain Locally)	Removal and installation of snap ring

◆ Service procedure



06286

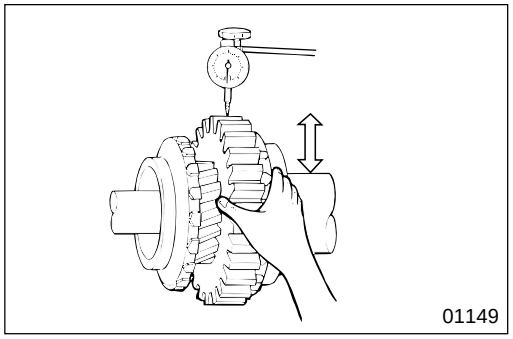
● Work before disassembly

[Inspection]

(1) End play of gears

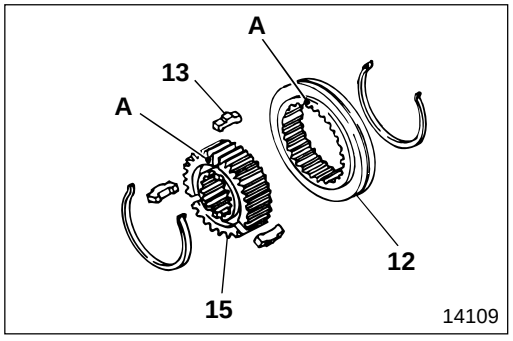
A : 1st gear
B : Reverse gear
C : 2nd gear
D : 3rd gear
E : 5th gear

If the measured value is higher than the limit, replace faulty parts.


01149

(2) Play of gears in the diameter direction

If the measured value is higher than the limit, replace faulty parts.

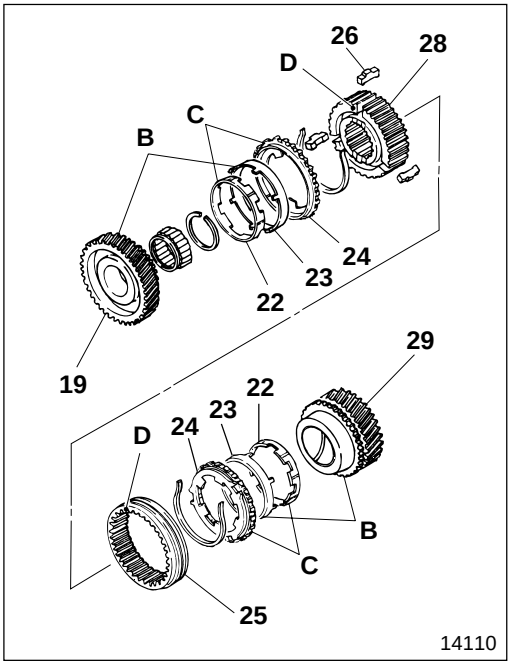


14109

[Alignment marks]

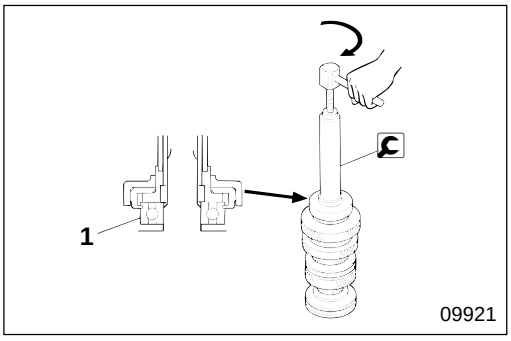
(1) Single cone synchromesh

Before disassembling synchronizer sleeve **12** and synchronizer hub **15**, put alignment marks **A** on the places where shifting keys **13** are installed. When reusing parts, align the alignment marks to reassemble.



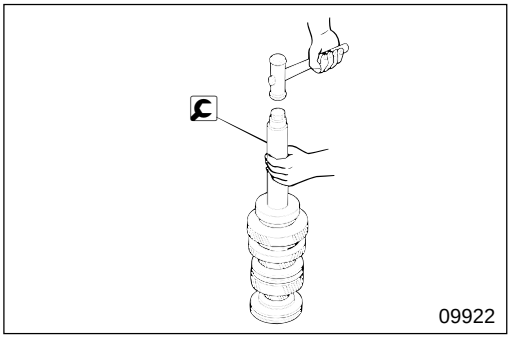
(2) Double cone synchromesh

- Before disassembling synchronizer center cone **23**, 2nd gear assembly **19**, and 3rd gear assembly **29**, put alignment marks **B** on them. Similarly, put alignment marks **C** on synchronizer inner ring **22**, and synchronizer outer ring **24**. When reusing parts, align the alignment marks to reassemble.
- Before disassembling synchronizer sleeve **25** and synchronizer hub **28**, put alignment marks **D** on the places where shifting keys **26** are installed. When reusing parts, align the alignment marks to reassemble.

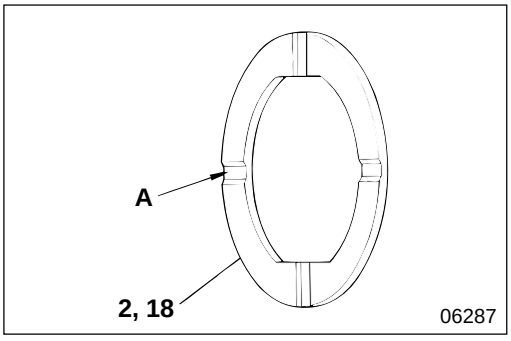


1 Bearing

[Removal]



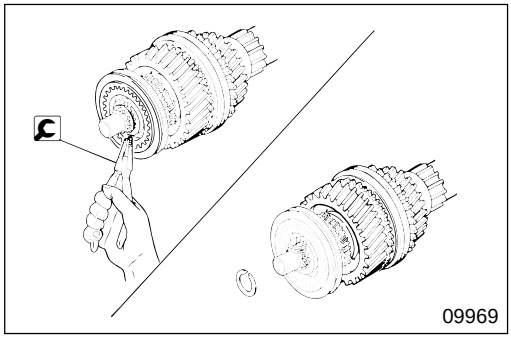
[Installation]
Press-fit bearing **1** with its snap ring groove facing the rear.



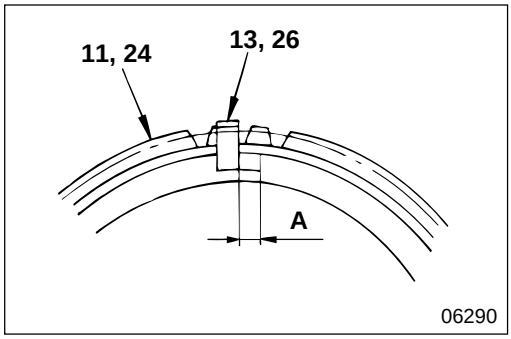
2 18 Installation of thrust washer

Install thrust washer with oil groove **A** facing gear side.

MAINSHAFT ASSEMBLY

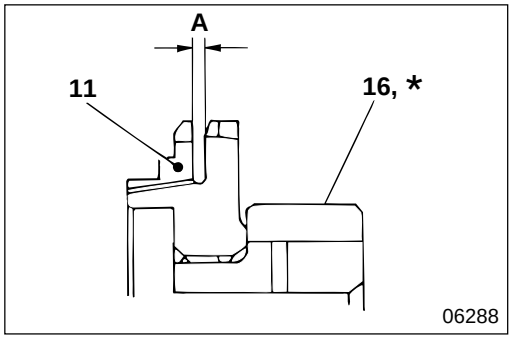


5 10 17 21 Removal and installation of snap ring



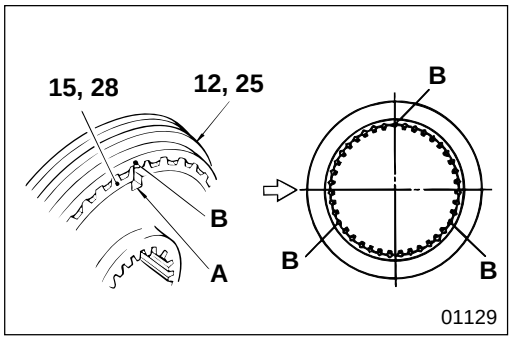
11 13 24 26 Clearance between synchronizer ring or synchronizer outer ring and shifting key

If the measured value for clearance **A** is higher than the limit, replace faulty parts.



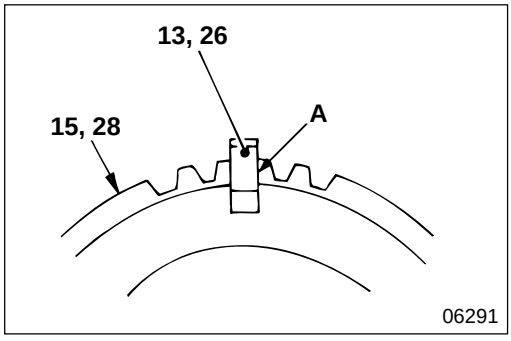
11 16 * Clearance between synchronizer ring and gear assemblies

- Press in synchronizer ring **11** evenly, and measure all circumferences.
- If the measured value for clearance **A** is lower than the limit, replace faulty parts.



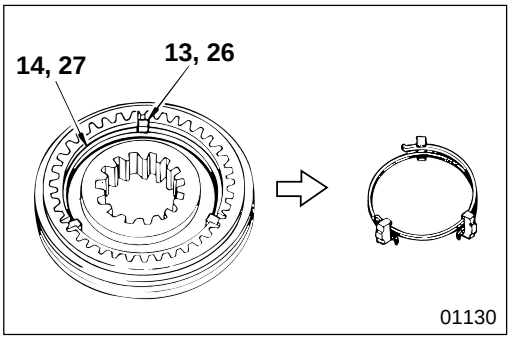
12 25 Installation of synchronizer sleeve

- To install synchronizer sleeves **12**, **25**, align three keyways **A** of synchronizer hubs **15**, **28** with the three stub teeth **B** of synchronizer sleeves.
- Before assembling synchronizer hubs **15**, **28** and synchronizer sleeves **12**, **25**, align the alignment marks (made before disassembly).



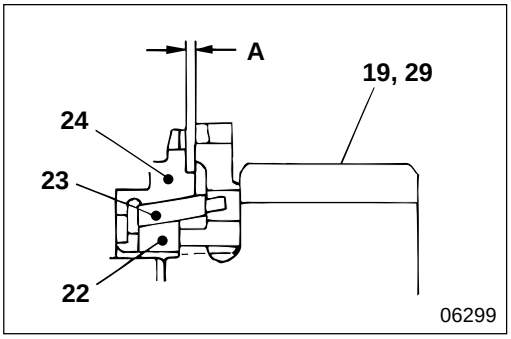
13 15 26 28 Clearance between shifting key and synchronizer hub

If the measured value for clearance **A** is higher than the limit, replace faulty parts.



14 **27** **Installation of shifting key spring**

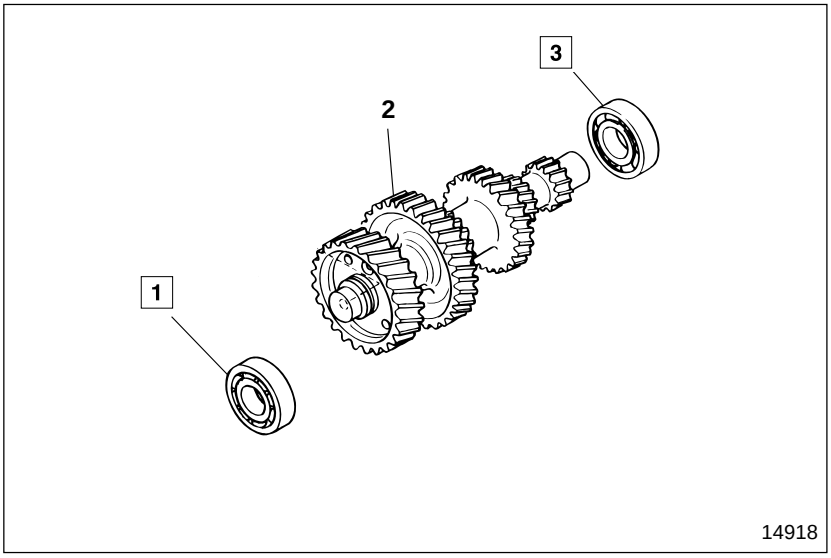
- Place shifting keys **13**, **26** into keyways of synchronizer hubs **15**, **28**, and install shifting key springs **14**, **27** taking care to locate the openings away from the shifting key positions.
- Two openings of shifting key springs **14**, **27** should not align with each other.



19 **24** **29** **Clearance between 2nd, 3rd gear assembly and synchronizer outer ring**

- Press in synchronizer inner ring **22**, synchronizer center cone **23** and synchronizer outer ring **24** evenly, and measure all circumferences.
- If the measured value for clearance **A** is lower than the limit, replace faulty parts.

COUNTERSHAFT ASSEMBLY



● **Disassembly sequence**

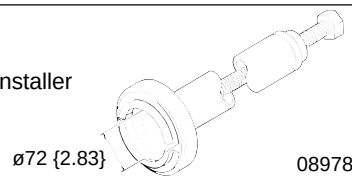
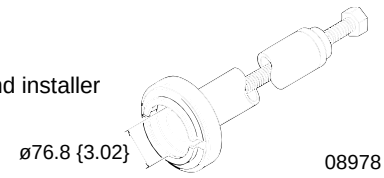
1 Countershaft front bearing
2 Countershaft assembly
3 Countershaft rear bearing

● **Assembly sequence**

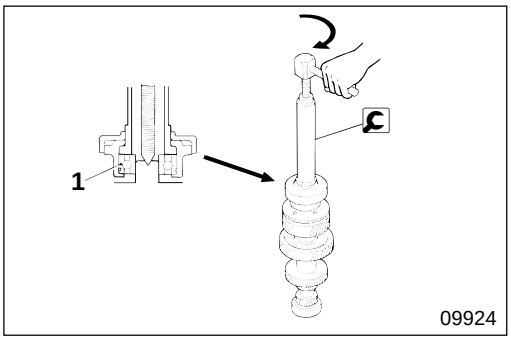
Follow the disassembly sequence in reverse.

Special tools

Unit : mm {in.}

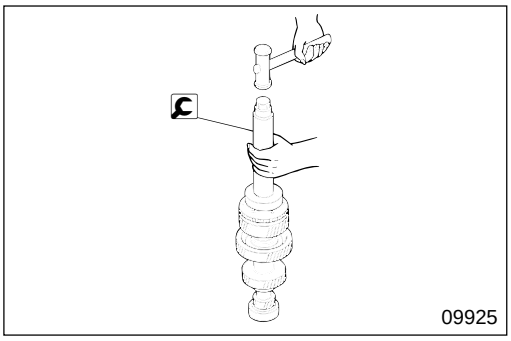
Location	Tool name and shape	Part No.	Application
1	Bearing puller and installer 	MH062697	Removal and installation of countershaft front bearing
3	Bearing puller and installer 		Removal and installation of countershaft rear bearing

◆ Service procedure



1 **Countershaft front bearing**

[Removal]

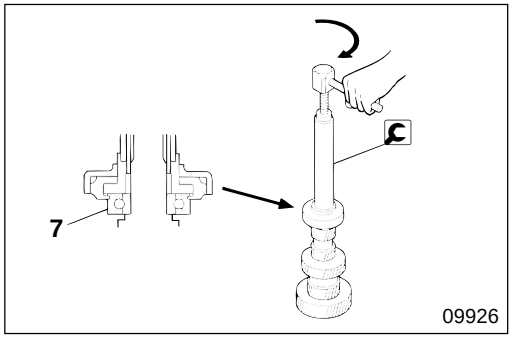


[Installation]
Press-fit countershaft front bearing **1** with its snap ring groove facing the gear side.

● **Positioning of sub-gear**

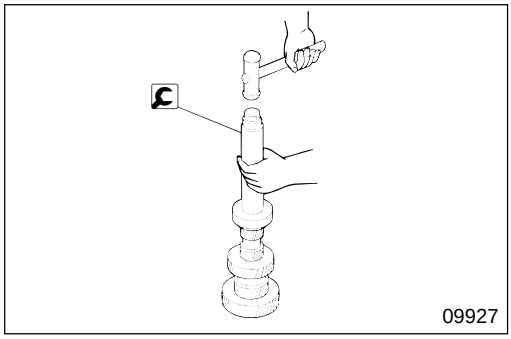
Turn sub-gear **4** to the right using ⚿a jig assembly, and insert ⚿b set pin into alignment hole **A**, in the direction as illustrated to secure the sub-gear, with all parts assembled except for snap ring **2** and countershaft front bearing **1**.
Turn the set pin so that the sub-gear and the constant mesh gear teeth are positioned identically.

COUNTERSHAFT ASSEMBLY



7 **Countershaft rear bearing**

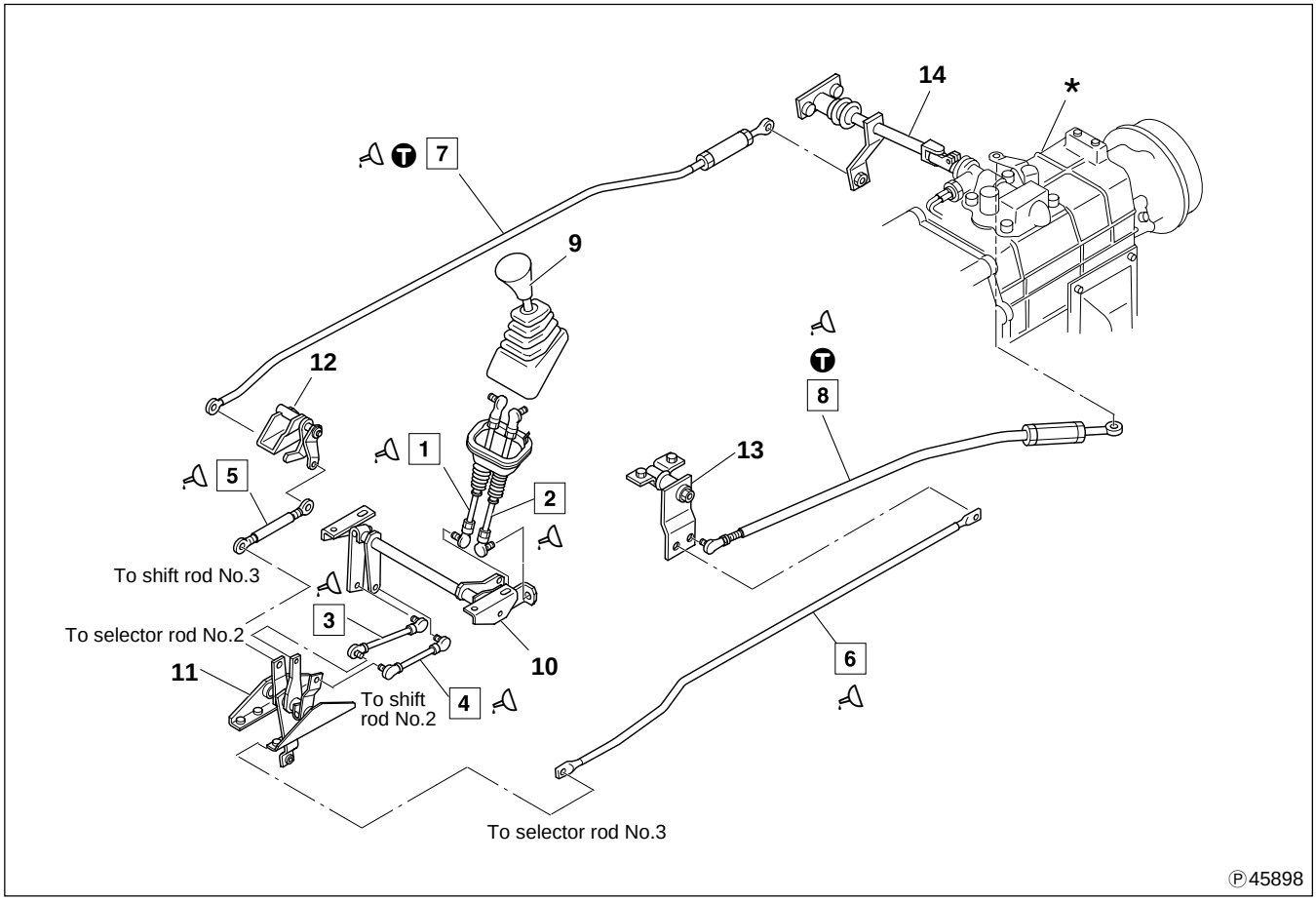
[Removal]



[Installation]
Press-fit countershaft rear bearing **7** with its snap ring groove facing the gear.

M E M O

TRANSMISSION CONTROL



● **Removal sequence**

1 Shift rod No.1
2 Selector rod No.1
3 Shift rod No.2
4 Selector rod No.2
5 Shift rod No.3
6 Selector rod No.3
7 Shift rod No.4
8 Selector rod No.4
9 Change lever assembly 🕮 P22-44
10 Lever assembly 🕮 P22-46
11 No.1 cross lever assembly 🕮 P22-48
12 Shift lever assembly 🕮 P22-50
13 Selector lever assembly 🕮 P22-51
14 Cross shaft assembly 🕮 P22-52

***** : Transmission assembly

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

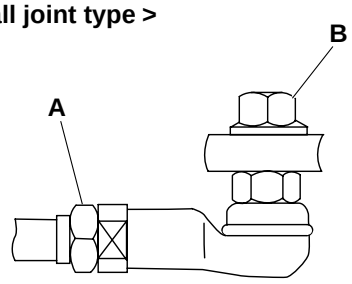
Location	Parts to be tightened	Tightening torque	Remarks
—	Nut (Ball joint mounting)	19 to 24 {14 to 17, 1.9 to 2.4}	—
—	Nut (Ball joint securing)	16 to 24 {12 to 17, 1.6 to 2.4}	—
7, 8	Knuckle (Turn buckle securing)	19 to 27 {14 to 20, 1.9 to 2.8}	—

Lubricant

Location	Points of application	Kinds	Quantity
1 to 8	Rod installation points	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure

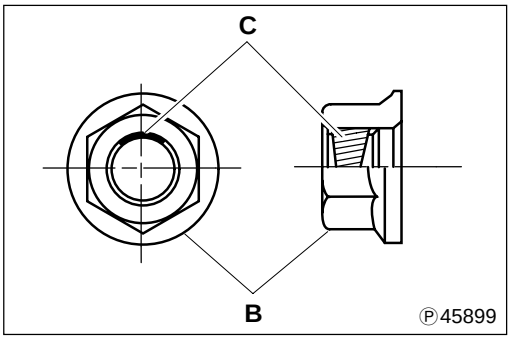
< Ball joint type >



Ⓟ45896

1 to **8** **Installation of rod**

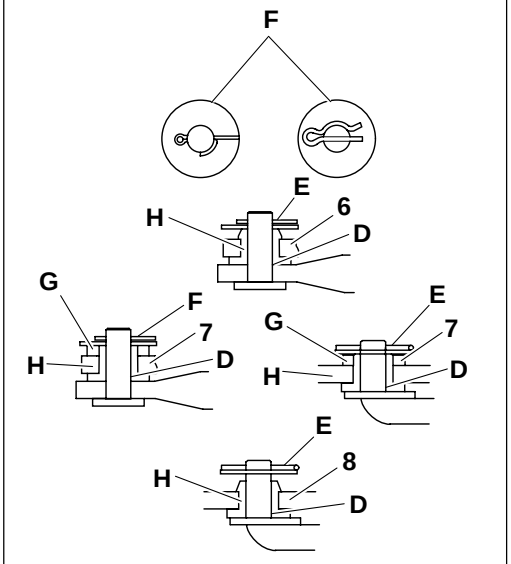
- Tighten nuts **A**, **B** at specified torque.
  A : ⓣ 16 to 24 N·m {12 to 17 ft.lbs, 1.6 to 2.4 kgf·m}
  B : ⓣ 19 to 24 N·m {14 to 17 ft.lbs, 1.9 to 2.4 kgf·m}



Ⓟ45899

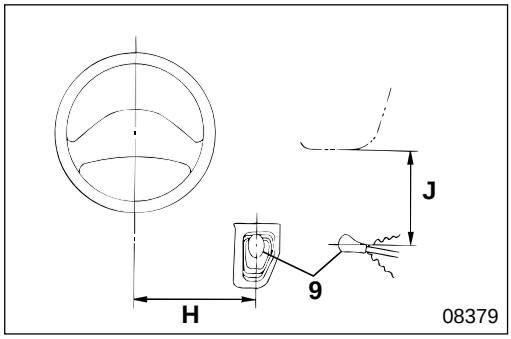
- Thread section **C** on nut **B** is galvanized (black chromate treatment) to prevent loosening. Check the nut surface to make sure the coating is intact. Note that the nut is non-reusable.

< Split pin type > < Snap pin type >



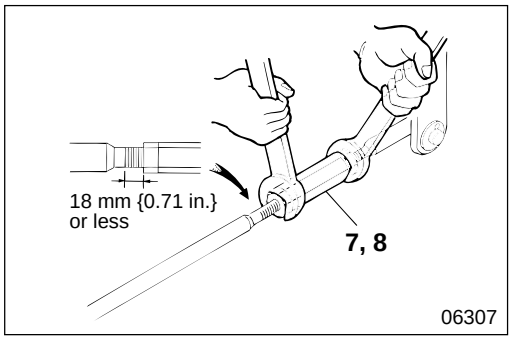
Ⓟ45897

- Apply grease to area **D**.
- Install split pin or snap pin **E**.
  F : Washer
  G : Spacer
  H : Bushing



- Turn the turn buckles of shift rod No.4 **7** and selector rod No.4 **8** to adjust change lever assembly **9** position.

Left and right direction H (mm {in.}) (Distance from steering wheel center)	Fore-and-aft direction J (mm {in.}) (Distance from instrument panel)
362 to 372 {14.3 to 14.6}	301 to 311 {11.9 to 12.2}

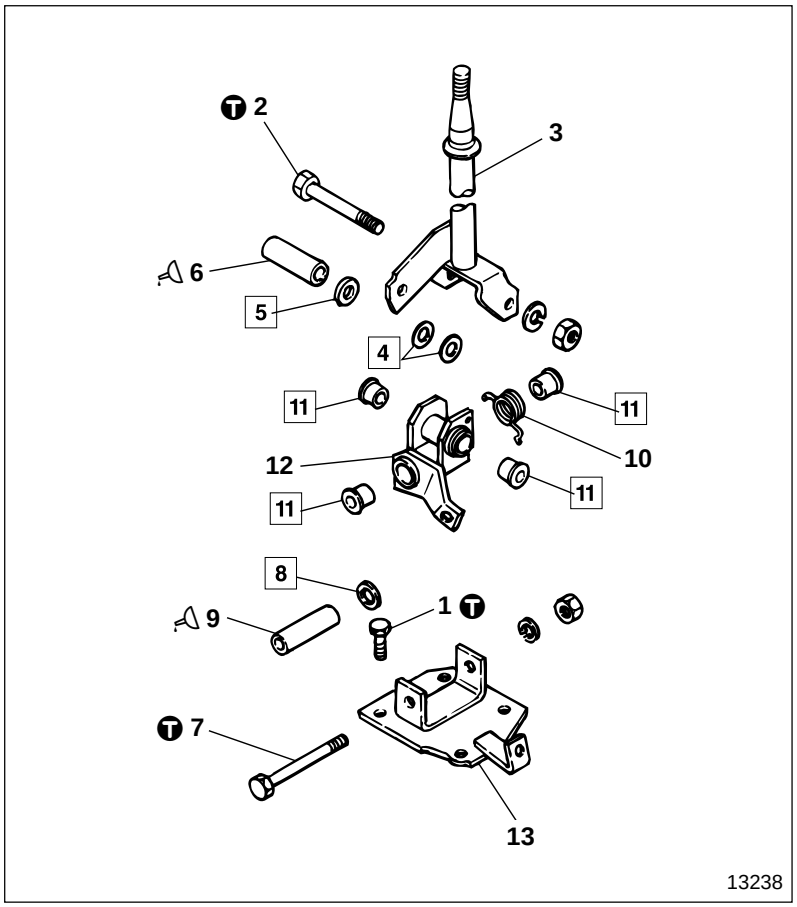


- Adjust the thread area dimension of rods **7**, **8** that extends from both ends of the turn buckles. Exposed threads should be almost identical at left and right ends.

- After adjustment, tighten lock nuts for turn buckles at specified torque.
- Make sure that shift or select into positions can be performed smoothly.

M E M O

Change Lever Assembly



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Lever assembly
4 Wave washers
5 Spacer
6 Collar
7 Bolt
8 Spacer
9 Collar
10 Return spring
11 Bushing
12 Cross sleeve
13 Change lever bracket

● **Assembly sequence**

13 → **8** → **7** → **3** → **5** → **4** → **2** → **1**
12 → **11** → **10** → **9** → **6**

Tightening torque

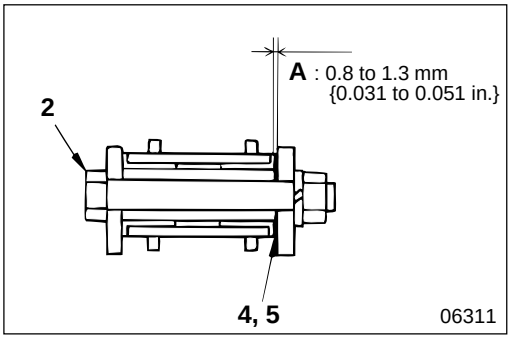
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Change lever assembly mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
2	Bolt (Lever assembly mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
7	Bolt (Cross sleeve mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—

Lubricant

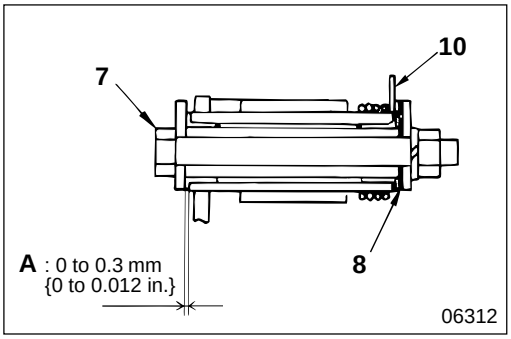
Location	Points of application	Kinds	Quantity
6, 9	Periphery of collar	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



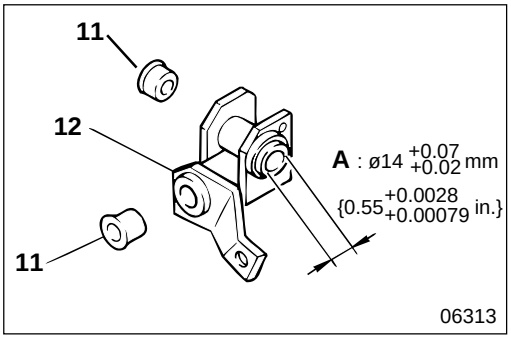
4 **5** **Selection of spacer and installation of wave washer**

- Select spacer **5** to give specified clearance **A** when bolt **2** is tightened at specified torque. Two thicknesses are available for the spacers: 0.3 mm {0.012 in.}, 0.5 mm {0.020 in.}.
- Obtain the specified clearance before inserting wave washer **4**.



8 **Selection of spacer**

- Select spacer **8** to give specified clearance **A** when bolt **7** is tightened at specified torque. Two thicknesses are available for the spacers: 0.3 mm {0.012 in.}, 0.5 mm {0.020 in.}.
- Levers should operate smoothly after installation.

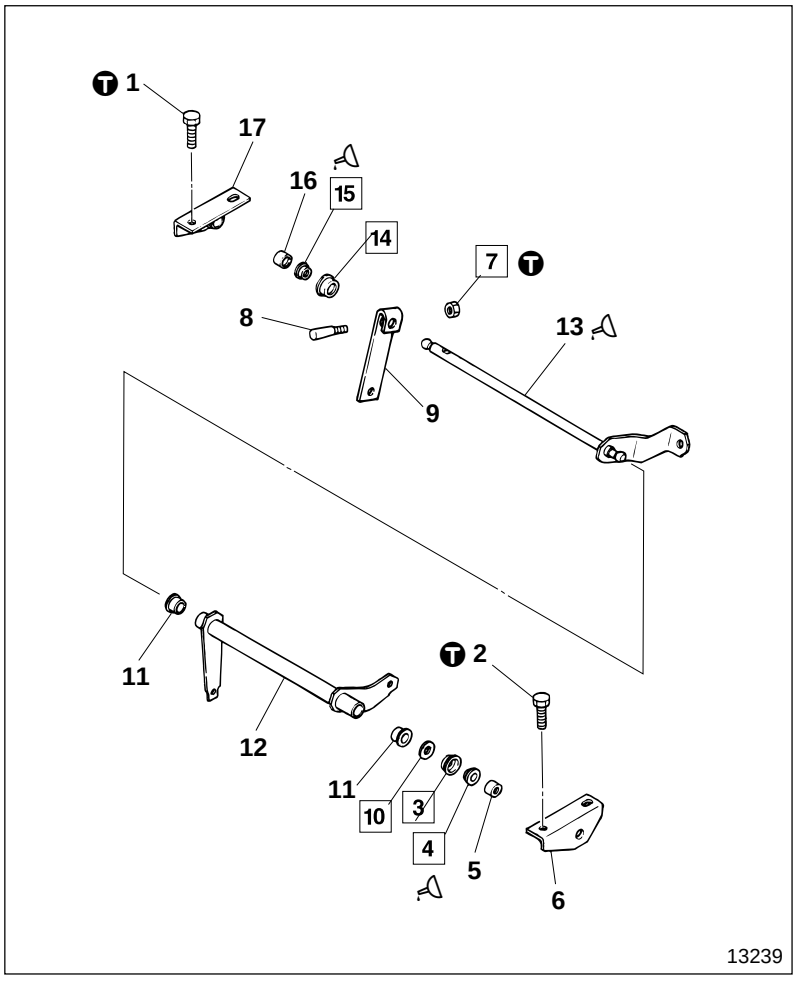


11 **Installation of bushings**

Press-fit bushings **11** (four bushings) into cross sleeve **12**, and ream to specified dimension **A** using a reamer.

TRANSMISSION CONTROL

Lever Assembly



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Cover
4 Dust boot
5 Bushing
6 Lever bracket A
7 Nut
8 Lock pin
9 Lever
10 Spacer
11 Bushing
12 Shift lever
13 Selector lever
14 Cover
15 Dust boot
16 Bushing
17 Lever bracket B

● **Assembly sequence**

17→16→15→14
9→13
→10
12→11
→2→1→8→7
6→5→4→3

Tightening torque

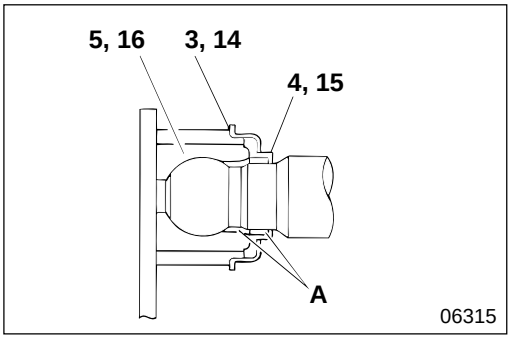
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 2	Bolt (Lever bracket mounting)	27 to 34 {20 to 25, 2.8 to 3.5}	—
7	Nut (Lock pin tightening)	9.8 to 15.0 {7.2 to 11, 1.0 to 1.5}	—

Lubricant

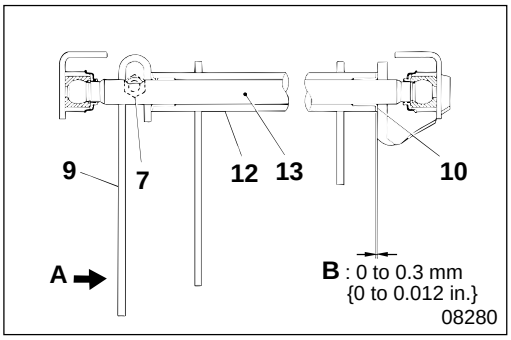
Location	Points of application	Kinds	Quantity
4, 15	Pack interior of dust boot	Chassis grease [NLGI No.1 (Ca soap)]	As required
13	Periphery of selector lever	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



3 **4** **14** **15** **Installation of cover and dust boot**

- Press in covers **3**, **14** fully.
- Pack grease into interior space **A** of dust boots **4**, **15**.



7 **Tightening nuts**

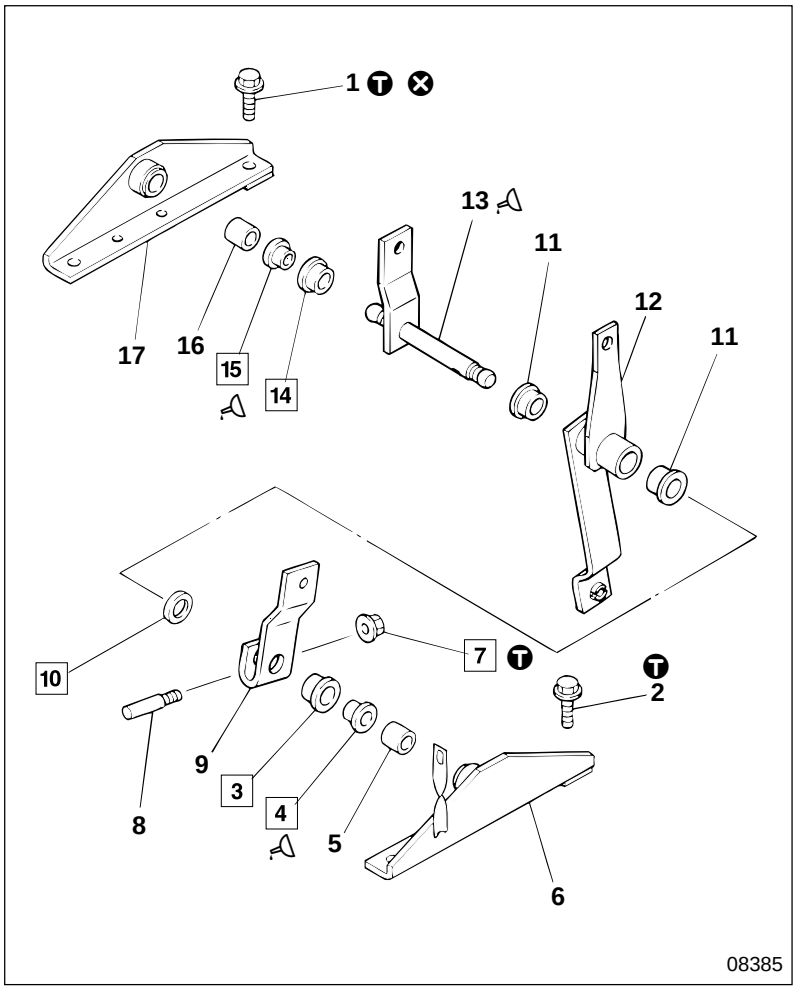
Tighten nut **7** at specified torque, pressing it to direction **A** at approximately 98 N {22 lbf, 10 kgf}.

10 **Selection of spacer**

- Select spacer **10** to give specified clearance **B** when nut **7** is tightened at specified torque. Two thicknesses are available for the spacers: 0.3 mm {0.012 in.}, 0.5 mm {0.020 in.}.

- Lever **9**, shift lever **12** and selector lever **13** should operate smoothly after installation.

No.1 Cross Lever Assembly



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Cover
4 Dust boot
5 Bushing
6 Lever bracket
7 Nut
8 Lock pin
9 Lever
10 Spacer
11 Bushing
12 Selector lever
13 Shift lever
14 Cover
15 Dust boot
16 Bushing
17 Lever bracket
⊗ : Non-reusable parts

● **Assembly sequence**

17→16→15→14
13→10→9
12→11→2→1→8→7
6→5→4→3

Ⓣ Tightening torque

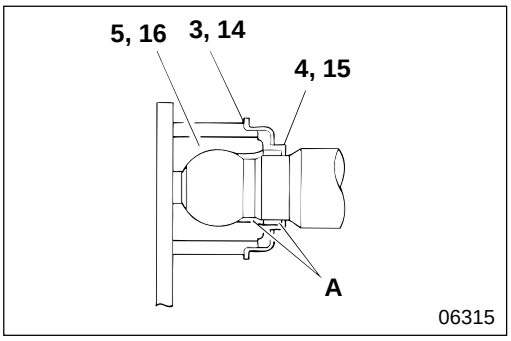
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 2	Bolt (Lever bracket mounting)	59 to 78 {43 to 58, 6.0 to 8.0}	—
7	Nut (Lock pin tightening)	9.8 to 15.0 {7.2 to 11, 1.0 to 1.5}	—

Lubricant

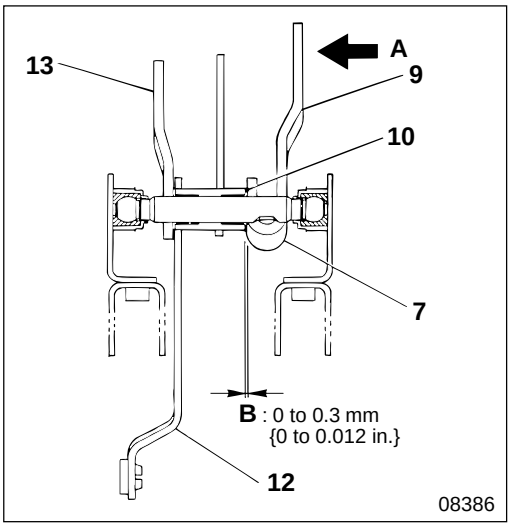
Location	Points of application	Kinds	Quantity
4, 15	Pack interior of dust boot	Chassis grease [NLGI No.1 (Ca soap)]	As required
13	Periphery of shift lever	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



3 **4** **14** **15** **Installation of cover and dust boot**

- Press in covers **3**, **14** fully.
- Pack grease into interior space **A** of dust boot **4**, **15**.



7 **Tightening nut**

Tighten nut **7** at specified torque pressing it to direction **A** at approximately 98 N {22 lbf, 10 kgf}.

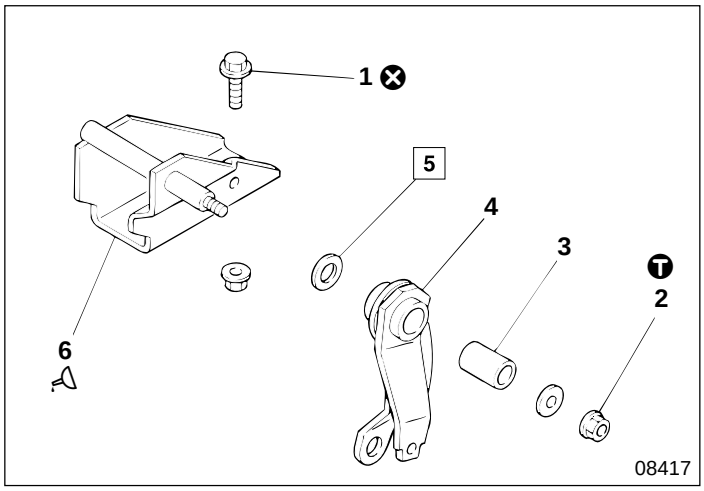
10 **Selection of spacer**

- Select spacer **10** to give specified clearance **B** when nut **7** is tightened at specified torque. Two thicknesses are available for the spacers: 0.3 mm {0.012 in.}, 0.5 mm {0.020 in.}.

- Lever **9**, selector lever **12** and shift lever **13** should operate smoothly after installation.

TRANSMISSION CONTROL

Shift Lever Assembly



● **Disassembly sequence**

1 Bolt
2 Nut
3 Bushing
4 Shift lever
5 Spacer
6 Shift lever bracket

⊗ : Non-reusable parts

● **Assembly sequence**

6→5
4→3
→2→1

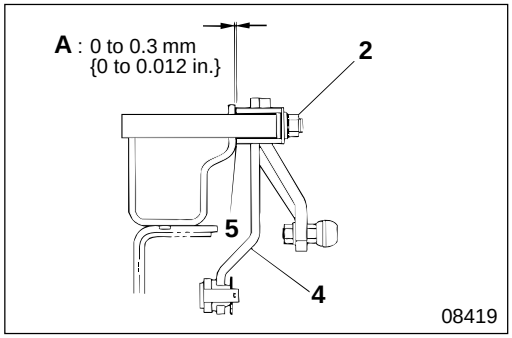
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Shift lever bracket mounting)	59 to 78 {43 to 58, 6.0 to 8.0}	—
2	Nut (Shift lever mounting)	27 to 34 {20 to 25, 2.8 to 3.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
6	Periphery of shift lever bracket shaft	Chassis grease [NLGI No.1 (Ca soap)]	As required

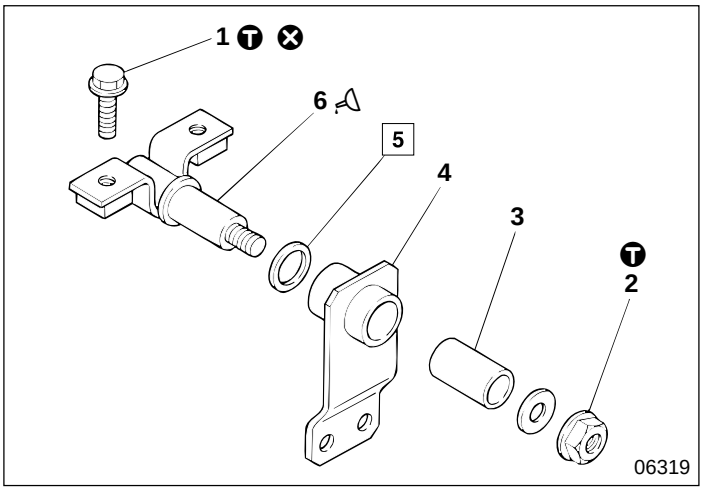


◆ Service procedure

5 **Selection of spacer**

- Select spacer **5** to give specified clearance **A** when nut **2** is tightened at specified torque. Two thicknesses are available for the spacers: 0.3 mm {0.012 in.}, 0.5 mm {0.020 in.}.
- Shift lever **4** should operate smoothly after installation.

Selector Lever Assembly



● **Disassembly sequence**

1 Bolt
2 Nut
3 Bushing
4 Selector lever
5 Spacer
6 Selector lever bracket
⊗ : Non-reusable parts

● **Assembly sequence**

6→5
4→3
→2→1

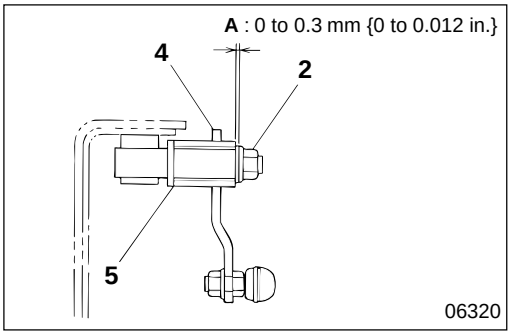
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Selector lever bracket mounting)	59 to 78 {43 to 58, 6.0 to 8.0}	—
2	Nut (Selector lever mounting)	27 to 34 {20 to 25, 2.8 to 3.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
6	Periphery of selector lever bracket shaft circumference	Chassis grease [NLGI No.1 (Ca soap)]	As required

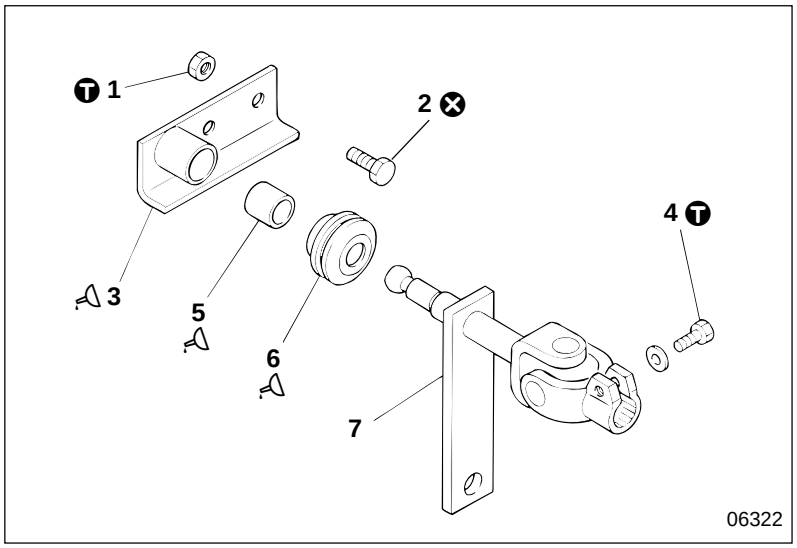


◆ Service procedure

5 **Selection of spacer**

- Select spacer **5** to give specified clearance **A** when nut **2** is tightened at specified torque. Two thicknesses are available for the spacers: 0.3 mm {0.012 in.}, 0.5 mm {0.020 in.}.
- Selector lever **4** should operate smoothly after installation.

Cross Shaft Assembly



● **Disassembly sequence**

1 Nut
2 Bolt
3 Cross shaft bracket
4 Bolt
5 Cross shaft bushing
6 Cross shaft boot
7 Cross shaft

⊗ :Non-reusable parts

● **Assembly sequence**

7→6→5→3→2→1→4

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Frame mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
4	Bolt (Transmission side mounting)	15 to 20 {11 to 14, 1.5 to 2.0}	—

Lubricant

Location	Points of application	Kinds	Quantity
3	Pack pipe of cross shaft bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required
5	Friction surfaces (inside and outside) of cross shaft bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required
6	Pack interior of cross shaft boot	Chassis grease [NLGI No.1 (Ca soap)]	As required

MITSUBISHI
FUSO

Group 23
Automatic Transmission

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-23

INDEX

SPECIFICATIONS 23- 2

STRUCTURE AND OPERATION 23- 3

TROUBLESHOOTING PROCEDURES 23-40

TROUBLESHOOTING 23-42

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Stall Test 23-52
- Time Lag Test 23-53
- Line Pressure Test 23-54
- Road Test 23-56
- Inspection of Automatic Transmission Fluid 23-58
- Changing Automatic Transmission Fluid 23-59

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23-60

OIL COOLER 23-66

AUTOMATIC TRANSMISSION CONTROL 23-70

REPLACEMENT OF AUTOMATIC TRANSMISSION PARTS 23-80

INSPECTION AND ADJUSTMENT OF OTHER DEVICES 23-86

LOCATIONS OF PARTS 23-90

ELECTRICAL WIRING DIAGRAM 23-91

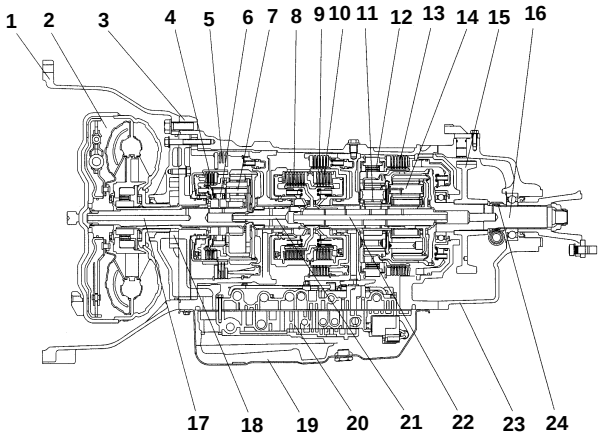
SPECIFICATIONS

Specifications

Item \ Vehicle model			FE	FG
Manufacturer			Aisin Seiki Co., Ltd.	
Transmission type			M035A4	
Torque converter	Type		3-element, 1-stage, 2-phase (with lock-up clutch)	
	Stall torque ratio		1.82	
Automatic transmission	Type		Planetary gear type, 4 forward speeds, 1 reverse speed	
	Gear ratio	1st	3.018	
		2nd	1.548	
		3rd	1.000	
		4th	0.703	0.765
		Rev	2.678	
Range selector pattern			P - R - N - D - 2 - L (Engine starts in P and N positions only)	
Automatic transmission fluid	Oil type		DEXRON III type	
	Total oil capacity L {qts}		13 {14}	
	Quantity of oil required in automatic transmission fluid change L {qts}		Approximately 4.5 {4.8}	

Automatic Transmission Assembly

< FE >



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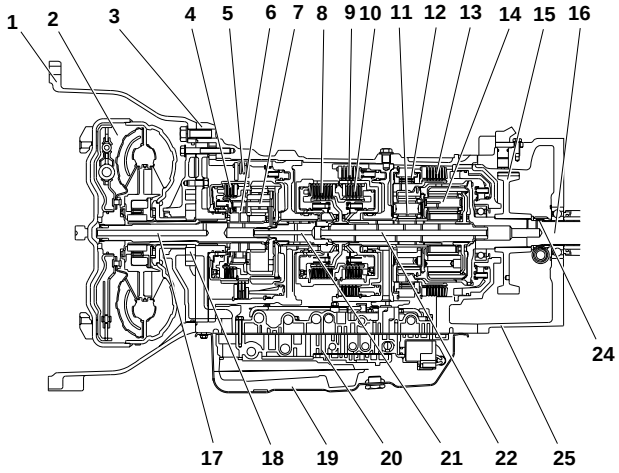
< FG >



Ⓟ36806

1 Converter housing
2 Torque converter
3 Transmission case
4 Overdrive direct clutch
5 Overdrive brake
6 Overdrive one-way clutch
7 Overdrive planetary gear
8 Front clutch
9 2nd brake
10 Rear clutch
11 Front planetary gear
12 No. 2 one-way clutch
13 1st and reverse brake
14 Rear planetary gear
15 Parking lock gear
16 Output shaft
17 Overdrive input shaft
18 Oil pump
19 Oil pan
20 Valve body
21 Input shaft
22 Intermediate shaft
23 Extension housing < FE >
24 Speedometer drive gear
25 Transfer case adapter < FG >

The automatic transmission is comprised of a torque converter with a lock-up mechanism and a fully automatic 4-speed gear system.

● **Torque converter**

The torque converter is driven by the engine crankshaft, and functions as the input device for the transmission. The torque converter is a fluid coupling device that magnifies torque produced by the engine and absorbs shock that generates when the vehicle accelerates from a standstill or when the transmission shifts. At a cruising speed, the lock-up mechanism prevents slippage for improved power transmitting efficiency.

● **Transmission gear section**

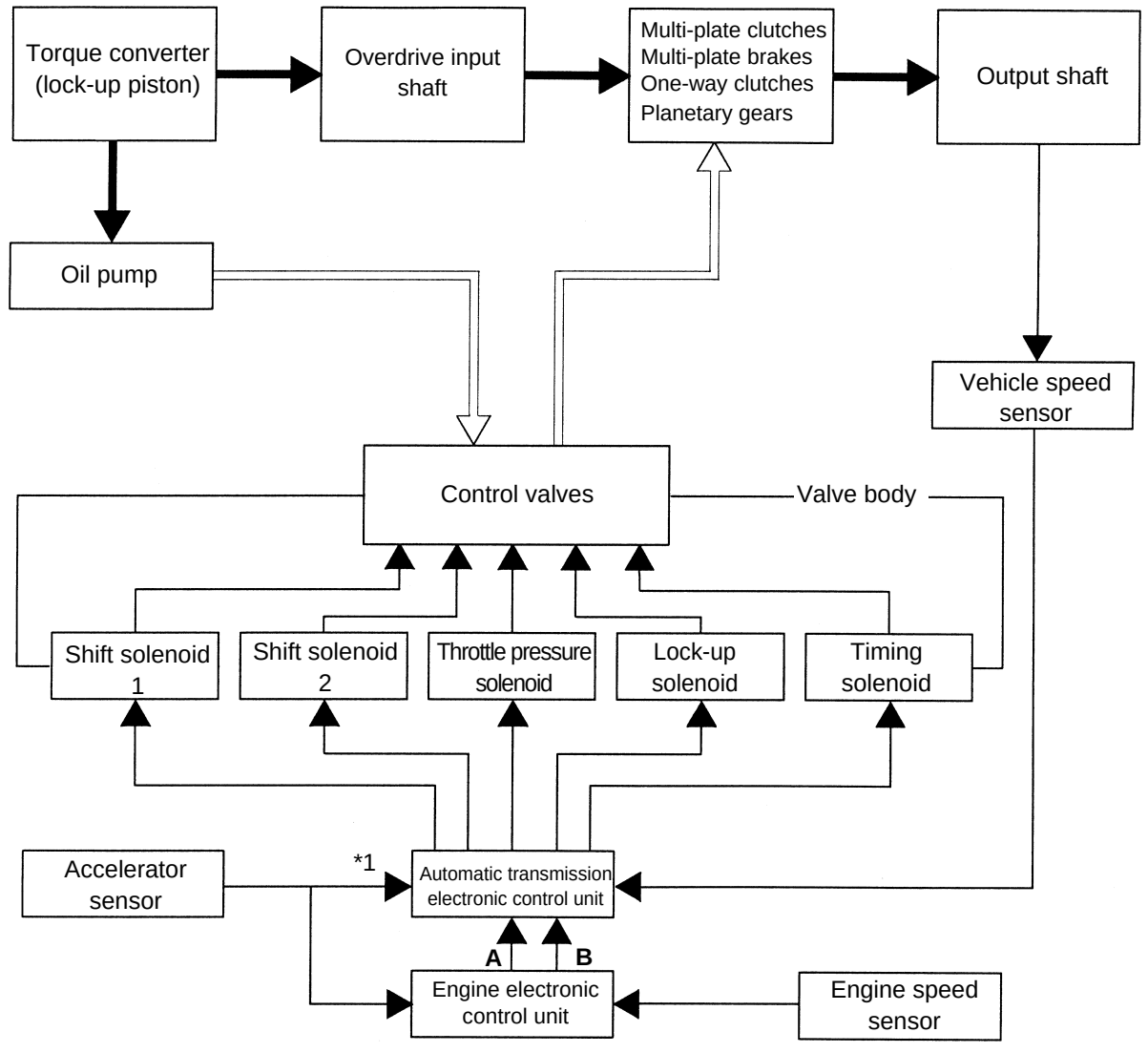
The gear system provides four forward speeds and one reverse speed. The gear section contains two one-way clutches, three sets of planetary gears, each comprised of a sun gear, pinion gears and a ring gear, three sets of hydraulic wet-type multi-plate clutches; and three sets of wet-type multi-plate brakes.

● **Hydraulic control section**

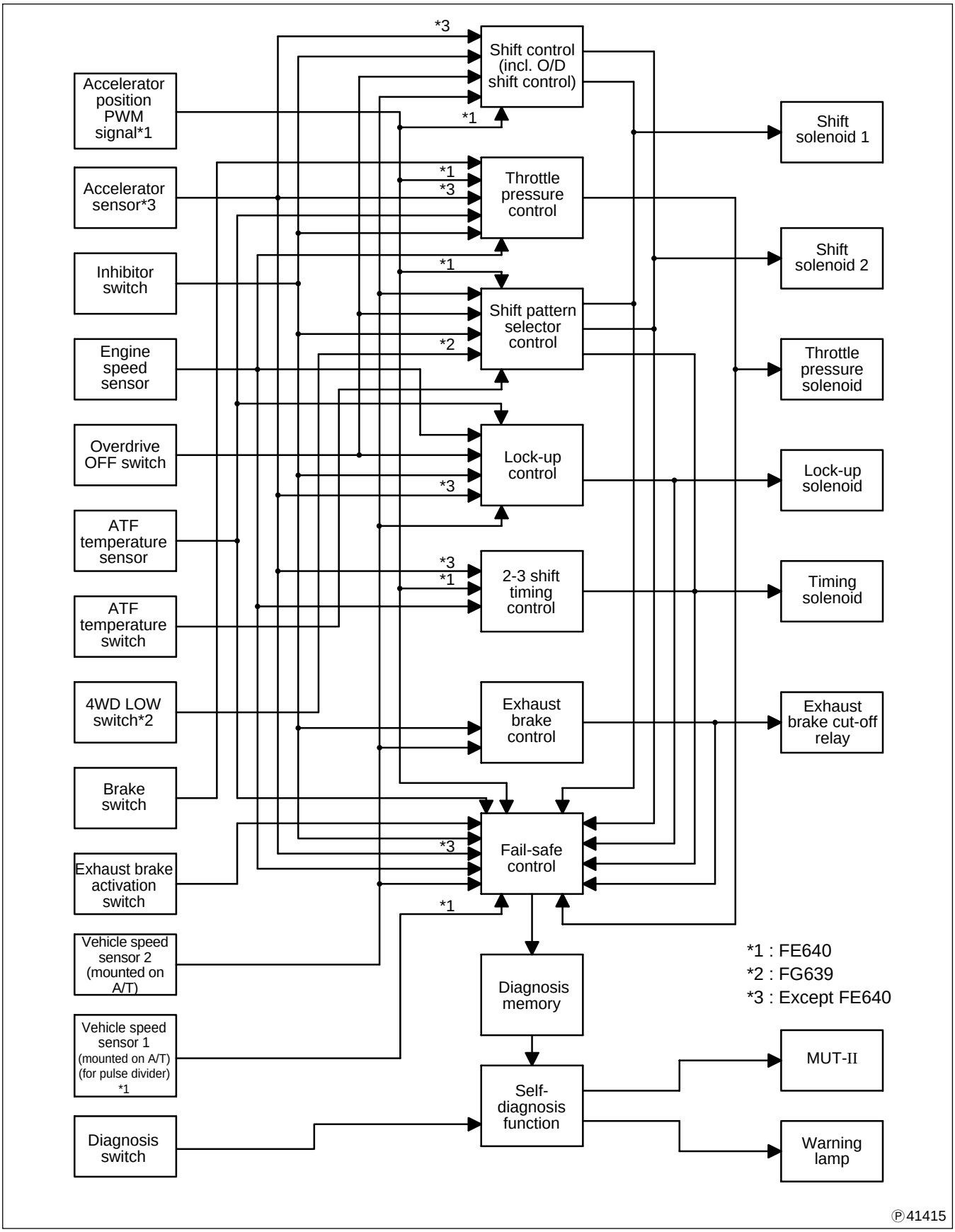
The electronic control system uses a microcomputer to regulate the mechanism operations for precise shifting.

Control Mechanisms

Control system



Control block diagram



STRUCTURE AND OPERATION

The control functions can be roughly divided into shift control, lock-up control and 2-3 shift control. The electronic control unit electronically controls these functions precisely in accordance with driving conditions.

Chart of control items, inputs and outputs

Item \ Control item			Shift control (incl. overdrive control)	Shift pattern selector control	Throttle pressure control	Lock-up control	2-3 shift control	Exhaust brake control	Fail-safe control	Self-diagnosis control
Input	Vehicle speed sensor 2	Mounted on transmission (output shaft rotation sensor)		○	○	○		○	○ Note 1	○
	Vehicle speed sensor 1 *1	Mounted on transmission	○ Note 3	○ Note 3	○ Note 3	○ Note 3		○ Note 3		
	Throttle position PWM signal		○*1	○*1	○*1	○*1	○*1	○*1	○*3 ○ Note 1 *1	○*3
	Engine speed sensor				○	○	○		○ Note 1	○
	Accelerator sensor *3		○		○	○	○	○	○ Note 1	○
	Overdrive OFF switch		○	○		○				
	Inhibitor switch		○	○	○	○		○	○ Note 1	○
	Automatic transmission fluid temperature switch			○						
	Automatic transmission fluid temperature sensor				○	○			○	○
	4WD LOW switch			○						
	Brake switch				○					
	Exhaust brake activation signal								○ Note 1	○
	Diagnosis switch									○ Note 2
Output	Shift solenoid 1		○	○					○ Note 1	○
	Shift solenoid 2		○	○					○ Note 1	○
	Timing solenoid			○			○		○ Note 1	○
	Lock-up solenoid					○			○ Note 1	○
	Throttle pressure solenoid				○				○ Note 1	○
	Exhaust brake cut-off relay							○	○ Note 1	○
	Warning lamp									○

Note 1 : The automatic transmission electronic control unit activates fail-safe functions when there is an abnormality in the input/output signals.
Note 2 : The self-diagnosis function actiates.
Note 3 : Backup for vehicle speed sensor 2 (mounted on transmission)
*1 : FE640
*2 : FG639
*3 : Except FE640

● **Shift control**

Based on the accelerator operation signal transmitted from the accelerator sensor and the signal from the vehicle speed sensor, the automatic transmission electronic control unit outputs signals according to the predetermined shift curve. These signals are sent to shift solenoid 1, shift solenoid 2 and the timing solenoid mounted on the valve body, and automatically shift to the optimum gear.

● **Throttle pressure control**

The accelerator sensor detects the degree of throttle operation. This data is used to control the throttle pressure solenoid, and the hydraulic pressure supplied from the reducing valve is maintained at the optimum level (throttle pressure) according to the vehicle's operating condition.

● **2-3 shift control**

Based on the signal from the throttle sensor and the signal from the engine speed sensor, the automatic transmission electronic control unit outputs a signal to the timing solenoid mounted on the valve body, and controls the discharge timing of automatic transmission fluid to reduce shift shock.

● **Lock-up control**

The lock-up mechanism eliminates slippage of the torque converter for improved power transmitting efficiency. Based on the accelerator operation signal transmitted from the accelerator sensor and the signal from the vehicle speed sensor, the automatic transmission electronic control unit outputs a signal according to the predetermined shift curve. This signal is sent to the lock-up solenoid mounted on the valve body, and engages or disengages the lock-up mechanism.

● **Fail-safe control**

The fail-safe functions minimize adverse effects to the vehicle operation caused by malfunctioning of the vehicle speed sensor, engine speed sensor, accelerator sensor, inhibitor switch or solenoids.

• Accelerator sensor

This sensor prohibits lock-up control change and 2-3 shift timing control by determining the shift-point vehicle speed at closed throttle position and the line pressure at maximum pressure, thus allowing vehicle operation.

• Inhibitor switch

If the inhibitor switch malfunctions in a stationary or moving vehicle and there is no signal input to the automatic transmission electronic control unit, the automatic transmission electronic control unit determines the transmission position setting as the D range and prohibits shifting from 3rd to 4th gear. If the automatic transmission electronic control unit receives two or more signals, the automatic transmission electronic control unit operates according to the following priority order for the range selector position and enables vehicle operation: L > R > 2 > D > N >P. Since the manual valve changes the hydraulic circuit in the valve body according to the range selector position, the vehicle operates as follows.

Range selector lever position	Inhibitor switch input signal	Vehicle operating condition
P	P and other selector signals	P
R	R and other selector signals	R
N	N and other selector signals	N
D	D and other selector signals (excludes R, L and 2 range signals)	$D_1 \leftrightarrow D_2 \leftrightarrow D_3 \leftrightarrow D_4$
↑	D and L range signals	$D_1 \leftrightarrow D_2 \leftarrow D_3$
↑	D and R range signals	D_4
↑	D and 2 range signals	$D_1 \leftrightarrow D_2 \leftrightarrow D_3$
2	2 and other selector signals (excludes R and L signals)	$2_1 \leftrightarrow 2_2 \leftarrow 2_3$
↑	2 and L range signals	$2_1 \leftrightarrow 2_2 \leftarrow 2_3$
↑	2 and R range signals	2_3
L	L and other selector signals	$L_1 \leftrightarrow L_2 \leftarrow L_3$

• Engine speed sensor

The 2-3 shift timing control becomes inactive to ensure proper vehicle operation.

• Shift solenoid 1 and shift solenoid 2

If a solenoid malfunction occurs when the transmission is in the D, 2 or L range, the operating conditions of the solenoids change as shown in the following table. The automatic transmission electronic control unit also deactivates the lock-up solenoid and timing solenoid to allow vehicle operation.

Range selector position	Normal				Malfunctioning of S1			Malfunctioning of S2			Malfunctioning of S1 and S2		
	S1	S2	ST	Gear	S1	S2	Gear	S1	S2	Gear	S1	S2	Gear
D range	○	×	×	1st	–	×→○	3rd	○	–	1st	–	–	4th
	○	○	×	2nd	–	○	3rd	○→×	–	4th	–	–	4th
	×	○	×	3rd	–	○	3rd	×	–	4th	–	–	4th
	×	×	×	4th	–	×	4th	×	–	4th	–	–	4th
2 range	○	×	×	1st	–	×→○	3rd	○	–	1st	–	–	3rd
	○	○	×	2nd	–	○	3rd	○→×	–	3rd	–	–	3rd
	×	○	×	3rd	–	○	3rd	×	–	3rd	–	–	3rd
L range	○	×	×	1st	–	×	1st	○	–	1st	–	–	1st
	○	○	×	2nd	–	○	2nd	○	–	1st	–	–	1st
	×	○	○	3rd	–	○	2nd	×	–	1st	–	–	1st

○ : Electric current supplied × : Electric current not supplied – : Malfunctioning → : Fail-safe function
S1 : Shift solenoid 1 S2 : Shift solenoid 2 ST : Timing solenoid

• Throttle pressure solenoid

The malfunctioning solenoid is deactivated to bring the line pressure to a maximum level, thus allowing vehicle operation.

• Timing solenoid and lock-up solenoid

The malfunctioning solenoid is deactivated to allow vehicle operation.

● **Self-diagnosis function**

The warning lamp lights when an abnormality occurs during vehicle operation.

- The warning lamp does not light if the abnormality causes minimum effect to vehicle operation.
- The warning lamp lights when the following parts are malfunctioning to indicate the abnormal condition since these malfunctions significantly reduce vehicle performance.
  - Vehicle speed sensor < except FE640 >
  - Vehicle speed sensor 1 < FE640 >
  - Throttle position PWM signal < except FE640 >
  - Vehicle speed sensors 1 and 2 < FE640 >
  - Shift solenoid 1
  - Shift solenoid 2
  - Accelerator sensor
  - Timing solenoid
  - Inhibitor switch
  - Throttle pressure solenoid

CAUTION ⚠

The warning lamp lights only when the malfunction prevents proper vehicle operation.

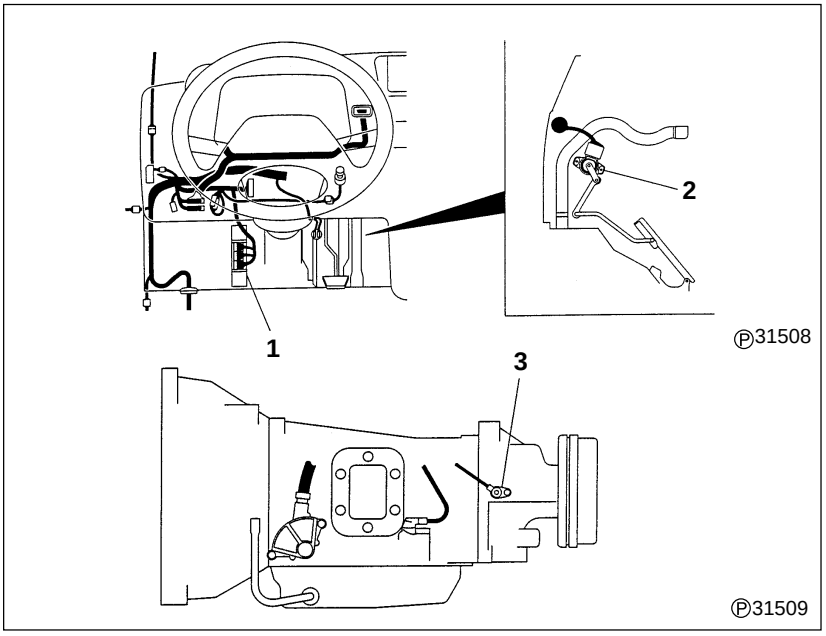
The indicator lamp provides self-diagnosis information.

- To facilitate the discovery of malfunctions that may not reproduce themselves frequently, the automatic transmission electronic control unit stores in the memory information of malfunctions that occur during vehicle operation.
- An input of a self-diagnosis start signal produces the output of the data from the memory, and causes the automatic transmission warning lamp to flash according to the data.

CAUTION ⚠

The automatic transmission electronic control unit stores information of all malfunctions that occur after the previous self-diagnosis operation.

Electronic Control Devices

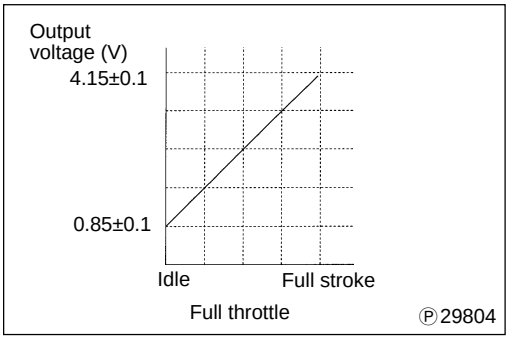


1 Automatic transmission electronic control unit
2 Accelerator sensor
3 Vehicle speed sensor

● **Automatic transmission electronic control unit**

The automatic transmission electronic control unit is mounted near the brake booster on the driver's seat side. It determines the vehicle operating conditions based on signals sent from sensors, and outputs signals to solenoids to regulate shift control, lock-up control and other automatic transmission functions.

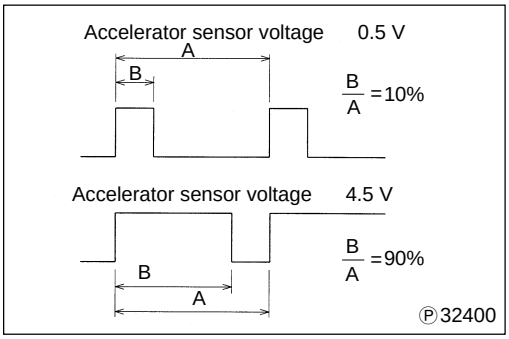
The automatic transmission electronic control unit is also equipped with a self-diagnosis function for the detection of malfunctions of main sensors and solenoids.



● **Accelerator sensor < Except FE640 >**

The accelerator sensor is mounted on the accelerator lever. It converts the accelerator pedal operation to voltage and sends it to the automatic transmission electronic control unit.

The output characteristic of the electric signal produced by the sensor is shown in the graph on the left. This output signal is used to determine the accelerator pedal angle and pressing speed.



● **Throttle position PWM signal < FE640 >**

The accelerator sensor voltage detected by the electronic governor control unit is converted to a PWM signal and output to the automatic transmission electronic control unit. The PWM signal is a chopping wave with a duty ratio shown in the diagram at the left.

● **Vehicle speed sensor**

< Except FE640 >

This sensor is mounted on the extension housing of the transmission, and converts the vehicle speed to a pulse signal by means of the parking lock gear and sends it to the automatic transmission electronic control unit.

< FE640 >

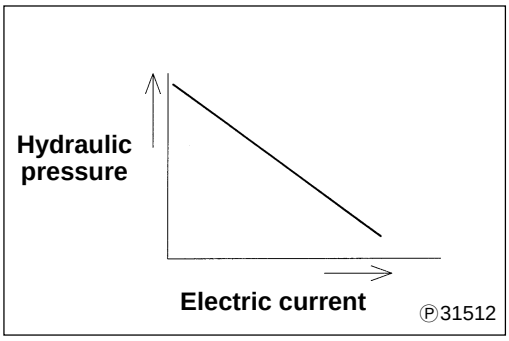
The vehicle speed monitoring system is composed of two sensor circuits; vehicle speed sensor **2** (output shaft rotation sensor) and vehicle speed sensor **1**. Accordingly, the normal driving mode is not disabled even when one of the vehicle speed sensor circuits is faulty.

● **Shift solenoids 1 and 2**

These solenoids are mounted on the valve body, and control shifting by turning ON and OFF in accordance with the signals sent from the automatic transmission electronic control unit.

The ON and OFF conditions of the two solenoids result in the following gear positions.

Shift solenoid 1	ON	ON	OFF	OFF
Shift solenoid 2	OFF	ON	ON	OFF
Gear position	1st gear	2nd gear	3rd gear	4th gear



● **Throttle pressure solenoid**

The throttle pressure solenoid is mounted on the valve body. It adjusts the throttle pressure based on the throttle opening signal sent from the automatic transmission electronic control unit. The throttle pressure adjustment characteristics are shown in the diagram.

● **Timing solenoid**

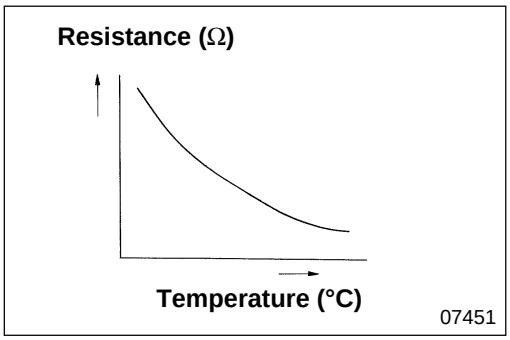
This solenoid is mounted on the valve body, and regulates the 2-3 shift timing control by turning ON and OFF in accordance with the signal sent from the automatic transmission electronic control unit.

● **Lock-up solenoid**

The lock-up solenoid is mounted on the valve body. According to the signal sent from the automatic transmission electronic control unit, the solenoid repeats ON and OFF operations, thereby opening and closing the drain circuit to control the hydraulic pressure at a predetermined level. The lock-up solenoid is a duty-cycle type that can control the ON and OFF time ratio in each cycle between 0 and 100%.

● **Automatic transmission fluid temperature switch**

This switch is mounted on the oil cooler outlet section of the transmission case. It detects abnormal temperatures of the automatic transmission fluid and turns on the warning lamp located on the meter cluster to indicate the abnormal condition.

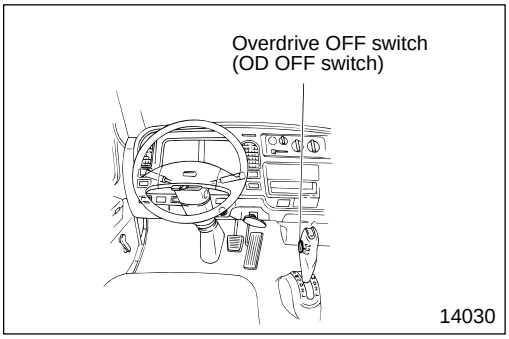


● **Automatic transmission fluid temperature sensor**

This sensor is mounted on the control valve in the transmission. It coverts temperature changes into continuous electric signals and sends them to the automatic transmission electronic control unit. The characteristics of the sensor's electric output signal are shown at the left. Based on this output signal, the automatic transmission electronic control unit prohibits overdrive shifting and lock-up operation and also performs partial correction of line pressure control.

● **Engine speed sensor**

The sensor converts the engine revolution speed to a pulse signal, and outputs to the electronic governor control unit. This signal is then transmitted from the electronic governor control unit to the automatic transmission control unit.



● **Overdrive OFF switch**

This switch is mounted on the range selector lever. It is operated by the driver, and it allows switching between the 3-speed and 4-speed modes.

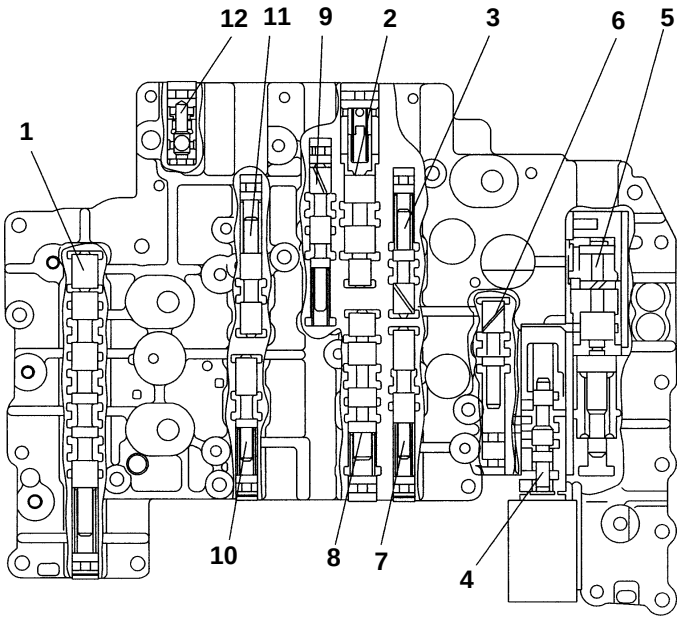
OFF : Transmission shifts to 4th gear for improved fuel efficiency.

ON : Transmission does not shift to 4th gear, thus increasing the engine brake effect and improving driveability on an up grade incline.

Hydraulic Control Devices

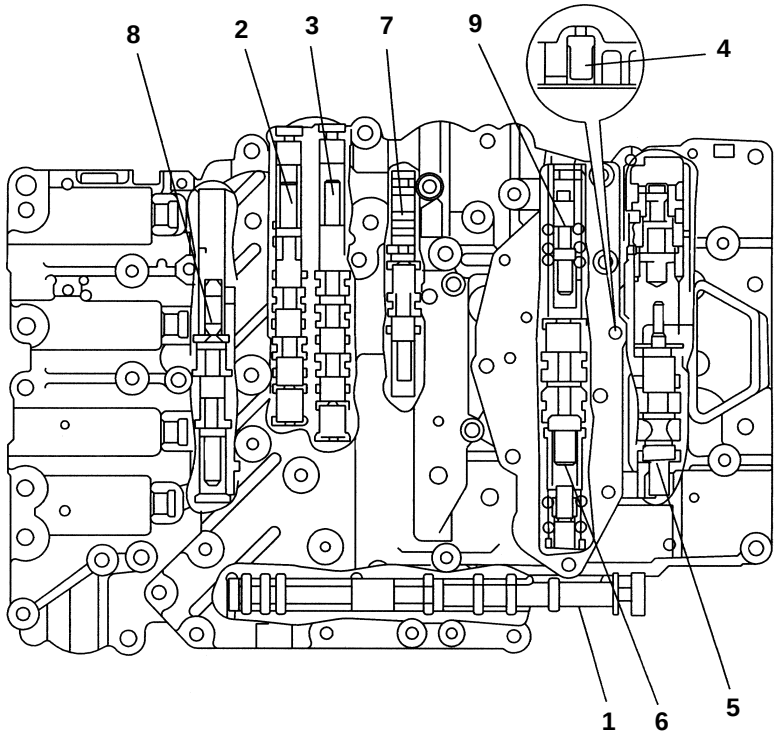
● **Valve Layout Diagram**

• **Upper valve body**



Ⓟ31513

• **Lower valve body**



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● Valve Functions

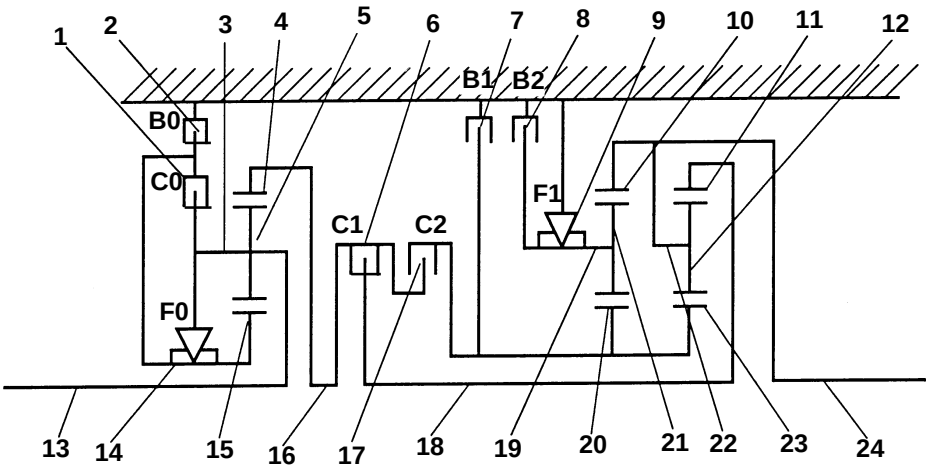
- **Upper valve body**

No.	Valve name	Description of function
1	2-3 Shift valve	Switches between 2nd and 3rd gears
2	Reverse inhibitor valve	When range selector is shifted to R range while vehicle is moving forward at moderate or high speed, this valve, operated by solenoid output, prevents shifting to reverse.
3	Modulator valve	Adjusts line pressure and supplies hydraulic pressure to lock-up signal valve and orifice control valve
4	Throttle valve	Adjusts signal pressure (throttle pressure) that is used to provide optimum line pressure in accordance with operating conditions
5	Secondary regulator valve	Controls pressure of automatic transmission fluid supplied from primary regulator valve to torque converter as well as lubricating oil pressure
6	Reducing valve	Reduces line pressure and feeds to throttle valve
7	Lock-up signal valve	Engages and disengages lock-up mechanism
8	Accumulator control valve	Lowers accumulator back pressure when throttle opening becomes smaller, and obtains accumulator control pressure from line pressure that is used to reduce shift shock
9	Low coast modulator valve	Lowers line pressure to reduce shift shock when range selector is shifted to L range
10	Orifice control valve	Switches orifices to reduce shock
11	Low inhibitor valve	When range selector is shifted to L range at high vehicle speed, this valve, operated by timing solenoid output, shifts to 3rd gear
12	Check valve	Switches fluid passage to rear clutch (C2) in D range and R ranges

- **Lower valve body**

No.	Valve name	Description of function
1	Manual valve	Switches fluid passage according to the position (P, R, N, D, 2, L) of range selector lever
2	1-2 Shift valve	Switches between 1st and 2nd gears
3	3-4 Shift valve	Switches between 3rd and overdrive gears
4	Pressure relief valve	Maintains pressure supplied to cooler at low level
5	Primary regulator valve	Regulates hydraulic pressure (line pressure) to devices
6	Lock-up control valve	Adjust flow rate of automatic transmission fluid to torque converter
7	C0 exhaust valve	Reduces shock in 3rd-to-2nd shifting
8	2-3 Timing valve	Adjusts hydraulic pressure switching timing in 3rd-to-2nd shifting to reduce shock
9	Cutback valve	Applies cutback pressure to throttle valve to reduce line pressure

Shift Function



1 Overdrive direct clutch (C0)
2 Overdrive brake (B0)
3 Overdrive planetary carrier
4 Overdrive planetary ring gear
5 Overdrive planetary pinion gears
6 Front clutch (C1)
7 2nd brake (B1)
8 1st and reverse brake (B2)
9 No. 2 one-way clutch (F1)
10 Front planetary ring gear
11 Rear planetary ring gear
12 Rear planetary pinion gears
13 Overdrive input shaft
14 Overdrive one-way clutch (F0)
15 Overdrive planetary sun gear
16 Input shaft
17 Rear clutch (C2)
18 Intermediate shaft
19 Front planetary carrier
20 Front planetary sun gear
21 Front planetary pinion gears
22 Rear planetary carrier
23 Rear planetary sun gear
24 Output shaft

• Clutch and brake functions

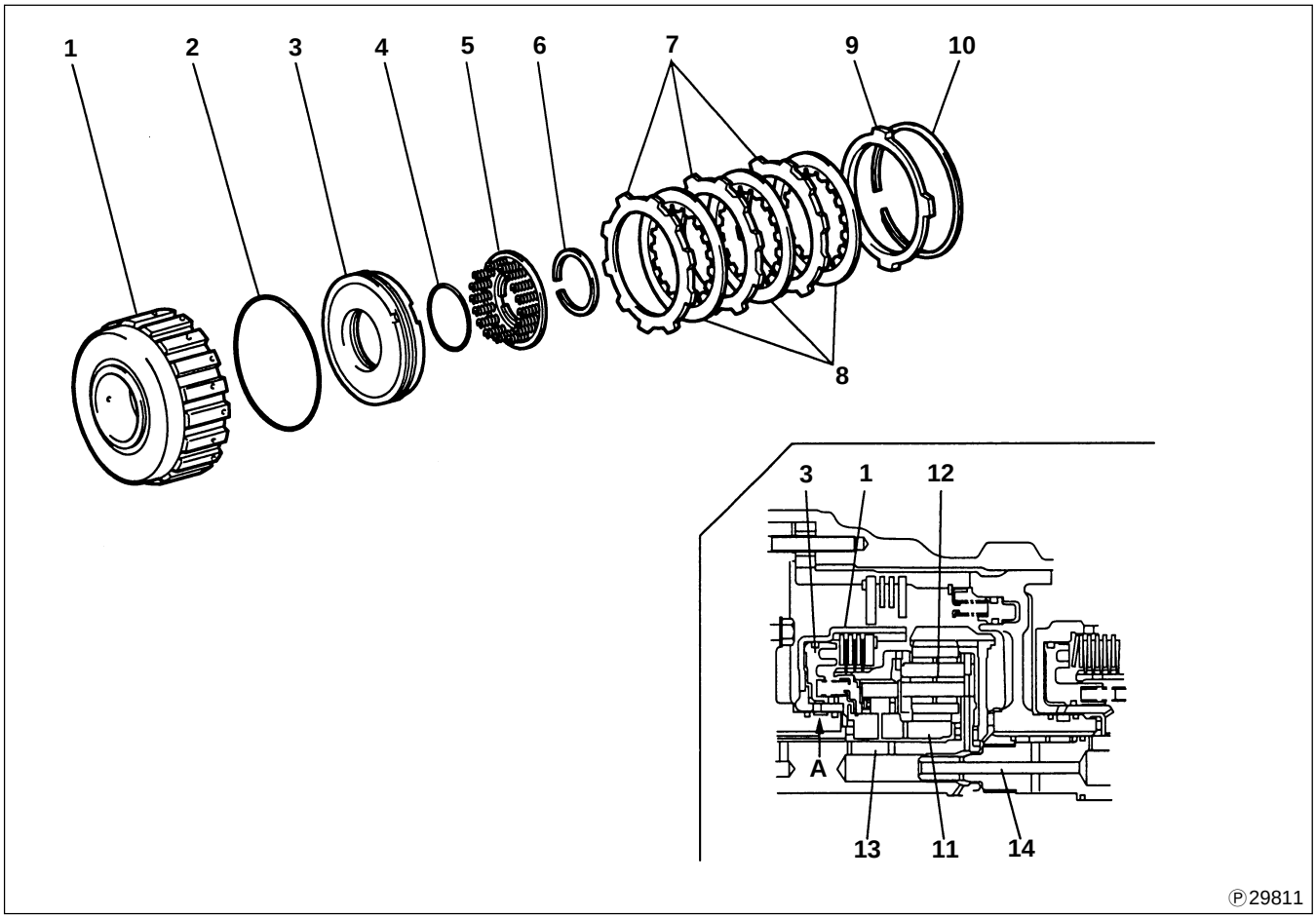
	Name	Function
	Overdrive direct clutch (C0)	Interlocks overdrive sun gear and overdrive planetary carrier
	Overdrive brake (B0)	Prevents rotation of overdrive sun gear
	Overdrive one-way clutch (F0)	Prevents overdrive planetary carrier from rotating in counterclockwise direction relative to overdrive sun gear during driving
	Front clutch (C1)	Interlocks input shaft and intermediate shaft
	Rear clutch (C2)	Interlocks input shaft with front and rear planetary sun gears
	2nd brake (B1)	Prevents rotation of front and rear planetary sun gears
	1st and reverse brake (B2)	Prevents rotation of front planetary carrier
	No. 2 one-way clutch (F1)	Prevents counterclockwise rotation of front planetary carrier and allows only clockwise rotation

● Clutch, Brake and Solenoid Operations

Shift position		C0	C1	C2	B0	B1	B2	F0	F1	S1	S2	Remarks
P	Parking				○					○		Parking
R	Reverse	○		○			○	●				Reverse
N	Neutral				○					○		Neutral
D	1st	○	○					●	●	○		Automatic shifting 1↔ 2↔ 3 ↔ 4 [Overdrive OFF mode 1↔ 2↔ 3 ↔ 4]
	2nd		○			○		●		○	○	
	3rd	○	○	○				●			○	
	Overdrive		○	○	○							
2	1st	○	○					●	●	○		Automatic shifting 1↔ 2 ↔ 3
	2nd	○	○			○		●		○	○	
	3rd	○	○	○				●			○	
L	1st	○	○				○	●	●	○		Locked in 1st gear 1← 2 ← 3 (3rd gear shifting occurs only when timing solenoid activates.)
	2nd	○	○			○		●		○	○	
	3rd	○	○	○				●			○	

S1 and S2 refer to shift solenoid 1 and shift solenoid 2, respectively ○ : Activates ● : Activates only during driving
↔ : Overrun preventive control

● Overdrive Direct Clutch



1 Overdrive direct clutch drum
2 O-ring
3 Overdrive direct clutch piston
4 O-ring
5 Overdrive clutch return springs
6 Snap ring
7 Clutch plates
8 Clutch discs
9 Clutch flange
10 Snap ring
11 Overdrive planetary sun gear
12 Overdrive planetary carrier
13 Overdrive input shaft
14 Input shaft

A : Operating pressure

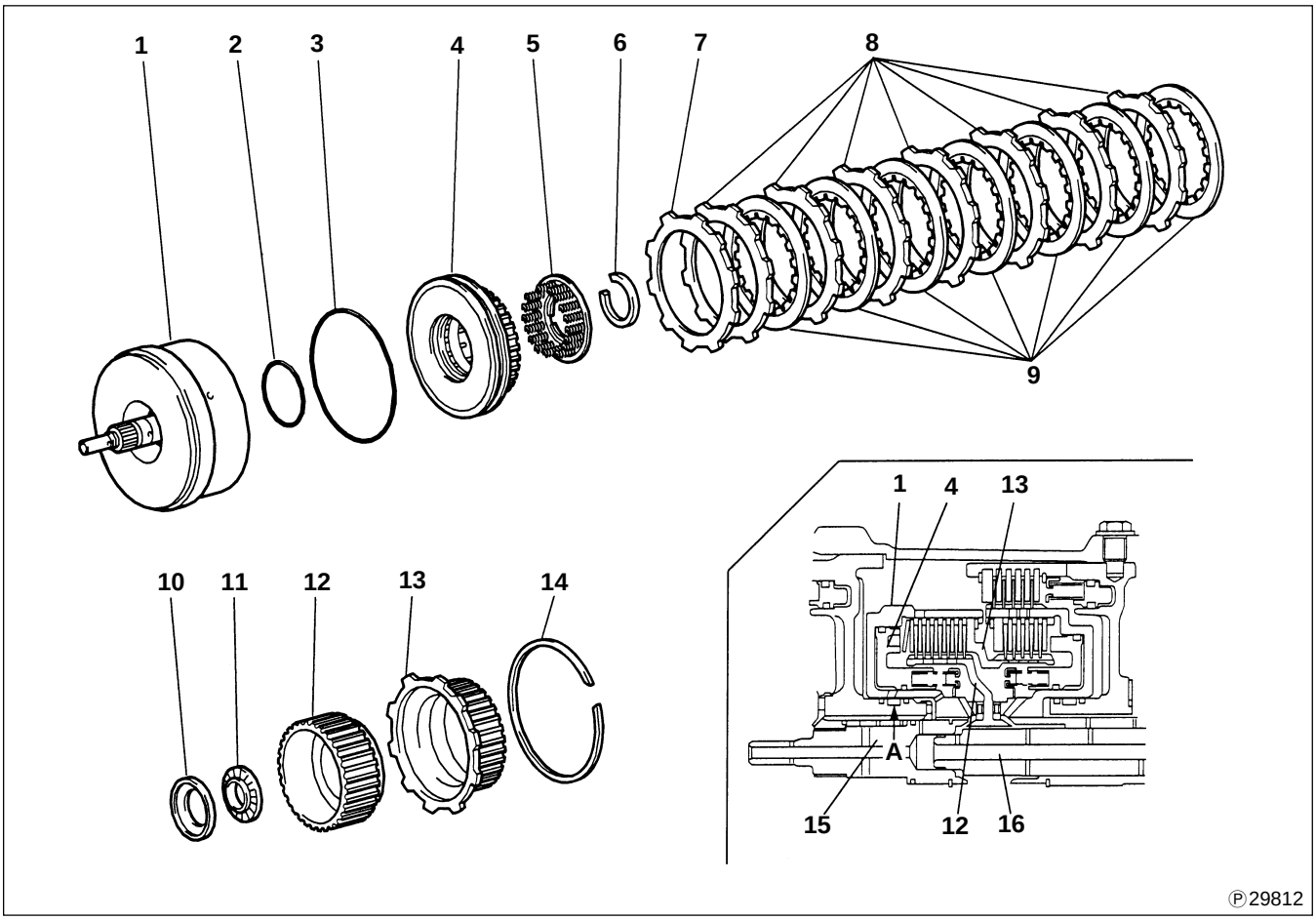
< Active condition >

The control valve supplies operating pressure **A** to overdrive direct clutch piston **3**, coupling clutch discs **8** and clutch plates **7**. This interlocks overdrive planetary sun gear **11** with overdrive planetary carrier **12**.
As a result, the entire overdrive planetary gear acts as a single unit to transmit the engine's driving power from overdrive input shaft **13** to input shaft **14**.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of overdrive clutch return springs **5** presses against overdrive direct clutch piston **3**.
As a result, clutch plates **7** are separated from clutch discs **8**, and the engine power is not transmitted.

● Front Clutch (C1)



1 Front clutch drum
2 O-ring
3 O-ring
4 Front clutch piston
5 Front clutch return springs
6 Snap ring
7 Clutch cushion plate
8 Clutch plates
9 Clutch discs
10 Thrust bearing race
11 Thrust bearing
12 Front clutch hub
13 Rear clutch hub
14 Snap ring
15 Input shaft
16 Intermediate shaft

A : Operating pressure

< Active condition >

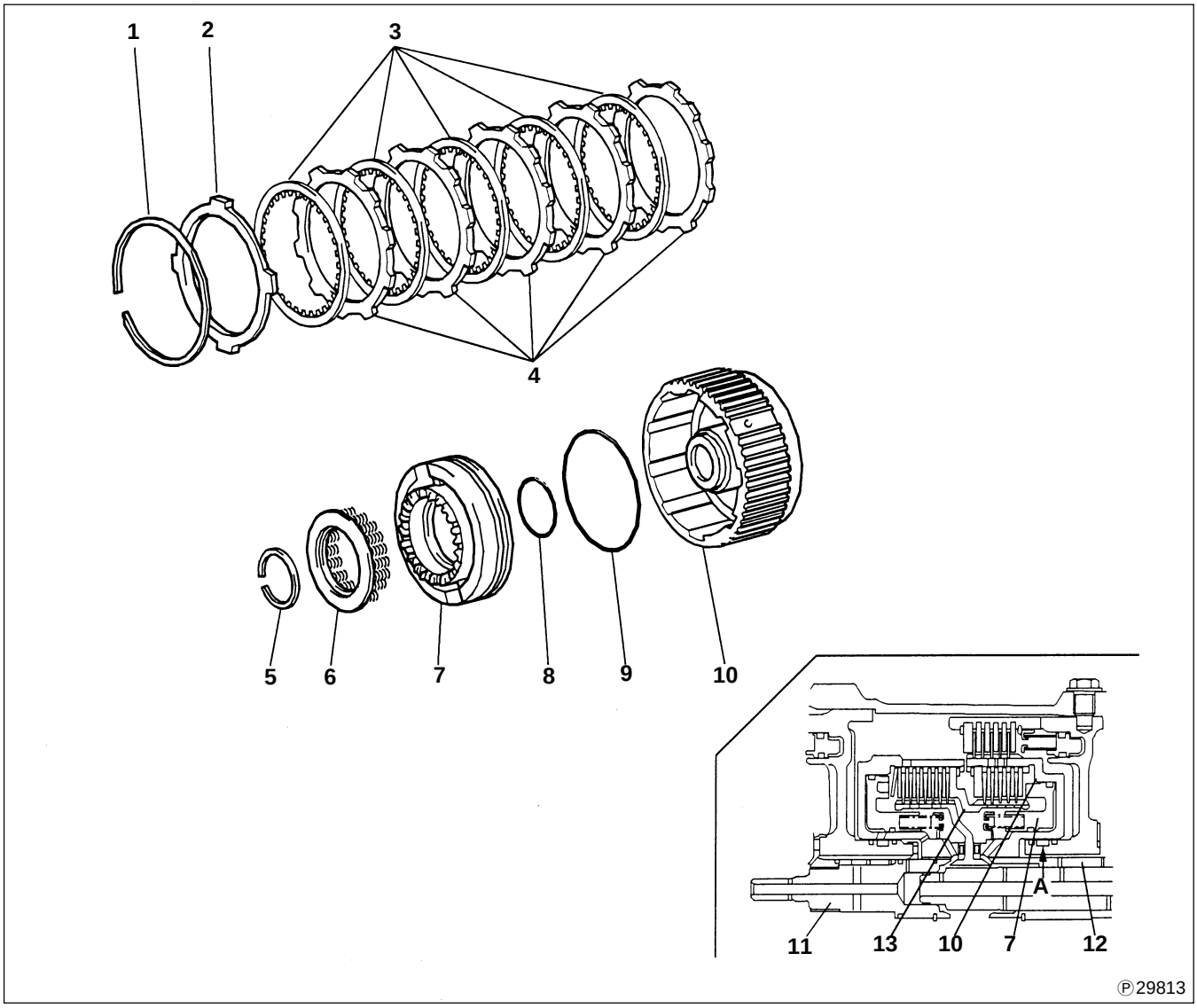
The control valve supplies operating pressure **A** to front clutch piston **4**, which causes the coupling of clutch discs **9** and clutch plates **8**, thus transmitting the engine's driving power from input shaft **15** to front clutch hub **12** and intermediate shaft **16**.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of front clutch return springs **5** presses against front clutch piston **4**.

As a result, clutch plates **8** are separated from clutch discs **9**, and the engine power is not transmitted.

● Rear Clutch (C2)



1 Snap ring
2 Clutch flange
3 Clutch discs
4 Clutch plates
5 Snap ring
6 Rear clutch piston return springs
7 Rear clutch piston
8 O-ring
9 O-ring
10 Rear clutch drum
11 Input shaft
12 Front and rear planetary sun gears
13 Rear clutch hub

A : Operating pressure

< Active condition >

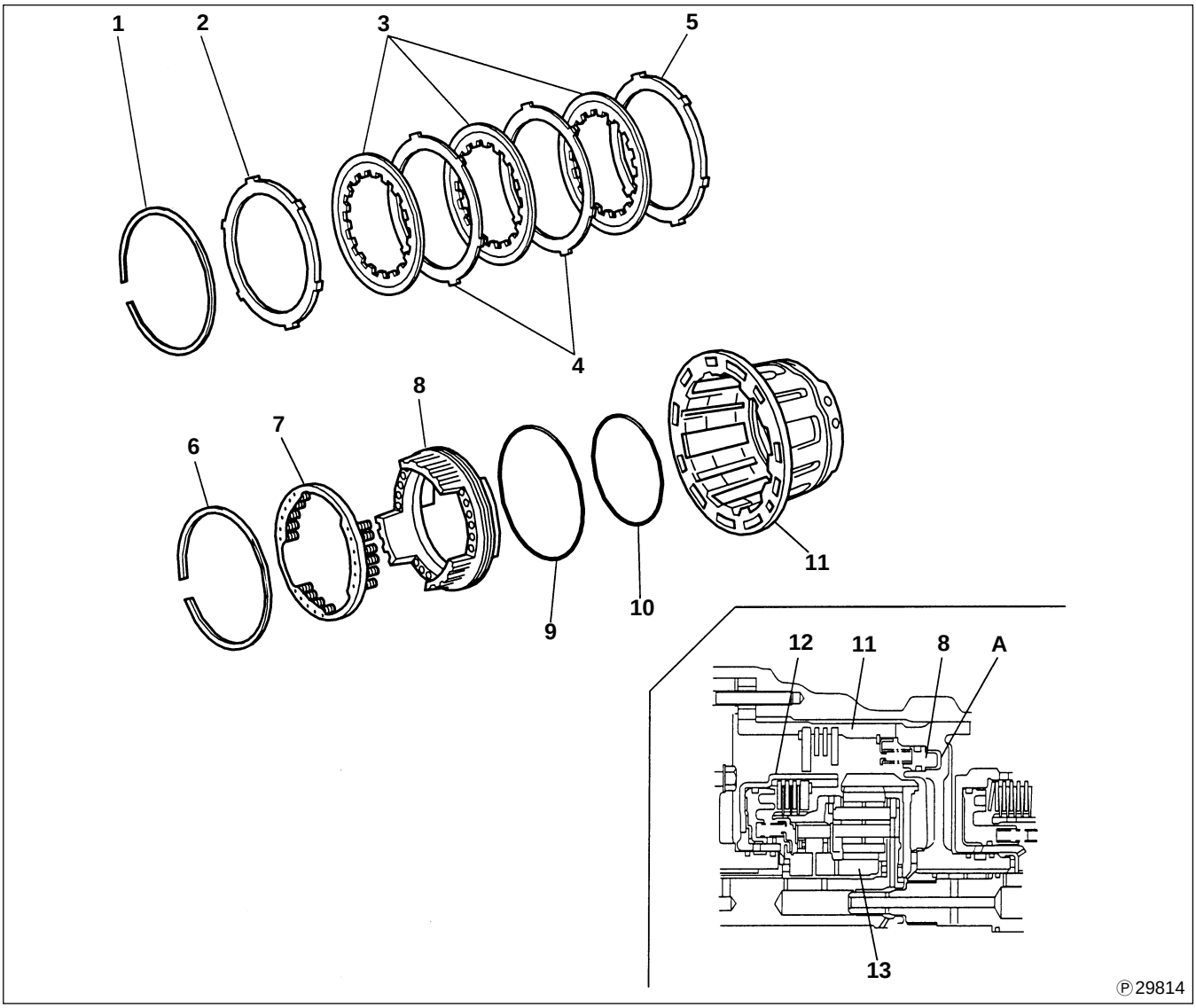
The control valve supplies operating pressure **A** to rear clutch piston **7**, which causes the coupling of clutch discs **3** and clutch plates **4**, thus transmitting the engine's driving power from input shaft **11** and rear clutch hub **13** to rear clutch drum **10** and front and rear planetary sun gears **12**.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of rear clutch piston return springs **6** presses against rear clutch piston **7**.

As a result, clutch plates **4** are separated from clutch discs **3**, and the engine power is not transmitted.

● Overdrive Brake (B0)



1	Snap ring	**6**	Snap ring	**11**	Overdrive case
2	Brake flange	**7**	Overdrive brake return springs	**12**	Overdrive direct clutch
3	Clutch discs	**8**	Overdrive brake piston	**13**	Overdrive planetary sun gear
4	Brake plates	**9**	O-ring		
5	Brake plates	**10**	O-ring	**A** :	Operating pressure

< Active condition >

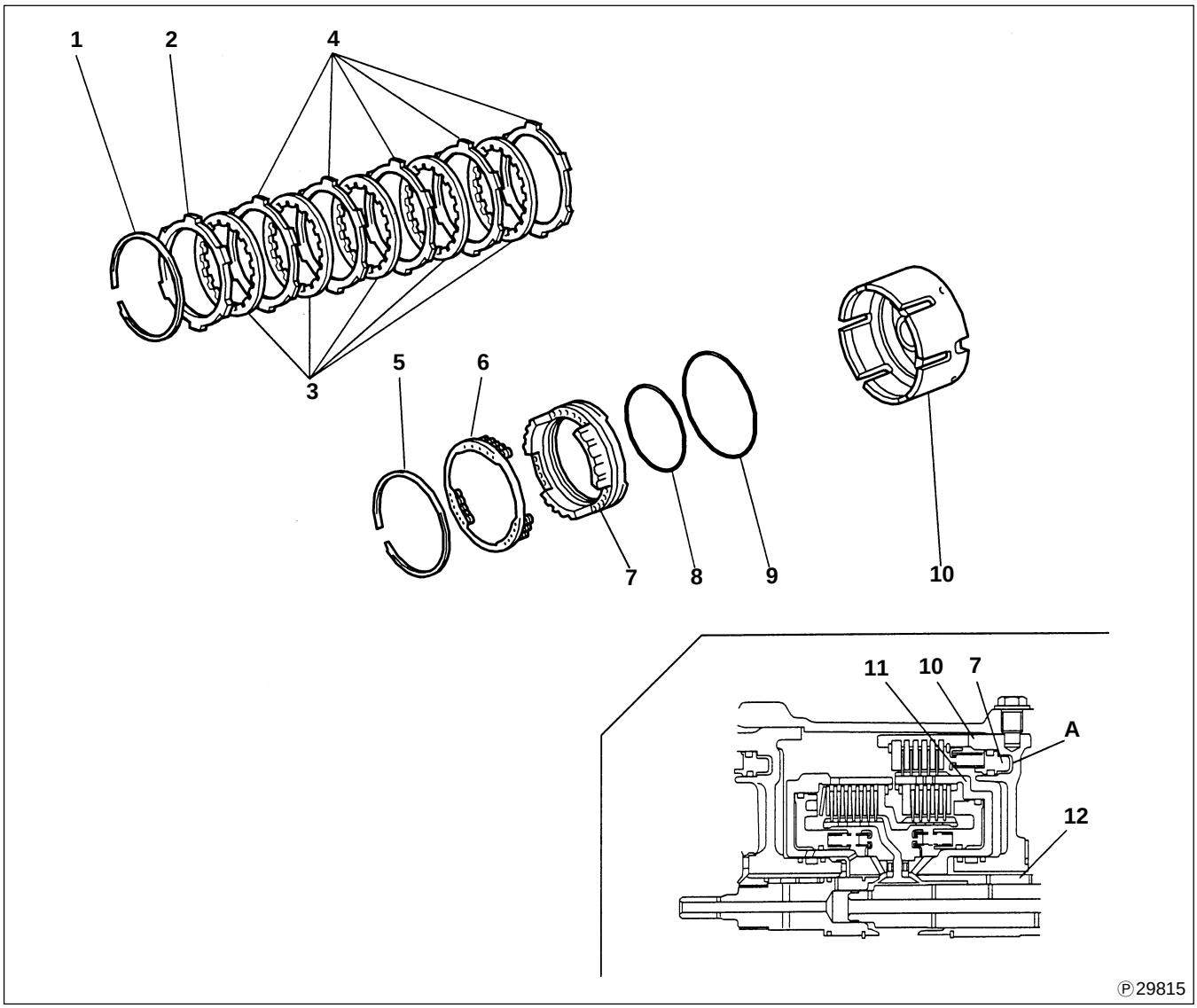
The control valve supplies operating pressure **A** to overdrive brake piston **8**, which causes the coupling of clutch discs **3** and brake plates **4**, **5**, thus interlocking overdrive direct clutch **12** with overdrive case **11**. This sets overdrive planetary sun gear **13** in locked condition.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of overdrive brake return springs **7** presses against overdrive brake piston **8**.

As a result, brake plates **4**, **5** are separated from clutch discs **3**, and the engine power is not transmitted.

● 2nd Brake (B1)



1 Snap ring
2 Brake flange
3 Clutch discs
4 Brake plates
5 Snap ring
6 2nd brake return springs
7 Brake piston No. 1
8 O-ring
9 O-ring
10 Center support
11 Rear clutch
12 Front and rear planetary sun gears
A : Operating pressure

< Active condition >

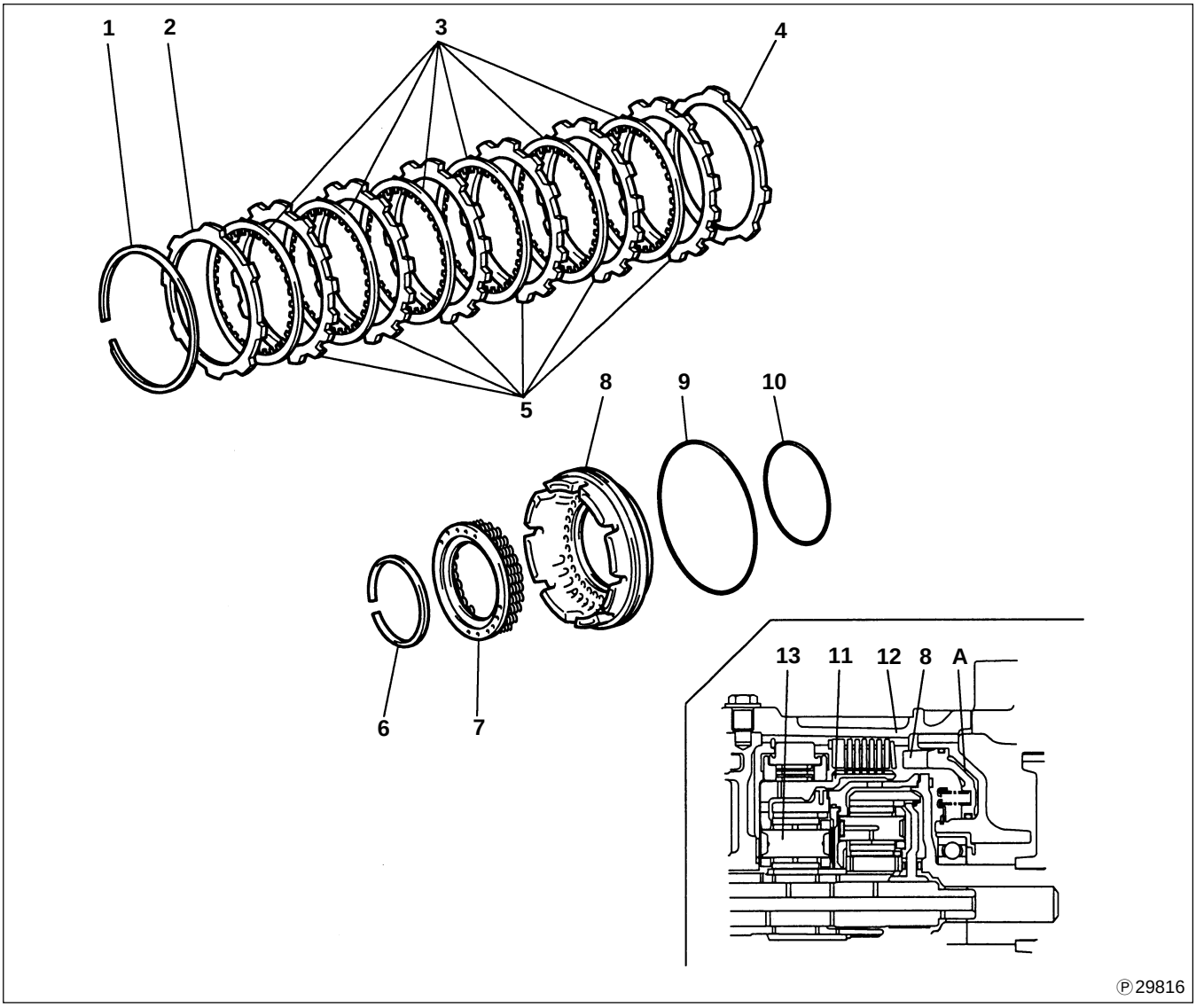
The control valve supplies operating pressure **A** to brake piston No. **7**, which causes the coupling of clutch discs **3** and brake plates **4**, thus interlocking rear clutch **11** with center support **10**. This sets front and rear planetary sun gears **12** in locked condition.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of 2nd brake return springs **6** presses against brake piston No.1 **7**.

As a result, brake plates **4** are separated from clutch discs **3**, and the engine power is not transmitted.

● 1st and Reverse Brake (B2)



1 Snap ring
2 Brake flange
3 Clutch discs
4 Brake cushion plate
5 Brake plates
6 Snap ring
7 1st and reverse brake return springs
8 1st and reverse brake piston
9 O-ring
10 O-ring
11 1st and reverse brake hub
12 Transmission case
13 Front planetary carrier

A : Operating pressure

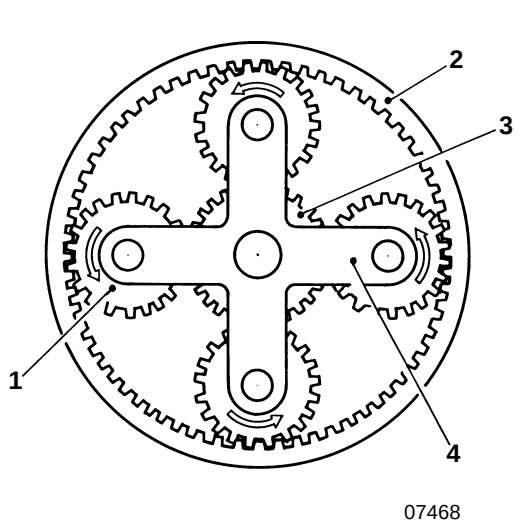
< Active condition >

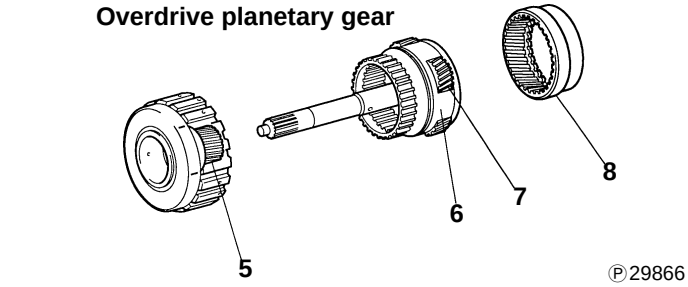
The control valve supplies operating pressure **A** to 1st and reverse brake piston **8**, which causes the coupling of clutch discs **3** and brake plates **5**, thus interlocking 1st and reverse brake hub **11** with transmission case **12**. This sets front planetary carrier **13** in locked condition.

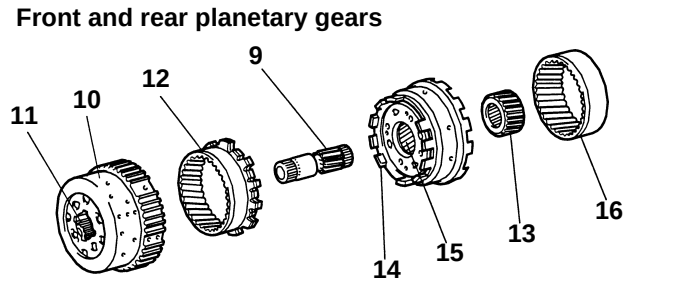
< Inactivate condition >

Since operating pressure **A** is not supplied, the force of 1st and reverse brake return springs **7** presses against 1st and reverse brake piston **8**.
As a result, brake plates **5** are separated from clutch discs **3**, and the engine power is not transmitted.

● Planetary Gears



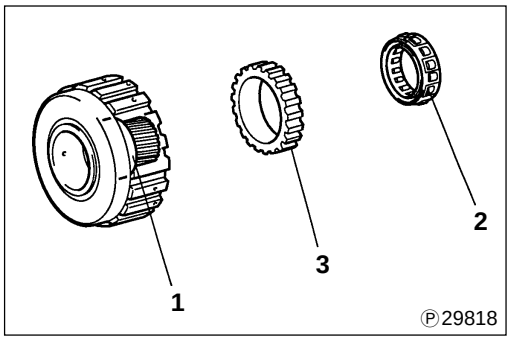




1 Pinion gear
2 Ring gear
3 Sun gear
4 Planetary carrier
5 Overdrive sun gear
6 Overdrive planetary carrier
7 Overdrive pinion gears
8 Overdrive ring gear
9 Front sun gear
10 Front planetary carrier
11 Front pinion gears
12 Front ring gear
13 Rear sun gear
14 Rear planetary carrier
15 Rear pinion gears
16 Rear ring gear

- Three sets of Simpson-type planetary gears provide a total of five gear ratios: four forward speeds and one reverse speed.
- Each planetary gear set consists of a sun gear **3** at the center and pinion gears **1** that revolve around the sun gear and on their axes. This set of gears are contained in a ring gear **2**. The pinion gears are attached to a planetary carrier **4**, so that all pinion gears rotate in the same direction and at the same rate. Gear shifting occurs when these four elements — sun gear, pinion gears, ring gear and planetary carrier — are provided with certain conditions. Clutches and brakes provide operating conditions to the planetary gears in accordance with shifting.

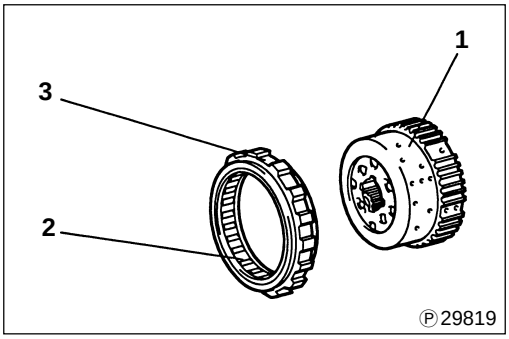
● Overdrive One-Way Clutch



1 Overdrive direct clutch drum and overdrive one-way clutch inner race
2 Overdrive one-way clutch
3 Overdrive one-way clutch outer race

- During acceleration in the 1st, 2nd and 3rd gears, the overdrive one-way clutch **2** engages and becomes interlocked with the overdrive sun gear and overdrive planetary carrier.
- In the 4th gear, the overdrive one-way clutch **2** rotates freely.

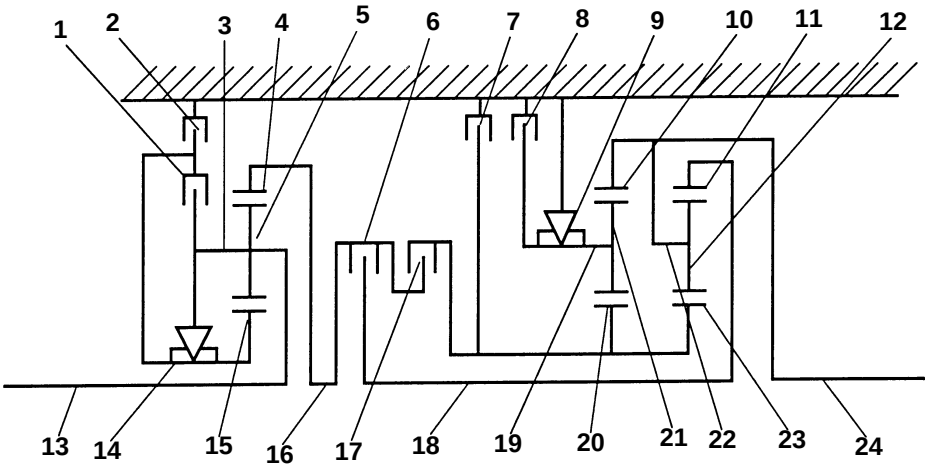
● No. 2 One-Way Clutch



1 Front planetary carrier and No. 2 one-way clutch inner race
2 No. 2 one-way clutch
3 No. 2 one-way clutch outer race

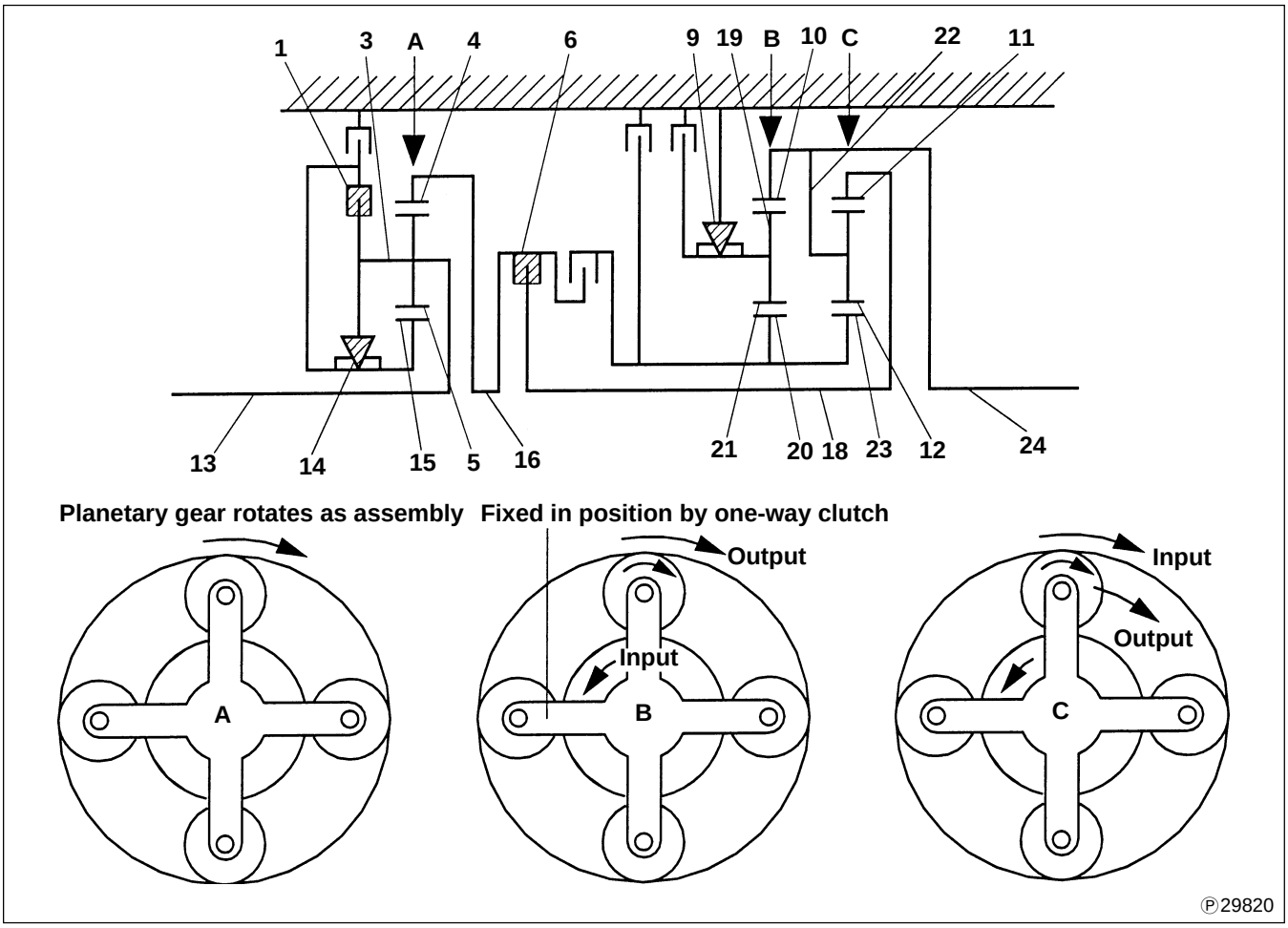
- During acceleration in the 1st gear, the No. 2 one-way clutch **2** engages and becomes interlocked with the front planetary carrier.
- In the 1st, 2nd and 3rd gears, the No. 2 one-way clutch **2** rotates freely.

Torque Transmission Process



1 Overdrive direct clutch
2 Overdrive brake
3 Overdrive planetary carrier
4 Overdrive planetary ring gear
5 Overdrive planetary pinion gears
6 Front clutch
7 2nd brake
8 1st and reverse brake
9 No. 2 one-way clutch
10 Front planetary ring gear
11 Rear planetary ring gear
12 Rear planetary pinion gears
13 Overdrive input shaft
14 Overdrive one-way clutch
15 Overdrive planetary sun gear
16 Input shaft
17 Rear clutch
18 Intermediate shaft
19 Front planetary carrier
20 Front planetary sun gear
21 Front planetary pinion gears
22 Rear planetary carrier
23 Rear planetary sun gear
24 Output shaft

● D, and 2 Ranges (1st Gear)



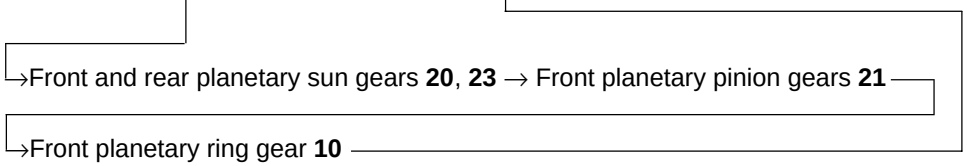
Overdrive direct clutch **1**, front clutch **6**, overdrive one-way clutch **14** and No. 2 one-way clutch **9** activate to provide the 1st gear. At overdrive planetary gear **A**, overdrive direct clutch **1** operates to interlock overdrive planetary carrier **3** (overdrive input shaft **13**) with overdrive planetary sun gear **15**. This disables overdrive planetary pinion gears **5** from rotating on their axes, and overdrive planetary carrier **3** becomes locked (direct coupling) in position with overdrive planetary ring gear **4**, thus transmitting driving force to input shaft **16**. Clockwise rotation of overdrive planetary carrier **3** results in a force that attempts to turn overdrive pinion gears **5** in a counterclockwise direction, producing clockwise rotating force for overdrive planetary sun gear **15**. However, since overdrive planetary sun gear **15** rotates faster than overdrive planetary carrier **3**, overdrive one-way clutch **14** activates, interlocking overdrive planetary carrier **3** with overdrive planetary sun gear **15**. This disallows overdrive planetary pinion gears **5** from rotating on their axes, in the same way as when overdrive direct clutch **1** activates. Therefore, overdrive planetary carrier **3** becomes locked (direct coupling) in position with overdrive planetary ring gear **4**, thus transmitting the driving force to input shaft **16**.

These two power transmitting systems reduce the load on overdrive direct clutch **1**.

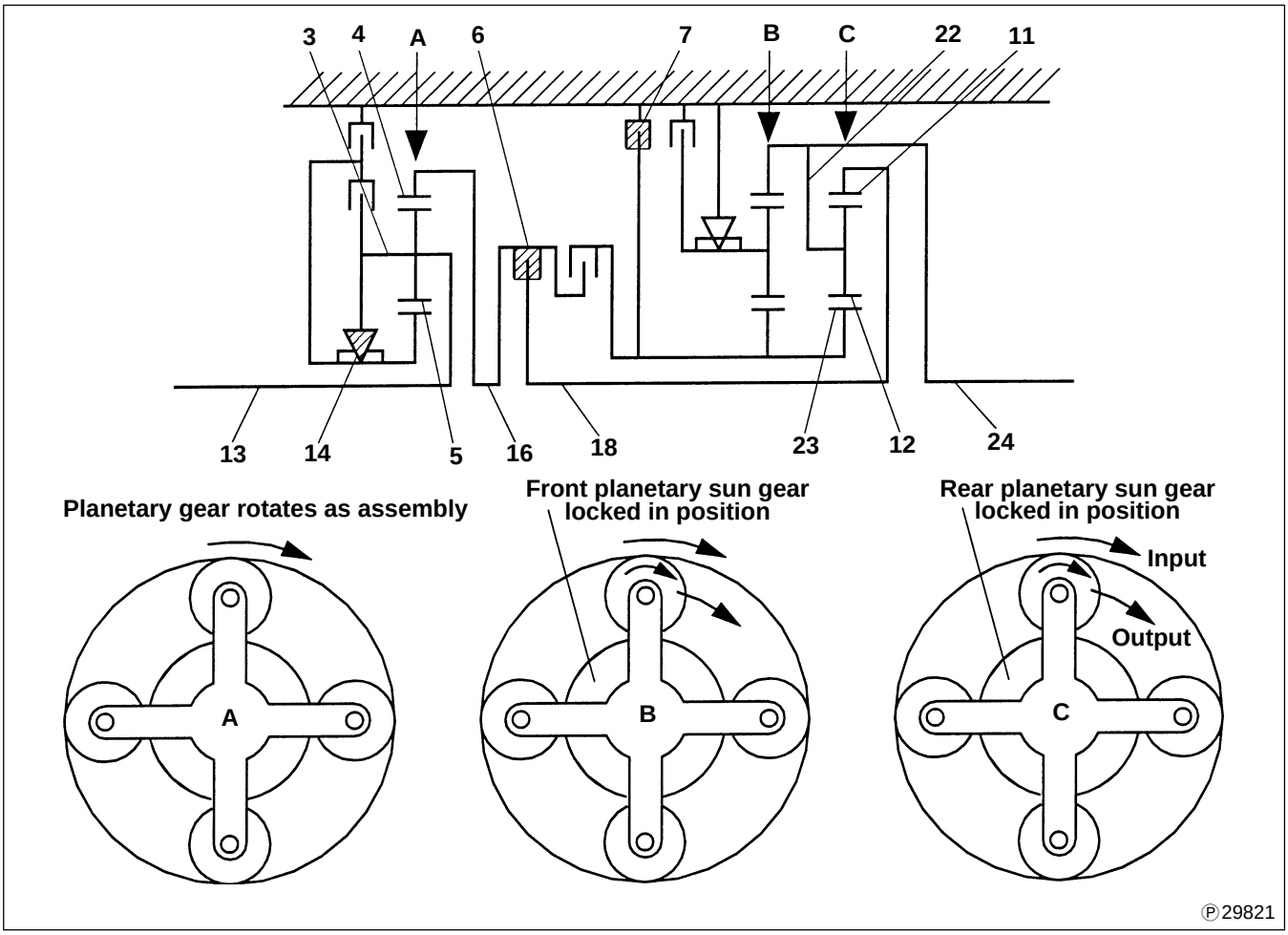
The clockwise rotating force of input shaft **16** is transmitted to intermediate shaft **18** by the action of front clutch **6**, then turns rear planetary pinion gears **12** clockwise by means of rear planetary ring gear **11**. In this process, rear planetary carrier **22** is stationary due to vehicle weight. Therefore, rear planetary sun gear **23** receives counterclockwise rotating force and transmits this force to front planetary pinion gears **21**, exerting force to rotate front planetary carrier **19** in a counterclockwise direction. However, since No. 2 one-way clutch **9** prevents front planetary carrier **19** from rotating in a counterclockwise direction, pinion gears **12**, **21** cause front planetary ring gear **10** and rear planetary carrier **22** to rotate in a clockwise direction, thereby transmitting the rotating force to output shaft **24**. (Rotational directions are described as viewed from the torque converter side.)

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**



● D Range (2nd Gear)

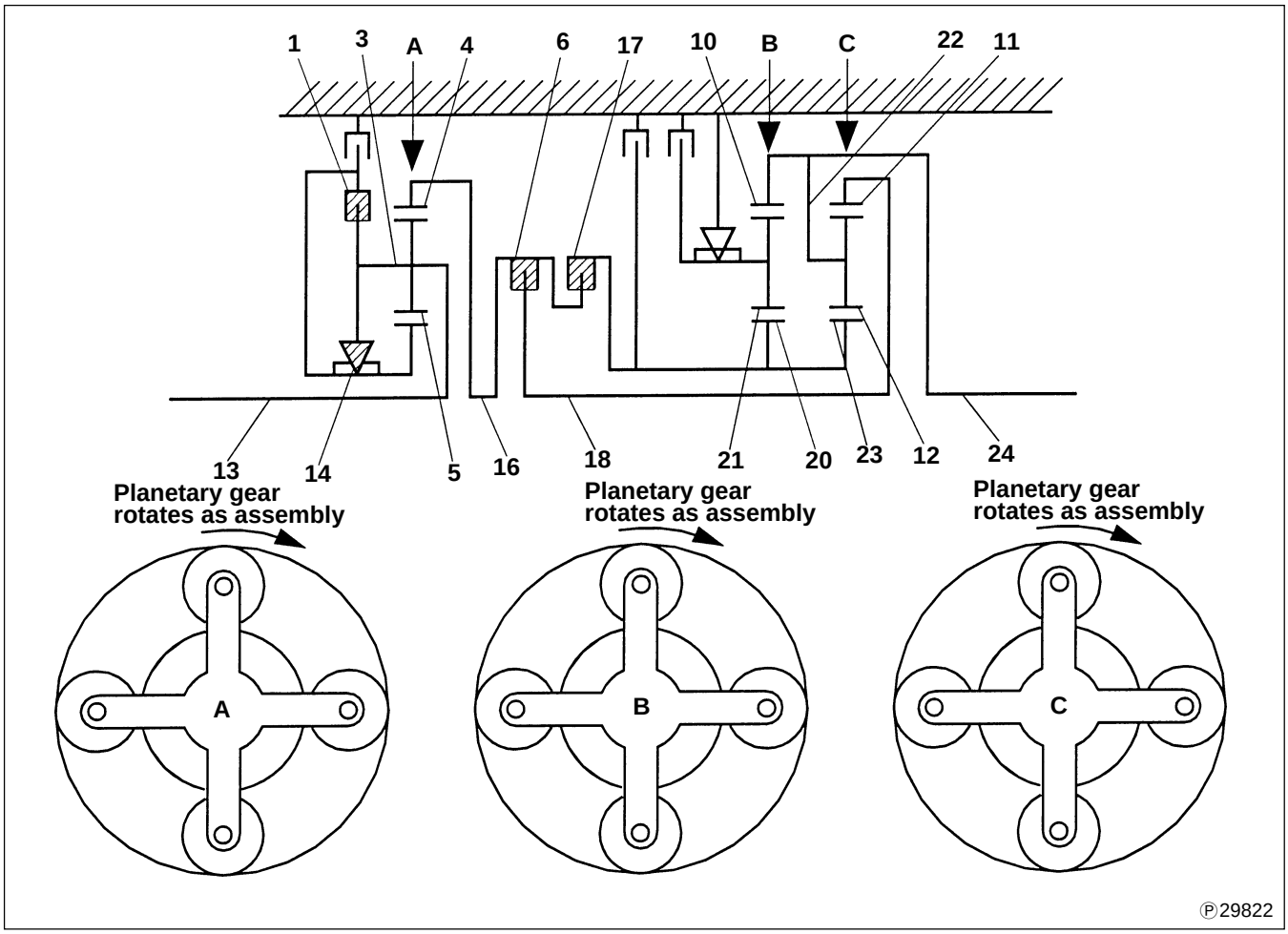


Front clutch **6**, 2nd brake **7** and overdrive one-way clutch **14** activate to provide the 2nd gear. In this gear, overdrive one-way clutch **14** transmits the rotating force of input shaft **16** to rear planetary pinion gears **12** by means of intermediate shaft **18** and rear planetary ring gear **11**. Although rear planetary sun gear **23**, which is meshed with pinion gears **12**, receives a counterclockwise rotating force, 2nd brake **7** prevents its rotation, disabling the transfer of the rotating force to front planetary gear **B**. As a result, the rotating force transmits to rear planetary carrier **22** via rear planetary pinion gears **12**, then to output shaft **24**.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**

● D, 2 and L Ranges (3rd Gear)



Overdrive direct clutch **1**, front clutch **6**, rear clutch **17** and Overdrive one-way clutch **14** activate to provide the 3rd gear. In this gear, front clutch **6** and rear clutch **17** cause intermediate shaft **18** and front and rear sun gears **20**, **23** to rotate in the same direction. Therefore, front and rear planetary pinion gears **12**, **21** become locked in position, thus the entire assemblies of planetary gears **A**, **B**, **C** rotate together to transmit the rotating force of input shaft **16** to output shaft **24** without reducing the rate of rotating speed.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** →Front clutch **6** → Intermediate shaft **18**

→Rear planetary ring gear **11** → Rear planetary pinion gears **12**

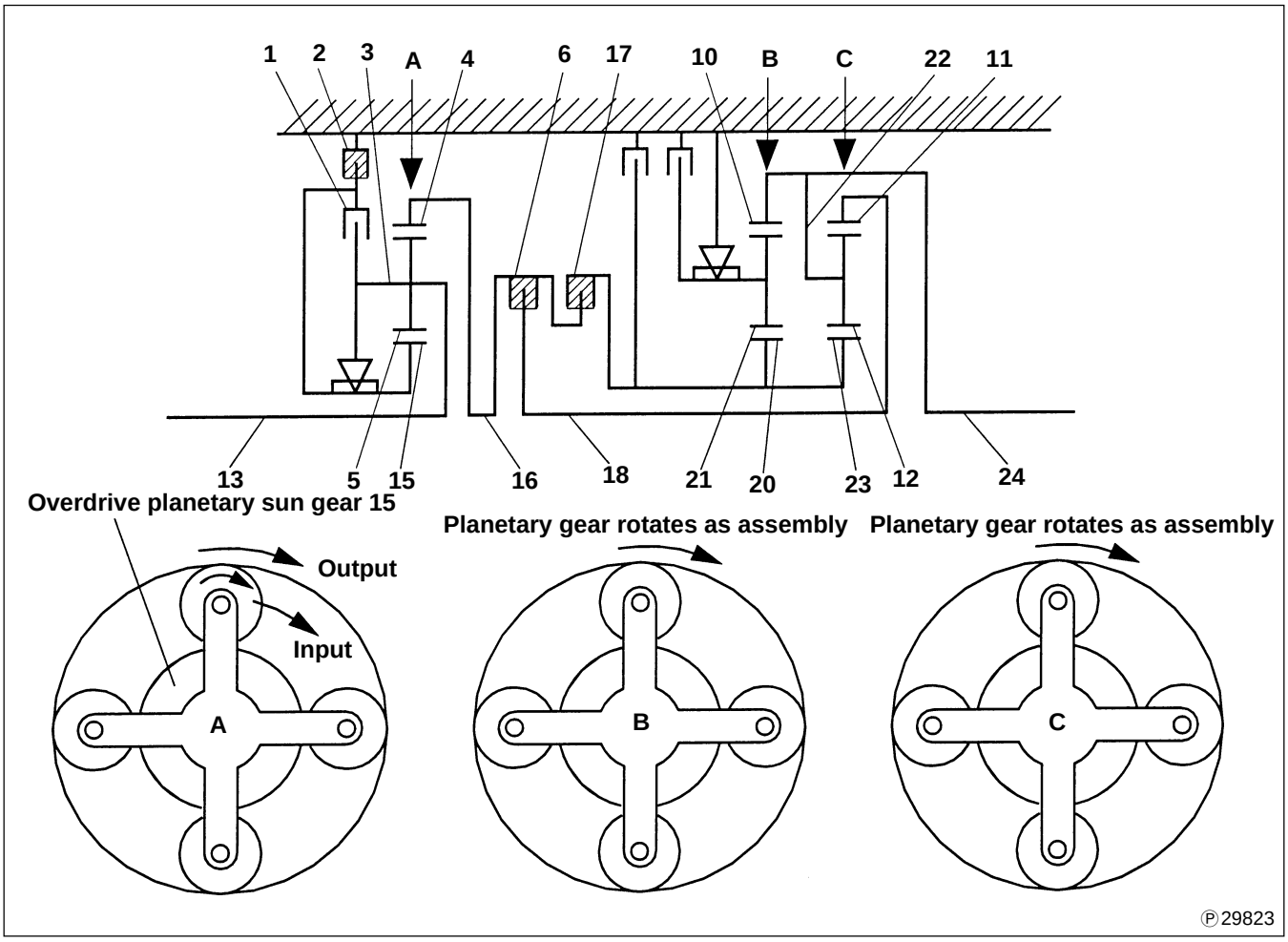
→Rear clutch **17**

→Rear planetary carrier **22** →Output shaft **24**

→Rear planetary sun gear **23** → Rear planetary pinion gears **12**

→Front planetary sun gear **20** → Front planetary pinion gears **21** → Front planetary ring gear **10**

● D Range (4th Gear)



If the overdrive conditions (see the table below) are fulfilled when the transmission is in 3rd gear, overdrive direct clutch **1** disengages, and overdrive brake **2** activates at the same time to provide the overdrive gear ratio. In the overdrive gear, overdrive brake **2** is in operation, thus locking overdrive planetary sun gear **15** in position. Therefore, the rotating force transmitted from overdrive input shaft **13** to overdrive planetary carrier **3** causes overdrive planetary pinion gears **5** to revolve around the sun gear and on their own axes, which results in an increased rotating speed of overdrive planetary ring gear **4** (input shaft **16**). The rotating force of input shaft **16** is transmitted to output shaft **24**, in the same way as in the 3rd gear.

Overdrive conditions

Shift position	D
Overdrive OFF SW	OFF
Temperature of oil in oil pan	Approximately 0°C {32°F} or higher

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18**

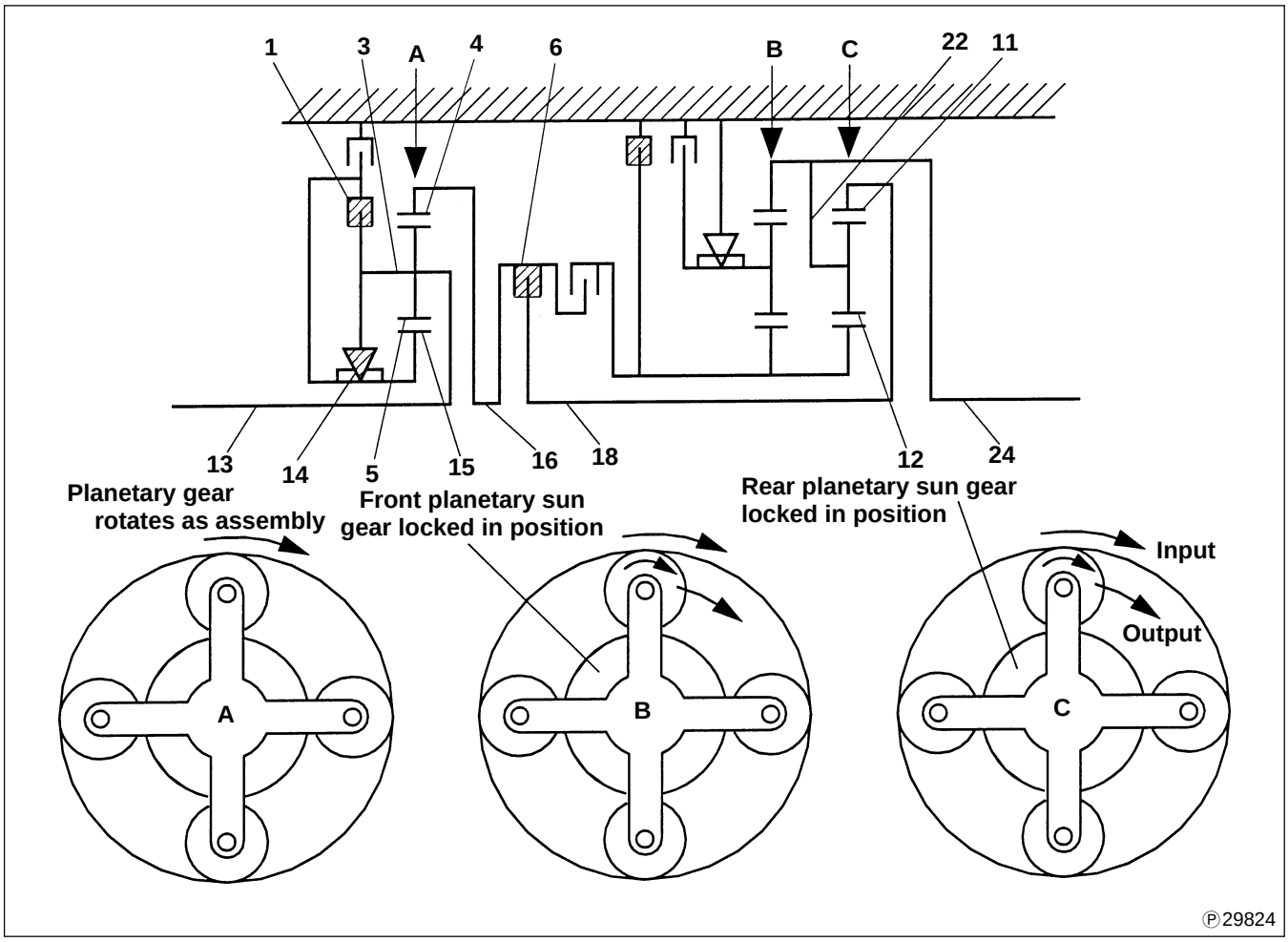
→ Rear planetary ring gear **11** → Rear planetary pinion gears **12**

→ Rear clutch **17** → Rear planetary carrier **22** → Output shaft **24**

→ Rear planetary sun gear **23** → Rear planetary pinion gears **12**

→ Front planetary sun gear **20** → Front planetary pinion gears **21** → Front planetary ring gear **10**

● 2 Range (2nd Gear)

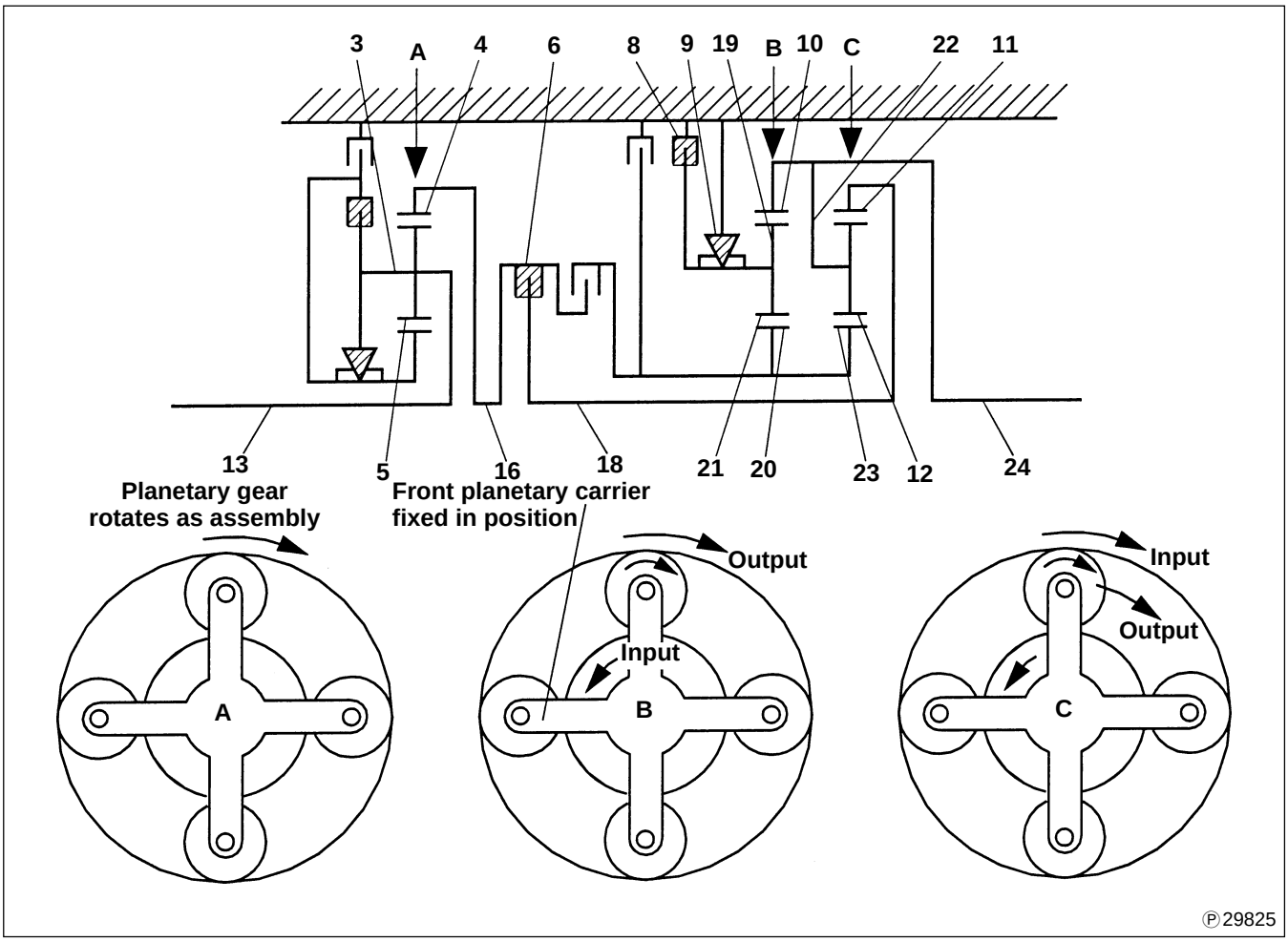


The rotating power is transmitted in the same way as in the previously described 2nd gear in the D range. However, when engine brake is applied, overdrive direct clutch **1** activates and prevents overdrive planetary sun gear **15** from rotating clockwise. In other words, when the transmission is in 2nd gear with the range selector in the D range, overdrive one-way clutch **14** transmits the rotating power to input shaft **16**. When the engine brake is applied, however, the counterclockwise rotating force of overdrive planetary sun gear **15** inactivates overdrive one-way clutch **14** and causes overdrive planetary sun gear **15** to spin freely. This disallows the transmission of the engine brake force. To properly transmit the engine brake force in the 2 range, overdrive direct clutch **1** is activated to interlock overdrive planetary sun gear **15** with overdrive planetary carrier **3**.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft**16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**

● L Range (1st Gear)



The rotating power is transmitted in the same way as in the previously described 1st gear in the D and L ranges. However, when the engine brake is applied, 1st and reverse brake **8** activates and prevents front planetary carrier **19** from rotating clockwise. In other words, when the transmission is in 1st gear with the range selector in the D or 2 range, No. 2 one-way clutch **9** prevents a counterclockwise rotation of front planetary carrier **19** and transmits the rotating power to output shaft **24**. When the engine brake is applied, however, a rotating force in the reverse direction is generated, inactivating No. 2 one-way clutch **9** and allowing front planetary carrier **19** to spin freely. This disallows the transmission of the engine brake force. To properly transmit the engine brake force in the L range, 1st and reverse brake **8** is activated to lock front planetary carrier **19** in position.

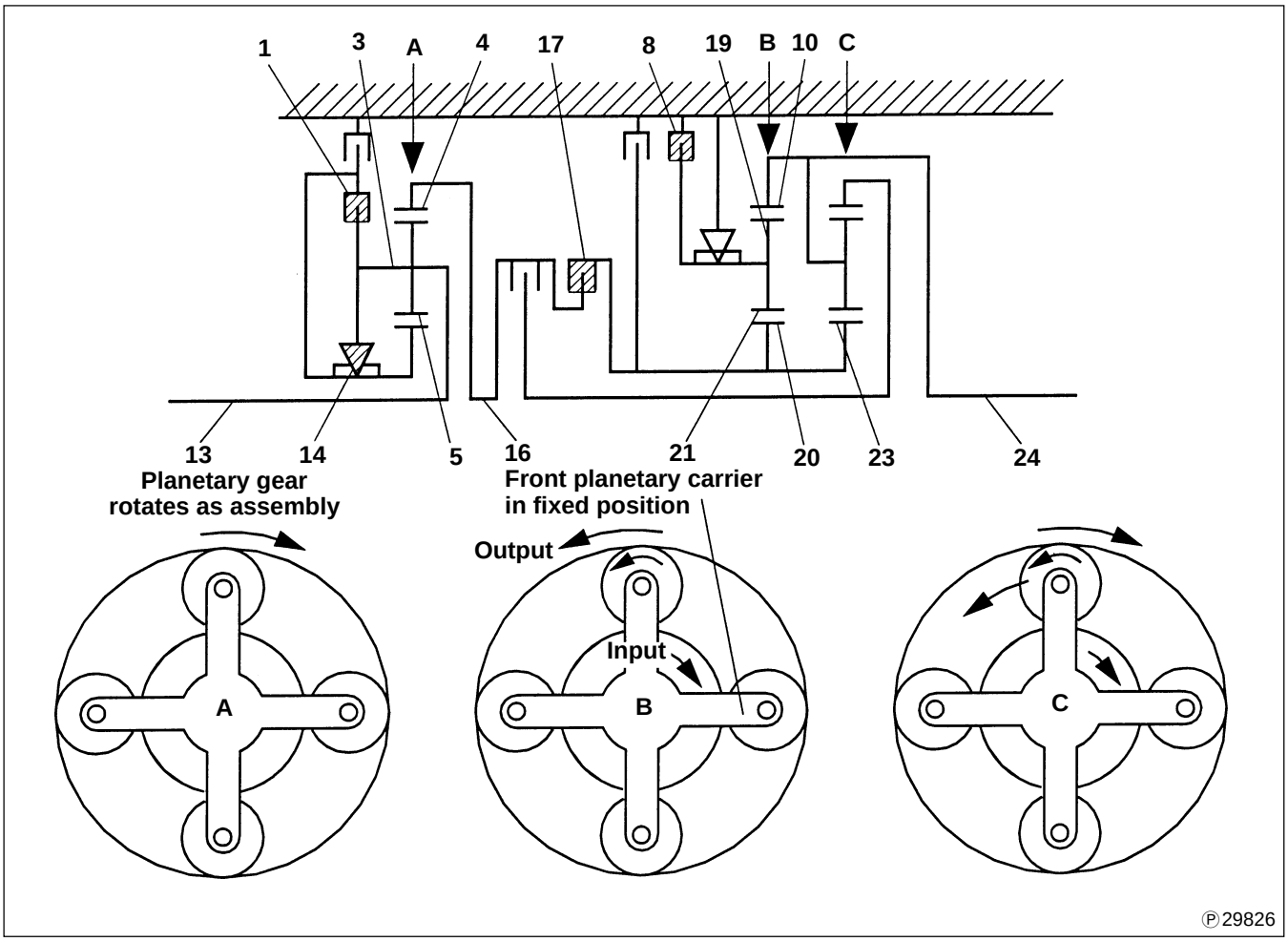
Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**

→Front and rear planetary sun gears **20**, **23** → Front planetary pinion gears **21**

→Front planetary ring gear **10**

● R Range

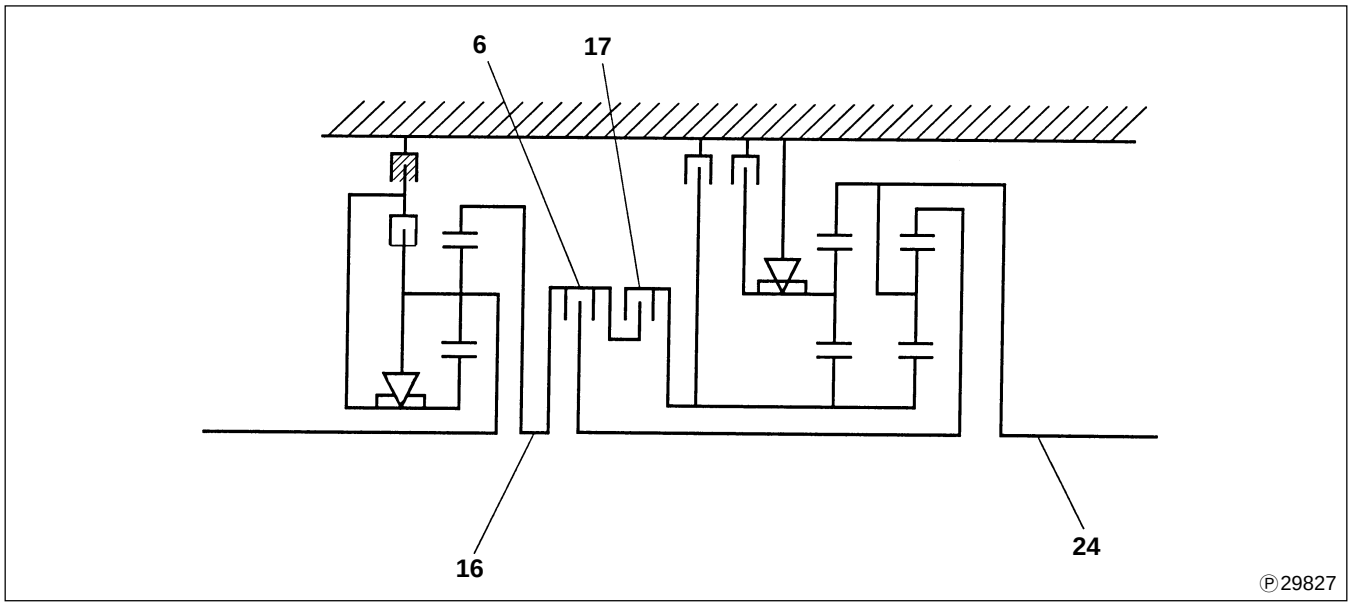


In the R range, overdrive direct clutch **1**, overdrive one-way clutch **14**, rear clutch **17** and 1st and reverse brake **8** activate to provide reverse gear. The rotating force of overdrive input shaft **13** is transmitted to input shaft **16** via direct coupling, in the same way as in the 1st gear in the D and 2 ranges. Since rear clutch **17** is in operation, the rotating force of input shaft **16** is transmitted to pinion gears **21** of front planetary gear **B** by means of the sun gear. However, because front planetary carrier **19** is locked in position by 1st and reverse brake **8**, the rotating force of front planetary sun gear **20** is transmitted to the ring gear by means of front planetary pinion gears **21**, thus providing a counterclockwise rotating force to output shaft **24**.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Rear clutch **17** → Front planetary sun gear **20** → Front planetary pinion gears **12** → Front planetary ring gear **10** → Output shaft **24**

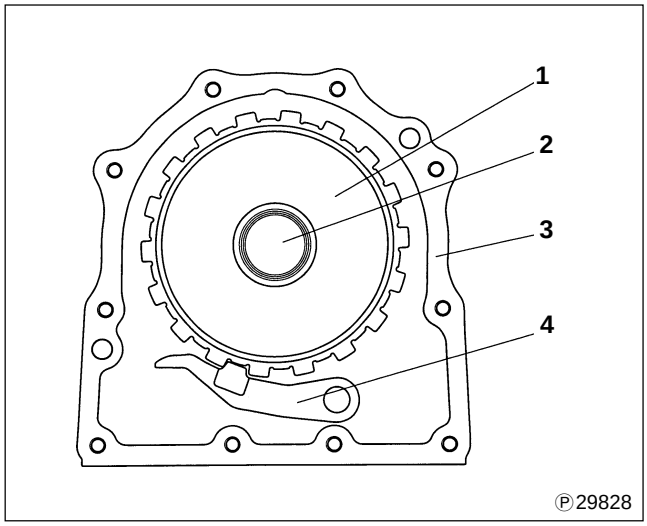
● N Range



- **N range**

  Since front clutch **6** and rear clutch **17** are disengaged, the driving force of input shaft **16** is not transmitted to output shaft **24**.

● P Range

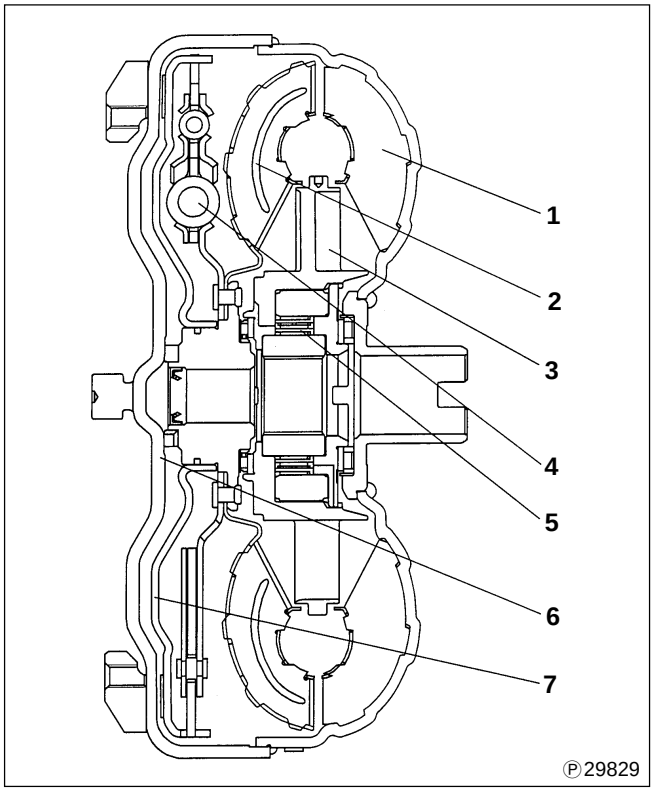


1 Parking lock gear
2 Output shaft
3 Transmission case
4 Parking lock pawl

- **P range**

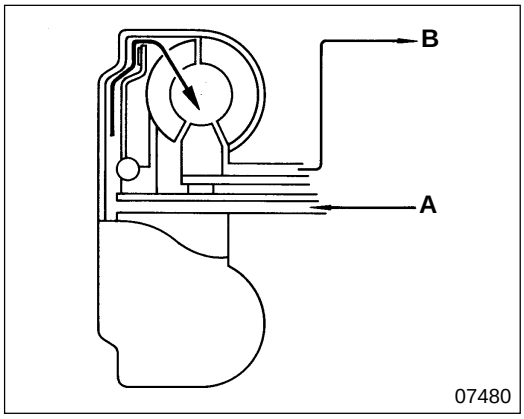
  In the same way as in the N range, the driving force of the input shaft is not transmitted to output shaft **2**. Parking lock pawl **4**, which is linked with the range selector lever, meshes with parking lock gear **1** which is directly connected to the output shaft, thus disallowing vehicle movement.

● Torque Converter



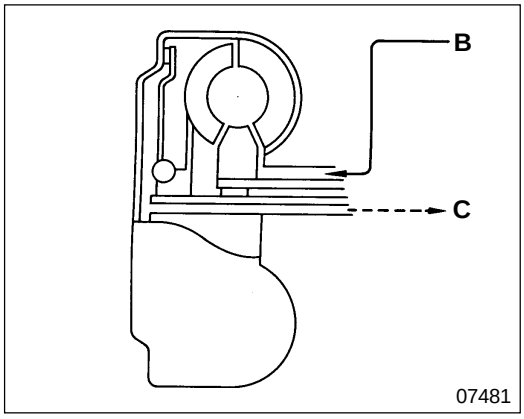
1 Pump impeller
2 Turbine liner
3 Stator
4 Lock-up damper
5 One-way clutch
6 Front converter cover
7 Lock-up piston

- The torque converter transfers engine torque to the transmission. It transmits engine torque by means of oil when it is not in a lock-up condition, and it transfers power via the lock-up piston when it is in a lock-up condition.
- The torque converter is a 3-element, 1-stage, 2-phase type.
- "1-stage" indicates that the torque converter has one turbine liner, which is an output element. "2-phase" means that it provides a torque converter function when the turbine liner speed is relatively slow as compared to the pump impeller speed, and acts as a fluid coupler when the turbine liner speed is high.



< Lock-up mechanism in inactive condition >

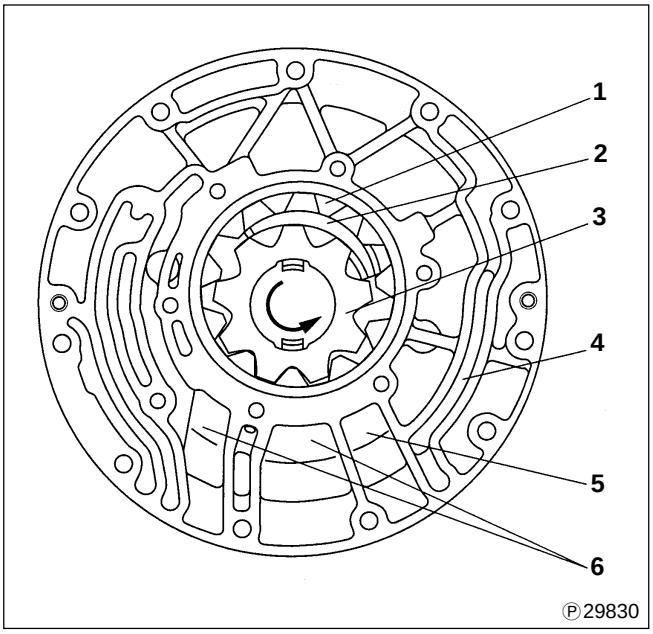
The lock-up control valve supplies the torque converter operating pressure through oil passage **A** to the space between the front converter cover and lock-up piston. This oil pressure separates the clutch facing of the lock-up piston from the front converter cover. As a result, the torque converter operating pressure supplied through oil passage **A** is released from oil passage **B**, and enters the oil cooler.



< Lock-up mechanism in active condition >

The lock-up control valve switches the operating oil passage. The torque converter operating pressure is supplied through oil passage **B** to the pump impeller, turbine liner and stator.
As a result, the oil pressure applied to the lock-up piston causes the clutch facing of the lock-up piston to engage with the front converter cover for improved power transmitting efficiency.
C : Drain

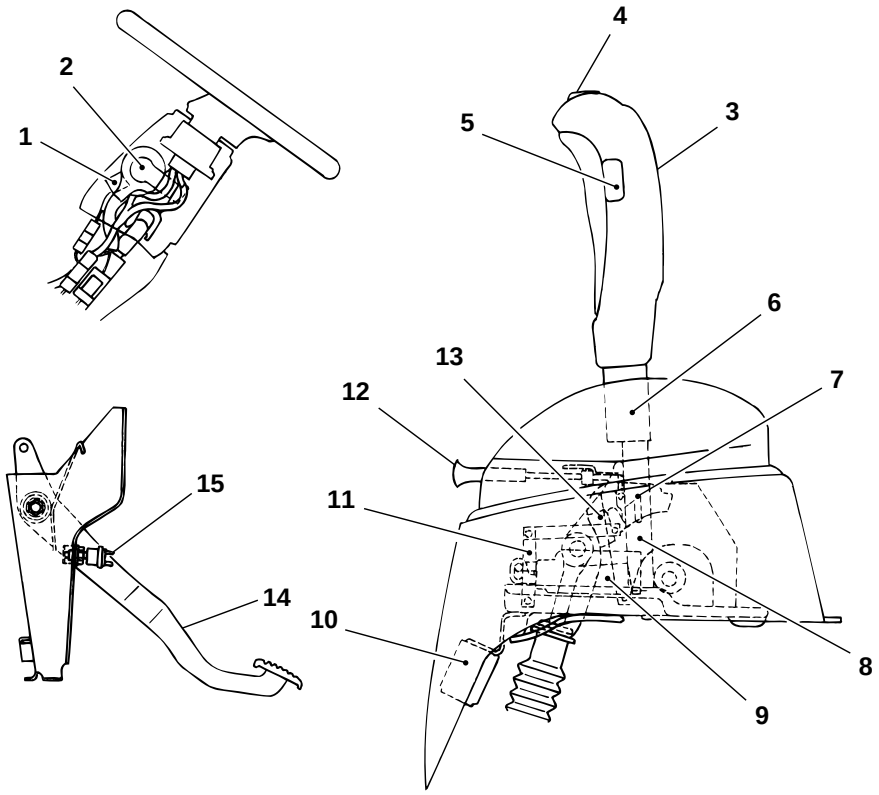
● Oil Pump



1 Driven gear
2 Crescent
3 Drive gear
4 Oil pump body
5 Outlet port
6 Inlet ports

- Feature ..... The oil pump gears have a small number of gear teeth and features a special high-performance tooth profile.
- Operation ··· The drive gear is fitted to the extension sleeve of the torque converter, and rotates in the same direction (in the direction of the arrow) as the engine to compress and discharge the intake oil.

Operation Error Protection Device



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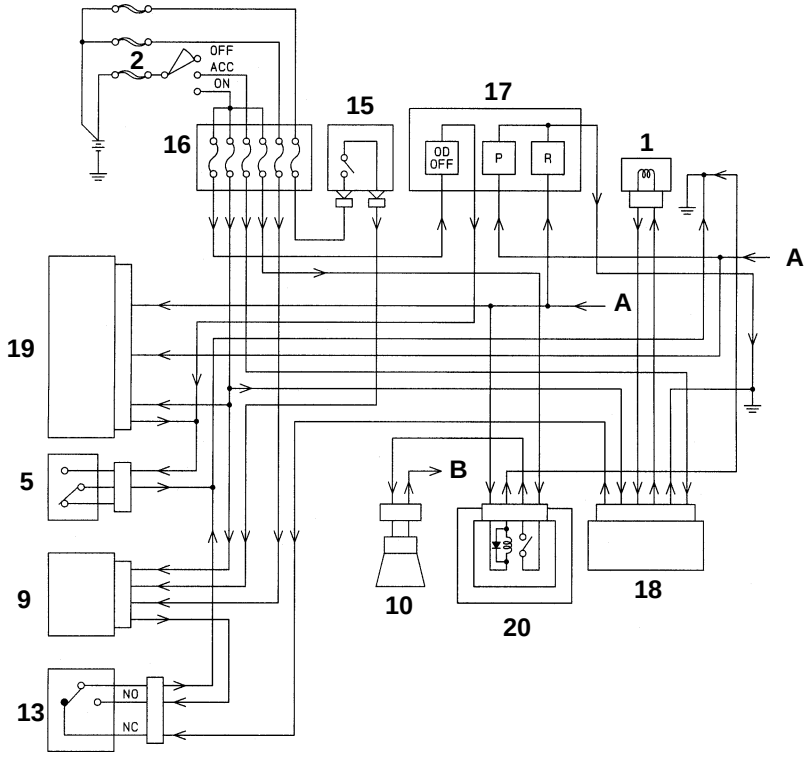


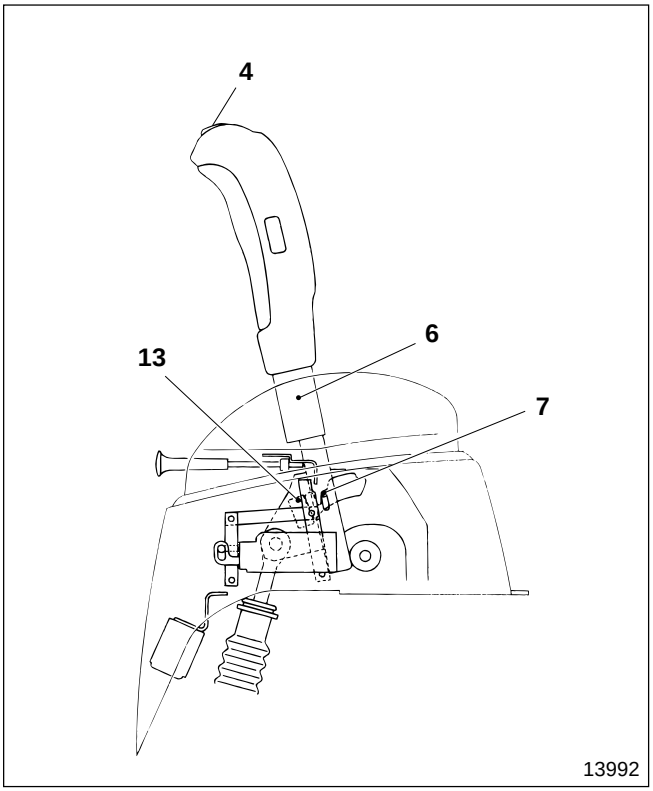
31559

1 Key interlock solenoid
2 Starter switch
3 Automatic transmission knob
4 Shift button
5 Overdrive OFF switch
6 Selector lever
7 Pin
8 Lever bracket
9 Shift lock actuator
10 Automatic transmission reverse buzzer
11 Shift lock link
12 Shift lock release knob
13 P range switch
14 Brake pedal
15 Stop lamp switch
16 Fuse box
17 Meter cluster
18 Key interlock electronic control unit
19 Automatic transmission electronic control unit
20 Backup lamp relay

A : From inhibitor switch
B : To backup buzzer

● **Parking Shift Lock Device with Key Interlock**

The key interlock device prevents the removal of the key unless selector lever **6** is in the P (Parking) range. The shift lock device disallows the selector lever from moving from the P range position unless brake pedal **14** is pressed, thereby preventing accidental vehicle movement caused by an unintended selector lever operation.



Key interlock device

< Lock condition >

Condition: When selector lever **6** is in a position other than the P range or when shift button **4** is pressed with the selector lever in the P range, pin **7** is not in contact with P range switch **13** (switch is set free). Therefore, the switch is ON.

↓

An electric current flows from key interlock electronic control unit **18** to key interlock solenoid **1** to activate the key interlock solenoid.

↓

Key interlock solenoid **1** turns ON to prevent starter switch **2** from being turned to the LOCK position, thus disabling the removal of the key.

< Unlock condition >

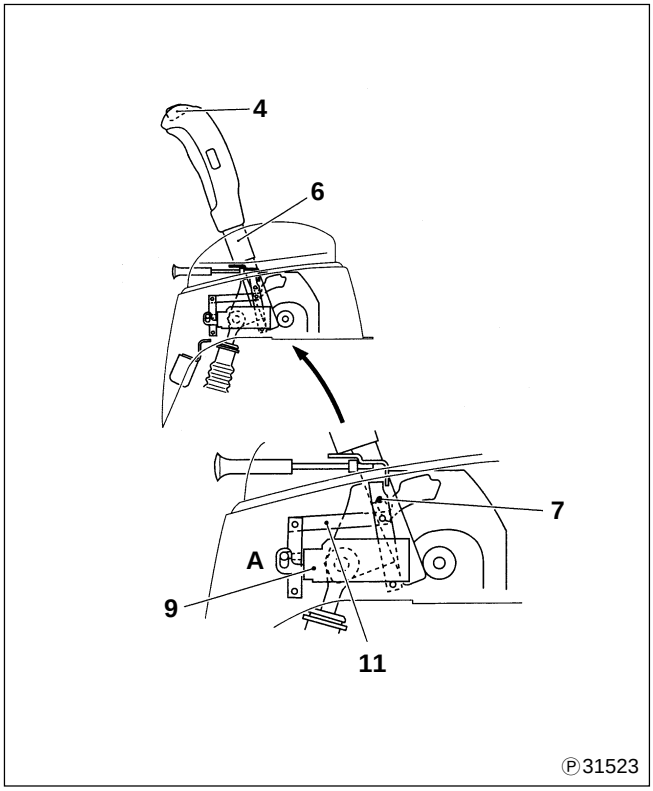
Condition: When selector lever **6** is in the P range and shift button **4** is not pressed, pin **7** presses against P range switch **13** (switch is activated). Therefore, the switch is OFF.

↓

No electric current flows from key interlock electronic control unit **18** to key interlock solenoid **1**. Therefore, the key interlock solenoid is OFF.

↓

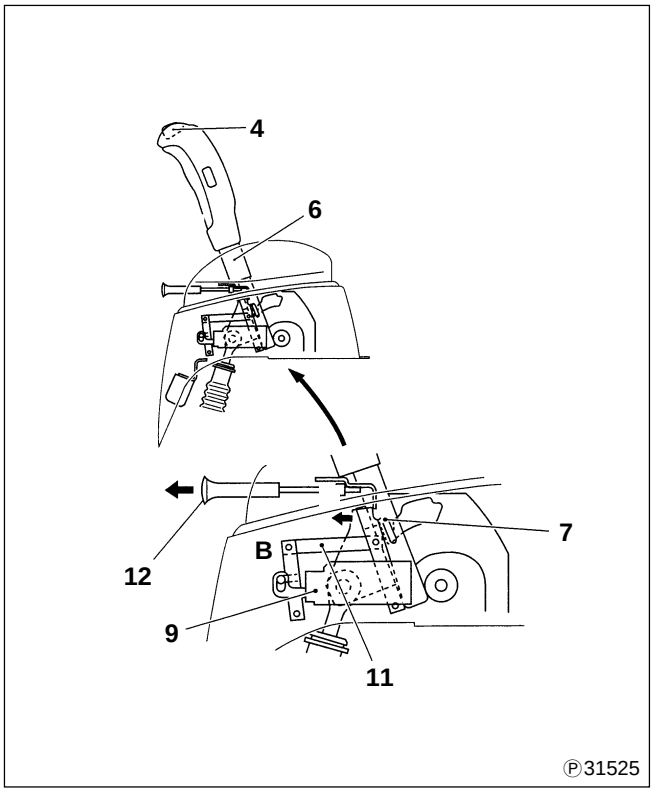
Key interlock solenoid **1** does not turn ON, thereby disengaging starter switch **2** and allowing the switch to turn to the LOCK position for the removal of the key.



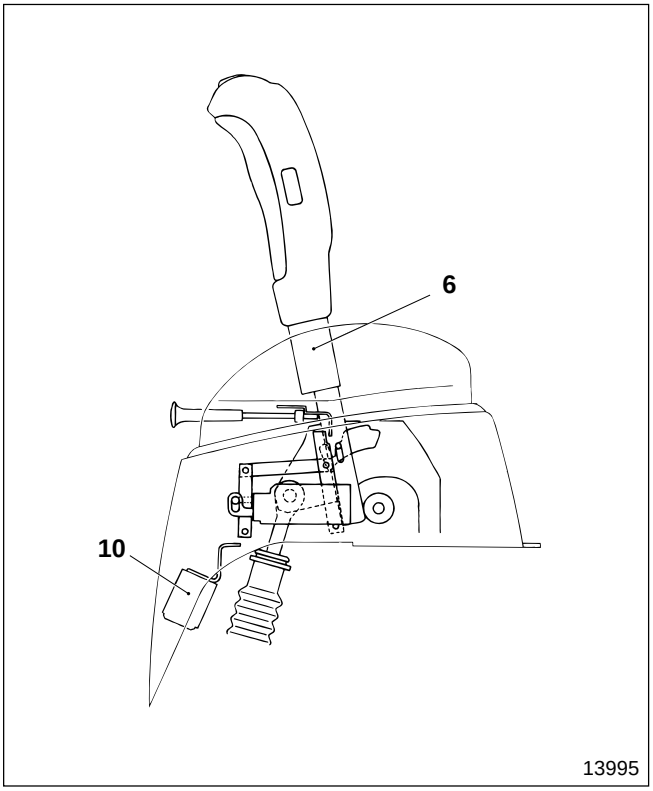
P shift lock device

- With selector lever **6** in the P range, when the electric current (see the table below) supplied to shift lock actuator **9** sets the shift lock actuator in lock position **A**, pin **7** is restrained by shift lock link **11** and disallows pressing of shift button **4**. Therefore, the selector lever cannot be moved from the P range.

Power supply		Switch		Operation mode	
IGN	+B	Brake	P range	Unlock	Lock
○	○	○	○	○←	
○	○		○		→○
○	○	○		○	
○	○			○	
	○	○	○		→○
	○		○		→○
	○	○		○	
	○			○	



- With selector lever **6** in the P range, when the electric current (see the above table) supplied to shift lock actuator **9** sets the shift lock actuator in unlock position **B**, shift lock link **11** is in the forward position to set pin **7** free, thus allowing pressing of shift button **4**. Therefore, the selector lever can be moved from the P range to another range position.
- Should an electrical problem occur and hinder proper operation, pulling of shift lock release knob **12** overrides the P shift lock.



● **Selector lever reverse position warning device**

When starter switch **2** is ON, moving selector lever **6** to the R (reverse) range activates the reverse position detecting switch (inhibitor switch: built into automatic transmission) and turns on automatic transmission reverse buzzer **10** to warn the driver that the selector lever is in the reverse position.

TROUBLESHOOTING PROCEDURES

Automatic transmission problems can be caused by the following malfunctions.

- Engine malfunction
- Improperly adjusted parts
- Faulty hydraulic system
- Faulty mechanical functions
- Faulty electrical system

When diagnosing the above abnormalities, be sure to inspect the following basic items.

- Engine condition
- Automatic transmission fluid level and condition: 🕮 P23-58
- Range selector cable adjustment

In addition to the inspection of the above items, use the self-diagnosis function to locate the cause of the problem and take necessary measures.

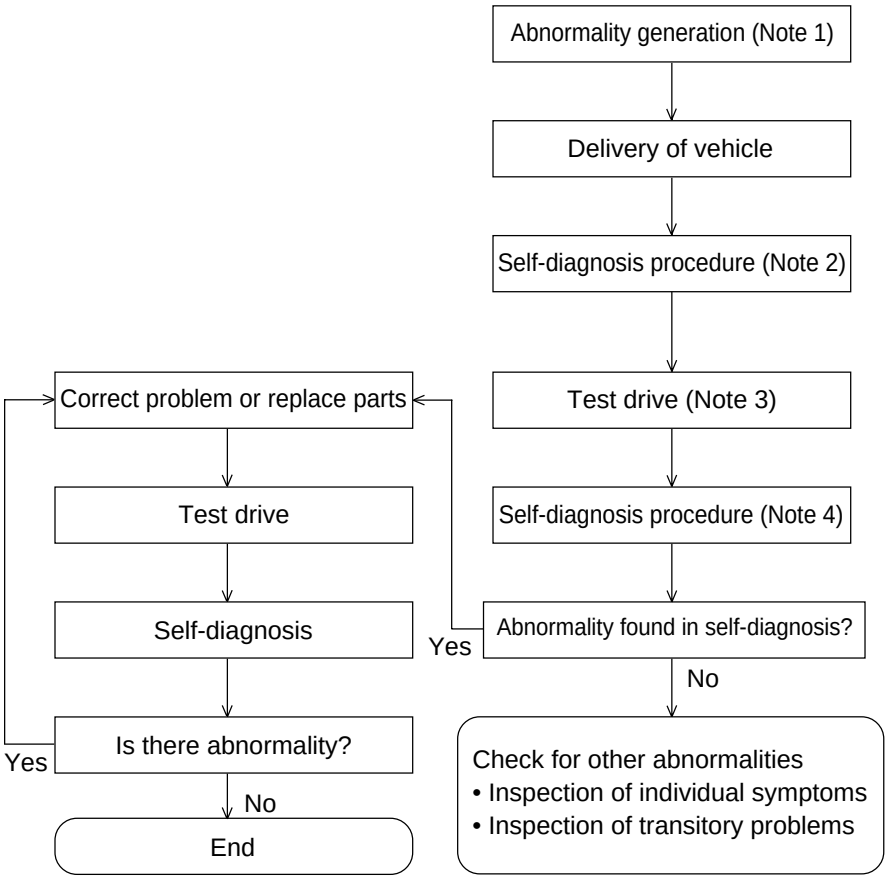
After repair is complete, test-drive the vehicle to determine whether the problem is corrected or further inspection is necessary.

If the cause of the problem cannot be located, or if repair work does not correct the problem, conduct a line pressure test and a stall test. 🕮 P23-52, 54

It should be noted that special knowledge and tools are required to repair the automatic transmission unit or replace parts. Therefore, conduct an inspection for the purpose of evaluating the operating condition of the transmission. For maintenance or repair of the automatic transmission, contact your nearest authorized Mitsubishi dealer or distributor.

Use of the MUT-II allows efficient inspection of the automatic transmission system.

Self-diagnosis process



Note 1 : The following abnormalities significantly lower driving performance. In the case that these abnormalities generate during operation, the automatic transmission warning lamp lights.
- Faulty operation of vehicle speed sensors
- Faulty operation of solenoid other than lock-up solenoid
- Faulty operation of accelerator sensor
- Faulty operation of inhibitor switch
- Faulty throttle position PWM signal

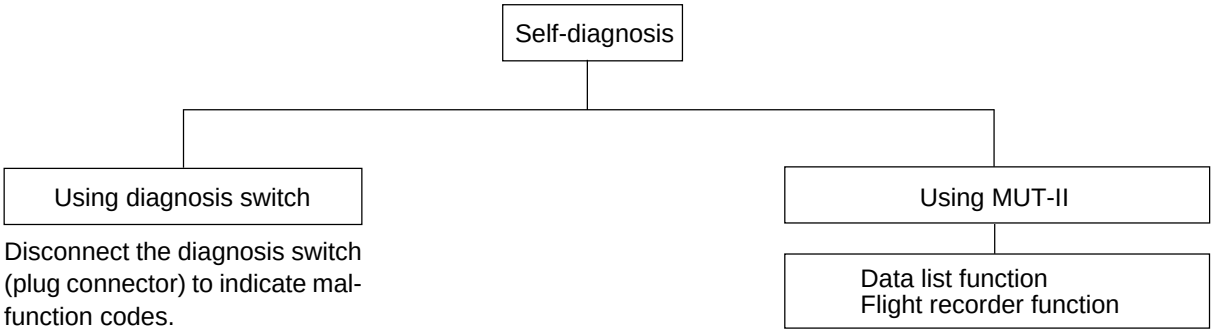
Note 2 : Inspect for malfunctions that occurred during user operation. Record inspection results.

Note 3 :
- Check abnormal conditions.
- In a test drive, operate the accelerator pedal in full range (from the released position to full throttle) with a vehicle speed of up to approximately 50 km/h {31.1 mph}.

Note 4 : Inspect problems that generate during a test drive. Record inspection results.

Types of Self-Diagnosis

The following two types of self-diagnosis function can be selected.



Disconnect the diagnosis switch (plug connector) to indicate malfunction codes.
Data of malfunctions stored in the memory can be deleted with the memory clear switch.

Connect the MUT-II to the automatic transmission electronic control unit via the data plug connector to download and display malfunction codes.
In addition to the self-diagnosis function, the MUT-II is equipped with a data list function that indicates sensor and switch values and a flight recorder function that records those data for a certain length of time before and after the triggering. These functions are useful in analyzing malfunctions.
(Refer to the MUT-II operation manual.)

Features of the two self-diagnosis methods

Item \ Self-diagnosis method	Use of diagnosis switch	Use of MUT-II
Convenience	○	◎
Number of self-diagnosis items	◎	◎
Data reading ease	○	◎
Data application range	×	◎

◎ : Good
○ : Fair
× : Bad

Using diagnosis switch to recall diagnosis codes and using memory clear switch to delete diagnosis codes

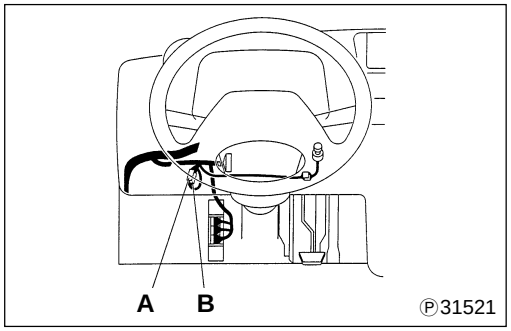
The diagnosis switch is used for the analysis of malfunction, and the memory clear switch allows deletion of stored diagnosis codes.

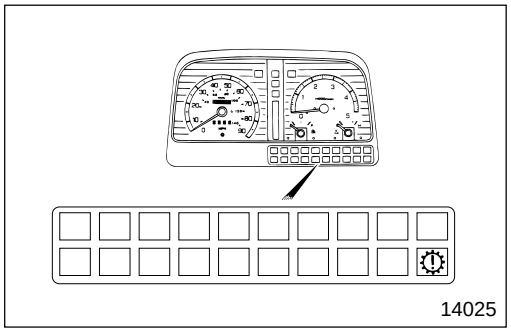
● **Recalling diagnosis code** 📖 P23-42

- Pull out the diagnosis switch to recall the diagnosis code of the current problem from the electronic control unit's memory.
- Pull out the diagnosis switch and memory clear switch to recall the diagnosis codes of the current and past problems from the electronic control unit's memory.

● **Deleting diagnosis codes** 📖 P23-43

Pull out and reinsert the memory clear switch to delete the diagnosis codes stored in the electronic control unit's memory.





● **Procedure for recalling diagnosis codes**

[Current diagnosis code]

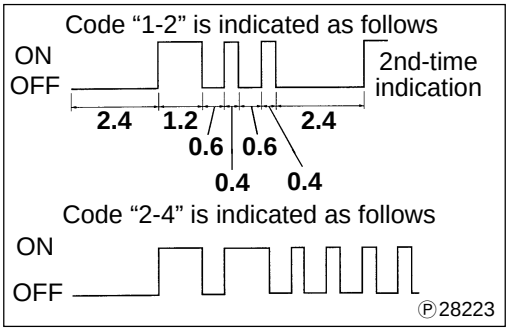
- Turn on the starter switch.
- Remove diagnosis switch **A** (plug connector). The warning lamp begins flashing. The flashing pattern indicates a diagnosis code. Check the code list to locate the problem location. 📖 P23-44

[Current and past diagnosis codes]

- Turn on the starter switch.
- Remove diagnosis switch **A** (plug connector) and memory clear switch **B** (1-pin connector). The warning lamp begins flashing to indicate diagnosis codes.
- The warning lamp indicates the diagnosis codes of past malfunctions and the diagnosis code of the current problem, if any.

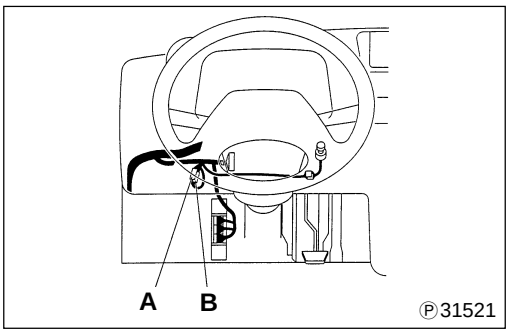
CAUTION ⚠

If diagnosis switch A is connected first, diagnosis codes in the electronic control unit's memory are deleted, and a "01" (normal) code is indicated.



● **Procedure for reading diagnosis codes**

- The automatic transmission electronic control unit’s memory is stored with the data of all malfunctions that occurred after the previous self-diagnosis operation.
- The warning lamp turns off for 2.4 seconds after the self-diagnosis operation starts, then indicates a code.
  - The tens digit is indicated by 1.2-second ON operation and 0.6-second OFF operation.
  - The ones digit is indicated by 0.4-second ON operation and 0.6-second OFF operation.
  - The lamp remains OFF for 2.4 seconds between codes.
- If there are two or more malfunction codes in the memory, they are output in an order from the smallest code number. Each malfunction code is indicated three times before the following code is output.
- After all malfunction codes in the memory are output, the indication process repeats from the beginning.



● **Procedure for deleting diagnosis codes**

- Keep diagnosis switch **A** (plug connector) connected.
- Turn on the starter switch.
- Disconnect memory clear switch **B** (1-pin connector). After more than one second, connect the memory clear switch. When the memory clear switch remains connected for more than three seconds, diagnosis codes in the electronic control unit are deleted.

● **Diagnosis Code Chart**

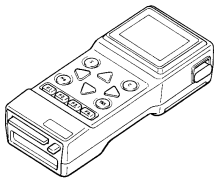
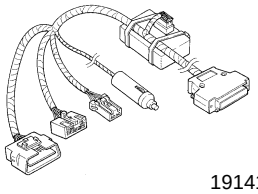
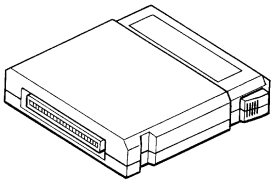
Diagnosis code	Problem location	Judgement criterion	Fail-safe measure
01	Normal		
11	Power supply voltage	Power supply voltage remains below 7.5 V for 1 second or longer with range selector in a position other than P or N range.	
12 < FE640 >	Vehicle speed sensor 1	• Vehicle speed sensor 1 indicates sudden speed decrease.	• Maintains the gear selected immediately before malfunction. • Turns off shift solenoids 1, 2 when engine speed sensor detects a value or less than 1000 rpm.
13	Oil temperature sensor	When oil temperature of more than 135°C {275°F} or lower than -50°C{-58°F} is detected. Note that MUT display is fixed at “40°C {104°F}” after fail-safe judgement result.	Maximum oil temperature
15	Engine speed sensor	Engine speed sensor detects a value of less than 300 rpm when range selector is in a position other than P or N range and when output shaft rotating speed is 1000 rpm or higher.	Prohibits 2-3 shift timing control.
24 < Except FE640 >	Accelerator sensor	• When accelerator sensor voltage is less than 0.4 V, or 4.6 V or higher	• Shift-point is set at 0% throttle opening. • Prohibits throttle learning function. • Prohibits 2-3 shift timing control. • Line pressure at maximum • Lock-up control change
24 FE640		• When accelerator sensor signal input to engine ECU is faulty	• Shift-point is set at 0% throttle opening. • Prohibits 2-3 shift timing control. • Executes controls assuming that throttle pressure is at maximum. • Prohibits lock-up control (lock-up solenoid OFF) except during driving at high speeds.
25	Vehicle speed sensor 2	• Vehicle speed sensor 2 indicates sudden speed decrease.	• Maintains the gear selected immediately before malfunction detection. • Turns off shift solenoids 1, 2 when engine speed sensor detects a value of less than 1000 rpm.
31	Shift solenoid 1	• When solenoid output short-circuit occurs while solenoid is receiving current. • When solenoid output disconnection occurs while solenoid is not receiving current.	• Turns off malfunctioning shift solenoid. • Turns off lock-up solenoid and timing solenoid. • Refer to the chart on P23-54 for gear selection.
32	Shift solenoid 2	• When solenoid output short-circuit occurs while solenoid is receiving current. • When solenoid output disconnection occurs while solenoid is not receiving current.	• Turns off malfunctioning shift solenoid. • Turns off lock-up solenoid and timing solenoid. • Refer to the chart on P23-54 for gear selection.
34	Line pressure solenoid	When wire breakage or short-circuit occurs.	Turns off line pressure solenoid.
35	Lock-up solenoid	• When solenoid output short-circuit occurs while solenoid is receiving current. • When solenoid output disconnection occurs while solenoid is not receiving current.	Turns off lock-up solenoid.

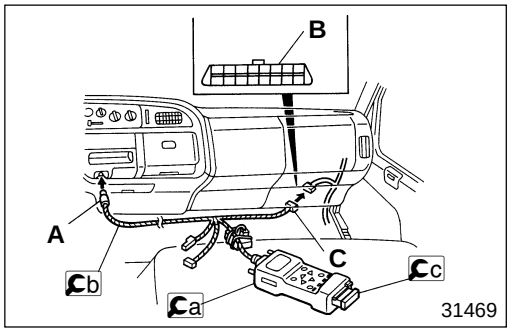
● **Diagnosis Code Chart**

Diagnosis code	Problem location	Judgement criterion	Fail-safe measure
43	Inhibitor switch	• No signal	Operates as D range and prohibits shifting to 4th gear.
		• Two or more signals	• Control function activates based on priority order of L > R > 2 > D > N (P). • Refer to pages 23 through 54 for actual vehicle operation conditions.
50	PTO solenoid	When solenoid output short-circuit occurs while solenoid is receiving current.	Turns off PTO solenoid.
		When solenoid output is cut off while solenoid is not receiving current.	
51	Timing solenoid	• When solenoid output short-circuit occurs while solenoid is receiving current.	Turns off timing solenoid.
		• When solenoid output disconnection occurs while solenoid is not receiving current.	
54	Exhaust brake cut-off signal	Exhaust brake activates when exhaust brake cut-off signal is generated.	• Prohibits exhaust brake cut-off control • Allows lock-up only at high cruising speed.
58 < Except FE640 >	PWM signal	Malfunction of engine electronic control unit (PWM signal fixed at 1 V or lower)	Shift-point is set at 0% throttle opening. Prohibits 2-3 shift timing control. Line pressure at maximum Prohibits throttle position learning function.
		Wire breakage or short-circuit	Prohibits throttle position learning function.

Procedure for servicing with MUT-II

Special tools

Location	Tool name and shape	Part No.	Application
—	MUT-II  19492	MB991496	System inspection
—	MUT-II harness  19141	MK327601	
—	ROM pack (MRT-E8.1)  19493	MH063580	



● **Connecting the MUT-II**

- Turn the starter switch to the LOCK position.
- Connect the b MUT Communication Harness to the a MUT-II, and insert the c ROM Pack.
- Plug connector **A** into the cigarette lighter socket.
- Fit connector **C** into Mut connector **B** (16-pin).

NOTE

Instructions for operation of the MUT-II are given in the separate MUT-II Reference Manual.

● **Inspection using MUT-II**

①The MUT-II indicates diagnosis codes that provide information of malfunctioning items (devices that require inspection).

②The MUT-II indicates sensor signal conditions with numerical values (service data). Comparison of the service data with judgement criteria allows evaluation of the transmission operation. Diagnosis codes and service data codes can be effectively used for troubleshooting.

①		②				
Indicated by MUT-II		Indicated by MUT-II			Inspection procedure	
Diagno-sis code	Malfunctioning item (devices that require inspection)	Service data code	Signal name	Service data	Inspection condition	Judgement criterion
11	POWER VOLTAGE					
12	VEH SPD SNSR 1	12	VEH SPEED 1	□□□.□ MPH	Vehicle stationary in position	0 mph
					Vehicle in operation	Correspond with speedometer
13	OIL TEMP SNSR	13	A/T OIL TEMP	□□□□.°F	When engine is cold	Equivalent to outside air temperature
					When engine is in warm-up operation	Gradual increase
					Non-operating engine after warm-up operation	Gradual decrease
15	ENG SPD SNSR	15	ENGINE SPEED	□□□□. RPM	Idle after warm-up operation	725 rpm < Except FE640 >
						650±25 rpm < FE640 >
					Increasing	Corresponds with tachometer
		17 < Except FE640 >	ACCEL PERCENT	□□□.%	Closed throttle	0 %
					Gradual pressing	Increases continuously
					Full throttle	100 %
		19	P POS. SW		Selector in P range	ON
					Selector in position other than P range	OFF
		20	R POS. SW		Selector in R range	ON
					Selector in position other than R range	OFF
		21	N POS. SW		Selector in N range	ON
					Selector in position other than N range	OFF
		22	D POS. SW		Selector in D range	ON
					Selector in position other than D range	OFF
24	ACCEL SNSR	24 < Except FE640 >	ACCEL VOLT	□.□□□V	Closed throttle	0.85±0.1 V < Except FE640 >
						0% < FE640 >
					Gradual pressing	Increases continuously
		< FE640 >	ACCEL PERCENT	□□□.%	Full throttle	4.15±0.1 V < Except FE640 >
						100% < FE640 >
25	VEH SPD SNSR 2	25	VEH SPEED 2	□□□.□ MPH	Vehicle stationary in position	0 mph
					Vehicle in operation	Correspond with speedometer
		26	2 POS. SW		Selector in 2 range	ON
					Selector in position other than 2 range	OFF
		27	L POS. SW		Selector in L range	ON
					Selector in position other than L range	OFF
		28	OD-OFF SW		Overdrive OFF SW ON	ON
					Overdrive OFF SW OFF	OFF
		29	POWER S/W		In power mode	ON
					In economy mode	OFF

①		②				
Indicated by MUT-II		Indicated by MUT-II			Inspection procedure	
Diagno -sis code	Malfunctioning item (devices that require inspection)	Service data code	Signal name	Service data	Inspection condition	Judgement criterion
31	SHIFT VALVE 1	31	SHIFT VALVE 1		Driving in 1st and 2nd gears	ON
					Driving in 3rd and 4th gears	OFF
32	SHIFT VALVE 2	32	SHIFT VALVE 2		Driving in 2nd and 3rd gears	ON
					Driving in 1st and 4th gears	OFF
34	LINE PRESS. V	34	LINE PRESS	□□□.□ lbf/in²	Idle	According to line pressure chart. 🕮 P23-54
					Stall	
35	LOCK UP VALVE	35	LOCK UP VALVE		Driving with consistent throttle opening	Turns ON according to lock-up vehicle speed chart during road test. 🕮 P23-57
					Vehicle stationary in D range	OFF
		36	OIL TEMP SW		Abnormal oil temperature (ATF temperature lamp ON)	ON
					Normal oil temperature (ATF temperature lamp OFF)	OFF
		37	BRAKE SW		Brake pedal pressed	ON
					Brake not applied	OFF
		38	EXH. BRAKE SW		Exhaust brake activation during driving	ON
					Exhaust brake inactive	OFF
43	INHIBIT SIG					🕮 P23-7
		47	ABS SW		ABS activation	ON
					ABS inactive	OFF
		48	M CLEAR SW		Connector disconnected	OPEN
					Connector in connection	CLOSE
		49	DIAGNOSIS SW		Plug connector disconnected	OPEN
					Plug connector in connection	CLOSE
50	PTO VALVE	50	PTO VALVE		PTO operation	ON
					PTO non-operation	OFF
51	TIMING VALVE	51	TIMING VALVE		2→3 shifting when accelerator pedal is released	ON
					Vehicle stationary in position	OFF
		53	DIAG LAMP		System malfunction (warming lamp ON)	ON
					System normal (warning lamp OFF)	OFF
54	EXB CUT SIG	54	EXB CUT SIG		Exhaust brake activation during driving	OFF
					Stopping using exhaust brake	OFF→ ON
		55	SELECTOR POS.	□·RANGE	Operate range selector from P to L in order.	Changes as follows: P→R→N→D→2→L
		56	GEAR POS.	1ST 2ND 3RD 4TH	Driving at constant speed Accelerating gradually from 0 km/h	According to lock-up vehicle speed chart during road test. 🕮 P23-56 (1ST → 2ND → 3RD → 4TH)
				N	Selector in N range	N
				REV	Selector in R range	REV

①		②				
Indicated by MUT-II		Indicated by MUT-II			Inspection procedure	
Diagno -sis code	Malfunctioning item (devices that require inspection)	Service data code	Signal name	Service data	Inspection condition	Judgement criterion
58	PWM SIG.	58 < Except FE640 >	PWM PERCENT	□□□.□ %	Closed throttle	0 %
					Accelerator pedal pressed gradually	Continuous increase
					Accelerator pedal at full throttle	100% or more
		59	PTO SW		PTO SW ON	ON
					PTO SW OFF	OFF

Symptoms and problems

Malfunction / Suspected problem factor	Abnormal movement						Abnormal shift operation												
	Vehicle runs in N range	Parking position is still engaged when selector is moved from P range	Vehicle moves in P range	Vehicle does not move in any range	Vehicle does not move in R range	Vehicle does not move in D, 2 or L range	Lock-up point extremely high or low	Does not lock up	No engine brake in 2 range	No engine brake in L range	Kick-down does not operate	Shift point extremely high or low	Engine revs up in 2-3 shift	Does not shift down from 2nd to 1st	Does not shift down from 3rd to 2nd	Does not shift down from 4th to 3rd	Does not shift up from 3rd to 4th	Does not shift up from 2nd to 3rd	Does not shift up from 1st to 2nd
Automatic transmission fluid level and condition				○															
Control linkage	○	○	○	○														○	○
Inhibitor switch																	○	○	○
Accelerator sensor							○	○			○	○	○						
Vehicle speed sensor							○				○	○		○	○	○	○	○	○
Engine speed sensor								○					○						
Engine idle speed																			
Line pressure				○				○											
Shift solenoid 1					○			○	○		○				○			○	
Shift solenoid 2					○			○	○	○	○			○		○	○		○
Timing solenoid													○						
Lock-up solenoid							○	○											
Starter circuit																			
Overdrive OFF switch																	○		
Exhaust brake switch								○											
Automatic transmission fluid temperature sensor								○									○		
Automatic transmission electronic control unit					○		○	○	○	○	○	○	○	○	○	○	○	○	○
Torque converter				○				○											
Automatic transmission unit malfunction	○	○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○

Malfunction / Suspected problem factor	Excess shock during shifting										Slippage						Others			
	During lock-up operation	When shifting from 3rd to 2nd	When shifting from 4th to 3rd	When shifting from 1st to 2nd, to 3rd, to 4th	When shifting from 3rd to 4th	When shifting from 2nd to 3rd	When shifting from 1st to 2nd	When shifting from N to D and from N to R	When shifting from N to D	When shifting from N to R	In 4th gear	In 3rd gear	In 2nd gear	In 1st gear	In reverse gear	In forward and backward	Transmission overheat and oil blow-off from breather	Engine stalls when range selector is moved to R, D, 2 or L, or when vehicle is stationary	Engine starts with range selector in position other than N or P range	Engine cannot be started with range selector in N or P range
Automatic transmission fluid level and condition																○	○			
Control linkage																			○	○
Inhibitor switch																			○	○
Accelerator sensor	○	○	○	○	○	○	○	○			○	○	○	○	○	○	○			
Vehicle speed sensor	○																			
Engine speed sensor						○														
Engine idle speed								○										○		
Line pressure								○								○	○			
Shift solenoid 1																				
Shift solenoid 2																				
Timing solenoid		○				○	○													
Lock-up solenoid																	○	○		
Starter circuit																				○
Overdrive OFF switch																				
Exhaust brake switch																				
Automatic transmission fluid temperature sensor				○																
Automatic transmission electronic control unit		○				○	○										○			
Torque converter	○															○	○	○		
Automatic transmission unit malfunction	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Stall Test

● **Purpose**

To check wearing of gears, slippage of one-way clutches, operation of torque converter and overall performance of the engine.

● **Measuring procedure**

Before the test, inspect the engine coolant, engine oil and automatic transmission fluid. Run the engine until the engine coolant temperature reaches an appropriate level. Also conduct a warm-up operation for the automatic transmission and bring the automatic transmission fluid temperature to an appropriate level.

- Place wheel chocks in front and back of all wheels, and apply the parking brake. When operating the accelerator pedal, be sure to press down firmly on the foot brake pedal.
- Shift the range selector lever to the D range.
- Press down on the accelerator pedal gradually to full throttle. When the engine speed stabilizes, quickly read the engine rpm (stall speed) and remove foot from the accelerator pedal.

CAUTION ⚠

- **Limit each measuring operation to five seconds. Extended testing causes automatic transmission fluid degradation and adverse effects to the internal parts.**
- **If the engine speed does not stabilize but continues to increase or suddenly jumps, stop the test immediately.**

- Shift the range selector lever to the N range, and let the engine run at approximately 1200 rpm for one minute or longer for cooling.
- Conduct tests in the same way with the range selector lever in each of the 2, L and R ranges.
- Stall speed

FE 639	1810±150 rpm
FE 649, FG 639	1890±150 rpm
FE 640	2070±150 rpm

● **Diagnosis of test result**

Measuring result	Suspected abnormality
Lower than standard value in all ranges	Insufficient engine output power
	Faulty operation of one-way clutch in torque converter
Higher than standard value in D range	Slippage of front clutch
	Faulty operation of No. 2 one-way clutch
	Low line pressure
Higher than standard value in R range	Slippage of rear clutch
	Slippage of 1st and reverse brake
	Low line pressure
Higher than standard value in all range	Low line pressure
	Inappropriate automatic transmission fluid level
	Slippage of overdrive direct clutch
	Faulty operation of overdrive one-way clutch

Time Lag Test

● **Purpose**

To check the conditions of overdrive direct clutch, front clutch, rear clutch and 1st and reverse brake.

● **Measuring procedure**

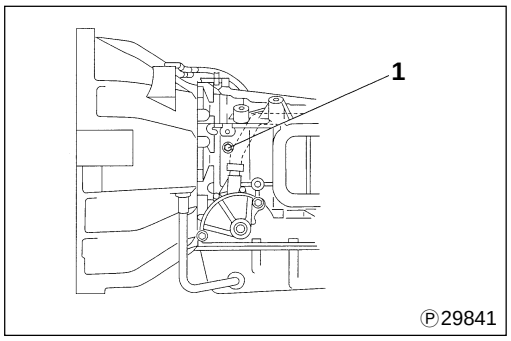
- Bring the oil temperature to normal operating level of between 50 and 80°C {122 and 176°F}.
- Start the engine and check the idle speed.
- Shift the range selector lever from the N range to the D range and use a stopwatch to measure the time it takes for shock to be felt.
- In the same way, measure the time lag by shifting the range selector lever from the N range to the R range.

	Standard value
N→D shifting	0.7 sec or less
N→R shifting	1.2 sec or less

● **Diagnosis of test result**

Measuring result	Suspected abnormality
Large time lag in N→D shift	Low line pressure
	Slippage of front clutch
	Faulty operation of overdrive one-way clutch
Large time lag in N→R shift	Low line pressure
	Slippage of rear clutch
	Slippage of 1st and reverse brake
	Faulty operation of overdrive one-way clutch

Line Pressure Test



● **Purpose**

To check the oil pump capacity, control valve functions and leaks in hydraulic circuit.

● **Measuring procedure**

CAUTION ⚠

The line pressure test requires two persons. One person must observe tire movement and wheel chocks from outside the vehicle, while the other person conducts the test.

- Apply the parking brake firmly.
- Place wheel chocks.
- Remove pressure detecting plug **1**, and mount the oil pressure gauge.
- Start the engine, and operate it until the automatic transmission fluid temperature reaches between 50 and 80°C {122 and 176°F}. Then, check the idle speed.
- While pressing the brake pedal firmly with the left foot, shift the range selector lever to the D range and measure the oil pressure while the engine is idling.
- Press the accelerator pedal all the way, and quickly measure the oil pressure at stall speed.

CAUTION ⚠

If the engine RPM's do not reach stall speed and the rear wheels start rotating, release the accelerator pedal and stop the test.

- Measure the oil pressure with the range selector lever in the R range by following the above procedure.
- After the measurement, re-install pressure detecting plug **1** and tighten to the specified torque.

Pressure detecting plug	Bolt size	1/2-20UNF
	Tightening torque	7.5 N·m {5.5 ft.lbs, 0.76 kgf·m}

● **Line pressure** kPa {psi, kgf/cm^2}

Idle oil pressure	D range	529 to 784 {77 to 115, 5.4 to 8.0}
	R range	755 to 1127 {110 to 165, 7.7 to 11.5}
Stall oil pressure	D range	990 to 1480 {145 to 215, 10.1 to 15.1}
	R range	1401 to 2107 {205 to 305, 14.3 to 21.5}

● **Diagnosis of test result**

Measuring result	Suspected abnormality
Higher than standard value in all ranges	Faulty adjustment of throttle cable
	Sticking of regulator valve
	Sticking of throttle valve
Lower than standard value in all ranges	Faulty adjustment of throttle cable
	Sticking of regulator valve
	Sticking of throttle valve
	Excessive wear of oil pump
	Faulty overdrive direct clutch
Lower than standard value only in D range	Oil leak in D range system
	Faulty front clutch
Lower than standard value only in R range	Oil leak in R range system
	Faulty rear clutch
	Faulty 1st and reverse brake

Road Test

● **Measuring procedure**

Before the road test, check the level and condition of the automatic transmission fluid. Also make sure that the range selector cable and the accelerator control cable are properly adjusted.
Operate the automatic transmission in every range position during the road test and check slippage and other operating conditions during shifting of gears.
Check to see if the shift feels too tight or too loose.
Check the shift points of up-shifting and downshifting.
Check shift-point vehicle speeds under various driving conditions.

● **Shift-point vehicle speeds**

< FE6▮9 >

Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	D1→D2	9.37 to 11.84 {5.82 to 7.36}
	D2→D3	20.96 to 23.43 {13.0 to 14.6}
	D3→D4	38.72 to 41.19 {24.1 to 25.6}
Full throttle	D1→D2	19.48 to 21.95 {12.1 to13.6}
	D2→D3	41.93 to 44.39 {26.1 to 27.6}
	D3→D4	73.99 to 78.92 {46.0 to 49.0}
Closed throttle	L2→L1	22.94 to 25.4 {14.3 to 15.8}
	23→22	51.79 to 54.26 {32.2 to 33.7}

< FE640 >

Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	D1→D2	7.2 to 9.9 {4.5 to 6.1}
	D2→D3	21.3 to 24.0 {13.3 to 14.9}
	D3→D4	39.6 to 42.3 {24.6 to 26.3}
Full throttle	D1→D2	20.5 to 23.2 {12.8 to 14.4}
	D2→D3	44.0 to 46.7 {27.4 to 29.0}
	D3→D4	77.4 to 82.7 {48.1 to 51.4}
Closed throttle	D1→D2	5.3 to 8.0 {3.3 to 5.0}
	D2→D3	5.3 to 8.0 {3.3 to 5.0}
	D3→D4	28.8 to 31.5 {17.9 to 19.6}

< FG639 >

Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	D1→D2	9.7 to 12.3 {6.0 to 7.6}
	D2→D3	25.5 to 28.1 {15.9 to 17.5}
	D3→D4	40.1 to 42.6 {24.9 to 26.5}
Full throttle	D1→D2	22.2 to 24.8 {13.8 to 15.4}
	D2→D3	47.5 tp 50.0 {29.5 to 31.1}
	D3→D4	80.4 to 85.5 {50.0 to 53.2}
Closed throttle	D1→D2	5.1 to 7.7 {3.2 to 4.8}
	D2→D3	5.1 to 7.7 {3.2 to 4.8}
	D3→D4	27.3 to 29.9 {17.0 to 18.6}

● **Lock-up vehicle speeds**

< FE6▮9 > Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	3rd gear ON (Overdrive ON)	48.09 to 50.56 {29.9 to 31.4}
	3rd gear ON (Overdrive OFF)	53.03 to 55.49 {33.0 to 34.5}
	4th gear ON	56.38 to 58.85 {35.0 to 36.6}
Full throttle	3rd gear ON	53.03 to 55.49 {33.0 to 34.5}
	4th gear ON	73.99 to 78.92 {46.0 to 49.0}
Closed throttle	3rd gear OFF	43.16 to 45.63 {26.8 to 28.4}
	4th gear OFF	

< FE640 > Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	3rd gear ON	36.0 to 38.7 {22.4 to 24.0}
	3rd gear ON	47.8 to 50.4 {29.7 to 31.3}
	4th gear ON	57.8 to 60.4 {35.9 to 37.6}
Full throttle	2nd gear ON	46.7 to 49.4 {29.0 to 30.7}
	3rd gear ON	47.8 to 50.4 {29.7 to 31.3}
	4th gear ON	77.4 to 82.7 {48.1 to 51.4}
Closed throttle	2nd gear OFF	36.0 to 38.7 {22.4 to 24.0}
	3rd gear OFF	46.7 to 49.4 {29.0 to 30.7}
	4th gear OFF	48.3 to 51.0 {30.0 to 31.7}

< FG639 > Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	3rd gear ON	33.4 to 36.0 {20.8 to 22.4}
	3rd gear ON	49.8 to 52.3 {30.9 to 32.5}
	4th gear ON	58.4 to 60.9 {36.3 to 37.9}
Full throttle	2nd gear ON	45.4 to 48.0 {28.2 to 29.8}
	3rd gear ON	54.9 to 57.4 {34.1 to 35.7}
	4th gear ON	76.6 to 81.7 {47.6 to 50.8}
Closed throttle	2nd gear OFF	34.5 to 37.0 {21.4 to 23.0}
	3rd gear OFF	44.7 to 47.2 {27.8 to 29.4}
	4th gear OFF	44.7 to 47.2 {27.8 to 29.4}

The above standard values are based on the following conditions.

- 5.714 differential gear ratio, 0.374 m tire radius (215/85R16) < FE6▮9 >
- 5.285 differential gear ratio, 0.374 m tire radius (215/85R16) < FE640 >
- 5.714 differential gear ratio, 0.374 m tire radius (215/85R16) < FG639 >

If the differential gear ratio and/or the tire radius are different from the above, proper standard values must be calculated based on the ratios of the differences and the above figures.

Inspection of Automatic Transmission Fluid (ATF)

If the automatic transmission has insufficient ATF, the pump draws air together with ATF. Air bubbles mixed in the ATF cause a “sponge” effect and lower the pressure. This can cause slipping of internal clutches.
On the other hand, if the ATF level is too high, excess air bubbles also result when rotating parts agitate the ATF, thus causing the same effect as when the ATF level is low.
In both cases, excess air bubbles lead to overheat, oxidation of oil and varnish generation, thereby hindering proper operation of the valves and clutches.
Excess air bubbles in the ATF also cause ATF to overflow from the vent hole and filler tube, which may be mistakenly diagnosed as an ATF leak.
To prevent these problems, read the ATF level accurately by following the procedure described below.

(1) Inspection of ATF condition

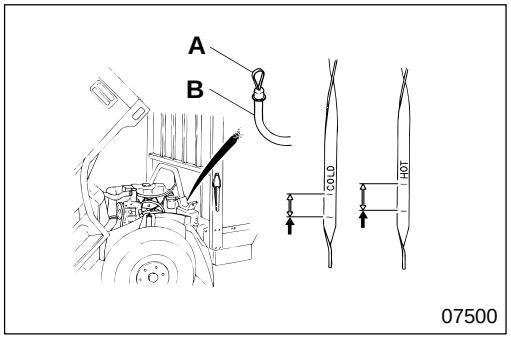
If ATF has a burned odor and contains metal shavings or particles, the automatic transmission needs an overhaul. Closely inspect the ATF adhered on level gauge **A**.
If ATF is suspected to be in poor condition, take out a sample and inspect closely.

(2) Inspection of ATF level

CAUTION ⚠

- **Inspection is conducted while the engine is running. Be careful of moving parts and hot areas to prevent personal injuries and burns.**
- **Before inspection, check the idle speed.**
- **Place the vehicle on level ground.**
- **Bring the transmission to normal operating temperature (70 to 80°C {158 to 176°F}) before inspection.**
- **Before pulling out level gauge A, clean the protective cap and the upper part of the filler tube B.**

- Apply the parking brake firmly, and place wheel chocks.
- With the engine idling, press down on the brake pedal and shift the range selector lever slowly from the P range to the L range, stopping at each position in between. Then return the range selector lever to the P range.
- With the engine idling, pull out level gauge **A**. Wipe the ATF from the level gauge and blow compressed air to remove lint and other particles. Insert the level gauge, and pull it out. Check to make sure that the ATF level is in the range marked “HOT.”

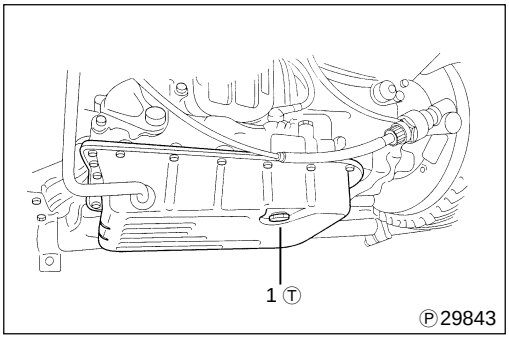


CAUTION ⚠

- **If the ATF temperature is low (20 to 30°C {68 to 86°F}), such as after an ATF change, bring the ATF level to the area on the level gauge marked “COLD.” Then, after the transmission temperature rises to normal operating level (70 to 80°C {158 to 176°F}), check to make sure that the ATF level is in the area on the level gauge marked “HOT.”**
- **If the markings on the front and back sides of the level gauge show different level indications, use the line that indicates the lower ATF level.**

- If the ATF level is low, add ATF from the filler tube **B** to the specified level on level gauge **A**.

Changing Automatic Transmission Fluid (ATF)



(1) Drain

- Place an ATF receiving tray under the automatic transmission oil pan. Remove the drain plug located at the back side of the pan to drain ATF.
  Tightening torque: 27 N·m {20 ft.lbs, 2.8 kgf·m}

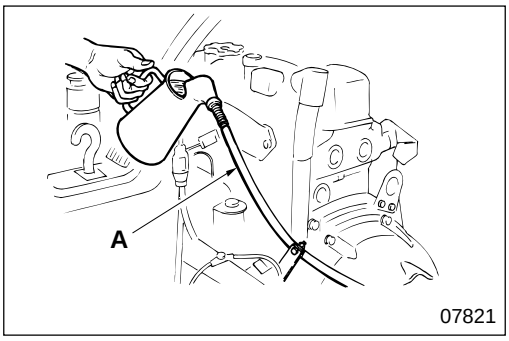
CAUTION ⚠

- **ATF is very hot immediately after the engine is turned off. Wait until the ATF temperature lowers sufficiently.**
- **For faster ATF drainage, warm up the engine.**
- **ATF in the hydraulic circuit, torque converter and oil cooler cannot be drained in the above process.**
- **Inspect the drained ATF for dirtiness and contamination such as metal shavings and particles.**

- After the above process, approximately 1 L {1.1 qts} of ATF remains in the oil pan. If you wish to drain this remaining ATF, remove the oil pan. 🕮 P23-80

Amount of drained ATF

ATF drained by removing oil pan : Approximately 4.5 L {4.8 qts}
ATF drained by removing drain plug : Approximately 3.5 L {3.7 qts}



(2) Adding ATF

- Prepare new ATF.
- Re-install the oil pan drain plug and gasket.
- At filler tube **A**, add the same amount of ATF as drained.

CAUTION ⚠

Be careful not to let dust and other particles mix with ATF.

- Start the engine and let it idle for at least two minutes.
- Shift the range selector lever into every position, then back to the P range.

CAUTION ⚠

Do not rev up the engine in the above process.

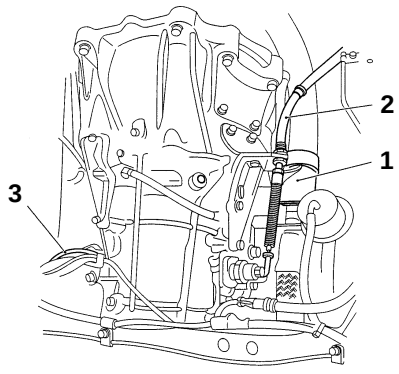
- Check the ATF level. 🕮 P23-58

(3) ATF leaks

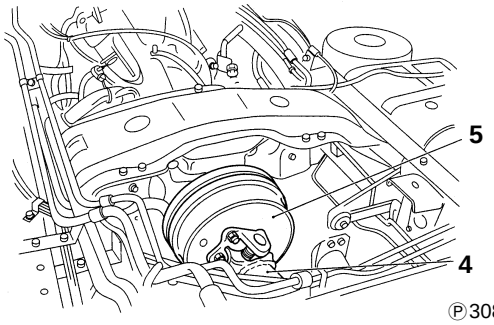
- Torque converter housing of the automatic transmission unit
- Check for leaking locations
  Since the torque converter and the surrounding area can be soiled with oil that leaks from the engine, inspect those areas carefully.
  ATF is red, so that it can be easily distinguished from engine oil.
- Before dismounting the automatic transmission, carefully examine if ATF leaks from the torque converter or the automatic transmission unit (oil seal of oil pump housing or connection of oil pump housing and case).

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY

Preparation



Ⓟ31515



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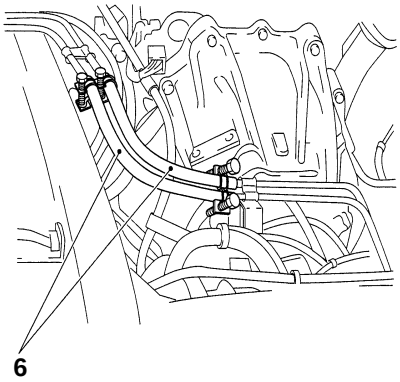
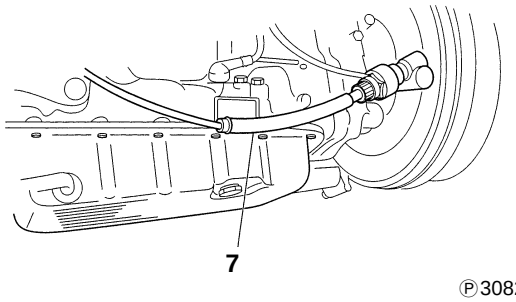


Ⓟ30920



Ⓟ30822

● **Removal sequence**

1 Exhaust pipe Gr 15
2 Selector cable P23-76
3 Electrical harness
4 Propeller shaft Gr 25
5 Parking brake Gr 36
6 Oil cooler hose P23-66
7 Speedometer cable

CAUTION

After removing propeller shaft 4, suspend the shaft at the same height as the installation position by securing it to the frame with a rope.

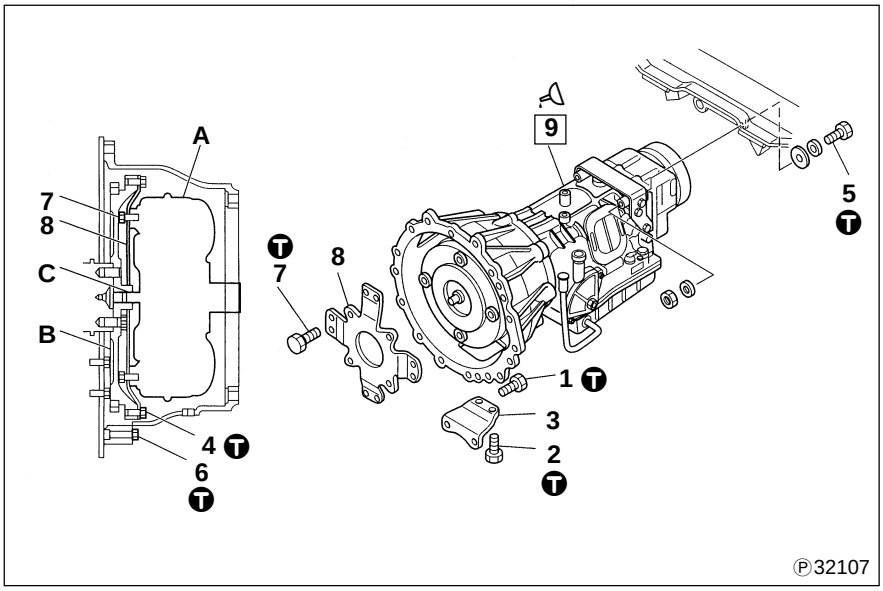
● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

If the automatic transmission unit is replaced due to a malfunction and if the automatic transmission fluid contains a large amount of impurities, conduct flushing of the oil cooler system. P23-66

Removal



● **Removal sequence**

1 Bolt
2 Bolt
3 Dust cover
4 Bolt (8)
5 Bolt
6 Bolt
7 Bolt (4)
8 Drive plate
9 Automatic transmission assembly

A: Torque converter
B: Flywheel
C: Pilot section

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

Remove the automatic transmission assembly with drive plate 8 attached to torque converter A.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

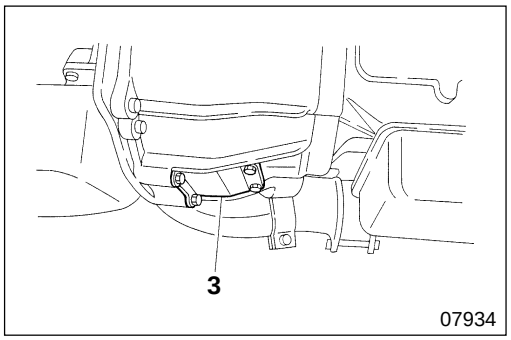
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Automatic transmission assembly mounting and dust cover mounting)	47 {35, 4.8}	—
2	Bolt (Dust cover mounting)	13 {9.4, 1.3}	—
4	Bolt (Flywheel and drive plate coupling)	32 {24, 3.3}	—
5	Bolt (Rear mounting)	83 to 105 {61 to 80, 8.5 to 11}	—
6	Bolt (Automatic transmission assembly mounting)	82 {61, 8.4}	M12
		47 {35, 4.8}	M10
	Bolt (Bracket mounting)	40 {30, 4.1}	—
7	Bolt (Drive plate mounting)	79±12 {59±8.7, 8.1±1.2}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
9	Pilot section C on torque converter A in automatic transmission assembly	Molybdenum disultide grease [NLGI No.2 (Li soap)]	As required

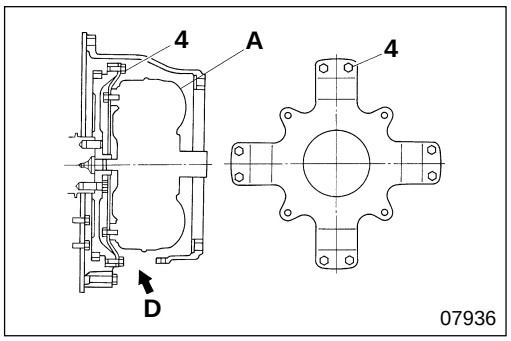
◆ Service procedure

9 Automatic transmission assembly

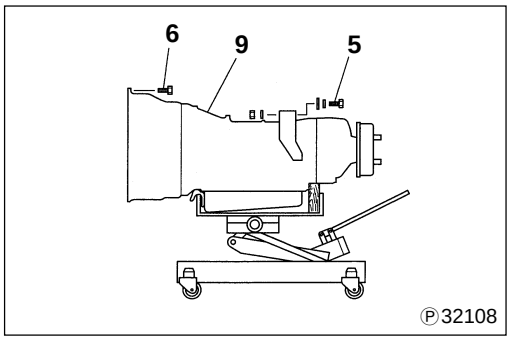


[Removal]

- Remove dust cover **3**.



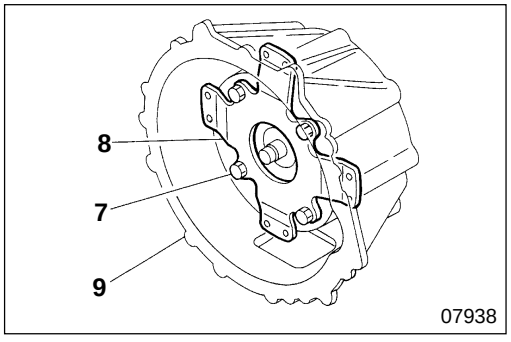
- Turn the engine so that bolt **4** is positioned at service window **D**.
- Remove eight bolts **4**. Remove two bolts at each of the four locations by turning the engine and stopping at the proper position.



- Support automatic transmission assembly **9** with a jack, then remove automatic transmission assembly mounting bolts **5**, **6**.
- Remove automatic transmission assembly **9** by pulling away from the back of the engine.

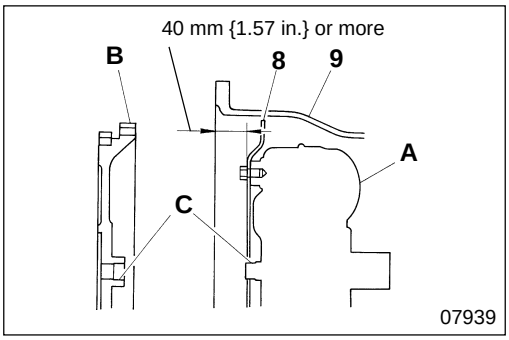
CAUTION ⚠

- **Do not support the automatic transmission by the oil pan, since it causes shape deformation of the oil pan and oil pan gasket.**
- **Since torque converter A can easily separate from the automatic transmission assembly, be careful not to drop the torque converter.**
- **Mounting bolts 6 are different in length. Record the length of each bolt when removing, so that bolts can be re-installed in the original locations.**

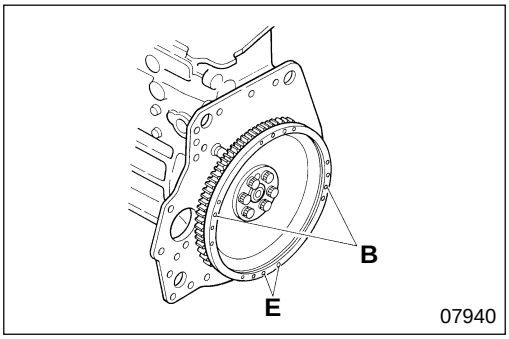


[Installation]

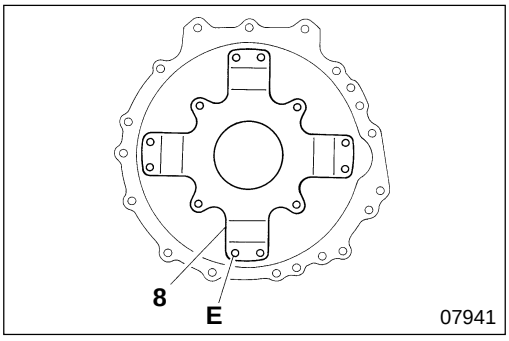
- Install drive plate **8** to torque converter **A** before installing the torque converter into automatic transmission assembly **9**.
  Tighten bolts **7** to the specified torque.



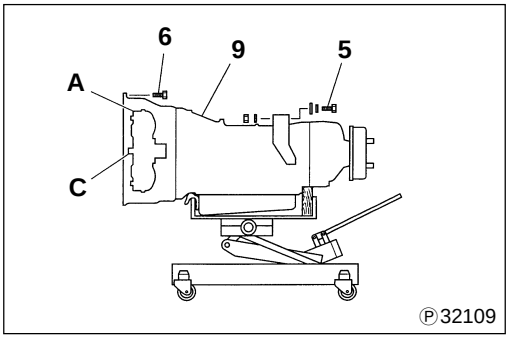
- Check to make sure that torque converter **A** is properly mounted in automatic transmission assembly **9**.
  When the torque converter is properly installed, the distance between the surface of drive plate **8** and the case mounting surface is as indicated in the diagram.
- Apply grease on pilot sections **C** of flywheel **B** and torque converter **A**.



- Turn flywheel **B** so that one of the bolt holes **E** on the flywheel is located at the lowest position. Bolt holes are used to connect the drive plate **8** to the flywheel.



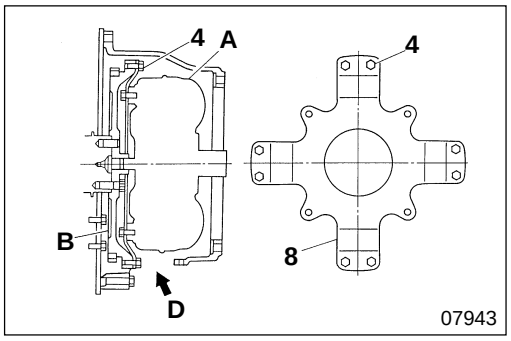
- Turn drive plate **8** so that one of the bolt holes **E** is located at the lowest position.



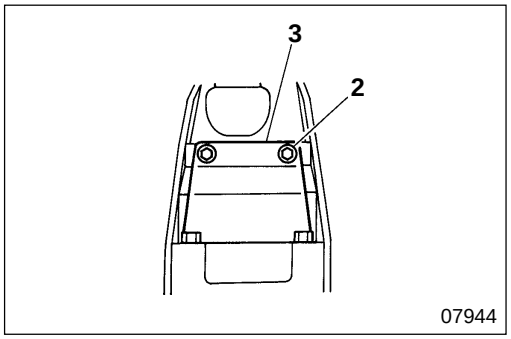
- Install automatic transmission assembly **9** into position slowly and carefully while aligning pilot section **C** and the dowel pin of the rear plate.
- Tighten several mounting bolts **6** on automatic transmission assembly **9** for temporary holding. Tighten bolts **5** to the specified torque to mount the automatic transmission assembly to the rear support.

CAUTION ⚠

- **Torque converter A can easily separate from the automatic transmission assembly 9. To keep the torque converter in place, set the back side of automatic transmission assembly slightly lower than the front part.**
- **Before mounting the automatic transmission assembly 9, wipe oil adhered on the internal wall of the torque converter housing.**



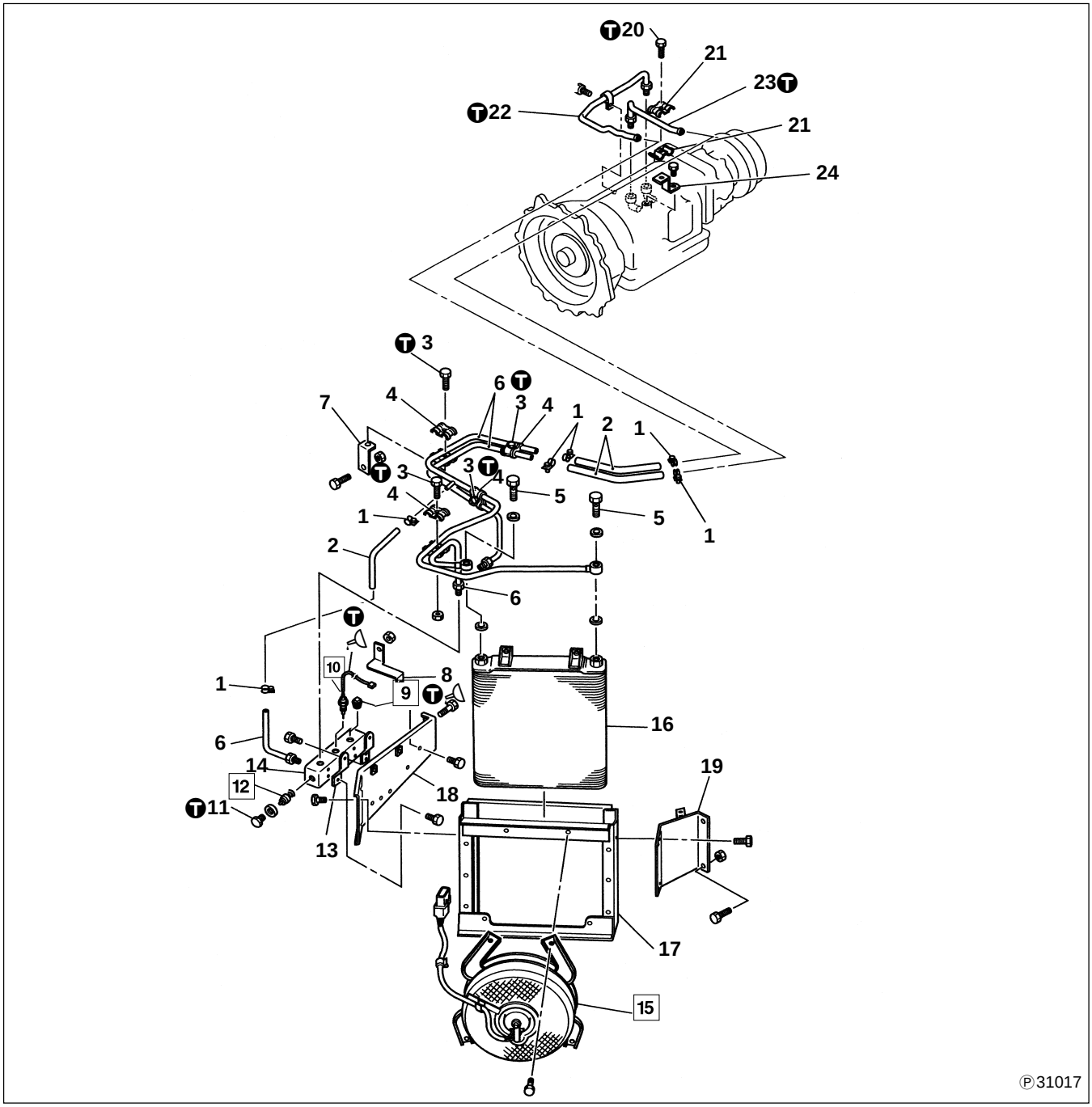
- Align the bolt holes of drive plate **8** and flywheel **B** by looking through service hole **D**, and mount bolts **4**.
- Temporarily tighten all eight bolts, two bolts at each of the four locations, by turning the engine and stopping at the proper position. Then, repeat the same process, and tighten the bolts to the specified torque.



- Tighten all automatic transmission assembly mounting bolts **6** to the specified torque.
- Tighten bolts **2** to the specified torque to secure dust cover **3** in place.

M E M O

OIL COOLER



● **Removal sequence**

1 Hose clamps
2 Rubber hoses
3 Bolts
4 Clamps
5 Eye bolt
6 Oil cooler tube
7 Bracket
8 Bracket
9 Plug
10 Automatic transmission fluid thermostat switch
11 Plug
12 Thermostat valve
13 Bracket
14 Connector block
15 Blower assembly
16 Oil cooler assembly
17 Oil cooler mount frame
18 Oil cooler front support
19 Oil cooler rear support
20 Bolt
21 Clamps
22 Oil cooler pipe
23 Oil cooler pipe
24 Bracket

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
10	Operating temperature of automatic transmission fluid thermostat switch	When rising (OFF→ON)	97±3°C {207±5.4°F}	—	Replace
		When falling (ON→OFF)	90°C {194°F} MIN		
12	Thermostat valve	Starting operation temperature	76.5±3°C {170±5.4°F}	—	Replace
		Bypass opening temperature	83±2°C {181±3.6°F}	—	Replace

Tightening torque

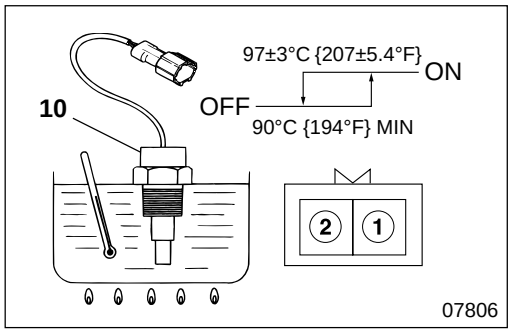
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Clamp mounting)	3.0 to 4.4 {2.2 to 3.3, 0.3 to 0.45}	—
9	Plug	29 to 39 {22 to 29, 3 to 4}	—
10	Automatic transmission fluid thermostat switch	29 to 39 {22 to 29, 3 to 4}	—
11	Plug	147 to 186 {110 to 139, 15 to 19}	Wet
20	Bolt (Clamp mounting)	3.0 to 4.4 {2.2 to 3.3, 0.3 to 0.45}	—
22, 23	Oil cooler pipe	29 to 30 {22 to 29, 3 to 4}	—

Sealant

Location	Points of application	Specified sealant	Quantity
9	Thread area of plug	THREEBOND 1110B	As required
10	Thread area of automatic transmission fluid thermostat switch	THREEBOND 1110B	As required

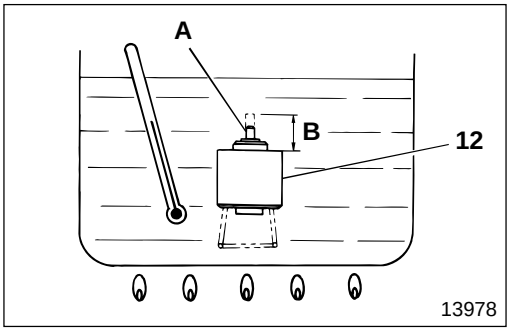
◆ Service procedure



10 **Inspection of automatic transmission fluid thermostat switch**

Carry out the following inspection and replace automatic transmission fluid thermostat switch **10** if there are any faults.

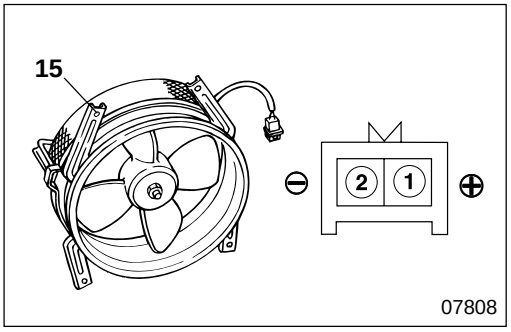
- Check that there is no continuity between terminals ① and ② at ambient temperature of 20±5°C {68±9°F}.
- Place automatic transmission fluid thermostat switch **10** in a container filled with automatic transmission fluid, and raise the temperature while stirring well.
  Measure the temperature when continuity has been achieved between terminals ① and ②, and check that the measured value conforms to the standard value.
- Lower and measure the temperature when continuity is lost between terminals ① and ②, and check that the measured value conforms to the standard value.



12 **Inspection of thermostat valve**

Carry out the following inspection. If any fault is found, replace thermostat valve **12**.

- Place thermostat valve **12** in a container filled with automatic transmission fluid and raise the fluid temperature while stirring the fluid.
  Make sure that end **A** starts stroking at a temperature of 76.5±3°C {170±5.4°F}.
- Raise the fluid temperature further and make sure that end **A** expands by 4.5 mm {1.18 in.} and dimension **B** in the illustration is 13.4 mm {0.53 in.} at a temperature of 83±2°C {181±3.6°F}.



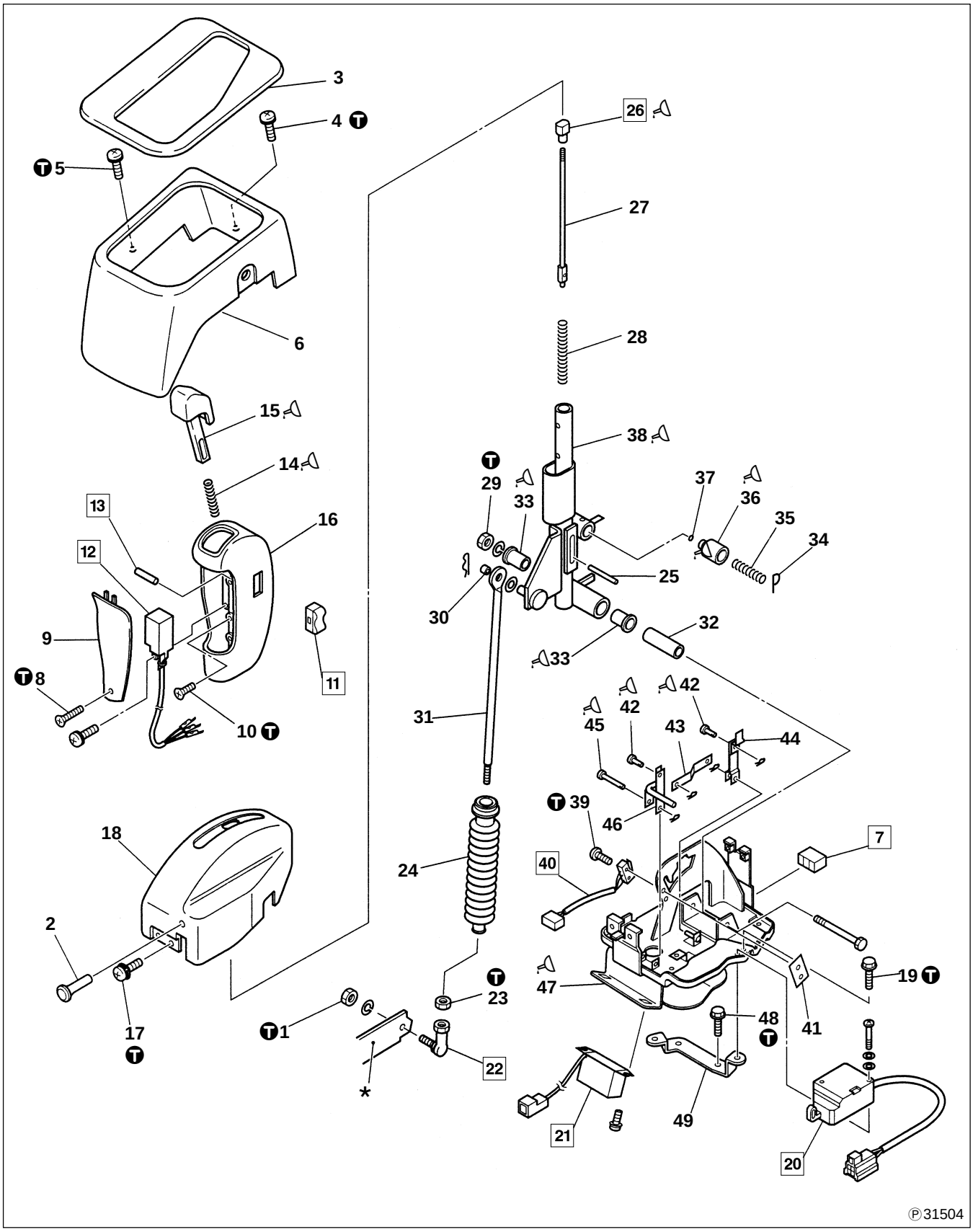
15 **Inspection of blower assembly**

Check blower assembly **15** and make sure it operates when battery voltage is loaded between terminals ① and ②. If any fault is found, replace the blower assembly.

M E M O

AUTOMATIC TRANSMISSION CONTROL

Range Selector Lever



● **Disassembly sequence**

1 Nut
2 Shift lock release knob
3 Adapter
4 Screw
5 Screw
6 Range selector lever cover
7 Connector
8 Screw
9 Cover
10 Screw
11 Switch button
12 Overdrive OFF switch
13 Pin
14 Spring
15 Shift button
16 Automatic transmission knob
17 Screw
18 Indicator panel
19 Bolt
20 Shift lock actuator
21 Automatic transmission reverse buzzer
22 Ball joint
23 Lock nut
24 Grommet
25 Pin
26 Sleeve
27 Rod
28 Spring
29 Nut
30 Bushing
31 Rod
32 Pipe
33 Bushings
34 Pin
35 Ball spring
36 Ball support
37 Steel ball
38 Selector lever
39 Screw
40 P-range switch
41 Plate
42 Clevis pins
43 Shift lock link
44 Shift lock link
45 Clevis pin
46 Shift lock link
47 Lever bracket
48 Bolt
49 Base plate

***** : Lever assembly P23-75

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

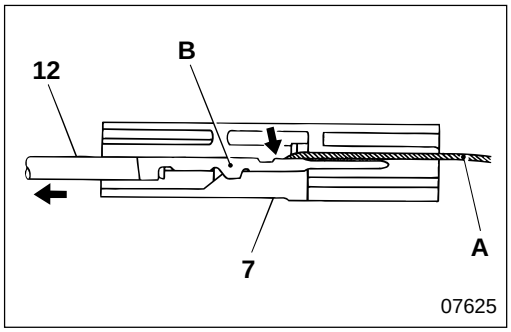
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Lever assembly mounting)	17 to 22 {12 to 16, 1.7 to 2.2}	—
4	Screw (Range selector lever cover mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
5	Screw (Range selector lever cover mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
8	Screw (Cover mounting)	2.0 {1.4, 0.2}	—
10	Screw (Automatic transmission knob mounting)	2.0 {1.4, 0.2}	—
17	Screw (Indicator panel mounting)	1 to 2 {0.7 to 1.4, 0.1 to 0.2}	—
19	Bolt (Lever bracket mounting)	9.8 to 15.0 {7.2 to 11.0, 1.0 to 1.5}	—
23	Lock nut (Ball joint mounting)	16 to 24 {12 to 17, 1.6 to 2.4}	—
29	Nut (Lever mounting)	9.8 to 14.0 {7.2 to 10.0, 1.0 to 1.4}	—
39	Screw (P-range switch mounting)	0.2 to 0.3 {0.1 to 0.2, 0.02 to 0.03}	—
48	Bolt (Base plate mounting)	9.8 to 15.0 {7.2 to 11.0, 1.0 to 1.5}	—

Lubricant

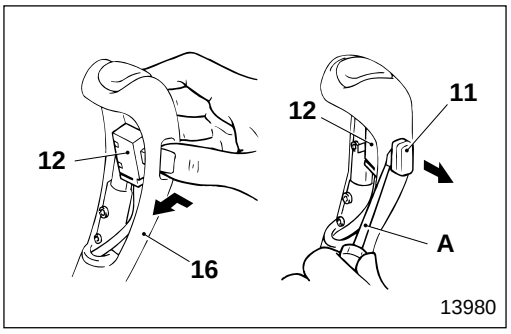
Location	Points of application	Specified lubricant	Quantity
14	Outside surface of spring	Multipurpose grease [NLGI No.2 (Li soap)]	As required
15	Sliding area of shift button	Multipurpose grease [NLGI No.2 (Li soap)]	As required
26	Sliding area of sleeve	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
33	Interior of bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required
36	Sliding area of ball support	Chassis grease [NLGI No.1 (Ca soap)]	As required
38	Sliding area of selector lever	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
42, 45	Sliding area of clevis pin	Chassis grease [NLGI No.1 (Ca soap)]	As required
47	Sliding area of lever bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



7 **Removal of connector**

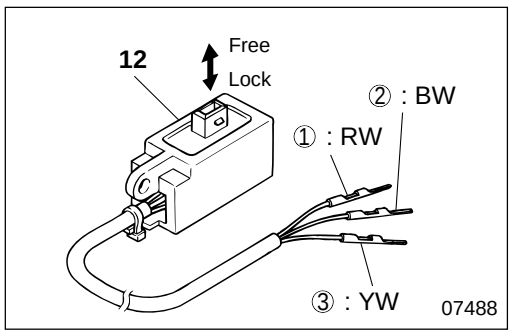
Using screwdriver **A**, pull out terminal **B** of overdrive OFF switch **12** from the inside of connector **7** and remove the connector.



11 **12** **Switch button, overdrive OFF switch**

[Removal]

- Using screwdriver **A**, remove switch button **11** from overdrive OFF switch **12**.
- Remove overdrive OFF switch **12** from automatic transmission knob **16** by pushing the switch out.

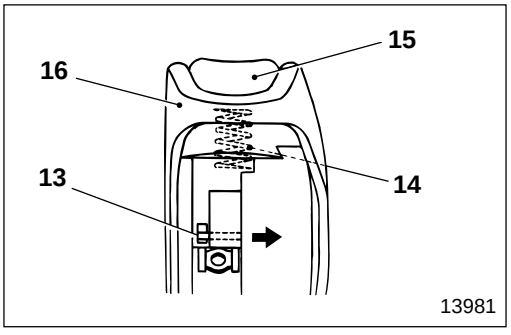


[Inspection of overdrive OFF switch **12**]

	① : RW	② : BW	③ : YW
Free	○		○
Lock	○	○	

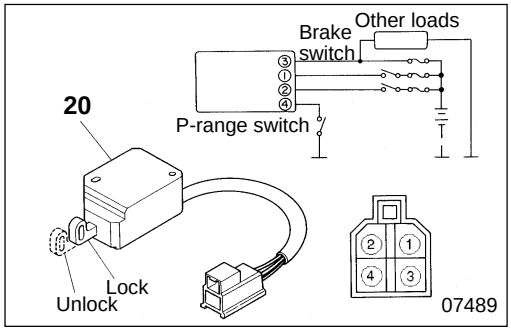
○——○ : There is continuity between terminals ○ and ○.

Replace overdrive OFF switch **12** if it is faulty.



13 **Removal of pin**

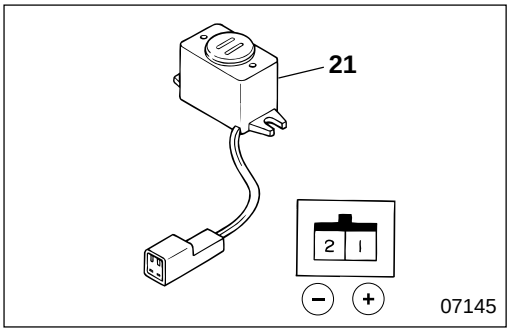
While keeping shift button **15** and spring **14** pressed down, remove pin **13** towards the inside (arrow direction) of automatic transmission knob **16**.



20 **Inspection of shift lock actuator**

Power supply		Switch		Operating mode	
IG	+B	Brake	P range	Unlock	Lock
○	○	○	○	○←	
○	○		○		→○
○	○	○		○	
○	○			○	
	○	○	○		→○
	○		○		→○
	○	○		○	
	○			○	

Check to make sure that shift lock actuator **20** is in operating mode under the above power supply and switch position.
Replace the shift lock actuator if it is faulty.

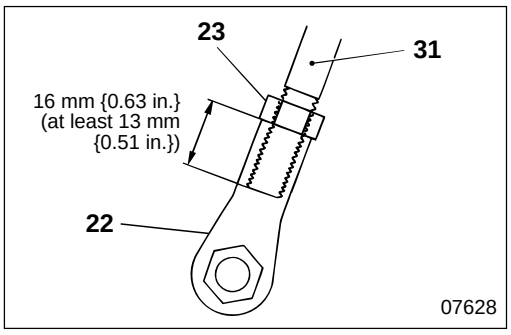


21 **Inspection of automatic transmission reverse buzzer**

- Check to make sure that the automatic transmission reverse buzzer sounds when 12 volts DC is loaded between terminals ① and ②.
- Replace automatic transmission reverse buzzer **21** if it is faulty.

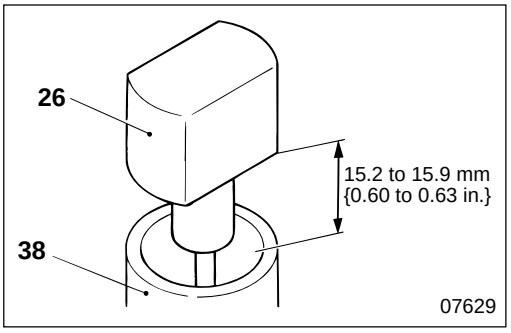
NOTE

- **Automatic transmission reverse buzzer 21 sounds continuously when you apply voltage.**
- **If you want to make automatic transmission reverse buzzer 21 sound intermittently, use the automatic transmission reverse buzzer and the back buzzer in combination.**



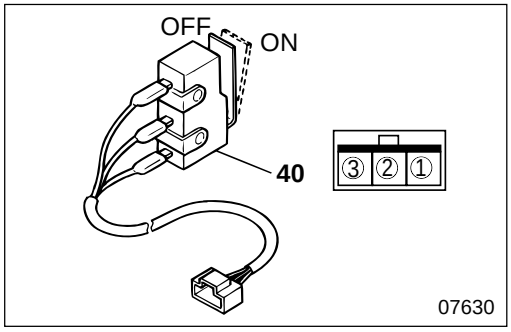
22 **Installation of ball joint**

Using ball joint **22** adjust rod **31** so that its thread ridge conforms to the dimensions as illustrated, then tighten with lock nut **23**.



26 **Installation of sleeve**

Shift range selector lever **38** to the P range. Install sleeve **26** by rotating it so that the dimension between the sleeve and the upper part of the lever conforms to the value as illustrated.



40 **P-range switch**

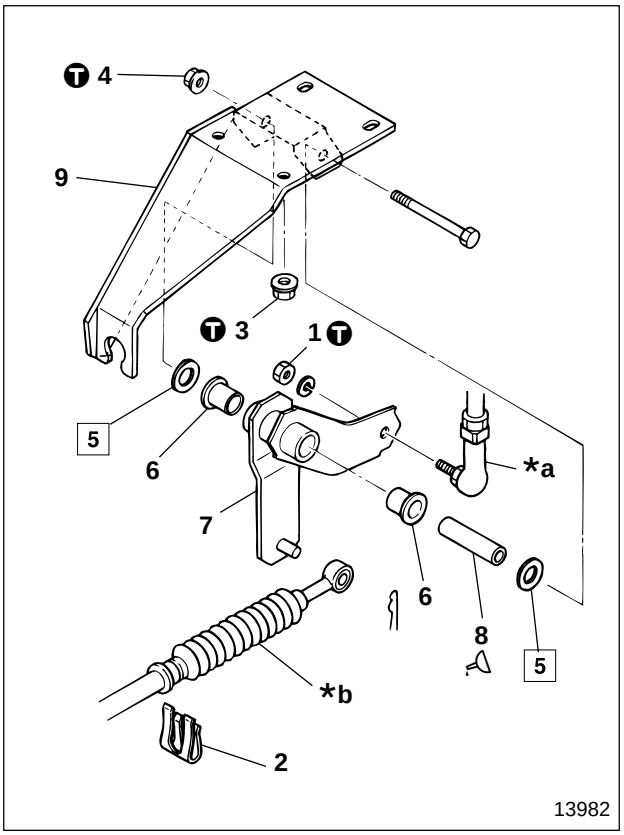
[Inspection]

	①	②	③
ON	○———		———○
OFF		○———	———○

○——○ : There is continuity between terminals ○ and ○.
Replace P-range switch **40** if it is faulty.

[Installation]
Install P-range switch **40** so that it is OFF when the range selector lever is in the P range.

Lever Assembly

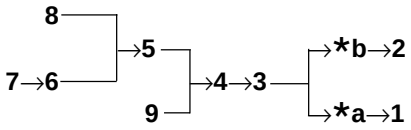


● **Disassembly sequence**

1 Nut
2 Clip
3 Nut
4 Nut
5 Spacer (for adjustment)
6 Bushings
7 Lever
8 Collar
9 Lever bracket

***a** : Range selector lever 🕮 P23-70
***b** : Selector cable 🕮 P23-76

● **Assembly sequence**



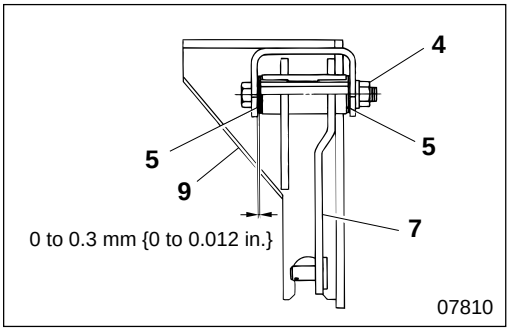
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Range selector lever mounting)	17 to 22 {12 to 16, 1.7 to 2.2}	—
3	Nut (Bracket mounting)	9.8 to 15.0 {7.2 to 11.0, 1.0 to 1.5}	—
4	Nut (Lever mounting)	17 to 22 {12 to 16, 1.7 to 2.2}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
8	Outside surface of collar	Chassis grease [NLGI No.1 (Ca soap)]	As required

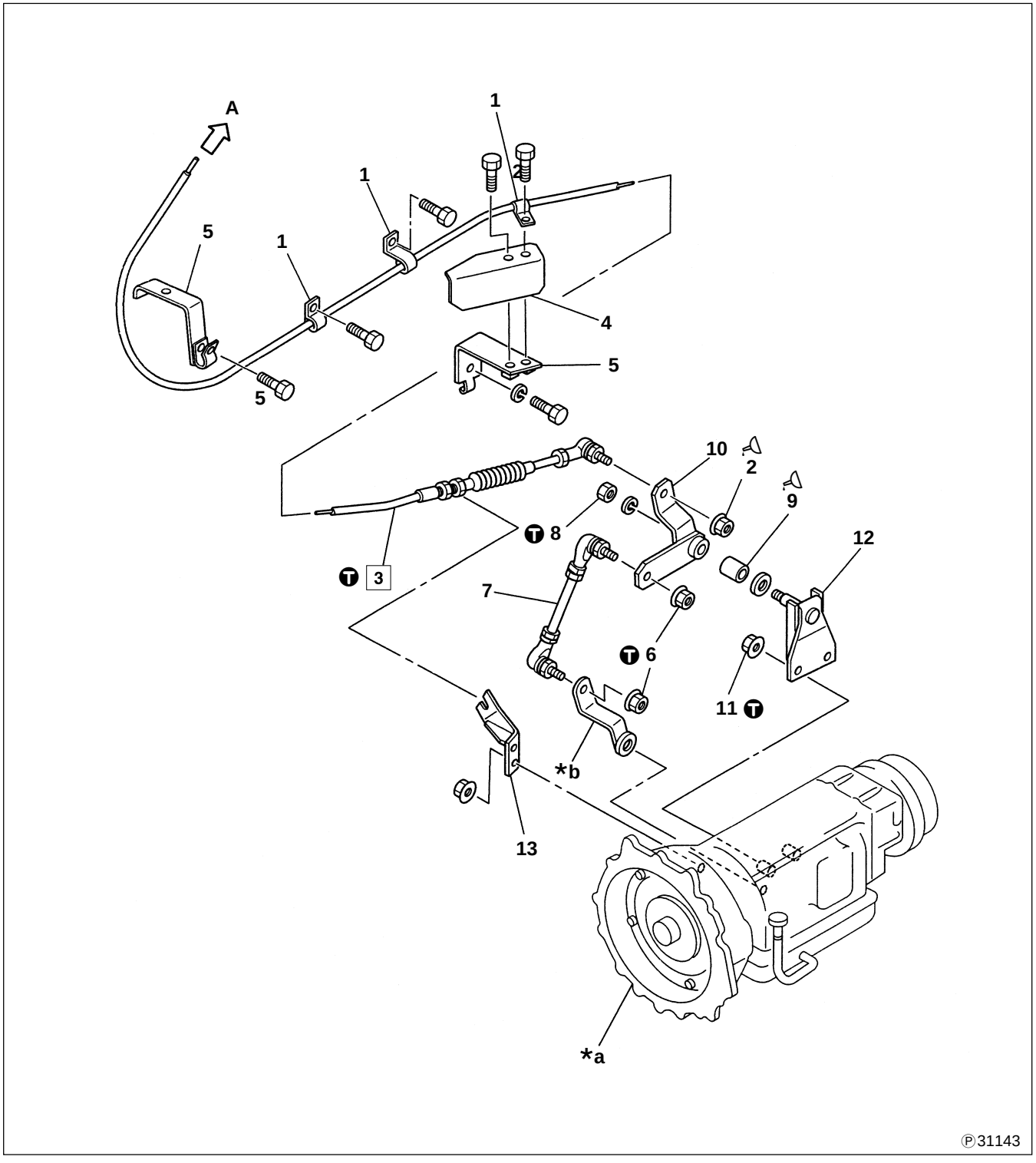


◆ Service procedure

5 **Selection of spacer**

- Select the spacer so that when nut **4** is tightened at specified torque the clearance between lever bracket **9** and spacer **5** conforms to the dimensions as illustrated.
  There are two spacer thicknesses available : 0.3, 0.5 mm {0.012, 0.020 in.}
- After installation make sure lever **7** can be operated smoothly.

AUTOMATIC TRANSMISSION CONTROL



● **Removal sequence**

1 Clip
2 Nut
3 Selector cable
4 Insulator
5 Bracket
6 Nut
7 Rod
8 Nut
9 Bushing
10 Lever
11 Nut
12 Bracket
13 Bracket

A : To range selector lever

***a** : Automatic transmission unit
***b** : Transmission control shift lever
🕮 P23-80

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

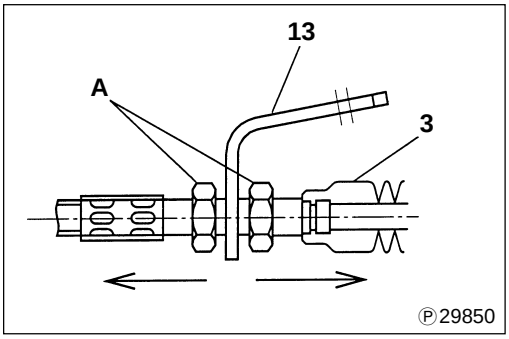
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Selector cable mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
3	Selector cable (For mounting on bracket)	60 to 85 {6.0 to 8.5}	—
6	Nut (Rod mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
8	Nut (Lever mounting)	28 to 35.7 {2.8 to 3.5}	—
11	Nut (Bracket mounting)	38 to 54 {28 to 40, 3.9 to 5.5}	—

Lubricant

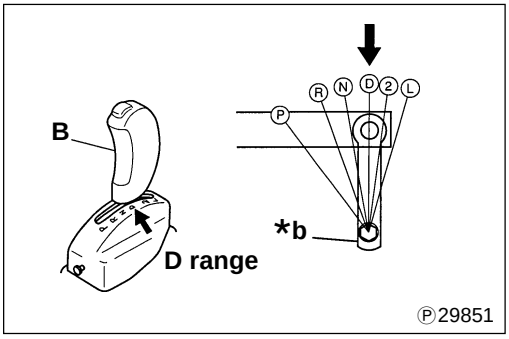
Location	Points of application	Specified lubricant	Quantity
9	Inside bushings	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure

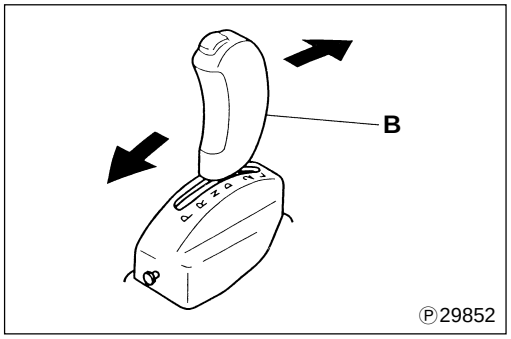


3 **Selector cable**

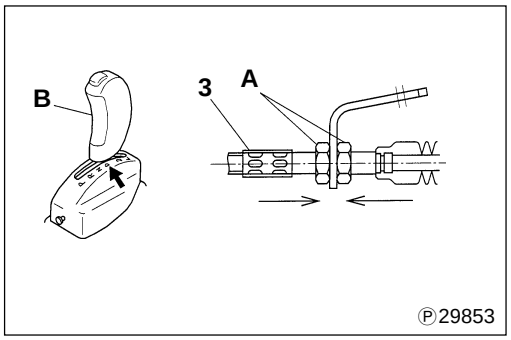
- Loosen nuts **A** on the selector cable **3** all the way to the ridges.



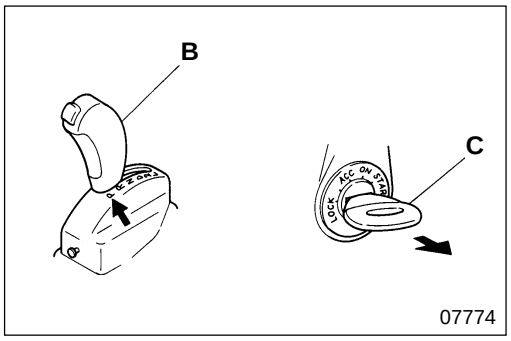
- Set automatic transmission lever knob **B** (located inside the cabin) and transmission control lever ***b** to the D range position.



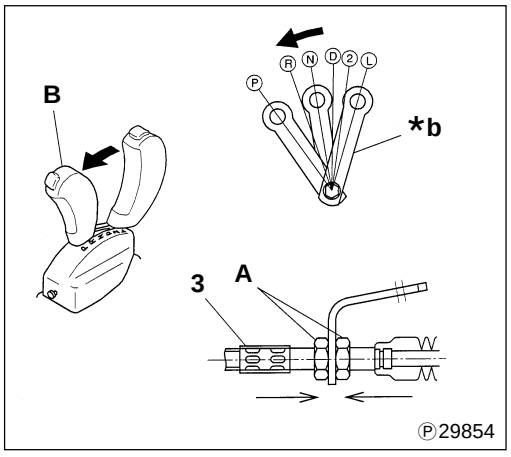
- Shake automatic transmission lever knob **B** back and forth.



- Check to make sure that automatic transmission lever knob **B** is in the D range, and tighten nuts **A** on selector cable **3** to the specified torque.



- Make sure that starter key **C** can be removed with automatic transmission lever knob **B** in the P range.



[Adjustment]

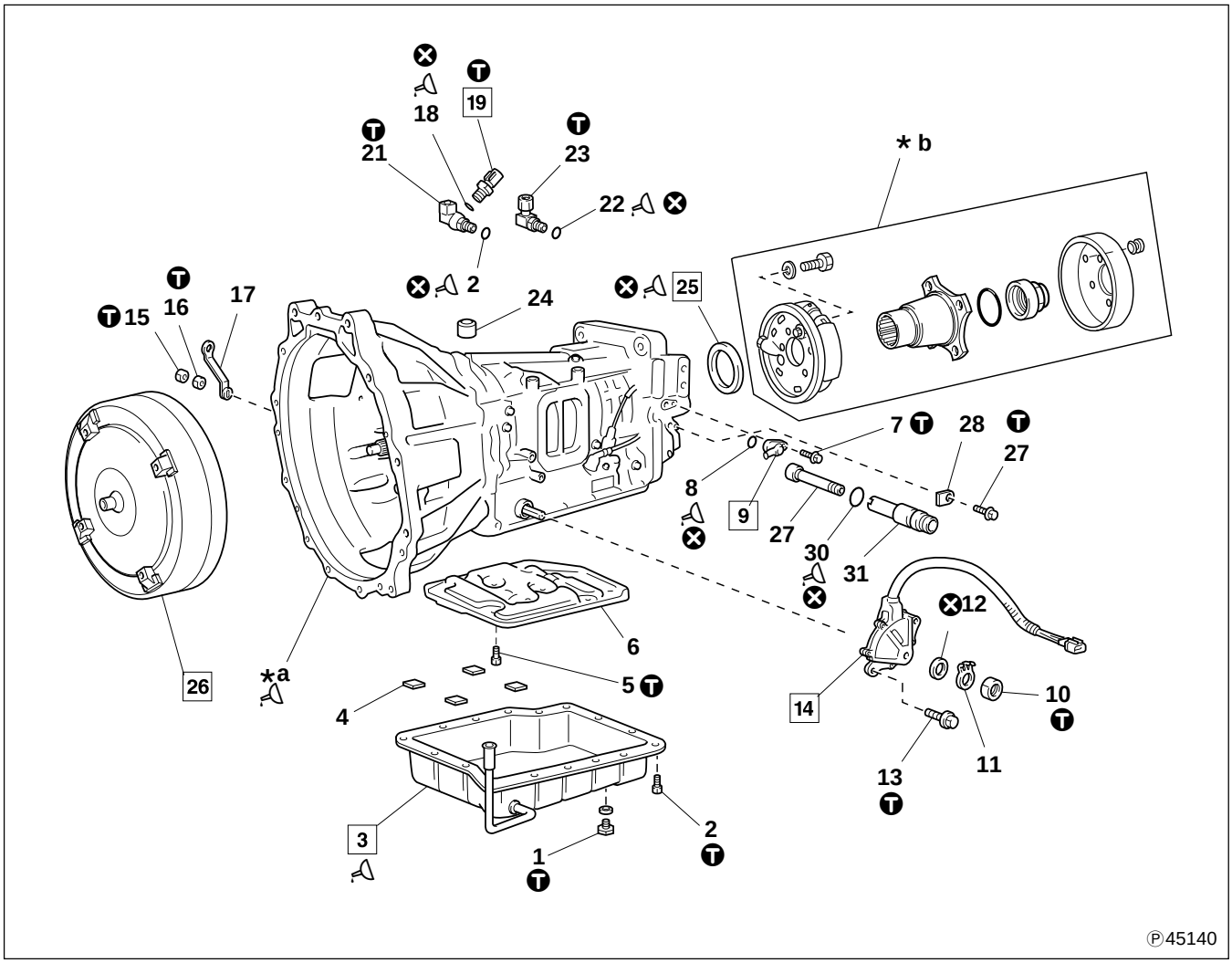
Adjust nuts **A** on selector cable **3** so that transmission control lever ***b** moves smoothly in the entire range when automatic transmission lever knob **B** is moved from the L range to P range.

CAUTION ⚠

If the adjustment of nuts A is improper, automatic transmission lever knob B produces resistance when it is moved to the L or P range. In some cases, the starter key cannot be removed with the automatic transmission lever knob in the P range.

M E M O

REPLACEMENT OF AUTOMATIC TRANSMISSION PARTS



● **Removal sequence**

1 Drain plug
2 Bolt
3 Oil pan
4 Oil cleaner magnet
5 Bolt
6 Oil strainer
7 Bolt
8 O-ring
9 Speed sensor
10 Nut
11 Lock washer
12 Gasket
13 Bolt
14 Inhibitor switch
15 Nut
16 Nut
17 Transmission control shift lever
18 O-ring
19 Oil temperature switch
20 O-ring
21 Elbow
22 O-ring
23 Elbow
24 Breather cap
25 Rear oil seal
26 Torque converter
27 Bolt
28 Speedometer sleeve lock plate
29 Speedometer driven gear
30 O-ring
31 Speedometer sleeve

***a** : Automatic transmission unit
***b** : Parking brake assembly
Gr 36
⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
9	Speed sensor resistance (at normal temperature)		560 to 680 Ω	—	Replace
19	Oil temperature switch activating temperature	OFF→ON	143 to 151°C {289 to 304°F}	—	Replace
		ON→OFF	Approximately 125°C {257°F}		

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

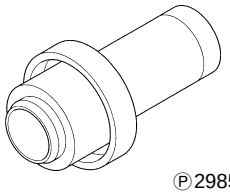
Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	27 {21, 2.8}	With magnets
2	Bolt (Oil pan mounting)	7 {5.1, 0.7}	—
5	Bolt (Strainer mounting)	10 {7.2, 1.0}	—
7	Bolt (Speed sensor mounting)	8 {5.8, 0.8}	—
10	Nut (Inhibitor switch mounting)	7 {5.1, 0.7}	—
13	Bolt (Inhibitor switch mounting)	12.5 {9.4, 1.3}	—
15	Nut (Transmission control shift lever mounting)	12.5 {9.4, 1.3}	—
16	Nut (Transmission control shift lever mounting)	12.5 {9.4, 1.3}	—
19	Automatic transmission fluid temperature switch	24.5 {18, 2.5}	—
21	Elbow	32 {24, 3.3}	—
23	Elbow	32 {24, 3.3}	—
27	Bolt (Speedometer sleeve lock plate mounting)	12.5 {9.4, 1.3}	—

Lubricant and/or sealant

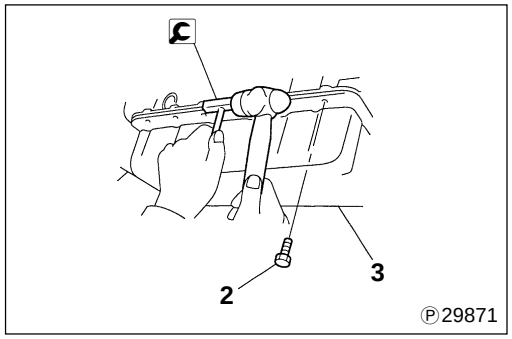
Location	Parts of application	Specified lubricant and/or sealant	Quantity
—	O-rings	Automatic transmission fluid	As required
3	Mounting surfaces of oil pan and automatic transmission unit	THREEBOND 1281B	As required
25	Lip section of oil seal	Wheel bearing grease [NLGI NO.2 (Li soap)]	As required
***a**	Perimeter of breather cap mounting pipe on automatic transmission unit	Cemendyne 540 Super X No. 8008	As required

REPLACEMENT OF AUTOMATIC TRANSMISSION PARTS

Special tools

Location	Tool name and shape	Part No.	Application
25	Oil seal installer  Ⓟ29857	MH063608	Installation of oil seal

◆ Service procedure



Ⓟ29871

3 Oil pan

[Removal]

- Remove bolts **2**.

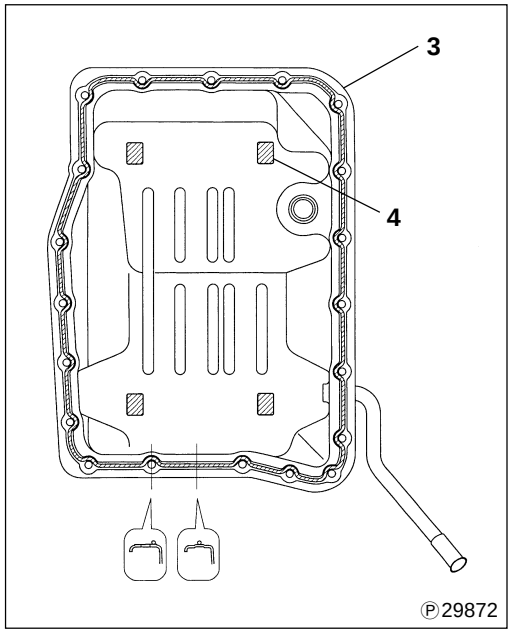
CAUTION

To prevent oil pan 3 from dropping when separating the sealant from the oil pan, keep several bolts (not tightened) mounted at intervals of three bolt holes.

- Insert oil pan remover at a corner of oil pan **3**, and separate the oil pan from the automatic transmission unit.

CAUTION

- **Be careful not to deform the shape of oil pan 3 when inserting oil pan remover.**
- **Do not tilt the oil pan during removal since the oil pan 3 contains oil.**



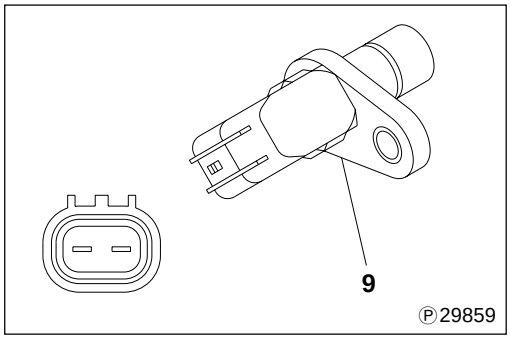
Ⓟ29872

[Installation]

- Remove the sealant from the mounting surfaces of the automatic transmission unit and oil pan **3**.
- Clean oil cleaner magnets **4**, and mount them in the oil pan.
- Apply sealant on oil pan **3**, and mount the oil pan on the automatic transmission unit.
- Tighten bolts **2** to the specified torque.

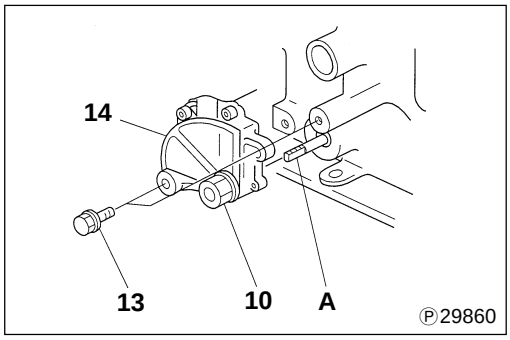
CAUTION

- **Do not allow automatic transmission fluid on the contact surfaces of oil pan 3 and the automatic transmission unit.**
- **Apply sealant continuously with a diameter of 2 or 3 mm {0.079 to 0.12 in.}, as shown in the diagram.**
- **Install the oil pan within 10 minutes after the application of the sealant.**
- **Tighten bolts 2 evenly by conducting the tightening operation for each bolt several times.**



9 Inspection of speed sensor

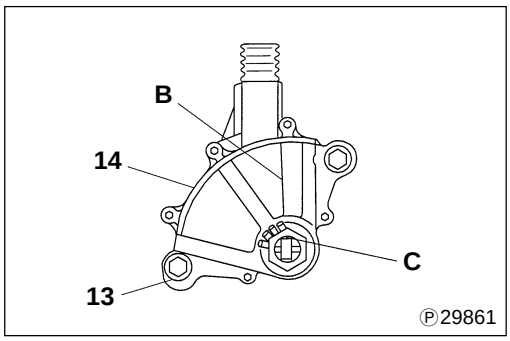
- Measure the resistance between the connector terminals shown in the diagram. If the measured value deviates from the standard value, the connector is defective.
- Standard resistance between terminals: 560 to 680 Ω (at normal temperature)



14 Inhibitor switch

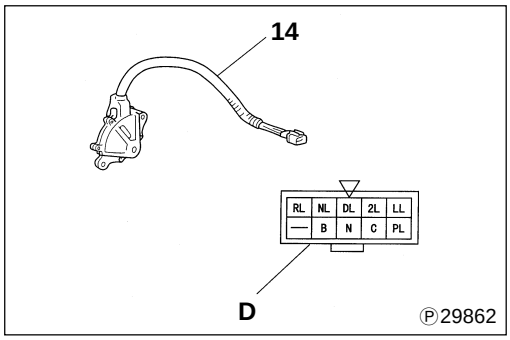
[Installation]

- Set control shaft **A** to the N position.
- Mount inhibitor switch **14** on control shaft **A**.
- Tighten two bolts **13**.
- Tighten nut **10**.



[Adjusting]

- Loosen two bolts **13**, and position inhibitor switch **14** so that reference line **B** on the inhibitor switch aligns with groove **C**.
- While holding inhibitor switch **14** with one hand, tighten two bolts **13** to the specified torque with the other hand.
- Bend the two lock tabs on the nut of inhibitor switch **14**.



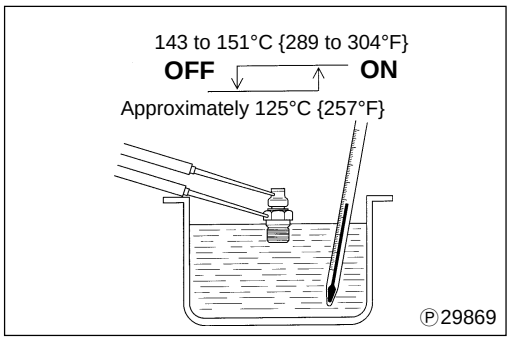
[Inspection]

Check the electric conduction at wire connector **D** of inhibitor switch **14** using a tester.

< Connection chart >

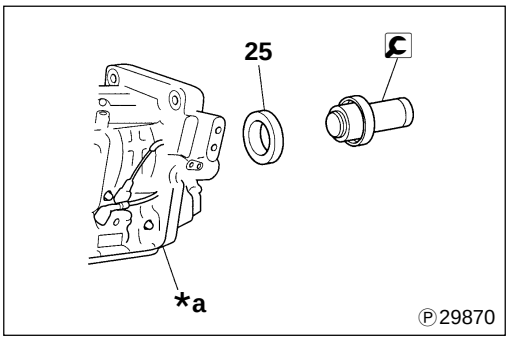
	B	N	C	PL	RL	NL	DL	2L	LL
P	○	○	○	○					
R			○		○				
N	○	○	○			○			
D			○				○		
2			○					○	
L			○						○

○——○ : Electric conduction between terminals



19 **Oil temperature switch**

Place oil temperature switch assembly **19** in a container filled with water. Vary the temperature of the water, and check to make sure that the switch operates (ON and OFF) at the specified temperatures.



25 **Installation of oil seal**

< FE >

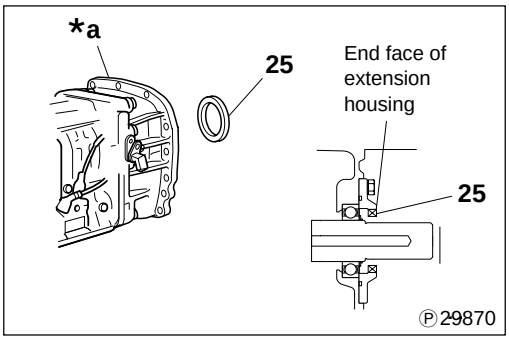
CAUTION

After the oil seal 25 is removed, clean the surface of the extension housing of automatic transmission unit *a to which oil seal is mounted.

- Apply grease on the lip section of oil seal **25**.
- Use oil seal installer to insert oil seal **25** all the way into the extension housing of automatic transmission unit ***a**.

CAUTION

- **Insert oil seal 25 evenly.**
- **Do not damage or deform the shape of oil seal 25.**



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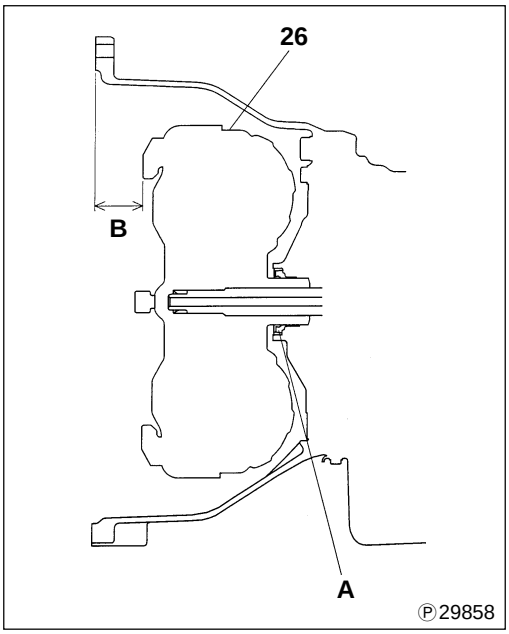
CAUTION

After the oil seal 25 is removed, clean the surface of the extension housing of automatic transmission unit *a to which oil seal is mounted.

- Apply grease on the lip section of oil seal **25**.
- Drive the oil seal **25** into the automatic transmission unit ***a** until its end face becomes flush with the end face of the extension housing.

CAUTION

- **Be sure to apply the installation force evenly on the entire periphery.**
- **Do not damage or deform the shape of oil seal 25.**



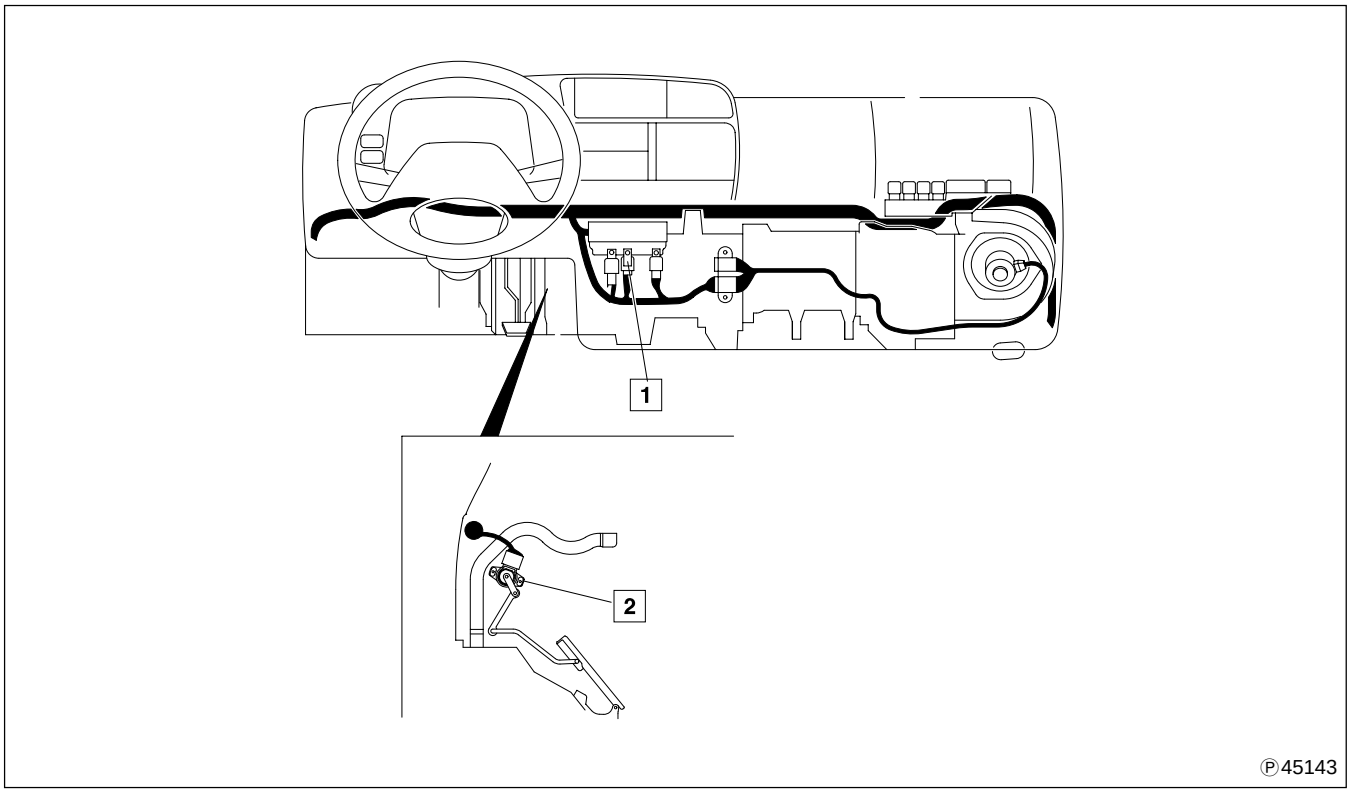
26 **Installation of torque converter**

- Pour new automatic transmission fluid into torque converter **26** when the torque converter to be installed is new.
  Automatic transmission fluid quantity : Approximately 2 L {2.1 qts}
- Apply automatic transmission fluid on front oil seal **A**, and mount torque converter **26** on the oil pump.

CAUTION

Be careful not to damage oil seal A when mounting torque converter 26.

- Measure dimension **B** between the torque converter housing and the set back of torque converter **26** to make sure that the torque converter is inserted into the proper depth.
  Dimension **B** : 44 mm {1.73 in.} or more

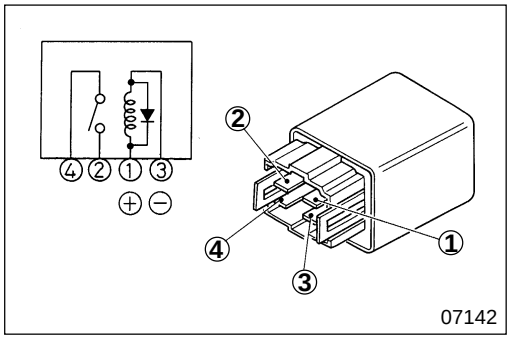


1 Automatic transmission fluid cooler fan relay
2 Accelerator sensor

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
1	Minimum relay operating voltage	11 V or higher	—	Replace

◆ Service procedure



1 **Inspection of relay (constant-open type, 4-pin)**

	①	②	③	④	Remarks
Electric current not supplied	⊕		⊖		—
Electric current not supplied	⊕	○ – –	⊖	○	Measure the voltage of electric current.

○——○ : Electric conduction between terminals
⊕– – –⊖ : Terminals applied with battery voltage
If an abnormality is found, replace the relay.

2 Accelerator sensor

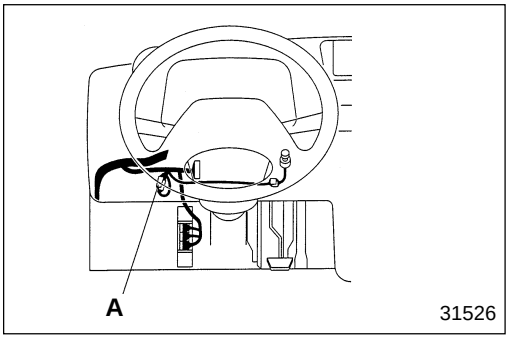
< Except FE640 >

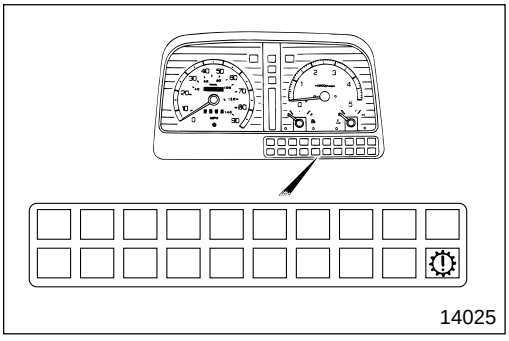
(1) Initial voltage data storage

When accelerator sensor **2** is dismounted or replaced, it is necessary to save the initial voltage value (full throttle) in the automatic transmission electronic control unit memory.

Check items

- Idle adjustment knob is appropriate.
- Accelerator sensor **2** are properly mounted. Gr 13B
- Make sure to apply the parking brake firmly.



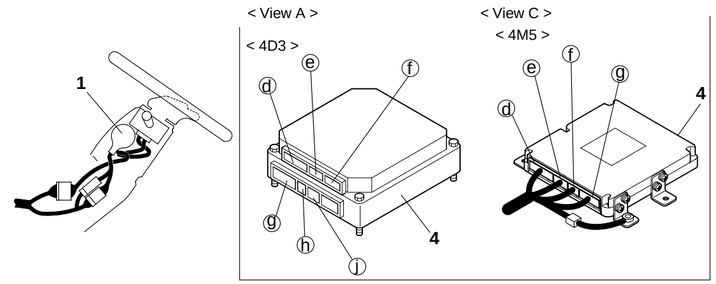


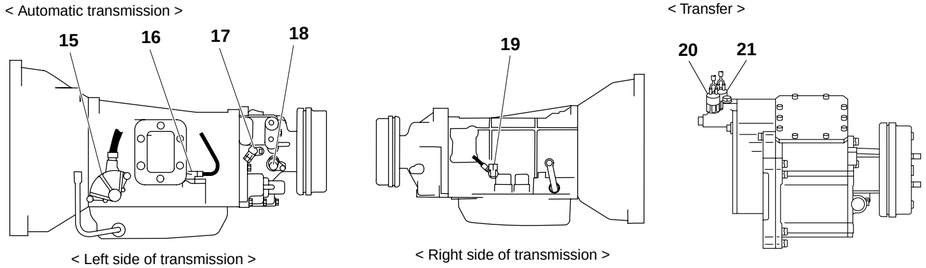
Initial full-throttle voltage data storage

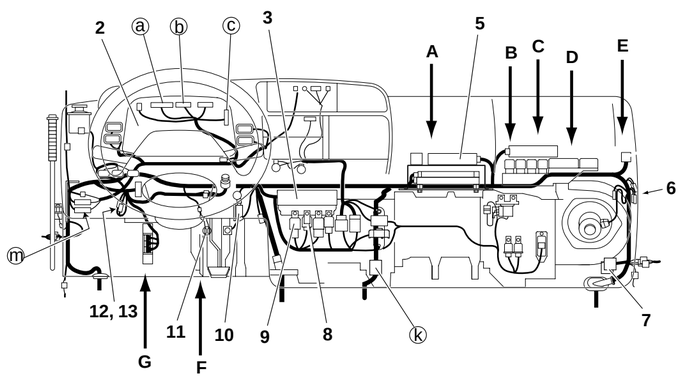
- Turn the starter switch to the ON position.
- Delete the data in the automatic transmission electronic control unit memory by keeping the following conditions for five seconds.
  Turn the starter switch to the ON position.
  Stop the vehicle (engine OFF).
  Shift the range selector lever to the L range.
  Turn off the overdrive OFF switch. (Overdrive OFF)
  Disconnect diagnosis switch (plug connector) **A**.
  Press on the brake pedal.
  Press on the accelerator pedal to full throttle.
  When data deletion is complete, the warning lamp flashes.
- Remove feet from the accelerator and brake pedals, and shift the range selector lever to the P range and connect diagnosis switch **A**.
- Hold the accelerator pedal at full throttle, and press down on the brake pedal for more than three seconds.
  During this process, the warning lamp lights for three seconds. After the full throttle position data is stored in the electronic control unit, the warning lamp turns off.
- After confirming that the warning lamp has turned off, remove feet from the brake and accelerator pedals. Then turn off the starter switch.
- If the warning lamp does not light, repeat the procedure from the beginning.

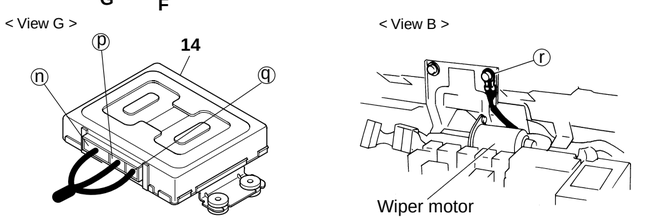
(2) Inspection of accelerator sensor

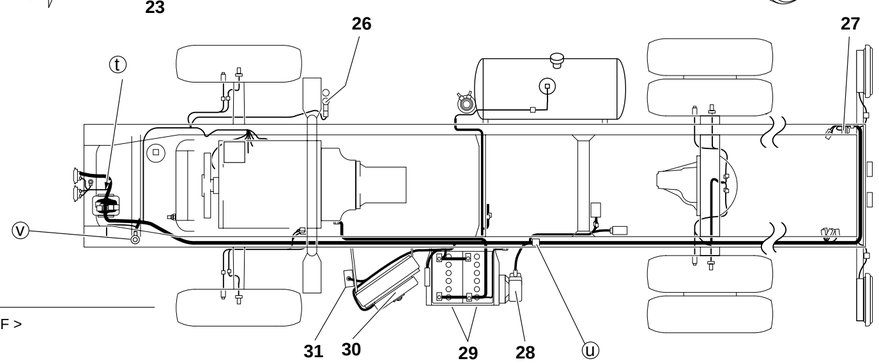
< FE640 > Gr 13EA

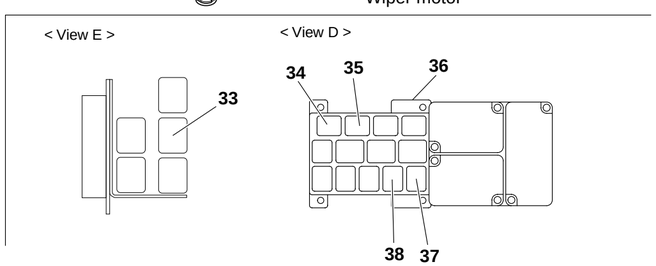


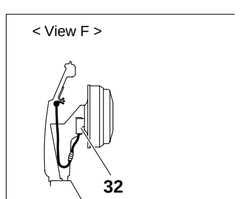




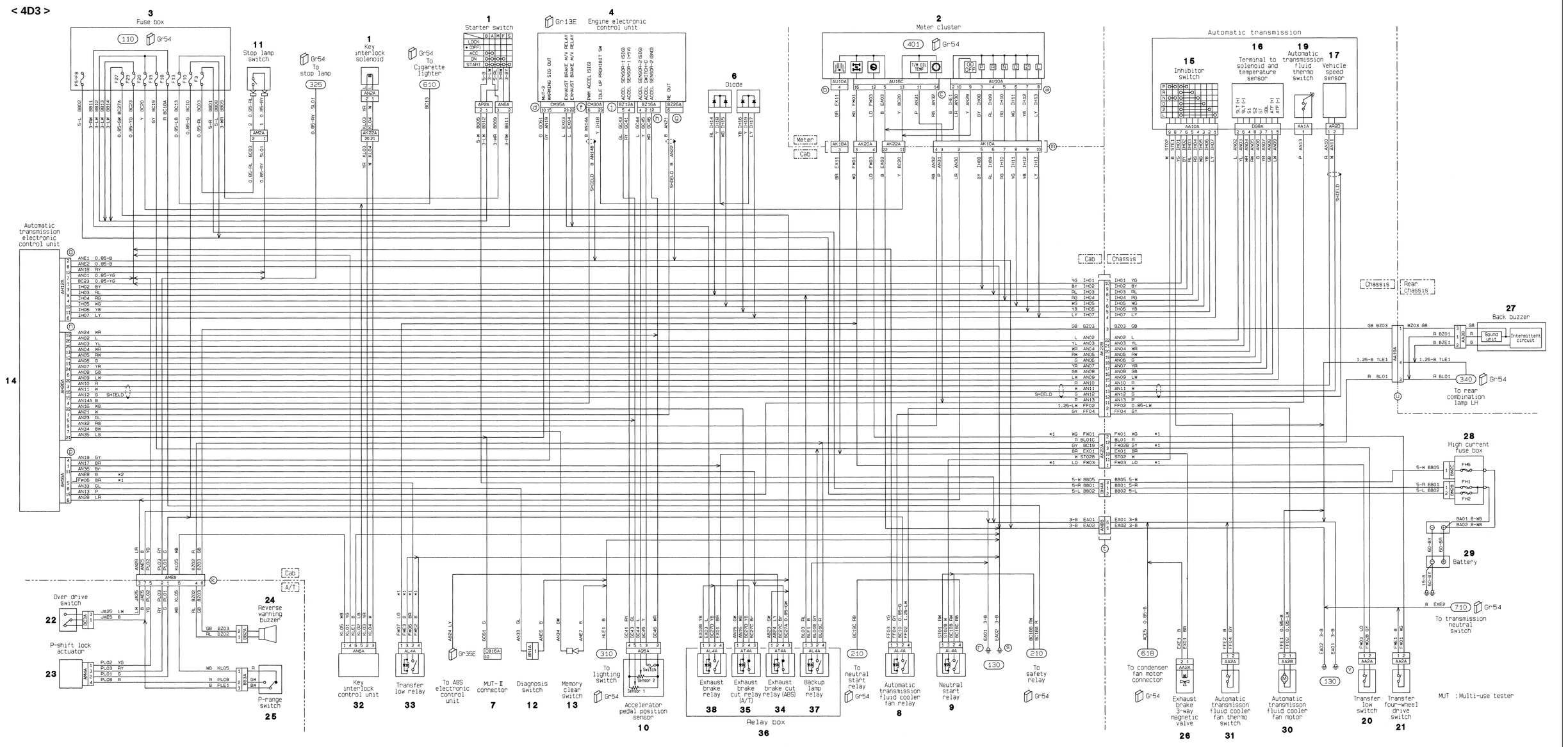






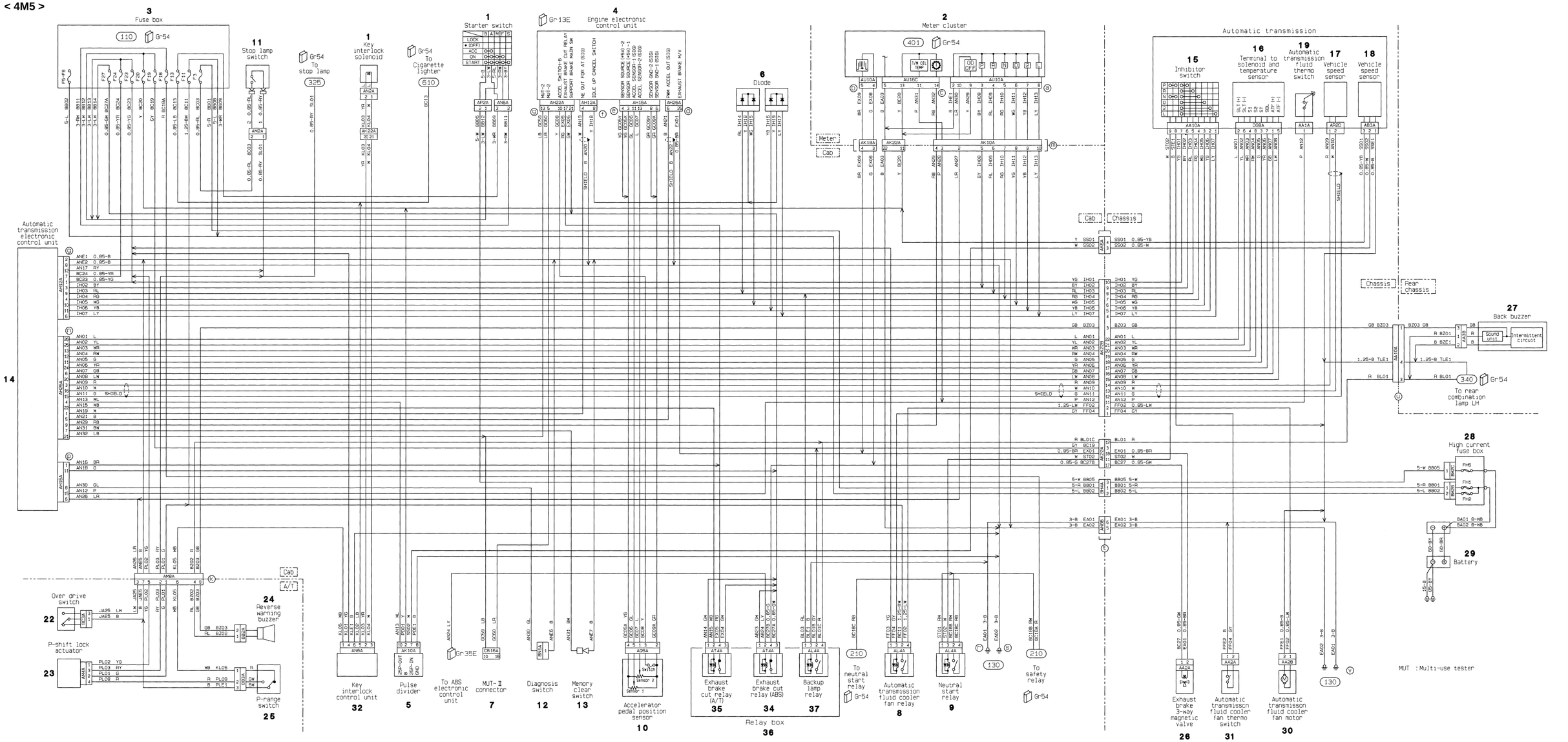


1 Starter switch (key interlock solenoid installed)
2 Meter cluster
3 Fuse box
4 Engine electronic control unit
5 Pulse divider
6 Diode
7 Multi-use tester II connector
8 Automatic transmission fluid cooler fan relay
9 Neutral relay
10 Accelerator pedal position sensor
11 Stop lamp switch
12 Diagnosis switch
13 Memory clear switch
14 Automatic transmission electronic control unit
15 Inhibitor switch
16 Terminal to solenoid and temperature sensor
17 Vehicle speed sensor
18 Vehicle speed sensor
19 Automatic transmission fluid thermo switch
20 Transfer low switch
21 Transfer 4-wheel drive switch
22 Over drive switch
23 P-shift lock actuator
24 Reverse warning buzzer
25 P-range switch
26 Exhaust brake 3-way magnetic valve
27 Back buzzer
28 High current fuse box
29 Battery
30 Automatic transmission fluid cooler fan motor
31 Automatic transmission fluid cooler fan thermo switch
32 Key interlock control unit
33 Transfer low relay
34 Exhaust brake cut relay (ABS)
35 Exhaust brake cut relay (A/T)
36 Relay box
37 Backup lamp relay
38 Exhaust brake relay


< 4D3 >
3 Fuse box
1 Starter switch
Gr13E
4 Engine electronic control unit
2 Meter cluster
Automatic transmission
15 Inhibitor switch
16 Terminal to solenoid and temperature sensor
19 Automatic transmission fluid thermo switch
17 Vehicle speed sensor
11 Stop lamp switch
To stop lamp
1 Key interlock solenoid
To Cigarette lighter
6 Diode
Automatic transmission electronic control unit
14
Cab
Chassis
Rear chassis
27 Back buzzer
Sound unit
Intermittent circuit
To rear combination lamp LH
28 High current fuse box
29 Battery
To transmission neutral switch
Over drive Switch
22
P-shift lock actuator
23
24 Reverse warning buzzer
P-range switch
25
Key interlock control unit
32
Transfer low relay
33
To ABS electronic control unit
7
MUT-II connector
Diagnosis switch
12
Memory clear switch
13
To lighting switch
Accelerator pedal position sensor
10
Relay box
36
Exhaust brake relay
38
Exhaust brake cut relay (A/T)
35
Exhaust brake cut relay (ABS)
34
Backup lamp relay
37
To neutral start relay
Automatic transmission fluid cooler fan relay
8
Neutral start relay
9
To safety relay
To condenser fan motor connector
Exhaust brake 3-way magnetic valve
26
Automatic transmisson fluid cooler fan thermo switch
31
Automatic transmisson fluid cooler fan motor
30
Transfer low switch
20
Transfer four-wheel drive switch
21
MUT : Multi-use tester

44415

< 4M5 >


3 Fuse box
110
Gr54
11 Stop lamp switch
To stop lamp
325
1 Key interlock solenoid
To Cigarette lighter
610
1 Starter switch
Gr13E
4 Engine electronic control unit
6 Diode
2 Meter cluster
401
Gr54
Meter
Cab
Automatic transmission
15 Inhibitor switch
16 Terminal to solenoid and temperature sensor
19 Automatic transmission fluid thermo switch
17 Vehicle speed sensor
18 Vehicle speed sensor
Automatic transmission electronic control unit
14
Cab
Chassis
Rear chassis
27 Back buzzer
Sound unit
Intermittent circuit
To rear combination lamp LH
340
Gr54
28 High current fuse box
29 Battery
Over drive switch
22
P-shift lock actuator
23
24 Reverse warning buzzer
P-range switch
25
Key interlock control unit
32
Pulse divider
5
To ABS electronic control unit
Gr35E
7 MUT-II connector
12 Diagnosis switch
13 Memory clear switch
Accelerator pedal position sensor
10
Exhaust brake cut relay (A/T)
35
Exhaust brake cut relay (ABS)
34
Backup lamp relay
37
Relay box
36
To neutral start relay
Gr54
8 Automatic transmission fluid cooler fan relay
9 Neutral start relay
130
To safety relay
Gr54
Exhaust brake 3-way magnetic valve
26
31 Automatic transmisscn fluid cooler fan thermo switch
30 Automatic transmisscn fluid cooler fan motor
MUT : Multi-use tester

MITSUBISHI
FUSO

Group 24
Transfer

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-24

INDEX

SPECIFICATIONS 24- 2

STRUCTURE AND OPERATION 24- 2

TROUBLESHOOTING 24- 4

REMOVAL AND INSTALLATION OF TRANSFER ASSEMBLY 24- 6

FRONT DRIVE 24- 10

IDLER GEAR AND REAR DRIVE 24- 16

TRANSFER CONTROL 24- 22

SPECIFICATIONS/STRUCTURE AND OPERATION

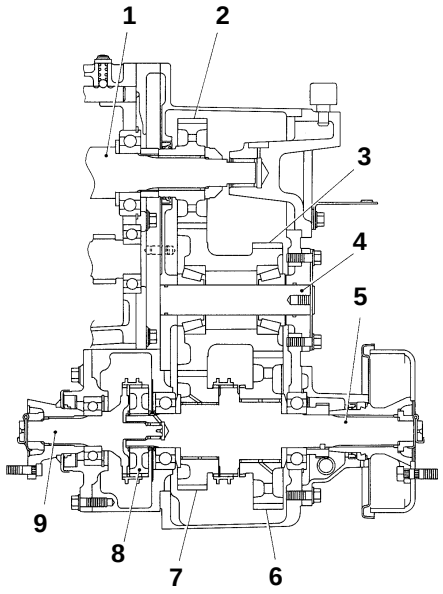
SPECIFICATIONS

Item		Specifications
Model		TF3
Gear ratio	HIGH	1.090
	LOW	1.987
Gear oil	Oil quantity L {qts.}	3.0 {3.2}
Dry mass (including transmission body) kg {lb}		Approximately 190 {420}
Control		Front drive and HIGH-LOW switching floor change remote control

STRUCTURE AND OPERATION

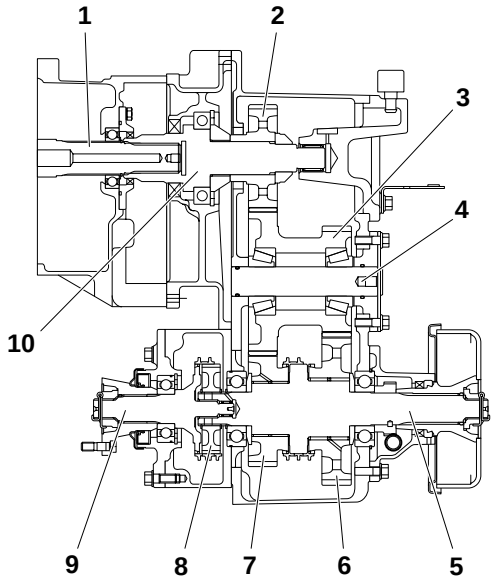
Transfer Body

< Manual transmission >



27272

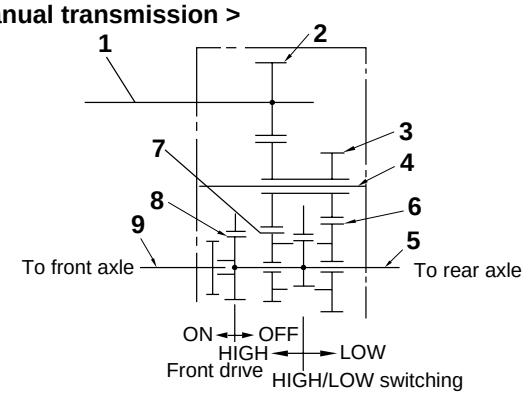
< Automatic transmission >



Ⓟ41094

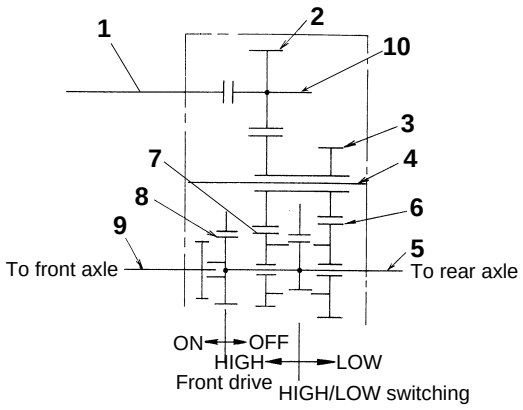
1 Transmission main shaft
2 Drive shaft gear
3 Transfer idler gear
4 Transfer idler shaft
5 Output shaft
6 Output shaft LOW gear
7 Output shaft HIGH gear
8 Front drive hub and sleeve
9 Front drive shaft
10 Transfer drive shaft
< Automatic transmission >

< Manual transmission >



06389

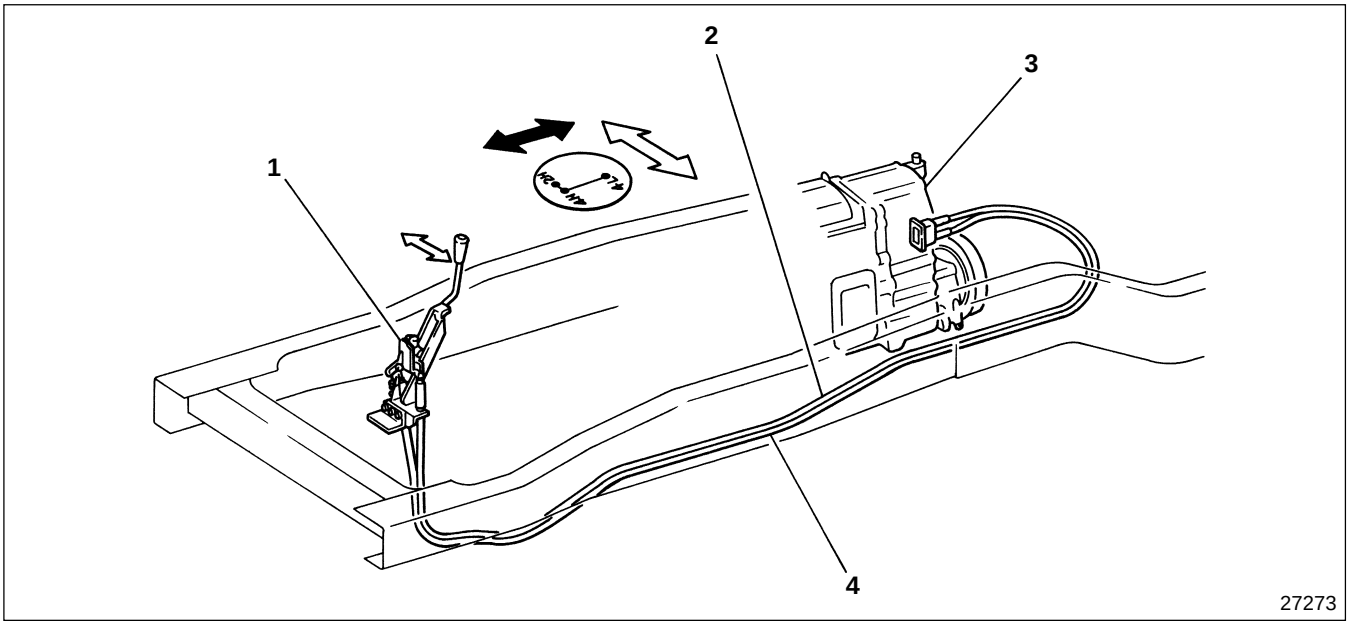
< Automatic transmission >



41095

The transfer functions as both the distributer for four-wheel drive and as the sub-transmission with a reduction device. This transfer is a three-shaft constant-mesh type.
HIGH/LOW changeover and front drive ON/OFF are controlled by a transfer control lever in the cab.

Transfer Control



27273

1 Transfer control lever
2 2H/4H control cable
3 Transfer
4 HIGH/LOW control cable

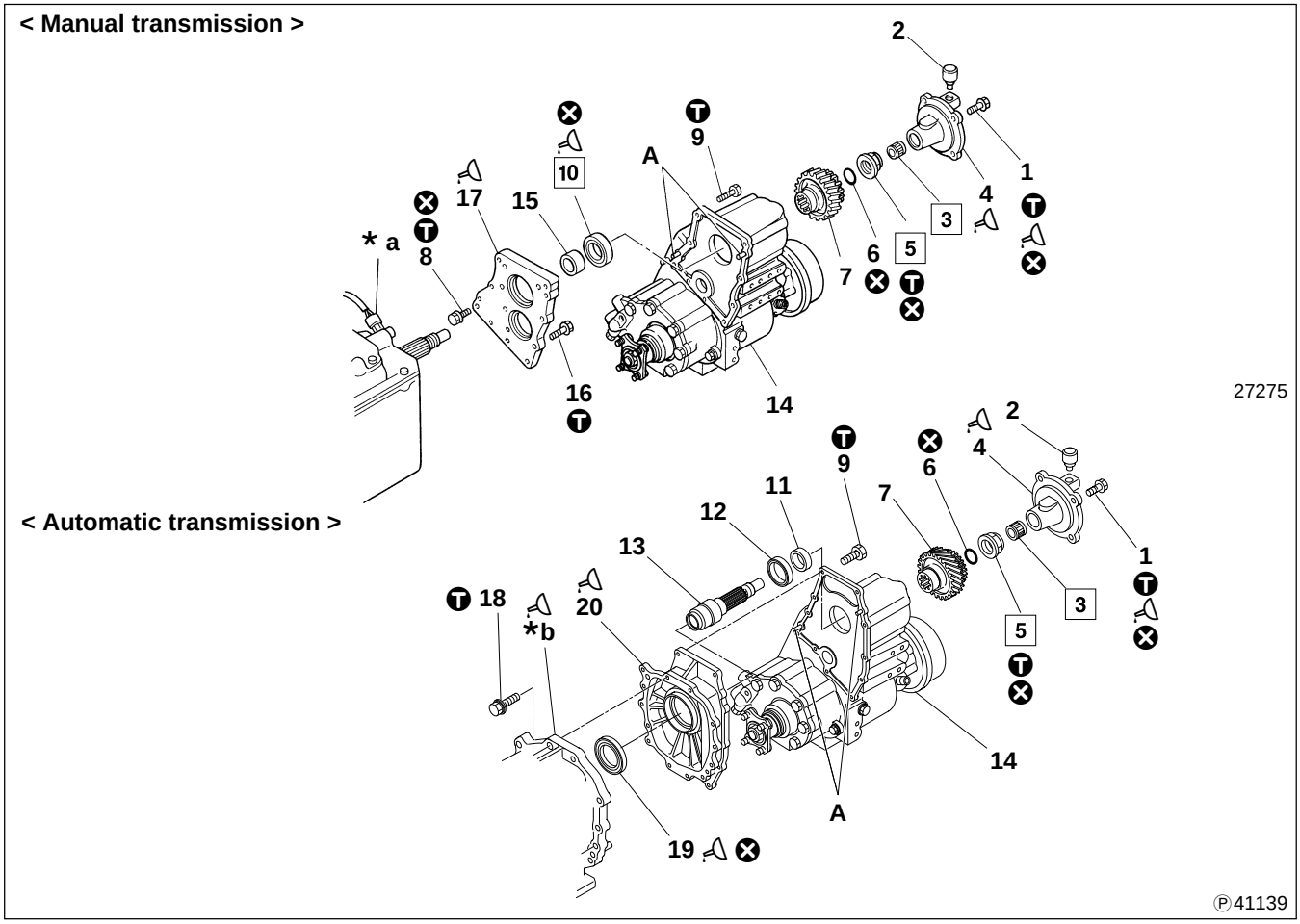
Move the transfer control lever **1** from left to right to change-over between two-wheel drive and four-wheel drive. Forward and backward movement changes between HIGH and LOW.

TROUBLESHOOTING

Possible causes \ Symptoms		Noise while cruising	Gears fail to engage at front drive changeover	Gears fail to engage at HIGH/LOW changeover	Gears slip out while cruising in front drive	Gears slip out while cruising	Gears fail to disengage on front drive changeover	Gears fail to disengage on HIGH/LOW changeover	Front drive is engaged, but indicator is not lit	LOW is selected, but indicator is not lit	Front drive is not engaged, but indicator is lit	LOW is not selected, but indicator is lit
Transfer body faulty	Front drive shaft and constant sleeve splines worn				○							
	Hub and HIGH/LOW constant sleeve splines worn					○						
	Idler shaft bearing worn or damaged	○										
	Output shaft bearing worn or damaged	○										
	Drive shaft needle bearing worn or damaged	○										
	Gears damaged	○										
	Output shaft LOW gear and HIGH gear backlash excessive	○										
	Gear oil insufficient	○										
	Gear oil viscosity unsuitable	○										
	Constant sleeve and dog clutch cracked		○		○							
	HIGH/LOW constant sleeve and hub cracked			○		○						
Control mechanism faulty	Shift rail bent		○	○								
	Shift rail friction movement poor				○	○						
	Shift fork bent		○	○								
	Shift fork claw worn		○	○								
	Steel ball and shift rail poppet groove worn					○						
	Poppet spring fatigued or cracked							○				
Transfer control system faulty	Control cable faulty		○	○			○	○				
	LOW switch faulty									○		○
	Transfer four-wheel drive switch faulty								○		○	
	Wiring broken or connection poor								○	○		

M E M O

REMOVAL AND INSTALLATION OF TRANSFER ASSEMBLY



● **Disassembly sequence**

1 Bolt
2 Air breather
3 Needle bearing
4 Transfer input rear cover
5 Lock nut
6 O-ring
7 Drive shaft gear
8 Bolt < M/T >
9 Bolt
10 Oil seal < M/T >
11 Spacer < A/T >
12 Bearing < A/T >
13 Transfer drive shaft < A/T >
14 Transfer assembly 📖 P24-10, 16
15 Distance pipe < M/T >
16 Bolt < M/T >
17 Extension spacer < M/T >
18 Bolt < A/T >
19 Oil seal < A/T >
20 Transfer front case < A/T >

A : Positioning pins
***a** : Manual Transmission
***b** : Automatic Transmission
M/T : Manual Transmission
A/T : Automatic Transmission
⊗ : Non-reusable parts
Ⓣ : Tightening Torque

NOTE

- **For removal from vehicle, see 📁 Gr 11A, B.**
- **Check backlash of drive shaft gear 7 before disassembly.**
- **Do not remove needle bearing 3 from transfer input rear cover 4 unless it is faulty.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Check backlash when assembling parts.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
7, 14	Drive shaft gear and transfer idler gear backlash	0.08 to 0.22 {0.0031 to 0.0087}	0.50 {0.020}	—

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

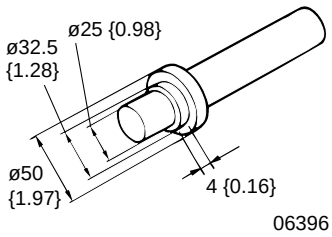
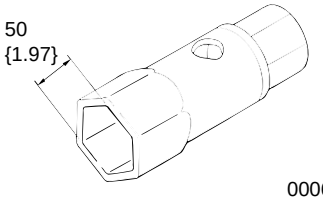
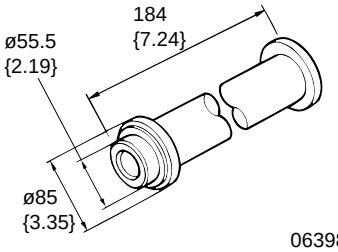
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Transfer input rear cover mounting)	44 {33, 4.5}	—
5	Lock nut tightening torque	490±49 {360±36, 50±5}	—
8	Bolt (Transfer assembly mounting)	44 {33, 4.5}	—
9	Bolt (Transfer assembly mounting)	44 {33, 4.5}	—
16	Bolt (Extension spacer mounting)	44 {33, 4.5}	—
18	Bolt (Transfer front case mounting)	44 {33, 4.5}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
***a**	Mounting surface of extension spacer transmission assembly	THREEBOND 1215	As required
***b**	Mounting surface of transfer front case automatic transmission	THREEBOND 1215	As required
1	Thread area of pierce bolt	THREEBOND 1104J	As required
4	Mounting surface of transfer assembly transfer input rear cover	THREEBOND 1215	As required
10	Lip area of oil seal and transfer assembly	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Mounting surface of transfer assembly extension spacer	THREEBOND 1215	As required
20	Mounting surface of transfer assembly transfer front caser	THREEBOND 1215	As required

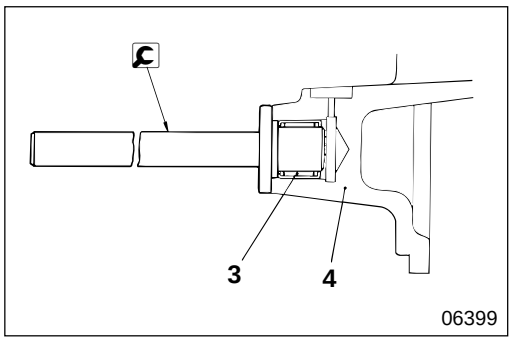
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Needle roller bearing installer 	MH061926	Installation of input rear cover needle bearing
5	Socket wrench 	N/A	Removal and installation of transmission main shaft lock nut
10	Oil seal installer 	MH061924	Installation of oil seal

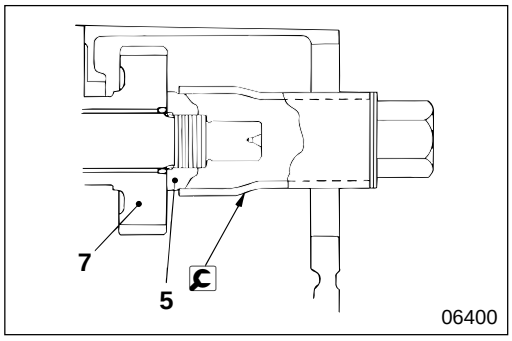
REMOVAL AND INSTALLATION OF TRANSFER ASSEMBLY

◆ Service procedure



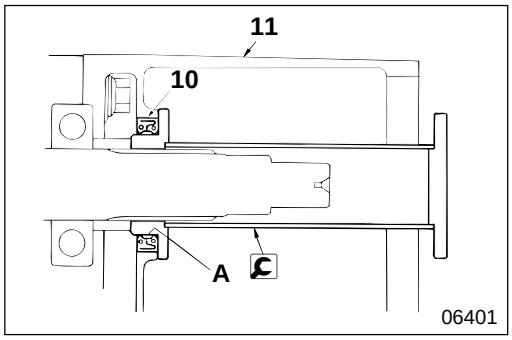
3 **Installation of needle bearing**

: Needle roller bearing installer



5 **Removal and installation of lock nut**

: Socket wrench



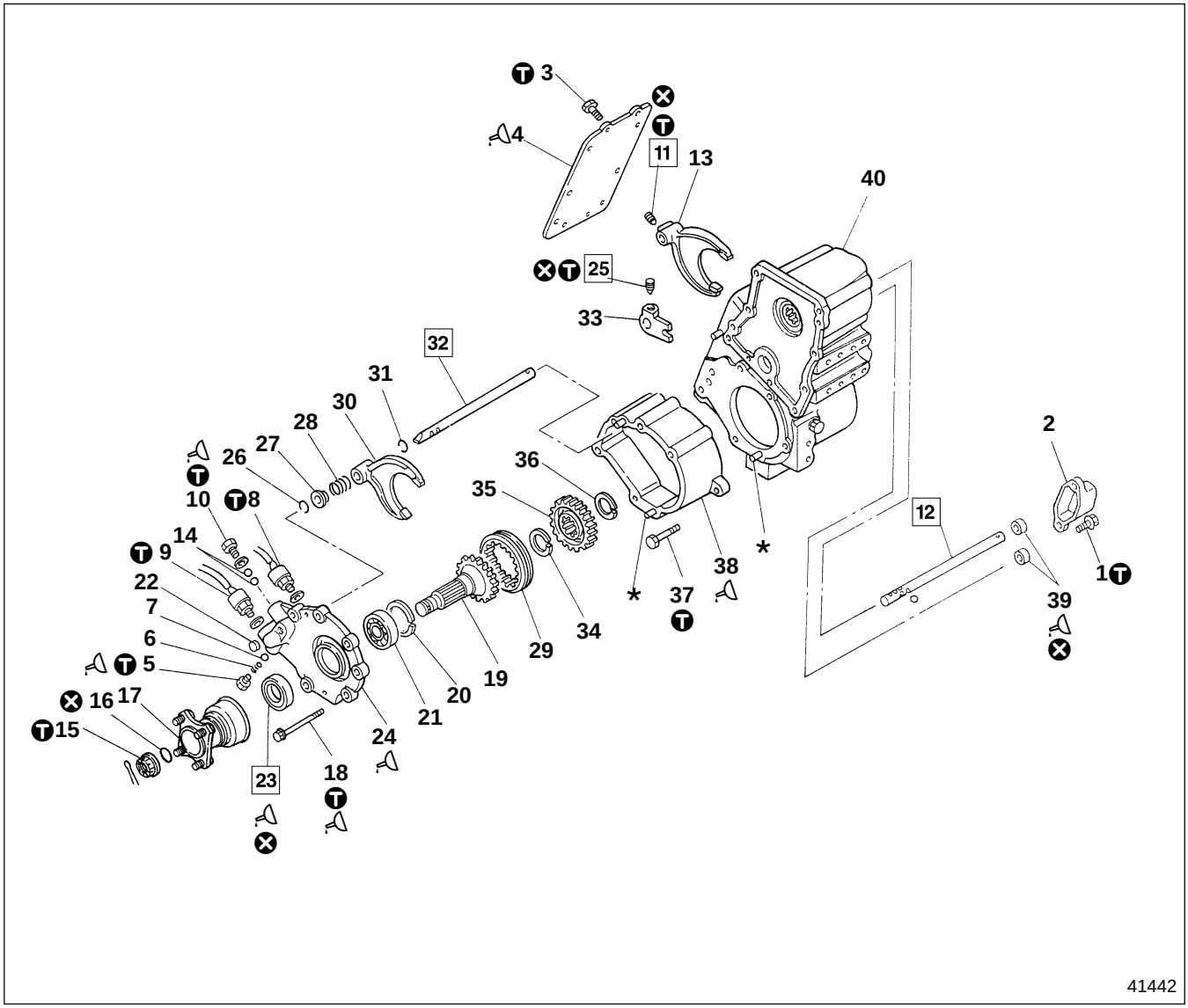
10 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **10**, and press-fit it.

: Oil seal installer

M E M O

FRONT DRIVE



● **Disassembly sequence**

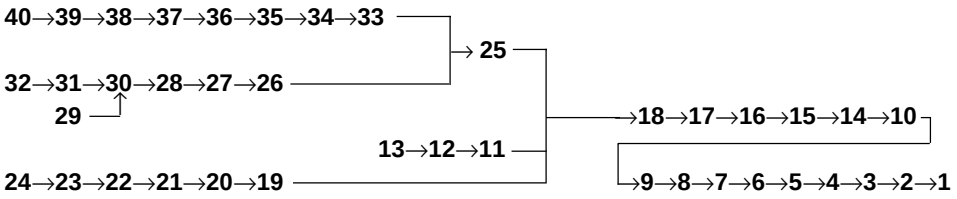
1 Bolt
2 Shift rail cover
3 Bolt
4 Transfer case side cover
5 Screw plug
6 Poppet spring
7 Steel ball
8 Transfer LOW switch
Gr 54
9 Transfer four-wheel drive switch Gr 54
10 Screw plug
11 Set bolt
12 HIGH/LOW shift rail
13 HIGH/LOW shift fork
14 Interlock ball
15 Lock nut
16 O-ring
17 Companion flange
18 Bolt
19 Front drive shaft
20 Snap ring
21 Bearing
22 Dust cap
23 Oil seal
24 Front drive case cover
25 Set bolt
26 Snap ring
27 Retainer
28 Spring
29 Synchronizer sleeve
30 Front drive shift fork
31 Snap ring
32 Front drive shift rail
33 Shift rail stopper
34 Snap ring
35 Front drive hub
36 Snap ring
37 Bolt
38 Front drive case
39 Oil seal
40 Transfer assembly

*: Dowel pin
⊗: Non-reusable parts

NOTE

HIGH and LOW shift rail 12 cannot be disassembled unless front drive shift rail 32 is set to front drive ON.

● **Assembly sequence**



Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6	Poppet spring free length	24.85 {0.98}	24.00 {0.94}	Replace
12	Deflection of HIGH/LOW shift rail	0.02 {0.00079} or less	0.03 {0.0012}	Correct or replace
12, 40	Clearance between HIGH/LOW shift rail and transfer assembly rail hole	[16 {0.63}] 0.05 to 0.09 {0.0020 to 0.0035}	0.2 {0.0079}	Replace faulty parts
13	Tilt of claw against HIGH/LOW shift fork hole	0.1 {0.0039} or less	0.2 {0.0079}	Replace
13, 29	Clearance between HIGH/LOW shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace faulty parts
29, 30	Clearance between front drive shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace faulty parts
30	Tilt of claw against front drive shift fork hole	0.1 {0.0039} or less	0.2 {0.0079}	Replace faulty parts
32	Front drive shift rail deflection	0.02 {0.00079} or less	0.03 {0.0012}	Correct or replace
32, 40	Clearance between front drive shift rail and transfer assembly rail hole	[16 {0.63}] 0.05 to 0.09 {0.0020 to 0.0035}	0.2 {0.0079}	Replace faulty parts

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

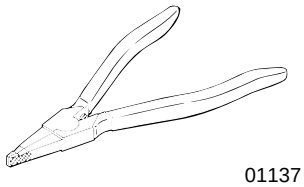
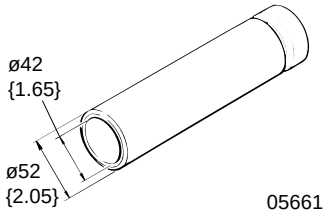
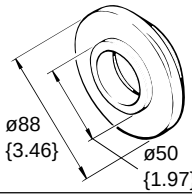
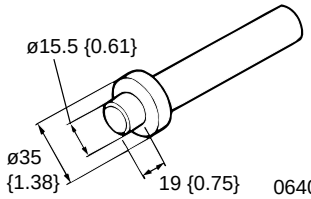
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Shift rail cover mounting)	44 {33, 4.5}	—
3	Bolt (Transfer case side cover mounting)	24 {17, 2.4}	—
5	Screw plug tightening	39 {29, 4}	—
8	Transfer LOW switch tightening	34±4.9 {25±3.6, 3.5±0.5}	—
9	Transfer four-wheel drive switch tightening	34±4.9 {25±3.6, 3.5±0.5}	—
10	Screw plug tightening	39 {29, 4}	—
11	Set bolt (Shift fork mounting)	29 {22, 3}	Stake at three points after tightening
15	Lock nut tightening	295±49 {215±36, 30±5}	—
18	Bolt (Front drive case cover mounting)	44 {33, 4.5}	—
37	Bolt (Front drive case mounting)	44 {33, 4.5}	—

Lubricant and/or sealant

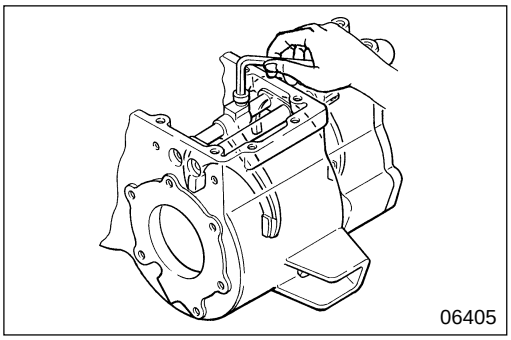
Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Mounting surface of transfer assembly transfer case side cover	THREEBOND 1215	As required
5	Thread area of screw plug	THREEBOND 1215	As required
10	Thread area of screw plug	THREEBOND 1215	As required
18	Thread area of pierce bolt	THREEBOND 1104J	As required
23	Pack between lips of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
24	Mounting surface of front drive case front drive case cover	THREEBOND 1215	As required
38	Mounting surface of transfer assembly front drive case	THREEBOND 1215	As required
39	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

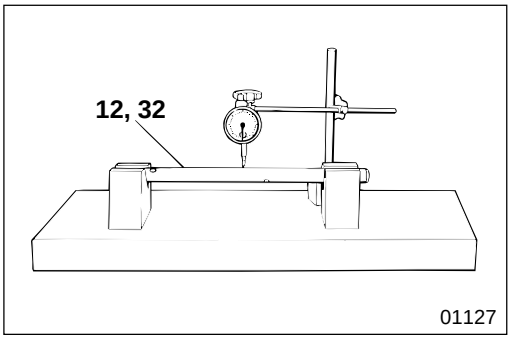
Location	Tool name and shape	Part No.	Application
20, 26, 34	Snap ring expander  01137	MH061268 (Obtain Locally)	Removal and installation of snap ring
23	Bearing installer  05661	MB999104	Installation of front drive case cover oil seal
	Differential bearing inner race installer adapter  05667	MB999105	
39	Oil seal installer  06404	MH061923	Installation of shift rail oil seal

◆ Service procedure



11 **25** **Removal and installation of set bolt**

Tighten shift fork mounting set bolt **11, 25** at specified torque, and stake the thread area at three points using a punch.

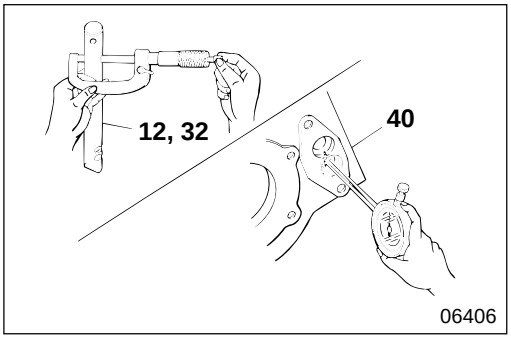


12 **32** **Inspection of shift rail**

If the measured value is higher than the limit, correct or replace shift rails **12**, **32**.

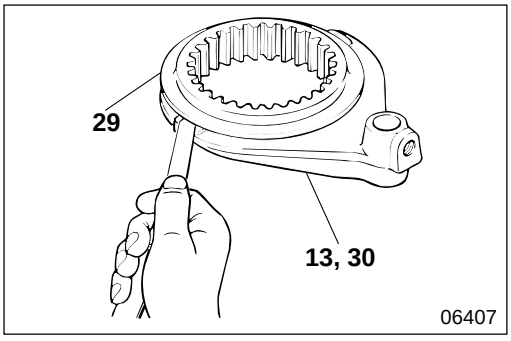
NOTE

To measure the deflection of shift rails 12, 32, turn them one full revolution and read the dial gauge indicator. The deflection is one half of the indicated value.



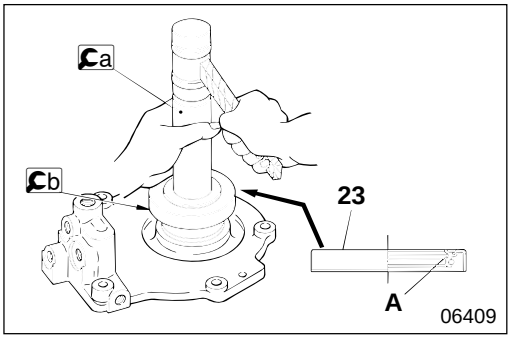
12 **32** **40** **Clearance between shift rail and transfer assembly rail hole**

Measure the outer diameter of shift rail **12**, **32** and the inner diameter of transfer assembly hole **40**. If the clearance is higher than the limit, replace faulty parts.



13 **29** **30** **Clearance between shift fork and synchronizer sleeve**

If the measured value is higher than the limit, replace faulty parts.

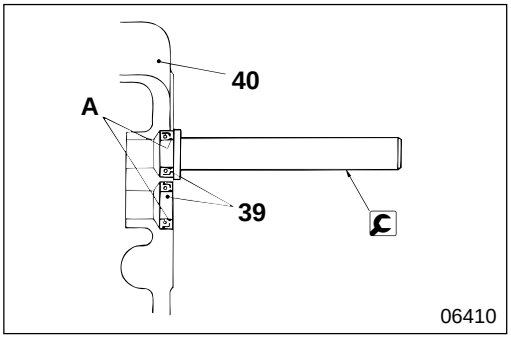


23 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **23**, and press-fit it.

a : Bearing installer

b : Differential bearing inner race installer adapter



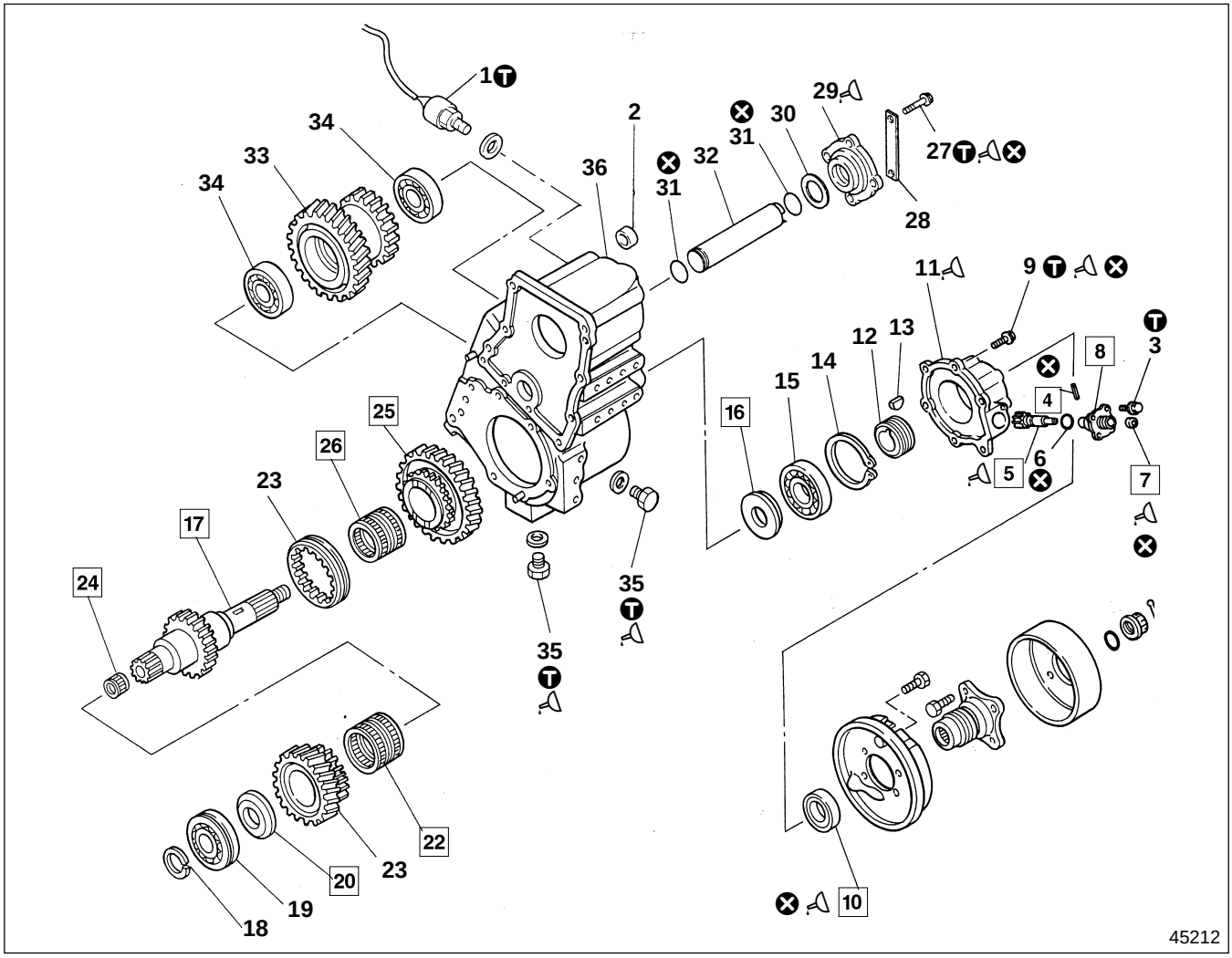
39 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **39** and press-fit it into transfer assembly **40**.

: Oil seal installer

M E M O

IDLER GEAR AND REAR DRIVE



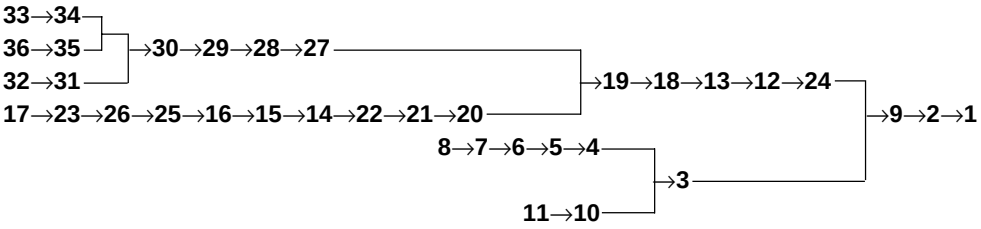
● **Disassembly sequence**

1 1st/reverse check switch < Manual transmission >
2 Dust plug < Manual transmission >
3 Bolt
4 Spring pin
5 Speedometer gear
6 O-ring
7 Oil seal
8 Speedometer gear bushing
9 Bolt
10 Oil seal
11 Output rear cover
12 Speedometer worm
13 Key
14 Snap ring
15 Bearing
16 Thrust washer
17 Rear drive shaft
18 Snap ring
19 Bearing
20 Thrust washer
21 Rear drive shaft HIGH gear
22 Needle bearing
23 Synchronizer sleeve
24 Needle bearing
25 Rear drive shaft LOW gear
26 Needle bearing
27 Bolt
28 Plate
29 Idler rear cover
30 Shim
31 O-ring
32 Transfer idler shaft
33 Transfer idler gear
34 Bearings
35 Drain plug, inspection plug
36 Transfer case

⊗ : Non-reusable parts

NOTE
- **Check backlash and end play of gears before disassembly.**
- **Do not remove needle bearing 24 from rear drive shaft 17 unless it is faulty.**

● **Assembly sequence**



NOTE
- **Check backlash and end play when assembling parts.**
- **Check friction and rotation movements when assembling rotating parts.**

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
—	Starting torque of transfer idler gear	0 to 2 {0 to 1.45, 0 to 0.2}	—	Adjust shim
5, 8	Clearance between speedometer gear and speedometer gear bushing	[12] 0.04 to 0.09 {[0.47] 0.0016 to 0.0035}	0.15 {0.0059}	Replace
17, 21, 22	Play of rear drive shaft HIGH gear in diameter direction after assembly	0.02 to 0.06 {0.00079 to 0.0024}	0.12 {0.0047}	Replace faulty parts
17, 25, 26	Play of rear drive shaft LOW gear in diameter direction after assembly	0.02 to 0.06 {0.00079 to 0.0024}	0.12 {0.0047}	Replace faulty parts
21	End play of rear drive shaft HIGH gear	0.25 to 0.40 {0.0098 to 0.0016}	0.60 {0.024}	Replace thrust washer or gear
21, 33	Backlash between rear drive shaft HIGH gear and transfer idler gear	0.08 to 0.22 {0.0031 to 0.0087}	0.50 {0.020}	Replace
23	Clearance between synchronizer sleeve groove and HIGH/LOW shift fork	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace faulty parts
25	End play of rear drive shaft LOW gear	0.25 to 0.40 {0.0098 to 0.016}	0.60 {0.024}	Replace thrust washer or gear
25, 33	Backlash between rear drive shaft LOW gear and transfer idler gear	0.08 to 0.24 {0.0031 to 0.0094}	0.50 {0.020}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	1st/reverse check switch	34±4.9 {25±3.6, 3.5±0.5}	—
3	Bolt (Speedometer gear bushing mounting)	24 {17, 2.4}	—
9	Bolt (Output rear cover mounting)	44 {33, 4.5}	—
27	Bolt (Plate and idler rear cover mounting)	44 {33, 4.5}	—
35	Drain plug and inspection plug tightening	69±15 {51±11, 7.0±1.5}	—

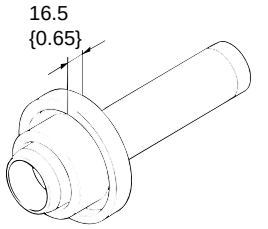
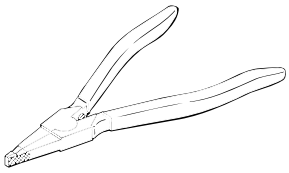
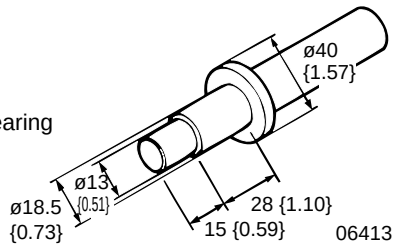
IDLER GEAR AND REAR DRIVE

Lublicant and/or sealant

Location	Points of application	Specified lublicant and/or sealant	Quantity
5	Friction surfaces between speedometer gear and speedometer gear bushing	Molybdenum disulfide grease	As required
7	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Thread area of bolt	THREEBOND 1104J	As required
10	Pack between lips of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
11	Mounting surface of transfer case output rear cover	THREEBOND 1215	As required
27	Thread area of bolt	THREEBOND 1104J	As required
29	Mounting surface of transfer case idler rear cover	THREEBOND 1215	As required
35	Thread area of drain plug and inspection plug	THREEBOND 1105D	As required

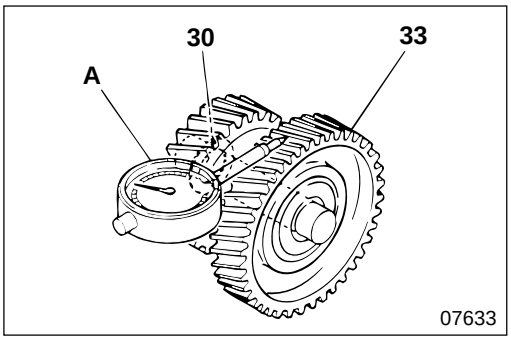
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
10	Oil seal installer  06252	MH062691	Installation of output rear cover oil seal
14	Snap ring expander  01137	MH061268 (Obtain Locally)	Removal and installation of snap rings
24	Needle roller bearing installer  06413	MH061927	Installation of rear drive shaft needle bearing

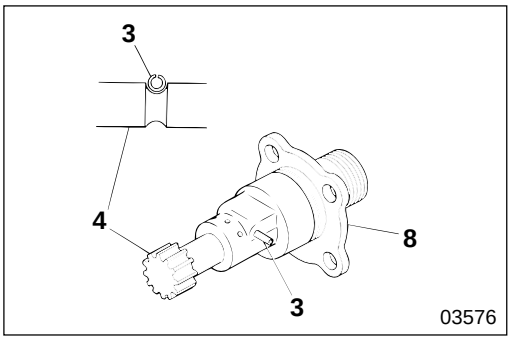
◆ Service procedure

Inspection before service



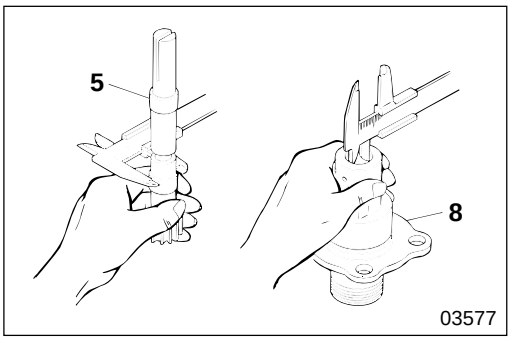
● **Starting torque of transfer idler gear**

- Disassemble parts, and measure the torque with push gauge **A** leaving only transfer idler gear **33** in transfer case.
  If the value deviates from the standard value, adjust it using shim **30**.
- On assembly, also check that starting torque is within the standard value range using the same method.
- Shim **30** is available in four thicknesses : 0.01 mm {0.00039 in.}, 0.02 mm {0.00079 in.}, 0.03 mm {0.0012 in.}, 0.06 mm {0.0024 in.}.



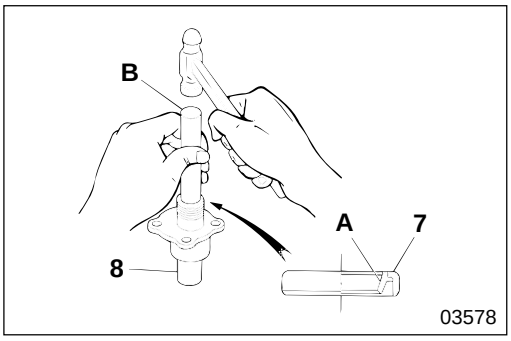
4 **Driving-in spring pin**

Drive spring pin **4** into speedometer gear bushing **8** with the opening in the opposite direction to speedometer gear **5**.



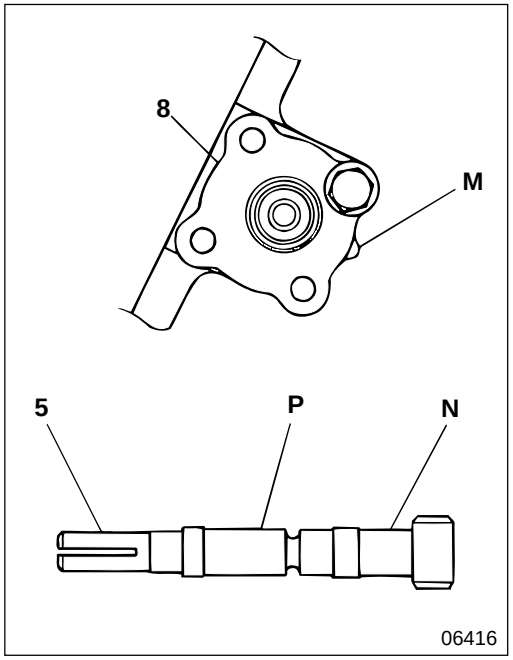
5 **8** **Clearance between speedometer gear and speedometer gear bushing**

If the clearance is higher than the limit, replace the faulty parts.



7 **Installation of oil seal**

Apply grease to lip area **A** of the inner rim of the oil seal, **7** and press-fit oil seal evenly into speedometer gear bushing **8** in the direction as illustrated using bar **B** (approximately ø15 mm {0.59 in.}).

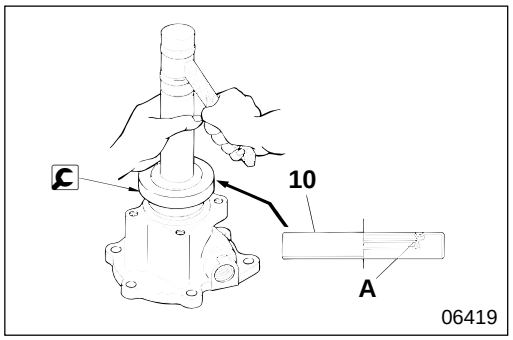


8 **Installation of speedometer gear bushing**

Due to its eccentric center arrangement, speedometer gear bushing **8** allows replacement of speedometer gear **5** with gears having a different number of teeth by changing only the installation direction, the worm gear does not have to be changed.
When installing the bushing, align the stamped number, identical to the number of speedometer gear teeth, with alignment mark **M** of output rear cover **11**.
The number of speedometer gear teeth can be identified by the identification marks stamped on **N** or **P**.

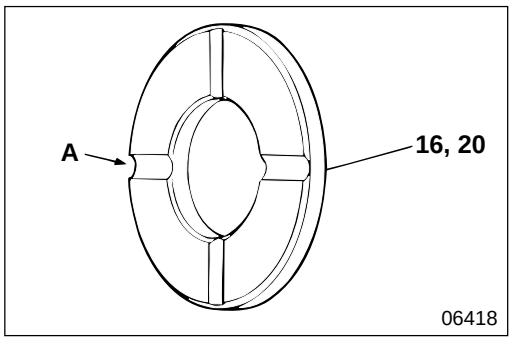
Identification mark and number of speedometer gear teeth

Identification mark	A	B	C	D	E	F	G	H	I	J	K	L
Number of teeth	15	16	17	18	19	20	21	22	23	24	25	26
Gear ratio	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2



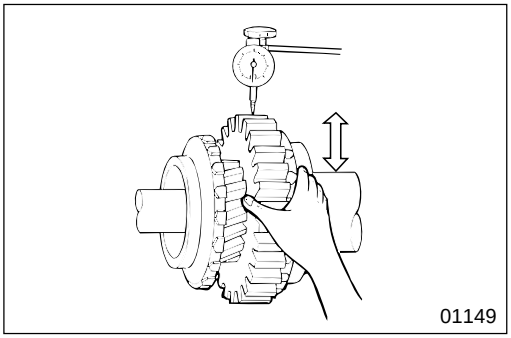
10 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **10** and press-fit it into output rear cover **11**.



16 **20** **Installation of thrust washer**

Install thrust washer **16**, **20** with oil groove **A** facing gear side.

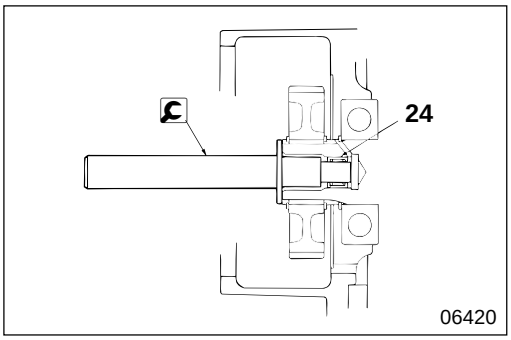


17 **20** **22** **25** **26** **Play of rear drive shaft gear in diameter direction after assembly**

If the measured value is higher than the limit, replace faulty parts.

NOTE

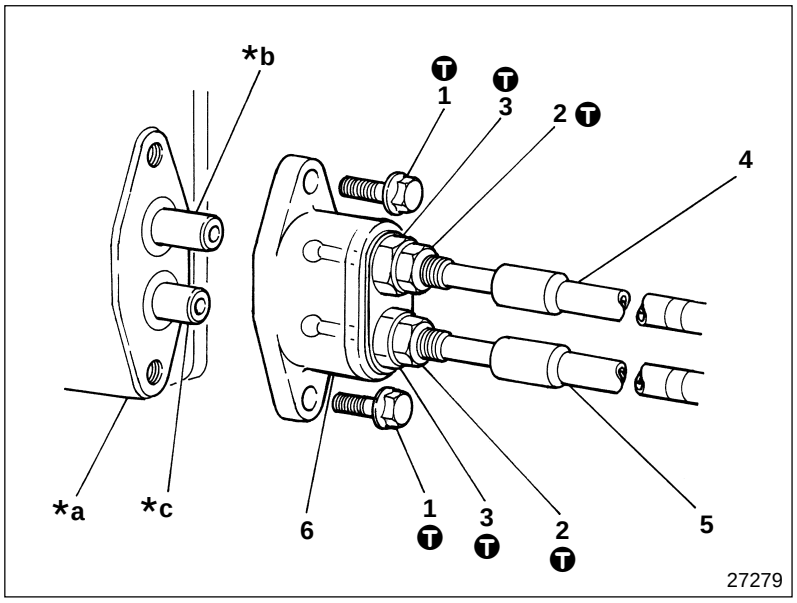
When replacing needle bearing 22, 26, use bearings from the same color package.



24 **Installation of needle bearing**

: Needle roller bearing installer

Control Cable < Removal from the transfer side >



● **Work before removal**

P24-22

● **Removal sequence**

1 Bolt
2 Nut
3 Nut
4 HIGH/LOW control cable
5 2H/4H control cable
6 Shift rail cover

***a** : Transfer body
***b** : HIGH/LOW shift rail
***c** : Front drive shift rail

● **Installation sequence**

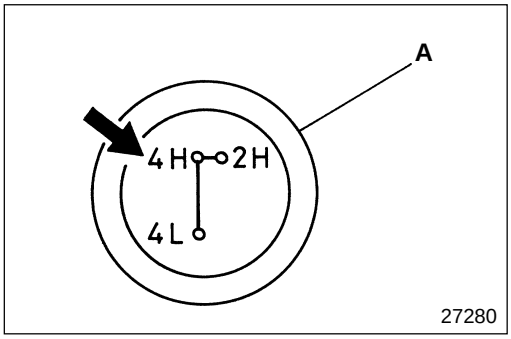
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

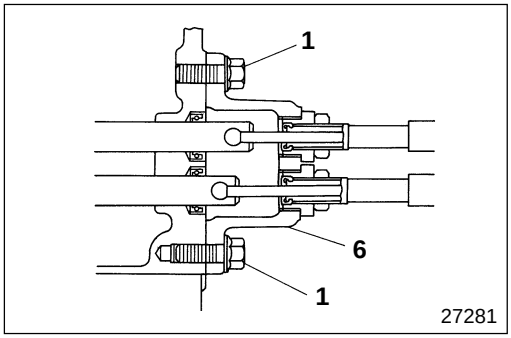
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Shift rail cover mounting)	44 {33, 4.5}	—
2, 3	Nut (HIGH/LOW and 2H/4H control cable mounting)	44 to 59 {33 to 43, 4.5 to 6.0}	—

◆ Service procedure



● **Work before removal**

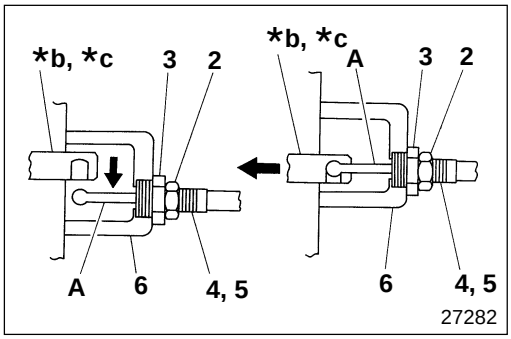
When removing, move shift lever knob **A** of the transfer control bar to the position of 4H.



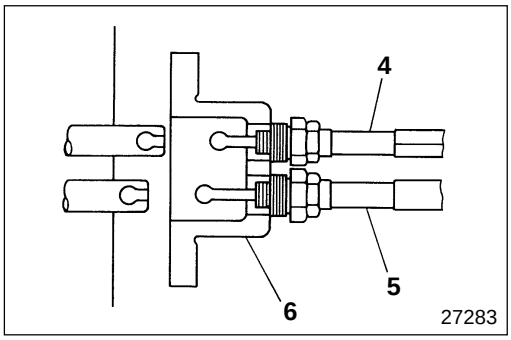
4 **5** **HIGH/LOW, 2H/4H Control Cable**

[Removal]

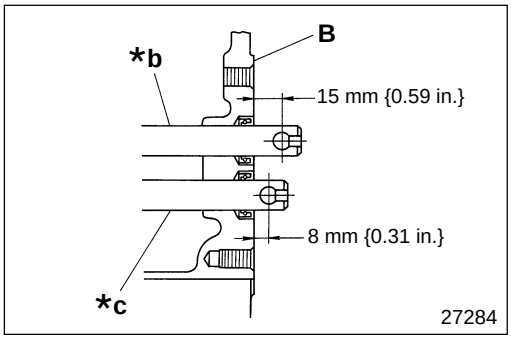
- Remove bolt **1** securing shift rail cover **6**.



- Remove shift rail cover **6**, and then remove inner cable **A** of HIGH/LOW and 2H/4H control cables **4** and **5**, from HIGH/LOW shift rail ***b**, and front drive shift rail ***c**. Loosen nuts **2** and **3** to the end of their threads.

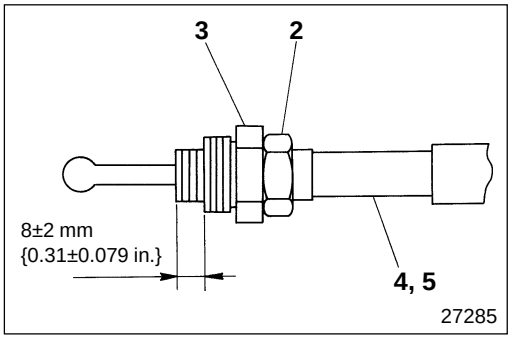


- Remove HIGH/LOW and 2H/4H control cables **4** and **5** from shift rail cover **6**.

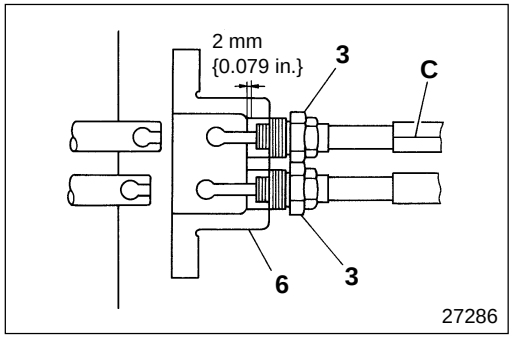


[Installation]

- Position HIGH/LOW shift rail ***b** and front drive shift rail ***c** as shown.
  B : Transfer end face



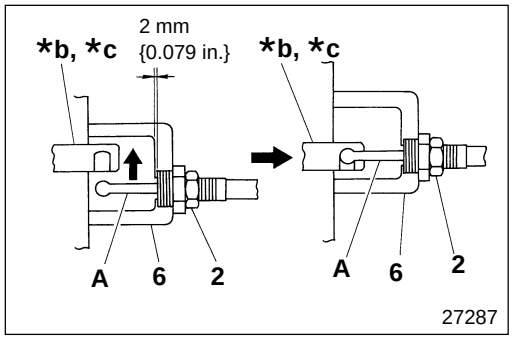
- Adjust nuts **2** and **3** to the end of the thread to align the end of HIGH/LOW and 2H/4H control cables **4** and **5** as shown.



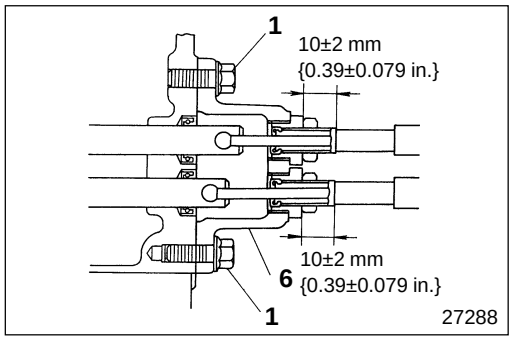
- Screw nut **3** into shift rail cover **6** and tighten it to the specified torque.

CAUTION⚠

- **Ensure that the HIGH/LOW and four-wheel / two-wheel drive control cables are not positioned incorrectly. The cable with the white line C is for HIGH/LOW.**
- **After installation, the end of nut 3 should be located 2 mm {0.079 in.} from the front face of shift rail cover 6.**



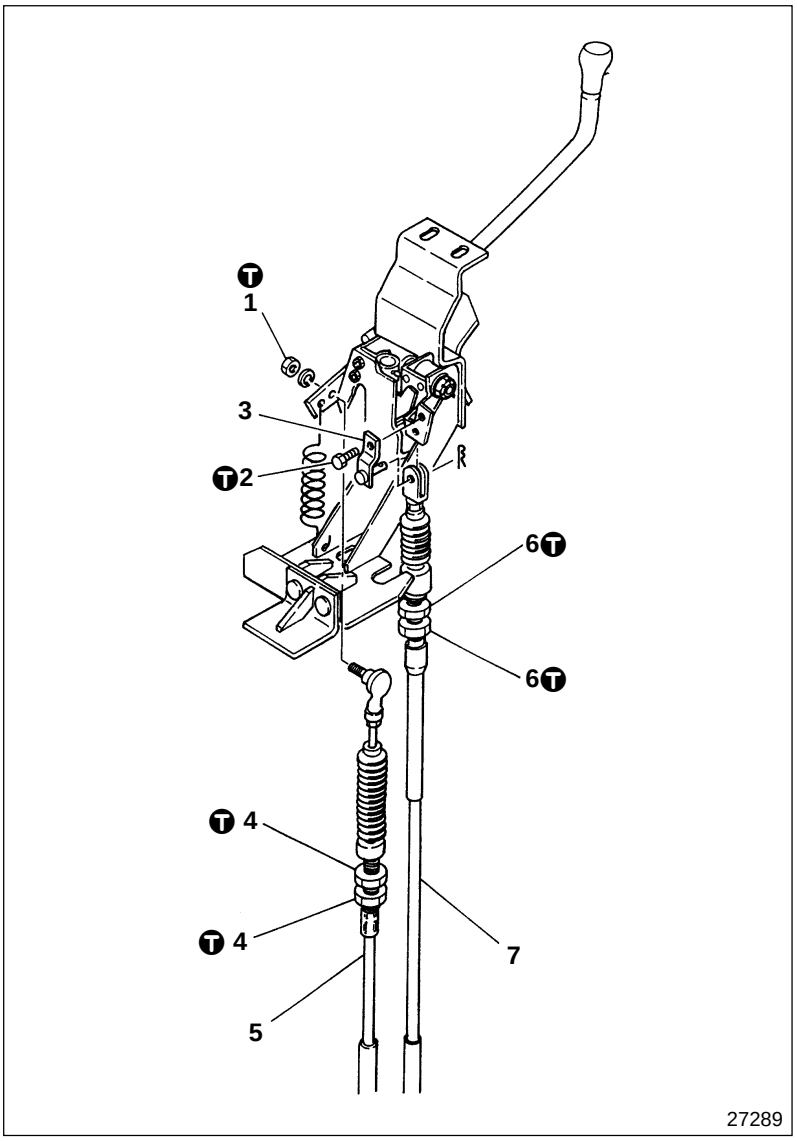
- Tighten the nut with its specified torque and lock it with nut **3**. Then slide the shift rail cover **6** and install the inner cable **A** to HIGH/LOW shift rail ***b** and front drive shift rail ***c**.



- Tighten shift rail cover **6** installation bolt **1** at the specified torque.

M E M O

Control cable < Removal from the transfer control cable side >



● **Removal Sequence**

1 Nuts
2 Bolt
3 Lock pin
4 Nuts
5 HIGH/LOW control cable
6 Nut
7 2H/4H control cable

● **Installation sequence**

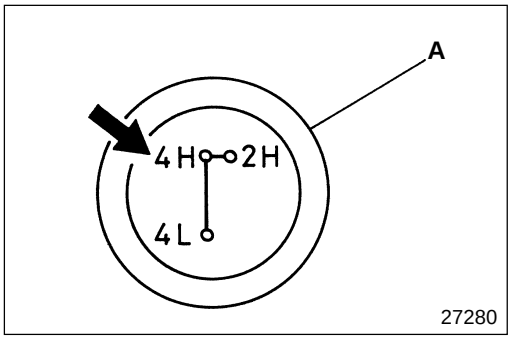
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

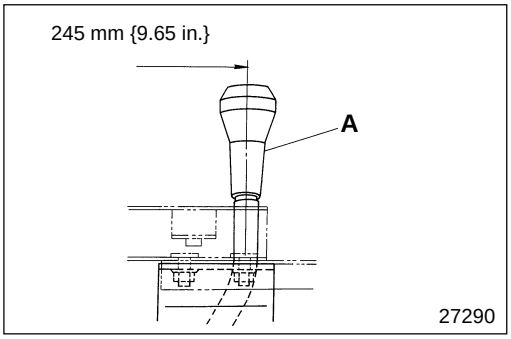
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (HIGH/LOW control cable mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
2	Bolt (2H/4H control cable mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
4, 6	Nut (HIGH/LOW control cable and 2H/4H control cable mounting)	44 to 59 {33 to 43, 4.5 to 6.0}	—

◆ Service procedure

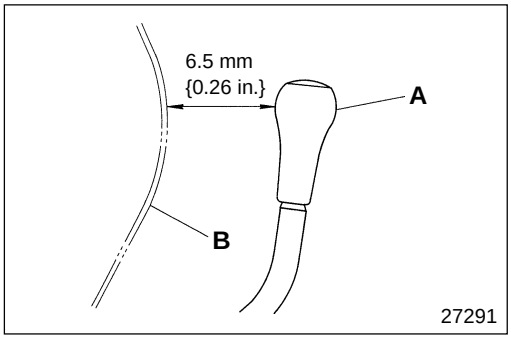


● Adjustment after installation

- Position shift lever **A** on position 4H.



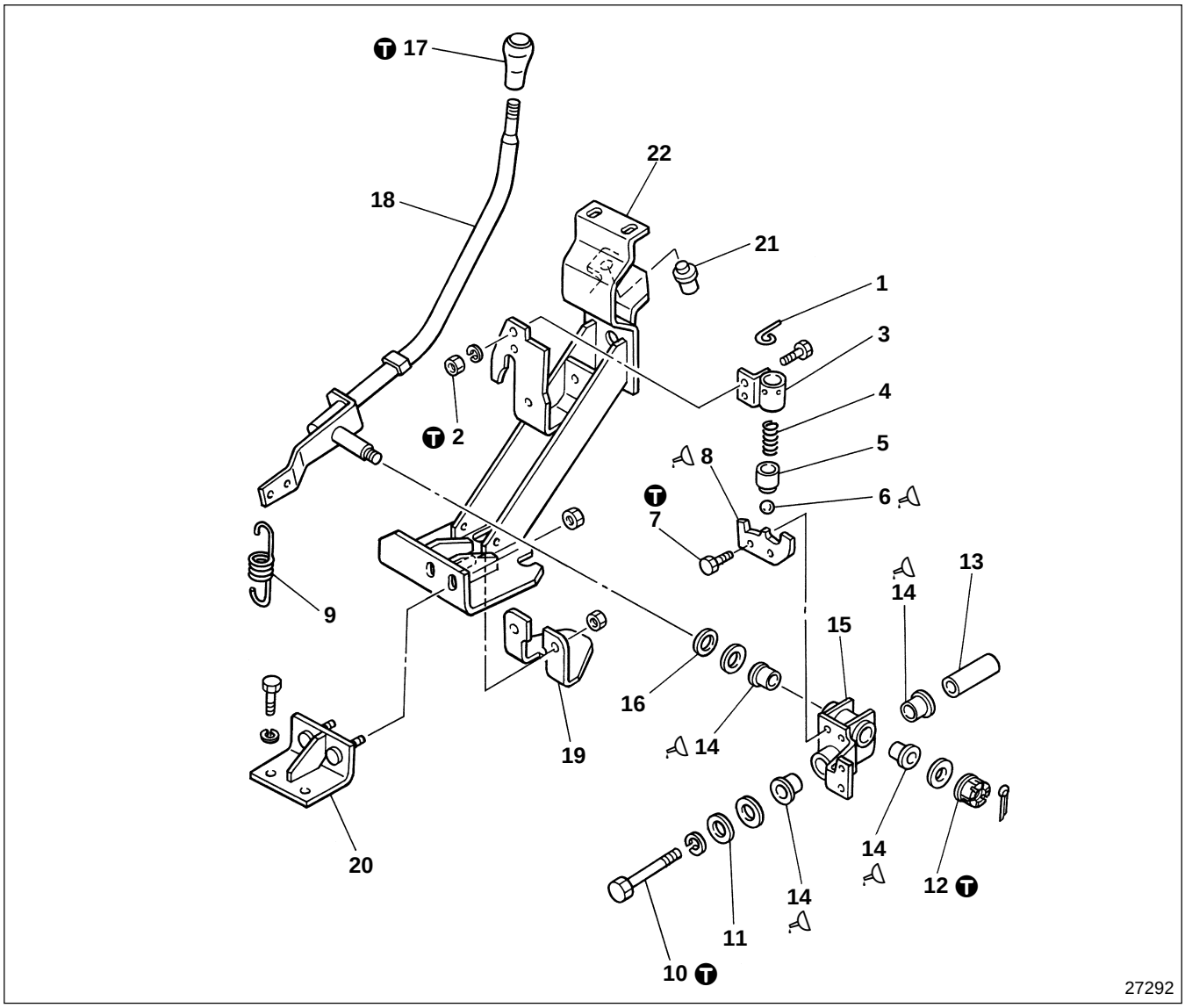
- Adjust the distance between the center of the steering wheel and center of the shift lever knob **A** using the nuts **6**.



- Adjust nuts **4** until the distance between shift lever **A** and the front face of inner panel **B** is equal to distance illustrated.

TRANSFER CONTROL

Transfer Control Level



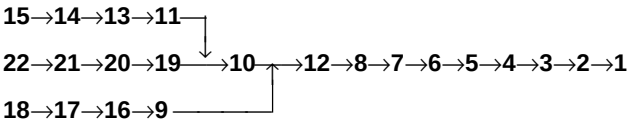
● **Disassembly sequence**

1	Pin	**9**	Spring	**17**	Shift lever knob
2	Nut	**10**	Bolt	**18**	Change lever assembly
3	Support holder	**11**	Conical spring	**19**	Bracket
4	Spring	**12**	Nut	**20**	Bracket
5	Ball supporter	**13**	Collar	**21**	Stopper
6	Steel ball	**14**	Bushings	**22**	Lever bracket
7	Bolt	**15**	Cross sleeve		
8	Detent plate	**16**	Conical spring		

CAUTION⚠

- **When removing pin 1, be careful that spring 4 does not fly out.**
- **When removing support holder 3, ensure that steel ball 6 is not dropped.**

● **Assembly sequence**



Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
9	Spring load (installation 133 {5.24})	46 N {10 lbf, 4.7 kgf}	41 N {9 lbf,4.2 kgf}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Support holder mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
7	Bolt (Detent plate mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
10	Bolt (Cross sleeve mounting)	8.8 to 13.7 {6.5 to 10.0, 0.9 to 1.4}	—
12	Nut (Change lever assembly mounting)	8.8 to 13.7 {6.5 to 10.1, 0.9 to 1.4}	—
17	Shift lever knob mounting	5.9±1.5 {4.3±1.08, 0.6±0.15}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
6	Apply grease all over the steel ball	Multipurpose type grease [NLGI No.2 (Li soap)]	As required
8	Apply grease all over detent plate	Multipurpose type grease [NLGI No.2 (Li soap)]	As required
14	Grease inside surface of bushing	Multipurpose type grease [NLGI No.2 (Li soap)]	As required

MITSUBISHI
FUSO

Group 25
Propeller Shaft

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-25

INDEX

SPECIFICATIONS 25- 2

STRUCTURE AND OPERATION 25- 3

TROUBLESHOOTING 25- 4

REMOVAL AND INSTALLATION OF PROPELLER SHAFT

< Transmission, transfer to rear axle > 25- 6

< Front axle to transfer > 25- 7

REAR PROPELLER SHAFT

< P2 : FG639 > 25- 8

< P2 : FG649 > 25-12

< P3 > 25-16

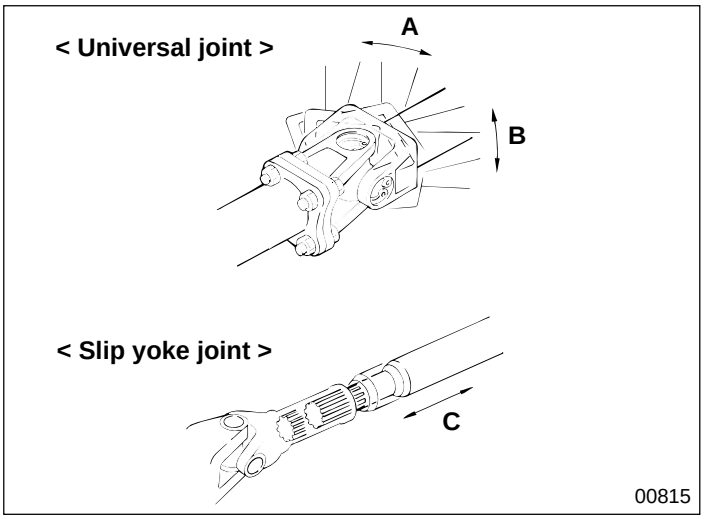
FRONT PROPELLER SHAFT 25-20

BALANCING PROPELLER SHAFT 25-24

SPECIFICATIONS

Item \ Model			P2	P3	
Pipe	Outer diameter×Wall thickness	mm {in.}	6.35×2.6 {2.50×0.10}	63.5×3.5{2.50×0.14}	82.6×2.3 {3.25×0.091}
Universal joint	Spider outer diameter	mm {in.}	19 {0.75}	21 {0.83}	
Needle bearing	Outer diameter	mm {in.}	2.5 {0.098}	3 {0.12}	
	Length	mm {in.}	13 {0.51}	15.3 {0.60}	
	No.		27	25	
Slip yoke joint	Spline diameter	mm {in.}	39 {1.54}	39 {1.54}	
Center bearing	Catalog No.		—	83A910CC3	
	Inner diameter×Outer diameter	mm {in.}	—	40×72 {1.57×2.83}	

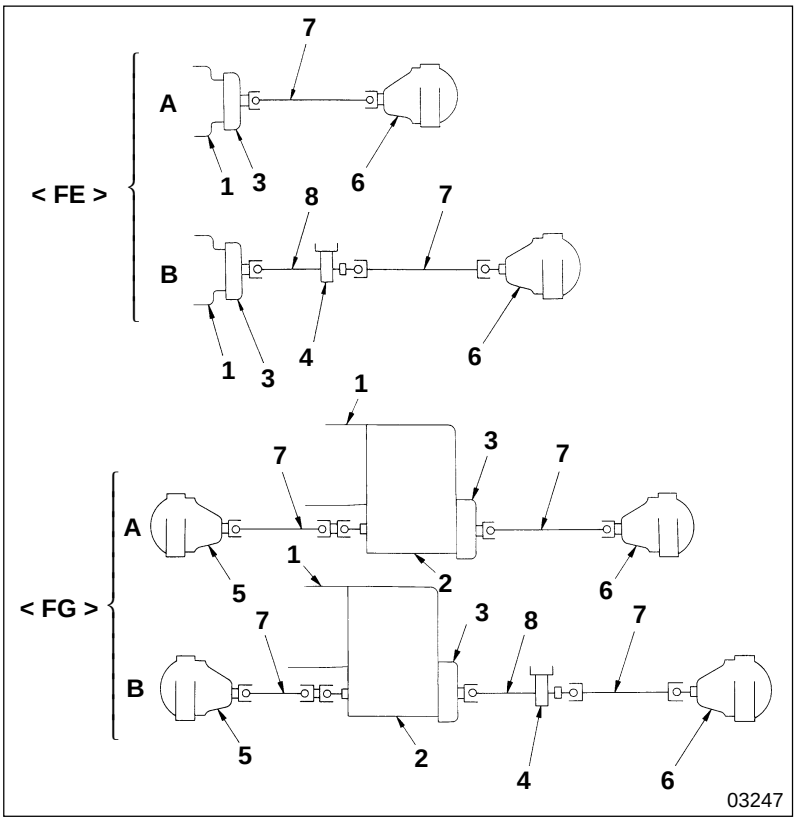
Swing of Propeller Shaft



A : Lateral swing
B : Longitudinal swing
C : Fore-and-aft movement

Relative positions of transmission, transfer, rear axle and front axle vary depending on the undulation of the road surface, and the vibration and load carried when operating the vehicle.
The universal joint and the slip yoke joint are provided to absorb these influences.

Configuration of Propeller Shaft Connection



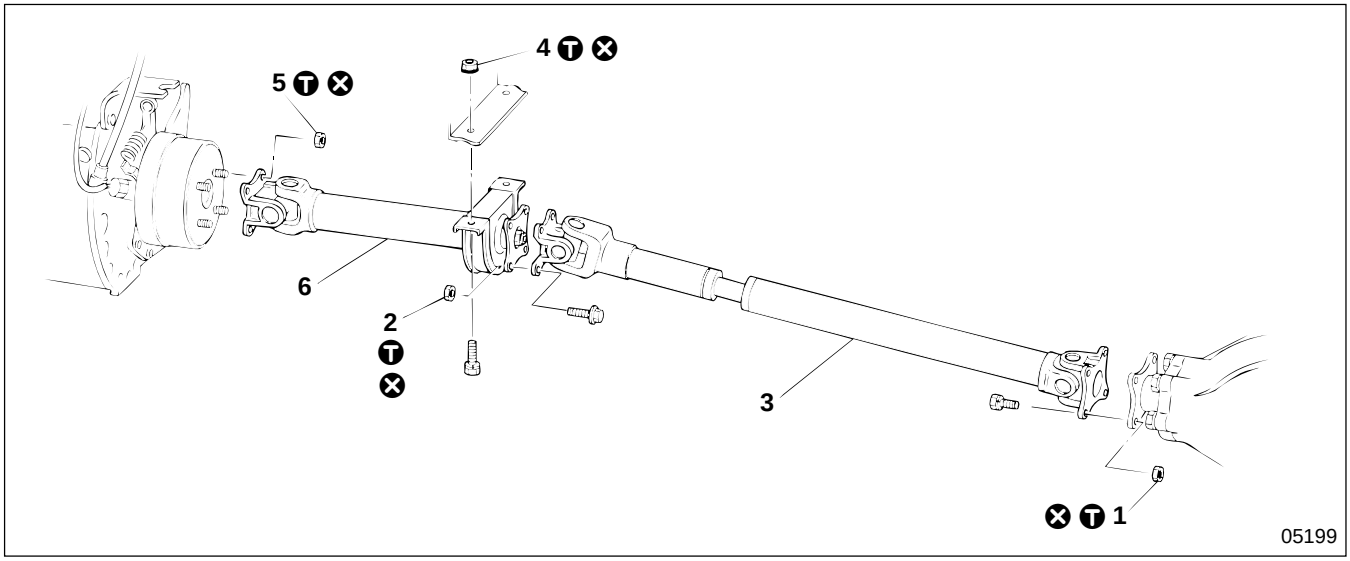
1 Transfer case
2 Transfer
3 Parking brake drum
4 Center bearing
5 Front axle
6 Rear axle
7 Rear propeller shaft
8 Front propeller shaft

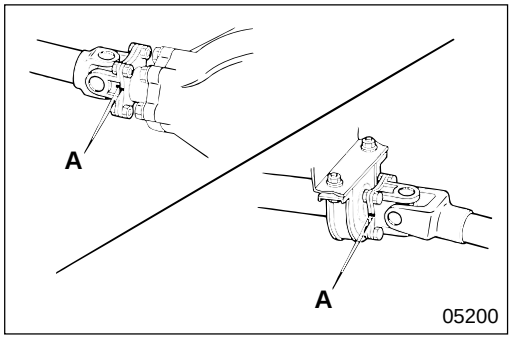
A : Single-shaft connection at rear
B : Twin-shaft connection at rear

TROUBLESHOOTING

Symptoms / Possible causes		Propeller shaft vibrating		Noise from propeller shaft		
		Vibration at high speed	Vibration at low speed	Noise when starting or while coasting	Noise during normal running	Clicking noise
Flange yoke assembly direction incorrect		○				
Companion flange tightening torque excessive						○
Slip yoke joint	Greasing insufficient				○	
	Spline play excessive		○	○		
Universal joint	Clearance in spider axial direction excessive		○		○	
	Needle bearing greasing insufficiently				○	
	Needle bearing worn	○		○	○	
Center bearing < Twin-shaft connection >	Greasing insufficient				○	
	Seized, worn, or rotation faulty	○			○	
	Cushion rubber fatigue or deformed			○		
	Hanger mounting bolt loose			○		
Propeller shaft	Mounting bolt loose	○		○		
	Bent	○				
	Dynamic balance adjusted incorrectly	○				
Transmission gear selection too high			○			

M E M O





◆ Service procedure

● **Work before removal**

WARNING ⚠

- **Since the propeller shaft will be removed, the parking brake cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**

Remember to make alignment marks **A** before removal.

● **Work before removal**

🕮 P25-6

● **Removal sequence**

1 Nut
2 Nut
3 Rear propeller shaft 🕮 P25-8
4 Nut
5 Nut
6 Front propeller shaft 🕮 P25-20

⊗ : Non-reusable parts

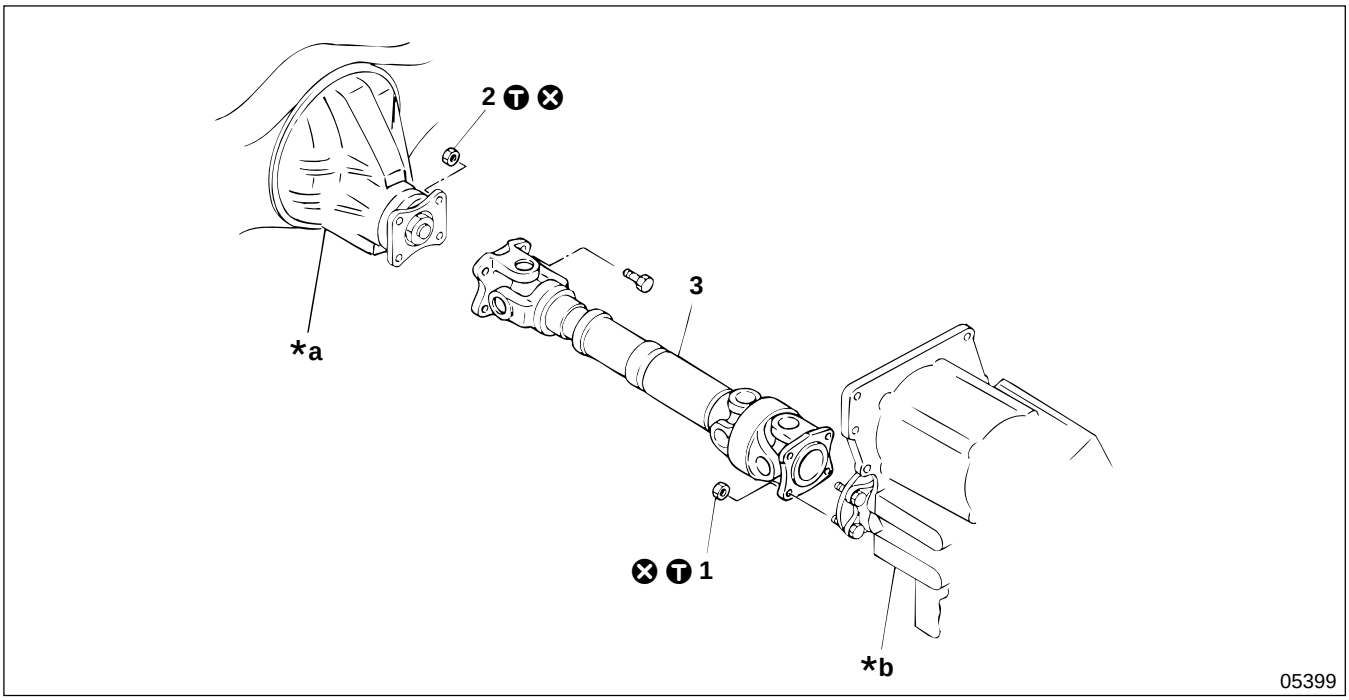
● **Installation sequence**

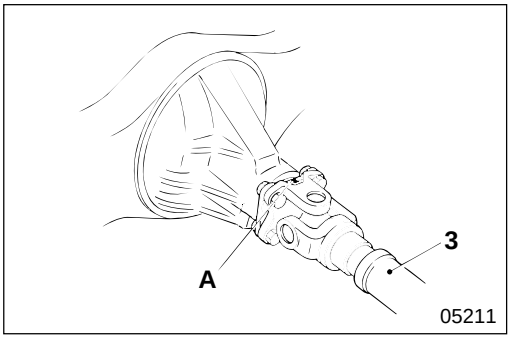
Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Rear axle side propeller shaft mounting)	98 to 120 {72 to 87, 10 to 12}	—
2	Nut (Center bearing side propeller shaft mounting)	98 to 120 {72 to 87, 10 to 12}	—
4	Nut (Front propeller shaft hanger mounting)	47 to 65 {35 to 48, 4.8 to 6.6}	—
5	Nut (Transmission side propeller shaft mounting)	98 to 120 {72 to 87, 10 to 12}	—





◆ Service procedure

● **Work before removal**

WARNING
- **Since the propeller shaft will be removed, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**

Remember to make alignment marks **A** before removal.

● **Work before removal**
P25-7

● **Removal sequence**

1 Nut
2 Nut
3 Rear propeller shaft
P25-8

***a** : Front axle
***b** : Transfer

⊗ : Non-reusable parts

● **Installation sequence**

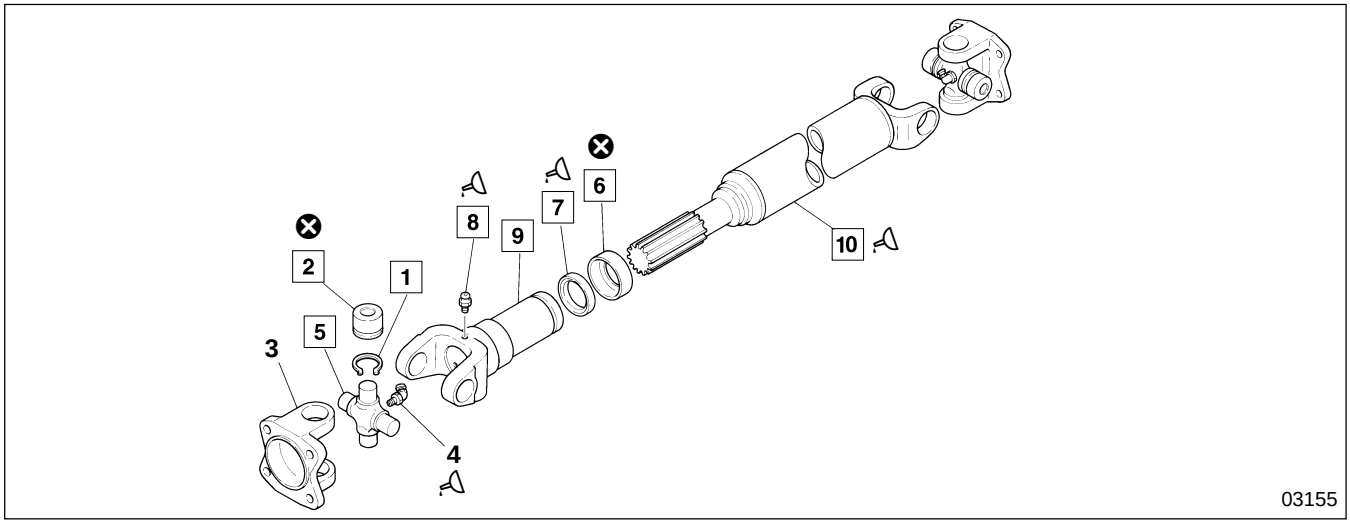
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Transfer side propeller shaft mounting)	59 to 74 {43 to 54, 6.0 to 7.5}	—
2	Nut (Front axle side propeller shaft mounting)	59 to 74 {43 to 54, 6.0 to 7.5}	—

REAR PROPELLER SHAFT < P2 : FG639 >



● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease nipple
5 Spider
6 Retainer packing
7 Sealed packing
8 Grease nipple
9 Slip yoke joint
10 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

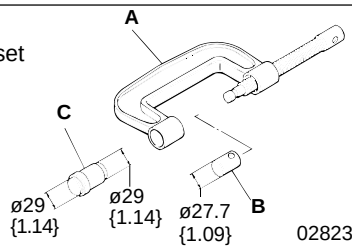
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 5	Clearance of spider in axial direction		0 to 0.06 {0 to 0.0024}	—	Adjust
2, 5	Clearance between needle bearing and spider		[19] 0.02 to 0.05 {[0.75] 0.00079 to 0.0020}	0.1 {0.00039}	Replace
9, 10	End play of slip yoke joint and rear propeller shaft splines	In rotation direction	0.01 to 0.09 {0.00039 to 0.0035}	0.3 {0.012}	Replace
		In diameter direction	0.02 to 0.16 {0.00079 to 0.0063}	0.3 {0.012}	Replace
10	Deflection of rear propeller shaft (Center)		—	0.4 {0.016}	Correct or replace

Lubricant

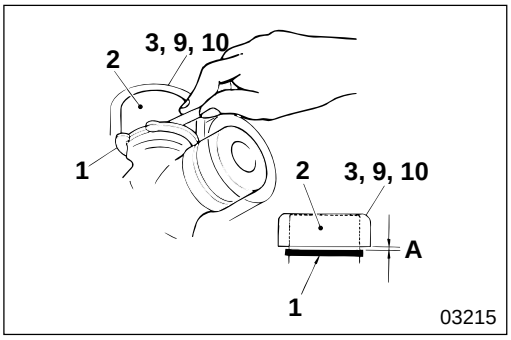
Location	Points of application	Kinds	Quantity
4	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from needle bearing oil seal
7	Sealed packing lip	Wheel bearing grease [NLGI No.2 (Li soap)]	—
8	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from dust plug
10	Spline of rear propeller shaft	Wheel bearing grease [NLGI No.2 (Li soap)]	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Universal joint tool set **A** : Yoke assembly **B** : Push rod **C** : Guide 	MB999024 **A** : MB999025 **B** : MB999026 **C** : MB999010 (Obtain Locally)	Removal and installation of needle bearing

◆ Service procedure

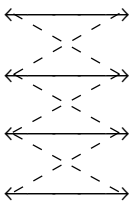


● Inspection before disassembly

Clearance in axial direction for spider

Press needle bearing **2** downward firmly, and measure clearance **A** between snap ring **1** and flange yoke **3**, slip yoke joint **9**, and rear propeller shaft **10**. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

< Available snap ring thicknesses and their combination : Combination indicated by solid line is preferred >

Part name	Thickness	Color identification mark	Combination	Thickness	Color identification mark
Snap ring	1.5 mm {0.059 in.}	None		1.5 mm {0.059 in.}	None
Snap ring	1.55 mm {0.061 in.}	Yellow		1.55 mm {0.061 in.}	Yellow
Snap ring	1.6 mm {0.063 in.}	Blue		1.6 mm {0.063 in.}	Blue
Snap ring	1.65 mm {0.065 in.}	Purple		1.65 mm {0.065 in.}	Purple

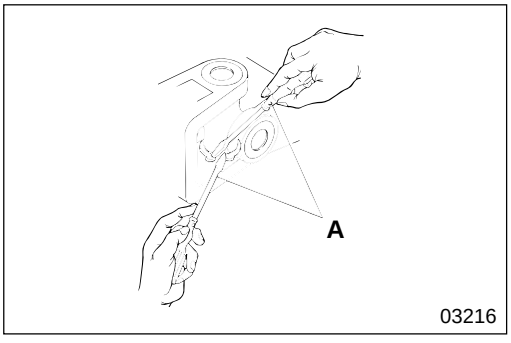
NOTE

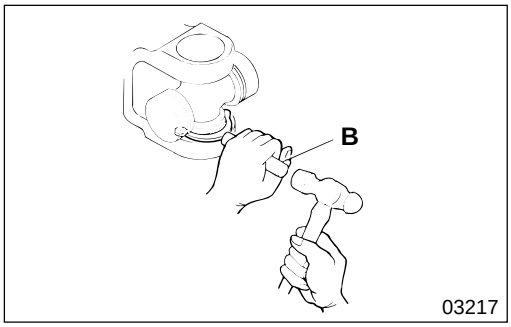
For snap ring 1, it is recommend that you use rings with the same thickness on both ends.

1 Snap ring

[Removal]

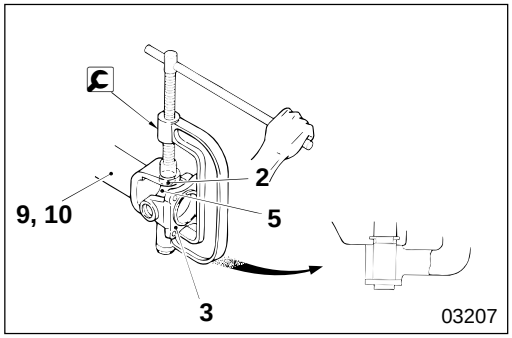
A : Flat-blade screwdriver





[Installation]

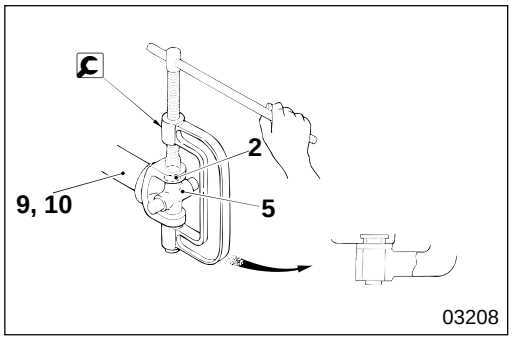
B : Drift



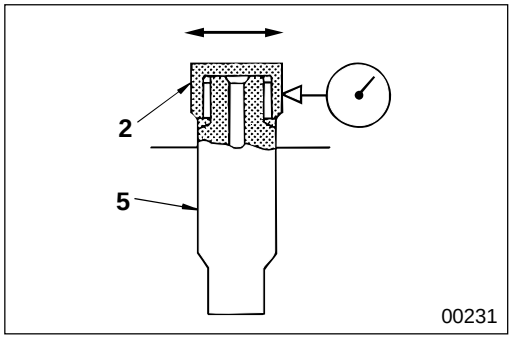
2 Needle bearing

[Removal]

- Put alignment marks on needle bearing **2** and spider **5**.
- Put alignment marks on flange yoke **3** and slip yoke joint **9** and propeller shaft **10**.

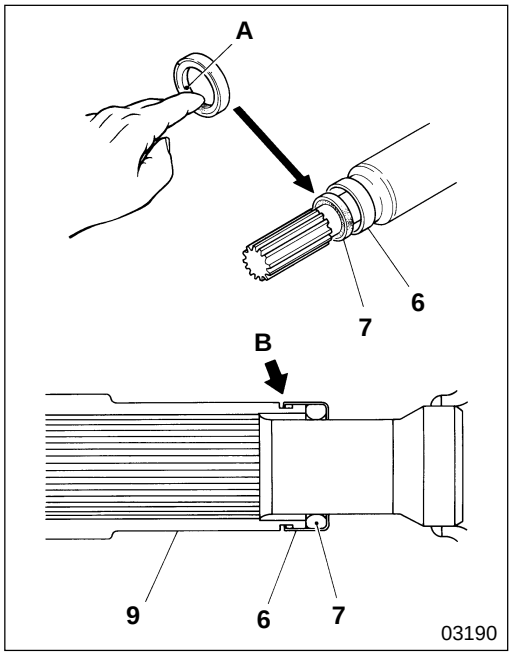


[Press-fitting]



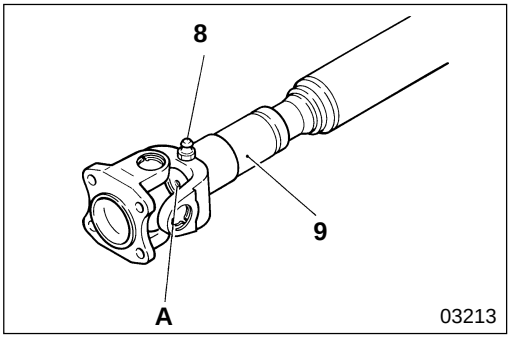
2 5 Clearance between needle bearing and spider

Measure the play towards the diameter direction between needle bearing **2** and spider **5**. If the measured value is higher than the limit, replace with universal joint spider kit.



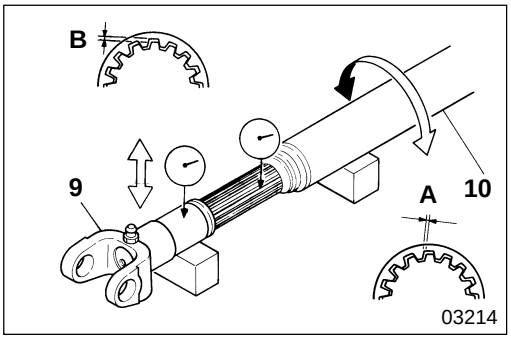
6 7 Installation of retainer packing and sealed packing

- Apply grease to inner periphery **A** of sealed packing **7** and install as illustrated.
- Press retainer packing **6** onto slip yoke joint **9**, and caulk claw **B** at eight points.



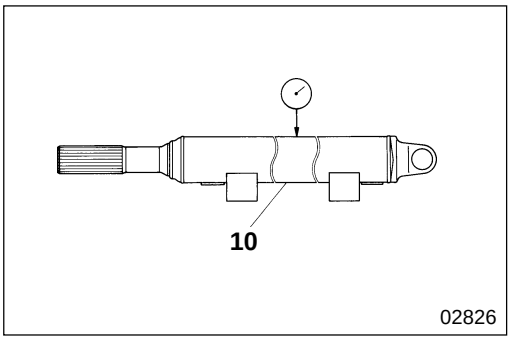
8 **Supply of grease via grease nipple**

Pack grease via grease nipple **8** until grease starts overflowing from dust plug **A** of slip yoke joint **9**.



9 **10** **Play between slip yoke joint and rear propeller shaft spline**

- Measure play **A** in the rotation direction between slip yoke joint **9** and rear propeller shaft **10** at the spline area. If the measured value is higher than the limit, replace the faulty parts.
- Measure play **B** in the rotation direction between slip yoke joint **9** and rear propeller shaft **10** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



10 **Deflection of rear propeller shaft**

Measure the deflection of rear propeller shaft **10** at the center. If the measured value is higher than the limit, correct or replace it.

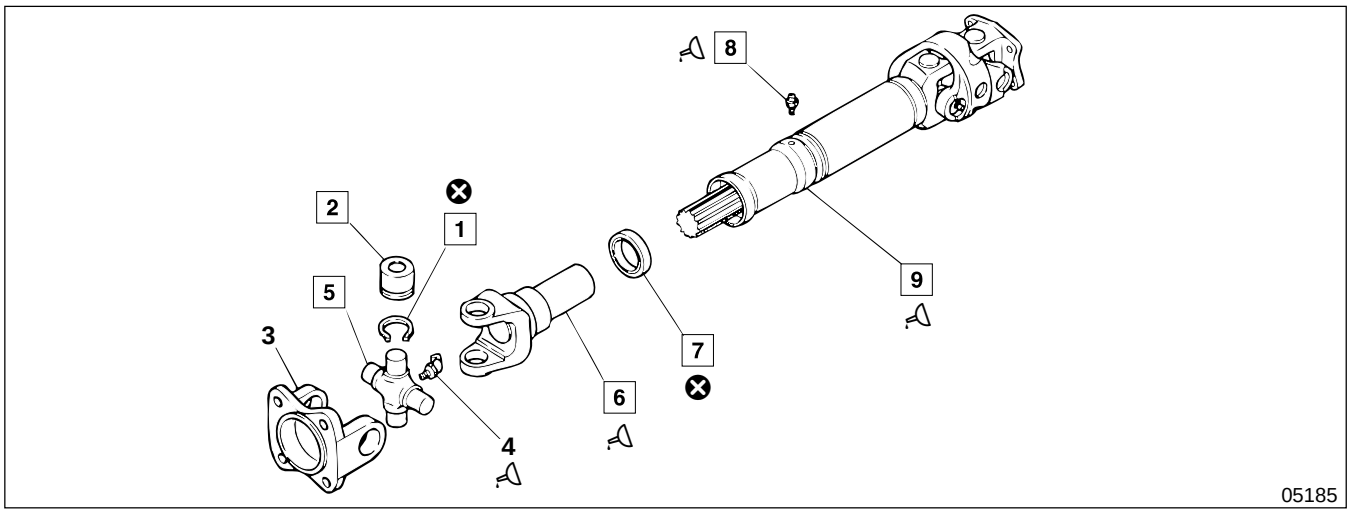
CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the deflection of rear propeller shaft 10, turn it one full revolution and read the dial gauge indicator. The deflection is one half of the indicated value.

REAR PROPELLER SHAFT < P2 : FG649 >



● **Inspection before disassembly**

P25-13

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease nipple
5 Spider
6 Slip yoke joint
7 Sealed packing
8 Grease nipple
9 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

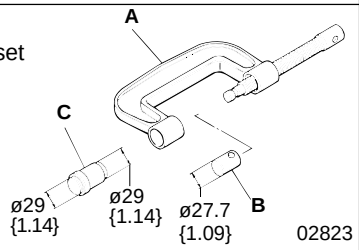
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 5	Clearance of spider in axial direction		0 to 0.06 {0 to 0.0024}	—	Adjust
2, 5	Clearance between needle bearing and spider		[19] 0.02 to 0.05 {[0.75] 0.00079 to 0.0020}	0.1 {0.0039}	Replace
6, 9	End play of slip yoke joint and rear propeller shaft splines	In rotation direction	0.01 to 0.09 {0.00039 to 0.0035}	0.3 {0.012}	Replace
		In diameter direction	0.02 to 0.16 {0.00079 to 0.0063}	0.3 {0.012}	Replace
9	Deflection of rear propeller shaft (Center)		—	0.4 {0.016}	Correct or replace

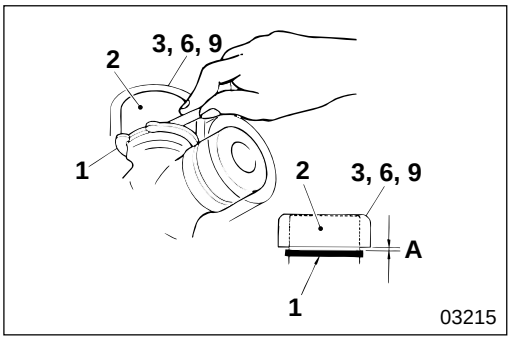
Lubricant

Location	Points of application	Specified lubricant	Quantity
4	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from needle bearing oil seal
6	Friction surface of slip yoke joint sealed packing	Wheel bearing grease [NLGI No.2 (Li soap)]	—
8	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from dust plug
9	Spline of rear propeller shaft	Wheel bearing grease [NLGI No.2 (Li soap)]	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Universal joint tool set **A** : Yoke assembly **B** : Push rod **C** : Guide 	MB999024 **A** : MB999025 **B** : MB999026 **C** : MB999010 (Obtain Locally)	Removal and installation of needle bearing



◆ Service procedure

● Inspection before disassembly

Clearance in axial direction for spider

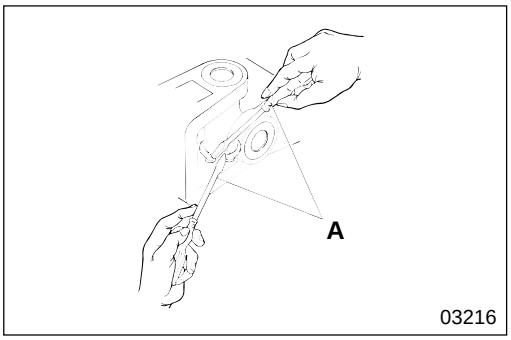
Press needle bearing **2** downward firmly, and measure clearance **A** between snap ring **1** and flange yoke **3**, slip yoke joint **6**, and rear propeller shaft **9**. If the measured value is higher than the limit, adjust it by changing the thickness of the snap ring.

< Available snap ring thicknesses and their combination : Combination indicated by solid line is preferred >

Part name	Thickness	Color identification mark	Combination	Thickness	Color identification mark
Snap ring	1.5 mm {0.059 in.}	None		1.5 mm {0.059 in.}	None
Snap ring	1.55 mm {0.061 in.}	Yellow		1.55 mm {0.061 in.}	Yellow
Snap ring	1.6 mm {0.063 in.}	Blue		1.6 mm {0.063 in.}	Blue
Snap ring	1.65 mm {0.065 in.}	Purple		1.65 mm {0.065 in.}	Purple

NOTE

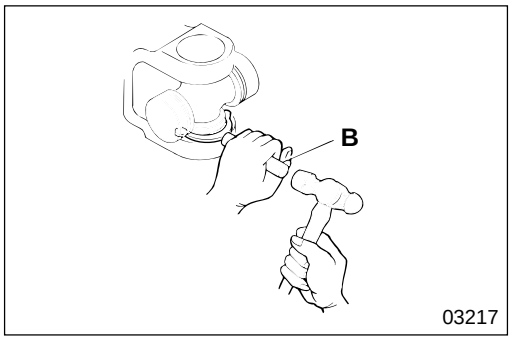
For snap ring 1, it is recommend that you use rings with the same thickness on both ends.



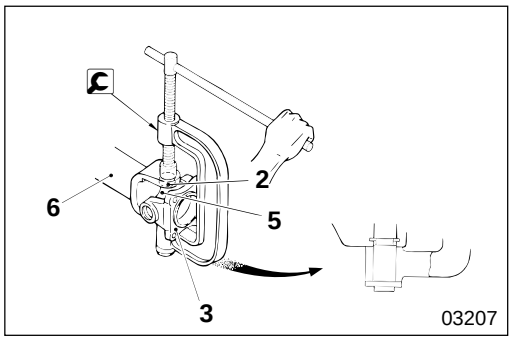
1 **Snap ring**

[Removal]

A : Flat-blade screwdriver



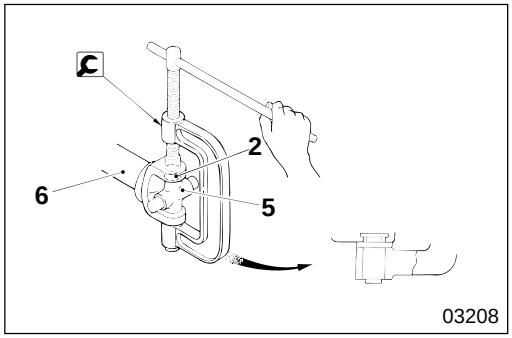
[Installation]
B : Drift



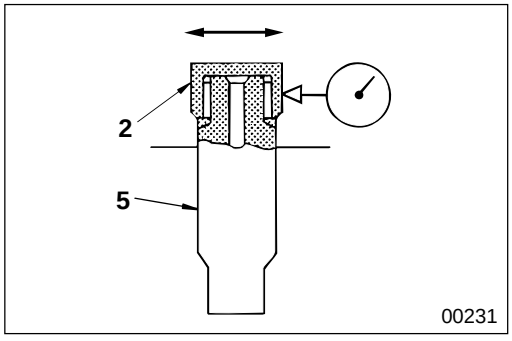
2 **Needle bearing**

[Removal]
- Put alignment marks on needle bearing **2** and spider **5**.
- Put alignment marks on flange yoke **3** and slip yoke joint **6**.

: Universal joint tool set

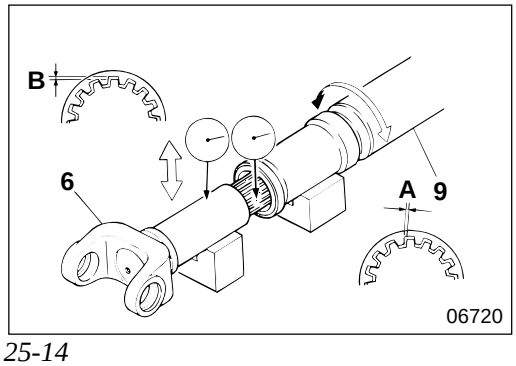


[Press-fitting]
: Universal joint tool set



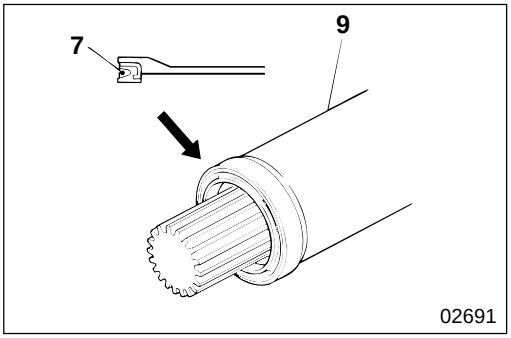
2 **5** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **2** and spider **5**. If the measured value is higher than the limit, replace with universal joint spider kit.



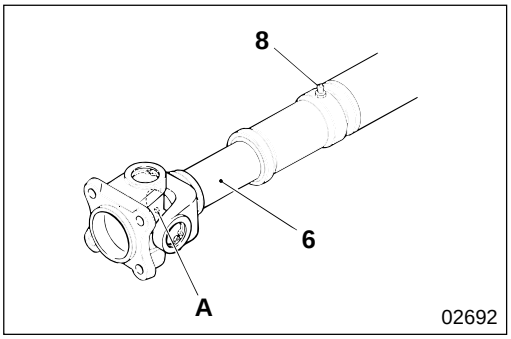
6 **9** **Play between slip yoke joint and rear propeller shaft spline**

- Measure play **A** in the rotation direction between slip yoke joint **6** and rear propeller shaft **9** at the spline area. If the measured value is higher than the limit, replace the faulty parts.
- Measure play **B** in the diameter direction between slip yoke joint **6** and rear propeller shaft **9** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



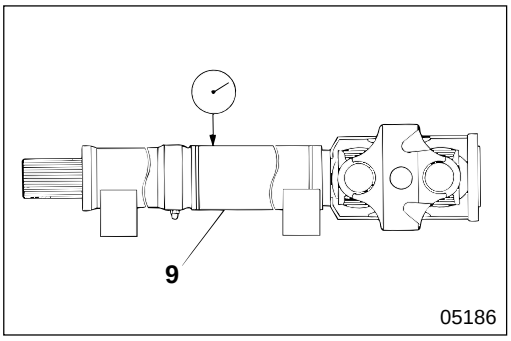
7 **Installation of sealed packing**

Install sealed packing **7** onto propeller shaft **9** in the direction illustrated until it is flush with the propeller shaft.



8 **Supply of grease via grease nipple**

Pack grease via grease nipple **8** until grease starts overflowing from dust plug **A** of slip yoke joint **6**.



9 **Deflection of rear propeller shaft**

Measure the deflection of rear propeller shaft **9** at the center. If the measured value is higher than the limit, correct or replace it.

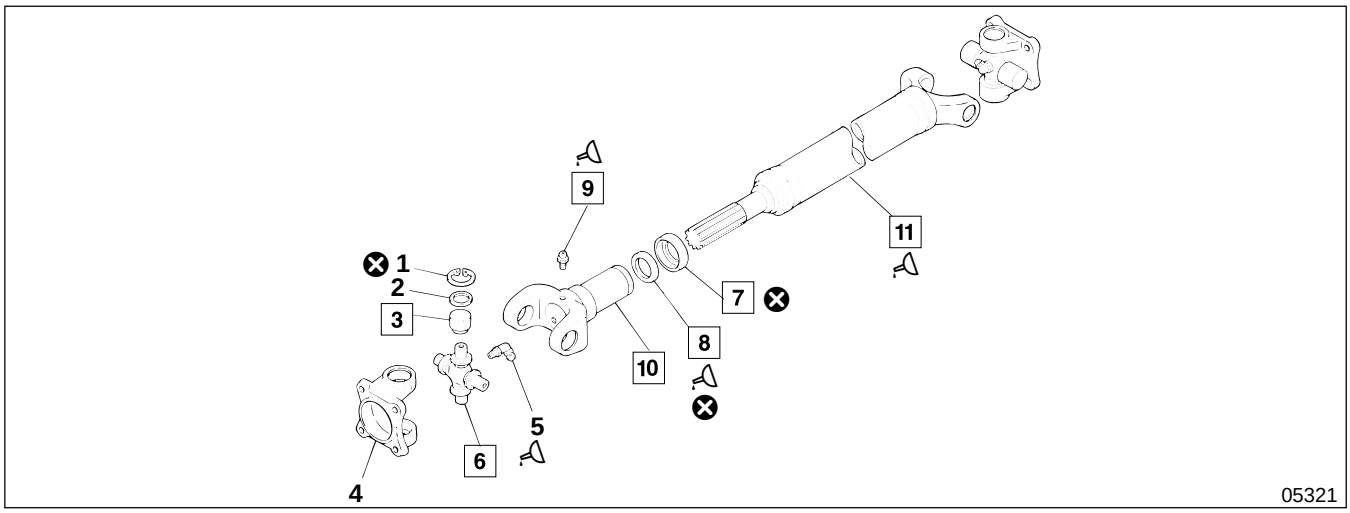
CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the deflection of rear propeller shaft 9, turn it one full revolution and read the dial gauge indicator. The deflection is one half of the indicated value.

REAR PROPELLER SHAFT < P3 >



● **Inspection before disassembly**

P25-17

● **Disassembly sequence**

1 Snap ring
2 Shim
3 Needle bearing
4 Flange yoke
5 Grease nipple
6 Spider
7 Retainer packing
8 Sealed packing
9 Grease nipple
10 Slip yoke joint
11 Rear propeller shaft

⊗ : Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

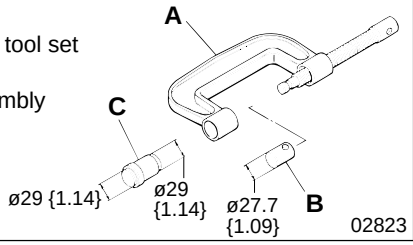
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 6	Clearance of spider in axial direction		0 to 0.06 {0 to 0.0024}	—	Adjust
3, 6	Clearance between needle bearing and spider		[21] 0.01 to 0.06 {[0.83] 0.00039 to 0.0024}	0.1 {0.0039}	Replace
10, 11	End play of slip yoke joint and rear propeller shaft splines	In rotation direction	0.01 to 0.09 {0.00039 to 0.0035}	0.3 {0.012}	Replace
		In diameter direction	0.02 to 0.16 {0.00079 to 0.0063}	0.3 {0.012}	Replace
11	Deflection of rear propeller shaft (Center)		—	0.4 {0.016}	Correct or replace

Lubricant

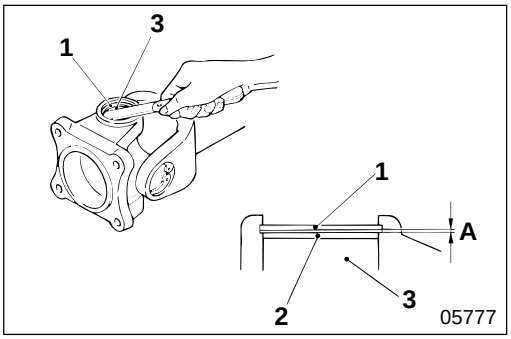
Location	Points of application	Specified lubricant	Quantity
5	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from needle bearing oil seal
8	Friction surface of slip yoke joint sealed packing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from dust plug
11	Spline of rear propeller shaft	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Universal joint tool set **A** : Yoke assembly **B** : Push rod **C** : Guide 	MB999024 **A** : MB999025 **B** : MB999026 **C** : MB999010 (Obtain Locally)	Removal and installation of needle bearing

◆ Service procedure



● Inspection before disassembly

Clearance in axial direction for spider

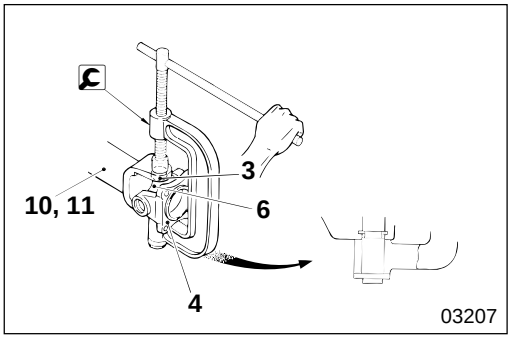
Press needle bearing **3** downward firmly, and measure clearance **A** between snap ring **1** and shim **2**. If the measured value is higher than the standard value, adjust it by changing the thickness of the shim.

Available shim thicknesses :

0.1 to 0.7 mm {0.0039 to 0.028 in.} (7 thicknesses available in 0.1 mm {0.0039 in.} increments)

NOTE

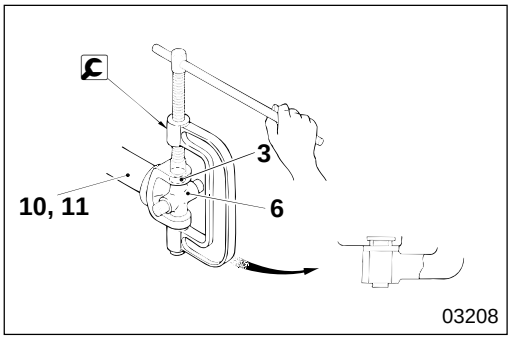
For shim 2, it is recommended that you use shims with the same thickness on both ends to ensure balanced revolution.



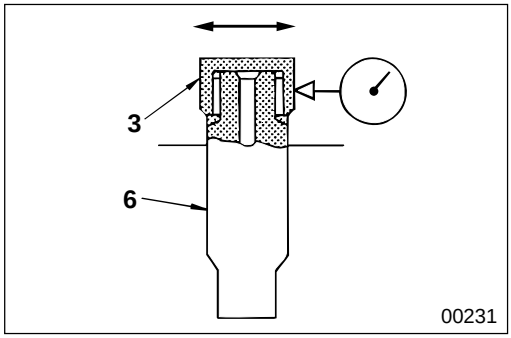
3 **Needle bearing**

[Removal]

- Put alignment marks on needle bearing **3** and spider **6**.
- Put alignment marks on flange yoke **4**, slip yoke joint **10** and rear propeller shaft **11**.

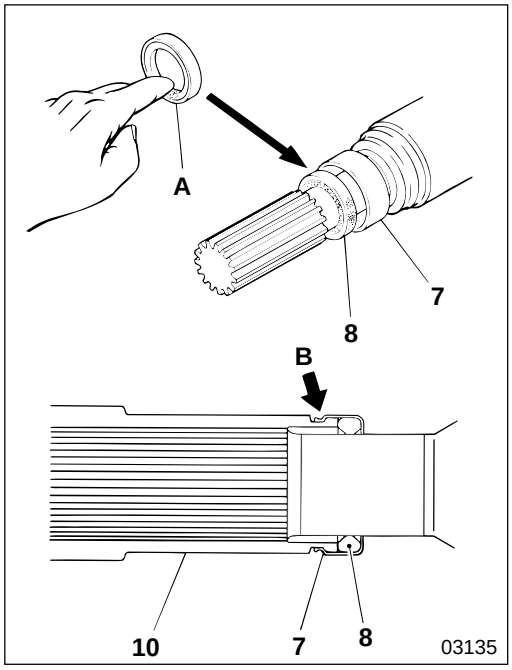


[Press-fitting]



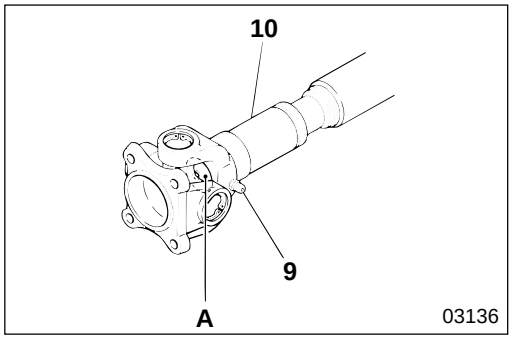
3 **6** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **3** and spider **6**. If the measured value is higher than the limit, replace with universal joint spider kit.



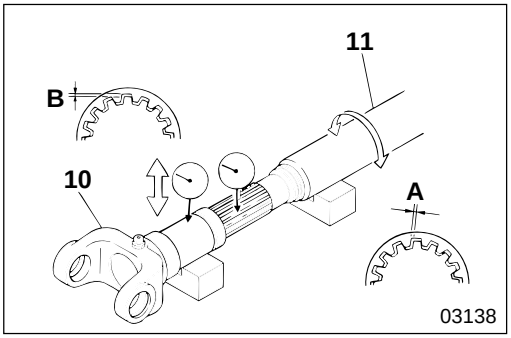
7 **8** **Installation of retainer packing and sealed packing**

- Apply grease to inner periphery **A** of sealed packing **8** and install it as illustrated.
- Press retainer packing **7** onto slip yoke joint **10**, and caulk claw **B** at eight points.



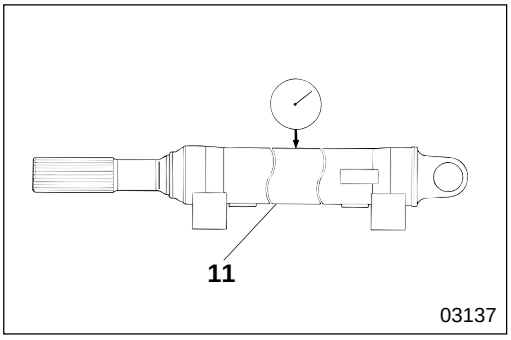
9 **Supply of grease via grease nipple**

Pack grease via grease nipple **9** until grease starts overflowing from dust plug **A** of slip yoke joint **10**.



10 **11** **Play between slip yoke joint and rear propeller shaft spline**

- Measure play **A** in the rotation direction between slip yoke joint **10** and rear propeller shaft **11** at the spline area. If the measured value is higher than the limit, replace the faulty parts.
- Measure play **B** in the diameter direction between slip yoke joint **10** and rear propeller shaft **11** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



11 **Deflection of rear propeller shaft**

Measure the deflection of rear propeller shaft **11** at the center. If the measured value is higher than the limit, correct or replace it.

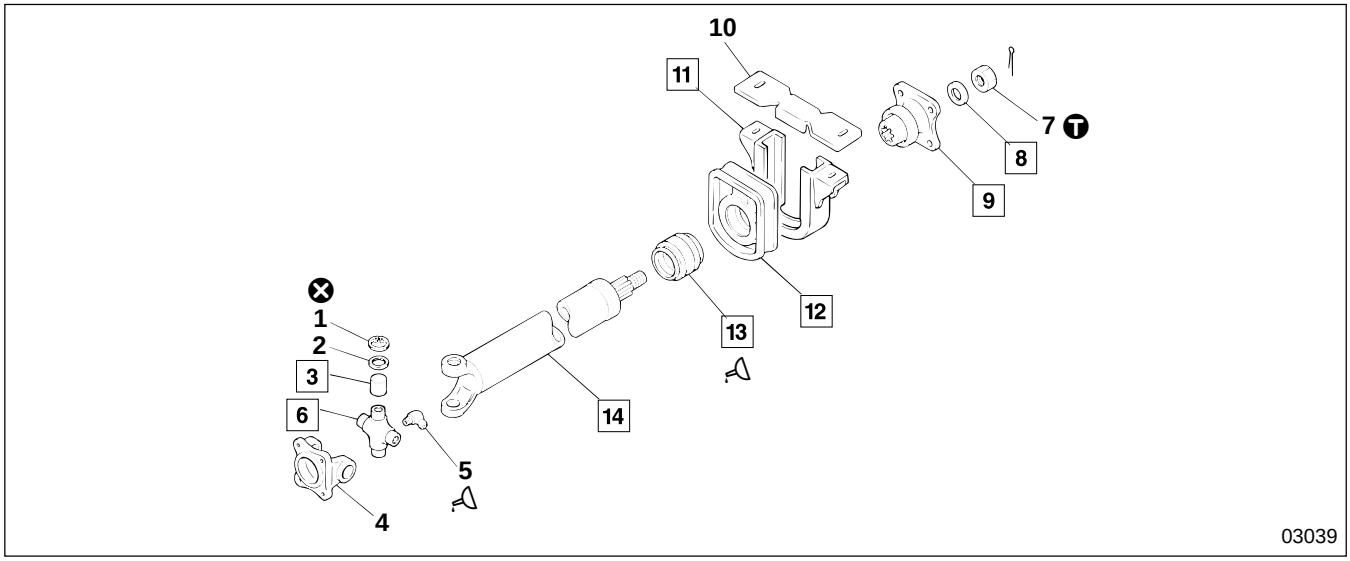
CAUTION ⚠

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the deflection of rear propeller shaft 11, turn it one full revolution and read the dial gauge indicator. The deflection is one half of the indicated value.

FRONT PROPELLER SHAFT



● **Inspection before disassembly**

P25-21

● **Disassembly sequence**

1 Snap ring
2 Shim
3 Needle bearing
4 Flange yoke
5 Grease nipple
6 Spider
7 Nut
8 Disc spring
9 Companion flange
10 Holder
11 Hanger
12 Cushion rubber
13 Center bearing assembly
14 Front propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 6	Clearance of spider in axial direction	0 to 0.06 {0 to 0.0024}	—	Adjust
3, 6	Clearance between needle bearing and spider	[21] 0.01 to 0.06 {[0.83] 0.00039 to 0.0024}	0.1 {0.0039}	Replace
14	Deflection of front propeller shaft (Center)	—	0.4 {0.016}	Correct or replace

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

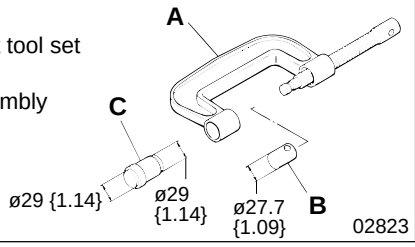
Location	Parts to be tightened	Tightening torque	Remarks
7	Nut (Companion flange mounting)	290 to 390 {215 to 290, 30 to 40}	—

Lubricant

Location	Points of application	Kinds	Quantity
5	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from needle bearing oil seal
13	Pack interior of center bearing assembly	Bearing grease [NLGI No.3 (Li soap)]	70 to 100% of capacity (20 to 29 g) {0.71 to 1.02 oz}
	Center bearing assembly seal lip area	Bearing grease [NLGI No.3 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Universal joint tool set **A** : Yoke assembly **B** : Push rod **C** : Guide 	MB999024 **A** : MB999025 **B** : MB999026 **C** : MB999010 (Obtain Locally)	Removal and installation of needle bearing

◆ Service procedure

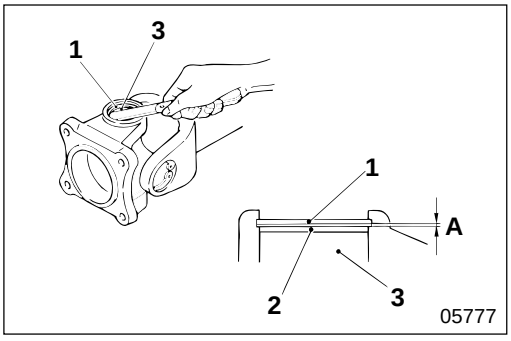
● Inspection before disassembly

Clearance in the axial direction for spider

Press needle bearing **3** downward firmly, and measure clearance **A** between snap ring **1** and shim **2**. If the measured value is higher than the standard value, adjust it by changing the thickness of the shim.

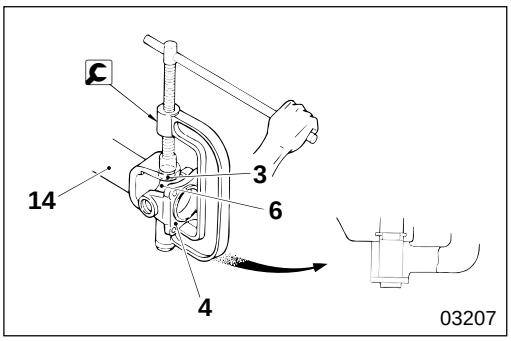
Available shim thicknesses :

0.1 to 0.7 mm {0.0039 to 0.028 in.} (7 thicknesses available in 0.1 mm {0.0039 in.} increments)



NOTE

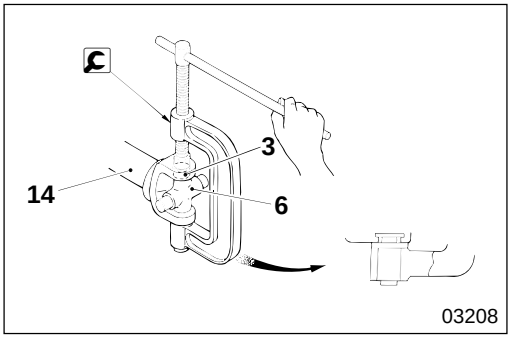
For shim 2, it is recommended that you use shims with the same thickness on both ends to ensure balanced revolution.



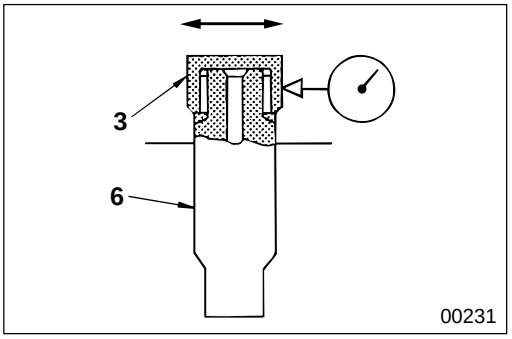
3 Needle bearing

[Removal]

- Put alignment marks on needle bearing **3** and spider **6**.
- Put alignment marks on flange yoke **4** and front propeller shaft **14**.

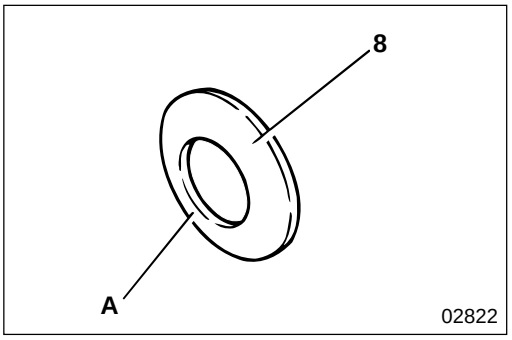


[Press-fitting]



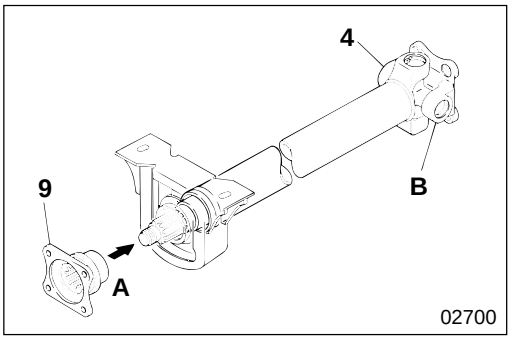
3 **6** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **3** and spider **6**. If the measured value is higher than the limit, replace with universal joint spider kit.



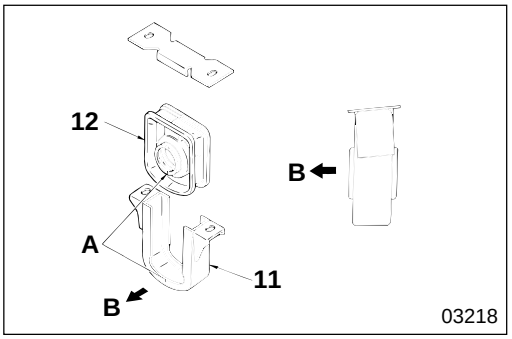
8 **Installation of disc spring**

Install disc spring **8** with its convex side **A** facing nut **7**.



9 **Installation of companion flange**

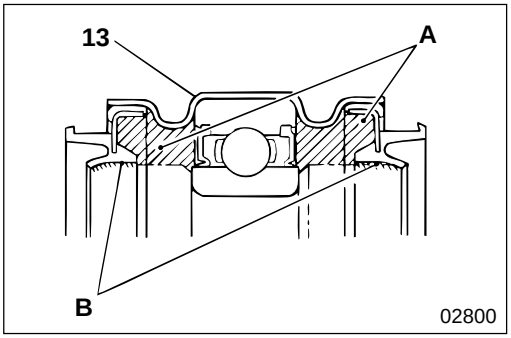
When installing, position concave side **A** of companion flange **9** and convex side **B** of flange yoke **4** as illustrated.



11 **12** **Hanger and cushion rubber**

[Removal]
Make alignment marks **A** before removal.

[Installation]
Install hanger **11** and cushion rubber **12** aligning alignment marks **A**.
The relative position to the front of vehicle **B** is as illustrated.

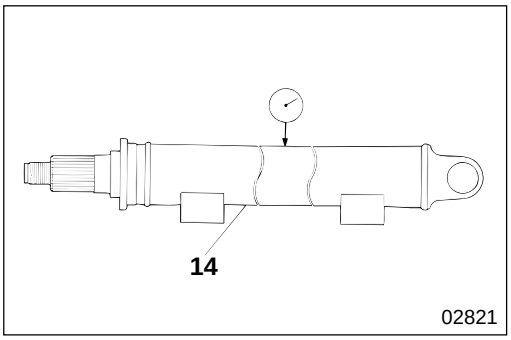


13 **Greasing center bearing assembly**

- Inspect the center bearing assembly for leaking grease every 50000 km {31000 miles} or at regular safety inspection. If a substantial grease leak is found, pack grease into housing **A**.
- Apply grease to seal lip area **B**.

NOTE

Bearing does not require greasing because it is sealed.



14 **Deflection of front propeller shaft**

Measure the deflection of front propeller shaft **14** at the center. If the measured value is higher than the limit, correct or replace it.

CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the deflection of front propeller shaft 14, turn it one full revolution and read the dial gauge indicator. The deflection is one half of the indicated value.

BALANCING PROPELLER SHAFT

(1) After correcting propeller shaft deflection or replacing the flange yoke, universal joint, or related parts, measure the balance of the completed propeller shaft assembly on a balancing machine and attach balance weights as required to correct amount of imbalance to within the permissible range.

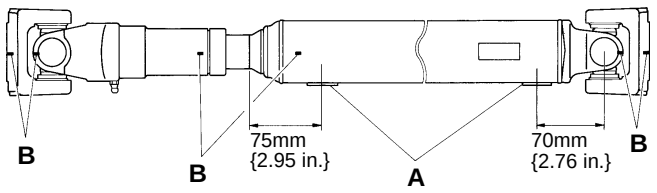
(2) Use the polar coordination method to correct dynamic balance.

(3) Permissible amount of imbalance for propeller shaft circumference
10 g or less/3,000 rpm < Rear propeller shaft >
5 g or less/3,000 rpm < Front propeller shaft >

(4) Correction procedure
- Balance weight attachment point

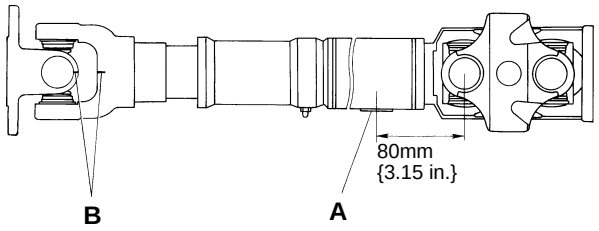
< Rear propeller shaft >

< P2 : FG639 >



03238

< P2 : FG649 >



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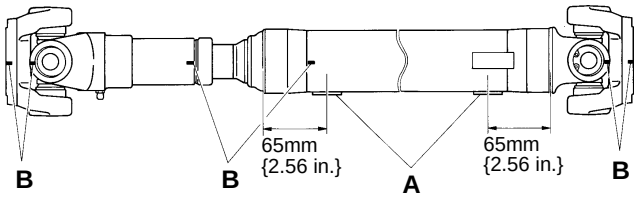
< P3 >



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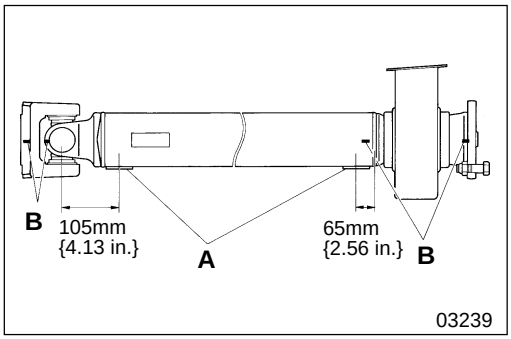
< Front propeller shaft >



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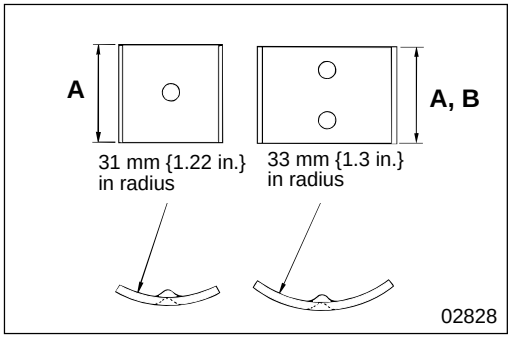
A : Balance weight attachment point
B : Alignment marks



- Available balance weights

Appropriate propeller shaft	Mass (g {oz})	Radius (mm {in.})
P2 < FG639 >, P3	2 {0.071}	31 {1.22}
	4 {0.14}	31 {1.22}
	6 {0.21}	31 {1.22}
	8 {0.28}	31 {1.22}
	10 {0.35}	31 {1.22}
	12 {0.42}	31 {1.22}
	16 {0.56}	31 {1.22}
	24 {0.85}	33 {1.30}
P2 < FG649 >	30 {1.06}	33 {1.30}
	35 {1.23}	33 {1.30}
	40 {1.41}	33 {1.30}
	45 {1.59}	33 {1.30}
	50 {1.76}	33 {1.30}

A : 30 mm {1.18 in.} or less
B : 45 mm {1.77} or less < P2 : FG649 >

NOTE

- **Maximum balance weight allowed for one point is 100 g {3.53 oz}.**
- **Use a combination that keeps number of balance weights to the minimum.**

MITSUBISHI
FUSO

Group 26A
Front Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-26A

INDEX

SPECIFICATIONS 26A- 2

STRUCTURE AND OPERATION 26A- 2

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE
- Adjustment of Wheel Alignment 26A- 4
- Adjustment of Steering Angle 26A- 7
- Measurement of Side Slip 26A- 7

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT AXLE.. 26A- 8

WHEEL HUB AND ROTOR 26A-10

FRONT AXLE, KNUCKLE AND KINGPIN 26A-19

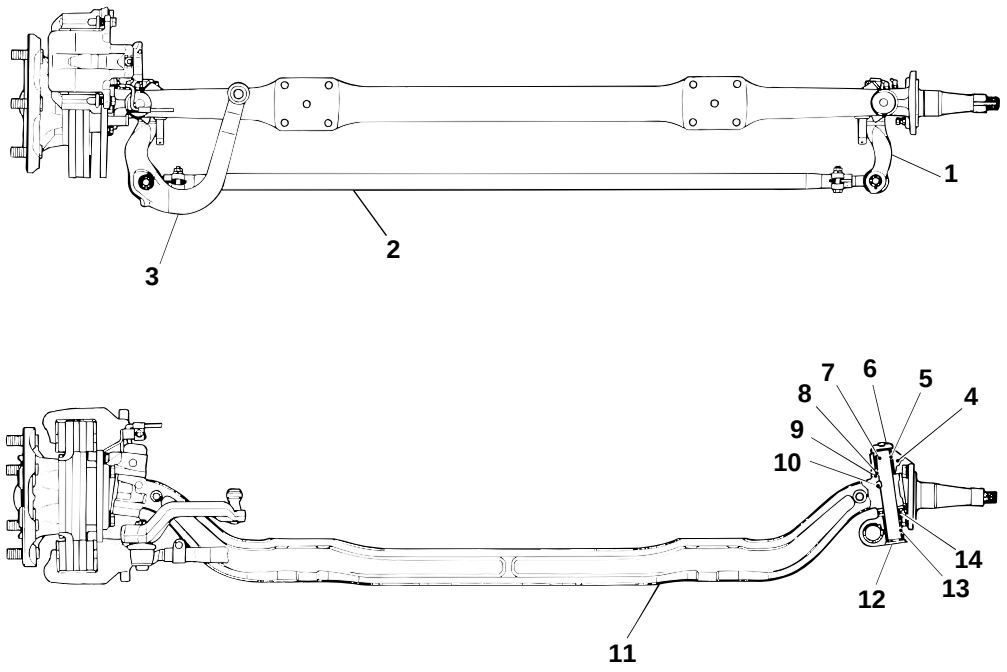
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item \ Vehicle model		FE639	FE649, FE640
Front axle	Model	F020T	F035T
	Type	I section, reverse Elliot type	
Kingpin	Outer diameter × Length mm {in.}	28×180 {1.10×7.09}	
Tread	mm {in.}	1665 {65.6}	
Mass	kg {lb}	Approximately 125 {275}	Approximately 155 {340}

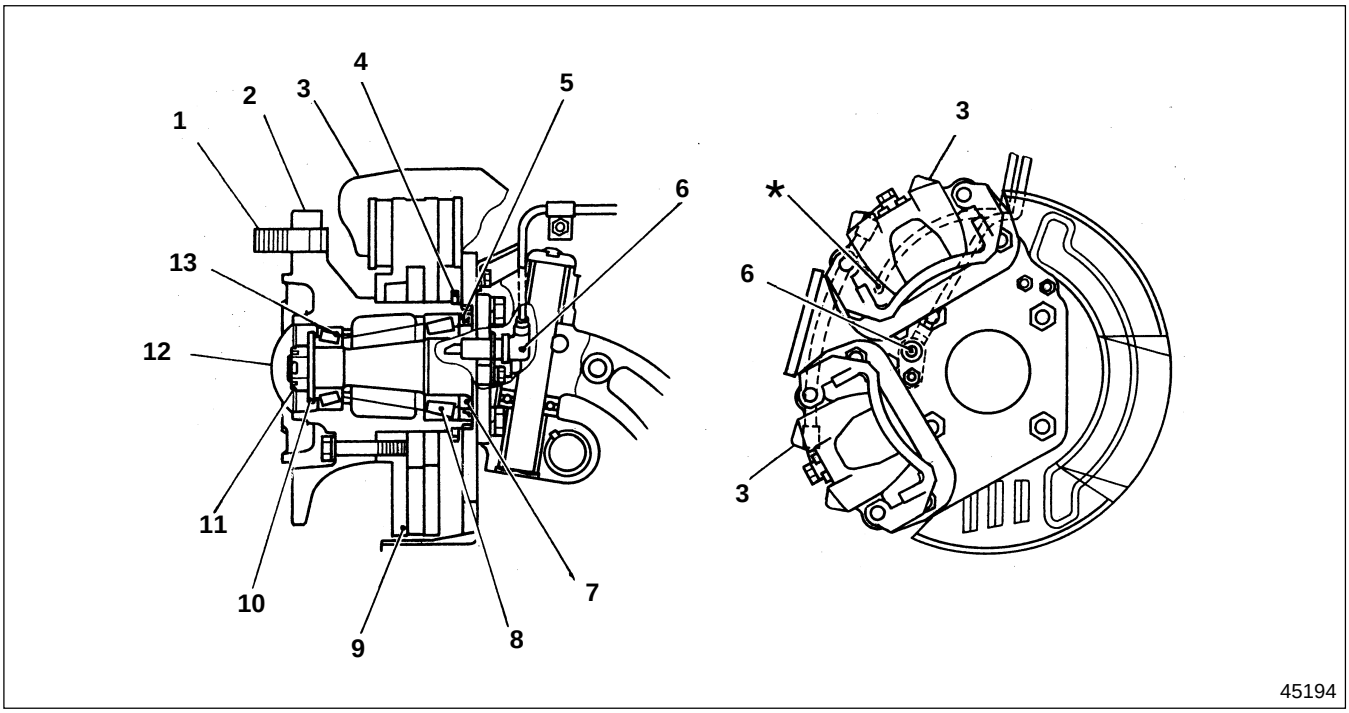
STRUCTURE AND OPERATION

Front Axle, Knuckle and Kingpin



1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Knuckle
5 Bushing
6 Dust cap
7 Kingpin
8 Dust seal
9 Kingpin shim
10 Lock pin
11 Front axle
12 Plug
13 Kingpin bushing
14 Thrust bearing

Wheel Hub and Rotor



1 Hub bolt
2 Wf~'l hub
3 Disc brake assembly
4 Rotor
5 Oil seal
6 Wheel speed sensor
7 Spacer
8 Inner bearing
9 Disc Rotor
10 Washer
11 Lock nut
12 Hub cap
13 Outer bearing
***** : Brake pad wear indicator

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

Adjustment of Wheel Alignment

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Wheel alignment	Toe-in (with tires on the ground)	0 to 6 {0 to 0.24}	—	—
		Camber	1°00'±30'	—	—
		Caster	2°30'±1°00'	—	—
		Kingpin inclination angle	8°	8°±10'	—

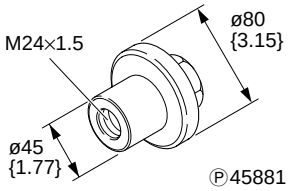
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Clamp bolt (Tie rod end clamp fastening)	25±5 {18±3.6, 2.5±0.5}	—

Special tools

Unit : mm {in.}

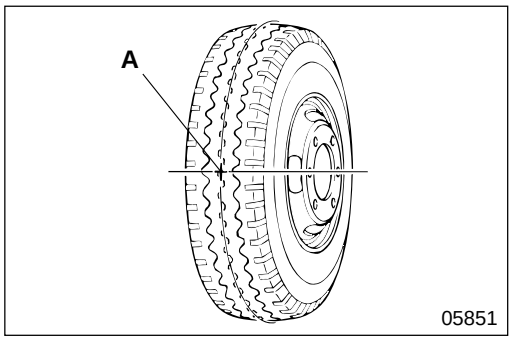
Location	Tool name and shape	Part No.	Application
—	Alignment gauge adapter 	MH063428 (Obtain Locally)	Measurement of camber and caster angles, and kingpin inclination angle: with free-wheel hub only

NOTE

- **Measure the wheel alignment when the vehicle is empty and level.**
- **Be sure that each part of the front axle has been serviced and is within specification before adjusting the wheel alignment.**

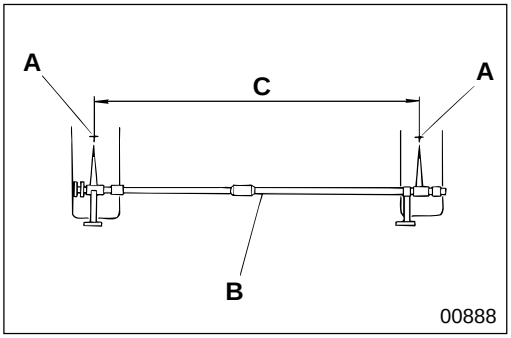
Before adjusting the wheel alignment, check for the following faults:

- Play in front wheel hub
- Play or looseness in kingpin
- Play or looseness in the joint between the tie rod and the knuckle arm
- Looseness of any fasteners
- Fatigued or damaged leaf springs
- Incorrect tire pressure
- Incorrect power steering booster backlash

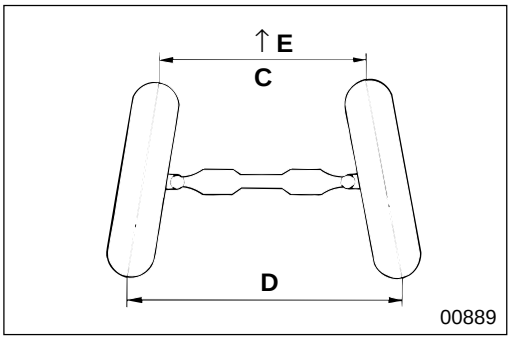


(1) Measurement and adjustment of toe-in

- Point the front wheels exactly forward.
- Put mark **A** on the left and right front tires at the height of front wheel axis and in the middle of the tire width.

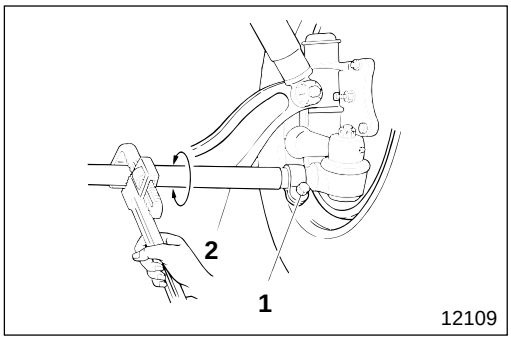


- Align the two points of toe-in gauge **B** to the respective marks **A** on the front tires. Measure the distance **C** between the marks at the front of the vehicle.

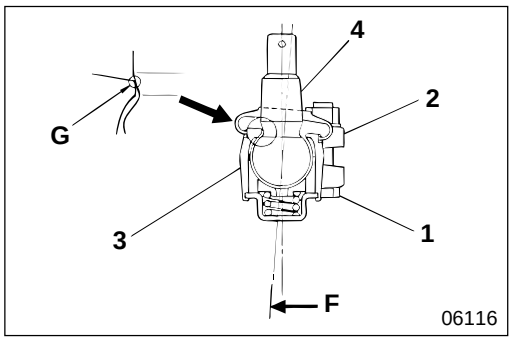


- Rotate the tires 180° and measure the distance **D** between the marks at the rear of the vehicle with the tires on the ground.
- Check if the difference between distances **C** and **D** is within the standard value.

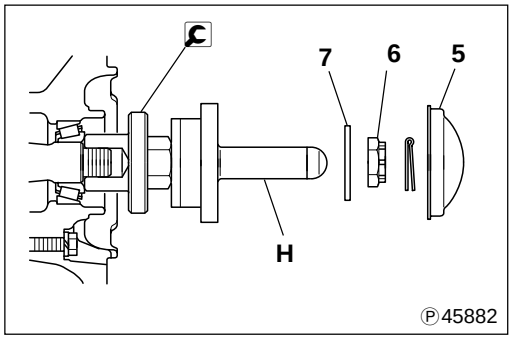
E : Front of the vehicle



- If the measured value deviates from the standard value, with the tires pointed forward, loosen left and right clamp bolts **1** and adjust the toe-in to the standard value by turning tie rod **2** with a pipe wrench.

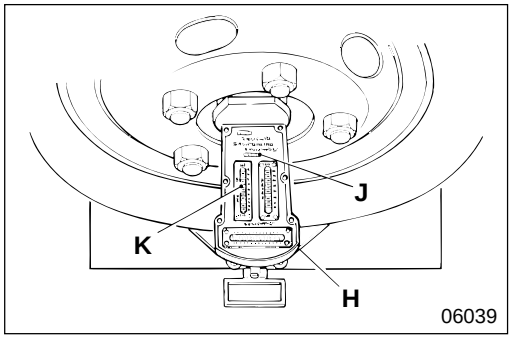


- Move the vehicle forward and turn tie rod **2** towards the front, with the tires pointed forward (**F** as illustrated). Make sure when adjusting toe-in to the standard value, that both left and right tie rod ends **3** are in contact with ball stud **4** (**G** as illustrated) at the same time. After adjustment, tighten clamp bolt **1** to secure the tie rod.

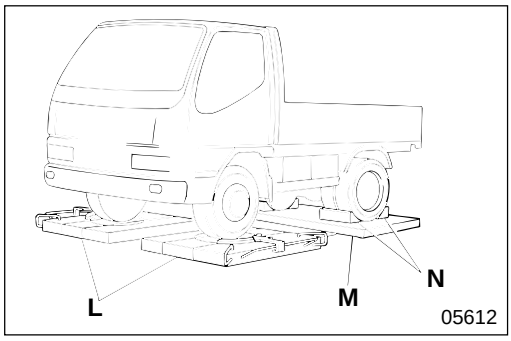


(2) Measurement of camber

- Point the front wheels exactly forward.
- Remove the hub cap **5**, lock nut **6** and lock washer **7**. Attach 🔧 alignment gauge adapter and mount camber/caster/kingpin gauge **H**.



- While keeping the bubble in level **J** centered, measure the camber angle by reading the scale mark at the center of the bubble on camber scale **K**. Follow this procedure to measure the camber angles on the left and right sides.

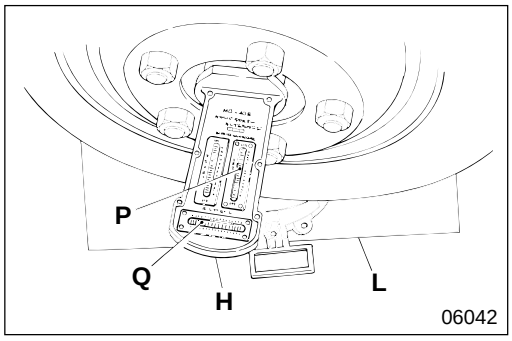


(3) Measurement of caster and kingpin inclination angle

- Align turning radius gauges **L**. Prepare a platform **M** having the same height as the turning radius gauges and place the platform under the rear wheels so that the vehicle is kept level.
- Keep turning radius gauges **L** locked.
- Jack up the vehicle and set the left and right front wheels so that the ground contact area of both front tires and the turntables of turning radius gauge **L** meet at their respective centers.

WARNING⚠

- **After jacking up the vehicle, chock the rear wheels securely with chocks N.**
- **Do not remove chocks N until the entire operation is completed.**



- Unlock turning radius gauge **L**, and set the scale to 0°.
- As in measuring camber explained previously, attach camber/caster kingpin gauge **H** tightly to the front wheel hub and keep the bubble centered.
- Apply the brake to the front wheels and turn the steering wheel slowly from the 0° point on the scale of turning radius gauge **L**, until direction changes 20° to the left for the left front wheel and 20° to the right for the right front wheel.

NOTE

It is not possible to obtain an exact reading of camber unless the brake is applied to the front wheels because the tires might rotate slightly.

- At the 20° point, align the bubbles in caster scale **P** and kingpin scale **Q** to 0° by turning the adjuster.

NOTE

Kingpin scale Q has scales for left and right; use the left scale when adjusting the left wheel, and the right scale when adjusting the right wheel.

- Turn the steering wheel slowly until the left front wheel changes its direction 20° to the right, or until the right front wheel changes its direction 20° to the left, past the 0° point of turning radius gauge **L** scale. At this point read the scale marks at the center of the bubbles on caster scale **P** and kingpin scale **Q**. The scale marks indicate the caster and kingpin inclination angles.

Adjustment of Steering Angle

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Steering angle	Inside (Outside : reference)	42° (33°)	—	Adjust

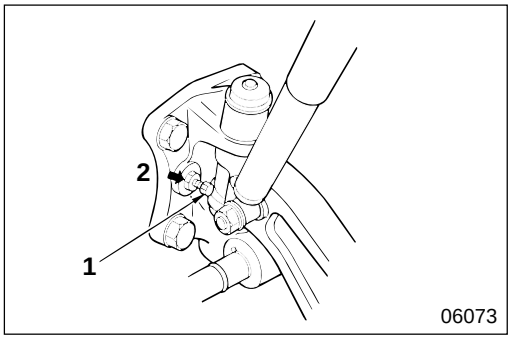
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (Knuckle stopper bolt fastening)	46.5±7 {34±5.4, 4.75±0.75}	—

NOTE

Be sure that wheel alignment is adjusted perfectly before adjusting the steering angle.



- To adjust the steering angle, set the turning radius gauges and platform in the same way as for caster and kingpin inclination angle measurement.
- Turn the steering wheel to the left or right completely, and from the position where the turning radius gauge is aligned to 0°, adjust knuckle stopper bolt **1**. Adjust so that the steering angle is within the standard inside steering angle value, to the left for the left front wheel, and to the right for the right front wheel. Then, tighten lock nut **2** at specified torque.

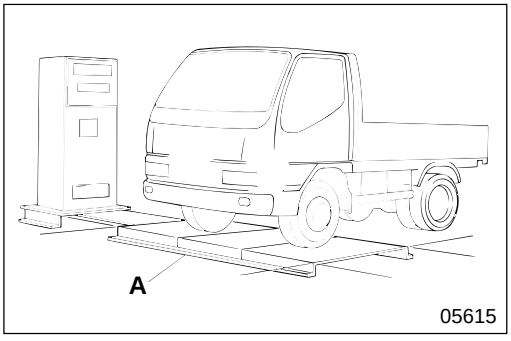
NOTE

Be sure when working on the vehicle, to adjust both stopper bolts 1 at the front and back of the knuckle arm side.

Measurement of Side Slip

NOTE

Be sure that wheel alignment is adjusted fully before measuring side slip.



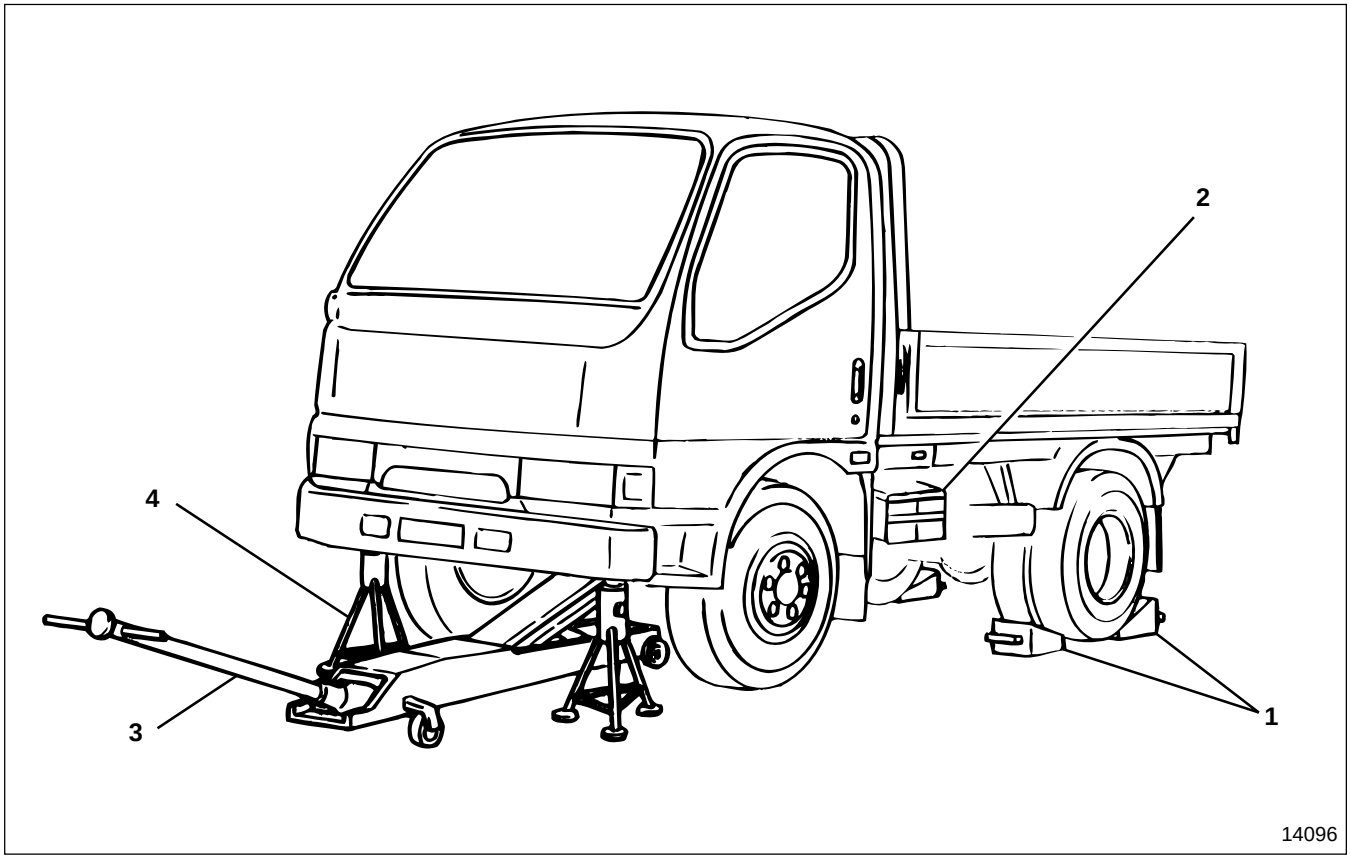
- Point the front wheels exactly forward.
- Maintain this position and slowly move vehicle forward, over side slip tester **A**, as slowly as possible.

NOTE

Make sure, when measuring side slip, that the wheels point exactly forward when the vehicle passes over side slip tester A. Do not allow the wheels to veer from side-to-side.

- The side slip is indicated by side slip tester **A** after the vehicle has passed through the tester. Readjust wheel alignment if slippage is 3 mm {0.12 in.} or more per meter {3.28 ft.}.

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT AXLE



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the front axle with a garage jack.
4 Support the front frame on jack stands.

WARNING

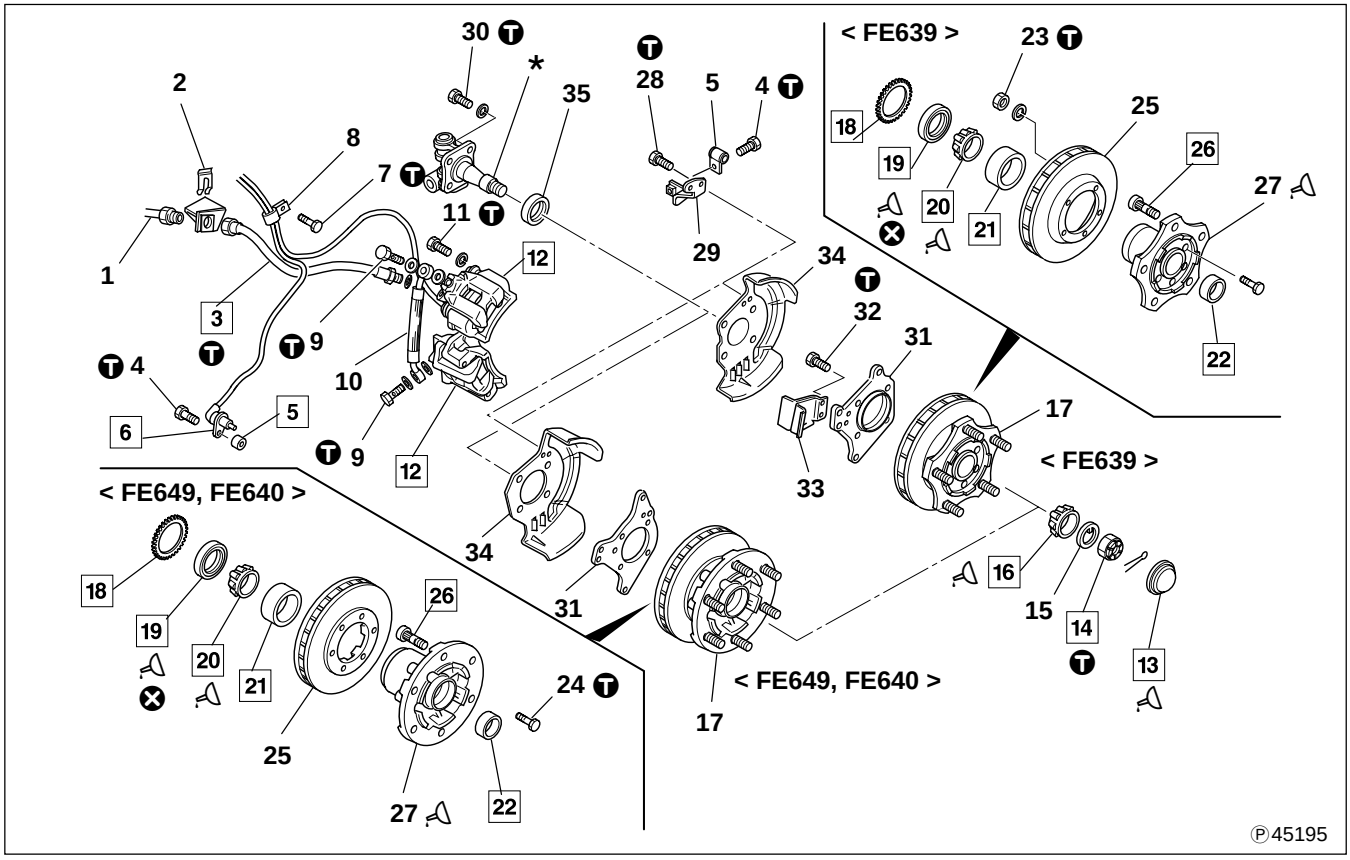
- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on jack stands.**
- **Leave the garage jack and stands in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

WHEEL HUB AND ROTOR



● **Disassembly sequence**

1 Brake pipe
2 Clip
3 Brake hose
4 Bolt
5 Clamp
6 Wheel speed sensor
7 Bolt
8 Clip
9 Eye bolt
10 Brake hose
11 Bolt
12 Disc brake assembly Gr 35A
13 Hub cap
14 Lock nut
15 Lock washer
16 Outer bearing inner race
17 Wheel hub and rotor assembly
18 Rotor
19 Oil seal
20 Inner bearing inner race
21 Inner bearing outer race
22 Outer bearing outer race
23 Nut < FE639 >
24 Bolt < FE649, FE640 >
25 Disc rotor Gr 35A
26 Hub bolt
27 Wheel hub
28 Bolt
29 Bracket
30 Bolt
31 Adapter
32 Bolt < FE639 >
33 Dust cover < FE639 >
34 Mud shield
35 Spacer

*: Knuckle P26A-19
⊗: Non-reusable parts

WARNING

When you work, take care not to burn yourself because disc brake assembly 12 and disc rotor 25 are hot immediately after the vehicle has been driven.

CAUTION

- **Before removing disc brake assembly 12, secure the disc brake assembly to the frame using wires, and do not disconnect the brake hose. Never allow the weight of the disk brake caliper assembly to hang from the hydraulic brake hose. Be sure to remove the harness clips to prevent damaging the pad wear indicator harness during the removal process.**
- **Be sure to protect brake hoses 3, 10 from dust by fitting blanking plugs after removal.**

NOTE

Do not disassemble disc rotor 25 and wheel hub 27 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence inreverse.

WARNING⚠

- **Do not allow oil or grease to adhere on the pad surface of disc brake assembly 12 or the rotor surface of wheel hub and rotor assembly 17 or rotors 25.**
- **You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A**

CAUTION⚠

Be careful not to damage rotor 18 or oil seal 19 when installing wheel hub and rotor assembly 17 onto knuckle *.

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
6	Wheel speed sensor	Resistance between terminals		1600±10% Ω	—	—
		Insulation resistance		100 kΩ minimum	—	—
16, 20 to 22	Starting torque of wheel hub bearing		FE639	1.5 N·m {1.08 ft.lbs, 0.15 kgf·m}	—	Tangential force at hub bolt: 14 N {3.1 lbf, 1.4 kgf}
			FE649, FE640	2 N·m {1.45 ft.lbs, 0.2 kgf·m}	—	Tangential force at hub bolt: 18 N {4.0 lbf, 1.8 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
3	Brake hose tightening (Axle side)		13 to 17 {9.4 to 12, 1.3 to 1.7}	—
4	Bolt (wheel speed sensor mounting)		9.8 to 14.8 {7.2 to 11, 1.0 to 1.5}	—
7, 28	Bolt (Clip and bracket mounting)		12.3±2.5 {9±1.8, 1.25±0.25}	—
9	Eye bolt (Brake hose mounting)		22±2 {16±1.8, 2.25±0.25}	—
11	Disc brake mounting	FE639	95.6±12 {71±9, 9.75±1.25}	—
		FE649, FE640	152±25 {110±18, 15.5±2.5}	—
14	Lock nut	Primary tightening	113±15 {83±11, 11.5±1.5}	Slackening off angle: Approximately 45° (one eighth of a turn)
		Secondary tightening, after slackening	59 {43, 6}	
23	Nut (Disc rotor and wheel hub mounting)	FE639	95.6±12 {71±9, 9.75±1.25}	—
24	Bolt (Disc rotor and wheel hub mounting)	FE649, FE640	85.8±12 {63±9, 8.75±1.25}	—
30	Bolt (Adapter and mud shield mounting)		118±20 {87±14, 12±2}	—
32	Bolt (Dust cover mounting)	FE639	12.3±2.5 {9±1.8, 1.25±0.25}	—

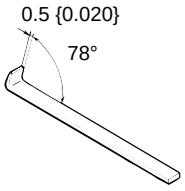
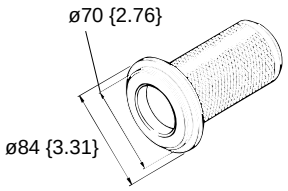
WHEEL HUB AND ROTOR

Lubricant

Location	Points of application		Kinds	Quantity
13	Pack wheel hub cap	FE639	Wheel bearing grease [NLGI No.2 (Li soap)]	65±10 g {2.29±0.35 oz}
		FE649, FE640	Wheel bearing grease [NLGI No.2 (Li soap)]	90±10 g {3.17±0.35 oz}
16, 20	Pack the space between rollers of outer bearing inner race and inner bearing inner race		Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Lip area of oil seal		Wheel bearing grease [NLGI No.2 (Li soap)]	As required
27	Pack interior space of wheel hub	FE639	Wheel bearing grease [NLGI No.2 (Li soap)]	210±20 g {7.41±0.71 oz}
		FE649, FE640	Wheel bearing grease [NLGI No.2 (Li soap)]	130±10 g {4.59±0.35 oz}

Special tools

Unit : mm {in.}

<table>
<tr><th>Location</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>13</td><td>Hub cap wrench
 
</td><td>MB999108
(Obtain Locally)</td><td>Removal of hub cap</td></tr>
<tr><td rowspan="2">19</td><td>Oil seal installer
 
</td><td>MB999097</td><td rowspan="2">Press-fitting of oil seal (Use in combination)</td></tr>
<tr><td>Bearing installer
<table>
<tr><th>Model</th><th>Part No.</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td>FE639</td><td>MB999099</td><td>ø88.5 {3.48}</td><td>ø71 {2.80}</td><td>ø51 {2.01}</td></tr>
<tr><td>FE649, FE640</td><td>MB999069</td><td>ø94.5 {3.72}</td><td>ø92.5 {3.64}</td><td>ø60 {2.36}</td></tr>
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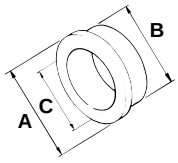
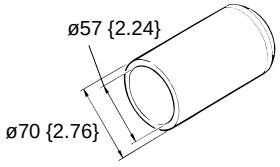

</td><td>MB999099
MB999069</td></tr>
<tr><td rowspan="2">16, 20</td><td>Bearing installer
 
</td><td>MB999100</td><td rowspan="2">Press-fitting of inner and outer bearing outer races (Use in combination)</td></tr>
<tr><td>Bearing installer
<table>
<tr><th>Model</th><th>Part No.</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td>FE639</td><td>MB999099</td><td>ø88.5 {3.48}</td><td>ø71 {2.80}</td><td>ø51 {2.01}</td></tr>
<tr><td>FE649, FE640 (Inner side)</td><td>MB999069</td><td>ø94.5 {3.72}</td><td>ø92.5 {3.64}</td><td>ø60 {2.36}</td></tr>
<tr><td>FE649, FE640 (Outer side)</td><td>MB999099</td><td>ø88.5 {3.48}</td><td>ø71 {2.80}</td><td>ø51 {2.01}</td></tr>
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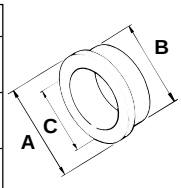
</td><td>MB999099
MB999069</td></tr>
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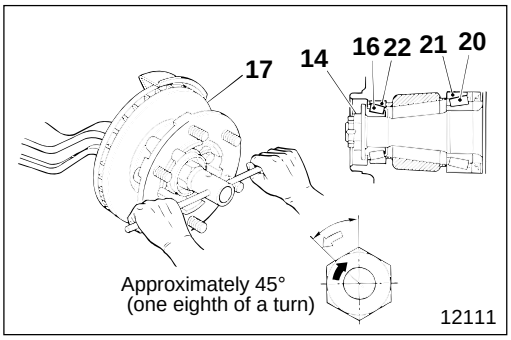
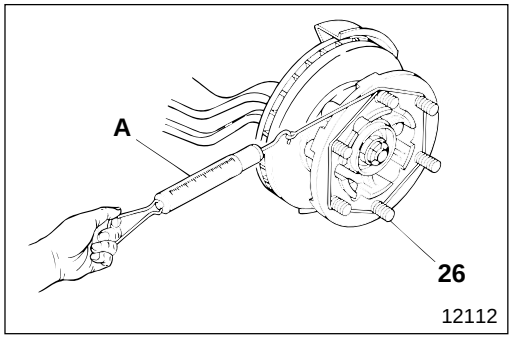
◆ Service procedure



● Starting torque of wheel hub bearing

[Adjustment]

- Tighten lock nut **14** at specified torque (primary tightening) while turning wheel hub and rotor assembly **17**. Then, slacken off.
- Turn wheel hub and rotor assembly **17** several times to smooth operation of outer bearings **16** and **22**, and inner bearings **20** and **21**, and retighten lock nut **14** at specified torque (secondary tightening).
- Slacken off lock nut **14** by approximately 45° (one eighth of a turn), and lock it with a split pin. If the split pin and the pin hole do not align, slacken off the lock nut slightly, making sure that there is no play in the axial direction.

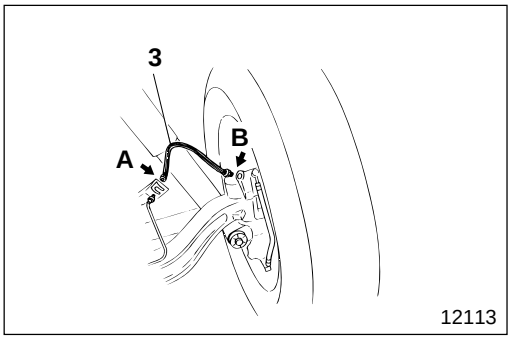


[Measurement]

- Fasten spring balance **A** to hub bolt **26** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the standard value, adjust the starting torque of the wheel hub bearing according to the procedure described above.
- If any fault is found after adjustment, replace outer and inner bearings **16**, **20** to **22**.

NOTE

- **Measure the starting torque when oil seal 19 has been installed.**

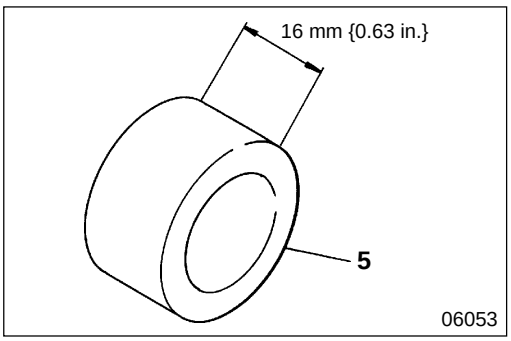


3 Removal and installation of brake hose

First remove brake hose **3** from bracket **A** (on the frame), then remove the brake hose from wheel brake **B**. For installation, follow this procedure in reverse.

CAUTION⚠

Make sure that brake hose 3 is not twisted when you install it.

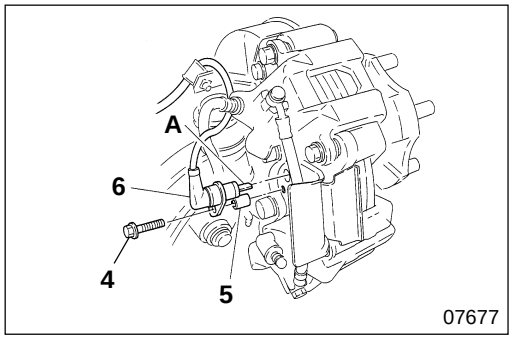


5 Installation of spacer

Check the thickness of spacer **5** before installation.

CAUTION⚠

Installation of spacer 5 with an improper thickness results in inaccurate wheel speed detection, thus causing faulty ABS operation.

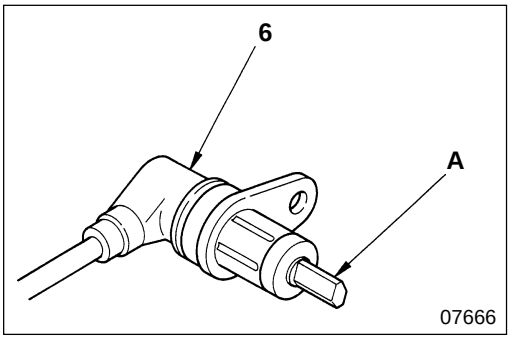


6 **Wheel speed sensor**

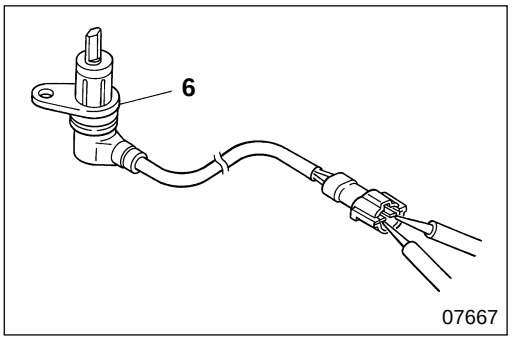
[Removal]
To prevent damaging pole piece **A** in wheel speed sensor **6**, remove the wheel speed sensor before removing wheel hub and rotor assembly **17**.

[Installation]
The connector of wheel speed sensor **6** is color-coded. Install the wheel speed sensors to the proper wheels according to the following table.

Installation of location	Connector
Left wheel	Gray
Right wheel	Black

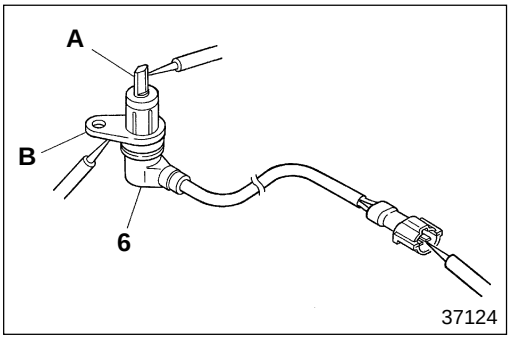


[Inspection]
Pole piece **A** in wheel speed sensor **6** is magnetized by a built-in magnet and attracts metals. Do not allow metal particles to stick to the pole piece.



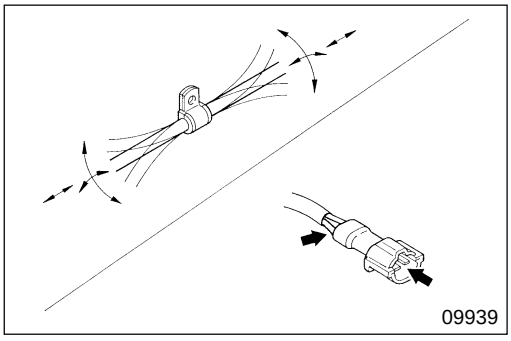
● **Measurement of resistance between terminals**

Measure resistance between the terminals of wheel speed sensor **6**.
If the measured value deviates from the standard value, replace the wheel speed sensor.



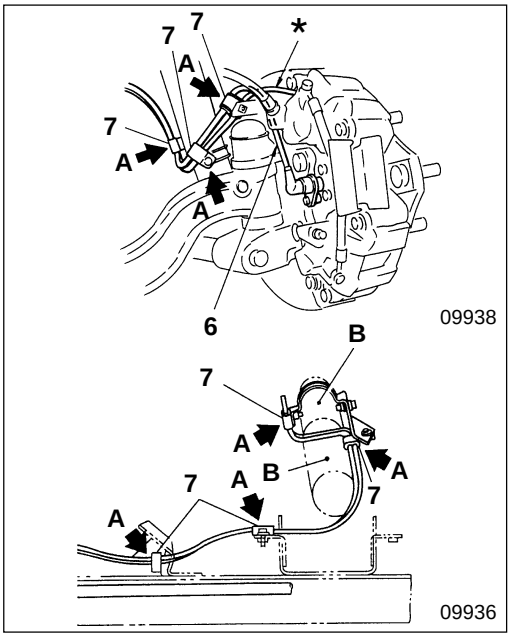
● **Measurement of insulation resistance**

Measure resistance between pole piece **A**, bracket **B** and each terminal of wheel speed sensor **6**.
If the measured value deviates from the standard value, replace the wheel speed sensor.



● **Inspection of open circuit in harness**

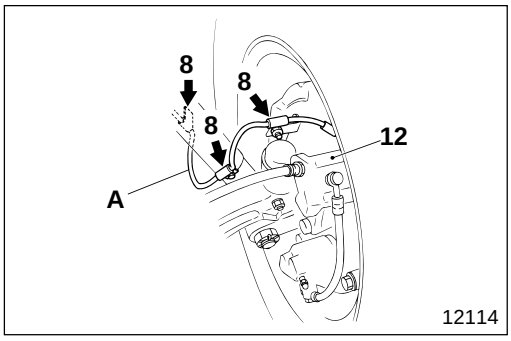
To check the harness for an open circuit, disconnect the harness clamp from the vehicle side, then bend and pull harness at the clamp to checkk if a momentary open circuit results. Also inspect the terminal contact conditions in the connector.
If an abnormality is found, replace wheel speed sensor **6**.



6 **7** **Installation of wheel speed sensor harness and clips**

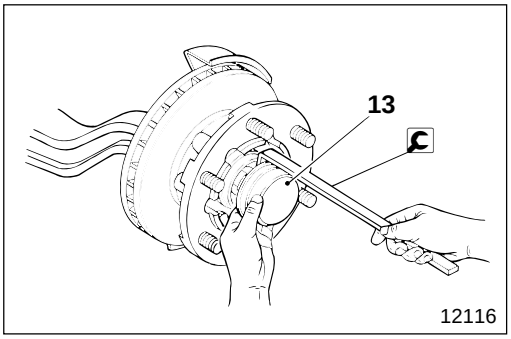
Starting from the wheel brake side, secure the harness of wheel speed sensor **6** in place at white tape sections **A** using clips **7**, while making sure that there is no interference, twisting or excessive sagging of the harness.

B : Shock absorber
***** : Pad wear indicator harness

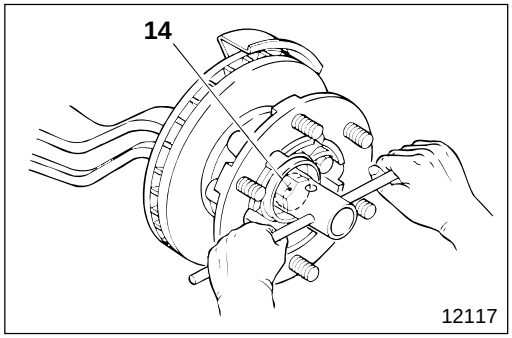


12 **Installation of brake pad wear indicator harness of disc brake assembly**

Fix the taping position for brake pad wear indicator harness **A** on disc brake assembly **12** using clip **8**.

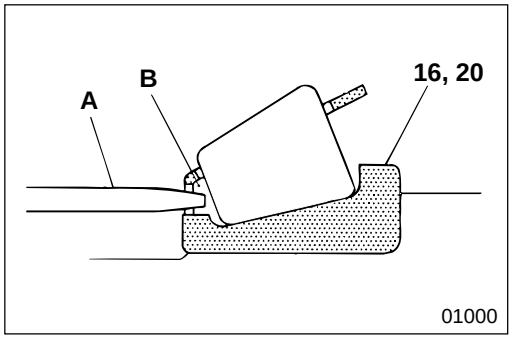


13 **Removal of hub cap**



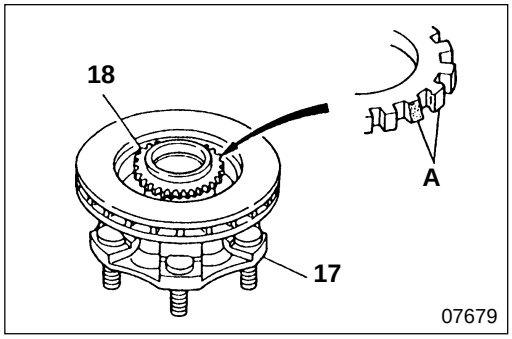
14 **Removal and installation of lock nut**

Refer to adjustment of the starting torque of the wheel hub bearing.
P26A-13



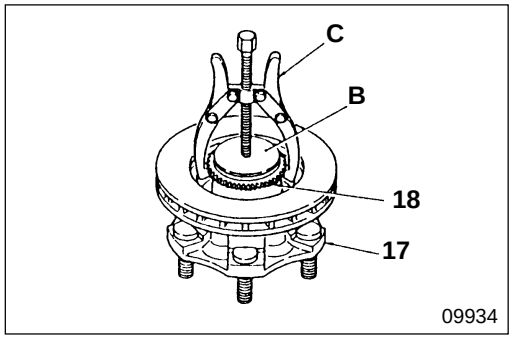
16 **20** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Between rollers



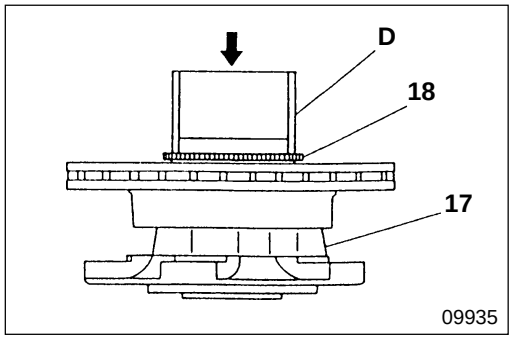
18 **Rotor**

[Inspection]
Check rotor **18** for chipped or crushed teeth (see section **A** in the diagram).
If an abnormality is found, replace the rotor.

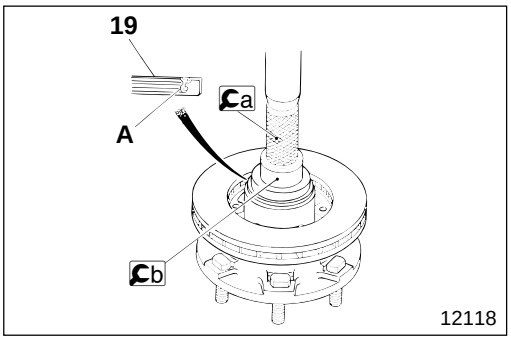


[Removal]

B : Iron plate
C : Gear puller

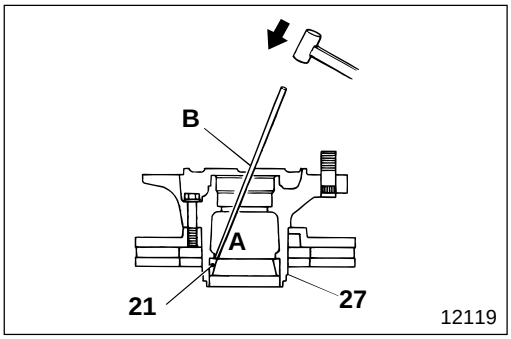


[Installation]
Before installing rotor **18** to wheel hub and rotor assembly **17**, heat the rotor to approximately 150°C {302°F}. Using pipe **D**, install the rotor to the wheel hub and rotor assembly by applying uniform pressure to prevent the rotor from tilting.



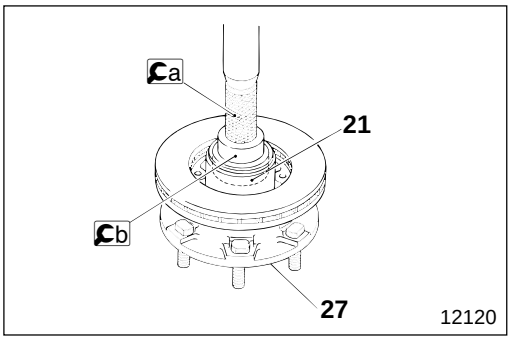
19 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **19** and press-fit it.

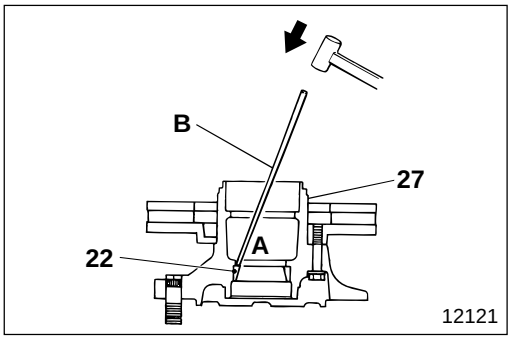


21 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **21** from the two indented parts **A** in wheel hub **27**.
B : Pin-punch

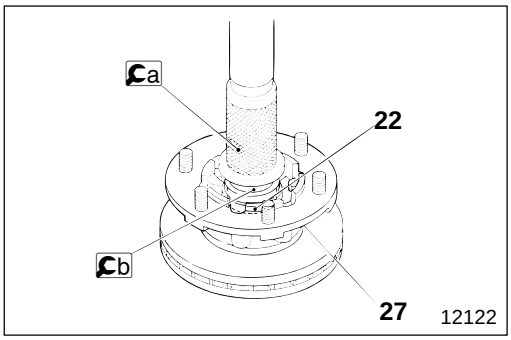


[Installation]

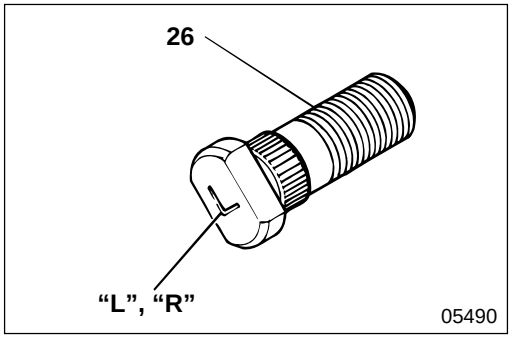


22 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **22** from the two indented parts **A** in wheel hub **27**.
B : Pin-punch

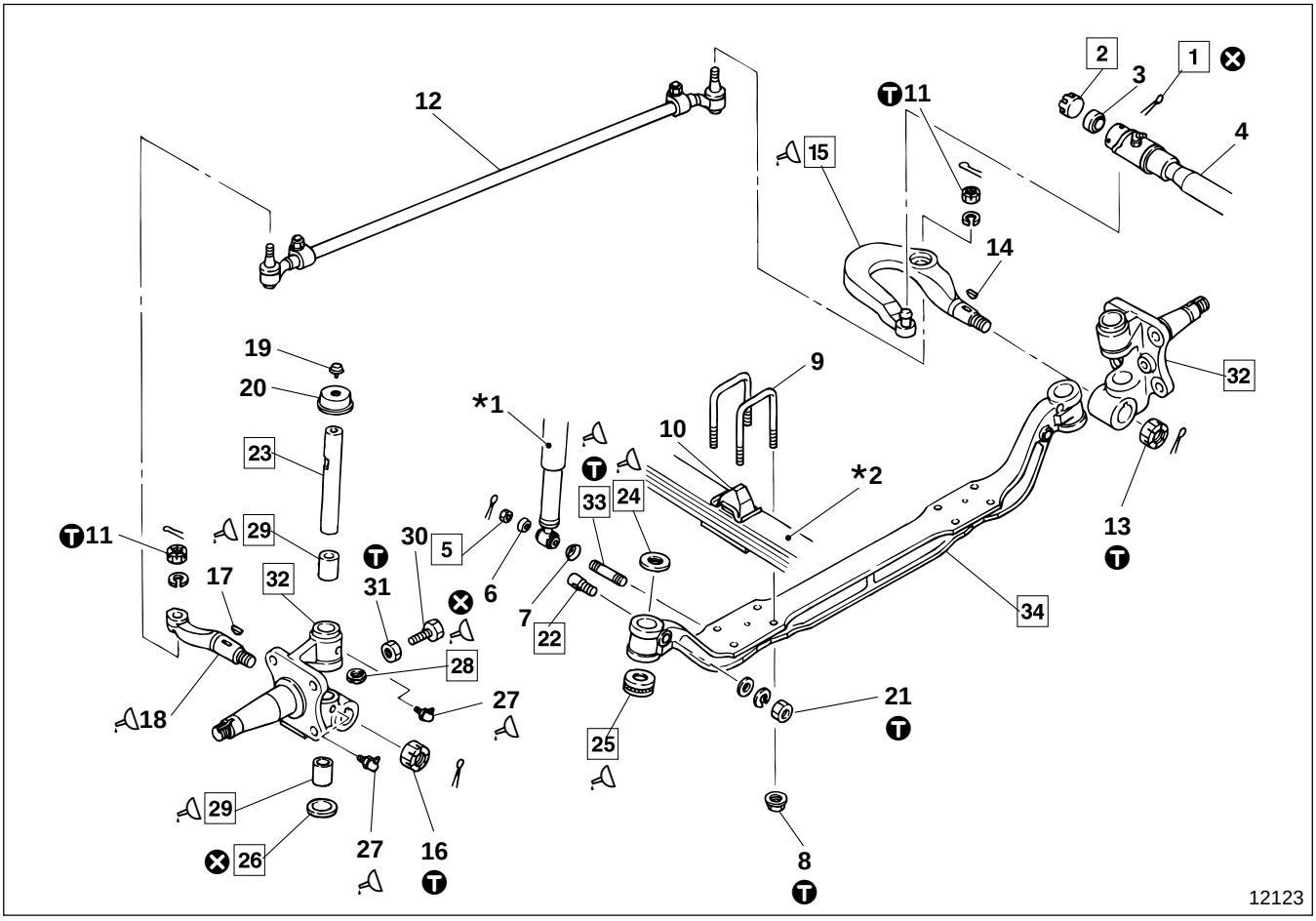


[Installation]



26 **Installation of hub bolt**

Hub bolt **26** is marked with "**L**" (left) or "**R**" (right) to indicate the side it is to be installed on. Check this symbol before installing the bolt.



● **Disassembly sequence**

1 Split pin
2 End plug
3 Ball seat
4 Drag link Gr 37
5 Nut
6 Eye washer
7 Washer
8 U-bolt nut
9 U-bolt
10 Front axle bumper
11 Nut
12 Tie rod assembly Gr 37
13 Nut
14 Key
15 Knuckle arm
16 Nut
17 Key
18 Tie rod arm
19 Dust plug
20 Dust cap
21 Nut
22 Lock pin
23 Kingpin
24 Kingpin shim
25 Thrust bearing
26 Plug
27 Grease nipple
28 Dust seal
29 Kingpin bushing
30 Knuckle stopper bolt
31 Lock nut
32 Knuckle
33 Stud bolt
34 Front axle

***1** : Shock absorber Gr 33
***2** : Leaf spring Gr 33
⊗ : Non-reusable parts

● **Assembly sequence**

31 → **30** → **32** → **29** → **28** → **27** → **26** ⟶ **23** → **22** → **21** → **20** → **18** → **16** → **15** → **13** → **12** → **11** → **10** → **9** → **8** → **7** → **6** → **5** → **4** → **3** → **2** → **1**

34 → **33** → **25** → **24** ⟶ (**19**, **17**, **14**)

Repair kit : Kingpin kit

FRONT AXLE, KNUCKLE AND KINGPIN

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
23	Kingpin outer diameter	$[28]^{-0.020}_{-0.053}$ $\left\{[1.102]^{-0.00079}_{-0.0021}\right\}$	27.9 {1.098}	Replace
29	Inner diameter of kingpin bushing (After press-fitting into knuckle)	$[28]^{+0.033}_{0}$ $\left\{[1.102]^{+0.0013}_{0}\right\}$	—	Replace
	Clearance between kingpin and kingpin bushing	0.020 to 0.086 {0.00079 to 0.0034}	0.15 {0.0059}	
32, 34	Vertical clearance between knuckle and front axle	0.02 to 0.10 {0.00079 to 0.0039}	0.20 {0.0079}	Adjust using kingpin shim
34	Bend in front axle, longitudinal direction	2 {0.079} or less	2 {0.079}	Replace
	Bend in front axle, vertical direction	2 {0.079} or less	2 {0.079}	
	Front axle kingpin inclination angle	8°	8°±10'	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

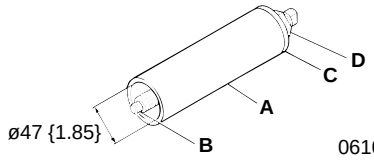
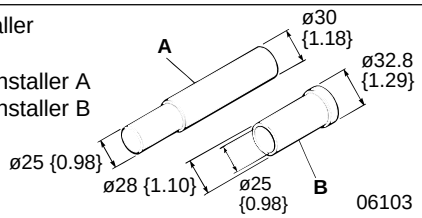
Location	Parts to be tightened		Tightening torque	Remarks
8	U-bolt nut (U-bolt mounting)		162±15 {120±11, 16.5±1.5}	—
11	Nut (Tie rod mounting)		93±25 {69±18, 9.5±2.5}	—
13	Nut (Knuckle arm mounting)		245±49 {180±36, 25±5}	—
16	Nut (Tie rod mounting)		245±49 {180±36, 25±5}	—
21	Nut (Lock pin mounting)		33±5 {25±3.6, 3.4±0.5}	—
31	Lock nut (Knuckle stopper bolt fastening)		46.5±7 {34±5.4, 4.75±0.75}	—
33	Stud bolt	Inserting	88 {65, 9}	—
		Removing	137 {100, 14}	—

Lubricant and sealant

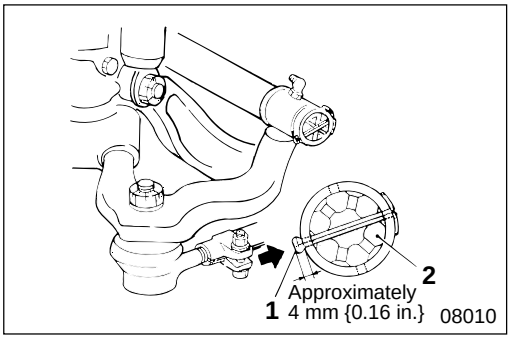
Location	Points of application	Kinds	Quantity
15, 18	Thread areas of knuckle arm and tie rod arm	Chassis grease [NLGI No. 1 (Ca soap)]	As required when reused
24	Both surfaces of kingpin shim	Chassis grease [NLGI No. 1 (Ca soap)]	As required
25	Upper surface of thrust bearing	Chassis grease [NLGI No. 1 (Ca soap)]	As required
27	Supply via grease nipple	Chassis grease [NLGI No. 1 (Ca soap)]	Pack until grease overflows from dust plug
28	Lip area of dust seal	Chassis grease [NLGI No. 1 (Ca soap)]	As required
29	Inner surface of kingpin bushing	Chassis grease [NLGI No. 1 (Ca soap)]	As required
33	Thread area of stud bolt	LOCTITE 271	As required

Special tools

Unit : mm {in.}

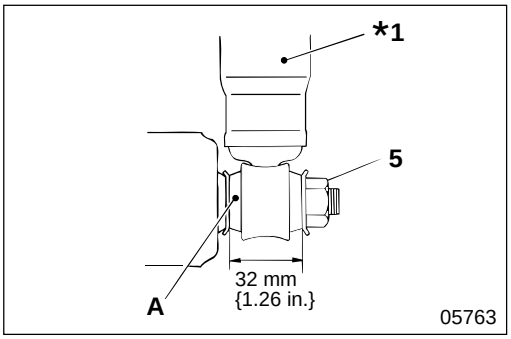
Location	Tool name and shape	Part No.	Application
23	Kingpin puller **A** : Pipe **B** : Bolt **C** : Cap **D** : Nut 	MB999013 **A**: MB999014 **B**: MB999015 **C**: MB999016 **D**: MB999017	Removal of kingpin
29	Bushing installer **A** : Bushing installer A **B** : Bushing installer B 	MB999066 **A**: MB999067 **B**: MB999068	Removal and installation of kingpin bushing

◆ Service procedure



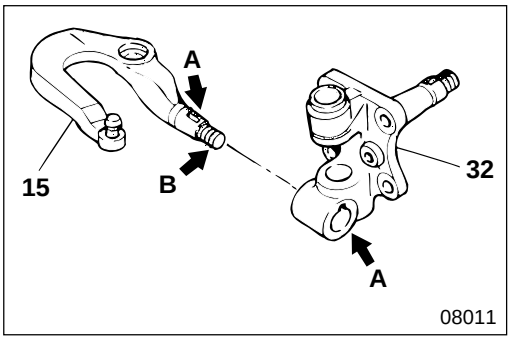
1 **2** **Mounting of split pin and end plug**

- Tighten end plug **2** fully and slacken off by one half of a turn, then turn the plug so that the head of split pin **1** faces the outside of the body.
- Caulk the head of split pin **1** until it is approximately 4 mm {0.16 in.} thick.



5 **Mounting of nut**

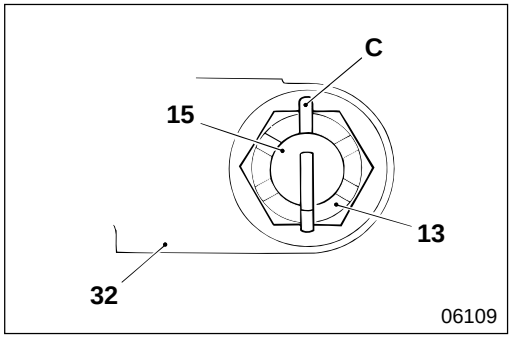
Mount and tighten nut **5** so that the dimensions of rubber bushing **A** of shock absorber ***1** are as illustrated.



15 **32** **Installation of knuckle arm and knuckle**

(1) Reassembly of existing knuckle arm 15 and/or knuckle 32

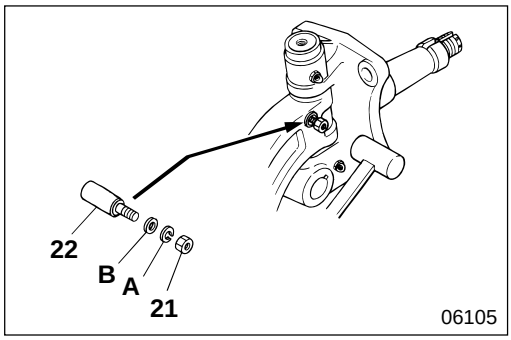
- Polish taper surfaces **A** of knuckle arm **15** and knuckle **32** with emery paper (120 grit or finer) uniformly, until abrasion traces left by the emery paper are only just visible. For new parts, polishing is not required.
- Clean taper surfaces **A** of knuckle arm **15** and knuckle **32**, and thread area **B** of the knuckle arm. (Use a cleaning solvent for acetone color checking or other solvent.)



- Install knuckle arm **15** after applying grease to thread area **B**. (Do not grease the taper surface of knuckle arm and knuckle **32**.)
- Tighten new nut **13** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

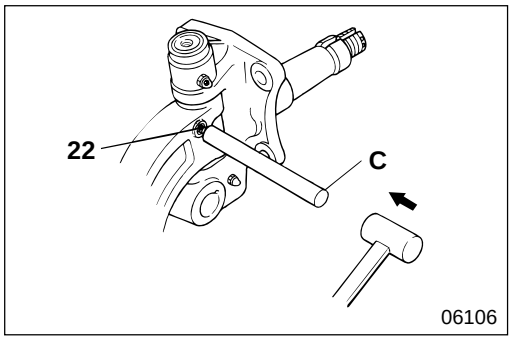
(2) Installation of new knuckle arm 15 and new knuckle 32

- Clean taper surfaces **A**, or thread area **B**, of knuckle arm **15** and knuckle **32**, and install them without greasing.
- Tighten new nut **13** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

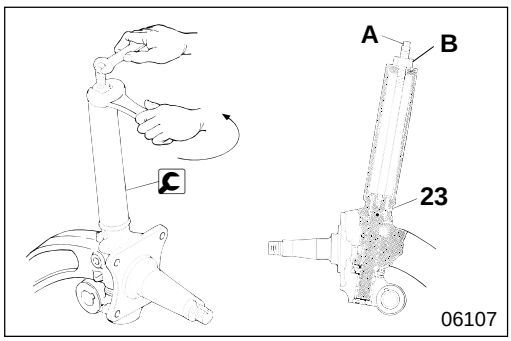


22 Removal of lock pin

- Remove nut **21**, spring washer **A**, and washer **B**. Screw the nut off lock pin **22** again until they are almost level with each other. Then, tap the nut lightly to loosen the lock pin.

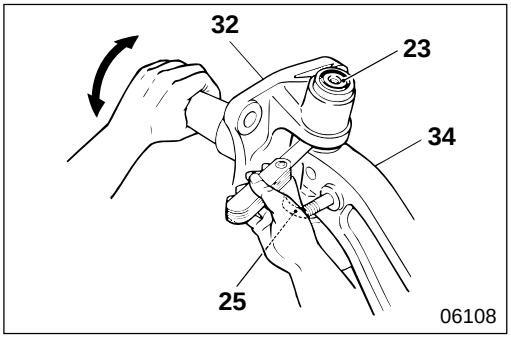


- Remove nut **21**. While holding drift **C** against lock pin **22**, tap the lock pin lightly to extract it.



23 Removal of kingpin

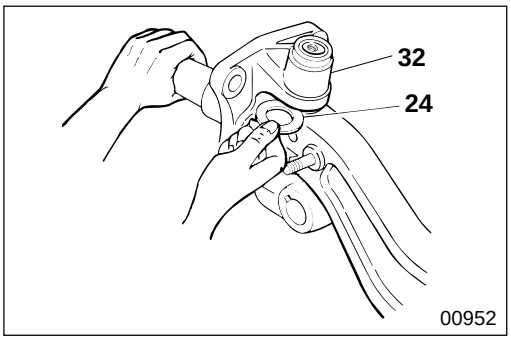
- Screw bolt **A** of the kingpin puller into the thread area of kingpin **23**.
- Fasten bolt **A** with nut **B**, and remove kingpin **23**.



24 **32** **34** **Kingpin shim, knuckle, and front axle**

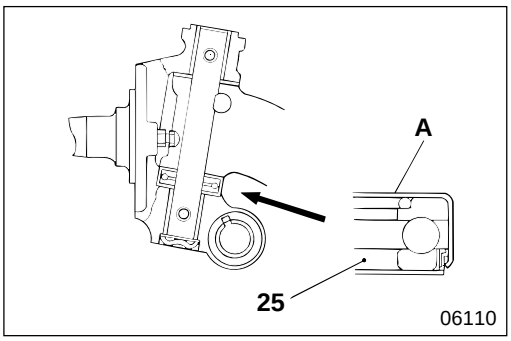
[Inspection]

- Assemble kingpin **23** and thrust bearing **25** temporarily, and turn knuckle **32** a couple of times to smooth its operation.
- Measure the clearance between the upper surface of front axle **34** and the lower part of knuckle **32**.
- If the measured value is higher than the limit, adjust the clearance.



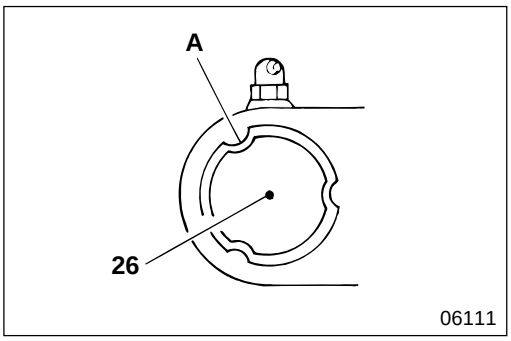
[Adjustment]

- Adjusting kingpin shim **24** is available in four thickness: 0.10 mm {0.0039 in.}, 0.15mm {0.0059 in.} 0.20 mm {0.0079 in.} and 0.30 mm {0.012 in.}
- Be sure to minimize the clearance by selecting appropriate kingpin shim **24**.
- Make sure that knuckle **32** turns smoothly after assembly.



25 **Installation of thrust bearing**

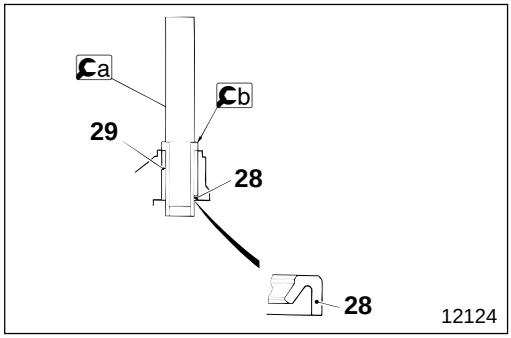
Install thrust bearing **25** with case **A** facing upwards.



26 **Mounting of plug**

Drift in plug **26**, and caulk it securely at three equidistant points around the circumference.

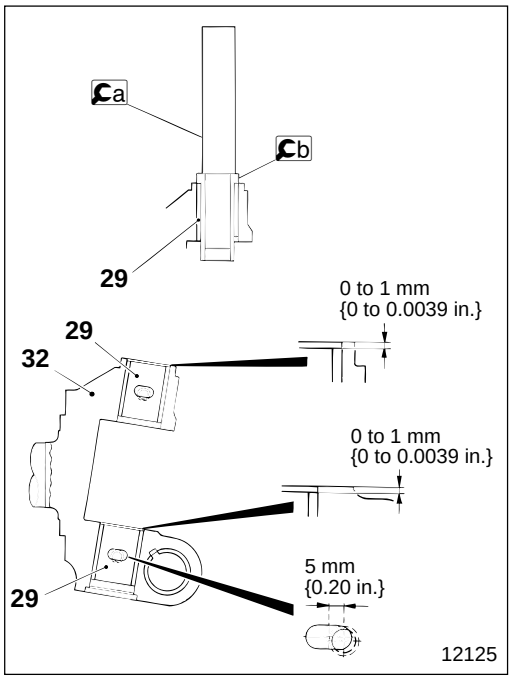
A : When caulked



28 **29** **Dust seal and kingpin bushing**

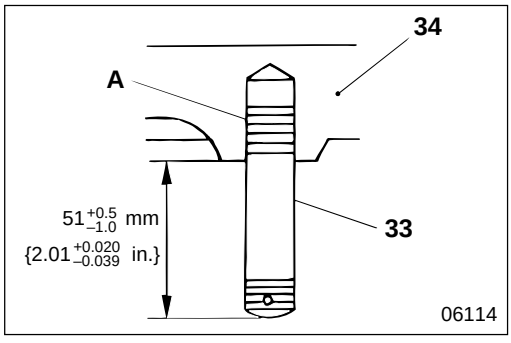
[Removal]

When removing the upper part of kingpin bushing **29**, remove dust seal **28** at the same time.



[Installation]

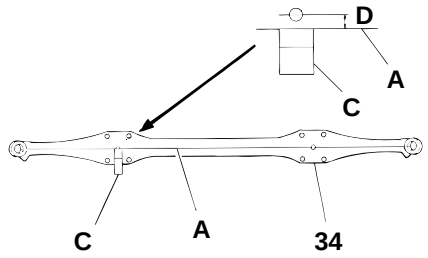
- Press-fit kingpin bushing **29** so that gap **A** between kingpin bushing **29** and knuckle **32** is within 0 to 1 mm {0 to 0.039 in.}.
- Oil hole of kingpin bushing **29** and tapped hole of knuckle **32** should not deviate from each other by more than 5 mm {0.20 in.}.
- Apply grease to lip area **C** of dust seal **28** and press-fit in the direction as illustrated in the upper figure.



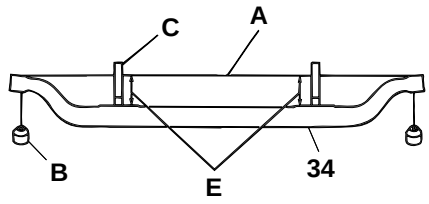
33 **34** **Stud bolt and front axle**

- Coat thread area **A** of stud bolt **33** in front axle **34** with lock tite.
- Mount stud bolt **33** maintaining a mounting dimension within $51^{+0.5}_{-1.0}$ mm {$2.01^{+0.020}_{-0.039}$ in.}.

< Longitudinal >



< Vertical >

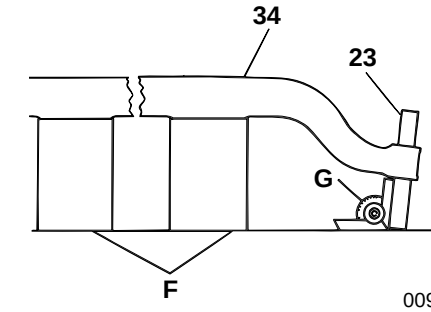


00954

34 Inspection of front axle

(1) Measurement of bend in front axle in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **34** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **34**.



00955

(2) Measurement of kingpin inclination angle

Mount kingpin **23** in front axle **34** as illustrated, and measure the kingpin inclination angle. If the measured value is higher the limit, replace the front axle.

F : Block gauge
G : Bevel square

MITSUBISHI
FUSO

Group 26B

Front Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-26B

INDEX

SPECIFICATIONS 26B- 2

STRUCTURE AND OPERATION 26B- 2

TROUBLESHOOTING 26B- 6

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Adjustment of Wheel Alignment 26B- 8
- Adjustment of Steering Angle 26B- 12
- Measurement of Side Slip 26B- 13

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT AXLE 26B- 14

WHEEL HUB AND BRAKE DRUM 26B- 16

KNUCKLE AND DRIVE SHAFT 26B- 26

AXLE HOUSING 26B- 32

REDUCTION AND DIFFERENTIAL 26B- 34

SPECIFICATIONS / STRUCTURE AND OPERATION

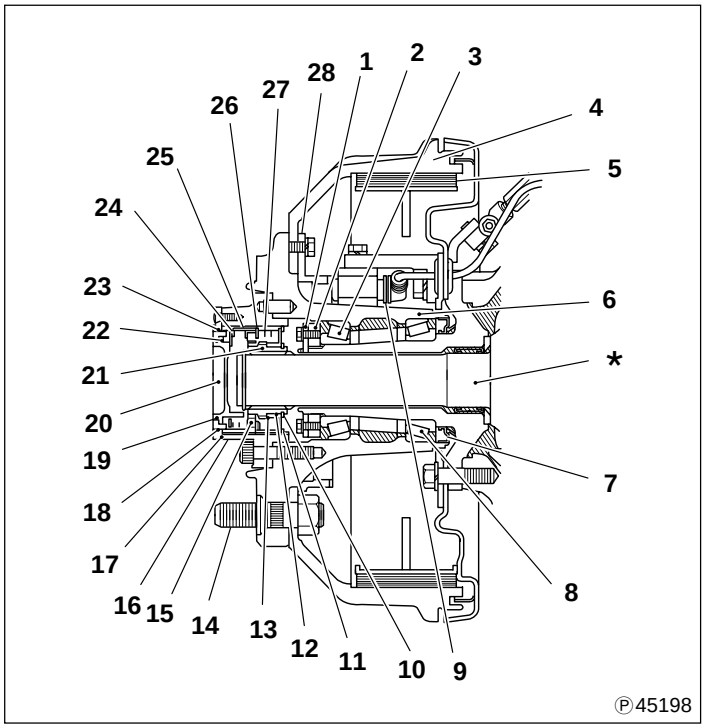
SPECIFICATIONS

Item		Specifications
Front axle	Model	F020TW
	Type	Full floating type with birfield joint
Tread	Torque mm {in.}	1665 {65.6}
Reduction	Model	D1H modified
	Type	Single-reduction gear
	Tooth shape	Hypoid gear
	Speed reduction ratio	5.714
Differential	Tooth shape	Straight bevel gear
Gear oil	Grade	* Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140
	Oil volume L {qts.}	3.0 {3.2}
Mass (reference) kg {lb}		Approximately 230 {505}

* When used under heavily-loaded, severe conditions such as continuous driving on uphill grades, it is recommended that you use gear oil with a SAE viscosity grade of 140. However, the air temperature must be above 10°C {50°F}.

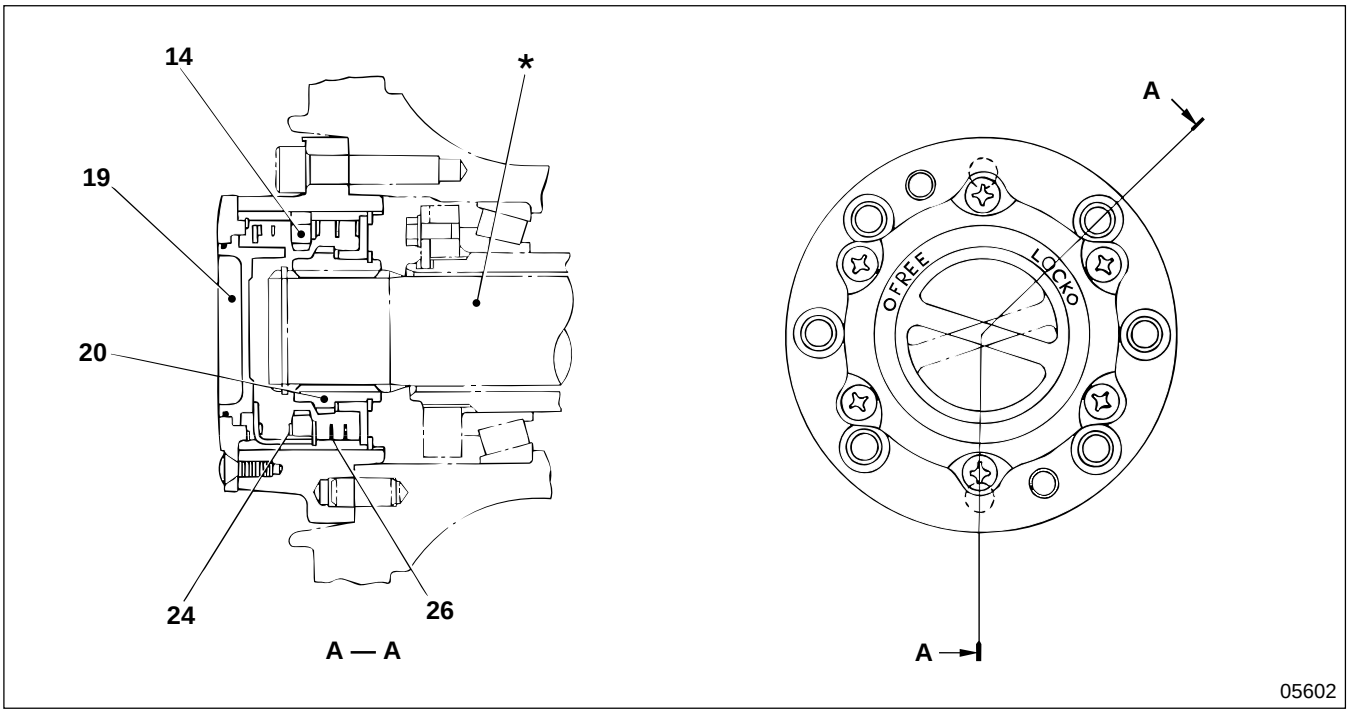
STRUCTURE AND OPERATION

Wheel Hub and Brake Drum

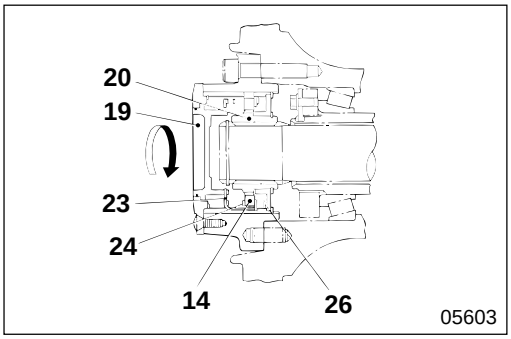


1 Lock washer
2 Lock nut
3 Outer bearing
4 Brake drum
5 Brake assembly
6 Wheel hub
7 Oil seal
8 Inner bearing
9 Wheel speed sensor
10 Snap ring
11 Snap ring
12 Center ring plate
13 Thrust washer
14 Hub bolt
15 Driven gear
16 Housing
17 Gasket
18 Cover
19 O-ring
20 Knob
21 Drive gear
22 Snap ring
23 Snap ring
24 Retainer
25 Shift spring
26 Retainer washer
27 Return spring
28 Sensor ring
***** : Drive shaft

Free-wheel Hub



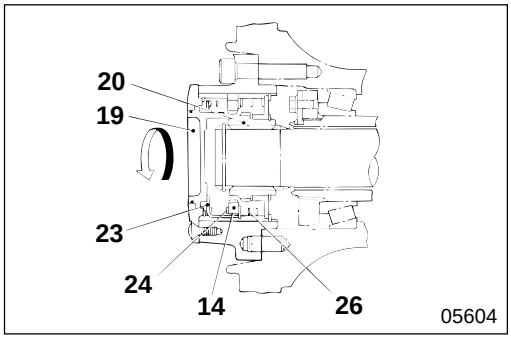
- In the case of a four-wheel drive vehicle, even when it is running in rear-wheel drive only, the drive shaft *, differential, propeller shaft, and driving parts of the transfer front drive shaft continue to run due to transmission of rotation from the wheels. This subjects the vehicle drive to a load, and it causes loss of driving power.
  Now, with a free-wheel hub, transmission of rotation from the front wheels to the drive shaft * is cut, reducing driving loss when running in rear-wheel drive only. This improves fuel efficiency and reduces vibration and noise.
- With a free-wheel hub, FREE (cutting of driving power) ↔ LOCK (transmission of driving power) is made easily by manual operation.



Operating mechanism

● **From FREE to LOCK**

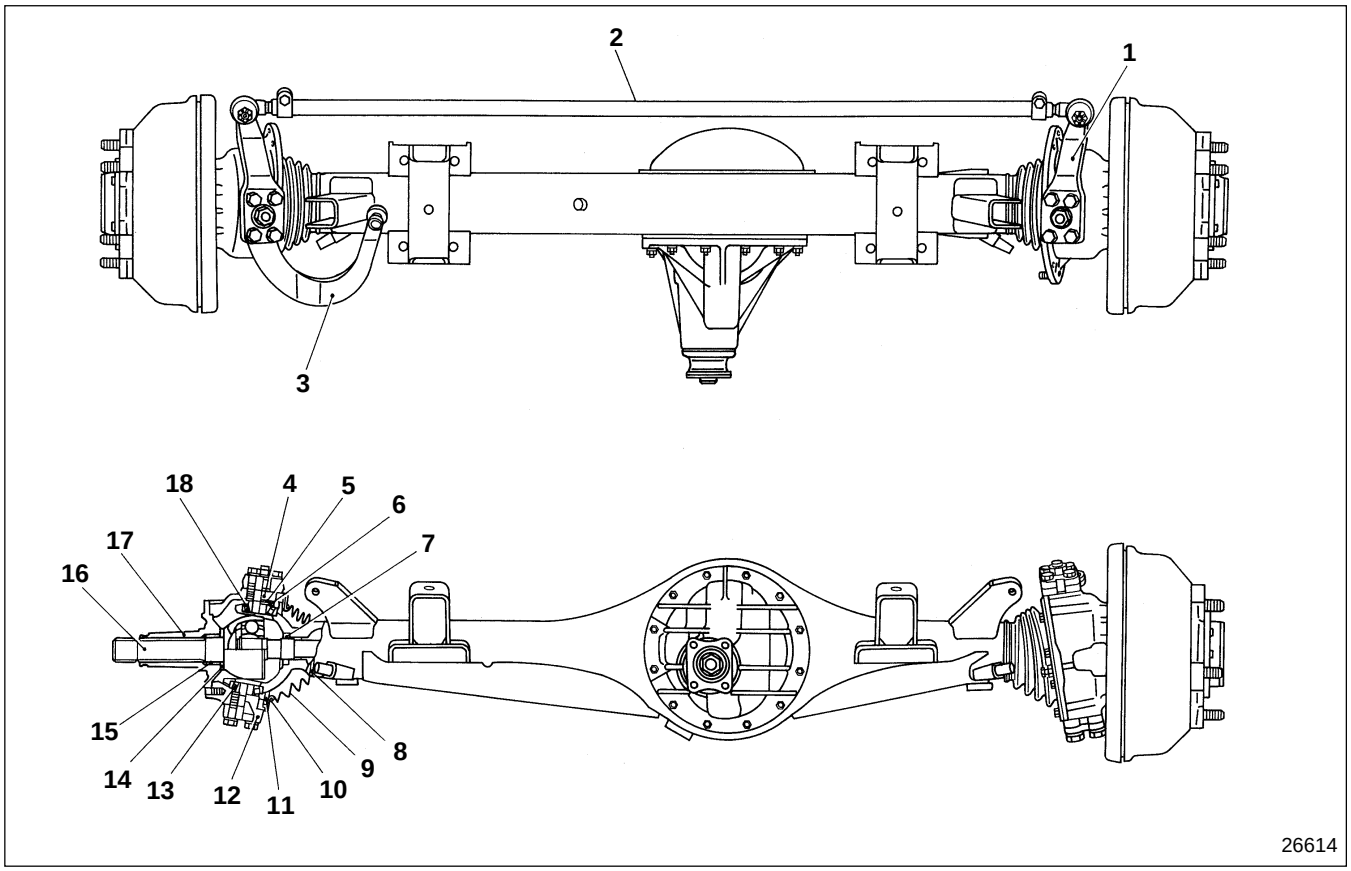
When knob **19** is turned to LOCK, retainer **23** shifts to the inside along with the shape of the knob, pressing return spring **26**. At this instance, driven gear **14**, being pressed by shift spring **24**, engages with drive gear **20** at the spline, and transmits the driving power.



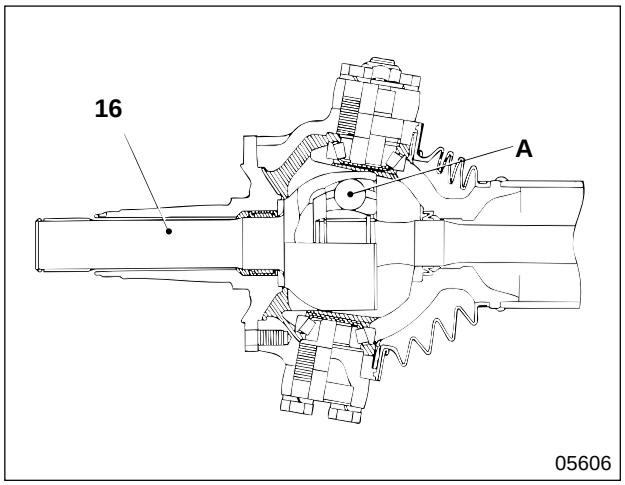
● **From LOCK to FREE**

When knob **19** is turned to FREE, the action is the reverse of FREE to LOCK, and the driving power is disengaged.

Axle, Knuckle, and Drive Shaft

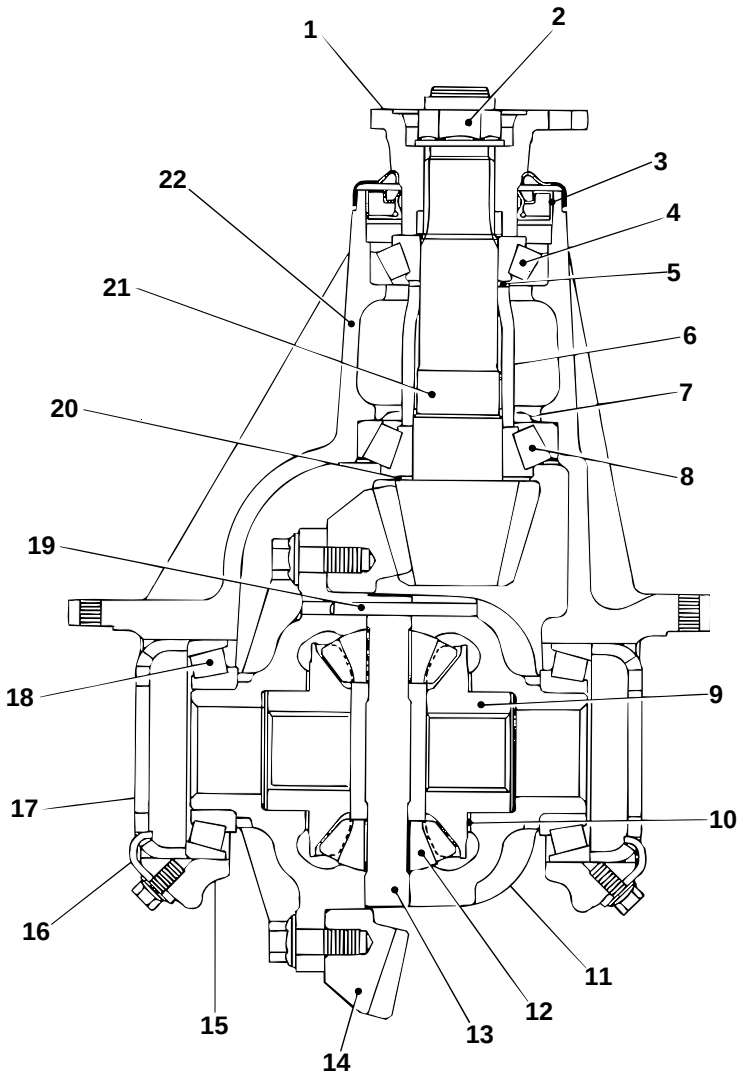


1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Kingpin, upper
5 Conical spring
6 Spacer
7 Oil seal
8 Boot band
9 Dust boot
10 Retainer
11 Dust seal
12 Kingpin, lower
13 Trunnion bearing
14 Spacer
15 Needle bearing
16 Axle shaft assembly
17 Knuckle spindle
18 Trunnion bearing



Axle shaft assembly **16** should transmit power in response to the variations in rotation speed that occur due to variations in steering angle, etc. when steering the vehicle.
To support this function, Birfield joint assembly area **A** in axle shaft assembly **16** uses a constant speed joint that transmits power evenly, eliminating variations in rotation speed between the driving shaft and the driven shaft.

Reduction and Differential



1 Companion flange assembly
2 Lock nut
3 Oil seal
4 Front bearing
5 Front bearing shim
6 Pinion spacer
7 Oil stopper
8 Rear bearing
9 Differential side gear
10 Differential side gear thrust washer
11 Differential inner case
12 Differential pinion gear
13 Pinion shaft
14 Final drive gear
15 Bearing cap
16 Lock plate
17 Side bearing nut
18 Side bearing
19 Lock pin
20 Rear bearing shim
21 Final drive pinion
22 Differential carrier

TROUBLESHOOTING

Possible causes	Symptoms	Oil leaking from companion flange assembly	Oil leaking from differential carrier and front axle housing	Oil leaking from drive shaft assembly	Power transmission incorrect					
					Propeller shaft turns but front wheels do not turn (at bench test)	Noise when starting and when changing gear	Continuous noise while cruising	Intermittent noise while cruising	Noise while steering into a bend	Tires drag while steering into a bend
Wheel hub, knuckle and drive shaft, and axle housing	Front axle housing bent						○			
	Drive shaft assembly bent						○			
	Drive shaft assembly damaged				○					
	Drive shaft assembly disengaged from differential gear spline				○					
	Birfield joint in drive shaft assembly faulty				○	○	○			
	Kingpin bearing loose								○	
	Knuckle bearing worn						○			
	Oil seal faulty			○						
	Wheel hub bearing seized, worn, or rotation faulty						○			
	Wheel hub bearing damaged							○		
Reduction and differential	Gear oil excessive	○								
	Gear oil insufficient					○	○			
	Oil seal faulty	○								
	Vent plug clogged	○		○						
	Sealant faulty		○							
	Side bearing seized, worn, or rotation faulty						○		○	
	Side bearing broken							○		
	Side bearing preload adjusted incorrectly						○			
	Reduction and differential assembly mounting nut loose		○					○		
	Differential carrier cracked or damaged		○							
	Final drive gear and differential case tightening bolt loose					○		○		
	Final drive gear or final drive pinion broken				○	○		○	○	
	Final drive gear or final drive pinion worn						○		○	
	Final drive gear or final drive pinion damaged						○			

Possible causes	Symptoms	Oil leaking from companion flange assembly	Oil leaking from differential carrier and front axle housing	Oil leaking from drive shaft assembly	Power transmission incorrect: Propeller shaft turns but front wheels do not turn (at bench test)	Power transmission incorrect: Noise when starting and when changing gear	Power transmission incorrect: Continuous noise while cruising	Power transmission incorrect: Intermittent noise while cruising	Power transmission incorrect: Noise while steering into a bend	Power transmission incorrect: Tires drag while steering into a bend
Reduction and differential	Final drive gear backlash excessive					○				
	Final drive gear backlash or tooth contact adjusted incorrectly						○			
	Final drive pinion starting torque adjusted incorrectly					○	○			
	Lock nut loose					○	○			
	Differential gear backlash excessive					○				
	Front or rear bearing seized				○		○			
	Front or rear bearing worn						○			
	Front or rear bearing broken							○		
	Differential gear or differential pinion broken				○			○	○	○
	Differential gear or differential pinion seized				○					○
	Differential gear or differential pinion worn								○	○
	Spacer worn or damaged							○	○	○
	Differential gear spline worn					○				

ON-VEHICLE INSPECTION AND ADJUSTMENT

Adjustment of Wheel Alignment

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Wheel alignment	Toe-in (with tires on the ground)	0 to 6 {0 to 0.24}	—	—
		Camber	1°00'±30'	—	—
		Caster	0°30'±1°00'	—	—
		Kingpin inclination angle	9°30'	9°30'±30'	—

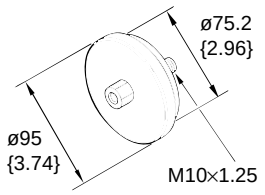
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Clamp bolt (Tie rod end clamp fastening)	25±5 {18±3.6, 2.5±0.5}	—

Special tools

Unit : mm {in.}

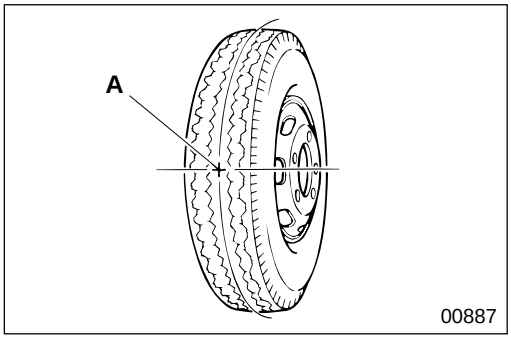
Location	Tool name and shape	Part No.	Application
—	Alignment gauge adapter 	MH061994 (Obtain Locally)	Measurement of camber and caster angles, and kingpin inclination angle: with free-wheel hub only

NOTE

- **Measure the wheel alignment when the vehicle is empty and level.**
- **Be sure that each part of the front axle has been serviced perfectly before adjusting the wheel alignment.**

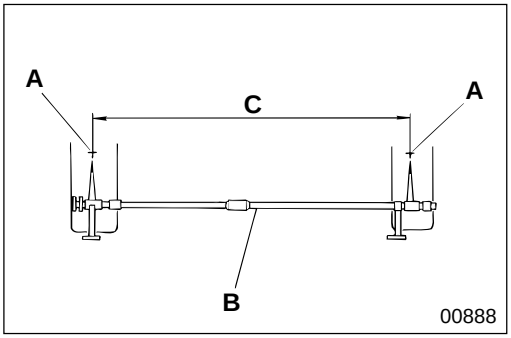
Before adjusting the wheel alignment, check for the following faults :

- Play in front wheel hub
- Play or looseness in kingpin
- Play or looseness in the joint between the tie rod and the knuckle arm
- Looseness of any fasteners
- Fatigued or damaged leaf springs
- Incorrect tire pressure
- Incorrect steering gear backlash

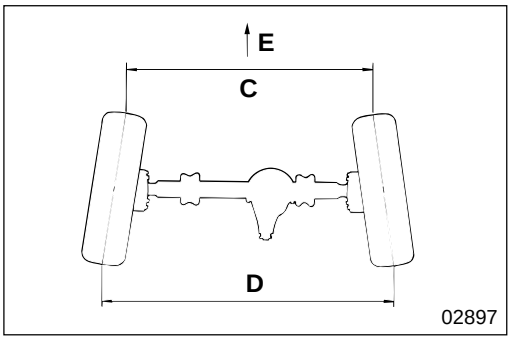


(1) Measurement and adjustment of toe-in

- Point the front wheels exactly forward.
- Put mark **A** on the left and right front tires at the height of front wheel axis and in the middle of the tire width.

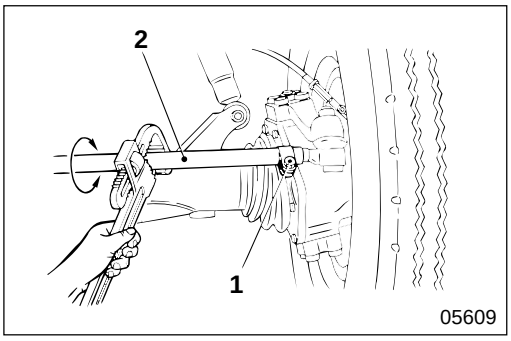


- Align the two points of toe-in gauge **B** to the respective marks **A** on the front tires. Measure the distance **C** between the marks at the front of the vehicle.

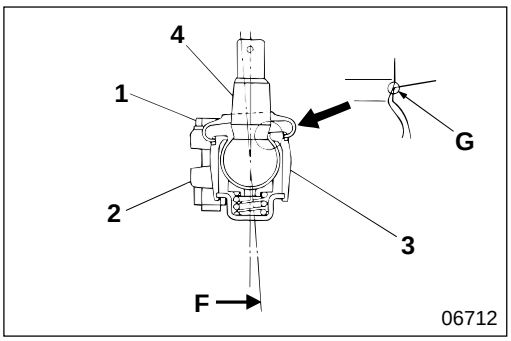


- Rotate the tires 180° and measure the distance **D** between the marks at the rear of the vehicle with the tires on the ground.
- Check if the difference between distances **C** and **D** is within the standard value.

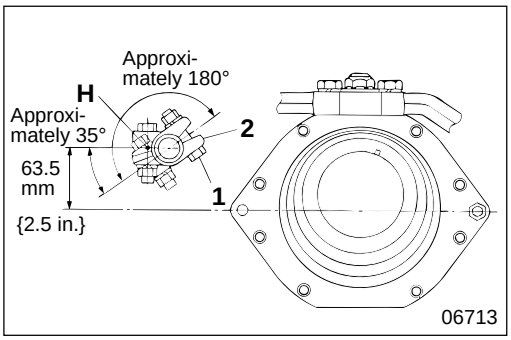
E : Front of the vehicle

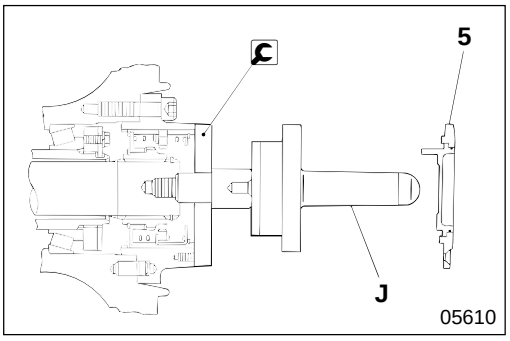


- If the measured value deviates from the standard value, with the tires pointed forward, loosen left and right clamp bolts **1** and adjust the toe-in to the standard value by turning tie rod **2** with a pipe wrench.



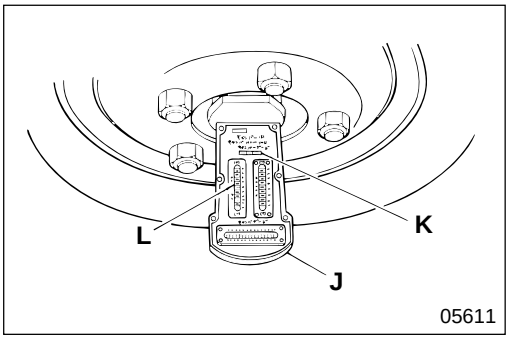
- Move the vehicle forward and turn tie rod **2** towards the front, with the tires pointed forward (**F** as illustated). Make sure when adjusting toe-in to the standard value, that both left and right tie rod ends **3** are in contact with ball stud **4** (**G** as illustrated) at the same time.
  After adjustment, tighten clamp bolt **1** to secure the tie rod.
- In order to keep the end of clamp bolts **1** away from the vehicle, mount tie rod **2** so that clamp center **H** is placed in the range as illustrated.



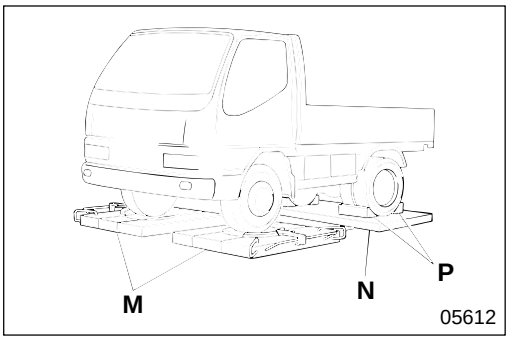


(2) Measurement of camber

- Point the front wheels exactly forward.
- Remove cover assembly **5** and attach 🔧 alignment gauge adapter. Then, attach camber/caster kingpin gauge **J**.



- While keeping the bubble in level **K** centered, measure the camber angle by reading the scale mark at the center of the bubble on camber scale **L**. Follow this procedure to measure the camber angles on the left and right sides.

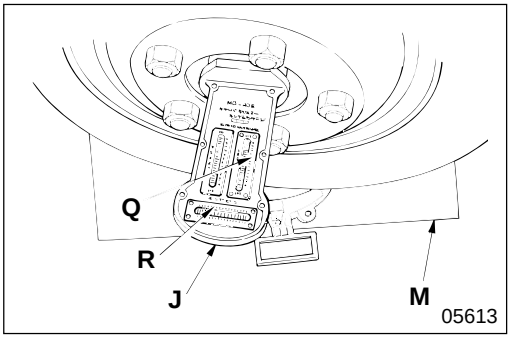


(3) Measurement of caster and kingpin inclination angle

- Align turning radius gauges **M**. Prepare a platform **N** having the same height as the turning radius gauges and place the platform under the rear wheels so that the vehicle is kept level.
- Keep turning radius gauges **M** locked.
- Jack up the vehicle and set the left and right front wheels so that the ground contact area of both front tires and the turntables of turning radius gauges **M** meet at their respective centers.

WARNING⚠

- **After jacking up the vehicle, chock the rear wheels securely with chocks P.**
- **Do not remove chocks P until the entire operation is completed.**



- Unlock turning radius gauges **M**, and set the scale at 0°.
- As in measuring camber explained previously, attach camber/caster kingpin gauge **J** tightly to the front wheel hub and keep the bubble centered.
- Apply the brake to the front wheels and turn the steering wheel slowly from the 0° point on the scale of turning radius gauges **M**, until direction changes 20° to the left for the left front wheel and 20° to the right for the right front wheel.

NOTE

It is not possible to obtain an exact reading of camber unless the brake is applied to the front wheels because the tires might rotate slightly.

- At the 20° point, align the bubbles in caster scale **Q** and kingpin scale **R** to 0° by turning the adjuster.

NOTE

Kingpin scale R has scales for left and right; use the left scale when adjusting the left wheel, and the right scale when adjusting the right wheel.

- Turn the steering wheel slowly until the left front wheel changes its direction 20° to the right, or until the right front wheel changes its direction 20° to the left, past the 0° point of turning radius gauge **M** scale. At this point read the scale marks at the center of the bubbles on caster scale **Q** and kingpin scale **R**. The scale marks indicate the caster and kingpin inclination angles.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Adjustment of Steering Angle

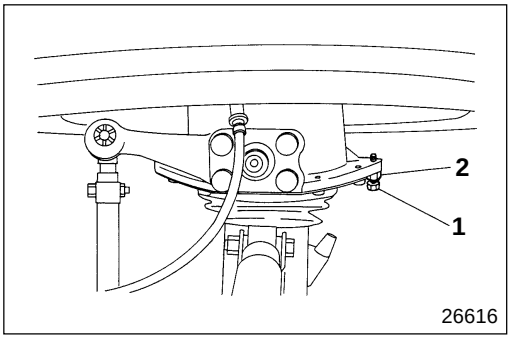
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Steering angle	Inside (Outside : reference)	30° (29°)	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (Knuckle stopper bolt tightening)	96±12 {71±9, 9.75±1.25}	—



NOTE

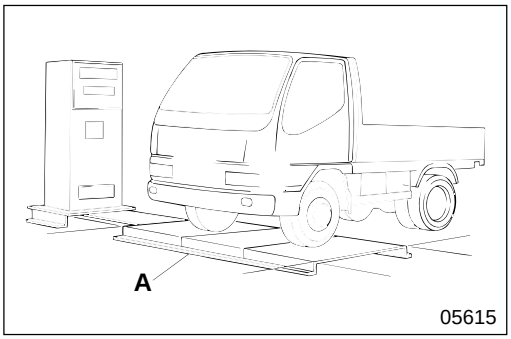
Be sure that wheel alignment is adjusted correctly before adjusting the steering angle.

- To adjust the steering angle, set the turning radius gauges and platform in the same way as for caster and kingpin inclination angle measurement.
- Turn the steering wheel to the left or right completely, and from the position where the turning radius gauge is aligned to 0°, adjust knuckle stopper bolt **1**. Adjust so that the steering angle is within the standard inside steering angle value, to the left for the left front wheel, and to the right for the right front wheel. Then, tighten lock nut **2** at specified torque.

NOTE

Be sure when working on the vehicle, to adjust both stopper bolts 1 at the front and back of the knuckle arm side.

Measurement of Side Slip



NOTE

Be sure that wheel alignment is adjusted correctly before measuring side slip.

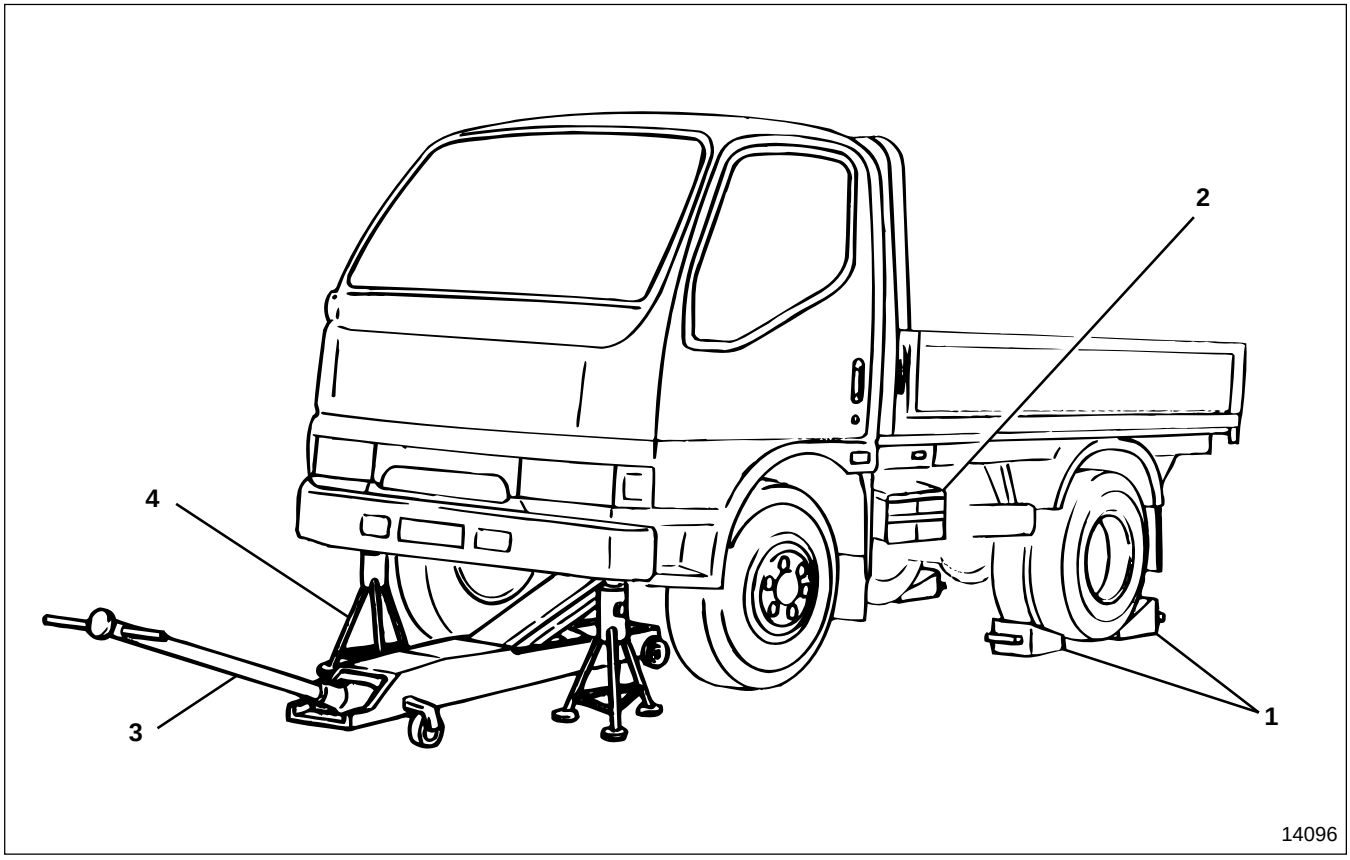
- Point the front wheels exactly forward.
- Maintain this position and slowly move vehicle forward, over side slip tester **A**, as slowly as possible.

NOTE

Make sure, when measuring side slip, that the wheels point exactly forward when the vehicle passes over side slip tester A. Do not allow the wheels to veer from side-to-side.

- The side slip is indicated by side slip tester **A** after the vehicle has passed through the tester. Readjust wheel alignment if slippage is 3 mm {0.12 in.} or more per meter {3.28 ft.}.

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT AXLE



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the front axle with a garage jack.
4 Support the front frame on jack stands.

WARNING

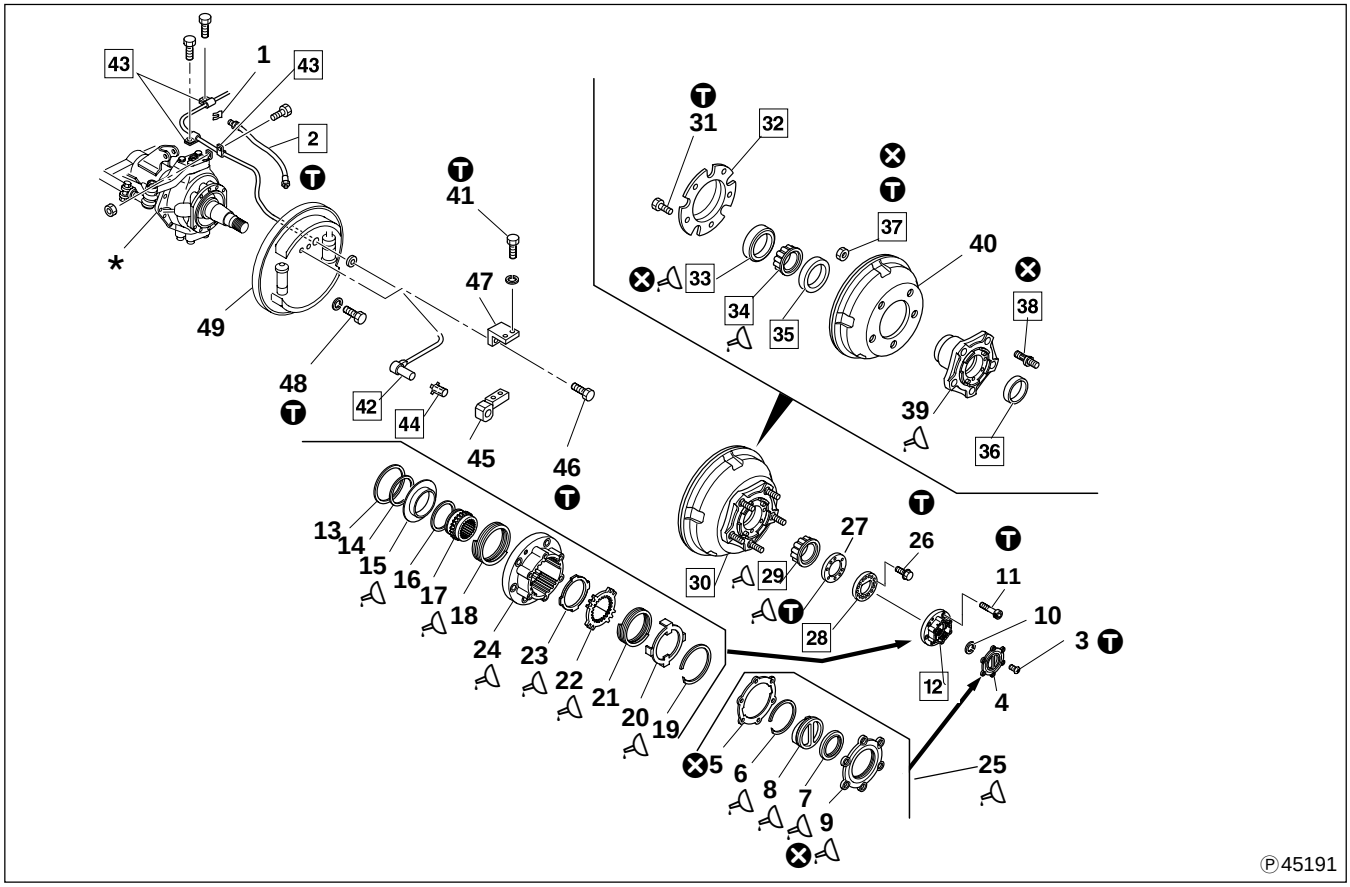
- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on jack stands.**
- **Leave the garage jack stands in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

WHEEL HUB AND BRAKE DRUM



● **Disassembly sequence**

1 Clip
2 Brake hose
3 Screw
4 Cover assembly
5 Gasket
6 Snap ring
7 O-ring
8 Knob
9 Cover
10 Snap ring
11 Bolt
12 Housing assembly
13 Snap ring
14 Snap ring
15 Center ring plate
16 Thrust washer
17 Drive gear
18 Return spring
19 Snap ring
20 Retainer
21 Shift spring
22 Driven gear
23 Retainer washer
24 Housing
25 Free-wheel hub assembly
26 Bolt
27 Lock washer
28 Lock nut
29 Outer bearing
30 Wheel hub and brake drum assembly
31 Bolt
32 Rotor
33 Oil seal
34 Inner bearing
35 Inner bearing race
36 Outer bearing race
37 Nut
38 Hub bolt
39 Wheel hub
40 Brake drum
41 Bolt
42 Wheel speed sensor
43 Clips
44 Spring spacer
45 Sensor holder
46 Bolt
47 Sensor bracket
48 Bolt
49 Brake assembly Gr 35A

* : Knuckle and drive shaft
P26B-26
⊗ : Non-reusable parts

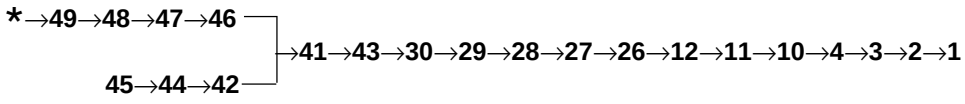
CAUTION

Be sure to protect brake hose 2 from dust by fitting plugs after removal.

NOTE

Do not disassemble wheel hub 39 and brake drum 40 except for replacement.

● **Assembly sequence**



4 : **9→8→7→6→5**

12 : **24→23→22→21→20→19→18→17→16→15→14→13**

25 : Free-wheel hub assembly

30 : **38→39→29→37→36→35→34→33→32→31**

WARNING

- **You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A**
- **Do not allow oil or grease to adhere on the lining surface of brake assembly 49 or the inside surface of wheel hub & brake drum assembly 30.**

CAUTION

- **Be careful not to damage oil seal 33, press-fitted into the top of wheel hub 39, when installing wheel hub and brake drum assembly 30 onto the knuckle and drive shaft.**
- **When installing wheel hub & brake drum assembly 30, be careful not to damage rotor 32, wheel speed sensor 42 or oil seal in the wheel hub.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
29, 34, 35, 36	Starting torque of wheel hub bearing		3±1 N·m {2.2±0.7 ft.lbs, 0.3±0.1 kgf·m}	—	Tangential force at hub bolt 18 to 34 N {4.0 to 7.7 lbf., 1.8 to 3.5 kgf}
42	Wheel speed sensor	Resistance between terminals	1750 ±10 % Ω	—	—
		Insulation resistance	1000 kΩ minimum	—	—

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
2	Brake hose tightening		13 to 17 {9.4 to 12, 1.3 to 1.7}	—
3	Screw (Cover assembly mounting)		5±1 {3.6±0.7, 0.5±0.1}	—
11	Bolt (Housing assembly mounting)		68.6±4.9 {51±3.6, 7±0.5}	—
26	Bolt (Lock washer mounting)		9±2 {6.5±1.4, 0.9±0.2}	—
28	Lock nut (Wheel hub bearing mounting : wheel hub bearing pre-pressure adjusting)	Primary tightening	113±15 {83±11, 11.5±1.5}	—
		After primary tightening, carry-out secondary tightening	25±5 {18±3.6, 2.5±0.5}	—
31	Bolt (rotor mounting)		8.8 to 13.8 {6.5 to 10, 0.9 to 1.4}	
37	Nut (Wheel hub and brake drum mounting)		343±39 {253±29, 35±4}	—
41	Bolt (Sensor holder mounting)		8.8 to 13.8 { 6.5 to 10, 0.9 to 1.4}	—
46	Bolt (Sensor bracket mounting)		11.8 to 12.8 { 8.7 to 9.4, 1.2 to 1.3}	—
48	Bolt (Brake assembly mounting)		123±5 {90±3.6, 12.5±0.5}	—

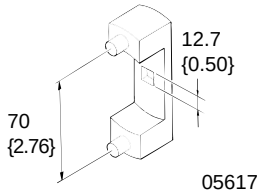
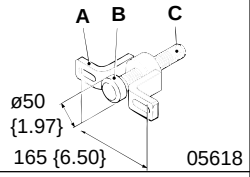
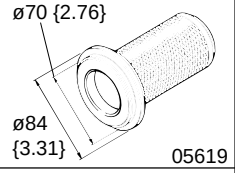
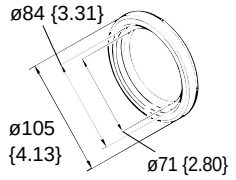
WHEEL HUB AND BRAKE DRUM

Lubricant and/or sealant

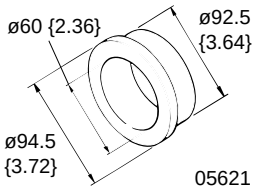
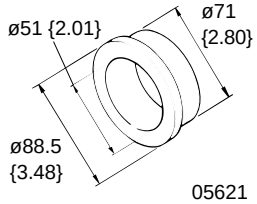
Location	Points of application	Specified lubricant and/or sealant	Quantity
6	Contact surfaces of snap ring and knob	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
7	O-ring	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
8	Contact surfaces of knob and retainer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Contact surfaces of knob and cover	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Drive gear joint surface of center ring plate	Wheel bearing grease [NLGI No.2 (Li soap)]	3 to 5 g {0.11 to 0.18 oz}
17, 22	Contact surfaces of drive gear and driven gear	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
20	Retainer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
23	Retainer washer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
24	Inner surface of housing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
25	Contact surfaces of free-wheel hub assembly and wheel hub	THREEBOND 1104J or 1215	As required
29	Thread area of lock nut	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
29, 34	Pack the space between rollers of outer and inner bearing inner races	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
33	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
39	Pack interior space of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	65±10 g {2.3±0.3oz}
	Housing assembling contact surface of wheel hub	THREEBOND 1104J or 1215	As required

Special tools

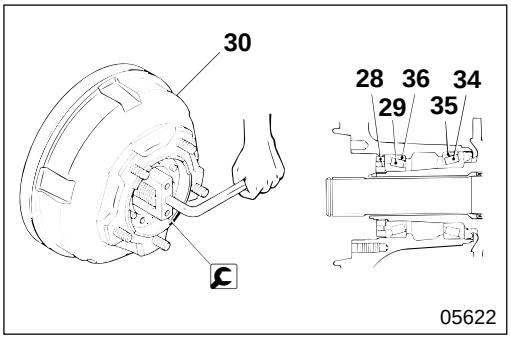
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Lock nut adjustment tool 	MB999151	Removal and installation of lock nut
7	Hub puller **A** : Hub puller body **B** : Attachment **C** : Bolt 	MB999070 **A** : MB999071 **B** : MB999072 **C** : MB999073	(Obtain Locally)
8, 10, 11	Bearing installer 	MB999097 (T90ST30)	Press-fitting of oil seal (Use in combination with *1) Press-fitting of inner bearing outer race (Use in combination with *2) Press-fitting of outer bearing outer race (Use in combination with *3)
8	*1 Oil seal installer 	MB999153	Press-fitting of oil seal (Use in combination)

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
10	*2 Bearing installer 	MB999069	(Obtain Locally)
11	*3 Bearing installer 	MB999099 (T90ST26)	(Obtain Locally)

◆ Service procedure

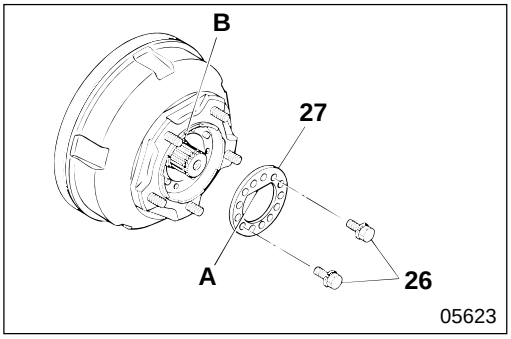


● Starting torque of wheel hub bearing

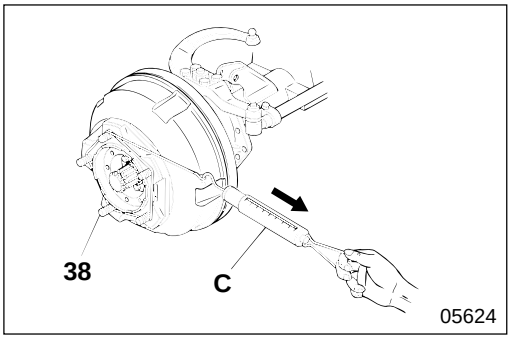
[Adjustment]

- Tighten lock nut **28** at specified torque (primary tightening) while turning wheel hub and brake drum assembly **30**, then slacken off.
- Turn wheel hub and brake drum assembly **30** several times to smooth operation of outer bearings **29**, **36**, and inner bearings **34**, **35** and retighten lock nut **28** at specified torque (secondary tightening).
- After adjustment, make sure that there is no play in the axial direction.

: Lock nut adjustment tool



- Insert lock washer **27** so that flat area **A** fits onto notch **B** of the knuckle spindle. Mount two bolts **26** (diagonally opposite each other) to lock nut **28**, and tighten them at specified torque.
- If lock nut **28** and the hole of lock washer **27** do not align, slacken off the lock nut slightly.



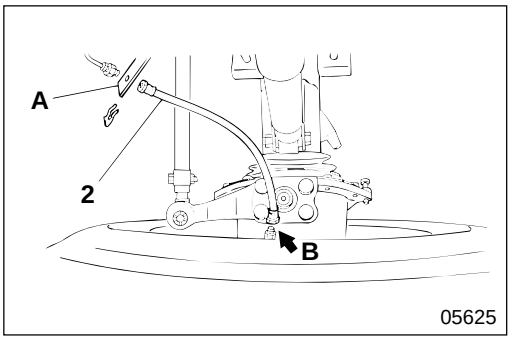
[Measurement]

- Fasten spring balance **C** to hub bolt **38** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- If the measured value deviates from the standard value, adjust the starting torque of the wheel hub bearing according to the procedure described above.

  If any fault is found after adjustment, replace outer bearings **29**, **34**, or inner bearings **34**, **35**.

NOTE

- **Make sure that there is no drag in the brake lining and brake drum 40 before you measure the tangential force.**
- **Make sure that you install oil seal 33.**
- **Do not install free-wheel hub assembly 25.**

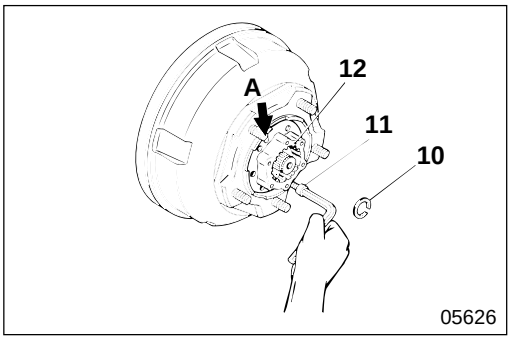


2 **Removal and installation of brake hose**

First remove brake hose **2** from bracket **A** (on the frame), then remove the brake hose from wheel brake **B**. For installation, follow this procedure in reverse.

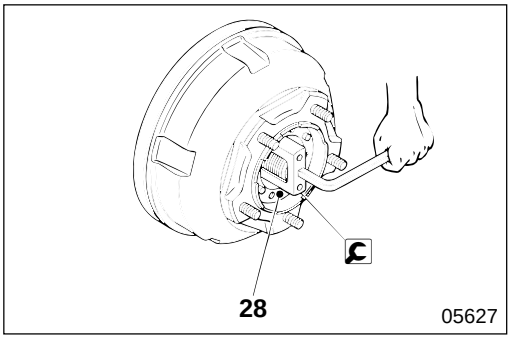
CAUTION

Make sure that brake hose 2 is not twisted when you install it.



12 **Removal of housing assembly**

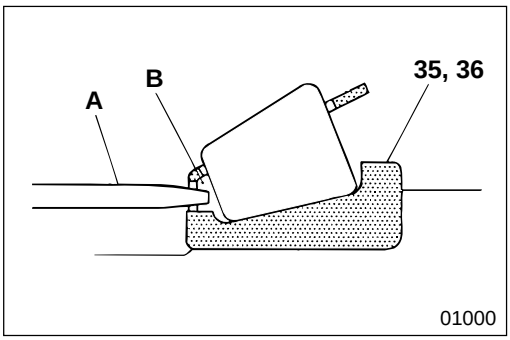
Remove snap ring **10**, and insert bolts **11** (to the same depth) into two tapped holes **A** provided for disassembly. Then, remove housing assembly **12**.



28 **Removal and installation of lock nut**

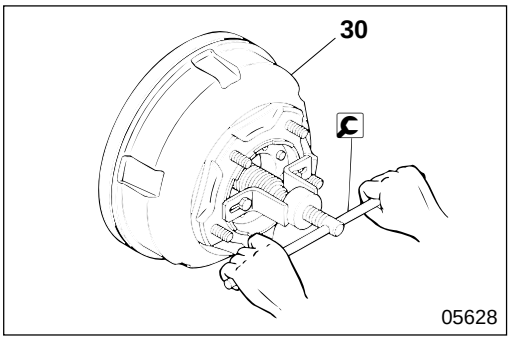
When mounting lock nut **28** see P26B-19 : adjustment procedure for starting torque of the wheel hub bearing.

: Lock nut adjustment tool



35 **36** **Packing grease in outer bearing inner race and inner bearing inner race**

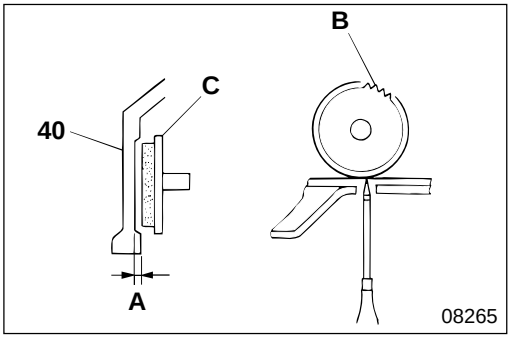
A : Grease pump nozzle
B : Between roller



30 **Wheel hub and brake drum assembly**

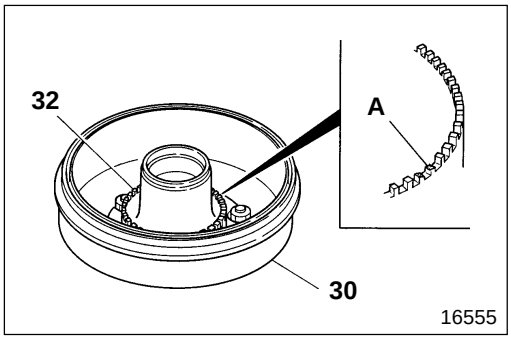
[Removal]

: Hub puller



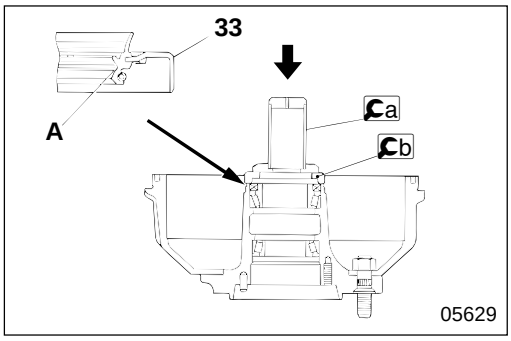
- If wheel hub and brake drum assembly **30** cannot be removed because of stepped wear **A** in brake drum **40**, remove the backing plate cover. Turn adjuster **B** in the opposite direction to the arrow on the backing plate to increase the clearance between the brake drum and brake shoe assembly **C**. Then, remove the wheel hub and brake drum assembly.
- Correct brake drum **40** if any fault is found. Gr 35A

[Installation]
After installing wheel hub and brake drum assembly **30**, adjust the clearance between brake drum **40** and brake shoe assembly **C**. Gr 35A



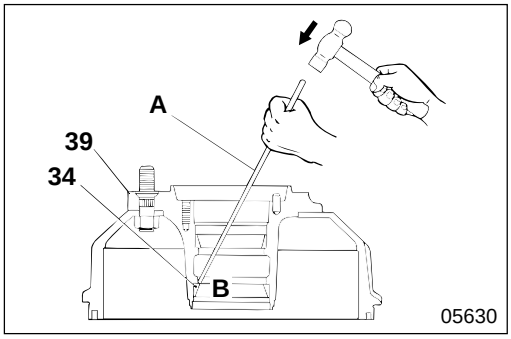
32 Rotor

[Inspection]
Check rotor **32** for chipped or crushed teeth (see section **A** in the diagram).
If an abnormality is found, replace the rotor.



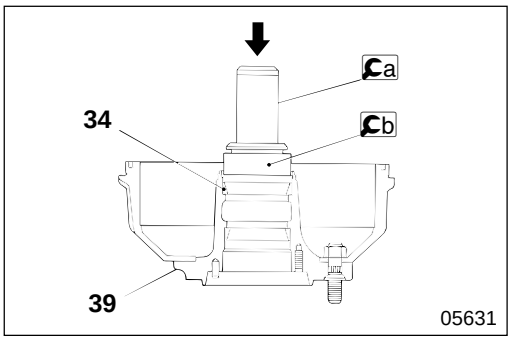
33 Installation of oil seal

Apply grease to lip area **A** of oil seal **33** and press-fit it.
a : Bearing installer
b : Oil seal installer

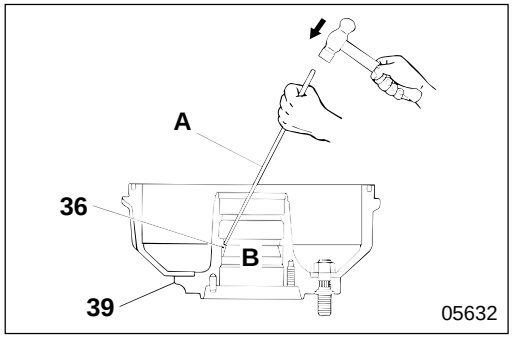


34 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **34** evenly from three indented parts **B** in wheel hub **39**.
A : Pin-punch

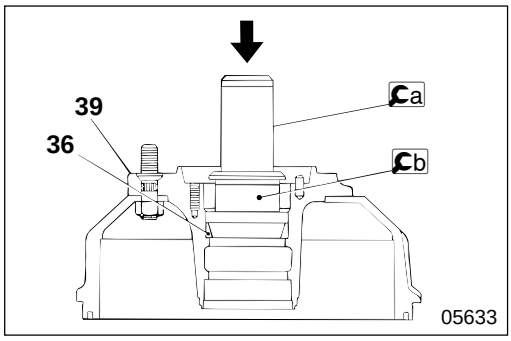


[Press-fitting]
a : Bearing installer
b : Bearing installer

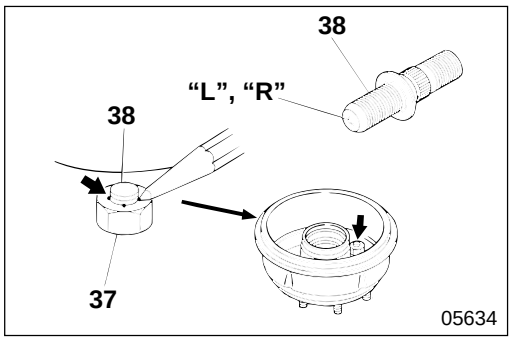


36 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **36** evenly from three indented parts **B** in wheel hub **39**.
A : Pin-punch

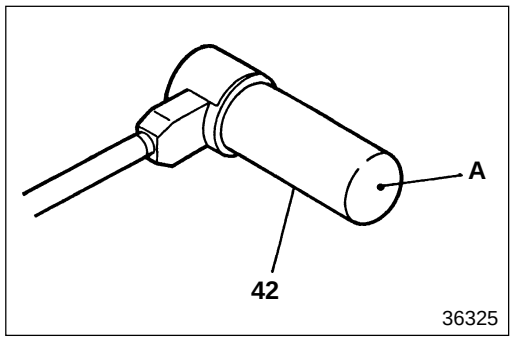


[Press-fitting]
Ca : Bearing installer
Cb : Bearing installer



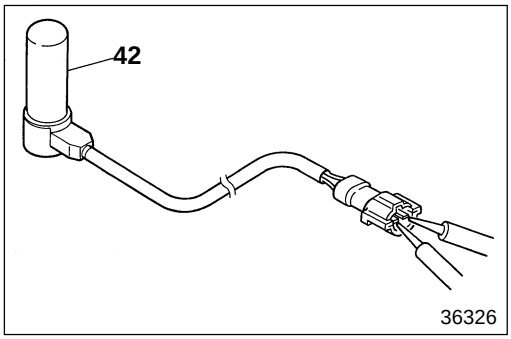
37 **38** **Installation of nut and hub bolt**

- Hub bolt **38** is marked with **"L"** (left) or **"R"** (right) to indicate the side it is to be mounted on. Check this symbol before mounting the bolt.
- Screw nut **37** onto hub bolt **38** and tighten at specified torque. Then, caulk the hub bolt to keep it from turning.



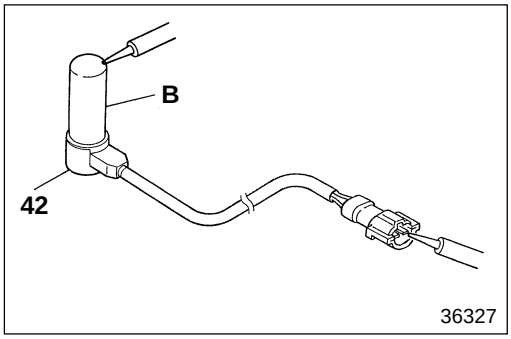
42 **Wheel speed sensor**

[Inspection]
Pole piece **A** in wheel speed sensor **42** is magnetized by a built-in magnet and attracts metals. Do not allow metal particles to stick to the pole piece.



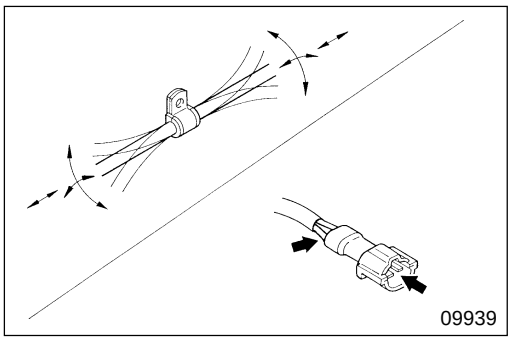
● **Measurement of resistance between terminals**

Measure resistance between the terminals of wheel speed sensor **42**. If the measured value deviates from the standard value, replace the wheel speed sensor.



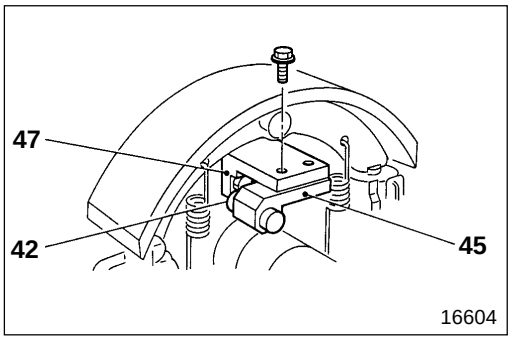
● **Measurement of insulation resistance**

Measure resistance between body **B** and each terminal of wheel speed sensor **42**.
If the measured value is lower than the standard value, replace the wheel speed sensor.



● **Inspection of open circuit in harness**

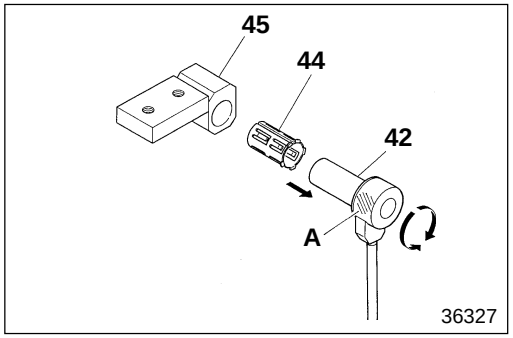
To check the harness for an open circuit, disconnect the harness clamp from the vehicle side, then bend and pull harness at the clamp to check if a momentary open circuit results. Also inspect the terminal contact conditions in the connector.
If an abnormality is found, replace wheel speed sensor **42**.



42 **44** **Wheel speed sensor and spring spacer**

The illustration shows the front-axle left wheel. The right wheel is symmetrical to the one shown in the diagram.
[Removal]

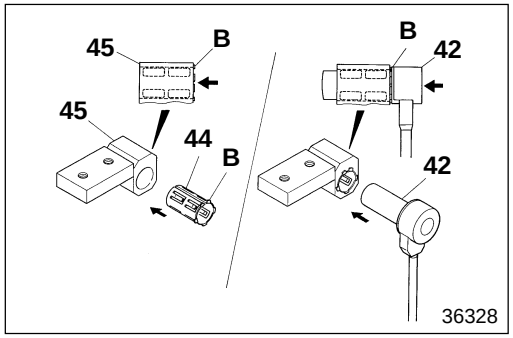
- Remove wheel speed sensor **42** and sensor holder **45** as an assembly.



- Using pliers, hold wheel speed sensor **42** at shaded section **A** in the diagram, and remove it by turning it slightly.

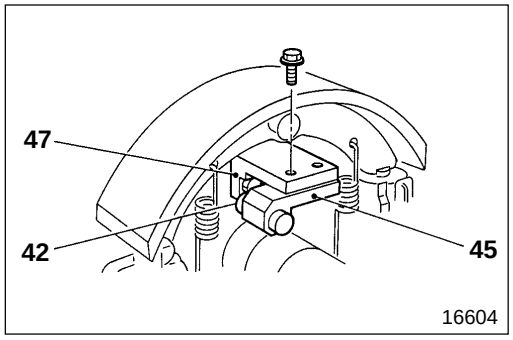
CAUTION ⚠

- **Do not hold wheel speed sensor 42 with pliers at positions other than shaded section A shown in the diagram.**
- **Do not apply excessive force to remove wheel speed sensor 42, such as by striking with a hammer, prying with a screwdriver, and pulling the harness. Excessive force can break wires in the wheel speed sensor.**
- **If only slight force is necessary to remove wheel speed sensor 42, replace spring spacer 44.**

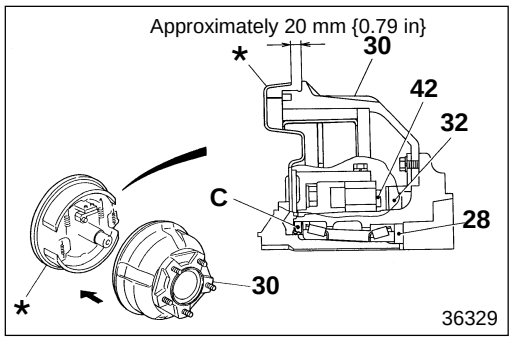


[Installation]

- Insert spring spacer **44** into sensor holder **45** until section **B** of the spring spacer contacts the sensor holder.
- Insert wheel speed sensor **42** until it contacts section **B**.



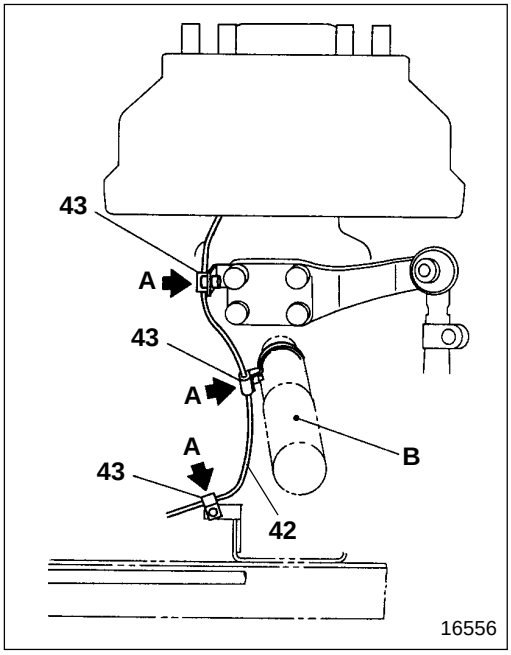
- Install wheel speed sensor **42** and sensor holder **45** as an assembly.



- Carefully install wheel hub & brake drum assembly **30** to avoid damaging oil seal **C**. Position the wheel hub & brake drum assembly at the location where the distance indicated in the illustration is approximately 20 mm {0.79in} (to prevent wheel speed sensor **42** from contacting rotor **32**).
- Slowly tighten lock nut **28** to the specified torque (primary tightening). Adjust and measure the starting torque of the wheel hub bearing.
  P26B-19

CAUTION ⚠

Do not apply excessive force to install wheel speed sensor 42, such as by striking with a hammer, prying with a screwdriver, and pulling the harness. Excessive force can break wires in the wheel speed sensor.

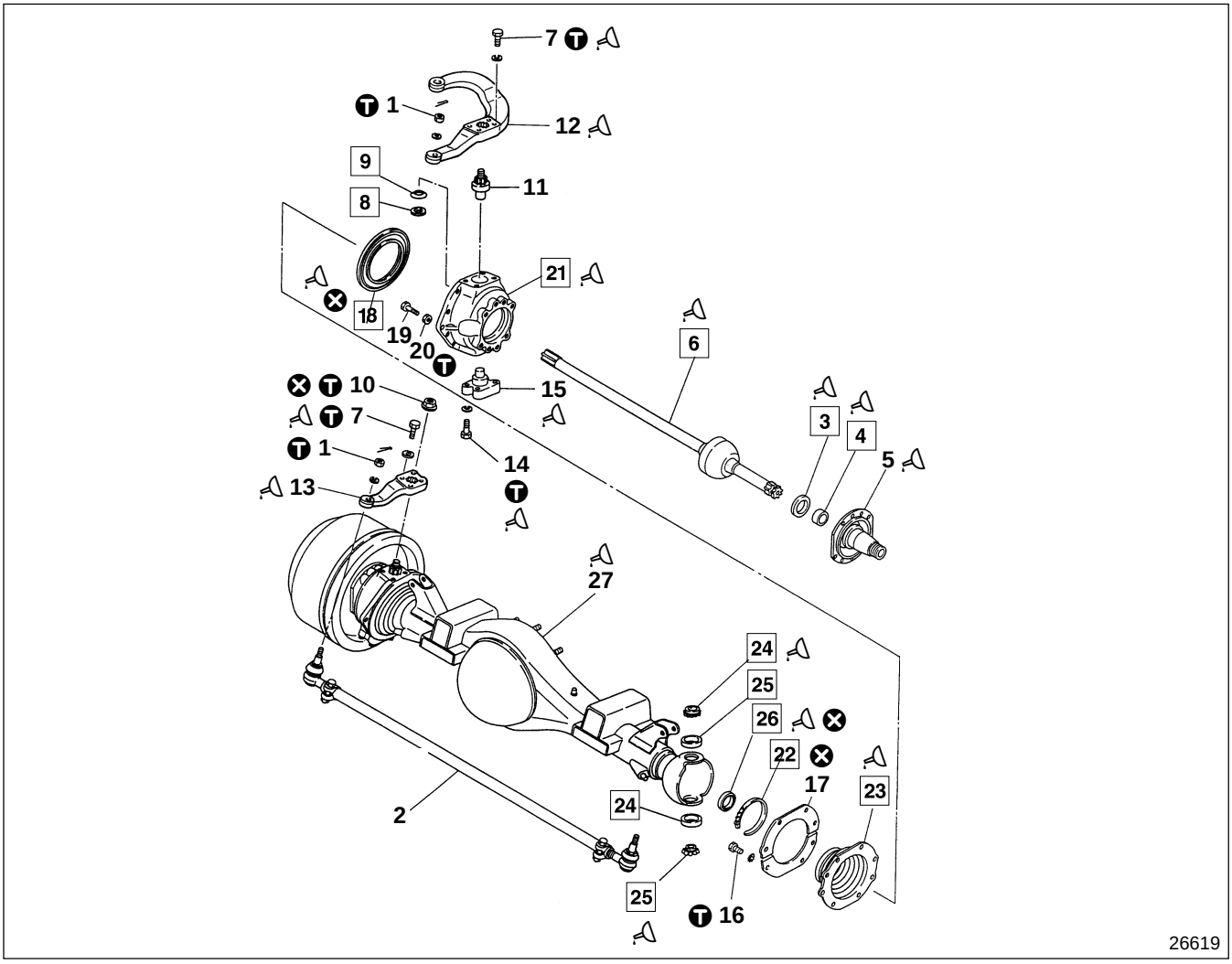


42 **43** **Installation of wheel speed sensor harness and clips**

Starting from the wheel brake side, secure the harness of wheel speed sensor **42** in place at white tape sections **A** using clips **43**, while making sure that there is no interference, twisting or excessive sagging of the harness.

B : Shock absorber

KNUCKLE AND DRIVE SHAFT



● **Disassembly sequence**

1 Nut
2 Tie rod assembly Gr 37
3 Spacer
4 Needle bearing
5 Knuckle spindle
6 Drive shaft assembly
7 Bolt
8 Spacer
9 Conical spring
10 Lock nut
11 Kingpin, upper
12 Knuckle arm
13 Tie rod arm
14 Bolt
15 Kingpin, lower
16 Bolt
17 Retainer
18 Dust seal
19 Knuckle stopper bolt
20 Lock nut
21 Steering knuckle
22 Boot band
23 Dust boot
24 Trunnion bearing inner race
25 Trunnion bearing outer race
26 Oil seal
27 Axle housing P26B-32

⊗ : Non-reusable parts

NOTE

Do not disassemble drive shaft assembly 6.

● **Assembly sequence**

27 → 26 → 23 → 18 → 20 → 19 → 25 → 24 → 21 → 17 → 16 → 8 → 9 → 11 → 12 → 13 → 7 → 10 → 6 → 2 → 1 → 22
15 → 14 → 21
5 → 4 → 3 → 6

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
6	Deflection in drive shaft assembly (Inner shaft)	0.75 {0.030} or less	1.5 {0.059}	Replace
	Play in axial direction of drive shaft assembly Birfield joint	0.4 {0.016} or less	—	Replace
21	Starting torque of steering knuckle	4.8±1.3 N·m {3.57±0.98 {ft.lbs, 49.4±13.6 kgf·cm}	—	Adjust end of arm at tie rod side with a spacer to tangential strength} of 28±7.8N {6.4 ±1.8 lbf., 2.9±0.8 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

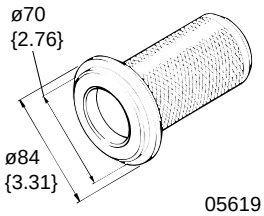
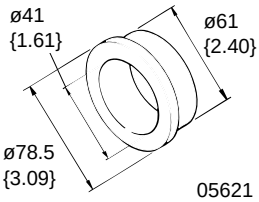
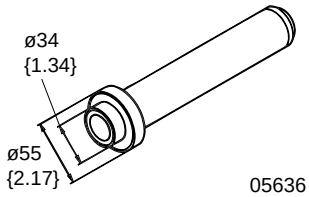
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Tie rod assembly mounting)	93.2±24.5 {69±18, 9.5±2.5}	—
7	Bolt (Tie rod arm and knuckle arm mounting)	162±15 {119±11, 16.5±1.5}	—
10	Lock nut	333±39 {246±29, 34±4}	—
14	Bolt (Kingpin, lower mounting)	162±15 {119±11, 16.5±1.5}	—
16	Bolt (Retainer and dust boot mounting)	4±1 {2.9±0.7, 0.4±0.1}	—
20	Lock nut (Knuckle stopper bolt tightening)	96±12 {71±9, 9.75±1.25}	—

Lubricant and/or sealant

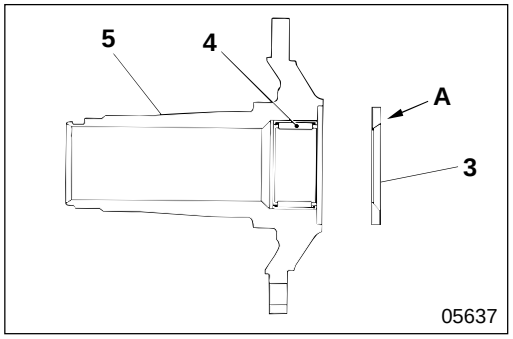
Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Chamfered side of spacer inner rim	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4	Pack the space between rollers of needle bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
5	Mounting surface of steering knuckle spindle	THREEBOND 1104J or 1215	As required
6	Pack the interior of Birfield joint of drive shaft assembly	Wheel bearing grease [NLGI No.2 (Li soap)]	90±10 g {3.17±0.35 oz}
7, 14	Thread area of bolt	THREEBOND 1104J or 1215	As required
12	Mounting surface of steering knuckle knuckle arm	THREEBOND 1104J or 1215	As required
13	Mounting surface of steering tie rod arm	THREEBOND 1104J or 1215	As required
15	Mounting surface of steering knuckle kingpin, lower	THREEBOND 1104J or 1215	As required
18	Lip area of dust seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
21	Pack the interior of steering knuckle	Wheel bearing grease [NLGI No.2 (Li soap)]	400±30 g {14.1±1.06 oz}
23	Mounting surface of steering knuckle dust boot	THREEBOND 1104J or 1215	As required
24	Pack the space between rollers of trunnion bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
26	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
27	Trunnion bearing mounting surface of axle housing ball yoke and outside surface of ball	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
25	Bearing installer 	MB999097 (T90ST30)	(Obtain Locally)
	Bearing installer 	MB999101 (T90ST25)	(Obtain Locally)
26	Oil seal installer 	MB999152	Press-fitting of oil seal

◆ Service procedure

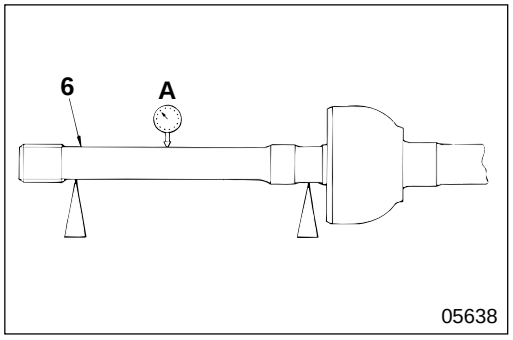


3 **4** **Installation of spacer and needle bearing**

- Pack the space between rollers of needle bearing **4** with grease and press-fit the needle bearing until it is level with the end of knuckle spindle **5**.
- Install spacer **3** on knuckle spindle **5** as illustrated.
- After installing spacer **3**, coat the chamfered side **A** of the inner diameter of the spacer with grease.

CAUTION

Take care not to use too much force when installing needle bearing 4.



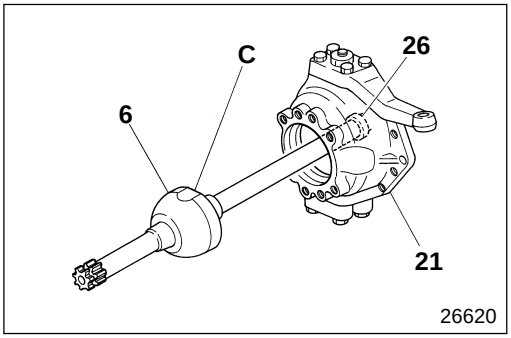
6 **Drive shaft assembly**

[Inspection]

Measure deflection **A** of drive shaft assembly **6** at the center of the inner shaft. If the measured value is higher than the limit, replace the drive shaft assembly.

NOTE

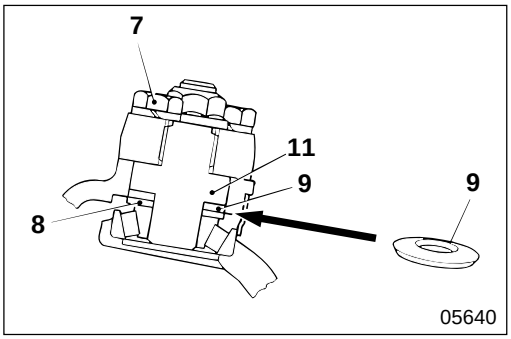
To measure the deflection of drive shaft assembly 6, turn it one full revolution and read the dial gauge indicator. The deflection is one half of the indicated value.



[Installation]
Insert drive shaft assembly **6** into steering knuckle **21** with flat part **C** of the Birfield joint facing upwards.

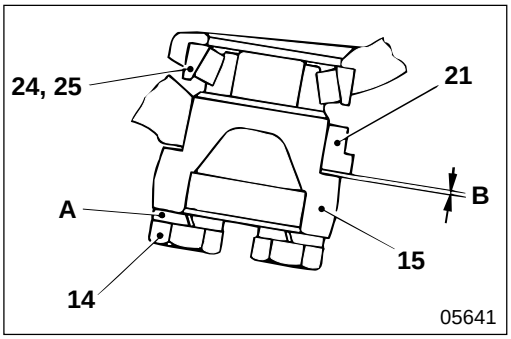
CAUTION

Be careful not to damage oil seal 26, when installing drive shaft assembly 6.



8 **9** **Spacer and conical spring**

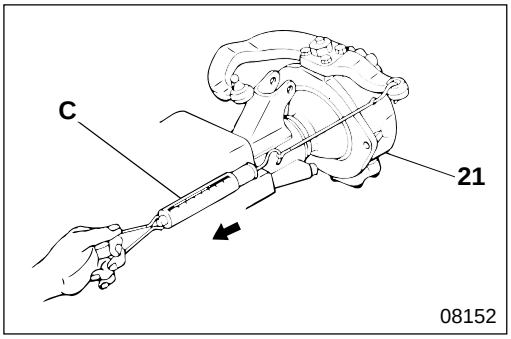
[Adjustment of pre-pressure in trunnion bearing]
Assemble conical spring **9** and spacer **8** (thickness=3.2 mm {0.13 in.}) and temporarily tighten kingpin, upper **11** with assembly bolt **7** as illustrated.



- Install kingpin, lower **15** into steering knuckle **21**. Screw bolt **14** into spring washer **A**, and tighten sufficiently but without applying tension to the spring washer.
- Tighten kingpin, lower **15** until it fits snugly into trunnion bearings **24**, **25** in the lower part.
- Measure clearance **B** between steering knuckle **21** and kingpin, lower **15**. Select spacer **8** based on the measured clearance.

Clearance B	Thickness of spacer
0.6 mm {0.024 in.} or more	3.2 mm {0.13 in.}
Less than 0.6 mm {0.024 in.}	3.6 mm {0.14 in.}

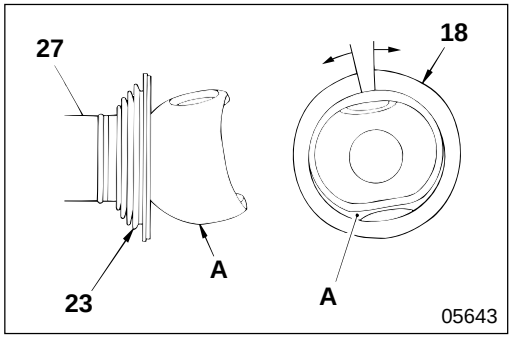
- If clearance **B** is 0.6 mm {0.024 in.} or more, tighten bolt **14** at specified torque.
  If clearance **B** is less than 0.6 mm {0.024 in.}, replace with spacer **8** (thickness=3.6 mm {0.14 in.}) and remeasure the clearance.



[Starting torque of steering knuckle]
- Fasten spring balancer **C** to steering knuckle **21** and measure whether the starting torque of the steering knuckle conforms to the standard value.
- If the measured value deviates from the standard value, adjust the starting torque of the steering knuckle according to the procedure described above. If any fault is found after adjustment, replace trunnion bearings **24**, **25**.

NOTE

Be sure to measure the starting torque before installing dust seal 18 and dust boot 23.

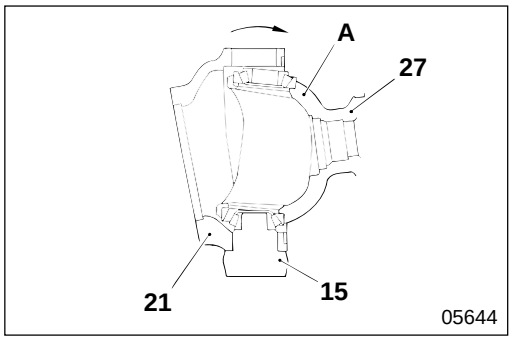


18 **23** **Installation of dust seal and dust boot**

Install dust boot **23** on kingpin ball yoke area **A** in axle housing **27**. Then, mount dust seal **18** while widening its end part.

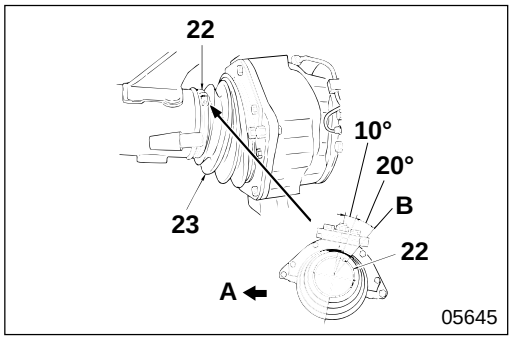
CAUTION

Do not widen dust seal 18 too much.



21 **Assembly of steering knuckle**

Install kingpin, lower **15** into steering knuckle **21**.
While turning the steering knuckle, install it into kingpin ball yoke area **A** in axle housing **27**.

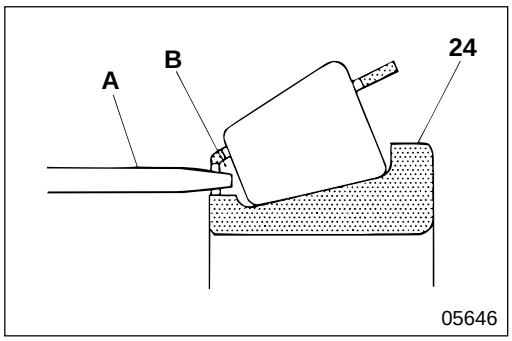


22 **Tightening of boot band**

Install boot band **22** at an angle within 20° as illustrated. Then, tighten and caulk it.
A : Front of the vehicle

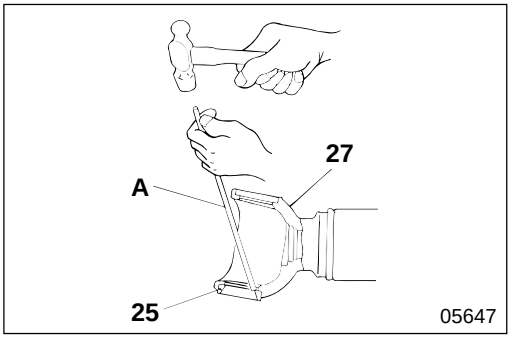
CAUTION

Be careful not to overtighten dust boot 23, and make sure that the rubber does not protrude too much from the joint surface.



24 **Packing grease in trunnion bearing inner race**

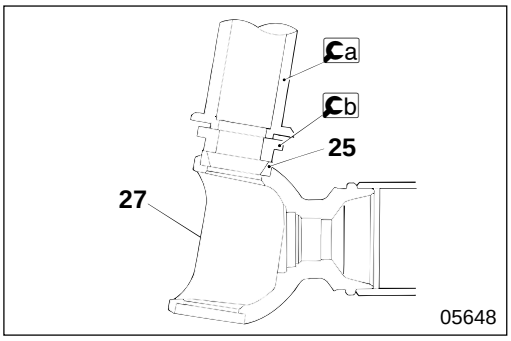
A : Grease pump nozzle
B : Between rollers



25 **Trunnion bearing outer race**

[Removal]

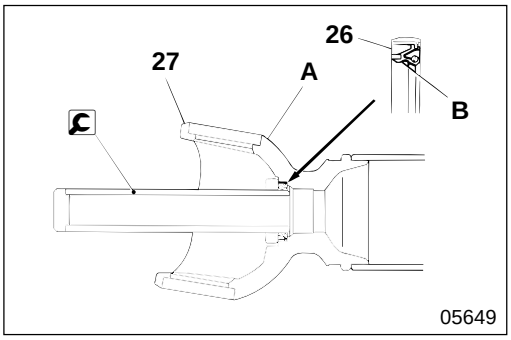
A : Pin-punch



[Press-fitting]

a : Bearing installer

b : Bearing installer

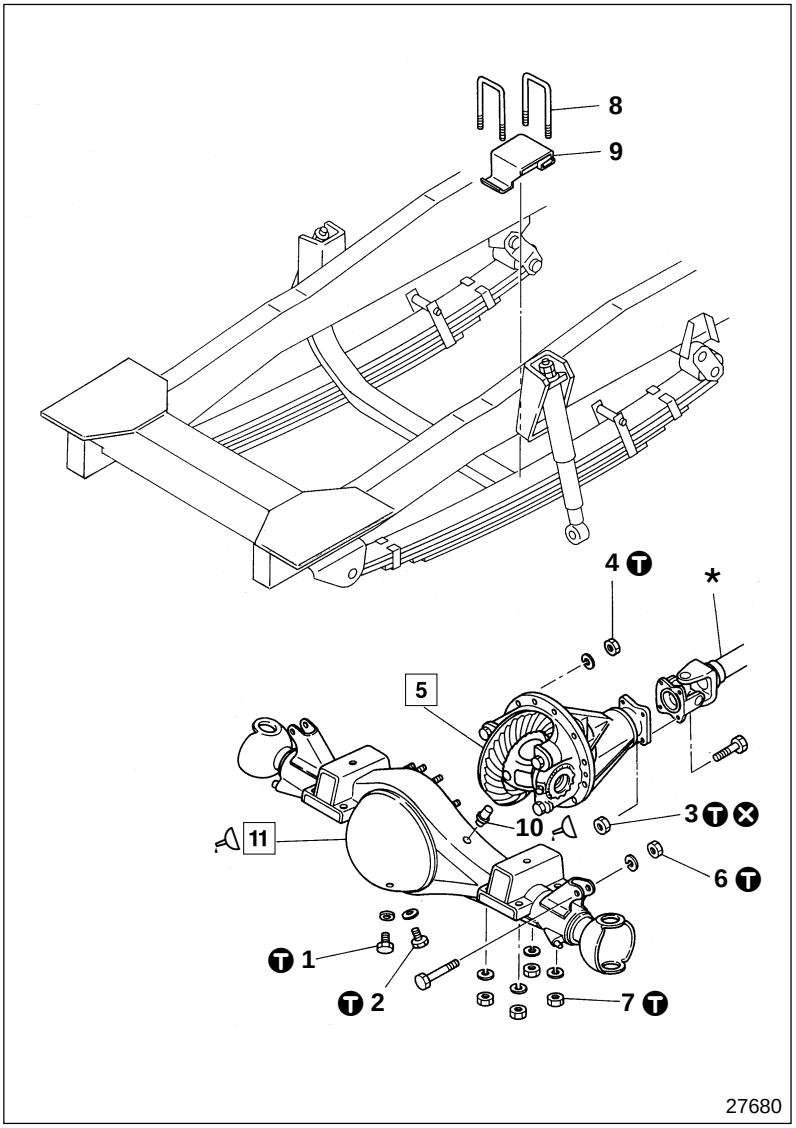


26 **Press-fitting of oil seal**

- Apply grease to lip area **B** of oil seal **26**.
- Press-fit oil seal **26** in the direction as illustrated so that the oil seal is level with the end of kingpin ball yoke **A** of axle housing **27**.

: Oil seal installer

AXLE HOUSING



● **Disassembly sequence**

1 Inspection plug
2 Drain plug
3 Nut
4 Nut
5 Reduction and differential assembly
📖 P26B-34
6 Nut
7 U-bolt nut
8 U-bolt
9 Front spring pad
10 Vent plug
11 Axle housing

*: Propeller shaft Gr 25
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Do not remove axle housing 11 unless it is faulty.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
11	Deflection in axle housing	within 1.6 {0.063}	5 {0.2}	—

T Tightening torque

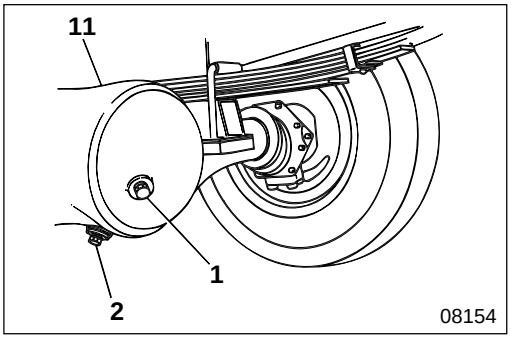
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	98 to 115 {72 to 87, 10 to 12}	—
2	Drain plug	98 to 115 {72 to 87, 10 to 12}	—
3	Nut (Propeller shaft mounting)	59 to 74 {43 to 54, 6.0 to 7.5}	—
4	Nut (Reduction and differential assembly mounting)	34 to 44 {25 to 33, 3.5 to 4.5}	—
6	Nut (Lower part of shock absorber mounting)	33 to 49 {25 to 36, 3.4 to 5.0}	—
7	U-bolt nut (U-bolt mounting)	105±7.8 {78±5.8, 10.8±0.8}	—

Sealant

Location	Points of application	Specified sealant	Quantity
10	Axle housing contact surface of vent plug	THREEBOND 1104J or 1215	As required
11	Reduction and differential assembly mounting surface of axle housing	THREEBOND 1215	As required

◆ Service procedure

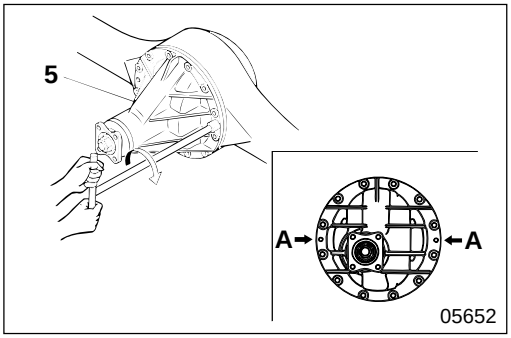


● Service operations before removal and after installation

(1) Before removing any part, remove inspection plug **1** and drain plug **2** and drain the gear oil from axle housing **11**.

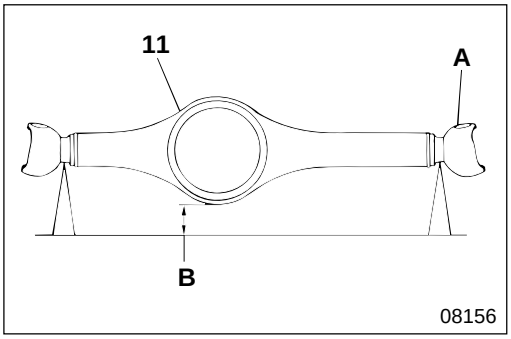
(2) After installing all parts, fill axle housing **11** with the specified amount of gear oil.

(3) Tighten drain plug **2** and inspection plug **1** at specified torque.



5 **Removal of reduction and differential assembly**

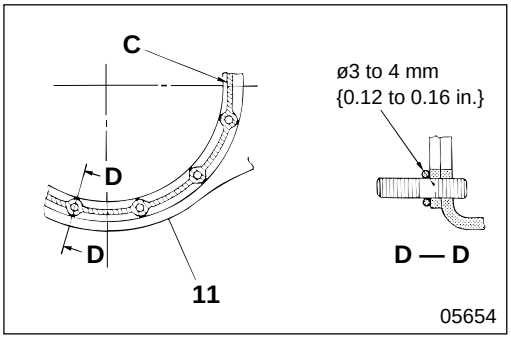
Tighten M10×1.25 mm bolts evenly into two screw holes **A** provided for removing reduction and differential assembly **5**.



11 **Axle housing**

[Inspection for deflection]

- Support both ends of kingpin ball yoke part **A** of axle housing **11** horizontally and measure axle housing height **B**.
- Turn axle housing **11** through 180° to measure height **B**.
- If the height difference is higher than the limit, replace axle housing **11**.



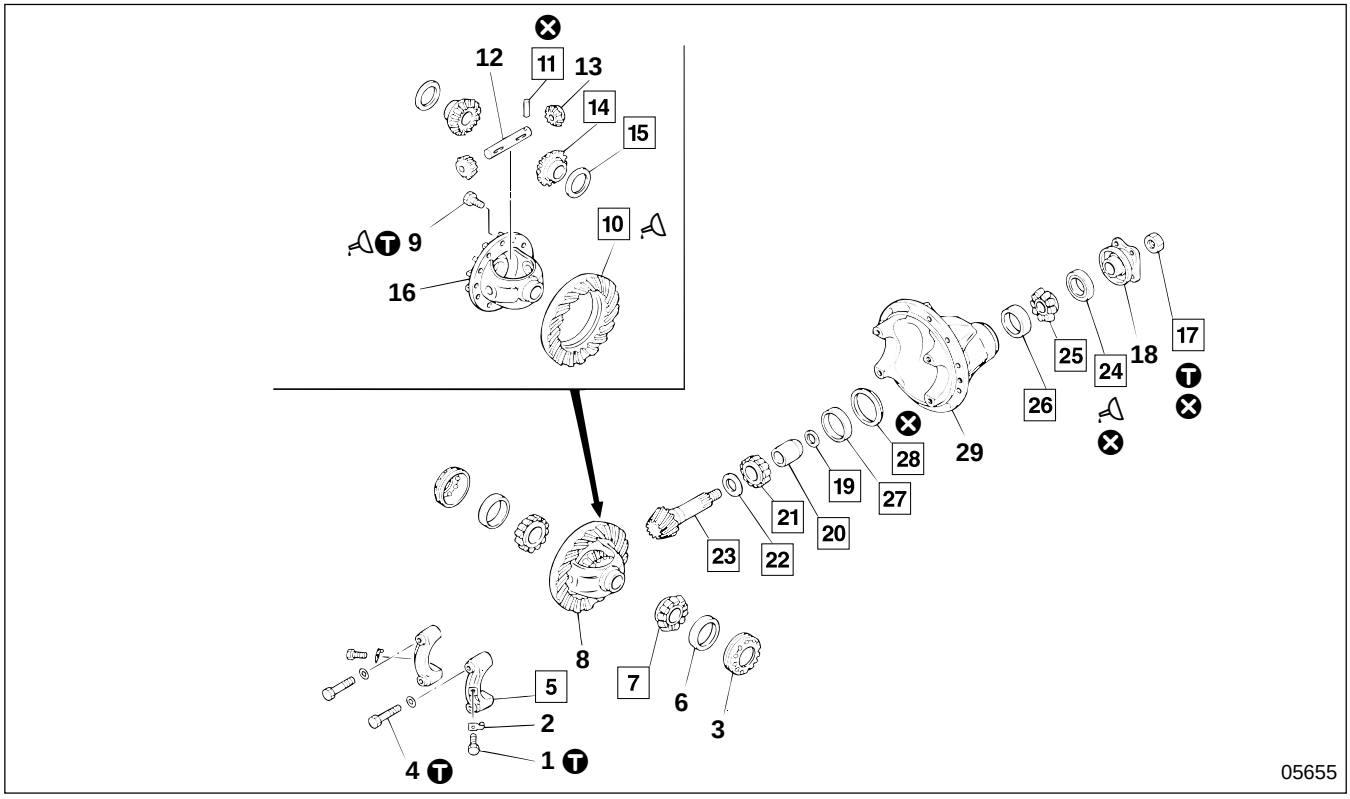
[Applying sealant]

- Apply sealant to reduction and differential assembly **5** mounting surface of axle housing **11**.
- Apply sealant linearly for part **C** and for the position that is symmetrical to an imaginary center line.

CAUTION ⚠

Make sure that sealant does not ooze from the mating surface after installing reduction and differential assembly 5.

REDUCTION AND DIFFERENTIAL



● **Work before disassembly** P26B-37

● **Inspection before disassembly** P26B-37

● **Disassembly sequence**

1 Bolt
2 Lock plate
3 Side bearing nut
4 Bolt
5 Bearing cap
6 Side bearing outer race
7 Side bearing inner race
8 Differential assembly
9 Bolt
10 Final drive gear
11 Lock pin
12 Pinion shaft
13 Differential pinion
14 Differential gear
15 Spacer
16 Differential case
17 Lock nut
18 Companion flange assembly
19 Front bearing shim
20 Pinion spacer
21 Rear bearing inner race
22 Rear bearing shim
23 Final drive pinion
24 Oil seal
25 Front bearing inner race
26 Front bearing outer race
27 Rear bearing outer race
28 Oil stopper
29 Differential carrier

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection and adjustment after assembly** P26B-38

CAUTION⚠

Be sure when replacing any of the following parts, to replace both it and its associated parts as a set :

- **For bolt 4, bearing cap 5 or differential carrier 29, replace the carrier assembly.**
- **For final drive gear 10 or final drive pinion 23, replace the gear set.**
- **Make sure you keep left and right side bearings 6, 7 separate after removal, and be careful not to mix then up when installing them.**

NOTE

Write down the thickness of front bearing shim 19, pinion spacer 20 and rear bearing shim 22 when disassembling to use it as reference when reassembling.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
10	Deflection of rear of final drive gear	within 0.05 {0.0020}	—	—
10, 23	Backlash between final drive gear and final drive pinion	0.15 to 0.20 {0.0059 to 0.0078}	—	Adjust or replace along with the gear set
13, 14	Backlash between differential pinion and differential gear	0.15 to 0.20 {0.0059 to 0.0078}	—	Adjust using the spacer or replace
14	Play in the rotating direction between drive shaft and differential gear spline part	0.07 to 0.16 {0.0028 to 0.0063}	—	Replace
23	Starting torque of final drive pinion	1 to 2 {0.7 to 1.4, 0.1 to 0.2}	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

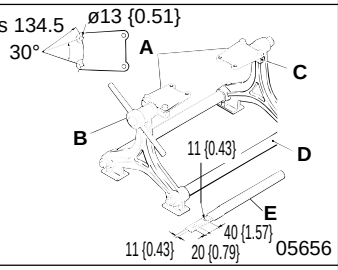
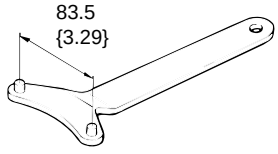
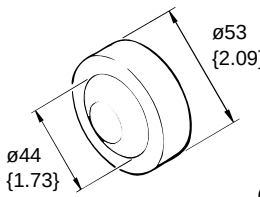
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	19.6 to 26.5 {14 to 20, 2.0 to 2.7}	—
4	Bolt (Bearing cap mounting)	68.6 to 78.4 {51 to 58, 7 to 8}	—
9	Bolt (Final drive gear mounting)	137.2 to 166.6 {101 to 122, 14 to 17}	—
17	Lock nut (Companion flange assembly installation)	313.6 to 411.6 {231 to 303, 32 to 42}	—

Lubricant and/or sealant

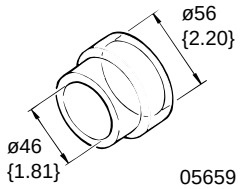
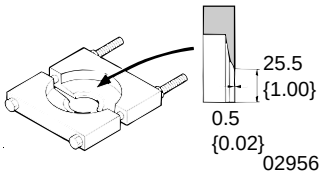
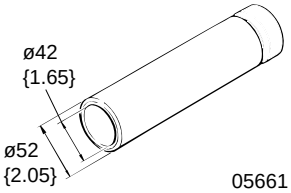
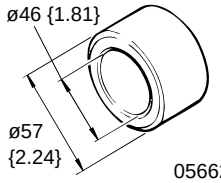
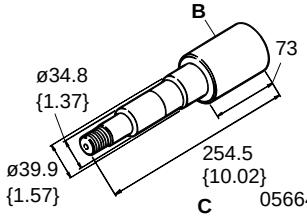
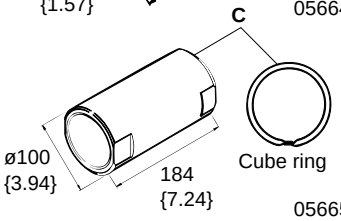
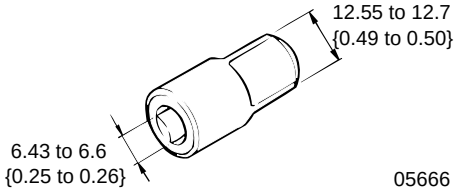
Location	Points of application	Specified lubricant and/or sealant	Quantity
10	Thread area of final drive gear	LOCTITE 271	As required
24	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required

Special tools

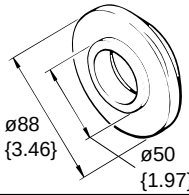
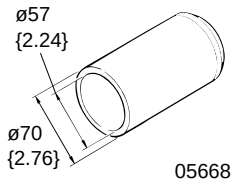
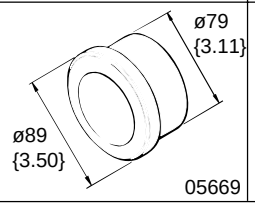
Unit : mm {in.}

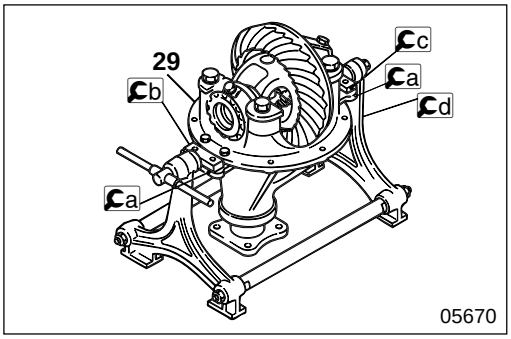
Location	Tool name and shape	Part No.	Application
—	Differential working base assembly **A** : Attachment **B** : Holder **C** : Holder **D** : Working base **E** : Flange stopper 	MB999034 **A** : MB999074 **B** : MB999036 **C** : MB999037 **D** : MB999035 **E** : MB999096	(Obtain Locally)
3	Differential side bearing adjustment tool 	MB999012	(Obtain Locally)
7	Adapter 	MB999077	(Obtain Locally)

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
7	Bearing installer 	MB999079	Press-fitting of side bearing inner race
21	Pinion rear bearing remover 	MB999045	Removal of rear bearing inner race
21, 24, 25	Bearing installer 	MB999104 (T90ST13)	Press-fitting of rear bearing inner race (Use in combination with *1) Press-fitting of oil seal (Use in combination with *2) Press-fitting of front bearing inner race
21	*1 bearing installer 	MB999044	Press-fitting of rear bearing inner race (Use in combination)
23	Drive pinion setting gauge set **A** : Tool box **B** : Pinion gauge **C** : Cylinder gauge  	MB999084 **A** : MB990824 **B** : MB999086 **C** : MB999087	Adjustment of starting torque and pinion height of final drive pinion
	Socket 	MB999054	Measurement of starting torque of final drive pinion

Unit : mm {in.}

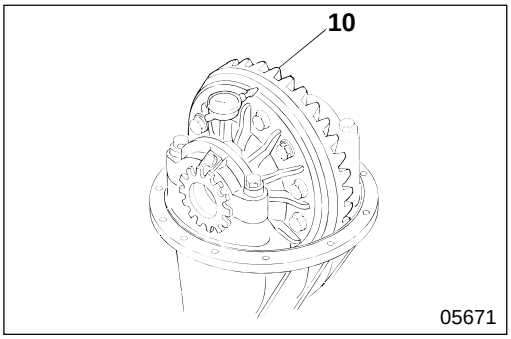
Location	Tool name and shape	Part No.	Application
24	*2 Bearing installer adapter 	MB999105 (T90ST07)	Press-fitting of oil seal (Use in combination)
26, 27	Bearing installer 	MB999100 (T90ST31)	Press-fitting of front and rear bearing outer race (Press-fit in combination)
	Bearing installer 	MB999089	



● **Work before disassembly**

Mount differential carrier **29** on c differential working base assembly.

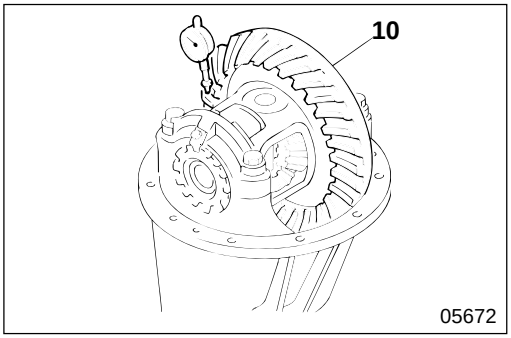
- a : Attachment
- b : Holder
- c : Holder
- d : Working base



● **Inspection before disassembly**

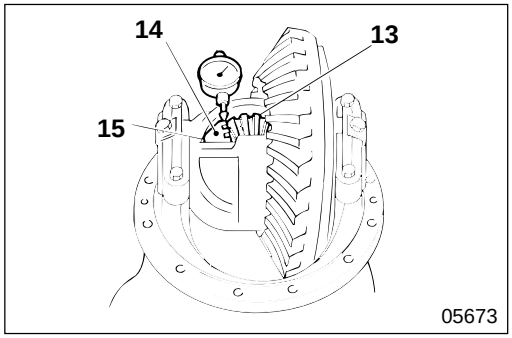
(1) Deflection of rear surface of final drive gear

Measure at the point of maximum diameter of final drive gear **10**.



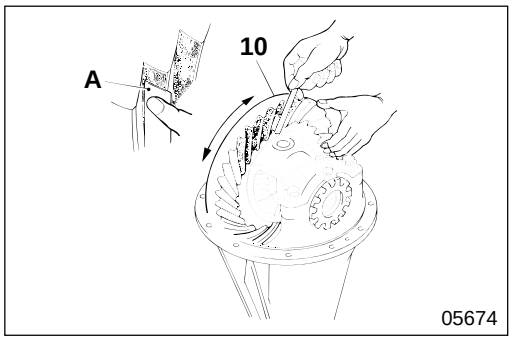
(2) Backlash between final drive gear and final drive pinion

Measure at three points on the circumference of final drive gear **10**.



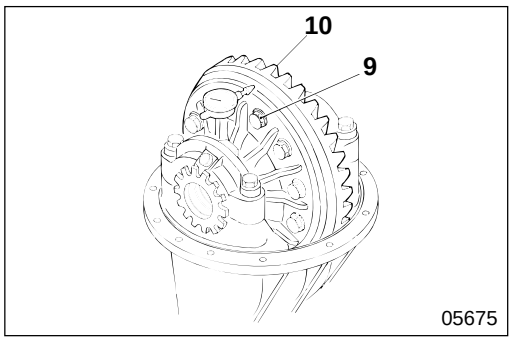
(3) Backlash between differential pinion and differential gear

Measure backlash between differential pinion **13** and differential gear **14**.



(4) Tooth contact of final drive gear

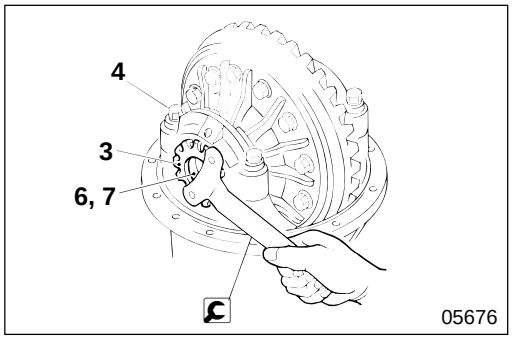
Apply red lead primer to the surfaces of three or four teeth of final drive gear **10**, examine tooth contact by turning the gears a few times.
A : Examine tooth contact using paper.



● **Inspection and adjustment after assembly**

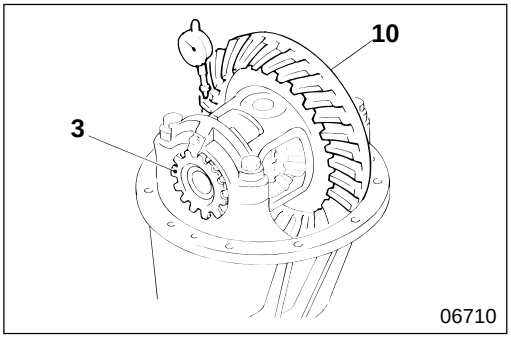
(1) Deflection of rear surface of final drive gear

- Measure at the point of maximum diameter of final drive gear **10**.
- If the measured value deviates from the standard value, check tightening torque of bolt **9** or replace along with the gear set.



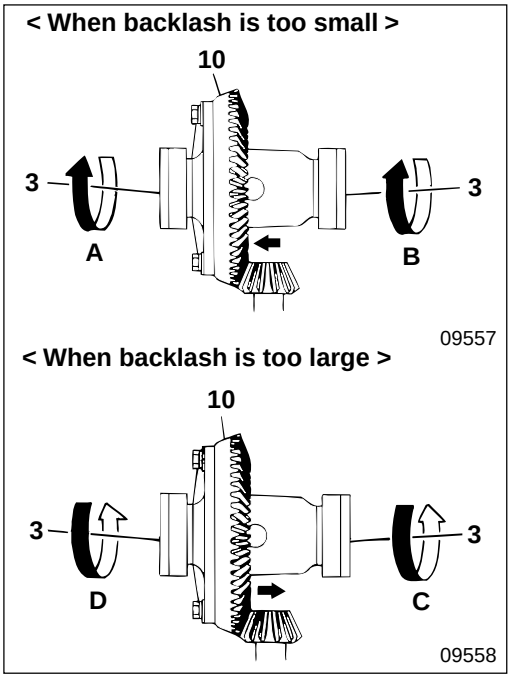
(2) Backlash of final drive gear

[Adjustment]
Before adjusting, tighten bolt **4** temporarily. Then, tighten side bearing nut **3** using 🔧 differential side bearing adjustment tool until just before pre-pressure is exerted on side bearings **6**, **7**.



[Measurement]

- Measure final drive gear **10** backlash at three points on the circumference of the final drive gear.



- If backlash deviates from the standard value, rotate left and right side bearing nuts **3** and move final drive gear **10** as illustrated using 🔧 side bearing adjusting tool to adjust backlash.

  < When backlash is too small >

  Adjust in order of **A** to **B**.

  A : Loosen

  B : Tighten

  < When backlash is too great >

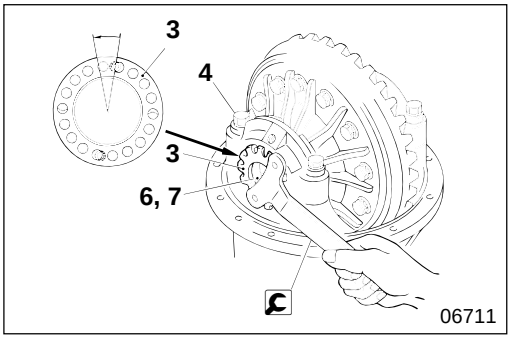
  Adjust in order of **C** to **D**.

  C : Loosen

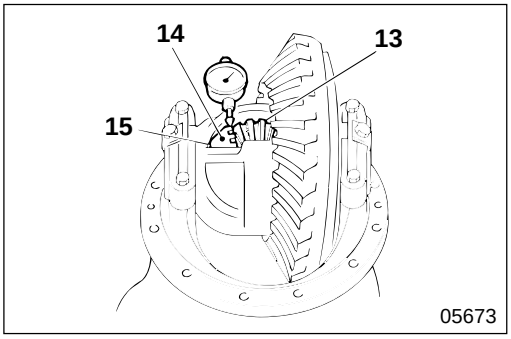
  D : Tighten

CAUTION ⚠

Be sure, when side bearing nut 3 on one side is loosened, to tighten the other side by the same amount.



- Tighten right and left side bearing nuts **3**, by half the pitch between the centers of adjacent holes, using 🔧 differential side bearing adjustment tool to add pre-pressure to side bearings **6**, **7**.
- Tighten bolt **4** at specified torque.



(3) Backlash between differential pinion and differential gear

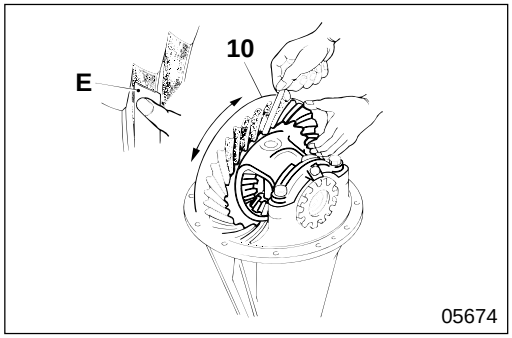
Measure backlash between differential pinion **13** and differential gear **14**. If the measured value deviates from the standard value, adjust with spacer **15**.

CAUTION ⚠

Make sure that the thickness of right spacer 15 is identical to that of the left spacer.

Spacer thicknesses :

1.4 to 1.6 mm {0.055 to 0.063 in.} (three thicknesses available in 0.1 mm {0.0039 in.} increments)



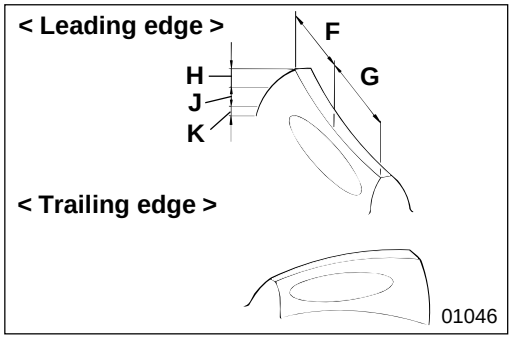
(4) Tooth contact of final drive gear

[Inspection]
Apply red lead primer to the surfaces of three or four teeth of final drive gear **10**, examine tooth contact by turning the gears a few times.
E : Examine tooth contact using paper.

[Adjustment]
If tooth contact deviates excessively from the standard value, adjust by increasing or decreasing backlash and rear bearing shim **22**.

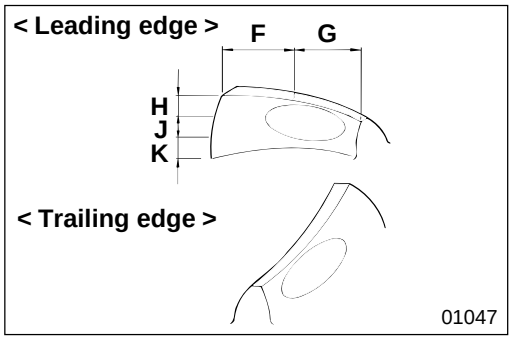
CAUTION

Be sure when replacing the gear because of abnormally worn teeth to replace the gear set of final drive gear 10 and final drive pinion 23 together.



● **Normal tooth contact at no load**

< Final drive gear >
F : Heel
G : Toe
H : Face
J : Flank
K : Clearance



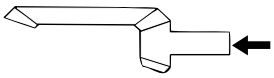
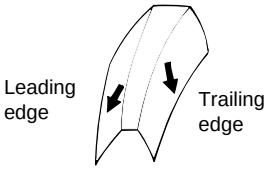
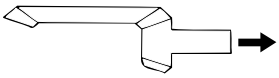
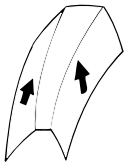
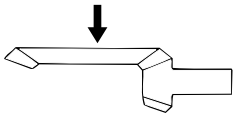
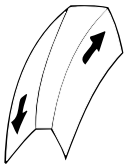
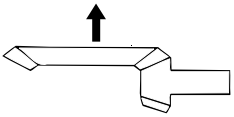
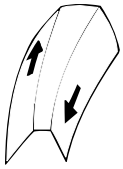
< Final drive pinion >
F : Heel
G : Toe
H : Face
J : Flank
K : Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center towards edge
		Vertical direction	From center towards top of tooth for final drive gear and center for final drive pinion
	Tooth contact shape	Length	Approximately 50 to 70% of tooth width
		Width	Approximately 50 to 70% of tooth depth
	Degree of tooth contact		It becomes weaker as it nears tooth root or tooth tip

NOTE

When tooth contact is near the toe at no load it becomes middle area contact at load.

Adjustment of tooth contact

	Method of adjustment	Moving direction
Adjustment by adding or reducing shims	Advance final drive pinion to final drive gear (Shims are added) 	 Tooth contact moves towards tooth root
	Retard final drive pinion from final drive gear (Shims are reduced) 	 Tooth contact moves towards tooth tip
Adjustment using side bearing nut	Advance final drive gear to final drive pinion center (Less backlash) 	 Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard final drive gear from final drive pinion center (More backlash) 	 Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth

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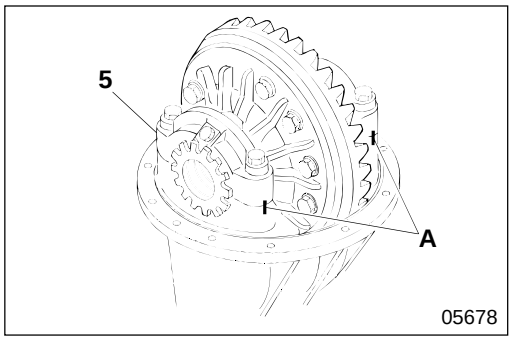
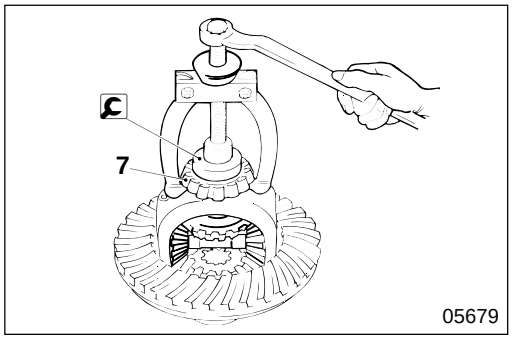
◆ Service procedure



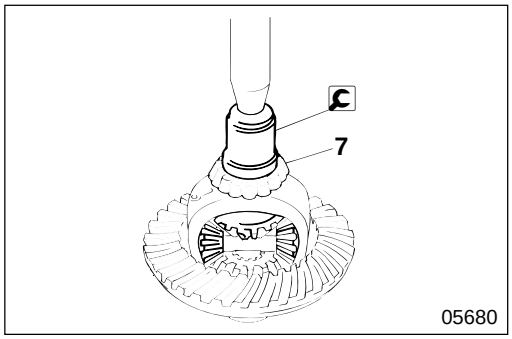
5 **Removal of bearing cap**

Put alignment marks **A** on bearing cap **5** to distinguish left and right.

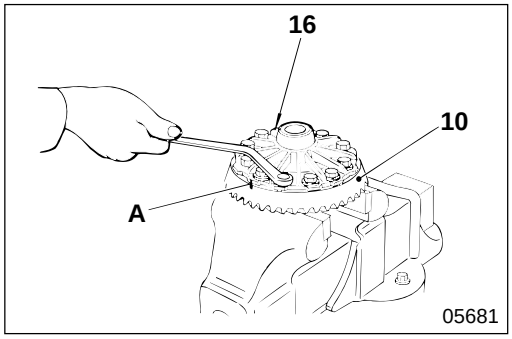


7 **Side bearing inner race**

[Removal]
: Adapter

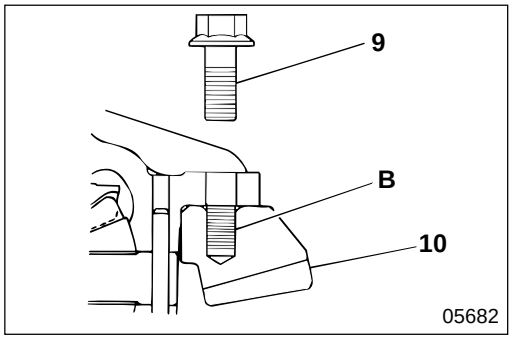


[Press-fitting]
: Bearing installer



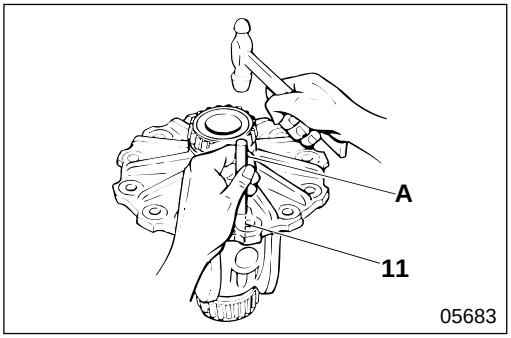
10 **Final drive gear**

[Removal]
Put alignment marks **A** on final drive gear **10** and differential case **16**.



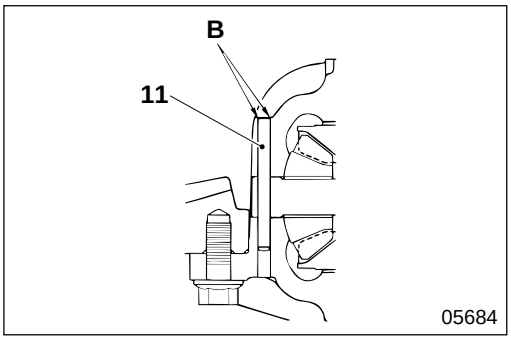
[Installation]
Apply LOCTITE to thread area of all bolt holes **B** of final drive gear **10** and tighten bolts **9** at specified torque.

CAUTION
- **Be sure to let bolts 9 harden for at least an hour, after installation, before driving.**
- **Furthermore, be sure to let bolts 9 harden for at least four hours before running at full torque.**

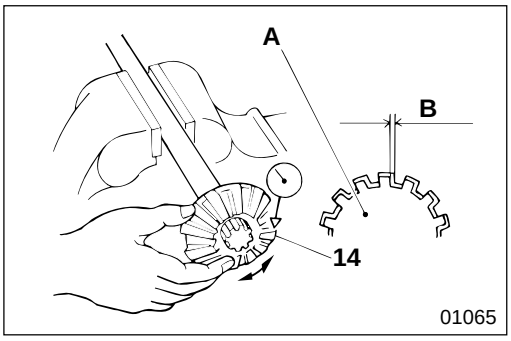


11 **Lock pin**

[Removal]
A : Punch

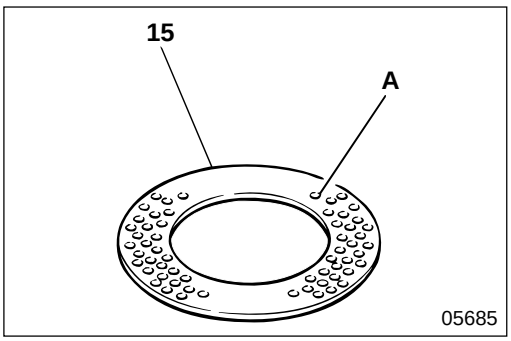


[Press-fitting]
After press-fitting lock pin **11**, stake part **B** at two points.



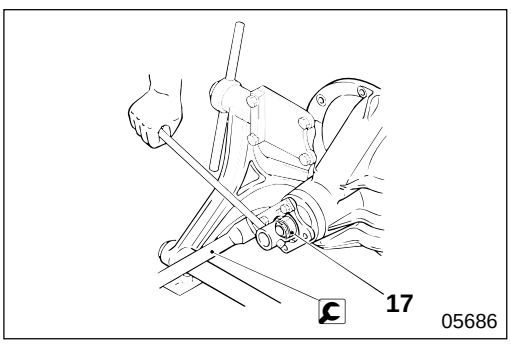
14 **Play between differential gear and drive shaft spline in the rotating direction**

If the measured value is higher than the limit, replace faulty parts.
A : Rear axle shaft
B : Play



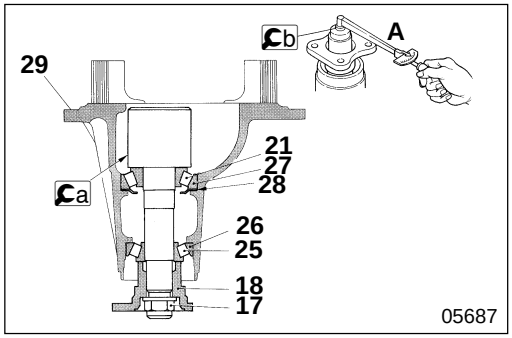
15 **Installation of spacer**

Install spacer **15** with oil grooves **A** side facing the differential gear.



17 **Removal and installation of lock nut**

: Flange stopper



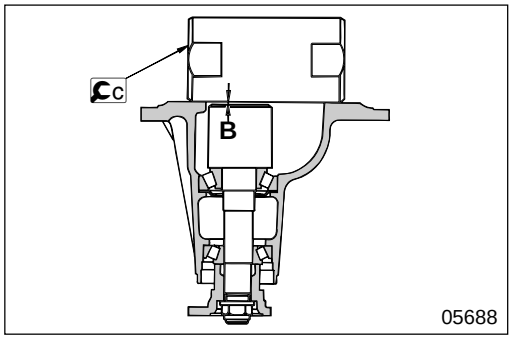
17 **19** **to** **23** **25** **to** **28** **Final drive pinion assembly**

[Selection of rear bearing shim]

- Install Ca pinion gauge temporarily in differential carrier **29** together with the parts illustrated.
- Tighten lock nut **17** using Cb socket to adjust starting torque **A** of the pinion gauge to the standard value.

CAUTION

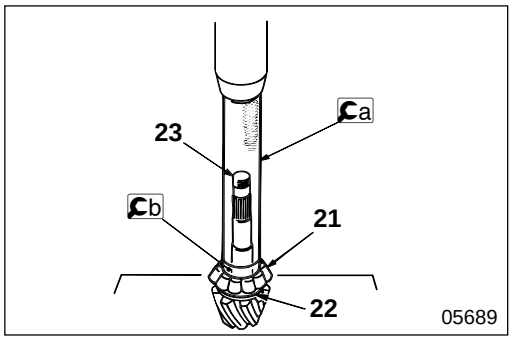
Do not assemble parts other than those illustrated.



- Set Cc cylinder gauge to standard starting torque to measure gap **B** as illustrated.
  Select rear bearing shim **22** using the calculation given below.
  < Calculation of rear bearing shim thickness C >
  C=B–1.5 mm {0.059 in.}
  Rear bearing shim thicknesses :
  0.3 mm {0.012 in.} and 1.38 to 1.65 mm {0.054 to 0.065 in.}
  (10 thicknesses available in 0.03 {0.0012 in.} mm increments)

CAUTION

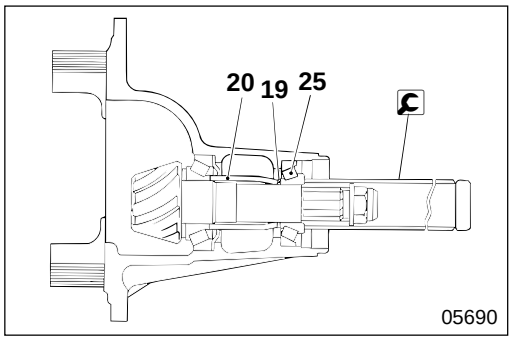
Be sure to keep the number of rear bearing shims 22 to the minimum and keep them as close to the standard value as possible.



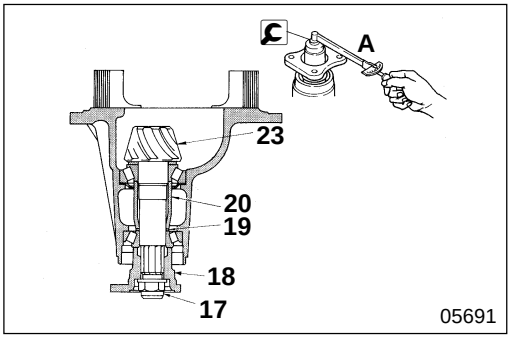
[Installation of rear bearing shim]
Install selected rear bearing shim **22** onto final drive pinion **23** and press-fit rear bearing inner race **21** using Ca Cb bearing installer.

CAUTION

Be sure, when installing rear bearing shim 22 comprised of a 0.3 mm {0.012 in.} shim and another shim, that the 0.3 mm {0.012 in.} shim is installed next to the bearing.



[Press-fitting of front bearing inner race]
Assemble pinion spacer **20** and front bearing shim **19** for press-fitting of front bearing inner race **25** using C bearing installer.



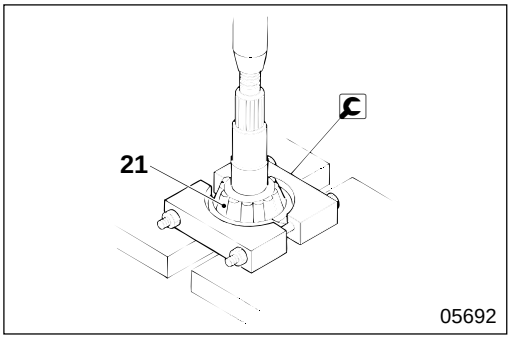
[Measurement of starting torque]

- After installing companion flange assembly **18**, tighten lock nut **17** at specified torque.
  Measure starting torque **A** of final drive pinion **23** using [E] socket.
- If the measured value deviates from the standard value, select pinion spacer **20** and front bearing shim **19** to adjust the starting torque to the standard value.

CAUTION

- **Do not install the oil seal before measuring the starting torque.**
- **Be sure to keep the number of shims to the minimum when selecting pinion spacers 20.**

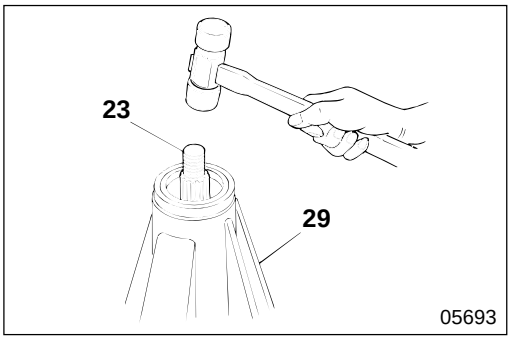
Pinion spacer heights:
64.07 mm {2.52 in.} and 64.40 mm {2.54 in.} (Painted white)
Front bearing shim thicknesses:
0.30 mm {0.012 in.} and 2.00 to 2.33 mm {0.079 to 0.092 in.}, (12 thicknesses available in 0.03 mm {0.0012 in.} increments)



21 Rear bearing inner race

[Removal]
[E] : Pinion rear bearing remover

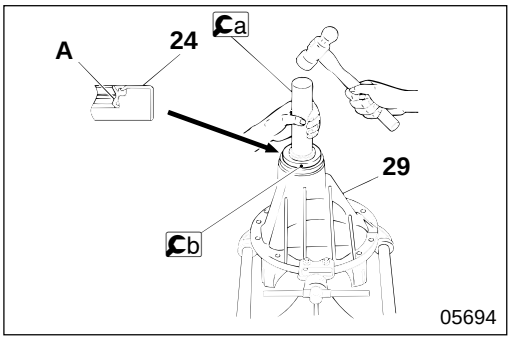
[Press-fitting]
P26B-44



23 Removal of final drive pinion

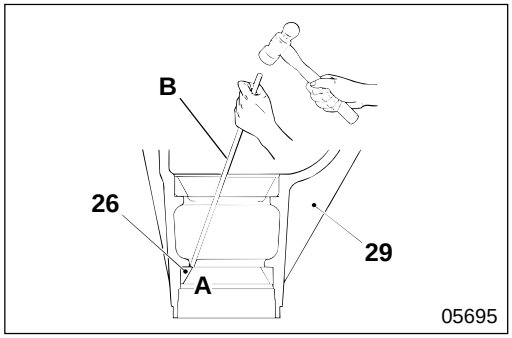
CAUTION

Be sure to use a plastic mallet when driving out final drive pinion 23, and prevent it from dropping to the ground by holding it.



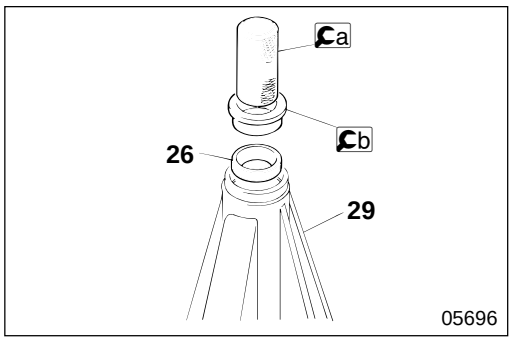
24 Press-fitting of oil seal

Apply grease to lip area **A** of oil seal **24** and press-fit the oil seal into differential carrier **29**.
[Ea] : Bearing installer
[Eb] : Bearing installer adapter

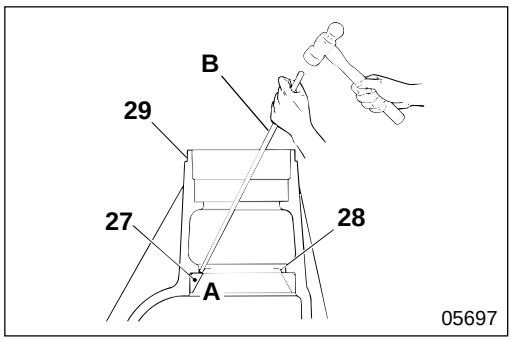


26 **Front bearing outer race**

[Removal]
Drive out front bearing outer race **26** evenly from three indented parts **A** of differential carrier **29**.
B : Pin-punch

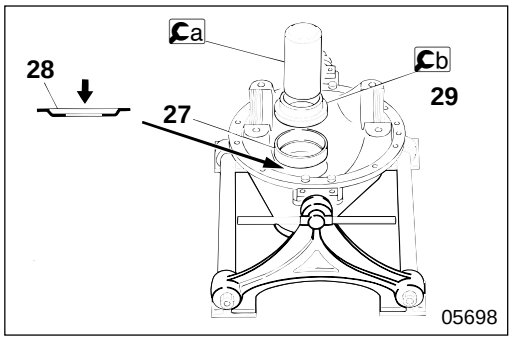


[Press-fitting]
a : Bearing installer
b : Bearing installer



27 **28** **Rear bearing outer race and oil stopper**

[Removal]
Drive out rear bearing outer race **27** and oil stopper **28** evenly from three indented parts **A** of differential carrier **29**.
B : Pin-punch



[Press-fitting]
Insert oil stopper **28** in the direction of the arrow as illustrated.
a : Bearing installer
b : Bearing installer

MITSUBISHI
FUSO

Group 27

Rear Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-27

INDEX

SPECIFICATIONS 27- 2

STRUCTURE AND OPERATION 27- 3

TROUBLESHOOTING 27- 7

WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE 27- 9

WHEEL HUB AND BRAKE DRUM < FE639, FG > 27- 10

WHEEL HUB AND ROTOR < FE640, FE649 > 27- 20

AXLE HOUSING 27- 30

REDUCTION AND DIFFERENTIAL 27- 34

MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY 27- 48

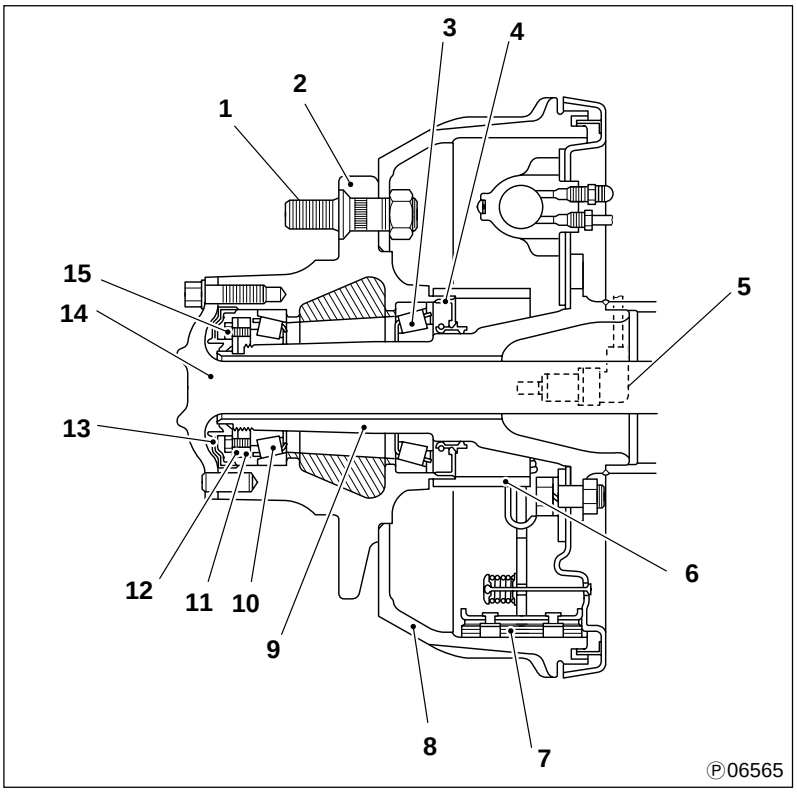
SPECIFICATIONS

Item \ Vehicle model		FE639, FG	FE640	FE649
Rear axle	Model	R033T		
	Type	Full floating shaft tube system		
Reduction	Model	D033H		
	Type	Single-reduction gear		
	Tooth shape	Hypoid gear		
	Speed reduction ratio	5.714	5.285	5.714
Differential	Tooth shape	Straight bevel gear		
Gear oil	Grade	* Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140		
	Oil volume L {qts.}	4.5 {4.8}		
Mass (reference) kg {lb}		Approximately 210 {460}		Approximately 230 {505}

* • When used under heavily-loaded, severe conditions such as continuous driving on uphill grades, it is recommended that you use gear oil with a SAE viscosity grade of 140. However, the air temperature must be above 10°C {50°F}.

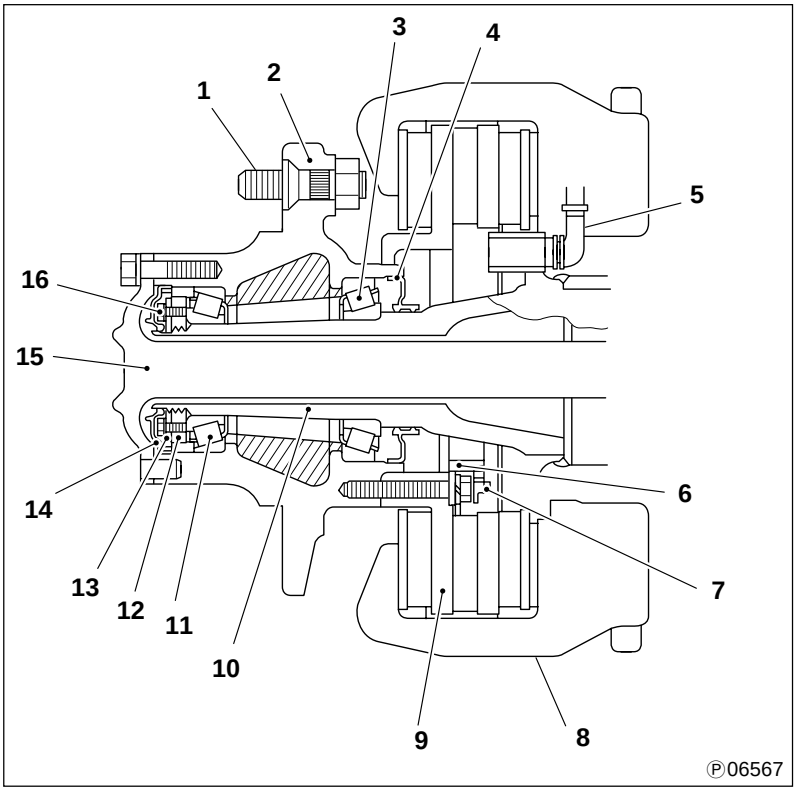
• Multiplate limited slip defferential < FG:option > uses limited slip differential oil API GL-5 SAE 90

Wheel Hub and Brake Drum < FE639, FG >



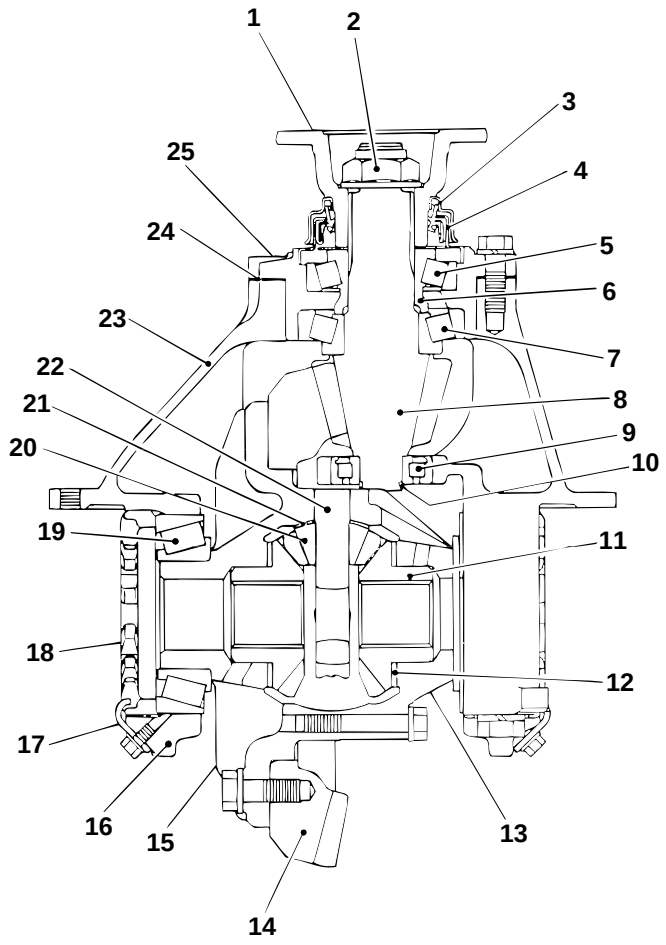
1 Hub bolt
2 Wheel hub
3 Inner bearing
4 Inner oil seal
5 Wheel speed sensor
6 Rotor
7 Brake assembly
8 Brake drum
9 Axle housing
10 Outer bearing
11 Lock nut
12 Lock washer
13 Outer oil seal
14 Axle shaft
15 Lock bolt

Wheel Hub and Rotor < FE640, FE649 >



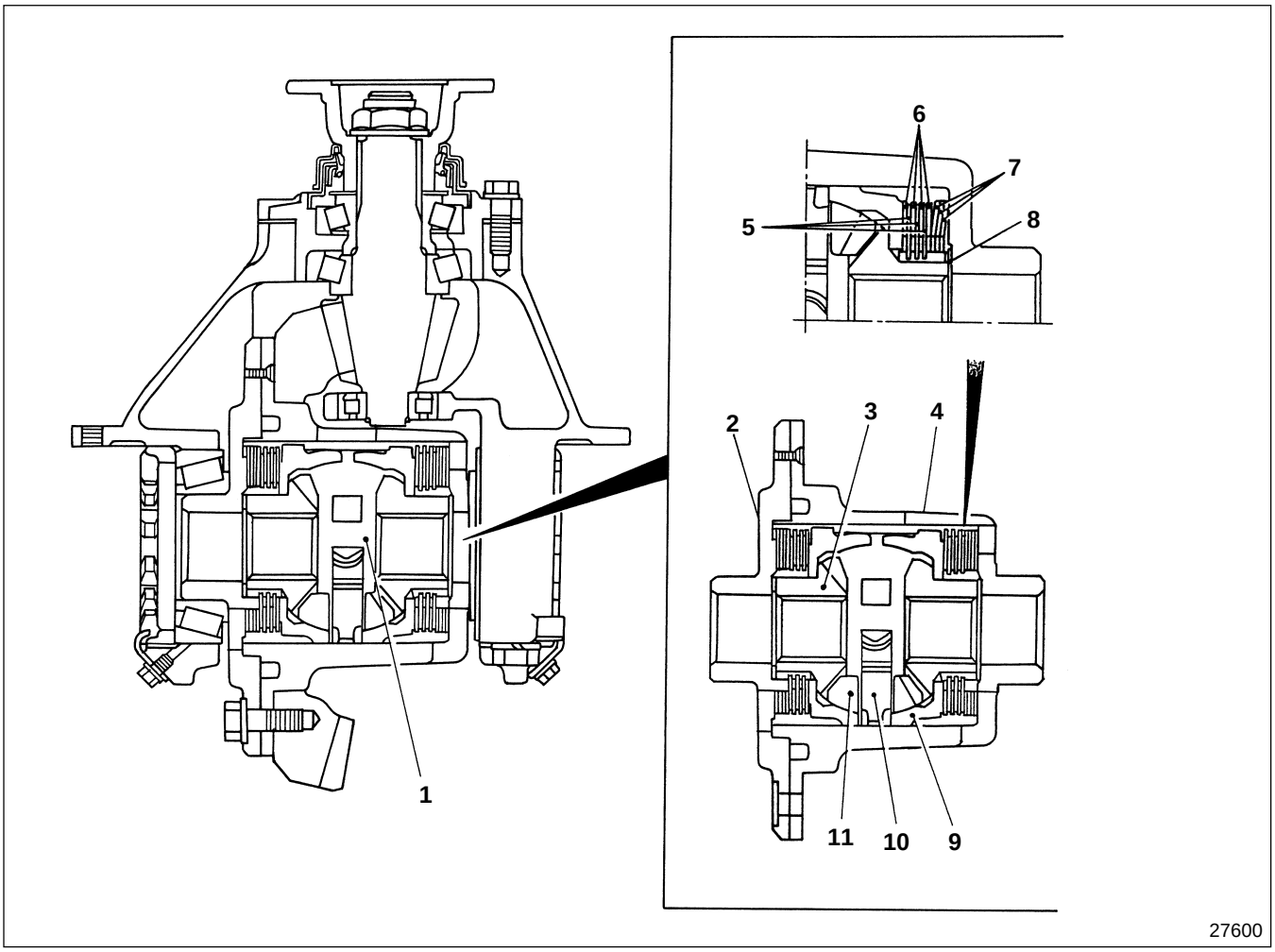
1 Hub bolt
2 Wheel hub
3 Inner bearing
4 Inner oil seal
5 Wheel speed sensor
6 Rotor flange
7 Rotor
8 Disc brake assembly
9 Disc rotor
10 Axle housing
11 Outer bearing
12 Lock nut
13 Lock washer
14 Outer oil seal
15 Axle shaft
16 Lock bolt

Reduction and Differential



1 Companion flange
2 Lock nut
3 Dust cover
4 Oil seal
5 Front bearing
6 Collar
7 Rear bearing
8 Final drive pinion
9 Pinion pilot bearing
10 Lock ring
11 Differential gear
12 Differential gear washer
13 Differential case, RH
14 Final drive gear
15 Differential case, LH
16 Bearing cap
17 Lock plate
18 Adjusting screw
19 Side bearing
20 Differential pinion
21 Differential pinion washer
22 Pinion spider
23 Differential carrier
24 Shim
25 Bearing retainer

MULTIPLE LIMITED SLIP DIFFERENTIAL ASSEMBLY

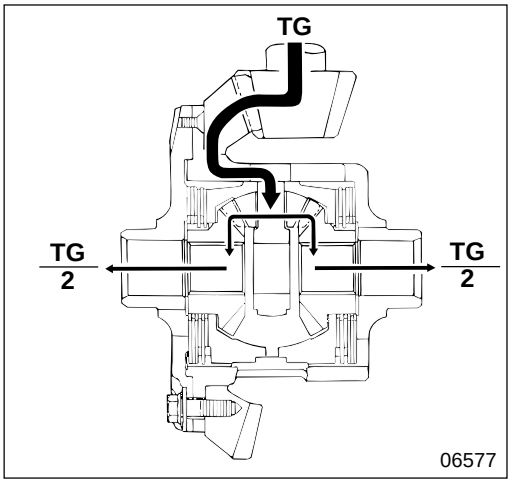


1 Limited slip differential assembly
2 Differential case, LH
3 Side gear
4 Differential case, RH
5 Friction disc
6 Friction plate
7 Spring plate
8 Thrust washer
9 Pressure ring
10 Pinion shaft
11 Differential pinion

Friction disc **5** and friction plate **6** engage side gear **3** and differential case RH **4**, respectively. These parts are pressed against pressure ring **9** by spring plate **7**. The pressure ring mates with the groove in the differential case RH and always turns at the same speed.

Operation mechanism

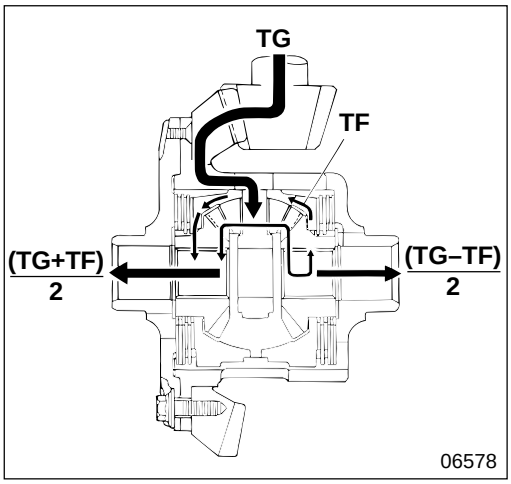
When the wheel of one side starts spinning, a rotational difference between side gear **3** and differential cases, LH **2** and RH **4** occurs. Then, friction disc **5** and friction plate **6** start rotating with a relative difference in revolution speed. This causes friction torque between the disc and plate.



● **Operation in straight movement**

In the case of straight movement, as the revolution speed of the left axle shaft and that of the right axle shaft are equal, no friction torque occurs.

TG : Torque input



● **Operation when there is a difference in revolution speed between left and right wheel**

When a difference in the resistance the wheels receive from the road surface occurs, such as when the wheel of one side encounters mud, the differential function comes into play, transmitting friction torque **TF**. This exertion of friction torque reduces the revolution speed causing the high-revolution speed axle to reduce its speed and the low-revolution speed axle to increase its speed.

Therefore, when the wheel of one side starts spinning, when caught in mud for example, a big difference in revolution speed occurs, causing a large amount of friction torque to come into action. The differential functions in such a manner that a smaller ratio of the torque is transmitted to the axle of the wheel which is spinning while the axle of the wheel on the other side receives a greater ratio of the torque. This makes it easier for the vehicle to get out of the mud.

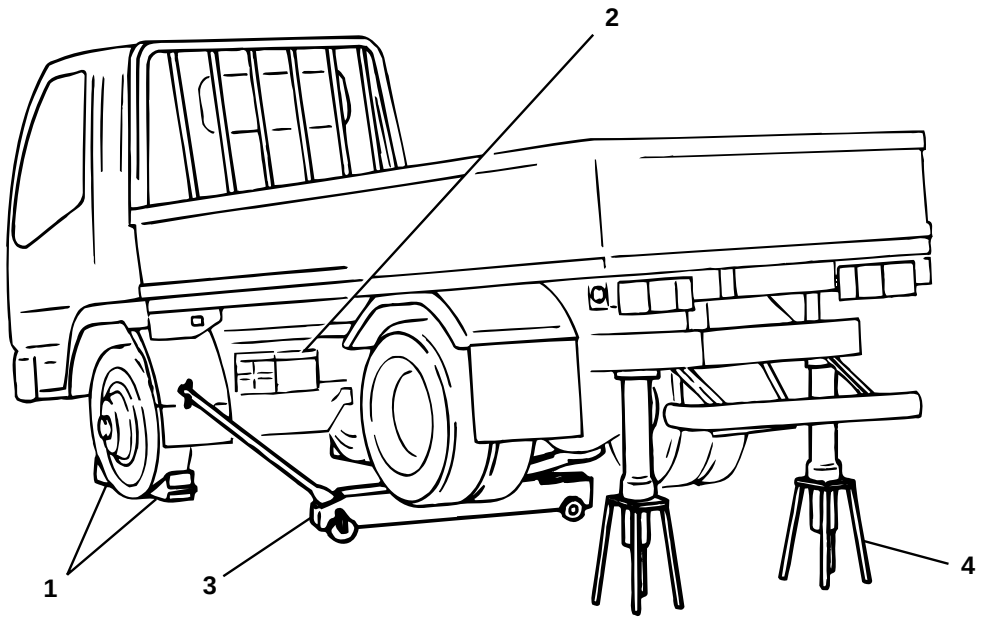
$\frac{(TG-TF)}{2}$ High rotation side (spin side)

$\frac{(TG+TF)}{2}$ Low rotation side

Possible causes \ Symptoms		Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient: Propeller shaft turns but vehicle does not move	Power transmission insufficient: Noise when starting and when changing gear	Power transmission insufficient: Continuous noise while cruising	Power transmission insufficient: Intermittent noise while cruising	Power transmission insufficient: Noise while cornering	Tires drag while cornering
Wheel hub, brake drum, disc rotor, or axle housing	Axle shaft mounting bolt loose			○				○		
	Axle shaft fractured				○					
	Axle shaft slips out of engagement				○					
	Oil seal faulty	○		○						
	Air breather clogged			○						
	Wheel hub bearing seized						○			
	Wheel hub bearing worn						○			
	Wheel hub bearing rotation faulty						○			
	Wheel hub bearing broken							○		
	Gear oil excessive	○								
	Sealant faulty		○							
	Inspection plug and drain plug loose		○							
Reduction and differential	Side bearing seized						○		○	
	Side bearing worn						○		○	
	Side bearing rotation faulty						○		○	
	Side bearing broken							○		
	Side bearing preload adjusted incorrectly						○			
	Reduction and differential assembly mounting bolt and nut loose		○					○		
	Differential carrier cracked or damaged		○							
	Final drive gear and differential case tightening bolts loose					○		○		
	Final drive gear or final drive pinion broken				○	○		○	○	
	Final drive gear or final drive pinion worn						○		○	
	Final drive gear or final drive pinion damaged						○			
	Final drive gear backlash excessive					○				
	Final drive gear backlash or tooth contact faulty						○			
	Final drive pinion starting torque faulty					○	○			
	Lock nut loose					○	○			

TROUBLESHOOTING

Possible causes	Symptoms	Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient: Propeller shaft turns but vehicle does not move	Power transmission insufficient: Noise when starting and when changing gear	Power transmission insufficient: Continuous noise while cruising	Power transmission insufficient: Intermittent noise while cruising	Power transmission insufficient: Noise while cornering	Power transmission insufficient: Tires drag while cornering
Reduction and differential	Front and rear bearings seized				○		○			
	Front and rear bearings worn						○			
	Front and rear bearings broken							○		
	Pinion pilot bearing worn						○			
	Pinion pilot bearing seized or broken							○		
	Pinion spider broken				○					
	Differential gear or differential pinion broken				○			○	○	○
	Differential gear or differential pinion seized				○					○
	Differential gear or differential pinion worn								○	○
	Differential gear washer worn or damaged							○	○	○
	Differential gear spline worn					○				
	Limited slip differential damaged				○	○	○	○	○	



14177

● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative terminal of the battery cable. Gr 54
3 Jack up the rear axle using a garage jack.
4 Support the rear frame on jack stands.

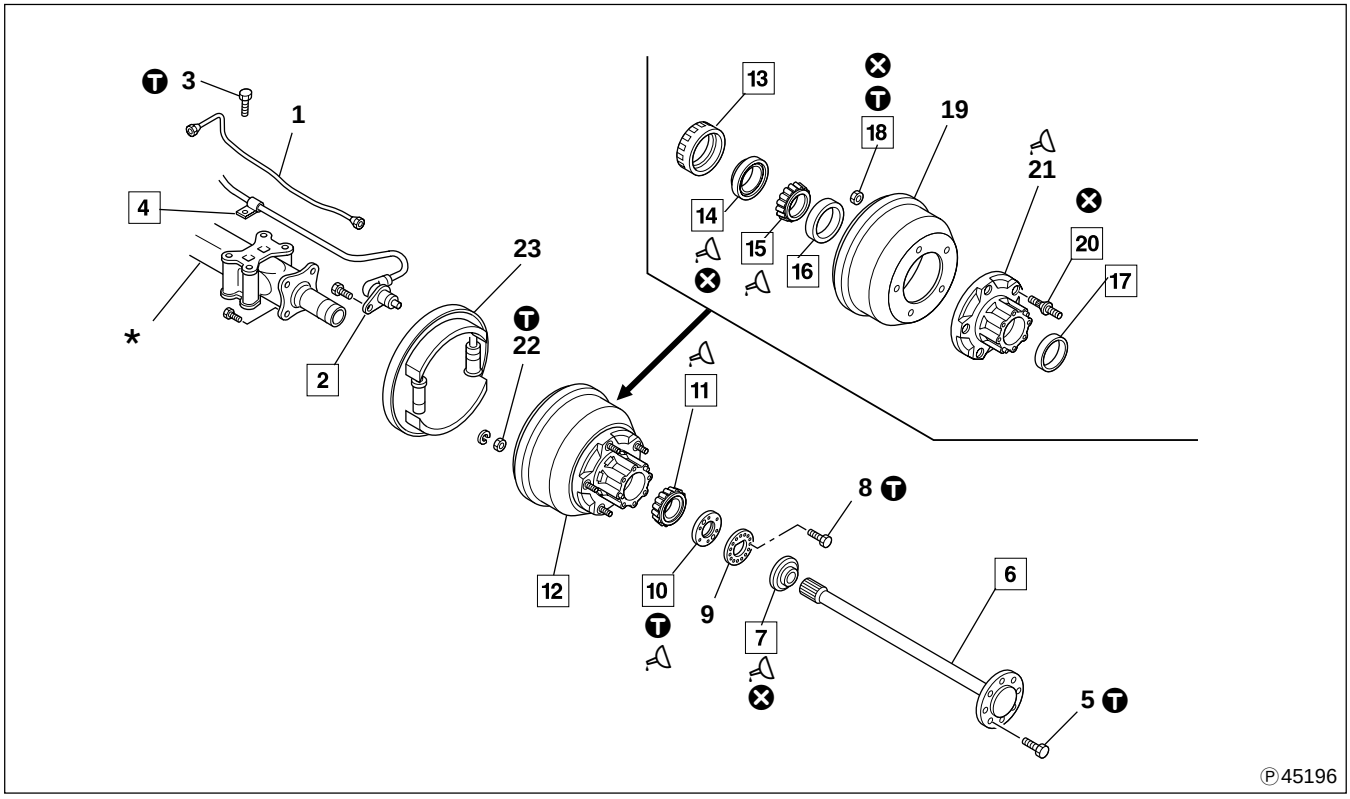
WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on jack stands.**
- **Leave the garage jack and stands in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

WHEEL HUB AND BRAKE DRUM < FE639, FG >



● **Disassembly sequence**

1 Brake pipe
2 Wheel speed sensor
3 Bolt
4 Clips
5 Bolt
6 Axle shaft
7 Outer oil seal
8 Bolt
9 Lock washer
10 Lock nut
11 Outer bearing inner race
12 Wheel hub and brake drum assembly
13 Rotor
14 Inner oil seal
15 Inner bearing inner race
16 Inner bearing outer race
17 Outer bearing outer race
18 Nut
19 Brake drum
20 Hub bolt
21 Wheel hub
22 Nut
23 Brake assembly Gr 35A

*: Axle housing P27-30
⊗: Non-reusable parts

CAUTION

Be sure to protect brake pipe 1 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 19 and wheel hub 21 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

- **Do not allow oil or grease to adhere on the lining surface of rear brake assembly * or the lining surface of brake drum 19.**
- **You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A**

CAUTION

Be careful not to damage rotor 13 or inner oil seal 14, when installing brake drum 12 into axle housing *.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2	Wheel speed sensor	Resistance between terminals	1600 ± 10% Ω	—	—
		Insulation resistance	100 kΩ minimum	—	—
6	Axle shaft	Bend of shaft center	1 {0.039} or less	2 {0.079}	Replace
		Wobble of flange face	0.03 {0.0012} or less	0.05 {0.0020}	
—	Starting torque of wheel hub bearing		2.0 to 3.9 N·m {1.4 to 2.9 ft.lbs, 0.20 to 0.40 kgf·m}	—	Tangential force at the hub bolt : 20 to 38 N {4.4 to 8.6 lbf, 2.0 to 3.9 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
3	Bolt (Clip mounting)		12 to 15 {87 to 108, 1.2 to 1.5}	—
5	Bolt (Axle shaft mounting)		98 to 115 {72 to 87, 10 to 12}	—
8	Bolt (Lock washer mounting)		4.9±0.98 {3.6±0.7, 0.5±0.1}	—
10	Lock nut (Wheel hub bearing mounting : wheel hub bearing preload adjustment)	Primary tightening	98 to 125 {72 to 94, 10 to 13}	—
		After slackening off completely, carry out secondary tightening	29 to 39 {22 to 29, 3 to 4}	—
18	Nut (Wheel hub and brake drum mounting)		345±39 {255±29, 35±4}	—
22	Nut (Brake assembly mounting)		98 to 135 {72 to 100, 10 to 14}	—

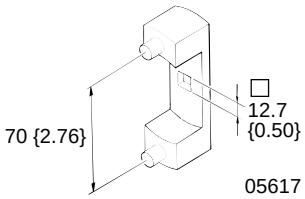
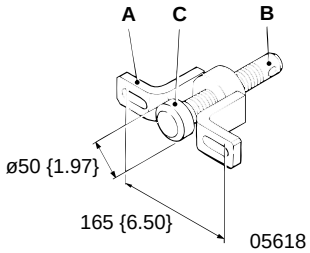
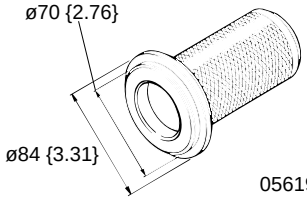
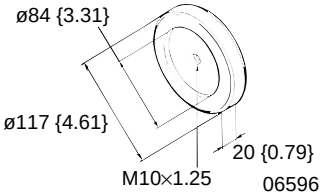
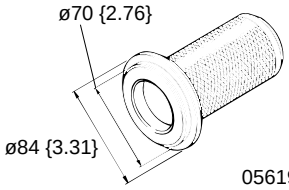
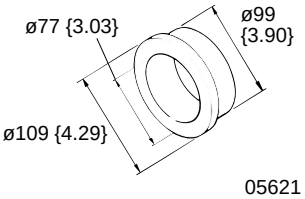
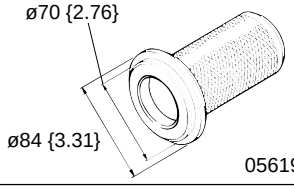
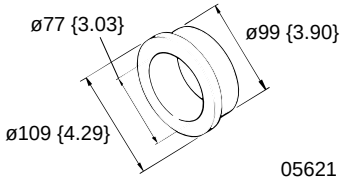
Lubricant

Location	Points of application	Kinds	Quantity
7, 14	Lip area of outer and inner oil seals	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
10	Thread area of lock nut	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
11, 15	Pack the space between rollers of outer and inner bearing inner races	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
21	Pack interior of wheel hub	Wheel bearing grease [NLGI No. 2 (Li soap)]	370±35 g {13.1±1.23 oz}

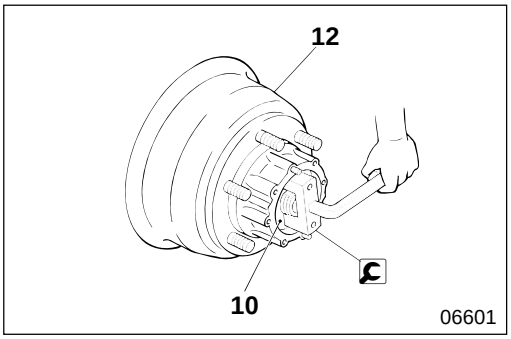
WHEEL HUB AND BRAKE DRUM < FE639, FG >

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
10	Lock nut adjustment tool 	MB999150	Removal and installation of lock nut
12	Hub puller components **A** : Hub puller body **B** : Bolt **C** : Attachment 	MB999070 **A** : MB999071 **B** : MB999072 **C** : MB999073	Removal of wheel hub and brake drum assembly
14	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of inner oil seal: Use in combination
	Oil seal installer 	MH062607	
16	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of outer bearing outer race: Use in combination
	Bearing installer 	MB999098 (T90ST05)	
17	Oil seal installer 	MB999097 (T90ST30) (Obtain Locally)	Press-fitting of inner bearing outer race: Use in combination
	Bearing installer 	MB999098 (T90ST05) (Obtain Locally)	

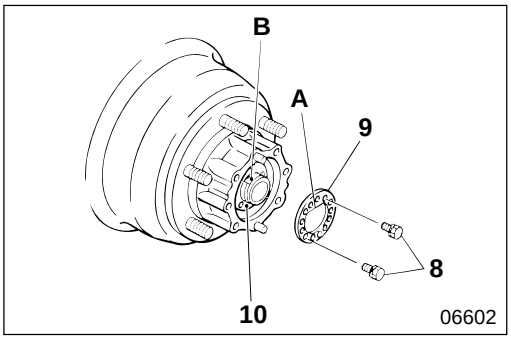
◆ Service procedure



● Starting torque of wheel hub bearing

[Adjustment]

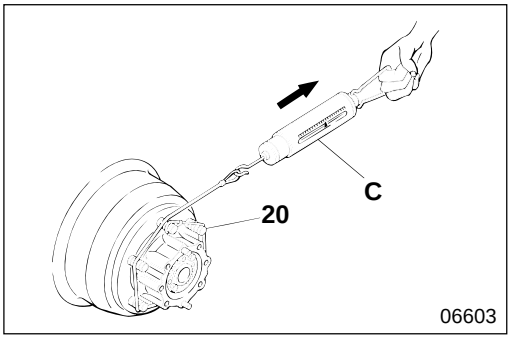
- Tighten lock nut **10** at specified torque for primary tightening, while turning wheel hub and brake drum assembly **12**.
- Slacken off lock nut **10** completely.
- Turn wheel hub and brake drum assembly **12** several times to smooth operation of outer bearings **11**, **17** and inner bearings **15**, **16.**
- Retighten lock nut **10** at specified torque for secondary tightening.



- Align flat area **A** with notch **B** to install lock washer **9**.
- Make sure that the mounting holes of lock washer **9** and lock nut **10** align. If they do not, slacken off the lock nut and align them.
- Install bolts **8** at the position as illustrated, aligning lock nut **10**.
- Tighten bolts **8** at specified torque.

CAUTION

After adjustment, make sure that there is no play in the axial direction of wheel hub and brake drum assembly 12.

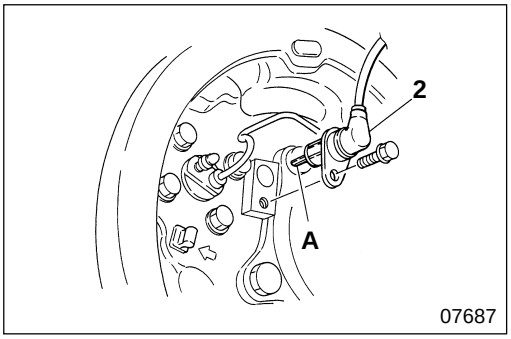


[Measurement]

- Install spring balance **C** on hub bolt **20**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the starting torque to become higher than the tangential force.
- If the measured value deviates from the specified value, readjust.
- If any fault is found after readjustment, replace outer bearings **11**, **17** and inner bearings **15**, **16**.

NOTE

- **Measure the starting torque with inner oil seal 14 installed.**
- **Measure the starting torque with rear axle shaft 6 and outer oil seal 7 removed.**
- **Make sure that there is no drag at brake lining and brake drum 19 before you measure the tangential force.**



2 Wheel speed sensor

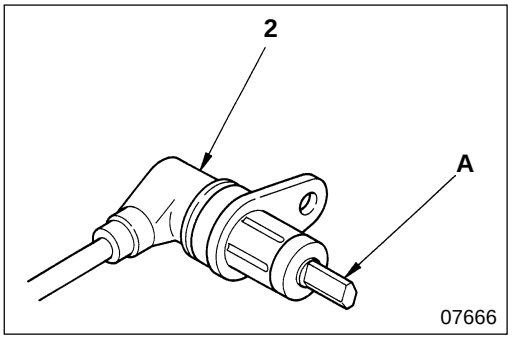
[Removal]

To prevent damaging pole piece **A** of wheel speed sensor **2**, remove the wheel speed sensor before removing wheel hub and drum assembly **12**.

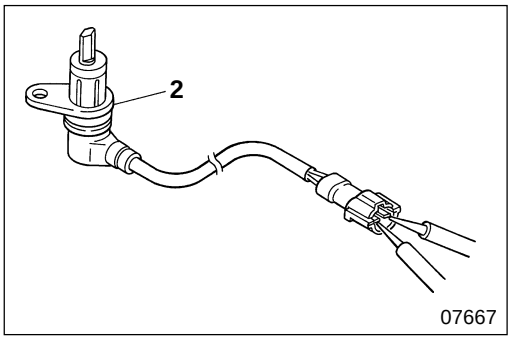
[Installation]

The connector of wheel speed sensor **2** is color-coded. Install the wheel speed sensors to the proper wheels according to the following table.

Installation location	Connector color	Connector shape	Right/left identification tape
Left wheel	Gray	Female	Yellow
Right wheel	Black	Male	None

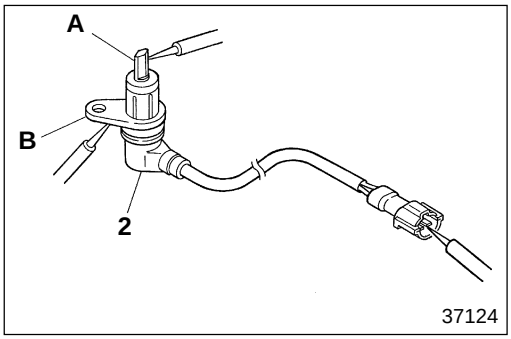


[Inspection]
Pole piece **A** in wheel speed sensor **2** is magnetized by a built-in magnet and attracts metals. Do not allow metal particles to stick to the pole piece.



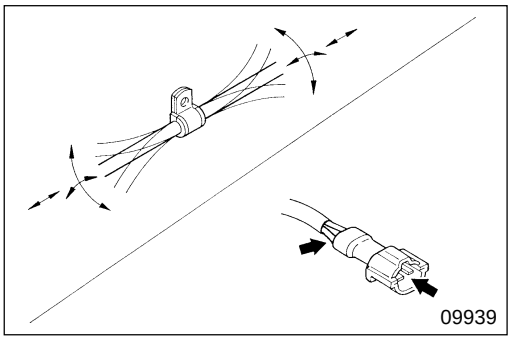
● **Measurement of resistance between terminals**

Measure resistance between the terminals of wheel speed sensor **2**.
If the measured value deviates from the standard value, replace the wheel speed sensor.



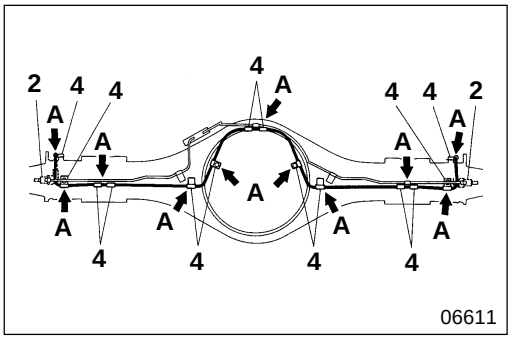
● **Measurement of insulation resistance**

Measure resistance between pole piece **A**, bracket **B** and each terminal of wheel speed sensor **2**.
If the measured value is lower than the standard value, replace the wheel speed sensor.



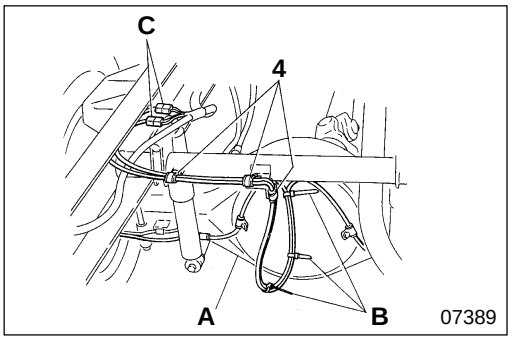
● **Inspection of open circuit in harness**

To check the harness for an open circuit, disconnect the harness clamp from the vehicle side, then bend and pull harness at the clamp to check if a momentary open circuit results. Also inspect the terminal contact conditions in the connector.
If an abnormality is found, replace wheel speed sensor **2**.

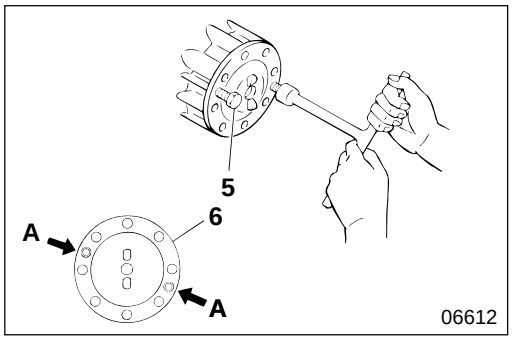


2 **4** **Installation of wheel speed sensor harness and clips**

Starting from the wheel brake side, secure the harness of wheel speed sensor **2** in place at tape sections **A** using clips **4**, while making sure that there is no interference, twisting or excessive sagging of the harness.

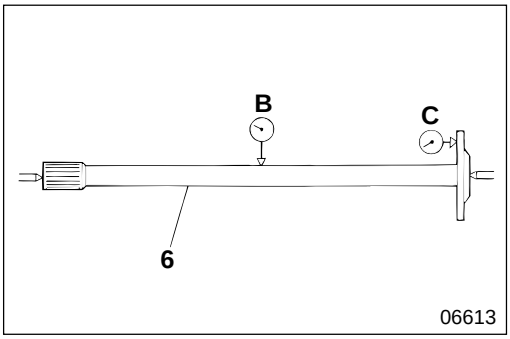


- As shown in the diagram, position the harness of wheel speed sensor **2**, starting from rear axle housing section **A** and moving toward the frame, making sure that there is no twisting or unnecessary slack in the harness. Use clips **4** and cable ties **B** to secure the harness in place, then connect connectors **C**.



6 **Axle shaft**

[Removal]
Insert two mounting bolts **5** of axle shaft **6** into two screw holes **A**, provided for disassembly, of the flange. Then, remove the rear shaft.

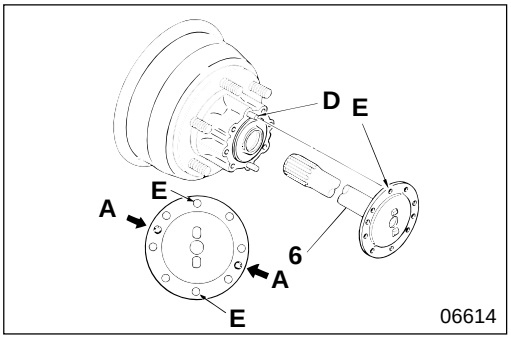


[Inspection]
B : Bend at the shaft center

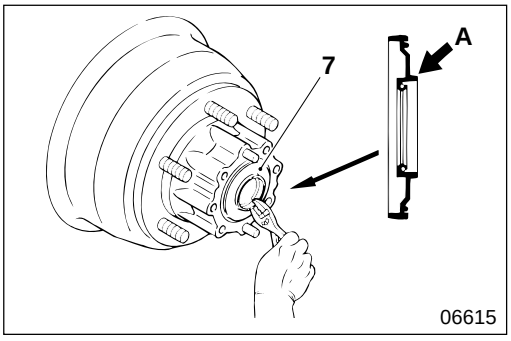
NOTE

To measure the bend of axle shaft 6, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

C : Bend of flange surface

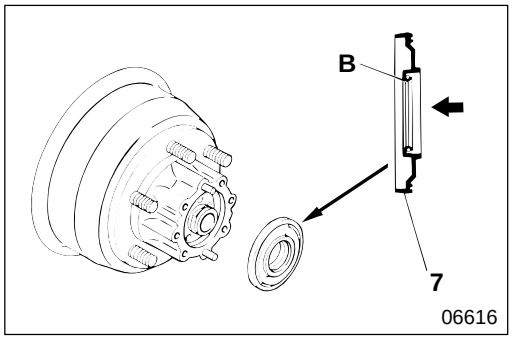


[Installation]
- Knock pin hole **E** of axle shaft **6** is the second hole clockwise from disassembly screw hole **A**.
- To mount axle shaft **6**, align knock pin **D** with knock pin hole **E**.

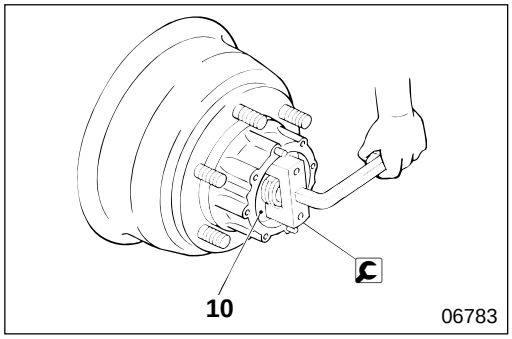


7 **Outer oil seal**

[Removal]
To remove outer oil seal **7**, use a pair of pliers and pull protrusion **A** of the outer oil seal circumference evenly.

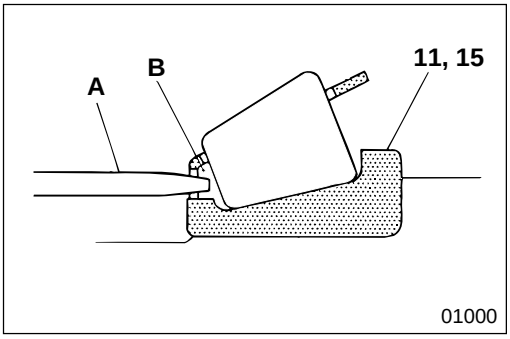


[Installation]
Apply grease to lip area **B** of outer oil seal **7** and press-fit the outer oil seal in the direction as illustrated.



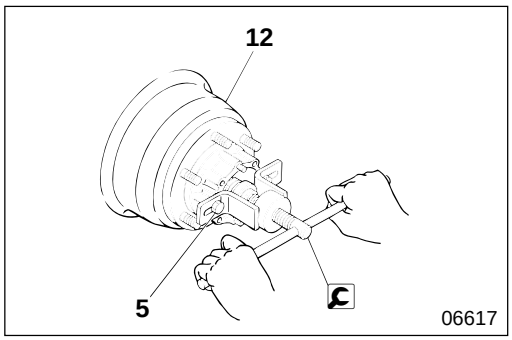
10 **Removal and installation of lock nut**

Adjust and measure the starting torque of wheel hub bearing during installation. P27-13



11 **15** **Packing grease in outer bearing inner race and inner bearing inner race**

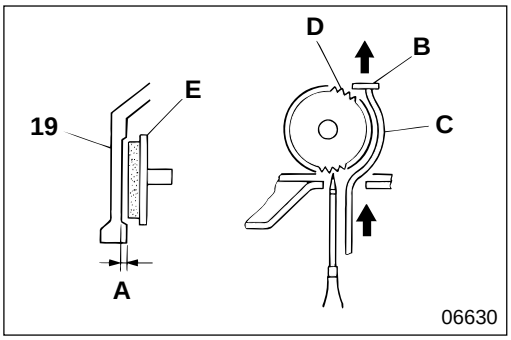
A : Grease pump nozzle
B : Space between rollers



12 **Wheel hub and brake drum assembly**

[Removal]
- Remove wheel hub and brake drum assembly **12** using mounting bolt **5** of axle shaft **6**.

CAUTION
Make sure you remove wheel hub and brake drum assembly 12 in a straight line to prevent damage to oil seal 14.

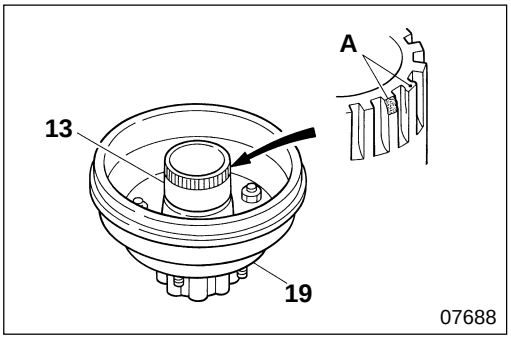


- If wheel hub and brake drum assembly **12** cannot be removed because of stepped wear **A** in brake drum **19**, do the following:
- Remove the backing plate cover.
- Lift lever **B**.
  C : Wire approximately ø2 mm {0.079 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the backing plate to retract brake shoe assembly **E**.
- Remove wheel hub and brake drum assembly **12**.

CAUTION⚠

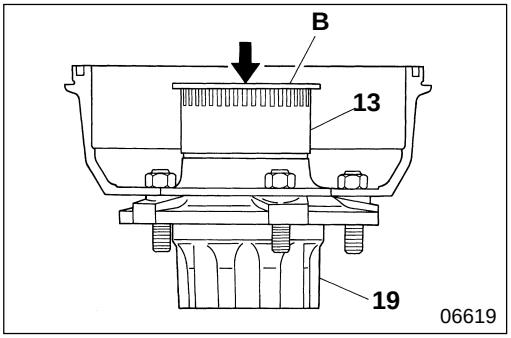
Correct brake drum 19 if any fault is found. 📦 **Gr 35A**

[Installation]
After installing wheel hub and brake drum assembly **12**, adjust the brake shoe clearance. 📦 Gr 35A

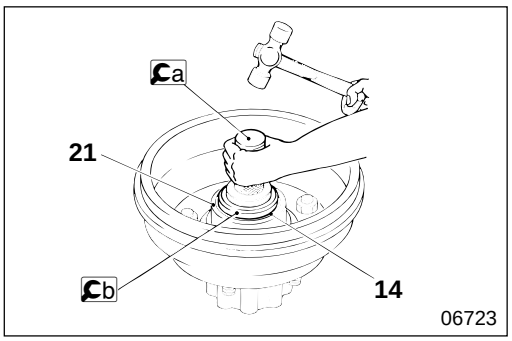


13 **Rotor**

[Inspection]
Check rotor **13** for chipped or crushed teeth (see section **A** in the diagram).
If an abnormality is found, replace the rotor.

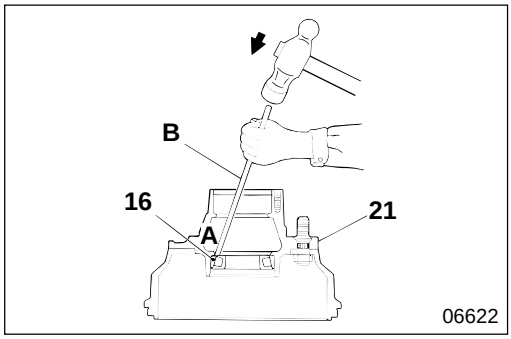


[Installation]
Before installing rotor **13** to brake drum **19**, heat the rotor to approximately 150°C {302°F}. Using iron plate **B**, install the rotor to the brake drum by applying uniform pressure, making sure that there is no gap between the rotor and the brake drum.



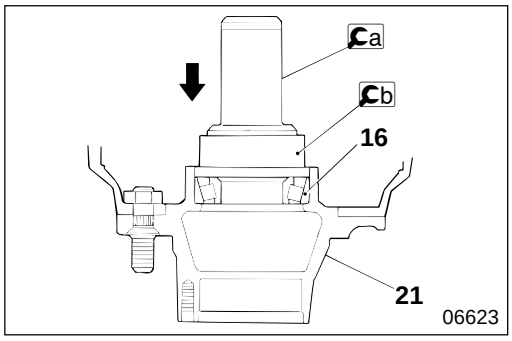
14 **Installation of inner oil seal**

Press-fit inner oil seal **14** until it is flush with the end of wheel hub **21**.

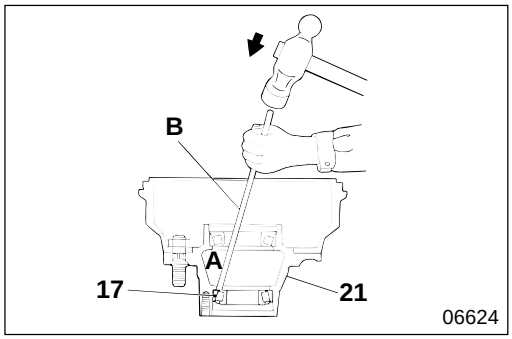


16 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **16** evenly from three indented parts **A** in wheel hub **21**.
B : Pin-punch

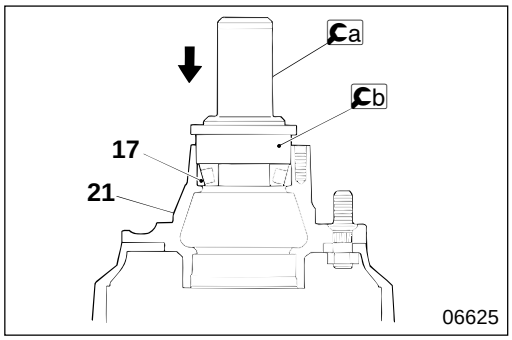


[Installation]

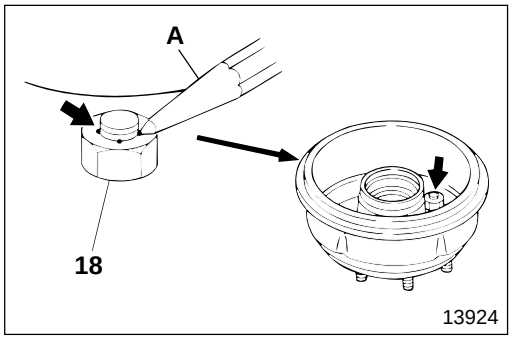


17 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **17** evenly from three indented parts **A** in wheel hub **21**.
B : Pin-punch

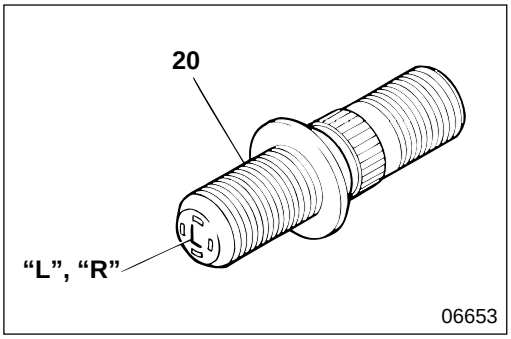


[Installation]



18 **Installation of nut**

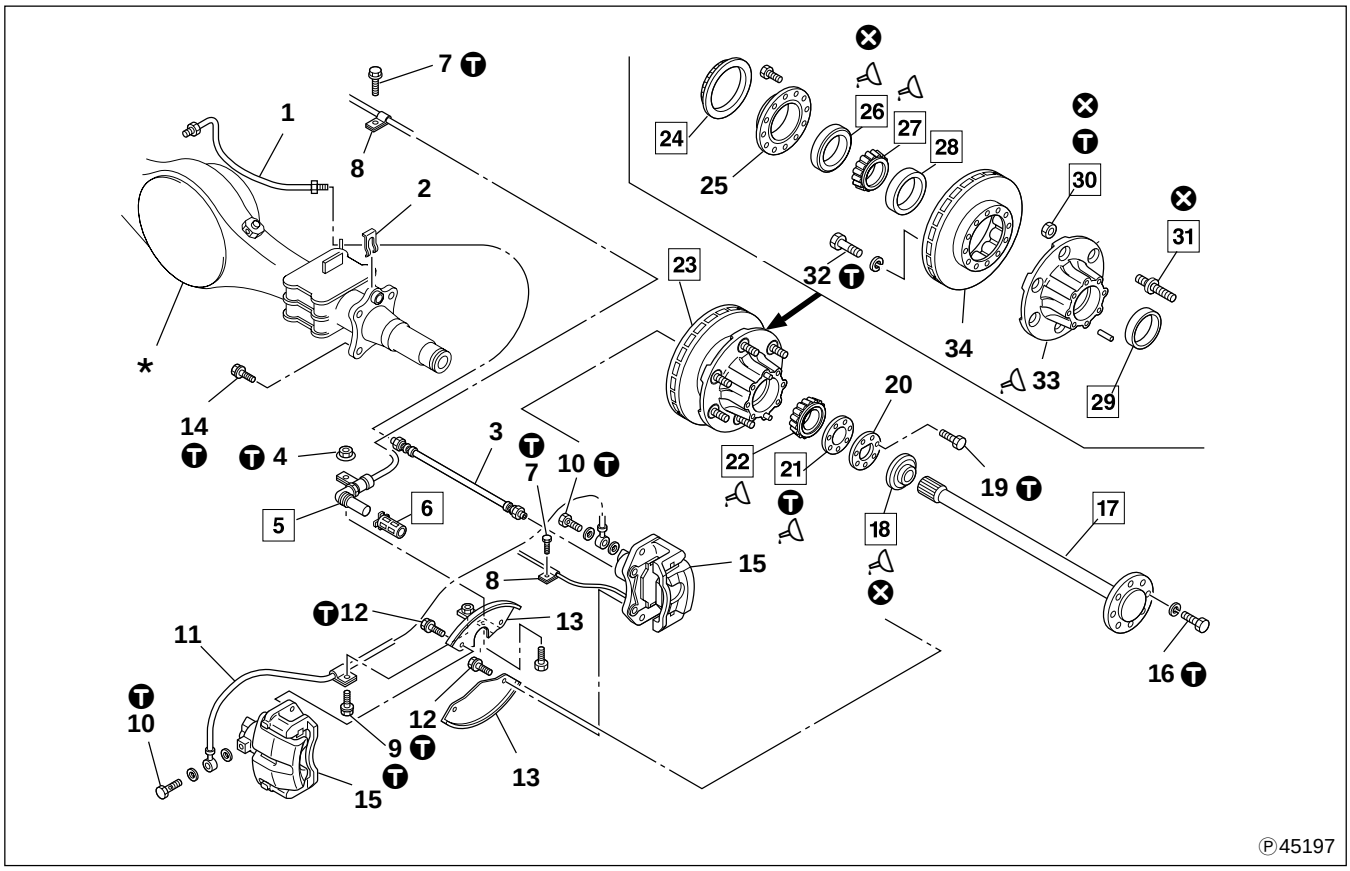
Tighten nut **18** at specified torque, then caulk the nut to keep it from turning.
A : Punch



20 **Installation of hub bolt**

Hub bolt **20** is marked with **L** (left) or **R** (right) to indicate the side it is to be mounted on. Check this symbol before press-fitting the bolt.

WHEEL HUB AND ROTOR < FE640, FE649 >



● **Disassembly sequence**

1 Brake pipe
2 Clip
3 Brake hose
4 Nut
5 Wheel speed sensor
6 Spring spacer
7 Bolt
8 Clip
9 Bolt
10 Eye bolt
11 Brake hose
12 Bolt
13 Dust shield
14 Bolt
15 Disc brake assembly
Gr 35A
16 Bolt
17 Axle shaft
18 Outer oil seal
19 Bolt
20 Lock washer
21 Lock nut
22 Outer bearing
23 Wheel hub and rotor assembly
24 Rotor
25 Rotor flange
26 Inner oil seal
27 Inner bearing
28 Inner bearing race
29 Outer bearing race
30 Nut
31 Hub bolt
32 Bolt
33 Wheel hub
34 Disc rotor

* : Axle housing P27-30
⊗ : Non-reusable parts

WARNING

Disc brake assembly 15 and disc rotor 34 are hot immediately after the vehicle has stopped, so take care not to burn yourself.

CAUTION

- **Before removing disc brake assembly 15 secure the disc brake assembly to the frame using wires, and do not disconnect the brake hose. Never allow the weight of the disk brake caliper assembly to hang from the hydraulic brake hose. Be sure to remove the harness clips to prevent damaging the pad wear indicator harness during the removal process.**
- **Be sure to protect brake pipe 1 and brake hoses 3, 11 from dust by fitting blanking plugs after removal.**

NOTE

Do not disassemble wheel hub 33 and disc rotor 34 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

- **Do not allow oil or grease to adhere on the pad surface of disc brake assembly 15 or the surface rotor 24.**
- **You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A**

CAUTION⚠

Be careful not to damage rotor 24 or inner oil seal 26 when installing wheel hub and rotor assembly 23 in axle housing *.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
5	Wheel speed sensor	Resistance between terminals	1750±10% Ω	—	—
		Insulation resistance	1000 kΩ minimum	—	—
17	Rear axle shaft	Bend of shaft center	1 {0.039} or less	2 {0.079}	Replace
		Wobble of flange face	0.03 {0.0012} or less	0.05 {0.0020}	Replace
24	Rotor runout		0.0039	—	—
—	Starting torque of wheel hub bearing		2.0 to 3.9 N·m {1.4 to 2.9 ft.lbs, 0.20 to 0.40 kgf·m}	—	Tangential force at hub bolt : 18 to 35 N {4.0 to 7.9 lbf, 1.8 to 3.6 kgf}

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

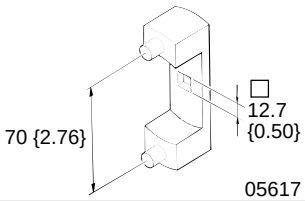
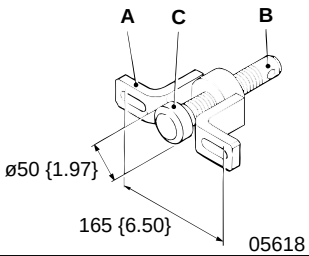
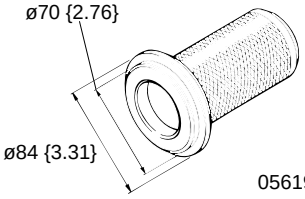
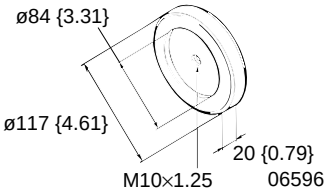
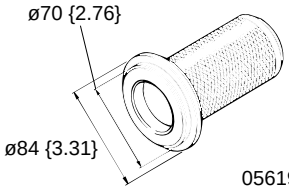
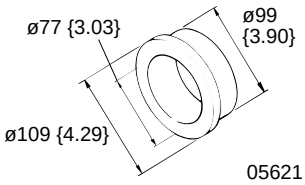
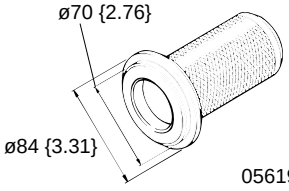
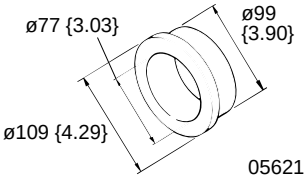
Location	Parts to be tightened		Tightening torque	Remarks
4	Nut (Clip mounting)		10 to 15 {72 to 108, 1.0 to 1.5}	—
7	Bolt (Clip mounting)		12 to 15 {87 to 108, 1.2 to 1.5}	—
9	Bolt (Clip mounting)		4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
10	Eye bolt (Brake hose mounting)		19.6 to 24.6 {14 to 18, 2 to 2.5}	—
12	Bolt (Dust shield mounting)		39 to 58 {28 to 43, 3.9 to 6.0}	—
14	Bolt (Disc brake assembly mounting)		125 to 175 {94 to 130, 13 to 18}	—
16	Bolt (Axle shaft mounting)		98 to 120 {72 to 87, 10 to 12}	—
19	Bolt (Lock washer mounting)		4.9±0.98 {3.6±0.7, 0.5±0.1}	—
21	Lock nut (Wheel hub bearing mounting : wheel hub bearing preload adjustment)	Primary tightening	98 to 130 {72 to 125, 10 to 13}	—
		After slacking off completely, carry out secondary tightening	30 to 40 {22 to 29, 3 to 4}	—
30	Nut (Hub bolt mounting)		340±40 {255±29, 35±4}	—
32	Bolt (Wheel nub and disc rotor mounting)		34 to 54 {25 to 40, 3.5 to 5.5}	—

Lubricant

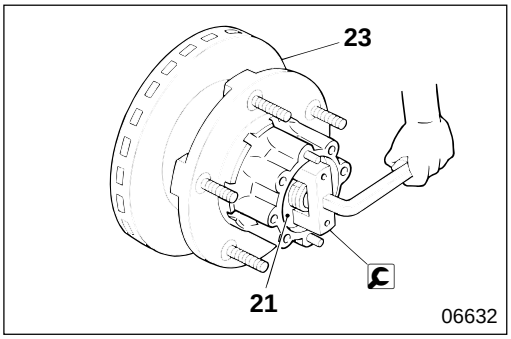
Location	Points of application	Kinds	Quantity
18, 26	Lip area of outer and inner oil seals	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
21	Thread area of lock nut	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
22, 27	Pack the space between rollers of outer and inner bearing inner races	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
33	Pack interior space of wheel hub	Wheel bearing grease [NLGI No. 2 (Li soap)]	370±37 g {13.1±1.31 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
21	Lock nut adjustment tool 	M B999150	Removal and installation of lock nut
23	Hub puller components **A** : Hub puller body **B** : Bolt **C** : Attachment 	M B999070 **A** : MB999071 **B** : MB999072 **C** : MB999073	Removal of wheel hub and rotor assembly
26	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of inner oil seal : Use in combination
	Oil seal installer 	MH062607	
28	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of inner bearing outer race : Use in combination
	Bearing installer 	MB999098 (T90ST05)	
29	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of outer bearing outer race : Use in combination
	Bearing installer 	MB999098 (T90ST05)	

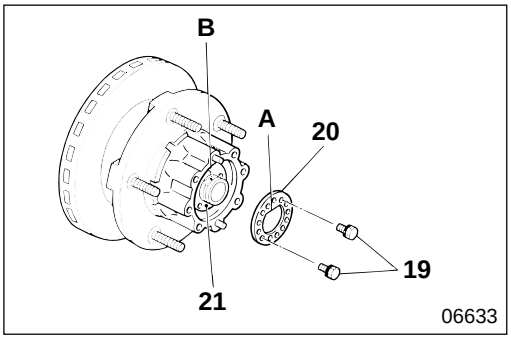
◆ Service procedure



● Starting torque of wheel hub bearing

[Adjustment]

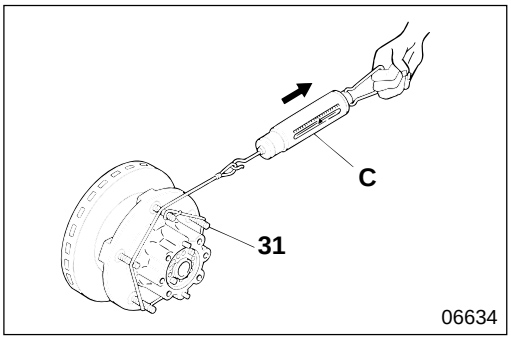
- Tighten lock nut **21** at specified torque for primary tightening, while turning wheel hub and rotor assembly **23**.
- Slacken off lock nut **21**completely.
- Turn wheel hub and rotor assembly **23** several times to smooth operation of outer bearings **22**, **29** and inner bearings **27, 28**.
- Tighten lock nut **21** at specified torque for secondary tightening.



- Insert lock washer **20** so that flat area **A** fits onto notch **B**.
- Make sure that the mounting holes of lock washer **20** and lock nut **21** align. If they do not, slacken off the lock nut and align them.
- Install bolts **19** at the positions as illustrated, aligning lock nut **21**.
- Tighten bolts **19** at specified torque.

CAUTION

After adjustment, make sure that there is no play in the axial direction of wheel hub and rotor assembly 23.

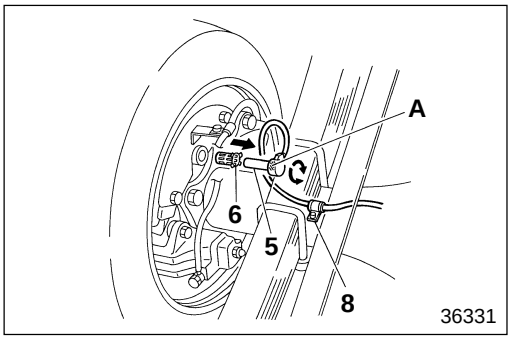


[Measurement]

- Install spring balance **C** on hub bolt **31**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the starting torque to become higher than the tangential force.
- If the measured value deviates from the specified value, readjust.
- If any fault is found after readjustment, replace outer bearings **22, 29** and inner bearings **27, 28**.

NOTE

- **Measure the starting torque with inner oil seal 26 installed.**
- **Measure the starting torque with disc brake assembly 15, outer oil seal 18 and axle shaft 17 removed.**



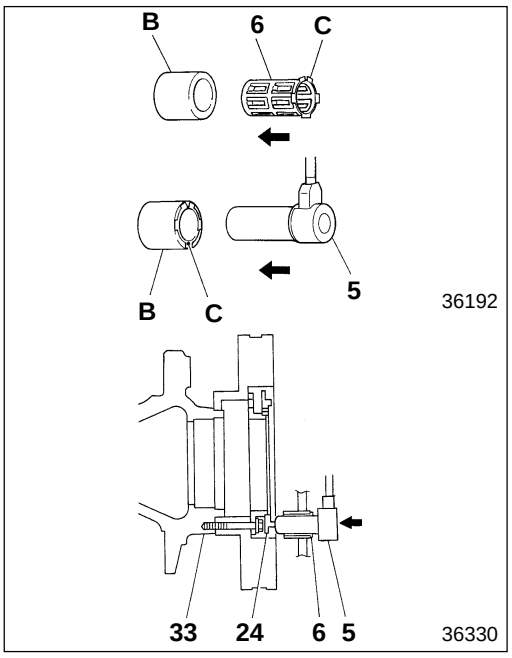
5 **6** **Wheel speed sensor and spacer**

[Removal]

Using pliers, hold wheel speed sensor **5** at shaded section **A** in the diagram, and remove it by turning it slightly.

CAUTION

- **Do not hold wheel speed sensor 5 with pliers at positions other than shaded section A shown in the diagram.**
- **Do not apply excessive force to remove wheel speed sensor 5, such as by striking with a hammer, prying with a screwdriver, and pulling the harness. Excessive force can break wires in the wheel speed sensor.**
- **If only slight force is necessary to remove wheel speed sensor 5, replace spring spacer 6.**



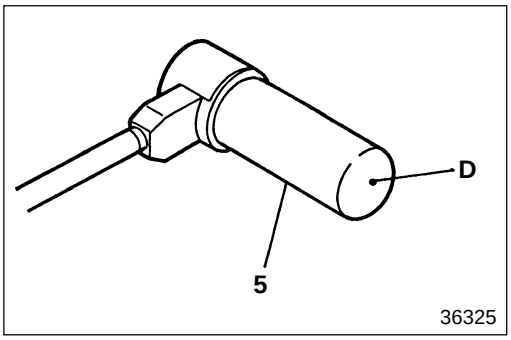
[Installation]
The connector of wheel speed sensor **5** is color-coded. Install the wheel speed sensors to the proper wheels according to the following table.

Installation location	Connector color	Connector shape	Right/left identification tape
Left wheel	Gray	Female	Yellow
Right wheel	Black	Male	None

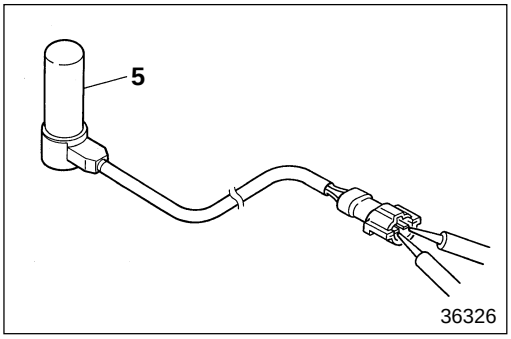
- Insert spring spacer **6** into holder section **B** of the backplate until stopper section **C** contacts the holder section.
- Insert wheel speed sensor **5** until it firmly contacts rotor **24**.
- Slowly rotate wheel hub **33** two or three turns (1 rotation per 2 seconds) to make sure it rotates smoothly.

CAUTION

Do not apply excessive force to install wheel speed sensor 5, such as by striking with a hammer, prying with a screwdriver, and pulling the harness. Excessive force can break wires in the wheel speed sensor.

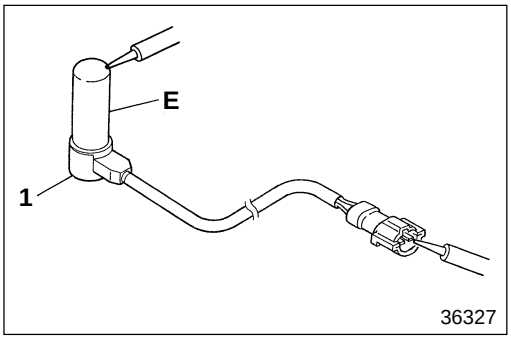


[Inspection]
Pole piece **D** in wheel speed sensor **5** is magnetized by a built-in magnet and attracts metals. Do not allow metal particles to stick to the pole piece.



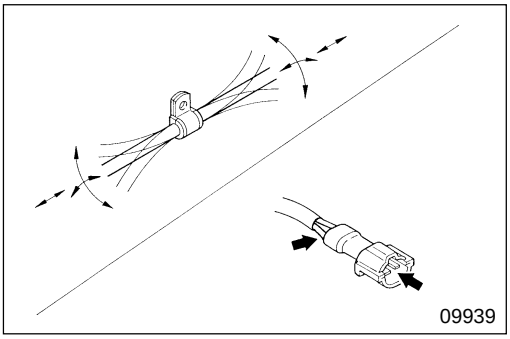
● **Measurement of resistance between terminals**

Measure resistance between the terminals of wheel speed sensor **5**.
If the measured value deviates from the standard value, replace the wheel speed sensor.



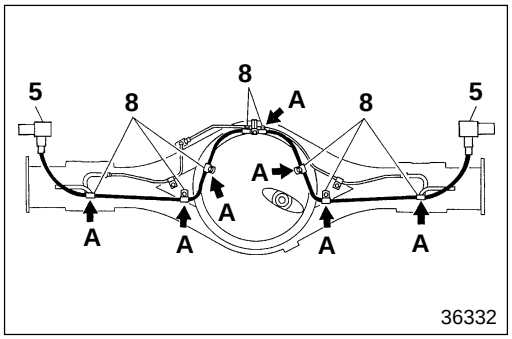
● **Measurement of insulation resistance**

Measure resistance between body **E** and each terminal of wheel speed sensor **5**.
If the measured value is lower than the standard value, replace the wheel speed sensor.



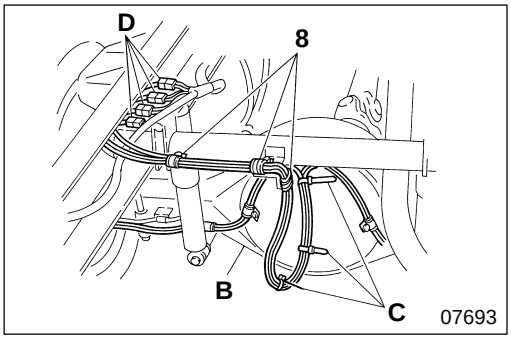
● **Inspection of open circuit in harness**

To check the harness for an open circuit, disconnect the harness clamp from the vehicle side, then bend and pull harness at the clamp to check if a momentary open circuit results. Also inspect the terminal contact conditions in the connector.
If an abnormality is found, replace wheel speed sensor **1**.

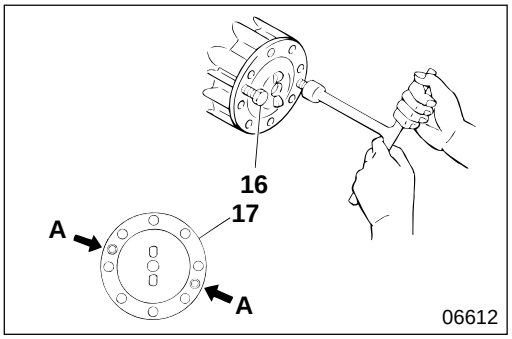


5 **8** **Installation of wheel speed sensor harness and clips**

- Starting from the wheel brake side, secure the harness of wheel speed sensor **5** and the pad wear indicator harness in place at tape sections **A** using clips **8**, while making sure that there is no interference, twisting or excessive sagging of the harnesses.

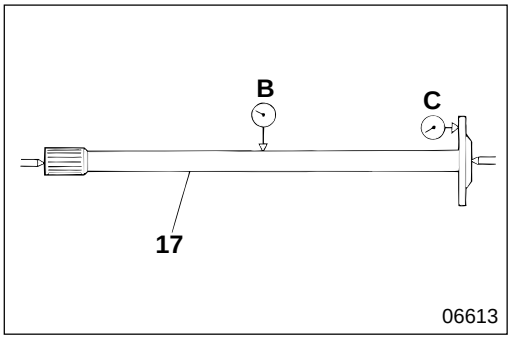


- As shown in the diagram, position the harness of speed sensor **5** and the pad wear indicator harness, starting from housing section **B** and moving toward the frame, making sure that there is no twisting or excessive sagging of the harnesses. Use clips **8** and cable ties **C** to secure the harnesses in place, then connect connectors **D**.



17 **Axle shaft**

[Removal]
Insert bolts **16** into screw holes **A** of axle shaft **17**. Then, remove the axle shaft.

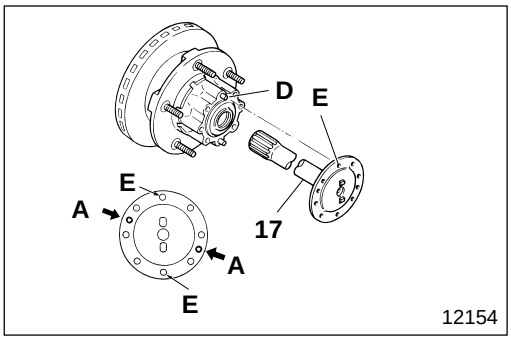


[Inspection]
B : Bend of shaft center

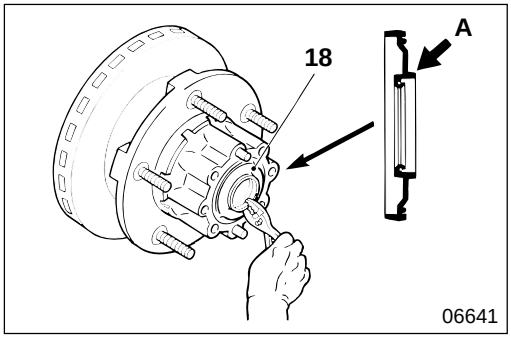
NOTE

To measure the bend of axle shaft 17, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

C : Wobble of flange face

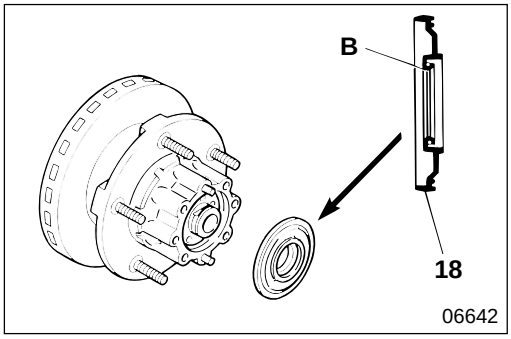


[Installation]
- Knock pin hole **E** of axle shaft **17** is the second hole clockwise from disassembly screw hole **A**.
- To mount axle shaft **17**, align knock pin **D** with knock pin hole **E**.

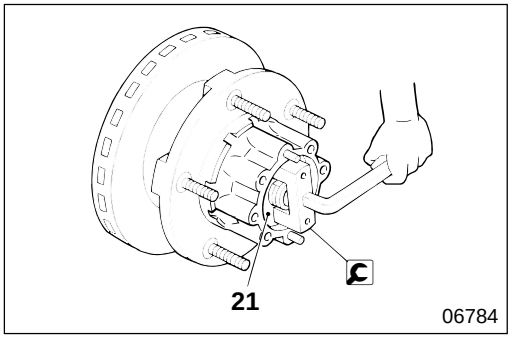


18 **Outer oil seal**

[Removal]
To remove outer oil seal **18**, use pliers and pull protrusion **A** of the outer oil seal circumference evenly.

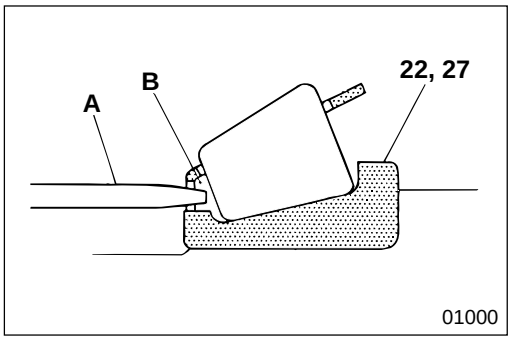


[Installation]
- Apply grease to lip area **B** of outer oil seal **18**.
- Press-fit outer oil seal **18** in the direction as illustrated.



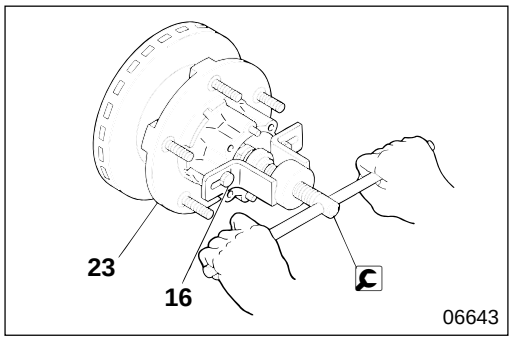
21 **Removal and installation of lock nut**

Adjust starting torque of wheel hub bearing during installation.
P27-23



22 **27** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Space between rollers

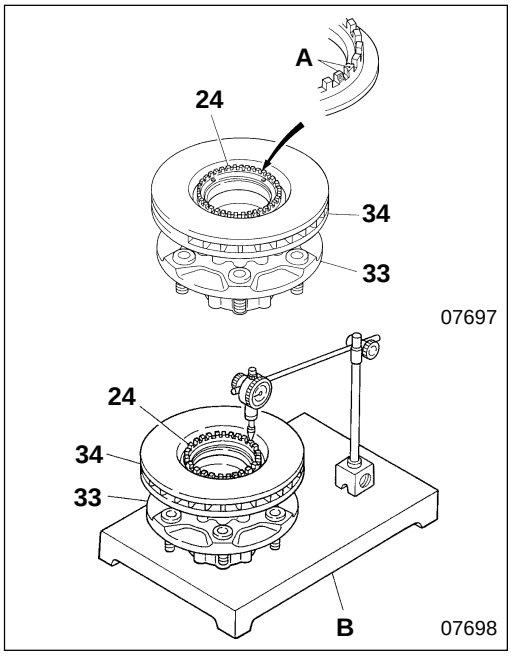


23 **Removal of wheel hub and rotor assembly**

Remove wheel hub and rotor assembly **23** using mounting bolt **16** of axle shaft **17**.

CAUTION

Make sure you remove wheel hub and rotor assembly 23 in a straight line to prevent damage to inner oil seal 26.



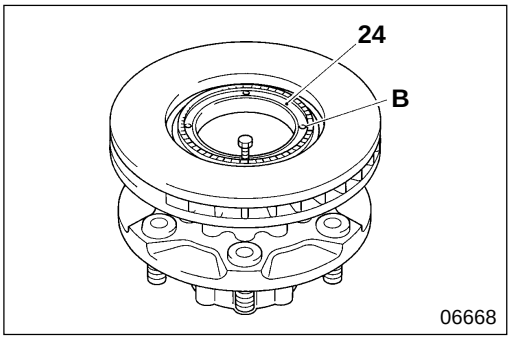
24 **Rotor**

[Inspection]

- Check rotor **24** for chipped or crushed teeth (see section **A** in the diagram).
  If an abnormality is found, replace the rotor.

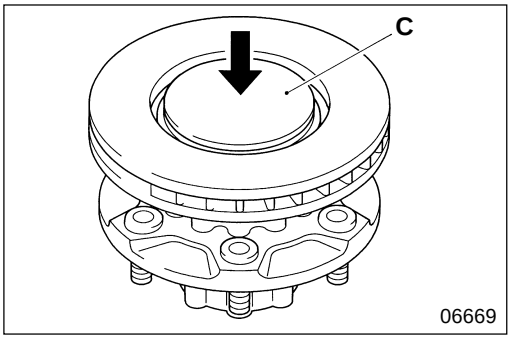
- If the amount of runout of rotor **24** deviates from the standard value, repeat the disassembly and reassembly procedures. If the amount of runout still deviates from the standard value after the reassembly, replace faulty parts.

  B : Platform



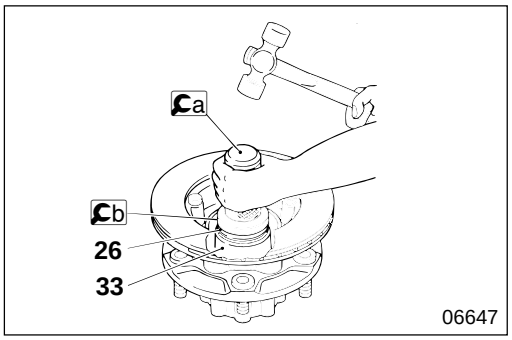
[Removal]

Install bolts (M6 × 1.0) in threaded holes **B** (holes for rotor removal) on rotor **24**, and tighten them evenly to remove the rotor.



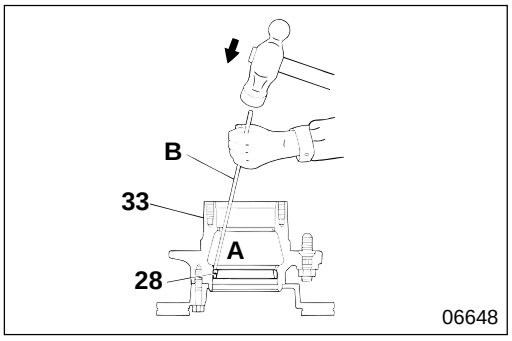
[Installation]

Before installing rotor **24** to rotor flange **25**, heat the rotor to approximately 150°C {302°F}. Using iron plate **C**, press-fit the rotor into the rotor flange by applying uniform pressure, making sure that there is no gap between the rotor and the rotor flange.



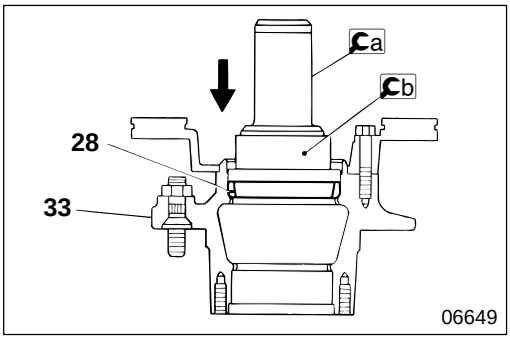
26 **Installation of inner oil seal**

Press-fit inner oil seal **26** so that it is flush with the end of wheel hub **33**.

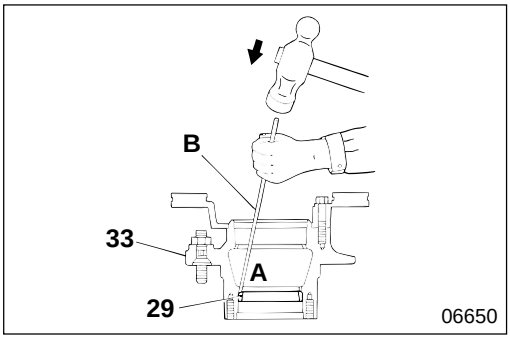


28 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **28** evenly from three indented parts **A** in wheel hub **33**.
B : Pin-punch

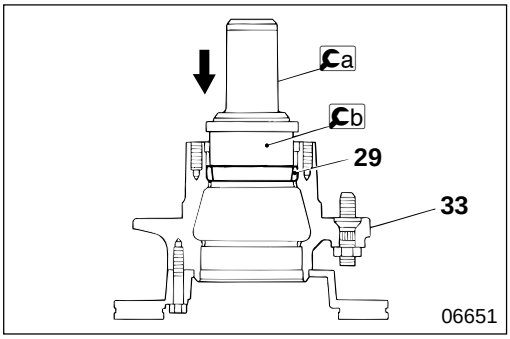


[Installation]

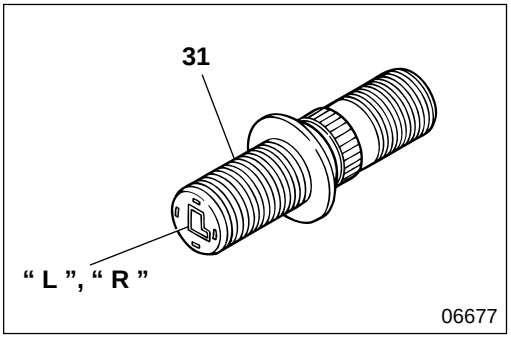


29 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **29** evenly from three indented parts **A** in wheel hub **33**.
B : Pin-punch

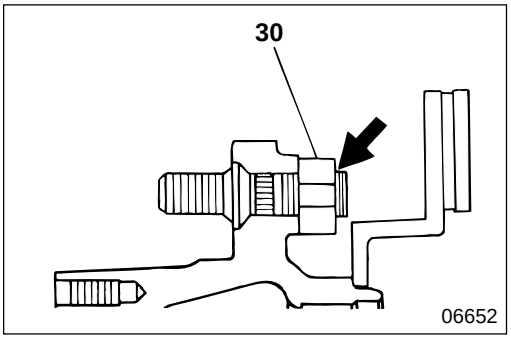


[Installation]



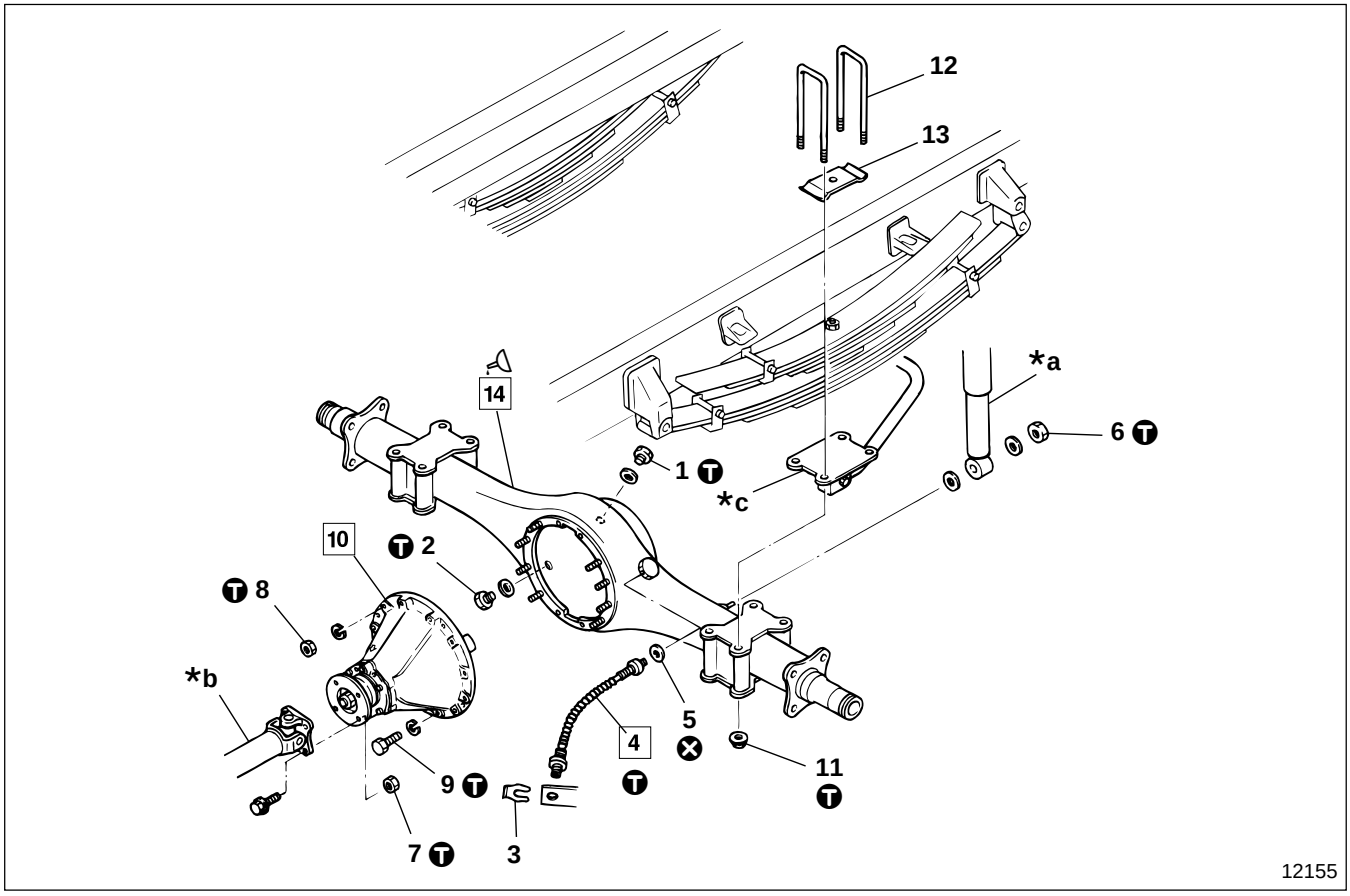
30 **31** **Installation of nut, hub bolt**

- Hub bolt **31** is marked with **L** (left) or **R** (right) to indicate the side it is to be mounted on. Check this symbol before press-fitting the bolt.



- Tighten nut **30** at specified torque.
- Drive nut **30** in using a punch to lock the nut.

AXLE HOUSING



● **Work before disassembly**

P27-32

● **Disassembly sequence**

1 Inspection plug
2 Drain plug
3 Clip
4 Brake hose
5 Packing
6 Nut
7 Nut
8 Nut
9 Bolt
10 Reduction and differential assembly P27-34
11 U-bolt nut
12 U-bolt
13 Spring pad
14 Axle housing

***a** : Shock absorber Gr 34
***b** : Propeller shaft Gr 25
***c** : Stabilizer Gr 34

⊗ : Non-reusable parts

CAUTION

Be sure to protect brake hose 4 from dust by fitting blanking plugs after removal.

NOTE

Do not remove axle housing 14 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

Make sure that brake hose 4 is not twisted when you install it.

● **Work after assembly**

P27-32

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
14	Axle housing	Runout of outer bearing mating area	0.5 {0.020} or less	1 {0.039}	Replace
		Difference of center area before and after turning	1 {0.039} or less	5 {0.20}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

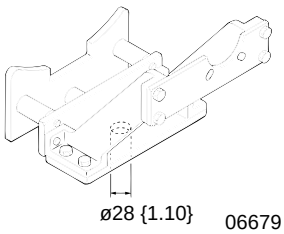
Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	98 to 115 {72 to 87, 10 to 12}	—
2	Drain plug	98 to 115 {72 to 87, 10 to 12}	—
4	Brake hose mounting (on the axle housing)	13 to 17 {9.4 to 12, 1.3 to 1.7}	—
6	Nut (Shock absorber mounting)	26.4 to 33.3 {20 to 25, 2.7 to 3.4}	—
7	Nut (Propeller shaft mounting)	98 to 120 {72 to 87, 10 to 12}	—
8	Nut (Reduction and differential assembly mounting)	69 to 93 {51 to 69, 7.0 to 9.5}	—
9	Bolt (Reduction and differential assembly mounting)	83 to 108 {61 to 80, 8.5 to 11.0}	—
11	U-bolt nut (U-bolt mounting)	339±24.5 {250±18, 34.6±2.5}	—

Sealant

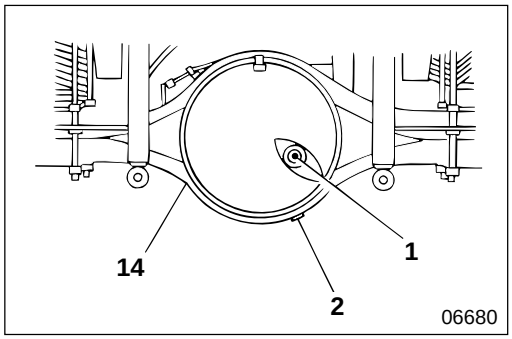
Location	Points of application	Kinds	Quantity
14	Reduction and differential assembly mounting surfaces of axle housing	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
10	Differential carrier base 	MB999102	(Obtain Locally)

◆ Service procedure



● **Work before disassembly**

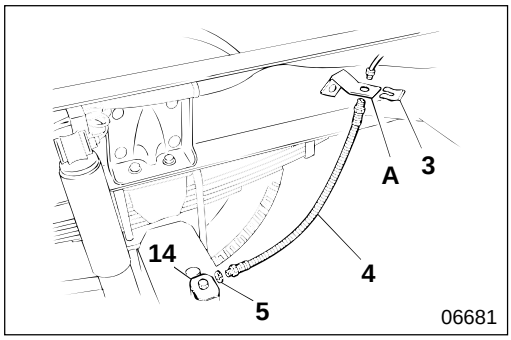
Remove inspection plug **1** and drain plug **2**, then drain the gear oil from axle housing **14**.

WARNING⚠

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

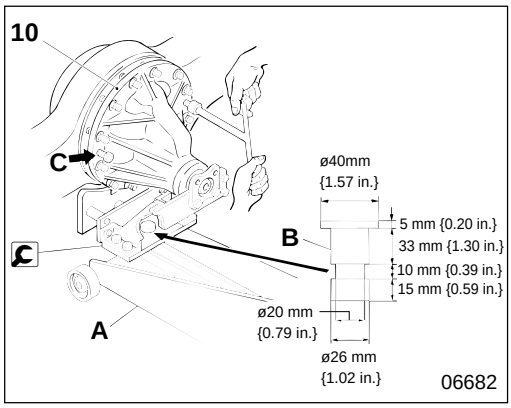
● **Work after assembly**

Fill axle housing **14** with the specified amount of gear oil via inspection plug **1**.



4 **Removal and installation of brake hose**

Remove brake hose **4** from bracket **A** (on the frame) first, then remove the brake hose from axle housing **14**. To assemble the brake hose follow the disassembly sequence in reverse.

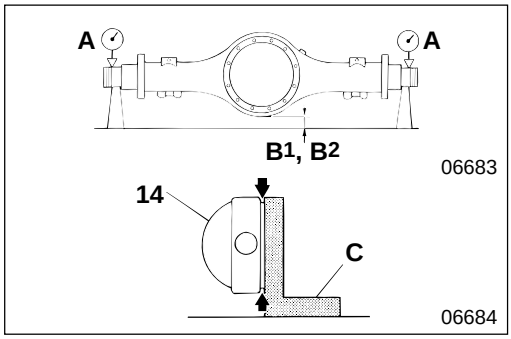


10 **Removal and installation of reduction and differential assembly**

- Remove the lift pad from garage jack **A** and mount differential carrier base, after turning pin **B** to the dimensions as illustrated insert it and secure it with the bolt which secured the lift pad.
- Tighten two bolts in screw holes **C** used for removing reduction and differential assembly **10** evenly, and remove the reduction and differential assembly.
  Bolt size : M12×1.25 mm

NOTE

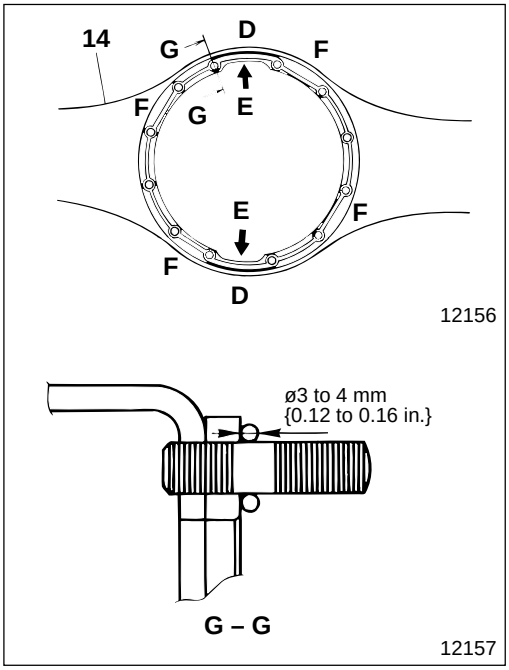
Be sure to completely remove adhered sealant from the mounting surface of the axle housing and carrier.



14 **Axle housing**

[Inspection]

- Support the inner bearing mating parts at both ends of the housing spindle of axle housing **14** horizontally.
- Set the dial gauge against outer bearing mating part **A** and turn it 360° to measure bend.
- Set axle housing **14** vertical using square **C**. After measuring B_1, turn the axle housing 180° and measure B_2 to find the difference.
- If the measured value is higher than the limit, replace axle housing **14**.



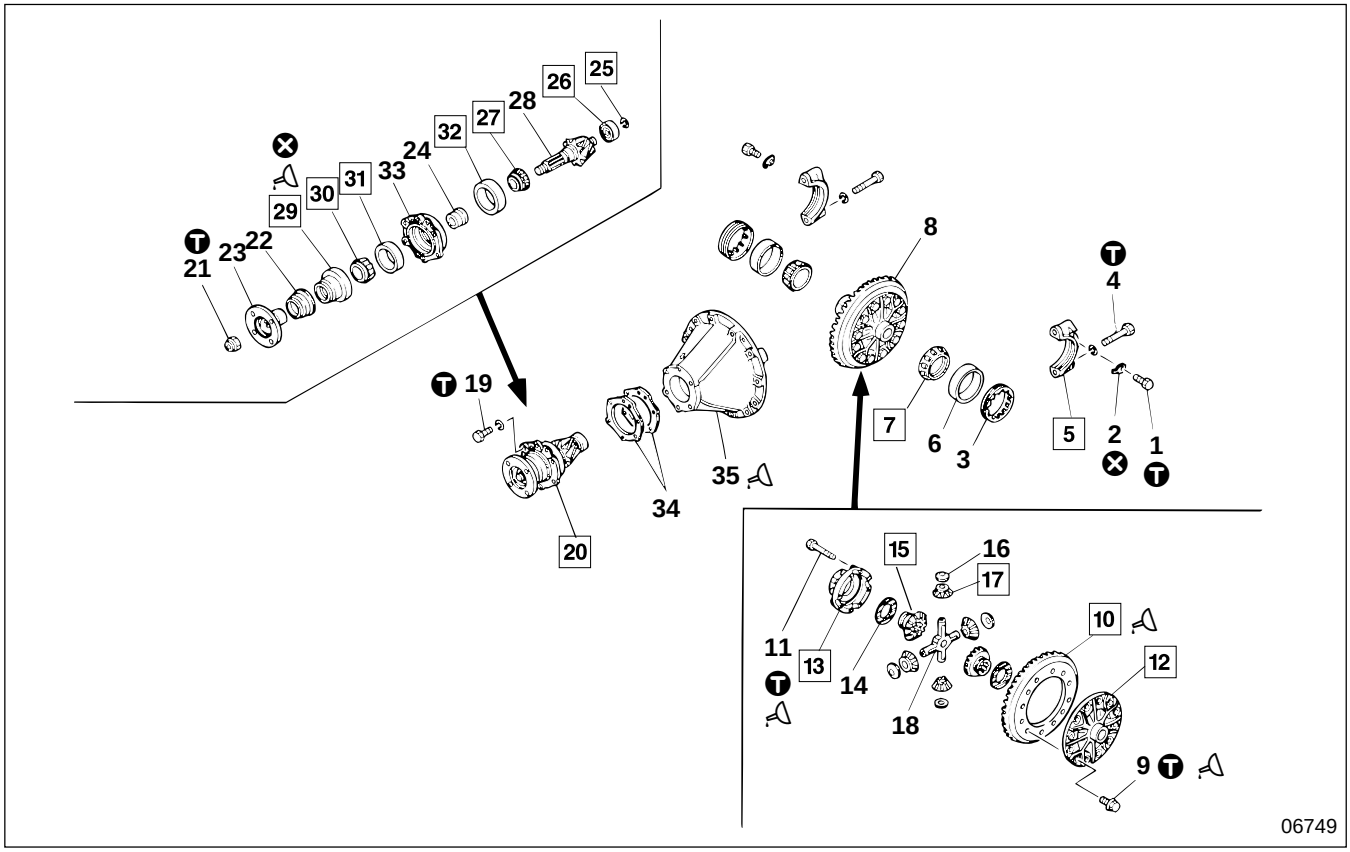
[Application of sealant]

- Apply sealant to reduction and differential assembly **10** mounting surface of axle housing **14**.
- Apply sealant around the periphery of indented area **E** for part **D**.
- Apply sealant linearly to part **F**.

NOTE

Make sure that sealant does not ooze from the mounting surface after installing reduction and differential assembly 10.

REDUCTION AND DIFFERENTIAL



- **Work before disassembly** P27-38
- **Inspection before disassembly** P27-38
- **Disassembly sequence**

1 Bolt
2 Lock plate
3 Adjusting screw
4 Bolt
5 Bearing cap
6 Side bearing outer race
7 Side bearing inner race
8 Differential assembly
Multiplate limited slip differential assembly P27-44
9 Bolt
10 Final drive gear
11 Bolt
12 Differential case, LH
13 Differential case, RH
14 Differential gear washer
15 Differential gear
16 Differential pinion washer
17 Differential pinion
18 Pinion spider
19 Bolt
20 Pinion assembly
21 Lock nut
22 Dust cover
23 Companion flange
24 Collar
25 Lock ring
26 Pinion pilot bearing
27 Rear bearing inner race
28 Final drive pinion
29 Oil seal
30 Front bearing inner race
31 Front bearing outer race
32 Rear bearing outer race
33 Bearing retainer
34 Shim
35 Differential carrier

⊗ : Non-reusable parts

- **Assembly sequence**

Follow the disassembly sequence in reverse.

- **Inspection and adjustment after assembly** P27-39

CAUTION

- **Be sure when replacing any of the following parts to replace both it and its associated parts as a set :**
  - **For bolt 4, bearing cap 5 or differential carrier 35, replace the differential carrier set.**
  - **For final drive gear 10 or final drive pinion 28, replace the reduction gear set.**
  - **For differential case RH 13 and differential case LH 12, replace the differential case set.**
- **Make sure you keep left and right side bearings 6, 7 separate after removal, and be careful not to mix them up when installing them.**

NOTE

Write down the thickness of shim 34 and collar 24 when disassembling to use it as reference when assembly.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
6, 7	Starting torque of side bearing		1.96 to 2.94 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using adjusting screw • Tangential force at 152 mm {5.98 in.} point around outer periphery of differential case: 25.5 to 38.2 N {5.7 to 8.6 lbf, 2.6 to 3.9 kgf}
10	Wobble of rear surface of final drive gear		0.1 {0.0039} or less	—	• Adjust or replace along with the gear set • Measure the wobble at a point 132 mm {5.20 in.} (on the radius) away from the center of the final drive gear
10, 28	Backlash between final drive gear and final drive pinion		0.20 to 0.28 {0.0079 to 0.011}	0.50 {0.020}	Adjust or replace along with the gear set
15	Play in the rotating direction between axle shaft and differential gear spline		0.05 to 0.15 {0.0020 to 0.0059}	0.50 {0.020}	Replace
15, 17	Backlash between differential gear and differential pinion		0.15 to 0.20 {0.0059 to 0.0079}	0.50 {0.020}	Replace
17, 18	Clearance between differential pinion and pinion spider		[22] 0.17 to 0.27 {[0.87] 0.0067 to 0.011}	0.50 {0.020}	Replace
20	Starting torque of pinion bearing	New parts	1.96 to 2.94 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using collar • Tangential force at 114 mm {4.49 in.} point around outer periphery of bearing retainer: 34.3 to 51.9 N {7.7 to 12 lbf, 3.5 to 5.3 kgf}
		Reused parts	1.6 to 2.4 N·m {1.2 to 1.7 ft.lbs, 0.16 to 0.24 kgf·m}	—	• Adjust using collar • Tangential force at 114 mm {4.49 in.} point around outer periphery of bearing retainer: 27 to 41 N {6.2 to 9.3 lbf, 2.8 to 4.2 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	19.6 to 26.5 {14 to 20, 2.0 to 2.7}	—
4	Bolt (Bearing cap mounting)	201.00 {150, 20.50}	—
9	Bolt (Final drive gear and differential case LH mounting)	166.6 to 225.4 {120 to 165, 17 to 23}	—
11	Bolt (Differential case RH and differential case LH mounting)	83.3 to 112.7 {61 to 83, 8.5 to 11.5}	—
19	Bolt (Pinion assembly mounting)	66.6 to 90.2 {49 to 67, 6.8 to 9.2}	—
21	Lock nut (Companion flange mounting)	372.4 to 470.4 {275 to 345, 38 to 48}	—

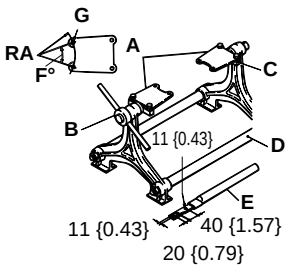
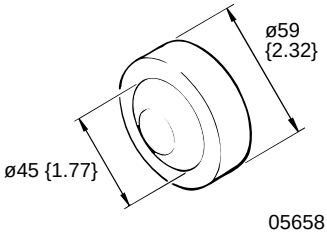
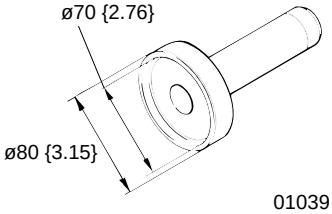
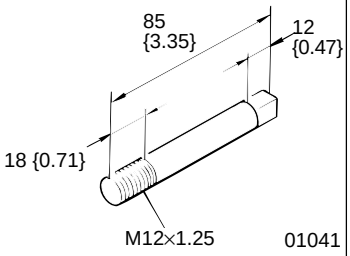
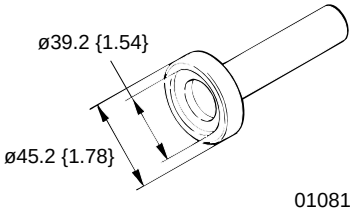
REDUCTION AND DIFFERENTIAL

Lubricant and sealant

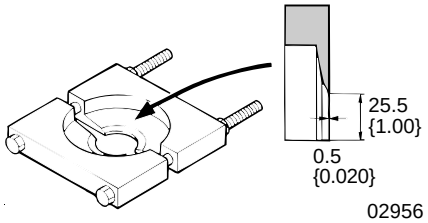
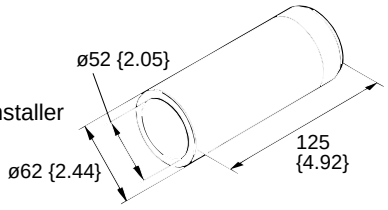
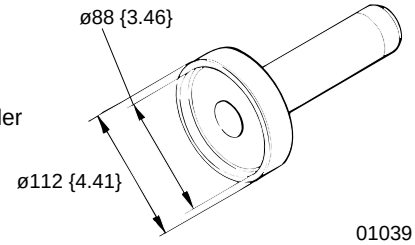
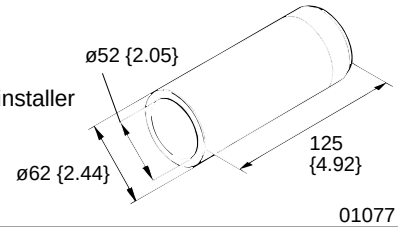
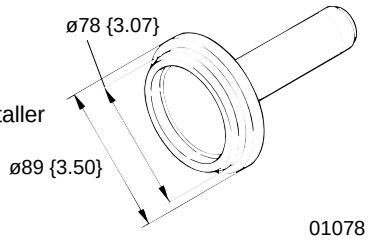
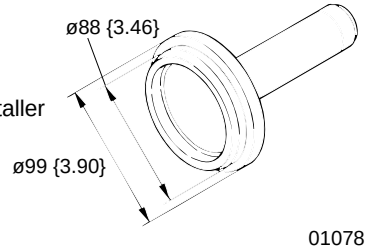
Location	Points of application	Kinds	Quantity
9, 11	Entire surface of bolt	Rust preventive	As required
10	Thread area of final drive gear	LOCTITE 271	As required
11	Thread area of bolt	LOCTITE 271	As required
29	Lip area of oil seal	Wheel bearing grease [NLG1 No.2 (Li soap)]	As required
35	Pinion pilot bearing mounting surface of differential carrier	LOCTITE 601	As required

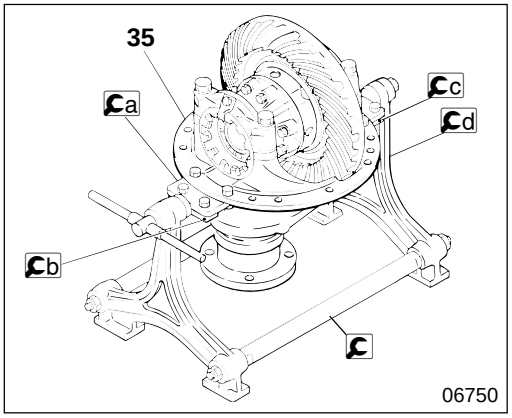
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Differential working base assembly **A** : Attachment **B** : Holder **C** : Holder **D** : Working base **E** : Flange stopper  05656	MB999034 **A** : MB999040 **B** : MB999036 **C** : MB999037 **D** : MB999035 **E** : MB999096	• Maintenance work bench for reduction and differential assembly • Flange stopper is used for installation and removal of the companion flange
7	Adaptor  05658	MB999076	Removal of side bearing inner race: Use in combination with available gear puller (General tool)
	Bearing installer  01039	MH061748	Press-fitting of side bearing inner race
20	Bearing retainer guide pin  01041	MH061745	Installation of pinion assembly: Use two
26	Pinion pilot bearing installer  01081	MH061976	Press-fitting of pinion pilot bearing

Unit : mm {in.}

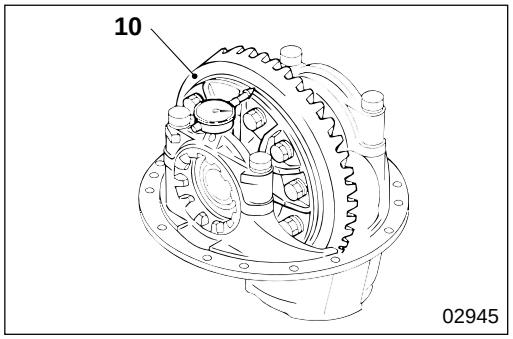
Location	Tool name and shape	Part No.	Application
27	Pinion rear bearing remover 	MB999045	Removal of rear bearing inner race
	Pinion bearing installer 	MH061005	Press-fitting of rear bearing inner race
29	Oil seal installer 	MH061750	Press-fitting of oil seal
30	Pinion bearing installer 	MH061005	Press-fitting of front bearing inner race
31	Pinion bearing installer 	MH061977	Press-fitting of front bearing outer race
32	Pinion bearing installer 	MH061264	Press-fitting of rear bearing outer race



◆ Service procedure

● **Work before disassembly**

Mount differential carrier **35** on a differential working base assembly.

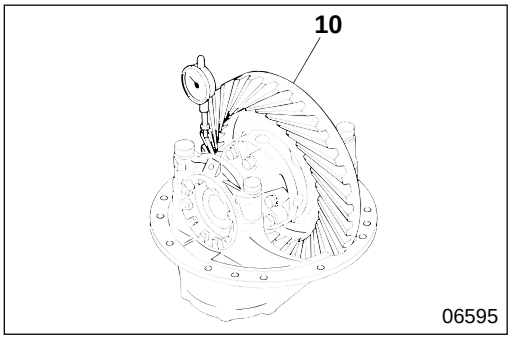


● **Inspection before disassembly**

Inspect for faulty parts before disassembly.

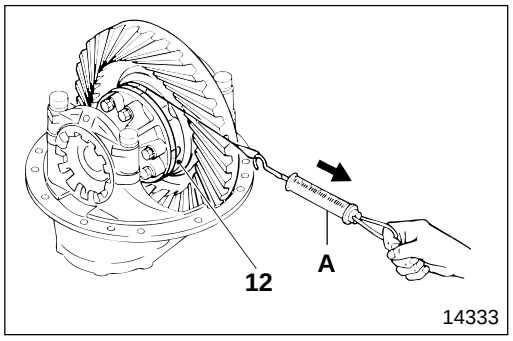
(1) Wobble of rear face of final drive gear

Measure wobble at a point 132 mm {5.20 in.} (on the radius) from the center of final drive gear **10**.



(2) Backlash of final drive gear and final drive pinion

Measure at three points on the circumference of final drive gear **10**.

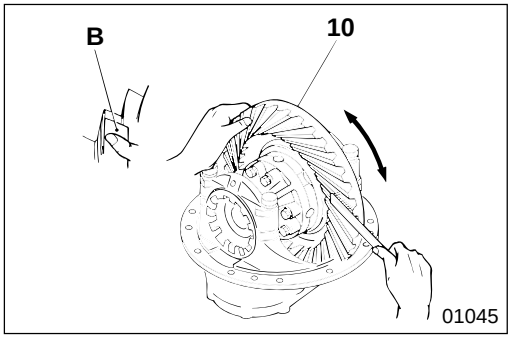


(3) Starting torque of side bearing

- Install spring balance **A** at 152 mm {5.98 in.} outer periphery point of differential case LH **12**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.

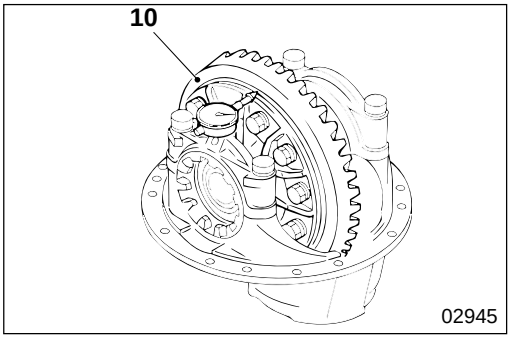
NOTE

Measure the starting torque within final drive gear 10 and final drive pinion 28 backlash range.



(4) Tooth contact of final drive gear

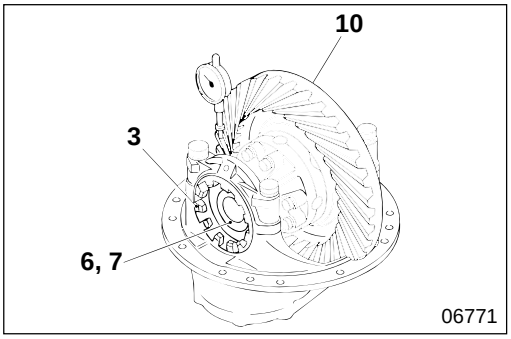
Apply red lead to three or four teeth of final drive gear **10**, examine tooth contact by turning the gears a few times.
B : Examine tooth contact using paper.



● **Inspection and adjustment after assembly**

(1) Inspection of wobble of back face of final drive gear

Measure wobble at a point 132 mm {5.20 in.} (on the radius) from the center of final drive gear **10**.



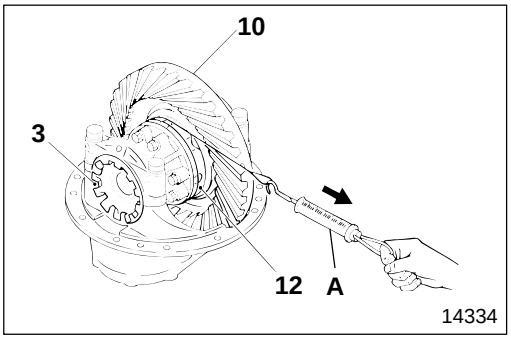
(2) Backlash of final drive gear and final drive pinion

[Adjustment]

- Adjust backlash using left and right adjusting screws **3** with the adjusted starting torques of side bearings **6**, **7** unchanged.
- Measure backlash at three points around the circumference of final drive gear **10**.

CAUTION

Make sure when you loosen one adjusting screw 3 that you tighten the other adjusting screw by the same amount, because the starting torque of the side bearings 6, 7 changes.



(3) Starting torque of side bearing

[Inspection]

- Install spring balance **A** at 152 mm {5.98 in.} outer periphery point of differential case LH **12**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

[Adjustment]

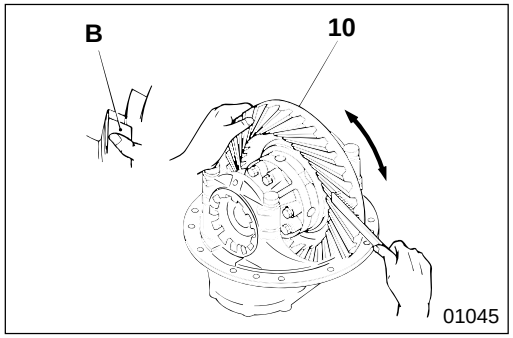
If the measured value deviates from the specified value, adjust it using left and right adjusting screws **3**.

CAUTION

Be sure to tighten left and right adjusting screws 3 by the same amount of pitch.

NOTE

Adjust the backlash to within the standard backlash of final drive gear 10 and final drive pinion 28.



(4) Tooth contact of final drive gear

[Inspection]

Apply red lead to three or four teeth of final drive gear **10**, examine tooth contact by turning the gears a few times.

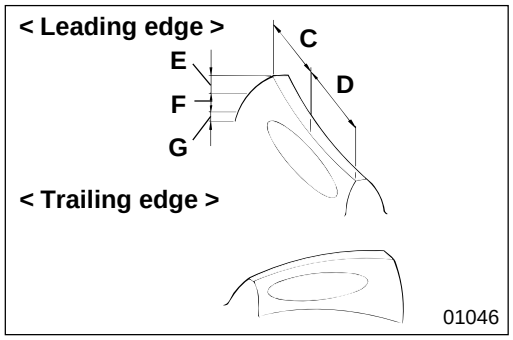
B : Examine tooth contact using paper.

[Adjustment]

If tooth contact has deteriorated, adjust by increasing or decreasing backlash and shim **34**.

CAUTION

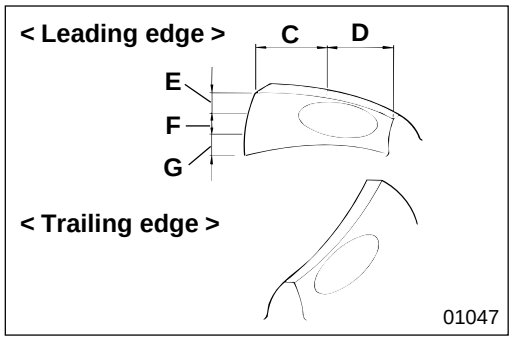
Be sure when replacing the gear because of abnormally worn teeth to replace the reduction gear set of final drive gear 10 and final drive pinion 28.



● **Normal tooth contact at no load**

< Final drive gear >

C : Heel
D : Toe
E : Face
F : Flank
G : Clearance



< Final drive pinion >

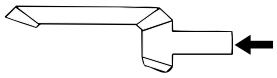
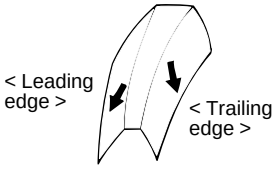
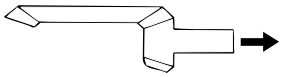
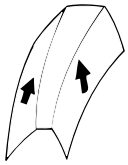
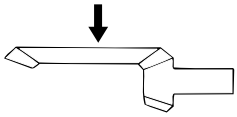
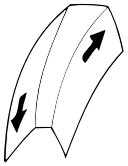
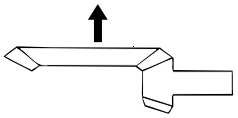
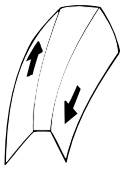
C : Heel
D : Toe
E : Face
F : Flank
G : Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center towards edge
		Vertical direction	From center towards top of tooth for final drive gear and center for final drive pinion
	Tooth contact shape	Length	Approximately 50 to 70% of tooth width
		Width	Approximately 50 to 70% of tooth depth
	Degree of tooth contact		It becomes weaker as it nears tooth root or tooth tip

NOTE

When tooth contact is near the toe at no load it becomes middle area contact at load.

Adjustment of tooth contact

	Method of adjustment	Moving direction
Adjustment by adding or reducing shims	Advance final drive pinion to final drive gear (Shims are reduced) 	 Tooth contact moves towards tooth root
	Retard final drive pinion from final drive gear (Shims are added) 	 Tooth contact moves towards tooth tip
Adjustment using adjusting screw	Advance final drive gear to final drive pinion center (Less backlash) 	 Tooth contact moves in lengthwise direction of tooth Leading edge : Nearer to toe and slightly nearer to root of tooth Trailing edge : Nearer to heel and slightly nearer to top of tooth
	Retard final drive gear from final drive pinion center (More backlash) 	 Tooth contact moves in lengthwise direction of tooth Leading edge : Nearer to heel and slightly nearer to top of tooth Trailing edge : Nearer to toe and slightly nearer to root of tooth

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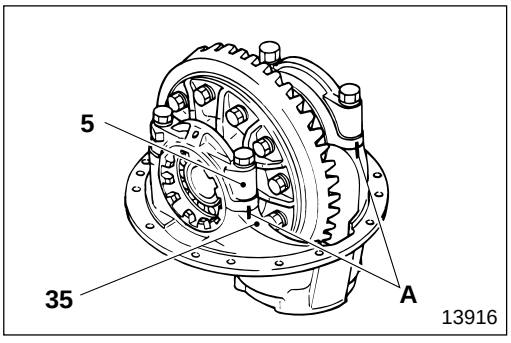
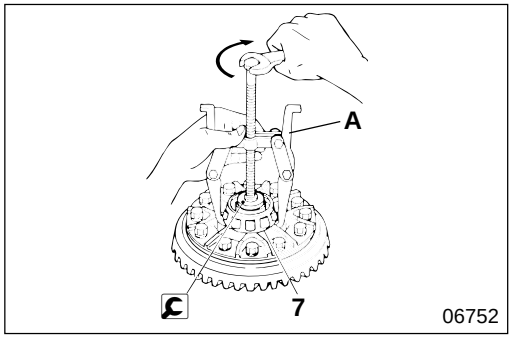


13916

5 Removal of bearing cap

Put alignment marks **A** on bearing cap **5** and differential carrier **35** to distinguish left and right.



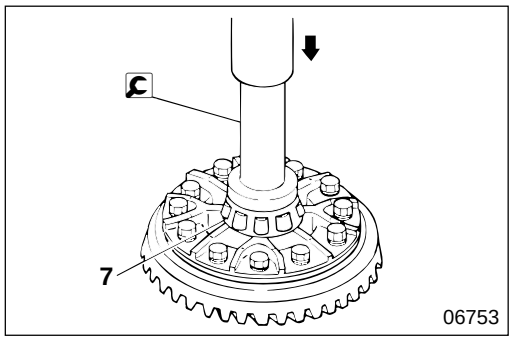
7 **Side bearing inner race**

[Removal]

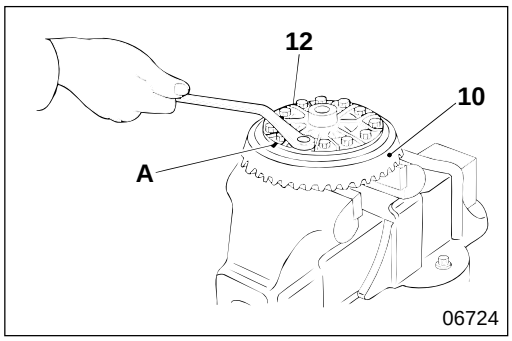
A : Gear puller (General tool)

NOTE

Make sure you keep left and right side bearings 6, 7 separate after removal, and be careful not to mix them up when installing them.



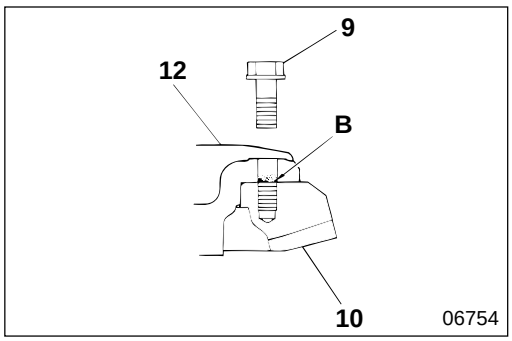
[Installation]



10 **12** **Final drive gear and differential case LH**

[Removal]

Put alignment marks **A** on final drive gear **10** and differential case LH **12**.

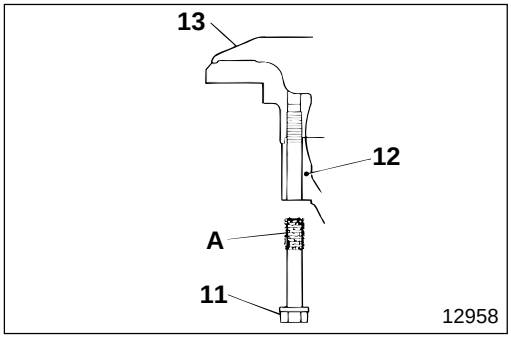


[Installation]

- Apply rust preventive to the entire surface of bolts **9**.
- Apply lock paint to the threads of all bolt holes **B** of final drive gear **10**.
- Tighten bolts **9** at specified torque.

CAUTION

- **Be sure to apply rust preventive because of the need to tighten bolt 9 at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

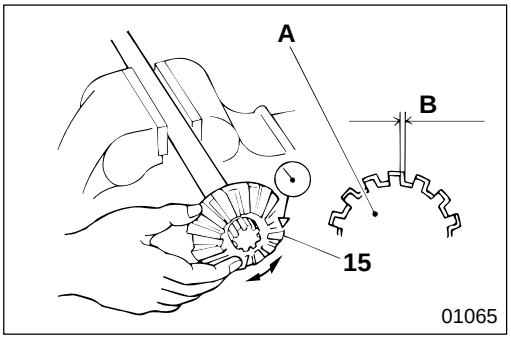


12 **13** **Installation of differential case RH and differential case LH**

- Apply rust preventive to the entire surface of bolts **11**.
- Apply lock paint to thread area **A** of bolts **11**.
- Tighten bolts **11** at specified torque.

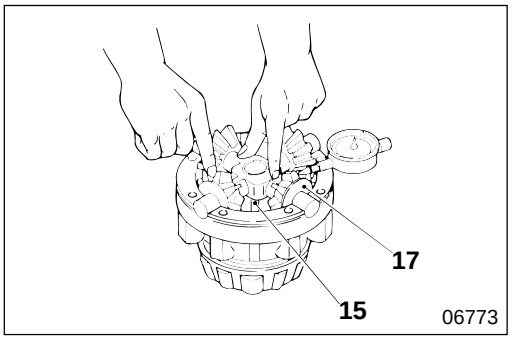
CAUTION

- **Be sure to apply rust preventive because of the need to tighten bolts 11 at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

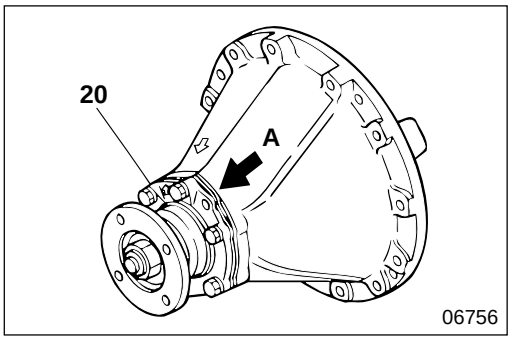


15 **Play between differential gear and axle shaft spline area in the rotating direction**

If the measured value is higher than the limit, replace the faulty parts.
A : Axle shaft
B : Play

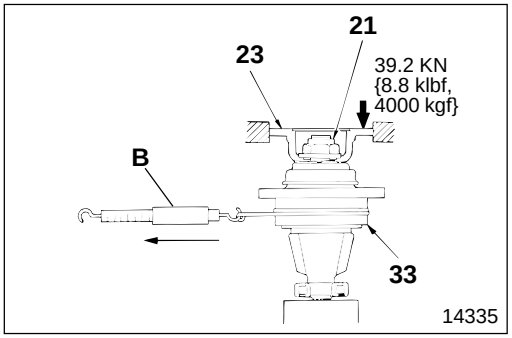


15 **17** **Backlash between differential gear and differential pinion**



20 **Pinion assembly**

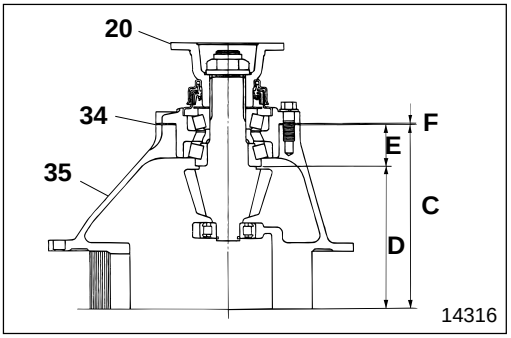
[Removal]
Screw M12×1.25 mm bolts into two holes **A** provided for removing pinion assembly **20**, then tighten bolts uniformly until the pinion assembly is removed.



[Inspection of starting torque after installation]
- Apply load of approximately 39.2 kN {8.8 klbf, 4000 kgf} to companion flange **23** or tighten lock nut **21** at specified torque.
- Install spring balance **B** at 114 mm {4.49 in.} outer periphery point of bearing retainer **33**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

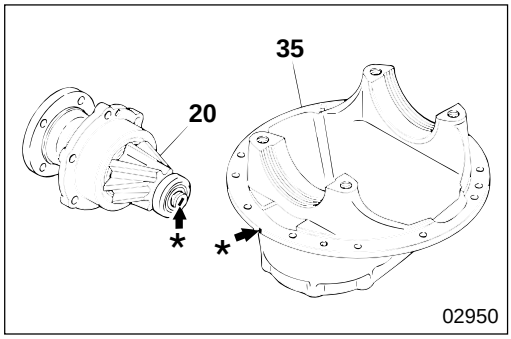
NOTE
- **Be sure to secure companion flange 23 before measurement.**
- **Be sure to remove oil seal 29 before measurement.**

[Adjustment of starting torque]
If the measured value deviates from the specified value, replace collar **24** so that the tangential force conforms to the standard value.
Collar thicknesses :
15.600 to 16.200 mm {0.61 to 0.64 in.} (25 thicknesses available in 0.025 mm {0.00098 in.} increments)



[Adjustment when installing]
- Carry out the following procedure so that **C**, **D** and **E** conform to the standard dimension.
- Calculate shim thickness **F** according to the following formula based upon the machining error data stamped on pinion assembly **20** and differential carrier **35**.
  Formula for calculation:
  F = 0.5 {0.020}–b+c+d

  c : Deviation from basic dimension **C**
  d : Deviation from basic dimension **D**
  e : Deviation from basic dimension **E**



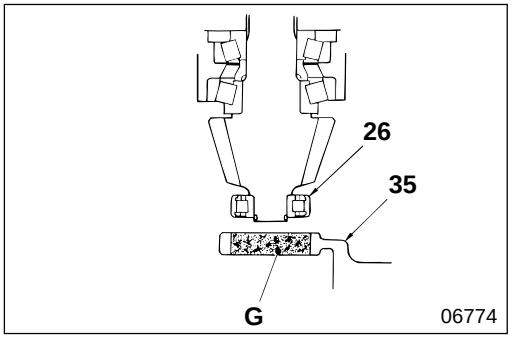
Unit : mm {in.}

Location	Standard dimension	How to calculate deviation
Shim thickness	0.5 {0.020}	—
C	203 {7.99}	The basic dimension, multiplied by 100, is stamped on the periphery of differential carrier **35** flange
D	157 {0.18}	The basic dimension is stamped on the top of pinion assembly **20**
E	46.5 {1.8}	Measure the deviation from **E** using a dial gauge. However, if it is difficult to measure the actual deviation, assume a value from 0 to 0.2 {0 to 0.0079}

***** : Stamped number position

NOTE
Thickness is stamped in millimeters.

- Select shim **34** from shim thickness **F**.
  Available thicknesses of shim **34** : 0.1 mm {0.0039 in.} and 0.2 mm {0.0079 in.}

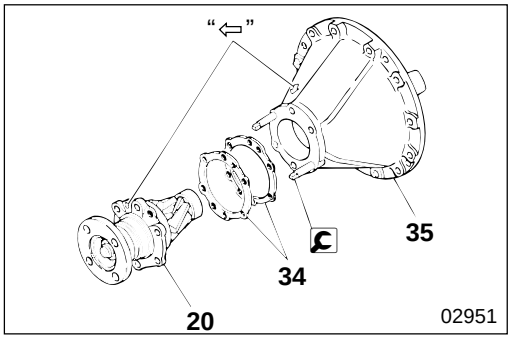


[Installation]

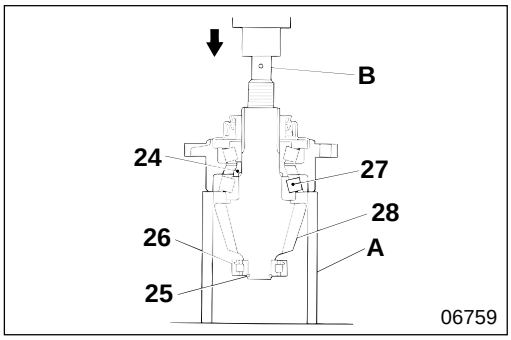
- Apply lock paint to entire mounting surface **G** of pinion pilot bearing **26** of differential carrier **35**.

CAUTION

- **Be sure to let the lock paint harden undisturbed for 30 minutes to two hours after installation.**
- **Be sure to wait at least three hours before running the vehicle, and if possible wait 24 hours to let the lock paint harden.**

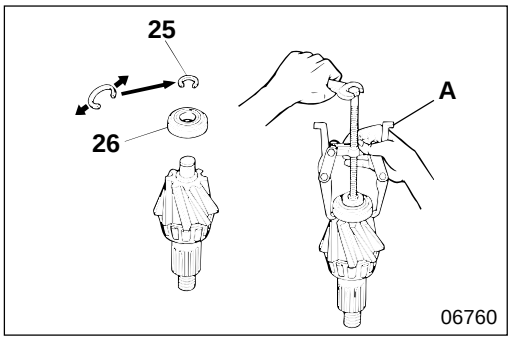


- Assemble differential carrier **35** and pinion assembly **20** with their alignment marks "⇦" aligned.



20 **Removal of pinion assembly**

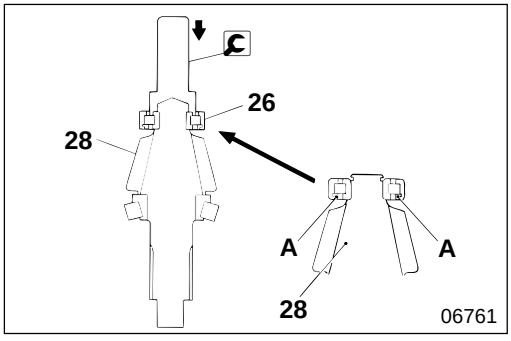
Using an appropriate cylinder **A** and press **B**, remove collar **24**, lock ring **25**, pinion pilot bearing **26**, rear bearing inner race **27**, and final drive pinion **28** together.



25 **26** **Lock ring and pinion pilot bearing**

[Removal]

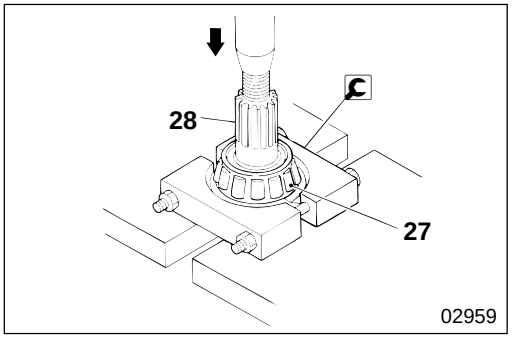
A : Gear puller (General tool)



[Installation]

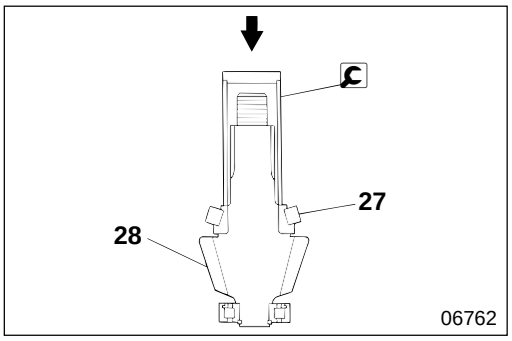
Press-fit pinion pilot bearing **26** in the direction as illustrated.

A : Lock ring

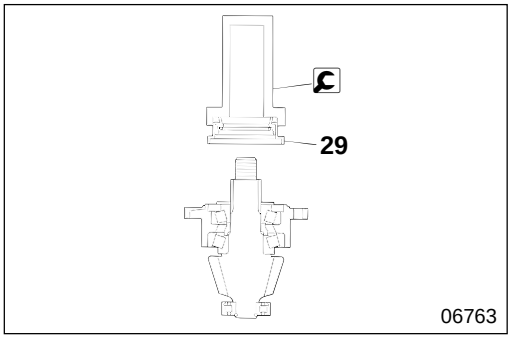


27 **Rear bearing inner race**

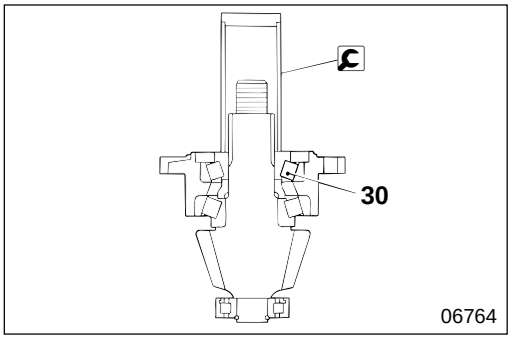
[Removal]



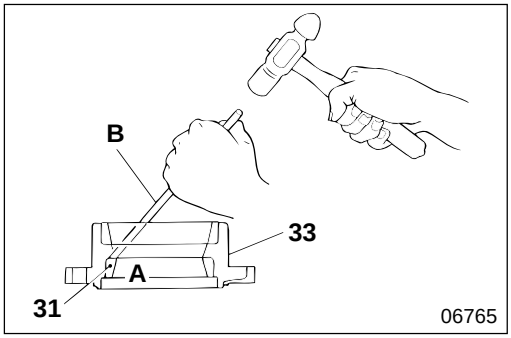
[Installation]



29 **Installation of oil seal**

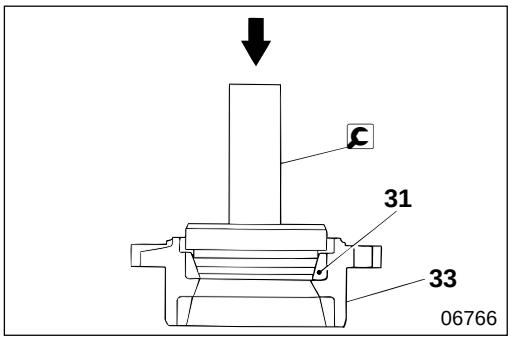


30 **Installation of front bearing inner race**

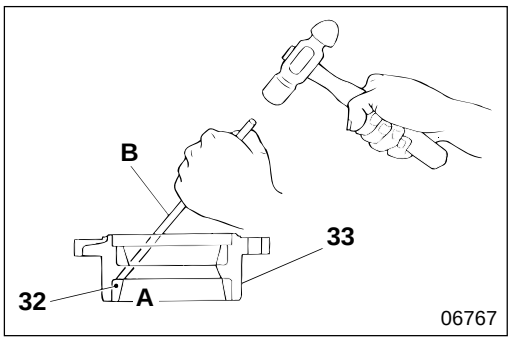


31 **Front bearing outer race**

[Removal]
Drive out front bearing outer race **31** evenly from three indented parts **A** in bearing retainer **33**.
B : Pin-punch

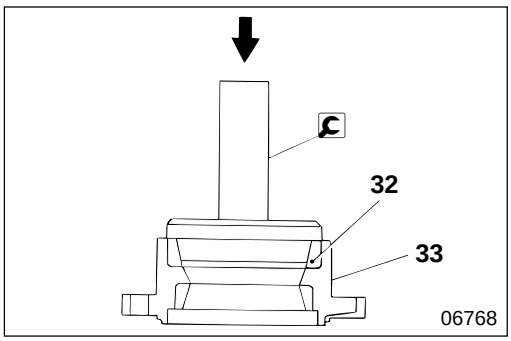


[Installation]



32 **Rear bearing outer race**

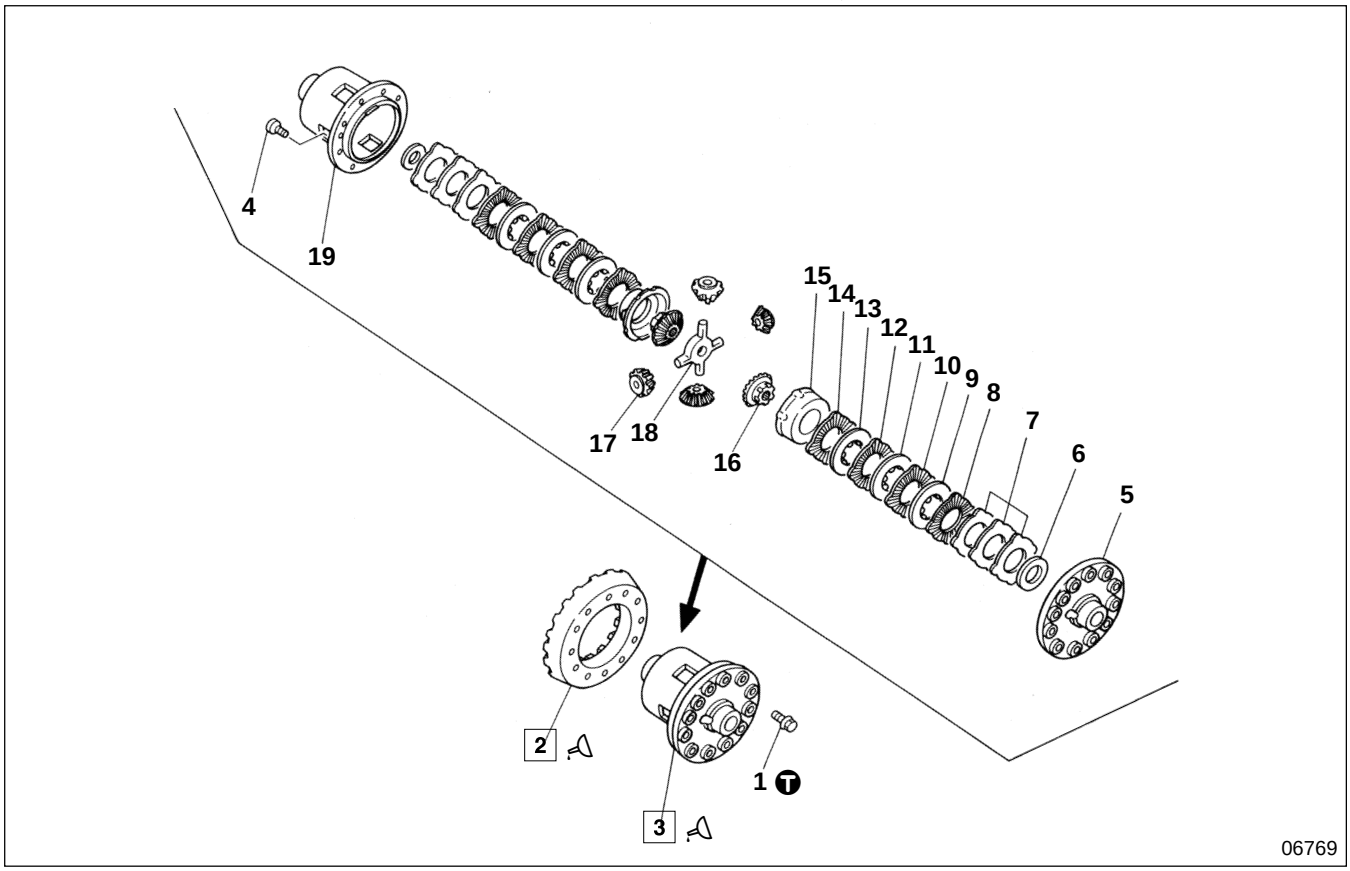
[Removal]
Drive out rear bearing outer race **32** evenly from three indented parts **A** in bearing retainer **33**.
B : Pin-punch



[Installation]

MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY

DISASSEMBLY AND ASSEMBLY



● **Disassembly sequence**

1 Bolt
2 Final drive gear
3 Multiplate limited slip differential assembly
4 Screw
5 Differential case, LH
6 Thrust washer
7 Spring plate
8 Friction plate
9 Friction disc
10 Friction plate
11 Friction disc
12 Friction plate
13 Friction disc
14 Friction plate
15 Pressure ring
16 Side gear
17 Differential pinion
18 Pinion shaft
19 Differential case, RH

NOTE

Clean the disassembled parts using washing oil and dry by blowing with compressed air.

● **Assembly sequence**

19→6→7→8→9→10→11→12→13→14→15→16→5→4→3→2→1
17→18

NOTE

Apply the specified type of gear oil to each part before assembly, paying particular attention to contact and sliding surfaces.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Rotation torque of multiplate limited slip differential assembly	When putting in a new clutch plate	200 to 295 N·m {150 to 215 ft.lbs, 20.5 to 30 kgf·m}	—	Inspect internal parts and replace faulty parts
		When putting in a used clutch plate	115 to 295 N·m {87 to 215 ft.lbs, 12 to 30 kgf·m}	—	
6, **15 to 18**	Variation of tolerance in vertical direction from back face of pressure ring to end face of thrust washer		0 to 0.05 {0 to 0.0020}	—	Adjust (Replace the thrust washer)
8 to 14	Deformed friction disc and friction plate		—	0.08 {0.0031}	Replace
	Wear of friction disc and friction plate		—	0.1 {0.0039}	Replace
	Difference in thickness between the left and right combinations of friction disc and friction plate		—	0 to 0.05 {0 to 0.0020}	Adjust Change the combination)
—	Side gear clearance in axial direction		0.05 to 0.20 {0.0020 to 0.0079}	—	Adjust (Replace the thrust washer)
—	Differential case clearance in axial direction		0.05 to 0.20 {0.0020 to 0.0079}	—	Adjust (Replace the thrust washer)

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

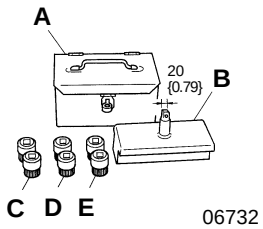
Location	Location tightened	Tightening torque	Remarks
1	Bolt (Final drive gear and differential case, LH mounting)	165 to 225 {120 to 165, 17 to 23}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Thread area of final drive gear	LOCTITE271	As required
3	Components of multiplate slip differential assembly	Limited slip differential oil API GL-5 SAE90	As required

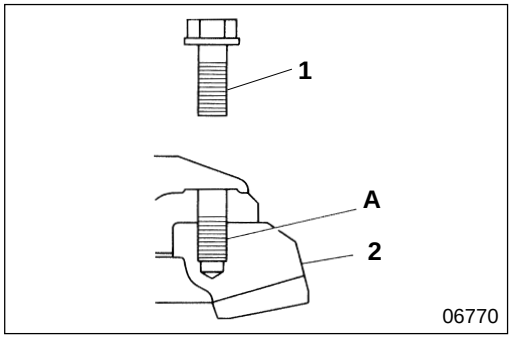
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Side gear holding tool set **A** : Gauge case **B** : Side gear holding base **C** : Side gear holding tool (outer diameter : 42) **D** : Side gear holding tool **E** : Side gear holding tool 	MB999140 **A**: MB990551 **B**: MB999141 **C**: MB999142 (D033H) **D**: MH063422 **E**: MH063423	Measurement of multiplate slip differential assembly clutch plate rotation torque

MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY

◆ Service procedure

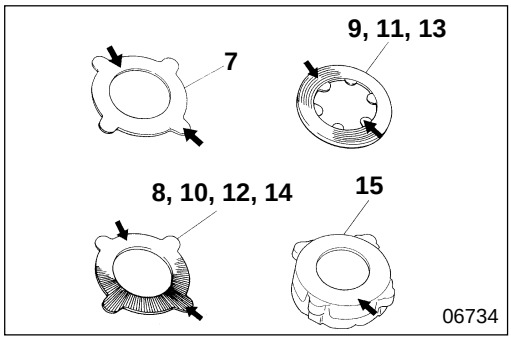


2 Final drive gear

Apply LOCKTITE to thread area **A** of all the bolt holes of final drive gear **2**.

CAUTION⚠

- **Be sure to let bolts 1 harden for at least an hour, after installation, before driving.**
- **Furthermore, be sure to let bolts 1 harden for at least four hours before running at full torque.**



3 Multiplate limited slip differential assembly

[Inspection of contact and sliding surfaces]

- Inspect spring plates **7**, friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13** and replace if the friction surface or sliding surface shows extreme wear or heat discoloration.

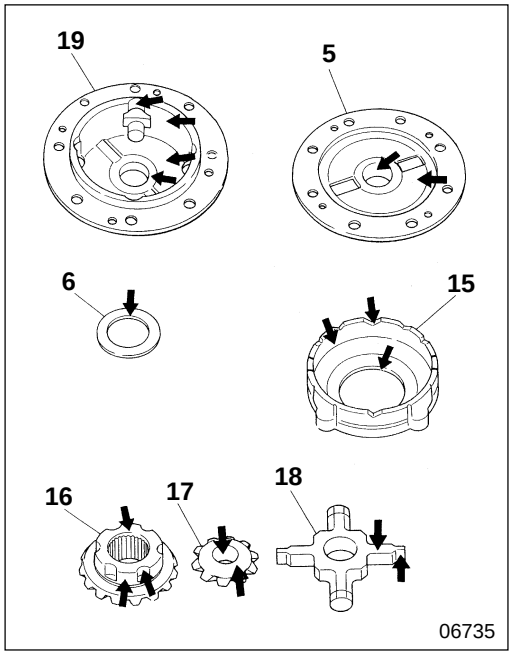
NOTE

The hardened area on the inner periphery of the friction surfaces of plates and discs 7 to 14 is due to the force exerted by the springs and should not be mistaken for abnormal wear.

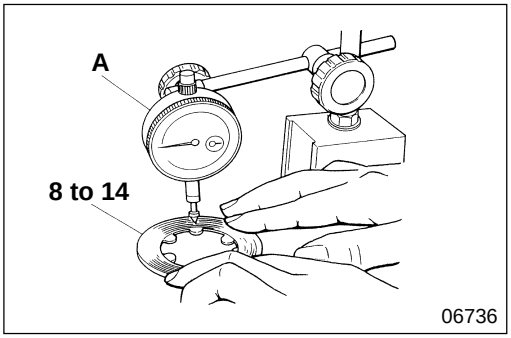
- Replace spring plates, friction discs and friction plates **7** to **14** if their protruding areas have cracks or are damaged.
- If there are nicks or marred areas on the friction and sliding surfaces of pressure rings **15** and friction plates **14** remove using an oil stone, then fit and correct on the base using compound.

NOTE

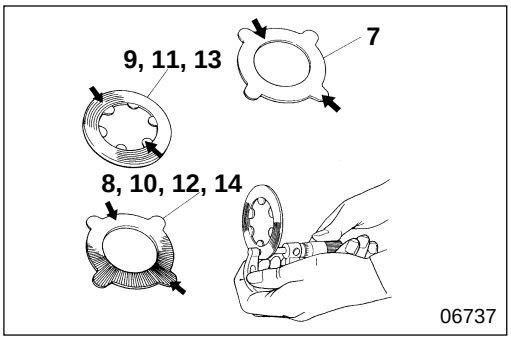
The hardened area on the inner periphery of the friction surfaces of plates and discs 7 to 14 is due to the force exerted by springs and should not be mistaken for abnormal wear.



- Inspect the contact and sliding parts (⬅) of differential case LH **5**, thrust washer **6**, pressure ring **15**, side gear **16**, differential pinion **17**, pinion shaft **18**, and differential case RH **19**. If there are nicks or marred areas remove using an oil stone.



[Inspection for deformation]
Check friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13** for deformation by mounting dial gauge **A** on a base and rotating the plate or disc and measuring its flatness.

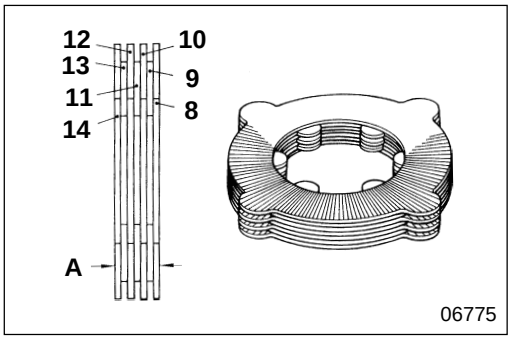


[Measurement of thickness]
Measure the thickness of the friction surfaces and the protruding parts (⬅) of spring plates **7**, friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13**. If the measured values deviate from the limit, replace the faulty parts.

NOTE

Measure several locations on each part.

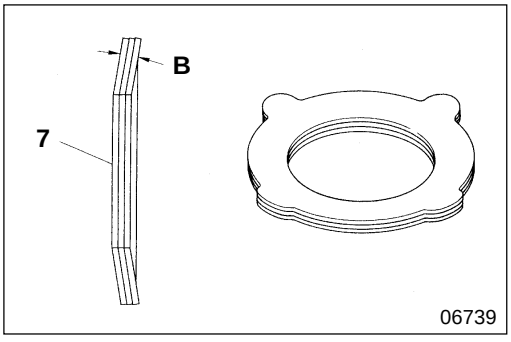
[Work before assembly]
In order to adjust the tolerance in the axial direction when the internal parts of differential cases LH **5** and RH **19** are inserted (clutch plates **7** to **14** friction force) and the tolerance in the axial direction of side gear **16** follow the procedure below.



- Put friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13** one on top of the other as illustrated. Using a micrometer measure thickness **A**, and by selecting the right combination of plates and discs for each set, make sure the difference in thickness between the left and right sets conforms to the standard value.

NOTE

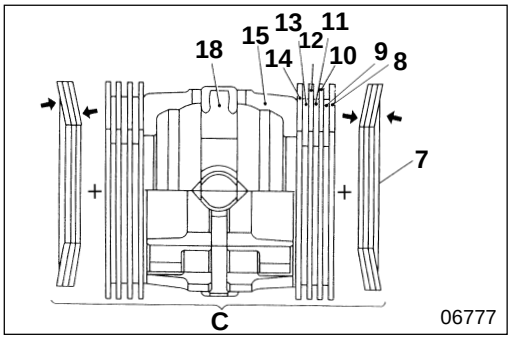
When using new parts, keep in mind that friction plates 8, 10, 12, 14 come in one size, 2.0 mm {0.0079 in.} and friction discs 9, 11, 13 in three sizes, 1.9 mm {0.075 in.}, 2.0 mm {0.079 in.} and 2.1 mm {0.083 in.}.



- Put spring plates **7** one on top of the other as illustrated. Using a micrometer measure thickness **B** and by selecting the right combination of plates for each set, make sure the difference in thickness between the left and right sets is minimal.

NOTE

When replacing spring plates 7 with new ones, the plate thickness is 2.0 mm {0.079 in.}.

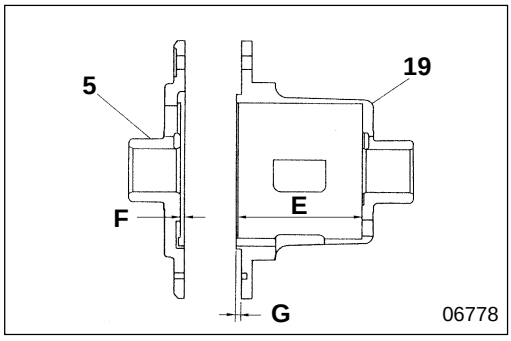


- Assemble pressure rings **15**, pinion shaft **18**, the friction discs, the friction plates and spring plates **7** to **14** and measure total width **C** using a micrometer.

NOTE

When measuring, press down both ends of pressure ring 15 to make sure its V-shaped groove is properly mated with pinion shaft 18.

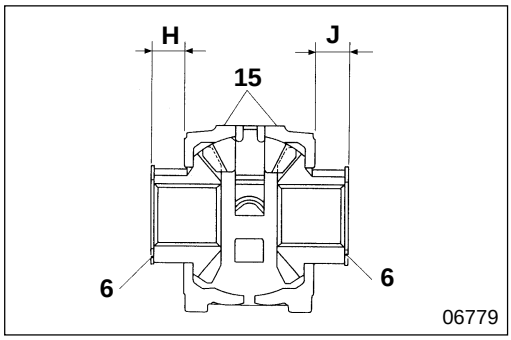
MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY



- Calculate dimension **D** between the surfaces of differential cases LH **5** and RH **19** which come in contact with spring plate **7** when the two cases are assembled.
  D = E + F – G
- If the above mentioned total width **C** and clearance **(D – C)** between differential cases LH **5** and RH **19** deviate from the standard value, adjust by changing friction discs **9**, **11**, **13**.

NOTE

When using new friction discs 9, 11, 13, keep in mind that there are three different sizes, 1.9 mm {0.075 in.}, 2.0 mm {0.079 in.} and 2.1 mm {0.083 in.}.



- Install thrust washers **6** as illustrated. Make sure the difference between dimensions **H** and **J** from the back face of pressure ring **15** to the end face of thrust washer on either side conforms to the standard value.

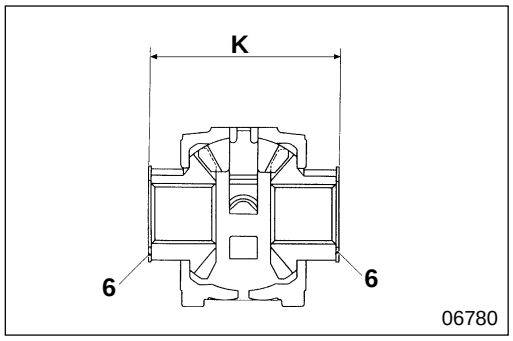
NOTE

When measuring press down both ends of pressure ring 15 to make sure its V-shaped groove is in full contact with pinion shaft 18.

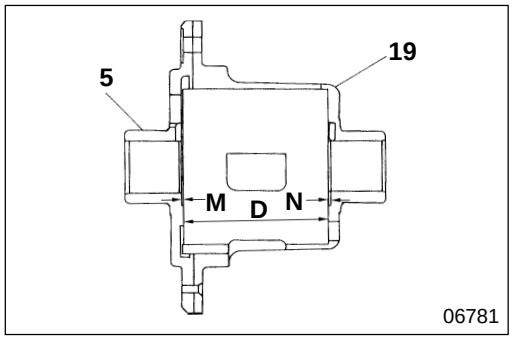
- If the variation of tolerance deviates from the standard value, adjust by changing thrust washers **6**.

NOTE

When using new thrust washers 6 keep in mind that there are three different sizes, 1.50 mm {0.059 in.}, 1.60 mm {0.063 in.} and 1.70 mm {0.067 in.}.



- Measure total width **K**.



- Calculate dimension **L** between the surfaces of differential cases LH **5** and RH **19** that come in contact with thrust washers **6** when the two cases are assembled.
  L = D + M + N

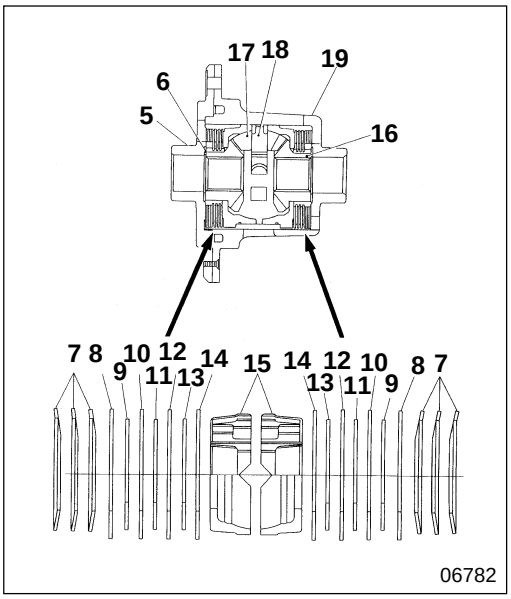
NOTE

Dimension D is the dimension between the surfaces of differential cases LH 5 and RH 19 that come in contact with spring plate 7 when the two cases are assembled and was calculated above.

- Make sure that side gear **16** clearance in the axial direction **(L – K)** conforms to the standard value. If the measured value deviates from the standard value, adjust by replacing thrust washers **6**.

NOTE

- **Select thrust washers 6 so that the difference in dimension between the left and right sides from the back face of pressure ring 15 to the end face of thrust washers conforms to the standard value.**
- **When using new thrust washers keep in mind that there are three sizes, 1.50 mm {0.059 in.}, 1.60 mm {0.063 in.} and 1.70 mm {0.067 in.}.**

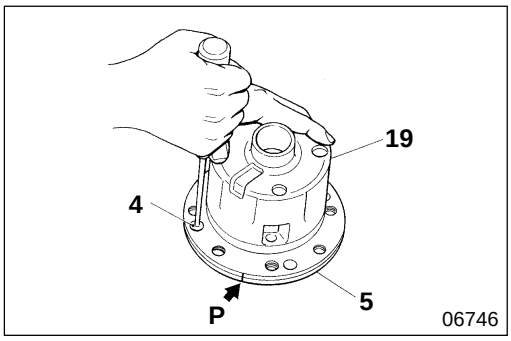


[Assembly]

Assemble the different parts in differential case RH **19** in the direction as illustrated.

CAUTION

- **Make sure that friction plates 8, 10, 12, 14 and friction discs 9, 11, 13 are installed in the correct order and that spring plate 7 is assembled in the correct direction.**
- **Apply the specified gear oil to each of the parts before assembly. Special attention should be given to applying oil to the contact and sliding surfaces.**

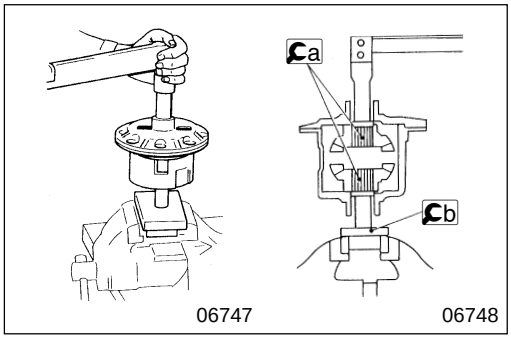


[Tightening of screws]

Align alignment marks **P** (identical Arabian numerals) on differential cases LH **5** and RH **19** and gradually tighten screws **4** evenly in diagonal order.

CAUTION

If differential cases LH 5 and RH 19 are not joined firmly even when screws 4 have been tightened, it may be because thrust washers 6 or spring plates 7 are not properly assembled and they should be reassembled.



[Measurement of rotational torque]

In order to verify the friction force of clutch plates **7** to **14** after assembly, use a side gear holding tool and b side gear holding base to measure the rotation torque and make sure it conforms to the standard value.

NOTE

When measuring the rotation torque, rotate the gear and measure after the rotation has reached a sufficiently steady pace.

MITSUBISHI
FUSO

Group 27
Rear Axle

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0304-27

INDEX

SPECIFICATIONS 27- 2

STRUCTURE AND OPERATION 27- 3

TROUBLESHOOTING 27- 7

WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE 27- 9

WHEEL HUB AND BRAKE DRUM < FE639, FG > 27- 10

WHEEL HUB AND ROTOR < FE640, FE649 > 27- 20

AXLE HOUSING 27- 30

REDUCTION AND DIFFERENTIAL 27- 34

MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY 27- 48

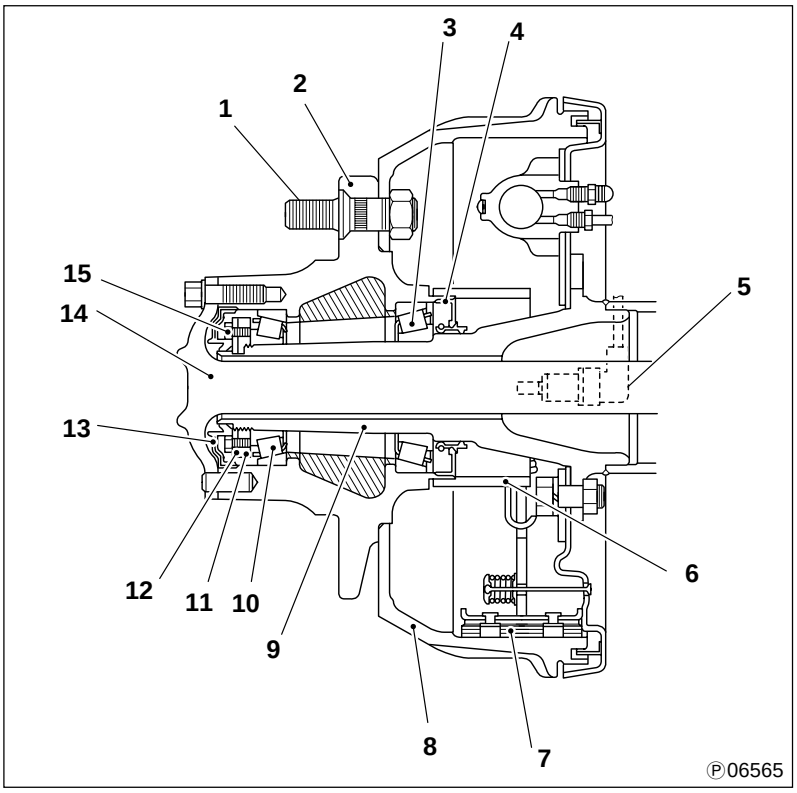
SPECIFICATIONS

Item \ Vehicle model		FE639, FG	FE640	FE649
Rear axle	Model	R033T		
	Type	Full floating shaft tube system		
Reduction	Model	D033H		
	Type	Single-reduction gear		
	Tooth shape	Hypoid gear		
	Speed reduction ratio	5.714	5.285	5.714
Differential	Tooth shape	Straight bevel gear		
Gear oil	Grade	* Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot area : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140		
	Oil volume L {qts.}	4.5 {4.8}		
Mass (reference) kg {lb}		Approximately 210 {460}		Approximately 230 {505}

* • When used under heavily-loaded, severe conditions such as continuous driving on uphill grades, it is recommended that you use gear oil with a SAE viscosity grade of 140. However, the air temperature must be above 10°C {50°F}.

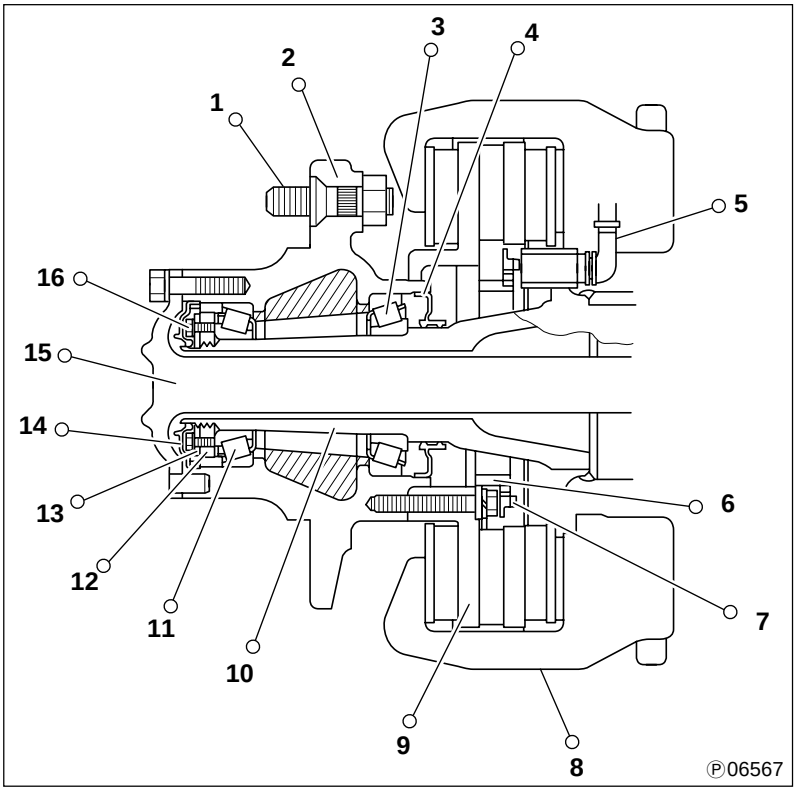
• Multiplate limited slip defferential uses limited slip differential oil API GL-5 SAE 90

Wheel Hub and Brake Drum < FE639, FG >



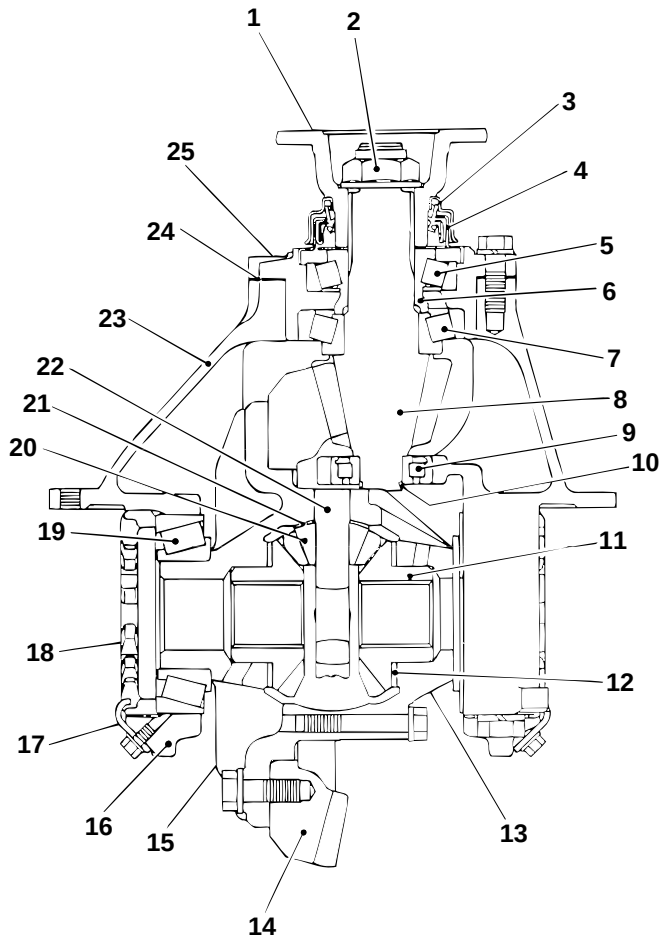
1 Hub bolt
2 Wheel hub
3 Inner bearing
4 Inner oil seal
5 Wheel speed sensor
6 Rotor
7 Brake assembly
8 Brake drum
9 Axle housing
10 Outer bearing
11 Lock nut
12 Lock washer
13 Outer oil seal
14 Axle shaft
15 Lock bolt

Wheel Hub and Rotor < FE640, FE649 >



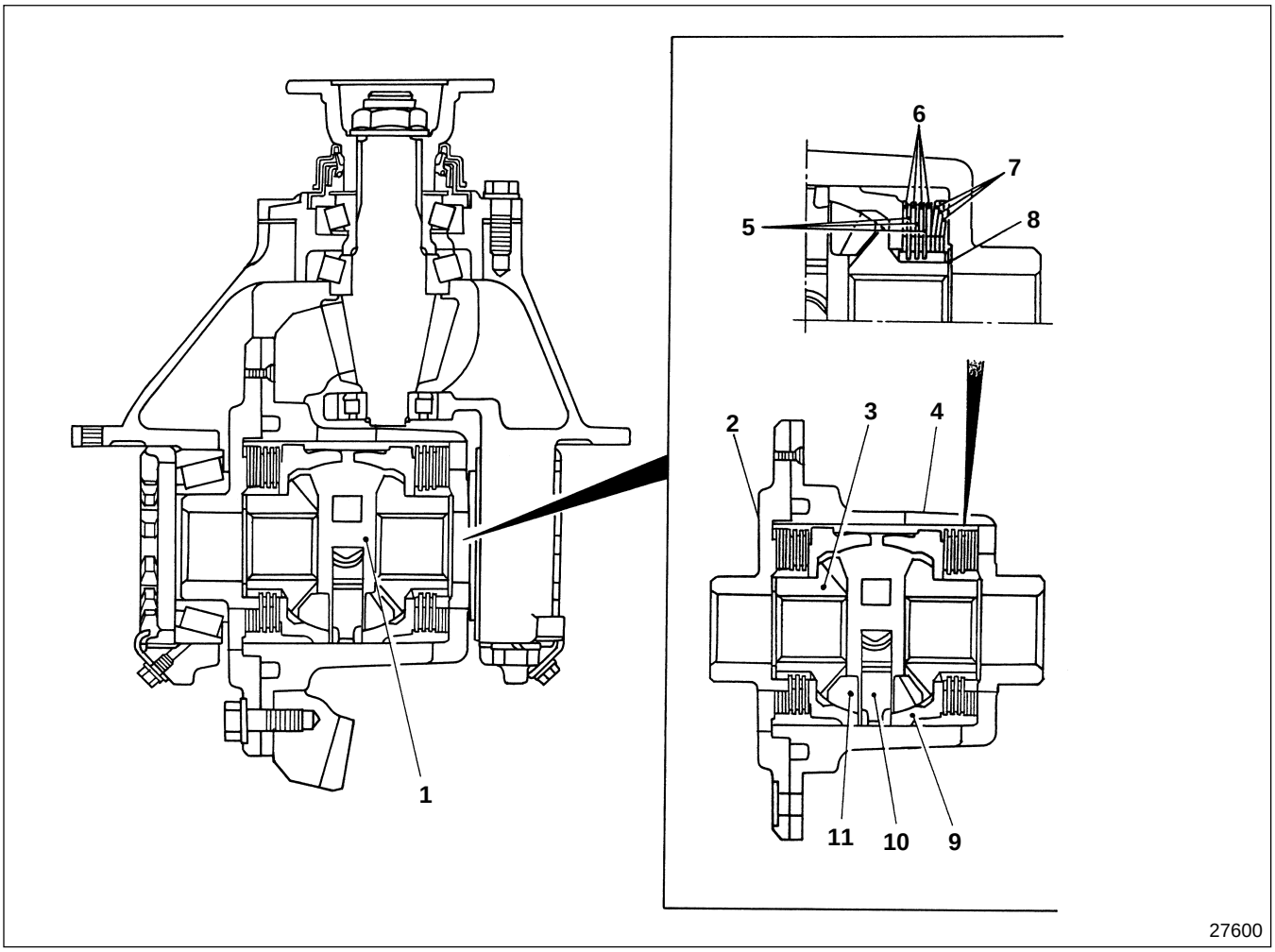
1 Hub bolt
2 Wheel hub
3 Inner bearing
4 Inner oil seal
5 Wheel speed sensor
6 Rotor flange
7 Rotor
8 Disc brake assembly
9 Disc rotor
10 Axle housing
11 Outer bearing
12 Lock nut
13 Lock washer
14 Outer oil seal
15 Axle shaft
16 Lock bolt

Reduction and Differential



1 Companion flange
2 Lock nut
3 Dust cover
4 Oil seal
5 Front bearing
6 Collar
7 Rear bearing
8 Final drive pinion
9 Pinion pilot bearing
10 Lock ring
11 Differential gear
12 Differential gear washer
13 Differential case, RH
14 Final drive gear
15 Differential case, LH
16 Bearing cap
17 Lock plate
18 Adjusting screw
19 Side bearing
20 Differential pinion
21 Differential pinion washer
22 Pinion spider
23 Differential carrier
24 Shim
25 Bearing retainer

MULTIPLE LIMITED SLIP DIFFERENTIAL ASSEMBLY

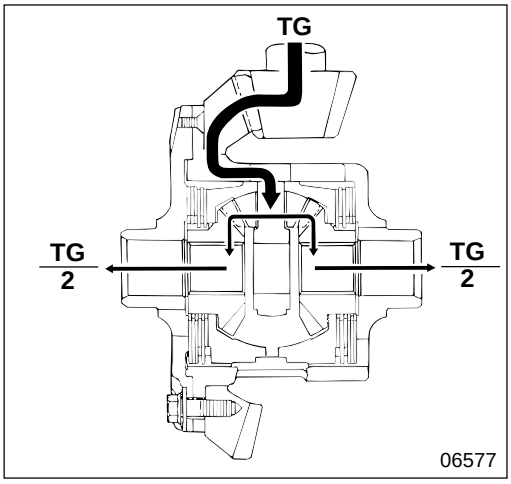


1 Limited slip differential assembly
2 Differential case, LH
3 Side gear
4 Differential case, RH
5 Friction disc
6 Friction plate
7 Spring plate
8 Thrust washer
9 Pressure ring
10 Pinion shaft
11 Differential pinion

Friction disc **5** and friction plate **6** engage side gear **3** and differential case RH **4**, respectively. These parts are pressed against pressure ring **9** by spring plate **7**. The pressure ring mates with the groove in the differential case RH and always turns at the same speed.

Operation mechanism

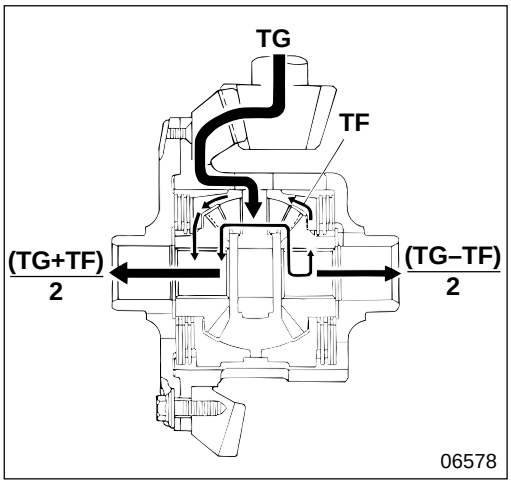
When the wheel of one side starts spinning, a rotational difference between side gear **3** and differential cases, LH **2** and RH **4** occurs. Then, friction disc **5** and friction plate **6** start rotating with a relative difference in revolution speed. This causes friction torque between the disc and plate.



● **Operation in straight movement**

In the case of straight movement, as the revolution speed of the left axle shaft and that of the right axle shaft are equal, no friction torque occurs.

TG : Torque input



● **Operation when there is a difference in revolution speed between left and right wheel**

When a difference in the resistance the wheels receive from the road surface occurs, such as when the wheel of one side encounters mud, the differential function comes into play, transmitting friction torque **TF**. This exertion of friction torque reduces the revolution speed causing the high-revolution speed axle to reduce its speed and the low-revolution speed axle to increase its speed.

Therefore, when the wheel of one side starts spinning, when caught in mud for example, a large amount of friction torque to come into action. The differential functions in such a manner that a smaller ratio of the torque is transmitted to the axle of the wheel which is spinning while the axle of the wheel on the other side receives a greater ratio of the torque. This makes it easier for the vehicle to get out of the mud.

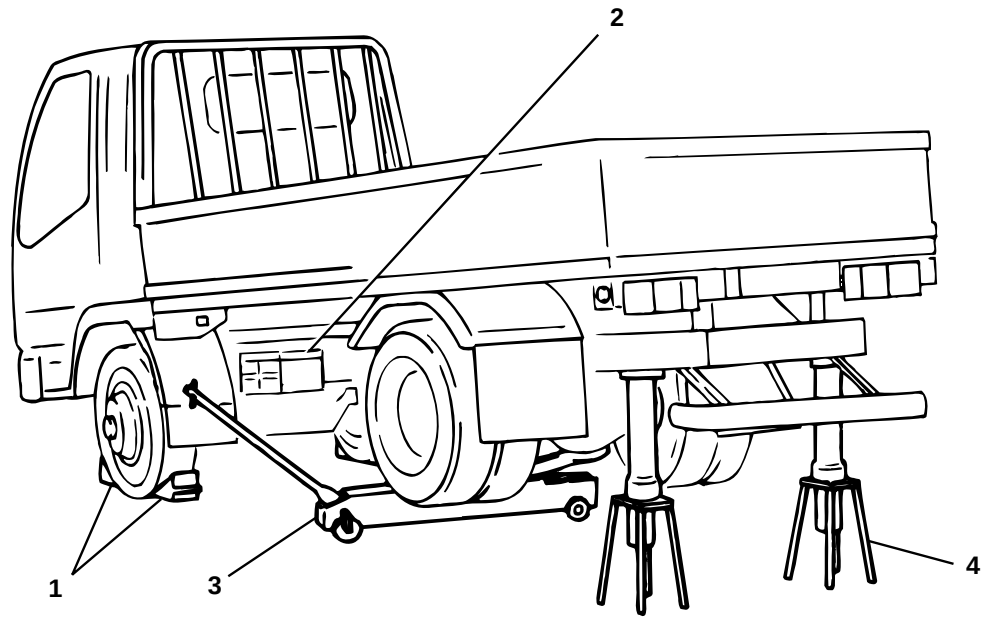
$\frac{(TG-TF)}{2}$ High rotation side (spin side)

$\frac{(TG+TF)}{2}$ Low rotation side

Possible causes	Symptoms	Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient: Propeller shaft turns but vehicle does not move	Power transmission insufficient: Noise when starting and when changing gear	Power transmission insufficient: Continuous noise while cruising	Power transmission insufficient: Intermittent noise while cruising	Power transmission insufficient: Noise while cornering	Tires drag while cornering
Wheel hub, brake drum, disc rotor, or axle housing	Axle shaft mounting bolt loose			○				○		
	Axle shaft fractured				○					
	Axle shaft slips out of engagement				○					
	Oil seal faulty	○		○						
	Air breather clogged			○						
	Wheel hub bearing seized						○			
	Wheel hub bearing worn						○			
	Wheel hub bearing rotation faulty						○			
	Wheel hub bearing broken							○		
	Gear oil excessive	○								
	Sealant faulty		○							
	Inspection plug and drain plug loose		○							
Reduction and differential	Side bearing seized						○		○	
	Side bearing worn						○		○	
	Side bearing rotation faulty						○		○	
	Side bearing broken							○		
	Side bearing preload adjusted incorrectly						○			
	Reduction and differential assembly mounting bolt and nut loose		○							
	Differential carrier and bearing cap mounting bolts loose							○		
	Differential carrier cracked or damaged		○							
	Final drive gear and differential case tightening bolts loose					○		○		
	Final drive gear or final drive pinion broken				○	○		○	○	
	Final drive gear or final drive pinion worn						○		○	
	Final drive gear or final drive pinion damaged						○			
	Final drive gear backlash excessive					○				
	Final drive gear backlash or tooth contact faulty						○			
	Final drive pinion starting torque faulty					○	○			
	Lock nut loose					○	○			

TROUBLESHOOTING

Possible causes	Symptoms	Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient: Propeller shaft turns but vehicle does not move	Power transmission insufficient: Noise when starting and when changing gear	Power transmission insufficient: Continuous noise while cruising	Power transmission insufficient: Intermittent noise while cruising	Power transmission insufficient: Noise while cornering	Power transmission insufficient: Tires drag while cornering
Reduction and differential	Front and rear bearings seized				○		○			
	Front and rear bearings worn						○			
	Front and rear bearings broken							○		
	Pinion pilot bearing worn						○			
	Pinion pilot bearing seized or broken							○		
	Pinion spider broken				○					
	Differential gear or differential pinion broken				○			○	○	○
	Differential gear or differential pinion seized				○					○
	Differential gear or differential pinion worn								○	○
	Differential gear washer worn or damaged							○	○	○
	Differential gear spline worn					○				
	Limited slip differential damaged				○	○	○	○	○	



14177

● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative terminal of the battery cable. Gr 54
3 Jack up the rear axle using a garage jack.
4 Support the rear frame on rigid racks.

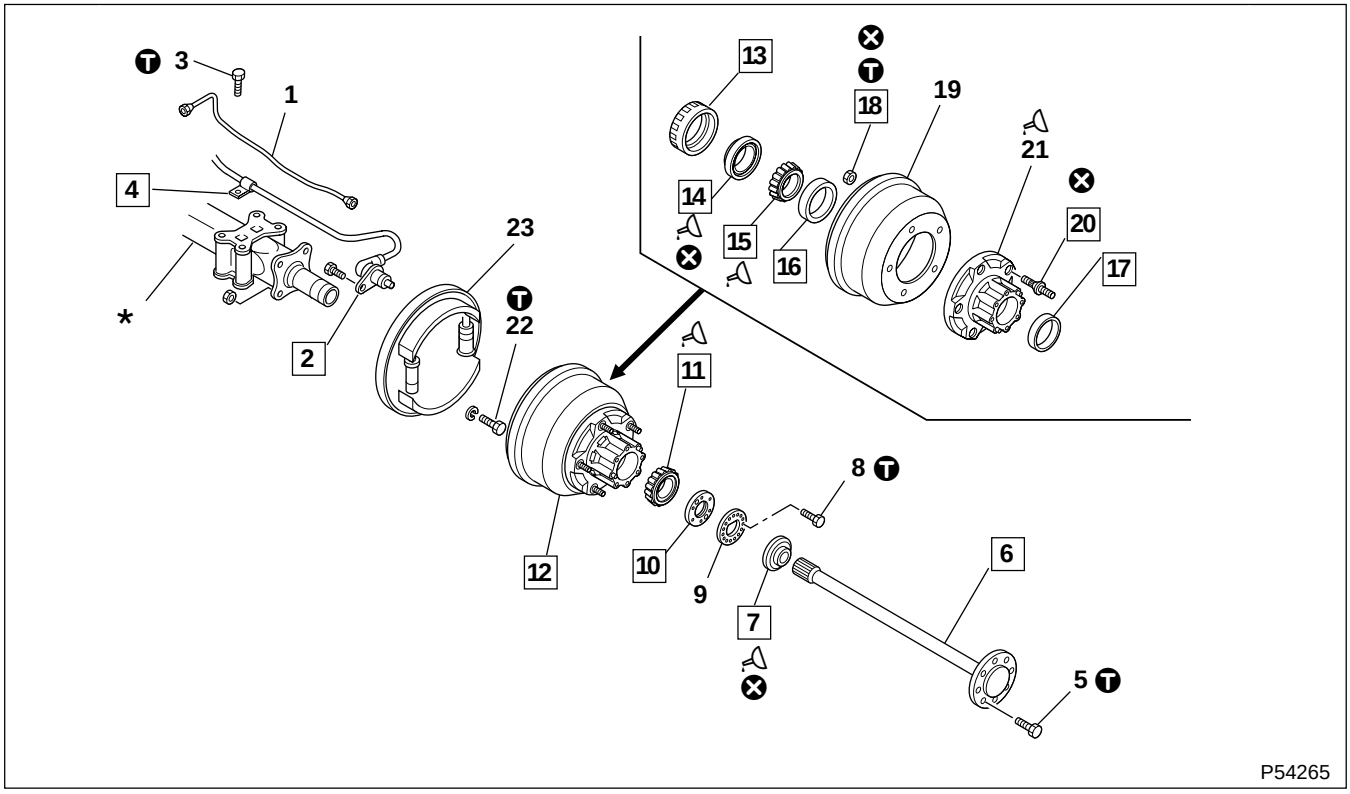
WARNING

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

WHEEL HUB AND BRAKE DRUM < FE639, FG >



● **Disassembly sequence**

1 Brake pipe
2 Wheel speed sensor
3 Bolt
4 Clips
5 Bolt
6 Axle shaft
7 Outer oil seal
8 Bolt
9 Lock washer
10 Lock nut
11 Outer bearing inner race
12 Wheel hub and brake drum assembly
13 Rotor
14 Inner oil seal
15 Inner bearing inner race
16 Inner bearing outer race
17 Outer bearing outer race
18 Nut
19 Brake drum
20 Hub bolt
21 Wheel hub
22 Bolt
23 Brake assembly Gr 35A

*: Axle housing P27-30
⊗: Non-reusable parts

CAUTION

Be sure to protect brake pipe 1 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 19 and wheel hub 21 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

- **Do not allow oil or grease to adhere on the lining surface of rear brake assembly 23 or the lining surface of brake drum 19.**
- **You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A**

CAUTION

Be careful not to damage rotor 13 or inner oil seal 14, when installing wheel hub and brake durm assembly 12 into axle housing *.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2	Wheel speed sensor	Resistance between terminals	1600 ± 10% Ω	—	—
		Insulation resistance	100 kΩ minimum	—	—
6	Axle shaft	Bend of shaft center	1 {0.039} or less	2 {0.079}	Replace
		Wobble of flange face	0.03 {0.0012} or less	0.05 {0.0020}	
—	Starting torque of wheel hub bearing		2.0 to 3.9 N·m {1.5 to 2.9 ft.lbs, 0.20 to 0.40 kgf·m}	—	Tangential force at the hub bolt : 20 to 38 N {4.5 to 8.5 lbf, 2.0 to 3.9 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
3	Bolt (Clip mounting)		12 to 15 {87 to 108, 1.2 to 1.5}	—
5	Bolt (Axle shaft mounting)		98 to 120 {72 to 89, 10 to 12}	—
8	Bolt (Lock washer mounting)		4.9±1.0 {3.6±0.7, 0.5±0.1}	—
10	Lock nut (Wheel hub bearing mounting : wheel hub bearing preload adjustment)	Primary tightening	98 to 130 {72 to 96, 10 to 13}	Wet
		After slackening off completely, carry out secondary tightening	30 to 40 {22 to 30, 3 to 4}	
18	Nut (Wheel hub and brake drum mounting)		340±40 {251±30, 35±4}	—
22	Bolt (Brake assembly mounting)		98 to 140 {72 to 103, 10 to 14}	—

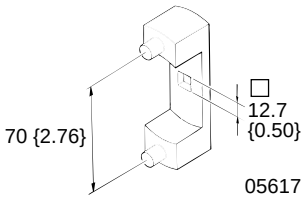
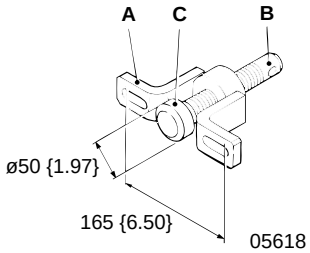
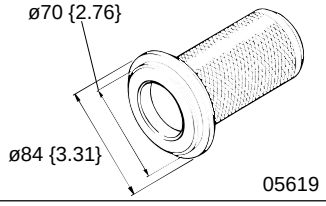
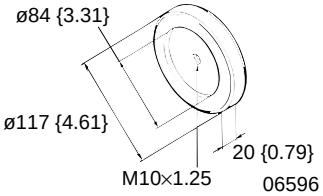
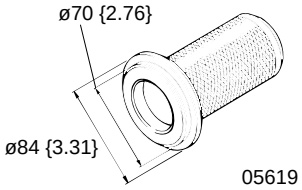
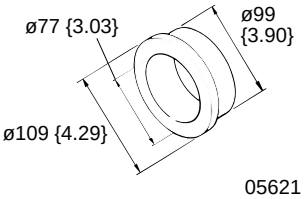
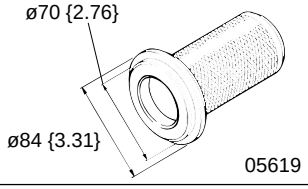
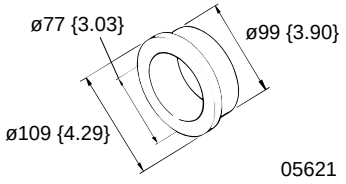
Lubricant

Location	Points of application	Kinds	Quantity
7, 14	Lip area of outer and inner oil seals	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
10	Thread area of lock nut	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
11, 15	Pack the space between rollers of outer and inner bearing inner races	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
21	Pack interior of wheel hub	Wheel bearing grease [NLGI No. 2 (Li soap)]	370±37 g {13.1±1.31 oz}

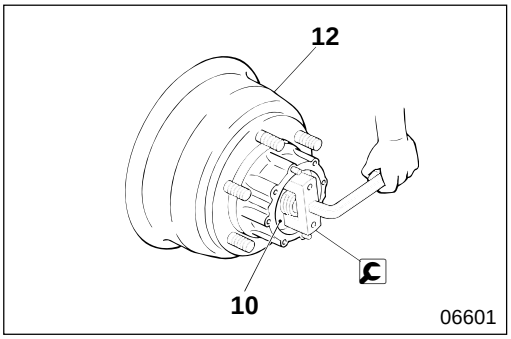
WHEEL HUB AND BRAKE DRUM < FE639, FG >

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
10	Lock nut adjustment tool 	MB999150	Removal and installation of lock nut
12	Hub puller components **A** : Hub puller body **B** : Bolt **C** : Attachment 	MB999070 **A** : MB999071 **B** : MB999072 **C** : MB999073	Removal of wheel hub and brake drum assembly
14	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of inner oil seal: Use in combination
	Oil seal installer 	MH062607	
16	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of inner bearing outer race: Use in combination
	Bearing installer 	MB999098 (T90ST05)	
17	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of outer bearing outer race: Use in combination
	Bearing installer 	MB999098 (T90ST05)	

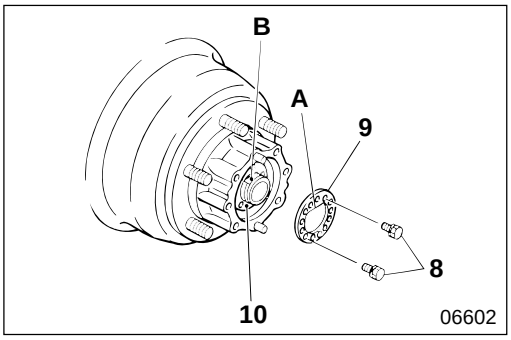
◆ Service procedure



● Starting torque of wheel hub bearing

[Adjustment]

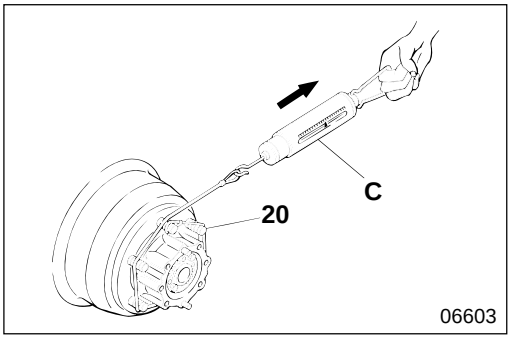
- Tighten lock nut **10** at specified torque for primary tightening, while turning wheel hub and brake drum assembly **12**.
- Slacken off lock nut **10** completely.
- Turn wheel hub and brake drum assembly **12** several times to smooth operation of outer bearings **11**, **17** and inner bearings **15**, **16.**
- Retighten lock nut **10** at specified torque for secondary tightening.



- Align flat area **A** with notch **B** to install lock washer **9**.
- Make sure that the mounting holes of lock washer **9** and lock nut **10** align. If they do not, slacken off the lock nut and align them.
- Install bolts **8** at the position as illustrated, aligning lock nut **10**.
- Tighten bolts **8** at specified torque.

CAUTION

After adjustment, make sure that there is no play in the axial direction of wheel hub and brake drum assembly 12.

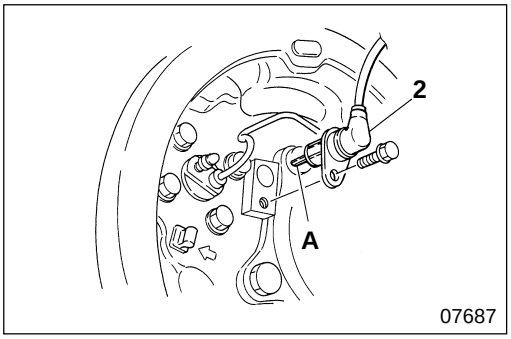


[Measurement]

- Install spring balance **C** on hub bolt **20**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the starting torque to become higher than the tangential force.
- If the measured value deviates from the specified value, readjust.
- If any fault is found after readjustment, replace outer bearings **11**, **17** and inner bearings **15**, **16**.

NOTE

- **Measure the starting torque with inner oil seal 14 installed.**
- **Measure the starting torque with rear axle shaft 6 and outer oil seal 7 removed.**
- **Make sure that there is no drag in brake lining and brake drum 19 before you measure the tangential force.**



2 Wheel speed sensor

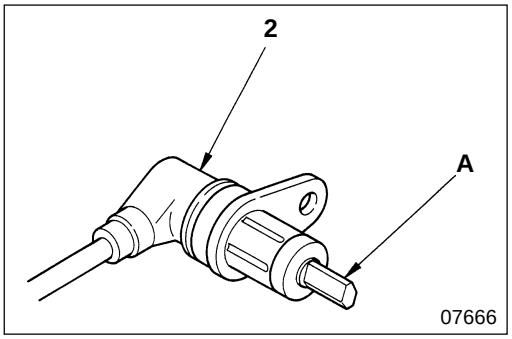
[Removal]

To prevent damaging pole piece **A** of wheel speed sensor **2**, remove the wheel speed sensor before removing wheel hub and drum assembly **12**.

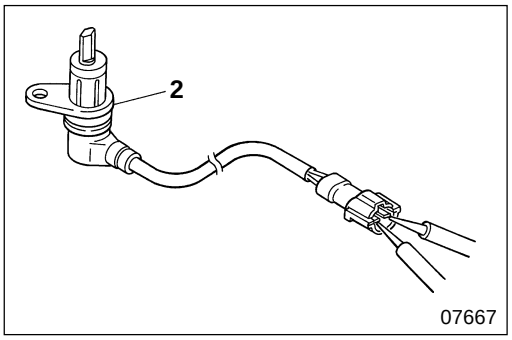
[Installation]

The connector of wheel speed sensor **2** is color-coded. Install the wheel speed sensors to the proper wheels according to the following table.

Installation location	Connector color	Connector shape	Right/left identification tape
Left wheel	Gray	Female	Yellow
Right wheel	Black	Male	None

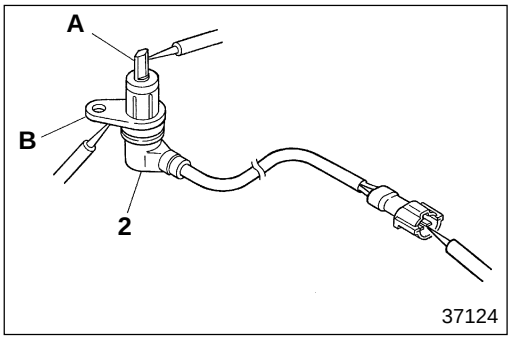


[Inspection]
Pole piece **A** in wheel speed sensor **2** is magnetized by a built-in magnet and attracts metals. Do not allow metal particles to stick to the pole piece.



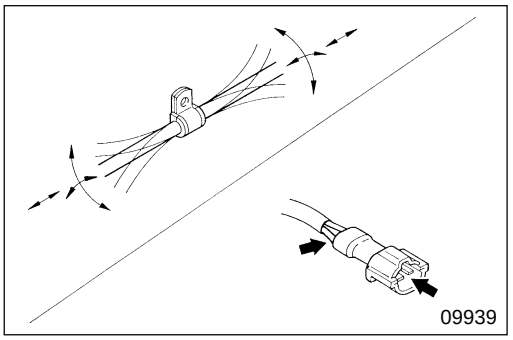
● **Measurement of resistance between terminals**

Measure resistance between the terminals of wheel speed sensor **2**.
If the measured value deviates from the standard value, replace the wheel speed sensor.



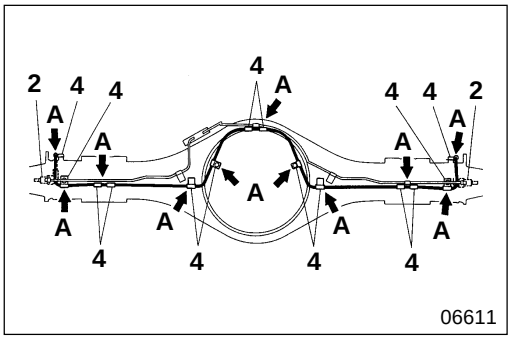
● **Measurement of insulation resistance**

Measure resistance between pole piece **A**, bracket **B** and each terminal of wheel speed sensor **2**.
If the measured value is lower than the standard value, replace the wheel speed sensor.



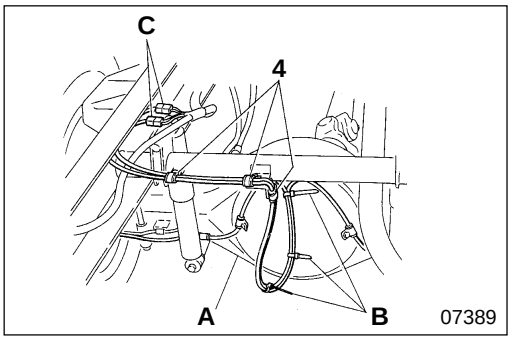
● **Inspection of open circuit in harness**

To check the harness for an open circuit, disconnect the harness clamp from the vehicle side, then bend and pull harness at the clamp to check if a momentary open circuit results. Also inspect the terminal contact conditions in the connector.
If an abnormality is found, replace wheel speed sensor **2**.

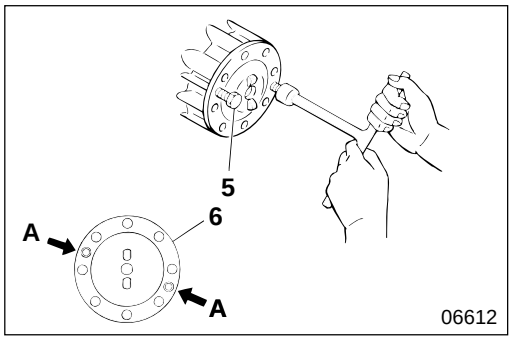


2 **4** **Installation of wheel speed sensor harness and clips**

Starting from the wheel brake side, secure the harness of wheel speed sensor **2** in place at tape sections **A** using clips **4**, while making sure that there is no interference, twisting or excessive sagging of the harness.

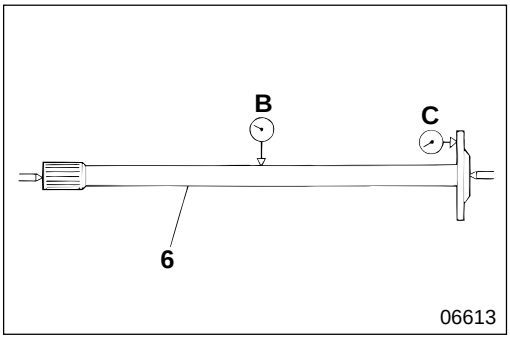


- As shown in the diagram, position the harness of wheel speed sensor **2**, starting from rear axle housing section **A** and moving toward the frame, making sure that there is no twisting or unnecessary slack in the harness. Use clips **4** and cable ties **B** to secure the harness in place, then connect connectors **C**.



5 **Axle shaft**

[Removal]
Insert two mounting bolts **5** of axle shaft **6** into two screw holes **A**, provided for disassembly, of the flange. Then, remove the rear shaft.

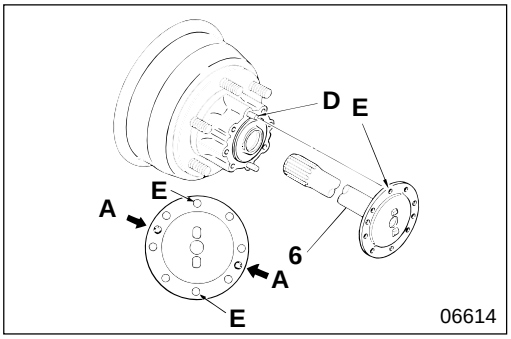


[Inspection]
B : Bend at the shaft center

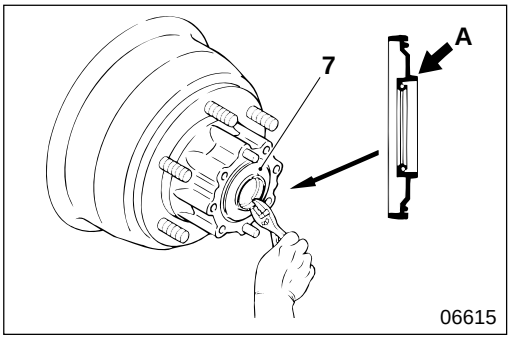
NOTE

To measure the bend of axle shaft 6, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

C : Bend of flange surface

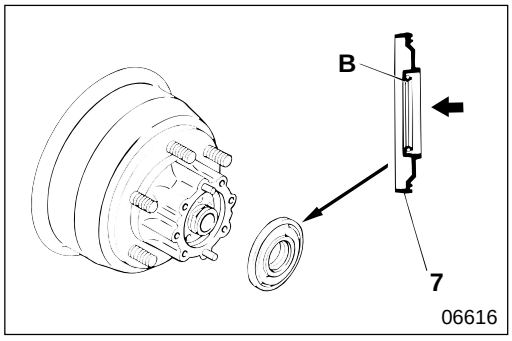


[Installation]
- Knock pin hole **E** of axle shaft **6** is the second hole clockwise from disassembly screw hole **A**.
- To mount axle shaft **6**, align knock pin **D** with knock pin hole **E**.

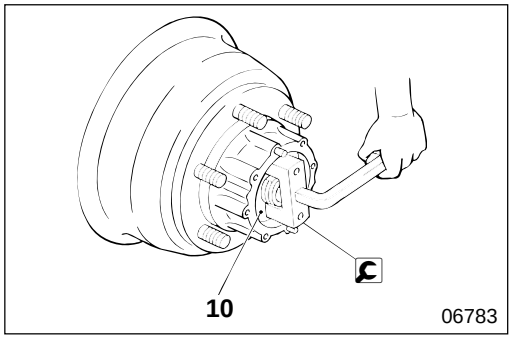


7 **Outer oil seal**

[Removal]
To remove outer oil seal **7**, use a pair of pliers and pull protrusion **A** of the outer oil seal circumference evenly.

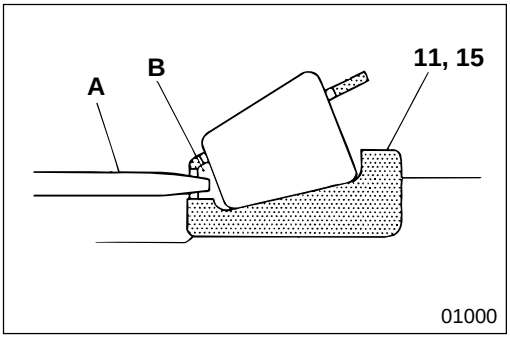


[Installation]
Apply grease to lip area **B** of outer oil seal **7** and press-fit the outer oil seal in the direction as illustrated.



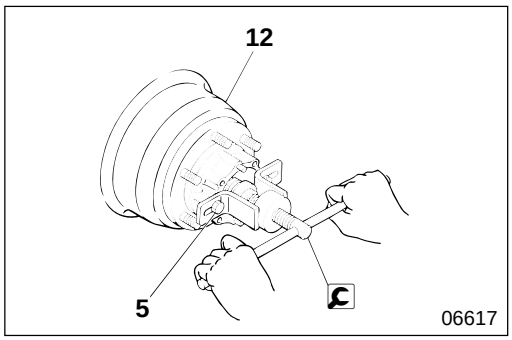
10 **Removal and installation of lock nut**

Adjust and measure the starting torque of wheel hub bearing during installation. P27-13



11 **15** **Packing grease in outer bearing inner race and inner bearing inner race**

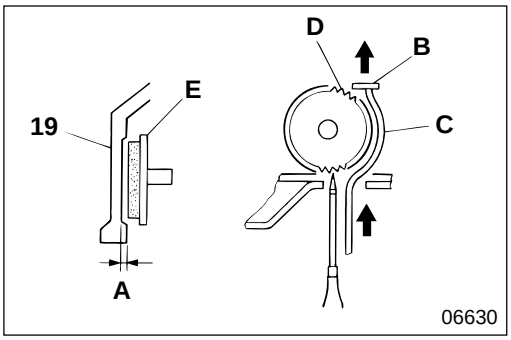
A : Grease pump nozzle
B : Space between rollers



12 **Wheel hub and brake drum assembly**

[Removal]
- Remove wheel hub and brake drum assembly **12** using mounting bolt **5** of axle shaft **6**.

CAUTION
Make sure you remove wheel hub and brake drum assembly 12 in a straight line to prevent damage to oil seal 14.

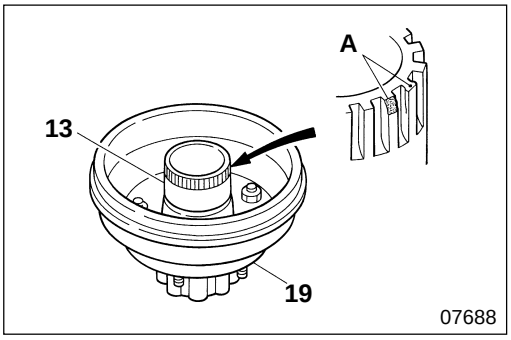


- If wheel hub and brake drum assembly **12** cannot be removed because of stepped wear **A** in brake drum **19**, do the following:
- Remove the backing plate cover.
- Lift lever **B**.
  C : Wire approximately ø2 mm {0.079 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the backing plate to retract brake shoe assembly **E**.
- Remove wheel hub and brake drum assembly **12**.

CAUTION⚠

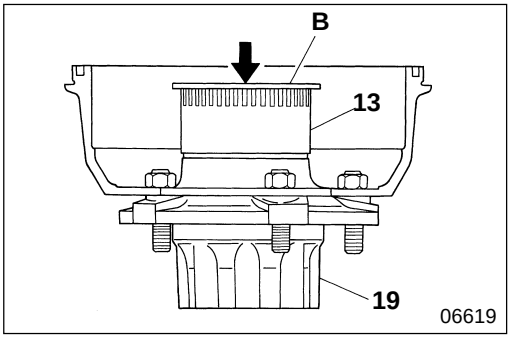
Correct brake drum 19 if any fault is found. 📦 **Gr 35A**

[Installation]
After installing wheel hub and brake drum assembly **12**, adjust the brake shoe clearance. 📦 Gr 35A

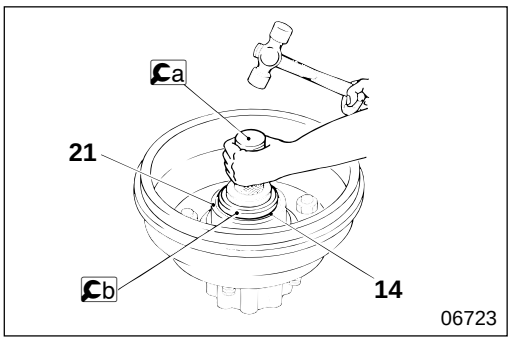


13 **Rotor**

[Inspection]
Check rotor **13** for chipped or crushed teeth (see section **A** in the diagram).
If an abnormality is found, replace the rotor.

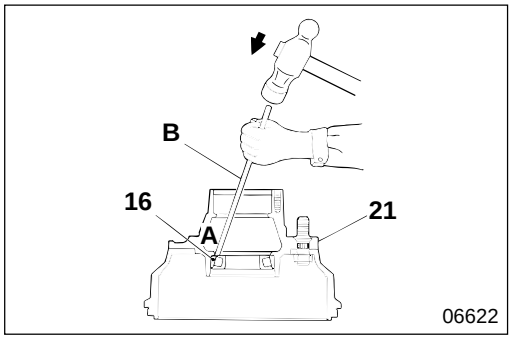


[Installation]
Before installing rotor **13** to brake drum **19**, heat the rotor to approximately 150°C {302°F}. Using iron plate **B**, install the rotor to the brake drum by applying uniform pressure, making sure that there is no gap between the rotor and the brake drum.



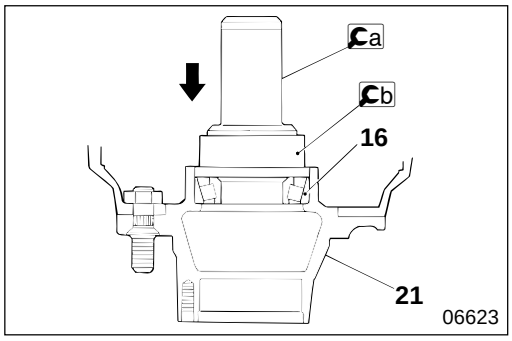
14 **Installation of inner oil seal**

Press-fit inner oil seal **14** until it is flush with the end of wheel hub **21**.

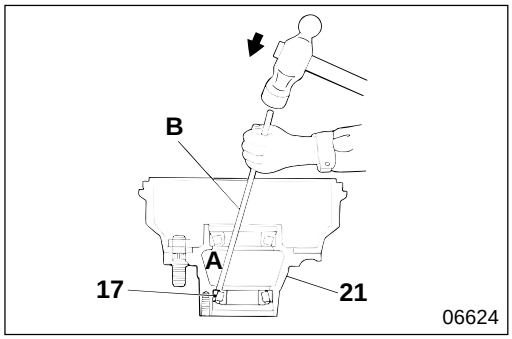


16 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **16** evenly from three indented parts **A** in wheel hub **21**.
B : Pin-punch

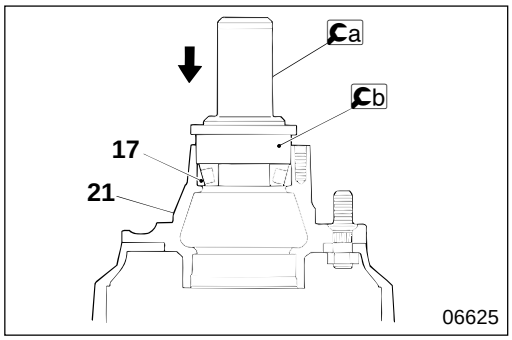


[Installation]

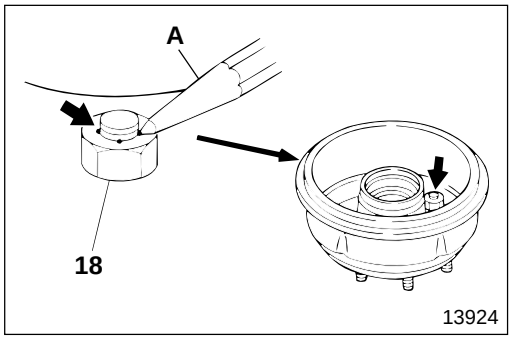


17 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **17** evenly from three indented parts **A** in wheel hub **21**.
B : Pin-punch

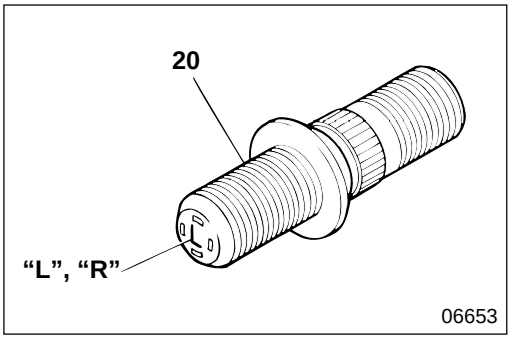


[Installation]



18 **Installation of nut**

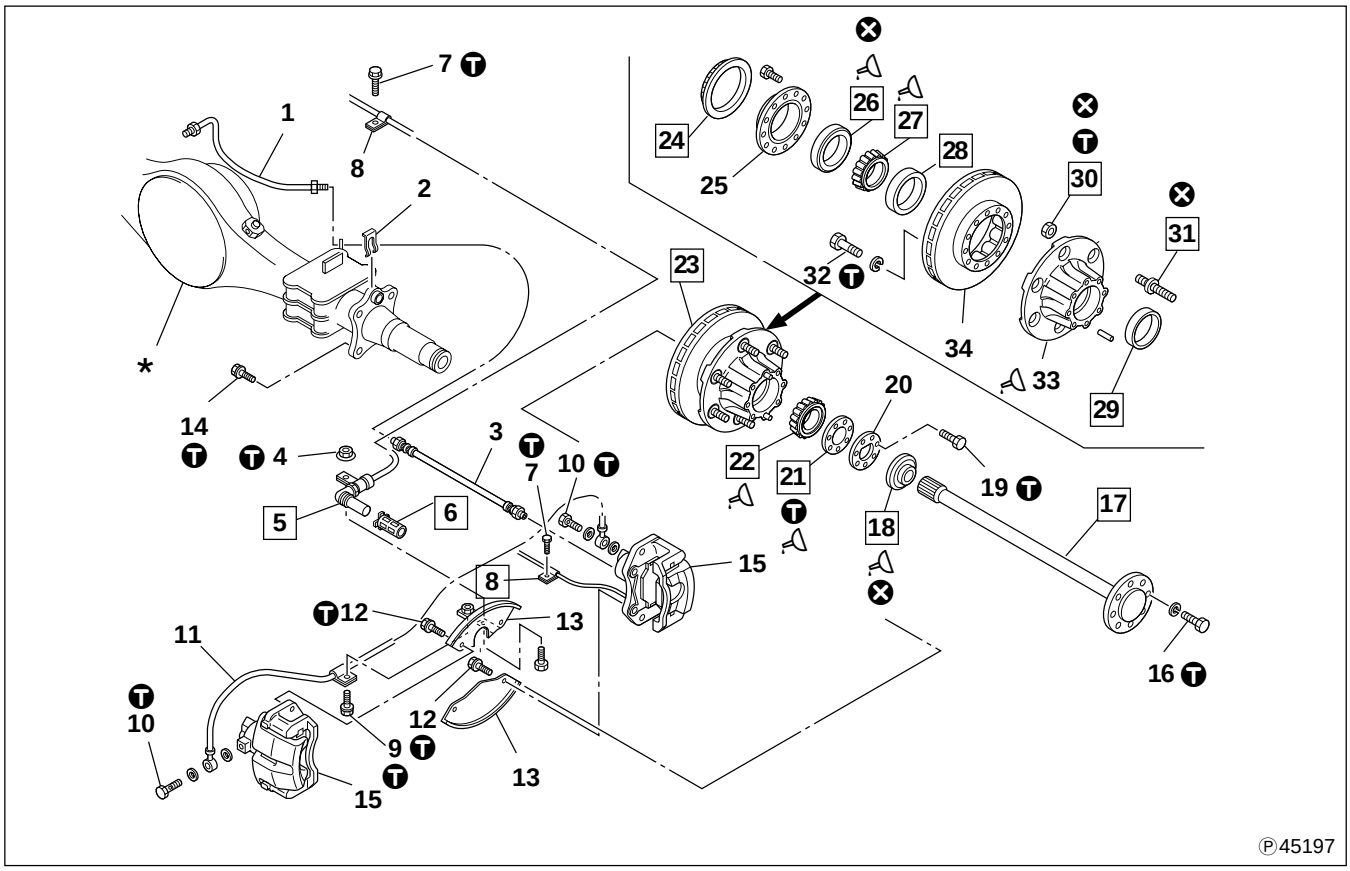
Tighten nut **18** at specified torque, then caulk the nut to keep it from turning.
A : Punch



20 **Installation of hub bolt**

Hub bolt **20** is marked with **L** (left) or **R** (right) to indicate the side it is to be mounted on. Check this symbol before press-fitting the bolt.

WHEEL HUB AND ROTOR < FE640, FE649 >



● **Disassembly sequence**

1 Brake pipe
2 Clip
3 Brake hose
4 Nut
5 Wheel speed sensor
6 Spring spacer
7 Bolt
8 Clip
9 Bolt
10 Eye bolt
11 Brake hose
12 Bolt
13 Dust shield
14 Bolt
15 Disc brake assembly
Gr 35A
16 Bolt
17 Axle shaft
18 Outer oil seal
19 Bolt
20 Lock washer
21 Lock nut
22 Outer bearing inner race
23 Wheel hub and rotor assembly
24 Rotor
25 Rotor flange
26 Inner oil seal
27 Inner bearing inner race
28 Inner bearing outer race
29 Outer bearing outer race
30 Nut
31 Hub bolt
32 Bolt
33 Wheel hub
34 Disc rotor

*: Axle housing P27-30
⊗: Non-reusable parts

WARNING

Disc brake assembly 15 and disc rotor 34 are hot immediately after the vehicle has stopped, so take care not to burn yourself.

CAUTION

- **Before removing disc brake assembly 15 secure the disc brake assembly to the frame using wires, and do not disconnect the brake hose. Never allow the weight of the disk brake caliper assembly to hang from the hydraulic brake hose. Be sure to remove the harness clips to prevent damaging the pad wear indicator harness during the removal process.**
- **Be sure to protect brake pipe 1 and brake hoses 3, 11 from dust by fitting blanking plugs after removal.**

NOTE

Do not disassemble wheel hub 33 and disc rotor 34 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

- **Do not allow oil or grease to adhere on the pad surface of disc brake assembly 15 or the surface rotor 24.**
- **You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A**

CAUTION⚠

Be careful not to damage rotor 24 or inner oil seal 26 when installing wheel hub and rotor assembly 23 in axle housing *.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
5	Wheel speed sensor	Resistance between terminals	1750±10% Ω	—	—
		Insulation resistance	1000 kΩ minimum	—	—
17	Rear axle shaft	Bend of shaft center	1 {0.039} or less	2 {0.079}	Replace
		Wobble of flange face	0.03 {0.0012} or less	0.05 {0.0020}	Replace
24	Rotor runout		0.0039	—	—
—	Starting torque of wheel hub bearing		2.0 to 3.9 N·m {1.5 to 2.9 ft.lbs, 0.20 to 0.40 kgf·m}	—	Tangential force at hub bolt : 18 to 35 N {4.0 to 7.9 lbf, 1.8 to 3.6 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

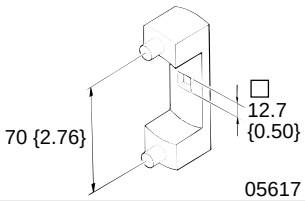
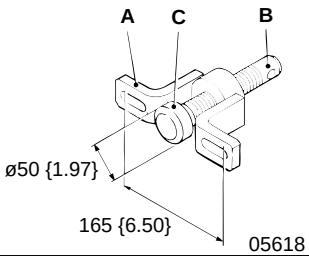
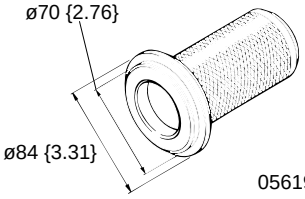
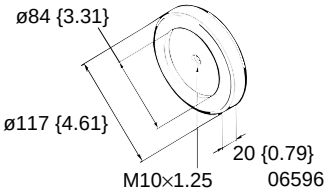
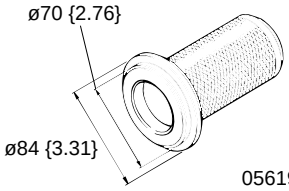
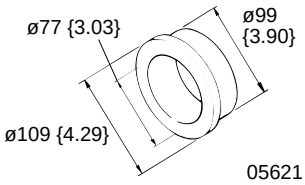
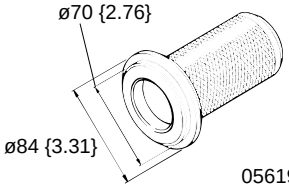
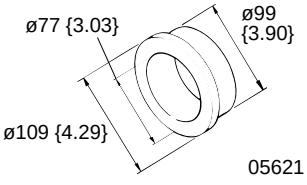
Location	Parts to be tightened		Tightening torque	Remarks
4	Nut (Clip mounting)		10 to 15 {72 to 108, 1.0 to 1.5}	—
7	Bolt (Clip mounting)		12 to 15 {87 to 108, 1.2 to 1.5}	—
9	Bolt (Clip mounting)		4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
10	Eye bolt (Brake hose mounting)		19.6 to 24.6 {14 to 18, 2 to 2.5}	—
12	Bolt (Dust shield mounting)		39 to 58 {28 to 43, 3.9 to 6.0}	—
14	Bolt (Disc brake assembly mounting)		98 to 140 {72 to 103, 10 to 14}	—
16	Bolt (Axle shaft mounting)		98 to 120 {72 to 89, 10 to 12}	—
19	Bolt (Lock washer mounting)		4.9±1.0 {3.6±0.7, 0.5±0.1}	—
21	Lock nut (Wheel hub bearing mounting : wheel hub bearing preload adjustment)	Primary tightening	98 to 130 {72 to 96, 10 to 13}	Wet
		After slacking off completely, carry out secondary tightening	30 to 40 {22 to 29, 3 to 4}	
30	Nut (Hub bolt mounting)		340±40 {251±30, 35±4}	—
32	Bolt (Wheel nub and disc rotor mounting)		45 to 60 {25 to 40, 4.5 to 6.0}	—

Lubricant

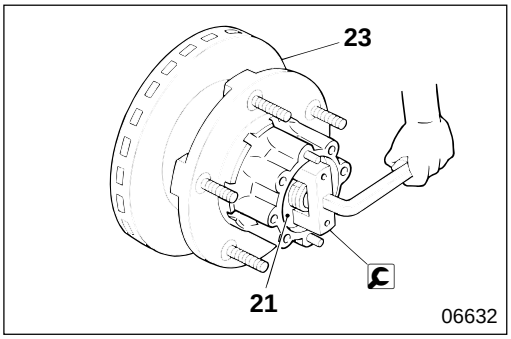
Location	Points of application	Kinds	Quantity
18, 26	Lip area of outer and inner oil seals	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
21	Thread area of lock nut	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
22, 27	Pack the space between rollers of outer and inner bearing inner races	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
33	Pack interior space of wheel hub	Wheel bearing grease [NLGI No. 2 (Li soap)]	370±37 g {13.1±1.31 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
21	Lock nut adjustment tool 	M B999150	Removal and installation of lock nut
23	Hub puller components **A** : Hub puller body **B** : Bolt **C** : Attachment 	M B999070 **A** : MB999071 **B** : MB999072 **C** : MB999073	Removal of wheel hub and rotor assembly
26	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of inner oil seal : Use in combination
	Oil seal installer 	MH062607	
28	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of inner bearing outer race : Use in combination
	Bearing installer 	MB999098 (T90ST05)	
29	Oil seal installer 	MB999097 (T90ST30)	Press-fitting of outer bearing outer race : Use in combination
	Bearing installer 	MB999098 (T90ST05)	

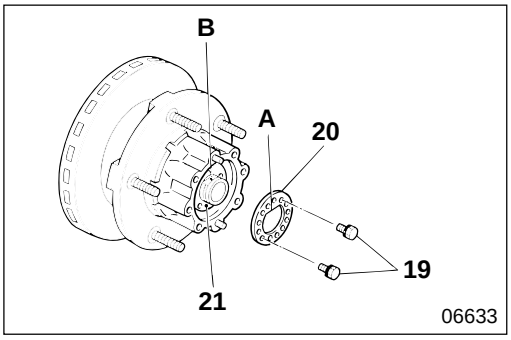
◆ Service procedure



● Starting torque of wheel hub bearing

[Adjustment]

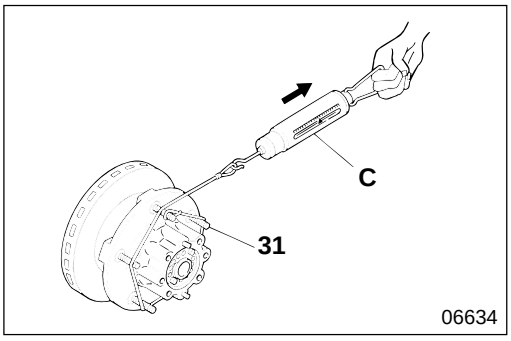
- Tighten lock nut **21** at specified torque for primary tightening, while turning wheel hub and rotor assembly **23**.
- Slacken off lock nut **21**completely.
- Turn wheel hub and rotor assembly **23** several times to smooth operation of outer bearings **22**, **29** and inner bearings **27, 28**.
- Tighten lock nut **21** at specified torque for secondary tightening.



- Insert lock washer **20** so that flat area **A** fits onto notch **B**.
- Make sure that the mounting holes of lock washer **20** and lock nut **21** align. If they do not, slacken off the lock nut and align them.
- Install bolts **19** at the positions as illustrated, aligning lock nut **21**.
- Tighten bolts **19** at specified torque.

CAUTION

After adjustment, make sure that there is no play in the axial direction of wheel hub and rotor assembly 23.

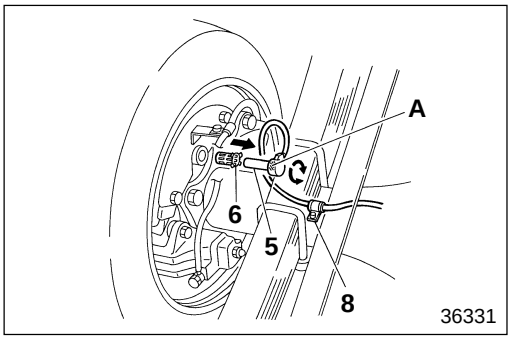


[Measurement]

- Install spring balance **C** on hub bolt **31**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the starting torque to become higher than the tangential force.
- If the measured value deviates from the specified value, readjust.
- If any fault is found after readjustment, replace outer bearings **22, 29** and inner bearings **27, 28**.

NOTE

- **Measure the starting torque with inner oil seal 26 installed.**
- **Measure the starting torque with disc brake assembly 15, outer oil seal 18 and axle shaft 17 removed.**



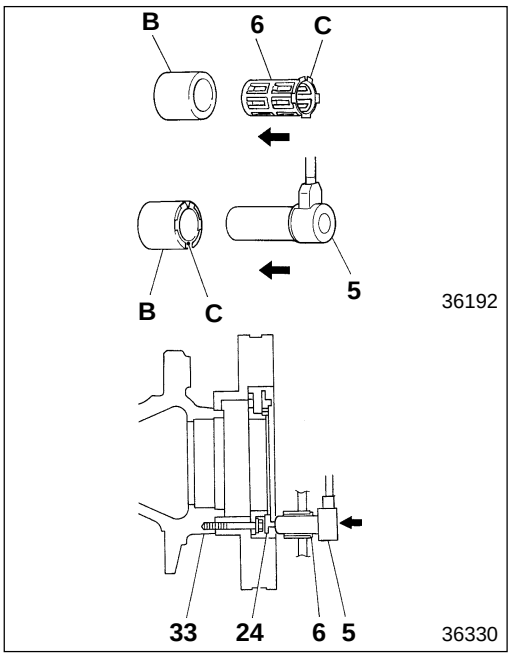
5 **6** **Wheel speed sensor and spacer**

[Removal]

Using pliers, hold wheel speed sensor **5** at shaded section **A** in the diagram, and remove it by turning it slightly.

CAUTION

- **Do not hold wheel speed sensor 5 with pliers at positions other than shaded section A shown in the diagram.**
- **Do not apply excessive force to remove wheel speed sensor 5, such as by striking with a hammer, prying with a screwdriver, and pulling the harness. Excessive force can break wires in the wheel speed sensor.**
- **If only slight force is necessary to remove wheel speed sensor 5, replace spring spacer 6.**



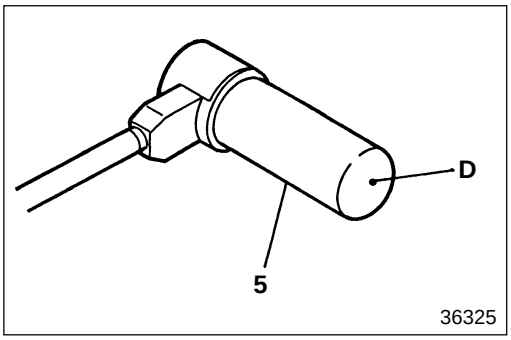
[Installation]
The connector of wheel speed sensor **5** is color-coded. Install the wheel speed sensors to the proper wheels according to the following table.

Installation location	Connector color	Connector shape	Right/left identification tape
Left wheel	Gray	Female	Yellow
Right wheel	Black	Male	None

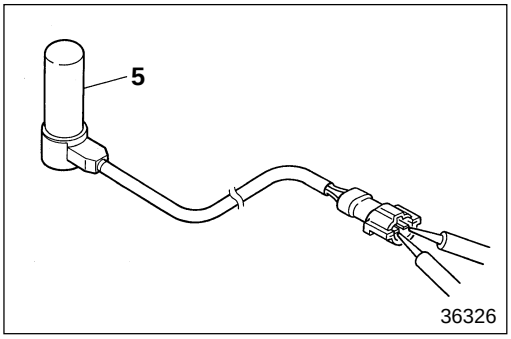
- Insert spring spacer **6** into holder section **B** of the backplate until stopper section **C** contacts the holder section.
- Insert wheel speed sensor **5** until it firmly contacts rotor **24**.
- Slowly rotate wheel hub **33** two or three turns (1 rotation per 2 seconds) to make sure it rotates smoothly.

CAUTION ⚠

Do not apply excessive force to install wheel speed sensor 5, such as by striking with a hammer, prying with a screwdriver, and pulling the harness. Excessive force can break wires in the wheel speed sensor.

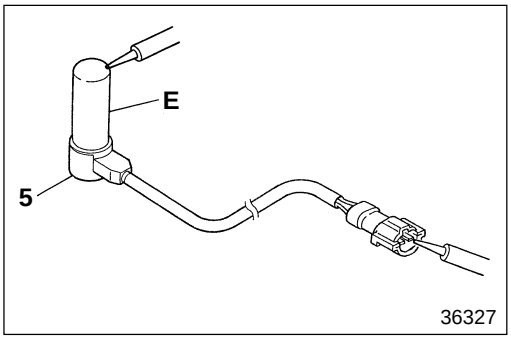


[Inspection]
Pole piece **D** in wheel speed sensor **5** is magnetized by a built-in magnet and attracts metals. Do not allow metal particles to stick to the pole piece.



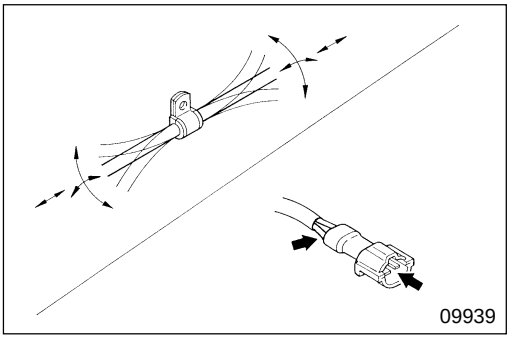
● **Measurement of resistance between terminals**

Measure resistance between the terminals of wheel speed sensor **5**.
If the measured value deviates from the standard value, replace the wheel speed sensor.



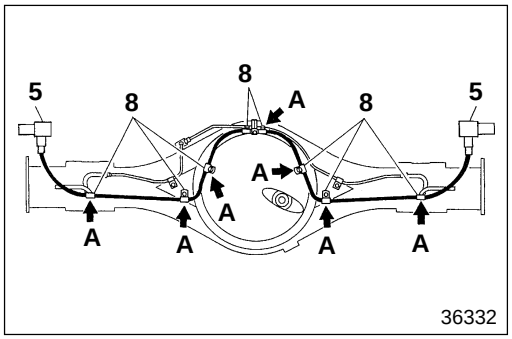
● **Measurement of insulation resistance**

Measure resistance between body **E** and each terminal of wheel speed sensor **5**.
If the measured value is lower than the standard value, replace the wheel speed sensor.



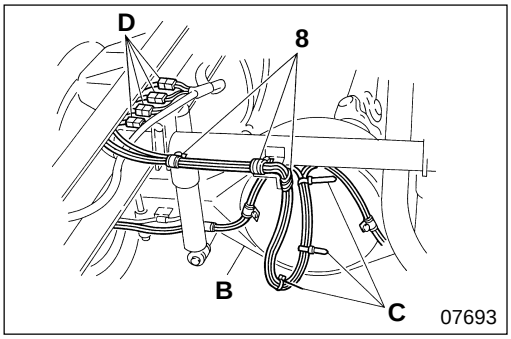
● **Inspection of open circuit in harness**

To check the harness for an open circuit, disconnect the harness clamp from the vehicle side, then bend and pull harness at the clamp to check if a momentary open circuit results. Also inspect the terminal contact conditions in the connector.
If an abnormality is found, replace wheel speed sensor **5**.

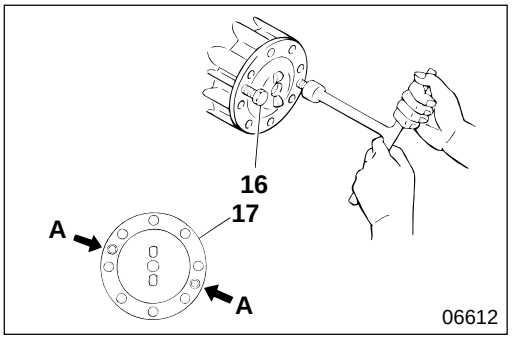


5 **8** **Installation of wheel speed sensor harness and clips**

- Starting from the wheel brake side, secure the harness of wheel speed sensor **5** and the pad wear indicator harness in place at tape sections **A** using clips **8**, while making sure that there is no interference, twisting or excessive sagging of the harnesses.

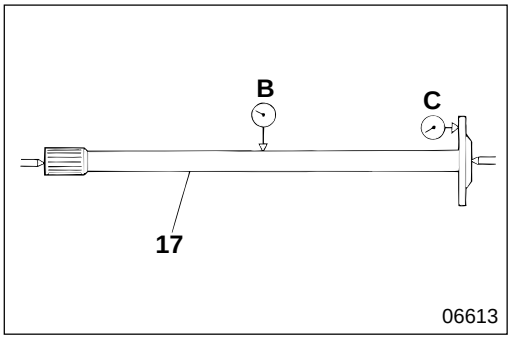


- As shown in the diagram, position the harness of speed sensor **5** and the pad wear indicator harness, starting from housing section **B** and moving toward the frame, making sure that there is no twisting or excessive sagging of the harnesses. Use clips **8** and cable ties **C** to secure the harnesses in place, then connect connectors **D**.



17 **Axle shaft**

[Removal]
Insert bolts **16** into screw holes **A** of axle shaft **17**. Then, remove the axle shaft.

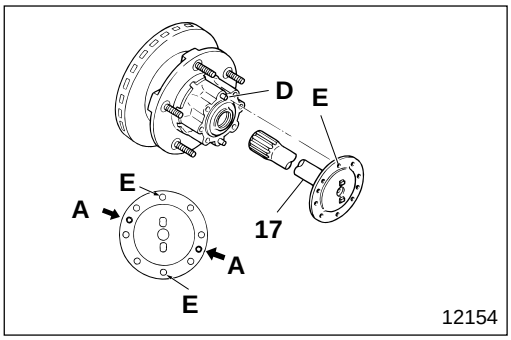


[Inspection]
B : Bend of shaft center

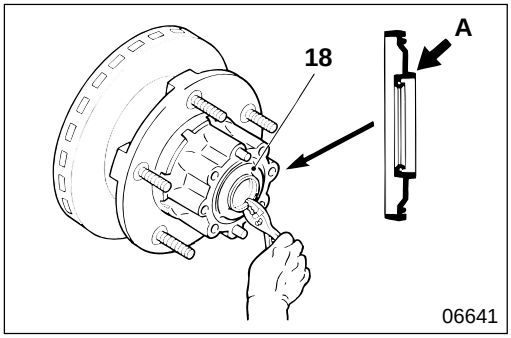
NOTE

To measure the bend of axle shaft 17, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

C : Wobble of flange face

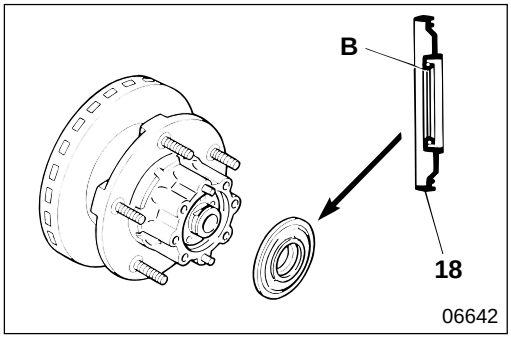


[Installation]
- Knock pin hole **E** of axle shaft **17** is the second hole clockwise from disassembly screw hole **A**.
- To mount axle shaft **17**, align knock pin **D** with knock pin hole **E**.

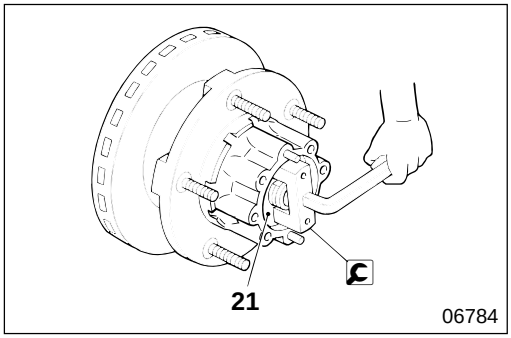


18 **Outer oil seal**

[Removal]
To remove outer oil seal **18**, use pliers and pull protrusion **A** of the outer oil seal circumference evenly.

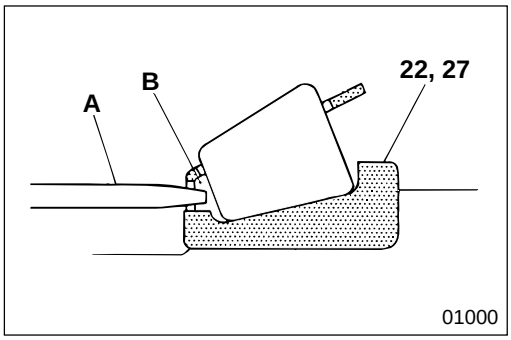


[Installation]
- Apply grease to lip area **B** of outer oil seal **18**.
- Press-fit outer oil seal **18** in the direction as illustrated.



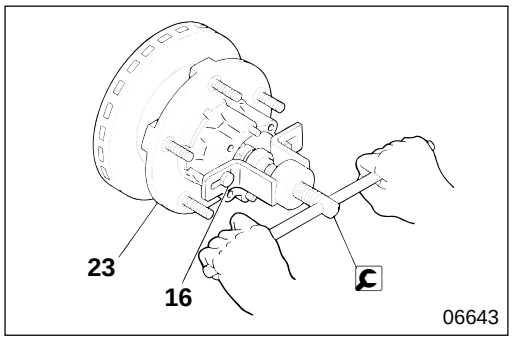
21 **Removal and installation of lock nut**

Adjust starting torque of wheel hub bearing during installation.
P27-23



22 **27** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Space between rollers

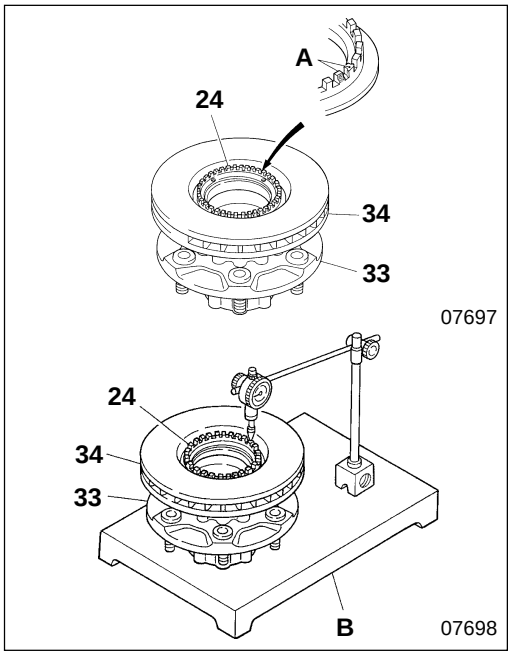


23 **Removal of wheel hub and rotor assembly**

Remove wheel hub and rotor assembly **23** using mounting bolt **16** of axle shaft **17**.

CAUTION

Make sure you remove wheel hub and rotor assembly 23 in a straight line to prevent damage to inner oil seal 26.



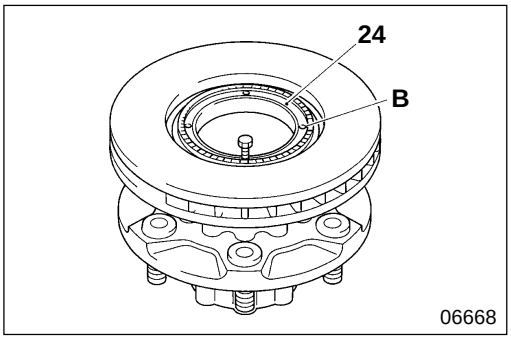
24 **Rotor**

[Inspection]

- Check rotor **24** for chipped or crushed teeth (see section **A** in the diagram).
  If an abnormality is found, replace the rotor.

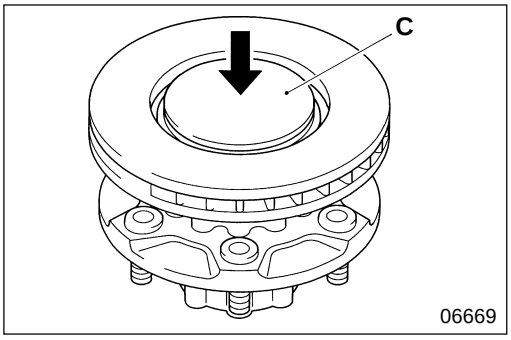
- If the amount of runout of rotor **24** deviates from the standard value, repeat the disassembly and reassembly procedures. If the amount of runout still deviates from the standard value after the reassembly, replace faulty parts.

  B : Platform



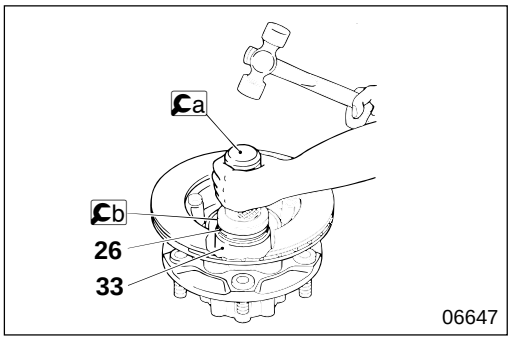
[Removal]

Install bolts (M6 × 1.0) in threaded holes **B** (holes for rotor removal) on rotor **24**, and tighten them evenly to remove the rotor.



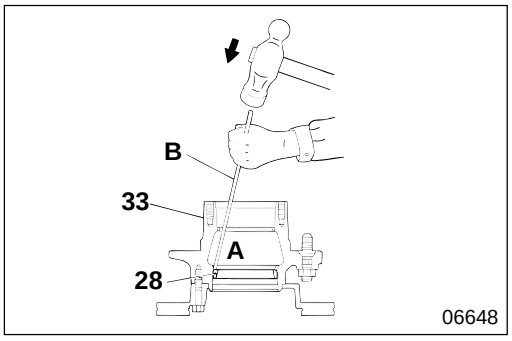
[Installation]

Before installing rotor **24** to rotor flange **25**, heat the rotor to approximately 150°C {302°F}. Using iron plate **C**, press-fit the rotor into the rotor flange by applying uniform pressure, making sure that there is no gap between the rotor and the rotor flange.



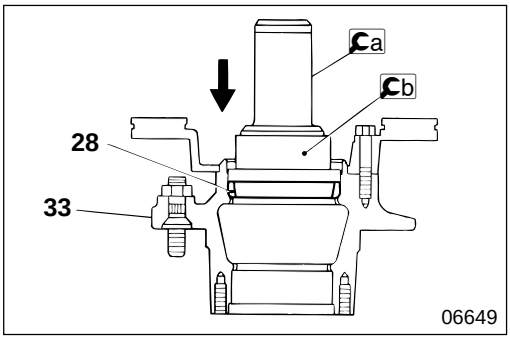
26 **Installation of inner oil seal**

Press-fit inner oil seal **26** so that it is flush with the end of wheel hub **33**.

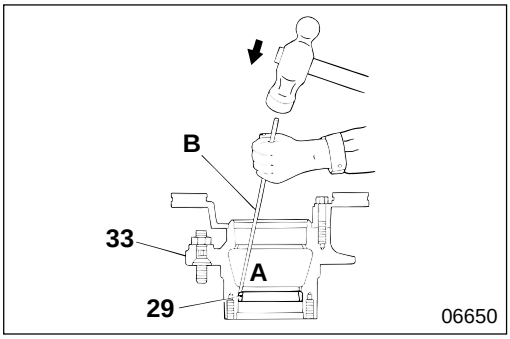


28 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **28** evenly from three indented parts **A** in wheel hub **33**.
B : Pin-punch

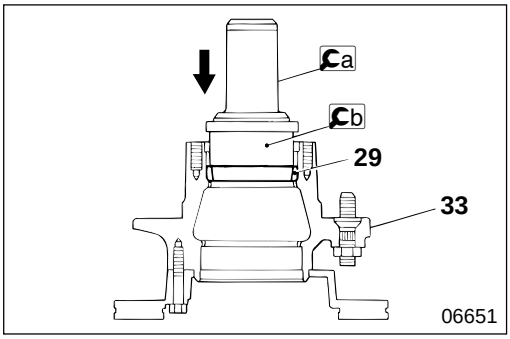


[Installation]

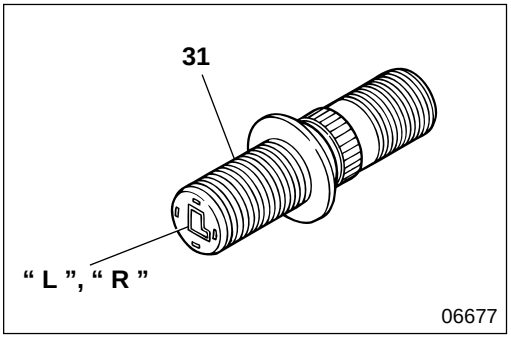


29 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **29** evenly from three indented parts **A** in wheel hub **33**.
B : Pin-punch

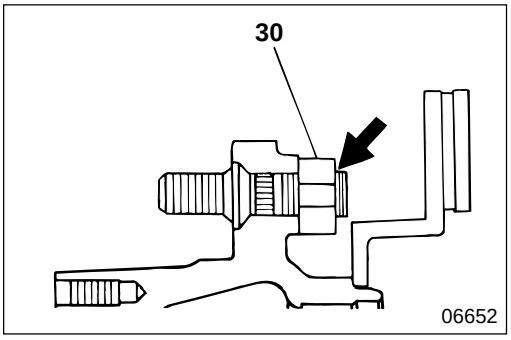


[Installation]



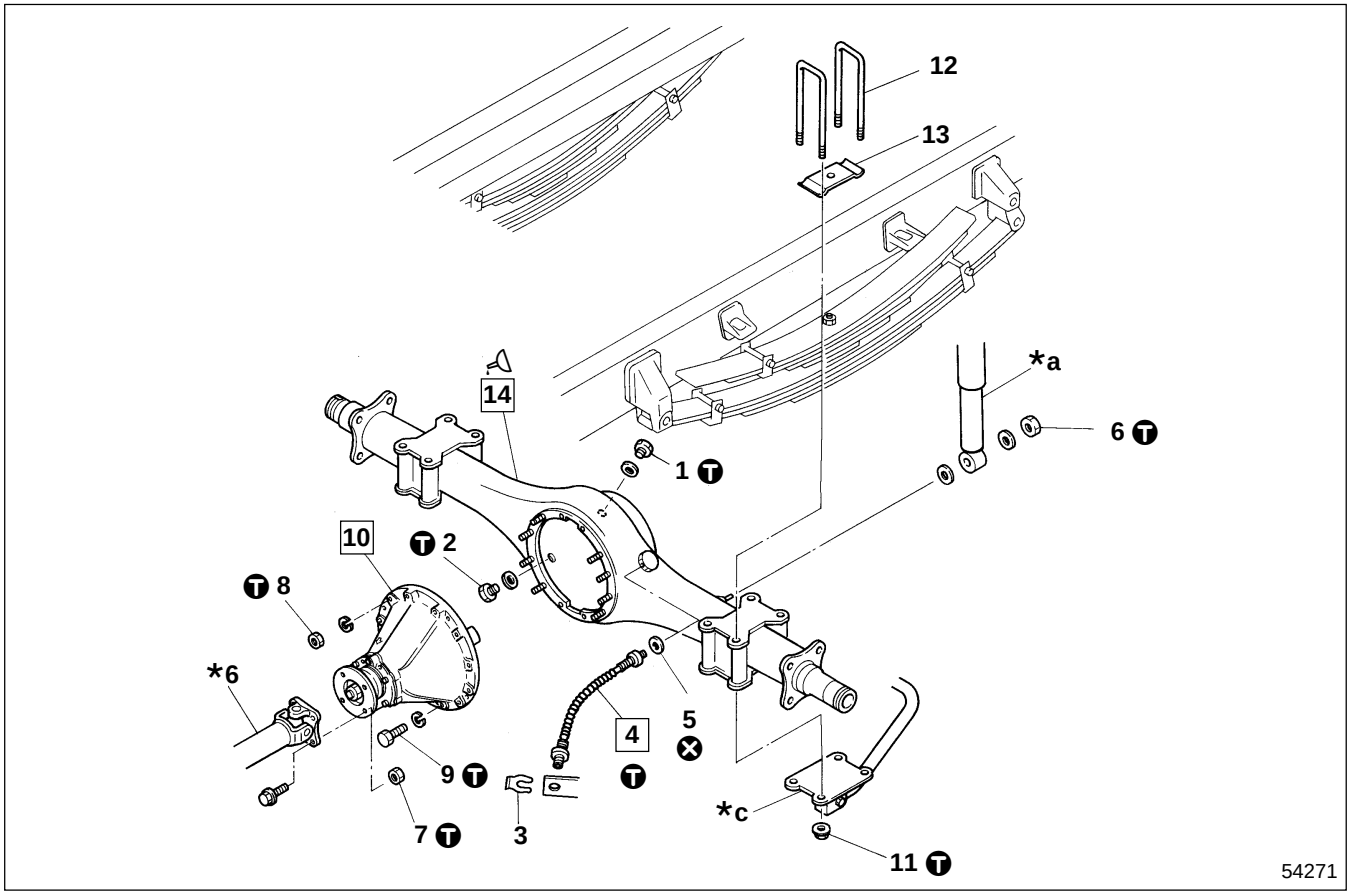
30 **31** **Installation of nut, hub bolt**

- Hub bolt **31** is marked with **L** (left) or **R** (right) to indicate the side it is to be mounted on. Check this symbol before press-fitting the bolt.



- Tighten nut **30** at specified torque.
- Drive nut **30** in using a punch to lock the nut.

AXLE HOUSING



● **Work before disassembly**

P27-32

● **Disassembly sequence**

1 Inspection plug
2 Drain plug
3 Clip
4 Brake hose
5 Packing
6 Nut
7 Nut
8 Nut
9 Bolt
10 Reduction and differential assembly P27-34
11 U-bolt nut
12 U-bolt
13 Spring pad
14 Axle housing

***a** : Shock absorber Gr 34
***b** : Propeller shaft Gr 25
***c** : Stabilizer Gr 34

⊗ : Non-reusable parts

CAUTION

Be sure to protect brake hose 4 from dust by fitting blanking plugs after removal.

NOTE

Do not remove axle housing 14 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

Make sure that brake hose 4 is not twisted when you install it.

● **Work after assembly**

P27-32

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
14	Axle housing	Runout of outer bearing mating area	0.5 {0.020} or less	1 {0.039}	Replace
		Difference of center area before and after turning	1 {0.039} or less	5 {0.20}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

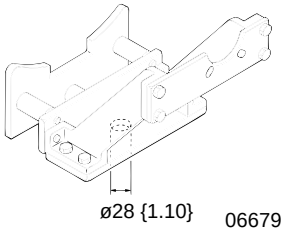
Location	Parts to be tightened		Tightening torque	Remarks
1	Inspection plug		98 to 120 {72 to 89, 10 to 12}	—
2	Drain plug		98 to 120 {72 to 89, 10 to 12}	—
4	Brake hose mounting (on the axle housing)		13 to 17 {9.4 to 12, 1.3 to 1.7}	—
6	Nut (Shock absorber mounting)		26 to 33 {20 to 25, 2.7 to 3.4}	—
7	Nut (Propeller shaft mounting)		98 to 120 {78 to 89, 10 to 12}	—
8	Nut (Reduction and differential assembly mounting)		69 to 93 {51 to 69, 7.0 to 9.5}	—
9	Bolt (Reduction and differential assembly mounting)		83 to 108 {61 to 80, 8.5 to 11.0}	—
11	U-bolt nut (U-bolt mounting)	Except FG	340±50 {251±37, 34.7±5.1}	—
		FG	240±15 {177±11, 24.5±1.5}	

Sealant

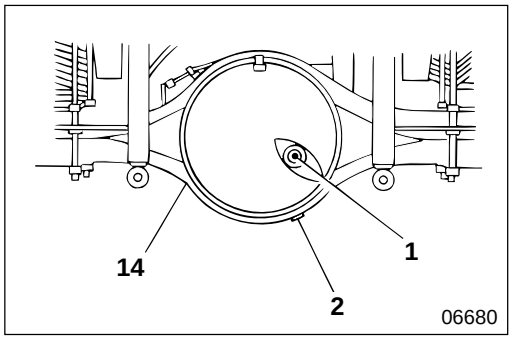
Location	Points of application	Kinds	Quantity
14	Reduction and differential assembly mounting surfaces of axle housing	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
10	Differential carrier base 	MB999102	Removal and installation of reduction and differential assembly

◆ Service procedure



● **Work before disassembly**

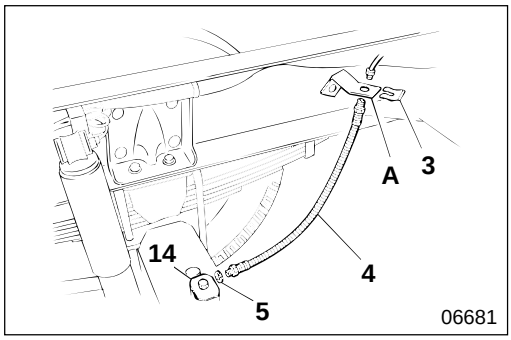
Remove inspection plug **1** and drain plug **2**, then drain the gear oil from axle housing **14**.

WARNING⚠

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

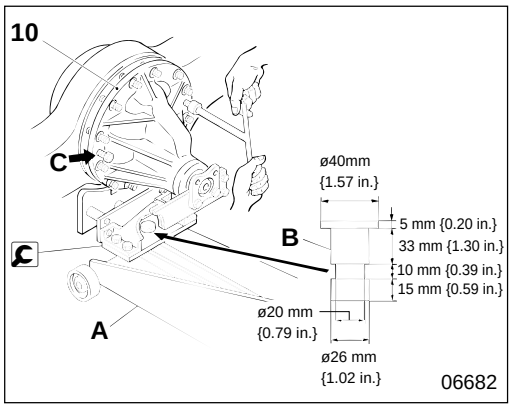
● **Work after assembly**

Fill axle housing **14** with the specified amount of gear oil via inspection plug **1**.



4 **Removal and installation of brake hose**

Remove brake hose **4** from bracket **A** (on the frame) first, then remove the brake hose from axle housing **14**. To assemble the brake hose follow the disassembly sequence in reverse.

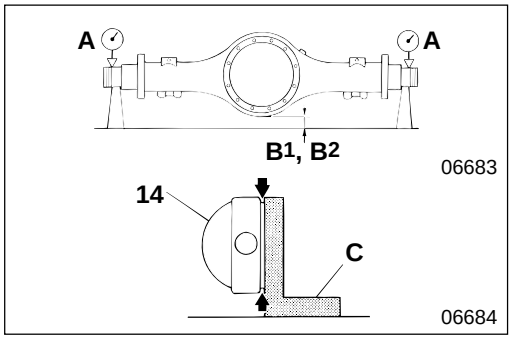


10 **Removal and installation of reduction and differential assembly**

- Remove the lift pad from garage jack **A** and mount differential carrier base, after turning pin **B** to the dimensions as illustrated insert it and secure it with the bolt which secured the lift pad.
- Tighten two bolts in screw holes **C** used for removing reduction and differential assembly **10** evenly, and remove the reduction and differential assembly.
  Bolt size : M12×1.25 mm

NOTE

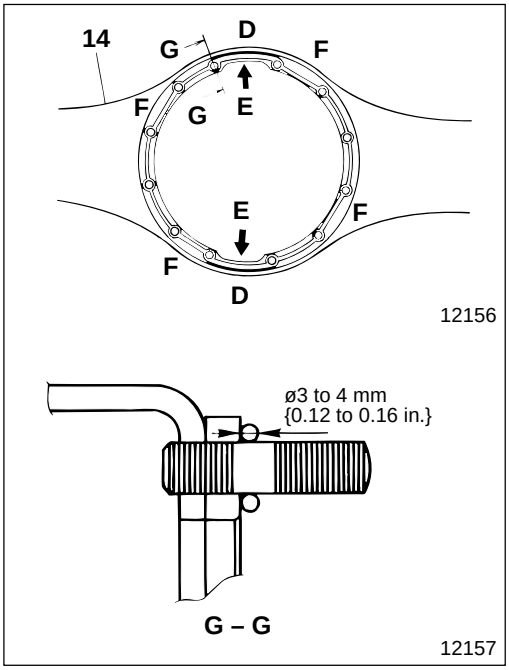
Be sure to completely remove adhered sealant from the mounting surface of the axle housing and carrier.



14 **Axle housing**

[Inspection]

- Support the inner bearing mating parts at both ends of the housing spindle of axle housing **14** horizontally.
- Set the dial gauge against outer bearing mating part **A** and turn it 360° to measure bend.
- Set axle housing **14** vertical using square **C**. After measuring B_1, turn the axle housing 180° and measure B_2 to find the difference.
- If the measured value is higher than the limit, replace axle housing **14**.



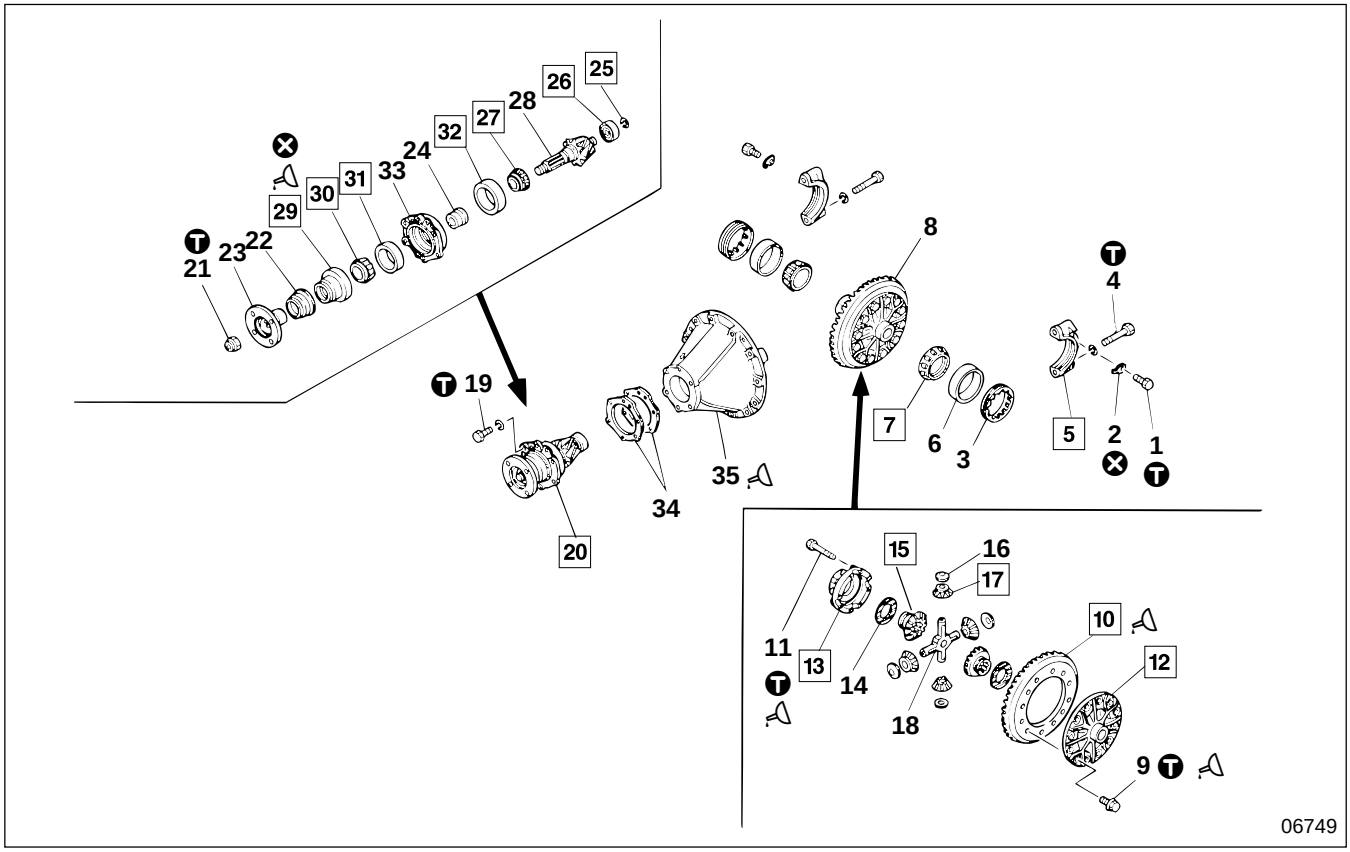
[Application of sealant]

- Apply sealant to reduction and differential assembly **10** mounting surface of axle housing **14**.
- Apply sealant around the periphery of indented area **E** for part **D**.
- Apply sealant linearly to part **F**.

NOTE

Make sure that sealant does not ooze from the mounting surface after installing reduction and differential assembly 10.

REDUCTION AND DIFFERENTIAL



- **Work before disassembly** P27-38
- **Inspection before disassembly** P27-38
- **Disassembly sequence**

1 Bolt
2 Lock plate
3 Adjusting screw
4 Bolt
5 Bearing cap
6 Side bearing outer race
7 Side bearing inner race
8 Differential assembly
Multiplate limited slip differential assembly P27-48
9 Bolt
10 Final drive gear
11 Bolt
12 Differential case, LH
13 Differential case, RH
14 Differential gear washer
15 Differential gear
16 Differential pinion washer
17 Differential pinion
18 Pinion spider
19 Bolt
20 Pinion assembly
21 Lock nut
22 Dust cover
23 Companion flange
24 Collar
25 Lock ring
26 Pinion pilot bearing
27 Rear bearing inner race
28 Final drive pinion
29 Oil seal
30 Front bearing inner race
31 Front bearing outer race
32 Rear bearing outer race
33 Bearing retainer
34 Shim
35 Differential carrier

⊗ : Non-reusable parts

- **Assembly sequence**

Follow the disassembly sequence in reverse.

- **Inspection and adjustment after assembly** P27-39

CAUTION

- **Be sure when replacing any of the following parts to replace both it and its associated parts as a set :**
  - **For bolt 4, bearing cap 5 or differential carrier 35, replace the differential carrier set.**
  - **For final drive gear 10 or final drive pinion 28, replace the reduction gear set.**
  - **For differential case RH 13 and differential case LH 12, replace the differential case set.**
- **Make sure you keep left and right side bearings 6, 7 separate after removal, and be careful not to mix them up when installing them.**

NOTE

Write down the thickness of shim 34 and collar 24 when disassembling to use it as reference when assembly.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
6, 7	Starting torque of side bearing		1.96 to 2.94 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using adjusting screw • Tangential force at 152 mm {5.98 in.} point around outer periphery of differential case: 25.5 to 38.2 N {5.7 to 8.6 lbf, 2.6 to 3.9 kgf}
10	Wobble of rear surface of final drive gear		0.1 {0.0039} or less	—	• Adjust or replace along with the gear set • Measure the wobble at a point 132 mm {5.20 in.} (on the radius) away from the center of the final drive gear
10, 28	Backlash between final drive gear and final drive pinion		0.20 to 0.28 {0.0079 to 0.011}	0.50 {0.020}	Adjust or replace along with the gear set
15	Play in the rotating direction between axle shaft and differential gear spline		0.05 to 0.15 {0.0020 to 0.0059}	0.50 {0.020}	Replace
15, 17	Backlash between differential gear and differential pinion		0.15 to 0.20 {0.0059 to 0.0079}	0.50 {0.020}	Replace
17, 18	Clearance between differential pinion and pinion spider		[22] 0.17 to 0.27 {[0.87] 0.0067 to 0.011}	0.50 {0.020}	Replace
20	Starting torque of pinion bearing	New parts	1.96 to 2.94 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using collar • Tangential force at 114 mm {4.49 in.} point around outer periphery of bearing retainer: 34.3 to 51.9 N {7.7 to 12 lbf, 3.5 to 5.3 kgf}
		Reused parts	1.6 to 2.4 N·m {1.2 to 1.8 ft.lbs, 0.16 to 0.24 kgf·m}	—	• Adjust using collar • Tangential force at 114 mm {4.49 in.} point around outer periphery of bearing retainer: 27 to 41 N {6.2 to 9.3 lbf, 2.8 to 4.2 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	19.6 to 26.5 {14 to 20, 2.0 to 2.7}	—
4	Bolt (Bearing cap mounting)	201.00 {150, 20.50}	—
9	Bolt (Final drive gear and differential case LH mounting)	167 to 225 {120 to 165, 17 to 23}	—
11	Bolt (Differential case RH and differential case LH mounting)	83.3 to 112.7 {61 to 83, 8.5 to 11.5}	—
19	Bolt (Pinion assembly mounting)	66.6 to 90.2 {49 to 67, 6.8 to 9.2}	—
21	Lock nut (Companion flange mounting)	372.4 to 470.4 {275 to 345, 38 to 48}	—

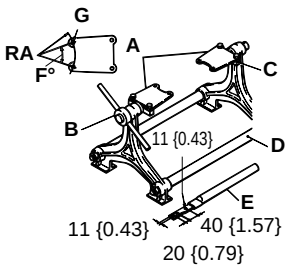
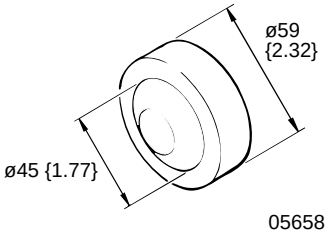
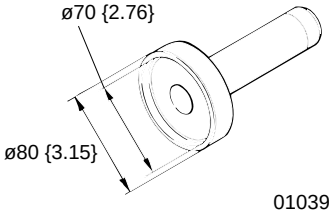
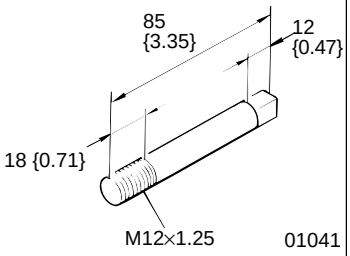
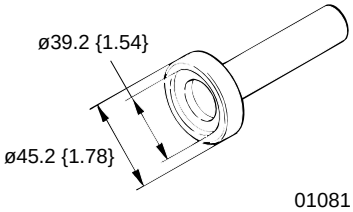
REDUCTION AND DIFFERENTIAL

Lubricant and sealant

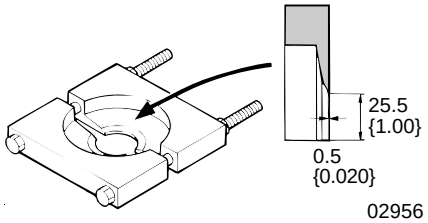
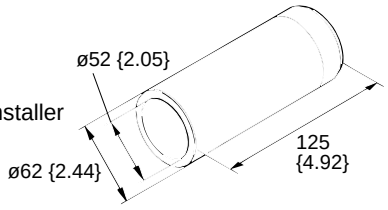
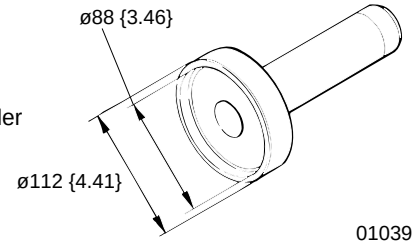
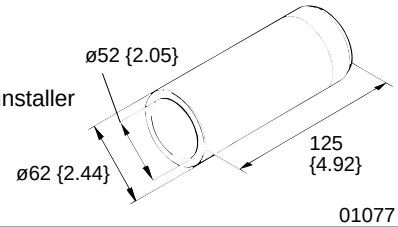
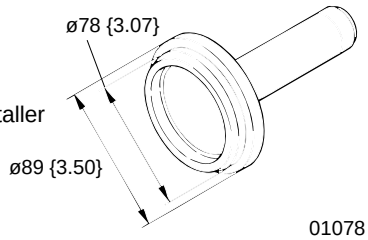
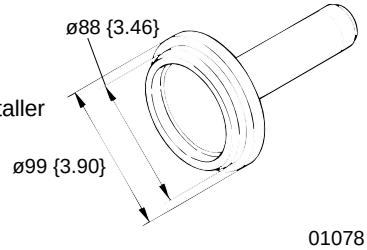
Location	Points of application	Kinds	Quantity
9, 11	Entire surface of bolt	Rust preventive	As required
10	Thread area of final drive gear	LOCTITE 271	As required
11	Thread area of bolt	LOCTITE 271	As required
29	Lip area of oil seal	Wheel bearing grease [NLG1 No.2 (Li soap)]	As required
35	Pinion pilot bearing mounting surface of differential carrier	LOCTITE 601	As required

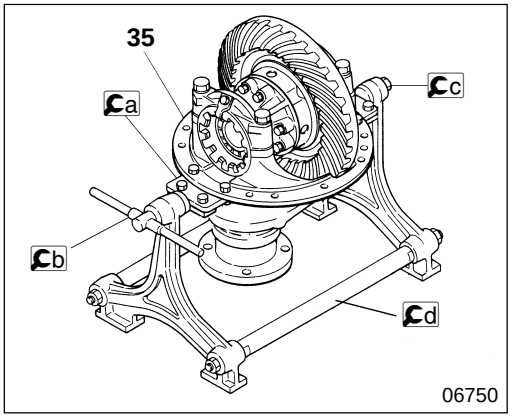
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Differential working base assembly **A** : Attachment **B** : Holder **C** : Holder **D** : Working base **E** : Flange stopper  05656	MB999034 **A** : MB999040 **B** : MB999036 **C** : MB999037 **D** : MB999035 **E** : MB999096	• Maintenance work bench for reduction and differential assembly • Flange stopper is used for installation and removal of the companion flange
7	Adaptor  05658	MB999076	Removal of side bearing inner race: Use in combination with available gear puller (General tool)
	Bearing installer  01039	MH061748	Press-fitting of side bearing inner race
20	Bearing retainer guide pin  01041	MH061745	Installation of pinion assembly: Use two
26	Pinion pilot bearing installer  01081	MH061976	Press-fitting of pinion pilot bearing

Unit : mm {in.}

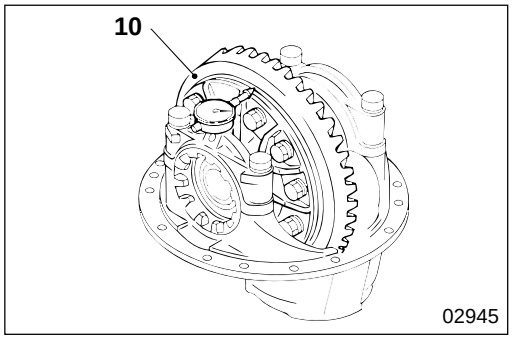
Location	Tool name and shape	Part No.	Application
27	Pinion rear bearing remover 	MB999045	Removal of rear bearing inner race
	Pinion bearing installer 	MH061005	Press-fitting of rear bearing inner race
29	Oil seal installer 	MH061750	Press-fitting of oil seal
30	Pinion bearing installer 	MH061005	Press-fitting of front bearing inner race
31	Pinion bearing installer 	MH061977	Press-fitting of front bearing outer race
32	Pinion bearing installer 	MH061264	Press-fitting of rear bearing outer race



◆ Service procedure

● **Work before disassembly**

Mount differential carrier **35** on a differential working base assembly.

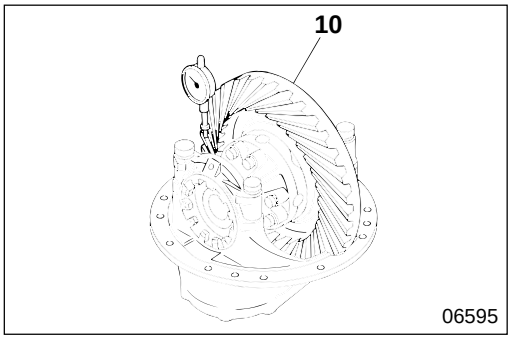


● **Inspection before disassembly**

Inspect for faulty parts before disassembly.

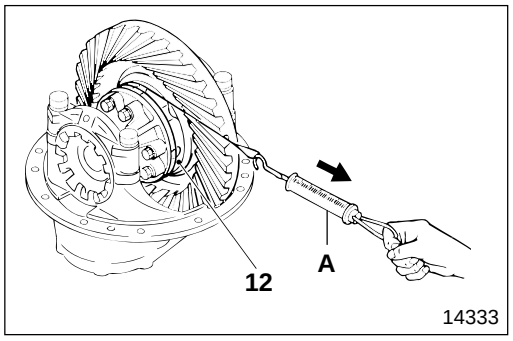
(1) Wobble of rear face of final drive gear

Measure wobble at a point 132 mm {5.20 in.} (on the radius) from the center of final drive gear **10**.



(2) Backlash of final drive gear and final drive pinion

Measure at three points on the circumference of final drive gear **10**.

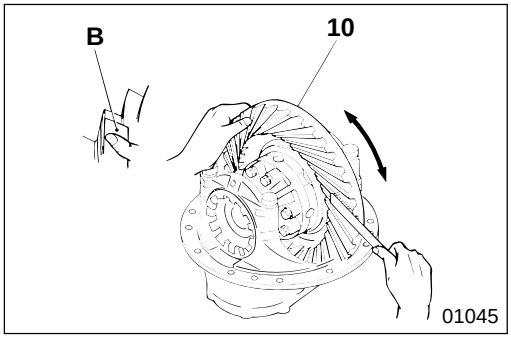


(3) Starting torque of side bearing

- Install spring balance **A** at 152 mm {5.98 in.} outer periphery point of differential case LH **12**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.

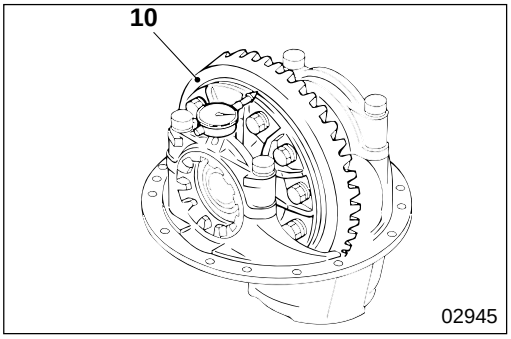
NOTE

Measure the starting torque within final drive gear 10 and final drive pinion 28 backlash range.



(4) Tooth contact of final drive gear

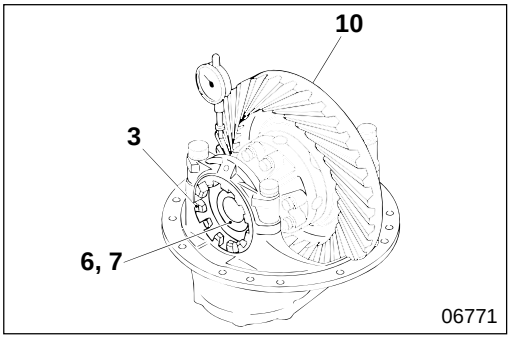
Apply red lead to three or four teeth of final drive gear **10**, examine tooth contact by turning the gears a few times.
B : Examine tooth contact using paper.



● **Inspection and adjustment after assembly**

(1) Inspection of wobble of back face of final drive gear

Measure wobble at a point 132 mm {5.20 in.} (on the radius) from the center of final drive gear **10**.



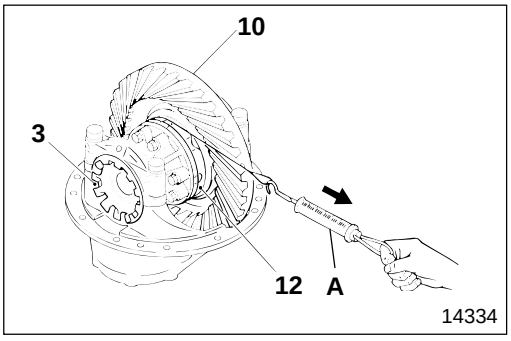
(2) Backlash of final drive gear and final drive pinion

[Adjustment]

- Adjust backlash using left and right adjusting screws **3** with the adjusted starting torques of side bearings **6**, **7** unchanged.
- Measure backlash at three points around the circumference of final drive gear **10**.

CAUTION

Make sure when you loosen one adjusting screw 3 that you tighten the other adjusting screw by the same amount, because the starting torque of the side bearings 6, 7 changes.



(3) Starting torque of side bearing

[Inspection]

- Install spring balance **A** at 152 mm {5.98 in.} outer periphery point of differential case LH **12**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

[Adjustment]

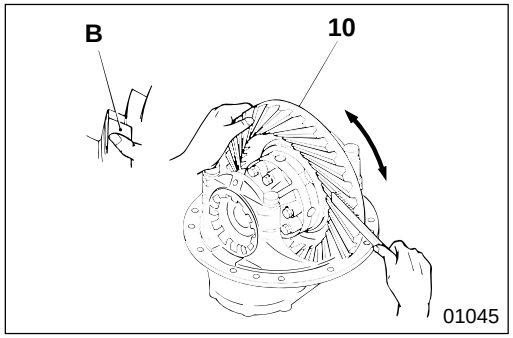
If the measured value deviates from the specified value, adjust it using left and right adjusting screws **3**.

CAUTION

Be sure to tighten left and right adjusting screws 3 by the same amount of pitch.

NOTE

Adjust the backlash to within the standard backlash of final drive gear 10 and final drive pinion 28.



(4) Tooth contact of final drive gear

[Inspection]

Apply red lead to three or four teeth of final drive gear **10**, examine tooth contact by turning the gears a few times.

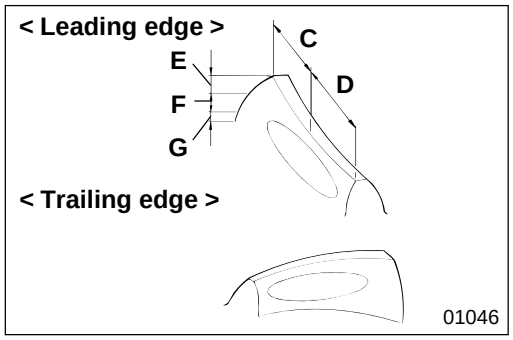
B : Examine tooth contact using paper.

[Adjustment]

If tooth contact has deteriorated, adjust by increasing or decreasing backlash and shim **34**.

CAUTION

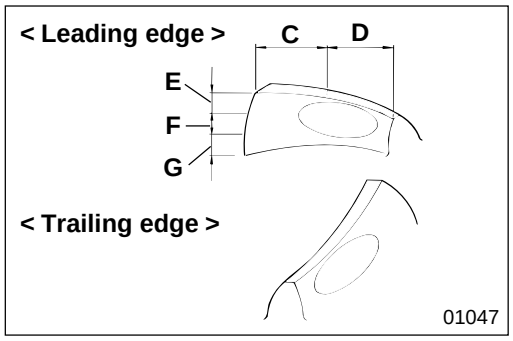
Be sure when replacing the gear because of abnormally worn teeth to replace the reduction gear set of final drive gear 10 and final drive pinion 28.



● **Normal tooth contact at no load**

< Final drive gear >

C : Heel
D : Toe
E : Face
F : Flank
G : Clearance



< Final drive pinion >

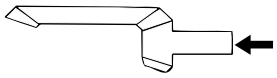
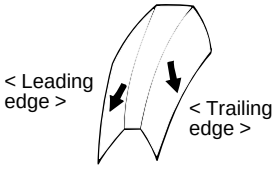
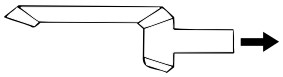
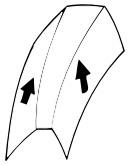
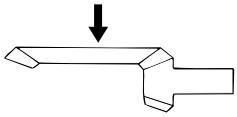
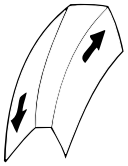
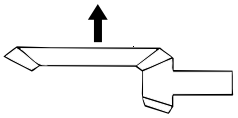
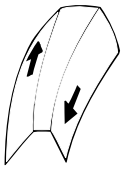
C : Heel
D : Toe
E : Face
F : Flank
G : Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center towards edge
		Vertical direction	From center towards top of tooth for final drive gear and center for final drive pinion
	Tooth contact shape	Length	Approximately 50 to 70% of tooth width
		Width	Approximately 50 to 70% of tooth depth
	Degree of tooth contact		It becomes weaker as it nears tooth root or tooth tip

NOTE

When tooth contact is near the toe at no load it becomes middle area contact at load.

Adjustment of tooth contact

	Method of adjustment	Moving direction
Adjustment by adding or reducing shims	Advance final drive pinion to final drive gear (Shims are reduced) 	 Tooth contact moves towards tooth root
	Retard final drive pinion from final drive gear (Shims are added) 	 Tooth contact moves towards tooth tip
Adjustment using adjusting screw	Advance final drive gear to final drive pinion center (Less backlash) 	 Tooth contact moves in lengthwise direction of tooth Leading edge : Nearer to toe and slightly nearer to root of tooth Trailing edge : Nearer to heel and slightly nearer to top of tooth
	Retard final drive gear from final drive pinion center (More backlash) 	 Tooth contact moves in lengthwise direction of tooth Leading edge : Nearer to heel and slightly nearer to top of tooth Trailing edge : Nearer to toe and slightly nearer to root of tooth

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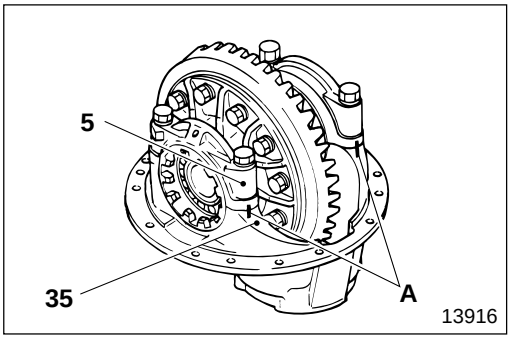
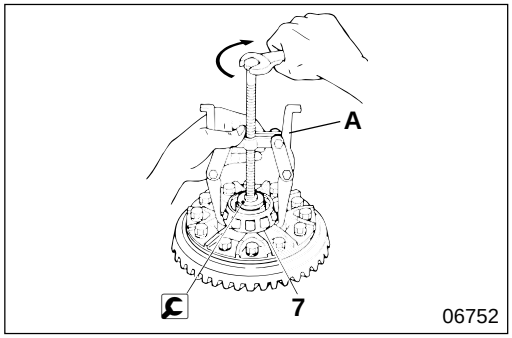


13916

5 Removal of bearing cap

Put alignment marks **A** on bearing cap **5** and differential carrier **35** to distinguish left and right.



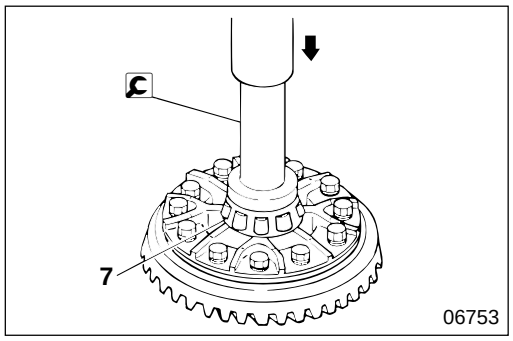
7 **Side bearing inner race**

[Removal]

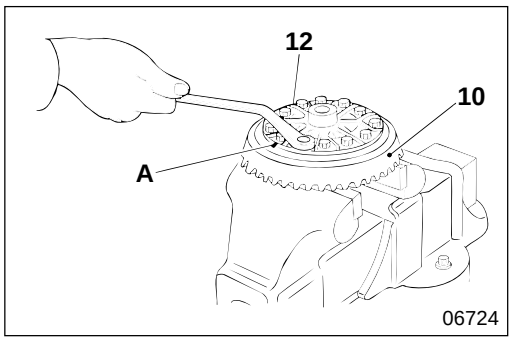
A : Gear puller (General tool)

NOTE

Make sure you keep left and right side bearings 6, 7 separate after removal, and be careful not to mix them up when installing them.



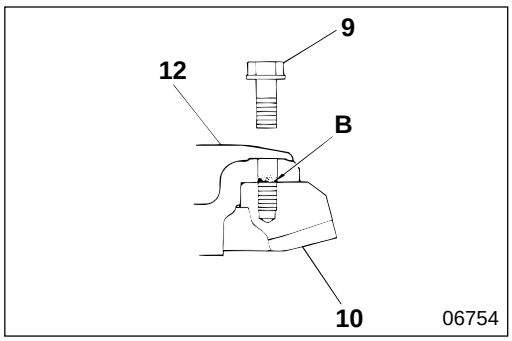
[Installation]



10 **12** **Final drive gear and differential case LH**

[Removal]

Put alignment marks **A** on final drive gear **10** and differential case LH **12**.

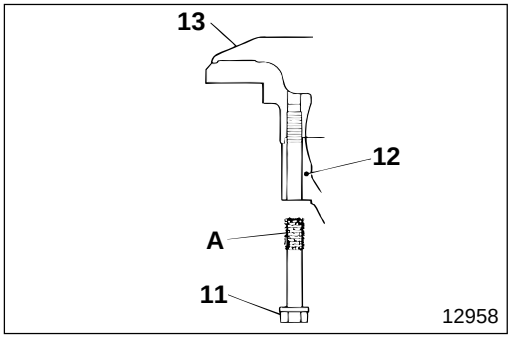


[Installation]

- Apply rust preventive to the entire surface of bolts **9**.
- Apply lock paint to the threads of all bolt holes **B** of final drive gear **10**.
- Tighten bolts **9** at specified torque.

CAUTION

- **Be sure to apply rust preventive because of the need to tighten bolt 9 at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

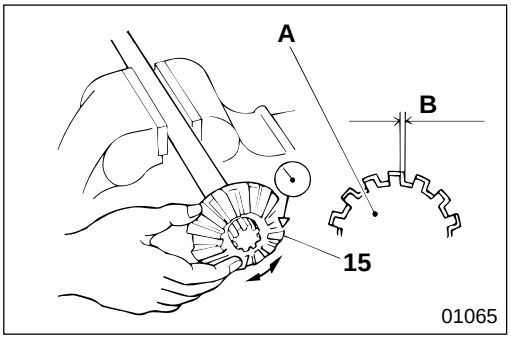


12 **13** **Installation of differential case RH and differential case LH**

- Apply rust preventive to the entire surface of bolts **11**.
- Apply lock paint to thread area **A** of bolts **11**.
- Tighten bolts **11** at specified torque.

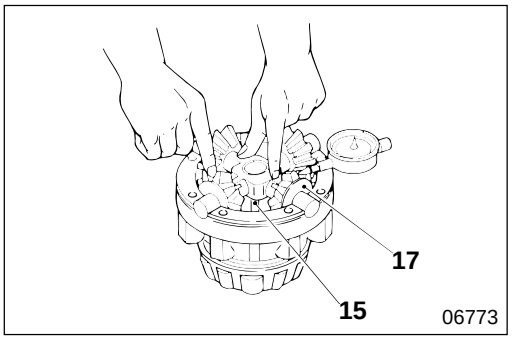
CAUTION

- **Be sure to apply rust preventive because of the need to tighten bolts 11 at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

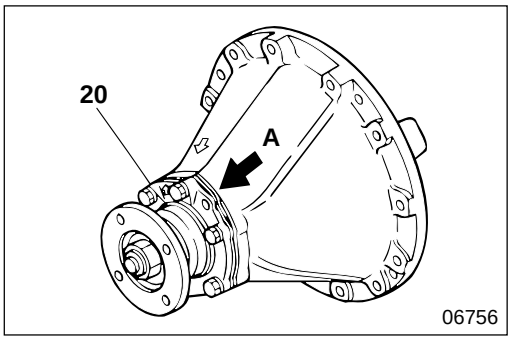


15 **Play between differential gear and axle shaft spline area in the rotating direction**

If the measured value is higher than the limit, replace the faulty parts.
A : Axle shaft
B : Play

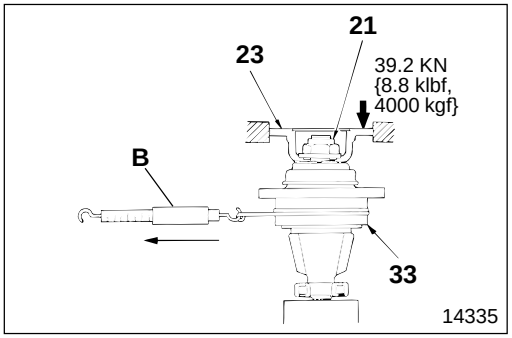


15 **17** **Backlash between differential gear and differential pinion**



20 **Pinion assembly**

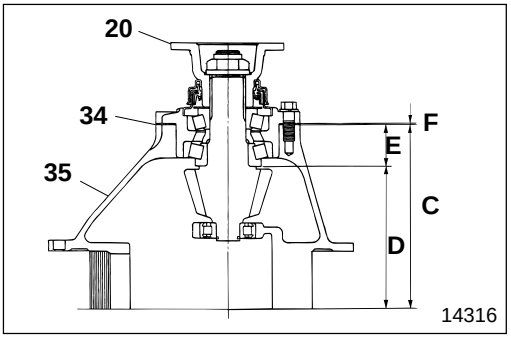
[Removal]
Screw M12×1.25 mm bolts into two holes **A** provided for removing pinion assembly **20**, then tighten bolts uniformly until the pinion assembly is removed.



[Inspection of starting torque after installation]
- Apply load of approximately 39.2 kN {8.8 klbf, 4000 kgf} to companion flange **23** or tighten lock nut **21** at specified torque.
- Install spring balance **B** at 114 mm {4.49 in.} outer periphery point of bearing retainer **33**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

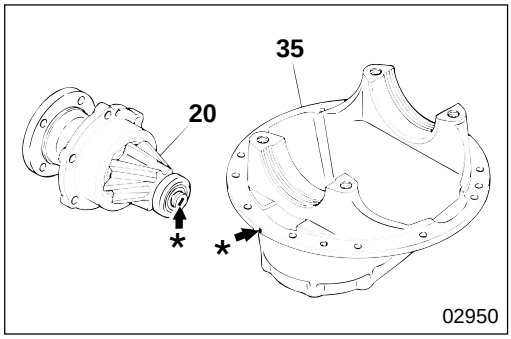
NOTE
- **Be sure to secure companion flange 23 before measurement.**
- **Be sure to remove oil seal 29 before measurement.**

[Adjustment of starting torque]
If the measured value deviates from the specified value, replace collar **24** so that the tangential force conforms to the standard value.
Collar thicknesses :
15.600 to 16.200 mm {0.61 to 0.64 in.} (25 thicknesses available in 0.025 mm {0.00098 in.} increments)



[Adjustment when installing]
- Carry out the following procedure so that **C**, **D** and **E** conform to the standard dimension.
- Calculate shim thickness **F** according to the following formula based upon the machining error data stamped on pinion assembly **20** and differential carrier **35**.
  Formula for calculation:
  F = 0.5 {0.020}–b+c+d

  c : Deviation from basic dimension **C**
  d : Deviation from basic dimension **D**
  e : Deviation from basic dimension **E**



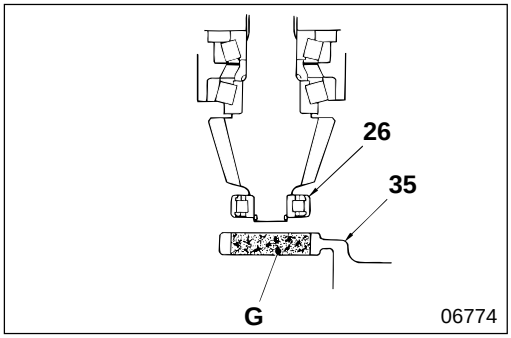
Unit : mm {in.}

Location	Standard dimension	How to calculate deviation
Shim thickness	0.5 {0.020}	—
C	203 {7.99}	The basic dimension, multiplied by 100, is stamped on the periphery of differential carrier **35** flange
D	157 {0.18}	The basic dimension is stamped on the top of pinion assembly **20**
E	46.5 {1.8}	Measure the deviation from **E** using a dial gauge. However, if it is difficult to measure the actual deviation, assume a value from 0 to 0.2 {0 to 0.0079}

***** : Stamped number position

NOTE
Thickness is stamped in millimeters.

- Select shim **34** from shim thickness **F**.
  Available thicknesses of shim **34** : 0.1 mm {0.0039 in.} and 0.2 mm {0.0079 in.}

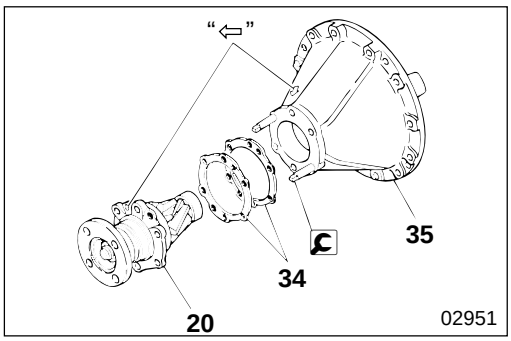


[Installation]

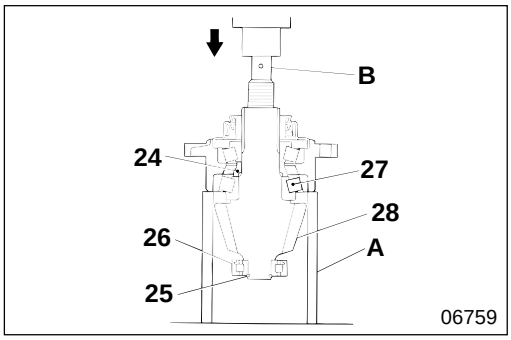
- Apply lock paint to entire mounting surface **G** of pinion pilot bearing **26** of differential carrier **35**.

CAUTION

- **Be sure to let the lock paint harden undisturbed for 30 minutes to two hours after installation.**
- **Be sure to wait at least three hours before running the vehicle, and if possible wait 24 hours to let the lock paint harden.**

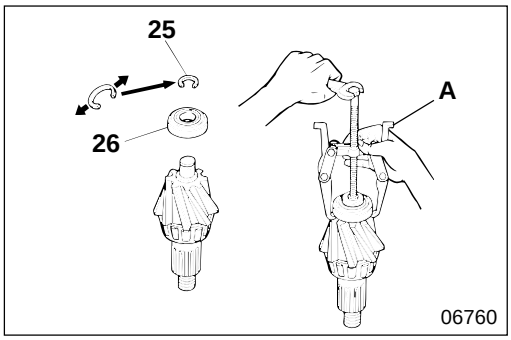


- Assemble differential carrier **35** and pinion assembly **20** with their alignment marks "⇦" aligned.



20 **Removal of pinion assembly**

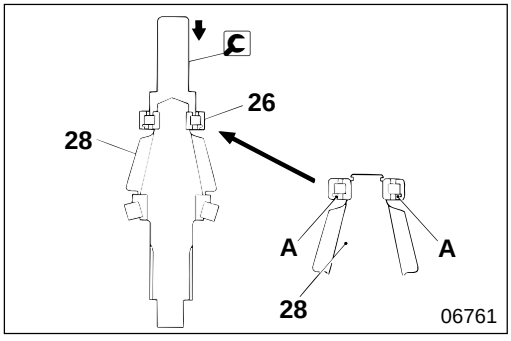
Using an appropriate cylinder **A** and press **B**, remove collar **24**, lock ring **25**, pinion pilot bearing **26**, rear bearing inner race **27**, and final drive pinion **28** together.



25 **26** **Lock ring and pinion pilot bearing**

[Removal]

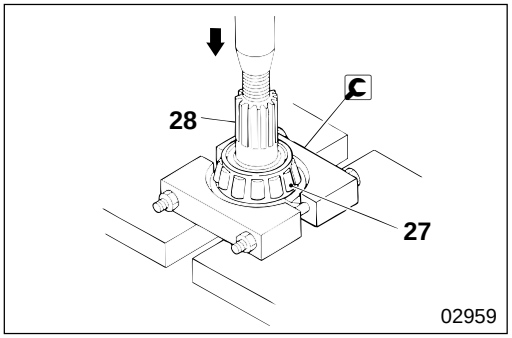
A : Gear puller (General tool)



[Installation]

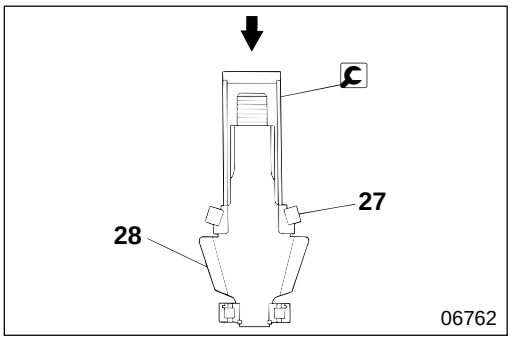
Press-fit pinion pilot bearing **26** in the direction as illustrated.

A : Lock ring

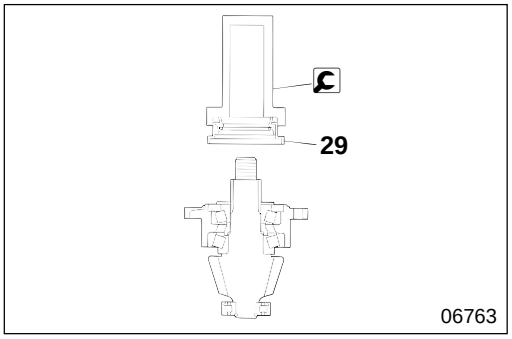


27 **Rear bearing inner race**

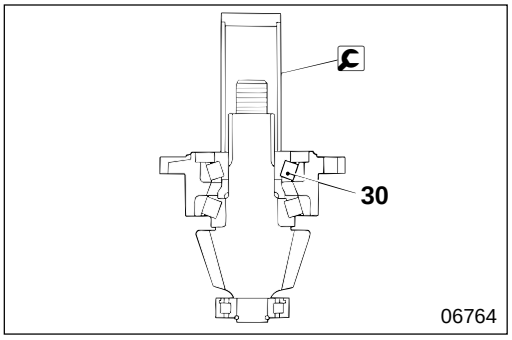
[Removal]



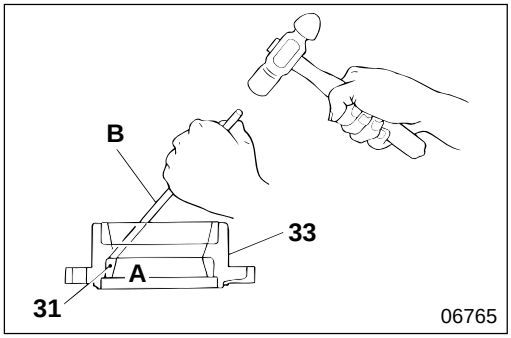
[Installation]



29 **Installation of oil seal**

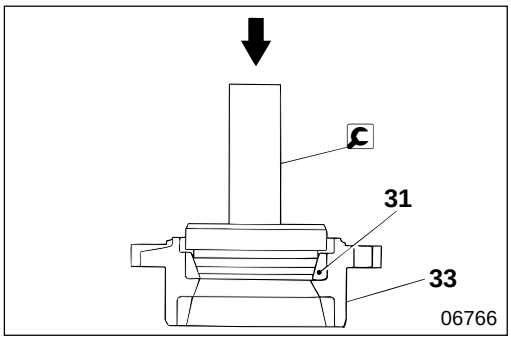


30 **Installation of front bearing inner race**

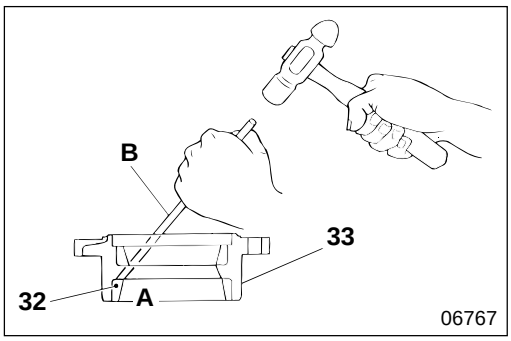


31 **Front bearing outer race**

[Removal]
Drive out front bearing outer race **31** evenly from three indented parts **A** in bearing retainer **33**.
B : Pin-punch

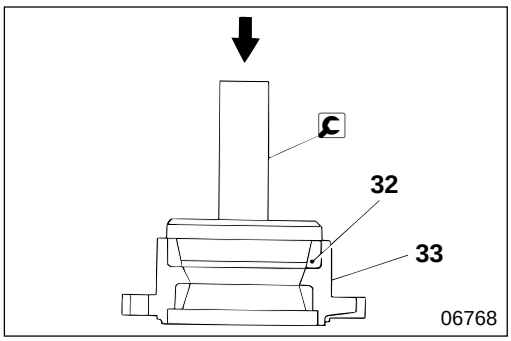


[Installation]



32 **Rear bearing outer race**

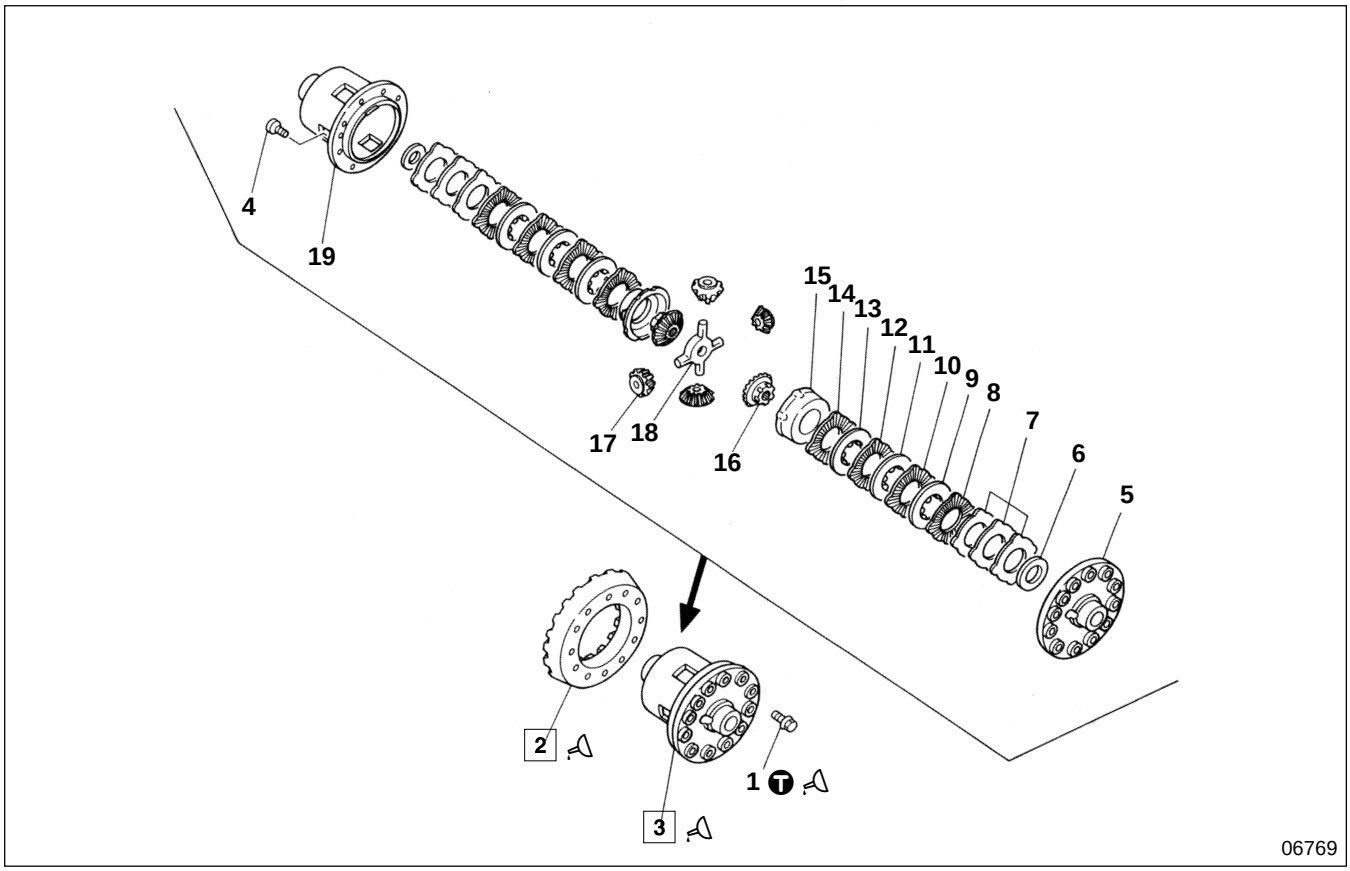
[Removal]
Drive out rear bearing outer race **32** evenly from three indented parts **A** in bearing retainer **33**.
B : Pin-punch



[Installation]

MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY

DISASSEMBLY AND ASSEMBLY



● **Disassembly sequence**

1 Bolt
2 Final drive gear
3 Multiplate limited slip differential assembly
4 Screw
5 Differential case, LH
6 Thrust washer
7 Spring plate
8 Friction plate
9 Friction disc
10 Friction plate
11 Friction disc
12 Friction plate
13 Friction disc
14 Friction plate
15 Pressure ring
16 Side gear
17 Differential pinion
18 Pinion shaft
19 Differential case, RH

NOTE

Clean the disassembled parts using washing oil and dry by blowing with compressed air.

● **Assembly sequence**

19→6→7→8→9→10→11→12→13→14→15→16→5→4→3→2→1
17→18

NOTE

Apply the specified type of gear oil to each part before assembly, paying particular attention to contact and sliding surfaces.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Rotation torque of multiplate limited slip differential assembly	When putting in a new clutch plate	201 to 295 N·m {150 to 215 ft.lbs, 20.5 to 30 kgf·m}	—	Inspect internal parts and replace faulty parts
		When putting in a used clutch plate	117 to 295 N·m {86 to 218 ft.lbs, 12 to 30 kgf·m}	—	
6, **15 to 18**	Variation of tolerance in vertical direction from back face of pressure ring to end face of thrust washer		0 to 0.05 {0 to 0.0020}	—	Adjust (Replace the thrust washer)
8 to 14	Deformed friction disc and friction plate		—	0.08 {0.0032}	Replace
	Wear of friction disc and friction plate		—	0.1 {0.0039}	Replace
	Difference in thickness between the left and right combinations of friction disc and friction plate		—	0 to 0.05 {0 to 0.0020}	Adjust Change the combination)
—	Side gear clearance in axial direction		0.05 to 0.20 {0.0020 to 0.0079}	—	Adjust (Replace the thrust washer)
—	Differential case clearance in axial direction		0.05 to 0.20 {0.0020 to 0.0079}	—	Adjust (Replace the thrust washer)

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

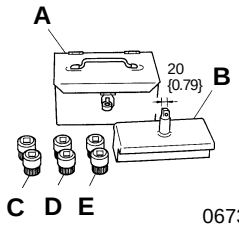
Location	Location tightened	Tightening torque	Remarks
1	Bolt (Final drive gear and differential case, LH mounting)	165 to 225 {120 to 165, 17 to 23}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
1	Entire surface of bolt	Rust preventive	As required
2	Thread area of final drive gear	LOCTITE271	As required
3	Components of multiplate slip differential assembly	Limited slip differential oil API GL-5 SAE90	As required

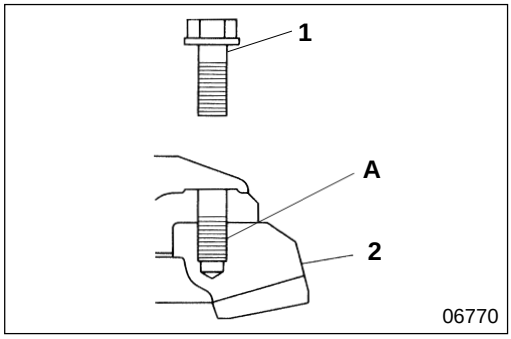
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Side gear holding tool set **A** : Gauge case **B** : Side gear holding base **C** : Side gear holding tool (outer diameter : 42) **D** : Side gear holding tool **E** : Side gear holding tool 	MB999140 **A**: MB990551 **B**: MB999141 **C**: MB999142 (D033H) **D**: MH063422 **E**: MH063423	Measurement of multiplate slip differential assembly clutch plate rotation torque

MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY

◆ Service procedure

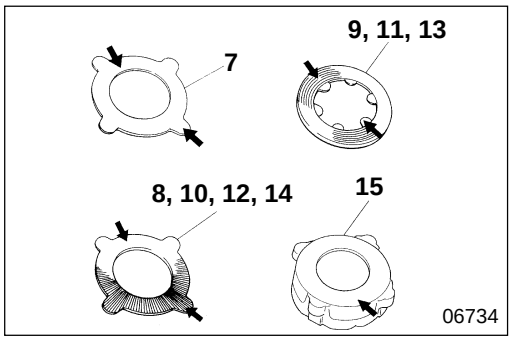


2 Installation of final drive gear

- Apply rust preventive to the entire surface of bolts **1**.
- Apply lock paint to the threads area **A** of all the bolt holes of final drive gear **2**.
- Tighten boltes **1** at specified torque.

CAUTION

- **Be sure to let bolts 1 harden for at least an hour, after installation, before driving.**
- **Furthermore, be sure to let bolts 1 harden for at least four hours before running at full torque.**



3 Multiplate limited slip differential assembly

[Inspection of contact and sliding surfaces]

- Inspect spring plates **7**, friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13** and replace if the friction surface or sliding surface shows extreme wear or heat discoloration.

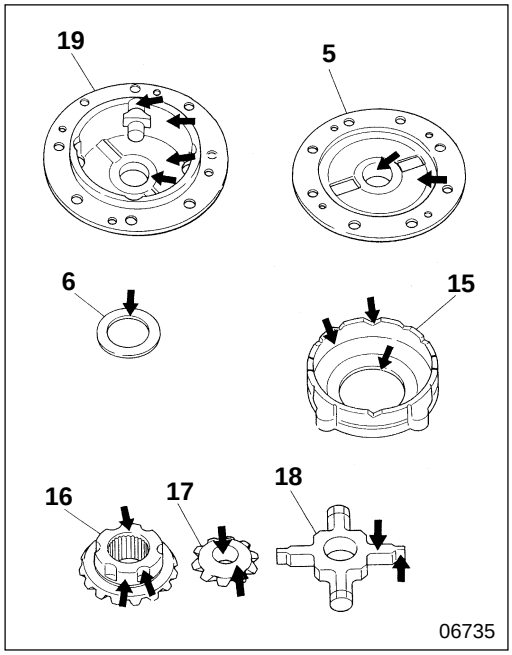
NOTE

The hardened area on the inner periphery of the friction surfaces of plates and discs 7 to 14 is due to the force exerted by the springs and should not be mistaken for abnormal wear.

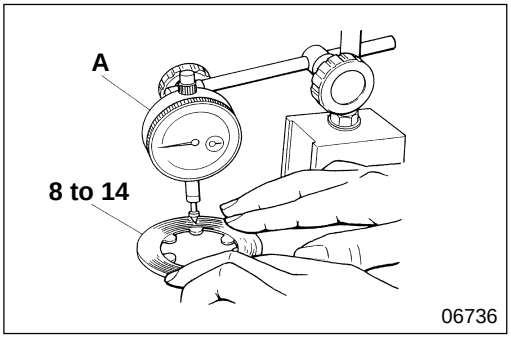
- Replace spring plates, friction discs and friction plates **7** to **14** if their protruding areas have cracks or are damaged.
- If there are nicks or marred areas on the friction and sliding surfaces of pressure rings **15** and friction plates **14**, remove using an oil stone and then fit and correct on the base using compound.

NOTE

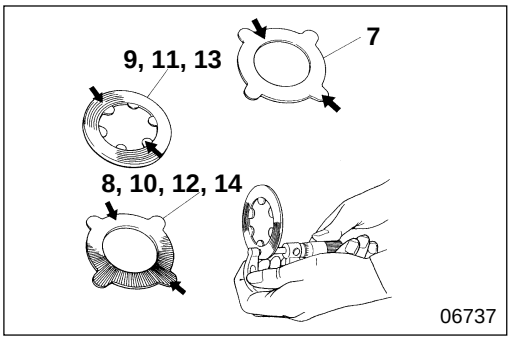
The hardened area on the inner periphery of the friction surfaces of plates and discs 7 to 14 is due to the force exerted by springs and should not be mistaken for abnormal wear.



- Inspect the contact and sliding parts (⬅) of differential case LH **5**, thrust washer **6**, pressure ring **15**, side gear **16**, differential pinion **17**, pinion shaft **18**, and differential case RH **19**. If there are nicks or marred areas, remove using an oil stone.



[Inspection for deformation]
Check friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13** for deformation by mounting dial gauge **A** on a base and rotating the plate or disc and measuring its flatness.

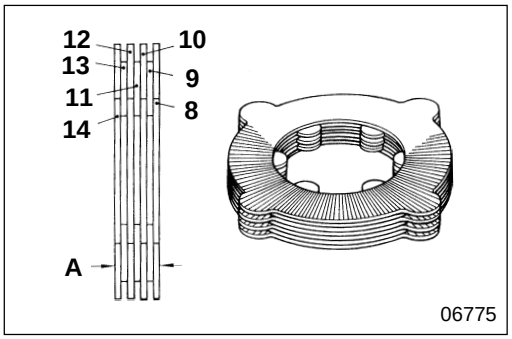


[Measurement of thickness]
Measure the thickness of the friction surfaces and the protruding parts (⬅) of spring plates **7**, friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13**. If the measured values deviate from the limit, replace the faulty parts.

NOTE

Measure several locations on each part.

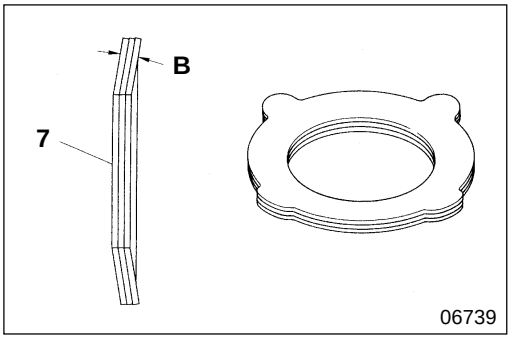
[Work before assembly]
In order to adjust the tolerance in the axial direction when the internal parts of differential cases LH **5** and RH **19** are inserted (clutch plates **7** to **14** friction force) and the tolerance in the axial direction of side gear **16** follow the procedure below.



- Put friction plates **8**, **10**, **12**, **14** and friction discs **9**, **11**, **13** one on top of the other as illustrated. Using a micrometer measure thickness **A**, and by selecting the right combination of plates and discs for each set, make sure the difference in thickness between the left and right sets conforms to the standard value.

NOTE

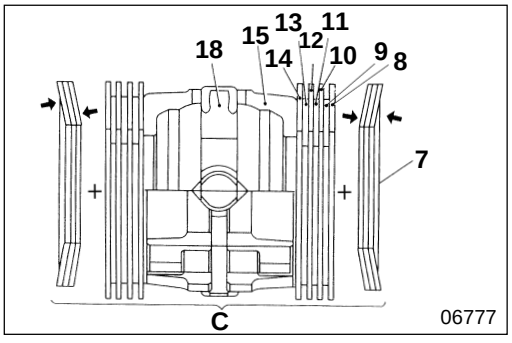
When using new parts, keep in mind that friction plates 8, 10, 12, 14 come in one size, 2.0 mm {0.0079 in.} and friction discs 9, 11, 13 in three sizes, 1.9 mm {0.075 in.}, 2.0 mm {0.079 in.} and 2.1 mm {0.083 in.}.



- Put spring plates **7** one on top of the other as illustrated. Using a micrometer measure thickness **B** and by selecting the right combination of plates for each set, make sure the difference in thickness between the left and right sets is minimal.

NOTE

When replacing spring plates 7 with new ones, the plate thickness is 2.0 mm {0.079 in.}.

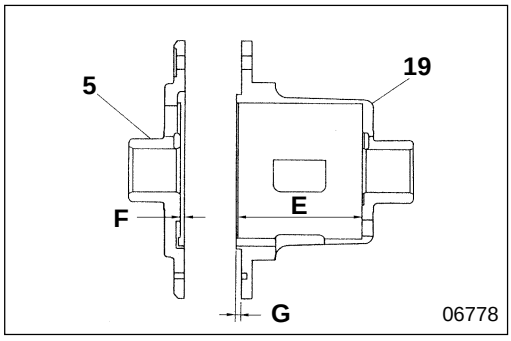


- Assemble pressure rings **15**, pinion shaft **18**, the friction discs, the friction plates and spring plates **7** to **14** and measure total width **C** using a micrometer.

NOTE

When measuring, press down both ends of pressure ring 15 to make sure its V-shaped groove is properly mated with pinion shaft 18.

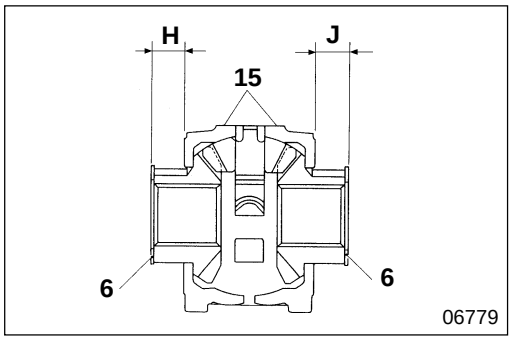
MULTIPLATE LIMITED SLIP DIFFERENTIAL ASSEMBLY



- Calculate dimension **D** between the surfaces of differential cases LH **5** and RH **19** which come in contact with spring plate **7** when the two cases are assembled.
  D = E + F – G
- If the above mentioned total width **C** and clearance **(D – C)** between differential cases LH **5** and RH **19** deviate from the standard value, adjust by changing friction discs **9**, **11**, **13**.

NOTE

When using new friction discs 9, 11, 13, keep in mind that there are three different sizes, 1.9 mm {0.075 in.}, 2.0 mm {0.079 in.} and 2.1 mm {0.083 in.}.



- Install thrust washers **6** as illustrated. Make sure the difference between dimensions **H** and **J** from the back face of pressure ring **15** to the end face of thrust washer on either side conforms to the standard value.

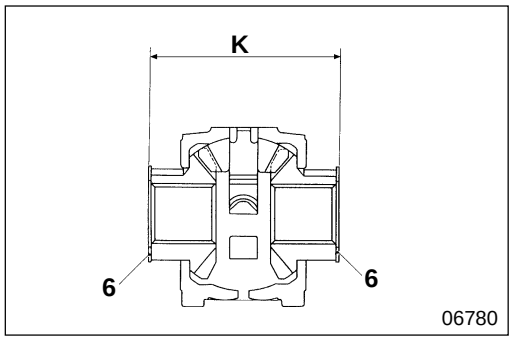
NOTE

When measuring press down both ends of pressure ring 15 to make sure its V-shaped groove is in full contact with pinion shaft 18.

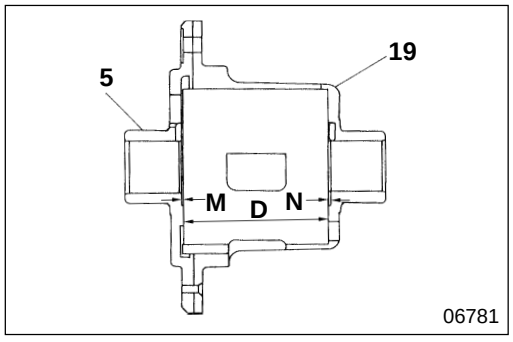
- If the variation of tolerance deviates from the standard value, adjust by changing thrust washers **6**.

NOTE

When using new thrust washers 6 keep in mind that there are three different sizes, 1.50 mm {0.059 in.}, 1.60 mm {0.063 in.} and 1.70 mm {0.067 in.}.



- Measure total width **K**.



- Calculate dimension **L** between the surfaces of differential cases LH **5** and RH **19** that come in contact with thrust washers **6** when the two cases are assembled.
  L = D + M + N

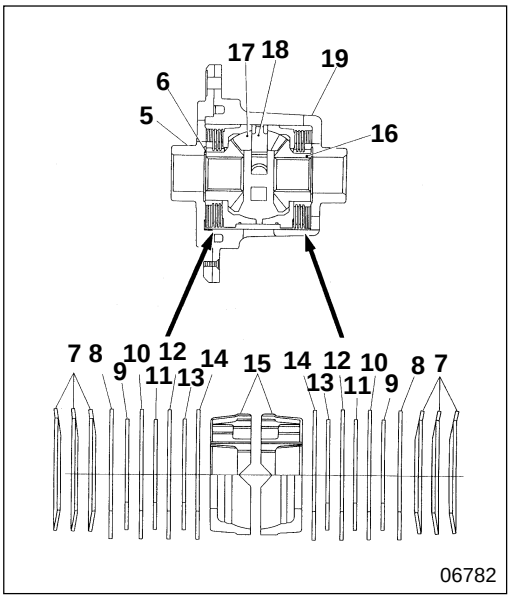
NOTE

Dimension D is the dimension between the surfaces of differential cases LH 5 and RH 19 that come in contact with spring plate 7 when the two cases are assembled and was calculated above.

- Make sure that side gear **16** clearance in the axial direction **(L – K)** conforms to the standard value. If the measured value deviates from the standard value, adjust by replacing thrust washers **6**.

NOTE

- **Select thrust washers 6 so that the difference in dimension between the left and right sides from the back face of pressure ring 15 to the end face of thrust washers conforms to the standard value.**
- **When using new thrust washers keep in mind that there are three sizes, 1.50 mm {0.059 in.}, 1.60 mm {0.063 in.} and 1.70 mm {0.067 in.}.**

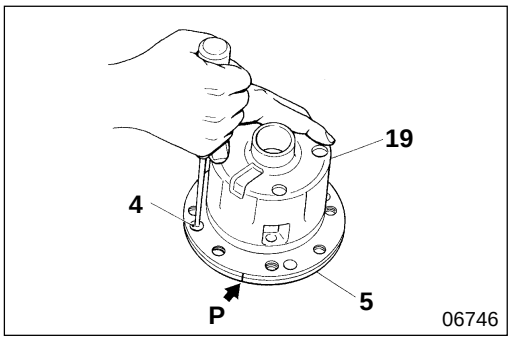


[Assembly]

Assemble the different parts in differential case RH **19** in the direction as illustrated.

CAUTION

- **Make sure that friction plates 8, 10, 12, 14 and friction discs 9, 11, 13 are installed in the correct order and that spring plate 7 is assembled in the correct direction.**
- **Apply the specified gear oil to each of the parts before assembly. Special attention should be given to applying oil to the contact and sliding surfaces.**

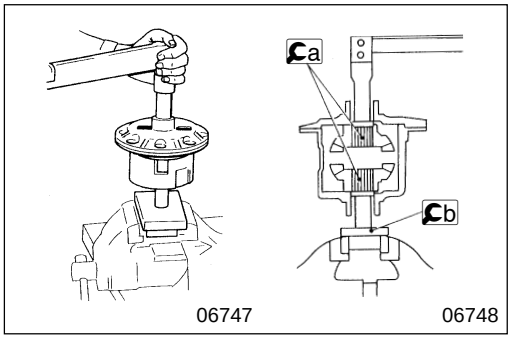


[Tightening of screws]

Align alignment marks **P** (identical Arabian numerals) on differential cases LH **5** and RH **19** and gradually tighten screws **4** evenly in diagonal order.

CAUTION

If differential cases LH 5 and RH 19 are not joined firmly even when screws 4 have been tightened, it may be because thrust washers 6 or spring plates 7 are not properly assembled and they should be reassembled.



[Measurement of rotational torque]

In order to verify the friction force of clutch plates **7** to **14** after assembly, use a side gear holding tool and b side gear holding base to measure the rotation torque and make sure it conforms to the standard value.

NOTE

When measuring the rotation torque, rotate the gear and measure after the rotation has reached a sufficiently steady pace.

MITSUBISHI
FUSO

Group 31
Wheel and Tire

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-31

INDEX

SPECIFICATIONS 31-2

TROUBLESHOOTING 31-2

WHEEL AND TIRE 31-3

SPECIFICATIONS/TROUBLESHOOTING

SPECIFICATIONS

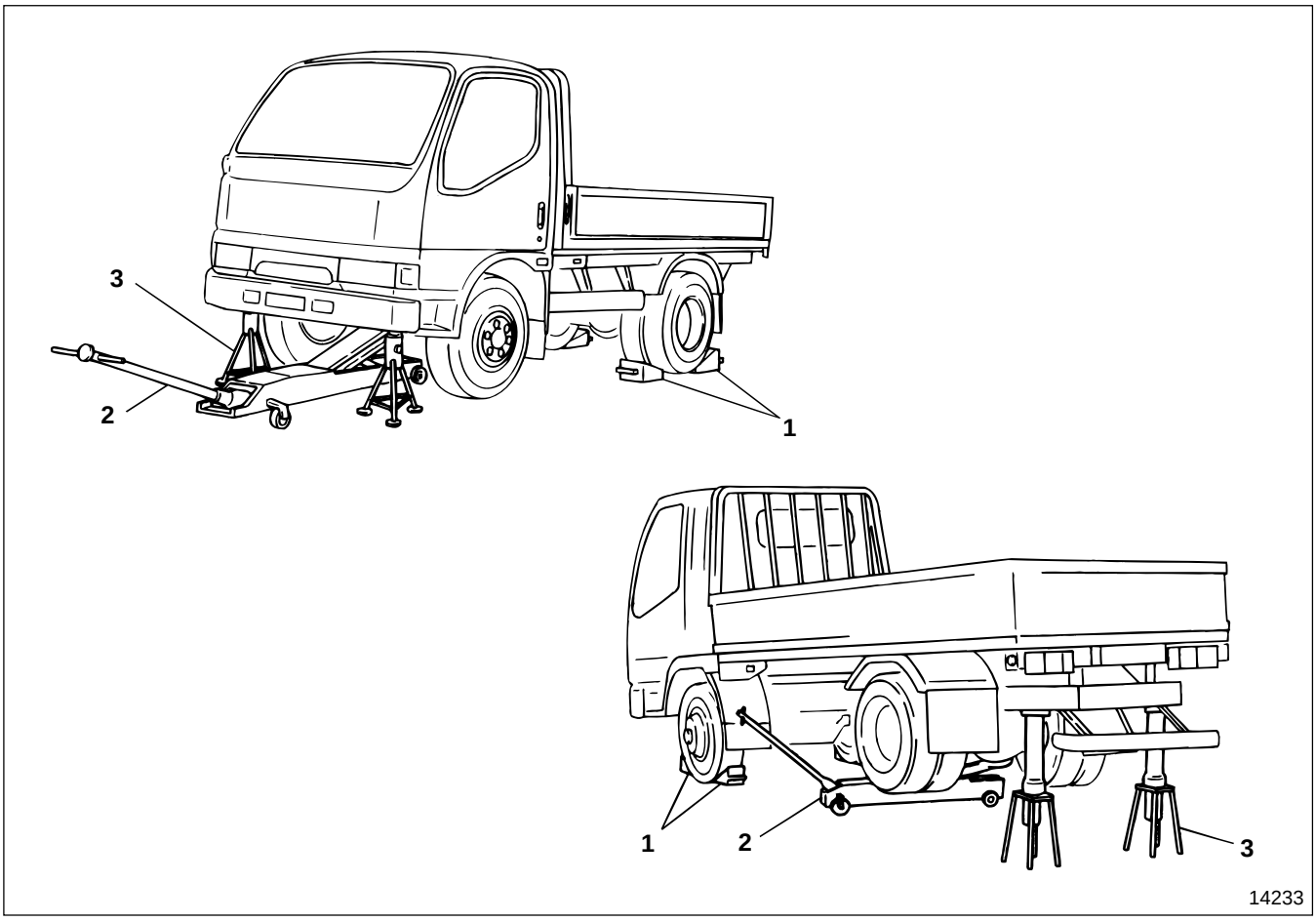
Item / Vehicle model	Tire size	Air pressure kPa {psi, kgf/cm²}		Application wheel
		Front	Rear	
FE639 (GVWR : 11600 lb, 5260 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}	16×6K-127-9 (wheel with 5 studs)
FE639 (GVWR : 13500 lb, 6120 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}	16×6K-127-9 (Wheel with 6 studs)
FE64□ (GVWR : 14500 lb, 6580 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}	16×6K-127-9 (wheel with 6 studs)
FE649 (GVWR : 14050 lb, 6375 kg)	215/85R16(E)	550 {80, 5.50}	550 {80, 5.50}	16×6K-127-9 (wheel with 6 studs)
FG639 (GVWR : 12000 lb, 5445 kg)	7.50R16(E)	550 {80, 5.50}	550 {80, 5.50}	16×6K-127-9 (wheel with 5 studs)
FG649 (GVWR : 14050 lb, 6375 kg)	235/85R16(E)	550 {80, 5.50}	550 {80, 5.50}	16×6K-135-9 (wheel with 6 studs)

GVWR : Gross vehicle weight rating

TROUBLESHOOTING

Possible causes / Symptoms			Tire tread worn										Remarks
			Both shoulders worn	Center worn	Outside worn	Inside worn	Feather-edged wear from outside to inside	Feather-edged wear from inside to outside	Wavy wear	Dished wear (one or more spots)	Pitted wear (dented) all around	Jagged wear	
Overloading			○										
Tire air pressure		Insufficient	○						○	○	○	○	
		Excessive		○									
Wheel alignment	Toe-in	Excessive			○		○						
Gr 26A, B		Insufficient				○							
	Camber	Excessive			○								
		Insufficient				○							
	Toe-out excessive					○		○					
	Overall misalignment		○		○	○	○	○	○	○	○		
Knuckle arm bent					○	○	○	○					Gr 26A, B
Left and right tie rod lengths different							○						Gr 26A, B
Wheel balance incorrect									○	○	○	○	
Wheel bearing loose									○	○	○	○	Gr 26A, B, 27
Ball joint loose										○			Gr 26A, B
Tie rod end loose										○			Gr 37
Brake drum eccentric										○	○		Gr 35A
Axle bent									○	○			Gr 26A, B, 27
Sudden starting, sudden braking or sharp turn										○	○		
Left and right front wheel turning radius incorrect												○	Gr 26A, B
Road surface influence					○	○							

Work for Removal and Installation of Wheel and Tire



● **Work sequence**

1 Place wheel chocks.
2 Jack up the front or rear axle using a garage jack placed under the center of the axle.
3 Support the frame on jack stands.

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on jack stands.**
- **Leave the garage jack and stands in place until the entire operation is completed. Never remove them during the operation.**

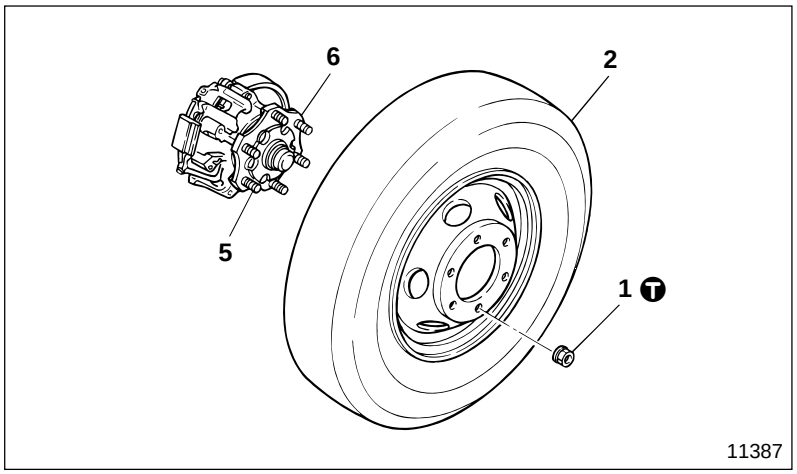
● **Work sequence after removal and installation**

Follow the work sequence in reverse.

NOTE

Use right-hand threaded wheel nuts marked “R” for right side wheel and left-hand threaded wheel nuts marked “L” for left side wheel.

< Single tire >



● **Removal sequence**

1 Wheel nut
2 Tire assembly P31-5
5 Hub bolt
6 Hub

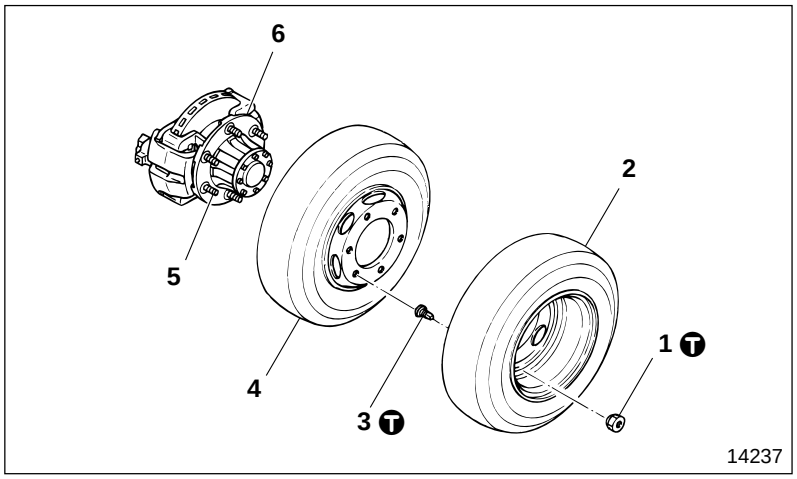
● **Cleaning before installation**

P31-4

● **Installation sequence**

Follow the removal sequence in reverse.

< Double tire >



● **Removal sequence**

1 Wheel nut (outer)
2 Tire assembly P31-5
3 Wheel nut (inner)
4 Tire assembly P31-5
5 Hub bolt
6 Hub

● **Cleaning before installation**

P31-4

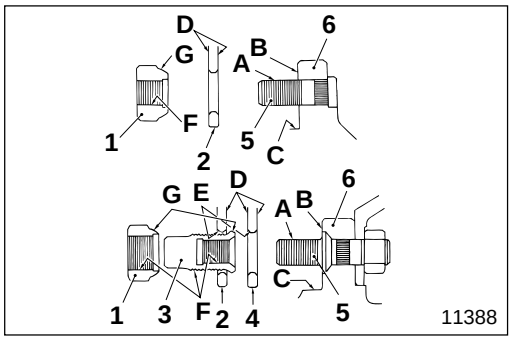
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3	Wheel nut	490±49 {360±36, 50±5}	—



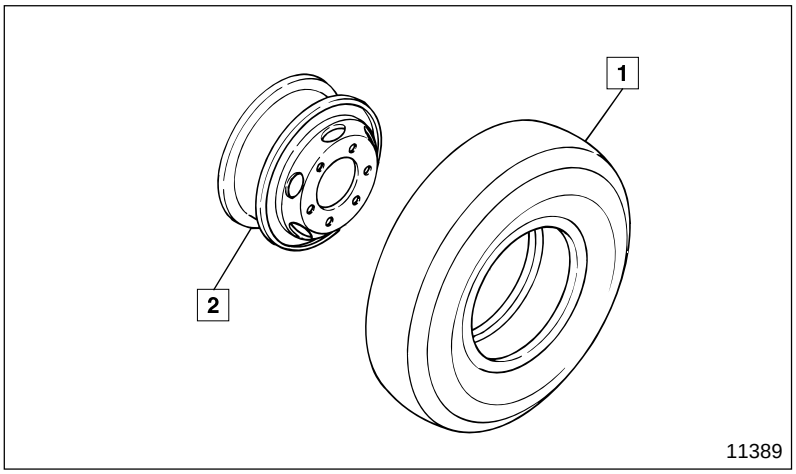
◆ Service procedure

● **Cleaning before installation**

To prevent wheel nuts **1** and **3** and hub bolt **5** from becoming loose and to prevent mounting parts (tire assemblies **2** and **4** and hub **6**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:

A : Hub bolt thread area
B : Wheel mounting surface of hub
C : Wheel alignment area of hub
D : Disc wheel mating surface
E : Disc wheel nut mounting surface
F : Wheel nut thread area
G : Wheel nut spherical area

Tire Assembly



● **Disassembly sequence**

1 Tire
2 Disc wheel

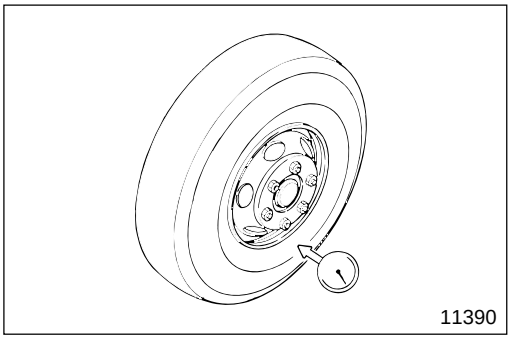
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

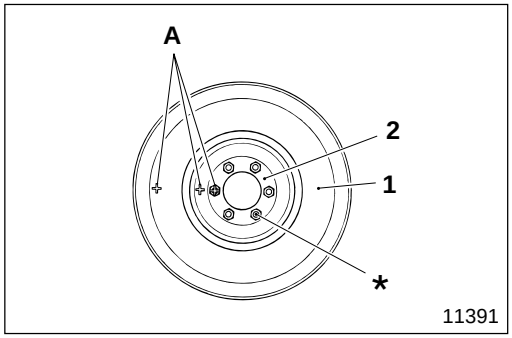
Location	Maintenance item		Standard value	Limit	Remedy
1	Horizontal deflection of tire (When assembled)		3.5 {0.14} or less	—	—
2	Disc wheel (wheel with 5 studs)	Flatness	0.4 {0.016} or less	—	—
		Horizontal deflection	1.5 {0.059} or less	—	—
		Vertical deflection	1.5 {0.059} or less	—	—
	Disc wheel (wheel with 6 studs)	Flatness	0.3 {0.012} or less	—	—
		Horizontal deflection	1.5 {0.059} or less	—	—
		Vertical deflection	1.5 {0.059} or less	—	—



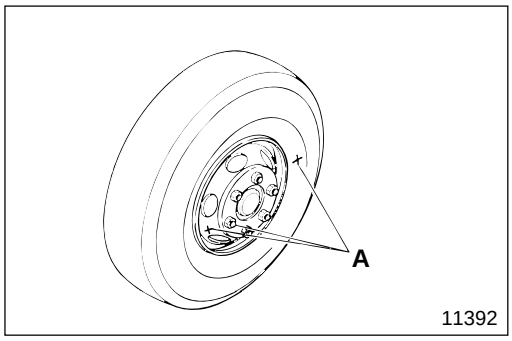
◆ Service procedure

1 **Deflection of tire**

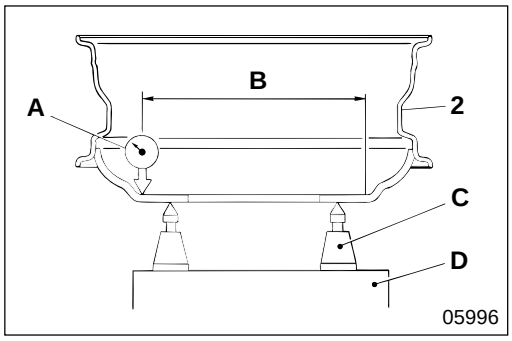
[Inspection]
If the measured value is higher than the limit, make corrections as follows.



[Correction]
- Put chalk marks on tire **1**, disc wheel **2**, and hub bolt * (positions **A** as illustrated).
- Remove tire **1** from disc wheel **2**.



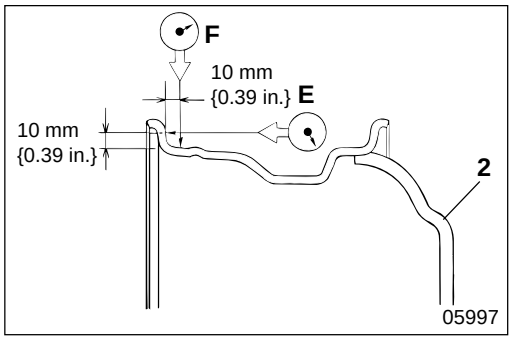
- Measure deflection of disc wheel **2**. If the most deflective position is near the chalk mark, reinstall tire **1** rotating it half a turn from the chalk mark and tighten nuts.
- Remeasure deflection of tire **1**.
- If the measured value is still higher than the limit, replace tire **1** and disc wheel **2** together as an assembly.



2 Inspection of disc wheel

(1) Flatness

- Measure flatness at specified position **B** from the center of disc wheel **2**.
  Measure flatness at five equidistant points (wheel with 5 studs) or six equidistant points (wheel with 6 studs) on the wheel.
  A : Dial gauge
  B : ø165 to 250 mm {6.50 to 9.84 in.}
  (wheel with 5 studs)
  ø170 to 270 mm {6.69 to 10.6 in.}
  (wheel with 6 studs)
  C : Portable screw jacks (x 4)
  D : Surface plate
- Replace disc wheel **2** if the measured value is higher than the limit.



(2) Deflection

Replace disc wheel **2** if the measured value is higher than the limit.
E : Horizontal deflection measuring point
F : Vertical deflection measuring point

MITSUBISHI
FUSO

Group 33
Front Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-33

INDEX

STRUCTURE AND OPERATION 33- 2

TROUBLESHOOTING 33- 3

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT SUSPENSION 33- 4

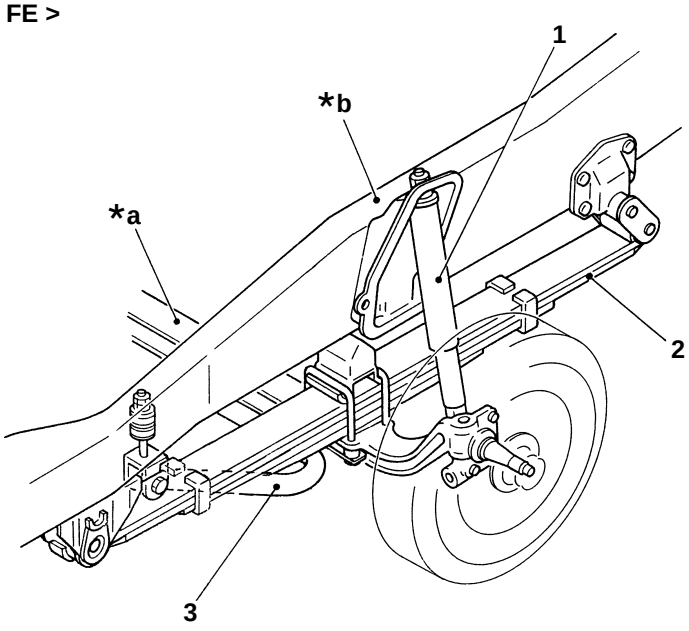
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY
- < FE > 33- 6
- < FG > 33- 8

LEAF SPRING ASSEMBLY
- < FE > 33- 12
- < FG > 33- 14

SHOCK ABSORBER
- < FE > 33- 16
- < FG > 33- 17

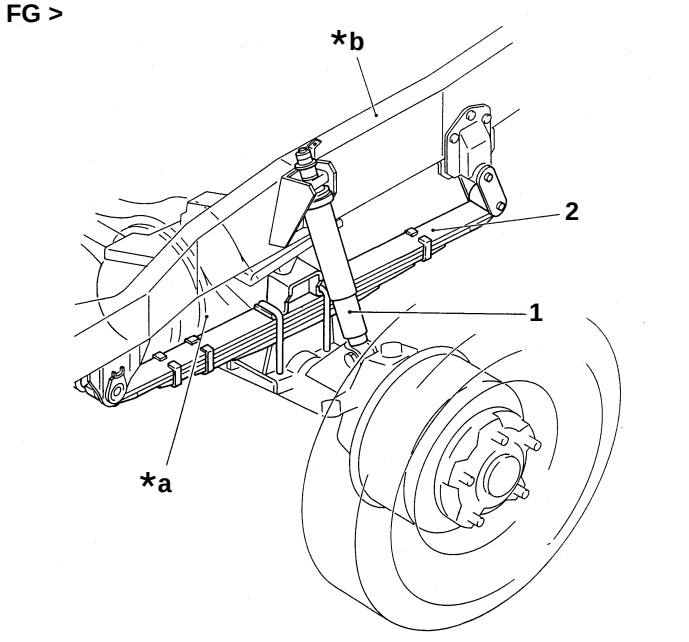
STABILIZER < FE > 33- 18

< FE >



27078

< FG >



27079

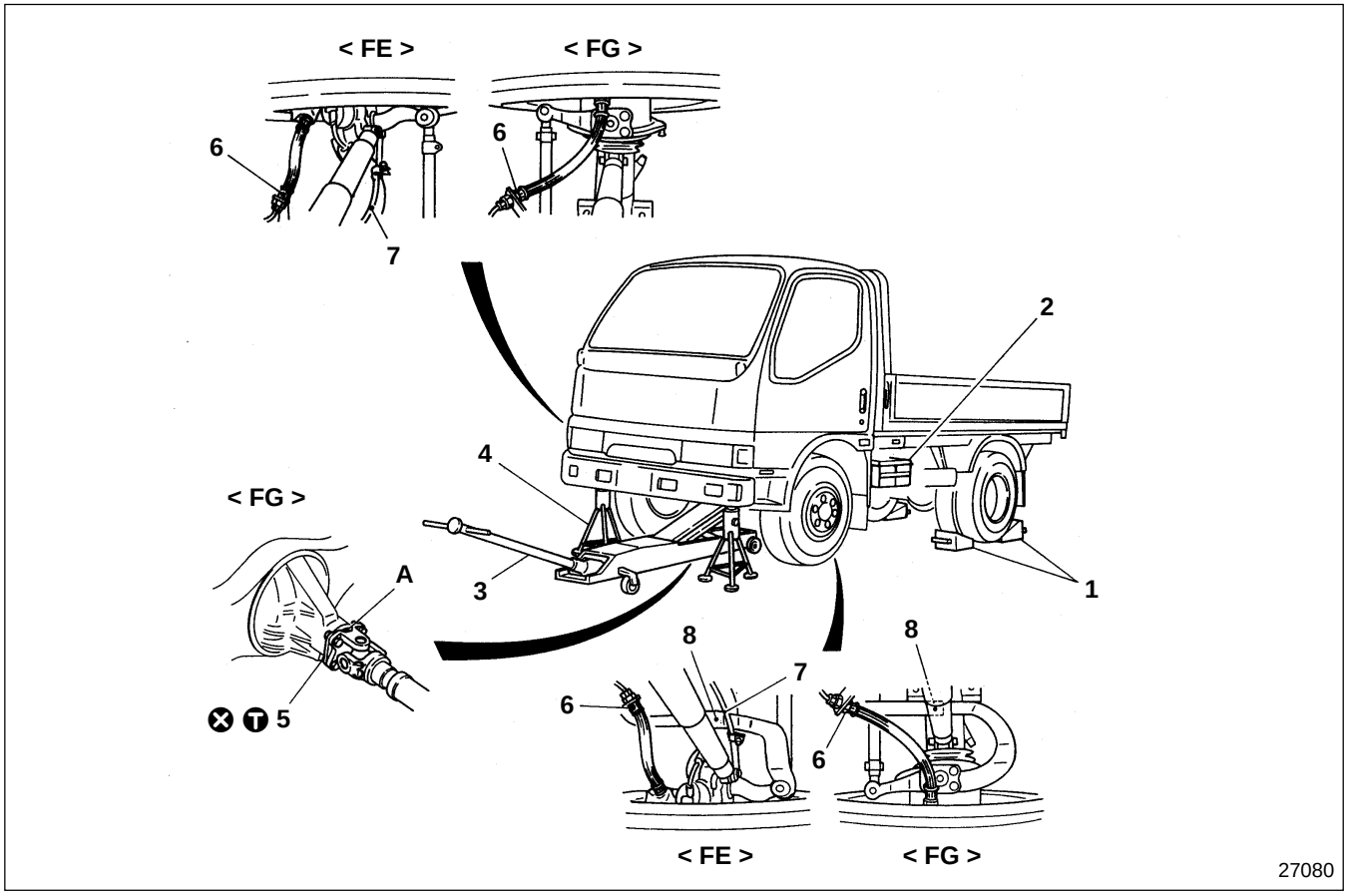
1 Shock absorber
2 Leaf spring assembly
3 Stabilizer < FE >

***a** : Front axle
***b** : Frame

Leaf spring assembly **2**, shock absorber **1**, and stabilizer **3** < FE > are installed between frame ***b** and front axle ***a** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability.

Possible causes	Symptoms	Ride spongy	Noise generated when vehicle is unloaded	Impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Excessive rolling while cruising	Periodic jolts received from the road surface	Remarks
Leaf spring	Cracked or damaged			○				
	Fractured		○					
	Spring hanger damaged				○			
	U-bolts loose				○			
	Spring bushing worn		○					
Front axle bumper	Damaged or broken				○			
Front spring pad < FG >	Damaged or broken				○			
Shock absorber	Noticeable oil leaking or damping force decreased	○						
	Rubber bushing worn		○					
	Installation loose		○					
Stabilizer < FE >	Stabilizer deformed or bushing worn			○		○		
Tire	Tires worn unevenly						○	
	Tires and wheels unbalanced						○	Gr 31
	Air pressure excessive			○				

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT SUSPENSION



● **Removal sequence**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the front axle with a garage jack.
4 Support the frame on jack stands.
5 Put alignment marks **A** on the front axle companion flange and the propeller shaft flange yoke, then remove the nuts (on the joint between the front axle and the propeller shaft). < FG >
6 Remove the brake hose joint (on the frame).
7 Remove the clamp of the brake pad wear indicator harness and disconnect the connector on the frame side. < FE >
8 Remove the drag link. Gr 37

⊗ : Non-reusable parts

WARNING

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on jack stands.**
- **Leave the garage jack and stands in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Be sure to protect the brake hose from dust by fitting plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

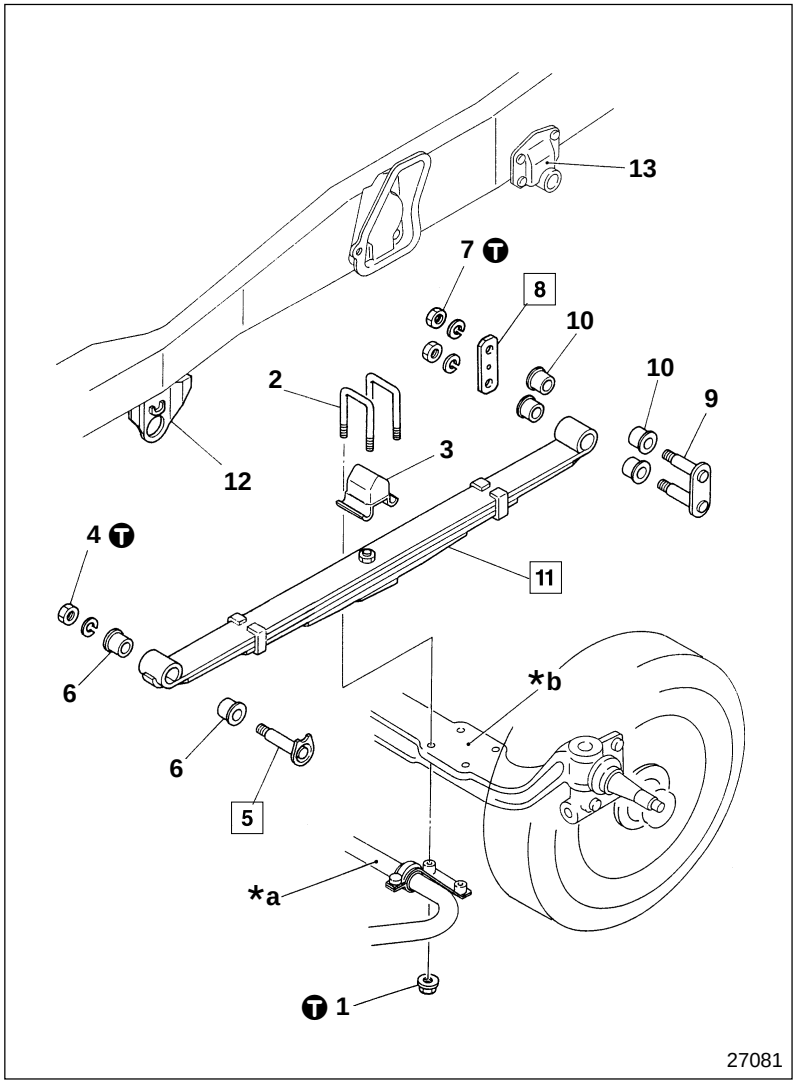
Be sure that the brake hose is not twisted when you install it.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Nut (Front axle and properller shaft connecting) < FG >	59 to 74 {43 to 54, 6.0 to 7.5}	—

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY < FE >



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Front axle bumper
4 Nut
5 Spring pin
6 Rubber bushing
7 Nut
8 Shackle plate
9 Spring shackle
10 Rubber bushing
11 Leaf spring assembly P33-12
12 Front spring hanger
13 Front shackle hanger

***a** : Stabilizer P33-18
***b** : Front axle Gr 26A

NOTE

Do not remove front spring hanger 12 or front shackle hanger 13 unless they are faulty. Gr 41

● **Installation sequence**

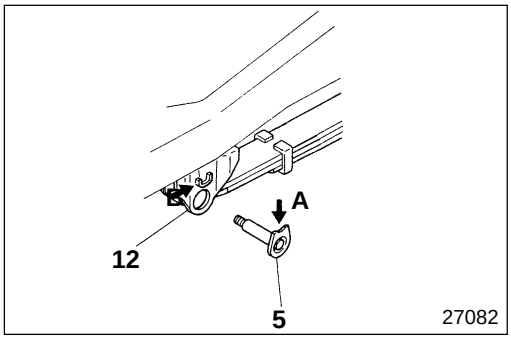
Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

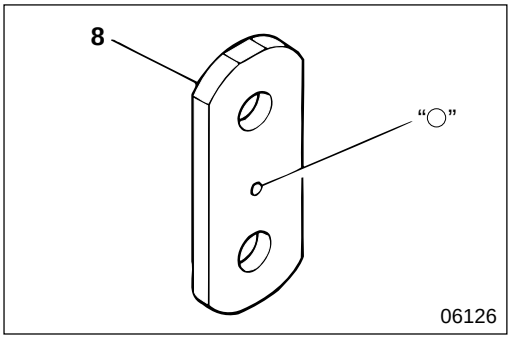
Location	Parts to be tightened	Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	162±15 {120±11, 16.5±1.5}	—
4	Nut (Spring pin mounting)	93 to 127 {69 to 94, 9.5 to 13.0}	—
7	Nut (Spring shackle mounting)	93 to 127 {69 to 94, 9.5 to 13.0}	—

◆ Service procedure



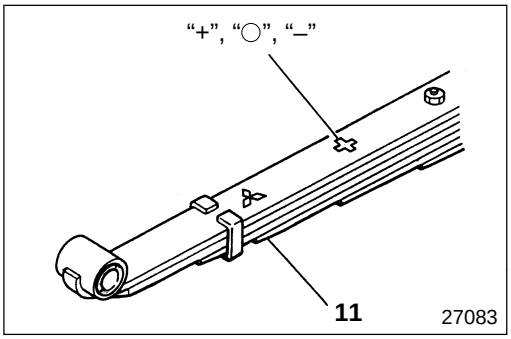
5 **Installation of spring pin**

Install spring pin **5** to front spring hanger **12** with indent **A** of the spring pin fitted to protrusion **B** of the front spring hanger.



8 **Installation of shackle plate**

Install shackle plate **8** with stamped mark "○" facing the leaf spring.



11 **Leaf spring assembly left/right height combinations**

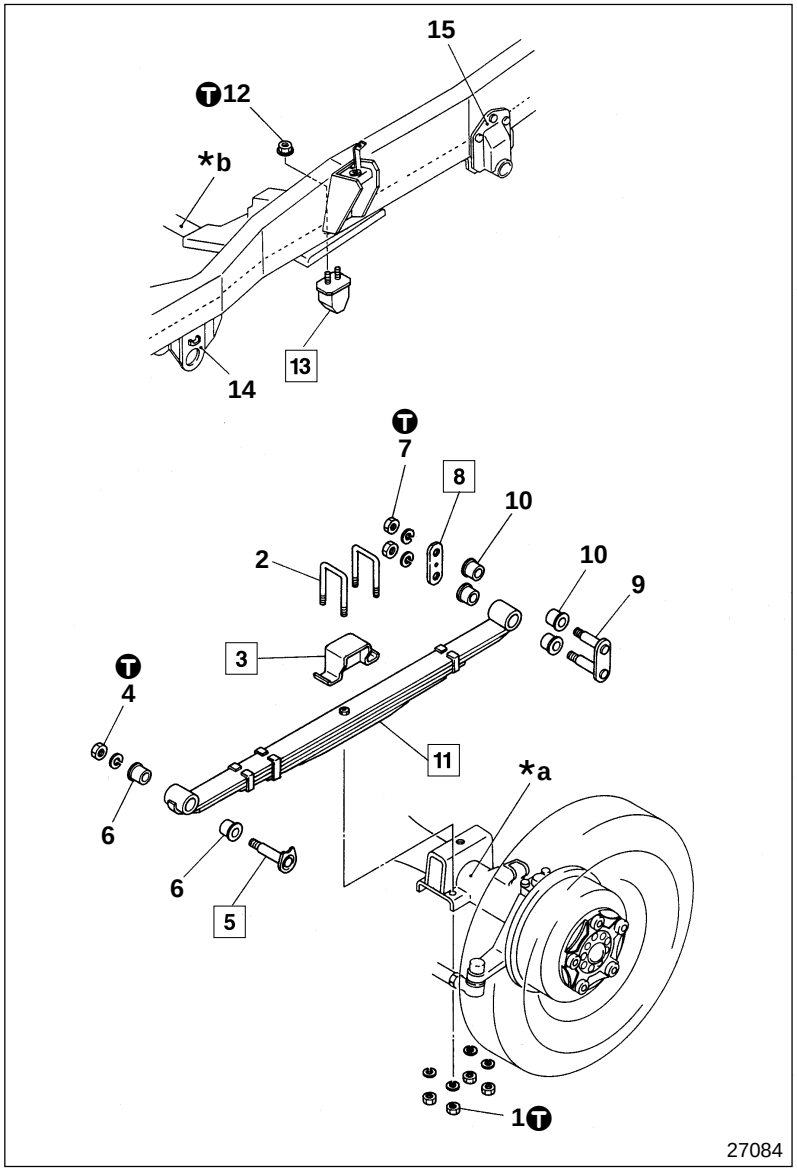
When replacing leaf spring assembly **11**, select the members so that the left and right height marks "+", "○" and "–" are combined as shown below.

Item	Combination				
	1	2	3	4	5
Right leaf spring assembly, assistant driver's seat side	–	–	○	○	+
Left leaf spring assembly, driver's seat side	–	○	○	+	+

CAUTION⚠

Passenger's side leaf spring assembly 11 differs from the driver's side leaf spring assembly in camber (arch). Do not mix them up when mounting, or this would cause vehicle lean.

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY < FG >



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Front spring pad
4 Nut
5 Spring pin
6 Rubber bushing
7 Nut
8 Shackle plate
9 Spring shackle
10 Rubber bushing
11 Leaf spring assembly P33-14
12 Nut
13 Front axle bumper
14 Front spring hanger
15 Front shackle hanger

***a** : Front axle Gr 26B
***b** : Engine mounting support Gr 41

NOTE

Do not remove front spring hanger 14 or front shackle hanger 15 unless they are faulty. Gr 41

● **Installation sequence**

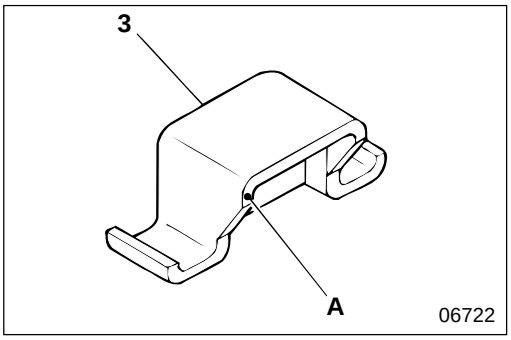
Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

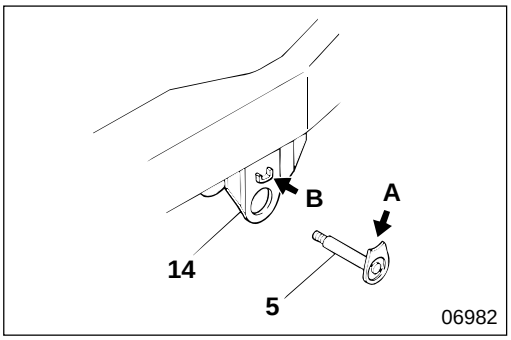
Location	Parts to be tightened	Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	106±7.8 {78±5.8, 10.8±0,8}	—
4	Nut (Spring pin mounting)	93 to 127 {69 to 94, 9.5 to 13.0}	—
7	Nut (Spring shackle mounting)	93 to 127 {69 to 94, 9.5 to 13.0}	—
12	Nut (Front axle bumper mounting)	21 to 30 {15 to 22, 2.1 to 3.1}	—

◆ Service procedure



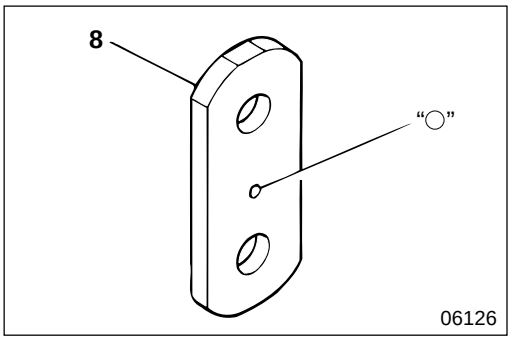
3 **Front spring pad**

Mount front spring pad **3** with protrusion **A** facing the outside of the vehicle.



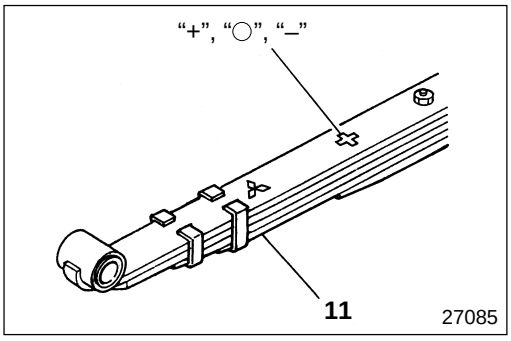
5 **Installation of spring pin**

Install spring pin **5** to front spring hanger **14** with indent **A** of the spring pin fitted to protrusion **B** of the front spring hanger.



8 **Installation of shackle plate**

Install shackle plate **8** with stamped mark "○" facing the leaf spring.



11 **Leaf spring assembly left/right height combinations**

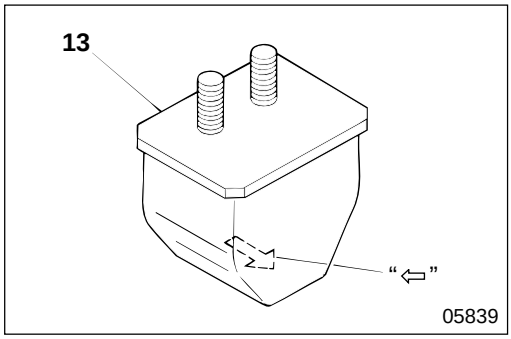
When replacing leaf spring assembly **11**, select the members so that the left and right height marks "+", "○" and "–" are combined as shown below.

Item	Combination				
	1	2	3	4	5
Right leaf spring assembly, assistant driver's seat side	–	–	○	○	+
Left leaf spring assembly, driver's seat side	–	○	○	+	+

CAUTION⚠

Passenger's side leaf spring assembly 11 differs from the driver's side leaf spring assembly in camber (arch). Do not mix them up when mounting, or this world couse vehicle tilt.

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY < FG >

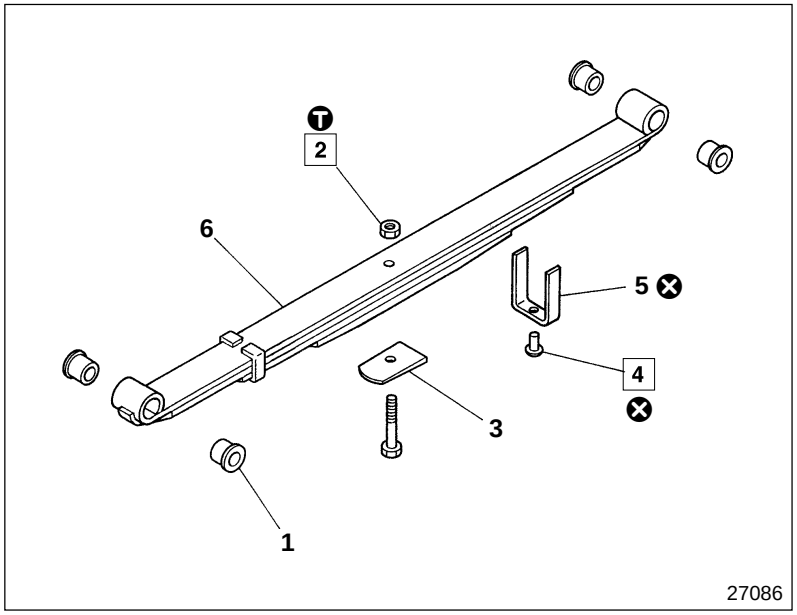


13 **Front axle bumper**

Mount front axle bumper **13** with arrow mark “⇦” facing the outside of the vehicle.

M E M O

LEAF SPRING ASSEMBLY < FE >



● **Disassembly sequence**

1 Collar
2 Center nut
3 Caster shim
4 Rivet
5 Clip
6 Leaf spring

⊗ : Non-reusable parts

● **Assembly sequence**

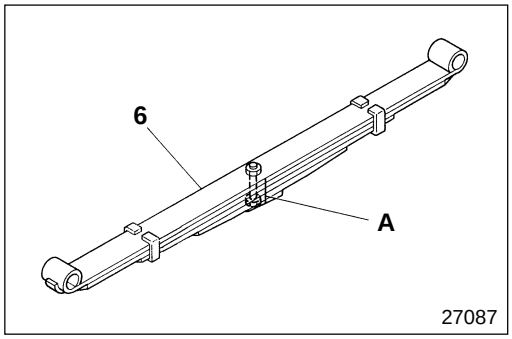
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Center nut (Leaf spring mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—

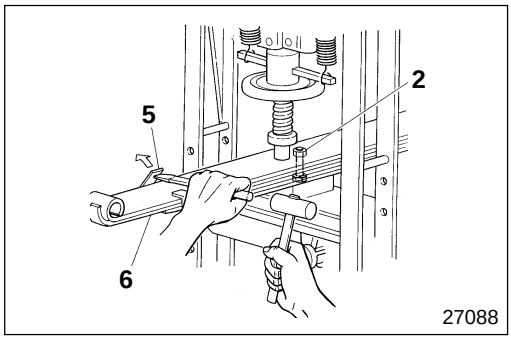
◆ Service procedure



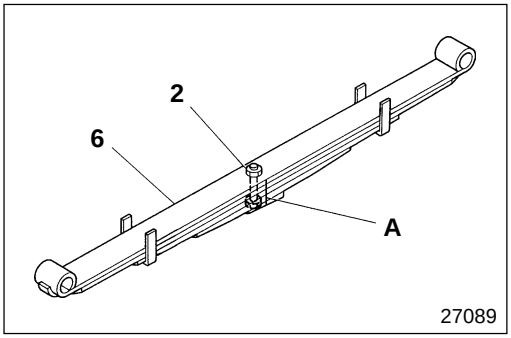
2 **Center nut**

[Removal]

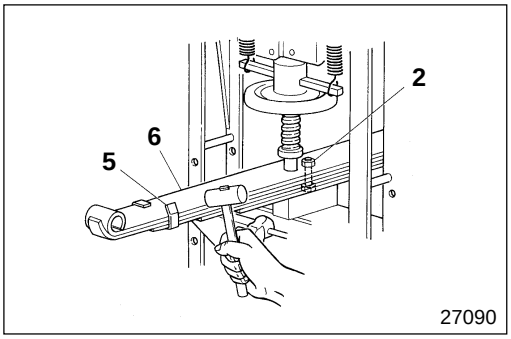
- Put alignment marks **A** on the side of leaf springs **6**.



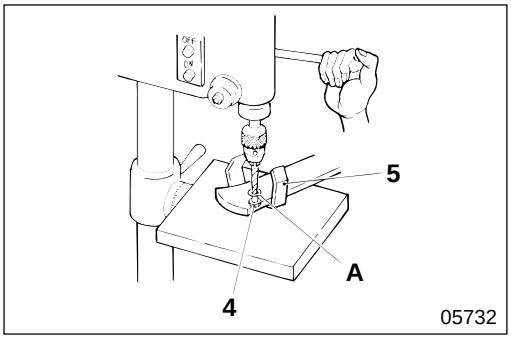
- Compress leaf springs **6** using a press, lever up the bent parts of clips **5** using a cold chisel, then remove center nut **2**.



[Installation]
- Align alignment marks **A** on the side of leaf springs **6**, assemble the component leaf springs, then tighten center nut **2** temporarily.

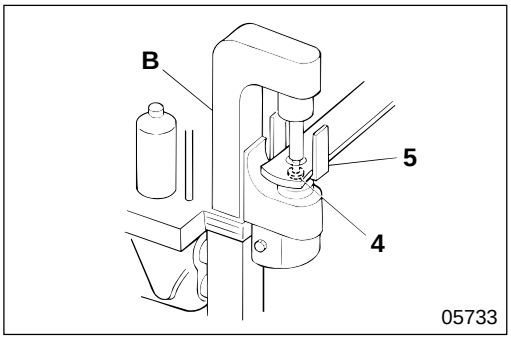


- Compress leaf springs **6** using a press, tighten center nut **2** at specified torque, then bend over clips **5**.



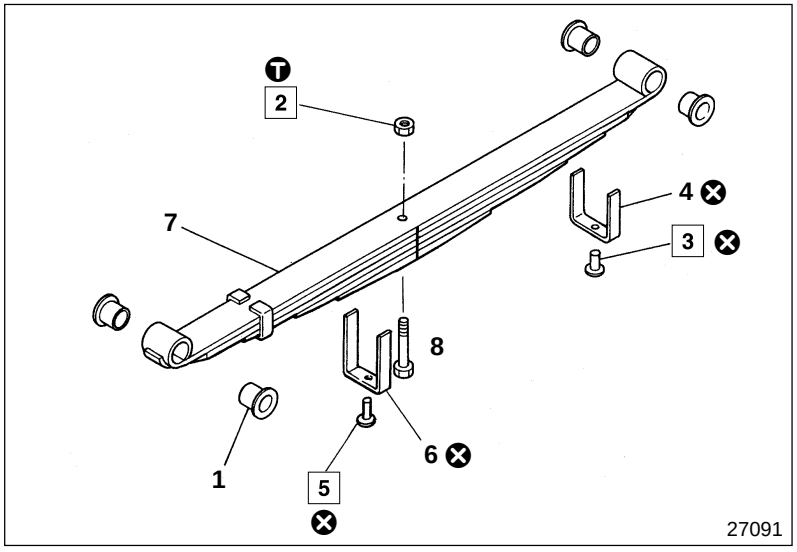
4 **Rivet**

[Removal]
- Drill out staked end **A** of rivet **4** on a drill press, then remove clip **5**.



[Installation]
- Using riveting machine **B**, mount inner clip **5** by staking rivet **4**.

LEAF SPRING ASSEMBLY < FG >



● **Disassembly sequence**

1 Collar
2 Center nut
3 Rivet
4 Clip
5 Rivet
6 Clip
7 Leaf spring

⊗ : Non-reusable parts

● **Assembly sequence**

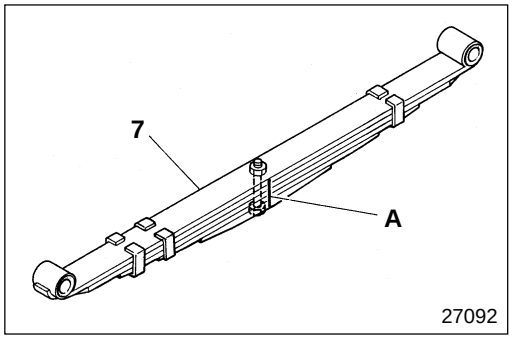
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Center nut (Leaf spring mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—

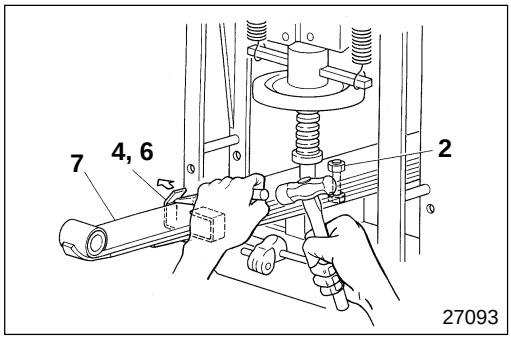
◆ Service procedure



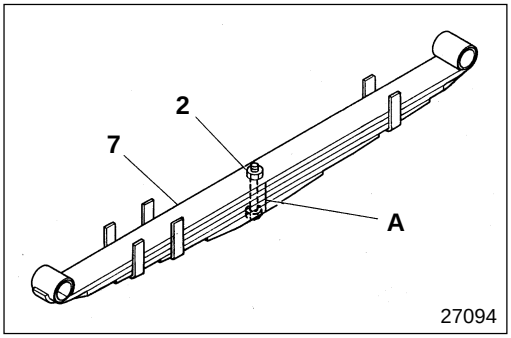
2 **Center nut**

[Removal]

- Put alignment marks **A** on the side of leaf springs **7**.

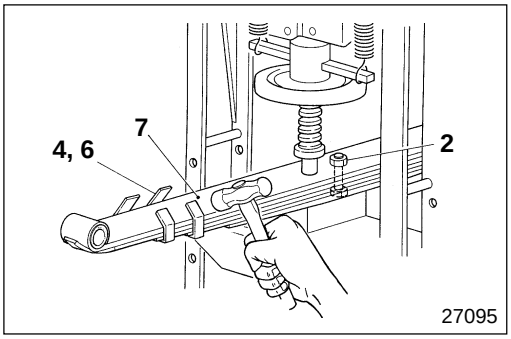


- Compress leaf springs **7** using a press, lever up the bent parts of clip **4, 6** using a cold chisel, then remove center nut **2**.

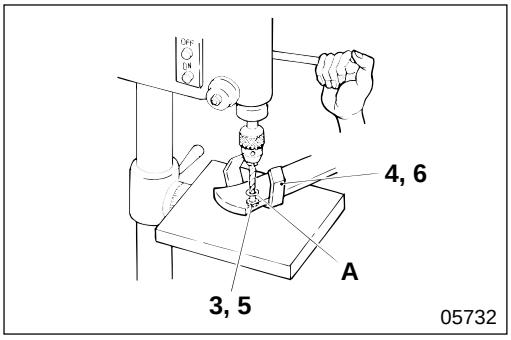


[Installation]

- Align alignment marks **A** on the side of leaf springs **7**, assemble the component leaf springs, then tighten center nut **2** temporarily.



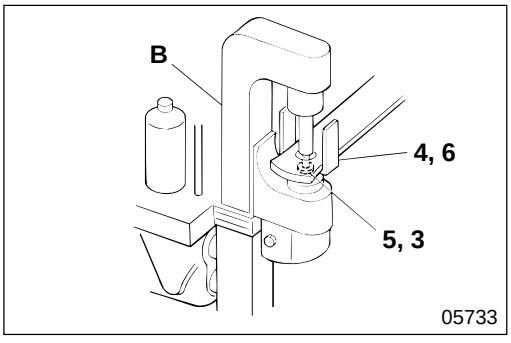
- Compress leaf springs **7** using a press, tighten center nut **2** at specified torque, then bend over clips **4, 6** using a hammer.



3 **5** **Rivet**

[Removal]

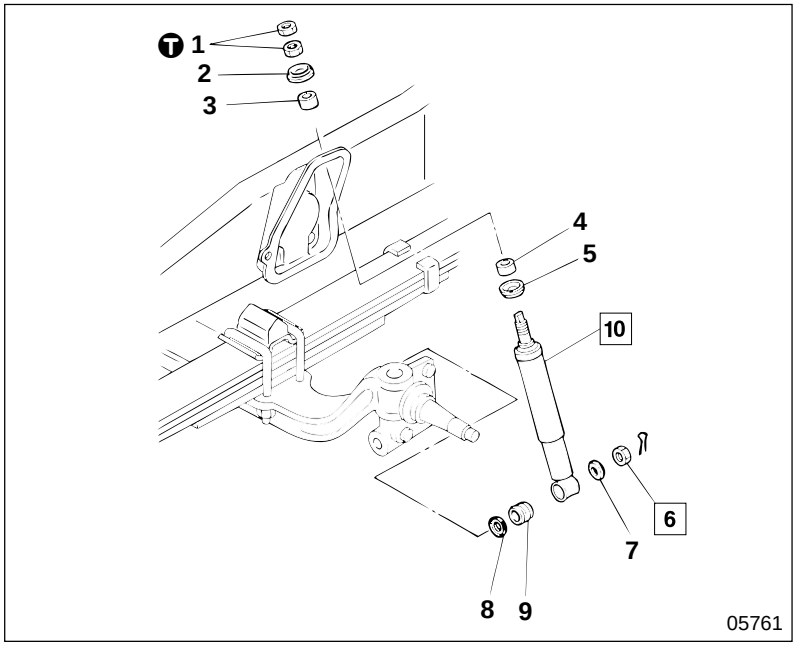
Drill out staked ends **A** of rivets **3**, **5** on a drill press, then remove clip **4** and inner clip **6**.



[Installation]

Using riveting machine **B**, mount inner clip **6** and clip **4** by staking rivets **5**, **3**.

SHOCK ABSORBER < FE >



● **Removal sequence**

1 Lock nut
2 Upper side washer
3 Rubber bushing
4 Rubber bushing
5 Upper side washer
6 Nut
7 Eye washer
8 Washer
9 Rubber bushing
10 Shock absorber

● **Installation sequence**

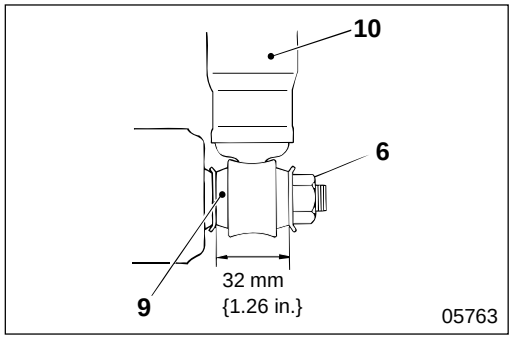
Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

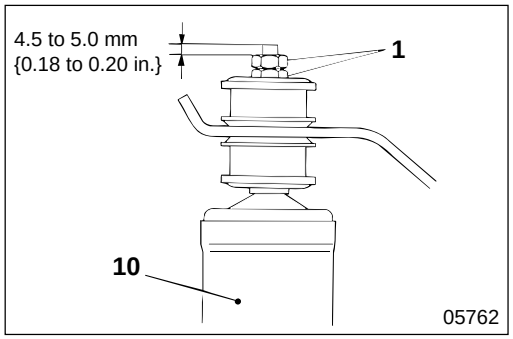
Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Shock absorber top mounting)	13 to 17 {9.4 to 12.3, 1.3 to 1.7}	—

◆ Service procedure



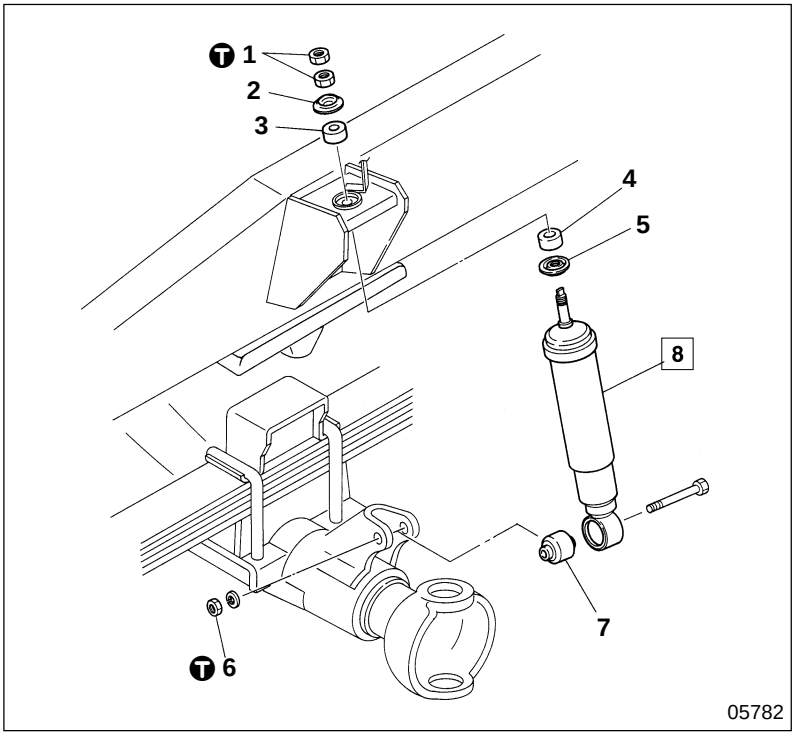
6 **Nut mounting**

Tighten nut **6** so that the length of rubber bushing **9** for shock absorber **10** is as illustrated.



10 **Shock absorber mounting**

Tighten lock nut **1** so that the top of shock absorber **10** protrudes from the lock nut by the amount as illustrated.



● **Removal sequence**

1 Lock nut
2 Upper side washer
3 Rubber bushing
4 Rubber bushing
5 Upper side washer
6 Nut
7 Rubber bushing
8 Shock absorber

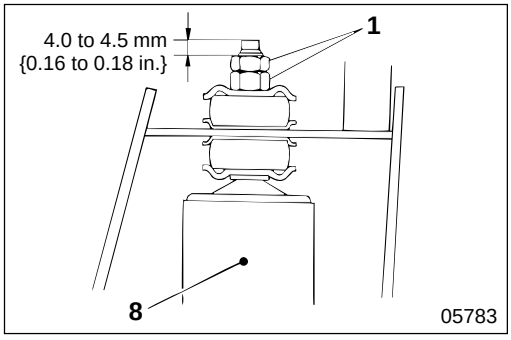
● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Shock absorber top mounting)	13 to 17 {9.4 to 12.3, 1.3 to 1.7}	—
6	Nut (Shock absorber bottom eye mounting)	33 to 49 {25 to 36, 3.4 to 5.0}	—

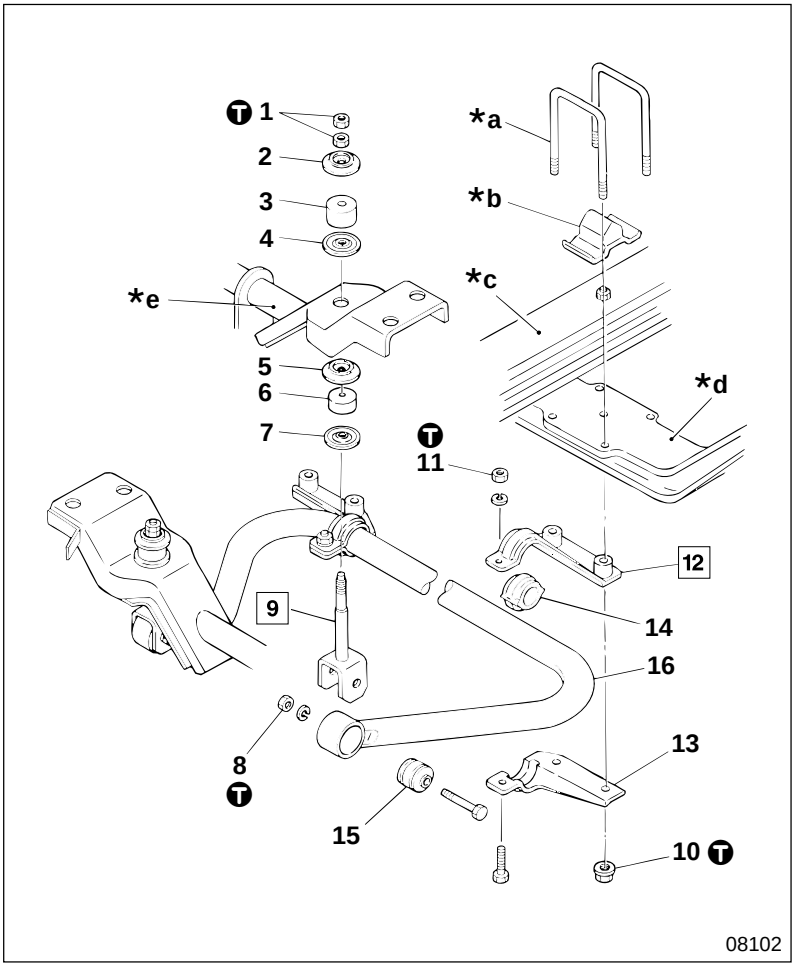


◆ Service procedure

8 **Shock absorber mounting**

Tighten lock nut **1** so that the top of shock absorber **8** protrudes from the lock nut by the amount as illustrated.

STABILIZER < FE >



● **Removal sequence**

1 Lock nut
2 Upper side washer
3 Rubber bushing
4 Centering washer
5 Centering washer
6 Rubber bushing
7 Upper side washer
8 Nut
9 Stabilizer hanger
10 U-bolt nut
11 Nut
12 Stabilizer upper bracket
13 Stabilizer lower bracket
14 Stabilizer bushing
15 Stabilizer rubber bushing
16 Stabilizer bar

***a** : U-bolt
***b** : Front axle bumper
***c** : Leaf spring assembly
***d** : Front axle Gr 26A
***e** : Radiator support Gr 14

● **Installation sequence**

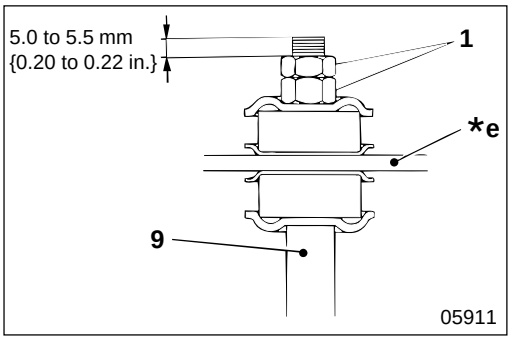
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

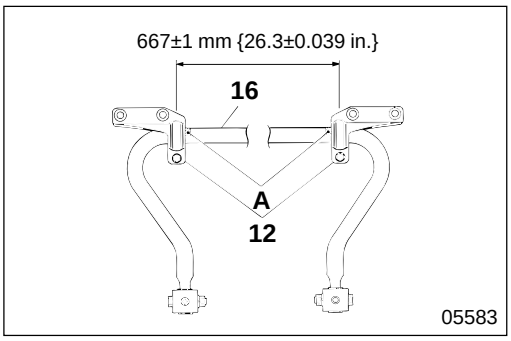
Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Stabilizer hanger top mounting)	13 to 17 {9.4 to 12.3, 1.3 to 1.7}	—
8	Nut (Stabilizer hanger bottom eye mounting)	70 to 95 {51 to 69, 7.0 to 9.5}	—
10	U-bolt nut	162±15 {120±11, 16.5±1.5}	—
11	Nut (Stabilizer upper bracket and lower bracket mounting)	35 to 55 {25 to 40, 3.5 to 5.5}	—

◆ Service procedure



9 **Stabilizer hanger mounting**

- Mount stabilizer hanger **9** to radiator support ***e** perpendicularly.
- Tighten lock nut **1** so that the top of stabilizer hanger **9** protrudes from the lock nut by the amount as illustrated.



12 **Stabilizer upper bracket mounting**

Mount stabilizer upper brackets **12** with their end faces aligned with mark **A** on stabilizer bar **16**.

MITSUBISHI
FUSO

Group 34
Rear Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-34

INDEX

STRUCTURE AND OPERATION 34- 2

TROUBLESHOOTING 34- 3

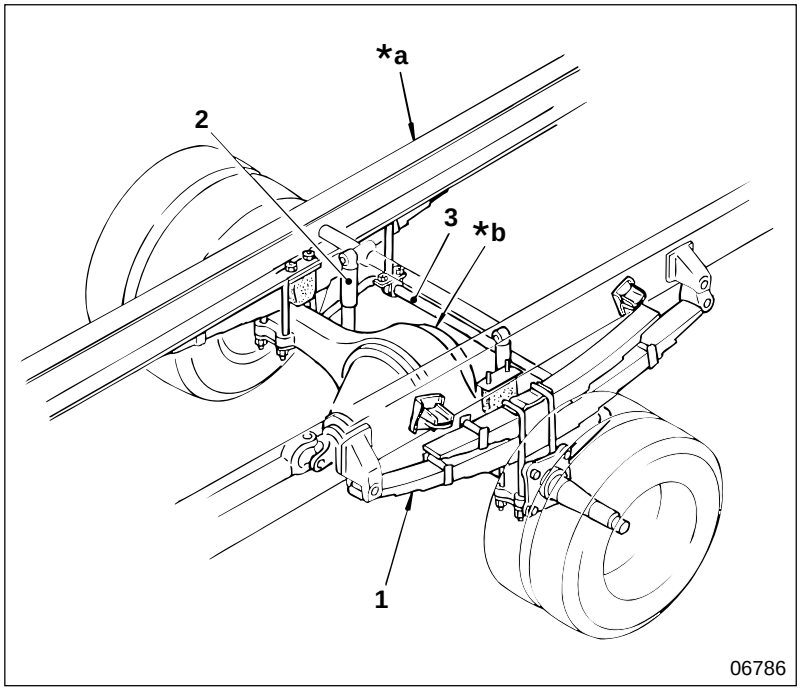
WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION 34- 4

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY
< FE > 34- 6
< FG > 34- 10

LEAF SPRING ASSEMBLY 34- 14

SHOCK ABSORBER 34- 17

STABILIZER < FE > 34- 18



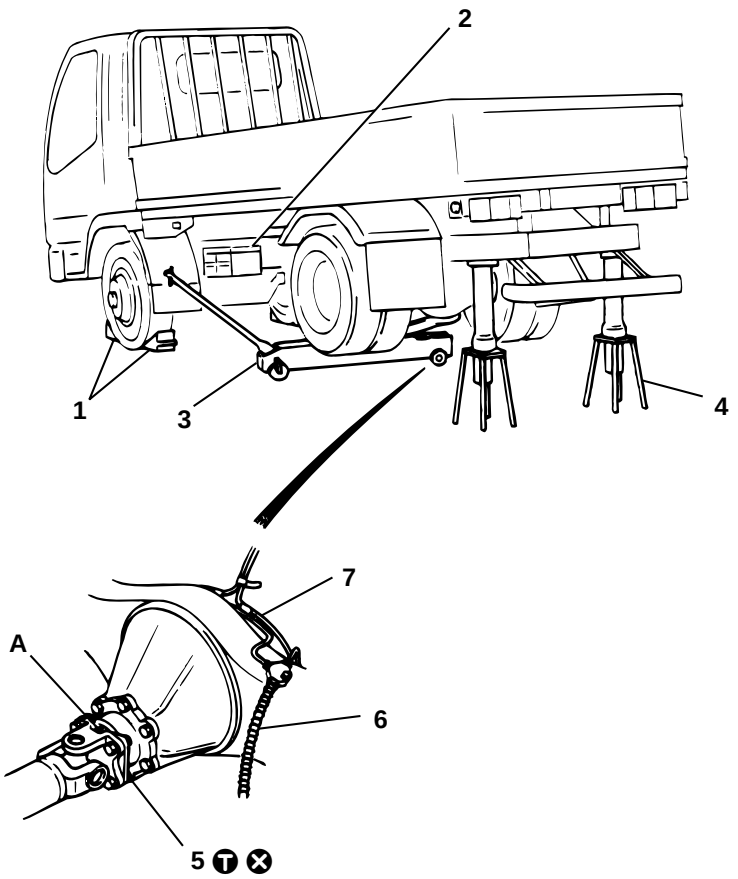
1 Leaf spring assembly
2 Shock absorber
3 Stabilizer < FE >

***a** : Frame
***b** : Rear axle

Leaf spring assembly **1** and shock absorber **2** are installed between frame ***a** and rear axle ***b** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability. Stabilizer **3** < FE > is installed to prevent sway.

Possible causes \ Symptoms		Ride soft with gentle swaying	Noise generated when vehicle is unloaded	Impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Excessive rolling while cruising	Periodic jolts received from the road surface	Remarks
Leaf spring	Cracked or damaged			○				
	Damaged		○					
	Spring hanger broken				○			
	U-bolts loose				○			
	Spring bushing worn		○					
Spring pins or shackle pins thrust play excessive			○					
Shackle pins tightening torque excessive					○			
Helper rubber or helper spring stopper damaged or broken					○			
Shock absorber	Noticeable oil leaking or damping force decreased	○						
	Rubber bushing worn		○					
	Bolt loose		○					
Stabilizer < FE >	Stabilizer deformed, bushing worn					○		
Tire	Tires worn unevenly						○	
	Tires and wheels unbalanced						○	Gr 31
	Air pressure excessive			○				

WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION



● **Removal sequence**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the rear axle with a garage jack.
4 Support the rear frame on jack stands.
5 Put alignment marks **A** on the rear axle companion flange and the propeller shaft flange yoke, then remove the nuts (on the joint between the rear axle and the propeller shaft).
6 Remove the brake hose joint (on the frame).
7 Remove the clamp of the brake pad wear indicator harness and disconnect the connector on the frame side.
< with disc brake >

⊗ : Non-reusable parts

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on jack stands.**
- **Leave the garage jack and stands in place until the entire operation is completed. Never remove them during the operation.**

CAUTION⚠

Be sure to protect the brake hose from dust by fitting plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

WARNING⚠

You must bleed air from the brake system and install the load sensing valve (with load sensing valve) after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

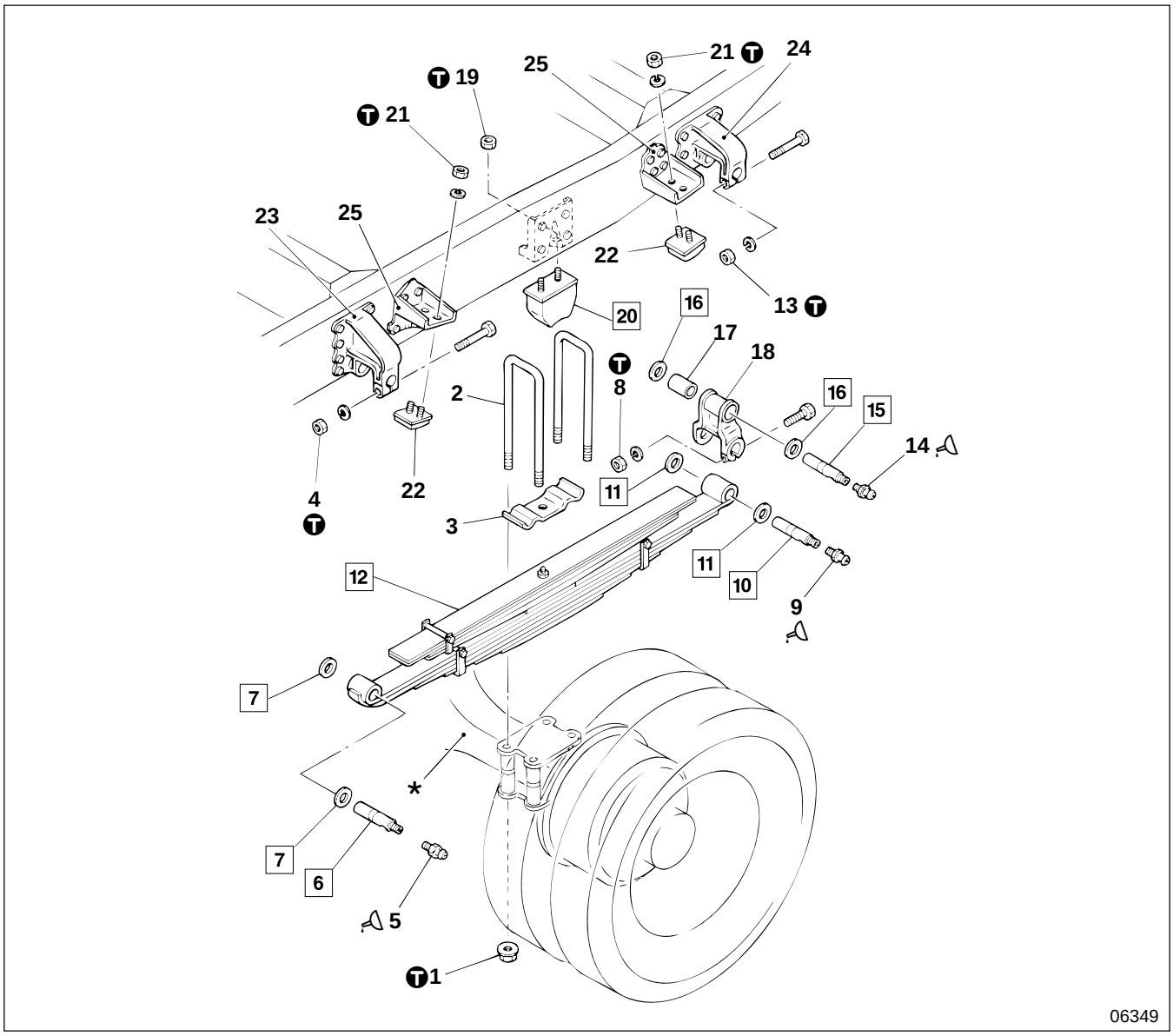
Be sure that the brake hose is not twisted when you install it.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Nut (Rear axle and propeller shaft connecting)	98 to 120 {72 to 87, 10 to 12}	—

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY < FE >



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Spring pad
4 Nut
5 Grease nipple
6 Spring pin
7 Side washer
8 Nut
9 Grease nipple
10 Spring pin
11 Side washer
12 Leaf spring assembly P34-14
13 Nut
14 Grease nipple
15 Spring pin
16 Side washer
17 Bushing
18 Spring shackle
19 Nut
20 Helper rubber
21 Nut
22 Helper spring stopper
23 Rear spring hanger
24 Rear shackle hanger
25 Helper spring bracket

***** : Rear axle Gr 27

NOTE

Do not remove rear spring hanger 23, rear shackle hanger 24, or helper spring bracket 25 unless they are faulty. Gr 41

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6, 10, 12	Clearance between spring pin and bushing of leaf spring assembly	[28] 0.04 to 0.14 {[1.10] 0.0016 to 0.0055}	0.5 {0.020}	—
6, 23	Clearance between spring pin and rear spring hanger	[28] 0.02 to 0.08 {[1.10] 0.00079 to 0.0031}	1.0 {0.039}	—
12, 18	Clearance between leaf spring assembly and spring shackle	0.5 to 1.2 {0.020 to 0.047}	1.5 {0.059}	Adjust side washer
12, 23	Clearance between leaf spring assembly and rear spring hanger	0.5 to 1.2 {0.020 to 0.047}	1.5 {0.059}	Adjust side washer
15, 17	Clearance between spring pin and bushing of spring shackle	[28] 0.04 to 0.14 {[1.10] 0.0016 to 0.0055}	0.5 {0.020}	—
18, 24	Clearance between spring shackle and rear shackle hanger	0.1 to 0.9 {0.0039 to 0.035}	1.0 {0.039}	Adjust side washer
10, 18	Clearance between spring pin and spring shackle	[28] 0.02 to 0.08 {[1.10] 0.00079 to 0.0031}	1.0 {0.039}	—
15, 24	Clearance between spring pin and rear shackle hanger	[28] 0.02 to 0.08 {[1.10] 0.00079 to 0.0031}	1.0 {0.039}	—

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

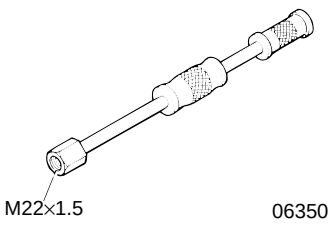
Location	Parts to be tightened	Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	339±51 {250±38, 34.6±5.2}	—
4	Nut (Spring pin mounting)	29.4 to 37.2 {22 to 27, 3.0 to 3.8}	—
8	Nut (Spring pin mounting)	29.4 to 37.2 {22 to 27, 3.0 to 3.8}	—
13	Nut (Spring pin mounting)	29.4 to 37.2 {22 to 27, 3.0 to 3.8}	—
19	Nut (Helper rubber mounting)	11.8 to 14.7 {8.7 to 11, 1.2 to 1.5}	—
21	Nut (Helper spring stopper mounting)	11.8 to 14.7 {8.7 to 11, 1.2 to 1.5}	—

Lubricant

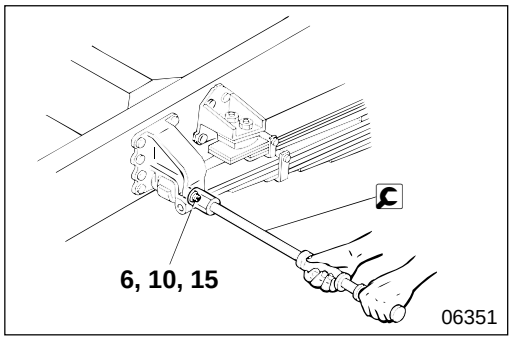
Location	Points of application	Specified lubricant	Quantity
5, 9, 14	Supply via grease nipple	Chassis grease [NLGI No.1 (Ca soap)]	As required

Special tools

Unit : mm {in.}

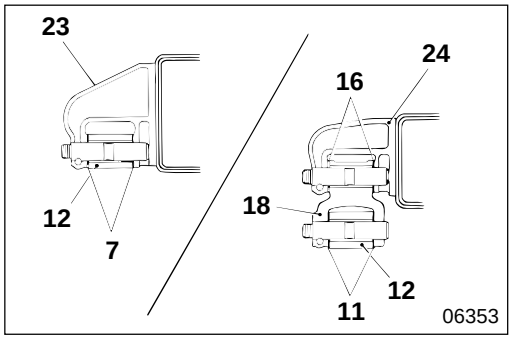
Location	Tool name and shape	Part No.	Application
6, 10, 15	Spring pin remover 	MB999112	Removal of spring pin

◆ Service procedure



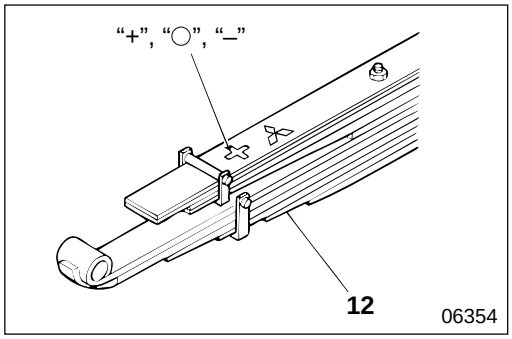
6 **10** **15** **Removal of spring pin**

Remove spring pins **6**, **10**, **15** using 🔧 spring pin remover.



7 **11** **16** **Adjustment of side washer (for adjustment)**

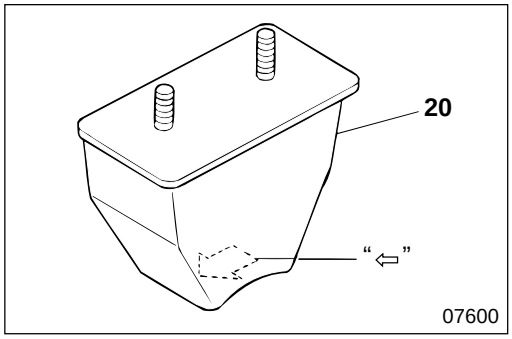
- Using side washer **11**, adjust the clearance between leaf spring assembly **12** and spring shackle **18** to the standard value.
- Using side washer **7**, adjust the clearance between leaf spring assembly **12** and rear spring hanger **23** to the standard value.
- Using side washer **16**, adjust the clearance between spring shackle **18** and rear shackle hanger **24** to the standard value.
- Two different thicknesses are available for side washers **7**, **11**, **16** : 0.5 mm {0.020 in.} and 1.0 mm {0.039 in.}



12 **Leaf spring assembly left/right height combinations**

When replacing leaf spring assembly **12**, select the members so that the left and right height marks "+", "○" and "–" are combined as shown below.

Item	Combination		
	1	2	3
Right leaf spring assembly, assistant driver's seat side	+	○	–
Left leaf spring assembly, driver's seat side	+	○	–

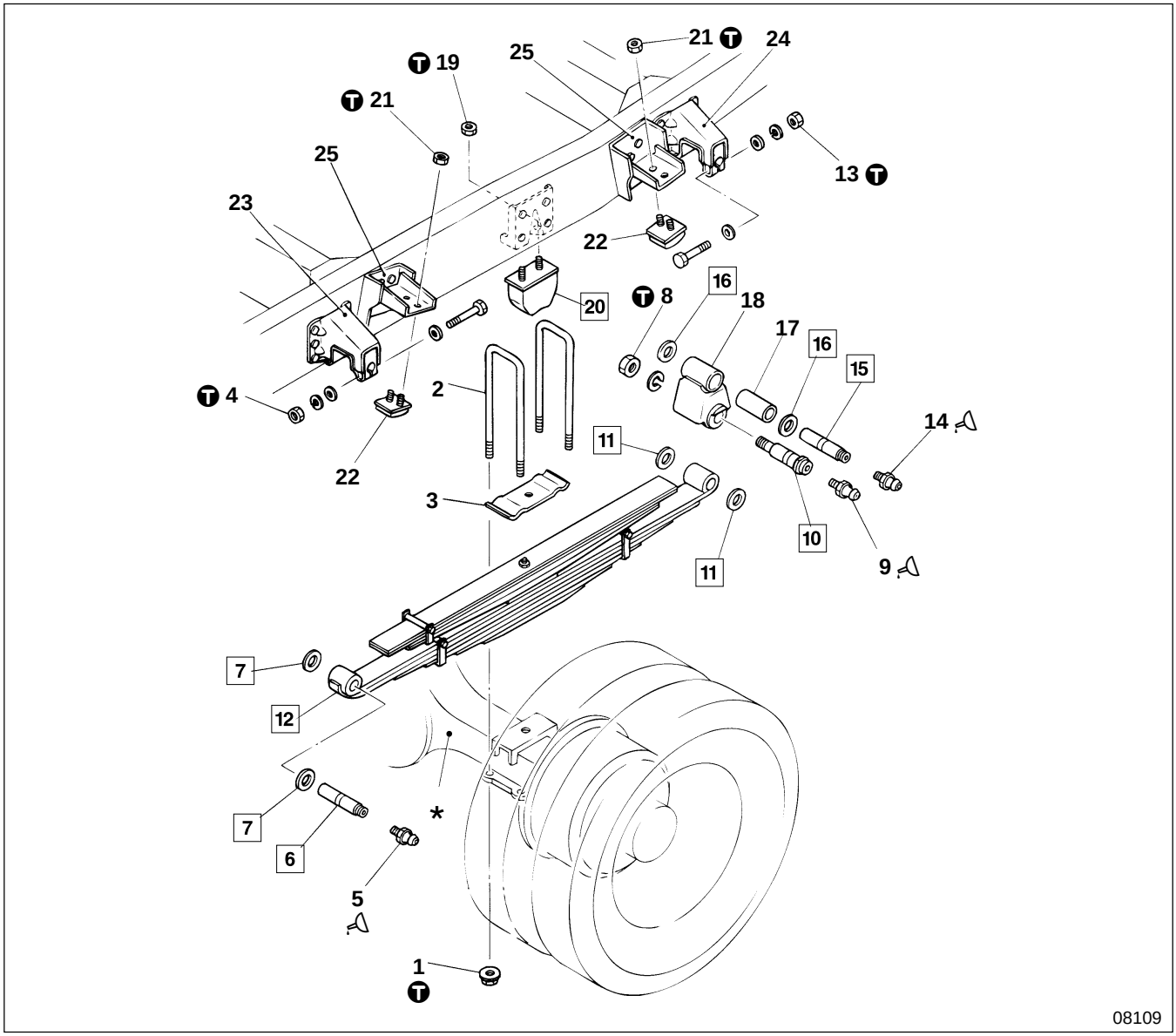


20 **Installation of helper rubber**

Install helper rubber **20** with installation mark "⇦" directed to the front of the vehicle.

M E M O

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY < FG >



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Spring pad
4 Nut
5 Grease nipple
6 Spring pin
7 Side washer (for adjustment)
8 Nut
9 Grease nipple
10 Shackle pin
11 Side washer (for adjustment)
12 Leaf spring assembly P34-14
13 Nut
14 Grease nipple
15 Spring pin
16 Side washer (for adjustment)
17 Bushing
18 Spring shackle
19 Nut
20 Helper rubber
21 Nut
22 Helper spring stopper
23 Rear spring hanger
24 Rear shackle hanger
25 Helper spring bracket

***** : Rear axle Gr 27

NOTE

Do not remove rear spring hanger 23, rear shackle hanger 24, or helper spring bracket 25 unless they are faulty. Gr 41

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6, 12	Clearance between spring pin and bushing of leaf spring assembly	[28] 0.04 to 0.14 {[1.10] 0.0016 to 0.0055}	0.5 {0.020}	—
6, 23	Clearance between spring pin and rear spring shackle	[28] 0.04 to 0.14 {[1.10] 0.0016 to 0.0055}	1.0 {0.039}	—
10, 12	Clearance between shackle pin and bushing of leaf spring assembly	[28] 0.04 to 0.14 {[1.10] 0.0016 to 0.0055}}	0.5 {0.020}	—
12, 18	Clearance between leaf spring assembly and spring shackle	0.1 to 0.7 {0.0039 to 0.028}	1.0 {0.039}	Adjust side washer
12, 23	Clearance between leaf spring assembly and rear spring hanger	0.1 to 1.0 {0.0039 to 0.039}	1.0 {0.039}	Adjust side washer
15, 17	Clearance between spring pin and bushing of spring shackle	[28] 0.04 to 0.14 {[1.10] 0.0016 to 0.0055}	0.5 {0.020}	—
15, 24	Clearance between spring pin and rear shackle hanger	[28] 0.02 to 0.08 {[1.10] 0.00079 to 0.0031}	1.0 {0.039}	—
18, 24	Clearance between spring shackle and rear shackle hanger	0.1 to 0.7 {0.0039 to 0.028}	1.0 {0.039}	Adjust side washer

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

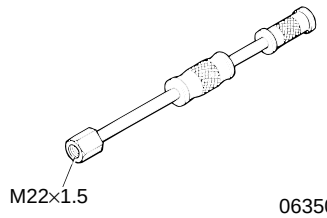
Location	Parts to be tightened	Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	240±15 {175±11, 24.5±1.5}	—
4	Nut (Spring pin mounting)	29.4 to 37.2 {22 to 27, 3.0 to 3.8}	—
8	Nut (Spring pin mounting)	148 to 201 {110 to 150, 15.1 to 20.5}	—
13	Nut (Spring pin mounting)	29.4 to 37.2 {22 to 27, 3.0 to 3.8}	—
19	Nut (Helper rubber mounting)	11.8 to 14.7 {8.7 to 11, 1.2 to 1.5}	—
21	Nut (Helper spring stopper mounting)	11.8 to 14.7 {8.7 to 11, 1.2 to 1.5}	—

Lubricant

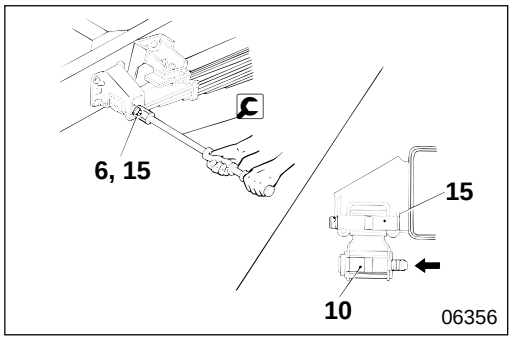
Location	Points of application	Specified lubricant	Quantity
5, 9, 14	Supply via grease nipple	Chassis grease [NLGI No.1 (Ca soap)]	As required

Special tools

Unit : mm {in.}

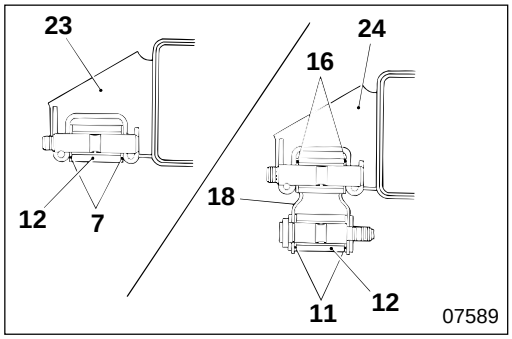
Location	Tool name and shape	Part No.	Application
6, 15	Spring pin remover  06350	MB999112	Removal of spring pin

◆ Service procedure



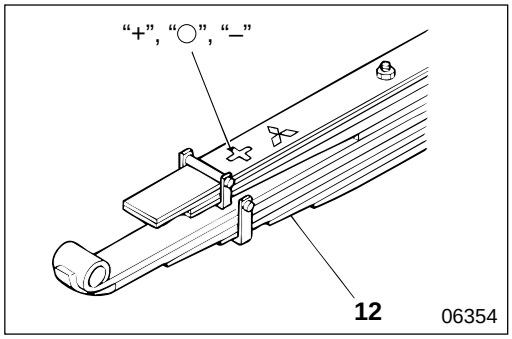
6 **10** **15** **Removal of spring pin and shackle pin**

- Remove spring pins **6**, **15** using 🔧 spring pin remover.
- Knock shackle pin **10** out from the inside of the vehicle using a hammer.



7 **11** **16** **Adjustment of side washer (for adjustment)**

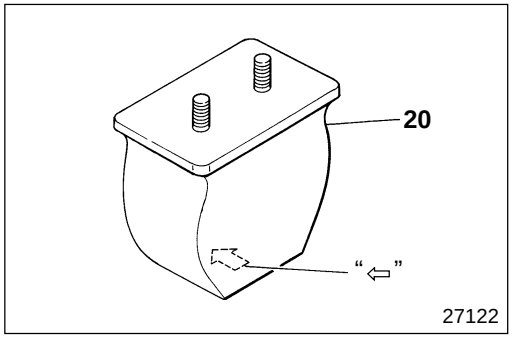
- Using side washer **11**, adjust the clearance between leaf spring assembly **12** and spring shackle **18** to the standard value.
- Using side washer **7**, adjust the clearance between leaf spring assembly **12** and rear spring hanger **23** to the standard value.
- Using side washer **16**, adjust the clearance between spring shackle **18** and rear shackle hanger **24** to the standard value.
- Two different thicknesses are available for side washers **7**, **11**, **16** : 0.5 mm {0.020 in.} and 1.0 mm {0.039 in.}



12 **Leaf spring assembly left/right height combinations**

When replacing leaf spring assembly **12**, select the members so that left and right height marks "+", "○" and "–" are combined as shown below.

Item	Combination		
	1	2	3
Right leaf spring assembly, assistant driver's seat side	+	○	–
Left leaf spring assembly, driver's seat side	+	○	–

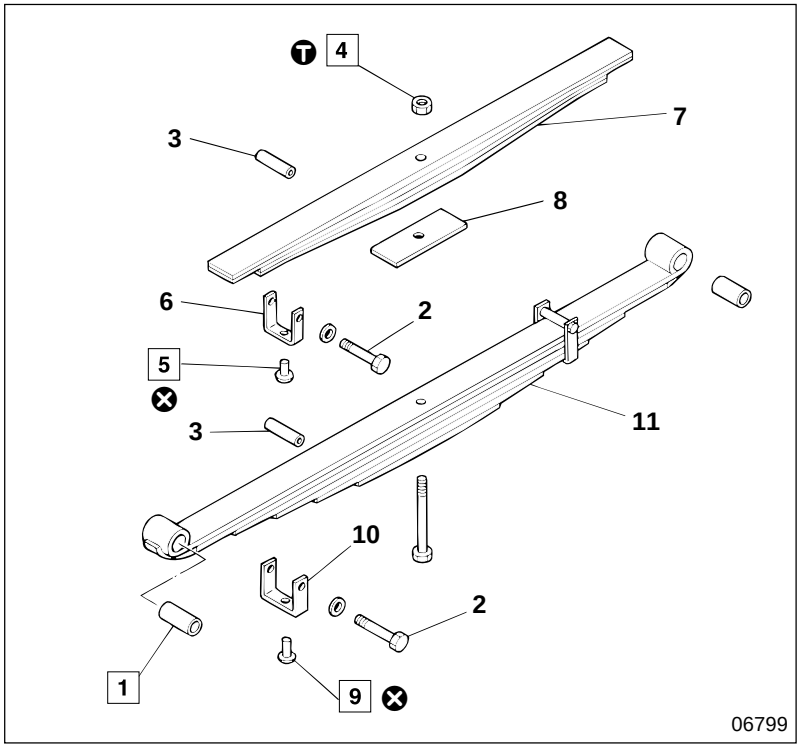


20 **Installation of helper rubber**

Install helper rubber **20** with installation mark "⇦" facing to the inside of the vehicle.

M E M O

LEAF SPRING ASSEMBLY



● **Disassembly sequence**

1 Bushing
2 Bolt
3 Pipe
4 Center nut
5 Rivet
6 Clip
7 Helper spring
8 Spacer
9 Rivet
10 Clip
11 Main spring

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

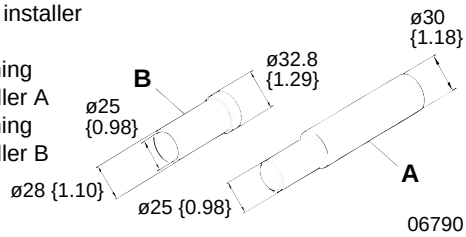
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

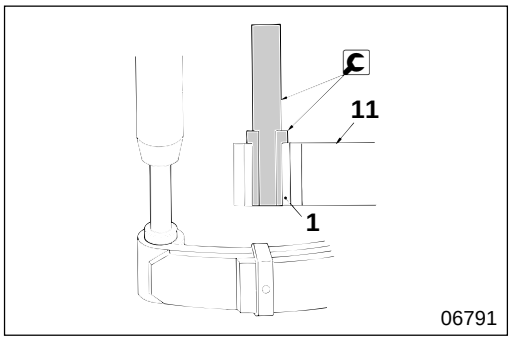
Location	Parts to be tightened	Tightening torque	Remarks
4	Center nut	69 to 93 {51 to 69, 7.0 to 9.5}	—

Special tools

Unit : mm {in.}

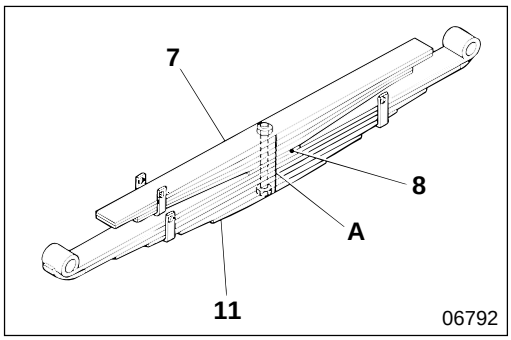
Location	Tool name and shape	Part No.	Application
1	Bushing installer **A** : Bushing installer A **B** : Bushing installer B 	MB999066 **A** : MB999067 **B** : MB999068	Removal and installation of bushing

◆ Service procedure



1 **Removal and installation of bushing**

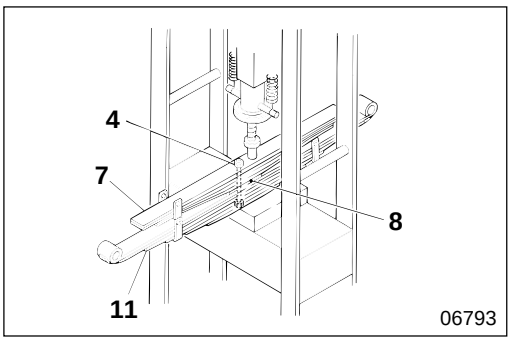
: Bushing installer



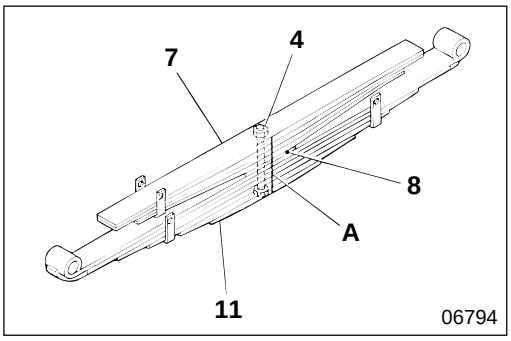
4 **Center nut**

[Removal]

- Put alignment marks **A** on the sides of helper springs **7**, spacer **8**, and main springs **11**.

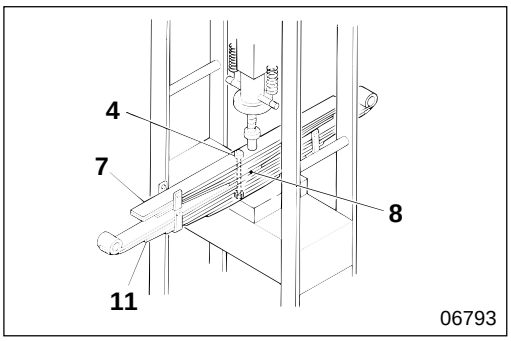


- Compress helper springs **7**, spacer **8**, and main springs **11**, then remove center nut **4**.



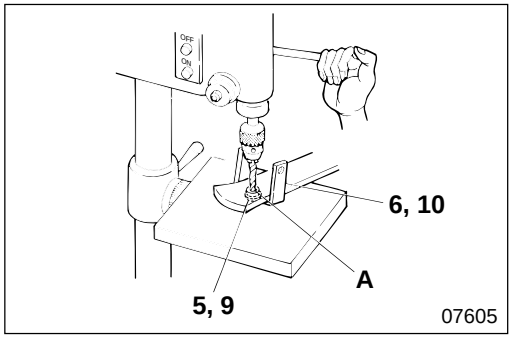
[Installation]

- Align alignment marks **A** on the sides of helper springs **7**, spacer **8**, and main springs **11**, assemble the springs, then tighten center nut **4** temporarily.



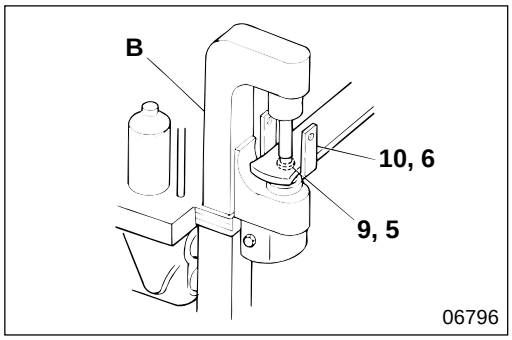
- Compress helper springs **7**, spacer **8**, and main springs **11**, then tighten center nut **4** at specified torque.

LEAF SPRING ASSEMBLY

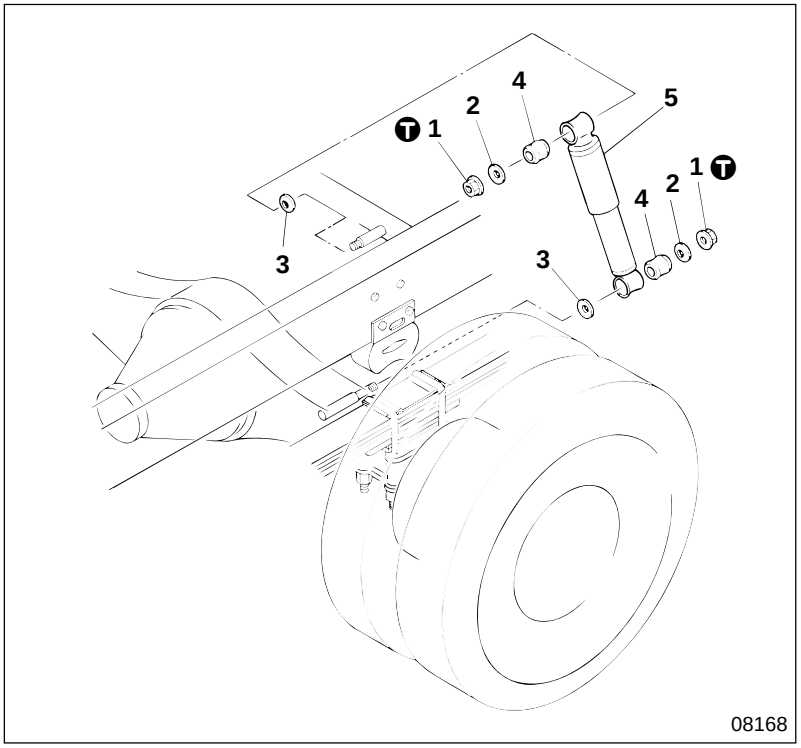


5 **9** **Rivet**

[Removal]
Drill out staked ends **A** of rivets **5**, **9** on a drill press, then remove clips **6**, **10**.



[Installation]
Using riveting machine **B**, mount clips **10**, **6** by staking rivets **9**, **5**.



● **Removal sequence**

1 Nut
2 Washer
3 Washer
4 Rubber bushing
5 Shock absorber

● **Installation sequence**

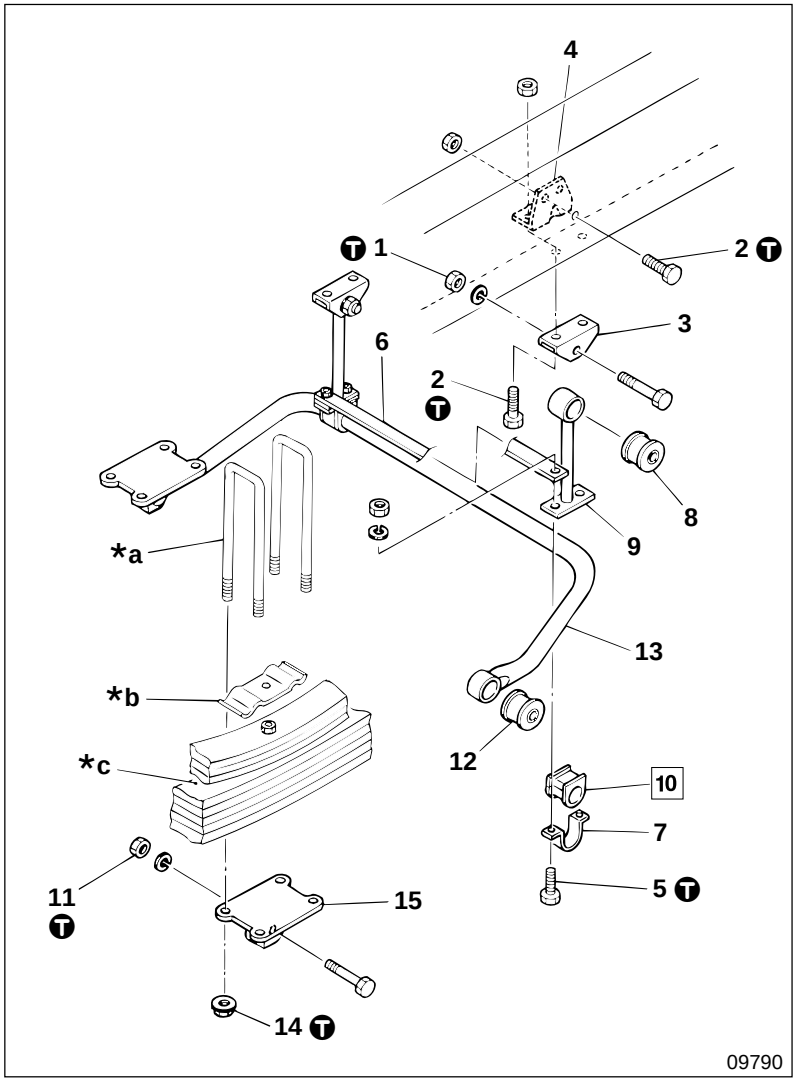
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Shock absorber mounting)	26.4 to 33.3 {20 to 25, 2.7 to 3.4}	—

STABILIZER < FE >



● **Removal sequence**

1 Nut
2 Bolt
3 Stabilizer bracket
4 Stabilizer reinforcement
5 Bolt
6 Plate
7 Clamp
8 Bushing
9 Stabilizer hanger
10 Stabilizer bushing
11 Nut
12 Bushing
13 Stabilizer bar
14 U-bolt nut
15 Stabilizer bracket

***a** : U-bolt
***b** : Spring pad
***c** : Leaf spring assembly

● **Installation sequence**

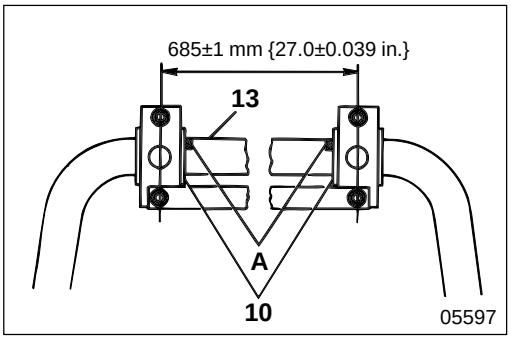
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Stabilizer bracket mounting)	33 to 49 {25 to 36, 3.4 to 5.0}	—
2	Bolt (Stabilizer reinforcement mounting)	38 to 59 {28 to 43, 3.9 to 6.0}	—
5	Bolt (Clamp and stabilizer hanger mounting)	12 to 15 {8.7 to 11, 1.2 to 1.5}	—
11	Nut (Stabilizer bracket mounting)	33 to 49 {25 to 36, 3.4 to 5.0}	—
14	U-bolt nut (U-bolt mounting)	339±51 {250±38, 34.6±5.2}	—

◆ Service procedure



10 **Stabilizer bushing**

Mount stabilizer bushings **10** with their end surfaces aligned with marks **A** on stabilizer bar **13**.

MITSUBISHI
FUSO

Group 35A
Brake

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-35A

INDEX

SPECIFICATIONS 35A- 2

STRUCTURE AND OPERATION 35A- 3

TROUBLESHOOTING 35A-24

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Replacement of Brake Fluid 35A-30
- Air Bleeding of Brake System 35A-32
- Inspection and Adjustment of Brake Pedal Free Play 35A-36
- Inspection and Adjustment of Clearance between Brake Pedal and Floor Panel 35A-36
- Inspection and Replacement of Disc Brake Pad 35A-37
- Drum Brake Lining Thickness Inspection and Replacement 35A-40
- Inspection of Brake Shoe Clearance 35A-40
- Inspection of Brake Booster (Master Vac) 35A-41

BRAKE MASTER CYLINDER 35A-46

BRAKE PEDAL AND BRAKE BOOSTER (MASTER VAC) 35A-48

FRONT WHEEL BRAKE
- < FE639 (EXCEPT FE639□6) :DISC BRAKE > 35A-50
- < FE639□6, FE64□:DISC BRAKE > 35A-54
- < DRUM BRAKE > 35A-58

REAR WHEEL BRAKE
- < DRUM BRAKE > 35A-64
- < DISC BRAKE > 35A-72

VACUUM PUMP 35A-76

EXHAUST BRAKE SYSTEM 35A-78
- INTAKE SILENCER 35A-80

SPECIFICATIONS

< Service Brake Equipment >

Item \ Vehicle model			FE639, FG	FE64□
Brake booster (Master vac)	Type		Tandem type	
	Diaphragm diameter in.		ø8+ø9	ø9+ø10
	Manufacturer		BOSCH BRAKING SYSTEMS CO., LTD.	
Brake master cylinder	Inner diameter mm {in.}		ø30.16 {1.19}	ø31.75 {1.25}
	Stroke	Front mm {in.}	17.4 {0.69}	16.0 {0.63}
		Rear mm {in.}	14.6 {0.57}	16.0 {0.63}
	Manufacturer		BOSCH BRAKING SYSTEMS CO., LTD.	
Vacuum pump	Type		Vane type	
	Delivery cm^3 {cu. in.}		60 {3.66}	90 {5.49}
	Manufacturer		MITSUBISHI ELECTRIC	

< Wheel Brake >

Item \ Vehicle model			FE639 (except FE639□6)
Front	Brake type		Disc brake (Full floating type)
	Cylinder inner diameter of caliper	mm {in.}	ø51.1 {2.01}
	Disc rotor outer diameter×Thickness	mm {in.}	ø288×24 {11.3×0.94}
	Brake pad thickness	mm {in.}	12 {0.47}
Rear	Brake type		Drum brake (Dual 2-leading type)
	Inner diameter of wheel cylinder	mm {in.}	ø28.57 {1.12}
	Inner diameter of brake drum	mm {in.}	ø320 {12.6}
	Brake lining width×Thickness	mm {in.}	75×9.3 {2.95×0.37}

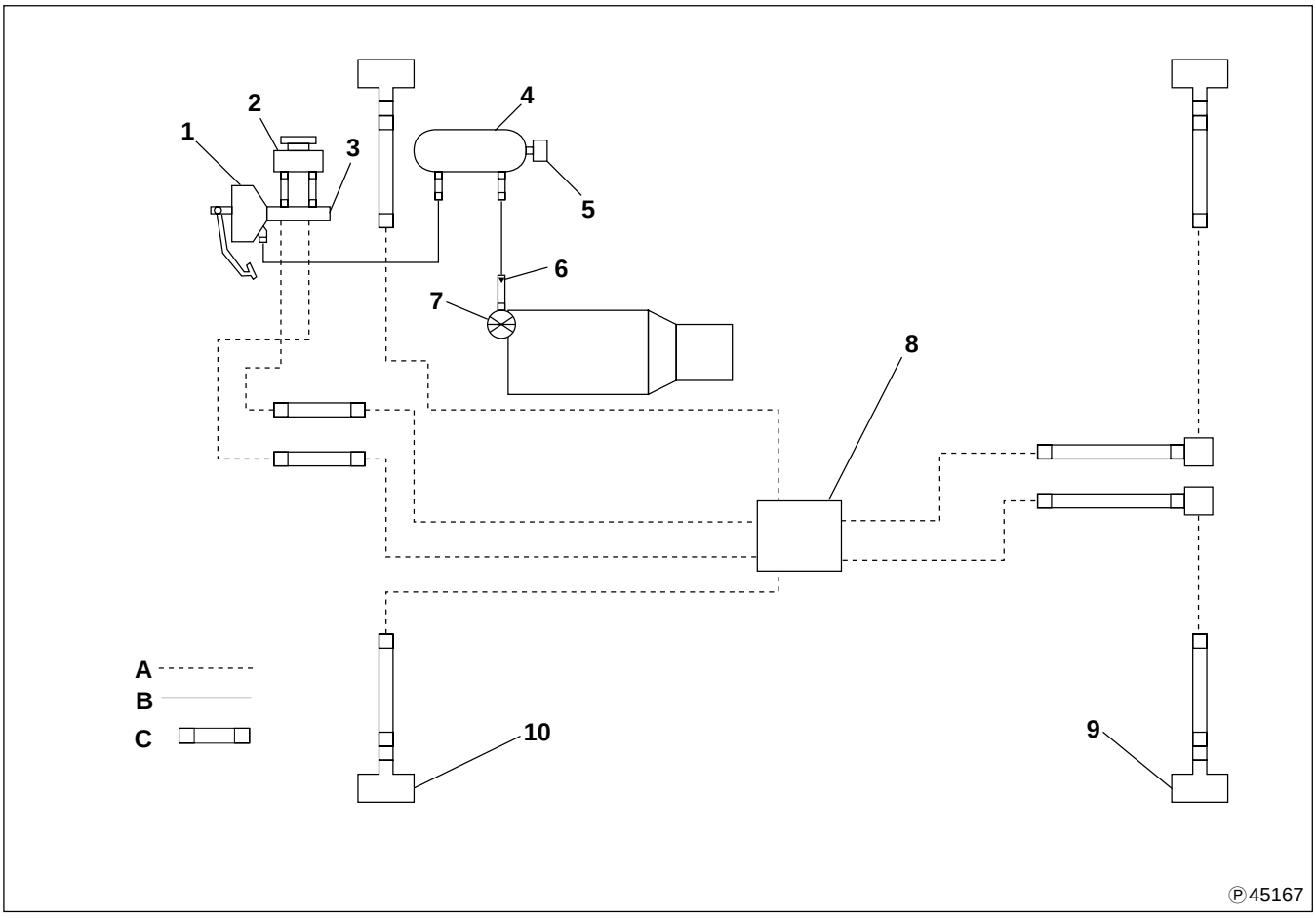
Item \ Vehicle model			FE639□6, FE64□
Front	Brake type		Disc brake (Full floating type)
	Cylinder inner diameter of caliper	mm {in.}	ø51.1 {2.01}
	Disc rotor outer diameter×Thickness	mm {in.}	ø293×40 {11.5×1.57}
	Brake pad thickness	mm {in.}	14 {0.55}
Rear	Brake type		Disc brake (Full floating type)
	Cylinder inner diameter of caliper	mm {in.}	ø51.1 {2.01}
	Disc rotor outer diameter×Thickness	mm {in.}	ø293×40 {11.5×1.57}
	Brake pad thickness	mm {in.}	14 {0.55}

Item \ Vehicle model			FG
Front	Brake type		Drum brake (2-leading type)
	Inner diameter of wheel cylinder	mm {in.}	ø31.75 {1.25}
	Inner diameter of brake drum	mm {in.}	ø320 {12.6}
	Brake lining width×thickness	mm {in.}	75×9.3 {2.95×0.37}
Rear	Brake type		Drum brake (Dual 2-leading type)
	Inner diameter of wheel cylinder	mm {in.}	ø28.57 {1.12}
	Inner diameter of brake drum	mm {in.}	ø320 {12.6}
	Brake lining width×thickness	mm {in.}	75×9.3 {2.95×0.37}

< Exhaust Brake System >

Item	Specifications
Control system	Combined electric and vacuum
Valve type	Butterfly valve type

Brake System

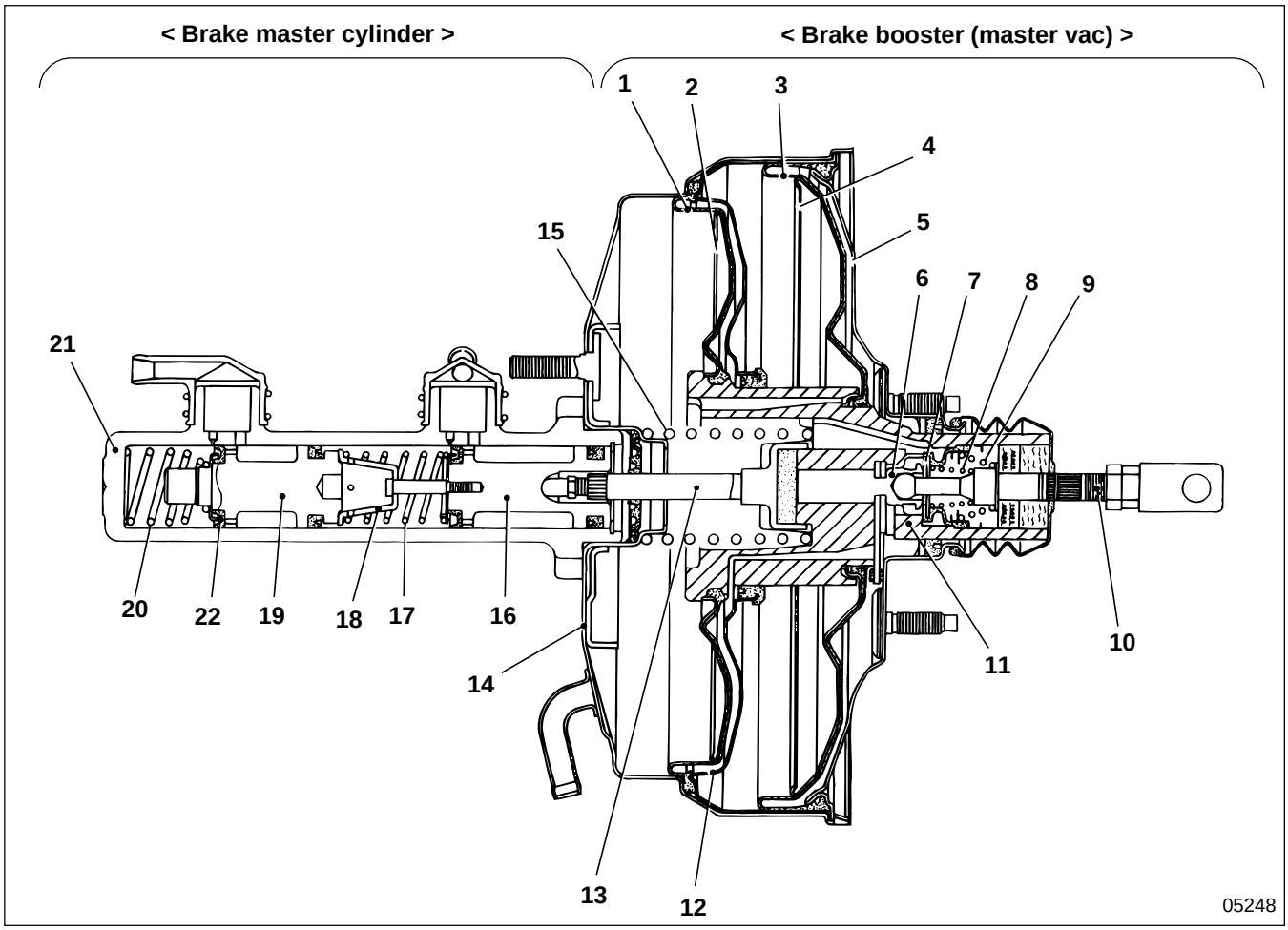


1 Brake booster (master vac)
2 Fluid tank
3 Brake master cylinder
4 Vacuum tank
5 Vacuum switch
6 Check valve
7 Vacuum pump
8 Hydraulic unit
9 Rear wheel brake
10 Front wheel brake

A : Fluid line
B : Vacuum line
C : Hose

The brake system is a vacuum servo all-wheel brake type, with brake booster (master vac) **1**.

Brake Booster (Master Vac) and Brake Master Cylinder



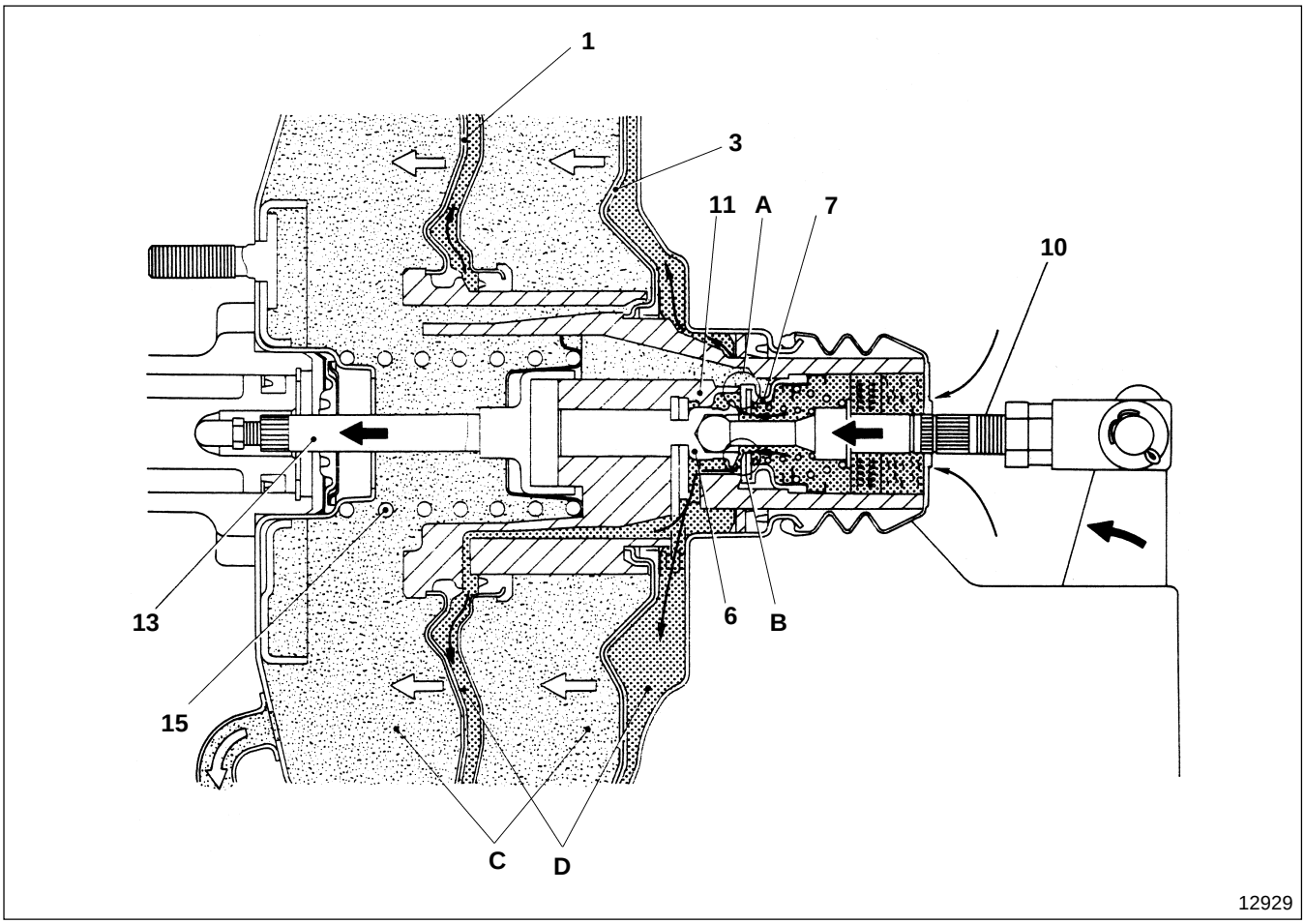
< Brake booster (master vac) >

- **1** Front diaphragm
- **2** Front diaphragm plate
- **3** Rear diaphragm
- **4** Rear diaphragm plate
- **5** Rear shell
- **6** Valve plunger
- **7** Poppet
- **8** Poppet spring
- **9** Valve return spring
- **10** Operating rod
- **11** Valve body
- **12** Center plate
- **13** Push rod
- **14** Front shell
- **15** Diaphragm plate spring

< Brake master cylinder >

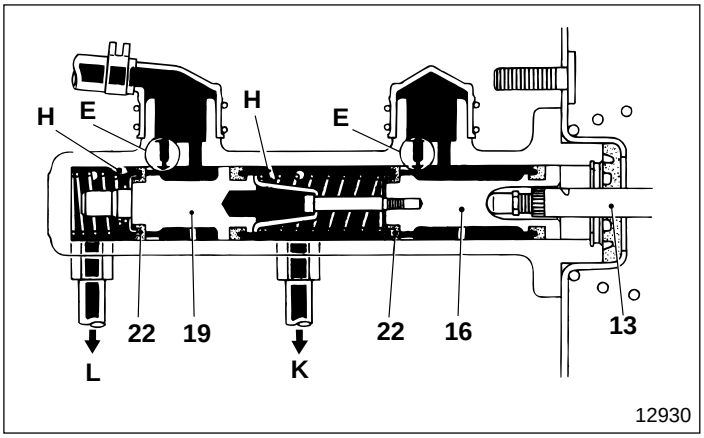
- **16** Primary piston
- **17** Primary piston return spring
- **18** Retainer
- **19** Secondary piston
- **20** Secondary piston return spring
- **21** Cylinder body
- **22** Packing cup

● **When depressing brake pedal**



Action of brake booster (master vac)

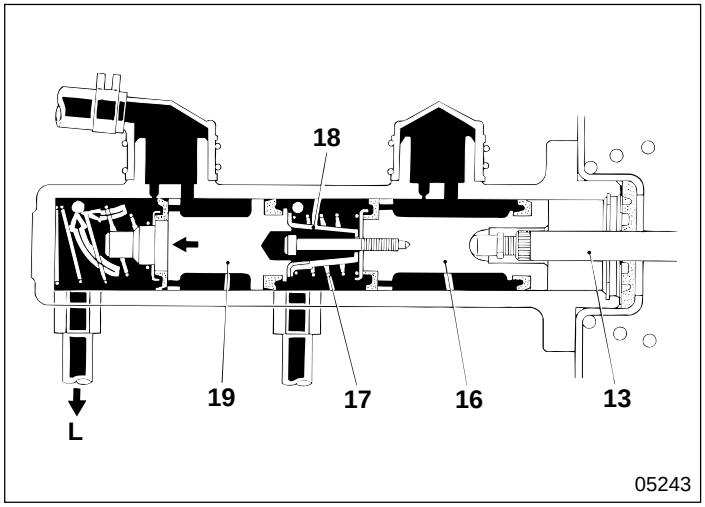
- When the brake pedal is released, chambers **C** and **D** are subjected to the vacuum created by the vacuum pump.
- Depressing the brake pedal activates operating rod **10**, placing poppet **7** in tight contact with the seat of valve body **11**. This action closes vacuum valve **A**, cutting off the vacuum to chamber **D**.
- Depressing the brake pedal further separates valve plunger **6** from poppet **7**, opening breather valve **B** permitting atmospheric pressure to flow into chamber **D**, producing a pressure difference between chambers **C** and **D**.
- This pressure difference between chambers **C** and **D** presses front diaphragm **1** and rear diaphragm **3**, boosting the depressing force.
- This boosted pedal depression force overcomes the repercussive force of diaphragm plate spring **15**, presses push rod **13**, and actuates the brake master cylinder.



Action of brake master cylinder

- Push rod **13** pushes in primary piston **16** and secondary piston **19**, and packing cup **22** passes return port **E**, generating hydraulic pressure in chamber **H**, feeding the fluid to the respective brake systems.

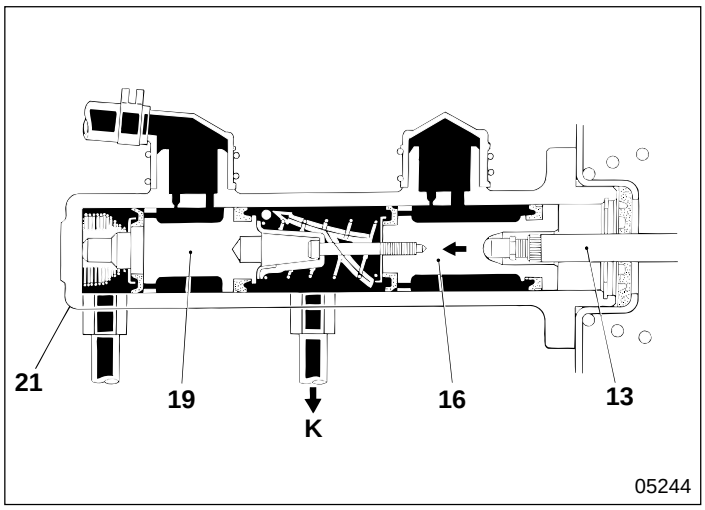
  K : To the front brake system
  L : To the rear brake system



● **Fluid leakage in the front brake system**

- Depressing the brake pedal makes push rod **13** push in primary piston **16**. However, if the brake fluid in the front brake system leaks, hydraulic pressure is not generated in the front brake system.
- Depressing the brake pedal further makes primary piston **16** compress primary piston return spring **17**, causing retainer **18** to push secondary piston **19**, thus generating hydraulic pressure only in the rear brake system.

L : To the rear brake system

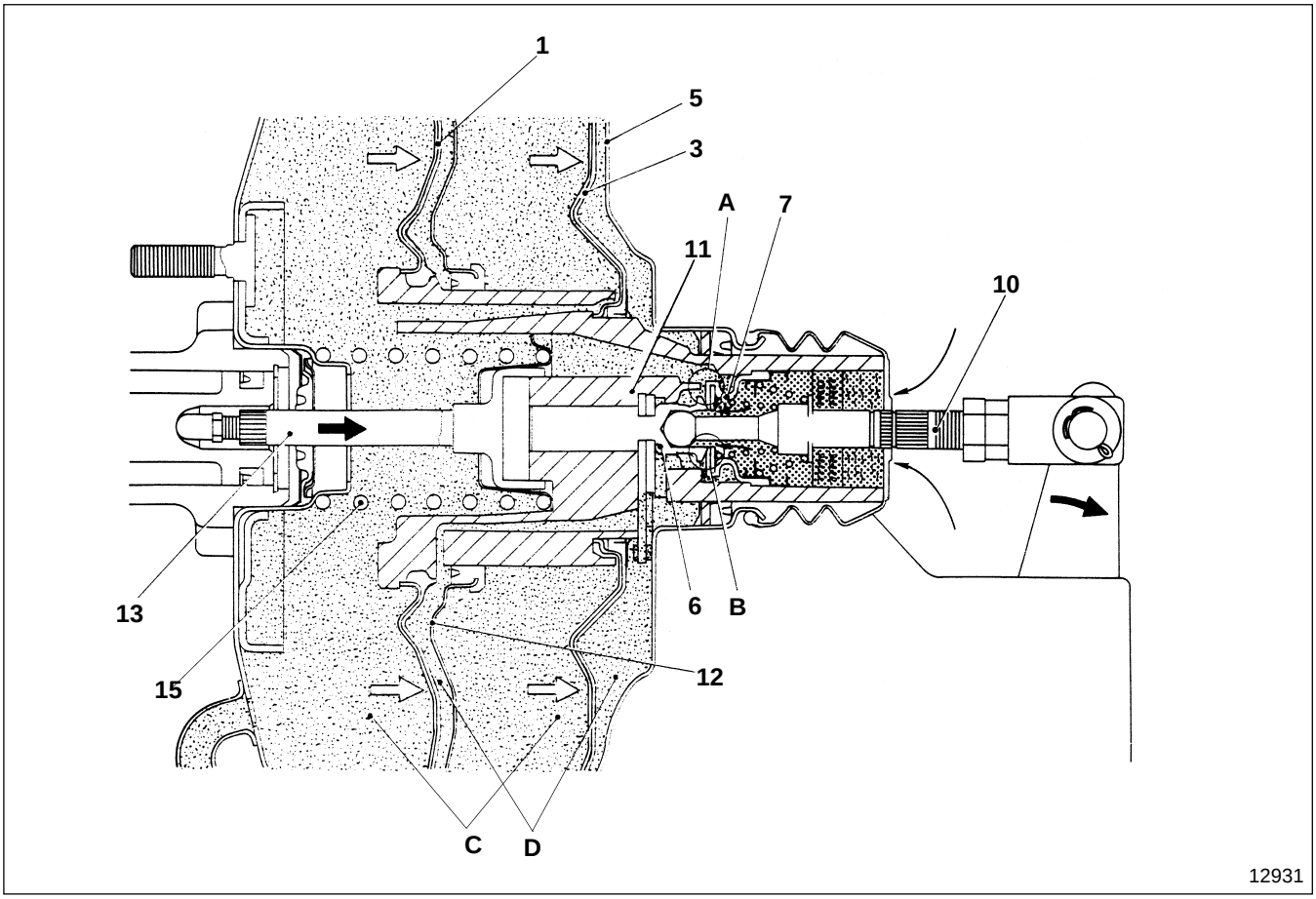


● **Fluid leakage in the rear brake system**

- Depressing the brake pedal makes push rod **13** push in primary piston **16** and secondary piston **19**. However, if the brake fluid in the rear brake system leaks, hydraulic pressure is not generated in the rear brake system.
- Depressing the brake pedal further makes the end of secondary piston **19** contact cylinder body **21**, pushing primary piston **16**, thus generating hydraulic pressure only in the front brake system.

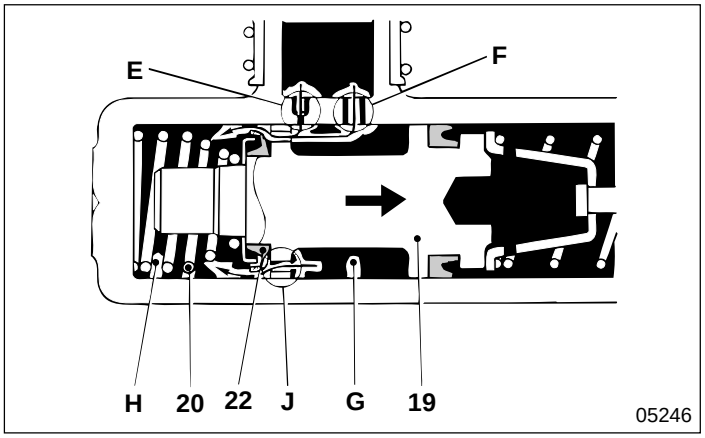
K : To the front wheel brake system

● **When releasing brake pedal**



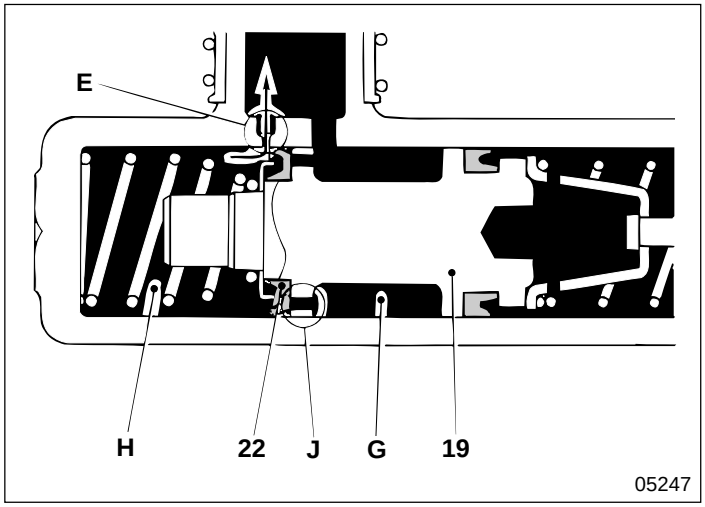
Action of brake booster (master vac)

- When the brake pedal is depressed, atmospheric air flows into chamber **D** as chamber **C** is subjected to negative pressure generated by the vacuum pump.
- When the brake pedal is released, since the pressing force acting on the operating rod **10** also is released, valve plunger **6** contacts poppet **7** tightly, closing breather valve **B** to cut off the flow of atmospheric air into chamber **D**. In addition, valve plunger separates from valve body **11** to open vacuum valve **A**. Then, the negative pressure generated by the vacuum pump creates a vacuum in chamber **D**, and the pressure difference between chambers **C** and **D** diminishes.
- This absence of a pressure difference between chambers **C** and **D**, allows rear diaphragm **3** to be pushed against the rear shell **5** by the repercussive force of diaphragm plate return spring **15**, and push rod **13** returns to its original position.



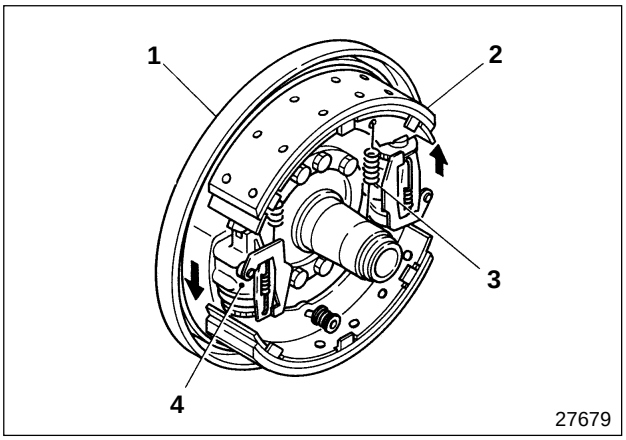
Action of brake master cylinder

- When push rod **13** returns to its original position, the repercussive force of the secondary piston return spring **20** immediately begins to return secondary piston **19**. However, the brake fluid delivered from the brake master cylinder cannot return quickly due to the absence of a pressure difference between chambers **H** and **G**.
- As secondary piston **19** begins to return, the pressure in chamber **H** becomes lower than that in chamber **G**, and this pressure difference deforms packing cup **22** to open a small passage **J**. Then, the brake fluid in chamber **G** is drawn into chamber **H**.



- When secondary piston **19** returns to its original position, the pressure difference between chambers **G** and **H** is diminished, and packing cup **22** closes the small passage **J**. The hydraulic oil in the brake pipe flows from chamber **H** to the fluid tank via return port **E**.
- The same operation takes place also on the primary side.

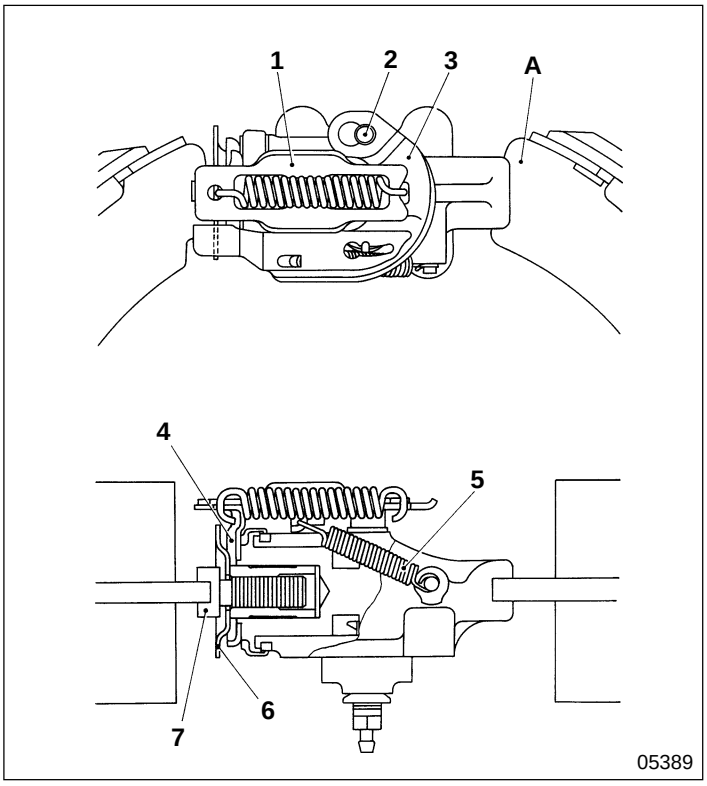
Front Drum Brake Assembly



1 Back plate
2 Brake shoe assembly
3 Return spring
4 Wheel cylinder assembly

The front drum brake assembly has two-leading brakes installed, and with single action wheel cylinder assembly **4**, the action coming from leading shoes when brake shoe assembly **2** is forward provides increased braking force through its independent double action.

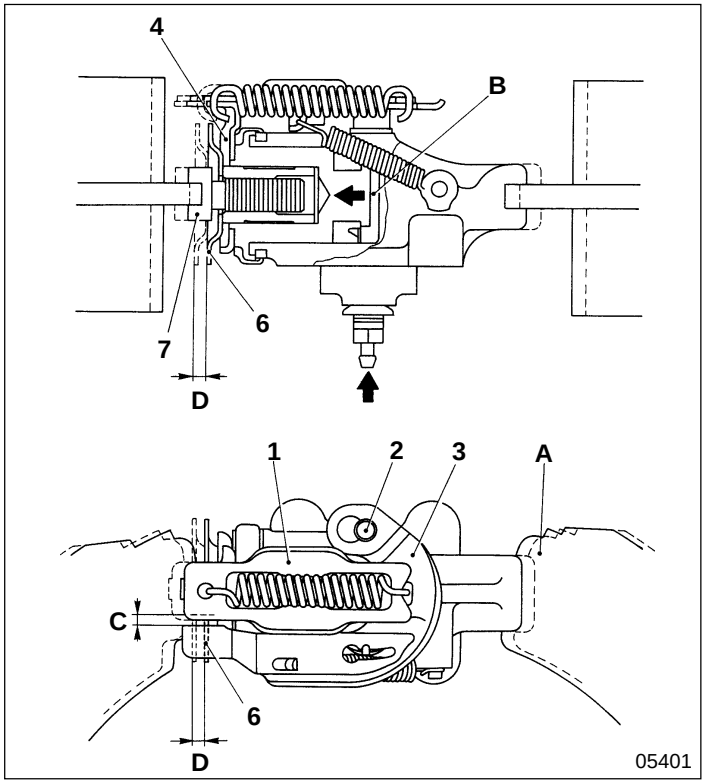
● **Wheel cylinder assembly**



1 Spring and fitting
2 Pin
3 Lever
4 Piston assembly
5 Set spring
6 Adjuster assembly
7 Adjusting screw

A : Brake shoe assembly

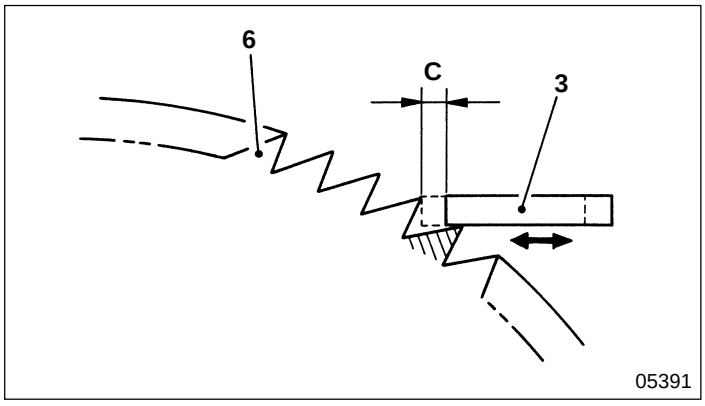
The wheel cylinder assembly is equipped with an auto adjusting mechanism to adjust the gap resulting from wear between the brake lining and brake drum, each time the brakes are applied.



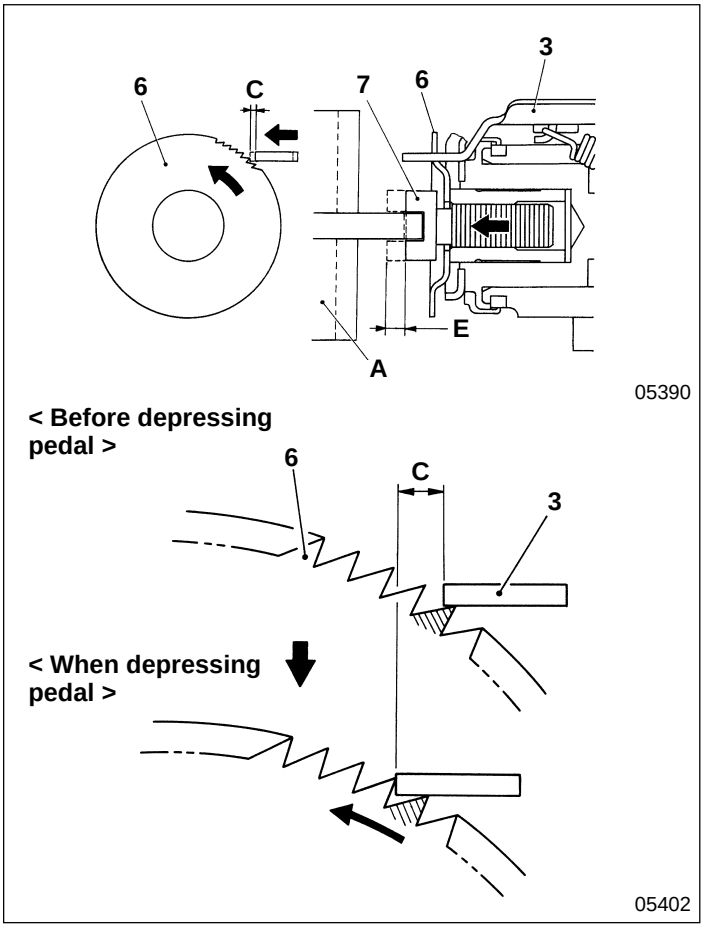
● **Automatic adjustment mechanism**

Operation

- When the brake pedal is pushed, hydraulic pressure from the brake master cylinder enters chamber **B**, driving out piston assembly **4** and pulling spring and fitting **1**. Lever **3** interlocks with spring and fitting **1**, rotating on pin **2**.
  C : Level travel
  D : Protrusion of piston assembly

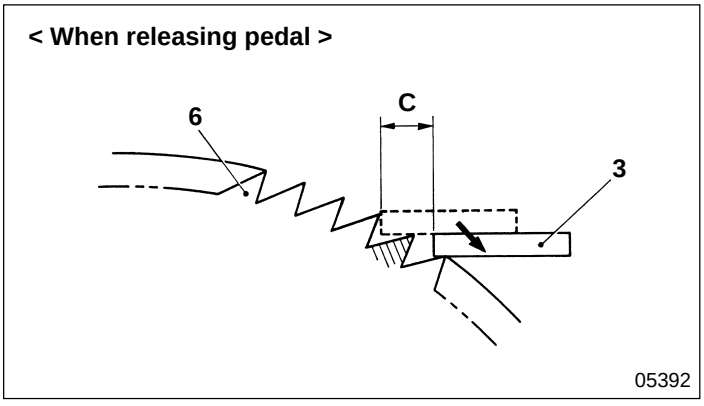


- When the clearance between the brake drum and brake lining is correct, adjuster assembly **6** does not rotate even when brakes are applied, as there is no action from lever **3**.
  C : Lever travel



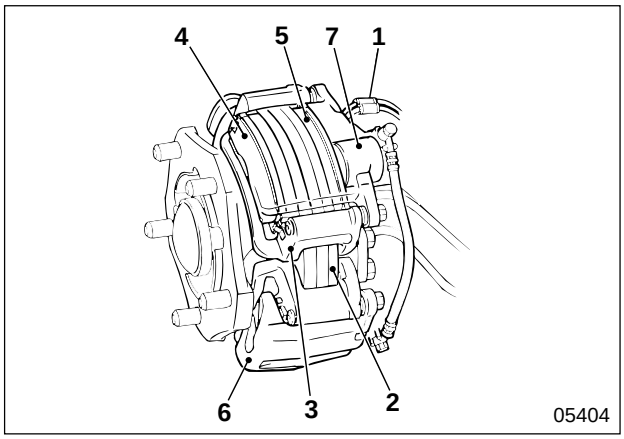
- When the clearance between the brake drum and brake lining increases, movement of piston assembly **4** and lever **3** increase.
  C : Lever travel
  E : portrusion of adjustor screw

- The force of lever **3** increases the rotation of adjuster assembly **6** and the force of screw of adjuster assembly ejects adjusting screw **7**, and brake shoe assembly **A** expands.



- By depressing brake pedal adjuster assembly **6** keep its rotated position while lever **3** goes back to the position deviated one step, and adjust the gap between the brake drum and brake lining correctly.
  C : Lever travel

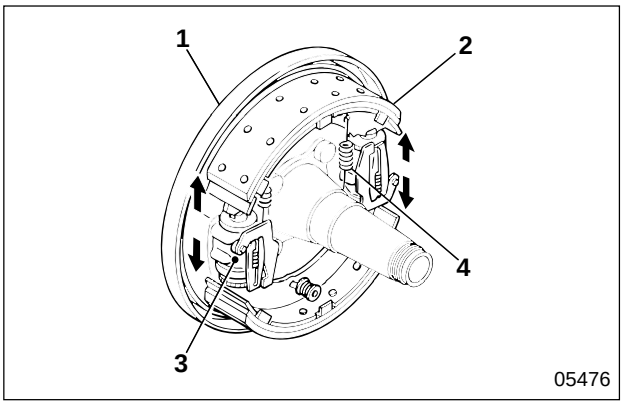
Front Disc Brake



1 Brake pad wear indicator
2 Disc rotor
3 Torque member
4 Outer pad
5 Inner pad
6 Caliper
7 Piston

Inner pad **5** is fitted with brake pad wear indicator **1** that gives warning when it is time to replace outer pad **4** and the inner pads.

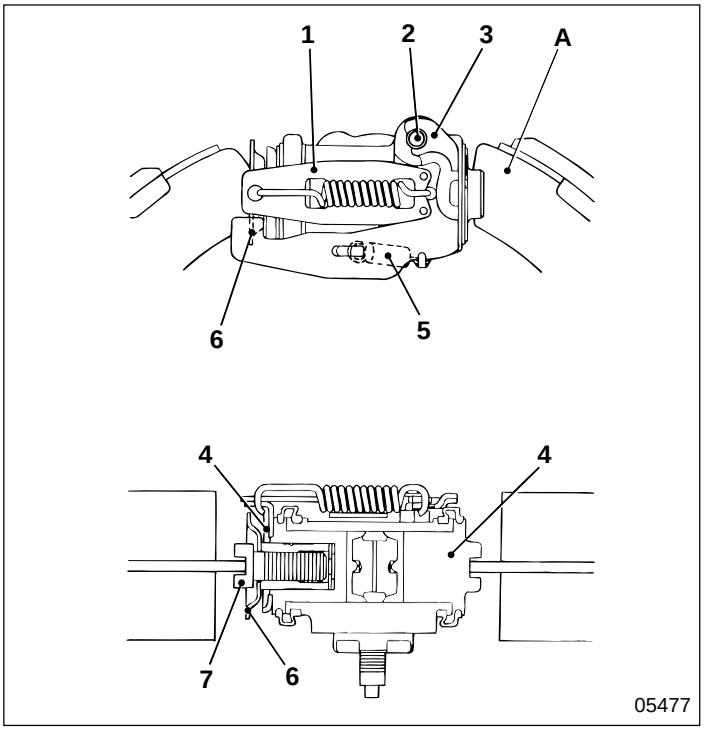
Rear Drum Brake Assembly



1 Backing plate
2 Brake shoe assembly
3 Wheel cylinder assembly
4 Return spring

The rear drum brake assembly is a dual 2-leading type brake and is fitted with wheel cylinder assembly **3**, the self-servo action of which produces a great braking force by using brake shoe assembly **2** as the leading shoe when the vehicle is travelling forwards.

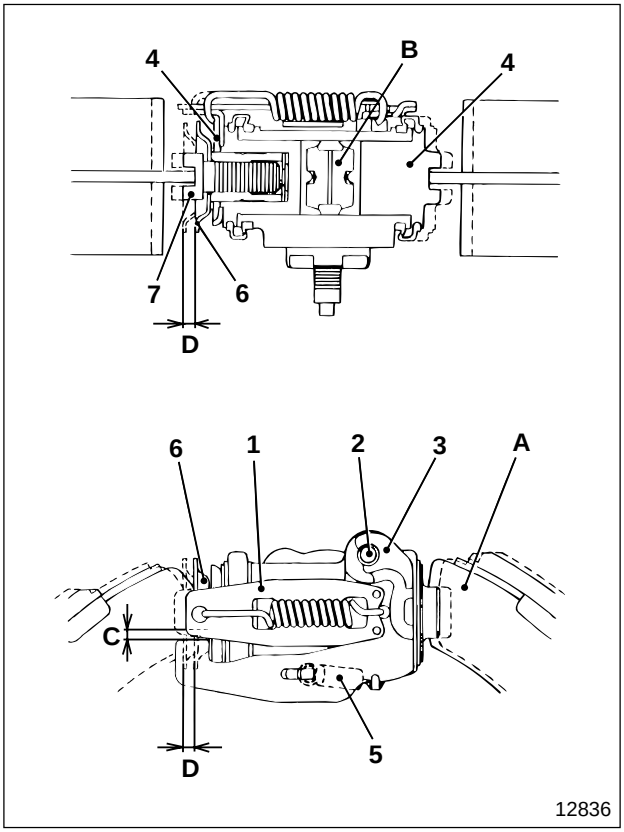
● **Wheel cylinder assembly**



1 Spring and fitting
2 Pin
3 Lever
4 Piston assembly
5 Set spring
6 Adjuster assembly
7 Adjusting screw

A : Brake shoe assembly

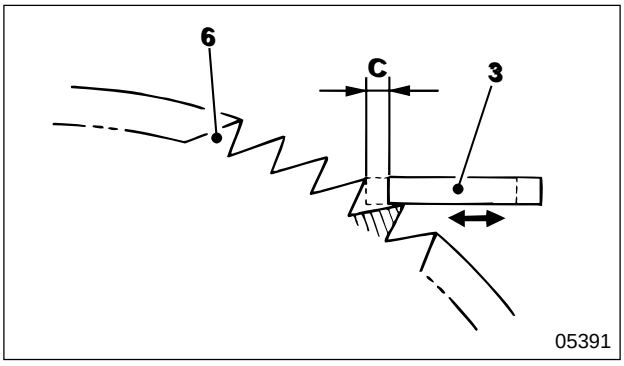
The wheel cylinder assembly has an automatic adjuster that corrects the increase in clearance that occurs between the brake lining and the brake drum, an increase caused by the wear of the brake lining. This increase occurs whenever the brake pedal is depressed.



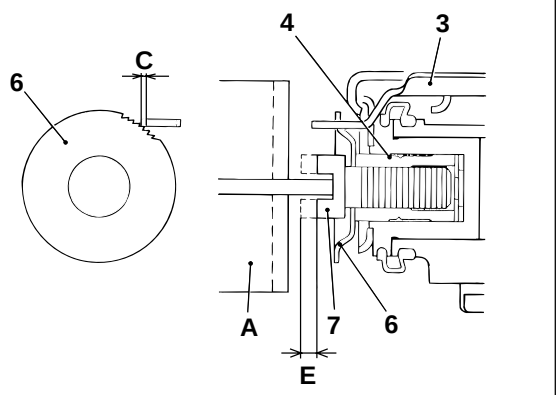
● **Automatic adjustment mechanism**

Operation

- When the brake pedal is pushed, hydraulic pressure from the brake master cylinder enters chamber **B**, driving out piston assembly **4** and pulling spring and fitting **1**. Lever **3** interlocks with spring and fitting **1**, rotating on pin **2**.
  C : Level travel
  D : Protrusion of piston assembly



- When the clearance between the brake drum and brake lining is correct, adjuster assembly **6** does not rotate even when brakes are applied, as there is no action from lever **3**.
  C : Lever travel



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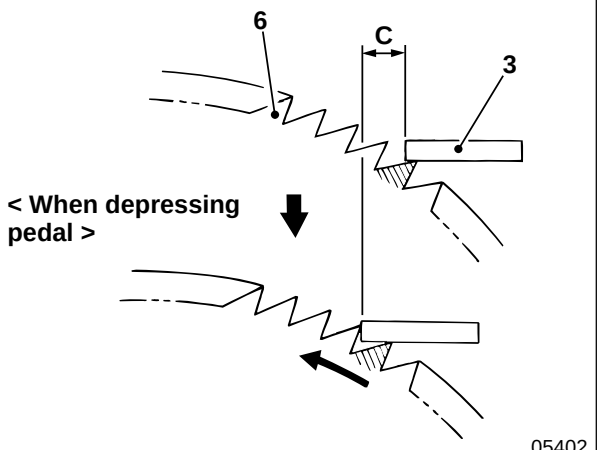
< Before depressing pedal >



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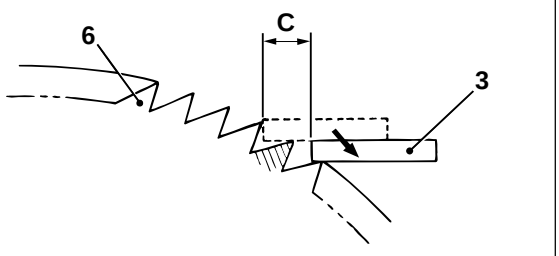
- As the clearance between the brake drum and the brake lining increases, the amount of protrusion of piston assembly **4** also increases, as does the amount of travel of lever **3**.
  C : Lever travel
  E : Protrusion of adjuster screw

- The action of lever **3** increases the rotation of adjuster assembly **6**, the screw action pushes out adjuster screw **7**, expanding brake shoe assembly **A**.

< When releasing pedal >



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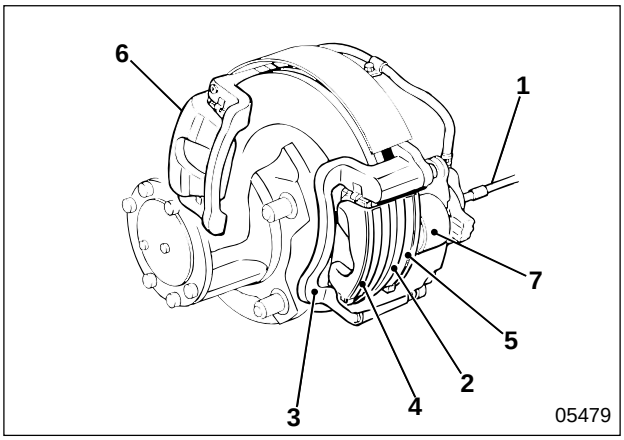
- When the brake pedal is released, since adjuster assembly **6** remains in its new position after turning, returned lever **3** enters the next position, moved by one notch. This assures correct clearance between the brake drum and the brake lining.
  C : Lever travel

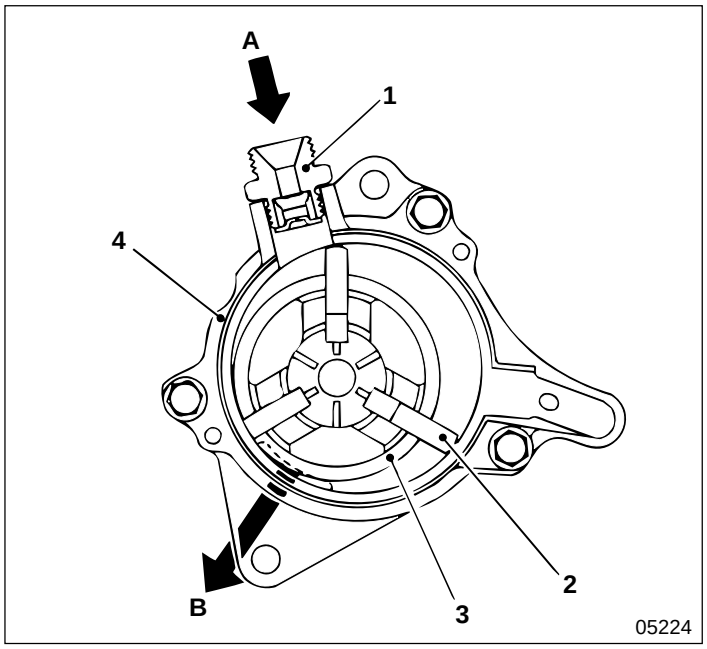
Rear Disc Brake



1 Brake pad wear indicator
2 Disc rotor
3 Torque member
4 Outer pad
5 Inner pad
6 Caliper
7 Piston

Inner pad **5** is fitted with brake pad wear indicator **1** that gives warning when it is time to replace outer pad **4** and the inner pads.

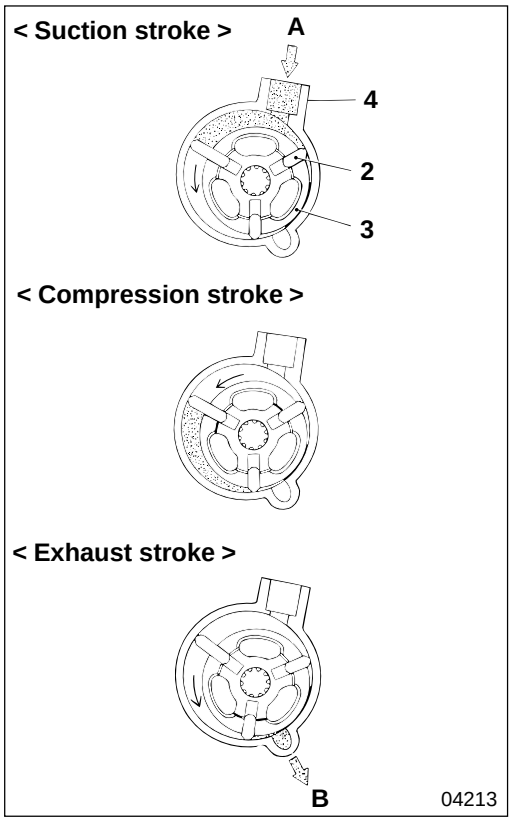
Vacuum Pump



1 Check valve assembly
2 Vane
3 Rotor
4 Housing

A : Inlet
B : Outlet

- The vacuum pump is installed on the timing gear case and is rotated by the injection pump gear or camshaft gear.
- Check valve assembly **1** is fitted to prevent the atmospheric pressure and the lubricating oil from flowing in reverse from the vacuum pump to the vacuum tank when the engine is stopped.



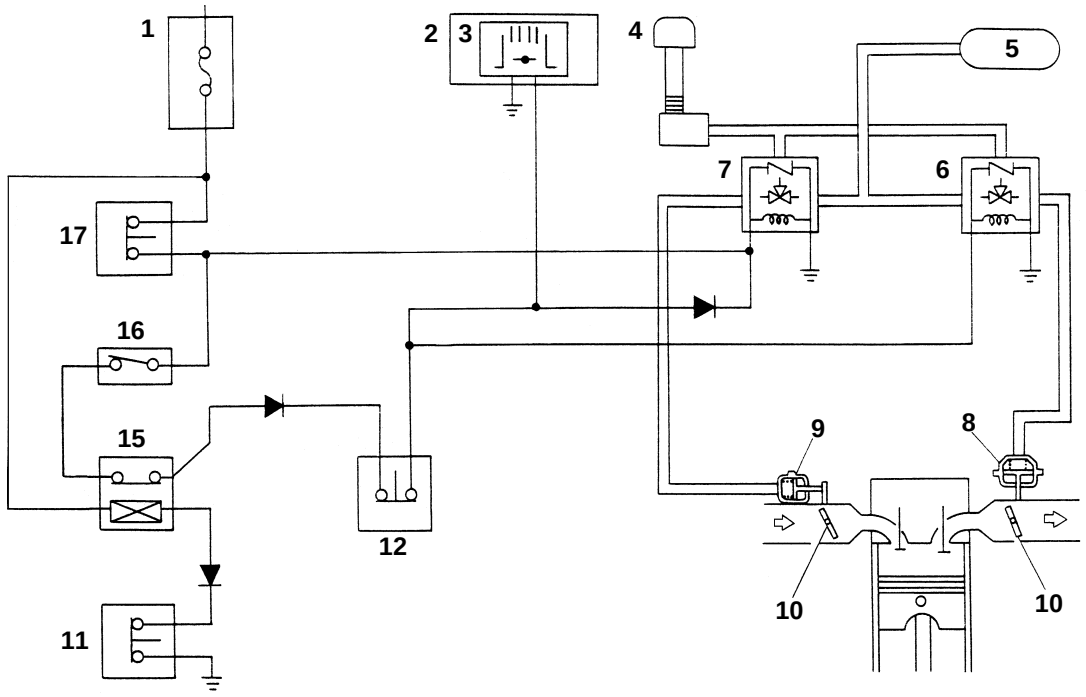
● **Operation**

- Inside cylindrical housing **4**, rotor **3** equipped with three vanes (movable blades) **2** rotates, pressing the vanes against the inside surface of the housing by centrifugal force.
- Since rotor **3** is eccentric with respect to housing **4**, as the rotor rotates, the atmospheric pressure of the vacuum tank is drawn in from inlet **A** and discharges from outlet **B** by the gradual compression of the air. This repetition of the suction, compression and exhaust strokes generates a vacuum, realizing a near-vacuum in the vacuum tank.
- The engine oil that lubricates and cools the inside of housing **4** is returned, along with air pressure, through outlet **B** to the oil pan.

M E M O

Exhaust Brake System

< Manual transmission >



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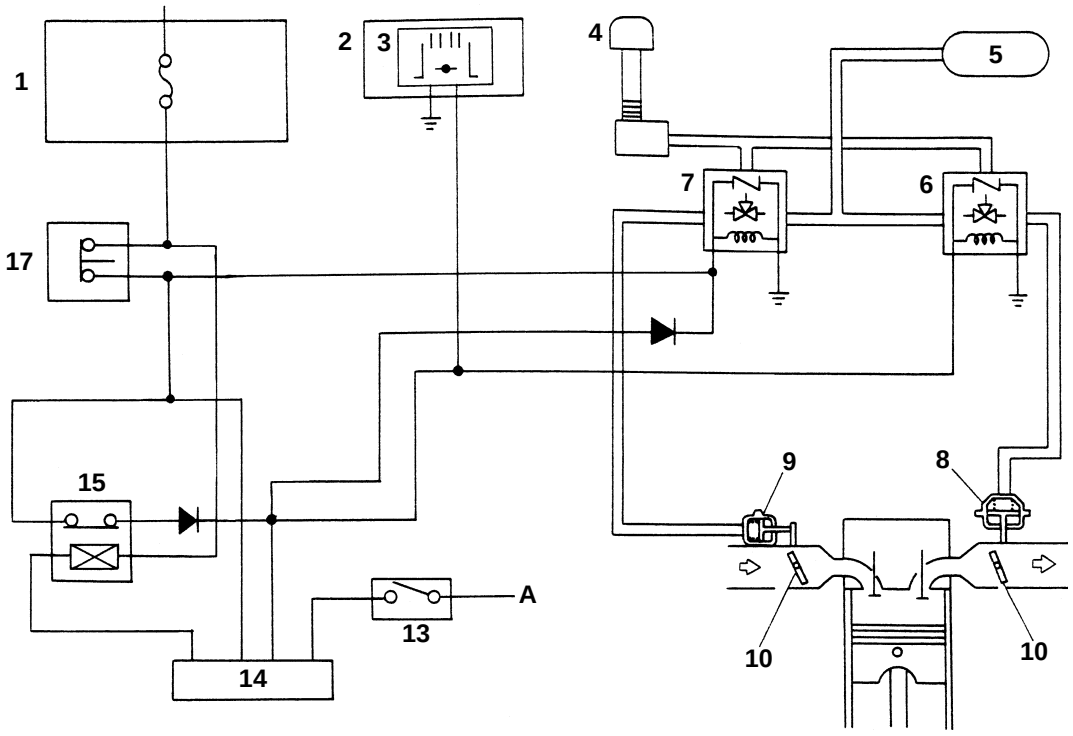
< Automatic transmission >



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1 Fuse box
2 Meter cluster
3 Exhaust brake indicator lamp
4 Air cleaner
5 Vacuum tank
6 Exhaust brake 3-way magnetic valve
7 Intake shutter 3-way magnetic valve
8 Exhaust brake unit
9 Intake shutter
10 Butterfly valves
11 Neutral switch < Manual transmission >
12 Clutch switch < Manual transmission >
13 Inhibiter switch < Automatic transmission >
14 Automatic transmission electric control unit < Automatic transmission >
15 Exhaust brake cut relay
16 Exhaust brake switch < Manual transmission >
17 Accelerator switch
18 Clutch switch < Manual transmission >

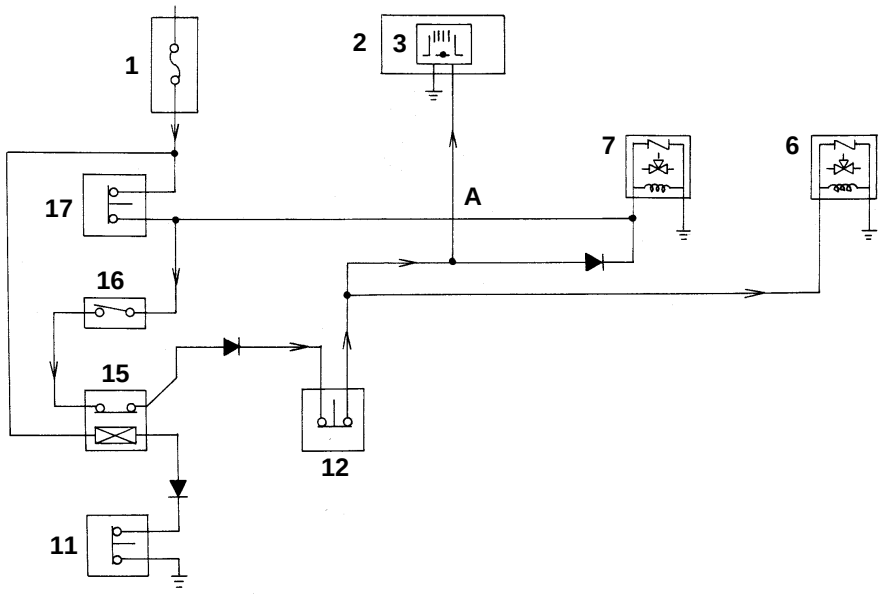
A : From starter switch

- The exhaust brake uses pressure to push and return the piston in the exhaust stroke. This pressure is generated when the exhaust pipe is shut and the pressure in the exhaust pipe increases.
- A butterfly valve type exhaust brake unit **8** is fitted as an auxiliary brake to assist the foot brake. Intake shutter **9** is fitted to reduce the suction noise generated when the exhaust brake is operated.
- When the exhaust brake switch **16** is turned ON, excitation of the coil of exhaust brake 3-way magnetic valve **6** closes the atmospheric valve and opens the vacuum valve. This makes the vacuum in the vacuum tank act on the exhaust brake unit **8** which closes butterfly valve **10**, activating the exhaust brake.

● **Operation**

Electrical System

< Manual transmission >



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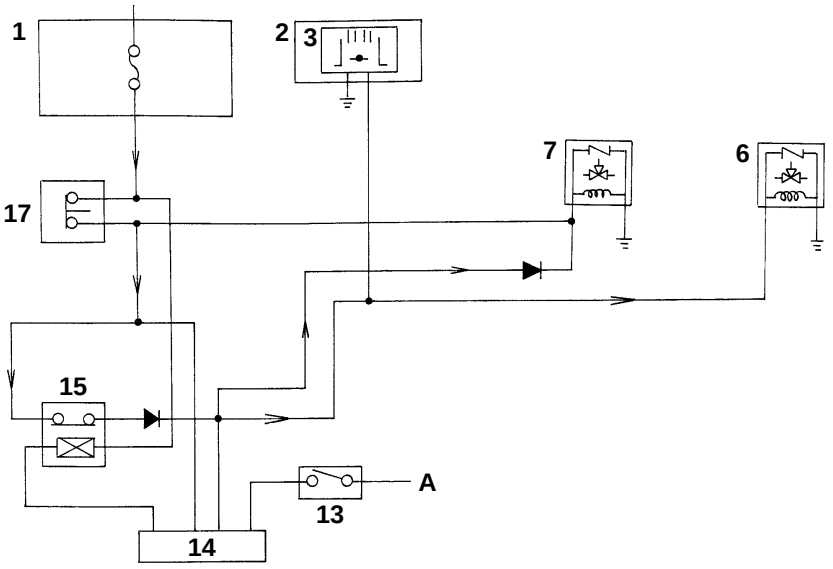
< Automatic transmission >



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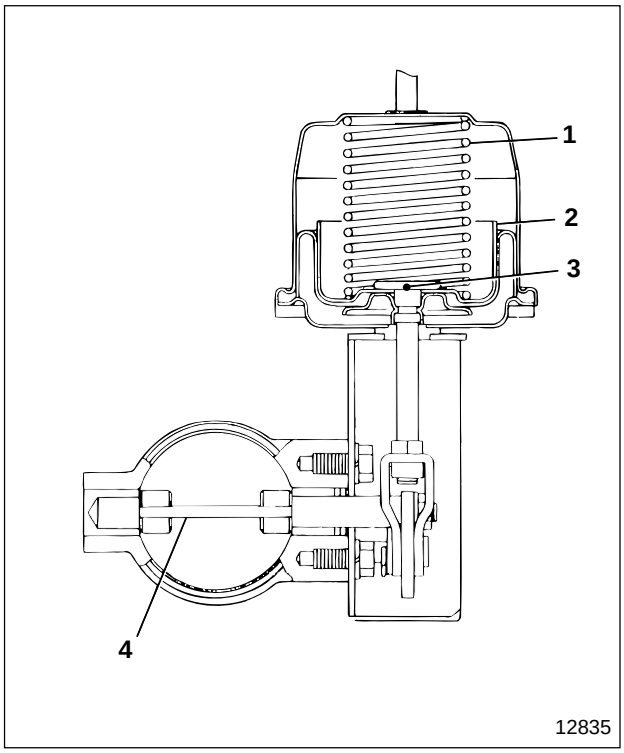
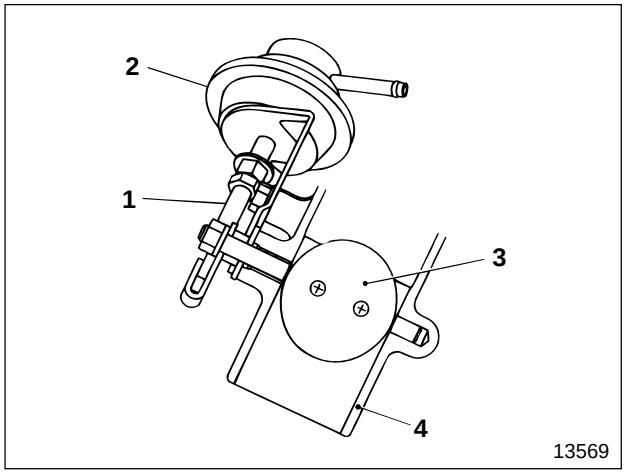
When exhaust brake switch **16** is turned ON, exhaust brake indicator lamp **3** within meter cluster **2** lights up and the exhaust brake 3-way magnetic valve **6** operates.
At this time, depressing the clutch pedal (clutch switch **12** OFF) or the accelerator pedal (accelerator switch **17** OFF) temporarily releases the exhaust brake. When the transmission is in neutral (neutral switch **11** or inhibiter switch **13** ON) because the vehicle is stopped or for some other reason, exhaust brake cut relay **15** operates, releasing the exhaust brake after approximately 10 seconds.
If the accelerator pedal is depressed and released after the exhaust brake is released by the exhaust brake cut relay, the exhaust brake operates again, and after approximately 10 seconds is released.

Exhaust Brake Unit



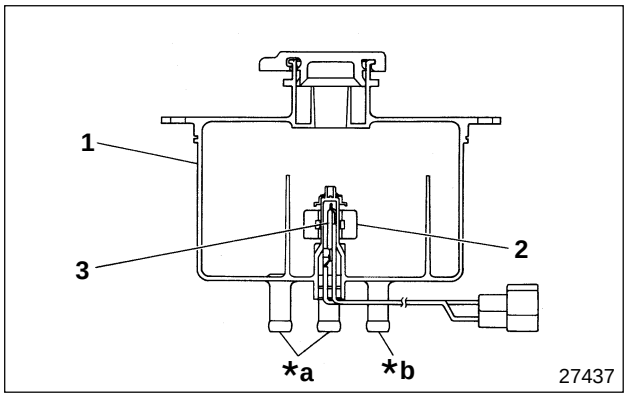
1 Spring
2 Diaphragm
3 Push rod
4 Butterfly valve

Intake Silencer



1 Push rod
2 Actuator assembly
3 Butterfly valve
4 Intake pipe

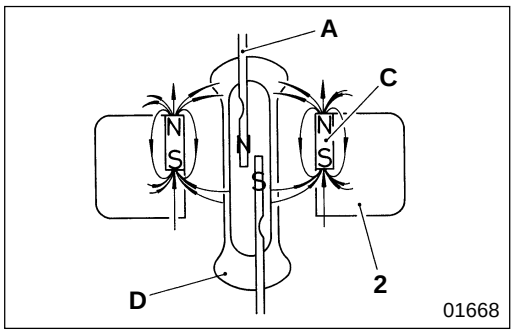
● **Brake fluid level switch**



1 Fluid tank
2 Float
3 Brake fluid level switch

***a** : For brakes
***b** : For clutch

- Brake fluid level switch **3**, installed on fluid tank **1**, monitors the brake fluid level in the fluid tank. If the brake fluid level drops below the specified level, float **2** moves and lights up the warning lamp within the meter cluster to alert the driver.



- If the brake fluid level in fluid tank **1** drops and float **2** drops lower than level **L**, magnetic force **B** that passes through the contact point (ferromagnetic body **A**), increases generating north and south poles at the ends of the contact points. Therefore, the contact points pull each other and overcome the repercussive force of the springs of the contact points, forming an electric circuit.
  C : Magnet
  D : Glass

M E M O

TROUBLESHOOTING

● Wheel Brake

Possible causes	Symptoms	One-sided braking	One-sided braking							Noise and shock when brakes are applied	
			Braking shoe return slow after releasing brake pedal	Braking force difference between left and right	Braking force unstable	Lock points difference	Braking force insufficient	Brake pedal stroke reduced	Noise and shock when brakes are applied	Noise generated when wheels are rotating, with vehicle jacked up	Continuous noise generated while braking (at low speed)
Tires	Air pressures uneven, etc. Gr 31	○									
	Left and right tire sizes different Gr 31	○									
Axle	Wheel hub bearing adjusted incorrectly Gr 26A, 26B, 27	○									○
	Left and right wheelbase difference excessive Gr 26A, 26B, 27	○									
	Wheel alignment incorrect Gr 26A, 26B	○									
	Kingpin bushing worn Gr 26A, 26B										
	Trunnion bearings worn Gr 26B										
Wheel brakes	Backing plate ledge surface rough		○		○						
	Backing plate ledge surface not smooth										
	Backing plate deformed, mounted incorrectly				○						
	Oil or water on brake lining or brake pad surfaces			○			○				
	Brake lining or brake pad changed in quality or wrong material used			○							
	Brake lining or brake pad unevenly worn or surface roughened			○							
	Brake lining or brake pad fading (surface change in material)						○				
	Brake lining or brake pad worn out completely										○
	Abrasive on brake lining or brake pad										
	Brake lining or brake pad worn										
	Brake lining or brake pad contact incorrect			○		○	○				
	Brake lining ground radius irregular					○					
	Wheel cylinder malfunctioning		○	○				○		○	
	Shoe return spring fatigued or broken		○							○	
	Brake drum or disc rotor worn unevenly			○							
	Brake drum or disc rotor warped				○						
	Brake drum or disc rotor worn					○					
	Brake drum or disc rotor surface roughened						○				
	Brake drum or disc rotor roughness excessive								○		

Possible causes	Symptoms	One-sided braking	One-sided braking							Noise and shock when brakes are applied	
		One-sided braking	Braking shoe return slow after releasing brake pedal	Braking force difference between left and right	Braking force unstable	Lock points difference	Braking force insufficient	Brake pedal stroke reduced	Noise and shock when brakes are applied	Noise generated when wheels are rotating, with vehicle jacked up	Continuous noise generated while braking (at low speed)
Wheel brakes	Brake drum or disc rotor glazed										
	Brake drum cracked								○		
	Brake drum clogged by foreign particles									○	
	Brake drum deformed or eccentric										
	Disc rotor thickness uneven										
	Brake shoe deformed or damaged							○			
	Brake shoe twisted or tilted										
	Shoe hold down cup broken									○	
	Moving parts greased insufficiently								○		
Brake pedal	Brake pedal stroke faulty (45 mm {1.77 in.} or more at 490 N {110 lbf, 50 kgf} foot pressure)						○				
	Brake pedal adjusted incorrectly, looseness excessive							○			
	Brake pedal return faulty										
	Brake pedal free play inadequate										
	Linkage rusted or deformed										
	Return spring fatigued or broken										
	Master vac operating rod pushing up										
Brake fluid system	Brake fluid insufficient							○			
	Brake fluid leaking							○			
	Air lock in system							○			
	Vapor lock							○			
	Brake fluid return insufficient because brake pipe tightened excessively										
Vacuum system	Degree of vacuum reduced						○				
Master vac	Master vac defective						○	○			
Brake master cylinder	Piston cup faulty							○			
	Return port clogged										

TROUBLESHOOTING

Possible causes	Symptoms	Brake drums overheating			Brakes squeaking					Remarks
		All wheels overheating	One wheel overheating	Brakes squeaking	Squeaking in new vehicle or after brake lining replacement	Action too severe	Brake pulsation/vibration	Brake pedal return faulty	Brake drags	
Tires	Air pressures uneven, etc.									Gr 31
	Left and right tire sizes different									Gr 31
Axle	Wheel hub bearing adjusted incorrectly		○	○			○			Gr 26A, 26B, 27
	Left and right wheelbase difference excessive									Gr 26A, 26B, 27
	Wheel alignment incorrect									Gr 26A, 26B
	Kingpin bushing worn						○			Gr 26A
	Trunnion bearings worn						○			Gr 26B
Wheel brakes	Backing plate ledge surface rough								○	
	Backing plate ledge surface not smooth		○							
	Backing plate deformed, mounted incorrectly					○				
	Oil or water on brake lining or brake pad surfaces									
	Brake lining or brake pad changed in quality or wrong material used									
	Brake lining or brake pad unevenly worn or surface roughened									
	Brake lining or brake pad fading (surface change in material)					○				
	Brake lining or brake pad worn out completely									
	Abrasive on brake lining or brake pad			○						
	Brake lining or brake pad worn			○						
	Brake lining or brake pad contact incorrect				○					
	Brake lining ground radius irregular									
	Wheel cylinder malfunctioning		○						○	
	Shoe return spring fatigued or broken		○						○	
	Brake drum or disk rotor worn unevenly									
	Brake drum or disk rotor warped									
	Brake drum or disk rotor worn									
	Brake drum or disk rotor surface roughened									
	Brake drum or disk rotor roughness excessive									
	Brake drum or disk rotor glazed					○				

Possible causes / Symptoms		Brake drums overheating		Brakes squeaking							Remarks
		All wheels overheating	One wheel overheating	Brakes squeaking	Squeaking in new vehicle or after brake lining replacement	Action too severe	Brake pulsation/vibration	Brake pedal return faulty	Brake drags		
Wheel brakes	Brake drum cracked										
	Brake drum clogged by foreign particle										
	Brake drum deformed or eccentric						○				
	Disc rotor thickness uneven						○				
	Brake shoe deformed or damaged					○					
	Brake shoe twisted or tilted		○								
	Shoe hold down cup broken										
	Moving parts greased insufficiently										
Brake pedal	Brake pedal stroke faulty (45 mm {1.77 in.} or more at 490 N {110 lbf, 50 kgf} foot pressure)										
	Brake pedal adjusted, looseness excessive										
	Brake pedal return faulty	○									
	Brake pedal free play inadequate								○		
	Linkage rusted or deformed							○			
	Return spring fatigued or broken							○			
	Master vac operating rod pushing up							○			
Brake fluid system	Brake fluid insufficient										
	Brake fluid leaking										
	Air lock in system										
	Vapor lock										
	Brake fluid return insufficient because brake pipe tightened excessively		○								
Vacuum system	Degree of vacuum reduced										
Master vac	Master vac defective	○							○		
Brake master cylinder	Piston cup faulty	○							○		
	Return port clogged	○							○		

● Exhaust Brake

Symptoms / Possible causes		Exhaust brake does not work	Exhaust brake does not release	Remarks
Vacuum system	Degree of vacuum insufficient	○		
	Pipe crushed	○		
3-way magnetic valve	Does not work	○	○	Gr 54
Exhaust brake unit	Valve assembly does not work	○	○	
	Valve assembly shaft stuck	○	○	
	Vacuum chamber does not work	○		
Electric system	Electric system faulty	○	○	Gr 54

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

Replacement of Brake Fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Air bleeder	Front disc brake < FE >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Front wheel cylinder < FG >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Rear wheel cylinder < FE639 (except FE639□6), FG >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Rear disc brake < FE639□6, FE64□ >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—

Fluid

Location	Points of application	Specified fluid	Quantity
—	Fluid tank	Brake fluid (SAE J1703f or FMVSS No. 116 DOT3)	As required

WARNING

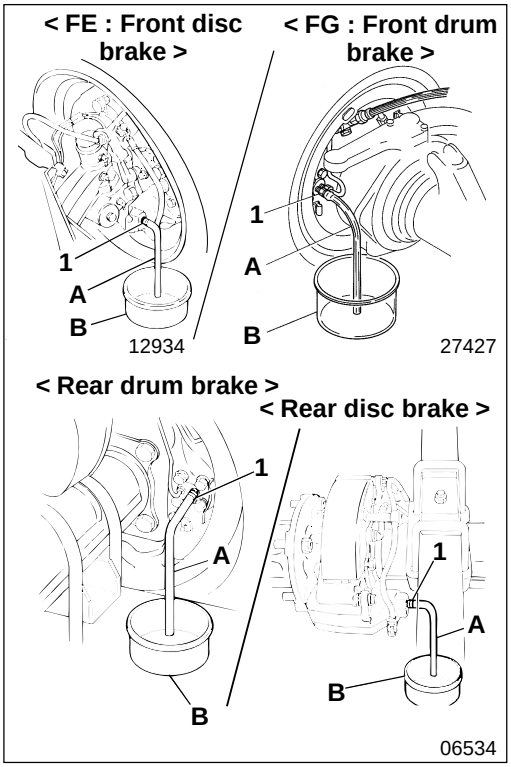
- **The clutch fluid system and the brake fluid system use the fluid tank in common. Therefore, replacement and air bleeding of the clutch fluid must be carried out simultaneously with that of the brake fluid. Gr 21**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in ineffective clutch and brake operations.**
- **If you use a container for adding brake fluid, keep it solely for that purpose.**

CAUTION

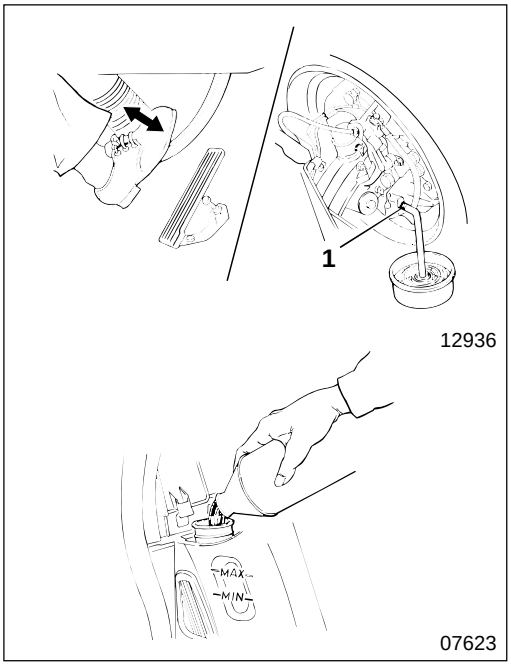
- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

NOTE

Supply and maintain the brake fluid level to the “MAX” level of the fluid tank.



- Start the engine and let it idle until you complete brake fluid replacement.
- Connect vinyl pipes **A** : one to the front disc brake < FE >, the front drum brake < FG > one to the rear drum brake < FE639 (except FE639□6, FG > or the rear disc brake < FE639□6, FE64□ >.
- Put the free ends of vinyl pipes **A** into containers **B**.



- Loosen air bleeders **1** and depress the brake pedal several times to drain brake fluid completely.
- Maintaining a supply of new brake fluid up to the “MAX” level of the fluid tank, depress the brake pedal repeatedly until the old brake fluid of the brake system is replaced with new fluid, and after you complete the work, tighten each air bleeder **1** at specified torque.

- Bleed air from the brake system.
  P35A-32

ON-VEHICLE INSPECTION AND ADJUSTMENT

Air Bleeding of Brake System

Tightening torque

Unit : N·m {lbf.ft, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Air bleeder	Front disc brake < FE >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Front wheel cylinder < FG >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Rear wheel cylinder < FE639 (except FE639□6), FG >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—
		Rear disc brake < FE639□6, FE64□ >	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—

Fluid

Location	Points of application	Specified fluid	Quantity
—	Fluid tank	Brake fluid (SAE J1703f or FMVSS No. 116 DOT3)	As required

WARNING

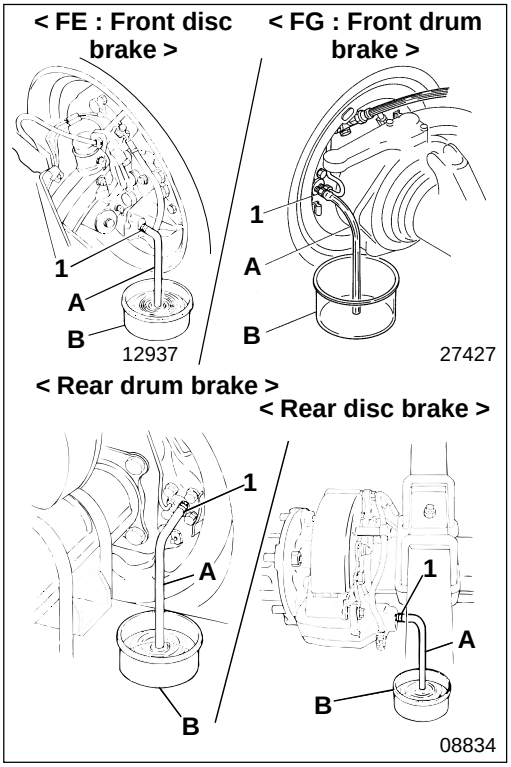
- **The clutch fluid system and the brake fluid system use the fluid tank in common. Therefore, replacement and air bleeding of the clutch fluid must be carried out simultaneously with that of the brake fluid. Gr 21**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in ineffective clutch and brake operations.**
- **If you use a container for adding brake fluid, keep it solely for that purpose.**

CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

NOTE

- **Supply and maintain the brake fluid level to the “MAX” level of the fluid tank.**
- **Make sure you maintain brake fluid at the “MAX” level of the fluid tank since the brake fluid level drops during air bleeding.**

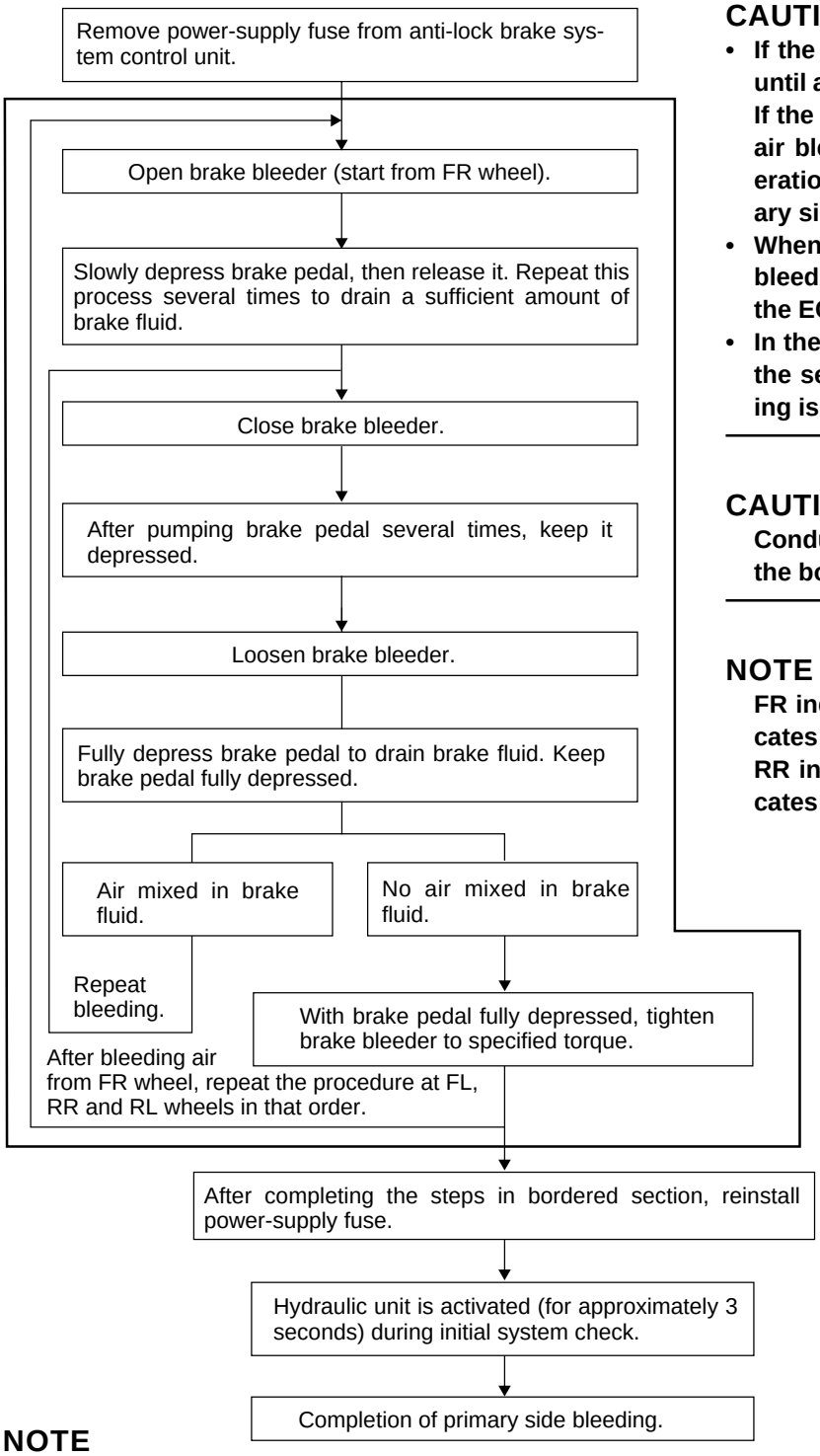


- Start the engine and let it idle until you complete air bleeding of the brake system.
- Connect vinyl pipes **A** : one to the front disc brake < FE >, the front drum brake < FG >, one to the rear drum brake < FE639, FG639 > or the rear disc brake < FE649 >.
- Put the free ends of vinyl pipes **A** into containers **B** and bleed the brake system as follows:

ON-VEHICLE INSPECTION AND ADJUSTMENT

(1) Air bleeding during regular maintenance, and hydraulic unit replacement

When air bleeding is conducted during regular maintenance or when the hydraulic unit is replaced, brake fluid flows into the secondary side (operating circuit) of the hydraulic unit. Therefore, bleed the primary side (normal circuit) by following the procedures below. In the event air enters the secondary side, bleed air by following the procedures described in (2).



CAUTION

- **If the battery is disconnected, do not reconnect until air bleeding of the primary side is complete. If the battery is reconnected before primary side air bleeding is complete, the system check operation is activated and air can enter the secondary side.**
- **When the battery must be connected prior to air bleeding, remove the power-supply fuse from the ECU.**
- **In the event air enters the secondary side, bleed the secondary side after primary side air bleeding is complete.**

CAUTION

Conduct the air bleeding operation described in the bordered section at every wheel.

NOTE

FR indicates front-axle right wheel, and FL indicates front-axle left wheel.
RR indicates rear-axle right wheel, and RL indicates rear-axle left wheel.

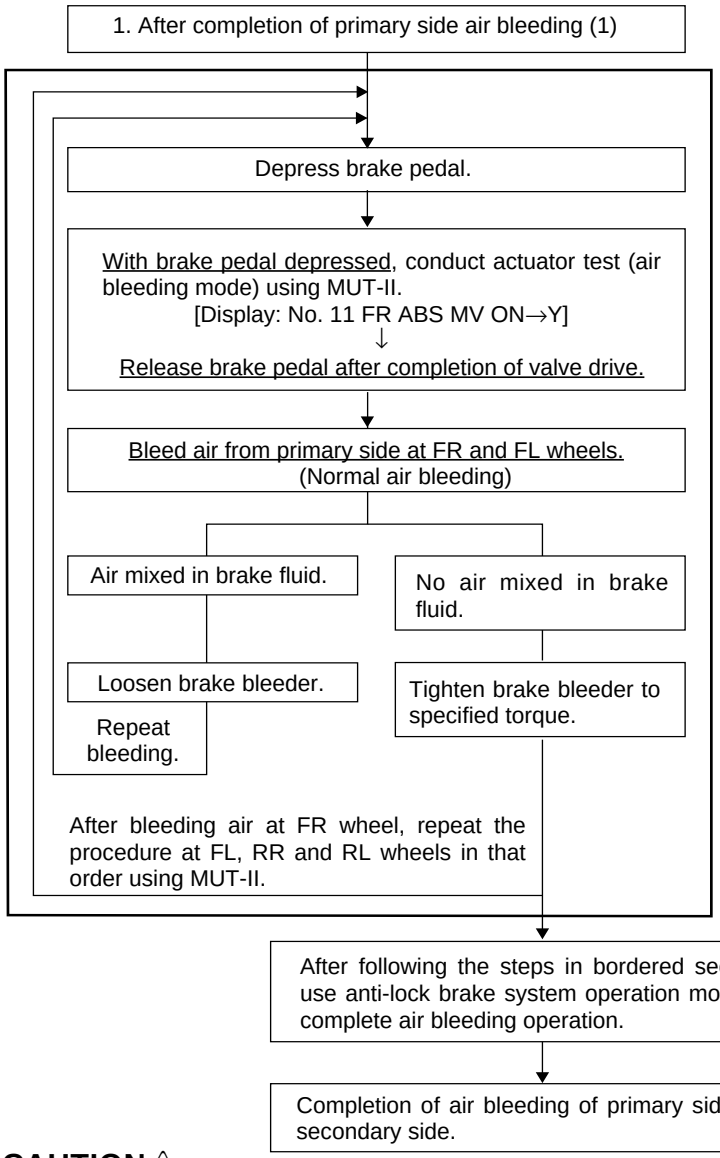
NOTE

- **The primary side (normal circuit) is a hydraulic circuit formed when the system is in non-operation.**
- **The secondary side (operating circuit) is a hydraulic circuit which connects with the primary side only when the system is in operation (when the system is in non-operation, the secondary side is disconnected from the primary side).**

(2) Air bleeding of secondary side

If the system starts operating before air bleeding of the primary side is complete, air can enter the secondary side. In the event the system accidentally starts before the completion of primary side air bleeding, follow the procedures below to bleed air. If air enters the secondary side, air flows into the primary side when the system starts, and this can extend the brake pedal stroke.
During air bleeding, use the MUT-II to conduct an actuator test (anti-lock brake system operation mode) at all wheels.

Use the MUT-II when bleeding air from the secondary side.



CAUTION⚠

Conduct air bleeding operation described in the bordered section at every wheel by using the anti-lock brake system operation mode.

CAUTION⚠

Bleed air from wheels other than FR according to the directions below.

(Refer to NOTE below)

For FL wheel
[Display: No. 12 FL ABS MV ON→Y]
↓
Bleed air from primary side at FR and FL wheels.

For RR wheel
[Display: No. 13 RR ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

For RL wheel
[Display: No. 14 RL ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

CAUTION⚠

- **Avoid continuous execution of the actuator test (anti-lock brake system drive) using the MUT-II; otherwise, excessive heating of the anti-lock brake system motor, valve and other parts can cause hydraulic unit damage.**
- **Do not conduct the actuator test with the MUT-II while bleeding air from the primary side; otherwise, air can enter the secondary side from the primary side.**
- **When mixing of air was found after air bleeding is conducted to correct an excessive brake pedal stroke, bleed air from the secondary side, too.**

NOTE

- **For the MUT-II operation for the actuator test during air bleeding, refer to section 4.**
- **If a drive operation is conducted for the FR and RL wheels at one time using the MUT-II, subsequent air bleeding of the primary side conducted at each wheel will not remove air from the secondary side.**

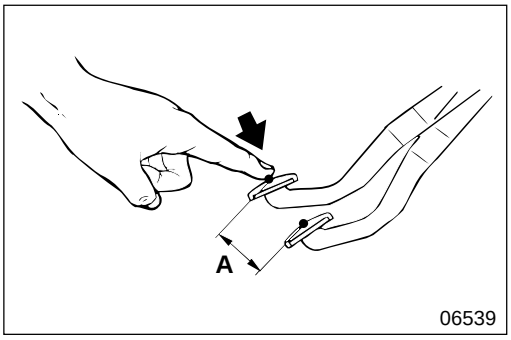
ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspection and Adjustment of Brake Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Free play of brake pedal	10 to 15 {0.39 to 0.59}	—	Adjust



[Inspection]
Check if brake pedal free play **A** confirms to the standard valve with the engine stopped. If the measured value deviates from the standard value, adjust the position of the brake pedal.

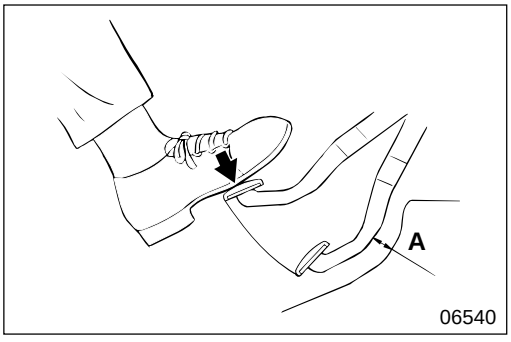
[Adjustment]
P35A-49

Inspection and Adjustment of Clearance between Brake Pedal and Floor Panel

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Clearance between brake pedal and floor panel (with pedal depressed at 490 N {110 lbf, 50 kgf})	45 {1.77} or more	—	Adjust



[Inspection]
Depress the brake pedal using 490 N {110 lbf, 50 kgf} when the engine is idling to check if clearance **A** between the brake pedal and the floor panel conforms to the standard value. If the measured value deviates from the standard value, adjust the position of the brake pedal.

[Adjustment]
P35A-49

Inspection and Replacement of Disc Brake Pad

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
5, 6	Thickness of outer and inner pads	FE639 (except FE639□6)	Front disc brake	12 {0.47}	4 {0.16}	Replace
		FE639□6	Front disc brake	14 {0.55}	4 {0.16}	Replace
		FE64□	Rear disc brake	14 {0.55}	4 {0.16}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

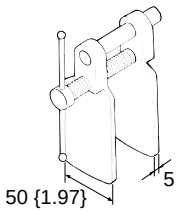
Location	Parts to be tightened	Tightening torque	Remarks
3	Slide pin bolt tightening	83.3 to 93.1 {61 to 69, 8.5 to 9.5}	Wet

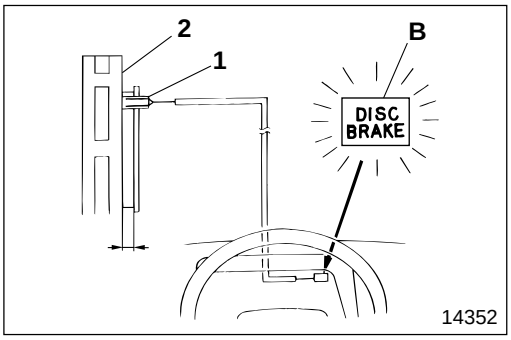
Fluid

Location	Points of application	Specified fluid	Quantity
3	Thread area of slide pin bolt	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

Special tools

Unit : mm {in.}

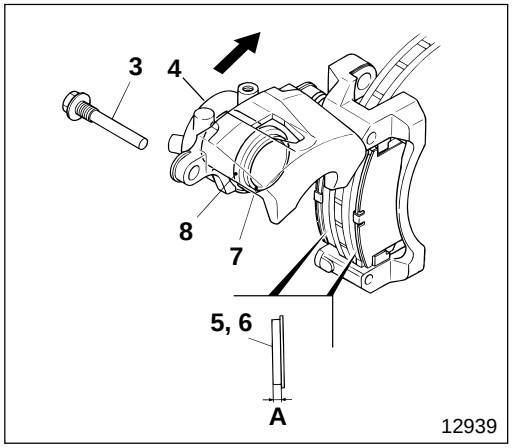
Location	Tool name and shape	Part No.	Application
—	Piston expander 	MB990520	Pushing back of piston when replacing brake pad



[Inspection]

- When brake pad thickness **A** decreases to approximately 4 mm {0.16 in.}, brake pad wear indicator **1** makes contact with disc rotor **2** and is disconnected. This lights up brake warning lamp **B** within the meter cluster, indicating that the brake pad should be replaced.

ON-VEHICLE INSPECTION AND ADJUSTMENT

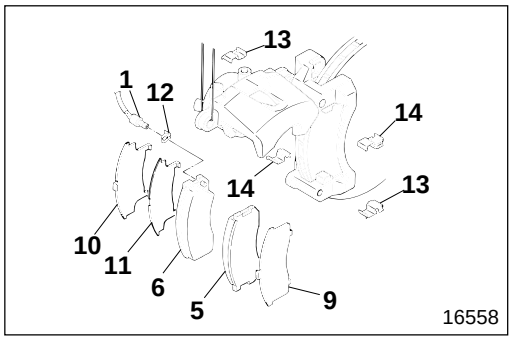


- Remove lower slide pin bolt **3**.
- Turn caliper **4** upward and secure it using wire.

CAUTION

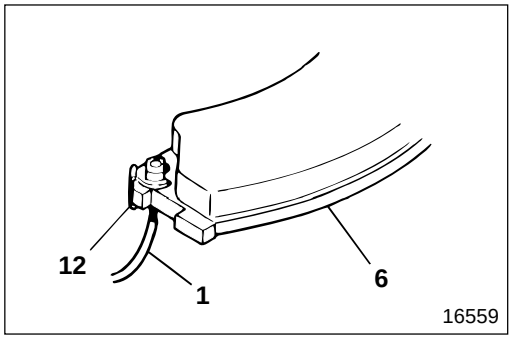
- **Make sure that you do not smear, or get dust on, the grease applied to slide pin bolt 3.**
- **Be careful when you secure caliper 4 that you do not use excessive force on the brake hose or brake pad wear indicator 1.**
- **Make sure that you secure caliper 4 securely.**

- Check thickness **A** of outer pad **5** and inner pad **6** and if the thickness is lower than the limit, replace the pads on the same axle as a unit.
- Check if any fluid is leaking from piston **7**, and check if piston boot **8** is damaged. If any fault is found, replace the faulty parts.

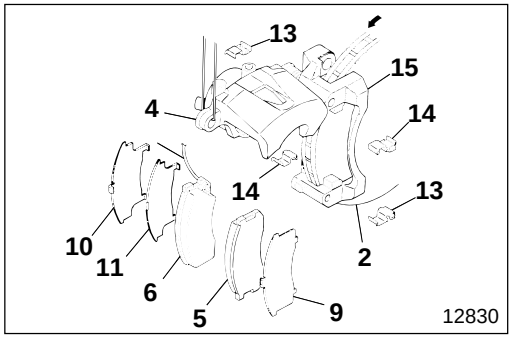


[Replacement]

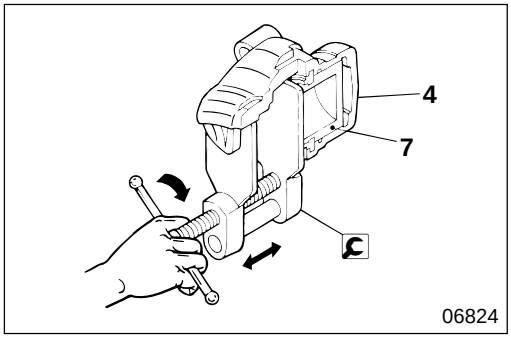
- Remove the following parts:
  - **9** Outer shim
  - **5** Outer pad
  - **10** Inner shim A
  - **11** Inner shim B
  - **12** Clip
  - **1** Brake pad wear indicator
  - **6** Inner pad
  - **13** Pad liner A
  - **14** Pad liner B



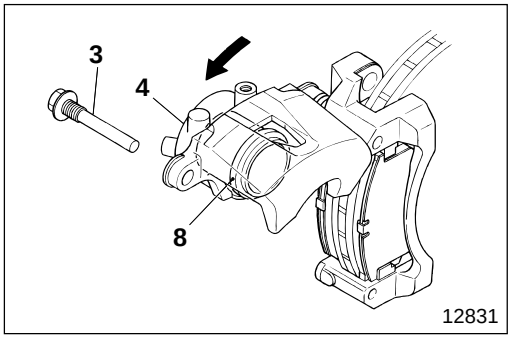
Install brake pad wear indicator **1** on inner pad **6** in the pad kit using clip **12**.



- Clean torque member **15**.
- Install the kit parts onto torque member **15** in the following order:
  - Install pad liner A **13** and pad liner B **14** on torque member **15**.
  - Install outer shim **9** on outer pad **5**.
  - Install inner shims **10**, **11** on inner pad **6**.
  - Install outer pad **5** on torque member **15**.
  - Install inner pad **6** on torque member **15**.
  - Install inner pad **6** so that brake pad wear indicator **1** faces the entrance side (when the vehicle is moving forwards) of disc rotor **2** of caliper **4**.



- Push piston **7** until it makes contact with the bottom of caliper **4**.
  : Piston expander



- Slacken off caliper **4**, taking care not to damage piston boot **8**.
- Bleed the bushing.
- Apply rubber grease thinly to the outer periphery of slide pin **3**. Apply brake fluid thinly to the thread area of slide pin bolt.
- Tighten slide pin bolt **3** at specified torque.
- Wire up the harness of brake pad wear indicator **1**. Gr 26A, 27
- Inspect drag torque. P35A-52, 56, 74
- Depress the brake pedal several times.
- Make sure that brake fluid is maintained at the “MAX” level of the fluid tank. If the level drops, add brake fluid. P35A-30

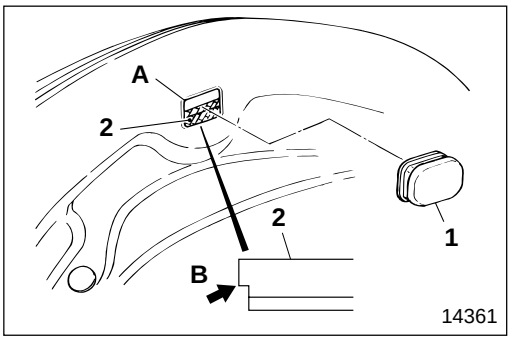
ON-VEHICLE INSPECTION AND ADJUSTMENT

Drum Brake Lining Thickness Inspection and Replacement

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Thickness of brake lining	—	4 {0.16} (Side shoulder means wear limit)	Replace



[Inspection]

NOTE

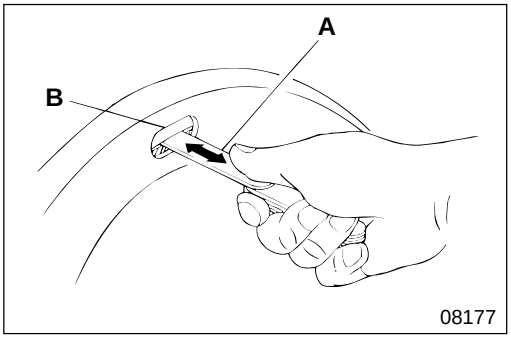
Be sure to inspect at two points for each wheel per side.

- Remove cover **1** from the backing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall cover **1**.

[Replacement]

P35A-58, 64

Inspection of Brake Shoe Clearance



Insert 0.2 mm {0.0079 in.} feeler gauge **A** into inspection hole **B** of the backing plate, and make sure that you can move the gauge in and out feeling some resistance. After this inspection, adjust the clearance if any abnormality is found.

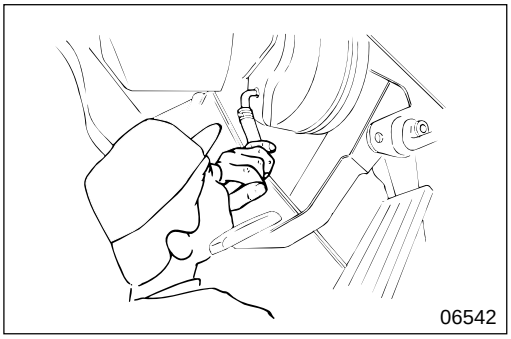
P35A-59, 65

Inspection of Brake Booster (Master Vac)

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Air tightness with no load (with vacuum meter at 67 kPa {19.7 in. Hg, 500 mmHg} and engine stopped)		Vacuum drop after 15 seconds should be 3.3 kPa {0.98 in. Hg, 25 mmHg} or less	—	Replace
	Airtightness with load (with brake pedal slightly depressed, vacuum meter at 67 kPa {19.7 in. Hg, 500 mmHg} and engine stopped)				
—	Boosting action (Fluid pressure with vacuum meter at 67 kPa {19.7 in. Hg, 500 mmHg} and brake pedal depressed at specified foot pressure)	8 in.+9 in.	4410 kPa {640 psi, 45 kgf/cm^2} (98 N {22 lbf, 10 kgf})	—	Replace
			8340 kPa {1210 psi, 85 kgf/cm^2} (295 N {66 lbf, 30 kgf})		
		9 in.+10 in.	3920 kPa {570 psi, 40 kgf/cm^2} (98 N {22 lbf, 10 kgf})		
			8830 kPa {1280 psi, 90 kgf/cm^2} (295 N {66 lbf, 30 kgf})		
	No boosting action (Fluid pressure after vacuum meter falls to 0 kPa {0 in. Hg, 0 mmHg} and brake pedal depressed at specified foot pressure)	8 in.+9 in.	295 kPa {43 psi, 3 kgf/cm^2} (98 N {22 lbf, 10 kgf})	—	Replace
			1670 kPa {240 psi, 17 kgf/cm^2} (295 N {66 lbf, 30 kgf})		
		9 in.+10 in.	195 kPa {28 psi, 2 kgf/cm^2} (98 N {22 lbf, 10 kgf})		
			1470 kPa {215 psi, 15 kgf/cm^2} (295 N {66 lbf, 30 kgf})		

[Inspection]
Two types of inspection are used to inspect the brake booster (master vac) operation, inspection without a tester and inspection with a simple tester. Make sure that there is no fluid leak or damage at the joints of the brake pipes and hoses before inspection.


06542

(1) Inspection of check valve operation

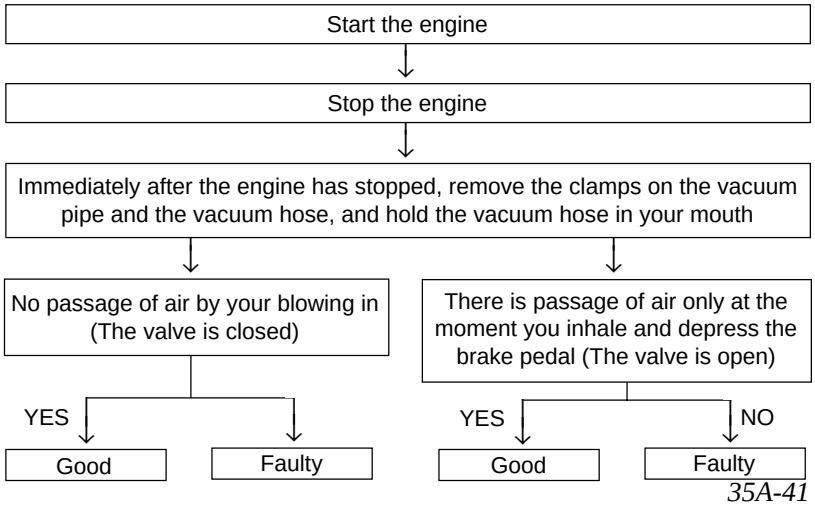
Be sure to inspect the check valve both when opened and when closed.

CAUTION

Make sure that your saliva does not enter the check valve when blowing air through the vacuum hose as this would cause the check valve to malfunction.

NOTE

The check valve fitted to the vacuum hose cannot be removed.



(2) Inspection of brake booster (master vac) operation

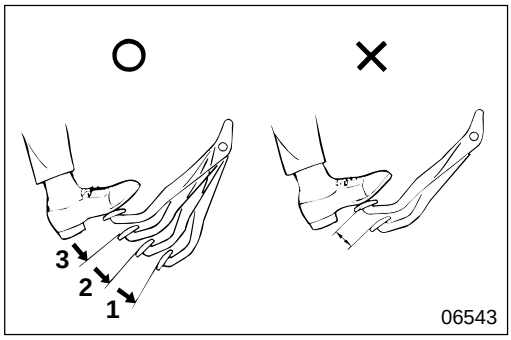
NOTE

If the brake booster (master vac) is faulty, determine the quality of the brake booster (master vac) as an independent device by means of a bench test specified by the maker's service station. This is because the above inspection of the brake booster (master vac) operation is merely a simplified inspection. If any fault is found, hand the device over to the service station without disassembling it, and replace the whole assembly. 📖 **P35A-48**

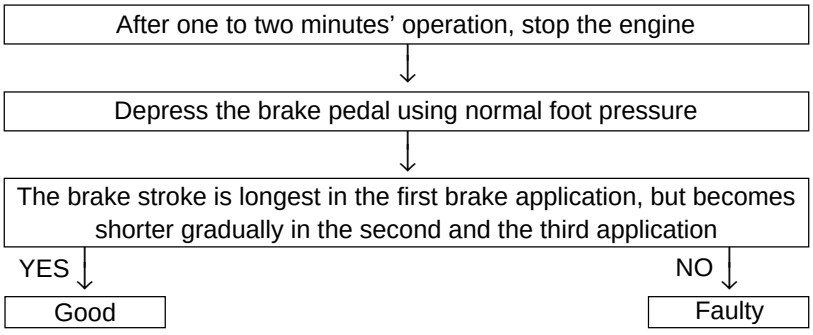
● **Inspection method without a tester**

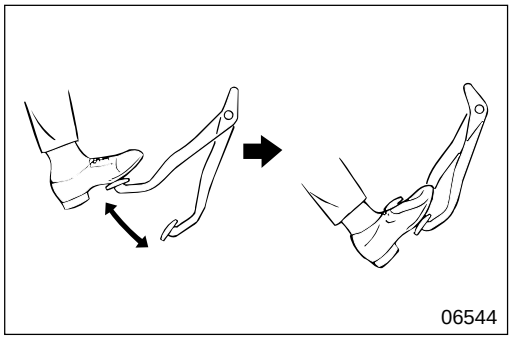
If the brake booster (master vac) is determined to be good by inspections 1 to 3 below, its operation is normal. If any fault is detected in any of the three inspections, the following parts are likely to be faulty.

- Check valve
- Vacuum hose
- Brake booster (master vac)
- Vacuum pump

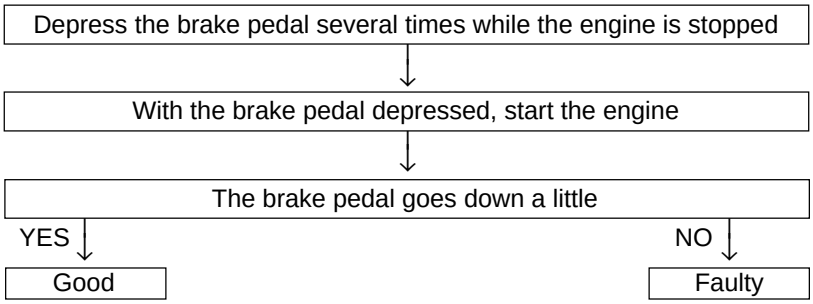


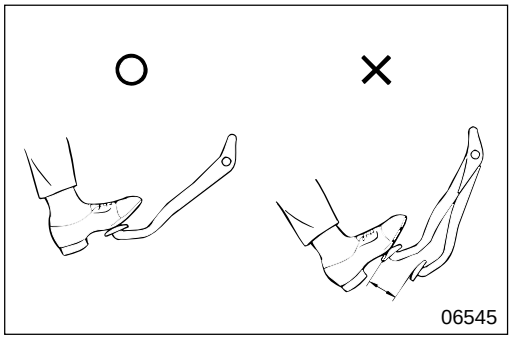
[Inspection 1]



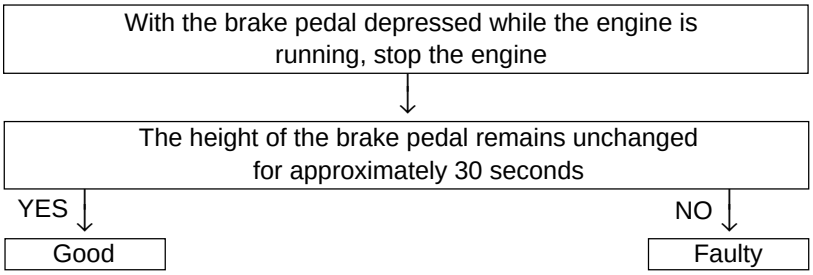


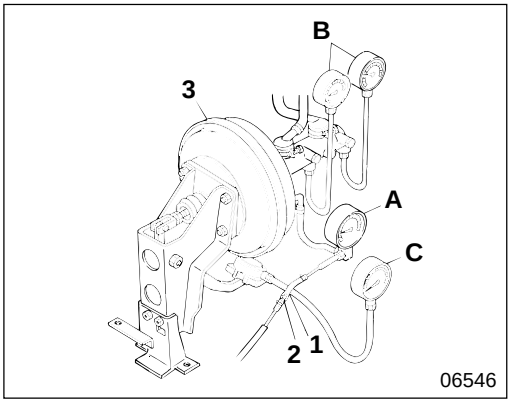
[Inspection 2]





[Inspection 3]



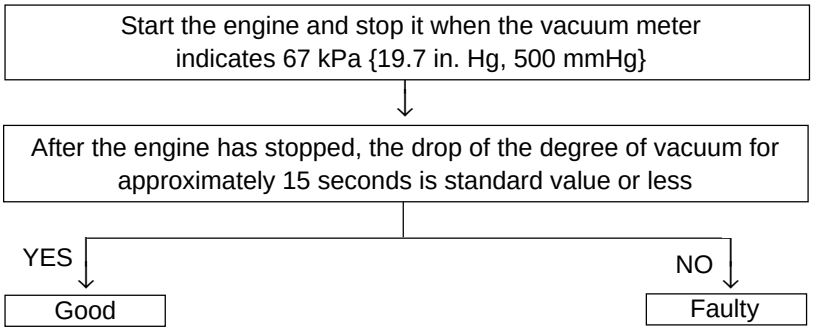


● Inspection with a simplified tester

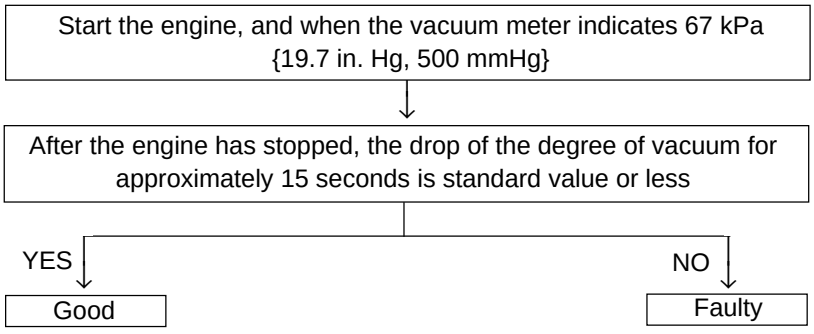
● Airtightness inspection

- Before inspection, observe the operation of check valve **2** fitted to vacuum hose **1**. P35A-41
- Remove vacuum hose **1** from brake booster (master vac) **3**, place the end without the white ○ mark on the brake booster (master vac) and connect it to vacuum meter **A**. Connect another vacuum hose (without a built-in check valve) between the vacuum meter and the brake booster (master vac).
  Connect pressure gauges **B** and foot pressure meter **C** as illustrated, and bleed the air from the pressure gauges.
- If the results of the following two airtightness inspections are satisfactory, the operation is normal. If any fault is found in any of the two inspections, the following parts are likely to be faulty.
  - Vacuum hose
  - Brake booster (master vac)

[No-load airtightness inspection]



[At load airtightness inspection]

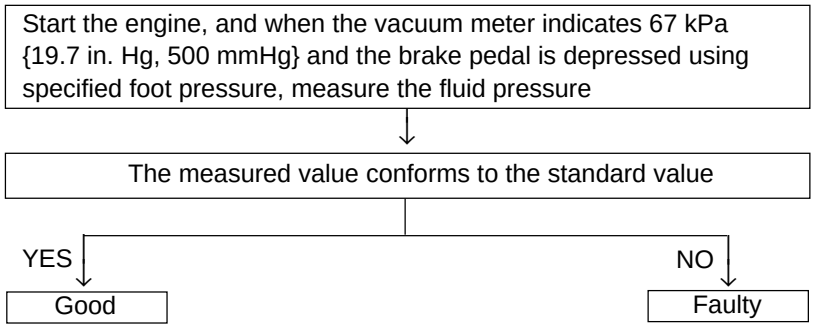


- Be sure when you attach vacuum hose **1** to brake booster (master vac) **3** after the inspection, that the end without the white ○ mark faces brake booster (master vac) **3**.

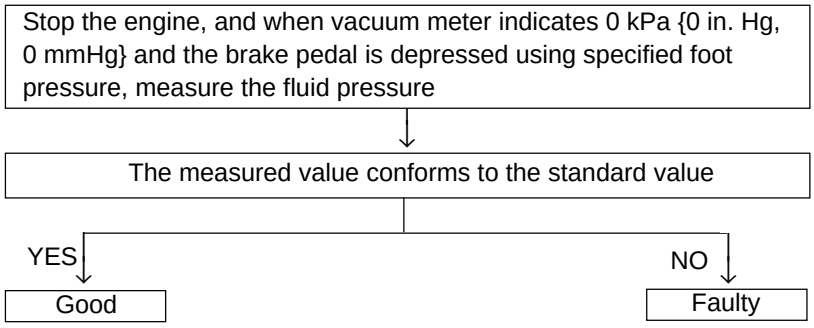
● **Inspection of characteristics**

- Inspect characteristics after the airtightness inspection is finished.
- If the results of the following two inspections are good, the operation is normal. If any fault is found in any of the two inspections, the following parts are likely to be faulty.
  - Vacuum hose
  - Brake booster (master vac)

[Boosting action inspection]



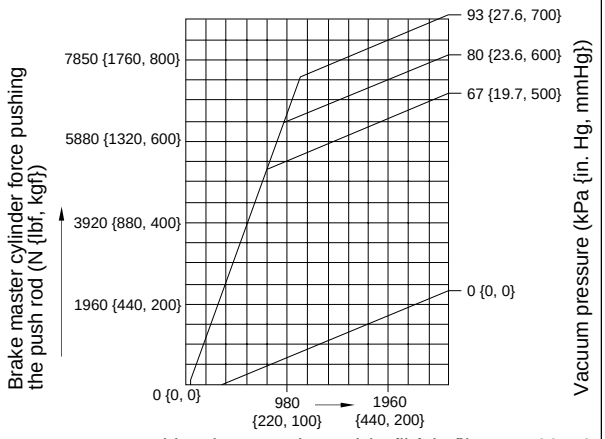
[No boosting action inspection]



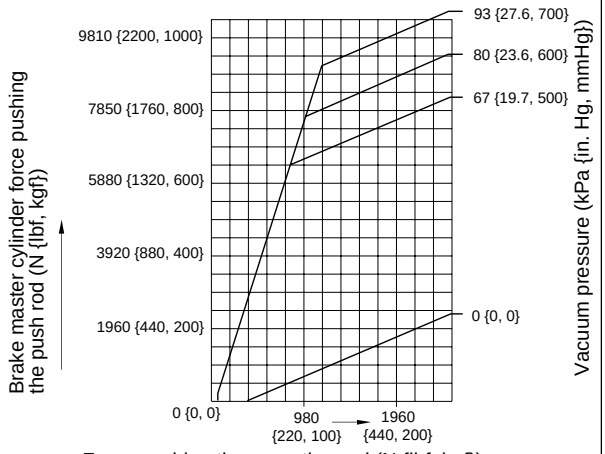
Be sure when you attach vacuum hose **1** to brake booster (master vac) **3** after the inspection, that the end without the white ○ mark faces brake booster (master vac) **3**.

● **Brake booster (master vac) performance diagram**

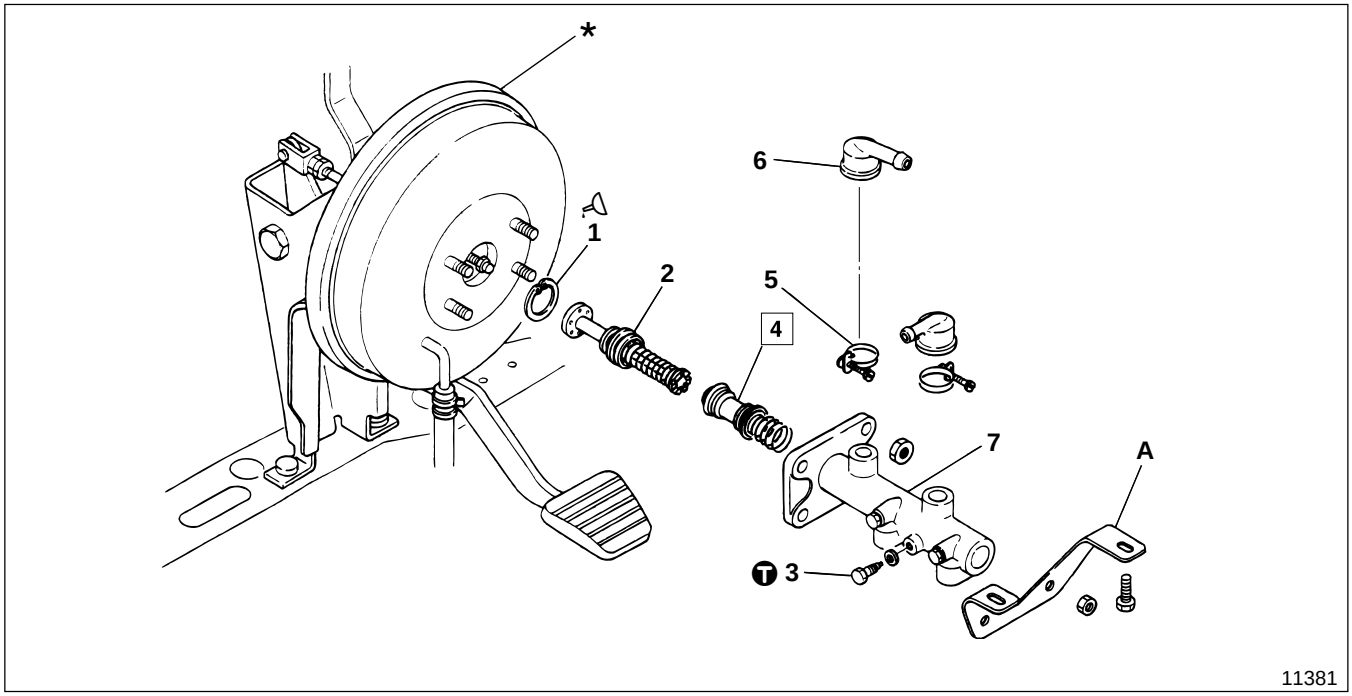
< 8 inch+9 inch >



< 9 inch+10 inch >



BRAKE MASTER CYLINDER



● **Disassembly sequence**

1 Retaining ring
2 Primary piston assembly
3 Set bolt
4 Secondary piston assembly
5 Clamp
6 Connector
7 Cylinder body

A : Master vac support
***** : Brake pedal and brake booster assembly 🕮 P35A-48

WARNING⚠

Be sure not to damage the inner surface of cylinder body 7, since it will cause air to get mixed in or will result in brake fluid leakage during the removal and installation of primary piston assembly 2 and secondary piston assembly 4.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
2	Primary piston assembly spring load	FE639, FG (Installed length 37.7 {1.48})		99 to 120 N {22 to 27 lbf, 10.1 to 12.3 kgf}	93 N {21 lbf, 9.5 kgf}	Replace
		FE64□ (Installed length 36.3 {1.43})		100 to 125 N {23 to 28 lbf, 10.5 to 12.7 kgf}	97 N {22 lbf, 9.9 kgf}	Replace
2, 4, 7	Clearance between primary and secondary piston assemblies and cylinder body		FE639 FG	[30.16] 0.02 to 0.10 {[1.19] 0.00079 to 0.0039}	0.2 {0.0079}	Replace
			FE64□	[31.75] 0.02 to 0.10 {[1.25] 0.00079 to 0.0039}	0.2 {0.0079}	Replace
4	Secondary piston assembly spring load	FE639, FG (Installed length 30.7 {1.21})		76 to 92 N {17 to 21 lbf, 7.8 to 9.4 kgf}	72 N {16 lbf, 7.3 kgf}	Replace
		FE64□ (Installed length 31.0 {1.22})		76 to 92 N {17 to 21 lbf, 7.8 to 9.4 kgf}	72 N {16 lbf, 7.3 kgf}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

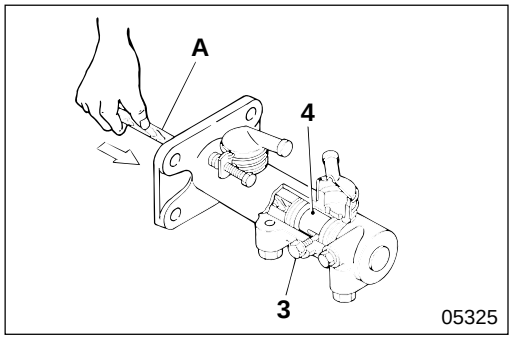
Location	Parts to be tightened	Tightening torque	Remarks
3	Set bolt	6.86 to 8.82 {5.1 to 6.5, 0.7 to 0.9}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
1	Periphery of retaining ring	Rubber grease	As required

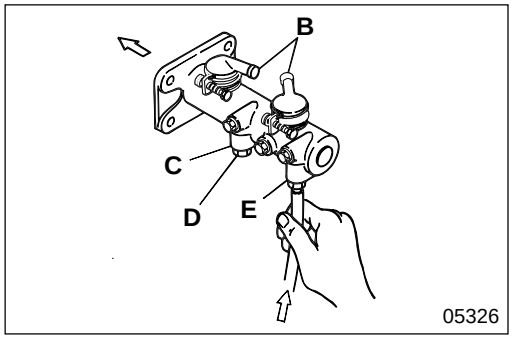
◆ Service procedure

4 Secondary piston assembly



[Removal]

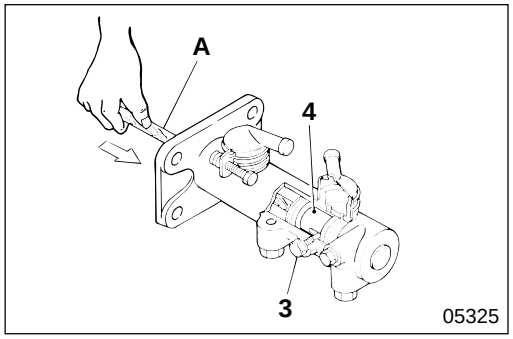
- Using rod **A**, push in secondary piston assembly **4**, then loosen set bolt **3**.



- Put plugs **D** into brake fluid filling port **B** and discharge port **C** that leads to the rear wheel brakes, then feed compressed air via discharge port **E** to the front wheel brakes to extract the secondary piston assembly.

WARNING⚠

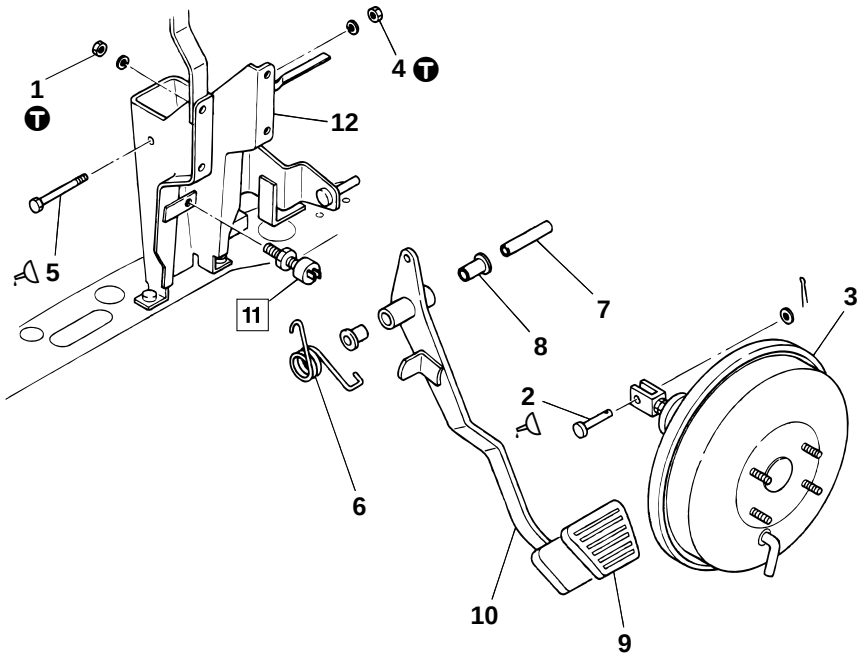
You must apply compressed air gradually when you remove secondary piston assembly 4. If you applied compressed air strongly at one time, the secondary piston assembly would be violently ejected.



[Installation]

Using rod **A**, push in secondary piston assembly **4**, then tighten set bolt **3** at specified torque.

BRAKE PEDAL AND BRAKE BOOSTER (MASTER VAC)



● **Disassembly sequence**

1 Nut
2 Clevis pin
3 Brake booster (master vac)
4 Nut
5 Bolt
6 Spring
7 Collar
8 Bushing
9 Pedal pad
10 Brake pedal
11 Stop lamp switch
Gr 54
12 Support assembly

NOTE

Do not disassemble brake booster (master vac) 3 because it is a non-disassemble type.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly** P35A-49

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
7, 8	Clearance between collar and bushing		[16] 0.02 to 0.26 {0.00079 to 0.010}	0.5 {0.020}	Replace
10	Brake pedal	Height from pedal pad center to instrument panel underside	264 {10.4}	—	Adjust
		Full stroke	170 {6.69}	—	Adjust
10, 11	Clearance between brake pedal stopper and tip of stop lamp switch thread area		0 to 0.1 {0 to 0.0039}	—	Adjust

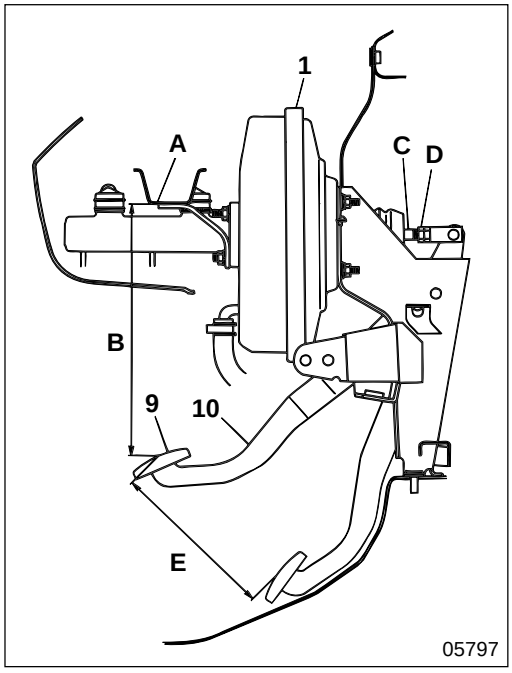
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Brake booster mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—
4	Nut (Brake pedal mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Sliding surface of clevis pin	Chassis grease [NLGI No.1 (Ca soap)]	As required
5	Friction surface of bolt bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required



◆ Service procedure

● Adjustment after assembly

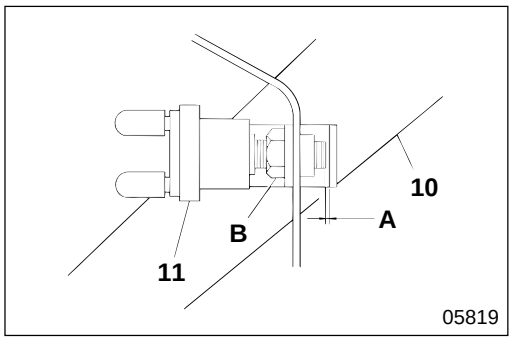
- Adjustment of brake pedal installation height
  By turning operating rod **C** of brake booster (master vac) **1**, adjust height **B** from the center of pedal pad **9** to the underside of instrument panel **A** to the standard value, then secure in place using nut **D**.

WARNING⚠

Make sure, when brake pedal 10 is depressed fully, that operating rod C of brake booster (master vac) 1 functions as the stopper and the pedal does not come to a stop by hitting against the floor panel, since this will reduce brake effectiveness.

- Inspection of brake pedal full stroke
  Make sure that full stroke **E** when brake pedal **10** is depressed fully conforms to the standard value.
  If there is any fault, adjust the installation height of the brake pedal.

- Inspection of play towards brake pedal 🕮 P35A-36



11 **Adjustment of stop lamp switch**

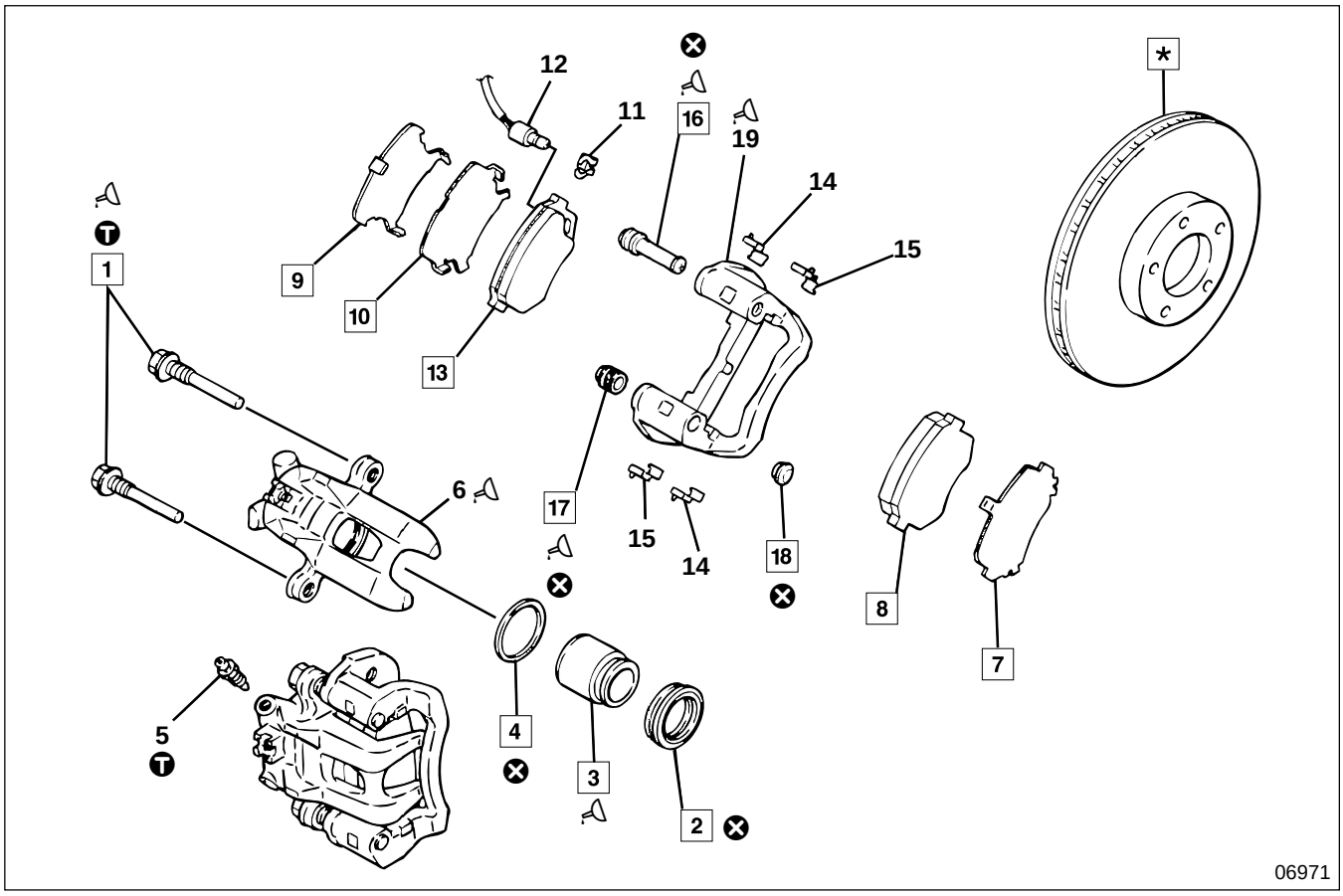
Turn stop lamp switch **11** to adjust clearance **A** between the top of the thread area of the stop lamp switch and the stopper of brake pedal **10** to the standard value, and fasten with lock nut **B**.

WARNING⚠

Make sure, when brake pedal 10 is released, that stop lamp switch 11 does not stop the pedal, since this will cause the brake to drag.

FRONT WHEEL BRAKE < FE639 (EXCEPT FE639□6 : DISC BRAKE >

This illustration shows the left side wheel disc brake viewed from the left front.



● **Disassembly sequence**

1 Slide pin bolt
2 Piston boot
3 Piston
4 Piston seal
5 Air bleeder (Lower)
6 Caliper
7 Outer shim
8 Outer pad
9 Inner shim A
10 Inner shim B
11 Clip (Upper)
12 Brake pad wear indicator (Upper)
13 Inner pad
14 Pad liner A
15 Pad liner B
16 Bushing
17 Pin boot
18 Cap
19 Torque member

*: Disc rotor Gr 26A
⊗: Non-reusable parts

WARNING⚠

Make sure that oil or grease does not stick to the surface of outer pad 8, inner pad 13 or disc rotor * since this will reduce brake effectiveness.

CAUTION⚠

When assembling, use the grease contained in the seal kit.

● **Assembly sequence**

19→16→17→15→14
13→12→11→10→9
8→7
→1→18
6→5→4
3→2

Repair kit : Pad kit
Seal kit
Pad wear indicator kit

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
8, 13	Thickness of outer and inner pads		12 {0.47}	4 {0.16}	Replace
*	Disc rotor	Wobble (When installed on front axle)	0.07 {0.0028} or less	0.10 {0.0039}	Replace
		Thickness	20 {0.79}	18 {0.71}	Replace
—	Drag torque	Immediately after releasing brake pedal (Approximately 5 seconds later)	9.8 N·m {7.2 ft.lbs, 1.00 kgf·m}	—	Tangential force at hub bolt : 95 N {21 lbf, 9.7 kgf}
		After rotating disc rotor 10 turns	6.9 N·m {5.1 ft.lbs, 0.70 kgf·m}	—	Tangential force at hub bolt : 67 N {15 lbf, 6.8 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

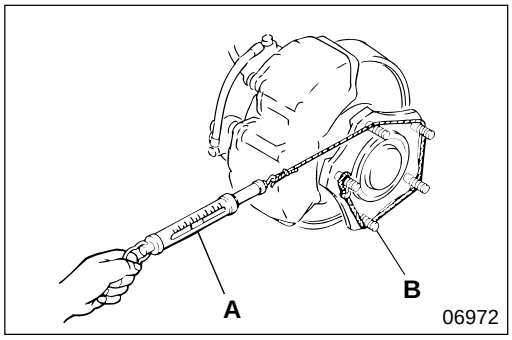
Location	Parts to be tightened	Tightening torque	Remarks
1	Slide pin bolt	83.3 to 93.1 {61 to 69, 8.5 to 9.5}	Wet
5	Air bleeder	6.9 to 8.8 {5.1 to 8.8, 0.7 to 0.9}	Wet

Lubricant and/or fluid

Location		Points of application	Specified lubricant and/or fluid	Quantity
1	Slide pin bolt	Periphery of slide	*Rubber grease	As required
		Contact surfaces of bushing and pin boot	Rubber grease	As required
		Thread area	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required
3	Piston		Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required
6	Cylinder lip of caliper		Rubber grease	As required
16	Bushing	Inner periphery	Rubber grease	As required
		Contact surface with slide pin bolt	Rubber grease	As required
17	Contact surfaces of pin boot and slide pin bolt		Rubber grease	As required
19	Torque member	Groove of pin boot	Rubber grease	As required
		Guide hole of main side	Rubber grease	As required
		Seat of cap	Rubber grease	As required

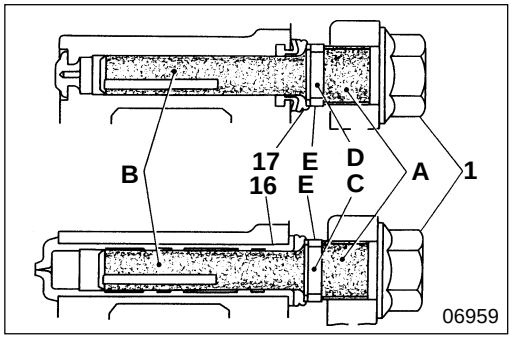
* : Rubber grease should be compatible with DOT3 brake fluid.

◆ Service procedure



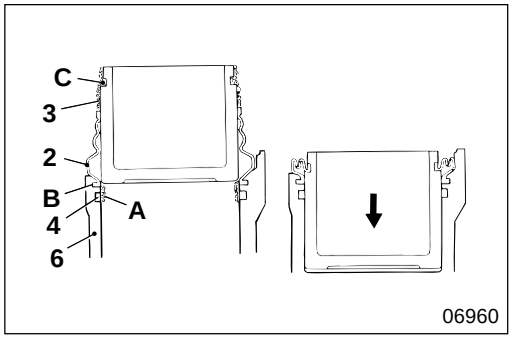
● Measurement of dragging torque

- Fasten spring balance **A** to hub bolt **B** and measure the tangential force.
- If the measured value is the specified value, the torque conforms to the standard value.
- If the measured value deviates from the specified value, inspect the friction surface between piston seal **4** and piston **3**.



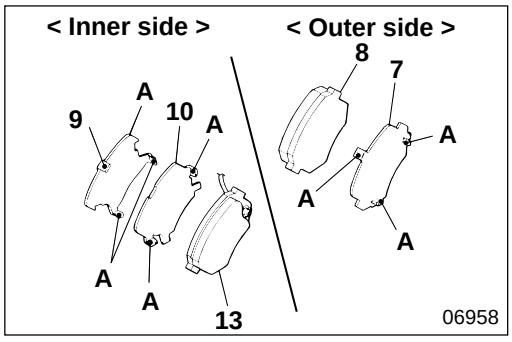
1 **Installation of slide pin bolt**

- Apply brake fluid to thread area **A** lightly, and apply grease to slide outer periphery **B**, bushing groove **C** or connecting surface **D** of pin boot **17**, then tighten slide pin bolt **1** at specified torque.
- Bleed bushing **16** or pin boot **17**.
- Check that seal **E** of bushing **16** or pin boot **17** is installed in bushing groove **C** of slide pin bolt **1** or connecting surface **D** of the pin boot.



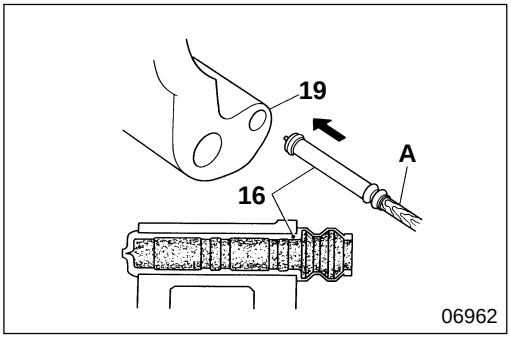
2 **to** **4** **Installation of piston boot, piston and piston seal**

- Apply brake fluid to the periphery of piston **3** to insert piston boot **2**.
- Spread the grease applied to piston seal **4** evenly and install it into the seal groove of caliper **6**.
- Apply grease to cylinder lip area **A** of caliper **6** evenly.
- Install the caliper side seal of piston boot **2** to the boot groove **B** of caliper **6**, then press in piston **3** slowly.
- Make sure that the piston side seal of piston boot **2** is installed in the boot groove **C** of piston **3**.



7 **to** **10** **13** **Installation of pad and shim**

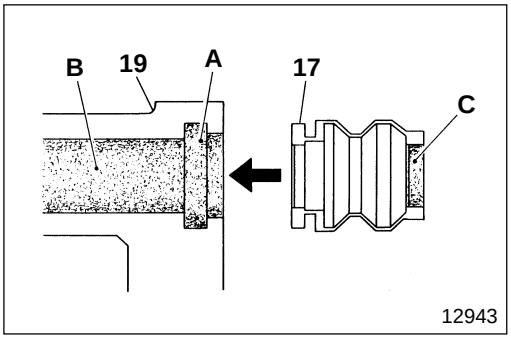
Make sure that you install the shims with pawls **A** facing the correct way.



16 **Installation of bushing**

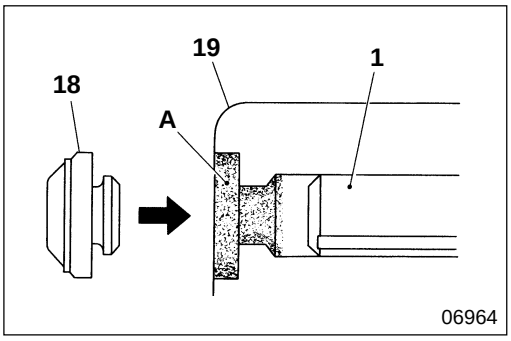
A : Push bar approximately ø8 mm {0.31 in.} long

After installation, apply grease to the whole inner periphery of bushing **16** and its contact surface with slide pin bolt **1**.



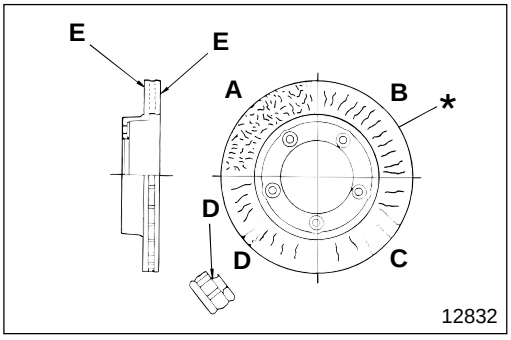
17 **Installation of pin boot**

- Apply grease to pin boot groove **A** of torque member **19**, the whole surface of guide hole **B**, and contact surface **C** between slide pin bolt **1** and pin boot **17**.
- Install pin boot **17**.



18 **Installation of cap**

- Apply grease to cap seat surface **A**.
- Install cap **18**.

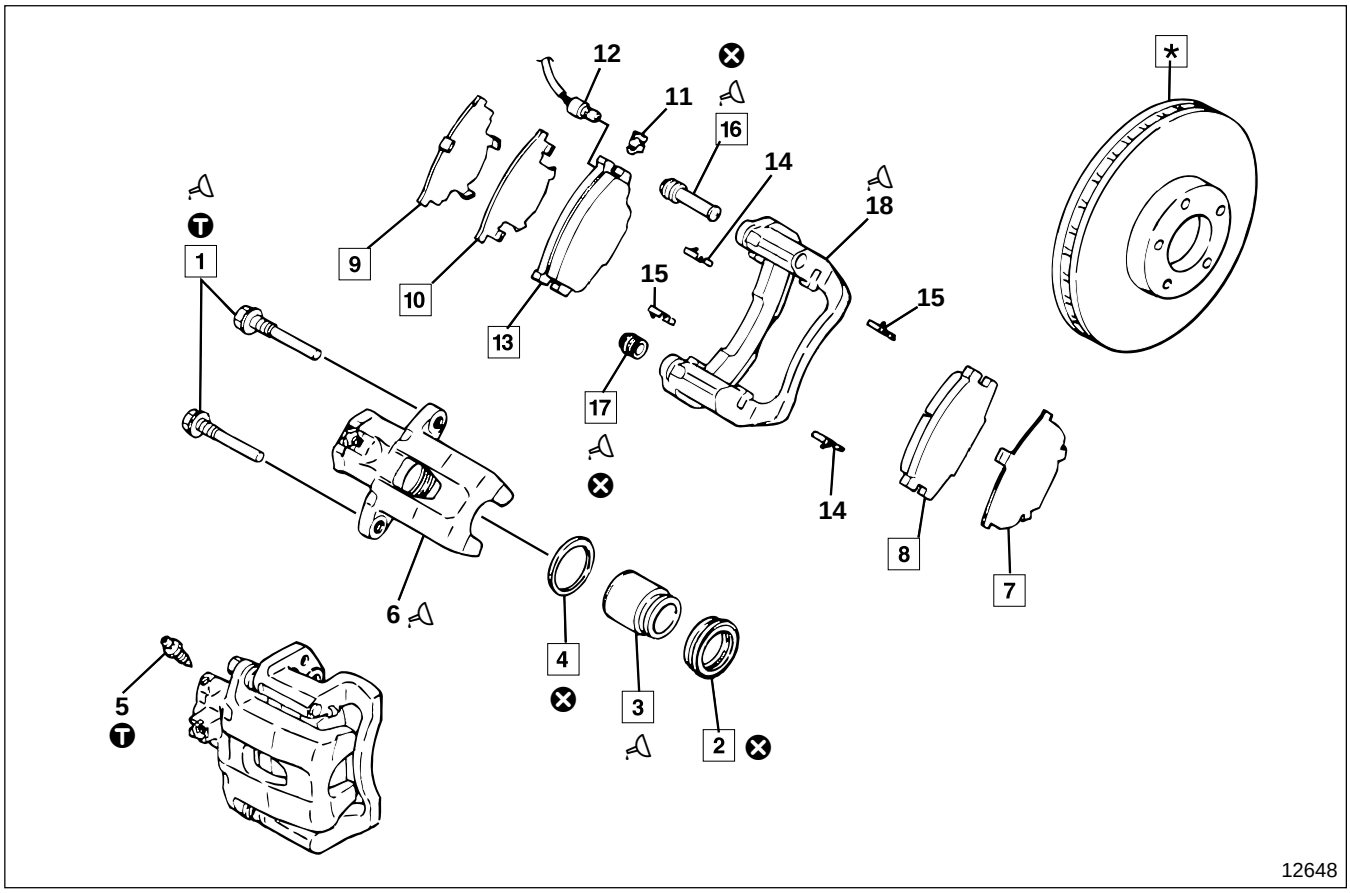


***** **Inspection of disc rotor**

- Inspect the friction surface **E** of disc rotor * visually.
- If any cracks are found, correct or replace disc rotor *.
  - **A** : Net pattern cracks (Correct or replace)
  - **B** : Radial cracks that do not reach the outer periphery (Correct or replace)
  - **C** : Radial cracks that have reached the outer periphery (Replace)
  - **D** : Through cracks (Replace)

FRONT WHEEL BRAKE < FE639□6, FE64□ : DISC BRAKE >

This illustration shows the left side wheel disc brake viewed from the left front.



● **Disassembly sequence**

1 Slide pin bolt
2 Piston boot
3 Piston
4 Piston seal
5 Air bleeder (Lower)
6 Caliper
7 Outer shim
8 Outer pad
9 Inner shim A
10 Inner shim B
11 Clip (Upper)
12 Brake pad wear indicator (Upper)
13 Inner pad
14 Pad liner A
15 Pad liner B
16 Bushing
17 Pin boot
18 Torque member

***** : Disc rotor Gr 26A
⊗ : Non-reusable parts

WARNING

Make sure that oil or grease does not stick to the surface of outer pad 8, inner pad 13 or disc rotor * since this will reduce brake effectiveness.

CAUTION

When assembling, use the grease contained in the seal kit.

● **Assembly sequence**

18→17→16→15→14
13→12→11→10→9
8→7
6→5→4
3→2
→1

Repair kit : Pad kit
Seal kit
Pad wear indicator kit

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
8, 13	Thickness of outer and inner pads		14 {0.55}	4 {0.16}	Replace
*	Disc rotor	Wobble (When installed on front axle)	0.07 {0.0028} or less	0.10 {0.0039}	Replace
		Thickness	40 {1.57}	38 {1.50}	Replace
—	Drag torque	Immediately after releasing brake pedal (Approximately 5 seconds later)	9.8 N·m {7.2 ft.lbs, 1.00 kgf·m}	—	Tangential force at hub bolt : 95 N {21 lbf, 9.7 kgf}
		After rotating disc rotor 10 turns	6.9 N·m {5.1 ft.lbs, 0.70 kgf·m}	—	Tangential force at hub bolt : 67 N {15 lbf, 6.8 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

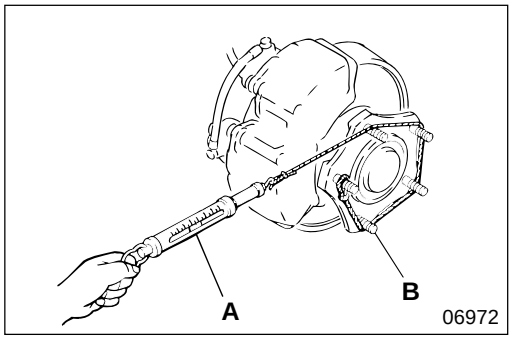
Location	Parts to be tightened	Tightening torque	Remarks
1	Slide pin bolt	83.3 to 93.1 {61 to 69, 8.5 to 9.5}	Wet
5	Air bleeder	6.9 to 8.8 {5.1 to 8.8, 0.7 to 0.9}	Wet

Lubricant and/or fluid

Location	Points of application		Specified lubricant and/or fluid	Quantity
1	Slide pin bolt	Periphery of slide	*Rubber grease	As required
		Contact surfaces of bushing and pin boot	Rubber grease	As required
		Thread area	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required
3	Piston		Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required
6	Cylinder lip of caliper		Rubber grease	As required
16	Bushing	Inner periphery	Rubber grease	As required
		Contact surface with slide pin bolt	Rubber grease	As required
17	Contact surfaces of pin boot and slide pin bolt		Rubber grease	As required
18	Torque member	Groove of pin boot	Rubber grease	As required
		Guide hole of main side	Rubber grease	As required

* : Rubber grease should be compatible with DOT3 brake fluid.

◆ Service procedure



● Measurement of dragging torque

- Fasten spring balance **A** to hub bolt **B** and measure the tangential force.
- If the measured value is the specified value, the torque conforms to the standard value.
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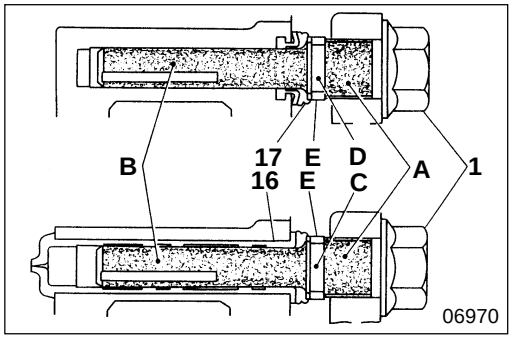
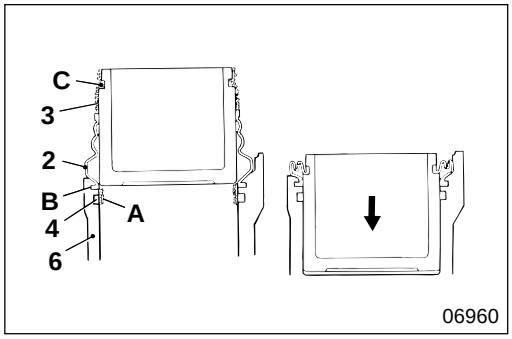


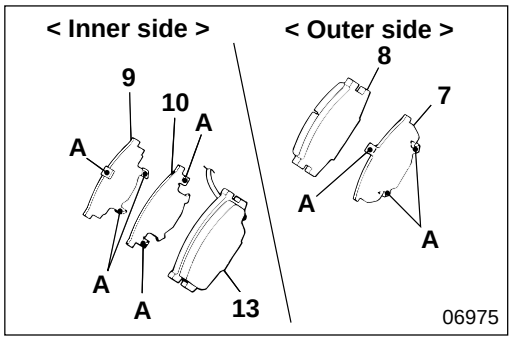
1 Installation of slide pin bolt

- Apply brake fluid to thread area **A** lightly, and apply grease to slide outer periphery **B**, bushing groove **C** or connecting surface **D** of pin boot **17**, then tighten slide pin bolt **1** at specified torque.
- Bleed bushing **16** or pin boot **17**.
- Check that seal **E** of bushing **16** or pin boot **17** is installed in bushing groove **C** of slide pin bolt **1** or connecting surface **D** of the pin boot.



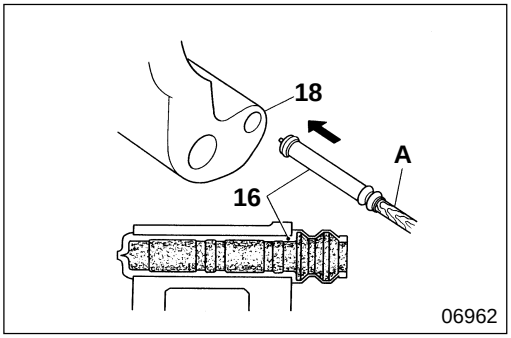
2 to 4 Installation of piston boot, piston and piston seal

- Apply brake fluid to the periphery of piston **3** to insert piston boot **2**.
- Spread the grease applied to piston seal **4** evenly and install it into the seal groove of caliper **6**.
- Apply grease to cylinder lip area **A** of caliper **6** evenly.
- Install the caliper side seal of piston boot **2** to the boot groove **B** of caliper **6**, then press in piston **3** slowly.
- Make sure that the piston side seal of piston boot **2** is installed in the boot groove **C** of piston **3**.



7 to 10 13 Installation of pad and shim

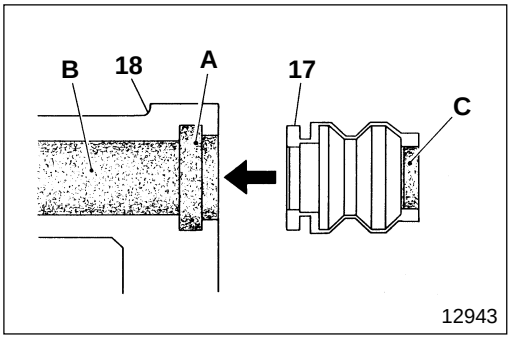
Make sure that you install the shims with pawls **A** facing the correct way.



16 **Installation of bushing**

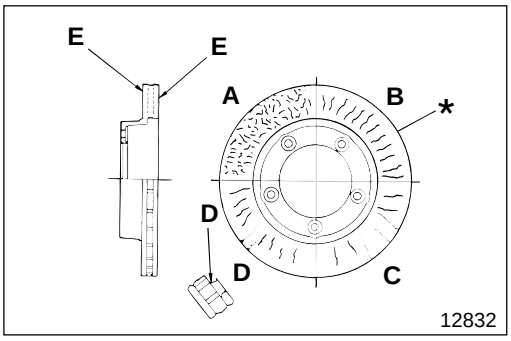
A : Push bar approximately ø8 mm {0.31 in.} long

After installation, apply grease to the whole inner periphery of bushing **16** and its contact surface with slide pin bolt **1**.



17 **Installation of pin boot**

- Apply grease to pin boot groove **A** of torque member **18**, the whole surface of guide hole **B**, and contact surface **C** between slide pin bolt **1** and pin boot **17**.
- Install pin boot **17**.

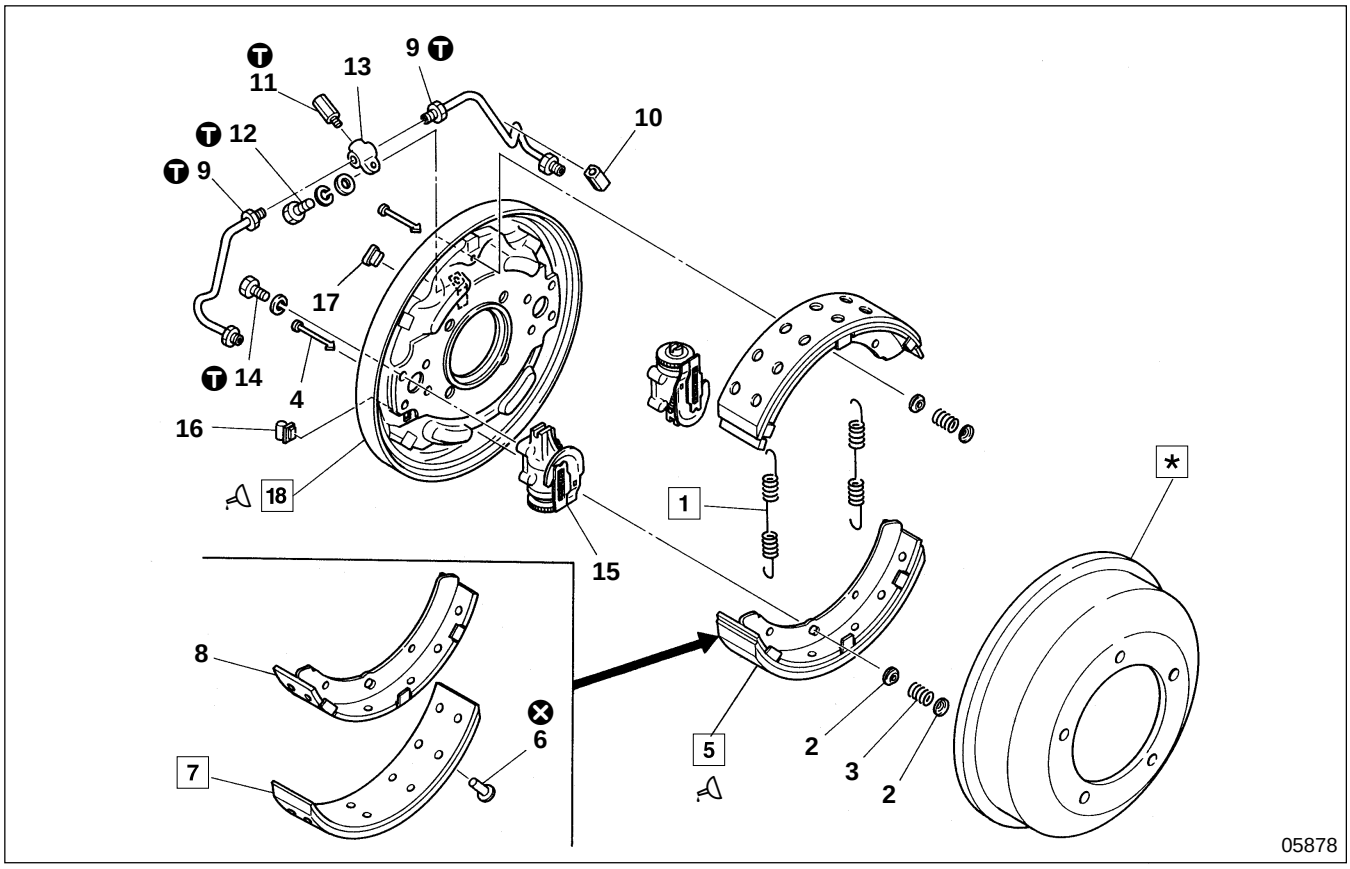


***** **Inspection of disc rotor**

- Inspect the friction surface **E** of disc rotor * visually.
- If any cracks are found, correct or replace disc rotor *.
  - **A** : Net pattern cracks (Correct or replace)
  - **B** : Radial cracks that do not reach the outer periphery (Correct or replace)
  - **C** : Radial cracks that have reached the outer periphery (Replace)
  - **D** : Through cracks (Replace)

FRONT WHEEL BRAKE < DRUM BRAKE >

Front Wheel Brake Assembly



● **Disassembly sequence**

1 Return spring
2 Shoe hold down cup
3 Shoe hold down spring
4 Shoe hold down pin
5 Brake shoe assembly
6 Rivet
7 Brake lining
8 Brake shoe
9 Pipe assembly
10 Spacer
11 Extension
12 Bolt
13 Connector
14 Bolt
15 Wheel cylinder assembly 📖 P35A-63
16 Cover
17 Cover
18 Backing plate

***** : Brake drum Gr 26B
⊗ : Non-reusable parts

WARNING⚠

Make sure that oil or grease does not stick to the lining surface of brake shoe assembly 5 and the inner surface of brake drum * since this will reduce brake effectiveness.

CAUTION⚠

Be sure, when replacing brake shoe assembly 5, to wash and apply rubber grease to the adjuster and adjuster screw of wheel cylinder assembly 15 since particles of brake lining 7 may have accumulated on these parts.
📖 P35A-63

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Initial adjustment of brake shoe clearance after installation** **📖 P35A-59**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
1	Return spring load (Installed length 190 {7.48})		195 to 235 N {44 to 53 lbf, 19.8 to 24.2 kgf}		175 N {40 lbf, 18 kgf}	Replace
5	Brake shoe assembly (Thickness of brake lining)		10.0 {0.39}		4.0 {0.16} (Side shoulder means wear limit)	Replace brake lining
*	Brake drum	Inner diameter	320 {12.60}	*321 {12.64}	322 {12.68} or replace	Correct
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct or replace

*Refers to the correction limit.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
9	Pipe assembly	12.75 to 14.71 {9.4 to 11, 1.3 to 1.5}	—
11	Extension	12.75 to 14.71 {9.4 to 11, 1.3 to 1.5}	—
12	Bolt (Connector mounting)	7.85 to 11.77 {5.8 to 8.7, 0.8 to 1.2}	—
14	Bolt (Wheel cylinder assembly mounting)	37.27 to 49.03 {27 to 36, 3.8 to 5.0}	—

Lubricant

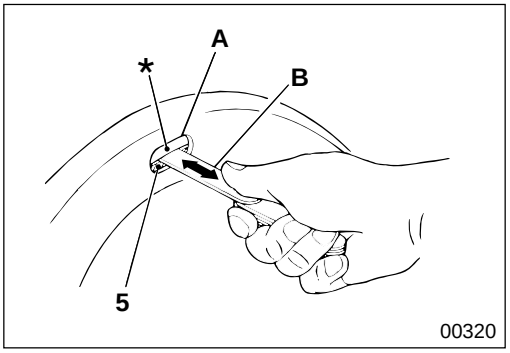
Location	Points of application	Specified lubricant	Quantity
5, 18	Contact surfaces between backing plate ledge and shoe rim, wheel cylinder assembly anchor area of shoe web, and adjusting screw contact point	Brake grease	As required

◆ Service procedure

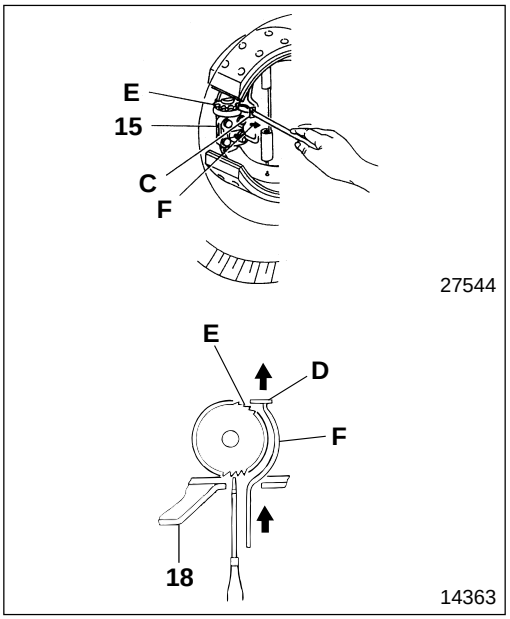
● **Initial adjustment of brake shoe clearance after installation**

Turning the adjuster of wheel cylinder assembly **15** in arrow direction expands brake shoe assembly **5**, narrowing the clearance between brake drum * and brake lining **7**.

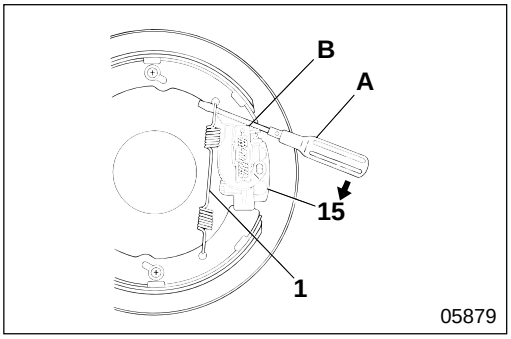
- Jack up the vehicle to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 26B
- Remove covers **16** and **17**.



- Adjust the brake shoe clearance as follows, so that 0.3 mm {0.012 in.} feeler gauge **B** can be inserted or extracted through check hole **A**, between brake drum * and brake lining **7** with a little resistance.

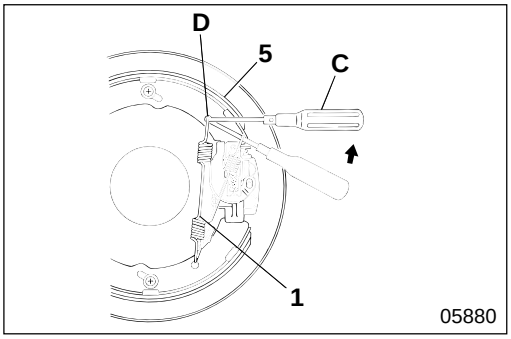


- To increase brake shoe clearance
  - Insert a wire (approximately ø2 mm {0.079 in.}) into the adjusting hole **C** and lift adjusting lever **D** of wheel cylinder assembly **15**.
  - Turn adjuster **E** of wheel cylinder assembly **15**, through adjusting hole **C**, in the opposite direction to arrow **F** on backing plate **15**.
- To decrease brake shoe clearance
  Turn adjuster **E** in the arrow **F** direction marked on backing plate **18** through adjusting hole **C**.
- Extract the feeler gauge and depress the brake pedal two or three times fully, then the specified value brake shoe clearance can be obtained.
- Insert a 0.2 mm {0.0079 in.} feeler gauge through check hole **A** and make sure that it can be inserted or extracted with a little resistance. If there is any fault, disassemble and inspect wheel cylinder assembly **15**. P35A-63

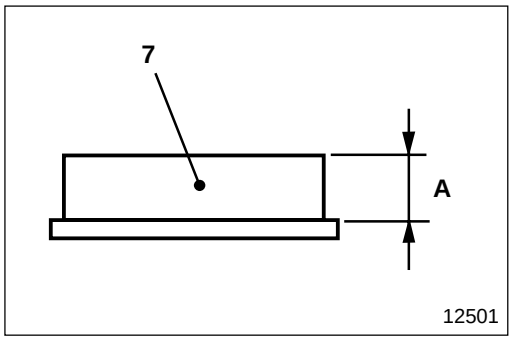


1 **Return spring**

[Removal]
To remove return spring **1**, place screwdriver **A** into the hook of the return spring, then pry and remove the return spring making use of wheel cylinder assembly **15** adjusting screw **B** as a fulcrum.

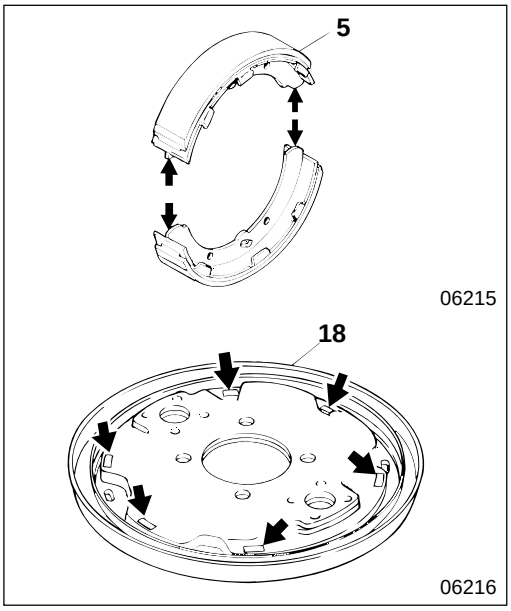


[Installation]
Insert a small Phillips screwdriver **C** into the hook of return spring **1**, insert the tip of the screwdriver into return spring installation hole **D** of brake shoe assembly **5** to pry on the return spring.



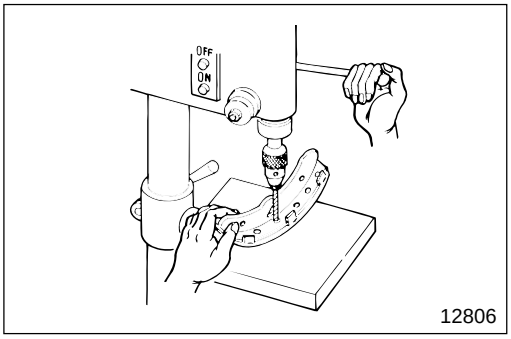
5 **Inspection of brake shoe assembly**

If thickness **A** of brake lining **7** is lower than the limit, replace the brake lining on the same axle as a unit.



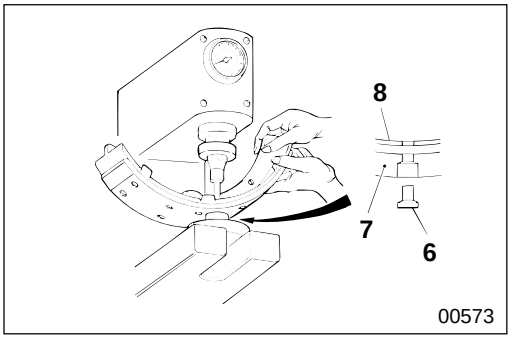
5 **18** **Installation of brake shoe assembly and backing plate**

Apply grease to the points as illustrated, and install brake shoe assembly **5** and backing plate **18**.



7 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **7** and brake shoe **8** with cleaning fluid and dry them.
- Insert rivets **6** from brake lining **7** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **8** and the brake lining.

  Staking load for rivets : 21±1 kN {4630±220 lbf, 2100±100 kgf}

- Make sure that you inspect contact with the inner surface of brake drum * after you replace brake linings **7**. If contact is incorrect, correct with the brake assembled.

WARNING⚠

Do not leave lubricant on the surface of brake lining 7 because this reduces braking performance.

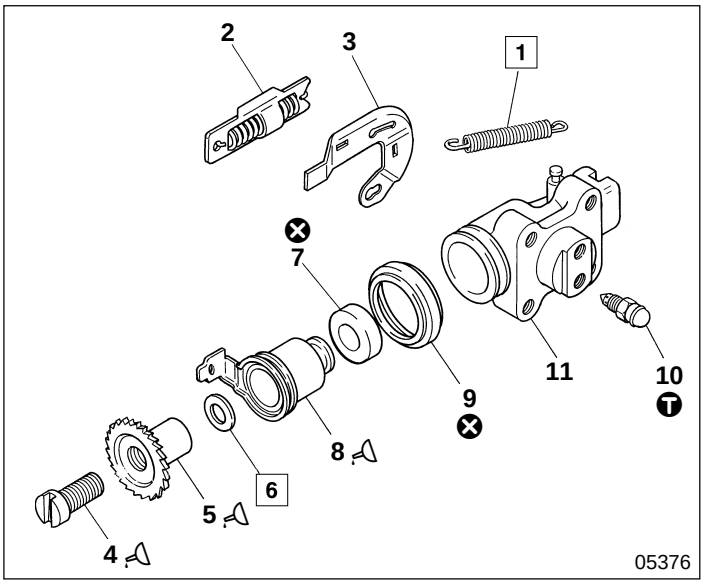
CAUTION⚠

Make sure that the type of brake linings 7 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one axle.

*** Correction of brake drum**

If the cylindrical accuracy of brake drum * is higher than the limit, or there are grooves, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Spring
2 Spring and fitting
3 Lever
4 Adjusting screw
5 Adjuster
6 Washer
7 Piston cup
8 Piston
9 Boot
10 Bleeder screw
11 Body

⊗ : Non-reusable parts

● **Assembly sequence**

11→10→9 ┐
8→7 ┘ **→6→5→4→3→2→1**

Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
8, 11	Clearance between piston and body	[28.57 {1.12}] 0.02 to 0.08 {0.00079 to 0.0031}	0.2 {0.0079}	Replace piston

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

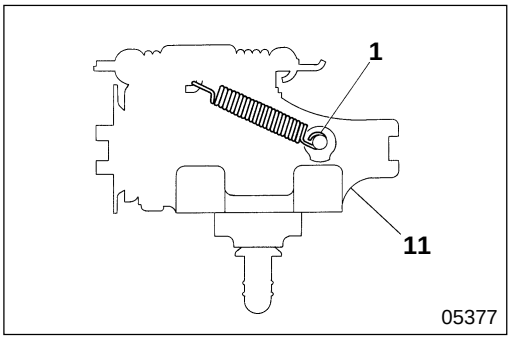
Location	Parts to be tightened	Tightening torque	Remarks
10	Bleeder screw	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
4, 5, 8	Thread areas of adjusting screw and adjuster, friction area of piston, and friction area of adjuster	*Rubber grease	As required

* : Rubber grease should be compatible with DOT3 brake fluid.

◆ Service procedure

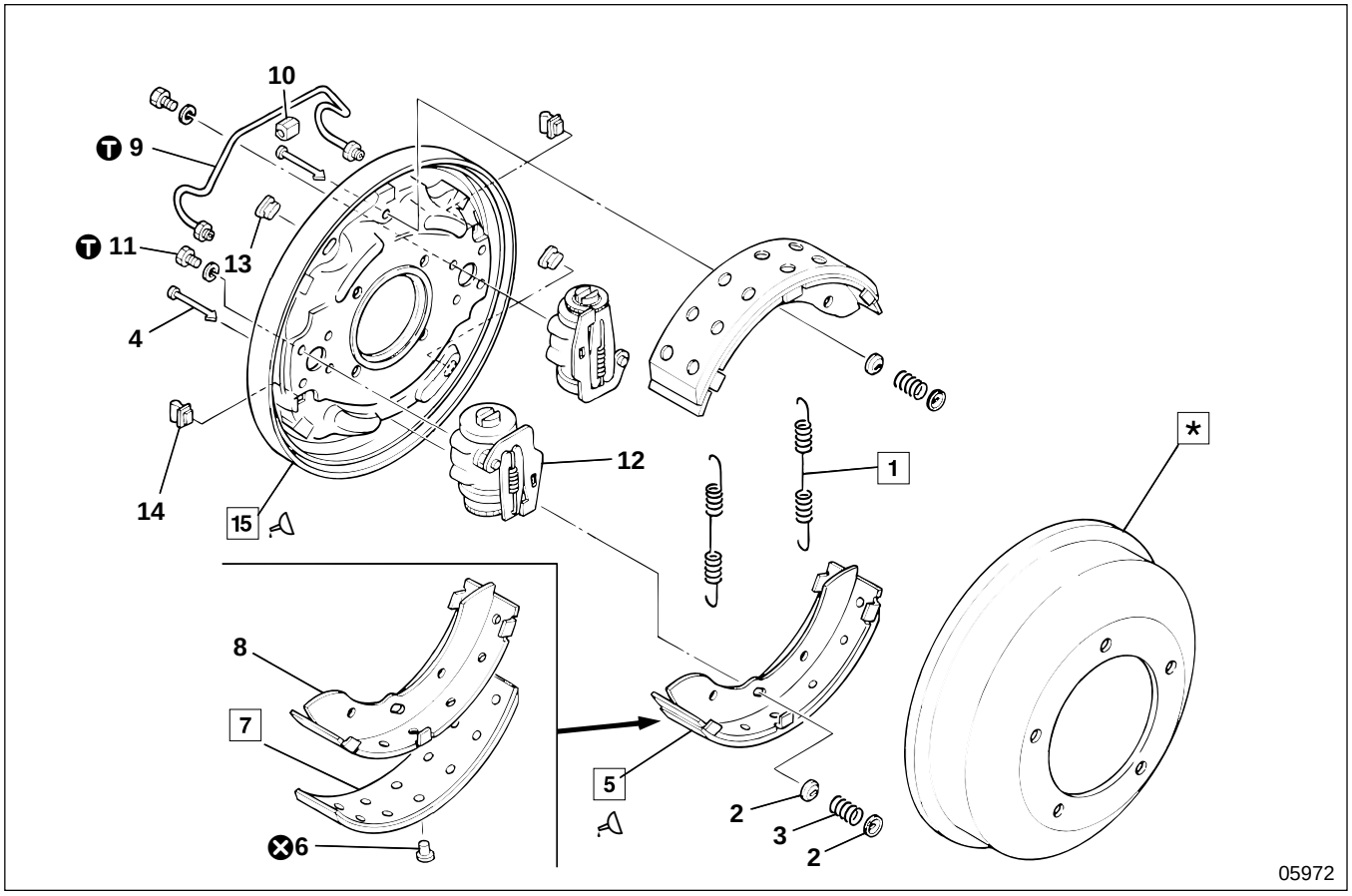


1 **Installation of spring**

Install the closed hook of spring **1** on body **11** side.

REAR WHEEL BRAKE < DRUM BRAKE >

Rear Wheel Brake Assembly



● **Disassembly sequence**

1 Return spring
2 Shoe hold down cup
3 Shoe hold down spring
4 Shoe hold down pin
5 Brake shoe assembly
6 Rivet
7 Brake lining
8 Brake shoe
9 Pipe assembly
10 Spacer
11 Bolt
12 Wheel cylinder assembly 📖 P35A-70
13 Cover
14 Cover
15 Backing plate

***** : Brake drum Gr 27
⊗ : Non-reusable parts

WARNING⚠

Make sure that oil or grease does not stick to the lining surface of brake shoe assembly 5 and the inner surface of brake drum * since this will reduce brake effectiveness.

CAUTION⚠

Be sure, when replacing brake shoe assembly 5, to wash and apply rubber grease to the adjuster and adjuster screw of wheel cylinder assembly 12 since particles of brake lining 7 may have accumulated on these parts.
📖 P35A-70

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Initial adjustment of brake shoe clearance after installation** 📖 P35A-65

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
1	Return spring load (Installed length 190 {7.48})		195 to 235 N {44 to 53 lbf, 19.8 to 24.2 kgf}		175 N {40 lbf, 18 kgf}	Replace
5	Brake shoe assembly (Thickness of brake lining)		10.0 {0.39}		4.0 {0.16} (Side shoulder means wear limit)	Replace brake lining
*	Brake drum	Inner diameter	320 {12.60}	*321 {12.64}	322 {12.68} or replace	Correct
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct or replace

*Refers to the correction limit.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
9	Pipe assembly	12.75 to 14.71 {9.4 to 11, 1.3 to 1.5}	—
11	Bolt (Wheel cylinder assembly mounting)	37.27 to 49.03 {27 to 36, 3.8 to 5.0}	—

Lubricant

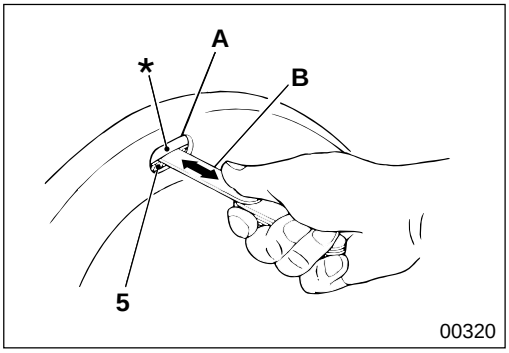
Location	Points of application	Specified lubricant	Quantity
5, 15	Contact surfaces between backing plate ledge and shoe rim, wheel cylinder assembly anchor area of shoe web, and adjusting screw contact point	Brake grease	As required

◆ Service procedure

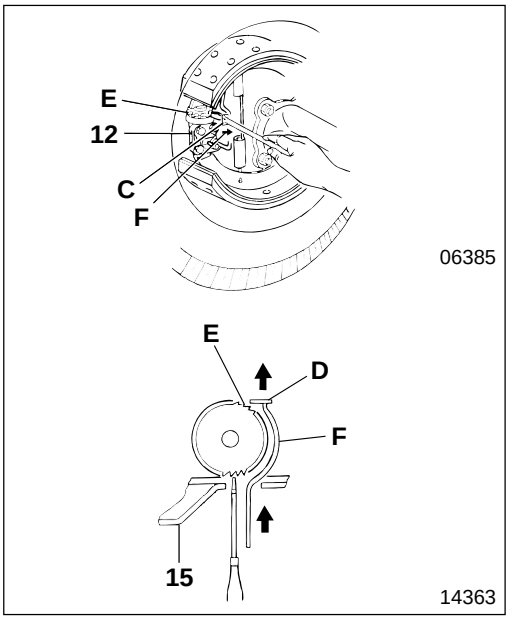
● **Initial adjustment of brake shoe clearance after installation**

Turning the adjuster of wheel cylinder assembly **12** in arrow direction expands brake shoe assembly **5**, narrowing the clearance between brake drum * and brake lining **7**.

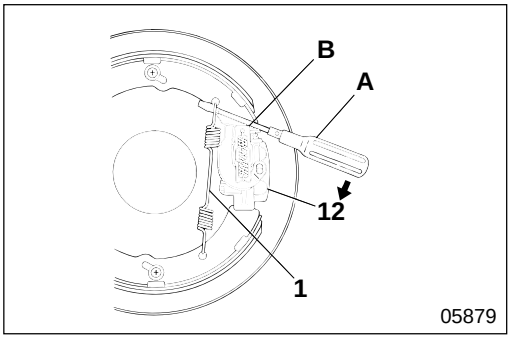
- Jack up the vehicle to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 27
- Remove covers **13** and **14**.



- Adjust the brake shoe clearance as follows, so that 0.3 mm {0.012 in.} feeler gauge **B** can be inserted or extracted through check hole **A**, between brake drum * and brake lining **7** with a little resistance.

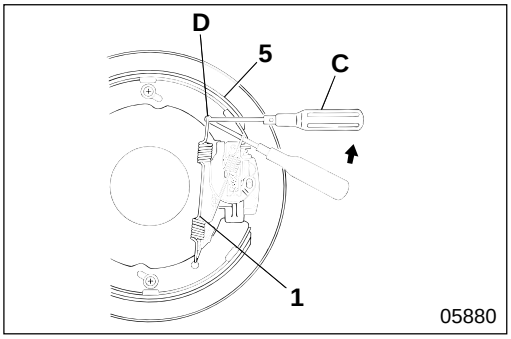


- To increase brake shoe clearance
  - Insert a wire (approximately ø2 mm {0.079 in.}) into the adjusting hole **C** and lift adjusting lever **D** of wheel cylinder assembly **12**.
  - Turn adjuster **E** of wheel cylinder assembly **12**, through adjusting hole **C**, in the opposite direction to arrow **F** on backing plate **15**.
- To decrease brake shoe clearance
  Turn adjuster **E** in the arrow **F** direction marked on backing plate **15** through adjusting hole **C**.
- Extract the feeler gauge and depress the brake pedal two or three times fully, then the specified value brake shoe clearance can be obtained.
- Insert a 0.2 mm {0.0079 in.} feeler gauge through check hole **A** and make sure that it can be inserted or extracted with a little resistance. If there is any fault, disassemble and inspect wheel cylinder assembly **12**. P35A-70

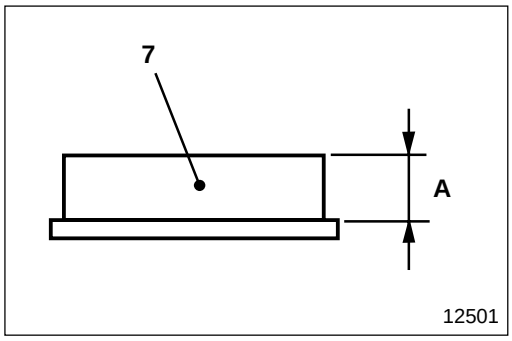


1 **Return spring**

[Removal]
To remove return spring **1**, place screwdriver **A** into the hook of the return spring, then pry and remove the return spring making use of wheel cylinder assembly **12** adjusting screw **B** as a fulcrum.

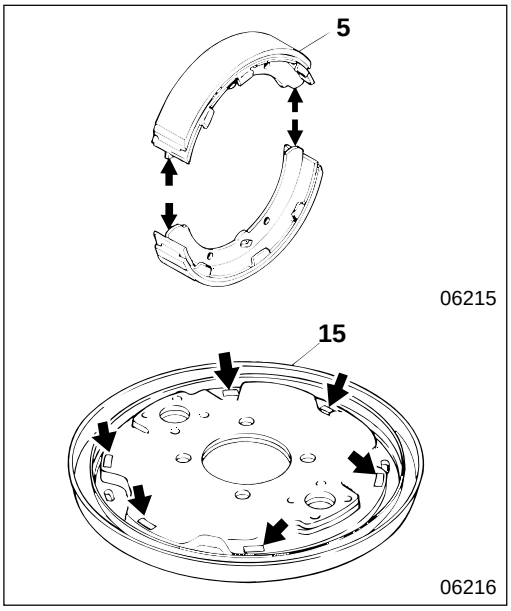


[Installation]
Insert a small Phillips screwdriver **C** into the hook of return spring **1**, insert the tip of the screwdriver into return spring installation hole **D** of brake shoe assembly **5** to pry on the return spring.



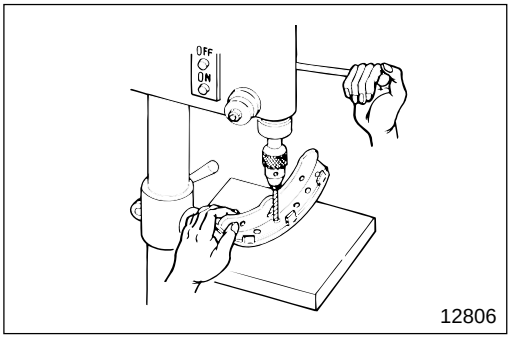
5 **Inspection of brake shoe assembly**

If thickness **A** of brake lining **7** is lower than the limit, replace the brake lining on the same axle as a unit.



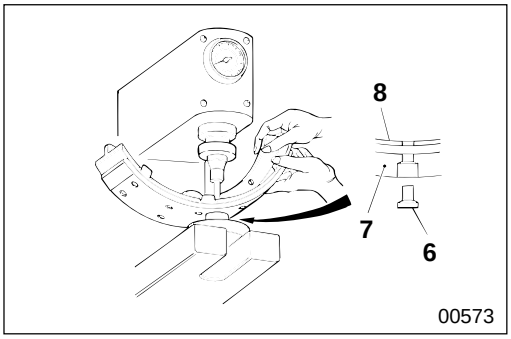
5 **15** **Installation of brake shoe assembly and backing plate**

Apply grease to the points as illustrated, and install brake shoe assembly **5** and backing plate **15**.



7 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **7** and brake shoe **8** with cleaning fluid and dry them.
- Insert rivets **6** from brake lining **7** side, and stake the rivets at the specified load so that there is no clearance between brake shoe **8** and the brake lining.

  Staking load for rivets : 21±1 kN {4630±220 lbf, 2100±100 kgf}

- Make sure that you inspect contact with the inner surface of brake drum * after you replace brake linings **7**. If contact is incorrect, correct with the brake assembled.

WARNING⚠

Do not leave lubricant on the surface of brake lining 7 because this reduces braking performance.

CAUTION⚠

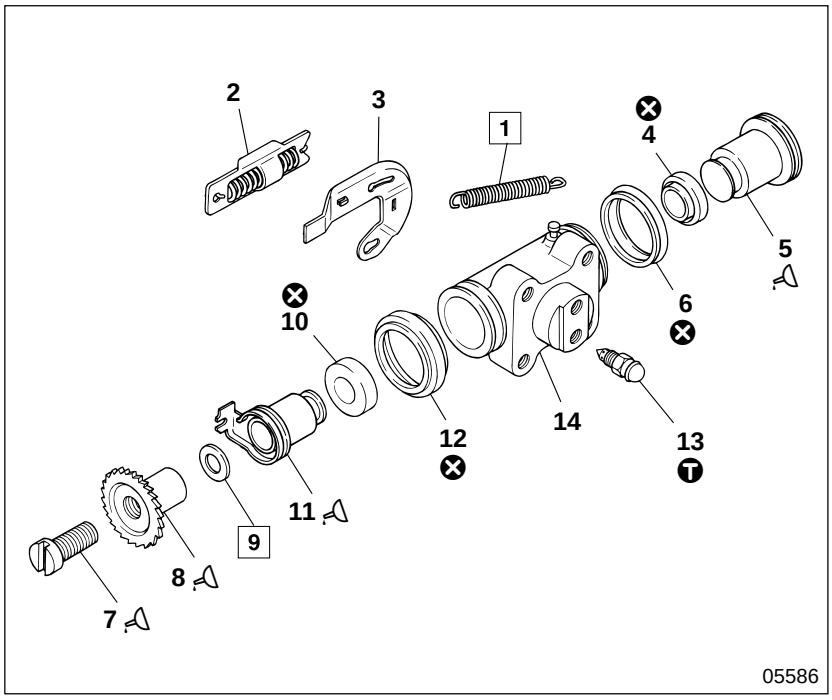
Make sure that the type of brake linings 7 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one axle.

*** Correction of brake drum**

If the cylindrical accuracy of brake drum * is higher than the limit, or there are grooves, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

M E M O

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Spring
2 Spring and fitting
3 Lever
4 Piston cup
5 Piston
6 Boot
7 Adjusting screw
8 Adjuster
9 Washer
10 Piston cup
11 Piston
12 Boot
13 Bleeder screw
14 Body

⊗ : Non-reusable parts

● **Assembly sequence**

14→13→12→9→8→7→6→3→2→1
11→10→
5→4→

Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
5, 11, 14	Clearance between piston and body	[28.57 {1.12}] 0.02 to 0.08 {0.00079 to 0.0031}	0.2 {0.0079}	Replace piston

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

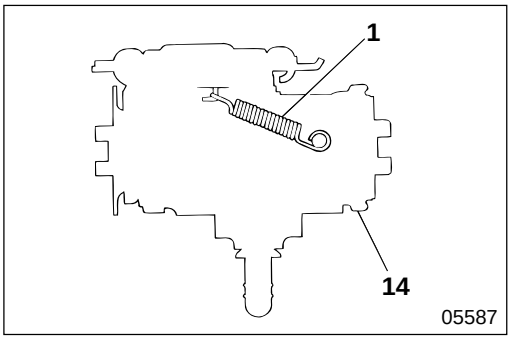
Location	Parts to be tightened	Tightening torque	Remarks
13	Bleeder screw	6.9 to 8.8 {5.1 to 6.5, 0.7 to 0.9}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
5, 7, 8, 11	Thread areas of adjusting screw and adjuster, friction area of piston, and friction area of adjuster	*Rubber grease	As required

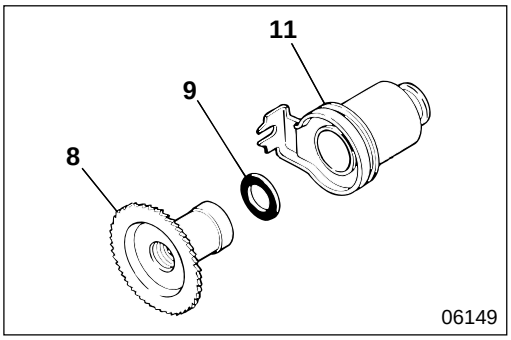
* : Rubber grease should be compatible with DOT3 brake fluid.

◆ Service procedure



1 **Installation of spring**

Install the closed hook of spring **1** on body **14** side.

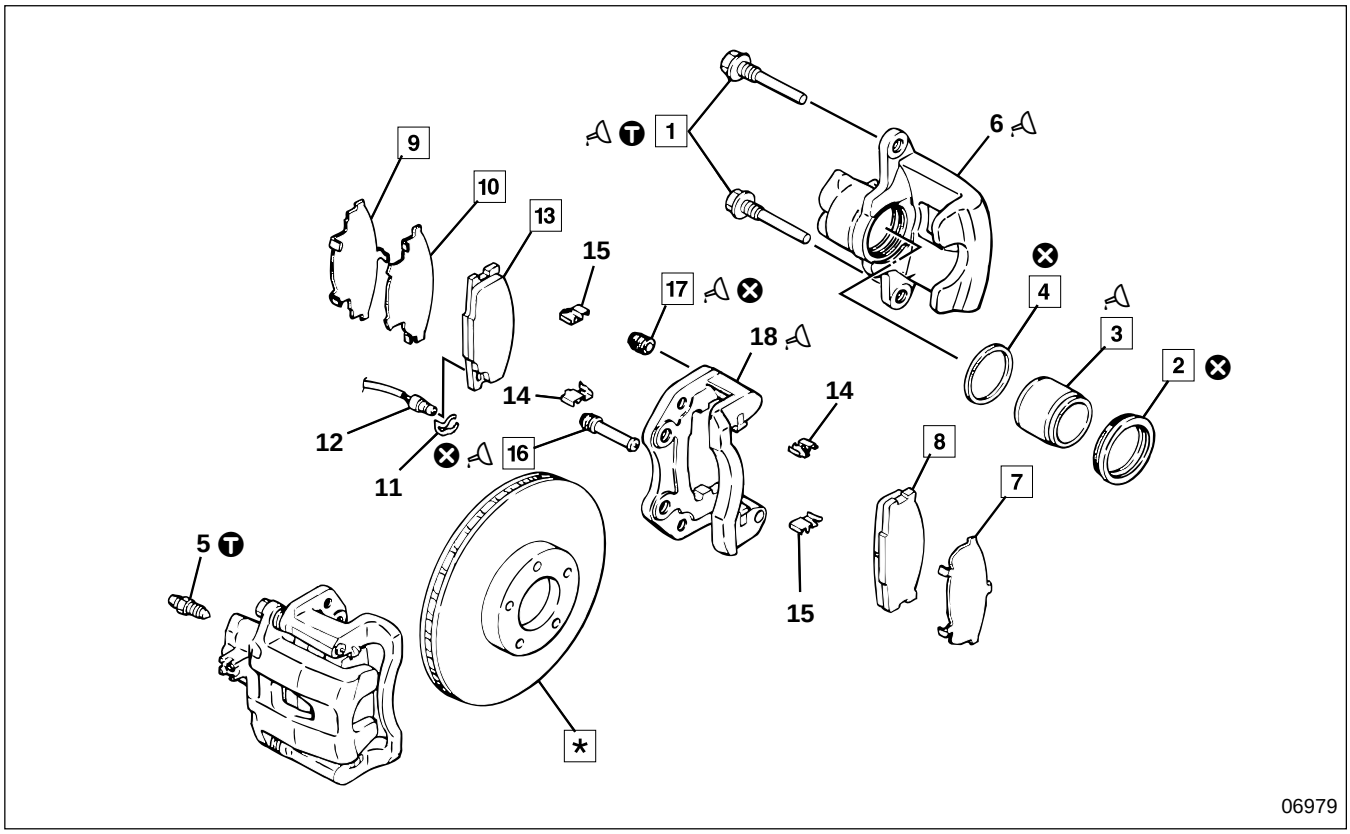


9 **Installation of washer**

Install the washer with its black side facing adjuster **8**.

REAR WHEEL BRAKE < DISC BRAKE >

This illustration shows the left side wheel disc brake viewed from the left front.



● **Disassembly sequence**

1 Slide pin bolt
2 Piston boot
3 Piston
4 Piston seal
5 Air bleeder
6 Caliper
7 Outer shim
8 Outer pad
9 Inner shim A
10 Inner shim B
11 Clip
12 Brake pad wear indicator
13 Inner pad
14 Pad liner A
15 Pad liner B
16 Bushing
17 Pin boot
18 Torque member

***** : Disc rotor Gr 27
⊗ : Non-reusable parts

WARNING ⚠

Make sure that oil or grease does not stick to the surface of outer pad 8, inner pad 13 or disc rotor * since this will reduce brake effectiveness.

CAUTION ⚠

When assembling, use the grease contained in the seal kit.

● **Assembly sequence**

18→17→16→15→14
13→12→11→10→9
8→7
6→5→4
3→2
→1

Repair kit : Pad kit
Seal kit
Pad wear indicator kit

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
8, 13	Thickness of outer and inner pads		14 {0.55}	4 {0.16}	Replace
*	Disc rotor	Wobble (When installed on rear axle)	0.07 {0.0028} or less	0.10 {0.0039}	Replace
		Thickness	40 {1.57}	38 {1.50}	Replace
—	Drag torque	Immediately after releasing brake pedal (Approximately 5 seconds later)	9.8 N·m {7.2 ft.lbs, 1.00 kgf·m}	—	Tangential force at hub bolt : 88 N {20 lbf, 9 kgf}
		After rotating disc rotor 10 turns	6.9 N·m {5.1 ft.lbs, 0.70 kgf·m}	—	Tangential force at hub bolt : 62 N {14 lbf, 6.3 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

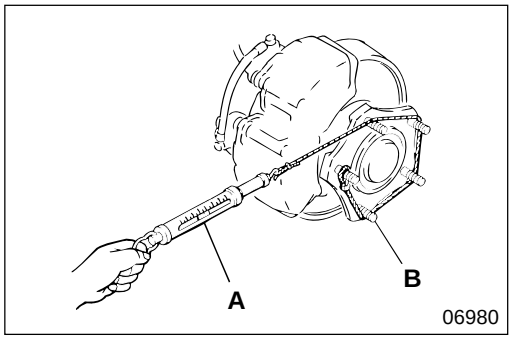
Location	Parts to be tightened	Tightening torque	Remarks
1	Slide pin bolt	83.3 to 93.1 {61 to 69, 8.5 to 9.5}	Wet
5	Air bleeder	6.9 to 8.8 {5.1 to 8.8, 0.7 to 0.9}	Wet

Lubricant and/or fluid

Location	Points of application		Specified lubricant and/or fluid	Quantity
1	Slide pin bolt	Periphery of slide	*Rubber grease	As required
		Contact surfaces of bushing and pin boot	Rubber grease	As required
		Thread area	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required
3	Piston		Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required
6	Cylinder lip of caliper		Rubber grease	As required
16	Bushing	Inner periphery	Rubber grease	As required
		Contact surface with slide pin bolt	Rubber grease	As required
17	Contact surfaces of pin boot and slide pin bolt		Rubber grease	As required
18	Torque member	Groove of pin boot	Rubber grease	As required
		Guide hole of main side	Rubber grease	As required

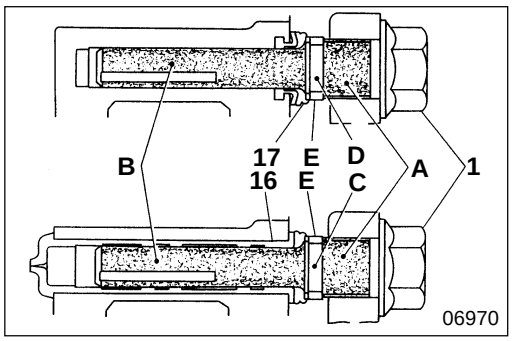
* : Rubber grease should be compatible with DOT3 brake fluid.

◆ Service procedure



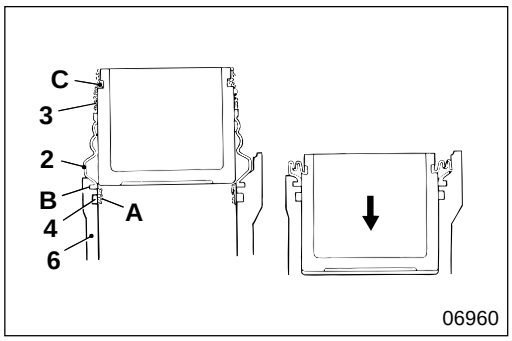
● Measurement of dragging torque

- Fasten spring balance **A** to hub bolt **B** and measure the tangential force.
- If the measured value is the specified value, the torque conforms to the standard value.
- If the measured value deviates from the specified value, inspect the friction surface between piston seal **4** and piston **3**.



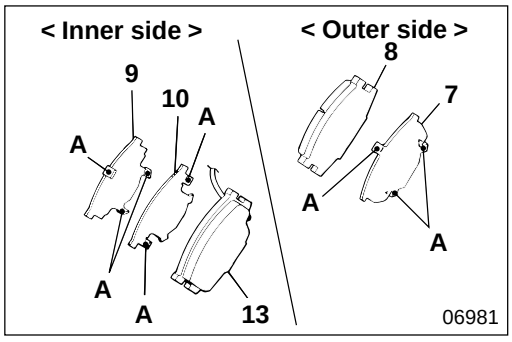
1 Installation of slide pin bolt

- Apply brake fluid to thread area **A** lightly, and apply grease to slide outer periphery **B**, bushing groove **C** or connecting surface **D** of pin boot **17**, then tighten slide pin bolt 1 at specified torque.
- Bleed bushing **16** or pin boot **17**.
- Check that seal **E** of bushing **16** or pin boot **17** is installed in bushing groove **C** of slide pin bolt **1** or connecting surface **D** of the pin boot.



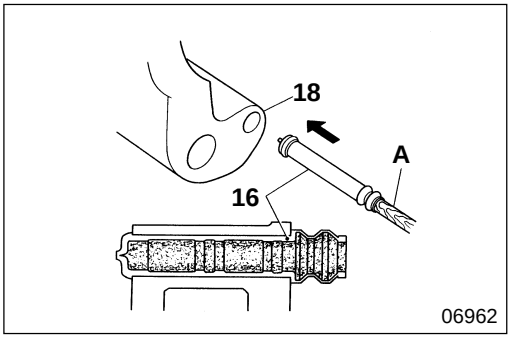
2 to 4 Installation of piston boot, piston and piston seal

- Apply brake fluid to the periphery of piston **3** to insert piston boot **2**.
- Spread the grease applied on piston seal **4** evenly to install it into the seal groove of caliper **6**.
- Apply grease to cylinder lip area **A** of caliper **6** evenly.
- Install the caliper side seal of piston boot **2** to the boot groove **B** of caliper **6**, then press in piston **3** slowly.
- Make sure that the piston side seal of piston boot **2** is installed in the boot groove **C** of piston **3**.



7 to 10 13 Installation of pad and shim

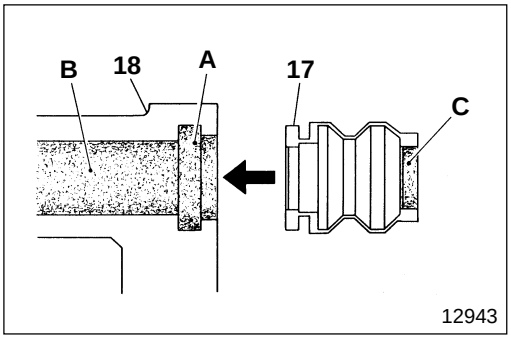
Make sure that you install the shims with pawls **A** facing the right way.



16 **Installation of bushing**

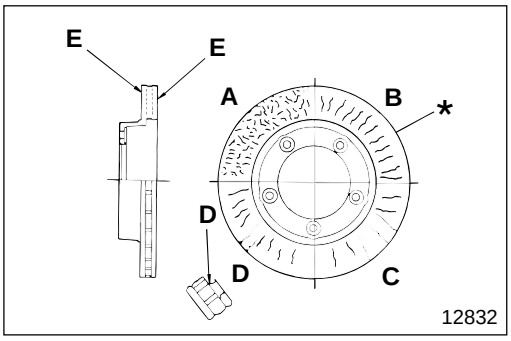
A : Push bar approximately ø8 mm {0.31 in.} long

After installation, apply grease to the whole inner periphery of bushing **16** and its contact surface with slide pin bolt **1**.



17 **Installation of pin boot**

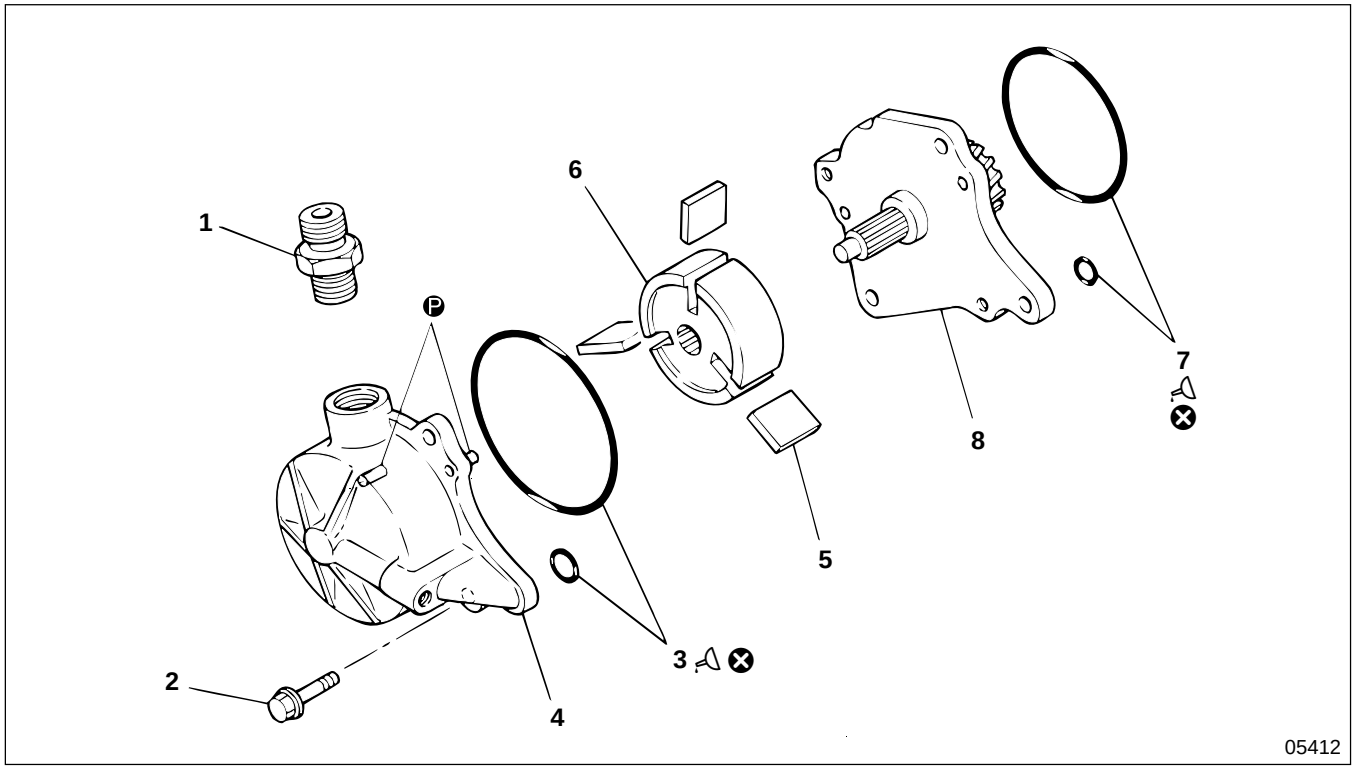
- Apply grease to pin boot groove **A** of torque member **18**, the whole surface of guide hole **B**, and contact surface **C** between slide pin bolt **1** and pin boot **17**.
- Install pin boot **17**.



***** **Inspection of disc rotor**

- Inspect the friction surface **E** of disc rotor ***** visually.
- If any cracks are found, correct or replace disc rotor *****.
  - **A** : Net pattern cracks (Correct or replace)
  - **B** : Radial cracks that do not reach the outer periphery (Correct or replace)
  - **C** : Radial cracks that have reached the outer periphery (Replace)
  - **D** : Through cracks (Replace)

VACUUM PUMP



● **Disassembly sequence**

1 Check valve assembly
2 Bolt
3 O-ring
4 Cylinder
5 Vane
6 Rotor
7 O-ring
8 Flange

Ⓟ : Positioning pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Degree of vacuum of pump	60 cm³ {3.66 cu. in.} : Engine speed 1500 rpm	93.3 kPa {27.6 in. Hg, 700 mmHg}	—	Replace
		90 cm³ {5.49 cu. in.} : Engine speed 3000 rpm	90.6 kPa {26.8 in. Hg, 680 mmHg} or more	—	Replace

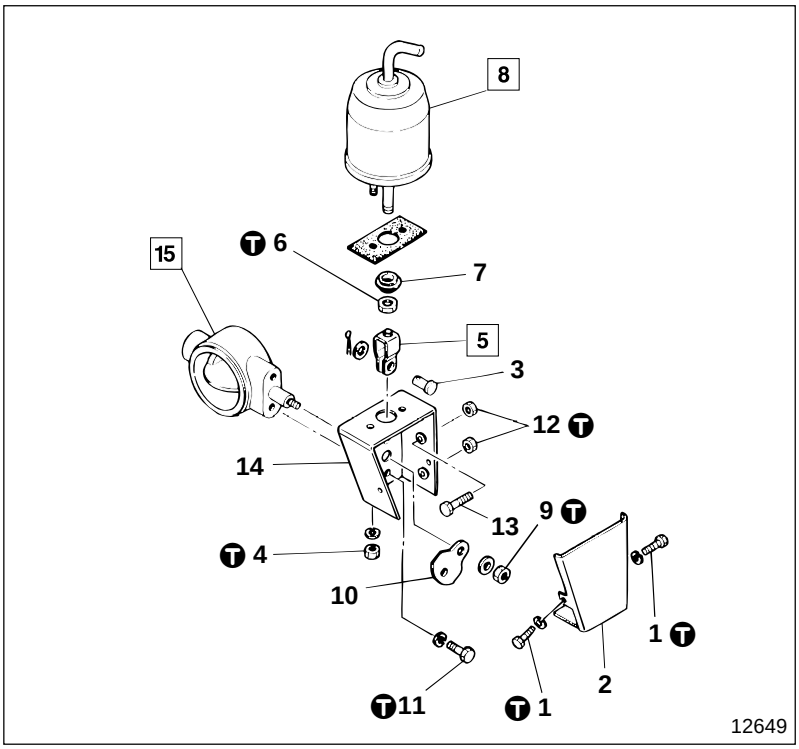
Lubricant

Location	Points of application	Specified lubricant	Quantity
3, 7	Periphery of the O-ring	Engine oil	As required

M E M O

EXHAUST BRAKE SYSTEM

Exhaust Brake Unit



● **Disassembly sequence**

1 Bolt
2 Cover
3 Clevis pin
4 Nut
5 Clevis
6 Lock nut
7 Bearing
8 Vacuum chamber
9 Nut
10 Lever
11 Bolt
12 Nut
13 Adjusting bolt
14 Bracket
15 Valve assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

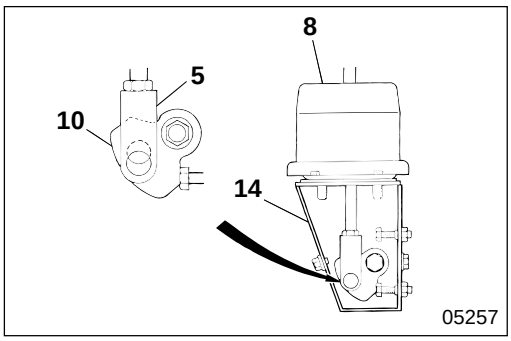
Location	Maintenance item	Standard value	Limit	Remedy
8	Airtightness in vacuum chamber (Airtightness 15 seconds after applying negative pressure 67 kPa {19.7 in. Hg, 500 mmHg})	63 kPa {18.7 in. Hg, 475 mmHg} or more	—	Replace
14	Average value of upper and lower clearance between butterfly valve and body, when butterfly valve is totally closed (Degree of vacuum in vacuum chamber 86.7 to 93.3 kPa {25.6 to 27.6 in. Hg, 650 to 700 mmHg})	0.10 to 0.25 {0.0039 to 0.0098}	—	Adjust

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

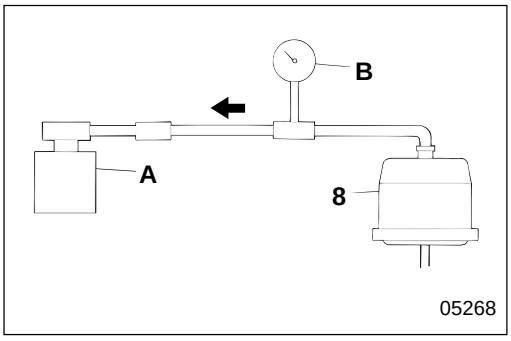
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Cover mounting)	4.9 to 6.9 {3.6 to 5.1, 0.5 to 0.7}	—
4	Nut (Vacuum chamber mounting)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
6	Lock nut (Clevis fixing)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
9	Nut (Lever mounting)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
11	Bolt (Bracket mounting)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
12	Nut (Adjusting bolt fixing)	4.9 to 6.9 {3.6 to 5.1, 0.5 to 0.7}	—

◆ Service procedure



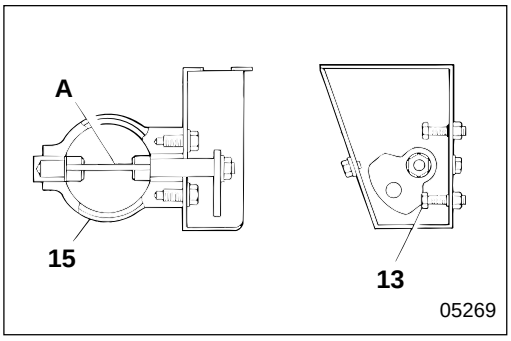
5 **Adjustment of clevis**

Install vacuum chamber **8** on bracket **14**, and adjust the position of clevis **5** so that the hole of the clevis is half the pitch of the hole of lever **10**.



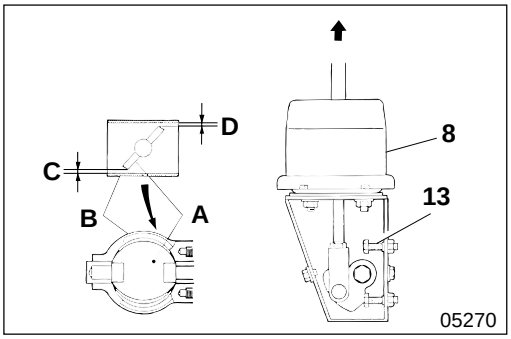
8 **Test of vacuum chamber airtightness**

Arrange piping as illustrated, and apply vacuum of 67 kPa {19.7 in. Hg, 500 mmHg} or more to vacuum chamber **8**, then stop vacuum pump **A**. After 15 seconds, ensure that the value of vacuum gauge **B** is the standard value. If the measured value deviates from the standard value, replace the vacuum chamber.



15 **Adjustment of valve assembly**

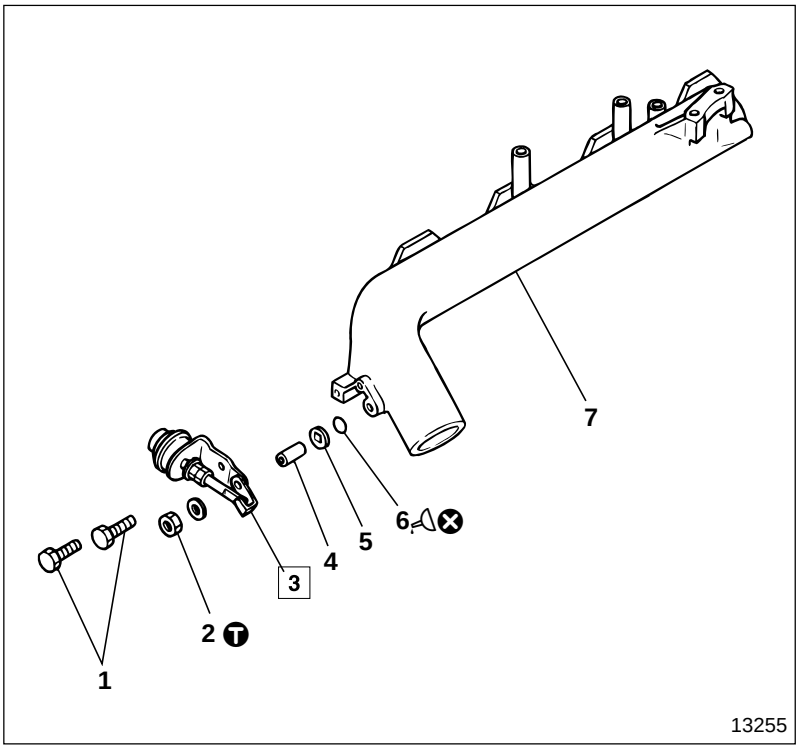
[Fully-opened adjustment]
Adjust using adjusting bolt **13** so that butterfly valve **A** of valve assembly **15** is fully opened.



[Fully-closed adjustment]
While applying vacuum 87 to 93 kPa {25.6 to 27.6 in. Hg, 650 to 700 mmHg} to vacuum chamber **8**, adjust using adjusting bolt **13** so that the average value of clearance **C** and **D** between butterfly valve **A** and body **B** is within the standard value.

Clearance=(C+D)/2

Intake Silencer



● **Disassembly sequence**

1 Bolt
2 Nut
3 Actuator
4 Spacer
5 Thrust plate
6 O-ring
7 Intake manifold

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly** P35A-81

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
3	Actuator (Push rod stroke when negative pressure of 40 kPa {11.8 in. Hg, 300 mmHg} applied)	15 {0.59} or more	—	Replace
—	Clearance between intake manifold and butterfly valve when fully closed	3.6 to 4.0 {0.14 to 0.16}	—	Adjust

Ⓣ Tightening torque

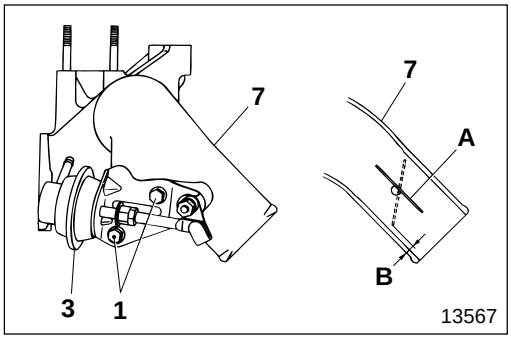
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut	8 {5.7, 0.8}	—

Lubricant

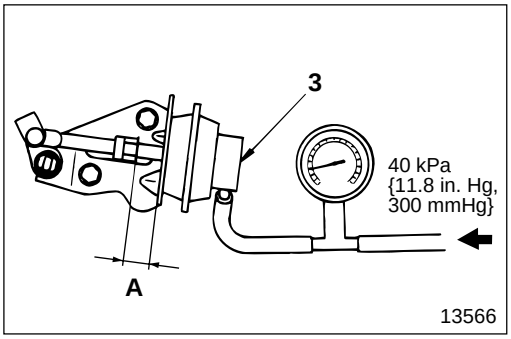
Location	Points of application	Specified lubricant	Quantity
6	O-ring	Molybdenum disulfide grease [NLGI No.2 Li soap]	As required

◆ Service procedure



● **Adjustment after assembly**

- Loosen bolts **1**.
- While applying negative pressure of 67 kPa {19.7 in. Hg, 500 mmHg} to actuator **3**, adjust the position of the actuator so that clearance **B** between intake manifold **7** and butterfly valve **A** conforms to the standard value.
- Tighten bolts **1** and fix actuator **3**.



3 **Inspection of actuator**

- Apply negative pressure of 40 kPa {11.8 in. Hg, 300 mmHg} to actuator **3** and measure stroke **A** of the push rod.
- If the measured value deviates from the standard value, replace actuator **3**.

MITSUBISHI
FUSO

Group 35E
Anti-Lock Brake System (ABS)

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-35E

INDEX

SPECIFICATIONS 35E- 2

STRUCTURE AND OPERATION 35E- 2

ON-VEHICLE INSPECTION AND ADJUSTMENT

- **Periodic Inspection Procedures 35E-15**
- **Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope 35E-16**
- **Hydraulic Unit Operation Check 35E-17**

TROUBLESHOOTING

- **Troubleshooting Procedures 35E-19**
- **Diagnosis Code Indication 35E-20**
- **Diagnosis Code Chart 35E-23**
- **Actuator Drive Chart 35E-23**
- **Service Data 35E-24**

ELECTRIC CIRCUIT AND PART INSTALLATION LOCATIONS 35E-26

SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item	Specifications
Brake system	Vacuum servo
Number of sensors/number of channels	4S/4K
Manufacturer	NIPPON ABS

STRUCTURE AND OPERATION
Anti-lock Brake System (ABS)

The anti-lock brake system (ABS) prevents tire slippage due to wheel lockup caused by sudden braking and braking on slippery road surfaces. The anti-lock brake system provides a driver with vehicle controllability and directional stability in braking.

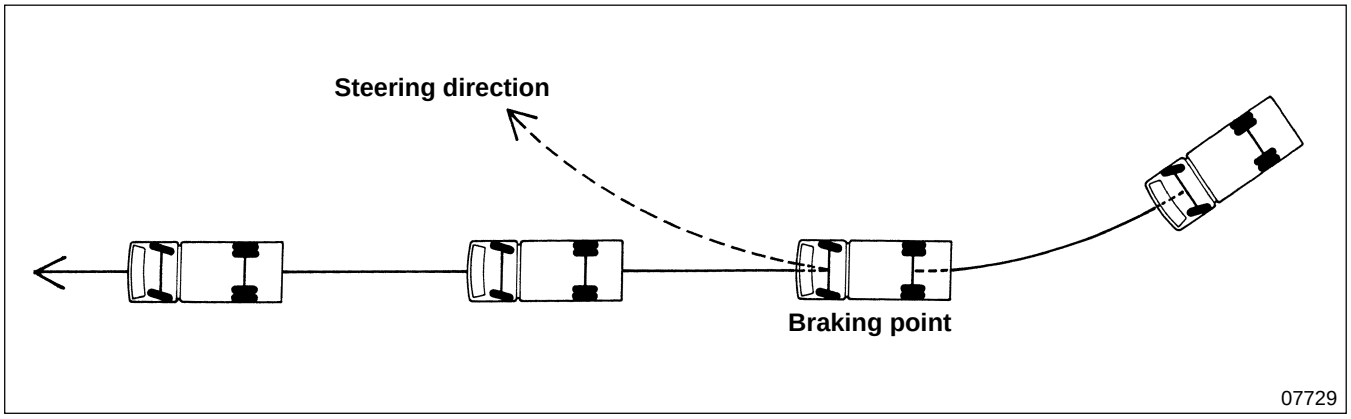
● Wheel lockup

Rotating tires of a moving vehicle have a tendency to continue traveling in the direction of tire rotation. Because of this characteristic, a driver can control the vehicle's traveling direction by moving the front wheels to a desired direction using the steering wheel.

In a vehicle not equipped with an anti-lock brake system, when a driver depresses the brake pedal with full force, the wheels can lock up under certain conditions. Tires in a wheel lockup condition lose the tendency to maintain directional characteristic, and the vehicle starts sliding in a direction of an externally applied force regardless of the tire direction. In other words, when wheel lockup occurs, the vehicle loses its directional stability, disallowing the driver to control the vehicle's movement.

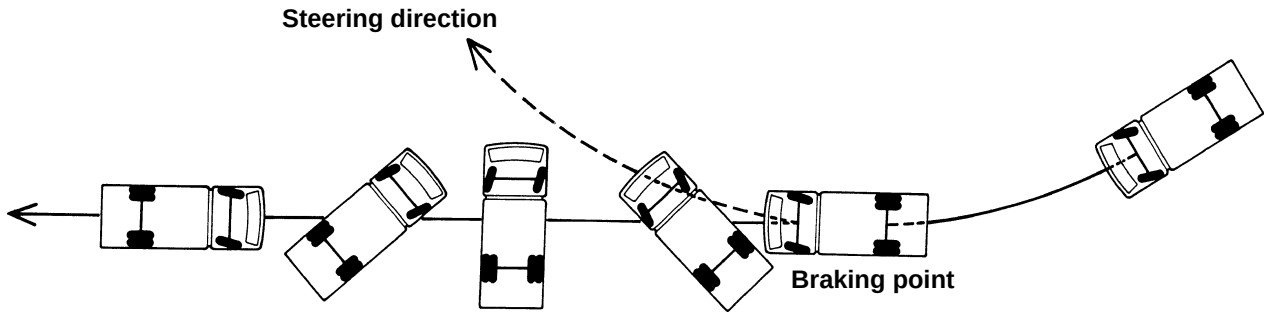
The following shows how a vehicle without anti-lock brake system loses its directional stability when different tires lock up on slippery road surfaces.

● Front wheel lockup (both front tires)



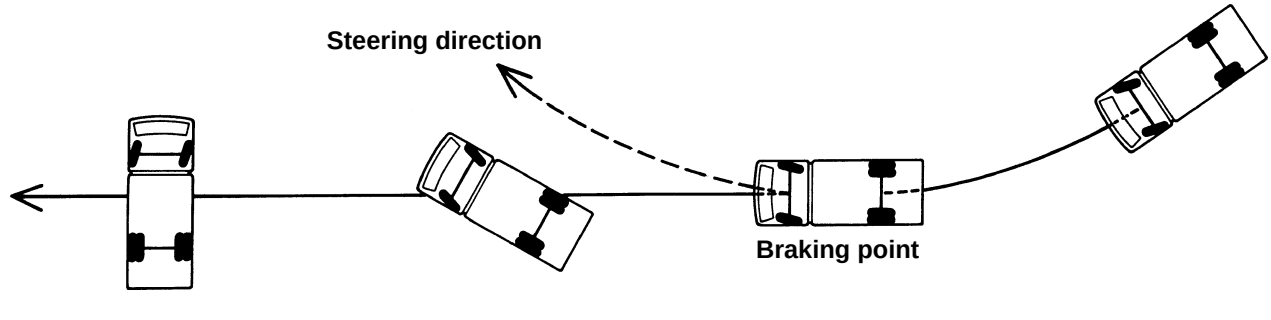
The front tires lose directional stability, but the rear tires try to travel in the direction of rotation since they are not locked up. Because of the front wheel lockup, a steering wheel operation does not change the vehicle's moving direction.

● **Rear wheel lockup (both rear tires)**



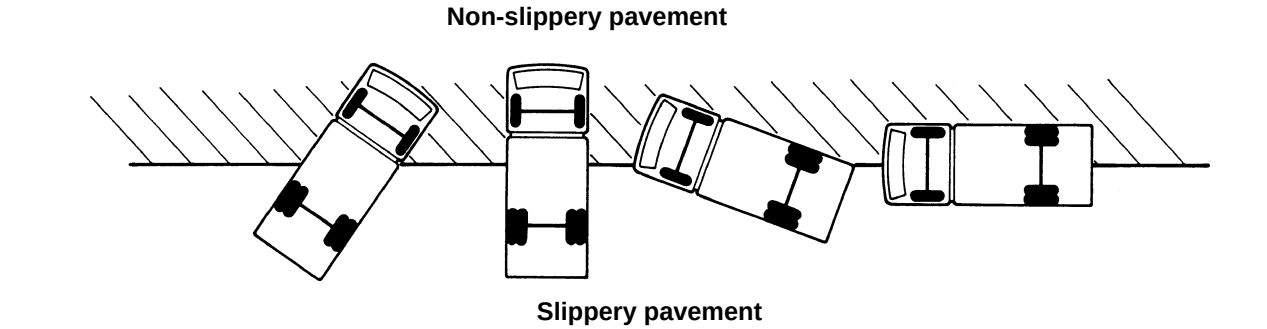
When the steering wheel is operated with the rear wheels in a lockup condition, the front tires try to change the vehicle's traveling direction, but the rear tires slide sideways, causing the vehicle to spin. If wheel lockup occurs in a vehicle traveling in a straight direction, the force of inertia continues to push the vehicle straight ahead from the back of the vehicle due to the lack of stopping force in the rear tires, and the vehicle can spin.

● **All wheel lock up (front and rear tires)**



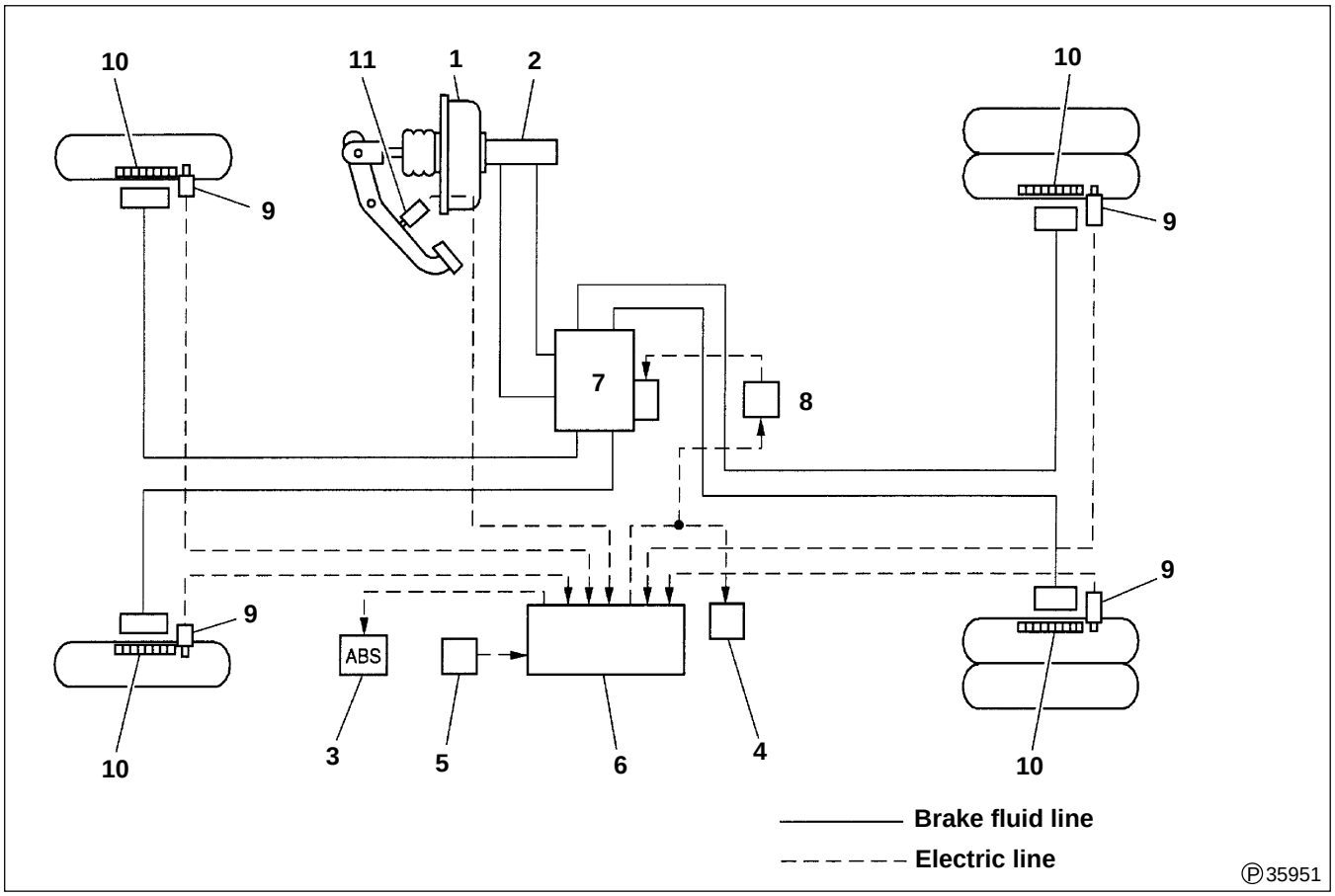
When wheel lockup occurs in both front and rear tires, all four tires lose directional stability. Therefore, the vehicle slips in the direction of inertia regardless of the steering direction.

● **Wheel lockup on surfaces with split μ factors (road surface with different friction coefficients for right and left tires)**



The tires on a surface with a lower friction coefficient lock up first. The tires in a lockup condition start sliding, thus failing to provide effective stopping force. Due to this imbalance in the stopping power between the right and left tires, one side of the vehicle slows down while the other side continues traveling, thus resulting in the loss of directional stability. When this happens during sudden braking, the vehicle spins.

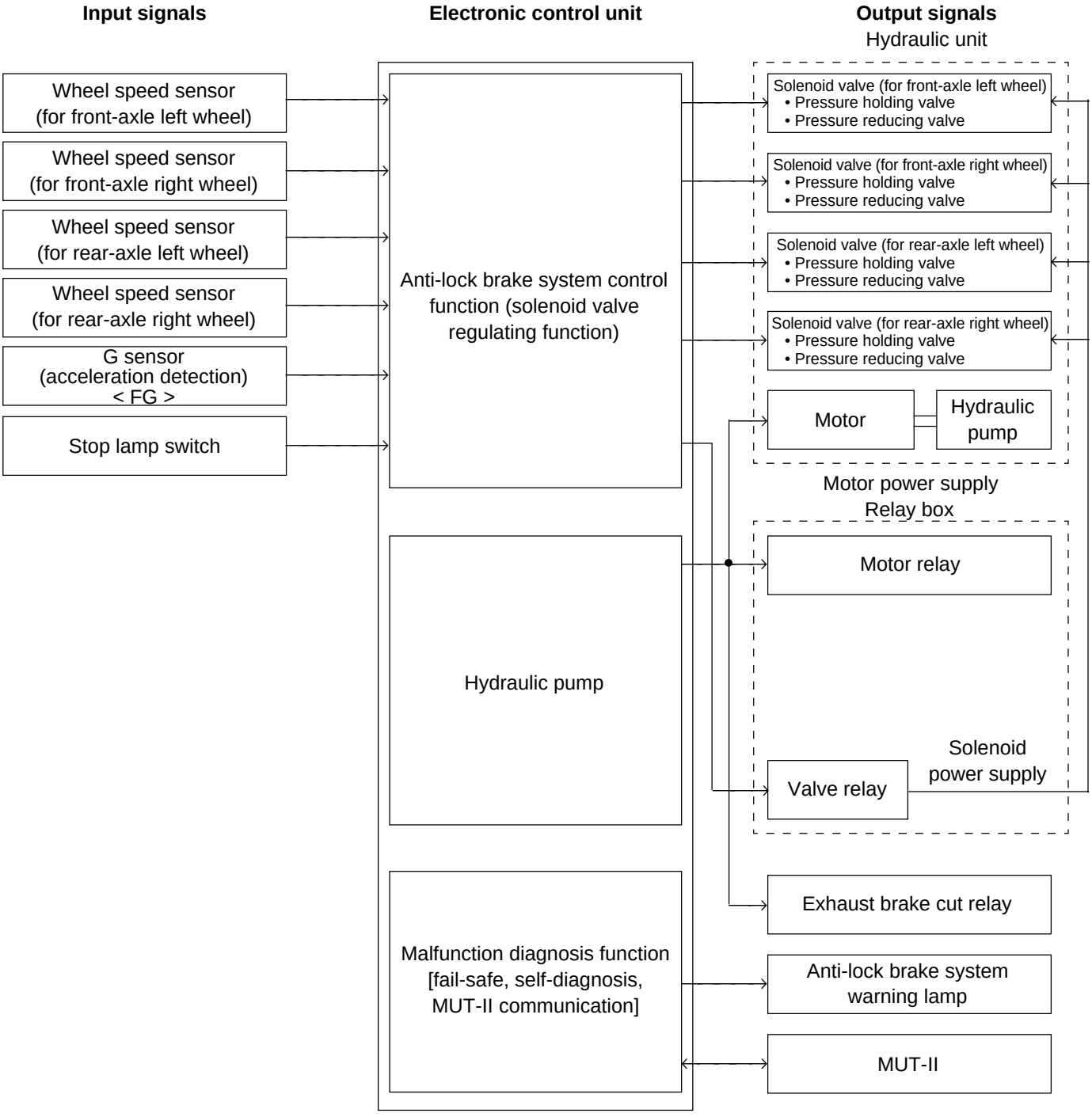
Structure of anti-lock brake system

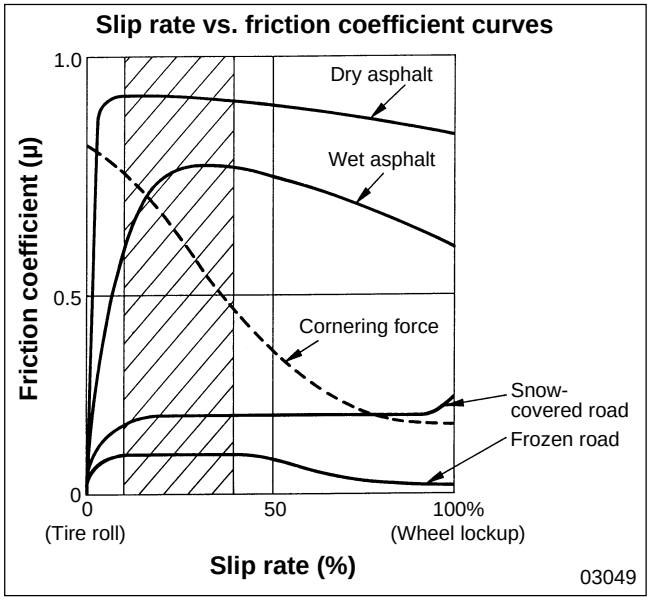


1 Brake booster (Mastervac)
2 Brake master cylinder
3 Anti-lock brake system warning lamp
4 Exhaust brake cut relay
5 G sensor < FG >
6 Electronic control unit
7 Hydraulic unit
8 Relay box
9 Wheel speed sensor
10 Rotor
11 Stop lamp switch

The ABS uses wheel speed sensors **9** and electronic control unit **6** to monitor the rotating speed of each wheel. The FG models are also equipped with G sensor **5** for the detection of the degree of vehicle's forward and backward acceleration. When the wheel speed exceeds the preset deceleration speed or slip rate during braking, the electronic control unit detects it as a tendency leading to wheel lockup, and sends control signals to hydraulic unit **7** and relay box **8**. The signals activate the solenoid valves to reduce the brake fluid pressure in the wheel brakes and ease the braking force to prevent wheel lockup. Then, when the wheel speed increases, wheel speed sensors **9** send signals to the solenoid valves in hydraulic unit **7** by way of electronic control unit **6** to increase the brake fluid pressure in the wheel brakes to augment the braking force. This control cycle is repeated to prevent wheel lockup on slippery pavements and ensure the vehicle's directional stability during braking. The 4-sensor 4-channel anti-lock brake system uses four wheel speed sensors **9**, which are located at the front and rear wheels, to control each of the four wheels.

● **Anti-lock brake system function**





● **Anti-lock brake system control function**

To provide optimum stopping power, the ABS controls the braking force based on the slip rate determined by the relationship between the wheel speed and the vehicle speed. When the brake is applied, the resulting force slows down the wheel rotation, thus reducing the vehicle speed. However, inertia acts on the vehicle and tries to maintain the vehicle's forward movement despite the stopping force applied by the tires. When there is a difference between the wheel speed and vehicle speed, slipping occurs. The degree of slippage is expressed by a slip rate.

$$\text{Slip rate (\%)} = \frac{\text{Vehicle speed} - \text{Wheel speed}}{\text{Vehicle speed}} \times 100$$

When the slip rate is 0%, there is no slippage between the tires and pavement. The slip rate of 100% refers to a wheel lockup condition.

The graph shows the time-based changes in the friction coefficient of a rolling tire during the process of wheel lockup. When the brake is applied gradually while the tires are rotating on pavement, the tires begin to slip while in rotation.

When the brake is applied harder, the tires stop rotating and start to slide on the pavement. This condition is called wheel lockup.

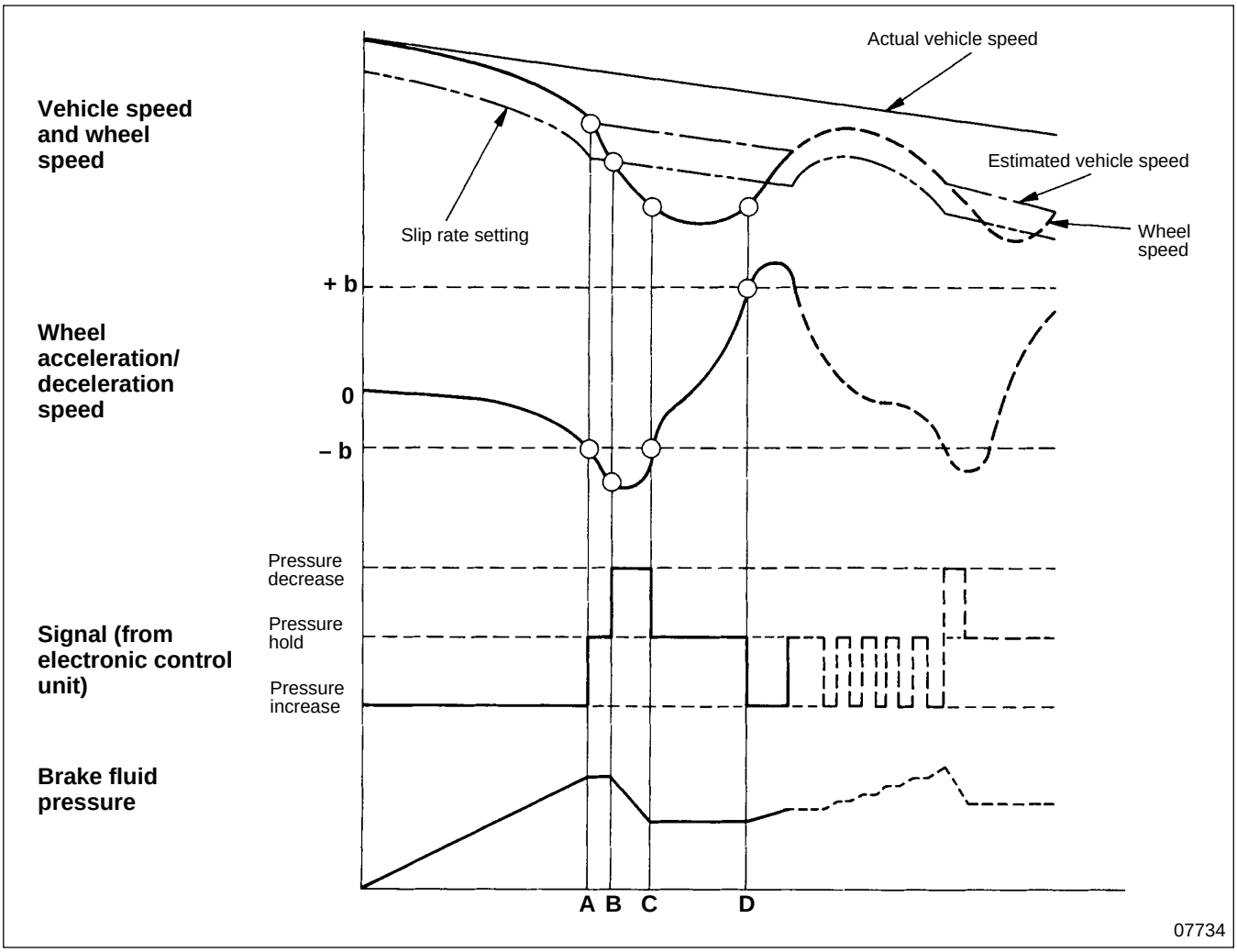
The friction coefficient is highest when the slip rate is within the shaded area on the graph.

In other words, tires provide maximum friction when the braking force is appropriately controlled to maintain the slip rate in the range indicated by the shaded area on the graph, rather than when the brake is applied at full force.

In a vehicle equipped with anti-lock brake system, the electronic control unit and hydraulic unit adjust the braking force and maintain it within the shaded area on the graph where the friction coefficient is high, thus preventing tire slippage and ensuring braking stability.

Anti-lock brake system operation

● **Anti-lock brake system control characteristic curve**



The above anti-lock brake system control characteristic graph shows the time-based changes in vehicle speed, wheel acceleration/deceleration speed and brake fluid pressure level during braking.

- When the wheel deceleration speed exceeds the speed setting **– b** at point **A**, the electronic control unit sends a signal to maintain the brake fluid pressure at the same level.
  At the same time, the electronic control unit estimates the vehicle speed according to a programmed calculation method.
- When the vehicle speed decreases further and the slip rate exceeds the setting at point **B**, the electronic control unit detects it as a tendency leading to wheel lockup, and sends a signal to reduce the brake fluid pressure.
- When the wheel speed increases because of the reduced brake fluid pressure and the wheel speed exceeds the setting **– b** at point **C**, the electronic control unit sends a signal to maintain the brake fluid pressure at the same level.
- When the wheel speed increases further and the wheel speed exceeds the setting **+ b** at point **D**, the electronic control unit determines that there is no risk of wheel lockup and sends a signal to increase the brake fluid pressure.

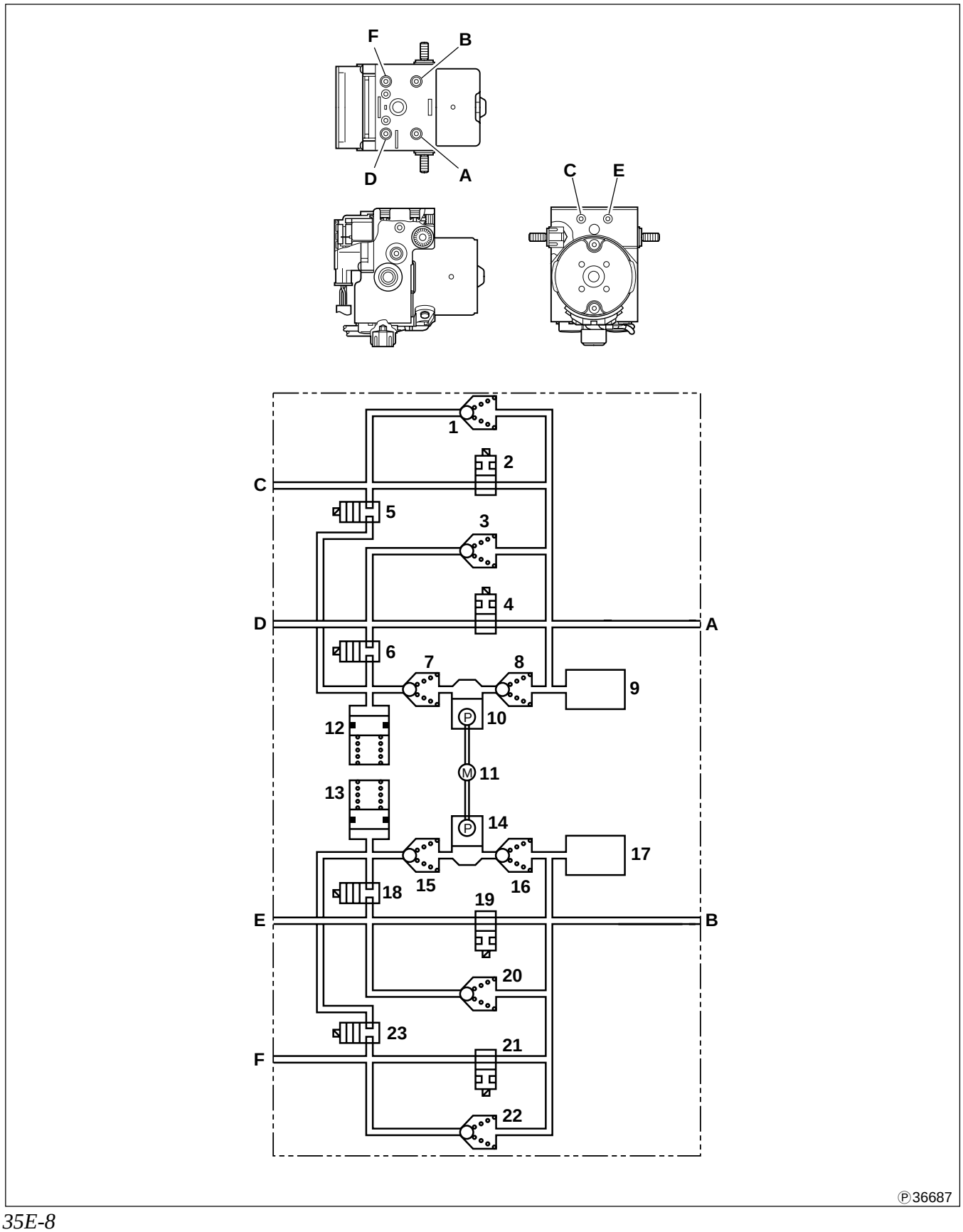
By repeating the above control cycle, the anti-lock brake system prevents wheel lockup and provides maximum friction between the tires and pavement to ensure high stability during braking.

● **Anti-lock brake system and exhaust brake system**

On slippery road surfaces, activation of the exhaust brake system can result in wheel lockup. If the exhaust brake activates during an anti-lock brake system braking operation, proper braking function cannot be provided by the anti-lock brake system.
To prevent this, the exhaust brake system is deactivated during anti-lock brake system operation even when the exhaust brake switch is turned ON. When the anti-lock brake system stops providing its function, the exhaust brake system becomes operable if the exhaust brake switch is ON.

Hydraulic Unit

(1) Internal circuit



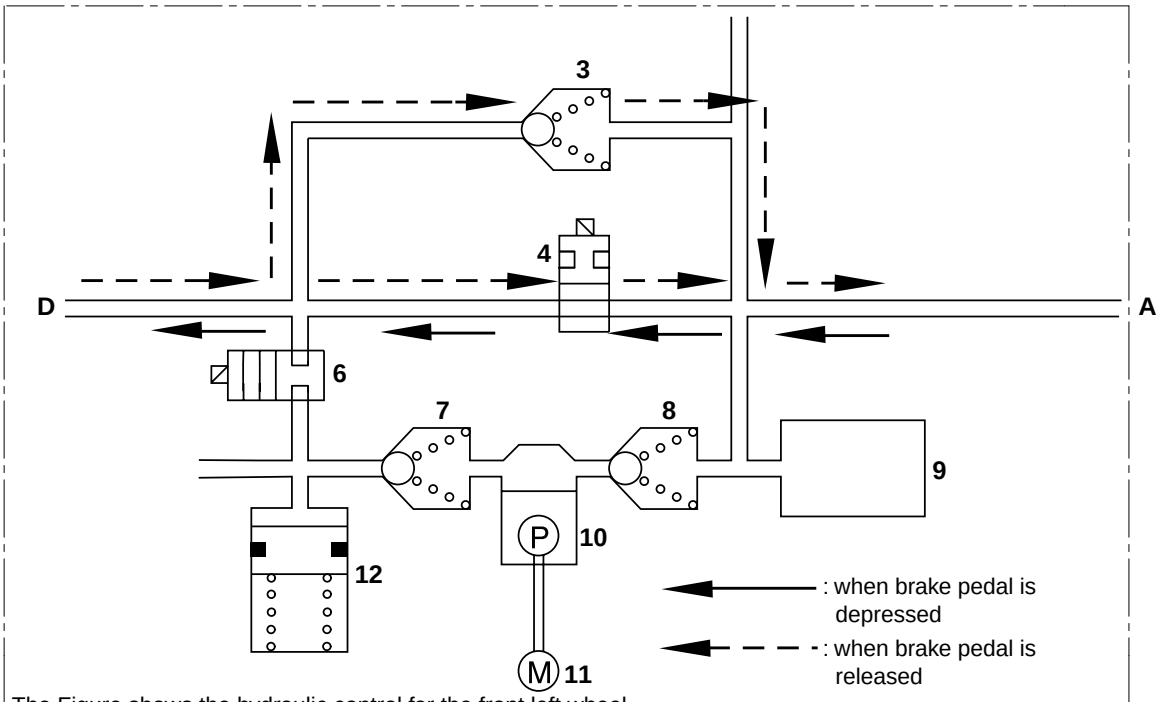
1 Check valve (front right wheel)
2 Solenoid valve (holding pressure for front right wheel)
3 Check valve (front left wheel)
4 Solenoid valve (holding pressure for front left wheel)
5 Solenoid valve (reducing pressure for front right wheel)
6 Solenoid valve (reducing pressure for front left wheel)
7 Inlet valve (front system)
8 Outlet valve (front system)
9 Damper (front system)
10 Plunger pump (front system)
11 Motor
12 Reservoir (front system)
13 Reservoir (rear system)
14 Plunger pump (rear system)
15 Inlet valve (rear system)
16 Outlet valve (rear system)
17 Damper (rear system)
18 Solenoid valve (reducing pressure for rear right wheel)
19 Solenoid valve (holding pressure for rear right wheel)
20 Check valve (rear right wheel)
21 Solenoid valve (holding pressure for rear left wheel)
22 Check valve (rear left wheel)
23 Solenoid valve (reducing pressure for rear left wheel)
A: From master cylinder (front system)
B: From master cylinder (rear system)
C: To wheel brake (front right wheel)
D: To wheel brake (front left wheel)
E: To wheel brake (rear right wheel)
F: To wheel brake (rear left wheel)

The hydraulic unit consists of various solenoid valves, a motor **11**, etc.
The solenoid valves and the motor are activated as shown in the following table by the control signal from the electronic control unit.

		Anti-lock brake system control											
		Front right wheel			Front left wheel			Rear right wheel			Rear left wheel		
		Pressure reduction	Pressure holding	Pressure increase	Pressure reduction	Pressure holding	Pressure increase	Pressure reduction	Pressure holding	Pressure increase	Pressure reduction	Pressure holding	Pressure increase
Solenoid valve	Reducing pressure for front right wheel **5**	○	×	×	—	—	—	—	—	—	—	—	—
	Holding pressure for front right wheel **2**	○	○	×	—	—	—	—	—	—	—	—	—
	Reducing pressure for front left wheel **6**	—	—	—	○	×	×	—	—	—	—	—	—
	Holding pressure for front left wheel **4**	—	—	—	○	○	×	—	—	—	—	—	—
	Reducing pressure for rear right wheel **18**	—	—	—	—	—	—	○	×	×	—	—	—
	Holding pressure for rear right wheel **19**	—	—	—	—	—	—	○	○	×	—	—	—
	Reducing pressure for rear left wheel **23**	—	—	—	—	—	—	—	—	—	○	×	×
	Holding pressure for rear left wheel **21**	—	—	—	—	—	—	—	—	—	○	○	×
Motor **11**		○											

○: ON
×: OFF

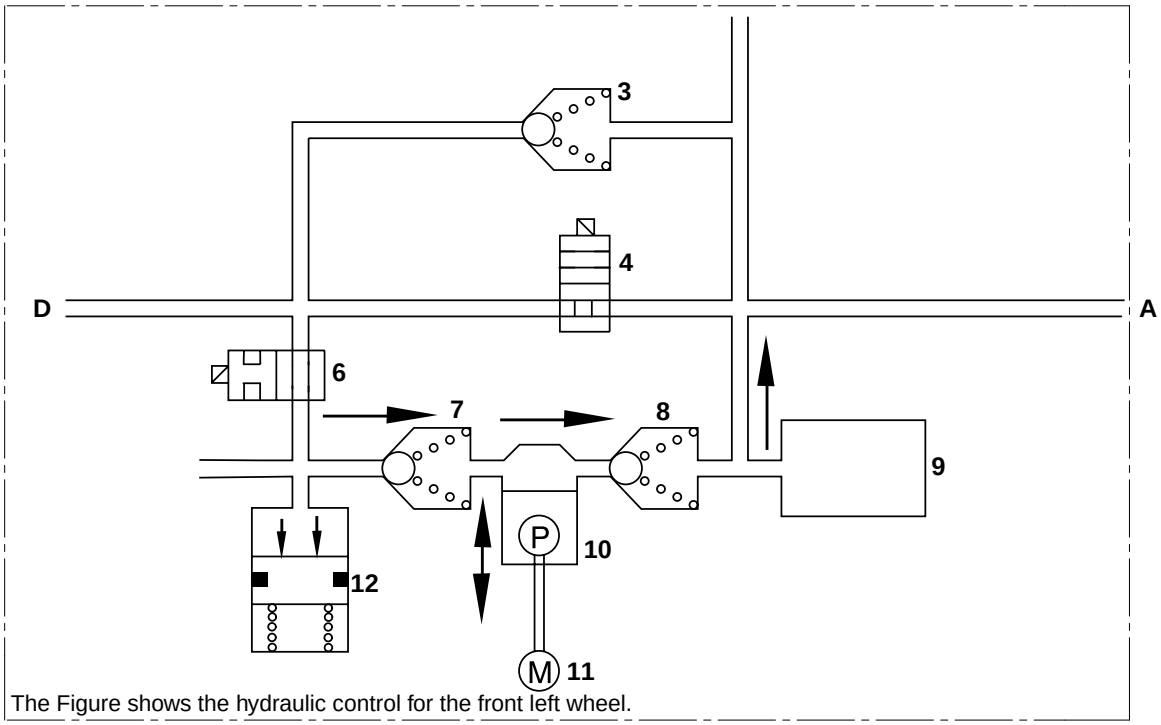
(2) Braking in normal conditions (anti-lock brake system not activated)



Ⓟ36688

- In the conditions where the brake pedal is depressed but ABS is not activated, no control signals are sent to the solenoid valve **6** (reducing pressure for front left wheel) and the solenoid valve **4** (holding pressure for front left wheel) in the hydraulic unit. Therefore, the solenoid valve **4** (holding pressure for front left wheel) is open and the solenoid valve **6** (reducing pressure for front left wheel) is closed.
- The brake fluid pressure **A** from the brake master cylinder is then fed to the wheel brake **D** through the solenoid valve **4** (holding pressure for front left wheel) without any modulation, braking the wheel.
- At that time, the brake fluid pressure is also applied to the damper **9** (front system), which is not activated with a normal brake fluid pressure.
- When the brake pedal is released, the brake fluid pressure **A** from the brake master cylinder is reduced. Therefore, the brake fluid pressure in the wheel brake **D** returns to the brake master cylinder through the solenoid valve **4** (holding pressure for front left wheel) and through the check valve **3** (front left wheel) whose ball is pressed off the seat by the pressure.

(3) When anti-lock brake system is activated (for reducing pressure)

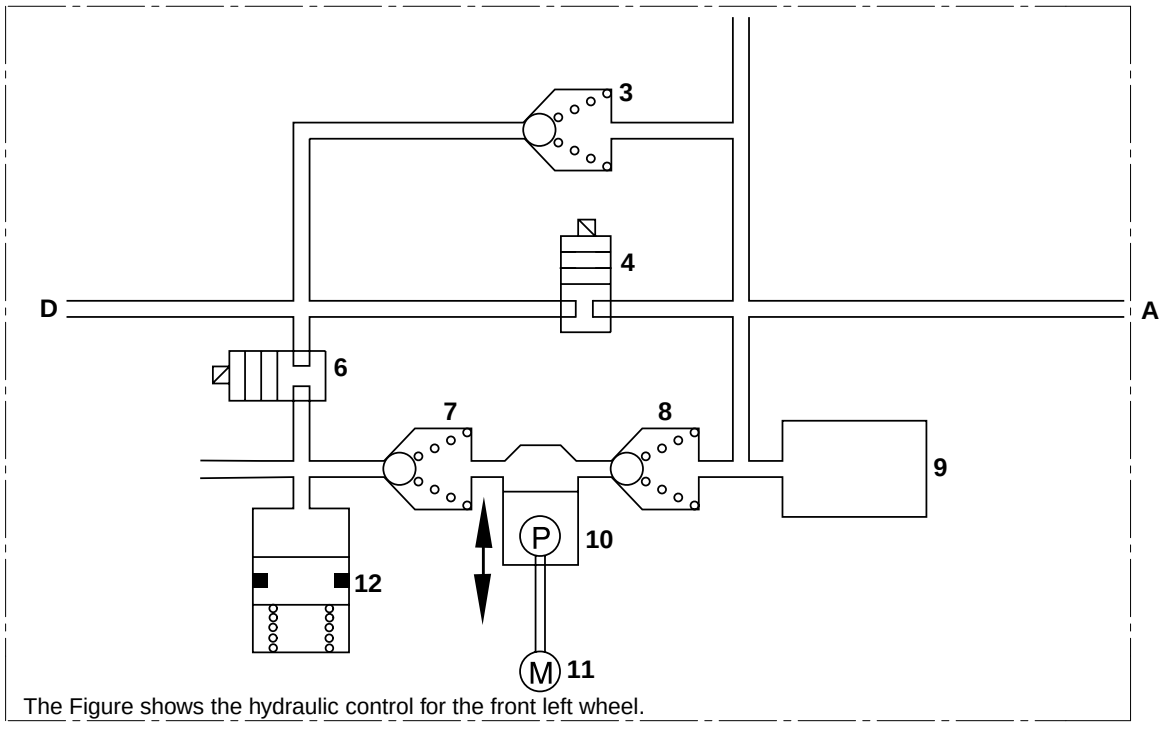


The Figure shows the hydraulic control for the front left wheel.

Ⓟ36689

- If the front left wheel shows signs of locking when the brake pedal is depressed, the electronic control unit sends the control signals to the solenoid valve **6** (reducing pressure for front left wheel) and the solenoid valve **4** (holding pressure for front left wheel). Then, the solenoid valve **6** (reducing pressure for front left wheel) opens and the solenoid valve **4** (holding pressure for front left wheel) closes.
- The brake fluid pressure in the wheel brake **D** is fed back into the reservoir **12** (front system) through the solenoid valve **6** (reducing pressure for front left wheel) and thereby it is reduced.
- Simultaneously with the control signals to the solenoid valve **6** (reducing pressure for front left wheel) and solenoid valve **4** (holding pressure for front left wheel), the electronic control unit also sends a control signal to the motor **11**, which operates the plunger pump **10** (front system). This causes the brake pressure in the reservoir to flow through the inlet valve **7** (front system) and outlet valve **8** (front system) into the damper **9** (front system).
- At this time, the check valve **3** (front left wheel) is closed by the brake fluid pressure **A** from the brake master cylinder. Accordingly, the brake fluid pressure is not fed from the brake master cylinder to the wheel brake.

(4) When anti-lock brake system is activated (for holding pressure)

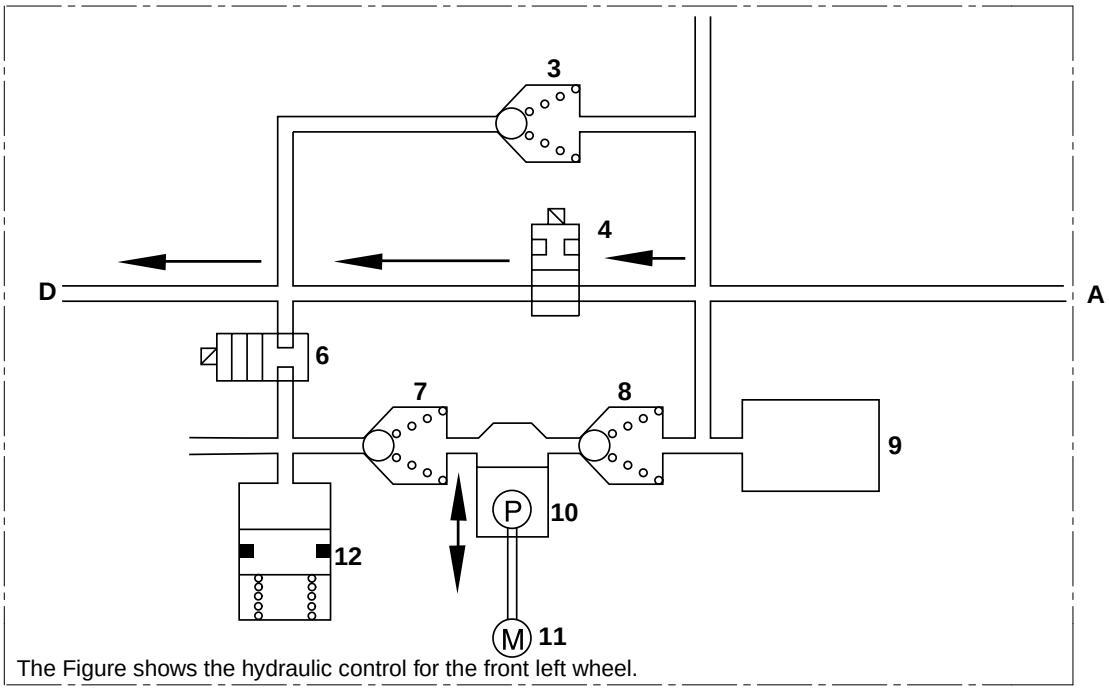


The Figure shows the hydraulic control for the front left wheel.

Ⓟ36690

If the brake fluid pressure **D** in the wheel brake should be maintained for sustained anti-lock brake system control, the electronic control unit sends the pressure holding signal to the solenoid valve **4** (holding pressure for front left wheel) and stops control signal to the solenoid valve **6** (reducing pressure for front left wheel). This causes both solenoid valve **4** (holding pressure for front left wheel) and solenoid valve **6** (reducing pressure for front left wheel) to close, thereby the brake fluid pressure being maintained.

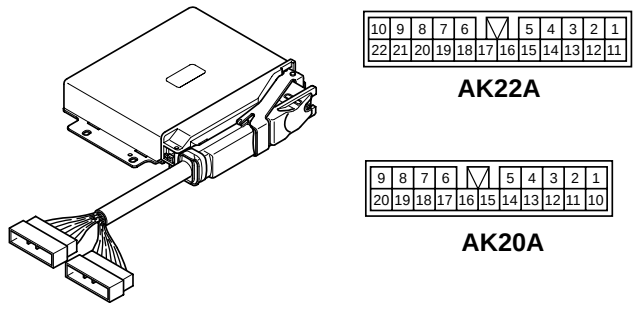
(5) When anti-lock brake system is activated (for increasing pressure)



The Figure shows the hydraulic control for the front left wheel.

Ⓟ36691

- If the brake fluid pressure **D** in the wheel brake should be increased, the electronic control unit stops sending control signals to the solenoid valve **4** (holding pressure for front left wheel) and solenoid valve **6** (reducing pressure for front left wheel) in the hydraulic unit.
- Then, the solenoid valve **4** (holding pressure for front left wheel) opens and the solenoid valve **6** (reducing pressure for front left wheel) closes. Namely, the same condition as where no anti-lock brake system control is provided brings about.
- At this time, the check valve **3** (front left wheel) is kept closed by the brake fluid pressure **A** from the brake master cylinder. Therefore, the brake fluid pressure **D** increased by the damper **9** (front system) is applied to the wheel brake irrespective of the brake fluid pressure in the brake master cylinder.



Ⓟ36208

● Electronic Control Unit

This component calculates the wheel speed and estimates the vehicle speed based on signals sent from the wheel speed sensors. Based on the calculation results, it determines the degree of wheel lockup tendency, and sends brake fluid pressure control signals to the solenoid valves of the hydraulic unit to regulate brake fluid pressure accordingly.

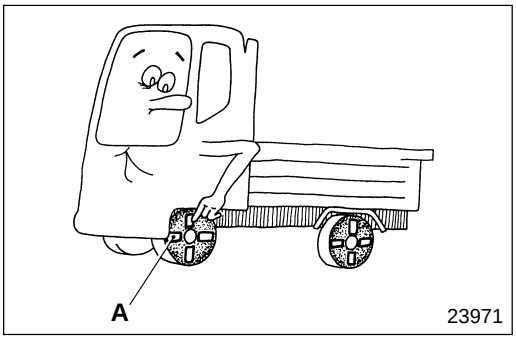
The electronic control unit is equipped with a self-diagnosis function. Should an abnormality occur, the electronic control unit turns on the warning lamp on the instrument panel to indicate the system malfunction and deactivates the anti-lock brake system control to set the brake system in normal condition (without anti-lock brake system control).

	AK22A	AK20A
Terminal No.	Connection destination	
1	Ground	G sensor (ground) < FG >
2	Ground	G sensor (signal) < FG >
3	–	–
4	Hydraulic unit (motor drive)	Meter cluster (anti-lock brake system warning lamp)
5	Hydraulic unit (motor drive monitor)	Starter switch terminal M (Electronic control unit power supply)
6	–	Wheel speed sensor (rear-axle right-wheel input)
7	Hydraulic unit (rear-axle right-wheel brake fluid pressure decrease)	Wheel speed sensor (rear-axle left-wheel input)
8	Hydraulic unit (rear-axle left-wheel brake fluid pressure decrease)	Wheel speed sensor (front-axle right-wheel input)
9	Hydraulic unit (front-axle right-wheel brake fluid pressure decrease)	Wheel speed sensor (front-axle left-wheel input) < FE >
10	Hydraulic unit (front-axle left-wheel brake fluid pressure decrease)	G sensor (power supply) < FG >
11	Ground	–
12	Ground	MUT-II connector
13	–	MUT-II connector
14	Relay box (valve relay drive)	Stop lamp switch
15	Relay box (valve relay and motor relay power supply)	–
16	Exhaust brake cut relay	Wheel speed sensor (front-axle left-wheel input) < FG >
17	Exhaust brake cut relay	Wheel speed sensor (rear-axle right-wheel grounding)
18	–	Wheel speed sensor (rear-axle left-wheel grounding)
19	Hydraulic unit (rear-axle right-wheel brake pressure hold)	Wheel speed sensor (front-axle right-wheel grounding)
20	Hydraulic unit (rear-axle left-wheel brake pressure hold)	Wheel speed sensor (front-axle left-wheel grounding)
21	Hydraulic unit (front-axle right-wheel brake pressure hold)	
22	Hydraulic unit (front-axle left-wheel brake pressure hold)	

Periodic Inspection Procedures

(1) Periodic inspection of Anti-lock brake system

- Inspect the vehicle's Anti-lock brake system following the procedure below.
- If an abnormality is found in this inspection, further inspect the Anti-lock brake system using MUT-II (multi-use tester-II) by referring to TROUBLESHOOTING section.
  P35E-19



- Inspection procedure
  ① With the vehicle stationary, press the brake pedal and inspect the hydraulic unit for fluid leaks.
  If fluid leaks from the hydraulic unit, replace the unit. If fluid leaks from the fluid pipe or connector, tighten the joint.
  ② Inspection using brake tester
  Check the braking force at each wheel with a brake tester by following the inspection procedure for ordinary vehicles.
  If an abnormality is found, inspect the wheel brake units, service brake system and hydraulic unit.
  ③ Drive the vehicle and check the operation of the Anti-lock brake system.
  - Conduct a test drive at an open area to ensure safety.
  - Conduct a test drive without cargo.

  Attach white tape **A** on the sides of tires, so that it is easy to observe the rotation of the front and rear wheels.
  - Turn the starter switch from the OFF position to the ON position, and make sure that the ABS warning lamp lights.
    Then, check that the ABS warning lamp turns off approximately two seconds after the starter switch is turned on.
  - Drive the vehicle at a speed of 20 to 30 km/h {12 to 19 mph}, and apply a sudden brake. Make sure that wheel lockup does not occur in any of the tires.

Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope

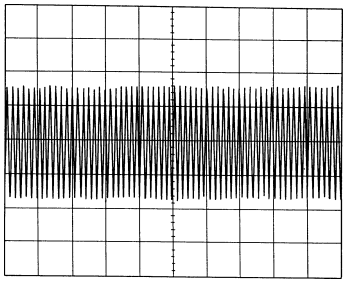
Inspect the rotor for dents using an oscilloscope, since the tester cannot be used for dent detection.

NOTE

Use an oscilloscope with a waveform recording function.

- Lift the wheel to be tested off the ground, and disconnect the connector at the wheel speed sensor.
- Connect the terminal of the oscilloscope to the terminal of the disconnected connector. Rotate the wheel at a constant speed. Check the waveform shown on the oscilloscope to check for dents on the rotor.

Normal waveform (no dent on rotor)



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- Rotor dents are often made by the rotor press-fit on the hub end contacting the axle during installation of the hub and brake drum assembly on the axle. When installing the hub & brake drum assembly, pay close attention to prevent the rotor from contacting other parts.
- If the wave is noticeably narrower in width than other observed waves, the rotor may be chipped. Visually inspect the rotor.

Hydraulic Unit Operation Check

Operation check using MUT-II

- Lift the vehicle using a jack and support it with jack stands, or position the tires on brake tester rollers.

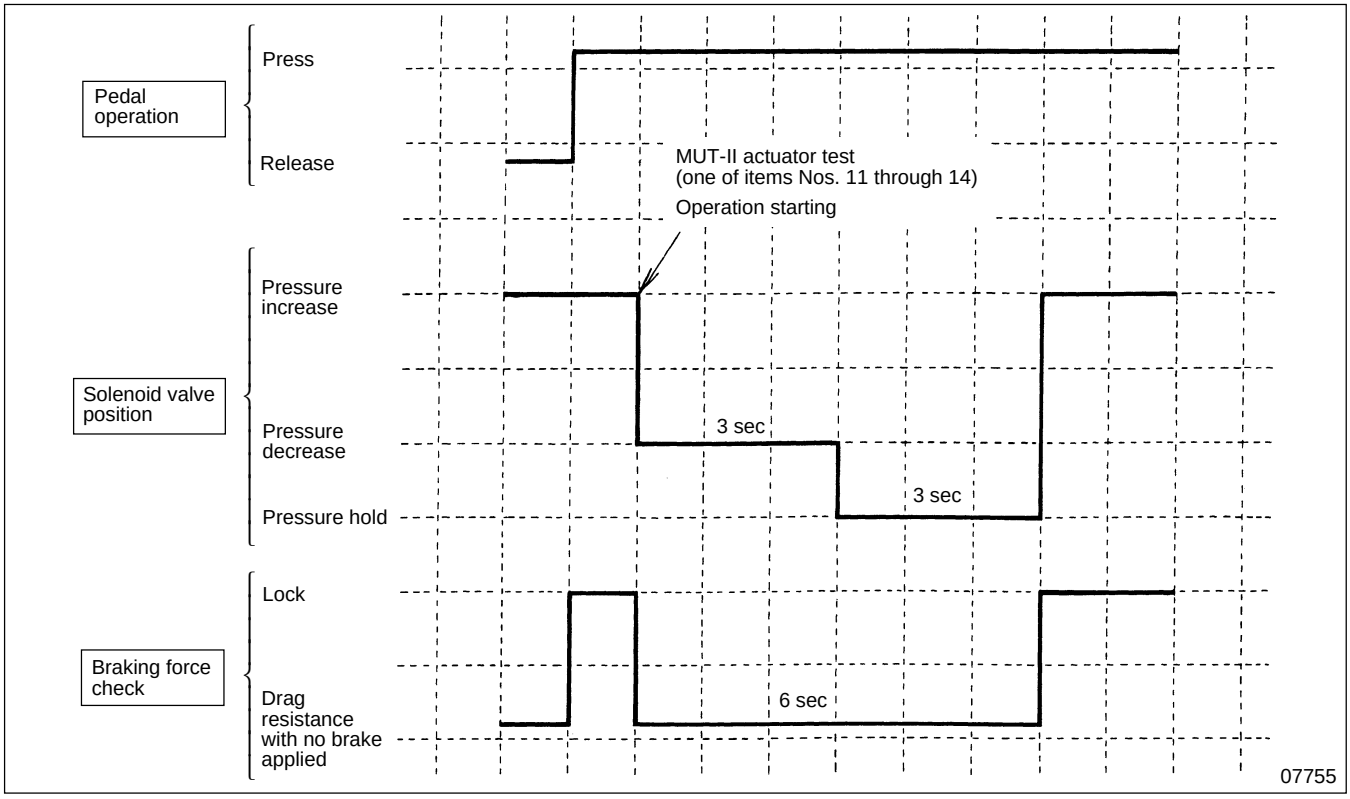
WARNING⚠

- **The brake tester rollers and tires must be dry during inspection.**
- **To test the front brakes, apply the parking brake. To test the rear brakes, place wheel chocks at the front tires to secure them in position.**

- Disengage the parking brake, and feel the drag resistance of the brake on each wheel.
  When using a brake tester, record the indicated drag resistance of the brake.
- Set the starter switch to the OFF position, then connect the MUT-II.
- Set the testing equipment and system on the MUT-II.
- After making sure that the transmission is in the neutral position, start the engine.

NOTE

- **When the engine is turned on, the anti-lock brake system switches to the MUT-II mode and the anti-lock brake system warning lamp flashes.**
- **When the anti-lock brake system function is deactivated due to the electronic control unit's fail-safe function, the actuator test cannot be performed with the MUT-II.**



- If an abnormality is found during the inspection, take appropriate measures described in the following operating condition evaluation chart.

Operating condition evaluation chart

Item No.	MUT-II indication	Operation	Judgment		Cause	Remedy
			Normal	Malfunction		
11	FR ABS MV ON	(1) Depress the brake pedal to lock wheels. (2) On the MUT-II, select the wheel to be tested and forcibly drive the actuator. (3) Rotate the selected wheel using the brake tester or by hand, and check the change in braking power.	Braking force eases for 6 seconds from locked condition.	Wheel does not lock when brake pedal is depressed.	Clogging in brake line other than HU	Inspect and clean brake lines.
12	FL ABS MV ON				Clogging in hydraulic line inside HU	Replace HU assembly.
13	RR ABS MV ON			Braking force does not ease.	Erroneous HU brake tube connection	Correct tube connection.
14	RL ABS MV ON				Faulty HU solenoid valve	Replace HU assembly.

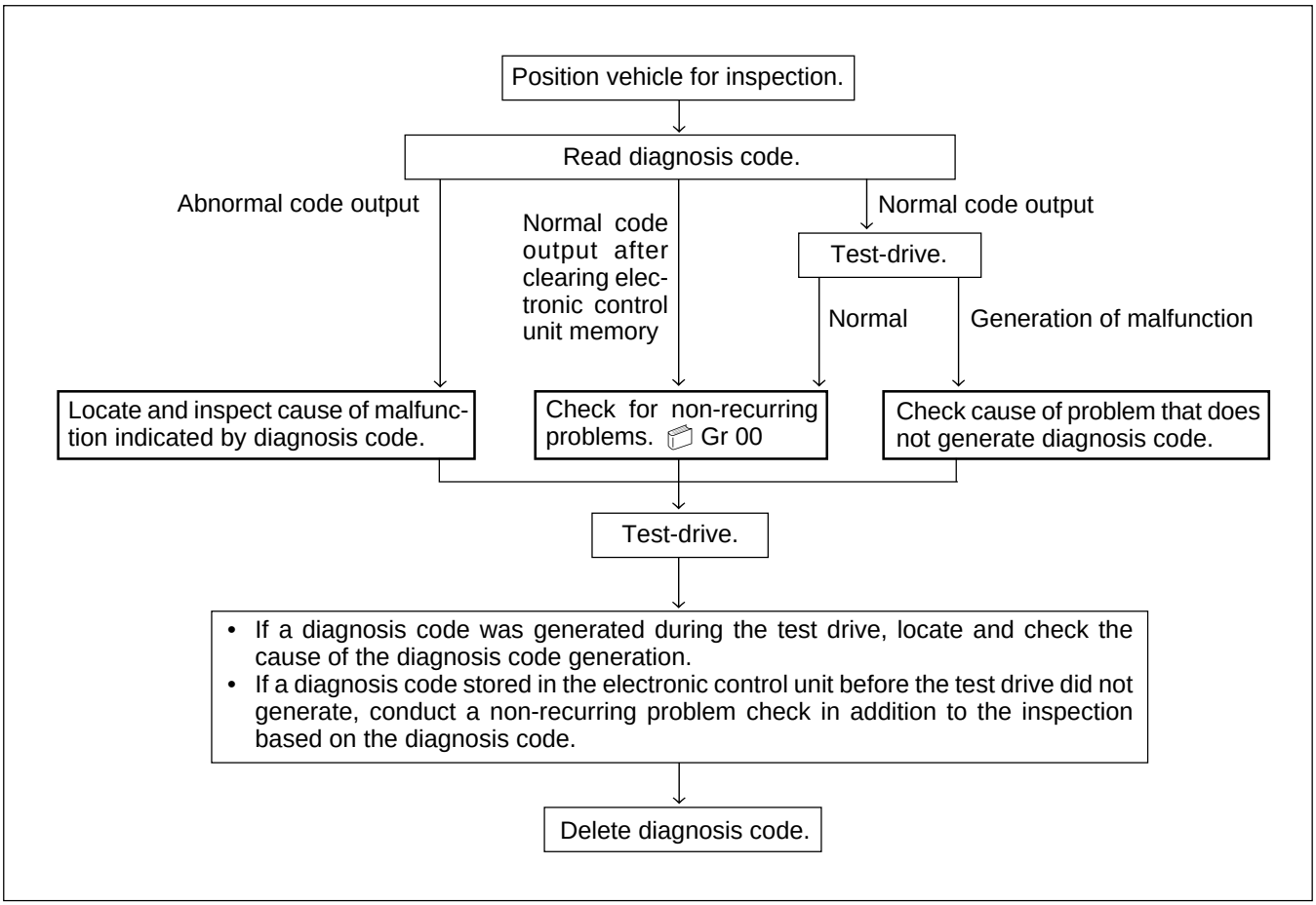
HU: Hydraulic unit • After inspection, set the starter switch to OFF before disconnecting the MUT-II.

Troubleshooting Procedures

Inspection flow chart

The MUT-II allows efficient inspection of the anti-lock brake system.
The types of system inspections can be roughly divided according to the malfunction condition and diagnosis code, as shown below.

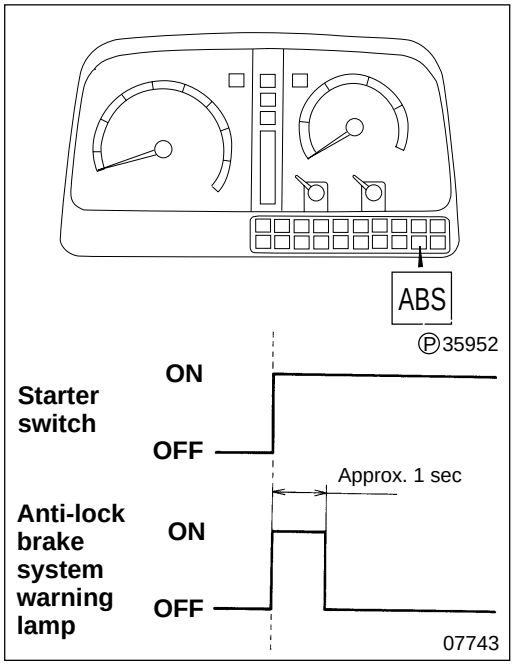
- Inspection based on individual malfunction diagnosis codes stored in the electronic control unit
- Inspection based on symptoms not indicated by diagnosis codes
- Correcting non-recurring problems



Cautions in malfunction diagnosis

- The anti-lock brake system uses electronic control to regulate the braking system. The following phenomena may occur during normal anti-lock brake system operation, but they do not denote a malfunction.

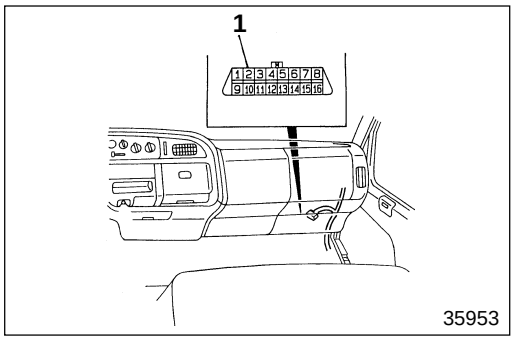
Phenomenon	Description
System checking sound	When the engine starts, a slight clunking sound may be generated in the left side of the frame near the cargo bed. This sound is produced by the system conducting an operation check, and does not denote a malfunction.
Anti-lock brake system operating sound	• Motor noise from the hydraulic unit (humming sound) • Noise generated as the brake pedal feel changes (grinding sound) • Noise from the chassis produced by repeated ON and OFF operations of the anti-lock brake system (wheels: short squeak, suspension: slight thud)
Anti-lock brake system operation effect (longer stopping distance)	On snow-covered surfaces and gravel roads, a vehicle equipped with anti-lock brake system may require a longer distance to come to a complete stop. Therefore, when driving on such road surfaces, reduce the speed sufficiently and drive carefully to minimize the use of brakes.



● Inspection of anti-lock brake system warning lamp

Check the anti-lock brake system warning lamp to make sure that the following operation turns on the lamp.

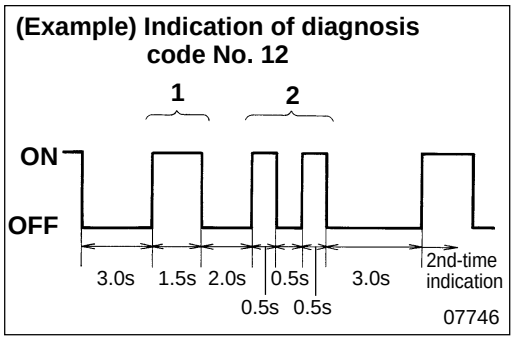
- Set the starter switch to the ON position, and check that the anti-lock brake system warning lamp lights for about 1 second and turns off.
- If the lamp does not light as described above, check diagnosis codes stored in the electronic control unit.



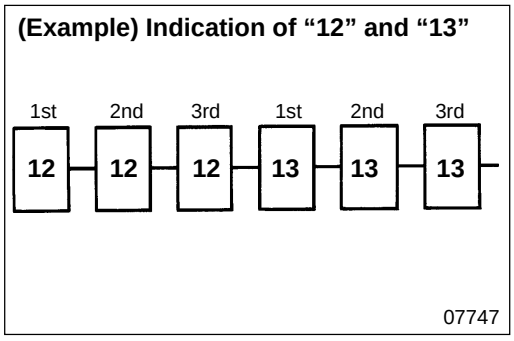
Diagnosis Code Indication

• Without MUT-II

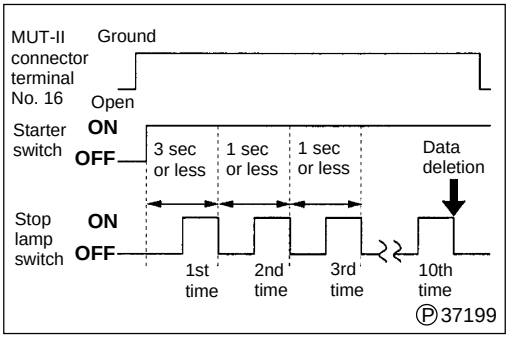
- With the vehicle stationary, ground terminal No. 16 of MUT-II connector **1**, then turn the starter switch to the ON position. The anti-lock brake system warning lamp will flash to indicate a diagnosis code.
- The anti-lock brake system warning lamp starts flashing 3.0 seconds after the starter switch is turned ON. The flashing pattern of the warning lamp indicates a diagnosis code.



- A diagnosis code is indicated in the following manner.
  - To indicate the tens digit (left digit), the lamp remains ON for 1.5 seconds, then remains OFF for 0.5 seconds. To indicate the ones digit (right digit), the lamp remains ON for 0.5 second, then remains OFF for 0.5 second.
  - Each diagnosis code is indicated three consecutive times. When there is no other diagnosis code to indicate, the lamp repeats the diagnosis code indication from the beginning.
  - When there is no diagnosis code stored in the memory (normal condition), the anti-lock brake system warning lamp repeats On/Off in 0.25-second intervals.



- When two or more diagnosis codes are stored in the electronic control unit.



● **Deletion of diagnosis codes**

Connect terminal No. 16 of the MUT-II connector to the chassis for grounding. While depressing the brake pedal, turn the starter switch on and off ten times in intervals of 1 second or less. Turn the key off, disconnect the ground wire. This erases diagnosis codes from the memory.

● **Completion of diagnosis code check**

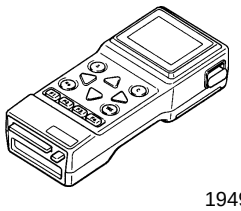
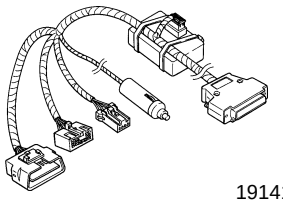
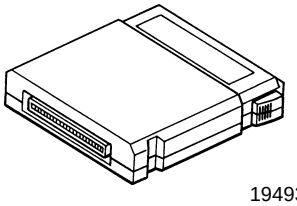
The diagnosis code check completes when diagnosis codes are erased from the electronic control unit of terminal No. 16 of the MUT-II connector is disconnected.

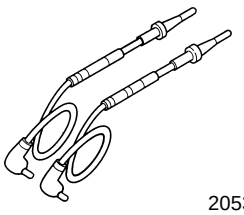
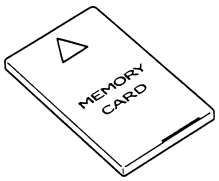
NOTE

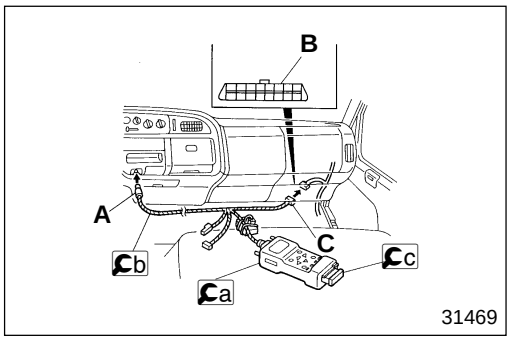
The diagnosis code check also ends when the vehicle moves from a stationary condition during the diagnosis code check.

With MUT-II

Special tools

Tool name and shape	Part No.	Application
MUT-II  19492	MB991496	Inspection of Anti-lock brake system
MUT-II harness (for data communication)  19141	MK327601	
ROM pack (MRT-E8.1)  19493	MH063580	

Tool name and shape	Part No.	Application
MUT-II harness (for circuit tester)  20536	MB991499	Inspection of Anti-lock brake system
Memory card (for MUT-II)  20538	MB991500	



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Connecting the MUT-II
- Turn the starter switch to the LOCK position.
- Connect the b MUT Communication Harness to the a MUT-II, and insert the c ROM Pack.
- Plug connector **A** into the cigarette lighter socket.
- Fit connector **C** onto MUT connector **B** (16 pin) in the relay box.

NOTE

Instructions for operation of the MUT-II are given in the separate MUT-II Reference Manual.

Current diagnosis codes
- Turn the starter switch to the ON position.
- Determine the fault location(s) in accordance with the MUT-II diagnosis code(s).

Past diagnosis codes
- Turn the starter switch to the ON position.
- Determine the fault location(s) in accordance with the past MUT-II diagnosis code(s).

Diagnosis code erasure
- Turn the starter switch to the ON position.
- Using the MUT-II, erase all diagnosis codes stored in the electronic control unit.

Diagnosis Code Chart

Diagnosis codes can be read by using the MUT-II or anti-lock brake system warning lamp.

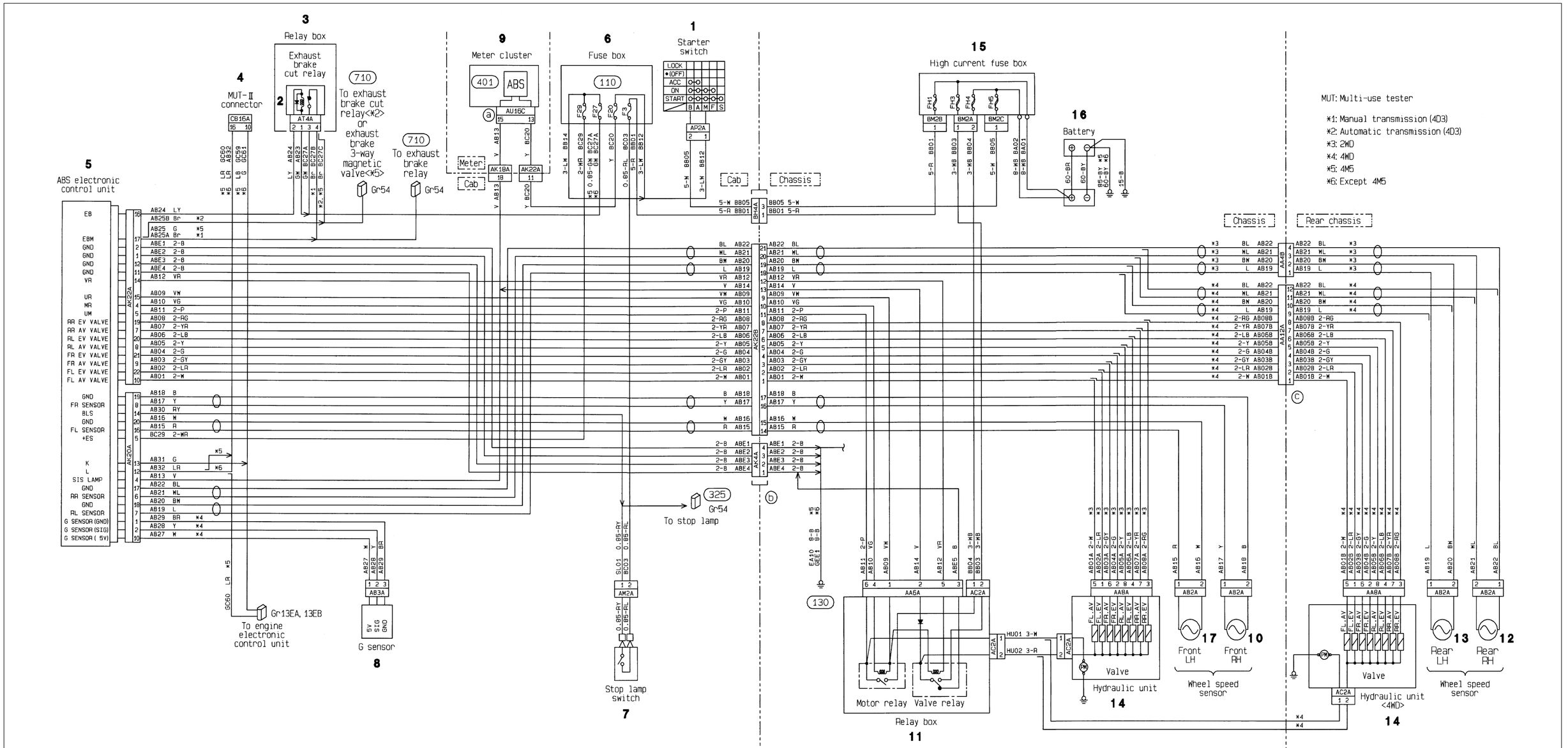
Diagnosis code	Malfunction location		
	MUT-II display	Description of malfunction	
11	FR-SNSR OPEN	Wheel speed sensor	Broken wire to front-axle right-wheel speed sensor
12	FL-SNSR OPEN		Broken wire to front-axle left-wheel speed sensor
13	RR-SNSR OPEN		Broken wire to rear-axle right-wheel speed sensor
14	RL-SNSR OPEN		Broken wire to rear-axle left-wheel speed sensor
*15	ROTA OR SNSR		Broken wire
16	ECU VOLTAGE	Drop in power supply voltage	
21	FR-SNSR SHORT	Wheel speed sensor	No broken wire to front-axle right-wheel speed sensor
22	FL-SNSR SHORT		No broken wire to front-axle left-wheel speed sensor
23	RR-SNSR SHORT		No broken wire to rear-axle right-wheel speed sensor
24	RL-SNSR SHORT		No broken wire to rear-axle left-wheel speed sensor
26	G SENSOR	G sensor	
35	EXB RLY	Exhaust brake cut relay	
38	STOP LAMP SW	Stop lamp switch	
41	FR-EV VALVE	Hydraulic unit	Front-axle right-wheel solenoid valve (pressure decrease)
42	FL-EV VALVE		Front-axle left-wheel solenoid valve (pressure decrease)
43	RR-EV VALVE		Rear-axle right-wheel solenoid valve (pressure decrease)
44	RL-EV VALVE		Rear-axle left-wheel solenoid valve (pressure decrease)
45	FR-AV VALVE		Front-axle right-wheel solenoid valve (pressure hold)
46	FL-AV VALVE		Front-axle left-wheel solenoid valve (pressure hold)
47	RR-AV VALVE		Rear-axle right-wheel solenoid valve (pressure hold)
48	RL-AV VALVE		Rear-axle left-wheel solenoid valve (pressure hold)
51	VALVE RLY	Relay box	Valve relay
53	MOTOR RLY		Motor relay or motor
			Motor monitor line
63	ECU ERR	Anti-lock brake system electronic control unit	

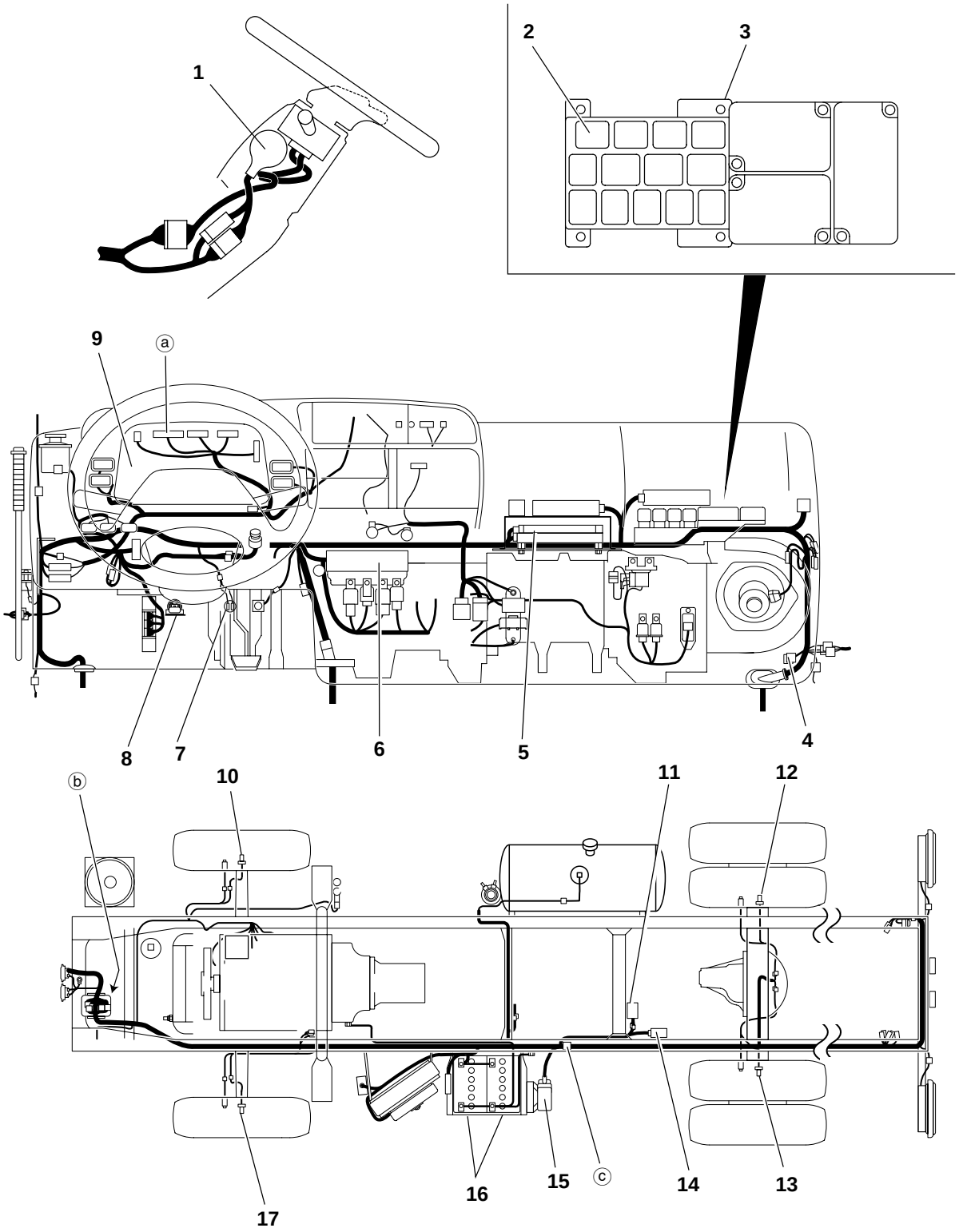
Actuator Drive Chart

MUT-II display	
Item No.	Item name
11	FR ABS MV ON
12	FL ABS MV ON
13	RR ABS MV ON
14	RL ABS MV ON

Service Data

MUT-II display			Inspection condition	Criterion
11	FR SPEED	■■■. ■ MPH	Constant-speed driving	Same as speedometer indication
12	FL SPEED	■■■. ■ MPH		
13	RR SPEED	■■■. ■ MPH		
14	RL SPEED	■■■. ■ MPH		
15	ECU VOLTAGE	■■ . ■ V	Starter switch ON	Same as battery voltage
16	G-SNS VOLTAGE	■ . ■■ V	Vehicle parked on level surface	2.3 ± 1.0 V
30	STOP LAMP SW	ON/OFF	Brake pedal depressed	ON
			Brake pedal released	OFF


MUT: Multi-use tester
*1: Manual transmission (4D3)
*2: Automatic transmission (4D3)
*3: 2WD
*4: 4WD
*5: 4M5
*6: Except 4M5
ABS electronic control unit
Relay box
Exhaust brake cut relay
MUT-II connector
To exhaust brake cut relay<*2> or exhaust brake 3-way magnetic valve<*5>
To exhaust brake relay
Meter cluster
Fuse box
Starter switch
High current fuse box
Battery
Chassis
Rear chassis
To engine electronic control unit
G sensor
To stop lamp
Stop lamp switch
Motor relay
Valve relay
Relay box
Hydraulic unit
Valve
Hydraulic unit <4WD>
Front LH
Front RH
Rear LH
Rear RH
Wheel speed sensor
45327



1 Starter switch
2 Exhaust brake cut relay
3 Relay box
4 Multi-use tester-II connector
5 Anti-lock brake system electronic control unit
6 Fuse box
7 Stop lamp switch
8 G sensor
9 Meter cluster
10 Front wheel speed sensor, RH
11 Relay box
12 Rear wheel speed sensor, RH
13 Rear wheel speed sensor, LH
14 Hydraulic unit
15 High current fuse box
16 Battery
17 Front wheel speed sensor, LH

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MITSUBISHI
FUSO

Group 36
Parking Brake

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-36

INDEX

SPECIFICATIONS 36- 2

STRUCTURE AND OPERATION 36- 2

TROUBLESHOOTING 36- 3

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

- Adjustment of Parking Brake Shoe Clearance and Ratchet Bar Pulling Stroke 36- 4

PARKING BRAKE CONTROL 36- 6

PARKING BRAKE ASSEMBLY 36- 8

BACKING PLATE AND SHOE ASSEMBLY 36-10

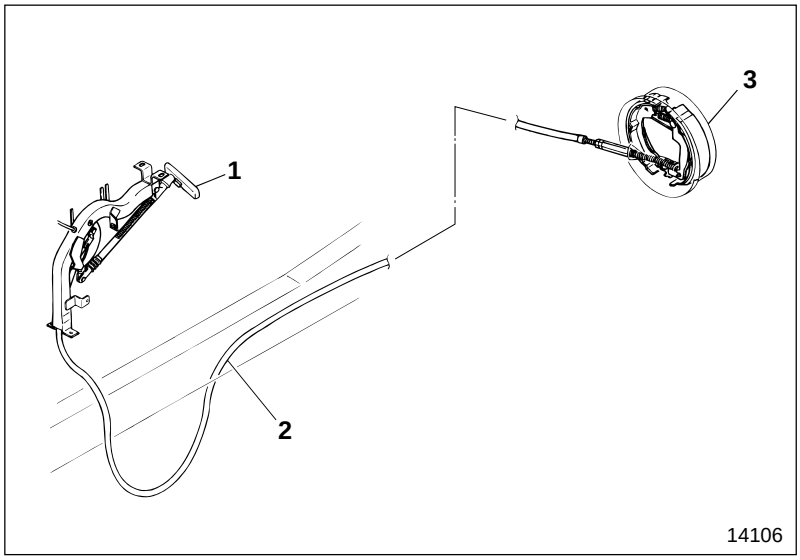
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Brake	Type	Propeller shaft internal expanding type brake
	Operation type	Mechanical cable type
Parking brake assembly	Type	Dual-servo type
	Inner diameter of drum mm {in.}	ø190 {7.48}
	Lining width × Thickness mm {in.}	45×4.0 {1.77×0.16}

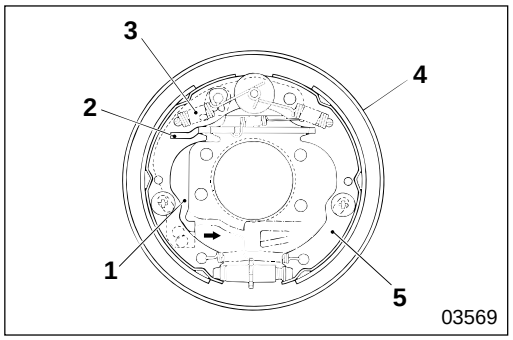
STRUCTURE AND OPERATION

Parking Brake Control



1 Parking brake ratchet bar
2 Parking brake cable
3 Parking brake assembly

Parking Brake Assembly



1 Parking lever
2 Strut
3 Shoe return spring
4 Backing plate
5 Shoe and lining assembly

- Pulling the parking brake ratchet bar pulls the parking brake cable, which in turn pulls parking brake lever **1** installed in the parking brake body, operating shoe and lining assembly **5**.
- Activation of parking lever **1** expands one shoe and lining assembly **5** via strut **2**, the parking lever itself expands the other shoe and lining assembly. Therefore, both shoe and lining assemblies function as leading shoes.
- When the ratchet bar (parking lever) is returned, the repercussive force of shoe return spring **3** releases the brake.

Possible causes / Symptoms		Parking brake does not work	Parking brake does not release smoothly (dragging)	Remarks
Parking brake cable	Inner cable stretched or damaged	○	○	
	Inner cable rusted		○	
	Inner spring of cable deteriorated, fractured		○	
Parking brake ratchet bar	Ratchet bar and ratchet pawl engaging incorrectly	○		
	Pulling stroke insufficient	○	○	
	Pulling stroke excessive	○		
Parking brake assembly	Shoe clearance insufficient		○	
	Shoe clearance excessive	○		
	Parking brake drum inner surface deformed or distorted	○		
	Parking brake drum inner surface greasy or oily	○		
	Linings worn unevenly	○		
	Lining surface greasy or oily	○		
	Shoe return spring deteriorated, fractured		○	

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE

Adjustment of Parking Brake Shoe Clearance and Ratchet Bar Pulling Stroke

Service standards

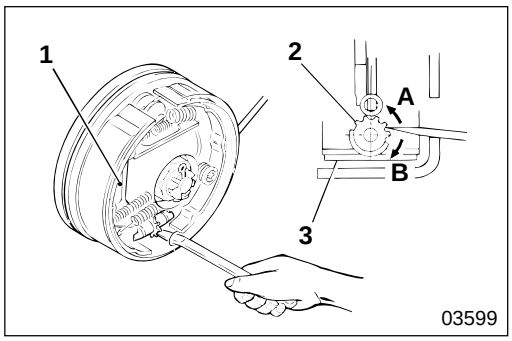
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Brake shoe clearance	0.2 to 0.25 {0.0079 to 0.0098}	—	Adjust
4	Ratchet bar pulling stroke (Operating force : 295 N {66 lbf, 30 kgf})	80 to 120 {3.15 to 4.72}	—	Adjust

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Lock nut	19 to 27 {14 to 20, 1.9 to 2.8}	—

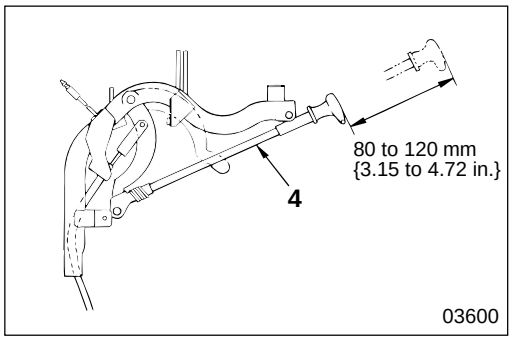


(1) Shoe clearance

When parking lever **1** is released, turn adjuster **2** in the expansion direction, using a screwdriver inserted through the shoe adjusting hole of the parking brake drum, and return 8 to 10 notches from the position where shoe **3** is in close contact with the drum. Then, the shoe clearance will be the standard value.

A : Contraction

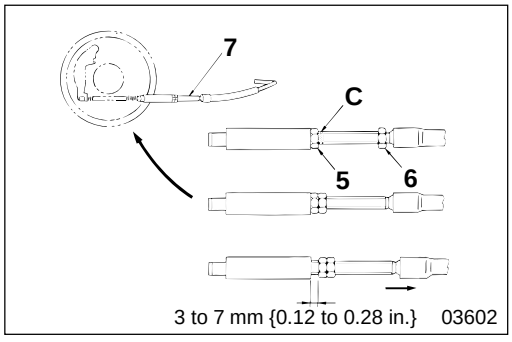
B : Expansion



(2) Ratchet bar pulling stroke

Adjust the adjusting nut of the parking brake cable so that the ratchet bar pulling stroke is the standard value when parking brake ratchet bar **4** is pulled from the released position by an operating force of 295 N {66 lbf, 30 kgf}.

Operate ratchet bar two or three times after adjusting to verify the pulling stroke, to make sure that the parking brake is operating properly and that the parking brake drum does not drag when the parking brake is released.

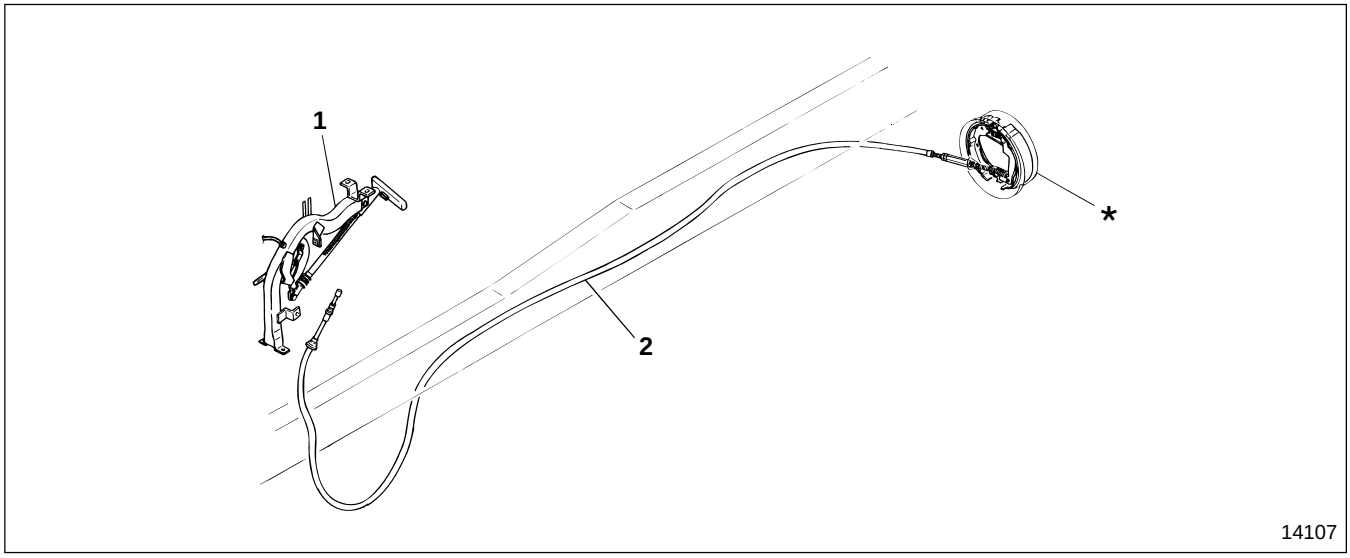


[Adjustment]

- Tighten adjusting nut **5** until mark **C** can be seen.
- Tighten lock nut **6** to the position of adjusting nut **5**.
- Tighten lock nut **6** at specified torque.
- Check clearance when the outer cable of parking brake cable **7** is pulled by an operating force of 59 to 98 N {13 to 22 ft.lbs, 6 to 10 kgf·m}.

M E M O

PARKING BRAKE CONTROL



● **Removal sequence**

1 Parking brake ratchet bar assembly 🕮 P36-7
2 Parking brake cable

***** : Parking brake assembly 🕮 P36-8

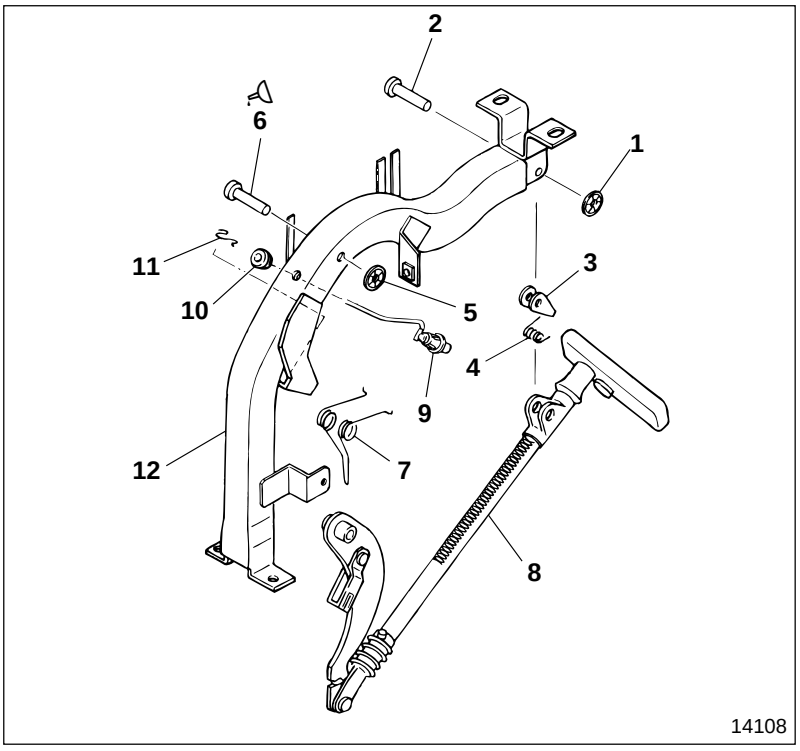
WARNING⚠

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Installation sequence**

Follow the removal sequence in reverse.

Parking Brake Ratchet Bar Assembly



● **Disassembly sequence**

1 Push nut
2 Pin
3 Ratchet pawl
4 Ratchet spring
5 Push nut
6 Pin
7 Return spring
8 Ratchet bar
9 Parking brake switch Gr 54
10 Grommet
11 Clip
12 Support

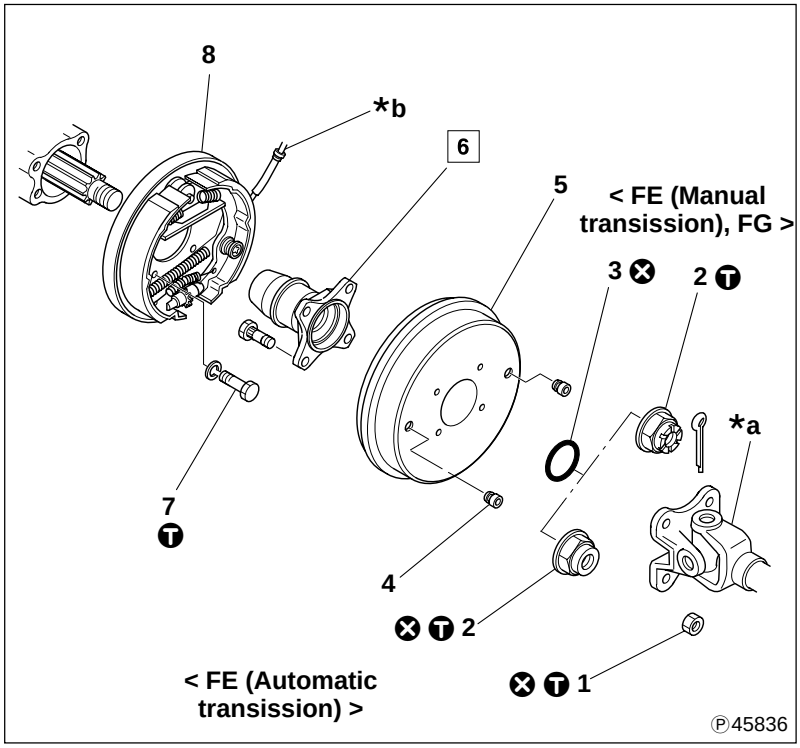
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Kinds	Quantity
6	Sliding area between pin and ratchet bar	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

PARKING BRAKE ASSEMBLY



● **Disassembly sequence**

1 Nut
2 Lock nut
3 O-ring
4 Dust plug
5 Parking brake drum
6 Companion flange
7 Bolt
8 Backing plate and shoe assembly
P36-10

*a : Propeller shaft Gr 25
*b : Parking brake cable P36-6
⊗ : Non-reusable parts

WARNING

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
5	Parking brake drum	Inner diameter	ø190 $^{+0.2}_{0}$ {7.48 $^{+0.0079}_{0}$}	ø191 {7.52}	Replace
		Squareness	0.05 {0.0020} or less	—	
		Concentricity	ø0.1 {0.0039} or less	—	
		Cylindrical accuracy	0.05 {0.0020} or less	—	
		Static rotation imbalance	0.49 N·cm {0.0036 lbf.ft, 50 gf·cm} or less	—	

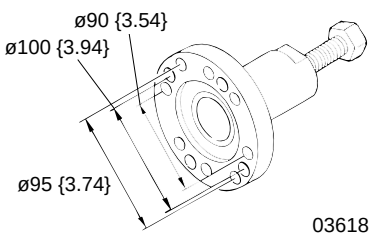
ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

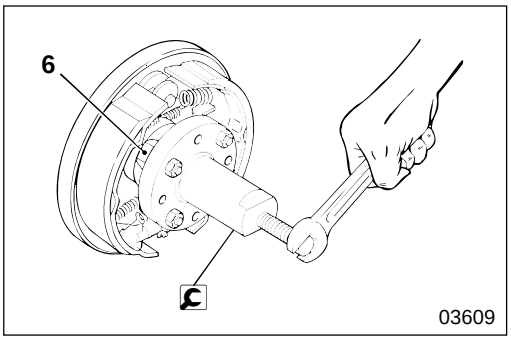
Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Propeller shaft mounting)		98 to 120 {72 to 87, 10 to 12}	—
2	Lock nut (Companion flange mounting)	FE (Manual transmission), FG	245 to 345 {180 to 255, 25 to 35}	—
		FE (Automatic transmission)	125 {94, 13}	—
7	Bolt (Backing plate and shoe assembly mounting)		52 to 67 {38 to 49, 5.3 to 6.8}	—

Special tools

Unit : mm {in.}

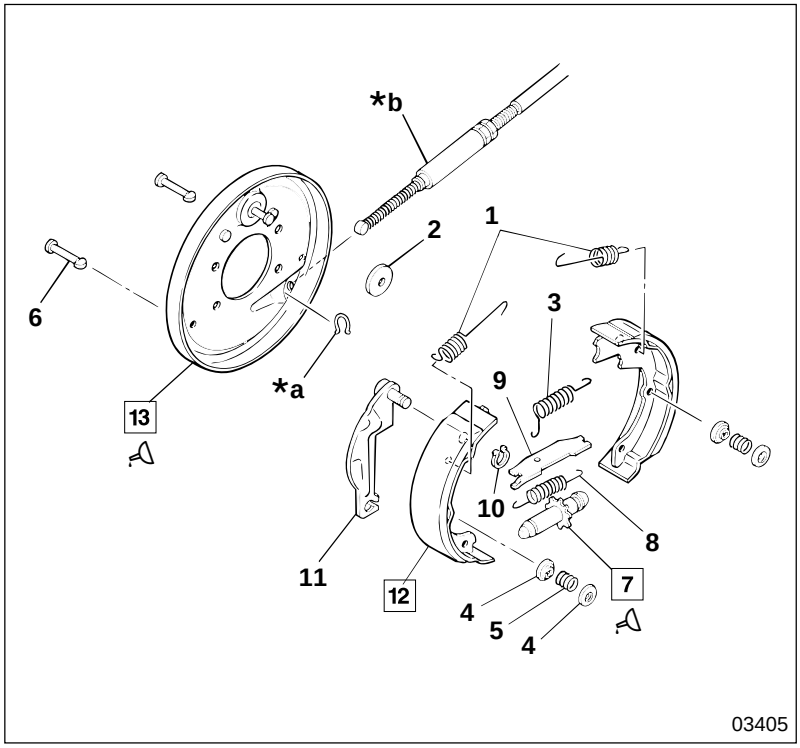
Location	Tool name and shape	Part No.	Application
6	Flange puller 	MH061848	Removal of companion flange

◆ Service procedure



6 **Removal of companion flange**

BACKING PLATE AND SHOE ASSEMBLY



● **Disassembly sequence**

1 Shoe return spring
2 Washer
3 Strut spring
4 Shoe hold down cup
5 Shoe hold down spring
6 Shoe hold down pin
7 Adjuster
8 Adjuster spring
9 Strut
10 Retainer
11 Parking lever
12 Shoe and lining assembly
13 Backing plate

***a** : Retainer
***b** : Parking brake cable 🕮 P36-6

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave grease or oil on the surface of shoe and lining assembly 12 because this reduces braking performance.

NOTE

If shoe and lining assembly 12 has been replaced with a new part, check correctness of contact with the parking brake drum.

Service standards

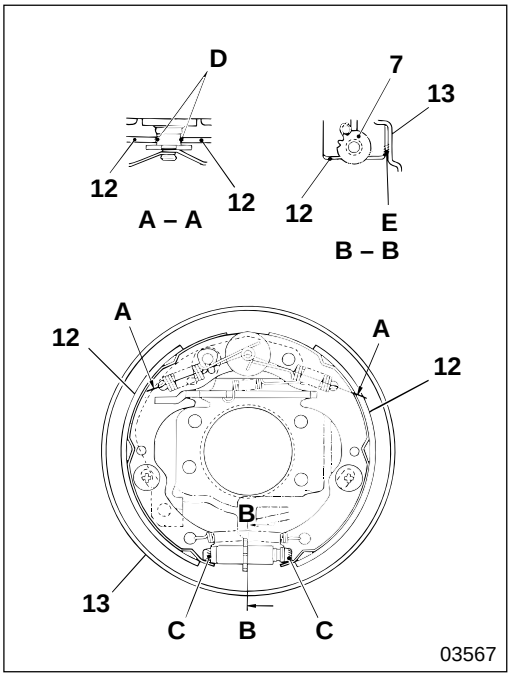
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (Installed length : 67.1 {2.64})	59±5.9 N {13±1.3 lbf.ft, 6±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace
3	Installed load of strut spring (Installed length : 49 {1.93})	29±2.9 N {6.6±0.7 lbf.ft, 3±0.3 kgf}	26 N {6 lbf, 2.7 kgf}	Replace
5	Installed load of shoe hold down spring (Installed length : 15.5 {0.61})	78±7.8 N {18±1.8 lbf.ft, 8±0.8 kgf}	71 N {16 lbf, 7.2 kgf}	Replace
8	Installed load of adjuster spring (Installed length : 78.2 {3.08})	59±5.9 N {13±1.3 lbf.ft, 6±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace
12	Thickness of lining	4 {0.16}	1.4 {0.055}	Replace

Lubricant

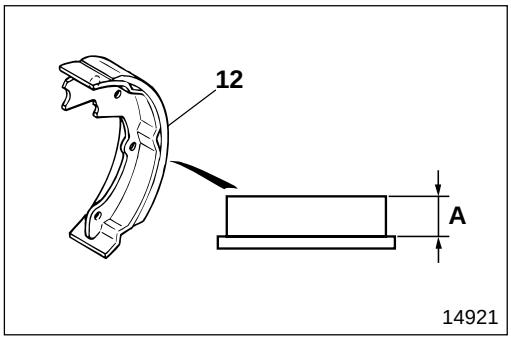
Location	Points of application	Kinds	Quantity
7	Contact surfaces of both ends of adjuster with shoe and lining assembly	Brake grease	As required
13	Anchor pin area and sliding face (6 points) of backing plate	Brake grease	As required

◆ Service procedure



7 **13** **Applying grease to adjuster and backing plate**

- Apply grease to contact surface **C** between both ends of adjuster **7** and shoe and lining assembly **12**.
- Apply grease to area **D** of the anchor pin and sliding face **E** (6 points) of backing plate **13**.



12 **Inspection of shoe and lining assembly**

Measure thickness **A** of the lining. If the measured value is lower the limit, replace shoe and lining assembly **12**.

MITSUBISHI
FUSO

Group 37
Steering

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-37

INDEX

SPECIFICATIONS 37- 2

STRUCTURE AND OPERATION 37- 3

TROUBLESHOOTING 37- 8

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Change of Power Steering Fluid 37- 11
- Bleeding of Power Steering System 37- 12
- Steering Wheel Play 37- 12
- Performance Verification Test of Power Steering System 37- 13

STEERING SYSTEM 37- 14

STEERING COLUMN SUBASSEMBLY 37- 20

POWER STEERING BOOSTER
< FE > 37- 24
< FG > 37- 30

POWER STEERING OIL PUMP 37- 36

POWER STEERING OIL TANK 37- 40

POWER STEERING FLUID LINE 37- 41

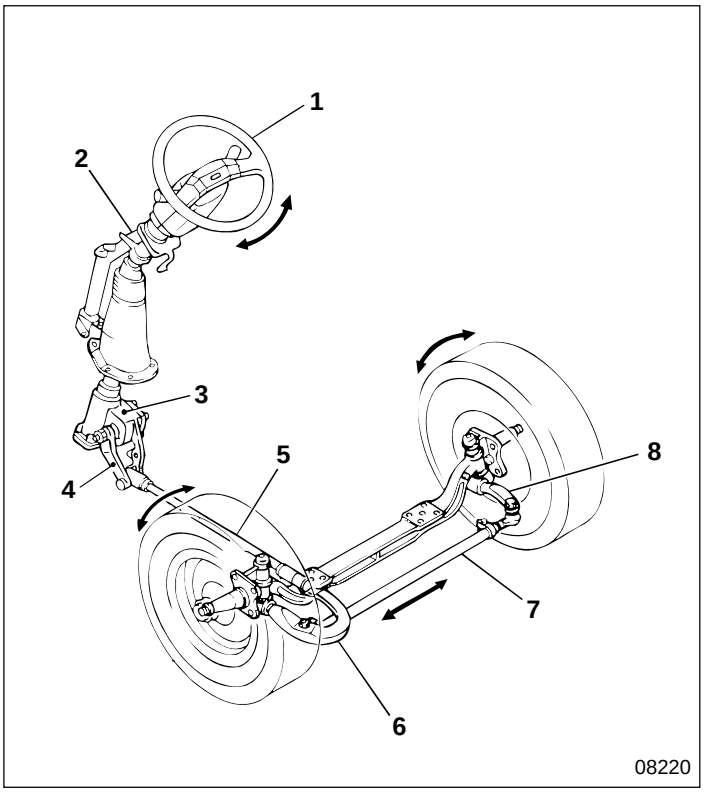
DRAG LINK 37- 42

TIE ROD ASSEMBLY 37- 44

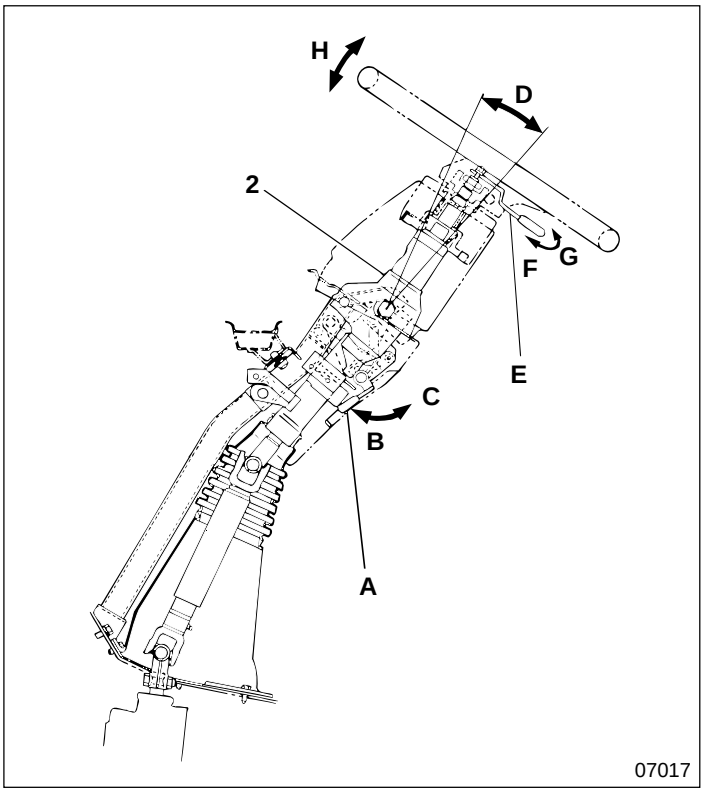
SPECIFICATIONS

Item \ Model		FE	FG
Steering wheel	Type	2-spoke type	
	Outer diameter mm {in.}	400 {15.7}	
Steering shaft	Type	Universal joint type (High tilt and telescopic type)	
Power steering booster	Manufacturer	KOYO SEIKO	
	Type	Ball nut type	
	Form	Integral type	
	Gear ratio	22.6	
	Cylinder diameter mm {in.}	78 {3.07}	
	Mass (without pitman arm and fluid) kg {lb}	18.2 {40}	16.7 {37}
Power steering oil pump	Manufacturer	NIPPON POWER STEERING	
	Type	Vane type	
	Discharge amount cm^3 {cu.in.}/rev	9.6 {0.59}	
	Regulated flow amount L {qts}/min	7 {7.4}	
	Regulated pressure (relief valve) MPa {lbf/in^2., kgf/cm^2}	9.3 {1350, 95}	10.3 {1490, 105}
	Permissible revolutions rpm	600 to 6500	
	Mass (without drive gear and fluid) kg {lb}	1.64 {3.6}	

Steering System

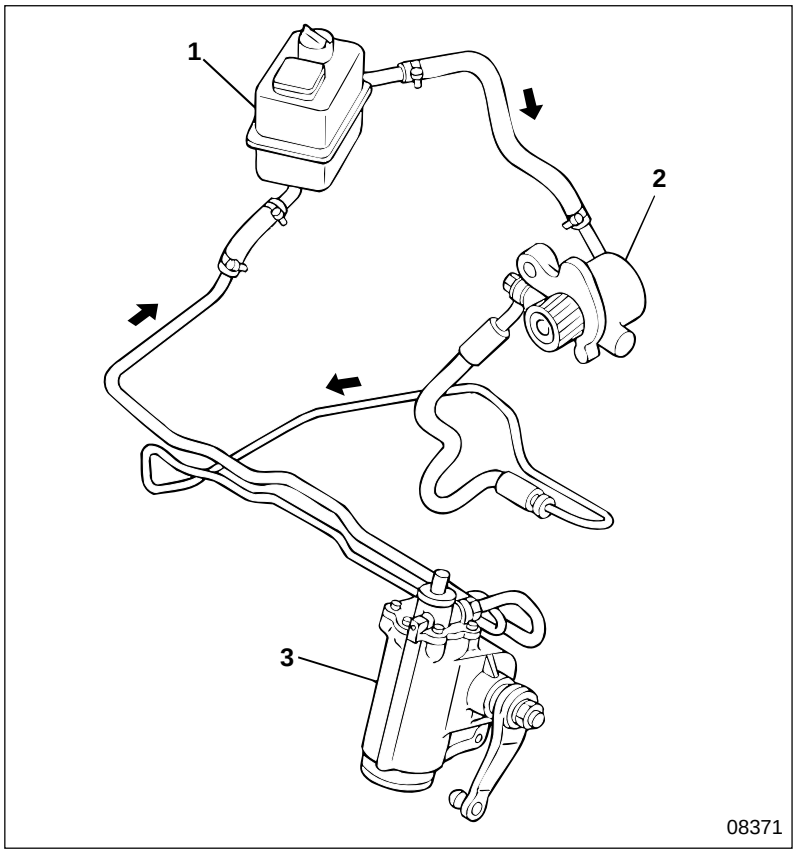


1 Steering wheel
2 Steering column subassembly
3 Power steering booster
4 Pitman arm
5 Drag link
6 Knuckle arm
7 Tie rod
8 Tie rod arm



Shifting lock lever **A** from lock position **B** to release position **C** produces high tilt **D**, and turning telescopic lever **E** (counterclockwise) from lock position **F** to release position **G** allows telescopic movement **H**. In this way, the structure of steering column subassembly **2** can be adjusted for optimum driving position.

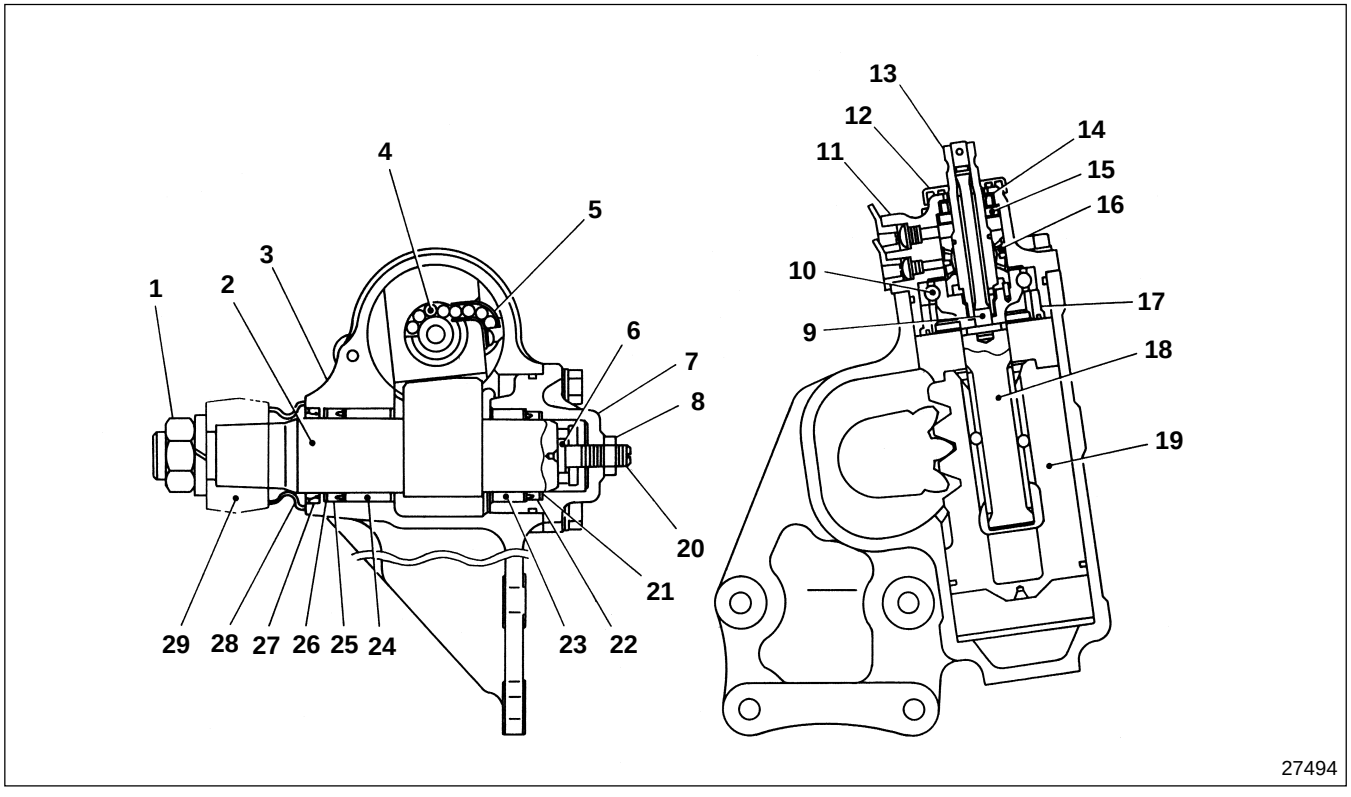
Power Steering System



1 Power steering oil tank
2 Power steering oil pump
3 Power steering booster

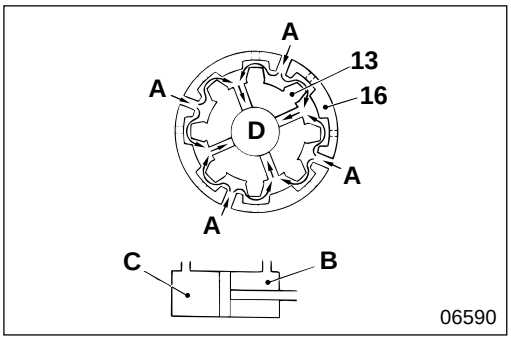
⬅ : Fluid flow

Power Steering Booster



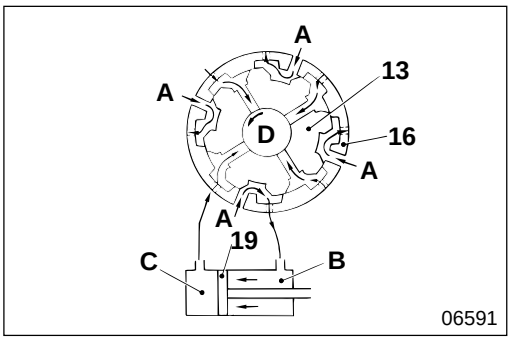
1 Lock nut
2 Sector shaft
3 Gear box
4 Steel ball
5 Circulator
6 Adjusting plate
7 Side cover
8 Nut
9 Torsion bar
10 Bearing
11 Valve housing
12 Dust cover
13 Input shaft
14 Oil seal
15 Bearing
16 Rotary valve
17 Lock screw
18 Main shaft
19 Rack piston
20 Adjusting bolt
21 Backup ring
22 U-packing
23 Needle bearing
24 Needle bearing
25 U-packing
26 Backup ring
27 Oil seal
28 Dust cover
29 Pitman arm

Rotary valve **16** is the central part of the power steering booster. Torsion bar **9** allows the steering reaction force and valve return to operate lightly and smoothly at low speed, and ensures stable steering feel even at high speed.



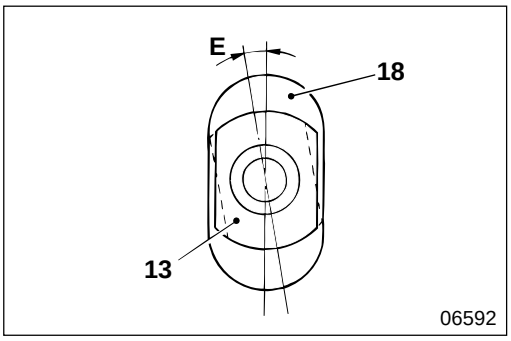
● **Straight-ahead drive operation**

When steering torque is not applied by the steering wheel, input shaft **13** is not activated and remains in neutral. At this time, pressurized fluid from the oil pump flows through the input shaft and the hole of rotary valve **16**, and returns to the oil tank without flowing into cylinder chambers **B**, **C**.
A : From the oil pump
D : To the oil tank



● **Steering operation**

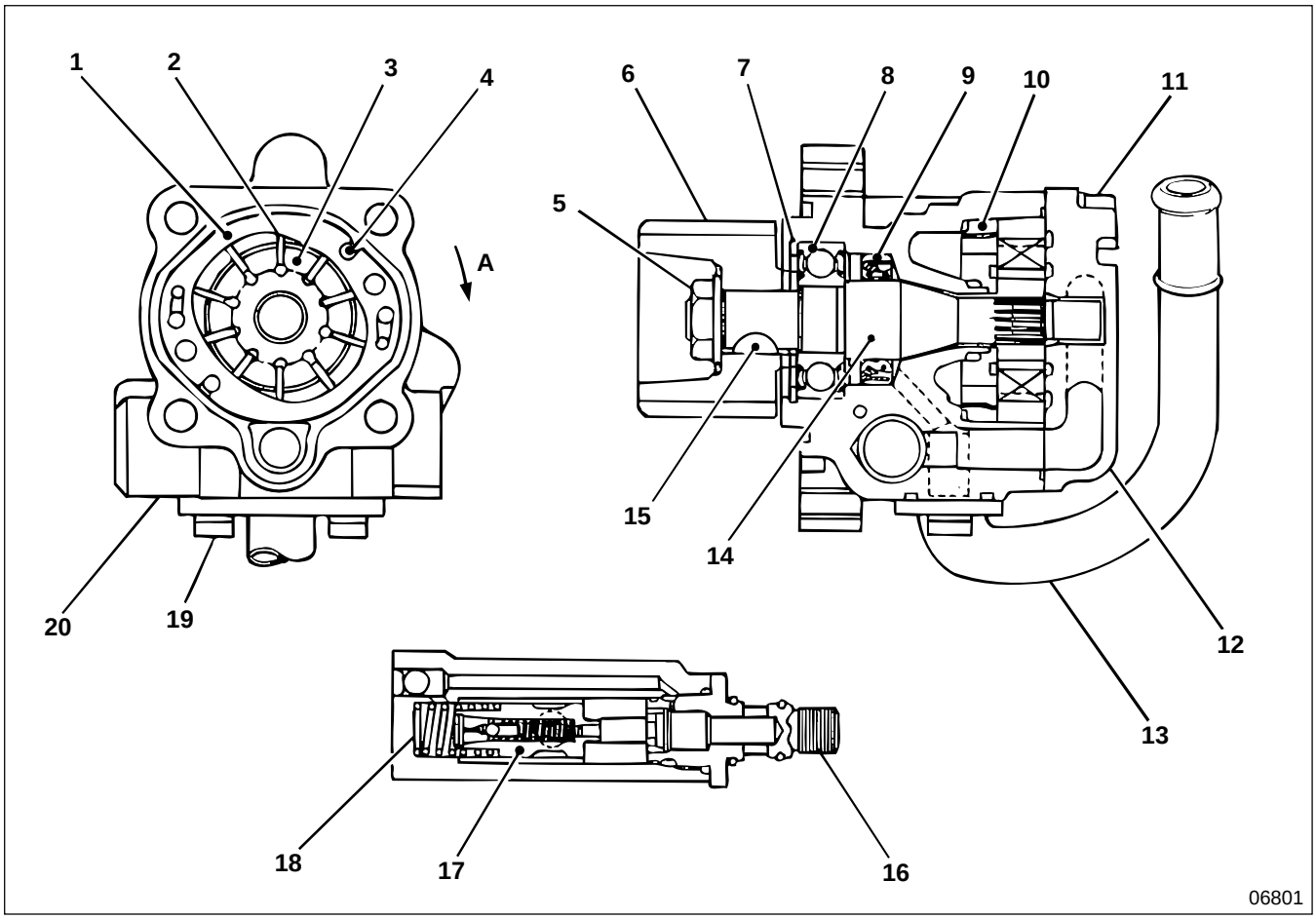
Turning the steering wheel rotates input shaft **13**, causing rotary valve **16** to close the fluid feed passage to cylinder chamber **C**. This produces a pressure difference between cylinder chambers **B**, **C**, which causes rack piston **19** to move, and facilitates rotation of main shaft **18**.
The illustration shows right-turn steering, and should be reversed for left-turn steering.



● **Operation when hydraulic circuit is faulty**

The safety structure means that when the fluid circuit is faulty, the stopper of input shaft **13** directly contacts the groove at the large end of main shaft **18** to transmit steering force, enabling manual operation.

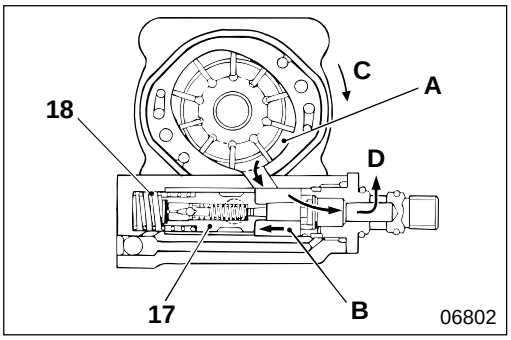
Power Steering Oil Pump



1 Cam ring
2 Vane
3 Rotor
4 Pin
5 Lock nut
6 Gear
7 Snap ring
8 Bearing
9 Oil seal
10 Side plate
11 Bolt
12 Cover
13 Suction connector
14 Shaft
15 Key
16 Connector
17 Relief valve assembly
18 Flow control spring
19 Bolt
20 Body

A : Direction of rotation

Relief Valve Assembly



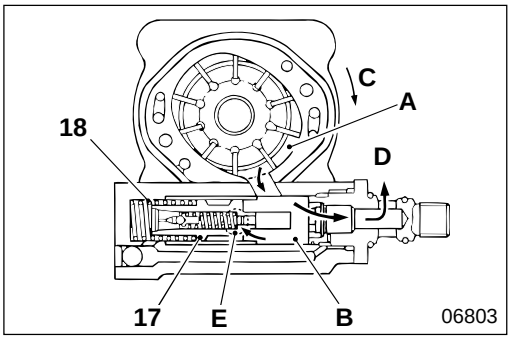
● **Operation of flow control valve**

(1) When not operating (Oil pump rotating at low speed)

Since pressure generated from pressure chamber **A** is low when the oil pump is rotating at low speed, fluid pressure in chamber **B** is also low. Therefore, relief valve assembly **17**, which is pressed by the repercussive force of flow control spring **18** is not activated.

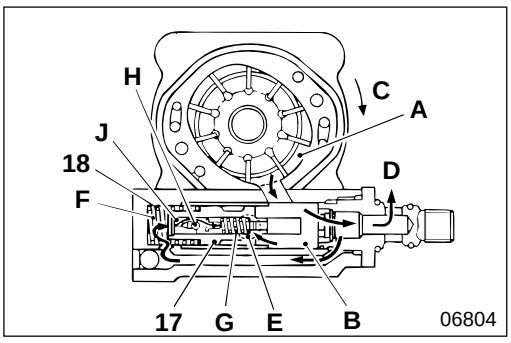
C : Direction of rotation

D : To the power steering booster



(2) When operating (Oil pump rotating at middle or high speed)

Since pressure generated from pressure chamber **A** is high when the oil pump is rotating at middle or high speed, fluid pressure in chamber **B** is also high. This will activate relief valve assembly **17**, overcoming the repercussive force of flow control spring **18**, and open port **E**, making excess fluid return to the inlet port to adequately regulate the flow of fluid to power steering booster **D**.



● **Operation of relief valve**

When the steering is lock-to-lock, pressure in chambers **B** and **F** increases and overcomes the repercussive force of relief spring **G** opening relief valve **J**, which was closed by steel ball **H**, causing the fluid to be returned to the inlet port through port **E**. Thus, if pressure in chamber **F** decreases, the relief valve closes again.

Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return bad	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Power steering mechanism faulty	Bearing damaged or worn	○			○	○								
	Ball or groove of ball screw set shaft worn	○	○		○									
	Air bled insufficiently	○												
	Fluid viscosity unsuitable	○												
	Power steering booster system faulty	○												
	Flow control valve malfunctioning	○												
	Rack or ball screw set shaft gear worn		○											
	Sector shaft bearing worn		○		○									
	Power steering booster mounting bolt loose		○											
	Ball screw set shaft and sector shaft play incorrect				○									
	Edge of valve control damaged or control seal ring broken				○									
	Power steering system fluid unsuitable				○									
	Rack engagement starting torque adjusted incorrectly	○				○								
	Fluid circuit clogged	○				○								
	Sector shaft gear worn		○											
	Torsion shaft serration damaged or worn		○											
	Power steering booster body faulty			○	○									
	O-ring or oil seal faulty								○					
	Sealant applied incorrectly								○					
Steering column and link mechanism faulty	Universal joint worn abnormally, damaged, lubricated incorrectly	○	○											
	Link deformed	○												
	Drag link ball stud excessive play		○		○									
	Tie rod end ball stud excessive play		○		○									
	Tie rod bent						○							
	Pitman arm mounting position incorrect							○						
	Steering wheel center offset			○										

Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return bad	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Front axle faulty	Kingpin lubricated incorrectly	○				○								
	Front wheel alignment (toe-in, camber, caster) incorrect	○		○	○	○								
	Thrust bearing damaged	○												
	Wheel hub bearing worn or damaged		○	○	○									Gr 26A, B
	Kingpin or bushing worn or damaged		○	○	○									
	Front axle deformed			○										
	Knuckle arm, tie rod arm, knuckle, etc. tightened incorrectly				○									
	U-bolt of front spring, nut loose				○									Gr 33
	Front axle parts overtightened					○								
	Turning angle adjusted incorrectly						○	○						Gr 26A, B
	Mounting parts, connection point loose		○											
	Knuckle stopper bolt adjusted incorrectly							○						
Oil pump faulty	Oil pump body faulty								○					
	O-ring, oil seal faulty								○					
	Bolt tightened incorrectly								○					
	Maximum generated fluid pressure insufficient									○				
	Fluid line crushed or clogged									○				
	Air lock in oil pump										○			
	Oil pump interior seized									○	○	○		
	Mounting bolt or nut loose												○	
	Pump body faulty												○	
	Valve malfunctioning									○				

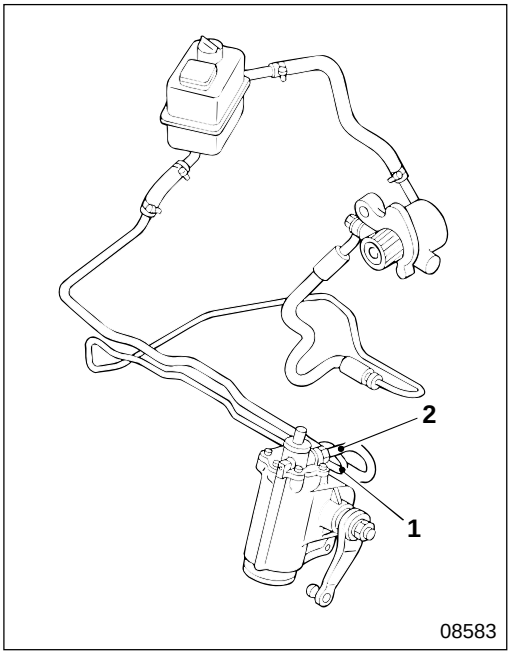
Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return bad	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Oil tank faulty	Oil tank leaking due to overflowing								○					
	Oil tank leaking due to air lock								○					
	Fluid level insufficient	○												
Other malfunctions	Load too far forward of load-carrying platform	○												
	Load too far rearward of load-carrying platform		○											
	Load too far to one side of load-carrying platform			○										
	Wheelbase gap between left and right excessive			○										
	Propeller shaft run out excessive				○									Gr 25
	Front axle bent < FE >				○									Gr 26A
	Front axle housing bent < FG >				○									Gr 26B
	Rear axle housing bent			○										Gr 27
	Final drive gear and final drive pinion damaged or engaged incorrectly				○									Gr 26B, 27
	Tire pressure insufficient	○												
	Tire pressure excessive		○											
	Tire wear difference between left and right excessive			○										Gr 31
	Tire outer diameter difference between left and right			○										
	Front tire radial and lateral runout, static balance or dynamic balance faulty				○									
	One-sided braking			○										Gr 35A

Change of Power Steering Fluid

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Pressure tube	29 to 39 {22 to 29, 3 to 4}	—
2	Return tube	39 to 49 {29 to 36, 4 to 5}	—



[Draining]

- Jack up the front wheels.
- Release pressure tube **1** and return tube **2** connected to the power steering booster.
- Turn the steering wheel fully left and right repeatedly, and drain the fluid from the power steering booster.
- After draining the fluid, tighten pressure tube **1** and return tube **2** at specified torque.

[Filling]

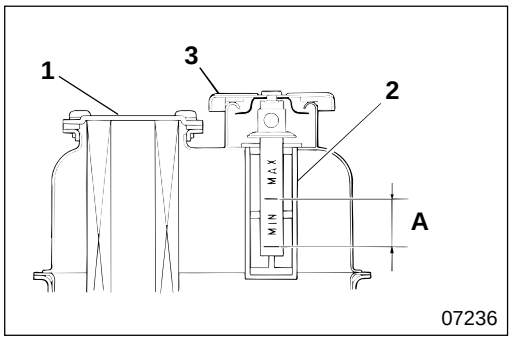
P37-12

ON-VEHICLE INSPECTION AND ADJUSTMENT

Bleeding of Power Steering System

Fluid

Location	Points of application	Kinds	Quantity
1	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Filler cap dipstick between MIN and MAX



CAUTION

Do not keep the steering wheel turned fully to the left or right for more than fifteen seconds when the engine is running, as this can cause the power steering oil pump to seize up.

- Pour fluid into power steering oil tank **1** up to the inner port of strainer **2**.
- With the engine stopped, jack up the front wheels and support with jack stands. Turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.

NOTE

Check the fluid level without screwing on filler cap 3.

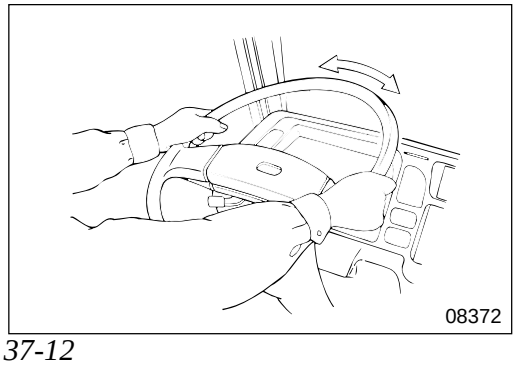
- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add the fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times to raise fluid temperature to approximately 60 to 80°C {140 to 176°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise, bleeding is completed.
- When bleeding is finished, check fluid level of power steering oil tank **1**, and pipe and hose connections for fluid leaks.

Steering Wheel Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering wheel play (Measure at the outer circumference of steering wheel)	0 to 50 {0 to 1.97}	—	Adjust

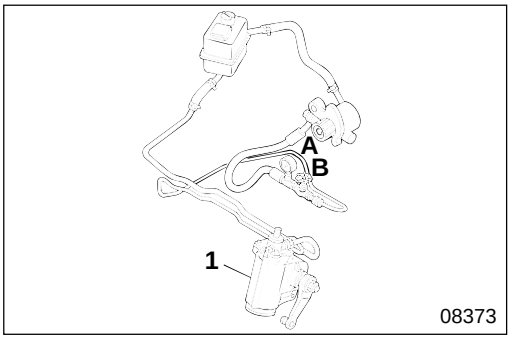


Point the wheels directly forward, start the engine and gently turn the steering wheel left and right to measure play at the outer circumference. If the play deviates from the standard value, adjust tightening points and power steering booster backlash. P37-26, 33

Performance Verification Test of Power Steering System

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Steering system fluid pressure (With hands off steering wheel)		490 kPa {71 psi, 5 kgf/cm^2}	—	Repair
—	Relief set pressure (Measure with engine speed at 1000 to 1500 rpm and stop valve closed)	FE	9.3 MPa {1350 lbf/in^2, 95 kgf/cm^2}	Maximum +195 kPa {28 psi, 2 kgf/cm^2} Minimum –295 kPa {43 psi, 3 kgf/cm^2}	Replace
		FG	10.3 MPa {1490 lbf/in^2, 105 kgf/cm^2}	Maximum 0 kPa {0 psi, 0 kgf/cm^2} Minimum –490 kPa {–71 psi, –5 kgf/cm^2}	Replace



Verify that the power steering booster and the power steering oil pump are operating properly by testing the following items.

CAUTION

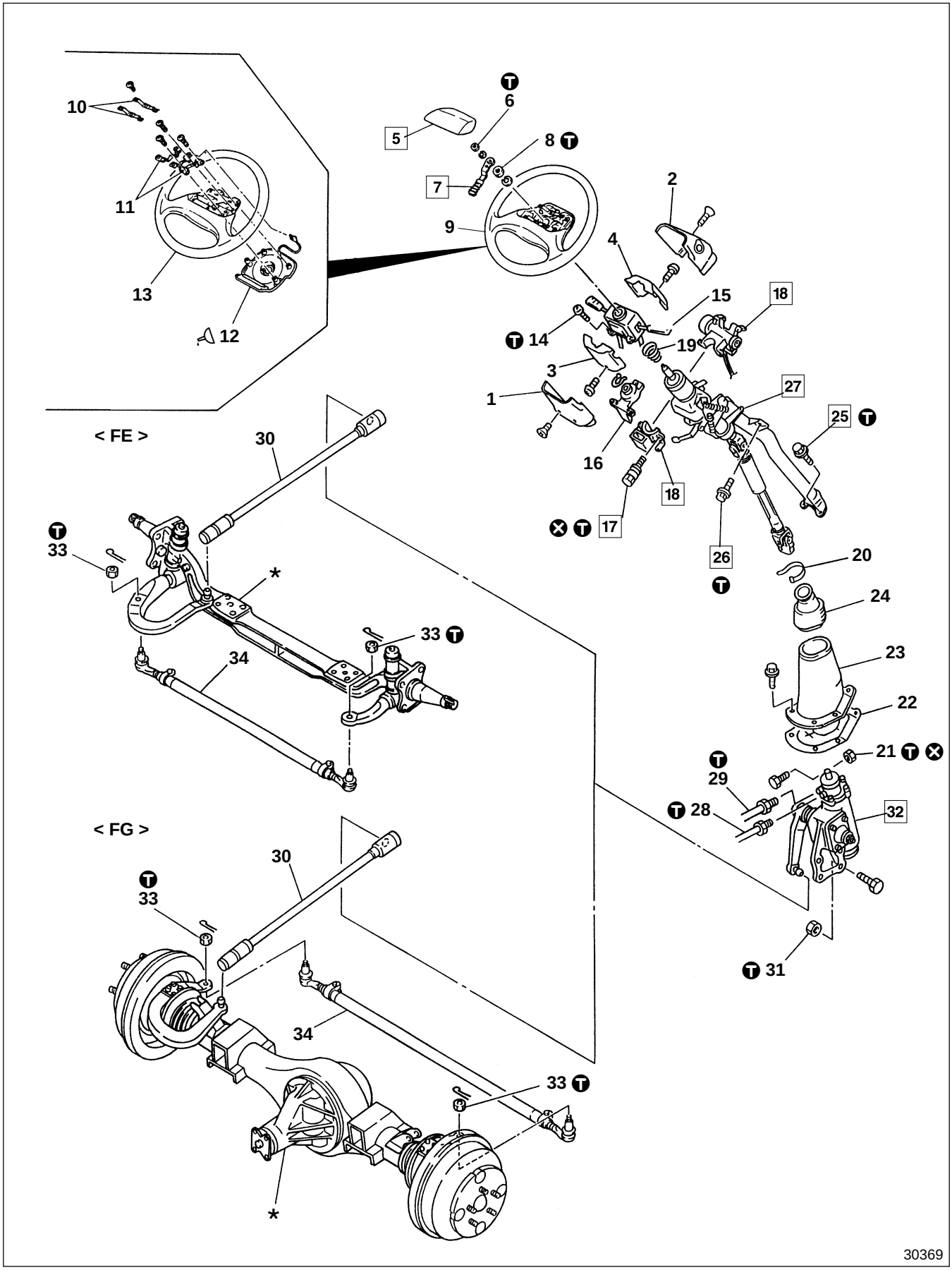
Do not keep the steering wheel turned fully to the left or right for more than fifteen seconds when the engine is running, as this can cause the power steering oil pump to seize up.

NOTE

If the fluid pressure is higher than 490 kPa {71 psi, 5 kgf/cm^2} with engine idling and the steering wheel free, inspect power steering booster 1 and fluid circuit for restriction.

Test item	Test procedure	Assembly standards
Verification of smooth operation	Jack up the front wheels and support with stands. Turn steering wheel fully left and right	Smooth operation throughout test
Measurement conditions	• Install oil pressure gauge **A** capable of measuring above 10.8 MPa {1560 lbf/in^2, 110 kgf/cm^2} and stop valve **B**, then bleed air • With engine idling, turn steering wheel left and right several times to raise fluid temperature to 50 to 60°C {122 to 140°F} • With the engine idling, open stop valve **B**	
Measurement of fluid pressure	• Measure fluid pressure with hands off steering wheel	490 kPa {71 psi, 5 kgf/cm^2}
Measurement of relief pressure	• Gradually increase engine speed and maintain it at 1000 to 1500 rpm, and close stop valve **B** to measure maximum fluid pressure	Relief set pressure 9.3 MPa {1350 lbf/in^2, 95 kgf/cm^2} < FE >, 10.3 MPa {1490 lbf/in^2, 105 kgf/cm^2} < FG >

STEERING SYSTEM



● **Removal sequence**

1 Column cover outer lower
2 Column cover outer upper
3 Column cover inner lower
4 Column cover inner upper
5 Horn pad
6 Nut
7 Telescopic lever
8 Nut
9 Steering wheel assembly
10 Horn spring
11 Contact plate
12 Cover assembly
13 Steering wheel
14 Screw
15 Combination switch Gr 54
16 Bracket
17 Head cutting bolt
18 Starter switch Gr 54
19 Spring
20 Band
21 Nut
22 Dust cover
23 Dust cover
24 Dust cover
25 Bolt
26 Bolt
27 Steering column subassembly P37-20
28 Pressure tube P37-41
29 Return tube P37-41
30 Drag link P37-42
31 Nut
32 Power steering booster P37-24, 30
33 Nut
34 Tie rod assembly P37-44

*: Front axle assembly
< FE > Gr 26
< FG > Gr 26B

⊗: Non-reusable parts

CAUTION⚠

When disconnecting pressure tube 28 and return tube 29, cover the ports to keep them free from dust and other foreign particles.

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

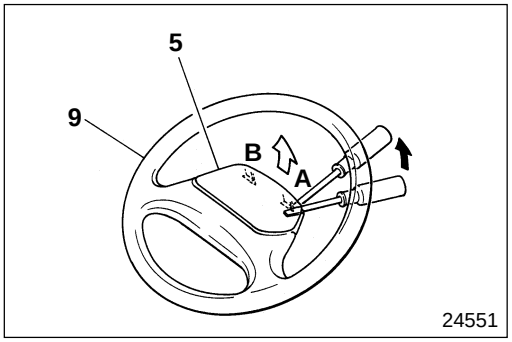
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Nut (Telescopic lever mounting)	8.8 to 9.8 {6.5 to 7.2, 0.9 to 1.0}	—
8	Nut (Steering wheel assembly mounting)	39 to 49 {29 to 36, 4 to 5}	—
14	Screw (Combination switch mounting)	2.5±0.5 {1.8±0.4, 0.25±0.05}	—
17	Head cutting bolt (Starter switch mounting)	14.2±1.5 {10±1.1, 1.45±0.15}	—
21	Nut (Steering column subassembly and power steering booster mounting)	53 to 65 {39 to 48, 5.4 to 6.6}	—
25	Bolt (Steering column at floor side mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
26	Bolt (Steering column subassembly to instrument panel side mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
28	Pressure tube	29 to 39 {22 to 29, 3 to 4}	—
29	Return tube	39 to 49 {29 to 36, 4 to 5}	—
31	Nut (Power steering booster mounting)	83.5 to 108 {61 to 80, 8.5 to 11.0}	—
33	Nut (Tie rod assembly mounting)	93±25 {69±18, 9.5±2.5}	—

Lubricant

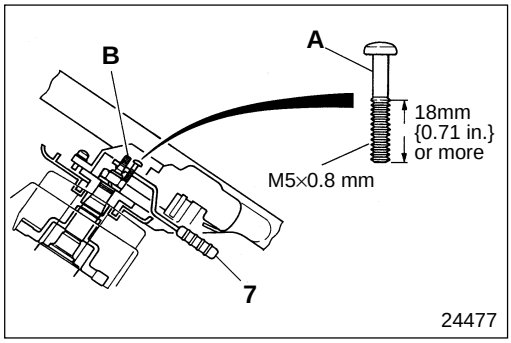
Location	Points of application	Specified lubricant	Quantity
12	Contact area between combination switch of cover assembly and horn contact	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



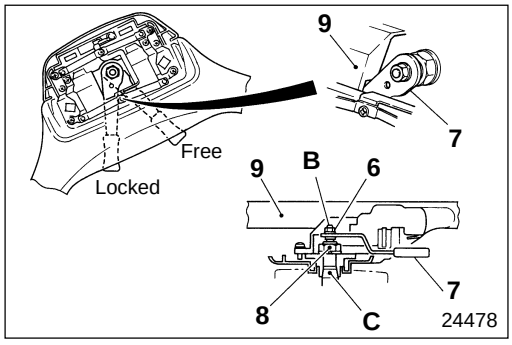
5 Removal of horn pad

- Insert a flat-tip screwdriver into the space between steering wheel assembly **9** and shoulder sections **A**, **B** of horn pad **5**, and disengage the latch by prying open the horn pad with the screwdriver until a clicking sound is produced.
- Insert fingers into the space behind lifted horn pad **5** and remove the horn pad.



7 Telescopic lever

[Removal]
Secure screw **A** (M5×0.8 mm) in tapped hole in telescopic lever **7** and remove telescopic lever from telescopic shaft **B**.



[Installation]
Make adjustment so that telescopic lever **7** positioned at the designated location applies the specified torque on telescopic shaft **B**.

CAUTION⚠

Be careful not to damage the threads on the tip of telescopic shaft B.

C : Telescopic shaft assembly

Start procedure

Install steering wheel assembly **9**. Using a long socket wrench, tighten nut **8** at specified torque 39 to 49 N·m {29 to 36 ft.lbs, 4 to 5 kgf·m}

Looseness found

Rotate telescopic shaft **B** counterclockwise with your fingers and check for looseness

No looseness

Using a flat-blade screwdriver turn telescopic shaft **B** clockwise and drive it in until it hits lightly with a "clunk", but do not turn it any further

CAUTION

Be careful not to over tighten or you will crush the end of the telescopic shaft, requiring replacement of telescopic shaft assembly C

Install telescopic lever **7** at a location that allows easy tightening, then tighten nut **6** until the telescopic lever will not slip

Tighten telescopic shaft **B** at operating torque 6.9 to 7.8 N·m {5.1 to 5.8 ft.lbs, 0.7 to 0.8 kgf·m}. (Tighten telescopic bar **7** at torque 69 to 78 N {15 to 18 lbf, 7 to 8 kgf} at 100 mm {3.94 in.} from the center of steering wheel assembly **9**)

To maintain lock, hold telescopic lever **7** clockwise, then loosen and remove lock nut **6**

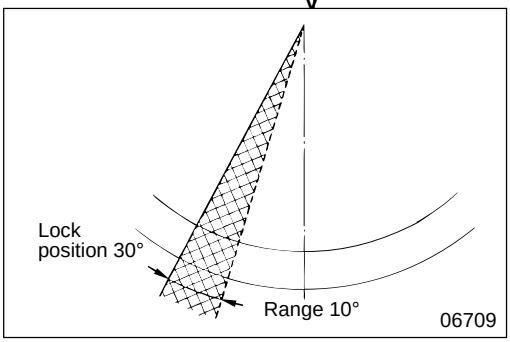
Remove telescopic lever **7**

NOTE

Remove telescopic lever 7 following the description under [Removal], taking care not to loosen telescopic shaft B.

Set telescopic lever **7** to specified lock position (within 10° before the position at which telescopic lever contacts steering wheel assembly **9**).

Tighten nut **6** at specified torque 8.8 to 9.8 N·m {6.5 to 7.2 ft.lbs, 0.9 to 1.0 kgf·m}



When telescopic lever **7** is released, and telescopic shaft **B** is retightened at operating torque 6.9 to 7.8 N·m {5.1 to 5.8 ft.lbs, 0.7 to 0.8 kgf·m}, the telescopic lever should lock in the 10° range this side of specified lock position 30°

Out of the range

Within the range

Jiggle steering wheel assembly **9** up and down and check for looseness

Looseness found

No looseness

Remove nut **6**

Procedure is completed

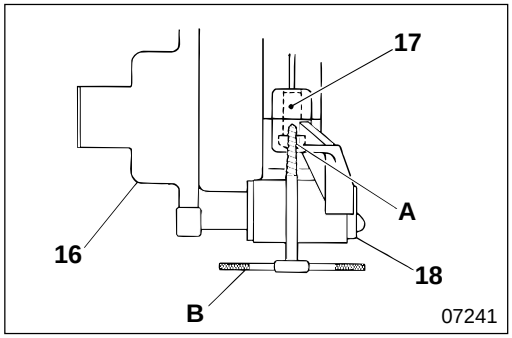
Remove telescopic lever **7**

CAUTION

Be sure not to operate telescopic shaft B while steering wheel assembly 9 is removed.

NOTE

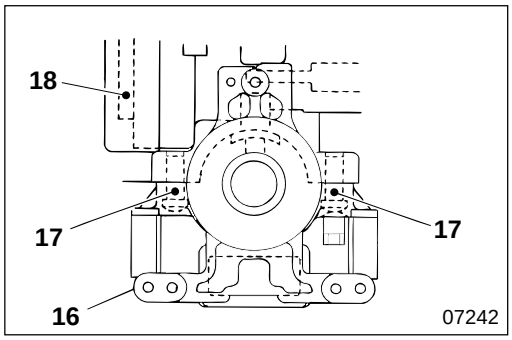
Be sure to assemble telescopic lever 7 only after steering wheel assembly 9 has been installed.



17 **18** **Head cutting bolt, starter switch**

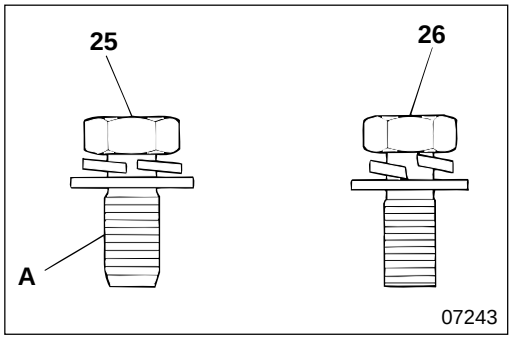
[Removal]

- After removing bracket **16**, drill a ø5.5 to 6.0 mm {0.22 to 0.24 in.} hole 10 to 15 mm {0.39 to 0.59 in.} deep on cutting face **A** of head cutting bolt **17** for mounting starter switch **18**.
- Screw in screw extractor **B** counterclockwise, then pull out head cutting bolt **17**.



[Installation]

- With new head cutting bolt **17**, tighten starter switch **18** at specified torque to cut the head off the bolt.
- After installing bracket **16**, verify operation of the steering lock function of starter switch **18**.

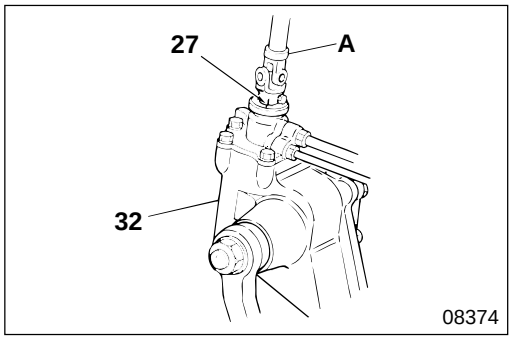


25 **26** **Installation of bolt**

Bolts **25** and **26**, differ in shape. Do not mix them up when installing.

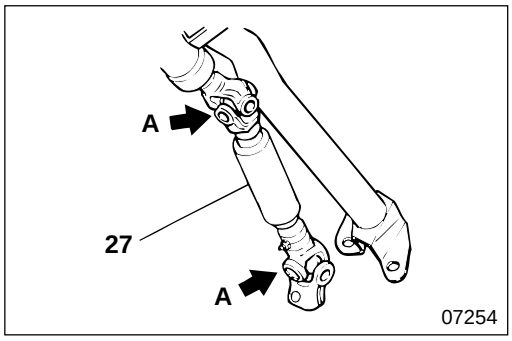
NOTE

Thread area A of bolt 25 is elliptical to facilitate grounding of the horn circuit.



27 **32** **Removal and installation of steering column subassembly and power steering booster**

Before removing steering column subassembly **27**, power streering booster **32**, be sure to make alignment mark **A**.

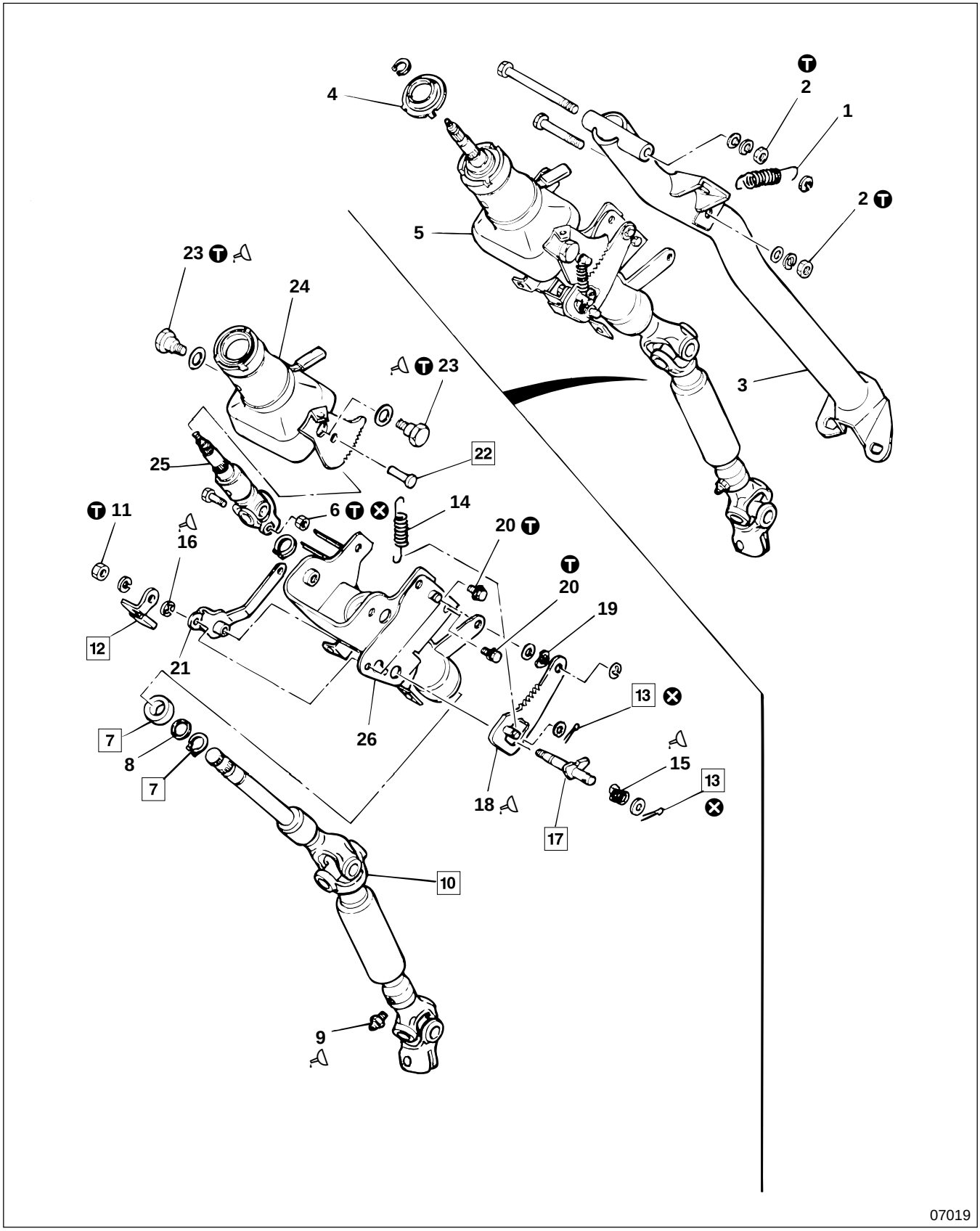


27 **Steering column subassembly**

When the spline of steering column subassembly **27** is disconnected, align the yokes to the same direction **A**.

M E M O

STEERING COLUMN SUBASSEMBLY



● **Disassembly sequence**

1 Return spring
2 Nut
3 Support bracket
4 Spring seat
5 Steering column assembly
6 Nut
7 Stopper
8 Bearing spacer
9 Grease nipple
10 Steering shaft assembly
11 Nut
12 Lock lever
13 Split pin
14 Return spring
15 Return spring
16 Snap ring
17 Cam
18 Lock plate
19 Wave washer
20 Bolt
21 Lever support
22 Clevis pin
23 Bolt
24 Column support upper
25 Telescopic shaft assembly
26 Column support lower

⊗ : Non-reusable parts

● **Assembly sequence**

5 → 4 → 3 → 2 → 1

5 : **25 → 24** / **26** → **23 → 22 → 21 → 20 → 19 → 18 → 17 → 16 → 15 → 14 → 13 → 12 → 11** / **10 → 9 → 8 → 7** → **6**

Tightening torque

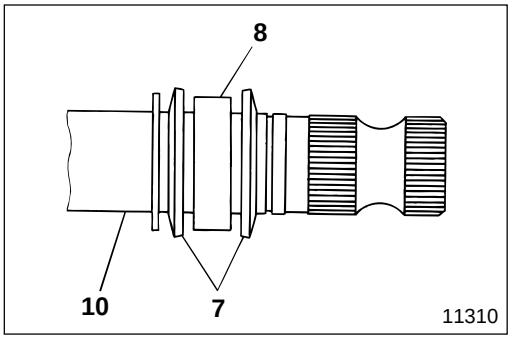
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Support bracket mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
6	Nut (Steering shaft assembly and telescopic shaft assembly mounting)	53 to 65 {39 to 48, 5.4 to 6.6}	—
11	Nut (Lock lever mounting)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
20	Bolt (Lever support mounting)	7 to 10 {5.1 to 7.2, 0.7 to 1.0}	—
23	Bolt (Column support upper and column support lower mounting)	15 to 20 {11 to 14, 1.5 to 2.0}	—

Lubricant and/or sealant

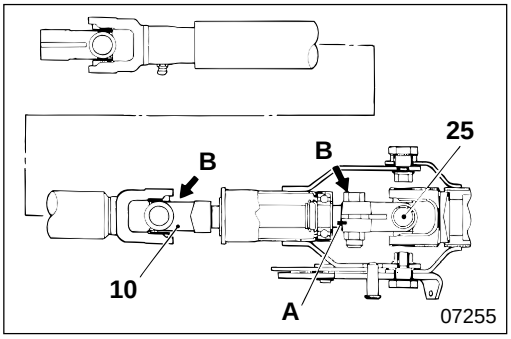
Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Friction surface of return spring and washer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
16	Friction surfaces of lever support and snap ring	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Friction surfaces of cam and lock plate return spring clevis pin	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
23	Thread area of bolt	THREEBOND thread lock super 103Q or LOCTITE 271	As required
	Friction surface of column support upper and bolt	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



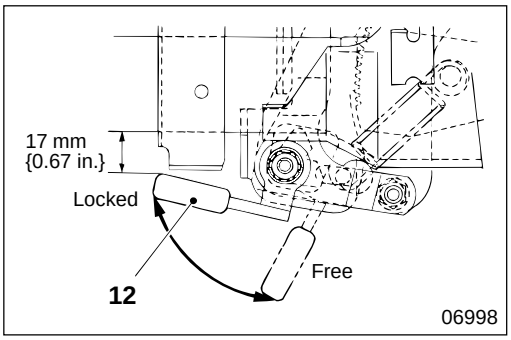
7 **Installation of stopper**

Install stoppers **7** on steering shaft assembly **10** in the direction as illustrated so that they straddle bearing spacer **8**.



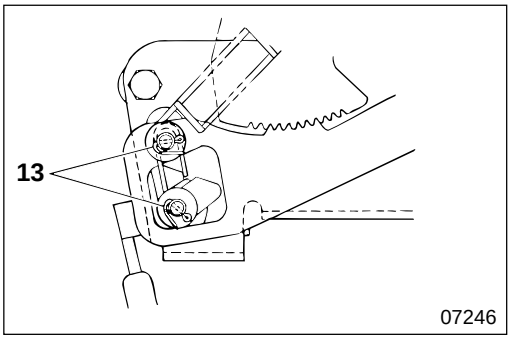
10 **Steering shaft assembly**

- Before removing steering shaft assembly **10**, be sure to make alignment mark **A**.
- Install the steering shaft with direction **B** of the telescopic shaft assembly **25** yoke and steering shaft assembly **10** yoke aligned or at phase angle of 90°.



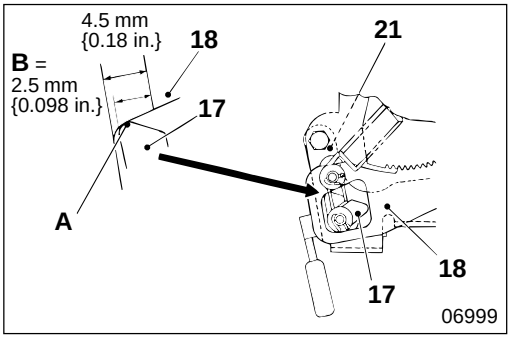
12 **Installation of lock lever**

- Install lock lever **12** so it is within the working angle when locked.
- After installing lock lever **12**, make sure that the lever operates smoothly (operating force less than 49 N {11 lbf, 5 kgf}). With the lever free, make sure that high tilt operates smoothly.



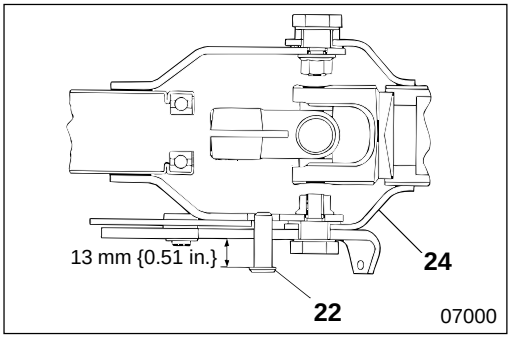
13 **Installation of split pin**

Bend split pin **13** to face outwards as illustrated.



17 **Installation of cam**

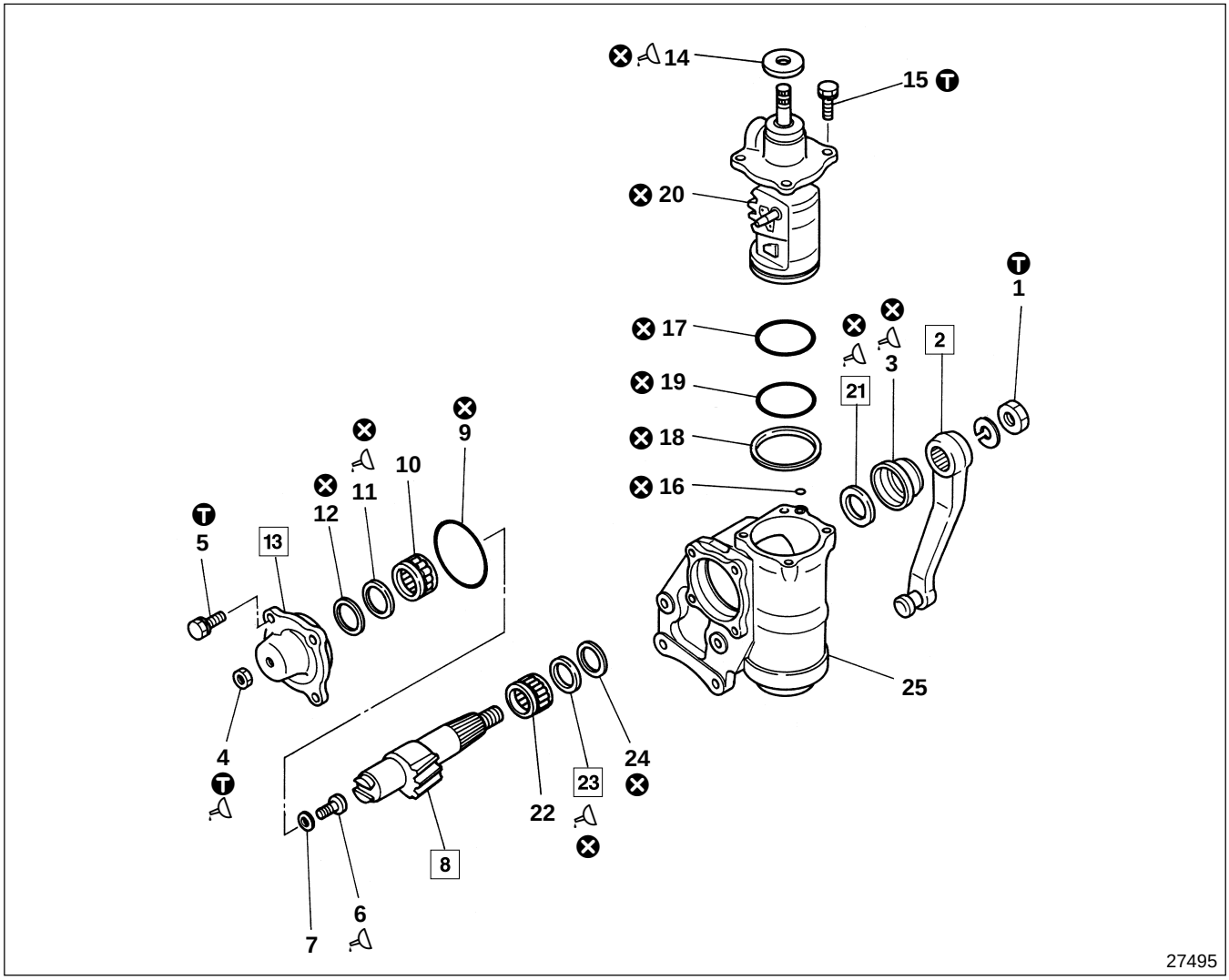
Adjust lever support **21** so that the top surface **A** of cam **17** is within dimension **B** of lock plate **18** to install the cam.



22 **Installation of clevis pin**

Drive clevis pin **22** into column support upper **24** so that the drive dimension is obtained.

POWER STEERING BOOSTER < FE >



● **Inspection before disassembly**

P37-26

● **Disassembly sequence**

1 Lock nut
2 Pitman arm
3 Dust cover
4 Nut
5 Bolt
6 Adjusting bolt
7 Adjusting plate
8 Sector shaft
9 O-ring
10 Needle bearing
11 U-packing
12 Backup ring
13 Side cover
14 Dust cover
15 Bolt
16 O-ring
17 O-ring
18 Seal ring
19 O-ring
20 Ball screw set shaft
21 Oil seal
22 Needle bearing
23 U-packing
24 Backup ring
25 Gear box

⊗ : Non-reusable parts

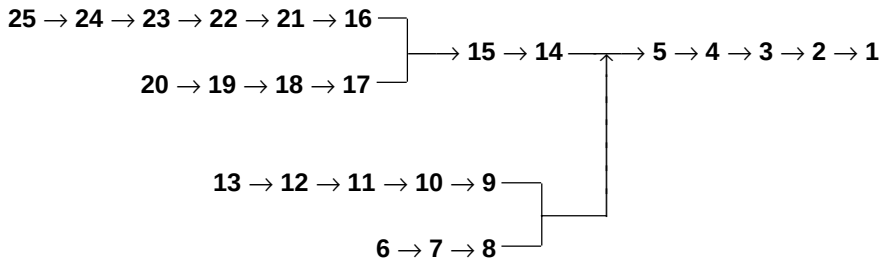
NOTE

- **Do not disassemble needle bearing 10, 22 and ball screw set shaft 20 unless they are faulty.**
- **Replace U-packings 11, 23 together with backup rings 12 and 24.**

● **Inspection after assembly**

P37-26

● **Assembly sequence**



Repair kit : Seal kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6, 8	Axial play of center shaft and adjusting bolt	0.1 {0.0039} or less	0.1 {0.0039}	Replace Sector shaft assy
8	Axis diameter of sector shaft (at gear box)	[42] –0.008 to +0.005 {[1.65] –0.00031 to +0.00020}	0.003 {0.00012}	Gap between worn area and unworn area
20	Rotating torque of ball screw set shaft	15 to 69 N·cm {0.11 to 0.51 lbf.ft, 1.5 to 7.0 kgf·cm}	—	—
20, 25	Clearance between ball screw set shaft and gear box	0.022 to 0.069 {0.00087 to 0.0027}	—	Replace
25	Inner diameter of gear box	[78] 0.012 to 0.034 {[3.1] 0.00047 to 0.0013}	0.05 {0.0020}	Gap between worn area and unworn area
—	Total starting torque with power steering booster	98 N·cm {0.72 lbf.ft, 10 kgf·cm} or less	—	Adjust
—	Engagement torque	20 to 49 N·cm {0.14 to 0.36 lbf.ft, 2 to 5 kgf·cm}	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

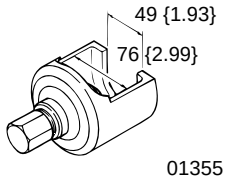
Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Pitman arm mounting)	245 to 294 {180 to 215, 25 to 30}	—
4	Nut tightening	29 to 39 {22 to 29, 3 to 4}	—
5, 15	Bolt (Side cover and valve housing mounting)	98 to 115 {72 to 87, 10 to 12}	—

Lubricant and/or sealant

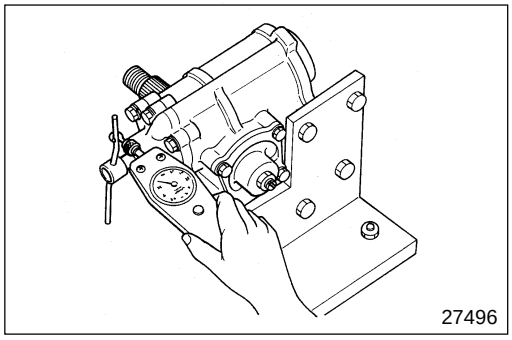
Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 14	Pack interior of dust cover	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4	Nut fixing point	THREEBOND 1104	As required
6	Head of the adjusting bolt	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
11, 23	Inside periphery of U-packing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
21	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

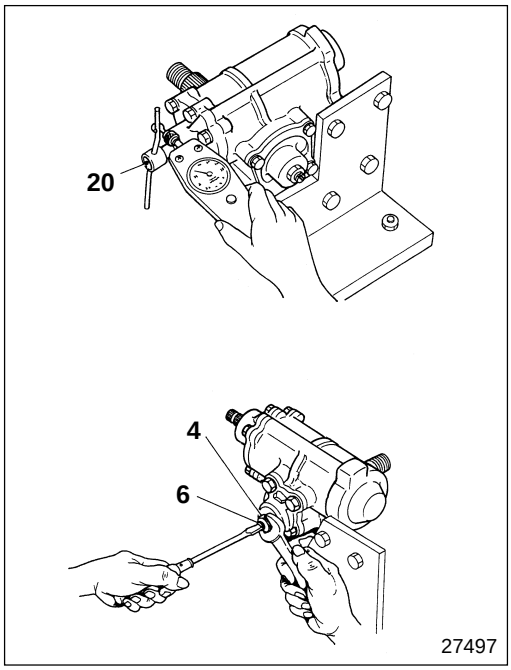
Location	Tool name and shape	Part No.	Application
2	Pitman arm puller 	MH062472	Removal of pitman arm

◆ Service procedure



● **Inspection before disassembly**

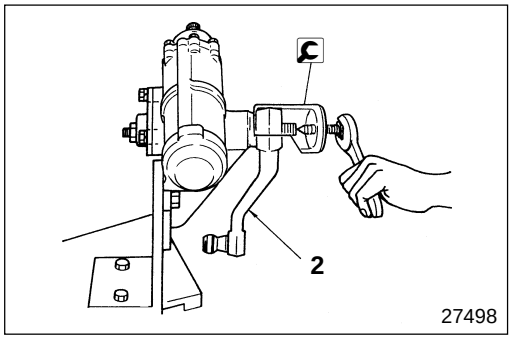
[Measurement of total starting torque]
Before disassembly, measure the total starting torque for a reference during assembly.



● **Inspection after assembly**

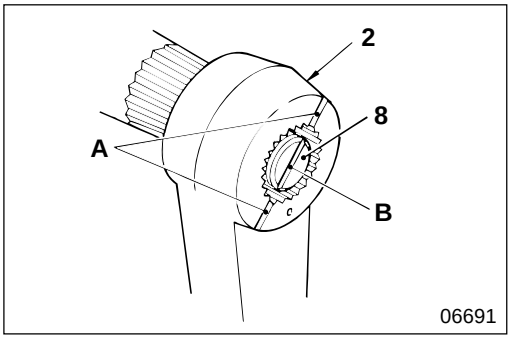
[Measurement of total starting torque]

- While turning ball screw set shaft **20**, one quarter of a turn left and right from the neutral position using a torque meter, drive adjusting bolt **6** in, then adjust so that the total starting torque or the engagement torque is within the standard value.
- After adjustment, tighten nut **4** at specified torque.

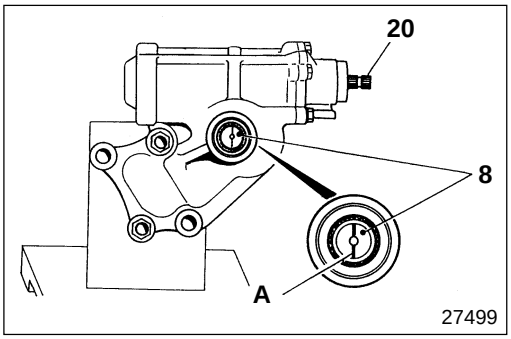


2 **Pitman arm**

[Removal]
: Pitman arm puller



[Installation]
Align slit **B** of the V-groove of sector shaft **8** on the same line as slit **A** of the V-groove of pitman arm **2** when installing it.



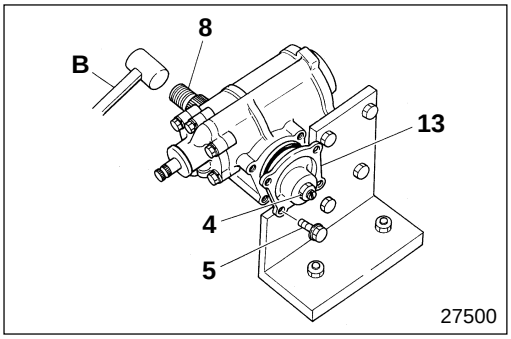
8 **13** **Sector shaft and side cover**

[Removal]

- Turn ball screw set shaft **20** counterclockwise to the lock position, then turn it clockwise approximately 2.6 turns, so that slit **A** of the V-groove at the end of sector shaft **8** is in the neutral position as illustrated.

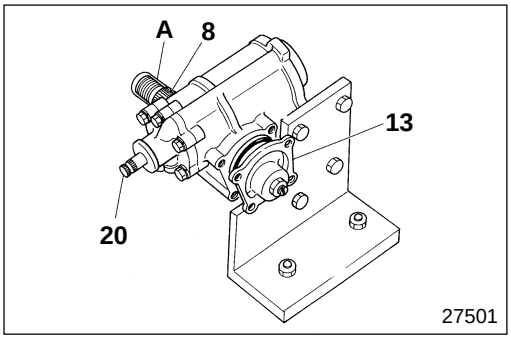
NOTE

At this time, make sure that slit A of the V-groove at the end of sector shaft 8 is at right angles to the axial line of ball screw set shaft 20.



- Loosen nut **4** and remove bolt **5**. After making sure that sector shaft **8** is in the neutral position, tap the end of the sector shaft, and pull out side cover **13** together with the sector shaft.

  B : Plastic-headed mallet



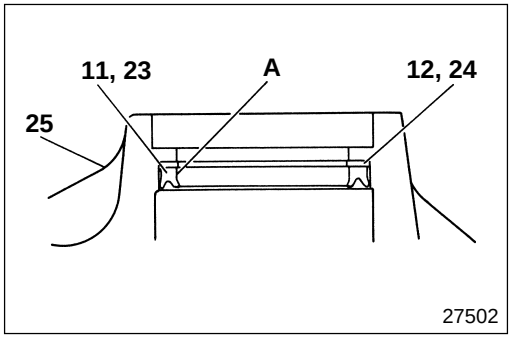
[Installation]
With ball screw set shaft **20** in the neutral position, insert sector shaft **8** and side cover **13**.

CAUTION ⚠

Insert sector shaft 8 with the thread area of the shaft end and serration area protected by cover A to prevent damage to the oil seal.

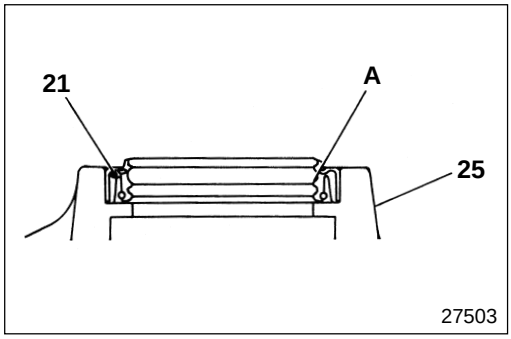
NOTE

- **Turn ball screw set shaft 20, and make sure that the shaft rotates approximately five turns lock-to-lock.**
- **If the number of turns is less, inspect engagement of ball screw set shaft 20 and sector shaft 8.**



11 **23** **Installation of U-packing**

Apply grease to lip area **A** of U-packing **11, 23** and install into gear box **25** as illustrated.

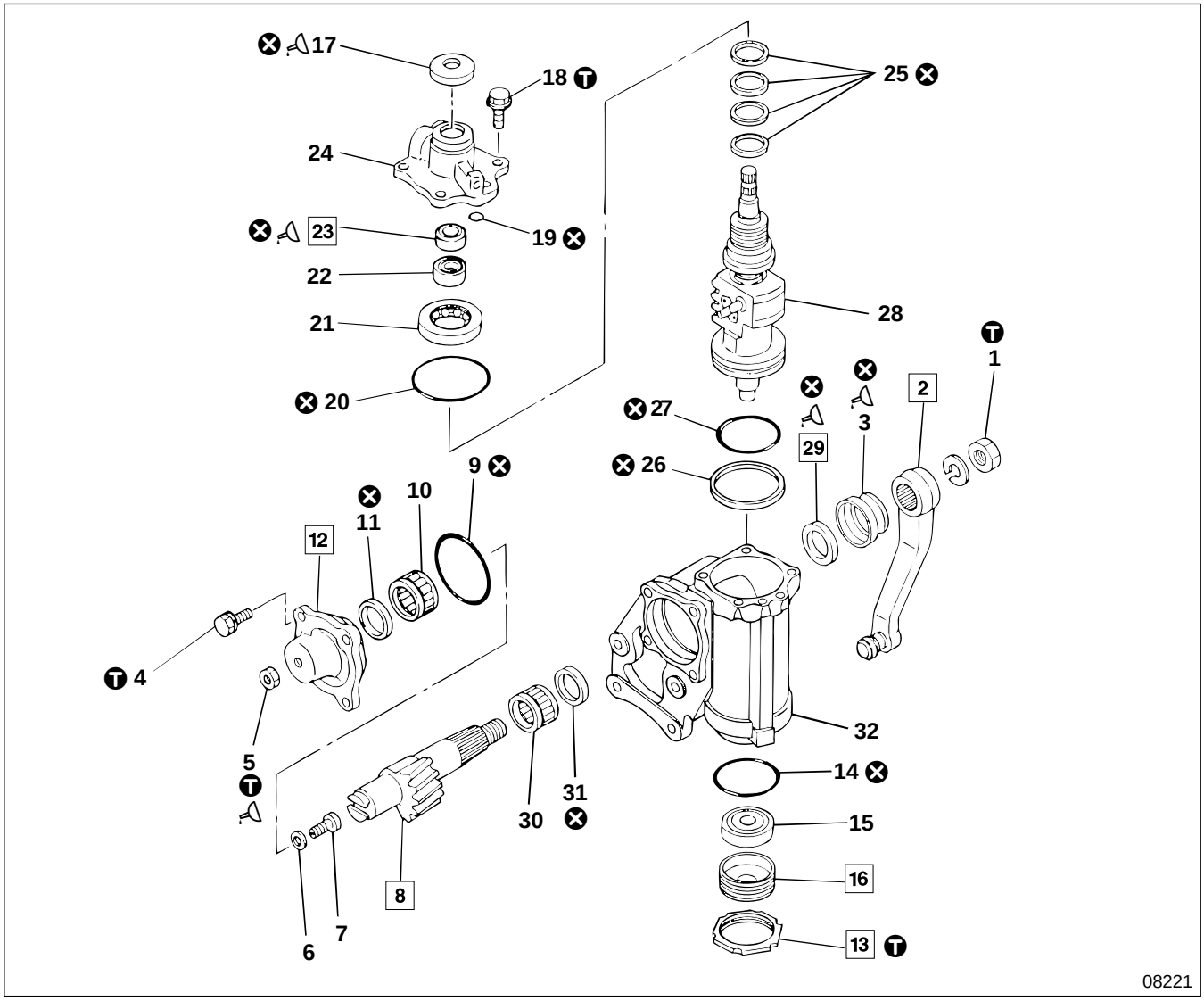


21 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **21** and install into gear box **25** as illustrated.

M E M O

POWER STEERING BOOSTER < FG >



● **Inspection before disassembly**

P37-32

● **Disassembly sequence**

1 Lock nut
2 Pitman arm
3 Dust cover
4 Bolt
5 Nut
6 Adjusting plate
7 Adjusting bolt
8 Sector shaft
9 O-ring
10 Needle bearing
11 U-packing
12 Side cover
13 Special nut
14 O-ring
15 Bearing
16 End cover
17 Dust cover
18 Bolt
19 O-ring
20 O-ring
21 Bearing
22 Bearing
23 Oil seal
24 Valve housing
25 Seal ring
26 Seal ring
27 O-ring
28 Ball screw set shaft
29 Oil seal
30 Needle bearing
31 U-packing
32 Gear box

⊗ : Non-reusable parts

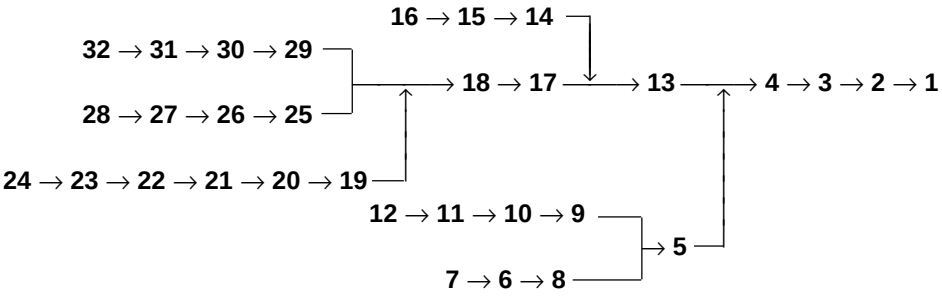
NOTE

Do not disassemble needle bearing 10, 30 and ball screw set shaft 28 unless they are faulty.

● **Inspection after assembly**

P37-33

● **Assembly sequence**



Repair kit : Seal kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
7, 8	Axial play of center shaft and adjusting bolt	0.1 {0.0039} or less	0.1 {0.0039}	Replace adjusting plate
8	Axis diameter of sector shaft (at gear box)	[40] –0.008 to +0.005 {[1.57] –0.00031 to +0.00020}	0.003 {0.00012}	Gap between worn area and unworn area
28	Main shaft outer diameter of ball screw set shaft	[22.5] –0.05 to 0 {[0.89] –0.0020 to 0}	—	Replace
	Rotating torque of ball screw set shaft	29 to 69 N·cm {0.22 to 0.51 lbf.ft, 3 to 7 kgf·cm}	—	Adjust
28, 32	Clearance between ball screw set shaft and gear box	0.022 to 0.069 {0.00087 to 0.0027}	—	Replace
32	Inner diameter of gear box	[78] 0.012 to 0.034 {[3.1] 0.00047 to 0.0013}	0.05 {0.0020}	Gap between worn area and unworn area
—	Total starting torque with power steering booster	98 N·cm {0.72 lbf.ft, 10 kgf·cm} or less	—	Adjust
—	Engagement torque	20 to 49 N·cm {0.14 to 0.36 lbf.ft, 2 to 5 kgf·cm}	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

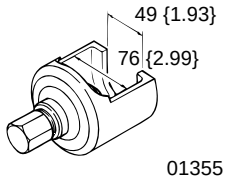
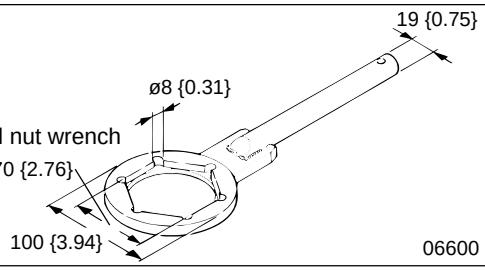
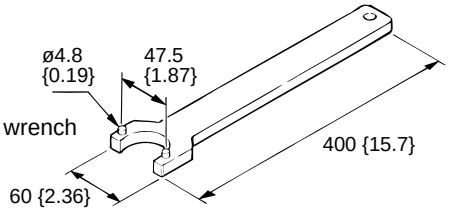
Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Pitman arm mounting)	245 to 294 {180 to 215, 25 to 30}	—
4	Bolt (Side cover mounting)	74 to 98 {54 to 72, 7.5 to 10}	—
5	Nut tightening	29 to 39 {22 to 29, 3 to 4}	—
13	Special nut mounting	177 to 226 {130 to 165, 18 to 23}	—
18	Bolt (Valve housing mounting)	44 to 54 {33 to 40, 4.5 to 5.5}	—

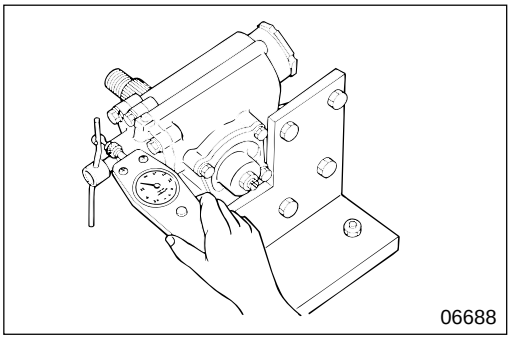
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 17	Pack interior of dust cover	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
5	Nut fixing point	THREEBOND 1104	As required
23, 29	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

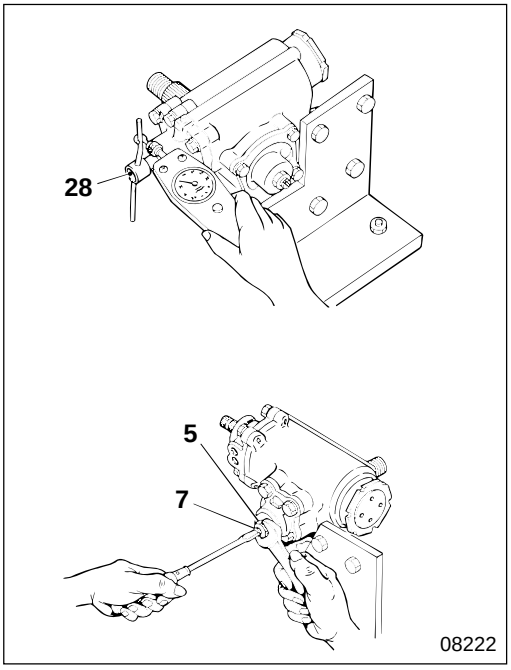
Location	Tool name and shape	Part No.	Application
2	Pitman arm puller 	MH062472	Removal of pitman arm
13	Special nut wrench 	MH061594	Removal and installation of special nut
16	End cover wrench 	MH061593	Removal and installation of end cover



◆ Service procedure

● **Inspection before disassembly**

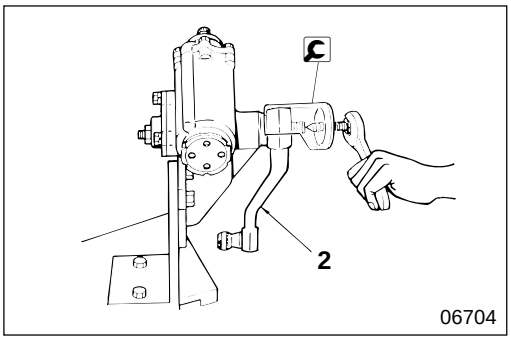
[Measurement of total starting torque]
Before disassembly, measure the total starting torque for a reference during assembly.



● **Inspection after assembly**

[Measurement of total starting torque]

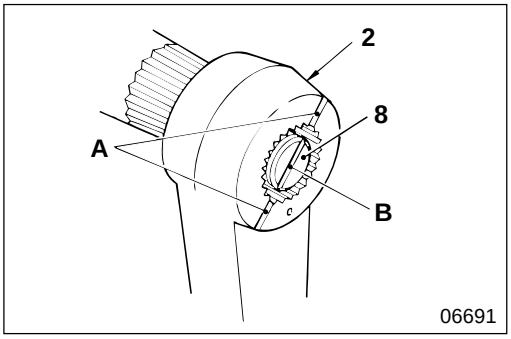
- While turning ball screw set shaft **28**, one quarter of a turn left and right from the neutral position using a torque meter, drive adjusting bolt **7** in, then adjust so that the total starting torque or the engagement torque is within the standard value.
- After adjustment, tighten nut **5** at specified torque.



2 **Pitman arm**

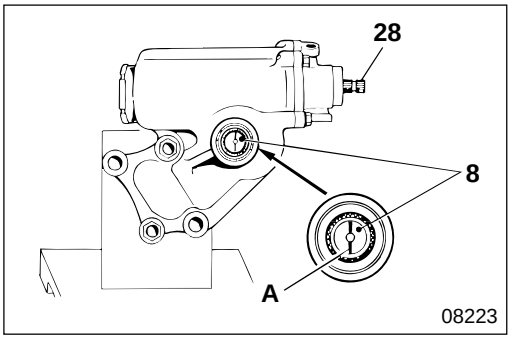
[Removal]

: Pitman arm puller



[Installation]

Align slit **B** of the V-groove of sector shaft **8** on the same line as slit **A** of the V-groove of pitman arm **2** when installing it.



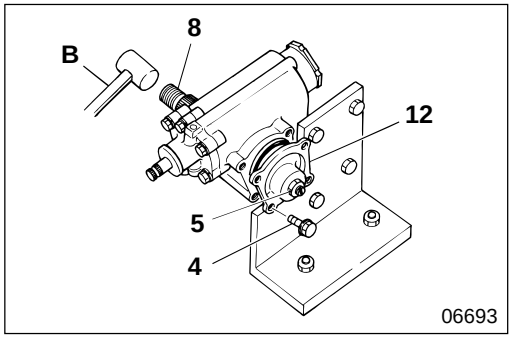
8 **12** **Sector shaft and side cover**

[Removal]

- Turn ball screw set shaft **28** counterclockwise to the lock position, then turn it clockwise approximately 2.6 turns, so that slit **A** of the V-groove at the end of sector shaft **8** is in the neutral position as illustrated.

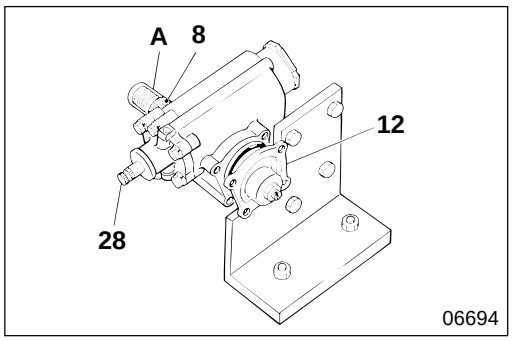
NOTE

At this time, make sure that slit A of the V-groove at the end of sector shaft 8 is at right angles to the axial line of ball screw set shaft 28.



- Loosen nut **5** and remove bolt **4**. After making sure that sector shaft **8** is in the neutral position, tap the end of the sector shaft, and pull out side cover **12** together with the sector shaft.

  B : Plastic-headed mallet



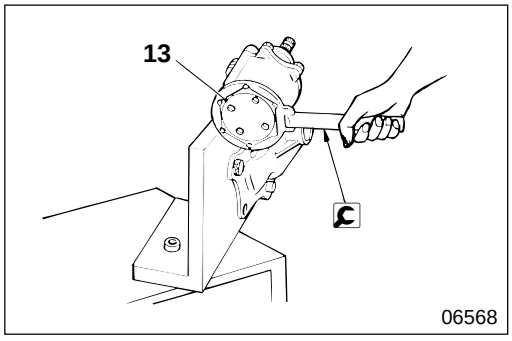
[Installation]
With ball screw set shaft **28** in the neutral position, insert sector shaft **8** and side cover **12**.

CAUTION

Insert sector shaft 8 with the thread area of the shaft end and serration area protected by cover A to prevent damage to the oil seal.

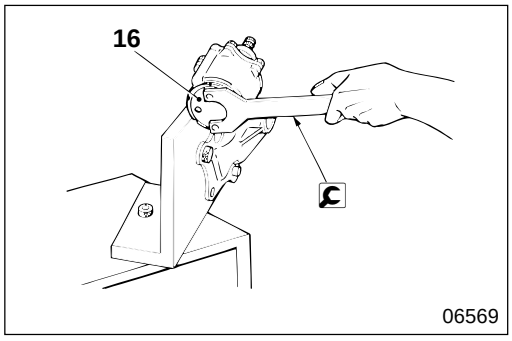
NOTE

- **Turn ball screw set shaft 28, and make sure that the shaft rotates approximately five turns lock-to-lock.**
- **If the number of turns is less, inspect engagement of ball screw set shaft 28 and sector shaft 8.**



13 Removal and installation of special nut

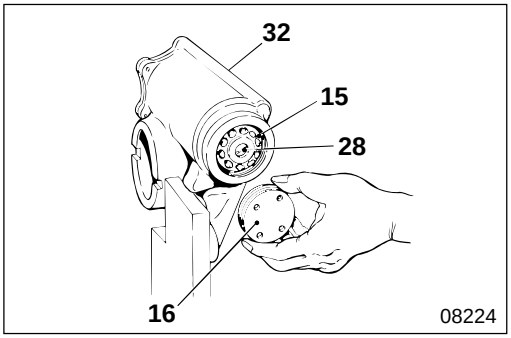
: Special nut wrench



16 End cover

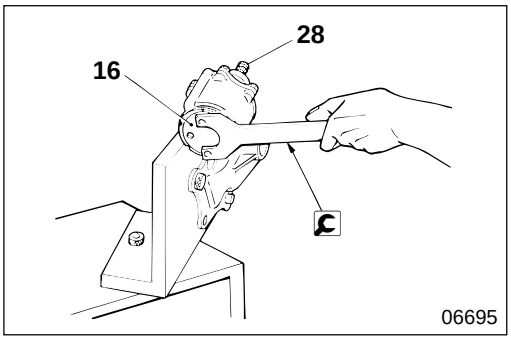
[Removal]

: End cover wrench

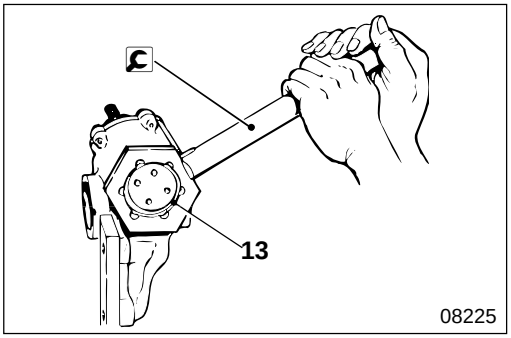


[Installation]

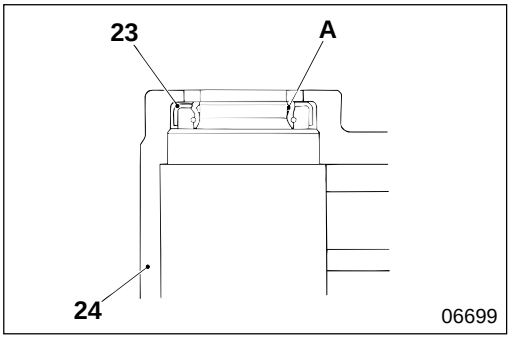
- Install inner race of bearing **15** onto the end of ball screw set shaft **28**, then install the outer race of the bearing onto end cover **16** and screw into gear box **32**.



- Making sure that the rotation torque of ball screw set shaft 28 is not uneven, thread end cover **16**, using 🔧 end cover wrench, until the rotation torque is within the standard value.

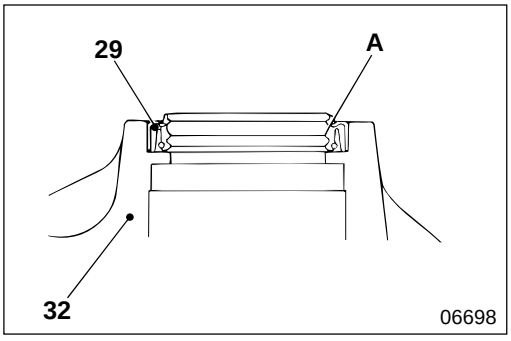


- At the point where the rotation torque is fixed, tighten special nut **13** at specified torque, using 🔧 special nut wrench.



23 **Installation of oil seal**

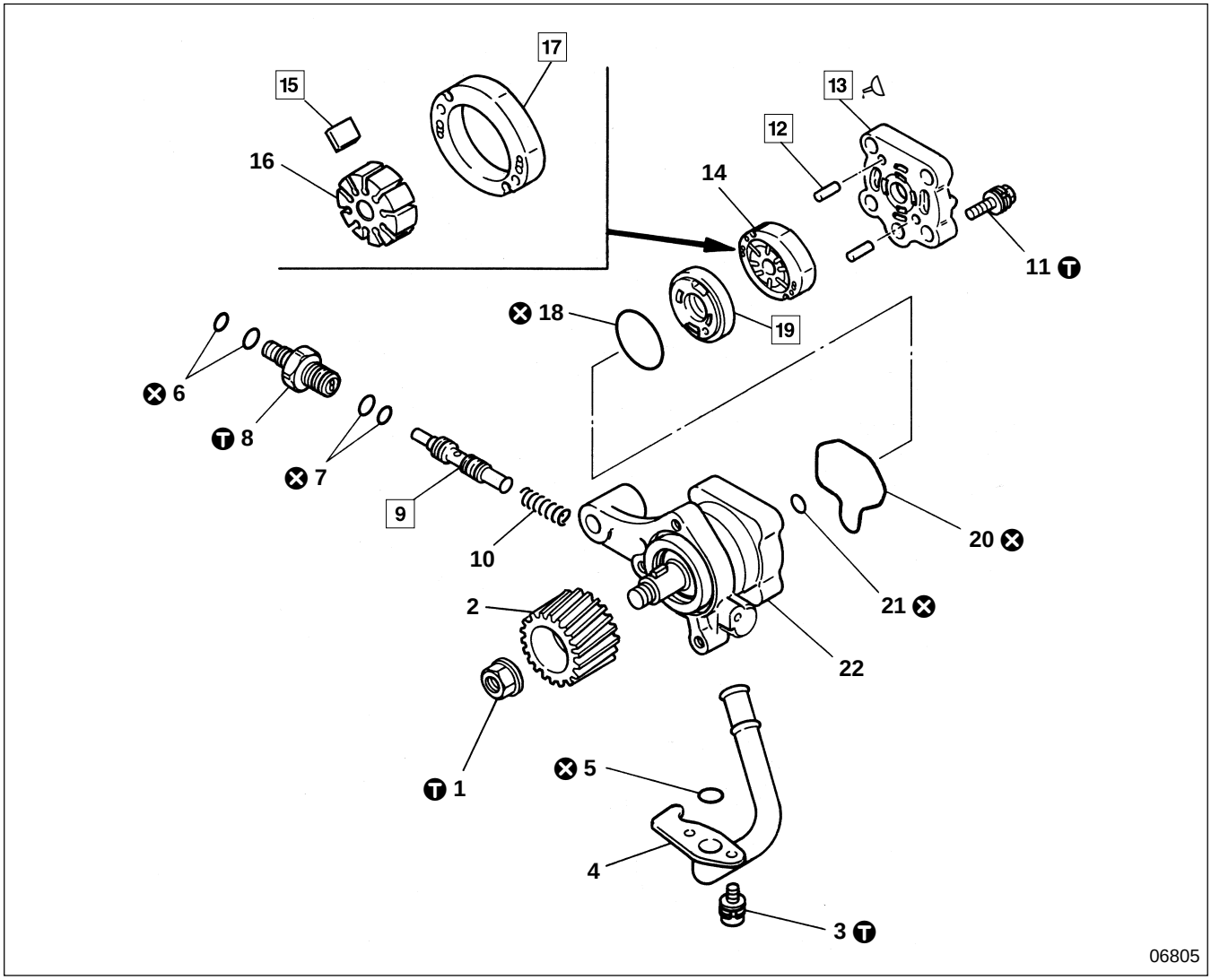
Apply grease to lip area **A** of oil seal **23** and install into valve housing **24** as illustrated.



29 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **29** and install into gear box **32** as illustrated.

POWER STEERING OIL PUMP



● **Disassembly sequence**

1 Lock nut
2 Gear
3 Bolt
4 Suction connector
5 O-ring
6 O-ring
7 O-ring
8 Connector
9 Relief valve assembly
10 Flow control spring
11 Bolt
12 Pin
13 Cover
14 Cartridge assembly
15 Vane
16 Rotor
17 Cam ring
18 O-ring
19 Side plate
20 O-ring
21 O-ring
22 Body and shaft assembly

⊗ : Non-reusable parts

● **Assembly sequence**

19→18 — **13→12** — **8→7→6** —
22→21→20 → **14** → **11→10→9** → **5→4→3→2→1**

14 : **15→16→17**

Repair kit : Seal kit, Cartridge assembly kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
9, 22	Clearance between relief valve assembly and body and shaft assembly	[14] 0.01 to 0.02 {[0.55] 0.00039 to 0.00079}	0.03 {0.0012}	—
10	Flow control spring free length	36.5 {1.44}	33.5 {1.32}	—
13	Wear of cover	—	0.05 {0.0020}	—
15, 16	Clearance between vane and rotor	0.01 {0.00039}	0.06 {0.0024}	—
19	Wear of side plate	—	0.05 {0.0020}	—

Tightening torque

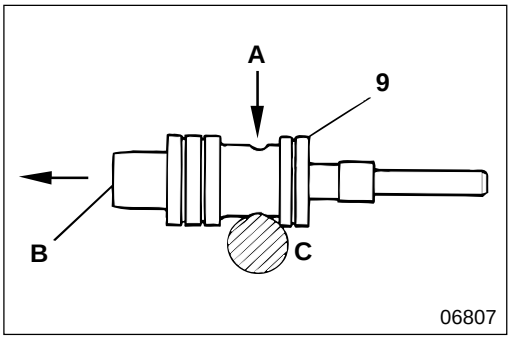
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Gear mounting)	34 to 45 {25 to 33, 3.5 to 4.6}	Wet
3	Bolt (Suction connector mounting)	6 to 10 {4.3 to 7.2, 0.6 to 1.0}	—
8	Connector	49 to 69 {36 to 51, 5 to 7}	—
11	Bolt (Cover mounting)	18 to 22 {13 to 16, 1.8 to 2.2}	—

Lubricant and/or sealant

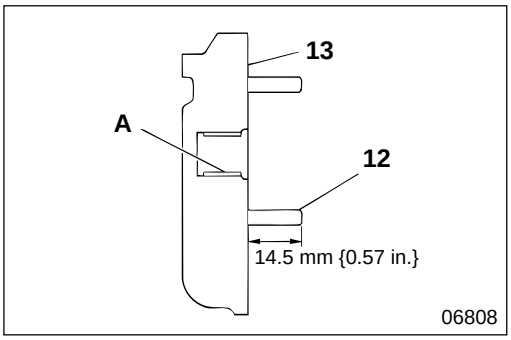
Location	Points of application	Specified lubricant and/or sealant	Quantity
13	Bushing of cover	Automatic transmission fluid (DEXRON or DEXRON II type)	As required

◆ Service procedure



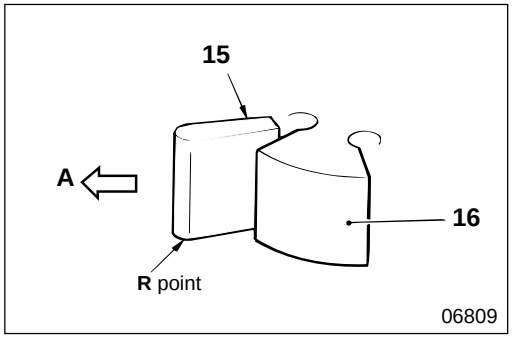
9 **Inspection of relief valve assembly**

Block one side of the hole of relief valve assembly **9**, with your finger **C**, then when air pressure **A** of 390 to 490 kPa {57 to 71 psi, 4 to 5 kgf/cm²} is applied from the other side, check whether air is released from small hole **B** at the rear. If air is not released, it is normal.



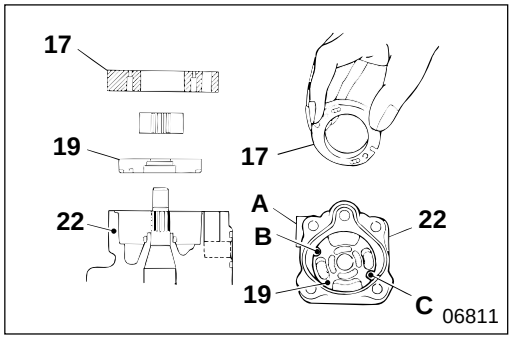
12 **13** **Installation of pin and cover**

- Press-fit pin **12** into cover **13**, to the press-fitting height.
- Apply hydraulic oil to bushing area **A** of the cover.



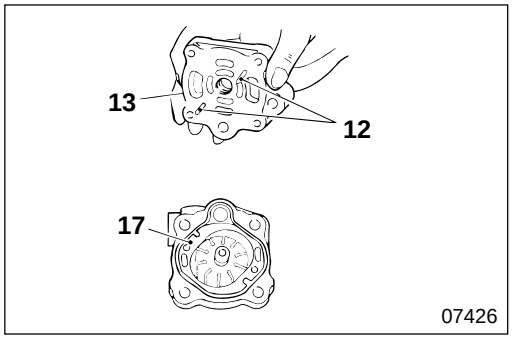
15 **Installation of vane**

With **R** point of vane **15** facing outside **A**, install it on rotor **16** and make sure that the vane moves smoothly. If it is faulty, replace cartridge **14**.



17 **19** **Installation of cam ring and side plate**

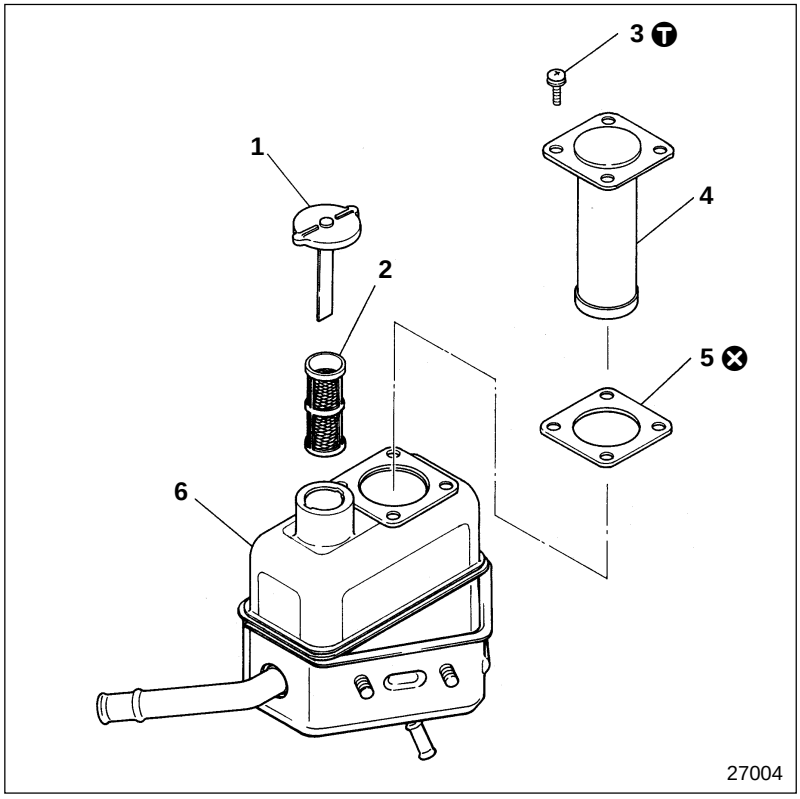
- Since the mounting direction of side plate **19** is determined, mount the side plate, so that relief valve side **A** is aligned with round hole **B** (standard pin side) and slotted hole **C** is located on a diagonal.



- Align cam ring **17** with pin **12** of cover **13**, then install the cam ring.

M E M O

POWER STEERING OIL TANK



● **Disassembly sequence**

1 Filler cap
2 Strainer
3 Screw
4 Filter
5 Packing
6 Tank

⊗ : Non-reusable parts

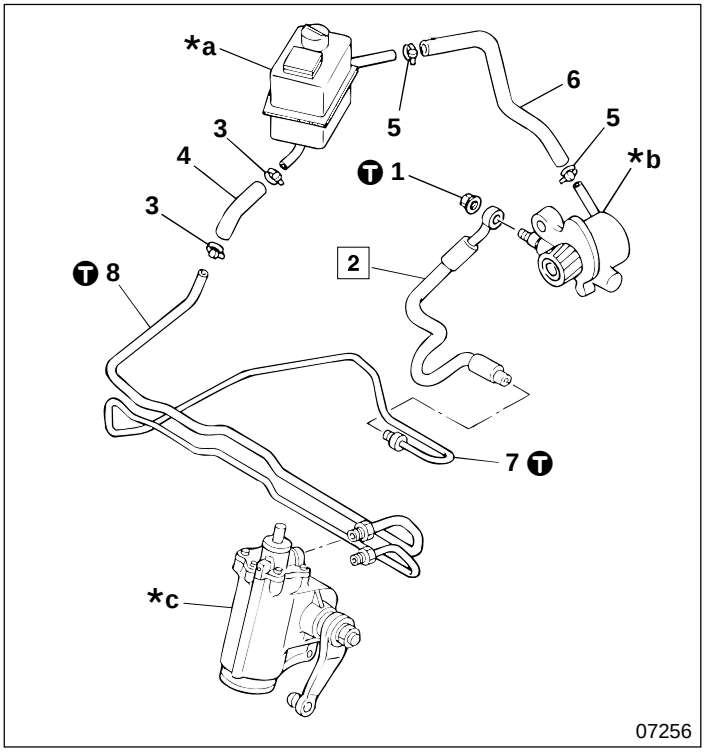
● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Screw (Filter mounting)	1.27±0.29 {0.94±0.22, 0.13±0.03}	—



● **Removal sequence**

1 Nut
2 Pressure hose
3 Clamp
4 Rubber hose
5 Clamp
6 Rubber hose
7 Pressure tube
8 Return tube

***a** : Power steering oil tank
***b** : Power steering oil pump
***c** : Power steering booster

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION⚠

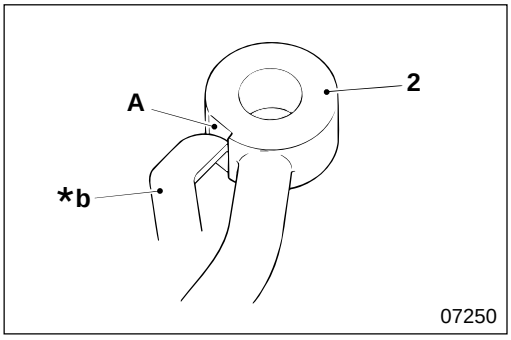
Be sure to bleed air if the fluid line was removed, failure to do so would cause the power steering to malfunction. 🕮 P37-12

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Pressure hose mounting)	29 to 39 {22 to 29, 3 to 4}	—
7	Pressure tube (Pressure hose and power steering booster connection)	29 to 39 {22 to 29, 3 to 4}	—
8	Return tube (Power steering booster connection)	39 to 49 {29 to 36, 4 to 5}	—

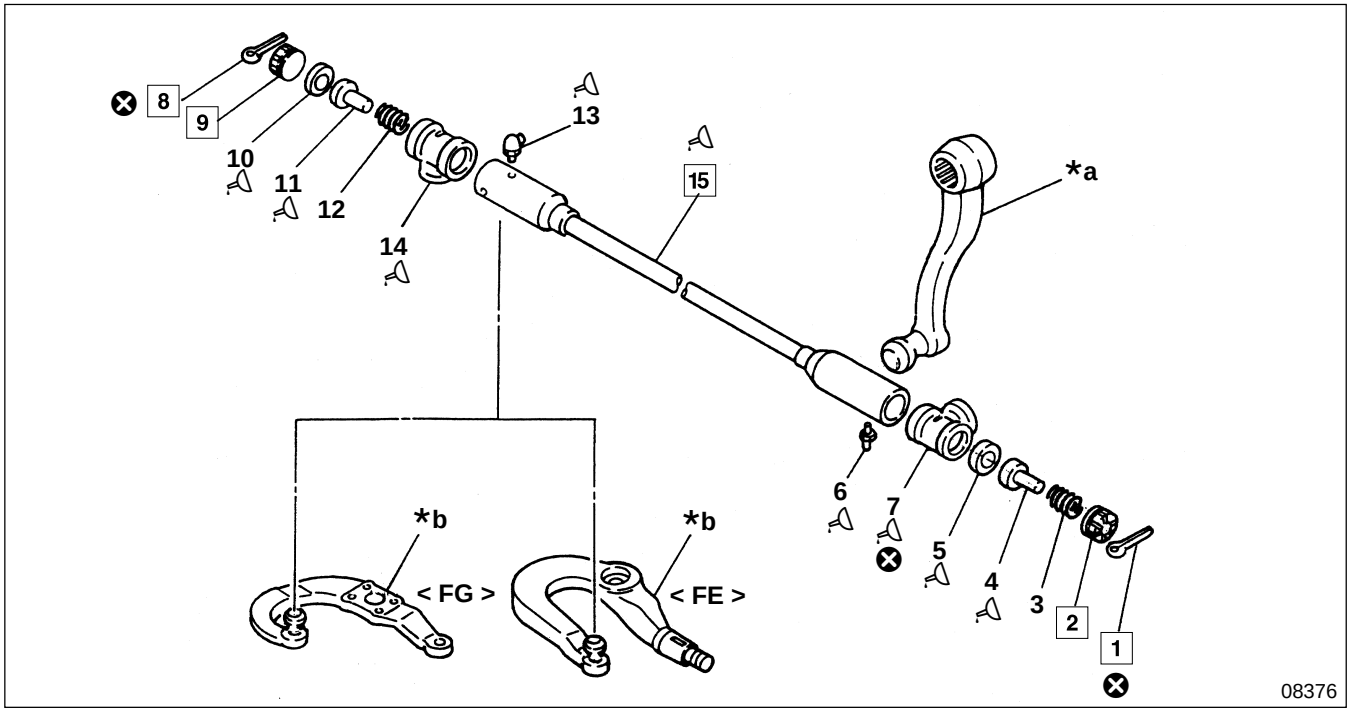
◆ Service procedure



2 **Installation of pressure hose**

Install pressure hose **2** so indent **A** of pressure hose **2** contacts the suction connector of power steering oil pump ***b**.

DRAG LINK



● **Disassembly sequence**

1 Split pin
2 End plug
3 Spring
4 Ball stud seat
5 Ball stud seat
6 Grease nipple
7 Dust cover
8 Split pin
9 End plug
10 Ball stud seat
11 Ball stud seat
12 Spring
13 Grease nipple
14 Dust cover
15 Drag link

***a** : Pitman arm
📖 P37-24, 30
***b** : Knuckle arm
< FE > Gr 26A
< FG > Gr 26B
⊗ : Non-reusable parts

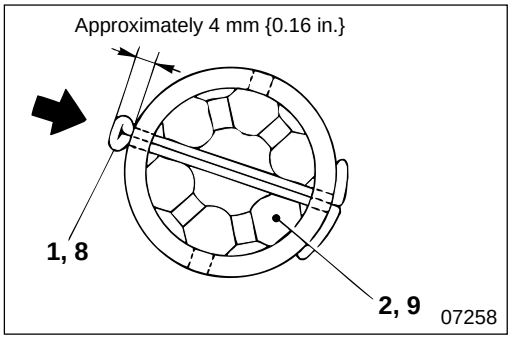
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

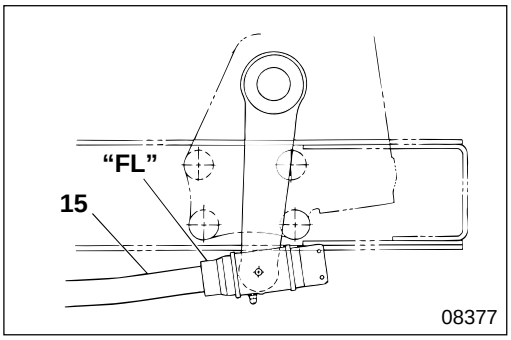
Location	Points of application	Specified lubricant	Quantity
4, 5, 10, 11	Whole area of ball stud seat	Chassis grease [NLGI No.1 (Ca soap)]	As required
6, 13	Supply via grease nipple	Chassis grease [NLGI No.1 (Ca soap)]	As required
7, 14	Arm mounting port of dust cover	Chassis grease [NLGI No.1 (Ca soap)]	As required
15	Pack interior of drag link	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



1 **2** **8** **9** **Installation of split pin and end plug**

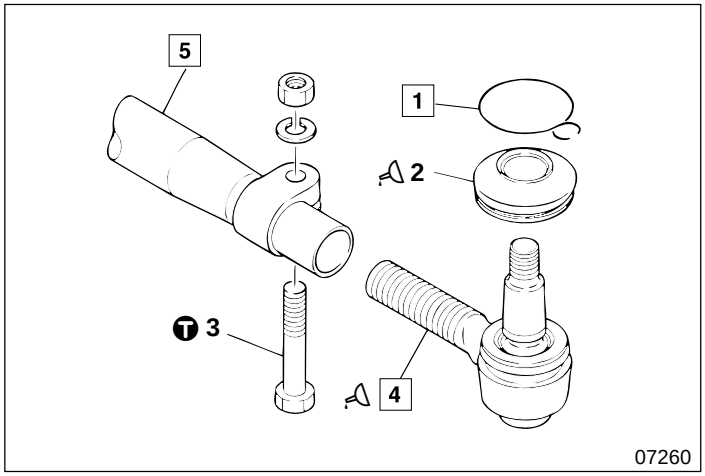
- Tighten end plug **2, 9** fully, then slacken it off by one half of a turn.
- Place split pins **1**, **8** so that the heads face the outside of the vehicle.
- Stake the heads of split pins **1**, **8** until they are approximately 4 mm {0.16 in.} thick.



15 **Installation of drag link**

Install drag link **15** with front mark **"FL"** facing the front of the vehicle.

TIE ROD ASSEMBLY



● **Disassembly sequence**

1 Clip
2 Dust cover
3 Clamp bolt
4 Tie rod end
5 Tie rod

NOTE

Do not remove clip 1 or dust cover 2 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
5	Bend of tie rod	1 {0.039} or less	1 {0.039}	Replace

Tightening torque

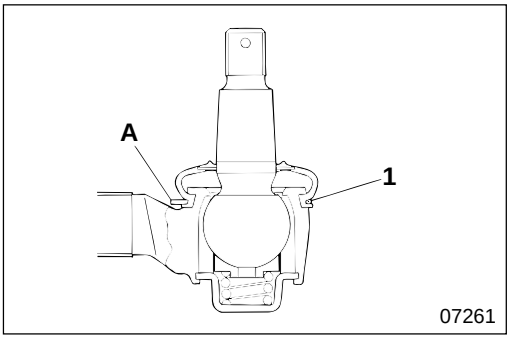
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Clamp bolt (Tie rod end clamp tightening)	25±5 {18±3.6, 2.5±0.5}	—

Lubricant

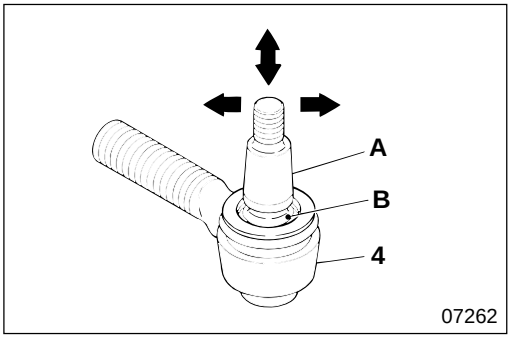
Location	Points of application	Specified lubricant	Quantity
2	Lip area of dust cover	Wheel bearing grease [NLGI No.2 Li soap]	As required
4	Pack interior of dust cover of tie rod end	Wheel bearing grease [NLGI No.2 Li soap]	As required

◆ Service procedure



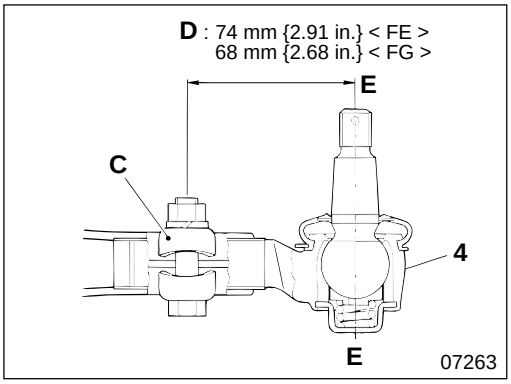
1 **Installation of clip**

Install clip **1** with alignment port **A** in the direction as illustrated.



4 **Tie rod end**

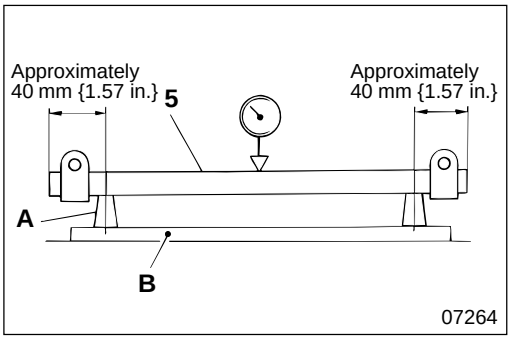
[Inspection]
Move ball stud area **A** vertically and horizontally to inspect for looseness. Ensure that ball **B** rotates evenly.



[Installation]
- Screw in tie rod end **4** so that dimension **D** of the tie rod end and clamp **C** differs by 1.5 mm {0.059 in.} or less between left and right.
- Secure axis **E – E** so that it is parallel both left and right.

NOTE

Deviation of the left and right screw-in amount of tie rod end 4 should be within one turn.



5 **Bending of tie rod**

Measure the bend of tie rod **5** at the center point. If the measured value exceeds the limit, correct or replace the tie rod.

NOTE

To measure the deflection of tie rod 5, turn it one full rotation and read the dial gauge indicator. The deflection is one half of the indicated value.

A : V-block
B : Surface plate

MITSUBISHI
FUSO

Group 37
Steering

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0304-37

INDEX

SPECIFICATIONS 37- 2

STRUCTURE AND OPERATION 37- 3

TROUBLESHOOTING 37- 8

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Change of Power Steering Fluid 37- 11
- Bleeding of Power Steering System 37- 12
- Steering Wheel Play 37- 12
- Performance Verification Test of Power Steering System 37- 13

STEERING SYSTEM 37- 14

STEERING COLUMN SUBASSEMBLY 37- 20

POWER STEERING BOOSTER 37- 24

POWER STEERING OIL PUMP 37- 30

POWER STEERING OIL TANK 37- 34

POWER STEERING FLUID LINE 37- 35

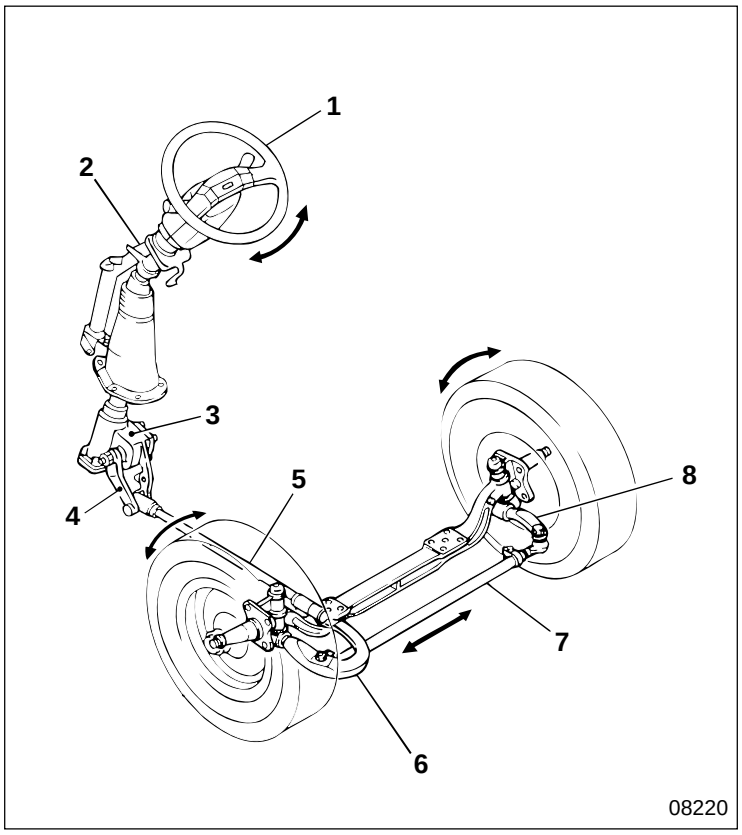
DRAG LINK 37-36

TIE ROD ASSEMBLY 37- 38

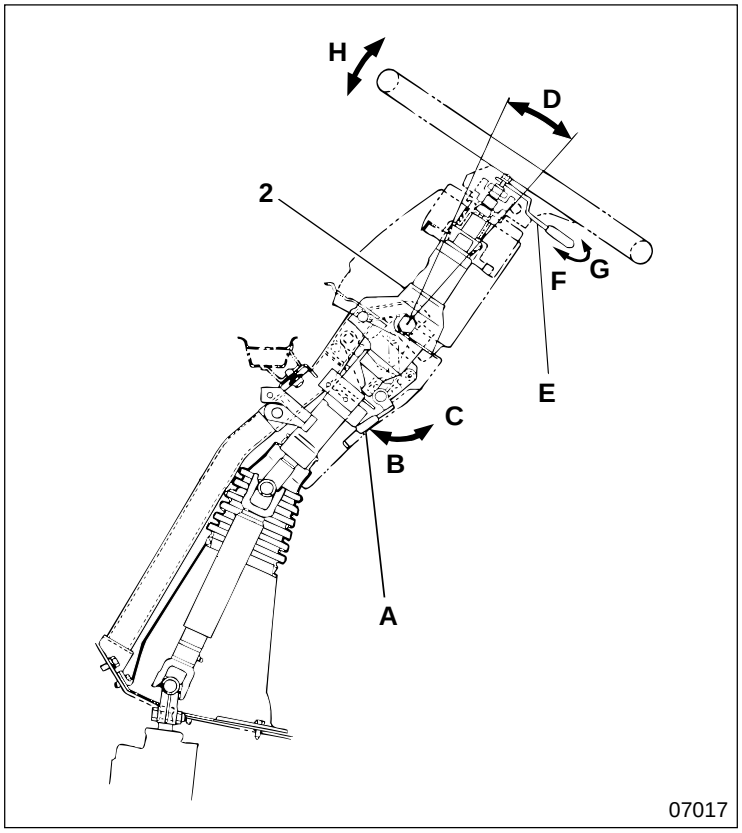
SPECIFICATIONS

Item \ Model			FE	FG
Steering wheel	Type		2-spoke type	
	Outer diameter mm {in.}		400 {15.7}	
Steering shaft	Type		Universal joint type (High tilt and telescopic type)	
Power steering booster	Manufacturer		KOYO SEIKO	
	Type		Ball nut type	
	Form		Integral type	
	Gear ratio		22.6	
	Operation angle	right steering	40° $^{+3°}_{0}$	34° $^{+3°}_{0}$
		left steering	41° $^{+3°}_{0}$	32° $^{+3°}_{0}$
	Cylinder diameter mm {in.}		78 {3.07}	
	Mass (approximately) kg {lb}		18 {40}	
Power steering oil pump	Manufacturer		KAYABA INDUSTORY	
	Type		Vane type	
	Discharge amount cm^3 {cu.in.}/rev		9.6 {0.59}	
	Regulated flow amount L {qts}/min		7 {7.4}	
	Regulated pressure (relief valve) MPa {lbf/in^2., kgf/cm^2}		9.3 {1350, 95}	
	Permissible revolutions rpm		600 to 6500	
	Mass (approximately) kg {lb}		1.8 {4.0} (Except FE640) 1.6 {3.5} (FE640)	1.8 {4.0}

Steering System

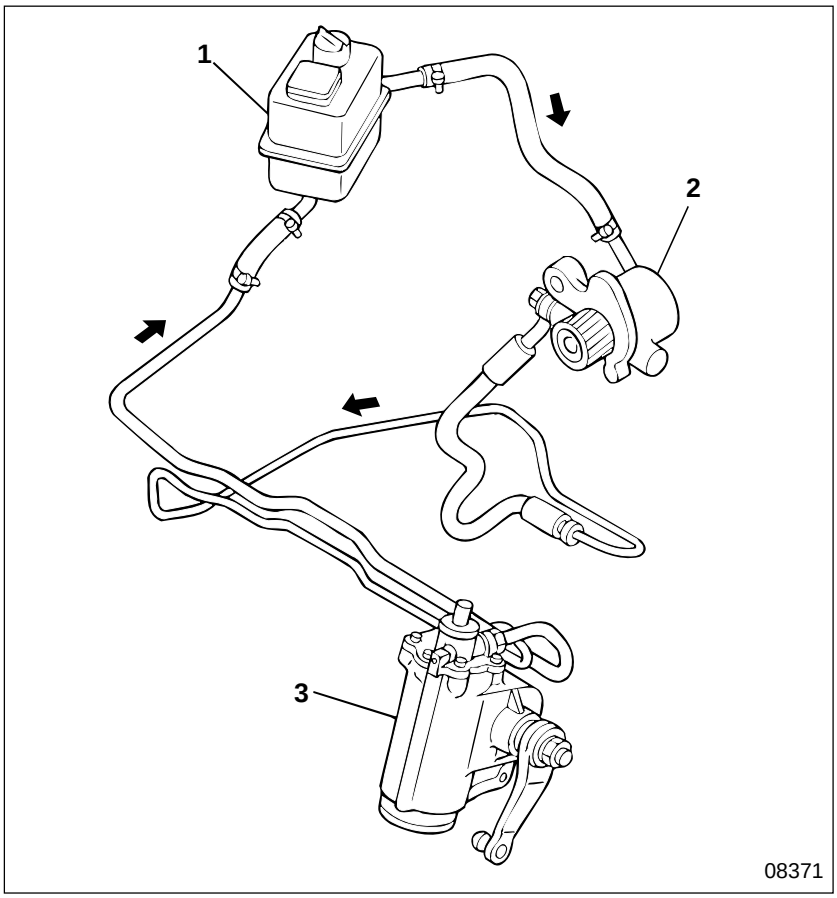


1 Steering wheel
2 Steering column subassembly
3 Power steering booster
4 Pitman arm
5 Drag link
6 Knuckle arm
7 Tie rod
8 Tie rod arm



Shifting lock lever **A** from lock position **B** to release position **C** produces high tilt **D**, and turning telescopic lever **E** (counterclockwise) from lock position **F** to release position **G** allows telescopic movement **H**. In this way, the structure of steering column subassembly **2** can be adjusted for optimum driving position.

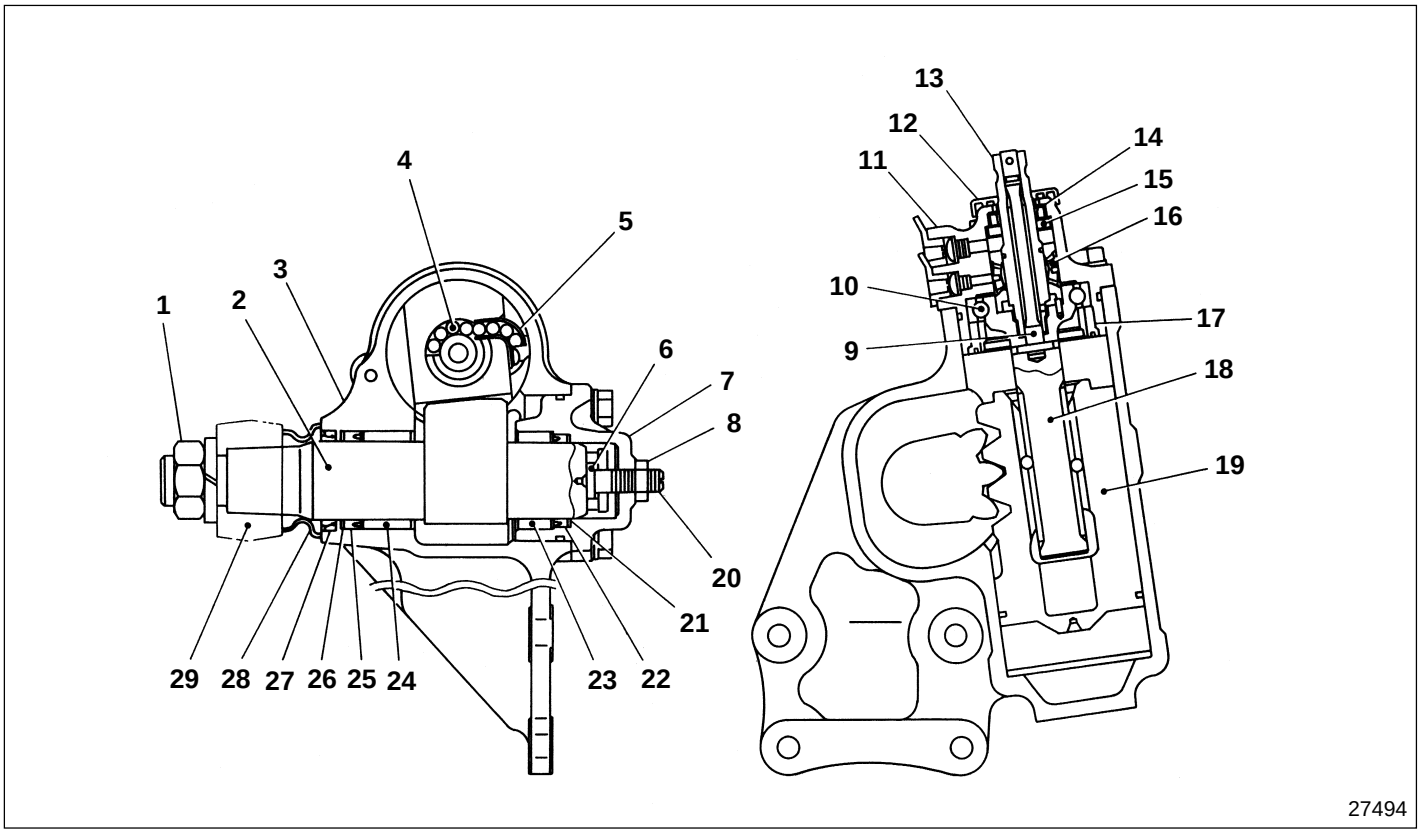
Power Steering System



1 Power steering oil tank
2 Power steering oil pump
3 Power steering booster

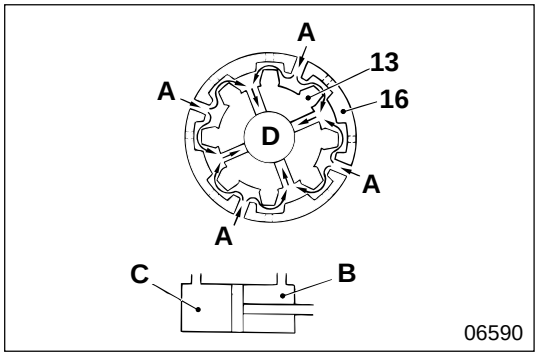
⬅ : Fluid flow

Power Steering Booster



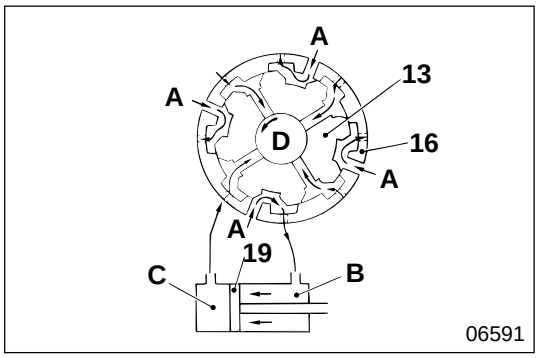
1 Lock nut
2 Sector shaft
3 Gear box
4 Steel ball
5 Circulator
6 Adjusting plate
7 Side cover
8 Nut
9 Torsion bar
10 Bearing
11 Valve housing
12 Dust cover
13 Input shaft
14 Oil seal
15 Bearing
16 Rotary valve
17 Lock screw
18 Main shaft
19 Rack piston
20 Adjusting bolt
21 Backup ring
22 Y-packing assembly
23 Needle bearing
24 Needle bearing
25 Y-packing assembly
26 Backup ring
27 Oil seal
28 Dust cover
29 Pitman arm

Rotary valve **16** is the central part of the power steering booster. Torsion bar **9** allows the steering reaction force and valve return to operate lightly and smoothly at low speed, and ensures stable steering feel even at high speed.



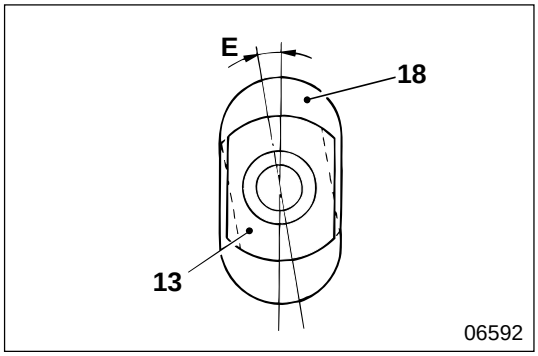
● **Straight-ahead drive operation**

When steering torque is not applied by the steering wheel, input shaft **13** is not activated and remains in neutral. At this time, pressurized fluid from the oil pump flows through the input shaft and the hole of rotary valve **16**, and returns to the oil tank without flowing into cylinder chambers **B**, **C**.
A : From the oil pump
D : To the oil tank



● **Steering operation**

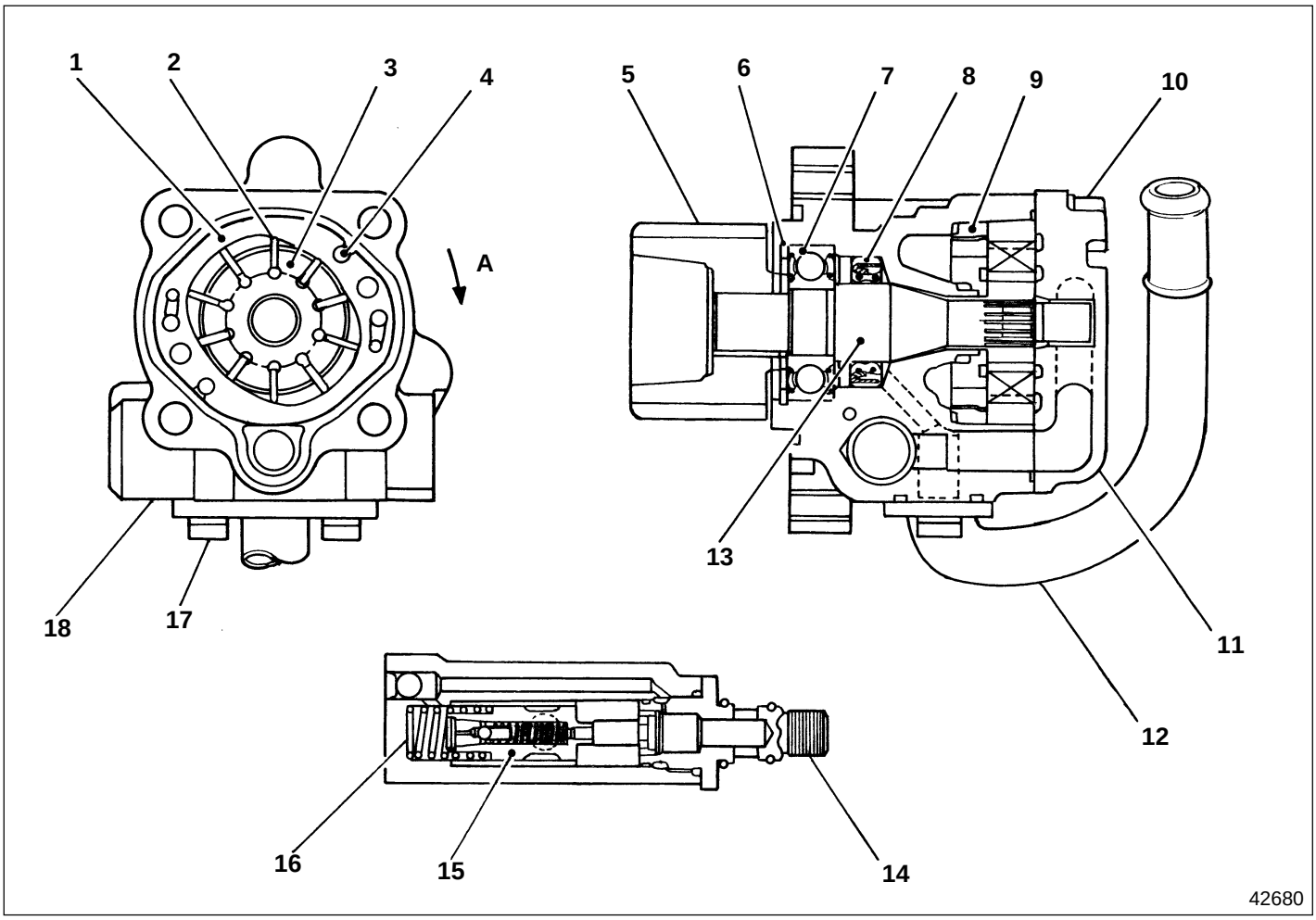
Turning the steering wheel rotates input shaft **13**, causing rotary valve **16** to close the fluid feed passage to cylinder chamber **C**. This produces a pressure difference between cylinder chambers **B**, **C**, which causes rack piston **19** to move, and facilitates rotation of main shaft **18**.
The illustration shows right-turn steering, and should be reversed for left-turn steering.



● **Operation when hydraulic circuit is faulty**

The safety structure means that when the fluid circuit is faulty, the stopper of input shaft **13** directly contacts the groove at the large end of main shaft **18** to transmit steering force, enabling manual operation.

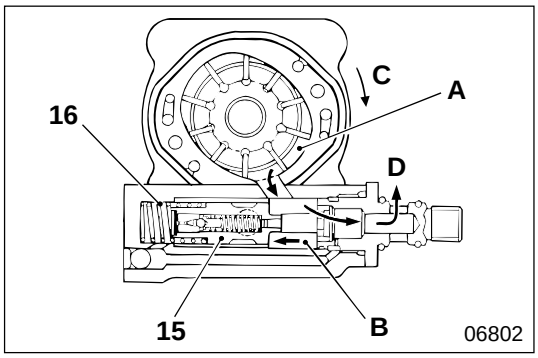
Power Steering Oil Pump



1 Cam ring
2 Vane
3 Rotor
4 Pin
5 Gear
6 Snap ring
7 Bearing
8 Oil seal
9 Side plate
10 Bolt
11 Cover
12 Suction connector
13 Shaft
14 Connector
15 Relief valve assembly
16 Flow control spring
17 Bolt
18 Body

A : Direction of rotation

Relief Valve Assembly



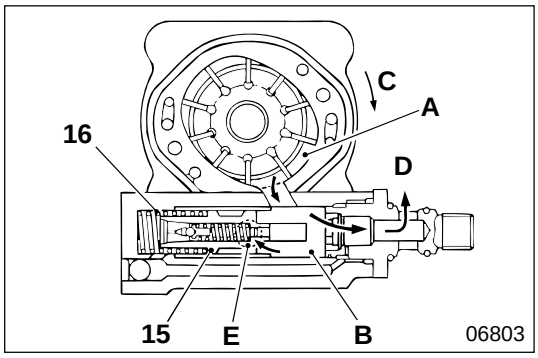
● **Operation of flow control valve**

(1) When not operating (Oil pump rotating at low speed)

Since pressure generated from pressure chamber **A** is low when the oil pump is rotating at low speed, fluid pressure in chamber **B** is also low. Therefore, relief valve assembly **15**, which is pressed by the repercussive force of flow control spring **16** is not activated.

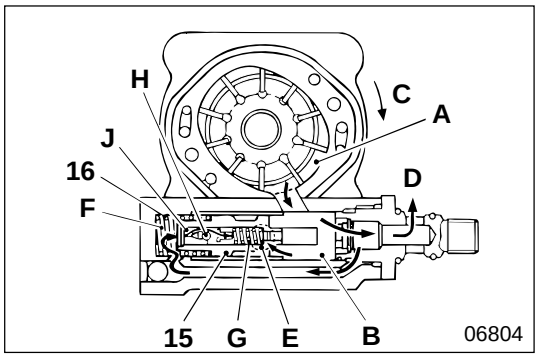
C : Direction of rotation

D : To the power steering booster



(2) When operating (Oil pump rotating at middle or high speed)

Since pressure generated from pressure chamber **A** is high when the oil pump is rotating at middle or high speed, fluid pressure in chamber **B** is also high. This will activate relief valve assembly **15**, overcoming the repercussive force of flow control spring **16**, and open port **E**, making excess fluid return to the inlet port to adequately regulate the flow of fluid to power steering booster **D**.



● **Operation of relief valve**

When the steering is lock-to-lock, pressure in chambers **B** and **F** increases and overcomes the repercussive force of relief spring **G** opening relief valve **J**, which was closed by steel ball **H**, causing the fluid to be returned to the inlet port through port **E**. Thus, if pressure in chamber **F** decreases, the relief valve closes again.

Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return bad	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Power steering mechanism faulty	Bearing damaged or worn	○			○	○								
	Ball or groove of ball screw set shaft worn	○	○		○									
	Air bled insufficiently	○												
	Fluid viscosity unsuitable	○												
	Power steering booster system faulty	○												
	Flow control valve malfunctioning	○												
	Rack or ball screw set shaft gear worn		○											
	Sector shaft bearing worn		○		○									
	Power steering booster mounting bolt loose		○											
	Ball screw set shaft and sector shaft play incorrect				○									
	Edge of valve control damaged or control seal ring broken				○									
	Power steering system fluid unsuitable				○									
	Rack engagement starting torque adjusted incorrectly	○				○								
	Fluid circuit clogged	○				○								
	Sector shaft gear worn		○											
	Torsion shaft serration damaged or worn		○											
	Power steering booster body faulty			○	○									
	O-ring or oil seal faulty								○					
	Sealant applied incorrectly								○					
Steering column and link mechanism faulty	Universal joint worn abnormally, damaged, lubricated incorrectly	○	○											
	Link deformed	○												
	Drag link ball stud excessive play		○		○									
	Tie rod end ball stud excessive play		○		○									
	Tie rod bent						○							
	Pitman arm mounting position incorrect							○						
	Steering wheel center offset			○										

Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return bad	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Front axle faulty	Kingpin lubricated incorrectly	○				○								
	Front wheel alignment (toe-in, camber, caster) incorrect	○		○	○	○								
	Thrust bearing damaged	○												
	Wheel hub bearing worn or damaged		○	○	○									Gr 26A, B
	Kingpin or bushing worn or damaged		○	○	○									
	Front axle deformed			○										
	Knuckle arm, tie rod arm, knuckle, etc. tightened incorrectly				○									
	U-bolt of front spring, nut loose				○									Gr 33
	Front axle parts overtightened					○								
	Turning angle adjusted incorrectly						○	○						Gr 26A, B
	Mounting parts, connection point loose		○											
	Knuckle stopper bolt adjusted incorrectly							○						
Oil pump faulty	Oil pump body faulty								○					
	O-ring, oil seal faulty								○					
	Bolt tightened incorrectly								○					
	Maximum generated fluid pressure insufficient									○				
	Fluid line crushed or clogged									○				
	Air lock in oil pump										○			
	Oil pump interior seized									○	○	○		
	Mounting bolt or nut loose												○	
	Pump body faulty												○	
	Valve malfunctioning									○				

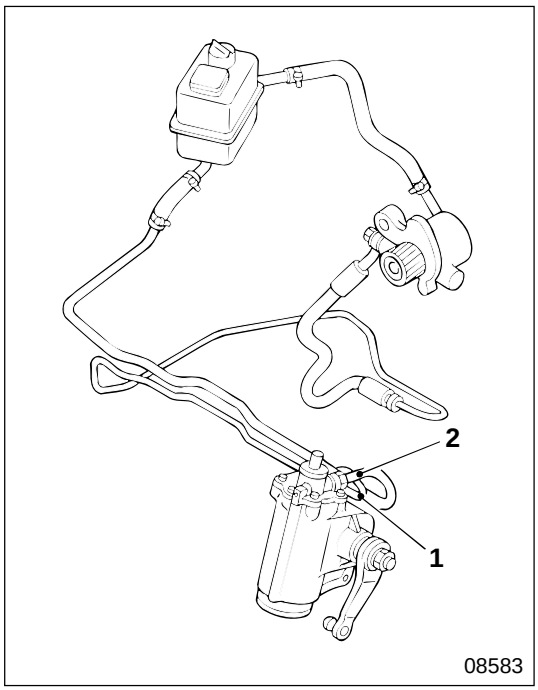
Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return bad	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Oil tank faulty	Oil tank leaking due to overflowing								○					
	Oil tank leaking due to air lock								○					
	Fluid level insufficient	○												
Other malfunctions	Load too far forward of load-carrying platform	○												
	Load too far rearward of load-carrying platform		○											
	Load too far to one side of load-carrying platform			○										
	Wheelbase gap between left and right excessive			○										
	Propeller shaft run out excessive				○									Gr 25
	Front axle bent < FE >				○									Gr 26A
	Front axle housing bent < FG >				○									Gr 26B
	Rear axle housing bent			○										Gr 27
	Final drive gear and final drive pinion damaged or engaged incorrectly				○									Gr 26B, 27
	Tire pressure insufficient	○												
	Tire pressure excessive		○											
	Tire wear difference between left and right excessive			○										Gr 31
	Tire outer diameter difference between left and right			○										
	Front tire radial and lateral runout, static balance or dynamic balance faulty				○									
	One-sided braking			○										Gr 35A

Change of Power Steering Fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Pressure tube	29 to 39 {21 to 29, 3 to 4}	—
2	Return tube	39 to 49 {29 to 36, 4 to 5}	—



[Draining]

- Jack up the front wheels.
- Release pressure tube **1** and return tube **2** connected to the power steering booster.
- Turn the steering wheel fully left and right repeatedly, and drain the fluid from the power steering booster.
- After draining the fluid, tighten pressure tube **1** and return tube **2** at specified torque.

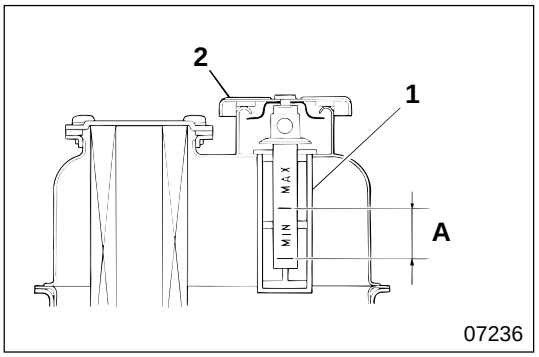
[Filling]

P37-12

Bleeding of Power Steering System

Fluid

Location	Points of application	Specified fluid	Quantity
—	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Filler cap dipstick between MIN and MAX



CAUTION

Do not keep the steering wheel turned fully to the left or right for more than fifteen seconds when the engine is running, as this can cause the power steering oil pump to seize up.

- Pour fluid into power steering oil tank up to the inner port of strainer **1**.
- With the engine stopped, jack up the front wheels and support with rigid racks. Turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.

NOTE

Check the fluid level without screwing on filler cap 2.

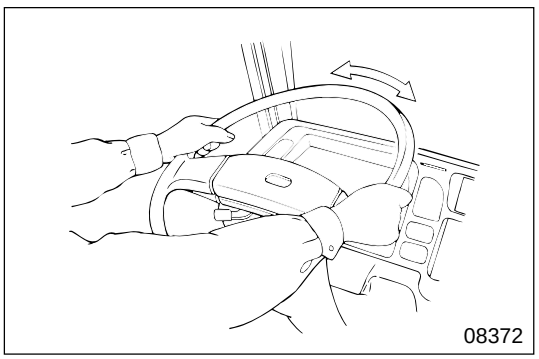
- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add the fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times to raise fluid temperature to approximately 60 to 80°C {140 to 176°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise, bleeding is completed.
- When bleeding is finished, check fluid level of power steering oil tank, and pipe and hose connections for fluid leaks.

Steering Wheel Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering wheel play (Measure at the outer circumference of steering wheel)	0 to 50 {0 to 1.97}	—	Adjust

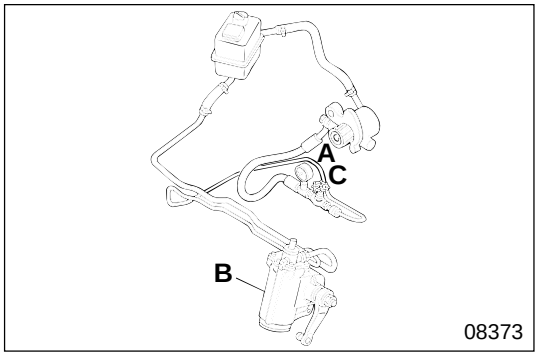


Point the wheels directly forward, start the engine and gently turn the steering wheel left and right to measure play at the outer circumference. If the play deviates from the standard value, adjust tightening points and power steering booster backlash. P37-26

Performance Verification Test of Power Steering System

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering system fluid pressure (With hands off steering wheel)	490 kPa {71 psi, 5 kgf/cm²}	—	Repair
—	Relief set pressure (Measure with engine speed at 1000 to 1500 rpm and stop valve closed)	9.3 MPa {1350 psi, 95 kgf/cm²}	Maximum +200 kPa {29 psi, 2 kgf/cm²} Minimum –300 kPa {43 psi, 3 kgf/cm²}	Replace



Verify that the power steering booster and the power steering oil pump are operating properly by testing the following items.

CAUTION

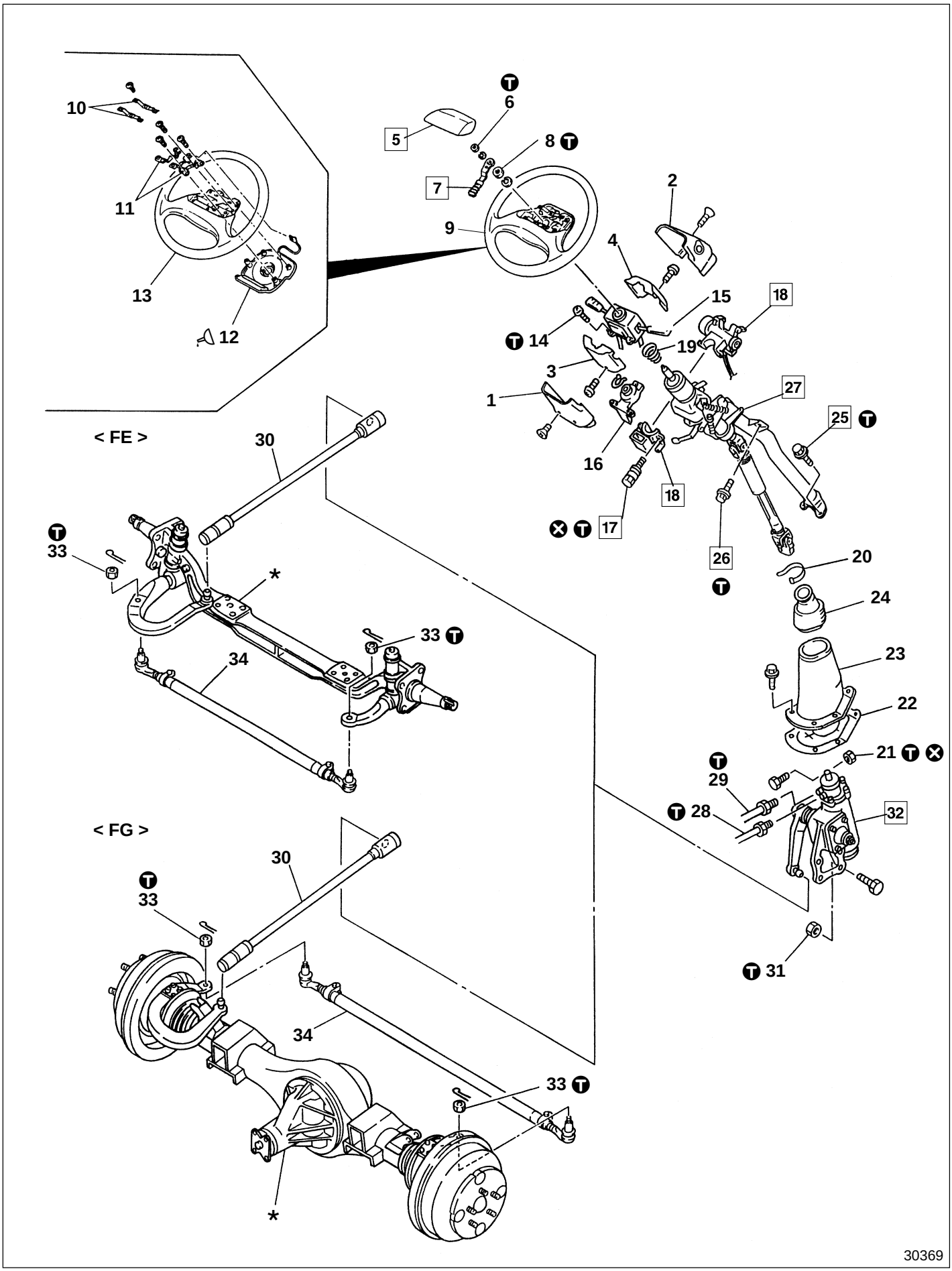
Do not keep stop valve C closed for more than fifteen seconds when the engine is running, as this can cause the power steering oil pump to seize up.

NOTE

If the fluid pressure is higher than 490 kPa {71 psi, 5 kgf/cm²} with engine idling and the steering wheel free, inspect power steering booster B and fluid circuit for clogging.

Test item	Test procedure	Assembly standards
Verification of smooth operation	Jack up the front wheels and support with rigid racks. Turn steering wheel fully left and right	Smooth operation throughout test
Measurement conditions	• Install oil pressure gauge **A** capable of measuring above 10.8 MPa {1570 psi, 110 kgf/cm²} and stop valve **C**, then bleed air and keep the stop valve opened. • With engine idling, turn steering wheel left and right several times to raise fluid temperature to 50 to 60°C {122 to 140°F} • Keep the engine idling, with opening stop valve **C** fully.	
Measurement of fluid pressure	• Measure fluid pressure with hands off steering wheel	490 kPa {71 psi, 5 kgf/cm²}
Measurement of relief pressure	• Gradually increase engine speed and maintain it at 1000 to 1500 rpm, and close stop valve **C** to measure maximum fluid pressure	Relief set pressure 9.3 MPa {1350 psi, 95 kgf/cm²}

STEERING SYSTEM



● **Removal sequence**

1 Column cover outer lower
2 Column cover outer upper
3 Column cover inner lower
4 Column cover inner upper
5 Horn pad
6 Nut
7 Telescopic lever
8 Nut
9 Steering wheel assembly
10 Horn spring
11 Contact plate
12 Cover assembly
13 Steering wheel
14 Screw
15 Combination switch Gr 54
16 Bracket
17 Head cutting bolt
18 Starter switch Gr 54
19 Spring
20 Band
21 Nut
22 Dust cover
23 Dust cover
24 Dust cover
25 Bolt
26 Bolt
27 Steering column subassembly P37-20
28 Pressure tube P37-35
29 Return tube P37-35
30 Drag link P37-36
31 Nut
32 Power steering booster P37-24
33 Nut
34 Tie rod assembly P37-38

***** : Front axle assembly
< FE > Gr 26A
< FG > Gr 26B

⊗ : Non-reusable parts

CAUTION

When disconnecting pressure tube 28 and return tube 29, cover the ports to keep them free from dust and other foreign particles.

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

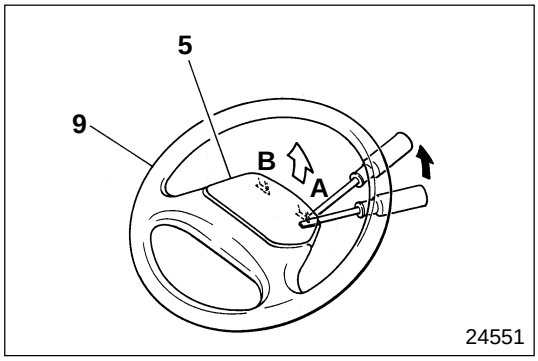
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Nut (Telescopic lever mounting)	8.8 to 9.8 {6.5 to 7.2, 0.9 to 1.0}	—
8	Nut (Steering wheel assembly mounting)	39 to 49 {29 to 36, 4 to 5}	—
14	Screw (Combination switch mounting)	2.5±0.5 {1.8±0.4, 0.25±0.05}	—
17	Head cutting bolt (Starter switch mounting)	14.2±1.5 {10±1.1, 1.45±0.15}	—
21	Nut (Steering column subassembly and power steering booster mounting)	53 to 65 {39 to 48, 5.4 to 6.6}	—
25	Bolt (Steering column at floor side mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
26	Bolt (Steering column subassembly to instrument panel side mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
28	Pressure tube	29 to 39 {22 to 29, 3 to 4}	—
29	Return tube	39 to 49 {29 to 36, 4 to 5}	—
31	Nut (Power steering booster mounting)	84 to 108 {61 to 80, 8.5 to 11.0}	—
33	Nut (Tie rod assembly mounting)	93±25 {69±18, 9.5±2.5}	—

Lubricant

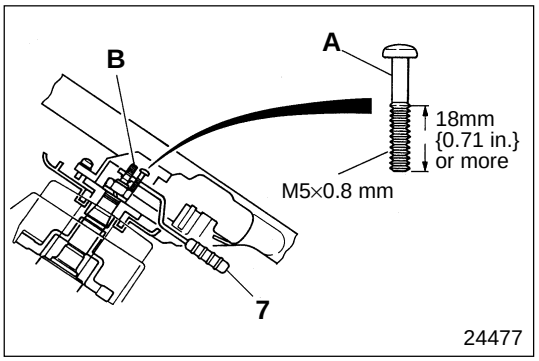
Location	Points of application	Specified lubricant	Quantity
12	Contact area between combination switch of cover assembly and horn contact	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



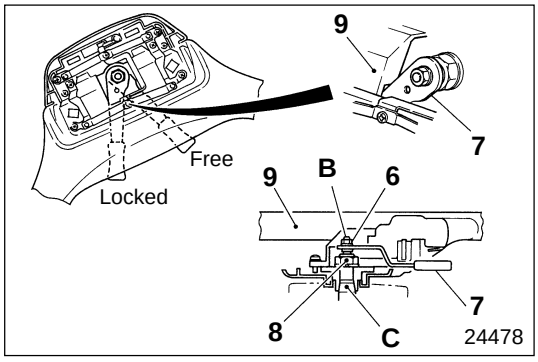
5 **Removal of horn pad**

- Insert a flat-tip screwdriver into the space between steering wheel assembly **9** and shoulder sections **A**, **B** of horn pad **5**, and disengage the latch by prying open the horn pad with the screwdriver until a clicking sound is produced.
- Insert fingers into the space behind lifted horn pad **5** and remove the horn pad.



7 **Telescopic lever**

[Removal]
Secure screw **A** (M5×0.8 mm) in tapped hole in telescopic lever **7** and remove telescopic lever from telescopic shaft **B**.



[Installation]
Make adjustment so that telescopic lever **7** positioned at the designated location applies the specified torque on telescopic shaft **B**.

CAUTION ⚠

Be careful not to damage the threads on the tip of telescopic shaft B.

C : Telescopic shaft assembly

Start procedure

Install steering wheel assembly **9**. Using a long socket wrench, tighten nut **8** at specified torque 39 to 49 N·m {29 to 36 ft.lbs, 4 to 5 kgf·m}

Rotate telescopic shaft **B** counterclockwise with your fingers and check for looseness

Looseness found

No looseness

Using a flat-blade screwdriver turn telescopic shaft **B** clockwise and drive it in until it hits lightly with a "clunk", but do not turn it any further

CAUTION

Be careful not to over tighten or you will crush the end of the telescopic shaft, requiring replacement of telescopic shaft assembly C

Install telescopic lever **7** at a location that allows easy tightening, then tighten nut **6** until the telescopic lever will not slip

Tighten telescopic shaft **B** at operating torque 6.9 to 7.8 N·m {5.1 to 5.8 ft.lbs, 0.7 to 0.8 kgf·m}. (Tighten telescopic bar **7** at torque 69 to 78 N {16 to 18 lbf, 7 to 8 kgf} at 100 mm {3.94 in.} from the center of steering wheel assembly **9**)

To maintain lock, hold telescopic lever **7** clockwise, then loosen and remove lock nut **6**

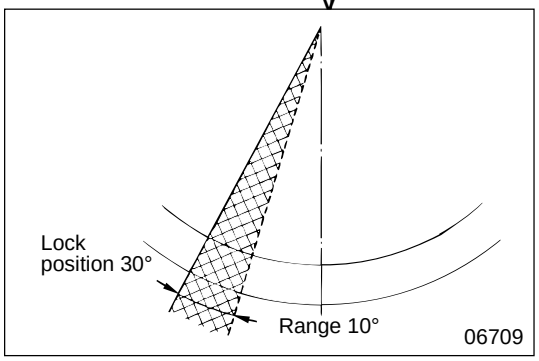
Remove telescopic lever **7**

NOTE

Remove telescopic lever 7 following the description under [Removal], taking care not to loosen telescopic shaft B.

Set telescopic lever **7** to specified lock position (within 10° before the position at which telescopic lever contacts steering wheel assembly **9**).

Tighten nut **6** at specified torque 8.8 to 9.8 N·m {6.5 to 7.2 ft.lbs, 0.9 to 1.0 kgf·m}



When telescopic lever **7** is released, and telescopic shaft **B** is retightened at operating torque 6.9 to 7.8 N·m {5.1 to 5.8 ft.lbs, 0.7 to 0.8 kgf·m}, the telescopic lever should lock in the 10° range this side of specified lock position 30°

Out of the range

Within the range

Jiggle steering wheel assembly **9** up and down and check for looseness

Looseness found

No looseness

Remove nut **6**

Procedure is completed

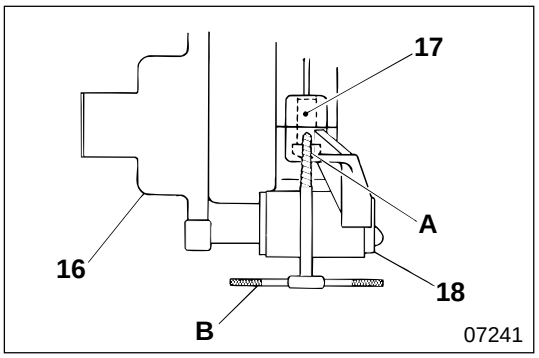
Remove telescopic lever **7**

CAUTION

Be sure not to operate telescopic shaft B while steering wheel assembly 9 is removed.

NOTE

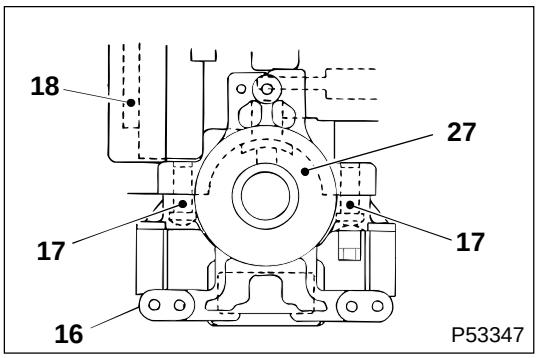
Be sure to assemble telescopic lever 7 only after steering wheel assembly 9 has been installed.



17 **18** **Head cutting bolt, starter switch**

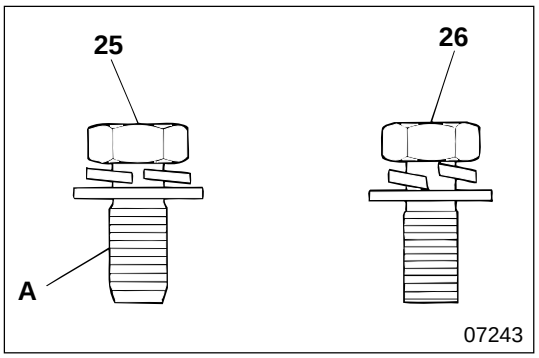
[Removal]

- After removing bracket **16**, drill a ø5.5 to 6.0 mm {0.22 to 0.24 in.} hole 10 to 15 mm {0.39 to 0.59 in.} deep on cutting face **A** of head cutting bolt **17** for mounting starter switch **18**.
- Screw in screw extractor **B** counterclockwise, then pull out head cutting bolt **17**.



[Installation]

- When install starter switch **18** on steering column assembly **27**, tighten new head cutting bolt **17** at specified torque to cut the head off the bolt.
- After installing bracket **16**, verify operation of the steering lock function of starter switch **18**.

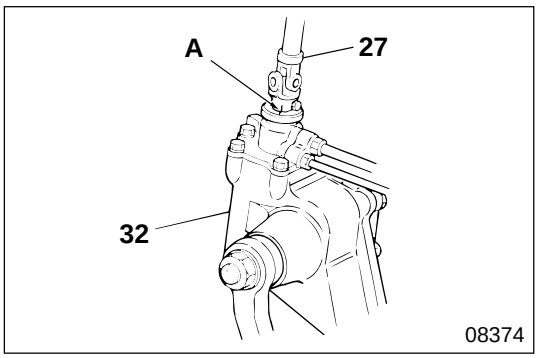


25 **26** **Installation of bolt**

Bolts **25** and **26**, differ in shape. Do not mix them up when installing.

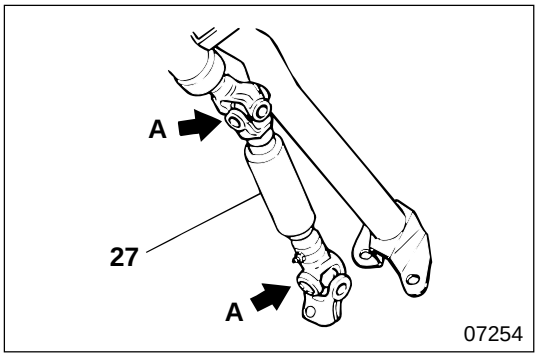
NOTE

Thread area A of bolt 25 is elliptical to facilitate grounding of the horn circuit.



27 **32** **Removal and installation of steering column subassembly and power steering booster**

Before removing steering column subassembly **27**, power streering booster **32**, be sure to make alignment mark **A**.

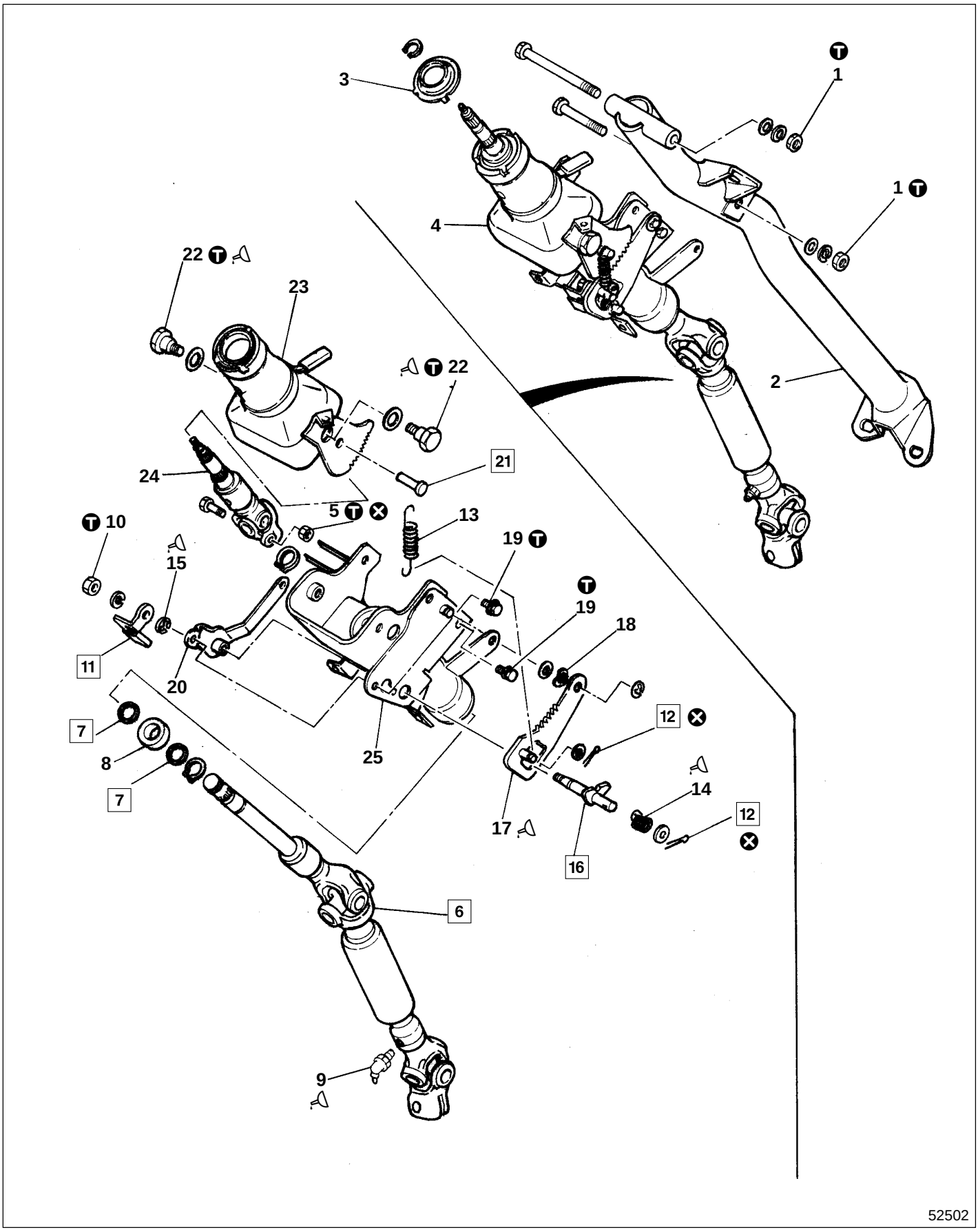


27 **Steering column subassembly**

When the spline of steering column subassembly **27** is disconnected, align the yokes to the same direction **A**.

M E M O

STEERING COLUMN SUBASSEMBLY



● **Disassembly sequence**

1 Nut
2 Support bracket
3 Spring seat
4 Steering column assembly
5 Nut
6 Steering shaft assembly
7 Stopper
8 Bearing spacer
9 Grease nipple
10 Nut
11 Lock lever
12 Split pin
13 Return spring
14 Return spring
15 Snap ring
16 Cam
17 Lock plate
18 Wave washer
19 Bolt
20 Lever support
21 Clevis pin
22 Bolt
23 Column support upper
24 Telescopic shaft assembly
25 Column support lower

⊗ : Non-reusable parts

● **Assembly sequence**

4 → 3 → 2 → 1

4 : **24 → 23** / **25** → **22 → 21 → 20 → 19 → 18 → 17 → 16 → 15 → 14 → 13 → 12 → 11 → 10** → **6 → 9 → 8 → 7** → **5**

Tightening torque

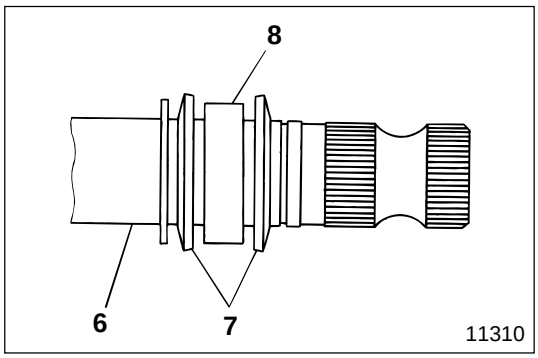
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Support bracket mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
5	Nut (Steering shaft assembly and telescopic shaft assembly mounting)	53 to 65 {39 to 48, 5.4 to 6.6}	—
10	Nut (Lock lever mounting)	4 to 6 {2.9 to 4.4, 0.4 to 0.6}	—
19	Bolt (Lever support mounting)	7 to 10 {5.1 to 7.4, 0.7 to 1.0}	—
22	Bolt (Column support upper and column support lower mounting)	15 to 20 {11 to 15, 1.5 to 2.0}	—

Lubricant and/or sealant

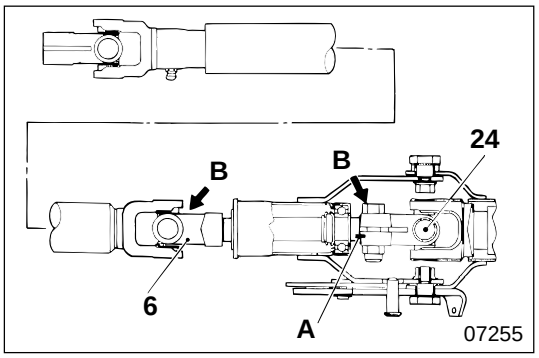
Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
14	Friction surface of return spring and washer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Friction surfaces of lever support and snap ring	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Friction surfaces of cam and lock plate return spring clevis pin	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Thread area of bolt	THREEBOND thread lock super 103Q or LOCTITE 271	As required
	Friction surface of column support upper and bolt	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



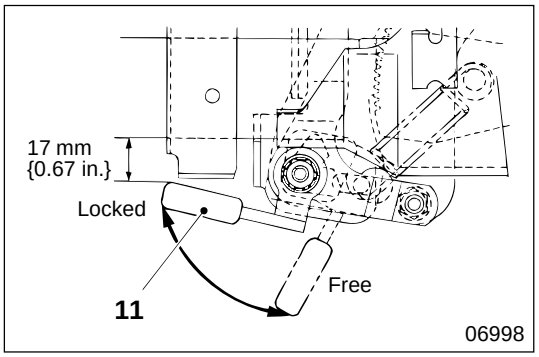
7 **Installation of stopper**

Install stoppers **7** on steering shaft assembly **6** in the direction as illustrated so that they straddle bearing spacer **8**.



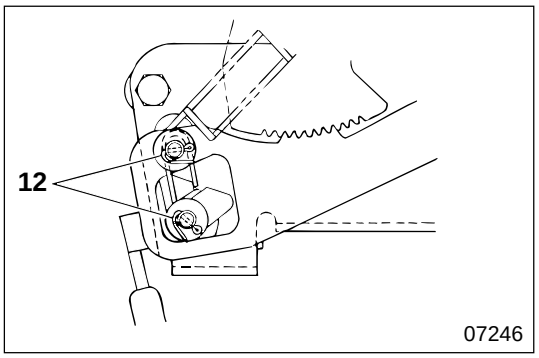
6 **Steering shaft assembly**

- Before removing steering shaft assembly **6**, be sure to make alignment mark **A**.
- Install the steering shaft with direction **B** of the telescopic shaft assembly **24** yoke and steering shaft assembly **6** yoke aligned or at phase angle of 90°.



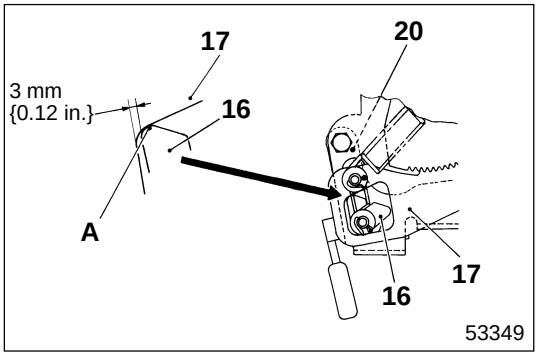
11 **Installation of lock lever**

- Install lock lever **11** so that it is stopped at the dimension position as illustrated when locked.
- After installing lock lever **11**, make sure that the lever operates smoothly (operating force less than 49 N {11 lbf, 5 kgf}). With the lever free, make sure that high tilt operates smoothly.



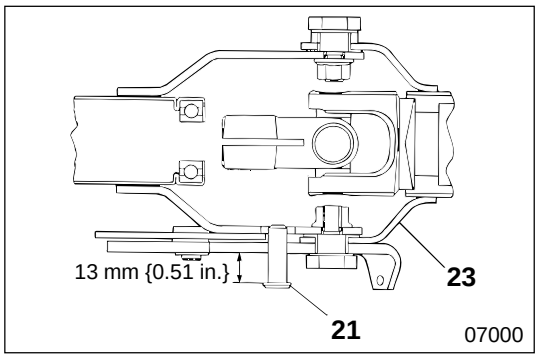
12 **Installation of split pin**

Bend split pin **12** to face outwards as illustrated.



16 **Installation of cam**

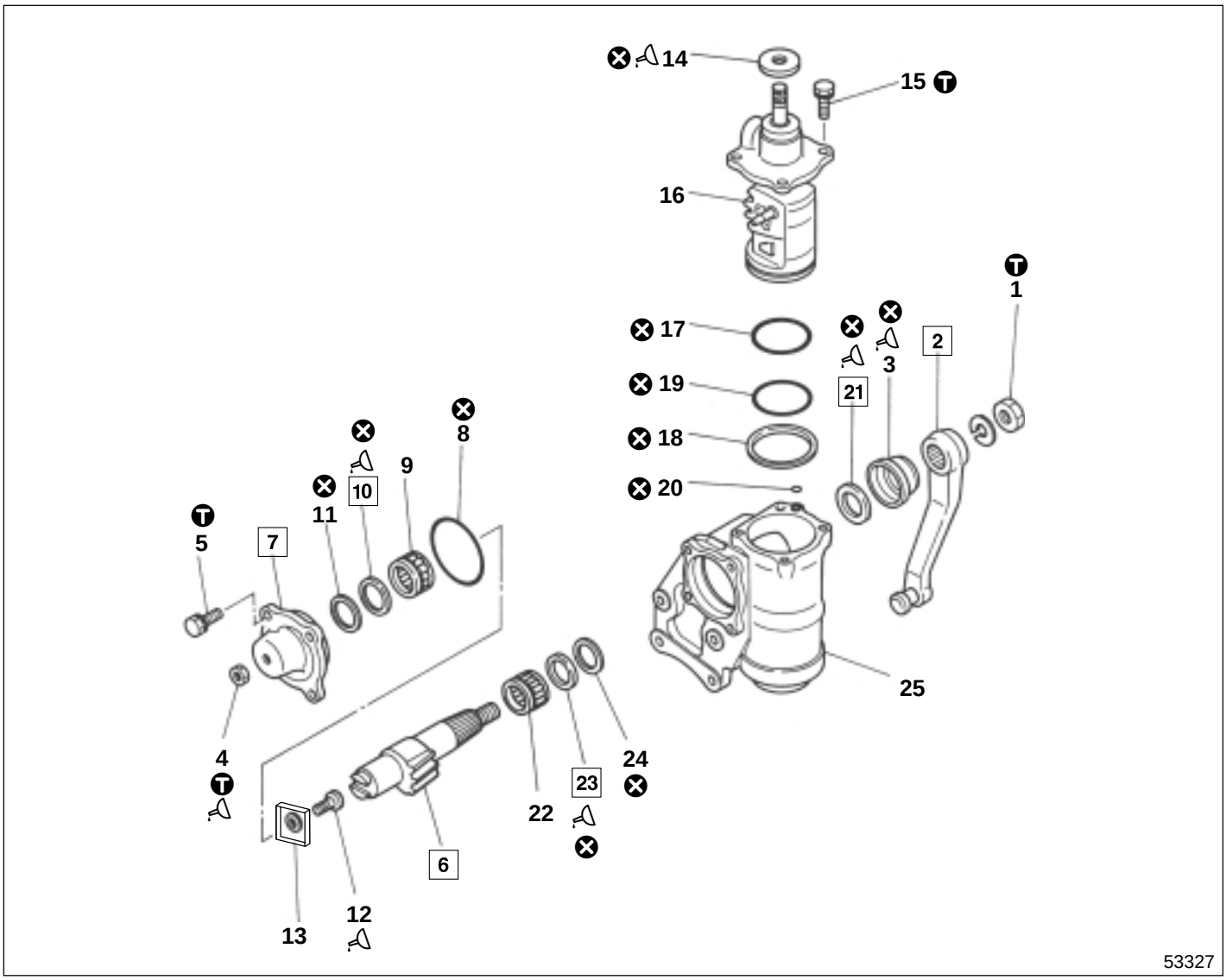
Adjust lever support **20** so that the top surface **A** of cam **16** is within the dimension of lock plate **17** to install the cam as illustrated.



21 **Installation of clevis pin**

Drive clevis pin **21** into column support upper **23** so that the drive dimension is obtained.

POWER STEERING BOOSTER



● **Inspection before disassembly**

P37-26

● **Disassembly sequence**

1 Lock nut
2 Pitman arm
3 Dust cover
4 Nut
5 Bolt
6 Sector shaft
7 Side cover
8 O-ring
9 Needle bearing
10 Y-packing
11 Backup ring
12 Adjusting bolt
13 Adjusting plate
14 Dust cover
15 Bolt
16 Ball screw set shaft
17 O-ring
18 Seal ring
19 O-ring
20 O-ring
21 Oil seal
22 Needle bearing
23 Y-packing
24 Backup ring
25 Gear box

⊗ : Non-reusable parts

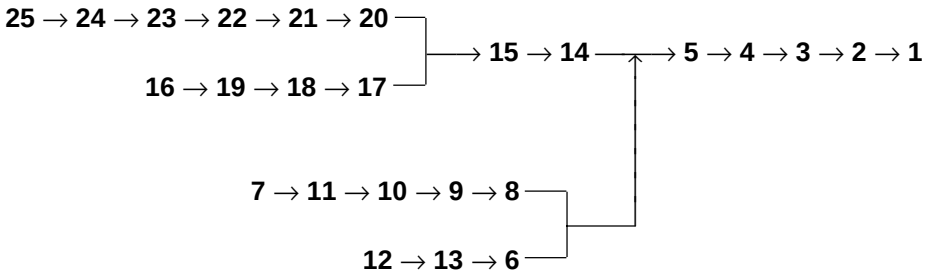
NOTE

- **Do not disassemble needle bearing 9, 22 and ball screw set shaft 16 unless they are faulty.**
- **Replace Y-packings 10, 23 together with backup rings 11 and 24.**

● **Inspection after assembly**

P37-26

● **Assembly sequence**



Repair kit : Seal kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6	Axis diameter of sector shaft (at gear box)	[42] –0.008 to +0.005 {[1.65] –0.00031 to +0.00020}	0.003 {0.00012}	Gap between worn area and unworn area
6, 12	Axial play of center shaft and adjusting bolt	0.1 {0.0039} or less	0.1 {0.0039}	Replace Sector shaft assy
16	Rotating torque of ball screw set shaft	15 to 69 N·cm {0.11 to 0.52 lbf.ft, 1.5 to 7.0 kgf·cm}	—	—
16, 25	Clearance between ball screw set shaft and gear box	0.022 to 0.069 {0.00087 to 0.0027}	—	Replace
25	Inner diameter of gear box	[78] 0.012 to 0.034 {[3.1] 0.00047 to 0.0013}	0.05 {0.0020}	Gap between worn area and unworn area
—	Total starting torque with power steering booster	98 N·cm {0.72 lbf.ft, 10 kgf·cm} or less	—	Adjust
—	Engagement torque	20 to 49 N·cm {0.13 to 0.36 lbf.ft, 2 to 5 kgf·cm}	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

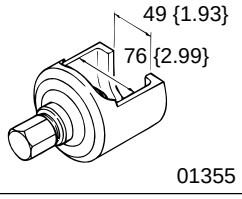
Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Pitman arm mounting)	245 to 294 {180 to 215, 25 to 30}	—
4	Nut tightening	29 to 39 {21 to 29, 3 to 4}	—
5, 15	Bolt (Side cover and valve housing mounting)	98 to 118 {72 to 87, 10 to 12}	—

Lubricant and/or sealant

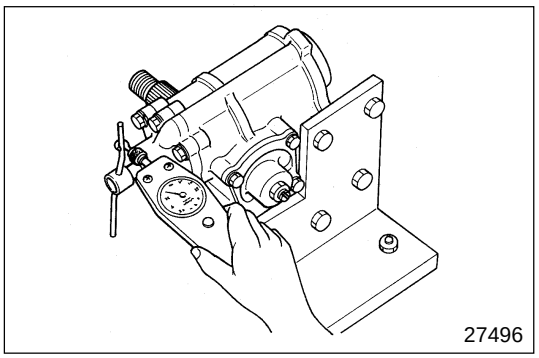
Location	Points of application	Specified lubricant and/or sealant	Quantity
3, 14	Pack interior of dust cover	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4	Nut fixing point	THREEBOND 1104	As required
10, 23	Inside periphery of Y-packing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
12	Head of the adjusting bolt	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
21	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

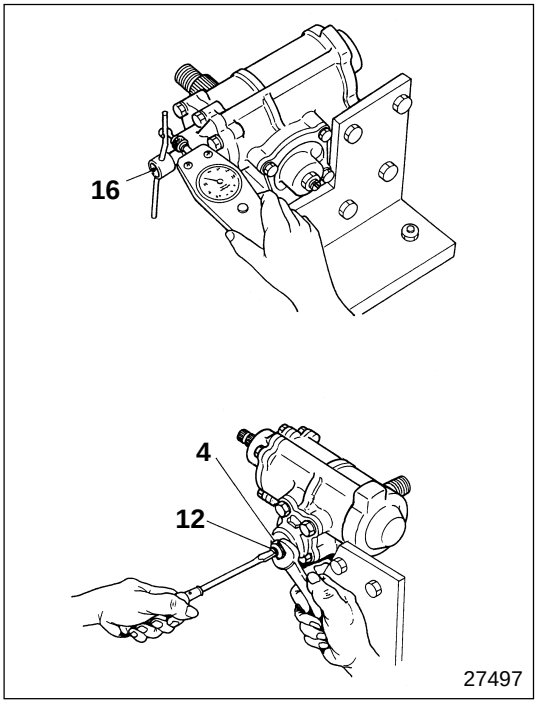
Location	Tool name and shape	Part No.	Application
2	Pitman arm puller 	MH062472	Removal of pitman arm

◆ Service procedure



● **Inspection before disassembly**

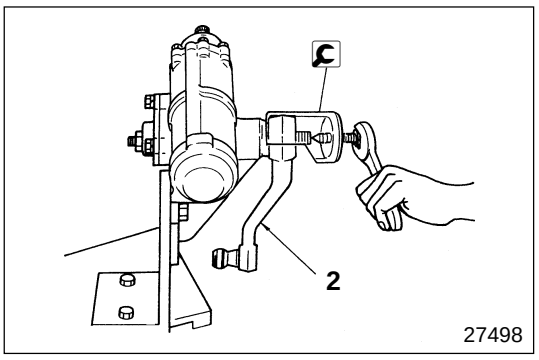
[Measurement of total starting torque]
Before disassembly, measure the total starting torque for a reference during assembly.



● **Inspection after assembly**

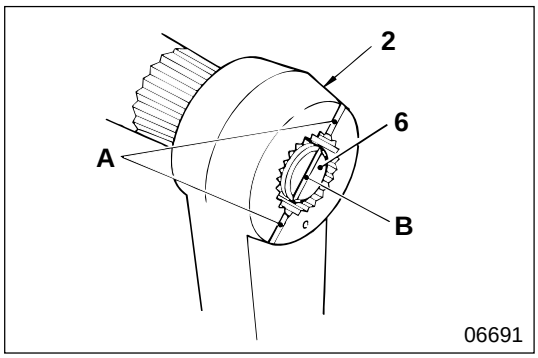
[Measurement of total starting torque]

- While turning ball screw set shaft **16**, one quarter of a turn left and right from the neutral position using a torque meter, drive adjusting bolt **12** in, then adjust so that the total starting torque or the engagement torque is within the standard value.
- After adjustment, tighten nut **4** at specified torque.

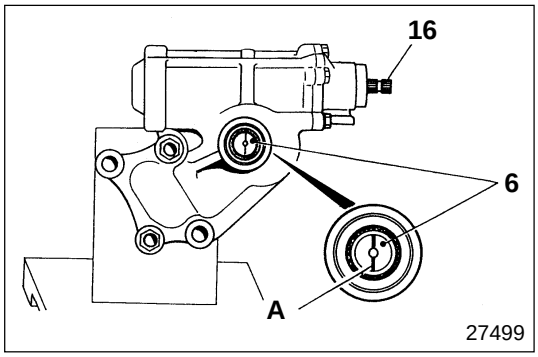


2 **Pitman arm**

[Removal]
: Pitman arm puller



[Installation]
Align slit **B** of the V-groove of sector shaft **6** on the same line as slit **A** of the V-groove of pitman arm **2** when installing it.



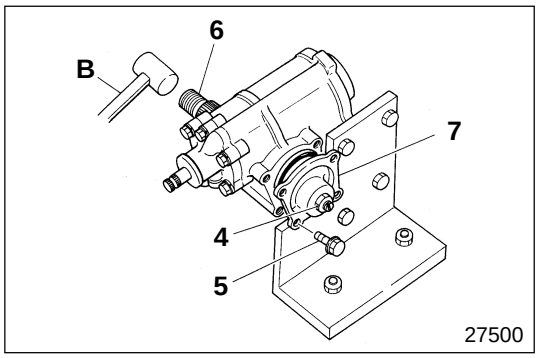
6 **7** **Sector shaft and side cover**

[Removal]

- Turn ball screw set shaft **16** counterclockwise to the lock position, then turn it clockwise approximately 2.6 turns, so that slit **A** of the V-groove at the end of sector shaft **6** is in the neutral position as illustrated.

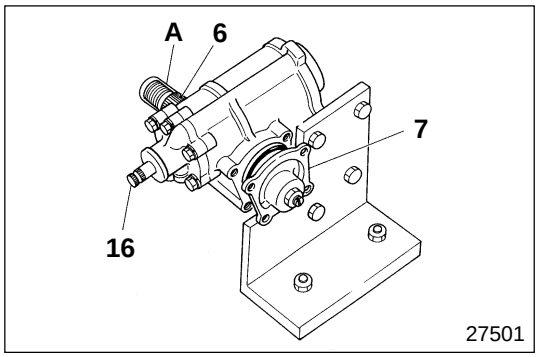
NOTE

At this time, make sure that slit A of the V-groove at the end of sector shaft 6 is at right angles to the axial line of ball screw set shaft 16.



- Loosen nut **4** and remove bolt **5**. After making sure that sector shaft **6** is in the neutral position, tap the end of the sector shaft, and pull out side cover **7** together with the sector shaft.

B : Plastic-headed mallet



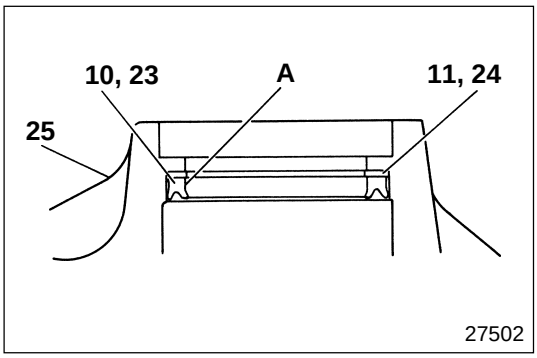
[Installation]
With ball screw set shaft **16** in the neutral position, insert sector shaft **6** and side cover **7**.

CAUTION

Insert sector shaft 6 with the thread area of the shaft end and serration area protected by cover A to prevent damage to the oil seal.

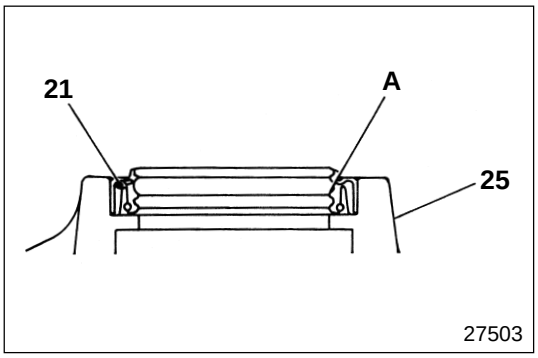
NOTE

- **Turn ball screw set shaft 16, and make sure that the shaft rotates approximately five turns lock-to-lock.**
- **If the number of turns is less, inspect engagement of ball screw set shaft 16 and sector shaft 6.**



10 **23** **Installation of Y-packing**

Apply grease to lip area **A** of Y-packing **10, 23** and install into gear box **25** as illustrated.



21 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **21** and install into gear box **25** as illustrated.

M E M O

POWER STEERING OIL PUMP

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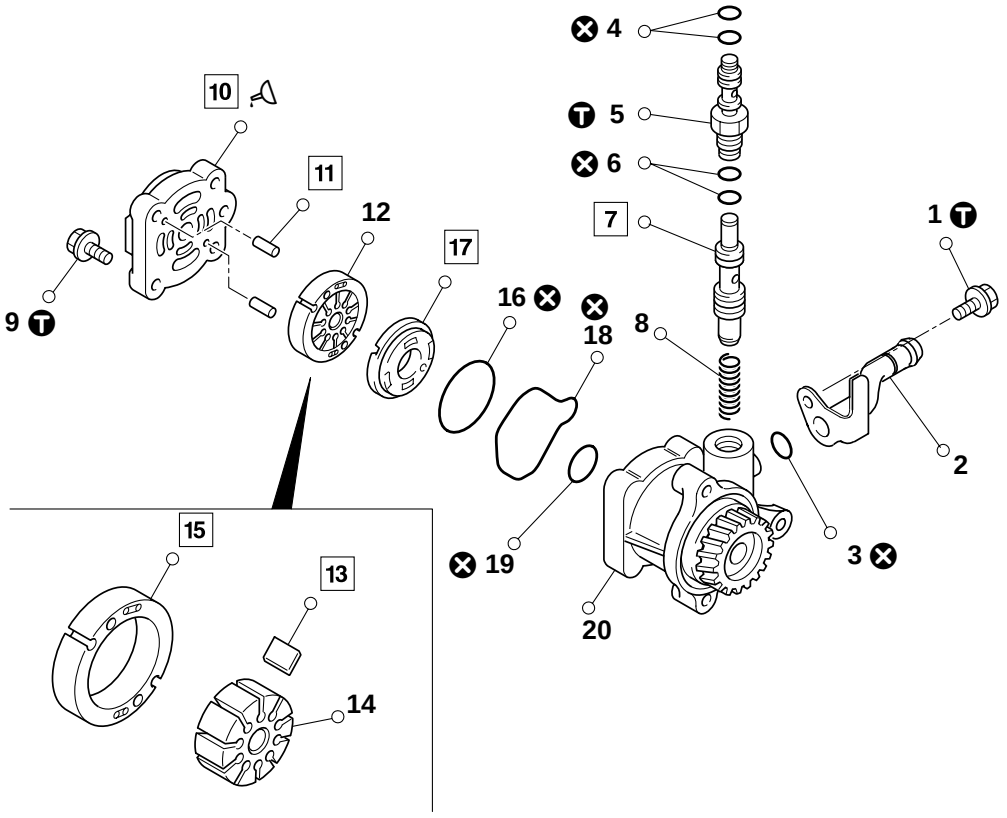

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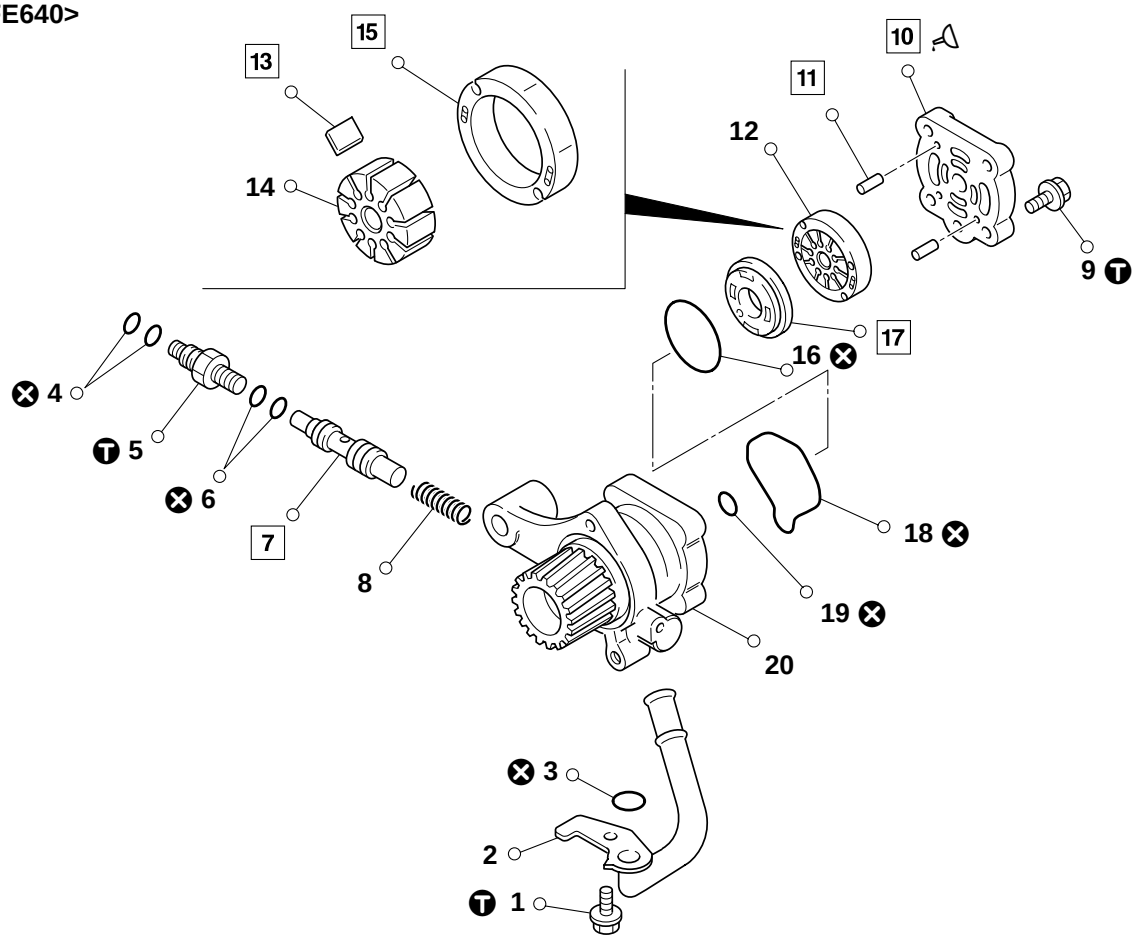


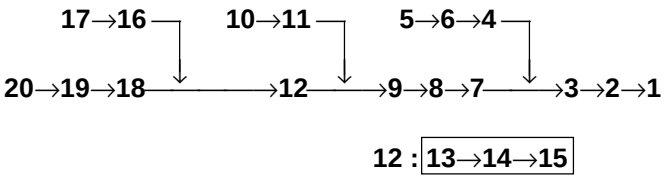
P52504

● **Disassembly sequence**

1 Bolt
2 Suction connector
3 O-ring
4 O-ring
5 Connector
6 O-ring
7 Relief valve assembly
8 Flow control spring
9 Bolt
10 Cover
11 Pin
12 Cartridge assembly
13 Vane
14 Rotor
15 Cam ring
16 O-ring
17 Side plate
18 O-ring
19 O-ring
20 Body and shaft assembly

⊗ : Non-reusable parts

● **Assembly sequence**



Repair kit : Seal kit, Cartridge assembly kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
7, 20	Clearance between relief valve assembly and body and shaft assembly	[14] 0.01 to 0.02 {[0.55] 0.00039 to 0.00079}	0.03 {0.0012}	—
8	Flow control spring free length	36.5 {1.44}	33.5 {1.32}	—
10	Wear of cover	—	0.05 {0.0020}	—
13, 14	Clearance between vane and rotor	0.01 {0.00039}	0.06 {0.0024}	—
17	Wear of side plate	—	0.05 {0.0020}	—

Ⓣ Tightening torque

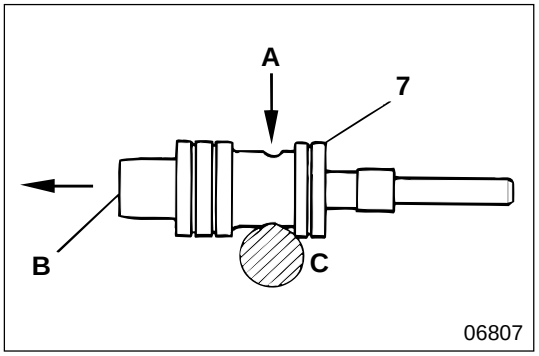
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Suction connector mounting)	7.8 to 11.8 {5.8 to 8.7, 0.8 to 1.2}	—
5	Connector	49 to 69 {36 to 51, 5 to 7}	—
9	Bolt (Cover mounting)	22 to 26 {16 to 19, 2.2 to 2.7}	—

Lubricant and/or sealant

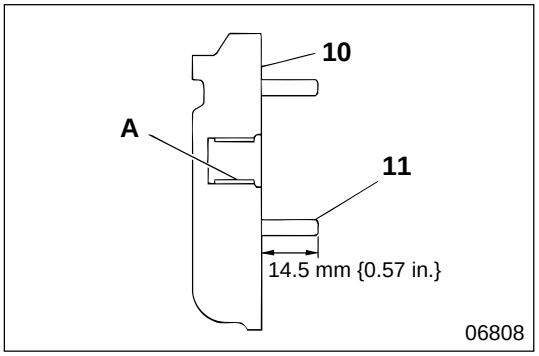
Location	Points of application	Specified lubricant and/or sealant	Quantity
10	Bushing of cover	Automatic transmission fluid (DEXRON or DEXRON II type)	As required

◆ Service procedure



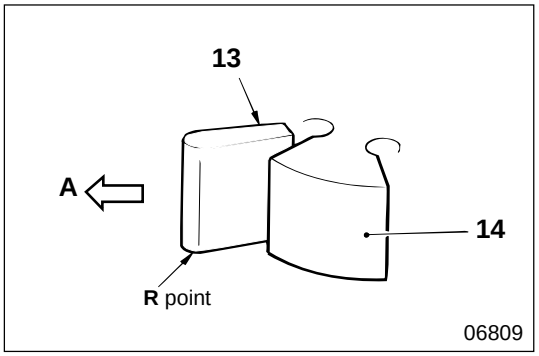
7 **Inspection of relief valve assembly**

Block one side of the hole of relief valve assembly **7**, with your finger **C**, then when air pressure **A** of 390 to 490 kPa {57 to 71 psi, 4 to 5 kgf/cm^2} is applied from the other side, check whether air is released from small hole **B** at the rear. If air is not released, it is normal.



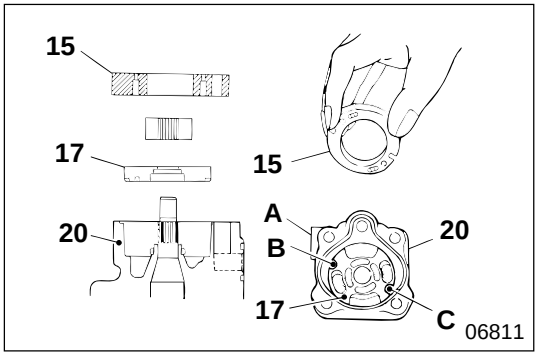
10 **11** **Installation of pin and cover**

- Press-fit pin **11** into cover **10**, to the press-fitting height.
- Apply hydraulic oil to bushing area **A** of the cover.



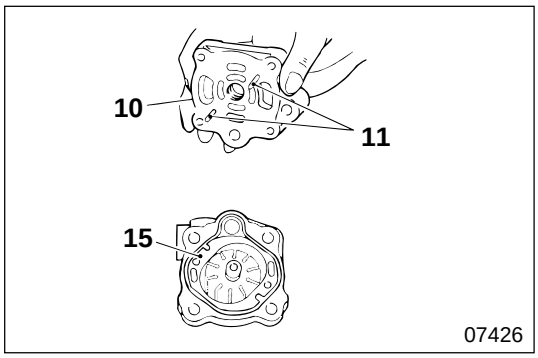
13 **Installation of vane**

With **R** point of vane **13** facing outside **A**, install it on rotor **14** and make sure that the vane moves smoothly. If it is faulty, replace cartridge **12**.



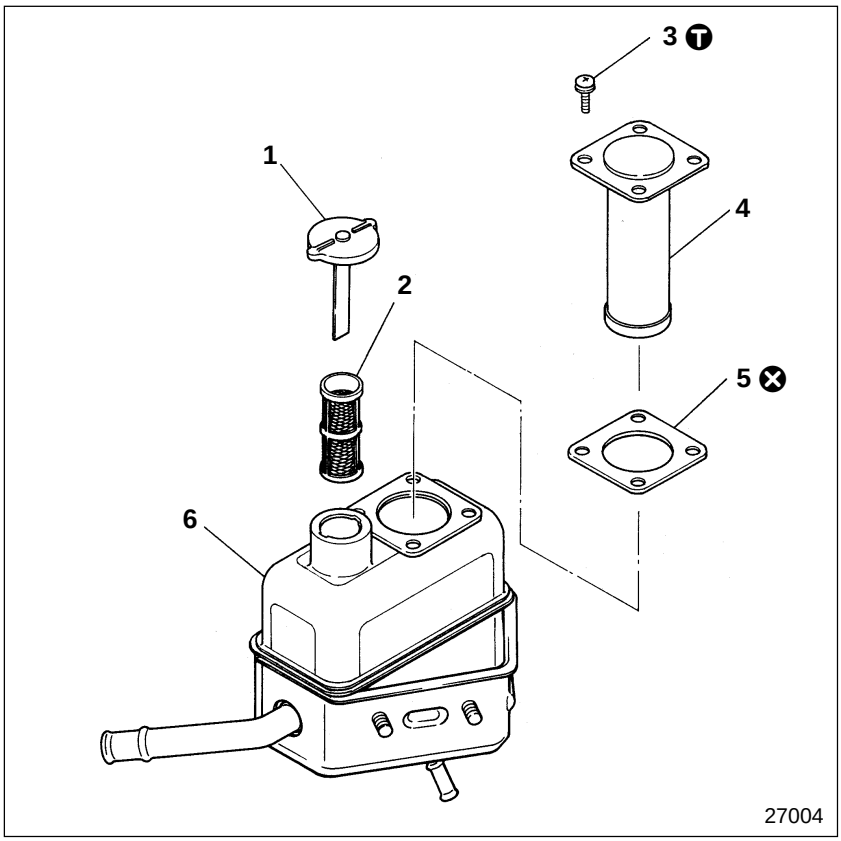
15 **17** **Installation of cam ring and side plate**

- Since the mounting direction of side plate **17** is determined, mount the side plate, so that relief valve side **A** is aligned with round hole **B** (standard pin side) and slotted hole **C** is located on a diagonal.



- Align cam ring **15** with pin **11** of cover **10**, then install the cam ring.

POWER STEERING OIL TANK



● **Disassembly sequence**

1 Filler cap
2 Strainer
3 Screw
4 Filter
5 Packing
6 Tank

⊗ : Non-reusable parts

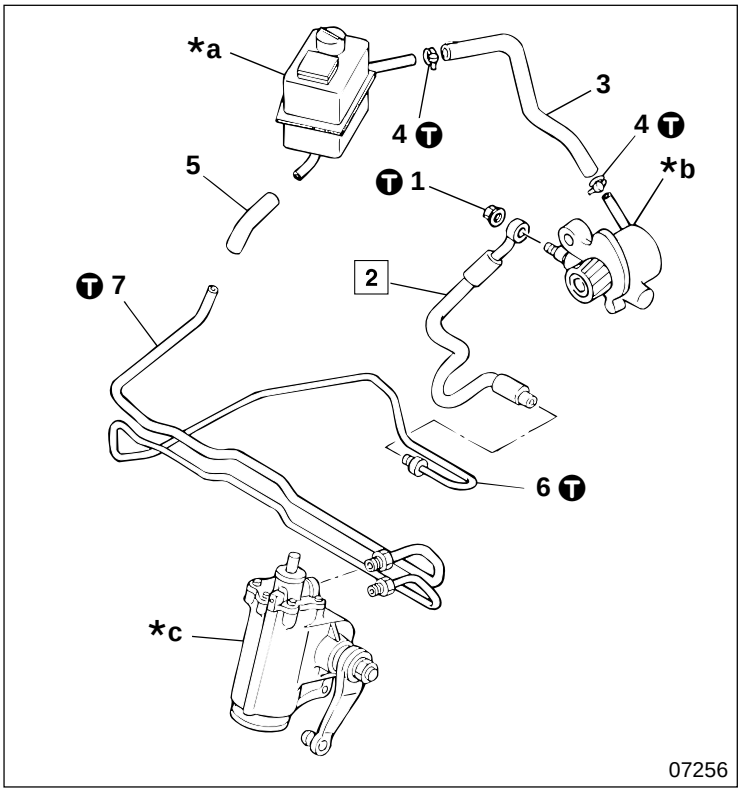
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Screw (Filter mounting)	1.27±0.29 {0.94±0.21, 0.13±0.03}	—



● **Removal sequence**

1 Nut
2 Pressure hose
3 Rubber hose
4 Clamp
5 Rubber hose
6 Pressure tube
7 Return tube

***a** : Power steering oil tank
***b** : Power steering oil pump
***c** : Power steering booster

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

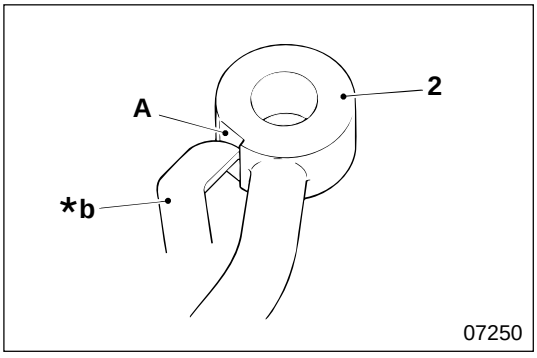
Be sure to bleed air if the fluid line was removed, failure to do so would cause the power steering to malfunction. P37-12

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Pressure hose mounting)	29 to 39 {21 to 29, 3 to 4}	—
6	Pressure tube (Pressure hose and power steering booster connection)	29 to 39 {21 to 29, 3 to 4}	—
7	Return tube (Power steering booster connection)	39 to 49 {29 to 36, 4 to 5}	—
4	Clamp (Rubber hose mounting)	2.9 to 3.4 {2.1 to 2.5, 0.30 to 0.35}	

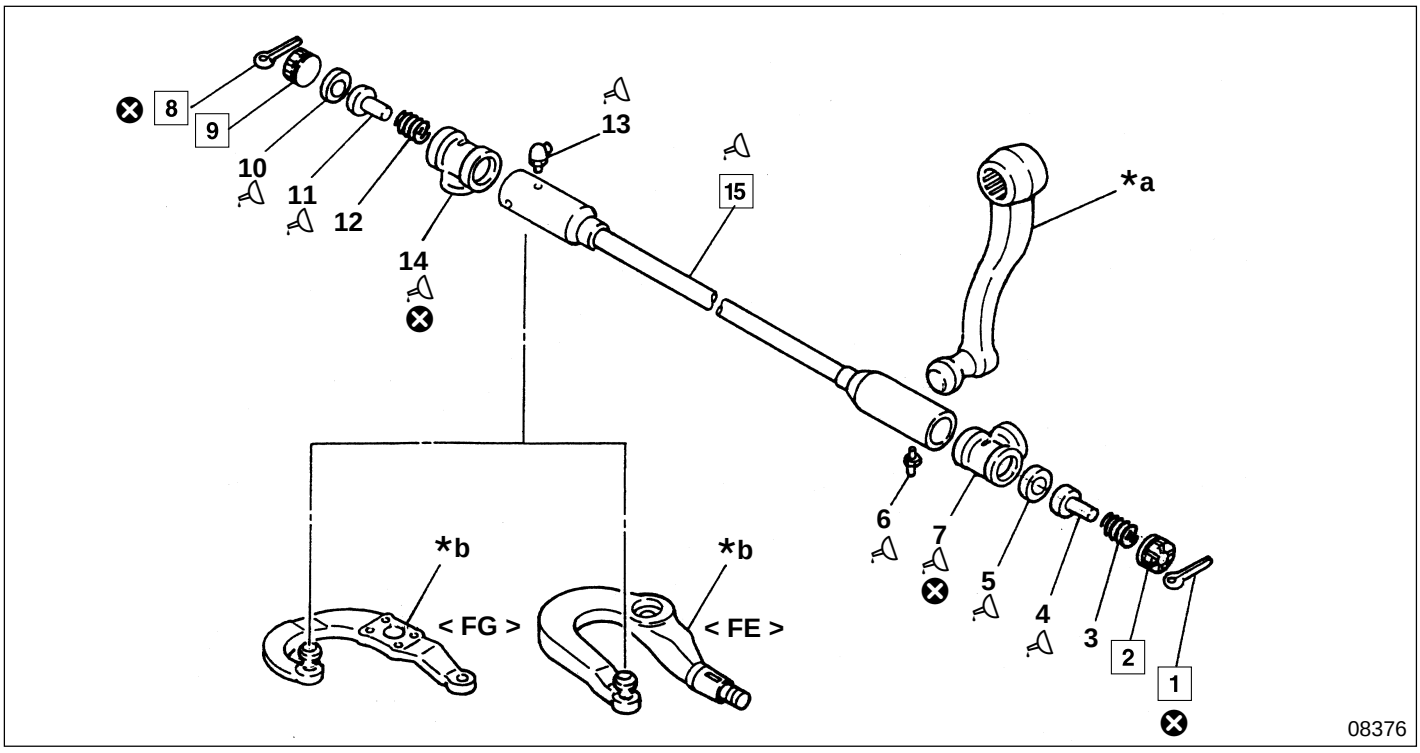
◆ Service procedure



2 **Installation of pressure hose**

Install pressure hose **2** so indent **A** of pressure hose **2** contacts the suction connector of power steering oil pump ***b**.

DRAG LINK



● **Disassembly sequence**

1 Split pin
2 End plug
3 Spring
4 Ball stud seat
5 Ball stud seat
6 Grease nipple
7 Dust cover
8 Split pin
9 End plug
10 Ball stud seat
11 Ball stud seat
12 Spring
13 Grease nipple
14 Dust cover
15 Drag link

***a** : Pitman arm
📖 P37-24
***b** : Knuckle arm
< FE > Gr 26A
< FG > Gr 26B
⊗ : Non-reusable parts

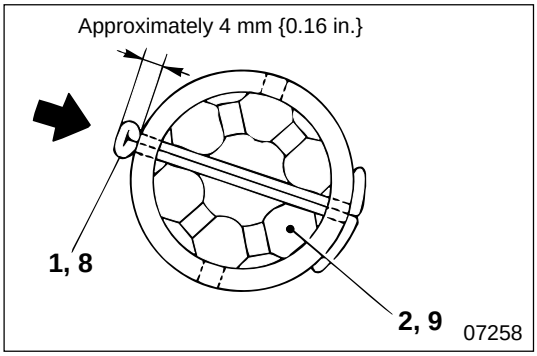
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

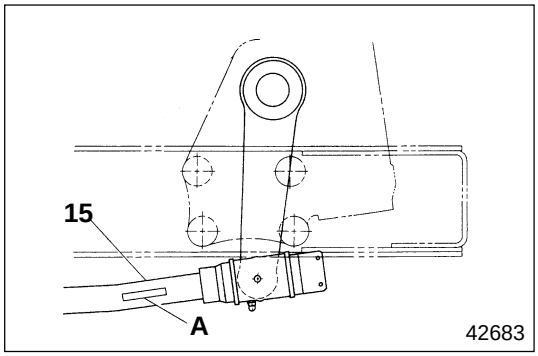
Location	Points of application	Specified lubricant	Quantity
4, 5, 10, 11	Whole area of ball stud seat	Chassis grease [NLGI No.1 (Ca soap)]	As required
6, 13	Supply via grease nipple	Chassis grease [NLGI No.1 (Ca soap)]	As required
7, 14	Arm mounting port of dust cover	Chassis grease [NLGI No.1 (Ca soap)]	As required
15	Pack interior of drag link	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



1 **2** **8** **9** **Installation of split pin and end plug**

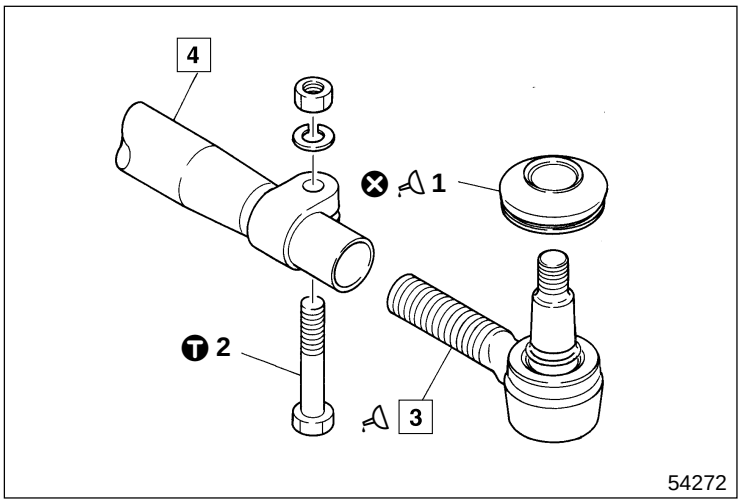
- Tighten end plug **2, 9** fully, then slacken it off by one half of a turn.
- Place split pins **1**, **8** so that the heads face the outside of the vehicle.
- Stake the heads of split pins **1**, **8** until they are approximately 4 mm {0.16 in.} thick.



15 **Installation of drag link**

Install drag link **15** with label **A** attached, facing the front of the vehicle.

TIE ROD ASSEMBLY



● **Disassembly sequence**

1 Dust cover
2 Clamp bolt
3 Tie rod end
4 Tie rod

NOTE

Do not remove dust cover 2 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
4	Bend of tie rod	1 {0.039} or less	1 {0.039}	Replace

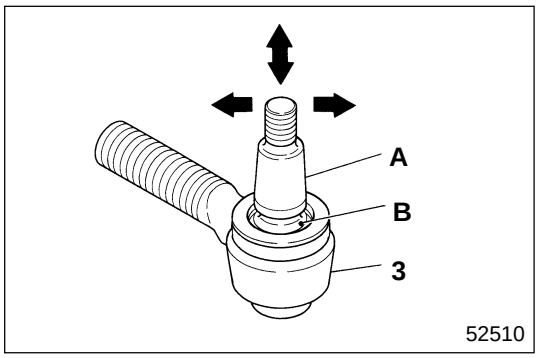
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Clamp bolt (Tie rod end clamp tightening)	20 to 29 {15 to 21, 2 to 3}	—

Lubricant

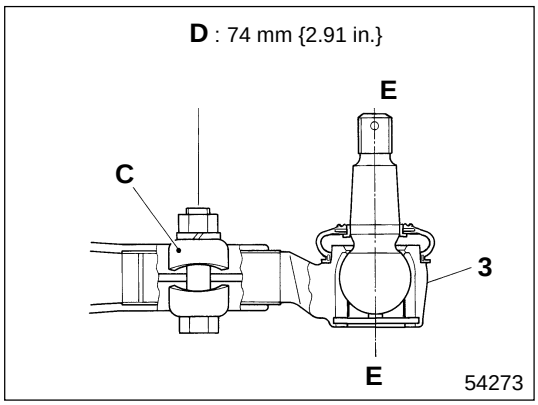
Location	Points of application	Specified lubricant	Quantity
1	Lip area of dust cover	Wheel bearing grease [NLGI No.2 Li soap]	As required
3	Pack interior of dust cover of tie rod end	Wheel bearing grease [NLGI No.2 Li soap]	As required



◆ Service procedure

3 Tie rod end

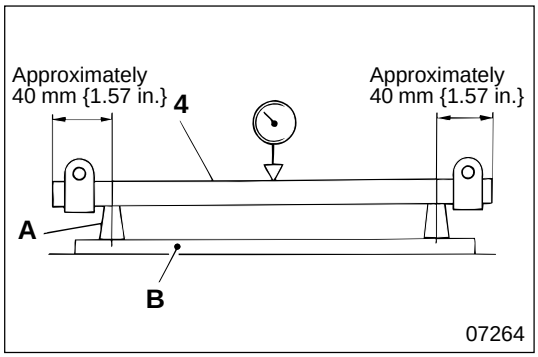
[Inspection]
Move ball stud area **A** vertically and horizontally to inspect for looseness. Ensure that ball **B** rotates evenly.



[Installation]
- Screw in tie rod end **3** so that dimension **D** of the tie rod end and clamp **C** differs by 1.5 mm {0.059 in.} or less between left and right.
- Secure axis **E – E** so that it is parallel both left and right.

NOTE

Deviation of the left and right screw-in amount of tie rod end 3 should be within one turn.



4 Bending of tie rod

Measure the bend of tie rod **4** at the center point. If the measured value exceeds the limit, correct or replace the tie rod.

NOTE

To measure the deflection of tie rod 4, turn it one full rotation and read the dial gauge indicator. The deflection is one half of the indicated value.

A : V-block
B : Surface plate

MITSUBISHI
FUSO

Group 41
Frame

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWSE0101-41

INDEX

SPECIFICATIONS 41-2

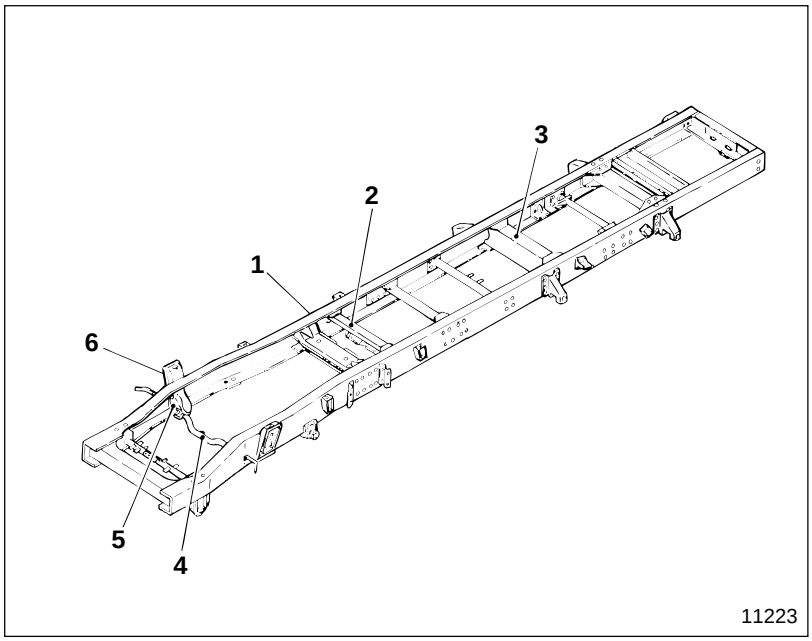
STRUCTURE AND OPERATION 41-2

INSPECTION AND REPAIR OF FRAMES 41-2

SPECIFICATIONS

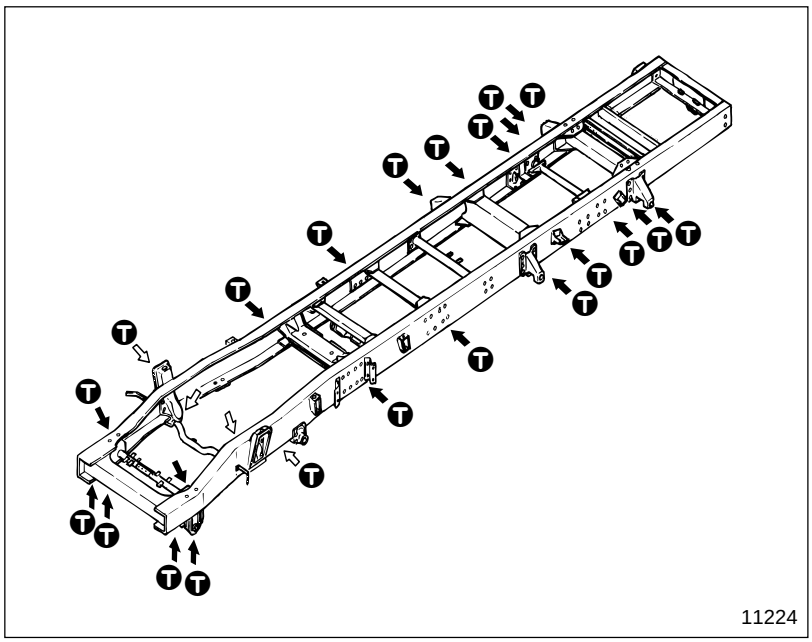
Item	Specifications
Frame type	Ladder type
Cross section configuration of side rail	⊐ shape channel section

STRUCTURE AND OPERATION



1 Side rail
2 Transmission mounting cross member < Automatic transmission >
3 Cross member
4 Front engine mounting support
5 Front engine mounting support bracket
6 Shock absorber bracket

INSPECTION AND REPAIR OF FRAMES



⬅ : Bolt (M10×1.25)
⇦ : Bolt (M12×1.25)

Tightening torque

Unit : N·m {ft.lbs, kg·m}

Location	Parts to be tightened	Tightening torque	Remarks
—	Bolt (⬅ area bolt : M10×1.25)	60 to 80 {43 to 58, 6 to 8}	—
—	Bolt (⇦ area bolt : M12×1.25)	98 to 120 {72 to 87, 10 to 12}	—

◆ Service procedure

● Cleaning of frame

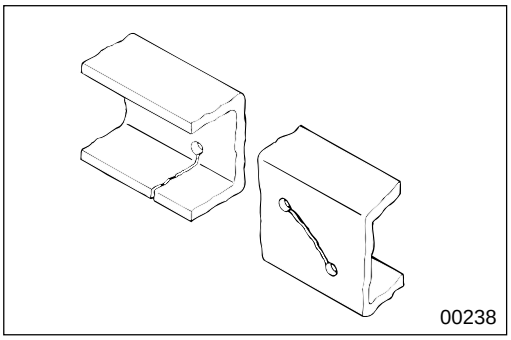
Carefully remove mud, grease, rust, etc. that is stuck to the outer and inner surfaces of the frame.

● Inspection for frame deformation

If any fault such as deformation is found, repair the frame.

● Inspection for cracks in frame

- Remove paint from any areas that are seemingly faulty and carefully inspect.
- If visual inspection is difficult, inspect using color contrast penetrant examination or other methods.
  If a crack is found, repair as follows.

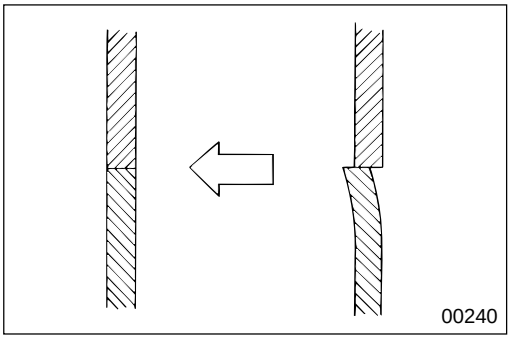


● Repair of crack in frame

- With the vehicle unloaded, level the frame.
- Drill a hole, about twice the thickness of the frame, 10 mm {0.39 in.} from the end of the crack.

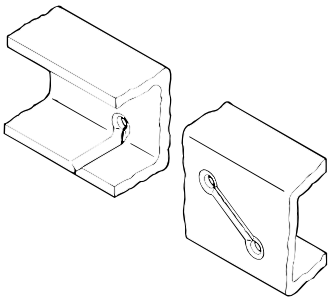
NOTE

If a crack is found inside the frame, drill holes at both ends of the crack.



- If the edges of the crack are not flush, make them flush with each other.

INSPECTION AND REPAIR OF FRAMES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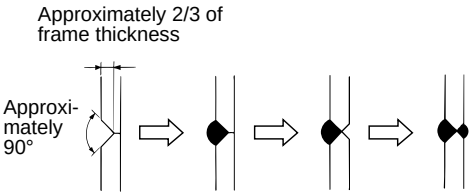


00242

- Using a grinder, etc., grind a 90° V-section channel, two-thirds of the frame thickness, then weld.

WARNING

You must cover any flammable materials, such as pipelines, wiring harnesses, rubber parts, and the fuel tank, that are near the welding site.

CAUTION

- **Do not use gas welding because the high temperature produced alters the material properties and weakens the welded area. Be sure, therefore, to use electric welding.**
- **Be sure to remove the negative terminal of the battery, then ground the welder near the area to be welded to prevent reversed flow of current from the welder which might burn out electrical components.**
- **Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.**

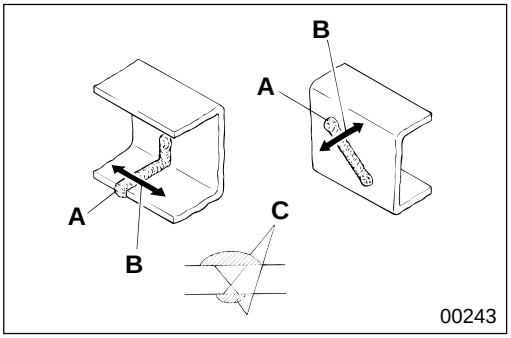
NOTE

- **Use low-hydrogen type coated CO_2 and arc welding electrodes for welding to prevent harmful defects such as undercutting, blow holes, etc.**
- **Preheat the area to be welded to approximately 50 to 350°C {122 to 662°F} before welding when the workshop temperature is below 0°C {32°F}.**

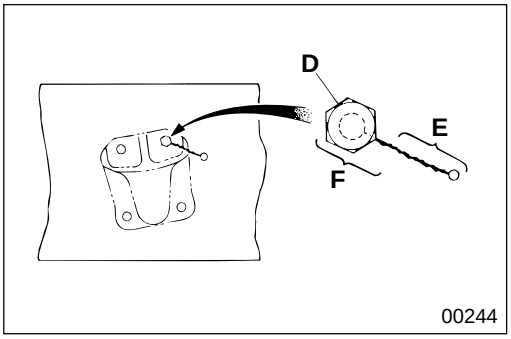
- Next, grind a V-section channel, as described above, on the opposite side of the weld and weld. At the same time, fill the holes at both ends of the crack by welding.

NOTE

In cold districts, heat the welded area to approximately 200°C {392°F} after welding.

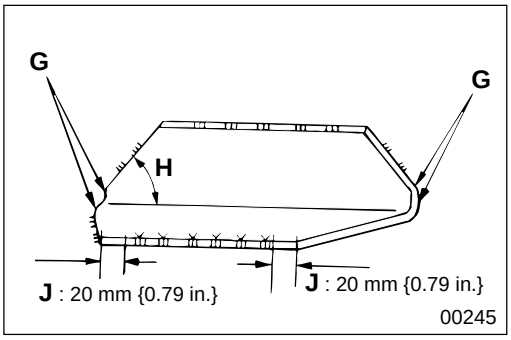


- After welding, grind bead **A** at right angles **B** to remove shaded area **C** as illustrated and grind the area flat.
- Finish the surface so that the frame thickness is identical to the original thickness.



[Repairing cracks caused by rivets or bolt holes]

- To make the edges of the holes flush at the cracked area, temporarily tighten bolt **D** in the hole.
- Weld cracked point **E** at least 20 mm {0.79 in.} from the center of the bolt.
  For welding method refer to the above-mentioned procedures for repairing cracks. P41-3.
- After removing the bolt and making the edges flush, weld remaining area **F** and fill the hole.
- After drilling a hole in the filled area, install a rivet or bolt.

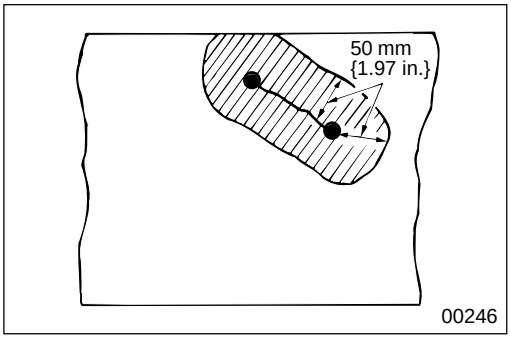


[Repairing using reinforcement plate]

- To prevent concentrated stress being produced at ends **G** of the reinforcement plate, weld the plate with angle **H** at both ends opened 30° or less.
  Do not weld area **J**.
- The reinforcement plate must have enough strength for the cracked area.

NOTE

- **Thickness of reinforcement plate : same as frame thickness**
- **Reinforcement plate material : SAPH440 (hot-rolled sheet steel for automobiles), SS400 (sheet steel for general construction), or equivalent strength.**

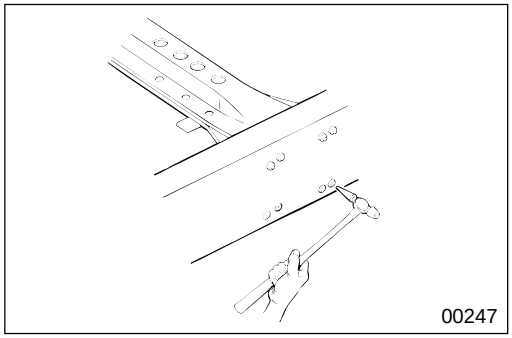


- After welding, heat the shaded area to 600 to 700°C {1112 to 1292°F}.

CAUTION

Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.

INSPECTION AND REPAIR OF FRAMES

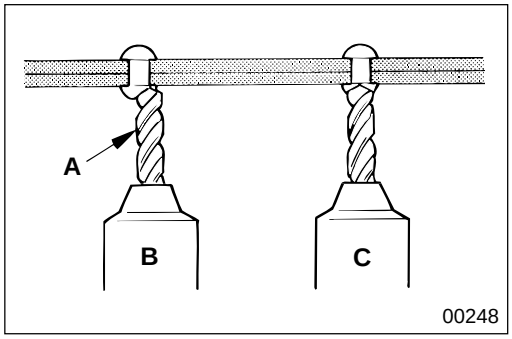


● **Inspection for loose rivets**

- Gently tap the rivet head using an inspection hammer and judge the condition by checking the vibration using the tip of your finger, or by listening to the sound.
- Rust between rivet and frame indicates that the rivet is loose.

CAUTION⚠

Be sure to replace loose rivets because they can break or cause cracking of the frame in the area around the rivet hole, causing accidents.

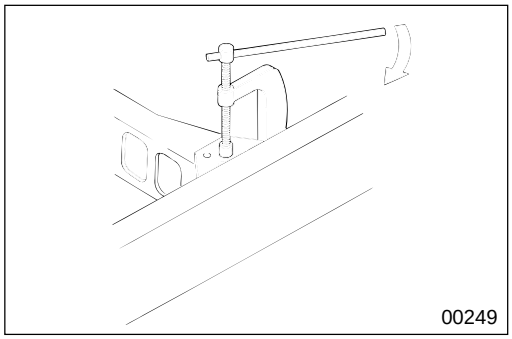


● **Repair of rivet**

- When removing rivets, use a center punch to make an indent in the center of the rivet head; then, drill out using drill **A** or grind.
  B : Incorrect
  C : Correct

CAUTION⚠

Make sure that you do not damage the rivet hole.



- When rivetting, first clamp both plates tightly near the rivet hole using a clamp to eliminate gaps between plates.

- Using a rivetting machine, insert the rivet (cold rivet).
- If rivetting is impossible, ream the rivet hole, drive in a reamer bolt, fully tightening the nut, then weld it in place.
  A flange bolt and flange nut should be used for the reamer bolt and nut.

● **Inspection for loose bolts and nuts**

- Inspect the mounting bolts in all areas for looseness. Loosened bolts should be tightened at specified torque. 🕮 P41-2

MITSUBISHI
FUSO

Group 42
Cab

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWSE0101-42

INDEX

SPECIFICATIONS 42- 2

STRUCTURE AND OPERATION 42- 3

TROUBLESHOOTING 42-12

INSPECTION AND ADJUSTMENT MOUNTED IN VEHICLE
- Adjustment of Cab Tilt 42-17
- Adjustment of Door Fitting 42-18

REMOVAL AND INSTALLATION OF CAB
< TILT CAB > 42-21
< FIXED CAB > 42-28

FRONT CAB MOUNTING 42-36

REAR CAB MOUNTING 42-40

CAB TILT LINK 42-42

FRONT DOOR 42-45

REAR DOOR < CREW CAB > 42-51

CAB EXTERIOR FITTING 42-54

MIRROR 42-58

WIPER AND WASHER 42-60

CAB INTERIOR FITTING 42-64

INSTRUMENT PANEL 42-66

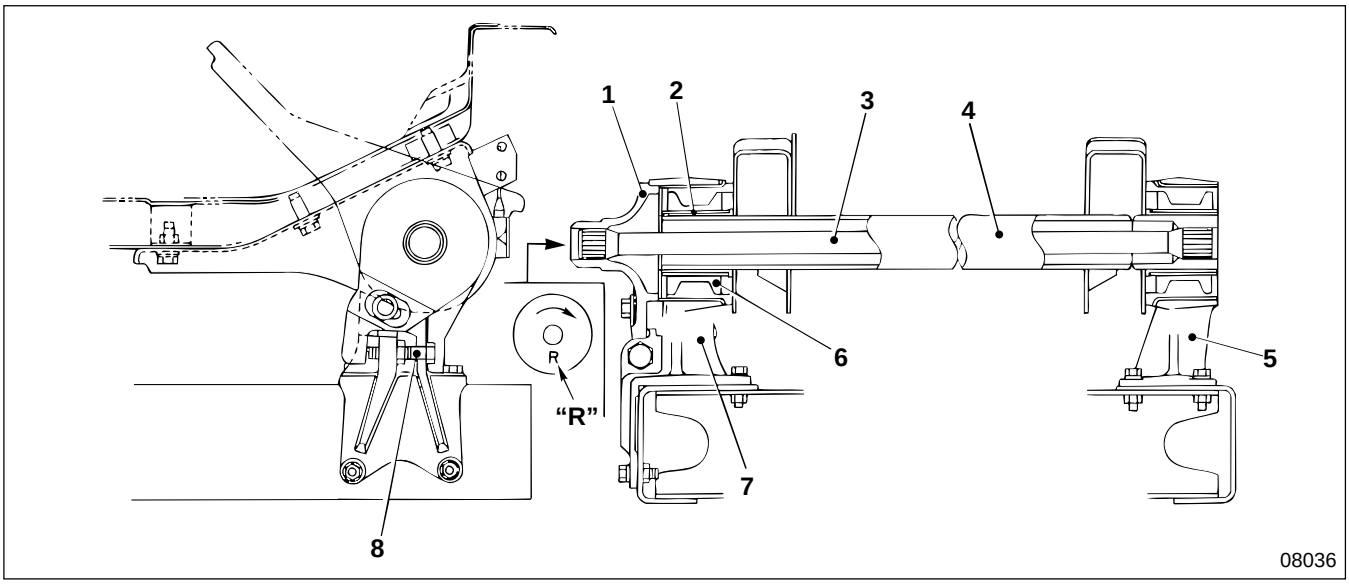
WINDOW GLASS 42-70

SPECIFICATIONS

Item			Specifications	
			Tilt cab	* Fixed cab
Cab assembly	Type		Cab over type (Forward control type)	←
	Mass	kg {lb}	Approximately 390 {860}	Approximately 580 {1280}
Cab tilt	Type		Torsion bar type	—
	Tilt angle		45°	—
Cab mounting		Type	Semi-floating type (using liquid rubber)	Fixed type
Windshield			Laminated glass	←
Glass other than windshield			Tempered glass	←
Door glass opening and closing mechanism	Front door		Electric control type (Cable driven)	Manual control type (Cable driven)
	Rear door		—	Manual control type (Arm link driven)

*: Fixed cab is used only for crew cab.

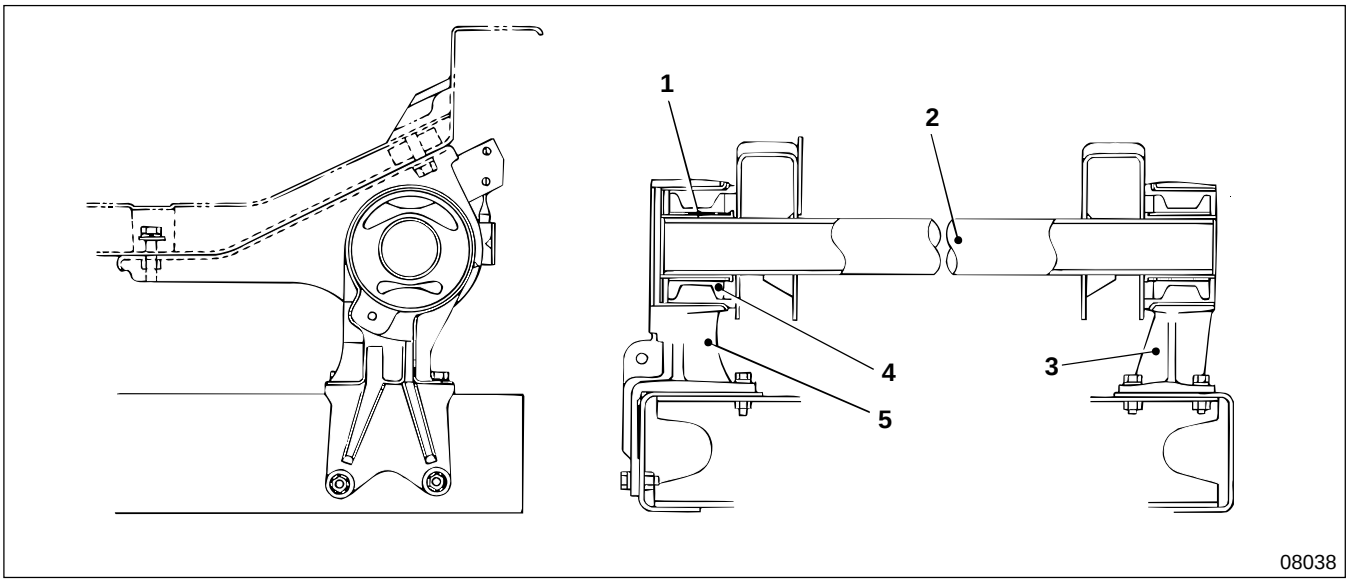
Front Cab Mounting < Tilt Cab >



1 Anchor lever
2 Bushing
3 Torsion bar
4 Front floor cross member assembly
5 Front cab mounting bracket, LH
6 Front rubber assembly
7 Front cab mounting bracket, RH
8 Adjusting bolt

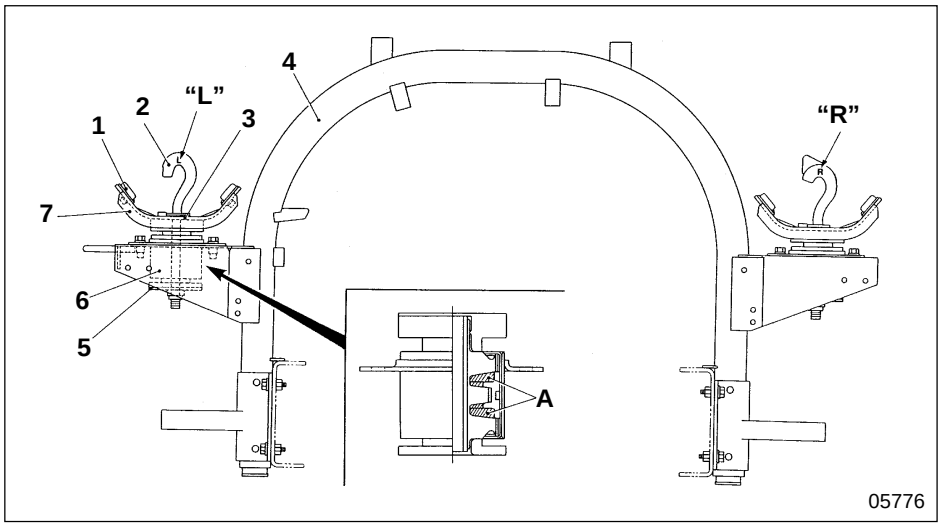
Since torsion bar **3** has torsional direction, it is marked **"R"** on its right end to indicate the torsional direction, preventing mistaken installation.

Front Cab Mounting < Fixed Cab >



1 Bushing
2 Front floor cross member assembly
3 Front cab mounting bracket, LH
4 Front rubber assembly
5 Front cab mounting bracket, RH

Rear Cab Mounting < Tilt Cab >

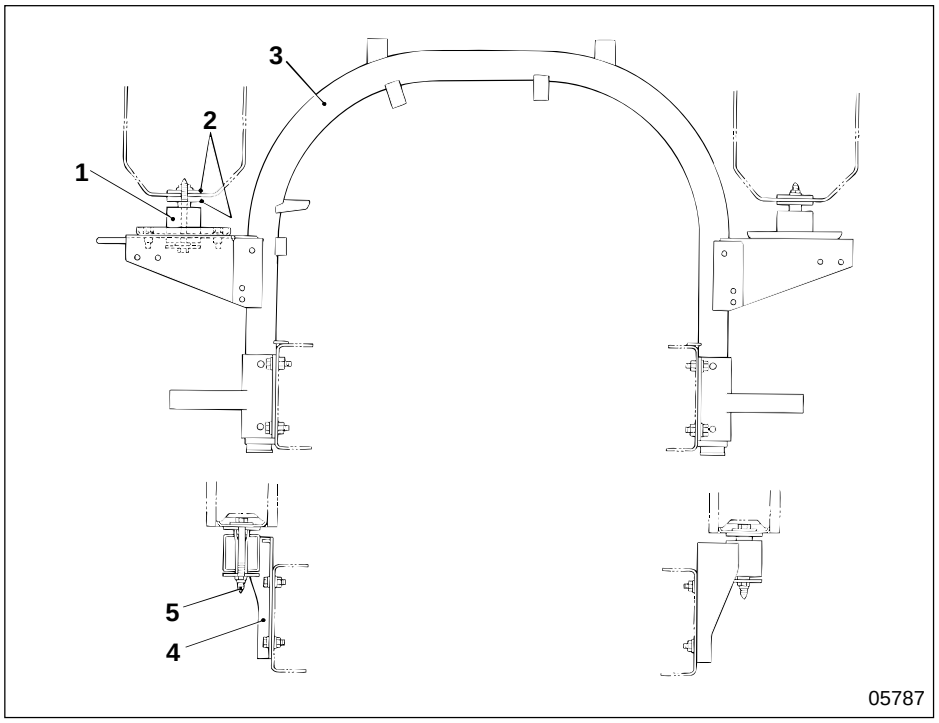


1 Side rubber
2 Anchor hook
3 Spacer
4 Rear mounting post
5 Plate
6 Rear rubber assembly
7 Cab hold bracket

A : Liquid

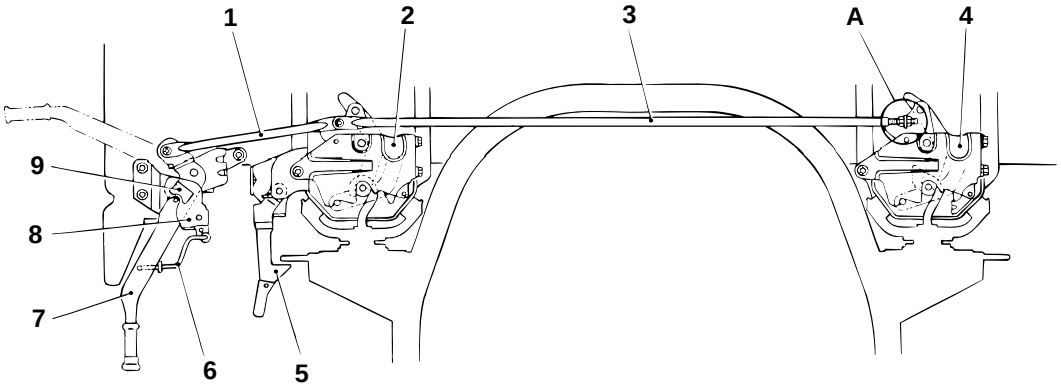
- Anchor hooks **2** are marked **"L"** and **"R"** to identify left and right.
- Between anchor hook **2** and cab hold bracket **7** is spacer **3**. By increasing or decreasing the number of spacers, the cab tilt operating force can be adjusted.
- Rear rubber assembly **6** is filled with liquid **A** that reduces vibration and noise.

Rear Cab Mounting < Fixed Cab >



1 Rubber assembly
2 Plate
3 Rear mounting post
4 Cab bracket assembly
5 Cone point bolt

Cab Tilt Link < Tilt cab >

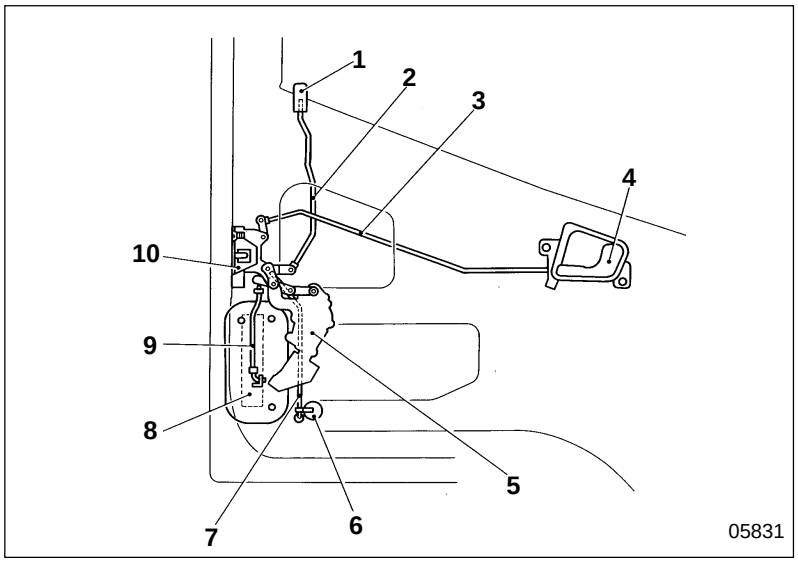


1 Lock handle rod
2 Link assembly, LH
3 Center rod
4 Link assembly, RH
5 L-lever
6 L-lever rod
7 Lock handle
8 Lock latch
9 Cab tilt lock switch

A : Center rod adjusting point

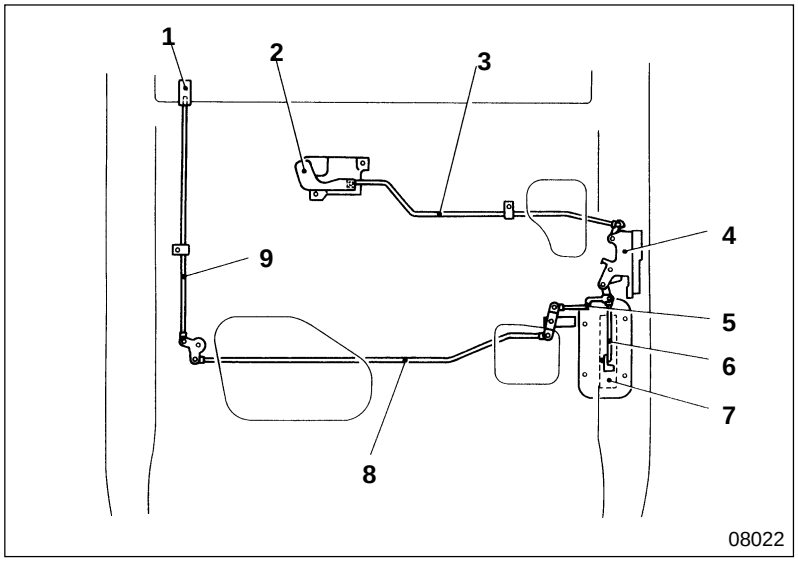
- The length of center rod **3** can be adjusted at mounting part **A** (center rod adjusting point) of link assembly RH **4**.
- Cab tilt lock switch **9**, mounted on lock latch **8**, detects whether lock handle **7** is locked securely.

Front Door Locking System



1 Door lock knob
2 Door lock rod
3 Door opening rod
4 Inside handle
5 Door lock actuator
< Centralized control door lock >
6 Door lock cylinder
7 Door lock cylinder rod
8 Outside handle
9 Door opening rod
10 Door lock latch

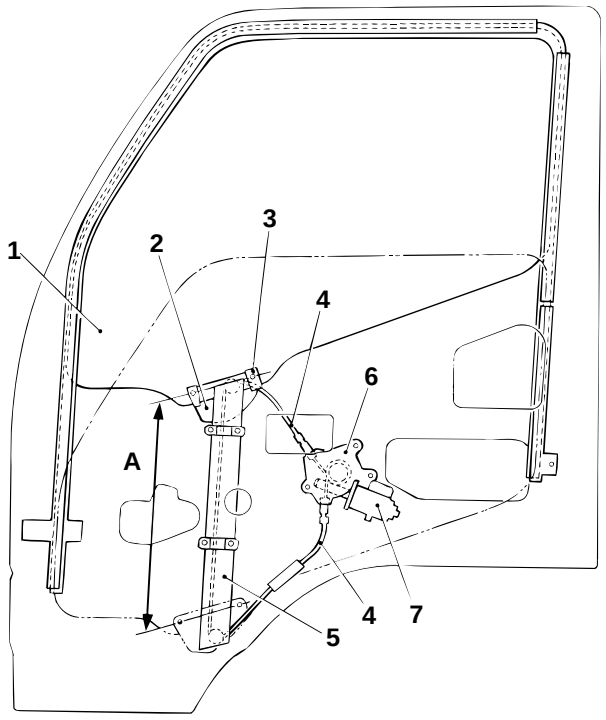
Rear Door Locking System < Crew Cab >



1 Door lock knob
2 Inside handle
3 Door opening rod
4 Door lock latch
5 Door lock rod C
6 Door opening rod
7 Outside handle
8 Door lock rod B
9 Door lock rod A

Front Door Glass Opening System

< With power windows >



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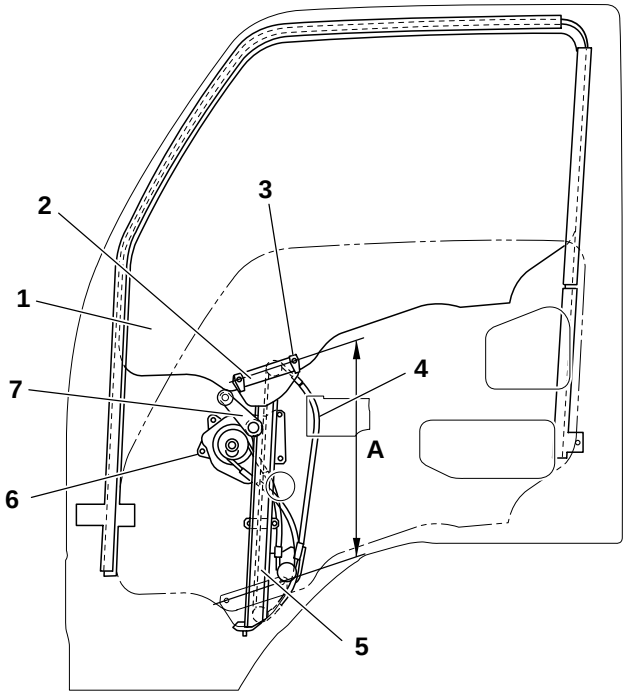
< Manual regulator >



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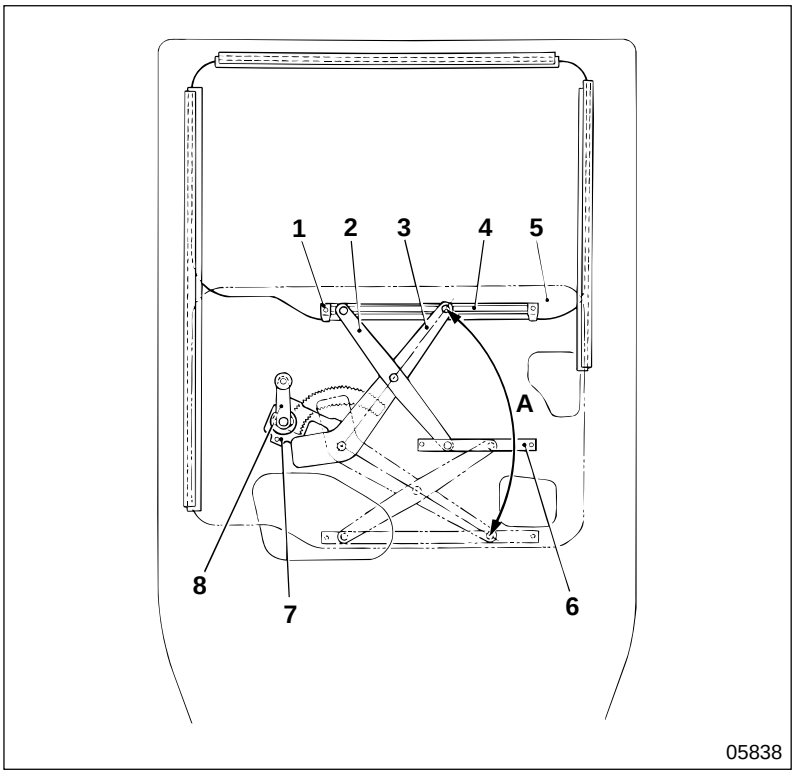
1 Door glass
2 Carrier plate
3 Glass holder
4 Cable
5 Rail
6 Regulator
7 Power window motor
< With power windows >
Regulator handle < Manual regulator >

A : Carrier plate moving range

- Both ends of cable **4** are secured to carrier plate **2**, and regulator **6** is installed in the middle of the cable.
- Regulator **6** winds cable **4**, and moves carrier plate **2** vertically to open and close door glass **1**.
- Carrier plate **2** and door glass **1** are secured by glass holder **3**.
- Power window motor **7** < with power windows > or regulator handle **7** < manual regulator > turns regulator **6**.

Rear Door Glass Opening System < Crew Cab >

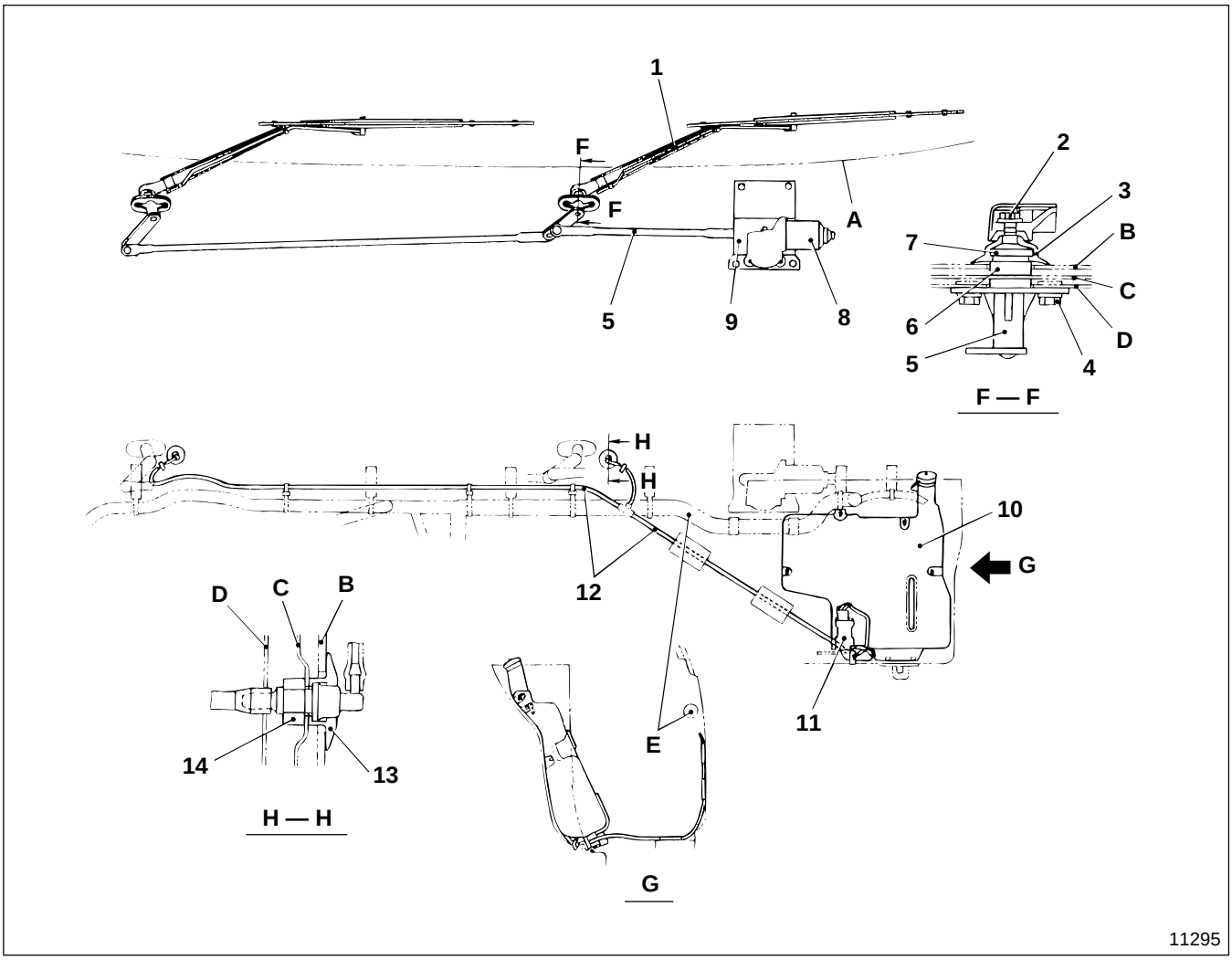


1 Glass holder
2 Arm
3 Arm
4 Rail
5 Door glass
6 Rail
7 Regulator
8 Regulator handle

A : Arm rotating range

- Glass holder **1** holds rail **4** on door glass **5**. Arms **3** and **2** slide on this rail.
- Arm **2** slides on rail **6** that is secured to the door panel.
- Regulator **7** turns arm **3** vertically to open and close door glass **5**.

Wiper and Washer

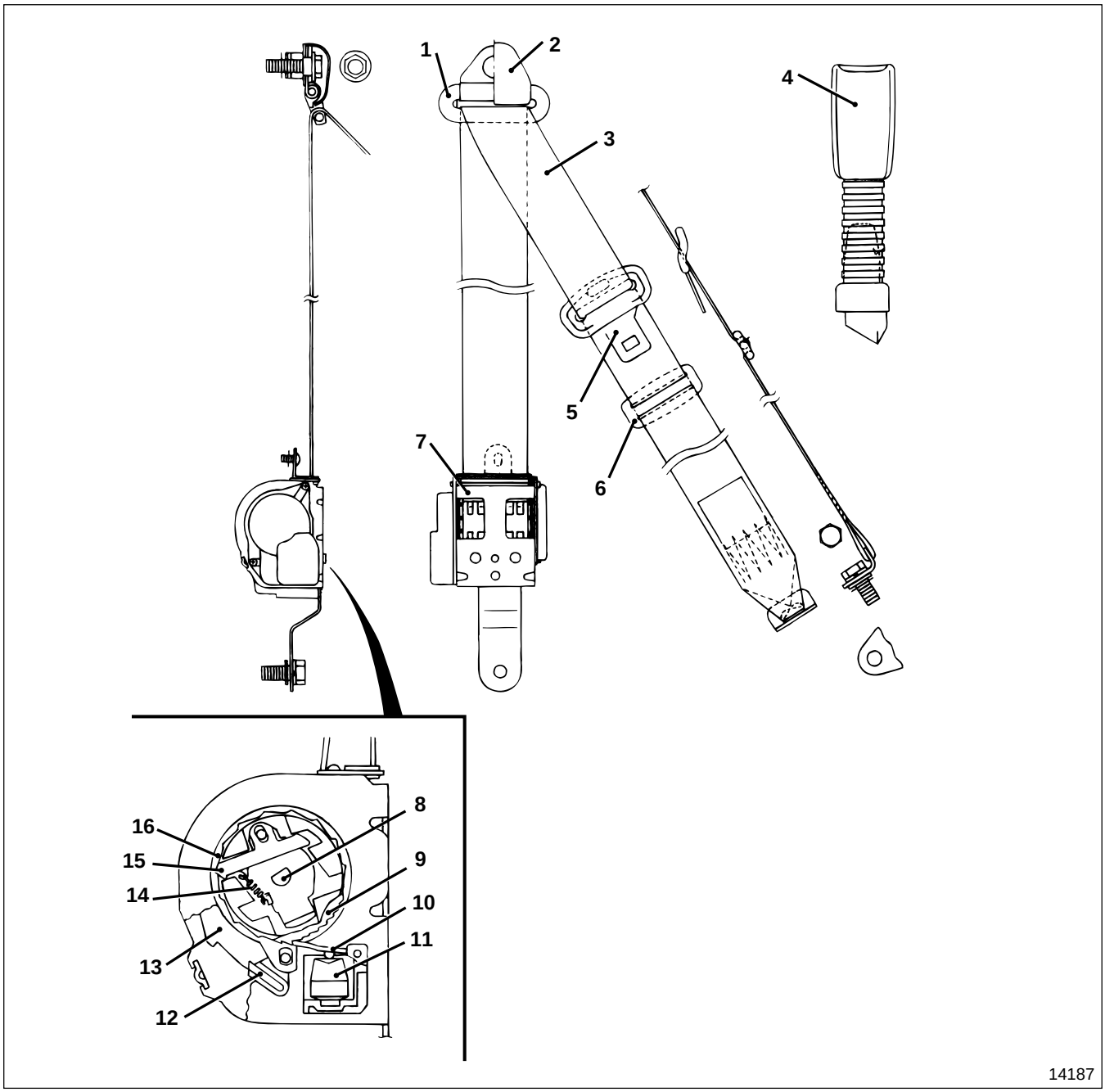


1 Wiper arm and blade assembly
2 Nut
3 Pivot cap
4 Nut
5 Wiper link assembly
6 Packing washer
7 Nut
8 Wiper motor
9 Wiper motor bracket
10 Washer tank
11 Washer motor
12 Washer hose
13 Hose joint
14 Nut

A : Weatherstrip ends
B : Front garnish
C : Front panel
D : Front rail
E : Cab harness

G : The viewpoint of this illustration is from inside the cab.

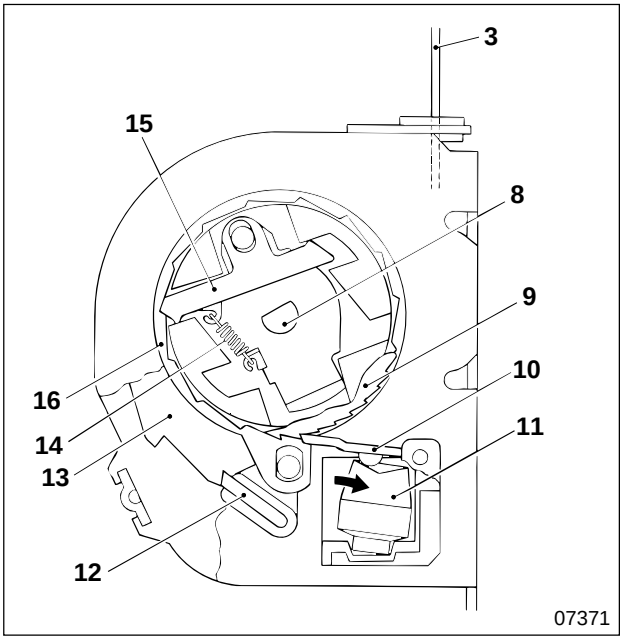
Emergency Locking Retractor (ELR) Type Seat Belt



1 Sash guide
2 Cover
3 Webbing
4 Buckle assembly
5 Tongue plate
6 Tongue stopper
7 Emergency locking retractor assembly
8 Spindle
9 Locking gear
10 Mechanism lever
11 Mechanism weight
12 Pawl
13 Ratchet gear
14 Sensor spring
15 Lock arm
16 Clutch

CAUTION⚠

Do not disassemble emergency locking retractor assembly 7, or malfunctions might occur.



Webbing detecting lock

- When the vehicle is subjected to a sudden impact, such as a crash, webbing **3** retracts according to the movement of passengers, and spindle **8** rotates.
- As the rotation of spindle **8** is higher than the specified value, the repercussive force of sensor spring **14** can no longer retain lock arm **15**. Then, the arm is pulled out from the specified position and is locked by clutch **16**.
- If spindle **8** further rotates, clutch **16** lifts pawl **12** to lock with ratchet gear **13**, making spindle rotation impossible.

Body detecting lock

- When the body is tilted excessively, mechanism weight **11** is tilted, engaging mechanism lever **10** with locking gear **9**, locking it.
- If spindle **8** further rotates, clutch **16** operates as described above, and the spindle cannot rotate.

Cab as a Whole

Possible causes \ Symptoms		Cab shimmy (pitching and rolling vibration)	Cab or steering wheel high-frequency vibration (above 20 Hz) or noise	Cab cannot be tilted up	Cab cannot be locked to rear mounting post	Cab tilt warning lamp does not light	Cab tilt warning lamp does not go out	Remarks
Cab-related	Cab mounting loose or play	○						
	Front rubber, rear rubber deteriorated		○					
	Cab mounted incorrectly		○					
	Link assembly from anchor hook does not release			○				
	L-lever release faulty			○				
	Torsion bar damaged or fatigued			○				
	Torsion bar arm installation position incorrect			○				
	Link assembly not hooked to anchor hook				○			
	Link assembly contact with side cushion incorrect				○			
	Cab tilt lock switch adjusted incorrectly					○	○	
	Cab tilt lock switch faulty					○	○	
	Cab tilt warning lamp bulb burnt-out					○		
	Fuse, high-current fuse blown					○		
	Wiring broken or connection faulty					○		
Engine-related	Crossed axes angle of propeller shaft excessive due to increased tilt caused by deteriorated engine mounting		○					
	Engine installation faulty		○					Gr 11
	Intake and exhaust system installation faulty		○					
Transmission-related	Transmission installation faulty		○					Gr 22, 23
Propeller shaft-related	Propeller shaft run-out excessive		○					
	Universal joint worn excessively		○					
	Slip yoke joint spline play		○					
	Center bearing play excessive		○					Gr 25
	Crossed axes angle of mounting dimension excessive due to deteriorated center bearing cushion rubber, etc.			○				
	Crossed axes angle of propeller shaft excessive due to increased tilt of drive axis caused by overloading		○					

Possible causes / Symptoms		Cab shimmy (pitching and rolling vibration)	Cab or steering wheel high-frequency vibration (above 20 Hz) or noise	Cab cannot be tilted up	Cab cannot be locked to rear mounting post	Cab tilt warning lamp does not light	Cab tilt warning lamp does not go out	Remarks
Front axle-related	Axle seat resonance	○						Gr 26
Rear axle-related	Reduction gear engaged incorrectly		○					Gr 27
	Differential gear engaged incorrectly		○					
Wheel and tire-related	Wheel and tire run-out excessive	○						Gr 31
	Wheel and tire unbalanced	○						
	Size and kinds of tire unequal	○						
	Wheel mounting surface warped	○						
Front suspension-related	Leaf spring friction between leaves excessive	○						Gr 33
Brake-related	Brake drum unbalanced	○						Gr 35A
	Brake drum eccentric	○						
	Rotor of disc brake eccentric	○						

Door Lock

Symptoms / Possible causes	Door latch does not engage, and door does not close	Door does not lock when door lock knob is pressed	Door does not lock when key is turned	Remote door lock does not operate	Door does not open when outside door handle is operated	Door does not open when inside door handle is operated	Inside door handle does not return properly to original position	There is interference between door and cab	Remarks
Door installation faulty		○							○
Striker installation faulty		○							
Faulty door locking mechanism of door latch		○	○	○		○	○		
Door latch rod deformed			○				○		
Door latch rod disconnected			○	○			○		
Door latch rod interference								○	
Door lock cylinder deformed				○					
Faulty auto door lock switch in power window & door lock switch					○				Gr 54
Door lock actuator faulty					○				
Fuse or high-current fuse blown					○				
Open circuit or faulty connection of wire					○				
Left-side outside door handle faulty						○			
Inside door handle installation faulty							○		
Spring fatigue in inside door handle								○	

Power Window

Symptoms / Possible causes	Door window glass drops of its own accord while cruising	Abnormal noise from power window regulator while cruising	Power window does not operate	Power window does not stop	Abnormal noise while power window operating	After the starter switch has been turned OFF the window does not operate within 30 seconds of the power window switch being operated	After the starter switch has been turned OFF and although the doors have been opened within 30 seconds, the window does not operate within 30 seconds of the power window switch being operated	Remarks
Power window switch faulty			○	○		○	○	
Power window regulator faulty	○		○	○	○			
Power window regulator mounting faulty					○			Gr 54
Fuse and high-current fuse burnt-out			○					
Wiring broken or connection faulty			○					
Power window glass and door belt line molding rattling		○						

Wiper and Washer

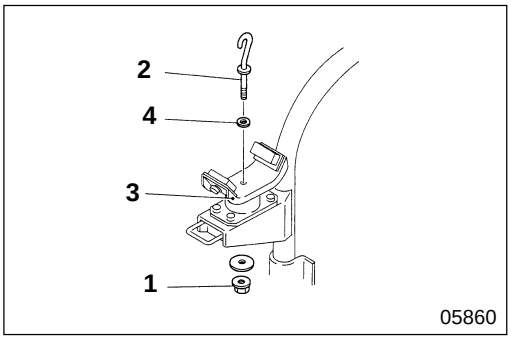
Symptoms / Possible causes	Wiper does not work	Wiper does not stop	Wiper intermittent operation does not work	Wiper blade stop position incorrect	Wiper operation inadequate	Noise during wiper operation	Washer motor does not work	Washer fluid jetting insufficient	Washer fluid does not jet	Remarks
Wiper motor faulty	○	○		○		○				
Washer motor faulty							○	○	○	
Wiper and washer switch faulty	○	○	○				○			
Multipurpose timing control unit faulty			○							Gr 54
Wiper relay faulty	○						○			
Fuse, high-current fuse blown	○						○			
Wiring broken or connection faulty	○		○				○		○	
Wiper motor crank arm set position faulty				○						
Wiper link and wiper arm connection faulty						○				
Wiper blade faulty					○	○				
Wiper arm faulty					○					
Washer hose twisted								○		
Washer hose connected incorrectly									○	
Washer nozzle clogged								○	○	
Washer fluid insufficient									○	

Adjustment of Cab Tilt

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Anchor hook mounting)	83 to 98 {61 to 72, 8.5 to 10.0}	—
5	Bolt (Lock handle mounting)	29 to 39 {22 to 29, 3.0 to 4.0}	—

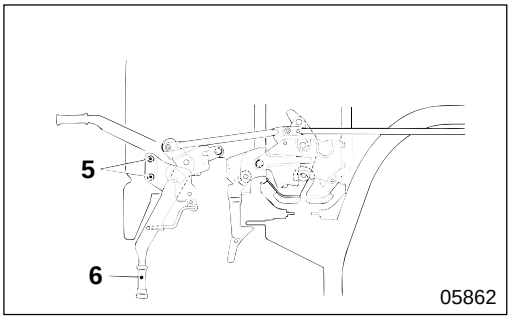


(1) Adjustment of lock handle operating force

- After removing lock nut **1**, remove anchor hook **2**.
- Adjust the operating force by increasing or decreasing the number of spacers **4** between anchor hook **2** and cab hold bracket **3**.

	Number of spacers
Heavy operating force	Increased
Light operating force	Decreased

- After adjustment, tighten lock nut **1** at specified torque:



(2) Adjustment for unsmooth latch

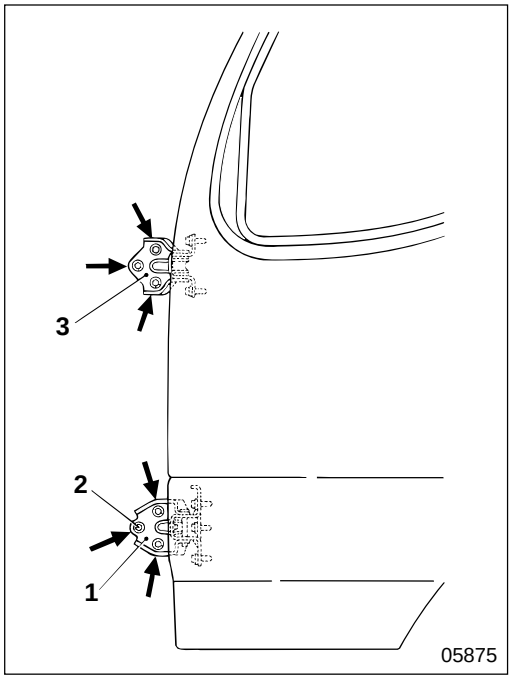
If latch operation is not smooth, loosen bolt **5**, and adjust installation of lock handle **6**.

Adjustment of Door Fitting

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Upper and lower hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
7	Screw (Striker mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—

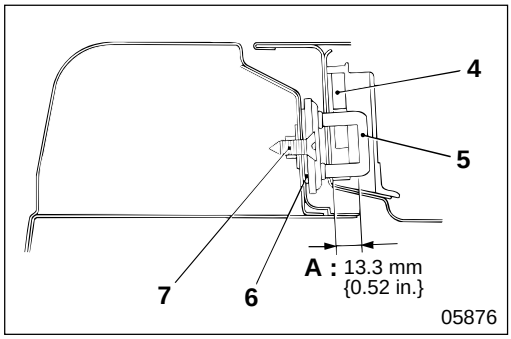


Adjust door fitting at hinge and striker.
(For door fitting dimensions: P42-19.)

(1) Adjustment of hinge

For adjustment, use front-side bolt **2** of lower hinge **1** as the reference point.

3 : Upper hinge



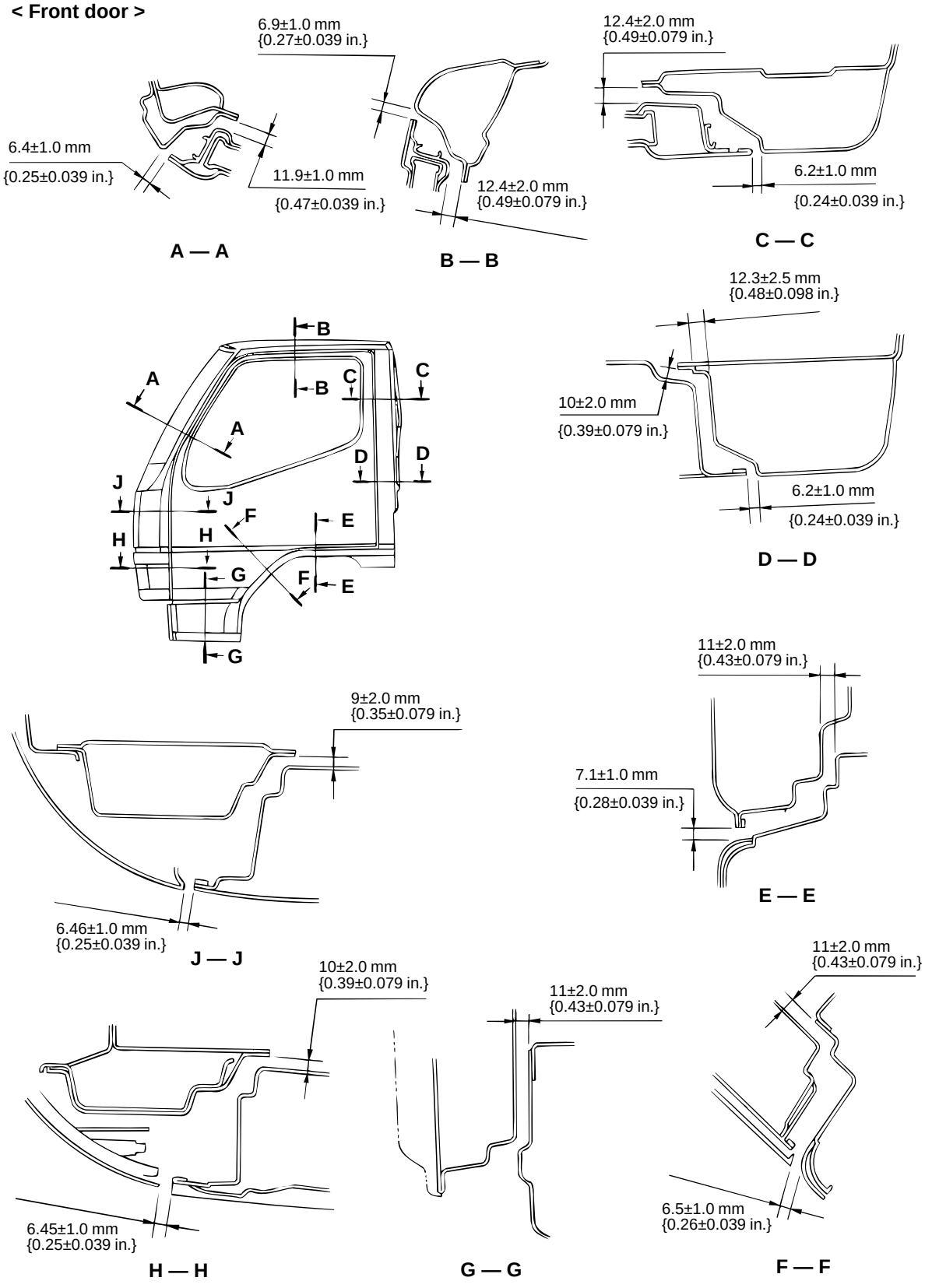
(2) Adjustment of striker

Engagement condition between door lock latch **4** and striker **5** should be adjusted with shim **6** within illustrated range **A**.

7 : Screw

Door Fitting Dimensions

< Front door >



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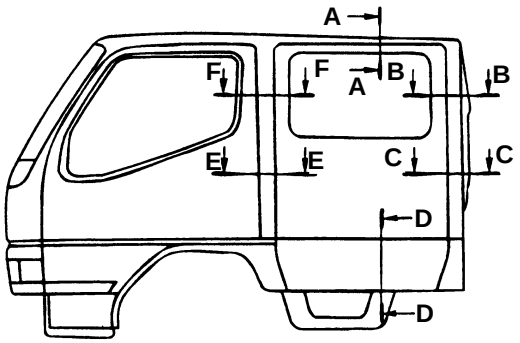
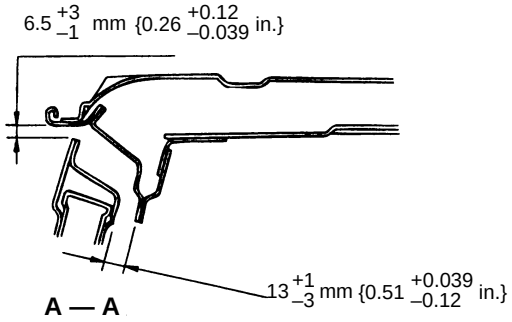
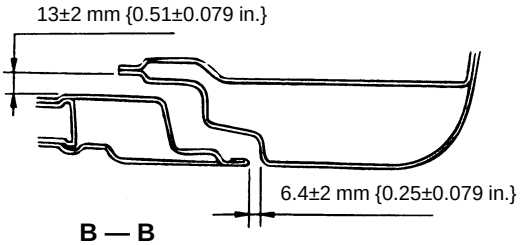
< Rear door (Fixed cab) >

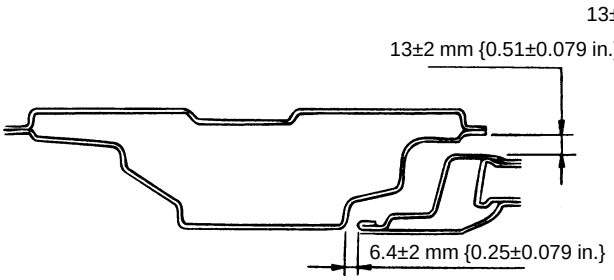




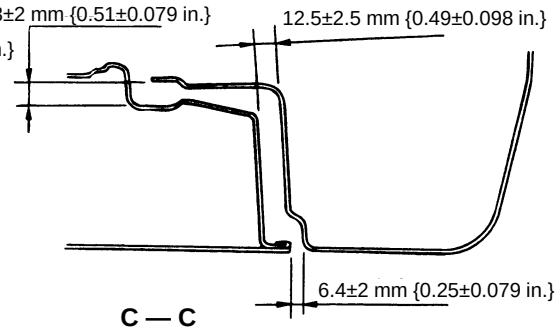
A — A



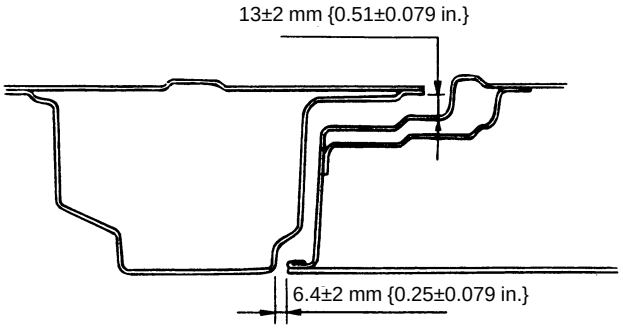
B — B



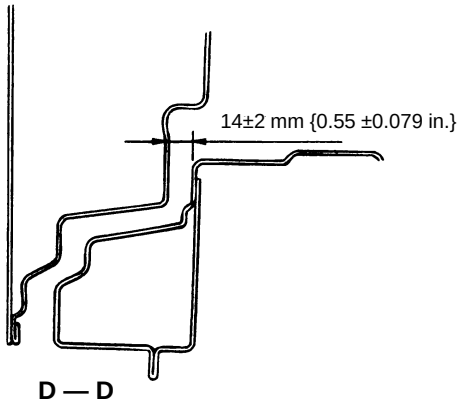
F — F



C — C



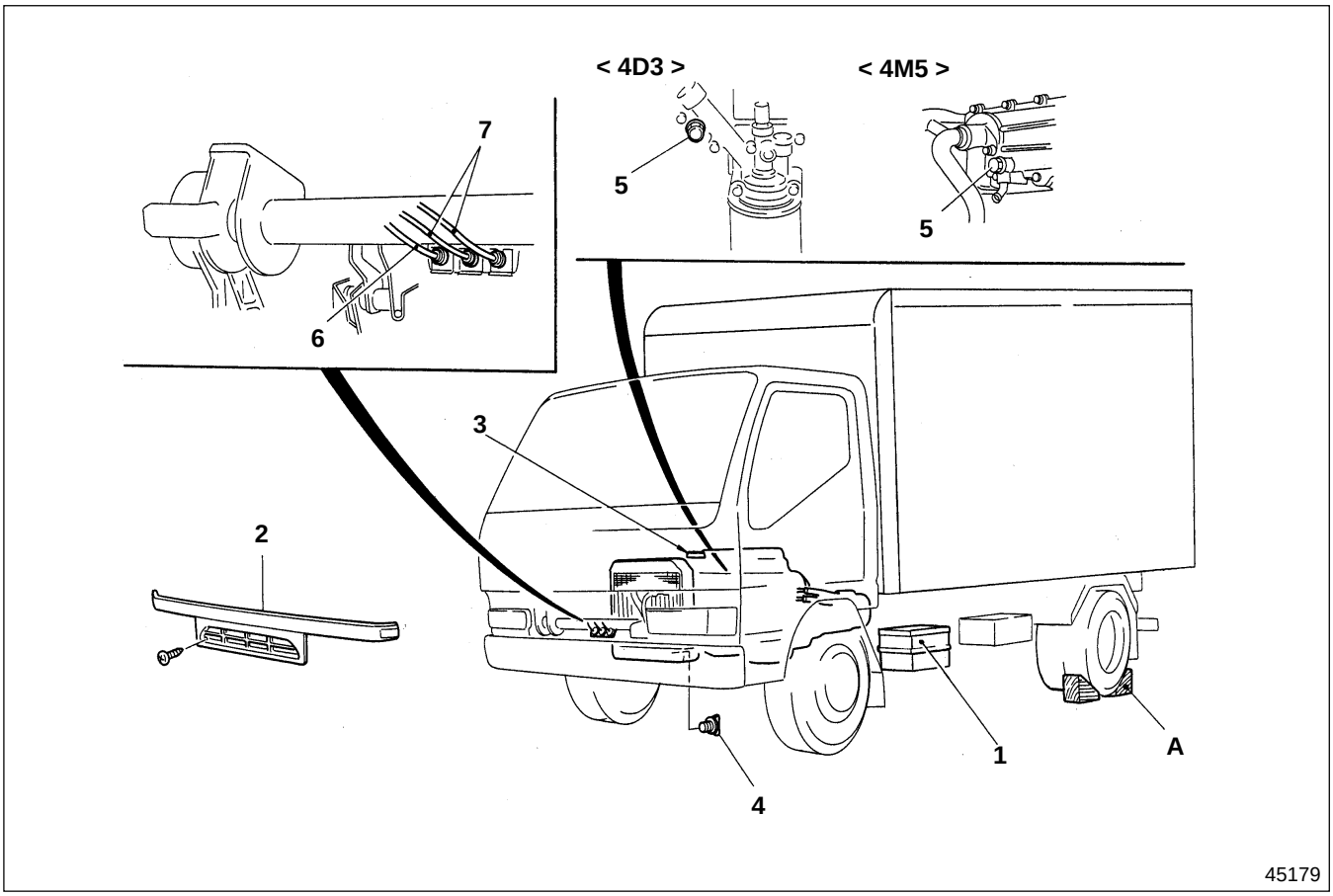
E — E



D — D

06007

Preliminary Work



● **Disassembly sequence**

1 Battery (negative terminal) Gr 54
2 Front grille
3 Pressure cap Gr 14A, B
4 Radiator drain plug Gr 14A, B
5 Crankcase drain plug Gr 14A, B
6 Clutch fluid pipe
< Manual transmission > Gr 21
7 Brake fluid pipe Gr 35A

A : Wheel chock

Work items

- Draining, filling, and air bleeding of clutch fluid and brake fluid Gr 21, Gr 35A
- Draining, filling, and air bleeding of coolant Gr 14A, B

WARNING

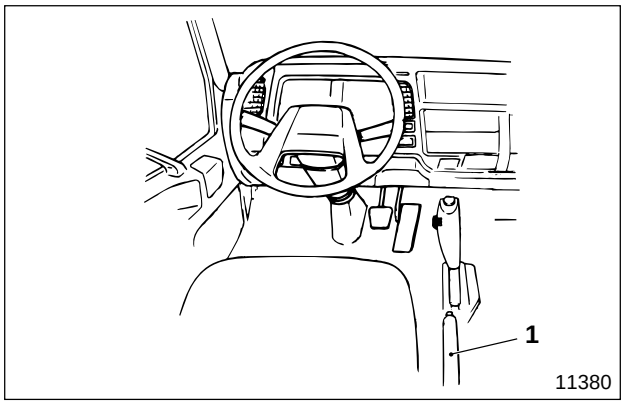
- **Put chocks A securely in place because the vehicle cannot be maintained at a standstill just by using the parking brake during removal and installation of the cab.**
- **Do not remove chocks A until the entire operation is completed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

REMOVAL AND INSTALLATION OF CAB < TILT CAB >

Work Inside Cab



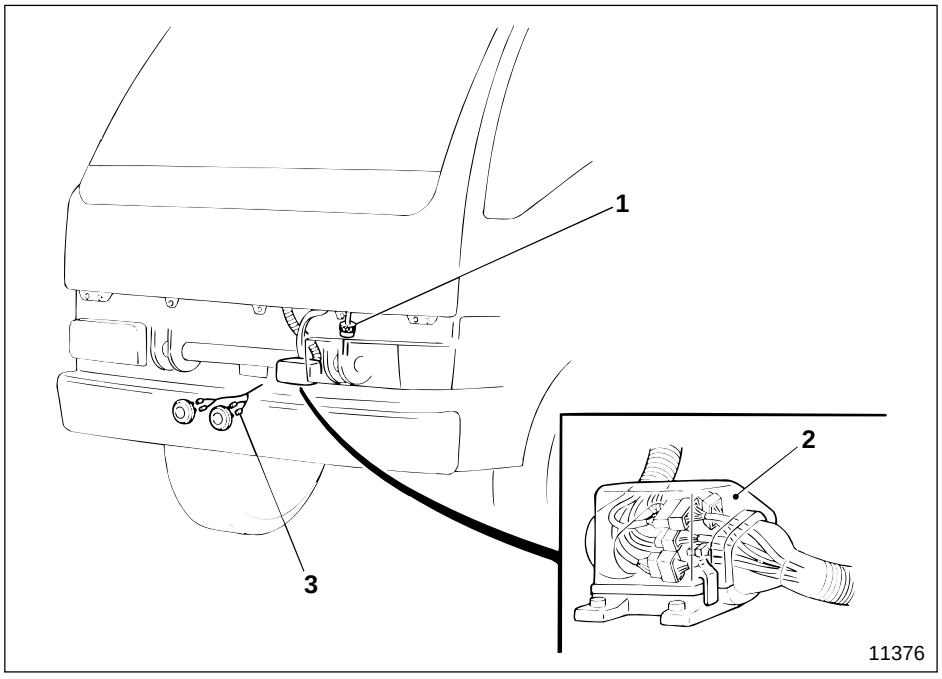
● **Disassembly sequence**

1 Parking brake cable Gr 36

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Work from Front of Cab



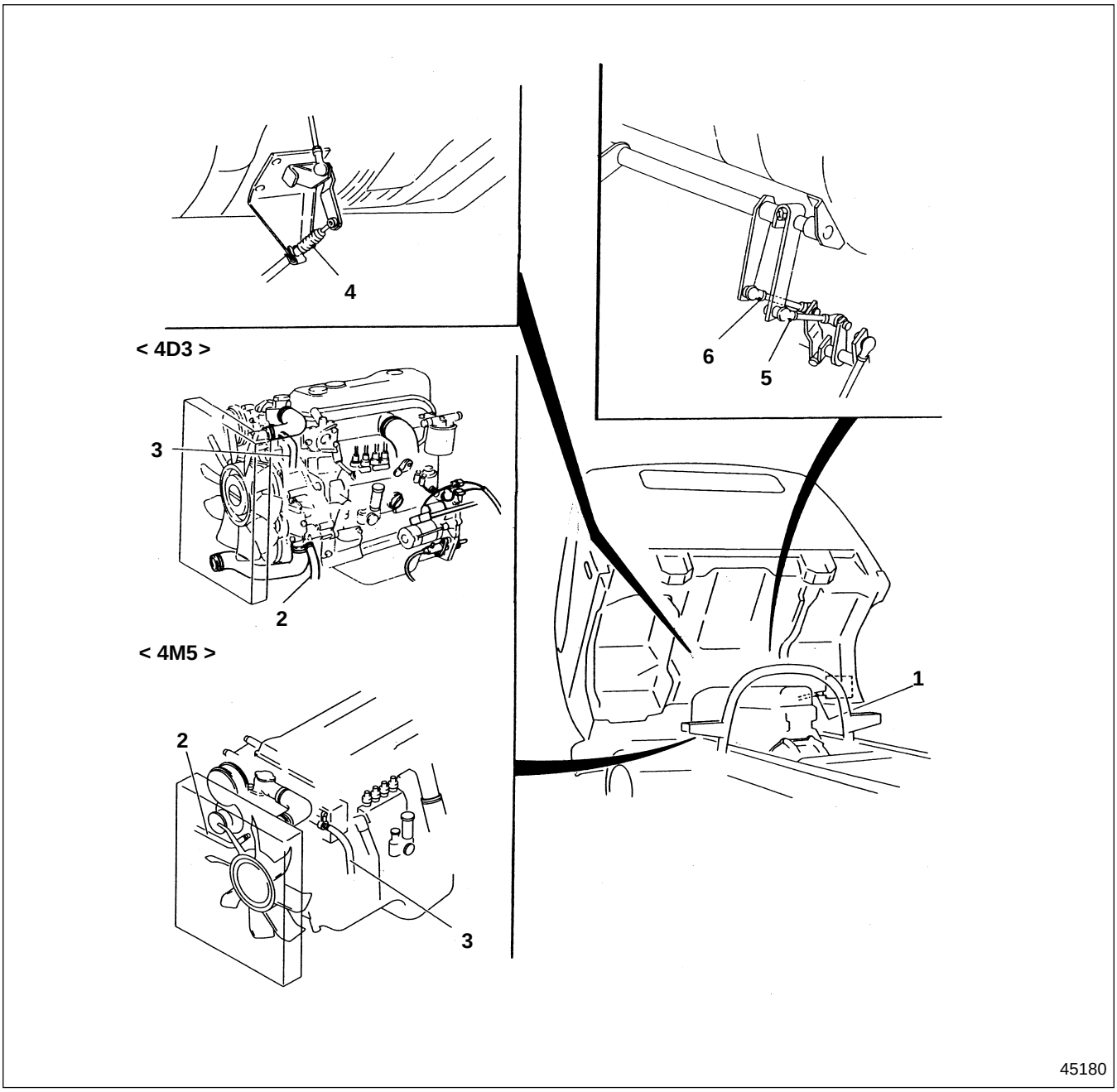
● **Disassembly sequence**

1 Speedometer cable
2 Connection between cab harness and chassis harness
3 Horn harness

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Work with Cab Tilted Up



● **Disassembly sequence**

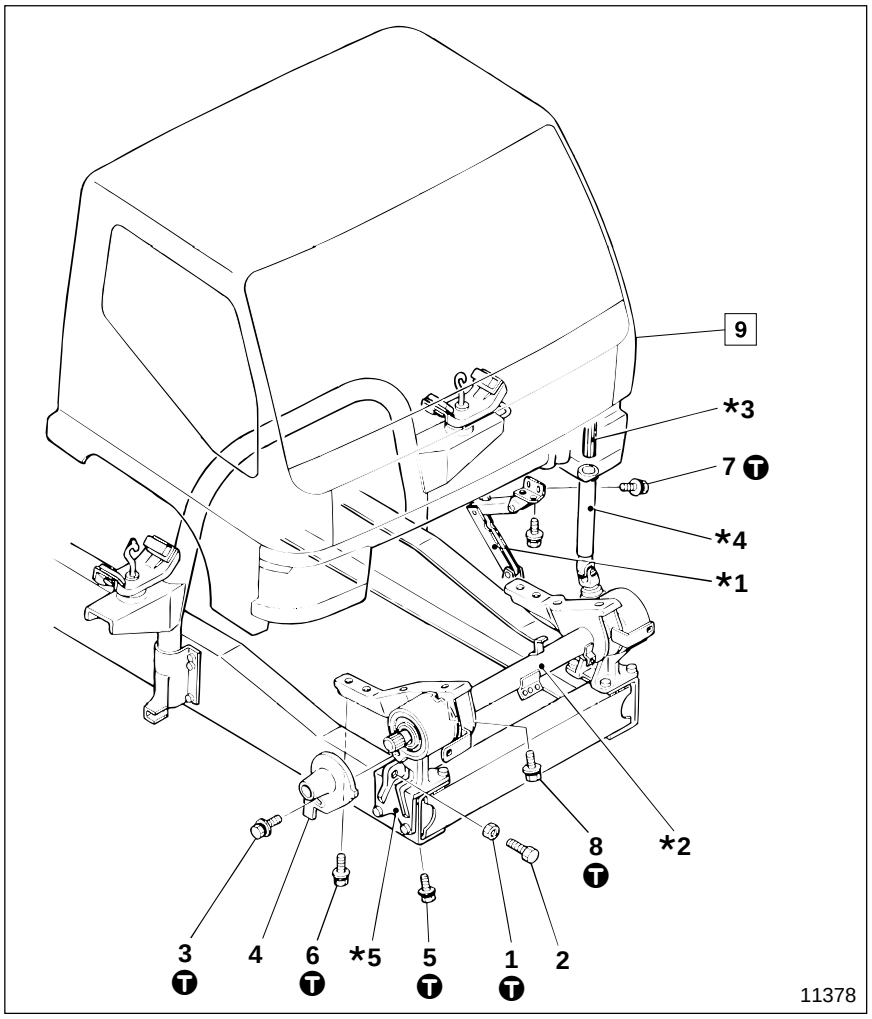
1 Vacuum hose
2 Heater hose (Engine in) Gr 55B
3 Heater hose (Engine out) Gr 55B
4 Range selector cable < Automatic transmission > Gr 23
5 No.2 shift rod < Manual transmission > Gr 22
6 No.2 selector rod < Manual transmission > Gr 22

● **Assembly sequence**

Follow the disassembly sequence in reverse.

REMOVAL AND INSTALLATION OF CAB < TILT CAB >

Removal and Installation of Tilt Cab Body



● **Disassembly sequence**

1 Nut
2 Bolt
3 Bolt
4 Anchor lever
5 Bolt
6 Bolt
7 Bolt
8 Bolt
9 Cab assembly

***1** : Cab stay
***2** : Front floor cross member
***3** : Steering yoke
***4** : Steering shaft
***5** : Front cab mounting bracket

● **Assembly sequence**

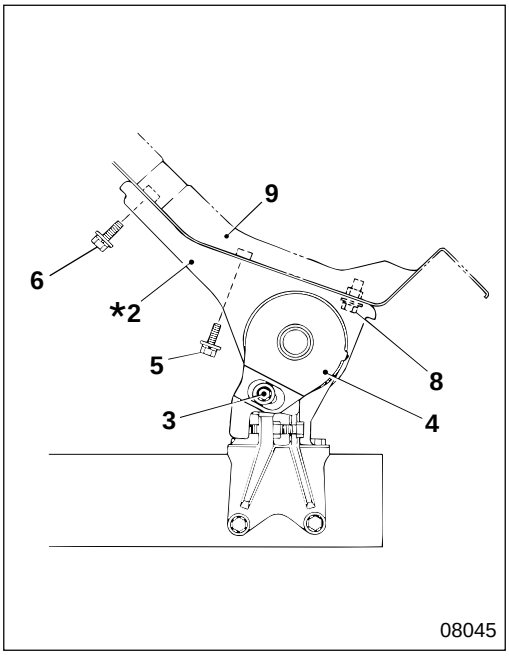
Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Anchor lever adjusting bolt locking)	59 to 83 {43 to 60, 6 to 8.5}	—
3	Bolt (Anchor lever mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—
5, 6, 8	Bolt (Front floor cross member mounting)	70 to 95 {51 to 70, 7.1 to 9.7}	—
7	Bolt (Cab stay mounting)	19 to 27 {14 to 21, 1.9 to 2.8}	—

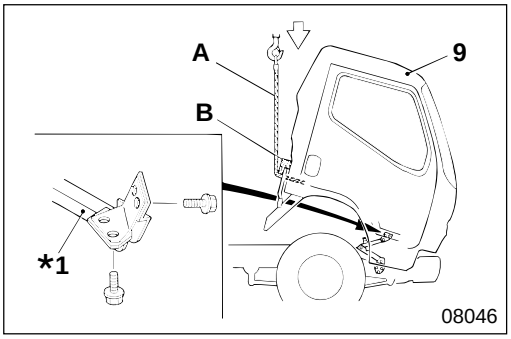
◆ Service procedure



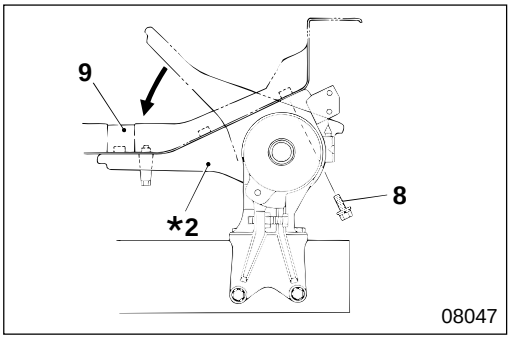
9 **Cab assembly**

[Removal]

- Tilt cab assembly **9** and lock cab stay ***1** securely.
- Remove bolt **3**, and remove anchor lever **4**.
- Of the three bolts that retain front floor cross member ***2**, remove bolts **5**, **6** at rear side, leaving bolt **8** at front side.

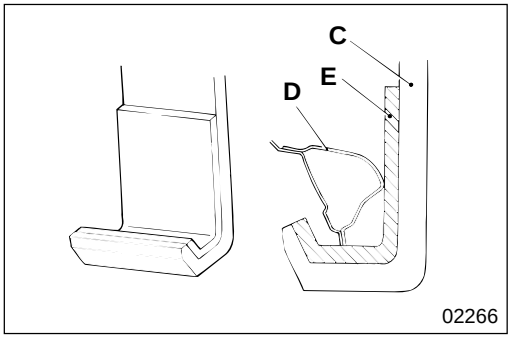


- To separate cab stay ***1** from cab assembly **9**, support the cab securely using crane **A** that is capable of lifting the cab.
  B : Use a wood block for protecting the rear of the cab
- Using crane **A**, lower cab assembly **9** until cab stay ***1** can be removed, then remove it.



- Fully lower cab assembly **9** to remove remaining bolt **8** that retains front floor cross member ***2**.

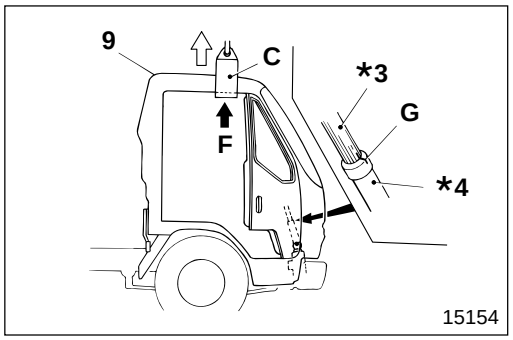
REMOVAL AND INSTALLATION OF CAB < TILT CAB >



- Set up hoist attachment **C** for the cab as illustrated.

CAUTION

- **Make sure when you set up hoist attachment C that it is capable of lifting cab assembly 9 which weighs approximately 390 kg {860 lb}.**
- **Make sure you install rubber E on hoist attachment C to prevent cab roof D being deformed when the cab is lifted.**



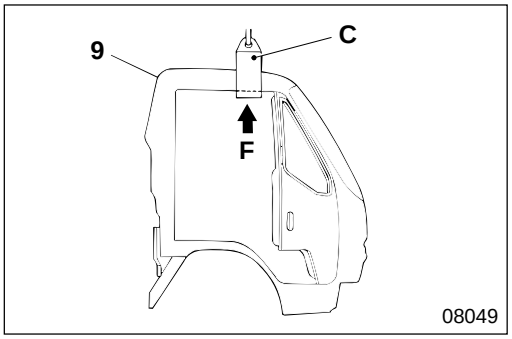
- Mount hoist attachment **C** at center-of-gravity point **F** of cab assembly **9**. Verify the position at which the cab can be lifted horizontally when the cab is lifted slightly.
- Slowly lift cab assembly **9** straight up, and finish lifting when steering yoke ***3** is pulled out from steering shaft ***4**. Make alignment mark **G** before the steering yoke is pulled out from the steering shaft.

WARNING

Never get under cab assembly 9 when it is being lifted.

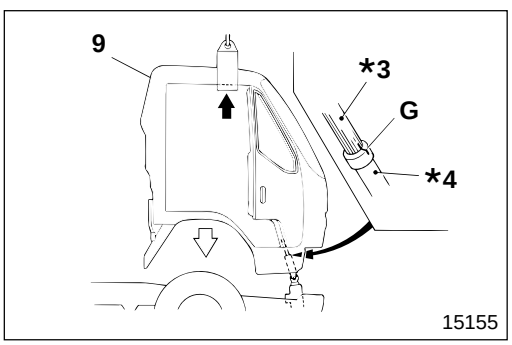
CAUTION

Make sure, when lifting cab assembly 9, that the wiring harness, cable, hoses, etc. are completely disconnected when the cab is lifted slightly.

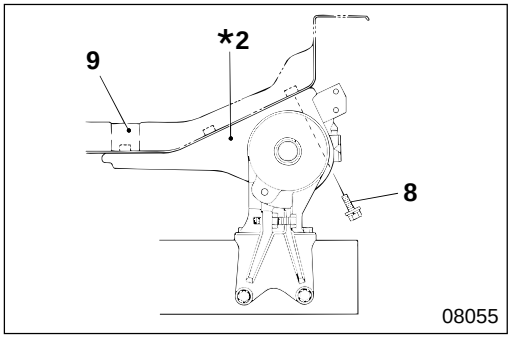


[Installation]

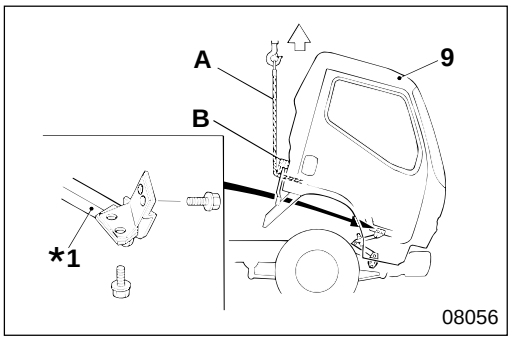
- Mount hoist attachment **C** at center-of-gravity point **F** of cab assembly **9**.



- Slowly lower cab assembly **9** horizontally to insert steering yoke ***3** into steering shaft ***4**, aligning alignment mark **G**.



- Slowly lower cab assembly **9** further, and remove hoist attachment **C** after it comes down fully.
- Tighten front bolt **8**, one of the three bolts used for installing front floor cross member ***2**.

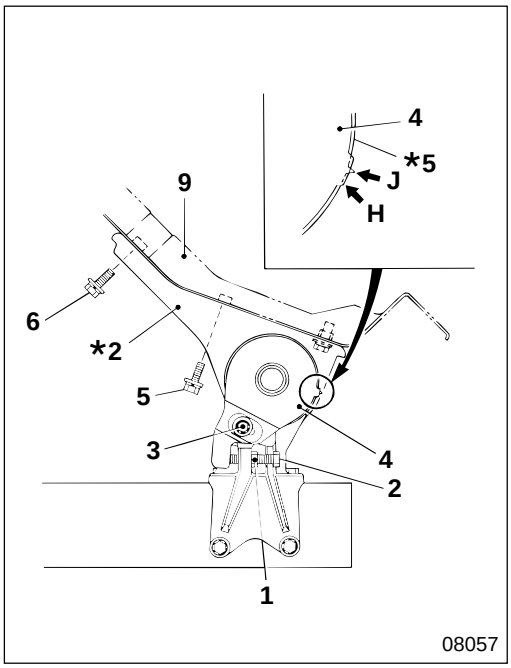


- Securely support cab on crane **A** to tilt cab assembly **9**.
  B : Use a wood block for protecting the rear of the cab
- Using crane **A** tilt cab assembly **9**, and install cab stay ***1**.

WARNING

You must pay close attention to the tilt angle when tilting cab assembly 9 using crane A. It is very dangerous to tilt the cab excessively because it will topple over.

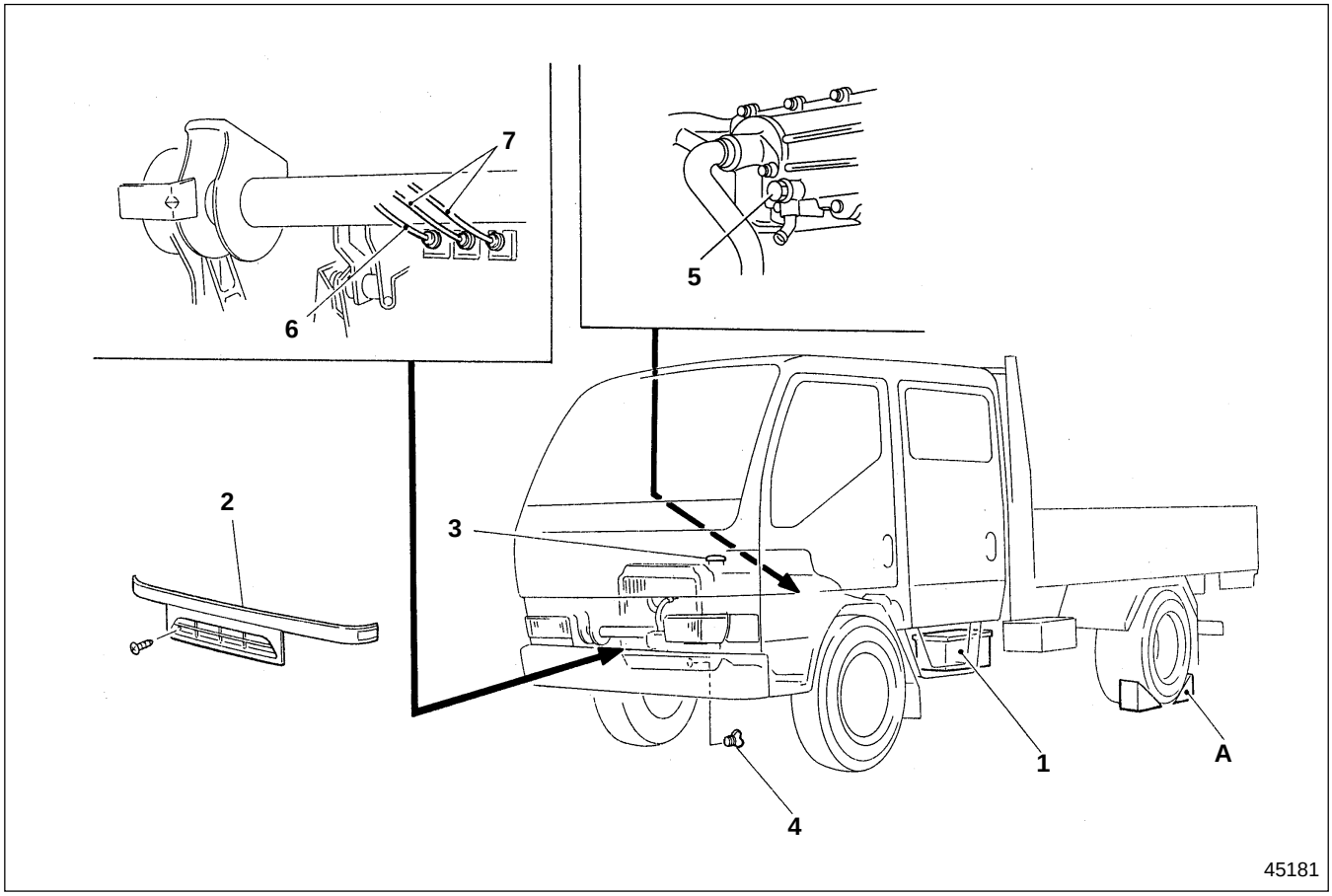
- After installing cab stay ***1**, tilt cab assembly **9** slowly until it is completely tilted, securely lock cab stay, then detach the cab from crane **A**.



- Tilt cab assembly **9**, and securely lock cab stay ***1**.
- Tighten bolts **5**, **6** to install front floor cross member ***2**.
- Position and install pointer **J** of front cab mounting bracket ***5** in convex area **H** of anchor lever **4** and fix it with bolt **3**.
- Position bolt **2** on anchor lever **4** and lock it with nut **1**.
- After mounting cab assembly **9**, check and adjust the operating force required for the lock handle. P42-17

REMOVAL AND INSTALLATION OF CAB < FIXED CAB >

Preliminary Work



● **Disassembly sequence**

1 Battery (negative terminal) Gr 54
2 Front grill
3 Pressure cap < Heater > 4D3, 4M4 Gr 14A, B
4 Radiator drain plug < Heater > 4D3, 4M4 Gr 14A, B
5 Crankcase drain plug < Heater > 4D3, 4M4 Gr 14A, B
6 Clutch fluid pipe Gr 21
7 Brake fluid pipe Gr 35A

A : Wheel chock

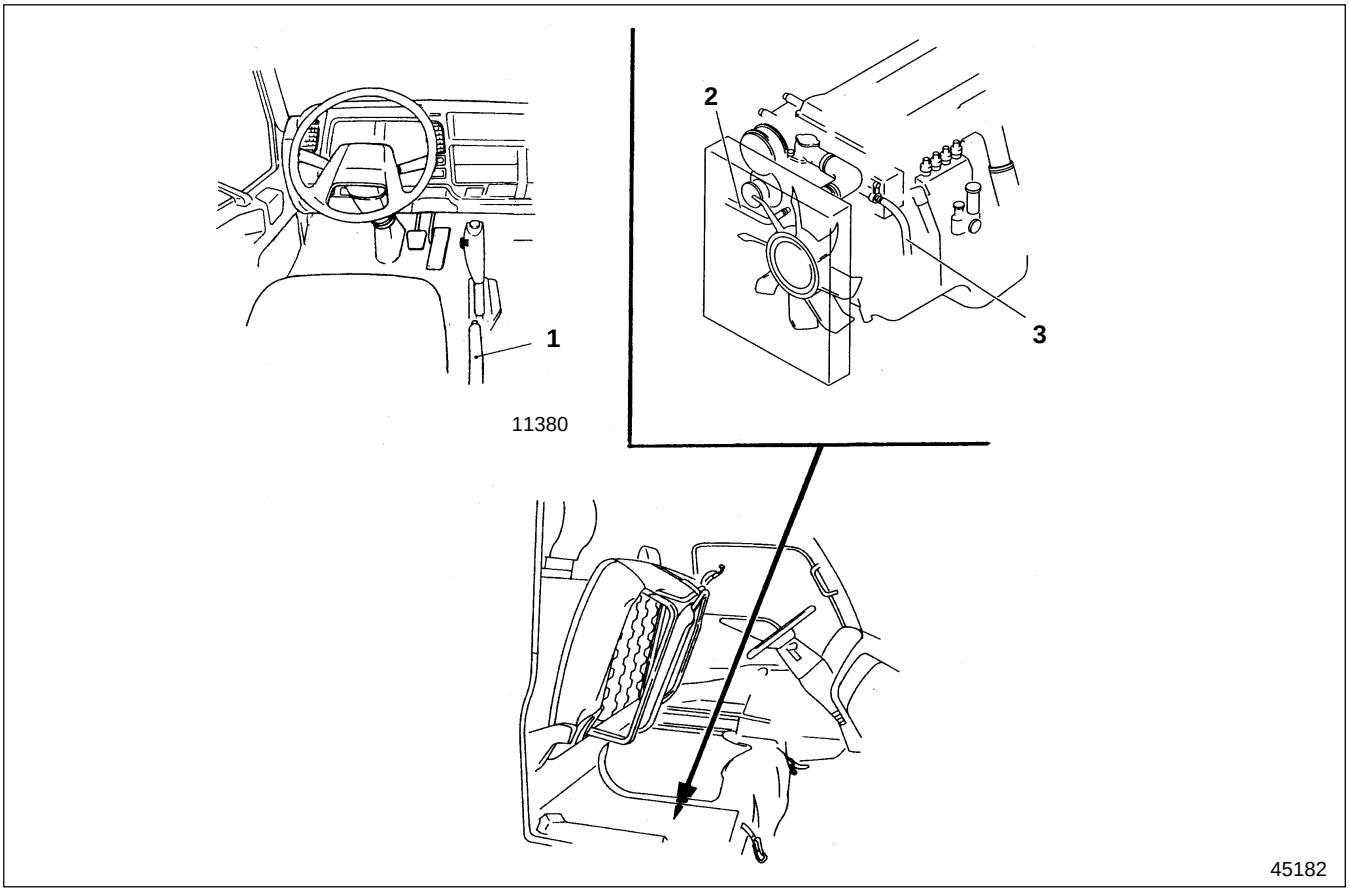
Work items

- Draining, filling, and air bleeding of clutch fluid and brake fluid
- Draining, filling, and air bleeding of coolant < Heater >

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Work Inside Cab



● **Disassembly sequence**

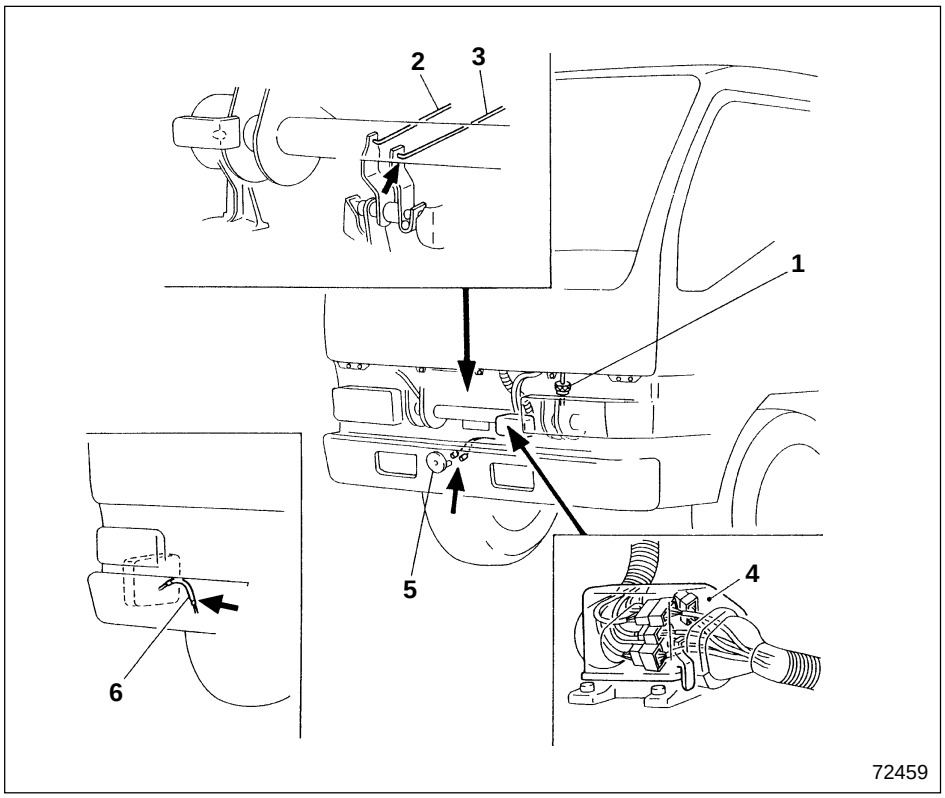
1 Parking brake cable Gr 36
2 Front heater hose (outlet) Gr 55
3 Front heater hose (return) Gr 55

● **Assembly sequence**

Follow the disassembly sequence in reverse.

REMOVAL AND INSTALLATION OF CAB < FIXED CAB >

Work on Cab Front and Under Cab



● **Disassembly sequence**

1 Speedometer cable
2 No.2 shift rod
3 No.2 selector rod
4 Connection between cab harness and chassis harness
5 Horn
6 Vacuum hose

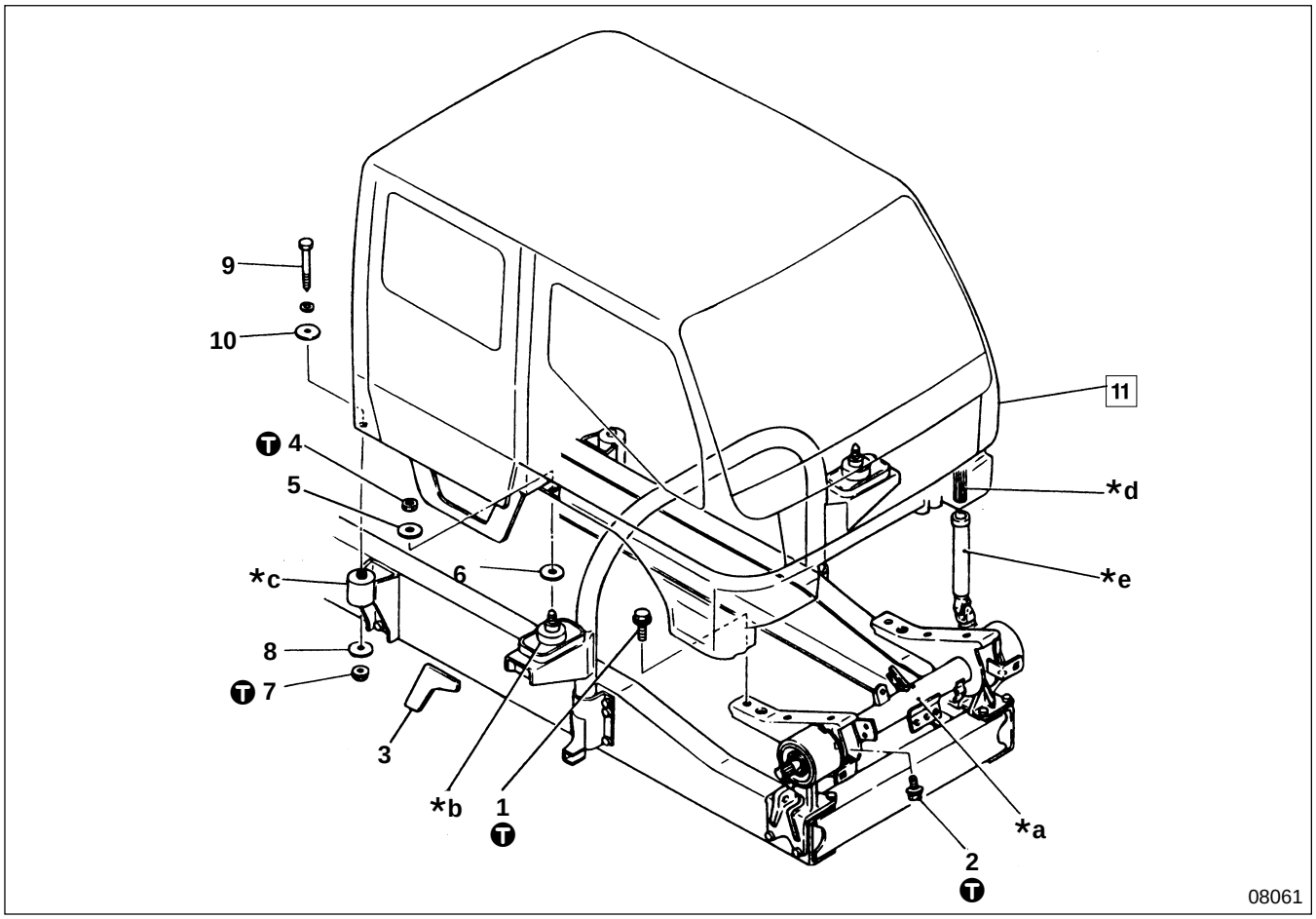
● **Assembly sequence**

Follow the disassembly sequence in reverse.

M E M O

REMOVAL AND INSTALLATION OF CAB < FIXED CAB >

Removal and Installation of Fixed Cab Body



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Garnish
4 Nut
5 Plate
6 Plate
7 Nut
8 Plate
9 Cone point bolt
10 Plate
11 Cab assembly

***a** : Front floor cross member
***b** : Rubber assembly
***c** : Rear rubber assembly
***d** : Steering shaft
***e** : Steering yoke

● **Assembly sequence**

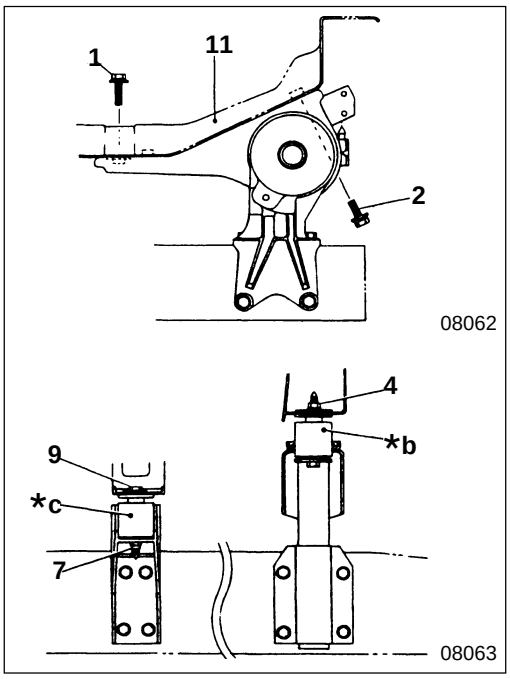
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front floor cross member mounting)	33 to 49 {3.4 to 5.0}	—
2	Bolt (Front floor cross member mounting)	70 to 95 {7.1 to 9.7}	—
4	Nut (Rubber assembly mounting)	39 to 59 {4 to 6}	—
7	Nut (Rear rubber assembly mounting)	59 to 69 {6 to 7}	—

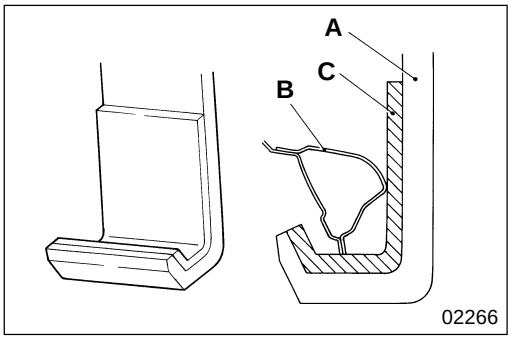
◆ Service procedure



11 **Cab assembly**

[Removal]

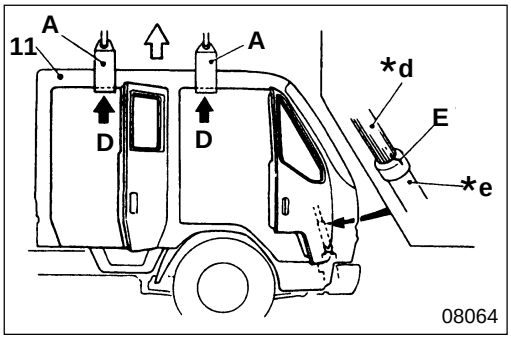
- Remove bolt **1** from the inside of cab assembly **11**, and bolt **2** from the outside.
- Remove nut **4** that fixes rubber assembly ***b**, then remove cone point bolt **9** and nut **7** that fix rear rubber assembly ***c**.



- Set up hoist attachment **A** as illustrated.

CAUTION

- **Make sure when you set up hoist attachment A that it is capable of lifting cab assembly 11 which weighs approximately 510 kg for the standard cab, and approximately 580 kg for the wide cab.**
- **Make sure you install rubber C on hoist attachment A to prevent cab roof B being deformed when the cab is lifted.**
- **Make sure you install hoist attachment A on both the front door side and the rear door side because installation of the hoist attachment on one side only causes deformation of the cab.**



- Mount hoist attachment **A** at center-of-gravity point **D** of cab assembly **11**. Verify the position at which the cab can be lifted horizontally when the cab is lifted slightly.
- Slowly lift cab assembly **11** straight up, and finish lifting when steering yoke ***d** is pulled out from steering shaft ***e**. Make alignment mark **E** before the steering yoke is pulled out from the steering shaft.

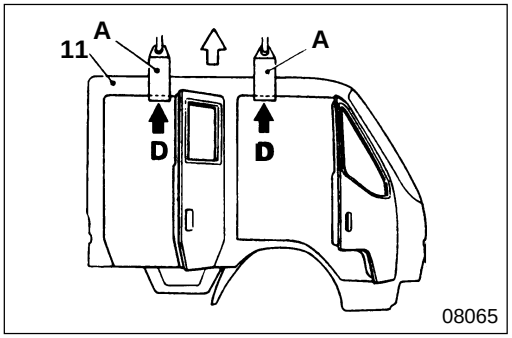
WARNING

Never get under cab assembly 11 when it is being lifted.

CAUTION

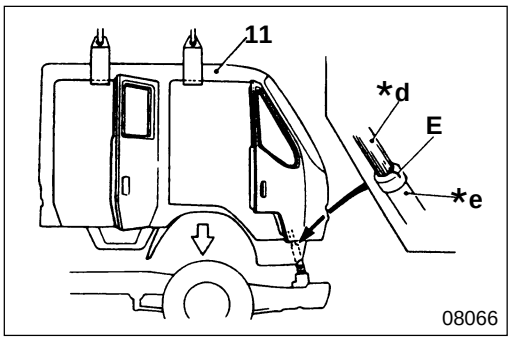
Make sure, when lifting cab assembly 11, that the wiring harness, cable, hoses, etc. are completely disconnected when the cab is lifted slightly.

REMOVAL AND INSTALLATION OF CAB < FIXED CAB >

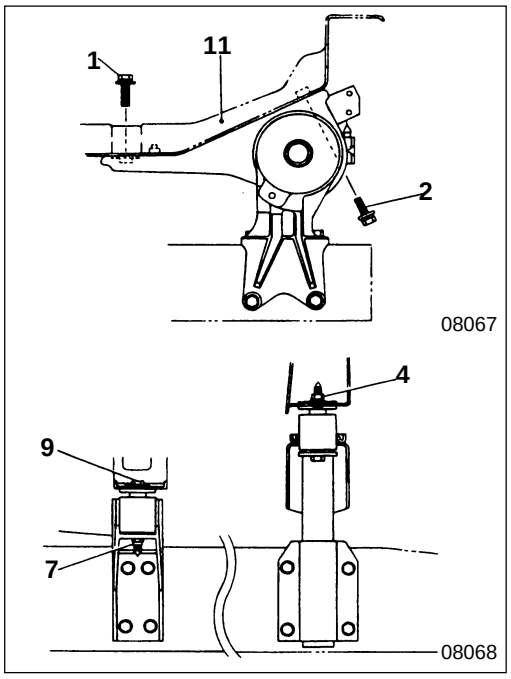


[Installation]

- Mount hoist attachment **A** at center-of-gravity point **D** of cab assembly **11**. P42-33



- Slowly lower cab assembly **11** horizontally to insert steering yoke ***d** into steering shaft ***e**, aligning alignment mark **E**.

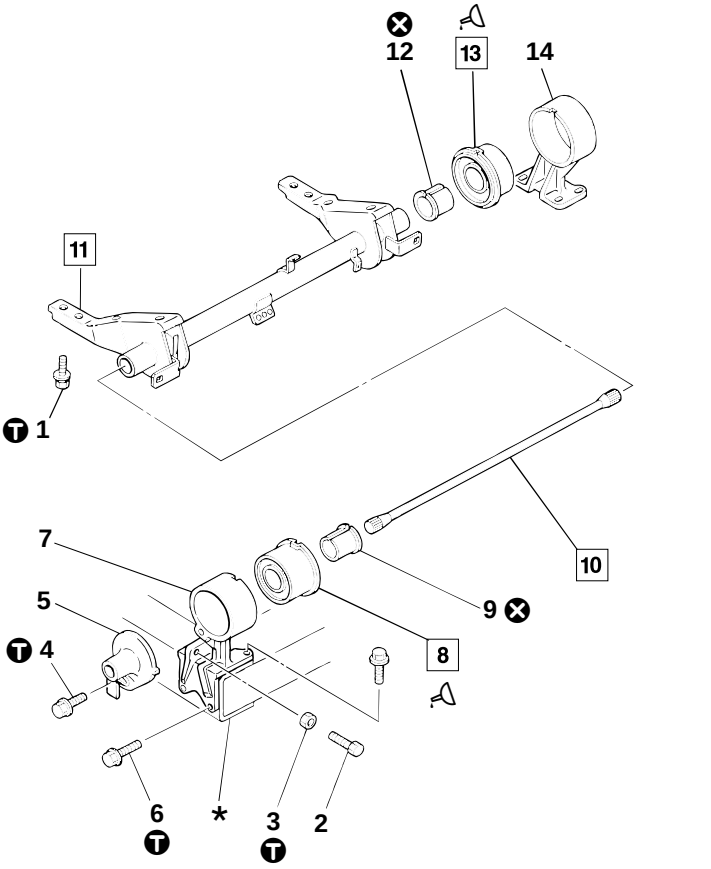


- Slowly lower cab assembly **11** further, and remove hoist attachment **A** after it comes down fully, then tighten bolts **1**, **2**, **9** and nuts **4**, **7** at specified torque.

M E M O

FRONT CAB MOUNTING

< Tilt Cab >



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● **Disassembly sequence**

1 Bolt
2 Bolt
3 Nut
4 Bolt
5 Anchor lever
6 Bolt
7 Front cab mounting bracket, RH
8 Front rubber assembly, RH
9 Bushing, RH
10 Torsion bar
11 Front floor cross member assembly
12 Bushing, LH
13 Front rubber assembly, LH
14 Front cab mounting bracket, LH

⊗ : Non-reusable parts
* : Frame

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Since the following parts are assembled at the time the cab is mounted, see removal and installation of cab (P42-21) for assembly procedure.
1 : Bolt (Connection of front floor cross member assembly and cab assembly)
2 : Bolt (Adjustment of anchor lever)
3 : Nut
4 : Bolt (Installation of anchor lever)
5 : Anchor lever

Ⓣ Tightening torque

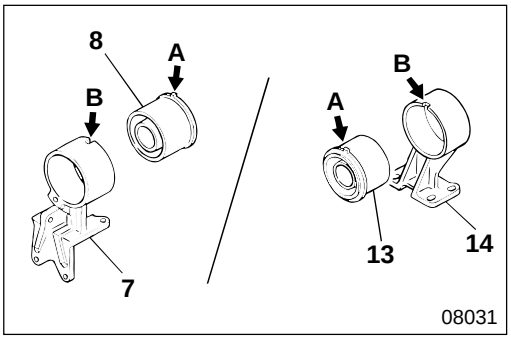
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front floor cross member assembly and cab assembly mounting)	70 to 95 {51 to 70, 7.1 to 9.7}	—
3	Nut (Lock of anchor lever adjustment bolt)	59 to 83 {43 to 61, 6 to 8.5}	—
4	Bolt (Anchor lever mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—
6	Bolt (Front cab mounting bracket mounting)	70 to 85 {51 to 63, 7.1 to 8.7}	—

Lubricant

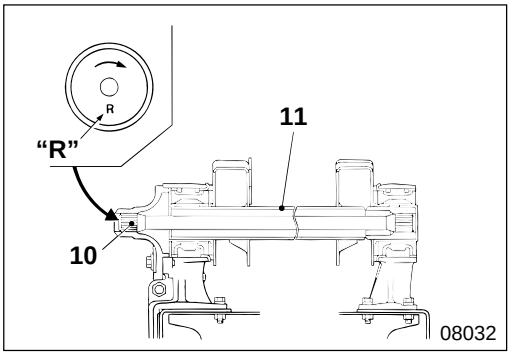
Location	Points of application	Kinds	Quantity
8, 13	Contact area between front rubber assemblies and front floor cross member assembly	Rubber grease	As required

◆ Service procedure



8 **13** **Installation of front rubber assembly**

Install front rubber assembly RH **8** and LH **13** fitting protrusions **A** to the indents **B** of mounting bracket RH **7** and LH **14** respectively.

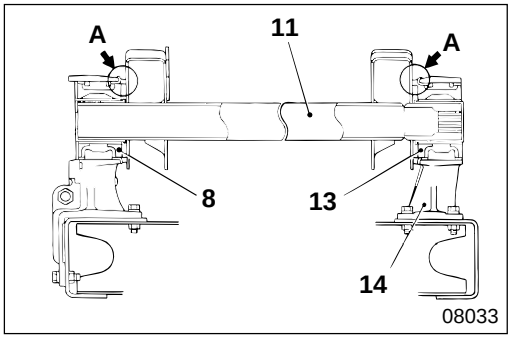


10 **Installation of torsion bar**

Install torsion bar **10** to front floor cross member assembly **11** in the direction as illustrated.

CAUTION⚠

Be sure not to mistake the left side for the right side, when installing torsion bar 10, because the torsion bar will be damaged if its torsion direction is reversed.

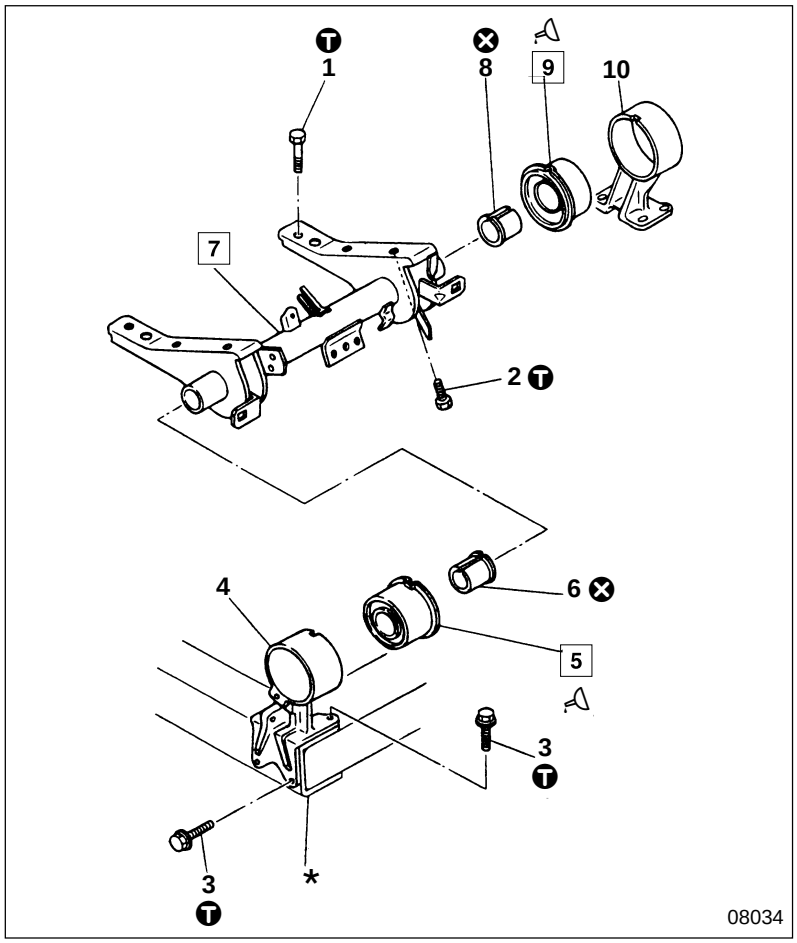


11 **Installation of front floor cross member assembly**

Install front floor cross member assembly **11**, adjusting front cab mounting bracket LH **14** so there is no gap between the front floor cross member assembly and front rubber assembly RH **8** and LH **13** at points **A**.

FRONT CAB MOUNTING

< Fixed Cab >



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Bolt
4 Front cab mounting bracket, RH
5 Front rubber assembly, RH
6 Bushing, RH
7 Front floor cross member assembly
8 Bushing, LH
9 Front rubber assembly, LH
10 Front cab mounting bracket, LH

⊗ : Non-reusable parts
* : Frame

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Since bolts 1, 2 (connection of front floor cross member assembly and cab assembly) are assembled at the time the cab is mounted, see removal and installation of cab (🕮 P42-32) for assembly procedure.

Ⓣ Tightening torque

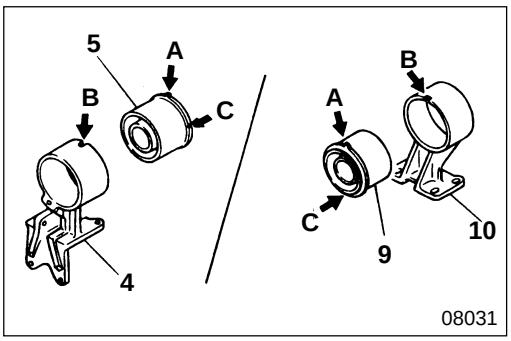
Unit : N·m {kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front floor cross member assembly and cab assembly mounting)	33 to 49 {3.4 to 5.0}	—
2	Bolt (Front floor cross member assembly and cab assembly mounting)	70 to 95 {7.1 to 9.7}	—
3	Bolt (Front cab mounting bracket mounting)	70 to 85 {7.1 to 8.7}	—

Lubricant

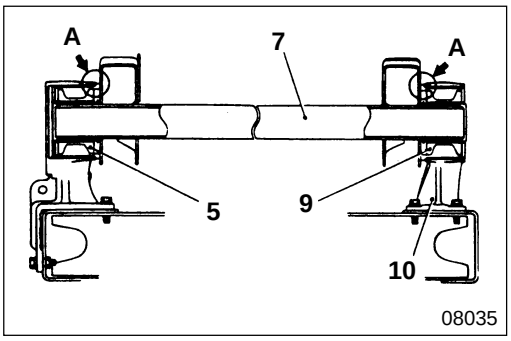
Location	Points of application	Specified lubricant	Quantity
5, 9	Contact area between front rubber assembly and front floor cross member assembly 🕮 P42-39	FUSO RUBBER GREASE RG-4	As required

◆ Service procedure



5 **9** **Installation of front rubber assembly**

- Install front rubber assembly, LH **9** and, RH **5** fitting protrusions **A** to the indents **B** of mounting bracket, LH **10** and, RH **4** respectively.
- After installation, apply grease to the entire periphery of contact area **C** with front floor cross member assembly **7**.

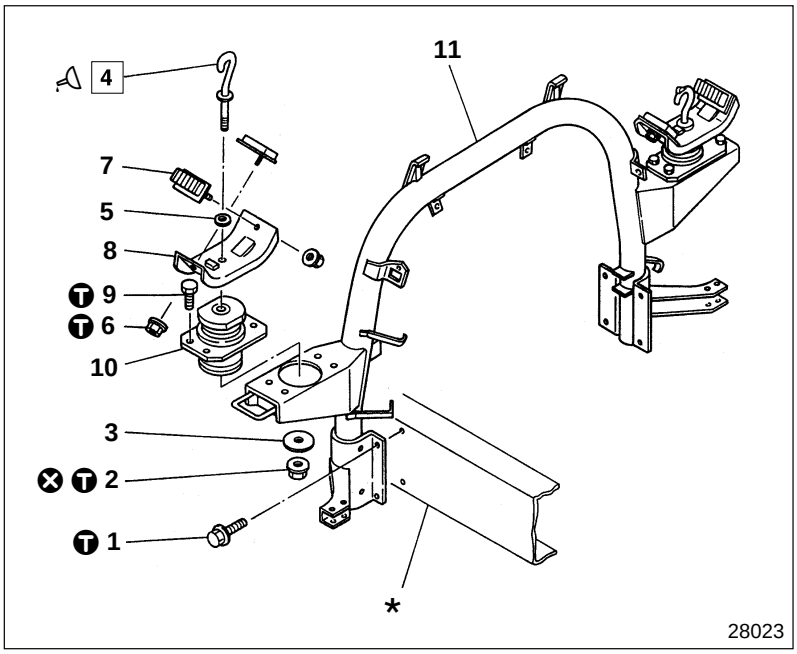


7 **Installation of front floor cross member assembly**

Install front floor cross member assembly **7**, adjusting front cab mounting bracket, LH **10** so there is no gap between the front floor cross member assembly and front rubber assembly, LH **9** and, RH **5** at points **A**.

REAR CAB MOUNTING

< Tilt Cab >



● **Disassembly sequence**

1 Bolt
2 Nut
3 Plate
4 Anchor hook
5 Spacer
6 Nut
7 Side rubber
8 Cab hold bracket
9 Bolt
10 Rear rubber assembly
11 Rear mounting post

⊗ : Non-reusable parts
* : Frame

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

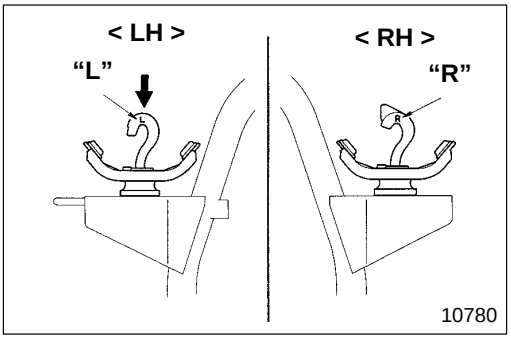
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Rear mounting post mounting)	78 to 105 {58 to 80, 8 to 11}	—
2	Nut (Anchor hook mounting)	83 to 98 {61 to 72, 8.5 to 10.0}	—
6	Nut (Side rubber mounting)	10 to 15 {7.2 to 11.0, 1.0 to 1.5}	—
9	Bolt (Rear rubber assembly mounting)	16 to 20 {12 to 14, 1.6 to 2.0}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
4	Upper side of anchor hook (contact area between lock handle and stopper)	Chassis grease [NLGI No. 1 (Ca Soap)]	—

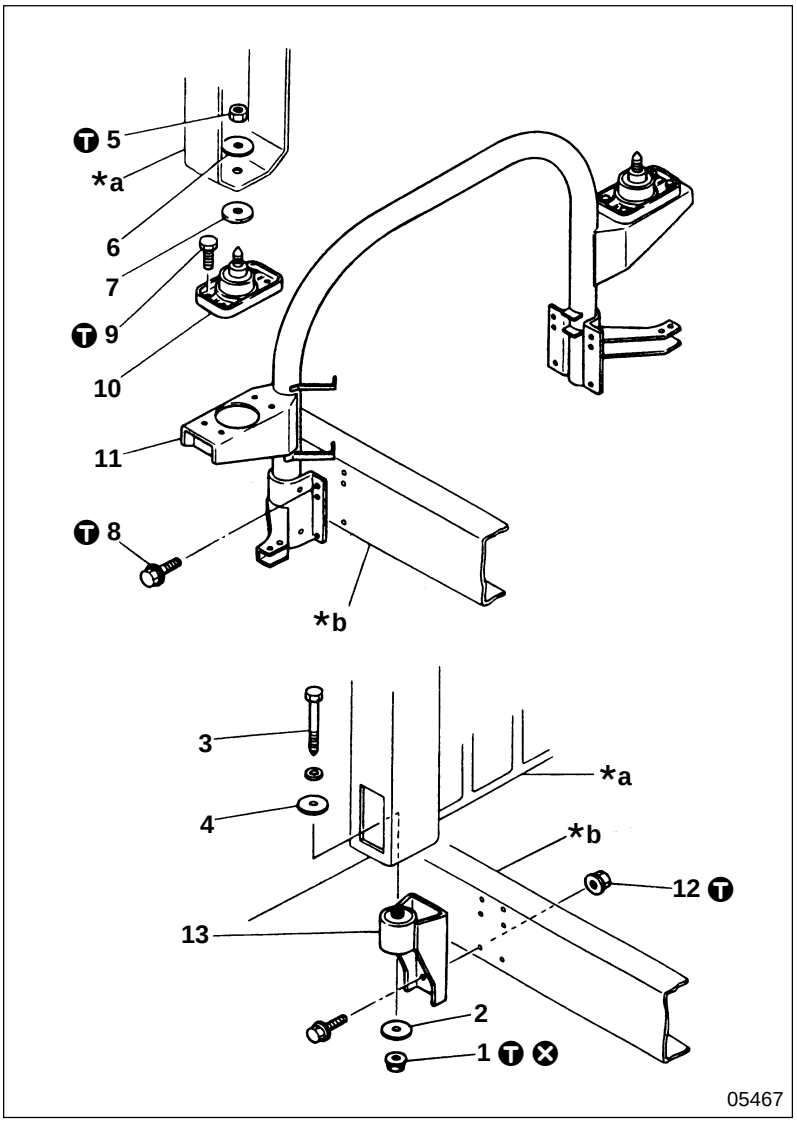
◆ Service procedure



4 **Installation of anchor hook**

Install anchor hook **4** so that open side of the hook comes to left side of the vehicle while aligning the identification marks "**L**" and "**R**".
Also always make sure to apply grease on upper part of the left anchor hook (⬇ part).

< Fixed Cab >



● **Disassembly sequence**

1 Lock nut
2 Plate
3 Cone point bolt
4 Plate
5 Nut
6 Plate
7 Plate
8 Bolt
9 Bolt
10 Rubber
11 Rear mounting post
12 Nut
13 Cab bracket assembly

⊗ : Non-reusable parts
***a** : Cab assembly
***b** : Frame

● **Assembly sequence**

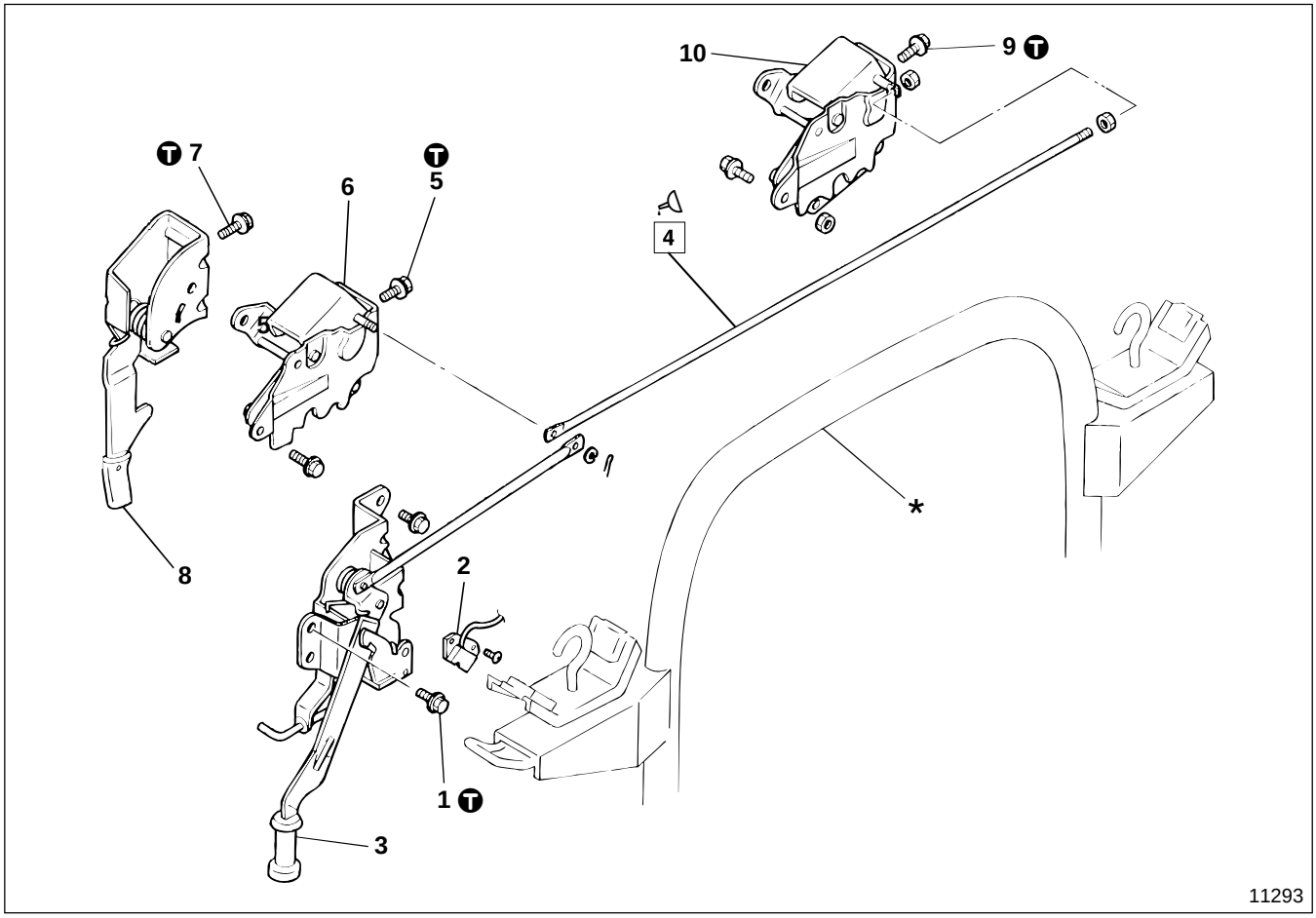
Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {kgf·m}(ft.lbs)

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Cab bracket assembly and cab assembly mounting)	59 to 69 {6 to 7}	—
5	Nut (Rear mounting post and cab assembly mounting)	39 to 59 {4 to 6}	—
8	Bolt (Rear mounting post mounting)	78 to 105 {8 to 11}	—
9	Bolt (Rubber assembly mounting)	16 to 20 {1.6 to 2.0}	—
12	Nut (Cab bracket assembly mounting)	59 to 69 {6 to 7}	—

CAB TILT LINK



● **Disassembly sequence**

1 Bolt
2 Cab tilt lock switch Gr 54
3 Lock handle assembly
4 Center rod
5 Bolt
6 Link assembly, LH
7 Bolt
8 L-lever assembly
9 Bolt
10 Link assembly, RH

* : Rear mounting post

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock handle assembly mounting)	29 to 39 {22 to 29, 3 to 4}	—
5	Bolt (Link assembly, LH mounting)	29 to 39 {22 to 29, 3 to 4}	—
7	Bolt (L-lever assembly mounting)	29 to 39 {22 to 29, 3 to 4}	—
9	Bolt (Link assembly, RH mounting)	29 to 39 {22 to 29, 3 to 4}	—

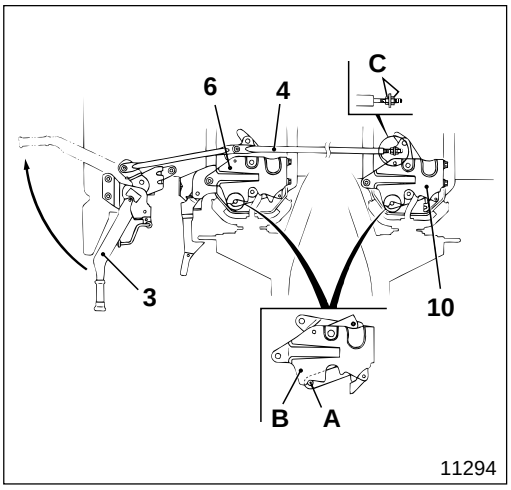
Lubricant

Location	Points of application	Kinds	Quantity
4	Connecting area between center rod link assembly, LH and lock handle assembly	Wheel bearing grease [NLGI No2 (Li soap)]	As required

◆ Service procedure

● Inspection after assembly

Make sure that operating force for lock handle assembly **3** is correct. If it is too heavy or too light, adjust. P42-17



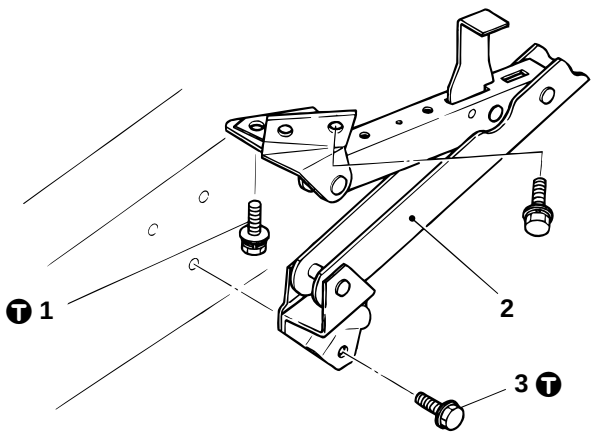
4 Installation of center rod

Adjust the length of center rod **4** using lock nut **C** to optimize locking and unlocking of rear cab mounting.

- Raise lock handle assembly **3** all the way, unlocking it.
- Turn and adjust lock nut **C** so that shafts **A** of link assembly LH **6** and RH **10** contact brackets **B**.

CAB TILT LINK

Cab Stay



● **Removal sequence**
1 Bolt
2 Cab stay assembly
3 Bolt

WARNING
You must use a hoist to support the cab when you remove the cab stay assembly.

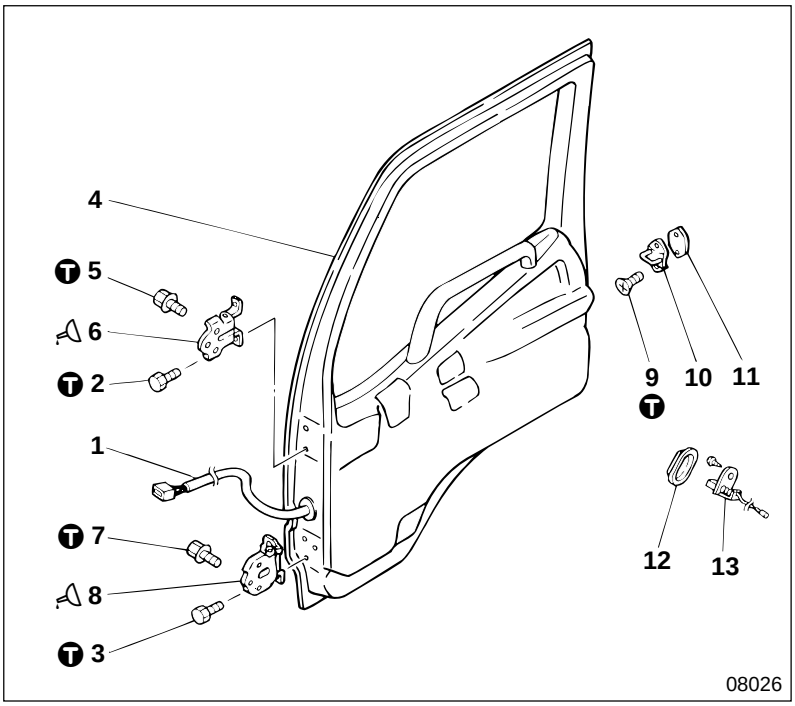
● **Installation sequence**
Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Cab stay mounting)	19 to 27 {14 to 20, 1.9 to 2.8}	—
3	Bolt (Cab stay mounting)	59 to 78 {43 to 65, 6 to 8}	—

Door Hinge and Striker



● **Disassembly sequence**

1 Door harness
2 Bolt
3 Bolt
4 Door assembly P42-46
5 Bolt
6 Upper hinge
7 Bolt
8 Lower hinge
9 Screw
10 Striker
11 Shim
12 Grommet
13 Door switch Gr 54

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection and adjustment after assembly**

P42-18

NOTE

For adjustment of door fitting: P42-18.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2, 3	Bolt (Door assembly mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
5	Bolt (Upper hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
7	Bolt (Lower hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
9	Screw (Striker mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—

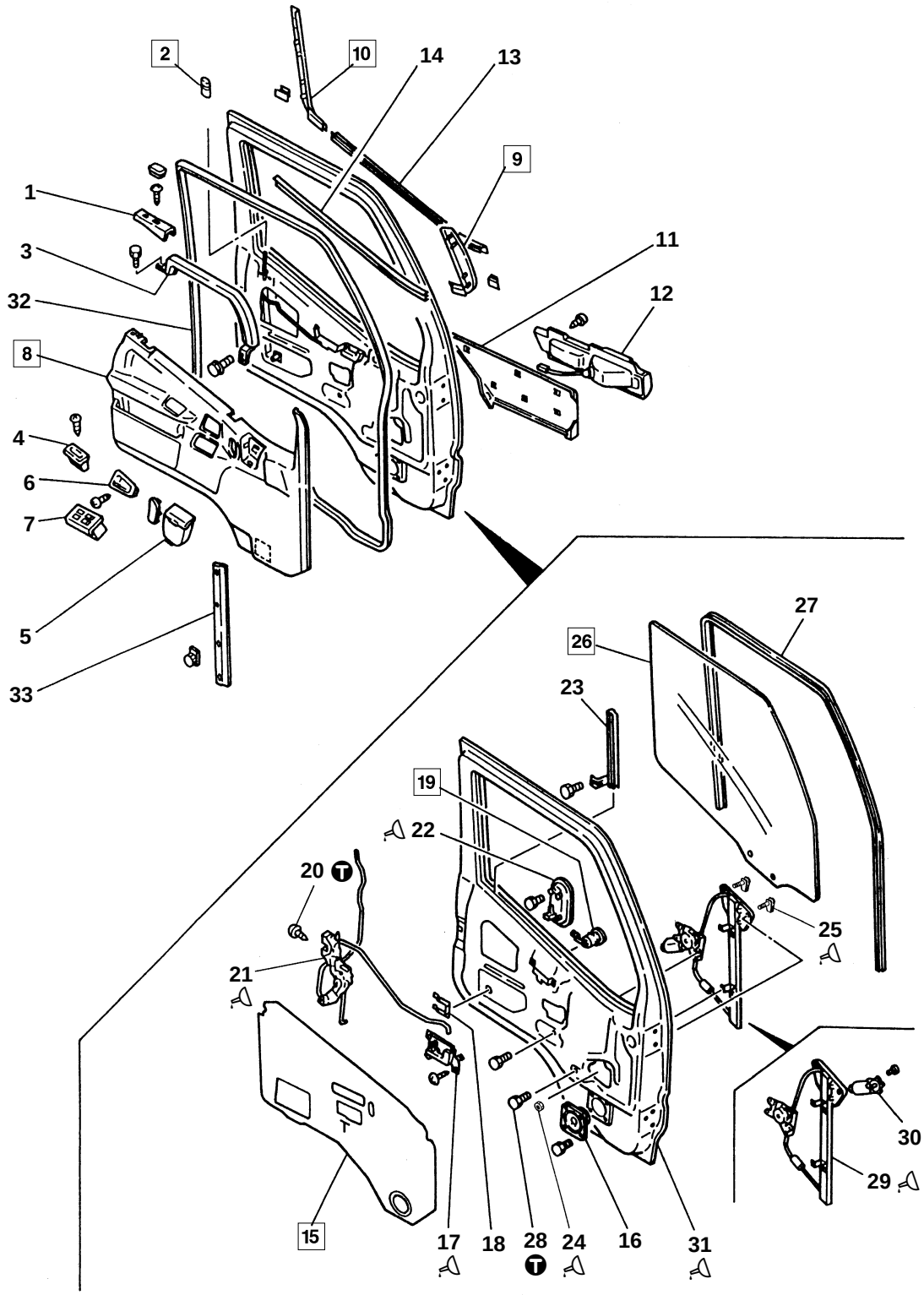
Lubricant

Location	Points of application	Kinds	Quantity
6	Upper hinge checker pin roller	Chassis grease [NLGI No.1 (Ca soap)]	As required
8	Lower hinge checker pin roller	Chassis grease [NLGI No.1 (Ca soap)]	As required

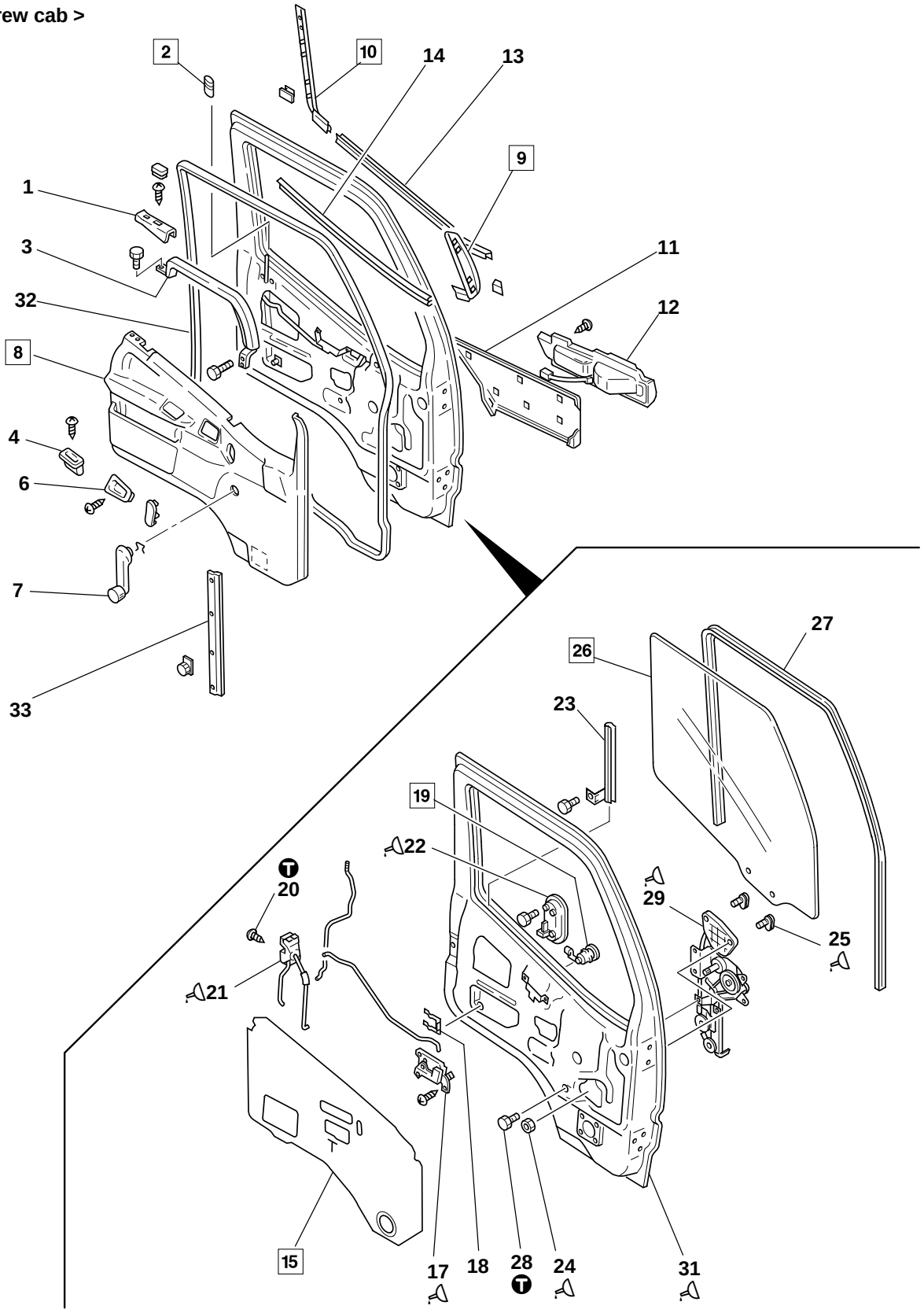
FRONT DOOR

Door Assembly

< Except crew cab >



< Crew cab >


2
10
14
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9
1
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12
8
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7
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27
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22
20
29
25
21
15
17
18
28
24
31
Ⓟ45743

FRONT DOOR

● **Disassembly sequence**

1 Cover
2 Door lock knob
3 Guard bar
4 Pull handle cover
5 Ashtray < Except crew cab >
6 Inside handle cover
7 Power window switch
< Except crew cab > Gr 54
Regulator handle < Crew cab >
8 Door trim
9 Front garnish
10 Rear garnish
11 Outer garnish
12 Side combination lamp Gr 54
13 Outer weather strip
14 Inner weather strip
15 Waterproof cover
16 Speaker < Except crew cab >
17 Inside handle
18 Clip
19 Door lock cylinder
20 Screw
21 Door lock actuator
< Except crew cab > Gr 54
Door lock assembly < Crew cab >
22 Outside handle
23 Lower sash
24 Nut
25 Glass holder
26 Door glass
27 Run channel
28 Bolt
29 Regulator & rail assembly
30 Power window motor
< Except crew cab > Gr 54
31 Door panel
32 Weather strip
33 Weather strip

● **Reassembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

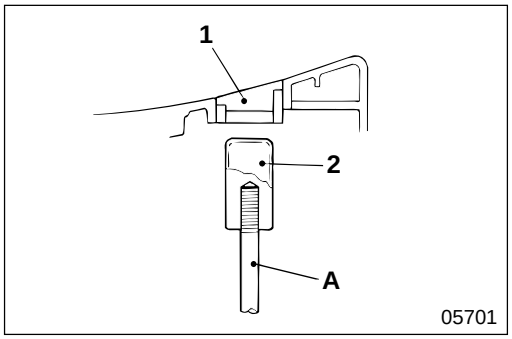
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
20	Screw (Door lock actuator mounting)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
28	Bolt (Regulator & rail assembly mounting)	6.9 to 10.8 {5.1 to 8.0, 0.7 to 1.1}	—

Lubricant and/or sealant

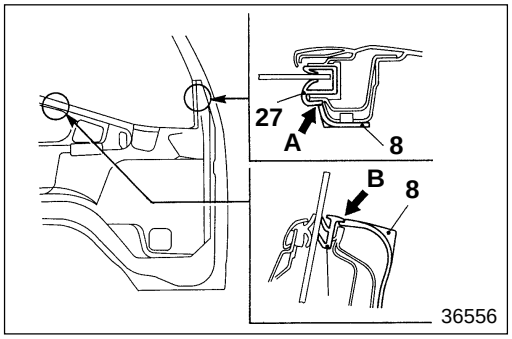
Location	Points of application	Specified lubricant and/or sealant	Quantity
17	Rotating surface of inside handle	Multipurpose grease [NGLI No.2 (Li soap)]	As required
21	Sliding surface of door lock actuator or door lock assembly	Multipurpose grease [NGLI No.2 (Li soap)]	As required
22	Sliding surface of outside handle	Multipurpose grease [NGLI No.2 (Li soap)]	As required
24	Threads of nut	Loctite (Japan) Drylock No. 203	As required
25	Threads of glass holder bolt	Loctite (Japan) Drylock No. 203	As required
29	Sliding surfaces of regulator & rail assembly	Dynamic GB	As required
31	Waterproof cover installation surface of door panel	Butyl tape	As required

◆ Service procedure



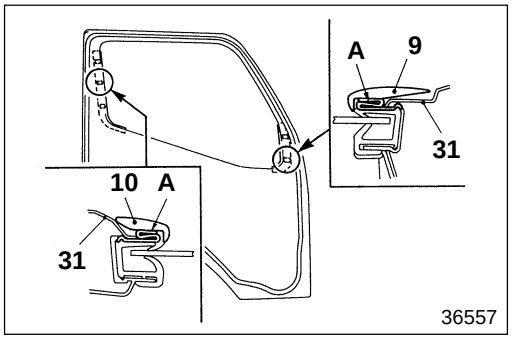
2 **Installation of door lock knob**

- Install door lock knob **2** to door lock rod A of door lock actuator **21**, and turn the knob fully in clockwise direction.
- Back off door lock knob **2** by turning it 1 or 2 turns in counterclockwise direction.
- Position cover **1** to prevent door lock knob **2** from turning.



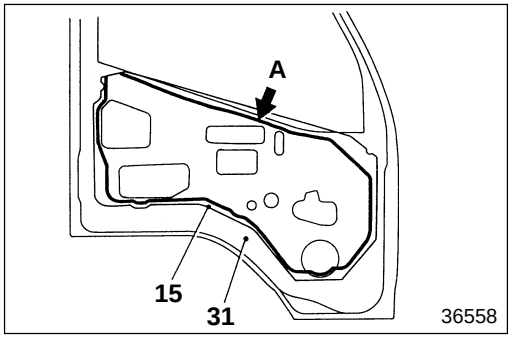
8 **Installation of door trim**

- On the front pillar section, install door trim **8** by pressing it to lip section **A** of run channel **27**.
- On the belt line section, install door trim **8** by pressing it to lip section **B** of inner weather strip **14**.



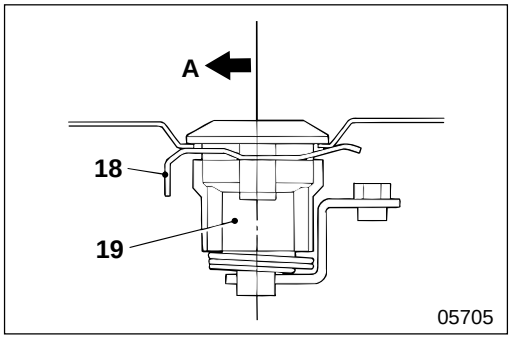
9 **10** **Installation of front and rear garnishes**

- Install clips **A** to door panel **31** prior to the installation of the garnishes.
- Install front garnish **9** and rear garnish **10** to clips **A**.



15 **Installation of waterproof cover**

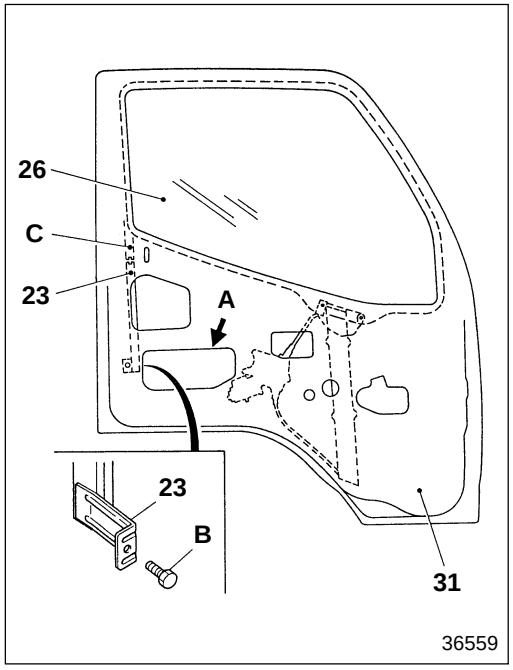
- Apply butyl tape **A** to door panel **31**, as indicated in the illustration.
- Install waterproof cover **15** by pasting onto butyl tape **A**.



19 **Installation of door lock cylinder**

Install door lock cylinder **19** to clip **18** in the direction indicated in the illustration.

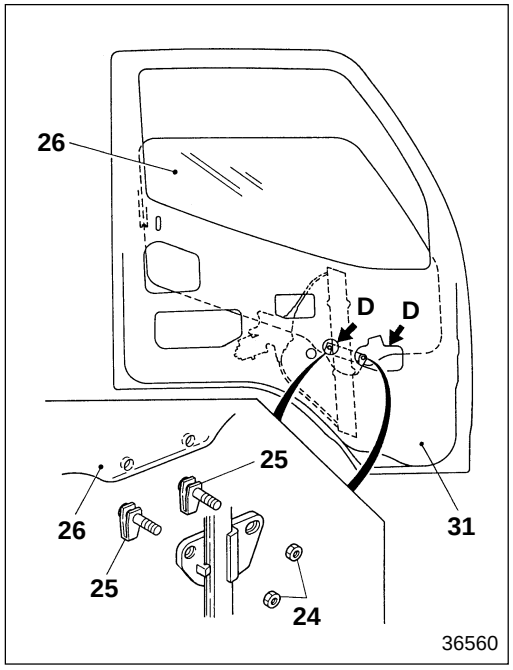
A : Vehicle front side



26 **Removal and installation of door glass**

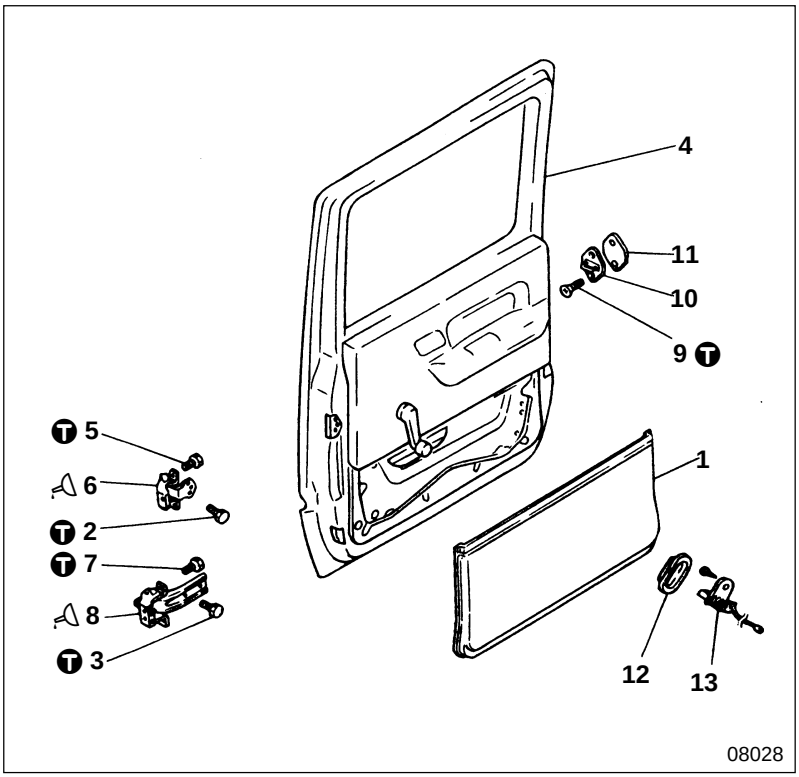
Remove all parts supporting door glass **26**, then remove the door glass through the open space in the door.

- Pull door glass **26** all the way to the top.
- Remove bolt **B** through hole **A** in door panel **31**, and remove lower sash **23**.
  Note that the lower sash is inserted in upper sash **C**.



- Lower door glass **26** until nut **24** becomes visible through hole **D** in door panel **31**.
- Support door glass **26** by hand, then remove glass holder **25**.
- Remove door glass **26** through the open space in the door.
- To install door glass **26**, follow the removal procedure in reverse.

Door Hinge and Striker



● **Disassembly sequence**

1 Lower panel
2 Bolt
3 Bolt
4 Door assembly P42-52
5 Bolt
6 Upper hinge
7 Bolt
8 Lower hinge
9 Screw
10 Striker
11 Shim
12 Grommet
13 Door switch Gr 54

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

For adjustment of door fit, see P42-18

T Tightening torque

Unit : N·m {kgf·m}

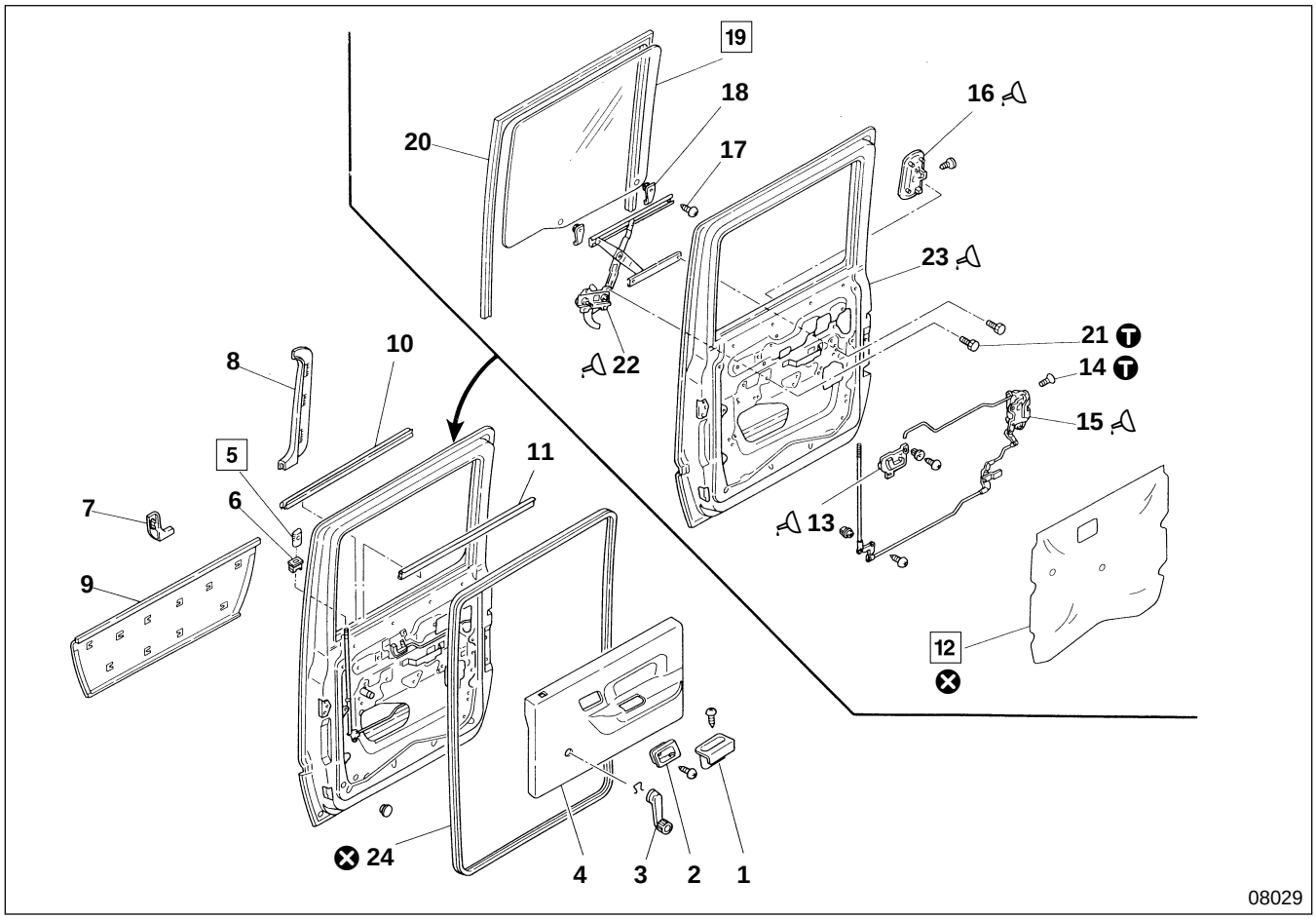
Location	Parts to be tightened	Tightening torque	Remarks
2, 3	Bolt (Door assembly mounting)	8.8 to 14 {0.9 to 1.4}	—
5	Bolt (Upper hinge mounting)	8.8 to 14 {0.9 to 1.4}	—
7	Bolt (Lower hinge mounting)	8.8 to 14 {0.9 to 1.4}	—
9	Screw (Striker mounting)	8.8 to 14 {0.9 to 1.4}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
6	Upper hinge checker pin roller	KYODO YUSHI PLUS GUARD SG	As required
8	Lower hinge checker pin roller	KYODO YUSHI PLUS GUARD SG	As required

REAR DOOR < CREW CAB >

Door Assembly



● **Disassembly sequence**

1 Pull handle cover
2 Inside handle cover
3 Regulator handle
4 Upper trim
5 Door lock knob
6 Bushing
7 Front garnish
8 Rear garnish
9 Outer garnish
10 Outer weatherstrip
11 Inner weatherstrip
12 Waterproof cover
13 Inside handle
14 Screw
15 Door lock assembly
16 Outside handle
17 Screw
18 Glass holder
19 Door glass
20 Run channel
21 Bolt
22 Regulator assembly
23 Door panel
24 Weatherstrip

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

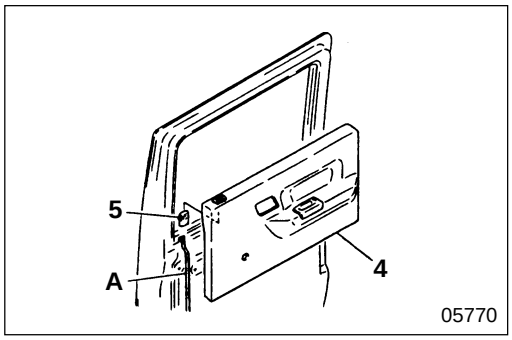
Unit : N·m {kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
14	Screw (Door lock assembly mounting)	3.9 to 5.9 {0.4 to 0.6}	—
23	Bolt (Regulator assembly mounting)	6.9 to 11 {0.7 to 1.1}	—

Lubricant

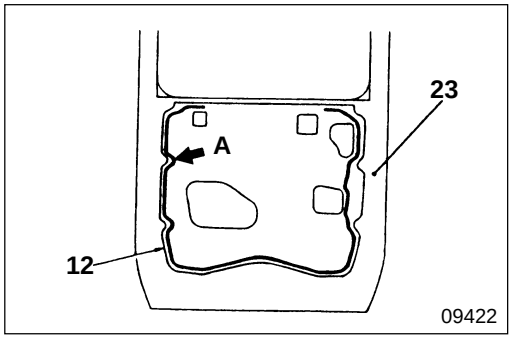
Location	Points of application	Specified lubricant	Quantity
13	Turning part of inside handle	SHOWA SHELL SEKIYU SUNLITE LA2	As required
15	Friction part of door lock assembly	KYODO YUSHI MULTEMP TAS	As required
16	Friction part of outside handle	SHOWA SHELL SEKIYU SUNLITE LA2	As required
22	Friction part of regulator assembly	DYNAMIC GB	As required
23	Door panel waterproof cover mounting surface	BUTYL TAPE	As required

◆ Service procedure



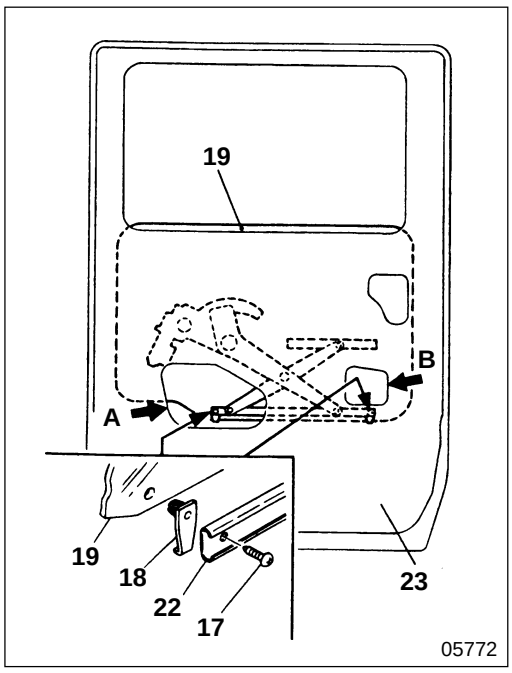
5 Installation of door lock knob

Twist door lock knob **5** onto door lock rod **A** fully, then slacken off by one or two turns and stop its rotation using upper trim **4**.



12 Installation of waterproof cover

Apply butyl tape **A** to door panel **23** as illustrated, then stick on waterproof cover **12** securely.

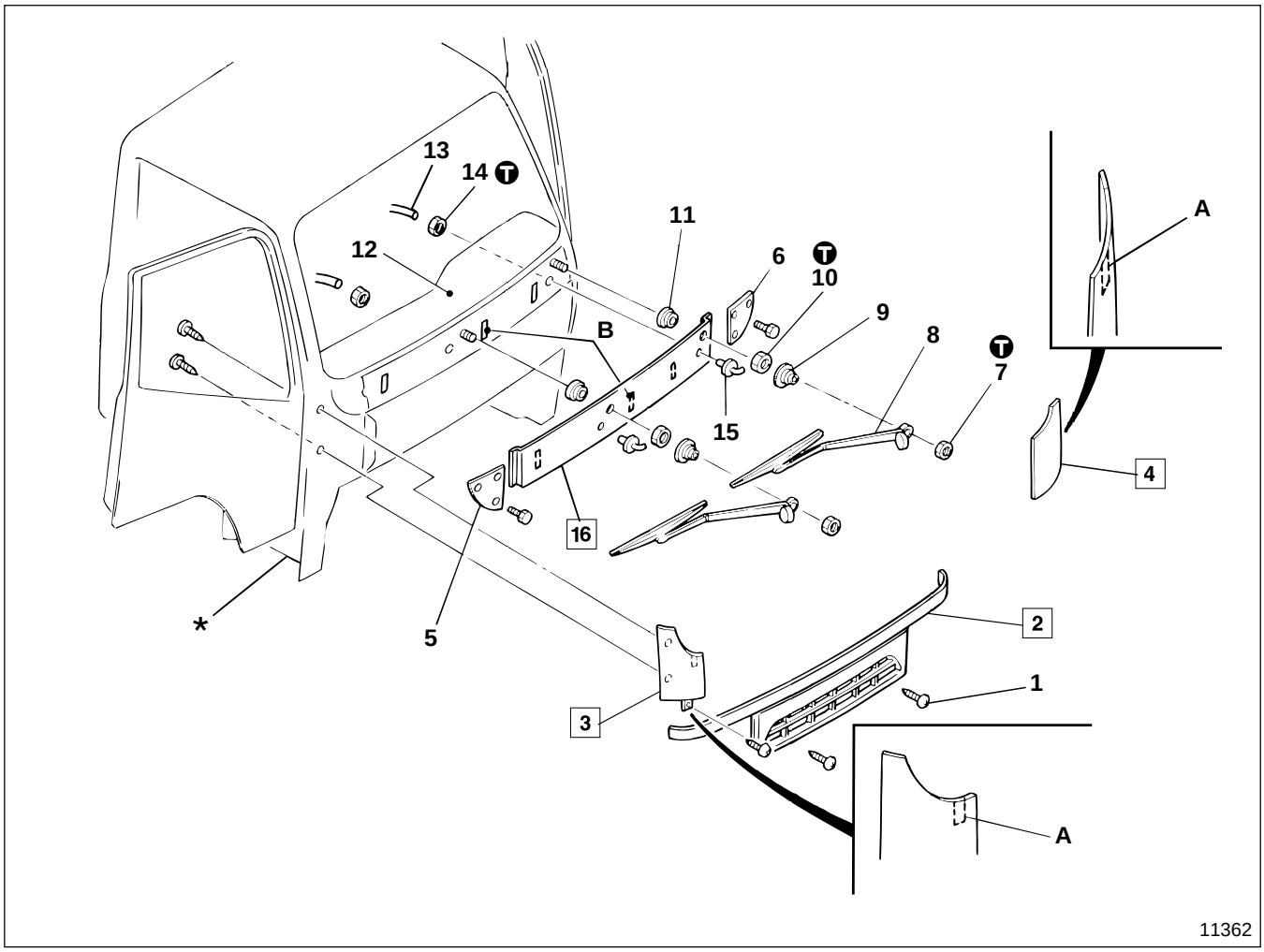


19 Removal and installation of door glass

- Position door glass **19** so that screw **17** can be seen through holes **A** and **B** on door panel **23**.
- Through these holes, remove screw **17** and glass holder **18**, detach door glass **19** from regulator assembly **22**, then lift up and remove the glass.

CAB EXTERIOR FITTING

Front Panel



● **Disassembly sequence**

1 Screw
2 Front grille
3 Front side panel, RH
4 Front side panel, LH
5 Side garnish, RH
6 Side garnish, LH
7 Nut
8 Wiper arm and blade assembly 🕮 P42-60
9 Pivot cap
10 Nut
11 Packing washer 🕮 P42-60
12 Instrument panel 🕮 P42-66
13 Washer hose
14 Nut
15 Hose joint
16 Front garnish

***** : Cab assembly
A : Pawl (Front side panel)
B : Magic tape

● **Assembly sequence**

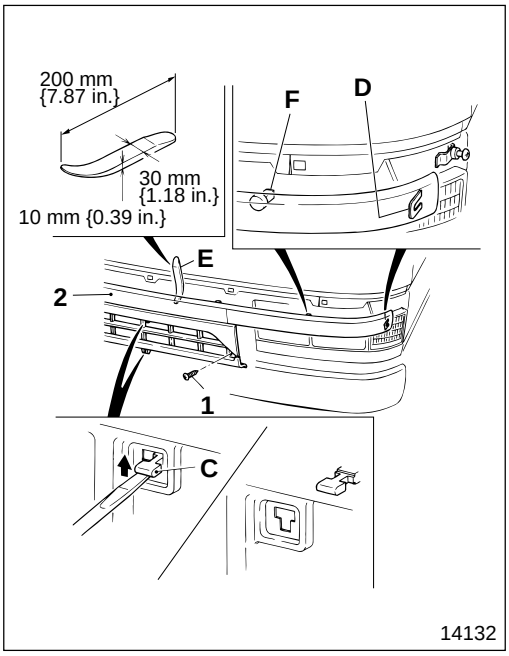
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Nut (Wiper arm and blade assembly mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
10	Nut (Packing washer mounting)	14 to 20 {10 to 14, 1.4 to 2.0}	—
14	Nut (Hose joint connecting)	0.59 to 0.88 {0.43 to 0.65, 0.06 to 0.09}	—

◆ Service procedure



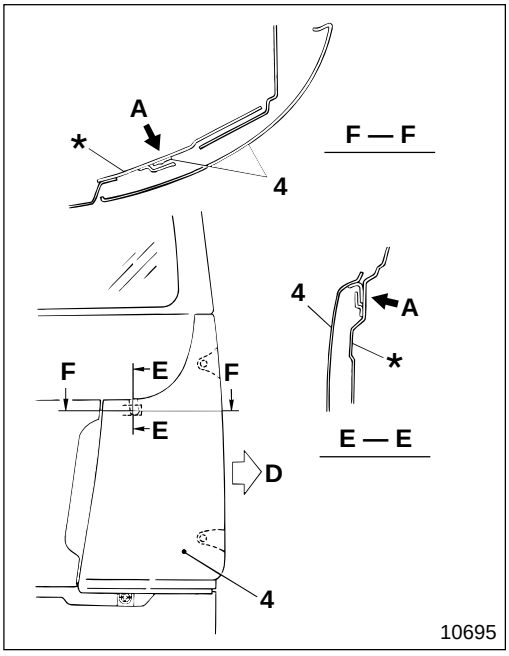
2 Removal and installation of front grille

- Remove screws **1** (two points) from front grilles **2**.
- Lift up the ends of clips **C** (two points), located in the center of front grilles **2**, using a screwdriver, and unlock them from the clips.
- Pull out front grille **2** horizontally, in the vehicle forward running direction, to remove them.

CAUTION

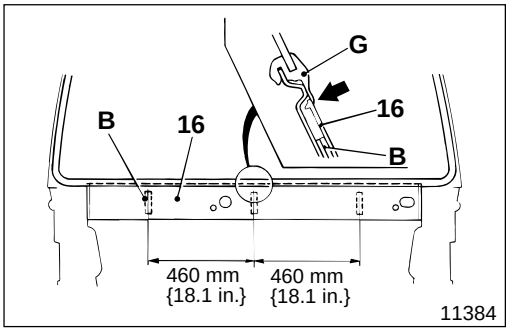
- **Be careful not to apply too much force to front grilles 2, because this would damage them. Be especially careful to avoid applying force to clips D at both sides, support the clips using your hands. If it is hard to remove the front grilles, remove them using nylon jig E as illustrated.**
- **Be careful not to use force when you pull out clips F (five points) from the tops of front grille 2, because this would damage them.**

- For installation, follow the removal sequence in reverse.



3 4 Installation and removal of front side panels RH, LH

- Move front side panels RH **3**, LH **4** to the outside of the vehicle to remove them from the cab assembly *.
  A : Pawl
  (The illustration shows front side panel LH **4**.)
- For installation, follow the removal sequence in reverse.



16 Installation of front garnish

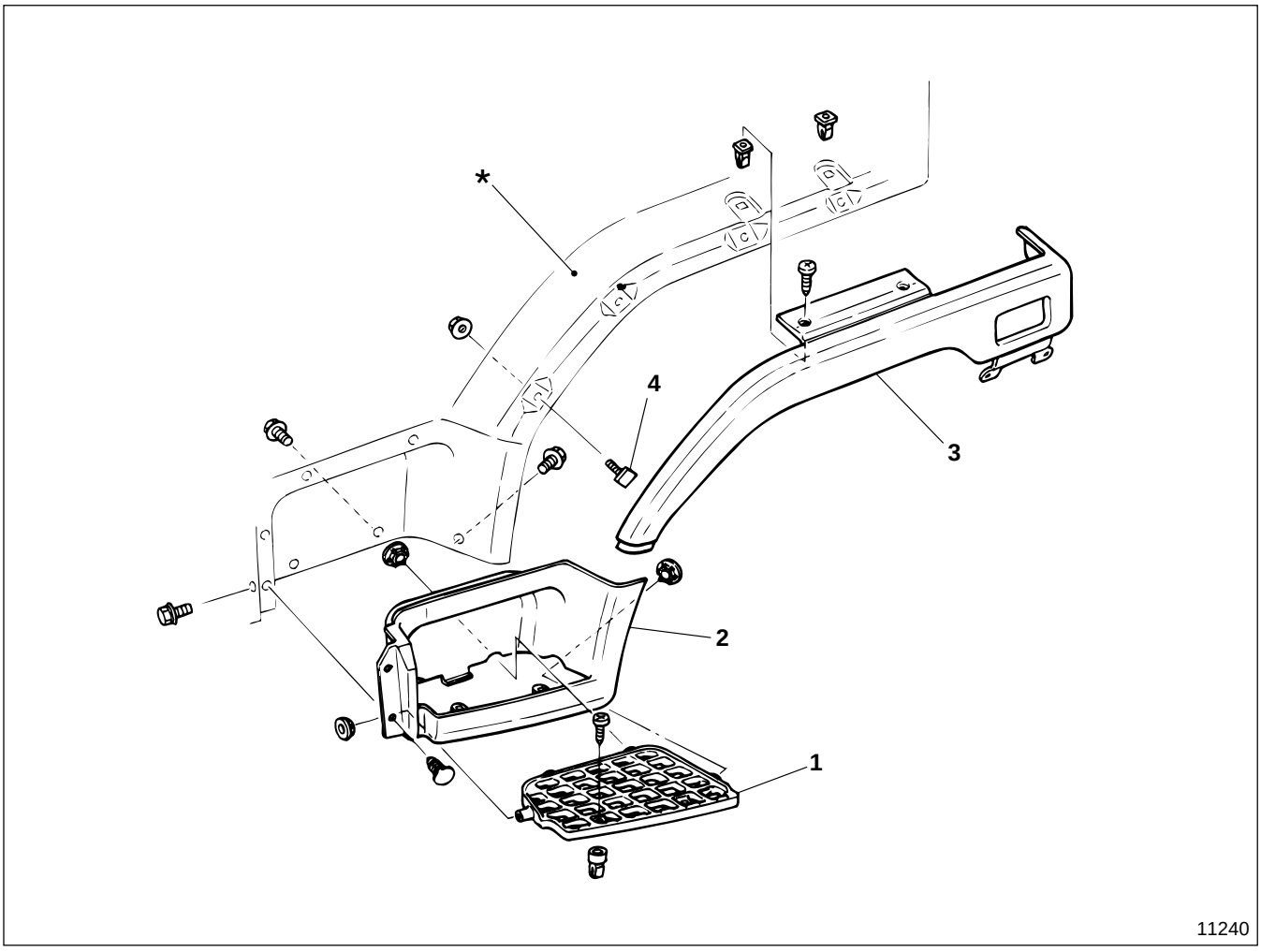
NOTE

When installing front garnish 16, be careful not to catch weatherstrip G of the windshield.

B : Magic tape (3 points)

CAB EXTERIOR FITTING

Step and Fender



● **Removal sequence**

1 Step
2 Step garnish
3 Fender garnish
4 Set bolt

***** : Cab assembly

● **Installation sequence**

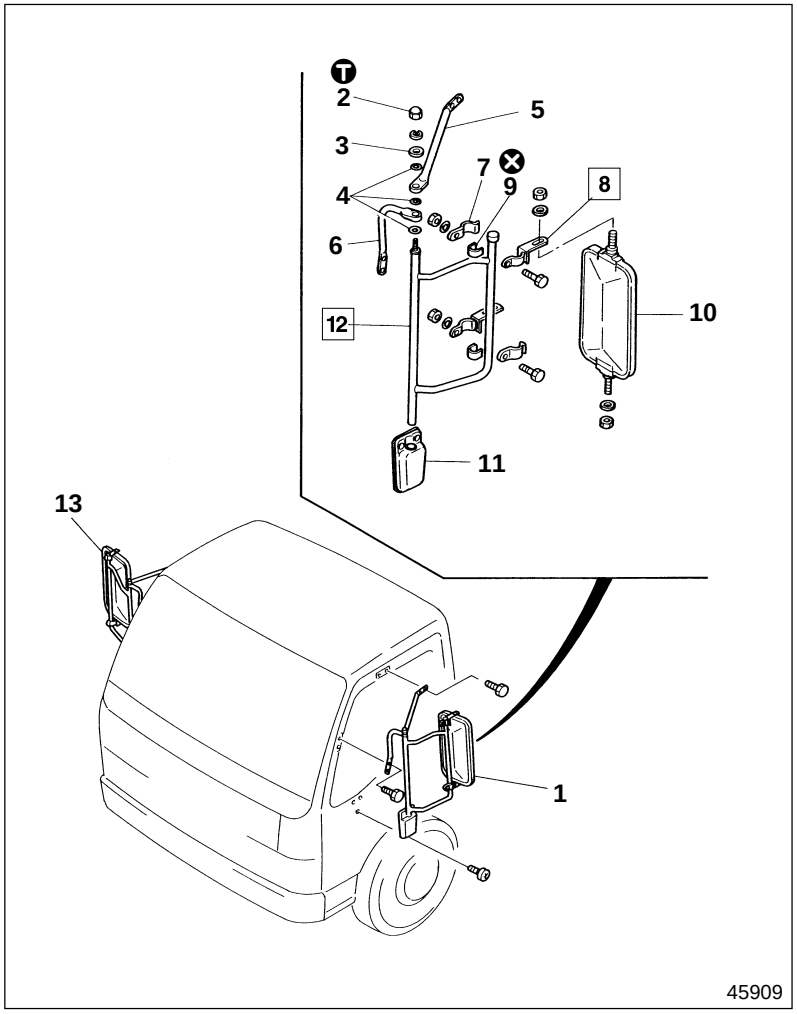
Follow the removal sequence in reverse.

NOTE

This illustration only shows the step and fender for the left side; the same service procedure described above is used for the right side.

M E M O

MIRROR



● **Removal sequence**

1 Outside mirror stay assembly, LH
2 Nut
3 Washer (Stainless)
4 Washers
5 Sub mirror stay
6 Sub mirror stay
7 Mirror holder B
8 Mirror holder
9 Packing
10 Outside mirror
11 Lower bracket
12 Main mirror stay
13 Outside mirror stay assembly, RH

⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

NOTE

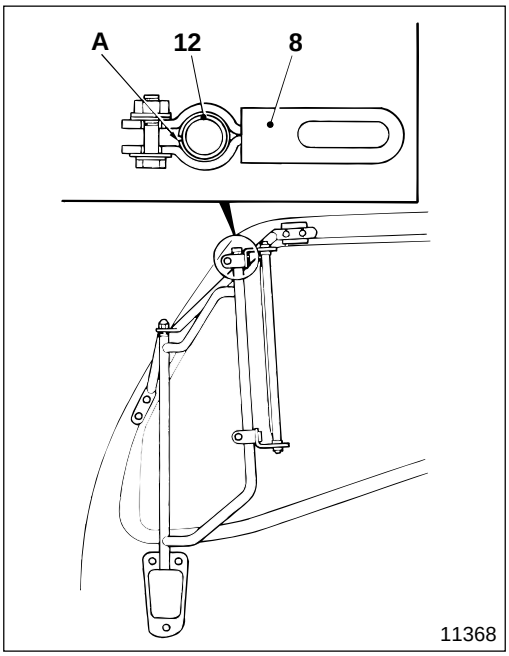
For outside mirror stay assembly RH 13, follow the same service procedure as for outside mirror stay assembly LH 1.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Sub mirror stay and main mirror stay mounting)	24.5 to 29.4 {18 to 22, 2.5 to 3.0}	—

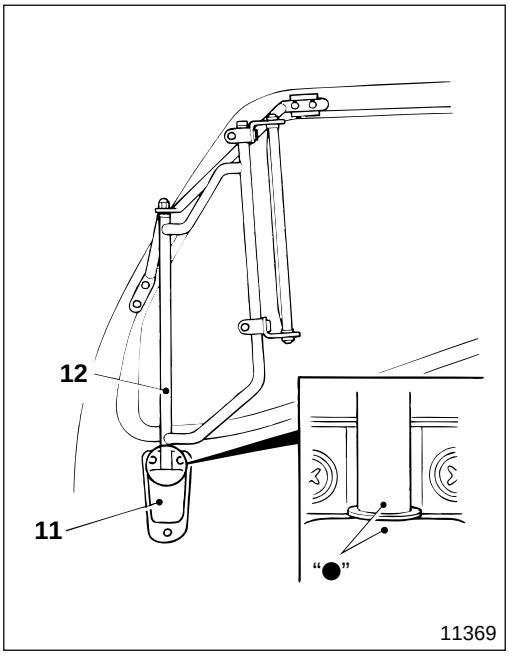
◆ Service procedure



8 **Installation of mirror holder**

Install mirror holder **8** onto main mirror stay **12** in the direction as illustrated.

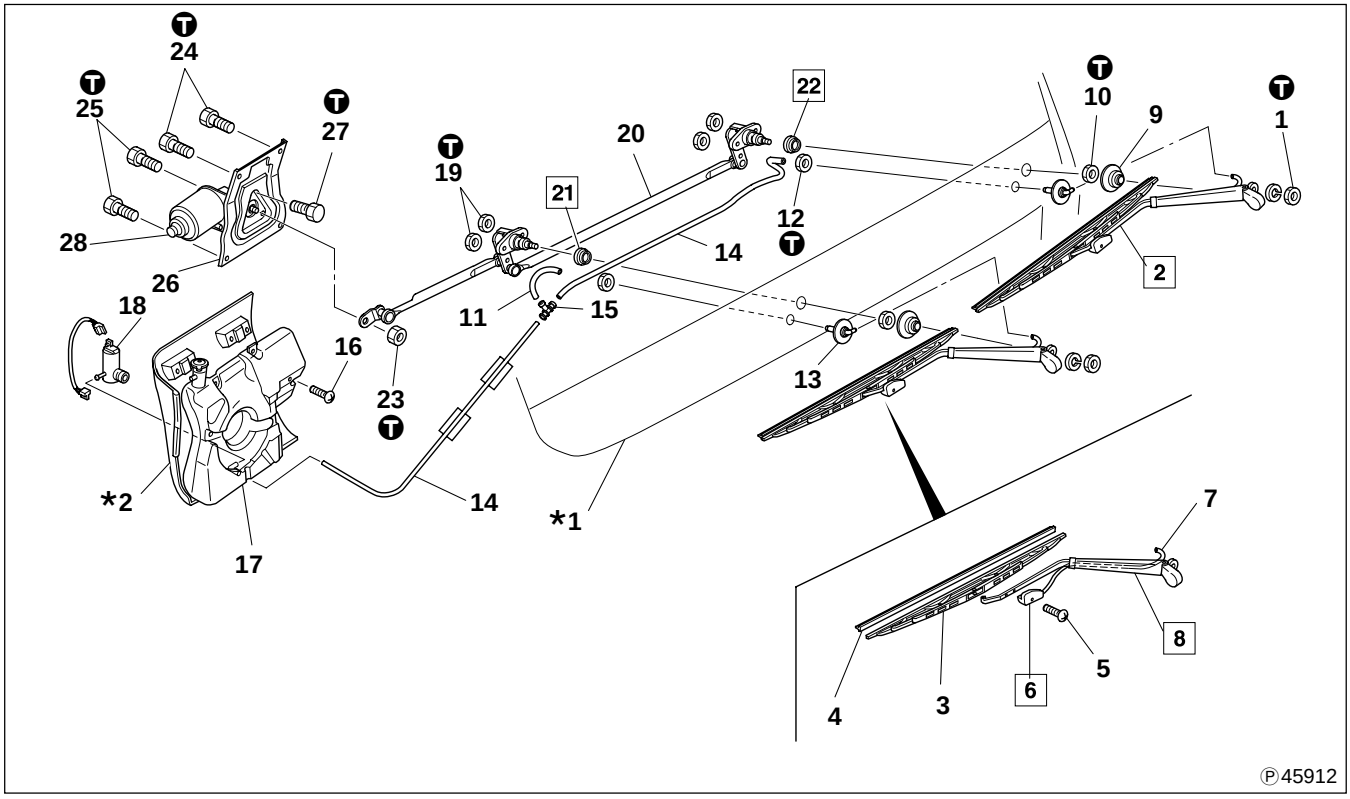
A : Indent of main mirror stay **12**.



12 **Installation of main mirror stay**

Install main mirror stay **12** and lower bracket **11** so that alignment marks "●" are aligned.

WIPER AND WASHER



● **Disassembly sequence**

1 Nut
2 Wiper arm and blade assembly
3 Wiper blade
4 Blade rubber
5 Screw
6 Washer nozzle assembly
7 Hose
8 Wiper arm
9 Pivot cap
10 Nut
11 Washer hose
12 Nut
13 Hose joint
14 Washer hose
15 Joint
16 Screw
17 Washer tank
18 Washer motor Gr 54
19 Nut
20 Wiper link assembly
21 Packing washer
22 Packing washer
23 Nut
24 Bolt (L : 16 mm {0.63 in.})
25 Bolt (L : 12 mm {0.47 in.})
26 Wiper motor bracket
27 Bolt
28 Wiper motor Gr 54

***1** : Front garnish
***2** : Assistant driver's side lower panel P42-66

NOTE

Before disassembling parts 11 to 28, remove the instrument panel to allow access to them. P42-66

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

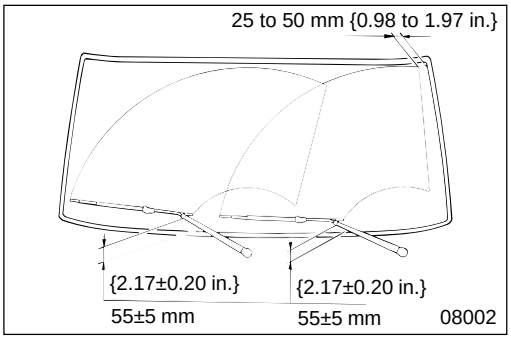
Location	Maintenance item	Standard value	Limit	Remedy
2	Wiping force of wiper arm	5.7±0.49 N {1.28±0.11 lbf, 0.58±0.05 kgf}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

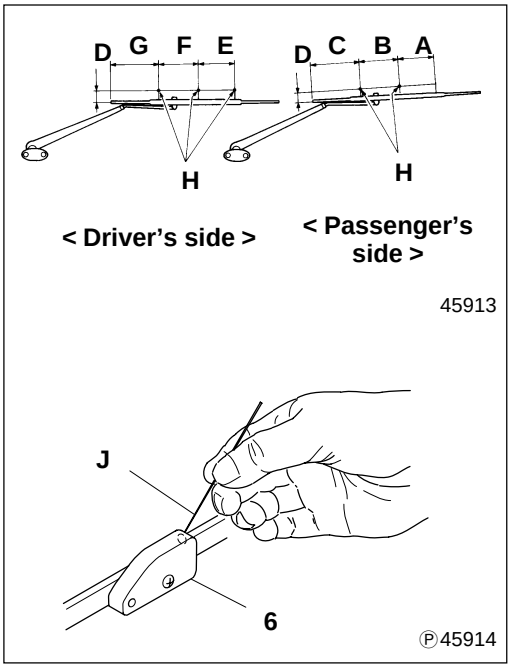
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Wiper arm and blade assembly mounting)	9.8 to 15 {7.2 to 11, 1 to 1.5}	—
10	Nut (Packing washer mounting)	14 to 20 {10 to 14, 1.4 to 2}	—
12	Nut (Hose joint mounting)	0.6 to 0.9 {0.4 to 0.7, 0.06 to 0.09}	—
19	Nut (Wiper link mounting)	9.8 to 15 {7.2 to 11, 1 to 1.5}	—
23	Nut (Wiper motor and wiper link mounting)	1.7 to 2.4 {1.2 to 1.7, 0.17 to 0.24}	—
24, 25	Bolt (Wiper motor bracket mounting)	9.8 to 15 {7.2 to 11, 1 to 1.5}	—
27	Bolt (Wiper motor mounting)	5.4 {4, 0.55}	—

◆ Service procedure



2 **Installation of wiper arm and blade assembly**

Install wiper arm and blade assembly **2** so that dimensions from the edges of the weatherstrip are as illustrated.



6 **Inspection of washer nozzle assembly**

Make sure that washer fluid spreading target positions **H** are within dimensions **A** to **G**. (Illustration shows the view from inside cab.)

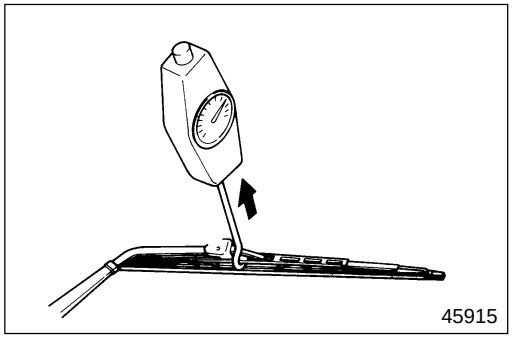
Unit : mm {in.}

		H
Passenger's side	A	–
	B	195 {7.68}
	C	129 {5.08}
Driver's side	D	13.5 {0.53}
	E	–
	F	212 {8.35}
	G	124 {4.88}

If washer fluid spreading target positions **H** deviate from these dimensions, adjust the jet hole angle of washer nozzle assembly **6** using wire **J**.

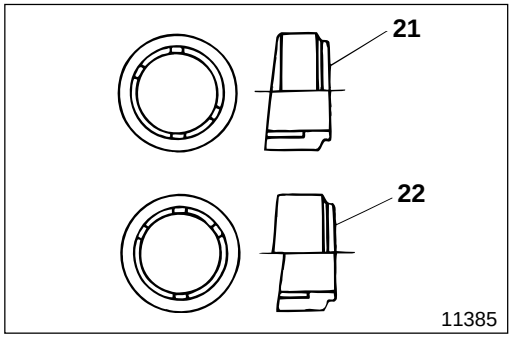
CAUTION⚠

Be careful not to damage the jet hole of washer nozzle assembly 6 with wire J when adjusting the angle.



8 **Inspection of wiper arm**

If the measured value deviates from the standard value, replace wiper arm **8**.



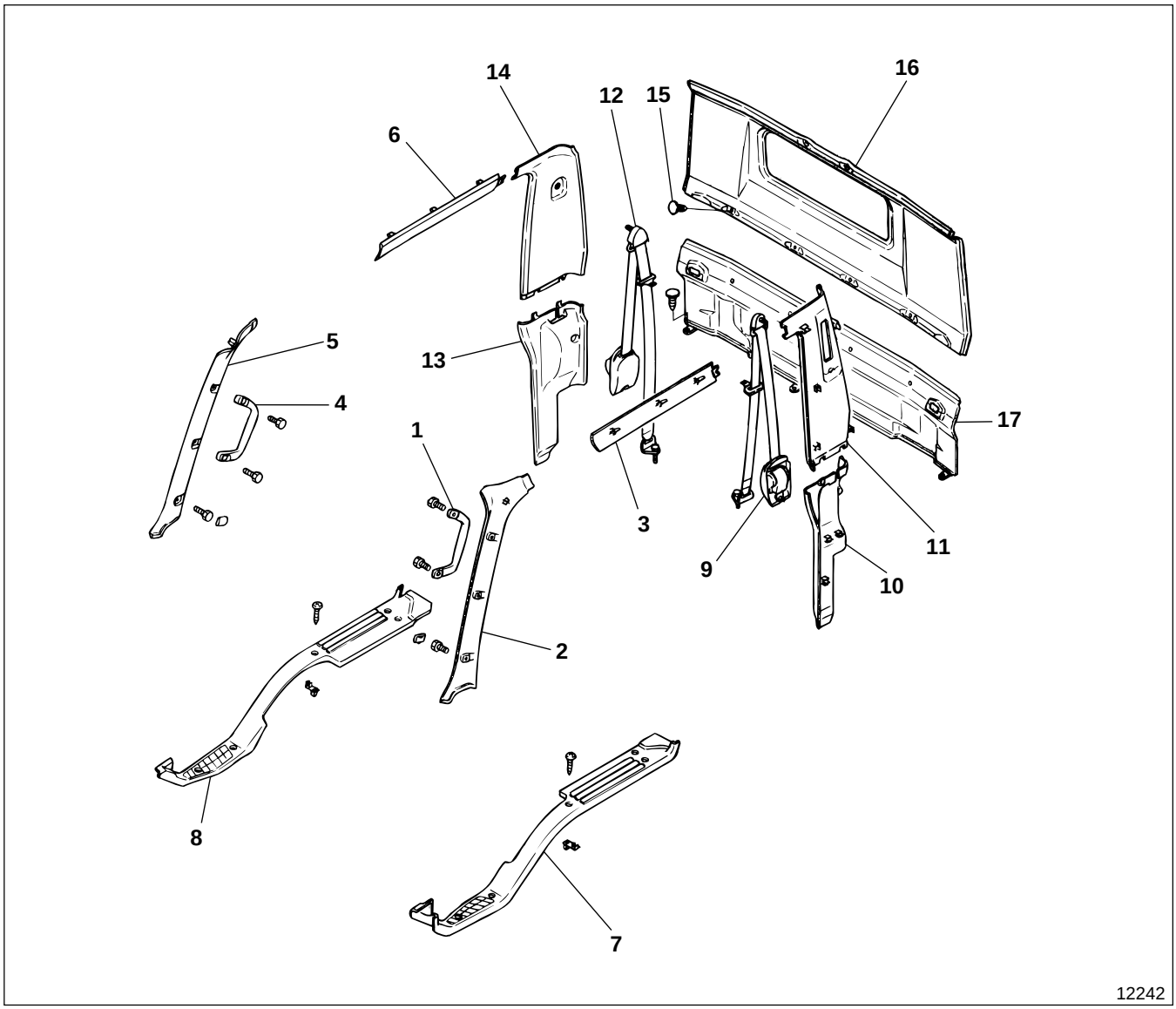
21 **22** **Packing washer**

Because the shape of packing washer **21** for the passenger's side and packing washer **22** for the driver's side are different, be careful not to mix them up during assembly.

M E M O

CAB INTERIOR FITTING

Trim



● **Removal sequence**

1 Front pillar grip, LH
2 Front pillar trim, LH
3 Roof side trim, LH
4 Front pillar grip, RH
5 Front pillar trim, RH
6 Roof side trim, RH
7 Scuff plate, LH
8 Scuff plate, RH
9 Seat belt assembly, LH
10 Lower rear pillar trim, LH
11 Upper rear pillar trim, LH
12 Seat belt assembly, RH
13 Lower rear pillar trim, RH
14 Upper rear pillar trim, RH
15 Rear trim clip
16 Upper rear trim
17 Lower rear trim

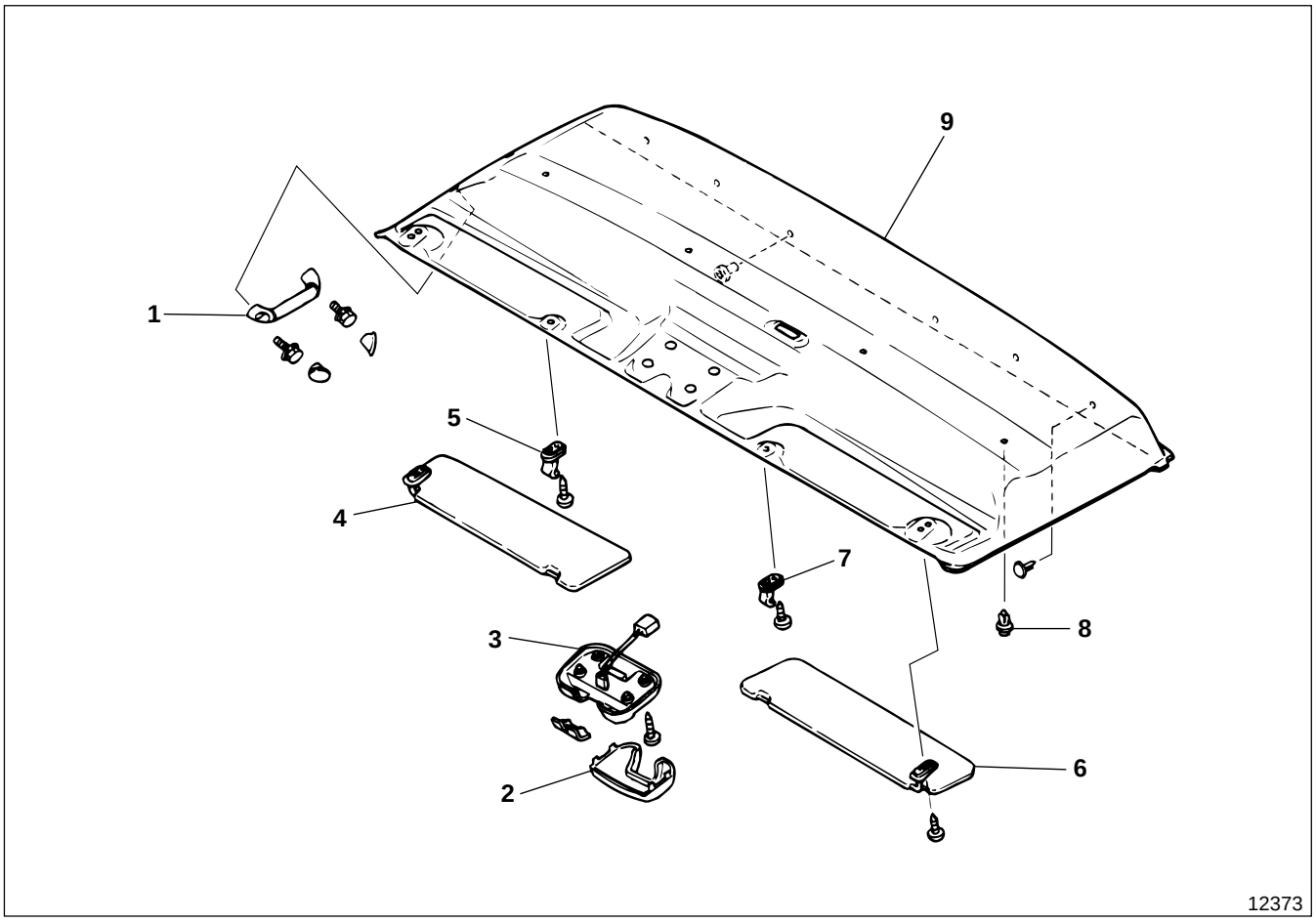
CAUTION⚠

Do not disassemble seat belt assemblies 9, 12 because this might cause malfunction of the emergency locking retractor.

● **Installation sequence**

Follow the removal sequence in reverse.

Headlining



● **Removal sequence**

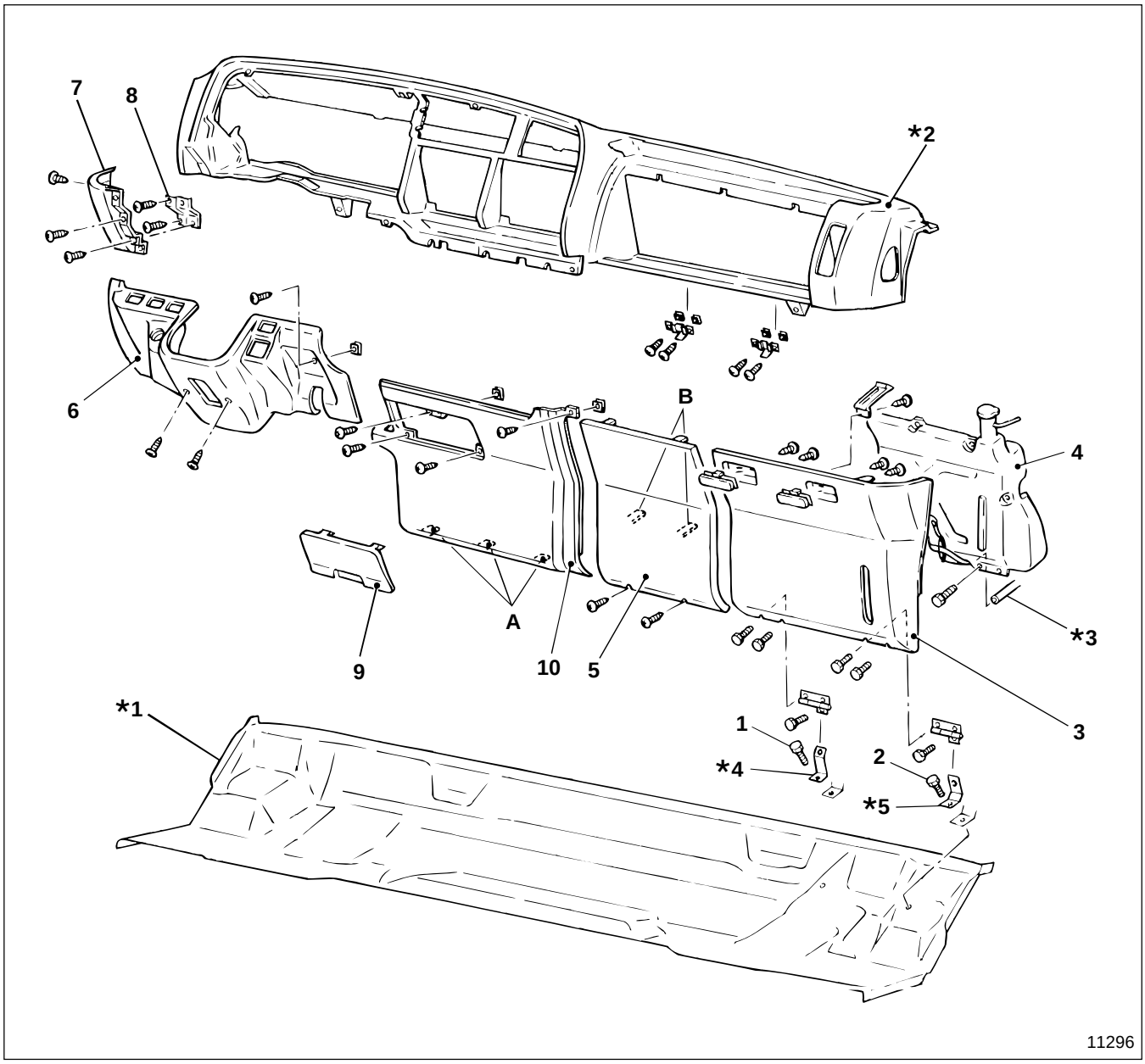
1 Grip
2 Lens
3 Cab lamp assembly Gr 54
4 Sun visor, RH
5 Hook
6 Sun visor, LH
7 Hook
8 Headlining clip
9 Headlining

● **Installation sequence**

Follow the removal sequence in reverse.

INSTRUMENT PANEL

Lower Panel



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Assistant driver's side lower panel
4 Window washer tank
5 Center lower panel
6 Driver's side lower panel
7 Side panel
8 Side panel bracket
9 Fuse box lid
10 Center lower panel

***1** : Front floor
***2** : Instrument panel
📖 P42-68

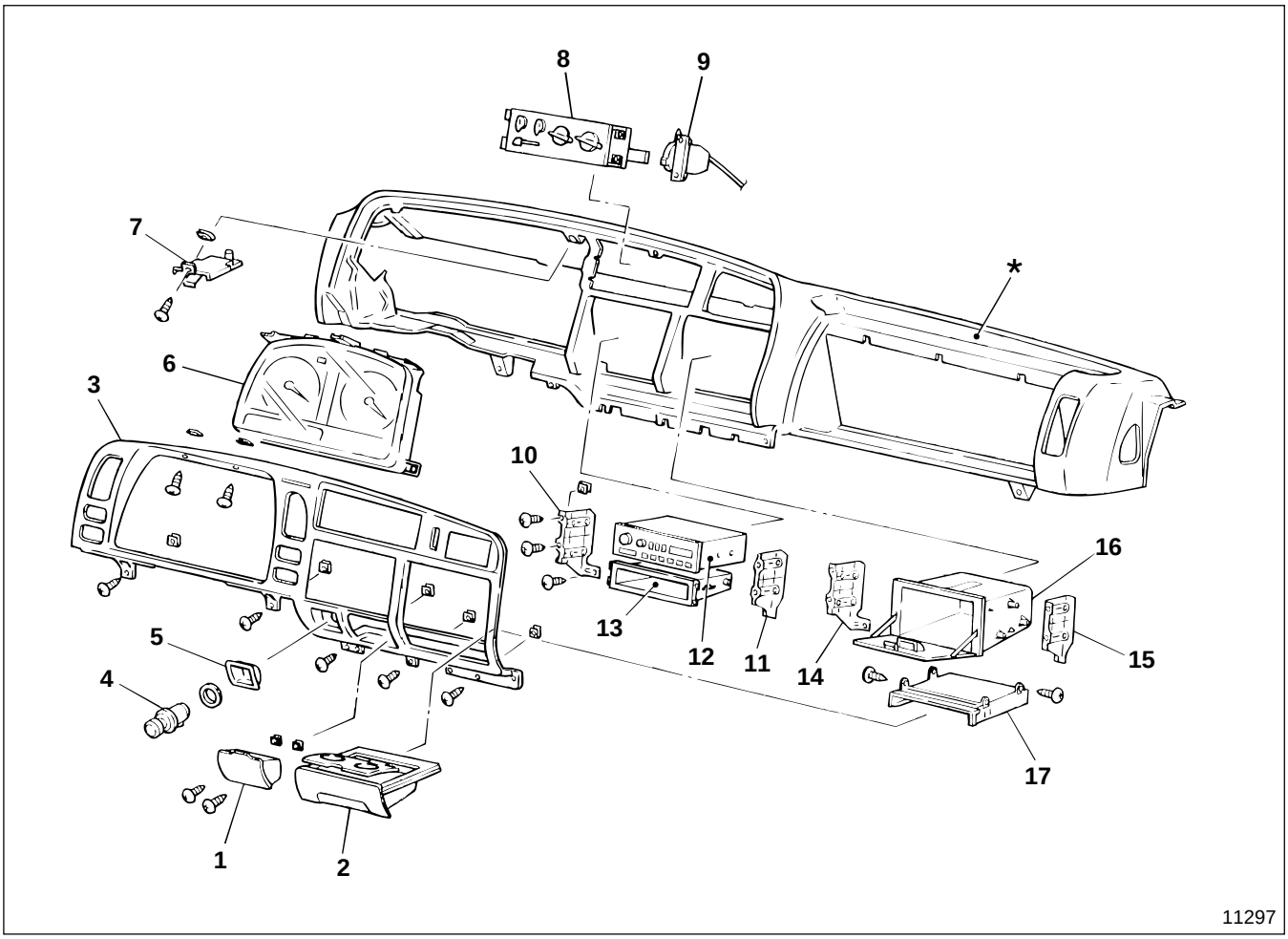
***3** : Water hose
***4** : Cooling unit
***5** : Blower unit

A : Fixed on heater unit
B : Fixed on joint duct

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Meter Bezel



● **Disassembly sequence**

1 Ashtray
2 Cup holder
3 Meter bezel
4 Cigarette lighter Gr 54
5 Protector
6 Meter cluster Gr 54
7 Card holder
8 Heater control assembly Gr 55B
9 Cool air bypass control assembly Gr 55B
10 Bracket, LH
11 Bracket, RH
12 Radio < Option >
13 Box
14 Bracket, LH
15 Bracket, RH
16 Glove compartment
17 Cup holder base

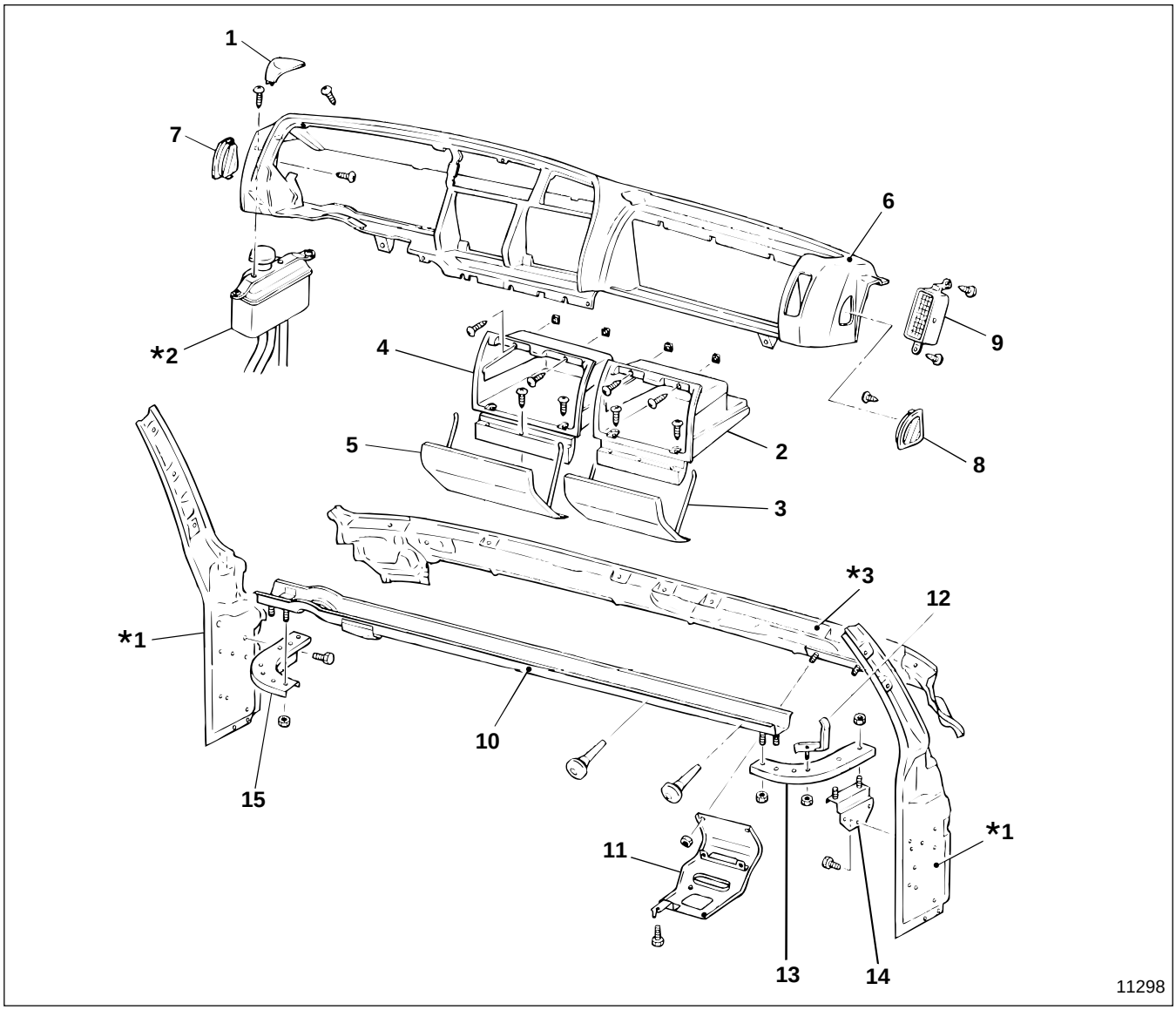
***** : Instrument panel P42-68

● **Assembly sequence**

Follow the disassembly sequence in reverse.

INSTRUMENT PANEL

Instrument Panel



● **Disassembly sequence**

1 Fluid tank lid
2 Glove compartment
3 Glove compartment lid
4 Glove compartment
5 Glove compartment lid
6 Instrument panel
7 Side demister grille
8 Side demister grille
9 Air outlet grille
10 Instrument panel frame
11 Relay bracket
12 Instrument panel support
13 Instrument panel bracket
14 Instrument panel bracket
15 Instrument panel bracket

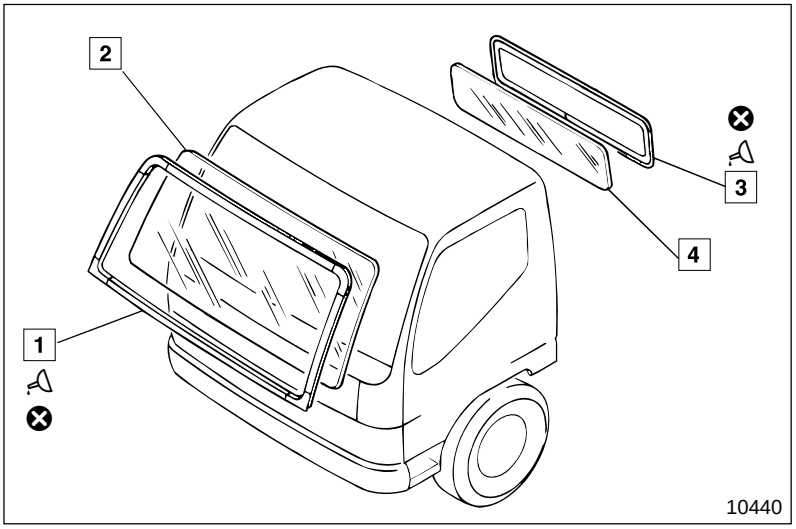
***1** : Front inner pillar
***2** : Fluid tank Gr 35A
***3** : Front window rail

● **Assembly sequence**

Follow the disassembly sequence in reverse.

M E M O

WINDOW GLASS



● **Disassembly sequence**

1 Weatherstrip
2 Windshield
3 Weatherstrip
4 Rear window glass

⊗ : Non-reusable parts

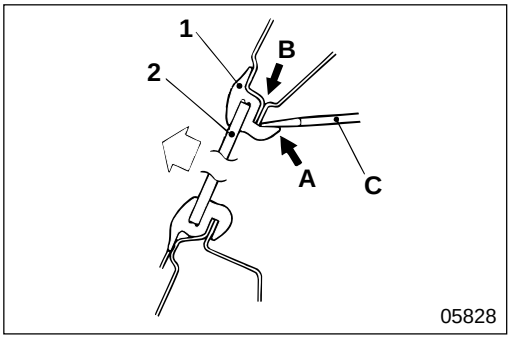
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Kinds	Quantity
1, 3	Lip area of weatherstrip	Soapy water	As required

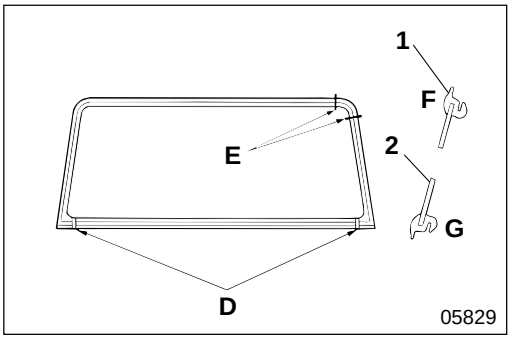
◆ Service procedure



1 **2** **Weatherstrip and windshield**

[Removal]

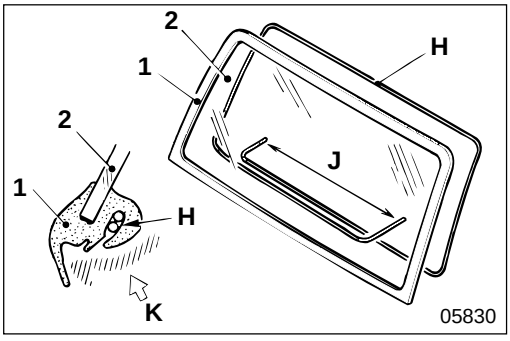
- From the inside of the cab, separate lip **A** of weatherstrip **1** from flange lip **B** of the cab.
  C : Screwdriver
- Push windshield **2** outward to remove it from the cab.



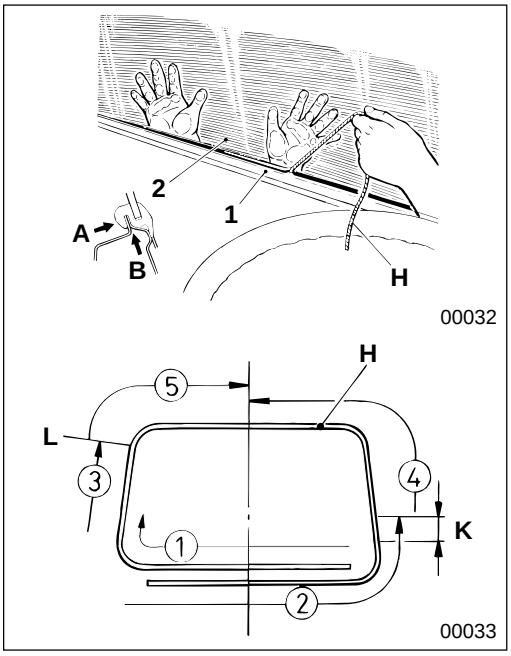
[Installation]

When installing the windshield, pull cord **H** attached to weatherstrip **1** and turn over lip **A**, following the procedure below:

- Position drain hole **D** and joint part **E** of weatherstrip **1** as illustrated and install them on windshield **2**.
  F : Outside
  G : Inside



- Lay cord **H** in the cab mounting groove of weatherstrip **1** as illustrated, and overlap the cord at the lower side of the glass by the specified length, see **J**.
- Apply soapy water **K** to weatherstrip **1**.
- Align windshield **2** with the cab.

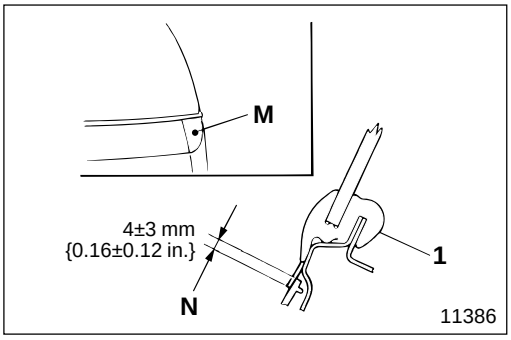


- Push windshield **2** inward from the outside of the cab firmly.
- Inside the cab, pull one end of cord **H** to install lip **A** of weatherstrip **1** into flange lip **B** of the cab.

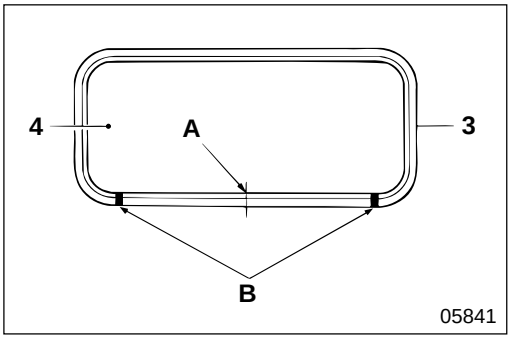
- Pull cord **H** in the numbered order as illustrated and at the same time have someone push windshield **2** into weatherstrip **1**, tapping the windshield with a rubber-headed mallet.
  - **K** : approximately 100 mm {3.94 in.} from the starting point of the straight section
  - **L** : up to the end of the straight section

CAUTION ⚠

Make sure that windshield 2 is installed correctly into the cab before hitting the windshield with the rubber-headed mallet, otherwise the windshield might be broken.



- Provide an overlapped margin **N** on weatherstrip **1** and side garnish **M** to prevent water flowing backwards from the water drain hole.



3 **4** **Weatherstrip, rear window glass**

- Install so that joint **A** of weatherstrip **3** is at the bottom center of rear window **4**.
  - **B** : Water drain hole
- Except for the point mentioned above, follow the same service procedure as for installation of the windshield. 🕮 P42-70

MITSUBISHI
FUSO

Group 54
Electrical

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-54

INDEX

HOW TO READ THIS GROUP

HOW THIS GROUP IS STRUCTURED 2

0 GENERAL

SPECIFICATIONS 54-0-2

STRUCTURE AND OPERATION

1. Starter 54-0-6
2. Alternator 54-0-8
3. Lamp 54-0-12
4. MUTIC (Multipurpose Timing Control Unit) 54-0-16
5. LAC (Lighting and Alarm Control Unit) 54-0-23

TROUBLESHOOTING

Power and charging 54-0-26

Enging starting, preheating and stopping 54-0-27

Lighting 54-0-28

Meter 54-0-31

Cigarette lighter and Audio 54-0-32

Accessory noise generation source 54-0-32

Horn 54-0-33

1 POWER, CHARGE AND GROUND CIRCUIT

(110) POWER CIRCUIT 54-1-2

(115) RESERVE POWER CIRCUIT 54-1-11

(125) BATTERY CHARGING CIRCUIT 54-1-12

(130) GROUND 54-1-14

2 STARTING AND PREHEATING CIRCUIT

(210) ENGINE STARTING CIRCUIT 54-2-2

(215) ENGINE STOPPING CIRCUIT ..... Gr 13EA Gr 13EB

(220) ENGINE PREHEATING CIRCUIT 54-2-4

(225) ENGINE WARM-UP CIRCUIT 54-2-5

3 LIGHTING CIRCUIT

(310) HEADLAMP CIRCUIT 54-3-2

(313) DAYTIME RUNNING LIGHT CIRCUIT 54-3-4

(320) TAIL , CLEARANCE AND LICENSE PLATE LAMP CIRCUIT 54-3-6

(325) STOP LAMP CIRCUIT 54-3-7

(330) TURN SIGNAL AND HAZARD LAMP CIRCUIT 54-3-8

(340) BACKUP LAMP CIRCUIT 54-3-9

(345) CAB LAMP CIRCUIT 54-3-11

(348) ILLUMINATION LAMP CIRCUIT 54-3-12

(349) MARKER AND IDENTIFICATION LAMP CIRCUIT 54-3-13

(352) VAN BODY DOME LIGHT CIRCUIT 54-3-14

4 METER CIRCUIT

(401) METER CLUSTER INTERNAL CIRCUIT 54-4-2

(410) TACHOMETER CIRCUIT 54-4-4

(412) SPEED SENSOR CIRCUIT 54-4-6

(420) FUEL GAUGE CIRCUIT 54-4-7

(425) WATER TEMPERATURE GAUGE CIRCUIT 54-4-8

5 INDICATOR AND WARNING LAMP CIRCUIT

(510) PARKING BRAKE INDICATOR CIRCUIT 54-5-2

(515) BRAKE WARNING CIRCUIT 54-5-3

(535) ENGINE OIL LEVEL AND OIL PRESSURE WARNING CIRCUIT 54-5-4

(537) OVERHEATING WARNING CIRCUIT 54-5-5

(540) BRAKE PAD WARNING CIRCUIT 54-5-6
(547) ATF TEMPERATURE WARNING CIRCUIT .... Gr 23
(550) CAB TILT WARNING CIRCUIT 54-5-7
(566) FUEL FILTER WARNING CIRCUIT 54-5-8

6 CAB SIDE ELECTRICAL CIRCUIT

(610) CIGARETTE LIGHTER CIRCUIT 54-6-2
(612) AUDIO CIRCUIT 54-6-3
(614) WIPER AND WASHER CIRCUIT 54-6-4
(616) HORN CIRCUIT 54-6-5
(618) HEATER CIRCUIT 54-6-6
(622) POWER WINDOW AND AUTO DOOR LOCK CIRCUIT 54-6-7
(629) MIRROR HEATER CIRCUIT 54-6-8

7 CHASSIS SIDE ELECTRICAL CIRCUIT

(710) EXHAUST BRAKE CIRCUIT 54-7-2

8 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

(810) FOUR-WHEEL DRIVE CIRCUIT 54-8-2
(850) TRANSMISSION POWER TAKE-OFF CIRCUIT 54-8-3

9 OTHERS CIRCUIT

(910) MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT 54-9-2
ELECTRONICALLY CONTROLED FUEL SYSTEM CIRCUIT ..... Gr 13EA Gr 13EB

10 PARTS INSTALLATION POSITION

Cab side
A SWITCH 54-10-2
B RELAY AND ELECTRONIC CONTROL UNIT 54-10-4
C FUSE, METER, SENSOR AND MOTOR 54-10-6
D HEATER AND AIR-CONDITIONER 54-10-8
E DOOR 54-10-10
F ROOF 54-10-11
J JOINT OF MAIN HARNESS CONNECTORS 54-10-12
Engine and transmission side
R ENGINE 54-10-14
S TRANSMISSION 54-10-16
Chassis side
T SWITCH AND SENSOR 54-10-17
U BATTERY, FUSE AND CONNECTOR 54-10-18
V MAGNETIC VALVE, MOTOR AND ACTUATOR 54-10-18
W BUZZER AND LAMP 54-10-18

11 INSPECTION OF PARTS

001 to 179 SWITCH 54-11-2
180 to 249 RELAY 54-11-8
250 to 349 SENSOR 54-11-11
350 to 409 CONTROL UNIT 54-11-13
410 to 509 MOTOR 54-11-14
510 to 559 ACTUATOR 54-11-16
560 to 609 MAGNETIC VALVE 54-11-17
610 to 649 BUZZER AND HORN 54-11-18
650 to 699 LAMP 54-11-19
750 to 859 OTHER 54-11-20
860 BATTERY 54-11-22
870 to 889 FUSE 54-11-26
890 METER CLUSTER 54-11-30

12 STARTER AND ALTERNATOR

930 STARTER 54-12-2
940 ALTERNATOR 54-12-30
950 INSPECTION OF ALTERNATOR 54-12-42
951 INSPECTION OF REGULATOR 54-12-43

13 ON-VEHICLE INSPECTION AND ADJUSTMENT

955 INSPECTION OF PREHEATING SYSTEM 54-13-2

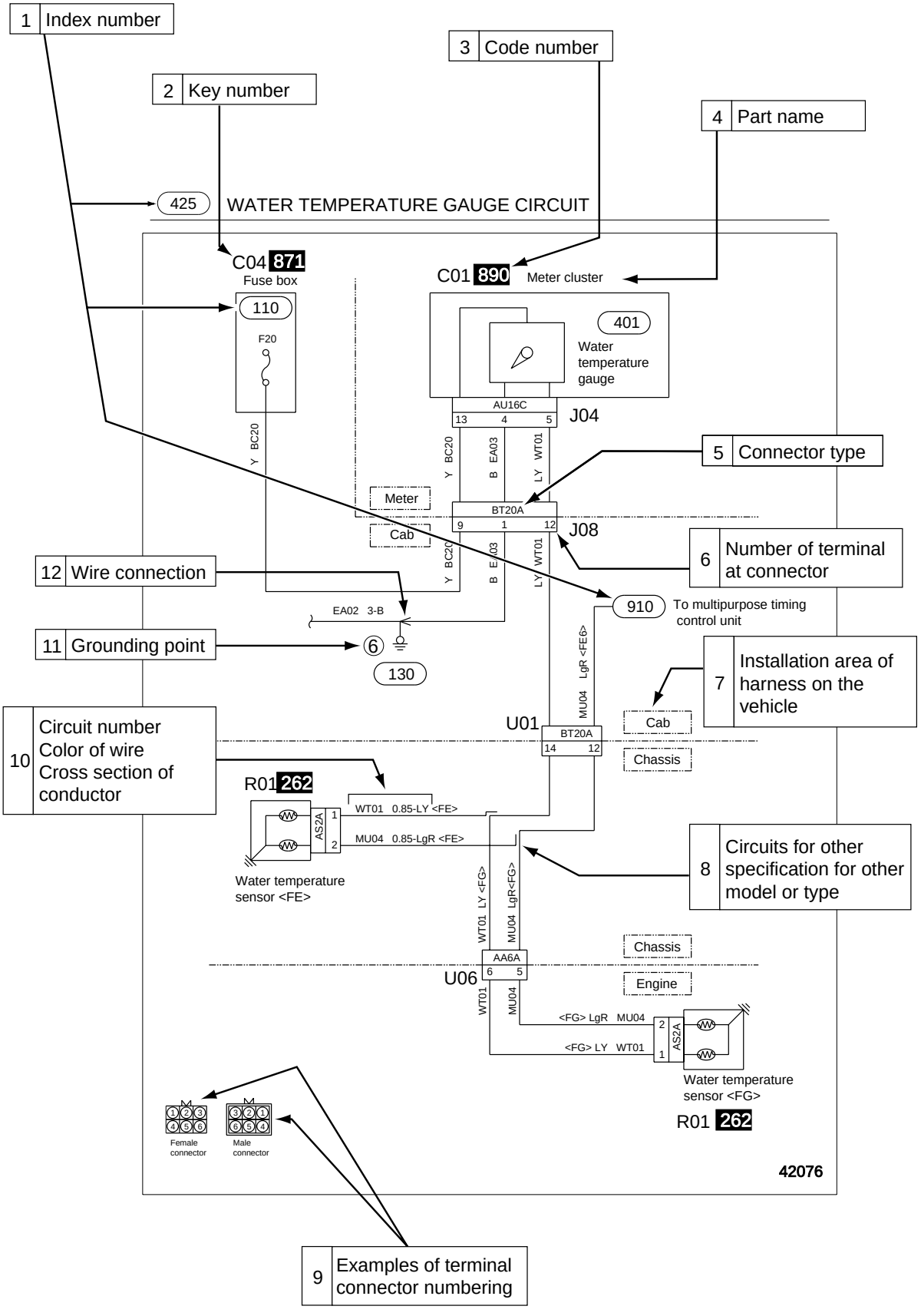
960 HEADLAMP AIMING 54-13-4

965 INSPECTION OF BRAKE FLUID LEVEL SWITCH 54-13-6

HOW TO READ THIS GROUP

HOW THIS GROUP IS STRUCTURED 2

HOW TO READ CIRCUITS(GROUP 54)



1 Index number: (110)

Each circuit has its own Index number respectively and has three digits ((110)).
How to read index number

- By proper using of the index number, it is possible to locate the correct place immediately since the circuit drawing of this manual book are classified as function by function. (including “POWER CIRCUIT” (110) and “GROUND” (130) .)
- How to check the location of circuit drawing in each part
  The circuit drawing which can not be diagramed in one page due to its complicated structure (such as meter cluster and electronic control unit etc.), has its remarked index number to be connected to other circuit drawing. ((401) , (910) , etc.)

2 Key number: A01~

Key number is the number to indicate the installation position of the parts, and is shown by A01 ~ Z.
The details of the installation position are described in GROUP 10 .

3 Code number: **001** ~

Code number is the number to indicate the one portion of the parts to be checked and has three digits (**001**).
The details of the parts to be checked are described in GROUP 11 .

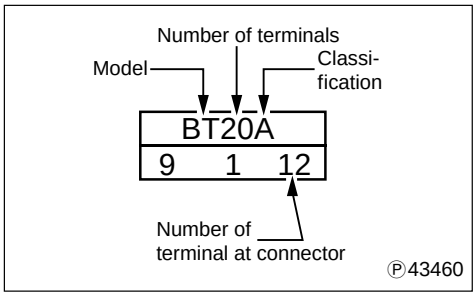
4 Part name

5 Connector type

Connectors are shown by □ without mentioning Male or Female and in the box it is described model of connector, number of terminals and its classification, etc.
Table of connectors is described in GROUP 14.

6 Number of terminal at connector

Terminal numbers of connector are shown by figures in the box.



7 Installation area of harness on the vehicle

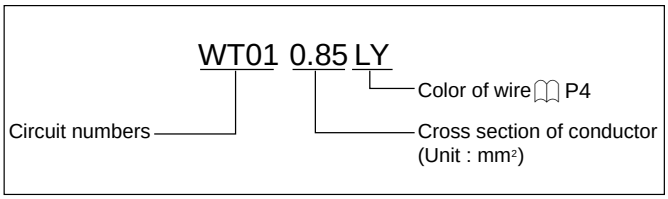
The location and boundary of the harnesses in the vehicle are shown in the each circuit drawing and it may help to check mounting position of connectors.

8 Circuits for other specification for other model or type

9 Examples of terminal connector numbering

As it is shown, for female connectors, with placing the lock upward then starting to put numbers from the upper left. And when it is male connector, put numbers from the upper right, also with placing the lock upward.

10 Circuit number, color of wire, and cross section of conductor are shown in circuit drawings.



Except for 0.5mm², Wire thickness is described in the circuit drawing. The reason why only wire thickness, 0.5 mm² is not described in the drawings is 0.5mm² is so common and so that the circuit drawing can be seen more easily.
(Examples) 0.5mm²: Y
0.85mm²: 0.85 — LY
3mm²: 3 — B

11 Grounding point

The actual locations of grounding points on the vehicle are shown. Refer to (130) for detailed information.

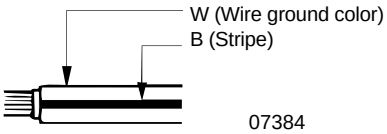
12 Wire connection

When the wires are connected into one point of the harnesses, the circuit drawing shows “Arrow mark”.

CAUTION !
Be careful that direction of the arrow does not show the direction of the electric current flow.

● Wire Colors

Example: WB means a wire whose ground color is white and whose stripe is black.



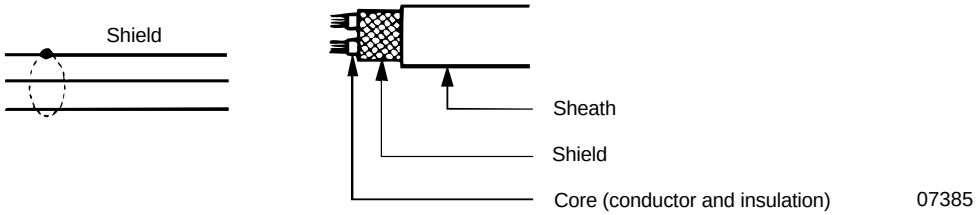
07384

Wire ground color		Wire ground color + Stripe							
W	White	WR	White red	WB	White black	WL	White blue	WG	White green
B	Black	BW	Black white	BY	Black yellow	BR	Black red		
R	Red	RW	Red white	RB	Red black	RY	Red yellow	RG	Red green
Y	Yellow	YR	Yellow red	YB	Yellow black	YG	Yellow green	YL	Yellow blue
G	Green	GW	Green white	GR	Green red	GY	Green yellow	GB	Green black
Br	Brown	BrW	Brown white						
L	Blue	LW	Blue white	LR	Blue red	LY	Blue yellow	LB	Blue black
Lg	Yellow green	LgR	Yellow green red	LgY	Yellow green yellow	LgB	Yellow green black	LgW	Yellow green white
O	Orange								
P	Pink	PB	Pink black						

● Shield Wire

A shield wire is clearly identified as follows:

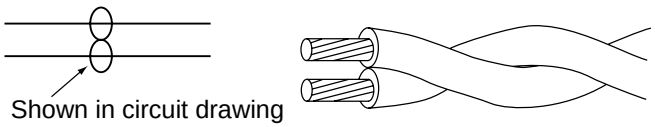
Example



07385

● Twist wire

Twist wires are made by twisting the core of wires by the constant pitch.
Example:



Ⓟ43533

0 GENERAL

SPECIFICATIONS

Battery

Item	Specifications
Model	115E41R
Voltage × Quantity	12 × 2 (Parallel connection)
Capacity (5-hour rating)	88

Alternator

Item	Specifications	
	4D3	4M5
Manufacturer	MITSUBISHI ELECTRIC	
Type	Alternator with built-in regulator (without brush external fan)	
Model	A4TU0488	A4TU0781
Output V-A	12-100	

Engine starter, Glow

Item			Specifications	
			4D3	4M5
Starter	Manufacturer		MITSUBISHI ELECTRIC	
	Reduction gear mechanism		Planetary gears	
	Model		M8T55073	M8T55371
	Out put	V-kW	12-3	
	Magnetic switch operating voltage	V	8 or less	
Starter relay	Model		U1X11272	U1T11672
	Excitation current	V-A	12-4	
	Closing voltage	V	8 or less	
	Operating voltage	V	3.5 or more	
	Allowable cutoff current	A	200	
Glow plug	Model		Sheathed type	
	Rated voltage current	V-A	11-5.5	11-8.5
Glow relay	Model		U1T11472	U1T11473
	Excitation current	V-A	12-4	
	Closing voltage	V	8 or more	
	Operating voltage	V	3.5 or more	
	Allowable cutoff current	A	60	
	Temperature fuse capacity	A	127	

SPECIFICATIONS

Lighting

Item			Specifications
Headlamp	Model		Seald beam
	Type		Reflex type
	Main beam	W	50
	Dipped beam	W	60/40 (Main/Dipped)
Front turn signal lamp (serving also as hazard warning lamp)		W	21 × 2
Clearance lamp		W	7.5
Side turn signal lamp (serving also as hazard warning lamp)		W	5
Clearance and side marker lamp		W	7.5
Rear combination lamp	Stop / Tail lamp	W	27/8
	Backup lamp	W	27
	Turn signal lamp (serving also as hazard warning lamp)	W	27
Cab lamp		W	10
License plate lamp		W	8
Identification lamp		W	7.5
Back buzzer	Rated voltage	V	12
	Rated current	A	50 or less
	Sound pressure	dB	85±10 (at 1 m {3.3ft.})
	Intermittent frequency	frequency per minute	85±15

All bulbs of the lamps shown above voltage rating of 12 V.

Meter

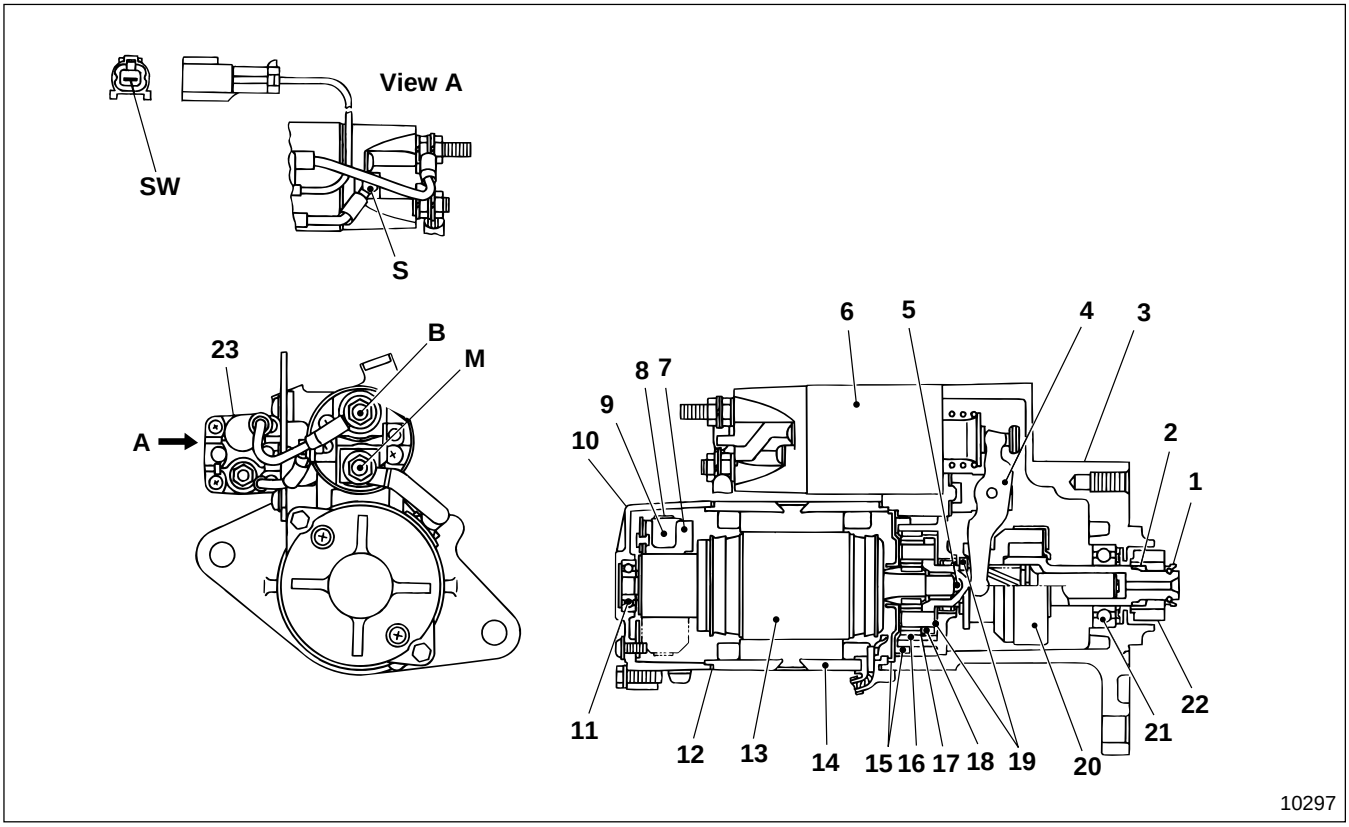
Item			Specifications
Meter cluster	Manufacturer		DENSO
	Rated voltage V		12
	Lighting bulb W		3, 3.4
	Indicator lamp bulb W		1.4
	Warning lamp bulb W		1.4
	Bulb for automatic transmission shift indicator W		1.12
	Meter warning buzzer	Rated current mA	50 or less (Mean value)
		Sound pressure dB	60^{+6}_{0}(at 1 m {3.3 ft.})

Relay, Motor, Horn, Buzzer

Item			Specifications
Relay	Rated voltage V		12
	Minimum operating voltage V		8 or more
Speaker	Rated input W		15
	Maximum input W		30
	Impedance Ω		4±0.6
Power window motor	Rated voltage V		13.5
	Rated current A		9 or less < Up >, 7 or less < Down >
Door lock actuator	Rated voltage V		12
	Bound current A		6 or less
Electric horn	Rated voltage V		12
	Current consumption mA		$3.0^{+0.5}_{-1.0}$
	Sound pressure dB		105±5 (at 2 m {6.6 ft.})
Automatic transmission reverse buzzer	Rated voltage V		12
	Current consumption mA		66 or less (Mean value)
	Sound pressure dB		80±10 (at 1 m {3.3 ft.})
Wiper motor	Rated voltage V		12
	Non-load current A		3.7 or less
	Bound current A		27 or less
Windshield washer motor	Rated voltage V		12
	Rated current A		3.8 or less

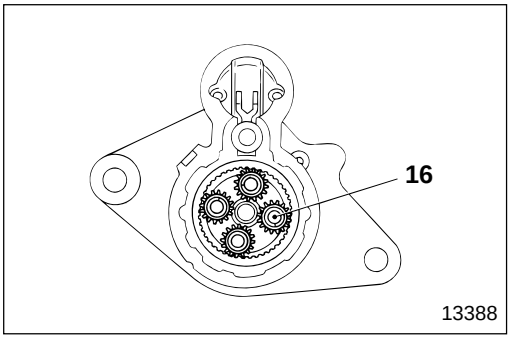
1. Starter

< 4D3 >



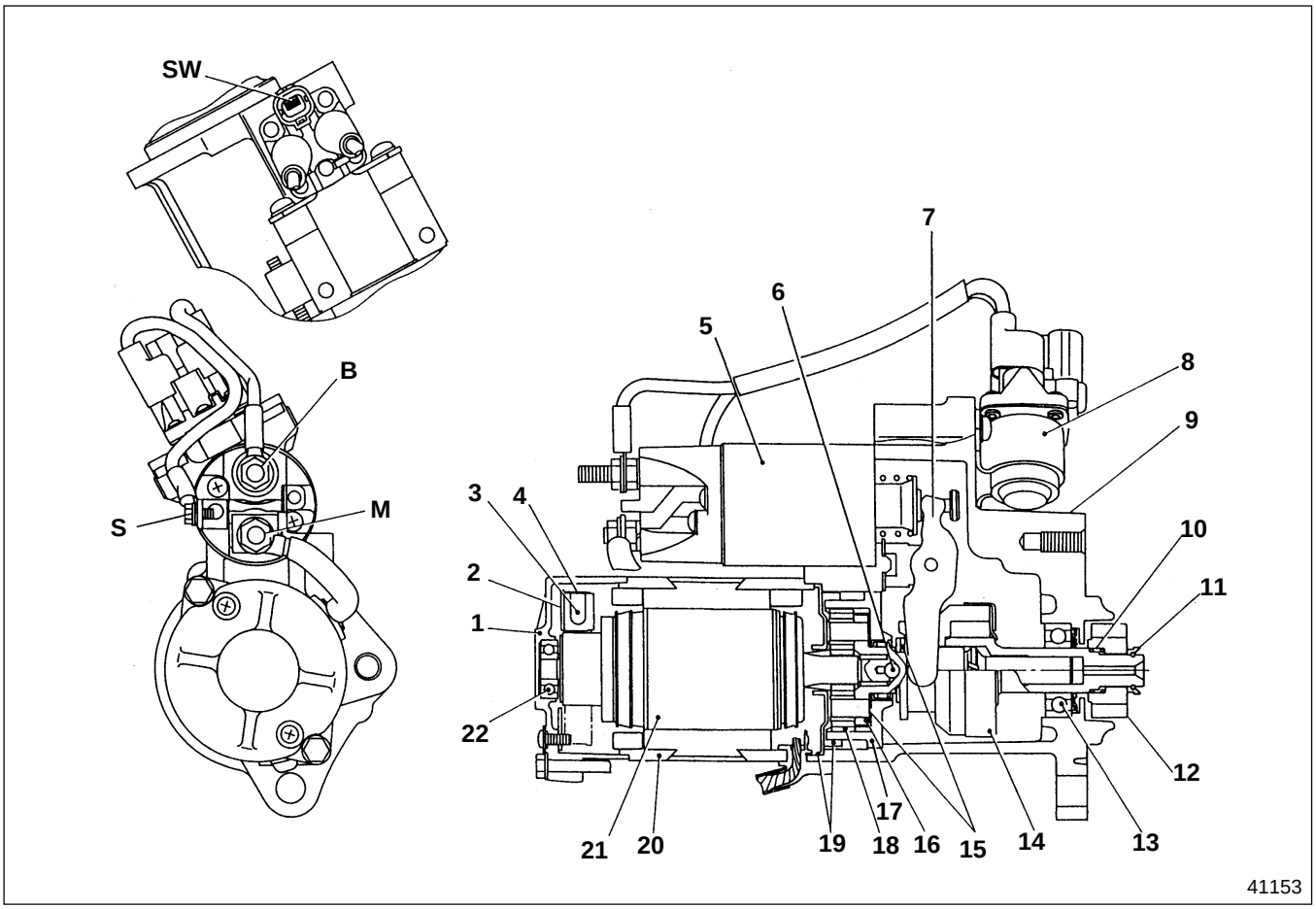
1 Pinion stopper
2 Spring
3 Front bracket
4 Lever
5 Ball
6 Magnetic switch
7 Brush holder
8 Brush spring
9 Brush
10 Rear bracket
11 Rear bearing
12 Rubber packing
13 Armature
14 Yoke assembly
15 Rubber packing
16 Planetary gear
17 Internal gear
18 Gear shaft
19 Washer
20 Overrunning clutch
21 Front bearing
22 Pinion
23 Starter relay

B : Terminal B
M : Terminal M
S : Terminal S
SW : Terminal SW



This starter uses planetary gear **16** for the reduction gear system.

< 4M5 >



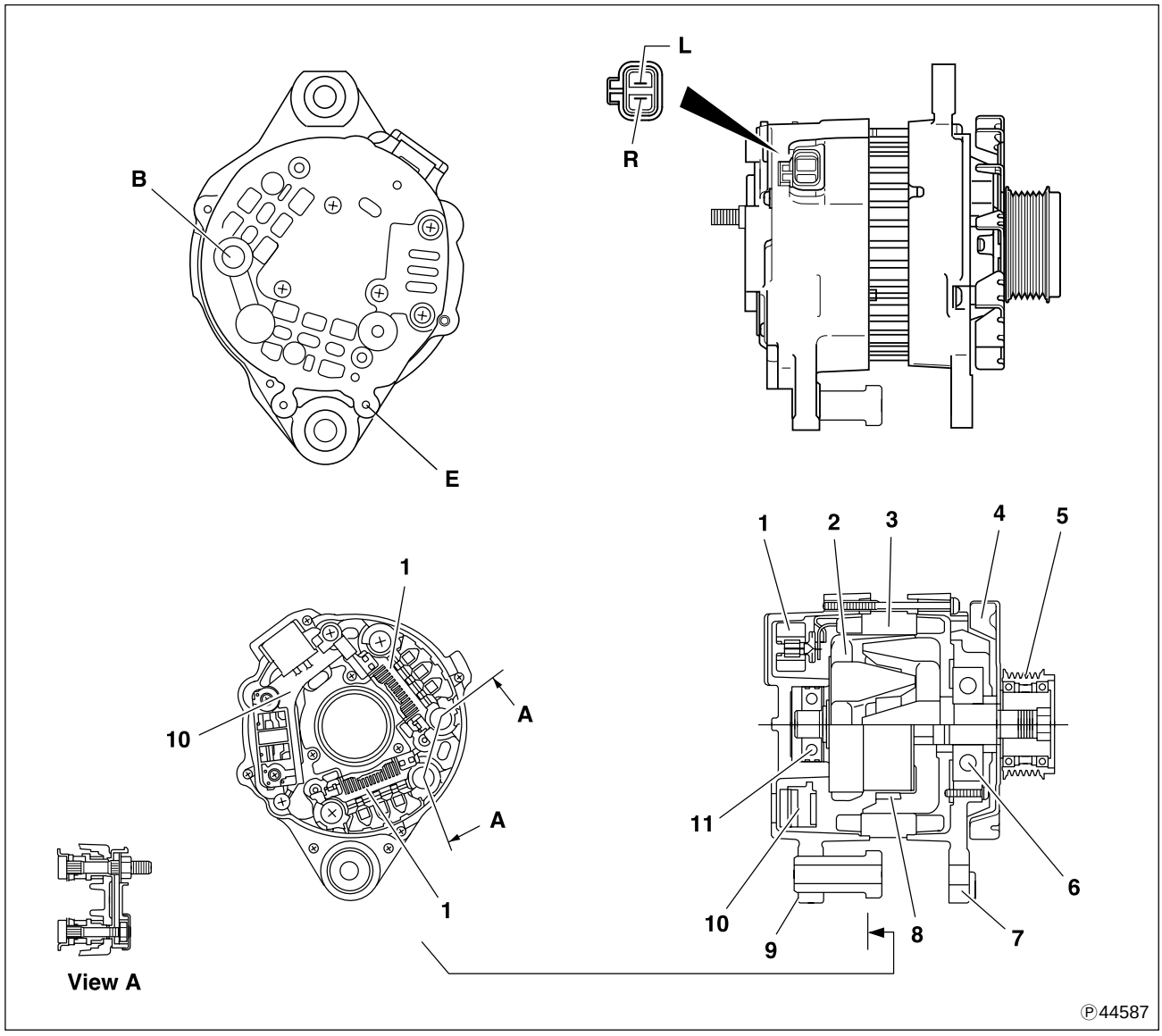
1 Rear bracket
2 Brush holder
3 Brush
4 Brush spring
5 Magnetic switch
6 Ball
7 Lever
8 Starter relay
9 Front bracket
10 Spring
11 Pinion stopper
12 Pinion
13 Front brearing
14 Overrunning clutch
15 E-ring
16 Gear shaft assembly
17 Internal gear assembly
18 Planetary gear
19 Rubber packing
20 York assembly
21 Armature assembly
22 Rear bearing

B: Terminal B
M: Terminal M
S: Terminal S
SW: Terminal switch

This starter uses planetary gears **18** as its reduction gearing machanism.

2. Alternator

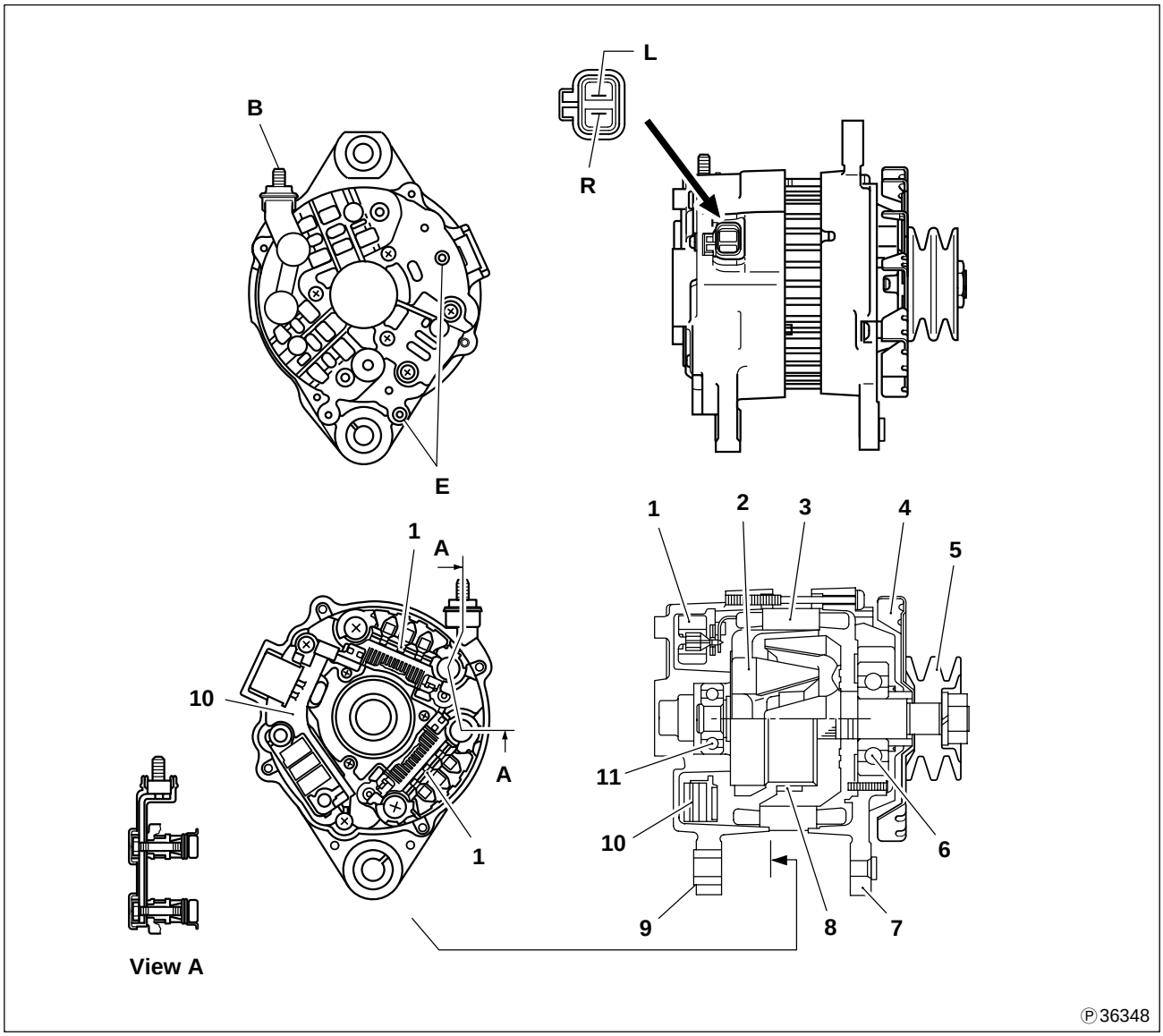
< 4M5 >



1 Rectifier
2 Rotor assembly
3 Stator assembly
4 Fan
5 Pulley
6 Front bearing
7 Front bracket
8 Field coil
9 Rear bracket
10 Regulator
11 Rear bearing

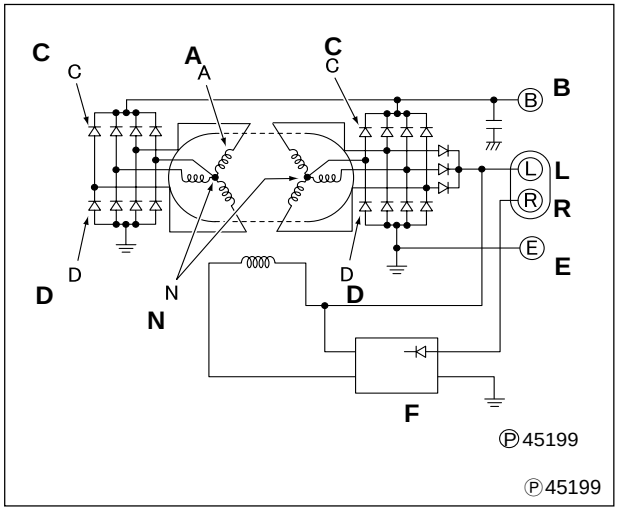
B : Terminal B
E : Terminal E
L : Terminal L
R : Terminal R

< 4D3 >



1 Rectifier
2 Rotor assembly
3 Stator assembly
4 Fan
5 Pulley
6 Front bearing
7 Front bracket
8 Field coil
9 Rear bracket
10 Regulator
11 Rear bearing

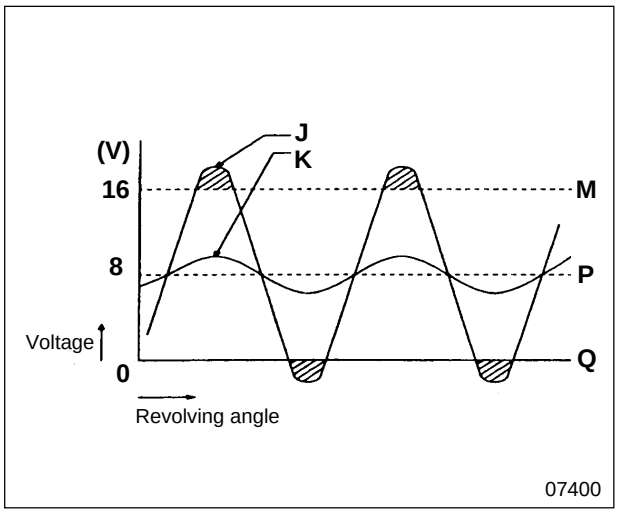
B : Terminal B
E : Terminal E
L : Terminal L
R : Terminal R



Features of alternator with neutral diodes

- The alternator is the same as the current alternator except neutral diodes **C** and **D** added.
- These neutral diodes **C** and **D** enable this alternator to provide higher DC output during operation at high speeds than the alternator without neutral diodes.

A : Stator coil
B : Alternator terminal B
E : Alternator terminal E
F : IC regulator
L : Alternator terminal L
N : Neutral point
R : Alternator terminal R



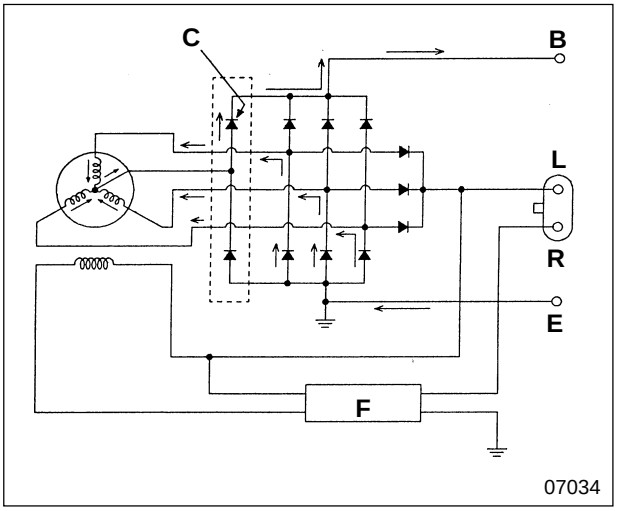
Variations of voltage at neutral point and operation of neutral diodes

- The potential at the neutral point **N** varies up and down with the neutral point DC voltage **P** as a center as shown.
- When alternator is operated at high speeds, the voltage at the neutral point **N** can increase to exceed the output voltage **M** (16 volts) and decrease to become lower than the ground voltage **Q** (0 volt). To adjust these over-voltage and under-voltage (shaded portions of diagram) the current from the excess voltages is taken by neutral diodes **C** and **D** and added to the DC output.

J : Voltage waveform at neutral point during high speed operation
K : Voltage waveform at neutral point during low speed operation
M: Output voltage
P : Average voltage at neutral point (1/2 of output voltage)
Q: Ground potential

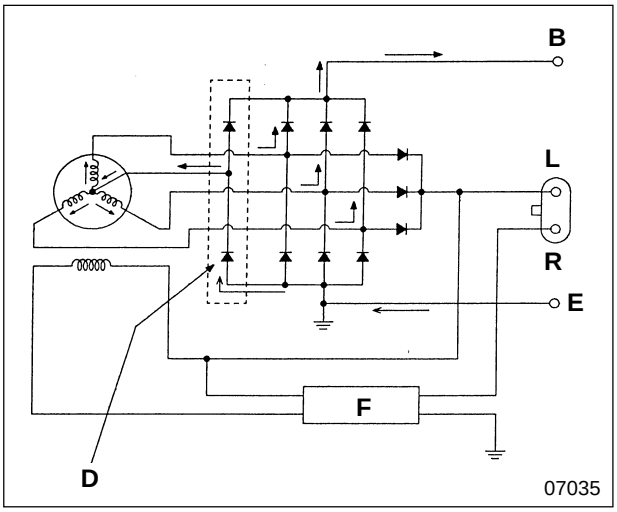
The operation of neutral diodes **C** and **D** for each voltage and potential is as follows.

- When the voltage at neutral point is in the range from 0 to 16 volts, the other 6 diodes are operated. Neutral diodes are not operated.



● **When the voltage at neutral point exceeds 16 volts**

The positive diode **C** adds extra output to the DC output for supply to each electric equipment.

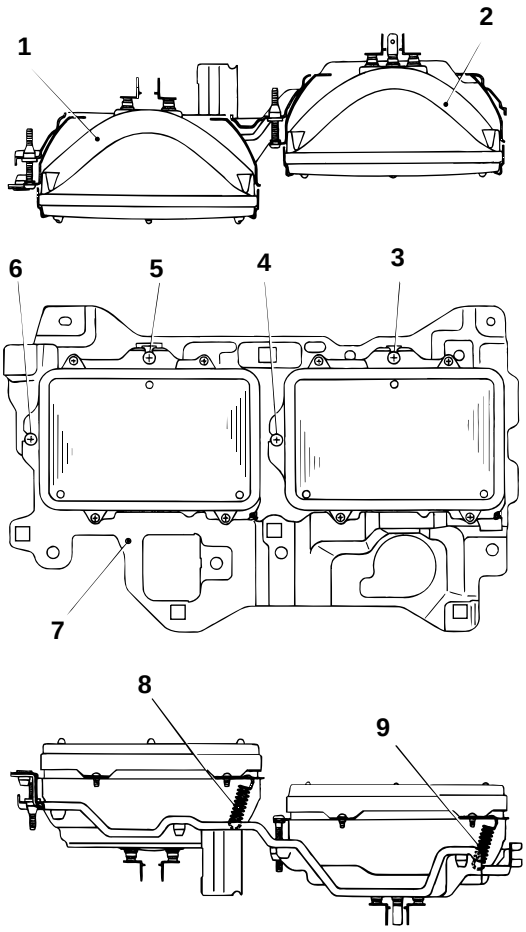


● **When the voltage at neutral point drops below 0 volt**

The negative diode **D** supplies the output from neutral point through the other 3 diodes.

3. Lamp

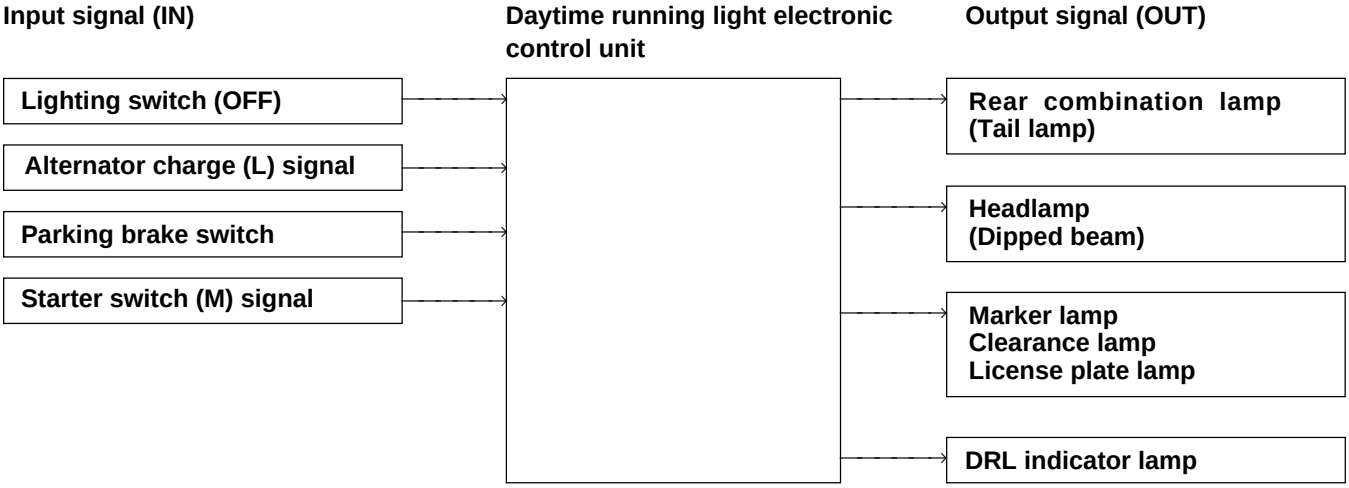
Headlamp



1 Sealed beam unit (Main beam)
2 Sealed beam unit (Dipped beam)
3 Screw (Dipped beam, vertical adjustment)
4 Screw (Dipped beam, horizontal adjustment)
5 Screw (Main beam, vertical adjustment)
6 Screw (Main beam, horizontal adjustment)
7 Housing
8 Extension spring
9 Extension spring

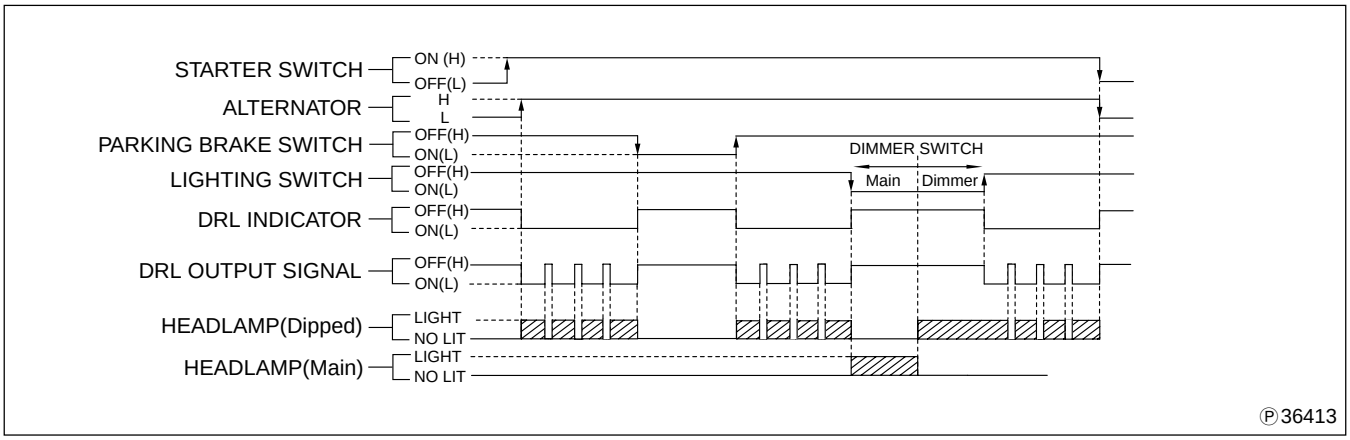
- The headlamp unit consists of sealed beam units **1, 2** separately installed in housing **7**. Sealed beam unit **1** is for Main beam, and sealed beam unit **2** is for Dipped beam.
- The headlamp aiming can be adjusted by changing the installation angle of sealed beam units **1, 2**.
- To adjust the installation angle of sealed beam unit **1**, turn screws **5, 6**. Extension spring **8** sets the angle of the sealed beam unit.
- To adjust the installation angle of sealed beam unit **2**, turn screws **3, 4**. Extension spring **9** sets the angle in the same way as for sealed beam unit **1**.

Daytime running light system



- In a daytime running light system, regardless the position of lighting switch while engine is running, the dipped beam of the headlamp and the tail lamp of the rear combinations, position lamp, license plate lamp will light on.
- Except for that the lighting switch is OFF or when the passing switch is ON, the same lamps as usual switch operation will light.

• Timing chart

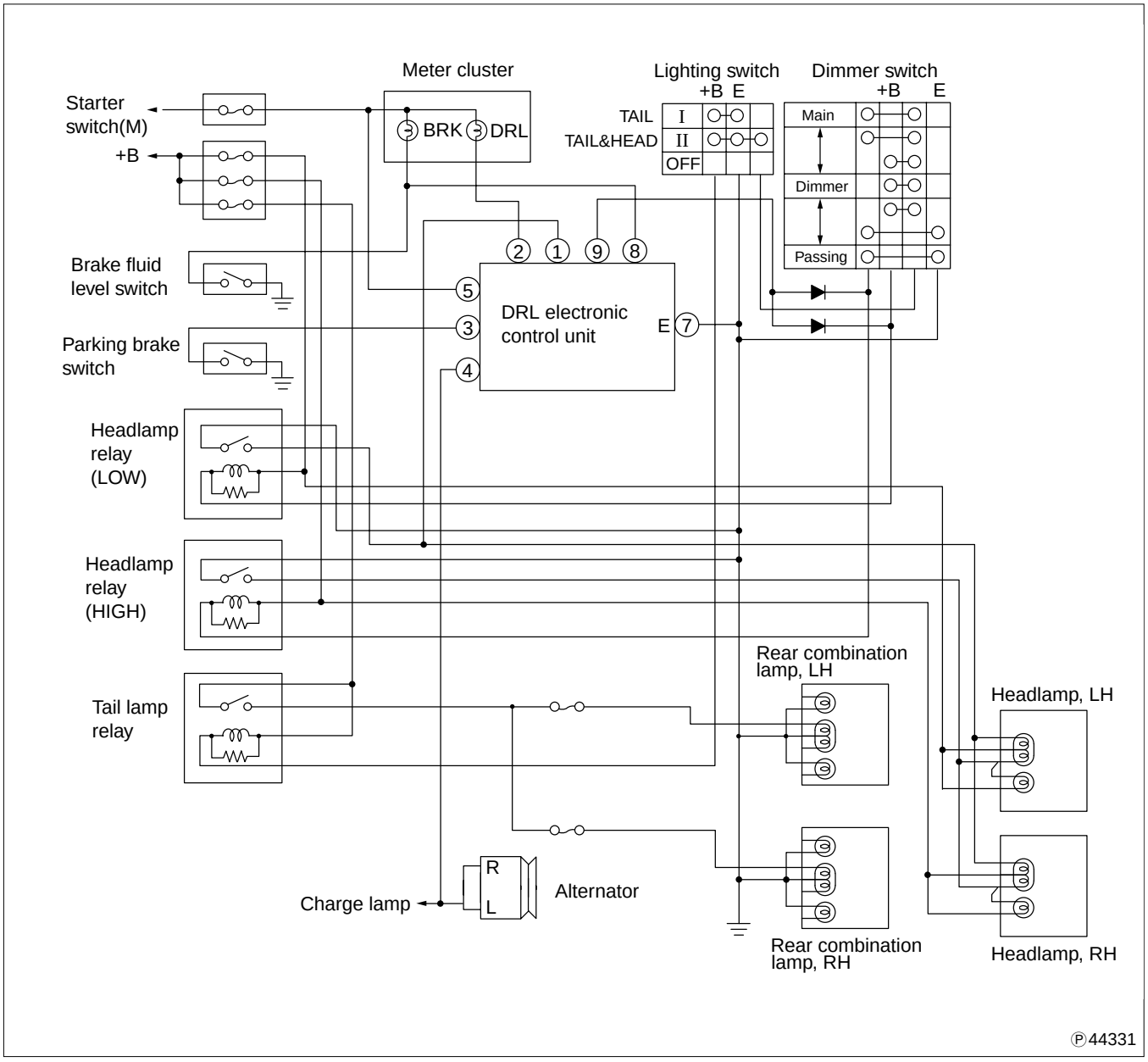


Headlamps repeat ON/OFF operations at 120 Hz according to the above timing chart. Because of the cyclic ON/OFF operations, the headlamps are dimmer than when the headlamp switch is ON.

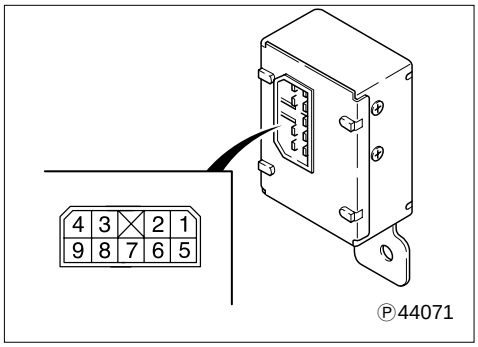
Explanation of timing chart

- After the engine starts, when alternator begins generating electricity with starter switch in the ON position, headlamps light.
- When parking brake switch is ON, the DRL turns off to switch off the headlamps.

• Daytime running light electronic control unit circuit diagram



• DRL electronic control unit



Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Head lamp (Dipped)	6	—
2	DRL indicator lamp	7	Ground
3	Parking brake switch	8	Parking brake indicator lamp
4	Alternator L terminal	9	Lighting switch
5	Starter switch M terminal	—	—

M E M O

4. MUTIC (Multipurpose Timing Control Unit)

- This control unit is an integrated control unit for controlling the following functions.

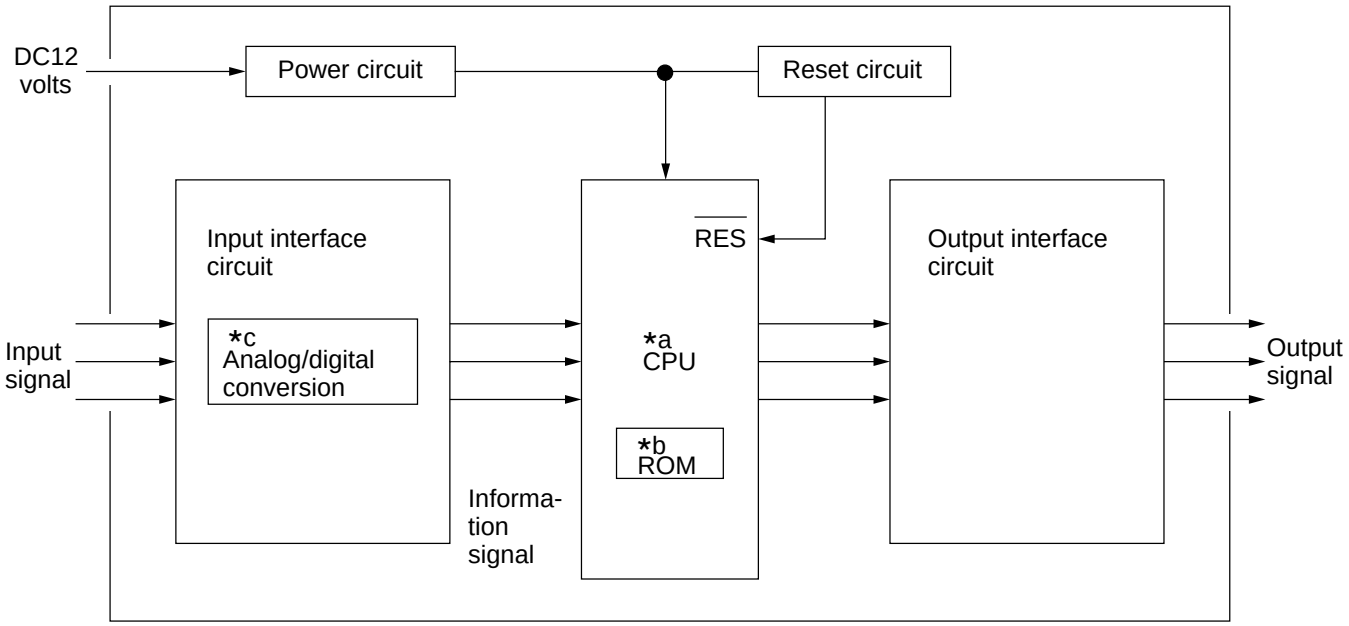
Preheating function 🕮 P54-0-20

Intermittent wiper activation function 🕮 P54-0-19

Starter continuous-ON prevention function 🕮 P54-0-22

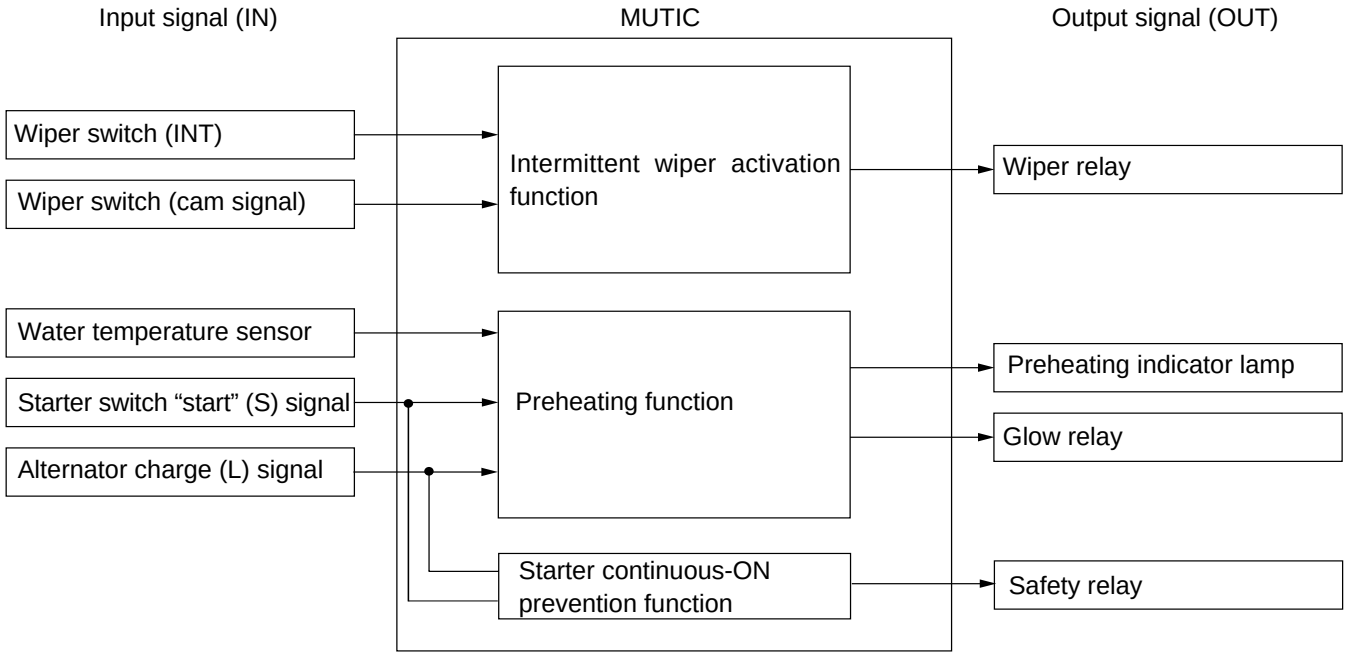
- For controlling each function, sensors and switches are needed as sources of information, and they are provided for respective systems.
- Based on the information provided by the sensors and switches, the MUTIC controls above functions by means of the circuits inside itself.

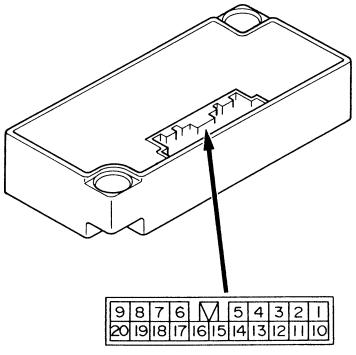
● **Internal structure of MUTIC**



- The MUTIC is internally made up roughly of the input interface circuit, CPU*a, ROM*b, and output interface circuit.
  *a: An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM and makes a decision and sends commands to the outputs.
  *b: An abbreviation for Read-Only Memory. It is an element used exclusively to have its contents read. It stores fixed data and program, and such retained information is not deleted even after power is cut off.
- Information sources such as sensor, switch send input signal to the input interface circuit.
- The input interface circuit performs A/D conversion*c of the input signals, and the converted signals are transmitted to the CPU as information signals.
  *c: An abbreviation for Analog/Digital conversion. It is a conversion from analog to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

System function schematic





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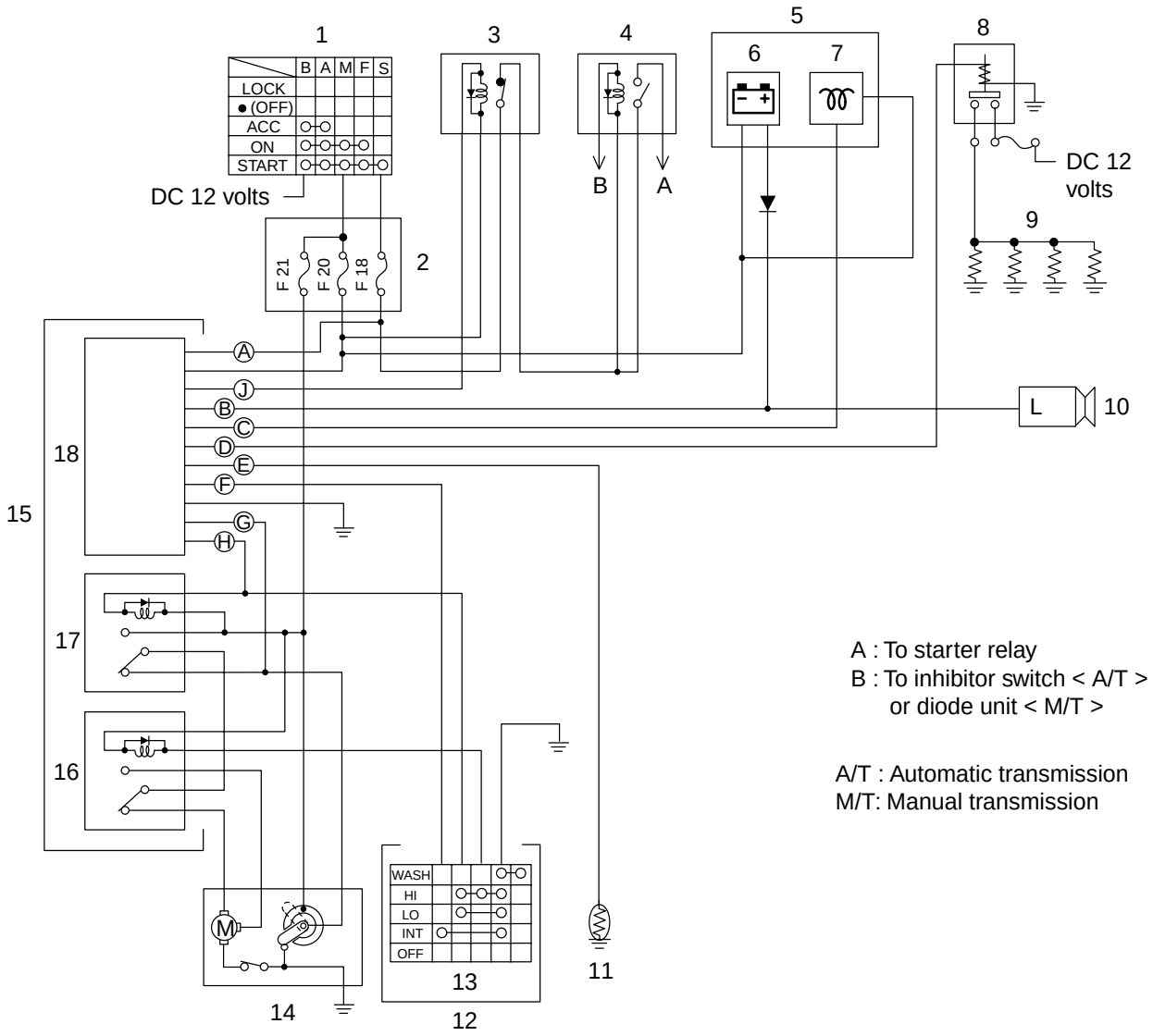
Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Glow relay	11	—
2	Wiper cam switch	12	—
3	Glow indicator lamp	13	Safety relay
4	Wiper relay	14	Ground
5	—	15	—
6	—	16	Alternator L terminal
7	—	17	—
8	—	18	Starter switch S terminal
9	Water temperature sensor	19	Wiper switch (INT)
10	+Va (starter switch M terminal)	20	—

MUTIC (Multipurpose Timing Control Unit) Functional Circuit Diagram



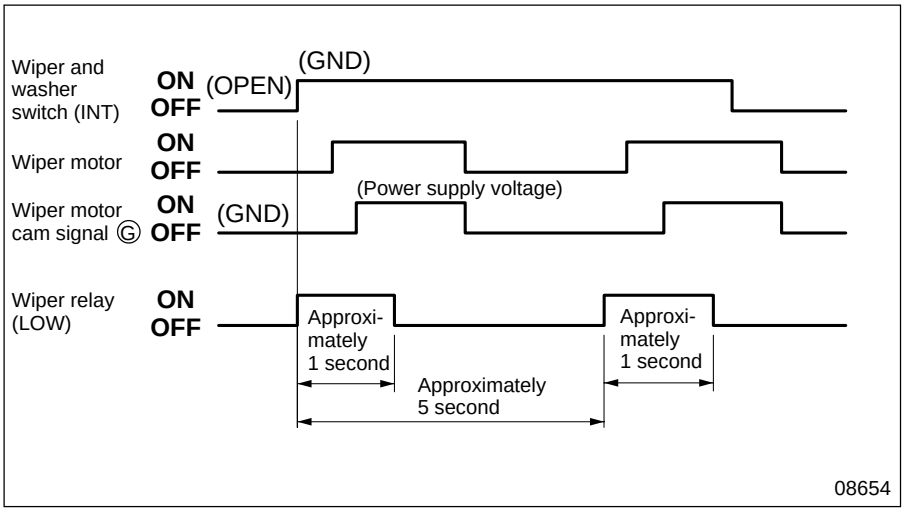
A : To starter relay
B : To inhibitor switch < A/T > or diode unit < M/T >

A/T : Automatic transmission
M/T: Manual transmission

Ⓟ44590

No.	Part name	Principal function sensors	Information signal
1	Starter switch	Start position detection	Ⓐ : Start signal
2	Fuse box	—	—
3	Safety relay	—	Ⓙ : Starter continuous-ON cancellation signal
4	Neutral start relay	—	—
5	Meter cluster	—	—
6	Battery charge indicator lamp	—	—
7	Enging preheating indicator lamp	—	Ⓒ : Lamp ON signal
8	Glow relay	—	Ⓓ : Glow relay activation signal
9	Glow plug	—	—
10	Alternator	Output of alternator charge signal	Ⓑ : Alternator charge signal
11	Water temperature sensor	Engine water temperature	Ⓔ : Engine water temperature signal
12	Combination switch	—	—
13	Wiper and washer switch	—	Ⓕ : Wiper interval switch signal
14	Wiper motor	—	Ⓖ : Wiper motor cam signal
15	Relay box	—	—
16	Wiper relay (HIGH)	—	—
17	Wiper relay (LOW)	Wiper intermittent operation	Ⓗ : Wiper relay activation signal
18	MUTIC	—	—

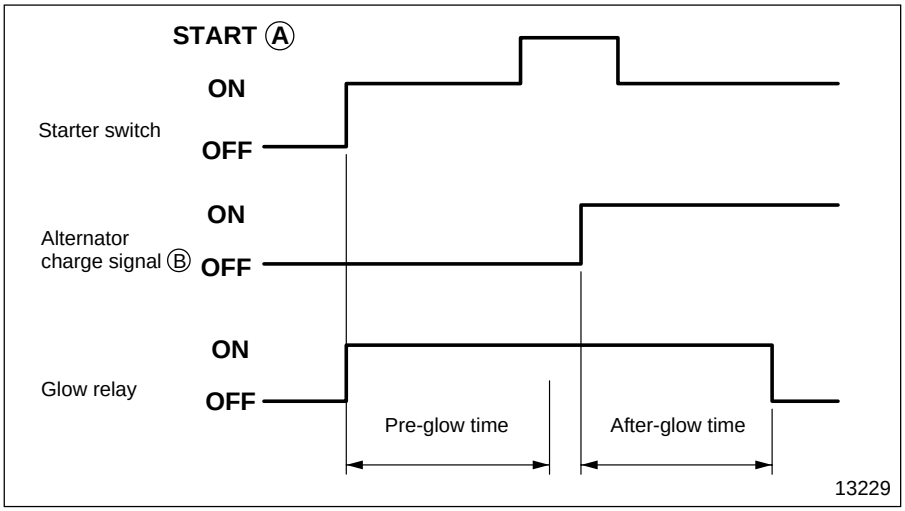
Intermittent Wiper Activation Function



The operation of intermittent wiper is controlled by MUTIC in a mode as shown.

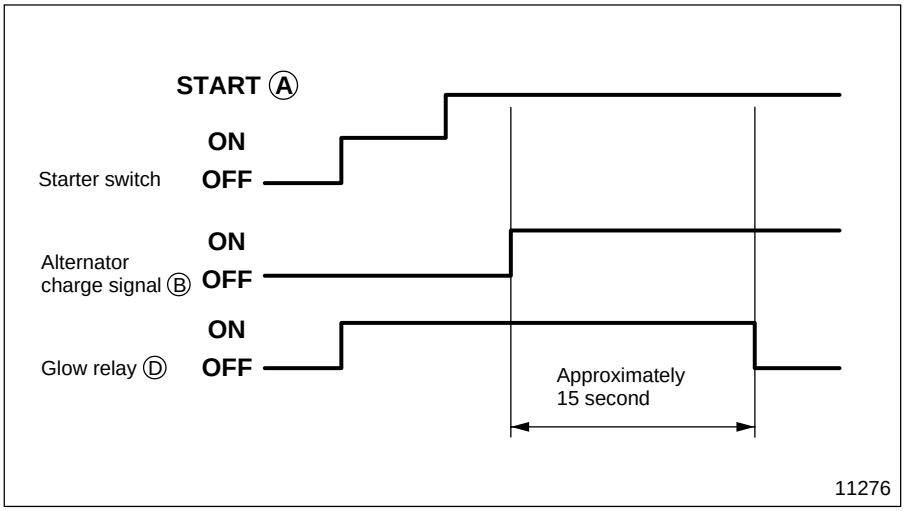
Preheating Function

This preheating function aims to enhance the engine start up when the engine coolant is low in cold weather or temperature.
MUTIC (Multipurpose Timing Control Unit) controls the entire function as follows:



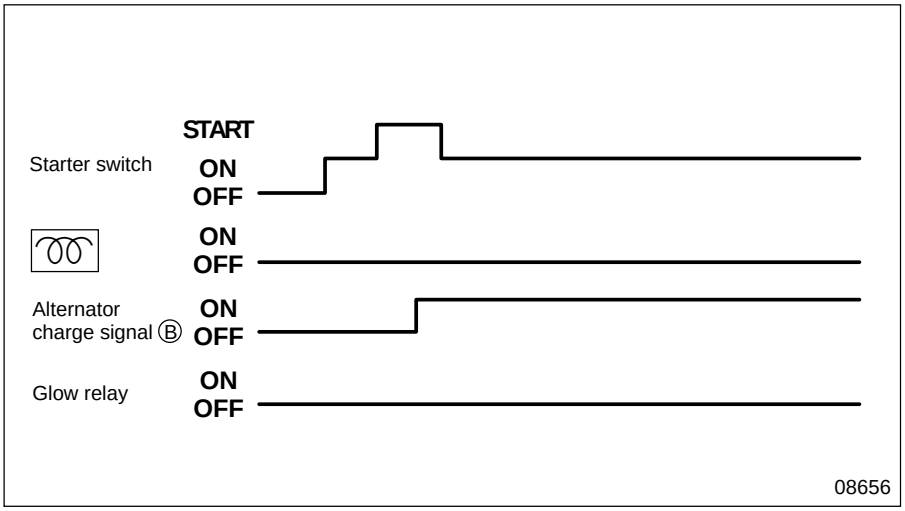
Pre-glow and After-glow

The preheating is operated with a pre-glow before the engine starting and an after-glow after the engine starting, which are controlled by the starter switch (S terminal) signal Ⓐ and the alternator (L terminal) signal Ⓑ.



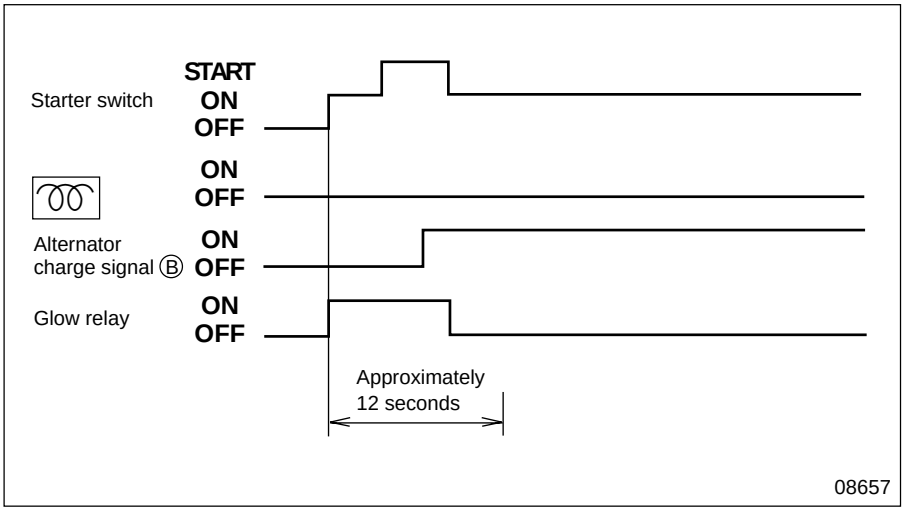
Fail Safe

- In case the contact point operating the glow relay in MUTIC has melted, the preheating indicator lamp flashes to warn this abnormality.
- Operation mode turns glow relay activation signal Ⓓ to OFF only after all the following condi-tions are met.
  - Where the engine coolant temperature is 60°C or less.
  - Alternator (L terminal) signal Ⓑ is ON for 15 seconds continuously.
  - Starter switch (S terminal) signal Ⓐ is ON.

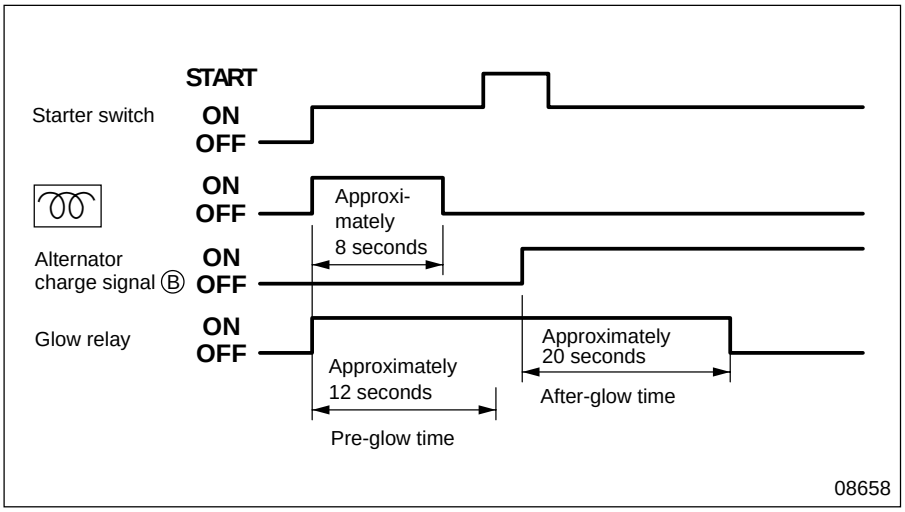


Operation mode

- Where the engine coolant temperature is 60°C {140 °F} or more.



- Where the engine coolant temperature is 0 to 60°C {32 to 140°F}.



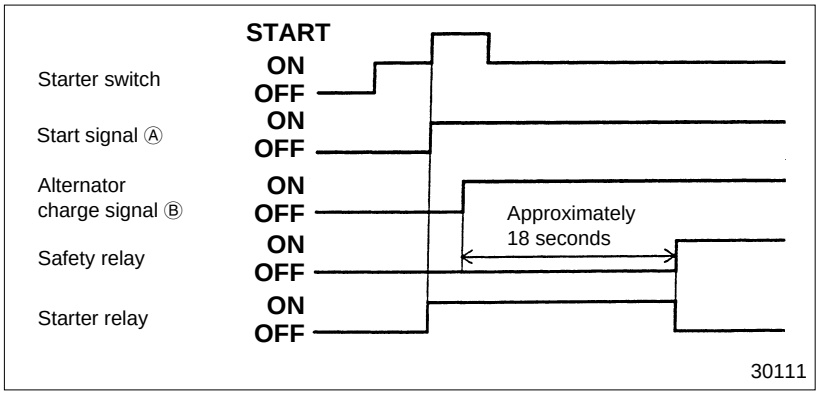
- Where the engine coolant temperature is 0°C {32°F} or less.

Starter Continuous-ON Prevention Function

- This function prevents a starter overrun.
- If the starter continues to operate for more than a preset time after the engine starts, the MUTIC detects a starter continuous-ON condition, and stops the current to the starter and starter relay to prevent the starter from seizing.

When a preset time elapses after the engine starts, the safey relay is activated (opening of contact) by signal Ⓑ from the alternator (terminal L).

Operation mode



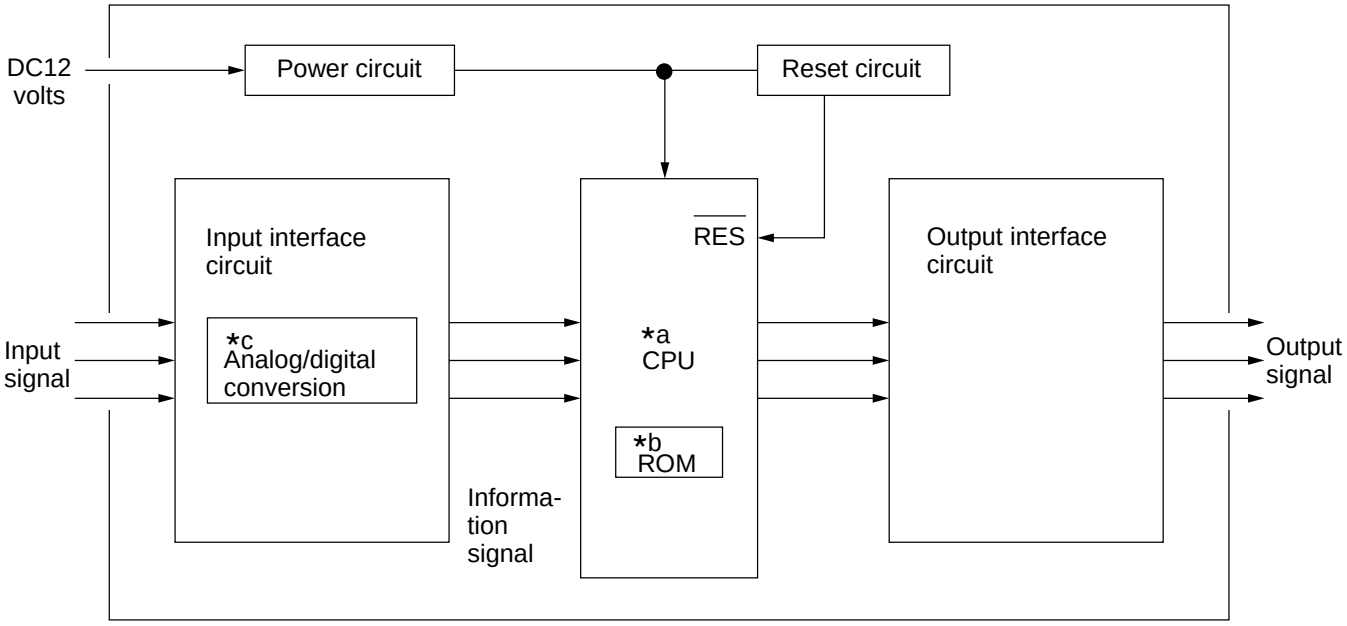
5. LAC (Lighting and Alarm Control Unit)

- This control unit is an integrated control unit for controlling the following functions.

Brake pad wear alarm function 🕮 P54-0-25

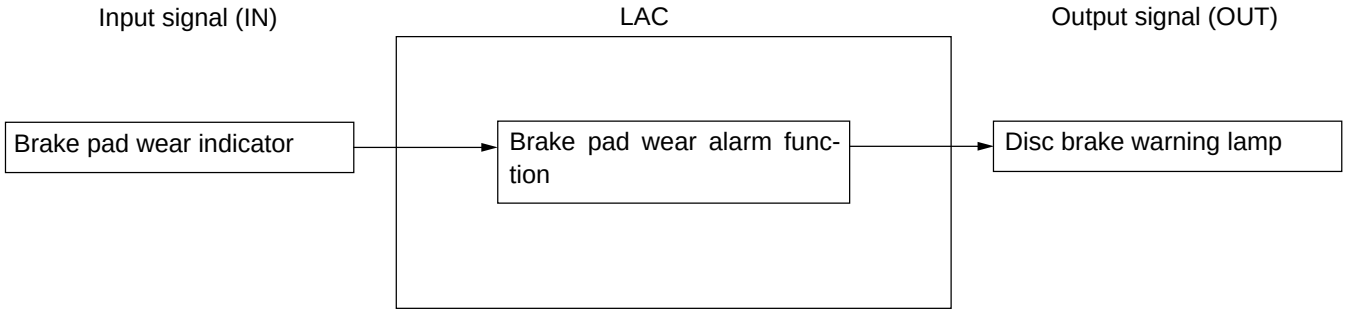
- For controlling each function, sensors and switches are needed as sources of information, and they are provided for respective systems.
- Based on the information provided by the sensors and switches, the LAC controls above functions by means of the circuits inside itself.

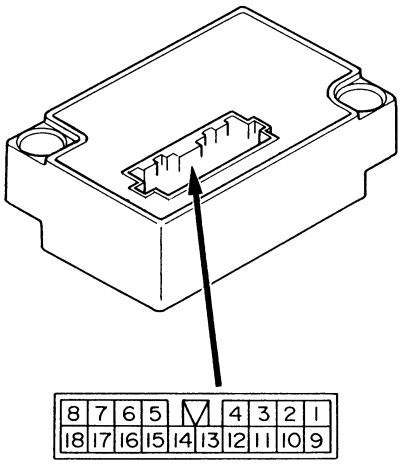
● **Internal structure of LAC**



- The LAC is internally made up roughly of the input interface circuit, CPU*a, ROM*b, and output interface circuit.
  *a: An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM and makes a decision and sends commands to the outputs.
  *b: An abbreviation for Read-Only Memory. It is an element used exclusively to have its contents read. It stores fixed data and program, and such retained information is not deleted even after power is cut off.
- Information sources such as sensor, switch send input signal to the input interface circuit.
- The input interface circuit performs A/D conversion*c of the input signals, and the converted signals are transmitted to the CPU as information signals.
  *c: An abbreviation for Analog/Digital conversion. It is a conversion from analog to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

System function schematic



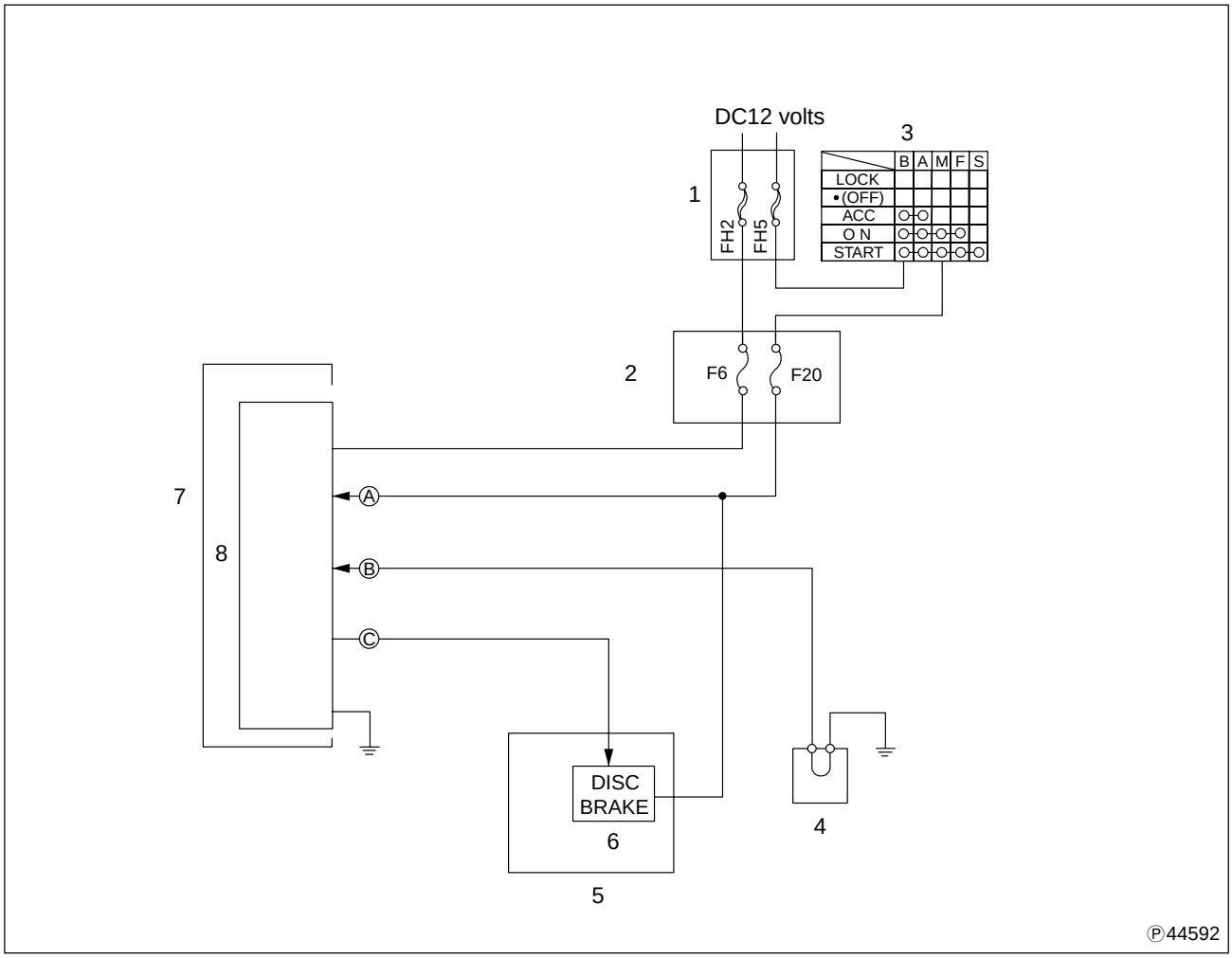


07505

Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Starter switch (M terminal)	10	—
2	—	11	—
3	—	12	Ground
4	Disc brake warning lamp	13	—
5	—	14	Fuse box
6	—	15	—
7	—	16	Brake pad wear indicator
8	—	17	—
9	—	18	—

LAC (Lighting and Alarm Control Unit) Functional Circuit Diagram

Brake Pad Wear Alarm Function



No.	Part name	Principal function sensors	Information signal
1	High-current fuse box	—	—
2	Fuse box	—	—
3	Starter switch	Start position detection	Ⓐ : Start signal
4	Brake pad wear indicator	—	Ⓑ : Disc brake wear signal
5	Meter cluster	—	—
6	Disc brake warning lamp	—	Ⓒ : DISC BRAKE lamp ON signal
7	Relay box	—	—
8	LAC	—	—

LAC **8** determines brake pad wear based on ON/OFF information by brake pad wear indicator **4**, and light up the disk brake warning lamp DISC BRAKE.

Power and charging

Symptoms / Possible causes		Battery electrolyte decreases too early	Battery overheating	Battery is normal but overdischarged	Charge warning lamp does not light when starter switch is turned ON, with engine stopped	Alternator is normal but battery overdischarged	Remarks
Defective connector connection, harness open/short circuit, defective grounding				○		○	
Fuse blown				○	○	○	
V-belts loose				○		○	Gr 14
V-belts damaged				○		○	Gr 14
Battery faulty		○				○	
Alternator	Stator coil broken			○			
	Stator coil short-circuited with core			○			
	Field coil faulty			○			
	Rectifier faulty			○			
	Regulator faulty		○	○	○		
	Wiring faulty			○			
Meter cluster faulty					○		

Engine starting, preheating and stopping

Possible causes \ Symptoms		Starter does not operate	Starter operates but engine does not start: Pinion does not engage with ring gear	Starter operates but engine does not start: Pinion engages with ring gear but does not rotate	Starter operates but engine does not start: Flywheel rotates but engine does not start	Engine does not stop	Engine cannot be preheated	Engine is hard to start	Engine warm-up function does not operate	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○			○	○	○		○	
High-current fuse blown		○								
Fuse blown		○				○	○		○	
Battery insufficiently charged		○		○						
Starter	Magnetic switch contacts stuck or fused together	○								
	Open circuit in magnetic switch coil	○								
	Overrunning clutch malfunctioning			○						
	Pinion worn or damaged		○							
Starter relay defective		○								
Starter switch defective		○				○				
Flywheel ring gear worn or damaged			○							Gr 11
Glow plugs defective							○	○		
Glow relay defective							○	○		
Water temperature sensor defective							○	○	○	
MUTIC (control unit) defective		○					○	○		
Faulty connection of connecting plate							○	○		Gr 11
Transmission neutral switch faulty < M/T >		○								
Transmission neutral relay faulty < M/T >		○								
Neutral start relay faulty		○								
Inhibitor switch faulty < A/T >		○								
Safety relay faulty		○								
Warm-up switch faulty									○	
Engine electronic control unit faulty									○	Gr 13E

A/T: Automatic transmission
M/T: Manual transmission

Lighting

Symptoms / Possible causes		Headlamp: Does not light	Headlamp: Dim	Headlamp: Does not switch to main beam	Headlamp: Does not switch to dipped beam	Tail lamp does not light	Stop lamp does not light	Clearance lamp does not light	Position lamp does not light	License plate lamp does not light	Backup lamp does not light	Back buzzer does not sound	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○				○	○	○	○	○	○	○	
Fuse blown		○				○	○	○	○	○	○	○	
Battery capacity insufficient			○										
Alternator output insufficient			○										
Bulb burnt-out		○				○	○	○	○	○	○	○	
Power (wattage) of bulb is lower than specified value													
Power (wattage) of bulb is higher than specified value													
Combination switch	Lighting switch faulty	○				○		○	○	○			
	Turn signal lamp switch faulty												
	Dimmer switch faulty			○	○								
	Hazard warning lamp switch faulty												
Relay box	Headlamp relay (HIGH, LOW) faulty	○		○	○								
	Tail lamp relay faulty					○		○	○	○			
	Flasher unit faulty												
Stop lamp switch faulty							○						
Backup lamp switch faulty											○	○	
Back buzzer faulty												○	
Cab lamp switch faulty													
Cab lamp or rear cab lamp faulty													
Door switch faulty													
Rheostat switch faulty													
Tail lamp bulb burnt-out												○	

Symptoms / Possible causes		Turn signal lamp (also used as hazard)					Cab lamp does not light	Interior illumination lamps for meters, heater control panel, etc. cannot be adjusted	Marker lamp does not light	Remarks
		Does not blink	Stays ON	Blinks too slowly	Blinks too quickly	Blinks irregularly				
Defective connector connection, harness open/short circuit, defective grounding		○					○	○	○	
Fuse blown		○					○		○	
Battery capacity insufficient			○							
Alternator output insufficient			○							
Bulb burnt-out		○			○			○	○	
Power (wattage) of bulb is lower than specified value					○					
Power (wattage) of bulb is higher than specified value				○						
Combination switch	Lighting switch faulty								○	
	Turn signal lamp switch faulty									
	Dimmer switch faulty									
	Hazard warning lamp switch faulty	○	○							
Relay box	Headlamp relay (HIGH, LOW) faulty									
	Tail lamp relay faulty							○	○	
	Flasher unit faulty	○	○	○	○	○				
Stop lamp switch faulty										
Backup lamp switch faulty										
Back buzzer faulty										
Cab lamp switch faulty							○			
Cab lamp or rear cab lamp faulty							○			
Door switch faulty							○			
Rheostat switch faulty								○		

Lighting

Symptoms / Possible causes		Van body dome light does not light	Daytime running light system does not operate after engine starts, and headlamps do not light	Identification lamp does not light	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○	○	
Fuse blown		○		○	
Battery capacity insufficient					
Alternator output insufficient			○		
Bulb burnt-out		○	○	○	
Power (wattage) of bulb is lower than specified value					
Power (wattage) of bulb is higher than specified value					
Combination switch	Lighting switch faulty	○			
	Turn signal lamp switch faulty				
	Dimmer switch faulty				
	Hazard warning lamp switch faulty				
Relay box	Headlamp relay (HIGH, LOW) faulty	○	○		
	Tail lamp relay faulty			○	
	Flasher unit faulty				
Van body dome light relay faulty		○			
Van body dome light switch faulty		○			
Daytime running light electronic control unit faulty			○		

Meter

Possible causes \ Symptoms		Pointer does not move	Pointer movement unstable	Indication error large	Abnormal noise from meter	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○			
Fuse blown		○				
Internal circuits of meter cluster faulty		○	○	○		
Printed wiring board of meter cluster faulty		○				
Tachometer	Engine speed sensor coil open-circuited	○				
	Engine speed sensor improperly mounted	○	○			Gr 11, 13
	Tachometer faulty	○	○	○	○	
	Engine electronic control unit faulty	○	○	○		Gr 13E
Speedometer	Speedometer cable broken	○				
	Speedometer cable connection faulty		○		○	
	Speedometer cable lubricant exhausted		○		○	
	Specified tires not used			○		Gr 31
	Tires worn or inflation pressure incorrect			○		Gr 31
	Specified L-joint of transmission not used (Different in gear ratio)			○		Gr 22
	Specified speedometer gear of transmission not used (Different in gear ratio)			○		Gr 22
	Installation angle of speedometer gear bushing on transmission incorrect (Not set at correct gear ratio position)			○		Gr 22
	Speedometer faulty	○	○	○	○	
Water temperature gauge	Water temperature sensor faulty	○		○		
	Water temperature gauge faulty	○		○		
	Thermostat does not close	○				Gr 14
Fuel gauge	Fuel level sensor faulty	○		○		
	Fuel gauge faulty	○		○		

Cigarette lighter and Audio

Symptoms / Possible causes	Cigarette lighter			Audio					Remarks
	Does not glow	Does not return	Night lamp does not light up	Specific frequency band does not work	Spurious noise generated	Sound quality poor	Sound from one side only	Left and right volume different	
Defective connector connection, harness open/short circuit, defective grounding	○		○		○		○		
Fuse blown	○		○						
Cigarette lighter faulty	○	○							
Tail lamp relay faulty			○						
Antenna and antenna cable connection faulty					○				
Speaker faulty				○	○	○	○	○	
Left and right speaker impedance different								○	

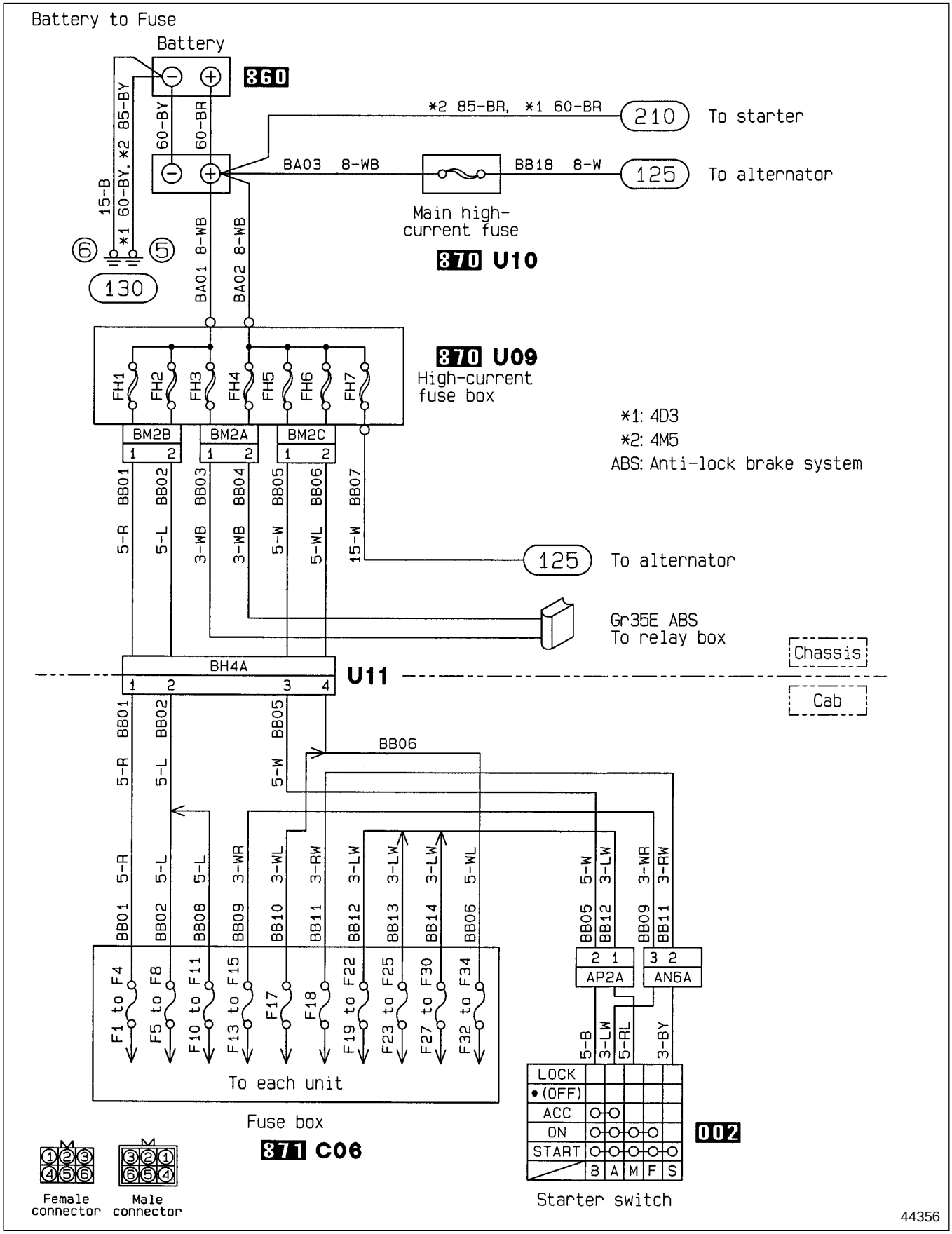
Accessory noise generation source

Accessory	Noise	Symptoms
Alternator	Whistling	High pitch sound when accelerator pedal suddenly depressed (Stops soon after engine stopped)
Water temperature gauge	Scratching	Occurs when engine running (Continues for a while after engine stops)
Engine oil pressure switch	Rattling	Depends on engine speed (Does not occur during idling)
Fuel level sensor	Scratching	Occurs when engine suddenly revved, while running on rough roads, or starter switch turned ON
Flasher unit	Banging	When turn signal blinks
Horn	Hissing	Occurs when horn button pressed or released
Wiper motor	Whining	Depends on wiper speed
Windshield washer	Whining	When windshield washer operates

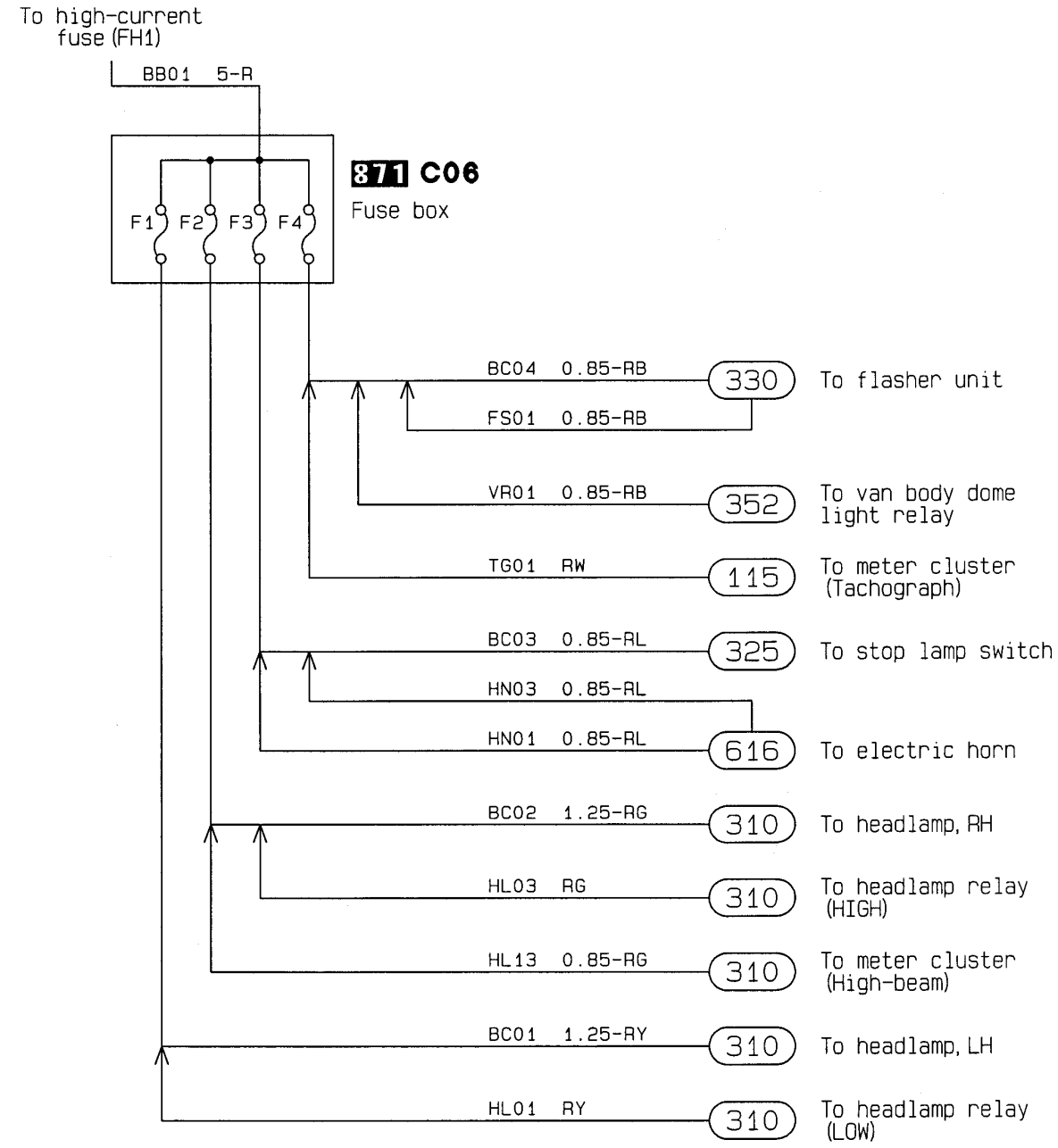
Horn

Symptoms / Possible causes	Horn				Remarks
	No Sound	Continuous sound	Small sound	Sound quality poor	
Defective connector connection, harness open/short circuit, defective grounding	○				
Fuse blown	○				
Horn switch faulty	○	○			
Horn faulty	○		○	○	
Horn stay warped			○	○	
Battery voltage insufficient	○		○		

1 POWER, CHARGE AND GROUND CIRCUIT

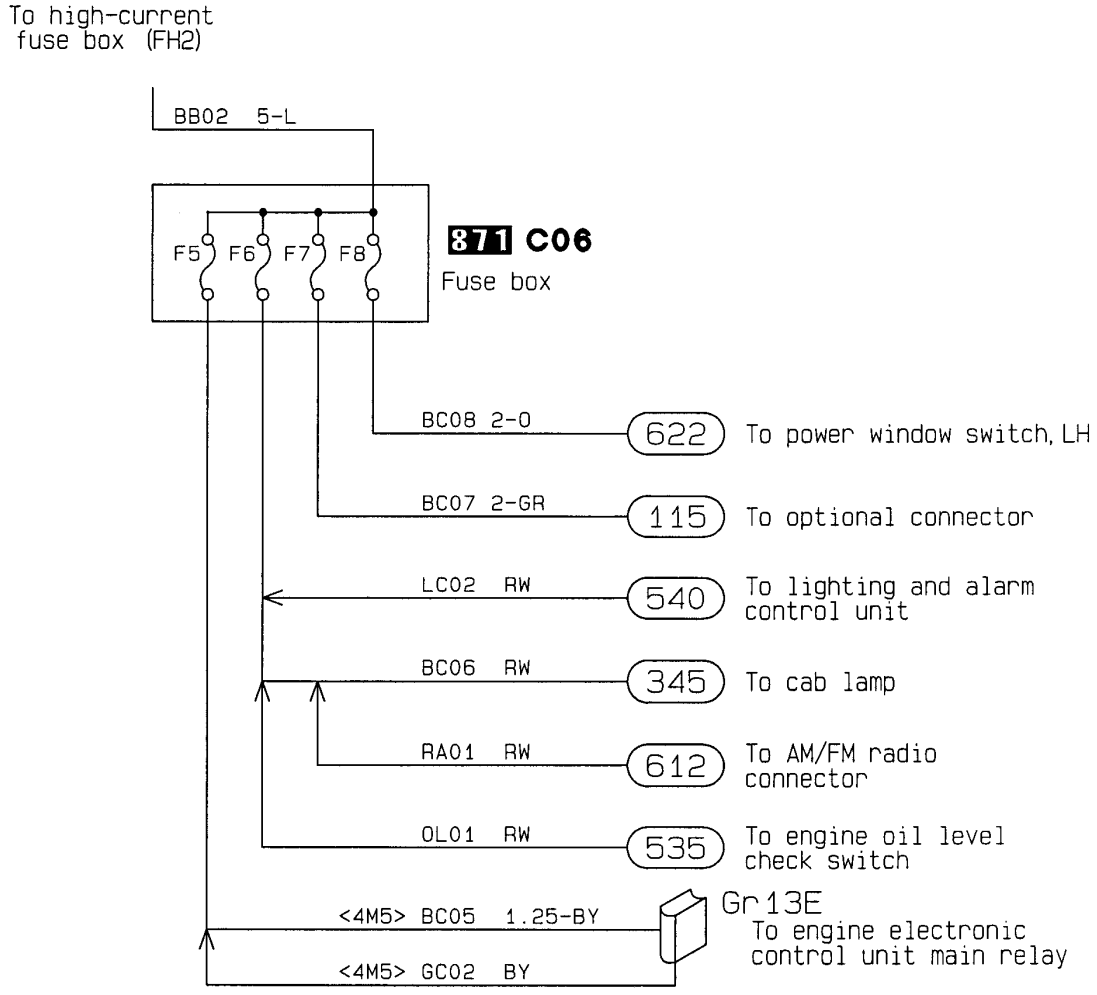

Battery to Fuse
Battery
860
60-BY
60-BR
15-B
*1 60-BY, *2 85-BY
*2 85-BR, *1 60-BR
210
To starter
BA03 8-WB
BB18 8-W
125
To alternator
Main high-current fuse
870 U10
6
5
130
BA01 8-WB
BA02 8-WB
870 U09
High-current fuse box
FH1
FH2
FH3
FH4
FH5
FH6
FH7
*1: 4D3
*2: 4M5
ABS: Anti-lock brake system
BM2B
BM2A
BM2C
5-R BB01
5-L BB02
3-WB BB03
3-WB BB04
5-W BB05
5-WL BB06
15-W BB07
125
To alternator
Gr35E ABS
To relay box
Chassis
Cab
BH4A
U11
BB06
F1 to F4
F5 to F8
F10 to F11
F13 to F15
F17
F18
F19 to F22
F23 to F25
F27 to F30
F32 to F34
To each unit
Fuse box
871 C06
AP2A
AN6A
5-B
3-LW
5-RL
3-BY
LOCK
• (OFF)
ACC
ON
START
B A M F S
002
Starter switch
Female connector
Male connector
44356

Fuse F1 to F4



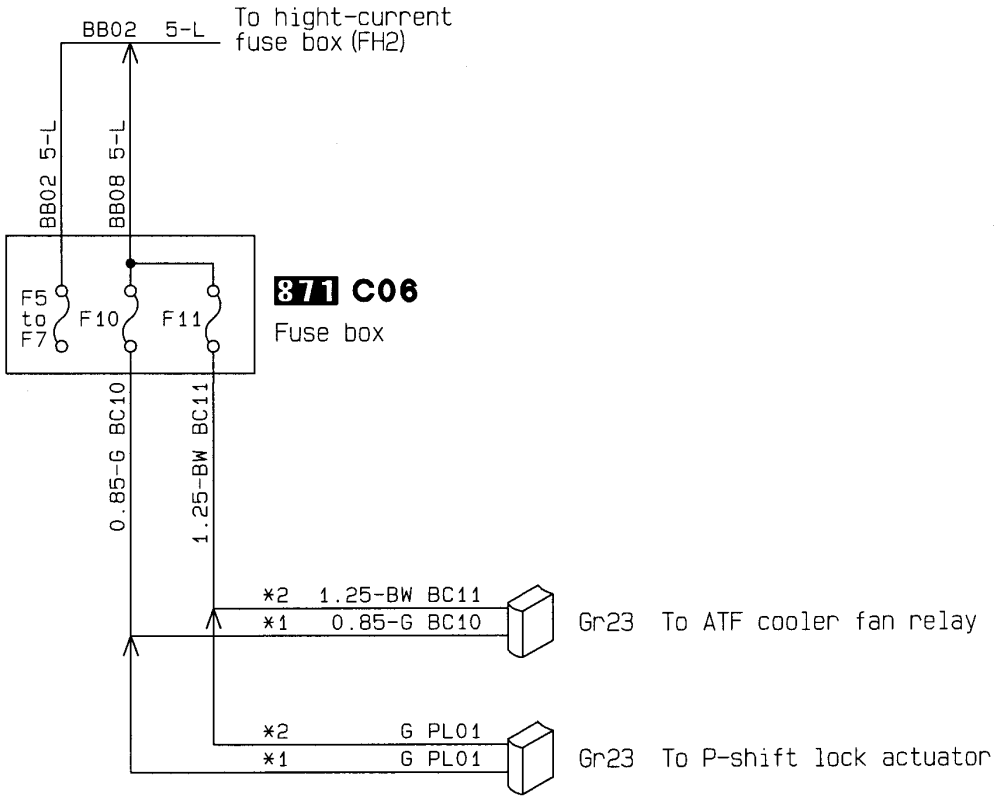
44357

Fuse F5 to F8



44358

Fuse F10 to F11 <Automatic transmission>

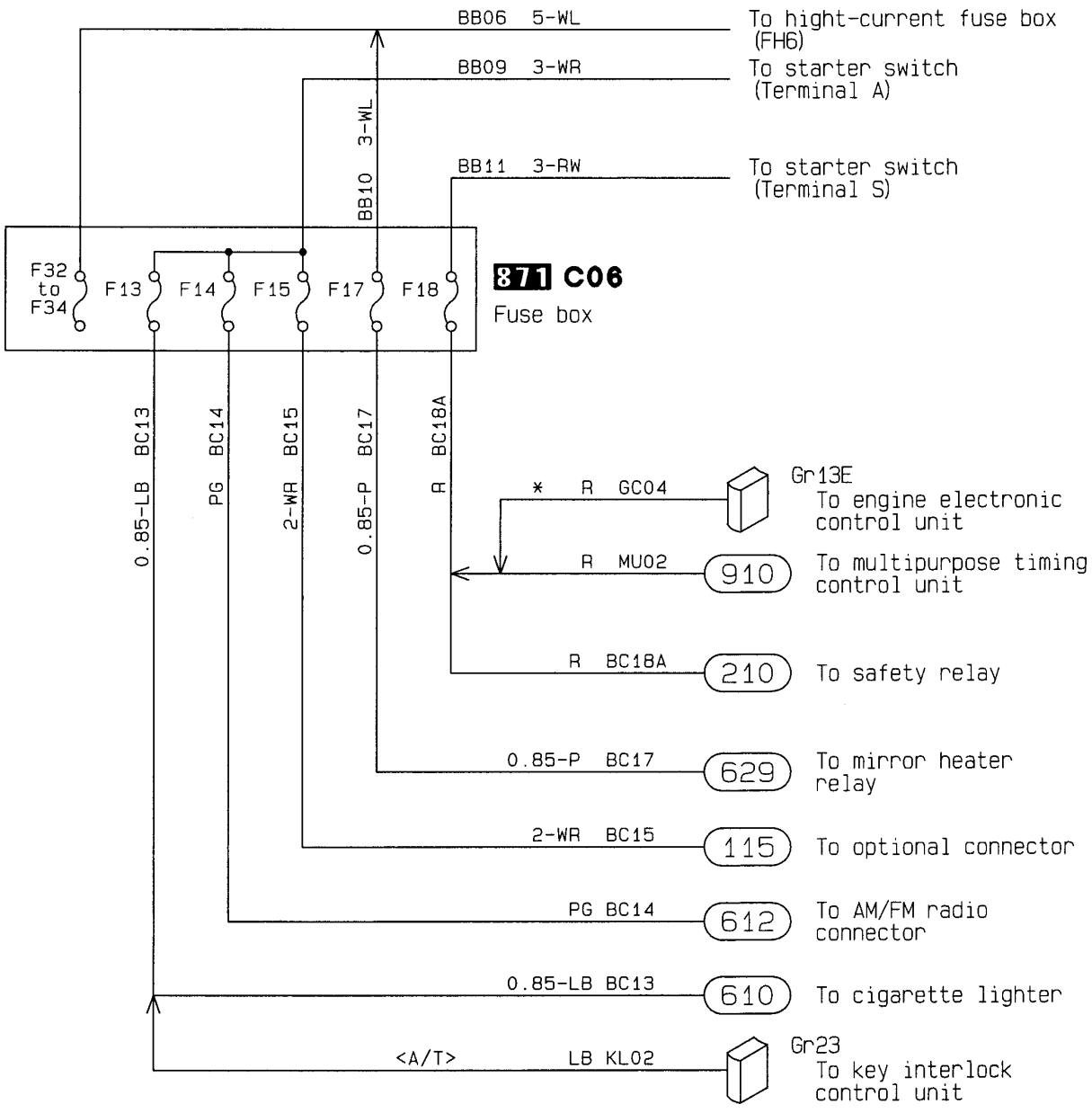


ATF: Automatic transmission fluid

*1: 4D3
*2: 4M5

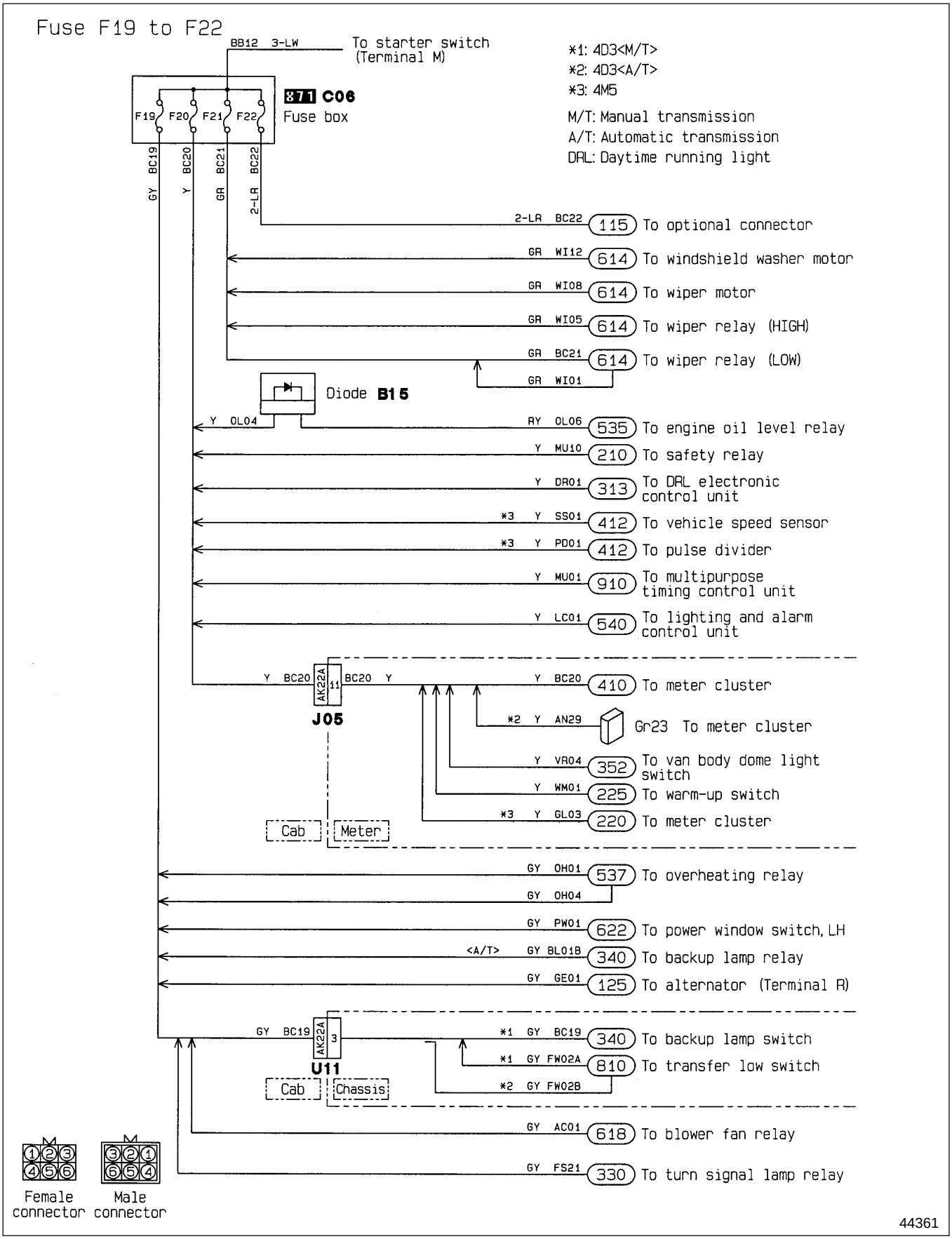
44359

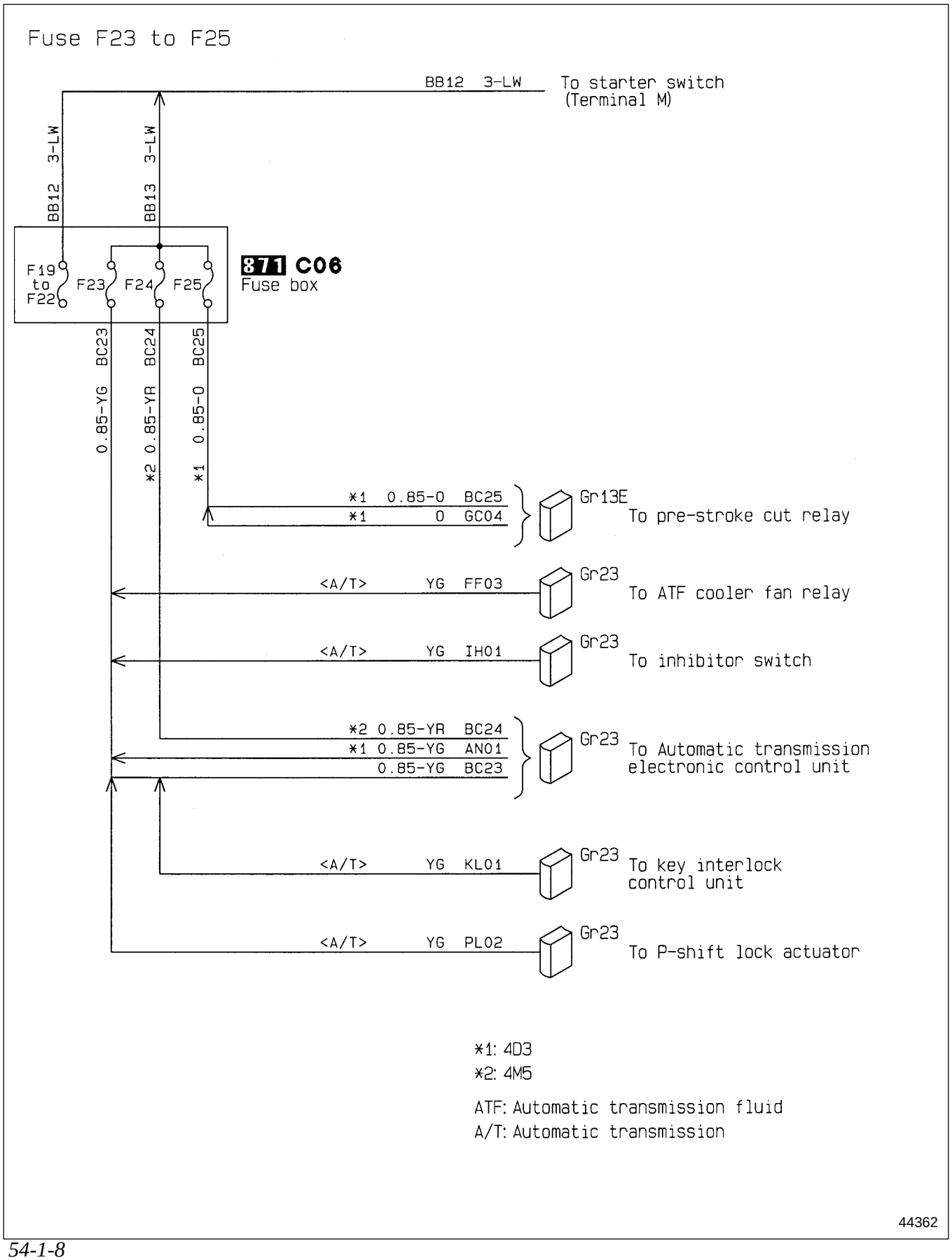
Fuse F13 to F18



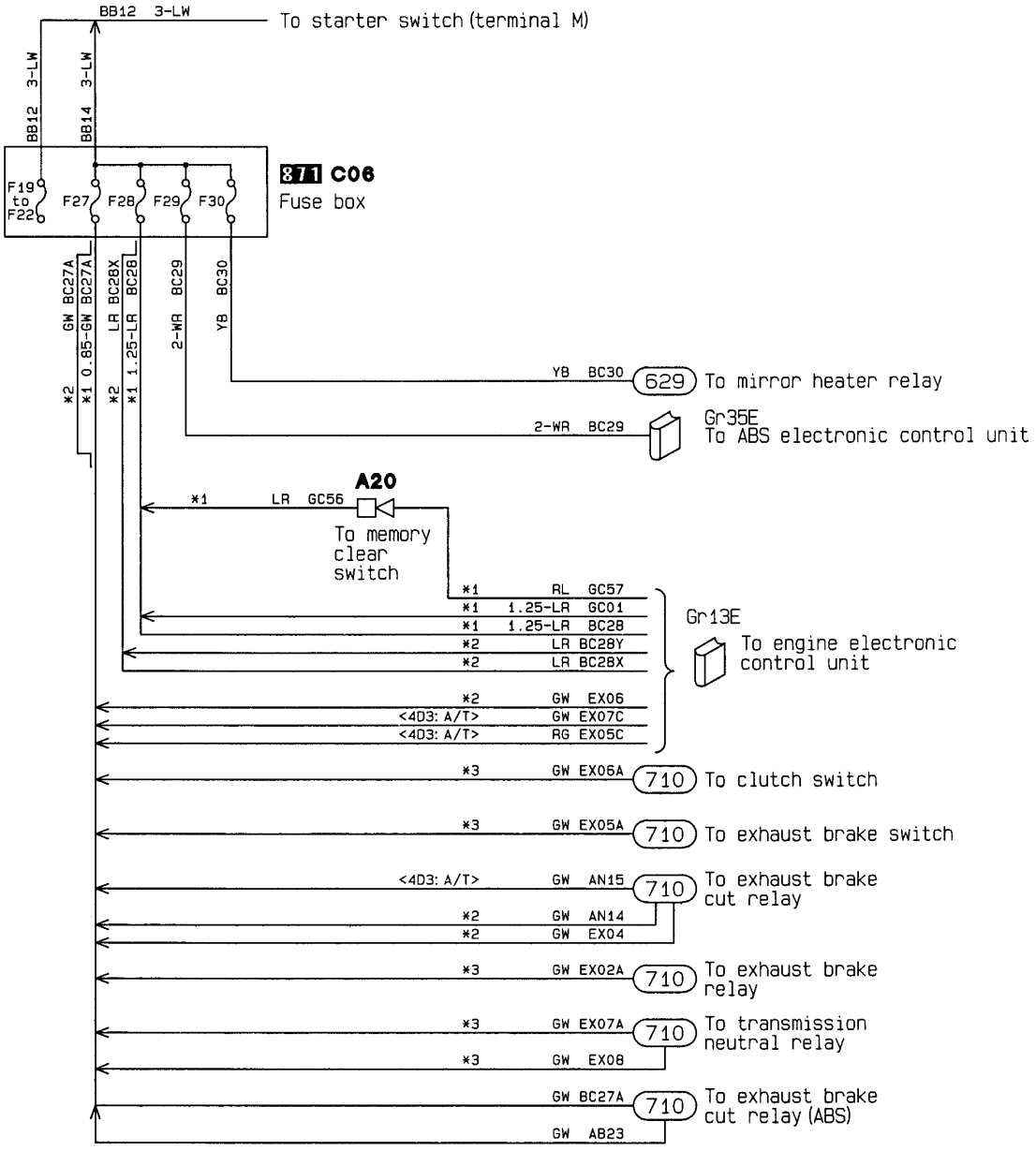
*: 4M5
A/T: Automatic transmission

44360


Fuse F19 to F22
BB12 3-LW
To starter switch (Terminal M)
*1: 4D3<M/T>
*2: 4D3<A/T>
*3: 4M5
M/T: Manual transmission
A/T: Automatic transmission
DRL: Daytime running light
371 C06
Fuse box
F19
F20
F21
F22
GY BC19
Y BC20
GR BC21
2-LR BC22
2-LR BC22 115 To optional connector
GR WI12 614 To windshield washer motor
GR WI08 614 To wiper motor
GR WI05 614 To wiper relay (HIGH)
GR BC21 614 To wiper relay (LOW)
GR WI01
Diode B15
Y OL04
RY OL06 535 To engine oil level relay
Y MU10 210 To safety relay
Y DR01 313 To DRL electronic control unit
*3 Y SS01 412 To vehicle speed sensor
*3 Y PD01 412 To pulse divider
Y MU01 910 To multipurpose timing control unit
Y LC01 540 To lighting and alarm control unit
Y BC20
AK22A 11
BC20 Y
J05
Y BC20 410 To meter cluster
*2 Y AN29
Gr23 To meter cluster
Y VR04 352 To van body dome light switch
Y WM01 225 To warm-up switch
*3 Y GL03 220 To meter cluster
Cab
Meter
GY OH01 537 To overheating relay
GY OH04
GY PW01 622 To power window switch, LH
<A/T> GY BL01B 340 To backup lamp relay
GY GE01 125 To alternator (Terminal R)
GY BC19
AK22A 3
U11
*1 GY BC19 340 To backup lamp switch
*1 GY FW02A 810 To transfer low switch
*2 GY FW02B
Cab
Chassis
GY AC01 618 To blower fan relay
GY FS21 330 To turn signal lamp relay
Female connector
Male connector
44361

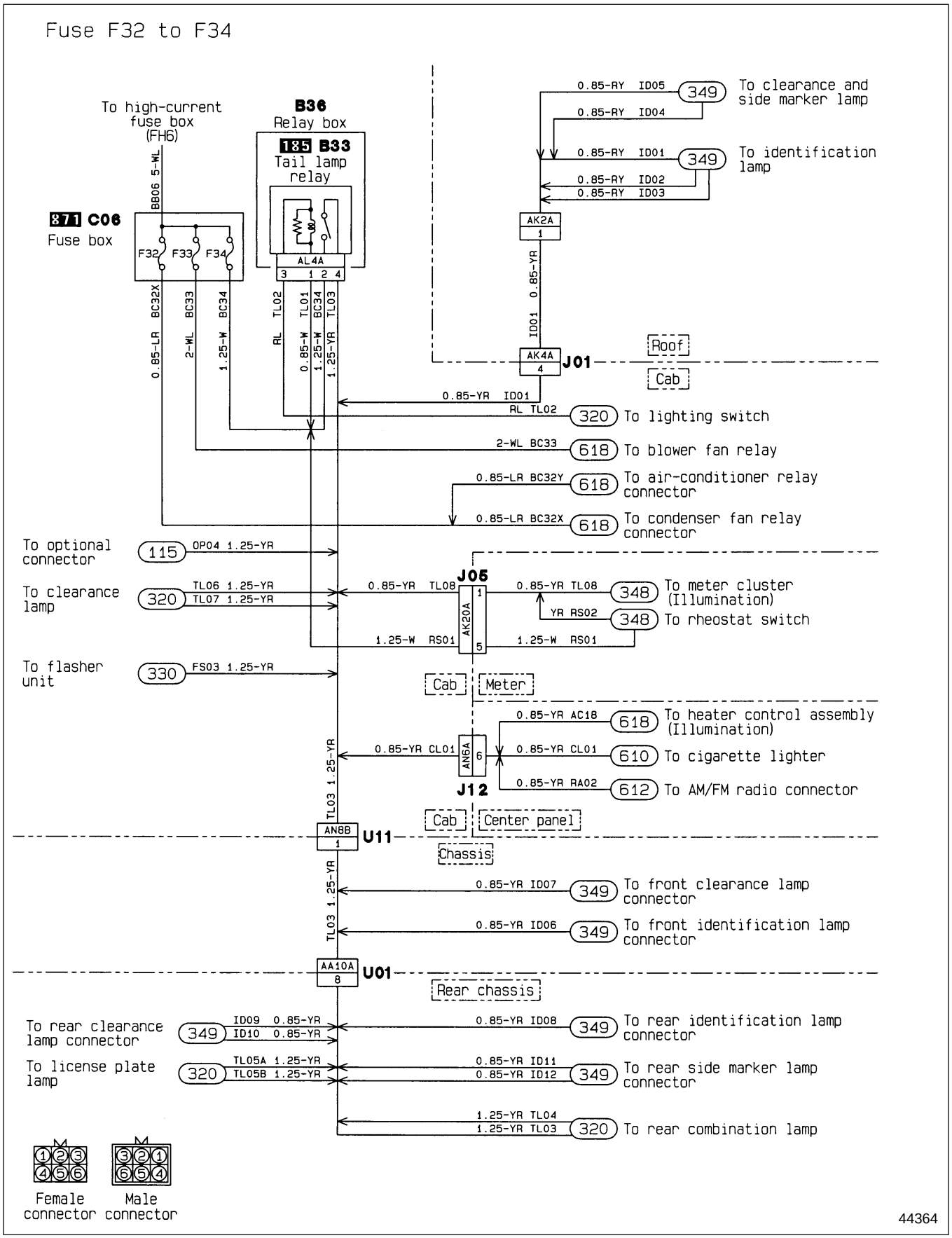

Fuse F23 to F25
BB12 3-LW
To starter switch
(Terminal M)
BB12 3-LW
BB13 3-LW
F19 to F22
F23
F24
F25
871 C06
Fuse box
0.85-YG BC23
*2 0.85-YR BC24
*1 0.85-O BC25
*1 0.85-O BC25
*1 O GC04
Gr13E
To pre-stroke cut relay
<A/T> YG FF03
Gr23
To ATF cooler fan relay
<A/T> YG IH01
Gr23
To inhibitor switch
*2 0.85-YR BC24
*1 0.85-YG AN01
0.85-YG BC23
Gr23
To Automatic transmission electronic control unit
<A/T> YG KL01
Gr23
To key interlock control unit
<A/T> YG PL02
Gr23
To P-shift lock actuator
*1: 4D3
*2: 4M5
ATF: Automatic transmission fluid
A/T: Automatic transmission
44362

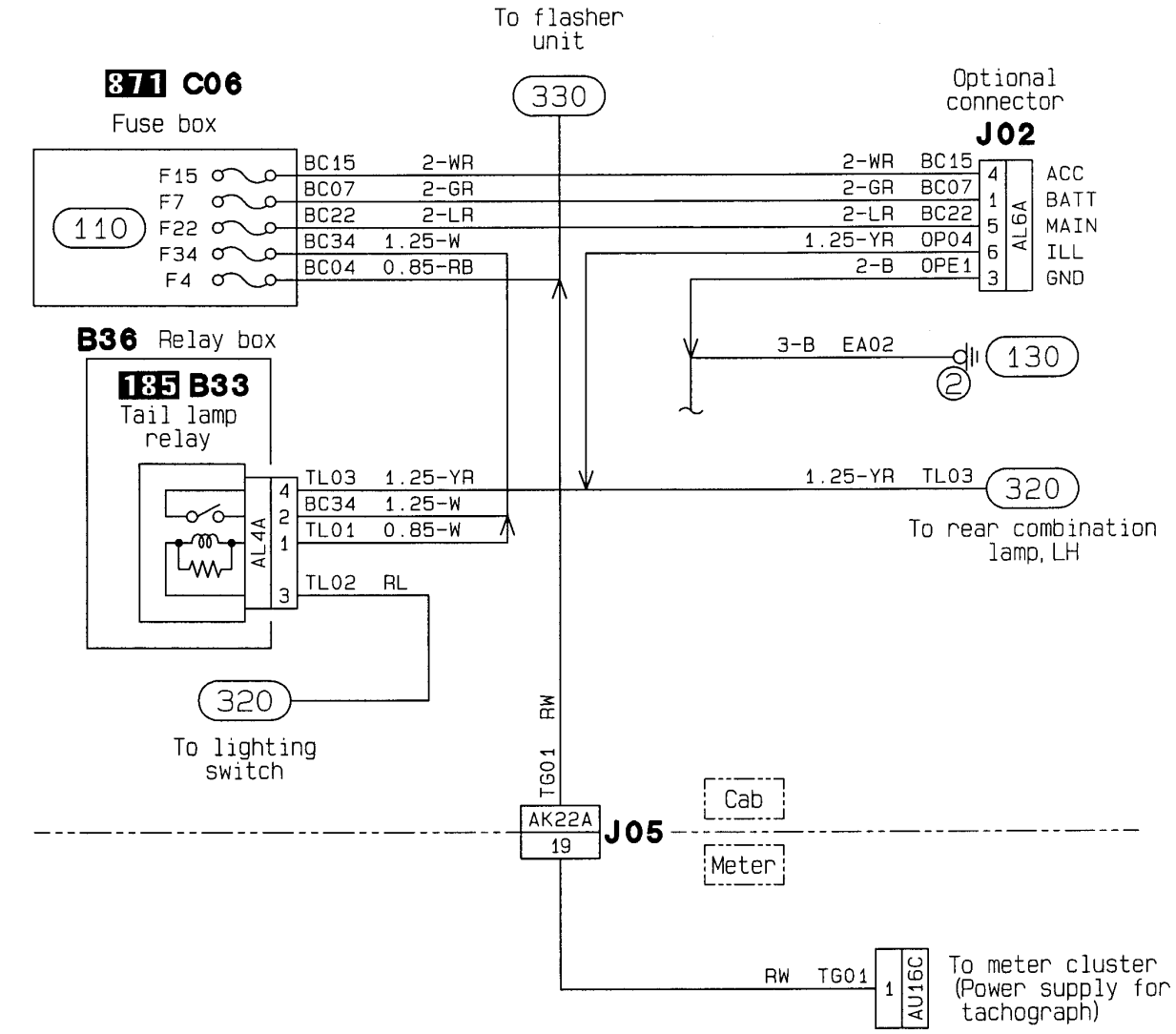
Fuse F27 to F30

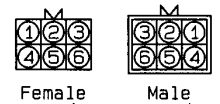


*1: 4D3
*2: 4M5
*3: Manual transmission (M/T)
*4: Automatic transmission (A/T)
ABS: Anti-lock brake system

44363


Fuse F32 to F34
To high-current fuse box (FH6)
B36
Relay box
185 B33
Tail lamp relay
871 C06
Fuse box
F32 F33 F34
AL4A
3 1 2 4
BB06 5-WL
0.85-LR BC32X
2-WL BC33
1.25-W BC34
RL TL02
0.85-W TL01
1.25-W BC34
1.25-YR TL03
0.85-RY ID05
0.85-RY ID04
0.85-RY ID01
0.85-RY ID02
0.85-RY ID03
349
To clearance and side marker lamp
To identification lamp
AK2A
1
ID01 0.85-YR
AK4A
4
J01
Roof
Cab
0.85-YR ID01
RL TL02
320
To lighting switch
2-WL BC33
618
To blower fan relay
0.85-LR BC32Y
To air-conditioner relay connector
0.85-LR BC32X
To condenser fan relay connector
To optional connector
115
OP04 1.25-YR
To clearance lamp
320
TL06 1.25-YR
TL07 1.25-YR
J05
AK20A
0.85-YR TL08
0.85-YR TL08
348
To meter cluster (Illumination)
YR RS02
To rheostat switch
1.25-W RS01
To flasher unit
330
FS03 1.25-YR
Cab
Meter
0.85-YR AC18
To heater control assembly (Illumination)
0.85-YR CL01
ANGA
6
610
To cigarette lighter
J12
0.85-YR RA02
612
To AM/FM radio connector
TL03 1.25-YR
AN8B
1
U11
Cab
Center panel
Chassis
0.85-YR ID07
To front clearance lamp connector
0.85-YR ID06
To front identification lamp connector
AA10A
8
U01
Rear chassis
To rear clearance lamp connector
ID09 0.85-YR
ID10 0.85-YR
0.85-YR ID08
To rear identification lamp connector
To license plate lamp
TL05A 1.25-YR
TL05B 1.25-YR
0.85-YR ID11
0.85-YR ID12
To rear side marker lamp connector
1.25-YR TL04
1.25-YR TL03
To rear combination lamp
Female connector
Male connector
44364

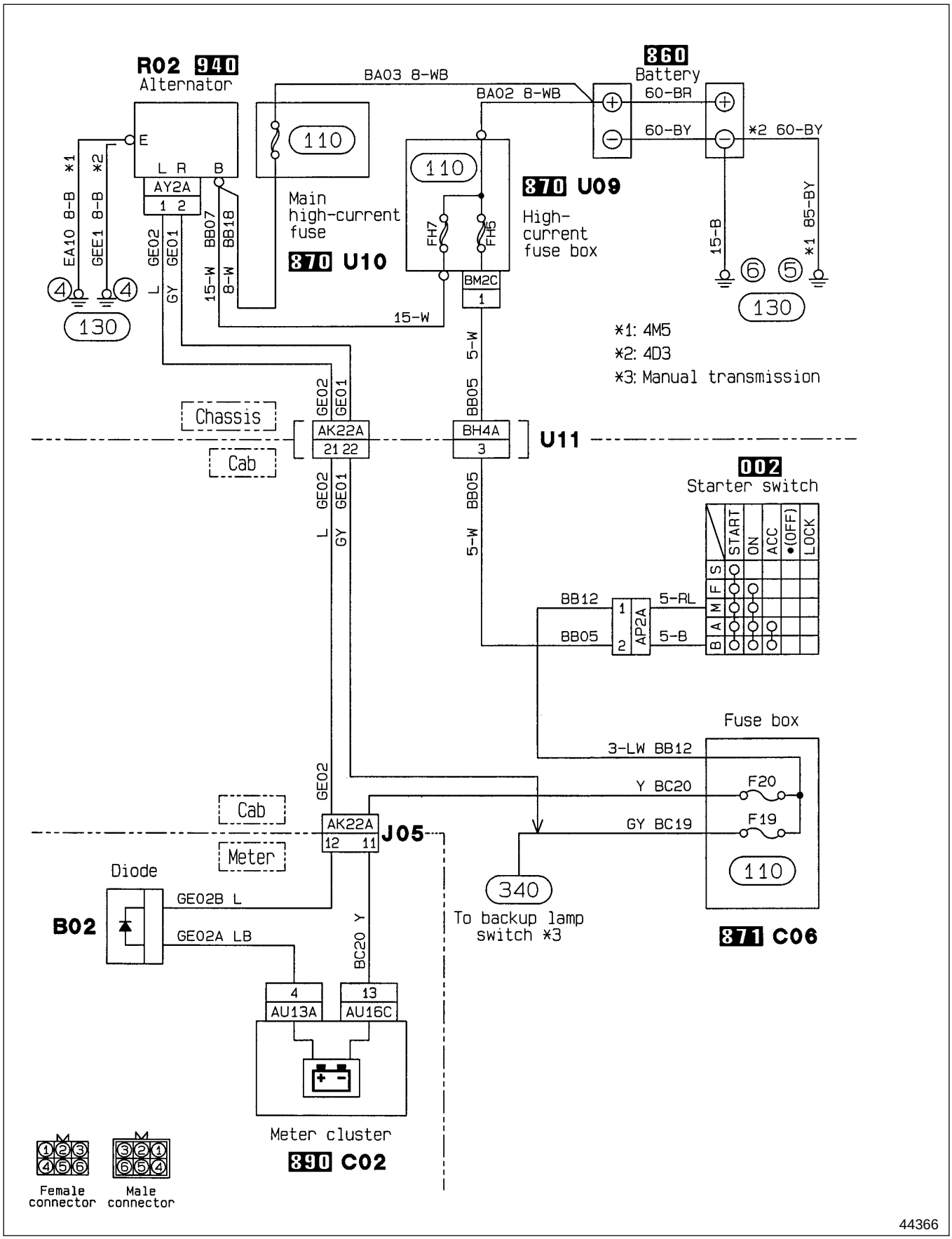




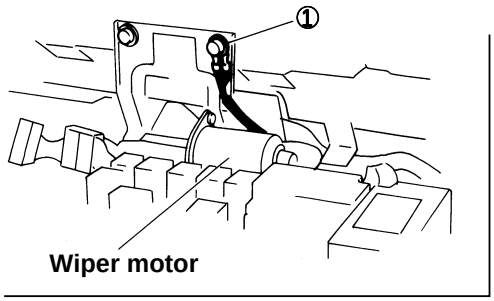
Female connector Male connector

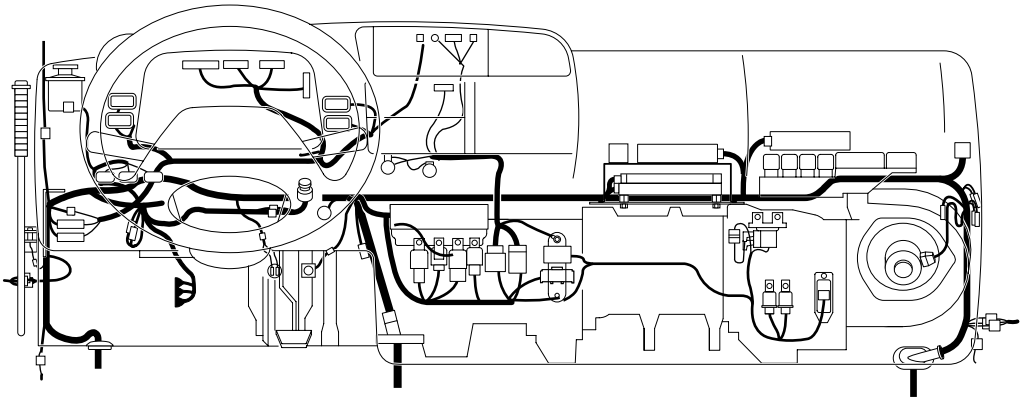
44365

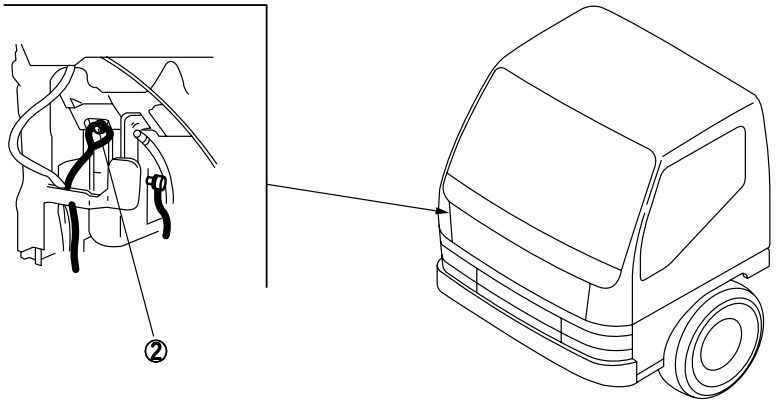
125 BATTERY CHARGING CIRCUIT

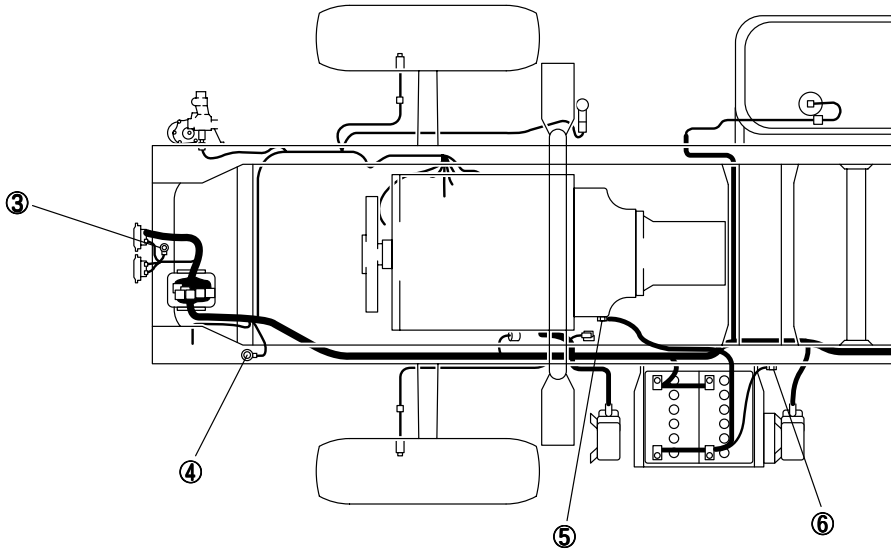


M E M O



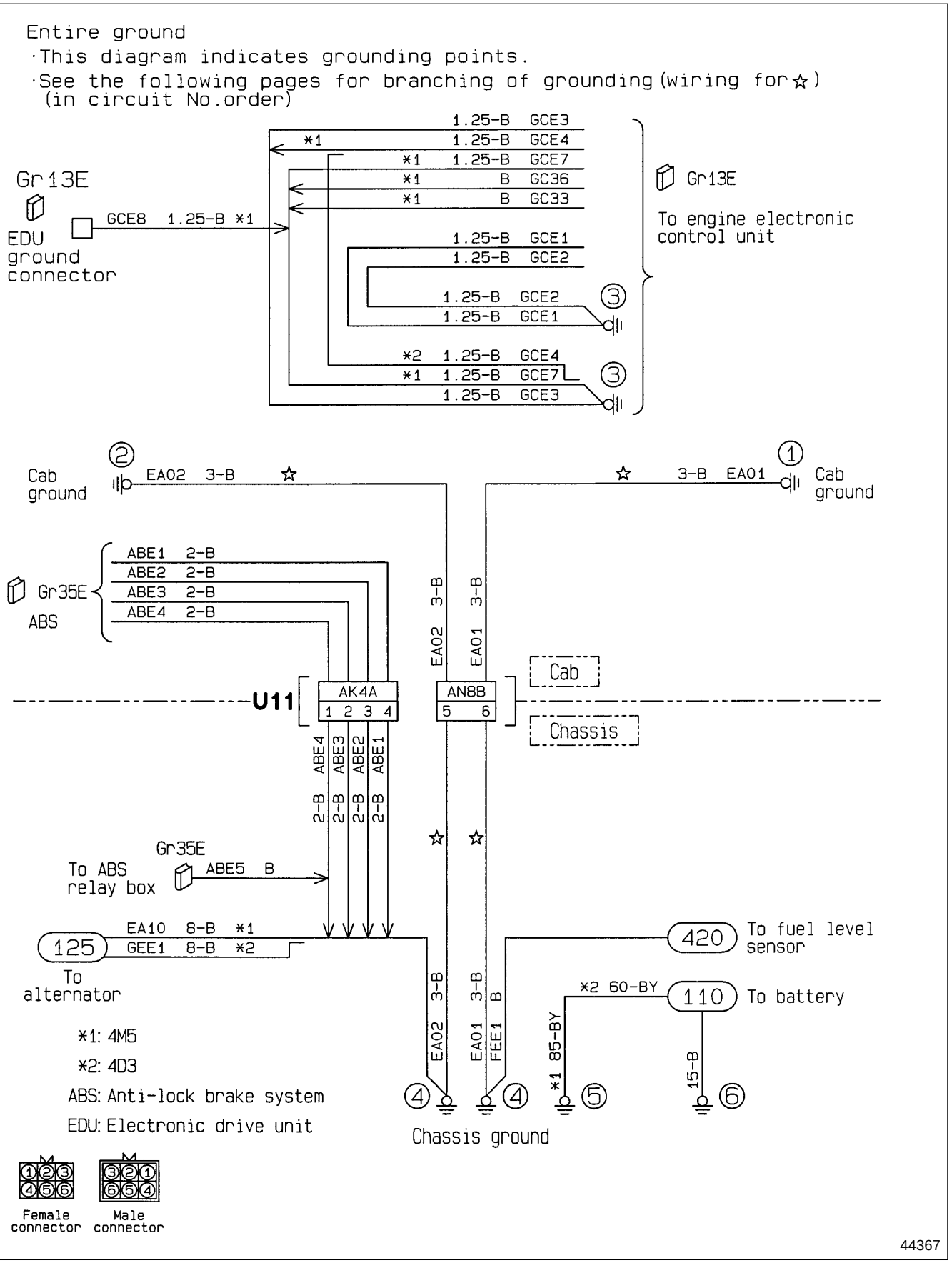


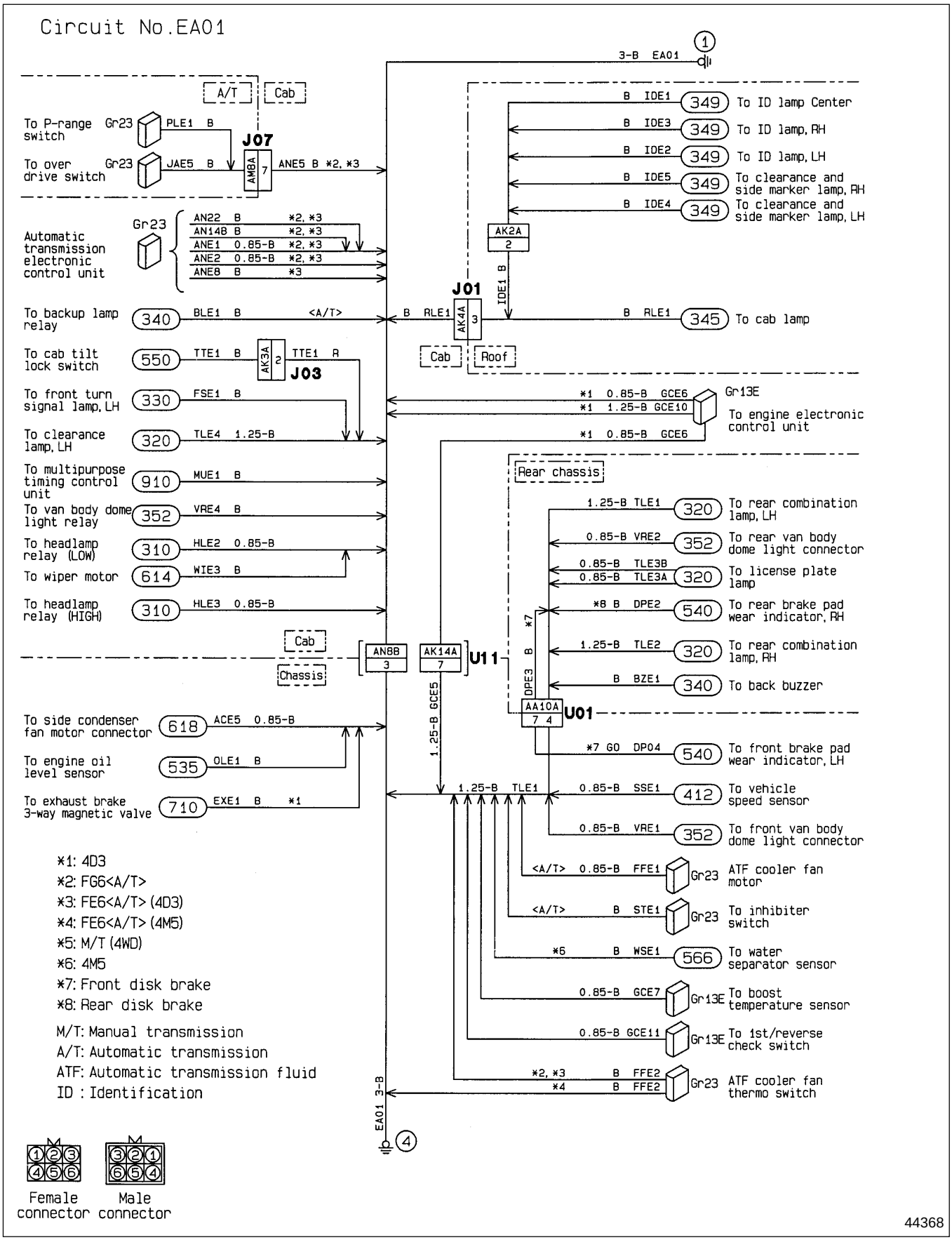




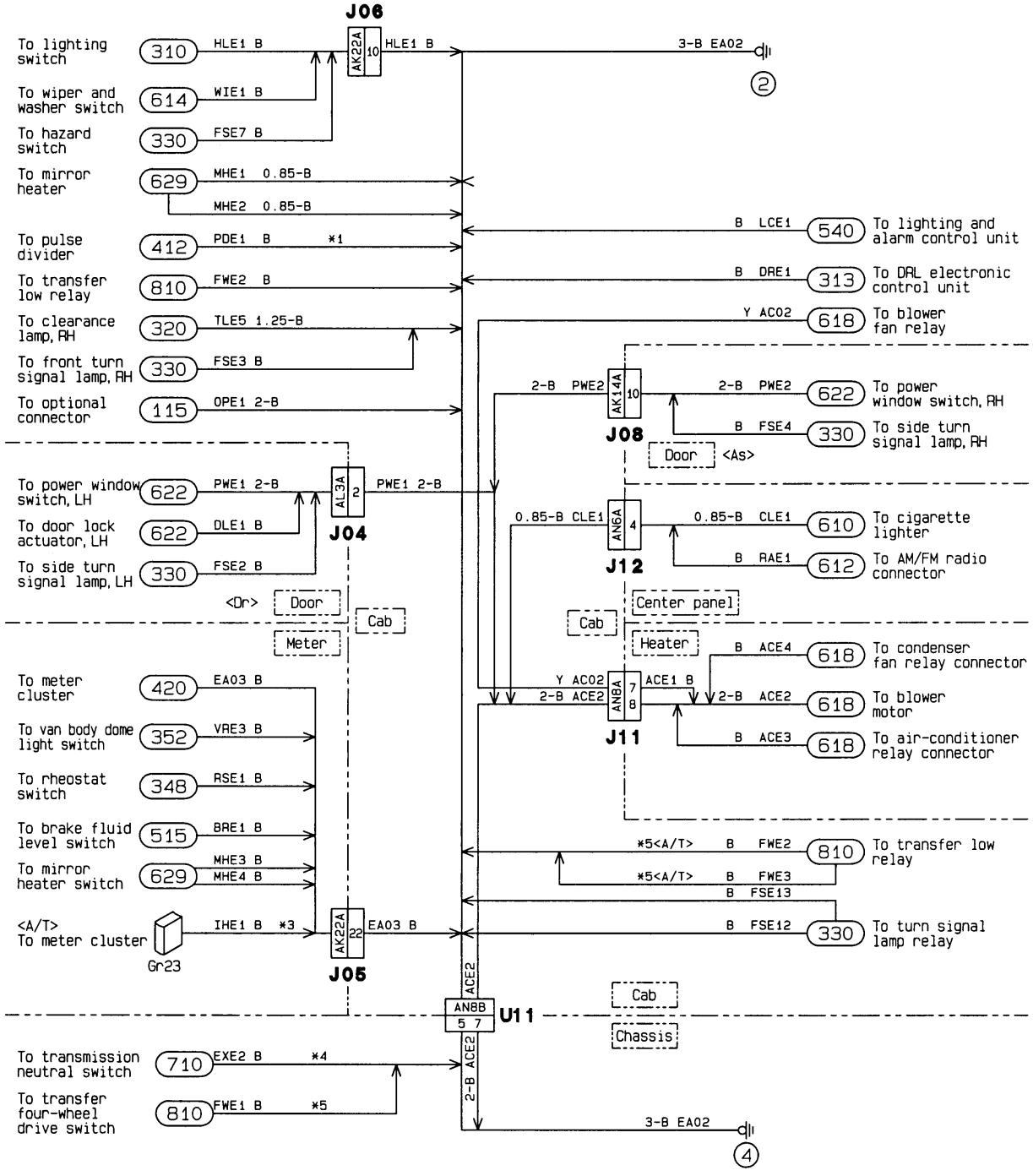
Ⓟ44742

Location	Circuit No.	Wire diameter-wire color	Remarks
①	EA01	3-B	
②	EA02	3-B	
③	GCE1	1.25-B	
	GCE2	1.25-B	
	GCE3	1.25-B	
	GCE4	1.25-B	4D3
	GCE7	1.25-B	4M5
④	EA01	3-B	
	EA02	3-B	
	EA10	3-B	4M5
	FEE1	0.85-B	
	GEE1	8-B	4D3
⑤	—	60-BY	4D3
		85-BY	4M5
⑥	—	15-B	


Entire ground
·This diagram indicates grounding points.
·See the following pages for branching of grounding (wiring for ☆)
(in circuit No.order)
Gr13E
EDU ground connector
GCE8 1.25-B *1
1.25-B GCE3
*1 1.25-B GCE4
*1 1.25-B GCE7
*1 B GC36
*1 B GC33
1.25-B GCE1
1.25-B GCE2
1.25-B GCE2
1.25-B GCE1
*2 1.25-B GCE4
*1 1.25-B GCE7
1.25-B GCE3
Gr13E
To engine electronic control unit
Cab ground
EA02 3-B
3-B EA01
Cab ground
Gr35E
ABS
ABE1 2-B
ABE2 2-B
ABE3 2-B
ABE4 2-B
U11
AK4A
1 2 3 4
AN8B
5 6
Cab
Chassis
EA02 3-B
EA01 3-B
ABE4 2-B
ABE3 2-B
ABE2 2-B
ABE1 2-B
Gr35E
To ABS relay box
ABE5 B
EA10 8-B *1
GEE1 8-B *2
125
To alternator
420
To fuel level sensor
*2 60-BY
110
To battery
*1 85-BY
15-B
EA02 3-B
EA01 3-B
FEE1 B
Chassis ground
*1: 4M5
*2: 4D3
ABS: Anti-lock brake system
EDU: Electronic drive unit
Female connector
Male connector
44367


Circuit No.EA01
3-B EA01
A/T
Cab
To P-range switch
Gr23
PLE1 B
J07
To over drive switch
JAE5 B
AM8A 7
ANE5 B *2, *3
Automatic transmission electronic control unit
AN22 B *2, *3
AN14B B *2, *3
ANE1 0.85-B *2, *3
ANE2 0.85-B *2, *3
ANE8 B *3
To backup lamp relay
340
BLE1 B <A/T>
To cab tilt lock switch
550
TTE1 B
AK3A 2
TTE1 R
J03
To front turn signal lamp, LH
330
FSE1 B
To clearance lamp, LH
320
TLE4 1.25-B
To multipurpose timing control unit
910
MUE1 B
To van body dome light relay
352
VRE4 B
To headlamp relay (LOW)
310
HLE2 0.85-B
To wiper motor
614
WIE3 B
To headlamp relay (HIGH)
310
HLE3 0.85-B
Cab
Chassis
AN8B 3
AK14A 7
U11
To side condenser fan motor connector
618
ACE5 0.85-B
To engine oil level sensor
535
OLE1 B
To exhaust brake 3-way magnetic valve
710
EXE1 B *1
1.25-B GCE5
EA01 3-B
4
B IDE1
349
To ID lamp Center
B IDE3
349
To ID lamp, RH
B IDE2
349
To ID lamp, LH
B IDE5
349
To clearance and side marker lamp, RH
B IDE4
349
To clearance and side marker lamp, LH
AK2A 2
IDE1 B
J01
B RLE1
AK4A 3
B RLE1
345
To cab lamp
Cab
Roof
*1 0.85-B GCE6
*1 1.25-B GCE10
*1 0.85-B GCE6
Gr13E
To engine electronic control unit
Rear chassis
1.25-B TLE1
320
To rear combination lamp, LH
0.85-B VRE2
352
To rear van body dome light connector
0.85-B TLE3B
0.85-B TLE3A
320
To license plate lamp
*8 B DPE2
540
To rear brake pad wear indicator, RH
1.25-B TLE2
320
To rear combination lamp, RH
B BZE1
340
To back buzzer
DPE3 B *7
AA10A 7 4
U01
*7 GO DP04
540
To front brake pad wear indicator, LH
1.25-B TLE1
0.85-B SSE1
412
To vehicle speed sensor
0.85-B VRE1
352
To front van body dome light connector
<A/T> 0.85-B FFE1
Gr23
ATF cooler fan motor
<A/T> B STE1
Gr23
To inhibiter switch
*6 B WSE1
566
To water separator sensor
0.85-B GCE7
Gr13E
To boost temperature sensor
0.85-B GCE11
Gr13E
To 1st/reverse check switch
*2, *3 B FFE2
*4 B FFE2
Gr23
ATF cooler fan thermo switch
*1: 4D3
*2: FG6<A/T>
*3: FE6<A/T> (4D3)
*4: FE6<A/T> (4M5)
*5: M/T (4WD)
*6: 4M5
*7: Front disk brake
*8: Rear disk brake
M/T: Manual transmission
A/T: Automatic transmission
ATF: Automatic transmission fluid
ID : Identification
Female connector
Male connector
44368

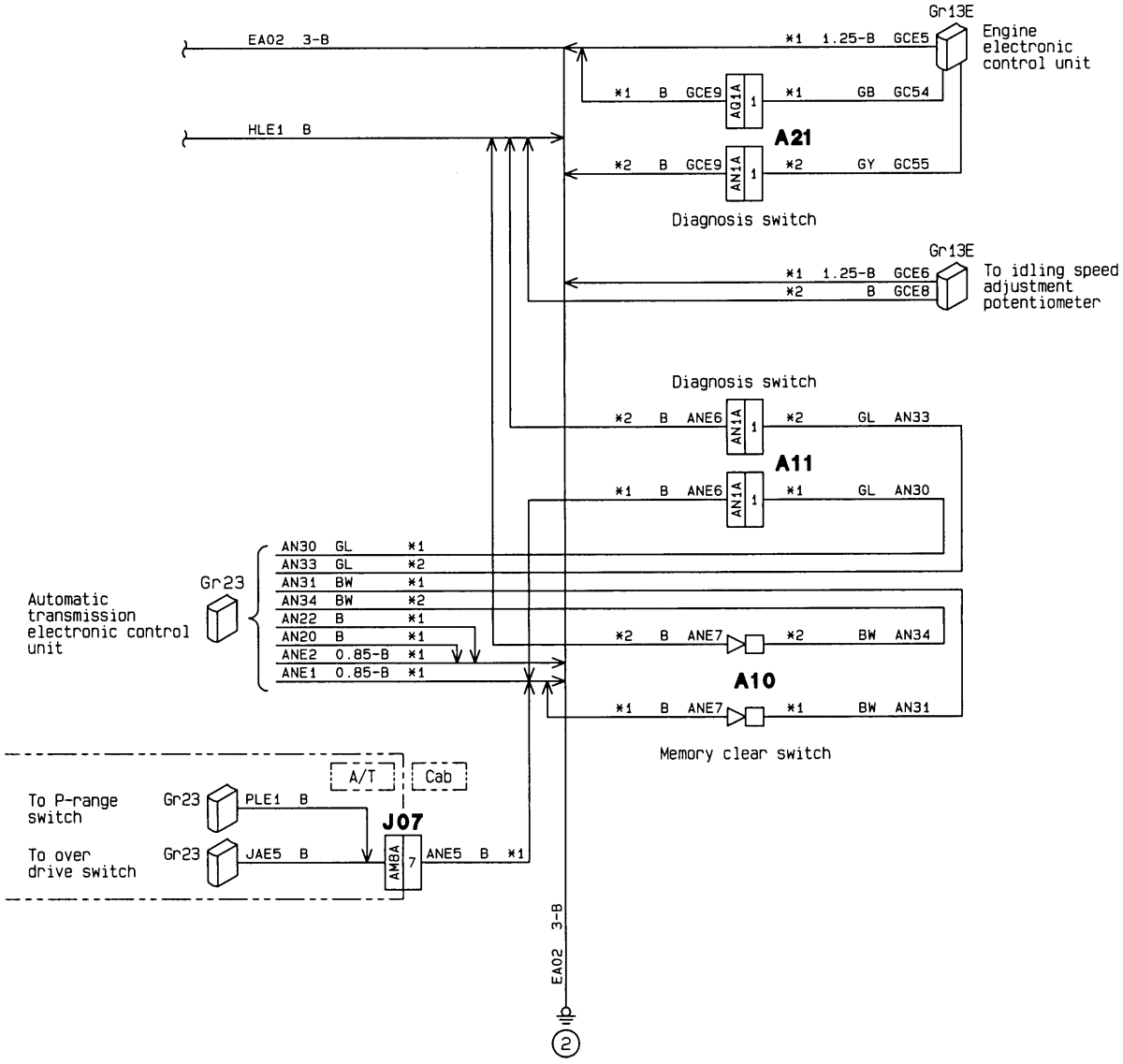
Circuit No.EA02



*1: 4M5
*2: 4D3
*3: Automatic transmission (A/T)
*4: Manual transmission (M/T)
*5: 4WD

Dr: Driver's seat side
As: Assistant driver's seat side
DRL: Daytime running light

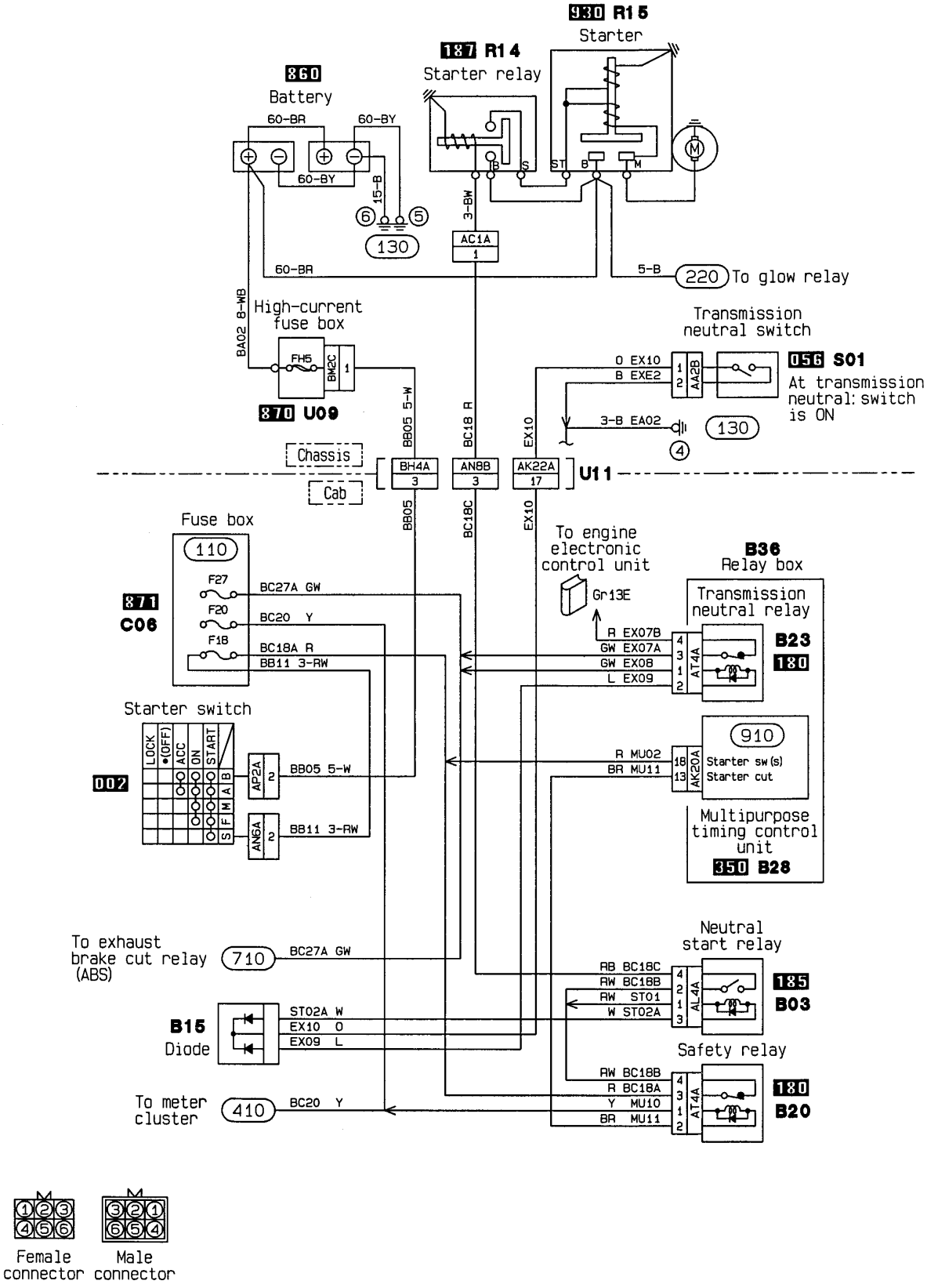
44369-1


Gr13E
Engine electronic control unit
EA02 3-B
*1 1.25-B GCE5
*1 B GCE9
AG1A 1
*1 GB GC54
HLE1 B
A21
*2 B GCE9
AN1A 1
*2 GY GC55
Diagnosis switch
Gr13E
To idling speed adjustment potentiometer
*1 1.25-B GCE6
*2 B GCE8
Diagnosis switch
*2 B ANE6
AN1A 1
*2 GL AN33
A11
*1 B ANE6
AN1A 1
*1 GL AN30
Gr23
Automatic transmission electronic control unit
AN30 GL *1
AN33 GL *2
AN31 BW *1
AN34 BW *2
AN22 B *1
AN20 B *1
ANE2 0.85-B *1
ANE1 0.85-B *1
*2 B ANE7
*2 BW AN34
A10
*1 B ANE7
*1 BW AN31
Memory clear switch
A/T
Cab
To P-range switch
Gr23
PLE1 B
J07
To over drive switch
Gr23
JAE5 B
AM8A 7
ANE5 B *1
EA02 3-B
2

44369-2

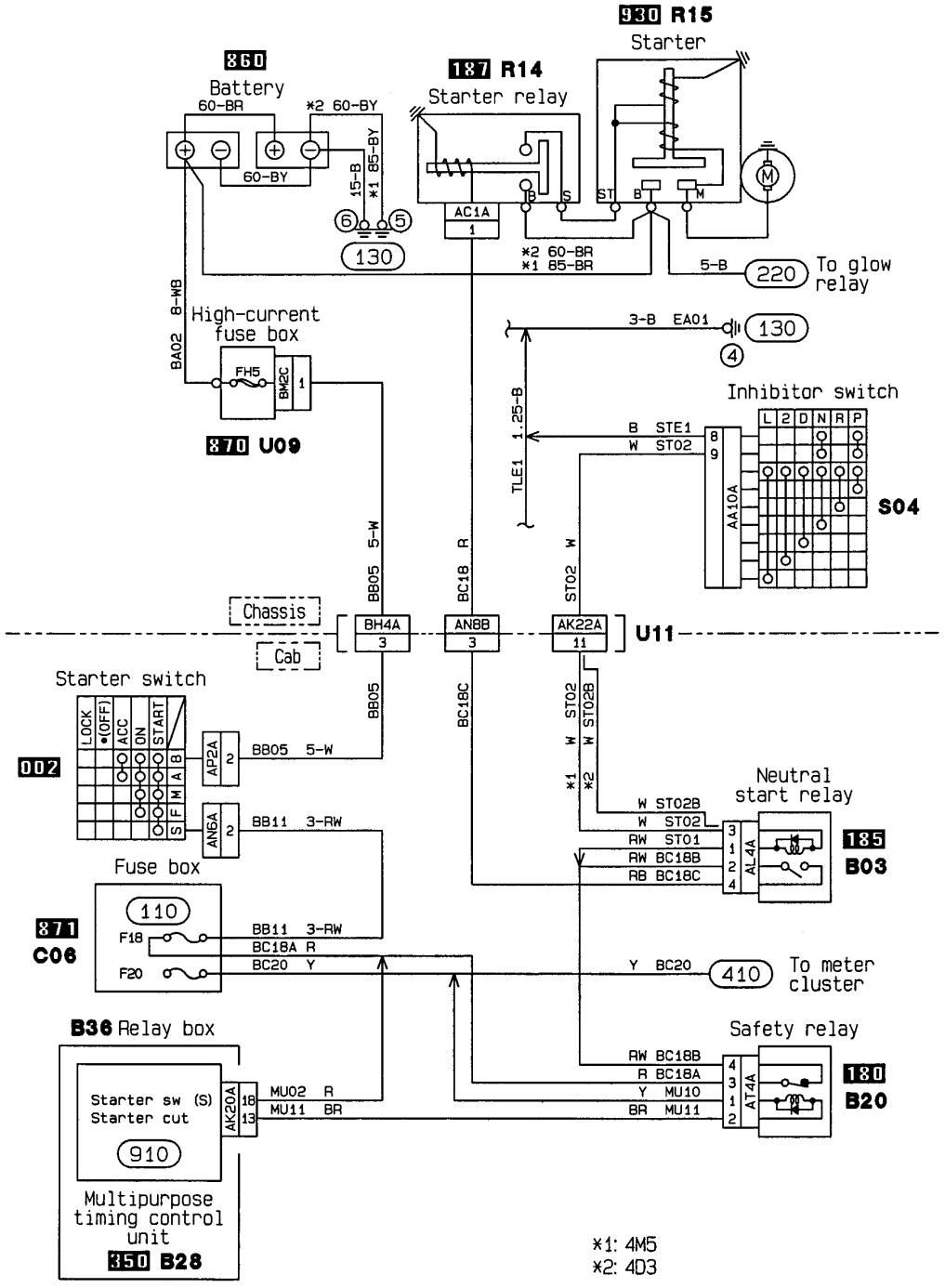
2 STARTING AND PREHEATING CIRCUIT

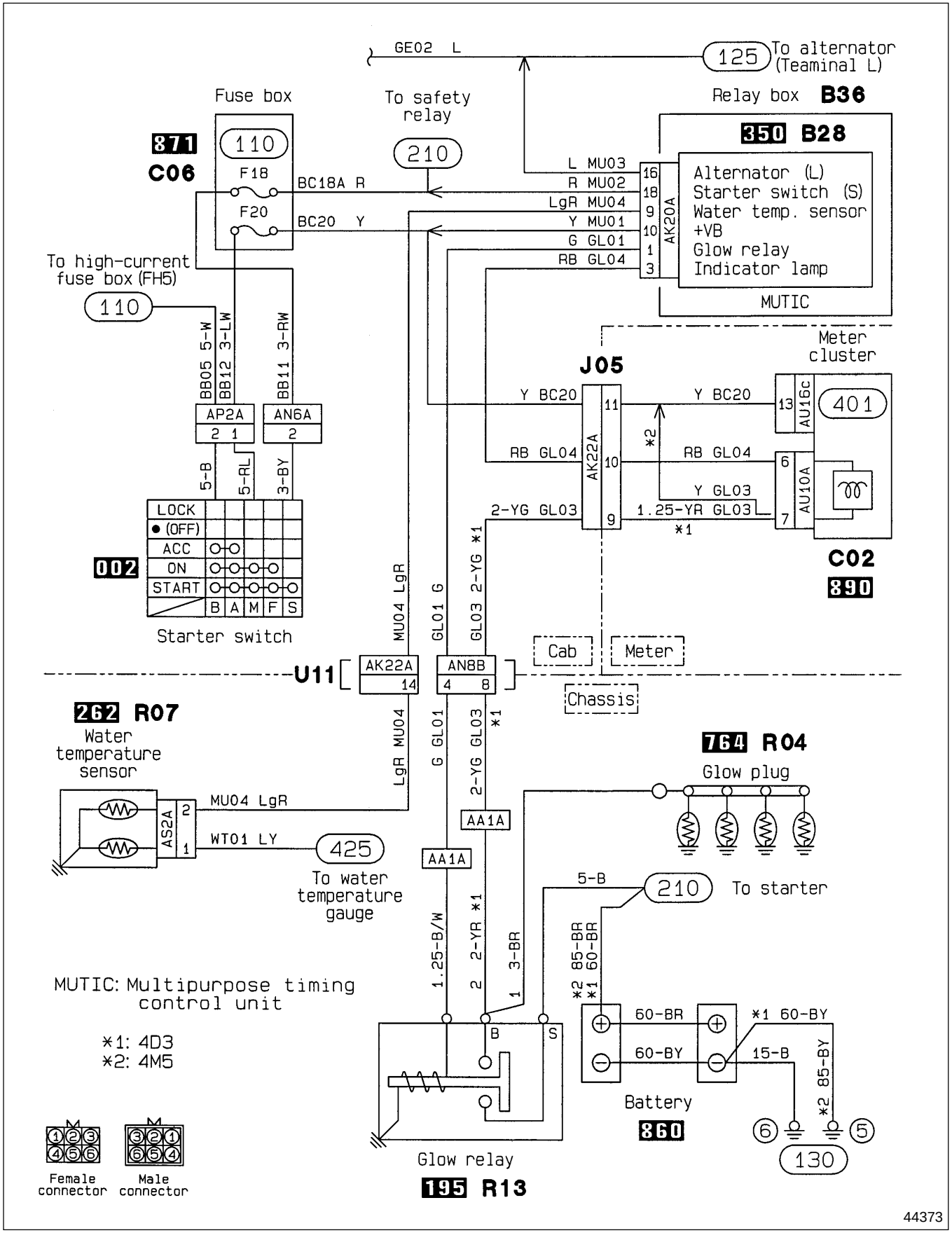
<Manual transmission>

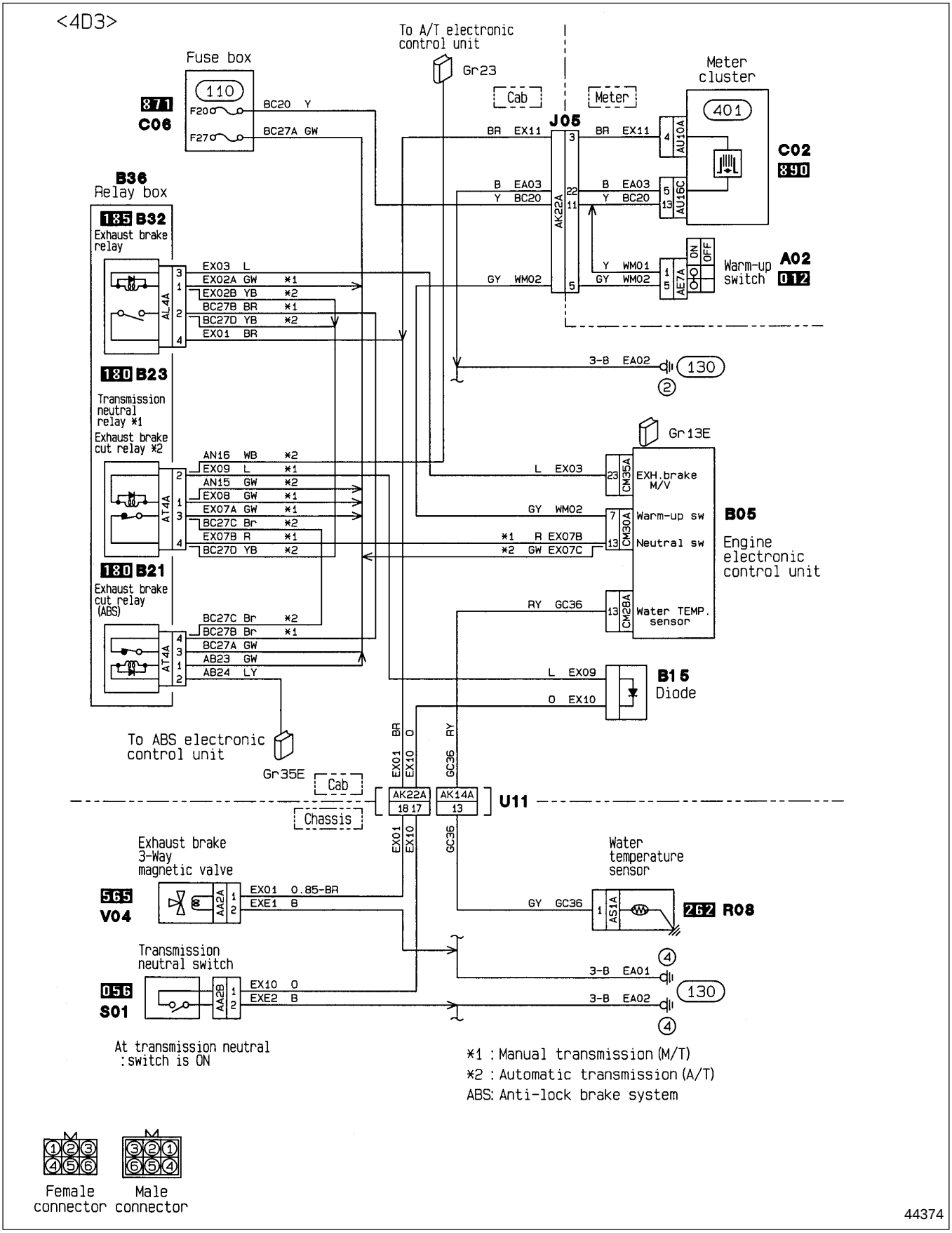


44370

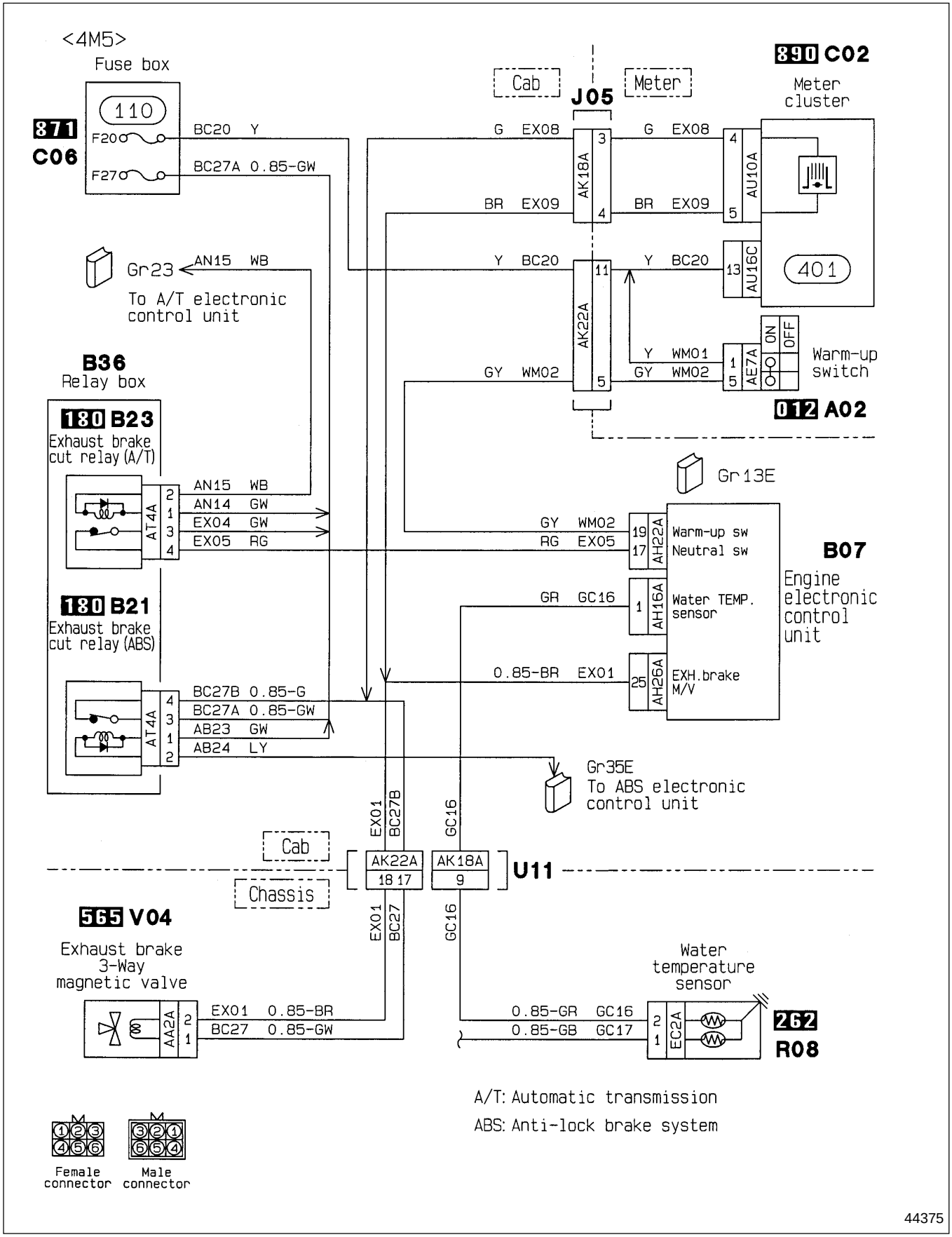
<Automatic transmission>



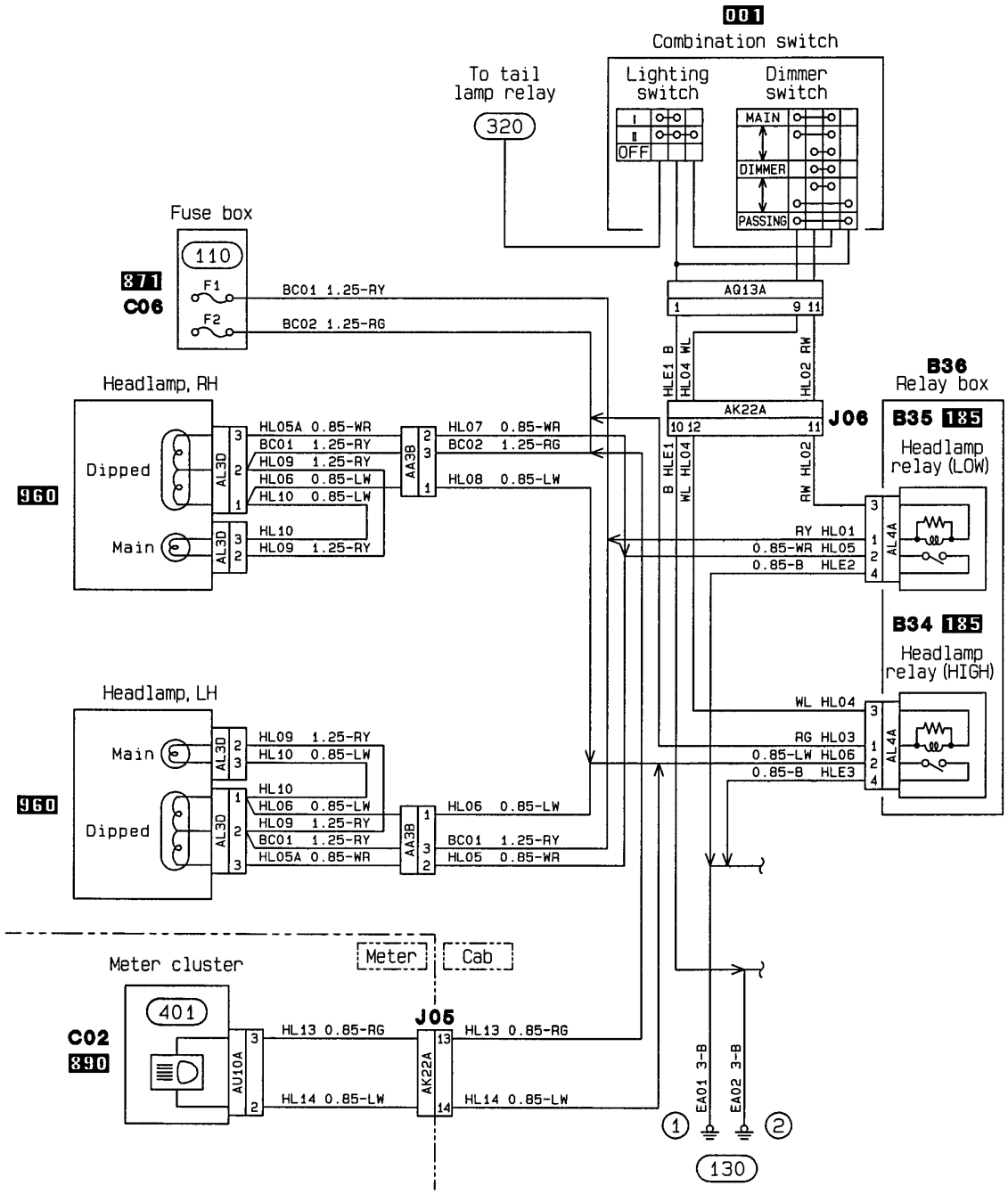

GE02 L
125
To alternator (Teaminal L)
Fuse box
To safety relay
Relay box B36
350 B28
871
C06
110
210
F18
F20
BC18A R
BC20 Y
L MU03
R MU02
LgR MU04
Y MU01
G GL01
RB GL04
16
18
9
10
1
3
AK20A
Alternator (L)
Starter switch (S)
Water temp. sensor
+VB
Glow relay
Indicator lamp
MUTIC
To high-current fuse box (FH5)
110
BB05 5-W
BB12 3-LW
BB11 3-RW
AP2A
2 1
AN6A
2
5-B
5-RL
3-BY
LOCK
● (OFF)
ACC
ON
START
B A M F S
002
Starter switch
Meter cluster
J05
Y BC20
RB GL04
AK22A
11
10
9
*2
Y BC20
RB GL04
Y GL03
1.25-YR GL03
*1
13
6
7
AU16c
AU10A
401
C02
890
2-YG GL03
2-YG *1
MU04 LgR
GL01 G
U11
AK22A
14
AN8B
4 8
Cab
Meter
Chassis
262 R07
Water temperature sensor
AS2A
2
1
MU04 LgR
WT01 LY
425
To water temperature gauge
LgR MU04
G GL01
2-YG GL03
*1
AA1A
AA1A
764 R04
Glow plug
5-B
210
To starter
1.25-B/W
2-YR *1
3-BR
*2 85-BR
*1 60-BR
60-BR
60-BY
*1 60-BY
15-B
*2 85-BY
B
S
Battery
860
6
5
130
Glow relay
195 R13
MUTIC: Multipurpose timing control unit
*1: 4D3
*2: 4M5
Female connector
Male connector
44373


<4D3>
To A/T electronic control unit
Gr23
Fuse box
110
F20
F27
871
C06
BC20 Y
BC27A GW
Cab
Meter
J05
Meter cluster
401
C02
890
BR EX11
B EA03
Y BC20
AK22A
AU10A
AU16C
B36
Relay box
185 B32
Exhaust brake relay
AL4A
EX03 L
EX02A GW *1
EX02B YB *2
BC27B BR *1
BC27D YB *2
EX01 BR
Y WM01
GY WM02
AE7A
ON
OFF
Warm-up switch
A02
012
3-B EA02
130
180 B23
Transmission neutral relay *1
Exhaust brake cut relay *2
AT4A
AN16 WB *2
EX09 L *1
AN15 GW *2
EX08 GW *1
EX07A GW *1
BC27C Br *2
EX07B R *1
BC27D YB *2
Gr13E
L EX03
GY WM02
*1 R EX07B
*2 GW EX07C
CM35A
CM30A
EXH.brake M/V
Warm-up sw
Neutral sw
B05
Engine electronic control unit
180 B21
Exhaust brake cut relay (ABS)
BC27C Br *2
BC27B Br *1
BC27A GW
AB23 GW
AB24 LY
RY GC36
CM28A
Water TEMP. sensor
L EX09
O EX10
B15
Diode
To ABS electronic control unit
Gr35E
Cab
Chassis
AK22A
AK14A
U11
EX01 BR
EX10 O
GC36 RY
Exhaust brake 3-Way magnetic valve
565
V04
AA2A
EX01 0.85-BR
EXE1 B
Water temperature sensor
GY GC36
AS1A
262 R08
Transmission neutral switch
056
S01
AA2B
EX10 O
EXE2 B
3-B EA01
3-B EA02
130
At transmission neutral :switch is ON
*1 : Manual transmission (M/T)
*2 : Automatic transmission (A/T)
ABS: Anti-lock brake system
Female connector
Male connector
44374

225 ENGINE WARM-UP CIRCUIT



3 LIGHTING CIRCUIT



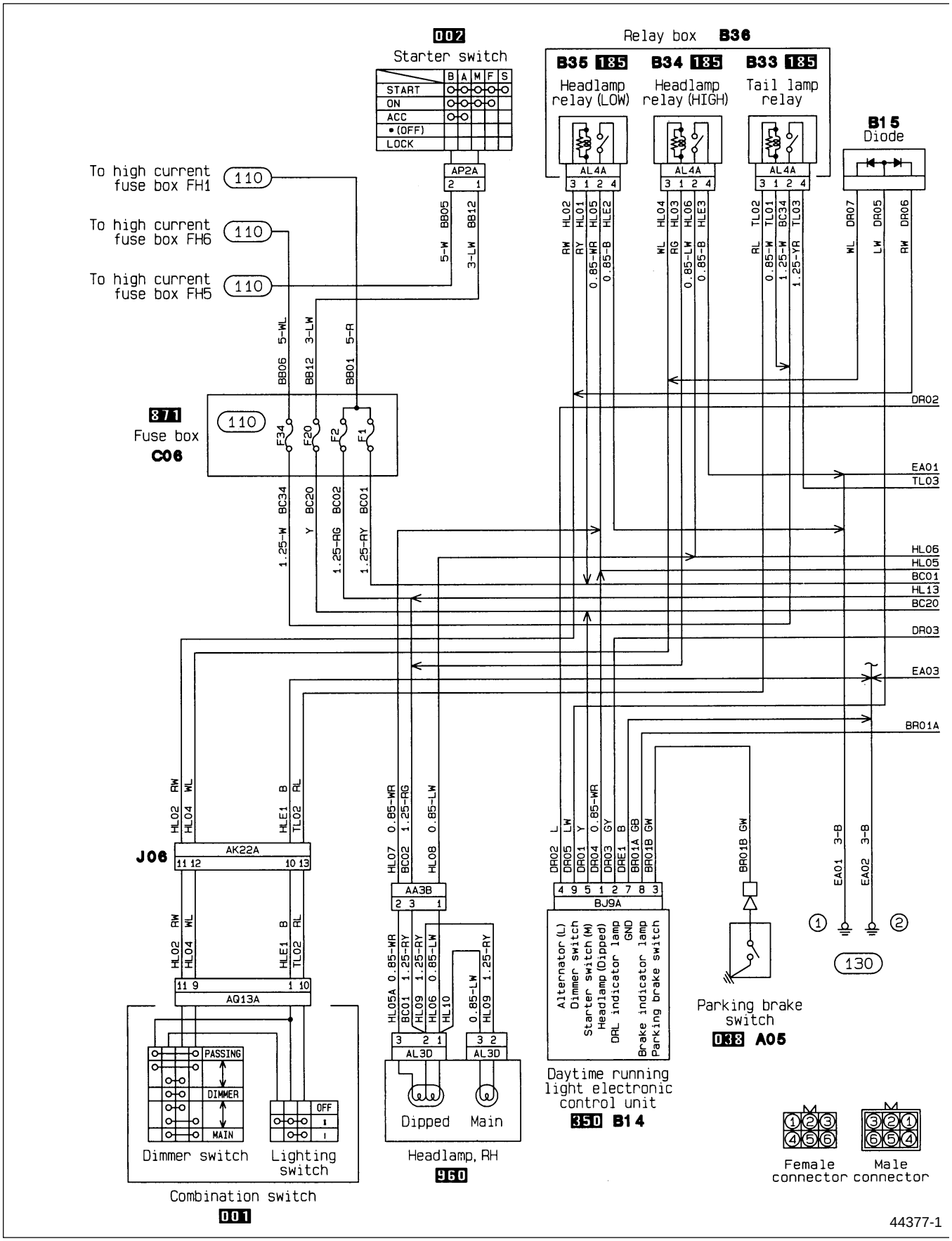
Female connector

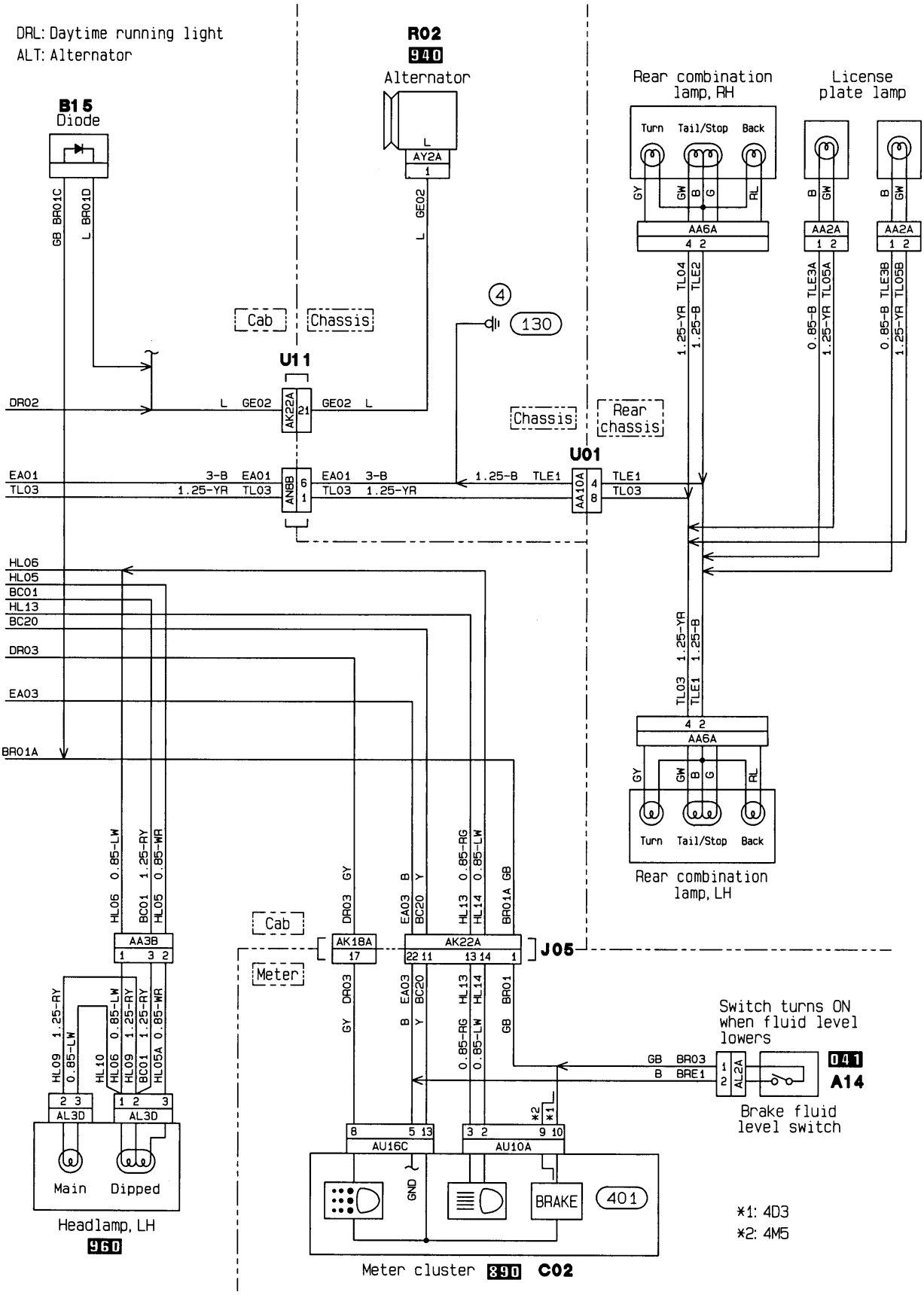
Male connector

44376

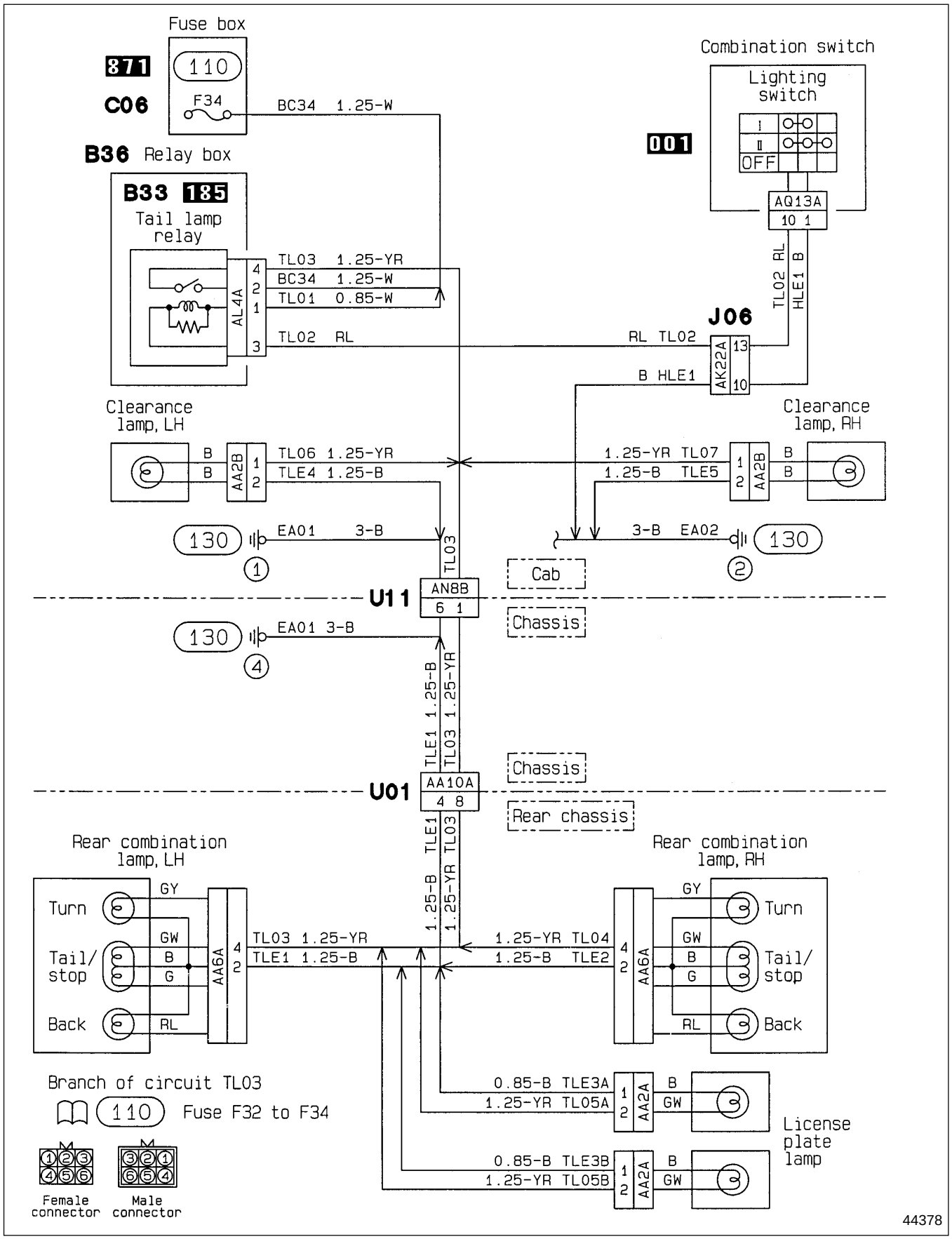
M E M O

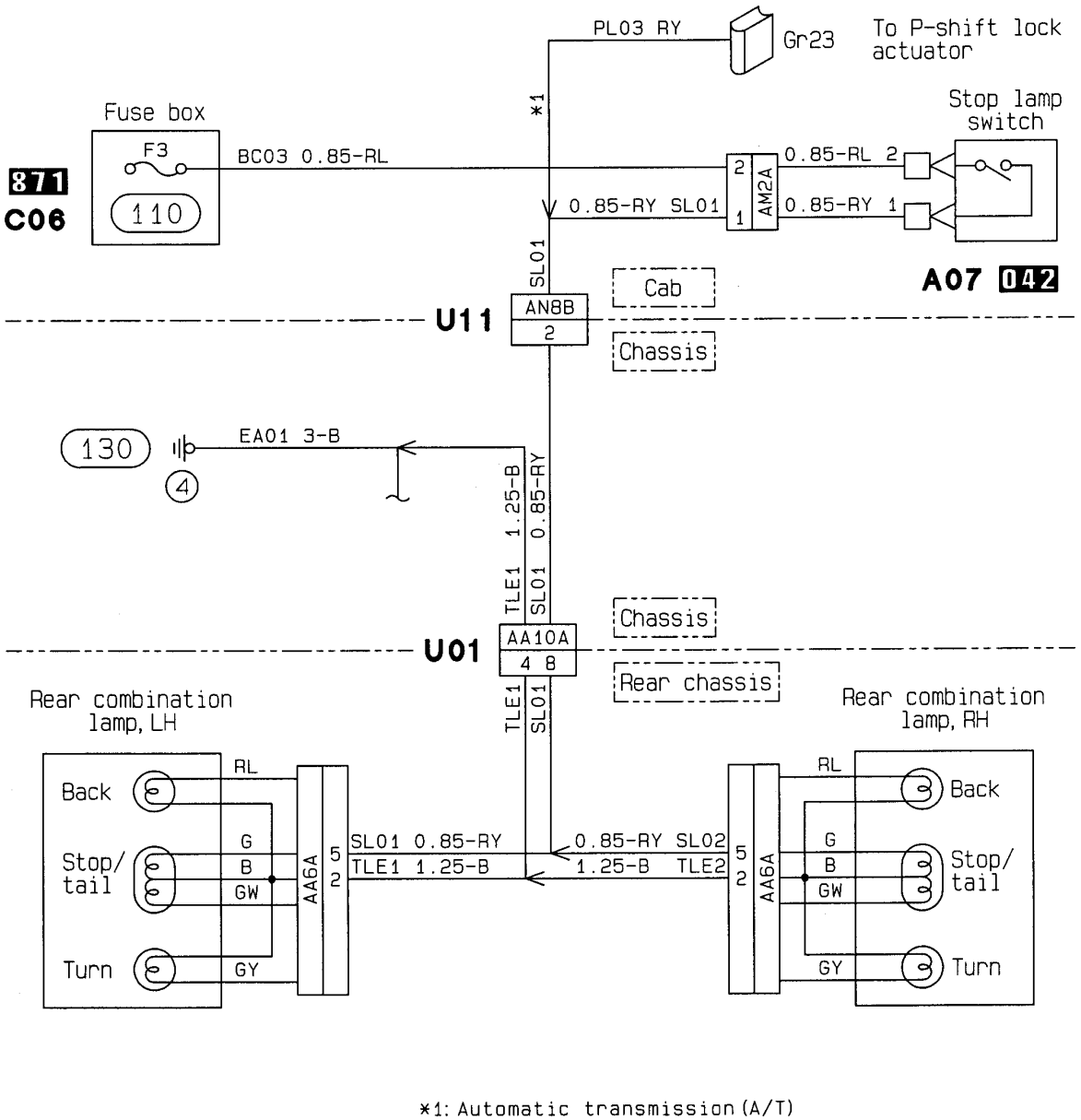
313 DAYTIME RUNNING LIGHT CIRCUIT



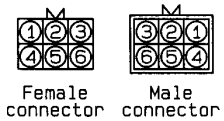

DRL: Daytime running light
ALT: Alternator
R02
940
Alternator
B15
Diode
Rear combination lamp, RH
License plate lamp
Turn
Tail/Stop
Back
Cab
Chassis
U11
130
Rear chassis
U01
Rear combination lamp, LH
Meter
J05
Switch turns ON when fluid level lowers
041
A14
Brake fluid level switch
Main
Dipped
Headlamp, LH
960
BRAKE
401
GND
Meter cluster 890 C02
*1: 4D3
*2: 4M5
44377-2

320 TAIL, CLEARANCE AND LICENSE PLATE LAMP CIRCUIT



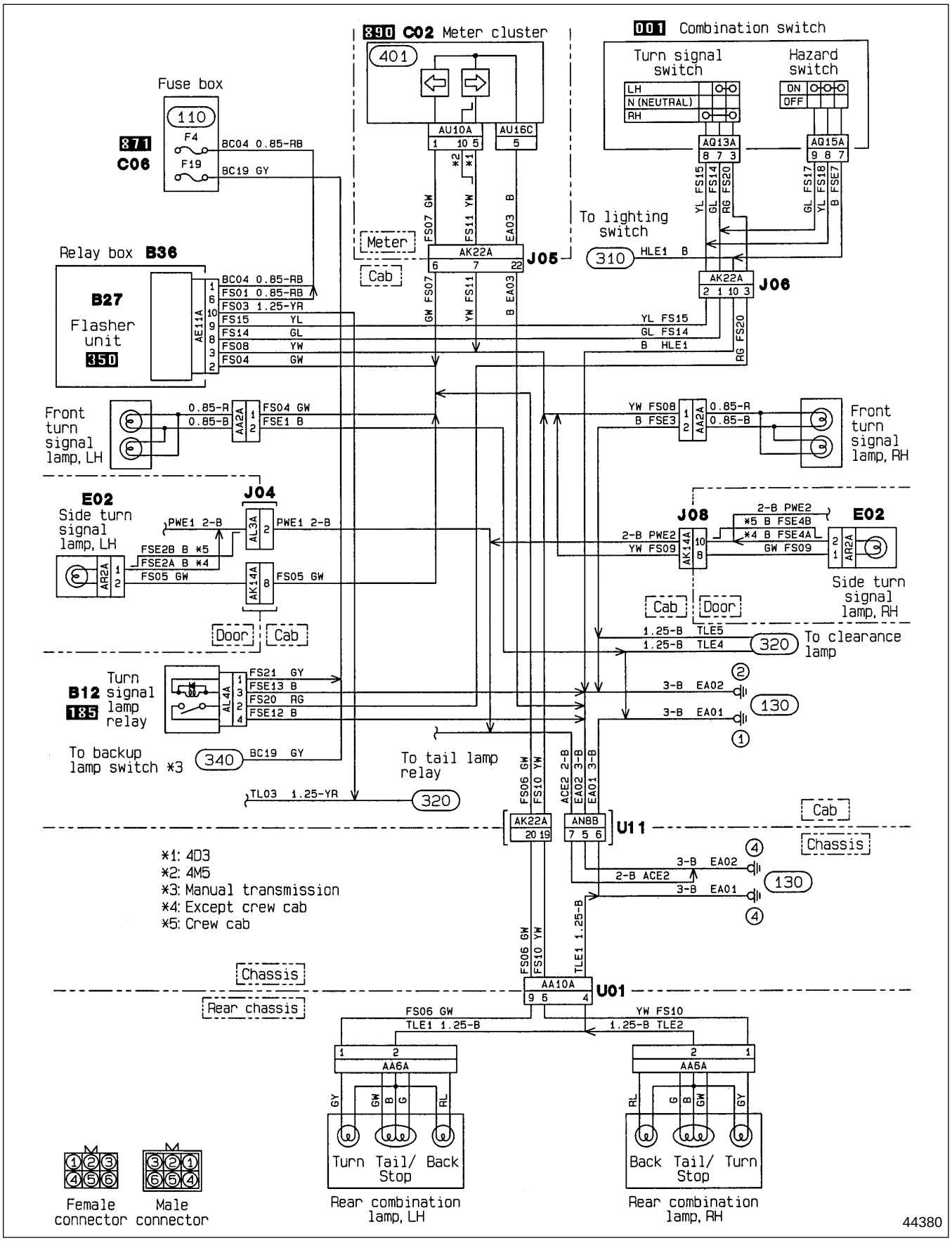


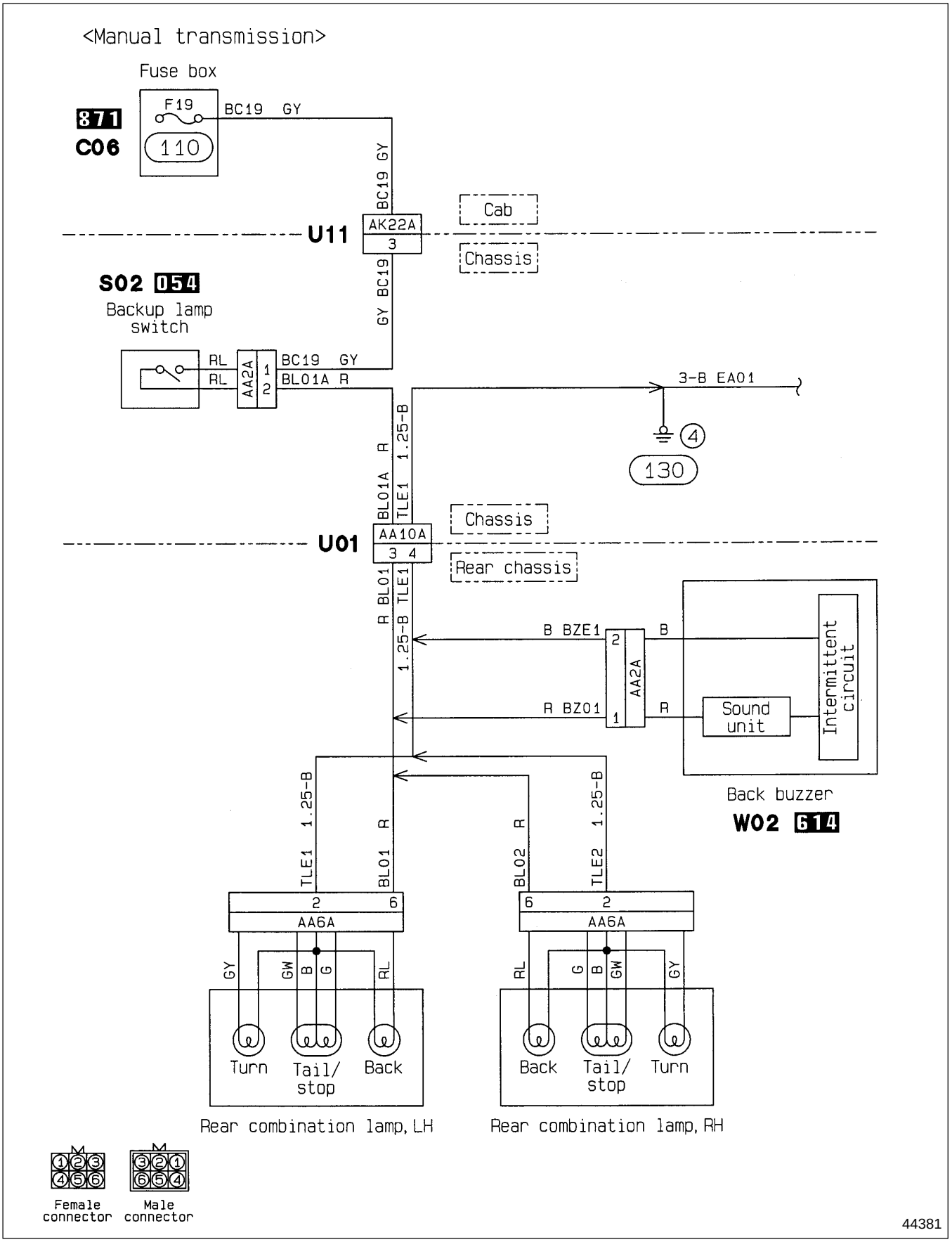
*1: Automatic transmission (A/T)



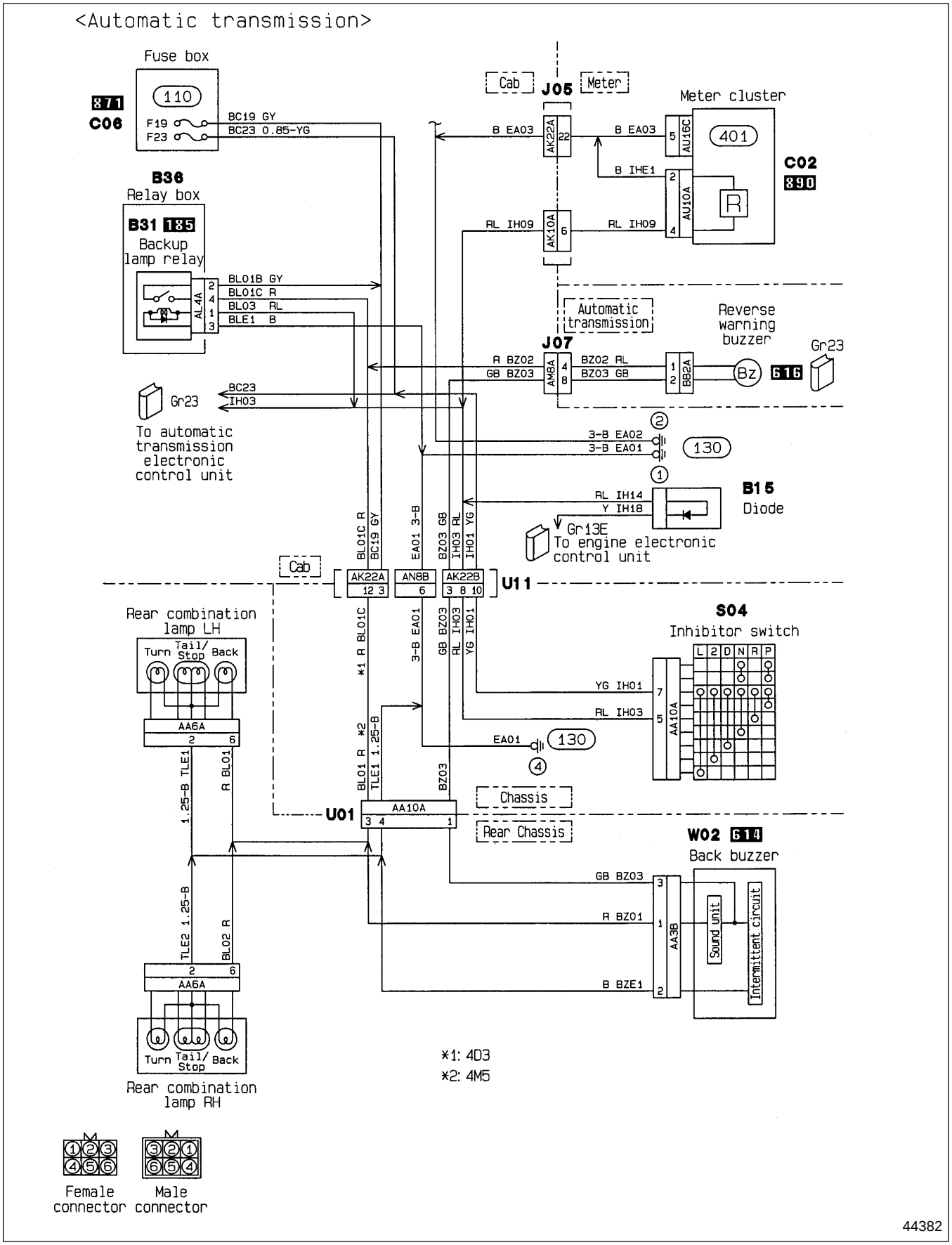
44379

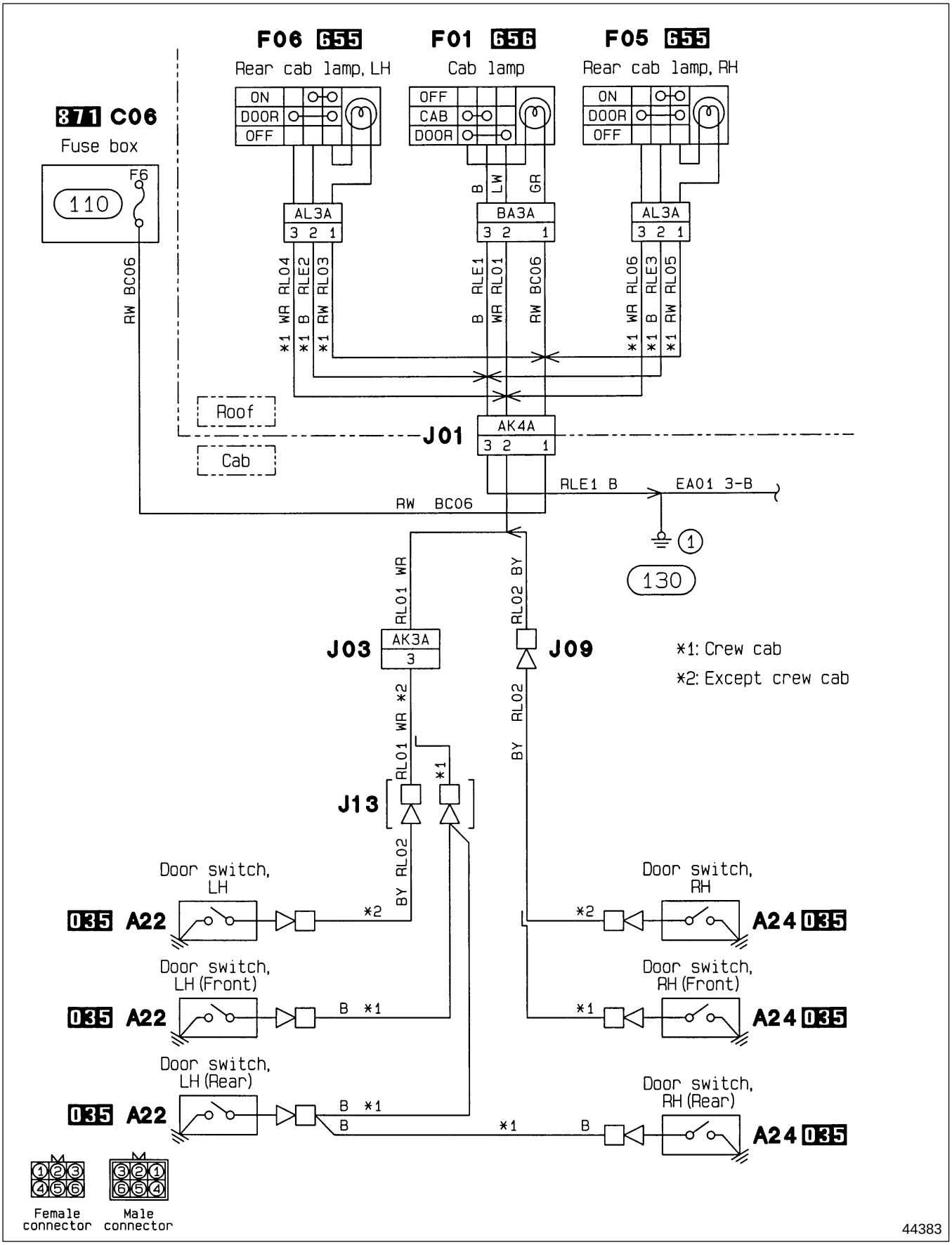
330 TURN SIGNAL AND HAZARD LAMP CIRCUIT



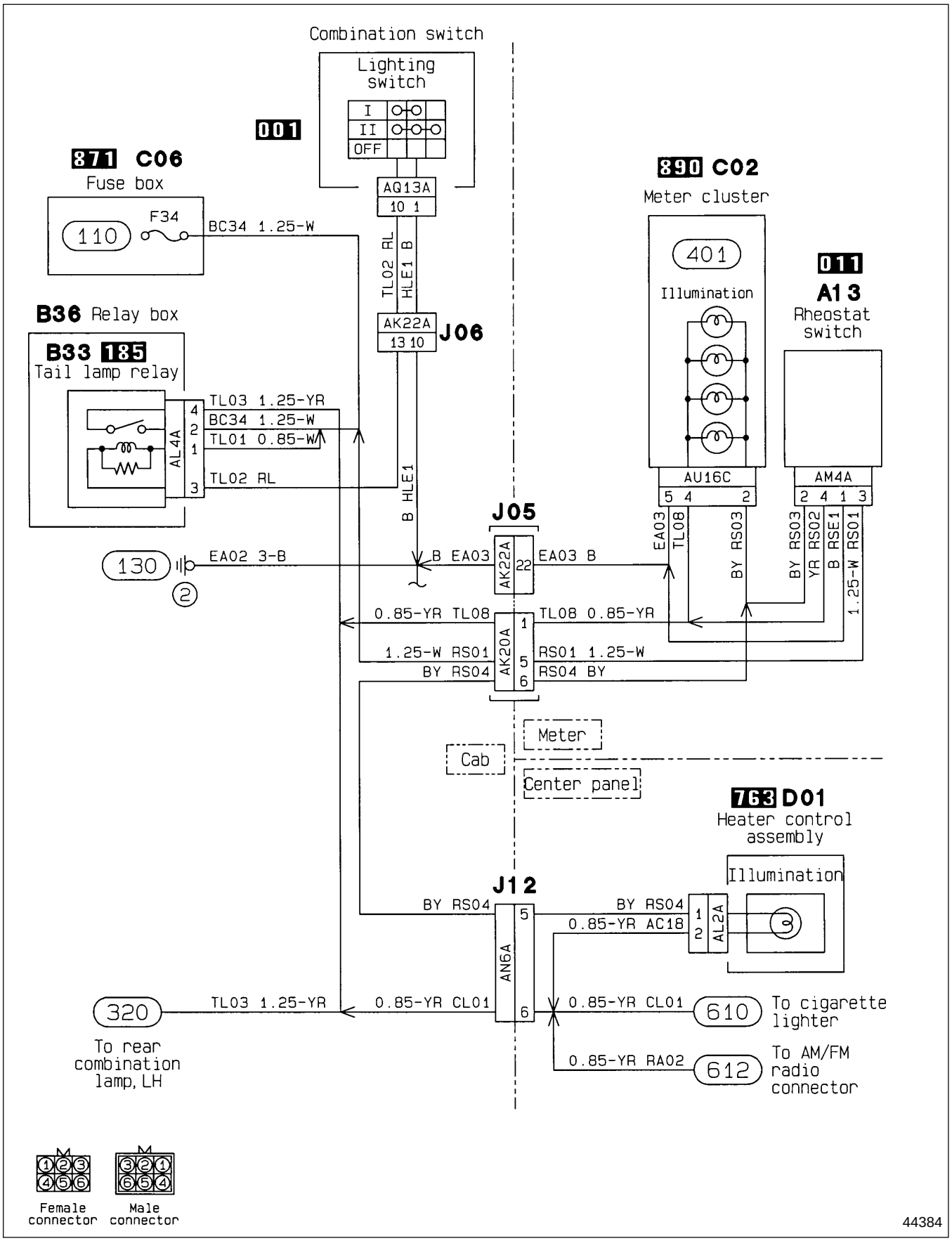

<Manual transmission>
Fuse box
871
C06
F19
110
BC19 GY
BC19 GY
Cab
U11
AK22A
3
Chassis
S02 054
Backup lamp switch
GY BC19
RL
RL
AA2A
1
2
BC19 GY
BL01A R
3-B EA01
4
130
BL01A R
TLE1 1.25-B
Chassis
U01
AA10A
3 4
Rear chassis
R BL01
TLE1
1.25-B
B BZE1
2
B
AA2A
R BZ01
1
R
Sound unit
Intermittent circuit
Back buzzer
W02 614
TLE1 1.25-B
BL01 R
BL02 R
TLE2 1.25-B
2
6
AA6A
6
2
AA6A
GY
GW
B
G
RL
RL
G
B
GW
GY
Turn
Tail/ stop
Back
Back
Tail/ stop
Turn
Rear combination lamp, LH
Rear combination lamp, RH
Female connector
Male connector
44381

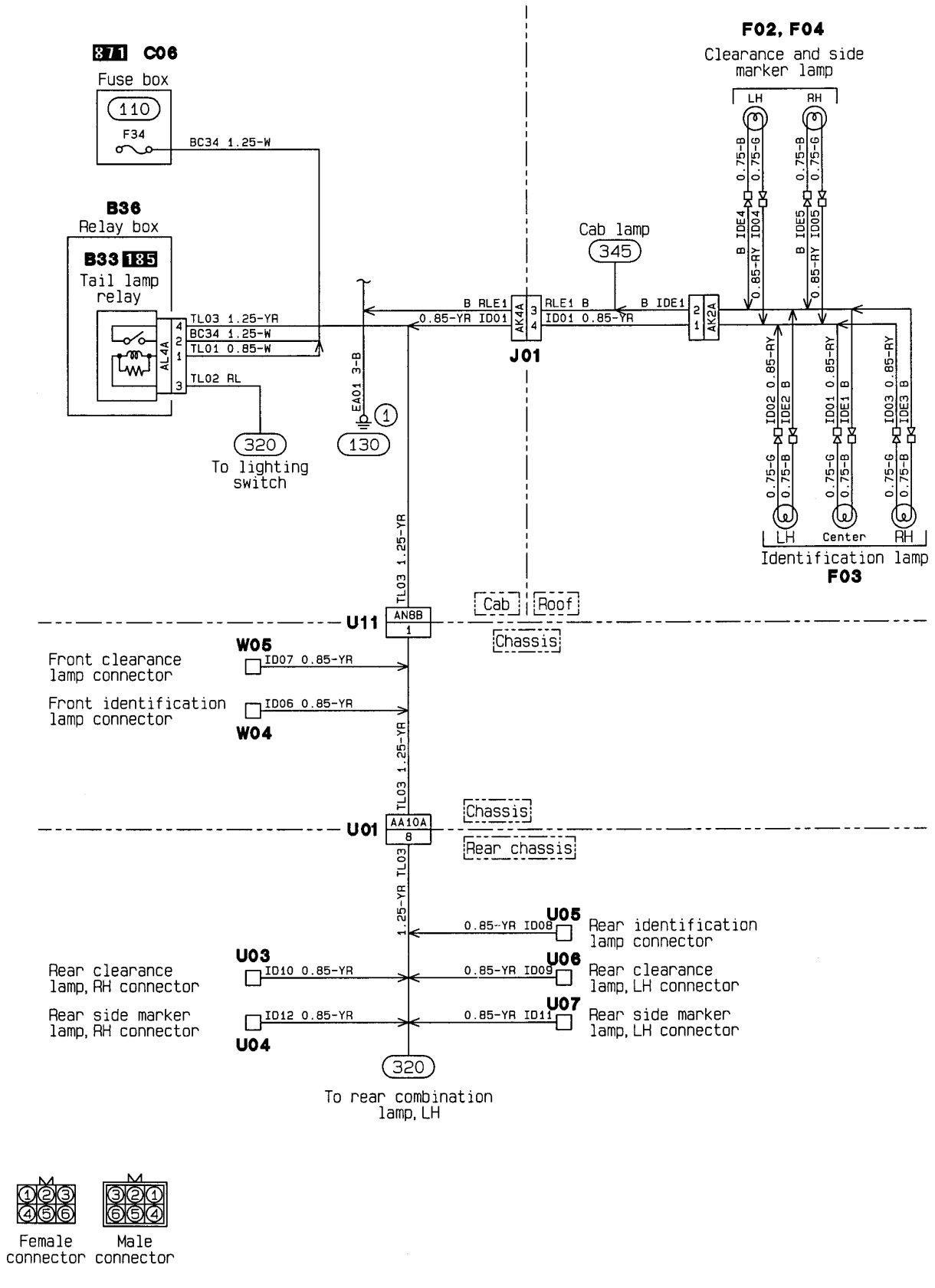
340 BACKUP LAMP CIRCUIT



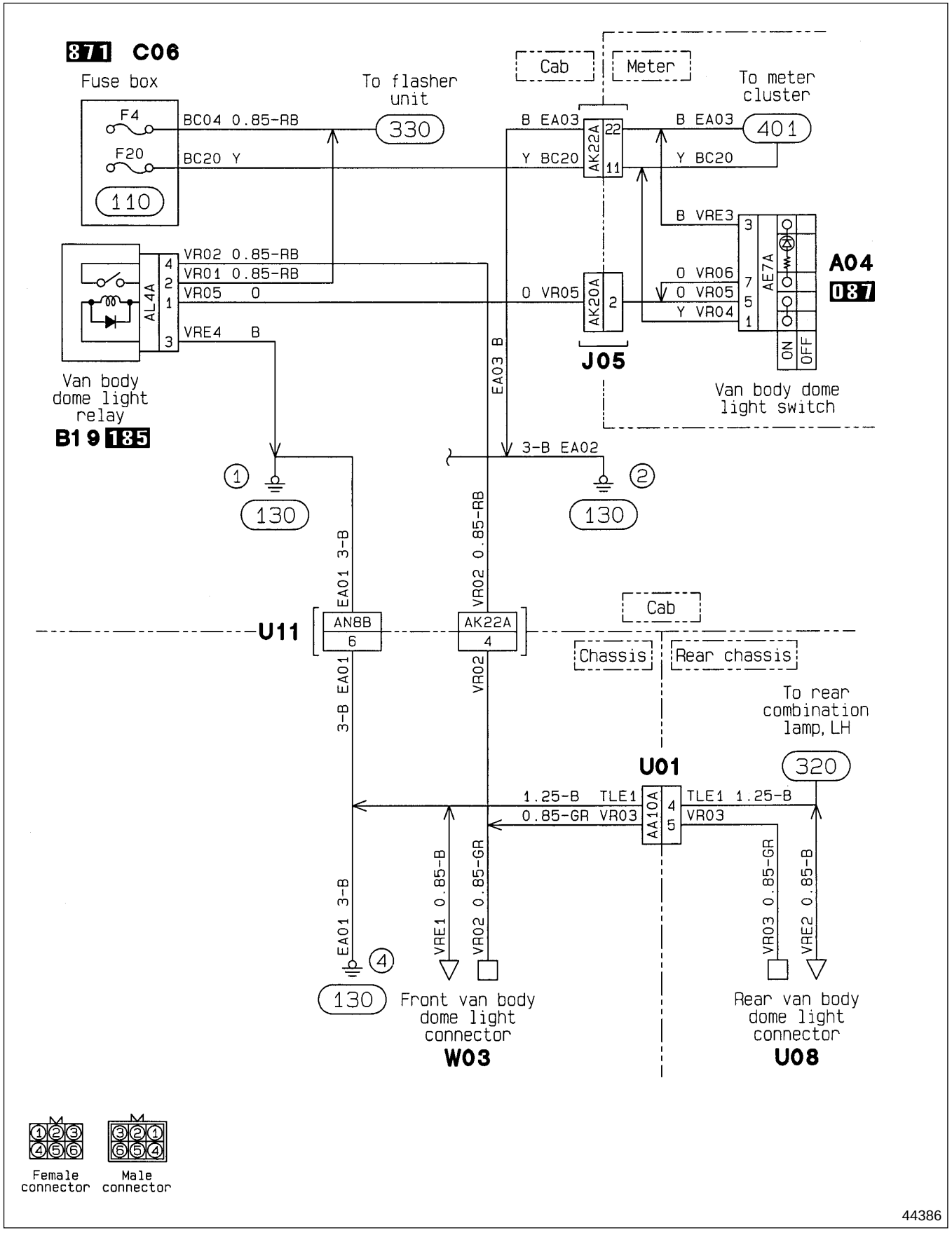

F06 655
Rear cab lamp, LH
F01 656
Cab lamp
F05 655
Rear cab lamp, RH
ON
DOOR
OFF
OFF
CAB
DOOR
ON
DOOR
OFF
871 C06
Fuse box
F6
110
AL3A
3 2 1
BA3A
3 2 1
AL3A
3 2 1
B LW GR
RW BC06
*1 WR RL04
*1 B RLE2
*1 RW RL03
B RLE1
WR RL01
RW BC06
*1 WR RL06
*1 B RLE3
*1 RW RL05
Roof
Cab
J01
AK4A
3 2 1
RLE1 B
EA01 3-B
RW BC06
1
130
RL01 WR
RL02 BY
J03
AK3A
3
J09
*1: Crew cab
*2: Except crew cab
RL01 WR *2
*1
BY RL02
BY RL02
J13
Door switch, LH
035 A22
*2
Door switch, RH
*2
A24 035
Door switch, LH (Front)
035 A22
B *1
Door switch, RH (Front)
*1
A24 035
Door switch, LH (Rear)
035 A22
B *1
B
*1
B
Door switch, RH (Rear)
A24 035
Female connector
Male connector
44383

348 ILLUMINATION LAMP CIRCUIT




871 C06
Fuse box
110
F34
BC34 1.25-W
B36
Relay box
B33 185
Tail lamp relay
AL4A
TL03 1.25-YR
BC34 1.25-W
TL01 0.85-W
TL02 RL
320
To lighting switch
EA01 3-B
130
B RLE1
0.85-YR ID01
AK4A
J01
RLE1 B
ID01 0.85-YR
B IDE1
AK2A
Cab lamp
345
F02, F04
Clearance and side marker lamp
LH
RH
0.75-B
0.75-G
B IDE4
ID04
0.85-RY
B IDE5
ID05
ID02 0.85-RY
IDE2 B
ID01 0.85-RY
IDE1 B
ID03 0.85-RY
IDE3 B
Center
Identification lamp
F03
TL03 1.25-YR
U11
AN8B
1
Cab
Roof
Chassis
W05
Front clearance lamp connector
ID07 0.85-YR
Front identification lamp connector
ID06 0.85-YR
W04
U01
AA10A
8
Rear chassis
1.25-YR TL03
U05
0.85-YR ID08
Rear identification lamp connector
U03
ID10 0.85-YR
U06
0.85-YR ID09
Rear clearance lamp, RH connector
Rear clearance lamp, LH connector
U07
ID12 0.85-YR
0.85-YR ID11
Rear side marker lamp, RH connector
Rear side marker lamp, LH connector
U04
320
To rear combination lamp, LH
Female connector
Male connector
44385

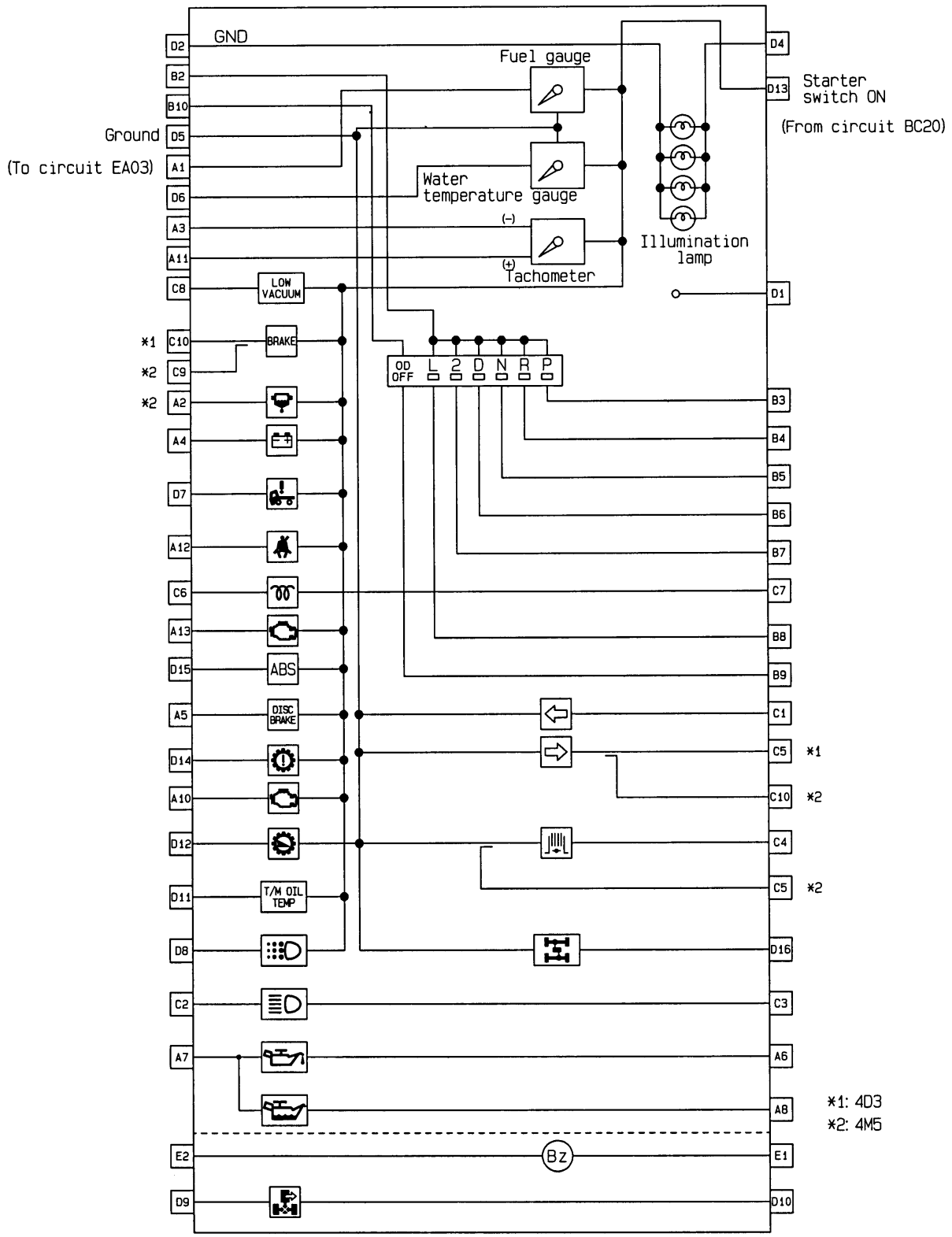
352 VAN BODY DOME LIGHT CIRCUIT

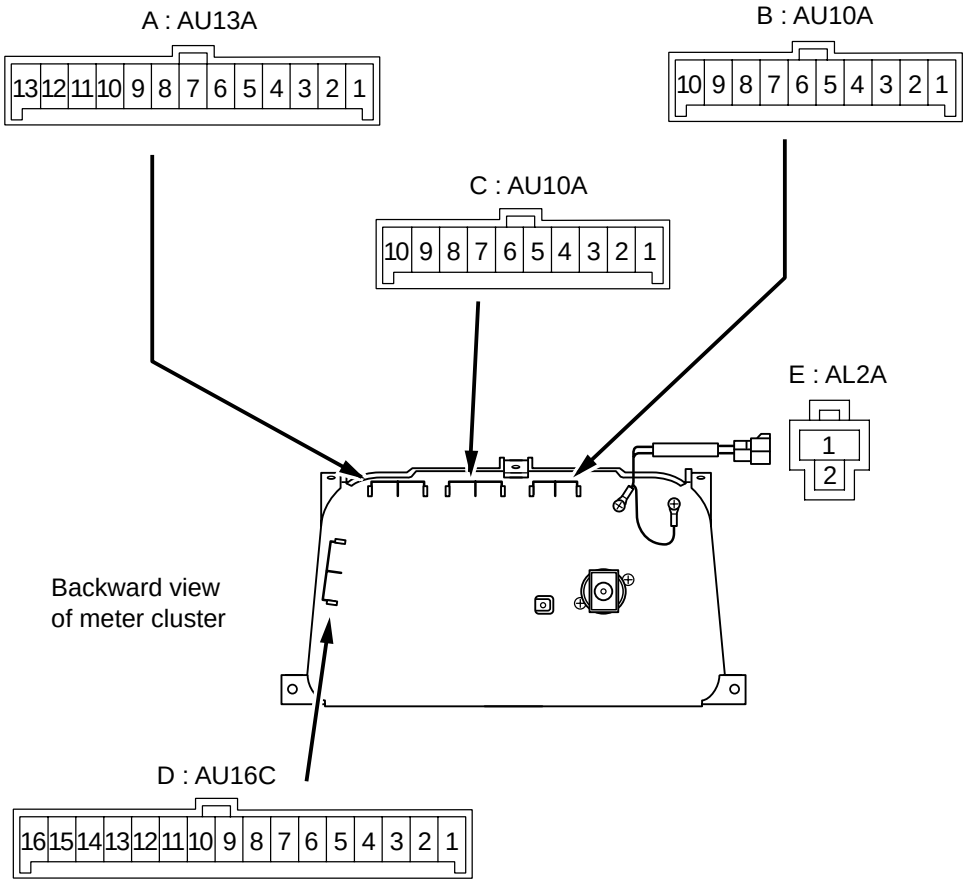


44386

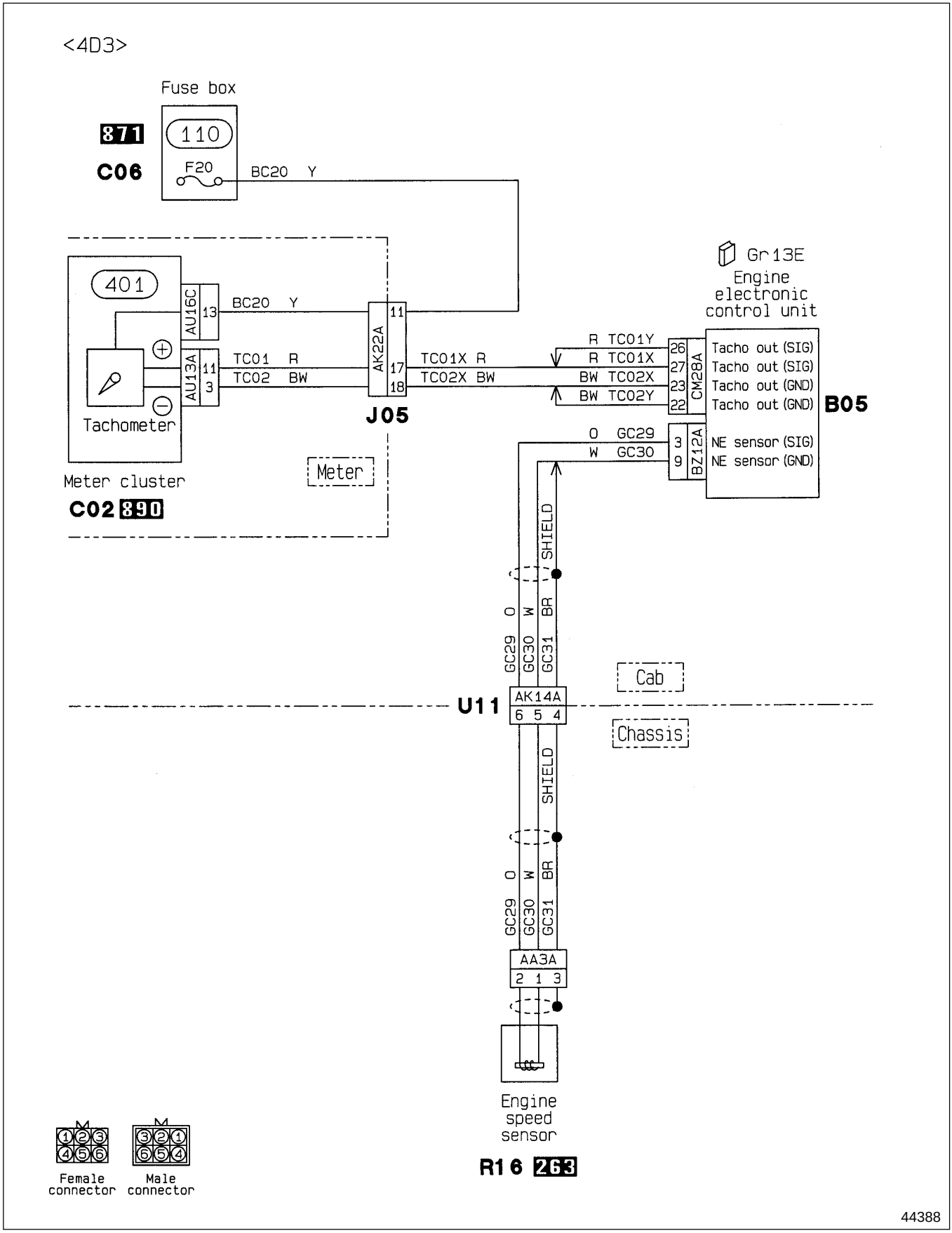
4 METER CIRCUIT

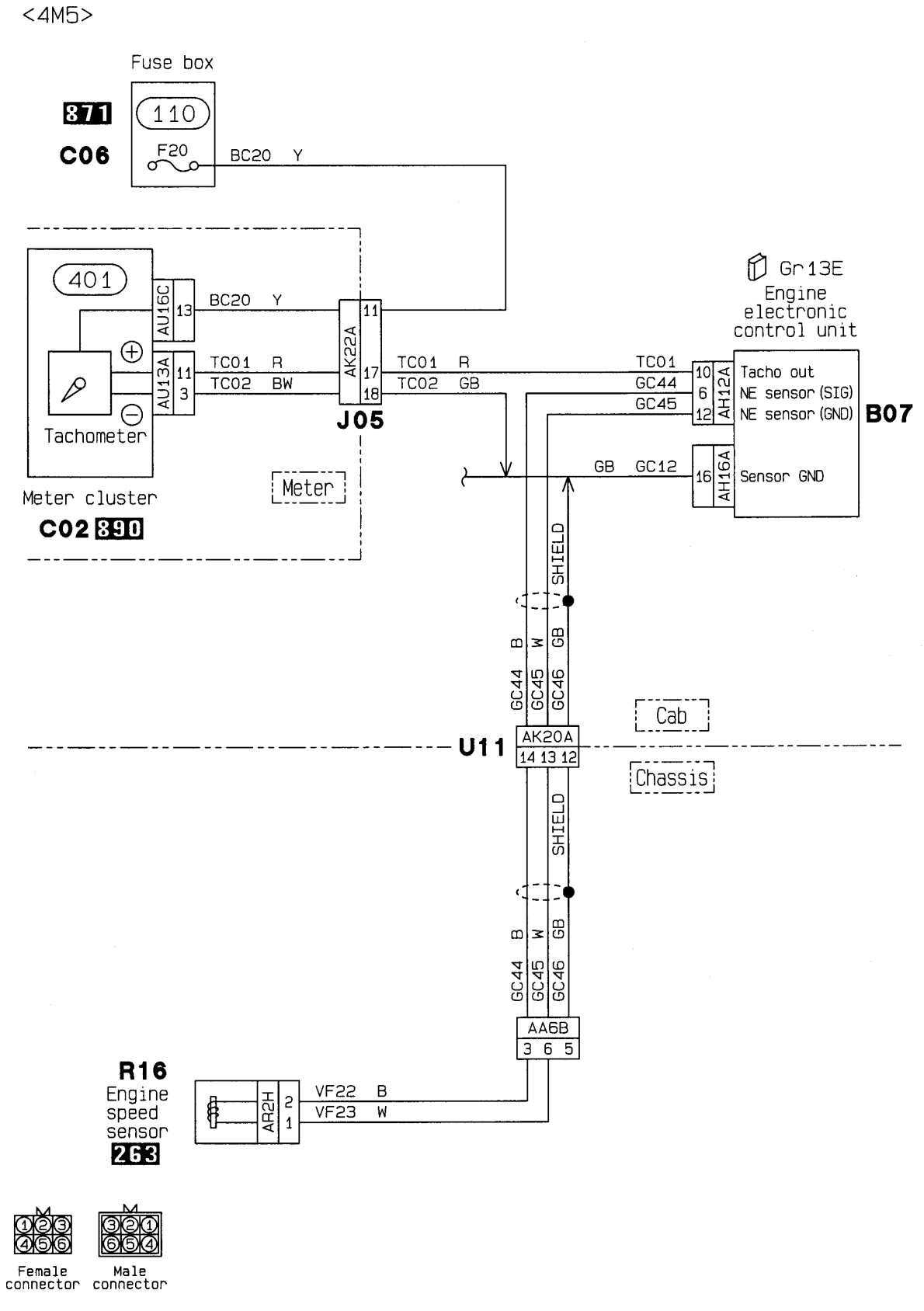
401 METER CLUSTER INTERNAL CIRCUIT

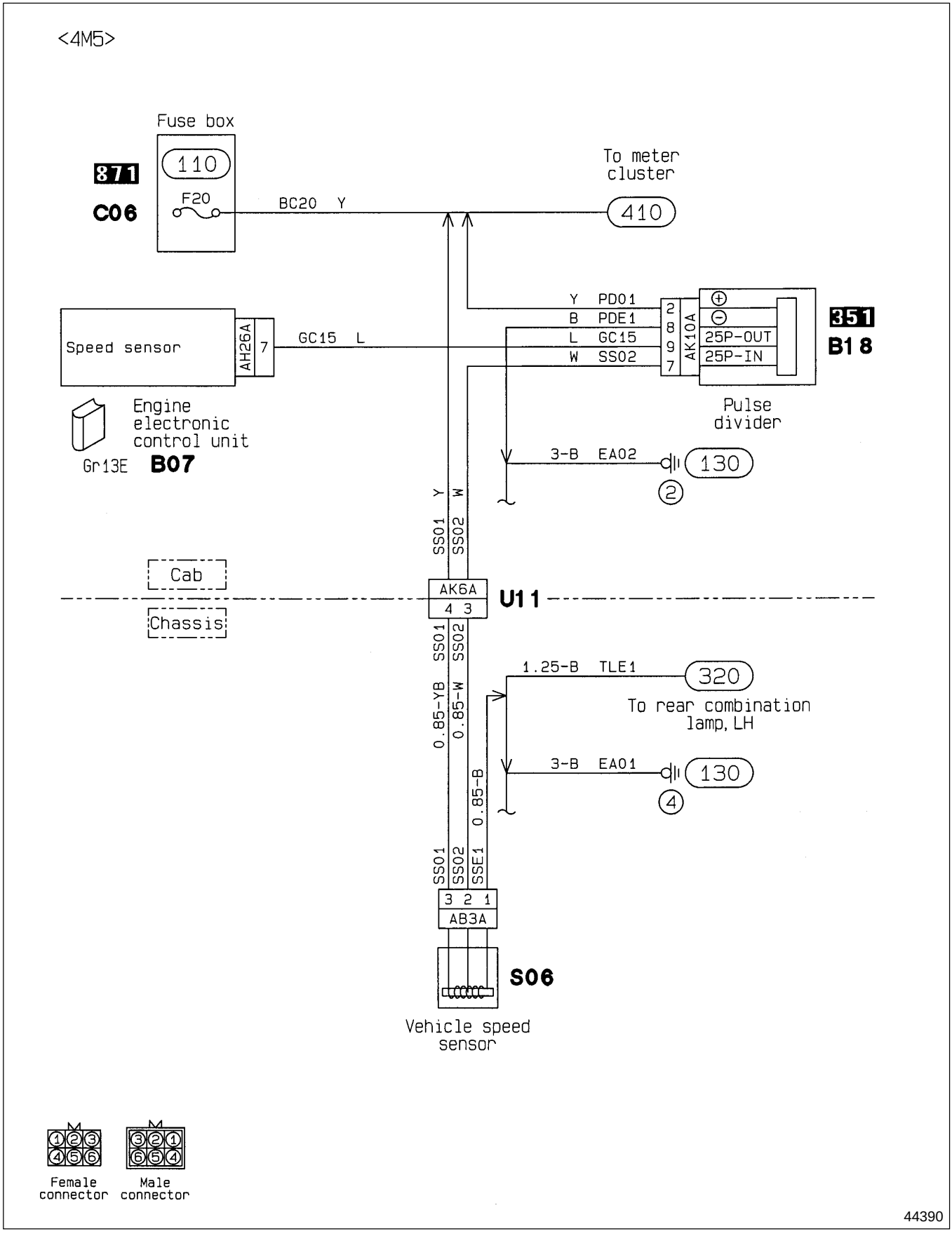


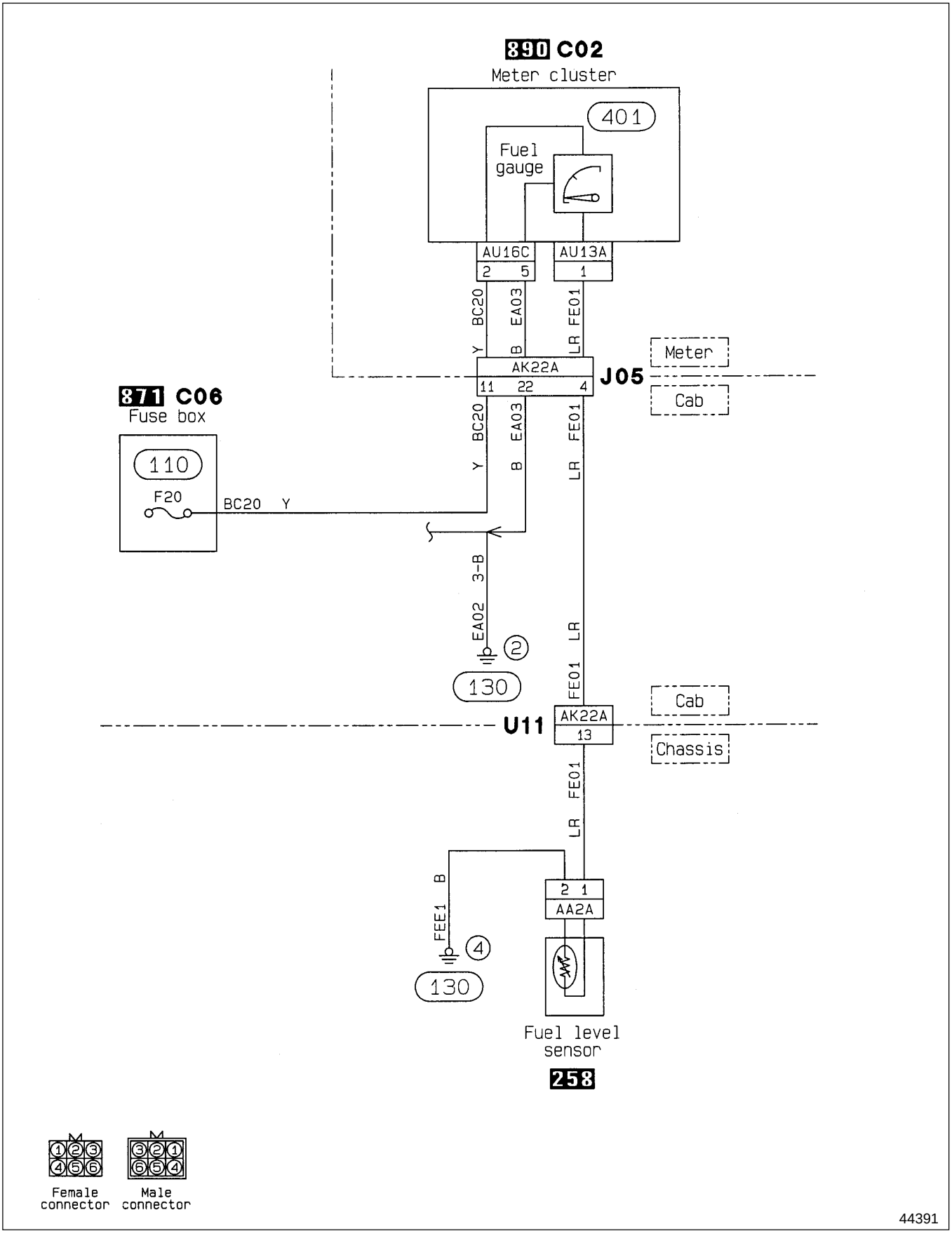

A : AU13A
13 12 11 10 9 8 7 6 5 4 3 2 1
B : AU10A
10 9 8 7 6 5 4 3 2 1
C : AU10A
10 9 8 7 6 5 4 3 2 1
E : AL2A
1
2
Backward view
of meter cluster
D : AU16C
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Ⓟ45110

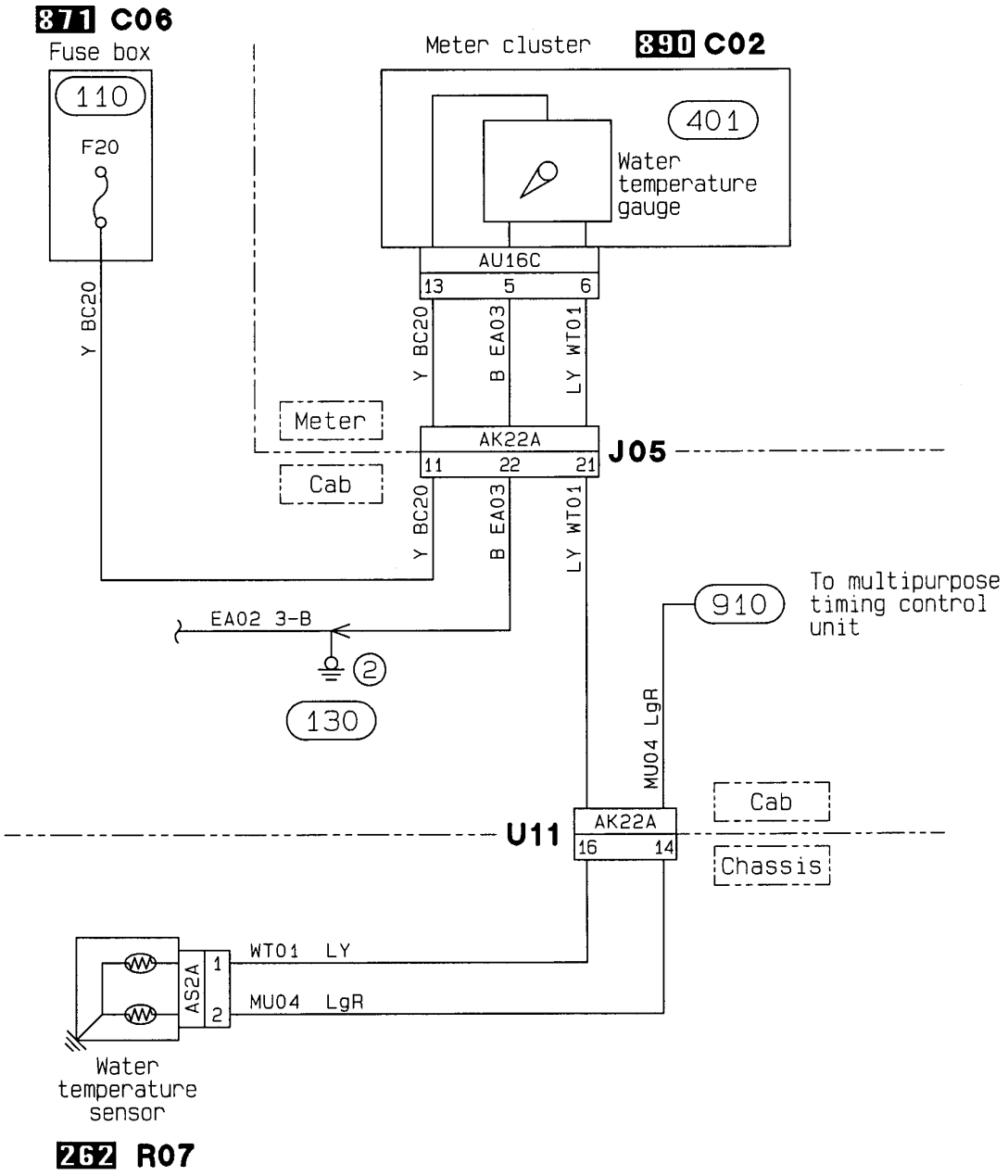

<4D3>
Fuse box
871
C06
110
F20
BC20 Y
401
AU16C
13
BC20 Y
AU13A
11
3
TC01 R
TC02 BW
Tachometer
Meter cluster
C02 890
Meter
AK22A
11
17
18
TC01X R
TC02X BW
J05
Gr13E
Engine electronic control unit
R TC01Y
R TC01X
BW TC02X
BW TC02Y
CM28A
26
27
23
22
Tacho out (SIG)
Tacho out (SIG)
Tacho out (GND)
Tacho out (GND)
B05
O GC29
W GC30
BZ12A
3
9
NE sensor (SIG)
NE sensor (GND)
SHIELD
GC29 O
GC30 W
GC31 BR
Cab
U11
AK14A
6 5 4
Chassis
SHIELD
GC29 O
GC30 W
GC31 BR
AA3A
2 1 3
Engine speed sensor
R16 263
Female connector
Male connector
44388

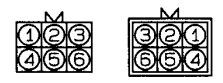

<4M5>
Fuse box
871
110
C06
F20
BC20 Y
401
AU16C
13
BC20 Y
AU13A
11
3
TC01 R
TC02 BW
AK22A
11
17
18
TC01 R
TC02 GB
J05
Tachometer
Meter cluster
C02 890
Meter
Gr13E
Engine electronic control unit
TC01
GC44
GC45
10
6
12
AH12A
Tacho out
NE sensor (SIG)
NE sensor (GND)
B07
GB GC12
16
AH16A
Sensor GND
SHIELD
B
W
GB
GC44
GC45
GC46
Cab
U11
AK20A
14 13 12
Chassis
SHIELD
AA6B
3 6 5
R16
Engine speed sensor
263
AR2H
2
1
VF22 B
VF23 W
Female connector
Male connector
44389


<4M5>
Fuse box
110
F20
87
C06
BC20 Y
To meter cluster
410
Y PD01
B PDE1
L GC15
W SS02
2
8
9
7
AK10A
25P-OUT
25P-IN
351
B18
Pulse divider
Speed sensor
AH26A
7
GC15 L
Engine electronic control unit
Gr13E B07
3-B EA02
130
2
SS01 Y
SS02 W
Cab
Chassis
AK6A
4 3
U11
SS01
SS02
0.85-YB
0.85-W
1.25-B TLE1
320
To rear combination lamp, LH
3-B EA01
130
4
0.85-B
SS01
SS02
SSE1
3 2 1
AB3A
S06
Vehicle speed sensor
Female connector
Male connector
44390


890 C02
Meter cluster
401
Fuel gauge
AU16C
2 5
AU13A
1
BC20 Y
EA03 B
FE01 LR
AK22A
11 22 4
J05
Meter
Cab
871 C06
Fuse box
110
F20
BC20 Y
3-B
EA02
2
130
FE01 LR
U11
AK22A
13
Cab
Chassis
FE01 LR
FEE1 B
2 1
AA2A
4
130
Fuel level sensor
258
Female connector
Male connector
44391

425 WATER TEMPERATURE GAUGE CIRCUIT

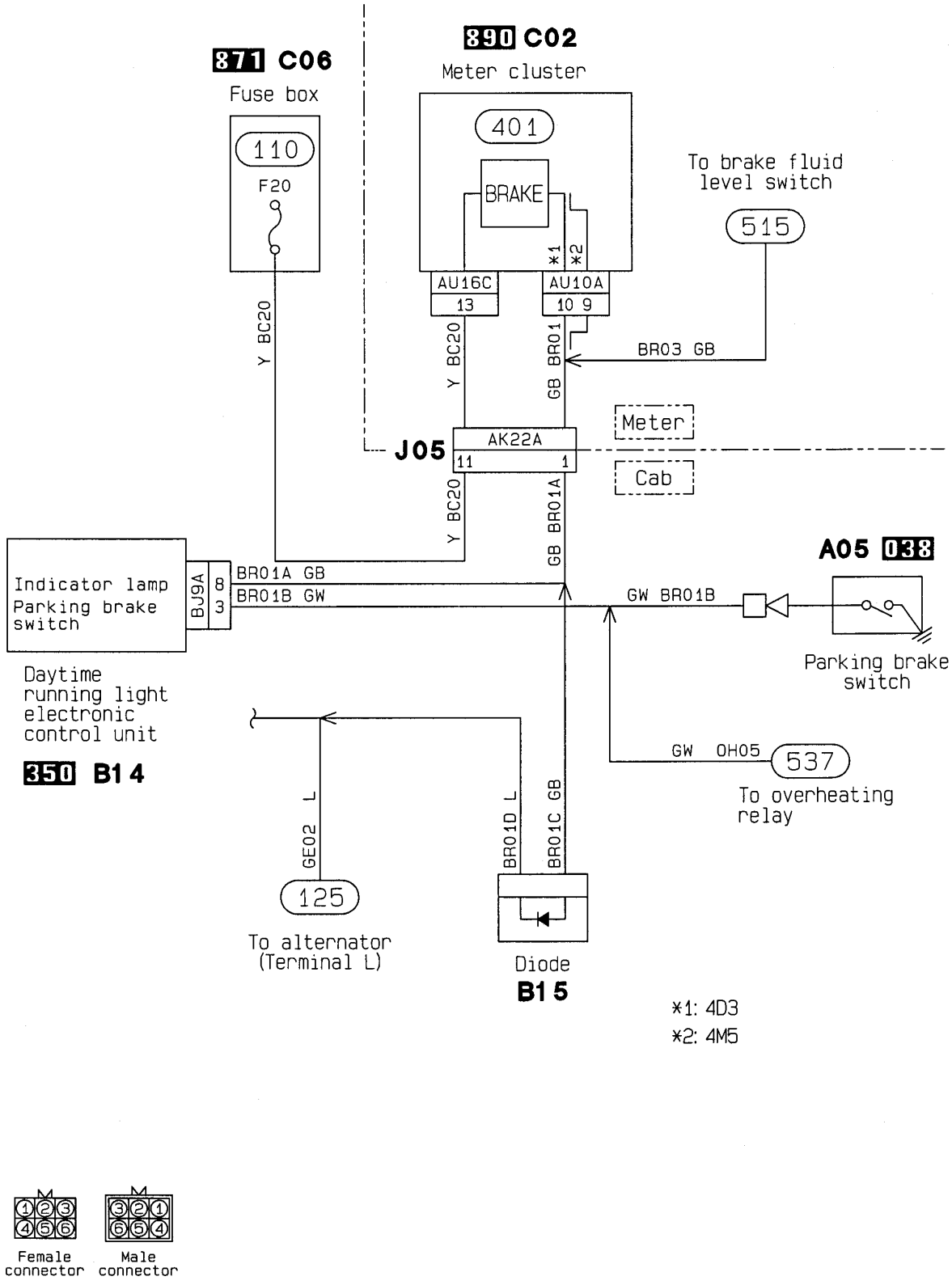


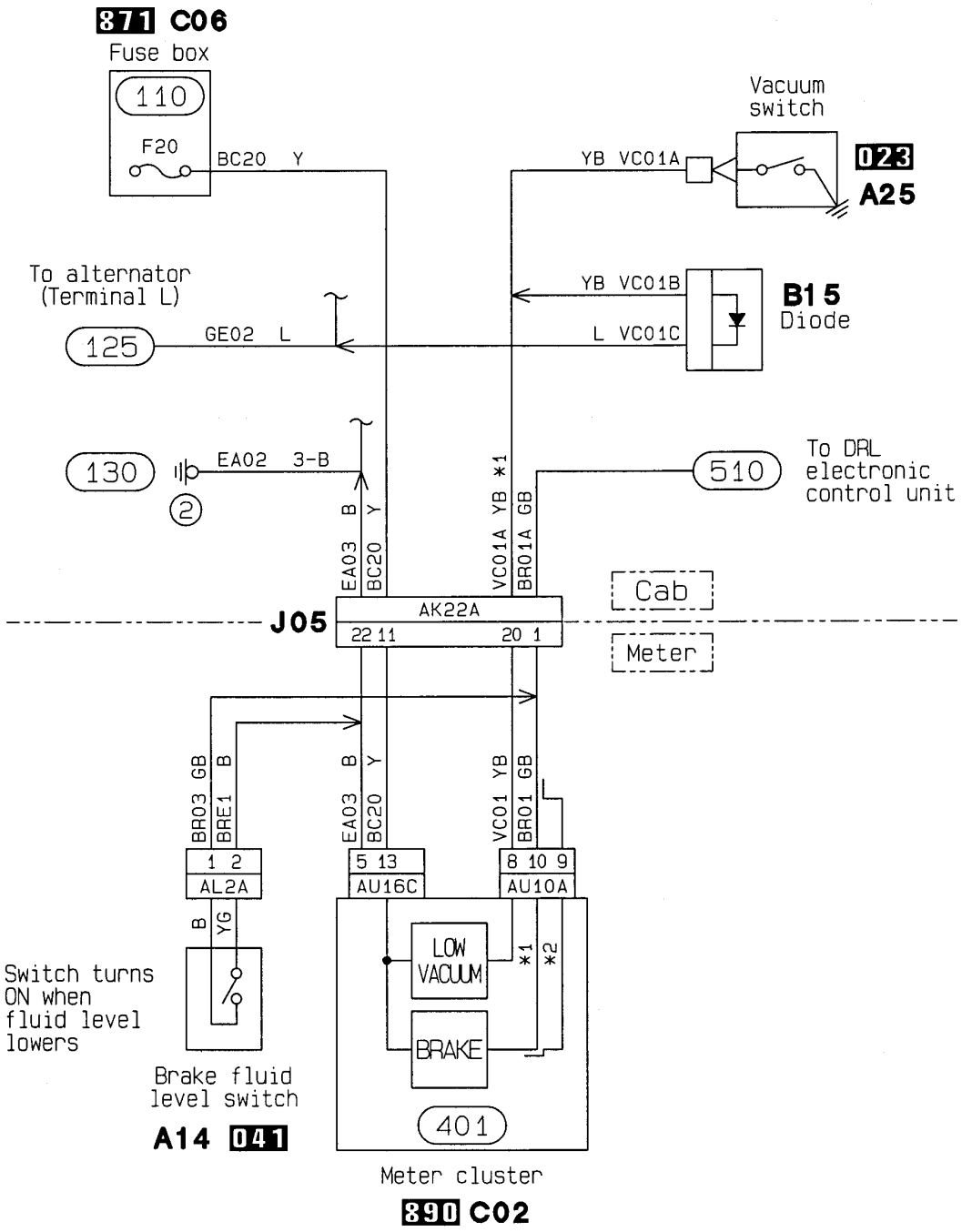


44392

5 INDICATOR AND WARNING LAMP CIRCUIT

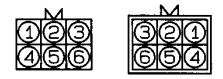
510 PARKING BRAKE INDICATOR CIRCUIT





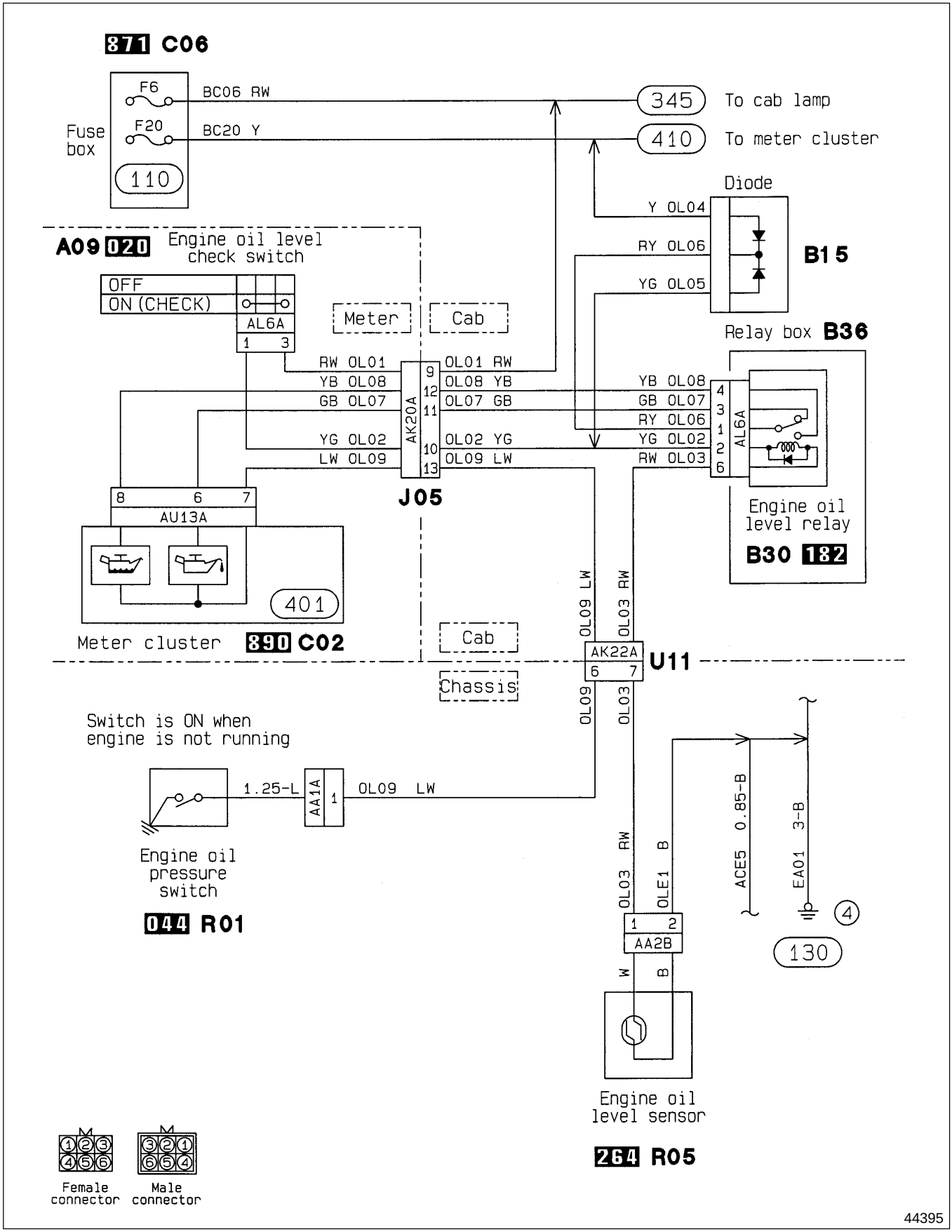
*1: 4D3
*2: 4M5

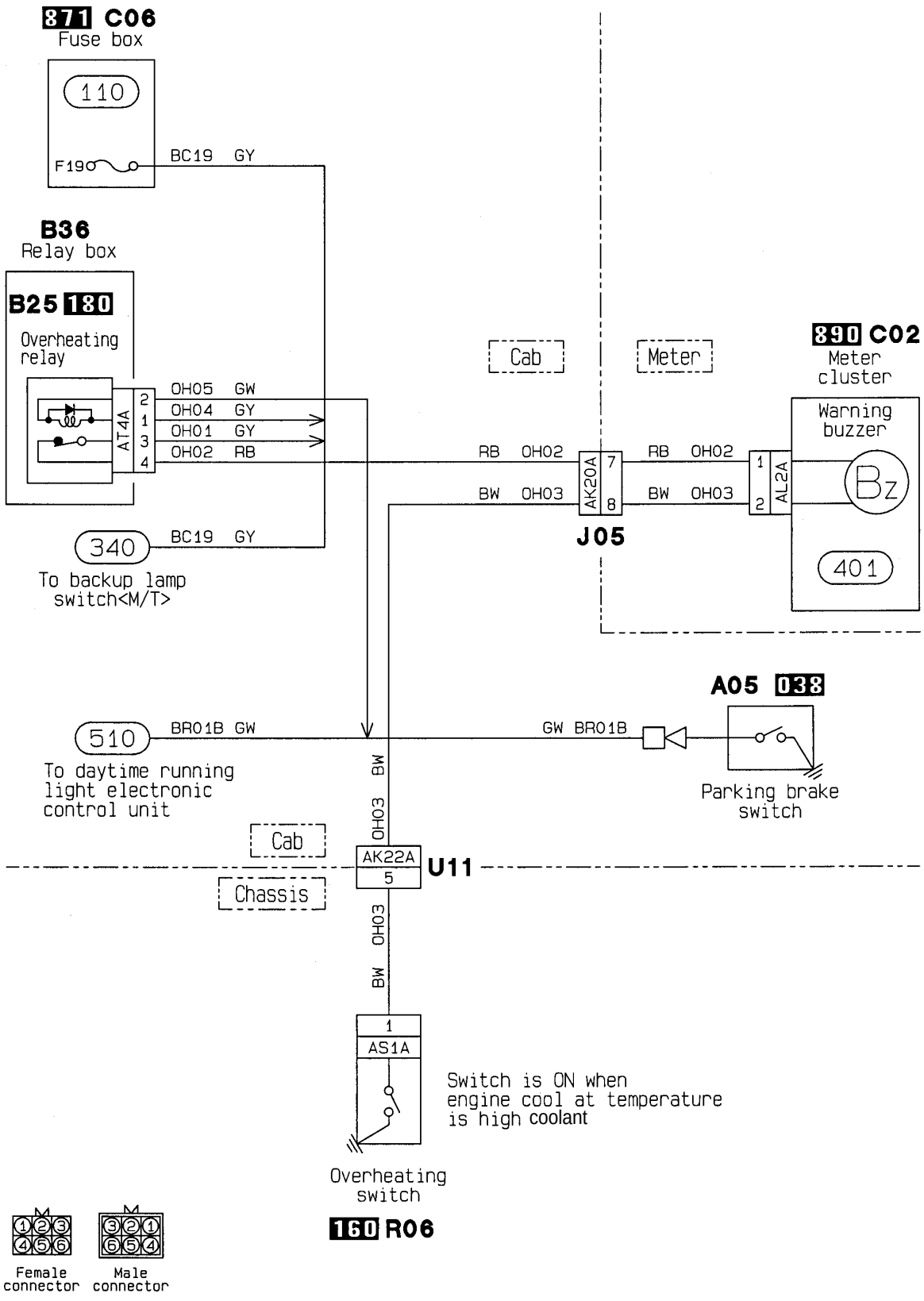
DRL: Daytime running light



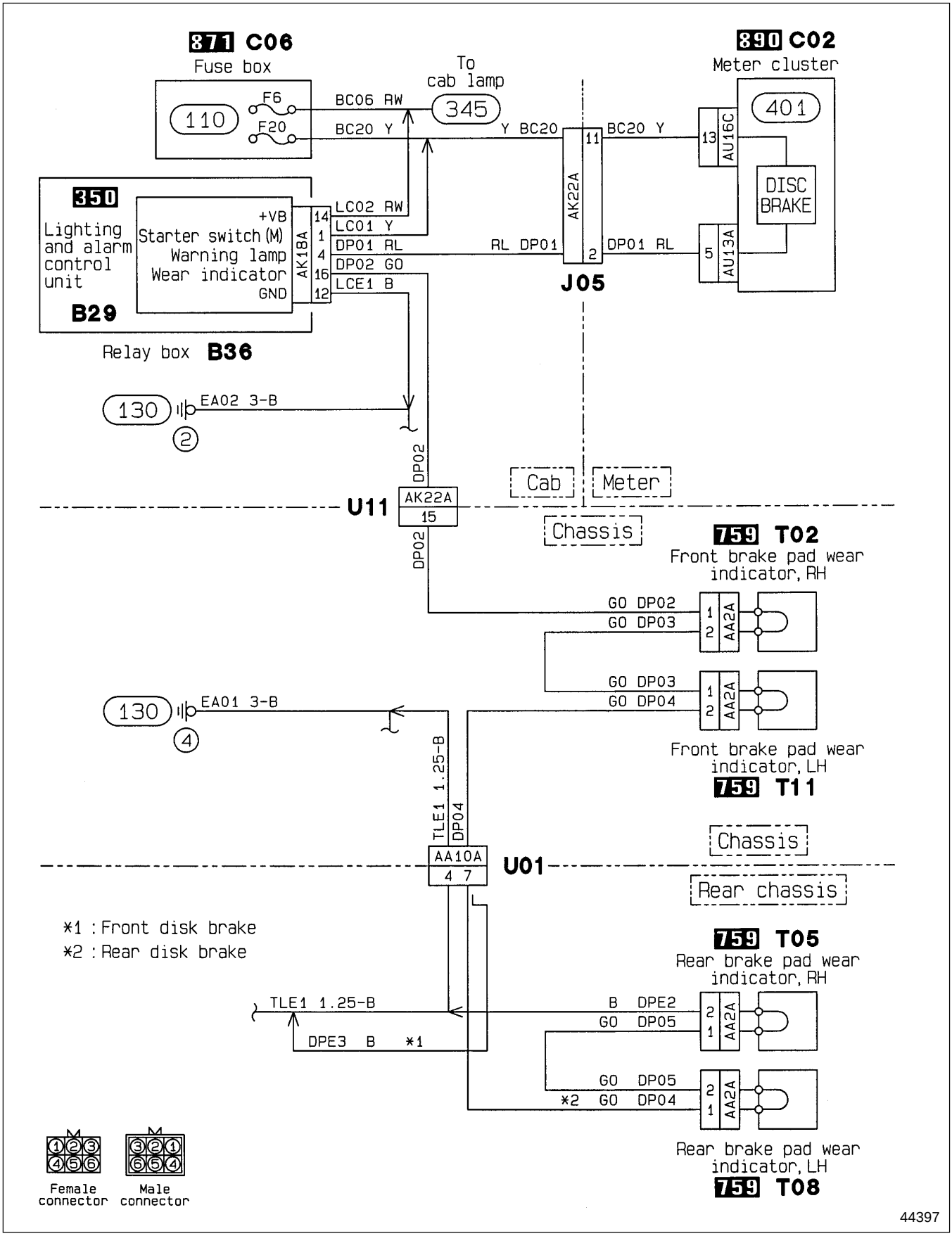
44394

535 ENGINE OIL LEVEL AND OIL PRESSURE WARNING CIRCUIT

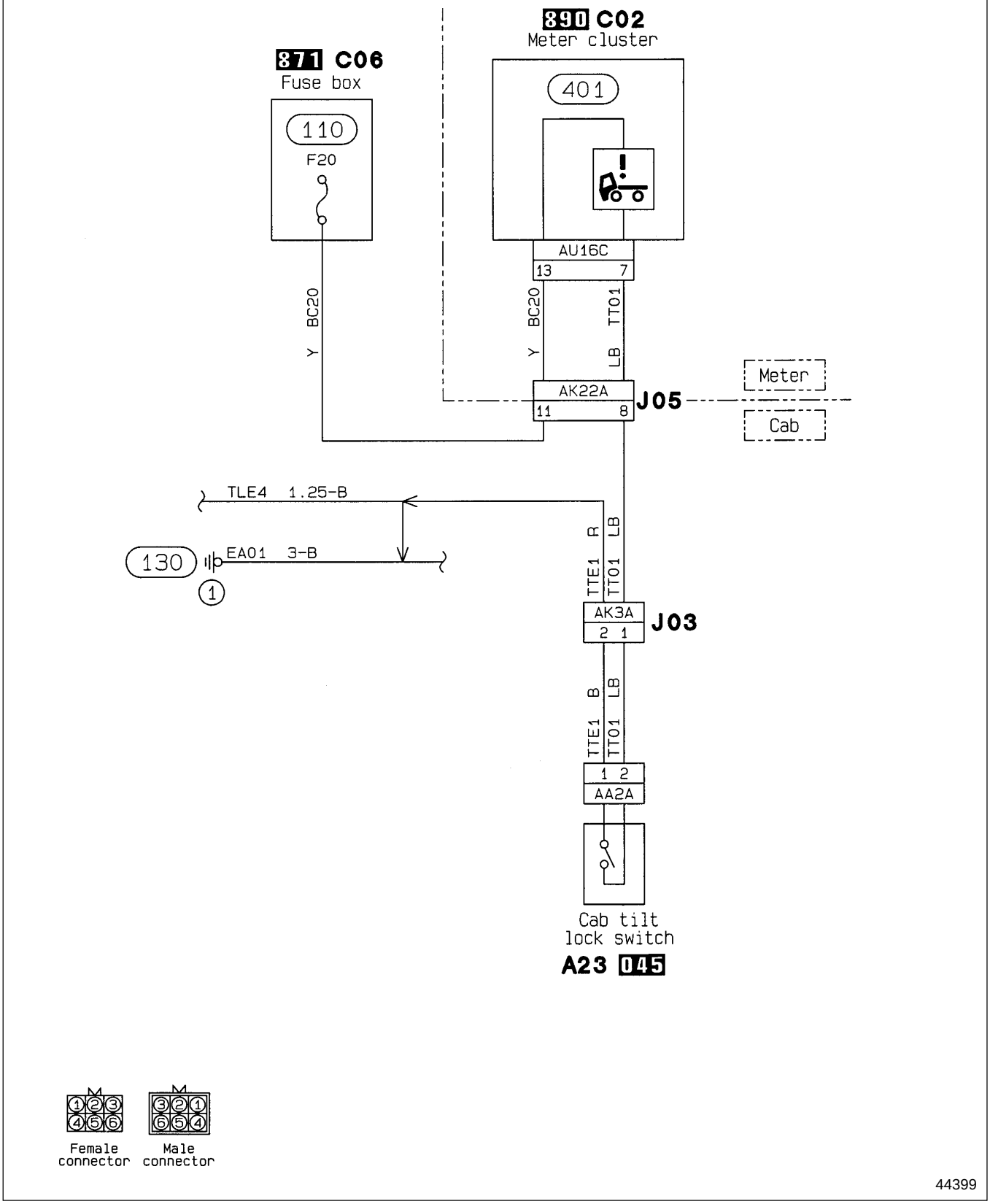



871 C06
Fuse box
110
F19
BC19 GY
B36
Relay box
B25 180
Overheating relay
AT4A
2
1
3
4
OH05 GW
OH04 GY
OH01 GY
OH02 RB
340
BC19 GY
To backup lamp switch<M/T>
Cab
Meter
890 C02
Meter cluster
Warning buzzer
Bz
401
RB OH02
BW OH03
AK20A
7
8
J05
RB OH02
BW OH03
1
2
AL2A
A05 038
Parking brake switch
510
BR01B GW
GW BR01B
To daytime running light electronic control unit
BW OH03
Cab
Chassis
AK22A
5
U11
BW OH03
1
AS1A
Switch is ON when engine cool at temperature is high coolant
Overheating switch
160 R06
Female connector
Male connector
44396

540 BRAKE PAD WARNING CIRCUIT

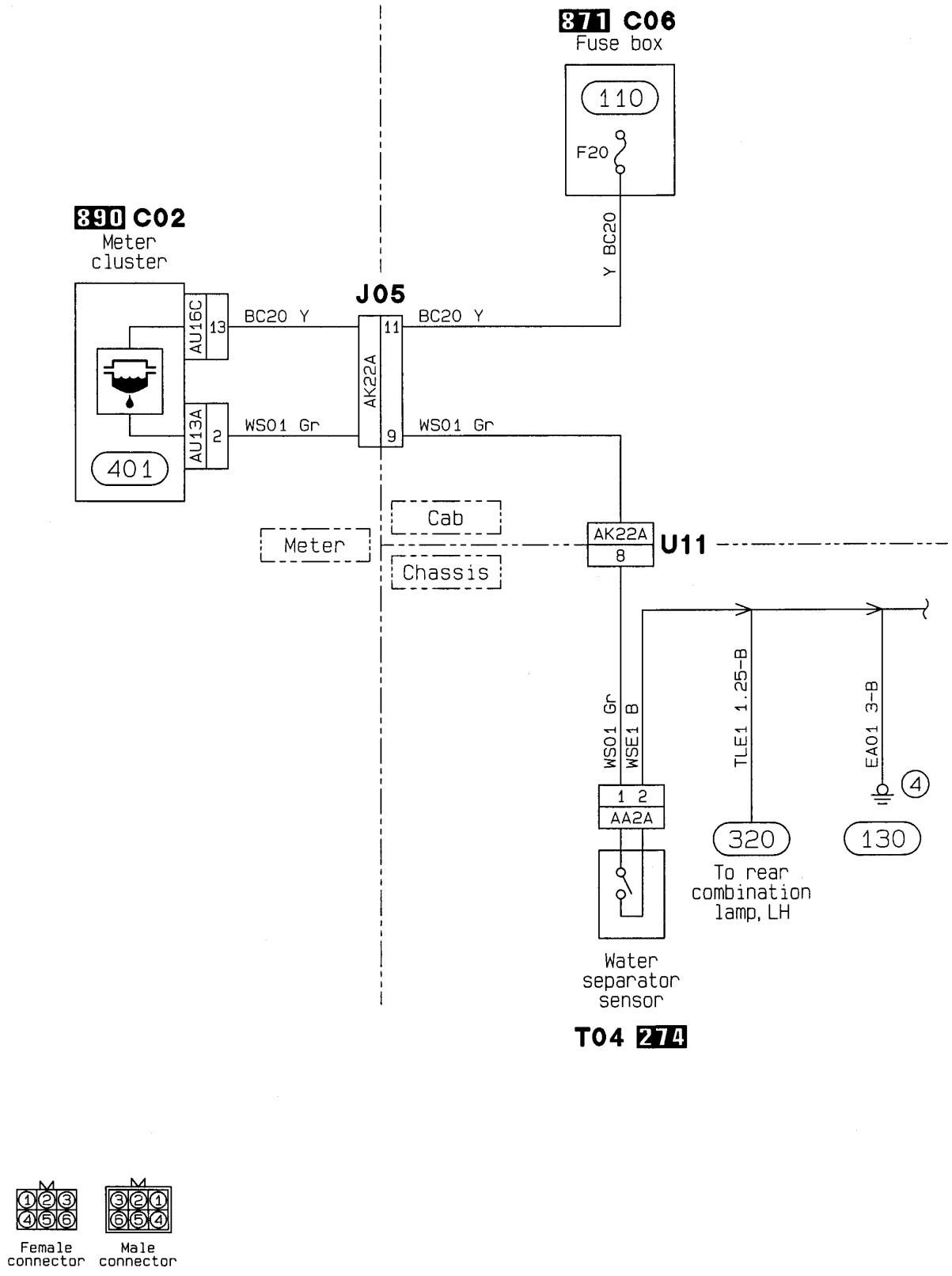


44397


890 C02
Meter cluster
401
871 C06
Fuse box
110
F20
AU16C
13 7
Y BC20
Y BC20
LB TT01
AK22A
11 8
J05
Meter
Cab
TLE4 1.25-B
130
EA01 3-B
1
R TTE1
LB TT01
AK3A
2 1
J03
B TTE1
LB TT01
1 2
AA2A
Cab tilt
lock switch
A23 045
Female
connector
Male
connector
44399

566 FUEL FILTER WARNING CIRCUIT

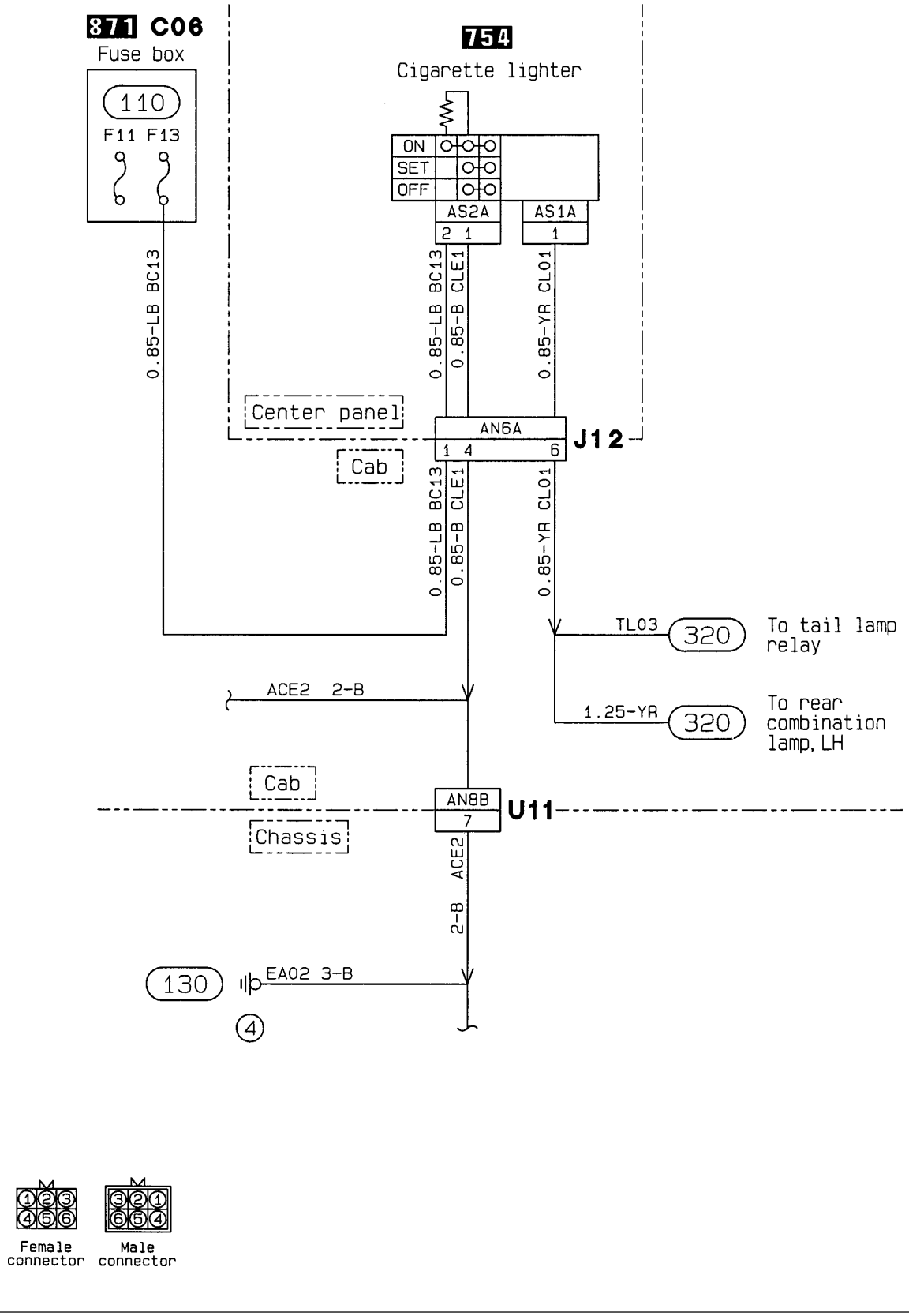
<4M5>

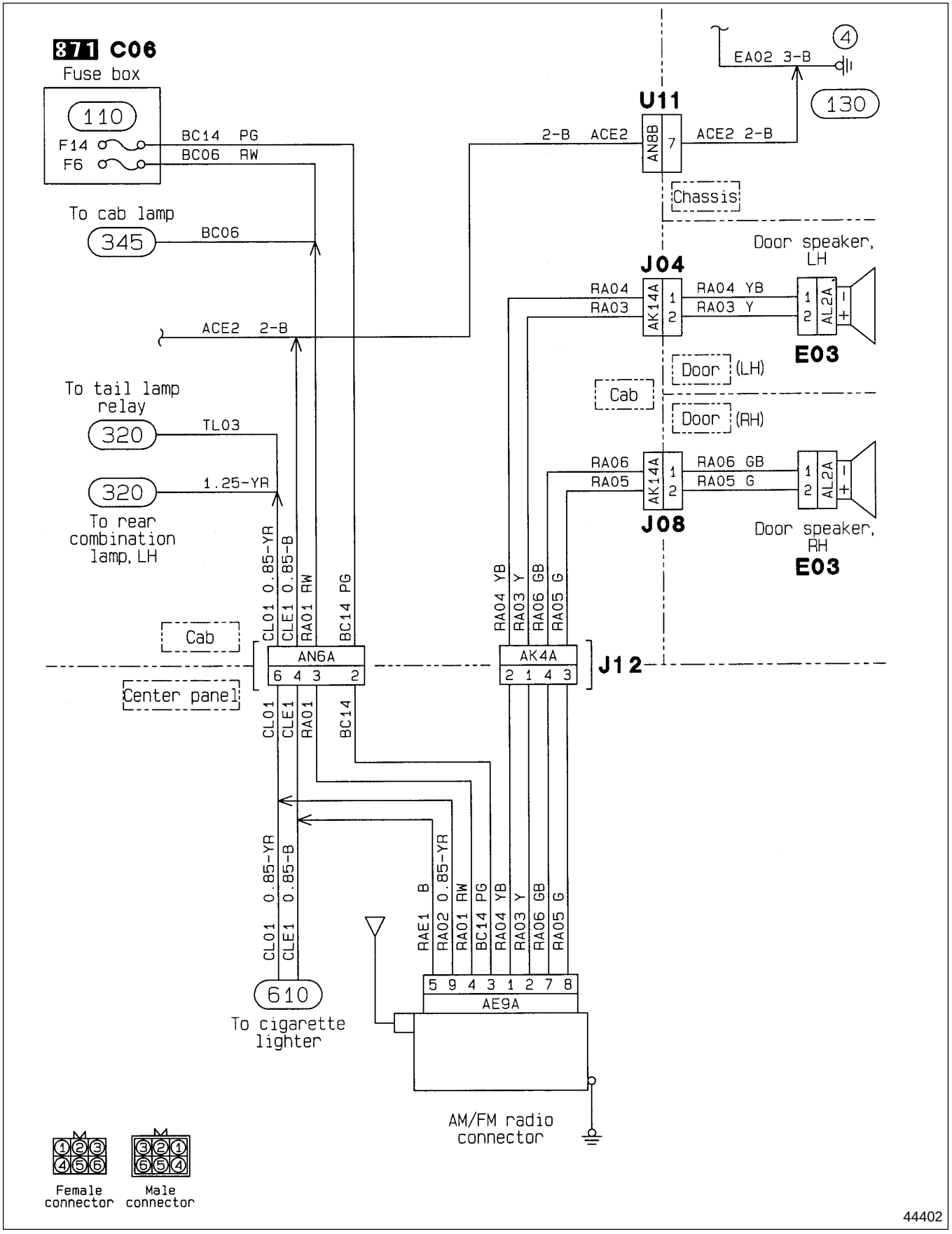


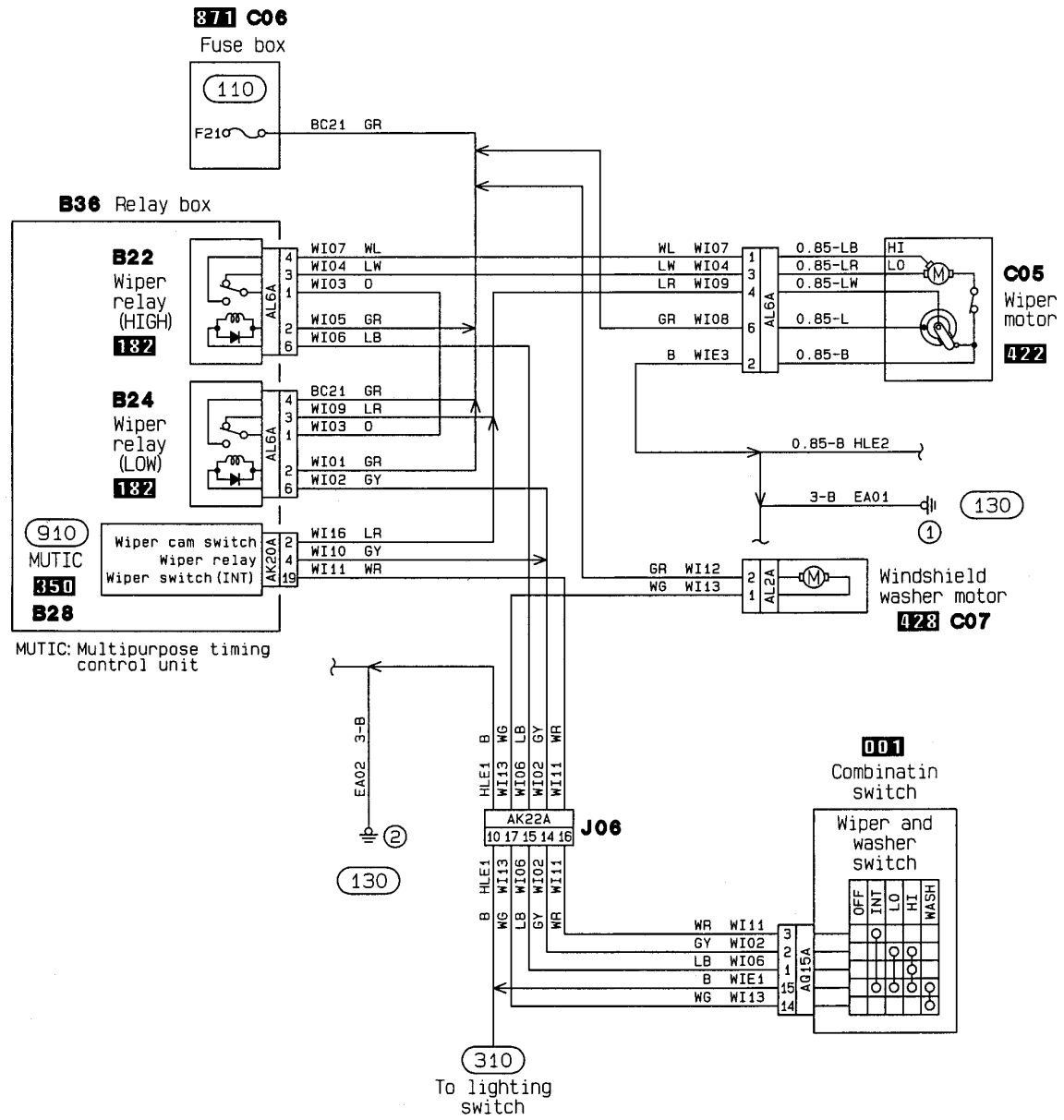
44400

⑥ CAB SIDE ELECTRICAL CIRCUIT

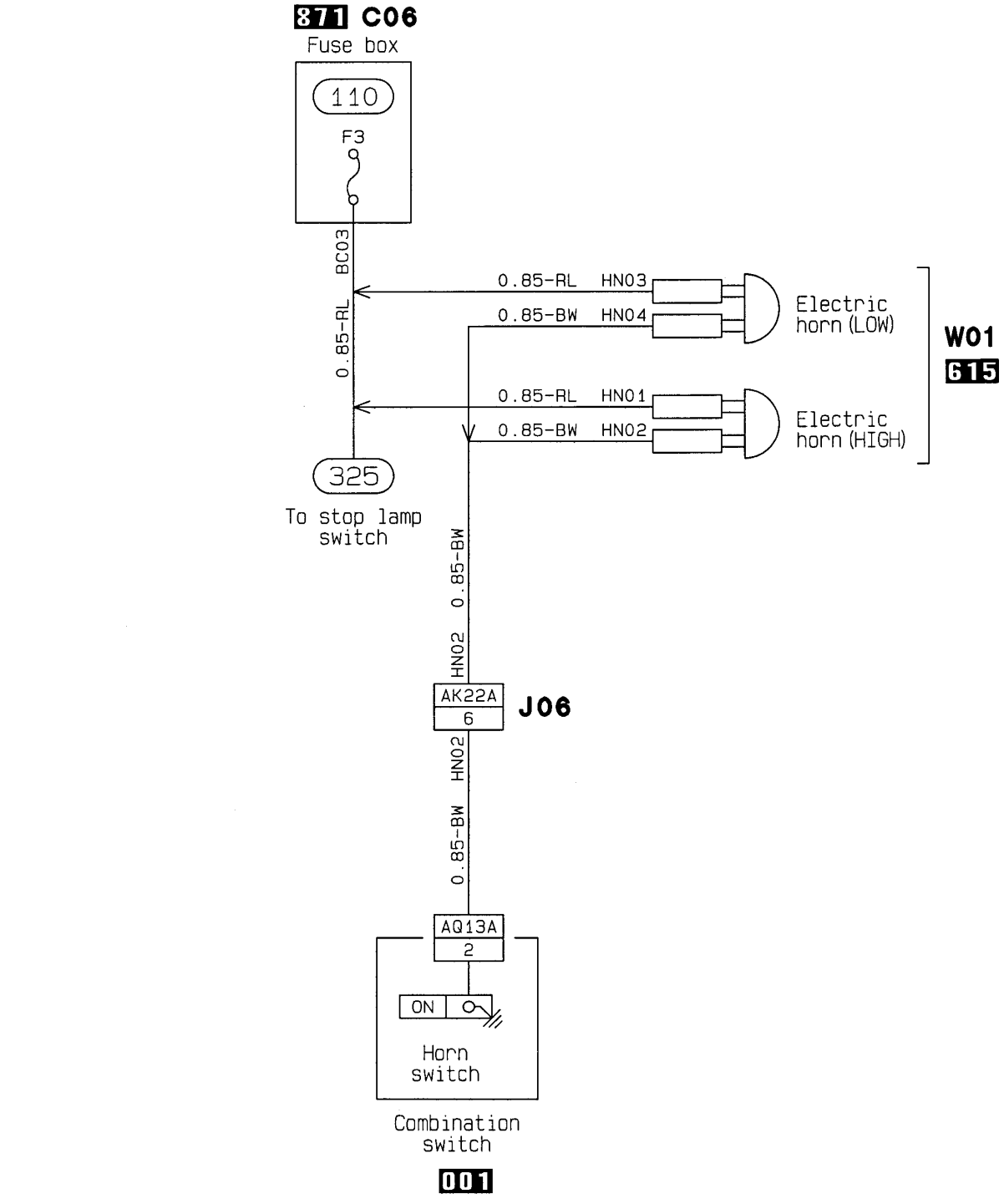
610 CIGARETTE LIGHTER CIRCUIT



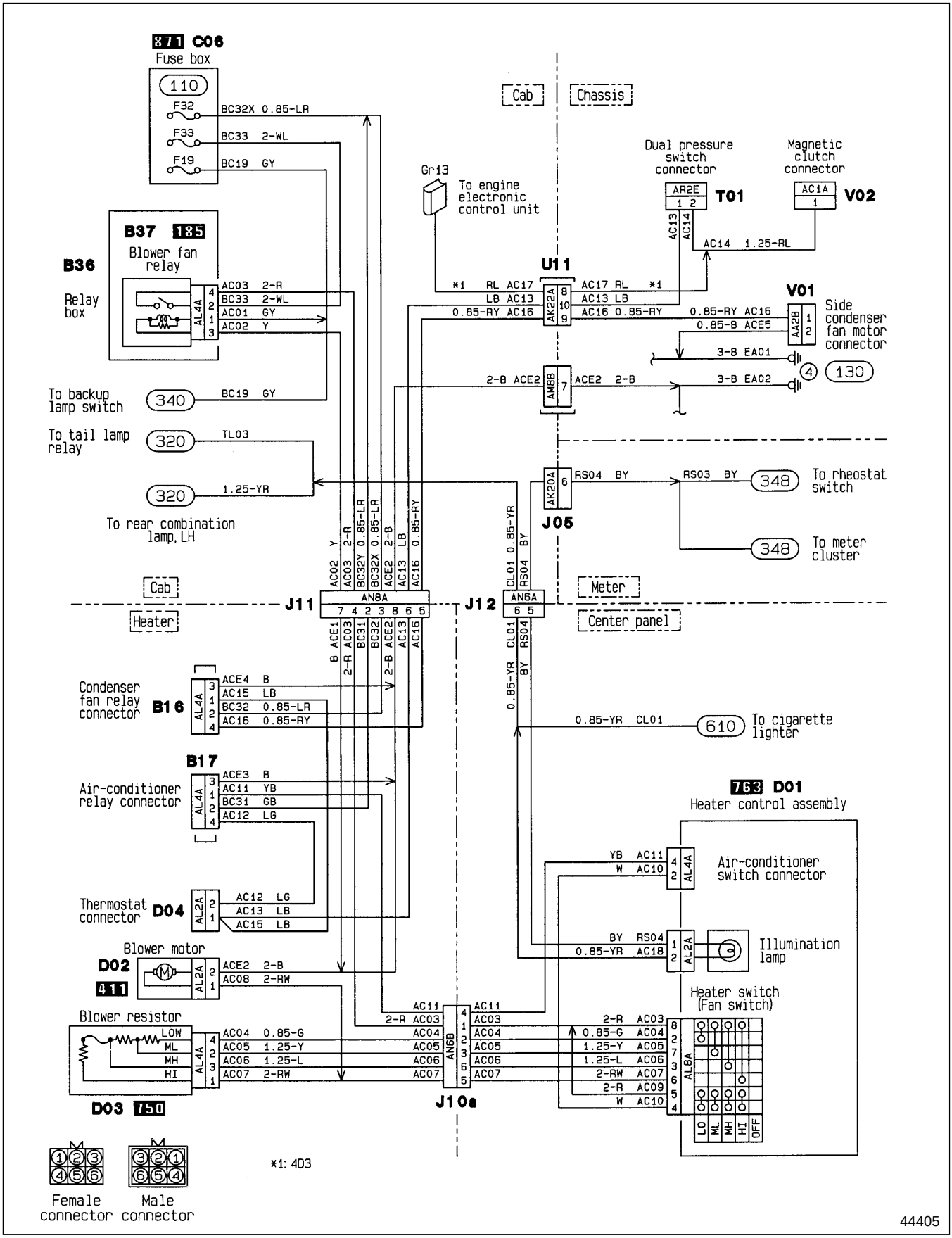

871 C06
Fuse box
110
F14
F6
BC14 PG
BC06 RW
To cab lamp
345
BC06
To tail lamp relay
320
TL03
320
1.25-YR
To rear combination lamp, LH
ACE2 2-B
2-B ACE2
U11
AN8B
7
ACE2 2-B
EA02 3-B
4
130
Chassis
Door speaker, LH
J04
RA04
RA03
AK14A
1
2
RA04 YB
RA03 Y
AL2A
E03
Door (LH)
Cab
Door (RH)
RA06
RA05
RA06 GB
RA05 G
J08
Door speaker, RH
E03
Cab
AN6A
6 4 3 2
AK4A
2 1 4 3
J12
Center panel
CL01 0.85-YR
CLE1 0.85-B
RA01 RW
BC14 PG
RA04 YB
RA03 Y
RA06 GB
RA05 G
CL01
CLE1
RA01
BC14
RAE1 B
RA02 0.85-YR
610
To cigarette lighter
5 9 4 3 1 2 7 8
AE9A
AM/FM radio connector
Female connector
Male connector
44402

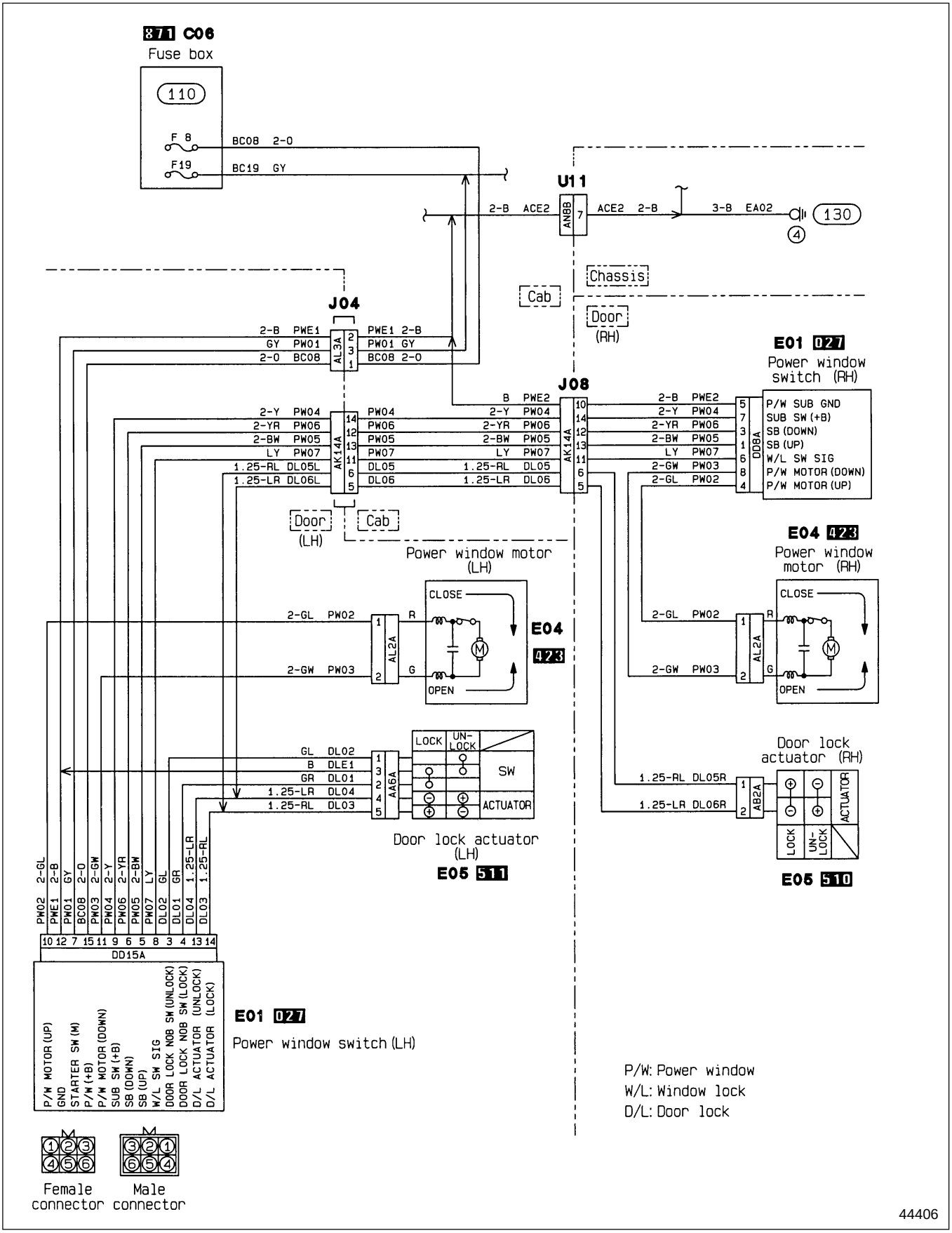

871 C06
Fuse box
110
F21
BC21 GR
B36 Relay box
B22
Wiper
relay
(HIGH)
182
B24
Wiper
relay
(LOW)
182
910
MUTIC
350
B28
MUTIC: Multipurpose timing
control unit
Wiper cam switch
Wiper relay
Wiper switch (INT)
AK20A
AL6A
WI07 WL
WI04 LW
WI03 O
WI05 GR
WI06 LB
BC21 GR
WI09 LR
WI03 O
WI01 GR
WI02 GY
WI16 LR
WI10 GY
WI11 WR
WL WI07
LW WI04
LR WI09
GR WI08
B WIE3
0.85-LB
0.85-LR
0.85-LW
0.85-L
0.85-B
HI
LO
C05
Wiper
motor
422
0.85-B HLE2
3-B EA01
130
1
GR WI12
WG WI13
AL2A
Windshield
washer motor
428 C07
EA02 3-B
2
130
HLE1 B
WG WI13
LB WI06
GY WI02
WR WI11
AK22A
10 17 15 14 16
J06
001
Combinatin
switch
Wiper and
washer
switch
OFF
INT
LO
HI
WASH
AG15A
WR WI11
GY WI02
LB WI06
B WIE1
WG WI13
310
To lighting
switch
Female
connector
Male
connector

44403

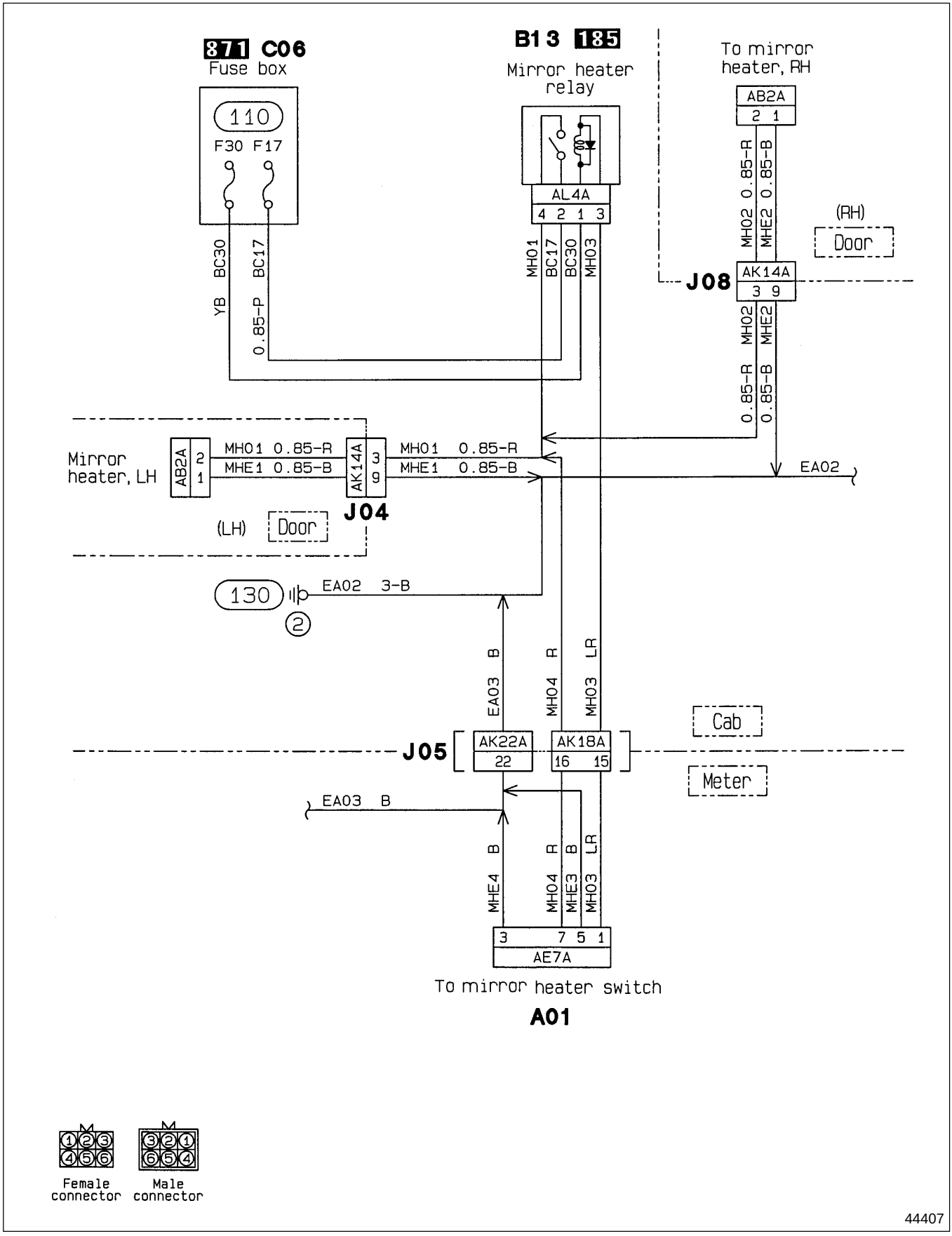

871 C06
Fuse box
110
F3
BC03
0.85-RL
0.85-RL HN03
0.85-BW HN04
Electric horn (LOW)
0.85-RL HN01
0.85-BW HN02
Electric horn (HIGH)
W01
615
325
To stop lamp switch
0.85-BW
HN02
AK22A
6
J06
HN02
0.85-BW
AQ13A
2
ON
Horn switch
Combination switch
001
Female connector
Male connector

44404

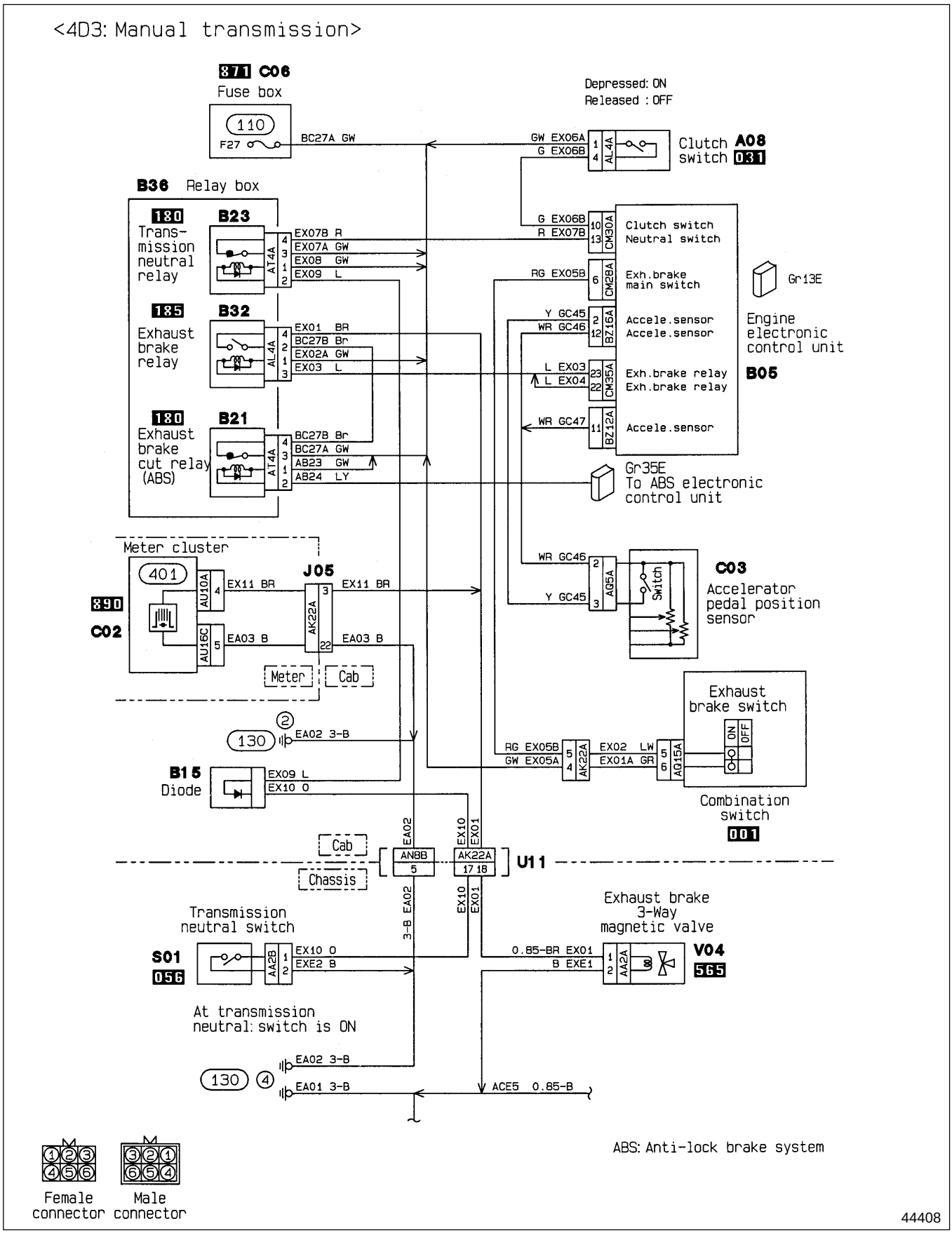

871 C06
Fuse box
110
F32
F33
F19
BC32X 0.85-LR
BC33 2-WL
BC19 GY
Cab
Chassis
Gr13
To engine electronic control unit
Dual pressure switch connector
AR2E
1 2
T01
Magnetic clutch connector
AC1A
1
V02
AC13
AC14
AC14 1.25-RL
B37 185
Blower fan relay
B36
Relay box
AL4A
AC03 2-R
BC33 2-WL
AC01 GY
AC02 Y
U11
*1 RL AC17
LB AC13
0.85-RY AC16
AK22A
AC17 RL *1
AC13 LB
AC16 0.85-RY
V01
Side condenser fan motor connector
AA2B
0.85-RY AC16
0.85-B ACE5
3-B EA01
4
130
2-B ACE2
AM8B
ACE2 2-B
3-B EA02
To backup lamp switch
340
BC19 GY
To tail lamp relay
320
TL03
320
1.25-YR
To rear combination lamp, LH
AK20A
RS04 BY
RS03 BY
348
To rheostat switch
J05
348
To meter cluster
Cab
Heater
J11
AN8A
7 4 2 3 8 6 5
J12
AN6A
6 5
Meter
Center panel
ACO2 Y
AC03 2-R
BC32Y 0.85-LR
BC32X 0.85-LR
ACE2 2-B
AC13 LB
AC16 0.85-RY
CL01 0.85-YR
RS04 BY
B ACE1
2-R AC03
BC31
BC32
2-B ACE2
AC13
AC16
CL01
RS04
0.85-YR
BY
Condenser fan relay connector
B16
ACE4 B
AC15 LB
BC32 0.85-LR
AC16 0.85-RY
0.85-YR CL01
610
To cigarette lighter
B17
Air-conditioner relay connector
ACE3 B
AC11 YB
BC31 GB
AC12 LG
763 D01
Heater control assembly
YB AC11
W AC10
Air-conditioner switch connector
Thermostat connector
D04
AL2A
AC12 LG
AC13 LB
AC15 LB
BY RS04
0.85-YR AC18
Illumination lamp
Blower motor
D02
411
ACE2 2-B
AC08 2-RW
Heater switch (Fan switch)
Blower resistor
LOW
ML
MH
HI
AC04 0.85-G
AC05 1.25-Y
AC06 1.25-L
AC07 2-RW
AC11
2-R AC03
AN6B
J10a
2-R AC03
0.85-G AC04
1.25-Y AC05
1.25-L AC06
2-RW AC07
2-R AC09
W AC10
AL8A
LO
ML
MH
HI
OFF
D03 750
*1: 4D3
Female connector
Male connector
44405

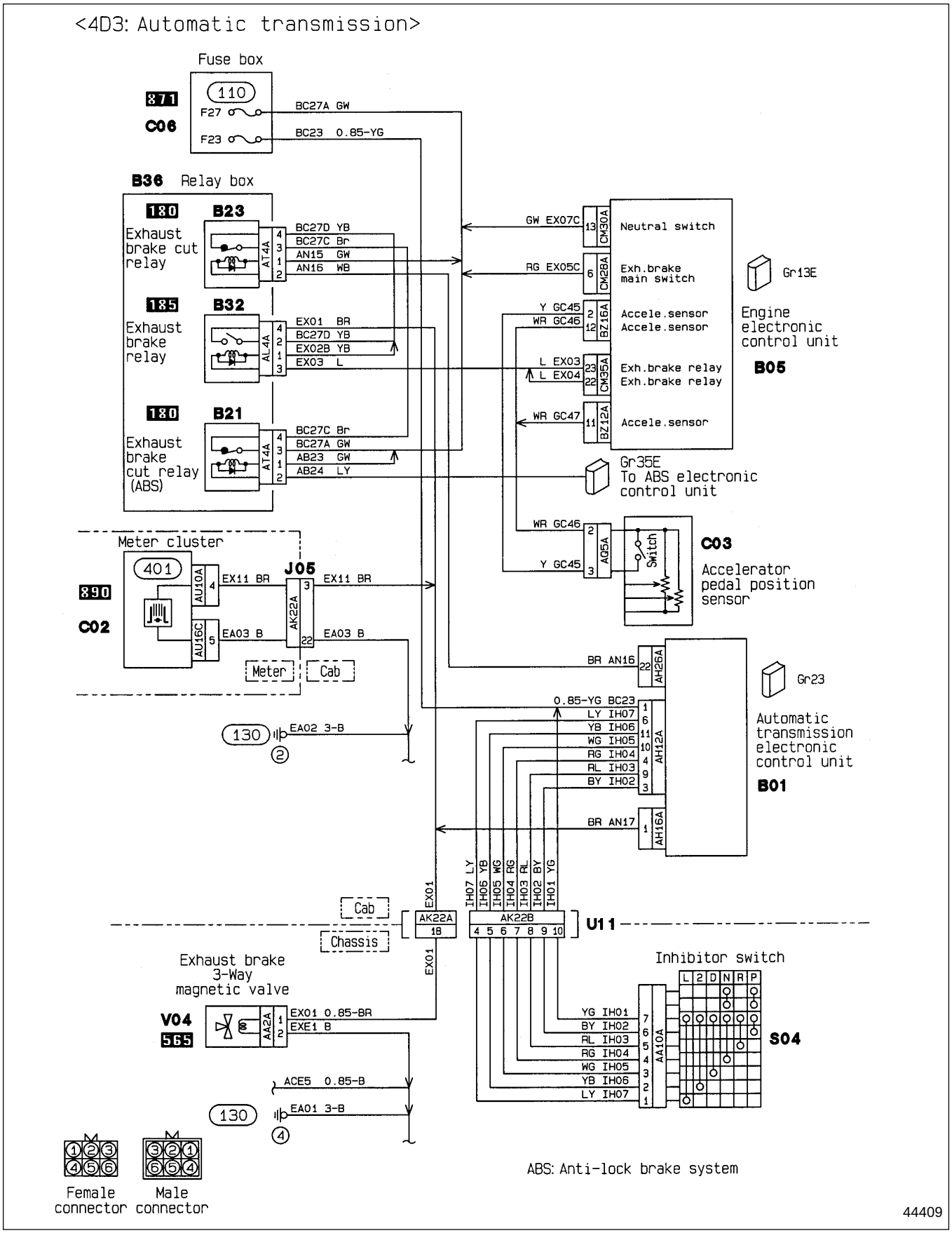

871 C06
Fuse box
110
F 8
F19
BC08 2-O
BC19 GY
U11
2-B ACE2
AN8B
7
ACE2 2-B
3-B EA02
130
4
Chassis
Cab
Door
(RH)
J04
AL3A
2-B PWE1
GY PW01
2-O BC08
PWE1 2-B
PW01 GY
BC08 2-O
J08
AK14A
AK14A
B PWE2
2-Y PW04
2-YR PW06
2-BW PW05
LY PW07
1.25-RL DL05L
1.25-LR DL06L
PW04
PW06
PW05
PW07
DL05
DL06
1.25-RL DL05
1.25-LR DL06
2-B PWE2
2-Y PW04
2-YR PW06
2-BW PW05
LY PW07
2-GW PW03
2-GL PW02
E01 027
Power window switch (RH)
DD8A
P/W SUB GND
SUB SW (+B)
SB (DOWN)
SB (UP)
W/L SW SIG
P/W MOTOR (DOWN)
P/W MOTOR (UP)
Door
(LH)
Cab
Power window motor (LH)
E04 423
CLOSE
OPEN
AL2A
2-GL PW02
2-GW PW03
R
G
Power window motor (RH)
E04 423
CLOSE
OPEN
AL2A
2-GL PW02
2-GW PW03
R
G
AA6A
GL DL02
B DLE1
GR DL01
1.25-LR DL04
1.25-RL DL03
LOCK
UN-LOCK
SW
ACTUATOR
Door lock actuator (LH)
E05 511
Door lock actuator (RH)
AB2A
1.25-RL DL05R
1.25-LR DL06R
ACTUATOR
LOCK
UN-LOCK
E05 510
PW02 2-GL
PW01 2-B
PW01 GY
BC08 2-O
PW03 2-GW
PW04 2-Y
PW06 2-YR
PW05 2-BW
PW07 LY
DL02 GL
DL01 GR
DL04 1.25-LR
DL03 1.25-RL
10 12 7 15 11 9 6 5 8 3 4 13 14
DD15A
P/W MOTOR (UP)
GND
STARTER SW (M)
P/W (+B)
P/W MOTOR (DOWN)
SUB SW (+B)
SB (DOWN)
SB (UP)
W/L SW SIG
DOOR LOCK NOB SW (UNLOCK)
DOOR LOCK NOB SW (LOCK)
D/L ACTUATOR (UNLOCK)
D/L ACTUATOR (LOCK)
E01 027
Power window switch (LH)
P/W: Power window
W/L: Window lock
D/L: Door lock
Female connector
Male connector
44406

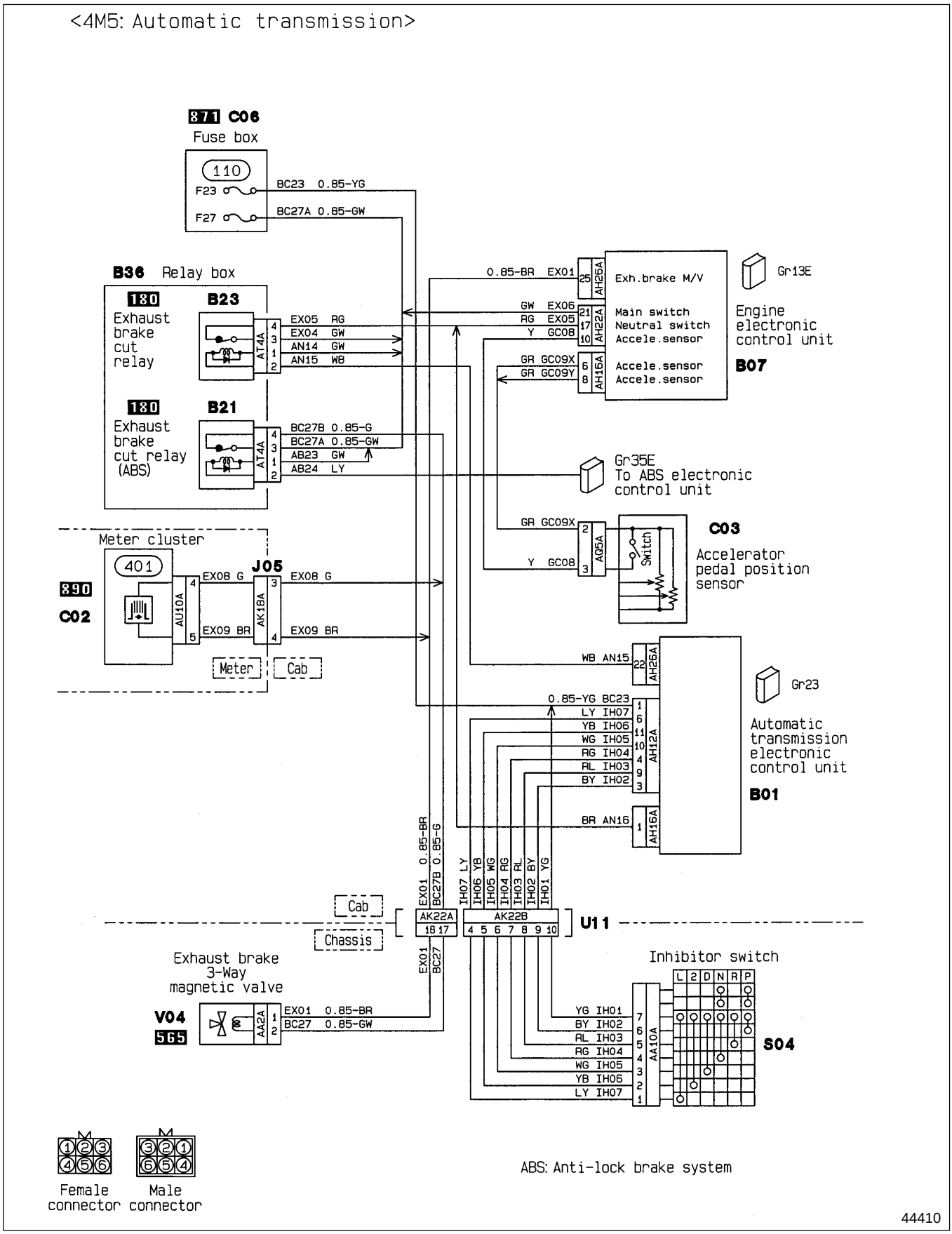
629 MIRROR HEATER CIRCUIT



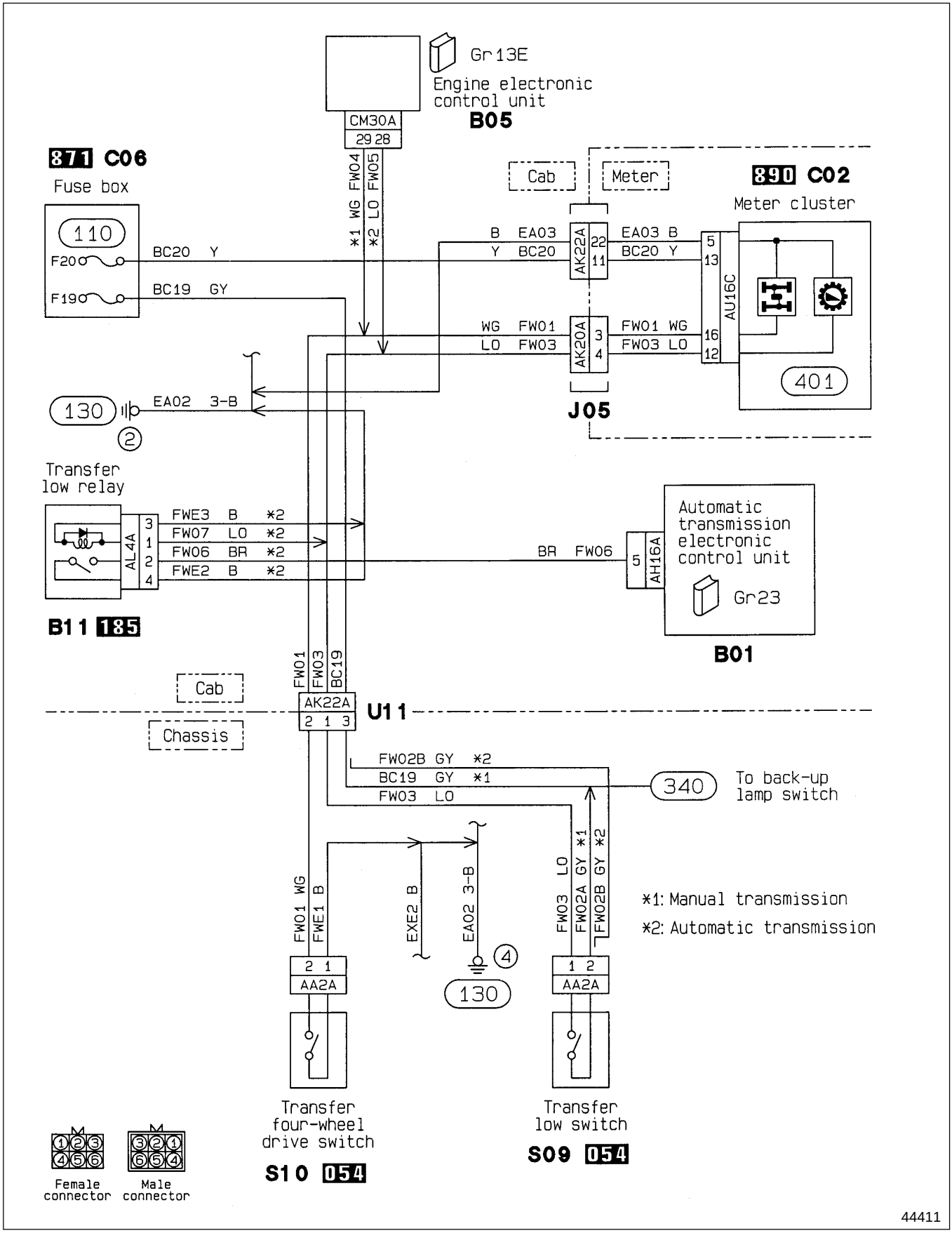
7 CHASSIS SIDE ELECTRICAL CIRCUIT

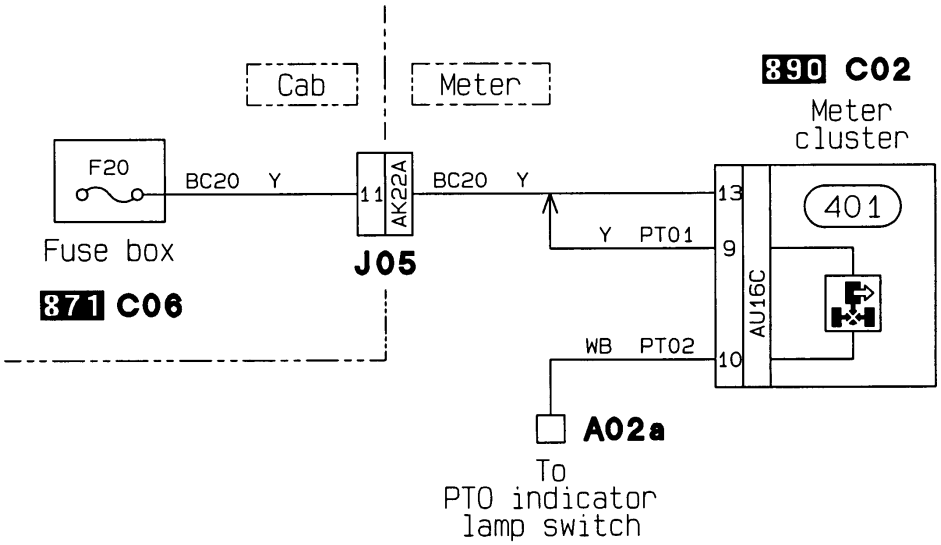

<4D3: Manual transmission>
871 C06
Fuse box
110
F27
BC27A GW
Depressed: ON
Released : OFF
GW EX06A
G EX06B
Clutch A08 031 switch
B36 Relay box
180 B23
Trans-mission neutral relay
EX07B R
EX07A GW
EX08 GW
EX09 L
185 B32
Exhaust brake relay
EX01 BR
BC27B Br
EX02A GW
EX03 L
180 B21
Exhaust brake cut relay (ABS)
BC27B Br
BC27A GW
AB23 GW
AB24 LY
G EX06B
R EX07B
Clutch switch
Neutral switch
RG EX05B
Exh.brake main switch
Y GC45
WR GC46
Accele.sensor
Accele.sensor
L EX03
L EX04
Exh.brake relay
Exh.brake relay
WR GC47
Accele.sensor
Gr13E
Engine electronic control unit
B05
Gr35E
To ABS electronic control unit
Meter cluster
401
890
C02
J05
EX11 BR
EX11 BR
EA03 B
EA03 B
Meter
Cab
WR GC46
Y GC45
C03
Accelerator pedal position sensor
Exhaust brake switch
ON
OFF
Combination switch
001
130
EA02 3-B
B15
Diode
EX09 L
EX10 O
RG EX05B
GW EX05A
EX02 LW
EX01A GR
Cab
Chassis
EA02
EX10
EX01
AN8B
AK22A
17 18
U11
3-B EA02
Transmission neutral switch
S01
056
EX10 O
EXE2 B
Exhaust brake 3-Way magnetic valve
0.85-BR EX01
B EXE1
V04
565
At transmission neutral: switch is ON
130
EA02 3-B
EA01 3-B
ACE5 0.85-B
ABS: Anti-lock brake system
Female connector
Male connector
44408


<4D3: Automatic transmission>
Fuse box
871
C06
110
F27
F23
BC27A GW
BC23 0.85-YG
B36 Relay box
180
B23
Exhaust brake cut relay
AT4A
BC27D YB
BC27C Br
AN15 GW
AN16 WB
185
B32
Exhaust brake relay
AL4A
EX01 BR
BC27D YB
EX02B YB
EX03 L
180
B21
Exhaust brake cut relay (ABS)
AT4A
BC27C Br
BC27A GW
AB23 GW
AB24 LY
GW EX07C
RG EX05C
Y GC45
WR GC46
L EX03
L EX04
WR GC47
CM30A
CM28A
BZ16A
CM35A
BZ12A
Neutral switch
Exh.brake main switch
Accele.sensor
Accele.sensor
Exh.brake relay
Exh.brake relay
Accele.sensor
Gr13E
Engine electronic control unit
B05
Gr35E
To ABS electronic control unit
WR GC46
Y GC45
A05A
Switch
C03
Accelerator pedal position sensor
Meter cluster
401
890
C02
AU10A
AU16C
EX11 BR
EA03 B
J05
AK22A
EX11 BR
EA03 B
Meter
Cab
130
EA02 3-B
BR AN16
AH26A
0.85-YG BC23
LY IH07
YB IH06
WG IH05
RG IH04
RL IH03
BY IH02
AH12A
BR AN17
AH16A
Gr23
Automatic transmission electronic control unit
B01
EX01
IH07 LY
IH06 YB
IH05 WG
IH04 RG
IH03 RL
IH02 BY
IH01 YG
Cab
Chassis
AK22A
18
AK22B
4 5 6 7 8 9 10
U11
Exhaust brake 3-Way magnetic valve
V04
565
AA2A
EX01 0.85-BR
EXE1 B
ACE5 0.85-B
130
EA01 3-B
Inhibitor switch
L 2 D N R P
YG IH01
BY IH02
RL IH03
RG IH04
WG IH05
YB IH06
LY IH07
AA10A
S04
Female connector
Male connector
ABS: Anti-lock brake system
44409


<4M5: Automatic transmission>
871 C06
Fuse box
110
F23
F27
BC23 0.85-YG
BC27A 0.85-GW
B36 Relay box
180
B23
Exhaust brake cut relay
AT4A
EX05 RG
EX04 GW
AN14 GW
AN15 WB
180
B21
Exhaust brake cut relay (ABS)
BC27B 0.85-G
BC27A 0.85-GW
AB23 GW
AB24 LY
0.85-BR EX01
GW EX05
RG EX05
Y GC08
GR GC09X
GR GC09Y
AH26A
AH22A
AH16A
Exh.brake M/V
Main switch
Neutral switch
Accele.sensor
Accele.sensor
Accele.sensor
Gr13E
Engine electronic control unit
B07
Gr35E
To ABS electronic control unit
GR GC09X
Y GC08
AQ5A
Switch
C03
Accelerator pedal position sensor
Meter cluster
401
890
C02
AU10A
J05
AK18A
EX08 G
EX09 BR
Meter
Cab
WB AN15
0.85-YG BC23
LY IH07
YB IH06
WG IH05
RG IH04
RL IH03
BY IH02
BR AN16
AH12A
Gr23
Automatic transmission electronic control unit
B01
Cab
Chassis
AK22A
AK22B
U11
EX01 0.85-BR
BC27B 0.85-G
IH07 LY
IH06 YB
IH05 WG
IH04 RG
IH03 RL
IH02 BY
IH01 YG
Exhaust brake 3-Way magnetic valve
V04
565
AA2A
EX01 0.85-BR
BC27 0.85-GW
EX01
BC27
Inhibitor switch
L 2 D N R P
YG IH01
BY IH02
RL IH03
RG IH04
WG IH05
YB IH06
LY IH07
AA10A
S04
Female connector
Male connector
ABS: Anti-lock brake system
44410

8 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT


Gr13E
Engine electronic control unit
B05
CM30A
29 28
871 C06
Fuse box
110
F20
F19
BC20 Y
BC19 GY
*1 WG FW04
*2 LO FW05
Cab
Meter
890 C02
Meter cluster
B EA03
Y BC20
AK22A
22
11
EA03 B
BC20 Y
5
13
AU16C
WG FW01
LO FW03
AK20A
3
4
FW01 WG
FW03 LO
16
12
401
J05
130
EA02 3-B
2
Transfer low relay
FWE3 B *2
FW07 LO *2
FW06 BR *2
FWE2 B *2
AL4A
3
1
2
4
B11 185
BR FW06
5
AH16A
Automatic transmission electronic control unit
Gr23
B01
FW01
FW03
BC19
Cab
Chassis
AK22A
2 1 3
U11
FW02B GY *2
BC19 GY *1
FW03 LO
340
To back-up lamp switch
FW01 WG
FWE1 B
EXE2 B
EA02 3-B
4
130
FW03 LO
FW02A GY *1
FW02B GY *2
2 1
AA2A
1 2
AA2A
*1: Manual transmission
*2: Automatic transmission
Transfer four-wheel drive switch
S10 054
Transfer low switch
S09 054
Female connector
Male connector
44411

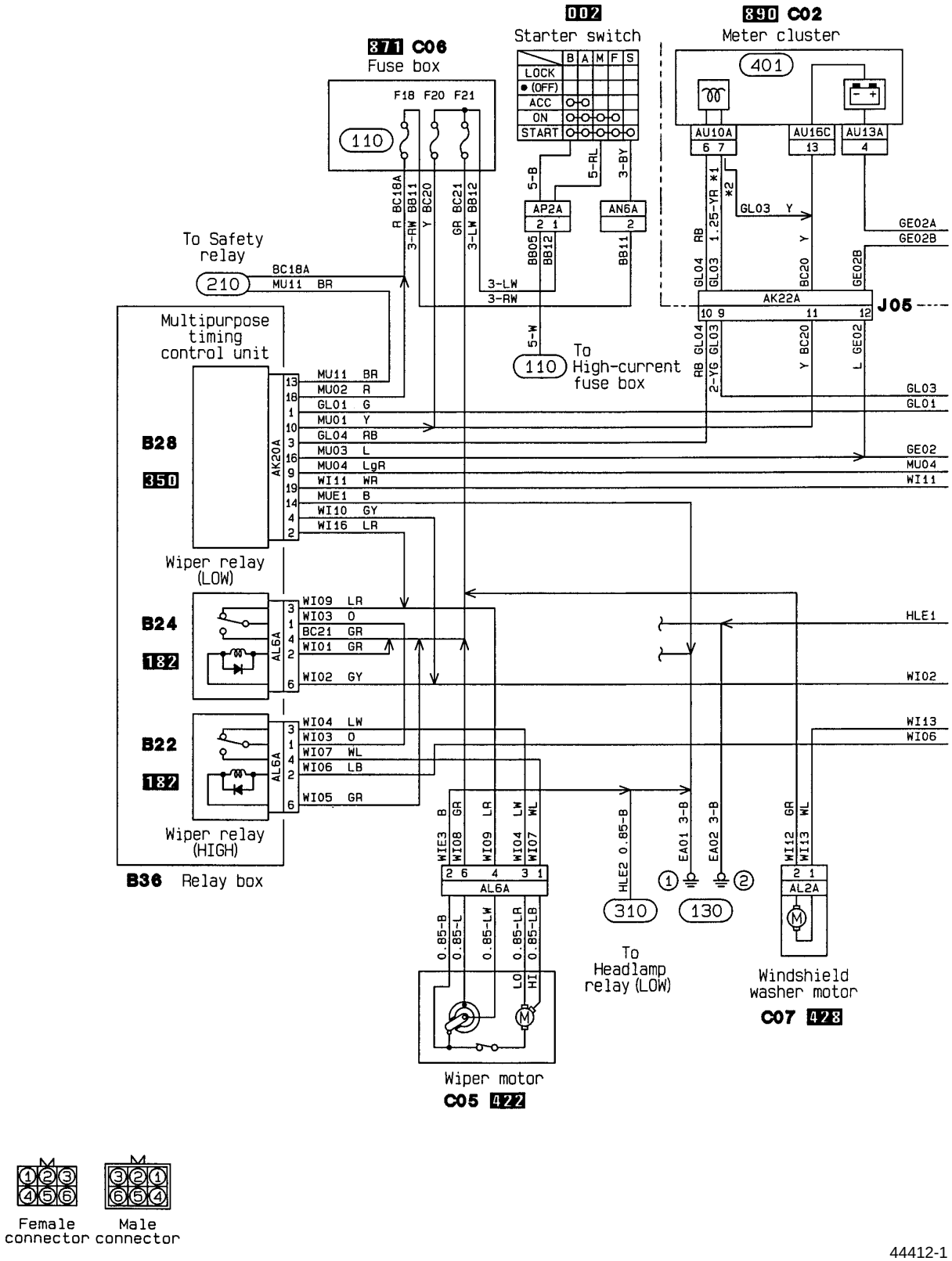


PTO: Power take-off

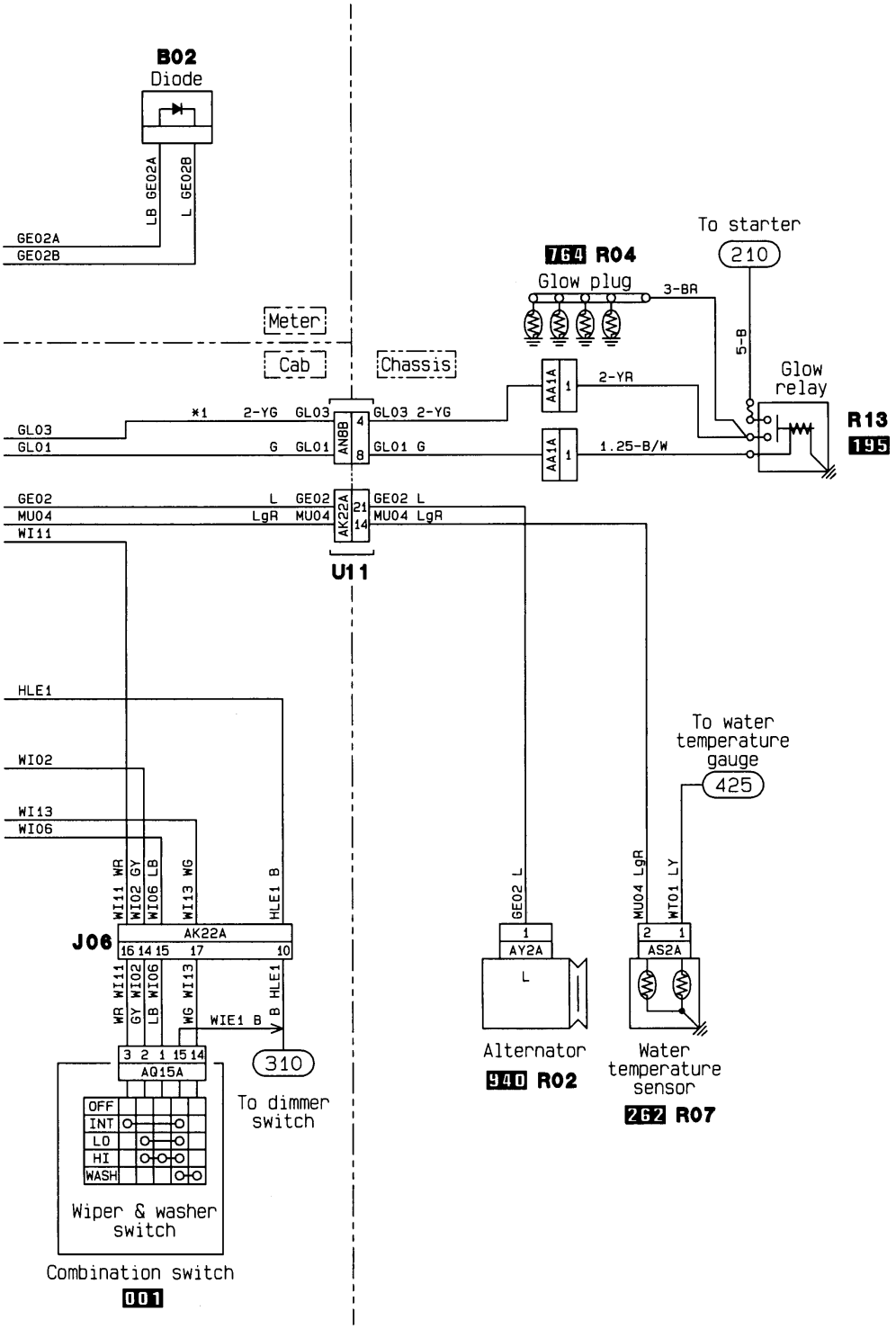
45947

⑨ OTHERS CIRCUIT

910 MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT



44412-1

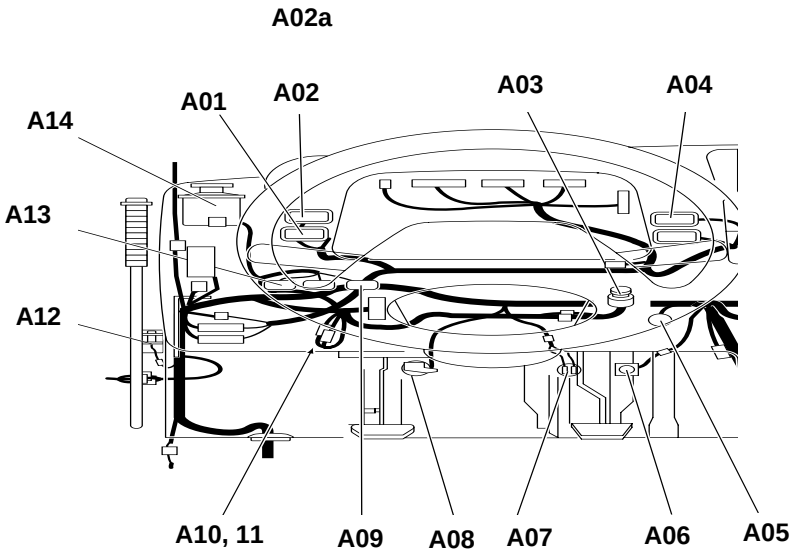

B02
Diode
LB GE02A
L GE02B
GE02A
GE02B
Meter
Cab
Chassis
764 R04
Glow plug
3-BR
To starter
210
5-B
Glow relay
R13
195
AA1A
2-YR
*1
2-YG GL03
GL03 2-YG
GL03
GL01
G GL01
GL01 G
1.25-B/W
AN8B
GE02 L
MU04 LgR
WI11
AK22A
U11
HLE1
WI02
WI13
WI06
To water temperature gauge
425
J06
AK22A
WI11 WR
WI02 GY
WI06 LB
WI13 WG
HLE1 B
WIE1 B
AQ15A
310
To dimmer switch
OFF
INT
LO
HI
WASH
Wiper & washer switch
Combination switch
001
GE02 L
AY2A
Alternator
940 R02
MU04 LgR
WT01 LY
AS2A
Water temperature sensor
262 R07

44412-2

10 PARTS INSTALLATION POSITION

A SWITCH

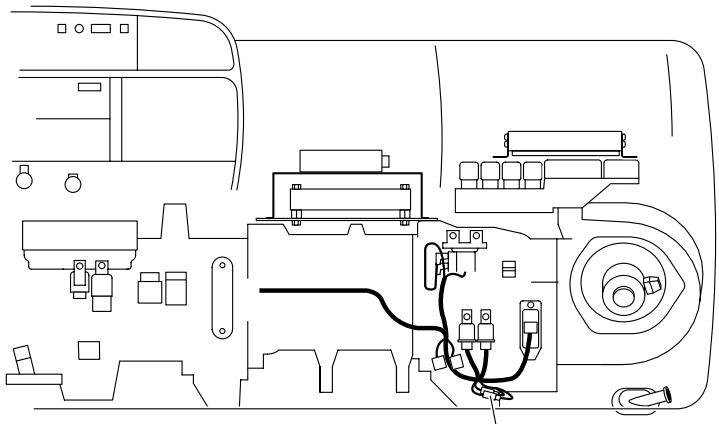
A 01 to 14



A01 Mirror heater switch
A02 Warm-up switch
A02a Transmission power take-off switch connector
A03 Idling speed adjustment potentiometer
A04 Van body dome light switch
A05 Parking brake switch
A06 Emergency engine stop switch < 4M5 >
A07 Stop lamp switch
A08 Clutch switch
A09 Engine oil level check switch
A10 Memory clear switch < Automatic transmission >
A11 Diagnosis switch < Automatic transmission >
A12 Transmission power take-off lever switch
A13 Rheostat switch
A14 Brake fluid level switch

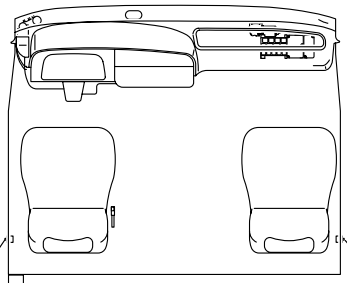
Ⓟ44479

A 20 to 25



A20, 21

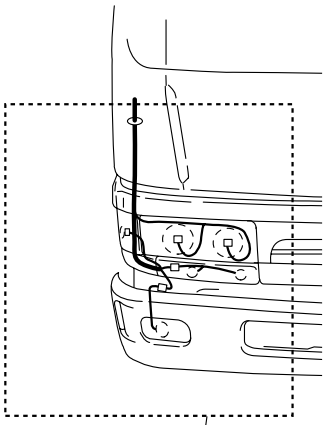
< Except crew cab >



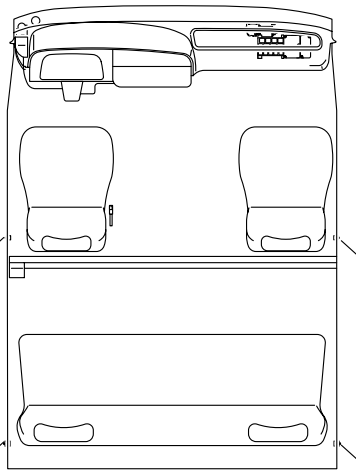
A22

A23

A24



< Crew cab >

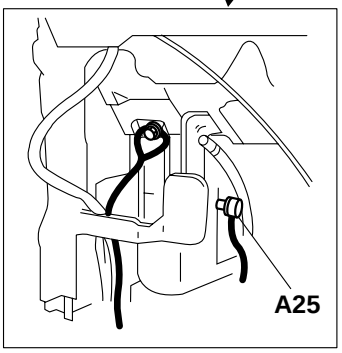


A22
(Front)

A24
(Front)

A22
(Rear)

A24
(Rear)



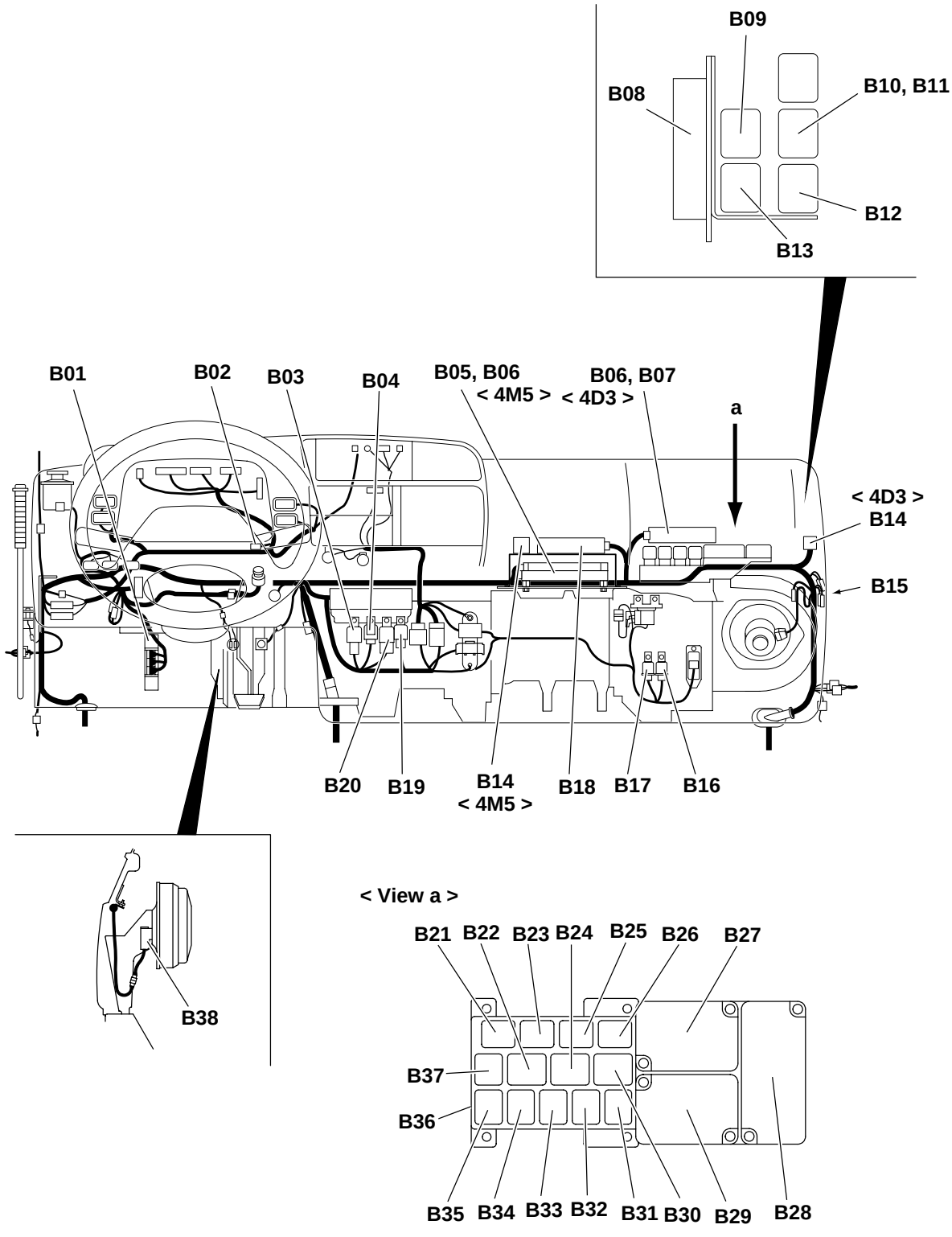
A25

A20 Memory clear switch < Engine control >
A21 Diagnosis switch < Engine control >
A22 Door switch, LH
A23 Cab tilt lock switch
A24 Door switch, RH
A25 Vacuum switch

Ⓟ44480

B RELAY AND ELECTRONIC CONTROL UNIT

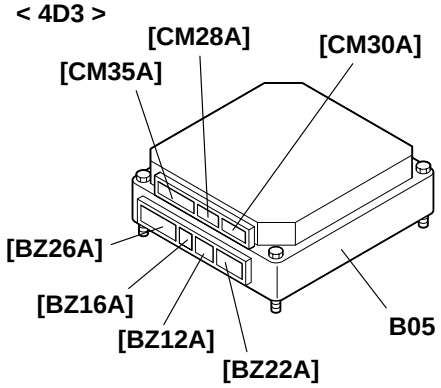
B 01 to 38



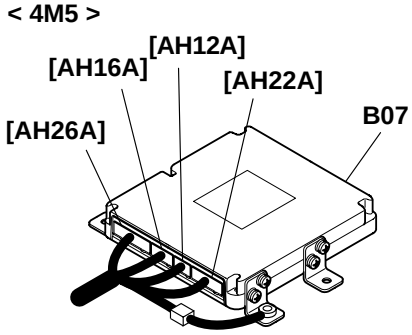
Ⓟ44536

< Engine electronic control unit >

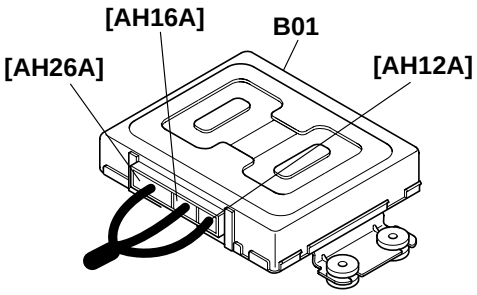
< 4D3 >



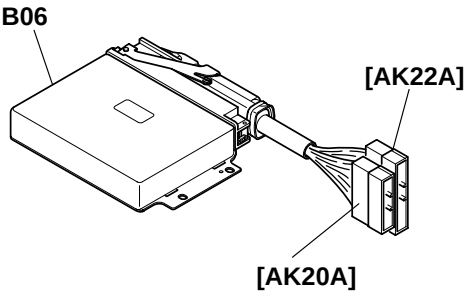
< 4M5 >



< Automatic transmission electronic control unit >



< Anti-lock brake system electronic control unit >



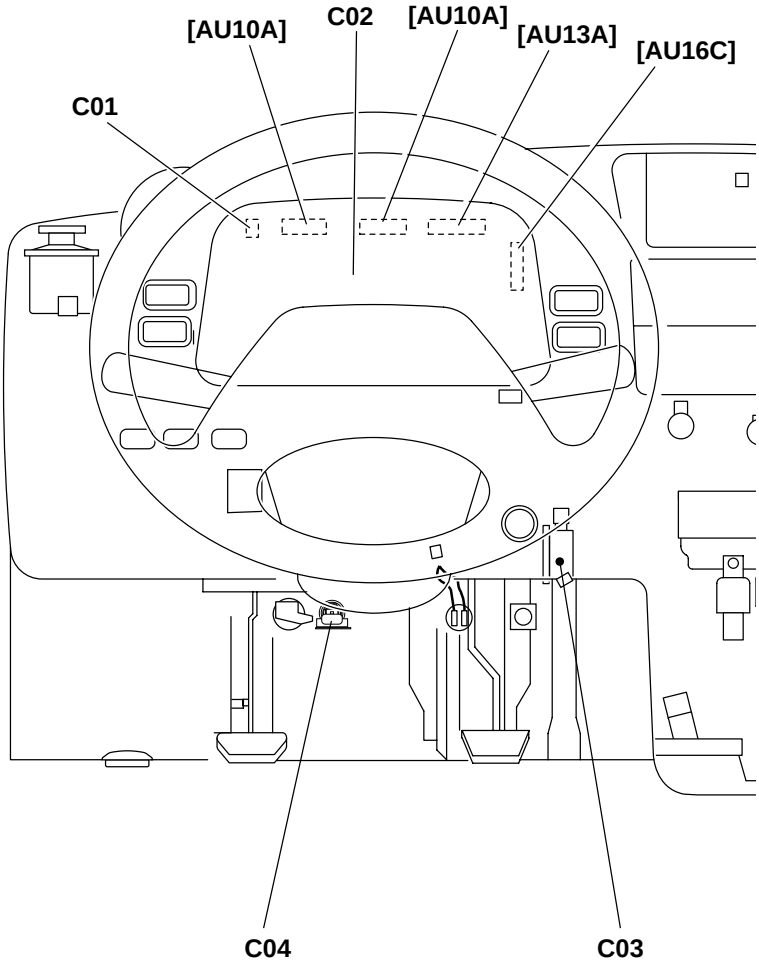
B01 Automatic transmission electronic control unit
B02 Diode
B03 Neutral start relay
B04 Automatic transmission fluid cooler fan relay
B05 Engine electronic control unit < 4D3 >
B06 Anti-lock brake system electronic control unit
B07 Engine electronic control unit < 4M5 >
B08 Electronic drive unit < 4M5 >
B09 Electronic drive unit relay < 4M5 >
B10 Engine electronic control unit main relay < 4M5 >
B11 Transfer low relay < FG >
B12 Turn signal lamp relay
B13 Mirror heater relay
B14 Daytime running light electronic control unit
B15 Diode
B16 Condenser fan relay
B17 Air conditioner relay
B18 Pulse divider
B19 Van body dome light relay
B20 Safety relay
B21 Exhaust brake cut relay < ABS >
B22 Wiper relay (HIGH)
B23 Transmission neutral relay < M/T >
Exhaust brake cut relay < A/T >
B24 Wiper relay (LOW)
B25 Overheating relay
B26 Pre-stroke cut relay
B27 Flasher unit
B28 Multi-purpose timing control unit
B29 Lighting and alarm control unit
B30 Engine oil level relay
B31 Backup lamp relay < A/T >
B32 Exhaust brake relay
B33 Tail lamp relay
B34 Headlamp relay (HIGH)
B35 Headlamp relay (LOW)
B36 Relay box
B37 Blower fan relay
B38 Key interlock control unit

ABS : Anti-lock brake system
A/T : Automatic transmission
M/T : Manual transmission

Indicate by connector type [ ].

Ⓟ44620

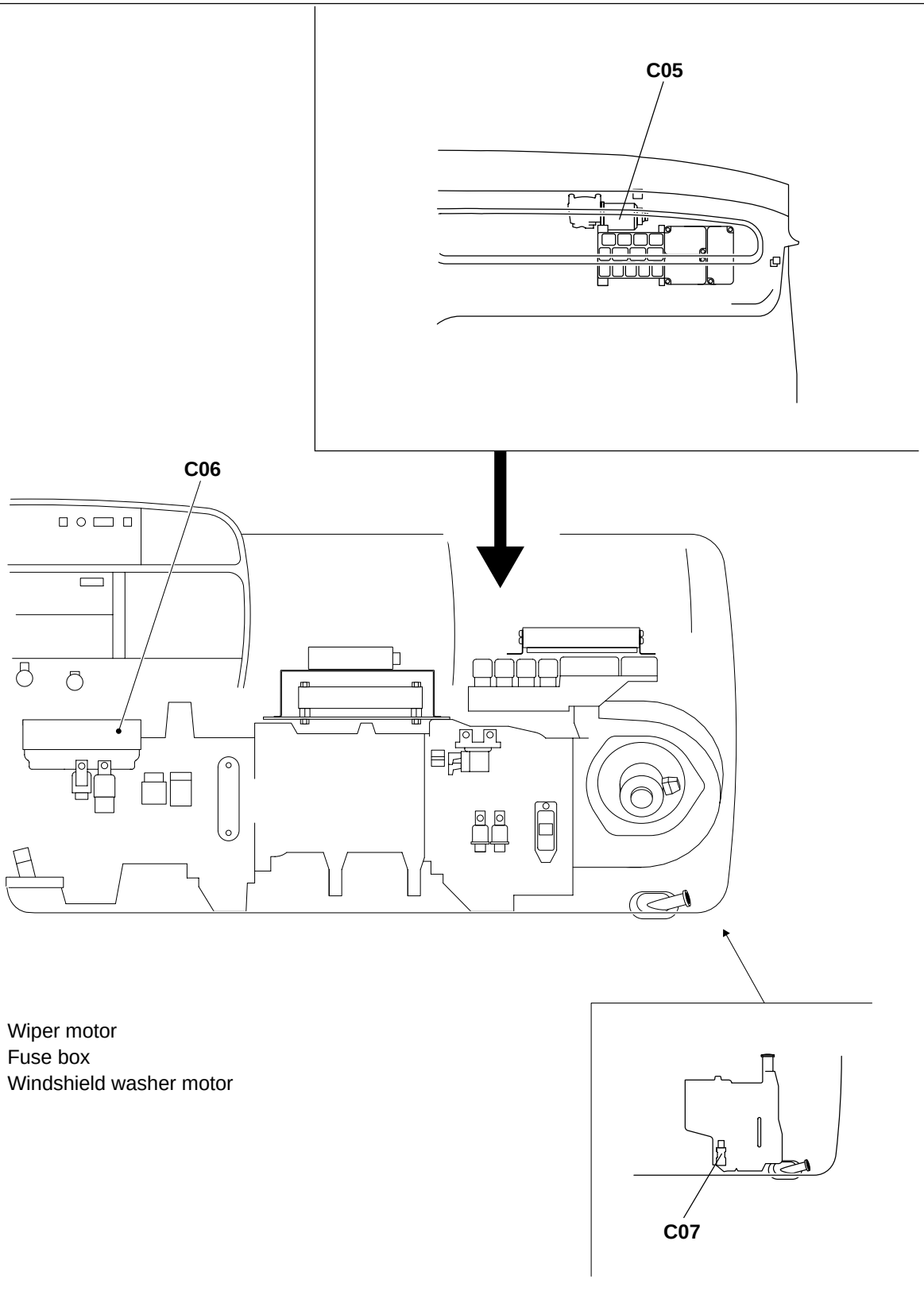
C 01 to 07



C01 Overheating warning buzzer
C02 Meter cluster
C03 Accelerator pedal position sensor
C04 G sensor < FG >

[ ]: Meter connector

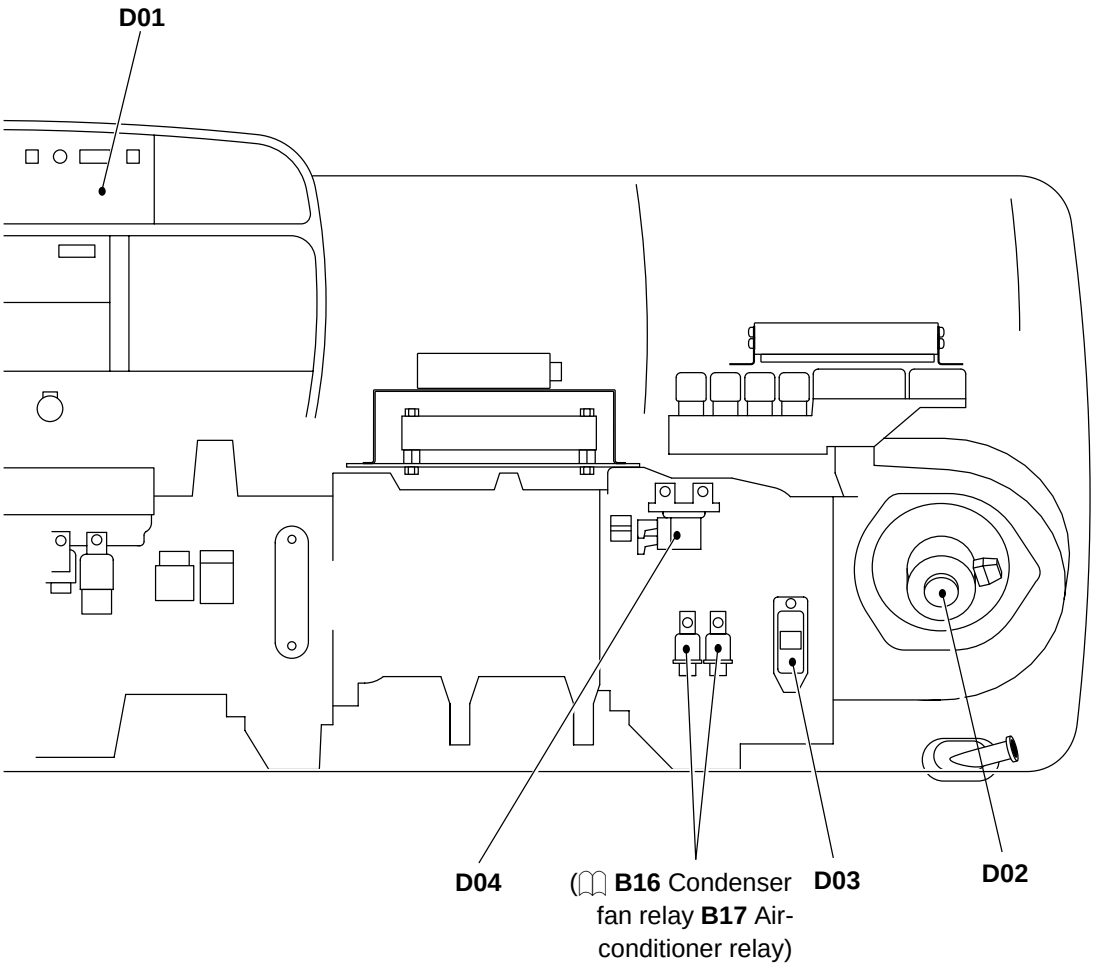
Ⓟ44538



C05 Wiper motor
C06 Fuse box
C07 Windshield washer motor

Ⓟ42963

D 01 to 04

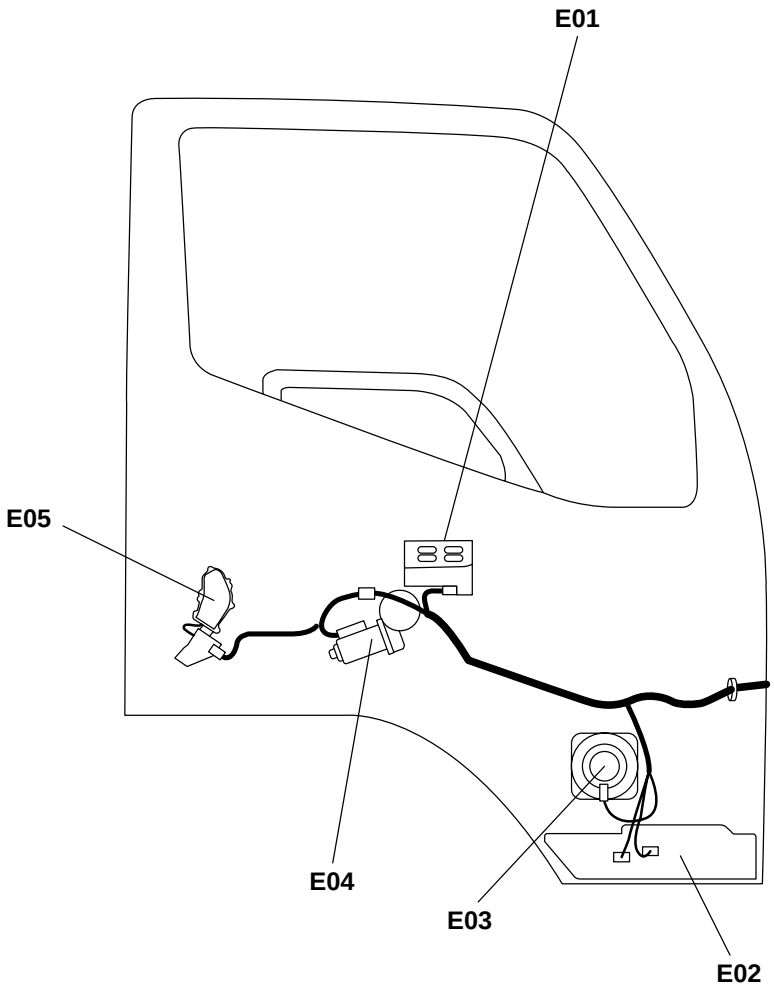


D01 Heater control assembly
D02 Blower motor
D03 Blower resistor
D04 Thermostat

Ⓟ42878

M E M O

E 01 to 05



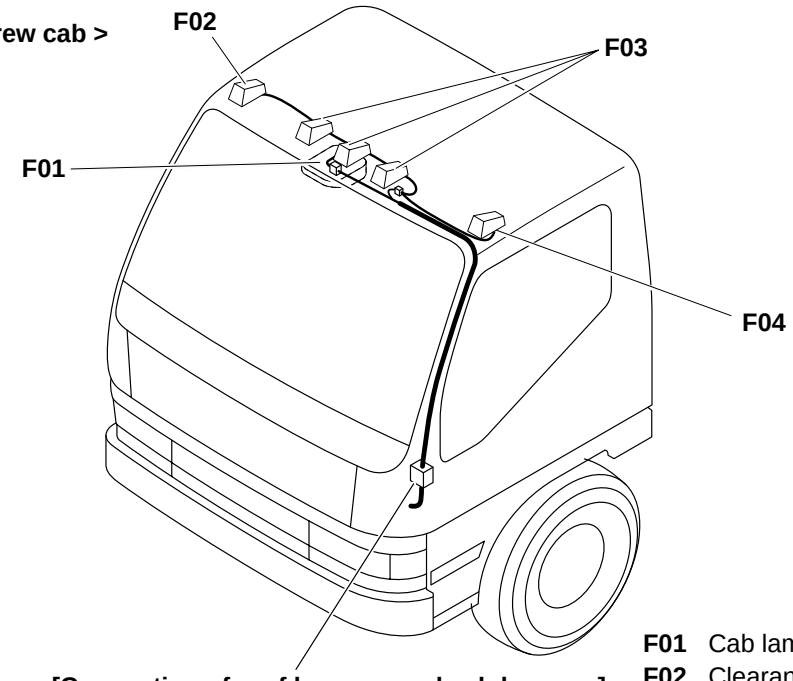
* This illustration show the left side door, the right side door is symmetrical.

E01 Power window switch
E02 Side turn signal lamp
E03 Door speaker
E04 Power window motor
E05 Door lock actuator

Ⓟ42800

F 01 to 06

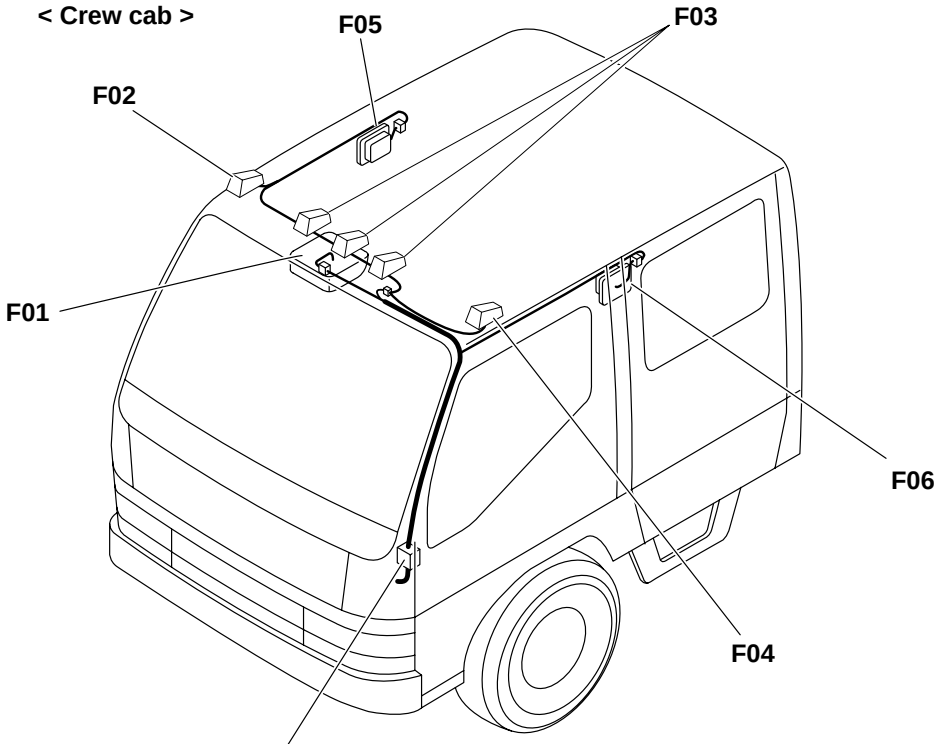
< Except crew cab >



[Connection of roof harness and cab harness]
(📖 J01)

F01 Cab lamp
F02 Clearance and side marker lamp, RH
F03 Identification lamp
F04 Clearance and side marker lamp, LH
F05 Rear cab lamp, RH
F06 Rear cab lamp, LH

< Crew cab >

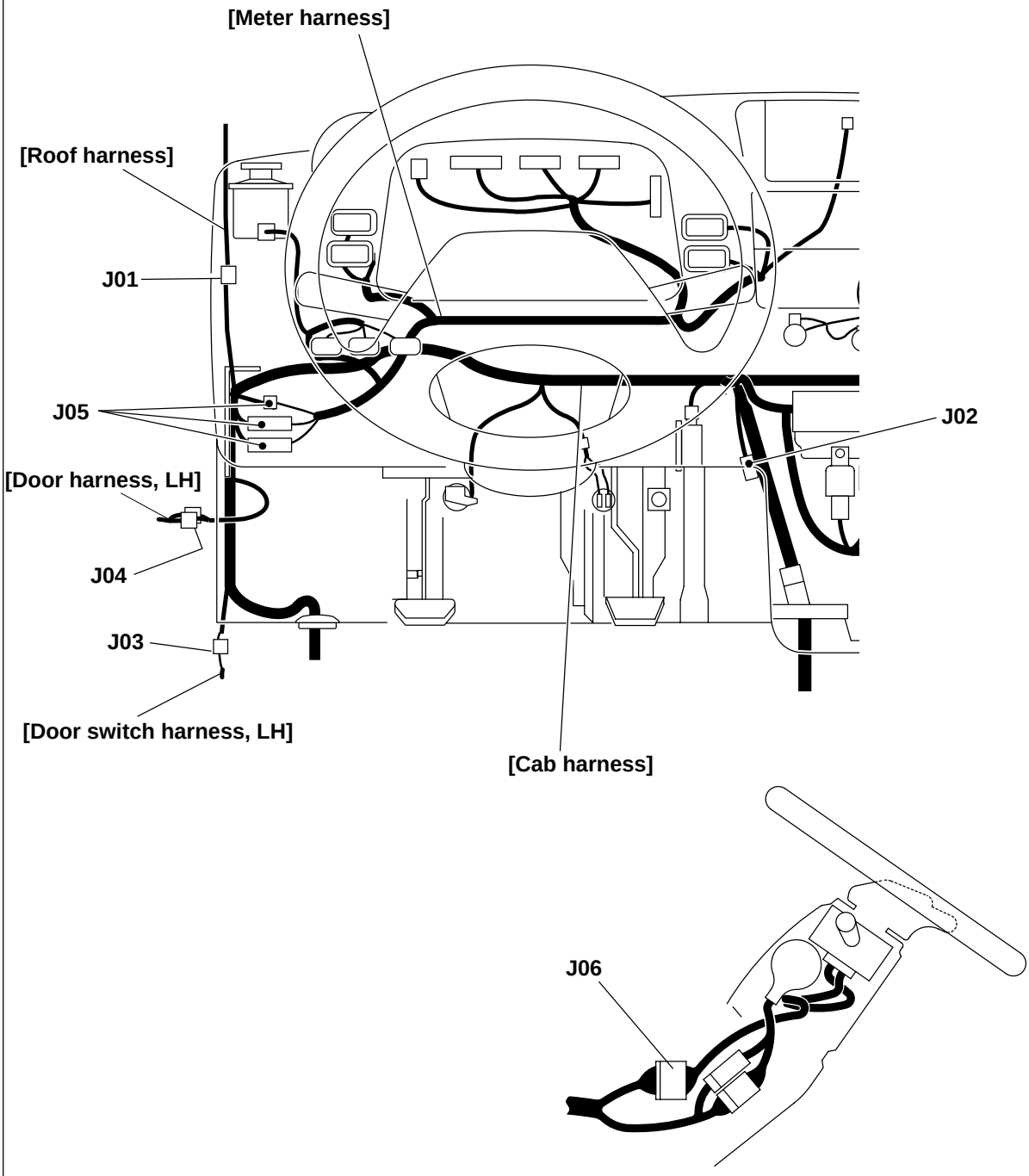


[Connection of roof harness and cab harness]
(📖 J01)

Ⓟ44550

J JOINT OF MAIN HARNESS CONNECTORS

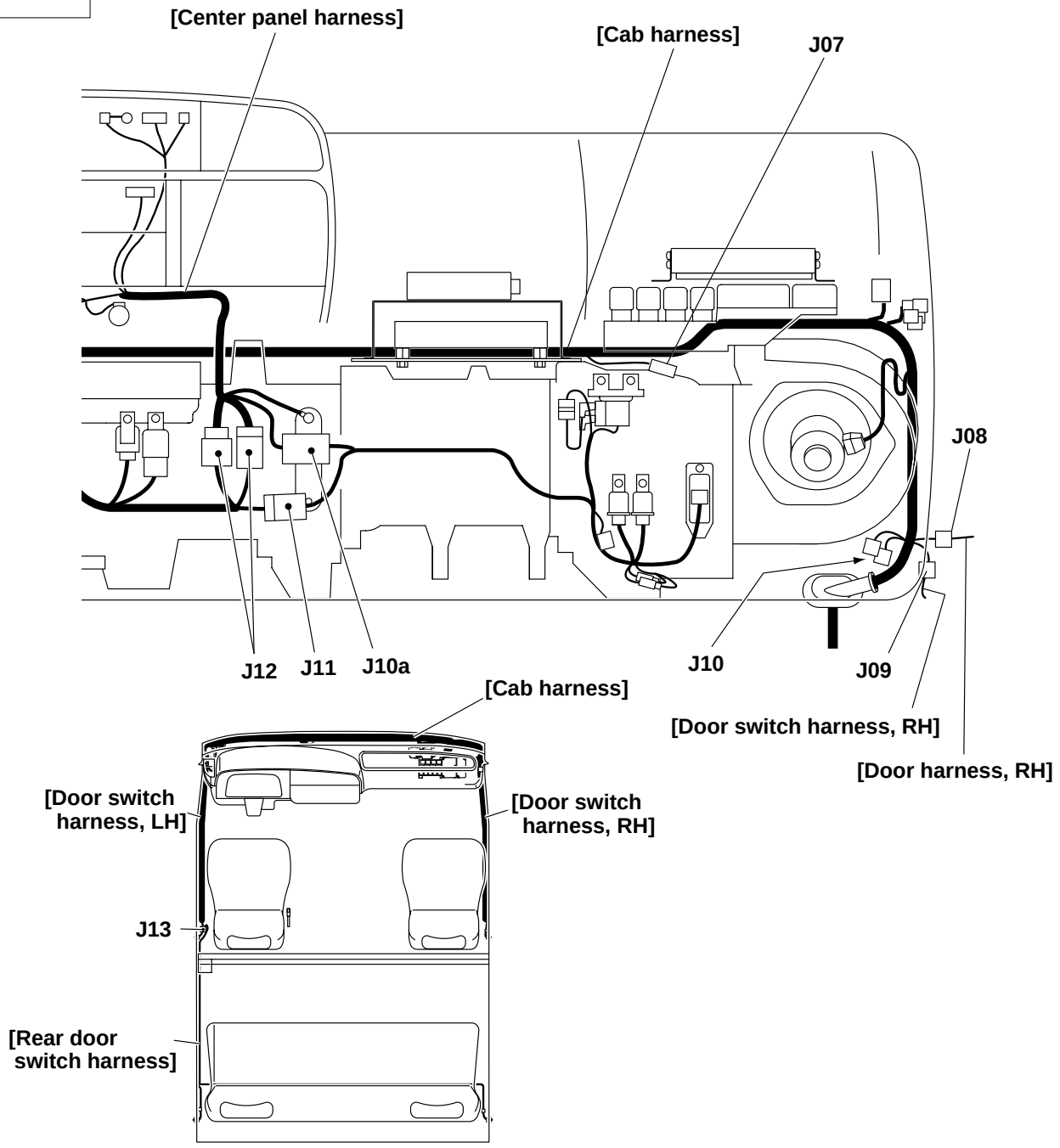
J 01 to 06



J01 Connection of cab harness and roof harness
J02 Optional connector (6pin)
J03 Connection of cab harness and door switch harness, LH
J04 Connection of cab harness and door harness, LH
J05 Connection of cab harness and meter harness
J06 Connection of cab harness and column harness

Ⓟ44554

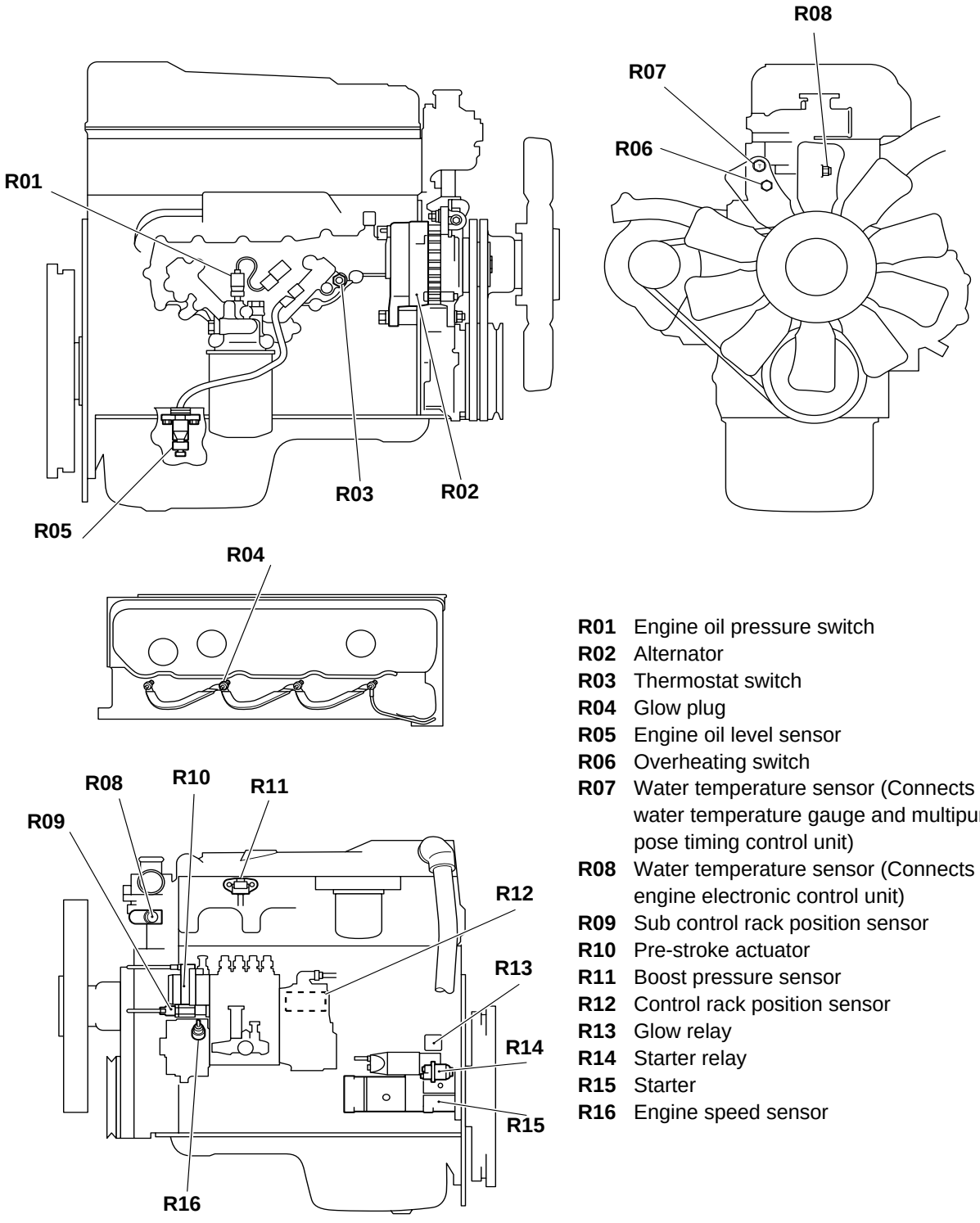
J 07 to 13



J07 Connection of cab harness and automatic transmission harness
J08 Connection of cab harness and door harness, RH
J09 Connection of cab harness and door switch harness, RH
J10 Multi use tester-II connector
J10a Connection of heater harness and center panel harness
J11 Connection of cab harness and heater harness
J12 Connection of cab harness and center panel harness
J13 Connection of door switch harness, LH and rear door switch harness

Ⓟ44555

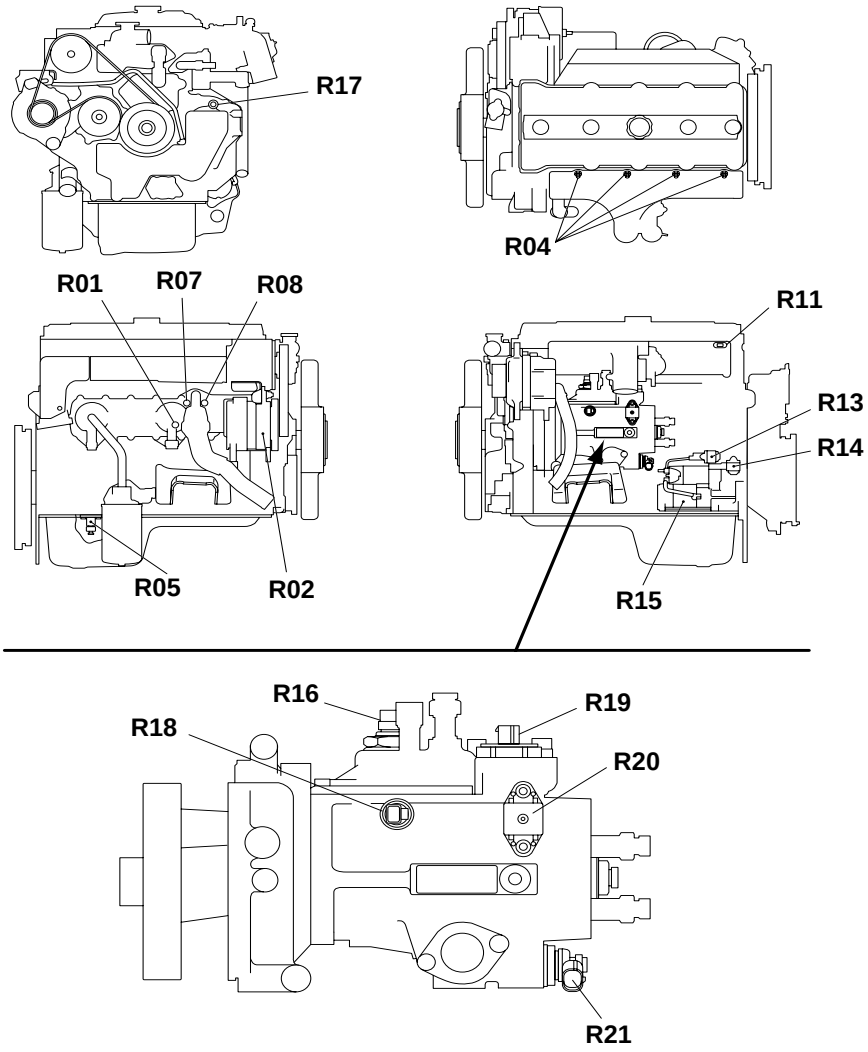
R 01 to 21 **< 4D3 >**



R01 Engine oil pressure switch
R02 Alternator
R03 Thermostat switch
R04 Glow plug
R05 Engine oil level sensor
R06 Overheating switch
R07 Water temperature sensor (Connects to water temperature gauge and multipurpose timing control unit)
R08 Water temperature sensor (Connects to engine electronic control unit)
R09 Sub control rack position sensor
R10 Pre-stroke actuator
R11 Boost pressure sensor
R12 Control rack position sensor
R13 Glow relay
R14 Starter relay
R15 Starter
R16 Engine speed sensor

Ⓟ44656

< 4M5 >



No relevant parts in a missing number

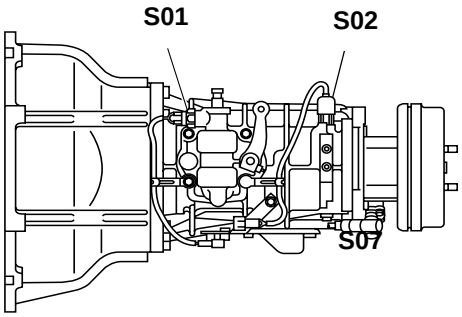
R17 Top dead center speed sensor
R18 Fuel temperature sensor
R19 Spil valve
R20 Fuel injection rate adjustment read only memory
R21 Timer control valve

Ⓟ41180

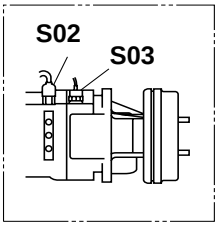
S 01 to 10

< Manual trasmission >

Upper view

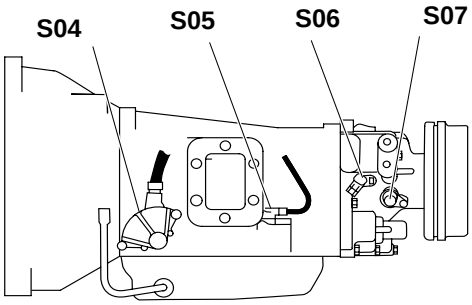


< FG >

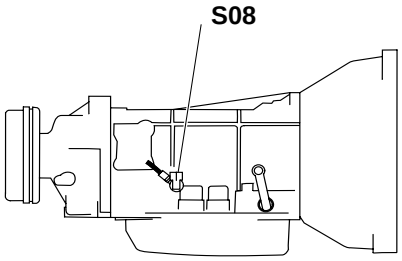


< Automatic transmission >

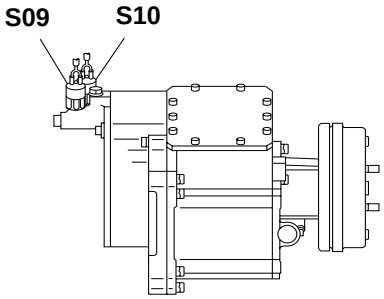
Left side view



Right side view



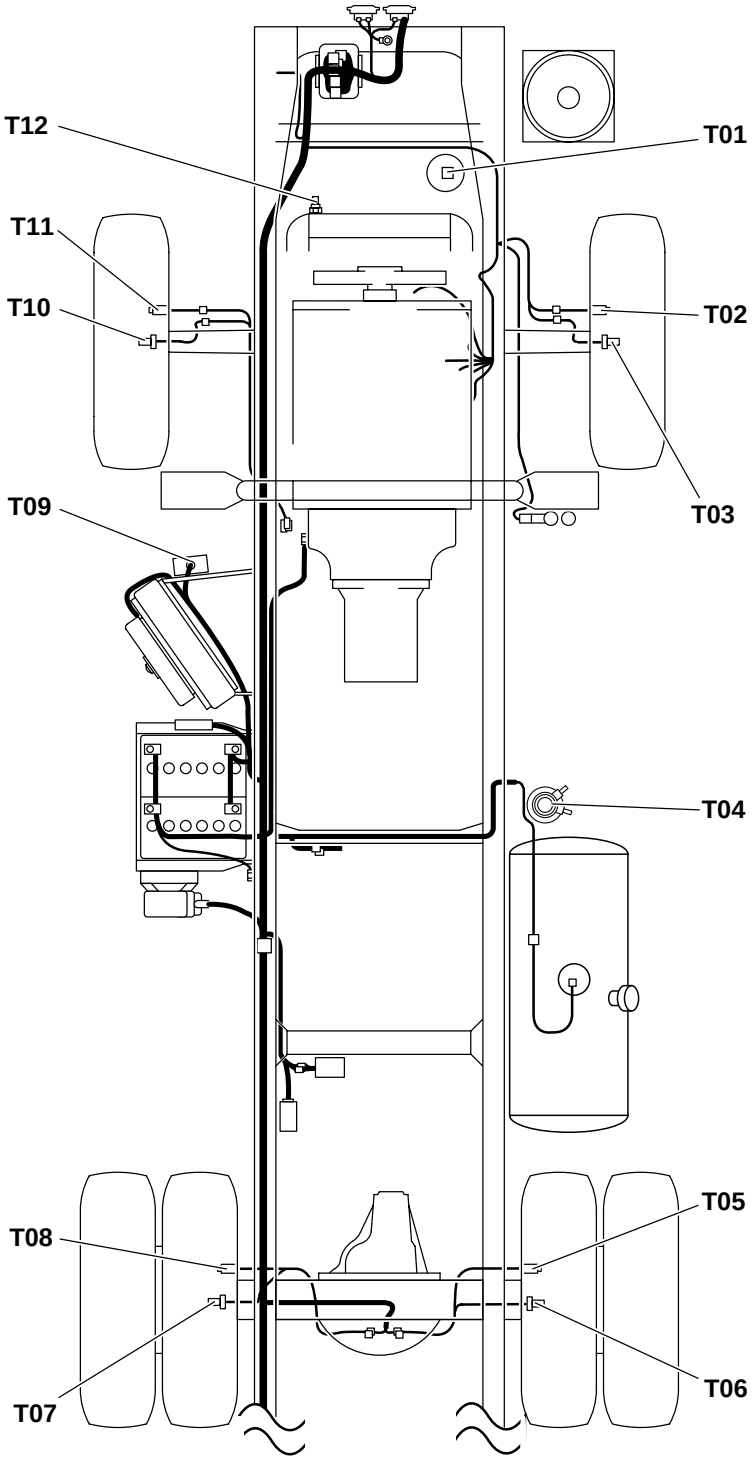
< Transfer >



S01 Transmission neutral switch
S02 Backup lamp switch
S03 First/reverse check switch
S04 Inhibitor switch
S05 Automatic transmission terminal to solenoid and temperature sensor
S06 Vehicle speed sensor < Automatic transmission >
S07 Vehicle speed sensor
S08 Automatic transmission fluid thermo switch
S09 Transfer low switch
S10 Transfer four-wheel drive switch

Ⓟ44655

T 01 to 12

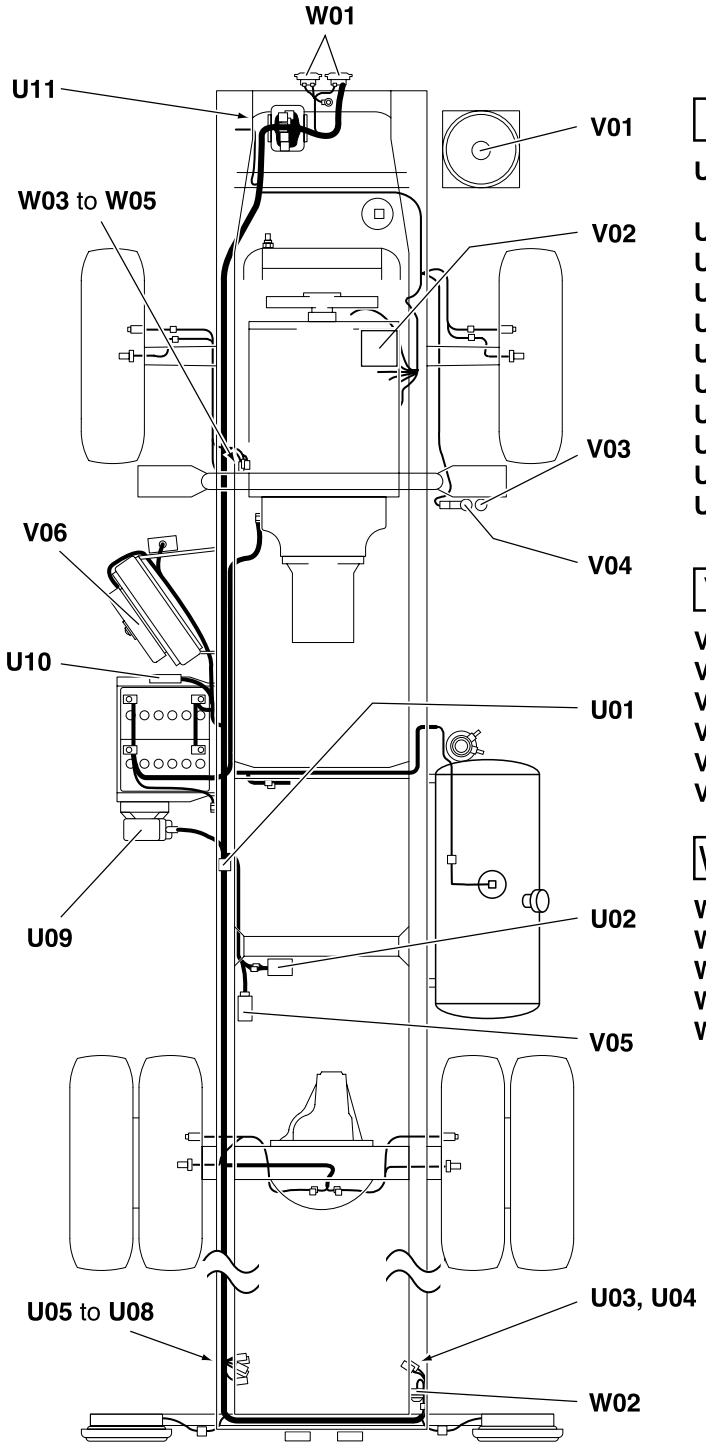


T01 Dual pressure switch connector
T02 Front brake pad wear indicator, RH
T03 Front wheel speed sensor, RH
T04 Water separator sensor
T05 Rear brake pad wear indicator, RH
T06 Rear wheel speed sensor, RH
T07 Rear wheel speed sensor, LH
T08 Rear brake pad wear indicator, LH
T09 Automatic transmission fluid cooler fan thermo switch
T10 Front wheel speed sensor, LH
T11 Front brake pad wear indicator, LH
T12 Boost temperature switch

Ⓟ44682

U BATTERY, FUSE AND CONNECTOR V MAGNETIC VALVE, MOTOR AND ACTUATOR W BUZZER AND LAMP

U 01 to 11 | V 01 to 06 | W 01 to 05



U

U01 Connection of chassis harness and rear chassis harness
U02 Relay box < Anti-lock brake system >
U03 Rear clearance lamp connector, RH
U04 Rear side marker lamp connector, RH
U05 Rear identification lamp connector
U06 Rear clearance lamp connector, LH
U07 Rear side marker lamp connector, LH
U08 Rear van body dome light connector
U09 High-current fuse box
U10 Main high-current fuse box
U11 Connection of chassis harness and cab harness

V

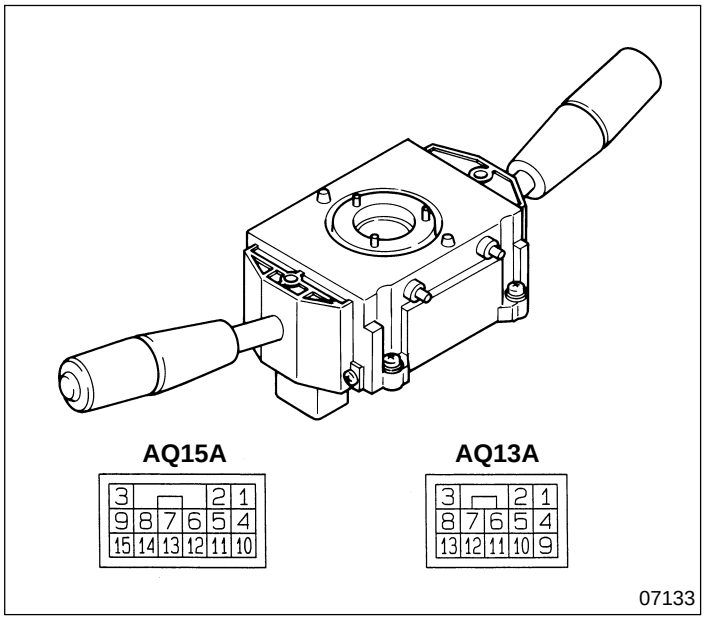
V01 Side condenser fan motor
V02 Magnetic clutch
V03 Intake silenser 3-way magnetic valve < 4M5 >
V04 Exhaust brake 3-way magnetic valve
V05 Hydraulic unit < Anti-lock brake system >
V06 Automatic transmission fluid cooler fan motor

W

W01 Electric horn
W02 Back buzzer
W03 Front van body dome light connector
W04 Front identification lamp connector
W05 Front clearance lamp connector

Ⓟ44683

11 INSPECTION OF PARTS



001 Inspection of combination switch

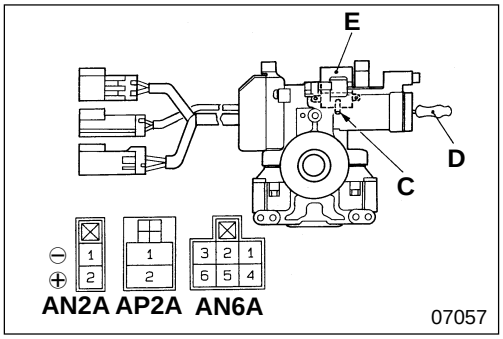
- Follow the table below to check for continuity.
  ○—○ : There is continuity between terminals.
- If any fault is found, replace the switch.

AQ13A Connector connection table

		①	②	③	⑦	⑧	⑨	⑩	⑪	Body ground	Internal connection
Lighting switch	OFF										
	I	○						○			
	II	○						○			○
Dimmer switch	Main						○				○
	↕						○		○		○
	Dimmer								○		○
	↕	○					○		○		○
	Passing	○					○				
Turn signal switch	LH			○	○						
	N (neutral)										
	RH			○		○					
Horn switch	OFF										
	ON		○							○	

AQ15A Connector connection table

		①	②	③	⑤	⑥	⑦	⑧	⑨	⑭	⑮
Wiper switch	OFF										
	INT (intermittent)			○							○
	LO (LOW)		○								○
	HI (HIGH)	○	○								○
	WASH (washer)									○	○
Exhaust brake switch	OFF										
	ON				○	○					
Hazard switch	OFF										
	ON						○	○	○		



002 Inspection of starter switch

- Follow the table below to check for continuity.
- If any fault is found, replace the switch. Gr 37

(1) Inspection of continuity

	AP2A		AN6A		
	②	①	③	④	②
LOCK					
• (OFF)					
ACC	○		○		
ON	○	○	○	○	
START	○	○		○	○
	B	M	A	F	S

○—○ : There is continuity between terminals.

(2) Inspection of key interlock solenoid <automatic transmission>

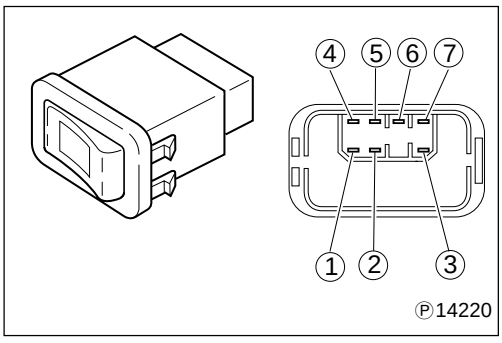
	AN2A ①	AN2A ②	LOCK	ACC	ON	START	Condition of plunger C
Motion of Starter	⊖	⊕		←	—	→	Plunger C is locked and starter key D cannot be pulled out
Key D				←	—	→	Plunger C is free and starter key D can be pulled out

⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

E : Key interlock solenoid

011 Inspection of rheostat switch

- Rheostat switch contains a control circuit, because of this it is difficult to inspect rheostat switch independently, therefore you should inspect the rheostat switch indirectly, by inspecting the system harness and the related parts.
- If no fault is found in the related parts but the system is faulty, replace the switch.



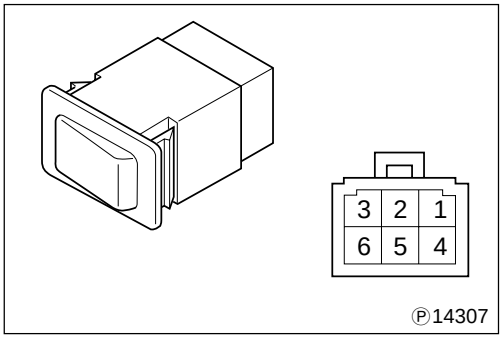
012 Inspection of warm-up switch

- Follow the table below to check for continuity.

	①	⑤
ON	○	○
OFF		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



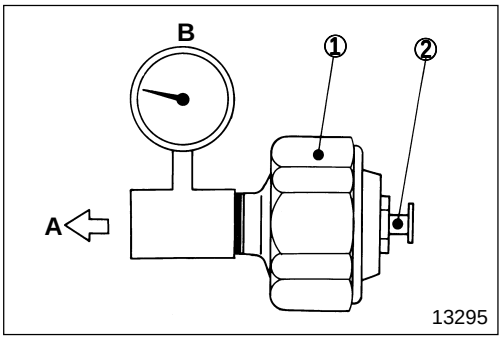
020 Inspection of engine oil level check switch

- Follow the table below to check for continuity.

	①	③
ON (CHECK)	○—○	
OFF		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



023 Inspection of vacuum switch

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying vacuum

Make sure that if there is no continuity between terminals ① and ② (body).

(2) Inspection by applying vacuum

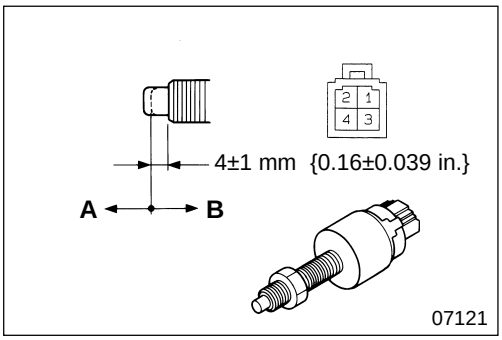
- Gradually apply vacuum **A** to vacuum switch starting from 0 kPa {0 in.Hg, 0 mmHg}.
- Measure the degree of vacuum at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets to the standard.

B: Vacuum gauge

Standard value	$-(47^{+3.3}_{-4.0})$ kPa {$-(13.8^{+0.98}_{-1.18})$ in.Hg, $-(350^{+25}_{-30})$ mm Hg }

027 Inspection of power window switch, and power window and auto door lock switch

- Switch contains a control circuit, because of this is difficult to inspect switches independently, therefore you should inspect the system harness, power window motor, door lock actuator etc. the related parts.
- If no fault is found in the related parts but the system is faulty, replace switches.



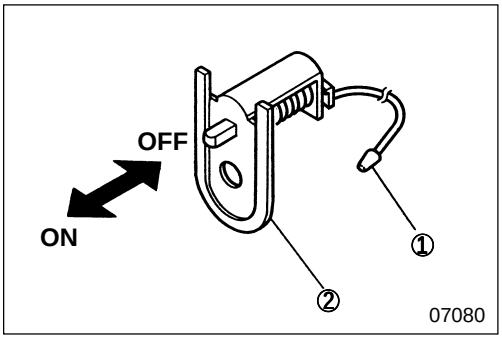
031 Inspection of clutch switch

- Follow the table below to check for continuity.

	①	②	③	④
A	○			○
B		○	○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 21



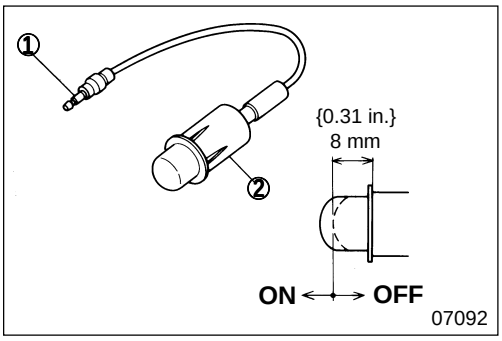
035 Inspection of door switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 42



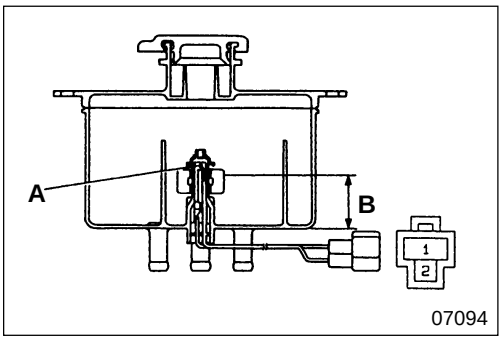
038 Inspection of parking brake switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 36



041 Inspection of brake fluid level switch

- Remove brake fluid slowly from fluid tank assembly.

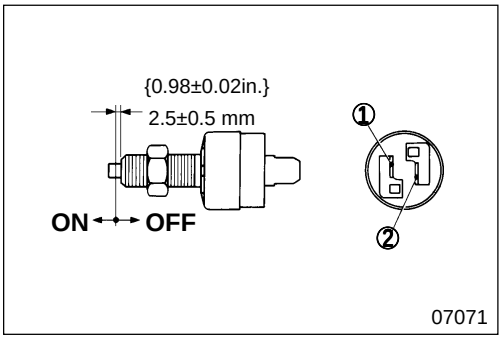
CAUTION ⚠

If brake fluid gets on a painted surface it will dissolve the paint, so wipe it off immediately.

- Measure the height **B** of switch **A** when the continuity is detected between terminals ① and ②.

Standard value	41.0±3 mm {1.61±0.12 in.} (equivalent to 120cm³ {7.32 cu.in., 0.12L})

- If the measured value deviates from the standard value, replace the brake fluid tank assembly. Gr 42



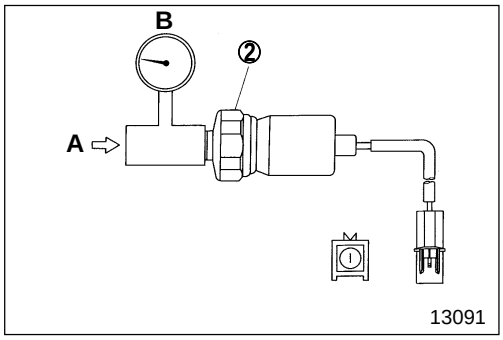
042 Inspection of stop lamp switch

- Follow the table below to check for continuity.

	①	②
ON	○—○	
OFF		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 35A



044 Inspection of engine oil pressure switch

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying air pressure

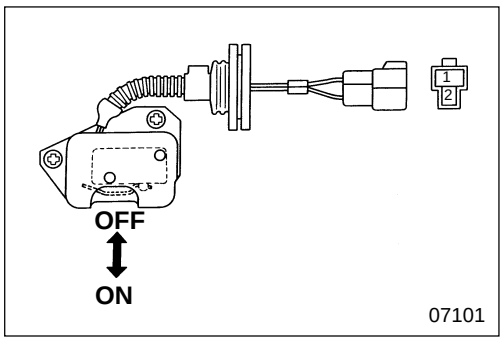
Make sure that there is continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	49±9.8 kPa {7.1±1.4 psi, 0.5 ± 0.1 kgf/cm²}



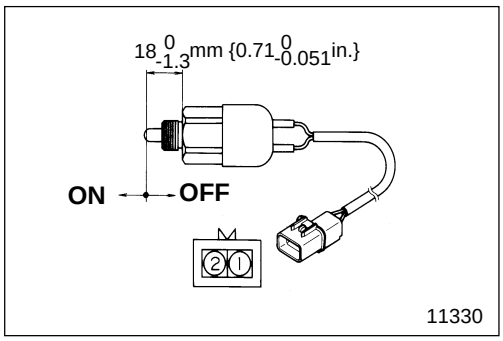
045 Inspection of cab tilt lock switch

- Follow the table below to check for continuity.

	①	②
ON	○—○	
OFF		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



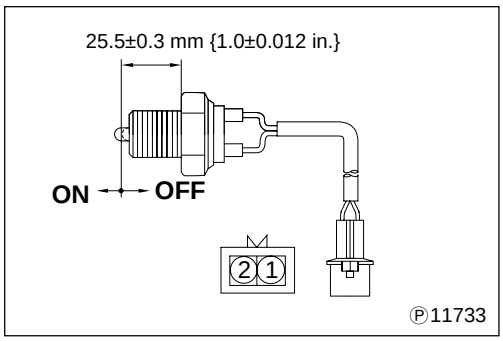
054 Inspection of switch

- Backup lamp switch
- Transfer low switch
- Transfer four-wheel drive switch
  - Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



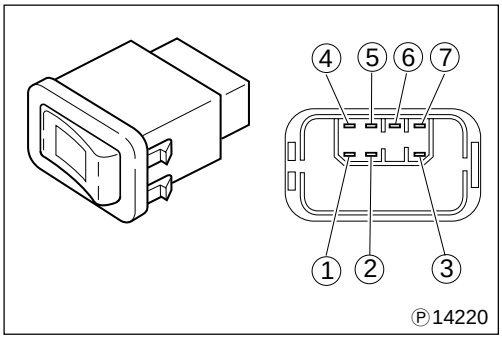
056 Inspection of transmission neutral switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 22



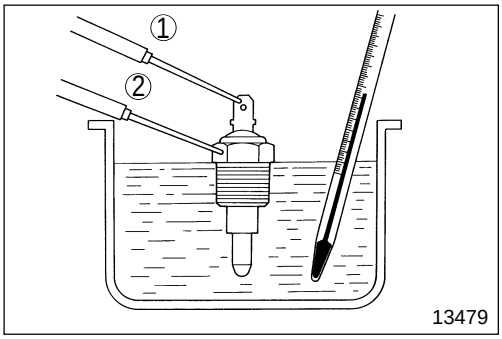
087 Inspection of van body dome light switch

- Follow the table below to check for continuity.

	①	⑤	⑦	LED (Operation indication light	③
ON	○—○		○	⟋⟍⟋ ▷|	○
OFF					

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.

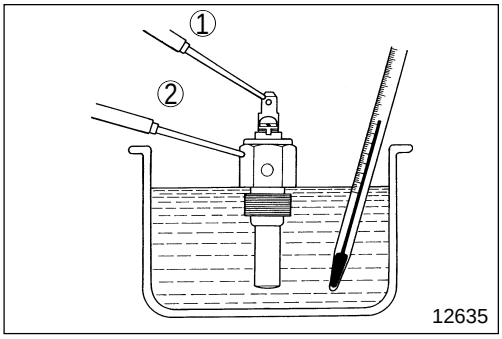


088 Inspection of thermostat switch

- Place the switch in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the operating temperature between terminals ① and ② (body) respectively.

Standard Value	When temperature increase (ON→OFF)	77±3°C {170±37°F}
	When temperature decrease (OFF→ON)	70°C {158°F}

- If the measured value deviates from the standard value, replace the switch. Gr 12

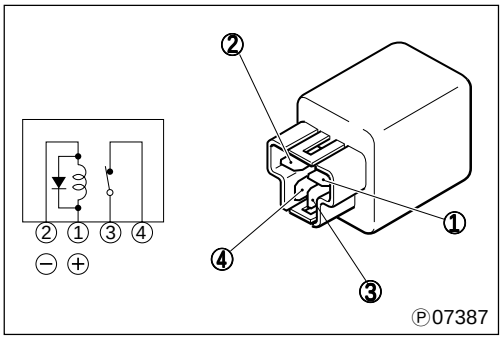


160 Inspection of overheating switch

- Place the switch in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the operating temperature between terminals ① and ② (body) respectively.

Standard Value	When temperature increase (ON→OFF)	110±2°C {230±36°F}
	When temperature decrease (OFF→ON)	110°C±4°C {230±39°F}

- If the measured value deviates from the standard value, replace the switch. Gr 14



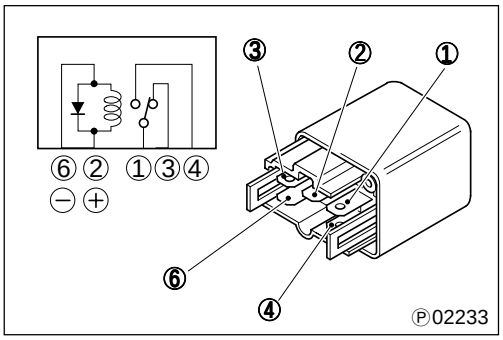
180 Inspection of relay (Close type 4-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④
No current	○—○		○—○	
Current	⊕	⊖	◌---◌	

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.
◌—◌ : Indicates the terminals across which there is no continuity.

- If any fault is found, replace the relay.



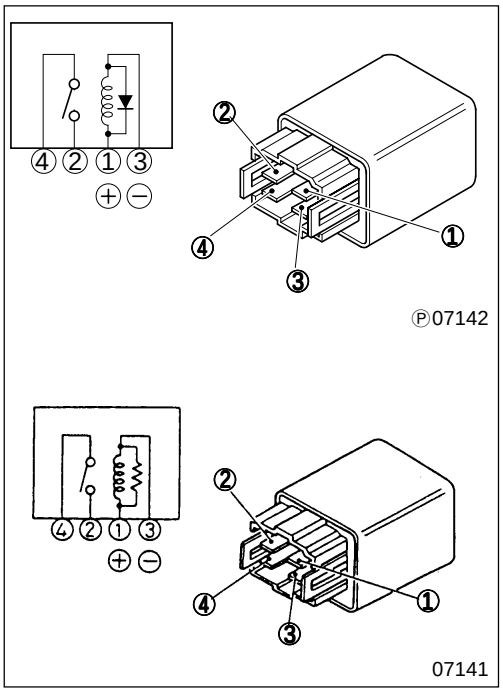
182 Inspection of relay (Open type 6-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④	⑥
No current	○	○	○		○
Current	○	⊕		○	⊖

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



185 Inspection of relay (Open type 4-pin)

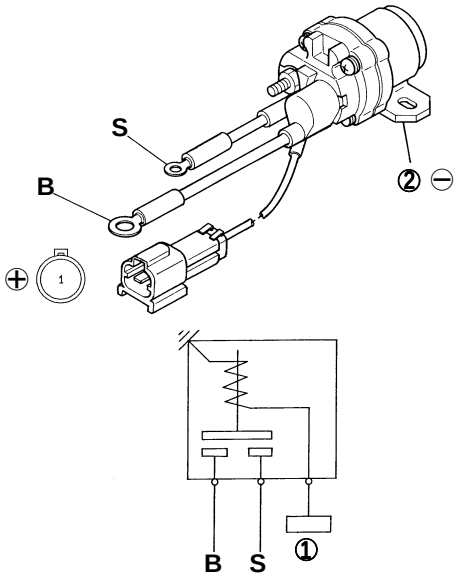
- Follow the table below to check for continuity and operation.

	①	②	③	④
No current	○		○	
Current	⊕	○	⊖	○

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

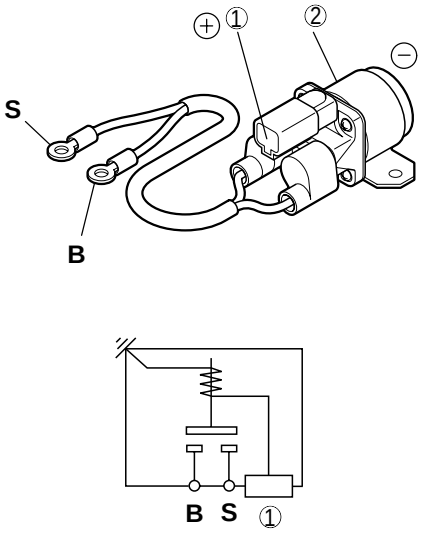
- If any fault is found, replace the relay.

< 4D3 >



07053

< 4M5 >



Ⓟ41157

187 Inspection of starter relay

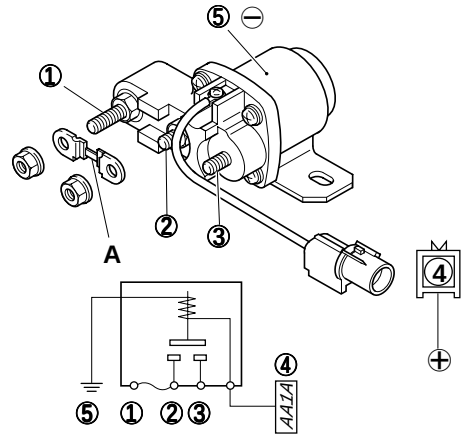
- Follow the table below to check for continuity and operation.

	B	S	①	②
No current			○—○	
Current	○—○		⊕—⊖	

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

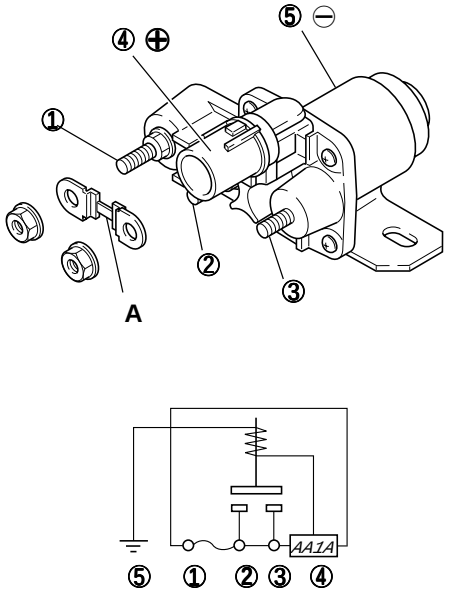
- If any fault is found, replace the relay.

< 4D3 >



Ⓟ24853

< 4M5 >



Ⓟ33889

195 Inspection of glow relay

(1) Inspection of fuse

If any fault is found, replace the fuse **A** (127 ampere).

(2) Inspection of main body

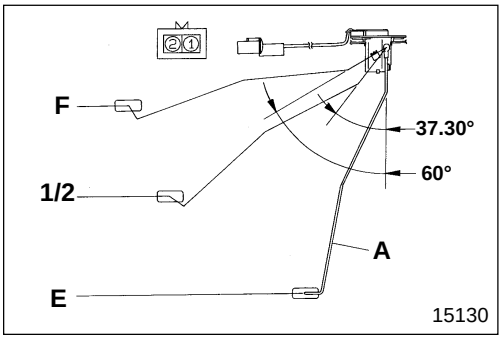
- Follow the table below to check for continuity and operation.

	①	②	③	④	⑤ (Body)
OFF	○	○		○	○
ON	○	○	○	⊕	⊖

○—○ : There is continuity between terminals.

⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.

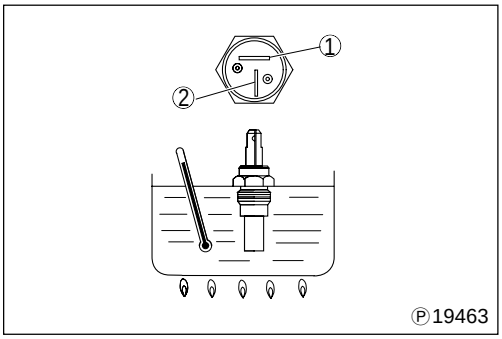


258 Inspection of fuel level sensor

- Measure the resistance between terminals ① and ② when float arm **A** contacts to both stoppers (positions **E** and **F**) and also 1/2 position.

Standard value	F (FULL position)	0^{+2}_{0} Ω
	1/2	50±3 Ω
	E (EMPTY position)	150±10 Ω

- If the measured value deviates from the standard value, replace the sensor. Gr 13A,B



262 Inspection of water temperature sensor

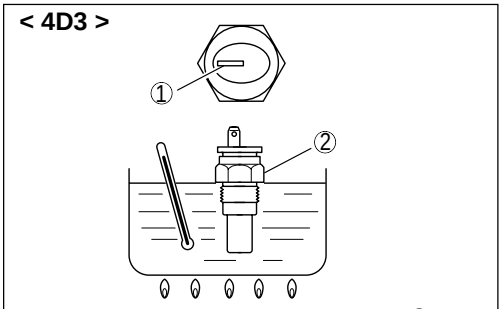
< For multipurpose timing control unit >

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ②, and the body respectively.
  Terminal ① : Water temperature gauge connection
  Terminal ② : Multipurpose timing control unit connection

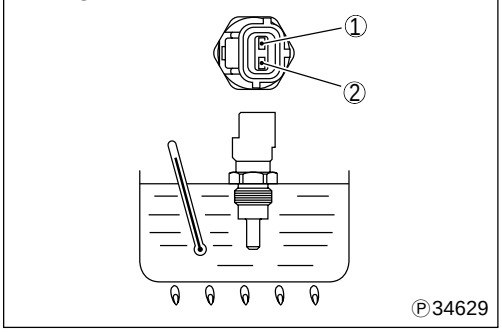
Standard Value	①—Body (connection side of water temperature sensor)	50°C {122°F}	153.9 Ω (Reference value)
		80°C {176°F}	$51.9^{+4.9}_{-4.4}$ Ω
		100°C {212°F}	$27.4^{+1.9}_{-1.2}$ Ω
	②—Body (connection side of multipurpose timing control unit)	20°C {68°F}	3.25 ± 0.33 kΩ
		60°C {140°F}	620 Ω (Reference value)
		80°C {176°F}	300 Ω (Reference value)

- If the measured value deviates from the standard value, replace the sensor. Gr 14

< 4D3 >



< 4M5 >

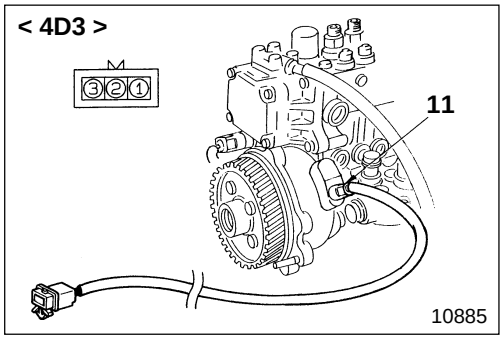


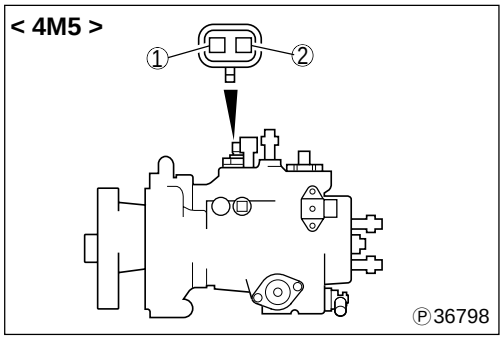
< For engine control >

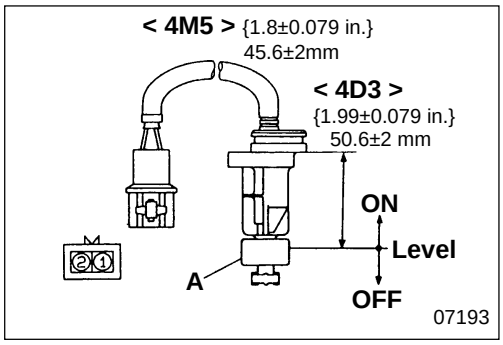
- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ②(body).

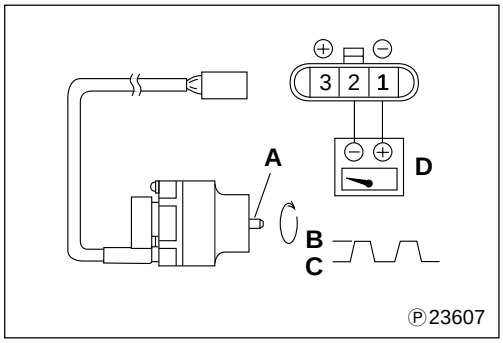
Standard value	4D3	20°C {68°F}	3.25 kΩ (Reference value)
		60°C {140°F}	620±62 Ω
		80°C {176°F}	300 Ω (Reference value)
	4M5	20°C {68°F}	2.3 to 2.6 kΩ
		80°C {176°F}	0.3 to 0.34 kΩ

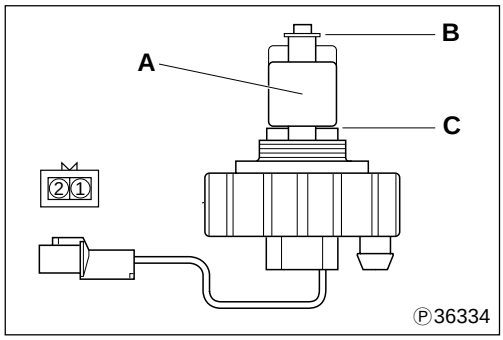
- If the measured value deviates from the standard value, replace the sensor. Gr 14











263 Inspection of engine speed sensor

< 4D3 >

- Measure the resistance between terminals ① and ②.

Standard value (at 25°C {77°F})	2.1 to 2.5 kΩ

- If the measured value deviates from the standard value, replace the sensor. Gr 13B

< 4M5 >

- Measure the resistance between terminals ① and ②.

Standard value (at 20°C {68°F})	230±25 Ω

- If the measured value deviates from the standard value, replace the sensor. Gr 13A

264 Inspection of engine oil level sensor

- Follow the table below to check for continuity.

	①	②
ON	○—○	
OFF		

○—○ : There is continuity between terminals.

A : Float

- If any fault is found, replace the sensor. Gr 12

265 Inspection of vehicle speed sensor

Perform the following checks, and if any fault is found, replace the sensor. Gr 23

- Turn slowly the portion **A** of the sensor with battery voltage applied between terminals ① and ③.
- Mesure the maximum value (high level **B**) and minimum value (low level **C**) of the voltages generated between terminals ① and ②.

D : Tester

Standard value	Low level of pulse	0.5 V or less
	High level of pulse	8±1 V

274 Inspection of water separator sensor

- Move float B to the specified positions to check continuity.

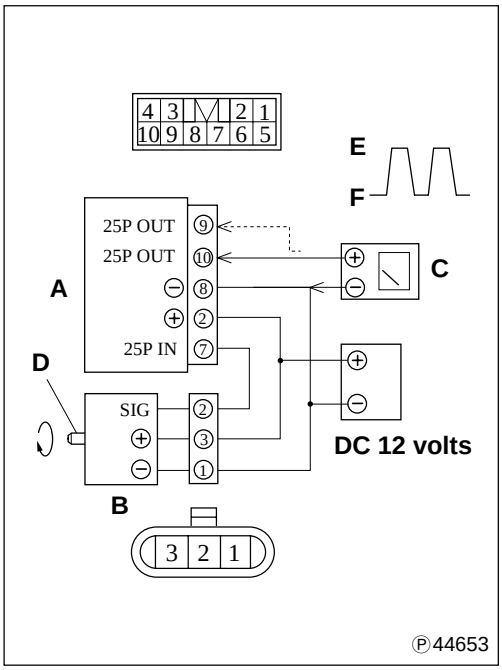
	①	②
B (maximum water level)	○—○	
C (minimum water level)		

○—○ : There is continuity between terminals.

- If any fault is found, replace the sensor.

350 Inspection of control units and other units

- Since the units alone cannot be readily checked in the off-vehicle state, check the harness, switch and other related parts in each system.
- If any fault is not found in the related parts, and the problem still remains in the system, replace the control units or other units.

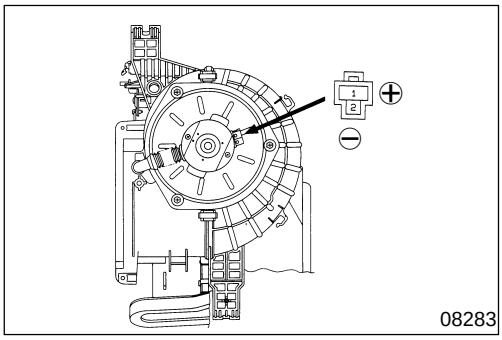


351 Inspection of pulse divider

- Connect the pulse divider **A** as shown.
  B : Vehicle speed sensor (25-pulse)
  C : Tester
- Slowly rotate the shaft **D** of the vehicle speed sensor **B** by hand and measure the maximum voltage (high pulse voltage **E**) and the minimum voltage (low pulse voltage **F**) of the voltage generated across each of the output terminals ⑨, ⑩ and terminal ⑧ of the pulse divider **A**.

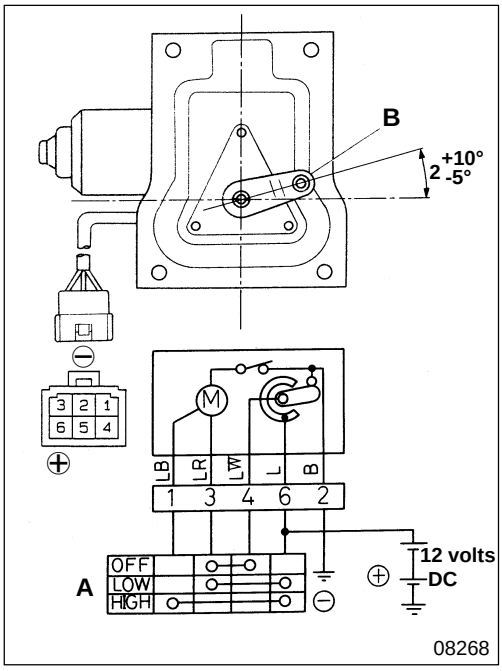
Standard value	Low pulse voltage **H**	0.6 V or less
	High pulse voltage **G**	8±1 V

- If the measured value deviates from the standard value, replace the pulse divider **A**.



411 Inspection of blower motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 55



422 Inspection of wiper motor

- Connect a switch to the motor as shown.

  A : Switch

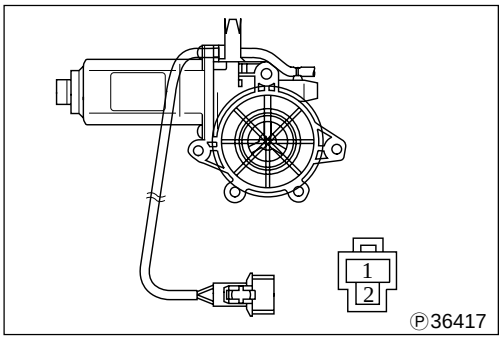
- Check the motor for correct operation as follows. If any fault is found, replace the motor. Gr 42

(1) Inspection of motor operation

- Set switch **A** in HIGH position to check that the motor rotates at high speed.
- Set switch **A** in LOW position to check that the motor rotates at low speed.

(2) Inspection of automatic stop position

- Set switch **A** in LOW position to let the motor rotates at low speed.
- When crank arm **B** is at a position other than the automatic stop position (outside the angles shown), set switch **A** in OFF position.
- Check to see the crank arm **B** stops at the automatic stop position (within the angles range shown).



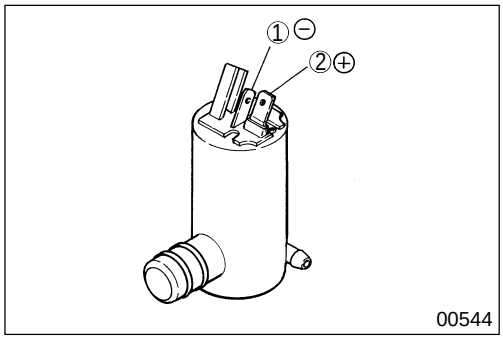
423 Inspection of power window motor

- Follow the table below to check for operation.

	①	②
UP	⊕	⊖
DOWN	⊖	⊕

⊕——⊖: Indicates the terminals where battery voltage is to be applied.

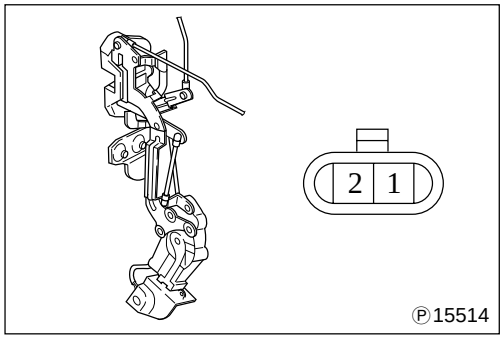
- If any fault is found, replace the motor. Gr 42

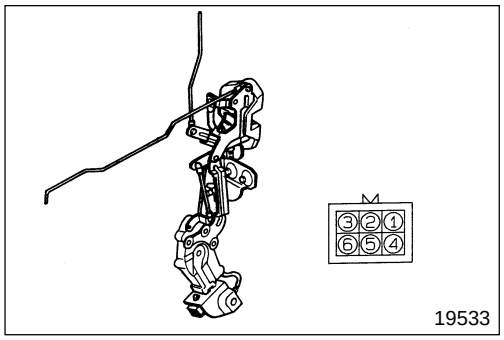


428 Inspection of windshield washer motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 42

510 to 559 ACTUATOR





510 Inspection of door lock actuator (Assistant driver's seat side)

- Follow the table below to check for operation.

	①	②
LOCK	⊕	⊖
UNLOCK	⊖	⊕

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42

511 Inspection of door lock actuator (Driver's seat side)

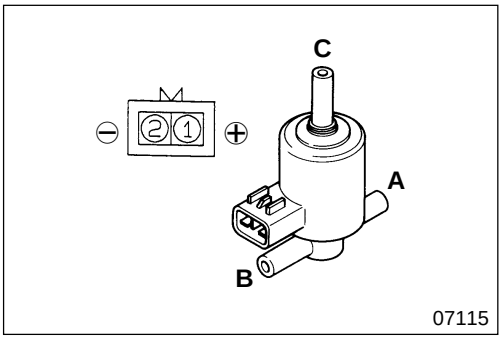
- Follow the table below to check for continuity and operation.

	①	③	②	④	⑤
LOCK		○——○		⊖	⊕
UNLOCK	○——○			⊕	⊖

○——○ : There is continuity between terminals. (OFF in LOCK position)

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42



565 Inspection of exhaust brake 3-way magnetic valve

Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation test

- Gradually apply battery voltage between terminals ① and ② from 0 volt.
- Measure the voltage (minimum operating voltage) at the moment when the 3-way magnetic valves starts operating. (The OFF to ON operating can be noticed from a sound the magnetic valve generates.)

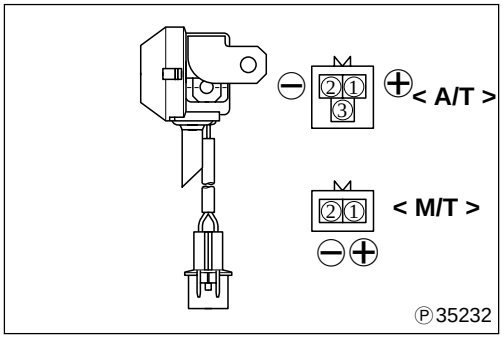
Standard value (Minimum operating voltage)	11V or more

(2) Continuity and airtightness test

Follow the table below to check for continuity.

	Input port A	Output port B	Exhaust port C
ON	○———	———○	
OFF		○———	———○

Air circuit table (○———○ : Air passage is open between ports.)
Negative pressure at the time of check : –100kpa
{–2.95in.Hg,–750mmHg}



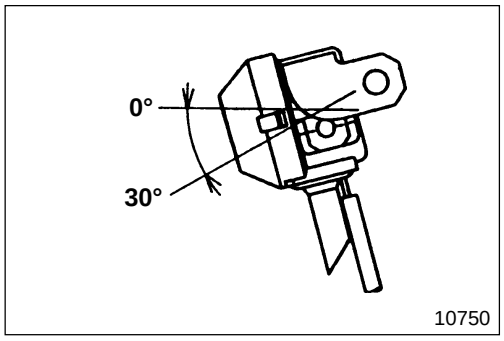
614 Back buzzer

[Inspection]
Perform the following checks, and if any fault is found, replace the buzzer.

(1) Back buzzer terminal
Make sure that the buzzer sounds intermittently when battery voltage is applied between terminals ① and ②.

(2) Automatic transmission reverse buzzer terminal
Make sure that there is continuity between terminals ② and ③.

M/T: Manual transmission
A/T: Automatic transmission

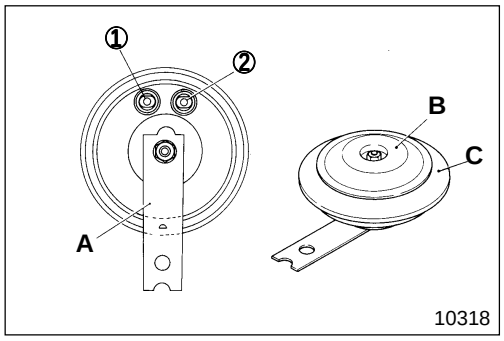


[Installation]
Attach the buzzer to the frame at an angle within the range shown.

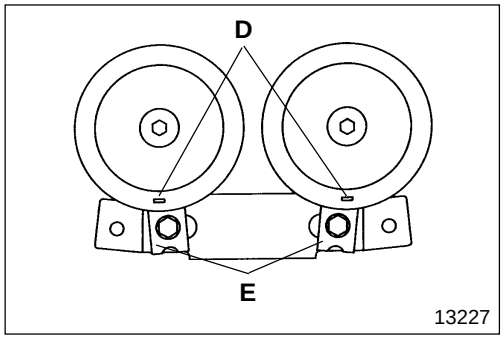
CAUTION
Be careful to install the buzzer within the illustrated angle range or the buzzer will not be drained normally.

615 Inspection of electric horn

CAUTION
Do not bend or damage stay A or the sound quality of electric horn may be changed and the horn capacity can deteriorate.

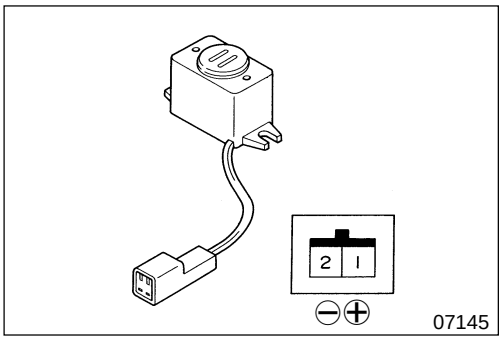


[Inspection]
- Apply battery voltage between terminals ① and ② (No polarity) to make sure that the horn sounds.
- If any fault is found, replace the horn.
- Remove foreign particles from resonator **B** or vibration plate **C**, if any.



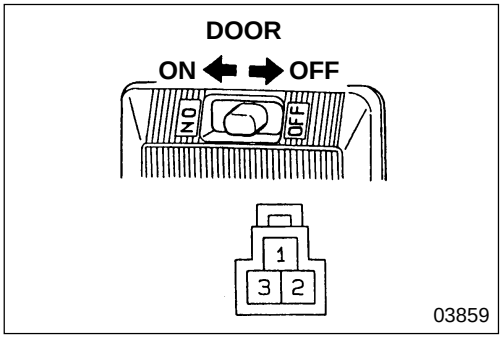
[Installation]
D : Water drain hole
E : Bolt

Tightening torques : Bolt (N·m {ft.lbs, kgf·m})	12 to 16 {8.7 to 12, 1.2 to 1.6}



616 Inspection of reverse warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.



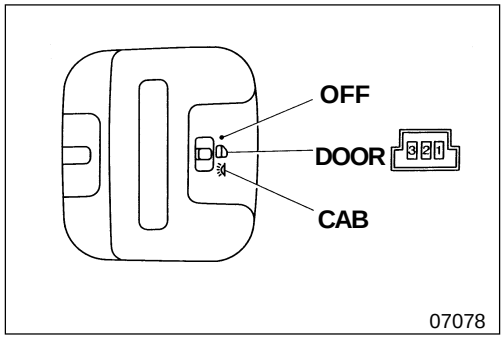
655 Inspection of rear cab lamp

- Follow the table below to check for continuity.

	①	②	③
OFF			
ON	○—○		
DOOR	○—○	○—○	

○—○ : There is continuity between the terminals. (when bulb is installed).

- If any fault is found, replace the lamp.



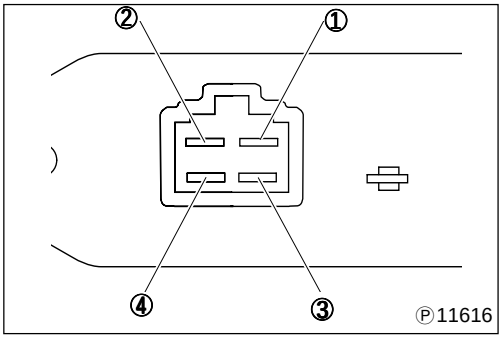
656 Inspection of cab lamp

- Follow the table below to check for continuity.

	①	②	③
OFF			
DOOR	○—○		
CAB	○—○	○—○	

○—○ : There is continuity between the terminals. (when bulb is installed).

- If any fault is found, replace the lamp.

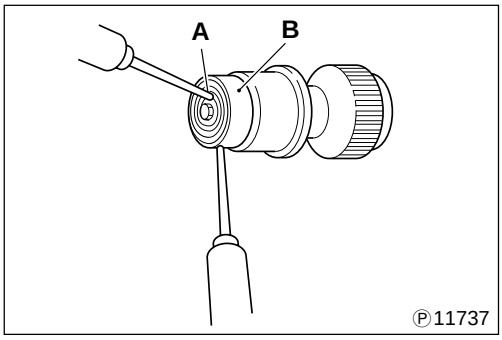


750 Inspection of blower resistor

- Follow the table below to check for resistance of between terminals.

Standard value	MIDDLE LOW	①—②	0.81 Ω
	MIDDLE HIGH	①—③	0.28 Ω
	LOW	①—④	1.94 Ω

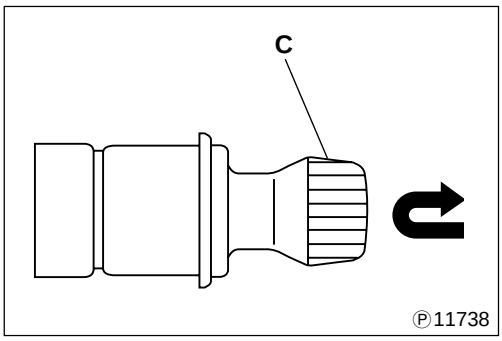
- If the measured value deviates from the standard value, replace the blower resistor.



754 Inspection of cigarette lighter

Perform the following checks, and if any fault is found, replace the cigarette lighter.

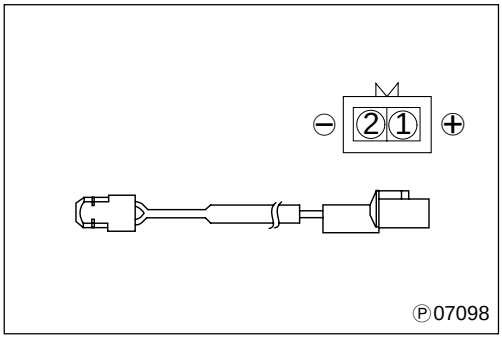
- Make sure that there is continuity between heater element **A** and body **B**.



- Make sure that when plug **C** is pushed in by hand, it immediately returns to its original position.
- Turn the starter switch at ACC or ON position.
- Push plug **C** into the socket in the cab.
- Measure the time required for plug **C** automatically returns.

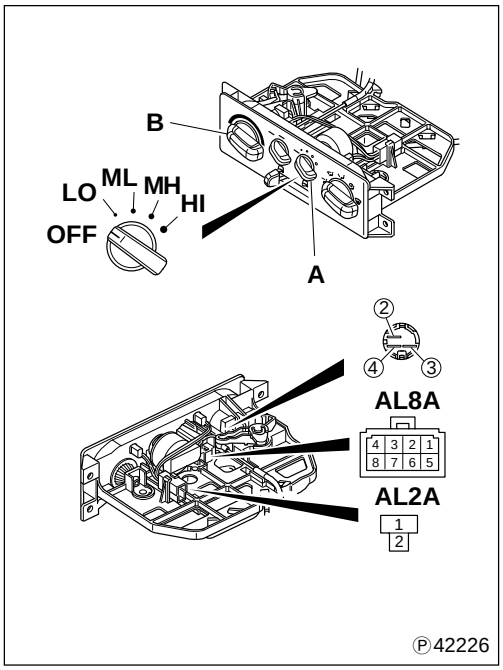
Standard value	15±5 seconds

- Check to see that heater element **A** is red-hot.



759 Inspection of brake pad wear indicator

- Make sure that there is continuity between terminals ① and ②.
- If any fault is found, replace brake pad wear indicator. Gr 35



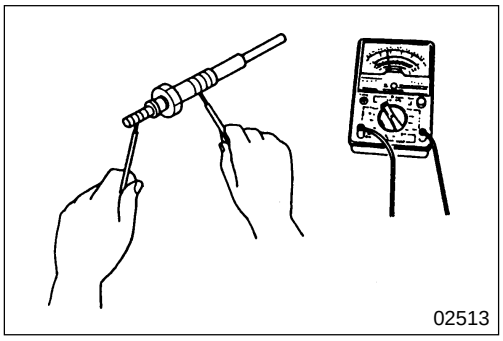
763 Inspection of heater control assembly

- Follow the table below to check for continuity.

	AL8A							AL2A	
	⑧	②	⑦	③	⑥	⑤	④	①	②
OFF									
LO (LOW)	○	○				○	○		
ML (MIDDLE LOW)	○		○			○	○		
MH (MIDDLE HIGH)	○			○		○	○		
HI (HIGH)	○				○	○	○		

○—○ :There is continuity between terminals.

- If any fault is found, replace the switch **A** or heater control assembly.
- If the illumination lamp has blown out, replace the bulb.



764 Inspection of glow plug

- Measure the resistance of glow plug as shown.

Standard Value (Cold resistance of glow plug)	1.0 Ω (Reference value)

- If the measured value deviates from the standard value, replace the glow plug. Gr 11

860 BATTERY

DANGER⚠

- **Because flammable hydrogen gas is generated from battery, be sure to obey the following:**
  - **Never attempt to short-circuit the positive and negative terminals of battery, and generate sparks, or smoke a cigarette near it.**
  - **Do not wear metal objects on your arms or do not lean over battery.**
- **Sulfuric acid of the electrolyte is very corrosive. Whenever handling battery, wear safety goggles and rubber gloves to protect your eyes and hands.**
- **Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.**

WARNING⚠

- **When you disconnect battery cables, disconnect the negative battery cable ⊖ first.**

CAUTION⚠

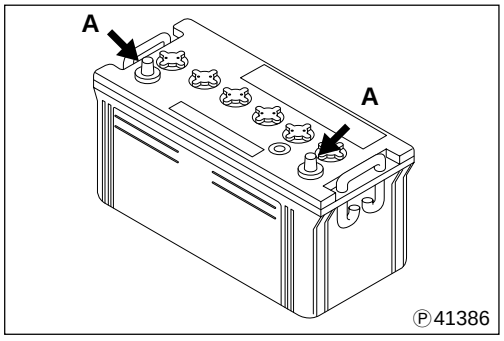
- **Make sure that all electrical switches of the vehicle are off before connecting battery cables.**
- **Be sure to connect the positive battery cable ⊕ first before you connect the negative battery cable ⊖.**
- **To prevent a short-circuit, take care that disconnected battery cables may not accidentally touch the battery terminals.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Specific gravity of battery electrolyte (20°C {68°F})	1.220 to 1.290	—	Charge or replace

◆ Service procedure

Inspection of battery

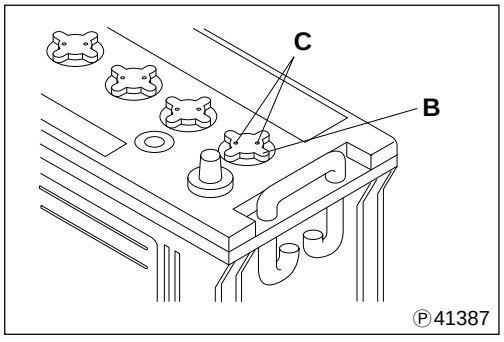


(1) Visual inspection

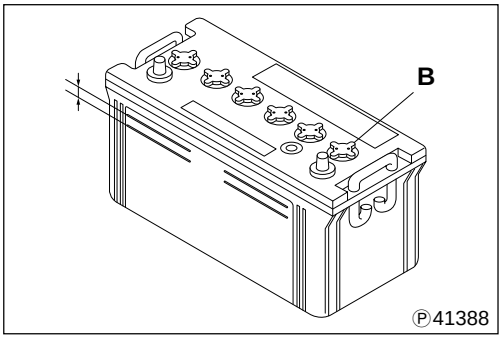
- If terminal **A** is corroded, scrub off the corrosion from it using a wire brush.
- If cracks or defects are found on battery, replace it since the cracks or defects can cause liquid spills.

CAUTION⚠

Make sure you grease the ⊕ side of terminal A because it is easily corroded.

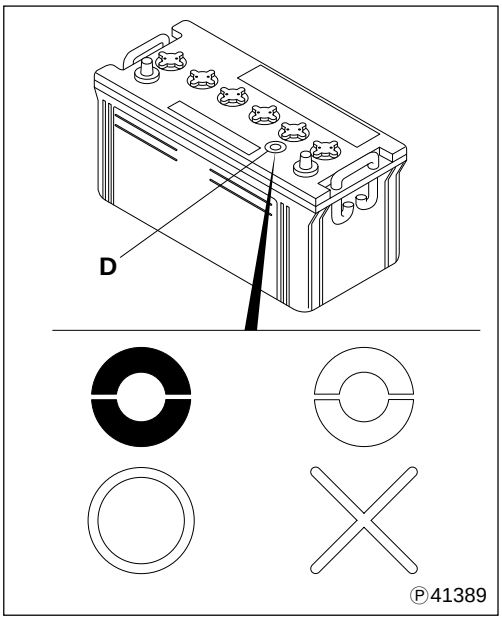


- If bleed hole **C** of vent plug **B** is clogged, clean the hole.



(2) Inspection of fluid level

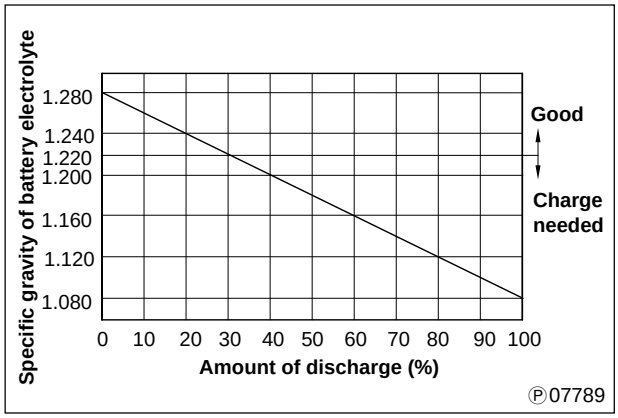
- Make sure that the battery electrolyte level is between UPPER and LOWER.
- If the level is below LOWER, remove vent plug **B** and fill the battery with distilled water or battery replenisher to UPPER.



(3) Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator **D**.

Blue	: Good
White	: Charge or replace



(4) Charging

- Although, as a rule, battery charging should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect battery cable ⊖.
- Remove vent plug before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	$\frac{\text{Value of 5-hour rating capacity}}{10}$	$\frac{\text{*Amount of discharge (Ah)}}{\text{Charge current (A)}} \times 1.2$ (to 1.5)	45 {113}
Quick charge	$\frac{\text{Value of 5-hour rating capacity}}{1.5}$	0.5	55 {131}

* Amount of discharge (Ah)=5-hour rating capacity (Ah)$\times \frac{\text{Amount of discharge (\%)}}{100}$

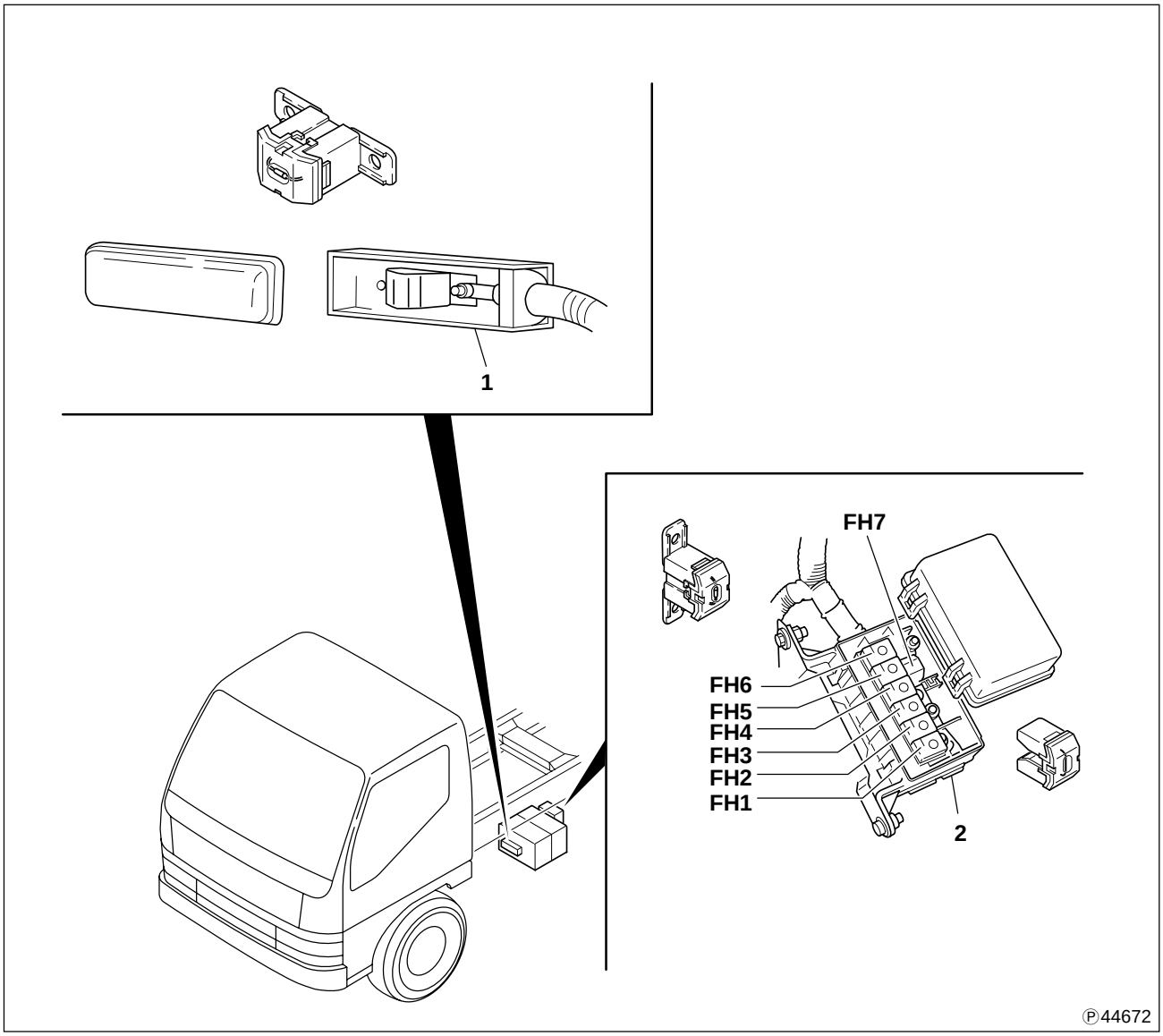
- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.
- The specific gravity of fully-charged battery electrolyte is 1.280 with the temperature at 20°C {68°F}.

DANGER ⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **Keep open flame away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it is dangerous.**
- **After charging the battery, tighten the vent plugs, wash away sulfuric acid from the battery using water, and dry the surface.**
- **Be sure to check the electrolyte level before charging the battery. Charging with the electrolyte level below the lower limit (LOWER LEVEL) can cause premature deterioration, heat generation and explosion of the battery.**

M E M O

870 Hgih-current fuse box



1 Main high-current fuse
2 High-current fuse box

WARNING⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing high-current fuses (FH1 to FH7). 🕮 860

With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:
Always (directly connected to the battery): FH1 to FH7

CAUTION⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use a fuse of the specified ampere.**

Main high-current fuse

Fuse No.	Main load	Capacity
—	Alternator	100A

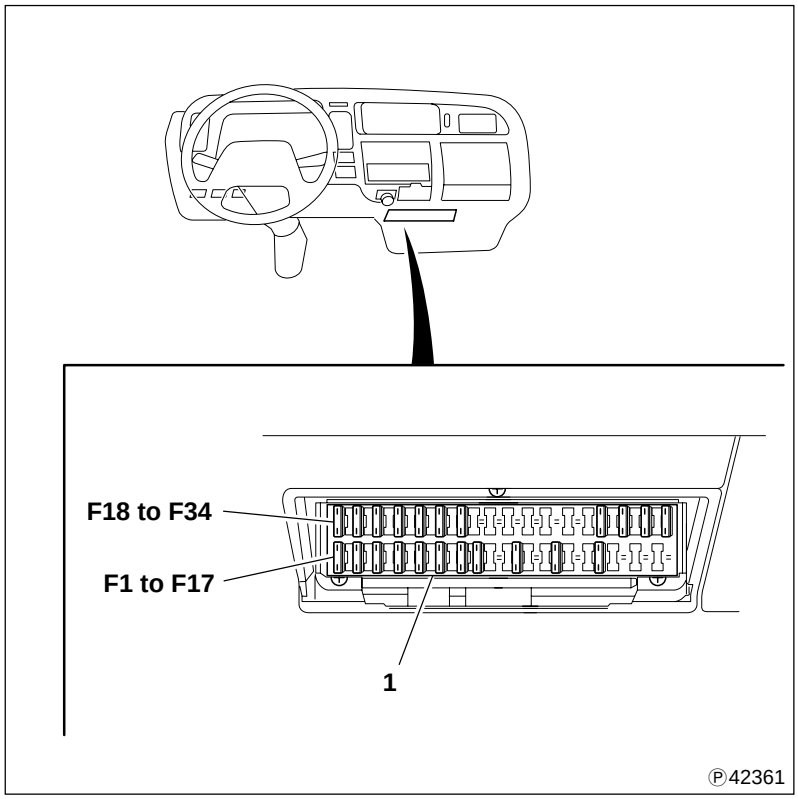
High-current fuse box

Fuse No.	Main load	Capacity
FH1	Fuse box (F1 to F4)	50A
FH2	Fuse box (F5 to F8, F10, F11)	50A
FH3	ABS	40A
FH4	ABS	30A
FH5	Starter switch (Terminal B)	50A
FH6	Fuse box (F31 to F34)	50A
FH7	Alternator	100A

ABS: Anti-lock brake system

870 to 889 FUSE

871 Fuse box



1 Fuse box

WARNING

To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before removing fuses (F1 to F34). 860

With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:

- **Always (directly connected to the battery): F1 to F12,F17,F31 to F34**
- **When starter switch is in ON position : F19 to F30**
- **When starter switch is in ACC position : F13 to F15**
- **When starter switch is in START position : F18**

CAUTION

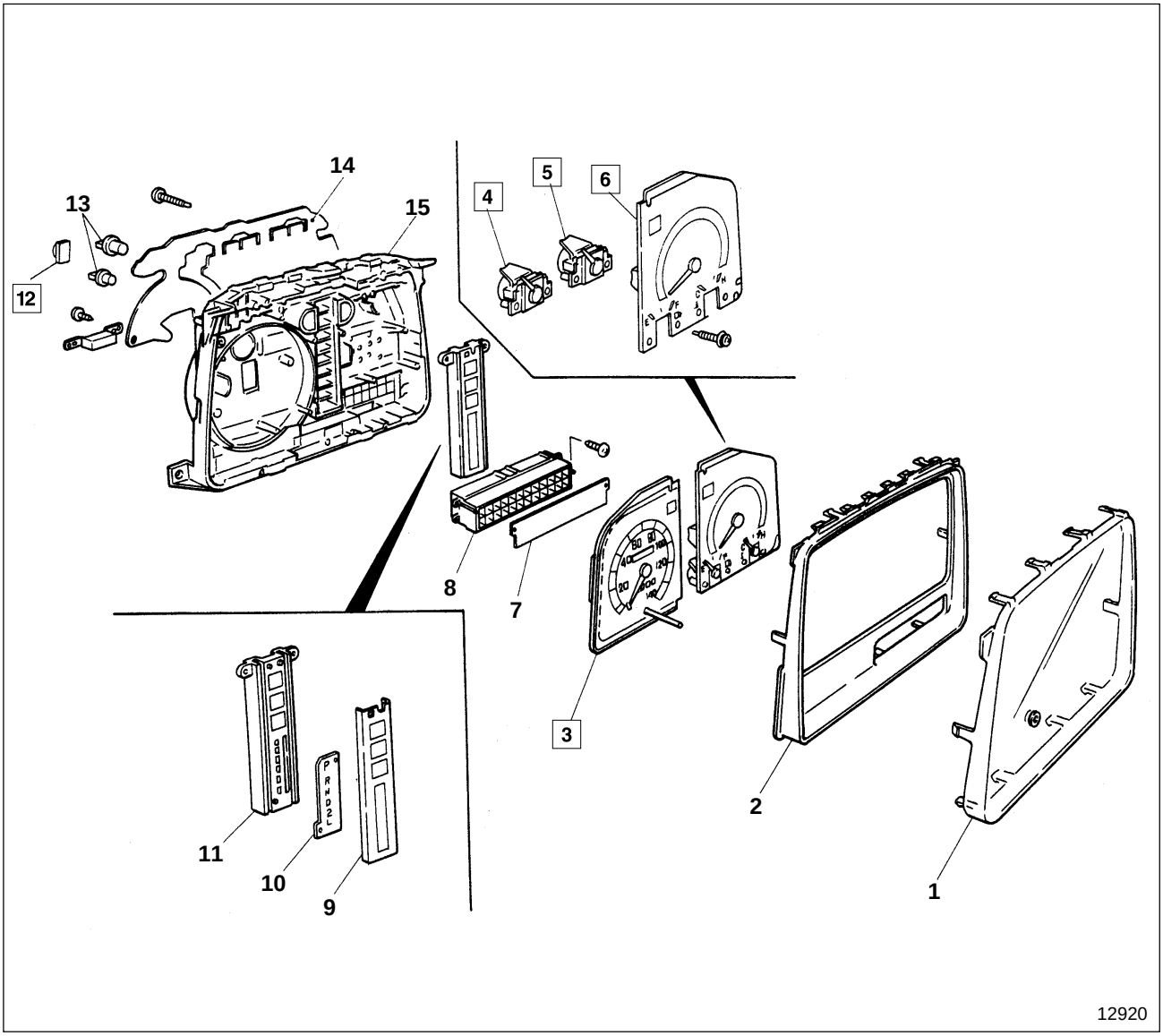
- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use a fuse of the specified ampere.**

Fuse box

Fuse No.	Main load		Capacity
F1	Headlamp, LH		15A
F2	Headlamp, RH		15A
F3	Stop lamp, horn		15A
F4	Turn signal lamp		15A
F5	Engine electronic control unit		20A
F6	Cab lamp		10A
F7	Reserve power (BATT)		10A
F8	Power window		25A
F9	—		—
F10	A/T		15A
F11	A/T		20A
F12	—		—
F13	Cigarette lighter		15A
F14	Radio		10A
F15	Reserve power (ACC)		10A
F16	—		—
F17	Mirror heater		10A
F18	Starter		10A
F19	Backup lamp		10A
F20	Meter cluster, DRL		10A
F21	Wiper		10A
F22	Reserve power (MAIN)		10A
F23	A/T	4D3	15A
		4M5	10A
F24	A/T < 4D3 >		10A
F25	Engine control (ACT)		10A
F26	—		—
F27	Exhaust brake		10A
F28	Engine electronic control unit		10A
F29	ABS		10A
F30	Mirror heater		10A
F31	—		—
F32	Air-conditioner		15A
F33	Blower fan		25A
F34	Tail lamp		20A

ABS : Anti-lock brake system
A/T : Automatic transmission
DRL : Daytime running light

890 METER CLUSTER



● **Disassembly sequence**

1 Meter glass
2 Window plate
3 Speedometer
4 Fuel gauge
5 Water temperature gauge
6 Tachometer
7 Indicator plate
8 Indicator case
9 Plate cover
10 Indicator plate < Automatic transmission >
11 Indicator case
12 Meter warning buzzer
13 Bulb
14 Printed board
15 Meter case

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Removal and installation of meter cluster Gr 42

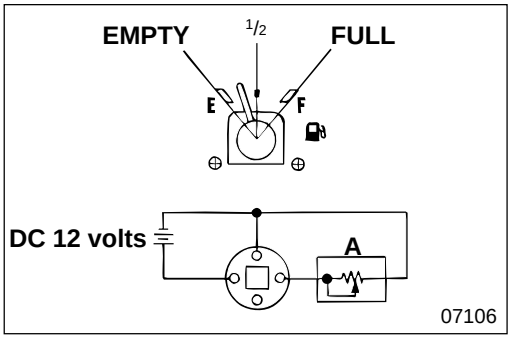
Service standards

Location	Maintenance item			Standard value	Limit	Remedy
3	Indication area of speedometer assembly		At 10 mph	$16.1^{+3.2}_{0}$ km/h {10^{+2}_{0} mph}	—	Replace
			At 20 mph	$32.2^{+3.2}_{0}$ km/h {20^{+2}_{0} mph}		
			At 40 mph	64.4^{+4}_{0} km/h {$40^{+2.5}_{0}$ mph}		
			At 50 mph	$80.5^{+4.8}_{0}$ km/h {50^{+3}_{0} mph}		
			At 60 mph	$96.6^{+4.8}_{0}$ km/h {60^{+3}_{0} mph}		
4	Resistance of fuel gauge	Needle position	FULL	4 Ω	—	Replace
			1/2	50 Ω		
			EMPTY	135 Ω		
5	Resistance of water temperature gauge	Needle position	50°C {122°F}	131 Ω	—	Replace
			83°C {181°F}	39.3 Ω		
			105°C {221°F}	21.6 Ω		
			120°C {248°F}	14.7 Ω		
6	Indication range of tachometer 20±2°C {68±36°F} 13.5±0.1V		At 550 rpm	550±50 rpm	—	Replace
			At 1000 rpm	1000±70 rpm		
			At 1500 rpm	1500±110 rpm		
			At 2000 rpm	2000±110 rpm		
			At 2500 rpm	2500±110 rpm		
			At 3000 rpm	3000±110 rpm		
			At 4500 rpm	4500±125 rpm		

◆ Service procedure

3 Inspection of speedometer

- Use the speedometer tester to check that the indication area of speedometer **3** does not deviate from the standard value at each speed.
- If the measured value deviates from the standard value, replace the speedometer.



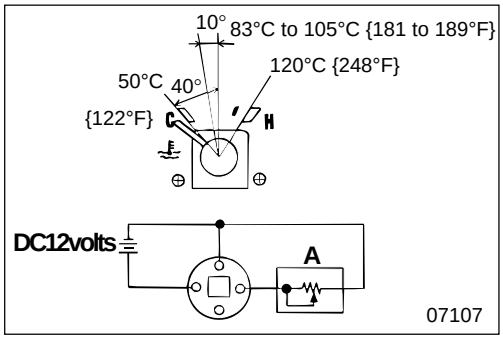
4 Inspection of fuel gauge

- Connect a variable resistor to fuel gauge **4** as shown.
  A : Variable resistor
- Measurement order
  FULL → 1/2 → EMPTY

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of fuel gauge **4** indicates FULL, 1/2, and EMPTY.
- If the measured value deviates from the standard value, replace fuel gauge **4**.



5 **Inspection of water temperature gauge**

- Connect a variable resistor to water temperature gauge **5** as shown.
  A : Variable resistor
- Measurement order
  50°C {122°F}→ 120°C {248°F}

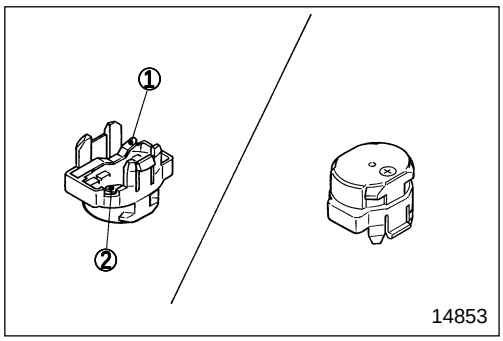
NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of water temperature gauge **5** indicates 50°C {122°F}, 83°C {181°F} to 105°C {189°F}, and 120°C {248°F}.
- If the measured value deviates from the standard value, replace water temperature gauge **5**.

6 **Inspection of tachometer**

- Use the engine revolution counter to check that the indication area of tachometer **6** is in the standard value at each revolution.
- If the measured value deviates from the standard value, replace tachometer **6**.



12 **Inspection of meter warning buzzer**

- Make sure that the buzzer operates when battery voltage is applied between terminals ① and ②.

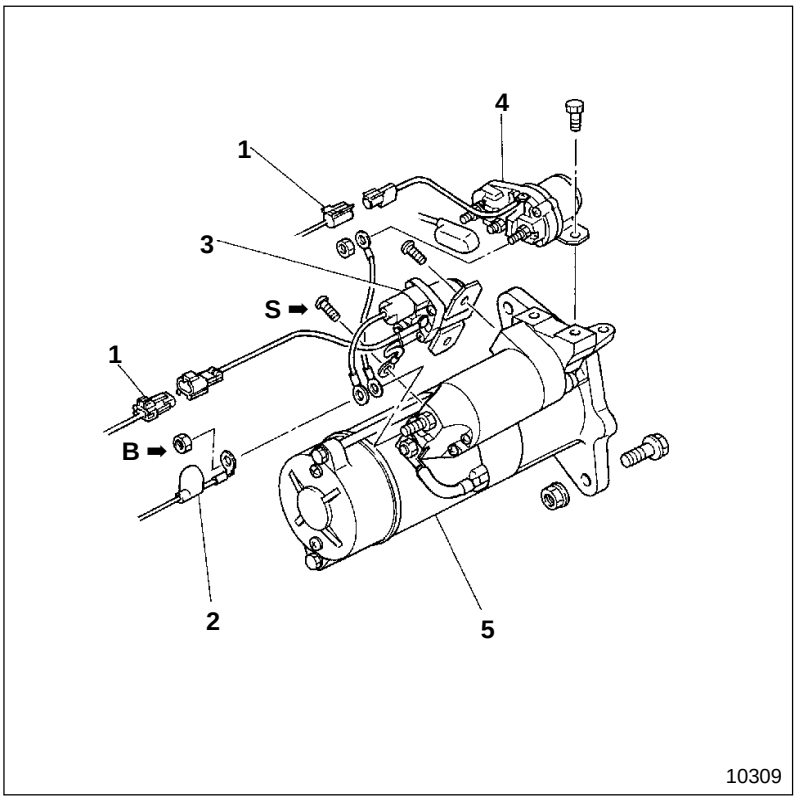
CAUTION

- **Be careful not to mix up ⊕ and ⊖ when you apply voltage to the buzzer 12, because this would damage the buzzer.**
- **Make sure you check ⊕ and ⊖ on the top of the buzzer 12.**

- If any fault is found, replace the buzzer **12**.

12 STARTER AND ALTERNATOR

< 4D3 >



● **Removal sequence**

1 Chassis harness
2 Starter cable
3 Starter relay 🕮 187
4 Glow relay 🕮 195
5 Starter 🕮 P54-12-4
B : Connect to terminal B
S : Connect to terminal S

WARNING⚠

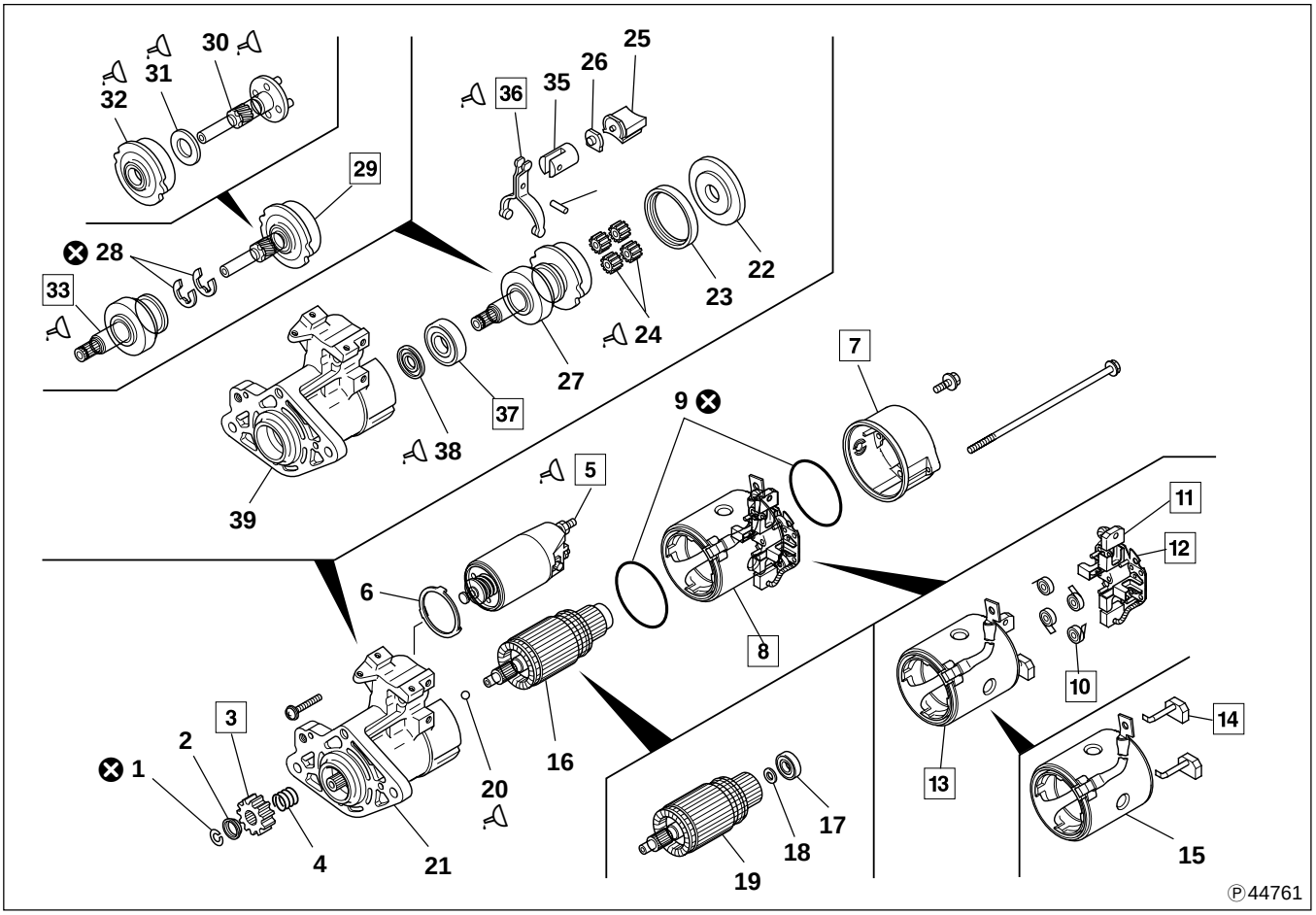
Never touch the starter 5 with tools when you remove the harness from terminal B. This is because voltage is always supplied to it from starter cable 2, and you will short-circuit the starter. Before removing the harness from terminal B, remove the ⊖ battery terminal and tape it up to insulate it.

● **Installation sequence**

Follow the removal sequence in reverse.

M E M O

Starter < 4D3 >



● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch assembly
6 Shim
7 Rear bracket
8 Yoke and brush holder assembly
9 Rubber packing
10 Brush spring
11 Brush ⊖
12 Brush holder assembly
13 Yoke assembly
14 Brush ⊕
15 Yoke
16 Armature assembly
17 Rear bearing
18 Washer
19 Armature
20 Ball
21 Front bracket assembly
22 Cover
23 Rubber packing
24 Planetary gear
25 Rubber packing
26 Plate
27 Gear shaft and overrunning clutch assembly
28 E-ring
29 Gear shaft and internal gear assembly
30 Gear shaft assembly
31 Washer
32 Internal gear
33 Overrunning clutch
34 Pin
35 Holder
36 Lever
37 Front bearing
38 Oil seal
39 Front bracket

⊗ : Non-reusable parts

CAUTION⚠

- **Do not remove bearings 17, 37 unless they are faulty.**
- **Be careful not to lose ball 20, since it might come out together with armature assembly 16 when you remove it.**

NOTE

- **You do not have to remove pinion 3 when you disassemble or inspect only the motor assembly, for example: when inspection of the brush assembly is required.**
- **Except for the above, make sure you remove pinon 3 before disassembling any parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Whenever magnetic switch assembly 5 has been replaced, be sure to adjust the pinion gap.

● **Inspection after assembly**

🕮 P54-12-6

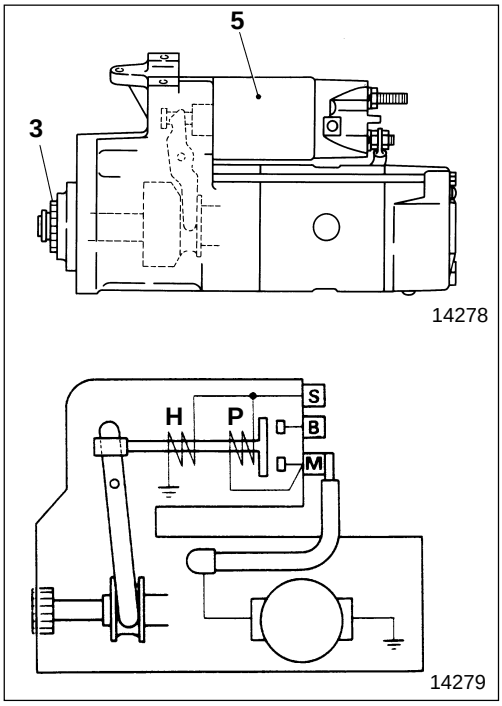
Service standards

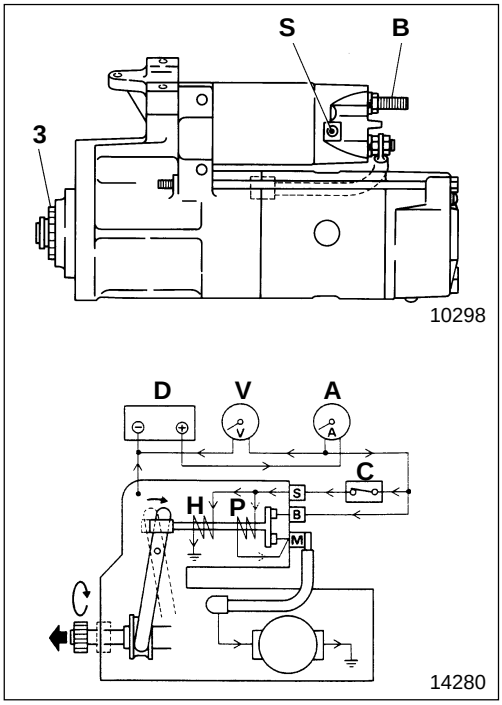
Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
—	Pinion gap			0.5 to 2.0 {0.02 to 0.079}	—	Adjust
—	No-load characteristic	With current of 11 V	Current	180 A or less	—	Inspect
			Revolutions per minute	3800 rpm or more	—	
10	Pressure of brush spring			29.2 to 39.4 N {6.6 to 8.9 lbs, 2.98 to 4.02 kgf}	13.7 N {3.1lbs, 1.4kgf}	Replace
11, 14	Length of brush			18 {0.71}	11 {0.43}	Replace
16	Outer diameter of commutator			32 {1.26}	31.4 {1.24}	Replace
	Deflection of commutator periphery			—	0.1 {0.0039} or more	Replace
	Mold depth between segments			—	0.2 {0.0079} or less	Correct or replace

Lubricant

Location	Points of application	Specified lubricant	Quantity
5	Lever contact surface of magnetic switch assembly	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Teeth of armature assembly gear	MOLYKOTE ® AG650	As required
16, 30	Sliding surface of armature assembly and gear shaft assembly	MOLYKOTE ® AG650	As required
20	Ball	MOLYKOTE ® AG650	As required
24, 32	Teeth of internal gear and planetary gear	MOLYKOTE ® AG650	As required
30, 33	Friction surfaces of gear shaft assembly and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
31	Washer	MOLYKOTE ® AG650	As required
33	Spline of overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
36	Friction surfaces of lever and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
38	Oil Seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required





◆ Service procedure

● Inspection after assembly

Inspection after assembling the starter should be carried out with current fed to the starter.

WARNING

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot during inspection.**

CAUTION

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits the coil might burn due to overheating.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**

(1) Performance test

- Connect the starter as shown.
  A : Ammeter
  B : Terminal B of starter
  C : Switch
  D : 12 volts DC
  S : Terminal S of starter
  V : Voltmeter
- Set the voltage to 11 volts DC.

CAUTION

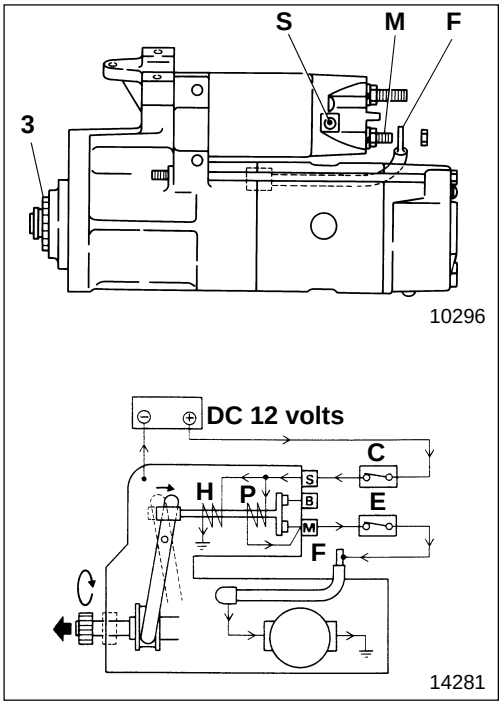
Up to 12 volts can be loaded.

- The following work should be done with current fed to the starter. You must complete measurement of the current and the number of revolutions within 30 seconds.
  - Turn switch **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

  CAUTION

  When switch C is turned ON, current is fed both to pull-in coil P and holding coil H. When a large amount of current is fed into terminal M from DC power supply D, via terminal B of the starter, the current stops flowing into the pull-in coil but continues to flow into the holding coil.
  To avoid burning the holding coil, be sure to carry out the performance test within 30 seconds.

  - Measure the current and the number of revolutions of the starter. Train a strobe light on pinion **3** to measure the number of revolutions.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, disassemble the starter again and inspect it.

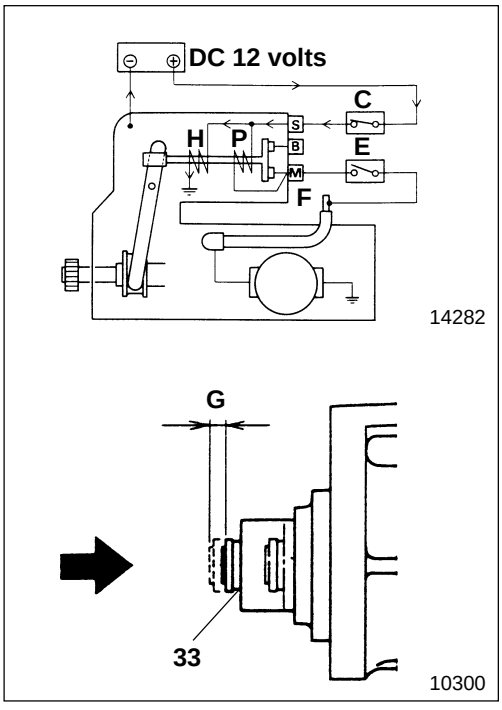


(2) Pinion gap

[Inspection]

- Connect the starter as shown.
  C : Switch
  E : Switch
  F : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete measurement of the pinion gap within 30 seconds.
  - Turn switches **C** and **E** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

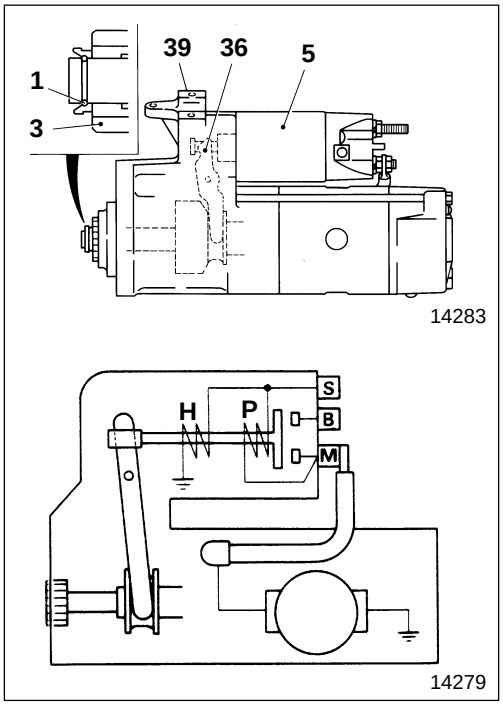


  - Within 5 seconds of pinion **3** rotating, turn switch **E** OFF to stop rotation of the pinion.

CAUTION ⚠

When switches C and E are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.
To avoid burning the pull-in coil, be sure to turn switch E OFF within 5 seconds of the pinion rotating.

  - Hold the end of overrunning clutch **33** with fingers, and pull it. Measure the distance **G** (pinion gap) in the shaft direction that the overrunning clutch moves when it is lightly pushed back by hand.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, replace lever **36**.



3 **Pinion**

[Removal]

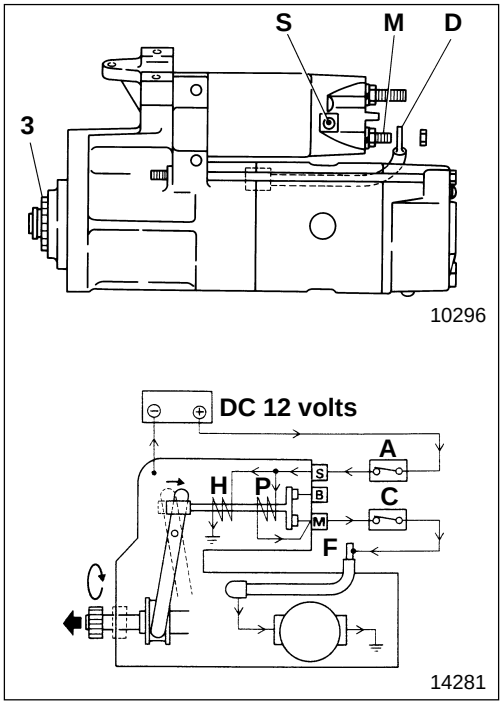
Feed current to the starter and protrude pinion **3** to remove the pinion.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot after inspection.**

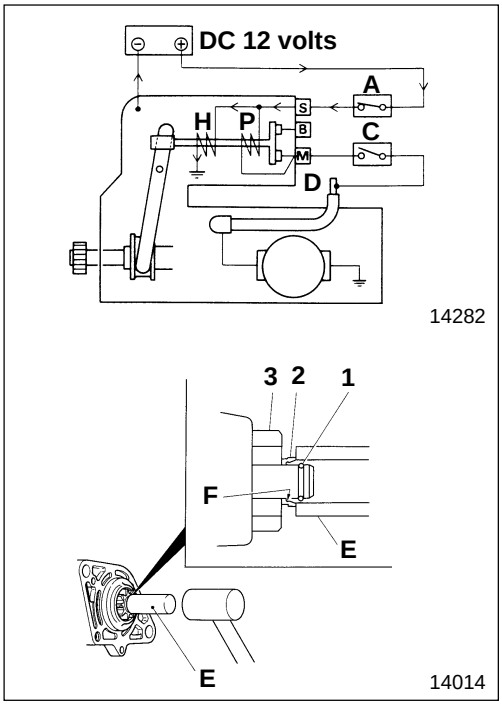
CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits, the coil might burn due to overheating.**
- **Before making pinion 3 jump out, be sure to feed current to the starter to obtain the correct state. If current is not fed to the starter and lever 36 is pulled to protrude the pinion, front bracket 39 or the lever might be damaged due to the shock produced on removal of stopper ring 1.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



- Connect the starter as shown.
  A : Switch
  C : Switch
  D : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete removal of pinion **3** within 30 seconds.
  - Turn switches **A** and **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



- Within 5 seconds of pinion **3** rotating, turn switch **C** OFF to stop rotation of the pinion**.**

CAUTION

When switches A and C are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.

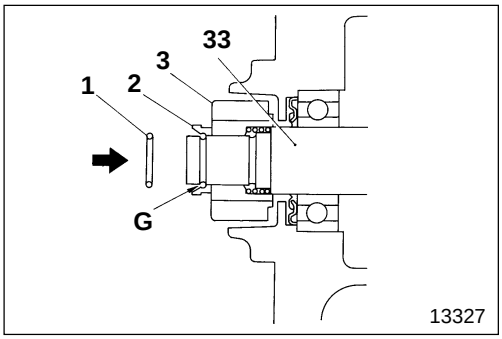
To avoid burning pull-in coil P, be sure to turn switch C OFF within 5 seconds after the pinion rotates.

- Apply pipe-shaped tool **E** onto pinion stopper **2**.
- Hit tool **E** lightly using a mallet to remove stopper ring **1** from ring groove **F** of pinion stopper **2**.
- Remove stopper ring **1** and pinion **3**.
- Turn switch **A** OFF to stop current to the starter.

NOTE

When the current to the starter is stopped, stopper ring 1 might fall back into ring groove F of pinion stopper 2 because pinion 3 is pushed inside.

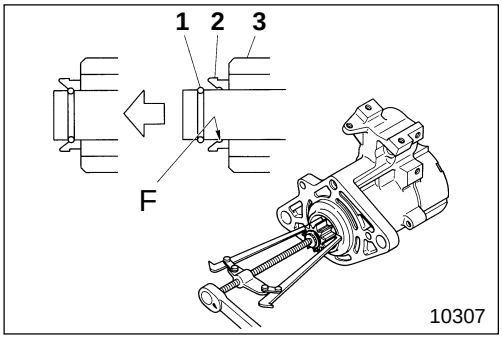
If this occurs, feed current to the starter again and carry out the work.



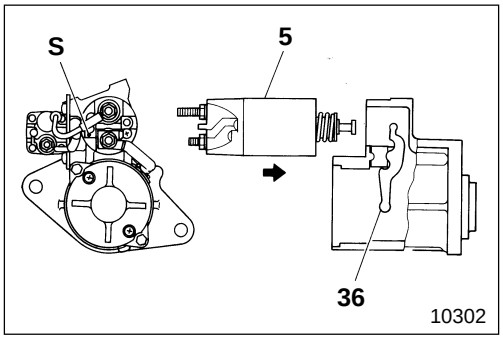
[Installation]

When installing pinion **3**, it is not necessary to feed current to the starter.

- Install pinion stopper **2** and pinion **3** onto overrunning clutch **33** in the direction as shown.
- Fit stopper ring **1** into ring groove **G** of overrunning clutch **33**.

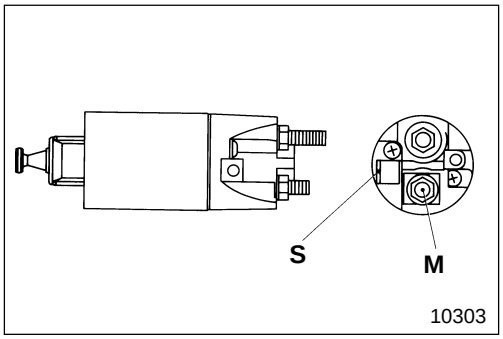


- Pull pinion **3** firmly and set stopper ring **1** on groove **F** of pinion stopper **2** securely.



5 Magnetic switch assembly

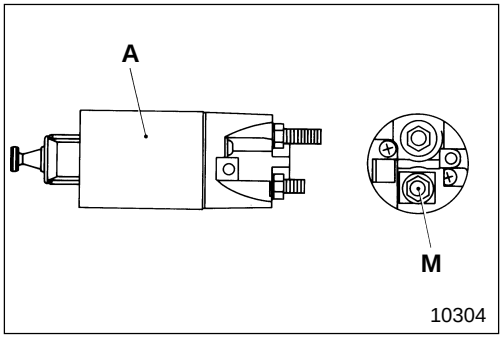
[Installation]
Install magnetic switch assembly **5** to lever **36**, with terminal **S** facing the direction as shown.



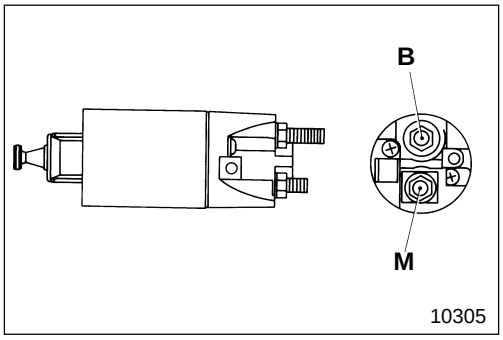
[Inspection]

(1) Testing for coil breakage

- Make sure that there is continuity between terminals **S** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.

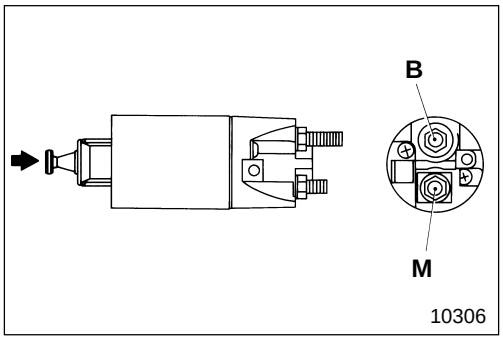


- Make sure that there is continuity between terminal **M** and body **A**.
- If there is no continuity, replace magnetic switch assembly **5**.



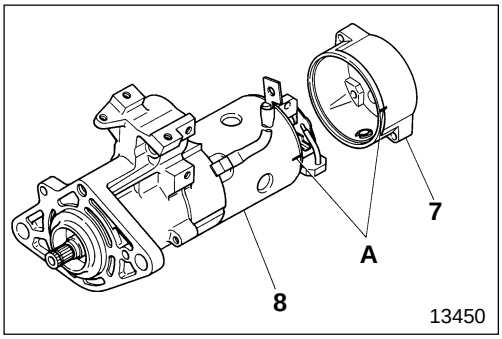
(2) Inspection of welded connections

- Make sure that there is no continuity between terminals **B** and **M**.
- If there is continuity, replace magnetic switch assembly **5**.



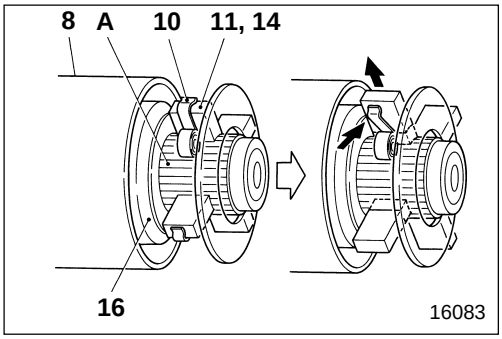
(3) Inspection of connections

- Push the tip of magnetic switch assembly **5** to close the internal connection.
  Make sure that there is continuity between terminals **B** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.



7 **Installation of rear bracket**

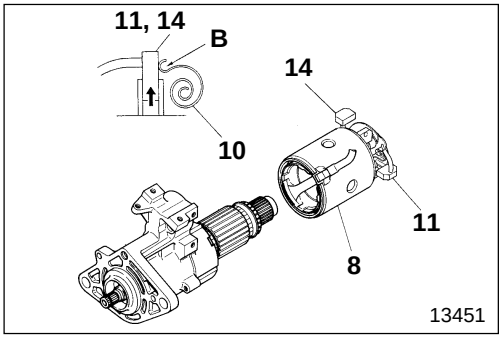
A : Alignment mark



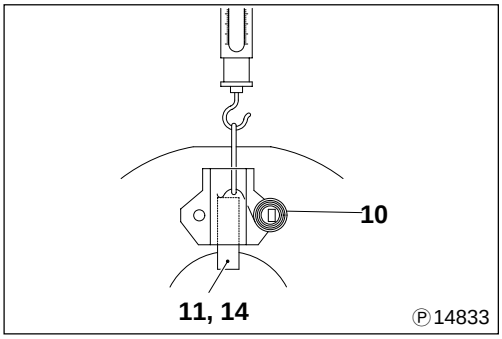
8 **Removal and installation of yoke and brush holder assembly**

Use the following method to remove the yoke and brush holder assembly **8** in order to prevent the commutator **A** of the armature assembly **16** from being damaged by the brushes **11** and **14**.

- Lift the brushes **11** and **14** away from the commutator **A** and hold them lifted by applying the brush springs **10** against the sides of the brush springs.

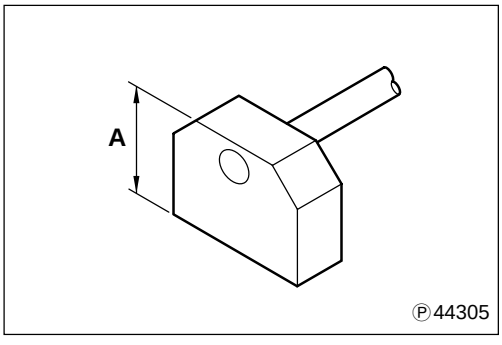


- Pull part **B** of each brush spring **10** and pull up the brushes **11** and **14**.
- Hold the brushes **11** and **14** in position with brush spring **10** as shown.
- Remove yoke and brush holder assembly **8**.
- To reinstall the yoke and brush holder assembly **8**, follow the removal instructions in, reverse.



10 **Inspection of brush spring**

- Use new brushes **11, 14** and measure the load when brush spring **10** is detached from the brushes.
- If the measured value is lower than the limit, replace brush spring **10**.



11 **14** **Inspection of brush**

(1) Length of brush

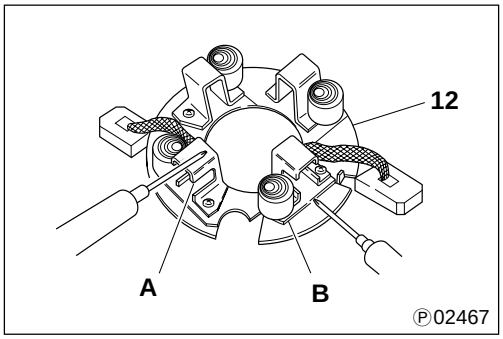
If the measured value **A** is lower than the limit, replace brushes **11, 14**.

NOTE

To replace brush ⊖ 11, replace entire brush holder assembly 12.

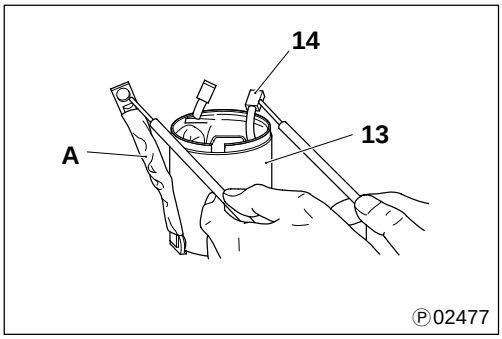
(2) Contact surface with commutator

If the surface where the brushes contact the commutator is rough or is worn unevenly, polish the surface with emery paper (300 to 500 grit).



12 Inspection of brush holder assembly

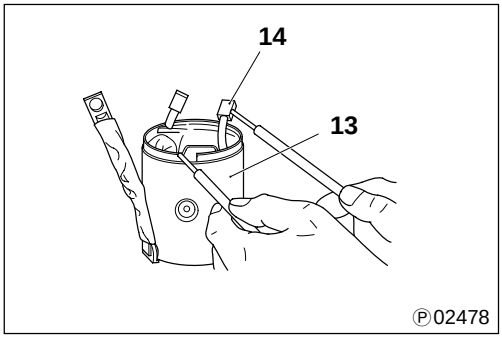
- Cleaning the brush holder **A** and holder plate **B**.
- Make sure that there is no continuity between the ⊕ side of the brush holder **A** and the ⊖ side of the holder plate **B**.
- If there is continuity between them, they are short-circuited. Replace brush holder assembly **12**.



13 Inspection of yoke assembly

(1) Testing for coil breakage

- Make sure that there is continuity between cable **A** and brush ⊕ **14**.
- If there is no continuity, they are broken. Replace brush ⊕ **14** or yoke assembly **13**.

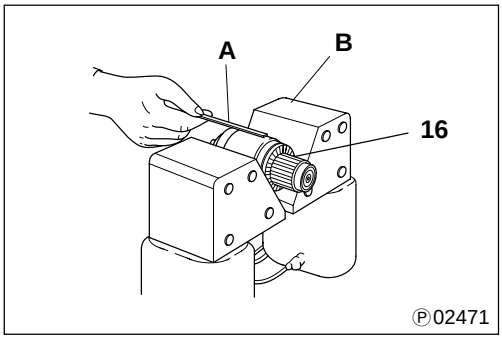


(2) Testing for coil grounding

- Make sure that there is no continuity between yoke assembly **13** and brush ⊕ **14**.
- If there is continuity, they are short-circuited. Inspect the insulated point. If it is hard to repair, replace brush ⊕ **14** or yoke assembly **13**.

NOTE

The coil may be short-circuited to the yoke assembly 13 due to the accumulation of worn-off metal particles from the brushes and/or armature.



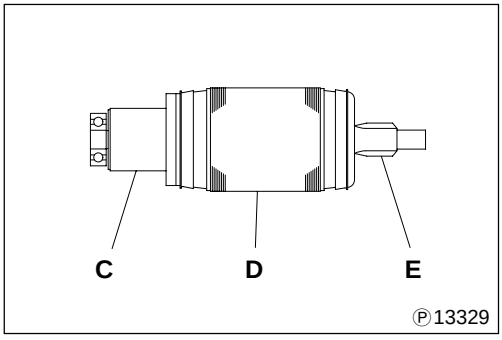
16 Inspection of armature assembly

(1) Testing for coil short-circuit

- Hold an iron rod **A** parallel with the armature assembly **16**.

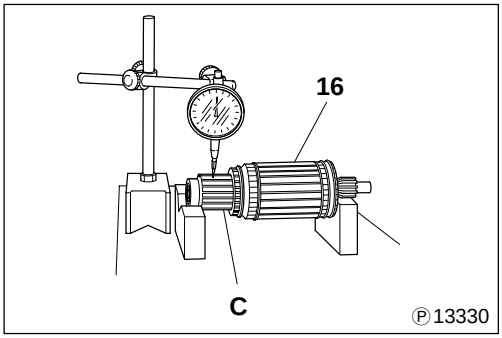
B : Armature tester

- Slowly rotate the armature assembly **16** by hand.
- If the iron rod **A** vibrates or is pulled toward the armature assembly **16**, the coil is short-circuited and the armature assembly must be replaced.



(2) Testing for coil grounding

- Make sure that there is no continuity between commutator **C** and core **D** (or shaft **E**).
- If there is continuity between them, they are short-circuited. Replace armature assembly **16**.

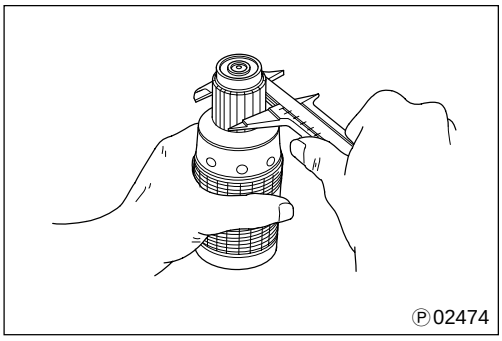


(3) Deflection of commutator

If the measured value is higher than the limit, correct the outer diameter of commutator **C** within the limit.

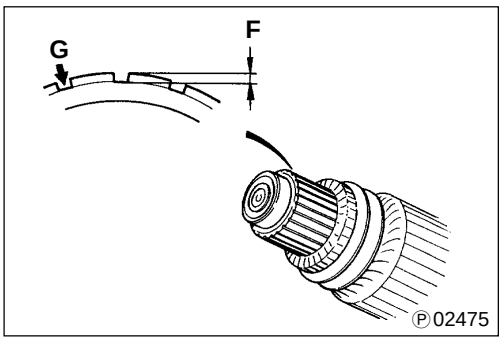
(4) Condition of the surface of commutator

- If the surface is rough or has stepped wear, polish the surface with emery paper (300 to 500 grit).
- After polishing, check deflection of commutator **C**.



(5) Outer diameter of commutator

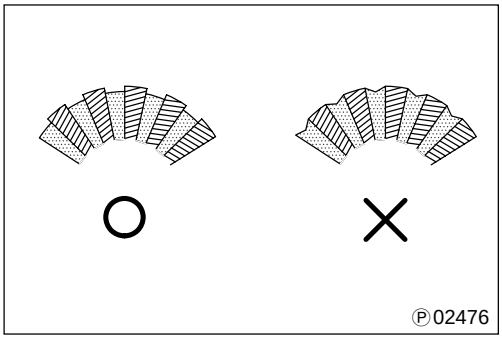
If the measured value is lower than the limit, replace armature assembly **16**.



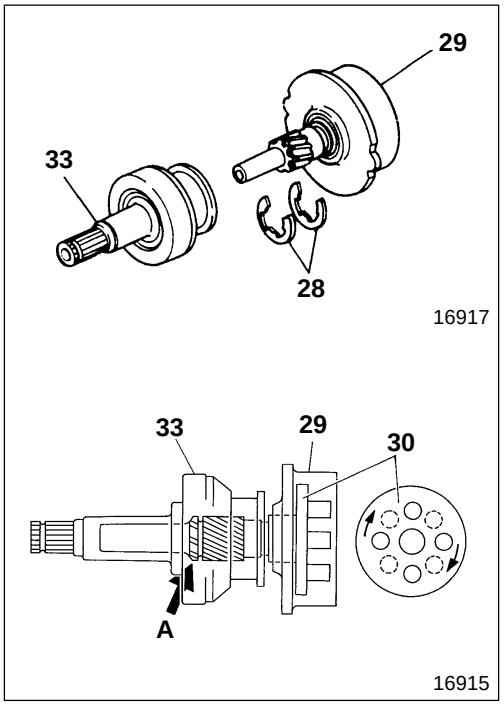
(6) Mold depth between segments

- If the measured value is lower than the limit, replace armature assembly **16**.
  F : Mold depth

- To rectify the armature assembly **16**, grind the shown portions **G**.



- If the mold is worn as shown, correct or replace armature assembly **16**.
  ○ : Good
  × : Faulty

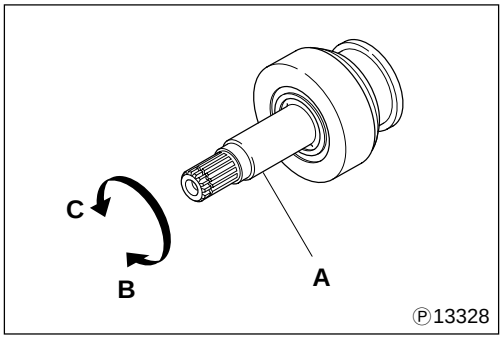


29 **Removal of gear shaft and internal gear assembly**

Remove the E-rings **28** and then the gear shaft and internal gear assembly **29** from the overrunning clutch **33**.

Proceed as follows if the gear shaft and internal gear assembly **29** cannot be removed due to interference of the splined section **A** of gear shaft assembly **30** with internal parts of the overrunning clutch **33**.

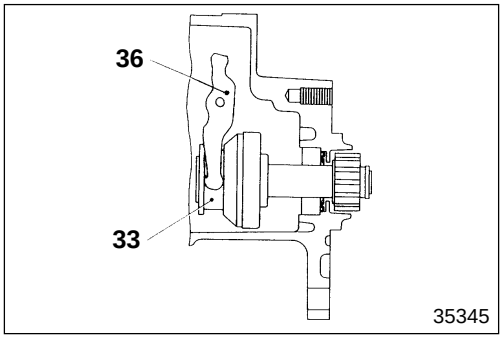
- Press the gear shaft assembly **30** against the overrunning clutch **33**.
- Turn the gear shaft assembly **30** approx. 1/8 of a turn to change the position of splined section **A**.



33 **Inspection of overrunning clutch**

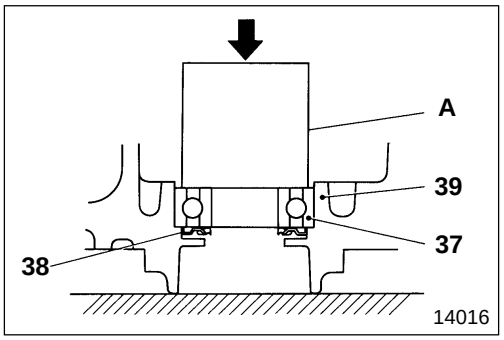
Perform the following checks, and if any fault is found, replace the overrunning clutch **33**.

- Make sure that shaft **A** turns smoothly when turned in direction **B**.
- Make sure that shaft **A** locks when turned in direction **C**.



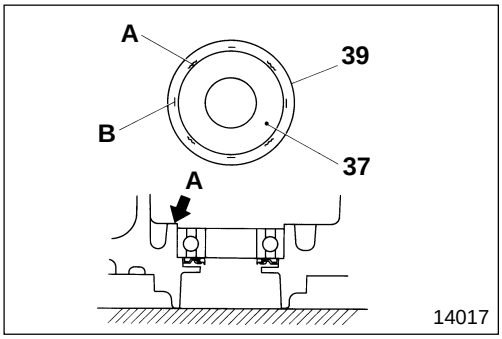
36 **Installation of lever**

Install lever **36** onto overrunning clutch **33** in the direction as shown.



37 **Installation of front bearing**

- Install oil seal **38** before press-fitting front bearing **37**.
- Press-fit front bearing **37** into front bracket **39** using pipe-shaped tool **A**.



- Re-caulk the side of front bracket **39**.

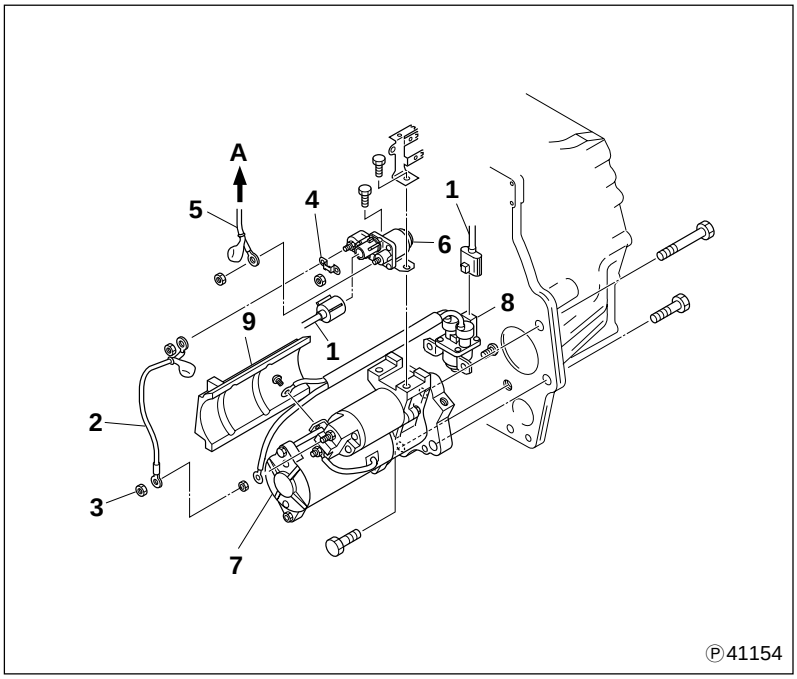
NOTE

Do not re-caulk previously caulked points B.

A : Caulking points (4 points)

930 STARTER

< 4M5 >



● **Removal sequence**

1 Chassis harness
2 Starter cable
3 Nut (connect to terminal B)
4 Fuse
5 Glow cable
6 Glow relay 🕮 **195**
7 Starter 🕮 P54-12-18
8 Starter relay 🕮 **187**
9 Rubber spacer
B : Connect to terminal B
S : Connect to terminal S

WARNING⚠

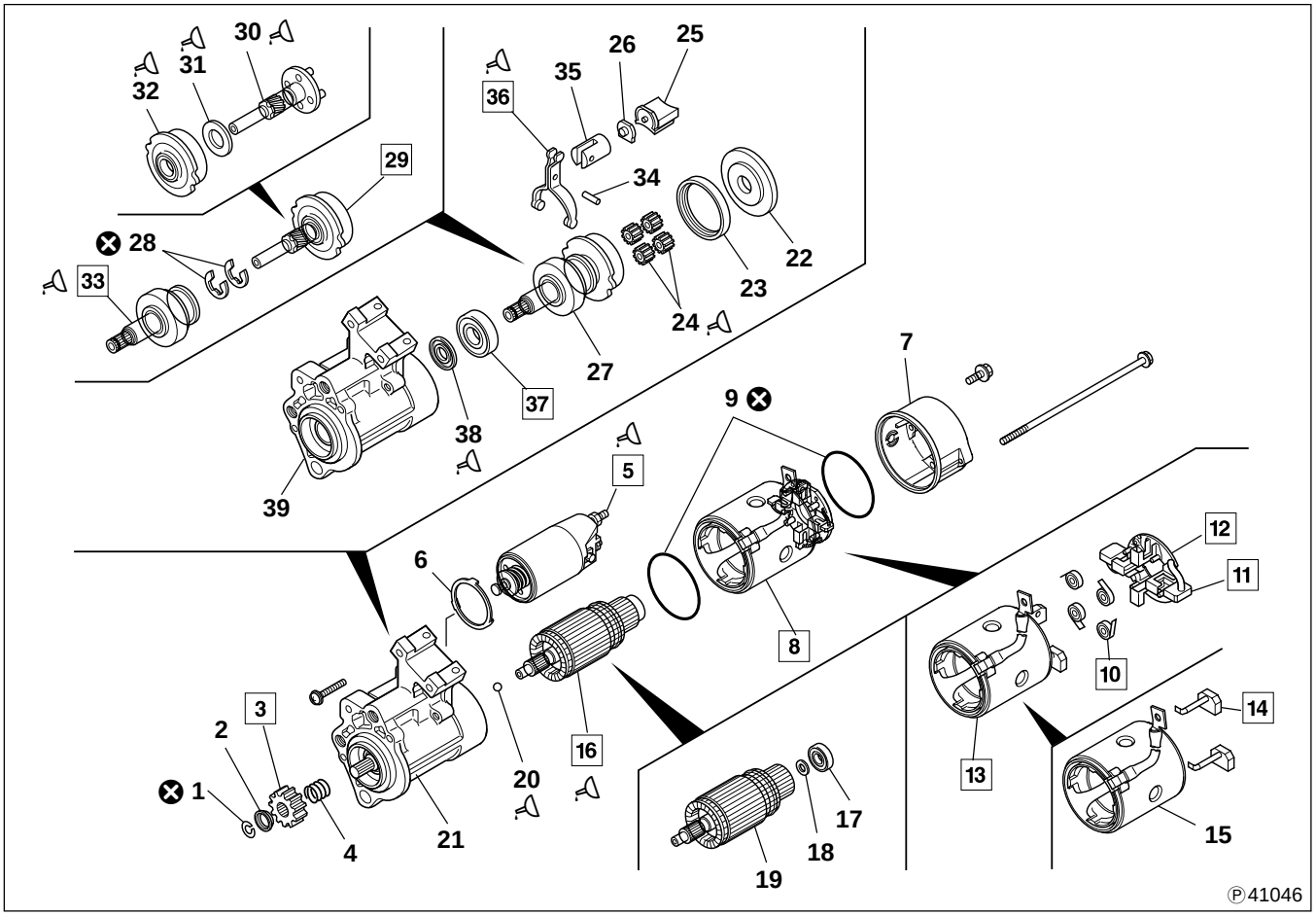
Never touch the starter 7 with tools when you remove the harness from terminal B. This is because voltage is always supplied to it from starter cable 2, and you will short-circuit the starter. Before removing the harness from terminal B, remove the ⊖ battery terminal and tape it up to insulate it.

● **Installation sequence**

Follow the removal sequence in reverse.

M E M O

Starter < 4M5 >



● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch assembly
6 Shim
7 Rear bracket
8 Yoke and brush holder assembly
9 Rubber packing
10 Brush spring
11 Brush ⊖
12 Brush holder assembly
13 Yoke assembly
14 Brush ⊕
15 Yoke
16 Armature assembly
17 Rear bearing
18 Washer
19 Armature
20 Ball
21 Front bracket assembly
22 Cover
23 Rubber packing
24 Planetary gear
25 Rubber packing
26 Plate
27 Gear shaft and overrunning clutch assembly
28 E-ring
29 Gear shaft and internal gear assembly
30 Gear shaft assembly
31 Washer
32 Internal gear
33 Overrunning clutch
34 Pin
35 Holder
36 Lever
37 Front bearing
38 Oil seal
39 Front bracket

⊗ : Non-reusable parts

CAUTION⚠

- **Do not remove bearings 17, 37 unless they are faulty.**
- **Be careful not to lose ball 20, since it might come out together with armature assembly 16 when you remove it.**

NOTE

- **You do not have to remove pinion 3 when you disassemble or inspect only the motor assembly, for example: when inspection of the brush assembly is required.**
- **Except for the above, make sure you remove pinon 3 before disassembling any parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Whenever magnetic switch assembly 5 has been replaced, be sure to adjust the pinion gap.

● **Inspection after assembly**

🕮 P54-12-20

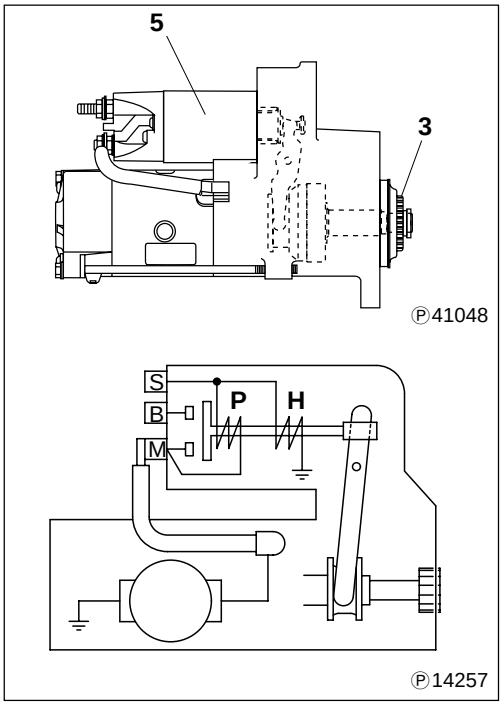
Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
—	Pinion gap			0.5 to 2.0 {0.02 to 0.079}	—	Adjust
—	No-load characteristic	With current of 11 V	Current	180 A or less	—	Inspect
			Revolutions per minute	3800 rpm or more	—	
10	Pressure of brush spring			29.2 to 39.4 N {6.6 to 8.9 lbs, 2.98 to 4.02 kgf}	13.7 N {3.1 lbs, 1.4 kgf}	Replace
11, 14	Length of brush			18 {0.71}	11 {0.43}	Replace
16	Outer diameter of commutator			32 {1.26}	31.4 {1.24}	Replace
	Deflection of commutator periphery			—	0.1 {0.0039} or more	Replace
	Mold depth between segments			—	0.2 {0.0079} or less	Correct or replace

Lubricant

Location	Points of application	Specified lubricant	Quantity
5	Lever contact surface of magnetic switch assembly	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Teeth of armature assembly gear	MOLYKOTE ® AG650	As required
16, 30	Sliding surface of armature assembly and gear shaft assembly	MOLYKOTE ® AG650	As required
20	Ball	MOLYKOTE ® AG650	As required
24, 32	Teeth of internal gear and planetary gear	MOLYKOTE ® AG650	As required
30, 33	Friction surfaces of gear shaft assembly and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
31	Washer	MOLYKOTE ® AG650	As required
33	Spline of overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
36	Friction surfaces of lever and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
38	Oil Seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● Inspection after assembly

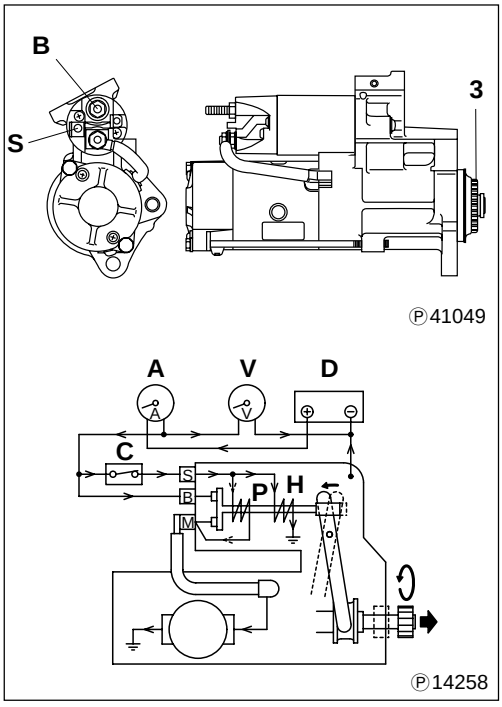
Inspection after assembling the starter should be carried out with current fed to the starter.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot during inspection.**

CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits the coil might burn due to overheating.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



(1) Performance test

- Connect the starter as shown.
  A : Ammeter
  B : Terminal B of starter
  C : Switch
  D : 12 volts DC
  S : Terminal S of starter
  V : Voltmeter
- Set the voltage to 11 volts DC.

CAUTION⚠

Up to 12 volts can be loaded.

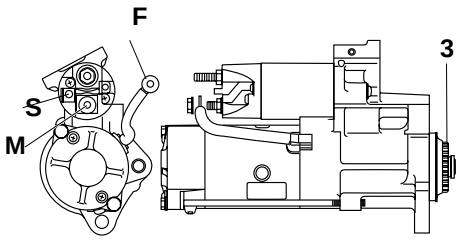
- The following work should be done with current fed to the starter. You must complete measurement of the current and the number of revolutions within 30 seconds.
  - Turn switch **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

CAUTION⚠

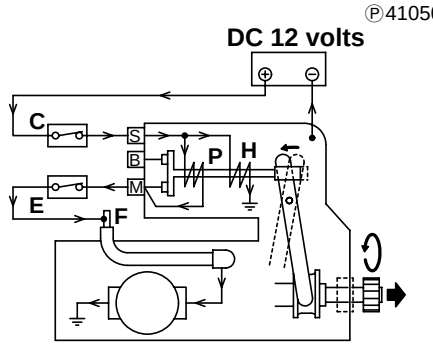
When switch C is turned ON, current is fed both to pull-in coil P and holding coil H. When a large amount of current is fed into terminal M from DC power supply D, via terminal B of the starter, the current stops flowing into the pull-in coil but continues to flow into the holding coil.

To avoid burning the holding coil, be sure to carry out the performance test within 30 seconds.

  - Measure the current and the number of revolutions of the starter. Train a strobe light on pinion **3** to measure the revolutions.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, disassemble the starter again and inspect it.



Ⓟ41050



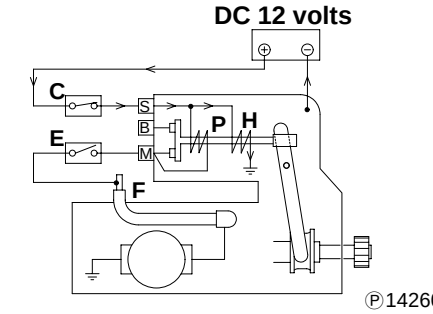
Ⓟ14259

(2) Pinion gap

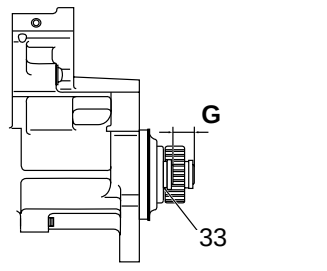
[Inspection]

- Connect the starter as shown.
  C : Switch
  E : Switch
  F : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete measurement of the pinion gap within 30 seconds.
  - Turn switches **C** and **E** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



Ⓟ14260



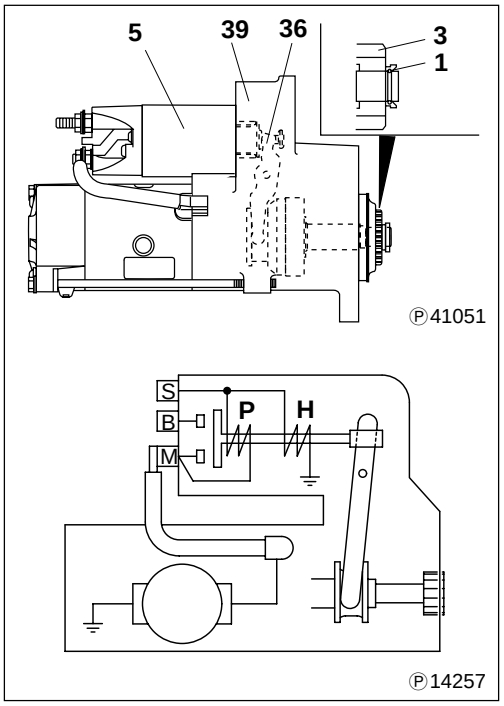
Ⓟ34689

  - Within 5 seconds of pinion **3** rotating, turn switch **E** OFF to stop rotation of the pinion.

CAUTION⚠

When switches C and E are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.
To avoid burning the pull-in coil, be sure to turn switch E OFF within 5 seconds of the pinion rotating.

  - Hold the end of overrunning clutch **33** with fingers, and pull it. Measure the distance **G** (pinion gap) in the shaft direction that the overrunning clutch moves when it is lightly pushed back by hand.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, replace lever **36**.



3 **Pinion**

[Removal]

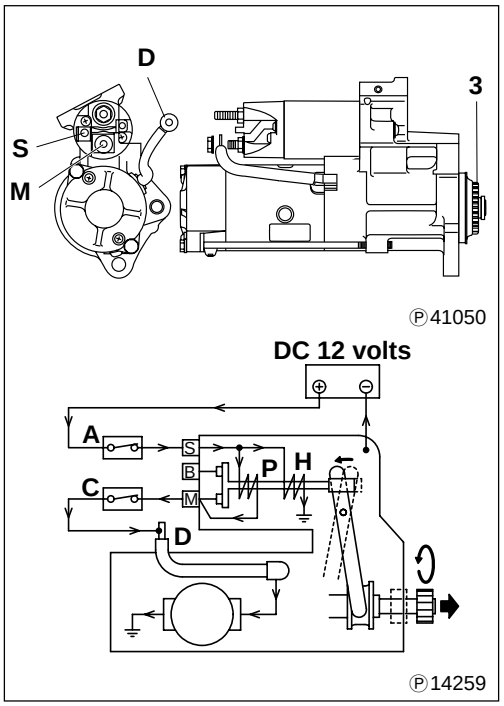
Feed current to the starter and protrude pinion **3** to remove the pinion.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot after inspection.**

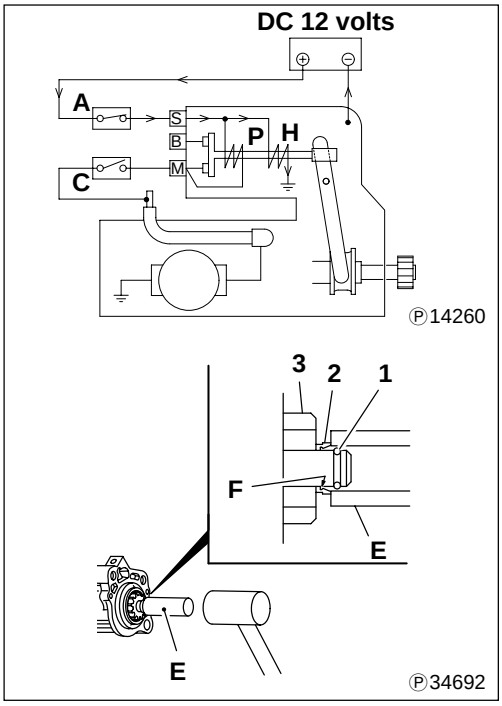
CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits, the coil might burn due to overheating.**
- **Before making pinion 3 jump out, be sure to feed current to the starter to obtain the correct state. If current is not fed to the starter and lever 36 is pulled to protrude the pinion, front bracket 39 or the lever might be damaged due to the shock produced on removal of stopper ring 1.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



- Connect the starter as shown.
  A : Switch
  C : Switch
  D : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete removal of pinion **3** within 30 seconds.
  - Turn switches **A** and **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



- Within 5 seconds of pinion **3** rotating, turn switch **C** OFF to stop rotation of the pinion**.**

CAUTION

When switches A and C are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.

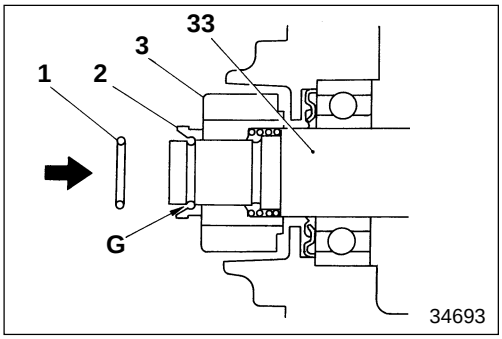
To avoid burning pull-in coil P, be sure to turn switch C OFF within 5 seconds after the pinion rotates.

- Apply pipe-shaped tool **E** onto pinion stopper **2**.
- Hit tool **E** lightly using a mallet to remove stopper ring **1** from ring groove **F** of pinion stopper **2**.
- Remove stopper ring **1** and pinion **3**.
- Turn switch **A** OFF to stop current to the starter.

NOTE

When the current to the starter is stopped, stopper ring 1 might fall back into ring groove F of pinion stopper 2 because pinion 3 is pushed inside.

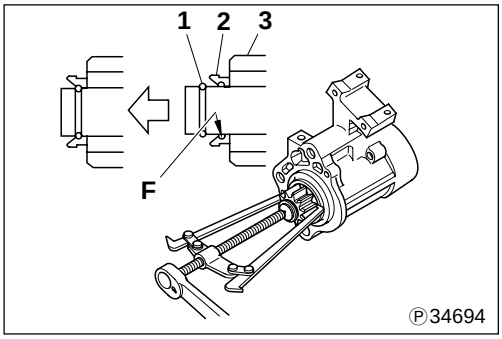
If this occurs, feed current to the starter again and carry out the work.



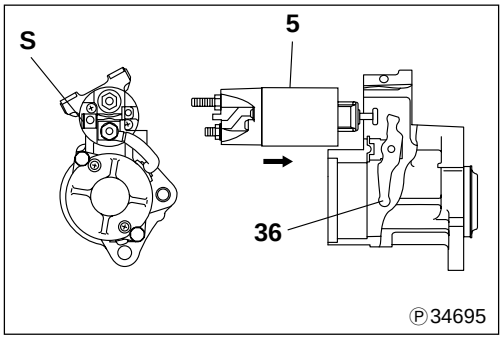
[Installation]

When installing pinion **3**, it is not necessary to feed current to the starter.

- Install pinion stopper **2** and pinion **3** onto overrunning clutch **33** in the direction as shown.
- Fit stopper ring **1** into ring groove **G** of overrunning clutch **33**.

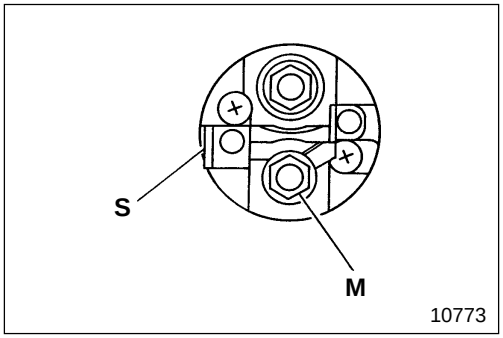


- Pull pinion **3** firmly and set stopper ring **1** on groove **F** of pinion stopper **2** securely.



5 Magnetic switch assembly

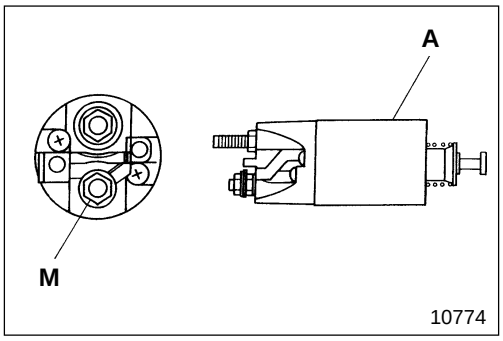
[Installation]
Install magnetic switch assembly **5** to lever **36**, with terminal **S** facing the direction as shown.



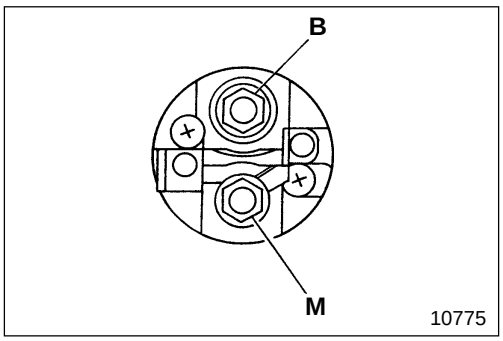
[Inspection]

(1) Testing for coil breakage

- Make sure that there is continuity between terminals **S** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.

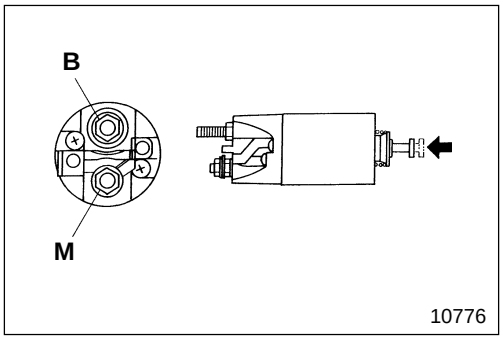


- Make sure that there is continuity between terminal **M** and body **A**.
- If there is no continuity, replace magnetic switch assembly **5**.



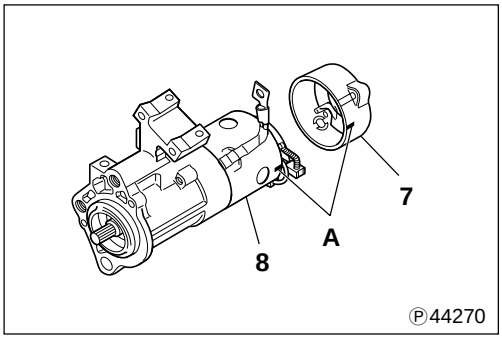
(2) Inspection of welded connections

- Make sure that there is no continuity between terminals **B** and **M**.
- If there is continuity, replace magnetic switch assembly **5**.



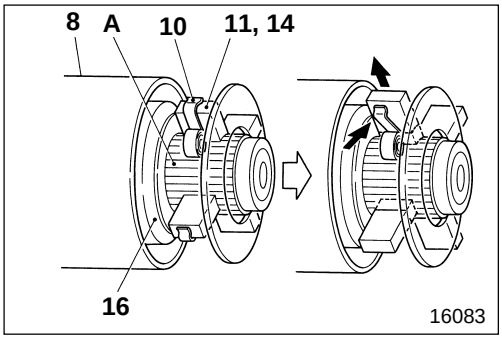
(3) Inspection of connections

- Push the tip of magnetic switch assembly **5** to close the internal connection.
  Make sure that there is continuity between terminals **B** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.



7 **Installation of rear bracket**

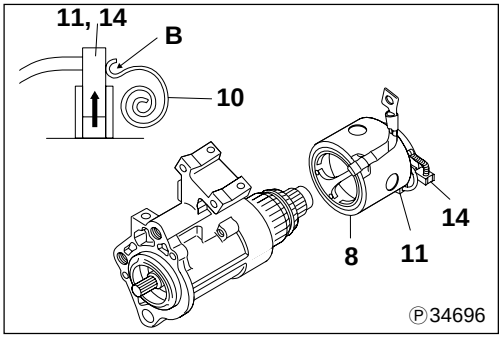
A : Alignment mark



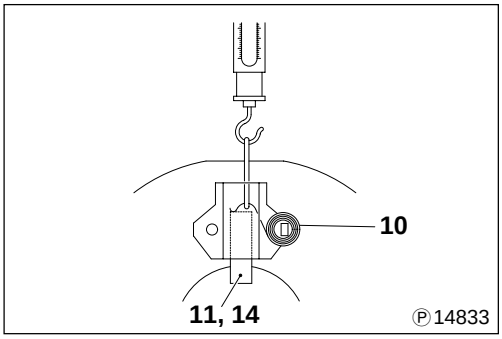
8 **Removal and installation of yoke and brush holder assembly**

Use the following method to remove the yoke and brush holder assembly **8** in order to prevent the commutator **A** of the armature assembly **16** from being damaged by the brushes **11** and **14**.

- Lift the brushes **11** and **14** away from the commutator **A** and hold them lifted by applying the brush springs **10** against the sides of the brush springs.

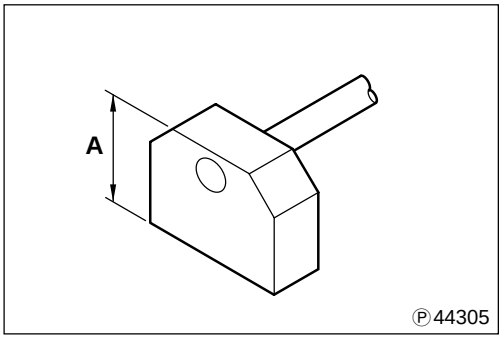


- Pull part **B** of each brush spring **10** and pull up the brushes **11** and **14**.
- Hold the brushes **11** and **14** in position with brush spring **10** as shown.
- Remove yoke and brush holder assembly **8**.
- To reinstall the yoke and brush holder assembly **8**, follow the removal instructions in, reverse.



10 **Inspection of brush spring**

- Use new brushes **11, 14** and measure the load when brush spring **10** is detached from the brushes.
- If the measured value is lower than the limit, replace brush spring **10**.



11 **14** **Inspection of brush**

(1) Length of brush

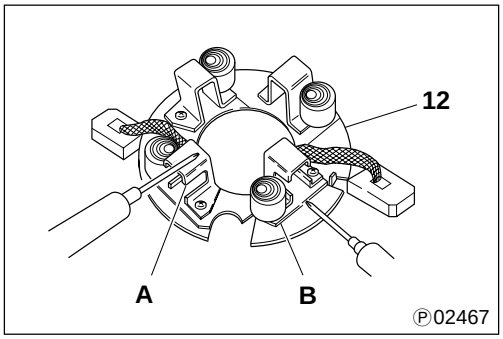
If the measured value **A** is lower than the limit, replace brushes **11, 14**.

NOTE

To replace brush ⊖ 11, replace entire brush holder assembly 12.

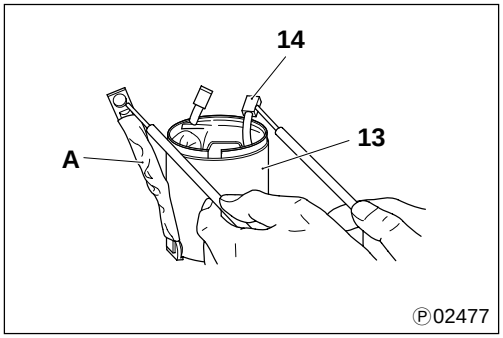
(2) Contact surface with commutator

If the surface where the brushes contact the commutator is rough or is worn unevenly, polish the surface with emery paper (300 to 500 grit).



12 Inspection of brush holder assembly

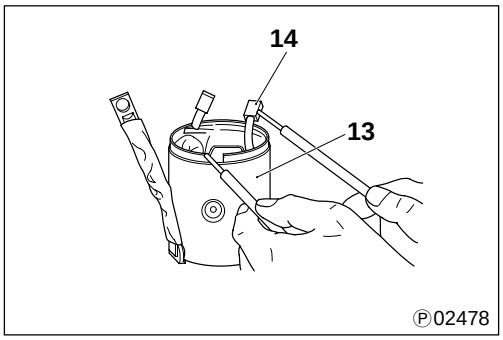
- Clearing the brush holder **A** and holder plate **B**.
- Make sure that there is no continuity between the ⊕ side of the brush holder **A** and the ⊖ side of the holder plate **B**.
- If there is continuity between them, they are short-circuited. Replace brush holder assembly **12**.



13 Inspection of yoke assembly

(1) Testing for coil breakage

- Make sure that there is continuity between cable **A** and brush ⊕ **14**.
- If there is no continuity, they are broken. Replace brush ⊕ **14** or yoke assembly **13**.

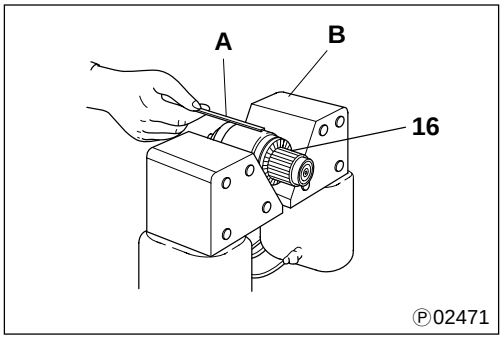


(2) Testing for coil grounding

- Make sure that there is no continuity between yoke assembly **13** and brush ⊕ **14**.
- If there is continuity, they are short-circuited. Inspect the insulated point. If it is hard to repair, replace brush ⊕ **14** or yoke assembly **13**.

NOTE

The coil may be short-circuited to the yoke assembly 13 due to the accumulation of worn-off metal particles from the brushes and/or armature.



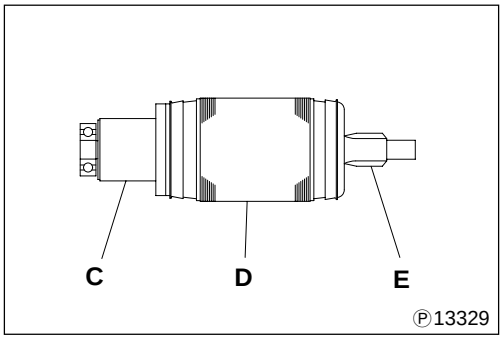
16 Inspection of armature assembly

(1) Testing for coil short-circuit

- Hold an iron rod **A** parallel with the armature assembly **16**.

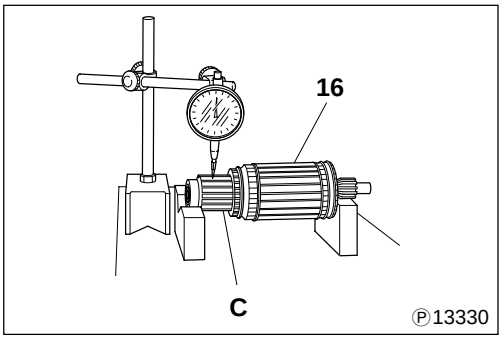
B : Armature tester

- Slowly rotate the armature assembly **16** by hand.
- If the iron rod **A** vibrates or is pulled toward the armature assembly **16**, the coil is short-circuited and the armature assembly must be replaced.



(2) Testing for coil grounding

- Make sure that there is no continuity between commutator **C** and core **D** (or shaft **E**).
- If there is continuity between them, they are short-circuited. Replace armature assembly **16**.

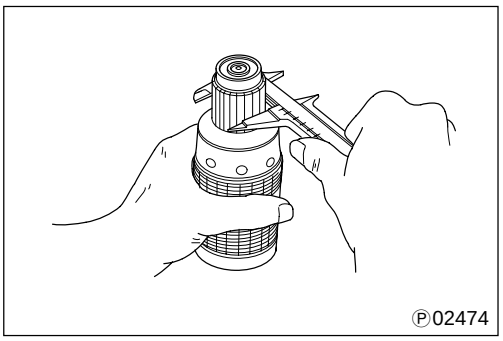


(3) Deflection of commutator

If the measured value is higher than the limit, correct the outer diameter of commutator **C** within the limit.

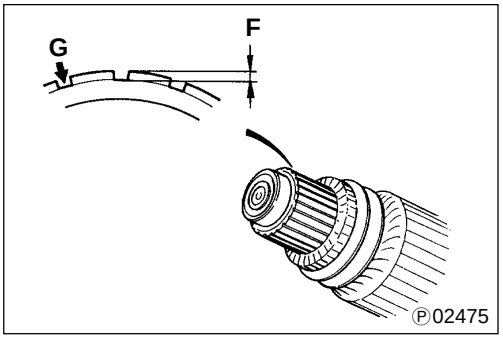
(4) Condition of the surface of commutator

- If the surface is rough or has stepped wear, polish the surface with emery paper (300 to 500 grit).
- After polishing, check deflection of commutator **C**.



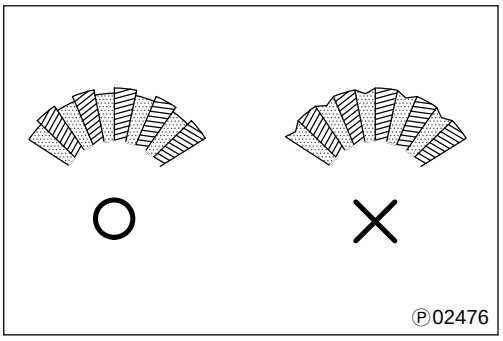
(5) Outer diameter of commutator

If the measured value is higher than the limit, replace armature assembly **16**.

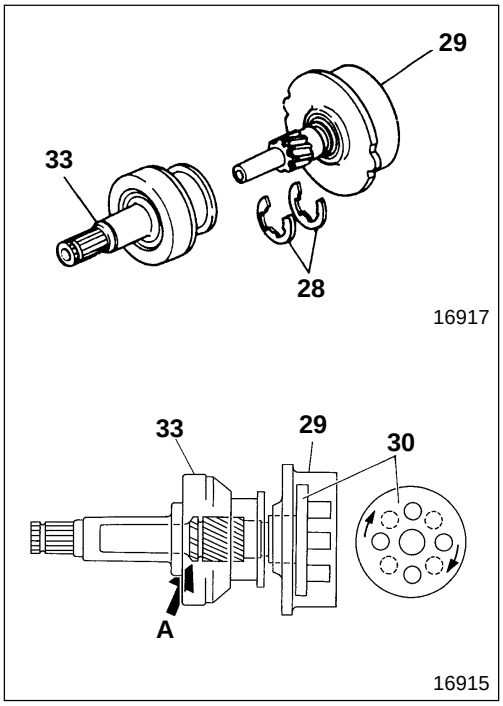


(6) Mold depth between segments

- If the measured value is lower than the limit, replace armature assembly **16**.
  F : Mold depth
- To rectify the armature assembly **16**, grind the shown portions **G**.



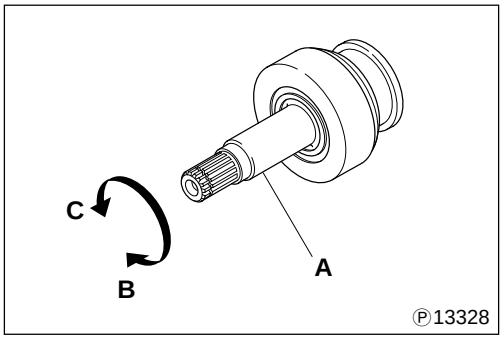
- If the mold is worn as shown, correct or replace armature assembly **16**.
  ○ : Good
  × : Faulty



29 Removal of gear shaft and internal gear assembly

Remove the E-rings **28** and then the gear shaft and internal gear assembly **29** from the overrunning clutch **33**.
Proceed as follows if the gear shaft and internal gear assembly **29** cannot be removed due to interference of the splined section **A** of gear shaft assembly **30** with internal parts of the overrunning clutch **33**.

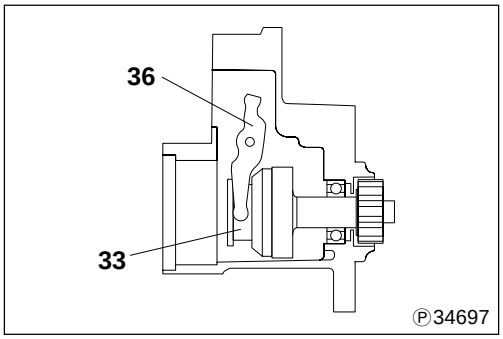
- Press the gear shaft assembly **30** against the overrunning clutch **33**.
- Turn the gear shaft assembly **30** approx. 1/8 of a turn to change the position of splined section **A**.



33 Inspection of overrunning clutch

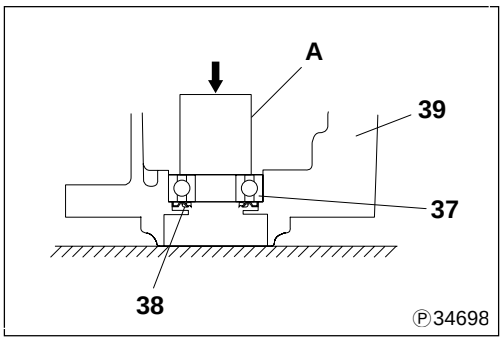
Perform the following checks, and if any fault is found, replace the overrunning clutch **33**.

- Make sure that shaft **A** turns smoothly when turned in direction **B**.
- Make sure that shaft **A** locks when turned in direction **C**.



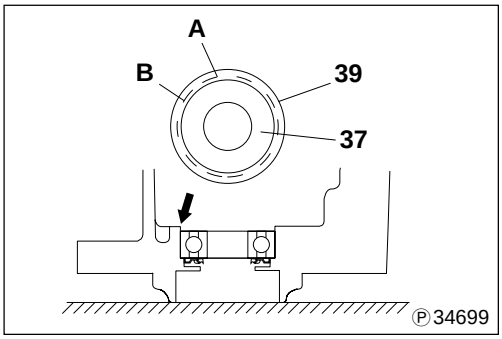
36 Installation of lever

Install lever **36** onto overrunning clutch **33** in the direction as shown.



37 Installation of front bearing

- Install oil seal **38** before press-fitting front bearing **37**.
- Press-fit front bearing **37** into front bracket **39** using pipe-shaped tool **A**.



- Re-caulk the side of front bracket **39**.

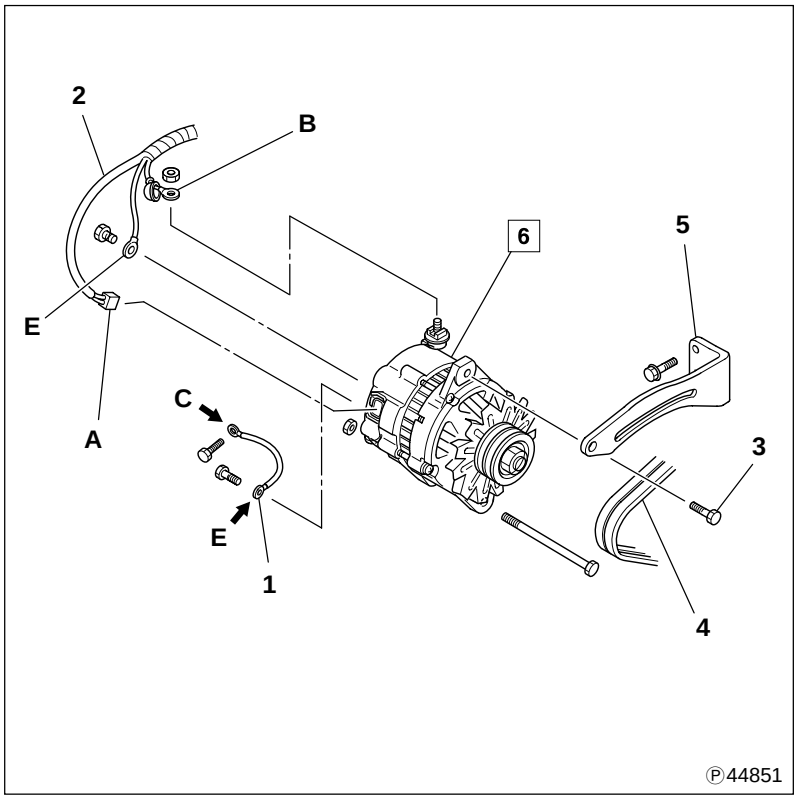
NOTE

Do not re-caulk previously caulked points B.

A : Caulking points (4 points)

940 ALTERNATOR

< 4D3 >



● **Removal sequence**

1 Ground cable
2 Chassis harness
3 Adjusting bolt
4 V-belts
5 Adjusting plate
6 Alternator 📖 P54-12-32

A : To terminals L and R
B : To terminal B
C : To crankcase
E : To terminal E

WARNING ⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing alternator 6.
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.

● **Installation sequence**

Follow the removal sequence in reverse.

● **Adjustment after installation**

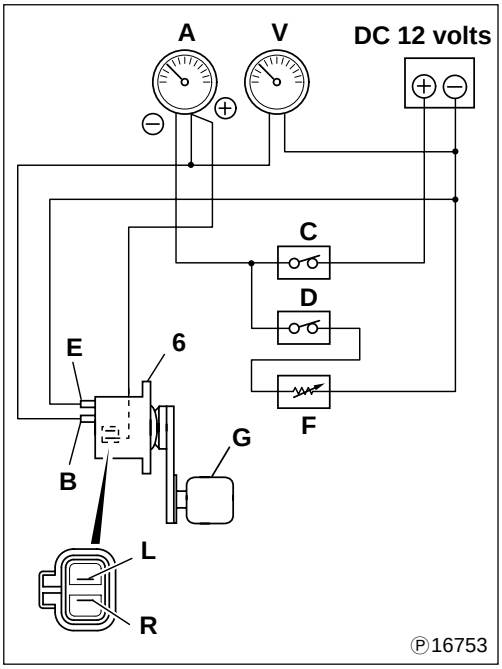
For adjustment of V-belt 4 tension
📁 Gr 14

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
6	Alternator output current (*When alternator is hot and producing 13.5V)	At 1500 rpm	53 A or more	—	Inspect
		At 2500 rpm	84 A or more	—	
		At 5000 rpm	102 A or more	—	
	Adjustment voltage of regulator (At 5000 rpm, 5A or less load)		14.7±0.3V	—	Replace

*The hot condition is the one after the alternator has been run at normal ambient temperature with 5000 rpm and maximum output for 30 minutes.

◆ Service procedure



6 **Inspection of alternator**

(1) Alternator performance check (bench test)

- Connect the alternator **6** as shown.

CAUTION⚠

Sufficiently thick wires should be used for wiring and each connection should be securely fastened.

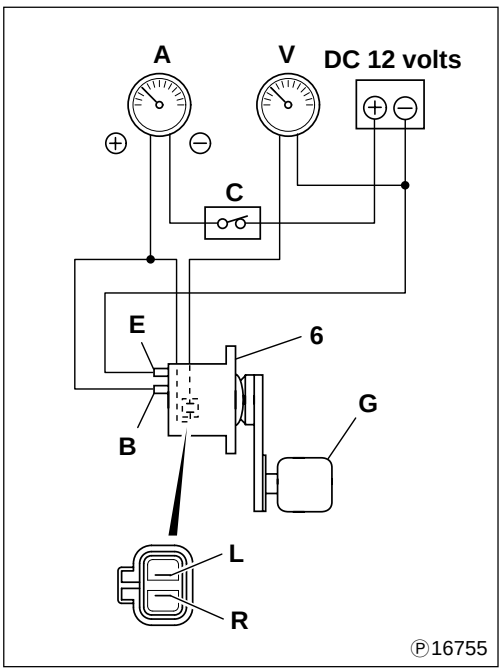
A : Ammeter
B : Alternator terminal B
C : Switch
D : Switch
E : Alternator terminal E
F : Load resistance (variable resistance)
G : Alternator drive motor
L : Alternator terminal L
R : Alternator terminal R
V : Voltmeter

- Increase load resistance **F** to the maximum (condition which the load current hardly flow).
- Turn switches **C** and **D** ON.
- Run alternator at 5000 rpm for 30 minutes by adjusting load resistance **F** so that electric current can conform to the specified standard.

  Alternator nominal current

  12V-100A

- Measure the current at each specified revolution of alternator **6**.
- If the measured value deviates from the standard value, disassemble and check alternator **6**. 📖 P54-12-32



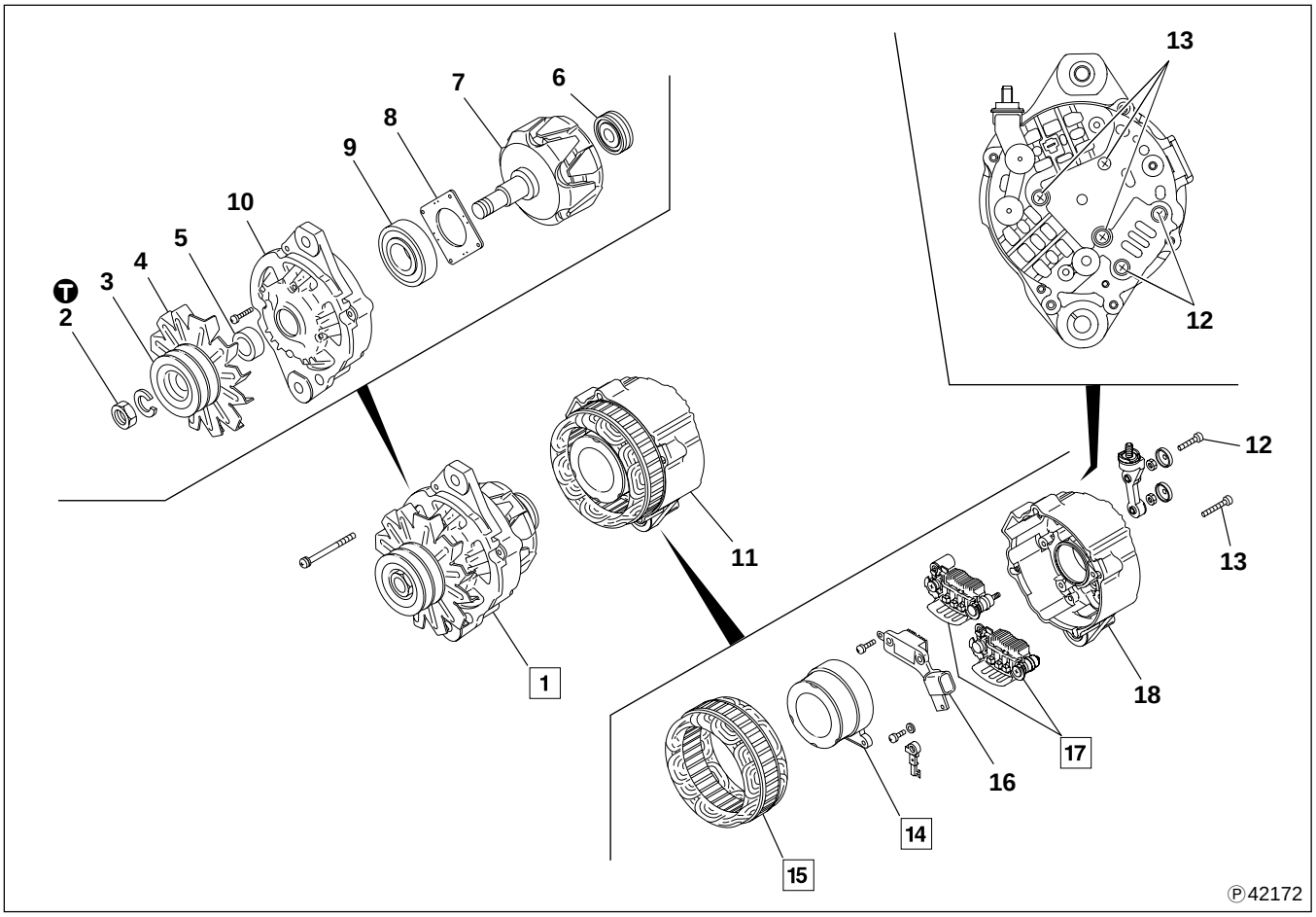
(2) Regulator performance check (bench test)

- Connect the alternator **6** as shown.

A : Ammeter
B : Alternator terminal B
C : Switch
E : Alternator terminal E
G : Alternator drive motor
L : Alternator terminal L
R : Alternator terminal R
V : Voltmeter

- Turn switches **C** ON.
- Run alternator **6** at low speeds.
- Increase the speed of alternator **6** to 5000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 5 amperes or less at 5000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If below the standard value: Inspect the alternator related parts before replacing the regulator.

< 4D3 >



● **Disassembly sequence**

1 Rotor and front bracket assembly
2 Nut
3 Pulley
4 Fan
5 Spacer
6 Rear bearing
7 Rotor assembly
8 Cover
9 Front bearing
10 Front bracket
11 Stator and rear bracket assembly
12 Screws
13 Screws
14 Field coil
15 Stator assembly
16 Regulator
17 Rectifiers
18 Rear bracket

NOTE

Do not remove parts 6, 9, 15 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

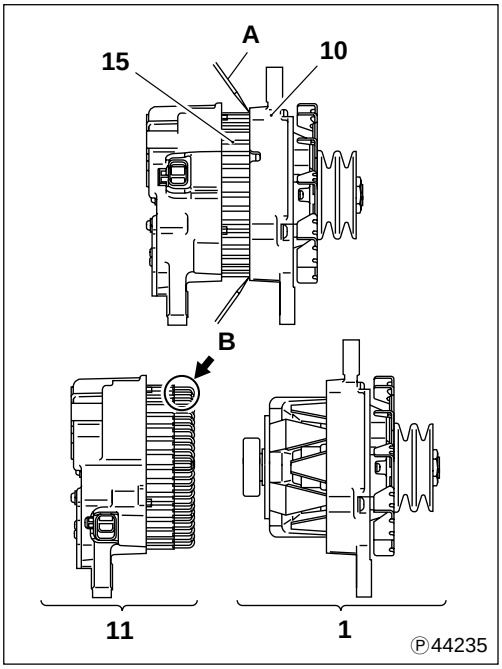
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
14	Field coil resistance (20°C {68°F})	2.0 to 2.4 Ω	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Pulley mounting)	132 to 162 {98 to 120, 13.5 to 16.5)	—



◆ Service procedure

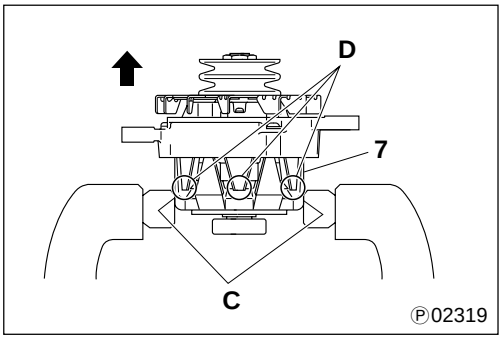
1 Rotor and front bracket assembly

[Removal]

- Insert a screwdriver **A** between front bracket **10** and stator assembly **15**.
- Use the screwdriver **A** to pry rotor and front bracket assembly **1** away from stator and rear bracket assembly **11**.

CAUTION

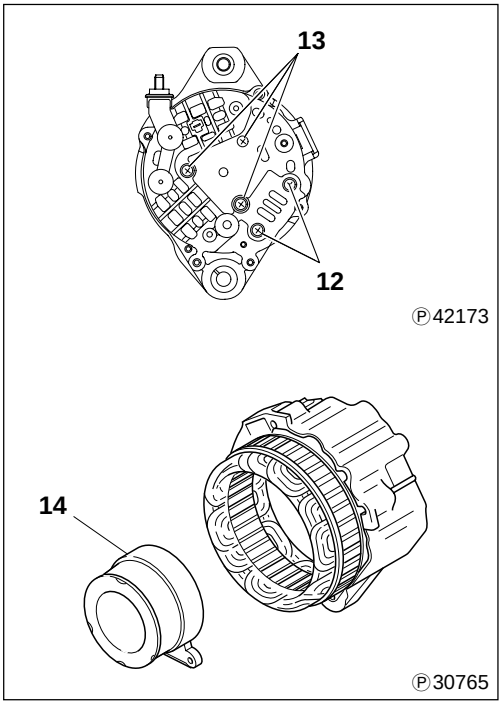
Be careful not to insert the screwdriver A too deep or it will damage coil B of stator assembly 15 and might cause a short-circuit.



[Disassembly]

CAUTION

Make sure, when you hold rotor assembly 7 in a vise, to grip root C of the core claws. Gripping claws D can damage them.



14 Field coil

[Removal]

- Remove screw **12** (2 places).

CAUTION

If screw 13 are removed first, the weight of field coil 14 may be placed on the joining portion with regulator 16 which is fixed with screw 12, causing break of the joining portion. To avoid this, remove screw 12 first.

- Remove screw **13** (3 places).

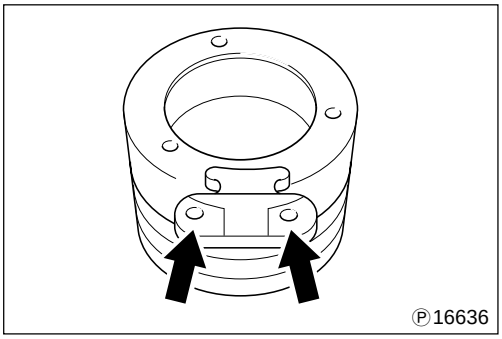
CAUTION

If screw 13 are removed, field coil 14 falls under its own weight. Keep the field coil supported by your hand.

- Remove field coil **14**.

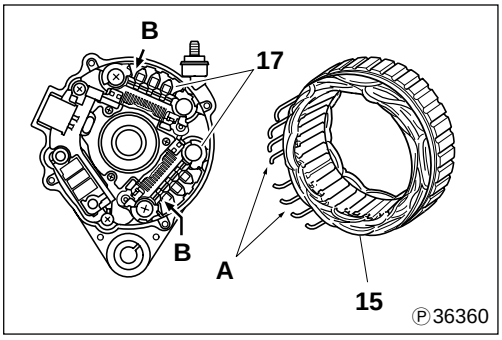
CAUTION

Do not take out field coil 14 forcibly. Otherwise the joining portion with regulator 16 may be caught by the stator coil.



[Inspection]

- Measure the resistance between the terminals of field coil **14**.
- If the measured value deviates from the standard value, replace field coil **14**.



15 Stator assembly

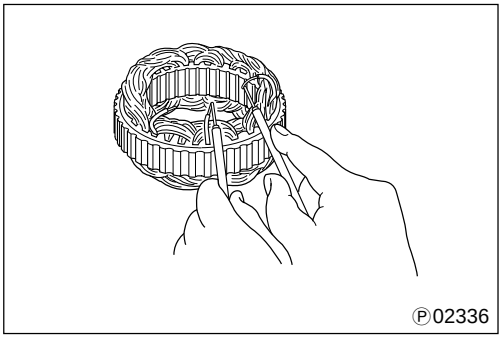
[Removal and installation]

- Disconnect lead **A** of stator assembly **15** from rectifier **17**. The lead is soldered to diode **B** of the rectifier at 8 places. (Each of the 2 rectifiers has 4 soldered sections.)

CAUTION

Unsolder within as short a time as possible (within 5 seconds), or diode can be easily damaged by heat.

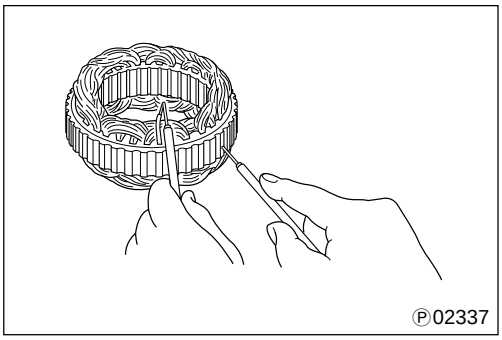
- To install, follow the removal sequence in reverse.



[Inspection]

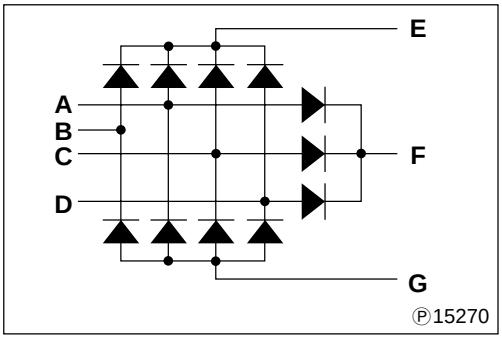
(1) Continuity between each lead wire

- Check that there is continuity between each stator lead.
- If there is no continuity, the lead is broken. Replace stator assembly **15**.



(2) Continuity between each lead wires and the core

- Check that there is no continuity between lead wires and the core.
- If there is continuity, the lead wires is short-circuited. Replace the stator assembly **15**.

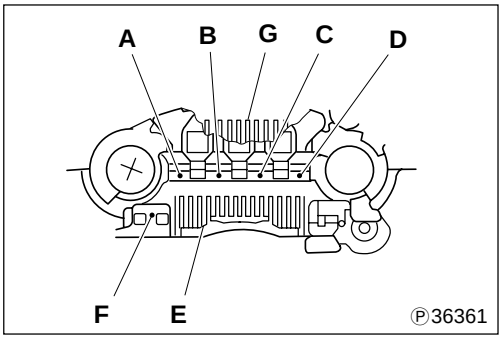


17 Inspection of rectifier

- Check the function of diodes within rectifier **17** properly. If any fault is found, replace the rectifier.

  If resistance is infinite in both cases, the diode is open.
  If resistance is close to 0Ω in both cases, the diode is shorted

  A, **B**, **C**, **D** : Lead connecting area of stator coil
  E, **G** : Heat sink area
  F : Regulator connecting area



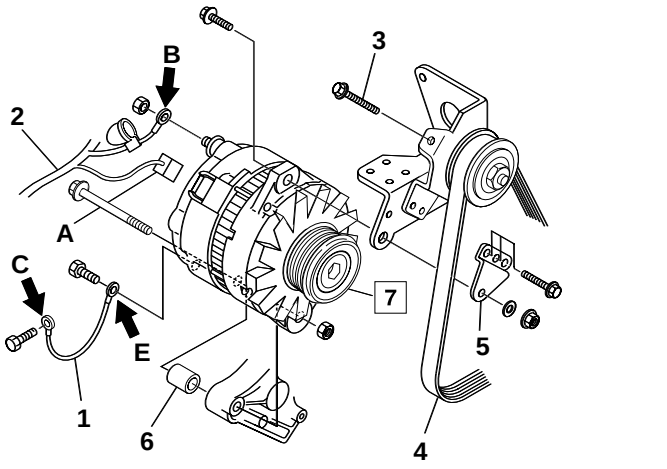
- Inspection should be repeated with the positive probe and the negative probe of the tester changed over.

CAUTION ⚠

When inspecting using a tester, the current flowing through rectifier 17 is smaller than usual. Therefore, an incorrect resistance value might be indicated on the tester.
Also, incorrect indication become larger as the range of the tester gets smaller. Set the tester to a largest possible scale.

940 ALTERNATOR

< 4M5 >



Ⓟ34708

● **Removal sequence**

1 Ground cable
2 Chassis harness
3 Adjusting bolt
4 V-belts
5 Adjusting plate
6 Spacer
7 Alternator 🕮 P54-12-38

A : To terminals L and R
B : To terminal B
C : To crankcase
E : To terminal E

WARNING⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing alternator 7.
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.

● **Installation sequence**

Follow the removal sequence in reverse.

● **Adjustment after installation**

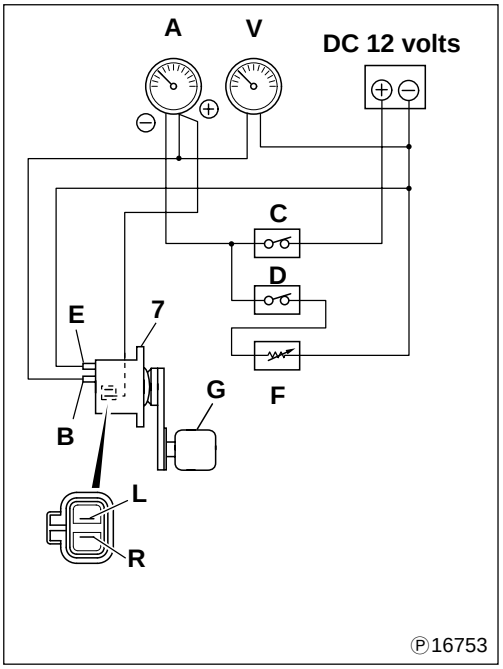
For adjustment of V-belt 4 tension
Gr 14

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
7	Alternator output current (*When alternator is hot and producing 13.5V)	At 1500 rpm	53A or more	—	Inspect
		At 2500 rpm	84A or more	—	
		At 5000 rpm	102A or more	—	
	Adjustment voltage of regulator (At 5000 rpm, 5A or less load)		14.7±0.3V	—	Replace

*The hot condition is the one after the alternator has been run at normal ambient temperature with 5000 rpm and maximum output for 30 minutes.

◆ Service procedure



7 Inspection of alternator

(1) Alternator performance check (bench test)

- Connect the alternator **7** as shown.

CAUTION⚠

Sufficiently thick wires should be used for wiring and each connection should be securely fastened.

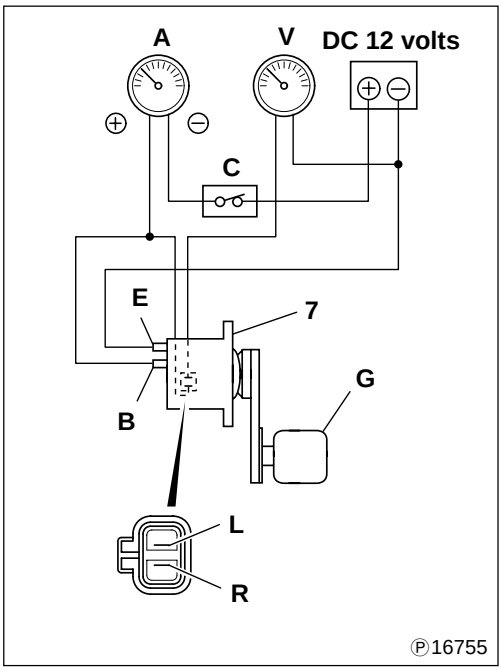
A : Ammeter
B : Alternator terminal B
C : Switch
D : Switch
E : Alternator terminal E
F : Load resistance (variable resistance)
G : Alternator drive motor
L : Alternator terminal L
R : Alternator terminal R
V : Voltmeter

- Increase load resistance **F** to the maximum (condition which the load current hardly flow).
- Turn switches **C** and **D** ON.
- Run alternator at 5000 rpm for 30 minutes by adjusting load resistance **F** so that electric current can conform to the current specified in the service standard.

  Alternator nominal current

12V-100A

- Measure the current at each specified revolution of alternator **7**.
- If the measured value deviates from the standard value, disassemble and check alternator **7**. 📖 P54-12-38



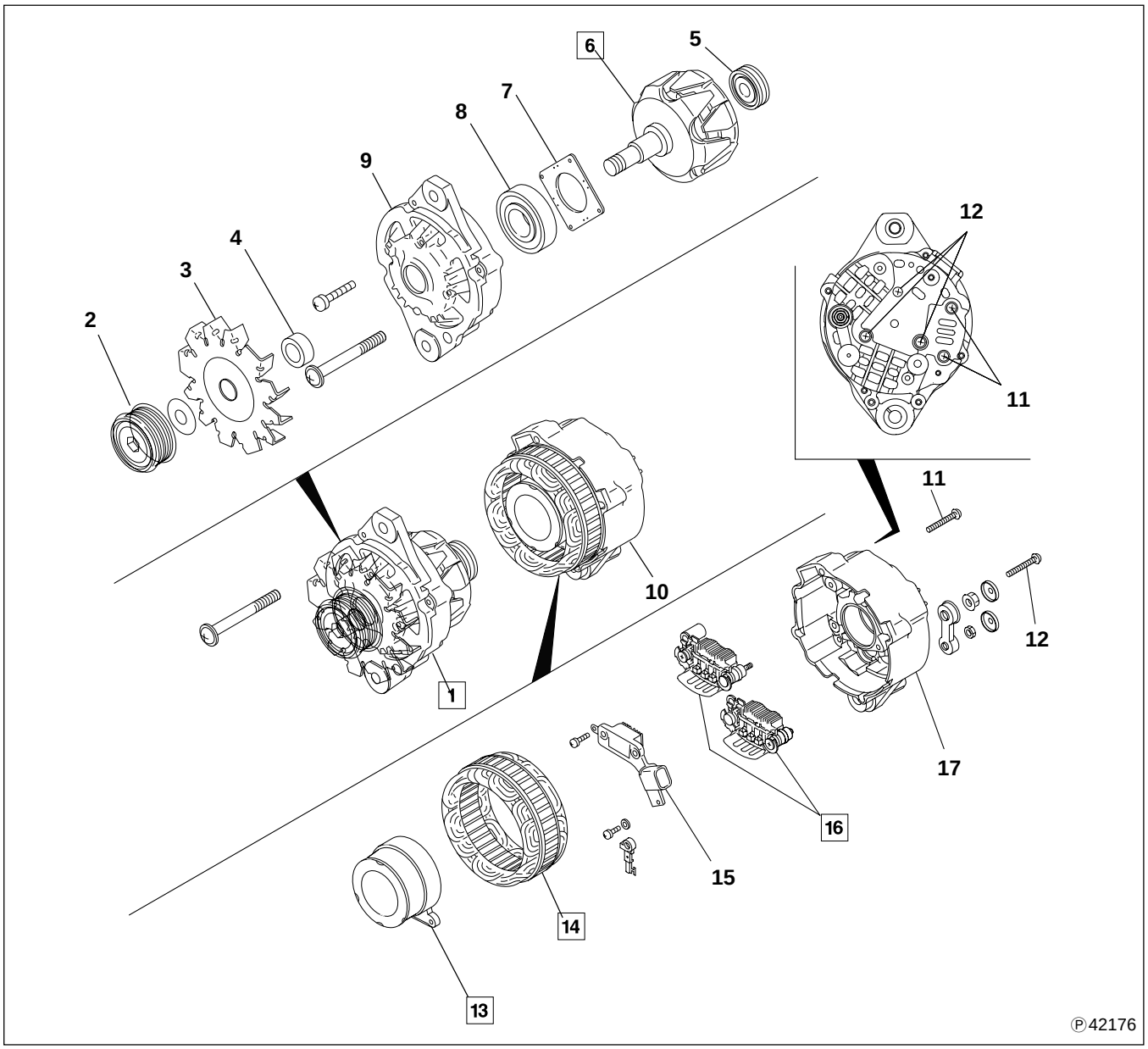
(2) Regulator performance check (bench test)

- Connect the alternator **7** as shown.

A : Ammeter
B : Alternator terminal B
C : Switch
E : Alternator terminal E
G : Alternator drive motor
L : Alternator terminal L
R : Alternator terminal R
V : Voltmeter

- Turn switches **C** ON.
- Run alternator **7** at low speeds.
- Increase the speed of alternator **7** to 5000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 5 amperes or less at 5000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If follow than the standard value: Inspect the alternator related parts before replacing the regulator.

< 4M5 >



● **Disassembly sequence**

1 Rotor and front bracket assembly
2 Pulley
3 Fan
4 Spacer
5 Rear bearing
6 Rotor assembly
7 Cover
8 Front bearing
9 Front bracket
10 Stator and rear bracket assembly
11 Screw
12 Screw
13 Field coil
14 Stator assembly
15 Regulator
16 Rectifier
17 Rear bracket

NOTE

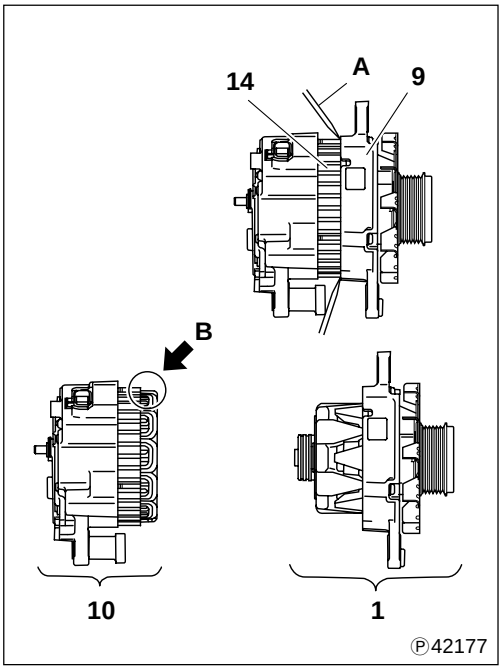
Do not remove parts 5, 8, 14 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
13	Field coil resistance (20°C {68°F})	2.0 to 2.4 Ω	—	Replace



◆ Service procedure

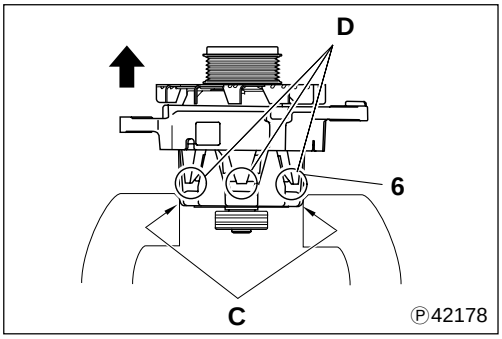
1 Rotor and front bracket assembly

[Removal]

- Insert a screwdriver **A** between front bracket **9** and stator assembly **14**.
- Use the screwdriver **A** to pry rotor and front bracket assembly **1** away from stator and rear bracket assembly **10**.

CAUTION ⚠

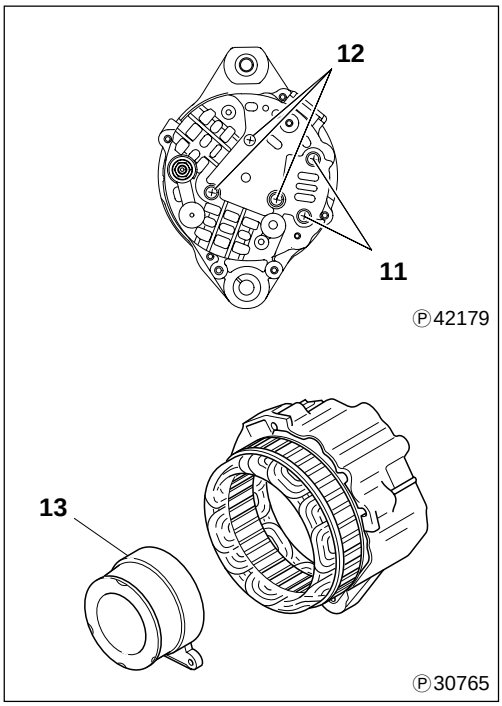
Be careful not to insert the screwdriver A too deep or it will damage coil B of stator assembly 14 and might cause a short-circuit.



[Disassembly]

CAUTION ⚠

Make sure, when you hold rotor assembly 6 in a vise, to grip root C of the core claws. Gripping claws D can damage them.



13 Field coil

[Removal]
- Remove screw **11** (2 places).

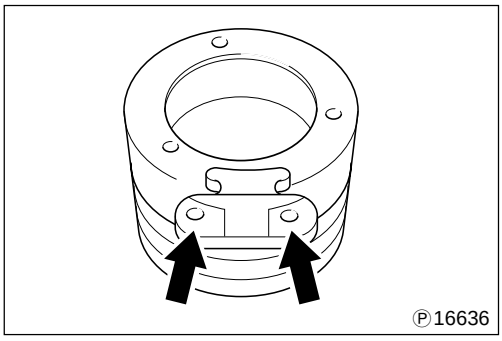
CAUTION
If screw 12 are removed first, the weight of field coil 13 may be placed on the joining portion with regulator 15 which is fixed with screw 11, causing break of the joining portion. To avoid this, remove screw 11 first.

- Remove screw **12** (3 places).

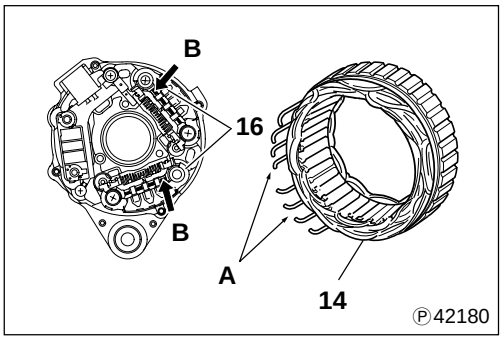
CAUTION
If screw 12 are removed, field coil 13 falls under its own weight. Keep the field coil supported by your hand.

- Remove field coil **13**.

CAUTION
Do not take out field coil 13 forcibly. Otherwise the joining portion with regulator 15 may be caught by the stator coil.



[Inspection]
- Measure the resistance between the terminals of field coil **13**.
- If the measured value deviates from the standard value, replace field coil **13**.

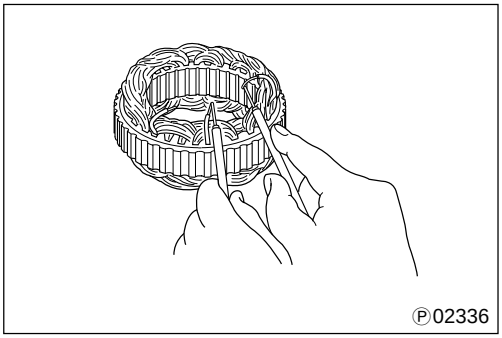


14 Stator assembly

[Removal and installation]
- Disconect lead **A** of stator assembly **14** from rectifier **16**. The lead is soldered to diode **B** of the rectifier at 8 places. (Each of the 2 rectifiers has 4 soldered sections.)

CAUTION
Unsolder within as short a time as possible (within 5 seconds), or diode can be easily damaged by heat.

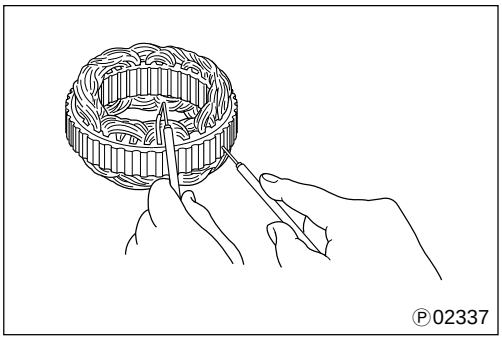
- To install, follow the removal sequence in reverse.


Ⓟ02336

[Inspection]

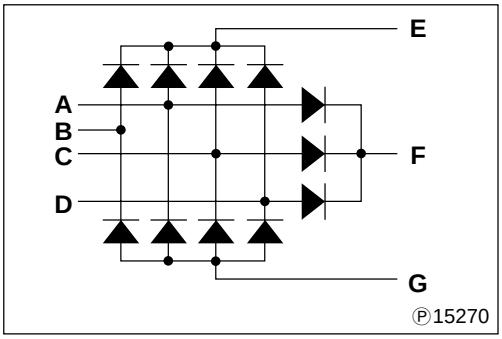
(1) Continuity between each lead wire

- Check that there is continuity between each stator lead.
- If there is no continuity, the lead is broken. Replace stator assembly **14**.


Ⓟ02337

(2) Continuity between each lead wires and the core

- Check that there is no continuity between lead wires and the core.
- If there is continuity, the lead wires is short-circuited. Replace the stator assembly **14**.



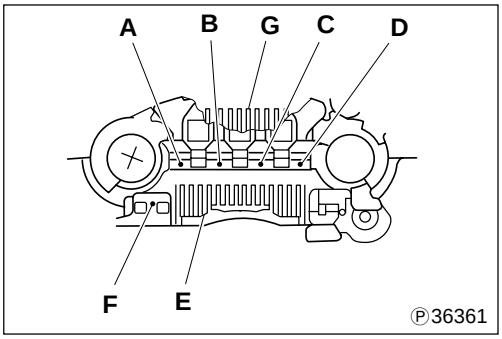
Ⓟ15270

16 Inspection of rectifier

- Check the function of diodes within rectifier **16** properly. If any fault is found, replace the rectifier.

  If resistance is infinite in both cases, the diode is open.
  If resistance is close to 0Ω in both cases, the diode is shorted

  A, **B**, **C**, **D** : Lead connecting area of stator coil
  E, **G** : Heat sink area
  F : Regulator connecting area



Ⓟ36361

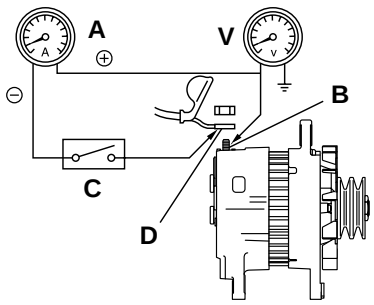
- Inspection should be repeated with the positive probe and the negative probe of the tester changed over.

CAUTION ⚠

When inspecting using a tester, the current flowing through rectifier 16 is smaller than usual. Therefore, an incorrect resistance value might be indicated on the tester.
Also, incorrect indication become larger as the range of the tester gets smaller. Set the tester to a largest possible scale.

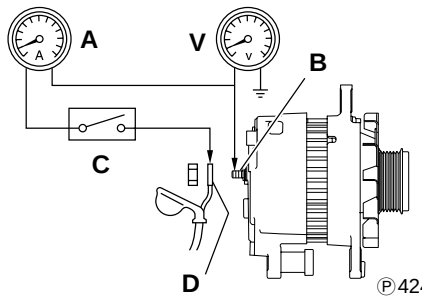
950 INSPECTION OF ALTERNATOR

< 4D3 >



Ⓟ42489

< 4M5 >



Ⓟ42490

Performance test

- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn on switch **C** and make sure that voltmeter **V** indicates battery voltage.
- Start the engine.
- Immediately turn on the switches for all lamps on the vehicle.
- Immediately accelerate the engine to the speed indicated below and measure the alternator's output current.

Engine speed	2100 to 2400 rpm

- The alternator is considered to be good if the measured value is 70% or more of the nominal output current.
  Alternator nominal output

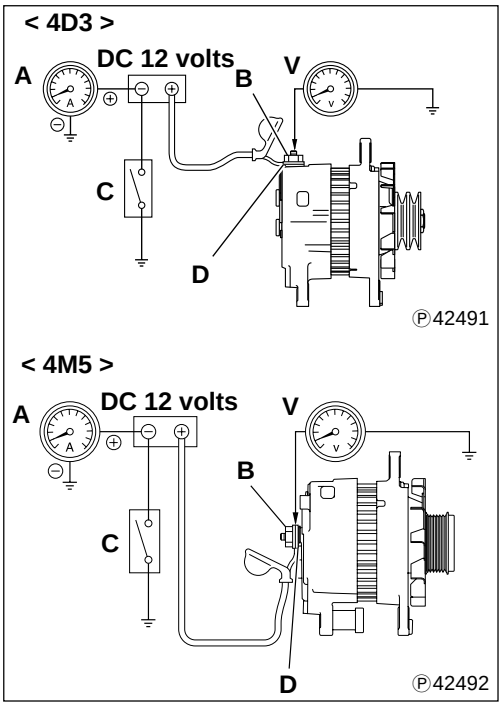
Voltage	Output current
12V	100A

NOTE

The on-vehicle inspection is only a simplified check. Use a test bench for accurate checking. 📖 940

Service standards

Location	Check item	Standard value	Limit	Remedy
—	Regulator adjusting voltage	14.7 ± 0.3V	—	Replace



- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn off the switches for lamps, heater, etc. so that electric loads may not be applied during the inspection.
- Turn on switch **C** and then start the engine.
- If the output current is 5 amperes or less when the engine speed is raised to the appropriate speed indicated below, then measure the voltage at terminal **B**.

Speed (rpm)
Approx. 2400

CAUTION

If the output current is in the range from 5 to 10 amperes, the measured value (regulated voltage) will be slightly lower.
16V – 0.2 to 0.3V

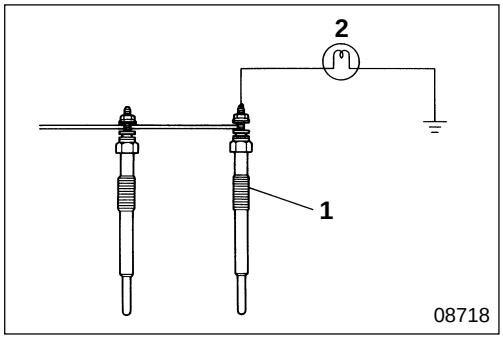
- If the output current is 5 amperes or more, do one of the following:
  - Run the engine for a while to charge the battery.
  - Replace the battery with a fully-charged one.
- If the measured value deviates from the standard value, conduct checking again on the test bench.

13 ON-VEHICLE INSPECTION AND ADJUSTMENT

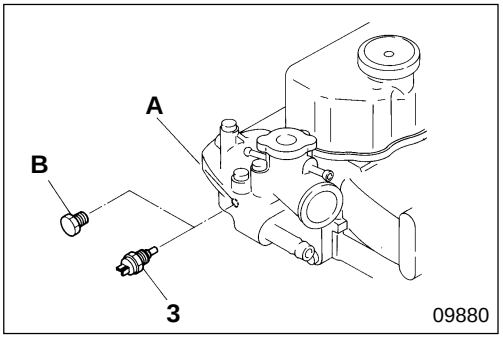
955 INSPECTION OF PREHEATING SYSTEM

Service standards

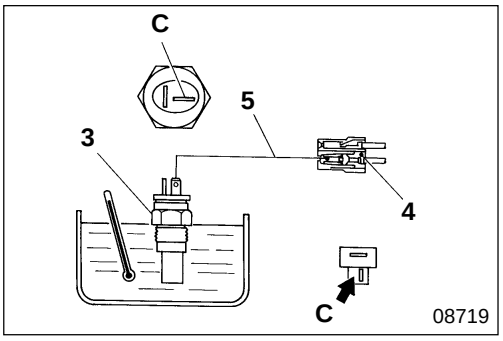
Location	Maintenance item			Standard value	Limit	Remedy
—	Pre-glow time	Coolant temperature	60°C {140°F} or more	Does not pre-glow	—	Inspect
			0 to 60°C {32 to 140°F}	About 12 seconds	—	
			0°C {32°F} or less	About 12 seconds	—	
	After-glow time	Coolant temperature	60°C {140°F} or more	Does not after-glow	—	
			0 to 60°C {32 to 140°F}	Does not after-glow	—	
			0°C {32°F} or less	About 20 seconds	—	
	Indicator lamp ON time	Coolant temperature	60°C {140°F} or more	Does not illuminate	—	
			0 to 60°C {32 to 140°F}	Does not illuminate	—	
			0°C {32°F} or less	About 8 seconds	—	



- Turn the starter switch to OFF.
- Connect a check lamp **2** to the glow plug **1** as shown.



- Remove the water temperature sensor **3** from the engine, and close the sensor mounting hole **A** with the plug **B** (M16 × 1.5 mm) {0.059 in.}.
  Removal and installation of the water temperature sensor **3** Gr 14



- Connect the extension harness **5** between the water temperature sensor **3** and connector **4**.

NOTE

Connect the extension harness 5 to the terminal C on the MUTIC (multipurpose timing control unit).

- Put water temperature sensor **3** into a container filled with water.
- Carry out the following inspection while changing the water temperature in the container. If any fault is found, inspect each unit.

(1) Inspection of pre-glow time and indicator lamp lighting time

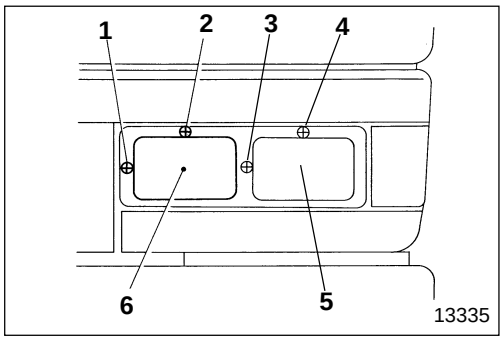
Turn the starter switch ON but do not start the engine. Make sure that the pre-glow time and the indicator lamp lighting time at each water temperature conform to the standard value.

- For pre-glow time inspection, measure the lighting time of inspection lamp **2**.
- For indicator lamp lighting time inspection, measure the lighting time of lamp within the meter cluster directly.

(2) Inspection of after-glow time

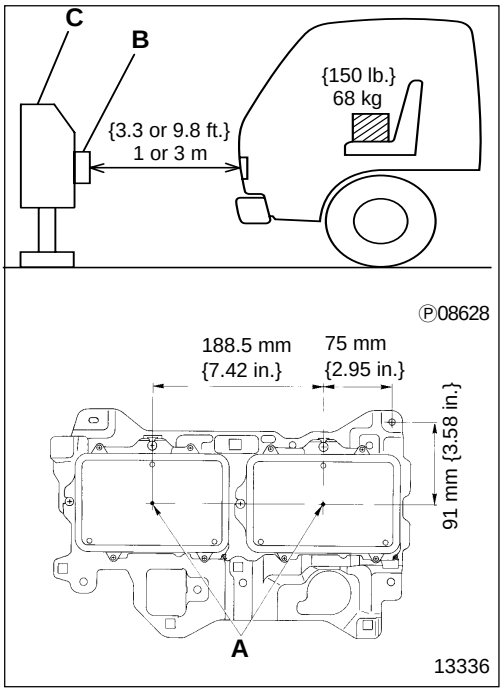
Start the engine and measure the lighting time of inspection lamp **2** from the point lamp within the meter cluster goes off, and make sure that the after-glow time conforms to the standard value.

960 HEADLAMP AIMING



1 Screw (Main beam, horizontal adjustment)
2 Screw (Main beam, vertical adjustment)
3 Screw (Dipped beam, horizontal adjustment)
4 Screw (Dipped beam, vertical adjustment)
5 Dipped beam
6 Main beam

To adjust the headlamp move the optical axis of Main beam **6** by turning screws **1, 2** and move the optical axis of Dipped beam **5** by turning screws **3, 4**. You need to adjust the aiming of both the Main and the Dipped beams on both the left and right headlamps.



(1) Preparation work before adjustment

- Park the vehicle on a level place.

WARNING

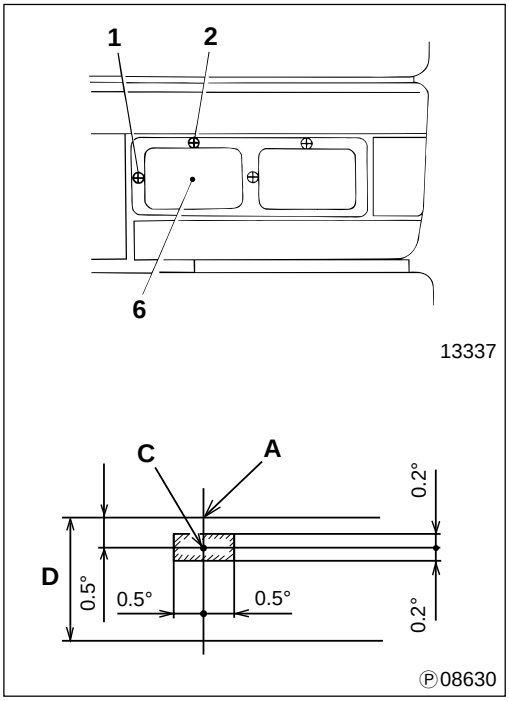
Be sure to put tire chocks securely in place.

- Unload the vehicle and make sure no one is in it.
- Inflate the tires to the specified pressure. Gr 31
- Seat one person of an equivalent mass (68 kg {150 lb}) in the vehicle
- Start the engine and check that the battery is being charged.
- Place convergent headlamp tester **C** in line with Main beam **6** or Dipped beam **5** of either the left or right headlamp at a distance of 1 m {3.3 ft.} or 3 m {9.8 ft.}.
- Align the center of convergent lens **B** of convergent headlamp tester **C** with lamp center **A** of Main beam **6** or Dipped beam **5**. (The illustration shows a left headlamp.)
- When adjusting one headlamp, mask the other to avoid light leakage.

(2) Adjustment

WARNING

Do not mask a lit headlamp for more than 10 minutes or the heat generated might cause a fire.



● **Adjustment of Main beam unit**

- Turn on Main beam **6**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Main beam **6** is located as shown:
  - Vertical adjustment: Turn screw **2** to adjust.
  - Horizontal adjustment: Turn screw **1** to adjust.

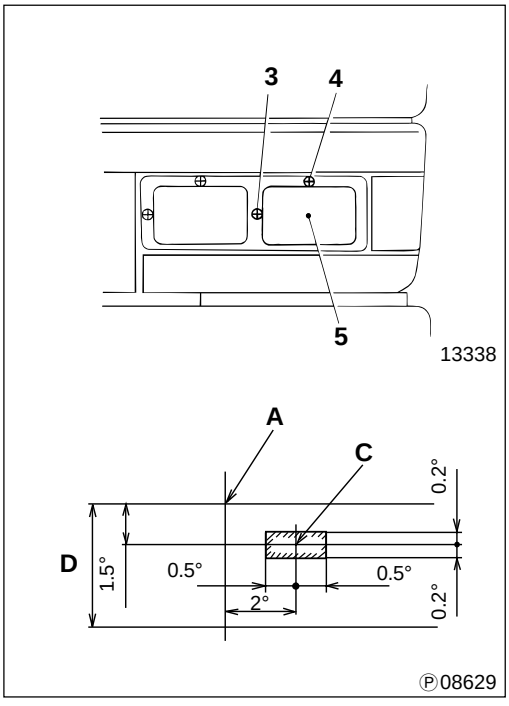
  The aiming of both left and right Main beams **6** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of headlamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 1	—	—	(Counter-clockwise)	(Clockwise)
Screw 2	(Clockwise)	(Counter-clockwise)	—	—

Turning direction of the screws in the table is as viewed from the front.



● **Adjustment of Dipped beam unit**

- Turn on the Low beam of Dipped beam **5**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Dipped beam is located as shown:
  - Vertical adjustment: Turn screw **4** to adjust.
  - Horizontal adjustment: Turn screw **3** to adjust.

  The aiming of both left and right Dipped beams **5** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of lamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 3	—	—	(Counter-clockwise)	(Clockwise)
Screw 4	(Clockwise)	(Counter-clockwise)	—	—

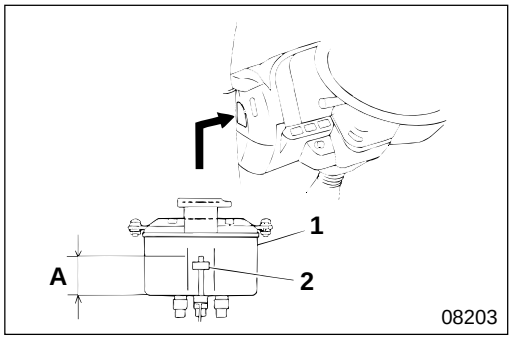
Turning direction of the screws in the table is as viewed from the front.

965 INSPECTION OF BRAKE FLUID LEVEL SWITCH

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Warning lamp lighting position for brake fluid level switch	41.0±3 {1.61±0.12}	—	Replace



- Start engine.
- Drain the brake fluid gradually from fluid tank assembly **1**.

CAUTION

If brake fluid is spilled on any part of the vehicle, wipe it off immediately, since the solvent in the fluid can damage the paintwork.

- Measure height **A** of brake fluid level switch **2** when BRAKE warning lamp within the meter cluster lights.
- If the measured value deviates from the standard value, remove and check fluid tank assembly **1**.

Removal and installation : Gr 42
Inspection : 041

MITSUBISHI
FUSO

Group 55A
Air-conditioner

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-55A

FOREWORD

This service manual describes the maintenance data consisting of construction & outline, inspection, and repair service of MITSUBISHI FUSO GENUINE TRUCK CAB AIR CONDITIONER

Table of contents

1. SPECIFICATIONS ---- 1
2. OUTLINES OF REFRIGERATION SYSTEM ---- 2
3. CONSTRUCTION ---- 4
4. TROUBLE SHOOTING ---- 11
5. REMOVAL AND INSTALLATION ---- 18
6. TREATMENT AFTER INSTALLATION ---- 21
7. MAINTENANCE ---- 27
8. COOLING UNIT ASSEMBLY ---- 28
9. COMPRESSOR & CLUTCH ASSEMBLY ---- 30

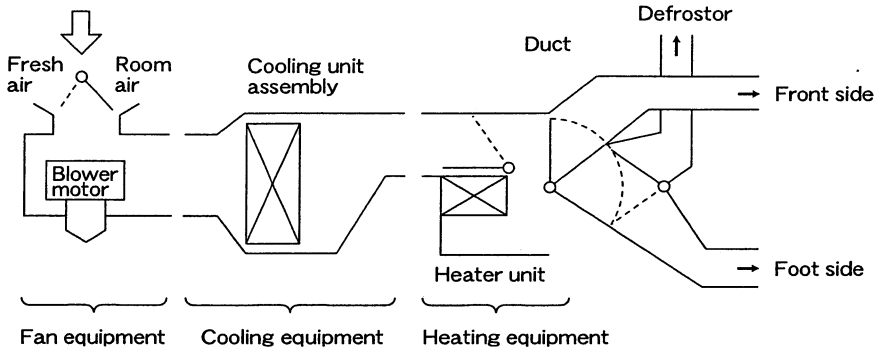
1. SPECIFICATIONS

Item			Specification
Vehicle model			FE・FG 2002
* Cooling capacity (on JIS conditions)			4,200W
Compressor	Model		MSC90T
	Displacement		90cm³
	Maximum revolution		MAX 9,000min^{-1}
	Compressor oil		SUN PAG 56, 120cm³
Magnetic clutch	Type		Dry single disc magnet
	Voltage & input		DC24V(4D34T4)
Cooling unit assembly	Type		Laminated fin type
Controls	Air flow control		Rotary switch, Four step type
	Temperature control		Air mix control
Condenser	Type		Corrugate fin type
Receiver assembly			Cylinder type, approx 350cm³
Protective equipment	Frost prevention (Thermostat)		OFF : 0.5℃ ON : 3.5℃
	Releif valve		Open : 3.50~4.10MPa Close : 2.94MPa
	Dual pressure switch	Low pressure switch	OFF : 0.2MPa ON : 0.22MPa
		High pressure switch	OFF : 2.94MPa ON : 2.35MPa
	Fuse (Fan equipmemt) Fuse (Magnetic clutch)		10A 10A
Refrigerant and quantity			HFC-134a, 23oz

- The * marked cooling capacity is based on JIS conditions.
- Compressor speed : 1,800min^{-1}
- Condensing temperature : 55℃
- Cooling unit inlet air dry bulb temperature : 27℃
- Cooling unit inlet air wet bulb temperature : 19.5℃
- Terminal voltage : DC24V

2 . OUTLINES OF REFRIGERATION SYSTEM

2.1 Air system



Cooling operation

Fresh air is induced to the cooling unit assembly by a blower fan. where it is cooled down and dehydrated, charged at the front side outlet through a duct.

Heating operation

Fresh air is induced to the heater unit by a blower fan through the cooling unit assembly, where it is heated, then discharged at the foot side outlet through a duct.

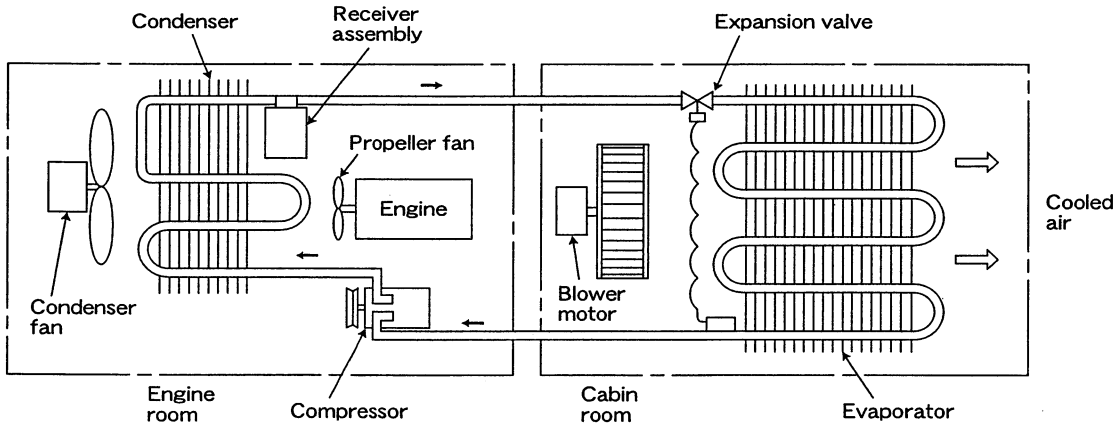
Dehumidifying operation

Fresh air is induced to the cooling by a blower fan, where it is cooled down and dehydrated, and succeedingly to the heater unit for warming, then discharged at the front side outlet through a duct.

Temperature control

Cooled air and warmed air are mixed for temperature control of the room inside.

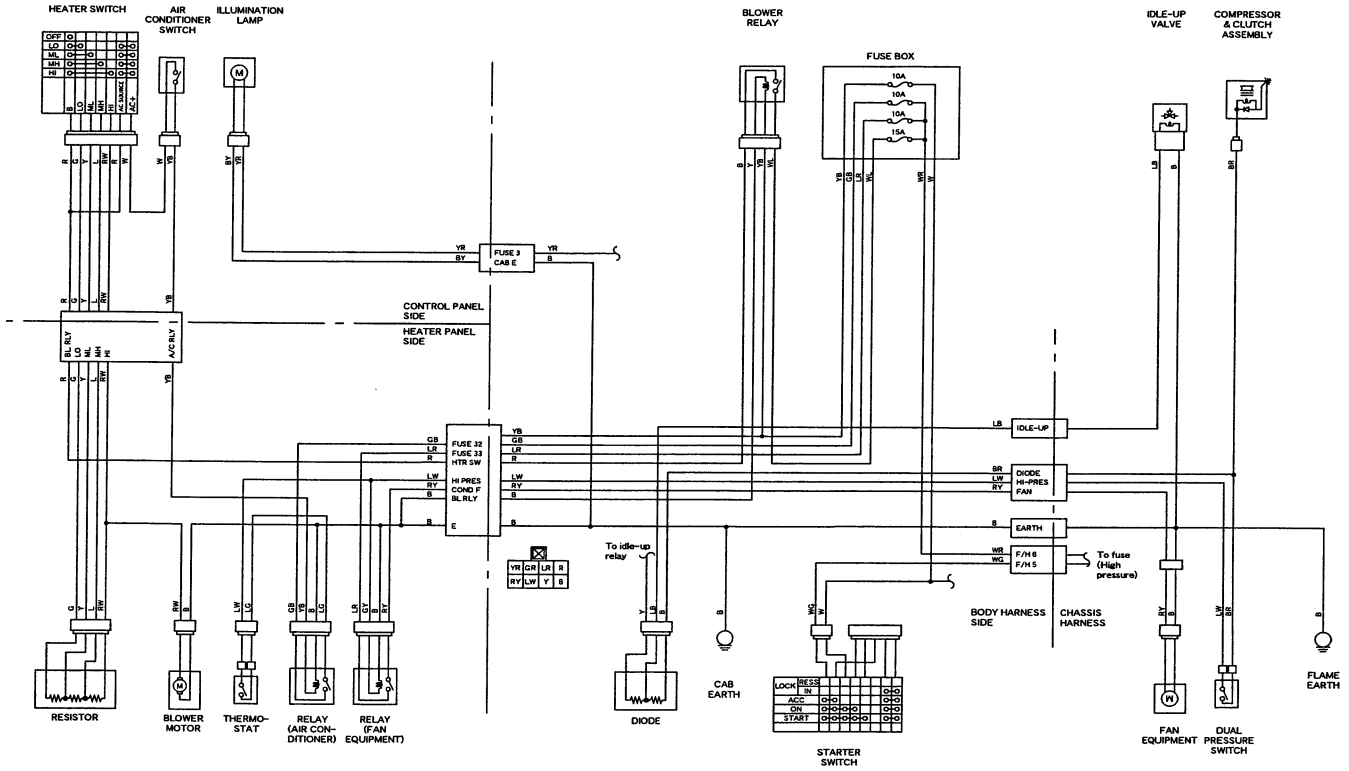
2.2 Refrigerating cycle



While the refrigerant, HFC-134a is cooling the air drawn into the evaporator, it evaporates and becomes a gas. This gas is compressed to high pressure and temperature in the compressor, and sent into the condenser, where it is cooled and becomes liquid.
This cooling in the condenser is carried out by the open air passing through the condenser sucked by radiator fan and vehicle motion of the vehicle.
The liquid refrigerant flows through the receiver assembly where water and dirt are removed, and then it enters the expansion valve. Here the liquid refrigerant is throttled and changed to a mixture of liquid and gas in low temperature and low pressure, and is sent to the evaporator.

In the evaporator, the refrigerant absorbs heat from the surroundings and becomes a gas. That is, because the evaporator it self is cooled at this time, the return air to the cooling unit assembly is cooled,
and the interior of the vehicle becomes cool. In this way the refrigerant flow makes a complete circuit.

2.3 Electrical system



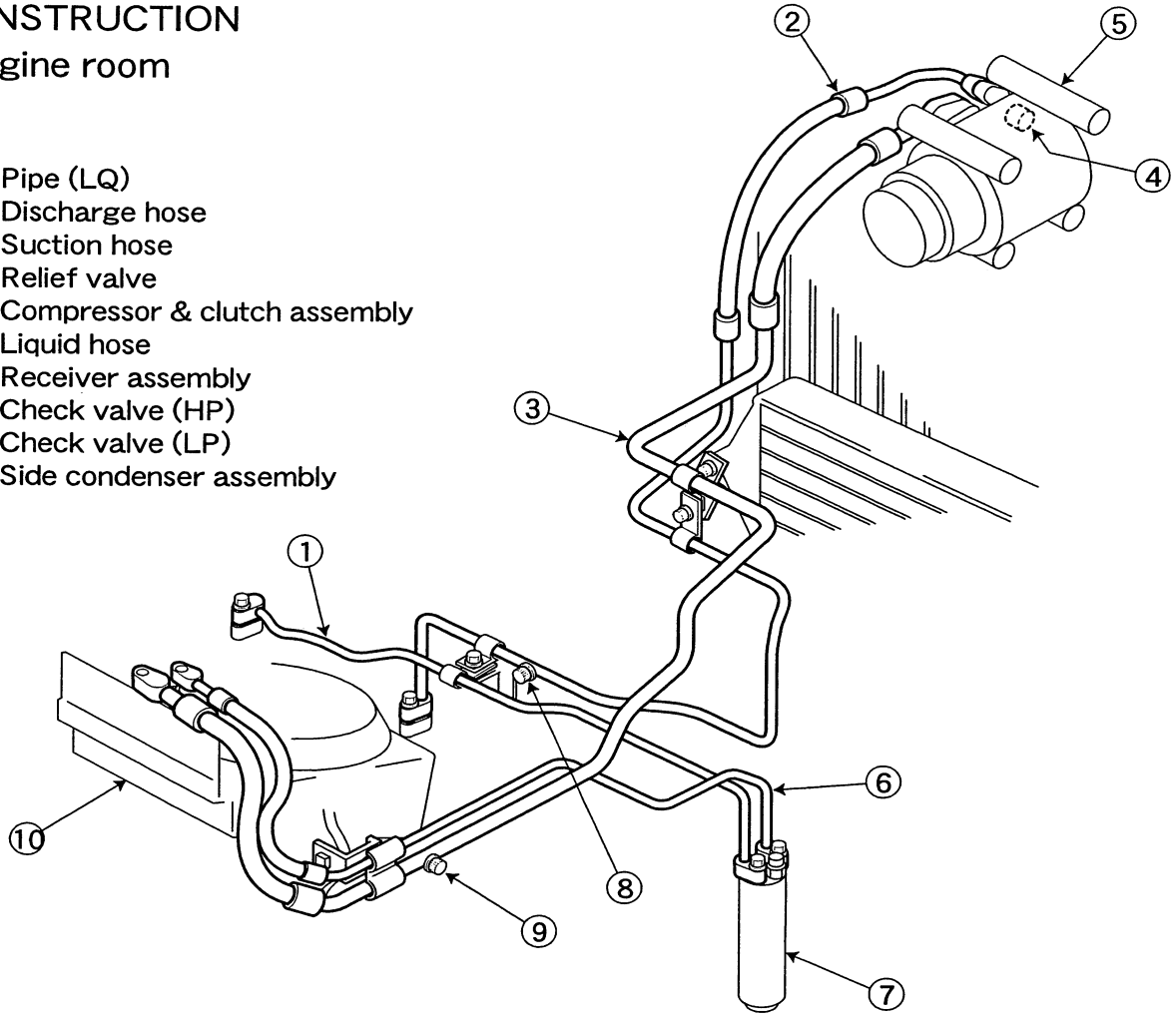
The power source is supplied from the TRUCK battery. When the blower switch is put ON, the power relay becomes ON, and electricity is connected to the magnetic clutch of the compressor. The magnetic clutch switches ON or OFF by air conditioner switch, fin thermo, and low pressure switch as the controls for operation service, or safety protection.

The cabin room air temperature is set to a preset point by adjusting the temperature control lever, and the opening degree of the air mix damper.

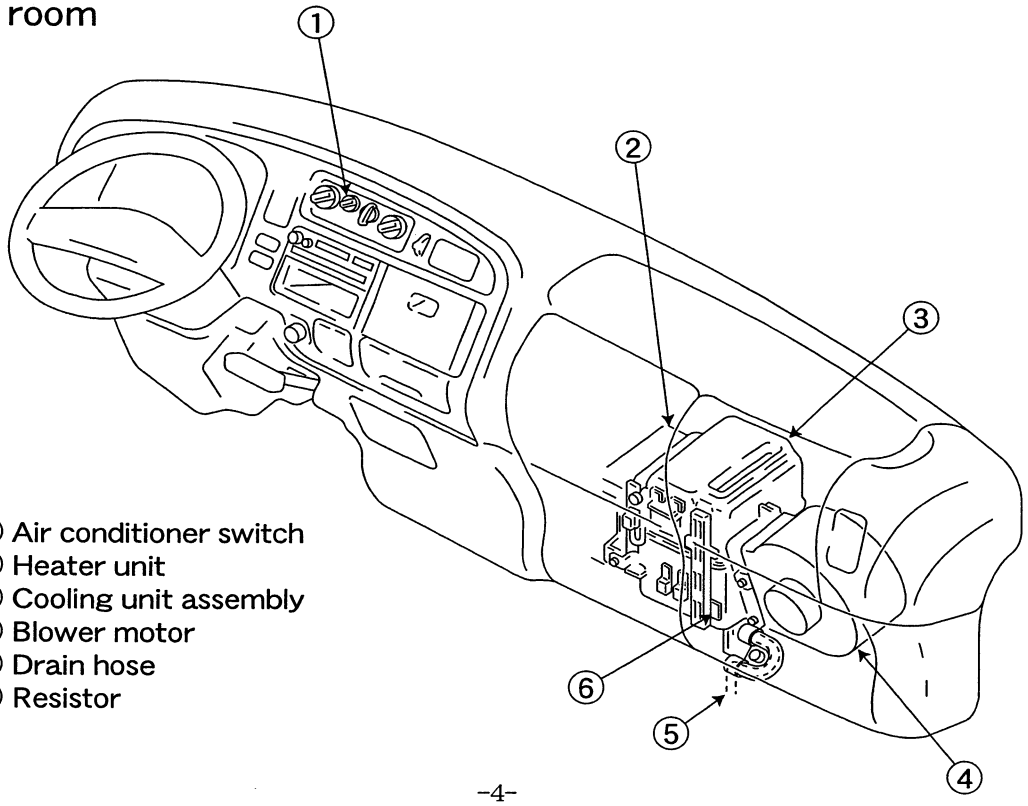
3 . CONSTRUCTION

3.1 Engine room

① Pipe (LQ)
② Discharge hose
③ Suction hose
④ Relief valve
⑤ Compressor & clutch assembly
⑥ Liquid hose
⑦ Receiver assembly
⑧ Check valve (HP)
⑨ Check valve (LP)
⑩ Side condenser assembly



3.2 Cabin room



① Air conditioner switch
② Heater unit
③ Cooling unit assembly
④ Blower motor
⑤ Drain hose
⑥ Resistor

3.3 Control system

(1) Control in panel

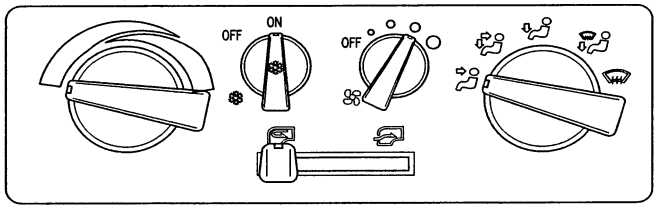
☐ Air conditioner switch
By select the air conditioner switch initially in cooling or drying operation, the compressor starts running.

☐ Fan switch
The air flow is selectable, out of the below four volume.

OFF	No air flow
◦	Gentle
◦	Low
○	Medium
○	High

☐ Air outlet mode select switch
The air outlet is selected by positioning in cooling and heating operation.

- ----- The conditioned air is discharged at the center and both side outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the center and both side and foot outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the foot outlets directed by the louvers as reguired.
- ----- The conditioned air for dehumidifying is discharged at the foot outlets and to the front glass.
- ----- The conditioned air for dehumidifying is discharged to the front glass.

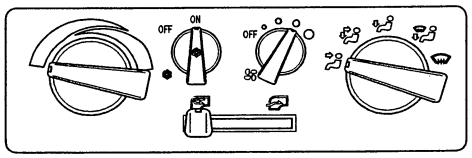
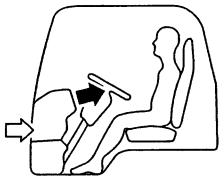
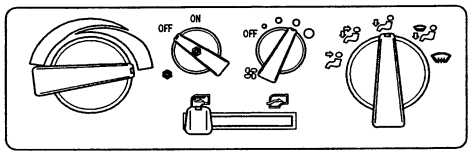
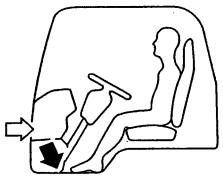
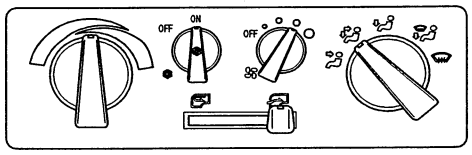
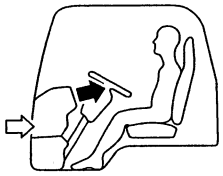
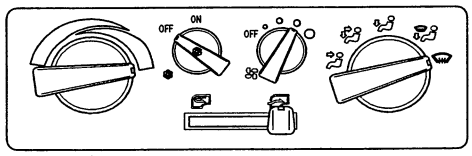
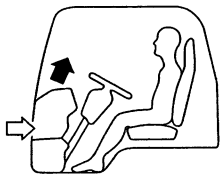
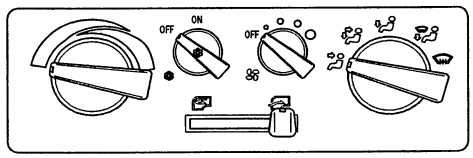
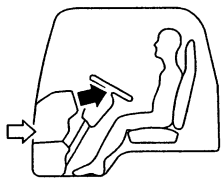


☐ Temperature control switch
The discharged air temperature is controllable by selecting the position of the control lever in cooling, heating or drying operation.
BLUE ZONE ------ For cool air flow
RED ZONE ------- For warm air flow
By turning the switch toward the BLUE and RED ZONE sides, the supply air temperature becomes more cooler and warmer respectively.

☐ Shift lever, air circulation
The recirculation air is selectable out of the below sirculation modes.

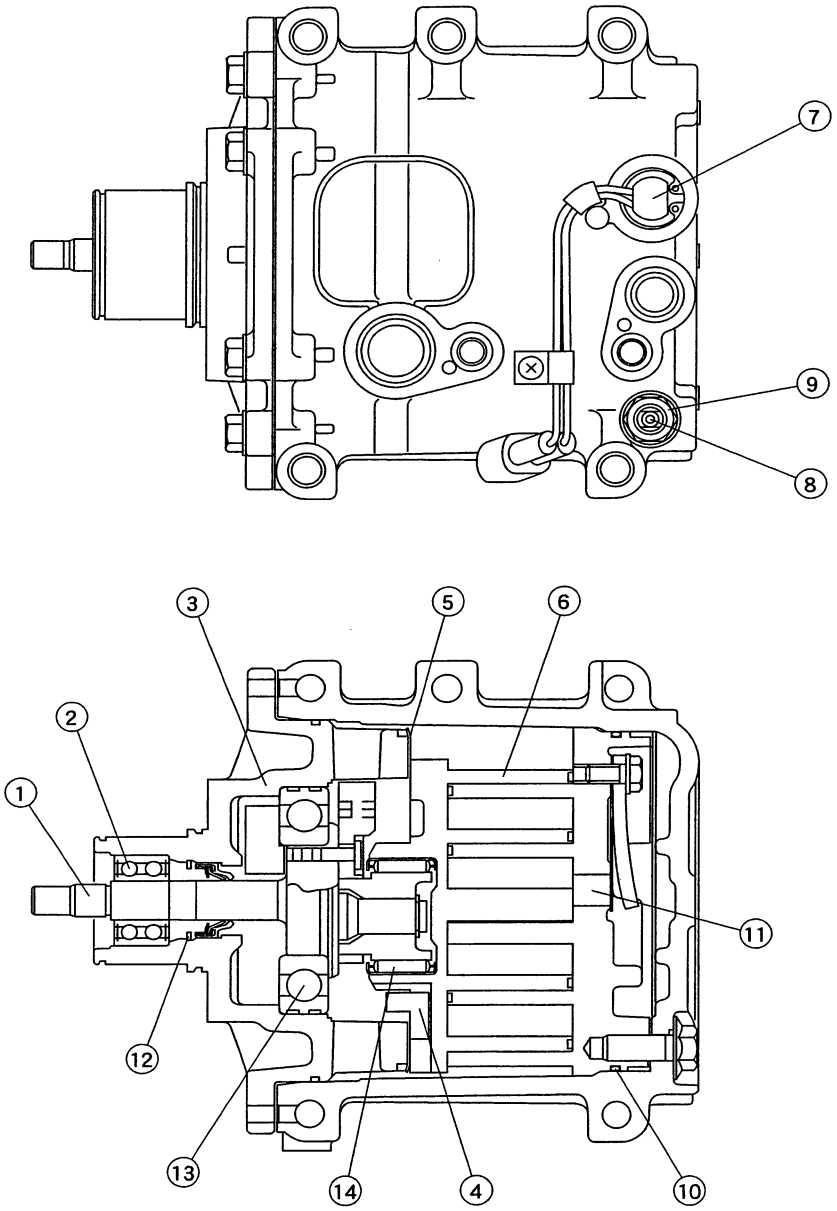
- ----- Room circulation
- ----- Fresh air intake

(2) Operation control

Operation mode	Setting control lever	Air delivery	Remarks
COOL			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation ——
HEAT			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation Air outlet mode select switch ——
DEHUMIDIFY			Wetty conditioning in head cooled, and foot warmed : Shift lever : Air outlet Air outlet mode select switch ——
DEFROST			
VENTILATION			

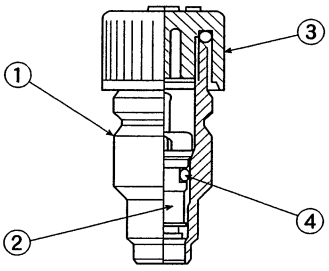
3.4 Compressor and clutch assembly

3.4.1 Compressor



① Crankshaft
② Bearing
③ Front case assembly
④ Housing assembly
⑤ Thrust plate
⑥ Orbit scroll assembly
⑦ Thermostat
⑧ Dust seal
⑨ H/P relief valve
⑩ O-ring
⑪ Port hole
⑫ Shaft seal
⑬ Bearing
⑭ Needle bearing

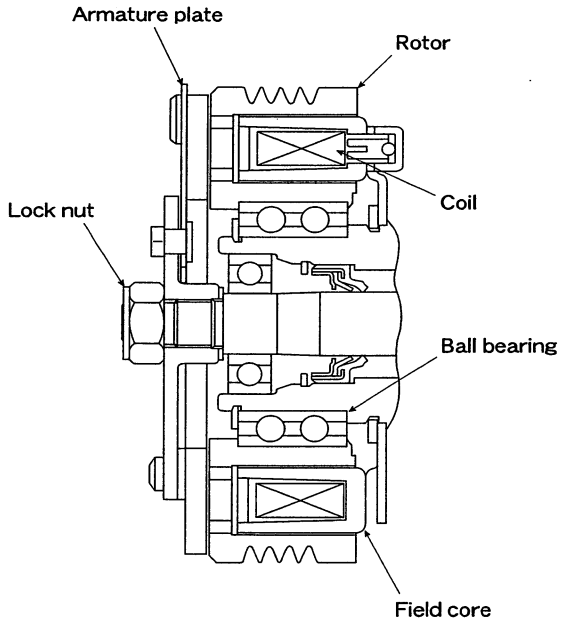
3.4.2 Check valve



① Valve body ③ Cap
② Valve core ④ Packing

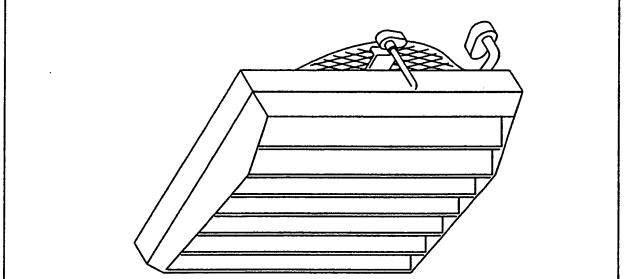
The suction hose and discharge hose are provided with check valve, and designed for gas evacuation and charging service. (shown above)
In the valves, a valve rubber tube, as in automobile tire tubes, is provided as shown in the figure.
Stackening the flare nut on the gauge manifold causes the passage to close automatically by the spring force, and tightening the flare nut causes the passage to open while pressing the compressed spring.

3.4.3 Magnetic clutch



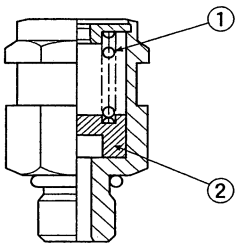
The magnetic clutch is mounted on the compressor crankshaft to start and stop the compressor.
This means that the magnetic clutch is actuated to control the compressor operation electrically by the thermostat.

3.5 Side condenser assembly



The condenser is a means to liquefy the refrigerant gas. As the condenser is cooled by the air pulled in by the condenser fan, the refrigerant in the condenser is cooled into liquid. Therefore, when any obstacle prevents the air from flowing evenly to the condenser or the air flow is short circuited, the cooling effect is reduced, with a decrease in the performance of the condenser. When the vehicle is driven at a high speed, the air flow increases resulting in an increase of the cooling effect, and performance of the condenser.

3.6 Relief valve



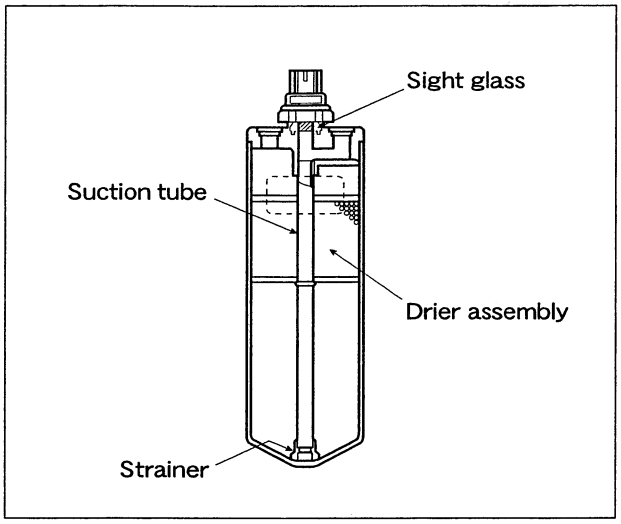
① Spring ② Valve

The relief valve is mounted to the compressor & clutch assembly. The releif valve is usually closed by spring. If pressure of refrigerant in air conditioner system is higher than spring pressure, refrigerant is discharged from relief valve. The pressure drop due to discharge refrigerant, and relief valve is closed again.

Unit : MPa

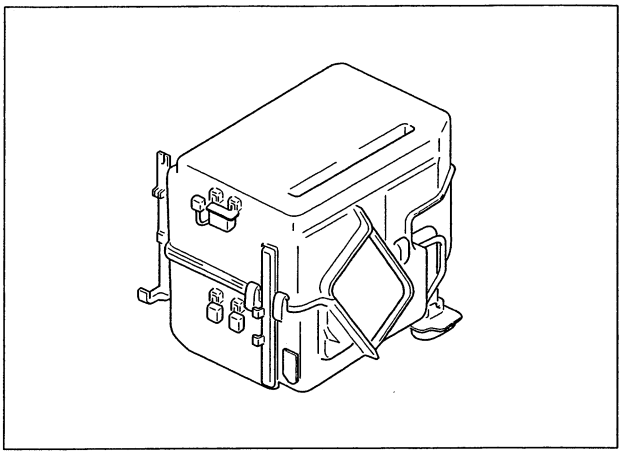
Open	3.50~4.10
Close	2.94

3.7 Receiver assembly



The receiver assembly is served as a refrigerant reservoir located between the condenser and expansion valve. The receiver assembly consists of a filter and a sight glass. The filter is used to remove dust , the drier is used to remove moisture from the refrigerant in the circuit, and the sight glass is used to check the refrigerant charge. Any moisture in the refrigerant may not only corrode metal surfaces in the refrigerant circuit, but also cause the throttle of the expansion valve to be frosted, resulting in the interruption of refrigerant circulation.
Therefore, the receiver assembly must be handled very carefully. When storing or installing it, care should be taken to protect it from the deterioration of drying performance due to exposure to the air.
The retardation of heat exchange, or any fire around the refrigerant circuit will cause excessive pressurization or heating of the refrigerant. Should such an accident occur, the refrigerant in the circuit must be expelled to the outside to prevent the above hazards.
The sight glass is a sort of peep window used to check the refrigerant flow in the refrigerant circuit.
The sight glass appears clear when the refrigerant flow is enough, and shows bubbles flowing when the refrigerant flow is short.

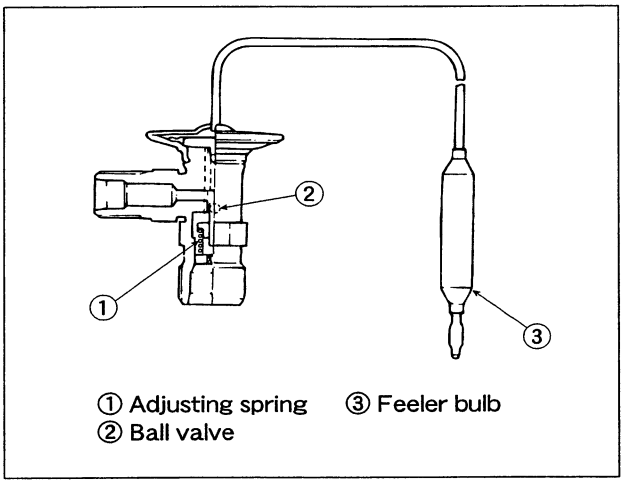
3.8 Cooling unit assembly



The evaporator core is a type of corrugated fin and tube. The tube is arranged in zigzag to achieve high effciency, and to make the core system compact.
A thicker reinforced plastic plate is used as the enclosure to inclease heat and shock resistance, and to protect the core from humidity. This case is a split type, and in a simple design to facilitate installation on the floor panel and the instrument panel frame of the vehicle.

3.8 Expansion valve

The expansion valve is mounted at the inlet of the cooling unit. The liquid refrigerant from the receiver is led to it through a narrow passage (for throttle action), where-in, the liquid refrigerant is condensed with pressure dropping and at the same time the flow rate is adjusted before the refrigerant is sent to the cooling unit.
The refrigeration load in the cooling unit is not constant, but usually fluctuates over a certain range. So the refrigerant flow should under go the control in design.
An automatic expansion valve performs this function automatically. The air condenser uses a thermal type automatic expansion valve.

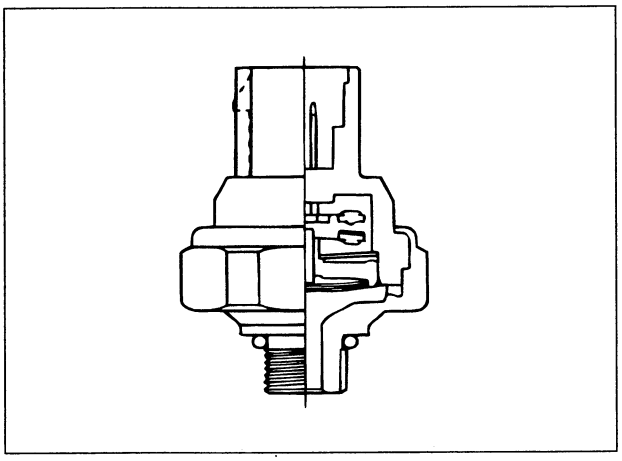


3.10 Dual pressure switch

The dual pressure switch, fixed to the receiver functions as a protector for stopping the compressor (OFF) at a preset value of pressure in the refrigerant circuit.

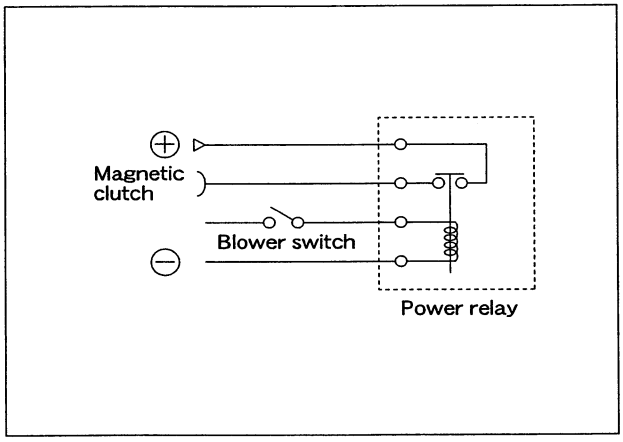
Unit : MPa

	LP side	HP side
OFF	0.2	2.94
ON	0.22	2.35



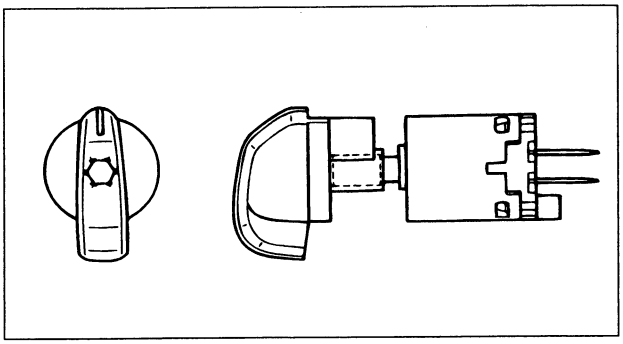
3.11 Power relay

The power relay is excited at a closed position of the micro switch and enables the magnetic clutch to be ready for engaging electically.



3.12 Air conditioner switch

The air conditioner switch function as an operation controller for starting or stopping the compressor in cooling and dehumidifying.
Set the it to the "ON" position, the magnetic clutch becomes engaged and the compressor starts.
Set the it to the "OFF" position, the magnetic clutch becomes disengaged and the compressor stops.

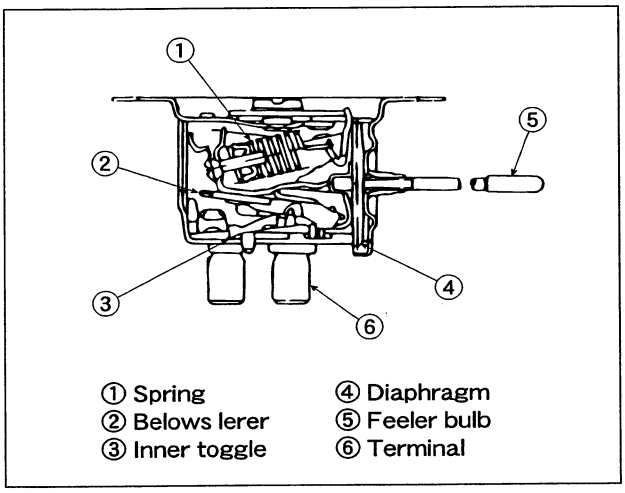


3.13 Thermostat

The thermostat is mounted on the evaporator case. It senses the temperature of evaporator fins, and controls the compressor operation for ON or OFF as specified below.

Unit : ℃

OFF	0.5
ON	3.5



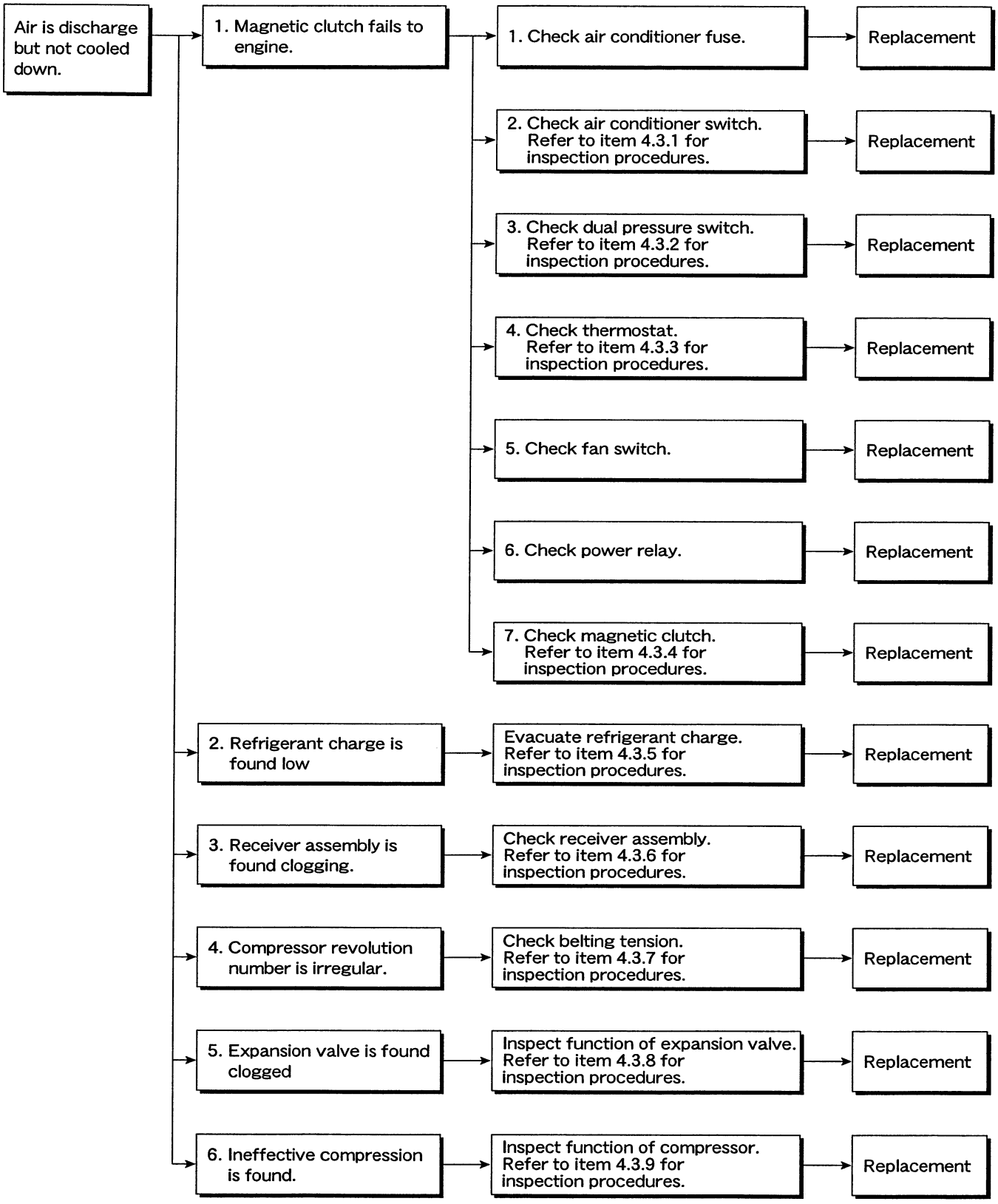
4 . TROUBLE SHOOTING

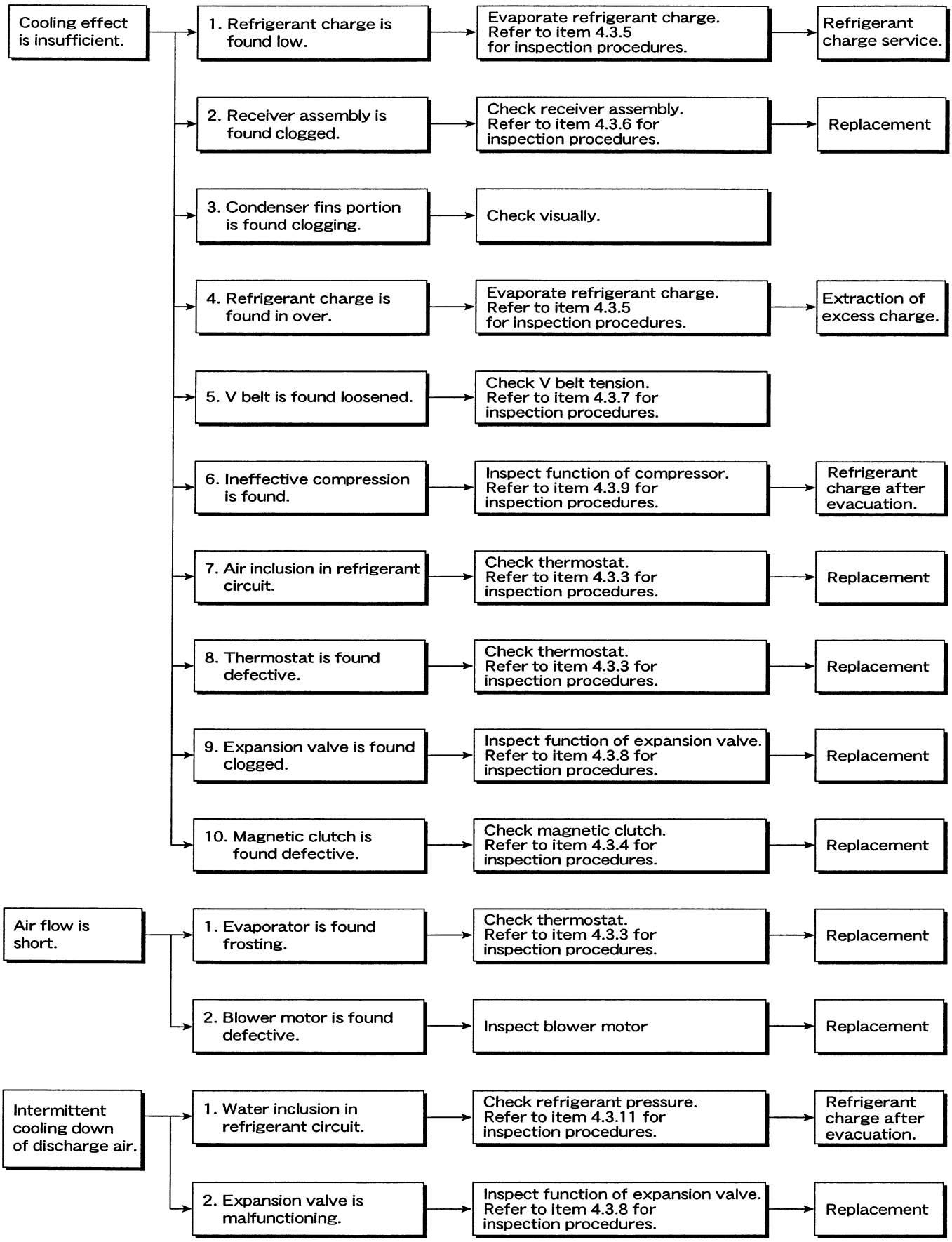
4.1 General precaution

(1) When handling refrigerant (HFC-134a), the following precautions must be observed.
   a. Allways wear eye protection and a pair of gloves which handling refrigerant.
   b. Be careful the liquid refrigerant dose not contact the skin.
   c. Keep the refrigerant container blow 40 degrees C.
   d. Do not handle the refrigerant in an enclosed area having an open flame. The refrigerant may produce a poisonous gas.
   e. When dumping the refrigerant from the system, release it slowly so as not to expell all the compressor oil.

(2) If liquid refrigerant strikes eye or skin.
   a. Do not rub eye or skin.
   b. Splash large quantities of cool water on the eye or skin.
   c. Rush to a physician or hospital for immediate professional treatment.

4.2 Trouble cause and remedy




Cooling effect is insufficient.
1. Refrigerant charge is found low.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Refrigerant charge service.
2. Receiver assembly is found clogged.
Check receiver assembly. Refer to item 4.3.6 for inspection procedures.
Replacement
3. Condenser fins portion is found clogging.
Check visually.
4. Refrigerant charge is found in over.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Extraction of excess charge.
5. V belt is found loosened.
Check V belt tension. Refer to item 4.3.7 for inspection procedures.
6. Ineffective compression is found.
Inspect function of compressor. Refer to item 4.3.9 for inspection procedures.
Refrigerant charge after evacuation.
7. Air inclusion in refrigerant circuit.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
8. Thermostat is found defective.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
9. Expansion valve is found clogged.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement
10. Magnetic clutch is found defective.
Check magnetic clutch. Refer to item 4.3.4 for inspection procedures.
Replacement
Air flow is short.
1. Evaporator is found frosting.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
2. Blower motor is found defective.
Inspect blower motor
Replacement
Intermittent cooling down of discharge air.
1. Water inclusion in refrigerant circuit.
Check refrigerant pressure. Refer to item 4.3.11 for inspection procedures.
Refrigerant charge after evacuation.
2. Expansion valve is malfunctioning.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement

4.3 Inspection procedure

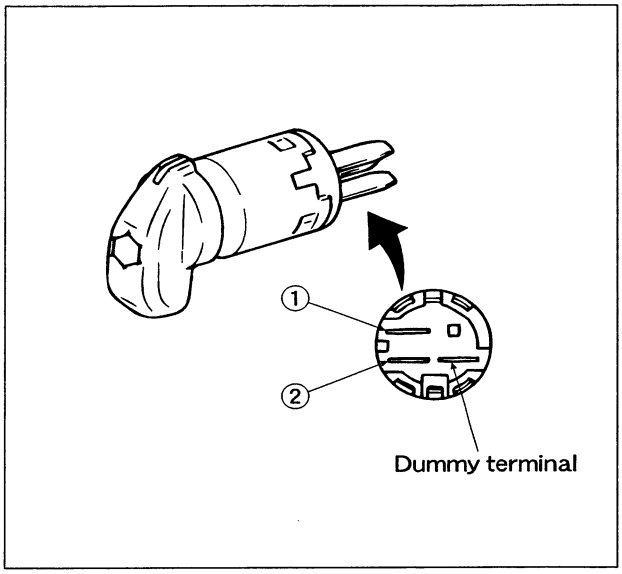
4.3.1 Air conditioner switch

(1) Unplug the air conditioner switch.
(2) Check the continuity between terminals of the air conditioner switch with a tester.

Continuity

Switch position	Terminal's number	Result, in normal
OFF	①-②	No
ON	①-②	Yes

Switch position \ Terminal's number	1	2
OFF	○	
ON	○	○

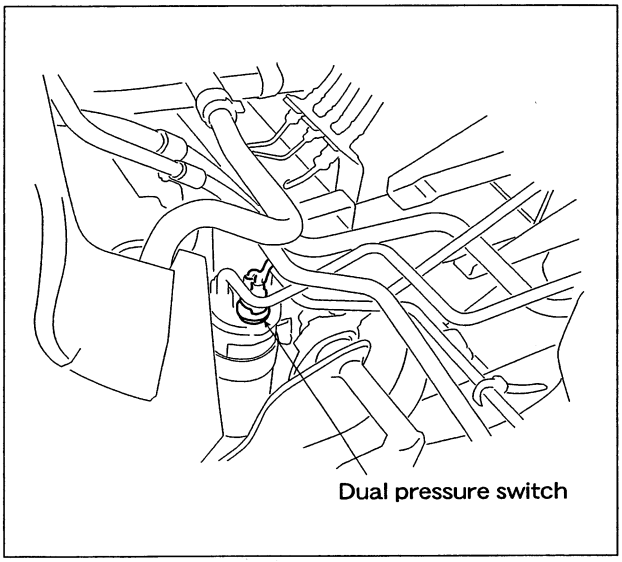


4.3.2 Dual pressure switch

The dual pressure switch is attached to the receiver assembly for controlling the operation of the air conditioner by checking the inside pressure of the receiver assembly.

Unit : MPa

	LP side	HP side
OFF	0.2	2.94
ON	0.22	2.35



(1) Unplug the connector at the receiver assembly.
(2) Check the continuity between terminals of the connector with a tester.
(3) When electric continuity is found, connect the connector to the high pressure switch.
(4) Attach the high pressure gauge and low pressure gauge.
(5) Operate the air conditioner.
(6) Cover the surface of the condenser by using a piece of paper.
(7) When the high pressure exceeds 2.94 MPa, if the magnetic clutch is turned off, the switch is normal.
(8) If the magnetic clutch is not turned off, replace pressure switch with new one.
(9) Check the accuracy of the preset as below.
  (a) Stop the air conditioner.
  (b) Purge the air conditioner of refrigerant slowly starting at over 0.22 MPa.
  (c) At reading the pressure 0.2 MPa, the switch opens.
  (d) Here, stop the purging, then turn it to charging.
  (e) At reading the pressure 0.22 MPa , the switch closes.

If the dual pressure switch does not meet specifications, replace the switch.

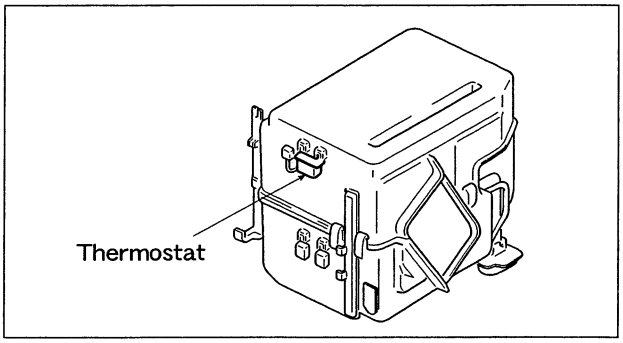
4.3.3 Thermostat

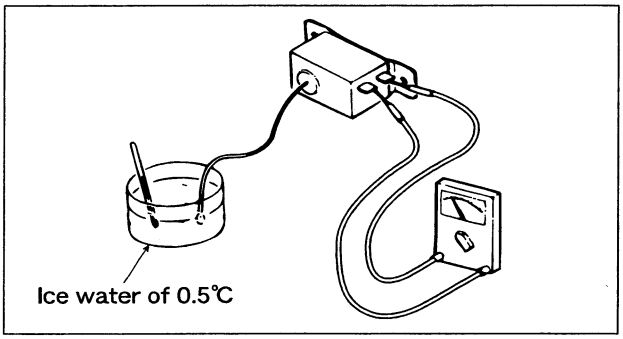
The thermostat is mounted on the evaporator case. It controls the operation of the air conditioner by sensing the temperature of the evaporator fins.

Unit : ℃

OFF	0.5
ON	3.5

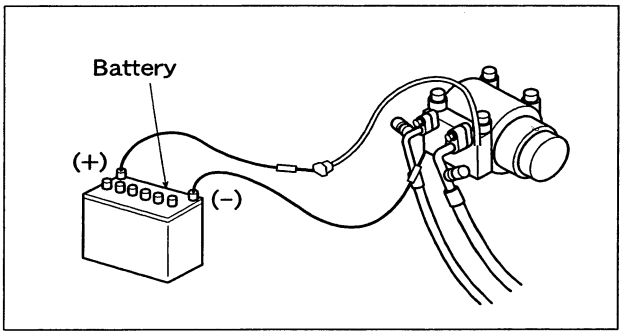
(1) Check the accuracy of the preset as below.
  (a) Soak the sensor of the thermostat in ice-water of below 0.5℃.
  (b) Check the continuity between the switch terminals.
  (c) Pull the senser out of the ice-water, and check the continuity at over 3.5℃ of the senser.





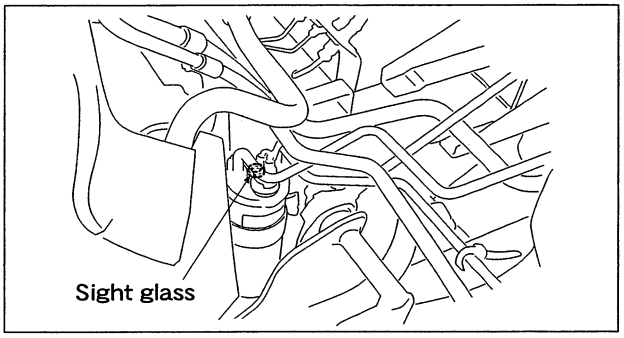
4.3.4 Magnetic clutch

(1) Disconnect the wiring to the magnetic clutch.
(2) Apply a positive side power voltage to the magnetic clutch through the wiring.
(3) In the case of regular functioning, the pulley and magnetic clutch are engaged with a clicking sound. The falling means any malfunction of the magnetic clutch.



4.3.5 Refrigerant charge

(1) Set the temperature control lever at the cool position.
(2) Open doors of the room.
(3) Set the blower switch at the ON position.
(4) Adjust the engine revolution at 1500min^{-1}.
(5) Operation the air conditioner switch for comp. ON.
(6) Watch the sight glass of the receiver assembly at the inside of the engine room.
  (a) If judged insufficient refrigerant charging, repair the leaks, then charge it additionally.
  (b) If judged as over charging of refrigerant, extract an excess refrigerant.
(7) Diagnosis by pressure reading.
  (a) Short of refrigerant:
    Lower pressure for both LP and HP reading.
  (b) Express of refrigerant:
    Higher pressure for LP and HP reading.

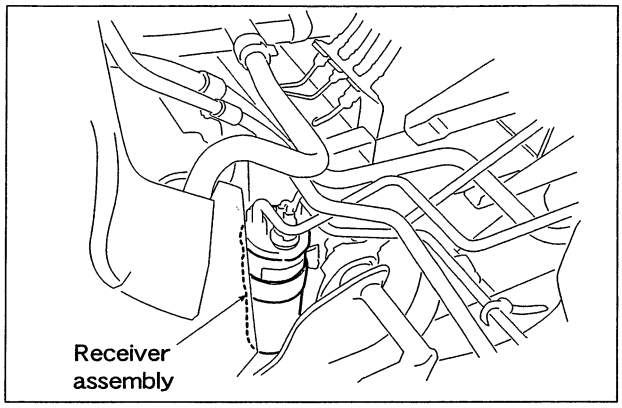


Sight glass		Remarks
Proper refrigerant level	Bubble	1. Bubble occasionally appears. 2. Bubble disappear if speed is a little increased.

Sight glass		Remarks
Insufficient refrigerant	Bubble	Considerable bubbles appear. If the system is extremely short of refrigerant, the sight glass appear white.
Excessive refrigerant		1. No bubbles appear. 2. Slight bubbles appear if speed is decreased.

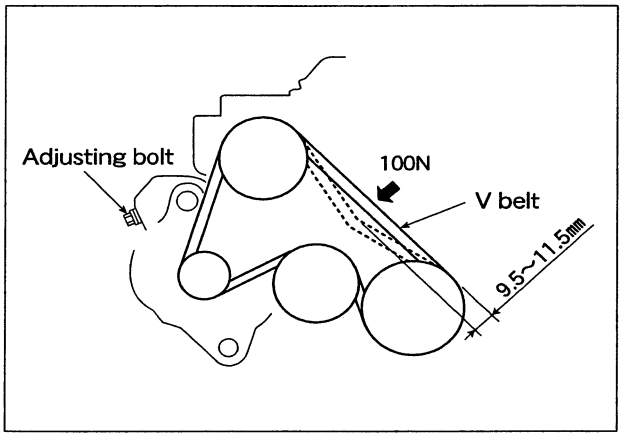
4.3.6 Receiver assembly

(1) While operating the air conditioner, touch the refrigerant piping with a hand at the inlet and outlet portions.
  (a) Sensed temperature difference:
    It is possible that clogging is happening at the inside, liquid receiver assembly is to be replaced with a new one.



4.3.7 Belt tension

(1) Depress the V belt with a thumb at the ⬅ marked position, and adjust the stretching as below.
  Stretching degree : 9.5~11.5 mm
(2) Adjustment
  (a) Loosen the nut of the tension pulley.
  (b) Control the belting tension by the adjusting bolt.
  (c) After finishing, retighten the nut as before.

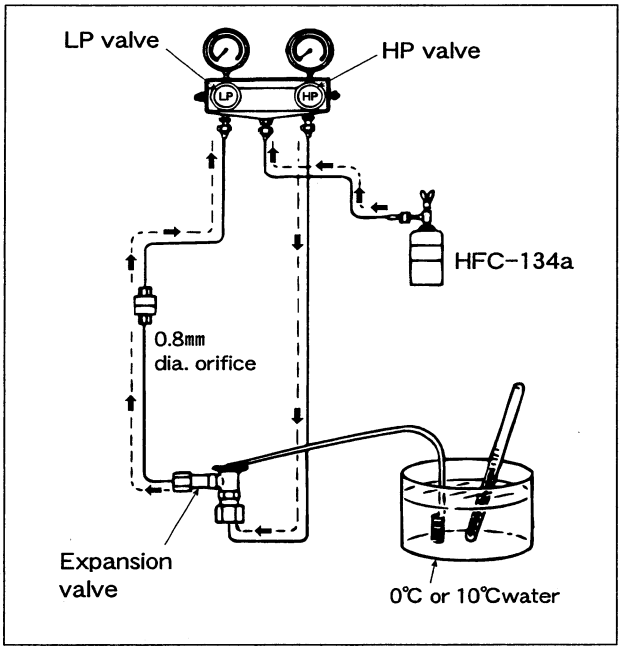


4.3.8 Expansion valve

⚠ CAUTION

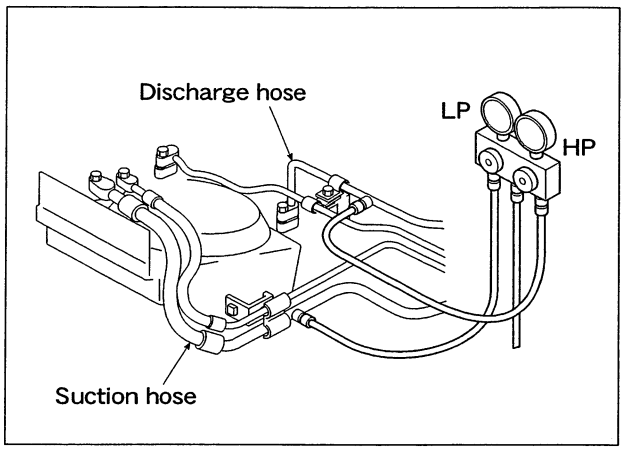
The test should be applied to only the case of the other components being free from troubles, and the expansion malfunctioning singly.

(1) Build up the test circuit with a gauge manifold.
(2) Soak the sensor bulb in ice water of 0℃, and of 10℃ respectively.
(3) Pressurize the HP side with dry nitrogen gas of 1.03MPa.
(4) Check the reading of the LP side pressure gauge for the standard range.
  At 0℃ ····0.127MPa
  At 10℃ ····0.23MPa



4.3.9 Pressure check

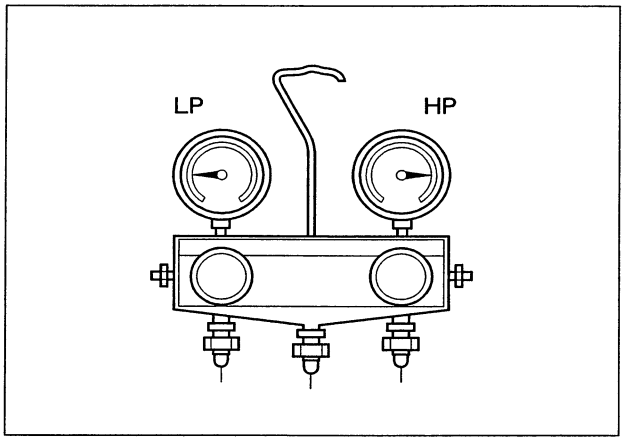
(1) Mount a low pressure gauge hose and a high pressure gauge hose on the check valve.
(2) Drive the air conditioner.
(3) Showing of higher LP side pressure and lower HP side pressure evidences ineffective compression.
Standard pressure
LP side pressure About 0.26MPa
HP side pressure About 1.42MPa



4.3.10 Air inclusion in ref.circuit

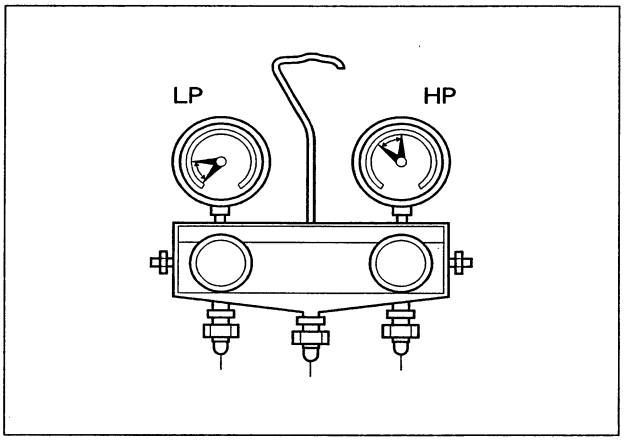
The abnormal reading of refrigerant circuit evidences air inclusion.

A little higher LP side pressure. Noticeably higher HP side pressure.



4.3.11 Moisture inclusion in ref.circuit

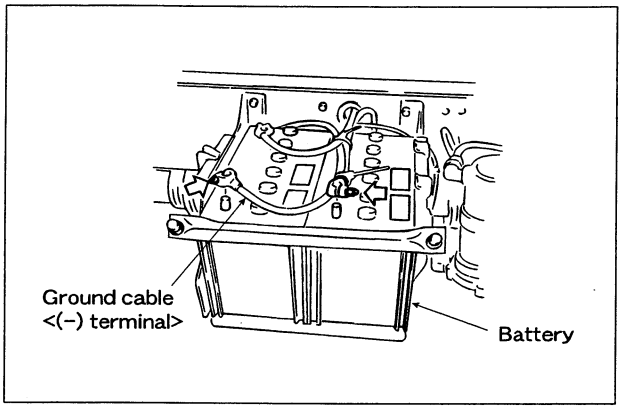
(1) During the operation, cooled air supply is interrupted periodically with a time interval.
This phenomenon evidences water inclusion.
(2) Check the refrigerant pressure at a stop of the cooled air supply to make sure of the water inclusion.
LP side pressure ····Almost vacuum
HP side pressure ····Noticeably low



5. REMOVAL AND INSTALLATION

5.1 Precaution for removal and installation

(1) Disconnect the (-) ground cable from the battery, and place a cover on the battery.

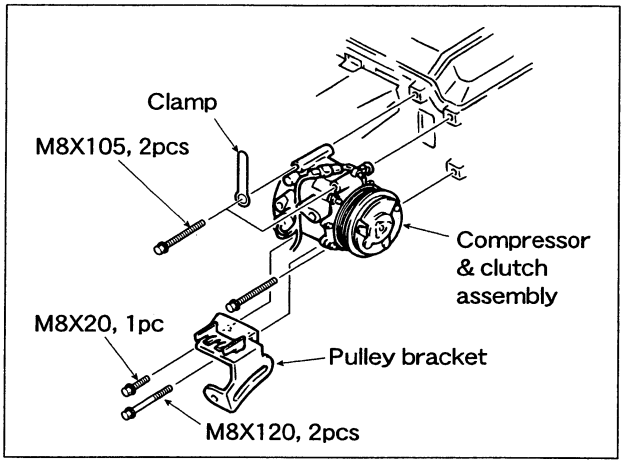


(2) Make certain all the openings are covered with caps in order to prevent entry of foreign substances such as dust and dirt.
(3) Never tamper with the brake and fuel systems, including the brake tubes and hoses.
(4) Avoid doing the work in a dusty place or outdoors in rainy weather. If tubes or functional parts are removed, put a cap in position immediately in order to prevent entry of dust and moisture.
(5) Connect the charging hose of the gauge manifold to the check valves (suction and discharge) of the suction hose and discharge hose, and recover the refrigerant by refrigerant recovery unit until its pressure is reduced to 0 kPa.
(Make sure that there is no internal pressure in the equipment.)
About discharging might result in the discharge of the refrigerant oil from the compressor.
(6) When coupling the flared tube, coat the flared portion with the compressor oil at the inner side.
(7) Make sure to use the wheel chocks.

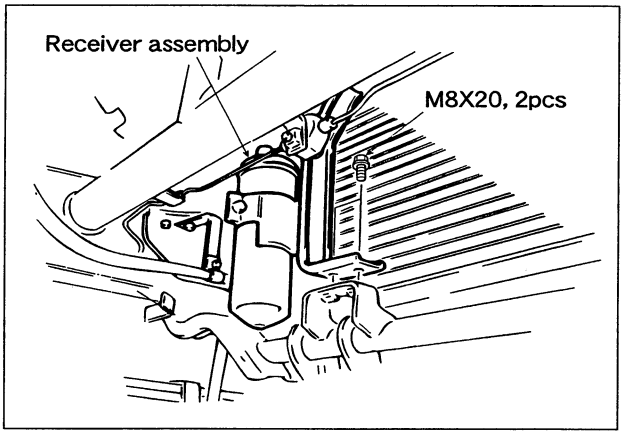
5.2 Removal

5.2.1 Inside engine room

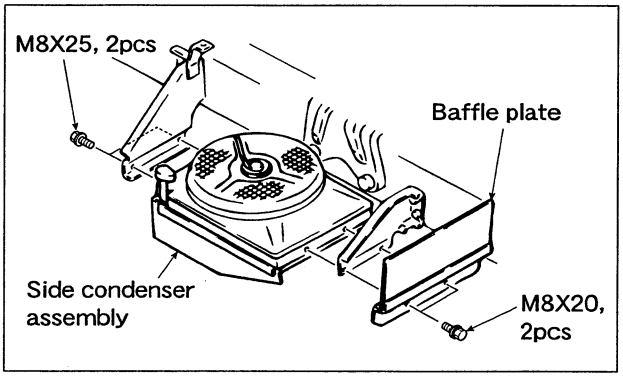
(1) Compressor & clutch assembly
(a) Withdraw the wiring of the magnetic clutch at the connector.
(b) Remove the V belt by loosening fixature of the tension pulley
(c) Take off the fixing bolts : M8X105, 2pcs and M8X 120, 2pcs. (with clamp)
(d) Dismount the compressor.



(2) Reciever assembly
(a) Unplug the dual pressure switch at the connector.
(b) Separete the interconnecting refrigerant pipe of the receiver assembly.
(c) Take off the fixing bolt : M8X20, 2pcs.
(d) Dismount the receiver assembly.



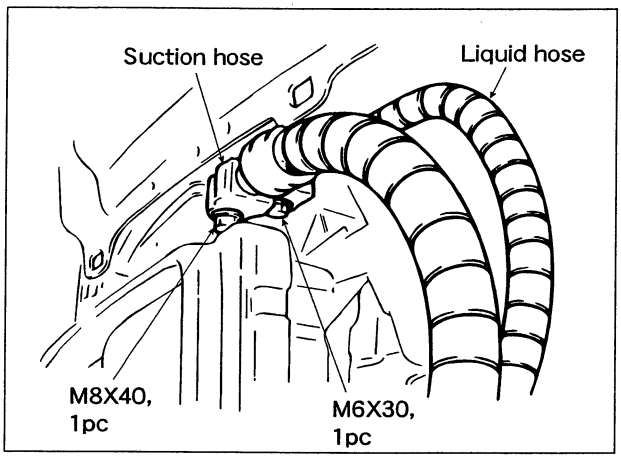
(3) Side condenser assembly
(a) Unplug the condenser fan harness at the vehicle side harness.
(b) Take off the fixing bolt : M8X20, 2pcs and M8X25, 2pcs.
(c) Dismount the side condenser assembly (and baffle plate).



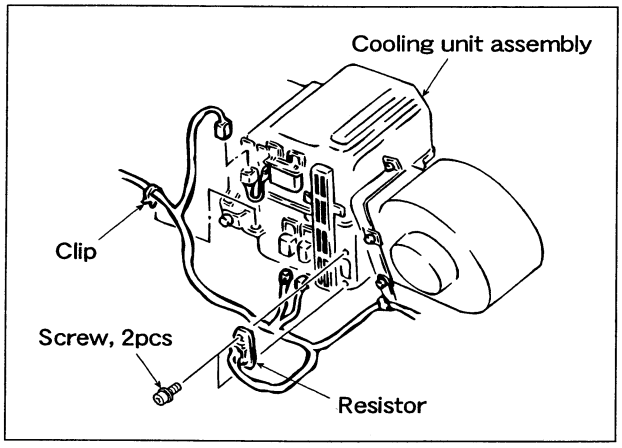
5.2 Cabin room

(1) Cooling unit assembly

(a) Separate the interconnecting refrigerant pipes of the cooling unit assembly.



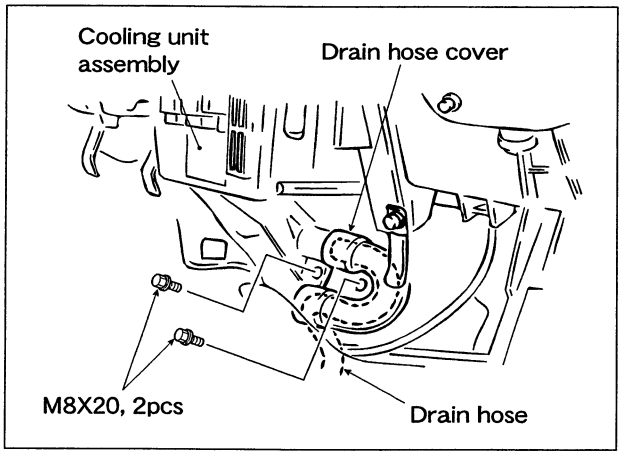
(b) Withdraw the wiring of the cooling unit assembly at the connectors.



(c) Take off the fixing bolt : M8X20, 2pcs.

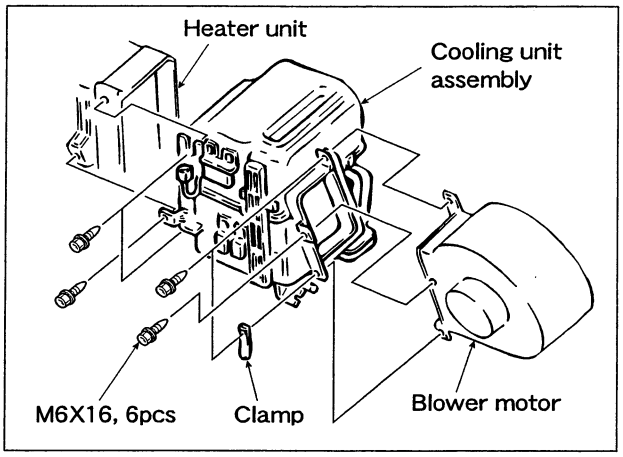
(d) Dismount the drain hose cover.

(e) Reconnect the drain hose from the cooling unit assembly.



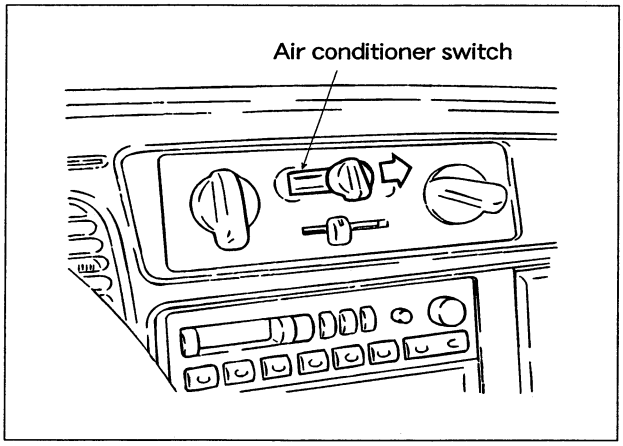
(f) Take off the fixing screws : M6X16, 6pcs.

(g) Dismount the cooling unit assembly.



(2) Air conditioner switch

Pull out the air conditioner switch.



5.3 Installation

Installation is performed in the opposite sequence of removal.

○ Torque for tightening coupler of refrigerant tubing.

Unit : N・m

Compressor suction hose	29~34
Compressor discharge hose	20~25
Condenser inlet hose	20~25
Condenser outlet hose	12~14
Liquid receiver assembly inlet and outlet hoses	12~14
Cooling unit inlet hose	12~14
Cooling unit outlet hose	29~34

○ Torque for tightening general bolt and nut

Unit : N・m

Nominal size	Pitch	Tightening torque		
		Head mark 4	Head mark 7	Head mark 8
M5	0.8	3~4	5~6	5~7
M6	1.0	5~6	9~11	8~12
M8	1.25	12~14	19~24	19~29
M10	1.25	24~29	38~48	43~58
M10	1.5	17~26	32~48	41~58
M12	1.25	34~43	58~77	82~106
M14	1.5	72~82	115~134	125~173

NOTE

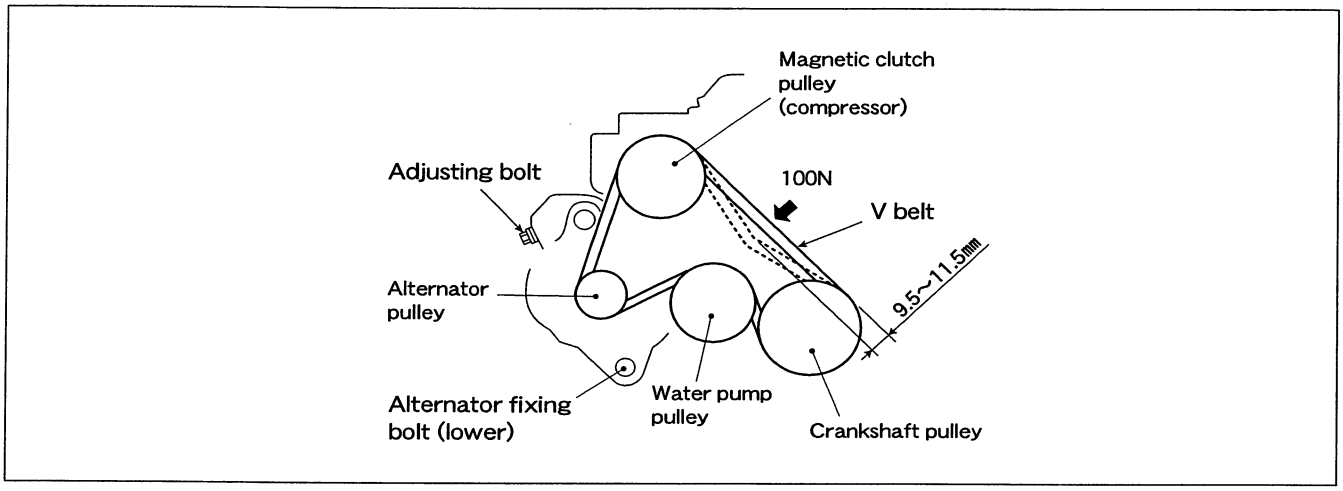
For the cases of spring washer seated, and thread or seating surface coated with oil, the value shall be reduced down to 85 percent of the data listed.

6. TREATMENT AFTER INSTALLATION

6.1 Check and adjustment

After installation, check the following points and confirm that everything is normal, then charge the gas, and do the performance and operation tests.

(1) Check if any abnormal vehicle performance, happens or not by installing the air conditioner.
(2) Check the operation of the magnetic clutch. (with the compressor disengaged)
(3) Check if any parts left unmounted or any tool left in the vehicle.
(4) Check to ensure that the temperature control lever operates properly.
(5) Check the tension of the belt.



6.2 Leak test

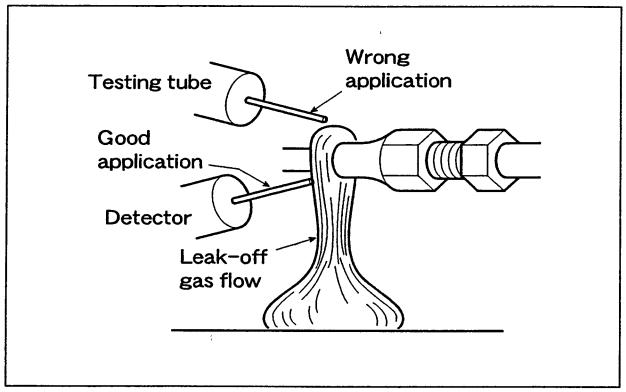
After all the piping works are completed, conduct an leak test by the following procedure to check any leaks at the flare coupling, etc. and then evacuate the system. If this leak test is omited and evacuation is immediately started, there is no way of detecting possible leak. If there are leaks, the specified vacuum cannot be attained. In order to save the service time be sure to conduct the leak test before evacuation.

6.2.1 Test point

(1) All pipe joint.
(2) Shaft seal and check valve on the compressor.

6.2.1 Test point

(1) For the gas leak test, the use of an electric gas leak detector is recommended. (HFC-134a SAE Approved)
(2) Perform the test at a place as in free from air flowing.
(3) The refrigerant is heavier than air. Leaks will concentrate at the bottom. Make certain that the testing tube is applied below the check point.



(4) The test should be performed patiently. Make certain that testing tube is moved slowly [approx. 10mm/sec.].
(5) The high pressure side refrigerant circuit should be tested for gas leaks during operation. Those areas which are dangerous or hard to test during operation (including areas around the compressor and condenser) should be tested direct after shutdown.

(6) The low pressure side refrigerant circuit should be tested during shutdown after the gas pressure has balanced.
(7) The test should be performed on the basis of the following standards:

Gas leak test standards

test point / Instrument	Compressor shaft seal	Other parts
Electric gas leak detector	Pointer shall not swing more than 0.1mA at the low sensitivity.	Pointer shall not swing more than 0.1mA at the low sensitivity.
handle torch gas leak detector	Flame colour (moss green) shall not change.	

⚠ WARNING

- Smoking should be forbidden if a gas leak is detected.
- If a flame is applied to the refrigerant, toxic phosgene gas will be produced. Do not keep the detector in contact with a leaky point for a long time.

- Leak test procedure

1. Attach refrigerant supply and gauge set as shown with all valves closed. Open refrigerant supply valve on can.
2. Loosen the center charging hose fitting at the gauge manifold end to blow any air from the hose until it hisses for a few seconds, then refrigerant.
3. Open both gauge valves to partially charge the system and then close both valves.
4. The system can then be checked for leaks using an electronic leak detector.
5. If leaks are found that require the system to be opened (to repair or replace hoses, fittings, etc.), release any charge in the system.
6. After checking and repairing leaks, system must be evacuated.

6.3 System charging

GENERAL PRECAUTIONS

⚠ WARNING

When handling refrigerant (HFC-134a), the following precautions must be observed.

- Always wear eye protection and gloves while handling refrigerant.
- Be careful that liquid refrigerant does not contact the skin.
  If liquid refrigerant strikes eye or skin:
  - Do not rub on skin.
  - Splash large quantities of cool water on the eye or skin.
  - Flush eyes or skin with cool water for 5 minutes.
  - Rush to a physician or hospital for immediate professional treatment.
  - Do not attempt to treat it yourself.
- Keep the refrigerant (HFC-134a) container below 40℃.
- Do not handle the refrigerant in an enclosed area having an open flame; the refrigerant may produce a poisonous gas.
- Use approved recovery equipment to recover HFC-134a refrigerant before attempting service of this or any other HFC-134a system.
- Do not attempt to leak test an HFC-134a system with high pressure air or nitrogen. Mixing HFC-134a with a concentrated quantity of air may be combustible in the presence of ignition.

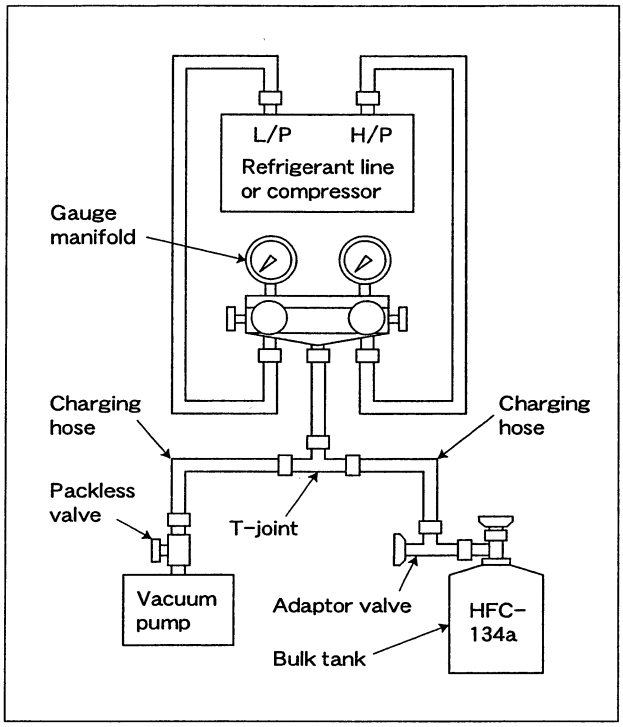
6.3.1 Evacuation

INSTALLATION OF CHARGE EQUIPMENT

(1) Connect the gauge manifold to the service valves.
(2) Connect the packless valve to the vacuum pump.
(3) With the charge valve handle turned back all the way, install the bulk tank.
(4) Connect each charge equipment as illustrated.

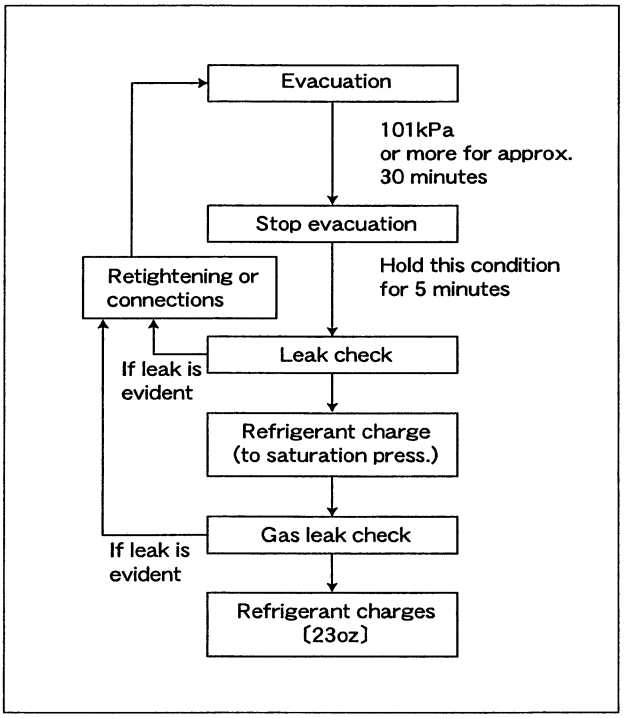
⚠ CAUTION

1. Do not connect the high and low pressure sides adversely. (Connect high pressure side to the condenser and low pressure side to the cooling unit.)
2. The indications "DIS" and "SUC" on the compressor indicate high and low pressure sides respectively.



6.3.2 Evacuate the system

The refrigerant system must have been evacuated using the previous procedure before charging. Charge using only HFC-134a refrigerant. HFC-134a is available in bulk tank. Follow the safety precautions for handling HFC-134a as listed in this section.
Follow the evacuation procedure below and at right.
This procedure assumes no HFC-134a refrigerant has been introduced into the system. If evacuating a charged system, it is necessary to recover the existing HFC-134a refrigerant before continuing with these instructions.
Refer to the recover equipment manufacture's instructions for proper refrigerant recovery.



CHARGING WITH BULK TANK

When using disposable cans of this type, follow carefully the tank manufactures instructions.

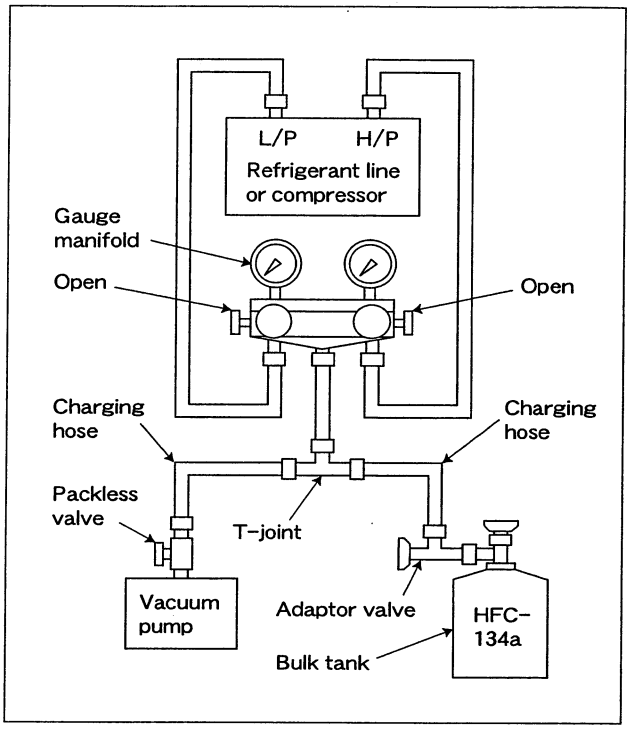
(1) Start up the vacuum pump.

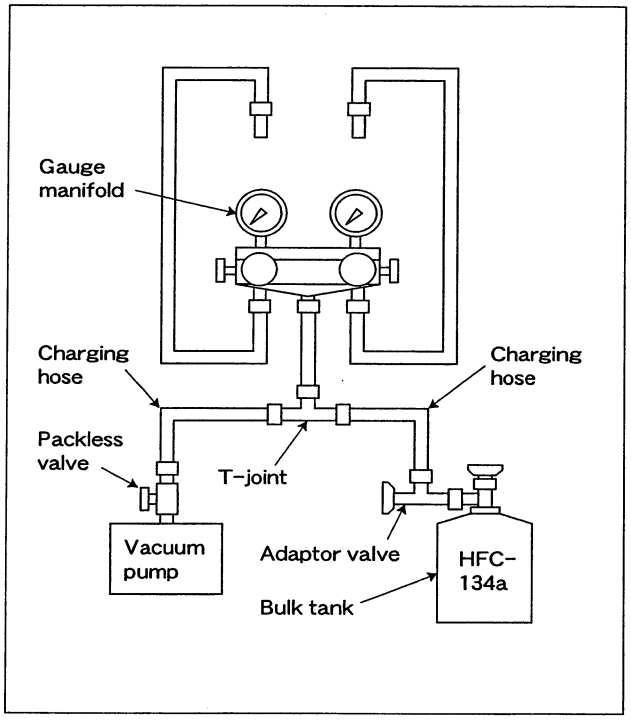
> ⚠ CAUTION
>
> 1. Do not use the compressor for evacaution.
> 2. Do not operate the compressor in the vacuum condition; damage may occur.

(2) Open the gauge manifold handles and the packless valve.
(3) Evacuate to a vacuum reading of 101kPa higher (approx.30 minutes).
(4) Turn back the packless valve all the way and close the bulk tank.
(5) Stop the vacuum pump and allow to stand for 5 minutes.
(6) Check for leak. (Good if the vacuum is held.)
(7) Tighten the charge valve handle to puncture the bulk tank.
(8) Open the charge valve to charge the system with refrigerant.
(9) When the refrigerant is no longer drawn in, turn back the high pressure side gauge manifold handles.
(10)Check for gas leaks using a leak detector.
(11)Start the engine.
(12)Operate the air conditioner and set at the lowest temperature (MAX. COOL).
(13)Fix the engine speed at 1500min^{-1}.
(14)Continue charging system until proper refrigerant quantity is introduced into the system.

> ⚠ CAUTION
>
> If the bulk tank is inverted, liquid refrigerant may be drawn into the compressor damaging it by liquid compression. Keep the bulk tank upright to ensure that refrigerant is charged in gas state.

(15)Upon completion of charging, turn back the low pressure side gauge manifold handles.





6.3.3 Removal of charge equipment

(1) Close the charge valve.
(2) Remove the gauge manifold from each service valves.

> ⚠ CAUTION
> Do not remove the bulk tank, T-joints and adaptor valves but keep them connected for next charge operation.

OPERATING LOW REFRIGERANT LEVEL

Locate the souce of the low refrigerant level, recover system, repair system, evacuate system, charge ststem, check for leaks.

> ⚠ CAUTION
> If the bulk tank is not emptied completely, keep the charge valve connected to the tank for next charging.

6.3.4 Discharging system

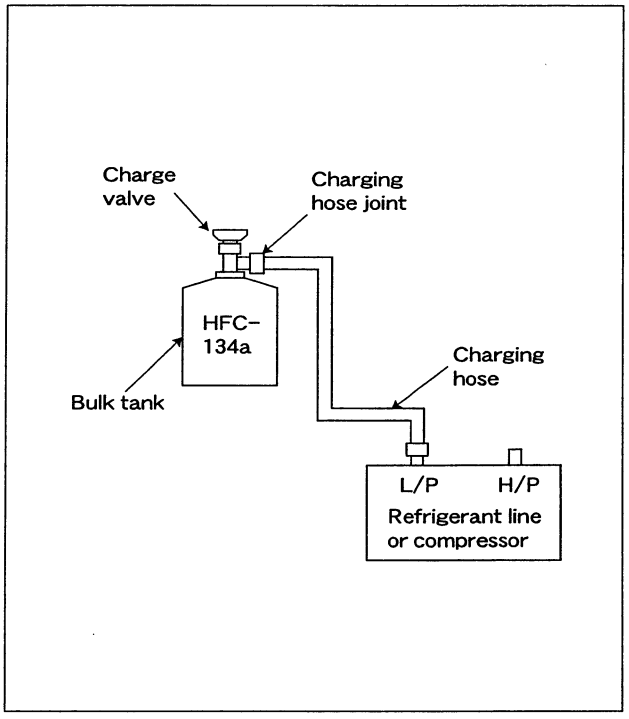
Use the refrigerant recovery unit which can be purchased in local market to discharge refrigerant gas from the system.

> ⚠ CAUTION
> Refer to that Refrigerant Recovery Unit Instruction Manual for operation which is attached on the unit.

LIQUID CHARGE, through high side using charging station:

> ⚠ CAUTION
> Do not run engine when performing liquid charge; compressor will be damage.

(1) After the system is evacuated, close gauge valves, connect center hose to refrigerant supply. Loosen center fitting at gauge to blow any air out of the hose and then retighten.
(2) Following charging station manufacture's instructions charge the system until 23oz of refrigerant is pumped into the system.
(3) When system is fully charged, close high gauge valve and refrigerant supply valve, then quickly disconnect gauge hoses from service
(4) After charging the system, refer to pre-delivery inspection.



6.4 Performance test

6.4.1 Preparation

Reinstall all vehicle parts that were removed for installation of the air conditioner at their original positions, adjust the mounting, and test the following items.

(1) Installation of grommets.

Install the specified grommets.

6.4.2 Stationary performance test

(1) Operating conditions

(a) Place the vehicle in the shade with doors open.

(b) Keep the return air temperature between 25 to 30℃ (Adjust by changing the opening degree of the doors).

(c) Set the fan switch to the max position.

(d) Turn the thermostat control lever to the cool position.

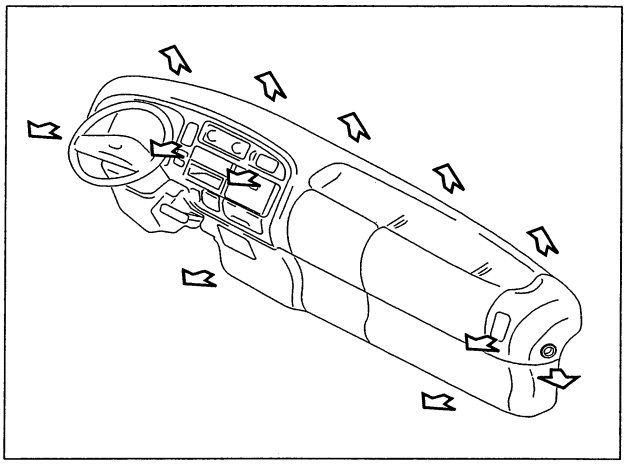
(e) Set the engine speed to approx. 1500min^{-1}.

(f) Set the high pressure at 1.17 to 1.37 MPa.

(If the high side pressure does not rise up, place paper or the like in front of the condenser.)

(2) Test procedure

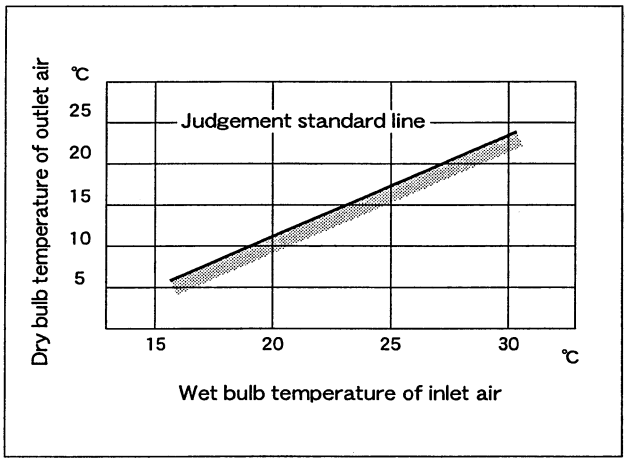
Operate the air conditioner for more than 10 minutes under the above operating conditions in order to stabilize the high and low pressures. Then perform the test by the following procedure:



(a) Measure the outlet air temperature at the inside space of the outlet grille.

(b) Measure the air conditioner intake air temperature, humidity, etc, and the items shown in the Table of Measuring Items at a position free from the effects of cool outlet air.

(c) The intersecting point of the plotted line perpendicular to the point which corresponds to the air conditioner intake and outlet air temperature difference and the plotted line perpendicular to the relative humidity of intake air should be between the oblique lines in figure.



7. MAINTENANCE

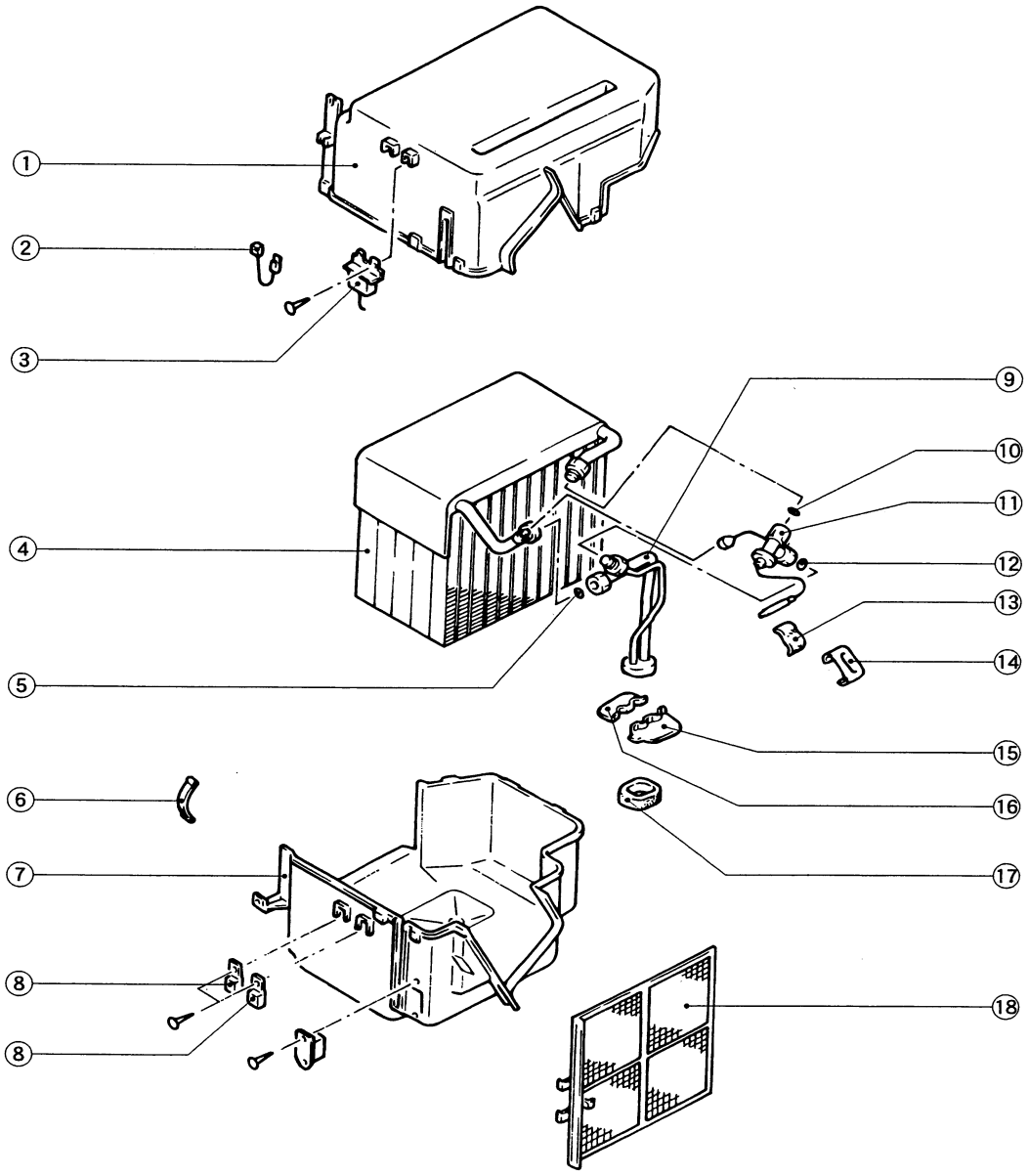
No.	Check point	Service and inspection intervals				
		When used only in summer (approx. for three months)		When used in all seasons		
		At the beginning or season	At the end of season	Every 5,000km (3,000miles)	Every 10,000km (6,000miles)	Every 20,000km (12,000miles)
1	Check condenser and radiator fin for clogging.	○	○	○		
2	Retighten all bolts.	○			○	
3	Check for refrigerant leaks.	○			○	
4	Check refrigerant level.	○		○		
5	Check V-belt tension.	○		○		
6	Check operation of magnetic clutch.	○			○	
7	Check operation of thermostat.	○				○
8	Cooling unit assembly performance test.	○		○		
9	Compressor overhaul.			Every four years		Every 40,000km (24,000miles)

⚠ WARNING

Even after the hot season is over, the air conditioner should be kept ready for operation all year round. Do not remove the V-belt or other parts.
This is because the air conditioner must be operated once a week for several minutes regardless of the season in order to prevent gas leaks caused by drying of the compressor shaft seal, and also to maintain the compressor itself in the best condition.

8. COOLING UNIT ASSEMBLY

8.1 Components



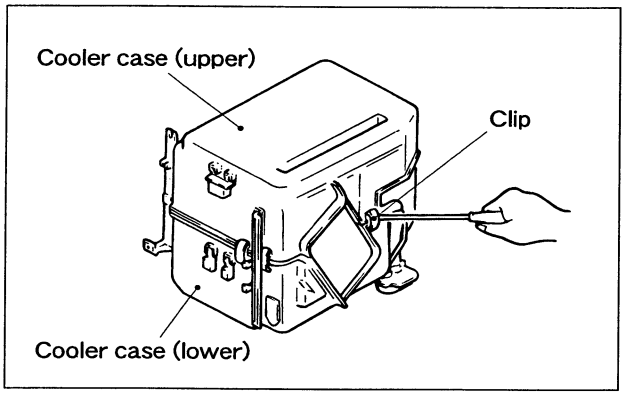
① Cooler case (upper)
② Joint harness
③ Thermostat
④ Evaporator
⑤ O-ring
⑥ Clip
⑦ Cooler case (lower)
⑧ Power relay
⑨ Pipe assembly
⑩ O-ring
⑪ Expansion valve
⑫ O-ring
⑬ Insulation rubber
⑭ Clip
⑮ Baffle plate
⑯ Baffle plate
⑰ Insulation rubber
⑱ Air filter

8.2 Cautions in disassembling

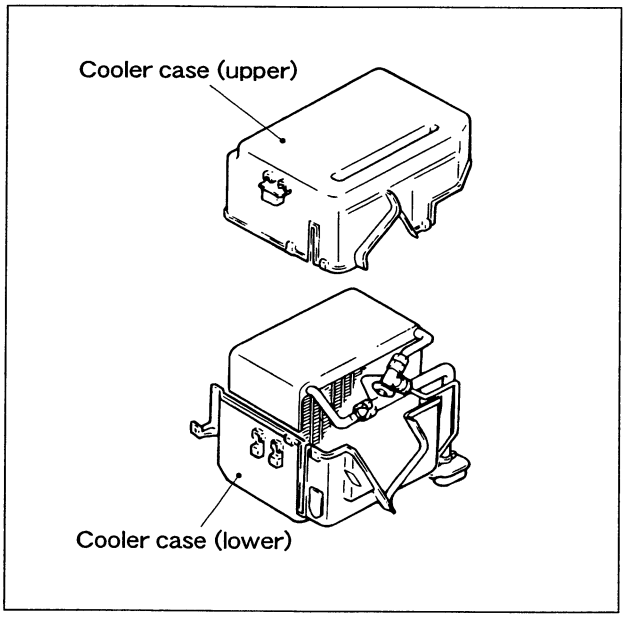
(1) Direct after disconnecting the refrigerant piping plug the opening to prevent dust and moisture etc. from entering in it.
(2) When disconnecting the expansion valve, surely apply two spanners to prevent unstable twisting from applyng with the one for supporting and the other for torquing at the connection.
(3) Pipings in the cooling unit assembly should be handled gently. Particularly, during the installation and removal.
(4) If the cooling unit assembly is stored, or transported on disassembled condition, be careful not to deform the fins.
(5) When disconnecting the wiring, avoid pulling it with the insulation cover catched, but apply force by pinching the terminals or by catching the connectors.

8.3 Disassembling

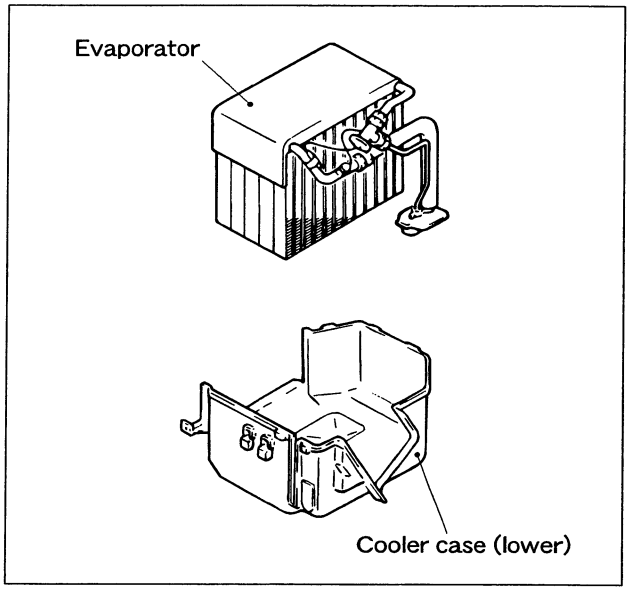
(1) Remove the clips for jointings the upper & lower side cooler case with a flat type screwdriver.



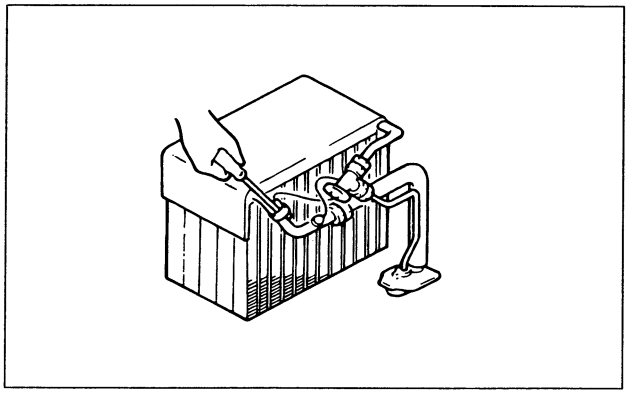
(2) Dismount the cooler case (upper).



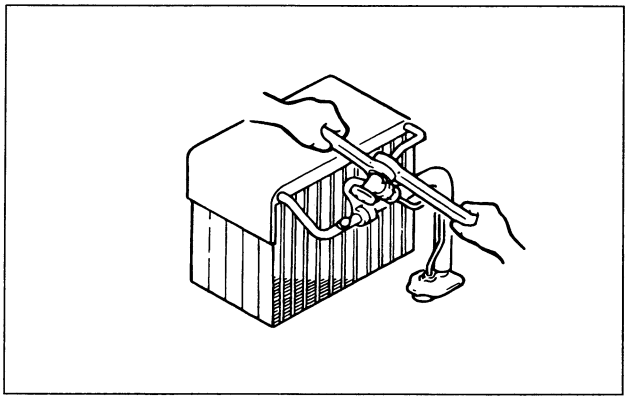
(3) Dismount the evaporator.



(4) Separate the expansion valve.
Dismount the feeler bulb at the suction side.

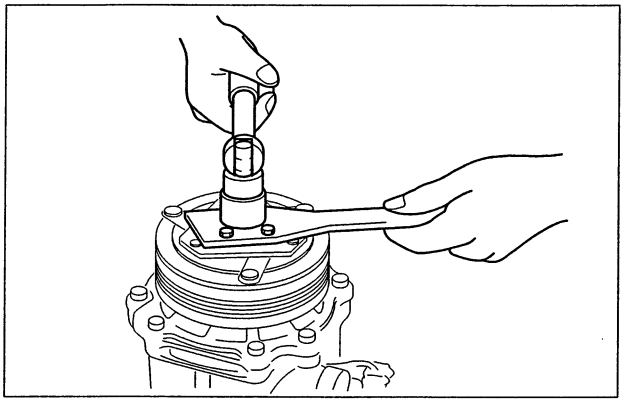


(5) Dismount the expansion valve from the circuit.

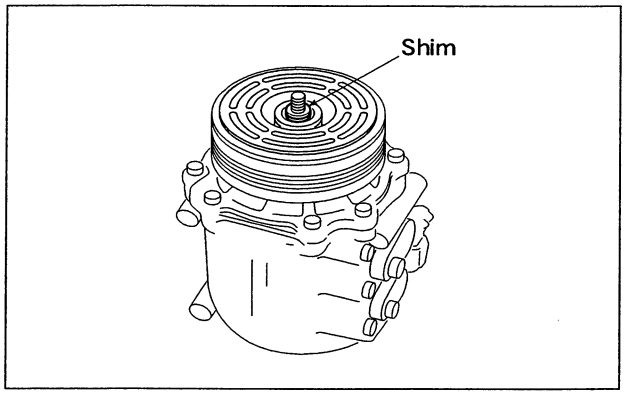


9. COMPRESSOR & CLUTCH ASSEMBLY

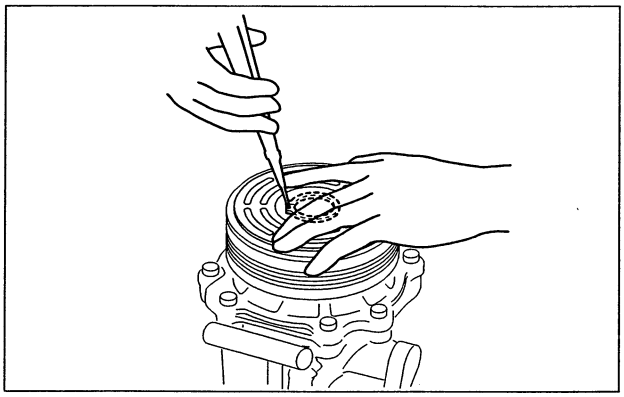
9.1 Disassembling the clutch



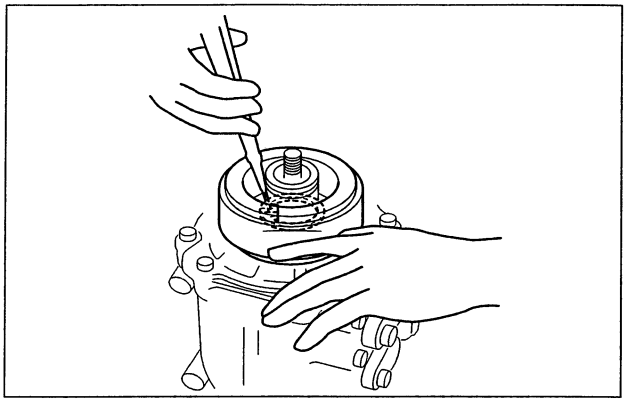
(1) Removal of armature plate.
  (a) Lock up the armature plate with a armature plate fixture and remove the lock nut.
  (b) Remove the armature plate.



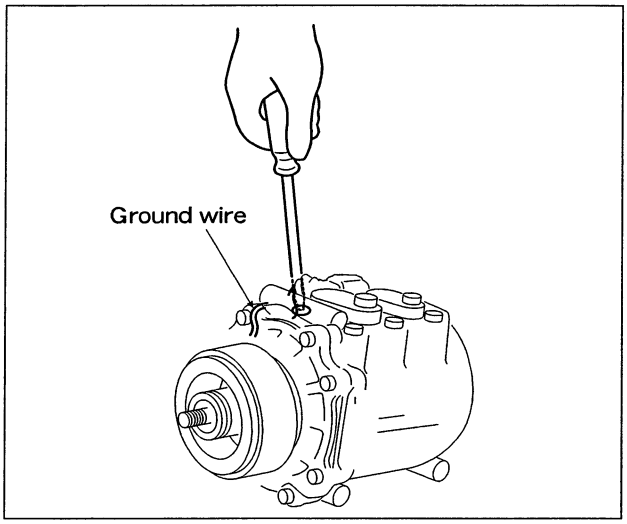
(2) Remove the shim.



(3) Withdrawing rotor.
  (a) Remove the snap ring at the front case side with snap ring pliers.
  (b) Withdraw the rotor toward you and remove it from the front case.

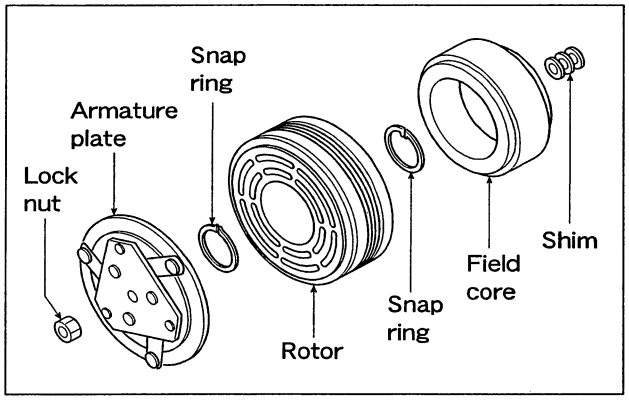


(4) Removal of field core.
  (a) Remove the snap ring for fixing the field core with snap ring pliers.



  (b) Remove the ground wire with a cross point screw-driver and withdraw the field core toward you to remove it from the crank case.

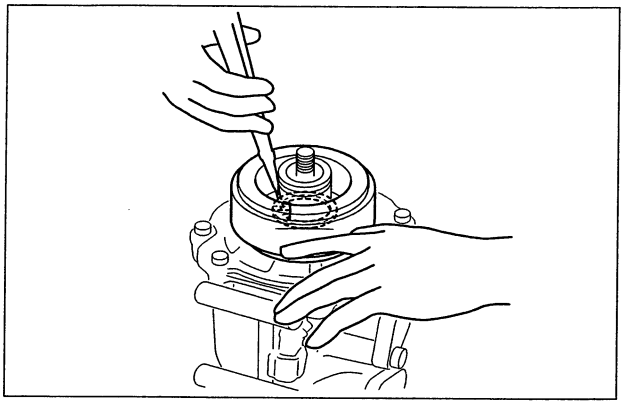
(5) Removal of key.
  Remove the key from the shaft using the top of a flat type screwdriver.



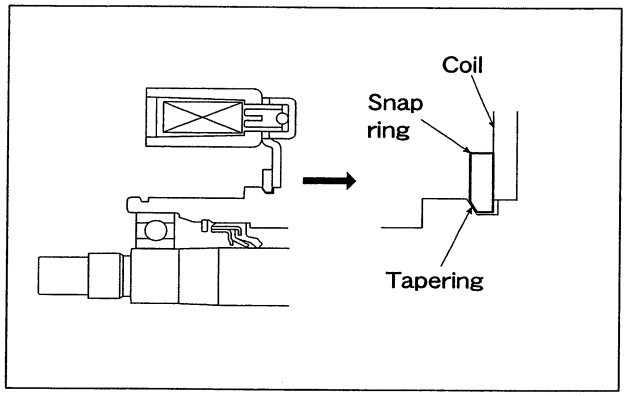
(6) Components of magnetic clutch.

9.2 Reassembly the clutch

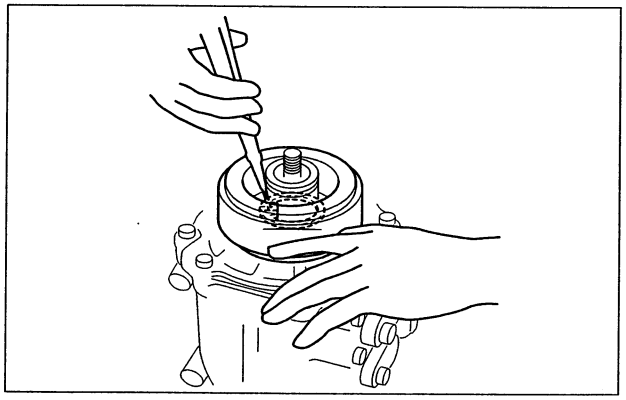
(1) Insert the key into the clankshaft.
(2) Insert the field core.



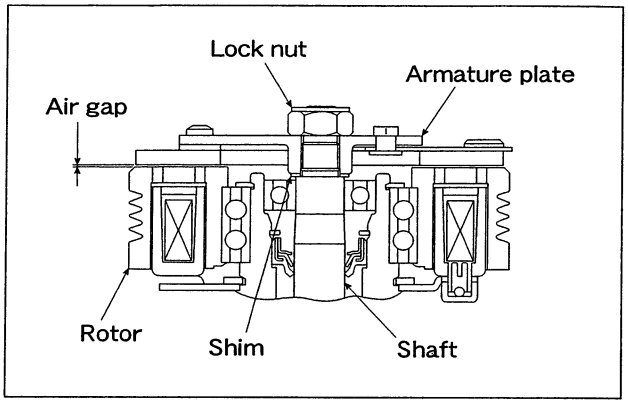
(a) Insert the field core into the front case and position it with a knock pin.
(b) Insert the snap ring for fixing field core into the groove and fix it with snap ring pliers as shown the below.



(c) Connect the ground wire.
(3) Insert the rotor into the front case.



(4) Insert the snap ring for the front case side into the groove with snap ring pliers.



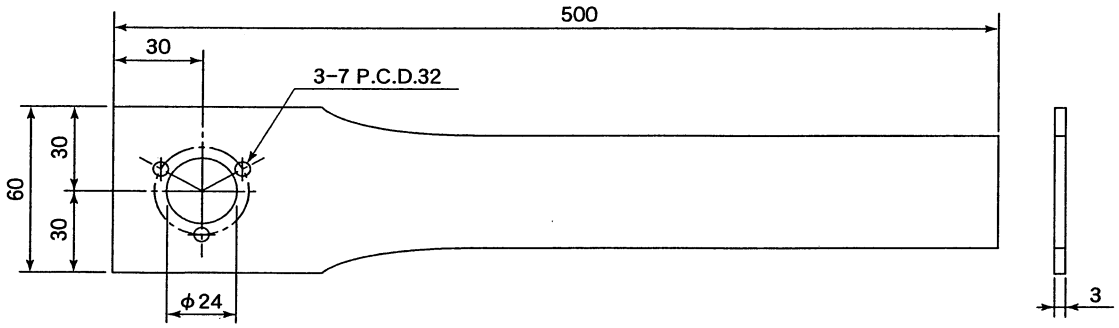
(5) Insert the armature plate.
(a) Place a shim on the end of the shaft and insert the armature plate, adjusting to the key.
(b) Tighten the center bolt to the specified torque, 15.7N.m, with in between plain washer.
(c) Measure the air gap.
The air gap should be within 0.4 to 0.65 ㎜.
Adjust it by shim if it is not within the specifications.
Adjusting shim : 0.1, 0.3, 0.5, or 0.8 ㎜.

9.3 Special tool figure

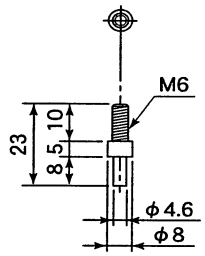
The dimensions are in millimeter

(1) Armature plate fixture

① Material S45C



② Material S45C(3個)



MITSUBISHI
FUSO

Group 55B

Heater

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWSE0101-55B

INDEX

SPECIFICATIONS 55B- 2

STRUCTURE AND OPERATION 55B- 3

TROUBLESHOOTING 55B- 9

HEATER HOSE 55B- 10

HEATER CONTROL 55B- 12

AIR DUCT 55B- 15

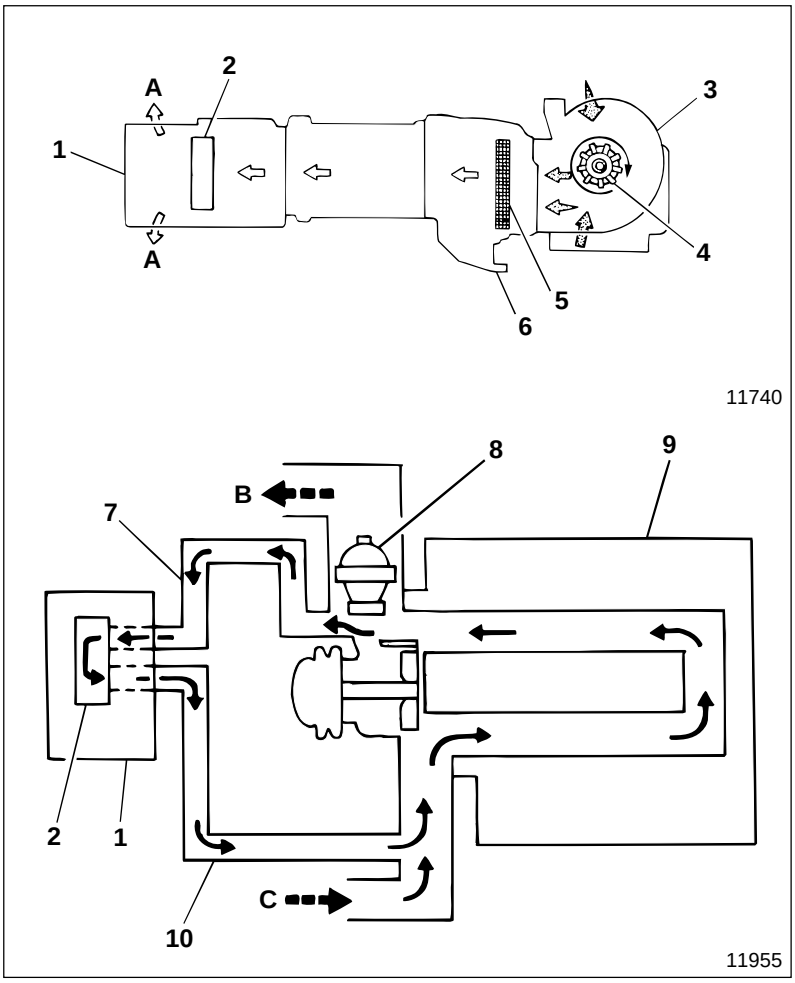
HEATER UNIT AND BLOWER ASSEMBLY 55B- 16

SPECIFICATIONS

Items		Specifications
System	Type	Inside/outside air combining, hot-water type heating system
	Standard voltage V	12
	Damper changeover system	Manual cable type
Blower assembly	Manufacturer	DENSO
	Power consumption W	170
	Maximum rotation rpm	3450
Heater unit assembly	Manufacturer	DENSO
	Temperature control system	Air mixing type
	* Heating performance kW {BTU/h, kcal/h}	*3.53 {12060, 3040}

* : Heating performance is shown under the following conditions.
Temperature difference : 65°C {119°F}
Water flow : 6 L/min {0.0035 ft^3/s}
Voltage : 12 V DC

Heater



1 Heater unit
2 Heater core
3 Blower assembly
4 Fan
5 Air filter
6 Duct assembly
7 Heater hose (Heater in)
8 Thermostat
9 Engine
10 Heater hose (Heater out)

A : To duct
B : To radiator
C : From radiator

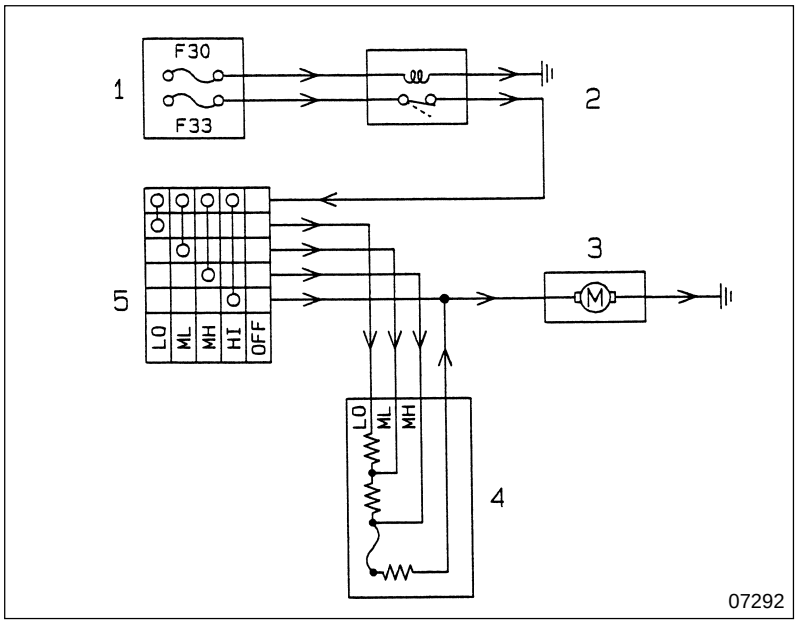
Outside air (Intake)

Inside air (Circulation)

Filtered air

- Warm engine coolant that has absorbed heat from engine **9** does not flow through thermostat **8** but circulates as follows:
  7→**2**→**10**→**9**
- Air sent to heater unit **1** from blower assembly **3** is warmed by heater core **2** (heat exchanger). Then the ducts deliver the warmed air to the cab.

Heater Electric Circuit



1 Fuse box
2 Blower fan relay
3 Blower motor
4 Blower resistor
5 Fan switch (Heater switch)

- The resistance of blower resistor **4** controls blower motor **3**, which in turn controls the air flow, except when the air flow is set to HI (high speed). When the air flow is set to HI, the current does not flow through the blower resistor.

Fan switch 5 set to LO position

- **1** (F30)→**2** (coil)→Ground
- **1** (F33)→**2** (contact point)→**5** (LO)→**4** (LO)→**3**→Ground

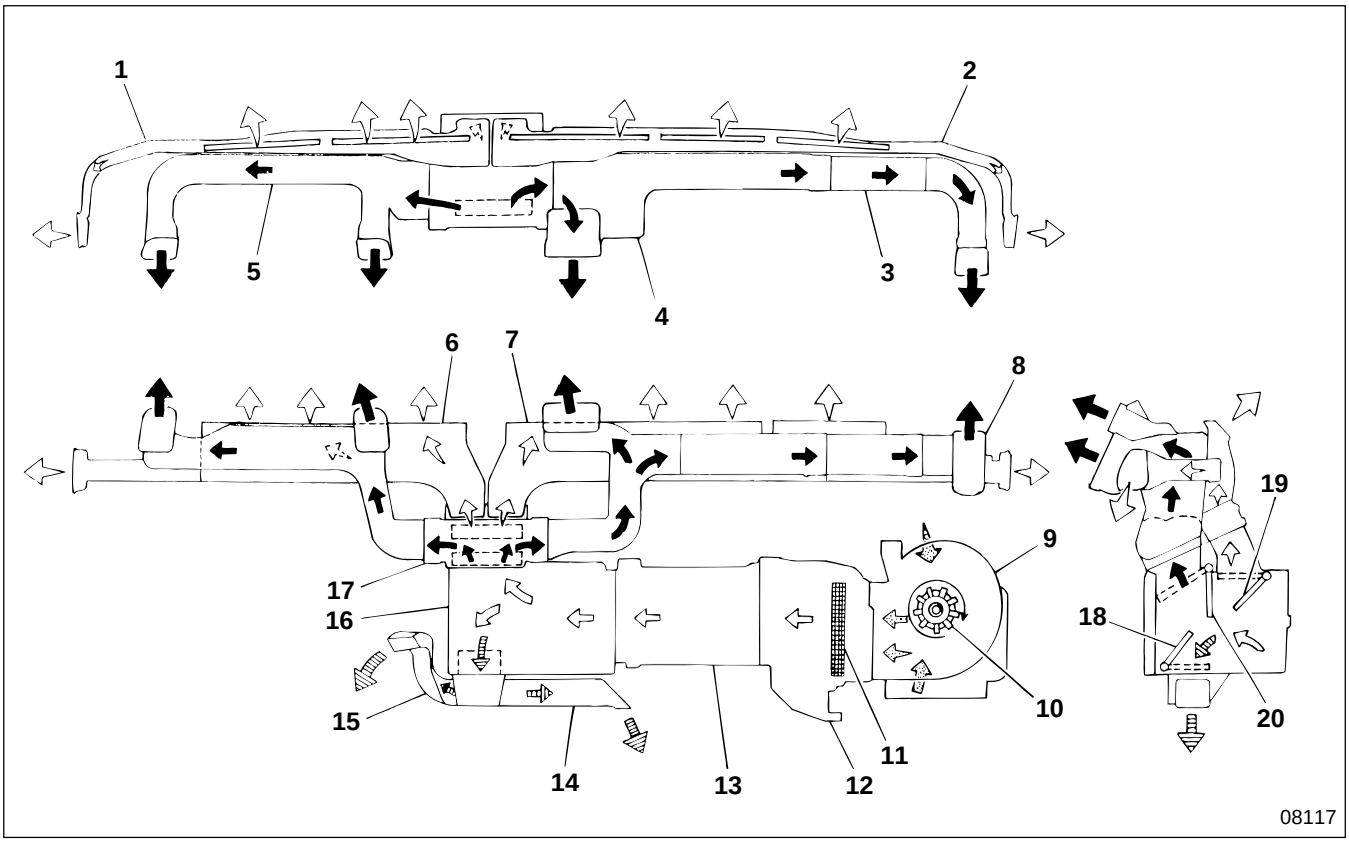
Fan switch 5 set to HI position

- **1** (F30)→**2** (coil)→Ground
- **1** (F33)→**2** (contact point)→**5** (HI)→**3**→Ground

Fan switch 5 set to either ML or MH position

The current flows through blower resistor **4** in the same way as when set to LO position, routing ML or MH respectively instead of LO.

Air Duct

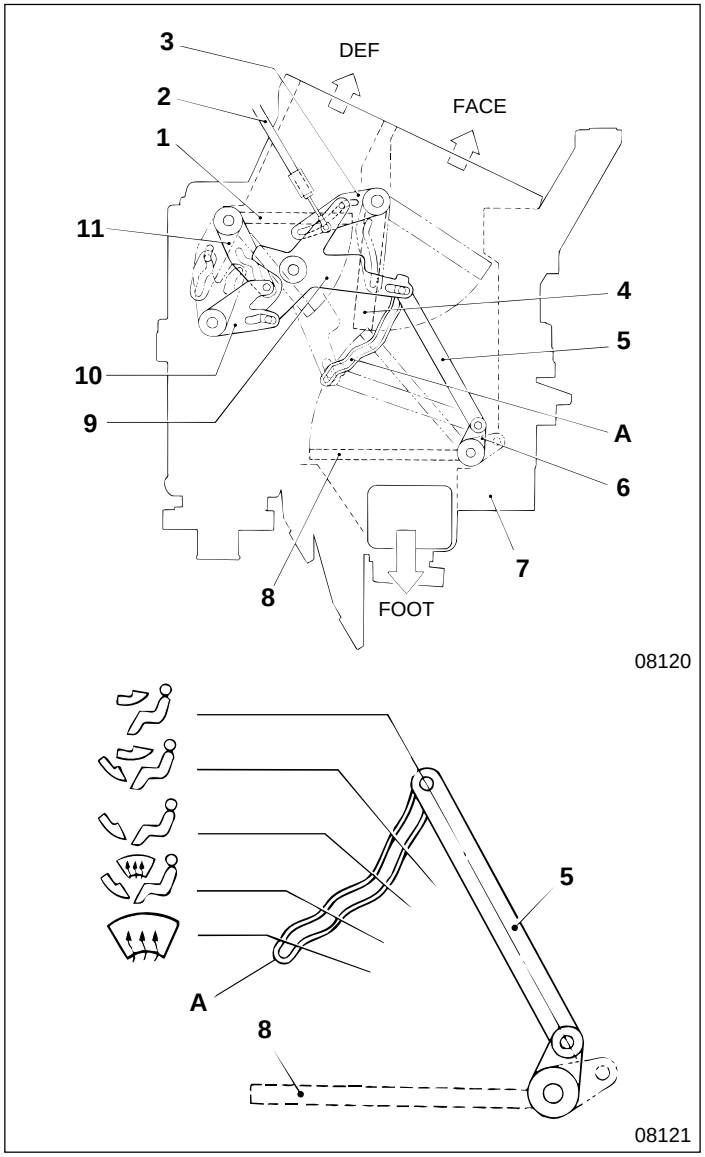


1 Defroster side duct, LH
2 Defroster side duct, RH
3 Face duct B
4 Center face duct
5 Face duct, LH
6 Front defroster, LH
7 Front defroster, RH
8 Face duct A
9 Blower assembly
10 Fan
11 Air filter
12 Duct assembly < without air-conditioner >
Cooling unit < with air-conditioner : option >
13 Joint duct
14 Foot duct, RH
15 Foot duct, LH
16 Heater unit
17 Center duct
18 Damper (FOOT)
19 Damper (DEF)
20 Damper (FACE)

Outside air (Intake) Inside air (Circulation) Filtered air (in heater and cooling unit)

Air (FACE) ( )Air (DEF) Air (FOOT)

Since dampers **18**, **19, 20** of heater unit **16** are opened and shut by the switching operation of the heater control assembly, the outside air and inside air coming from blower assembly **9** flow as illustrated.



● **Mode changeover system**

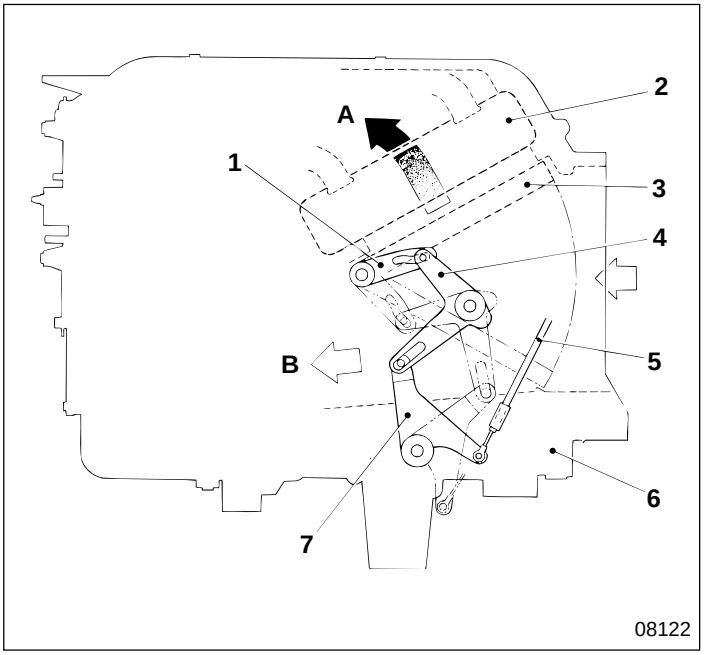
1 Damper (DEF)
2 Mode changeover control cable
3 Lever
4 Damper (FACE)
5 Lever
6 Lever
7 Heater unit
8 Damper (FOOT)
9 Lever
10 Lever
11 Lever

A : Rail

- The opening and closing of dampers **1**, **4**, **8** is mechanically controlled by the movement of mode changeover control cable **2**, transmitted as follows:
  2→**9**→**3**→**4** (FACE)
  →**5**→**6**→**8** (FOOT)
  →**10**→**11**→**1** (DEF)

  Levers **3**, **5**, **6**, **10**, **11** move together with lever **9**. Dampers **1**, **4** , **8** move together with levers **3**, **6**, **11**, the degree of opening is determined by the shape of the lever grooves.

- Lever **5** is connected to rail **A**. Since the lever moves along the groove of the rail, damper **8** (FOOT) can be opened and closed in combination with other modes to activate bi-level mode.

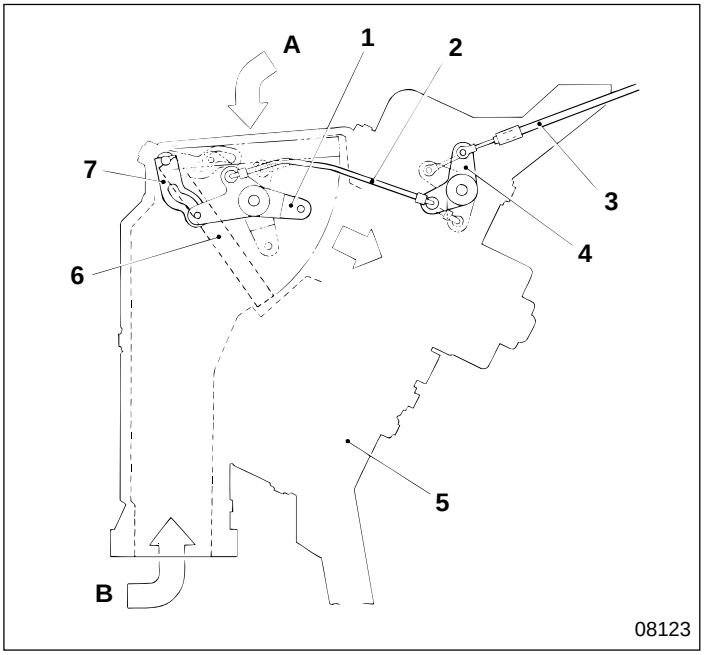


● **Air mixing control**

1 Lever
2 Heater core
3 Damper
4 Lever
5 Air mixing control cable
6 Heater unit
7 Lever

A : Warm air
B : Unwarmed air

- The degree of opening of damper **3** controls the flow of both air **A** that has passed through and been warmed by heater core **2**, and air B that has not been warmed.
- Damper **3** is mechanically operated by the movement of air mixing control cable **5**, transmitted as follows:
  5→7→4→1→3
  Lever 1 moves together with damper **3**.

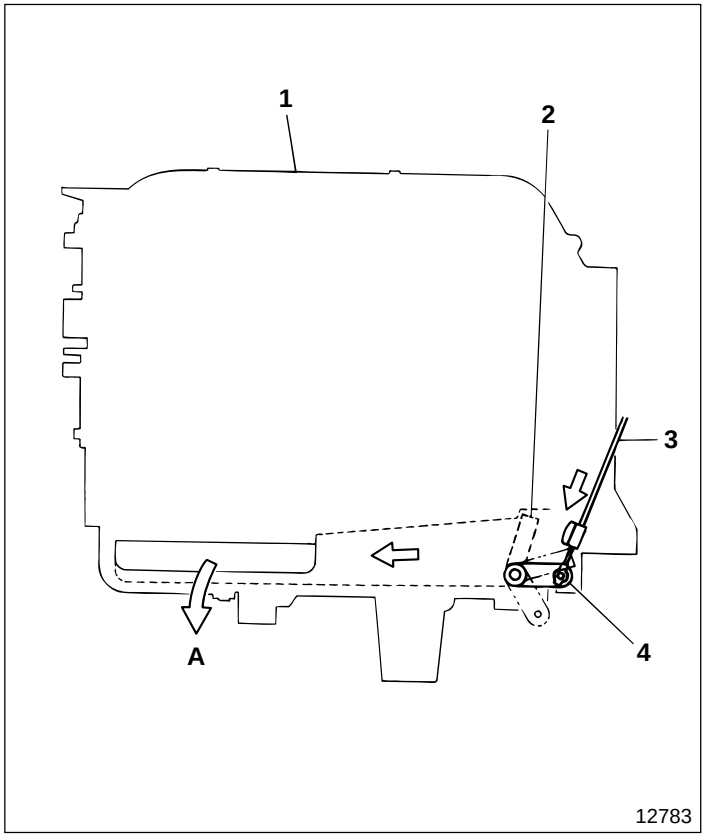


● **Air intake control**

1 Lever
2 Rod
3 Inside/outside air changeover control cable
4 Lever
5 Blower assembly
6 Damper
7 Lever

A : Inside air
B : Outside air

- Changeover of air intake from inside to outside is controlled by the opening and closing of damper **6**.
- Damper **6** is mechanically operated by the movement of inside/outside air changeover control cable **3**.
  3→4→2→1→7→6
  Lever 7 moves together with damper **6**.



● **Air flow bypass changeover**

1 Heater unit
2 Damper
3 Air flow bypass changeover control cable
4 Lever

A : Air not warmed by heater core

- Damper **2** is opened and closed to change the air flow from warm air to air that has not passed through and been warmed by heater core **2**.
- Damper **2** is mechanically operated by the movement of air flow bypass changeover control cable **3**, transmitted as follows:
  3→**4**→**2**
  Lever **4** moves together with damper **2**.

Symptoms / Possible causes	Air does not flow from vents	Heater does not work well	Airflow control setting cannot be changed	Drafts from vents	Temperature control setting cannot be adjusted	Outside/inside air control cannot be changed	Air volume from vents unstable	Control switches operation heavy	Air flow bypass cannot be changed	Remarks
Blower motor coil broken or short-circuited	○									
Blower motor relay contact point melted, coil broken or short-circuited	○									
Blower resistor operation malfunctioning							○			
Mode damper opening and closing faulty			○	○				○		
Air mixing damper opening and closing faulty				○	○			○		
Inside/outside air changeover damper opening and closing faulty				○		○		○		
Heater control assembly faulty	○	○	○	○	○	○				
Thermostat does not close		○								Gr 14A, B
Coolant amount insufficient		○								Gr 14A, B
Connector connection faulty, harness broken or grounding faulty	○		○	○	○	○				
Fuse blown	○									
Heater pipes clogged, loose or connection faulty		○								
Duct connection faulty				○						
Heater unit clogged		○								
Control cable sliding movement faulty, installation faulty			○	○		○		○		
Control cable connecting lever of units bent			○	○		○		○		
Control cable connecting lever sliding parts of units worn or lubricated insufficiently			○	○		○		○		
Air flow bypass changeover damper opening and closing faulty									○	

HEATER HOSE

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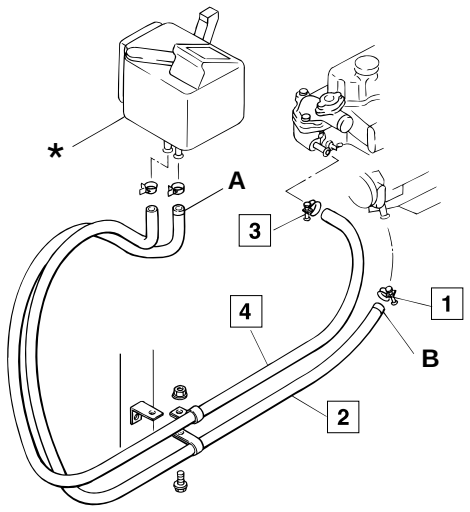

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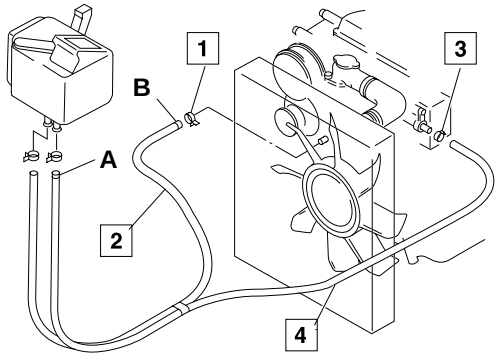

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● **Disassembly sequence**

1 Hose clamp
2 Heater hose (Heater out)
3 Hose clamp
4 Heater hose (Heater in)

***** : Heater unit
A : White mark
B : Yellow mark

NOTE

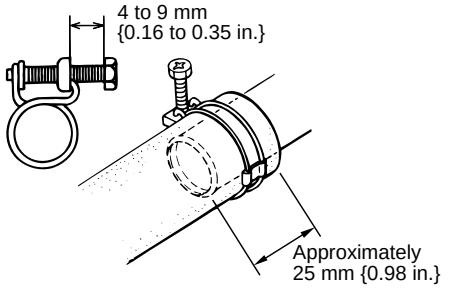
- **Drain engine coolant from radiator before removing hoses.** **Gr 14A, B**
- **Make sure that yellow mark B on heater hose 2 and white mark A on heater hose 4 are clearly visible before removing parts. If there are no marks, make identification marks before removing parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

- **Be sure that hoses are inserted securely to prevent coolant leaking.**
- **Make sure not to mix up heater hoses 2, 4 when connecting them because mistaken connection would damage the heater unit.**



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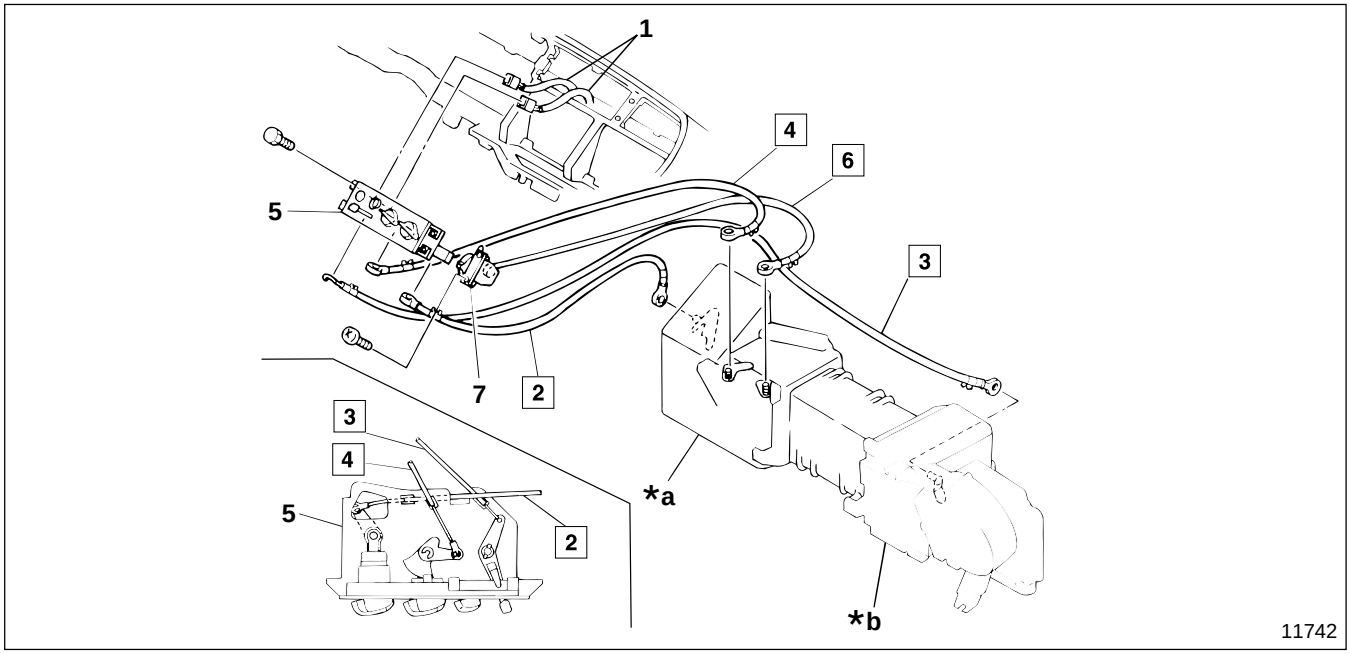
◆ Service procedure

1 **to** **4** **Installation of heater hose and hose clamp**

- Install heater hoses **2**, **4** to conform to the dimension as illustrated.
- Tighten hose clamps **1**, **3** to conform to the dimension as illustrated.

M E M O

HEATER CONTROL



● **Disassembly sequence**

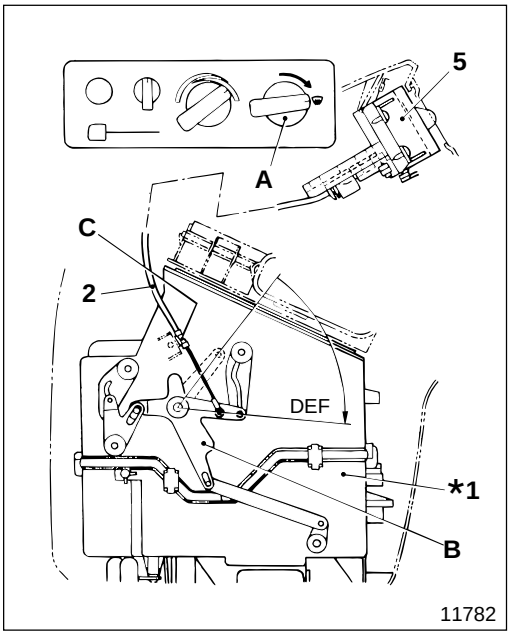
1 Harness
2 Mode changeover control cable
3 Inside/outside air changeover control cable
4 Air mixing control cable
5 Heater control assembly Gr 54
6 Air bypass changeover control cable
7 Air bypass control lever

***a** : Heater unit assembly P55B-16
***b** : Blower assembly P55B-16

● **Assembly sequence**

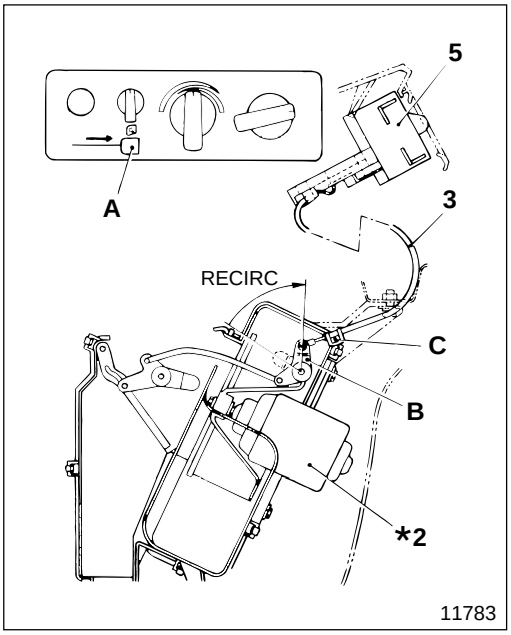
Follow the disassembly sequence in reverse.

◆ Service procedure



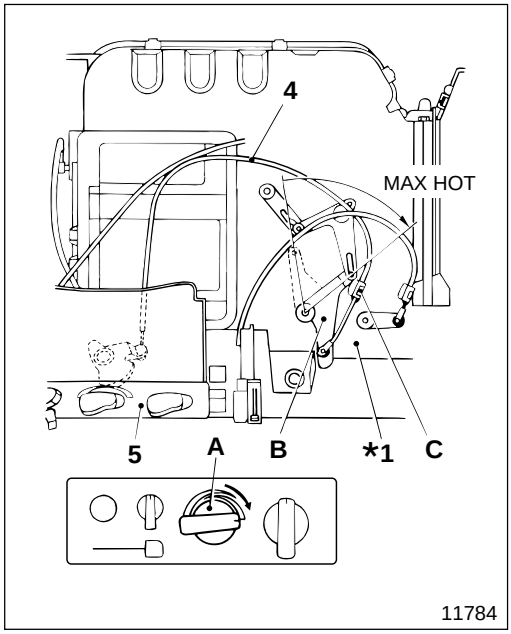
2 Installation of mode changeover control cable

- Turn mode changeover control dial **A** of heater control assembly **5** to (DEF).
- Turn mode changeover damper lever **B** of heater unit assembly ***1** to DEF.
- Under these conditions, install mode changeover control cable **2** onto mode changeover damper lever **B** and fasten it with clip **C**.



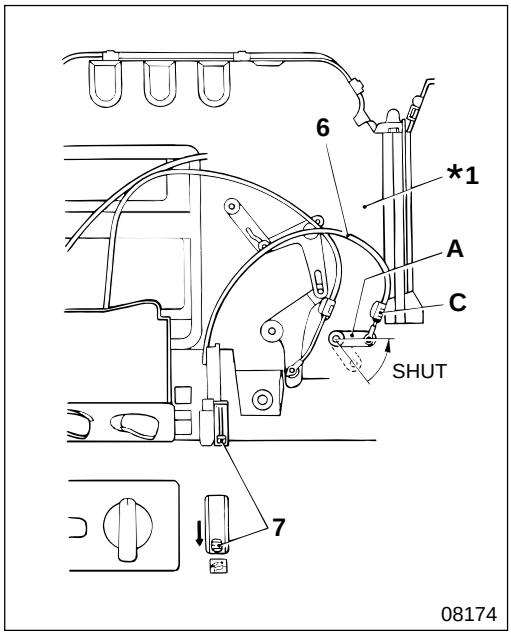
3 Installation of inside/outside air changeover control cable

- Set inside/outside changeover lever **A** of heater control assembly **5** to (RECIRC : Inside air).
- Turn inside/outside air changeover damper lever **B** of blower assembly ***2** to RECIRC.
- Under these conditions, install inside/outside air changeover control cable **3** onto inside/outside air changeover damper lever **B** and fasten it with clip **C**.



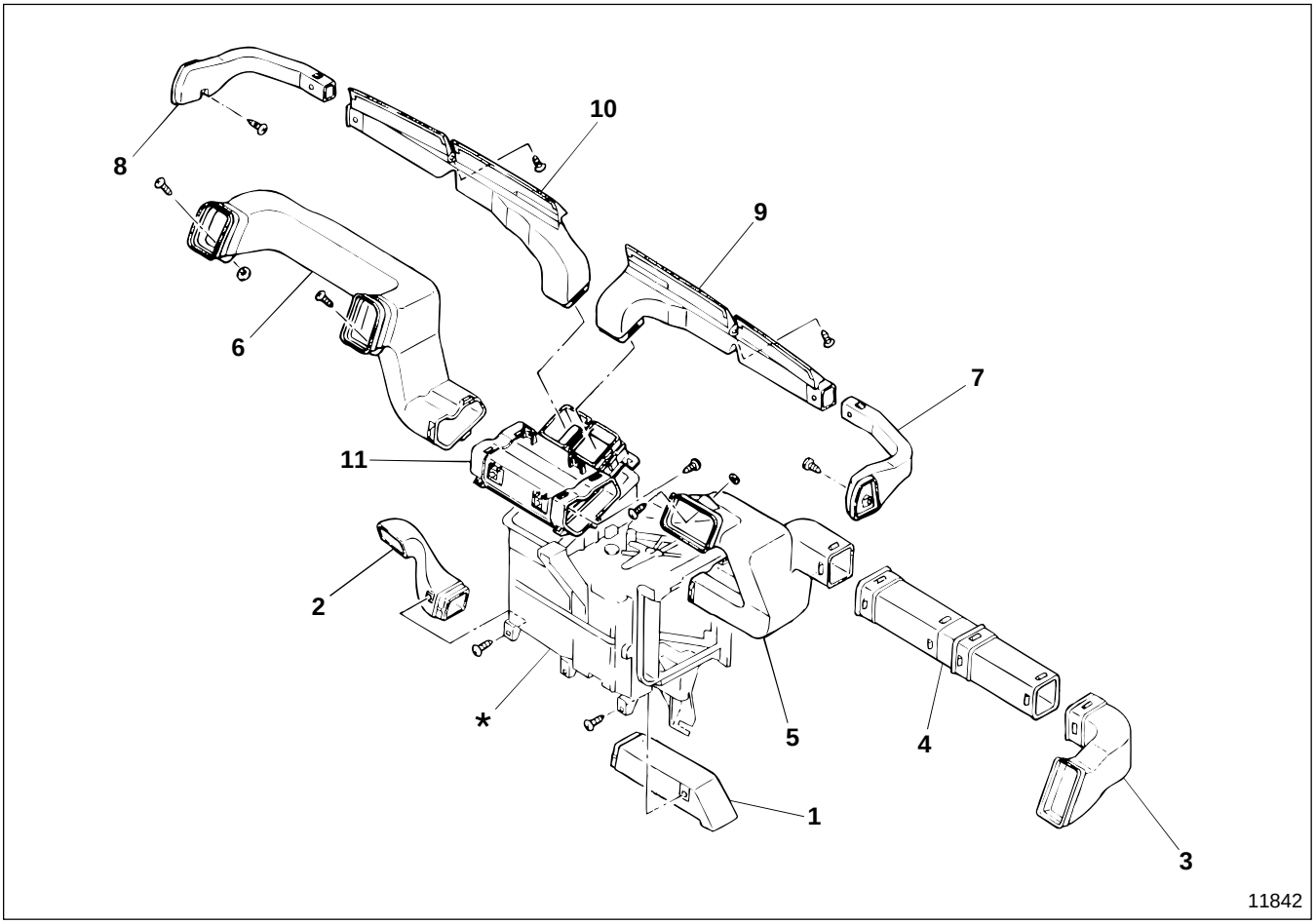
4 Installation of air mixing control cable

- Fully turn temperature control dial **A** of heater control assembly **5** clockwise to MAX HOT (maximum heating).
- Turn air mixing damper lever **B** of heater unit assembly ***1** to MAX HOT (maximum heating).
- Under these conditions, install air mixing control cable **4** onto air mixing damper lever **B** and fasten it with clip **C**.



6 Installation of air bypass changeover control cable

- Set air bypass changeover control lever **7** to SHUT.
- Set air bypass lever **A** of heater unit assembly ***1** to SHUT.
- Under these conditions, install air bypass changeover control cable **6** onto air bypass lever **7** and fasten it with clip **C**.



● **Disassembly sequence**

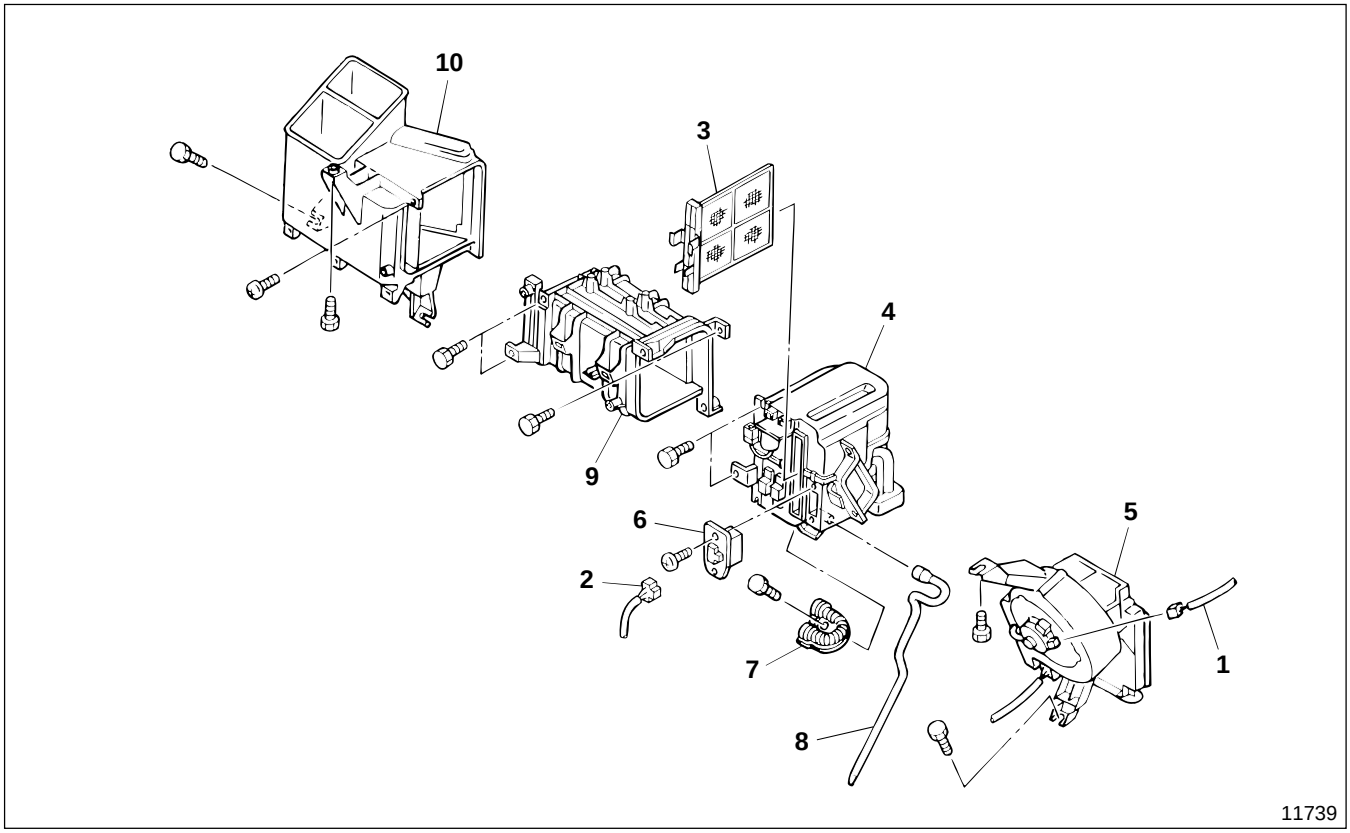
1 Foot duct, RH
2 Foot duct, LH
3 Face duct A
4 Face duct B
5 Center face duct
6 Face duct, LH
7 Defroster side duct, RH
8 Defroster side duct, LH
9 Front defroster duct, RH
10 Front defroster duct, LH
11 Center duct

***** : Heater unit

● **Assembly sequence**

Follow the disassembly sequence in reverse.

HEATER UNIT AND BLOWER ASSEMBLY



● **Disassembly sequence**

1 Harness
2 Harness
3 Air filter
4 Duct assembly
5 Blower assembly Gr 54
6 Blower resistor Gr 54
7 Cover
8 Drain hose
9 Joint duct
10 Heater unit assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

FH

SERVICE MANUAL
2003 Model

FOREWORD

This Service Manual contains maintenance and repair methods for personnel involved in the maintenance and repair of the Mitsubishi Fuso Truck FH Series. Read this manual carefully as an aid to providing correct, efficient and fast maintenance. Please note, however, that due to continued vehicle improvements the specifications and numbers given for use in maintenance might change without notice. If you have any questions, or encounter a problem, please do not hesitate to contact your nearest Mitsubishi Fuso Dealer or Distributor.

HOME

GROUP INDEX

HOW TO READ THIS MANUAL
GENERAL 00
MAINTENANCE SCHEDULE 01
ENGINE
< 4M5 > 11A
< 6D3 > 11B
LUBRICATION
< 4M5 > 12A
< 6D3 > 12B
FUEL AND ENGINE CONTROL
< 4M5 > 13A
< 6D3 > 13B
ELECTRONICALLY CONTROLLED FUEL SYSTEM
< 4M5 > 13EA
< 6D3 > 13EB
COOLING
< 4M5 > 14A
< 6D3 > 14B
INTAKE AND EXHAUST
< 4M5 > 15A
< 6D3 > 15B
CLUTCH 21
MANUAL TRANSMISSION 22
AUTOMATIC TRANSMISSION
< FH210 > 23A
< FH211 > 23B
PROPELLER SHAFT 25
FRONT AXLE 26
REAR AXLE 27
WHEEL AND TIRE 31
FRONT SUSPENSION 33
REAR SUSPENSION 34
BRAKE 35A
ANTI-LOCK BRAKE SYSTEM 35E
PARKING BRAKE
< FH210 > 36A
< FH211 > 36B
STEERING 37
FRAME 41
CAB 42
ELECTRICAL 54
AIR-CONDITIONER 55A
HEATER 55B

MITSUBISHI
FUSO

How to Read this Manual

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

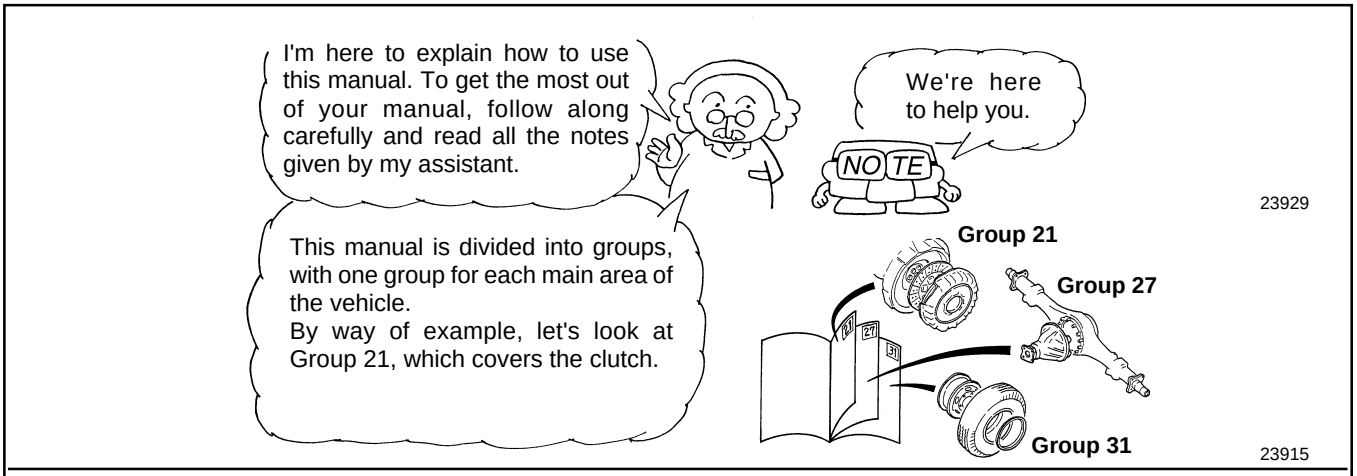
Pub No. TWME0202-H

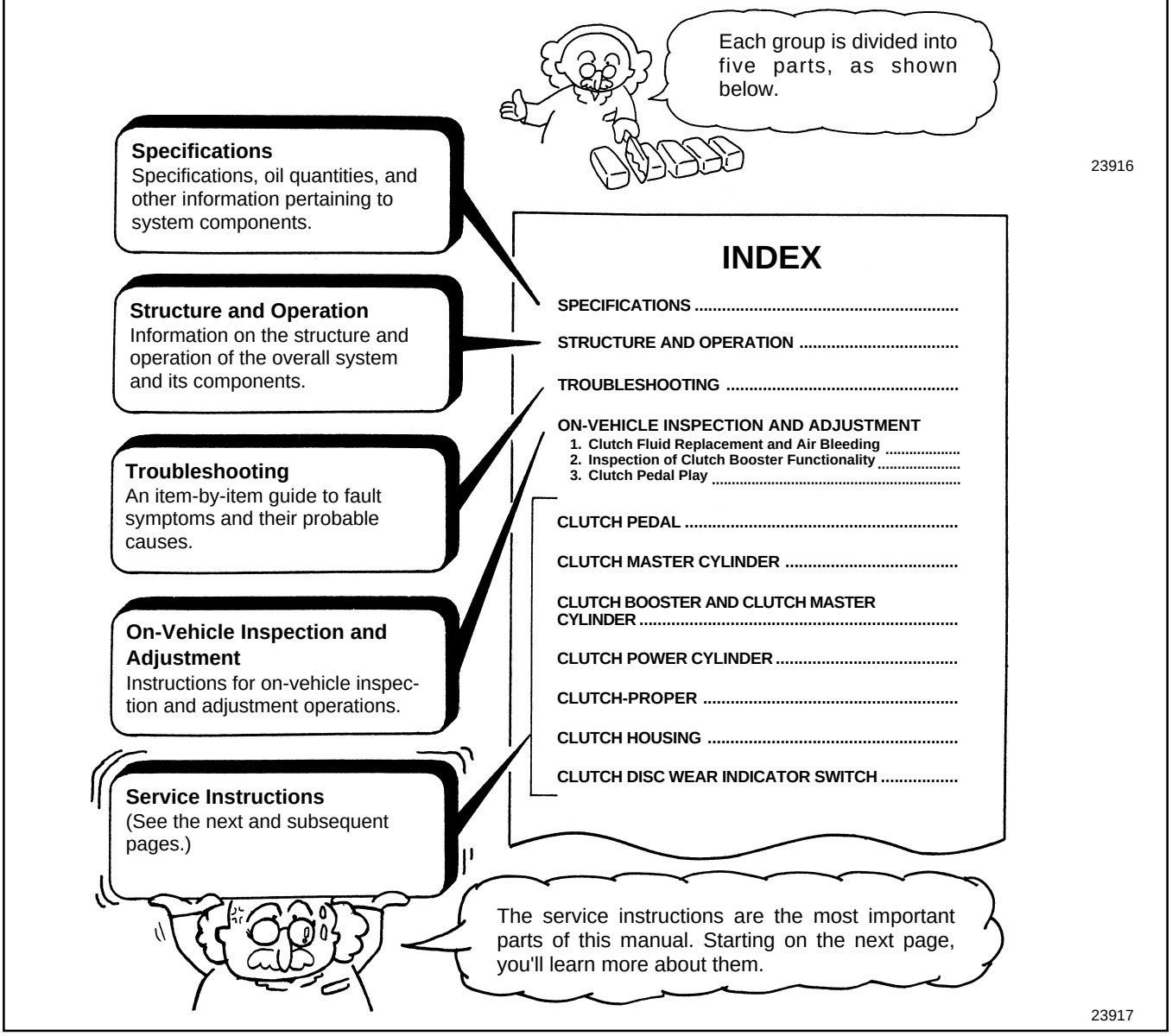
INDEX

HOW THIS MANUAL IS STRUCTURED..... 2

TERMS..... 15

HOW THIS MANUAL IS STRUCTURED





Service procedures

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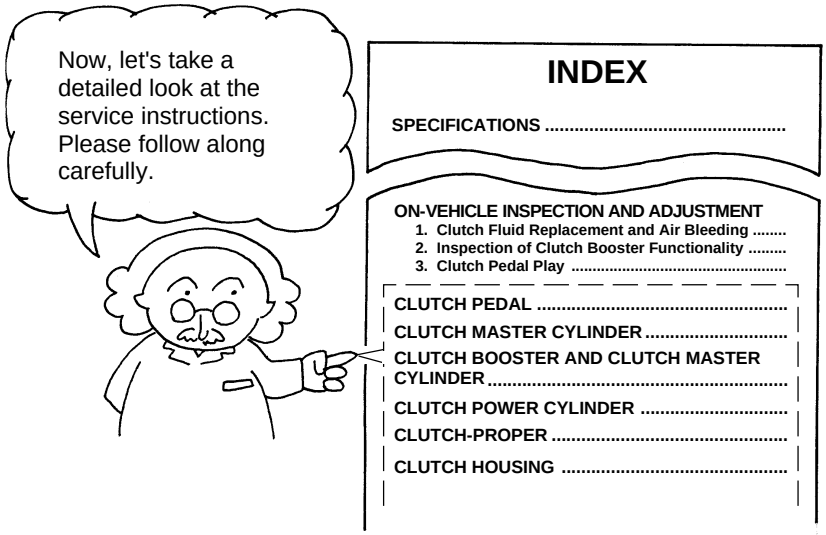

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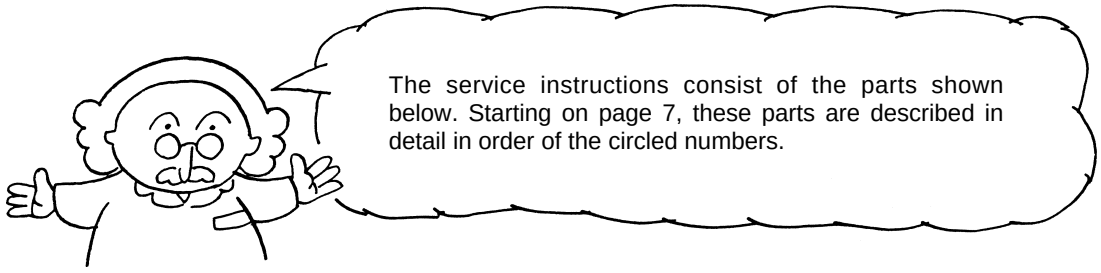

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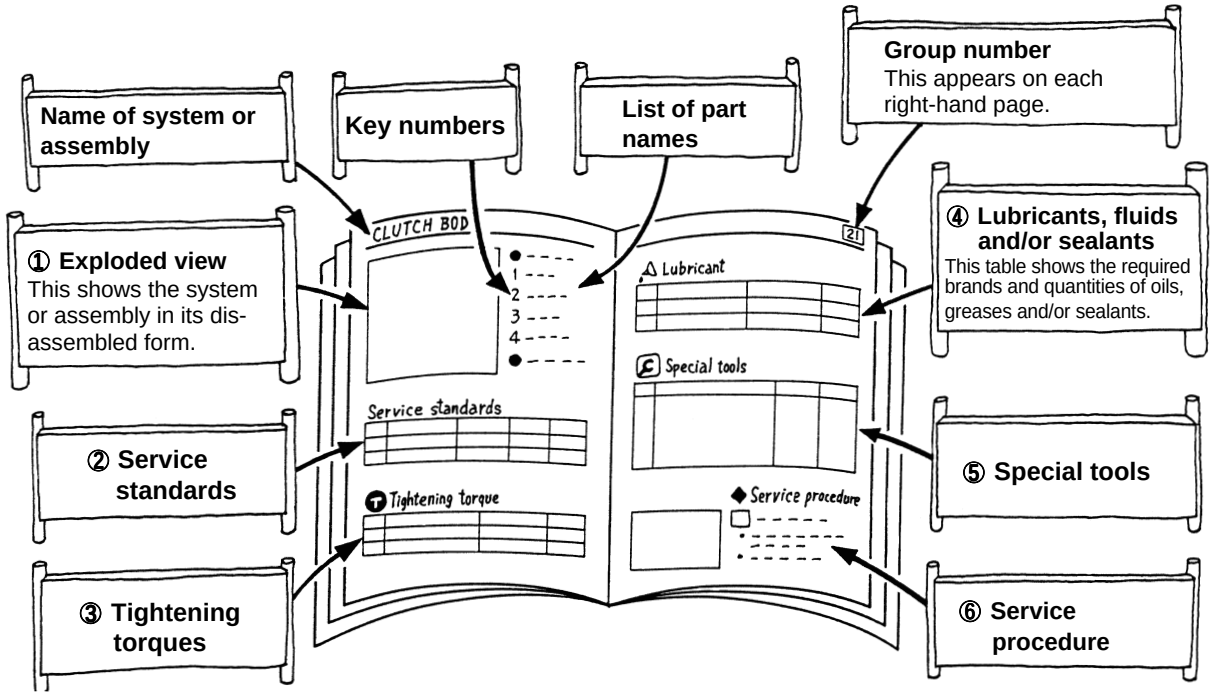

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HOW THIS MANUAL IS STRUCTURED

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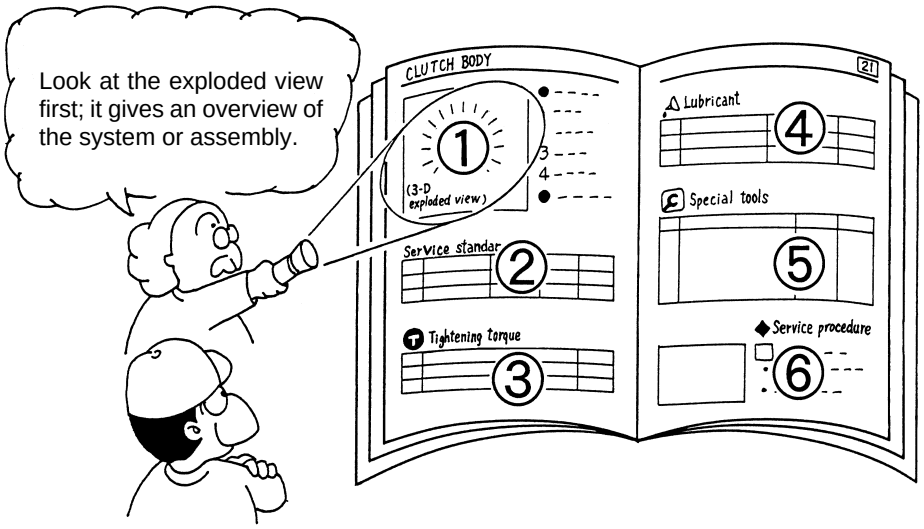

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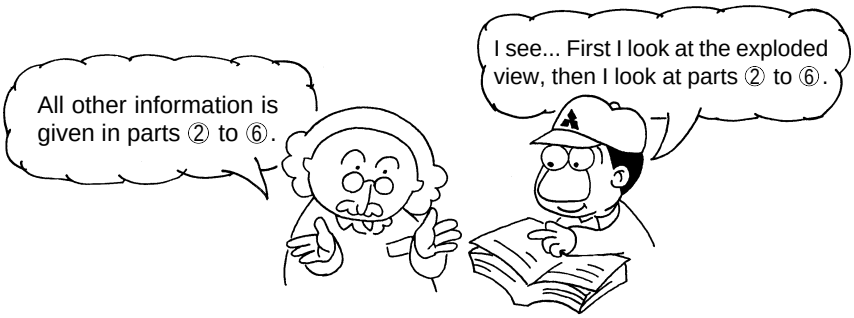

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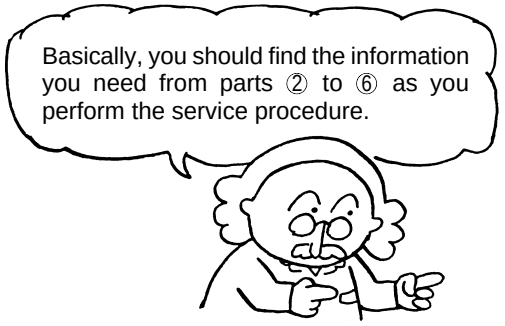

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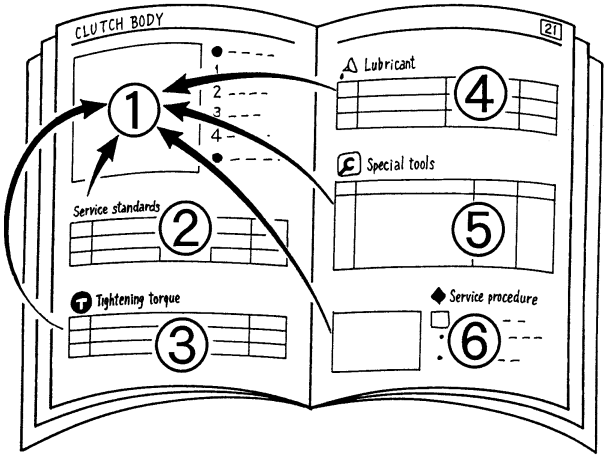

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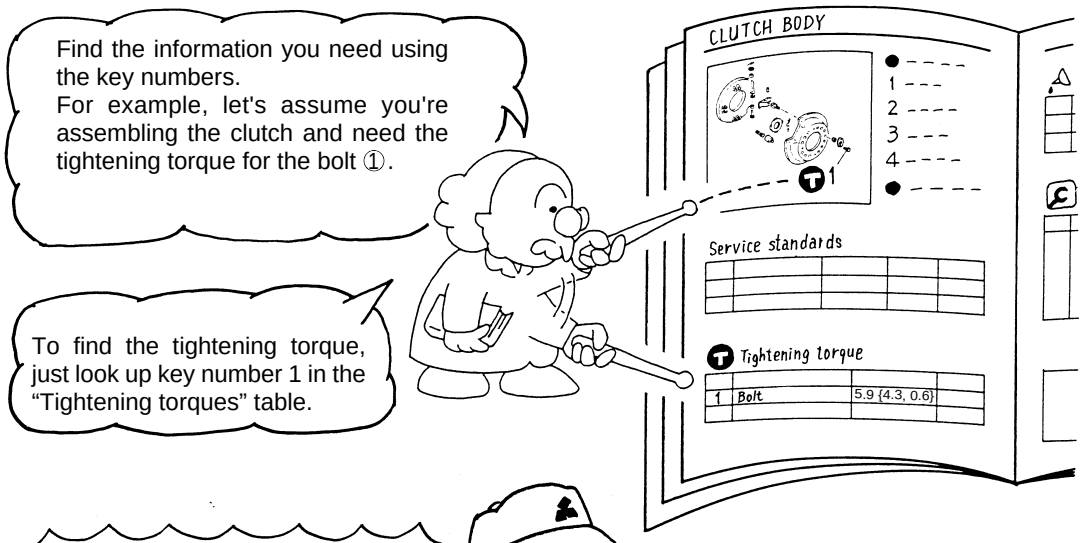

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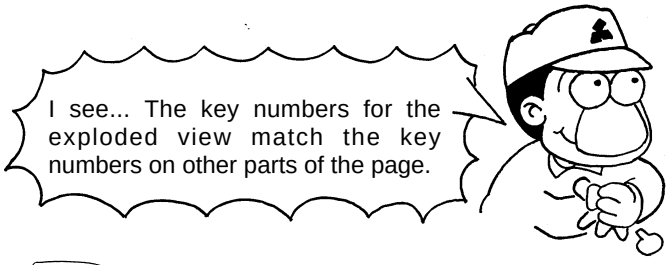

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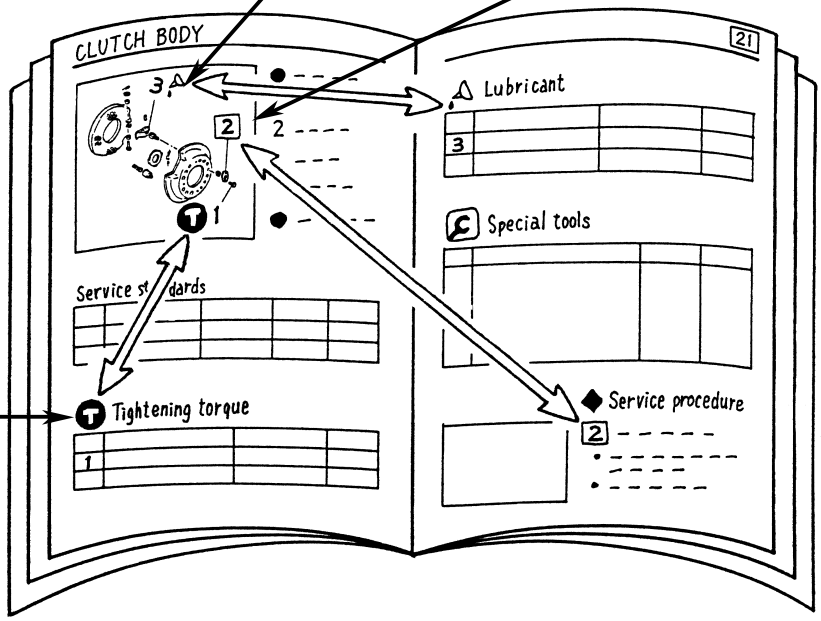
NOTE

To help you find information quickly:
Tightening torques are marked with T.
Lubricants, fluids and sealants are marked with △.
And every key number that appears in the service procedure is enclosed with a square.



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HOW THIS MANUAL IS STRUCTURED

① Exploded view

1

Explanatory notes for the exploded view are given below. Explanatory notes for the parts list are given on the facing page.

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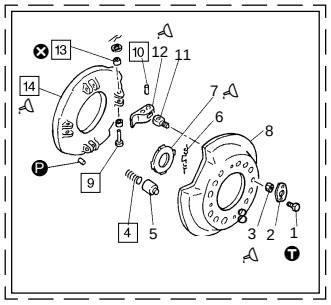
CLUTCH-PROPER <C5>

Pressure Plate-and-Lever Assembly



● **Pre-disassembly operations**
P21-44

• **Disassembly sequence**
1 Bolt
2 Lock plate
3 Support nut
4 Pressure spring
5 Pressure spring cap
6 Return spring
7 Release lever plate
8 Clutch cover
9 Release lever pin
10 Support lever pin
11 Support lever
12 Release lever
13 Bushing
14 Pressure plate

Ⓟ Positioning pin
⊗ : Non-reusable part

NOTE
Do not remove the bushing 13 unless it is defective.

● **Assembly sequence**
Reverse the order of disassembly.
Repair kit : Clutch release
Lever kit

● **Post-assembly Inspection and adjustment**
P21-44

23926

NOTE

This mark indicates a part that cannot be reused.

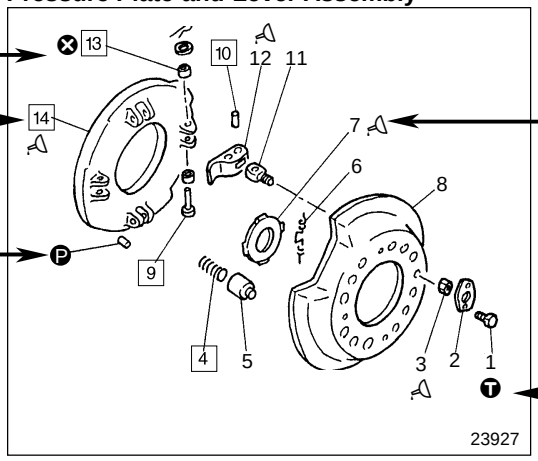
NOTE

The key number enclosed with a square indicates that the part is mentioned in the service procedure.

NOTE

Ⓟ: Indicates positioning pin.

Pressure Plate-and-Lever Assembly



23927

NOTE

This mark indicates that lubricant or sealant must be applied to the part.

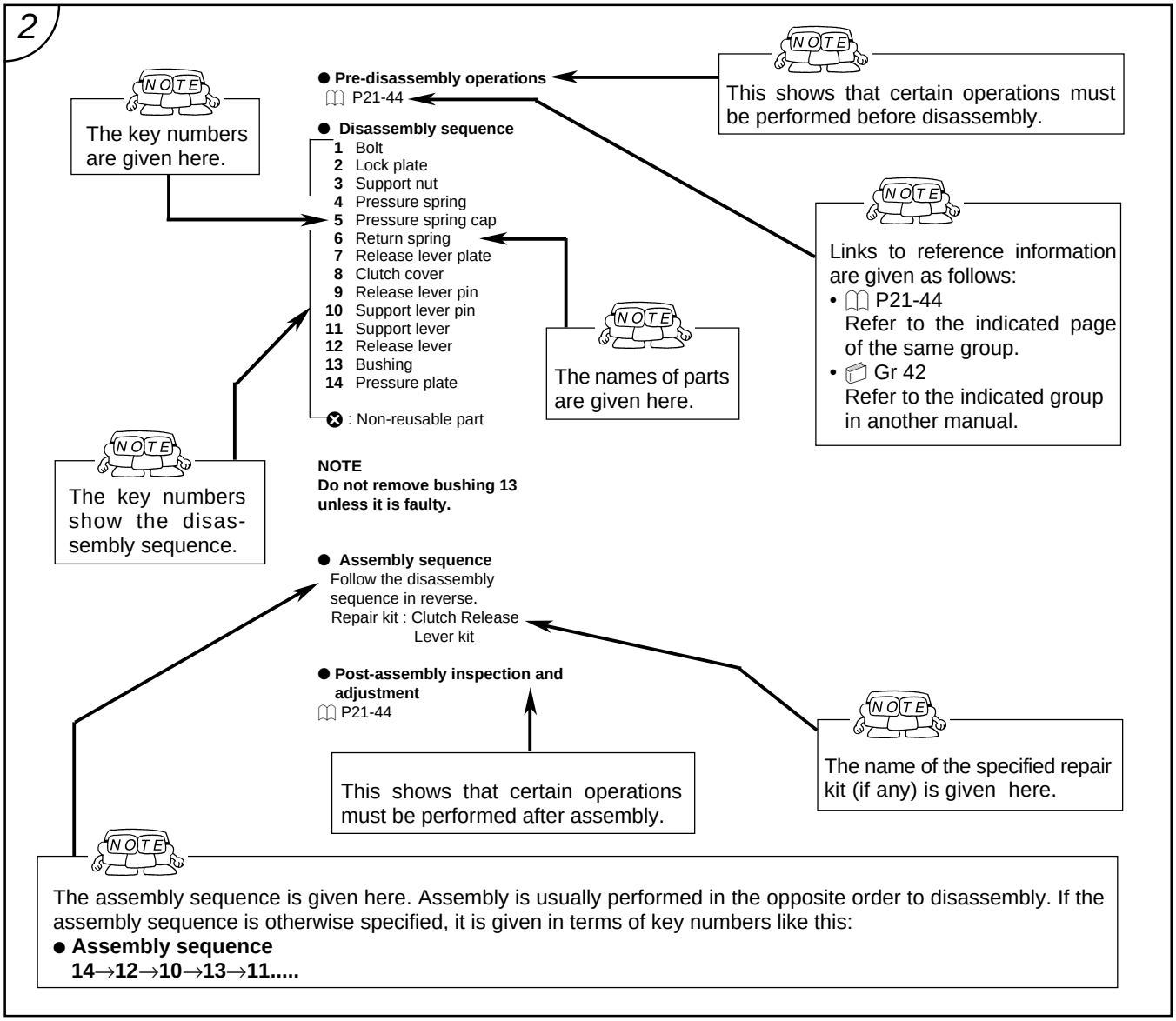
NOTE

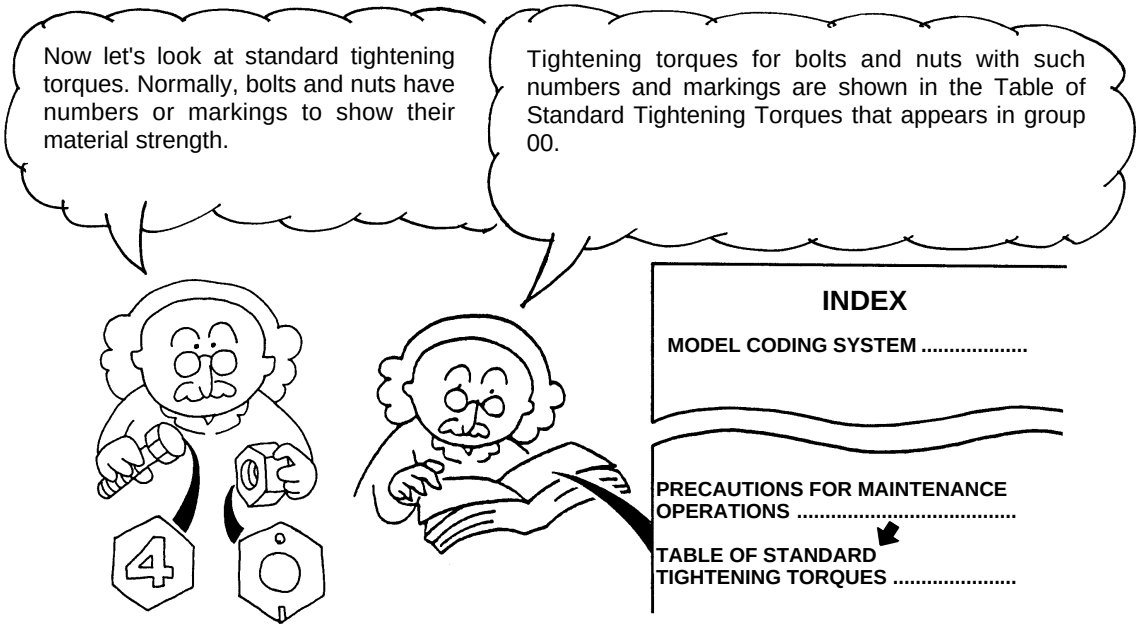
This mark indicates that a tightening torque is specified for the part.

So parts without Ⓣ marks don't have specified tightening torques ?

No, they don't. But every bolt and nut must be tightened to a standard torque. A Ⓣ mark shows either that the part must be tightened to a torque other than the standard torque or that the standard torque cannot be determined from the part's shape or markings.
Standard tightening torques are explained at the bottom of the next page.

23928


2
NOTE
This shows that certain operations must be performed before disassembly.
● Pre-disassembly operations
P21-44
NOTE
The key numbers are given here.
● Disassembly sequence
1 Bolt
2 Lock plate
3 Support nut
4 Pressure spring
5 Pressure spring cap
6 Return spring
7 Release lever plate
8 Clutch cover
9 Release lever pin
10 Support lever pin
11 Support lever
12 Release lever
13 Bushing
14 Pressure plate
: Non-reusable part
NOTE
Links to reference information are given as follows:
• P21-44
Refer to the indicated page of the same group.
• Gr 42
Refer to the indicated group in another manual.
NOTE
The names of parts are given here.
NOTE
The key numbers show the disassembly sequence.
NOTE
Do not remove bushing 13 unless it is faulty.
● Assembly sequence
Follow the disassembly sequence in reverse.
Repair kit : Clutch Release Lever kit
● Post-assembly inspection and adjustment
P21-44
NOTE
The name of the specified repair kit (if any) is given here.
This shows that certain operations must be performed after assembly.
NOTE
The assembly sequence is given here. Assembly is usually performed in the opposite order to disassembly. If the assembly sequence is otherwise specified, it is given in terms of key numbers like this:
● Assembly sequence
14→12→10→13→11.....


Now let's look at standard tightening torques. Normally, bolts and nuts have numbers or markings to show their material strength.
Tightening torques for bolts and nuts with such numbers and markings are shown in the Table of Standard Tightening Torques that appears in group 00.
INDEX
MODEL CODING SYSTEM .....
PRECAUTIONS FOR MAINTENANCE OPERATIONS .....
TABLE OF STANDARD TIGHTENING TORQUES .....
23930

HOW THIS MANUAL IS STRUCTURED

② Service standards

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
4	Pressure spring	Installed load (Installed length 49.1 {1.93})	885 N {200 lbf, 90.2 kgf}	750 N {170 lbf,76.7 kgf}	Replace
		Squareness	2.9 {0.11} or less	5.0 {0.20}	Replace
7	Release lever plate height		53.8±0.7 {2.12±0.028}	Relative difference 0.5 {0.020} maximum	Adjust
10, 13	Clearance between release lever pin and bushing		[10 {0.39}] 0.02 to 0.11 {0.00079 to 0.0043}	0.4 {0.016}	Replace
14	Pressure plate	Thickness	23.6±0.1 {0.93±0.0039}	21 {0.83}	Replace
		Flatness	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Strap bolt hole I.D.	10.2 to 10.25 {0.40 to 0.40}	10.5 {0.41}	Replace

NOTE

Number(s) in this column match the key number(s) on the exploded view ①.

③ Tightening torques

Tightening torque

Unit : N·m {ft.lbs, kgf.m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	5.9 to 7.8 {4.3 to 5.8, 0.6 to 0.8}	—

NOTE

Number(s) in this column match the key number(s) on the exploded view ①.

NOTE

If oil or grease must be applied to threads before tightening, the word "Wet" appears in this column.

	Remarks
	Wet

④ Lubricants, fluids and/or sealants

Lubricant

Location	Points of application	Specified lubricant	Quantity
3	Threads and spherical surface of support nut	Anti-seizure compound	As required
7, 12	Sliding surfaces of release lever plate and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
11, 12	Sliding surfaces of support lever and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
11, 14	Sliding surfaces of support lever and pressure plate	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

NOTE

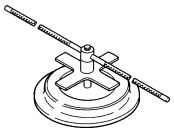
Number(s) in this column match the key number(s) on the exploded view ①.

NOTE

The specified types/brand are shown here.

⑤ Special tools

Special tools Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Clutch Installer  01277	MH061051	Removal and installation of clutch cover

NOTE
Number(s) in this column match the key number(s) on the exploded view ①. For any special tool that is not a Mitsubishi genuine part, no illustration is shown; only the part number is given, as shown below.

Special tools

Location	Tool name and shape	Part No.	Application
21	Insertion Tool	*910-24461	Installation of O-ring
32	Retainer	*910-24590	Retention of primary piston

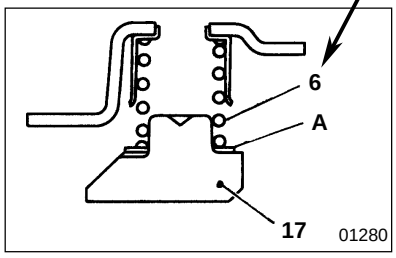
* BOSCH BRAKING SYSTEMS Co. Ltd. product number

⑥ Service procedure

1

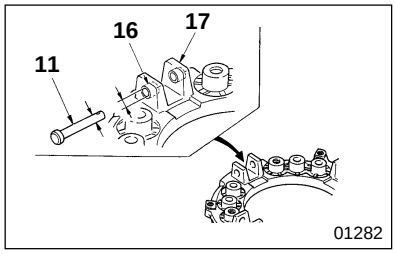
NOTE
Number(s) is this column match the key number(s) exploded view ①.

NOTE
The service procedure gives instructions in order of key numbers.



6 **Installation of pressure spring**
If the pressure plate **17** has been reqround, insert between the pressure plate and pressure spring **6** an adjusting washer **A** whose thickness matches that of the ground off material.

Regrind amount	Thickness and number of washer(s)
Less than 1 mm {0.039 in.}	Not required
1 mm {0.039 in.} (or more) to less than 2 mm {0.079 in.}	1.2 mm {0.047 in.}×1
2 mm {0.079 in.} (or more) to less than 3 mm {0.12 in.}	1.2 mm {0.047 in.}×2 or 2.3 mm {0.091 in.}×1



11 16 **Clearance between release lever pin and bushing**
If the measurement exceeds the specified limit, replace the defective part(s).

NOTE
Perform this check with the bushing 16 press-fitted into the pressure plate 17.

HOW THIS MANUAL IS STRUCTURED

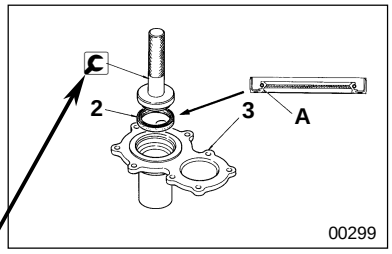
2

Service procedures contain a variety of symbols and other indications. Let's look at some examples.

23931

Key number

[Example 1: Special tools]

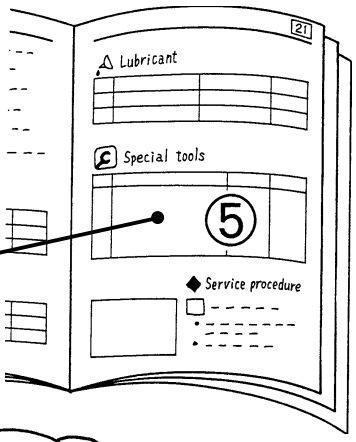


00299

2 Installation of oil seal

- Apply grease to the lip **A** of the oil seal **2**.
- Using the Oil Seal Installer, fit the oil seal **2** into the front bearing retainer **3**. Make sure the oil seal is aligned as illustrated.

Name of special tool



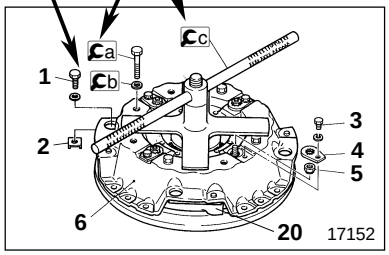
26315

Every special tool is indicated by a symbol. The text of the service procedure also includes the special tool's name. To see the part number and shape of a special tool, find the tool's key number and name in the "Special tools" table ⑤.

23932

If more than one special tool is used, the symbols are supplemented by letters (for example, a, b and c) to enable cross-referencing between the exploded view and service procedure.

20277



17152

6 Removal and installation of clutch cover

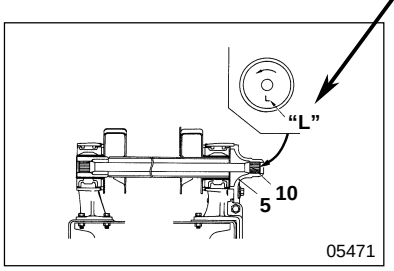
[Removal]

- Compress the pressure spring **8** using the c Clutch Installer, then remove the a Stopper Bolt, b Washer, strap bolt **1**, washer **2**, bolt **3**, lock plate **4** and support nut **5**.
- Gradually loosen the c Clutch Installer until the pressure spring **8** is ineffective, then remove the clutch cover **6**.

3

[Example 2: Identification or mating marks]

NOTE Any mark on an actual part is given in quotation marks " " in the service procedure.

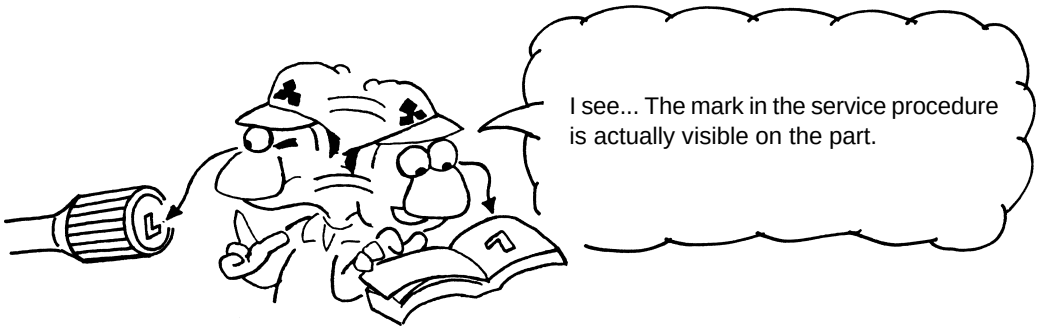


10 Installation of torsion bar

Fit the torsion bar **10** such that the "**L**" identification mark is on the side of the anchor lever **5**.

CAUTION ⚠

Make sure the torsion bar 10 aligned as specified. If the torsion bar is installed the wrong way around, the torsion direction will be reversed, resulting in damage.

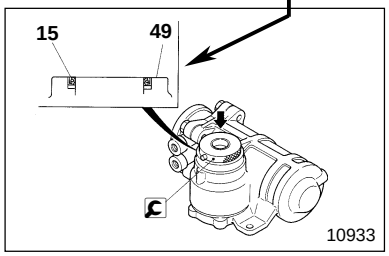


26304

4

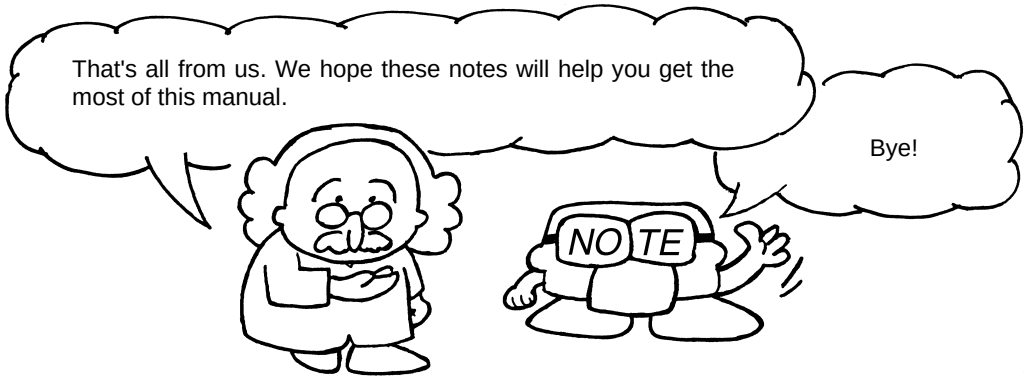
[Example 3 : Alignment of parts]

NOTE All illustrations show the correct alignment/direction of parts relative to each other. Provided the alignment/direction is shown clearly in the exploded view ①, no further explanation is given in the text of the service procedure.



15 Installation of oil seal

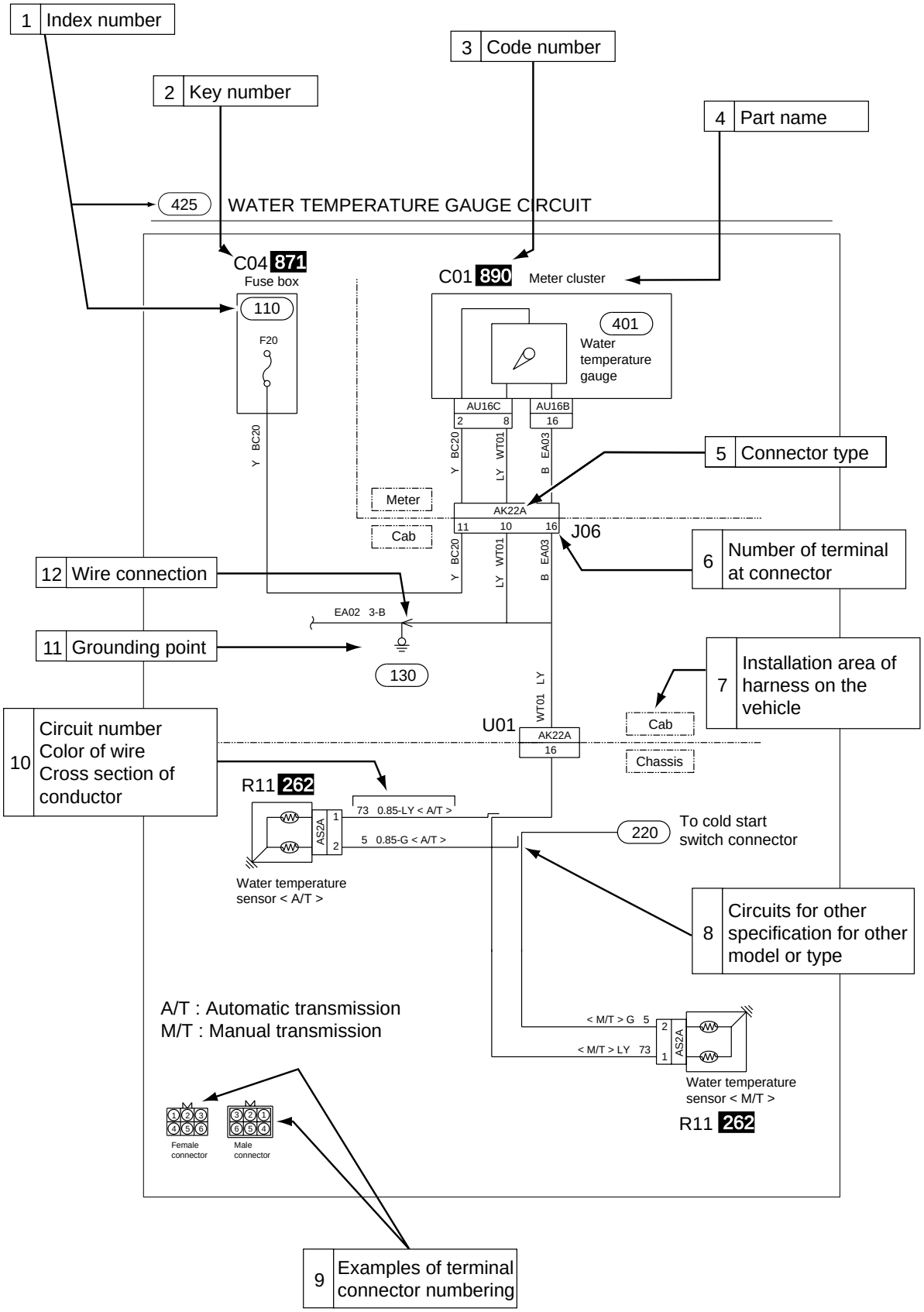
Fit the oil seal **15** into the body **49,** making sure it is aligned as illustrated.



23934

HOW THIS MANUAL IS STRUCTURED

HOW TO READ CIRCUITS (GROUP 54)



Ⓟ45405

1 Index number: (110)

Each circuit has its own Index number respectively and has three digits ((110)).
How to read index number

- By proper using of the index number, it is possible to locate right place immediately since the circuit drawing of this manual book are classified as function by function. (including “POWER CIRCUIT” (110) and “GROUND ” (130) .)
- How to check the location of circuit drawing in each part
  The circuit drawing which can not be diagramed in one page due to its complicated structure (such as meter cluster and electronic control unit etc.), has its remarked index number to be connected to other circuit drawing. ((401) , (910) , etc.)

2 Key number: A01~
Key number is the number to indicate the installation position of the parts, and is shown by A01 ~ Z.
The details of the installation position are described in GROUP 10.

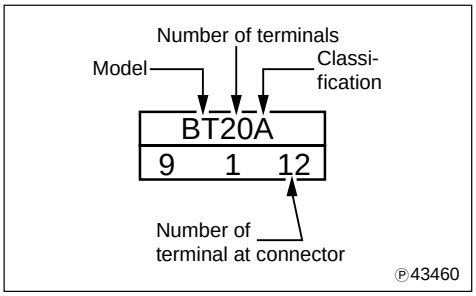
3 Code number: **001** ~

Code number is the number to indicate the one portion of the parts to be checked and has three digits (**001**).
The details of the parts to be checked are described in GROUP 11.

4 Part name

5 Connector type
Connectors are shown by □ without mentioning Male or Female and in the box it is described model of connector, number of terminals and its classification, etc.
Table of connectors is described in GROUP 14.

6 Number of terminal at connector
Terminal numbers of connector are shown by figures in the box.

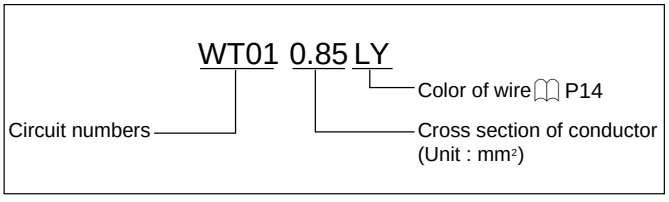


7 Installation area of harness on the vehicle
The location and boundary of the harnesses in the vehicle are shown in the each circuit drawing and it may help to check mounting position of connectors.

8 Circuits for other specification for other model or type

9 Examples of terminal connector numbering
As it is shown, for female connectors, with placing the lock upward then starting to put numbers from the upper left. And when it is male connector, put numbers from the upper right, also with placing the lock upward.

10 Circuit number, color of wire, and cross section of conductor are shown in circuit drawings.



Except for 0.5mm², Wire thickness is described in the circuit drawing. The reason why only wire thickness, 0.5 mm² is not described in the drawings is 0.5mm² is so common and so that the circuit drawing can be seen more easily.
(Examples) 0.5mm²: Y
0.85mm²: 0.85 — LY
3mm²: 3 — B

11 Grounding point
The actual locations of grounding points on the vehicle are shown. Refer to (130) for detailed information.

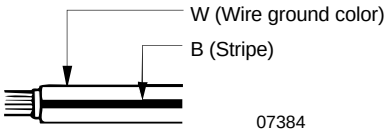
12 Wire connection
When the wires are connected into one point of the harnesses, the circuit drawing shows “Arrow mark”.

CAUTION !
Be careful that direction of the arrow does not show the direction of the electric current flow.

HOW THIS MANUAL IS STRUCTURED

● Wire Colors

Example: WB means a wire whose ground color is white and whose stripe is black.

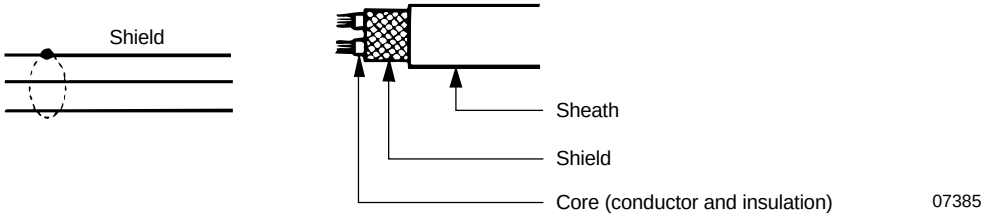


Wire ground color		Wire ground color + Stripe									
W	White	WR	White red	WB	White black	WL	White blue	WG	White green		
B	Black	BW	Black white	BY	Black yellow	BR	Black red				
R	Red	RW	Red white	RB	Red black	RY	Red yellow	RG	Red green	RL	Red blue
Y	Yellow	YR	Yellow red	YB	Yellow black	YG	Yellow green	YL	Yellow blue	YW	Yellow white
G	Green	GW	Green white	GR	Green red	GY	Green yellow	GB	Green black	GL	Green blue
Br	Brown	BrW	Brown white								
L	Blue	LW	Blue white	LR	Blue red	LY	Blue yellow	LB	Blue black	LO	Blue orange
Lg	Yellow green	LgR	Yellow green red	LgY	Yellow green yellow	LgB	Yellow green black	LgW	Yellow green white		
O	Orange										
P	Pink	PB	Pink black								

● Shield Wire

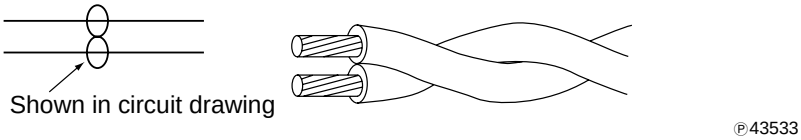
A shield wire is clearly identified as follows:

Example



● Twist wire

Twist wires are made by twisting the core of wires by the constant pitch.
Example:



The terms in this manual are defined as follows.

● This service manual contains important cautionary instructions and supplementary information under the following four headings which identify the nature of the instructions and information:

DANGER⚠ Precautions that should be taken in handling potentially dangerous substances such as battery fluid and coolant additives.

WARNING⚠ Precautionary instructions, which, if not observed, could result in serious injury or death.

CAUTION⚠ Precautionary instructions, which, if not observed, could result in damage to or destruction of equipment or parts.

NOTE Suggestions or supplementary information for more efficient use of equipment or a better understanding.

● **Front and rear**

The terms “front” is the fan side and “rear” the flywheels side of the engine.

● **Left and right**

The terms “right” and “left” shall be used to indicate the side as viewed from the flywheel side of the engine.

● **Terms of service standards**

(1) Standard value

Standard value dimensions in designs indicating: the design dimensions of individual parts, the standard clearance between two parts when assembled, and the standard value for an assembly part, as the case may be.
The figure in [ ] is the basic diameter.

(2) Limit

When the value of a part exceeds this, it is no longer serviceable in respect of performance and strength and must be replaced or repaired.

● **Tightening torque**

Appropriate tightening torque has particular importance in respect of performance. Accordingly, tightening torque is specified in locations that are to be tightened.
Where there is no specified figure for tightening torque, follow the table covering standard tightening torques.
When the item is to be tightened in a “wet” state, wet is indicated. Where there is no indication, read it as dry, and tighten at specified torque.

MITSUBISHI
FUSO

Group 00

General

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-00

INDEX

MODEL CODING SYSTEM 00- 2

POWER TRAIN TABLE 00- 3

CHASSIS NUMBER AND ENGINE NUMBER 00- 4

POWER TRAIN LABEL 00- 4

VEHICLE IDENTIFICATION NUMBER 00- 5

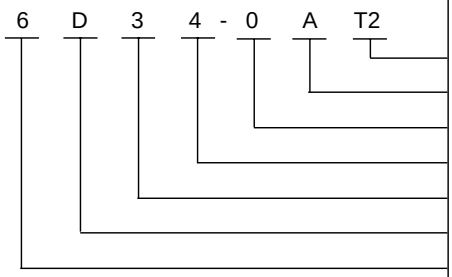
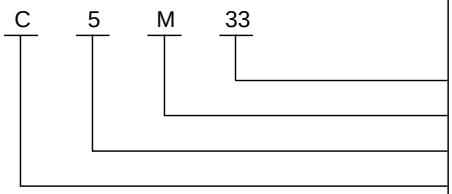
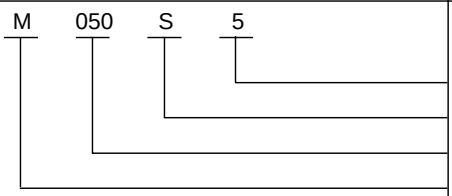
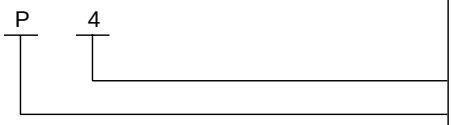
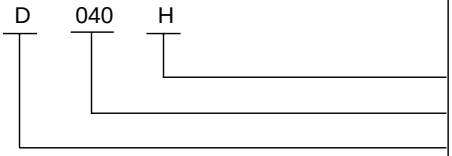
PRECAUTIONS FOR MAINTENANCE OPERATION 00- 6

TABLE OF STANDARD TIGHTENING TORQUES 00-18

CONNECTOR CONFIGURATION CHART 00-22

MODEL CODING SYSTEM

Equipment Model Code

Equipment name	Model description	Code description
Engine		With turbocharger Stands for automobile } These are omitted in the Remodeling sequence } Service Manual Version number Series number Stands for diesel engine No. of cylinders
Clutch		Disc outer diameter Facing material (M : Cera-metallic) Loading capacity of major type (tonnage) Stands for clutch
Transmission		No. of forward speeds Meshing (S : Synchromesh, A : Automatic) Loading capacity of major type (tonnage) Stands for transmission
Propeller shaft		Loading capacity of major type (tonnage) Stands for propeller shaft
Reduction and differential		Teeth shape (H : hypoid gear) Loading capacity of major type (tonnage) Stands for reduction and differential

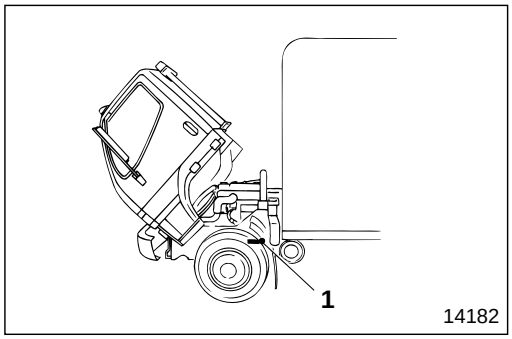
POWER TRAIN TABLE

Model	Engine model	Clutch model	Transmission model	Propeller shaft	Rear axle model	Final reduction and gear ratio
FH210, E, G, H, J, K G. V. W. 8120 kg {17995 lb}	4M50T2 175 HP/2700 rpm 347 ft.lbs/2000 rpm (SAE, Gross)	Torque converter (ø288H)	M035A4 (AISIN A445 3.018/0.703	P4	R040T	D040H 5.571
FH211C G. V. W. 8160 kg {17995 lb}	6D34T2 175 HP/2900 rpm 325 ft.lbs/2000 rpm (SAE, Gross)	C5M33	M050S5 6.875/1.000			D040H 4.111
FH211E, G, H, J, K G. V. W. 8160 kg {17995 lb}			M050S6 6.523/0.803			D040H 4.625
FH211C, E, G, H, J, K G. V. W. 8160 kg {17995 lb}		Torque converter (TC290-1.72)	M4A4 (Allison AT542 or AT545) 3.454/1.000			D040H 4.111

CHASSIS NUMBER AND ENGINE NUMBER/POWER TRAIN LABEL

CHASSIS NUMBER AND ENGINE NUMBER

The serial numbers for chassis and engines are assigned to the respective vehicles and engines in manufacturing sequence: every vehicle and engine has its own numbers. These numbers are required for registration and incidental inspection of the vehicle. Please do not fail to mention these numbers to the dealers when ordering spare parts.



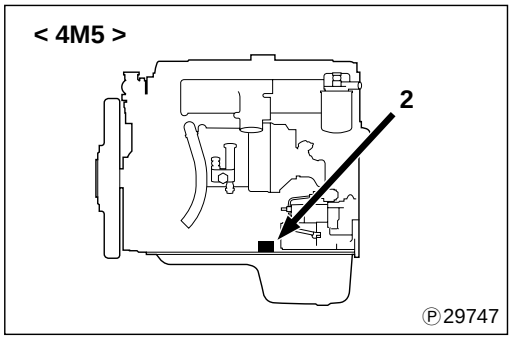
Chassis number

Chassis number **1** is punch-marked on the frame by the left-side front wheel.

Example : FH21□□–□□□□□□

Vehicle model

Chassis number



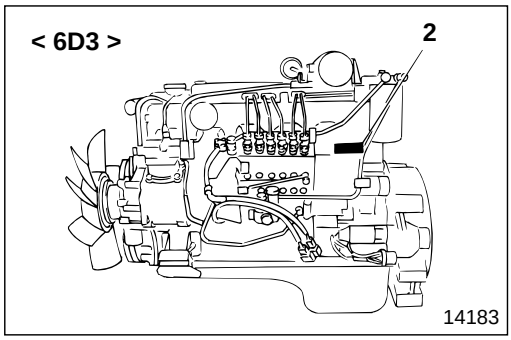
Engine number

Engine number **2** is punch-marked on the left of the crankcase.

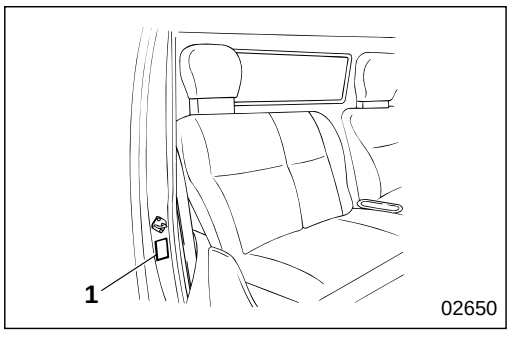
Example : 6D34–□□□□□□

Engine number

Engine model

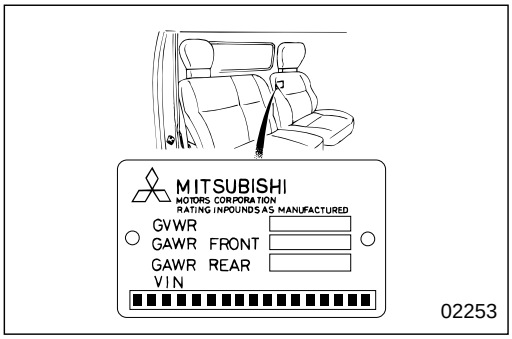


POWER TRAIN LABEL



Power train label **1** located in the position illustrated indicates the vehicle model, chassis number and information relevant to the vehicle's power transmission components.

VEHICLE IDENTIFICATION NUMBER



The vehicle identification number is punch-marked on the plate, which is attached in the position as illustrated.
The vehicle identification number consists of a 17-digit set of alphanumeric characters. Each digit represents the following specifications.

J W 6 C C C 1 G □ 3 □ □ □ □ □ □ □

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫

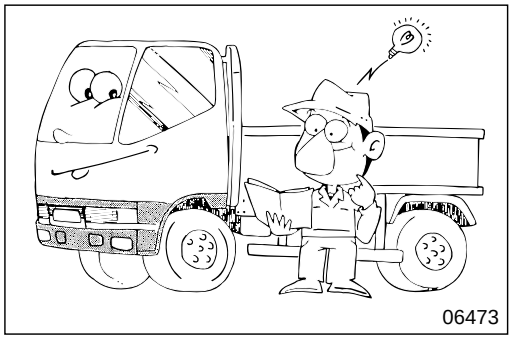
①	Country	J :	Japan
②	Make	W :	Mitsubishi Fuso
③	Vehicle type	6 :	Incomplete Vehicle
④	Gross vehicle weight/Brake system	C :	16001 to 19500 lbs/Hydraulic
⑤	Line	C :	FH211
		P :	FH210
⑥	Series (Wheelbase)	C :	2.6 to 2.89 m {8.53 to 9.48 ft.}
		E :	3.2 to 3.49 m {10.49 to 11.44 ft.}
		G :	3.8 to 4.09 m {12.46 to 13.41 ft.}
		H :	4.1 to 4.39 m {13.45 to 14.40 ft.}
		J :	4.4 to 4.69 m {14.43 to 15.38 ft.}
		K :	4.7 to 4.99 m {15.41 to 16.37 ft.}
⑦	Cab chassis type	1 :	Chassis cab
⑧	Engine	G :	5.861 ℓ Diesel turbocharged and charge air cooled
		S :	4.899 ℓ Diesel turbocharged and charge air cooled
⑨	Check digit		
⑩	Model year	3 :	2003
⑪	Plant	K :	Kawasaki-1
		L :	Kawasaki-2
		M :	Kawasaki-3
⑫	Plant sequential number		

PRECAUTIONS FOR MAINTENANCE OPERATION

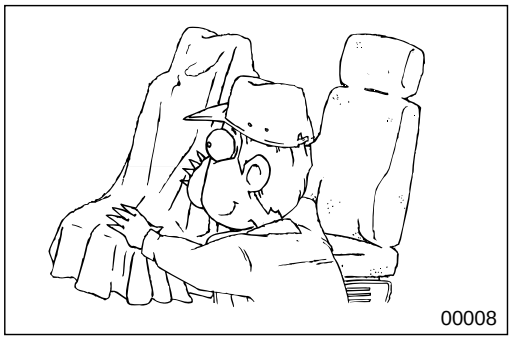
DANGER⚠

This product contains or emits chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

In order to determine the condition of the vehicle adequately, attend the vehicle beforehand to find and keep record of the accumulated mileage, operating condition, what the customer's demand is, and other information that may be necessary. Prepare the steps to be taken and perform efficient and wasteless maintenance procedure.

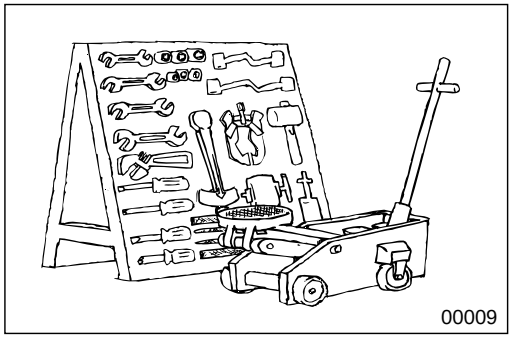

06473

Determine where the fault exists and check for the cause to see whether removal or disassembly of the part is necessary. Then follow the procedure specified by this manual.


00008

Perform maintenance work at a level area.
Prepare the following.

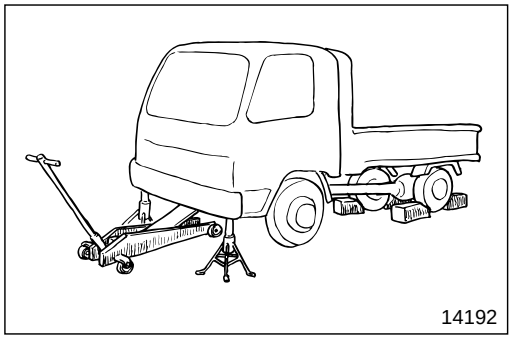
- To prevent the seats, upholstery, floor and bodywork from being spoiled or scratched, cover with workshop sheet cover(s).


00009

- Prepare general and special tools necessary for the maintenance work.

WARNING⚠

Do not attempt to use tools other than special tools where use of special tools is specified in this manual. This will avoid injury or damage.

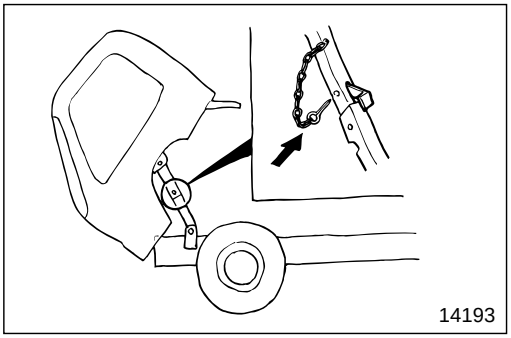

14192

When jacking up the vehicle to work under the vehicle, carry out the following preparatory work:

- Chock the wheels on both sides.
- Jack up the vehicle using a garage jack.
- Support the frame on rigid racks.

WARNING⚠

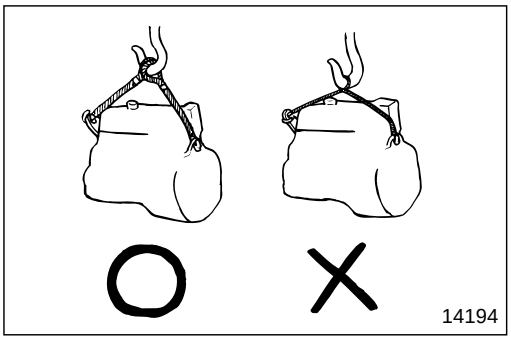
- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**



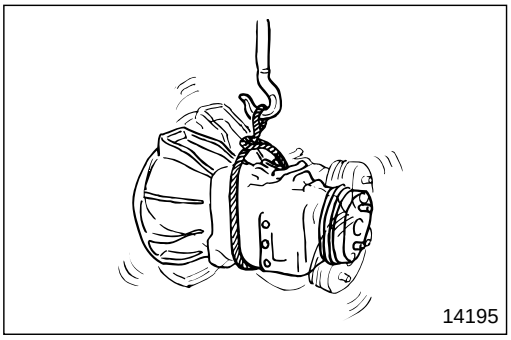
When tilting the cab, be sure to insert the safety pin into the cab stay so that the cab stay remains locked and is not released when the cab is tilted.

Pay special attention to safety when removing or installing heavy items such as engines, transmissions and axles.

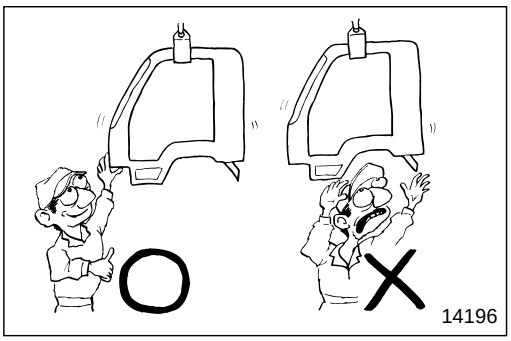
When lifting up heavy items using cables, pay special attention to the following points:



- Check the mass of the item to be lifted and use a cable capable of lifting that mass.

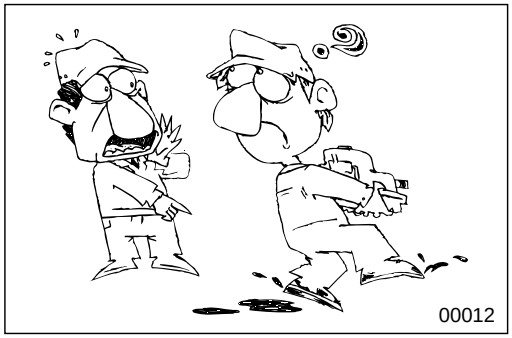


- If you do not have the specified lifting hanger, secure the item using cable taking the point-of-balance of the item into consideration.

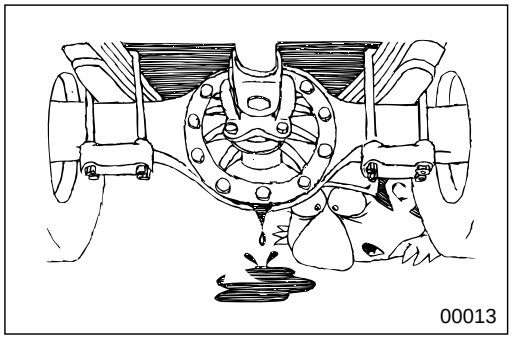


- You must work in a position where you will not be injured even if the cable comes undone and the lifted item falls.

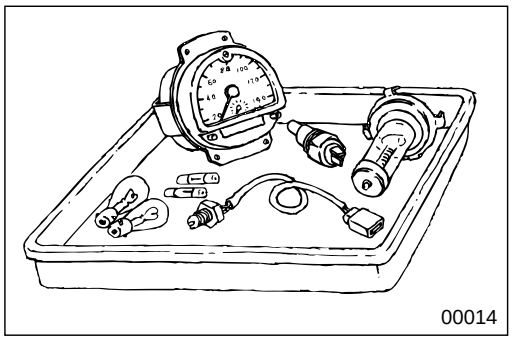
PRECAUTIONS FOR MAINTENANCE OPERATION



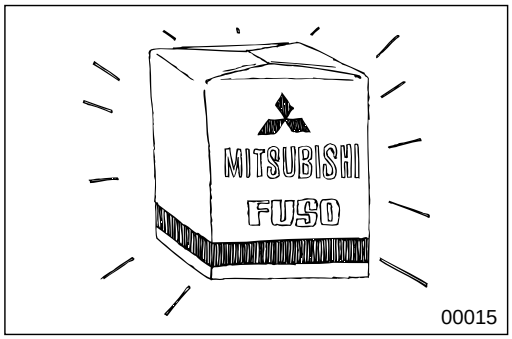
Be particularly careful not to work in shoes that have oily soles and are slippery. When working as a team of two or more, arrange signals in advance and keep confirming safety. Be careful not to accidentally bump switches or levers.



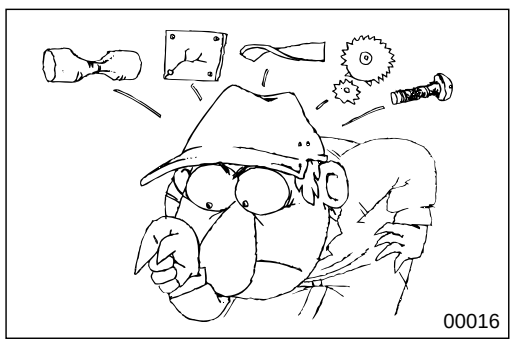
Check for oil leakage before cleaning the area having the fault otherwise you might miss detecting the leakage.



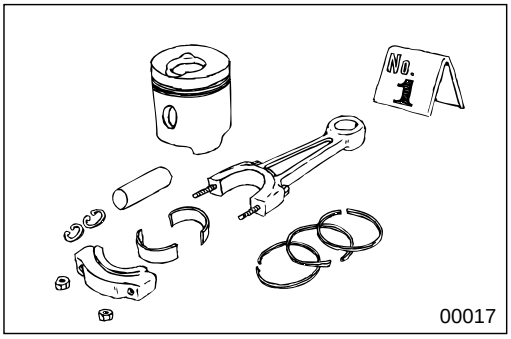
Prepare replacement part(s) beforehand.



Replace oil seals, packing, O-rings and other rubber parts; gaskets and split pins with new parts whenever any of them has been removed. Use only genuine MITSUBISHI replacement parts.



On disassembly, visually inspect all parts for wear and tear, cracks, damage, deformation, degradation, rust, corrosion, smoothness in rotation, fatigue, clogging and any other possible defect.

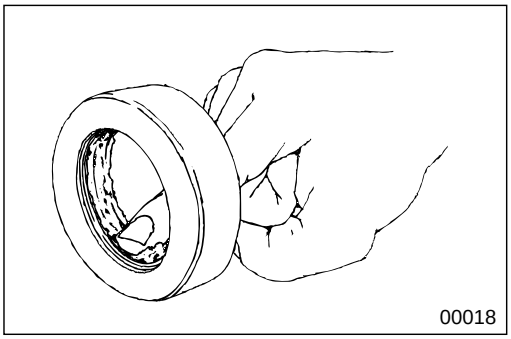


00017

Put alignment marks on part combinations before disassembly and arrange the disassembled parts neatly. This will help avoid mismating of the parts later.
Put the alignment marks, punch marks, etc. where performance and appearance will not be affected.
Cover the area left open after removal of parts to keep it free from dust.

CAUTION⚠

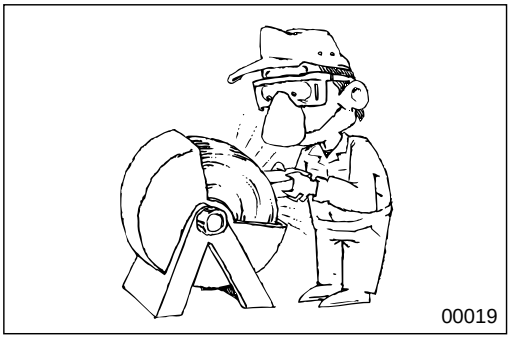
- **Take care to avoid mixing up numerous parts, similar parts, left and right, etc.**
- **Keep new parts for replacement and original (removed) parts separate.**


00018

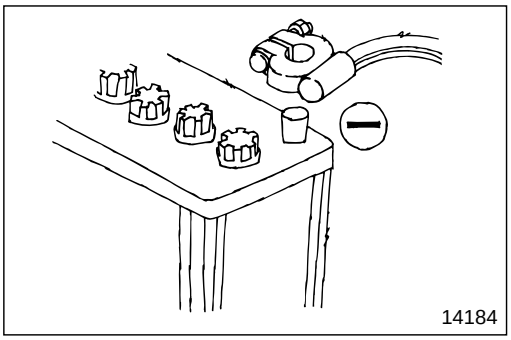
Apply the specified oil or grease to U-packings, oil seals, dust seals and bearings during assembly.
Use only the specified oil, grease, etc. for lubricant, remove the excess immediately after application with a piece of waste, etc.

CAUTION⚠

When the specified lubricant, fluid and sealant is not available, you may use an equivalent.


00019

Wear goggles when using a grinder or welder. Pay full attention to safety by wearing gloves when necessary. Watch out for sharp edges, etc. that might injure your hands or fingers.

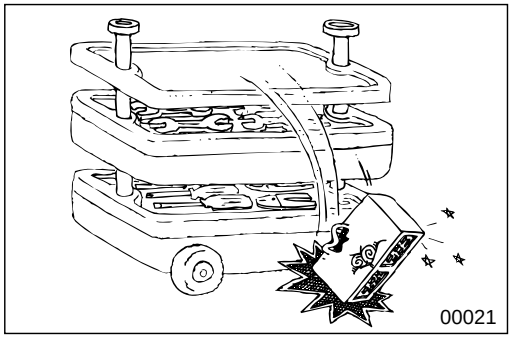

14184

Before carrying out maintenance work on the electric system, disconnect the negative terminals of the batteries to prevent them from short-circuiting and burning-out.

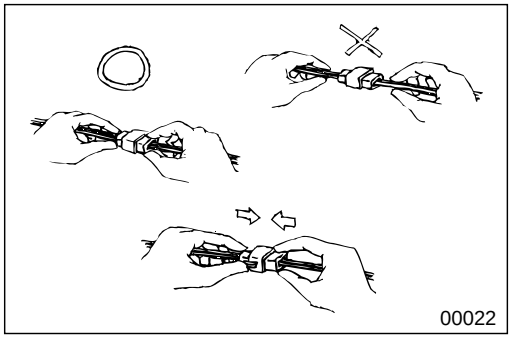
CAUTION⚠

Be sure to turn starter and lighting switches, etc. off before disconnecting or connecting battery terminals, because the semiconductors can be damaged.

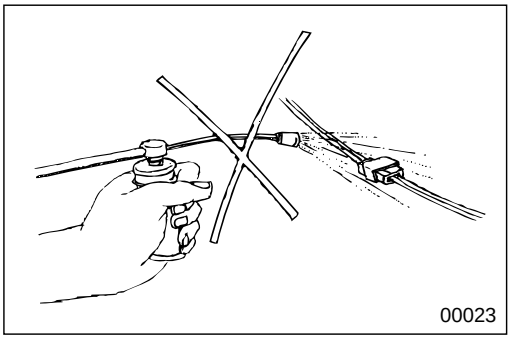
PRECAUTIONS FOR MAINTENANCE OPERATION



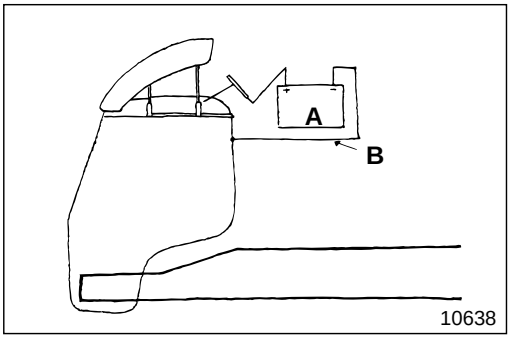
Take care when handling sensors, relays, etc. which are vulnerable to shock and heat. Do not attempt to remove the cover from, or apply paint to, the electronic control unit.



Pull the connector, and not the harness lead, to separate connectors. To separate a lock-type connector, first push toward arrow mark. To reconnect a lock-type connector, press the separated parts until they click together.



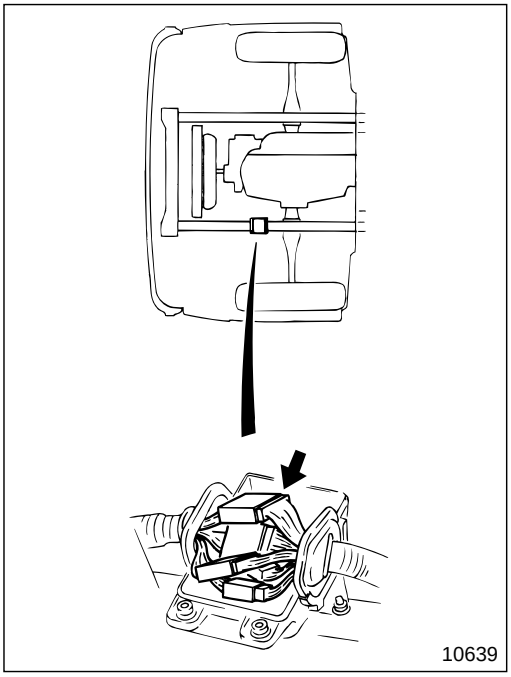
When washing the vehicle, cover the electric system parts and instruments with waterproof material beforehand (Cover with vinyl sheet or the like). Keep water away from harness wire connectors and sensors. If any of them should get wet, wipe them off immediately.



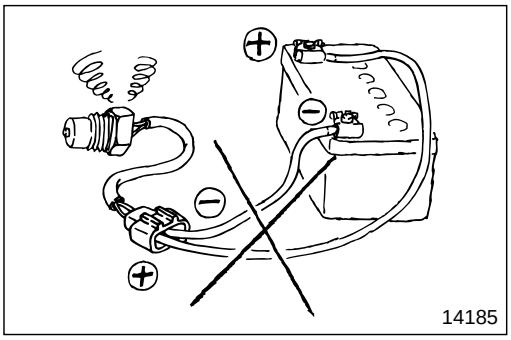
When using an electric welder, such electronic parts that are directly connected to the batteries might be damaged due to the flow of current from the welder that flows through the negative circuit. Parts that have switches might be subject to the same danger if the switches are left on. Therefore, do not fail to observe the following.

A : Welder

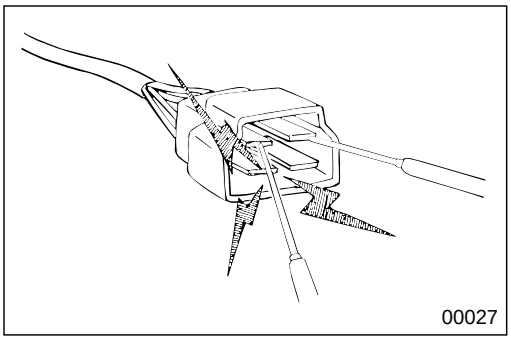
B : Connect the negative terminal of the welder as near as possible to the area that is to be welded.


10639

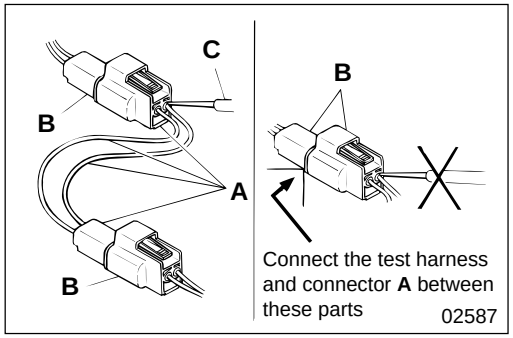
- Disconnect the negative terminals of batteries.
- Disconnect connections between the cab harness wires and the chassis harness wires.


14185

To apply voltage for testing, check that the positive and negative cables are connected properly, then increase voltage gradually from 0 volt. Do not apply voltage higher than the specified value.
In particular, pay close attention to the electronic control unit and sensors, since they are not always fed the battery voltage.


00027

When using testers or the like for continuity tests, be careful not to allow test probes to touch the wrong terminals.



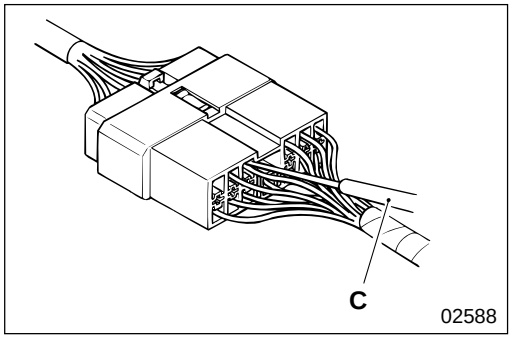
Measurement procedures using connectors

- **Test with connectors engaged (continuity through circuit obtained)**

  < Waterproof connector >

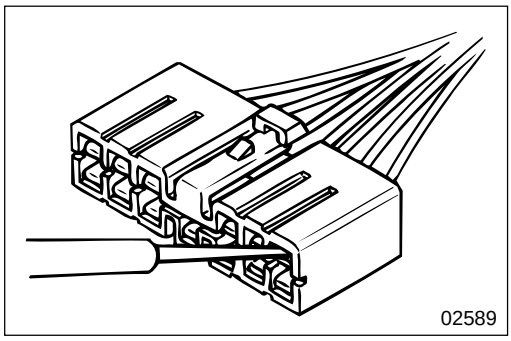
  Prepare a test harness and connectors **A**, then connect if between the two parts of harness **B** that is to be tested. Check the circuit by touching test probe **C** to the test connector.

  Never insert the test probe from the harness side of the waterproof connection, or waterproof performance might be diminished causing corrosion of the connector.



< Non-waterproof connector >

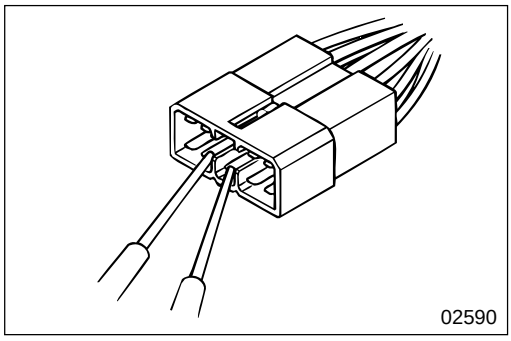
Insert test probe **C** from the harness side of the connector. Where control units, etc. have connectors that are too small to accept the test probe, do not force the test probe into them.



- **Test with connectors disengaged**

  Using female pins

  Insert a test probe into a terminal. However, do not force the probe into the terminal, or it will cause a poor contact.

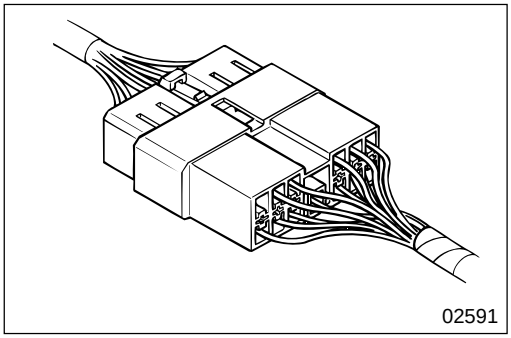


Using male pins

Touch the pins directly using test probes.

CAUTION⚠

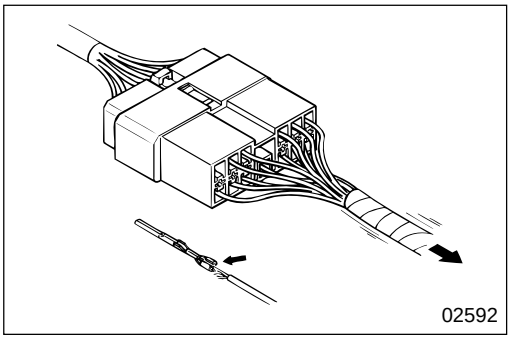
Be sure that you do not short circuit the connector pins when you use the test probe because this could damage the internal circuit of the electronic control unit.



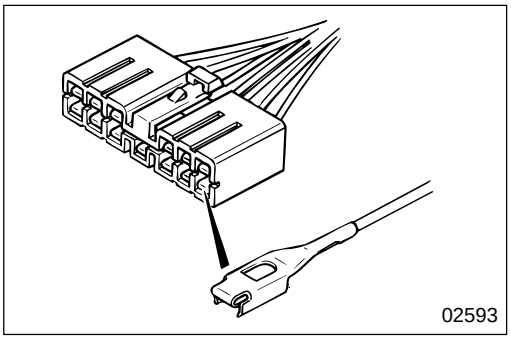
Connector inspection procedures

- **Visual inspection**

  Check for loose connection and poor engagement.

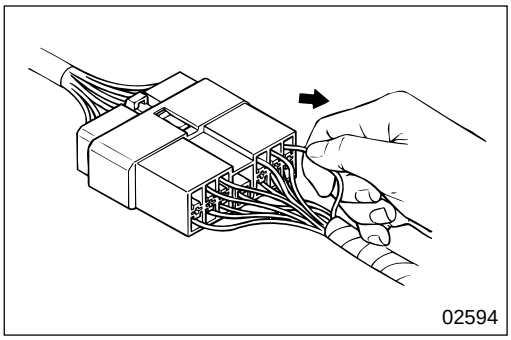


Check if harnesses are broken by pulling gently around the terminals.



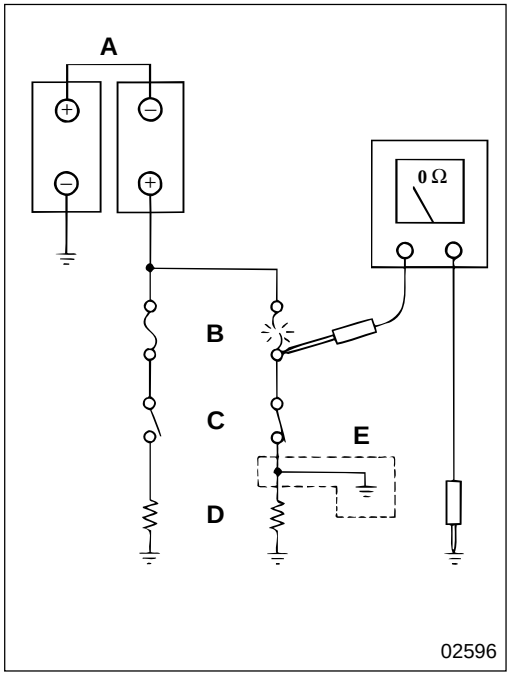
Check for a decrease in contact pressure between the male and female terminals.

Check for poor contact caused by connector pins having fallen out, rusted terminals or foreign particles.



- **Connector pin fall out inspection**

  Damaged connector pin stoppers can cause poor engagement of the terminals (male and female pins) even if the connector body is secured, and might cause some pins to fall out. Check if the pins have fallen out from the connector by pulling each harness gently.

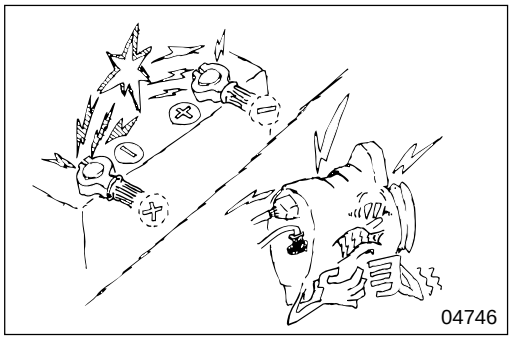


Inspection procedures for blown fuses

Remove fuse **B** and measure resistance between the loaded side of the fuse and ground.
Turn on all circuit switches (connected to the fuse). If the resistance value reading is approximately 0 Ω, a short has occurred between the switch and the loaded point. A value of other than zero may indicate that the fuse was blown by a temporary short but the short is no longer present.

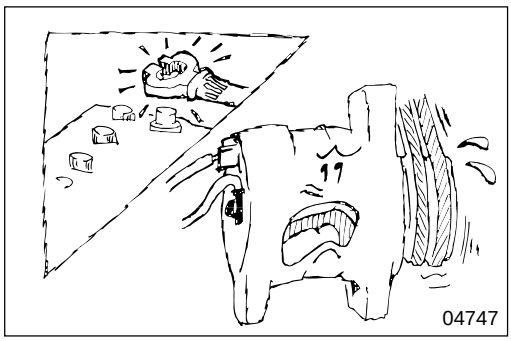
The major causes of a short circuit are as follows:
- Harness stuck onto the vehicle body.
- Harness sheath damaged by friction or heat.
- Water in connectors or circuits.
- Mistakes (accidental short circuits)

  A : Battery
  B : Fuse
  C : Loaded switch
  D : Load
  E : Short circuit

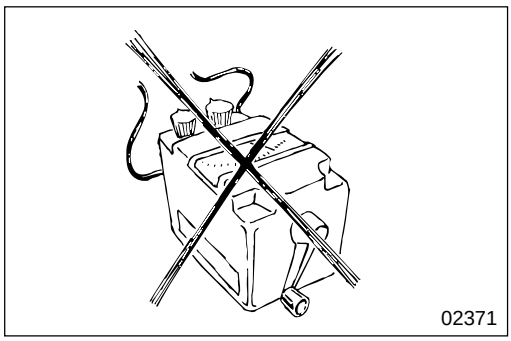


Precautions for handling alternator

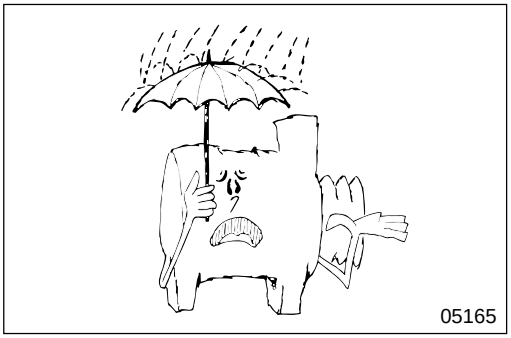
When servicing the alternator, pay attention to the following :
- Do not connect the alternator with battery polarities reversed.
  If the alternator is connected with reversed polarities, a large current flow from the battery to the alternator occurs, and the diode or regulator might be damaged.



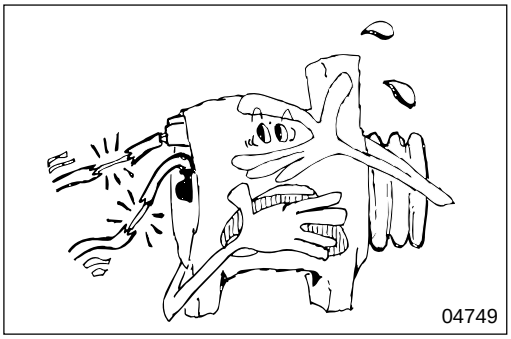
- While the engine is running, do not remove the battery terminals. If the battery terminals are removed at that time, a surge voltage is generated and the diode or regulator might be weakened.



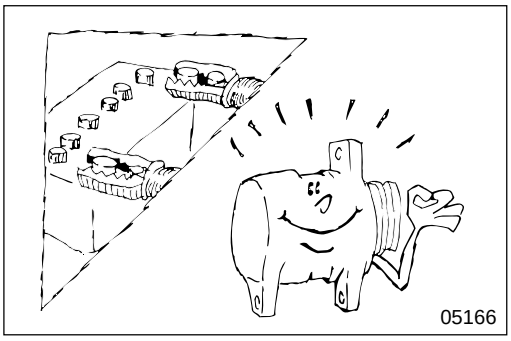
- Do not use a high-voltage tester such as a megger for inspection.
  If a high-voltage tester is used, the diode or regulator might be destroyed.



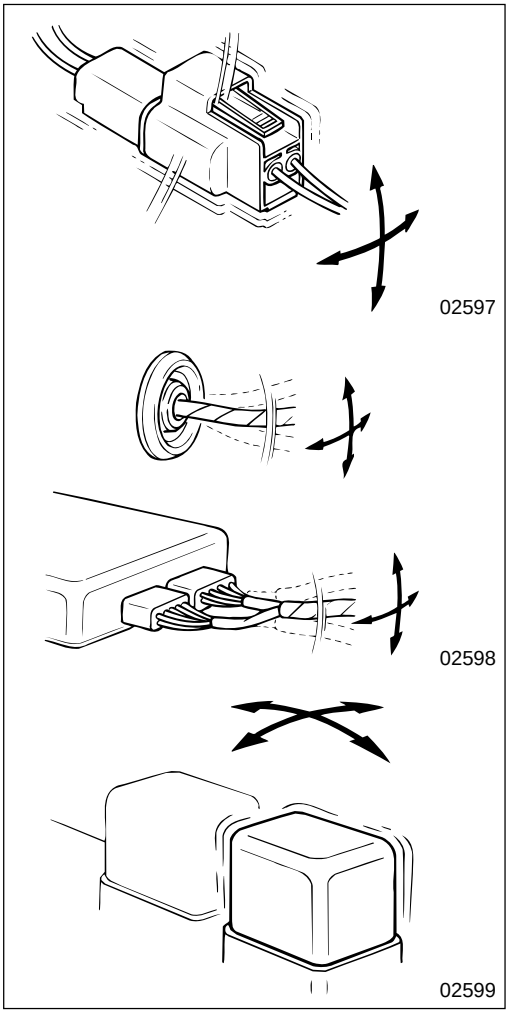
- Do not splash water over the alternator.
  If water is directly splashed over the alternator, individual components will be short-circuited and might be destroyed.



- Do not short-circuit terminal **B** and terminal **L** while running the alternator.
  If the terminals are short-circuited while the alternator is running, the diode trio might be destroyed.



- Disconnect the battery terminals before quick-charging the battery. Quick-charging without disconnecting the battery terminals might damage the diode or regulator.



Measures for temporary faults

Temporary faults often occur under certain conditions. So identifying those conditions helps to find possible causes. To find the conditions under which temporary faults occurred, you need to reproduce the faults after interviewing customers in detail about actual driving conditions, weather, frequency of occurence and fault phenomena.
Then determine if the faults were caused by vibration, temperature or other possible elements depending on the actual conditions identified.
If vibration is suspected as a possible cause, inspect individual connectors as follows to check if the fault will occur:

- Shake the connector gently in all four directions of the arrows as illustrated.
- Shake the wiring harness gently in all four directions of the arrows as illustrated.
- Wiggle each sensor or piece of equipment by hand.
- Gently shake the wiring harnesses near movable parts such as suspensions.

The inspection subjects include possible causes related to the diagnosis code outputs and faults, as well as the connectors and other parts in the inspection procedure.

M E M O

TABLE OF STANDARD TIGHTENING TORQUES

- Use specified bolts and nuts and tighten them at specified torques according to the following table, unless otherwise specified.
- Threads and contact seats shall be dry.
- Where there is a difference in strength classification between the nut and bolt (or stud bolt), the torque specified for the bolt shall apply.

Hex-head Bolt and Stud Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Repre-sentation / Diameter symbol	(Stud)		(Stud)		(Stud)	
M 5	2 to 3 {1.4 to 2.2, 0.2 to 0.3}	—	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	5 to 7 {3.6 to 5.1, 0.5 to 0.7}	—
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	7 to 11 {5.1 to 8.0, 0.7 to 1.1}	—	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—
M 8	9 to 14 {6.5 to 10, 0.9 to 1.4}	—	17 to 26 {12 to 19, 1.7 to 2.6}	—	20 to 29 {14 to 22, 2.0 to 3.0}	—
M 10	19 to 28 {14 to 20, 1.9 to 2.8}	18 to 26 {13 to 20, 1.8 to 2.7}	36 to 52 {25 to 40, 3.5 to 5.5}	33 to 49 {25 to 36, 3.5 to 5.0}	45 to 60 {33 to 43, 4.5 to 6.0}	41 to 59 {31 to 50, 4.3 to 6.9}
M 12	35 to 50 {25 to 36, 3.4 to 5.0}	31 to 46 {22 to 34, 3.1 to 4.7}	70 to 95 {51 to 69, 7.0 to 9.5}	65 to 85 {47 to 61, 6.5 to 8.5}	85 to 110 {61 to 80, 8.5 to 11}	75 to 100 {54 to 72, 7.5 to 10}
M 14	60 to 85 {43 to 61, 6.0 to 8.5}	55 to 75 {40 to 54, 5.5 to 7.5}	120 to 160 {87 to 115, 12 to 16}	110 to 140 {80 to 100, 11 to 14}	130 to 180 {94 to 130, 13 to 18}	120 to 160 {87 to 120, 12 to 17}
M 16	90 to 130 {69 to 94, 9.5 to 13}	90 to 120 {65 to 87, 9.0 to 12}	180 to 240 {130 to 175, 18 to 24}	160 to 220 {115 to 160, 16 to 22}	200 to 270 {145 to 195, 20 to 27}	190 to 260 {135 to 190, 19 to 26}
M 18	140 to 190 {100 to 135, 14 to 19}	120 to 160 {87 to 115, 12 to 16}	260 to 340 {180 to 255, 25 to 35}	220 to 290 {160 to 215, 22 to 30}	290 to 390 {215 to 290, 30 to 40}	260 to 340 {190 to 255, 26 to 35}
M 20	190 to 260 {135 to 190, 19 to 26}	170 to 230 {120 to 165, 17 to 23}	350 to 470 {260 to 345, 36 to 48}	320 to 420 {230 to 310, 32 to 43}	410 to 550 {295 to 405, 41 to 56}	370 to 490 {265 to 360, 37 to 50}
M 22	260 to 340 {190 to 255, 26 to 35}	230 to 300 {165 to 225, 23 to 31}	470 to 640 {345 to 470, 48 to 65}	430 to 570 {310 to 420, 43 to 58}	550 to 740 {405 to 540, 56 to 75}	490 to 670 {360 to 490, 50 to 68}
M 24	340 to 450 {255 to 330, 34 to 46}	290 to 390 {210 to 290, 29 to 40}	630 to 840 {455 to 620, 63 to 86}	540 to 730 {395 to 535, 55 to 74}	730 to 980 {535 to 725, 74 to 100}	630 to 840 {460 to 620, 64 to 86}

Hex-head Flange Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Repre-sentation / Diameter symbol						
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—	9 to 14 {6.5 to 10, 0.9 to 1.4}	—
M 8	10 to 15 {7.0 to 11, 1.0 to 1.5}	—	19 to 28 {14 to 20, 1.9 to 2.8}	—	22 to 32 {16 to 24, 2.2 to 3.3}	—
M 10	21 to 30 {15 to 22, 2.1 to 3.1}	20 to 28 {14 to 21, 1.9 to 2.9}	39 to 58 {28 to 43, 3.9 to 6.0}	37 to 53 {26 to 39, 3.6 to 5.4}	50 to 65 {36 to 47, 5.0 to 6.5}	45 to 65 {33 to 47, 4.5 to 6.5}
M 12	38 to 54 {27 to 40. 3.8 to 5.5}	35 to 51 {25 to 38, 3.4 to 5.2}	80 to 110 {58 to 80, 8.0 to 11}	70 to 95 {51 to 69, 7.0 to 9.5}	90 to 120 {65 to 87, 9.0 to 12}	85 to 110 {61 to 80, 8.5 to 11}

Hex-head Nut

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		6 T	
Representation / Diameter symbol				
	Standard screw	Coarse screw	Standard screw	Coarse screw
M 5	2 to 3 {1.4 to 2.2, 0.2 to 0.3}	—	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	7 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
M 8	9 to 14 {6.5 to 10, 0.9 to 1.4}	—	17 to 26 {12 to 19, 1.7 to 2.6}	—
M 10	19 to 28 {14 to 20, 1.9 to 2.8}	18 to 26 {13 to 20, 1.8 to 2.7}	36 to 52 {25 to 40, 3.5 to 5.5}	33 to 49 {25 to 36, 3.5 to 5.0}
M 12	35 to 50 {25 to 36, 3.4 to 5.0}	31 to 46 {22 to 34, 3.1 to 4.7}	70 to 95 {51 to 69, 7.0 to 9.5}	65 to 85 {47 to 61, 6.5 to 8.5}
M 14	60 to 85 {43 to 61, 6.0 to 8.5}	55 to 75 {40 to 54, 5.5 to 7.5}	120 to 160 {87 to 115, 12 to 16}	110 to 140 {80 to 100, 11 to 14}
M 16	90 to 130 {69 to 94, 9.5 to 13}	90 to 120 {65 to 87, 9.0 to 12}	180 to 240 {130 to 175, 18 to 24}	160 to 220 {115 to 160, 16 to 22}
M 18	140 to 190 {100 to 135, 14 to 19}	120 to 160 {87 to 115, 12 to 16}	260 to 340 {180 to 255, 25 to 35}	220 to 290 {160 to 215, 22 to 30}
M 20	190 to 260 {135 to 190, 19 to 26}	170 to 230 {120 to 165, 17 to 23}	350 to 470 {260 to 345, 36 to 48}	320 to 420 {230 to 310, 32 to 43}
M 22	260 to 340 {190 to 255, 26 to 35}	230 to 300 {165 to 225, 23 to 31}	470 to 640 {345 to 470, 48 to 65}	430 to 570 {310 to 420, 43 to 58}
M 24	340 to 450 {255 to 330, 34 to 46}	290 to 390 {210 to 290, 29 to 40}	630 to 840 {455 to 620, 63 to 86}	540 to 730 {395 to 535, 55 to 74}

Hex-head Flange Nut Unit : N·m {ft.lbs, kgf·m}

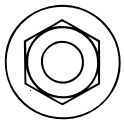
Strength classification	tion	
4 T / Representation		
	Standard screw	Coarse screw
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
M 8	10 to 15 {7.0 to 11, 1.0 to 1.5}	—
M 10	21 to 30 {15 to 22, 2.1 to 3.1}	20 to 28 {14 to 21, 1.9 to 2.9}
M 12	38 to 54 {27 to 40, 3.8 to 5.5}	35 to 51 {25 to 38, 3.4 to 5.2}

TABLE OF STANDARD TIGHTENING TORQUES

Tightening torque for flair nut for general purpose

Unit : N·m {ft.lbs, kgf·m}

Pipe diameter	ø4.76 mm {0.19 in.}	ø6.35 mm {0.25 in.}	ø8 mm {0.31 in.}	ø10 mm {0.39 in.}	ø12 mm {0.47 in.}	ø15 mm {0.59 in.}
Tightening torque	17 {12, 1.7}	25 {19, 2.6}	39 {29, 4.0}	59 {43, 6.0}	88 {65, 9.0}	98 {72, 10.0}

Tightening torque for air piping nylon tube for general purpose {DIN type}

Unit : N·m {ft.lbs, kgf·m}

Standard diameter	6×1 mm {0.24×0.039 in.}	10×1.25 mm {0.39×0.049 in.}	12×1.5 mm {0.47×0.059 in.}	15×1.5 mm {0.59×0.059 in.}
Tightening torque	$20^{+5.9}_{-0}$ {$14^{+4.3}_{-0}$, $2.0^{+0.6}_{-0}$}	$29^{+9.8}_{-0}$ {$22^{+7.2}_{-0}$, $3.0^{+1.0}_{-0}$}	$49^{+9.8}_{-0}$ {$36^{+7.2}_{-0}$, $5.0^{+1.0}_{-0}$}	$54^{+4.9}_{-0}$ {$40^{+7.2}_{-0}$, $5.5^{+1.0}_{-0}$}

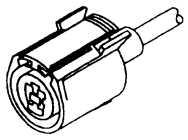
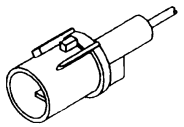
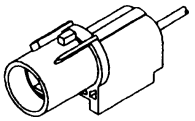
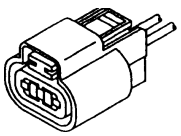
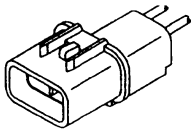
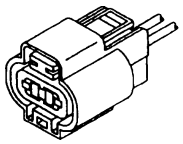
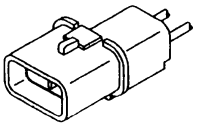
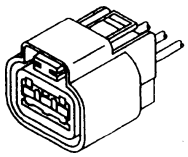
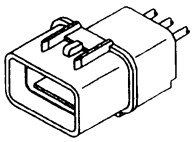
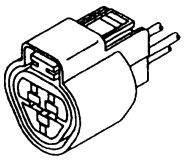
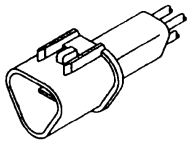
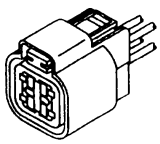
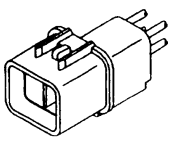
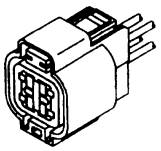
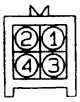
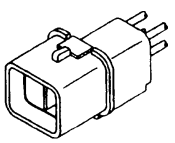
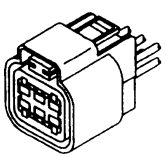
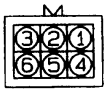
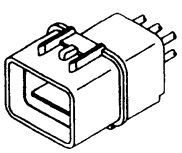
Tightening torque for air piping nylon tube for general purpose {SAE type}

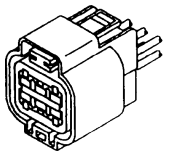
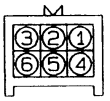
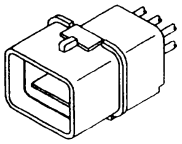
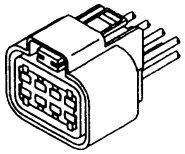
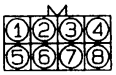
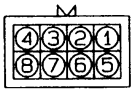
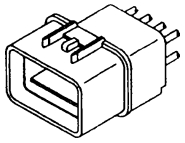
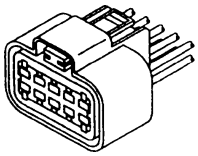
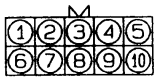
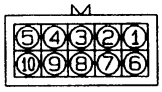
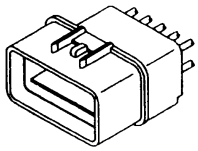
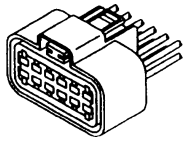
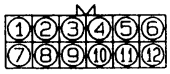
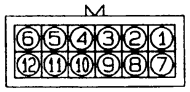
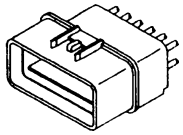
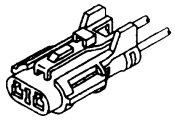
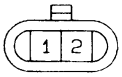
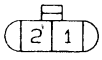
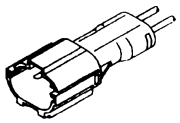
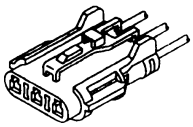
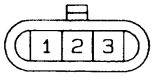
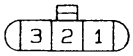
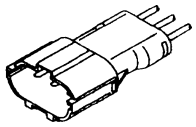
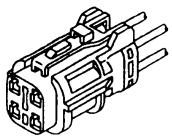
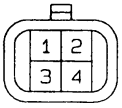
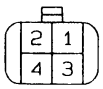
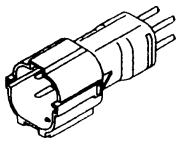
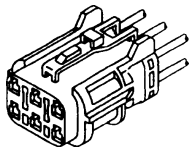
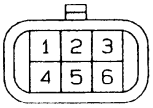
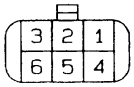
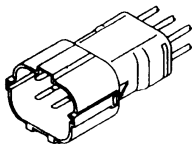
Unit : N·m {ft.lbs, kgf·m}

Standard diameter	1/4 in.	3/8 in.	1/2 in.	5/8 in.
Tightening torque	$13^{+3.9}_{-0}$ {$9.4^{+2.9}_{-0}$, $1.3^{+0.4}_{-0}$}	$29^{+4.9}_{-0}$ {$22^{+3.6}_{-0}$, $3.0^{+0.5}_{-0}$}	$49^{+4.9}_{-0}$ {$36^{+3.6}_{-0}$, $5.0^{+0.5}_{-0}$}	$64^{+4.9}_{-0}$ {$47^{+3.6}_{-0}$, $6.5^{+0.5}_{-0}$}

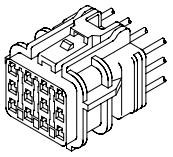
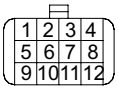
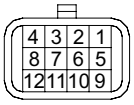
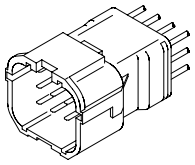
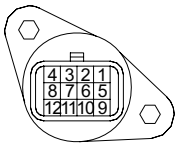
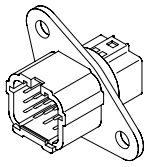
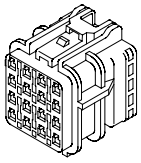
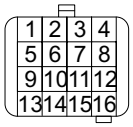
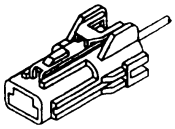
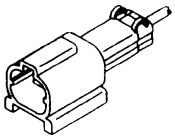
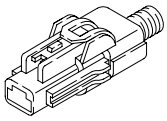
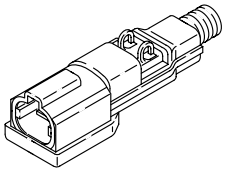
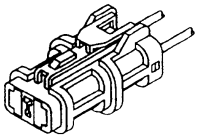
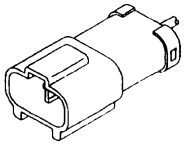
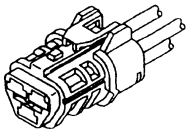
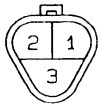
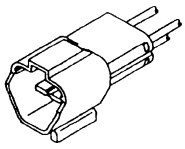
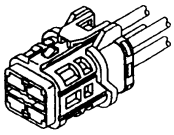
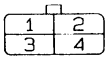
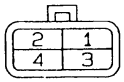
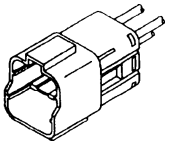
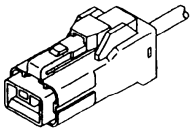
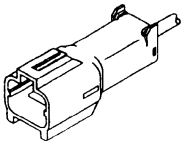
M E M O

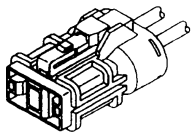
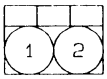
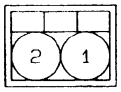
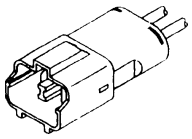
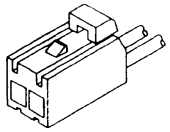
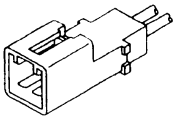
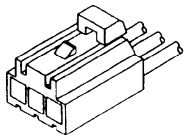
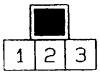
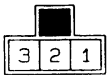
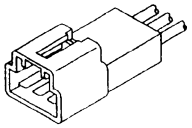
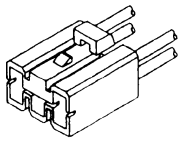
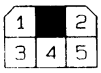
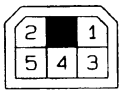
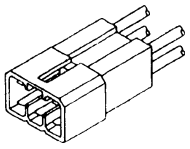
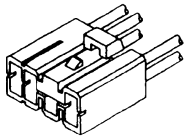
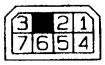
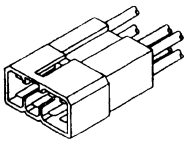
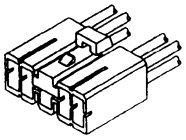
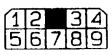
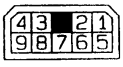
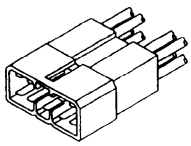
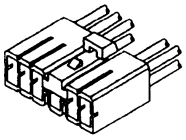
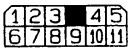
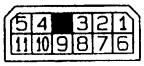
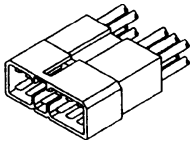
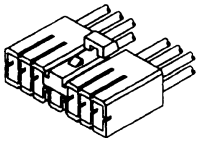
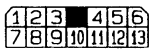
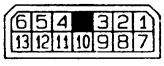
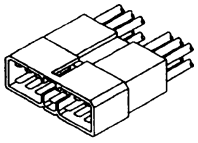
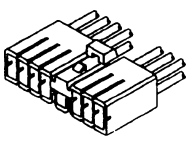
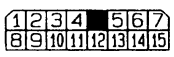
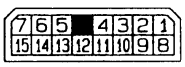
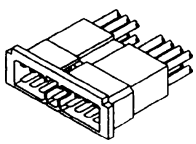
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AA	AA 1 A				
					
	AA 2 A				
	AA 2 B				
	AA 3 A				
	AA 3 B				
	AA 4 A				
	AA 4 B				
	AA 6 A				

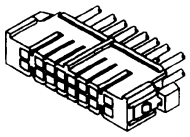
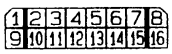
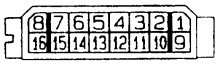
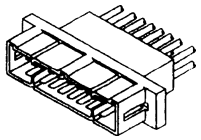
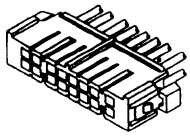
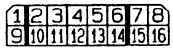
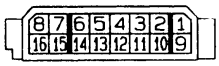
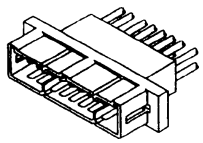
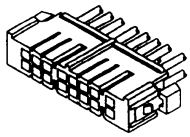
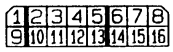
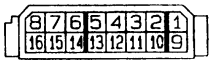
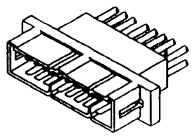
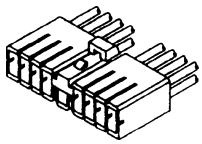
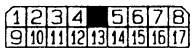
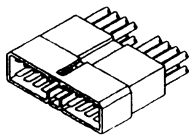
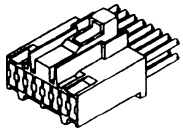
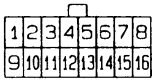
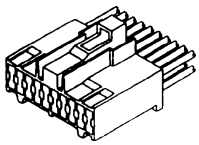
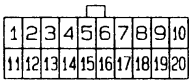
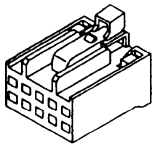
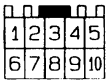
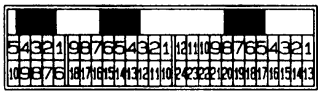
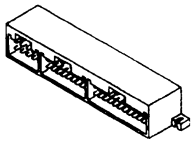
Model (Number shows number of pins)		Connection			
AA	AA 6 B				
	AA 8 A				
	AA10A				
	AA12A				
AB	AB 2 A				
	AB 3 A				
	AB 4 A				
	AB 6 A				

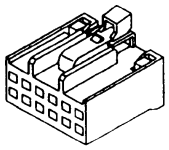
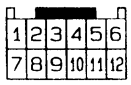
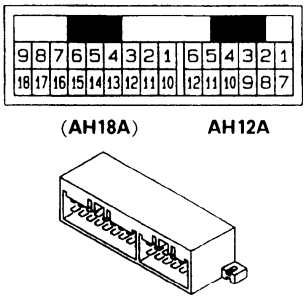
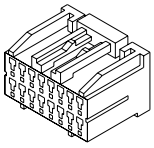
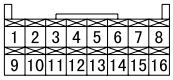
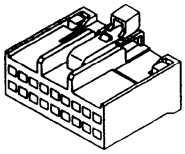
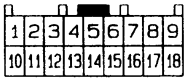
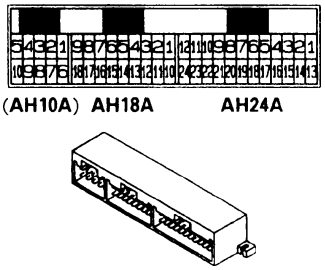
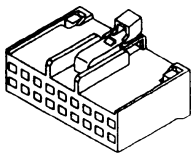
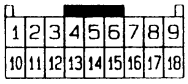
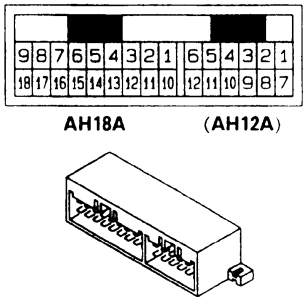
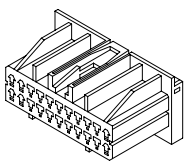
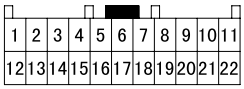
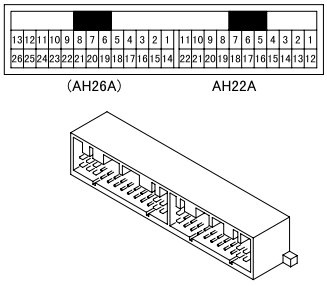
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AB	AB12A				
					
	AB16B				
AC	AC 1 A				
	AC 1 B				
	AC 2 A				
	AC 3 A				
	AC 4 A				
AD	AD 1 A				

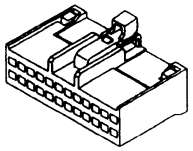
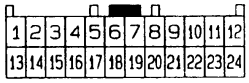
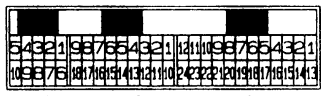
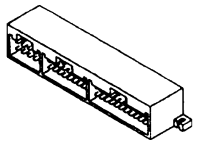
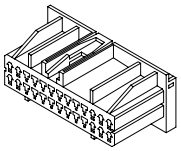
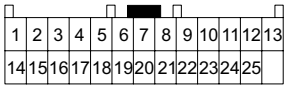
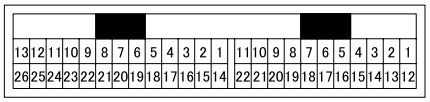
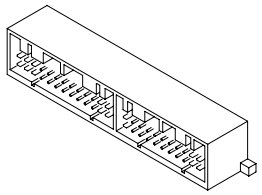
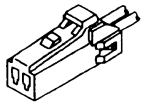
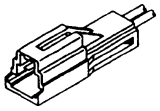
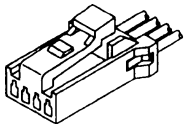
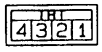
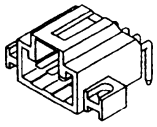
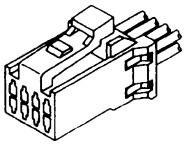
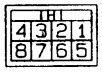
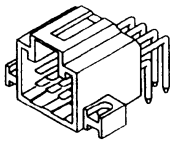
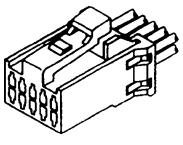
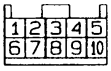
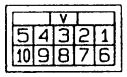
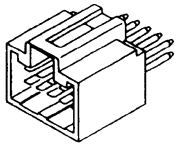
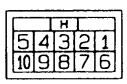
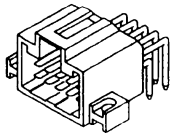
Model (Number shows number of pins)		Connection			
AD	AD2 A				
AE	AE 2 A				
	AE 3 A				
	AE 5 A				
	AE 7 A				
	AE 9 A				
	AE11A				
	AE13A				
	AE15A				

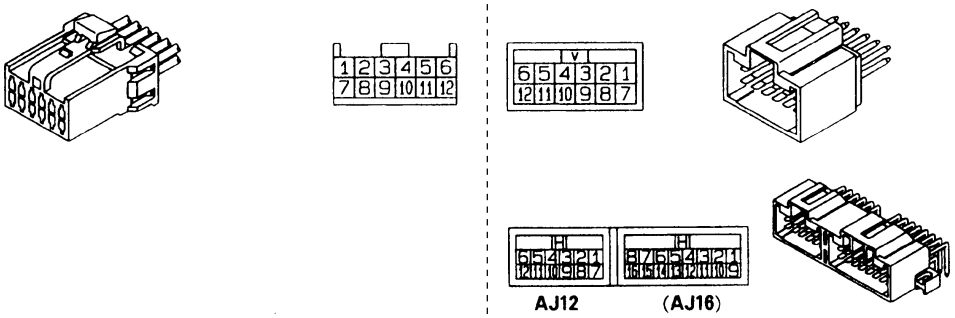
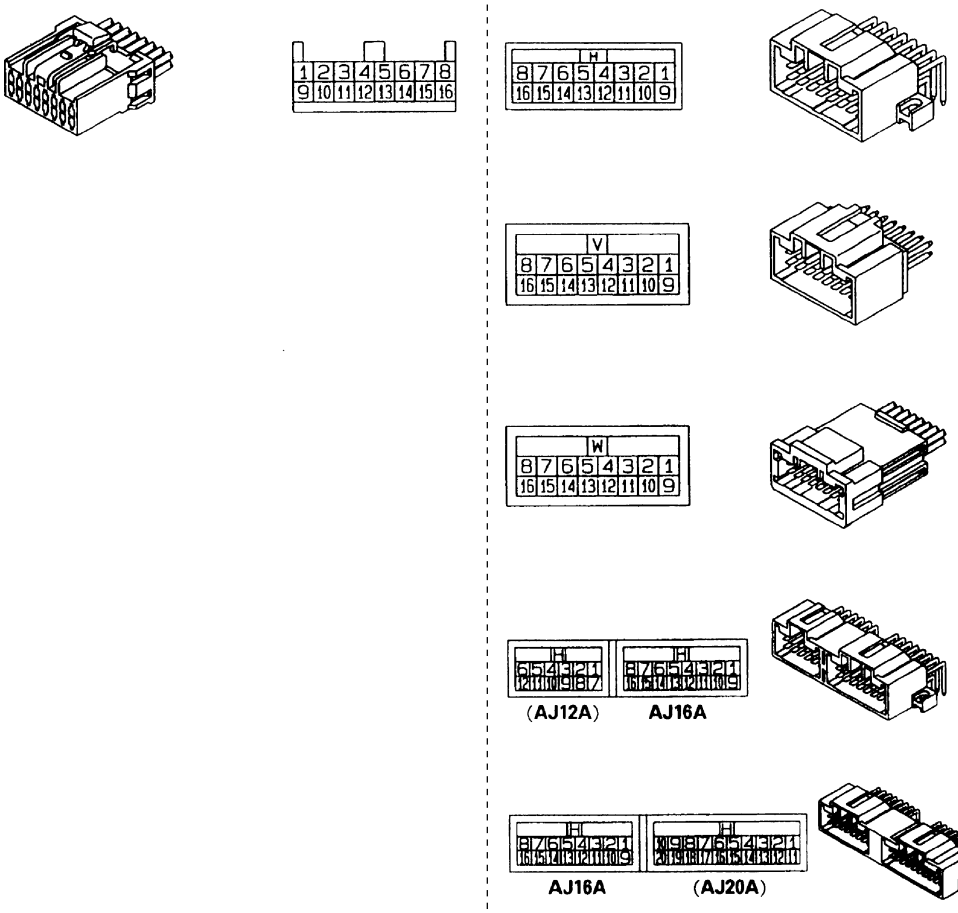
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AE	AE16A (White, Gray, Black)				
	AE16B (Green)				
	AE16C (Blue)				
	AE17A				
AG	AG16A				
	AG20A				
AH	AH10A			 AH10A (AH18A) (AH24A) 	

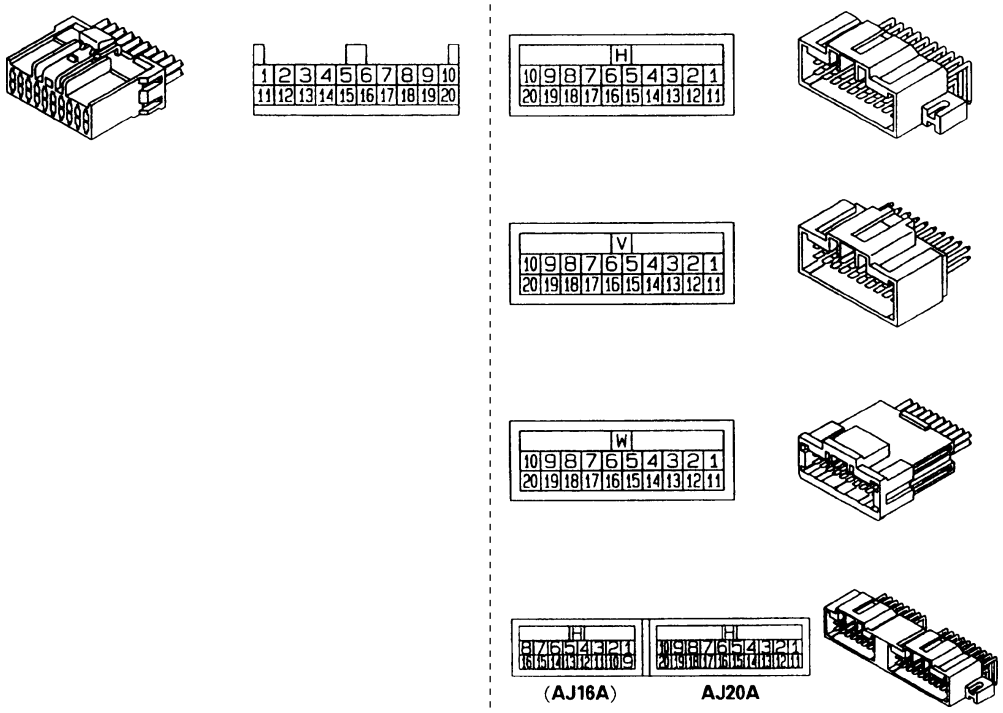
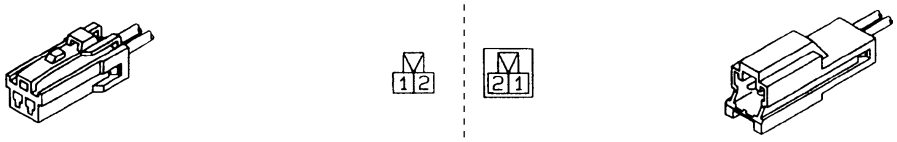
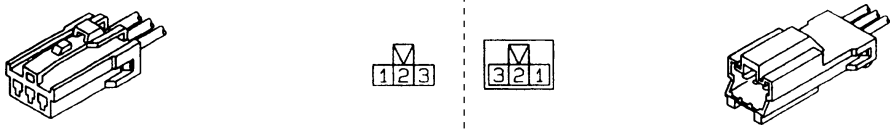
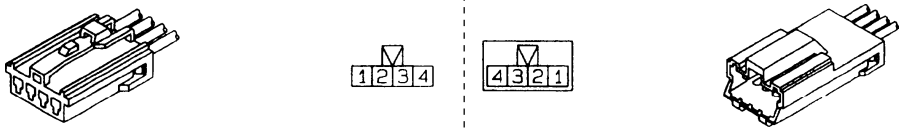
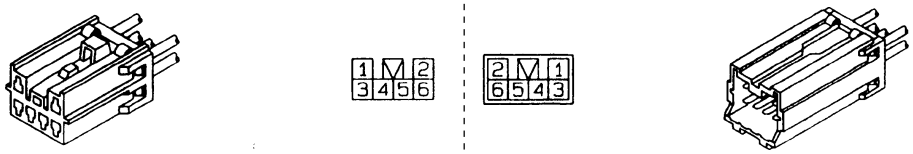
Model (Number shows number of pins)		Connection		
AH	AH12A			
	AH16A			
	AH18A			
	AH18B			
	AH22A			

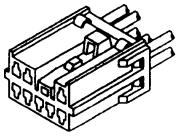
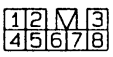
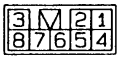
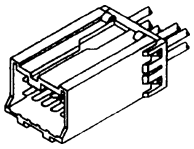
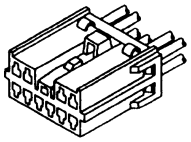
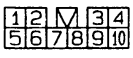
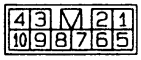
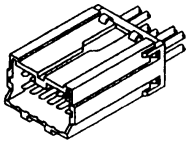
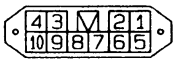
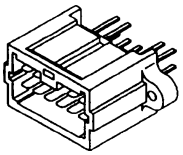
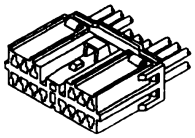
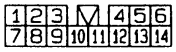
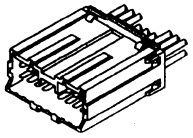
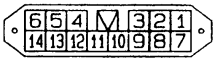
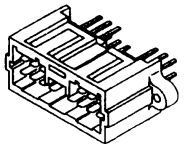
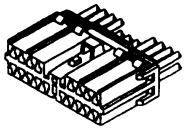
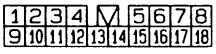
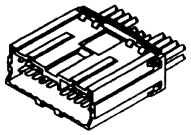
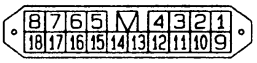
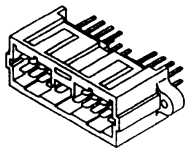
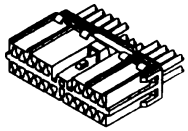
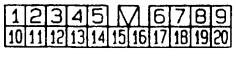
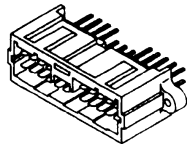
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AH	AH24A	   
	AH26A	   
AJ	AJ 2 A	 
	AJ 4 A	  
	AJ 8 A	  
	AJ10A	     

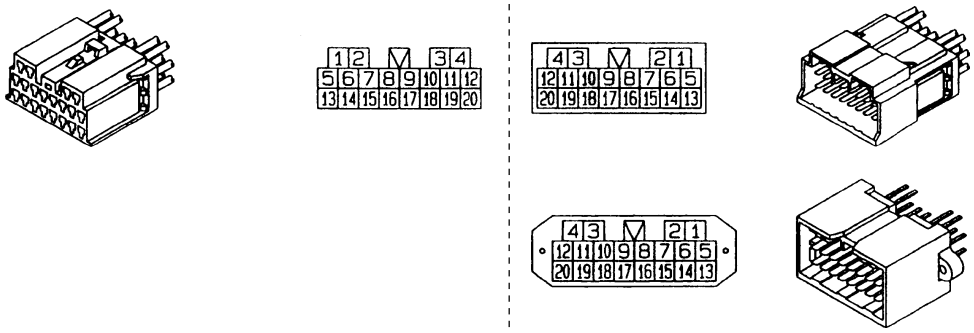
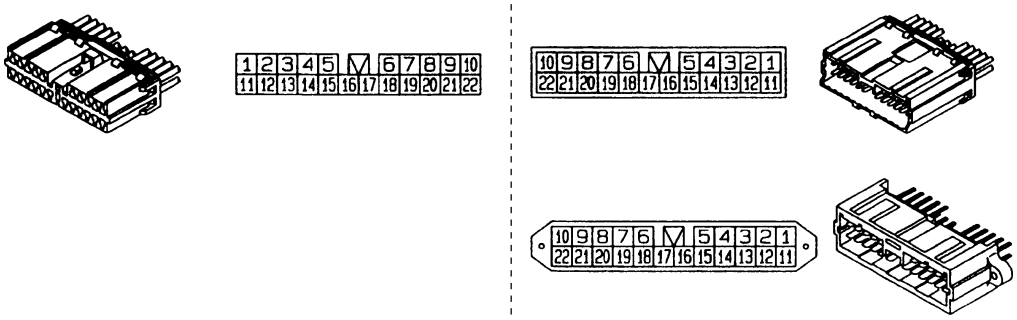
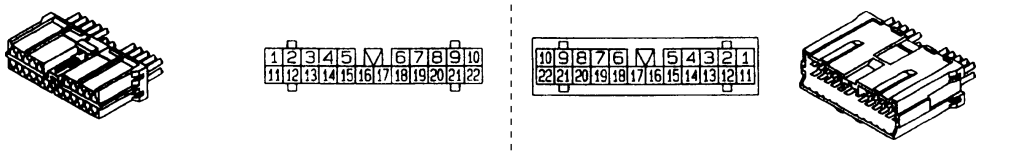
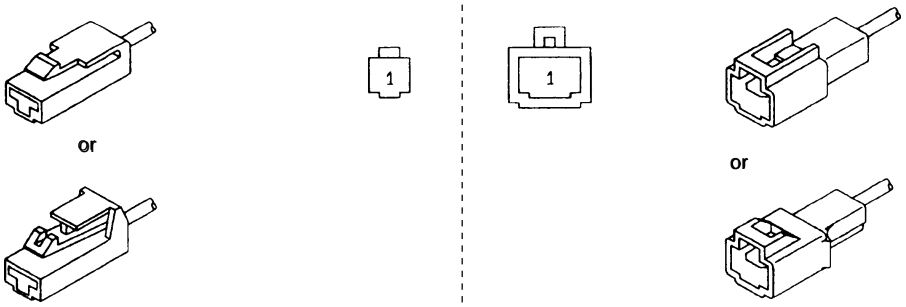
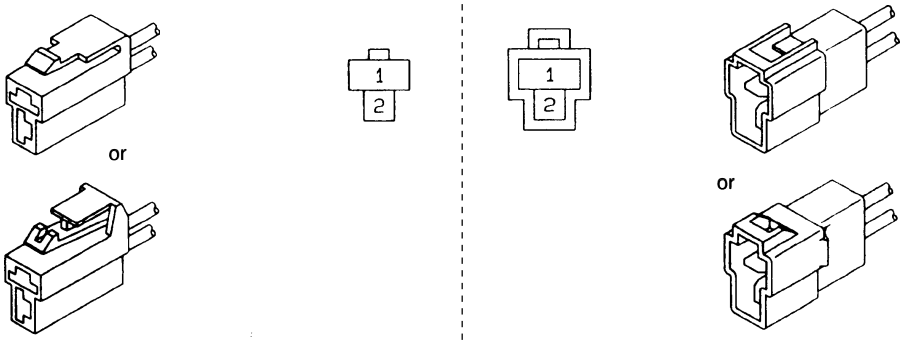
Model (Number shows number of pins)		Connection
AJ	AJ12A	
	AJ16A	

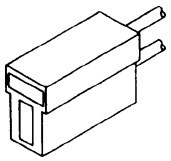
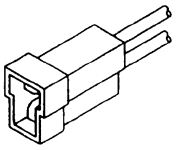
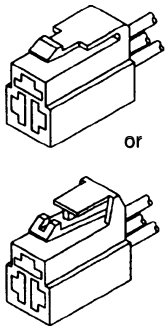
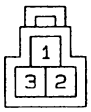
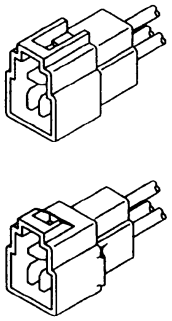
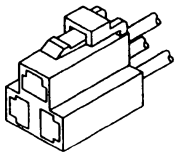
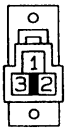
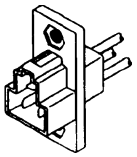
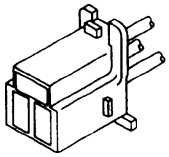
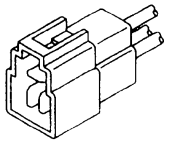
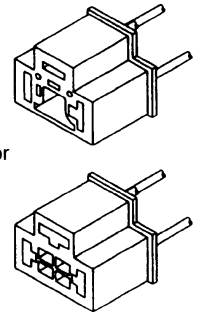
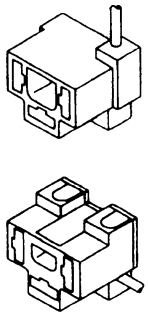
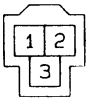
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AJ	AJ20A	
AK	AK 2 A	
	AK 3 A	
	AK 4 A	
	AK 6 A	

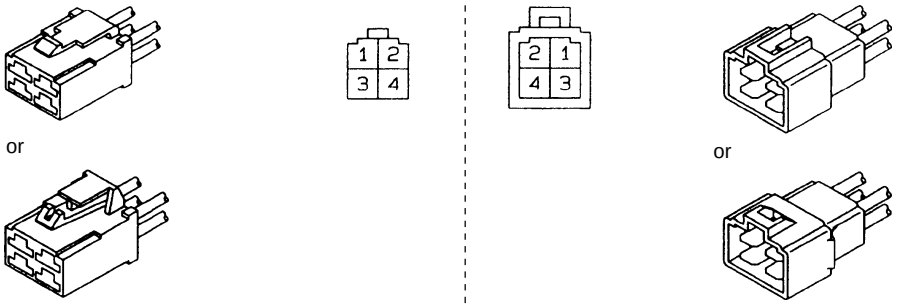
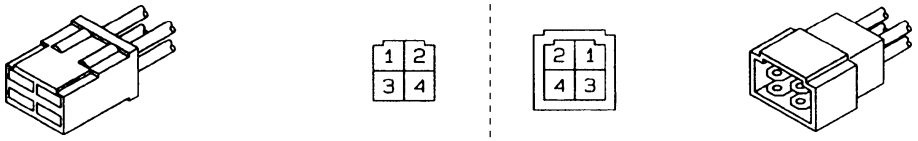
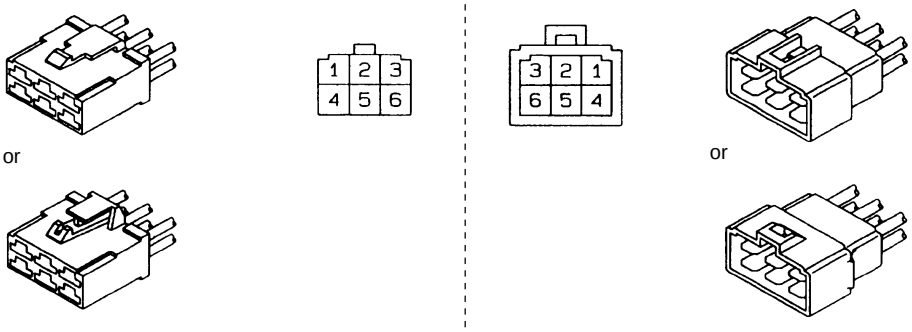
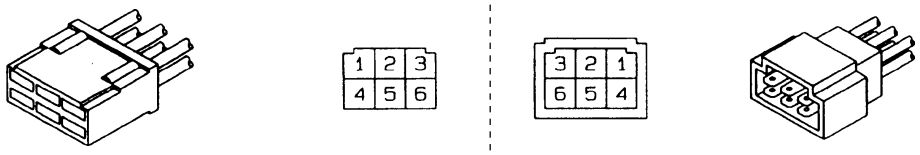
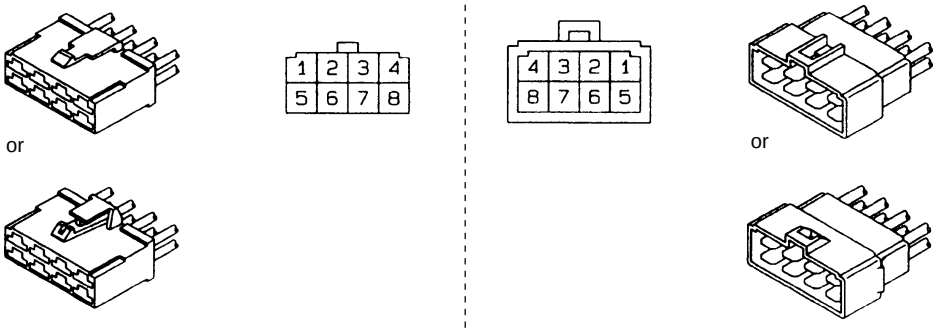
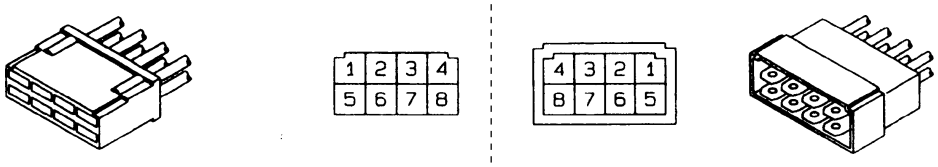
Model (Number shows number of pins)		Connection			
AK	AK 8 A				
	AK10A				
					
	AK14A				
					
	AK18A				
					
	AK20A				

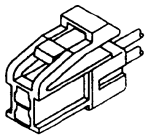
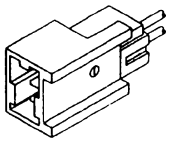
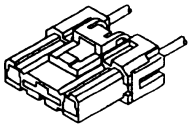
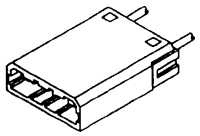
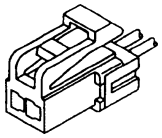
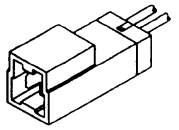
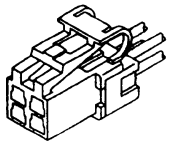
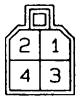
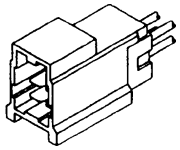
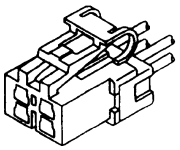
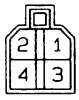
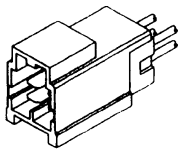
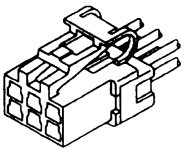
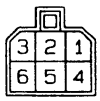
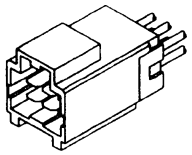
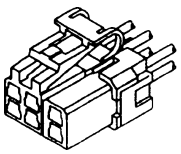
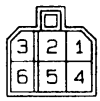
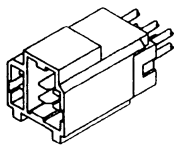
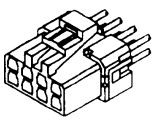
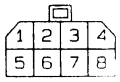
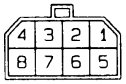
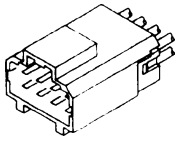
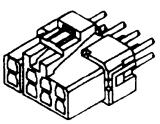
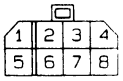
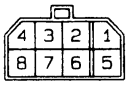
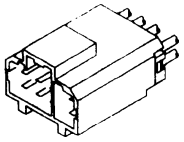
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AK	AK20B	
	AK22A	
	AK22B	
AL	AL 1 A	
	AL 2 A	

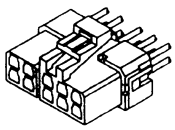
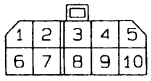
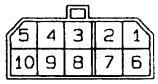
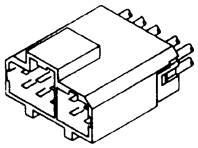
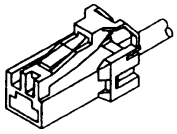
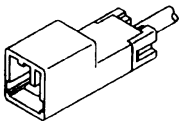
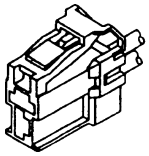
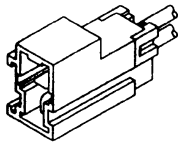
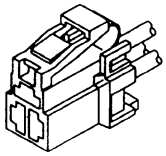
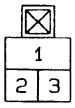
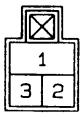
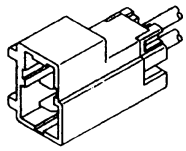
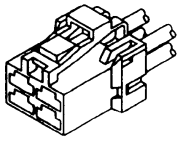
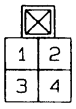
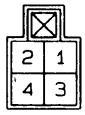
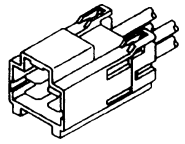
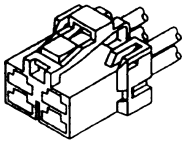
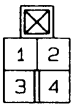
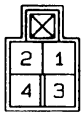
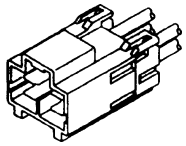
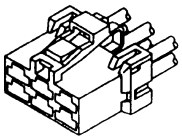
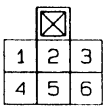
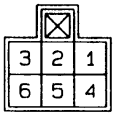
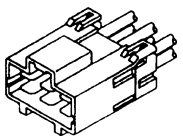
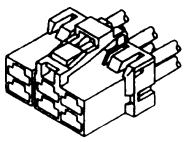
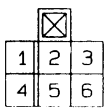
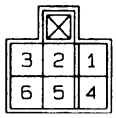
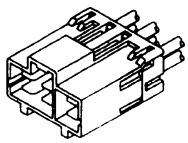
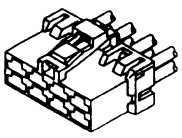
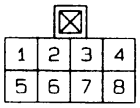
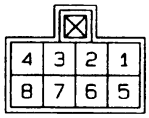
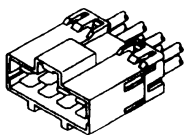
Model (Number shows number of pins)		Connection			
AL	AL 2 B				
	AL 3 A				
	AL 3 B				
	AL 3 C				
	AL 3 D				
	AL 3 E				

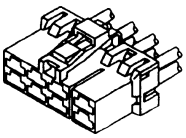
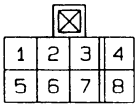
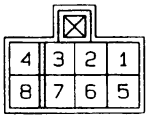
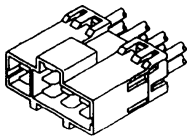
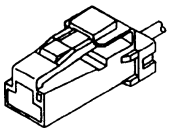
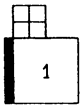
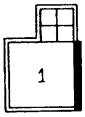
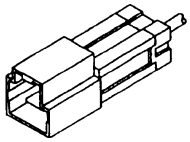
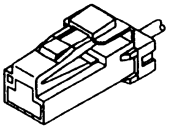
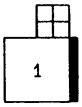
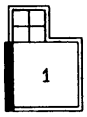
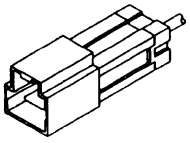
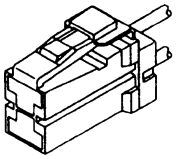
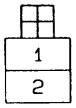
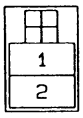
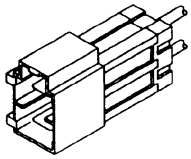
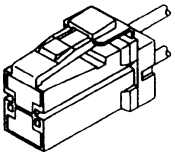
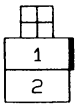
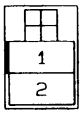
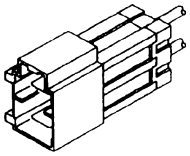
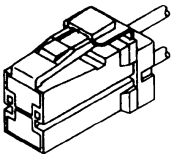
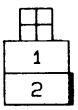
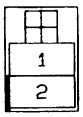
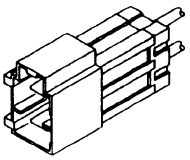
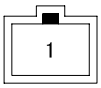
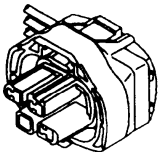
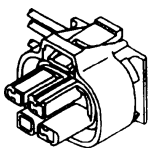
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AL	AL 4 A	
	AL 4 B	
	AL 6 A	
	AL 6 B	
	AL 8 A	
	AL 8 B	

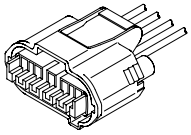
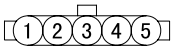
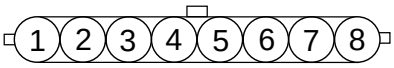
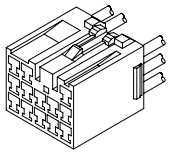
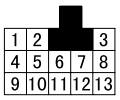
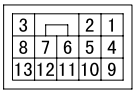
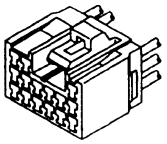
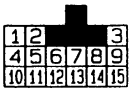
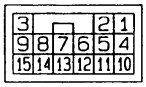
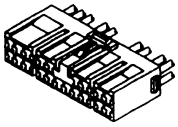
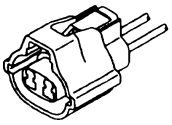
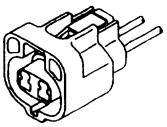
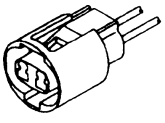
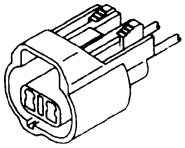
Model (Number shows number of pins)		Connection			
AM	AM 2 A				
	AM 2 B				
	AM 2 C				
	AM 4 A				
	AM 4 B				
	AM 6 A				
	AM 6 B				
	AM 8 A				
	AM 8 B				

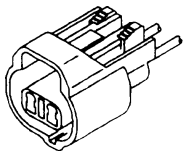
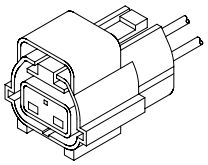
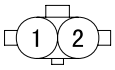
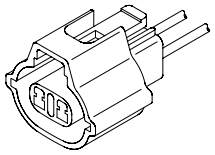
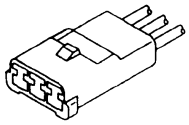
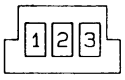
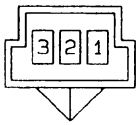
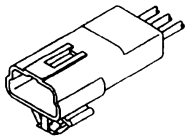
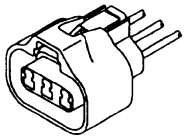
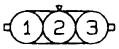
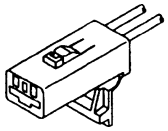
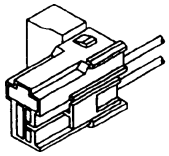
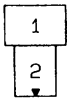
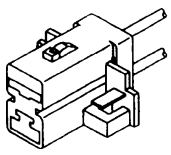
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AM	AM10A				
AN	AN 1 A				
	AN 2 A				
	AN 3 A				
	AN 4 A				
	AN 4 B				
	AN 6 A				
	AN 6 B				
	AN 8 A				

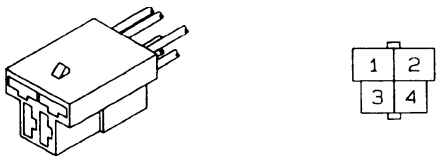
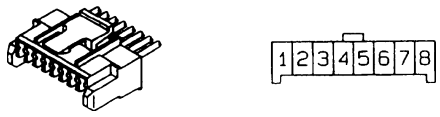
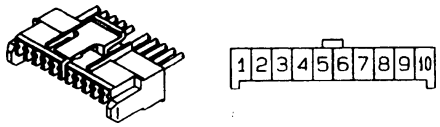
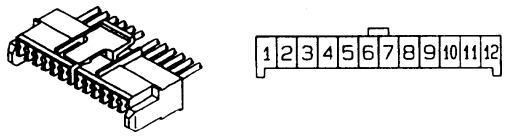
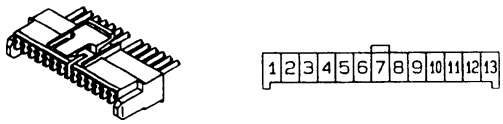
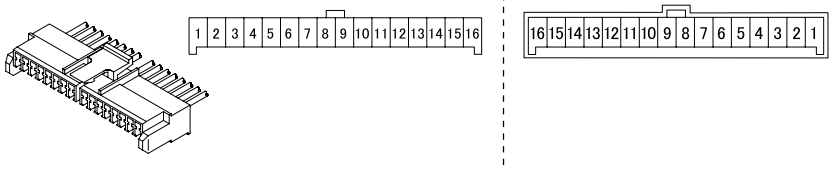
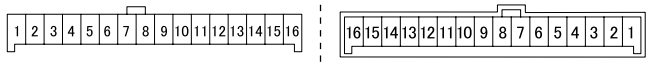
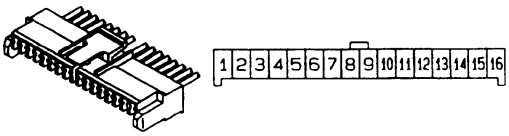
Model (Number shows number of pins)		Connection			
AN	AN 8 B				
AP	AP 1 A				
	AP 1 B				
	AP 2 A				
	AP 2 B				
	AP 2 C				
AQ	AQ 1 A				
	AQ 3 A				
	AQ 3 B				

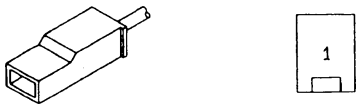
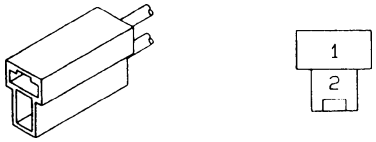
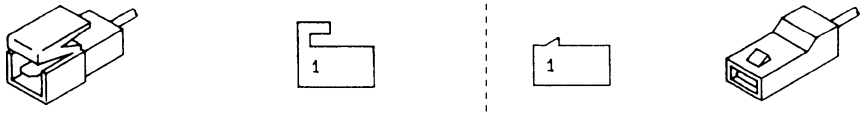
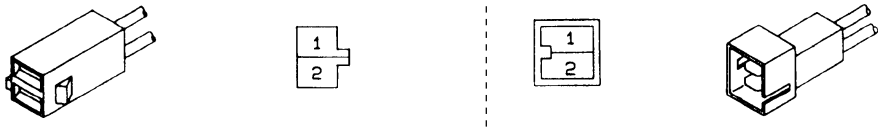
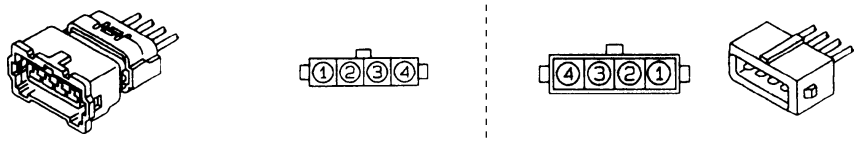
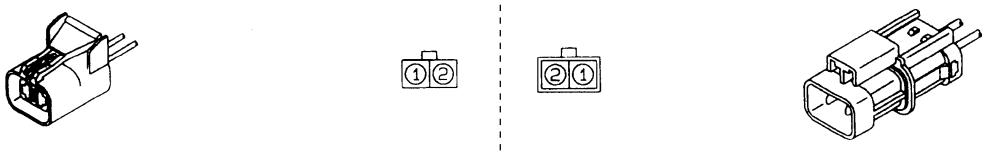
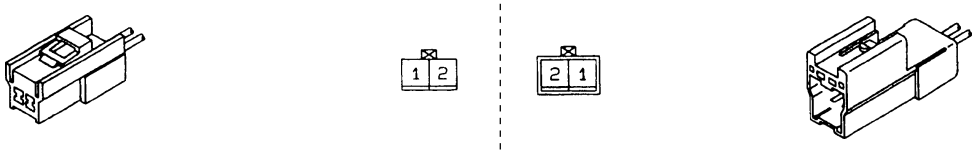
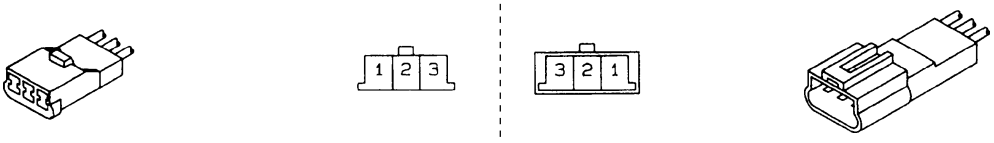
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection		
AQ	AQ 5 A			
	AQ 8 A			
	AQ13A			
	AQ15A			
	AQ20A			
AR	AR 2 A			
	AR 2 B			
	AR 2 C			
	AR 2 D			

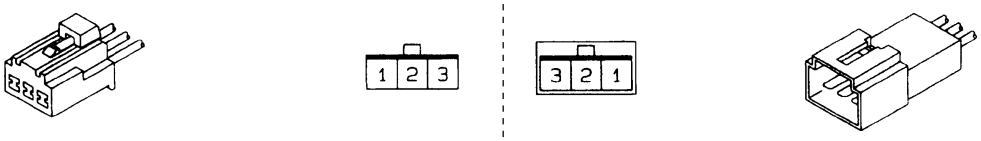
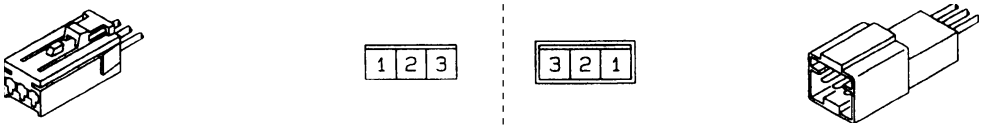
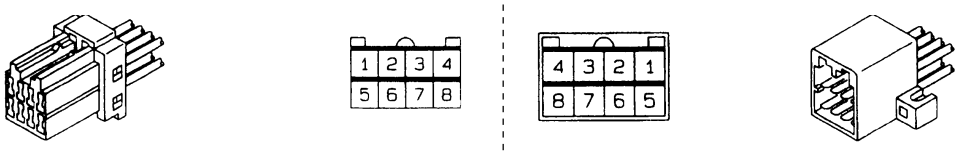
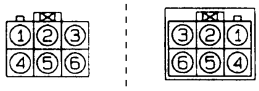
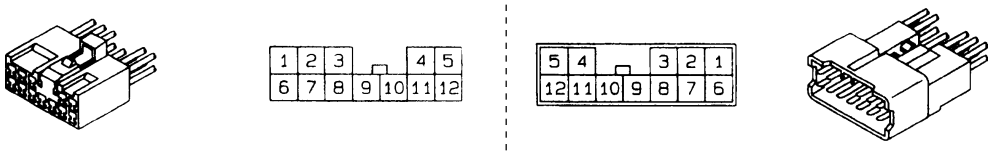
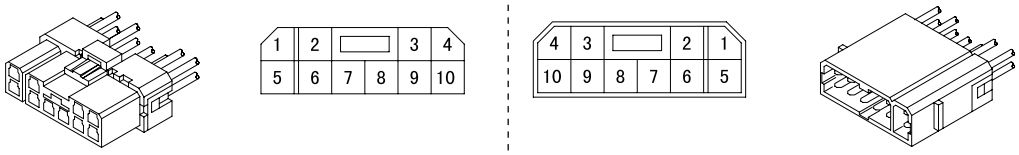
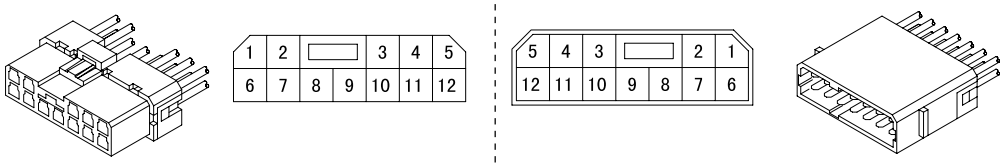
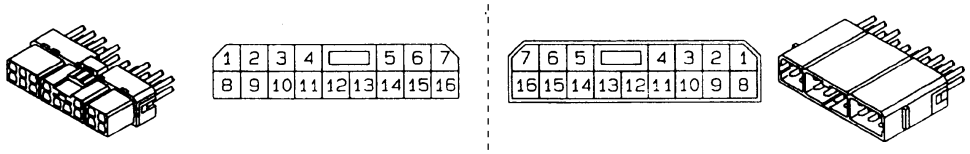
Model (Number shows number of pins)		Connection
AR	AR 2 E	
	AR 2 F	
	AR 2 G	 
	AR 2 H	
	AR 3 A	     
AS	AS 1 A	
	AS 2 A	 
	AS 2 B	

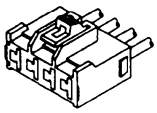
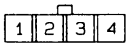
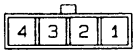
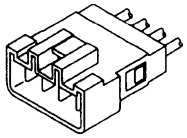
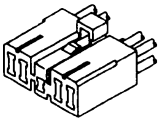
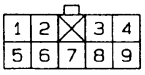
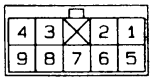
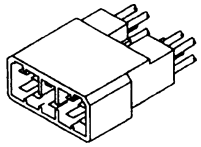
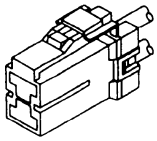
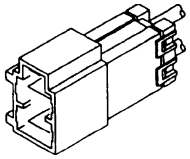
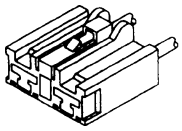
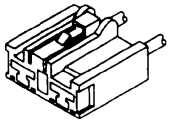
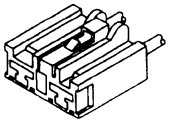
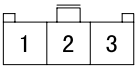
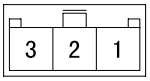
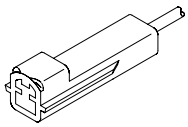
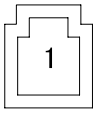
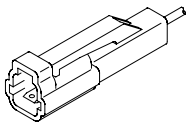
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AT	AT 4 A	
AU	AU 6 A	
	AU 8 A	
	AU10A	
	AU12A	
	AU13A	
	AU16A	
	AU16B	
	AU16C	

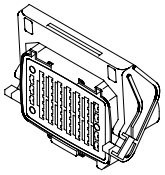
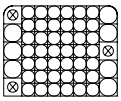
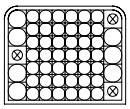
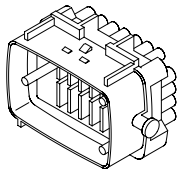
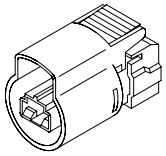
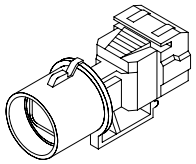
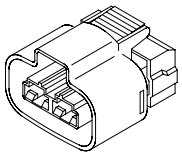
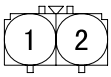
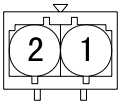
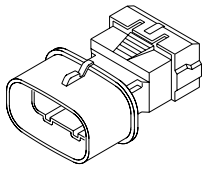
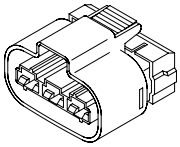
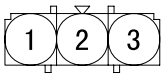
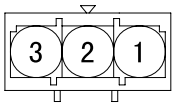
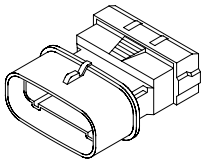
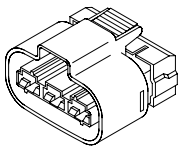
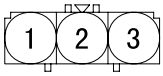
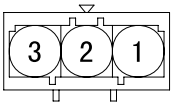
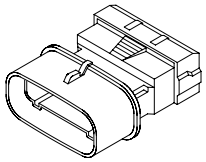
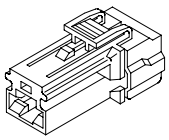
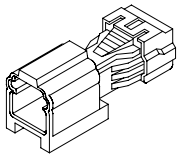
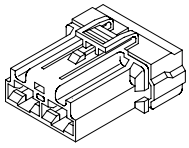
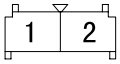
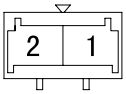
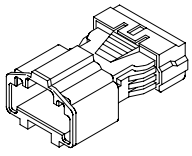
Model (Number shows number of pins)		Connection
AV	AV 1 A	
	AV 2 A	
AW	AW 1 A	
	AW 1 B	
	AW 2 A	
AX	AX 4 A	
AY	AY 2 A	
AZ	AZ 2 A	
BA	BA 3 A	

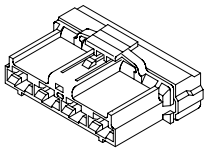
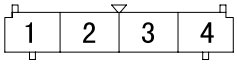
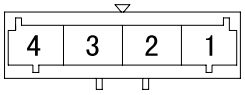
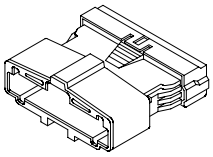
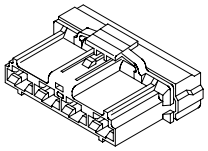
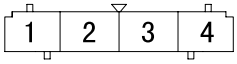
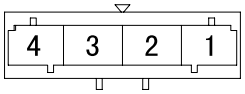
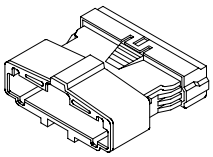
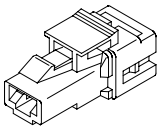
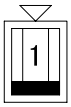
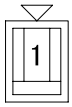
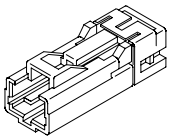
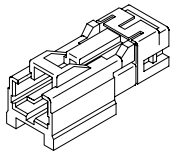
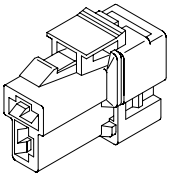
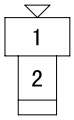
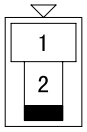
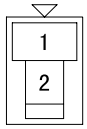
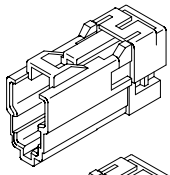
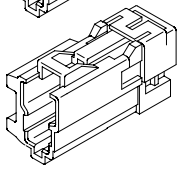
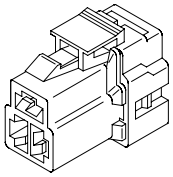
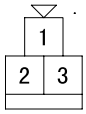
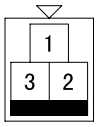
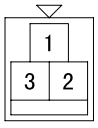
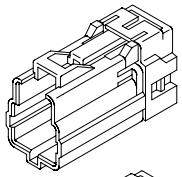
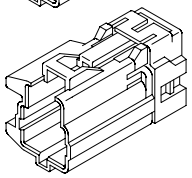
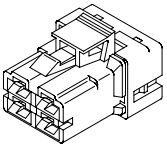
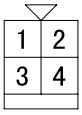
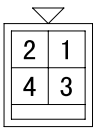
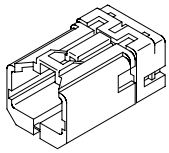
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
BB	BB 2 A	
	BB 3 A	
BC	BC 3 A	
BD	BD 8 A	
BE	BE 6 A	
BF	BF12A	
BG	BG10A	
	BG12A	
	BG16A	

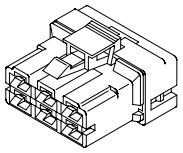
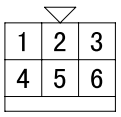
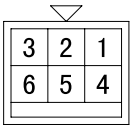
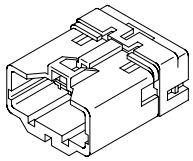
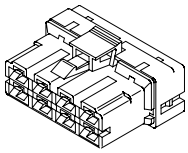
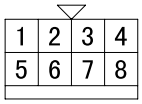
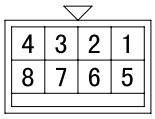
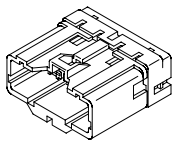
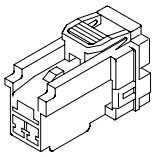
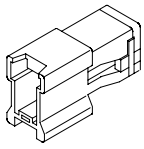
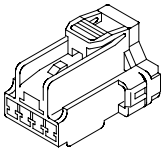
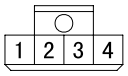
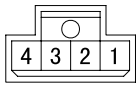
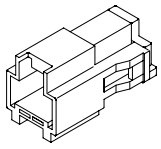
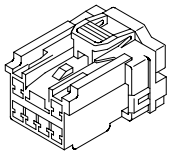
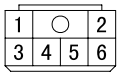
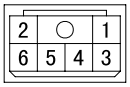
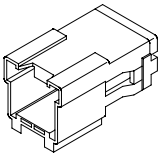
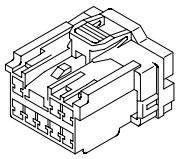
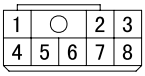
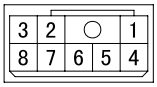
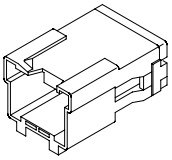
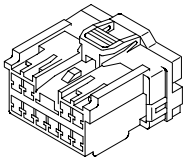
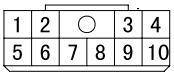
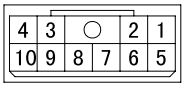
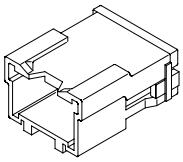
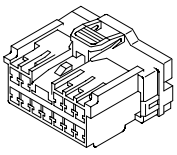
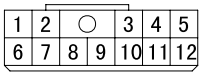
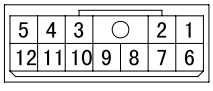
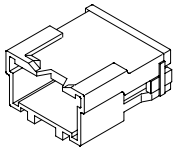
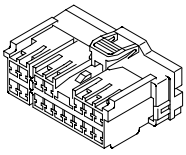
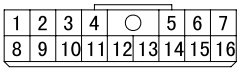
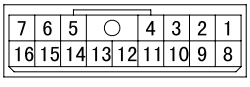
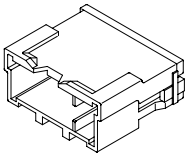
Model (Number shows number of pins)		Connection			
BH	BH 4 A				
BJ	BJ 9 A				
BL	BL 2 A				
BM	BM 2 A				
	BM 2 B				
	BM 2 C				
	BM 3 A				
BN	BN 1 A				

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BP	BP49A				
BQ	BQ 1 A				
	BQ 2 A				
	BQ 3 A				
	BQ 3 B				
BR	BR 1 A				
	BR 2 A				

Model (Number shows number of pins)		Connection			
BR	BR 4 A (Gray)				
	BR 4 B (Black)				
BS	BS 1 A			 	 
	BS 2 A			 	 
	BS 3 A			 	 
	BS 4 A				

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BS	BS 6 A				
	BS 8 A				
BT	BT 2 A				
	BT 4 A				
	BT 6 A				
	BT 8 A				
	BT10A				
	BT 12 A				
	BT16A				

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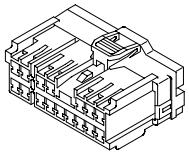
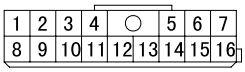
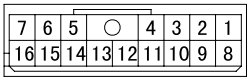
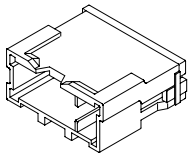
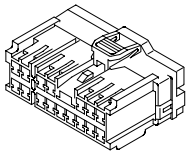
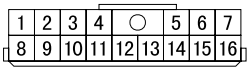
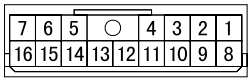
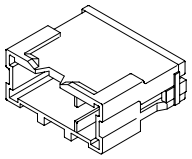
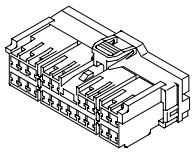
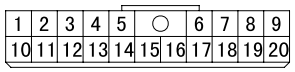
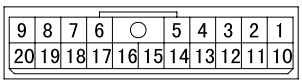
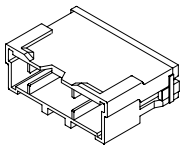
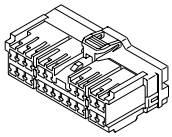
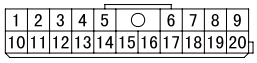
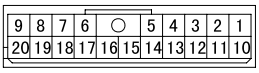
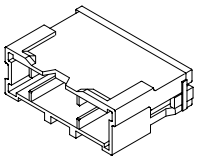
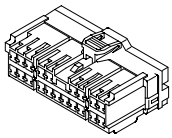
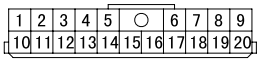
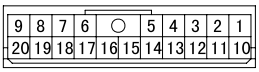
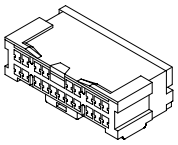
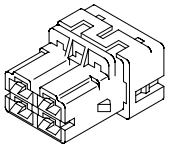
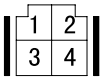
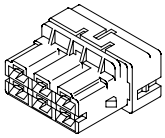
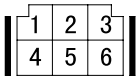
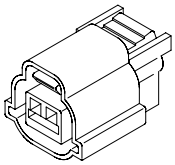
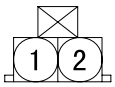
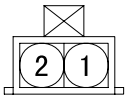
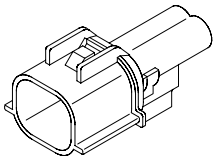
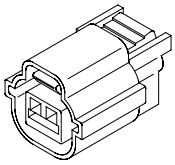
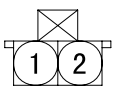
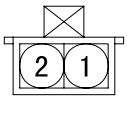
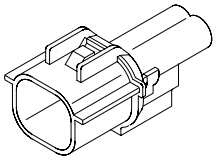
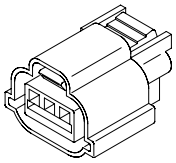
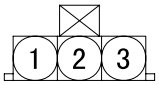
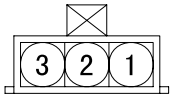
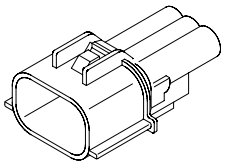
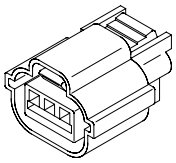
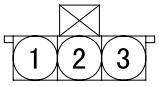
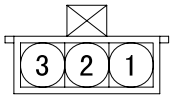
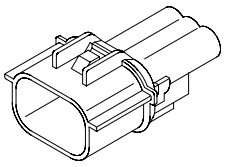
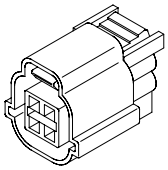
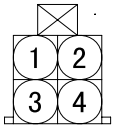
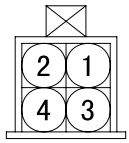
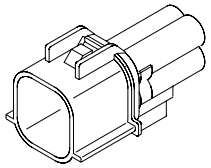
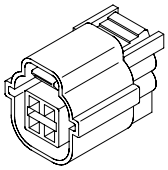
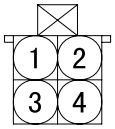
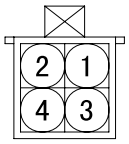
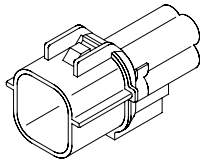
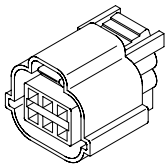
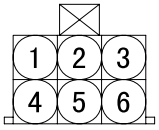
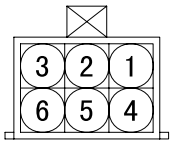
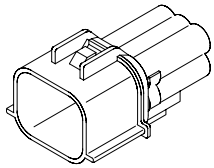
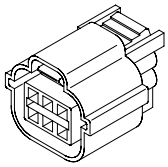
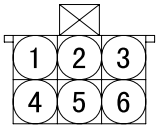
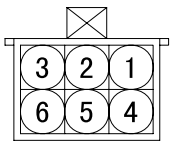
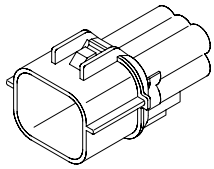
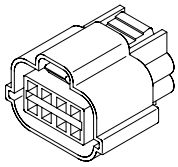
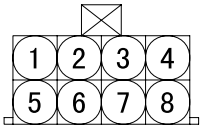
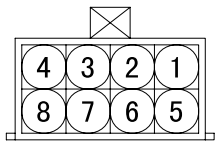
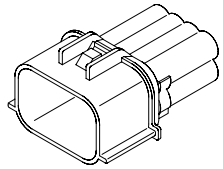
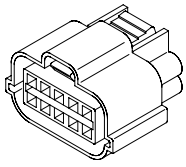
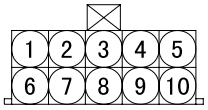
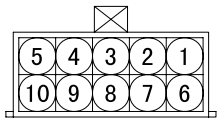
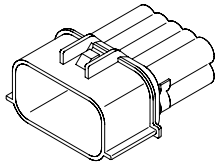
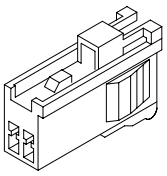
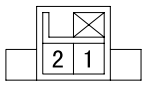
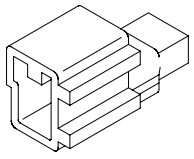
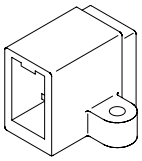
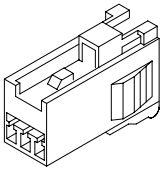
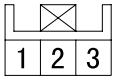
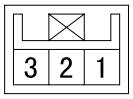
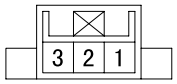
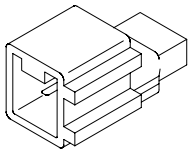
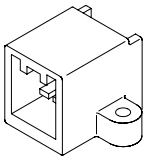
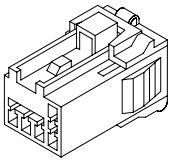
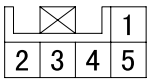
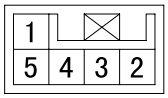
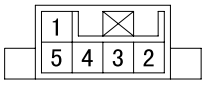
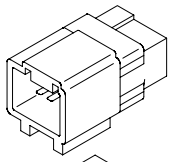
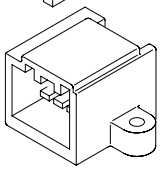
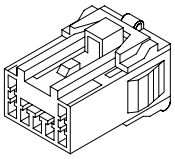
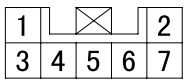
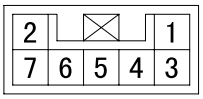
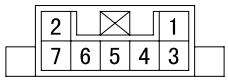
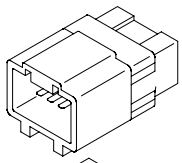
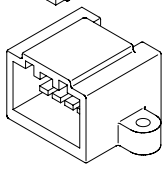
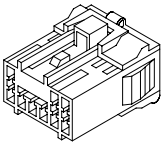
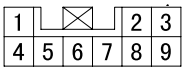
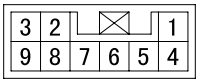
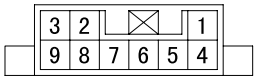
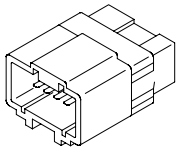
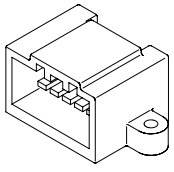
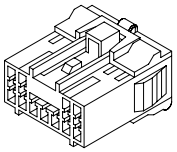
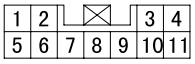
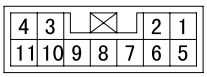
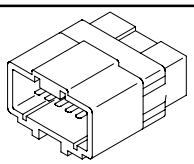
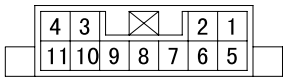
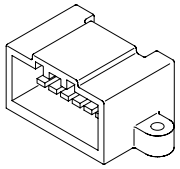
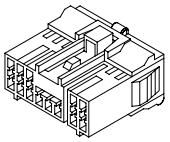
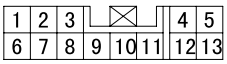
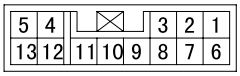
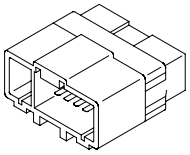
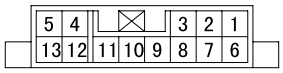
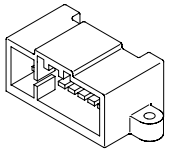
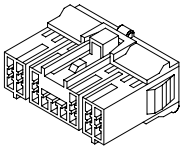
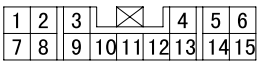
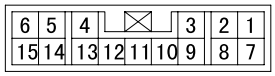
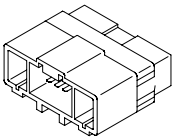
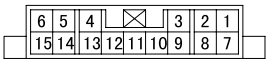
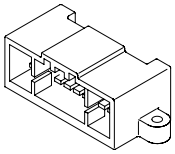
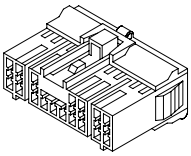
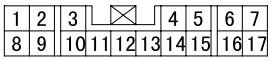
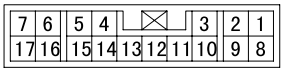
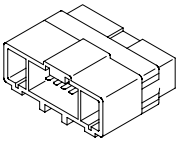
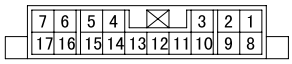
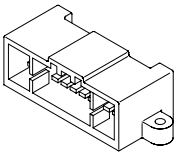
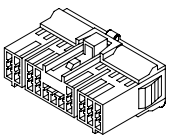
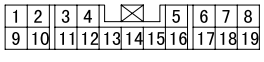
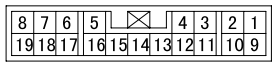
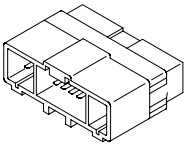
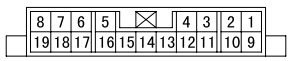
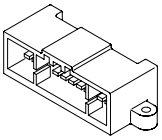
BT	BT16B				
	BT16C				
	BT20A				
	BT20B				
	BT20C				
BU	BU 4 A				
	BU 6 A				
BW	BW 2 A				
	BW 2 B				

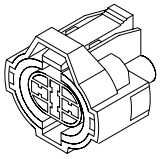
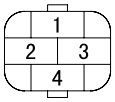
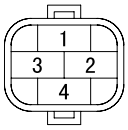
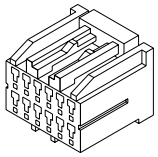
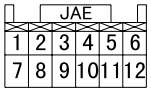
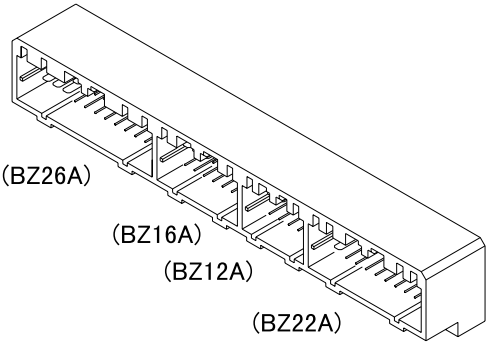
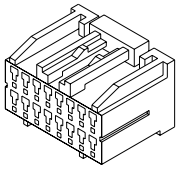
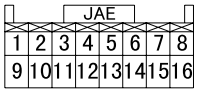
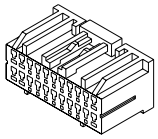
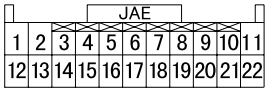
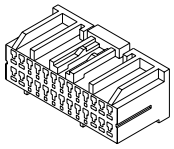
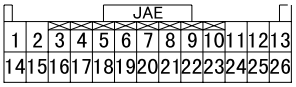
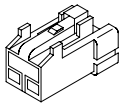
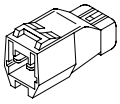
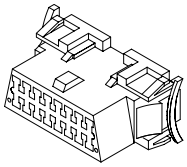
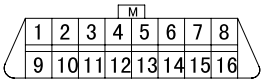
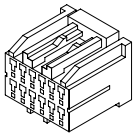
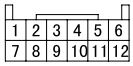
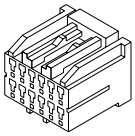
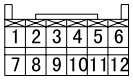
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BW	BW 3 A				
	BW 3 B				
	BW 4 A				
	BW 4 B				
	BW 6 A				
	BW 6 B				
	BW 8 A				
	BW10A				

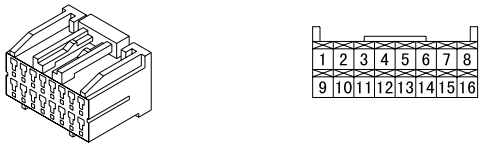
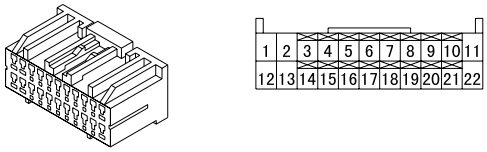
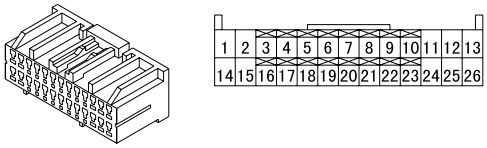
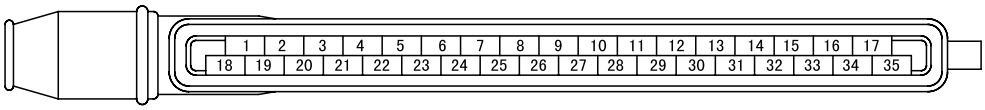
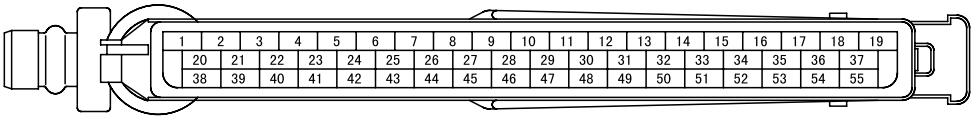
Model (Number shows number of pins)		Connection			
BX	BX 2 A				 
	BX 3 A			 	 
	BX 5 A			 	 
	BX 7 A			 	 
	BX 9 A			 	 

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
BX	BX11A	     
	BX13A	     
	BX15A	     
	BX17A	     
	BX19A	     

Model (Number shows number of pins)		Connection	
BY	BY 4 A	 	
BZ	BZ12A	 	 (BZ26A) (BZ16A) (BZ12A) (BZ22A)
	BZ16A	 	
	BZ22A	 	
	BZ26A	 	
CA	CA 2 A		
CB	CB16A	 	
CC	CC12A	 	
	CC12B	 	

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CC	CC16A	
	CC22A	
	CC26A	
CD	CD35A	
	CD55A	
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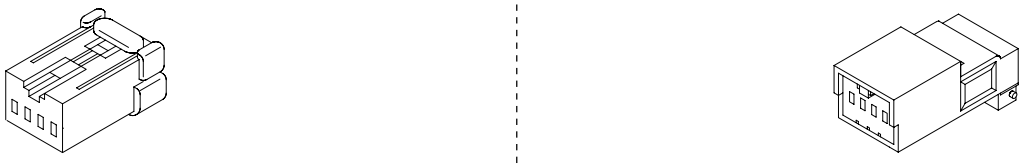
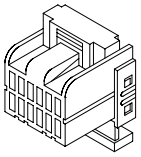
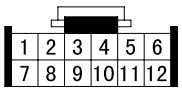
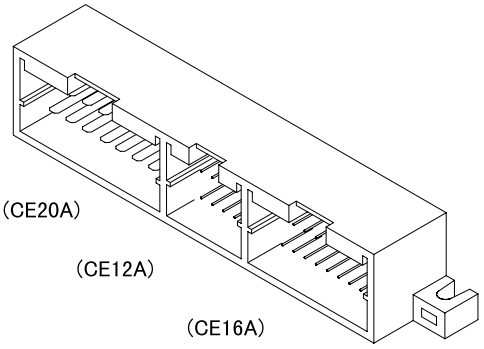
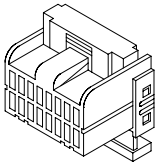
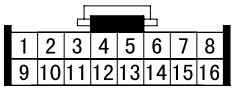
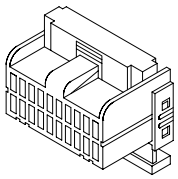
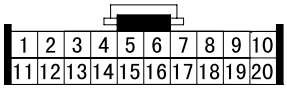
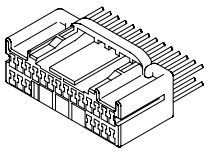
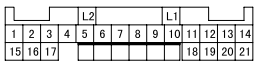
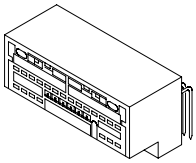
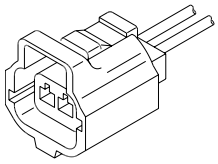
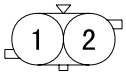
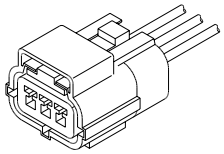
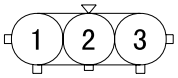
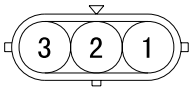
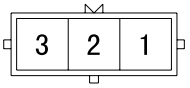
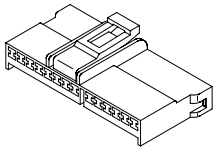
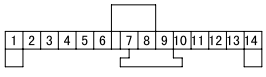
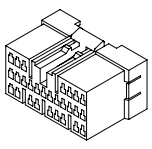
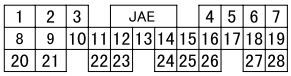
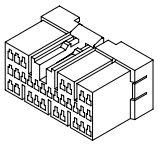
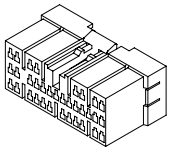
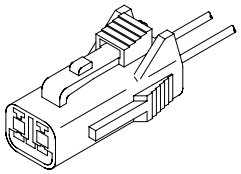
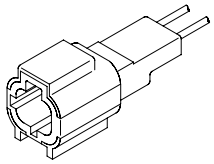
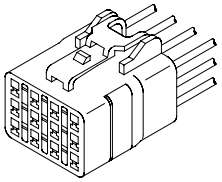
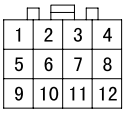
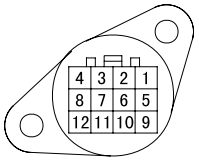
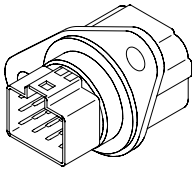
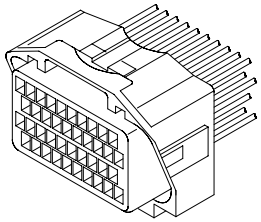
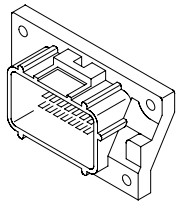
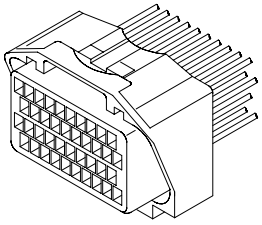
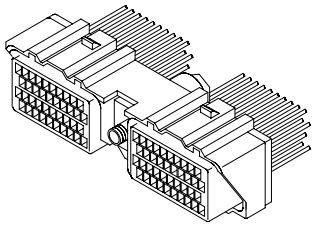
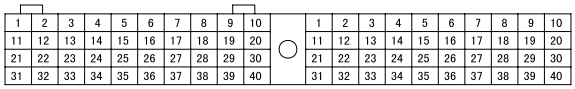
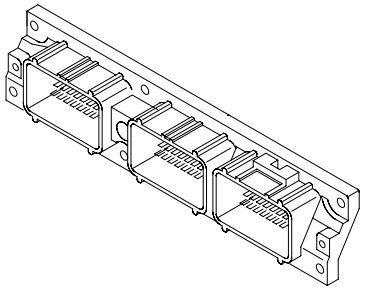
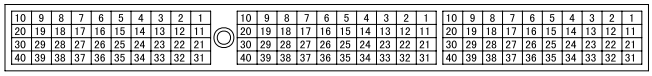
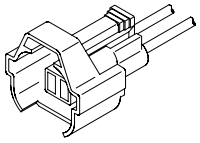
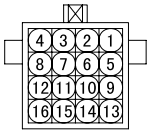
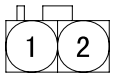
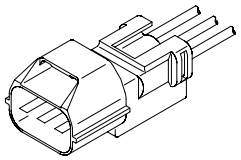
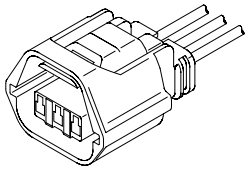
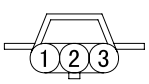
	CE 4 A	

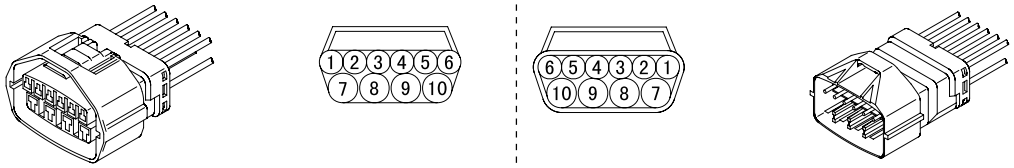
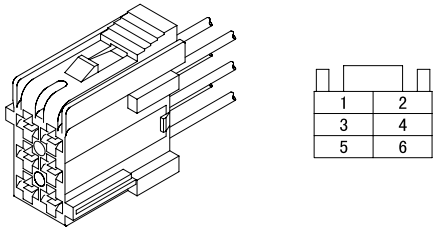
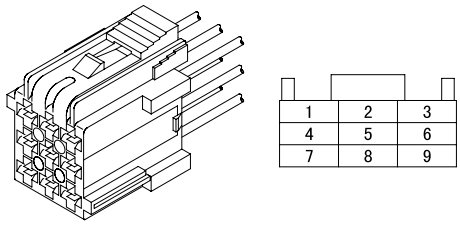
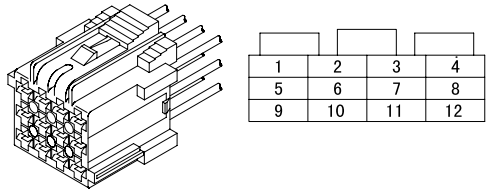
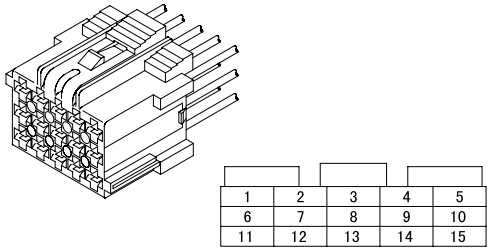
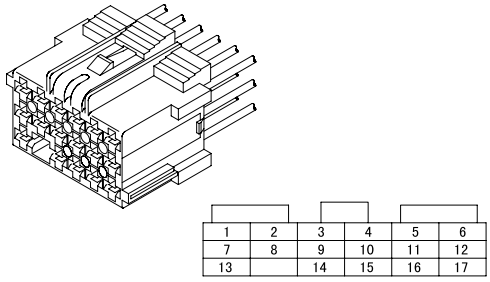
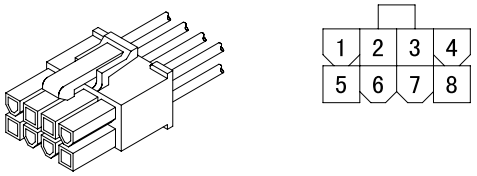
Model (Number shows number of pins)		Connection	
CE	CE12A	 	CE48A 
	CE16A	 	
	CE20A	 	
CF	CF21A	 	
CH	CH 2 A	 	
	CH 3 A	 	
CK	CK 3 A		
CL	CL14A	 	
CM	CM28A	 	

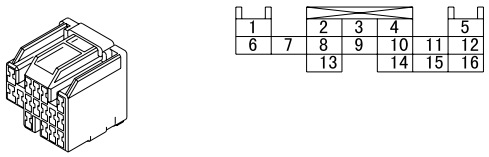
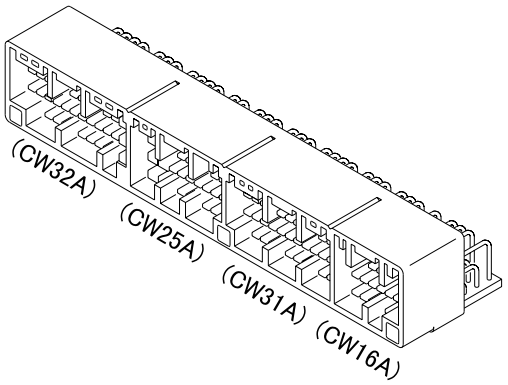
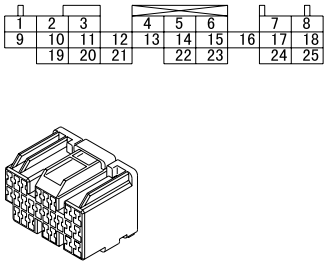
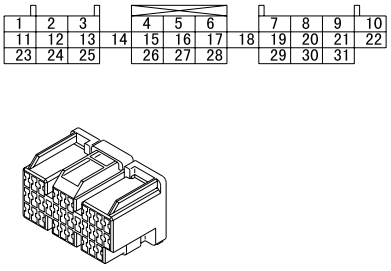
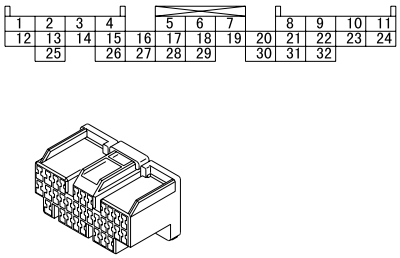
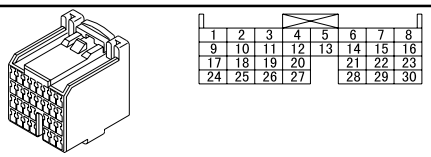
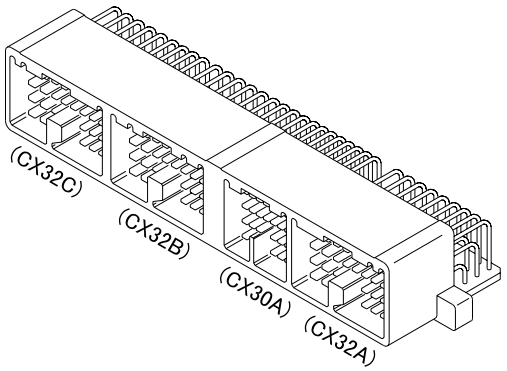
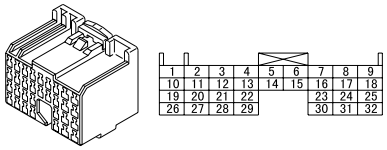
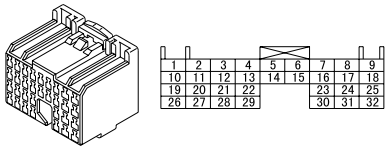
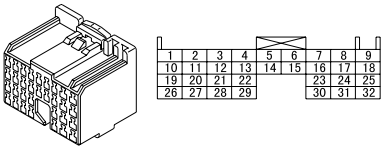
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CM	CM30A	
		JAE: 1 2 3 | 4 5 | 6 7 / 8 9 10 11 12 13 14 15 16 17 18 19 20 / 21 22 23 24 25 26 27 28 29 30
	CM35A	
		JAE: 1 2 | 3 4 | 5 6 | 7 8 / 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 / 24 25 26 27 28 29 30 31 32 33 34 35
CN	CN 2 A	 
	CN12A	   
CP	CP40A	 
		1 2 3 4 5 6 7 8 9 10 / 11 12 13 14 15 16 17 18 19 20 / 21 22 23 24 25 26 27 28 29 30 / 31 32 33 34 35 36 37 38 39 40
		10 9 8 7 6 5 4 3 2 1 / 20 19 18 17 16 15 14 13 12 11 / 30 29 28 27 26 25 24 23 22 21 / 40 39 38 37 36 35 34 33 32 31
	CP40B	
		1 2 3 4 5 6 7 8 9 10 / 11 12 13 14 15 16 17 18 19 20 / 21 22 23 24 25 26 27 28 29 30 / 31 32 33 34 35 36 37 38 39 40

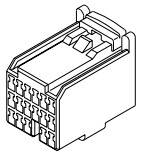
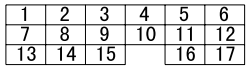
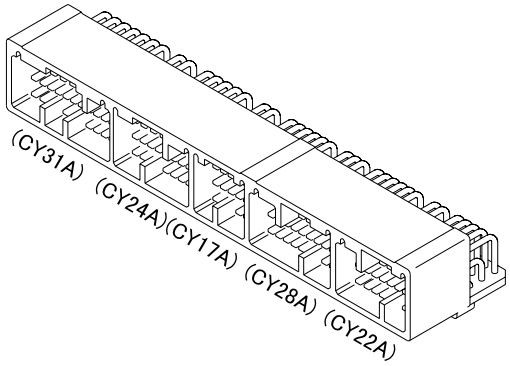
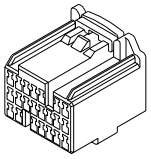
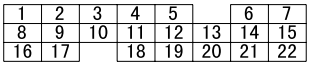
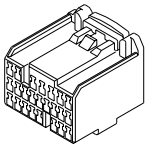
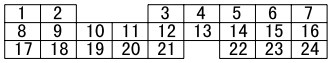
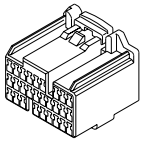
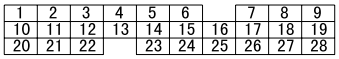
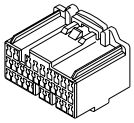
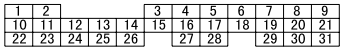
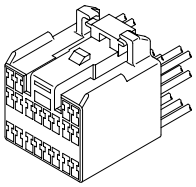
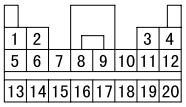
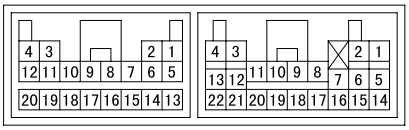
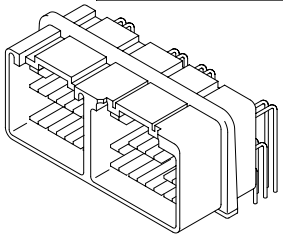
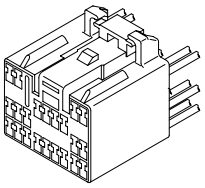
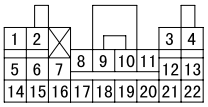
Model (Number shows number of pins)		Connection
CP	CP80A	 
	CP40B CP80A	  (CP80A) (CP40B)
CQ	CQ 2 A	
CR	CR16A	
CS	CS 2 A	
CT	CT 3 A	 
	CT 3 B	 

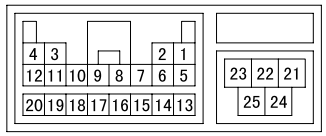
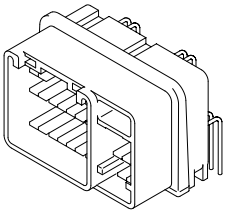
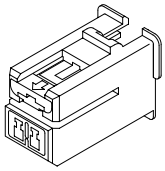
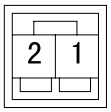
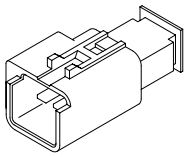
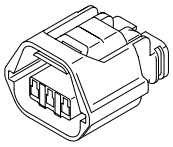
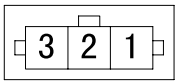
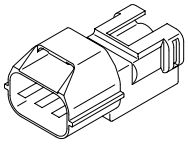
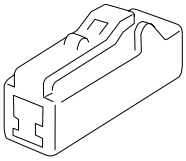
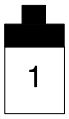
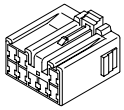
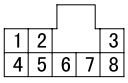
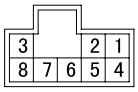
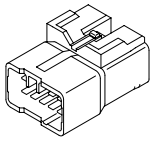
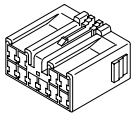
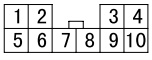
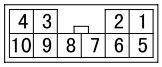
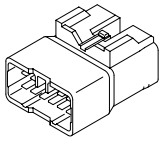
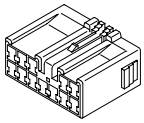
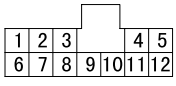
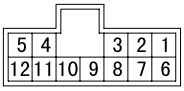
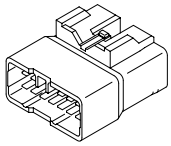
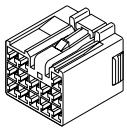
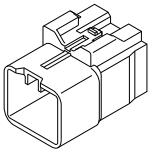
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CT	CT10A	
CU	CU 6 A	
	CU 9 A	
	CU12A	
	CU15A	
	CU17A	
CV	CV 8 A	

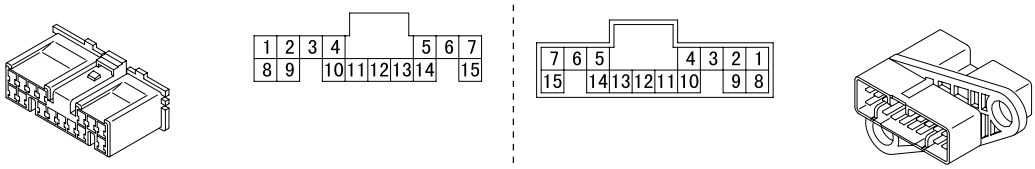
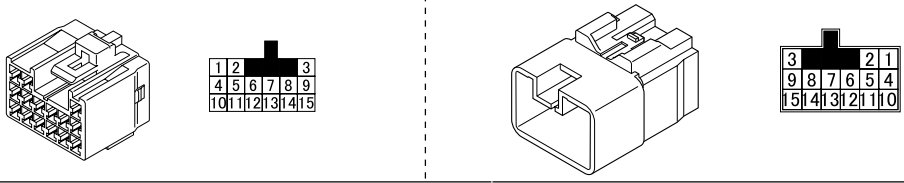
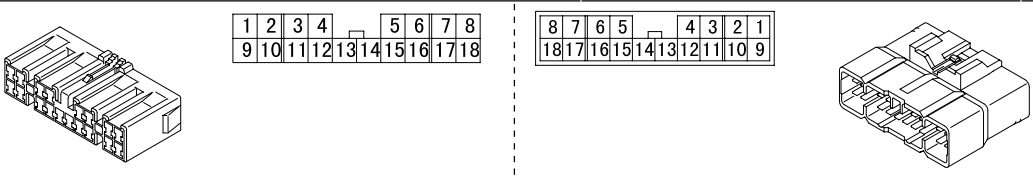
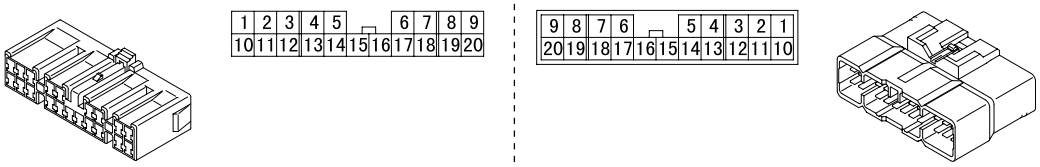
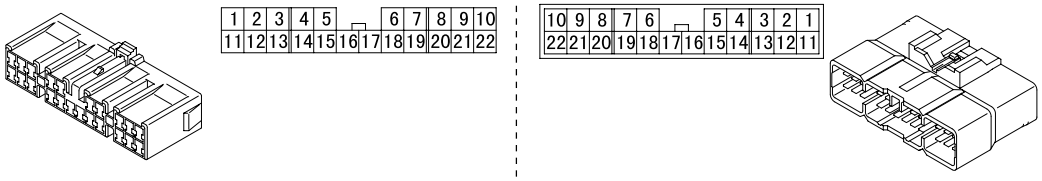
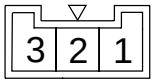
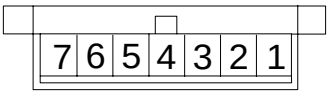
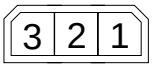
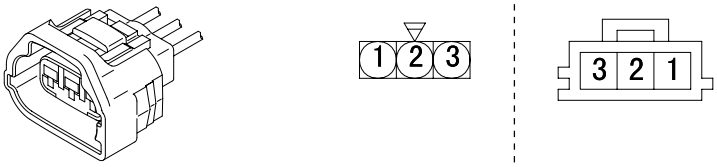
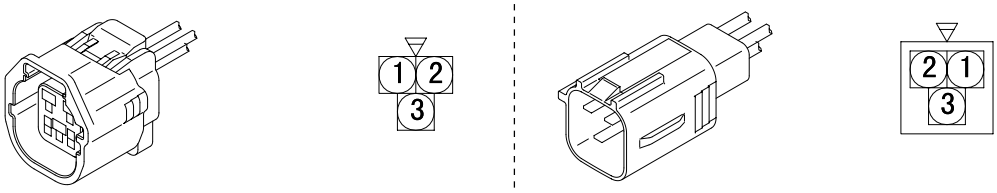
Model (Number shows number of pins)		Connection
CW	CW16A	 
	CW25A	
	CW31A	
	CW32A	
CX	CX30A	 
	CX32A	
	CX32B	
	CX32C	

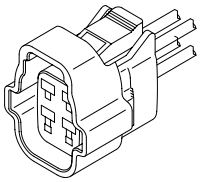
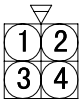
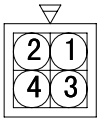
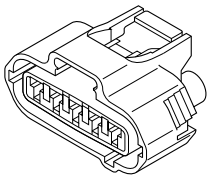
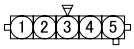
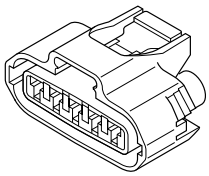
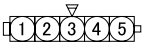
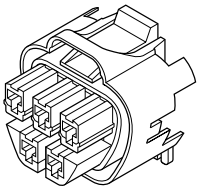
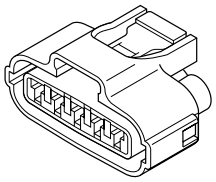
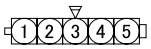
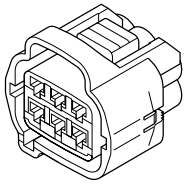
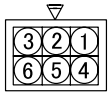
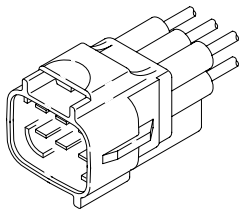
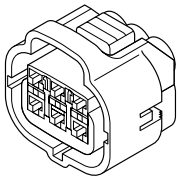
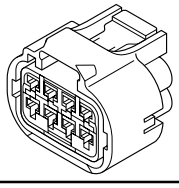
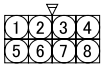
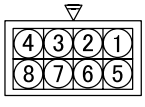
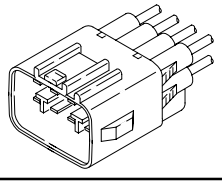
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CY	CY17A	  
	CY22A	 
	CY24A	 
	CY28A	 
	CY31A	 
DA	DA20A	   
	DA22A	 

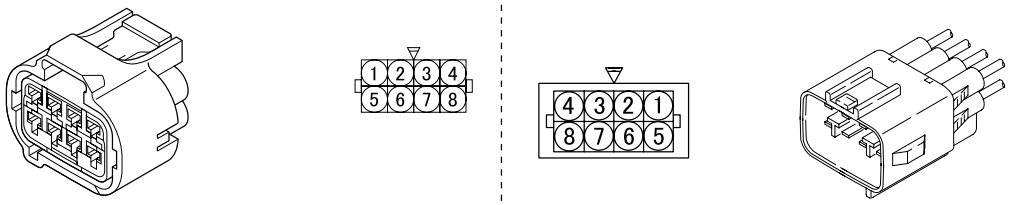
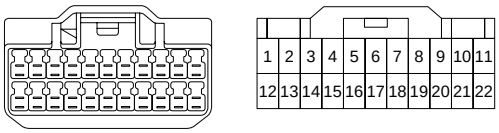
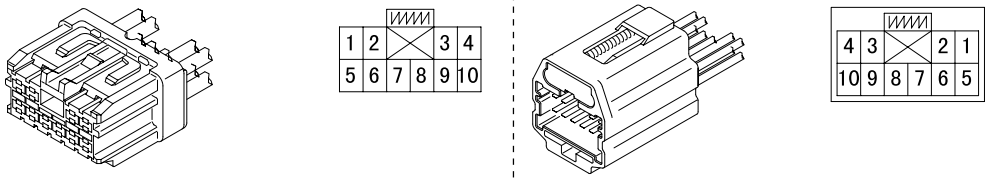
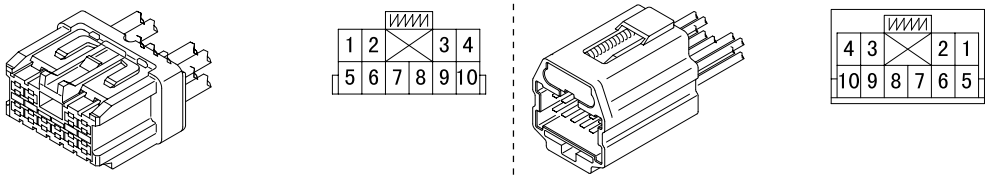
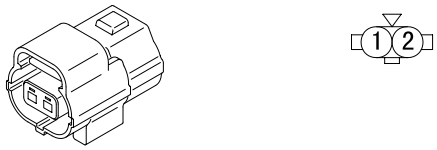
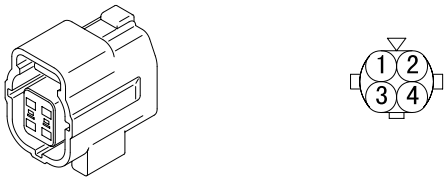
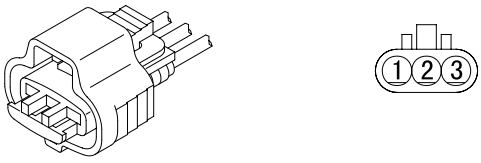
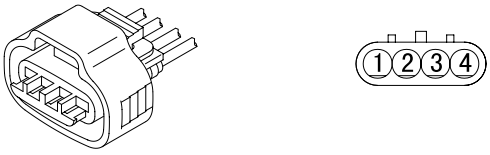
Model (Number shows number of pins)		Connection
DA	DA25A	 
DB	DB 2 A	  
DC	DC 3 A	  
DD	DD 1 A	 
	DD 8 A	   
	DD10A	   
	DD12A	   
	DD13A	 

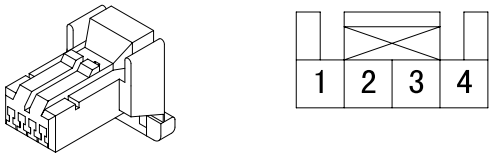
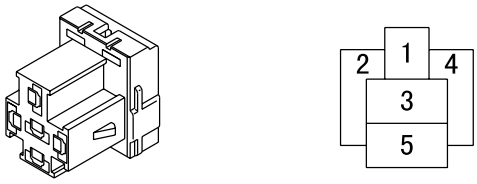
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
DD	DD15A	
	DD15B	
	DD18A	
	DD20A	
	DD22A	
DE	DE 3 A	
	DE 7 A	
DF	DF 3 A	
DG	DG 3 A	
	DG 3 B	

Model (Number shows number of pins)		Connection		
DG	DG 4 A			
	DG 5 A			
	DG 5 B			
	DG 5 C			
	DG 5 D			
	DG 6 A			 
	DG 6 B			
	DG 8 A			 

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
DG	DG 8 B	
DH	DH22A	
DJ	DJ10A	
	DJ10B	
DK	DK 2 A	
	DK 4 A	
DM	DM 3 A	
	DM 4 A	

Model (Number shows number of pins)		Connection
DN	DN 4 A	
DP	DP 5 A	
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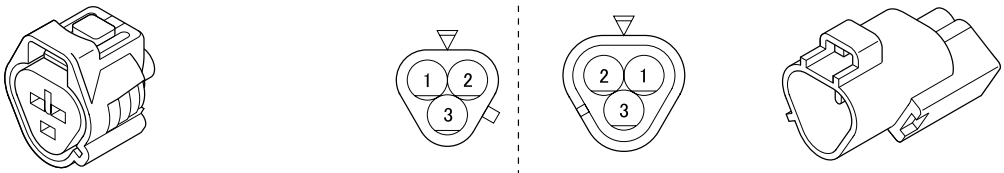
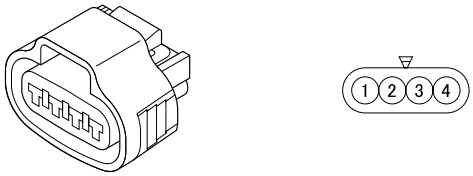
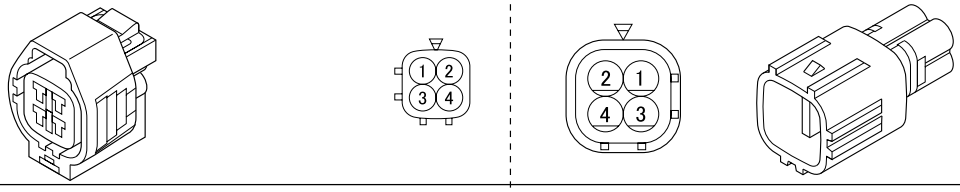
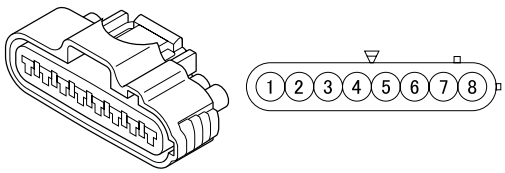
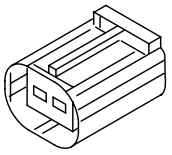
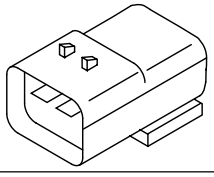
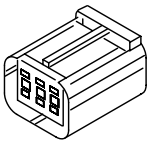
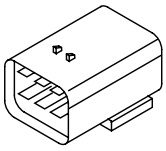
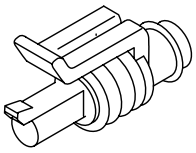
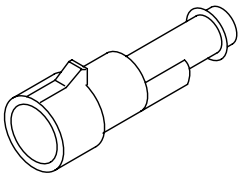
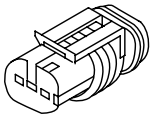
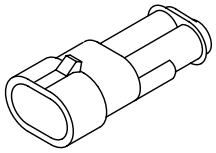
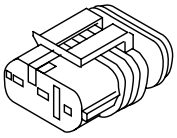
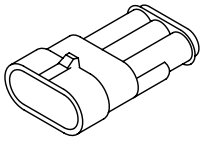
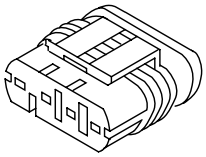
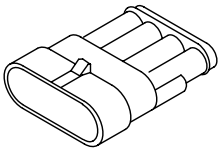
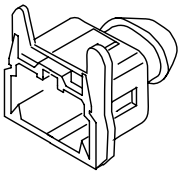
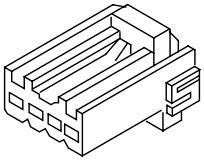
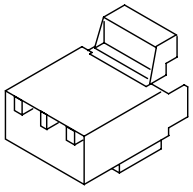
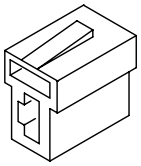
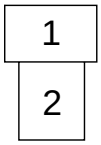
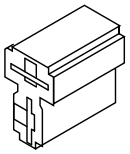
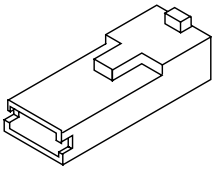
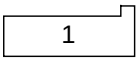
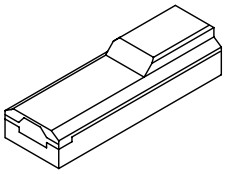
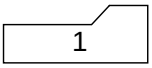
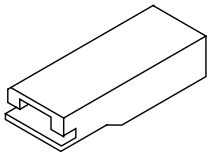
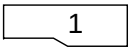
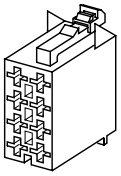
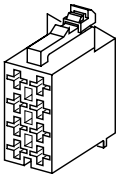
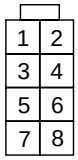
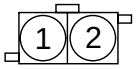
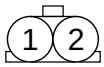
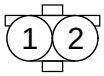
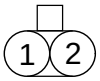
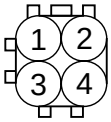
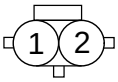
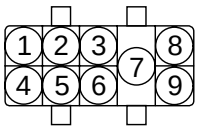
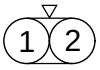
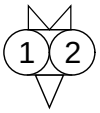
	DQ 2 C	
	DQ 3 A	
	DQ 4 A	
	DQ 4 B	
	DQ 8 A	

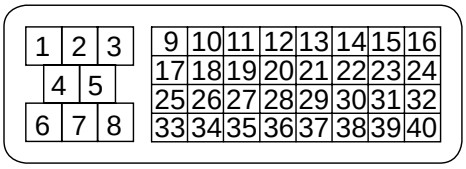
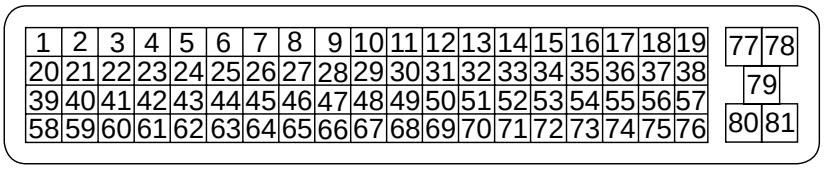
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection	
DS	DS 2 A		
	DS 6 A		
DT	DT 1 A		
	DT 2 A		
	DT 3 A		
	DT 4 A		
DU	DU 2 A		
DV	DV 4 A		

Model (Number shows number of pins)		Connection
DW	DW 2 A	 
DX	DX 2 A	
DY	DY 2 A	 
	DY 2 B	 
DZ	DZ 1 A	 
EA	EA 8 A	
	EA 8 B	
EB	EB 8 A	

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
EC	EC 2 A	
ED	ED 2 A	
EE	EE 2 A	
EF	EF 2 A	
EG	EG 4 A	
EH	EH 2 A	
EJ	EJ 9 A	
EK	EK 2 A	
EL	EL 2 A	

Model (Number shows number of pins)		Connection
EM	EM40A	
	EM81A	

MITSUBISHI
FUSO

Group 01
Maintenance Schedule

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-01

INDEX

HOW TO READ THE MAINTENANCE SCHEDULE TABLES 01- 2

MAINTENANCE SCHEDULE TABLES 01- 3

MAINTENANCE OPERATIONS

- Replacement of Oil Filter 01- 8
- Replacement of Fuel Filter 01- 10
- Draining of Water Separator Condensation 01- 12
- Cleaning of Fuel Feed Pump Gauze Filter < 6D3 > 01- 12
- Bleeding of Air from Fuel Line 01- 13
- Adjustment of V-Ribbed Belt Tension < 4M5 > 01- 14
- Adjustment of V-Belt Tension < 6D3 > 01- 16
- Cleaning and Replacement of Air Cleaner Element 01- 18
- Inspection of Clutch Pedal Free Play 01- 19
- Tire 01- 19
- Inspection of Brake Pedal Free Play 01- 25
- Inspection of Clearance between Brake Pedal and Floor Panel 01- 25
- Inspection of Brake Lining Thickness 01- 26
- Battery 01- 26
- Fuse 01- 29

LUBRICATION TABLES 01- 31

LUBRICATION

- Engine Oil 01- 32
- Clutch Fluid (Brake Fluid) 01- 36
- Manual Transmission Gear Oil 01- 38
- Automatic Transmission Fluid < FH210 > 01- 39
- Automatic Transmission Fluid and Oil Filter < FH211 > 01- 41
- Rear Axle Gear Oil 01- 44
- Power Steering Fluid 01- 45
- Brake Fluid 01- 47
- Greasing Various Areas of Chassis 01- 52

HOW TO READ THE MAINTENANCE SCHEDULE TABLES

Example Table :

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance (1)		Time of inspection and maintenance (2)					Working procedures (3)	Remarks (4)
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Inspection interval: Every 30000 km/18000 miles *1	Inspection interval: Every 60000 km/36000 miles *2		
ENGINE								
1	Air, fuel, oil or coolant leaks from engine			×			Check engine for air, fuel, oil and coolant leaks	Gr 11, 12, 13, 14
2	Ⓔ Ⓝ Engine starting performance, speed, noise and exhaust gas conditions			×			Check for engine starting performance, idling speed, abnormal engine noise, black smoke or other abnormal exhaust gas during idling and acceleration. Check engine speed on tachometer	Gr 11, 13, 15
3	Retightening of inlet and exhaust manifold bolts					×	Check manifold bolts for looseness	Gr 15
4	Ⓔ Valve clearance		×			×	Check valve clearance with feeler	Gr 11
5				Every 20000 km /12000 miles			Replace element	

(1) This column contains the maintenance and inspection items.
(2) The periods between inspection and service are based on the assumption that the vehicle will be driven approximately 60000 kilometers (36000 miles) per year.
Inspections which must be made are indicated by an "×" or by the appropriate period between servicing.
(3) This column provides a simplified explanation of the operational procedures involved for each inspection or maintenance item.
(4) The Gr. No. refers to the "group number" in this vehicle Service Manual. For visual checks and simple inspections, see the sections labelled "Working Procedures".

< 4M5 >

Ⓔ : Exhaust emission items
Ⓝ : Noise control items

	Inspection and maintenance	Time of inspection and maintenance: New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Every 20000 km/12000 miles	Every 30000 km/18000 miles	Every 40000 km/24000 miles	Every 50000 km/30000 miles	Every 90000 km/54000 miles	Every 250000 km/150000 miles	Working procedures	Remarks
ENGINE											
1	Manifold bolts and nuts torque						×			Check inlet and exhaust manifold bolts and nuts for looseness	Gr 15A
2	Ⓔ Check and adjust valve clearance	×					×			Check valve clearance with feeler gauge	Gr 11A
3	Ⓔ Oil filter replacement		Every 10000 km/6000 miles or 12 months							Replace oil filter	P01-8
4	Ⓔ Injection nozzle Ⓝ							×	×	Check and clean injection nozzle	Gr 13A
5	Ⓔ Fuel filter replacement		Every 20000 km/12000 miles or 12 months							Replace fuel filter	P01-10
6	Ⓔ Fuel line		Every 20000 km/12000 miles or 12 months							Inspect fuel tank, cap and lines for damage causing leakage	Gr 13A
7	Ⓔ V-ribbed belts or V-belts tension and Ⓝ damage		Every 10000 km/6000 miles or 12 months							Inspect V-ribbed belt or V-belts for cracks, wear and tension	P01-14
8	Ⓔ Cooling system			×						Check radiator and radiator cap for sealing performance and mounting condition. Inspect hoses for looseness, deterioration, damage causing leakage. Remove dust and foreign deposits from radiator and intercooler front	Gr 14A
9	Coolant replacement		Every 24 months							Replace coolant	Gr 14A
10	Ⓔ Turbocharger rotor play								×	Check turbocharger rotor play	Gr 15A
11	Air cleaner element		Every 5000 km/3000 miles							Clean air cleaner element by blowing clean compressed air	P01-18
12	Ⓔ Air cleaner element Ⓝ replacement					×				Replace air cleaner element	Gr 15A
13	Ⓔ Exhaust system Ⓝ			×						Inspect exhaust system for damage, corrosion and loose connection causing leakage	Gr 15A

MAINTENANCE SCHEDULE TABLES

< 6D3 >

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance		Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Every 30000 km/18000 miles *1	Every 60000 km/36000 miles *2		
ENGINE								
1	Air, fuel, oil or coolant leaks from engine			×			Check engine for air, fuel, oil and coolant leaks	Gr 11B, 12B, 13B, 14B
2	Ⓔ Ⓝ Engine starting performance, speed, noise and exhaust gas conditions			×			Check for engine starting performance, idling speed, abnormal engine noise, black smoke or other abnormal exhaust gas during idling and acceleration. Check engine speed on tachometer	Gr 11B, 13B, 15B
3	Retightening of inlet and exhaust manifold bolts					×	Check manifold bolts for looseness	Gr 15B
4	Ⓔ Valve clearance		×			×	Check valve clearance with feeler gauge	Gr 11B
5	Ⓔ Oil filter replacement			Every 20000 km/12000 miles On new vehicles, replace the first filter at 10000 km/6000 miles			Replace element	P01-8
6	Ⓔ Ⓝ Check injection nozzles			Every 90000 km/54000 miles			Check and clean of injection nozzles	Gr 13B
7	Ⓔ Ⓝ Fuel injection pressure and spray pattern of injection nozzles			Every 250000 km/150000 miles			Remove injection nozzle and check with nozzle tester	Gr 13B
8	Ⓔ Ⓝ Fuel injection timing					×	Turn crankshaft in normal running direction and check injection starting timing of No.1 cylinder	Gr 13B
9	Ⓔ Cleaning fuel feed pump gauze filter					×	Remove connector from fuel feed pump inlet and clean filter inside connector with diesel fuel	P01-12
10	Ⓔ Fuel filter replacement				×		Replace element	P01-10
11	Ⓔ Water separator water discharge	×					Loosen water separator drain plug to discharge water	Gr 13B
12	Ⓔ Draining water and sediment from fuel tank			Every 24 months			Remove fuel tank drain plug and remove water and sediment	P01-12
13	Retightening of fuel tank bracket bolts			×			Check the bolts for looseness and retighten to a torque of 34 to 54 N·m {25 to 40 ft.lbs, 3.5 to 5.5 kgf·m}	Gr 13B
14	Ⓔ Replacing fuel hose in engine compartment			Every 24 months			Replace fuel hose in engine compartment	Gr 13B
15	Ⓔ Check fuel line outside the engine compartment			Every 24 months			Check fuel line outside the engine compartment. Replace if necessary	Gr 13B
16	Ⓔ Ⓝ V-belt tension and damage	×		×			Press midpoint of V-belt firmly with your finger to measure deflection and check for belt damage	P01-16
17	Coolant level and leaks from cooling system	×					Check coolant level and if level is low, check for coolant leaks	Gr 14B
18	Coolant replacement			Every 24 months			Replace with new coolant	Gr 14B
19	Surge tank cap condition			×			Check surge tank cap for sealing and mounting condition	Gr 14B
20	Ⓔ Cooling system hose clamp position and clamping condition			×			Check clamp position and clamping condition of cooling system hose	Gr 14B
21	Ⓔ Turbocharger rotor play			Every 250000 km/150000 miles			Check rotor for excessive end play by using a dial indicator	Gr 15B
22	Ⓔ Ⓝ Cleaning the air cleaner element	×		×			Check air cleaner dust indicator. If red signal appears, clean the element	P01-18
23	Ⓔ Ⓝ Air cleaner element replacement			Every 50000 km/30000 miles			Replace element	P01-18
24	Ⓔ Ⓝ Damage of air intake system, looseness of clamp and loss of parts			×			Check air intake system for damage and inspect all parts for installation	Gr 15B
25	Ⓝ Looseness and damage of exhaust pipe and muffler			×			Check installation and connection to ensure that there are no damage and exhaust gas leaks	Gr 15B
26	Starter function					×	Operate starter switch and check the switch for proper function	Gr 54
27	Alternator function					×	Check for function with a circuit tester	Gr 54

< Chassis >

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance		Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Inspection interval: Every 30000 km/18000 miles *1	Inspection interval: Every 60000 km/36000 miles *2		
POWER TRAIN								
28	Oil leaks from power train			×			Check power train for oil leaks	
29	Clutch pedal play			×			Press clutch lightly and check that its play is adequate	🕮 P01-19
30	Clutch function			×			(1) Press the clutch pedal to check for unusual noise or stiffness. Also check if gear engages quietly (2) Check that clutch does not slip and engages smoothly	🗀 Gr 21
31	Manual transmission gearshift control looseness				×		In NEUTRAL position, check gearshift lever for looseness. With gearshift lever in each gear position, check all gears engage smoothly without excessive looseness. Also check that control rod is not bent or damaged	🗀 Gr 22
32	Automatic transmission range selector linkage and throttle (modulator) linkage condition				×		Shifting to each position must be correct and secure	🗀 Gr 23B
33	Propeller shaft couplings and bearings looseness		×	×			(1) Check flange yoke bolts and center bearing bolts for looseness (2) Turn propeller shaft manually to check for loose spline coupling (3) Check for looseness between spider and needle roller bearing	🗀 Gr 25
			On new vehicle inspection at 4000 km/2500 miles, check only the looseness of blots					
FRONT AND REAR AXLES								
34	Axle shaft torsion and cracks					×	Remove axle shaft and check for torsion, bend, and cracks	🗀 Gr 27
35	Front wheel hub bearing looseness				×		With front axle jacked up, move the wheel up and down by holding tire's top and bottom to check for bearing looseness	🗀 Gr 26
36	Rear wheel hub bearing damage					×	Disassemble rear wheel and check for hub bearing wear and damage	🗀 Gr 27
37	Retightening wheel nuts		×	×			Check wheel nuts for looseness after replacing tires, also after 1000 km/600 miles	🕮 P01-19
38	Disc wheel damage			×			Check disc wheel for corrosion, deformation and cracks	🗀 Gr 31
39	Tire inflation pressure, cracking, tread groove depth, abnormal wear, etc.	×		×			(1) Measure inflation pressure with tire gauge, and check that tire tread groove is deep enough (2) Check tire tread and side walls for cracks, damage, uneven wear, stepped wear and other abnormal wear	🕮 P01-19
40	Tire rotation			×			Rotate all tires	🕮 P01-19
SUSPENSION SYSTEM								
41	Looseness, play and damage of suspension system				×		Check suspension system for looseness, play and damage	🗀 Gr 33, 34
42	Damage and looseness of leaf springs	×			×		Check leaf springs for damage and looseness	🗀 Gr 33, 34
43	Retightening U-bolts		×		×		Check U-bolts for looseness	🗀 Gr 33, 34
44	Oil leaks and damage of shock absorbers				×		Check for oil leaks and damage of cylinder, etc.	🗀 Gr 33, 34
BRAKING SYSTEM								
45	Fluid leaks from braking system and power steering system			×			Check braking system and power steering system for fluid leaks	🗀 Gr 35A, 37
46	Looseness, play and damage of braking system parts			×			Check braking system parts for looseness, play and damage	🗀 Gr 35A
47	Brake pedal play and stroke	×		×			Depress the brake pedal lightly and check that play is not as specified. While the engine is idling, fully depress the brake pedal and check the distance between pedal and floor	🕮 P01-25
48	Brake booster (hydraulic booster) emergency pump	×					With the engine stopped, depress the brake pedal and check the operating sound of the emergency pump	🗀 Gr 35A

MAINTENANCE SCHEDULE TABLES

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

	Inspection and maintenance	Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Every 30000 km/18000 miles *1	Every 60000 km/36000 miles *2		
49	Service brake effectiveness	×		×			While driving the vehicle at low speed, check braking effect and check for uneven braking	Gr 35A
50	Operation of exhaust brake	×		×			Check exhaust brake operation	Gr 35A
51	Exhaust brake vacuum chamber diaphragm replacement			Every 12 months			Check exhaust brake vacuum chamber diaphragm; replace if necessary	Gr 35A
52	Brake shoe clearance				×		Measure clearance with feeler gauge	Gr 35A
53	Brake lining wear				×		Check lining wear	P01-26
54	Brake drum wear					×	Disassemble and check drum for wear, cracks and damage	Gr 35A
55	Parking brake effectiveness			×			On a slope, check that vehicle can be held stationary	Gr 36A, B
56	Parking brake lever stroke	×		×			With lever fully pulled, check that lever is locked completely and that there is allowance in pulling stroke	Gr 36A, B
57	Parking brake drum and lining wear					×	Disassemble and check drum for wear, cracks and damage and check lining for wear	Gr 36A, B
58	Wheel cylinder piston cup and dust seal replacement			Every 12 months			Check wheel cylinder piston cup and dust seal; replace if necessary	Gr 35A
59	Brake hose replacement			Every 12 months			Check brake hose; replace if necessary	Gr 35A
60	Brake fluid reservoir tank tube replacement			Every 24 months			Check and replace brake fluid reservoir tank tube	Gr 35A
STEERING SYSTEM								
61	Fluid leaks from steering system			×			Check steering system for fluid leaks	Gr 37
62	Steering wheel play	×		×			Turn steering wheel right and left to measure play at steering wheel rim. Measure while engine is running	Gr 37
63	Steering operating condition	×		×			Check steering wheel to see if it vibrates, pulls to one side or requires unusual steering effort	Gr 37
64	Looseness and play of steering system (including hoses and pipes)			×			(1) Check steering system for looseness and play (2) Check power steering hoses and pipes for looseness	Gr 37
65	Wheel alignment					×	Measure toe-in, camber, caster and kingpin inclination angles	Gr 26
66	Right and left turning angles and power steering function					×	Check that stopper bolt is sufficiently tight, without damage, and that steering linkage operates smoothly until blocked by stopper bolt. Also check that steering wheel does not make contact with other parts	Gr 26
67	Power steering booster and oil pump internal rubber parts replacement			Every 48 months			Replace internal rubber parts	Gr 37
68	Power steering hose replacement			Every 48 months			Replace power steering hose	Gr 37
CAB AND FRAME								
69	Looseness and damage of chassis and body			×			(1) Check frame, cross members and other parts for loose rivets (2) Also check for body damage and loose mounting bolts	Gr 41, 42
70	Heater and defroster operation			×			Check operation and installation of defroster	Gr 55
71	Reflection of rearview mirrors and reflectors	×					Check for reflecting condition, stains and damage	Gr 42
72	Door lock function			×			Check door lock mechanism functions properly	Gr 42
73	Seat belt mounting condition			×			Check seat belt for damage, buckle and retracting function and mounting condition	Gr 42
ELECTRICAL SYSTEM								
74	Looseness and damage of electrical wiring and connections			×			Check wiring, connectors and battery terminals for looseness and corrosion	Gr 54

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance		Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Inspection interval: Every 30000 km/18000 miles *1	Inspection interval: Every 60000 km/36000 miles *2		
75	Battery electrolyte level and specific gravity			Every 20000 km/12000 miles			(1) Check electrolyte level (2) Measure electrolyte specific gravity with hydrometer	🕮 P01-26
76	Operation and damage of lighting system	×		×			Check operation, damage and installation of each lighting unit	Gr 54
77	Operation of horn and turn signal lamps	×		×			Check operation, damage and mounting condition. Also check turn signal lamps are operated by turn signal switch	Gr 54
78	Operation and fluid level of windshield wiper and washer	×		×			Check operation, damage and mounting condition. Check if fluid level in washer tank is okay	Gr 42
79	Gauges and pilot lamps function	×		×			Check function of gauges and pilot lamps	Gr 54
80	Switch function					×	Check operation, damage and installation of each switch	Gr 54
OTHER								
81	Road test of vehicle			×			Drive the vehicle to check for overall vehicle operating condition	

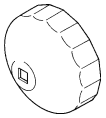
Replacement of Oil Filter
< 4M5 >

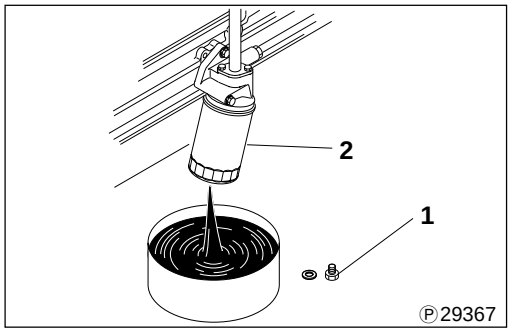
Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Oil filter	Engine oil (API CD or higher)	Approximately 1 L {1.1 qts}

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
2	Oil Filter Element Socket  08550	OBTAIN LOCALLY	Oil filter removal
	Oil Filter Wrench ø107 to 120 {ø4.21 to 4.72} 01503	OBTAIN LOCALLY	



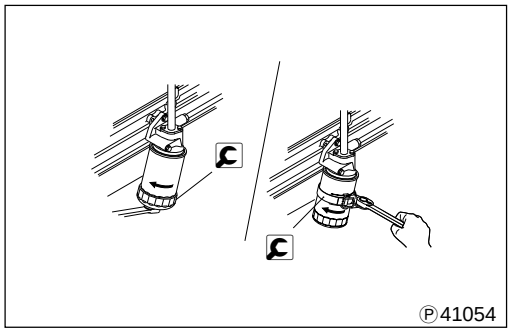
Ⓟ29367

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

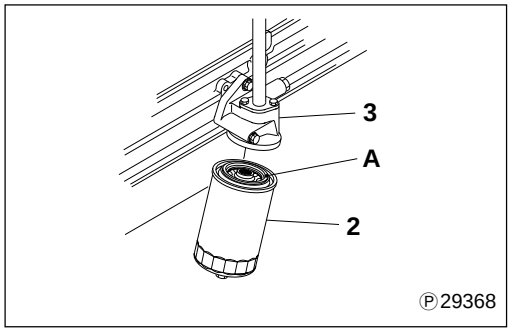
CAUTION ⚠

When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.


Ⓟ41054

Loosen oil filter drain plug **1** to drain the engine oil from inside the filter **2**.
[Removal]

: Oil Filter Element Socket or Filter Wrench



Ⓟ29368

[Installation]

- Clean the surface of oil filter head **3** to which oil filter **2** is fitted.
- Apply a thin coat of engine oil to the gasket **A** of oil filter **2**.
- Screw oil filter **2** into oil filter head **3** by hand until gasket **A** contacts the oil filter head. Then, tighten oil filter **2** further by giving it a 3/4 turn.
- After installing the oil filter, start the engine and check gasket **A** for oil leakage.
- Check to see if the engine oil level is in the specified range.

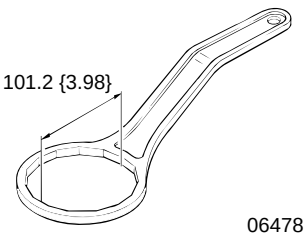
< 6D3 >

Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Inside oil filter	Engine oil	Approximately 1 L {1.1 qts}
	Gasket area of oil filter with thin application	Engine oil	As required

Special tools

Unit : mm {in.}

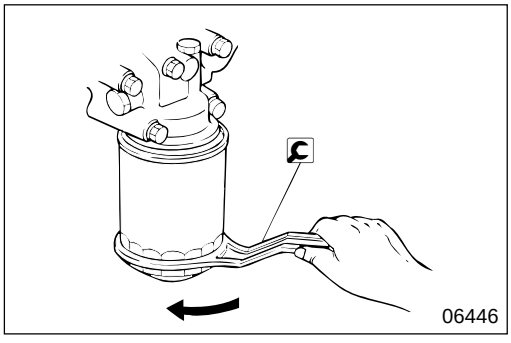
Location	Tool name and shape	Part No.	Application
2	Oil filter wrench  06478	MH061587	Removal of oil filter

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**

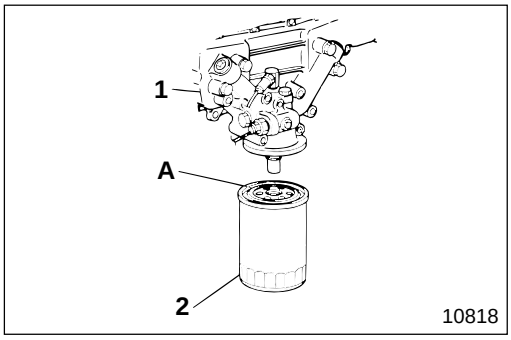
CAUTION

Take care not to spill engine oil on the V-belts, because this would cause them to slip, reducing service life.



[Removal]

: Oil filter wrench

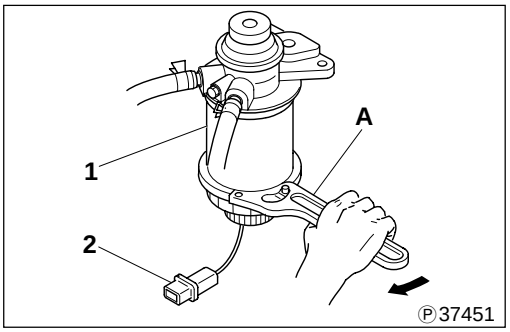


[Installation]

- Clean the surface of oil cooler body **1** that makes contact with oil filter **2**.
- Apply engine oil thinly and evenly to gasket area **A** of oil filter **2**.
- Screw oil filter **2** into oil cooler body **1** until gasket area **A** sits on the body. From this position, tighten further by rotating by three quarters of a turn.
- After installation, run the engine and check that there is no oil leakage from gasket area **A**.
- Check the oil level and if it is low, top it up.

Replacement of Fuel Filter
< 4M5 >
Lubricant

Location	Parts to be tightened	Specified lubricant	Quantity
3	Gasket for fuel filter cartridge	Engine oil	As required



[Removal]

A: Filter Wrench
(Commercially available one: For filter diameter of approx. 90 mm {3.54 in.})

WARNING
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To minimize the risk of fire, wipe up any spilled fuel.**

CAUTION
- **The water level sensor 2 may be reused if it properly functions.**

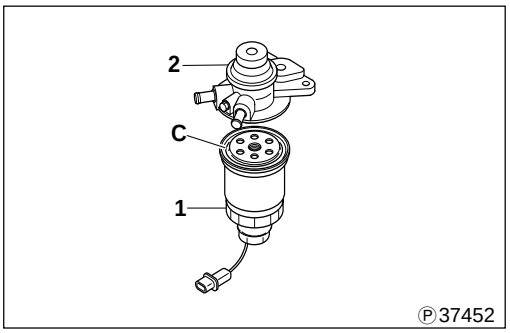
[Installation]

WARNING

Use of an unsuitable fuel filter cartridge 1 can lead to fuel leaks and fires. Be sure to use a genuine filter.

CAUTION

To prevent injection failures, keep dust and dirt out of the fuel filter cartridge 1 and the fuel pipe.



- To fit the fuel filter cartridge **1**, turn it until the gasket **C** touches seal surface of the fuel filter head **2**. Be sure to turn the filter by hand clockwise.
  Then, tighten the filter by 3/4 turn.
- After fitting the filter, start the engine and check that no fuel leakage occurs.
- Bleed all air out of the fuel system. P01-13

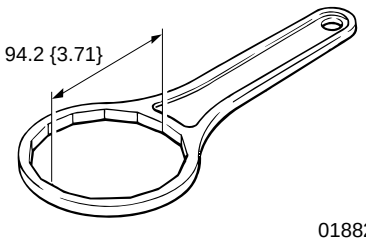
< 6D3 >

Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Gasket contact surfaces of fuel filter and fuel filter head	Engine oil	As required

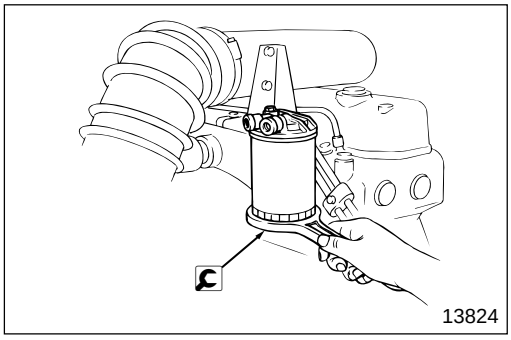
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Filter wrench  01882	MH061572	Removal of fuel filter

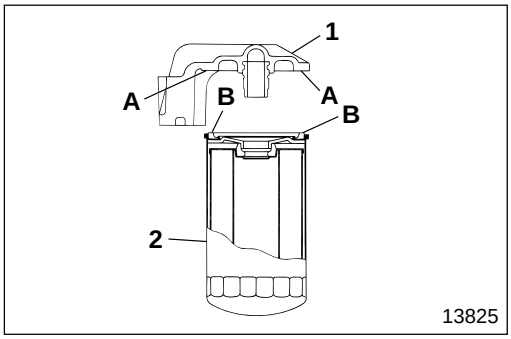
WARNING

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any diesel fuel that has been spilled because it can cause a fire.**
- **Do not use an unsuitable filter because it can cause a fire.**


13824

[Removal]

: Filter wrench



13825

[Installation]

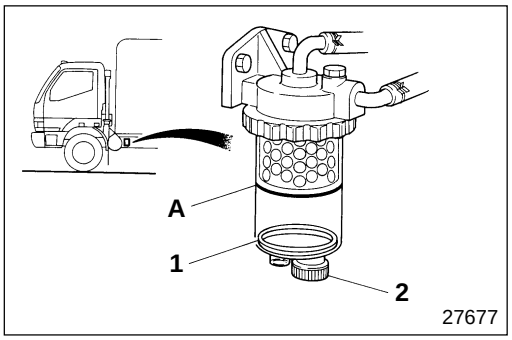
- Install by tightening three quarters to one full turn after contact surface **A** of fuel filter head **1** makes contact with gasket **B** of fuel filter **2**. Be sure to tighten by hand.
- After installation, run the engine and check for fuel leakage.

Draining of Water Separator Condensation

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Drain plug	3 to 4 {2.2 to 2.9, 0.3 to 0.4}	—



Visually inspect the water separator before driving.
When float **1** reaches red line **A**, drain the condensation as follows:

- Loosen drain plug **2** and drain out the condensation.
- When float **1** has dropped to the bottom, tighten drain plug **2**.
- Carefully wipe the water separator and the surrounding area.
- Check for fuel leakage.

Cleaning of Fuel Feed Pump Gauze Filter < 6D3 >

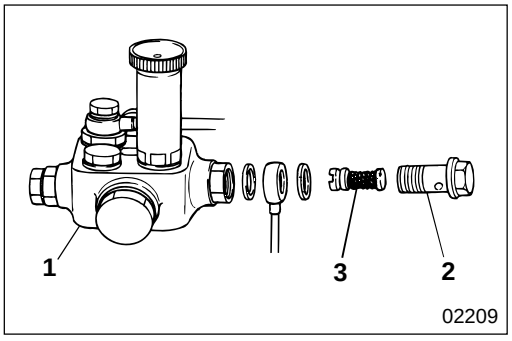
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Eye bolt	25 to 29 {18 to 22, 2.5 to 3}	—

WARNING

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any diesel fuel that has been spilled because it can cause a fire.**



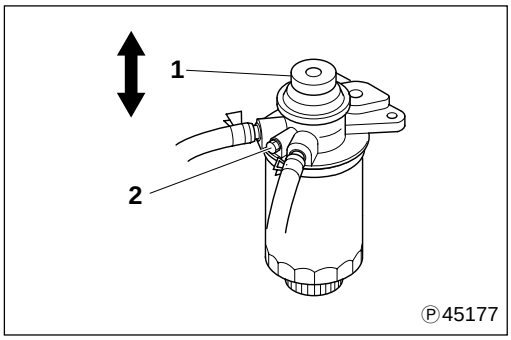
- Remove eye bolt **2** on the inlet side of fuel feed pump **1**.
- Remove gauze filter **3** from eye bolt **2**.
- Clean gauze filter **3** with gas oil.
- Follow the removal sequence in reverse and reinstall gauze filter **3**. Install eye bolt **2** in the fuel feed pump.
- Bleed the air from the fuel line.
- Start the engine and check for fuel leakage.

Bleeding of Air from Fuel Line
< 4M5 >

Tightening torque Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
2	Air vent plug	4M5	6±1 {4.3±0.7, 0.6±0.1}	—

WARNING⚠
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**

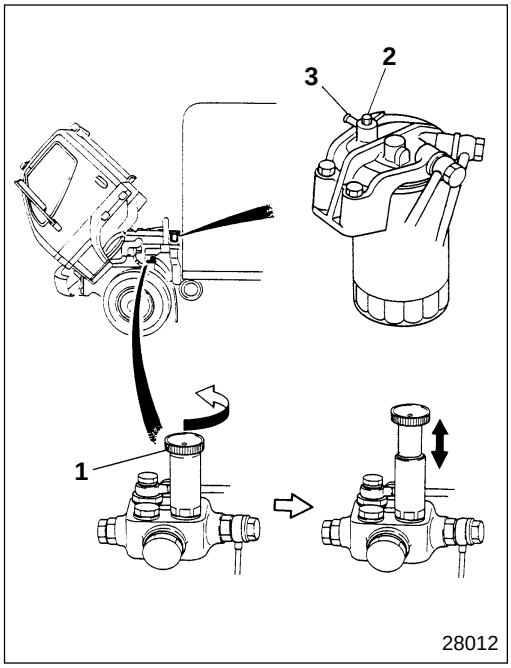


- Loosen the fuel filter air vent plug **2**.
- Operate the priming pump **1** to pump up fuel.
- Continue to pump fuel until no air bubbles are found in the fuel flowing out from the air vent plug **2**.
- After ascertaining that air bubbles have completely disappeared, tighten the air vent plug **2** securely.
- Operate the priming pump **1** further until it feels heavy.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

< 6D3 >

Tightening torque Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Air vent plug	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—



WARNING⚠
- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any diesel fuel that has been spilled because it can cause a fire.**

- Turn the top of priming pump **1** of the injection pump counterclockwise and pull it up so the top protrudes.
- Loosen air vent plug **2** of the fuel filter and move the top part of priming pump **1** up and down.
- Move priming pump **1** up and down repeatedly until air bubbles are no longer present in the fuel drained from air vent cock **3**.
- When the fuel being drained is free of air bubbles, tighten air vent plug **2**.
- After moving priming pump **1** up and down another five or six times, push the top down and turn clockwise tighten.
- After bleeding the air, carefully wipe up spilled fuel and start the engine.
- Check for fuel leakage.

Adjustment of V-Ribbed Belt Tension < 4M5 >

Newly installed V-ribbed belt can stretch during their initial running-in period. To prevent this from becoming a problem, run the engine for several minutes after installing the V-ribbed belt, then readjust. Perform this cycle several times.

WARNING⚠

You must take special precautions to prevent the engine from rotating while a V-ribbed belt or is being inspected or adjusted.

CAUTION⚠

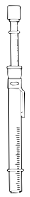
- **Make sure that you turn off the engine before attempting to inspect or adjust the V-ribbed belt.**
- **Make sure that you fasten all bolts and nuts securely after adjusting the V-ribbed belt. Remember that too much tension can damage the V-ribbed belt and bearings.**
- **Do not grease V-ribbed belt. This causes them to slip, which reduce service life.**

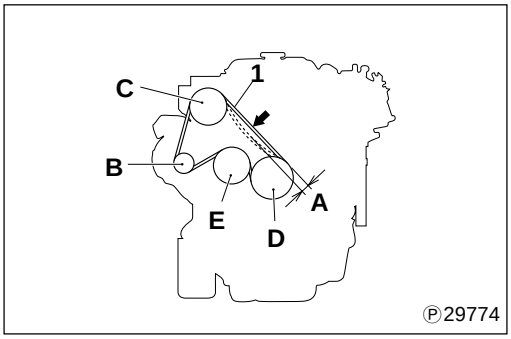
Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1	V-ribbed belt tension	When belt is new	9 to 11 {0.35 to 0.43}	—	Adjust
		When belt in use is re-tensioned	11 to 13 {0.43 to 0.51}	—	

Special tools

Location	Tool name and shape	Part No.	Application
1	Belt tension gauge  03612	MH062345	Measurement of tension of V-ribbed belt



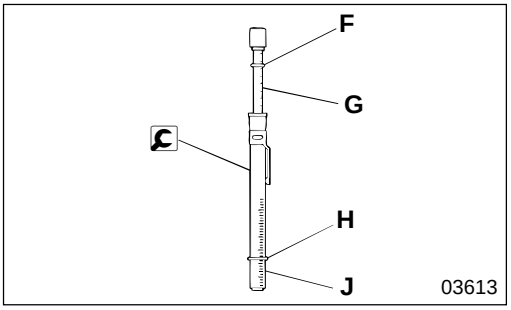
[Inspection]

NOTE

Before checking for tension, crank the engine one turn or more clockwise.

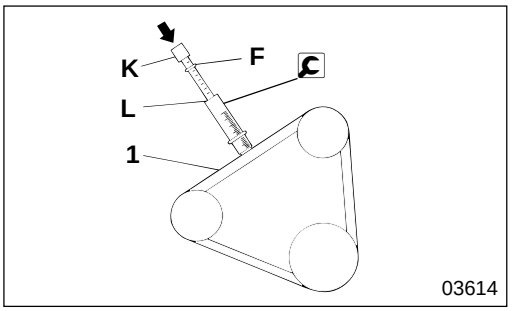
Apply force of approximately 98 N {22 lbf, 10 kgf) to the span center of the V-ribbed belt **1** and measure the extent of belt deflection **A**.

A : Alternator pulley
C : Air-conditioner compressor pulley or tension pulley
D : Fan pulley
E : Water pump pulley

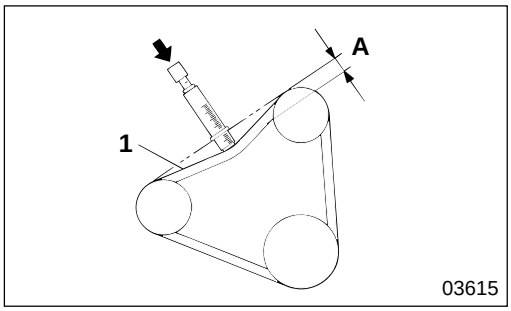


Use of belt tension gauge

- Set the upper O-ring **F** of the Belt Tension Gauge to a push load of 98 N {22 lbf, 10 kgt} on scale **G**.
- Set the lower O-ring **H** of the Belt Tension Gauge to the belt's specified maximum deflection value on scale **J**.



- Apply the Belt Tension Gauge to the center of V-ribbed belt **1** and push **K** until the upper O-ring **F** reaches the flange **L**.

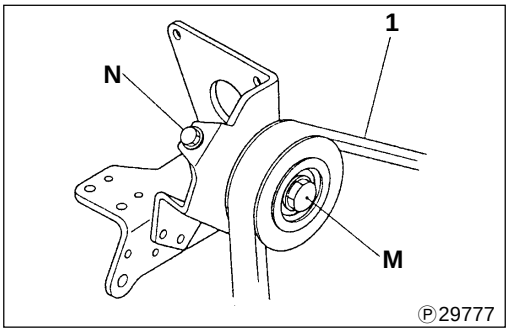


- Measure the deflection **A** of the V-ribbed belt **1**. If the measurement does not comply with the standard value, adjust the tension in accordance with the following procedure.

[Adjustment]

CAUTION ⚠

- **Excessive tension in the V-ribbed belt 1 may damage the belt and related bearings.**
- **Keep the V-ribbed belt 1 free of oil. If the belt becomes oily, it may slip, resulting in overheating of the engine and insufficient charging of the battery.**



- Loosen the tension pully mounting sleeve **M** and adjust the tension of the V-ribbed belt **1** using the adjusting bolt **N**.
- After the adjustment, tighten the sleeve **M** securely.

Adjustment of V-Belt Tension < 6D3 >

Newly installed V-belts can stretch during their initial running-in period. To prevent this from becoming a problem, run the engine for several minutes after installing the V-belt, then readjust. Perform this cycle several times.

WARNING⚠

You must take special precautions to prevent the engine from rotating while a V-belt is being inspected or adjusted.

CAUTION⚠

- **Make sure that you turn off the engine before attempting to inspect or adjust the V-belts.**
- **Make sure that you fasten all bolts and nuts securely after adjusting the V-belts. Remember that too much tension can damage the V-belts and bearings.**
- **Do not grease V-belts. This causes them to slip, which reduce service life.**

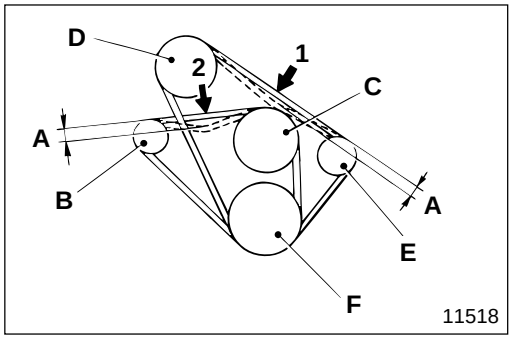
Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1, 2	V-belt tension (Each one)	Fan	12 to 16 {0.47 to 0.63}	—	Adjust
		Air-conditioner	16 to 20 {0.63 to 0.79}		

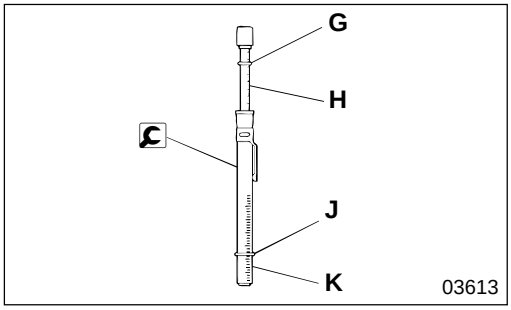
Special tools

Location	Tool name and shape	Part No.	Application
1, 2	Belt tension gauge 03612	MH062345	Measurement of tension of V-belt



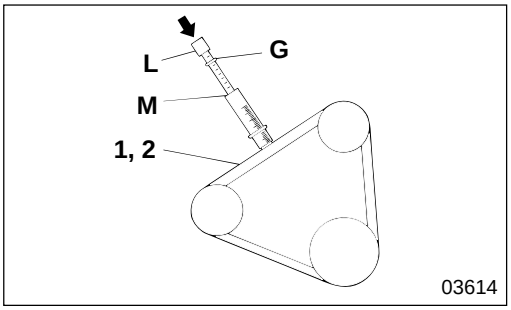
[Inspection]
Measure the extent of flex **A** when the center of V-belts **1**, **2** as illustrated is depressed with a force of 98 N·m {72 ft.lbs, 10 kgf·m}.

B : Alternator pulley
C : Water pump pulley
D : Cooler compressor pulley (Air-conditioner)
E : Tension pulley
F : Crankshaft pulley

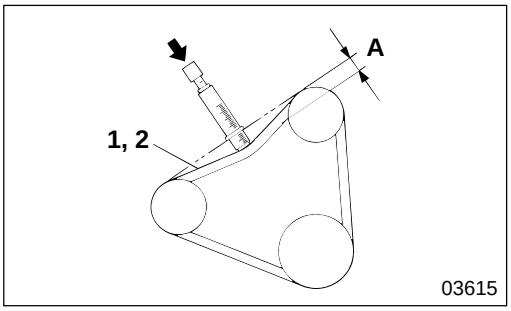


Use of special tool belt tension gauge

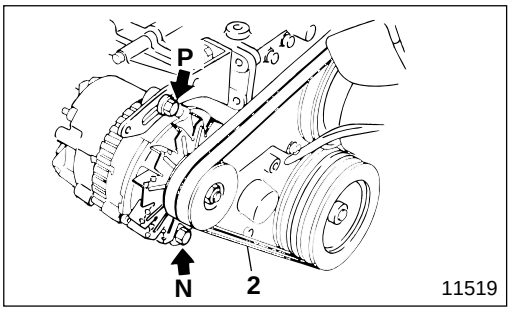
- Set upper O-ring **G** of 🔧 belt tension gauge to 98 N·m {72 ft.lbs, 10 kgf·m} (push load) on graduation **H**.
- Set lower O-ring **J** of 🔧 belt tension gauge to graduation **K** (maximum flex of belt).



- Place 🔧 belt tension gauge at the center of V-belts **1**, **2** perpendicularly as illustrated and push top **L** all the way down until upper O-ring **G** hits upper edge **M**.



- Measure the extent of flex **A** of V-belts **1**, **2** at this point, and if the measured value deviates from the standard value, adjust as follows:



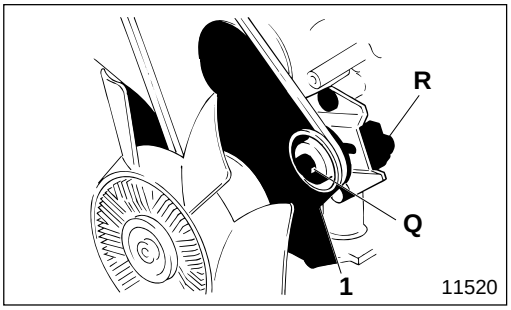
[Adjustment]

(1) Adjustment of tension of V-belt for fan

- Loosen alternator mounting bolts **N** (two points), and adjust the tension of V-belts **2** by moving adjusting bolt **P**.
- After adjustment, tighten the bolts **N**, **P** securely.

CAUTION⚠

- **Bear in mind that excessive tension of V-belts 2 might damage the belts and bearings that engage with the V-belts.**
- **Be sure to replace V-belts 2 as a set to maintain even tension between them.**
- **Be careful not to let oil stick to V-belts 2. If oil gets onto the belts, it causes slipping, resulting in overheating and insufficient battery charging.**



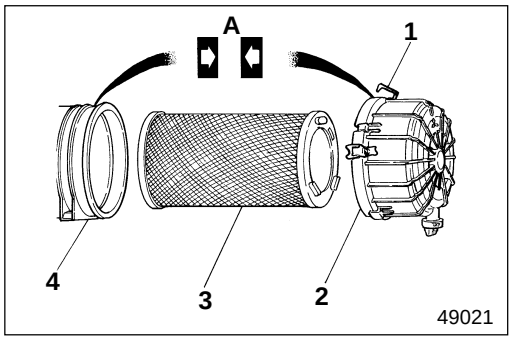
(2) Adjustment of tension of V-belt for air-conditioner

- Loosen tension pulley mounting nut **Q**, and adjust the tension of V-belt **1** moving adjusting bolt **R**.
- After adjustment, tighten mounting nut **Q** securely.

CAUTION⚠

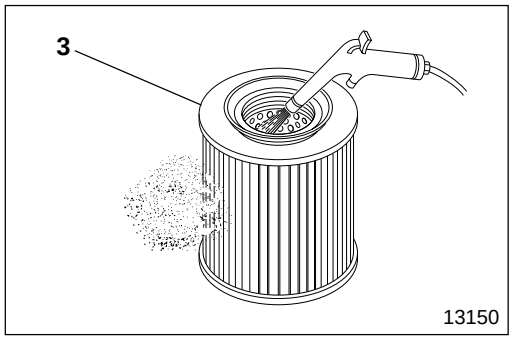
- **Bear in mind that excessive tension of V-belt 1 might damage the belt and bearings that engage with the V-belt.**
- **Be careful not to let oil stick to V-belt 1. If oil gets onto the belt, it causes slipping, resulting in poor performance of the air conditioner.**

Cleaning and Replacement of Air Cleaner Element



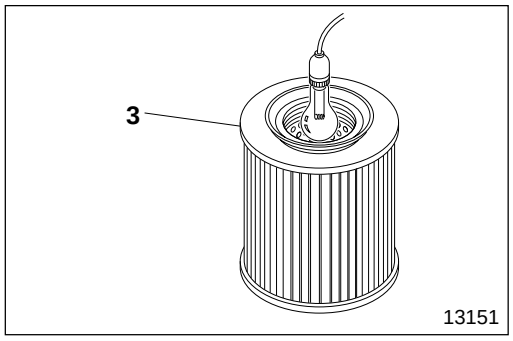
[Removal]
- Remove clamp **1** to remove cover **2**.
- Remove air cleaner element **3**.

[Installation]
Install case **4** and cover **2** by aligning arrows **A**.



[Cleaning]
- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **3** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of air cleaner element **3** evenly.

CAUTION⚠
- **Do not tap or hit air cleaner element 3 to remove dust.**
- **Do not blow compressed air through air cleaner element 3 from the outside.**



[Inspection]
- Illuminate the inside of air cleaner element **3**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of air cleaner element **3** is damaged, replace the air cleaner element.

NOTE

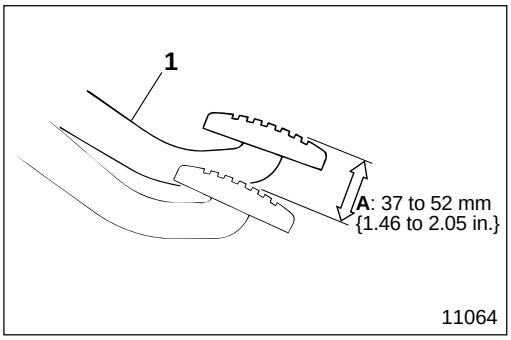
If the dust on air cleaner element 3 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.

Inspection of Clutch Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Clutch pedal free play	37 to 52 {1.46 to 2.05}	—	Adjust or replace



[Confirmation]
Push clutch pedal **1** with your hand and measure the amount of movement **A** (free play) until you meet resistance. If the measured value does not conform to the standard value, adjust by stroke of clutch power cylinder push rod, or replace the clutch disc.

[Clutch operation]
- Check for unusual noises when clutch pedal **1** is pressed while the engine is idling, and also for abnormally heavy clutch operation. Also check to be certain that it is not difficult to shift the vehicle into first and reverse gears.
- Gradually release clutch pedal **1** to set the vehicle in motion.
  Check to be sure there is no slippage, and that the clutch engages smoothly.

Tire

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Depth of tire tread grooves	—	1.6 {0.063}	Replace

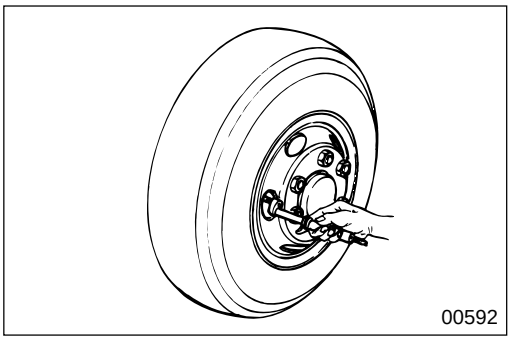
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Wheel nut	370 to 410 {275 to 305, 38 to 42}	Wet

Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Wheel nut spherical area	Chassis grease [NLGI No.1 (Ca soap)] or Wheel bearing grease [NLGI No.1 (Li soap)]	As required
4	Wheel nut (inner) at thread area and spherical area		
6	Thread area of hub bolt		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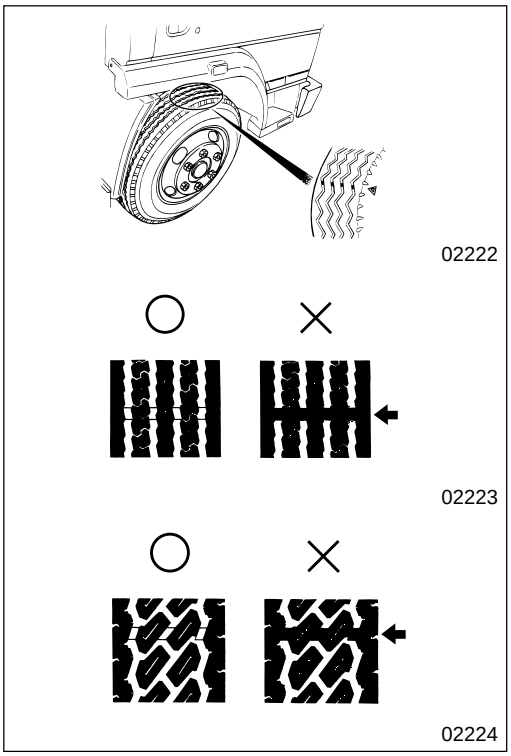
Air pressure

Tire air pressure should be checked before the vehicle is driven, while the tires are still cool.

Tire Size	Air Pressure kPa {psi, kgf/cm^2}
215/75R 17.5 124/123L	700 {100, 7.00}

CAUTION

- **Make certain that there is no difference in the air pressure between the inner and outer rear tires.**
- **Make certain you use valve caps on the air valves.**
- **It is not necessary to increase the air pressure for high-speed driving.**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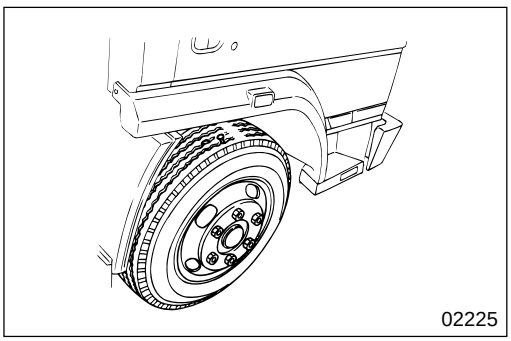
Checking tread depth

- Check all around the tire treads to make sure that the depth of the tread grooves is above the wear limit.
- If the tread grooves are not deep enough, slip sign **A** appears at the position of the ⚠ mark, where the tread groove has worn away.

WARNING

If the depth of the tread grooves is not adequate, the tires will slip on wet roads and present a hazard. Such tires are also extremely dangerous because they are more susceptible to hydroplaning when the vehicle is running at high speeds in the rain. Such tires must be replaced with new ones as soon as possible.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Checking for cracks, damage, and objects embedded in the treads

- Check the tire treads and walls for cracks and damage.
- Check tire treads for uneven wear or other abnormal wear.
- Check if metal objects or nails have penetrated the tires.
- Check for stones embedded between double tires.

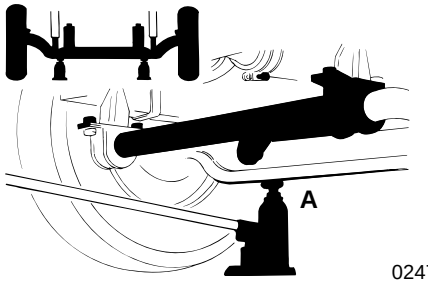
WARNING

Badly damaged or worn tires are extremely dangerous, because they can be punctured more easily when the vehicle is running, they must be replaced with new ones as soon as possible.

Removing tires

- Jacking up point
  - For front wheels : Front axle bottom **A**
  - For rear wheels : Rear axle tube bottom **B**

< Front wheel >



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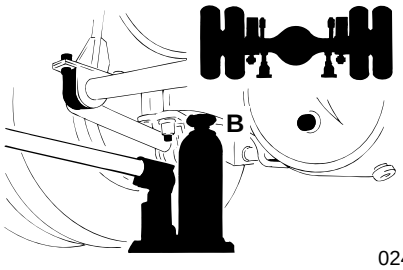
< Rear wheel >



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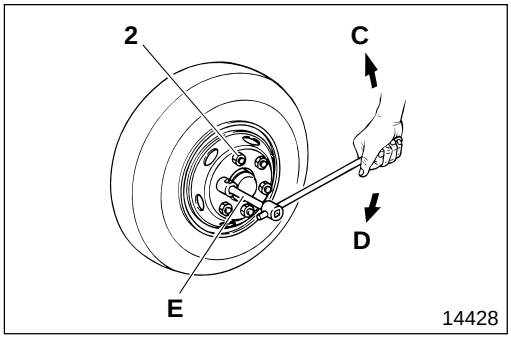
WARNING

- **The jack should be placed on flat, solid ground, and should not be used to raise the vehicle higher than necessary.**
- **Do not use the jack at vehicle locations other than those illustrated.**
- **Keep in mind the danger of a slipping jack. Never crawl under the vehicle while the jack is in use or rock the vehicle. Also, do not start the engine while the vehicle is jacked up.**
- **To increase safety, use supports for the vehicle when it is necessary to leave it jacked up for long periods.**
- **Chock both the tire to be removed and the tire diagonally opposite to it so that they will not rotate when you are removing the tire.**



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- Loosen wheel nuts **2** slightly. The wheel nuts for right tires **C** have right-hand threads "**R**", and the wheel nuts for left tires **D** have left-hand threads "**L**".

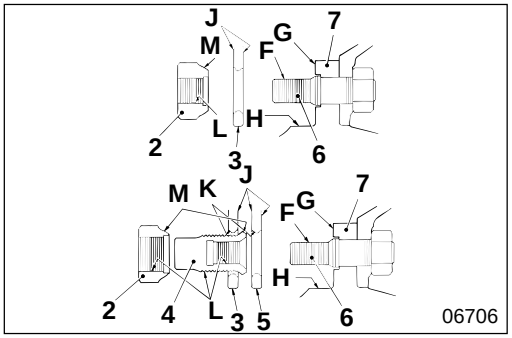
WARNING

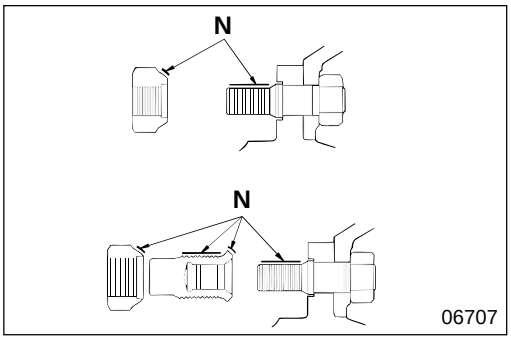
Make certain that wheel nut wrench E is fully engaged, all the way to the back of nuts 2. If it is not, it could slip.

CAUTION

Only loosen wheel nuts 2 slightly. Do not remove them.

- Jack up the vehicle carefully, until the tire is slightly off the ground. Remove wheel nuts **2**, then remove the tire.
- When working on the double tires at the rear of the vehicle, first remove the outside tire, then lower the vehicle and loosen the nuts on the inside tire. After doing this, jack the vehicle back up and remove the tire.



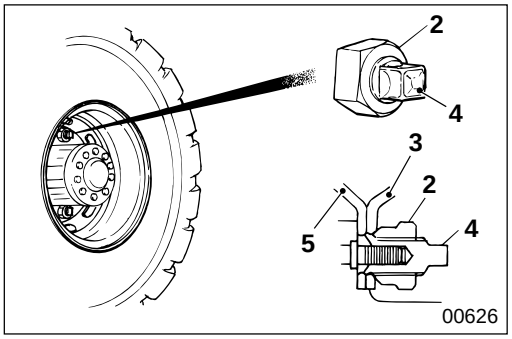


Mounting tires

- To prevent wheel nuts **2**, **4** and hub bolt **6** from becoming loose and to prevent mounting parts (tire assemblies **3**, **5** and hub **7**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:
  F : Hub bolt thread area
  G : Wheel mounting surface of hub
  H : Wheel alignment area of hub
  J : Disc wheel mating surface
  K : Disc wheel nut mounting surface
  L : Wheel nut thread area
  M : Wheel nut spherical area
  N : Grease application area

WARNING⚠

Never use grease containing molybdenum disulfide, since it can cause loosening of fitted screws.



- Put on the double rear tires as follows:
  - After mounting inner tire **5** and fully tightening inner wheel nuts **4**, jack the vehicle up and mount on outer tire **3**, then tighten outer wheel nuts **2**.
  - Even if only outside tire **3** is to be changed, do not mount it until inner wheel nuts **4** have been fastened at the specified torque.
  - Slide the air valves on the inside and outside tires down when mounting the tires.

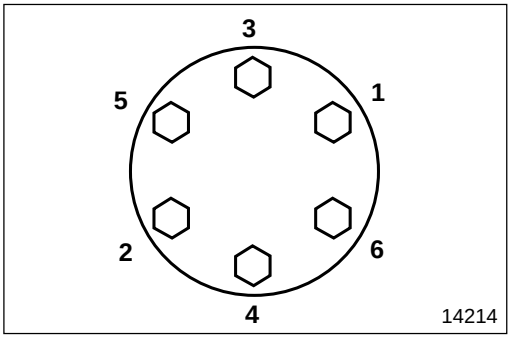
WARNING⚠

If the threads are scored, or the disc wheel is deformed or cracked, change bolts 6, nuts 2, 4 and disc. Driving the truck before correcting such problems can cause the tire in question to come loose, which could be the source of major accidents.

CAUTION⚠

Check hub bolt 6 threads carefully for scratches before putting the tire on.

- Place the tapered end of wheel nuts **2, 4** towards the disc wheel and fasten temporarily. Center so that there is no eccentricity between bolts **6** and the disc wheel bolt holes.
- Lower the vehicle.



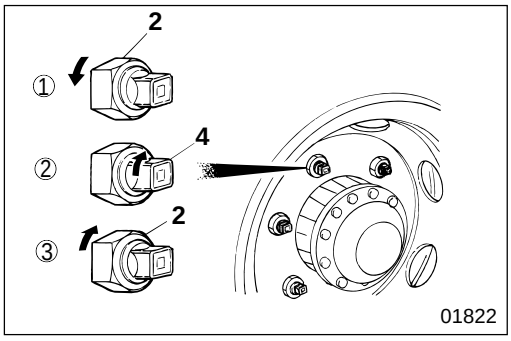
- Tighten the nuts in the order as illustrated, tightening each nut two or three times. To finish, tighten each nut at the specified torque.

WARNING

Always use the specified torque when tightening the wheel nuts. If the wheel nuts are not tightened properly, the wheels could come loose while the vehicle is being driven, which could result in life threatening accidents or the truck being disabled.

CAUTION

Over-tightening the wheel nuts can damage them.



Checking the wheel nuts for looseness

The wheel nuts should be checked for looseness every 10000 km (6000 miles). All nuts should be tightened at the specified torque.

- Check the double rear tires for looseness as follows:

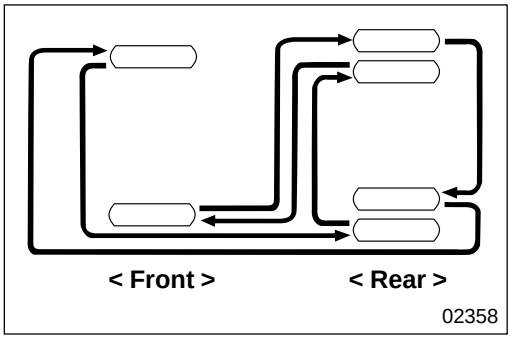
① Loosen outer wheel nuts **2**.
② Tighten inner wheel nuts **4** at specified torque.
③ Tighten outer wheel nuts **2** at specified torque.

CAUTION

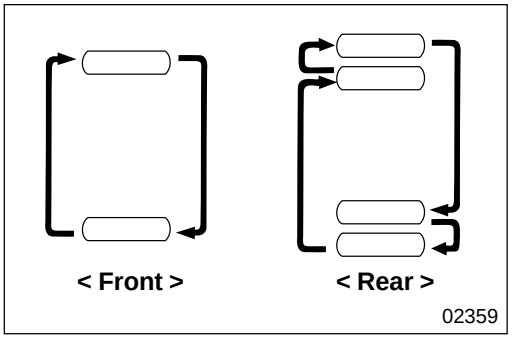
If outer wheel nuts 2 are tightened without first being loosened, it might not be possible to tighten them at the specified torque.

Tire rotation

Tires wear differently, according to the location where they are mounted. To make this wear uniform and prolong the life of your tires, they should be rotated every 10000 km (6000 miles) in the rotation order shown below:



- When the tread patterns for all tires are identical:



- When the tread patterns are different for the front and rear tires:

CAUTION⚠

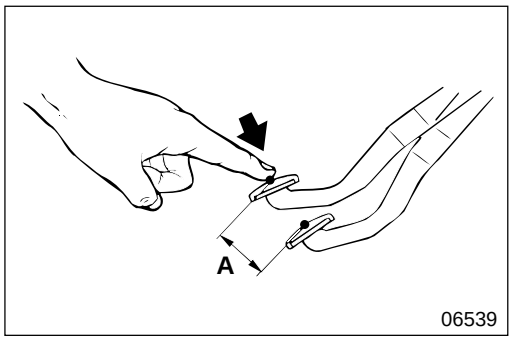
- **Always adjust air pressure after running-in new tires.**
- **When using tires of different tread patterns, use rib-type patterns for the front tires and traction type patterns for the rear tires.**
- **Avoid using both radial and biased tires on the same vehicle.**

Inspection of Brake Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Free play of brake pedal	10 to 15 {0.39 to 0.59}	—	Adjust



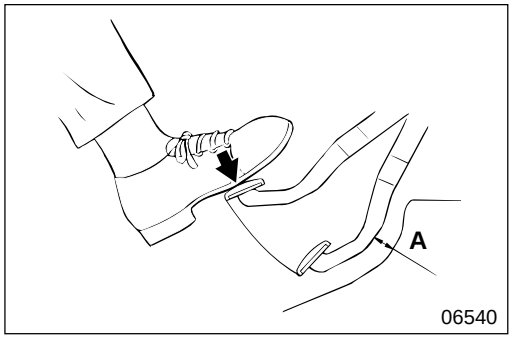
[Inspection]
Check if brake pedal free play **A** confirms to the standard valve with starter switch OFF. If the measured value deviates from the standard value, adjust the position of the brake pedal.

Inspection of Clearance between Brake Pedal and Floor Panel

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Clearance between brake pedal and floor panel (with pedal depressed at 490 N {110 lbf, 50 kgf}	34 {1.34} or more	—	Adjust



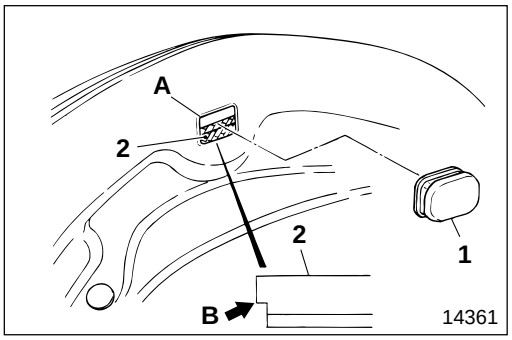
[Inspection]
Depress the brake pedal using 490 N {110 lbf, 50 kgf} when the engine is idling to check if clearance **A** between the brake pedal and the floor panel conforms to the standard value. If the measured value deviates from the standard value, adjust the position of the brake pedal.

Inspection of Brake Lining Thickness

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Thickness of brake lining	—	5 {0.20} (Wear limit at side step)	Replace



NOTE

Be sure to inspect at two points for each wheel per side.

- Remove check hole plug **1** from the packing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall check hole plug **1**.

Battery

DANGER⚠

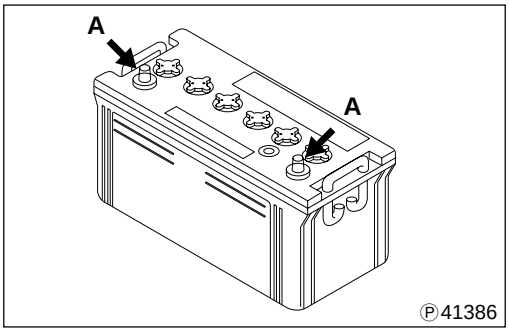
- **Since flammable hydrogen gas is generated by the battery, be sure to obey the following warnings :**
  - **Do not short-circuit the ⊕ and ⊖ terminals on the battery.**
  - **Keep sparks and lit cigarettes away from the battery.**
  - **Do not wear metal objects on your arms and lean over the battery.**
- **Because the battery electrolyte is diluted sulfuric acid and is corrosive, when handling the battery wear safety glasses and rubber gloves to protect the eyes and hands.**
- **Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.**

WARNING⚠

To prevent a short-circuit be sure that disconnected the battery cables do not accidentally touch the battery terminals.

CAUTION⚠

- **Make sure that you disconnect the battery cable ⊖ first when you disconnect the battery cables.**
- **Make sure that all electrical switches of the vehicle are OFF before connecting the battery cables.**
- **Make sure that you connect the battery cable ⊕ before you connect the battery cable ⊖.**

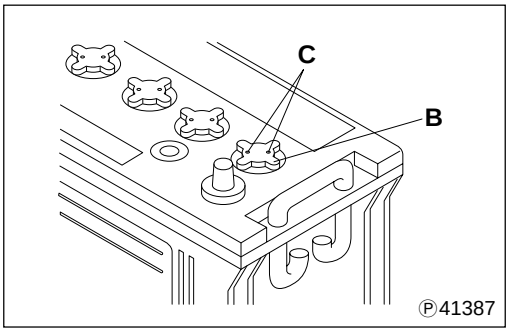


Visual inspection

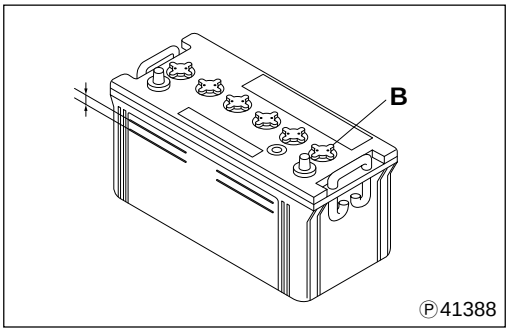
- If terminal **A** is corroded, scrub the corrosion off of it using a wire brush.
- If cracks or defects are found on the battery, replace it since the cracks or defects can cause liquid spills.

CAUTION⚠

Make sure you grease the ⊕ side of terminal A because it is easily corroded.

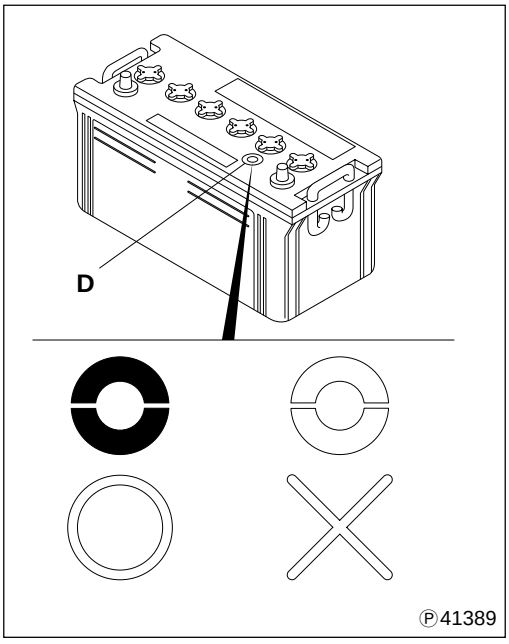


- If bleed hole **C** of vent plug **B** is clogged, clean the hole.



Inspection of fluid level

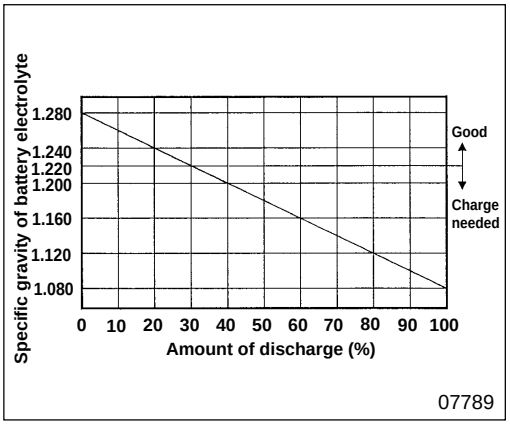
- Make sure that the battery electrolyte level is between the UPPER and LOWER level lines.
- If the level is below the LOWER level line, remove vent plug **B** and fill the battery with distilled water or battery replenisher to the UPPER level.



Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator **D**.

Blue : Good
White : Charge or replace



Charging

- Although, as a rule, charging of the battery should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect the battery cable ⊕.
- Remove vent plug **B** before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	$\frac{\text{Value of 5-hour rating capacity}}{10}$	$\frac{\text{* Amount of discharge (Ah)}}{\text{charge current (A)}} \times 1.2$ (to 1.5)	45 {113}
Quick charge	$\frac{\text{Value of 5-hour rating capacity}}{1.5}$	0.5	55 {131}

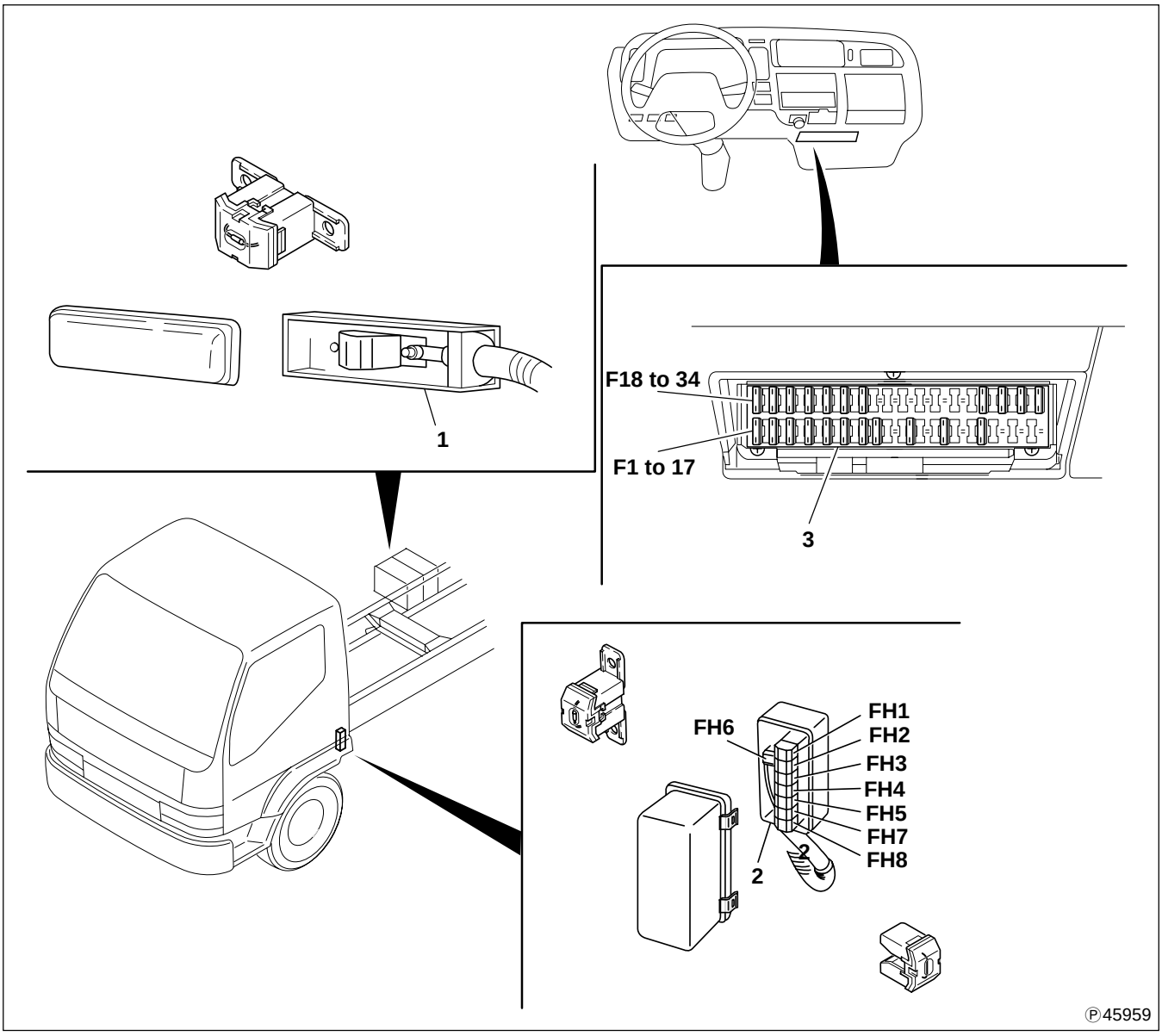
* Amount of discharge (Ah) = 5-hour rating capacity (Ah) $\times \frac{\text{Amount of discharge (\%)}}{100}$

- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.
- The specific gravity of fully-charged battery electrolyte is 1.280 with the temperature at 20°C {68°F}.

DANGER ⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **Keep unprotected lights away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it is dangerous.**
- **After charging the battery, tighten vent plug B, wash away sulfuric acid from the battery using water, and dry the surface.**
- **Be sure to check the electrolyte level before charging the battery. Charging with the electrolyte level below the lower limit (LOWER LEVEL) can cause premature deterioration, heat generation and explosion of the battery.**

Fuse



1 Main high-current fuse
2 High-current fuse box
3 Fuse box

CAUTION⚠

- **If a fuse blows, make sure you identify and remedy the cause, then replace the fuse.**
- **Make sure that you replace the fuse with one having the same rating.**
- **Make sure that you remove the ⊖ terminal of the battery cable before removing main high-current fuse 1 and high-current fuses FH1 to 8.**

Main high-current fuse

Fuse No.	Main load	Capacity
—	High-current fuse box	140A
—	ABS	50A

High-current fuse box

Fuse No.	Main load	Capacity
FH1	Fuse box (**F1** to **F4**)	50A
FH2	Fuse box (**F6** to **F11**)	40A
FH3	ABS	30A
FH4	Starter switch (Terminal B)	50A
FH5	Glow relay	50A
FH6	Alternator	140A
FH7	Fuse box (**F17, F31** to **F34**)	40A
FH8	ABS	40A

Fuse box

Fuse No.	Main load	Capacity
F1	Headlamp, LH	15A
F2	Headlamp, RH	15A
F3	Stop lamp, horn	15A
F4	Turn signal lamp	15A
F5	— < FH211 >	—
	Engine control (ECU) < FH210 >	20A
F6	Cab lamp	10A
F7	Van body dome light	10A
F8	A/T cooler fan motor	20A
F9	—	—
F10	Power window	25A
F11	Reserve power (BATT)	20A
F12	—	—
F13	Cigarette lighter	15A
F14	Radio	10A
F15	Reserve power (ACC)	10A
F16	— < FH211 >	—
	A/T < FH210 >	10A
F17	Mirror heater	10A
F18	MUTIC < FH211 >	10A
	Starter < FH210 >	10A
F19	Backup lamp	10A

Fuse No.	Main load	Capacity
F20	Meter cluster, DRL	10A
F21	Wiper	10A
F22	Engine control	10A
F23	— < FH211 >	—
	A/T < FH210 >	10A
F24	ABS	10A
F25	Reserve power (MAIN)	10A
F26	Mirror heater < FH211 >	10A
	— < FH210 >	—
F27	Exhaust brake, A/T	10A
F28	Transmission power take-off < FH211>	10A
	— < FH210 >	—
F29	Engine control (ACT)	10A
F30	Heater (A/C control)	10A
F31	Heater (A/C compressor)	10A
F32	Heater (A/C condenser fan)	15A
F33	Blower motor	25A
F34	Tail lamp	20A

PTO : Power take-off
A/T : Automatic transmission
DRL : Daytime running light
ABS : Anti-lock brake system
MUTIC : Multipurpose timing control unit
ACT : Actuator
A/C : Air-conditioner

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
Ⓔ : Exhaust emission items

	Inspection and maintenance	Time of inspection and maintenance					Lubrication procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Inspection interval: Every 30000 km/18000 miles *1	Inspection interval: Every 60000 km/36000 miles *2		
1	Ⓔ Engine oil contamination and oil level	×					Engine oil API classification CD, CD/SF, CE, CE/SF or CF-4 Over 30°C {86°F} ..... SAE 40 40 to –5°C {104 to 23°F} ..... SAE 30 15 to -15°C {59 to 5°F} ..... SAE 20W-20 Over -15°C {5°F} ..... SAE 15W-40 Below 0°C {32°F} ..... SAE 10W-30	🕮 P01-32, 34
	Ⓔ Engine oil replacement		×	×				
2	Brake fluid tank fluid level	×		×			Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	🕮 P01-36, 47
	Brake fluid tank fluid replacement					×		
3	Lubrication of clutch fork shaft				×		Wheel bearing grease [NLGI No.2 (Li soap)]	🕮 P01-51
4	Lubrication of clutch shifter			When replacing clutch disc assembly				
5	Manual transmission oil level			×			Gear oil, API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region) Engine oil Long period of high-speed driving API classification CC or CC/SF SAE 30 or SAE 40	🕮 P01-38
	Manual transmission oil replacement		×	Every 50000 km/30000 miles				
6	Automatic transmission fluid level			×			Automatic transmission fluid (DEXRON, DEXRON II type)	🕮 P01-39, 41
	Automatic transmission fluid and filter replacement		Every 40000 km/25000 miles Replace the fluid at the first 10000 km/6000 miles inspection on new vehicle, replace at the first 10000 km/6000 miles					
7	Axle housing gear oil level			×			Gear oil API classification GL-5 Below 40°C {104°F} ..... SAE 90 Over 40°C {104°F} ..... SAE 140 Use SAE 140 when operating vehicle at high load such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more	🕮 P01-44
	Axle housing gear oil replacement		×			×		
8	Hub bearing grease and oil seal replacement					×	Wheel bearing grease [NLGI No.2 (Li soap)]	🗀 Gr 26, 27
9	Power steering fluid level			×			Automatic transmission fluid (DEXRON, DEXRON II type)	🕮 P01-45
	Power steering fluid replacement					×		
10	Lubrication of propeller shaft (universal joint, slip joint, center bearing)			×			Wheel bearing [NLGI No.2 (Li soap)]	🕮 P01-52
11	Lubrication of kingpins			×			Chassis grease [NLGI No.1 (Li soap)]	🕮 P01-52
12	Lubrication of all chassis parts			×				🕮 P01-52

LUBRICATION

Engine Oil
< 4M5 >

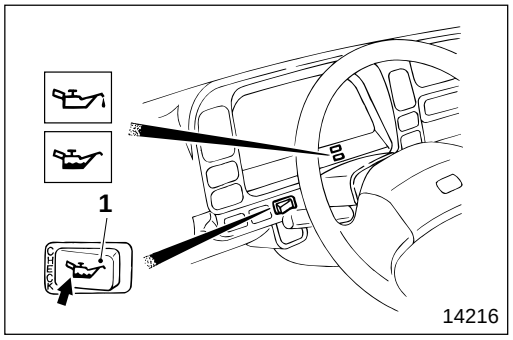
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Oil pan drain plug	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	—
5	Oil filter drain plug	9.8±1.96 {7.2±1.4, 1.0±0.2}	—

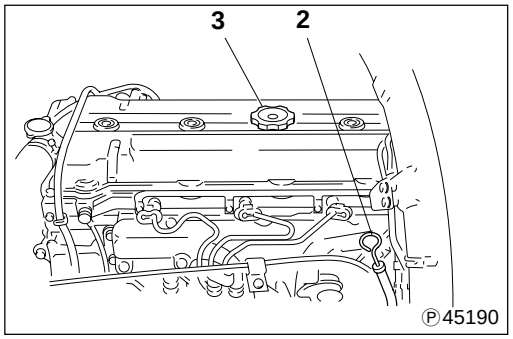
Lubricant

Point of application	Specified lubricant	Quantity	Remarks
Oil pan	Engine oil (API CD or higher)	Approximately 9 L {9.5 qts}	—
Oil filter		Approximately 1 L {1.1 qts}	—

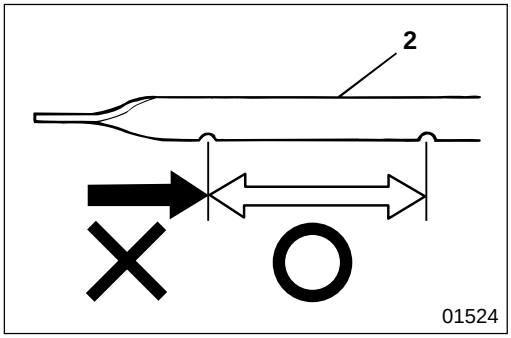


[Inspection]
There are two methods for inspecting the engine oil level; using oil level check switch **1**, and using dipstick **2**. Inspection using the oil level check switch is a simple inspection method. For a more accurate inspection use the dipstick.

- Inspection using oil level check switch **1** (simple inspection)
  - Press oil level check switch **1** before starting the engine. Check the oil level using the illuminated lamp.
    lamp (green) : Correct oil level
    lamp (red) : Low oil level
  - If the level is low, fill to correct level.



- Inspection using dipstick **2**
  - Tilt the cab.
  - Pull out dipstick **2**, wipe off the oil with a cloth.
  - Reinsert dipstick **2**, then pull it out carefully.
  - Oil level is correct if there is oil sticking to the dipstick between the two notches.
  - If the level is low, fill to correct level.



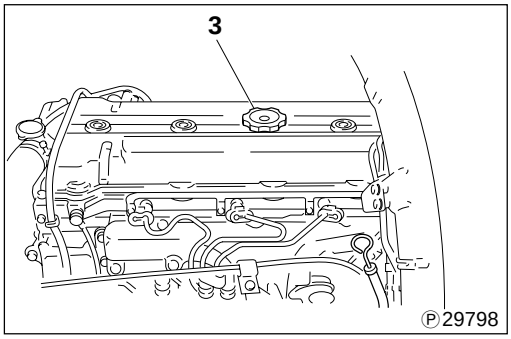
[Replenishment]
- Clean the area surrounding oil filler cap **3** and prevent dust from entering through the filler.
- Remove oil filler cap **3** and top up with engine oil.
- Wait five minutes before checking the oil level.
- Replace filler cap **3**.

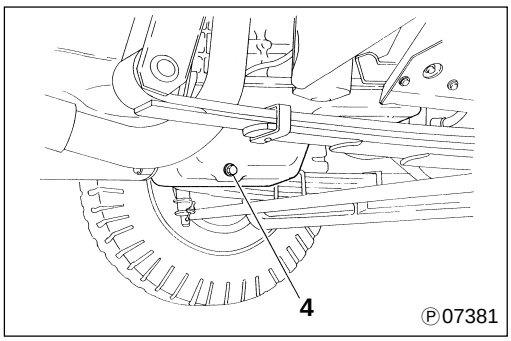
WARNING⚠

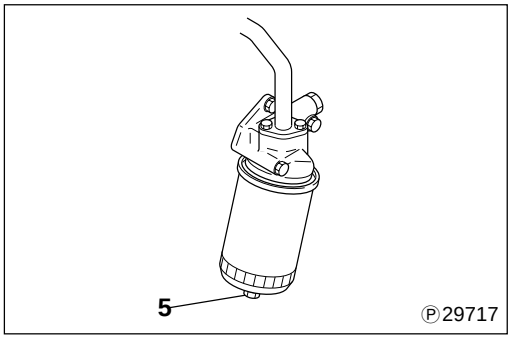
Wipe up any spilled engine oil since it can cause a fire.
Do not touch oil when the engine is hot since it can inflict severe burns.

CAUTION⚠

When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.







[Draining]
- Warm up the engine, then remove oil filter cap **3**.
- Remove oil pan drain plug **4** and oil filter drain plug **5**. Then, drain the engine oil.

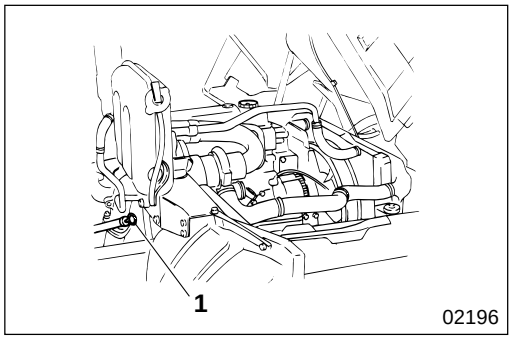
[Filling]
Tighten oil pan drain plug **4** and oil filter drain plug **5** to their specified torques. Then, add new engine oil to the specified level.

< 6D3 >

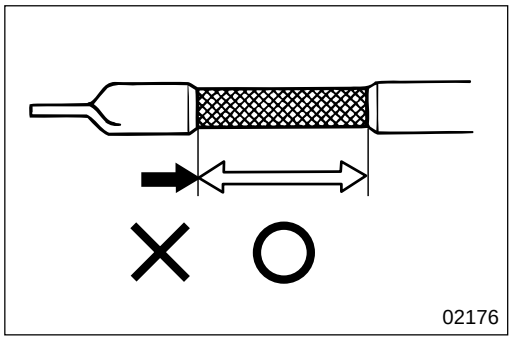
Tightening torque

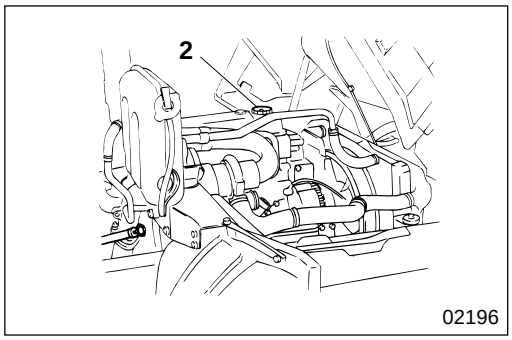
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Oil pan drain plug	69 {51, 7}	—



[Inspection]
- Pull out dipstick **1**, wipe off the oil with a cloth.
- Reinsert dipstick **1**, then pull it out carefully.
- Oil level is correct if there is oil sticking to dipstick **1** within the hatched area.
- If the level is low, top it up.
- Tilt the cab.



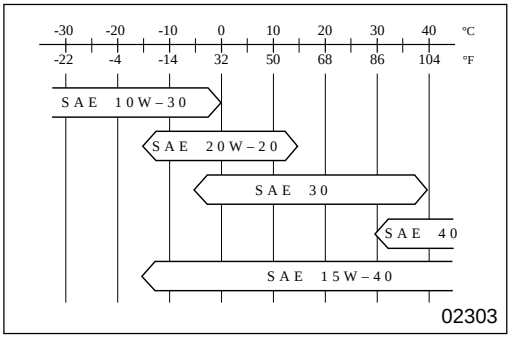


[Replenishment]
- Clean the area surrounding oil filler cap **2** and prevent dust from entering through the filler.
- Remove oil filler cap **2** and top up with engine oil.
- Wait five minutes before checking the oil level.
- Replace filler cap **2**.

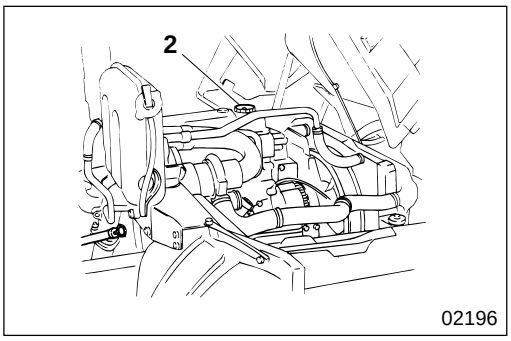
WARNING⚠
- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot as it will burn you.**

CAUTION⚠

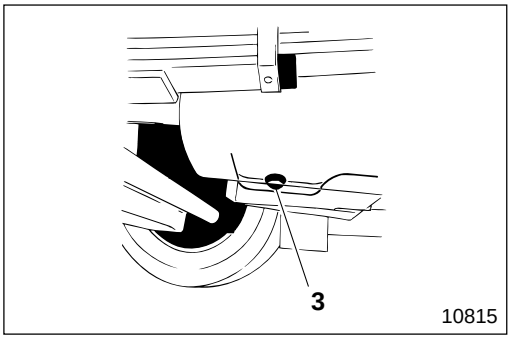
Take care not to spill engine oil on the V-belts, because this would cause them to slip, reducing service life.



[Replacement]
Since engine oil greatly influences the performance, the life expectancy, and the ability to start the engine, use only oil of the specified grade and viscosity.
The chart illustrates the relationship between oil viscosity and the ambient air temperature.



- Clean the area surrounding oil filler cap **2** and prevent dust from entering through the filler.
- Remove oil filler cap **2**.
- Remove oil pan drain plug **3**, and drain the oil. At the same time replace the oil filter.
- After reinstalling drain plug **3**, slowly add engine oil through the oil filler.
- Using the dipstick, check the oil level after more than six minutes have passed.
- Start the engine and let it idle. When the oil has reached all parts, stop the engine. Let 30 minutes pass before checking the oil level again.



Clutch Fluid (Brake Fluid)

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Air bleeder	25 to 34 {18 to 25, 2.5 to 3.5}	—

Fluid

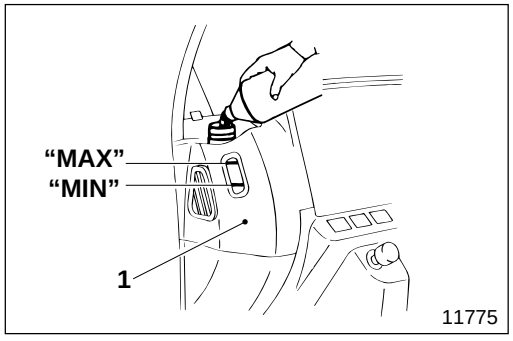
Location	Points of application	Specified fluid	Quantity
1	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

WARNING

- **The clutch fluid system and the brake fluid system use the fluid tank in common.**
- **You must use new brake fluid (SAE J1703f or FMVSS No.116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in ineffective clutch and brake operations.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose.**

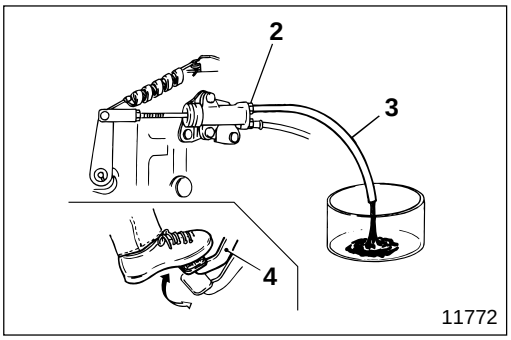
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**



[Inspection and replenishment]

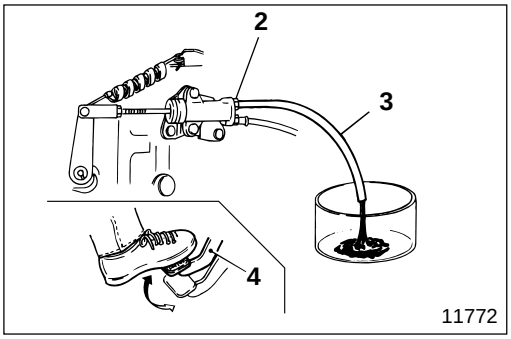
- Inspect the level of the brake fluid in fluid tank **1**. It should fall between the "**MAX**" and "**MIN**" levels.
- If it is below the "**MIN**" level, lift up the lid flap and remove the cap from fluid tank **1**, then supply the specified brake fluid until the level has come up to the "**MAX**" level. Do not fill above the "**MAX**" level.



[Replacement]

- Attach vinyl pipe **3** to air bleeder **2** of the clutch power cylinder.
- Loosen air bleeder **2** and depress clutch pedal **4** several times to drain brake fluid completely.

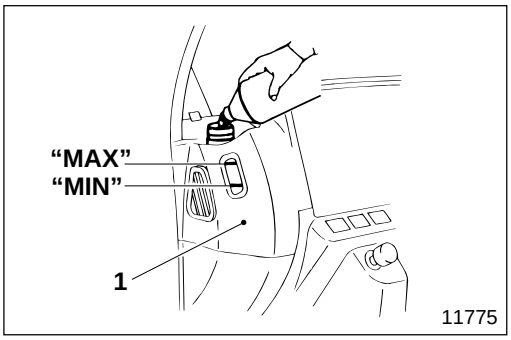
- Supply new brake fluid to the **"MAX"** level of fluid tank **1**. Depress clutch pedal **4** repeatedly until the old brake fluid discharged from vinyl pipe **3** is replaced by the new brake fluid.



NOTE

Carry out this operation maintaining the brake fluid level in fluid tank 1 between "MAX" and "MIN".

- Attach vinyl pipe **3** to air bleeder **2** of the clutch power cylinder as in the replacement procedure.
- Fill fluid tank **1** with brake fluid, and loosen air bleeder **2** of the clutch power cylinder then depress clutch pedal **4** continuously.
- Keep depressing clutch pedal **4**, and tighten air bleeder **2** when air is bled completely.
- Depress clutch pedal **4** several times again, then keep it depressed at its fullest extent.
- With clutch pedal **4** depressed, loosen air bleeder **2** to drain brake fluid containing air. Release the pedal after tightening the air bleeder.



- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten air bleeder **2** at specified torque.
- Check that brake fluid is at the "**MAX**" level of fluid tank **1**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **4** depressed.

Manual Transmission Gear Oil

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

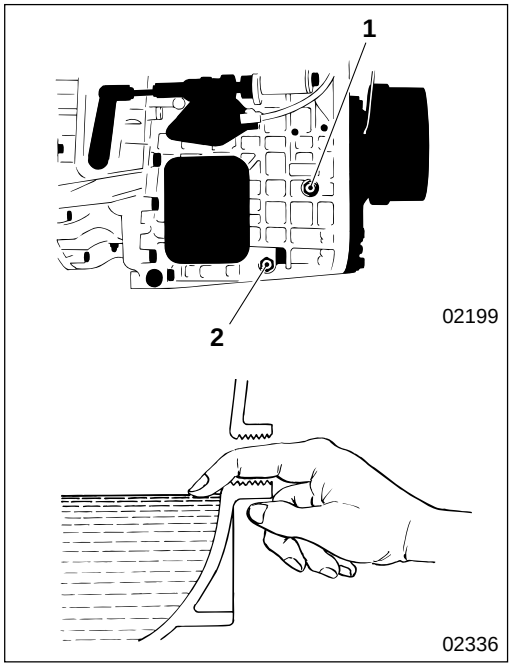
Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	69±15 {51±11, 7±1.5}	—
2	Drain plug	69±15 {51±11, 7±1.5}	—

Sealant

Location	Points of application	Specified sealant	Quantity
1	Thread area of inspection plug	THREEBOND 1105D	As required
2	Thread area of drain plug	THREEBOND 1105D	As required

WARNING

The oil temperature is high immediately after the vehicle stopped, so take care not to scald yourself.



[Inspection and replenishment]

- Remove inspection plug **1** and check whether the oil level is up to the edge of the entrance.
- If the level is low, add oil through the inspection plug hole until the level comes up to the edge of the entrance.

[Replacement]

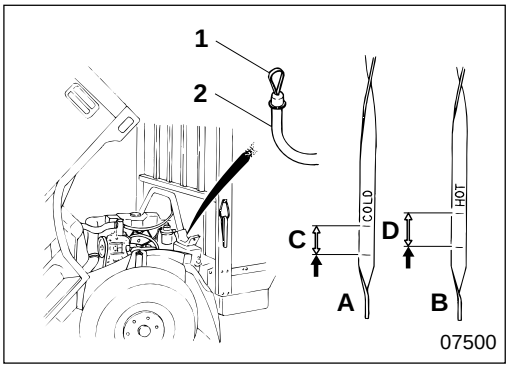
- Drain the oil after removing inspection plug **1** and drain plug **2**.
- Remove any metal particles sticking to the magnetic part of drain plug **2** before reinstalling the plug.
- Add oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Reinstall inspection plug **1**.

Automatic Transmission Fluid < FH210 >

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain plug	29 to 39 {22 to 29, 3 to 4}	—



[Inspection and replenishment]

- Park the vehicle on level ground, make sure that the parking brake is fully activated and chock the wheels to keep them from rolling.
- Start the engine and let it idle. To fill the hydraulic circuit with automatic transmission fluid, slowly shift the range selector lever once through the P to L ranges and finally shift into the N range.
- While the engine is still idling, pull out dipstick **1** and wipe off the fluid sticking to it. Reinsert the dipstick, then pull it out again and check the fluid level.
- If the fluid level is inspected right after the engine is started and the fluid temperature is still low (40±15°C {104±27°F}) the level should be within area **C** marked COLD on dipstick **1** as illustrated in **A**.
- If the fluid level is inspected after the vehicle has been driven and the fluid temperature is high (65±15°C {149±27°F}) the level should be within area **D** marked HOT on dipstick **1** as illustrated in **B**.

WARNING⚠

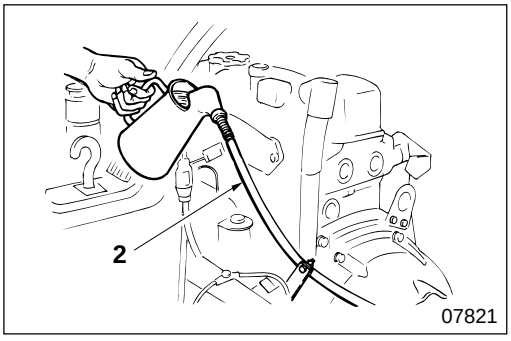
Take care during the inspection because the engine will be running. Take sufficient care to avoid burns or injuries resulting from contact with moving parts.

CAUTION⚠

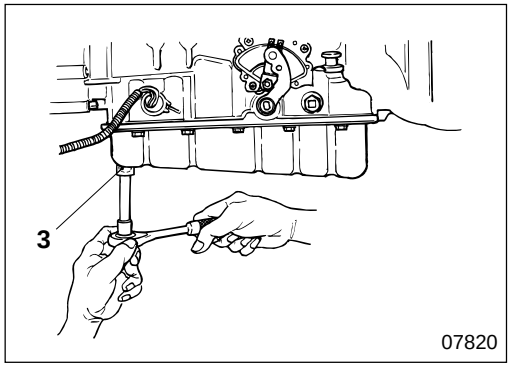
Be sure to wipe off the dust from the safety cap and the upper part of filler tube 2 before you pull out dipstick 1.

NOTE

- **Make sure the vehicle is parked on level ground when you are checking the fluid level.**
- **Make sure the range selector lever is in the N range and the engine is idling when you are checking the fluid level. When the engine is at standstill, the fluid level appears higher than it actually is.**
- **To ensure the fluid is correct, reinspect the fluid level after an actual drive.**



- If the fluid level is low, top it up to the specified level by supplying automatic transmission fluid (DEXRON III type) through filler tube **2**.



[Replacement]

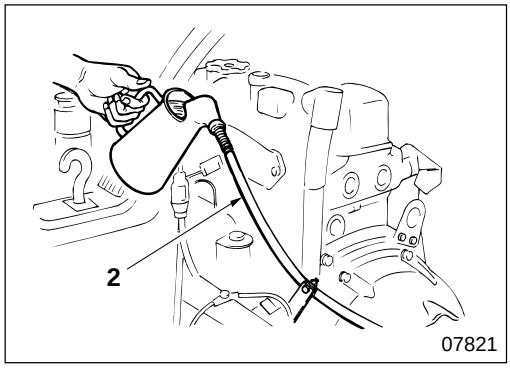
- Place a container under the oil pan, remove drain plug **3** in the front of the oil pan and drain the fluid.

WARNING

Take care because the automatic transmission fluid temperature immediately after the engine has stopped is very high. To avoid scalds, wait until a safe temperature has been reached before draining the fluid.

NOTE

- **The fluid will drain faster if the engine is first run to raise the fluid temperature.**
- **The fluid cannot be drained from the hydraulic circuit, the torque converter or the oil cooler.**



- Reinstall the gasket, and oil pan drain plug **3**.
- Add automatic transmission fluid (DEXRON III type) through filler tube **2**.

CAUTION

Make sure that dirt and foreign particles do not become mixed in with the fluid when it is added.

- Shift the range selector lever into the N range, start the engine and let it idle for at least two minutes.
- After shifting the lever through all ranges once, shift it back into N.

CAUTION

To prevent burning out the interior of the automatic transmission assembly, make sure that the engine is not allowed to race when you do the above.

- Supply the fluid until the fluid level is at the lower limit of the specified area on dipstick **1**. Next, check the fluid level to make sure it is within the specified limit.

NOTE

- **Determining the fluid level immediately after supplying the fluid might be difficult due to the fluid stuck in the inside of the filler tube. Therefore, check the fluid level a few times between intervals.**
- **If the fluid is overfilled, it will overflow and can be mistaken for leakage.**
- **Let the engine idle and, while paying attention to the fluid level, pour in the fluid slowly.**

Automatic Transmission Fluid and Oil Filter < FH211 >

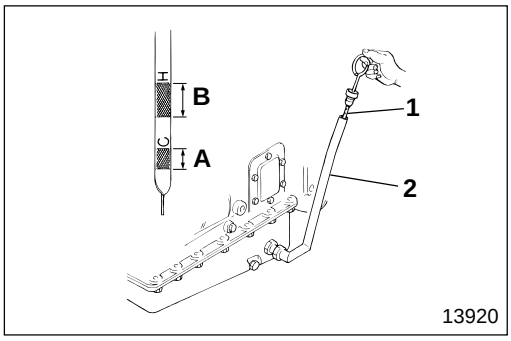
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Drain plug	20 to 27 {15 to 20, 2.05 to 2.75}	—
5	Dipstick guide connector	125 to 135 {91 to 100, 12.55 to 13.76}	—
6	Bolt (Oil pan mounting)	14 to 18 {10 to 13, 1.4 to 1.8]	—
8	Bolt (Oil filter mounting)	14 to 18 {10 to 13, 1.4 to 1.8]	—
12	Oil filter	9.8 to 20 {7 to 14, 1 to 2}	—

Fluid

Location	Points of application	Specified fluid	Quantity
11	Body of O-ring	Automatic transmission fluid (DEXRON or DEXRON II type)	As required
12	Gasket of oil filter with thin application	Automatic transmission fluid (DEXRON or DEXRON II type)	As required



[Inspection and replenishment]

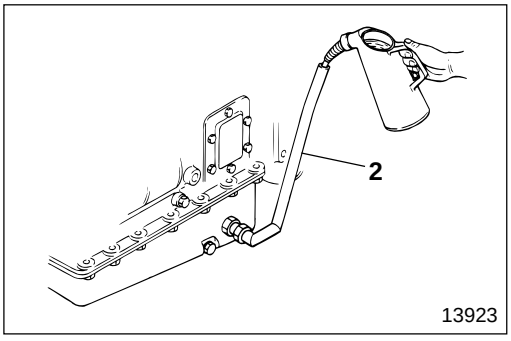
- Park the vehicle on level ground, make sure that the parking brake is fully activated and chock the wheels to keep them from rolling.
- Start the engine and let it idle. To fill the hydraulic circuit with automatic transmission fluid, shift the range selector lever from N → R → N → D → 2 → D → N. Repeat this process five times, finally shifting to N.
- While the engine is still idling, pull out dipstick **1** and wipe off the fluid sticking to it. Reinsert the dipstick, then pull it out again and check the fluid level.
- If the fluid level is inspected right after the engine is started and the fluid temperature is still low (approximately 15 to 49°C {60 to 120°F}), the level should be within area **A** marked COLD on dipstick **1**.
- If the fluid level is inspected after the vehicle has been driven and the fluid temperature is high (approximately 71 to 93°C {160 to 200°F}), the level should be within area **B** marked HOT on dipstick **1**.

WARNING

Take care during the inspection because the engine will be running. Take sufficient care to avoid burns or injuries resulting from contact with moving parts.

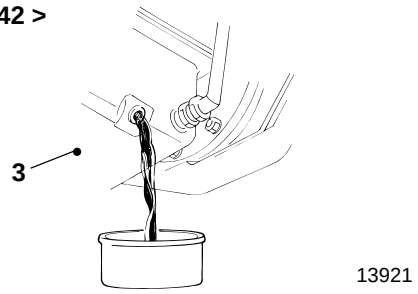
NOTE

- **Make sure the vehicle is parked on level ground when you are checking the fluid level.**
- **Make sure the range selector lever is in the N position and the engine is idling when you are checking the fluid level. When the engine is stopped, the fluid level appears higher than it actually is.**
- **Be sure to wipe off the dust from the safety cap and the upper part of dipstick guide 2 before you pull out dipstick 1.**
- **To ensure the fluid is correct, reinspect the fluid level after an actual drive.**



- If the fluid level is low, add automatic transmission fluid (DEXRON or DEXRON II type) through dipstick guide **2** until the correct level on dipstick **1** is reached.

< AT542 >



13921

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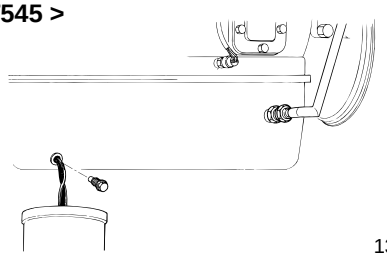

13922

[Replacement]

- Park the vehicle on level ground, chock the wheels and shift the range selector lever to the N position.
- Place a container under oil pan **3**, remove drain plug **4** and drain the fluid.

WARNING⚠

Take care because the fluid temperature immediately after the engine has stopped is very high. To avoid scalds, wait until a safe temperature has been reached before draining the fluid.

NOTE

- **The fluid will drain faster if the engine is first run to raise the fluid temperature.**
- **The fluid cannot be drained from the hydraulic circuit, the torque converter or the oil cooler.**
- **Check the drained fluid for dirt, metal particles and metal fragments.**

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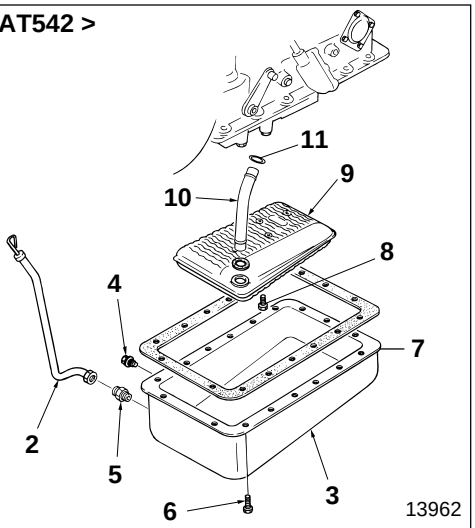

13962

- Remove oil pan **3**, intake pipe **10**, O-ring **11**, gasket **7** and oil filter **9**.
- Clean oil pan **3**.
- Replace O-ring **11**, gasket **7** and oil filter **9**.

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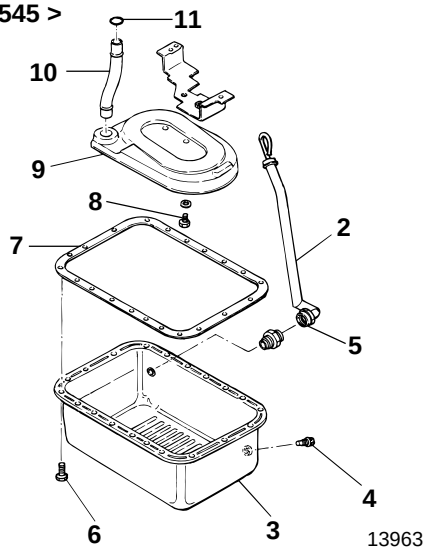
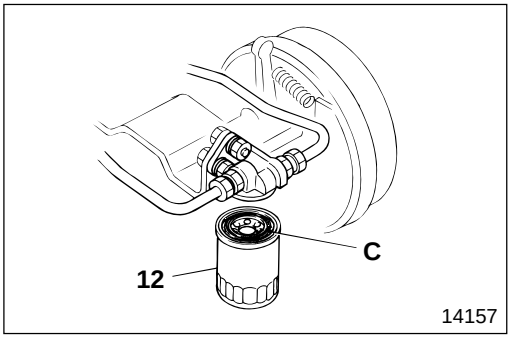
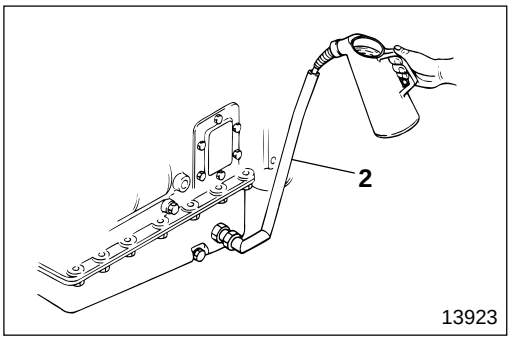


13963



- Remove oil filter **12** (for oil cooler) by turning it counterclockwise.
- Lightly coat gasket **C** with the fluid before installing oil filter **12**. Then tighten the oil filter.



- Supply fluid through dipstick guide **2**.

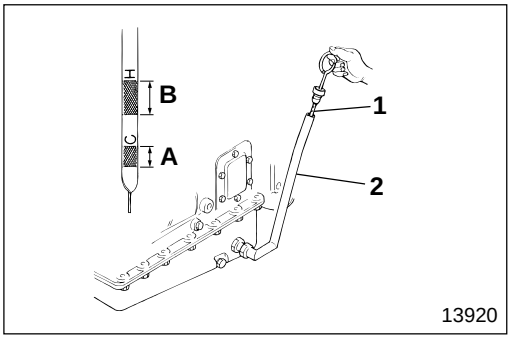
CAUTION

Make sure that dirt and foreign particles do not become mixed in with the fluid when it is added.

- Shift the range selector lever to the N position, start the engine and let it idle for about one minute.
- After shifting the lever through all positions once, shift it back to N position.

CAUTION

To prevent burning out the interior of the automatic transmission assembly, make sure that the engine is not allowed to race when you do the above.



- Check and adjust so that the fluid level is within the specified area on dipstick **1**.

NOTE

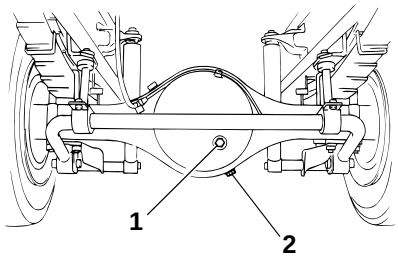
- **As the temperature of the fluid rises, so does the fluid level. If you add fluid while the temperature is still low (approximately 15 to 49°C {60 to 120°F}), make sure that the level stays within area A, marked COLD on dipstick 1.**
- **Let the engine idle and, while paying attention to the fluid level, pour in the fluid slowly.**
- **It is sometimes hard to check the fluid level, immediately after supplying fluid, because of the fluid adhering to the interior of dipstick guide 2. If this is the case, check the fluid level several times at intervals.**
- **Be careful not to supply too much fluid because you might mistake the fluid that overflows from the air breather for fluid leakage.**

Rear Axle Gear Oil

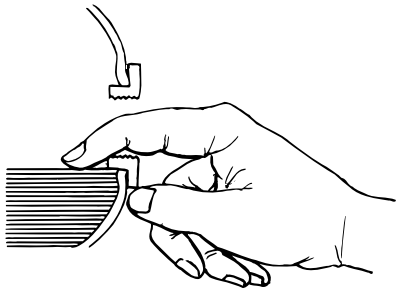
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	98 to 115 {72 to 87, 10 to 12}	—
2	Drain plug	98 to 115 {72 to 87, 10 to 12}	—



02201



02340

[Inspection and replenishment]

WARNING

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

- Remove inspection plug **1**, check the oil level and make sure it is up to the edge of the entrance.
- If the oil level is low, add oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Insert inspection plug **1**.

[Replacement]

- Drain the oil after removing inspection plug **1** and drain plug **2**.
- Remove any metal particles sticking to the magnetic part of drain plug **2** before reinstalling the plug.
- Supply oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Reinstall the inspection plug.

Power Steering Fluid

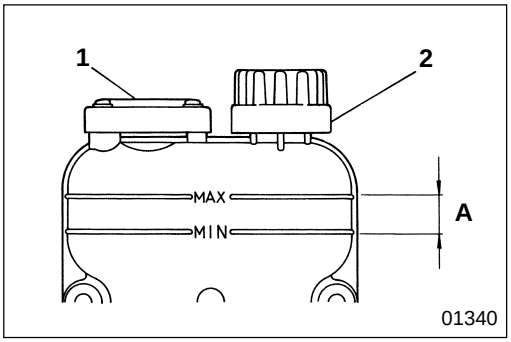
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Oil pipe	66.69±12.75 {49±9.4, 6.8±1.3}	—

Fluid

Location	Points of application	Specified fluid	Quantity
1	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Between "MAX" and "MIN" on the power steering oil tank



WARNING⚠

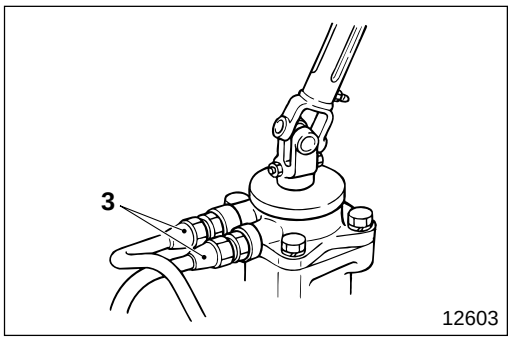
Because the brake booster (hydraulic booster) uses power steering fluid, do not let other fluids such as brake fluid, etc. get mixed with the power steering fluid inside the power steering oil tank.

[Inspection and replenishment]

- Straighten the front wheels and stop the engine.
- Inspect the level of the fluid in power steering oil tank **1**. It should fall between fluid level range **A**.
- If it is below the **"MIN"** level, remove filler cap **2** from power steering oil tank **1**, then supply the specified fluid until the level has come up to the **"MAX"** level. Do not fill above the **"MAX"** level.

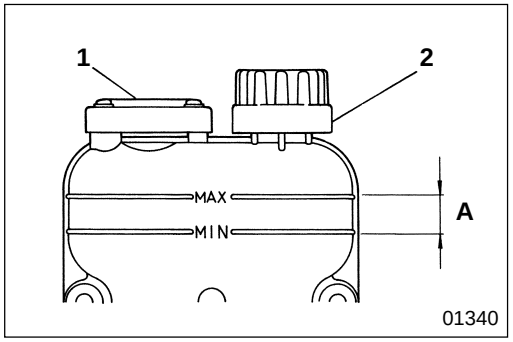
CAUTION⚠

If the fluid level is far below the recommended range, the fluid may be leaking.



[Replacement]

- Drainage
  - Jack up the front wheels.
  - Disconnect oil pipe **3** connected to the power steering booster.
  - Turn the steering wheel fully left and right repeatedly, and drain the fluid from the power steering booster.
  - After draining the fluid, tighten oil pipe **3** at specified torque.



[Supply]

- Supply fluid into power steering oil tank **1** up to filler cap **2**.
- With the engine stopped, jack up the front wheels and turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.
- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- Depress the brake pedal fully several times repeatedly, until as in the case of the steering wheel, the fluid level does not drop anymore. (The steering wheel at such time does not need to be operated)
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times, next depress the brake pedal several times to raise the fluid temperature to approximately 60 to 80°C {140 to 176°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times to make sure there is no abnormal noise.
- With the engine stopped, depress the brake pedal several times, activate the brake booster (hydraulic booster) emergency pump and bleed air.
- When there is no abnormal noise after the above procedure has been performed, bleeding is completed. Check oil tank **1** fluid level, and pipe and hose connections for fluid leakage.
- After bleeding is completed, inspect brake booster (hydraulic booster) performance (input and output characteristics). Gr 35A

Brake Fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

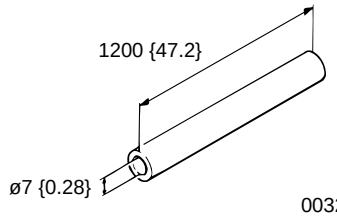
Location	Parts to be tightened	Tightening torque	Remarks
2	Air bleeder	7.8 to 12 {5.8 to 8.5, 0.8 to 1.2}	—

Fluid

Location	Points of application	Specified fluid	Quantity
1	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Vinyl hose 	MH033102	Air bleeding

WARNING

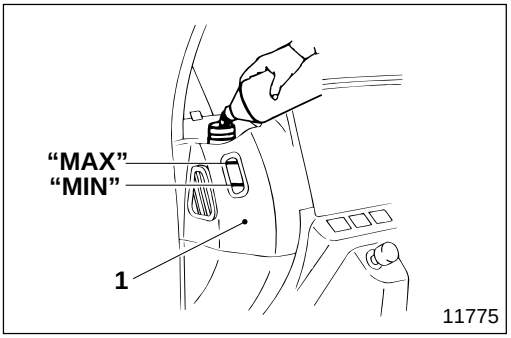
- **The clutch fluid system and the brake fluid system use the fluid tank in common.**
- **You must use new brake fluid (SAE J1703f or FMVSS No.116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in ineffective clutch and brake operations.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose.**

CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

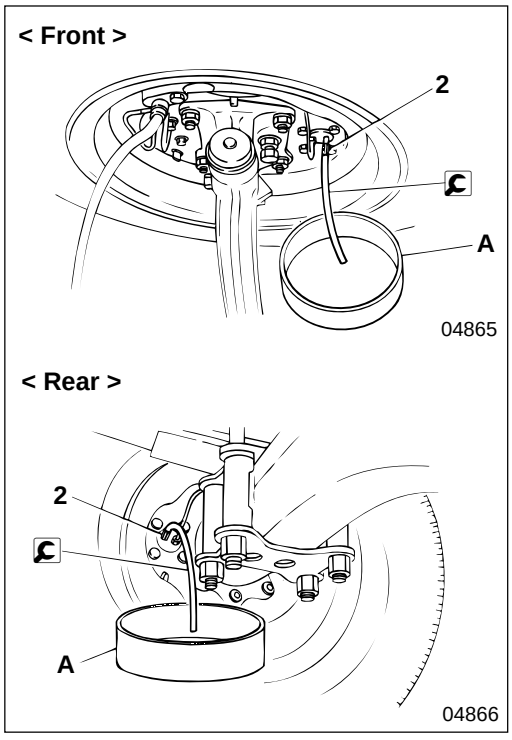
NOTE

Supply and maintain brake fluid level to the "MAX" level of the fluid tank.

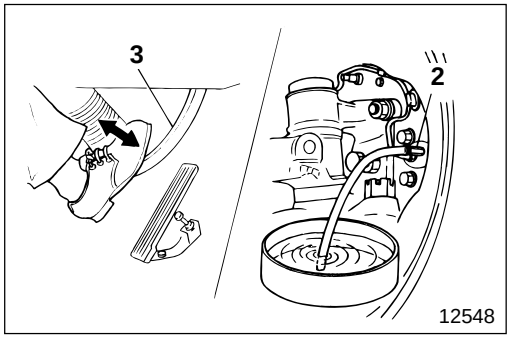


[Inspection and replenishment]
- Inspect the level of the brake fluid in fluid tank **1**. It should fall between the "**MAX**" and "**MIN**" levels.
- If it is below the "**MIN**" level, remove the cap from fluid tank **1**, then supply the specified brake fluid until the level comes up to the "**MAX**" level. Do not fill above the "**MAX**" level.

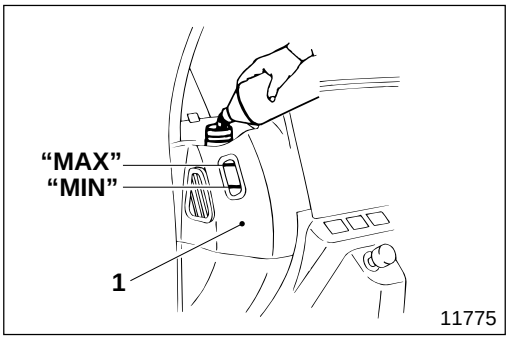
[Replacement]
- Start engine and let it idle until brake fluid replacement is completed.



- Attach one end of vinyl hose to air bleeder **2** and place the other end in container **A**.

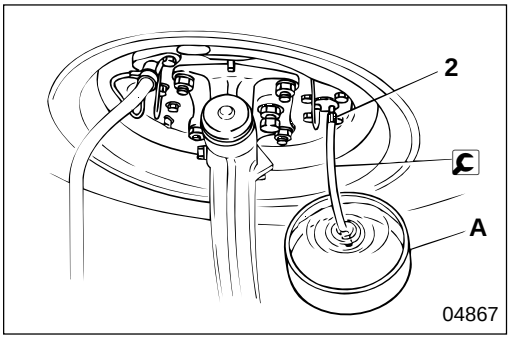


- Loosen air bleeders **2** and depress brake pedal **3** several times to drain brake fluid completely.



- Maintaining a supply of new brake fluid up to the "**MAX**" level of fluid tank **1**, depress brake pedal **3** repeatedly until the old brake fluid of the brake system is replaced with new fluid.
- Carry out air bleeding of the brake system.

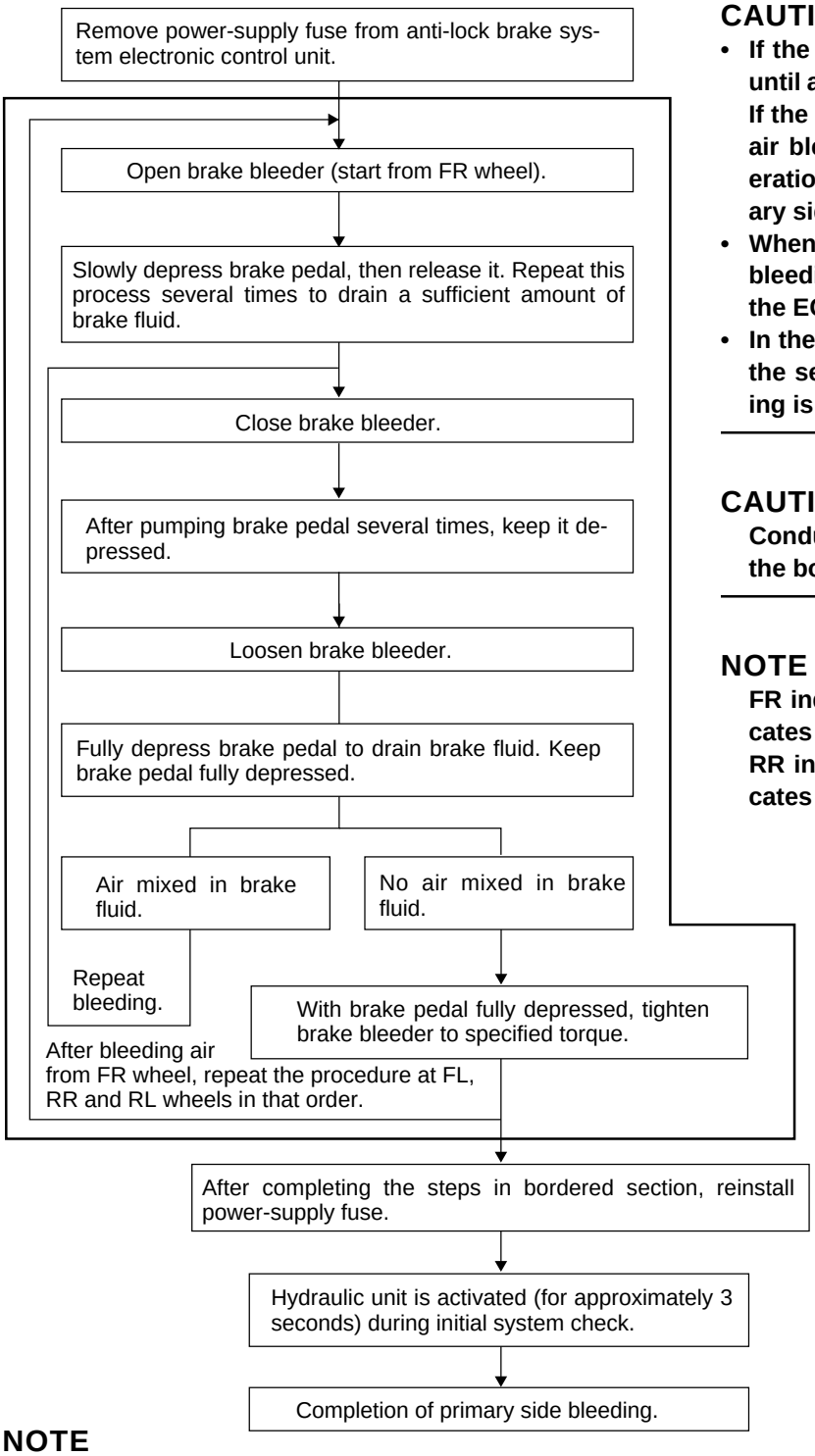
[Air bleeding]



- Start the engine and let it idle until brake fluid replacement is completed.
- Attach one end of vinyl hose to air bleeder **2** of the wheel brake. Place free end in container **A** filled with brake fluid.
- Carry out air bleeding in the following sequence:

(1) Air bleeding during regular maintenance, and hydraulic unit replacement

When air bleeding is conducted during regular maintenance or when the hydraulic unit is replaced, brake fluid flows into the secondary side (operating circuit) of the hydraulic unit. Therefore, bleed the primary side (normal circuit) by following the procedures below. In the event air enters the secondary side, bleed air by following the procedures described in (2).



CAUTION

- **If the battery is disconnected, do not reconnect until air bleeding of the primary side is complete. If the battery is reconnected before primary side air bleeding is complete, the system check operation is activated and air can enter the secondary side.**
- **When the battery must be connected prior to air bleeding, remove the power-supply fuse from the ECU.**
- **In the event air enters the secondary side, bleed the secondary side after primary side air bleeding is complete.**

CAUTION

Conduct the air bleeding operation described in the bordered section at every wheel.

NOTE

FR indicates front-axle right wheel, and FL indicates front-axle left wheel.
RR indicates rear-axle right wheel, and RL indicates rear-axle left wheel.

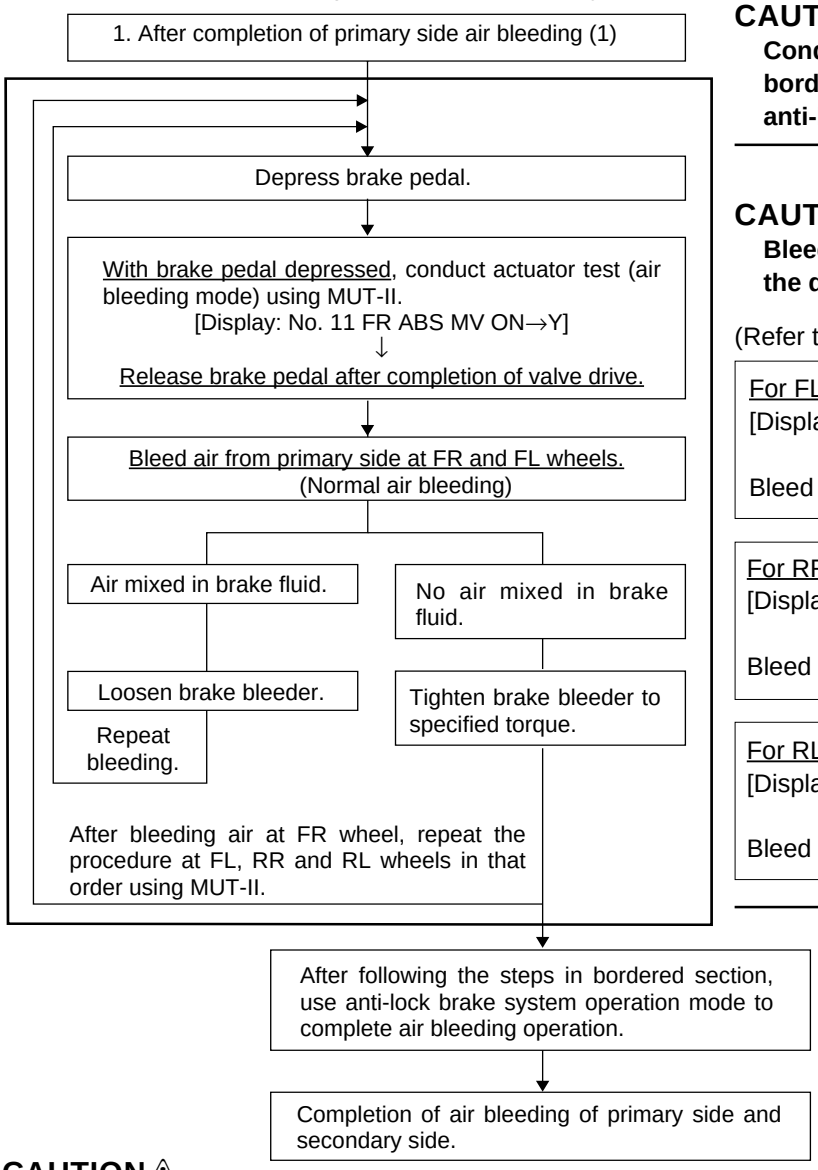
NOTE

- **The primary side (normal circuit) is a hydraulic circuit formed when the system is in non-operation.**
- **The secondary side (operating circuit) is a hydraulic circuit which connects with the primary side only when the system is in operation (when the system is in non-operation, the secondary side is disconnected from the primary side).**

(2) Air bleeding of secondary side

If the system starts operating before air bleeding of the primary side is complete, air can enter the secondary side. In the event the system accidentally starts before the completion of primary side air bleeding, follow the procedures below to bleed air. If air enters the secondary side, air flows into the primary side when the system starts, and this can extend the brake pedal stroke.
During air bleeding, use the MUT-II to conduct an actuator test (anti-lock brake system operation mode) at all wheels.

Use the MUT-II when bleeding air from the secondary side.



CAUTION

Conduct air bleeding operation described in the bordered section at every wheel by using the anti-lock brake system operation mode.

CAUTION

Bleed air from wheels other than FR according to the directions below.

(Refer to NOTE below)

For FL wheel
[Display: No. 12 FL ABS MV ON→Y]
↓
Bleed air from primary side at FR and FL wheels.

For RR wheel
[Display: No. 13 RR ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

For RL wheel
[Display: No. 14 RL ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

CAUTION

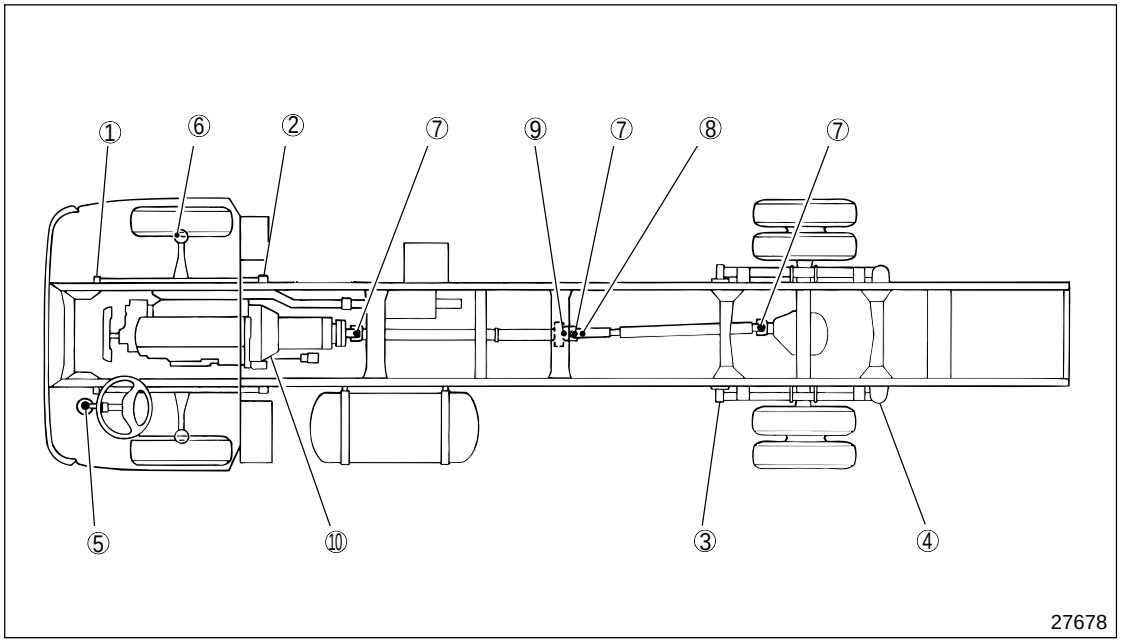
- **Avoid continuous execution of the actuator test (anti-lock brake system drive) using the MUT-II; otherwise, excessive heating of the anti-lock brake system motor, valve and other parts can cause hydraulic unit damage.**
- **Do not conduct the actuator test with the MUT-II while bleeding air from the primary side; otherwise, air can enter the secondary side from the primary side.**
- **When mixing of air was found after air bleeding is conducted to correct an excessive brake pedal stroke, bleed air from the secondary side, too.**

NOTE

- **For the MUT-II operation for the actuator test during air bleeding, refer to section 4.**
- **If a drive operation is conducted for the FR and RL wheels at one time using the MUT-II, subsequent air bleeding of the primary side conducted at each wheel will not remove air from the secondary side.**

● Greasing Various Areas of Chassis

Carefully clean away all dust and dirt from the grease nipples, and use the specified type of grease. The areas to be greased are shown in the following illustration.



27678

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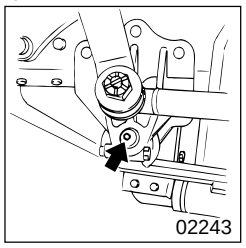
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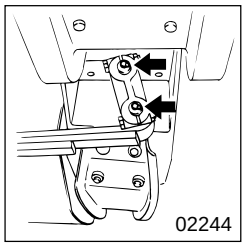
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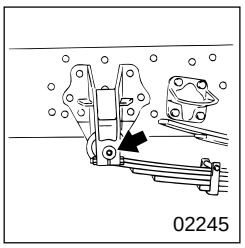
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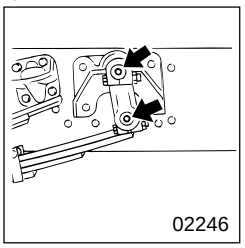
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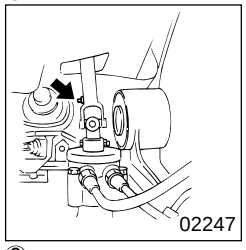
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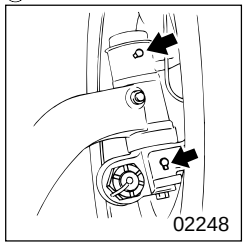
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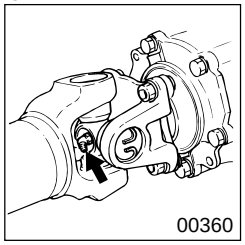
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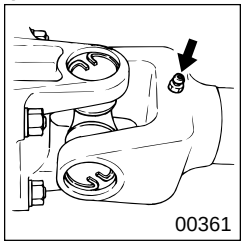
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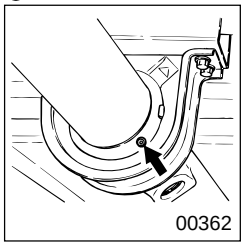
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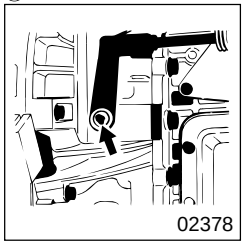
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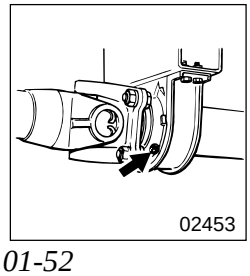
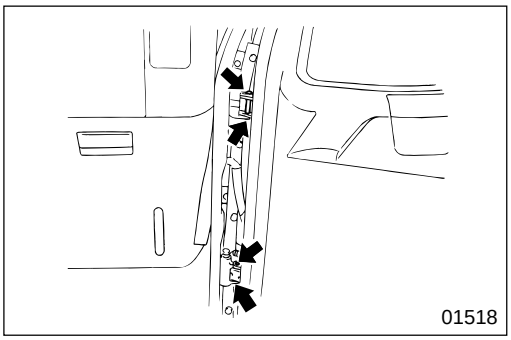

02453

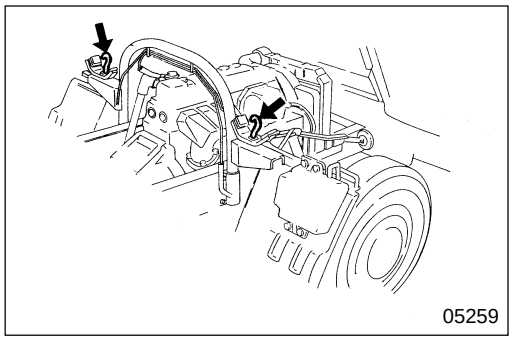
Supply grease to the center bearing until grease overflows from the escape valve at the back of the grease nipple.

① Front spring pin front (left and right, 2 points)
② Front spring pin rear (left and right, 4 points)
③ Rear spring pin front (left and right, 2 points)
④ Rear spring pin rear (left and right, 4 points)
⑤ Steering shaft
⑥ Kingpin bearing (left and right, 4 points)
⑦ Universal joint of propeller shaft
⑧ Slip joint of propeller shaft
⑨ Center bearing of propeller shaft
⑩ Clutch fork shaft (left and right, 2 points)

● **Door hinge**



● **Anchor hook**



MITSUBISHI
FUSO

Group 11A

Engine

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-11A

INDEX

SPECIFICATIONS 11A- 2

STRUCTURE AND OPERATION 11A- 4

TROUBLESHOOTING 11A-14

ON-VEHICLE INSPECTION AND ADJUSTMENT 11A-16

REMOVAL AND INSTALLATION OF ENGINE 11A-20

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS 11A-24

CYLINDER HEAD AND VALVE MECHANISM 11A-38

FRONT CASE 11A-52

TIMING GEARS AND BALANCE SHAFTS 11A-56

PISTONS, CONNECTING RODS AND CYLINDER LINERS 11A-64

FLYWHEEL 11A-76

CRANKSHAFT AND CRANKCASE 11A-80

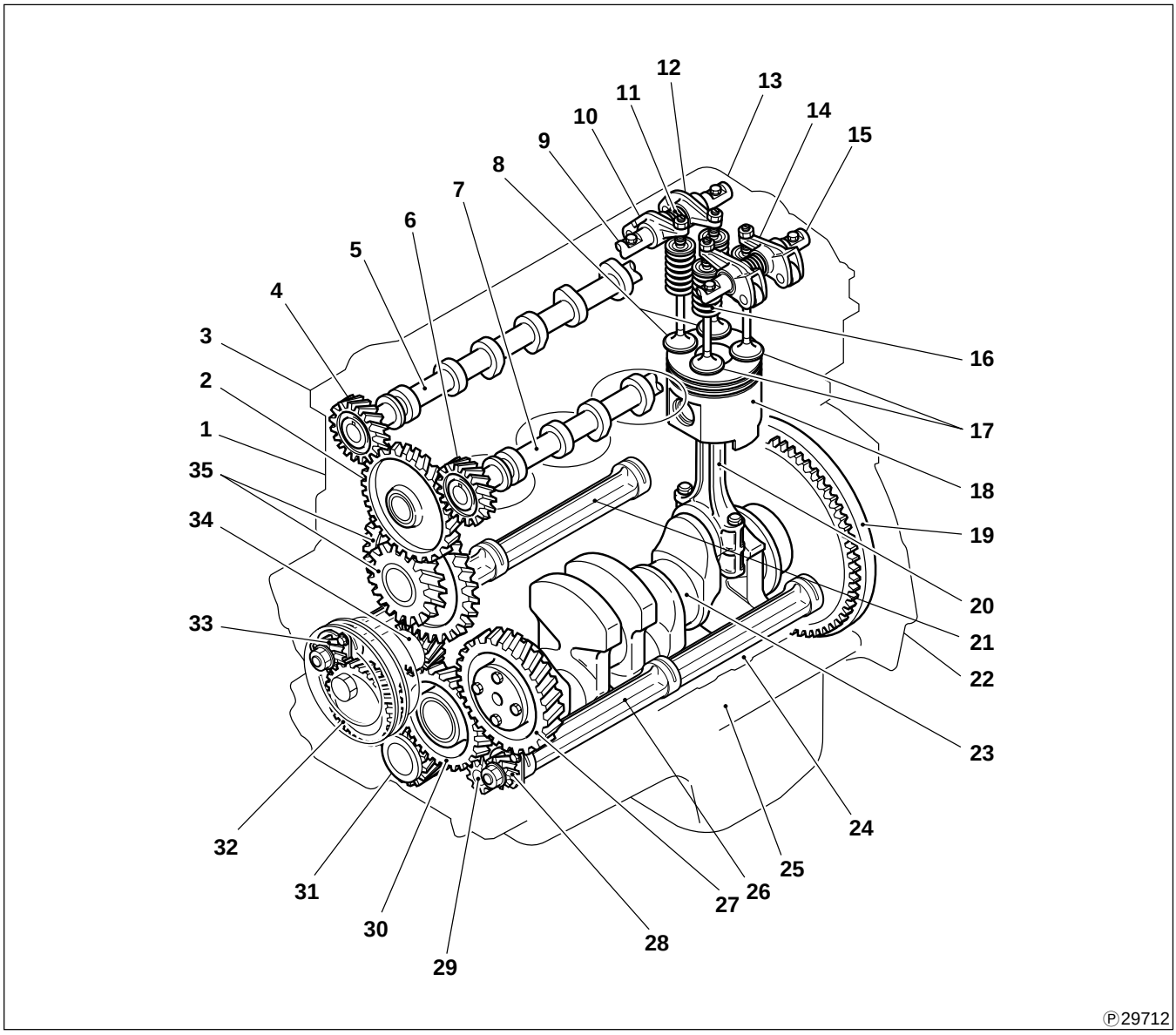
BALANCE SHAFT BUSHINGS 11A-88

SPECIFICATIONS

Item		Specifications
Engine model		4M50T2
Type		4-cylinder, in-line, water-cooled, 4-cycle diesel
Combustion chamber type		Direct injection
Valve mechanism		Double overhead camshaft
Max. power output	HP/rpm (SAE Gross)	175/2700
Max. torque	lbf.ft/rpm (SAE Gross)	347/1800
Cylinder bore × stroke	mm {in.}	ϕ 114 × 120 {4.49 × 4.72}
Total displacement	ℓ	4.899
Compression ratio		17.5

MEMO

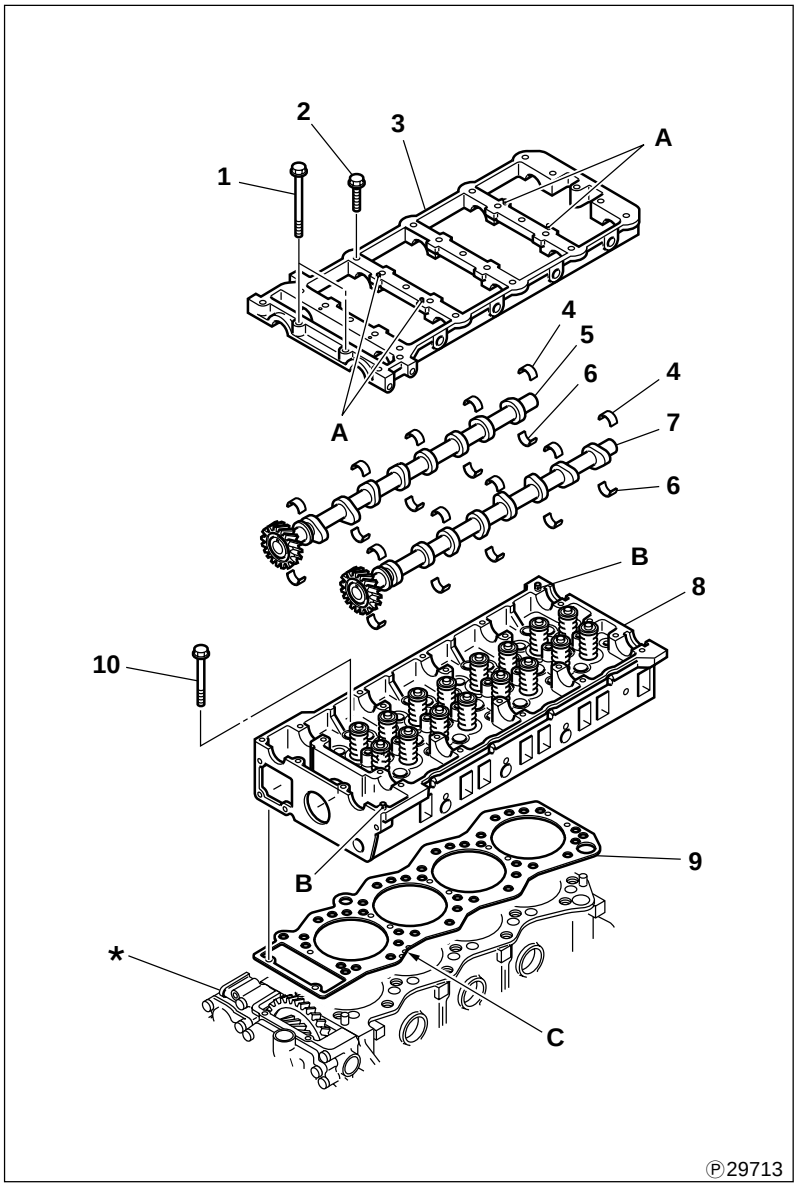
Engine-proper



1 Cylinder head
2 Head idler gear
3 Camshaft frame
4 Camshaft gear (Exhaust side)
5 Exhaust camshaft
6 Camshaft gear (Inlet side)
7 Inlet camshaft
8 Exhaust valve
9 Exhaust rocker shaft
10 Short rocker
11 Rocker shaft spring
12 Long rocker
13 Rocker cover
14 Short rocker
15 Inlet rocker shaft
16 Valve spring
17 Inlet valve
18 Piston
19 Flywheel
20 Connecting rod
21 Balance shaft RH
22 Rear plate
23 Crankshaft
24 Upper crankcase
25 Lower crankcase
26 Balance shaft LH
27 Injection pump gear
28 Balance shaft gear LH
29 Vacuum pump gear
30 No. 1 idler gear
31 Crankshaft gear
32 Oil pump gear
33 Balance shaft gear RH
34 Fan shaft assembly
35 Idler gear assembly

The 4M50T2 engine is of the double overhead camshaft (DOHC) type. The valve mechanism and timing gear arrangement is illustrated above.

Cylinder Head, Cylinder Head Gasket, Camshaft and Camshaft Frame

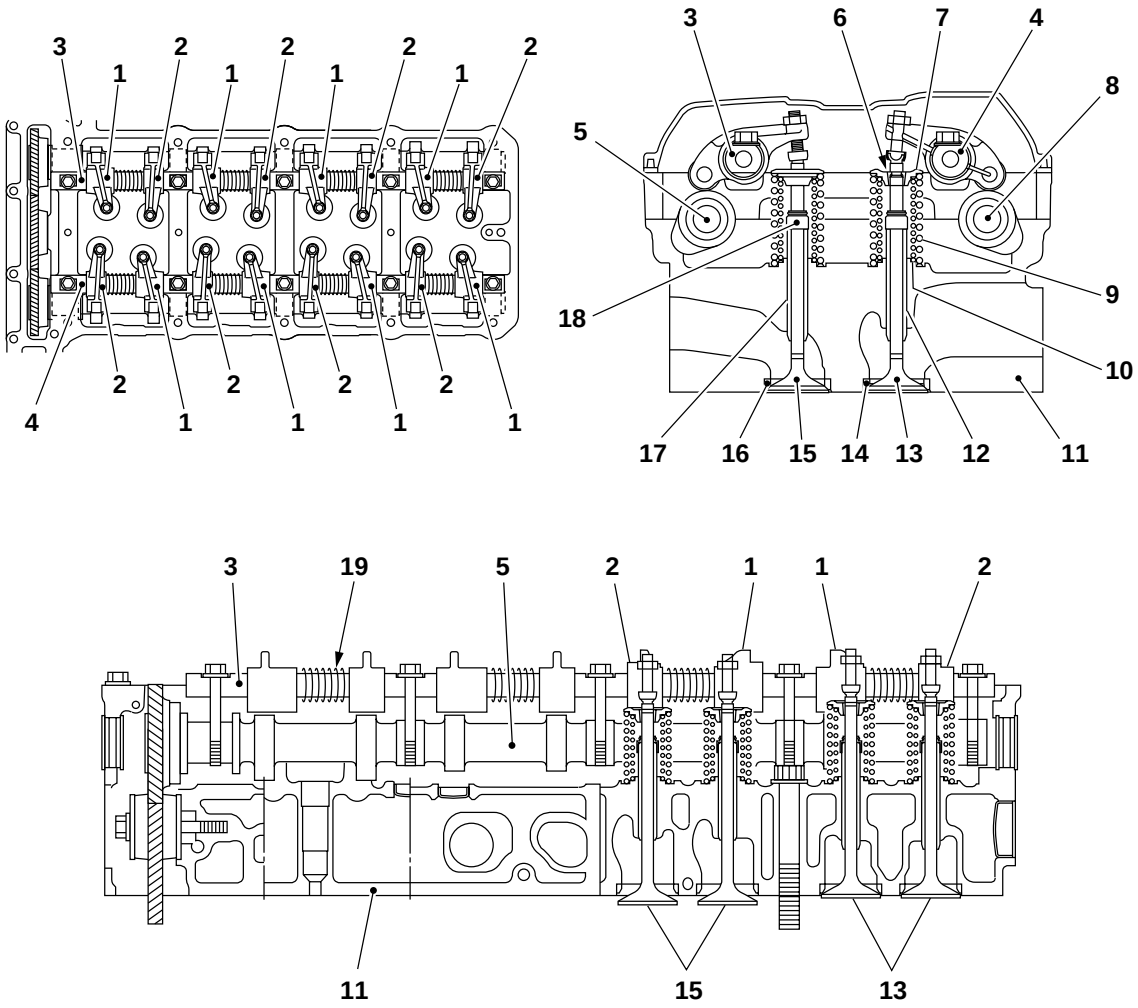


1 Bolt (× 2)
2 Bolt (× 13)
3 Camshaft frame
4 Camshaft bearing (Upper)
5 Exhaust camshaft
6 Camshaft bearing (Lower)
7 Inlet camshaft
8 Cylinder head
9 Cylinder head gasket
10 Cylinder head bolt

A : Locating pin
B : Locating pin
C : Notched portion
*** :** Front

- The camshafts **5** and **7** have their journals supported by the cylinder head **8**, and are held down from above by the camshaft frame **3**.
- The camshaft bearings **4** and **6**, both upper and lower, are identical parts. When they are reassembled, however, be sure to reinstall them in their original positions, as they were before disassembly.
- The exhaust camshaft **5** and the inlet camshaft **7** have the same gears but use different cams. Use care not to confuse them at reassembly.
- As for the cylinder head gasket **9**, select and use one of proper thickness suitable for the projection of piston. The thickness of gaskets is identifiable by a difference in the shape of the notched portion **C**.
- The bolts **2** (× 13) are threaded into the cylinder head **8**, whereas the bolts **1** (× 2) are threaded into the front case *****.

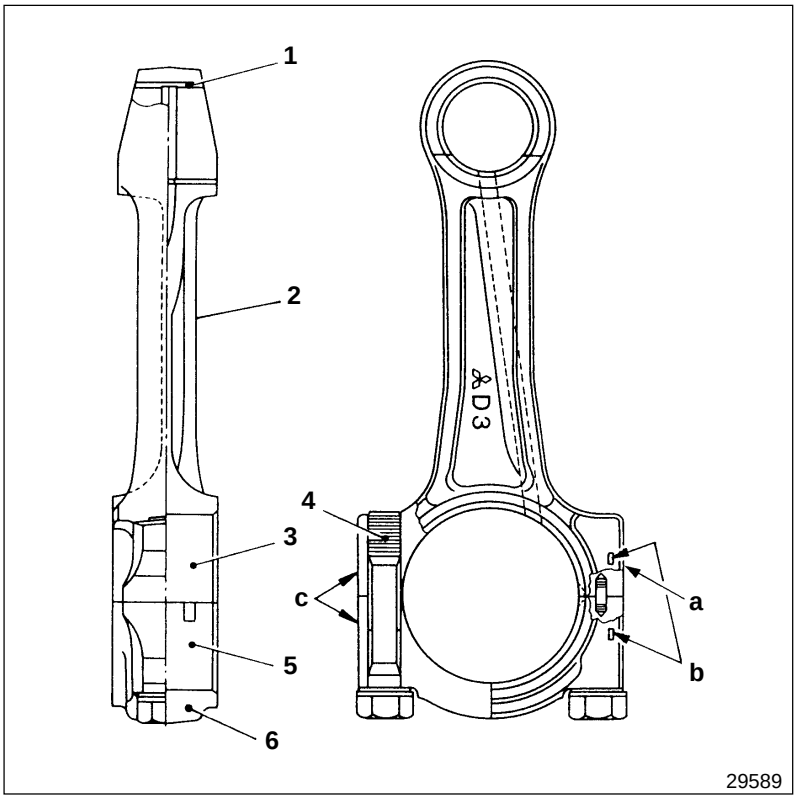
Valve Mechanism



1 Short rocker
2 Long rocker
3 Exhaust rocker shaft
4 Inlet rocker shaft
5 Exhaust camshaft
6 Valve collet
7 Upper retainer
8 Inlet camshaft
9 Outer valve spring
10 Inner valve spring
11 Cylinder head
12 Inlet valve guide
13 Inlet valve
14 Inlet valve seat
15 Exhaust valve
16 Exhaust valve seat
17 Exhaust valve guide
18 Valve stem seal
19 Rocker shaft spring

- The rockers come in two types; short rockers **1** and long rockers **2**, and are mounted in different directions as illustrated.
- The valve springs include the outer springs **9** and inner springs **10**. A pair of outer and inner springs are used for a valve.

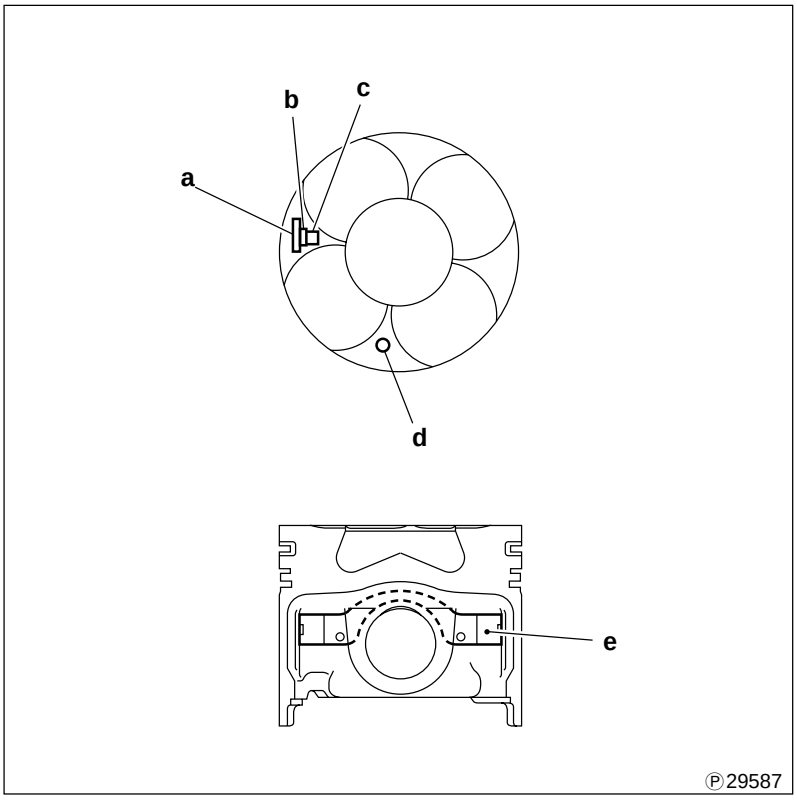
Connecting Rods



1 Connecting rod bushing
2 Connecting rod
3 Upper connecting rod bearing
4 Connecting rod bolt
5 Lower connecting rod bearing
6 Connecting rod cap

***a :** Weight mark stamp
"A" to "G"
(where "A" indicates the maximum connecting rod weight.)
***b :** Alignment mark
***c :** Alignment mark

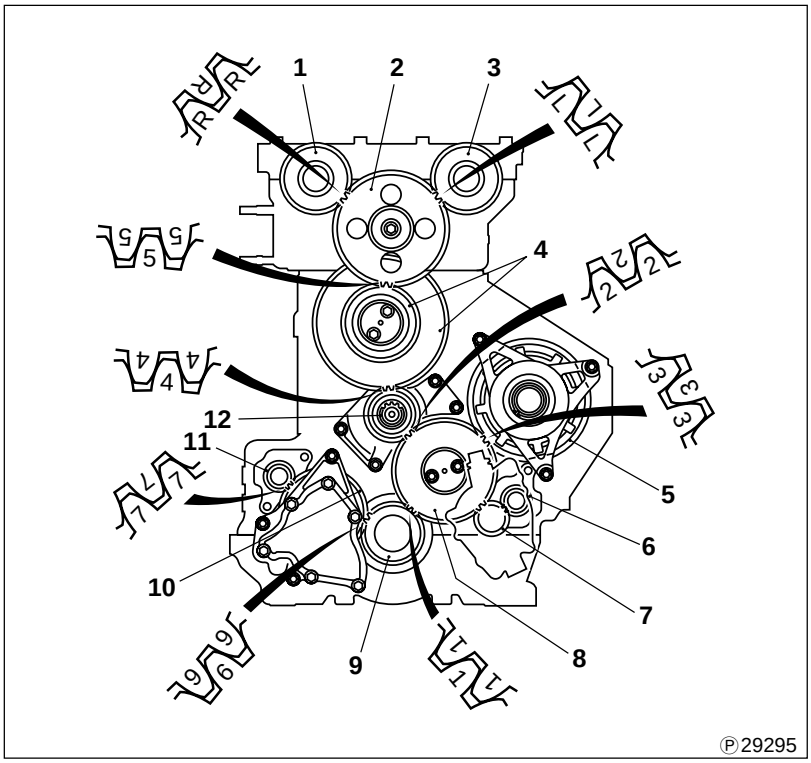
Pistons



a : Part number
b : Weight mark
c : Size mark
"**A**", "**B**"
Pistons marked "**B**" are larger than those marked "**A**" in the outside diameter.
d : Front mark
Indicated by "○".
e : Strut

- Pistons to be used can be selected by matching the size mark of the piston with that of the cylinder liner. 📖 P11A-11
- The piston is made of special aluminum alloy. Its total height is relatively low and both end faces of the piston in the direction of the piston pin are concaved for weight reduction.
- The piston is an autothermic piston reinforced with strut **e**.

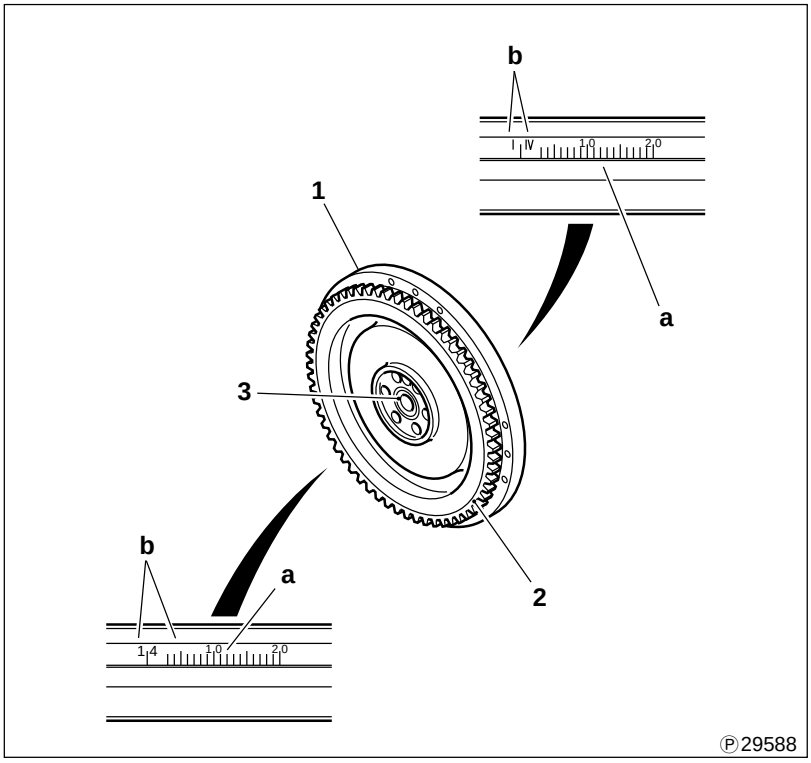
Timing Gears



1 Camshaft gear RH (32)
2 Head idler gear (54)
3 Camshaft gear LH (32)
4 Idler gear (63, 36)
5 Injection pump gear (56)
6 Balance shaft gear LH (14)
7 Vacuum pump gear (15)
8 No. 1 idler gear (49)
9 Crankshaft gear (28)
10 Oil pump gear (41)
11 Balance shaft gear RH (14)
12 Fan shaft (25)
Number of teeth shown in parentheses

Each of the timing gears (except the vacuum pump gear) has alignment marks to ensure correct assembly.

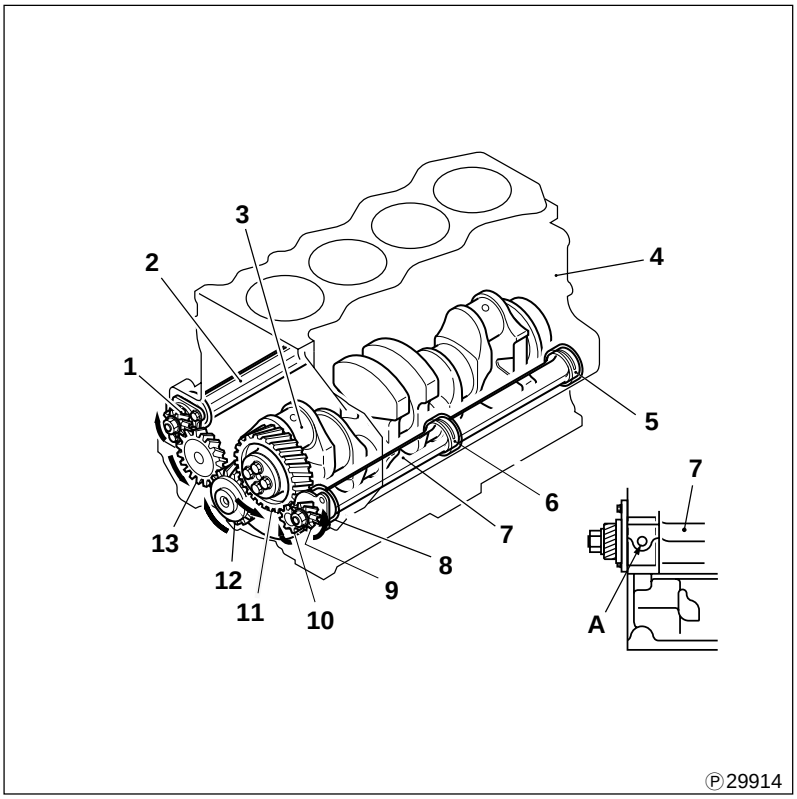
Flywheel



1 Flywheel
2 Ring gear
3 Pilot bearing

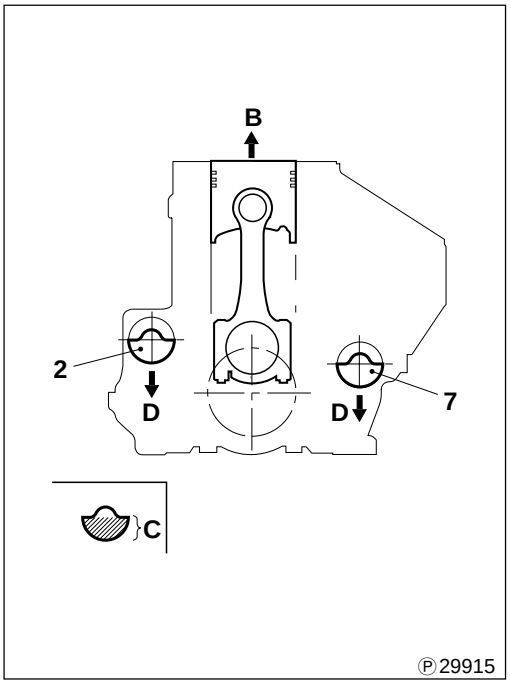
a : Angle scale
b : Cylinder No. (“1 4”, “I IV”)

Balance Shaft



1 Balance shaft gear RH
2 Balance shaft RH
3 Crankshaft
4 Upper crankcase
5 No. 3 balance shaft bushing
6 No. 2 balance shaft bushing
7 Balance shaft LH
8 No. 1 balance shaft bushing
9 Balance shaft gear LH
10 Vacuum pump gear
11 No. 1 idler gear
12 Crankshaft gear
13 Oil pump gear

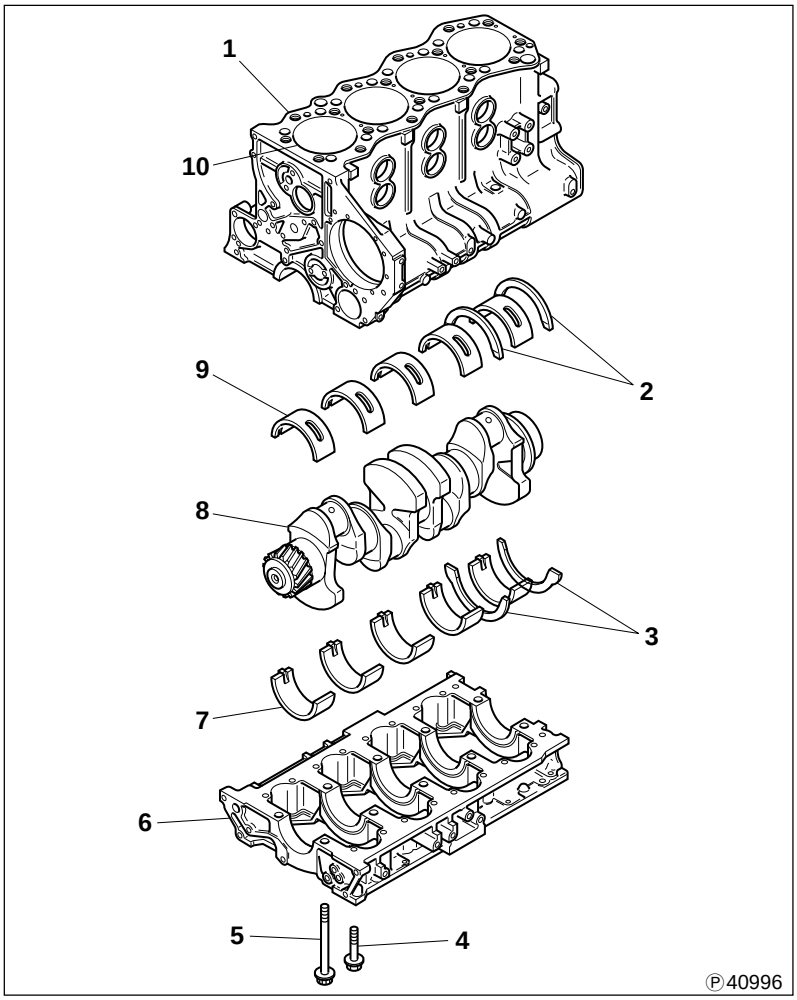
- The balance shafts RH **2** and LH **7** are mounted in the upper crankcase **4** with the crankshaft **3** sandwiched in between, and serve to reduce the engine vibration caused by rotation of the crankshaft.
- Both balance shafts RH **2** and LH **7** are supported by the three balance shaft bushings **5**, **6** and **8** mounted in upper crankcase **4** and driven by the timing gears (🕮 P11A-8).
- The balance shaft LH **7** is provided with a positioning hole **A** to ensure correct assembly. 🕮 P11A-63



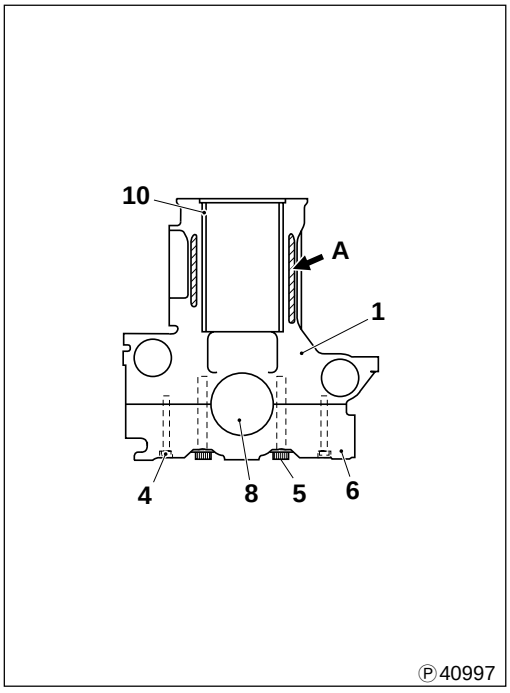
● **Reduction of vertical vibration (Secondary components)**

- The reciprocating motion of the piston produces inertial force **B**, the source of vertical vibration, at the top and bottom dead centers of the piston.
- The balance shafts RH **2** and LH **7** rotate in such a way that at the top and bottom dead centers of the piston, the semi-circular weight portion **C** will always be placed opposite to the piston head in terms of top or bottom position.
- As a result, at the top and bottom dead centers of the piston, both balance shafts RH **2** and LH **7** produce equal centrifugal force **D** to offset inertial force **B** of the piston, thereby reducing vertical vibration.
- In addition, in the medium and high engine speed ranges, the crankshaft rotation moments (secondary components) are also reduced by the balance shafts.

Crankcase and Main Bearings

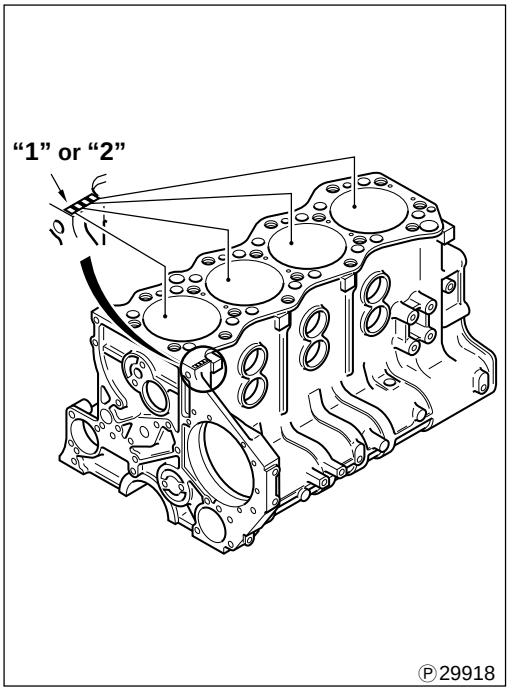


1 Upper crankcase
2 Upper thrust plate
3 Lower thrust plate
4 Bolt
5 Main cap bolt
6 Lower crankcase
7 Lower main bearing
8 Crankshaft
9 Upper main bearing
10 Cylinder liner

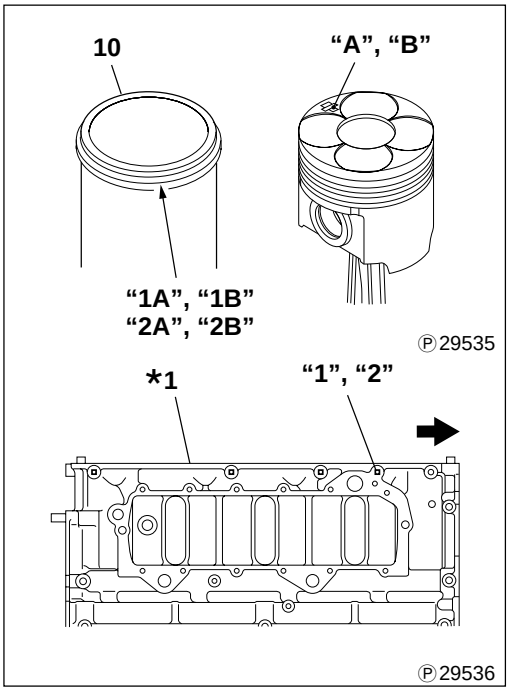


● **Crankcase**

- The crankcase is composed of two parts; upper crankcase **1** and lower crankcase **6**, which are coupled together with crankshaft **8** in between.
- The upper crankcase **1** has four cylinder bores provided into which cylinder liners **10** are fitted.
- Water jacket **A** is provided around the cylinders to cool down the cylinder liners **10**.
- The bolts **4** used to couple the upper crankcase **1** and the lower crankcase **6** and the main cap bolts **5** require the specified procedure to be followed when tightened. P11A-83



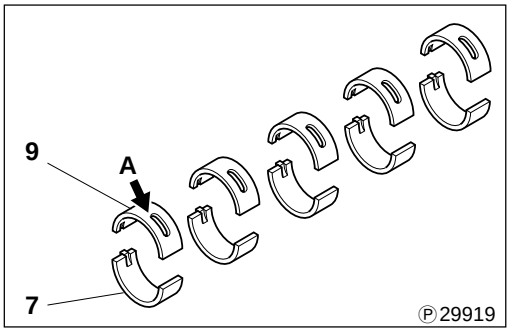
- Size mark "**1**" or "**2**" is stamped on the upper crankcase **1** for selective fitting of pistons in the crankcase.
- The size marks for the four cylinders are collectively stamped at a single location, and indicate the sizes of the respective cylinder liners as illustrated. P11A-7



● **Cylinder liner**

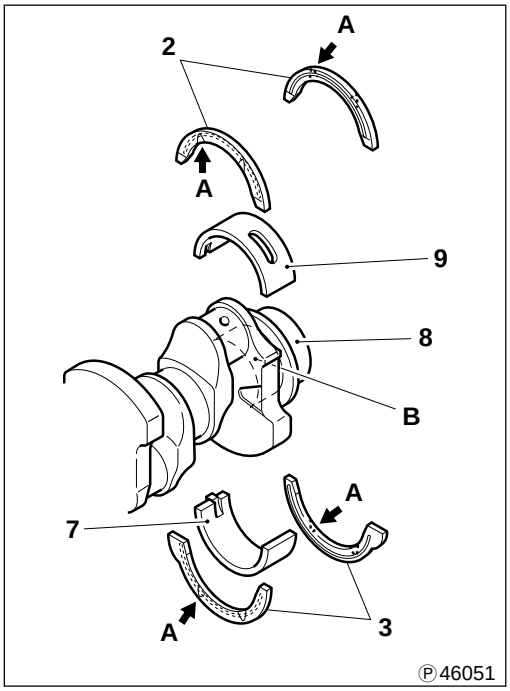
- Select a cylinder liner **10** which has the same size mark as those stamped on the upper crankcase ***1** the piston.
- The size marks on the upper crankcase ***1** are arranged in the order of No. **1**, **2**, **3** and **4** cylinders starting from the engine front **C**.

Size marks on upper crankcase	Size marks on cylinder liners	Size mark on pistons
"1"	"1A"	"A"
	"1B"	
"2"	"2A"	"B"
	"2B"	



● **Main bearings**

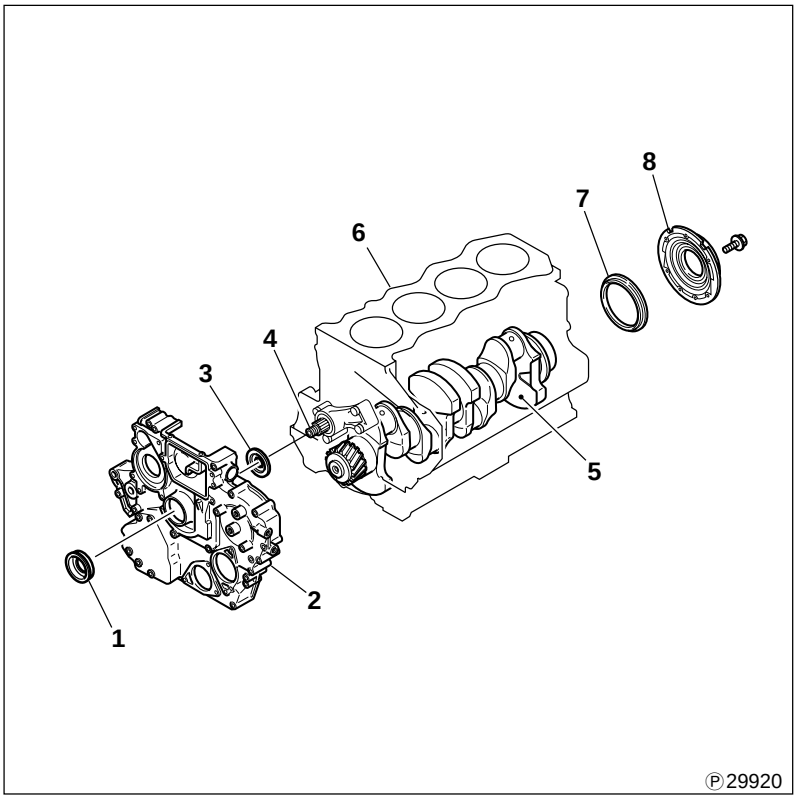
The upper main bearing **9** has an oil hole **A** through which engine oil is supplied to the journal of the crankshaft **8**.



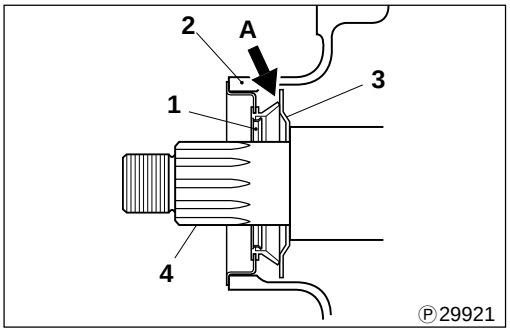
● **Thrust plates**

- The thrust plates include upper thrust plates **2** and lower thrust plates **3**. They are mounted at both ends of the upper main bearing **9** and the lower main bearing **7** at the rearmost portion of the crankshaft **8**.
- The thrust plates to be used should have a proper thickness suitable for the end play of the crankshaft **8**.
  Each thrust plate has an oil groove in two places to assure its smooth sliding on the journal **B** of the crankshaft **8**.

Oil Seals

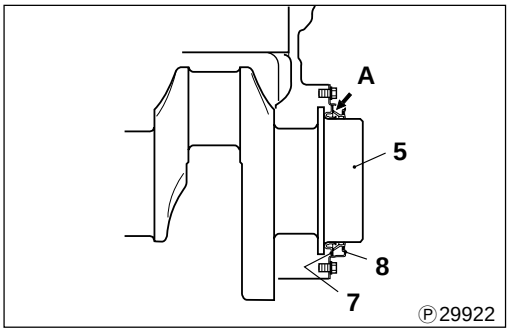


1 Front oil seal
2 Front case
3 Front oil seal slinger
4 Fan shaft
5 Crankshaft
6 Crankcase
7 Rear oil seal slinger
8 Rear oil seal



● **Front Oil Seal**

- The front oil seal **1** is mounted on the front case **2**. Its lip **A** is in contact with the front oil seal slinger **3** for sealing.
- The front oil seal slinger **3** is fitted on the fan shaft **4**.



● **Rear Oil Seal**

- The rear oil seal **8** is mounted on the crankcase **6**. Its lip **A** is in contact with the rear oil seal slinger **7** for sealing.
- The rear oil seal slinger **7** is press-fitted on the rear end of the crankshaft **5**.

TROUBLESHOOTING

Possible Causes \ Symptoms		Low power output	Abnormal engine noise	Remarks
Cylinder head and valve mechanism	Incorrect valve clearance	○	○	
	Defective cylinder head gasket	○	○	
	Worn valve and valve seat, and deposited carbon	○	○	
	Weakened valve spring	○	○	
	Defective rocker shaft and bracket		○	
	Poor lubrication of rocker shaft bracket		○	
Timing gears	Incorrect backlash in timing gears		○	
	Poor lubrication of timing gear peripheries and idler shafts		○	
Camshaft	Excessive end play in camshaft		○	
	Worn camshaft		○	
Pistons and connecting rods	Worn/damaged piston ring groove(s)	○	○	
	Worn/damaged piston ring(s)	○	○	
	Worn piston pin and connecting rod small end bushing		○	
Crankshaft	Excessive end play in crankshaft		○	
	Incorrectly fitted fan pulley		○	
	Worn/damaged crankshaft pin and connecting rod bearing		○	
	Worn/damaged crankshaft journal and main bearing		○	
Fuel	Defective bearing in injection pump bearing housing		○	
	Faulty injection nozzle spray condition	○	○	Gr 13A
	Incorrect injection timing	○	○	Gr 13A
	Air trapped in fuel system	○		Gr 13A
Cooling	Defective cooling system	○		Gr 14A
	Loose/damaged V belt		○	
Intake and exhaust	Clogged air cleaner	○	○	Gr 15A
	Clogged muffler	○	○	
Incorrect oil viscosity		○		
Improper fuel		○		
Incorrectly fitted piping, hose, etc.			○	
Defective/incorrectly fitted auxiliaries like injection pump and alternator			○	

MEMO

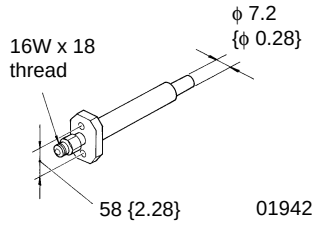
ON-VEHICLE INSPECTION AND ADJUSTMENT

Measuring Compression Pressure
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Compression pressure	Each cylinder (at 200 rpm)	2550kPa {370 psi, 26 kgf/cm²}	1960 kPa {285 psi, 20 kgf/cm²}	Inspect
		Cylinder-to-cylinder pressure difference	–	0.4 kPa {57 psi, 4 kgf/cm²}	Inspect

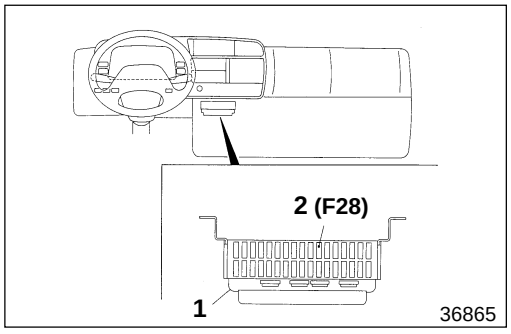
Special tools

Unit: mm {in.}

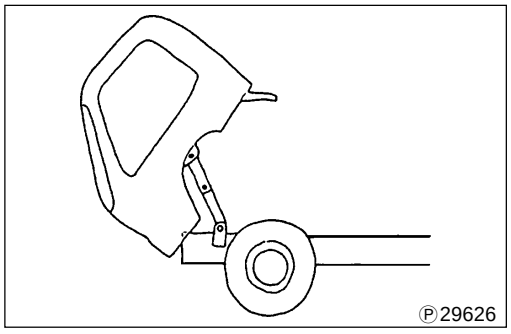
Location	Tool name and shape	Part No.	Application
–	Compression Gauge Adapter 	MH063434	Measuring compression pressure

A drop in compression pressure should be used as a guide in determining a time to overhaul the engine.
Measure the compression pressure at regular intervals, and keep track of its transition which will provide a useful tool for troubleshooting. On a new vehicle, or for a while after replacement of parts with new ones, the compression pressure will be somewhat higher, depending on the break-in condition of piston rings, valve seats, etc., but will return to normal as the parts wear down.

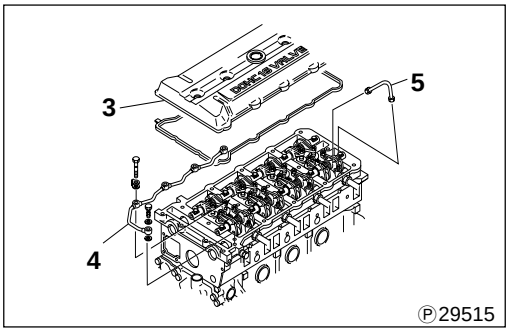
- Prior to an inspection, check to ensure that the engine oil, starter and battery are in normal condition.
- Place the vehicle in the following condition.
  - Warm up the engine until the coolant temperature reaches approx. 75 to 85 °C {167 to 185 °F}.
  - Turn off the lights and auxiliaries.
  - Place the transmission in neutral.
  - Place the steering wheel in the straight-ahead position.



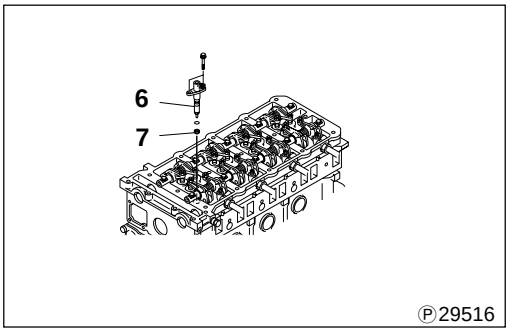
- Remove the fuel cut motor fuse **2** from the fuse box **1** in the cab to make sure that the fuel is not injected when the engine is cranked by the starter.



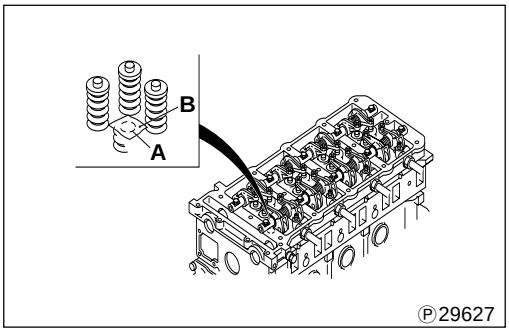
- Tilt the cab.



- Remove the rocker cover **3**, fuel leak-off pipe **4** and injection pipe **5**.
  P11A-24



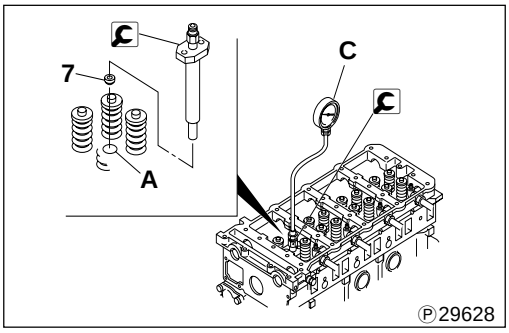
- Remove all injection nozzle assemblies **6** and nozzle gaskets **7**.
  P11A-38



- Cover the injection nozzle mounting holes with pieces of waste cloth **B**. After cranking the engine by the starter, check to ensure that no foreign substances are deposited on the waste cloth.

WARNING ⚠

If there is a crack in any of the cylinders, some of the coolant, engine oil, fuel, etc. will enter the cylinder through the crack. If the engine is cranked in such a condition, these substances heated to high temperatures will blow out from nozzle mounting holes A and can be very dangerous. When the engine is cranked, therefore, stay away from the nozzle mounting holes.



- Fit the nozzle gasket **7** and the Compression Gauge Adapter onto the injection nozzle mounting hole **A** and mount the compression gauge **C**.
- Crank the engine and measure the compression pressure.
- On all of the cylinders, measure the compression pressure and determine the pressure difference between cylinders.
- If any compression pressure or cylinder-to-cylinder pressure difference is out of the limits, pour in a small amount of engine oil from injection nozzle mounting hole **A** and check by measuring the compression pressure again.
  - If the compression pressure increases:
    Worn/damaged piston rings and cylinder inner surfaces are suspected.
  - If the compression pressure remains unchanged:
    A seized valve, incorrectly seated valve or defective cylinder head gasket is suspected.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspecting and Adjusting Valve Clearances

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
–	Valve clearance (when cold)	Inlet	0.4 {0.016}	–	Adjust
		Exhaust	0.5 {0.020}	–	Adjust

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (adjusting screw tightening)	11.2 {8.25, 1.14}	–

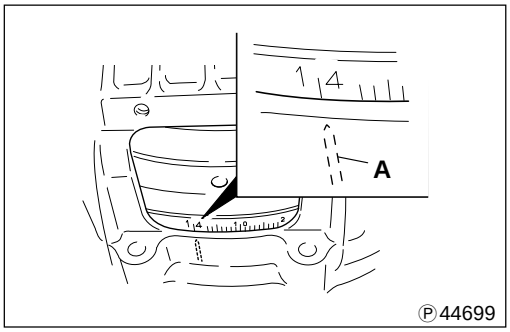
Special tools

Location	Tool name and shape	Part No.	Application
–	Cranking handle Ⓟ45041	MH063568 < without refrigerator > MH063569 < with refrigerator >	Turning fan pulley

Valve clearances should be checked and adjusted as follows while the engine is cold.

[Inspection]

- Tilt the cab.
- Remove the rocker cover. P11A-24
- To place the piston No. 1 or No. 4 at the top dead center on the compression stroke, crank the engine until the pointer **A** in the converter housing (on automatic transmission) inspection window is aligned with the mark between "**1** and **4**" inscribed in the flywheel.

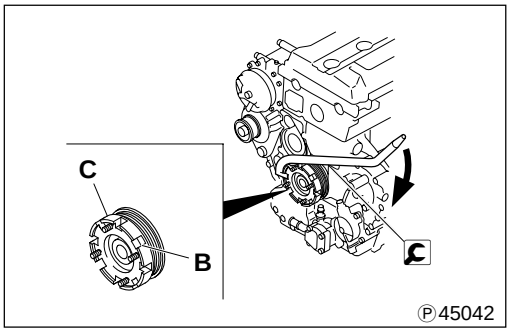


Ⓟ44699

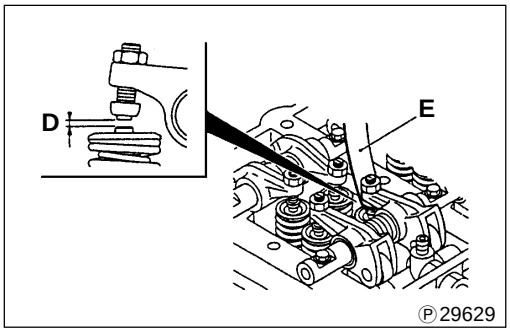
NOTE

Find the cylinder where the rocker arms for both the inlet and exhaust valves can be pushed down. The piston of the cylinder is at the top dead center (TDC) on the compression stroke.

- Use the cranking handle to crank the engine: set it in the groove **B** located on the outer circumference of the fan pulley **C** to turn the crank shaft.



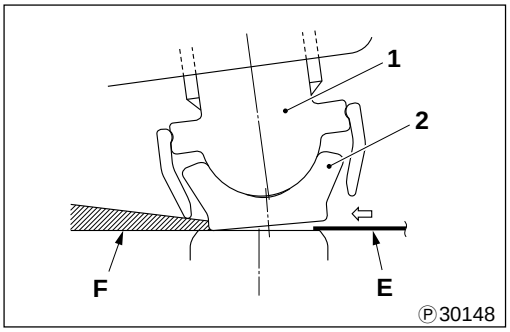
Ⓟ45042



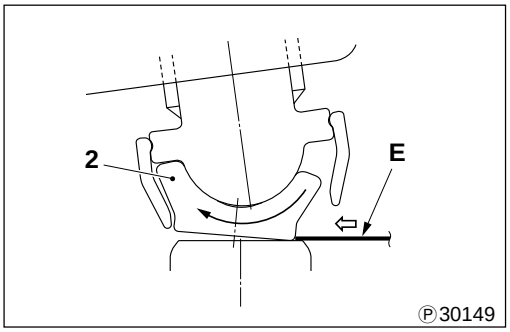
Ⓟ29629

- With the piston No. 1 or No. 4 at the top dead center (TDC) on the compression stroke, measure the valve clearance **D** at the valves marked × in the following table.

Cylinder No.	1		2		3		4	
Valve arrangement	IN	EXH	IN	EXH	IN	EXH	IN	EXH
Piston No. 1 at TDC on compression stroke	×	×	×	–	–	×	–	–
Piston No. 4 at TDC on compression stroke	–	–	–	×	×	–	×	×



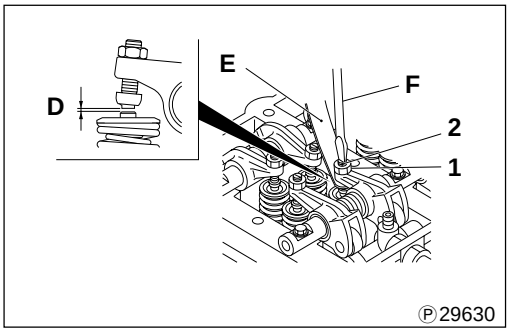
- When measuring the clearances, push the pad **2** of the adjusting screw **1** with the tip of a plain screwdriver **F** or something else from opposite the side where the feeler gauge **E** is to be inserted to open a gap as illustrated, then insert the feeler gauge in the gap.



- If an attempt is made to insert a feeler gauge **E** without opening a gap, the pad will be tilted as illustrated, making it impossible to insert the feeler gauge.

NOTE

- **The feeler gauge E must have a slight drag when taking a measurement.**
- **If the feeler gauge moves without any resistance, the measurement is incorrect (too loose).**

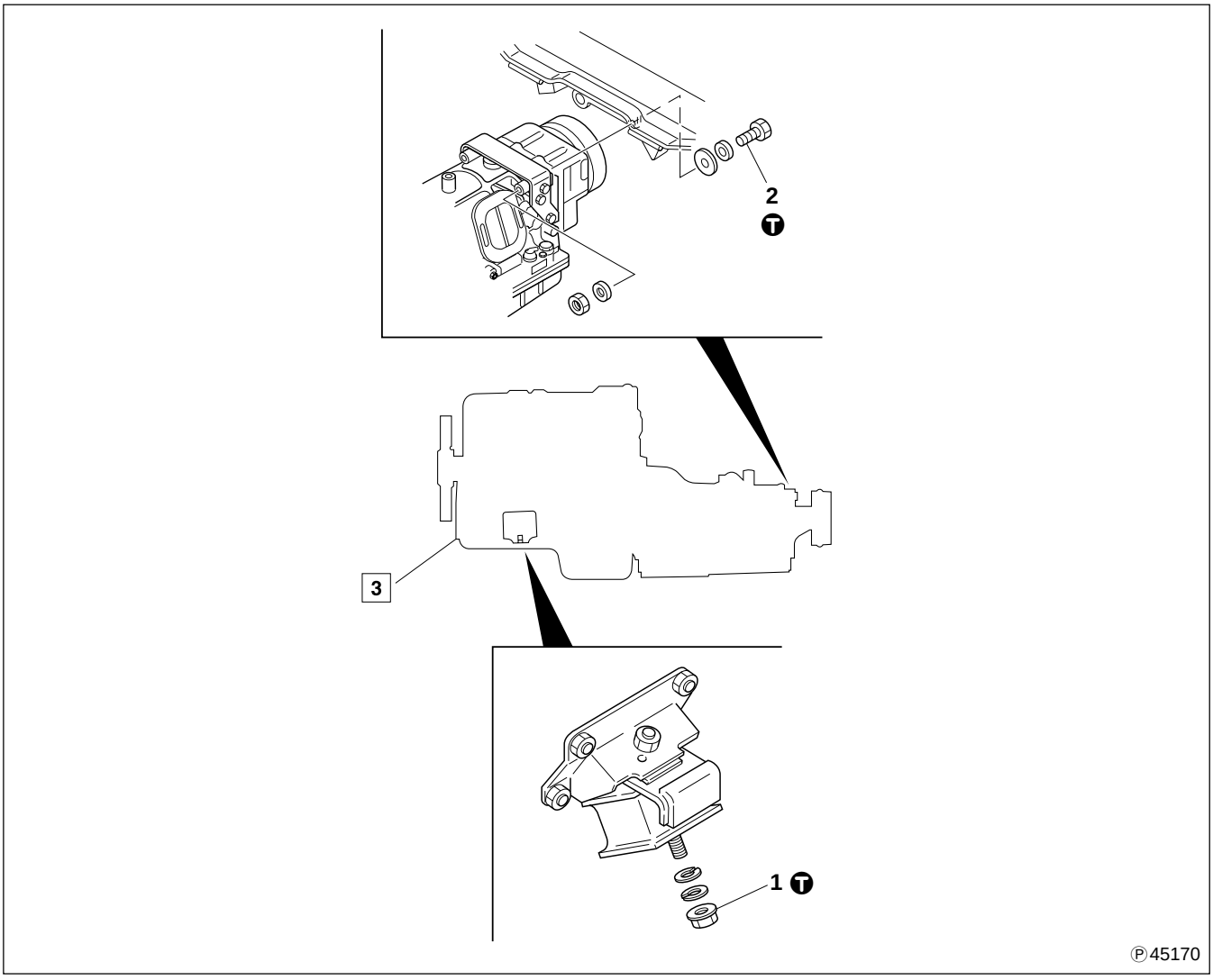


- If the reading is out of specification, adjust by the following procedures.

[Adjustment]

- To adjust the valve clearance **D**, loosen the lock nut **1** and rotate the adjusting screw **2** to adjust the clearance to the extent that the feeler gauge **E** is somewhat hard to move.
- After the adjustment, hold the adjusting screw **2** in position with a screwdriver **F** and tighten the lock nut **1** to the specified torque.
  Thereafter, re-check the valve clearance **D** with the feeler gauge **E**.

REMOVAL AND INSTALLATION OF ENGINE



● **Removal Squence**

1 Nut
2 Bolt
3 Engine and automatic transmission assembly

WARNING ⚠

When lifting the engine and automatic transmission assembly 3, be sure to use a lifting gear or engine hoist capable of lifting an engine of 3.9 to 4.7 kN {880 to 1060 lbs, 400 to 480 kg}

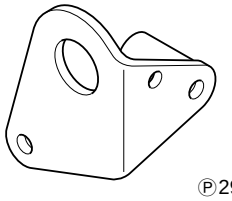
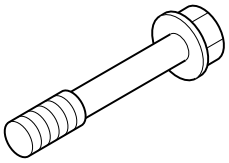
● **Intallation sequence**

Follow the removal sequence in reverse.

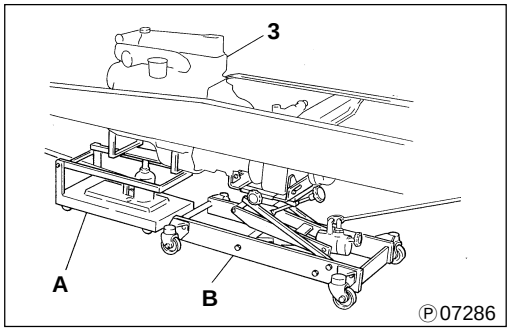
T Tightening torque Unit: N·m{ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (For attaching front mounting)	69 to 99 {51 to 65, 7 to 9}	–
2	Bolt (For attaching rear mounting)	83 to 105 {61 to 80, 8.5 to 11.0}	–

Special tools

Location	Tool name and shape	Part No.	Application
4	Engine front hanger  Ⓟ29983	MH062781	Removal and installation of engine
4	Flange bolt  Ⓟ29984	MF140234 MF140235	Mounting of hanger

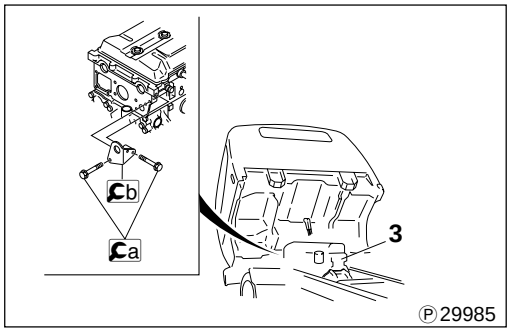
◆ Service procedure



Ⓟ07286

● **Preparatory operation for removal < Fixed cab >**

- Support engine and transmission assembly **3** on engine lifter **A** and transmission jack **B**.
- Make sure that the wiring and hoses are disconnected.

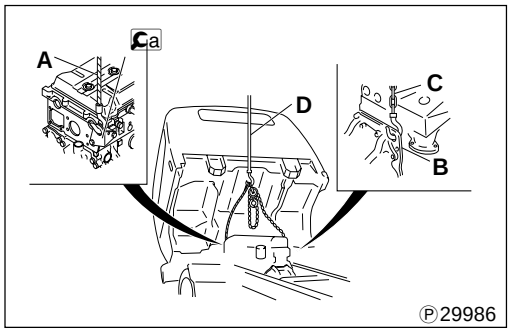


Ⓟ29985

3 **Removal of engine and transmission assembly**

Using a flange bolts, install b engine front hanger to engine and automatic transmission assembly **3**.

REMOVAL AND INSTALLATION OF ENGINE



- Attach wire rope **A** to Ca engine front hanger, and chain block **C** to rear plate **B**. Use crane **D** to make the ropes taut.

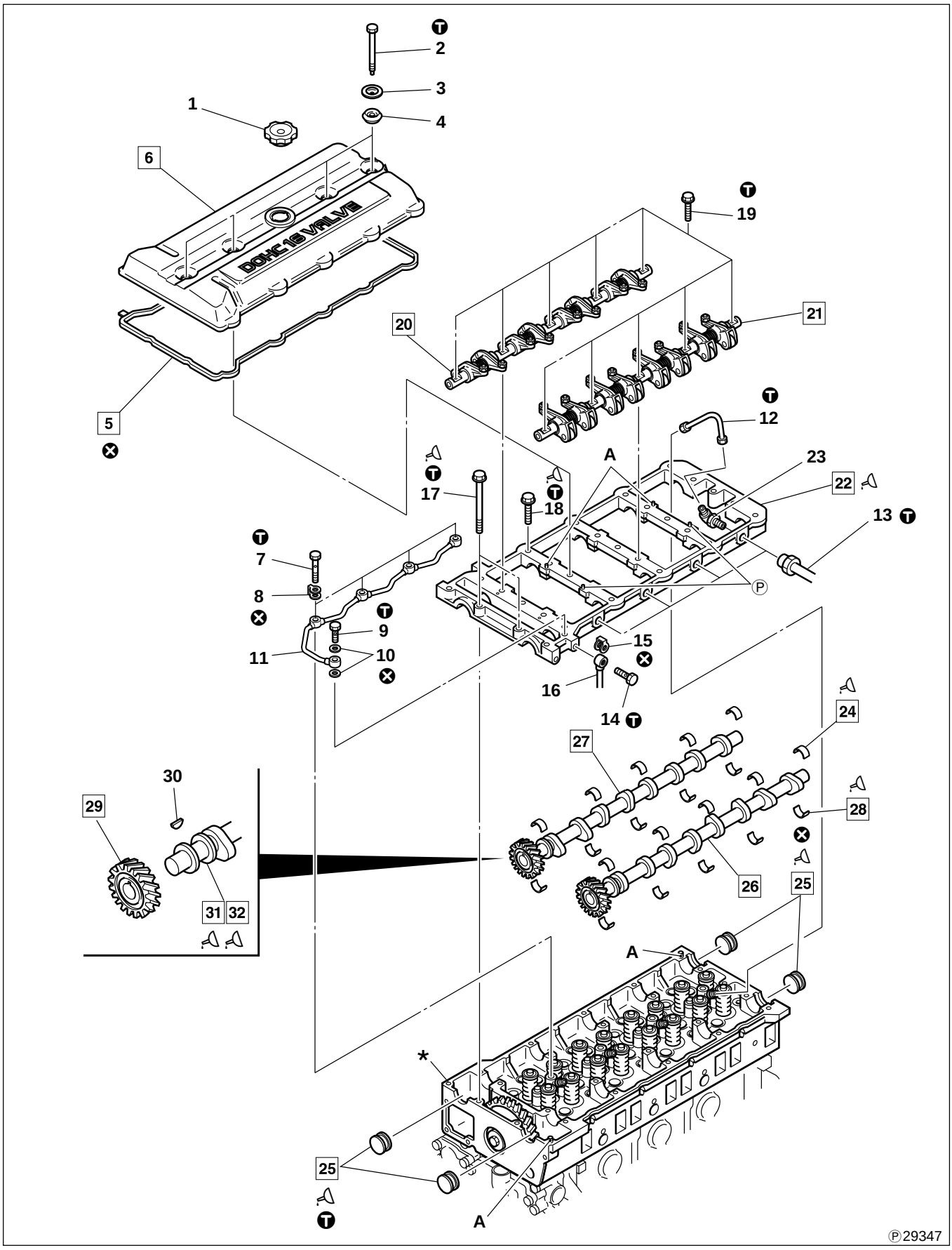
WARNING ⚠

To lift engine and automatic transmission assembly 3, use hanging hardware suitable for hoisting an engine weighing 3.9 to 4.7 kN {880 to 1060 lbs, 400 to 480 kg}.

- Make sure that harnesses and pipes are disconnected.
- Slowly lift engine and automatic transmission assembly **3**, making sure that the assembly does not contact the frame or cab.

MEMO

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS



● **Pre-disassembly inspection**

P11A-27

● **Pre-disassembly work**

Some work is necessary before disassembly. P11A-27

● **Disassembly sequence**

1 Oil filler cap
2 Bolt
3 Plate
4 Rubber grommet
5 Rocker cover gasket
6 Rocker cover
7 Eye bolt
8 Gasket
9 Eye bolt
10 Gasket
11 Fuel leak-off pipe
12 Injection pipe
Gr 13A
13 Injection pipe
Gr 13A
14 Eye bolt
15 Gasket
16 Fuel return pipe
Gr13A
17 Bolt (× 2)
18 Bolt (× 13)
19 Bolt (× 10)
20 Exhaust rocker shaft assembly
P11A-34
21 Inlet rocker shaft assembly
P11A-34
22 Camshaft frame
23 Injection pipe connector
24 Camshaft bearing (upper)
25 Packing
26 Inlet camshaft assembly
27 Exhaust camshaft assembly
28 Camshaft bearing (lower)
29 Camshaft gear
30 Key
31 Inlet camshaft
32 Exhaust camshaft

***** : Cylinder head assembly
P11A-38
Ⓟ : Locating pin
⊗ : Non-reusable part

NOTE

- **Avoid removing the camshaft gear 29 unless something wrong is evident.**
- **The camshaft frame 22 and the cylinder head assembly * have been machined jointly when manufactured. It is impossible to replace only either of the parts. Be sure not to change the combination.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
–	Backlash	Between head idler gear assembly and camshaft gear	0.09 to 0.12 {0.0035 to 0.0047}	0.3 {0.012}	Replace
		Between head idler gear assembly and idler gear assembly	0.11 to 0.14 {0.0043 to 0.0055}	0.3 {0.012}	
	End play	Camshaft assembly	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Check all the parts.
		Head idler gear assembly	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	
24, 28	Camshaft bearing free span		–	35.5 {1.39} or more	Replace

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
26	Inlet camshaft	Cam lift	For long rocker	7.157 {0.281}	7.107 {0.297}	Lobe height: 42.157 {1.66} Base circle diameter: 35 {1.38}
			For short rocker	9.202 {0.36}	9.152 {0.36}	Lobe height: 44.201 {1.74} Base circle diameter: 35 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace
		Journal oil clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.0063}	Replace
27	Exhaust camshaft	Cam lift	For long rocker	7.217 {0.284}	7.167 {0.282}	Lobe height: 42.217 {1.66} Base circle diameter: 35 {1.38}
			For short rocker	9.279 {0.365}	9.229 {0.363}	Lobe height: 44.279 {1.74} Base circle diameter: 35 {1.38}
		Bend		0.01 {0.00039}	0.03 {0.0012}	Replace
		Journal oil clearance		0.07 to 0.12 {0.0028 to 0.0047}	0.16 {0.0063}	Replace
29, 31, 32	Camshaft gear and camshaft interference			[30 {1.18}] 0.007 to 0.041 {0.00028 to 0.00160}	–	Replace

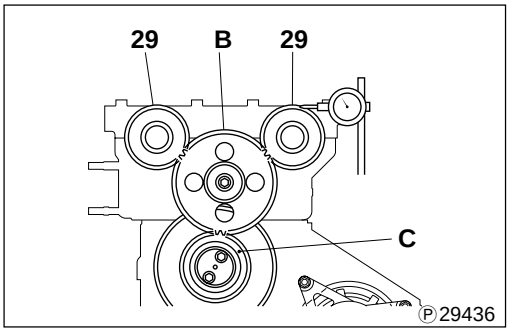
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (mounting rocker cover)	2.0 {14.0, 0.2}	–
7, 9	Eye bolt (mounting fuel leak-off pipe)	20.6 {15.0, 2.1}	
12, 13	Injection pipe	38.2 {28, 3.9}	–
14	Eye bolt (mounting fuel return pipe)	20.6 {15.0, 2.1}	–
17	Bolt (mounting camshaft frame)	23.5 {17.0, 2.4}	Wet
18	Bolt (mounting camshaft frame)	27.5 {20.0, 2.8}	Wet
19	Bolt (mounting rocker shaft assembly)	27.5 {20.0, 2.8}	Wet

Lubricant and sealant

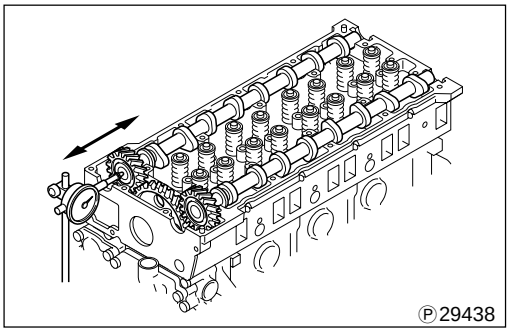
Location	Points of application	Specified lubricant and/or sealant	Quantity
17, 18	Bolt threads and seating surface	Engine oil	As required
22	Surface of camshaft frame which makes contact with cylinder head	THREEBOND 1207C or D	As required
24, 28	Inside surface of camshaft bearing	Engine oil	As required
25	Circumference of packing	THREEBOND 1207C or D	As required
31, 32	Journal and cam portions of camshaft	Engine oil	As required



● **Pre-disassembly inspection**

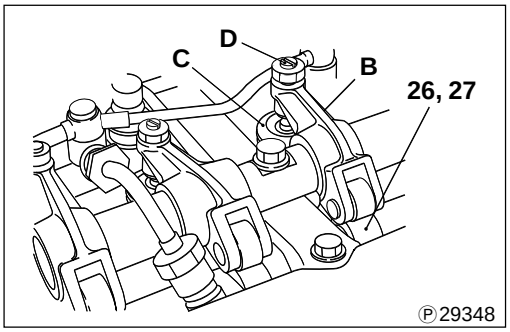
(1) Backlash between head idler gear B and camshaft gear 29 and idler gear assembly C

On a pair of gears, measure backlash at more than three positions. If the reading is more than the limit, replace defective parts.



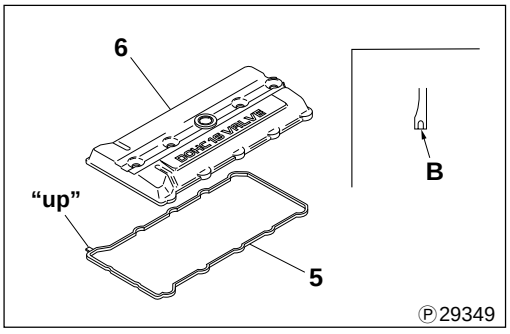
(2) End play of camshaft

If the reading is more than the limit, replace defective parts.



● **Pre-disassembly work**

If the rocker **B** forced up by the camshaft **26** or **27** is pressing the valve spring **C** down, loosen the adjusting screw **D** of the rocker to set the valve spring free.



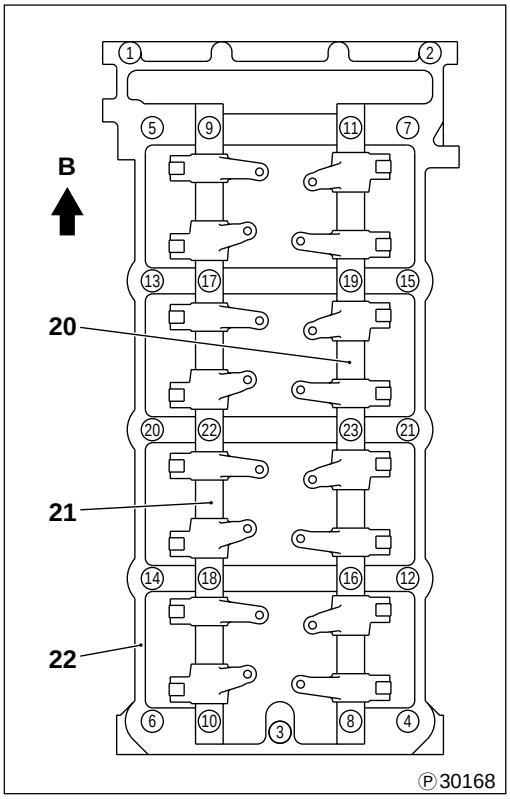
◆ Service procedure

5 **6** **Installation of rocker cover and rocker cover gasket**

- Before installing the rocker cover **6**, remove oil and other deposits thoroughly from the gasket groove **B**.
- Face the rocker cover gasket **5** as illustrated when it is installed on the rocker cover **6**.

CAUTION ⚠

Make sure that the rocker cover gasket 5 is not twisted when installed.

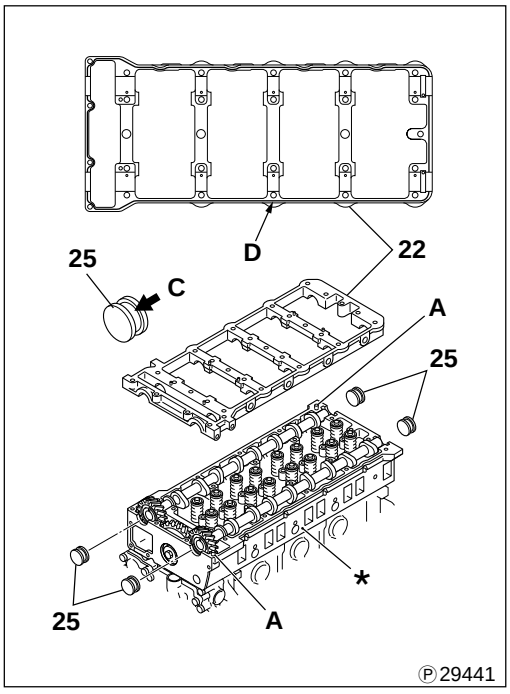


20 to **22** , **25** **Rocker shaft assemblies, camshaft frame and packing**

[Removal]

Loosen the bolts **18** and **19** (① through ㉓) one after another, a small amount at a time, in the numbered sequence shown in the illustration. Then remove the rocker shaft assemblies **20** and **21** and the camshaft frame **22**.

B : Front of engine



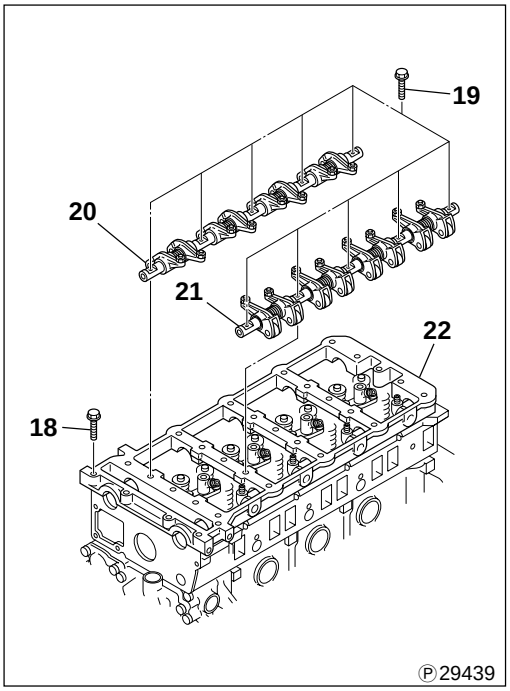
[Installation]

- Apply an even bead of sealant (ϕ 2 ± 1 mm {ϕ 0.079 ± 0.039}) without any break to all around the illustrated portion **C** of the four packings **25**.
- Apply an even bead of sealant (ϕ 1 mm {0.039}) without any break on the circumference **D** of the camshaft frame **22**.
- After the sealant application, install the camshaft frame **22** and the packings **25** on the cylinder head assembly * in less than three minutes.

CAUTION ⚠

- **Check to ensure that the sealant application surfaces C and D are clean and free from any oil or other deposits.**
- **When installing the parts, make sure that the sealant is not forced out of position.**
- **Do not start the engine in less than an hour after installation.**

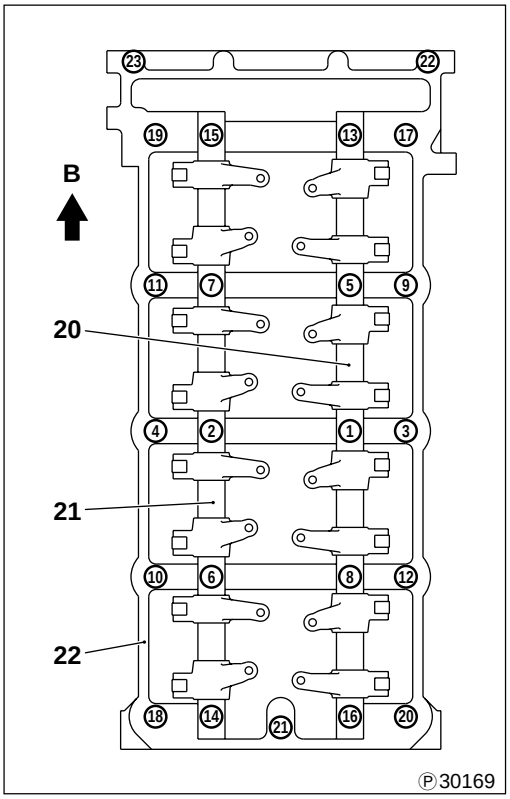
A : Locating pin



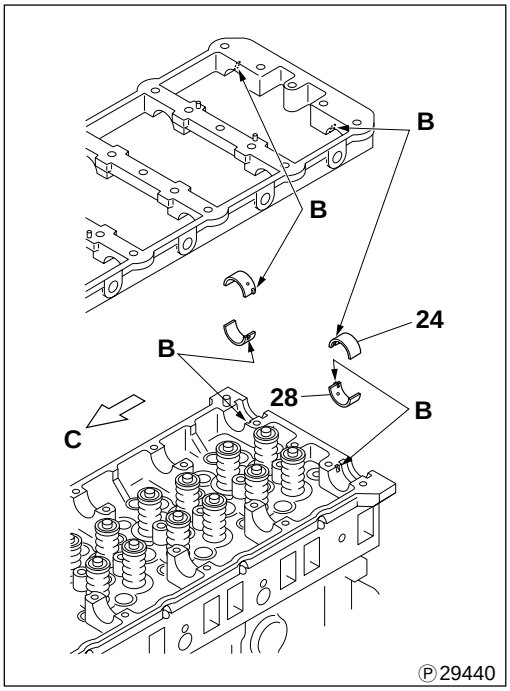
- The bolts **18** (× 13) and **19** (× 10) must be tightened in the following sequence. Therefore, secure the rocker shaft assemblies **20** and **21** together with the camshaft frame **22**.

CAUTION ⚠

When the bolts 18 and 19 were loosened or removed after installation, be sure to re-apply sealant.



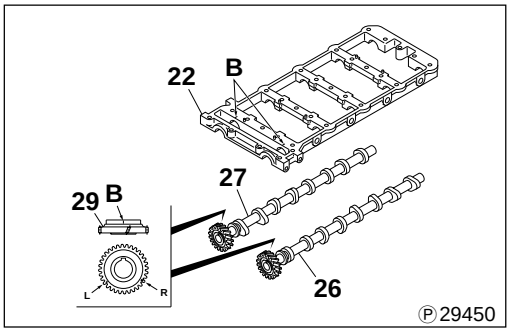
- Tighten the bolts **18** and **19** (① through ㉓) to the specified torque in the numbered sequence shown in the illustration.



24 **28** **Installation of camshaft bearings**

Be sure to fit the lugs **B** of the camshaft bearings **24** and **28** in the mating notches.

C : Front of engine

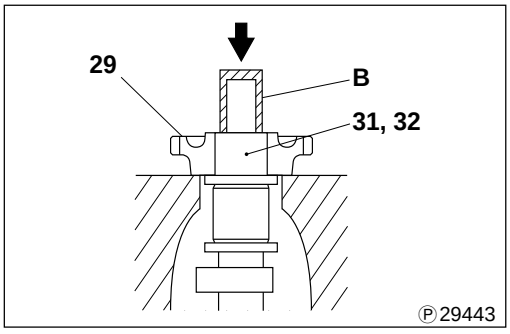


26 **27** **Installation of camshaft assemblies**

- Place the piston of No. 1 cylinder at the top dead center on the compression stroke.
- Install the camshaft assemblies **26** and **27** with the alignment marks **B** on the camshaft gear **29** and on the camshaft frame **22** in alignment.

NOTE

The alignment marks "L" and "R" on the camshaft gear 29 and those on the head idler gears need not always be in alignment, because the alignment mark of the head idler gears, depending on their mounted condition, does not always match that of the camshaft gear.



29 **Camshaft gear**

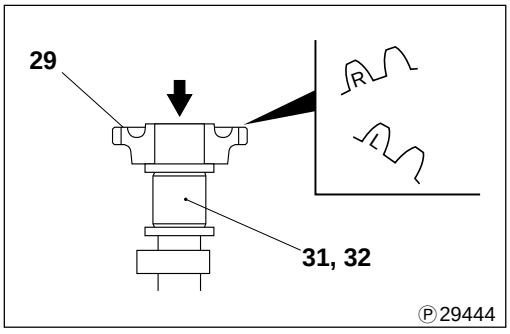
[Removal]

Remove the camshaft gear **29** by pressing the camshaft end with a press.

B : Removal block

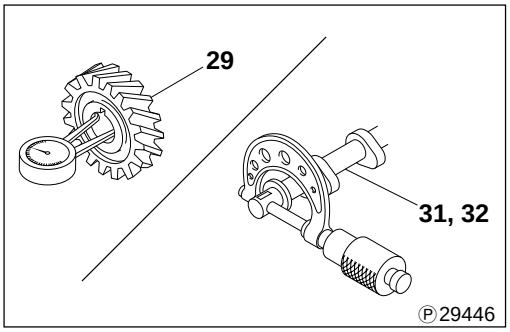
CAUTION ⚠

Never strike the camshaft gear 29 with a hammer to remove it. Be sure to use a press or a similar tool.



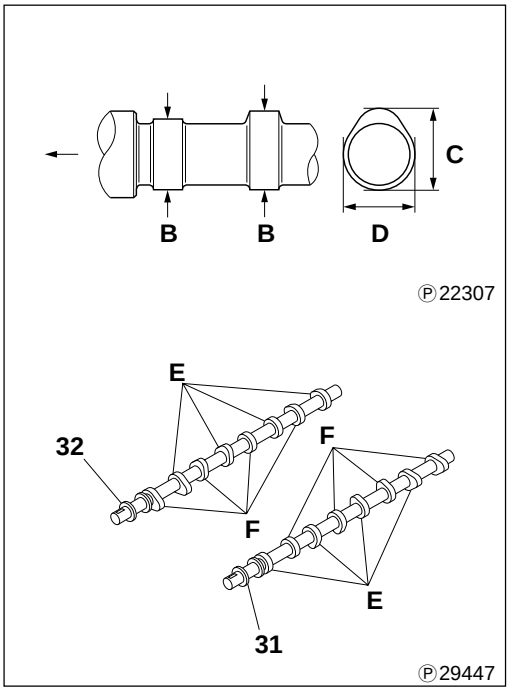
[Installation]

- Heat the camshaft gear **29** to 150 °C {302°F} by a piston heater or a similar tool and install it with the alignment mark "R" or "L" directed as shown.
- Install the camshaft gear **29** such that it is held tightly against the camshaft **31** or **32**.



29 31 32 Camshaft gear and camshaft interference

If the reading is out of the standard values, replace defective parts.



31 32 Inspection of camshafts

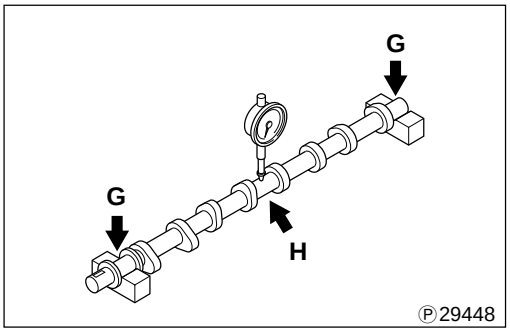
(1) Cam lift (Difference between lobe height and base circle diameter)

If the reading is less than the limit, replace the camshafts **31** and **32**.

B : Measuring position
C : Cam lobe height
D : Base circle diameter
E : Long rocker side cam
F : Short rocker side cam

NOTE

The cam dimensions are different between the long rocker side cams E and the short rocker side cams F.

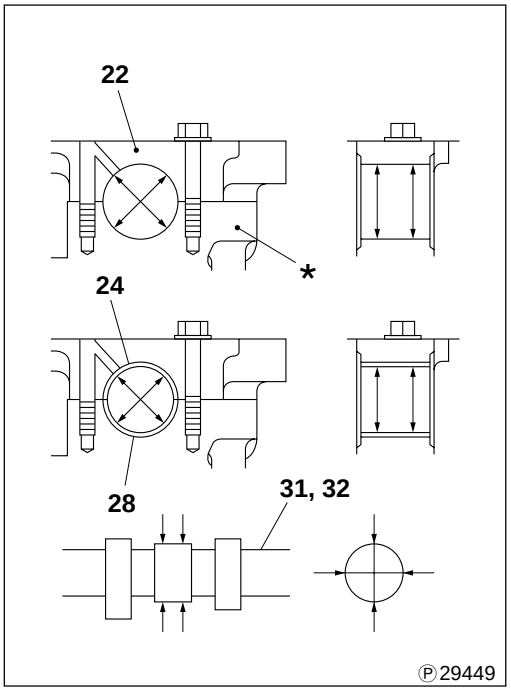


(2) Bend

Measure the bend of the camshafts **31** and **32** at the journal **H** with the journals **G** supported. If the reading is in excess of the limit, replace the camshaft.

NOTE

The bend of the camshafts 31 and 32 is one half of the reading of the dial indicator taken after turning the camshaft through a rotation.



(3) Oil clearance between journals and bearings

Measure the oil clearance. If the reading is in excess of the limit, replace defective parts.

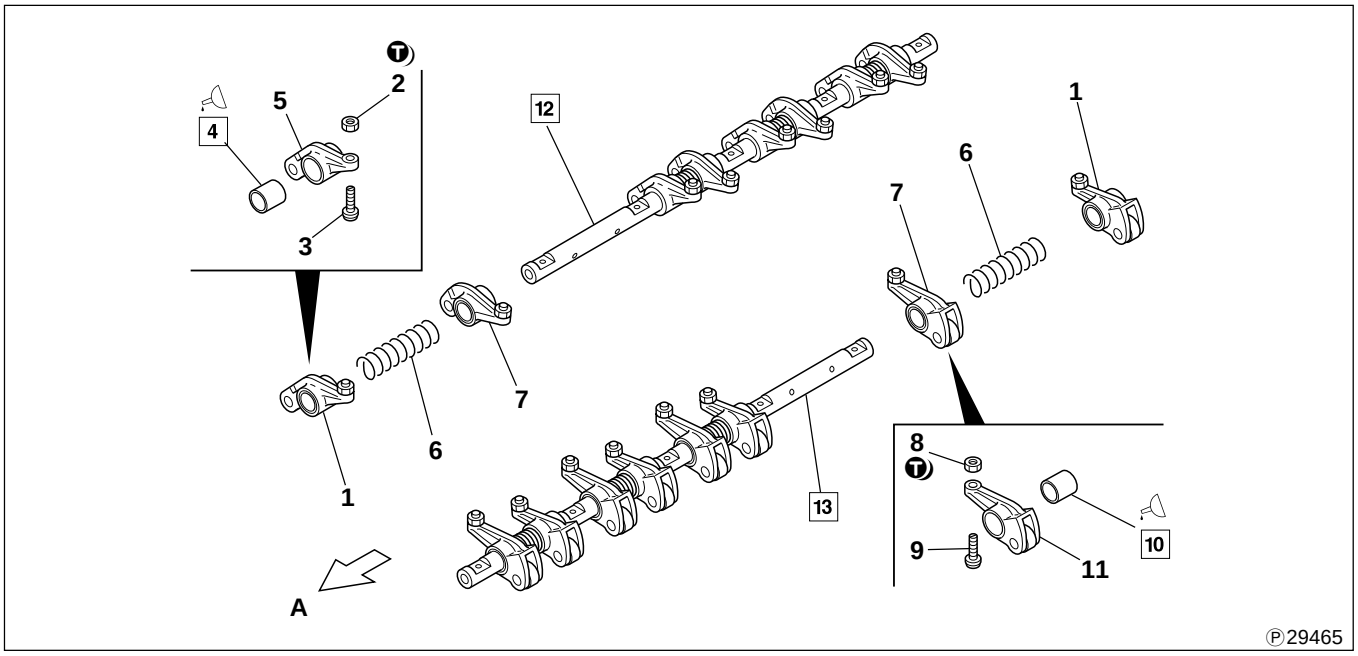
CAUTION ⚠

If a camshaft bearing 24 or 28 is to be replaced, make sure that both upper and lower halves are simultaneously replaced as a pair.

MEMO

ROCKER COVER, ROCKER ASSEMBLIES AND CAMSHAFTS

Rocker Shaft and Rocker Assembly



● Disassembly sequence

1 Short rocker assembly
2 Lock nut
3 Adjusting screw
4 Rocker bushing
5 Short rocker
6 Rocker shaft spring
7 Long rocker assembly
8 Lock nut
9 Adjusting screw
10 Rocker bushing
11 Long rocker
12 Exhaust rocker shaft
13 Inlet rocker shaft

A : Front of engine

● Assembly sequence

Follow the disassembly sequence in reverse.

CAUTION ⚠

The rockers come in two types; short rocker assembly 1 and long rocker assembly 7. Note the difference in mounting sequence between the inlet and exhaust rocker shafts.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1, 7	Radial play of rocker assembly rollers	0.038 to 0.100 {0.0014 to 0.0039}	–	Replace
4, 10, 12, 13	Clearance between rocker bushing and rocker shaft	[22 {0.87}] 0.01 to 0.08 {0.0039 to 0.0031}	0.12 {0.0047}	Replace

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

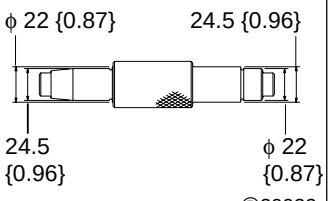
Location	Parts to be tightened	Tightening torque	Remarks
2, 8	Lock nut (securing adjusting screw)	11.2 {8.24, 1.14}	

Lubricant

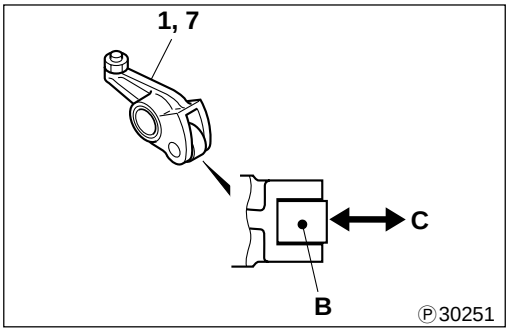
Location	Points of application	Specified lubricant	Quantity
4, 10	Inside of rocker bushing	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4, 10	Rocker Bushing Puller 	Use Equivalent	Installation and removal of rocker bushing

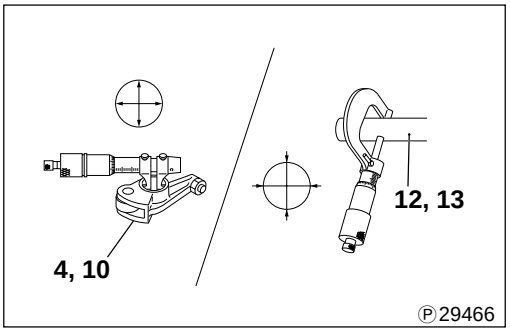
◆ Service procedure



1 **7** **Inspection of rocker assemblies**

If the play **C** of the roller **B** of the rocker assembly **1** or **7** are out of the standard values, replace the assembly.

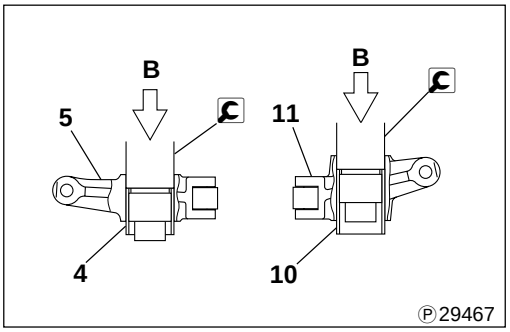
C : Radial play



4 **10** **12** **13** **Rocker bushing and rocker shaft**

[Inspection]

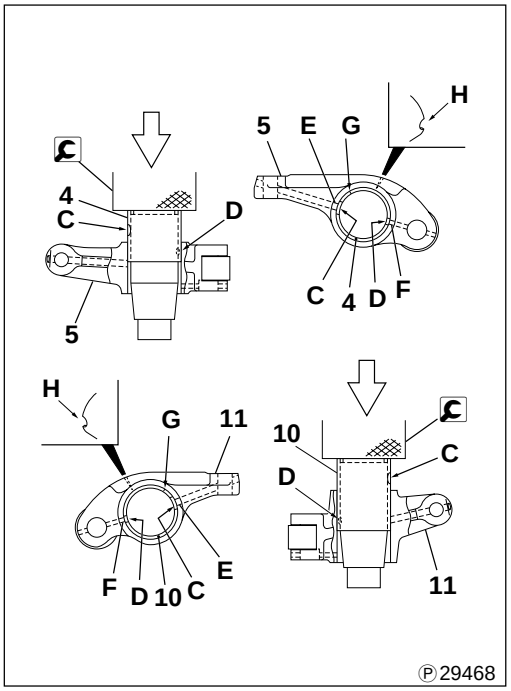
If the clearance is in excess of the limit, replace defective parts.



Rocker bushing

[Removal]

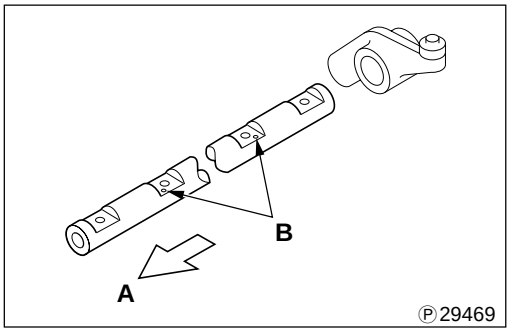
: Rocker Bushing Puller
B : Press



[Installation]

Install the rocker bushings **4** and **10** on the rockers **5** and **11** in the illustrated direction.

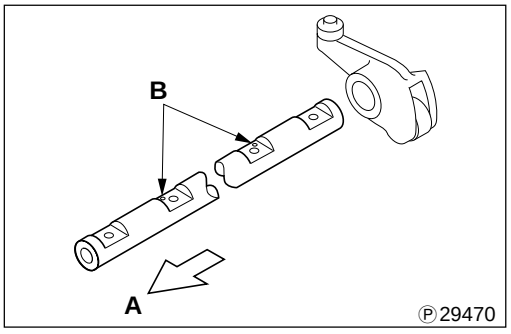
- **: Rocker Bushing Puller
- **C :** Rocker bushing oil hole
- **D :** Rocker bushing oil hole
- **E :** Rocker oil hole
- **F :** Rocker oil hole
- **G :** Rocker bushing clinch (seam)
- **H :** Rocker bushing notch (rear side)



12 Installation of exhaust rocker shaft

Install the exhaust rocker shaft **12** in the illustrated direction.

- **A :** Front of engine
- **B :** Camshaft frame locating pin mounting hole



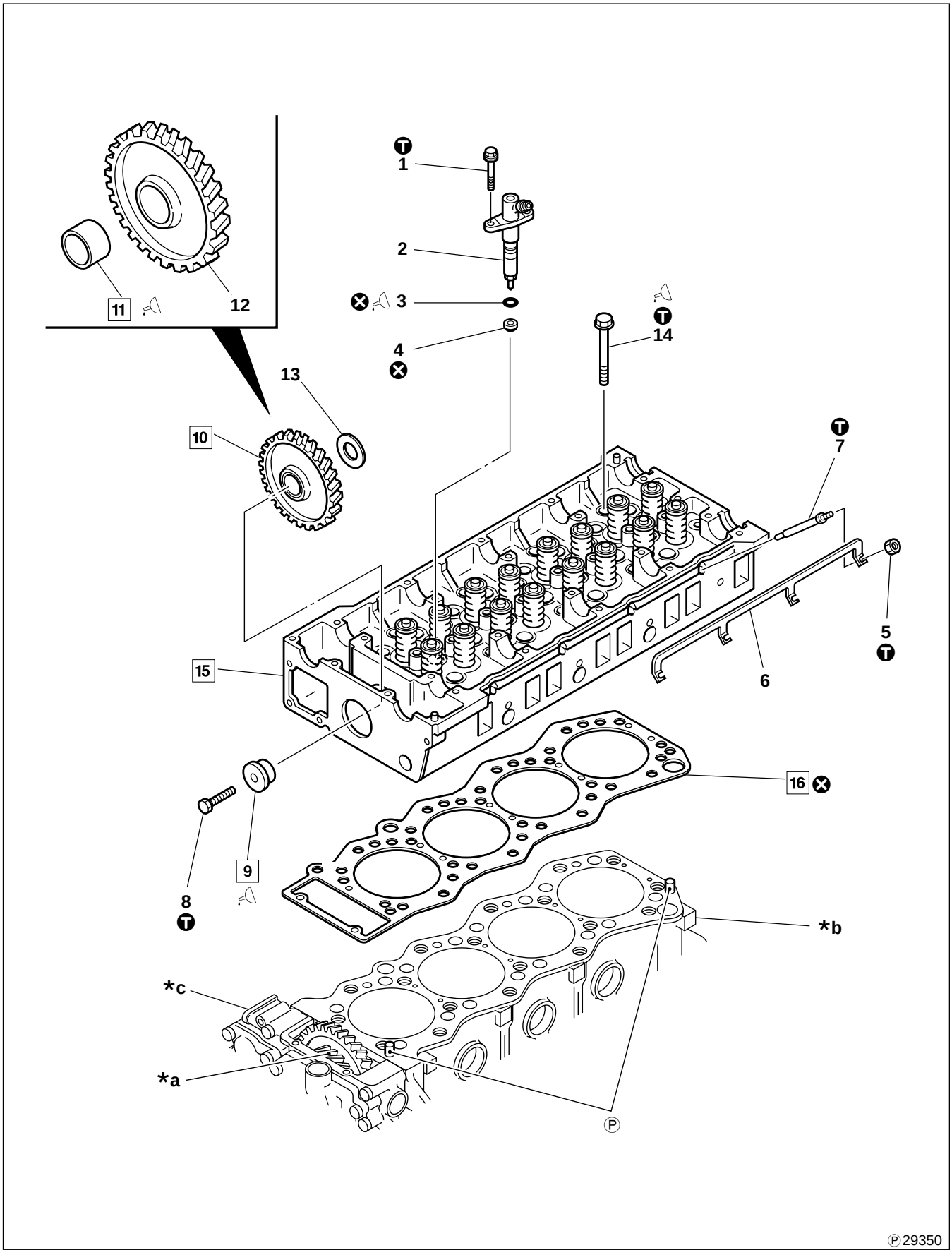
13 Installation of inlet rocker shaft

Install the inlet rocker shaft **13** in the illustrated direction.

- **A :** Front of engine
- **B :** Camshaft frame locating pin mounting hole

MEMO

CYLINDER HEAD AND VALVE MECHANISM



● **Pre-disassembly inspection**

P11A-40

● **Disassembly sequence**

1 Bolt
2 Injection nozzle Gr13A
3 O-ring
4 Nozzle tip gasket
5 Nut
6 Connecting plate
7 Glow plug
8 Bolt
9 Head idler shaft
10 Head idler gear assembly
11 Head idler gear bushing
12 Head idler gear
13 Thrust plate
14 Cylinder head bolt
15 Cylinder head assembly
P11A-44
16 Cylinder head gaskect

***a:** Idler gear assembly
P11A-56
***b:** Upper crankcase
P11A-80
***c:** Front case assembly
P11A-52

Ⓟ : Locating pin
⊗ : Non-reusable part

CAUTION ⚠

The cylinder head bolts 13, 14 utilize the torque-turn tightening method. Any cylinder head bolt that has apparently been tightened three times already must be replaced with a new one. P11A-41

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
9, 11	Head idler shaft and head idler gear bushing clearance	[32 {1.26}] 0.01 to 0.05 {0.00039 to 0.002}	0.1 {0.0039}	Replace

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

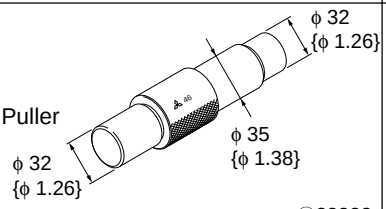
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (injection nozzle installation)	14.7 {11, 1.5}	–
5	Nut (connection plate installation)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	–
7	Glow plug	22.6 {17, 2.3}	–
8	Bolt (Head idler shaft installation)	51.0 {38, 5.2}	–
14	Cylinder head bolt	147 {110, 15} + 90°	Wet

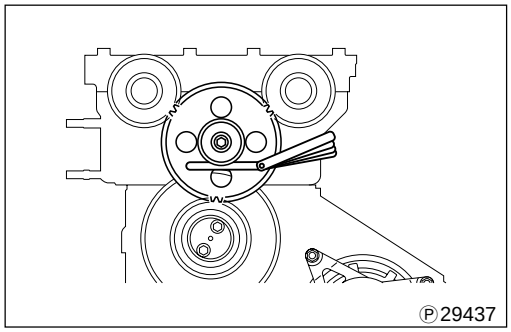
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	O-ring	Engine oil	As required
9	Outer surface of head idler shaft	Engine oil	As required
***c**	Upper surface of joint section between front case assembly and crankcase assembly and cylinder head gasket contacting surface	Threebond 1211	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
11	Idler Gear Bushing Puller 	MH061779	Removal and installation of idler gear bushing

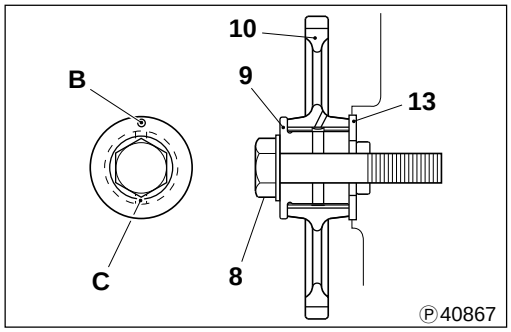


◆ Service procedure

● **Pre-disassembly inspection**

End play of head idler gear assembly

If any measurement exceeds the specified limit, replace the defective part(s).



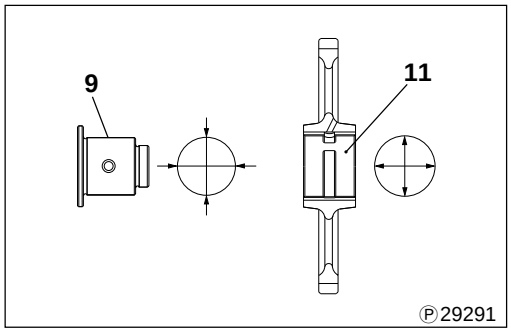
9 **Installing head idler shaft**

Install the head idler shaft **9** as illustrated.

B : Depression
C : Oil hole

CAUTION ⚠

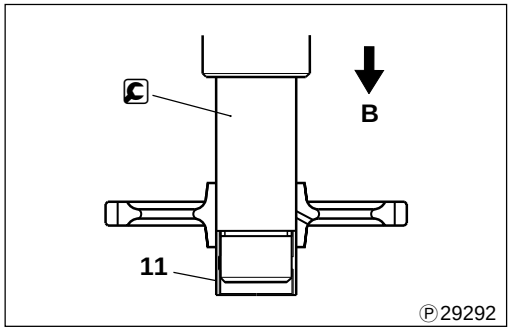
Don't forget to install the thrust plate 13.



9 **11** **Head idler shaft and head idler gear bushing**

[Inspection]

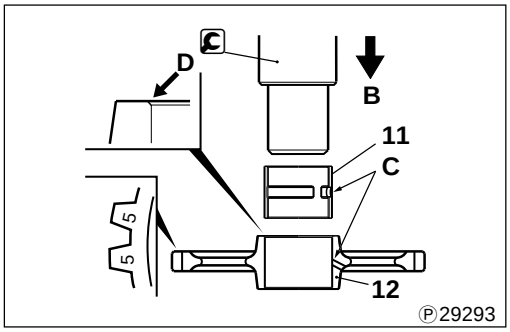
If the clearance exceeds the specified limit, replace the defective part(s).



Head idler gear bushing

[Removal]

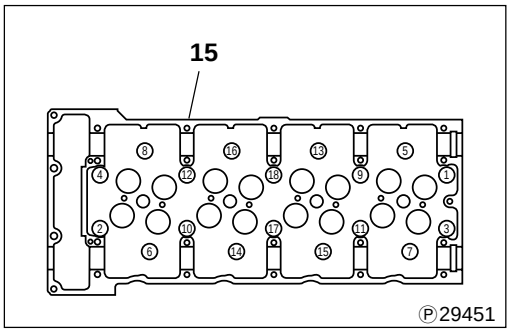
B : Press
Special tool : Idler Gear Bush Puller



[Installation]

- Fit the idler gear bushing **11** in the head idler gear **12** in the illustrated direction so that the oil holes **C** may be aligned with each other when press-fitted.
- Using the C Idler Gear Bush Puller, press the bushing into the head idler gear **12** until its end face becomes flush with the chamfered end **D** of the gear.

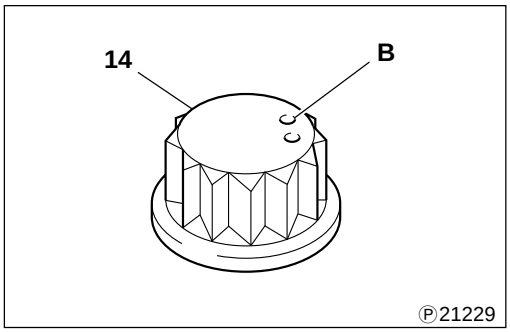
  B : Press
- After press-fitting, measure the clearance again. If the measurement is below the specified limit, ream the head idler gear bushing **11** to the standard value.



15 Cylinder head assembly

[Removal]

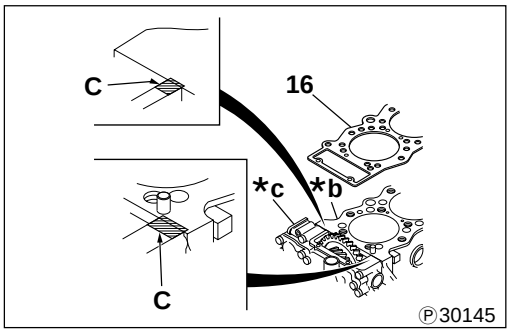
Loosen and remove the cylinder head bolts **14** in the sequence shown (① to ㉒). Each cylinder head bolt should be loosened a little at a time.



[Fitting]

CAUTION ⚠

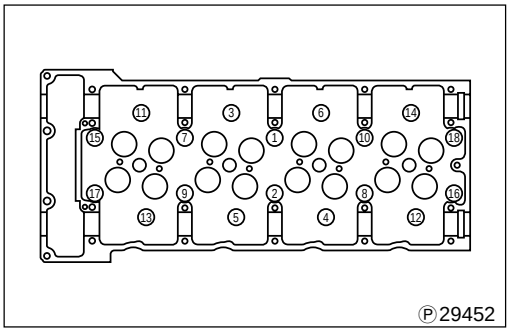
- **Before fitting any cylinder head bolt 14, check the punch marks B on its head. Do not use bolt if there are more than two punch marks.**
- **The punch marks indicate the number of times each bolt has been tightened using the torque-turn tightening method. Any bolt that already has three punch marks must be replaced.**



- Select an appropriate cylinder head gasket **16**. 📖 P11A-42
- Apply a coat of specified sealant to the upper surface **C** of the joint section between the frontcase assembly ***c** and the crankcase assembly ***b**.
- Within 3 minutes after the sealant application, install the cylinder head assembly to the crankcase assembly ***b** together with the cylinder head gasket **16**.

CAUTION ⚠

- **Check to ensure that the sealant application surface C is clean and free of oil and other foreign matter.**
- **During installation of the cylinder head assembly, use care to ensure that the sealant is kept in place.**
- **Do not start the engine for at least 1 hour after the cylinder head assembly is installed.**
- **Whenever the cylinder head bolt 14 is loosened or removed after the cylinder head assembly has been installed, always apply a fresh coat of specified sealant.**

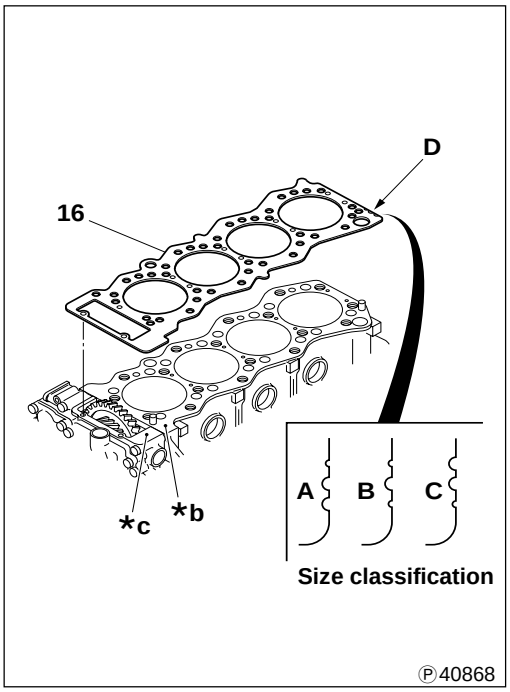


Ⓟ29452

- Tighten the cylinder head bolts **14** (① through ⑱) to a torque of 145 N·m {110 ft.lbs, 15 kgf·m}(wet) in the sequence shown.
  After tightening,give the bolts an additional 90 degree turn in the sequence of the numbers shown.
- After tightening the cylinder head bolts **14** using the torque-turn tightening method, make a punch mark on the head of each one to indicate the times of use.

CAUTION ⚠

Since the cylinder head bolts utilize the torque-turn tightening method, they must not be tightened further after the angular tightening procedure has been performed.



Ⓟ40868

16 Cylinder head gasket

[Removal]

CAUTION ⚠

Be careful not to scratch cylinder head assembly 15, the crankcase assembly *b and the front case assembly *c when removing cylinder head gasket 16.

[Installation]

Cylinder head gasket **16** installed must be the one which can accommodate the piston projection. Select such a gasket as follows:

- Measure the piston projection at each cylinder. 🕮 P11A-66
- Select a cylinder head gasket **16** appropriate for the piston projection average value from the following table.
- If any of the piston projection measurements is more than 0.05 mm {0.002 in.} larger than the average value, then use the gasket one rank higher than that rank (**A** → **B**, **B** → **C**).

Unit: mm {in.}

Average value of piston projection	Cylinder head gasket	
	Size classification	Thickness when tightening
–0.088 to –0.027 {–0.0034 to 0.0106}	A	0.75 ± 0.03 {0.029 ± 0.0012}
–0.027 to –0.033 {–0.0106 to 0.0129}	B	0.80 ± 0.03 {0.031 ± 0.0012}
–0.035 to –0.094 {–0.0129 to 0.0370}	C	0.85 ± 0.03 {0.033 ± 0.0012}

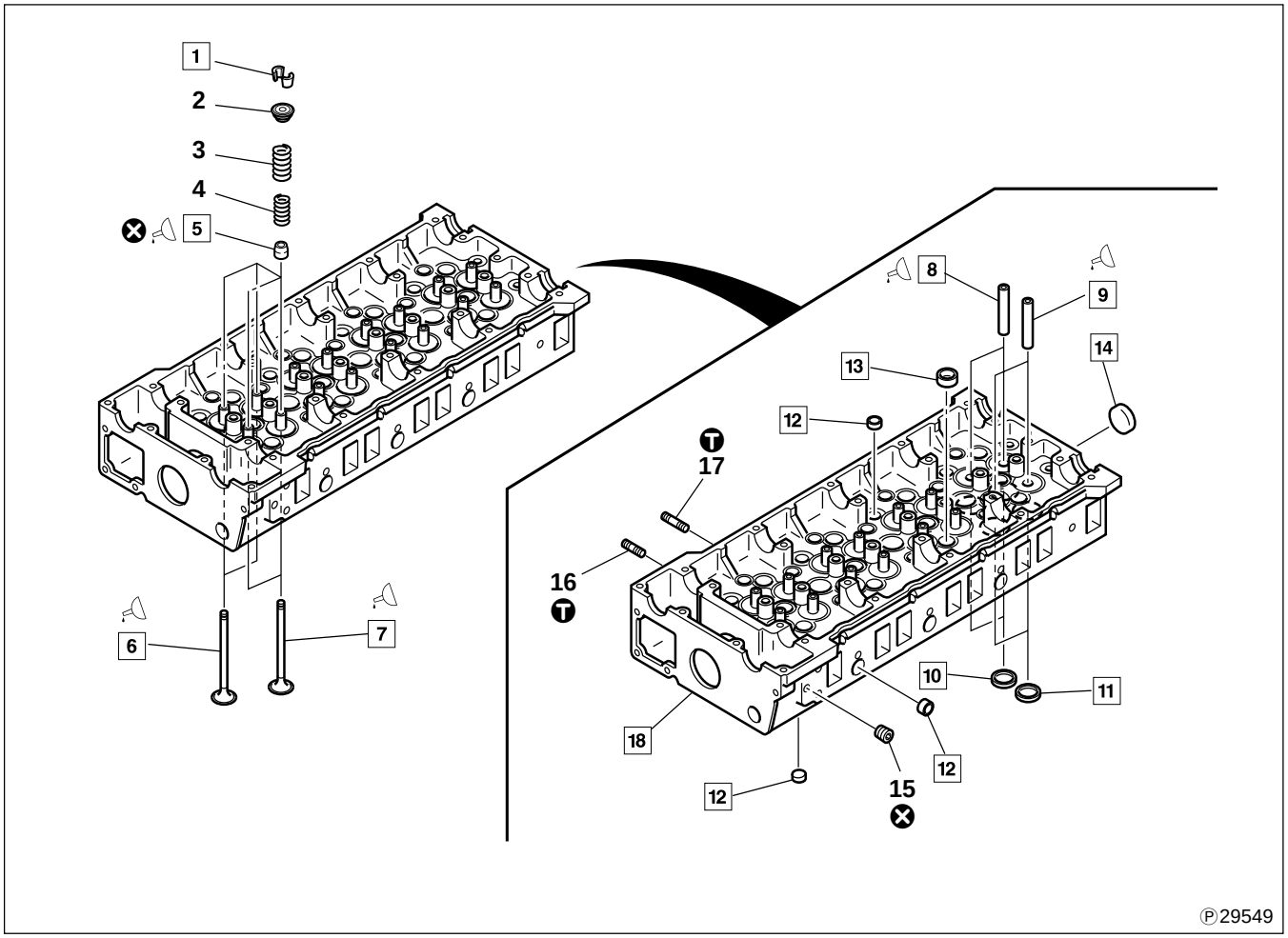
- The classification (size) of the cylinder head gasket **16** can be known from the shape of the notches **D** cut in the gasket edge.
- Install the cylinder head gasket **16** on the crankcase ***b** in the direction as illustrated.

  E : Part number

MEMO

CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head Assembly



● **Disassembly sequence**

1 Valve collets
2 Upper retainer
3 Outer valve spring
4 Inner valve spring
5 Valve stem seal
6 Exhaust valve
7 Inlet valve
8 Exhaust valve guide
9 Inlet valve guide
10 Exhaust valve seat
11 Inlet valve seat
12 Sealing cup plug (22 mm {ϕ 0.87 in.})
13 Sealing cup plug (30 mm {ϕ 1.18 in.})
14 Sealing cup plug (40 mm {ϕ 1.57 in.})
15 Taper plug
16 Stud (short)
17 Stud (long)
18 Cylinder head

⊗ **:** Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Any valve stem seal 5 removed from an exhaust valve 6 or inlet valve 7 must be replaced.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
3	Outer valve spring	Free length	87.8 {3.45}	–	Replace
		Installed load (at 57 {2.24} installed length)	360N {36.7 kgf}	–	Replace
		Squareness	–	2.5 {0.098}	Replace
4	Inner valve spring	Free length	78.8 {3.10}	–	Replace
		Installed load (at 52.3 {2.05} installed length)	168N {17.1 kgf}	–	Replace
		Squareness	–	2.5 {0.098}	Replace
6	Exhaust valve	Stem outside diameter	$\phi 8\ ^{-0.060}_{-0.075}$ {$\phi 0.31\ ^{-0.0024}_{-0.0029}$}	–	Replace
		Sinkage from cylinder head bottom surface	0.2 ± 0.25 {0.0079 ± 0.00098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45°	–	Correct
6, 8	Exhaust valve stem-to-valve guide clearance		[8 {0.31}]0.07 to 0.10 {0.0028 to 0.0039}	0.2 {0.0079}	Replace
7	Inlet valve	Stem outside diameter	$\phi 8\ ^{-0.025}_{-0.040}$ {$\phi 0.31\ ^{-0.00098}_{-0.00160}$}	–	Replace
		Sinkage from cylinder head bottom surface	0.2 ± 0.25 {0.0079 ± 0.00098}	–	Inspect
		Valve margin	1.5 {0.059}	–	Reface or replace
		Seat angle	45°	–	Correct
7, 9	Inlet valve stem-to-valve guide clearance		[8 {0.31}] 0.03 to 0.06 {0.0012 to 0.0024}	0.2 {0.0079}	Replace
10	Exhaust valve seat width		2.5 ± 0.2 {0.098 ± 0.0079}	3.5 {0.13}	Correct or replace
11	Inlet valve seat width		2 ± 0.2 {0.079 ± 0.0079}	2.8 {0.11}	Correct or replace
18	Cylinder head	Bottom surface distortion	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Height from top to bottom surface	107 ± 0.5 {4.21 ± 0.02}	106.5 {4.19}	Replace

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

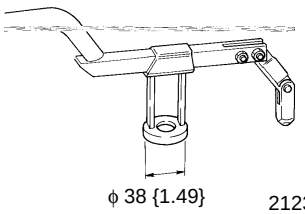
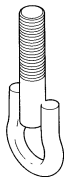
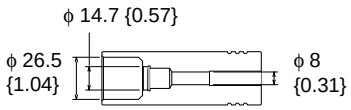
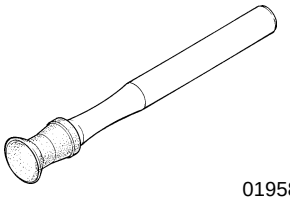
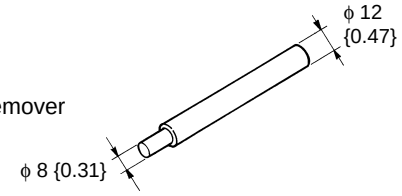
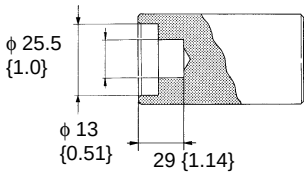
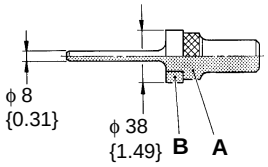
Location	Parts to be tightened	Tightening torque	Remarks
15	Taper plug	14 {10, 1.4}	–
16, 17	Stud	20 {14, 2.0}	–

Lubricant and/or sealant

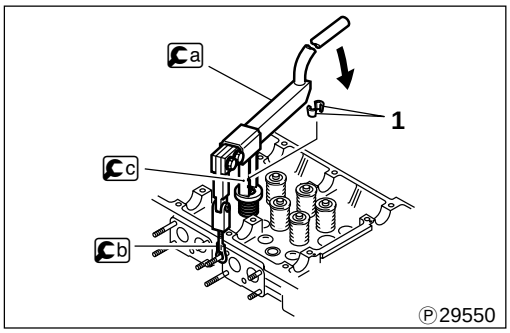
Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Lip of valve stem seal	Engine oil	As required
6,7	Valve stem	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
1	A: Valve Lifter B: Valve Lifter Seat 	Obtain Locally	Removing and installing valve cotters
	Valve Lifter Hook 	Use Equivalent	
5	Valve Stem Seal Installer 	Use Equivalent	Installing valve stem seals
6, 7	Valve Lapper 	Obtain Locally	Lapping inlet and exhaust valves and valve seats
8, 9	Valve Guide Remover 	Obtain Locally	Removing valve guides
	Valve Guide Installer 	MH063604	Installing valve guides
10, 11	**A**: Caulking Tool Body **B**: Caulking Ring 	Use Equivalent	Installing inlet and exhaust valve seats

◆ Service procedures



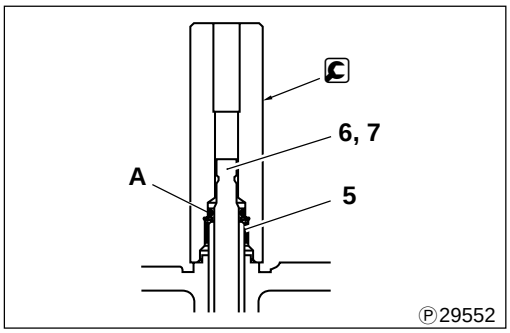
1 Valve cotter

[Removal]

To remove the valve collets **1**, use the a Valve Lifter, b Valve Lifter Hook and c Valve Lifter Seat to evenly compress the valve springs **3**, **4**.

[Installation]

To install valve collets, follow the removal instructions in reverse.

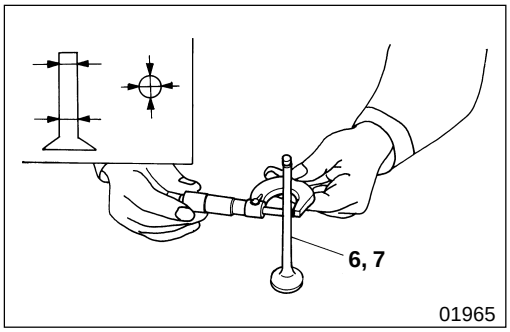


5 Installing valve stem seals

- Apply engine oil to the lip **A** of the valve stem seal **5**.
- Install the valve stem seal **5** using the Valve Stem Seal Installer.
- Strike the Valve Stem Installer until it sits snugly on the cylinder head **18**.

CAUTION ⚠

After installing the valve stem seal 5, check that its spring area is neither deformed nor damaged.



6 7 Inlet and exhaust valves

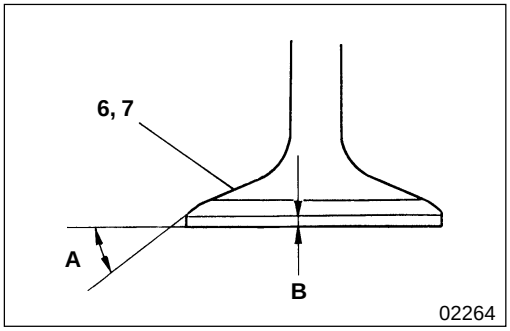
[Inspection]

(1) Valve stem outside diameter

Replace the valve **6**, **7** if its stem's outside diameter is below specification or severely worn.

CAUTION ⚠

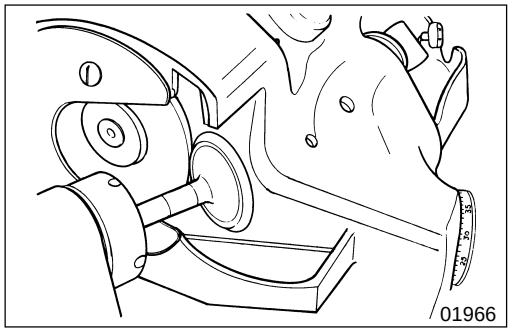
Whenever a valve 6, 7 is replaced, be sure to lap the valve and valve seat 10, 11. 📖 **P11A-49**



(2) Valve seat angle and valve margin

Reface or replace the valve **6**, **7** if the valve seat angle or valve margin exceeds the specified limits.

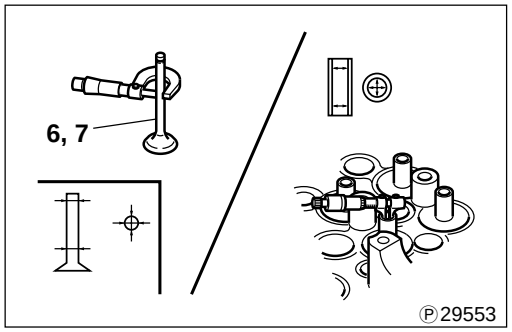
A : Valve seat angle
B : Valve margin



[Rectification]

NOTE

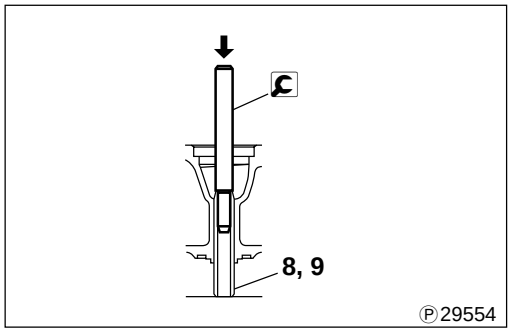
- **Keep grinding to a minimum.**
- **If the valve margin is below specification after grinding, replace the valve 6, 7.**
- **After grinding, be sure to lap the valve 6, 7 and valve seat 10, 11.** **P11A-45**



6 to 9 Valve and valve guides

[Inspection]

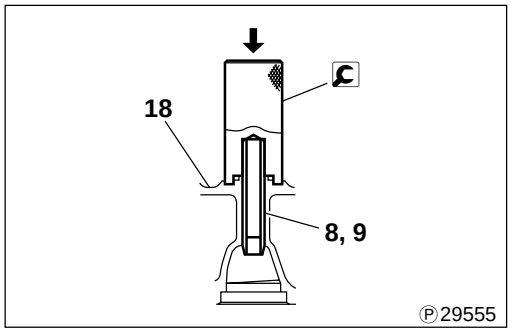
If any clearance exceeds the specified limit, replace the defective part(s).



Valve guides

[Removal]

: Valve Guide Puller

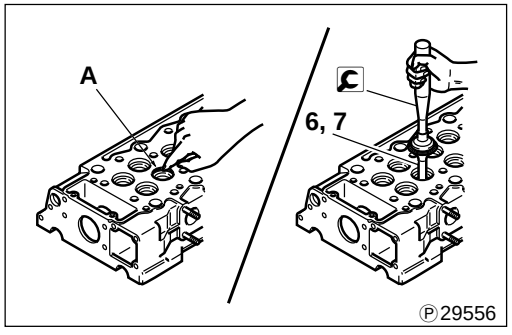


[Installation]

Using the Valve Guide Installer, install the valve guide **8**, **9** until the tool sits snugly on the cylinder head **18**.

CAUTION

- **The valve guides 8, 9 must be pressed in to the specified depth.Be sure to use the Valve Guide Installer for this operation.**
- **Exhaust valve guides 8 are longer than inlet valve guides 9.Be sure to install the correct type of guide in each location.**



6 7 10 11 Valves and valve seats

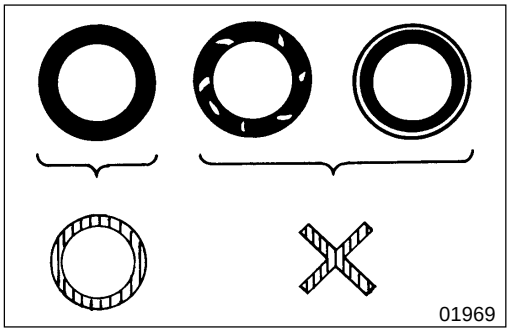
[Inspection]

- Apply an even coat of prussian blue to the valve seat **10**, **11** surface **A** that makes contact with the valve **6**, **7**.
- Strike the valve **6**, **7** against the valve seat **10**, **11** once. Do not rotate the valve during this operation.

: Valve Lapper

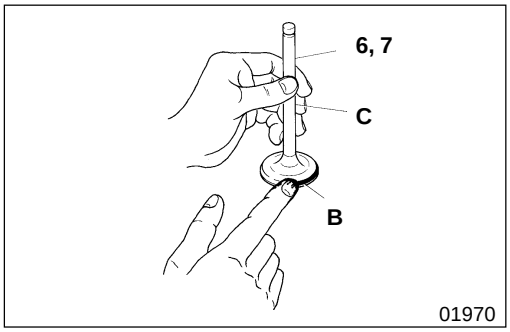
NOTE

Carry out these inspections after inspecting the valves 6, 7 and valve guides 10, 11.



- If the prussian blue deposited on the valve **6**, **7** indicates a poor contact pattern, rectify the contact pattern as follows:

Contact	Corrective action
Minor defect	Lapping
Serious defect	Reface or replace valve and valve seat



[Refacing]

Lap the valve in accordance with the following procedure:

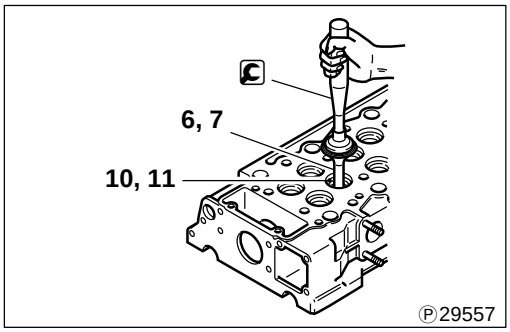
- Apply a thin, even coat of lapping compound to the surface **B** of the valve **6**, **7** that makes contact with valve seat **10**, **11**.

CAUTION ⚠

- **Ensure that no compound adheres to the stem C of the valve 6, 7.**

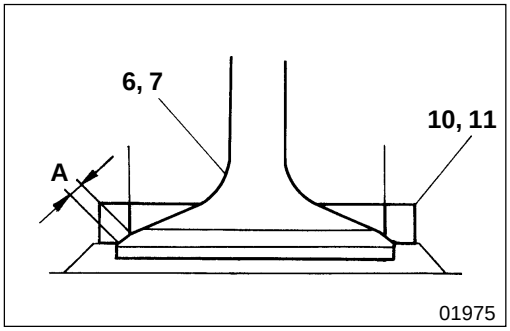
NOTE:

- **Start with intermediate-mesh compound (120 to 150 mesh) and finish with fine-mesh compound (200 mesh or more).**
- **The addition of a small amount of engine oil makes lapping compound easier to apply.**



- Strike the valve **6**, **7** against the valve seat **10**, **11** while turning it little by little.

  : Valve Lapper
- Wash away the compound with cleaning fluid.
- Apply engine oil to the contact surfaces of the valve seat **10**, **11** and rub it in so that the contact surfaces are lubricated and mate together snugly.
- Inspect the contact pattern of the valve **6**, **7** and valve seat **10**, **11** once more.
- If the contact pattern is still defective, replace the valve seat **10**, **11**.



10 **11** **Valve seats**

[Inspection]

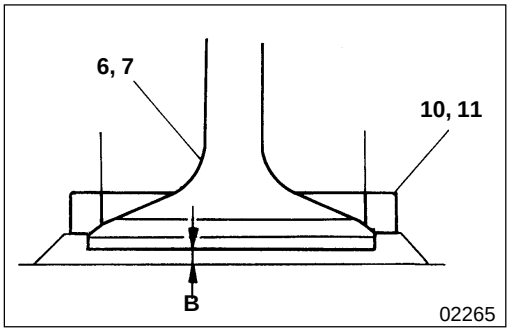
(1) Valve seat width

If the measurement exceeds the specified limit, rectify or replace the valve seat **10**, **11**.

A : Valve seat width

NOTE

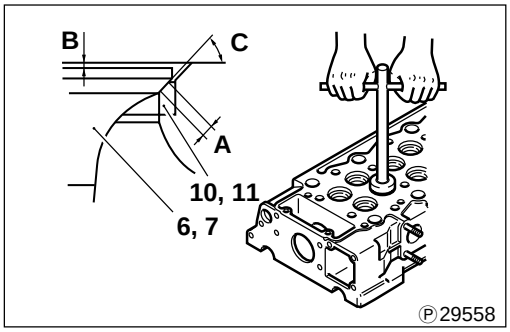
Whenever a valve seat 10, 11 is rectified or replaced, be sure to lap the valve seat and valve 6, 7.



(2) Valve sinkage from cylinder head bottom surface

If any measurement exceeds the specified limit, rectify or replace the defective part(s).

B : Valve sinkage



[Rectification]

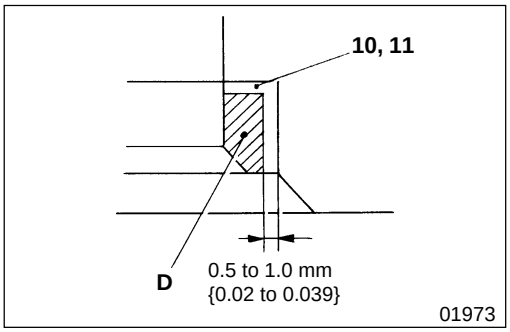
- Grind the valve seat **10**, **11** using a valve seat cutter or valve seat grinder.
- Use a 15° or 75° cutter to achieve the specified valve seat width **A** of the valve **6**, **7**.
- After grinding, put some sandpaper of around #400 grade between the cutter and valve seat and grind the valve seat lightly.

C : Valve seat angle

CAUTION ⚠

Ensure that grinding does not cause the sinkage B of the valve 6, 7 to exceed the specified limit.

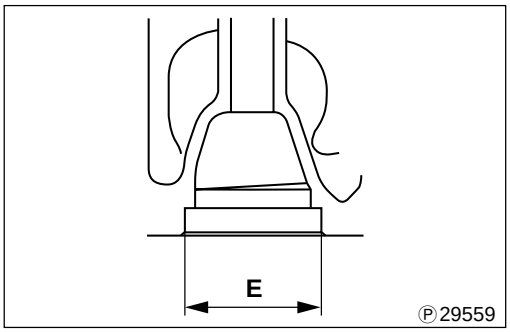
- After rectification, lap the valve **6**, **7** and valve seat **10**, **11**.
  📖 P11A-49



[Removal]

Valve seats **10**, **11** are installed by expansion fitting. To remove a valve seat, grind the inside surface to reduce its thickness, then remove the valve seat at room temperature.

D : Material to be ground

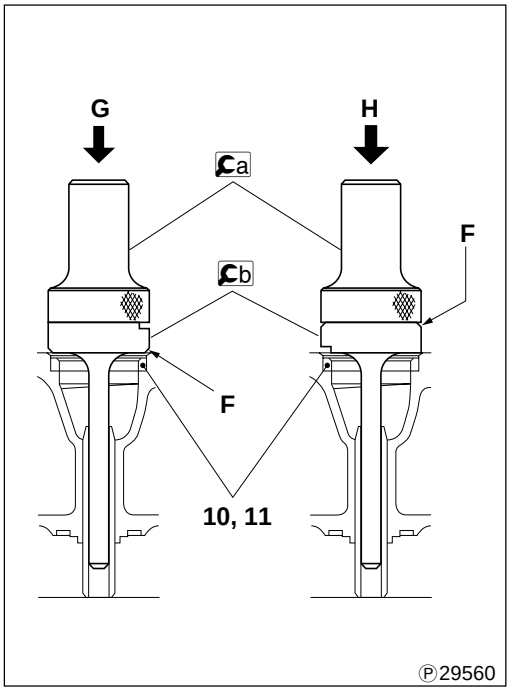


[Installation]

- Check that the valve seat hole diameter **E** in the cylinder head **18** conforms with the value shown below.

Unit: mm {in.}

	Hole diameter
Valve seat hole: **E**	$38\ ^{+0.025}_{0}$ {$1.49\ ^{+0.00098}_{0}$}



- Cool the valve seat **10**, **11** by immersing it in liquid nitrogen.
- Install the valve seat **10**, **11** in the cylinder head **18** using the a Caulking Tool Body and the b Caulking Ring.

CAUTION ⚠

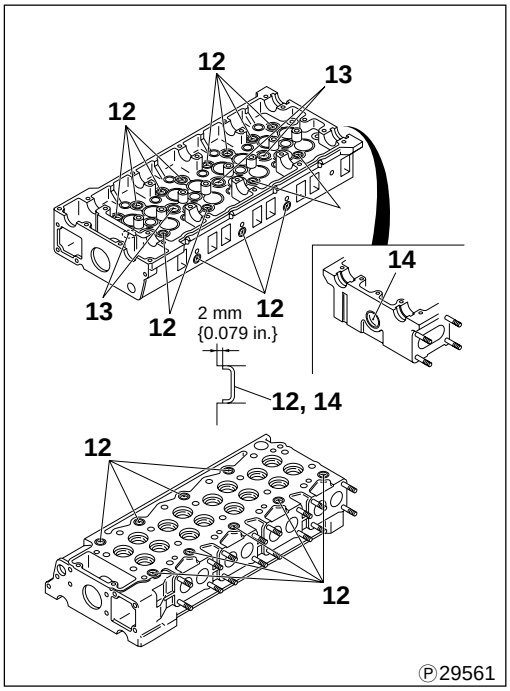
- **For installation, the chamfered side F of the b Caulking Ring must be against the valve seat 10, 11.**

G : Configuration for installation

- Invert the b Caulking Ring such that its chamfered side **F** is against the a Caulking Tool Body, then caulk the valve seat **10**, **11**.

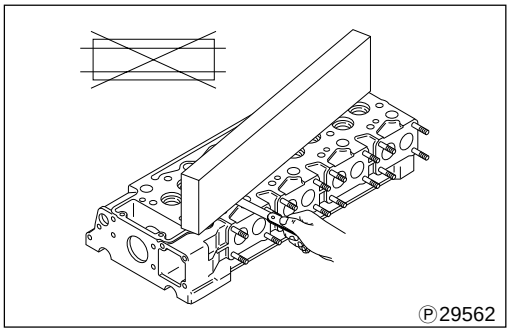
H : Configuration for caulking

- After installing the valve seat **10**, **11**, lap the valve seat and valve **6**, **7**. P11A-49



12 to 14 Installing sealing cup plugs

Drive the sealing cups **12** to **14** in the cylinder head **18** until the specified depth is reached.



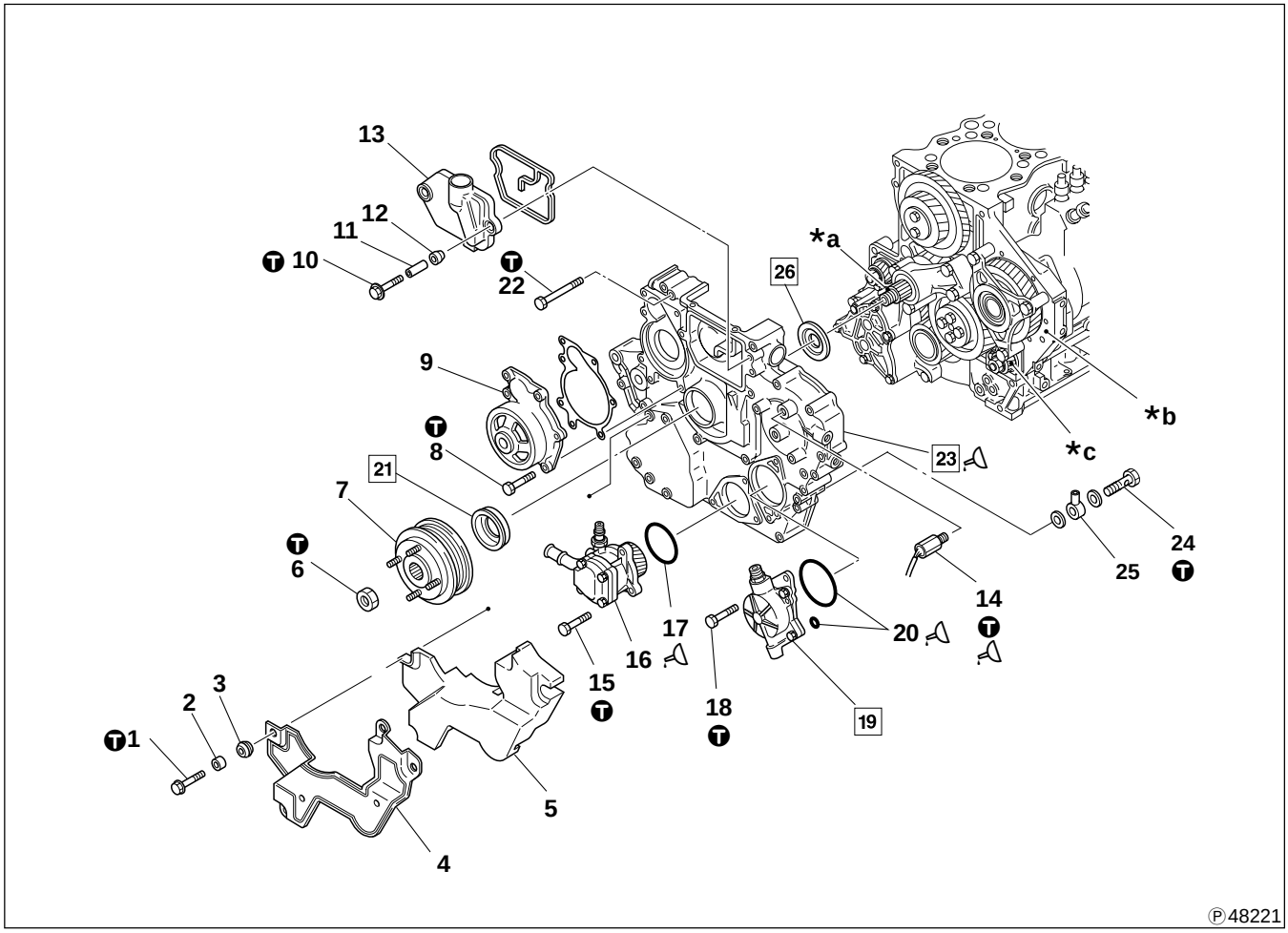
18 Inspecting cylinder head

Measure the extent of distortion in the cylinder head **18** bottom surface. If the degree of distortion exceeds the specified limit, rectify the distortion with a surface grinder.

CAUTION ⚠

Ensure that grinding does not cause the cylinder head 18 top surface-to-bottom surface distance to fall below the specified limit.

FRONT CASE



● **Disassembly sequence**

1 Bolt
2 Spacer
3 Insulator
4 Front case cover
5 Front case rubber insulation
6 Nut
7 Fan pulley
8 Bolt
9 Water pump assembly
Gr 14A
10 Bolt
11 Spacer
12 Rubber
13 Breather cover
14 Engine speed sensor
Gr 54
15 Bolt
16 Power steering oil pump assembly
Gr 37
17 O-ring
18 Bolt
19 Vacuum pump assembly
Gr 35A
20 O-ring
21 Front oil seal
22 Bolt
23 Front case
24 Eye bolt
25 Oil jet
26 Front oil seal slinger

***a:** Fan shaft assembly
P11A-56
***b:** Upper crankcase
P11A-80
***c:** Balance shaft assembly LH
P11A-56
⊗: Non-reusable part

CAUTION ⚠

- **When the vacuum pump assembly 19 is removed, be sure to follow the specified procedure. Blind removal will result in failure of the assembly being positioned with the balance shaft assembly LH *c.**
- **Do not remove the front oil seal 21 unless something wrong is evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

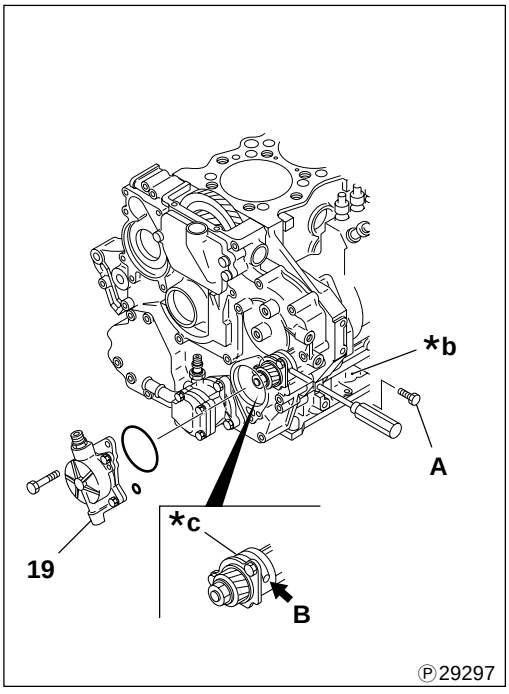
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (mounting front case cover)	2.9 to 3.9 {2.2 to 2.9, 0.3 to 0.4}	–
6	Nut (mounting fan pulley)	196.1 {145, 20.0}	–
8	Bolt (mounting water pump assembly)	23.5 {17, 2.4}	–
10	Bolt (mounting breather cover)	2.9 {2.2, 0.3}	–
14	Engine speed sensor	29.4 {22, 3.0}	–
15	Bolt (mounting power steering oil pump assembly)	23.5 {17, 2.4}	–
18	Bolt (mounting vacuum pump assembly)	23.5 {17, 2.4}	–
22	Bolt (mounting front case)	23.5 {17, 2.4}	–
24	Eye bolt (mounting oil jet)	10 {7.4, 1.0}	–

Lubricant and sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
14	Threaded portion of engine speed sensor	THREEBOND 1104J	As required
17, 20	All around O-ring	Engine oil	As required
21	Lip of front oil seal	Engine oil	As required
23	Front case mounting surface	THREEBOND 1207C or D	As required



◆ Service procedure

19 Installation of vacuum pump assembly

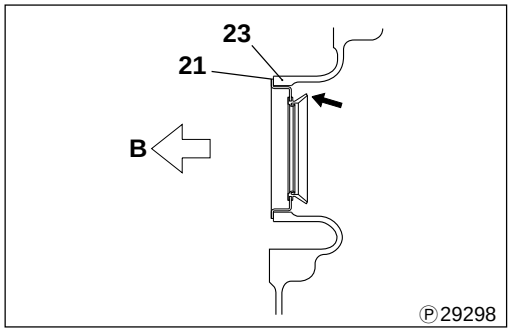
The vacuum pump assembly **19** serves also to position the balance shaft assembly LH ***c**. For this reason, before the assembly is installed, the balance shaft assembly must be kept in the right position by the following procedure.

- Place the piston of cylinder No. 1 at the top dead center on the compression stroke.
- Remove plug **A** from the upper crankcase ***b**.
- Insert a screwdriver into the hole from which the plug **A** was removed until it slightly touches the balance shaft assembly LH ***c**.

CAUTION ⚠

Be sure not to force the screwdriver in, as there is danger of damage to the No. 1 journal of the balance shaft assembly LH *c.

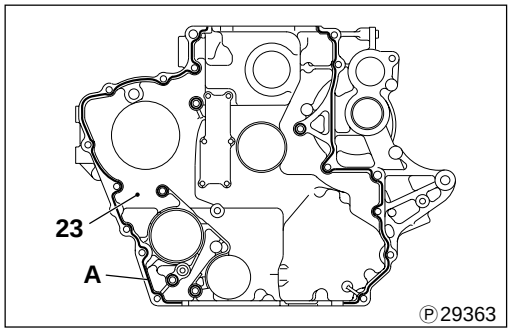
- Slowly rotate the balance shaft assembly LH ***c** to align the tip of the screwdriver with the shaft support hole **B** in the No. 1 journal of the balance shaft.
- Supporting the balance shaft by inserting the screwdriver in the hole, install the vacuum pump assembly **19**.
- After the installation, remove the screwdriver.



21 **Installation of front oil seal**

Install the front oil seal **21** on the front case **23** in the illustrated direction after applying engine oil to the lip **A**.

B : Front of vehicle

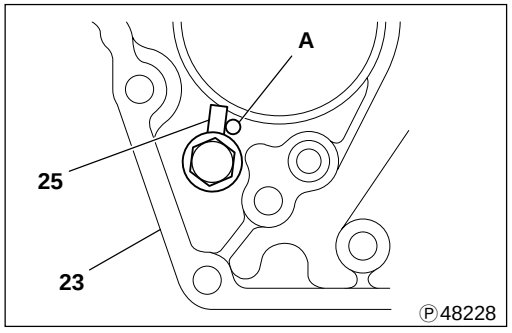


23 **Installation of front case**

- Apply sealant **A** evenly without any break to the mounting surface of the front case **23** as shown. (Approximately ϕ 1 mm {ϕ 0.0393})
- After application of sealant **A**, install the front case **23** in less than three minutes.

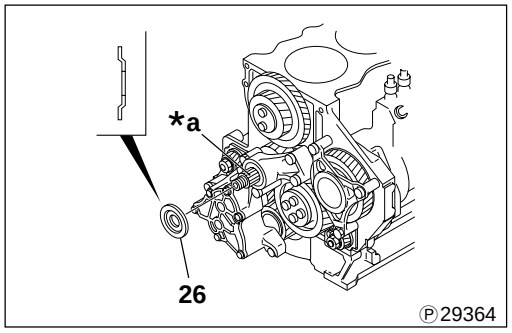
CAUTION ⚠

- **Check to ensure that the sealant application surface is clean and free from any oil and other deposits.**
- **When installing the parts, make sure that the sealant is not forced out of position.**
- **Do not start the engine less than an hour after installation.**
- **If the mounting bolts were loosened or removed after installation of the front case 23, be sure to re-apply sealant A.**



25 **Installation of oil jet**

Install oil jet **25** to the front case **23** in the direction as shown with boss **A** contacting to oil jet.

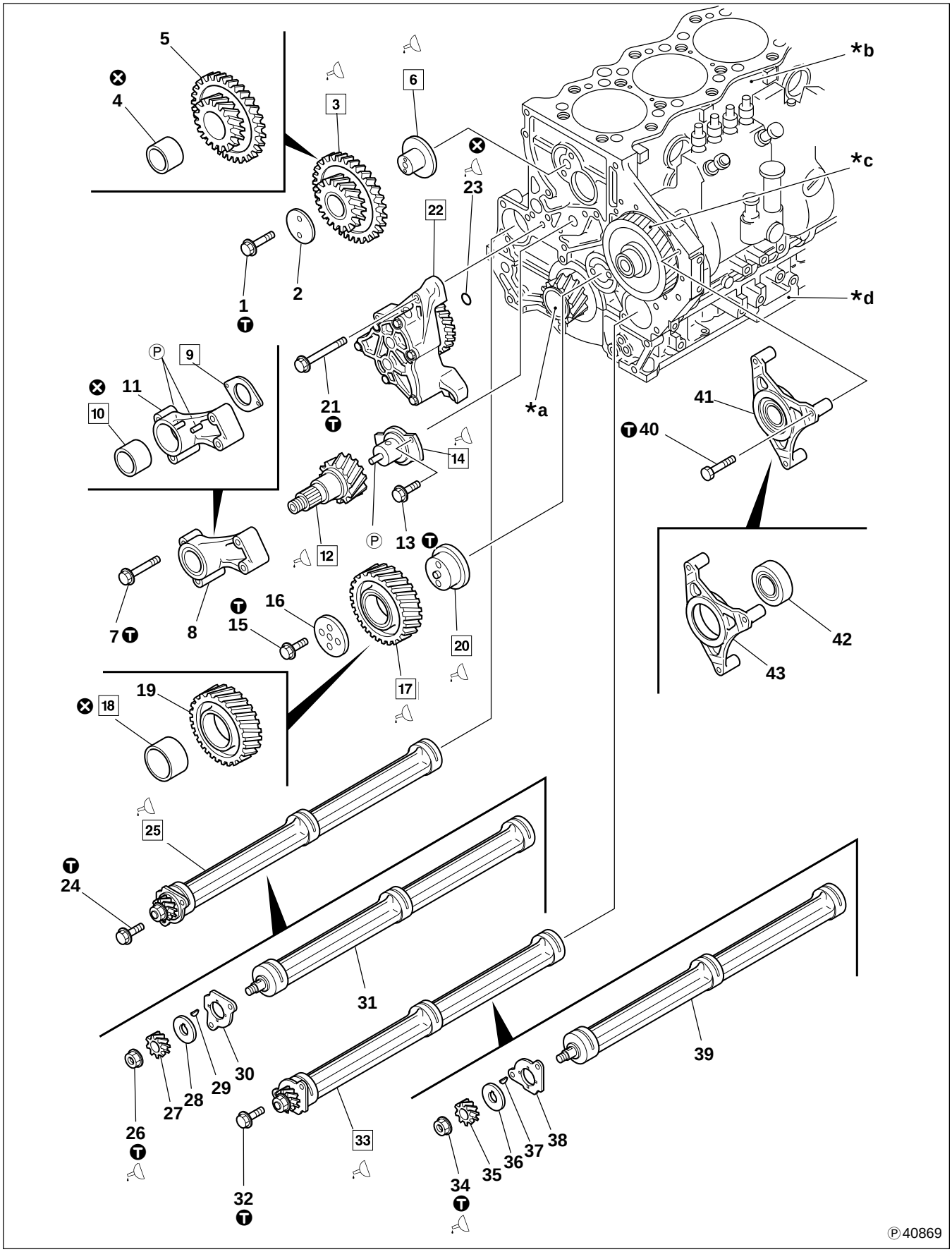


26 **Installation of front oil seal slinger**

Install the front oil seal slinger **26** on the fan shaft assembly ***a** in the illustrated direction.

MEMO

TIMING GEARS AND BALANCE SHAFTS



● **Pre-disassembly inspection**

P11A-59

● **Disassembly sequence**

1 Bolt
2 Thrust plate
3 Idler gear assembly
4 Idler gear bushing
5 Idler gear
6 Idler shaft
7 Bolt
8 Fan shaft case assembly
9 Thrust plate
10 Fan shaft case bushing
11 Fan shaft case
12 Fan shaft assembly
13 Bolt
14 Fan gear shaft
15 Bolt
16 Thrust plate
17 No. 1 idler gear assembly
18 No. 1 idler gear bushing
19 No. 1 idler gear
20 No. 1 idler shaft
21 Bolt
22 Oil pump assembly
Gr 12A
23 O-ring
24 Bolt
25 Balance shaft assembly RH
26 Nut
27 Balance shaft gear RH
28 Thrust spacer
29 Key
30 Thrust plate
31 Balance shaft RH
32 Bolt
33 Balance shaft assembly LH
34 Nut
35 Balance shaft gear LH
36 Thrust spacer
37 Key
38 Thrust plate
39 Balance shaft LH
40 Bolt
41 Injection pump bearing housing assembly
42 Bearing
43 Injection pump bearing housing

***a :** Crankshaft gear P11A-80
***b :** Upper crankcase P11A-80
***c :** Injection pump gear Gr 13A
***d :** Lower crankcase P11A-80

Ⓟ **:** Locating pin
⊗ **:** Non-reusable part

CAUTION ⚠

For details on the balance shaft removal and installation procedures, refer to P11A-88.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

TIMING GEARS AND BALANCE SHAFTS

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
–	Backlash between gears	Idler gear assembly and fan shaft assembly	0.09 to 0.13 {0.0035 to 0.0051}	0.3 {0.012}	Replace
		Fan shaft assembly and No. 1 idler gear assembly	0.06 to 0.10 {0.0024 to 0.0039}	0.3 {0.012}	
		No. 1 idler gear assembly and crankshaft gear	0.11 to 0.13 {0.0043 to 0.0051}	0.3 {0.012}	
		No. 1 idler gear assembly and injection pump gear	0.09 to 0.12 {0.0035 to 0.0047}	0.3 {0.012}	
		Crankshaft gear and oil pump gear	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	
		Balance shaft gear RH and oil pump gear	0.19 to 0.22 {0.0075 to 0.0087}	0.3 {0.012}	
–	End play of each gear and shaft	Idler gear assembly	0.10 to 0.20 {0.0039 to 0.0079}	0.3 {0.012}	Replace
		Fan shaft assembly	0.07 to 0.19 {0.0028 to 0.0075}	0.3 {0.012}	
		No. 1 idler gear assembly	0.15 to 0.25 {0.0059 to 0.0098}	0.3 {0.012}	
		Balance shaft RH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
		Balance shaft LH	0.1 to 0.2 {0.0039 to 0.0079}	0.3 {0.012}	
4, 6	Clearance between idler gear bushing and idler shaft		[51 {2.0}] 0.02 to 0.06 {0.00079 to 0.0024}	0.1 {0.0039}	Replace
10, 12	Clearance between fan shaft case bushing and fan shaft assembly		[41 {1.61}] 0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
12, 14	Clearance between fan shaft assembly and fan gear shaft		[36 {1.41}] 0.01 to 0.05 {0.00039 to 0.0020}	0.1 {0.0039}	Replace
18, 20	Clearance between No. 1 idler gear bushing and No. 1 idler shaft		[59 {2.32}] 0.03 to 0.07 {0.0012 to 0.0028}	0.1 {0.0039}	Replace
25	Bend of balance shaft assembly RH		0.025 {0.00098}	0.05 {0.002}	Replace
33	Bend of balance shaft assembly LH		0.025 {0.00098}	0.05 {0.002}	Replace

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

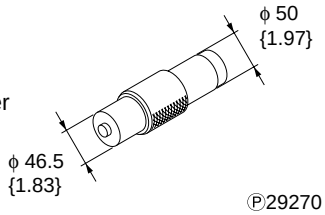
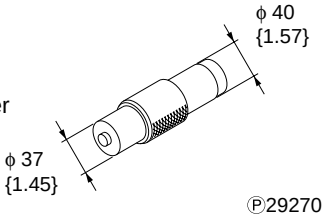
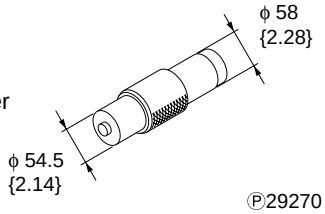
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (mounting idler shaft)	32.3 {24, 3.3}	–
7	Bolt (mounting fan shaft case assembly)	23.5 {17, 2.4}	–
13	Bolt (mounting fan gear shaft)	23.5 {17, 2.4}	–
15	Bolt (mounting No. 1 idler shaft)	53.9 {40, 5.5}	–
21	Bolt (mounting oil pump assembly)	27.4 {20, 2.8}	–
24	Bolt (mounting balance shaft assembly RH)	23.5 {17, 2.4}	–
26	Nut (mounting balance shaft gear RH)	96.1 {71, 9.8}	Wet
32	Bolt (mounting balance shaft assembly LH)	23.5 {17, 2.4}	–
34	Nut (mounting balance shaft gear LH)	96.1 {71, 9.8}	Wet
40	Bolt (mounting injection pump bearing housing assembly)	27.4 {20, 2.8}	–

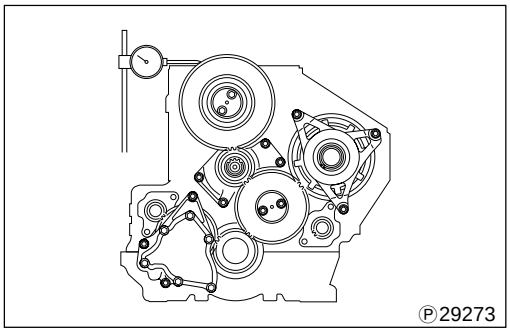
Lubricant

Location	Points of application	Specified lubricant	Quantity
3, 17	Inside surface of bushing of each gear	Engine oil	As required
6, 12, 14, 20	Outside circumference of each shaft	Engine oil	As required
23	All around O-ring	Engine oil	As required
25, 33	Journal portions of balance shaft	Engine oil	As required
26, 34	Threaded portion of nut	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4	Idler Gear Bushing Puller 	Use Equivalent	Installation and removal of idler gear bushing
10	Idler Gear Bushing Puller 	MH062601	Installation and removal of fan shaft case bushing
18	Idler Gear Bushing Puller 	Use Equivalent	Installation and removal of No. 1 idler gear bushing

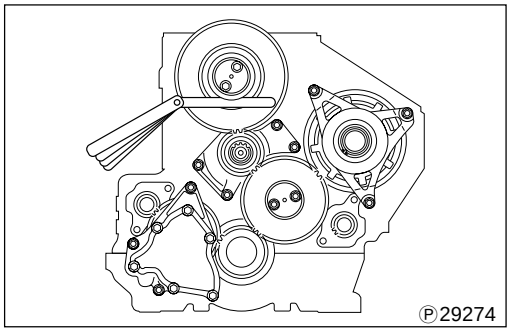


◆ Service procedure

● **Pre-disassembly inspection**

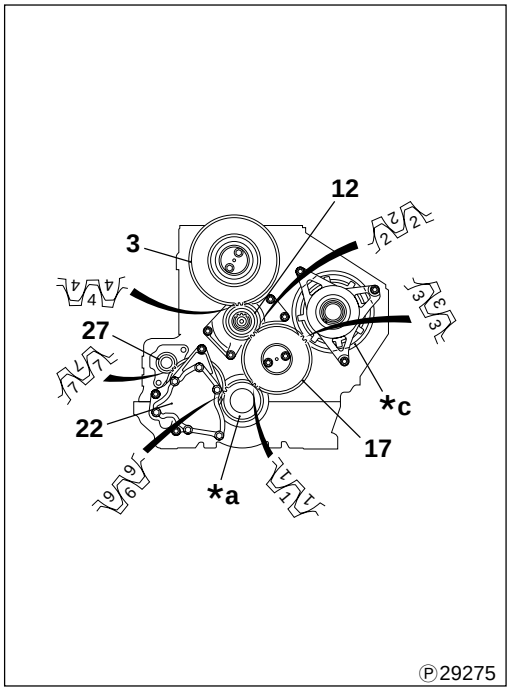
(1) Backlash between gears

On a pair of gears, measure backlash at more than three positions. If the reading is more than the limit, replace defective parts.



(2) End play of each gear and shaft

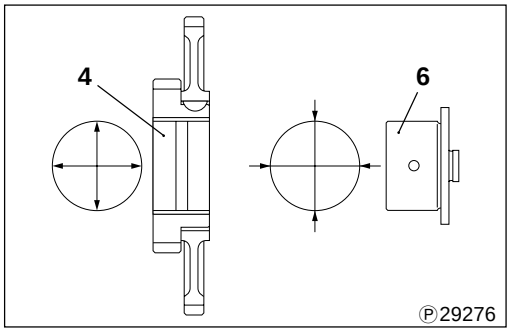
If the reading is more than the limit, replace defective parts.



3 12 17 22 Installation of timing gears

Install the timing gears in the following sequence.

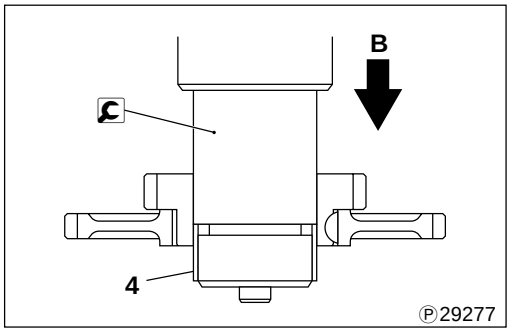
- Place the piston of No. 1 cylinder at the top dead center to position the crankshaft gear ***a**.
- Install the gear of the oil pump assembly **22** while aligning the alignment marks "**6**" and "**7**" with those on the crankshaft gear ***a** and balance shaft gear RH **27**, respectively.
- Install No. 1 idler gear assembly **17** while aligning the alignment marks "**1**" and "**3**" with those on the crankshaft gear ***a** and injection pump gear ***c**, respectively.
- Install the fan shaft assembly **12** while aligning the alignment mark "**2**" with that of No. 1 idler gear assembly **17**.
- Install the idler gear assembly **3** while aligning the alignment mark "**4**" with that of the fan shaft assembly **12**.



4 6 Idler gear bushing and idler shaft

[Inspection]

If the reading is more than the limit, replace defective parts.

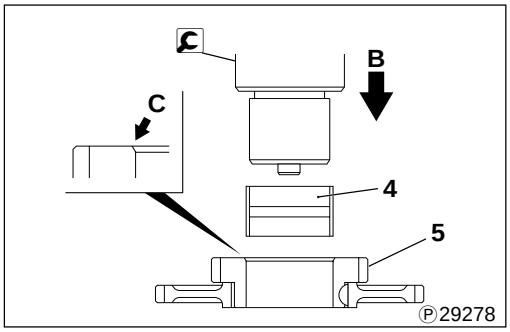


Idler gear bushing

[Removal]

B : Press

**: Idler Gear Bushing Puller

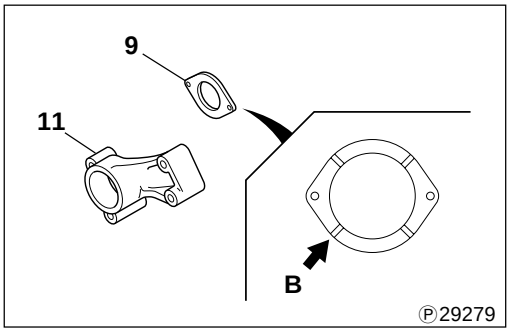


[Installation]

- Face the idler gear **5** in the illustrated direction. Using 🔧 Idler Gear Bushing Puller, press-fit the idler gear bushing **4** into the idler gear up to the chamfered portion **C**.

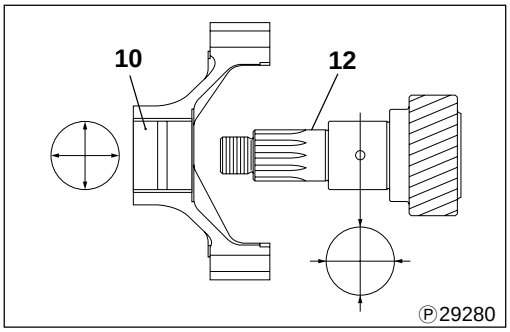
  B : Press

- After press-fitting the bushing, re-measure the clearance. If the reading is less than the standard limits, ream the idler gear bushing **4** until the clearance falls within the standard limits.



9 **Installation of thrust plate**

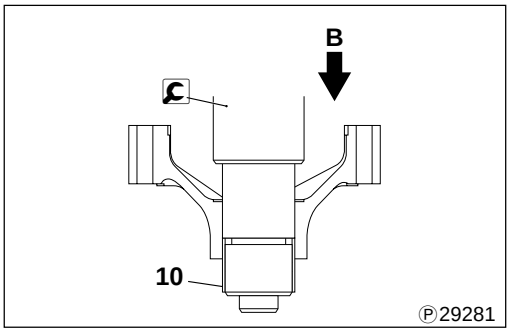
Install the thrust plate **9** with that side which does not have oil grooves **B** toward the fan shaft case **11**.



10 **12** **Fan shaft case bushing and fan shaft assembly**

[Inspection]

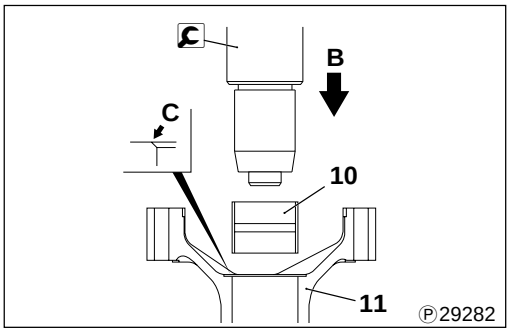
If the clearance is more than the limit, replace defective parts.



Fan shaft case bushing

[Removal]

B : Press
🔧 **:** Idler Gear Bushing Puller

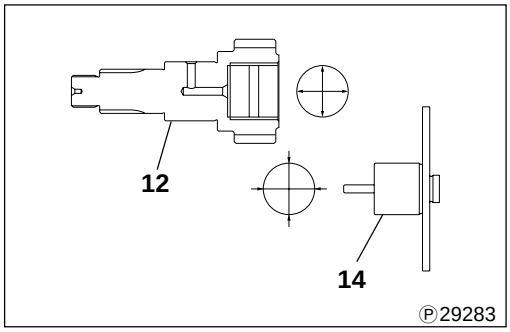


[Installation]

- Face the fan shaft case in the illustrated direction. Using 🔧 Idler Gear Bushing Puller, press-fit the fan shaft case bushing up to the chamfered portion **C** of the fan shaft case.

  B : Press

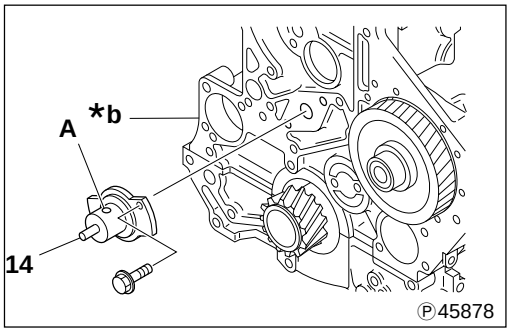
- After press-fitting the bushing, re-measure the clearance. If the reading is less than the standard limits, ream the fan shaft case bushing **10** until the clearance falls within the standard limits.



12 **14** **Fan shaft assembly and fan gear shaft**

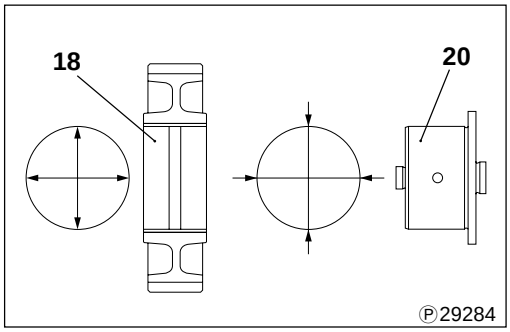
[Inspection]

If the clearance is more than the limit, replace defective parts.



14 **Installation of fan gear shaft**

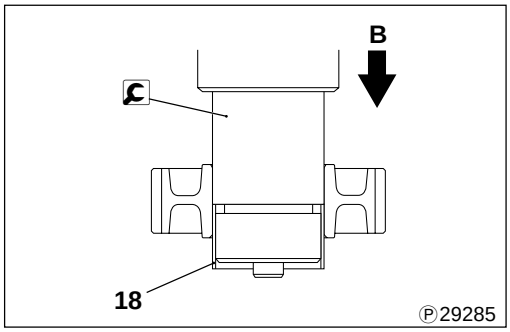
With oil hole **A** in fan gear shaft **14** facing up, install the fan gear shaft to upper crankcase ***b**.



18 **20** **No. 1 idler gear bushing and No. 1 idler shaft**

[Inspection]

If the clearance is more than the limit, replace defective parts.

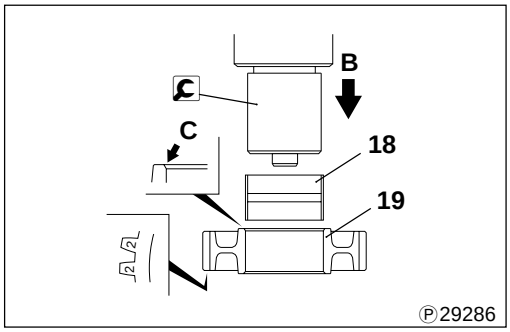


Idler gear bushing

[Removal]

B : Press

C : Idler Gear Bushing Puller

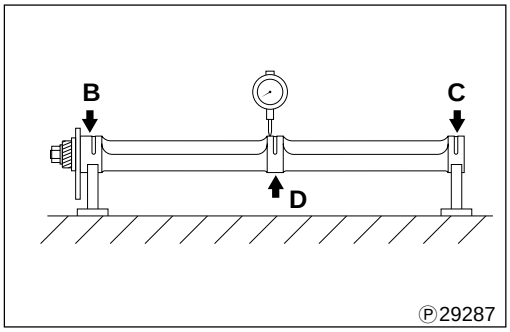


[Installation]

- Face the No. 1 idler gear **19** in the illustrated direction. Using C Idler Gear Bushing Puller, press-fit the idler gear bushing up to the chamfered portion **C** of the No. 1 idler gear.

  B : Press

- After press-fitting the bushing, re-measure the clearance. If the reading is less than the standard limits, ream the No. 1 idler gear bushing **18** until the clearance falls within the standard limits.



25 **33** **Balance shaft assembly**

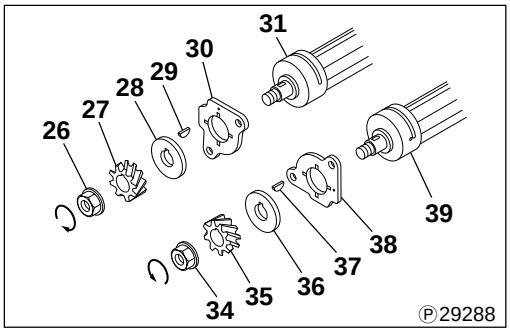
[Inspection]

- Check the balance shaft assemblies RH **25** and LH **33** for bend.
- Measure the balance shaft bend at No. 2 journal **D** while supporting the shaft at No. 1 journal **B** and No. 3 journal **C**.

NOTE

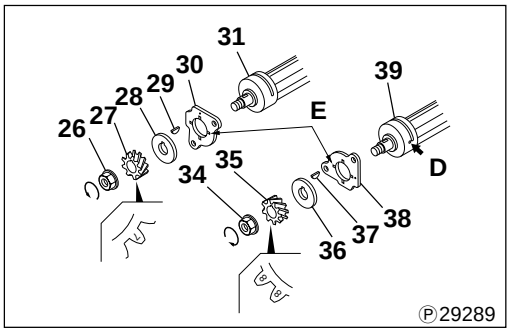
The bend of the balance shaft assemblies RH 25 and LH 33 is one half of the reading of the dial indicator taken after turning the balance shaft assembly through a rotation.

- If the reading exceeds the limit, disassemble the balance shaft assembly RH **25**, LH **33**, and replace the balance shaft RH **31**, LH **39**.



[Disassembly]

- The nut **26** of the balance shaft RH **31** and the nut **34** of the balance shaft LH **39** are different in the thread cutting direction.
- Remove the nut **26** by turning counter-clockwise. Remove the nut **34** by turning clockwise.



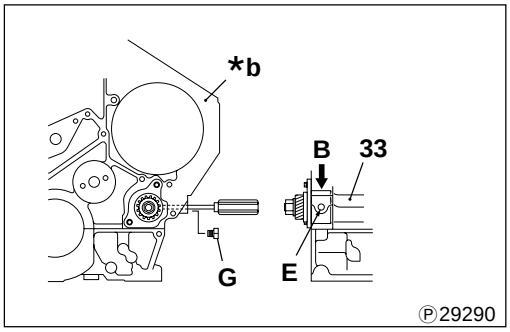
[Assembly]

- Of the balance shaft RH **31** and LH **39**, one with a shaft support hole **D** (ϕ 5 mm {ϕ 0.2 in.}) in No. 1 journal is the balance shaft LH **39**.
- Install the thrust plates **30** and **38** in the illustrated direction.

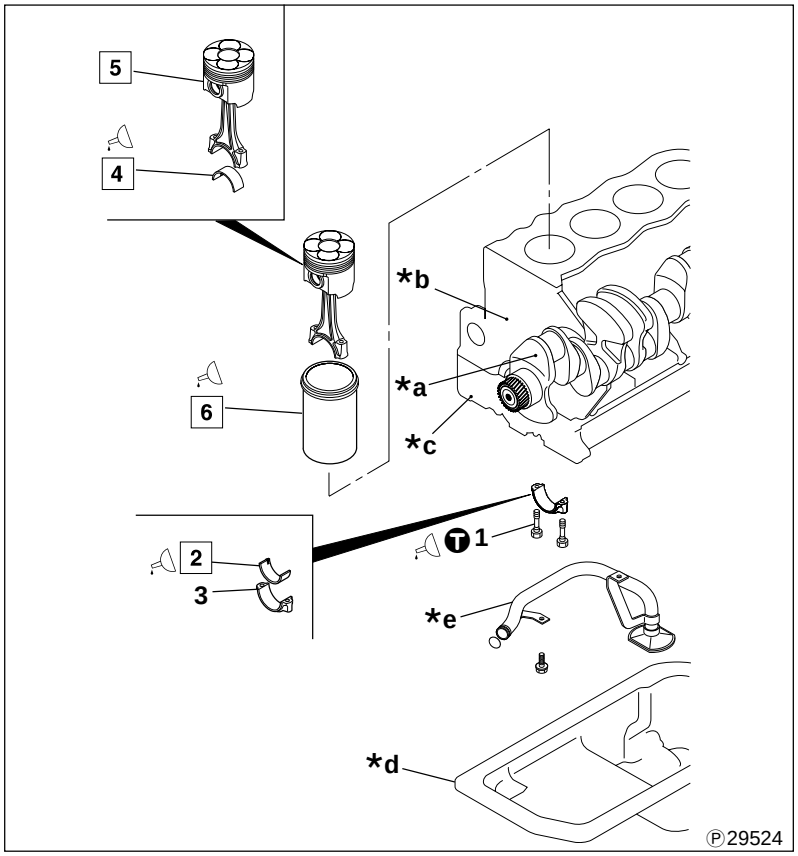
  E : Oil groove
- Install the balance shaft gears RH **27** and LH **35** in the illustrated direction.
- Install the nut **26** by turning clockwise. Install the nut **34** by turning counter-clockwise.

[Installation]

- The installation position of the balance shaft assembly RH **25** is determined by the gears to put in mesh when oil pump assembly **22** is installed. 🕮 P11A-60
- The balance shaft assembly LH **33** is not brought in mesh with any gear until when the vacuum pump assembly is installed with the front case attached. Therefore, the following steps must be performed before installation.
  - Remove the plug **G** from the upper crankcase ***b**.
  - Insert a screwdriver from the hole from which the plug **G** was removed into the shaft support hole **E** (ϕ 5 mm {ϕ 0.2 in.}) provided in the No. 1 journal **B** of the balance shaft assembly LH **33** to support the balance shaft assembly.
  - Align the alignment marks of all the timing gears. 🕮 P11A-60
  - By so doing, the balance shaft assembly LH **33** can be positioned. Keep it in position until the vacuum pump assembly is installed (🕮 P11A-53).



PISTONS, CONNECTING RODS AND CYLINDER LINERS



● **Pre-disassembly inspection**

P11A-65

● **Removal sequence**

1 Bolt
2 Lower connecting rod bearing
3 Connecting rod cap
4 Upper connecting rod bearing
5 Piston and connecting rod assembly P11A-71
6 Cylinder liner
***a :** Crankshaft assembly P11A-80
***b :** Upper crankcase P11A-80
***c :** Lower crankcase P11A-80
***d :** Oil pan Gr 12A
***e :** Oil strainer Gr 12A

NOTE

Since the bolts 1 (for installing connecting rod cap 3) utilize the torque-turn tightening method, they must not be removed unless it is absolutely necessary.

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
–	Piston protrusion		–0.09 to 0.09 {–0.0035 to 0.0035}	–	Inspect each location
	Connecting rod end play		0.15 to 0.45 {0.0039 to 0.018}	0.6 {0.024}	Replace
2, 4	Connecting rod bearing	Oil clearance	[65 {2.56}] 0.04 to 0.09 {0.0016 to 0.0035}	0.2 {0.0079}	Replace
		Span when free	–	Less than 69.5 {2.73}	
5, 6	Piston and connecting rod assembly-to-cylinder Liner clearance		[114 {4.49}] 0.125 to 0.145 {0.0049 to 0.0057}	–	Replace
6	Cylinder liner	Flange projection	0.01 to 0.07 {0.00039 to 0.0028}	–	Replace
		Inside diameter	ϕ 114 to 114.02 {ϕ 4.4881 to 4.4889}	ϕ 114.25 {ϕ 4.498}	Replace
		Cylindricity	0.03 {0.0012} or less	–	Replace
		Difference in cylinder liner flange projection from adjacent cylinders	0.04 {0.0016} or less	–	Replace

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

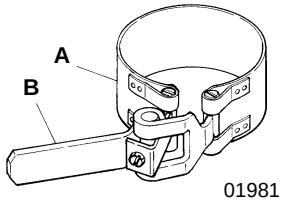
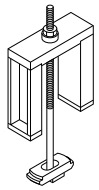
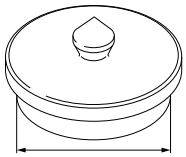
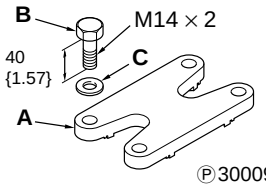
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (connecting rod cap installation)	29 {22, 3} +90°	Wet

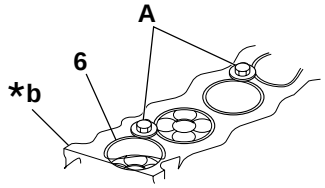
Lubricant

Location	Points of application	Specified lubricant	Quantity
1	Bolt threads	Engine oil	As required
2, 4	Connecting rod bearing inside surface	Engine oil	As required
6	Portions of cylinder liner held by upper crankcase	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
5	**A**: Piston Guide Clamp **B**: Piston Guide Lever  01981	**A**: MH063432 **B**: MH061658	Installing piston and connecting rod assembly
6	Cylinder Liner Extractor  Ⓟ30008	MH062537	Removing cylinder liners
	Cylinder Liner Installer  ϕ 113.5 {ϕ 4.46} Ⓟ30010	MH063606	Installing cylinder liners
	A: Adapter **B**: Bolt **C**: Washer  Ⓟ30009	**A**: MH063433 **B**: MF130625 **C**: MH005012	Measuring cylinder liner flange projection amount and their difference from adjacent cylinders.



Ⓟ29525

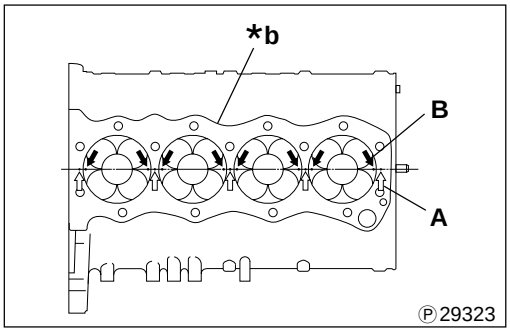
◆ Service procedure

● **Pre-disassembly inspection**

CAUTION ⚠

The cylinder liners 6 may be forced out if the upper crankcase *b is turned over or if the crankshaft assembly *a is rotated with the pistons inserted. Before beginning with inspection procedures, be sure to hold each cylinder liner at its flange section using a washer A or a similar tool.

PISTONS, CONNECTING RODS AND CYLINDER LINERS



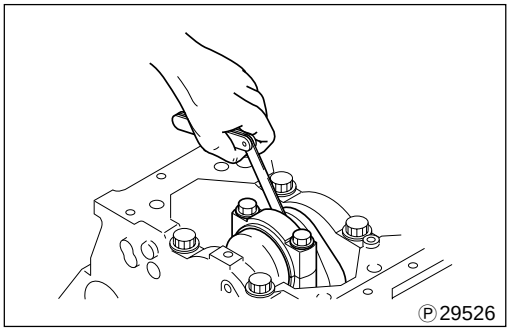
(1) Piston protrusion from crankcase top surface

NOTE

The piston protrusion affects engine performance and must therefore be checked.

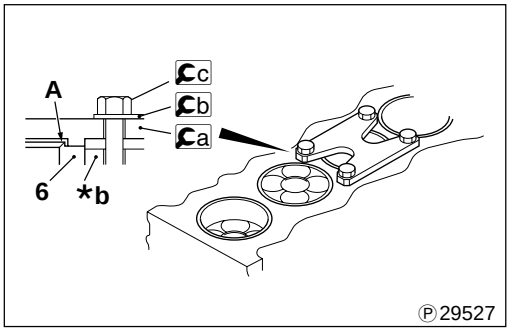
- Set the piston at top dead center.
- Make standard points **A** (five points) on upper crankcase assembly ***b** the 0 (zero) point and measure any protrusion relative to this point.
- Measure at four points on each piston at the nearest standard point from the zero point and produce the average value.

  B : Measurement point (16 points)
- If the average value is out of specification, check the clearances between all relevant parts.



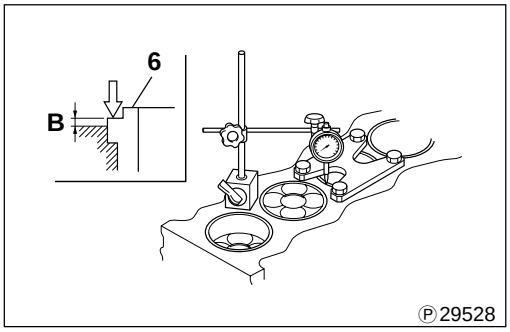
(2) Connecting rod end play

- Measure the end play every connecting rod.
- If any measurement exceeds the specified limit, replace the defective part (s).



(3) Cylinder liner flange protrusion amount and its difference between adjacent cylinders.

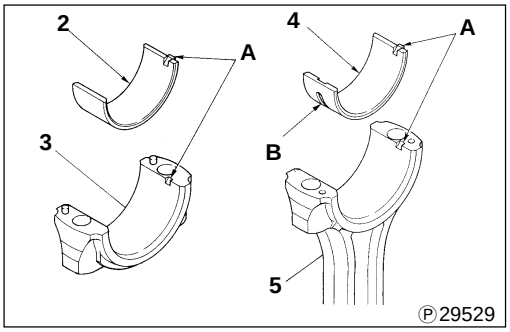
- Install the a Adapter on the upper crankcase in such a way that it may not ride on the flange **A** of the cylinder liner **6** and secure it by tightening the b Washer and c Bolt to a torque of 49 N·m {36 ft.lbs, 5 kgf·m}.



- Measure the protrusion amount **B** of flange of the cylinder liners **6**.
- If the measurement is out of specification, replace the defective part(s).
- Calculate the differences of the protrusion amounts between adjacent cylinders. If any difference is out of specification, check the mounting condition of the liners and replace the defective part(s).

CAUTION ⚠

If the cylinder liner 6 flange protrusion is insufficient, bearing pressure on the cylinder head gasket will be too low in the region of the bore, possibly causing gas to leak.



2 4 Connecting rod bearings

[Installation]

Fit the lower connecting rod bearing **2** into the connecting rod cap **3**, and fit the upper connecting rod bearing **4** into the piston and connecting rod assembly **5.** Make sure the lugs **A** on the bearings are fitted into their respective grooves.

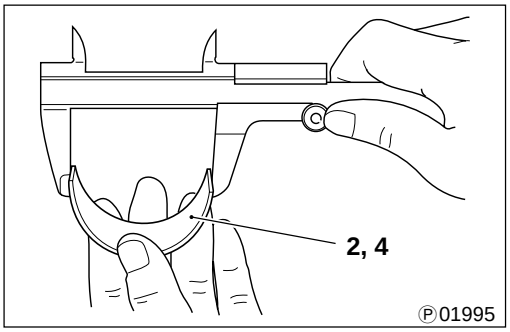
CAUTION ⚠

The upper connecting rod bearing 4 has an oil hole B. The lower connecting rod bearing 2 has no oil hole. Take care not to confuse the upper and lower parts.

[Inspection]

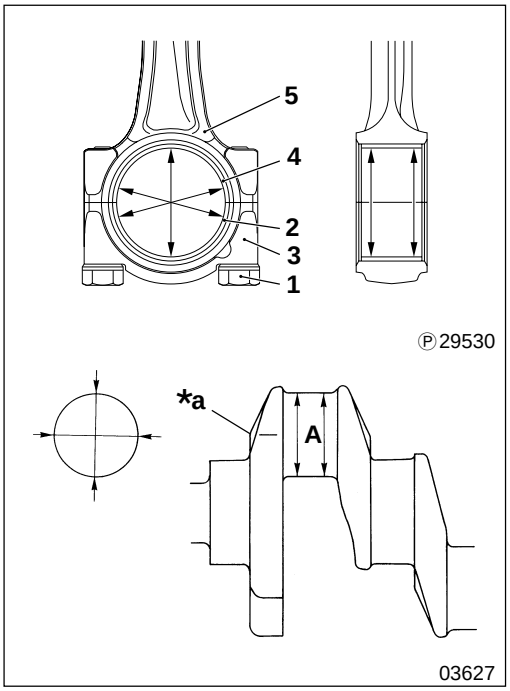
CAUTION ⚠

- **Do not attempt to manually expand a connecting rod bearing 2, 4 if its span is insufficient.**
- **Upper and lower connecting rod bearing 2,4 must be replaced as a set.**



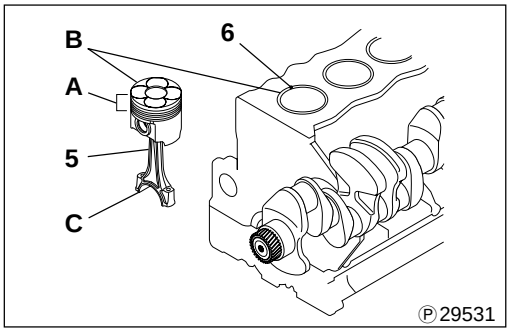
(1) Span when free

If the span is less than the specified requirement, replace the upper and lower connecting rod bearings **2**, **4** as a set.



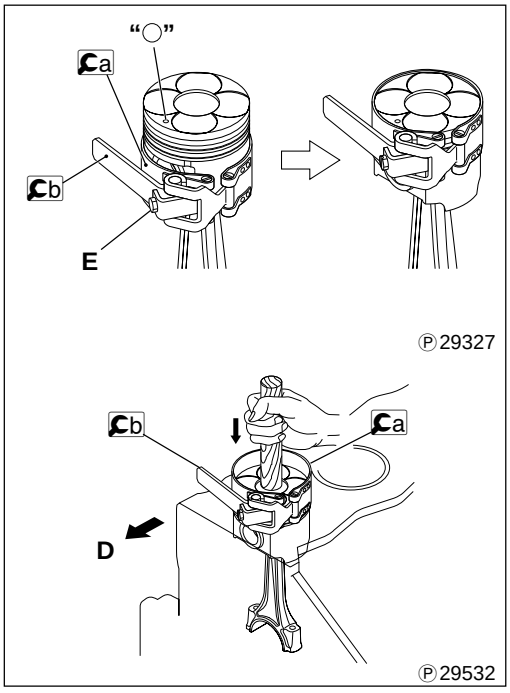
(2) Connecting rod bearing-to-crankshaft pin clearance (oil clearance)

- Fit the lower connecting rod bearing **2** into the connecting rod cap **3**, and fit the upper connecting rod bearing **4** into the piston and connecting rod assembly **5**. Then, tighten the bolts **1** to the specified torque.
- Measure the inside diameter of the connecting rod bearings **2**, **4** and the outside diameter of the crankshaft ***a** pin **A**. If the clearance exceeds the specified limit, replace the defective part(s).
- If the connecting rod bearing **2**, **4** have to be changed to undersized ones, adjust crankshaft ***a** pin outer diameter **A** in accordance with the specified procedure to fit the undersized dimensions. 🕮 P11A-86

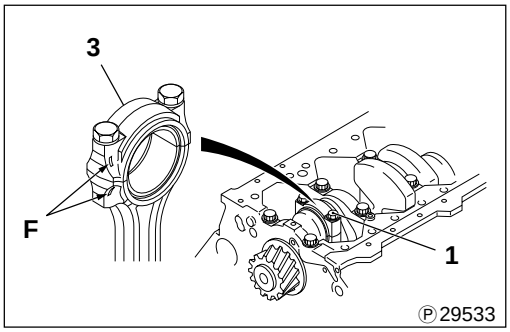


5 Installing piston and connecting rod assembly

- Ensure the gaps of the piston rings **A** remain in their correct positions. 🕮 P11A-74
- Check that the size marks **B** on the piston and cylinder liner are the same. 🕮 P11A-69
- Use care to prevent the connecting rod **C** from damaging the cylinder liner **6** and crankshaft pin.



- With the piston's front mark "○" facing the front of the engine **D**, carefully insert the piston and connecting rod assembly into the cylinder liner.
- Using the bolt **E** of the ⓑ Piston Guide Lever, adjust the inside diameter of the ⓐ Piston Guide Clamp such that it matches the piston's outside diameter.
- After adjustment, remove it from the piston and smear engine oil over the following items**:**
  - Outside of piston
  - Inside of the ⓐ Piston Guide Clamp
  - Inside of the cylinder liner

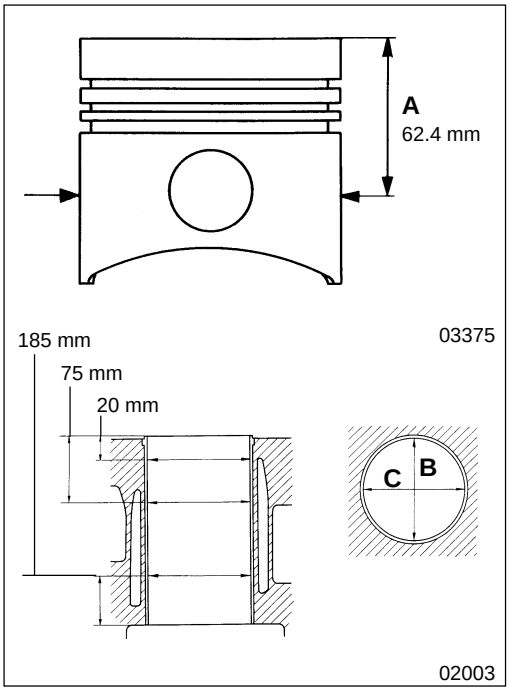


- With the piston installed, align the mating marks **F** on the connecting rod and connecting rod cap **3** and tighten the bolts **1** to the specification.
- Tighten bolts **1** alternately in the following manner.
  - First tighten to a torque of 29 N·m {22 ft.lbs, 3 kgf·m}.
  - Then tighten further 90° ± 5°.

NOTE

After installation of connecting rod cap 3, inspect the following points:

- **End play of the connecting rod: 🕮 P11A-66**
- **Piston Protrusion: 🕮 P11A-66**



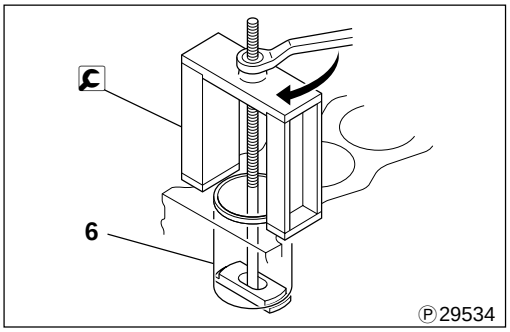
5 **6** **Piston-and-connecting rod assembly and cylinder liners**

[Inspection]

- Take measurements to determine the clearance between the piston and cylinder liner **6**.

  A : Outside diameter measurement position
  B : Direction of crankshaft axis
  C : Perpendicular to crankshaft axis

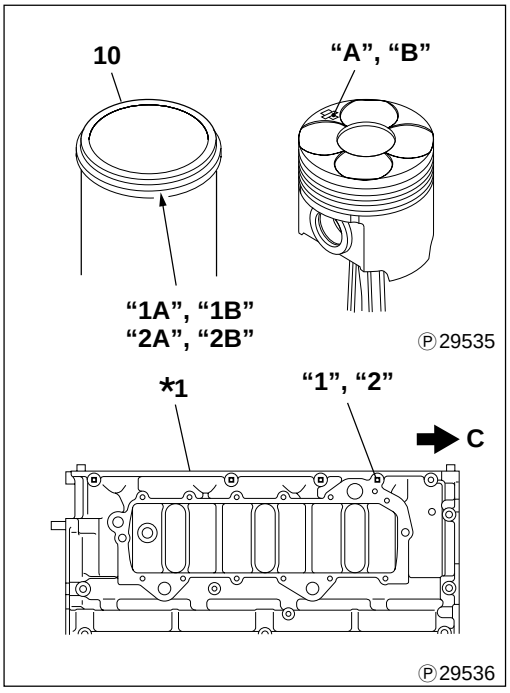
- If the clearance is out of specification, replace the defective part(s).



Cylinder liners

[Removal]

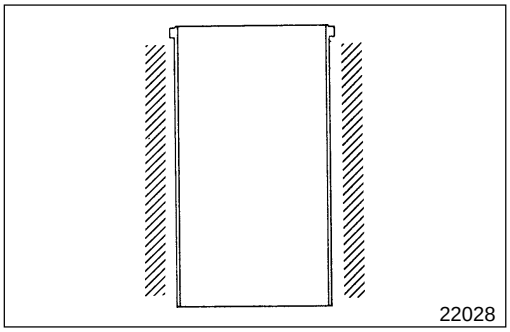
: Cylinder Liner Extractor



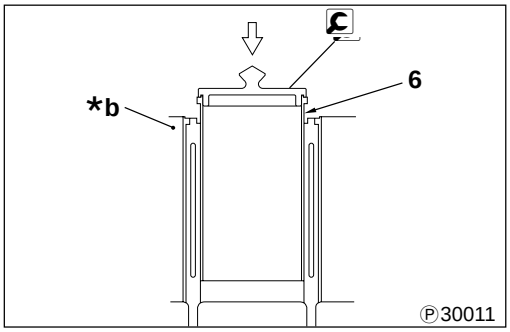
[Installation]

- Select a cylinder liner **6** which has the same size mark as those stamped on the upper crankcase ***b** and the piston.
- The size marks on the upper crankcase ***b** are arranged in the order of No. **1**, **2**, **3** and **4** cylinders starting from the engine front **C**.

Size marks on upper crankcase	Size marks on cylinder liners	Size mark on pistons
"1"	"1A"	"A"
	"1B"	
"2"	"2A"	
	"2B"	"B"



- Apply engine oil to the indicated ▨ parts of the cylinder liner **6**.

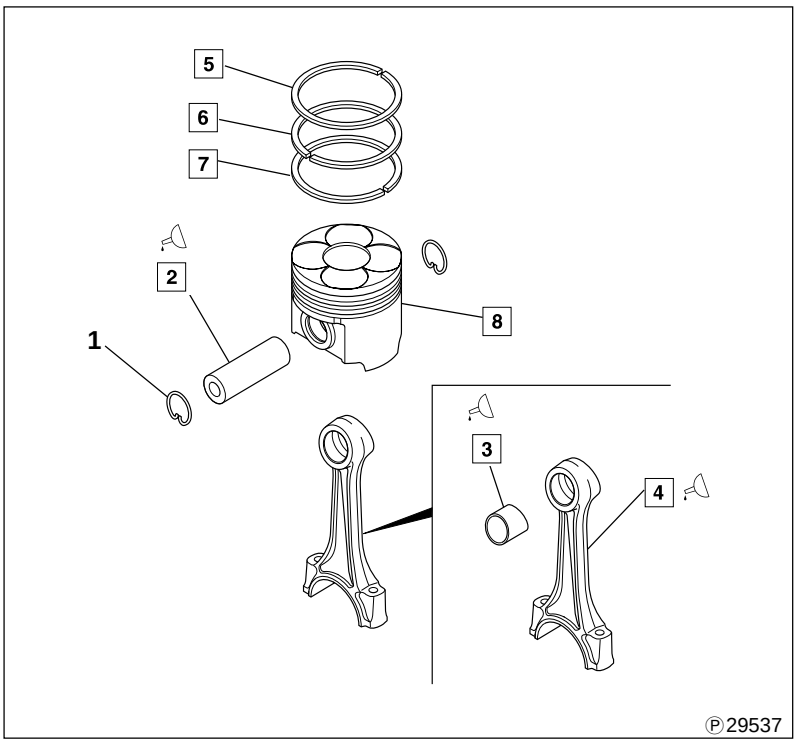


- Using the Cylinder Liner Installer, gently tap down the cylinder liner **6** until it is snugly seated on the upper crankcase ***b**.

CAUTION ⚠

The cylinder liner 6 is thin in wall thickness.
Use utmost care when handling it.

Piston and Connecting Rod Assembly



● **Disassembly sequence**

1 Snap ring
2 Piston pin
3 Connecting rod bushing
4 Connecting rod
5 1st compression ring
6 2nd compression ring
7 Oil ring
8 Piston

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

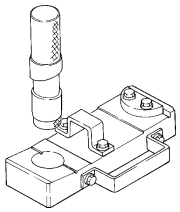
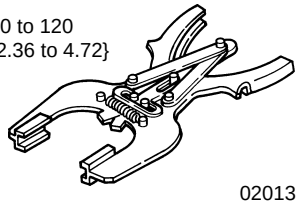
Location	Maintenance item		Standard value	Limit	Remedy
2, 3	Piston pin-to-connecting small end bushing clearance		[36 {1.42}] 0.03 to 0.04 {0.0012 to 0.0016}	0.1 {0.0039}	Replace
2, 8	Piston pin-to-piston clearance		[36 {1.42}] 0.007 to 0.021 {0.00028 to 0.00083}	0.05 {0.002}	Replace
4	Connecting rod bend		–	0.05 {0.002}	Replace
	Connecting rod twist		–	0.1 {0.0039}	Replace
5 to 7	Piston ring end gap	1st compression ring	0.3 to 0.45 {0.012 to 0.018}	1.5 {0.059}	Replace
		2nd compression ring	0.4 to 0.55 {0.016 to 0.022]	1.5 {0.059}	
		Oil ring	0.3 to 0.5 {0.012 to 0.02}	1.5 {0.059}	
5 to 8	Piston ring-to-piston ring groove clearance	1st compression ring	0.02 to 0.10 {0.00079 to 0.0039}	0.2 {0.0079}	Replace
		2nd compression ring	0.07 to 0.10 {0.0028 to 0.0039}	0.15 {0.0059}	
		Oil ring	0.03 to 0.06 {0.0012 to 0.0024}	0.15 {0.0059}	

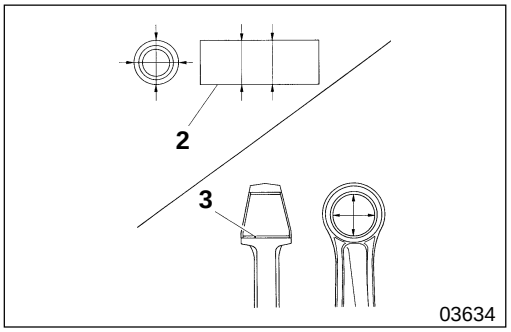
Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Piston pin outer surface	Engine oil	As required
3	Connecting rod bushing outer surface	Engine oil	As required
4	Bushing installation surface of connecting rod	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
3	Connecting Rod Bushing Puller Kit  02015	Use Locally Manufactured Equivalent	Removing and installing connecting rod bushings
5 to 7	Piton Ring Tool  02013	Obtain Locally	Removing and installing rings



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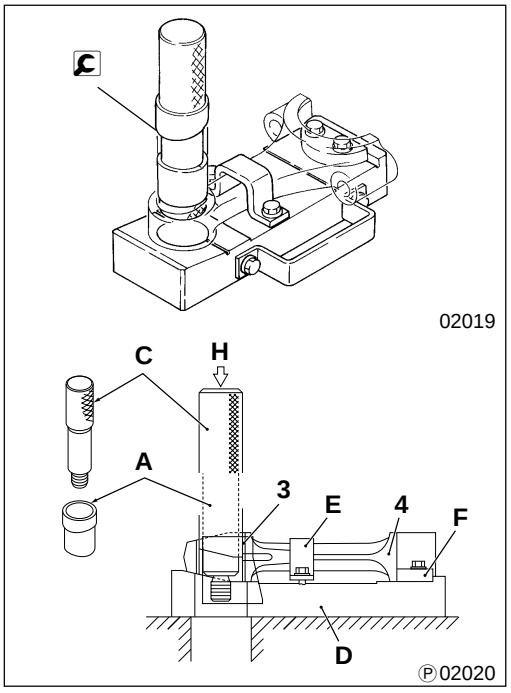
◆ Service procedure

2 **3** **Piston pin and connecting rod**

[Inspection]

If the clearance exceeds the specified limit, replace the defective part(s).



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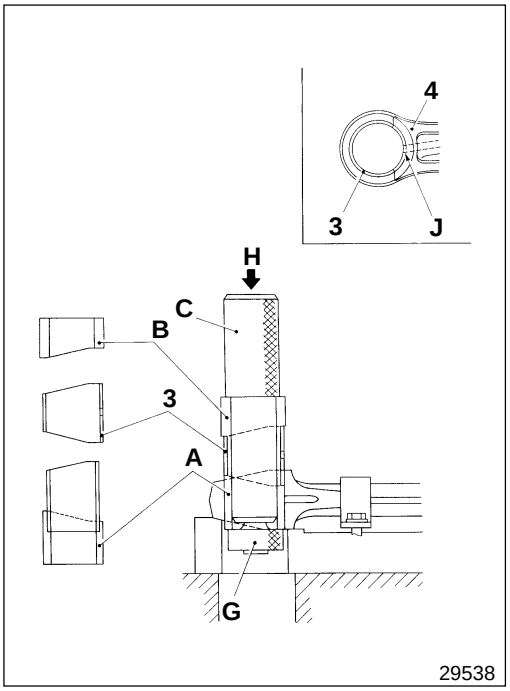
Connecting rod bushing

Replace the connecting rod bushing **3** using the Connecting Rod Bushing Puller Kit.
(Components of the Connecting Rod Bushing Puller Kit)

- **A :** Collar
- **B :** Collar
- **C :** Puller
- **D :** Base
- **E :** Bracket
- **F :** Plate
- **G :** Nut

[Removal]

- Remove the upper bearing (if fitted) from the big end of the connecting rod **4**.
- Mount the connecting rod **4** on the base **D** and lock it in position with the bracket **E** and place **F**.
- Fit the Collar **A** over the Puller **C** in the direction shown. Then, slowly apply pressure of approximately 49 kN (11020 lbf, 5,000 kgf) **H** until the connecting rod bushing **3** is pressed out.

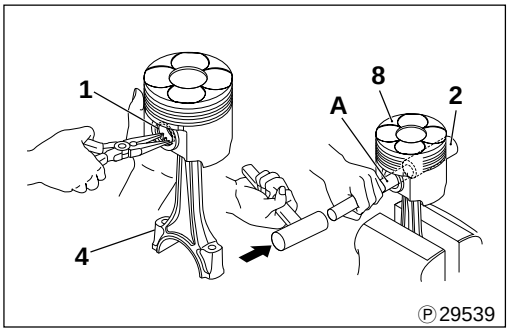


[Installation]

- Apply engine oil to the small end of the connecting rod **4** and to the outer surface of the connecting rod bushing **3**.
- Fit the Collar **B** over the Puller **C**, position the connecting rod bushing **3** and the Collar **A**, and lock this arrangement together with the Nut **G**.
- Align the oil holes **J** in the connecting rod bushing **3** and in the small end of the connecting rod **4**. Then, use a press to slowly apply pressure of approximately 49 kN (11020 lbf, 5,000 kgf) **H** until the bushing is pressed into place.
- After press-fitting the connecting rod bushing **3**, ream it to achieve the specified normal clearance between the bushing and piston pin **2**.

NOTE

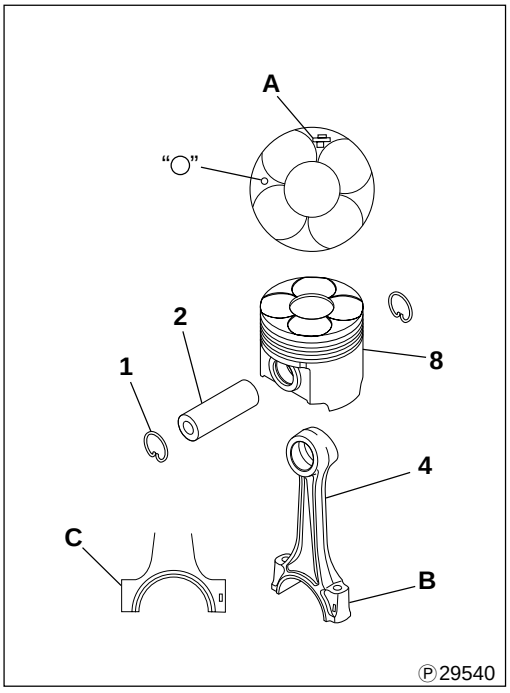
After reaming the connecting rod bushing 3, insert the piston pin 2 and check that it turns smoothly and without play.



2 | 4 | 8 Piston Pin, connecting rod, and piston.

[Removal]

- Removal the snap ring **1** and tap out the piston pin **2** using a rod **A** and hammer.
- If the piston pin **2** is difficult to remove, heat the piston **8** in hot water or using a piston heater.

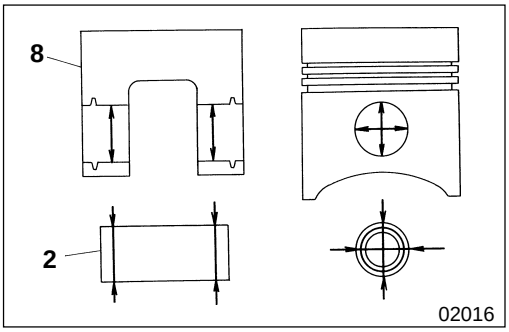


[Installation]

- Apply engine oil to the piston pin **2**. With the connecting rod **4** and piston **8** and aligned as illustrated, insert the piston pin to hold these components together.
  - **A :** Weight mark
  - **B :** Weight mark (**A** through **G**: "**A**" stands for the largest weight)
  - **C :** Alignment mark for connecting rod cap
  - "○"**:** Front mark
- If the piston pin **2** is difficult to insert, heat the piston pin **8** in hot water or using a piston heater.

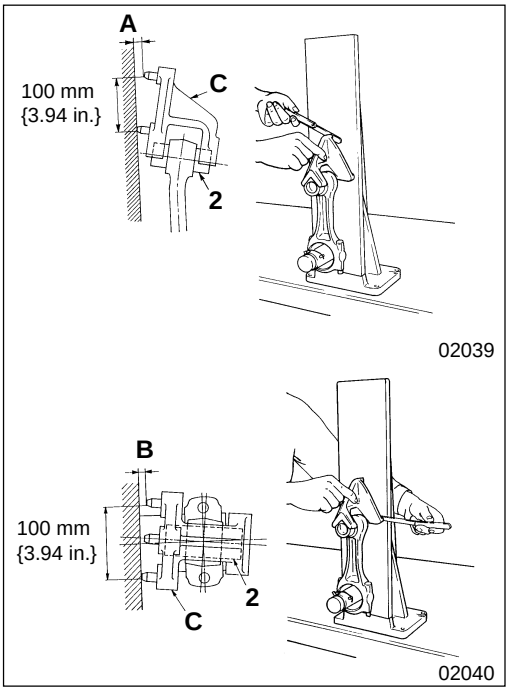
CAUTION ⚠

- **Make sure that all pistons have the same weight mark.**
- **The connecting rods must all have the same weight mark.**
- **After inserting the pin 2, check that it turns smoothly and without play.**



2 **8** **Piston pin-to-piston clearance**

If the clearance exceeds the specified limit, replace the defective part(s).



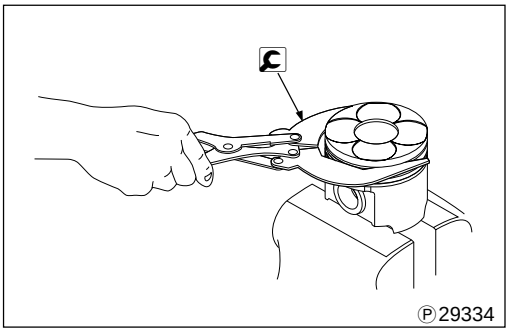
4 **Connecting rod bend and twist**

- Fit the connecting rod bushing **3** and piston pin **2** in their respective positions of the connecting rod **4**.
- Measure the extent of bending **A** and twisting **B** in the connecting rod **4**. If either measurement exceeds the specified limit, replace the connecting rod.

  C : Connecting rod aligner (Measurement device)

NOTE

- **Before mounting the connecting rod 4 on the connecting rod aligner C, install the upper and lower connecting rod bearings in their respective positions.** **P11A-67**
- **Measurements must be made with the connecting rod cap mounting bolts tightened to the specification.** **P11A-67**

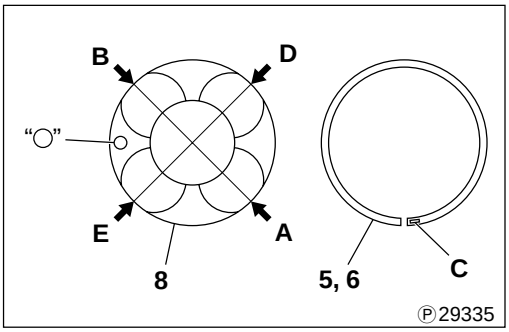


5 **to** **8** **Piston rings and piston**

Piston rings

[Removal]

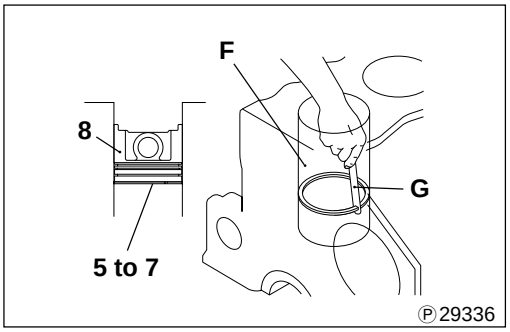
C **:** Piston Ring Tool



[Installation]

- Fit the oil ring **7** onto the piston **8** with its gap **A** and the expander spring end joint **B** in the position illustrated.
- Fit the piston ring **5**, **6** onto the piston **8** such that the manufacturer's marks **C** near the gaps face upward.
- Align the gaps **D**, **E** of the piston ring **5**, **6** as illustrated.

  D **:** 1st compression ring gap
  E **:** 2nd compression ring gap
  "○" **:** Front mark



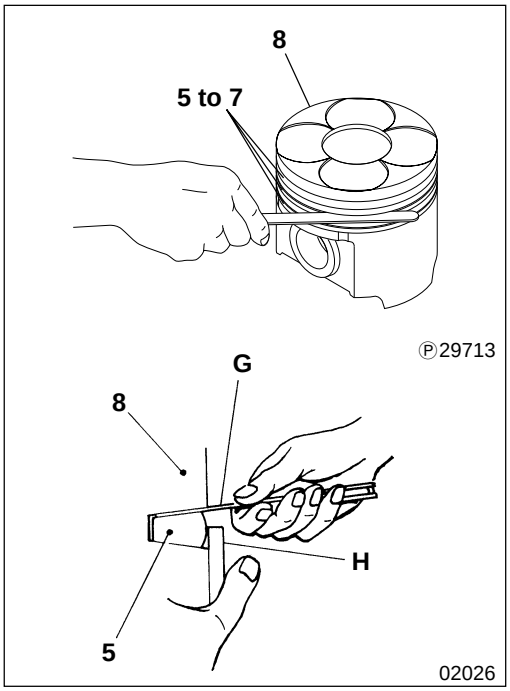
[Inspection]

(1) Piston ring end gap

- Using the crown of a piston **8**, push the piston ring **5**, **6** or **7** horizontally into a cylinder liner **F** in the upper crankcase for measurement.
- Taking care not to remove the piston ring **5**, **6** or **7**, measure the end gap using a thickness gauge **G**. Replace all the rings of piston if any gap exceeds the specified limit.

NOTE

- **To keep the piston ring 5, 6 or 7 horizontal, be sure to insert them into the cylinder liner F using a piston 8.**
- **Push the piston ring 5, 6 or 7 down to the bottom of cylinder liner F; the bottom should be less worn than the top.**
- **Piston rings 5, 6 or 7 must be replaced as a set. Never replace piston rings individually.**



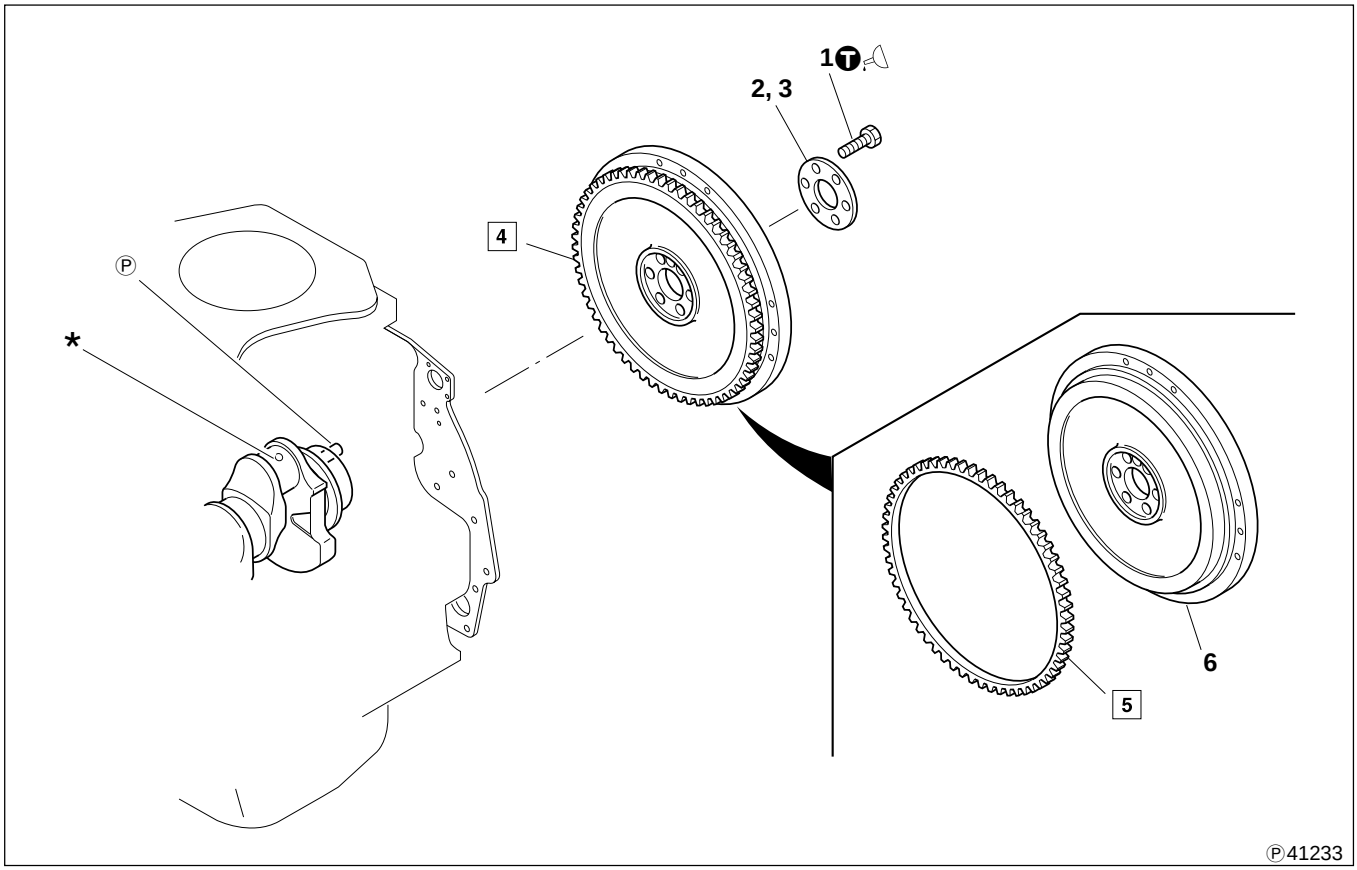
(2) Piston ring-to-piston ring groove clearance

- If any measurement exceeds the specified limit, replace the defective part(s).
- Measure the 1st compression ring **5** clearance with a thickness gauge **G** while pressing the ring against the piston **8** with a straight edge **H**.

NOTE

- **Remove any carbon deposits from the ring groove of the piston 8 and measure the clearance around the piston's entire periphery.**
- **Piston ring 5, 6, 7 must be replaced as a set. Never replace piston rings individually.**

FLYWHEEL



● **Disassembly sequence**

1 Bolt
2 Plate
3 Pilot bearing
4 Flywheel assembly
5 Ring gear
6 Flywheel
***** : Crankshaft assembly P11A-80
Ⓟ : Locating pin

● **Assembly sequence**
Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure that the mounting surface of the flywheel assembly 4 is free from any foreign substances, oil and detrimental flaws.**
- **After installing flywheel assembly 4, check for runout.**

NOTE

- **Do not remove the pilot bearing 3 or ring gear 5 unless an abnormality is evident.**

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

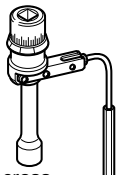
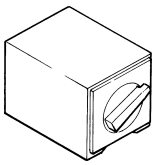
Location	Parts to be tightened	Tightening torque	Remarks
1	Blot (flywheel assembly installation)	39.0 {29.0, 4.0} +40°	Wet

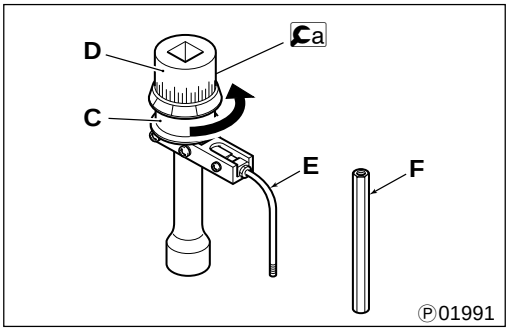
Lubricant

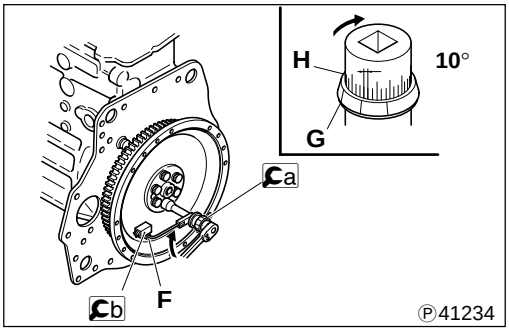
Location	Points of application	Specified lubricant	Quantity
1	Blot threads	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
4	Socket Wrench  Width across flats: 22 {0.87} Ⓟ01984	Obtain Locally	Installation of flywheel
	Magnet Base  00471	Obtain Locally	





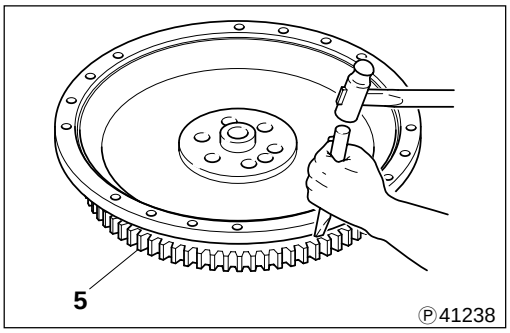
◆ Service procedure

5 Installation of flywheel assembly

- Tighten the bolts **1** to the specified torque (39.0 N·m {29 ft.lbs, 4.0 kgf·m}. After that, turn the bolts further in accordance with the following procedure.
- Turn the holder **C** of the Ca Socket Wrench counterclockwise to the tension the built-in spring.

  D : Socket
  E : Rod
  F : Rod (extension)

- Fit the Cb Magnet Base on the flywheel at a position where it can come in contact with the Rod **F** (for extension) as shown in the illustration.
- Set the rod **F** (for extension) such that it may be pressed against the Cb Magnet Base by the spring force.
- Align any inscribed line **G** on the holder **C** with any inscribed line **H** on the socket **D**. (Use this point as reference 0° position.)
- From the above reference position, turn the socket **D** clockwise by 40° to tighten the bolt further.



5 Ring gear

[Inspection]

Inspect ring gear **5** for damage and abnormal wear. If any defect is evident, the ring gear must be replaced.

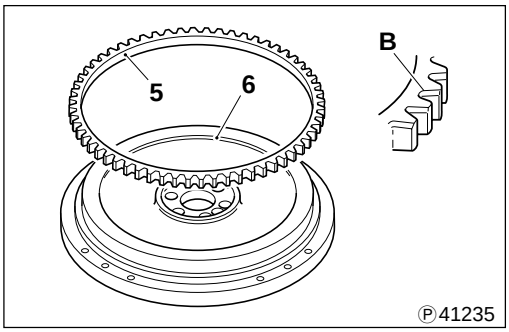
[Removal]

Heat the ring gear **5** evenly with an acetylene torch or the like.

WARNING ⚠

Be careful not to get burned.

- Remove the ring gear **5** from the flywheel by tapping around its entire periphery.



[Installation]

Using an acetylene torch or the like, heat the ring gear **5** to approximately 100 °C {212 °F} for **3** minutes.

WARNING ⚠

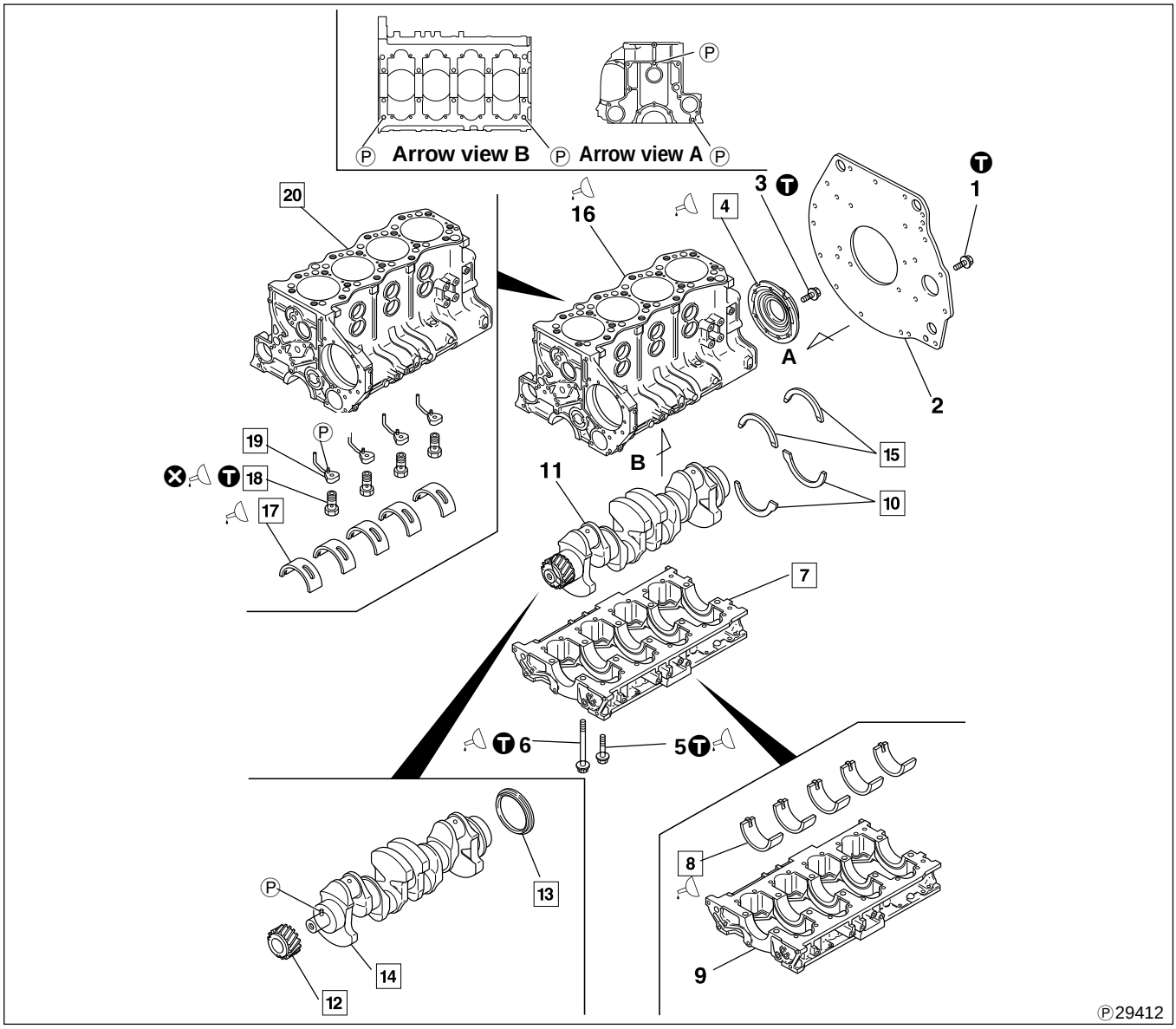
Be careful not to get burned.

- Fit the ring gear **5** with the non-chamfered side of its teeth toward the flywheel **6**.

  B : Chamfered side of ring gear **5**.

MEMO

CRANKSHAFT AND CRANKCASE



● **Pre-disassembly inspection**

P11A-82

● **Disassembly sequence**

1 Bolt
2 Rear plate
3 Bolt
4 Rear oil seal
5 Bolt
6 Main cap bolt
7 Lower crankcase assembly
8 Lower main bearing
9 Lower crankcase
10 Lower thrust plate
11 Crankshaft assembly
***12** Crankshaft gear
***13** Rear oil seal slinger
14 Crankshaft
15 Upper thrust plate
16 Upper crankcase assembly
17 Upper main bearing
***18** Check valve
19 Oil jet
20 Upper crankcase

Ⓟ **:** Locating pin
⊗ : Non-reusable part

NOTE

- **Do not remove parts marked * unless defects are evident.**
- **The lower crankcase 9 and upper crankcase 20 have been machined in a pair. Therefore, replacing either one of the pair is not allowed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **If the main cap bolt shows evidence of having been tightened three times, replace it. P11A-83**
- **Do not overtighten the check valve 18. If the tightening torque exceeds the specified one, the check valve may malfunction, resulting in seizure of the engine.**

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
–	Crankshaft end play			0.10 to 0.28 {0.0039 to 0.0110}	0.4 {0.016}	Replace thrust plate
8, 17	Main bearing	Oil clearance	No. 1, 2, 4, 5	[86 {3.385}] 0.04 to 0.11 {0.0016 to 0.0043}	0.15 {0.0059}	Replace
			No. 3	[86 {3.385}] 0.06 to 0.13 {0.0024 to 0.0051}		
		Span when free		–	Less than 91.5 {3.60}	Replace
14	Crankshaft	Bend		0.02 {0.00079} or less	0.05 {0.002}	Correct or replace
		Pin and journal	Roundness	0.01 {0.00039} or less	0.03 {0.0012}	Correct or replace
			Cylindricity	0.006 {0.00024} or less	–	Correct or replace
20	Distortion of upper crankcase top surface			0.07 {0.0028} or less	0.2 {0.0079}	Replace

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

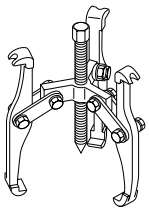
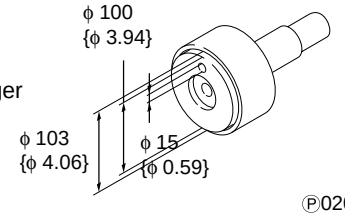
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (rear plate installation)	63,7 {47, 6.5}	—
3	Bolt (rear oil seal installation)	9.8 {7.2, 1.0}	—
5	Bolt (lower crankcase installation)	23.5 {17, 2.4}	Wet
6	Main cap bolt (lower crankcase installation)	49 {36, 5.0} + 90°	• Wet • Reusable 3 times
18	Check valve	29.4 {22, 3.0}	Wet

Lubricant and sealant

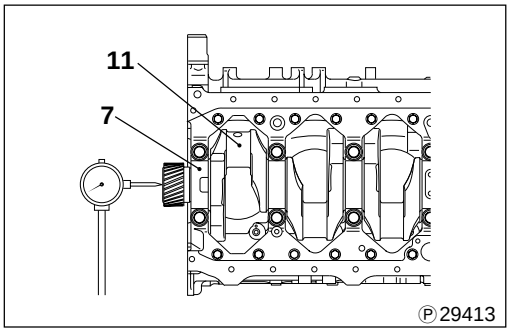
Location	Points of application	Specified lubricant/sealant	Quantity
4	Rear oil seal lip	Engine oil	As required
	Upper and lower crankcase contracting surface of rear oil seal	Threebond 1207	As required
5, 6	Bolt threads and seating surface	Engine oil	As required
8, 17	Main bearing inside surfaces	Engine oil	As required
16	Lower crankcase attaching surface of upper crankcase	Threebond 1207	As required
18	Check valve threads	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
12	Gear Puller  Ⓟ02065	Obtain Locally	Removing crankshaft gear
13	Rear Oil Seal Slinger Installer  Ⓟ02051	MH061470A	Installing rear oil seal slinger

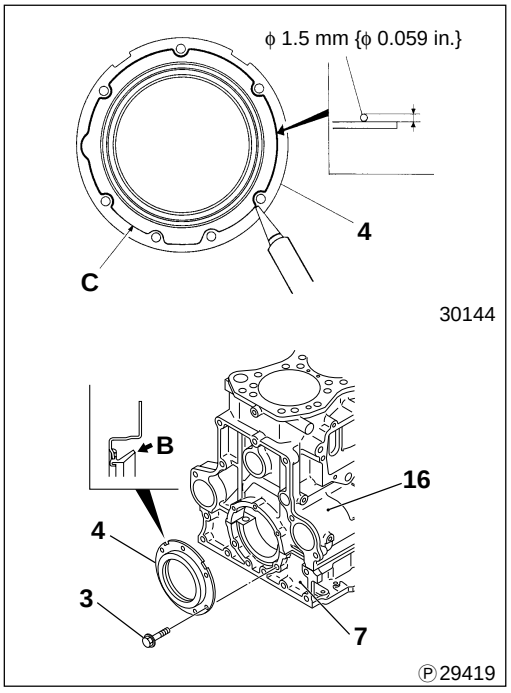
◆ Service procedure



Ⓟ29413

● **Pre-disassembly inspection**
Crankshaft end play

- Before removing the lower crankcase assembly **7**, measure the extent of crankshaft end play.
- If the measurement exceeds the specified limit, replace the thrust plates with oversize ones. P11A-85



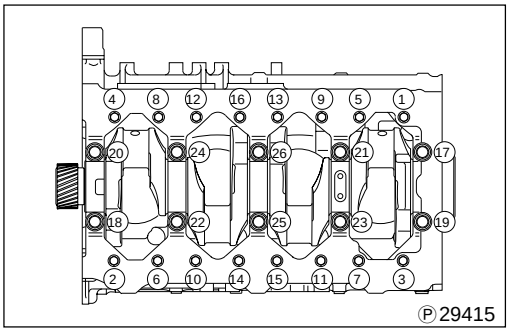
Ⓟ29419

4 **Mounting of rear oil seal**

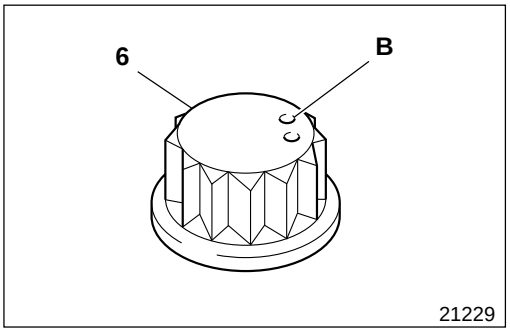
- Apply engine oil to lips **B** of rear oil seal **4**.
- Apply sealant **D** along black line **C** stamped on the rear oil seal **4** evenly without break. (ϕ 1.5 mm {ϕ 0.059 in.})
- After applying sealant **D**, install the rear oil seal **4** between the lower crankcase assembly **7** and upper crankcase assembly **16** within three minutes.

CAUTION ⚠

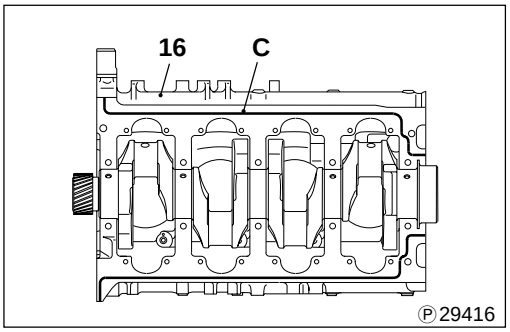
- **Make sure that the sealant application surfaces are clean and free from grease and oil.**
- **Use care not to let the applied sealant slip out of place during installation.**
- **After fitting rear oil seal, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant D whenever mounting bolts 3 of rear oil seal have been loosened.**



Ⓟ29415



21229



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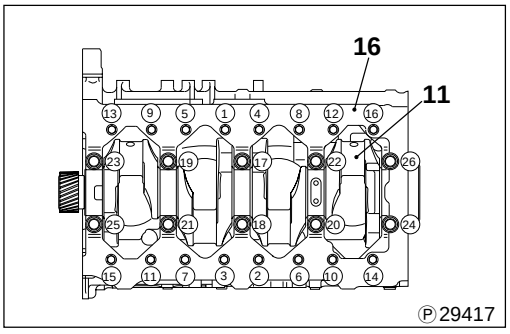


Ⓟ29417

7 Lower crankcase assembly

- ① – ⑯ : Bolt **5**
- ⑰ – ㉖ : Main cap bolt **6**

[Removal]

- Gradually loosen the bolts **5** in the sequence of numbers ① – ⑯ shown in the illustration.
- Then, gradually loosen the main cap bolts **6** in the sequence of numbers ⑰ – ㉖ shown, and remove.

[Installation]

CAUTION ⚠

- **Before installing the lower crankcase assembly check the head of the main cap bolt 6 for punch marks B.**
- **The number of punch marks corresponds to the number of times the bolt has been tightened using torque-turn method (bolts with two or less punch marks are reusable). If there are three, replace the main cap bolt.**

- Apply ϕ 2 mm {ϕ 0.079 in.} thick bead of specified sealant **C** to the fitting surface of the upper crankcase assembly **16** as shown.
- After applying sealant **C**, install the lower crankcase assembly **7** to the upper crankcase assembly **16** within three minutes and secure with the main cap bolts **6** and the bolts **5** as follows:

CAUTION ⚠

- **Make sure that the sealant application surfaces are clean and free from grease and oil.**
- **Use care not to let the applied sealant C slip out of place during installation.**

- Apply a thin coat of engine oil to the threaded part and seating surface of each main cap bolt **6**, then tighten the bolts to a torque of 49 N·m {36 ft.lbs, 5.0 kgf·m} in the sequence of the numbers shown (⑰ – ㉖)
- After tightening, give the bolts an additional 90° turn.
- Following the main cap bolts **6**, tighten the bolts **5** to the specified torque in the sequence of the numbers shown (① – ⑯).

CAUTION ⚠

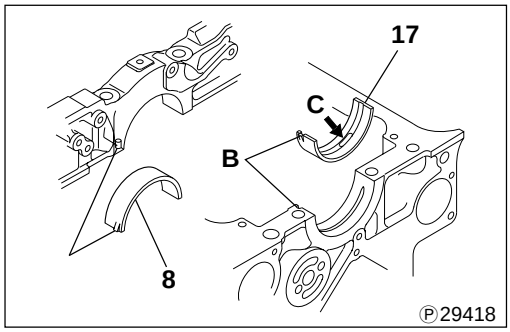
- **After installation, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant C whenever the bolts 5 or the main cap bolts 6 have been loosened.**

- After tightening the main cap bolts **6** using the torque-turn tightening method, make a punch mark on the head of each one to indicate the time of use.

NOTE

Since bolts 1 utilize the torque-turn tightening method, they must not be tightened further after this procedure.

- After installing the lower crankcase assembly, check the following:
  - Smooth rotation of crankshaft assembly **11**
  - End play of the crankshaft assembly **11** P11A-82



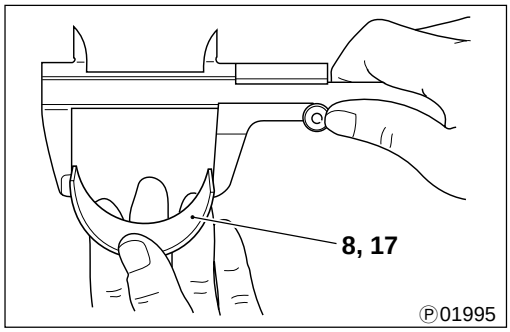
8 **17** **Main bearings**

[Installation]

Install the main bearings **8**, **17** such that their lugs **B** fit into the corresponding grooves.

CAUTION

The upper main bearing 17 has an oil hole C. The lower main bearing 8 has no oil hole. Take care not to confuse the upper and lower parts.



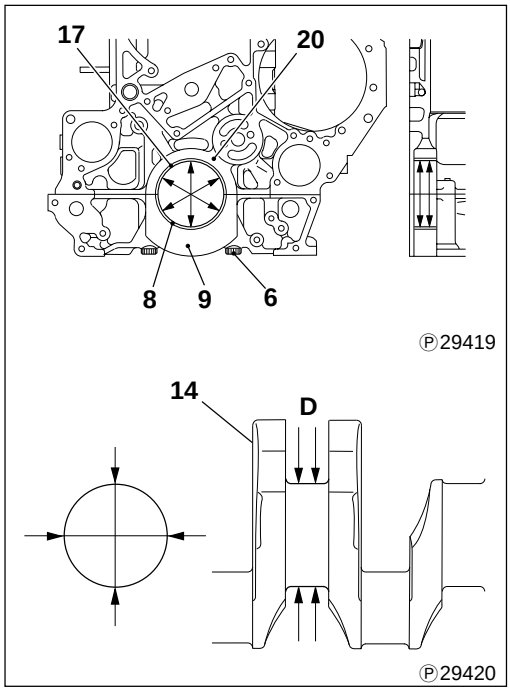
[Inspection]

CAUTION

- **Do not attempt to manually expand either bearing 8, 17 if its span is insufficient.**
- **Upper and lower bearings 8, 17 must be replaced as a set.**

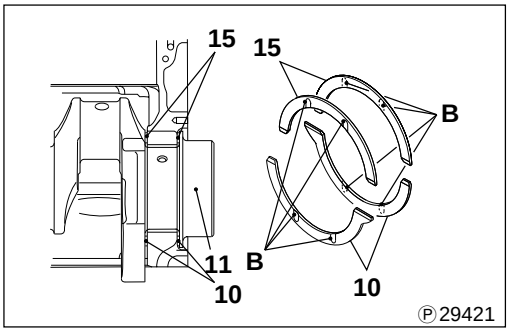
(1) Span when free

If either bearing's span when free exceeds the specified limit, the bearings **8**, **17** must be replaced.



(2) Main bearing-to-crankshaft clearance

- Fit the upper main bearing **17** into the upper crankcase **20** and the lower main bearing **8** into the lower crankcase **9**. Then, tighten the main cap bolts **6** to their specified torque (49 N·m {36 ft.lbs, 5.0 kgf·m}).
- Measure the internal diameters of the main bearings **8**, **17** and the journal outside diameter **D** of the crankshaft **14**. If the clearance exceeds the specified limit, replace the defective part(s).

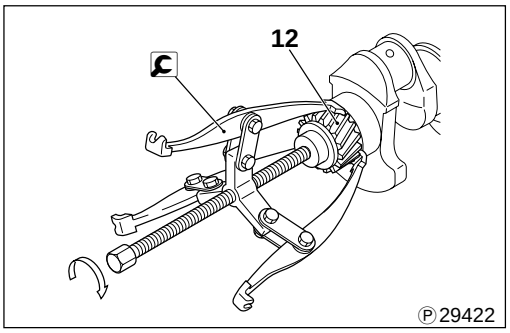


10 **15** **Thrust plate**

Install the thrust plates **10**, **15** to the crankshaft assembly **11** at No. 5 journal only. Install all halves of the thrust plates with the oil groove **B** oriented outward.

NOTE

If any oversize thrust plates are to be used, be sure to use an upper thrust plate 15 and lower thrust plate 10 of the same size at one side. However, using the same size upper (or lower) thrust bearings on both sides is not necessary.
Available oversize: 0.15, 0.30, 0.45 mm {0.0059, 0.012, 0.018 in.}



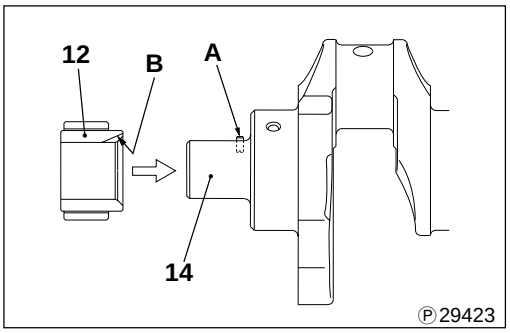
12 **Crankshaft gear**

[Removal]

: Gear Puller

CAUTION ⚠

Do not tap off the crankshaft gear 12 since this could damage it.



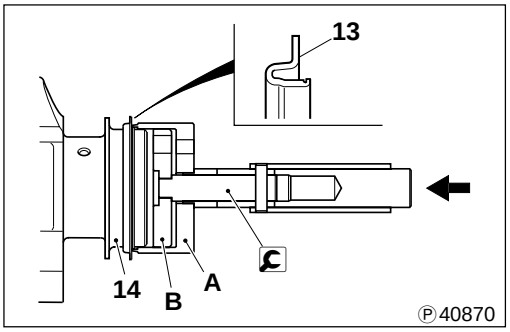
[Installation]

- Using a piston heater or the like, heat the crankshaft gear **12** to a temperature of approximately 150 °C {302 °F}.

WARNING ⚠

Be careful not to get burned.

- Align the location pin **A** on the crankshaft **14** with the notch **B** in the crankshaft gear **12**. Then, drive the gear into position by striking its end face with a plastic mallet.



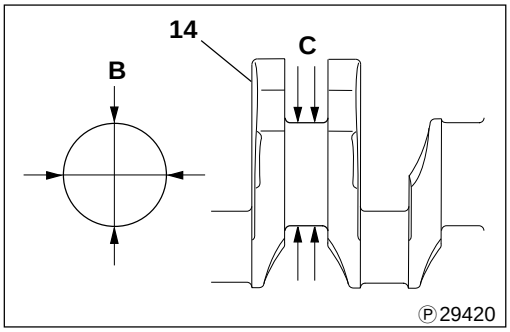
13 **Rear oil seal slinger**

[Removal]

Taking care not to damage the crankshaft **14**, split the oil seal slinger using a chisel or the like.

[Installation]

With the rear oil seal slinger **13** directed as illustrated, drive it onto the crankshaft using the Rear Oil Slinger Installer until the tools end face **A** is pressed firmly against the guide **B**.



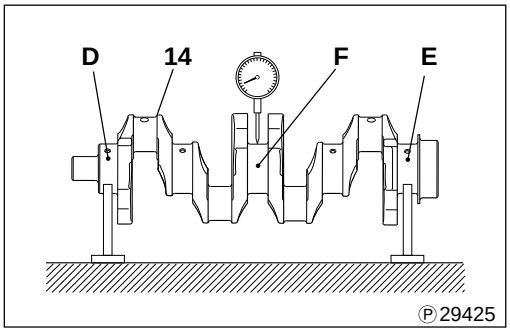
14 Crankshaft

[Inspection]

(1) Roundness and cylindricity of crankshaft journal and pin

If either measurement exceeds the specified limit, grind it to undersize or replace the crankshaft **14**.

B : Roundness
C : Cylindricity

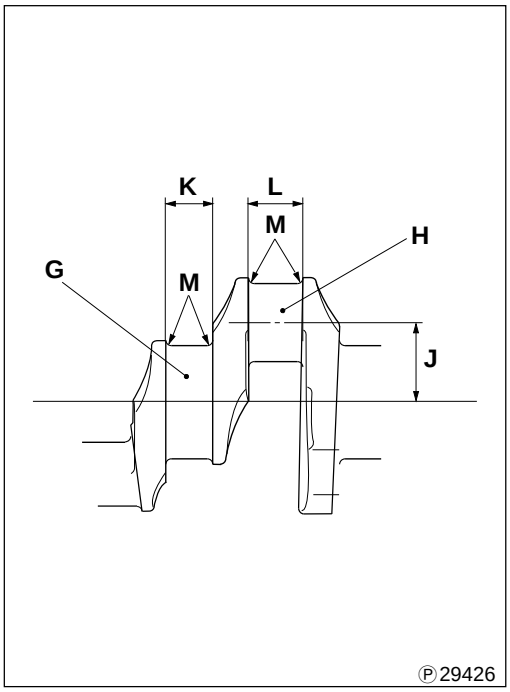


(2) Bend

- Support the crankshaft **14** at its No. 1 journal **D** and No. 7 journal **E**. Measure the extent of bending in the crankshaft at the center of the No. 4 journal **F**.
- If the measurement exceeds the specified limit, replace the crankshaft **14**.

NOTE

Turn the crankshaft 14 through one revolution. One-half of the dial indicator reading represents the extent of bending.



[Rectification]

NOTE

If the crankshaft 14 is rectified by grinding, the main bearings 8, 17 must be replaced with undersized ones.
Available undersizes: 0.25 mm, 0.50 mm 0.75 mm, 1.00 mm {0.0098, 0.02, 0.03, 0.039 in.}

- Grind such that the center-to-center distance **J** between the journal **G** and pin **H** never be changed.

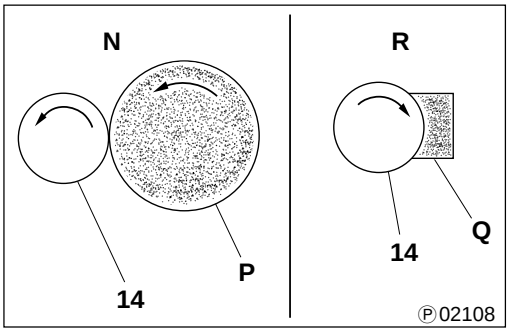
  J : 60 ± 0.05 mm {2.36 ± 0.002 in.}
- Grind such that the journal width **K** and pin width **L** do not change.

  K : 33.5 mm {1.32 in.} (No. 1 journal)
  35 mm {1.38 in.} (No. 2 to No. 4 journals)
  $35^{+0.039}_{0}$ mm {$1.38^{+0.0015}_{0}$ in.} (No. 5 journal)
  L : $41^{+0.2}_{0}$ mm {$1.61^{+0.0079}_{0}$ in.}
- Finish the corner fillet smoothly and to the specified radius M.

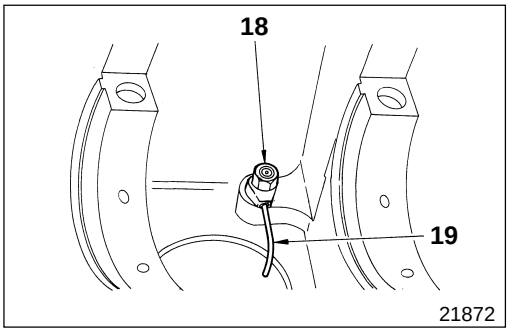
  M : 4 mm {0.16 in.}
- Carry out a magnetic inspection to check for cracks caused by grinding. Also, check that the Shore hardness of the surface has not dropped below Hs 75.

Crankshaft undersize dimensions Unit: mm {in.}

		Degree of undersize			
		0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finished journal diameter	No. 1, 2, 4, 5	85.68 to 85.70 {3.373 to 3.374}	85.43 to 85.45 {3.363 to 3.364}	85.18 to 85.20 {3.353 to 3.354}	84.93 to 84.95 {3.343 to 3.344}
	No. 3	85.66 to 85.68 {3.372 to 3.373}	85.41 to 85.43 {3.362 to 3.363}	85.16 to 85.18 {3.352 to 3.353}	84.91 to 84.93 {3.342 to 3.343}
Finished pin diameter		64.69 to 64.71 {2.546 to 2.547}	64.44 to 64.46 {2.537 to 2.5378}	64.19 to 64.21 {2.527 to 2.528}	63.94 to 63.96 {2.517 to 2.518}
Roundness		0.01 {0.00039} or less			
Cylindricity		0.006 {0.00024} or less			



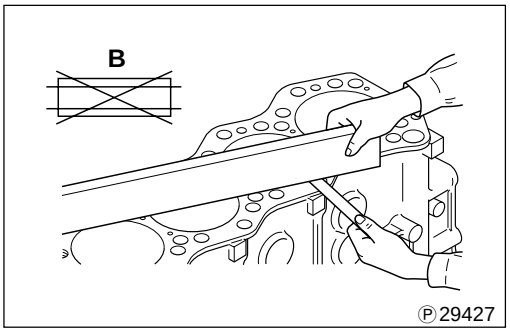
- When grinding **N**, turn the crankshaft **14** counter-clockwise as viewed from its front end. The grinder **P** should rotate in the same direction.
- When finishing **R** the crankshaft **14** with whetstone or sandpaper **Q**, rotate the crankshaft clockwise.



18 **19** **Installation of check valve and oil jet**

CAUTION ⚠

Do not overtighten the check valve 18. If the tightening torque exceeds the specified one, the check valve may malfunction, resulting in seizure of the engine.



20 **Inspecting upper crankshaft**

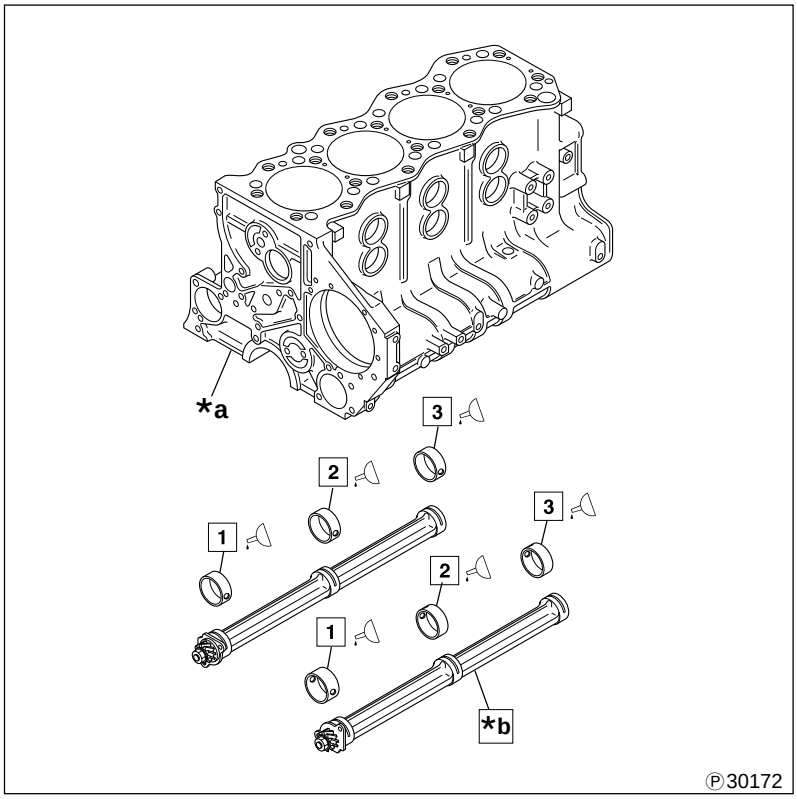
- Measure the upper surface distortion of the upper crankcase **20**.
- If distortion exceeds the specified limit, correct it with a surface grinder.

B : Measurement positions

CAUTION ⚠

When grinding the crankcase 20, take care that the piston protrusions stay within specification.

BALANCE SHAFT BUSHINGS



● **Disassembly sequence**

1 No. 1 balance shaft bushing
2 No. 2 balance shaft bushing
3 No. 3 balance shaft bushing

***a** : Upper crankcase 🕮 P11A-80
***b** : Balance shaft 🕮 P11A-56

CAUTION ⚠

Do not remove the balance shaft bushings 1 through 3 unless something wrong is evident.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

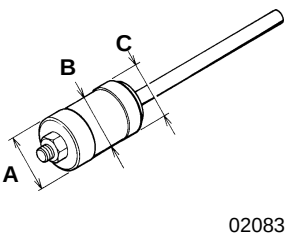
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
***b, 1 to 3**	Clearance between balance shaft and balance shaft bushing	No. 1 journal	[51.5 {2.027}] 0.055 to 0.099 {0.0021 to 0.0039}	0.15 {0.0059}	Replace
		No. 2 journal	[51 {2.0}] 0.075 to 0.119 {0.0029 to 0.0046}		
		No. 3 journal	[50.5 {1.98}] 0.055 to 0.099 {0.0021 to 0.0039}		

Lubricant

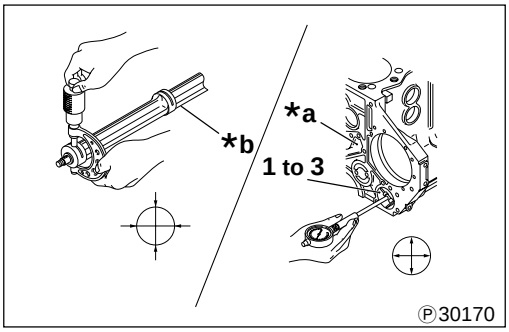
Location	Points of application	Specified lubricant and/or sealant	Quantity
1 to 3	Inside surface of balance shaft bushing	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
1 to 3	Balance shaft bushing installer and extractor (See table below)  02083	MH062782	Installation and removal of balance shaft bushing

	Dimensions A and C	Dimension B
No. 1	ϕ 55.25 {ϕ 2.175}	ϕ 51.5 {ϕ 2.027}
No. 2	ϕ 55 {ϕ 2.165}	ϕ 51 {ϕ 2.007}
No. 3	ϕ 55.75 {ϕ 2.155}	ϕ 50.5 {ϕ 1.988}



◆ Service procedure

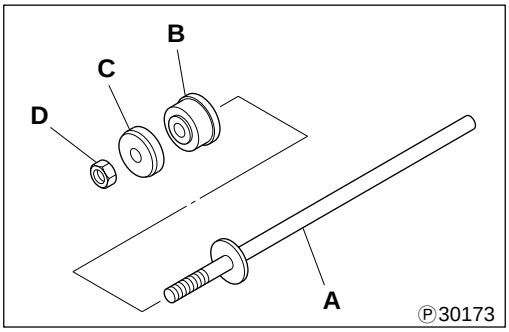
[*b] [1] to [3] Balance shaft and balance shaft bushing

[Inspection]

If the clearance is more than the limit, replace defective parts.

NOTE

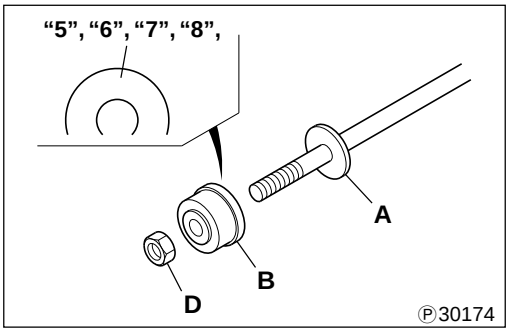
Measure the inner diameter of the balance shaft bushings 1 through 3 with the bushings installed on the upper crankcase *a.



Balance shaft bushing

Use the [SST] Balance Shaft Bushing Installer & Extractor to replace the balance shaft bushings **1** through **3**.
(Components of [SST] Balance Shaft Bushing Installer & Extractor)

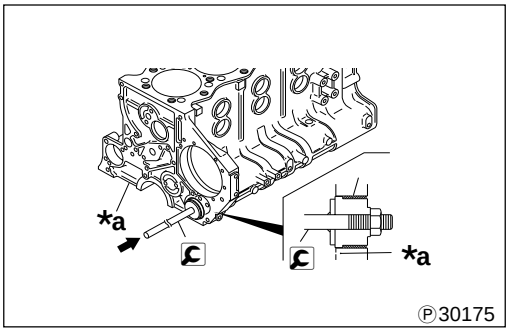
A : Rod
B : Adapter
C : Guide piece
D : Nut



[Removal]

- Drive out the balance shaft bushings **1** to **3** using the [SST] Balance Shaft Bushing Installer & Extractor consisting of the adapter **B** appropriate to each bushing secured on rod **A** with nut **D**.

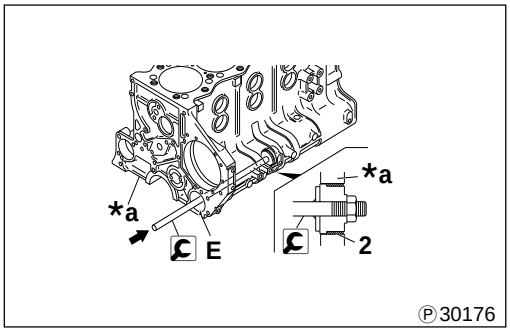
Balance shaft bushing		Identification mark of adapter **B**
No. 1	Left	5
	Right	6
No. 2		7
No. 3		8



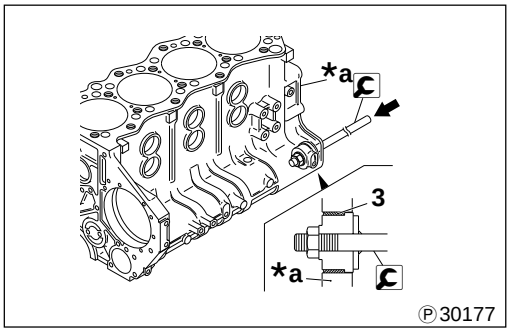
- Remove the No. 1 balance shaft bushing **1** from the front side of the upper crankcase ***a**.

[SST] **:** Balance Shaft Bushing Installer & Extractor

BALANCE SHAFT BUSHINGS

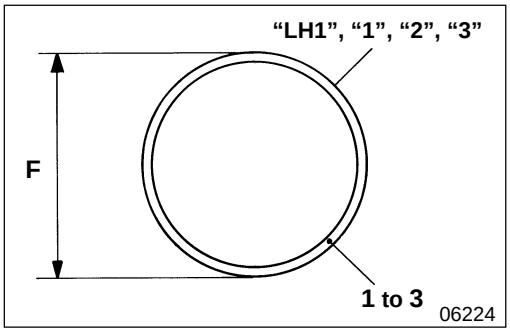


- Remove the No. 2 balance shaft bushing **2** from the upper crankcase ***a** by inserting the 🔧 Balance Shaft Bushing Installer & Extractor through the hole **E** from which the No. 1 balance shaft bushing was removed.



- Remove the No. 3 balance shaft bushing **3** from the rear side of the upper crankcase ***a**.

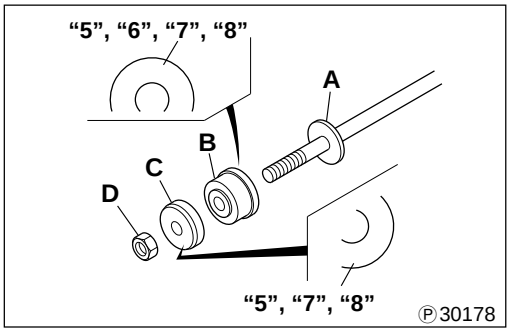
  🔧 **:** Balance Shaft Bushing Installer & Extractor



[Installation]

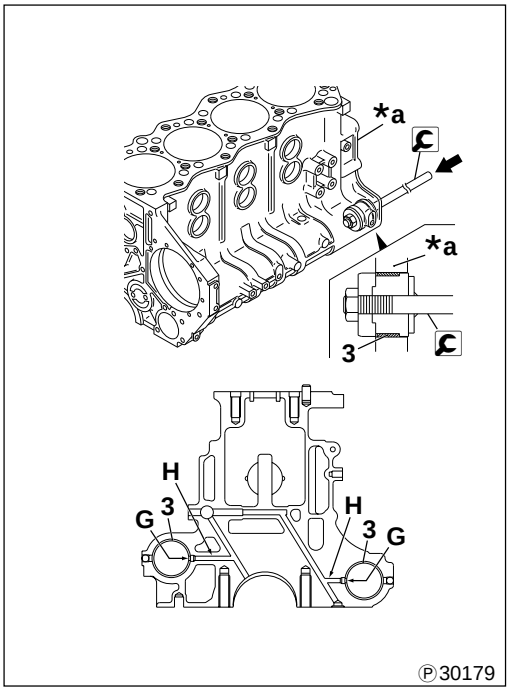
- Identify balance shaft bushings **1** through **3** by the marks "1", "2", "3" or "LH1" stamped on each bushing.
  If the mark on a bushing is unclear, identify the bushing by measuring the outside diameter **F** of the bushing.

Balance shaft bushing (from front of engine)		Mark	Outside diameter (mm {in.})
No. 1	Left (two oil holes)	LH1	ϕ 55.25 {ϕ 2.175}
	Right (one oil hole)	1	
No. 2		2	ϕ 55 {ϕ 2.165}
No. 3		3	ϕ 54.75 {ϕ 2.155}

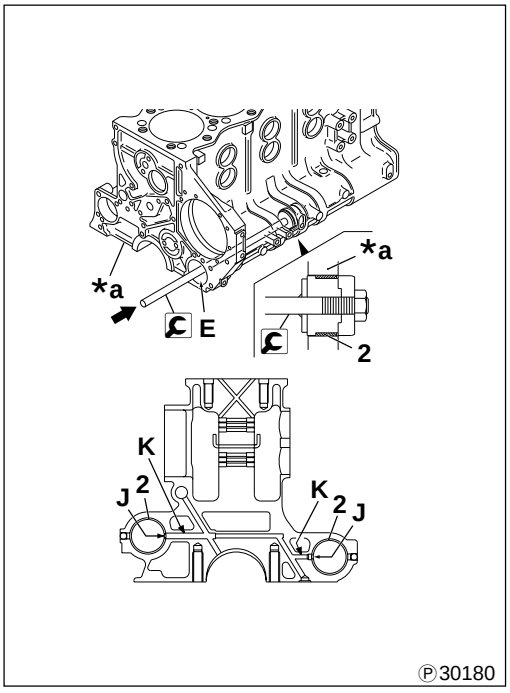


- Drive the balance shaft bushings **1** through **3** in position by hammering on the 🔧 Balance Shaft Bushing Installer & Extractor consisting of the adapter **B** and guide piece **C** appropriate to each bushing secured on the rod **A** with nut **D**.

Balance shaft bushing		Identification mark of adapter **B**	Identification mark of guide piece **C**
No. 1	Left	5	5
	Right	6	
No. 2		7	7
No. 3		8	8

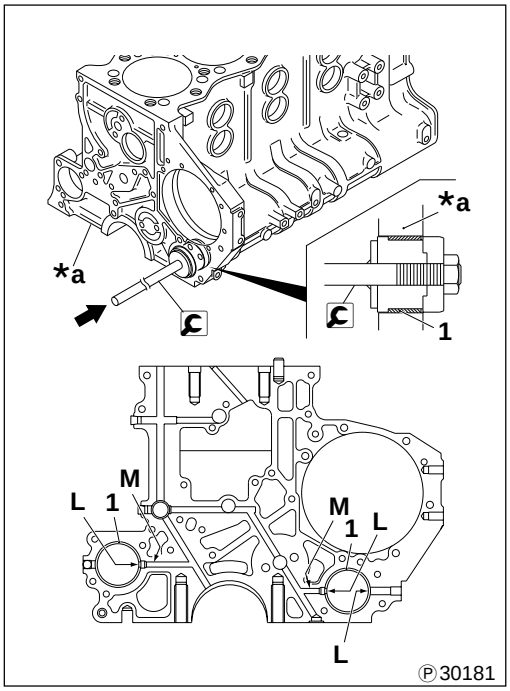


- Install the No. 3 balance shaft bushing **3** from the rear side of the upper crankcase ***a**.
  In this case, make sure that the oil hole **G** in the bushing matches the oil passage **H** in the crankcase.
  : Balance Shaft Bushing Installer & Extractor



- Install the No. 2 balance shaft **2** by inserting the Balance Shaft Bushing Installer & Extractor through the No. 1 balance shaft bushing mounting hole **E** of the upper crankcase ***a**.
  In this case, make sure that the oil hole **J** in the bushing matches the oil passage **K** in the crankcase.
  : Balance Shaft Bushing Installer & Extractor

BALANCE SHAFT BUSHINGS



- Install the No. 1 balance shaft bushing **1** from the front side of the upper crankcase ***a**.
  In this case, make sure that the oil hole **L** in the bushing matches the oil passage **M** in the crankcase.

  : Balance Shaft Bushing Installer & Extractor

CAUTION ⚠

- **The No. 1 balance bushings 1 include the right and left ones which are different from each other. Use care to prevent confusion when installing them.**
  The left one has two oil holes, whereas the right one has one oil hole.
- **Before installing No. 1 balance bushing 1, check to ensure that No. 2 balance shaft bushing 2 has been installed.**

MITSUBISHI
FUSO

Group 11B

Engine

< 6D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-11B

INDEX

SPECIFICATIONS 11B- 2

STRUCTURE AND OPERATION 11B- 3

TROUBLESHOOTING 11B- 6

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Inspection of Engine Compression 11B- 7
- Inspection and Adjustment of Valve Clearance 11B- 9

REMOVAL AND INSTALLATION OF ENGINE 11B-10

CYLINDER HEAD AND VALVE MECHANISM 11B-12

TIMING GEAR 11B-26

CAMSHAFT 11B-30

PISTON, CONNECTING ROD AND CYLINDER SLEEVE 11B-36

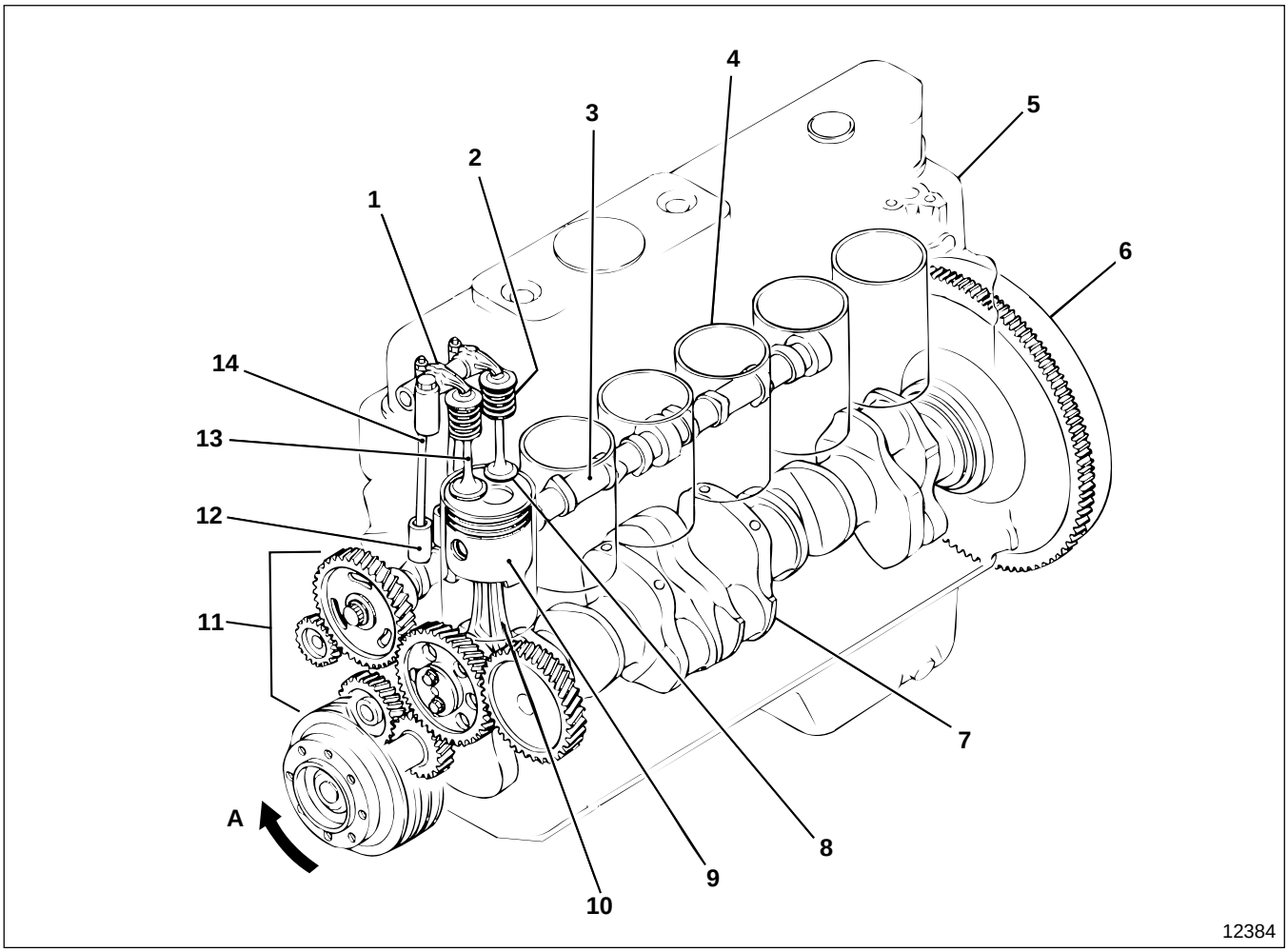
FLYWHEEL 11B-50

CRANKSHAFT AND CRANKCASE 11B-54

SPECIFICATIONS

Item	Specifications
Engine model	6D34T2
Type	6-cylinder in-line, water-cooled 4-cycle diesel
Combustion chamber type	Direct injection type
Valve mechanism	Overhead valve (OHV) type
Maximum output HP/rpm (SAE Gross)	175/2900
Maximum torque lbs.ft/rpm (SAE Gross)	325/2000
Bore×stroke mm {in.}	ø104×115 {4.09×4.53}
Total displacement cm^3 {cu. in.}	5861 {357.7}
Compression ratio	18

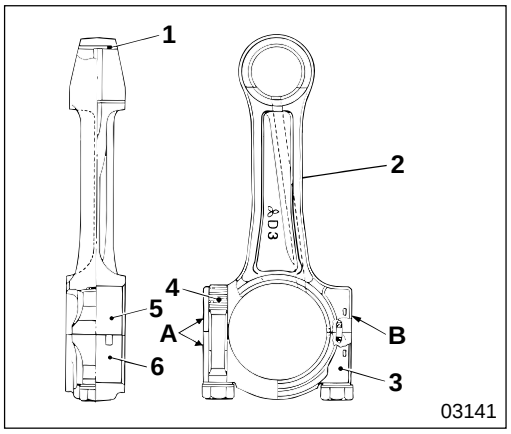
Engine Body



1 Rocker arm
2 Valve spring
3 Camshaft
4 Cylinder sleeve
5 Cylinder head
6 Flywheel
7 Crankshaft
8 Exhaust valve
9 Piston
10 Connecting rod
11 Timing gear
12 Tappet
13 Inlet valve
14 Push rod

A : Direction of rotation

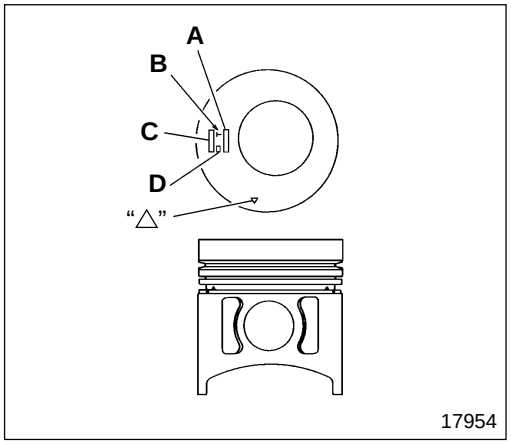
Connecting Rod



1 Connecting rod bushing
2 Connecting rod
3 Connecting rod cap
4 Connecting rod bolt
5 Upper connecting rod bearing
6 Lower connecting rod bearing

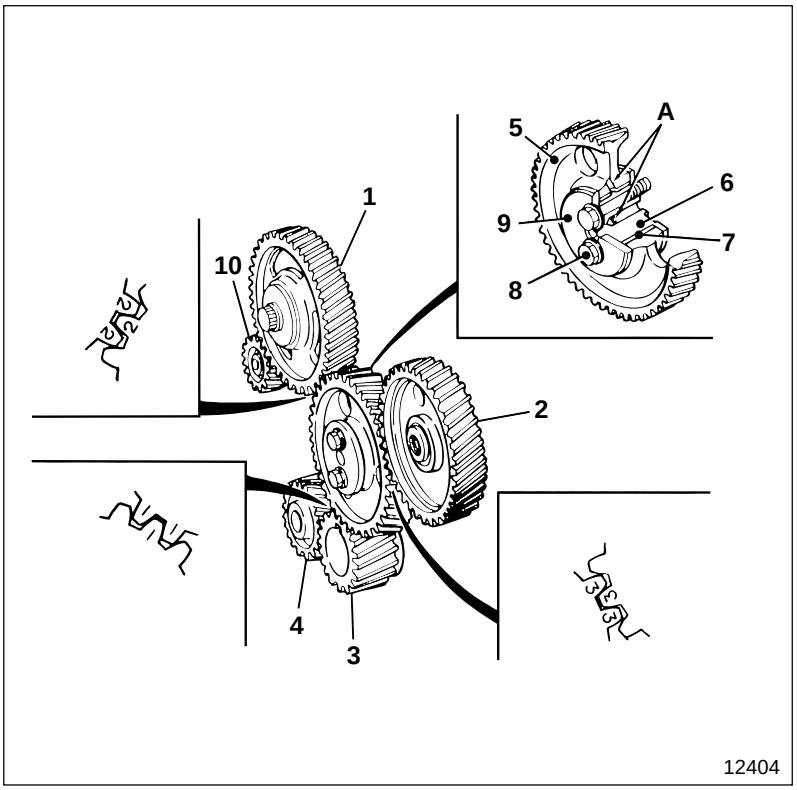
A : Alignment mark
B : Mass mark
(A, B, C, D, E, F, G)

Piston



A : Stamped mass
B : Stamped "T"
C : Part number
D : Oversize code (0.50, 1.00)
△ : Front mark

Timing Gear



1 Camshaft gear
2 Injection pump gear
3 Crankshaft gear
4 Oil pump gear
5 Idler gear
6 Idler shaft
7 Idler bushing
8 Bolt
9 Thrust plate
10 Power steering oil pump gear

A : Oil hole

Alignment marks "**1**", "**2**", "**3**" are punch-marked on each timing gear to ensure proper engagement of the gears at installation.

TROUBLESHOOTING

Symptoms / Possible causes	Decrease of power	Engine noise abnormal	Remarks
Oil viscosity unsuitable	○		Gr 12B
Fuel incorrect or unsuitable	○		
Valve clearance faulty	○	○	
Head gasket faulty	○	○	
Valve and valve seat worn, and carbon deposits	○	○	
Valve spring fatigued	○	○	
Piston ring worn or damaged	○	○	
Piston ring grooves worn or damaged	○	○	
Injection timing faulty	○	○	Gr 13A
Injection pump malfunctioning	○	○	Gr 13A
Cooling system malfunctioning	○		Gr 14B
Injection nozzle malfunctioning	○	○	Gr 13A
Fuel system sucking air	○		Gr 13A
Air cleaner mesh clogged	○		Gr 15B
Muffler clogged	○		Gr 15B
Pipe and hose installation faulty		○	
Ancillary equipment (injection pump, alternator, etc.) or installation faulty		○	Gr 13B Gr 54
V-belt loose or damaged		○	Gr 14B
Crankshaft pulley mounted incorrectly		○	
Air cleaner or muffler malfunctioning		○	Gr 15B
Rocker shaft and bracket faulty		○	
Rocker shaft bracket lubrication faulty		○	
Timing gear backlash faulty		○	
Timing gear system and idler shaft lubrication faulty		○	
Connecting rod small end bushing worn and piston pin worn		○	
Crankshaft pin and big end bearing of connecting rod worn or damaged		○	
Crankshaft journal and main bearing worn or damaged		○	
Crankshaft and camshaft end play excessive		○	
Tappet and camshaft worn		○	

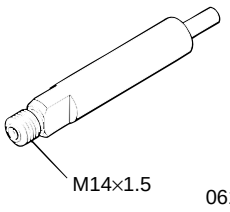
Inspection of Engine Compression

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Engine Compression	Each cylinder (200 rpm)	2550 kPa {370 lbf/in^2, 26 kgf/cm^2}	1960 kPa {285 lbf/in^2, 20 kg/cm^2}	Inspect
		Pressure difference between each cylinder	—	within 390 kPa {57 lbf/in^2, 4 kgf/cm^2}	Inspect

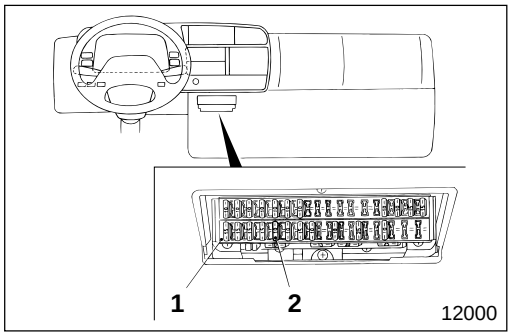
Special tools

Unit : mm {in.}

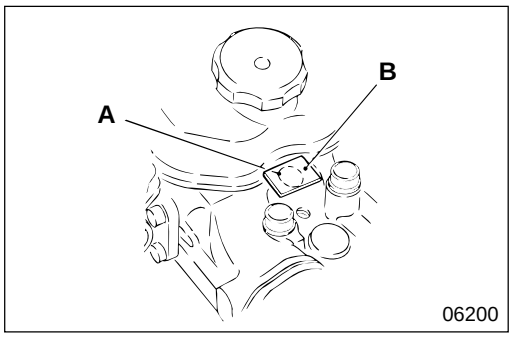
Location	Tool name and shape	Part No.	Application
—	Compression gauge adapter  06197	MH061460	Measurement of engine compression

The decrease of engine compression is a signal that it is time to overhaul the engine. It is strongly recommended that this item is inspected periodically and that you record the history of deterioration in engine performance as this will help you to diagnose causes of future irregularities.
When the vehicle is still new or immediately after installation of new parts, there may be a slight increase in engine compression, but normal performance will be restored soon.

- Before inspection make sure that engine oil, starter and battery are in normal condition.
- Before inspecting the vehicle do the following:
  - Run the engine to bring the temperature of the coolant up to approximately 75 to 85°C {167 to 185°F}.
  - Turn all the lights and accessory equipment OFF.
  - Put transmission in neutral. (N range for automatic transmission)
  - Set the steering wheel at center and straight position.



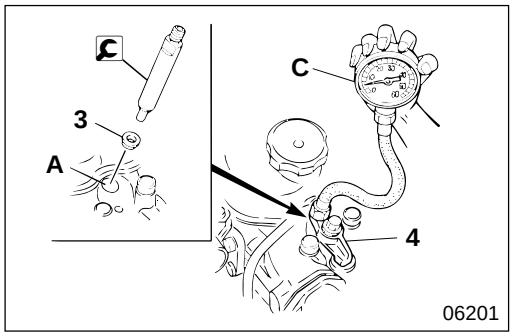
- Remove fuse **2** for the fuel-cut motor from fuse box **1** inside the cab to prevent the fuel from being injected when the engine is cranked by the starter.



- Remove all the injection nozzles. Gr 13B
- Check that no foreign particles are sticking to waste cloth **B** covering injection nozzle mounting hole **A** after cranking the engine.

WARNING⚠

You must stay clear of injection nozzle mounting hole A when you crank the engine during this inspection. Assume that all cylinders have cracked, and that coolant, engine oil, fuel, etc. have seeped into the cylinder chambers. If this is the state when the engine is cranked, there is an extreme danger of these substances being injected out of the injection nozzle mounting hole at high temperature.



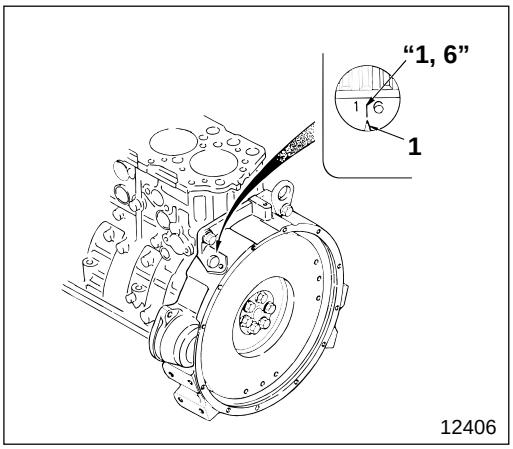
- Mount gasket **3** and compression gauge adaptor in injection nozzle mounting hole **A** and fasten them with nozzle bridge **4**, then mount compression gauge **C**.
- Measure engine compression while cranking the engine.
- Measure engine compression of cylinders and calculate the difference among the cylinders.
- If the engine compression and pressure difference between each cylinder deviate from the limit, reinspect by pouring a small amount of engine oil into injection nozzle mounting hole **A**.
  - When pressure is high : It is likely that either wear or damage of the slide-contact area of both the piston ring and the cylinder inner surface has taken place.
  - When pressure is low : It is likely that burning of the valve, faulty contact of valve surfaces and/or faults in the cylinder head gasket have developed.

Inspection and Adjustment of Valve Clearance

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Valve clearance (When engine is cold)	0.4 {0.016}	—	Adjust



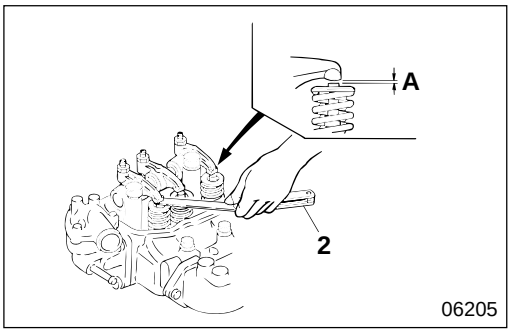
Inspect and adjust the valve clearance while the engine is cold in the following way.

[Inspection]

- Crank the engine to move No.1 or No.6 piston to top dead center, and align stamped marks "**1**, **6**" on the flywheel with pointer **1** on the flywheel housing.

NOTE

The cylinder whose push rod is not pushing up the inlet/outlet rocker is the one whose piston is at top dead center.



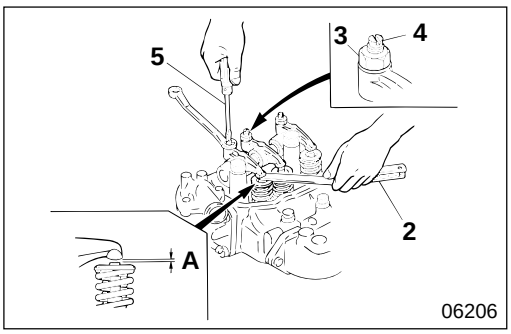
- Measure valve clearance **A** when either No.1 or No.6 piston is at top dead center in accordance with the following tabulated sequence of each valve.

Piston No.	1		2		3		4		5		6	
Valve arrangement	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust
No.1 piston at top dead center	○	○	○	×	×	○	○	×	×	○	×	×
No.6 piston at top dead center	×	×	×	○	○	×	×	○	○	×	○	○

NOTE

Be sure when taking measurements using feeler gauge 2 that some resistance is felt when inserting the gauge. If the gauge can be inserted freely without any resistance, an accurate measurement cannot be obtained.

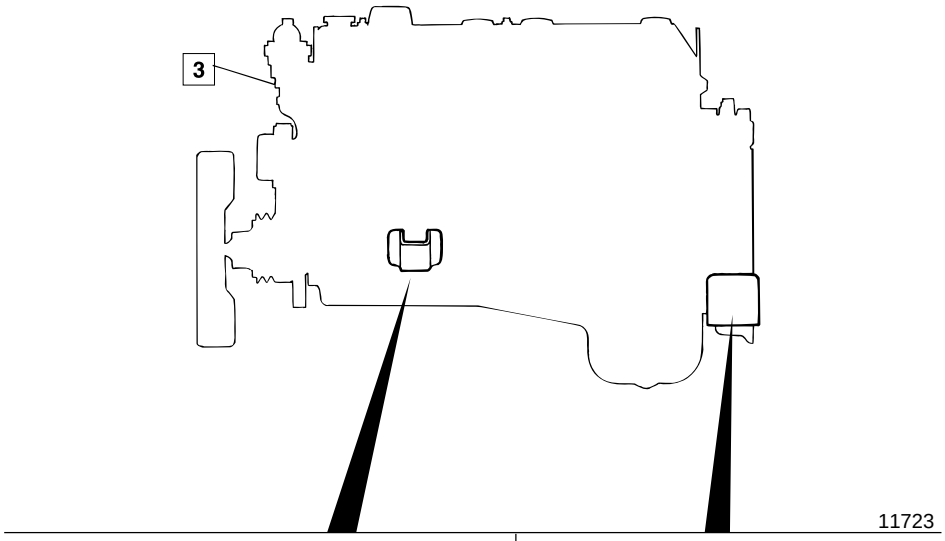
- If the measured value deviates from the limit, adjust as follows:



[Adjustment]

- Adjust valve clearance **A** so that feeler gauge **2** encounters some resistance when it is inserted. Do this by loosening lock nut **3** and turning adjusting screw **4**.
- After adjusting, tighten adjusting screw **4** using screwdriver **5** and tighten lock nut **3**. Reinspect valve clearance **A** using feeler gauge **2**.

REMOVAL AND INSTALLATION OF ENGINE



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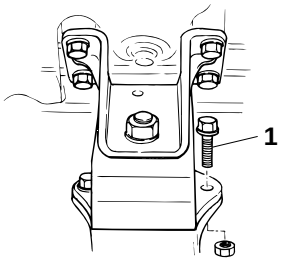

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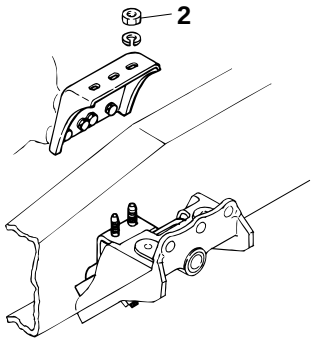

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● **Removal sequence**

1 Bolt
2 Nut
3 Engine assembly

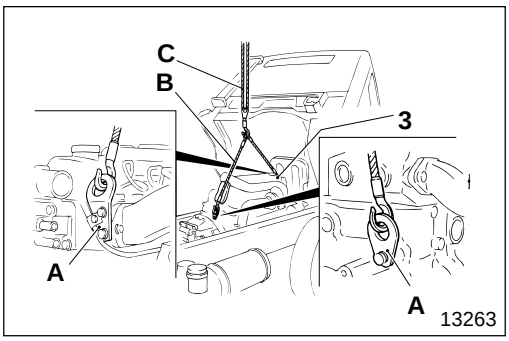
WARNING ⚠

When you lift engine assembly 3, you must use lifting gear that is strong enough to lift the mass of the engine (approximately 550 kg {1210 lb}).

● **Installation sequence**

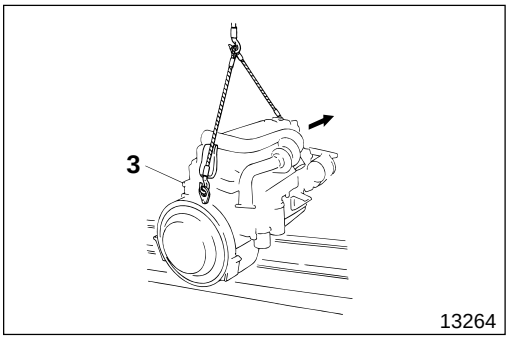
Follow the removal sequence in reverse.

◆ Service procedure



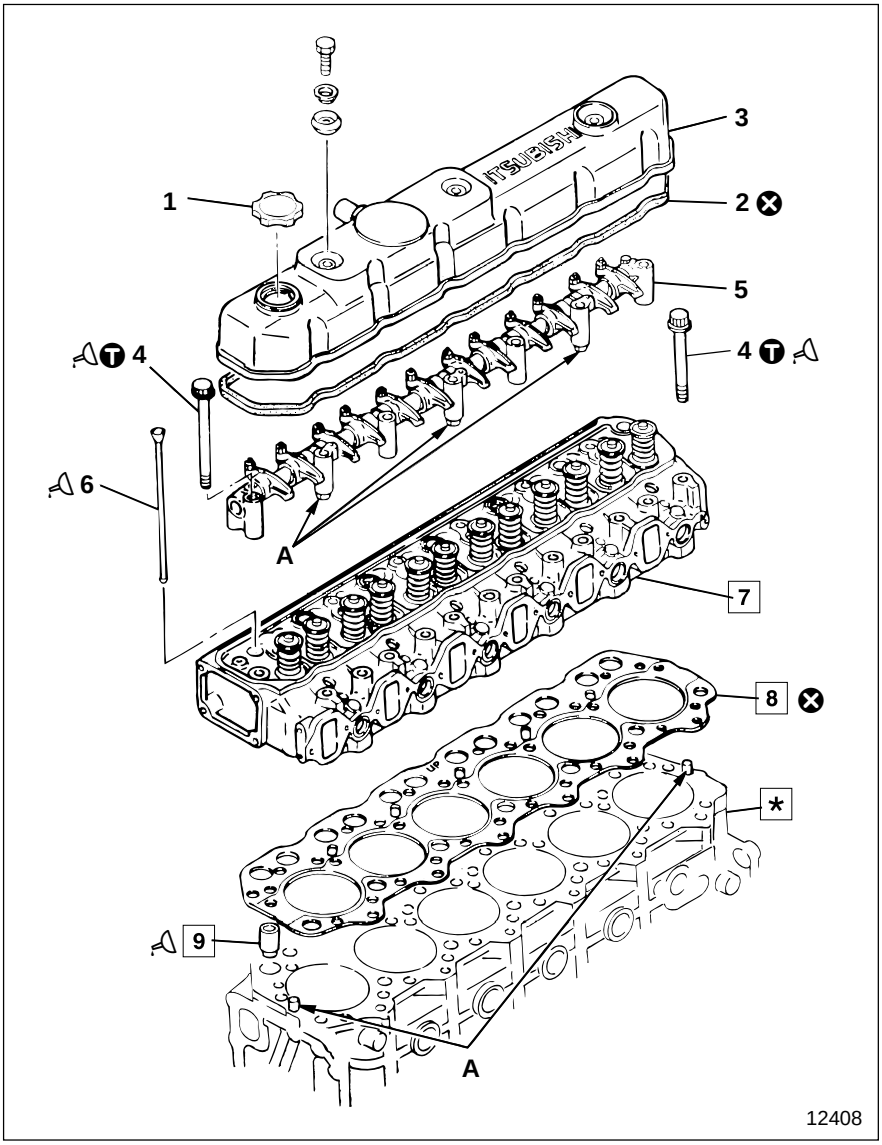
3 Removal of engine assembly

- Hook lifting gear **B** to two hangers **A** on engine assembly **3** and lift the engine using crane **C** until the lifting gear becomes taut.
- Make sure that wiring and hoses are disconnected.



- Lower engine assembly **3** slowly so that it does not hit the frame or cab.
- When the lower part of engine assembly **3** appears from the frame, turn the engine assembly 90° to remove it.

CYLINDER HEAD AND VALVE MECHANISM



● **Disassembly sequence**

1 Oil filler cap
2 Rocker cover gasket
3 Rocker cover
4 Cylinder head bolt
5 Rocker and bracket assembly 🕮 P11B-16
6 Push rod
7 Cylinder head and valve assembly 🕮 P11B-18
8 Cylinder head gasket
9 Tappet

* : Crankcase 🕮 P11B-54
A : Positioning pin
⊗ **:** Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6	Push rod deflection	—	0.4 {0.016}	Replace
9, *	Clearance between tappet and crankcase tappet hole	[28] 0.05 to 0.09 {[1.10] 0.0020 to 0.0035}	0.2 {0.0079}	Replace

Ⓣ Tightening torque

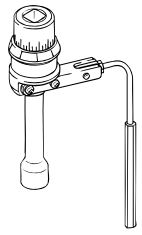
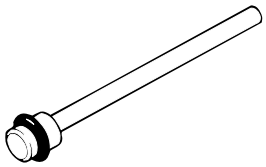
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Cylinder head bolt	145 {110, 15}+90°	Wet Reuse up to three times

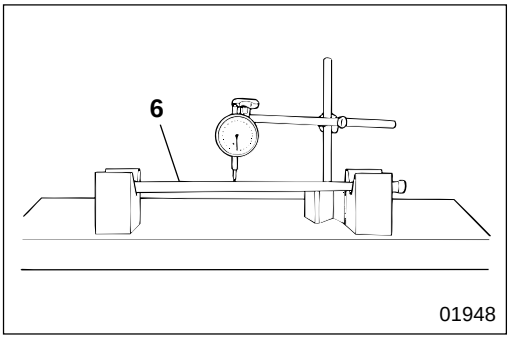
Lubricant

Location	Points of application	Kinds	Quantity
4	Thread area of cylinder head bolt	Engine oil	As required
6	Both ends of push rod	Engine oil	As required
9	External periphery of tappet	Engine oil	As required

Special tools

Location	Tool name and shape	Part No.	Application
7	Socket wrench  01984	MH061560	Installation of cylinder head and valve assembly
9	Tappet extractor  03320	MH063329	Removal of tappet

◆ Service procedure



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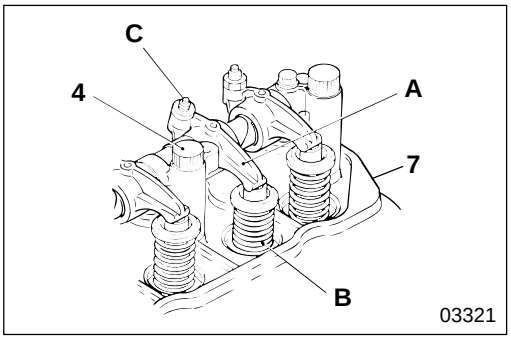
6 **Push rod deflection**

If the measured value is higher than the limit, replace push rod **6**.



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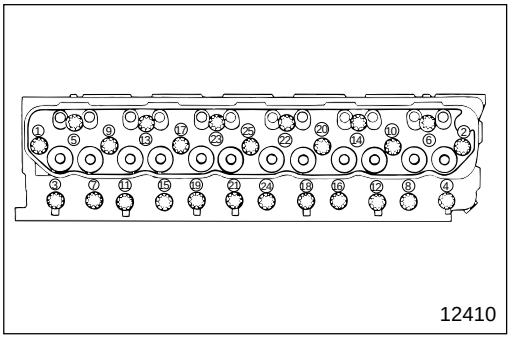
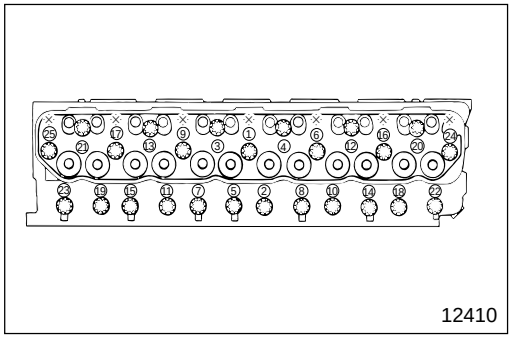
7 **Cylinder head and valve assembly**

[Removal]

- Before undoing cylinder head bolts **4**, first loosen adjusting screw **C** of rocker **A** that pushes down valve spring **B**.


12410

- First loosen cylinder head bolts **4** in the numbered order as illustrated, then remove them.



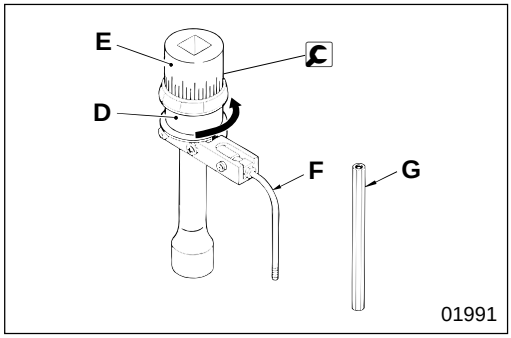
[Installation]

- Center punch the heads of cylinder head bolts **4** before installation.

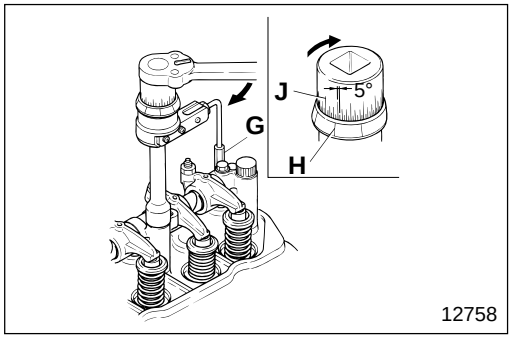
CAUTION⚠

If there are already three center-punch marks, replace the cylinder head bolt with a new one.

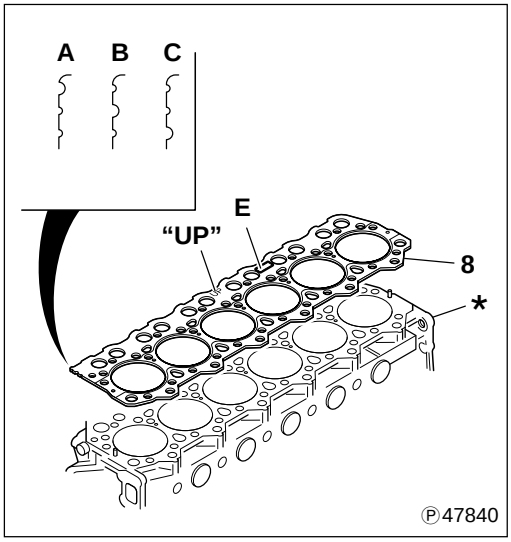
- After tightening cylinder head bolts **4** at specified torque in the numbered order as illustrated, tighten further as follows:
  ·⁜· : Tightened simultaneously with rocker and bracket assembly



- Turn socket wrench holder **D** counterclockwise and keep the spring in the wrench compressed.
  E : Socket
  F : Rod
  G : Rod (for connection)



- Set socket wrench holder **D** so that the repercussive force of the spring presses rod **G** (for connection) against adjacent parts such as, the rocker shaft bracket or the injection pipe.
- Select a scale that is convenient for reading graduation **H** on holder **D**.
- Tighten further by turning socket **H** clockwise by 90° (setting is in 5° increments), referring to graduation **J** on the selected scale.



8 **Cylinder head gasket**

[Removal]

CAUTION

Be careful not to scratch the cylinder head or crankcase * when you remove cylinder head gasket 8.

[Installation]

Select proper cylinder head gasket **8** with the following procedures.

- Measure the piston protrusion value of each cylinder. P11B-38
- Then, select the cylinder head gasket **8** with thickness corresponding to its average piston protrusion value from the table below.
- If there are one cylinder or more which have average piston protrusion value with 0.05 mm or more compared with the average piston protrusion value, use the gasket with one-rank-up thickness (A→B, B→C).

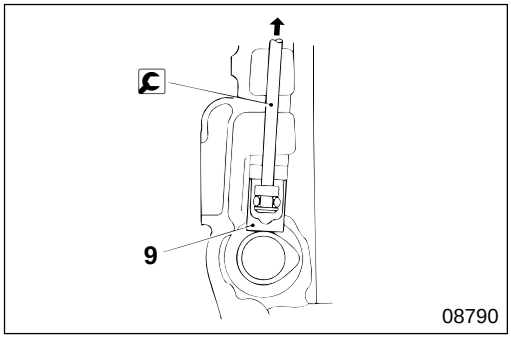
Unit: mm

Average protrusion value of piston	Cylinder head gasket	
	Size classification	Thickness when tightened
0.463 to 0.530	A	1.30 ± 0.05
0.531 to 0.598	B	1.35 ± 0.05
0.599 to 0.666	C	1.40 ± 0.05

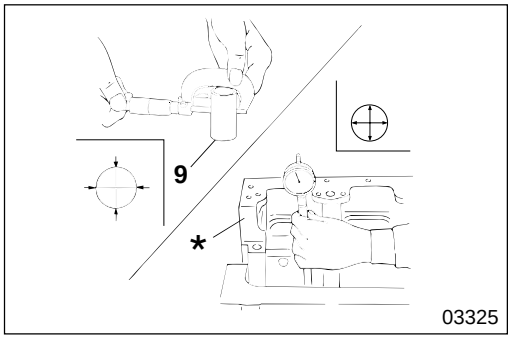
- Identify the kind of cylinder head gasket **8** is based on the notched part **D**.
- Install cylinder head gasket **8** to crankcase * in the direction as shown.
  E : parts number

CAUTION

When changing piston, connecting rod, etc., make sure to measure the protrusion value of piston because it varies.



9 **Removal of tappet**

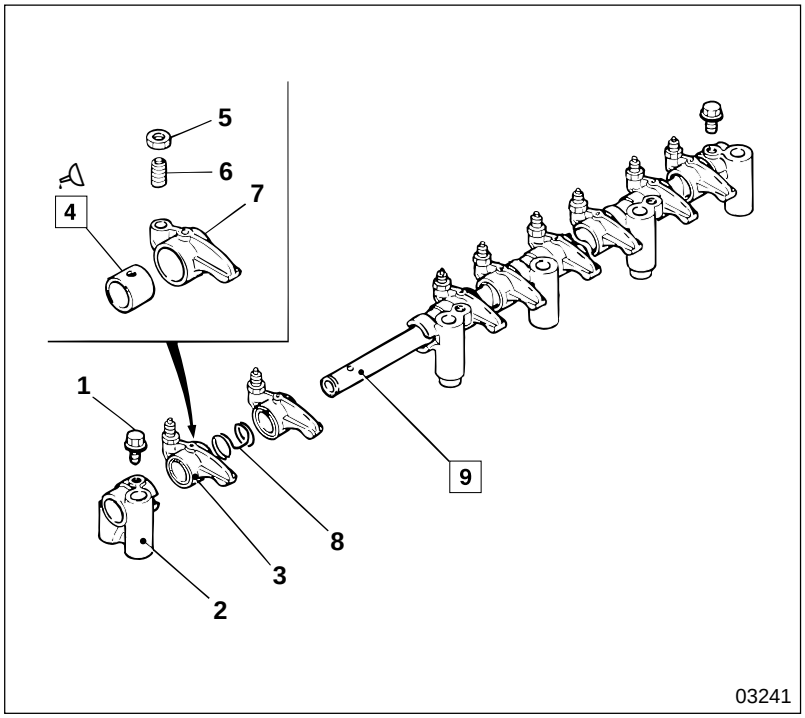


9 ***** **Clearance between tappet and crankcase tappet hole**

If the measured value is higher than the limit, replace the faulty parts.

CYLINDER HEAD AND VALVE MECHANISM

Rocker and Bracket Assembly



● **Disassembly sequence**

1 Set bolt
2 Rocker shaft bracket
3 Rocker assembly
4 Rocker bushing
5 Lock nut
6 Adjusting screw
7 Rocker
8 Rocker shaft spring
9 Rocker shaft

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

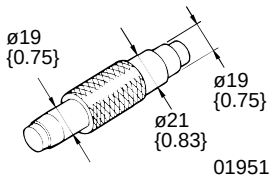
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
4, 9	Clearance between rocker bushing and rocker shaft	[19] 0.06 to 0.11 {[0.75] 0.0024 to 0.0043}	0.2 {0.0079}	Replace

Lubricant

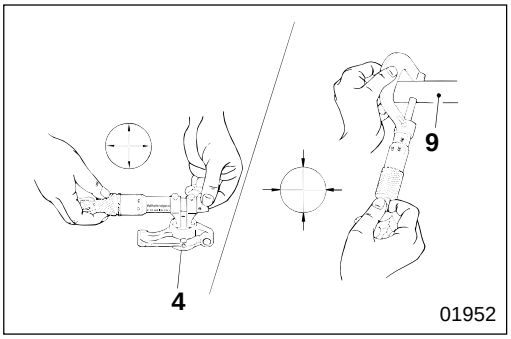
Location	Points of application	Kinds	Quantity
4	Inner surface of rocker bushing	Engine oil	As required

Special tools

Unit : mm {in.}

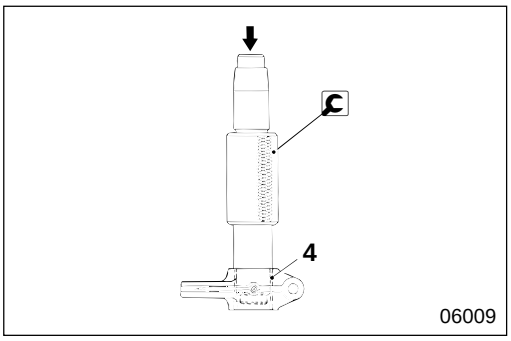
Location	Tool name and shape	Part No.	Application
4	Rocker bushing puller 	MH061378	Removal and installation of rocker bushing

◆ Service procedure



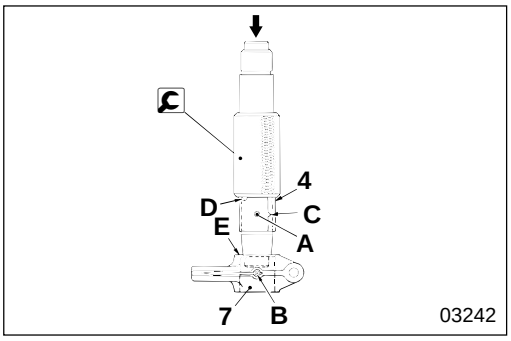
4 **9** **Rocker bushing and rocker shaft**

[Inspection]
If the clearance is higher than the limit, replace the faulty parts.

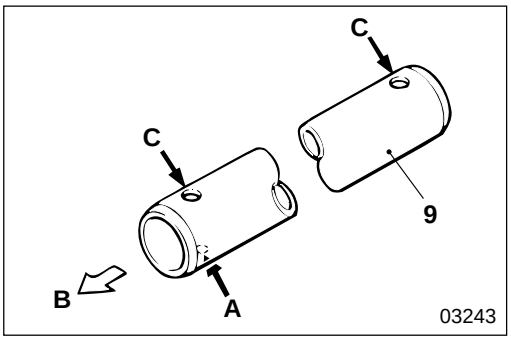


Rocker bushing

[Removal]



[Press-fitting]
- Align oil hole **A** of rocker bushing **4** with oil hole **B** of rocker **7**.
- Position clinch **C** and split **D** of rocker bushing **4** in the direction as illustrated.
- Press-fit rocker bushing **4** from chamfered side **E** of rocker **7**.



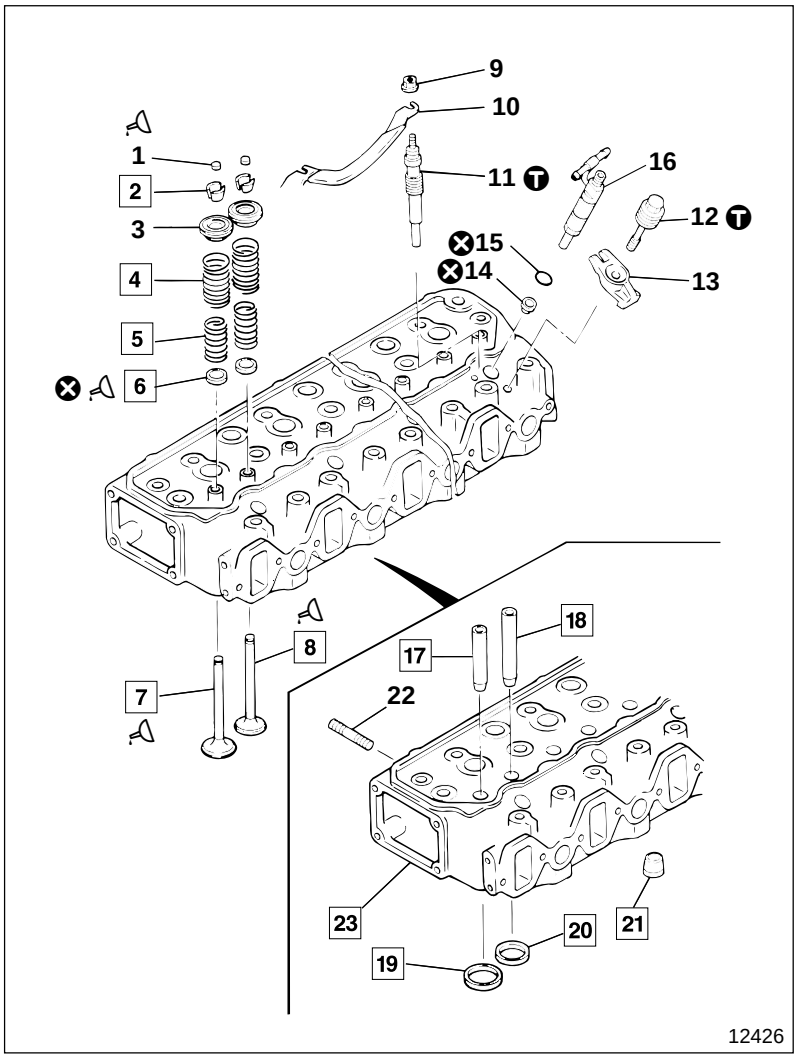
9 **Installation of rocker shaft**

When installing rocker shaft **9**, bring oil passage hole for lubrication **A** to front side **B**.

C : Fixing hole of the set bolt.

CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head and Valve Assembly



● **Disassembly sequence**

1 Valve cap
2 Valve cotter
3 Upper retainer
4 Outer valve spring
5 Inner valve spring
6 Valve stem seal
7 Inlet valve
8 Exhaust valve
9 Nut
10 Connecting plate
11 Glow plug Gr 54
12 Bolt
13 Nozzle bridge
14 Nozzle tip gasket
15 O-ring
16 Injection nozzle Gr 13B
17 Inlet valve guide
18 Exhaust valve guide
19 Inlet valve seat
20 Exhaust valve seat
21 Water director
22 Stud
23 Cylinder head

⊗ : Non-reusable parts

CAUTION

Be careful of the protrusion of glow plug 11 and injection nozzle 16 from the bottom surface of cylinder head 23.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

When inlet valve 7 and exhaust valve 8 have been removed, replace valve stem seal 6.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
4	Outer valve spring	Without load	60.84 {2.43}	57.8 {2.28}	Replace
		Installed load (Installed length 47.25 {1.86})	240±12 N {54±2.6 lbf, 24.5±1.2 kgf}	205 N {46 lbf, 20.8 kgf}	Replace
		Tilt	—	2.5 {0.098}	Replace
5	Inner valve spring	Without load	55.07 {2.17}	52.1{2.05}	Replace
		Installed load (Installed length 40.3 {1.59})	93±4.4 N {21±1.0 lbf, 9.5±0.45 kgf}	79 N {18 lbf, 8.1 kgf}	Replace
		Tilt	—	2 {0.079}	Replace
7	Inlet valve	Stem diameter	8.96 to 8.97 {0.3529 to 0.3531}	8.85 {0.348}	Replace
		Valve recess from the cylinder head bottom surface	0.75 to 1.25 {0.030 to 0.049}	1.5 {0.059}	Inspect each part
		Valve margin	1.5 {0.059}	1.2 {0.047}	Correct or replace
		Valve seat angle	45°±15'	—	Correct or replace
7, 17	Clearance between inlet valve stem and inlet valve guide		[9] 0.04 to 0.06 {[0.35] 0.0016 to 0.0024}	0.15 {0.0059}	Replace
8	Exhaust valve	Outer diameter of stem	8.93 to 8.94 {0.3515 to 0.3519}	8.85 {0.348}	Replace
		Valve recess from the cylinder head bottom surface	0.75 to 1.25 {0.030 to 0.049}	1.7 {0.067}	Inspect each part
		Valve margin	1.5 {0.059}	1.2 {0.047}	Correct or replace
		Valve seat angle	45°±15'	—	Correct or replace
8, 18	Clearance between exhaust valve stem and exhaust valve guide		[9] 0.07 to 0.1 {[0.35] 0.0028 to 0.0039}	0.2 {0.0079}	Replace
19	Seat width of inlet valve seat		2±0.2 {0.079±0.0079}	2.8 {0.11}	Correct or replace
20	Seat width of exhaust valve seat		2±0.2 {0.079±0.0079}	2.8 {0.11}	Correct or replace
23	Cylinder head	Distortion of bottom	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Height from top to bottom	95±0.1 {3.74±0.0039}	94.6 {3.72}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

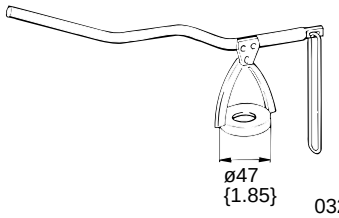
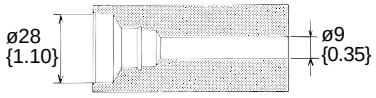
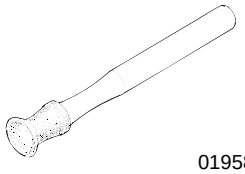
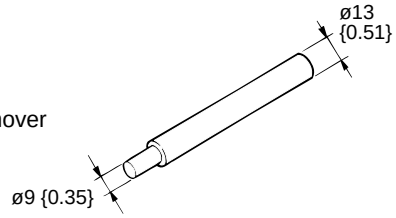
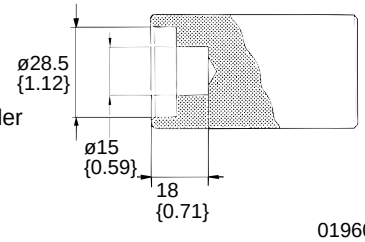
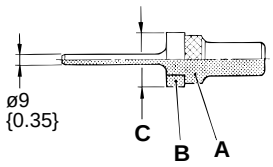
Location	Parts to be tightened	Tightening torque	Remarks
11	Glow plug	15 to 20 {11 to 14, 1.5 to 2.0}	—
12	Bolt (Nozzle bridge mounting)	25 {18, 2.5}	—

Lubricant

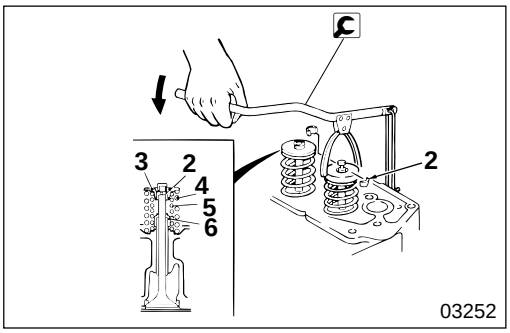
Location	Points of application	Kinds	Quantity
1	Slide contact areas of valve cap and rocker	Engine oil	As required
6	Lip of valve stem seal	Engine oil	As required
7, 8	Valve stem	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Valve lifter  03265	30091-08500	Removal and installation of valve cotter
6	Valve stem seal installer  01957	MH061293	Installation of valve stem
7, 8	Valve lapper  01958	30091-07500	Fitting of valve and valve guide
17, 18	Valve guide remover  01959	MH061066	Removal of valve guide
	Valve guide installer  01960	MH061998	Press-fitting of valve guide
19, 20	**A** : Caulking tool body **B** : Caulking ring | | **C** dimension | | Inlet | ø47.6 {1.87} | | Exhaust | ø40.6 {1.60} |  01961	**A** : MH061067 **B** : MH061275 (Inlet) MH061069 (Exhaust)	Press-fitting of valve seat

◆ Service procedure



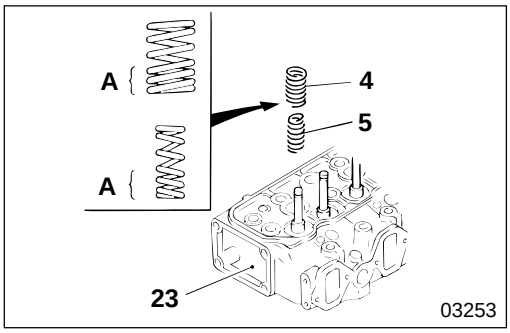
2 **Valve cotter**

[Removal]
Remove valve cotter **2** making sure that valve springs **4**, **5** are squarely and evenly pressed down by 🔧 valve lifter.

[Installation]
Follow the removal procedure in reverse.

CAUTION⚠

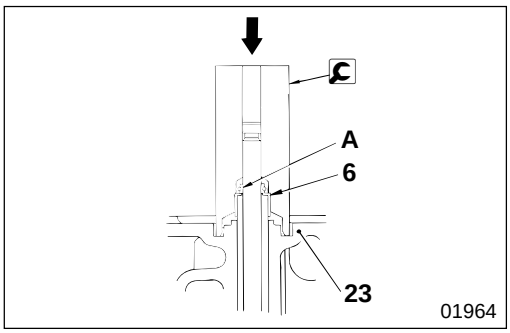
Be sure not to press down on valve springs 4, 5 too hard because this would cause upper retainer 3 to contact valve stem seal 6 and damage it.



4 **5** **Installation of outer and inner valve springs**

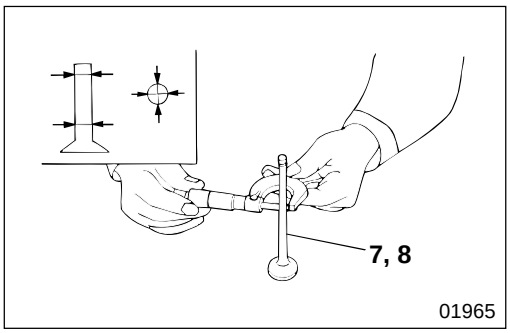
Install outer springs **4** and inner springs **5** in cylinder head **23** in the direction as illustrated.

A : Closely wound area



6 **Installation of valve stem seal**

- Apply engine oil to lip **A** of valve stem seal **6**.
- Tap down 🔧 valve stem seal installer until it hits cylinder head **23**.



7 **8** **Inlet valve and exhaust valve**

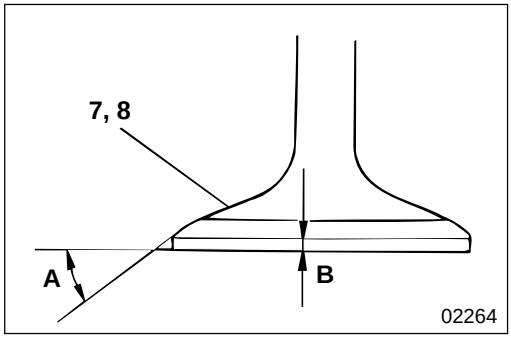
[Inspection]

(1) Inspection of stems

If the measured value is lower than the limit or in the case of excessive wear, replace valves **7**, **8**.

CAUTION⚠

Be sure to lap valve seats 19, 20 when valves 7, 8 are replaced with new ones. 🕮 **P11B-21**

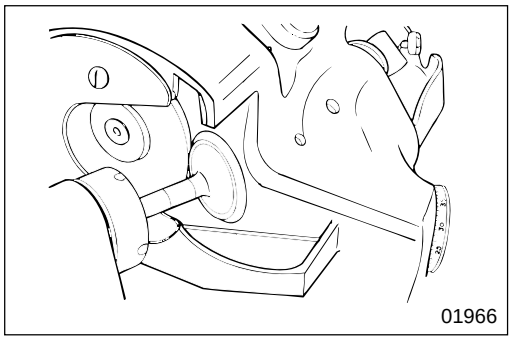


(2) Valve seat angle and valve margin

If the measured value is higher than the limit, correct or replace valves **7**, **8**.

A : Valve seat angle

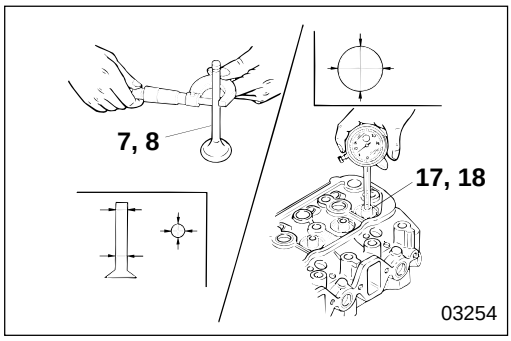
B : Valve margin



[Correction]

NOTE

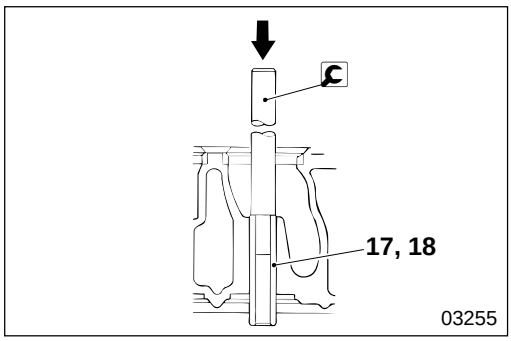
- **Be sure to keep the grinding work as light as possible.**
- **Be sure to replace valves 7, 8 after grinding if valve margin deviates from the limit.**
- **Be sure to lap valve 7, 8 and valve seats 19, 20 after grinding.** **P11-21**



7 **8** **17** **18** **Valve and valve guide**

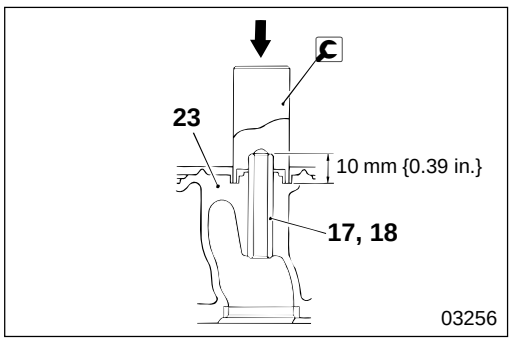
[Inspection]

When the clearance is higher than the limit, replace the faulty parts.



Valve guide

[Removal]

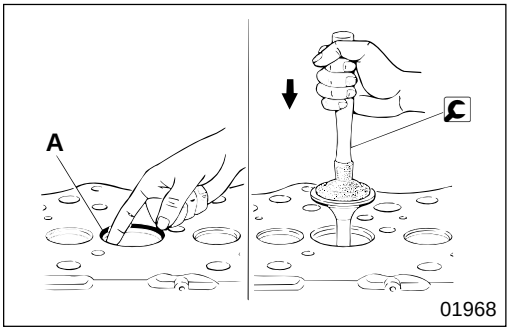


[Installation]

- Tap down valve guides **17**, **18** with 09916-58210 valve guide installer until it hits cylinder head **23**.

CAUTION

- **The length of fit of valve guides 17, 18 is standardized. Be sure to use 09916-58210 valve guide installer.**
- **Be sure to distinguish between valve guides 17, 18. Exhaust valve guide 18 is longer.**



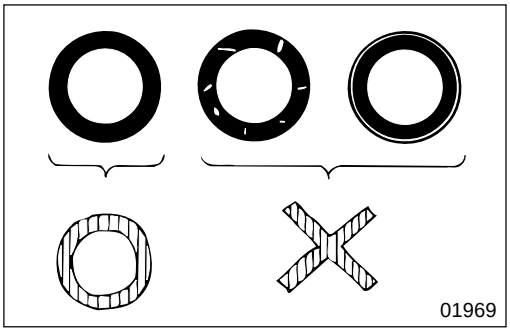
7 **8** **19** **20** **Valve and valve seat**

[Inspection]

- Apply red lead evenly to entire surface **A** of valve seats **19**, **20** that contact valves **7**, **8**.
- Fit valves **7**, **8** to valve seats **19**, **20** and tap once without rotating.

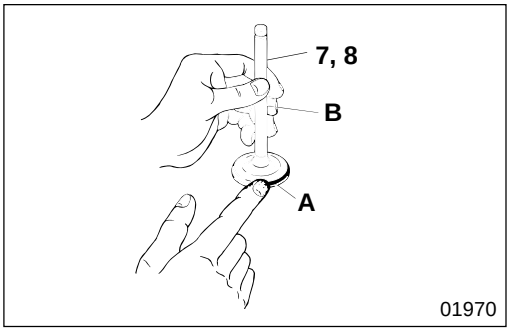
NOTE

Be sure to carry out inspection under the condition that valves 7, 8 and all parts of valve guides 17, 18 are normal.



- Check how much red lead has transferred to valves **7**, **8** to determine the contact of the valve and the seat. According to the degree of abnormality, take proper measures to correct it.

Contact conditions	Correction measures
Minor fault	Valve lapping
Major fault	Repair of valve and seat or replacement of both



[Correction]

Valve polishing is done in the following manner:

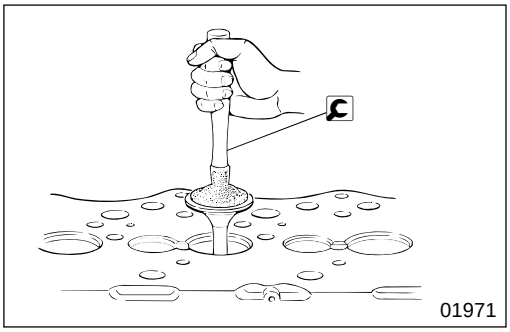
- Apply valve lapping compound thinly to contact surface **A** of valves **7**,**8** with valve seats **19**, **20**.

CAUTION

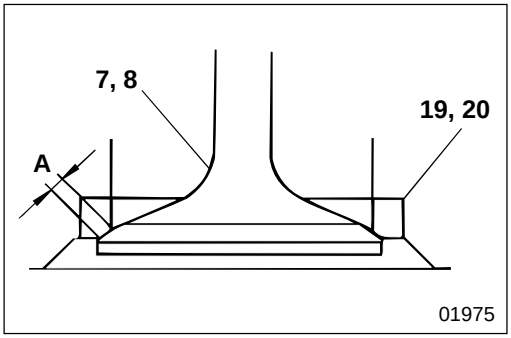
Take care not to smear stems B of valves 7, 8 with the compound.

NOTE

- **Start with medium grit compound (120 to 150 grit) and for finishing up, use finer grit (200 grit or finer).**
- **Mixing with a small amount of engine oil will make the compound consistent and make even application easier.**



- Tap valves **7**, **8** against valve seats **19**, **20** several times while rotating the valves slightly at each strike.
- Clean off the compound with gas oil.
- Apply engine oil to contact surface **A** of valve seats **19**, **20** and smooth the surface.
- Check the contact of valves **7**, **8** and valve seats **19**, **20**.
- If contact does not take place completely around the seat, replace valve seats **19**, **20**.



19 **20** **Valve seat**

[Inspection]

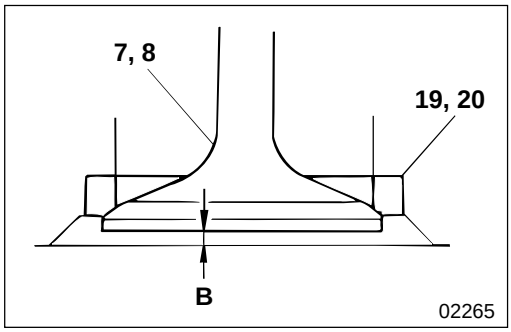
(1) Valve seat width

If the measured value is higher than the limit, replace valve seats **19**, **20**.

A : Valve seat width

NOTE

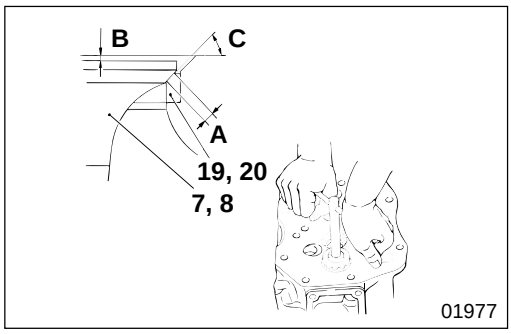
Be sure to lap and fit valves 7, 8 and valve seats 19, 20 after correction or replacement.



(2) Extent of valve recess from the bottom surface of cylinder head

If the measured value is higher than the limit, correct or replace the faulty parts.

B : Extent of valve recess



[Correction]

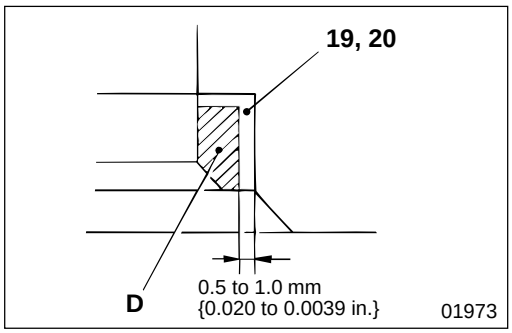
- Grind valve seats **19**, **20** using valve seat cutter or valve seat grinder.
- After grinding, do another light abrasion using 400 grit emery paper placed between the cutter and the seat.
- Adjust the seat width **A** of valves **7**, **8** using 15° or 75° cutter to make seat width conform to the standard value.

C : Valve seat angle

CAUTION ⚠

Be sure that as a result of grinding, recess B of valves 7, 8 does not become higher than the limit.

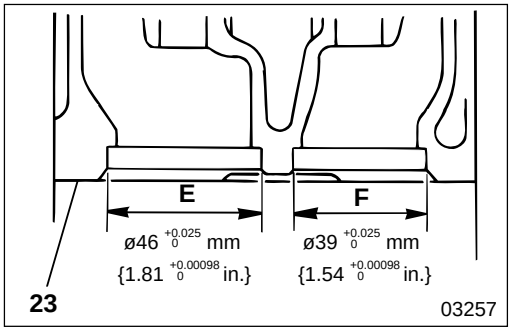
- After correction is done, be sure to carry out lapping and fitting on valves **7**, **8** and valve seats **19**, **20**.



[Removal]

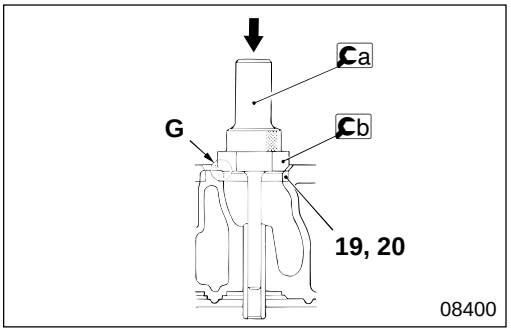
- Valve seats **19**, **20** have been set in by the cooling-off-process, and have to be thinned by grinding off the inner side for removal under normal temperature.

D : Part to be ground



[Installation]

- Make sure that the diameter of valve seat hole of cylinder head **23** conforms to the standard value.
  E : Inlet valve seat hole diameter
  F : Exhaust valve seat hole diameter

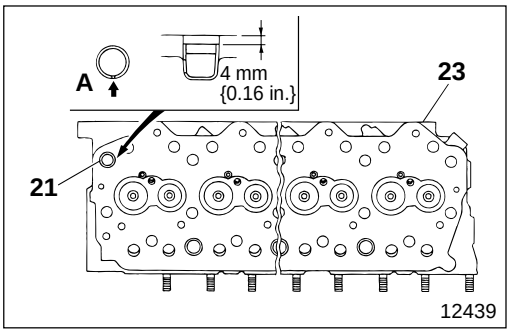


- Immerse valve seats **19**, **20** in liquid nitrogen and cool them substantially. Press-fit into the cylinder head using Ca caulking tool body and Cb caulking rings inlet and exhaust.

CAUTION

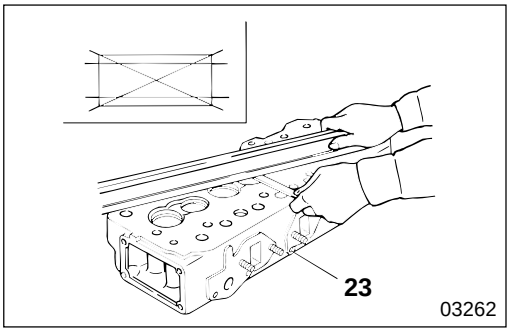
Be sure, when press-fitting, to place the chamfered side G of Cb caulking rings inlet and exhaust against valve seats 19, 20.

- After installation of valve seats **19**, **20**, work until they contact valves **7**, **8** smoothly.



21 Installation of water director

- With indent **A** set in the direction as illustrated, press-fit water director **21** into cylinder head **23** to the specified depth.



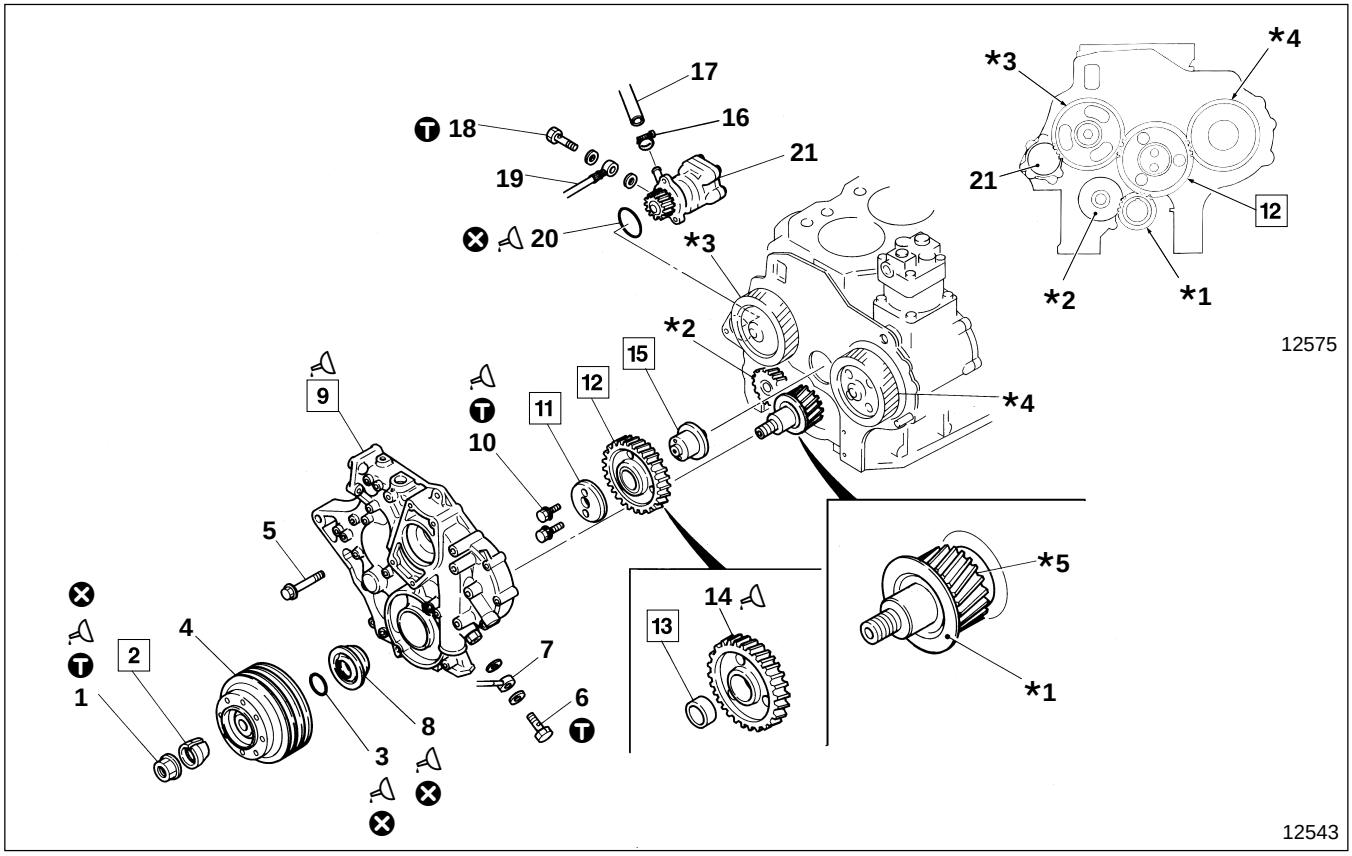
23 Inspection of cylinder head

Measure the extent of distortion of the bottom of cylinder head **23**, and if the measured value is higher than the standard value, grind using a surface grinder.

CAUTION

Be sure to keep the amount of grinding within the limit of the height of cylinder head 23.

TIMING GEAR



● **Inspection before disassembly**

P11B-26

● **Disassembly sequence**

1 Nut
2 Taper cone
3 O-ring
4 Crankshaft pulley
5 Bolt
6 Eye bolt
7 Suction pipe Gr 14B
8 Front oil seal
9 Timing gear case
10 Bolt
11 Thrust plate
12 Idler gear assembly
13 Idler gear bushing
14 Idler gear
15 Idler gear shaft
16 Clamp
17 Oil hose Gr 37
18 Bolt
19 Oil hose Gr 37
20 O-ring
21 Power steering oil pump Gr 37

***1** : Crankshaft gear P11B-54
***2** : Oil pump gear Gr 12B
***3** : Camshaft gear P11B-30
***4** : Air compressor gear Gr 35A
***5** : Front oil seal slinger P11B-54

⊗ : Non-reusable parts

NOTE

Do not remove front oil seal 8, unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
—	Backlash of gears	Idler gear assembly and crankshaft gear	0.07 to 0.15 {0.0023 to 0.0059}	0.3 {0.012}	Replace
		Idler gear assembly and camshaft gear	0.07 to 0.17 {0.0023 to 0.0067}	0.3 {0.012}	
		Idler gear assembly and injection pump gear	0.07 to 0.17 {0.0023 to 0.0067}	0.3 {0.012}	
		Crankshaft gear and oil pump gear	0.10 to 0.18 {0.0039 to 0.0071}	0.3 {0.012}	
		Camshaft gear and power steering oil pump gear	0.08 to 0.16 {0.0031 to 0.0063}	0.3 {0.012}	
—	End play of idler gear		0.05 to 0.15 {0.0020 to 0.0059}	0.3 {0.012}	Inspect
13, 15	Clearance between idler gear bushing and idler shaft		[45] 0.03 to 0.06 {[1.77] 0.0012 to 0.0024}	0.1 {0.0039}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

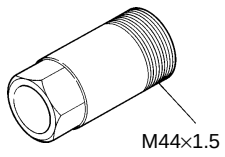
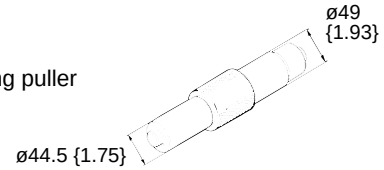
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Taper cone mounting)	490 {360, 50}	Wet
6	Eye bolt (Air and water sunction pipe mounting)	25 {19, 2.6}	—
10	Bolt (Thrust plate mounting)	24 {17, 2.4}	—
18	Bolt (Oil hose mounting)	125 {94, 13}	—

Lubricant and sealant

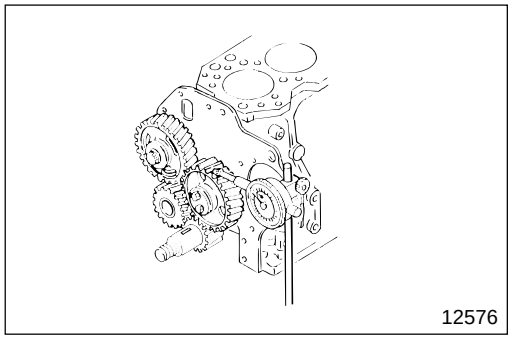
Location	Points of application	Kinds	Quantity
1	Thread area of nut	Engine oil	As required
3, 20	Entire body of O-ring	Engine oil	As required
8	Front oil seal lip	Engine oil	As required
	Dust lip of front oil seal	Grease (Lithium series)	
9	Mounting surface of timing gear case	THREEBOND 1207C	As required
10	Thread area of bolt	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Cone puller  12708	MH062496	Removal of taper cone
13	Idler gear bushing puller  03532	MH062224	Removal and installation of idler gear bushing

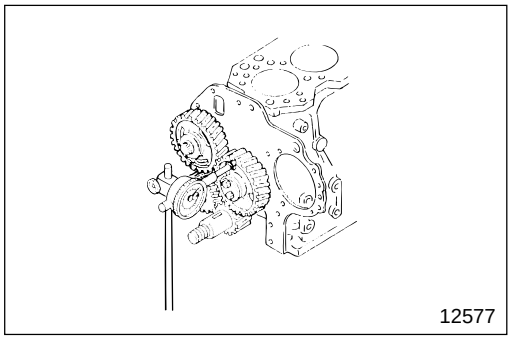
◆ Service procedure



● **Inspection before disassembly**

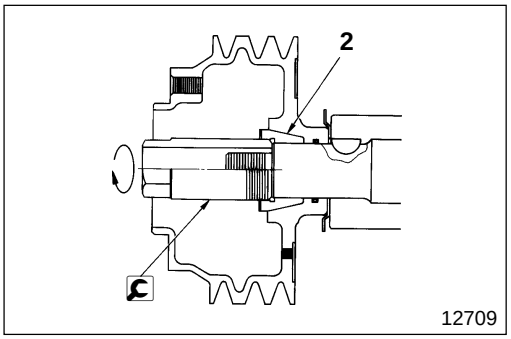
(1) Backlash of each gear

Measure three or more locations on the pairing gears and if the measurements are higher than the limit, replace the faulty parts.

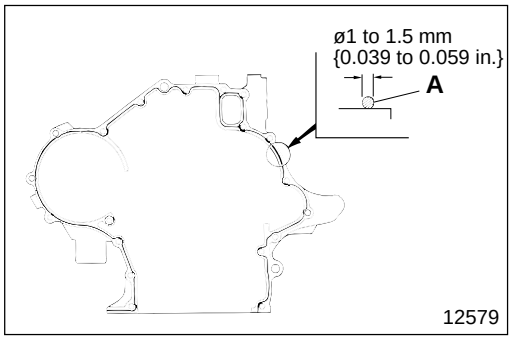


(2) End play of idler gear

If the measured value is higher than the limit, replace the faulty parts.



2 **Removal of taper cone**

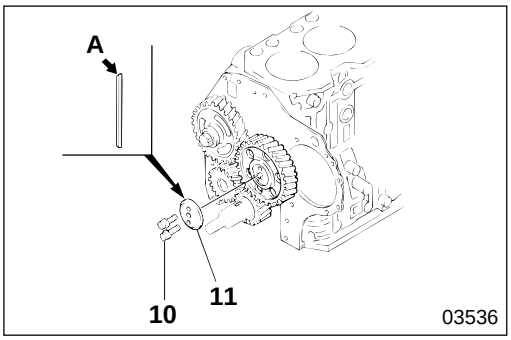


9 **Installation of timing gear case**

Apply sealant **A** to the mounting surface of timing gear case **9** evenly without break. After applying sealant, within three minutes, mount to the front plate.

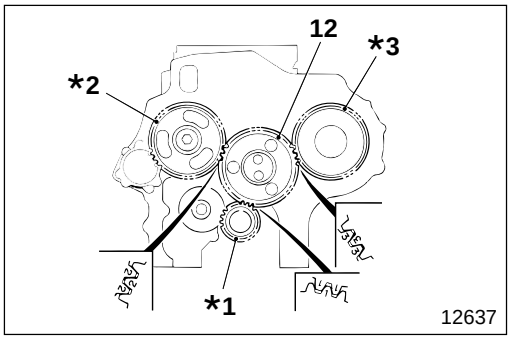
CAUTION⚠

- **Be sure to clean and wipe off oily substances from the surface where sealant A is to be applied.**
- **Make sure that sealant A is not transferred to other areas while the mounting work is being done.**
- **Be sure to reapply sealant A if the bolts are loosened or removed by any cause whatsoever after mounting.**
- **Do not start the engine within an hour of mounting.**



11 **Installation of thrust plate**

A : Chamfered side



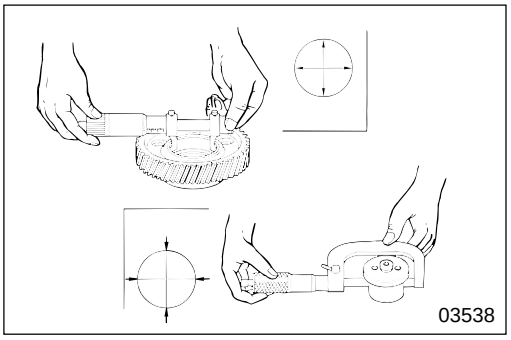
12 **Installation of idler gear assembly**

Install idler gear assembly **12** by matching alignment marks **"1"**, **"2"**, **"3"** on the gears that engage with those on the assembly.

***1** : Crankshaft gear
***2** : Camshaft gear
***3** : Air compressor gear

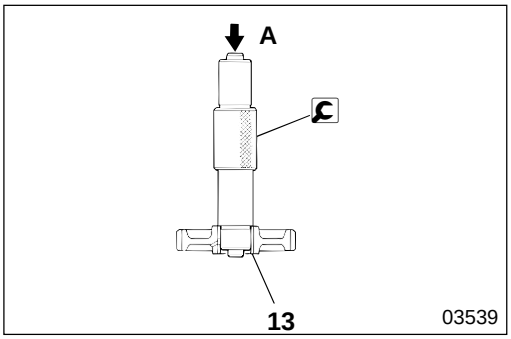
NOTE

When aligning each gear with its alignment mark, make sure that pistons No.1, 6 are higher than top dead center.



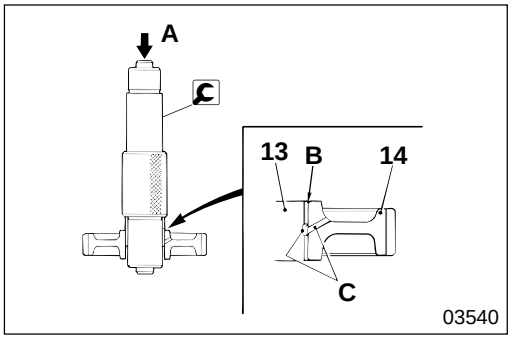
13 **15** **Idler gear bushing and idler shaft**

[Inspection]
If the clearance is higher than the limit, replace the faulty parts.



Idler gear bushing

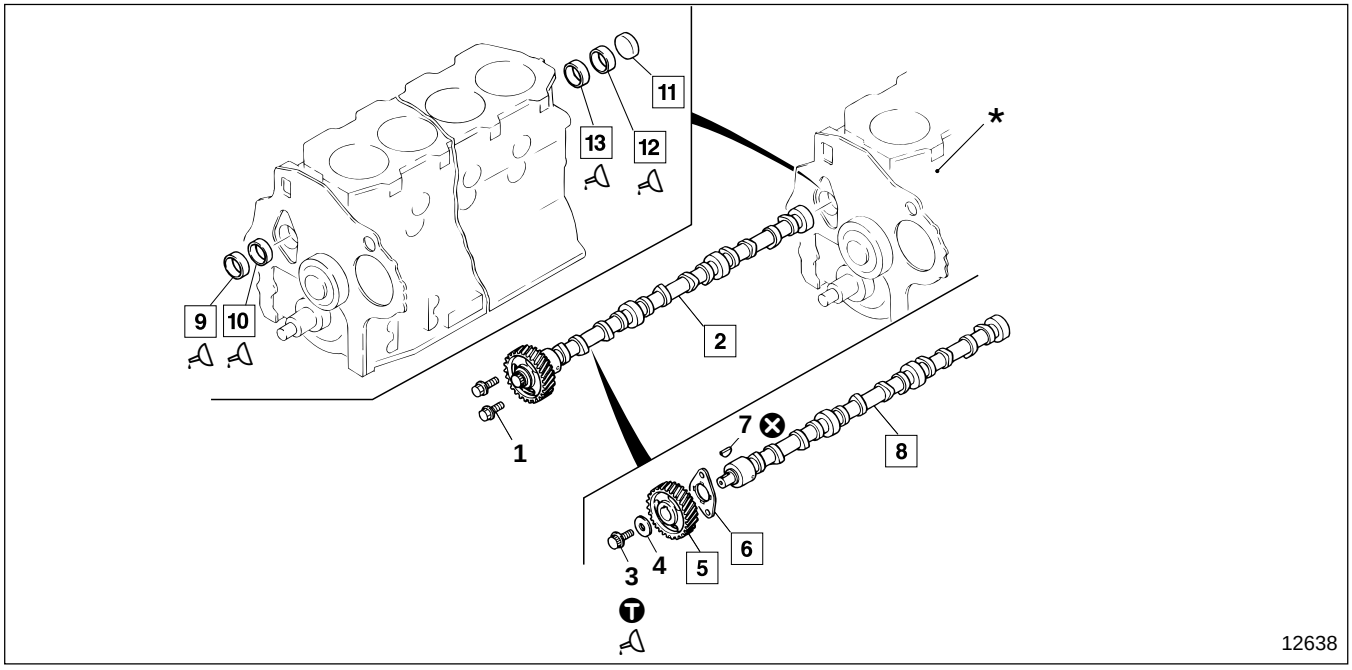
[Removal]
A : Press idler gear bushing 13 using 🔧 idler gear bushing puller.



[Press-fitting]

- Press-fit idler gear bushing **13** from chamfered side **B** of idler gear **14** and align oil holes **C** of the idler gear and the bushing.
- After press-fitting, finish the fitting by bringing the clearance between idler gear bushing **13** and the idler shaft to the standard value.

CAMSHAFT



● **Disassembly sequence**

1 Bolt
2 Camshaft assembly
3 Bolt
4 Washer
5 Camshaft gear
6 Thrust plate
7 Key
8 Camshaft
9 No.1 camshaft bushing
10 No.2 camshaft bushing
11 Sealing cap
12 No.4 camshaft bushing
13 No.3 camshaft bushing

***** : Crankcase 🕮 P11B-54
⊗ : Non-reusable parts

NOTE

Do not remove camshaft gear 5 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
—	End play of camshaft			0.05 to 0.22 {0.0020 to 0.0087}	0.3 {0.012}	Inspect
8	Camshaft	Difference between long and short diameters	Inlet	7.195±0.05 {0.28±0.0020}	6.70 {0.26}	Replace: Long diameter 47.105 {1.85} Short diameter 39.910 {1.57}
			Exhaust	7.321±0.05 {0.29±0.0020}	6.82 {0.27}	Replace: Long diameter 46.979 {1.84} Short diameter 39.658 {1.56}
		Bend		0.02 {0.00079} or less	0.05 {0.0020}	Replace
9, 10, 12, 13	Clearance between camshaft and camshaft bushing		No.1 to No.3	[54.5] 0.03 to 0.08 {[2.15] 0.0012 to 0.0031}	0.15 {0.0059}	Repair or replace
			No.4	[53] 0.03 to 0.08 {[2.09] 0.0012 to 0.0031}	0.15 {0.0059}	

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

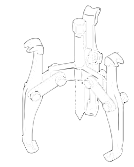
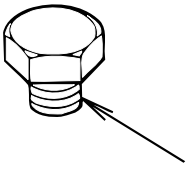
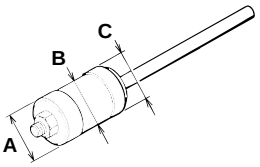
Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Camshaft gear mounting)	175 {130, 18}	Wet
1	Bolt (Camshaft thrust plate)	34 to 39 {25 to 29, 3.5 to 4.0}	—

Lubricant

Location	Points of application	Kinds	Quantity
3	Thread area of bolt	Engine oil	As required
9, 10 12, 13	Inner surface of camshaft bushing	Engine oil	As required

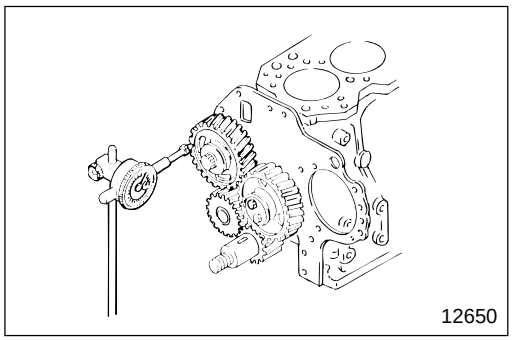
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Gear puller  02065	MH061326	Removal of camshaft gear
	Plug  M14×1.5 03543	MF665004	Blind plug for removal of camshaft gear
9, 10, 12, 13	Camshaft bushing installer and extractor  02083	MH061276	Removal and press-fitting of camshaft bushing

	A, C Dimension	B Dimension
No. 1	ø58.5 {2.30}	ø54.5 {2.15}
No. 2	ø58 {2.28}	ø54.5 {2.15}
No. 3		
No. 4	ø57 {2.24}	ø53 {2.09}

◆ Service procedure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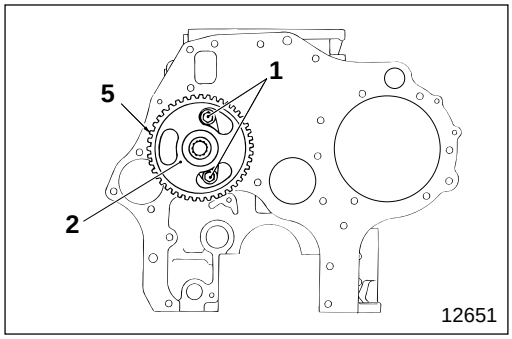
● Inspection before disassembly

Camshaft end play

If the measured value is higher than the limit, replace the faulty parts.



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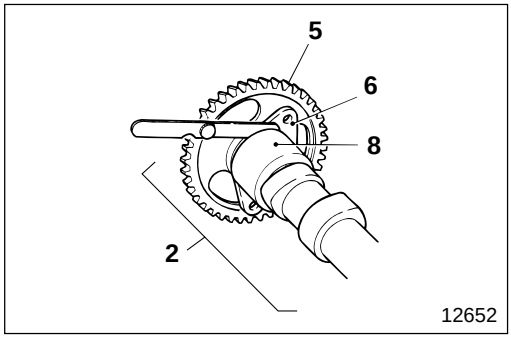
2 Camshaft assembly

[Removal]

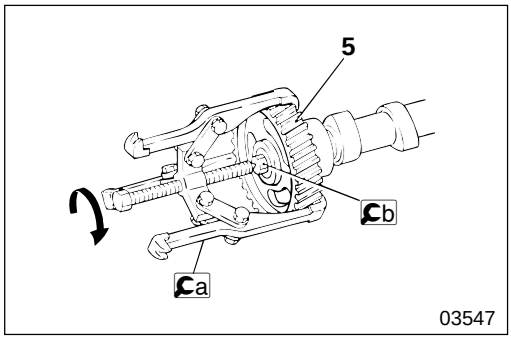
Remove camshaft assembly **2** by undoing bolts **1** through the holes in camshaft gear **5**.

CAUTION

Be careful not to damage the camshaft bushings when you remove camshaft assembly 2.

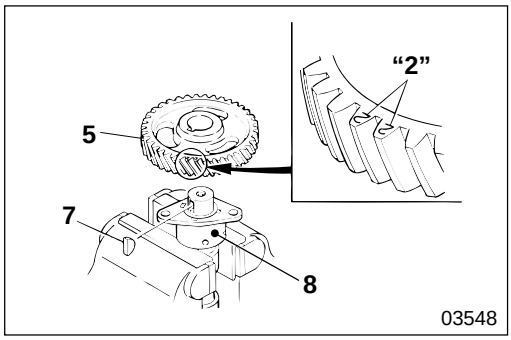


[Installation]
- Before installing camshaft assembly **2**, measure the end play between thrust plate **6** and camshaft **8**.
- If the measured value is higher than the limit, replace the faulty parts.
- Install the camshaft assembly by matching the alignment mark on camshaft gear **5** with the alignment mark on the idler gear. 📖 P11-

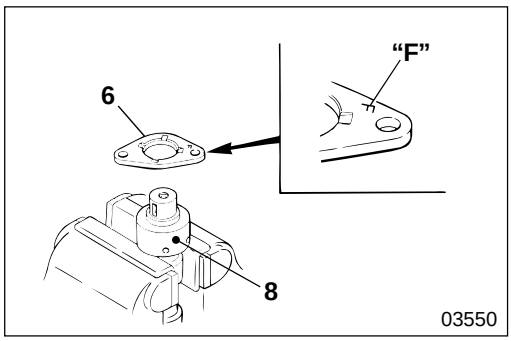


5 **Camshaft gear**

[Removal]
- Never remove camshaft gear **5** by striking, hitting, or hammering it.

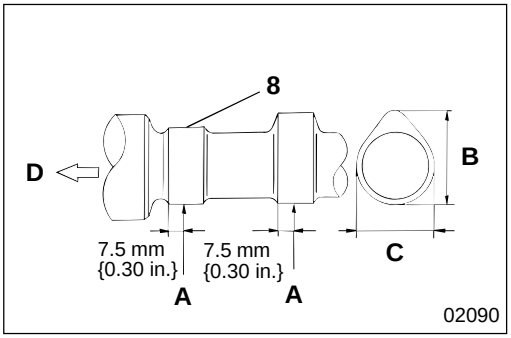


[Installation]
- Install camshaft gear **5** onto camshaft **8** in the direction as illustrated.
- Be sure when finishing the installation to install key **7**.



6 **Installation of thrust plate**

Install thrust plate **6** onto camshaft **8** in the direction as illustrated.



8 Inspection of camshaft

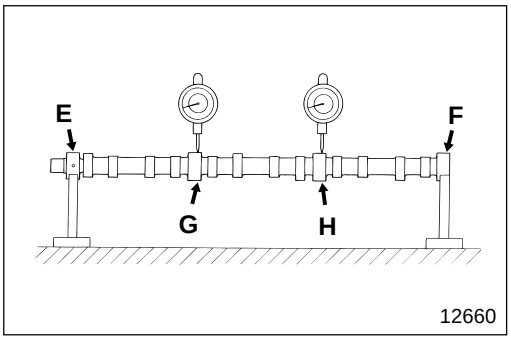
(1) Difference between long diameter and short diameter

If the measured value is lower than the limit, replace camshaft **8**.

NOTE

Measure at point A, as illustrated, because the cam is tapered.

B : Long diameter
C : Short diameter
D : Front of the engine

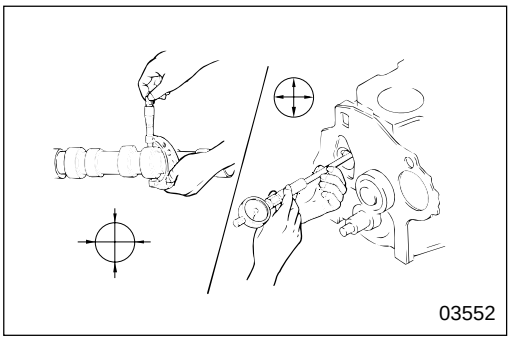


(2) Degree of bend

To measure deflection, support camshaft **8** at area **E** of No.1 journal, and area **F** of No.4 journal . Then, measure the amount of deflection at area **G** of No.2 journal, and area **H** of No.3 journal. If any of the measured values is higher than the limit, replace the camshaft.

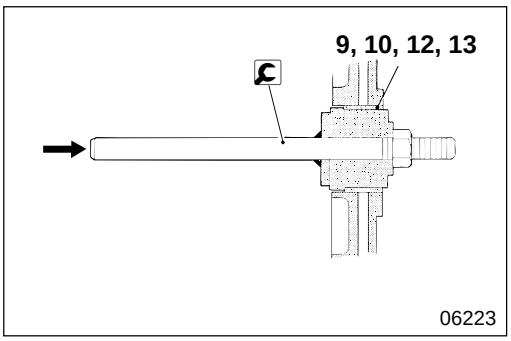
NOTE

Degree of bend of camshaft 8 is a half of the indicated value of the gauge after rotating the shaft 360°.



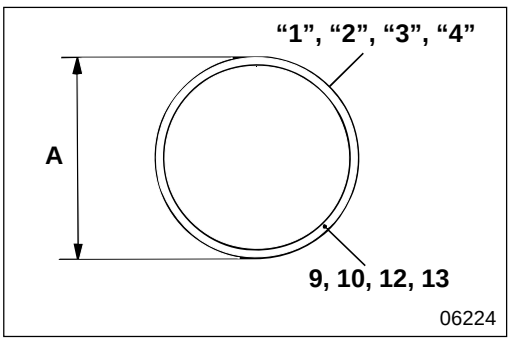
8 to 10 12 13 Camshaft and camshaft bushing

[Inspection]
If the clearance is greater than the limit, replace the faulty parts.



Camshaft bushing

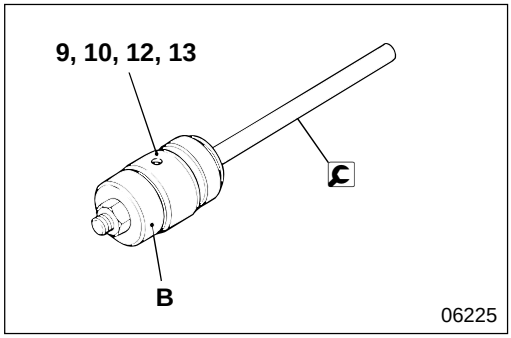
[Removal]
Remove No.3 camshaft bushing **13**, and No.4 camshaft bushing **12** from the rear end of the crankcase.



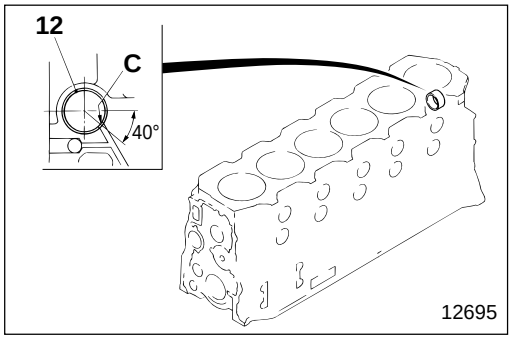
[Press-fitting]

- Identify, by referring to the table below, No.1 to No.4 camshaft bushings by noting marks **"1"**, **"2"**, **"3"**, **"4"** on camshaft bushings **9**, **10**, **12**, **13**. If you cannot identify the mark, measure outer diameter **A** of the bushing and refer to the table below.

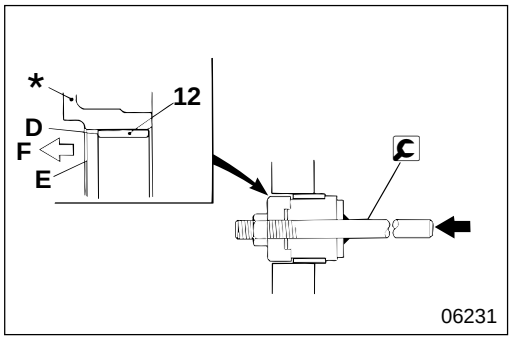
Bushing No. (from the front of the engine)	Mark	Outer diameter A (mm {in.})
No.1	1	ø58.50 {2.30}
No.2	2	ø58.06 {2.28}
No.3	3	ø57.5 {2.26}
No.4	4	ø57.06 {2.25}



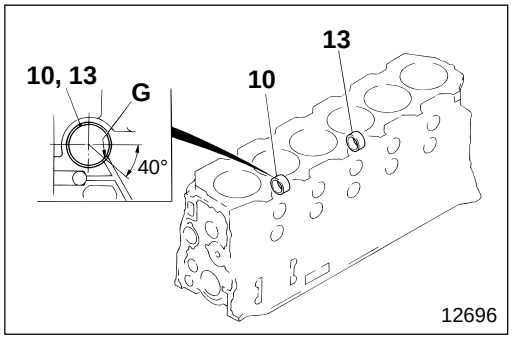
- For press-fitting, mount guide **B** to camshaft bushing installer and extractor.
- Install camshaft bushings **9**, **10**, **12**, **13** in descending order, from No.4 to No.1.
- Install No.4 camshaft bushing **12** from the rear end of the engine, and No.3 to No.1 camshaft bushings **9**, **10**, **13** from the front end of the engine.



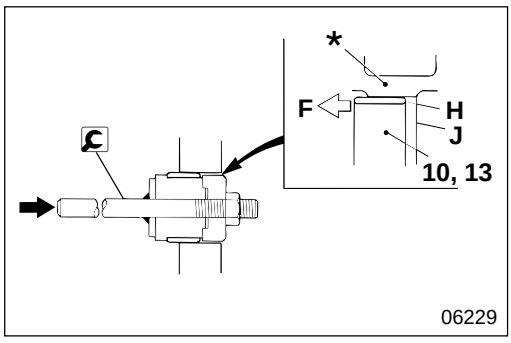
- Align oil hole **C** of No.4 camshaft bushing **12** in the direction as illustrated.



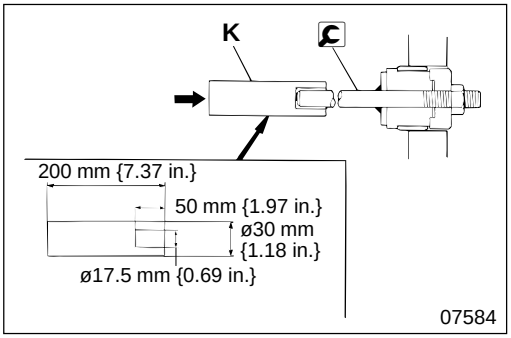
- Press in until surface **D** of No.4 camshaft bushing **12** is flush with chamfered part **E** of crankcase *.
  F : Front of the engine



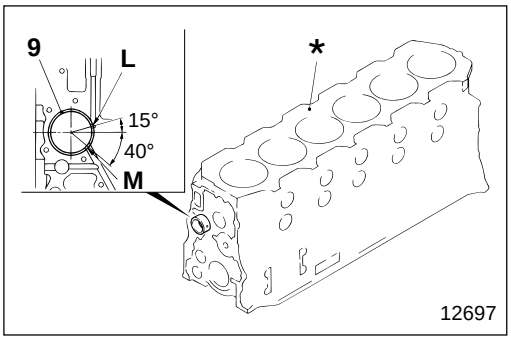
- Align oil hole **G**, of No.2 to No.3 camshaft bushings **10**, **13**, in the direction as illustrated, and press-fit in the order of No.3, 2.



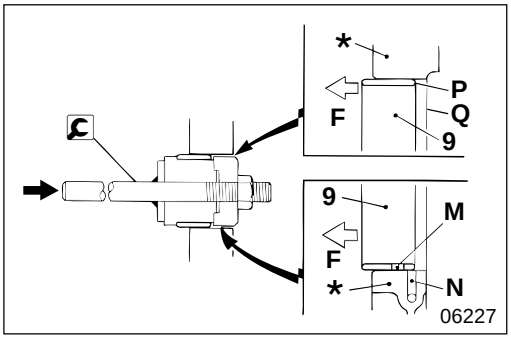
- Press in until surface **H** of No.2 to No.3 camshaft bushings **10**, **13** is flush with surface **J** of crankcase *.
  F : Front of the engine



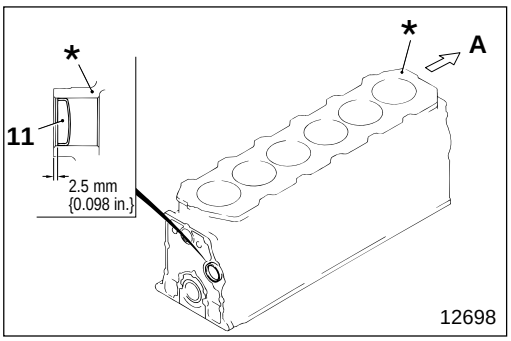
- For press-fitting of No.3 camshaft bushing **13**, use tool **K** as illustrated.



- Align oil holes **L**, **M** of No.1 camshaft bushing **9** in the direction as illustrated.
  L : ø3 mm {0.11 in.}
  M : ø8 mm {0.31 in.}
  ***** : Crankcase



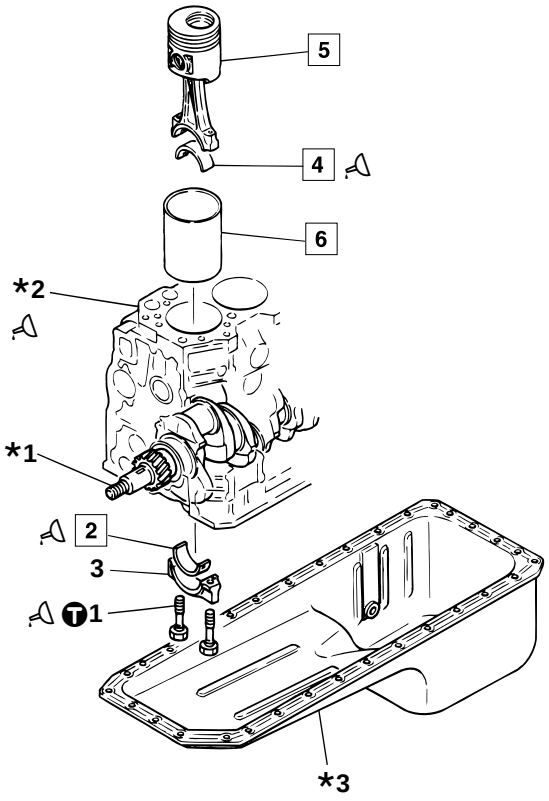
- Align oil hole **M** of No.1 camshaft bushing **9** with oil hole **N** of crankcase ***** and press in until camshaft bushing surface **P** is flush with crankcase surface **Q**.
  F : Front of the engine



11 **Installation of sealing cap**

Press-fit sealing cap **11** into crankcase ***** to the specified depth.
A : Front of the engine

PISTON, CONNECTING ROD AND CYLINDER SLEEVE



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● **Disassembly sequence**

1 Bolt
2 Lower connecting rod bearing
3 Connecting rod cap
4 Upper connecting rod bearing
5 Piston and connecting rod assembly
📖 P11B-44
6 Cylinder sleeve

***1** : Crankshaft 📖 P11B-54
***2** : Crankcase 📖 P11B-54
***3** : Oil pan Gr 12B

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
—	Extent of piston protrusion		0.43 to 0.69 {0.017 to 0.027}	—	Inspect
—	End play of connecting rod		0.15 to 0.45 {0.0059 to 0.018}	0.6 {0.024}	Inspect
2, 4	Connecting rod bearing	Oil clearance	[60] 0.04 to 0.09 {[2.36] 0.0016 to 0.0035}	0.2 {0.0079}	Replace
		Expansion	—	Upper : less than 64.5 {2.54} Lower : less than 64.27 {2.53}	
5, 6	Clearance between piston and connecting rod assembly and cylinder sleeve		[104] 0.10 to 0.14 {[4.094] 0.0039 to 0.0055}	—	Adjust or replace with oversizes
6	Cylinder sleeve	Inner diameter	104 to 104.03 {4.094 to 4.095}	104.25 {4.10}	Adjust or replace with oversizes
		Circular accuracy	0.01 {0.00039} or less	—	
		Cylindrical accuracy	0.03 {0.0012} or less	—	
6, *2	Interference between cylinder sleeve and crankcase	Standard	0.17 to 0.23 {0.0067 to 0.0091}	—	Replace with oversizes
		Oversize	0.19 to 0.21 {0.0075 to 0.0083}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt	30 {22, 3}+90°±5°	Wet

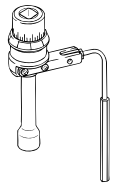
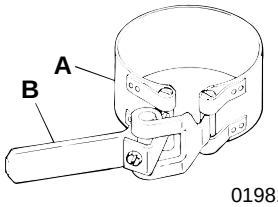
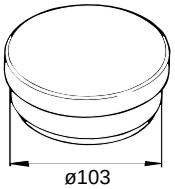
Lubricant

Location	Points of application	Kinds	Quantity
1	Thread area of bolt	Engine oil	As required
2, 4	Inner surface of bearing	Engine oil	As required
***2**	Sleeve hole of crankcase	Spindle oil (ISO VG 32)	As required

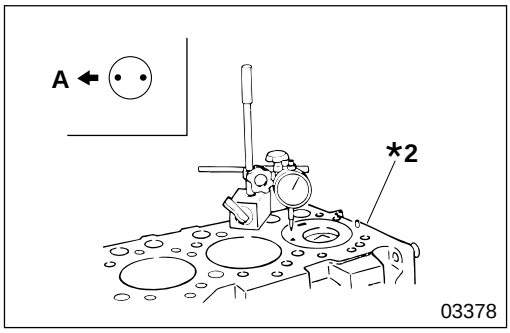
PISTON, CONNECTING ROD AND CYLINDER SLEEVE

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Socket wrench  01984	MH061560	Installation of piston and connecting rod assembly
	A : Piston guide clamp **B** : Piston guide lever  01981	**A** : MH061890 **B** : MF061658	
6	Cylinder sleeve installer  ø103 {4.06} 03377	MH062228	Installation of cylinder sleeve

◆ Service procedure



03378

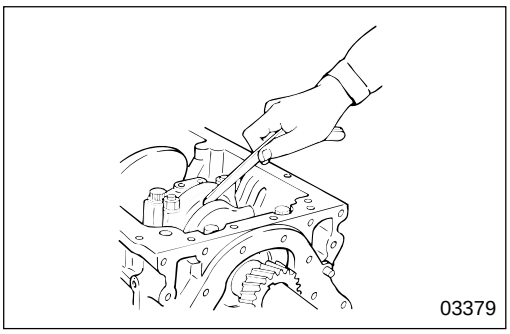
● **Inspection before disassembly**

(1) Extent of piston protrusion from the upper surface of crankcase *2

NOTE

Always inspect the extent of piston protrusion because it affects the engine performance greatly.

- Measure piston protrusion at two points on the top of the piston, and produce the average value.
  A : Front of the engine
- If the average valve deviates from the limit, inspect clearance of the related parts.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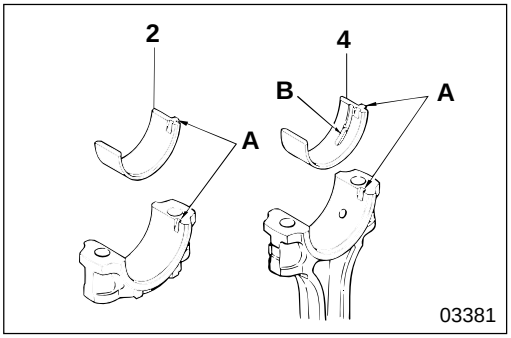
(2) End play of connecting rod

- Measure the end play of each connecting rod.
- If the measured value is higher than the limit, replace the faulty parts.



2 **4** **Connecting rod bearing**

[Installation]
Install connecting rod bearings **2**, **4** by matching lugs **A** to the connecting rods.

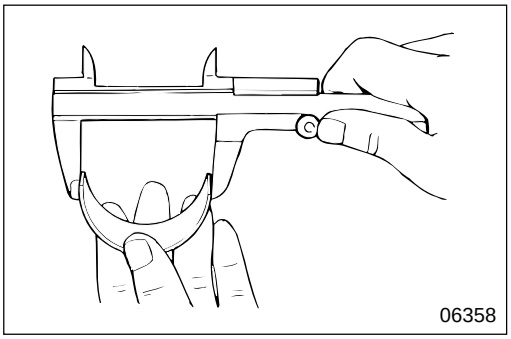
CAUTION

Be sure to distinguish between upper and lower connecting rod bearings 2, 4. The upper bearing has oil opening B while the lower bearing has no oil opening.

[Inspection]

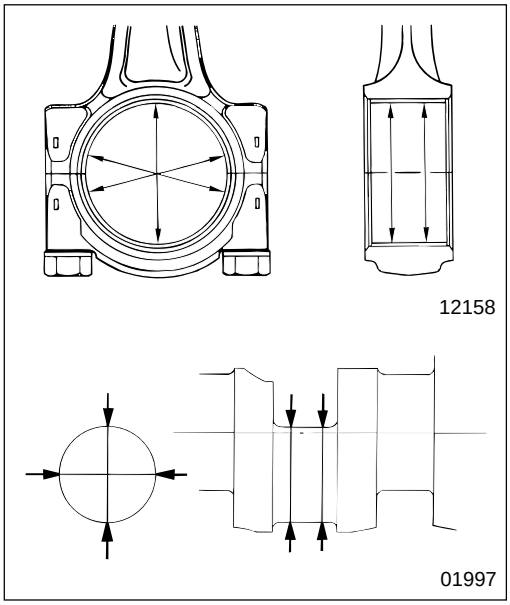
CAUTION

- **Do not forcibly open or expand connecting rod bearings 2, 4.**
- **When either upper or lower connecting rod bearings 2, 4 needs replacing, replace as a set.**



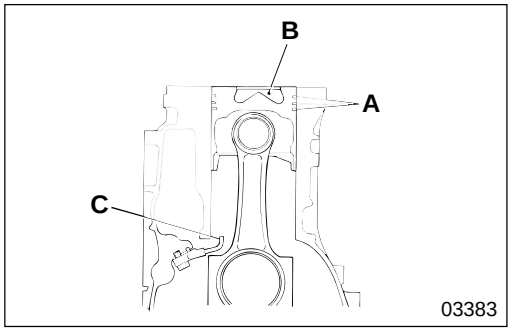
(1) Expansion at free state

If the measured value is lower than the limit, replace connecting rod bearings **2**, **4**.



(2) Clearance between connecting rod bearing and crankshaft

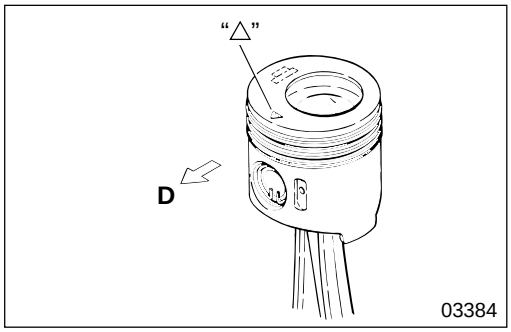
If the clearance between connecting rod bearing **2**, **4** and crankshaft ***1** is lower than the limit, replace the faulty parts.



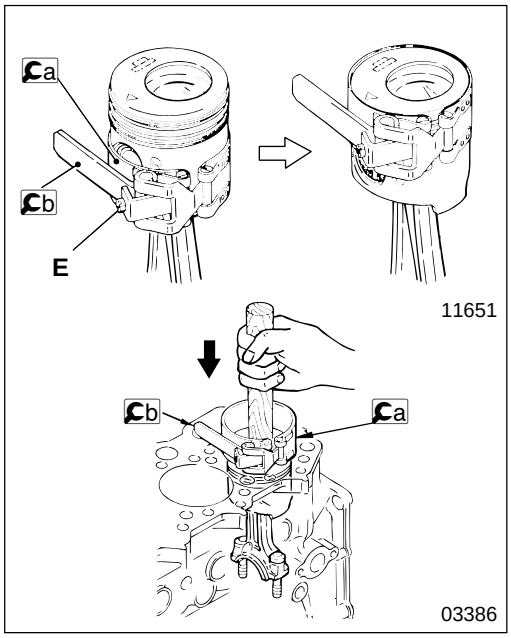
5 **Installation of piston and connecting rod assembly**

CAUTION

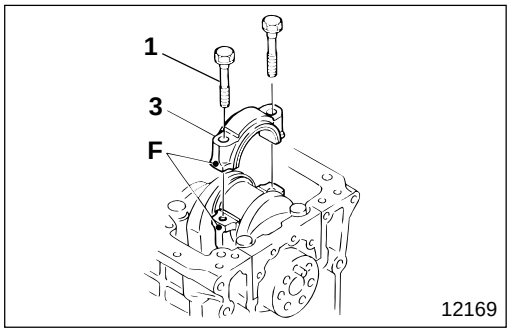
- **Be sure to fit piston ring A in the correct position.**
  P11-48
- **Be careful not to scratch or damage head B of the piston (a part of the combustion chamber).**
- **Make sure that the connecting rod does not hit oil jet C.**



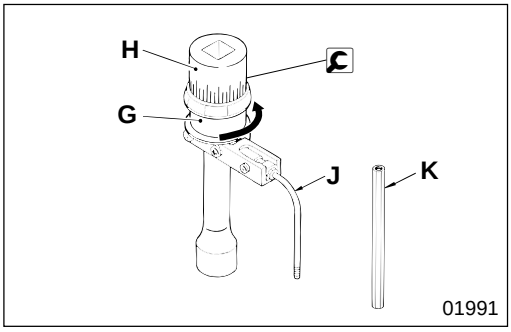
- Install piston front mark "△" directed towards the front of the engine using the following procedure.
  D : Front of the engine



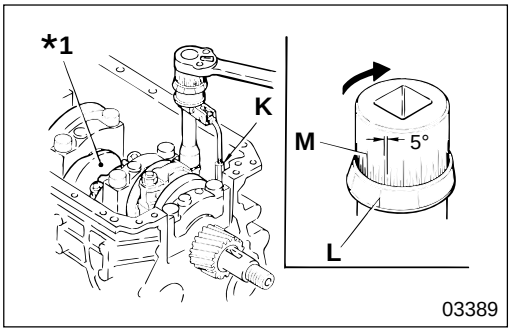
- Match the inner diameter of a piston guide clamp to the outer diameter of the piston skirt by turning adjusting bolt **E** of b piston guide lever.
- After adjusting, set a piston guide clamp and b piston guide lever at the top of the piston so that the clamp is flush with the top of the piston.



- After the piston is inserted, align alignment marks **F** on the connecting rod with the alignment marks on connecting rod cap **3** and tighten bolt **1** at specified torque. Then tighten the bolt further as follows:



- Turn 🔧 socket wrench holder **G** counterclockwise and keep the spring in the wrench compressed.
  H : Socket
  J : Rod
  K : Rod (for connection)

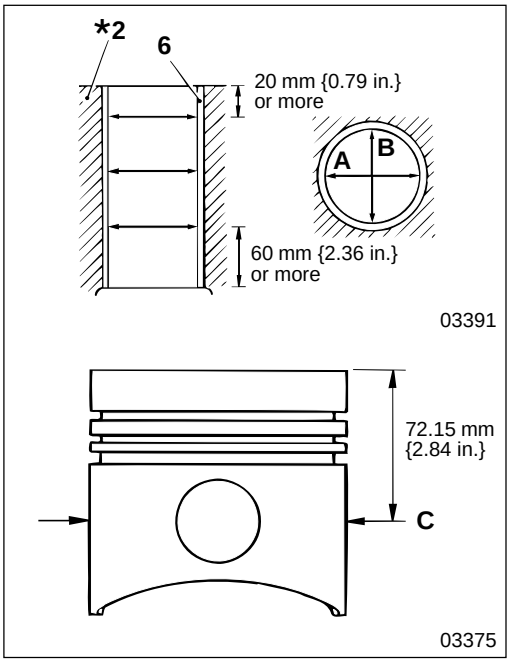


- Set 🔧 socket wrench holder **G** so that the repercussive force of the spring presses rod **K** (for connection) against crankshaft ***1**.
- Select a scale that is convenient for reading graduation **L** on holder **G**.
- Tighten further by turning socket **H** clockwise by 90°±5° (setting is in 5° increments), referring to graduation **M** on the selected scale.

NOTE

After installation of connecting rod cap 3, inspect the following points :

- **End play of the connecting rod : 🕮 P11B-38**
- **Piston protrusion : 🕮 P11B-38**



5 **6** **Piston and connecting rod assembly, and cylinder sleeve**

[Inspection]

- If the inner diameter of cylinder sleeve **6** is higher than the limit, bore the cylinder sleeve oversize and use an oversized piston.
  A : In the direction of the crankshaft axis
  B : At right angles to the crankshaft axis

- If the clearance between piston **5** and cylinder sleeve **6** deviates from the standard value, even when the inner diameter of the cylinder sleeve is within the limit, replace the piston.

[Selection of oversized piston]

Extent of oversize : 0.50, 1.00 mm {0.020, 0.039 in.}

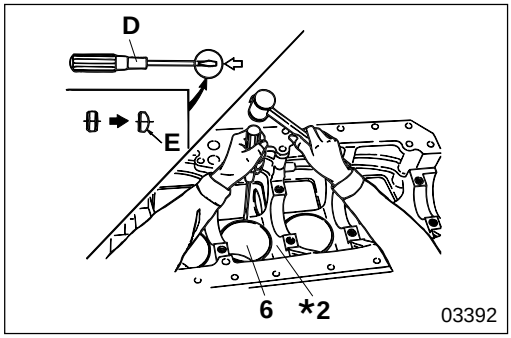
- Determine the extent of oversize by measuring the inner diameters of all the cylinders and calculating the maximum wear amount of all the cylinders.
- Measure the outer diameter of the oversized piston to be used.
  C : Position to measure the outer diameter of the piston

- Bore cylinder sleeve **6** and hone it to make the clearance between piston **5** and the cylinder sleeve conform to the standard value.

NOTE

- **Even if only one cylinder sleeve 6 requires boring, all the other cylinder sleeves must be bored to the identical oversize.**
- **Piston rings must be replaced with the corresponding oversized ones.**

PISTON, CONNECTING ROD AND CYLINDER SLEEVE



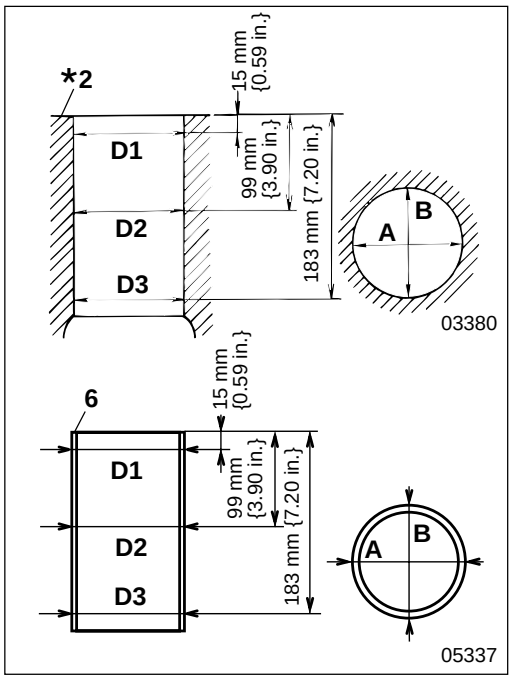
Cylinder sleeve

[Removal]

- Mount a boring machine on crankcase ***2** and center. Centering must be done at the lower part of cylinder sleeve **6** which is less unevenly worn.
- Bore until the thickness of cylinder sleeve **6** is approximately 0.5 mm {0.020 in.}.
- Insert tool **D** (a modified screwdriver) between crankcase ***2** and cylinder sleeve **6**, break the sleeve by tapping it gently, then remove.

CAUTION

Make sure when inserting tool D that round part E is facing crankcase *2.



[Installation]

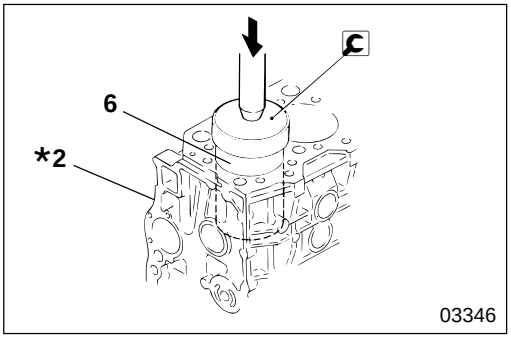
- Inspect sleeve hole of crankcase ***2** before installing cylinder sleeve **6**. If there are irregularities, such as defects or insufficient interference, correct them by boring.

NOTE

- **Pull out cylinder sleeve 6 of all cylinders and bore the sleeve holes perfectly round when you bore the sleeve holes of crankcase *2.**
- **Apply spindle oil (ISO VG 32) when you push cylinder sleeve 6 into the sleeve hole of crankcase *2.**

Inspection of interference must be carried out as follows.

- Measure the inner diameter of the sleeve hole of crankcase ***2** and the outer diameter of cylinder sleeve **6** at the specified positions illustrated.
- Take the average value at the top, middle and bottom (**D1**, **D2**, **D3**) and across the diameter (**A**, **B**). If the interference is lower than the limit, bore the sleeve hole of crankcase ***2** oversize.



< If interference is sufficient >

- Press-fit cylinder sleeve **6** into crankcase ***2** from the chamfered end using [C] cylinder sleeve installer.

NOTE

Align the top of cylinder sleeve 6 with the top of crankcase *2 when press-fitting.

- After press-fitting, make the inner diameter of cylinder sleeve **6** conform to the standard value by honing the surface.

< If interference is insufficient >

- Prepare cylinder sleeve **6** which is 0.5 mm {0.020 in.} oversize in diameter.
- Hone crankcase ***2**, making the clearance between the outer diameter of cylinder sleeve **6** and the sleeve hole of crankcase ***2** conform to the standard value.
- Press-fit cylinder sleeve **6** into crankcase ***2** from the chamfered end using [C] cylinder sleeve installer.

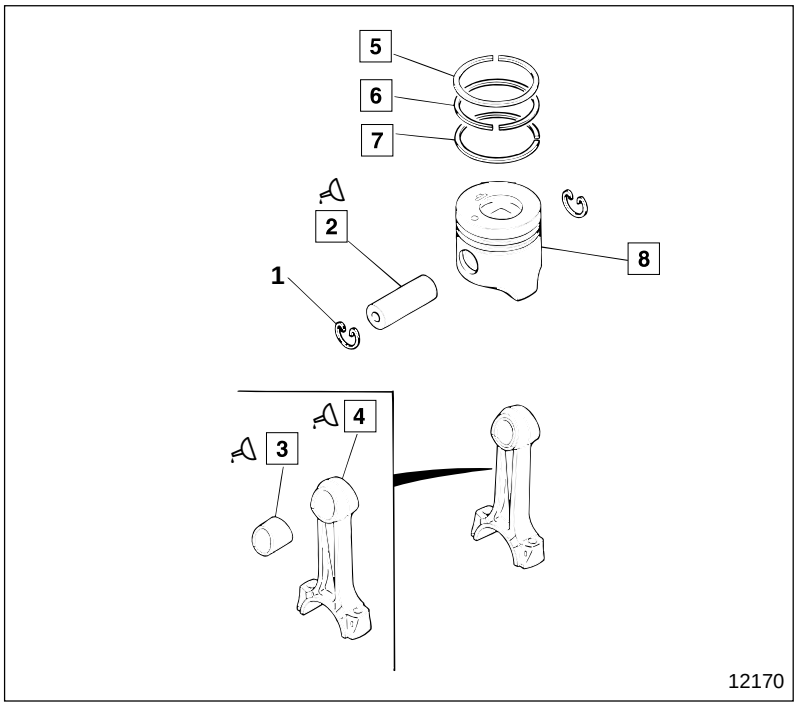
NOTE

Align the upper face of cylinder sleeve 6 with the upper face of crankcase *2 when press-fitting.

- After press-fitting, make the inner diameter of cylinder sleeve **6** conform to the standard value by honing the surface.

PISTON, CONNECTING ROD AND CYLINDER SLEEVE

Piston and Connecting Rod Assembly



● **Disassembly sequence**

1 Snap ring
2 Piston pin
3 Connecting rod bushing
4 Connecting rod
5 1st compression ring
6 2nd compression ring
7 Oil ring
8 Piston

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

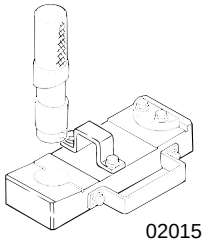
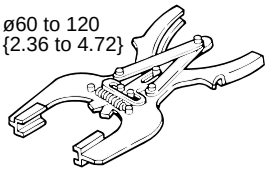
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
2, 3	Clearance between piston pin and connecting rod bushing		[36] 0.03 to 0.04 {[1.42] 0.0012 to 0.0016}	0.1 {0.0039}	Replace
2, 8	Clearance between piston and piston pin		[36] 0.007 to 0.021 {[1.42] 0.00028 to 0.00083}	0.05 {0.0020}	Replace
4	Degree of bend and distortion of connecting rod		—	0.05 {0.0020}	Repair or replace
5 to 7	Deviation of piston ring fitted position	1st compression ring	0.3 to 0.45 {0.012 to 0.018}	1.5 {0.059}	Replace
		2nd compression ring	0.4 to 0.55 {0.016 to 0.022}		
		Oil ring	0.25 to 0.45 {0.0098 to 0.018}		
5 to 8	Clearance between piston ring and piston ring groove	1st compression ring	0.02 to 0.10 {0.00079 to 0.0039}	0.2 {0.0079}	Replace
		2nd compression ring	0.05 to 0.08 {0.0020 to 0.0031}	0.15 {0.0059}	
		Oil ring	0.03 to 0.06 {0.0012 to 0.0024}		

Lubricant

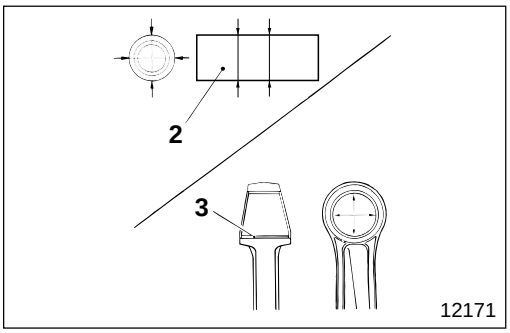
Location	Points of application	Kinds	Quantity
2	Exterior of piston pin	Engine oil	As required
3	Exterior of connecting rod bushing	Engine oil	As required
4	Bushing attachment area of connecting rod	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Connecting rod bushing puller kit  02015	MH062225	Removal and installation of connecting rod bushing
5 to 7	Piston ring tool  02013	MH060014	Removal and installation of piston ring

◆ Service procedure



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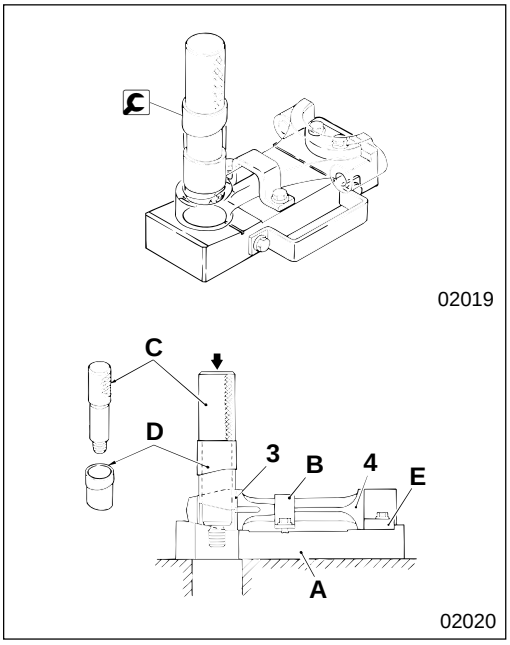
2 **3** **Piston pin and connecting rod bushing**

[Inspection]
If the clearances are higher than the limit, replace the faulty parts.



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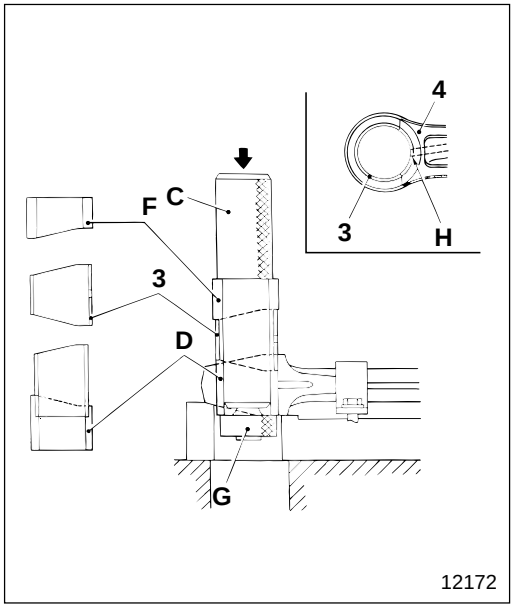
Connecting rod bushing

Use 🔧 connecting rod bushing puller kit to replace connecting rod bushing **3**.
(Components of 🔧 connecting rod bushing puller kit)
A : Base **B** : Bracket **C** : Puller **D** : Collar
E : Plate **F** : Collar **G** : Nut

[Pulling-out]

- Remove upper connecting rod bearing from the big end of connecting rod **4**.
- Place connecting rod **4** on base **A** and fix it to the base at two points, bracket **B** and plate **E**.
- Fit collar **D** in puller **C** in the direction as illustrated, and pull out connecting rod bushing **3** with a gradual load of approximately 49 kN {11020 lbf, 5000 kgf}.

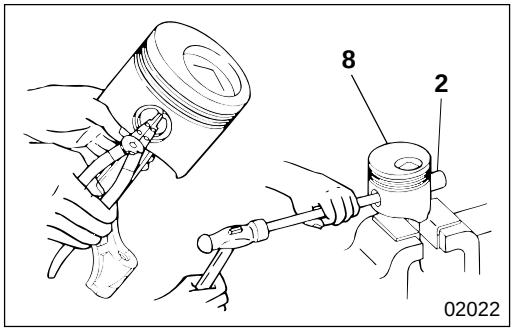


[Press-fitting]

- Apply engine oil to the exterior peripheral area of connecting rod bushing **3** and the inner area of the bushing fitting ring of connecting rod **4**.
- Fit collar **F**, connecting rod bushing **3** and collar **D** in puller **C** in the arrangement and direction as illustrated and mount them with nut **G**.
- Align oiling holes **H** of connecting rod bushing **3** and connecting rod **4**, and gradually press in the bushing with approximately 49 kN {11023 lbf, 5000 kgf} load.
- After press-fitting, ream connecting rod bushing **3** to make its clearance with piston pin **2** conform to the standard value.

NOTE

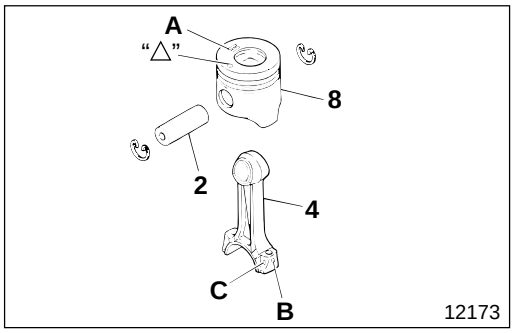
After press-fitting bushing 3, insert piston pin 2 and make sure that the rod moves smoothly without any excessive play.



2 4 8 Piston pin and connecting rod and piston

[Disassembly]

- Drift out piston pin **2** using a rod.
- When removal of piston pin **2** is difficult, warm piston **8** using a piston heater or hot water.

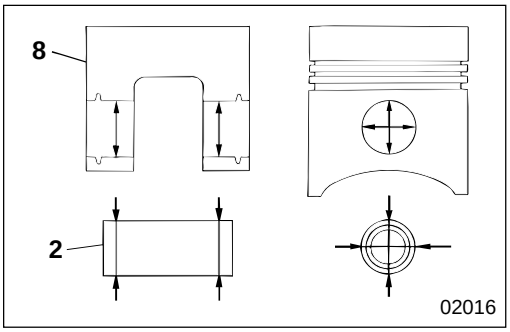


[Installation]

- Apply engine oil to piston pin **2** and assemble connecting rod **4** and piston **8** in the direction as illustrated.
  A : Piston mass (Mass of piston is marked)
  B : Connecting rod mass mark (Alphabetical: A, B, C, D, E, F, G)
  C : Mounting base of connecting rod cap
  △ : Front mark
- When piston pin **2** insertion is difficult, warm piston **8** using a piston heater or hot water.

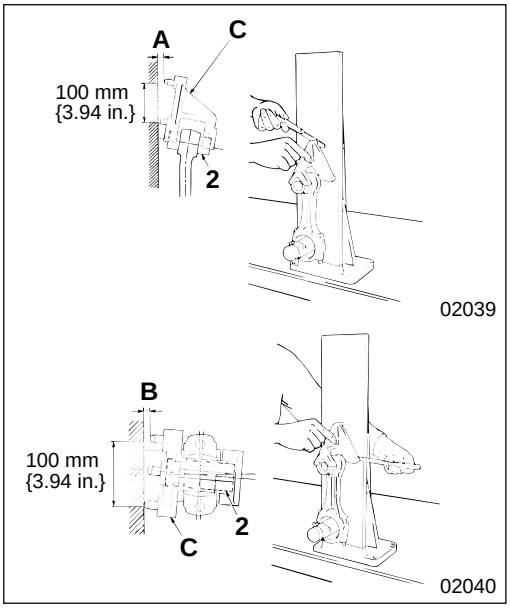
CAUTION⚠

- **Make sure that the total mass error of all pistons 8 in one engine is 10 g {0.35oz} or less.**
- **Be sure to install connecting rods 4, to be used in one engine, that have identical mass mark B.**
- **Be sure that after inserting piston pin 2 the connecting rod operates smoothly without excessive play.**



2 **8** **Clearance between piston pin and piston**

If the clearance is higher than the limit, replace the faulty parts.



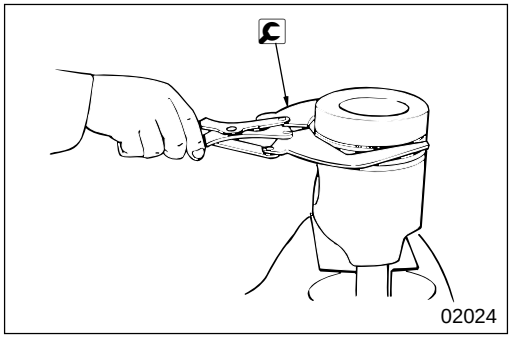
4 **Degree of bend or distortion of connecting rod**

- Mount connecting rod bushing **3** and piston pin **2** to connecting rod **4**.
- Measure degree of bend **A** and distortion **B** of connecting rod **4**. If the measured value is higher than the limit, repair or replace the connecting rod.
  C : Connecting rod aligner (Measuring instrument)

NOTE

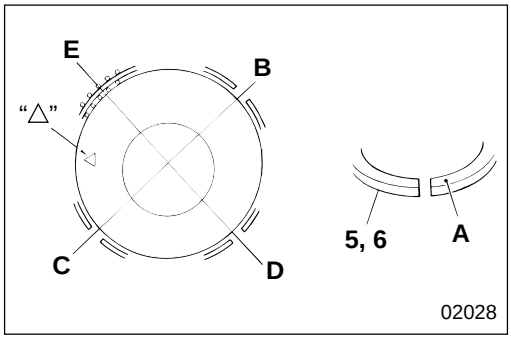
- **When making measurements by mounting connecting rod 5 to connecting rod aligner C, make sure that the upper connecting rod bearing and the lower connecting rod bearing are mounted on the rod.**
- **Mount the connecting rod cap by tightening the bolt at specified torque.** 🕮 **P11B-36**

PISTON, CONNECTING ROD AND CYLINDER SLEEVE

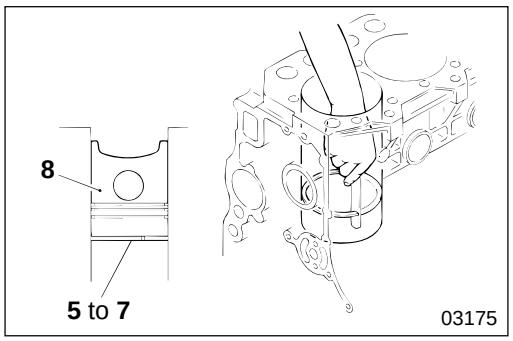


5 to 8 Piston ring and piston

Piston ring
[Removal]



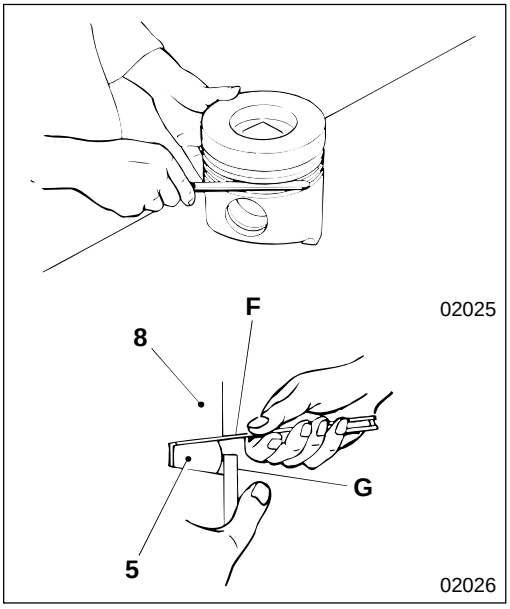
[Installation]
- Install oil ring **8** so that split **D** and the butting joint of expander spring **E** come to the points as illustrated.
- Compression rings **5** and **6** have a manufacturer's mark **A** at the split, and installation should be made with the mark outward.
  B : The split of the 1st compression ring
  C : The split of the 2nd compression ring
  D : Oil ring slit
  E : Oil ring expander spring butt joint
  △ : Front mark of piston



[Inspection]

(1) Clearance of piston ring slit
- Install piston rings **5** to **7** into the crankcase cylinder sleeve using the head of piston **8** to level the piston ring.
- Measure the clearance of the piston ring split while keeping them level and stationary. If the measured value is higher than the limit, replace the piston ring.

NOTE
- **Use piston 8 to ensure that piston rings 5 to 7 are kept level when inserting them into the crankcase cylinder sleeve.**
- **Insert piston rings 5 to 7 into the lower part of the crankcase cylinder sleeve, where the area is less worn, when measuring clearance of piston ring split 5 to 7.**
- **Exchange the whole set of piston rings 5 to 7 as a set if any of the rings is faulty.**



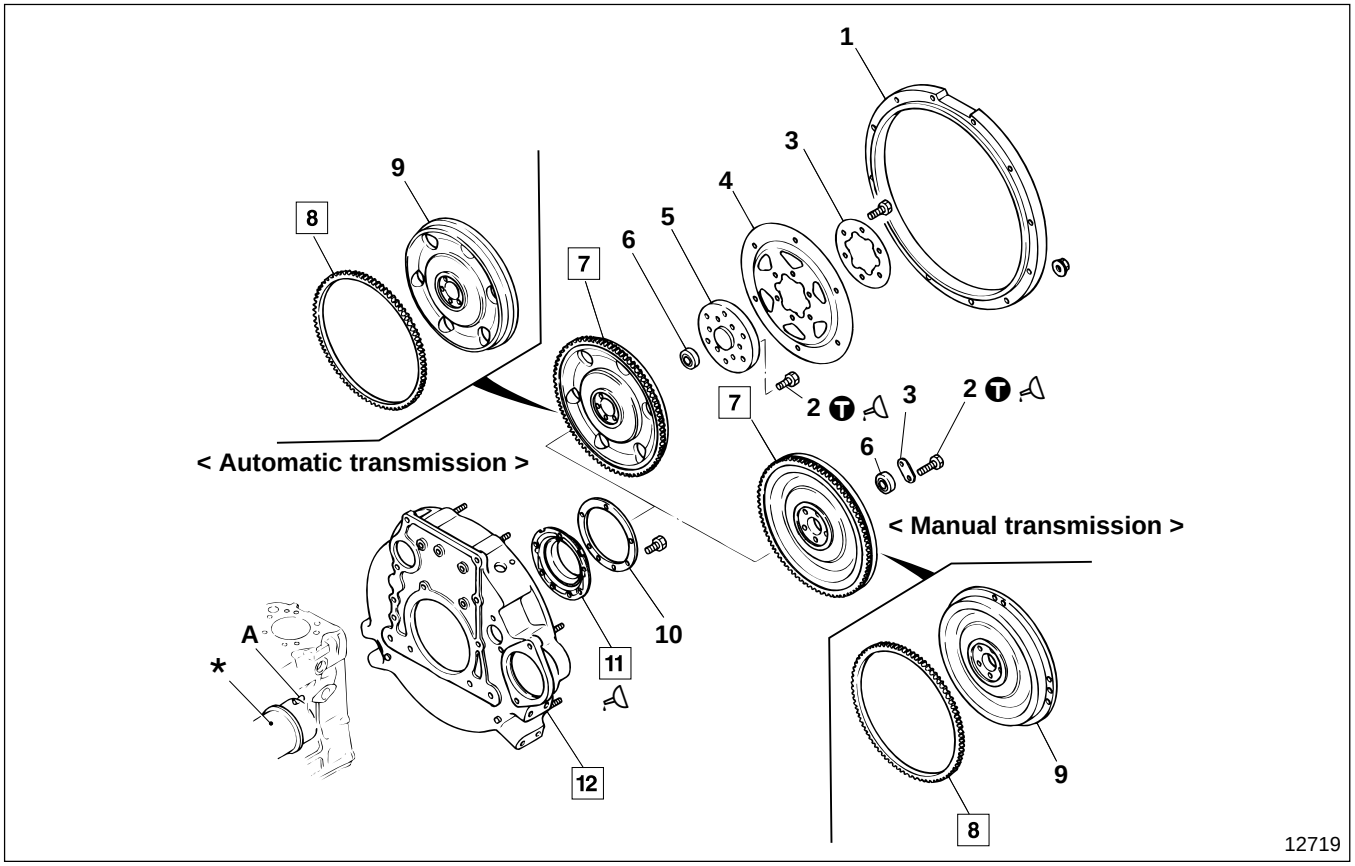
(2) Clearance between piston ring and ring groove

- If the measured value is higher than the limit, replace the faulty parts.
- Measure using feeler gauge **F**, by pressing 1st compression ring **5** against piston **8** with straight edge **G**.

NOTE

- **Measurement has to be conducted around the whole periphery of piston 8 after removing carbon deposits.**
- **Be sure to exchange the whole set of piston rings 5 to 7 as a set if any of the rings is faulty.**

FLYWHEEL



● **Disassembly sequence**

1 Flywheel housing adaptor < Automatic transmission >
2 Bolt
3 Plate < Manual transmission > Wear plate < Automatic transmission >
4 Flex plate < Automatic transmission >
5 Flywheel adaptor < Automatic transmission >
6 Bearing
7 Flywheel assembly
8 Ring gear
9 Flywheel
10 Washer plate
11 Rear oil seal
12 Flywheel housing

***** : Crankshaft assembly 🕮 P11B-54
A : Positioning pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Be sure to check wobble of flywheel 9 after installing flywheel assembly 7. 🕮 **P11B-51**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
7	Flywheel assembly < Manual transmission >	Height from bolt mounting surface to friction surface	24.5 {0.96}	23.5 {0.93}	Correct or replace
		Distortion of friction surface	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Wobble of friction surface when installed	—	0.2 {0.0079}	Correct or replace
12	Eccentricity of spigot when installed		—	0.2 {0.0079}	Inspect or replace

Tightening torque

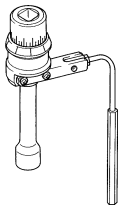
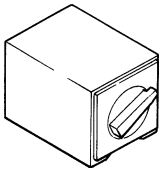
Unit : N·m {ft.lbs, kgf·m}

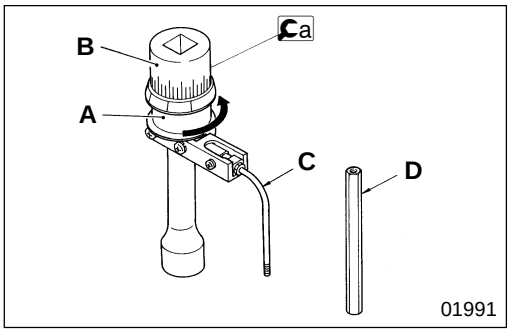
Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Flywheel mounting)	39 {29, 4.0}+47°±3°	Wet

Lubricant and sealant

Location	Points of application	Kinds	Quantity
2	Thread area of bolt	Engine oil	As required
11	Lip area of rear oil seal	Engine oil	As required
	Crankcase mounting surface of rear oil seal	THREEBOND 1207C	As required

Special tools

Location	Tool name and shape	Part No.	Application
7	Socket wrench  01984	MH062183	Installation of flywheel
	Magnetic base  00471	MH062356	

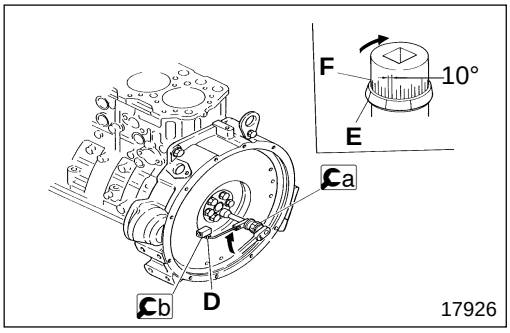


01991

◆ Service procedure

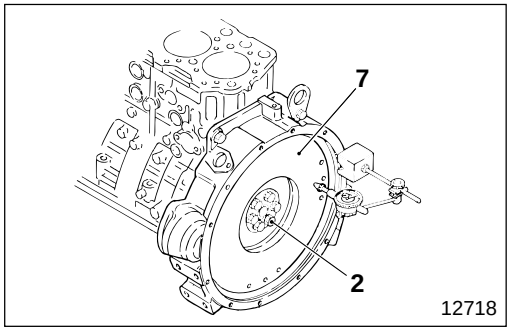
7 Flywheel assembly

- After tightening bolt **2** at specified torque, tighten further as follows:
- Turn a socket wrench holder **A** counterclockwise and keep the spring in the wrench compressed.
  B : Socket
  C : Rod
  D : Rod (for connection)



17926

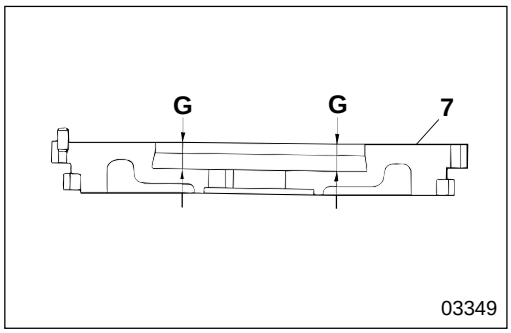
- Install b magnetic base in a position where it makes contact with rod **D** (for connection) as illustrated.
- Set a socket wrench holder **A** so that the repercussive force of the spring pressed rod **D** (for connection) against b magnetic base.
- Select a scale that is convenient for reading graduation **E** on holder **A**.
- Tighten further by turning socket **B** clockwise by 47°±3° (setting is in 10° increments), referring to graduation **F** on the selected scale.



[Inspection]

(1) Wobble

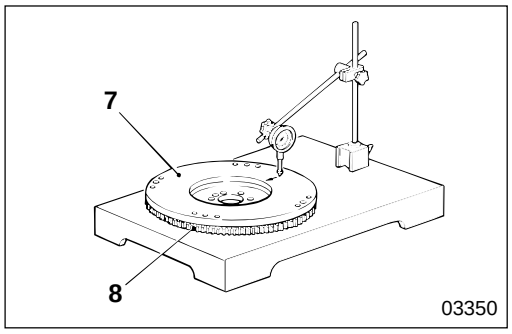
If the measured value is higher than the limit, check the fastening of bolt **2**, the attachment surface of crankshaft assembly, and depending on the condition found, either repair or replace flywheel assembly **7**.



(2) Height of friction surfaces

If the measured value is lower than the limit, repair or replace flywheel assembly **7**.

G : Height from bolt mounting surface to friction surface

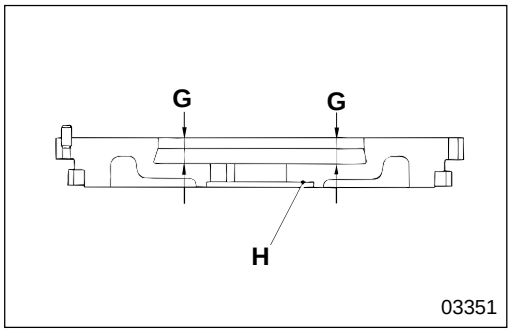


(3) Distortion of friction surface

If the measured value is lower than the limit, repair or replace flywheel assembly **7**.

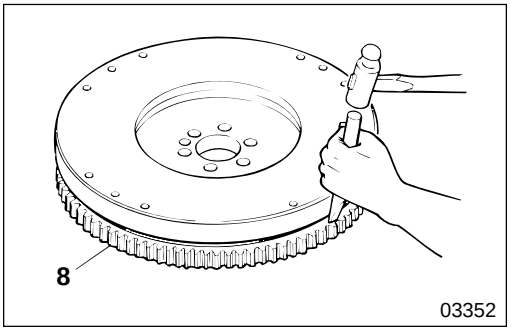
NOTE

If any fault is found in ring gear 8, replace it first, then begin the inspection.



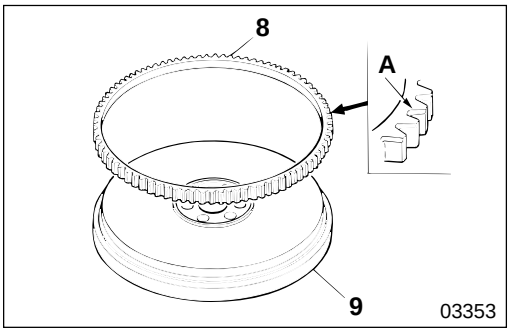
[Correction]

Make sure when grinding the friction surfaces for correction, that height **G** is not lower than the limit while maintaining the degree of parallel with surface **H** within 0.1 mm {0.0039 in.}.

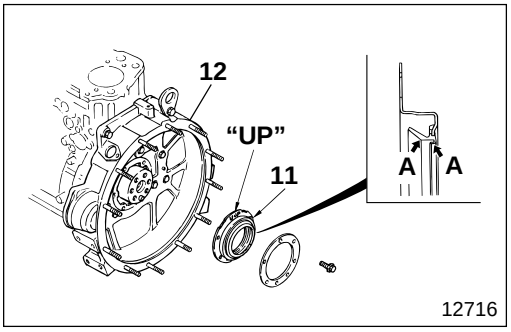


8 Ring gear

[Inspection]
Check and see if there is any damage, wear or other fault, and if any fault is found, replace ring gear **8**.
[Removal]
- Heat up ring gear **8** evenly using an acetylene torch.
- Hammer the outer edge of ring gear **8** evenly until it drops off.

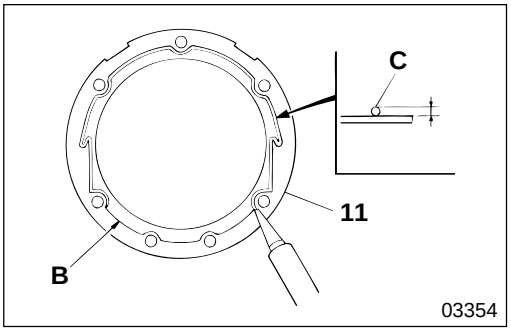


[Installation]
- Heat up ring gear **8** using a piston heater to approximately 100°C {212°F} for three minutes.
- With the side of the chamfered teeth of ring gear **8** facing you, mount it on flywheel **9**.
  A : Chamfered ring gear side



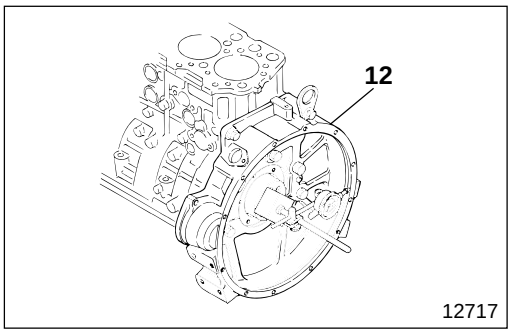
11 Mounting of rear oil seal

- Apply engine oil to lip area **A** of rear oil seal **11**.
- Install rear oil seal **11** in flywheel housing **12** in the direction as illustrated.



- Apply sealant **C** along line **B** on rear oil seal **11** evenly without break
- After applying sealant **C**, within three minutes, mount rear oil seal **11**.

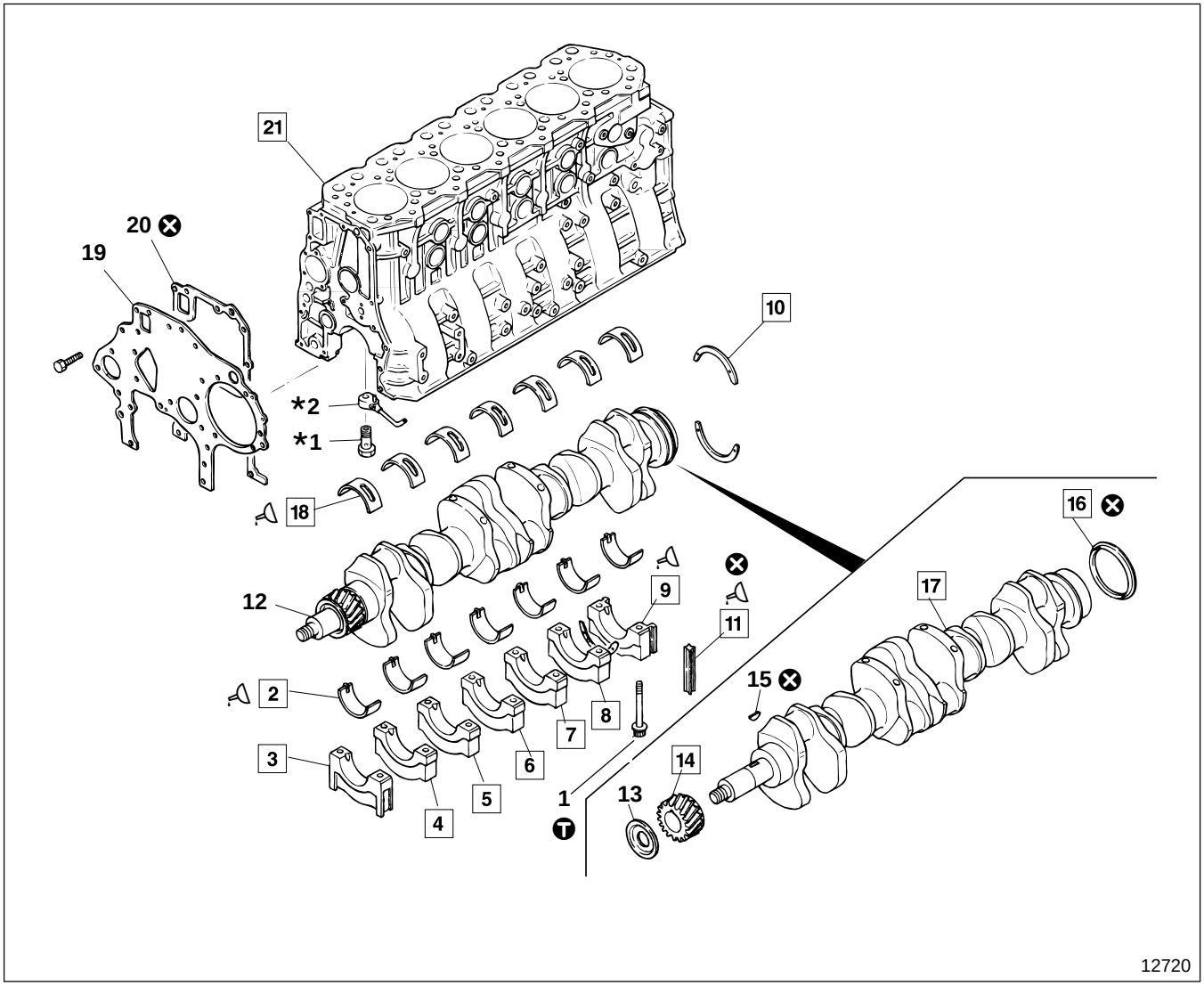
CAUTION ⚠
- **Do not start the engine within an hour of installing rear oil seal 11.**
- **Be sure to reapply sealant C if the bolts (for mounting rear oil seal 11) are loosened or removed by any cause whatsoever after mounting.**



12 Inspection of flywheel housing

Mount of eccentricity
- If the measured value is higher than the limit, reassemble flywheel housing **12**.
- After reassembly, if the measured value is still higher than the limit, replace the faulty parts.

CRANKSHAFT AND CRANKCASE



● **Inspection before disassembly**

P11B-56

● **Disassembly sequence**

1 Bolt
2 Main bearing, lower
3 No.1 main bearing
4 No.2 main bearing
5 No.3 main bearing
6 No.4 main bearing
7 No.5 main bearing
8 No.6 main bearing
9 Rear main bearing
10 Thrust plate
11 Side seal
12 Crankshaft assembly
13 Front oil seal slinger
14 Crankshaft gear
15 Key
16 Rear oil seal slinger
17 Crankshaft
18 Main bearing, upper
19 Front plate
20 Gasket
21 Crankcase

***1** : Check valve Gr 12B
***2** : Oil jet Gr 12B
⊗ : Non-reusable parts

CAUTION

Do not remove crankshaft gear 14, check valve *1 or oil jet *2 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
—	Camshaft end play			0.10 to 0.26 {0.003 to 0.010}	0.4 {0.010}	Inspect
2, 18	Main bearing	Oil clearance		[78] 0.03 to 0.09 {[3.07] 0.0012 to 0.0035}	0.15 {0.0059}	Replace
		Free tension		—	less than 82.5 {3.25}	Replace
17	Crankshaft	Bend		0.02 {0.00079} or less	0.05 {0.0020}	Replace
		Pin and journal	Circular accuracy	0.01 {0.00039} or less	0.03 {0.0012}	Correct or replace
			Cylindrical accuracy	0.006 {0.00024} or less	—	Correct or replace
21	Distortion of crankcase top surface			0.07 {0.0028} or less	0.2 {0.0079}	Correct or replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

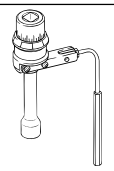
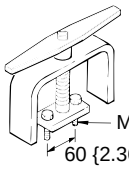
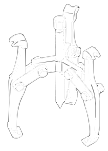
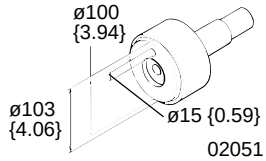
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Main bearing cap mounting)	59 {43, 6}+90°±5°	Wet Reuse up to three times

Lubricant and sealant

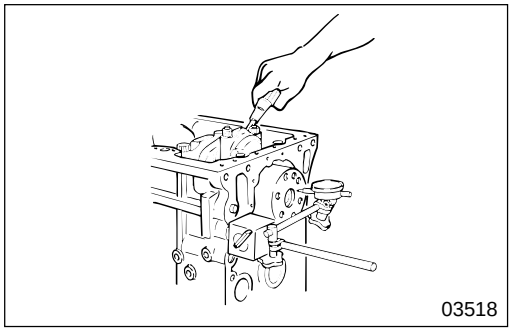
Location	Points of application	Kinds	Quantity
2, 18	Interior of main bearing	Engine oil	As required
9	Pack side seal driving-in groove of rear main bearing	THREEBOND 1207C	As required
11	Side seal tip	THREEBOND 1207C	As required

Special tools

Unit : mm {in.}

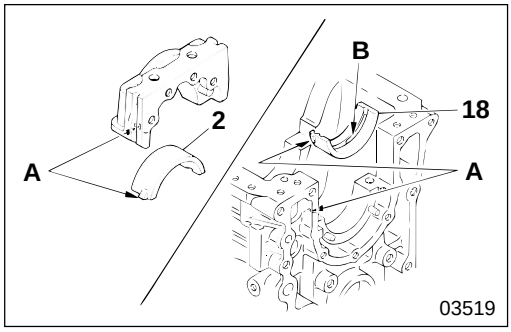
Location	Tool name and shape	Part No.	Application
3 to **9**	Socket wrench  01984	MH061560	Installation of main bearing cap
9	Bearing cap extractor  03516	MH061083	Removal of rear main bearing cap
14	Gear puller  02065	MH061326	Removal of crankshaft gear
16	Rear oil seal slinger installer  02051	MH062677	Installation of rear oil seal slinger

◆ Service procedure



● **Inspection before disassembly**

Crankshaft assembly end play
If the measured value is higher than the limit, replace thrust plates **10** with oversized ones. 🕮 P11B-58
< Available oversize ones >
+0.15, +0.30, +0.45 mm
{+0.0059, +0.012, +0.018 in.}

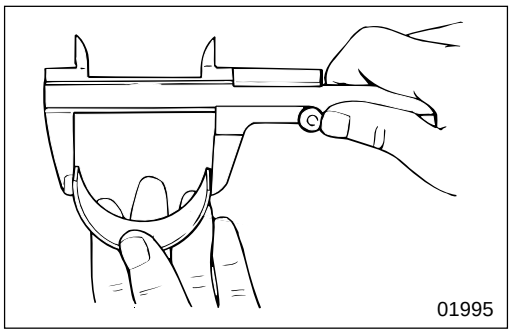


2 **18** **Main bearing**

[Installation]
When installing main bearings **2**, **18**, align lugs **A**.

CAUTION⚠

Be sure to distinguish between main bearings 2, 18. The upper bearing has oil opening B while the lower bearing has no oil opening.



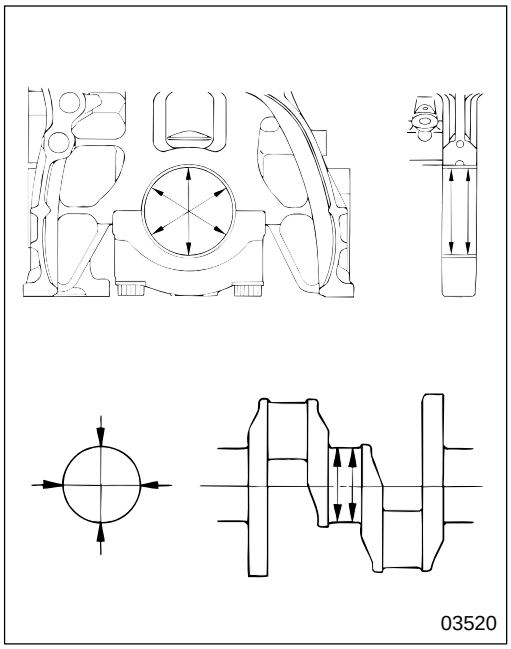
[Inspection]

CAUTION⚠

- **Do not forcibly expand main bearings 2, 18.**
- **Be sure to replace both upper and lower main bearings 2, 18 as a pair when replacement is necessary.**

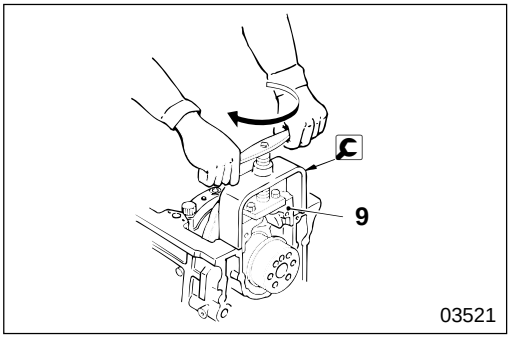
(1) Expansion at free state

If the measured value is lower than the limit, replace main bearings **2**, **18**.



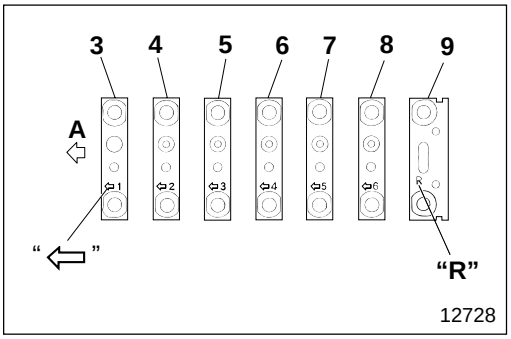
(2) Clearance between main bearing and crankshaft

If the measured value is lower than the limit, replace faulty parts.

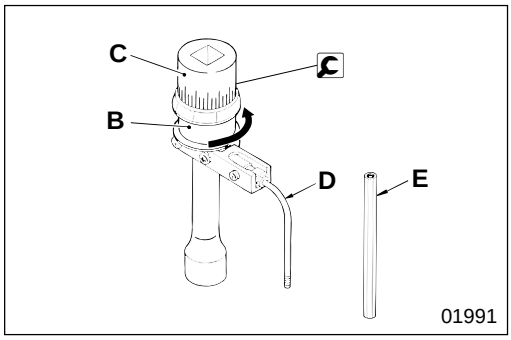


3 to **9** **Main bearing cap**

[Removal]
Use bearing cap extractor to remove rear main bearing cap **9** because side seal **11** is installed between crankcase **21** and the rear main bearing.



[Installation]
- Install main bearing caps **3** to **8** in the direction as illustrated.
  A : Front of engine

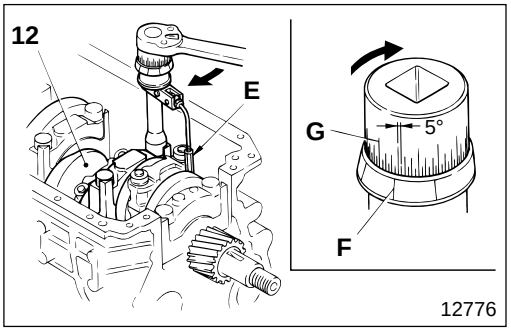


- Center punch the head of bolt **1** before installation.

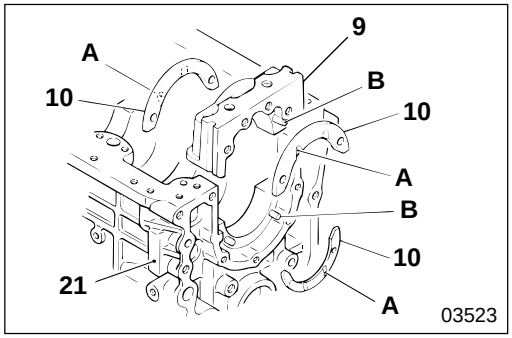
CAUTION⚠

If there are already three center-punch marks, replace the cylinder head bolt with a new one.

- After tightening bolt **1** at specified torque, tighten further as follows:
- Turn socket wrench holder **B** counterclockwise and keep the spring in the wrench compressed.
  C : Socket
  D : Rod
  E : Rod (for connection)



- Set socket wrench holder **B** so that the repercussive force of the spring presses rod **E** (for connection) against crankshaft assembly **12**.
- Select a scale that is convenient for reading graduation **F** on holder **B**.
- Tighten further by turning socket **C** clockwise by 90° (setting is in 5° increments), referring to graduation **G** on the selected scale.
- After installation, check the following points :
  - Crankshaft assembly **12** can be rotated easily by hand.
  - The end play of crankshaft assembly **12**. P11B-56



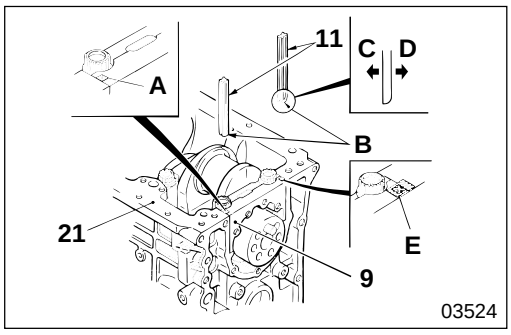
10 **Installation of thrust plate**

Install thrust plates **10** on both ends of rear main bearing **9** and the rear end of crankcase **21** in the direction as illustrated.

A : Oil groove
B : Positioning pin

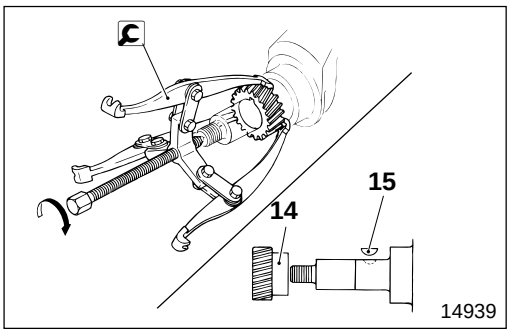
CAUTION

When installing oversized thrust plates 10, mount them on the front and rear of rear main bearing cap 9. It is not necessary that the thrust plates used are all of the same size, but use the same-size-combination of thrust plates for mounting on the rear of crankcase 21 and on the rear of the rear bearing cap.



11 **Installation of side seal**

- Supply sealant in side seal mounting groove **A** of rear main bearing cap **9**.
- Apply sealant at end **B** of side seal **11**.
- Press in side seal **11** between rear main bearing cap **9** and crankcase **21** in the direction as illustrated.
  C : Rear main bearing cap side
  D : Crankcase side
- After pressing in, apply sealant to side seal mounting **E** of rear main bearing cap **9**.



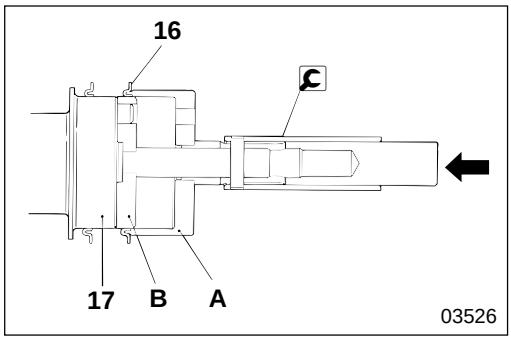
14 **Crankshaft gear**

[Removal]
Never remove crankshaft gear **14** by striking, hitting or hammering it.

[Installation]
Before installing heat up crankshaft gear **14** using a piston heater or similar device to approximately 100°C {212°F}.

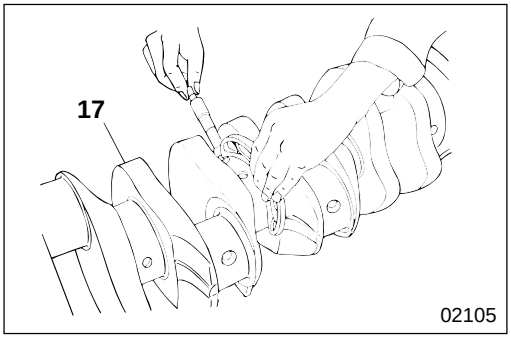
NOTE

Install key 15 to prevent rotation.



16 **Installation of rear oil seal slinger**

Install rear oil seal slinger **16** using oil seal slinger installer. Strike installer **A** until it hits guide **B** positively.

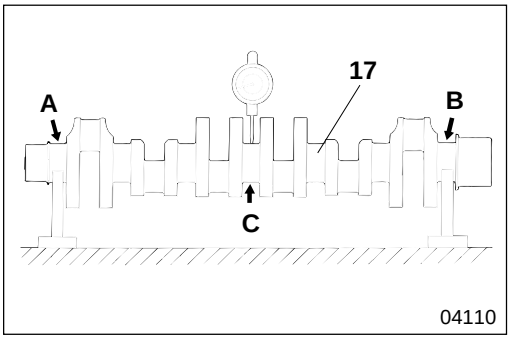


17 Crankshaft

[Inspection]

(1) Cylindrical and circular accuracy of the journal and the pin

If the measured value is higher than the limit, grind and correct crankshaft **17** to convert it to the undersize specifications or replace it.

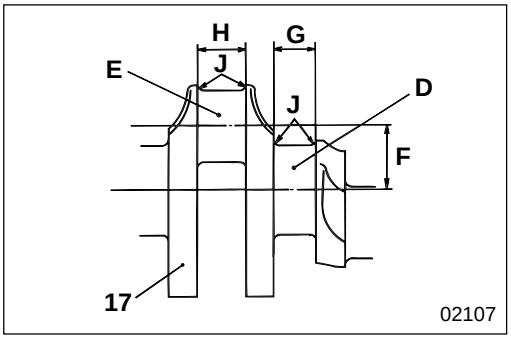


(2) Degree of bend

The degree of bend of crankshaft **17** is measured at No.4 journal **C** by supporting No.1 journal **A** and No.7 journal **B.** If the measured value is higher than the limit, replace the crankshaft.

NOTE

The degree of bend of crankshaft 17 is half of the indicated value of the gauge after rotating the shaft 360°.



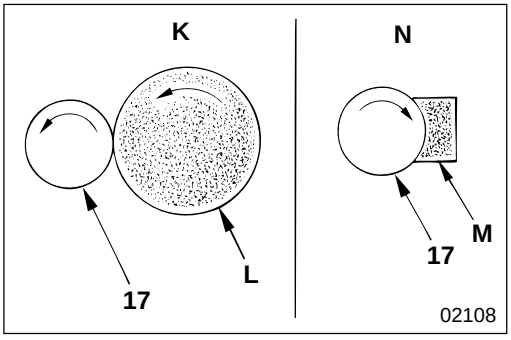
[Correction]

NOTE

Be sure to replace main bearings 2, 18 with those that meet the undersize specifications after crankshaft 17 is corrected by grinding.

- Set **F**, distance between the center line of the journal **D** and that of the pin **E**, constant.
  F : 57.5±0.075 mm {2.26±0.0030 in.}
- Set the width of journal **G** and pin **H** so they are constant.
  G : 35 mm {1.38 in.} (32 mm {1.26 in.} for No.1 journal)
  H : $41\ ^{+0.2}_{0}$ mm
  $\{1.61\ ^{+0.0079}_{0}$ in.$\}$

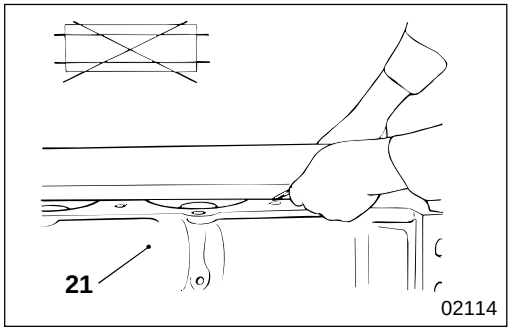
- Finish the fillet **J** smoothly.
  J : R4±0.2 mm {0.0079 in.}
- Check and confirm that there has been no cracking caused by grinding using the magnetic particle inspection method (Magnafluxing).
  Also make sure the surface hardness has not deteriorated (Shore hardness to be maintained at not less than Hs 75).
- When grinding **K**, set crankshaft **17** and grinder **L** so that they both rotate counterclockwise as viewed from the front of the crankshaft.
- To finish grinding **M** using a grindstone or emery paper **N,** rotate crankshaft **17** clockwise.



Undersize specifications of crankshaft

Unit : mm {in.}

	Undersize scales			
	0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finish outer diameter of journal	77.69 to 77.70 {3.058 to 3.059}	77.44 to 77.45 {3.048 to 3.049}	77.19 to 77.21 {3.038 to 3.039}	76.94 to 76.95 {3.0291 to 3.0295}
Finish outer diameter of pin	64.69 to 64.71 {2.546 to 2.547}	64.44 to 64.46 {2.5370 to 2.5377}	64.19 to 64.21 {2.5271 to 2.5279}	63.94 to 63.96 {2.517 to 2.518}
Circular accuracy	0.01 {0.00039} or less			
Cylindrical accuracy	0.006 {0.00024} or less			



21 **Crankcase top surface distortion**

If the measured value is higher than the limit, grind and correct using a surface grinder.

CAUTION⚠

When grinding crankcase 21 be sure that the extent of piston protrusion does not deviate from the standard value.
Piston protrusion : 🕮 P11B-38

MITSUBISHI
FUSO

Group 12A
Lubrication

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-12A

INDEX

SPECIFICATIONS 12A- 2

STRUCTURE AND OPERATION 12A- 4

TROUBLESHOOTING 12A-13

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Oil Filter Replacement 12A-14
- Engine Oil Replacement 12A-15
- Oil Pressure Measurement 12A-16

OIL PAN, OIL STRAINER AND OIL JET 12A-18

OIL PUMP 12A-20

OIL FILTER 12A-24

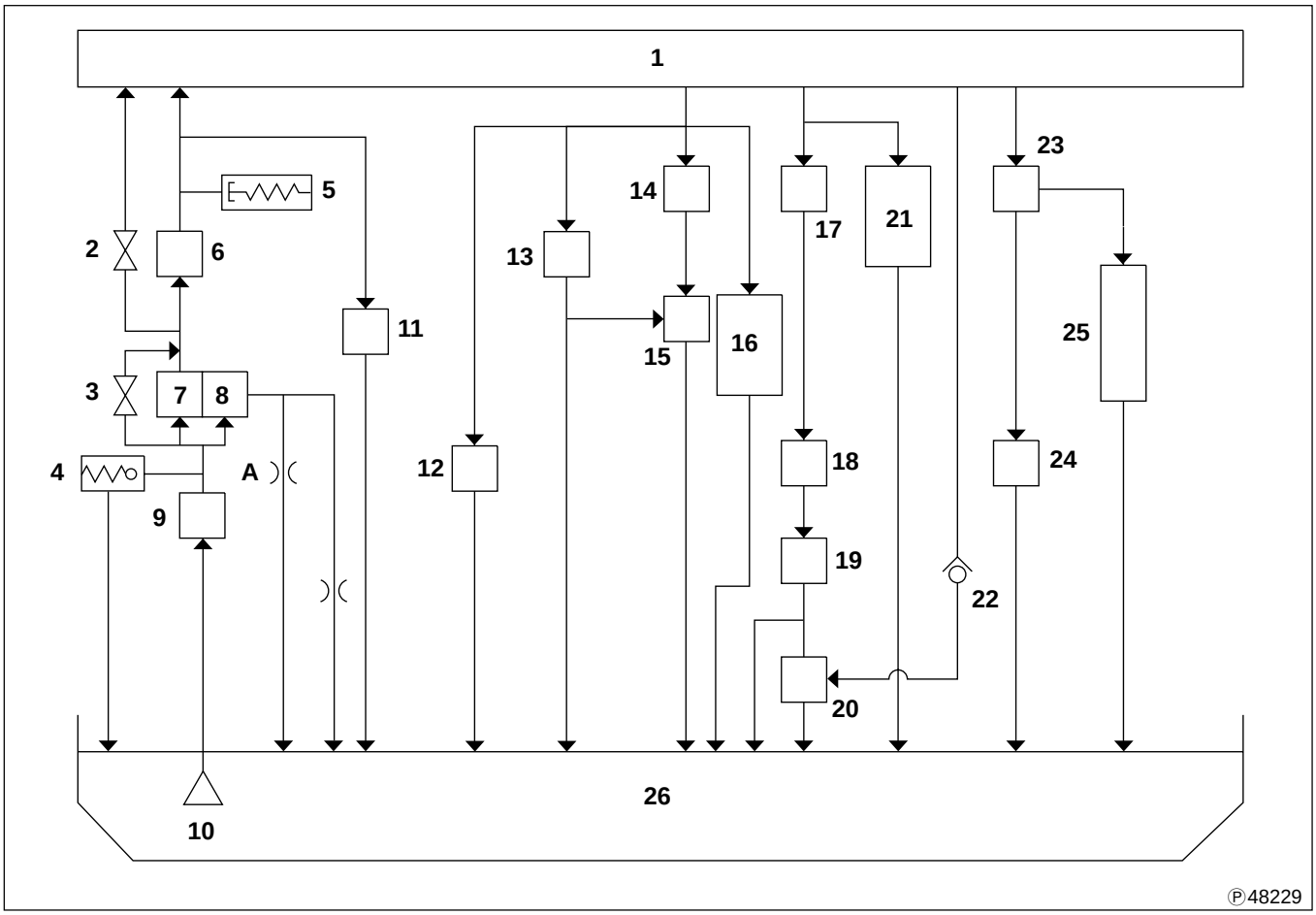
OIL COOLER 12A-26

SPECIFICATIONS

Item			Specifications
Mode of lubrication			Oil pump type
Oil filter type			Paper-filter, spin-on type
Oil cooler type			Shell and plate type (multi-plate type)
Engine oil	Grade		API CD or higher
	Oil quantity	Oil pan	Approximately 9 L {9.5 qts}
		Oil filter	Approximately 1 L {1.1 qts}

M E M O

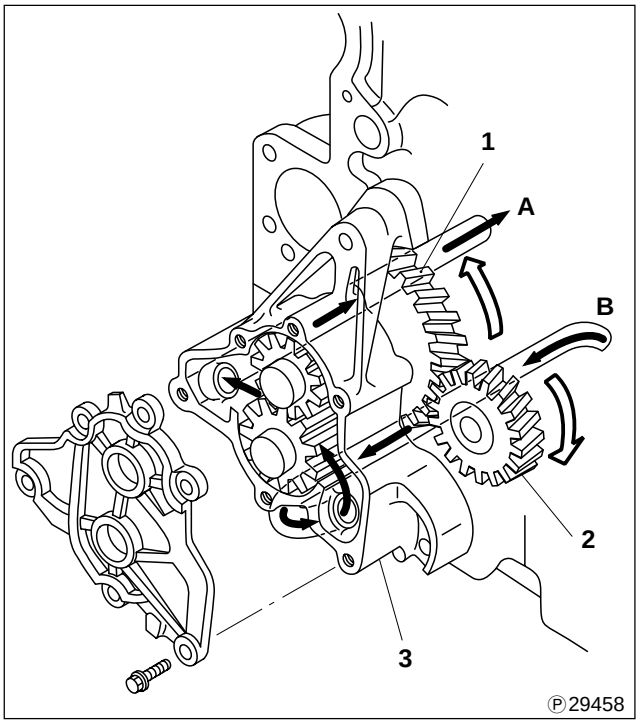
Lubrication System (Oil Flow)



1 Main oil gallery
2 Bypass valve
3 Bypass valve
4 Relief valve
5 Engine oil pressure switch
6 Oil cooler
7 Full-flow oil filter
8 Bypass oil filter
9 Oil pump
10 Oil strainer
11 Turbocharger
12 Vacuum pump gear
13 Vacuum pump
14 Idler bushing
15 Timing gear
16 Balancer bushing LH
17 Crankshaft main bearing
18 Connecting rod bearing
19 Connecting rod bushing
20 Piston
21 Balancer bushing RH
22 Oil jet check valve
23 Rocker bushing
24 Camshaft bushing
25 Rocker roller
26 Oil pan

A : Orifice

Oil Pump

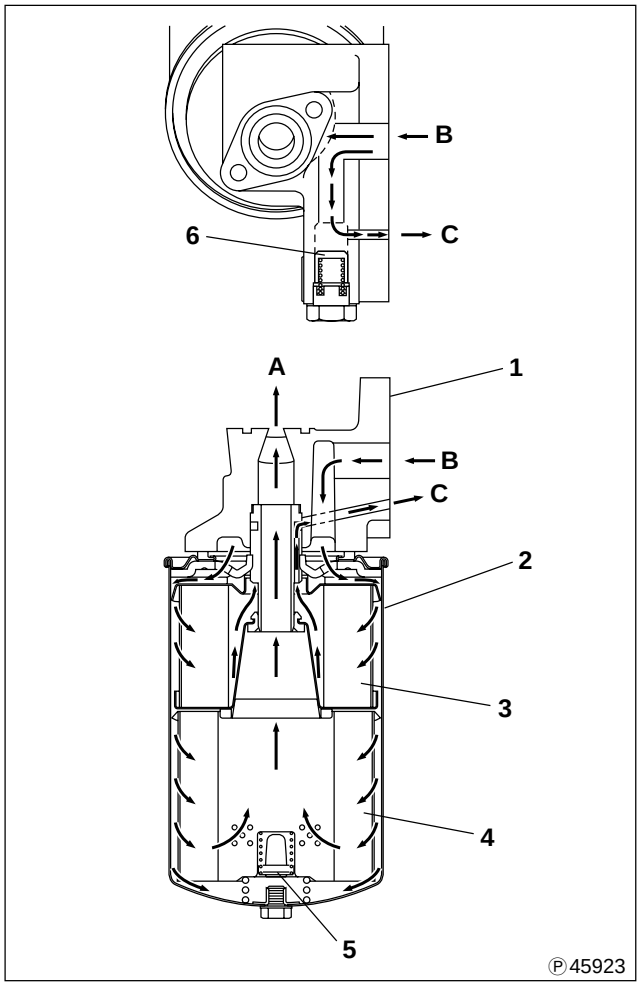


1 Oil pump gear
2 Crankshaft gear
3 Oil pump

A : To oil filter
B : From oil strainer

Oil pump **3** is a gear type. It is driven by rotation of the crankshaft via crankshaft gear **2** and oil pump gear **1**.

Oil Filter

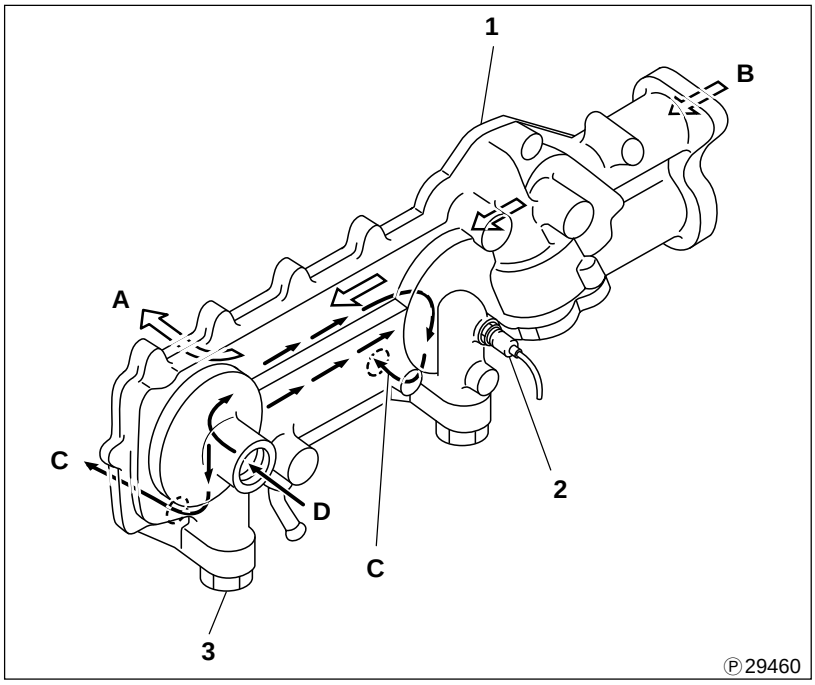


1 Oil filter head
2 Oil filter
3 Bypass filter
4 Full-flow filter
5 Bypass valve
6 Regulator valve

A : To oil cooler
B : From oil pump
C : To oil pan

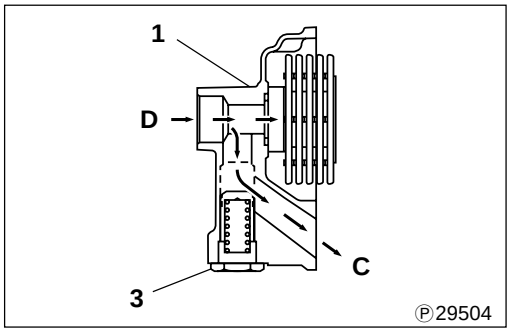
- The oil filter is a spin-on filter-paper type incorporating a bypass filter **3** and a full-flow filter **4**.
  A bypass valve **5** is fitted at the bottom of the filter assembly. If the elements become clogged, the bypass valve opens and allows oil to flow to oil cooler without passing through the elements. This operation prevents seizure of the engine.
- When the pressure of oil going to the main oil gallery exceeds a specified level, regulator valve **6** opens, allowing some of the engine oil to return to the oil pan. The oil pressure is thus constantly regulated.

Oil Cooler



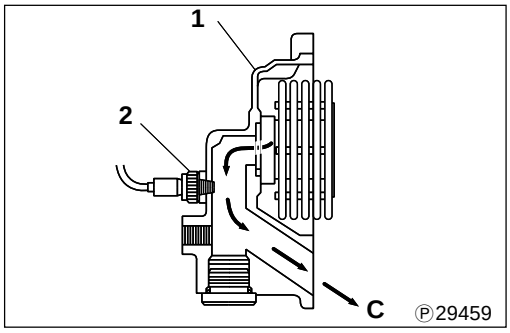
1 Oil cooler
2 Engine oil pressure switch
3 Bypass valve

A : Coolant outlet
B : Coolant inlet
C : To main oil gallery
D : From oil filter



● **Bypass valve**

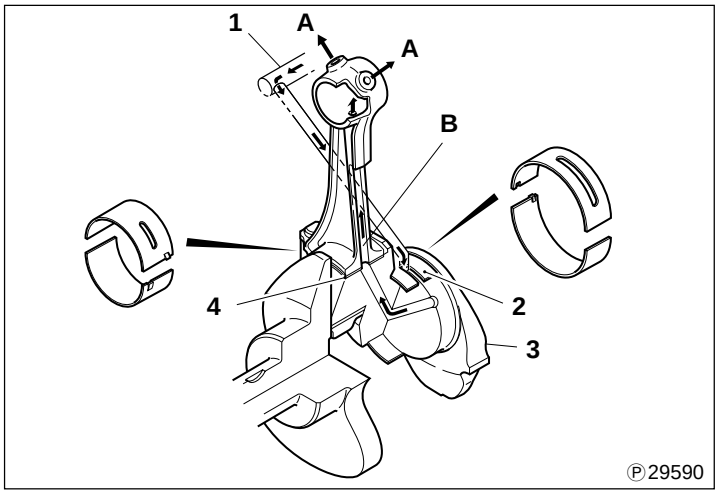
When the oil's viscosity is high at low temperatures or when oil cooler **1** element is clogged and resists the oil's flow, bypass valve **3** opens, thus allowing engine oil to flow to main oil gallery without passing through the cooler.



● **Oil pressure switch**

If the pressure of oil fed to main oil gallery drops below the specified level, electric contacts close inside engine oil pressure switch **2**. As a result, a warning lamp illuminates in the meter cluster to alert the driver.

Lubrication of Related Parts

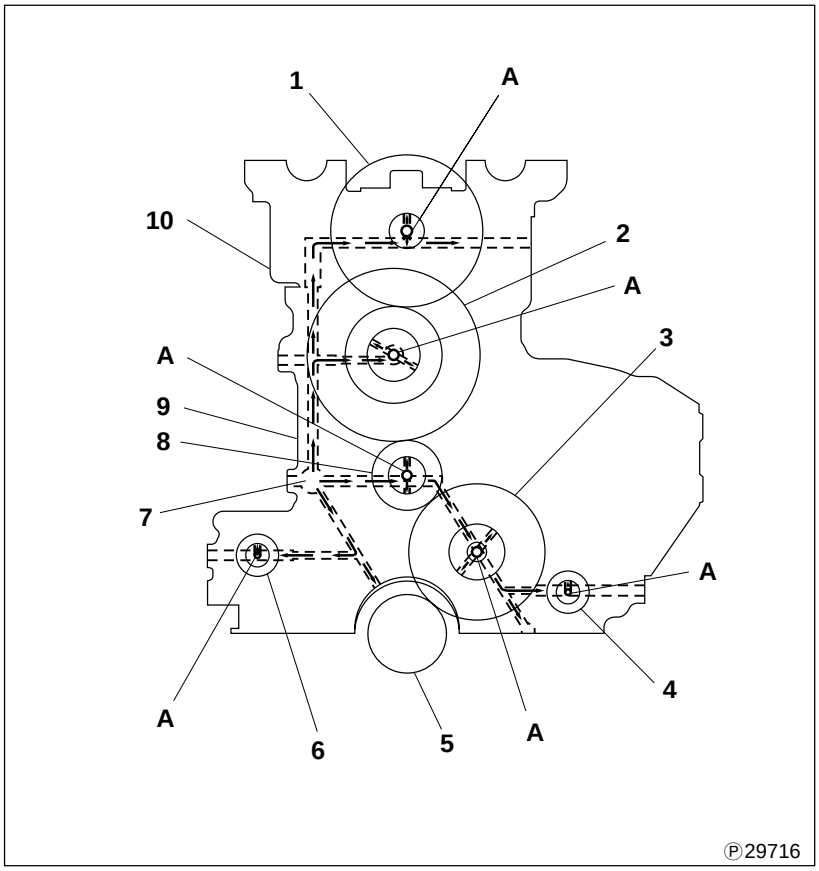


● **Main bearing and connecting rod bearing**

1 Main oil gallery
2 Main bearing
3 Crankshaft
4 Connecting rod bearing

A : Oil jet
B : Connecting rod oil passage

Oil supplied via the oil passage in the crankshaft flows through oil passage **B** in the connecting rod to lubricate the connecting rod's small end. The oil then sprays out from oil jet **A** at the top of the connecting rod to cool the piston.

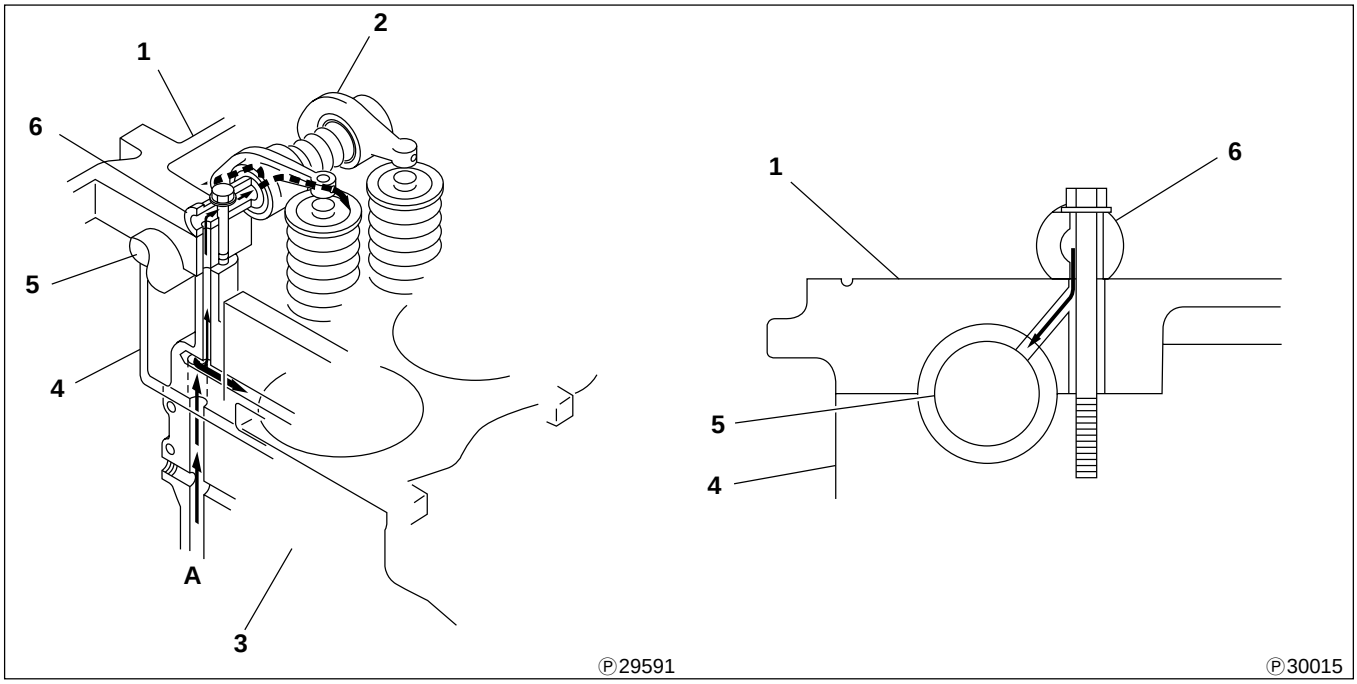


● **Timing gear**

1 Head idler gear
2 Idler gear A, B
3 Idler gear No.1
4 Balanceshaft gear LH
5 Crankshaft gear
6 Balanceshaft gear RH
7 Main oil gallery
8 Fan shaft assembly
9 Upper crankcase
10 Cylinder head

A : Oil hole

Engine oil from main oil gallery **7** passes through upper crankcase **9** and cylinder head **10** to lubricate the journals of the gears. The oil that has lubricated head idler gear **1** sprays out of oil hole in the gear boss and returns to the oil pan through inside the front case while lubricating the gears.

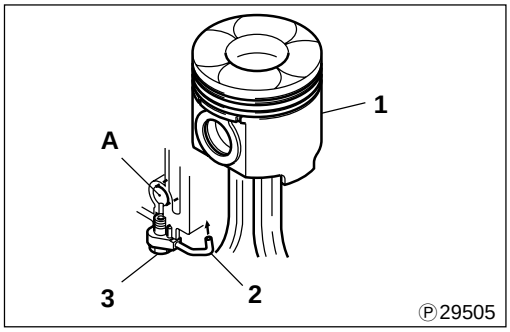


● **Valve mechanism**

1 Camshaft frame
2 Rocker arm
3 Upper crankcase
4 Cylinder head
5 Camshaft
6 Rocker shaft

A : From main oil gallery

Engine oil from main oil gallery **A** passes through upper crankcase **3**, cylinder head **4** and camshaft frame **1** to rocker shaft **6**. Then, the oil flows through the oil passage of rocker shaft and returns to the oil pan while lubricating rocker arm **2** and camshaft **5**.

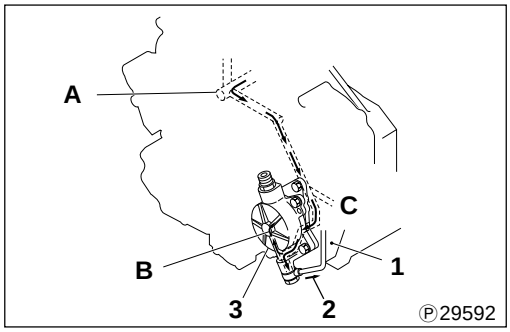


● **Oil jet**

1 Piston
2 Oil jet
3 Check valve

A : Main oil gallery

An oil jet **2** is fitted in the lower part of the main oil gallery **A** for each cylinder. These oil jets cool the pistons **1** by injecting oil into them. Each oil jet is fitted with check valve **3** that opens and closes at specified oil pressure levels. At low engine speeds, these check valves close to maintain the required volume of oil in the lubrication system and prevent reductions in oil pressure.



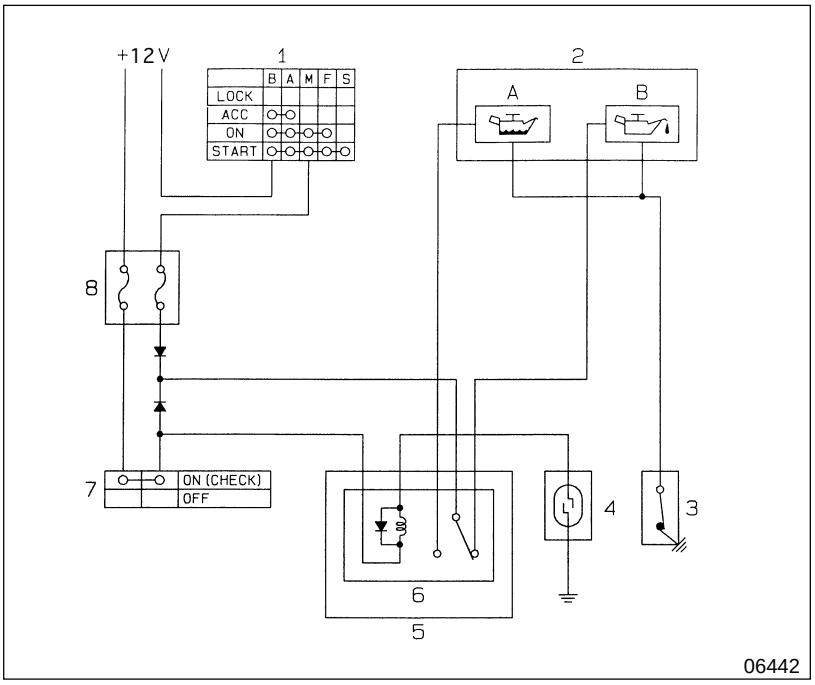
● **Vacuum pump**

1 Front case
2 Oil pipe
3 Vacuum pump

A : Main oil gallery
B : To front case
C : To automatic timer

Engine oil delivered from main oil gallery **A** flows to vacuum pump **3** where it branches into two flows; one is, after lubricating the vanes, discharged into front case **1** from the air vent hole and returns to the oil pan. The other passes through oil pipe **2** to lubricate various parts of the automatic timer and then returns to the oil pan.

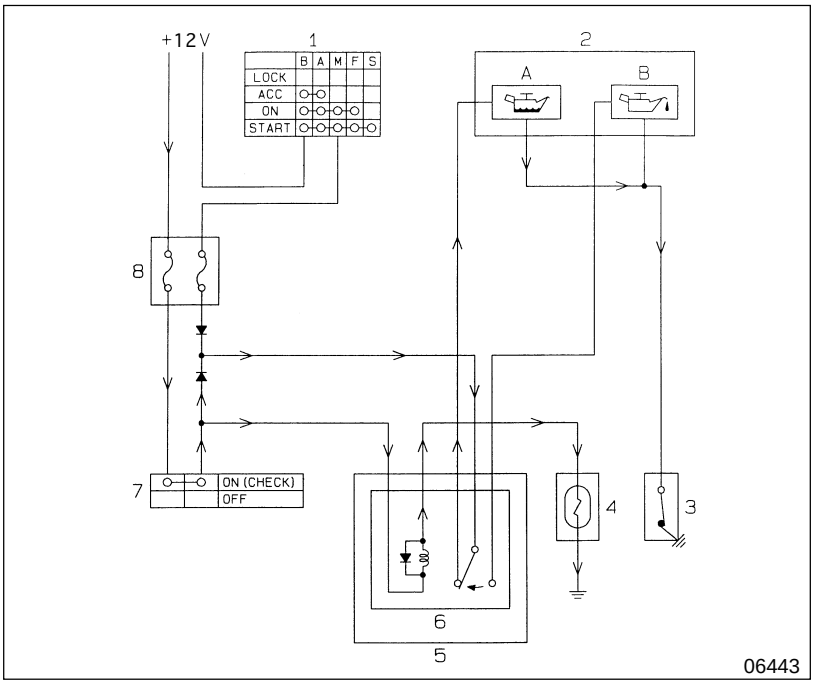
Lubrication System Monitoring Circuit



1 Starter switch
2 Meter cluster
3 Oil pressure switch
4 Oil level sensor
5 Relay box
6 Oil level relay
7 Oil level check switch
8 Fuse box

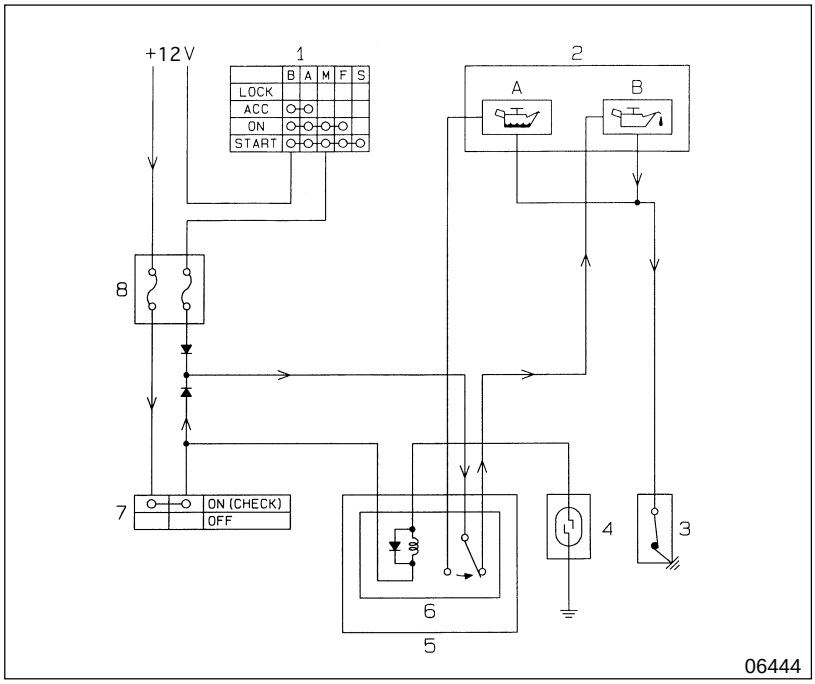
A : Oil level indicator lamp
B : Oil pressure warning lamp

This circuit monitors the lubrication system by detecting the pressure and level of engine oil.



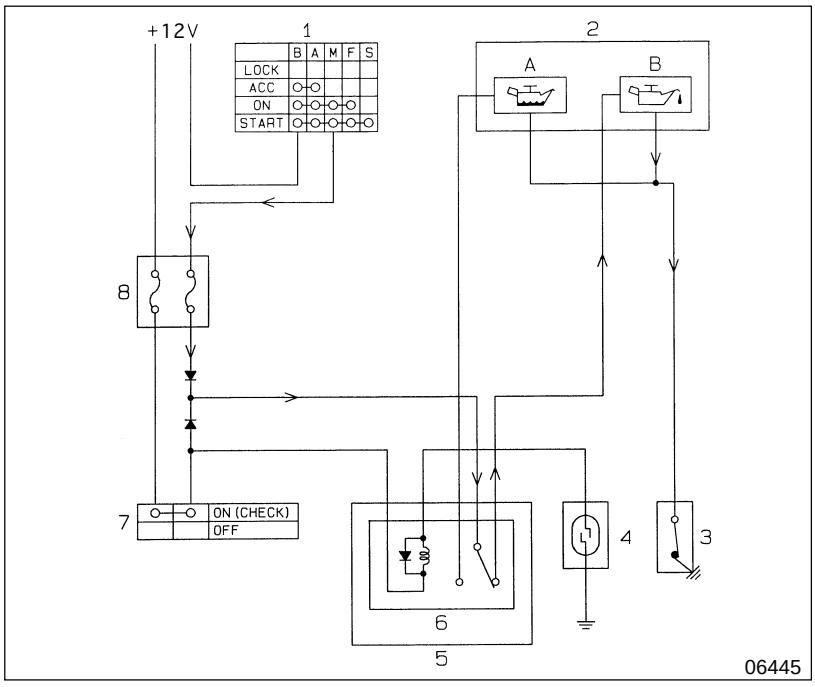
● Oil level normal (oil level sensor ON)
When oil level check switch **7** is turned ON while the engine is not running (oil pressure switch **3** ON), oil level sensor **4** is grounded and therefore oil level relay **6** is energized. This allows current to flow through the route given below and turn on oil level indicator lamp **A**.

Fuse box **8** → oil level check switch **7** → relay box **5**
→ oil level relay **6** → oil level sensor **4** → ground
→ meter cluster **2** → oil level indicator lamp **A**
→ oil pressure switch **3** → ground



● Oil level low (oil level sensor OFF)
Even when oil level check switch **7** is turned ON while the engine is not running (oil pressure switch **3**: ON), oil level relay **6** is not energized because oil level sensor **4** is off. This causes the current to flow through the route given below and turn on oil pressure warning lamp **B**.

Fuse box **8** → oil level switch **7** → Relay box **5** → oil level relay **6** → meter cluster **2** → oil pressure warning lamp **B** → oil pressure switch **3** → ground



● Oil pressure abnormal (oil pressure switch ON)
The oil pressure drops while the engine is running oil pressure switch **3** turns ON. As a result, current flows through the route given below to turn on oil pressure warning lamp **B**. When oil pressure is normal, oil pressure switch **3** remains off and no current flow.

Starter switch **1** → fuse box **8** → relay box **5** → oil level relay **6** → meter cluster **2** → oil pressure warning lamp **B** → oil pressure switch **3** → ground

Possible causes \ Symptoms		Engine hard to start	Overheating	Low oil pressure	Excessive oil consumption (oil leakage)	Remarks
Oil cooler	Oil cooler element installed poorly		○	○	○	
	Gasket defective		○	○	○	
	O-ring defective		○	○	○	
	Oil cooler element clogged		○	○		
	Oil cooler element damaged		○	○	○	
	Fatigue in bypass valve spring		○			
Oil pump	Oil pump malfunctioning		○	○		
	Interference between oil pump gear and oil pump case or cover	○		○		
Oil filter	Oil filter fitted poorly				○	
	Element clogged		○	○		
	Gasket defective			○		
Fatigue in regulator valve spring				○		
Oil strainer installed poorly, clogged			○	○		
Front case installed poorly					○	Gr 11A
Fan shaft front oil seal defective					○	Gr 11A
Crankshaft rear oil seal defective					○	Gr 11A
Piston cooling oil jet(s) defective			○			
Oil working its way up into combustion chamber(s)					○	
Oil working its way down into combustion chamber(s)					○	
Oil viscosity too high		○				
Unsuitable of quality			○			
Deterioration in oil			○			
Fuel mixed with oil			○			

ON-VEHICLE INSPECTION AND ADJUSTMENT

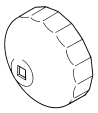
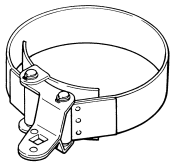
Oil Filter Replacement

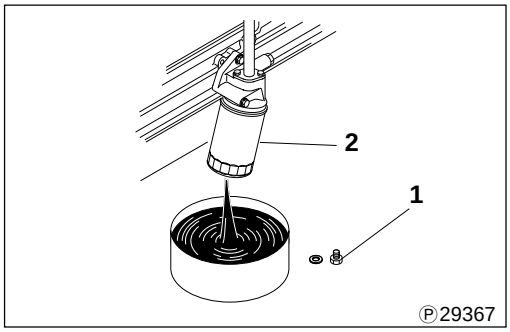
Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Oil filter	Engine oil (API CD or higher)	Approximately 1 L {1.1 qts}

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
—	Oil Filter Element Socket  08550	MH061566	Oil filter removal
	Oil Filter Wrench  ø107 to 120 {ø4.21 to 4.72} 01503	MH063200	



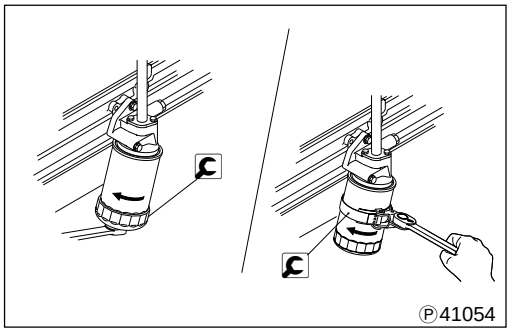
Ⓟ29367

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

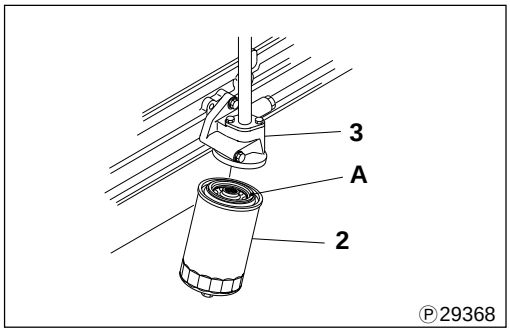
CAUTION ⚠

When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.


Ⓟ41054

Loosen oil filter drain plug **1** to drain the engine oil from inside the filter **2**.
[Removal]

: Oil Filter Element Socket or Filter Wrench



Ⓟ29368

[Installation]

- Clean the surface of oil filter head **3** to which oil filter **2** is fitted.
- Apply a thin coat of engine oil to the gasket A of oil filter **2**.
- Screw oil filter **2** into oil filter head **3** by hand until gasket **A** contacts the oil filter head. Then, tighten oil filter **2** further by giving it a 3/4 turn.
- After installing the oil filter, start the engine and check gasket **A** for oil leakage.
- Check to see if the engine oil level is in the specified range.

Engine Oil Replacement

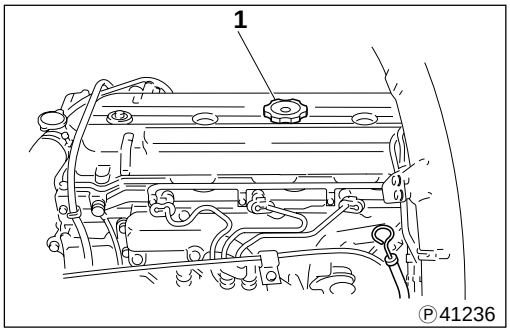
Tightening torques

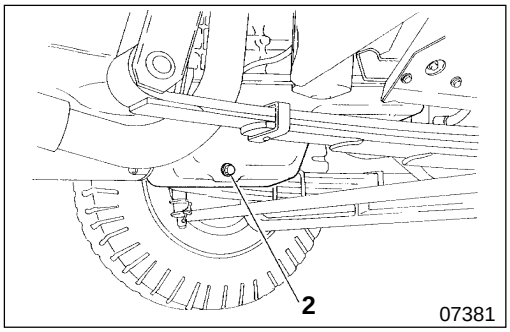
Unit: N·m {ft.lbs, kgf·m}

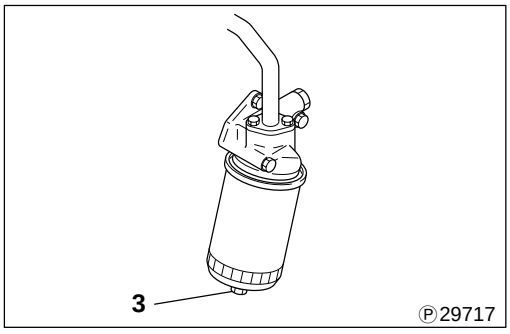
Location	Parts to be tightened	Tightening torque	Remarks
2	Oil pan drain plug	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	—
3	Oil filter drain plug	9.8±1.96 {7.2±1.4, 1.0±0.2}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
—	Oil pan	Engine oil (API CD or higher)	Approximately 9 L {9.5 qts}
—	Oil filter	Engine oil (API CD or higher)	Approximately 1 L {1.1 qts}







WARNING ⚠

- **Wipe up any spilled engine oil since it can cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

CAUTION ⚠

When pouring oil into the engine, take care not to spill any on the V-ribbed belt. Contact with oil could make the V-ribbed belt slip, rendering the cooling system less effective.

[Draining]

- Warm up the engine, then remove oil filler cap **1**.
- Remove oil pan drain plug **2** and oil filter drain plug **3**. Then, drain the engine oil.

[Filling]

Tighten oil pan drain plug **2** and oil filter drain plug **3** to their specified torques. Then, add new engine oil to the specified level.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Oil Pressure Measurement
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Oil pressure (at oil temperature of 158 to 194°F, 70 to 90°C)	At no-load minimum speed	145 kPa {21 psi, 1.5kgf/cm^2}	49 kPa {7.1 psi, 0.5 kgf/cm^2}	Check
		At no-load maximum speed	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm^2}	195 kPa {28 psi, 2 kgf/cm^2}	

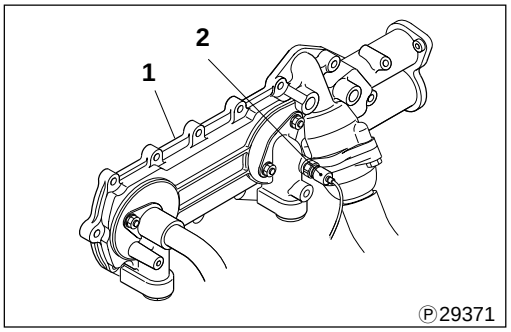
Tightening torque

Unit: N·m {ft.lbs, kgf·m}

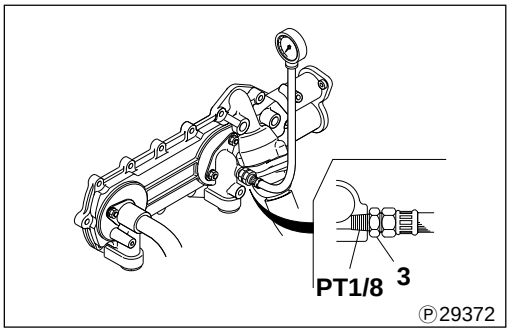
Location	Parts to be tightened	Tightening torque	Remarks
2	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11.0, 0.8 to 1.5}	Check with engine cold

Sealant

Location	Point of application	Specified sealant	Quantity
2	Threaded part of engine oil pressure switch	Teflon tape	3 and half turns



- Remove engine oil pressure switch **2** from oil cooler **1**.



- Fit adapter **3** onto the engine oil pressure switch **2** mounting, then fit the oil pressure gauge onto the adapter.
- Warm up the engine until the oil temperature reaches 158 to 194°F (70 to 90°C).
- Measure the oil pressure at no-load minimum speed and at no-load maximum speed. If the measured values are below the specified standard values, overhaul the lubrication system.
- After taking measurements, fit oil pressure switch **2** and tighten it to the specified torque.

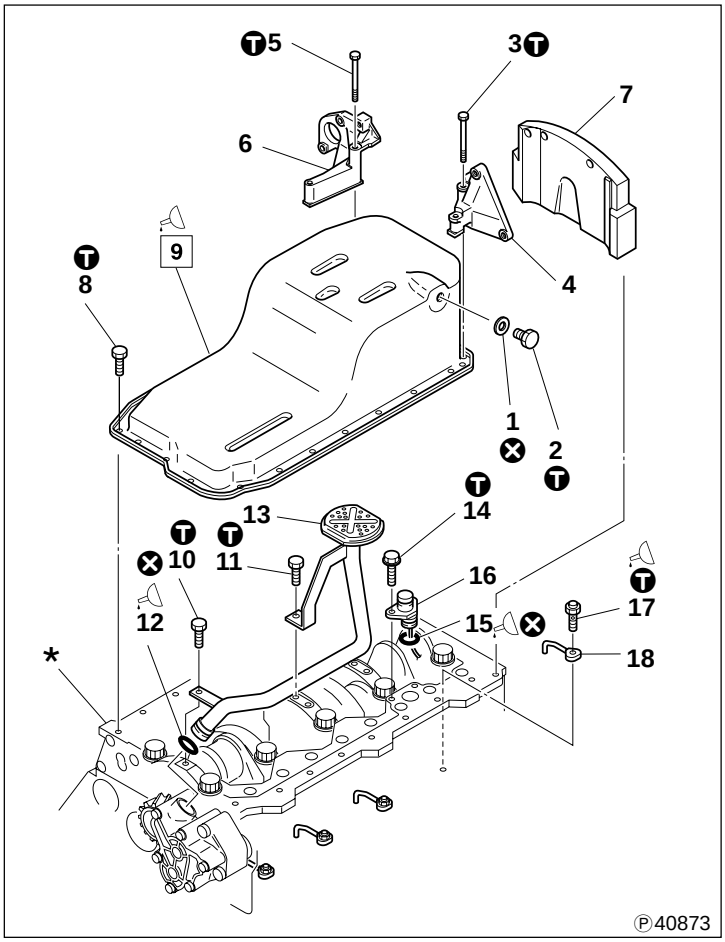
CAUTION ⚠

Oil pressure switch 2 must be fitted when the engine is cold.

Inspection of oil pressure switch
Gr 54

M E M O

OIL PAN, OIL STRAINER AND OIL JET



● **Disassembly sequence**

1 Gasket
2 Oil drain plug
3 Bolt
4 Stiffner RH
5 Bolt
6 Stiffner LH
7 Rubber spacer
8 Bolt
9 Oil pan
10 Bolt
11 Bolt
12 O-ring
13 Oil strainer
14 Bolt
15 O-ring
16 Engine oil level sensor Gr 54
17 Check valve
18 Oil jet

***** : Crankcase Gr 11A
⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Do not tighten check valve 17 in excess of the specified torque. Excessive tightness can cause defective operation, resulting in scorching of the engine.

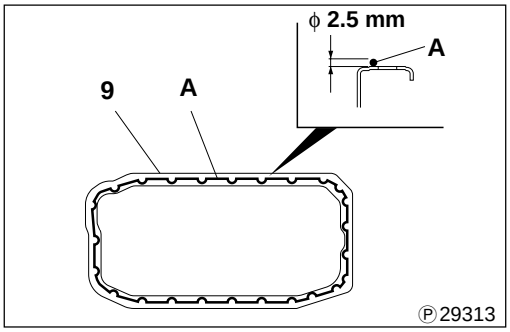
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Oil drain	34.3 to 43.1 {25 to 32, 3.5 to 4.4}	—
3	Bolt (spacer stay RH mounting)	23.5 {17.3, 2.4}	—
5	Bolt (spacer stay LH mounting)	23.5 {17.3, 2.4}	—
8	Bolt (oil pan mounting)	23.5 {17.3, 2.4}	—
10	Bolt (oil strainer mounting)	23.5 {17.3, 2.4}	—
11	Bolt (oil strainer mounting)	23.5 {17.3, 2.4}	—
14	Bolt (engine oil level sensor mounting)	23.5 {17.3, 2.4}	—
17	Check valve	29.4 {22, 3.0}	Wet

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Crankcase mounting surface of oil pan	Threebond 1207C	As required
12, 15	Entire circumference of O-ring	Engine oil	As required
17	Threads of check valve	Engine oil	As required



◆ Service procedure

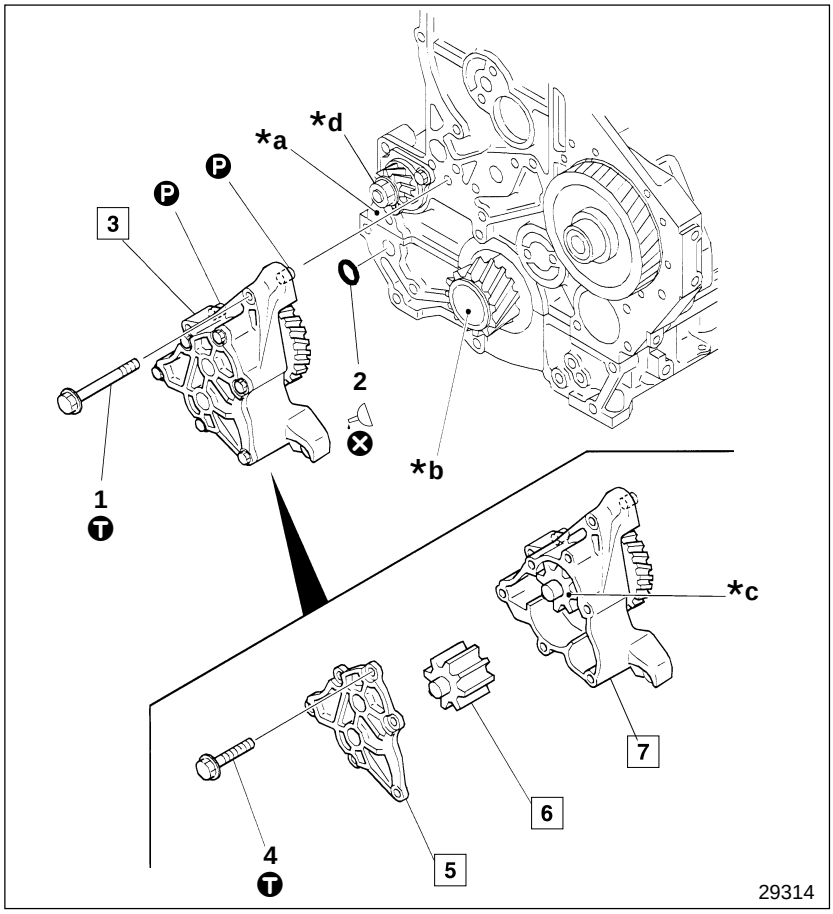
9 **Fitting oil pan**

- Apply sealant **A** to the mounting surface of oil pan **9** as illustrated. Apply the sealant evenly and without breaks.
- Within three minutes of applying sealant **A**, fit oil pan **9** onto the crankcase*.

CAUTION ⚠

- **Clean the oil pan mounting surface and ensure it is free of oily substances before applying sealant.**
- **Carefully mount oil pan exactly in the correct position. Ensure that sealant A does not spread to other areas.**
- **After fitting oil pan 9, wait at least one hour before starting the engine.**
- **Reapply sealant A to the oil pan mounting surface whenever the mounting bolts 8 of oil pan 9 have been loosened.**

OIL PUMP



● **Disassembly sequence**

1 Bolt
2 O-ring
3 Oil pump assembly
4 Bolt
5 Oil pump cover
6 Driven gear assembly
7 Oil pump case assembly

***a :** Crankcase Gr 11A
***b :** Crankshaft gear
***c :** Drive gear
***d :** Balanceshaft gear RH
P : Locating pin (Bushing)
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value (Basic diameter in[ ])	Limit	Remedy
—	Backlash between oil pump gear and crankshaft gear Gr 11A	0.12 to 0.15 {0.0047 to 0.0059}	0.3 {0.012}	Replace
—	Backlash between oil pump gear and balanceshaft gear Gr 11A	0.19 to 0.22 {0.0075 to 0.0087}	0.3 {0.012}	Replace
5, 6, 7	Clearance between gear shaft and oil pump case and cover	[20 {0.79}] 0.04 to 0.075 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
5, *C	Clearance between gear shaft and oil pump cover	[20 {0.79}] 0.04 to 0.075 {0.0016 to 0.0028}	0.15 {0.0059}	Replace
6, 7, *C	Difference between height of each gear and depth of oil pump case	0.040 to 0.094 {0.0016 to 0.0035}	0.15 {0.0059}	Replace
	Clearance between tooth tips of each gear and oil pump case	0.13 to 0.22 {0.0051 to 0.0087}	0.23 {0.0091}	Replace

T Tightening torques

Unit: N·m {ft.lbs, kgf·m}

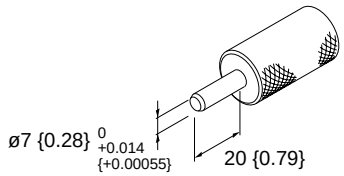
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (oil pump assembly mounting)	27.4 {20, 2.8}	—
4	Bolt (oil pump cover mounting)	8.2±2.46 {5.8±1.8, 0.8±0.25}	—

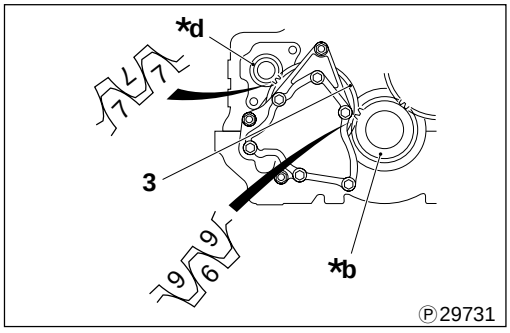
Sealant

Location	Points of application	Specified sealant	Quantity
—	Oil pump gears	Engine oil	As required
2	Entire circumference of O-ring	Engine oil	As required

Special tools

Unit: mm {in.}

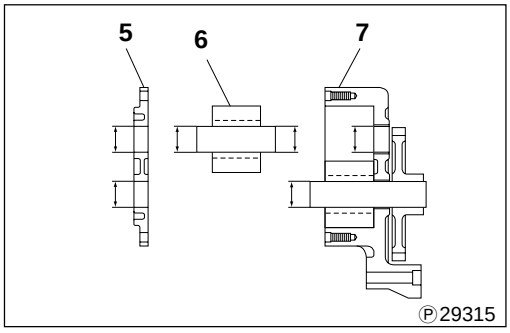
Location	Tool name and shape	Part No.	Application
5	Pump Cover Pin 	MH063431	Oil pump cover installation



◆ Service procedure

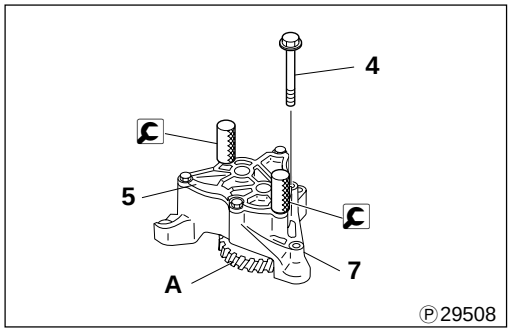
3 Installation of oil pump assembly

- With No. 1 cylinder set at its top dead center, position crankshaft gear ***b**.
- Install oil pump assembly **3** while meshing its gear with crankshaft gear ***b** and balance shaft gear RH ***d** at the match marks "**6**" and "**7**" as shown.



5 to 7 Inspection of oil pump cover, driven gear assembly and oil pump case assembly

Measure the clearance between each gear shaft and oil pump case assembly **7** or cover **5**. Replace the oil pump assembly if any measurement is out of specification.

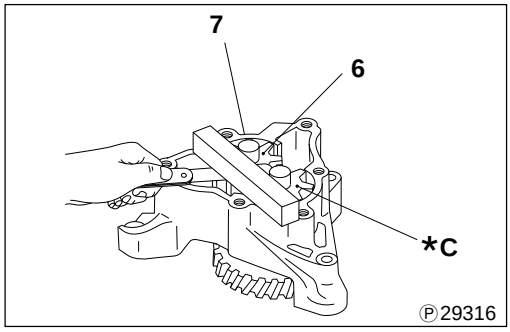


5 **7** **Installation of oil pump cover and oil pump case assembly**

- Position oil pump cover **5** on oil pump case assembly **7** using two 🔧 Pump Cover Pins.
- Fit bolt **4** and tighten it to the specified torque.
- Remove 🔧 Pump Cover Pins, then fit other bolts **4** and tighten them to the specified torque.

CAUTION ⚠

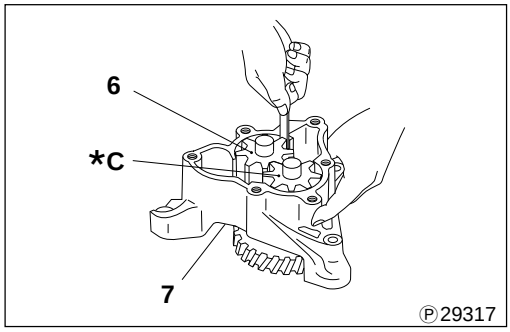
- **Before assembly, apply engine oil to various parts. Pour approximately 5 cm³ {0.3 Cu.in.} of engine oil into the assembly from the oil outlet before installing to the engine.**
- **After assembly, turn the oil pump gear A by hand and check that it rotates smoothly. If the gear does not rotate smoothly, disassemble and reassemble the components.**



6 **7** **Inspection of driven gear assembly and oil pump case assembly**

(1) Differences between gear heights and oil pump case depth

Replace the oil pump assembly if the measurement is out of specification.

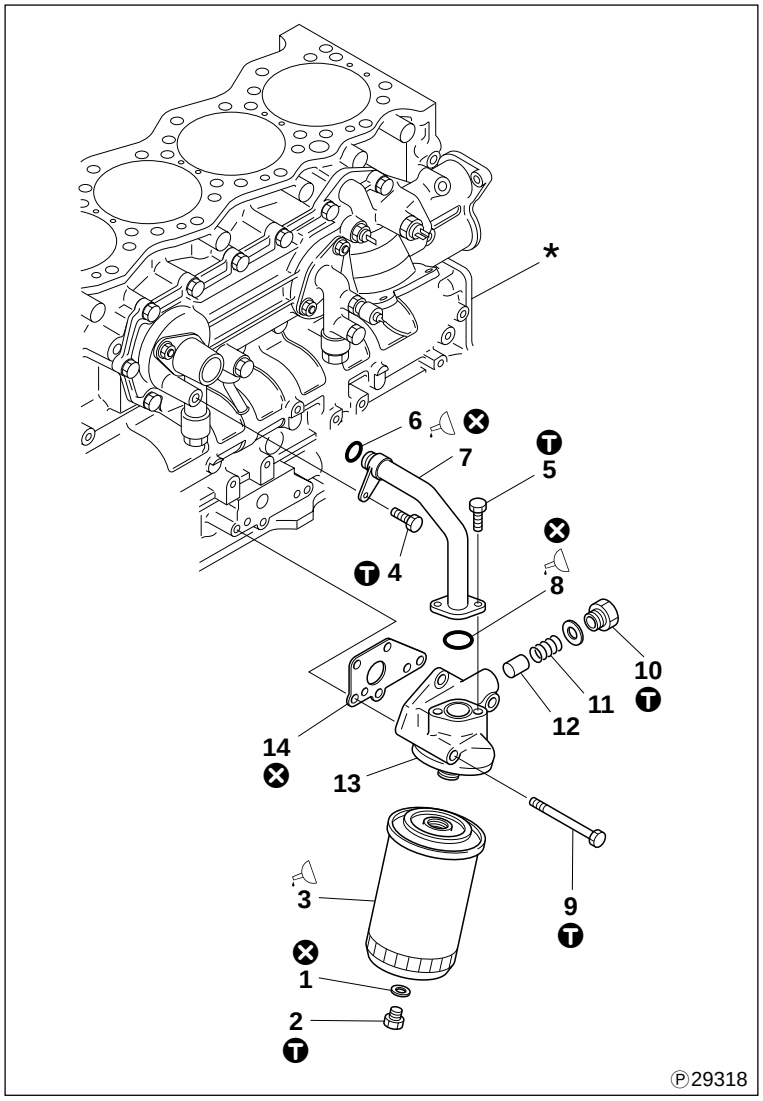


(2) Clearance between gear teeth tip and oil pump case

Replace the oil pump assembly if the measurement is out of specification.

M E M O

OIL FILTER



● **Disassembly sequence**

1 Gasket
2 Oil drain plug
3 Oil filter P12A-14
4 Bolt
5 Bolt
6 O-ring
7 Oil pipe
8 O-ring
9 Bolt
10 Plug
11 Spring
12 Regulator valve
13 Oil filter head
14 Gasket

***** : Crankcase Gr 11A
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Wipe up any spilled engine oil since it may cause a fire.**
- **Do not touch oil when the engine is hot since it can inflict severe burns.**

CAUTION ⚠

- **When pouring oil into the engine, take care not to spill any on the V-ribbed belts. Contact with oil could make the V-ribbed belts slip, rendering the cooling system less effective.**
- **Fit gasket 14 in right direction. If installed in wrong direction, it blocks oil hole.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
12	Regulator valve opening pressure	$600\ ^{+100}_{0}$ kPa {$85\ ^{+14.2}_{0}$ psi, $6\ ^{+1}_{0}$ kgf/cm^2}	—	Replace spring

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

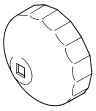
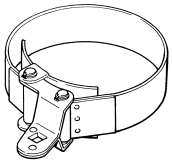
Location	Parts to be tightened	Tightening torque	Remarks
2	Oil drain plug	9.8±1.96 {7.2±1.4, 1.0±0.2}	—
4	Bolt (Oil pipe mounting)	9.8 {7.2, 1.0}	—
5	Bolt (Oil pipe mounting)	23.5 {17, 2.4}	—
9	Bolt (Oil filter head mounting)	44.1 {33, 4.5}	—
10	Plug (Regulator valve mounting)	60 {43, 6.0}	—

Lubricant

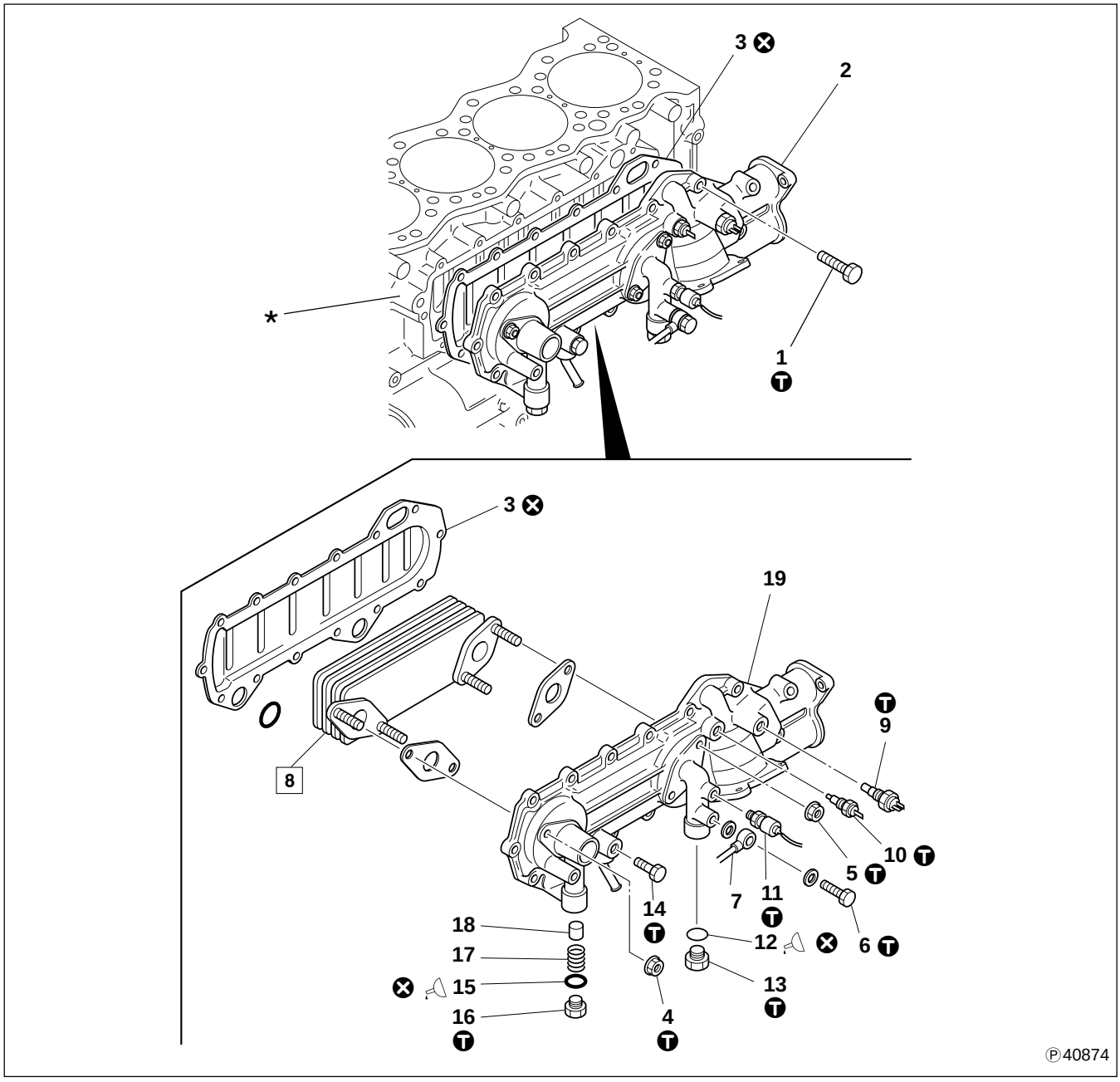
Location	Points of application	Specified lubricant	Quantity
3	Gasket of oil filter	Engine oil	As required
6, 8	Entire circumference of O-ring	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
3	Oil Filter Element Socket  08550	Obtain Locally	Oil filter removal
	Filter Wrench  ø107 to 120 {4.21 to 4.72} 01503	Obtain Locally	

OIL COOLER



● **Disassembly sequence**

1 Bolt
2 Oil cooler assembly
3 Gasket
4 Nut
5 Nut
6 Eyebolt
7 Oil pipe
8 Oil cooler element
9 Coolant temperature sensor (for engine control)
Gr 54
10 Coolant temperature sensor (for MUTIC)
Gr 54
11 Engine oil pressure switch
Gr 54
12 O-ring
13 Plug
14 Water drain valve
15 O-ring
16 Plug
17 Spring
18 Bypass valve
19 Oil cooler body

***** : Crankcase Gr 11A
⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
8	Oil cooler element air leakage (air pressure of 980 kPa {140 psi, 10 kgf/cm^2} for 15 seconds)	0 cm^3 {0 Cu.in.}	—	Replace
18	Bypass valve opening pressure	390 kPa {57 psi, 4 kgf/cm^2}	—	Replace spring

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Oil cooler assembly mounting)	23.5 {17, 2.4}	—
4	Nut (Oil cooler element mounting)	24.5±5 {18±3.6, 2.5±0.5}	—
5	Nut (Oil cooler element mounting)	24.5±5 {18±3.6, 2.5±0.5}	—
6	Eyebolt (Oil pipe mounting)	21.6 {16, 2.2}	—
9	Coolant temperature sensor	34.3 {25, 3.5}	—
10	Coolant temperature sensor	34.3 {25, 3.5}	—
11	Engine oil pressure switch	7.8 to 14.7 {5.8 to 11.0, 0.8 to 1.5}	—
13	Plug	34.5±5 {25±3.6, 3.5±0.5}	—
14	Water drain valve	19.5 to 29.5 {14 to 22, 2.0 to 3.0}	—
16	Plug	34.3±4.9 {25±3.6, 3.5±0.5}	—

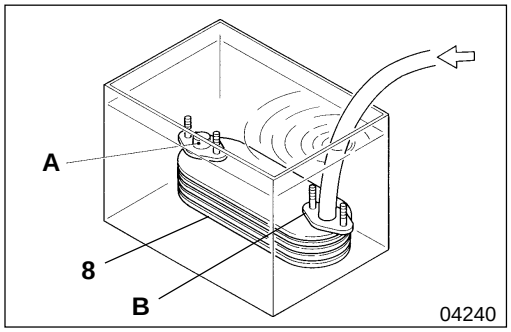
Lubricant

Location	Points of application	Specified lubricant	Quantity
12, 15	Entire circumference of O-ring	Engine oil	As required

◆ Service procedure

● Cleaning

- Check whether carbon deposits or sludge have accumulated in the oil passage of oil cooler element **8** or in the oil cooler's bypass arrangement. Remove any deposits with cleaning solvent.
- Clean out any water scale or fur that has accumulated in the oil cooler element **8** or oil cooler body **19**.



8 **Inspection of oil cooler element**

- Plug outlet **A** of oil cooler element **8** and connect a hose to the oil inlet **B**. Then, immerse the oil cooler element in a tank of water.
- Apply an air pressure of 980 kPa {140 psi, 10 kgf/cm^2} via the hose and check that no air leaks from the oil cooler element **8**.
- If any air leaks, replace the oil cooler element **8**.

MITSUBISHI
FUSO

Group 12B

Lubrication

< 6D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-12B

INDEX

SPECIFICATIONS 12B- 2

STRUCTURE AND OPERATION 12B- 3

TROUBLESHOOTING 12B-11

ON-VEHICLE INSPECTION AND ADJUSTMENT

- **Replacement of Oil Filter 12B-12**
- **Replacement of Engine Oil 12B-13**
- **Measurement of Oil Pressure 12B-14**

OIL PAN, OIL STRAINER AND OIL JET 12B-16

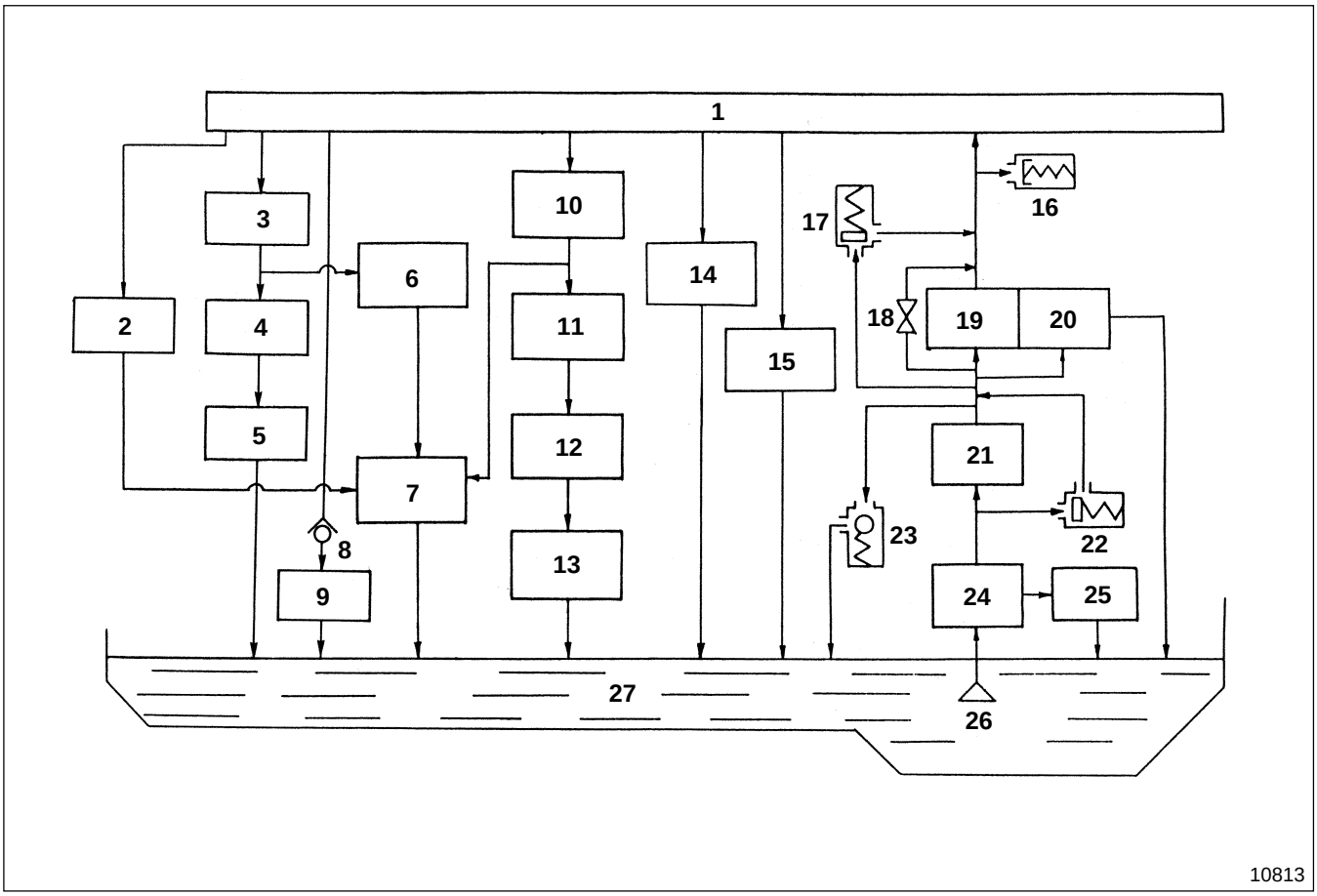
OIL PUMP 12B-18

OIL COOLER AND OIL FILTER 12B-22

SPECIFICATIONS

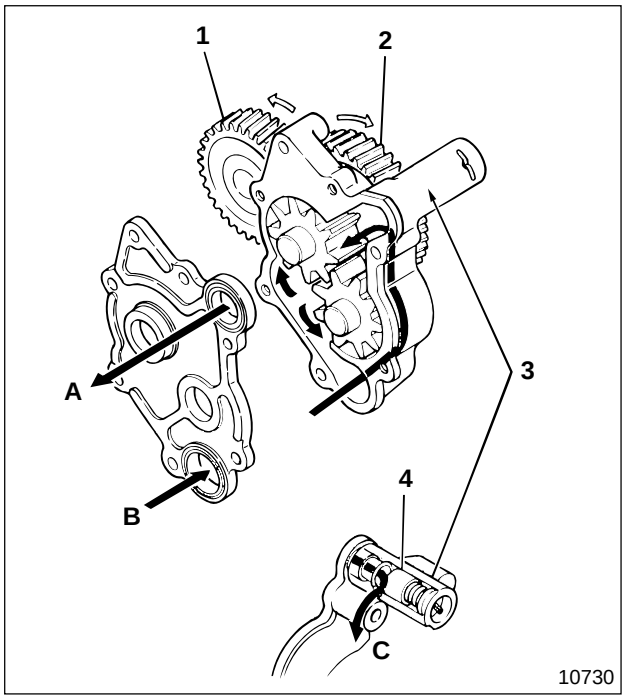
Item			Specifications
Mode of lubrication			Oil pump type
Oil filter type			Spin-on filter paper type
Oil cooler type			Shell and plate type (Multiple-plate type)
Engine oil	Grade		Grade CD or above as per API classification
	Quantity of oil L {qts}	Oil pan	Approximately 9.5 {10}
		Oil filter	Approximately 1 {1.1}

Lubrication System (Flow of Oil)



1 Main oil gallery
2 Air compressor
3 Crankshaft main bearing
4 Connecting rod bearing
5 Connecting rod busing
6 Idler gear bushing
7 Timing gear
8 Check valve for oil jet
9 Piston
10 Camshaft bushing
11 Rocker bushing
12 Push rod
13 Tappet
14 Injection pump
15 Turbocharger
16 Engine oil pressure switch
17 Engine oil bypass alarm switch
18 Bypass valve (Built-in within oil pump)
19 Full-flow filter element
20 Bypass filter element
21 Oil cooler
22 Bypass valve
23 Regulator valve
24 Oil pump
25 Relief valve (Built-in within oil pump)
26 Oil strainer
27 Oil pan

Oil Pump

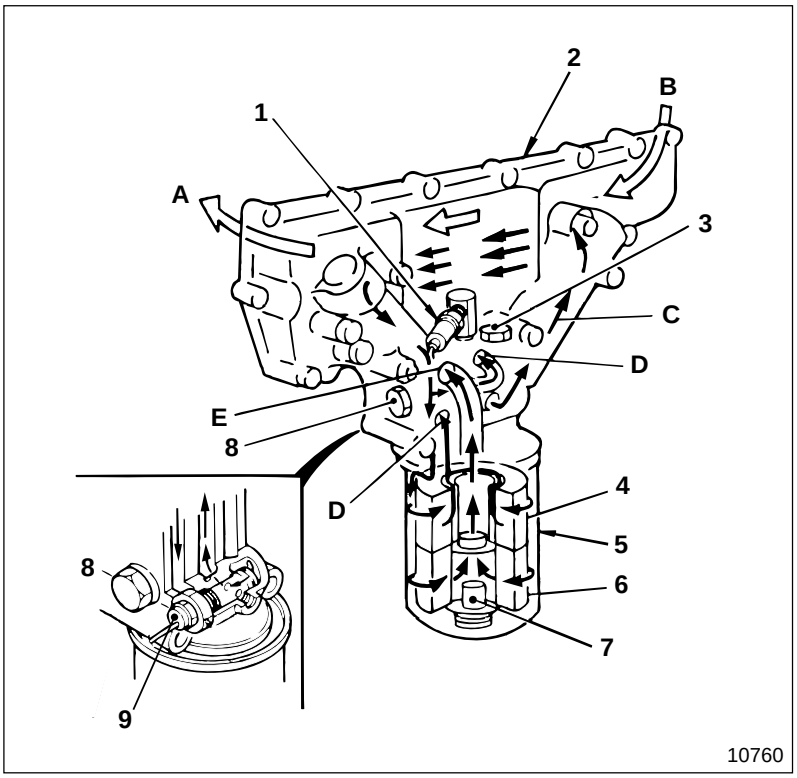


1 Crankshaft gear
2 Oil pump gear
3 Oil pump
4 Relief valve

A : To oil cooler
B : From oil strainer
C : To oil pan

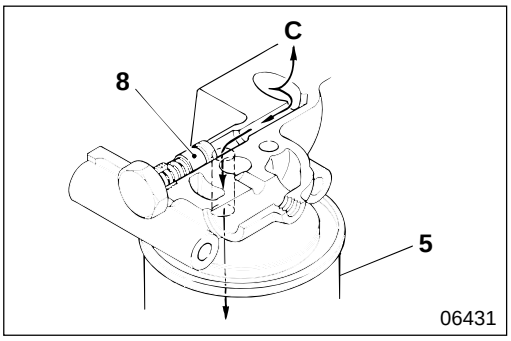
Oil pump **3** is a gear type, driven by rotation of the crankshaft transmitted by crankshaft gear **1** that engages oil pump gear **2**. Relief valve **4** is installed on the oil pump and when the oil pump discharge pressure becomes higher than the standard pressure level, part of the engine oil is returned to the oil pan by relief action of the valve, protecting the lubricating system from breakdown caused by excessive oil pressure.

Oil Cooler and Oil Filter



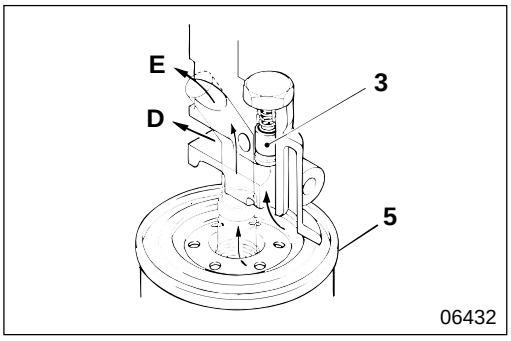
1 Engine oil pressure switch
2 Oil cooler
3 Regulator valve
4 Bypass filter element
5 Oil filter
6 Full-flow filter element
7 Bypass valve
8 Bypass valve
9 Engine oil bypass alarm switch

A : Coolant exit port
B : Coolant entry port
C : To oil cooler
D : To oil pan
E : To main oil gallery



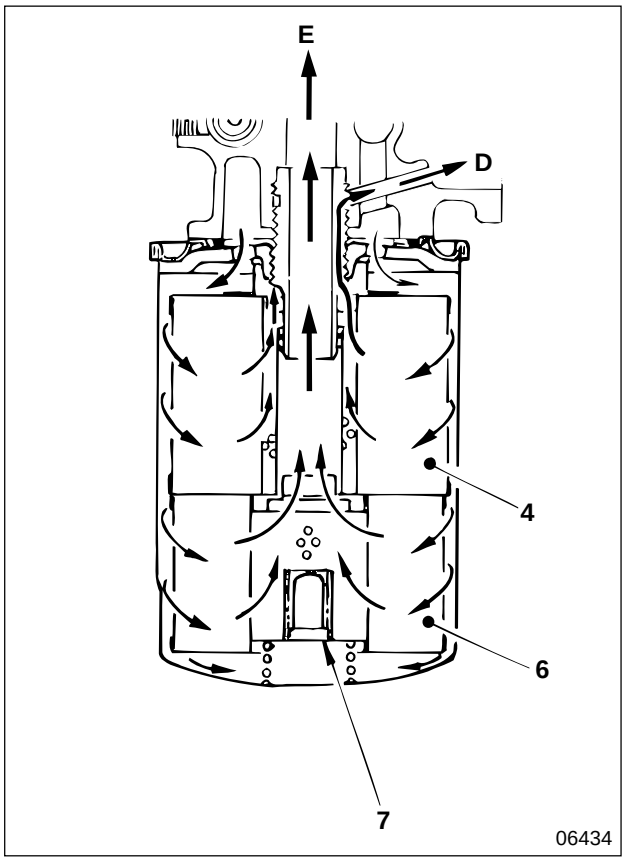
Operation of bypass valve

When the viscosity of the engine oil is high at low temperatures, or when oil cooler **2** element is clogged, flow resistance is high, and if this happens, bypass valve **8** opens to let the engine oil return directly to oil filter **5** without going through the oil cooler.



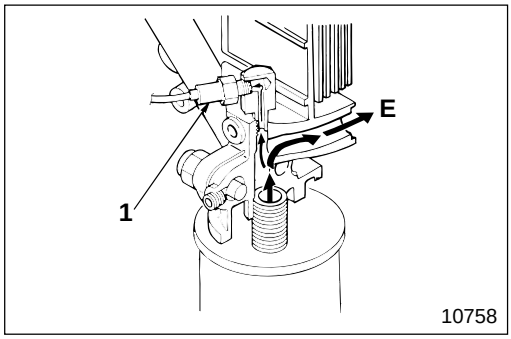
Operation of regulator valve

When the oil pressure in the main oil gallery becomes higher than standard, regulator valve **3** opens to let part of the oil return to oil pan **D**, thereby regulating the oil pressure.



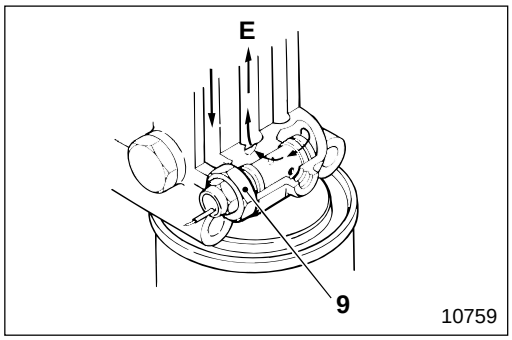
● **Oil filter element**

This oil filter uses a spin-on, filter paper type element, that integrates full-flow filter element **6** and bypass filter element **4**. When the filter element is clogged, bypass valve **7**, installed at the base of the filter, opens to let the oil bypass the element and flow directly to main oil gallery **E**, preventing engine seizure.



Operation of engine oil pressure switch

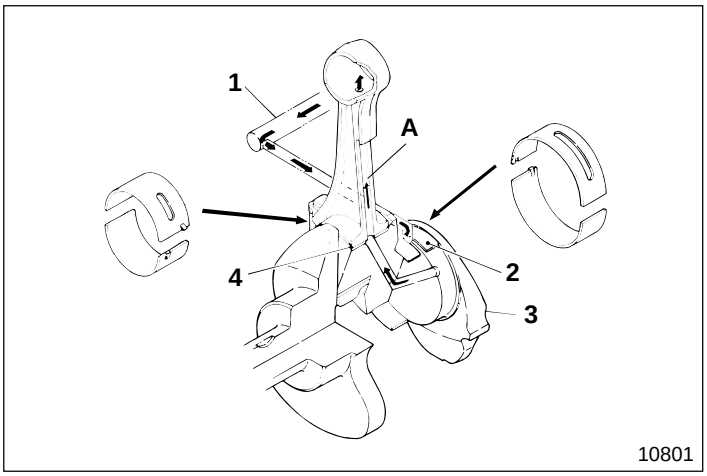
When pressure for delivering the oil to main oil gallery **E** becomes lower than standard, the built-in electric contact point of engine oil pressure switch **1** closes to light warning lamp in the meter cluster, warning the driver that the oil pressure is abnormal.



Operation of engine oil bypass alarm switch

- When the oil filter element is clogged, the engine oil level becomes low and might cause seizure of engine parts, engine oil bypass alarm switch **9** is installed to prevent this.
- When the oil filter element is clogged, engine oil bypass alarm switch **9** lets the oil flow directly to main oil gallery **E**, bypassing full-flow filter element **6**. When the engine oil bypass alarm switch is activated it lights the warning lamp, warning the driver that the oil filter element is clogged.

Lubrication of Related Parts

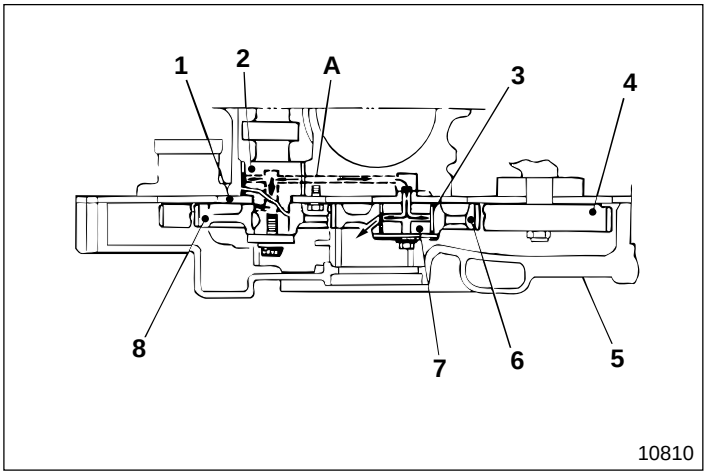


● **Main bearing and connecting rod bearing**

1 Main oil gallery
2 Main bearing
3 Crankshaft
4 Connecting rod bearing

A : Connecting rod oil passage

Engine oil supplied through the oil passage drilled in crankshaft **3** flows through connecting rod oil passage **A** to lubricate the small end of the connecting rod.

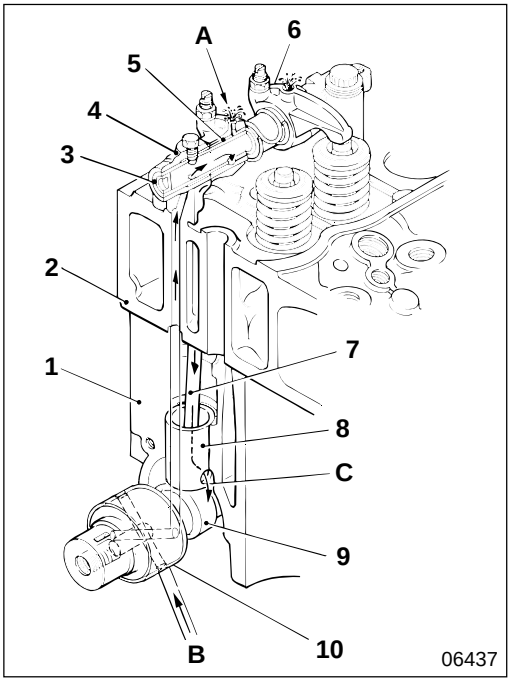


● **Timing gear**

1 Thrust plate
2 Camshaft
3 Idler gear bushing
4 Air compressor gear
5 Timing gear case
6 Idler gear
7 Idler shaft
8 Camshaft gear

A : From main oil gallery

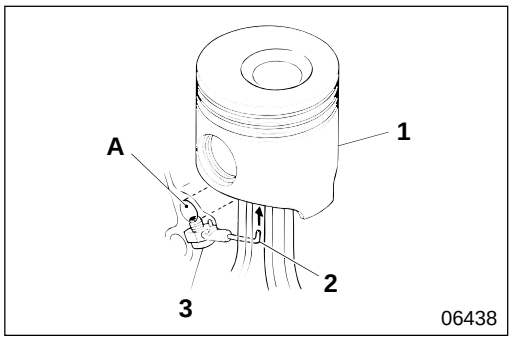
Engine oil from main oil gallery **A** flows through the inside of camshaft **2** and idler shaft **6** and lubricates each gear.



● **Valve mechanism**

1 Crankcase
2 Cylinder head
3 Rocker shaft
4 Rocker shaft bracket
5 Rocker bushing
6 Rocker
7 Push rod
8 Tappet
9 Camshaft
10 No. 1 camshaft bushing

A : Rocker oil hole
B : From main oil gallery
C : To oil pan

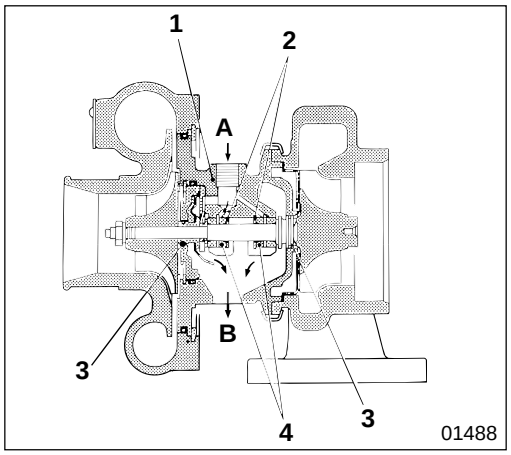


● **Oil jet**

1 Piston
2 Oil jet
3 Check valve

A : Main oil gallery

An oil jet **2** is installed, in the lower part of main oil gallery **A**, for each cylinder and cools piston **1** by injecting engine oil toward the inside of the piston. The oil jet is fitted with check valve **3** which opens and closes at standard oil pressure levels. This prevents a decrease of oil volume at low oil pressure as well as a decrease of oil pressure itself.

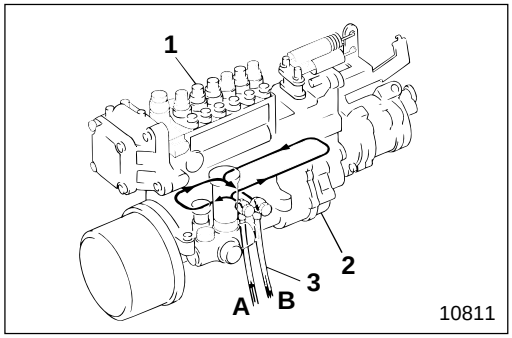


● **Turbocharger**

1 Bearing housing
2 Snap ring
3 Piston ring
4 Bearing

A : From main oil gallery
B : To oil pan

Engine oil is delivered from the main oil gallery to bearing housing **1** through the oil pipe to lubricate bearing **4**. Piston ring **3** installed at both ends of the turbine wheel shaft works as an oil seal.

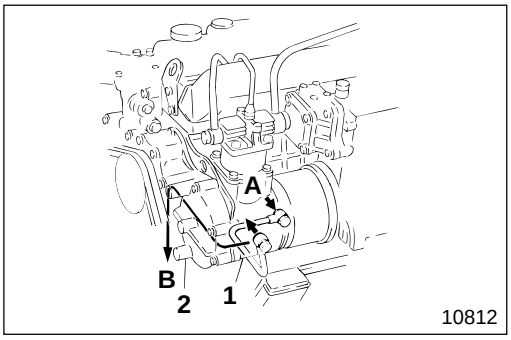


● **Injection pump**

1 Injection pump
2 Governor
3 Oil return pipe

A : From main oil gallery
B : To oil pan

Engine oil that has lubricated injection pump **1** and governor **2** returns to the oil pan through oil return pipe **3**.



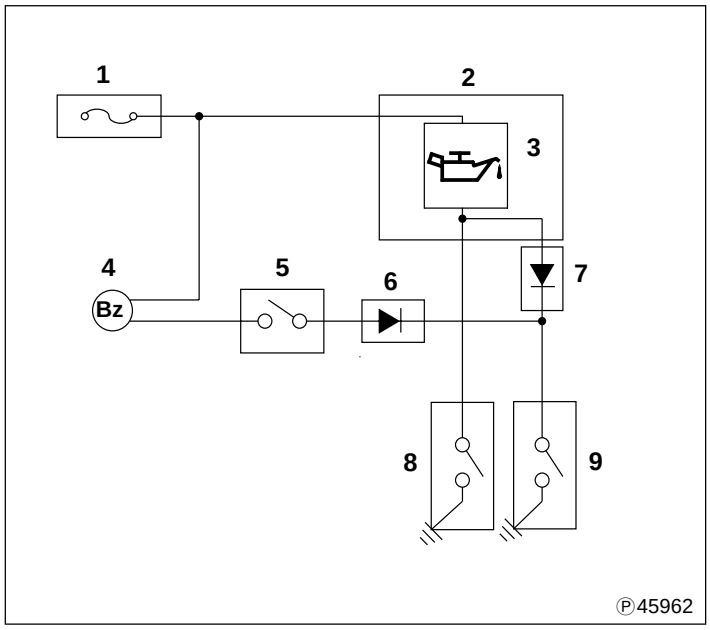
● **Air compressor**

1 Air compressor
2 Timing gear case

A : From main oil gallery
B : To oil pan

Engine oil from the main oil gallery lubricates the inside of air compressor **1** and returns to the oil pan through timing gear case **2**.

Lubrication System Electric Circuit



1 Fuse box
2 Meter cluster
3 Engine oil pressure/clogged oil filter warning lamp
4 Warning buzzer
(Buzzer does not work when parking brake is engaged.)
5 Parking brake switch
6 Diode
7 Diode
8 Engine oil bypass alarm switch
9 Engine oil pressure switch

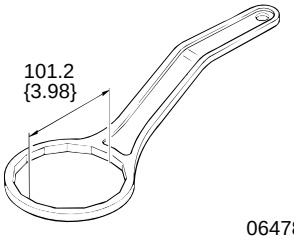
Possible causes / Symptoms		Engine hard to start	Overheating	Oil pressure low	Oil consumption excessive (Oil leakage)	Remarks
Oil cooler	Oil cooler element installation faulty		○	○	○	
	Gasket faulty		○	○	○	
	O-ring faulty		○	○	○	
	Oil cooler element clogged		○	○		
	Oil cooler element damaged		○	○	○	
	Bypass valve spring fatigued		○			
	Regulator valve spring fatigued			○		
Oil pump	Malfunctioning		○	○		
	Oil pump gear interfering with oil pump case or cover	○		○		
	Relief valve spring fatigued			○		
Oil filter	Installation faulty				○	
	Element clogged		○	○		
	Gasket faulty			○		
Oil strainer installation faulty or clogged			○	○		
Crankshaft front oil seal faulty					○	Gr 11B
Crankshaft rear oil seal faulty					○	Gr 11B
Timing gear case installation faulty					○	Gr 11B
Oil jet for piston cooling faulty			○			
Oil working its way up into combustion chamber					○	
Oil working its way down into combustion chamber					○	
Oil viscosity too high		○				
Oil quality unsuitable			○			
Oil deteriorated			○			
Fuel mixed with oil			○			

ON-VEHICLE INSPECTION AND ADJUSTMENT

Replacement of Oil Filter

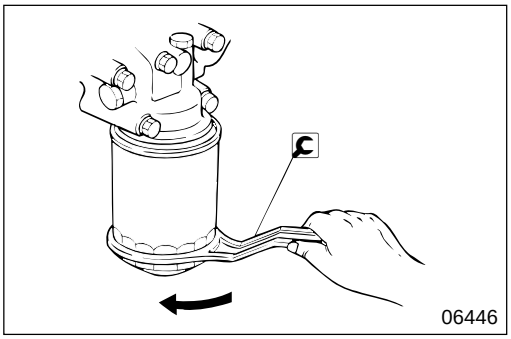
Special tools

Unit : mm {in.}

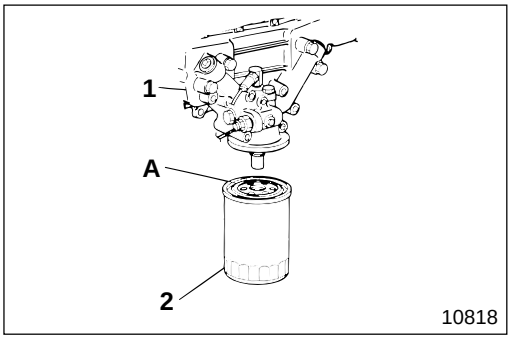
Location	Tool name and shape	Part No.	Application
2	Oil filter wrench  06478	MH061587	Removal of oil filter

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**
- **When replacing oil filter 2, take care not to spill oil on the V-belt.**



[Removal]



[Installation]

- Clean the surface of oil cooler body **1** that makes contact with oil filter **2**.
- Apply engine oil thinly and evenly to gasket area **A** of oil filter **2**.
- Screw in oil filter **2** to oil cooler body **1** until gasket area **A** sits on the body. From this position, tighten further by rotating by five eighths of a turn.
- After installation, run the engine and check that there is no oil leakage from gasket area **A**.
- Check the oil level and if it is low, top it up.

Replacement of Engine Oil

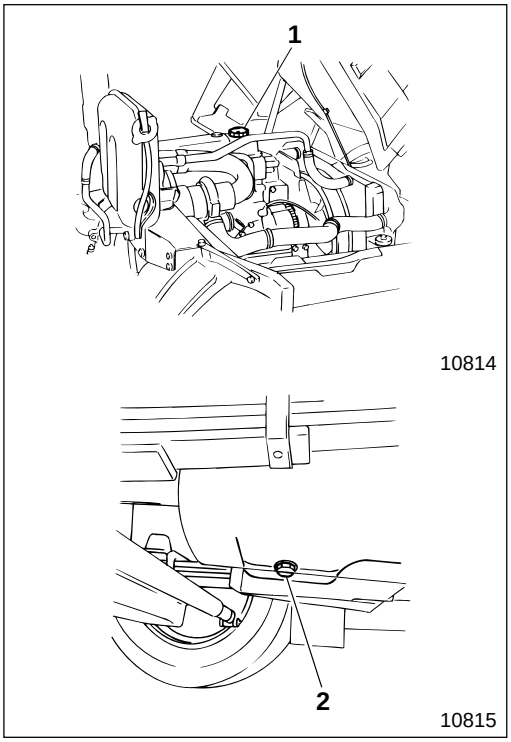
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Oil pan drain plug	69 {51, 7}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	Oil pan	Engine oil (Grade CD or above as per API Classification)	Approximately 9.5 L {10 qts}
—	Oil filter	Engine oil (Grade CD or above as per API Classification)	Approximately 1 L {1.1 qts}



[Draining]
After warming-up the engine, remove oil filler cap **1** and remove drain plug **2** of the oil pan and drain the engine oil.

[Refilling]
Tighten drain plug **2** of the oil pan at specified torque and fill with the specified quantity of engine oil.

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**
- **When replacing engine oil take care not to spill oil on the V-belt.**

ON-VEHICLE INSPECTION AND ADJUSTMENT

Measurement of Oil Pressure

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Oil pressure (Oil temperature 70 to 90°C {158 to 194°F})	At no-load minimum revolution	145 kPa {21 psi, 1.5 kgf/cm^2}	49 kPa {7.1 psi, 0.5 kgf/cm^2}	Inspect
		At no-load maximum revolution	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm^2}	195 kPa {28 psi, 2 kgf/cm^2}	

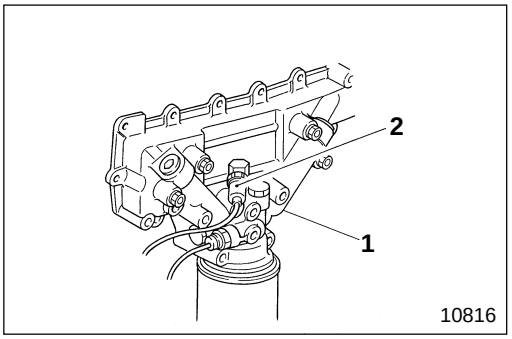
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

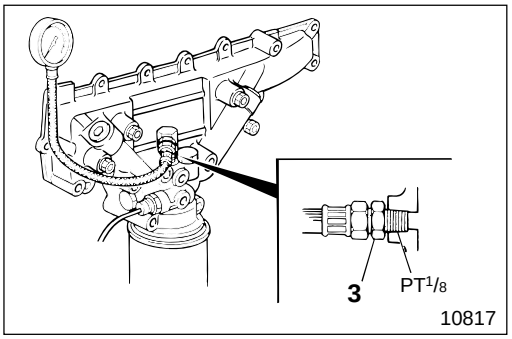
Location	Parts to be tightened	Tightening torque	Remarks
2	Engine oil pressure switch	15 to 22 {11 to 16, 1.5 to 2.2}	When engine is cold

Sealant

Location	Points of application	Kinds	Quantity
2	Thread area of engine oil pressure switch	Teflon tape	3 1/2 turns



- Remove oil pressure switch **2** from oil cooler **1**.
- Mount the oil pressure gauge after installing adaptor **3** onto oil cooler **1**.
- Warm up the engine until the oil temperature reaches 70 to 90°C {158 to 194°F}.
- Measure oil pressure at no-load minimum revolution and at no-load maximum revolution. If the measured values are lower than the limit, overhaul the lubricating system.



- After measurement, install engine oil pressure switch **2** and tighten at specified torque.

CAUTION

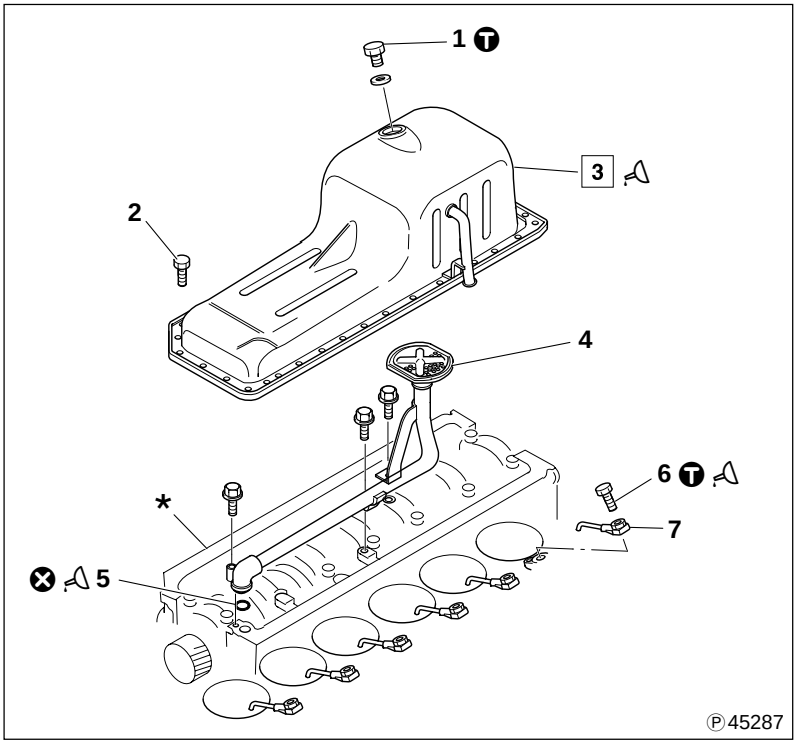
Be sure to install oil pressure switch 2 when the engine is cold.

Inspection of engine oil pressure switch

Gr 54

M E M O

OIL PAN, OIL STRAINER AND OIL JET



● **Disassembly sequence**

1 Drain plug
2 Bolt
3 Oil pan
4 Oil strainer
5 O-ring
6 Check valve
7 Oil jet

***** : Crankcase
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Make sure that you do not tighten check valve 10 higher than the specified torque. Overtightening will cause damage to the check valve, resulting in serious overheating damage to the engine.

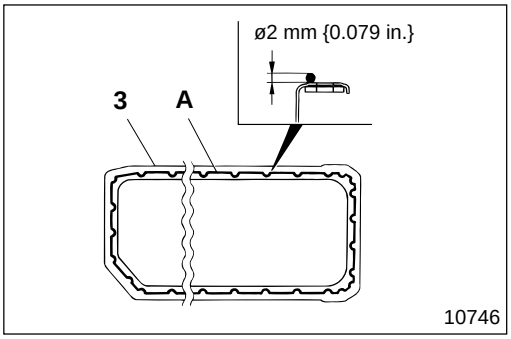
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	69 {51, 7}	—
6	Check valve	29 {22, 3 }	Wet

Lubricant and sealant

Location	Points of application	Kinds	Quantity
3	Oil pan to crankcase connecting surface	THREEBOND 1207C	As required
5	Body of O-ring	Engine oil	As required
6	Thread area of check valve	Engine oil	As required



◆ Service procedure

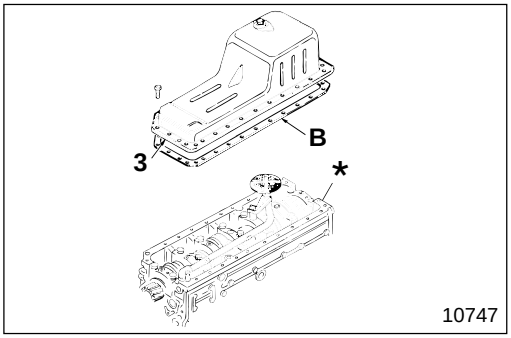
3 **Installation of oil pan**

< When using sealant >

- Apply sealant **A** to lower connecting surface of oil pan **3** as illustrated evenly without break.
- After applying sealant **A**, within three minutes, mount oil pan **3** to crankcase *****.

CAUTION ⚠

- **Be sure to clean and wipe off oily substances from the surface where sealant A is to be applied.**
- **Make sure that sealant A is not transferred to other areas while the mounting work is being done.**
- **Do not start the engine within an hour of mounting oil pan 3.**
- **Be sure to reapply sealant A if bolts 2 (for mounting oil pan 3) are loosened or removed by any cause whatsoever after mounting.**

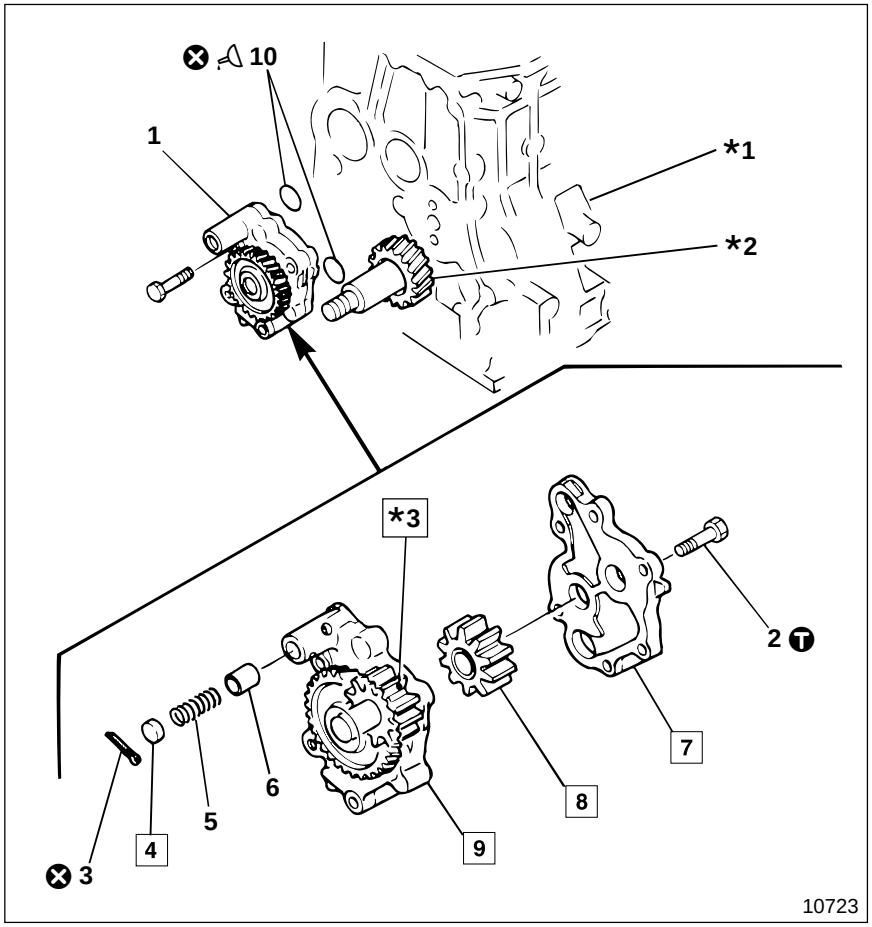


< When not using sealant >

NOTE

If sealant is not available, install oil pan 3 to crankcase * using sheet gasket B.

OIL PUMP



● **Disassembly sequence**

1 Oil pump assembly
2 Bolt
3 Split pin
4 Seat
5 Spring
6 Relief valve
7 Oil pump cover
8 Driven gear assembly
9 Oil pump case assembly
10 O-ring

***1** : Crankcase Gr 11B
***2** : Crankshaft gear
***3** : Drive gear
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
—	Backlash between oil pump gear and crankshaft gear Gr 11B	0.09 to 0.18 {0.0035 to 0.0071}	0.3 {0.012}	Replace
5	Relief valve spring load (Installed length 38 {1.50})	225 N {51 lbf, 23.15 kgf}	—	Replace
6	Relief valve opening pressure	1080±98 kPa {155±14 psi, 11±1.0 kgf/cm^2}	—	—
7, *3	Clearance between gear shaft and oil pump cover	[20] 0.04 to 0.07 {[0.79] 0.0016 to 0.0028}	0.15 {0.0059}	Replace
8, 9	Clearance between gear shaft and driven gear	[20] 0.04 to 0.07 {[0.79] 0.0016 to 0.0028}	0.15 {0.0059}	Replace
8, 9, *3	Difference between height of each gear and depth of oil pump case	0.01 to 0.07 {0.00039 to 0.0028}	0.18 {0.0071}	Replace
	Clearance between tooth tip of each gear and oil pump case	0.10 to 0.19 {0.0039 to 0.0075}	0.2 {0.0079}	Replace

Ⓣ Tightening torque

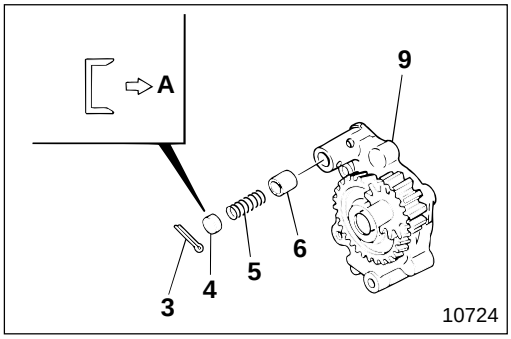
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Oil pump cover mounting)	9.8±2.0 {7.2±1.4, 1.0±0.2}	—

Lubricant

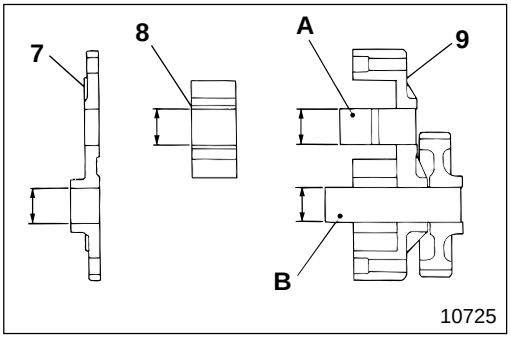
Location	Points of application	Kinds	Quantity
10	Body of O-ring	Engine oil	As required

◆ Service procedure



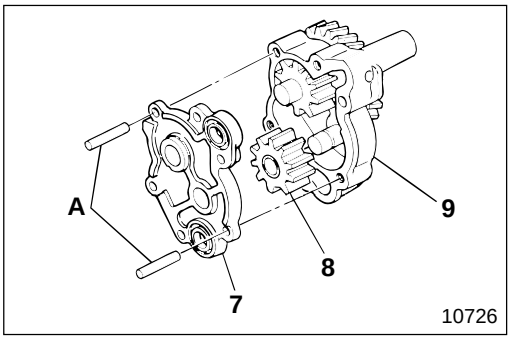
4 **Installation of seat**

A : Oil pump case assembly side



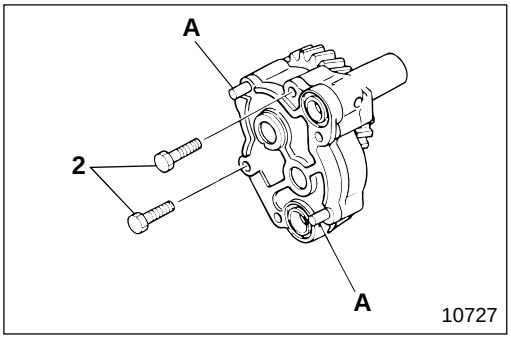
7 **to** **9** **Inspection of oil pump cover, driven gear assembly, and oil pump case assembly**

- Measure the clearance between oil pump cover **7** and drive gear shaft **B**, and between driven gear assembly **8** and driven gear shaft **A**.
- If the measured value is lower than the limit, replace the faulty parts.

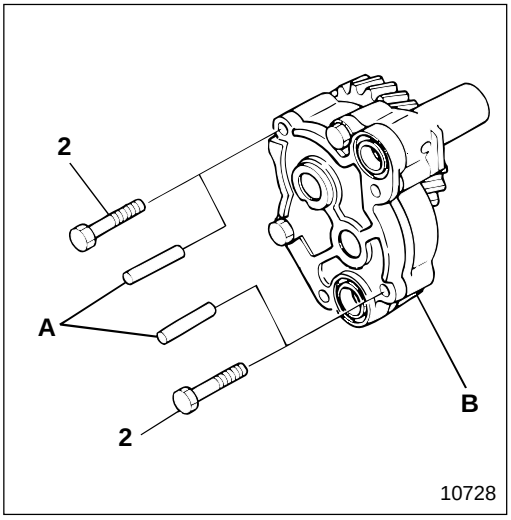


7 **9** **Installation of oil pump cover and oil pump case assembly**

- Prepare two pins **A** of 9 mm {0.35 in.} in outer diameter and position oil pump cover **7** and oil pump case assembly **9** as illustrated.



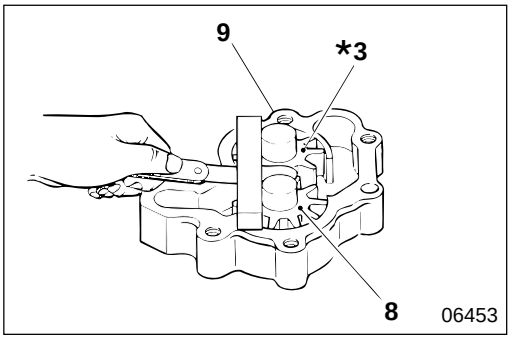
- Tighten the illustrated bolts **2** at specified torque.



- Remove pins **A**, replacing them with bolts **2** and tighten at specified torque.

NOTE

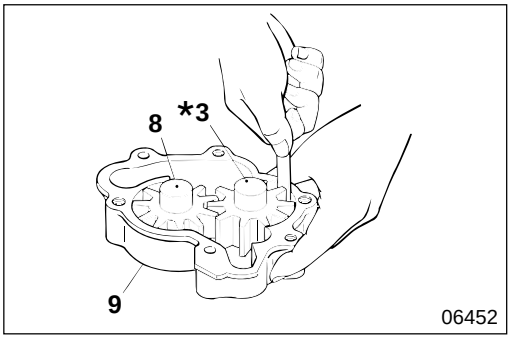
Confirm smooth movement by rotating oil pump gear B by hand. If it catches, disassemble and reassemble it.



8 9 *3 Inspection of driven gear assembly, and oil pump case assembly

(1) Difference between height of each gear and depth of oil pump case

If the measured value is higher than the limit, replace the faulty parts.

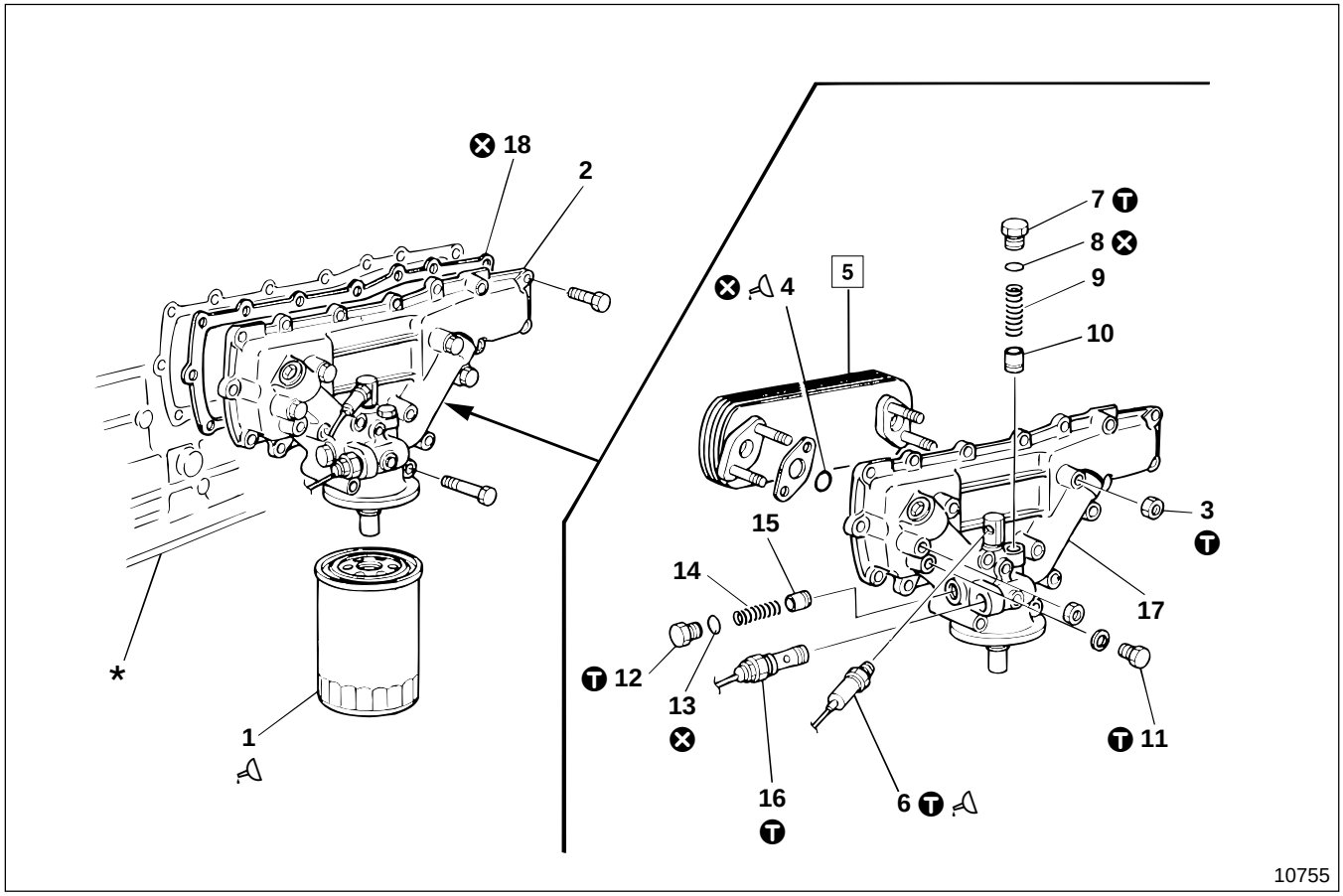


(2) Clearance between tooth tip and oil pump case

If the measured value is higher than the limit, replace the faulty parts.

M E M O

OIL COOLER AND OIL FILTER



● **Disassembly sequence**

1 Oil filter P12B-12
2 Oil cooler assembly
3 Nut
4 O-ring
5 Oil cooler element
6 Engine oil pressure switch Gr 54
7 Plug
8 O-ring
9 Spring
10 Regulator valve
11 Drain plug
12 Plug
13 O-ring
14 Spring
15 Bypass valve
16 Engine oil bypass alarm switch Gr 54
17 Oil cooler body
18 Gasket

* : Crankcase assembly Gr 11B
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
5	Oil cooler element air leakage (Air pressure 980 kPa {140 psi, 10 kgf/cm²}, 15 seconds)	0 cm³ {0 cu. in.}	—	Replace
10	Regulator valve opening pressure	440±29 kPa {64±4.3 psi, 4.5±0.3 kgf/cm²}	—	Replace
15	Bypass valve opening pressure	390±29 kPa {57±4.3 psi, 4.0±0.3 kgf/cm²}	—	Replace
16	Engine oil bypass alarm switch	190^{+60}_{-0} kPa {$27^{+8.3}_{-0}$ psi, $1.9^{+0.6}_{-0}$ kgf/cm²}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (oil cooler element mounting)	19.5±5 {14±3.6, 2.0±0.5}	—
6	Engine oil pressure switch	15 to 22 {11 to 16, 1.5 to 2.2}	When engine is cold
7	Plug (Regulator valve spring mounting)	19.5±5 {14±3.6, 2.0±0.5}	—
11	Drain plug (Oil cooler)	34 {25, 3.5}	—
12	Plug (Bypass valve spring mounting)	19.5±5 {14±3.6, 2.0±0.5}	—
16	Engine oil bypass alarm switch	12 to 18 {8.7 to 13, 1.2 to 1.8}	—

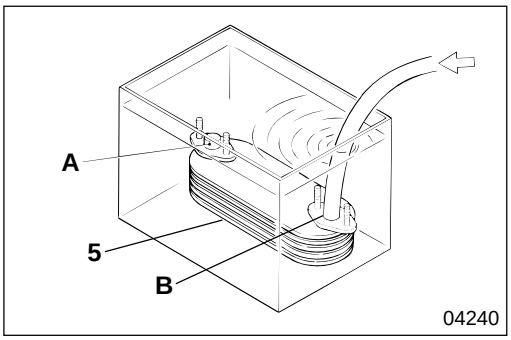
Lubricant and sealant

Location	Points of application	Kinds	Quantity
1	Gasket area of oil filter with thin application P12B-12	Engine oil	As required
4	Body of O-ring	Engine oil	As required
6	Thread area of engine oil pressure switch	Teflon tape	3 1/2 turns

◆ Service procedure

● Cleaning

- Check and see if any carbon deposits or sludge have developed in the oil passage of oil cooler element **5** or its bypass. Clean any deposits off thoroughly with cleaning solvent.
- Also clean any water scale or fur found in oil cooler element **5** or oil cooler body **17**.



5 **Inspection of oil cooler element**

- Immerse oil cooler element **5** in a water tank after plugging exit port **A** and connecting the hose to engine oil entry port **B**.
- Apply air pressure of 980 kPa {140 lbf/in², 10 kgf/cm²} via the hose and see if there is any air leakage from any part of oil cooler element **5**.
- If you see any leakage, replace oil cooler element **5**.

MITSUBISHI
FUSO

Group 13A
Fuel and Engine Control

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-13A

INDEX

SPECIFICATIONS 13A- 2

STRUCTURE AND OPERATION
- **1. Fuel System (Fuel flow) 13A- 3**
- **2. Engine Control 13A- 4**
- **3. Fuel Filter 13A- 5**

ON-VEHICLE INSPECTION AND ADJUSTMENT
- **1. Checking Minimum and Maximum No-Load Speeds 13A- 6**
- **2. Bleeding Air from Fuel System 13A- 7**
- **3. Replacing Fuel Filter 13A- 7**

ENGINE CONTROL 13A-10

FUEL TANK 13A-14

FUEL FILTER 13A-15

INJECTION PUMP 13A-16

INJECTION NOZZLE 13A-20

For system control of the electronically controlled injection pump, refer to Group 13EA Electronically Controlled Fuel System.

SPECIFICATIONS

Injection Pump Assembly

Item		Specification
Manufacturer		DENSO
Model		V4
Type		Distributor type electronically controlled pump
Spill valve solenoid		Electronically controlled
Timer	Control	High-pressure chamber control
	Drive	Timer controlled valve (TCV)
Feed pump type		Vane

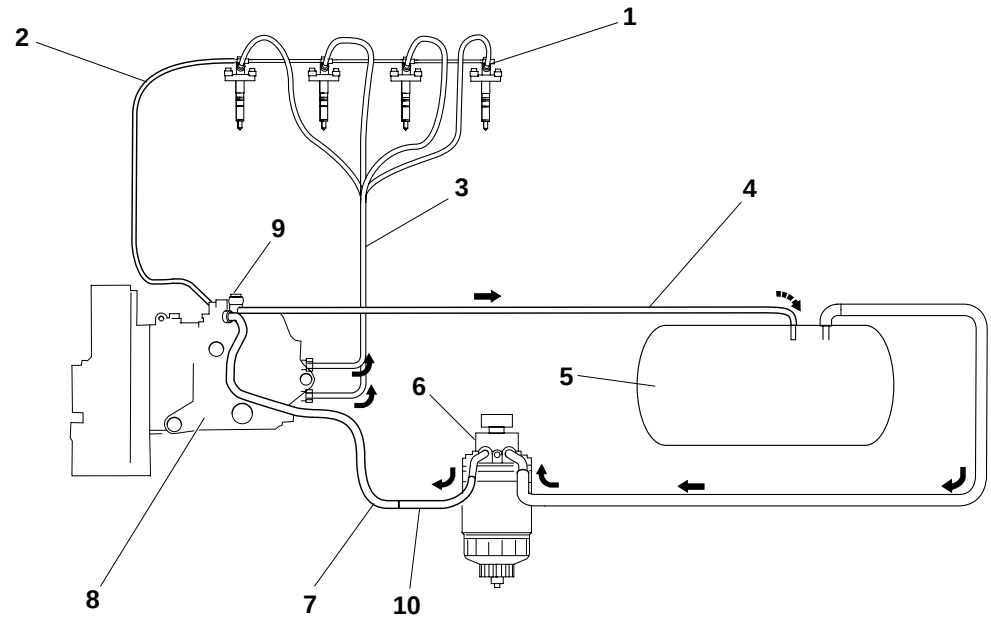
Injection Nozzle Assembly

Item	Specification
Manufacturer	DENSO
Type	Hole-type (2-spring)
No. of holes	6
Hole diameter mm {in.}	ϕ 0.20 {0.0079}

Fuel Filter

Item	Specification
Fuel filter type	Spin-on type (paper filter)
Water level alarm	Provided
Priming pump	Provided

1. Fuel System (Fuel flow)

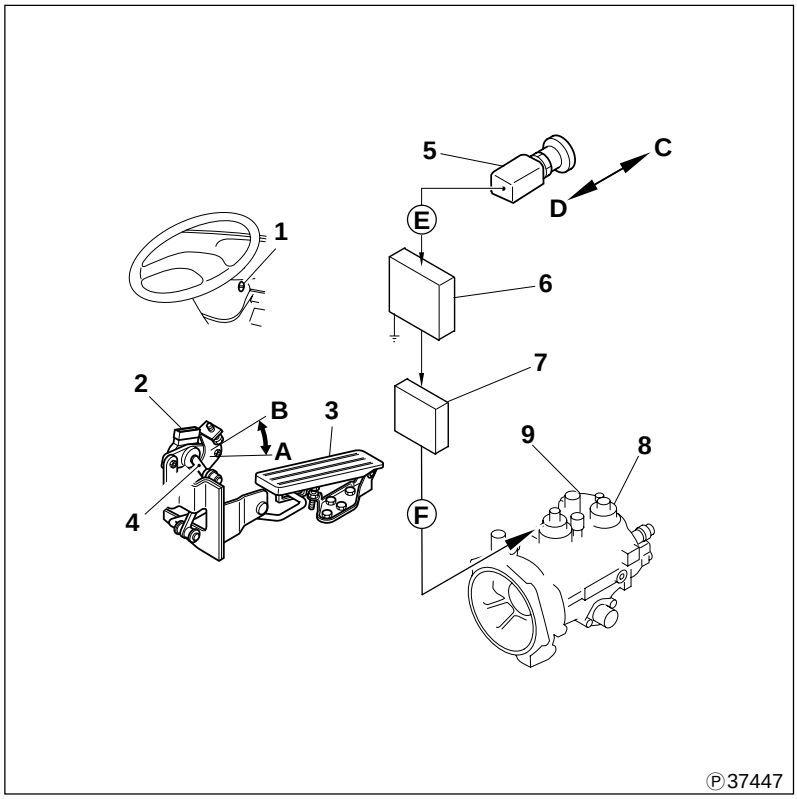


Ⓟ49019

1 Injection nozzle
2 Fuel leak-off pipe
3 Injection pipe
4 Fuel return pipe
5 Fuel tank
6 Fuel filter
7 Fuel suction pipe
8 V4 injection pump
9 Overflow valve
10 Fuel hose

- Fuel from the fuel tank **5** is drawn up by the feed pump, which is driven by the V4 injection pump **8**. Then, the fuel is delivered into the V4 injection pump through the fuel filter **6**.
- After filtration, the fuel is fed to the V4 injection pump **8**. From there, it is fed under high pressure to the injection nozzles **1**. The injection nozzles spray the fuel into the combustion chambers.
- Excess fuel from the injection nozzles **1** returns to the fuel tank **5** by way of the fuel leak-off pipe **2**.
- If the fuel pressure in the V4 injection pump **8** exceeds a preset level, the overflow valve **9** opens to allow excess fuel to return from the fuel return pipe **4** to the fuel tank **5**.

2. Engine Control



1 Starter switch
2 Accelerator position sensor & accelerator switch assembly
3 Accelerator pedal
4 Lever
5 Emergency engine stop switch
6 Engine control unit
7 Drive Unit
8 Spill valve
9 V4 injection pump assembly

A : Idling position
B : Full-load position
C : Engine stopping position
D : Engine starting position
E : Fuel cut signal
F : Power supply

● **Accelerator position sensor & accelerator switch unit**

The accelerator position sensor & accelerator switch unit **2** consists of an accelerator position sensor and a built-in accelerator switch.

- The accelerator switch responds to the foot pressure acting upon the accelerator pedal **3**.
- The accelerator position sensor detects the movement of the accelerator pedal **3** and outputs an electric signal to the engine control unit **6**. The lever **4** is constantly pulled by the return spring toward the idling position **A**.

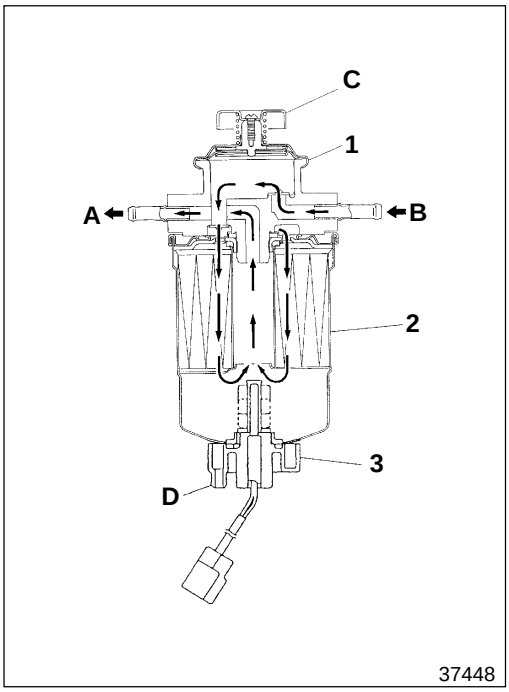
● **Emergency engine stop switch**

The emergency engine stop switch **5** is used to stop the engine when the starter switch **1** placed in the ACC position fails to do it due to a system failure or for other reason. If the switch is pulled into the engine stopping position **C**, a fuel cut signal **F** is sent to the engine control unit **6**, which in turn supplies power **F** to the spill valve **8** of the V4 injection pump assembly **9** to stop the engine.

CAUTION ⚠

When restarting the engine stopped by means of the emergency engine stop switch 5, set the starter switch 1 to the ACC or LOCK position beforehand to initialize the computer in the engine control unit 6.

3. Fuel Filter



1 Fuel filter head
2 Fuel filter cartridge
3 Water level sensor

A : To injection pump
B : From fuel tank
C : Priming pump
D : Drain port

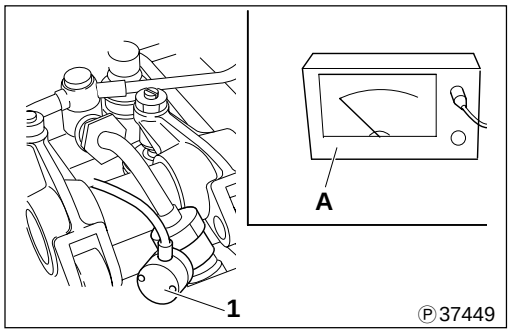
The fuel filter cartridge **2** serves also as a water separator, it separates water from fuel as well as removes impurities. Separated water is collected in the lower part of the filter. The filter is provided with a water level sensor **3**. When water is collected to a certain level, this sensor turns on the warning lamp in the meter cluster.
Collected water can be drained away through the drain port **D** by loosening the water level sensor **3**. The fuel filter head **1** is equipped with a priming pump **C** for bleeding the fuel system.

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Checking Minimum and Maximum No-Load Speeds

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	No-load minimum speed (Idling speed)	650±25 rpm	–	Check
–	No-load maximum speed	3400±50 rpm	–	Check



● **No-load minimum speed**

Prepare the vehicle for inspection as follows.

- Engine coolant temperature: 176 to 203°F {80 to 95°C}
- Lamps and electrical equipment: Off
- A/T: “P” range
- Steering wheel: Neutral position
- Connect a tachometer **A** to the injection nozzle **1** or the injection pipe.

NOTE

Before connecting the tachometer A to the injection pipe, undo all clamps from the pipe.

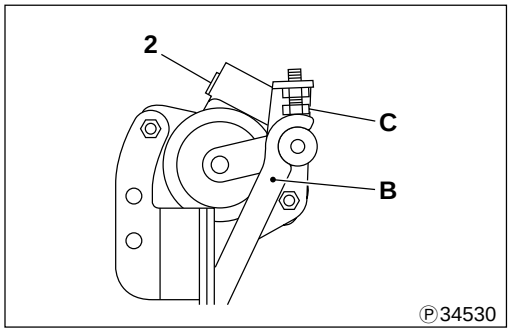
- Check that the minimum speed meets the standard value when the accelerator pedal is free of foot pressure.
- If the reading deviates from the standard value, check the accelerator position sensor & accelerator switch unit **2** for malfunction. Gr 13EA
- If the accelerator position sensor & accelerator switch unit **2** is found normal, check the fuel system diagnosis code, injection pump and ECU. Gr 13EA

● **No-load maximum speed**

- Connect a tachometer **A** to the injection nozzle **1** or the injection pipe.

NOTE

Before connecting the tachometer A to the injection pipe, undo all clamps from the pipe.



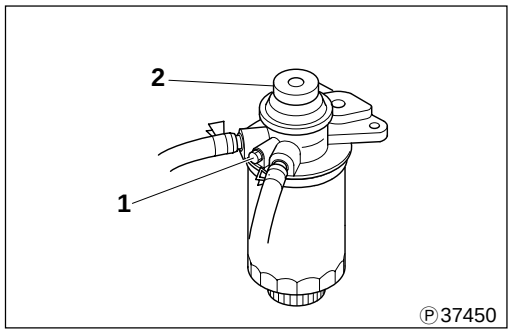
- Check that the maximum speed meets the standard value when the lever **B** of the accelerator position sensor & accelerator switch unit **2** is in contact with the full load stopper bolt **C**.
- If the reading deviates from the standard value, check the accelerator position sensor & accelerator switch unit **2** for malfunction. Gr 13EA
- If the accelerator position sensor & accelerator switch unit **2** is found normal, check the fuel system diagnosis code, injection pump and ECU. Gr 13EA

2. Bleeding Air from Fuel System

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Air vent plug	6±1 {4.3±0.7, 0.6±0.1}	–



- Loosen the fuel filter air vent plug **1**.
- Operate the priming pump **2** to pump up fuel.
- Continue to pump fuel until no air bubbles are found in the fuel flowing out from the air vent plug **1**.
- After ascertaining that air bubbles have completely disappeared, tighten the air vent plug **1** securely.
- Operate the priming pump **2** further until it feels heavy.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

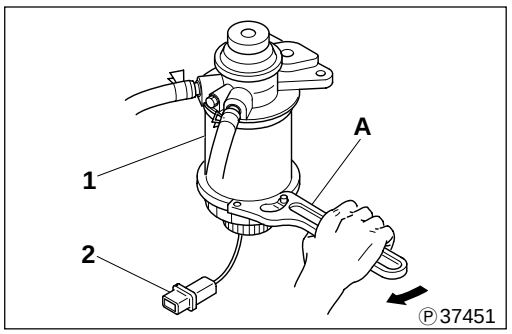
WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**

3. Replacing Fuel Filter

Lubricant

Location	Point of application	Specified lubricant	Quantity
1	Gasket for fuel filter cartridge	Engine oil	As required



[Removal]

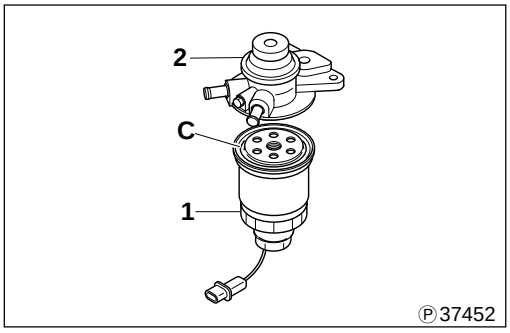
A: Filter Wrench
(Commercially available one: For filter diameter of approx. 90 mm {3.54 in.})

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To minimize the risk of fire, wipe up any spilled fuel.**

CAUTION ⚠

- **The water level sensor 2 may be reused if it properly functions.**



[Installation]

WARNING ⚠

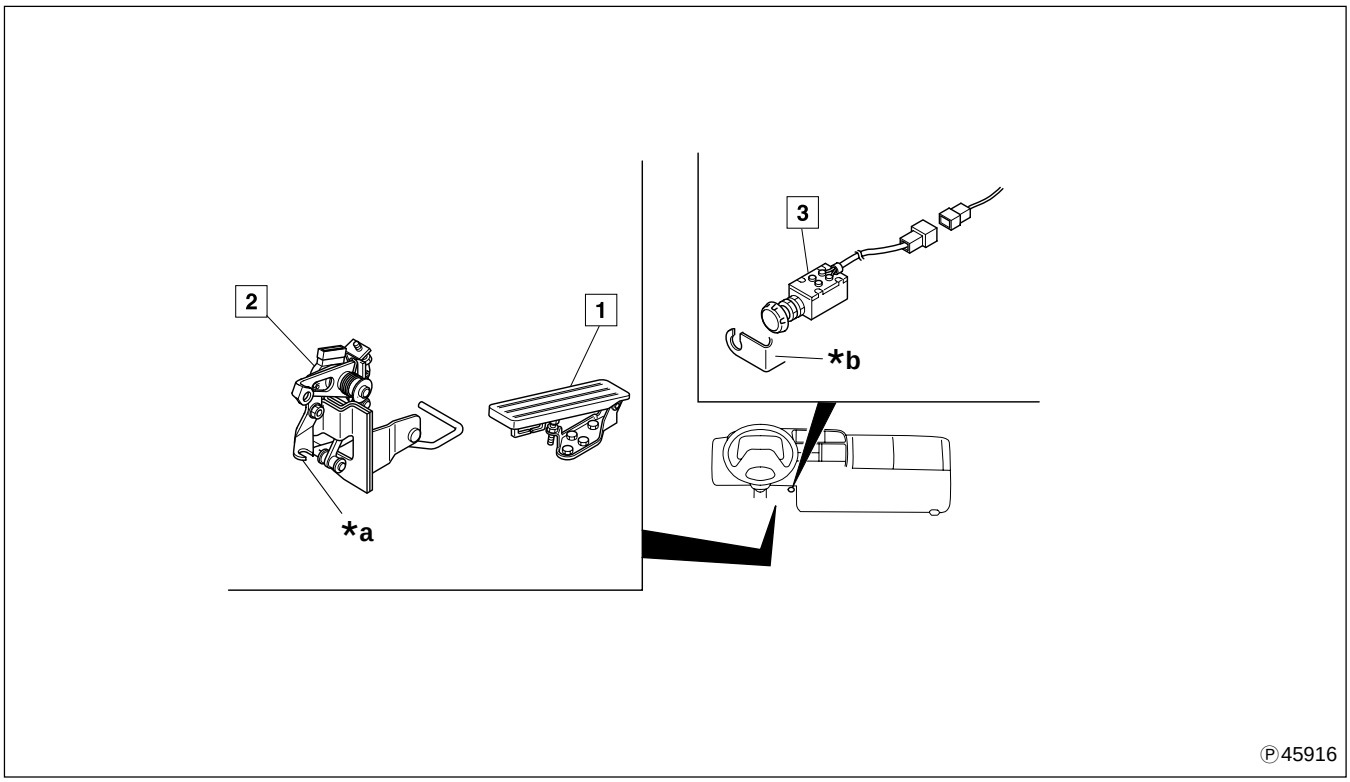
Use of an unsuitable fuel filter cartridge 1 can lead to fuel leaks and fires. Be sure to use a genuine filter.

CAUTION ⚠

To prevent injection failures, keep dust and dirt out of the fuel filter cartridge 1 and the fuel pipe.

- To fit the fuel filter cartridge **1**, turn it until the gasket **C** touches seal surface of the fuel filter head **2**. Be sure to turn the filter by hand clockwise.
  Then, tighten the filter by 3/4 turn.
- Bleed all air out of the fuel system. 🕮 P13A-7
- After fitting the filter, start the engine and check that no fuel leakage occurs.

M E M O



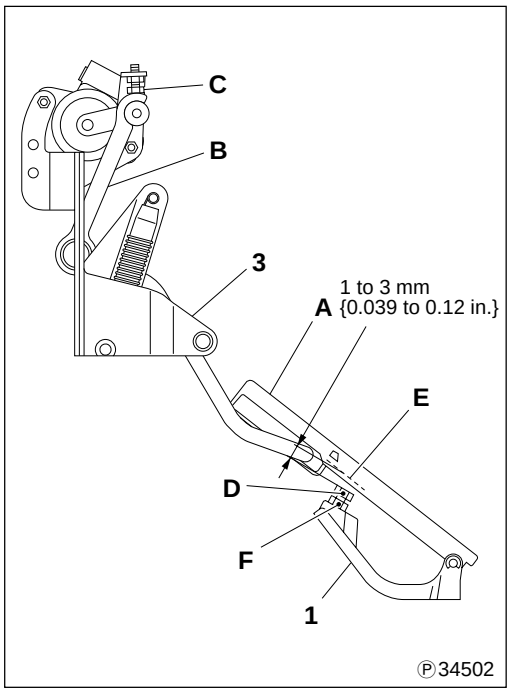
● **Removal sequence**

1 Accelerator pedal assembly 🕮 P13A-12
2 Accelerator pedal position sensor assembly 🕮 P13A-13
3 Emergency engine stop switch Gr 13EA

***a :** Lever and bracket assembly
***b :** Bracket

● **Installation sequence**

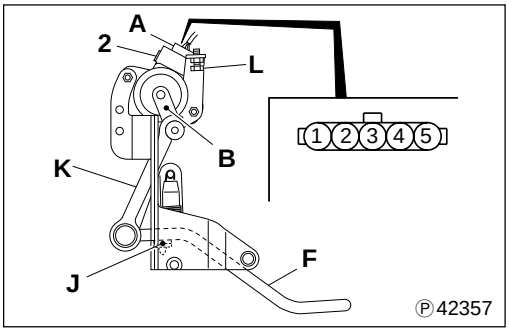
Follow the removal sequence in reverse.



◆ Service procedure

1 **Installation of accelerator pedal assembly**

- Fit the accelerator pedal assembly **1** onto the accelerator pedal position sensor assembly **3**.
- Depress the accelerator pedal **A** until the accelerator control extension **B** touches the stopper bolt **C** of the accelerator pedal position sensor assembly **3**.
- Check that the clearance between the stopper bolt **D** and the stopper bolt contact surface **E** of the accelerator pedal **A** is as shown in the illustration.
- Adjust the stopper bolt **D**, if necessary, to achieve the illustrated clearance. Lock the stopper bolt with the nut **F** after adjustment.



2 **Inspect the accelerator pedal position sensor**

[Inspection]

- Set the starter switch to ON.
- Measure the output voltage of the accelerator position sensor **2** from the back side of harness connector **A** according to the following table.

		Accelerator Position Sensor I		Accelerator Position Sensor II		Accelerator Switch	
		②	①	②	⑤	②	③
Lever **B** position		⊕	⊖	⊕	⊖	⊕	⊖
Standard value	Idling position **C**	0.85±0.1 V		0.85±0.1 V		4V or more	
	Accelerator operating position **D**	1.0±0.24 V		1.0±0.24 V		1V or less	
	Full load position **E**	4.0±0.1 V		4.0±0.1 V			

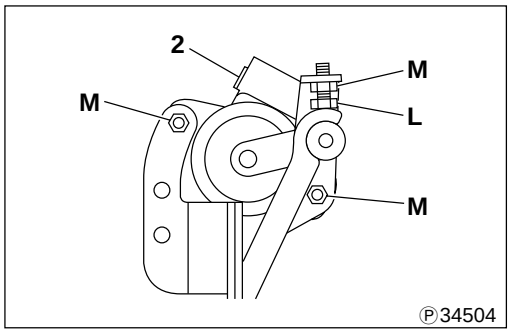
◯——◯ : There must be continuity between the pins.
⊕——⊖ : Polarity when voltage is measured.

C : Where accelerator control arm **F** is in contact with stopper **J**.

D : Where voltage across pins ② and ③ is reduced to 1V or less by slowly depressing the accelerator pedal.

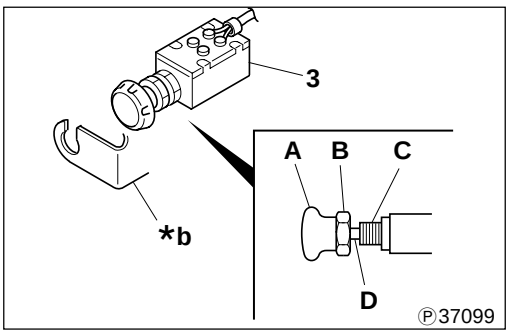
E : Where accelerator control extension **K** is in contact with stopper bolt **L**.

- If the output voltage is out of the standard value range, adjust by the following procedures.



[Adjustment]

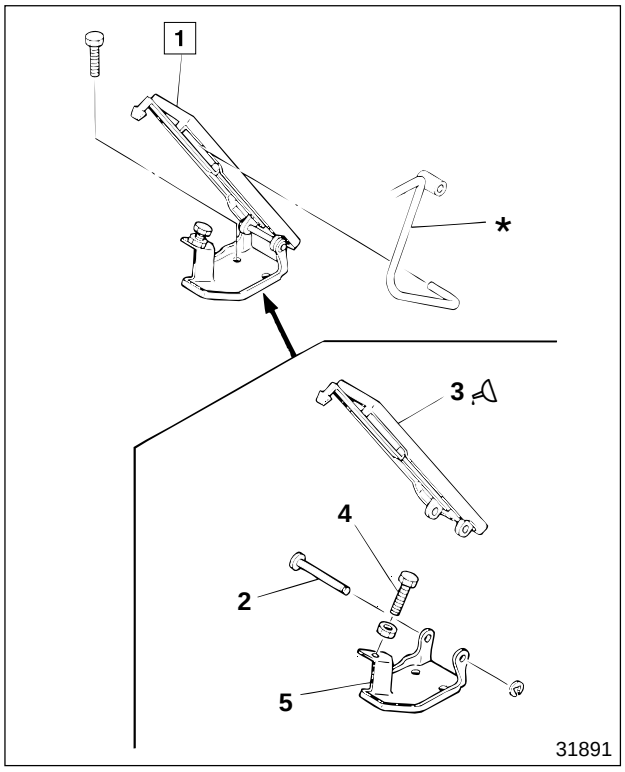
- Adjust the output voltage at the idling position **C** by loosening the screw **M** and moving the accelerator position sensor **2**.
  After the adjustment, retighten the screw.
- Adjust the output voltage at the full load position **E** by loosening the nut **M** and adjusting the stopper bolt **L**.
  After the adjustment, lock the bolt with the nut.



3 **Installation of emergency engine stop switch**

- Pull the knob **A** of the emergency engine stop switch **3** into the OFF position. Loosen the nut **B** to remove from the threaded end **C** of the switch.
- Set the shaft **D** in the bracket ***b**.
- Position the shaft **D** properly in the hole of the bracket ***b** and tighten the nut **B**.

Accelerator Pedal Assembly



● **Disassembly sequence**

1 Accelerator pedal assembly
2 Clevis pin
3 Accelerator pedal
4 Stopper bolt
5 Accelerator pedal bracket

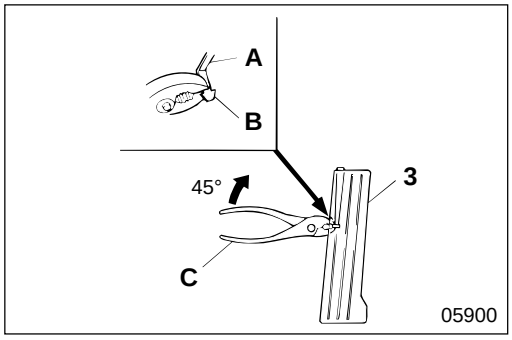
* : Accelerator pedal position sensor assembly P13A-13

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Kinds	Quantity
3	Slide-contacting surfaces of accelerator pedal and bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required



◆ Service procedure

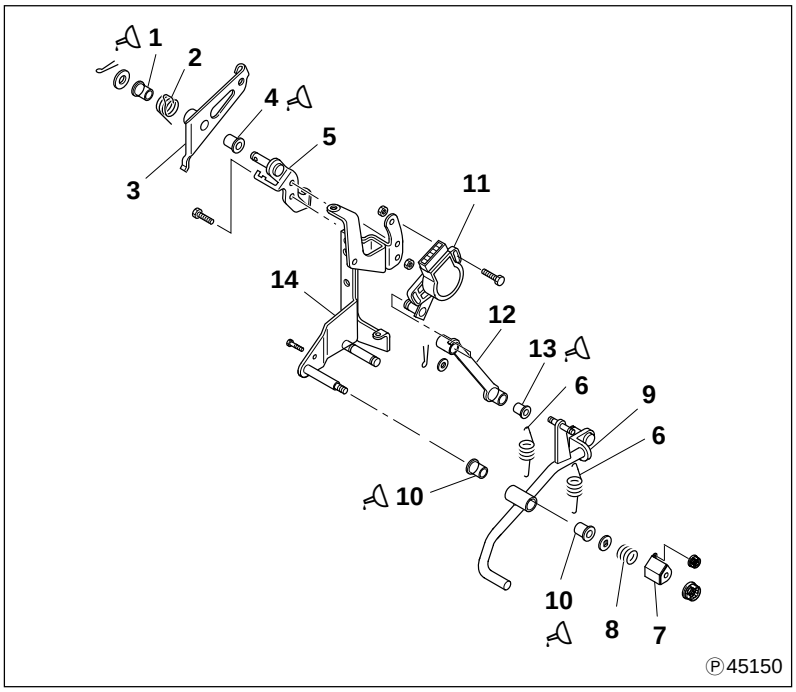
1 **Removal of accelerator pedal assembly**

Pinch hook **B** of stopper **A** of accelerator pedal **3** using pliers **C** and rotating approximately 45° pull out the stopper towards the front of the vehicle.

CAUTION

Take care not to damage stopper A itself during removal, do not pull it out too forcibly.

Accelerator Pedal Position Sensor Assembly



● **Removal sequence**

1 Bushing < Mixer >
2 Spring < Mixer >
3 Lever assembly < Mixer >
4 Bushing < Mixer >
5 Bracket assembly < Mixer >
6 Return spring
7 Shaft cover
8 Spring
9 Accelerator control arm
10 Bushing
11 Throttle position sensor
12 Accelerator control extension
13 Bushing
14 Bracket

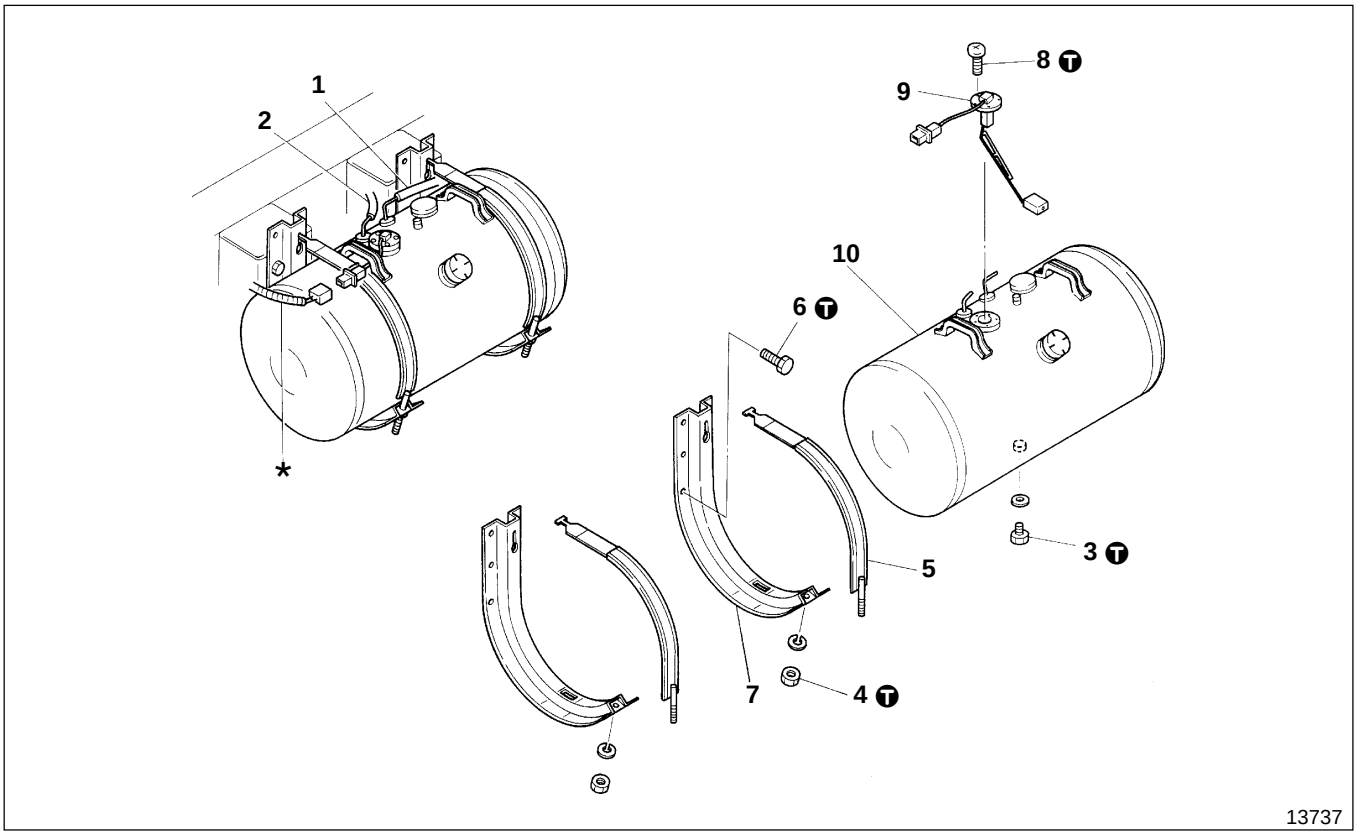
● **Installation sequence**

Follow the removal sequence in reverse.

Lubricant

Location	Points of application	Specified Lubricant	Quantity
1, 4, 10, 13	Slide-contacting surfaces of bushing and support assembly	Chassis grease [NLGI No.1 (Ca soap)]	As required

FUEL TANK



● **Work before removal**

WARNING ⚠

- **Keep unprotected lights away because of the risk of explosion.**
- **Wipe up any spilled fuel because it can cause a fire.**

NOTE

Drain fuel before working on the job.

● **Removal sequence**

1 Suction hose
2 Return hose
3 Drain plug
4 Nut
5 Fuel tank band
6 Bolt
7 Fuel tank bracket
8 Screw
9 Fuel gauge unit Gr 54
10 Fuel tank
***** : Chassis harness Gr 54

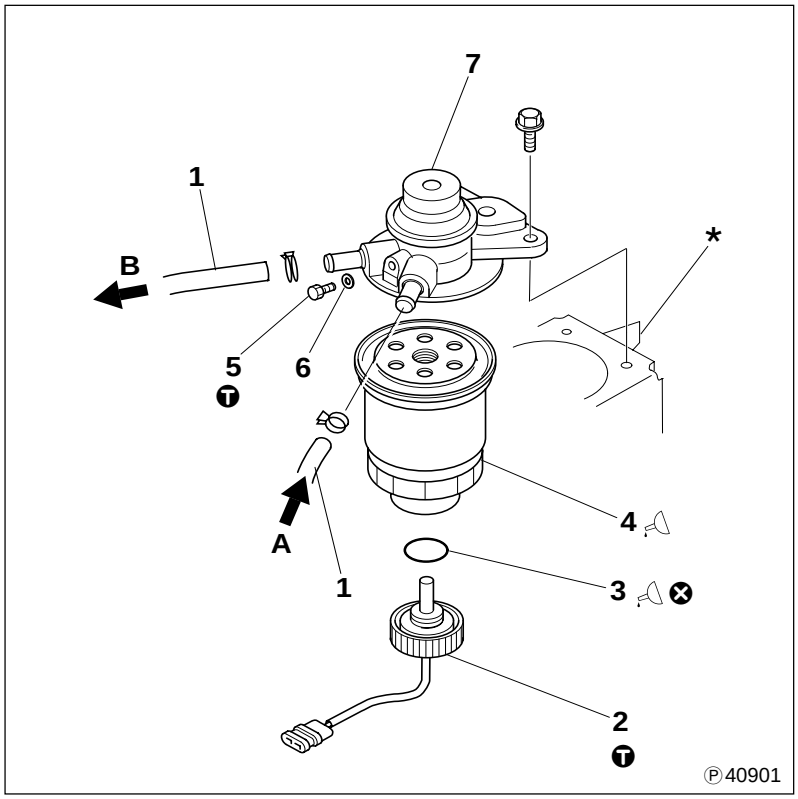
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain plug	59 to 98 {43 to 72, 6 to 10}	–
4	Nut (Fuel tank band mounting)	5.9 to 9.8 {4.3 to 7.2, 0.6 to 1.0}	–
6	Bolt (Fuel tank bracket mounting)	59 to 78 {43 to 58, 6 to 8}	–
8	Screw (Fuel gauge unit mounting)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	–



● **Disassembly sequence**

1 Fuel hose
2 Water level sensor Gr 54
3 O-ring
4 Fuel filter cartridge P13A-7
5 Air vent plug
6 Gasket
7 Fuel filter head

A : From fuel tank
B : To injection pump
*** :** Bracket
⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

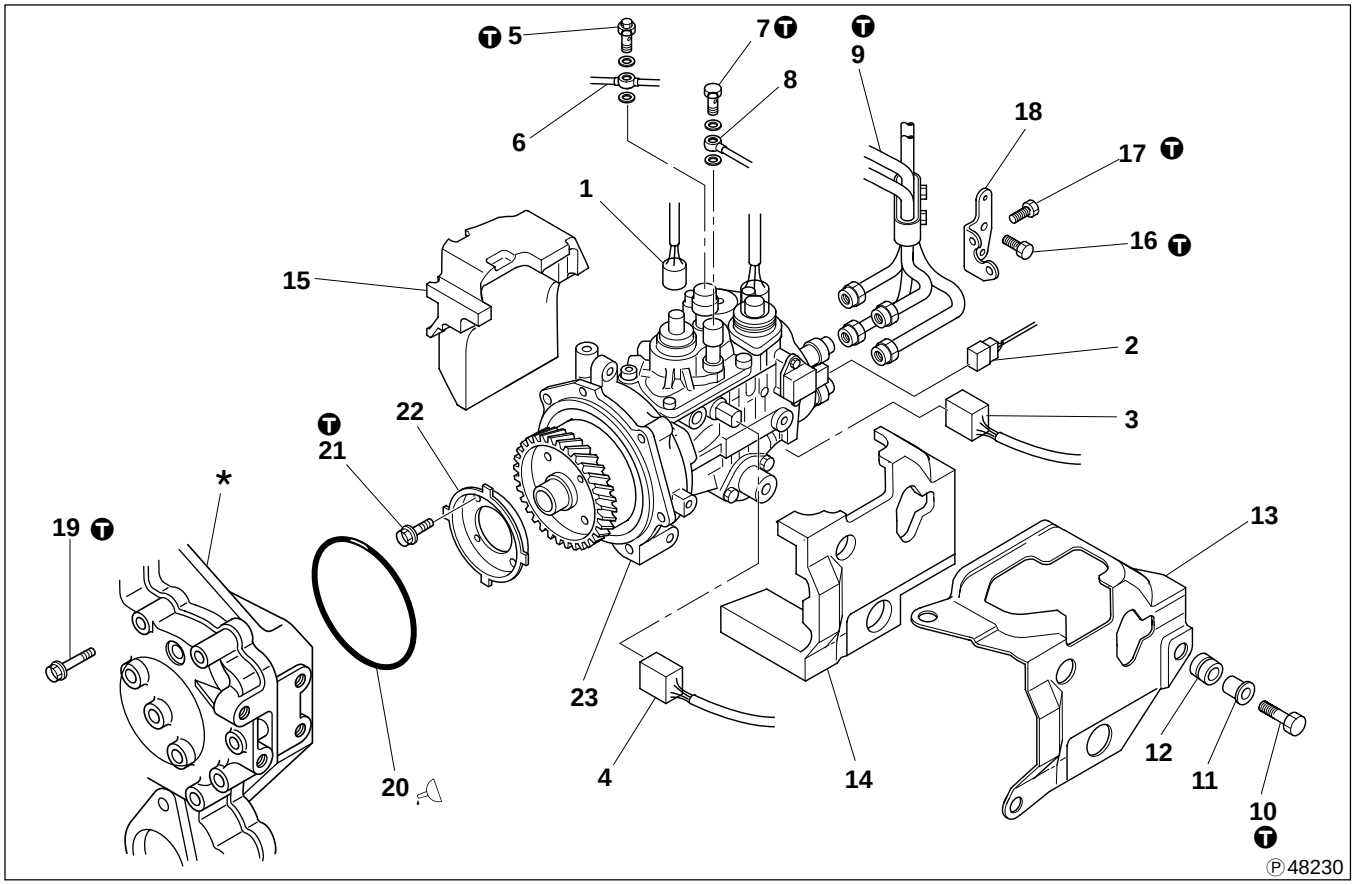
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Water level sensor	2.5±0.5 {1.81±0.36, 0.25±0.05}	–
5	Air vent plug	6±1 {4.3±0.7, 0.6±0.1}	–

Lubricant

Location	Points of application	Specified sealant	Quantity
3	O-ring	Engine oil	As required
4	Fuel filter cartridge gasket (surface in contact with fuel filter head)	Engine oil	As required

INJECTION PUMP



● **Disassembly sequence**

1 Harness connector (Engine speed sensor)
2 Harness connector (Injection control ROM)
3 Harness connector (Timer control valve)
4 Harness connector (Fuel temperature sensor)
5 Overflow valve
6 Fuel return pipe
7 Eyebolt
8 Fuel suction pipe
9 Injection pipe
10 Bolt
11 Spacer
12 Insulator
13 Injection pump cover
14 Injection pump sound insulation
15 Rubber spacer
16 Bolt
17 Bolt
18 Pump bracket
19 Bolt
20 O-ring
21 Bolt
22 Sensor plate
23 Injection pump assembly

***** : Front case assembly Gr 11A
⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **For maintenance of the injection pump assembly 23, please contact a Denso service station.**
- **Dirt particles in the injection pump assembly 23 can seriously detract from engine performance. To prevent enter of dirt, cover all pipes, hoses and other parts after removal.**

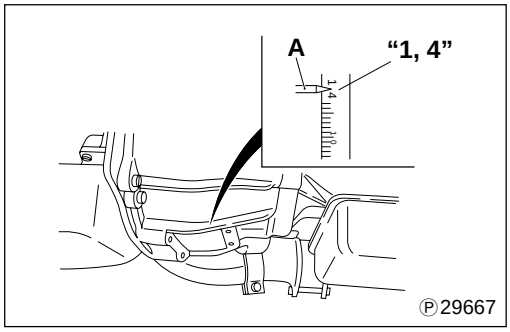
Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Overflow valve (fuel return pipe mounting)	19.6 to 29.5 {14 to 22 , 2 to 3}	–
7	Eyebolt (fuel suction pipe mounting)	19.6 to 29.5 {14 to 22 , 2 to 3}	–
9	Injection pipe (union nut mounting)	29.4 {22, 3}	–
10	Bolt (injection pump cover mounting)	9.8 {7.2, 1}	–
16	Bolt (pump bracket mounting)	44.1 {33, 4.5}	–
17	Bolt (injection pump assembly mounting)	47.0 {35, 4.8}	–
19	Bolt (injection pump assembly mounting)	23.5 {17, 2.4}	–
21	Bolt (sensor plate mounting)	4.9 {3.6, 0.5}	–

Lubricant

Location	Points of application	Specified lubricant	Quantity
20	O-ring	Engine oil	As required



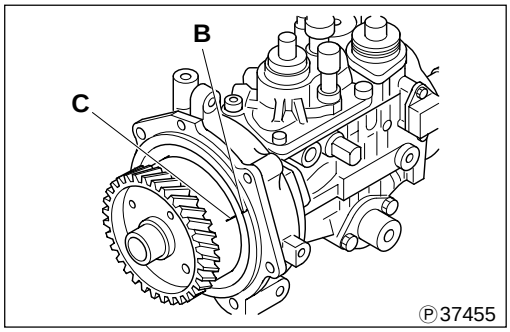
◆ Service procedure

23 Installation of injection pump assembly

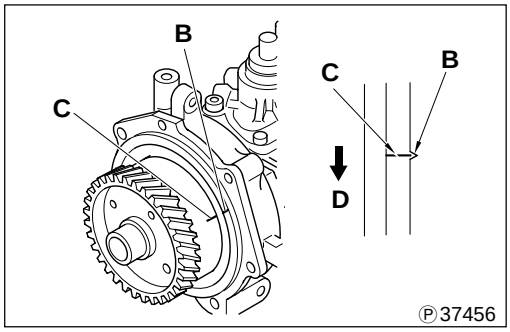
- Crank the engine clockwise to bring the cylinder No. 1 piston to the top dead center of compression stroke; align the pointer **A** in the torque converter housing inspection opening with the inscribed mark between "**1**" and "**4**" on the flywheel.
- Check that the rocker arms of both inlet and exhaust valves of the cylinder No. 1 move.
- If the rocker arms still hold the valves down, give the engine another turn.

NOTE

There are two kinds of marks inscribed in the flywheel, "I" and "IV" and "1" and "4". Do not confuse.



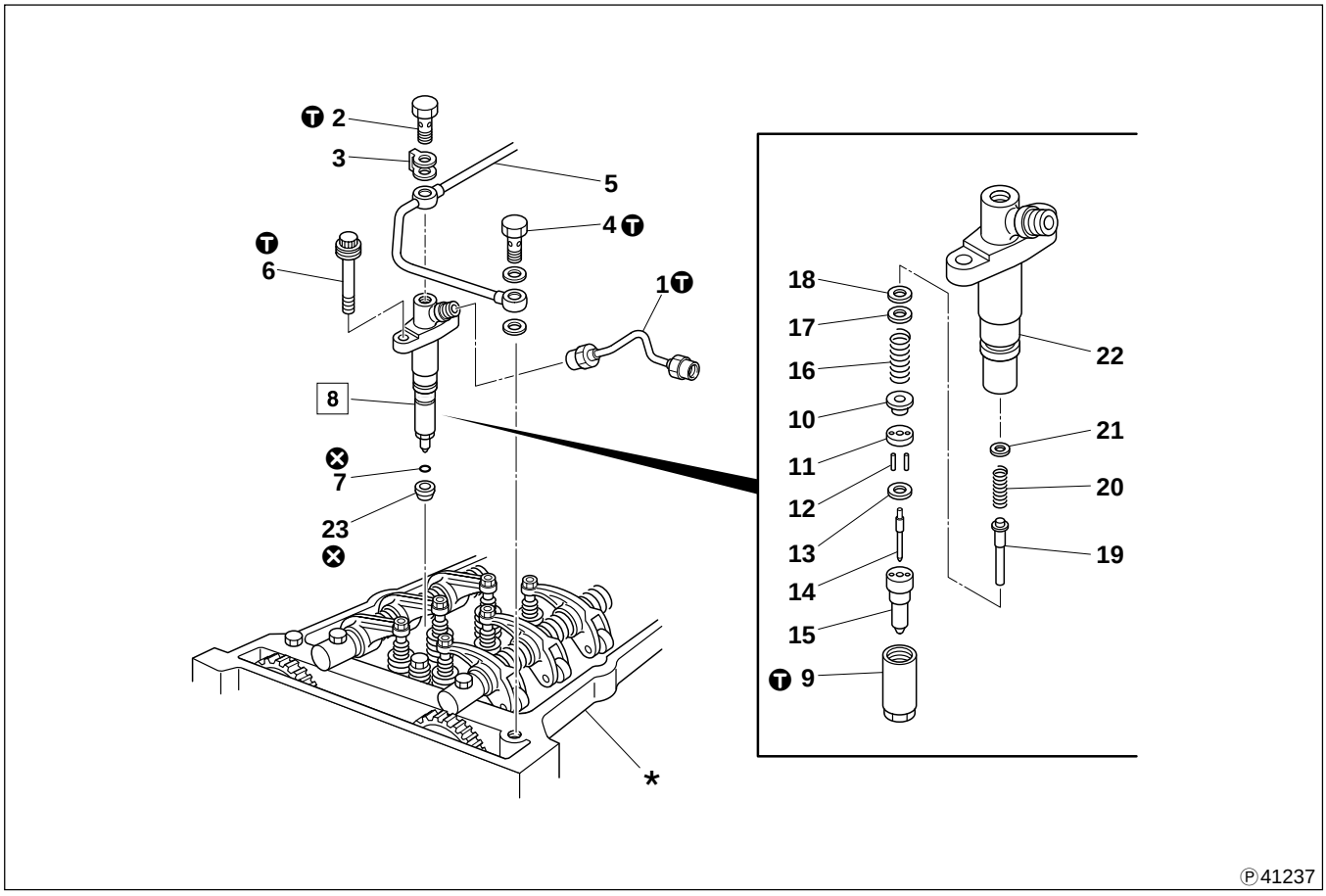
- Align the notch **B** in the flange plate with the inscribed mark **C** on the injection pump gear.



- Ascertaining the alignment between notch **B** and inscribed mark **C**, push in the injection pump assembly to install in position. At this time, the inscribed mark moves in the direction **D**.

M E M O

INJECTION NOZZLE



● **Disassembly sequence**

1. Injection pipe
2. Eyebolt
3. Gasket
4. Eyebolt
5. Leak-off pipe
6. Bolt
7. O-ring
8. Injection nozzle assembly
9. Retaining nut
10. Spring seat (for adjustment of pre-lift)
11. Tip packing
12. Straight pin
13. Washer (for adjustment of needle valve lift)
14. Needle valve
15. Nozzle
16. 2nd pressure spring
17. Adjusting shim (for adjustment of 2nd valve opening pressure)
18. Spring seat
19. Pressure pin
20. 1st pressure spring
21. Adjusting shim (for adjustment of 1st valve opening pressure)
22. Nozzle holder
23. Nozzle gasket

*: Cylinder head Gr 11A
⊗: Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

- **Take care not to touch the sliding part of the needle valve 14. It could be scratched or corroded in the worst case, resulting in the loss of airtightness between the valve and the nozzle 15.**
- **Under no circumstances change the needle valve 14 and nozzle 15 combination between cylinders.**
- **Dirt particles can seriously detract from engine performance. To prevent ingress of dirt, cover parts to which the injection nozzle assemblies 8 were fitted after removal.**

NOTE

Clean off any carbon deposits before disassembling, reassembling or adjusting the injection nozzle assembly 8. Before disassembly, check the pressure and shape of the spray and inspect the assembly for fuel leads. If no abnormality is apparent, do not commence disassembly.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
8	Injection nozzle assembly injection pressure (valve opening pressure)	1st valve opening pressure	$16.18\,^{+0.98}_{0}$ MPa $\{2346\,^{+142}_{0}$ psi, $165\,^{+10}_{0}$ kgf/cm$^2\}$	–	Adjust
		2nd valve opening pressure	20.10±0.49 MPa {2915±71 psi, 205±5 kgf/cm^2}	–	
–	Prelift		0.08±0.01mm {0.0031±0.14in}	–	Adjust
–	Needle valve lift		$0.25\,^{+0.03}_{-0.02}$ $\{0.0098\,^{+0.0012}_{-0.00079}\}$	–	Adjust

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Union nut (injection pipe mounting)	38.2 {28, 3.9}	–
2	Eyebolt (leak-off pipe (nozzle side) mounting)	29.4 {22, 3.0}	–
4	Eyebolt (leak-off pipe (head side) mounting)	20.6 {15, 2.1}	–
6	Bolt (injection nozzle assembly mounting)	14.7 {11, 1.5}	–
9	Retaining nut	25 to 34 {18 to 25, 2.5 to 3.5}	–

Special tool

Location	Tool name	Part No.	Application
–	Nozzle Cleaning Tool	***105789-0010**	Cleaning injection nozzle assemblies
–	Tool Set	*95093-00040	Disassembly, assembly and adjustment of injection nozzle
–	*1 Attachment Measure	*95093-10300	Measurement of prelift
–	*1 Base	*95093-10230	Assembly of injection nozzle
–	Master Spring Seat	*95093-10330	Adjustment of 2nd valve opening pressure

***** : BOSCH AUTOMOTIVE SYSTEMS product number
* : DENSO product number
*1 : Component of Tool Set (95093-00040)

◆ Service procedure

● Inspection before disassembly

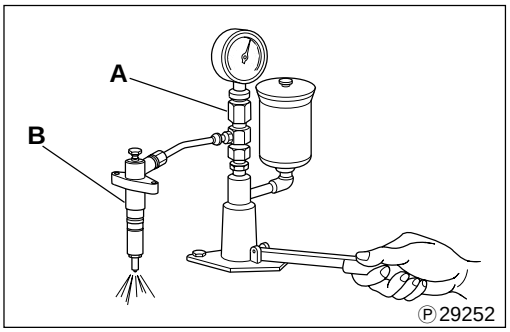
Fit the injection nozzle assembly **8** onto the nozzle tester **A** ready for inspection.

WARNING ⚠

Do not touch the spray that comes out of the nozzle.

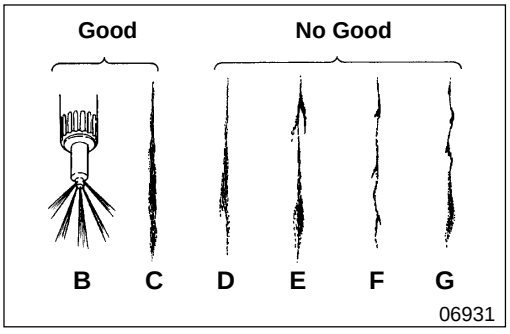
NOTE

Before commencing inspection, operate the lever on the nozzle tester A two or three times to bleed all air out of the arrangement.



(1) Checking valve opening pressure

- Push down the lever on the nozzle tester **A** at a rate of 1 to 2 seconds per stroke. The pressure gauge reading will gradually rise, then the needle will suddenly deflect. Note the pressure when the needle starts to deflect.
- If the measurement is out of specification, disassemble the nozzle, clean it and make adjustments by changing the shims **17**, **21**.
- If the measurement is still out of specification after adjustment, replace the injection nozzle assembly **8**.

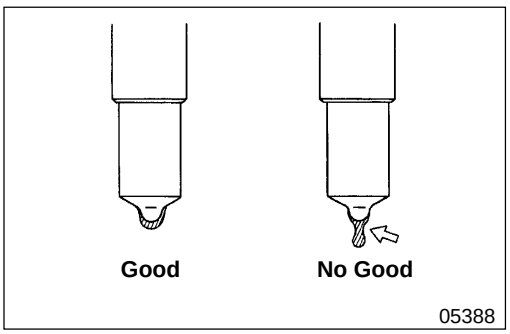


(2) Inspecting spray condition

- Pump the lever on the nozzle tester **A** at a rate of about 1 to 2 strokes per second and maintain a continuous spray.

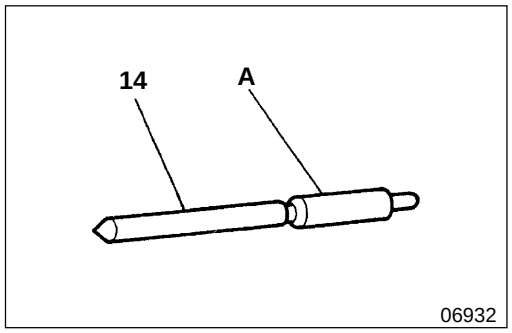
  B : Even spray from all five injection orifices (Good)
  C : Even and symmetrical spray (Good)
  D : Asymmetrical spray (No Good)
  E : Branched spray (No Good)
  F : Thin spray (No Good)
  G : Irregular spray (No Good)

- If the spray is unsatisfactory, disassemble and clean the injection nozzle assembly **8**, then inspect the spray again. If the spray is still unsatisfactory, replace the injection nozzle assembly.
- Check that no fuel drips from the nozzle after the spray is complete.



(3) Inspecting for oil-tightness and leaks

- Slowly increase the nozzle pressure to the pressure below the specified 1st valve opening pressure by 1.96 MPa {285 lbf/in^2, 20 kgf/cm^2}. Maintain this pressure for 10 seconds and check that no fuel drips from the end of the nozzle.
- If the injection nozzle assembly **8** appears defective, disassemble and clean it, then inspect it again. If the injection nozzle assembly still appears defective, it must be replaced.

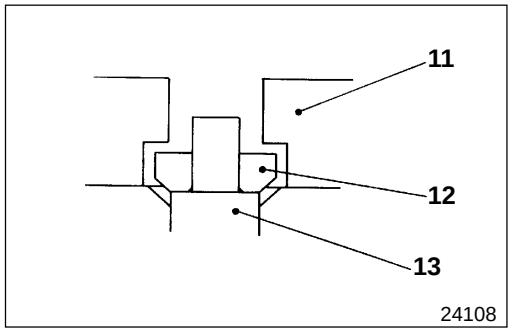


8 **Injection nozzle assembly**

[Disassembly]

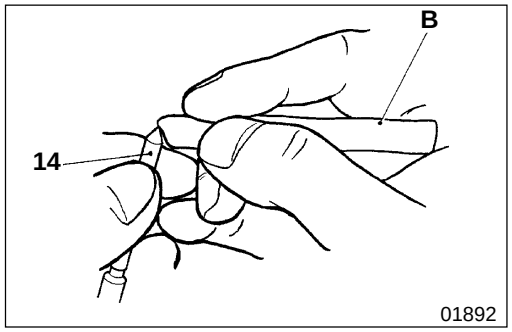
CAUTION ⚠

- **Never touch the sliding part A of the needle valve 14.**
- **Never change the needle valve 14 and nozzle 15 combination on each cylinder.**



[Assembly]

Assemble the tip packing **11** and the washer **12** (for adjustment of needle valve lift) in the illustrated directions.



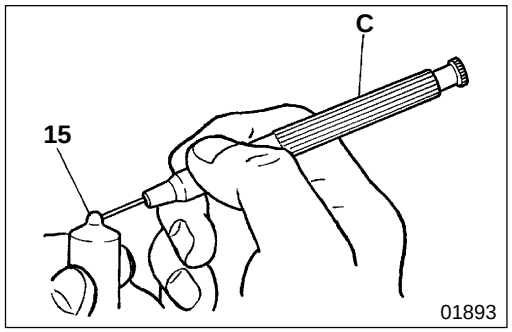
[Cleaning]

Wash the needle valve **14** and nozzle **15** in diesel fuel, then use the Cleaning Tool to remove any carbon deposits in accordance with the following procedure.

- Remove carbon from the end of the needle valve **14** using the Cleaning Bar **B** of the Cleaning Tool.

CAUTION ⚠

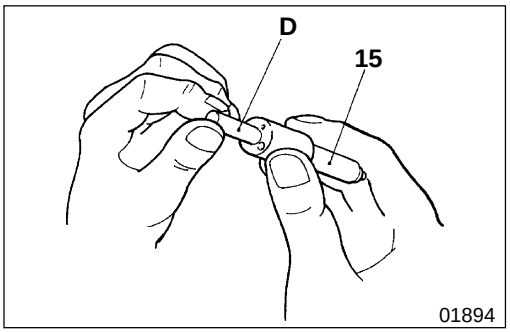
Do not use a wire brush or any hard metallic object for cleaning.

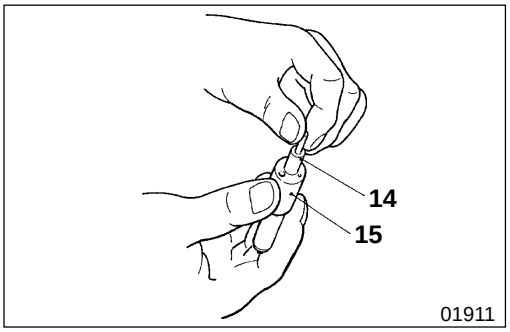


- Remove carbon from the injection orifice of the nozzle **15** using the Cleaning Needle **C** of the Cleaning Tool. Insert the Cleaning Needle and rotate it to remove carbon.

  Cleaning needle diameter: 0.20 mm {0.0079 in.} or smaller

INJECTION NOZZLE





- Clean the seat of the nozzle **15** using the Cleaning Scraper **D** of the Cleaning Tool.
- To remove burned and hardened carbon, use FUSO Carbon Remover.

[Inspection]

- Wash the needle valve **14** and nozzle **15** in diesel fuel, then fit them together.
- Pull up the needle valve **14** by approximately 1/3 of its entire stroke, then check that it drops under its own weight. Repeat this test several times, turning the needle valve each time.
- If the needle valve **14** does not drop as required, wash it in diesel fuel and carry out this test again. If the needle valve is still defective, replace the needle valve and nozzle **15** as a set.

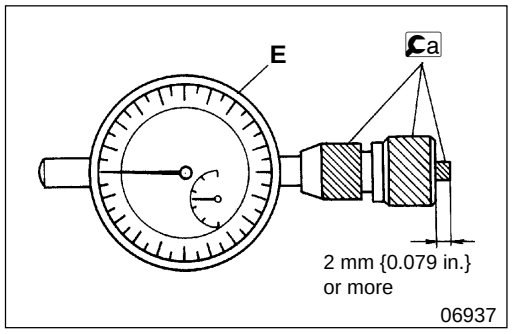
[Adjustment]

During reassembly, make adjustments in the sequence shown below.

CAUTION

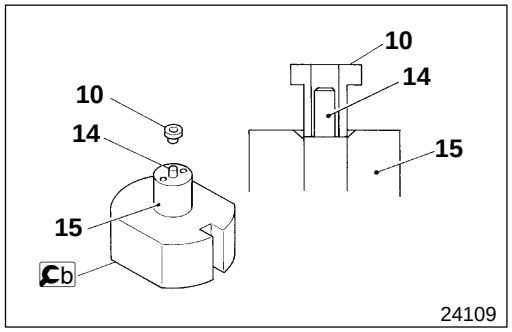
- **Before making adjustments, wash all parts in diesel fuel and ensure that they are free of dirt and other foreign material.**
- **Do not touch the sliding surfaces of the needle valve 14.**

- Check needle valve full lift
- Check prelift
- Adjust 2nd valve opening pressure
- Adjust 1st valve opening pressure

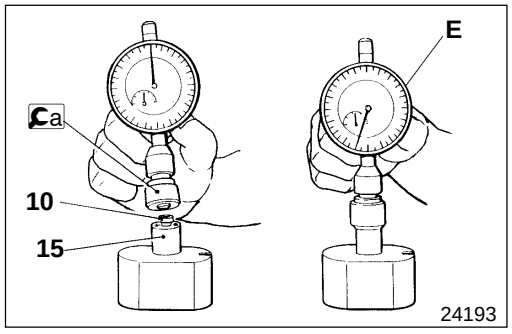


● **Checking needle valve full lift**

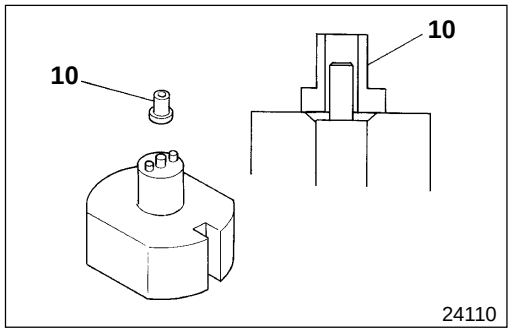
- Set the a Attachment Measure to a dial gauge **E**.



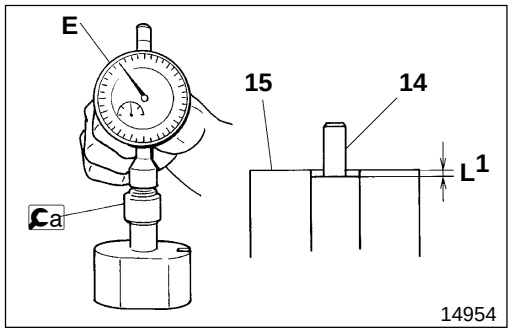
- Mount the nozzle **15** on the b base, with the needle valve **14** and spring seat **10** (for adjustment of pre-lift) fitted to the nozzle in that order.



- Fit the a Attachment Measure onto the nozzle **15**.
- Zero the dial gauge **E**.

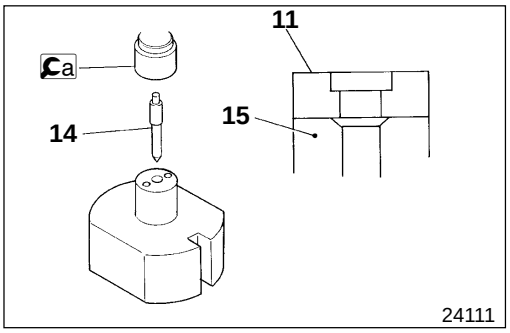


- Remove the a Attachment Measure. Remove the spring seat **10** (for adjustment of pre-lift) and refit it to the nozzle upside down.

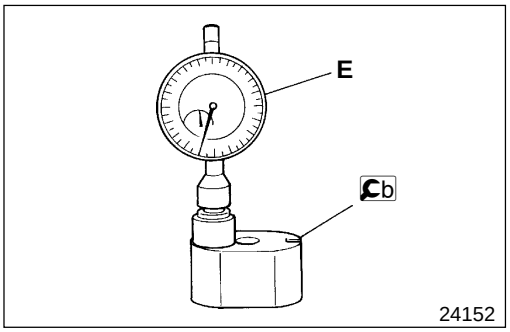


- Fit the a Attachment onto the nozzle **15** again, and read the dial gauge **E**. The reading should be the illustrated dimension L^1.

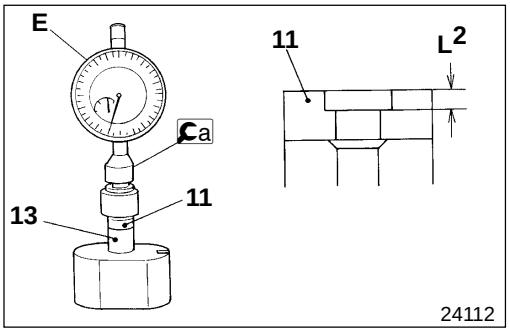
INJECTION NOZZLE



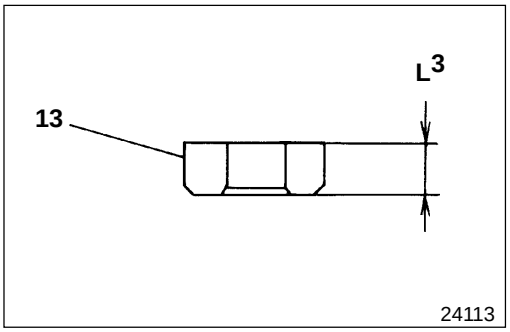
- Remove the a Attachment Measure and the needle valve **14**. Fit the tip packing **11** to the nozzle **15** as shown.



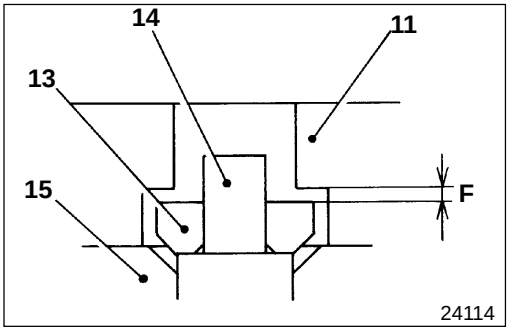
- Zero the dial gauge **E** on the b base.



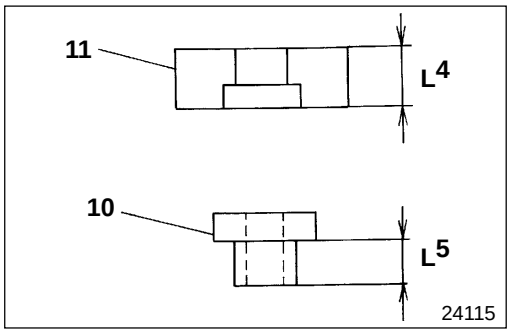
- Fit the a Attachment Measure to the tip packing **11**, and read the dial gauge **E**.
  The reading should be the illustrated dimension L^2.



- Measure the thickness L^3 of the washer **13** (for adjustment of needle valve lift).

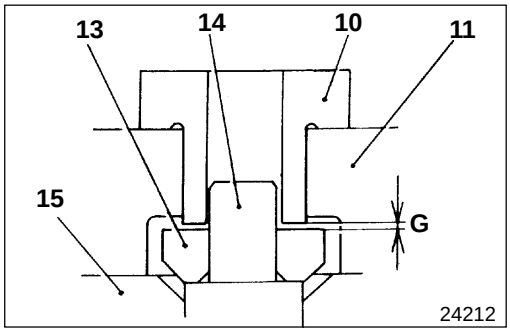


- Calculate the maximum lift **F** of the needle valve **14** from the measurements L^1, L^2 and L^3 as follows.
  Maximum lift **F** = $L^1 + L^2 - L^3$
- If the calculated value is out of specification, make the necessary adjustment by changing the washer **13** (for adjustment of needle valve lift).
  Washers **13** are available in the following thicknesses (L^3):
  2.40, 2.425, 2.45, 2.475, 2.50 mm {0.094, 0.095, 0.096, 0.097, 0.098 in.} (5 sizes)

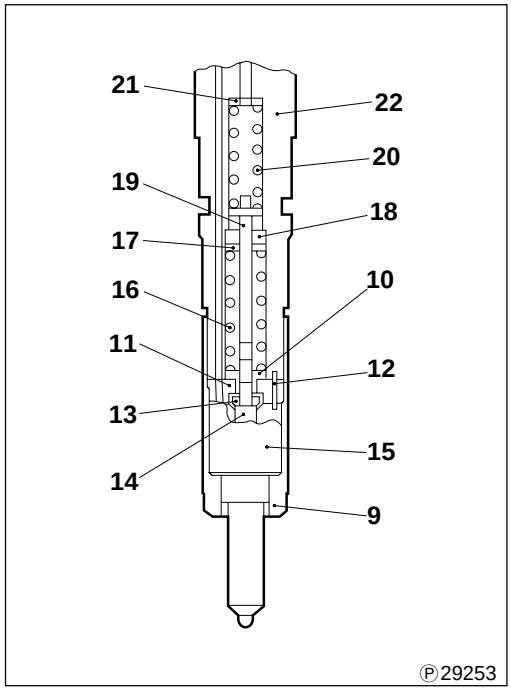


● **Adjusting pre-lift**

- Measure the thickness L^4 of the tip packing **11**.
- Measure the thickness L^5 of the spring seat **10 (**for adjustment of pre-lift).



- Calculate the pre-lift **G** from the measurements L^1, L^3, L^4 and L^5 as follows.
  Pre-lift **G** = $L^4 - L^5 - L^3 + L^1$
- If the calculated value is out of specification, make the necessary adjustment by changing the spring seat **10** (for adjustment of pre-lift).
  Spring seats **10** are available in the following thicknesses (L^5):
  2.59 to 2.80 mm {0.101 to 0.110 in.} (22 sizes at steps of 0.01 mm {0.00039 in.})



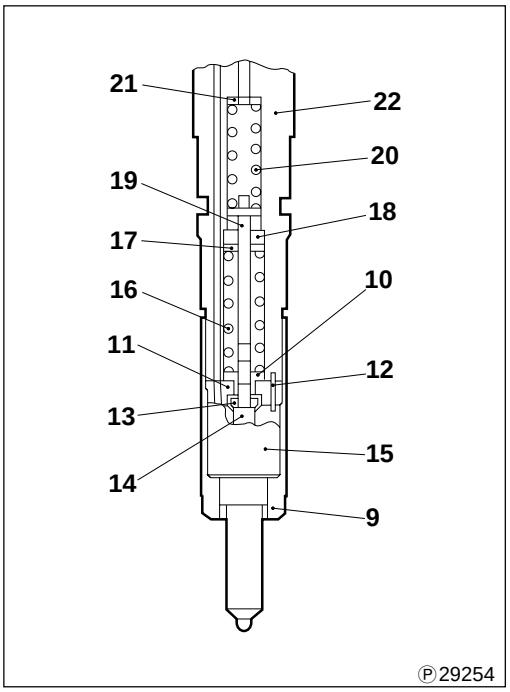
● **Adjusting 2nd valve opening pressure**

- Assemble parts to the nozzle holder **22** as shown. Fit the SC Master Spring Seat in the place of the spring seat **10** (for adjustment of pre-lift).
- Tighten the retaining nut **9** to the specified torque.
- Fit the nozzle assembly onto the nozzle tester and measure the 2nd valve opening pressure.

CAUTION ⚠

Never touch the spray that comes out of the nozzle.

- If the reading is out of specification, make the necessary adjustment by changing the adjusting shim **17** (for adjustment of 2nd valve opening pressure). Adjusting shims **17** are available in the following thicknesses.
  0.70 to 2.15 mm {0.028 to 0.085 in.} (30 sizes at steps of 0.05 mm {0.002 in.})
  0.975 to 1.775 mm {0.038 to 0.070 in.} (17 sizes at steps of 0.05 mm {0.002 in.})
- A difference of 0.025 mm {0.00098 in.} in the thickness of the adjustment shim **17** changes the 2nd valve opening pressure by 345 kPa {50 psi, 3.5 kgf/cm^2}.



● **Adjusting 1st valve opening pressure**

- Assemble parts to the nozzle holder **22** as shown.
- Tighten the retaining nut **9** to the specified torque.
- Fit the nozzle assembly onto the nozzle tester and measure the 1st valve opening pressure.

CAUTION ⚠

Never touch the spray that comes out of the nozzle.

- If the reading is out of specification, make the necessary adjustment by changing the adjusting shim **21** (for adjustment of 1st valve opening pressure).

  Adjusting shims **21** are available in the following thicknesses:
  0.8 to 2.0, 2.05, 2.075 to 2.2 mm {0.031 to 0.079, 0.080, 0.081 to 0.087 in.} (56 sizes at steps of 0.025 mm {0.00098 in.})
  A difference of 0.025 mm {0.00098 in. } in the thickness of the adjusting shim **21** changes the 1st valve opening pressure by 345 kPa {20 psi, 3.5 kgf/cm^2}.

MITSUBISHI
FUSO

Group 13B

Fuel and Engine Control

< 6D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWME0202-13B

INDEX

SPECIFICATIONS 13B- 2

STRUCTURE AND OPERATION 13B- 3

TROUBLESHOOTING 13B-10

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Checking and Adjusting Injection Timing 13B-12
- Bleeding Air from Fuel System 13B-13
- Cleaning Gauze Filter 13B-13
- Replacing Fuel Filter 13B-14

ENGINE CONTROL 13B-16

FUEL TANK 13B-21

FUEL FILTER 13B-22

WATER SEPARATOR 13B-23

INJECTION PUMP 13B-24

INJECTION PUMP DRIVE CASE 13B-30

INJECTION NOZZLE 13B-34

SPECIFICATIONS

Injection Pump

Item	Specifications
Manufacturer	BOSCH AUTOMOTIVE SYSTEMS
Body model	MD-TICS (Pre-stroke control type)
Governor type	RED-III electronically controlled governor
Feed pump model	KD
Automatic timer model	SPG mechanical type

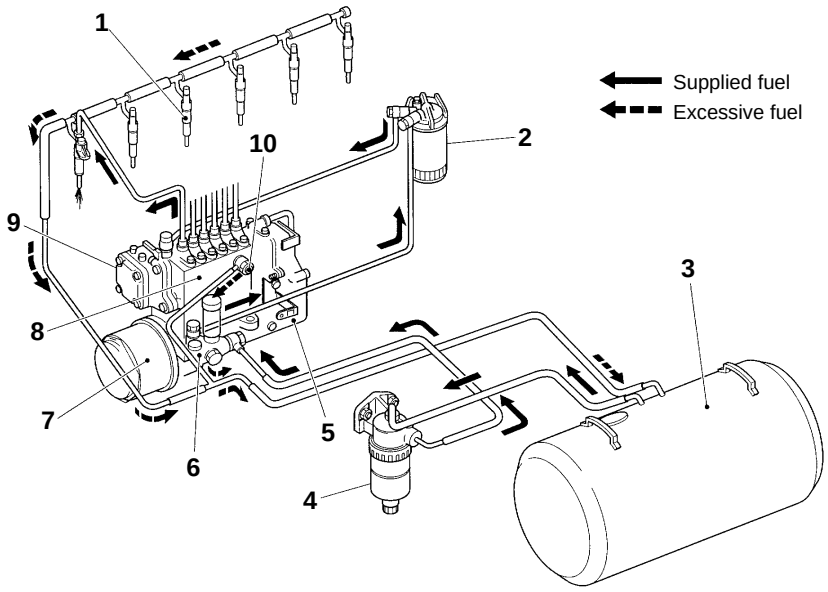
Injection Nozzle

Item	Specifications
Manufacturer	BOSCH AUTOMOTIVE SYSTEMS
Model and type	DLLA hole type 1-spring nozzle
Nozzle orifice quantity	5
Orifice diameter mm {in.}	ø0.23 {0.0091}

Fuel Filter

Item	Specifications
Filter type	Spin-on type

Fuel System (Flow of Fuel)

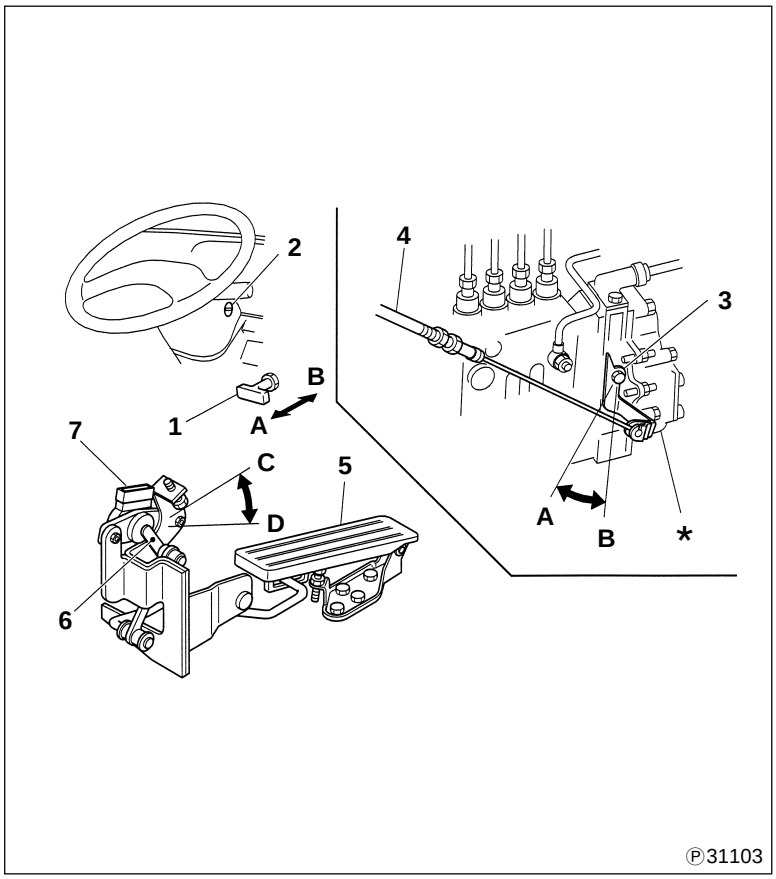


Ⓟ31102

1 Injection nozzle
2 Fuel filter
3 Fuel tank
4 Water separator
5 Governor
6 Feed pump
7 Automatic timer
8 Injection pump
9 Pre-stroke actuator
10 Overflow valve

Fuel in fuel tank **3** is sucked up by feed pump **6** which is driven by the cam action of injection pump **8** and is filtered through fuel filter **2** which removes dirt and other foreign particles.
Filtered fuel is sent to the injection pump where the fuel pressure is boosted and injected through injection nozzle **1** into the combustion chamber.
When fuel pressure is higher than the specified value, overflow valve **10** opens to let the fuel return to the fuel tank.

Engine Control



1 Emergency engine stop button
2 Starter switch
3 Engine stop lever
4 Engine stop cable
5 Accelerator pedal assembly
6 Lever
7 Accelerator pedal position sensor

***** : Electronic governor

A : Engine-stop position
B : Engine start-up position
C : Full-load position
D : Idling position

● **Accelerator switch**

The accelerator switch is integrated in the accelerator pedal position sensor **7**. It detects the pressing of accelerator pedal assembly **5**.

● **Accelerator pedal position sensor**

Accelerator pedal position sensor **7** detects the movement of accelerator pedal assembly **5**, and sends an electric signal to the engine electronic control unit. Lever **6** of the accelerator pedal position sensor is constantly pulled by the return spring towards idle position **D**.

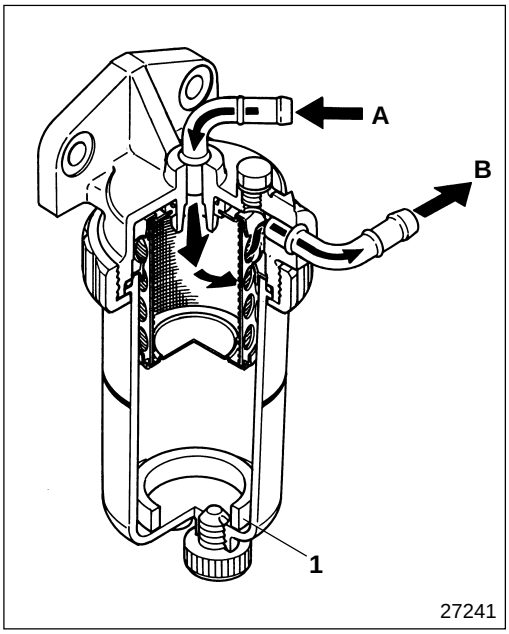
● **Emergency engine stop button**

In normal condition, turn starter switch **2** to the ACC position to electrically shut down the engine operation.
In the case the engine does not stop when the starter switch is turned to the ACC position due to malfunction of the electronic governor system or other cause, stop the engine by pulling emergency engine stop button **1** to move stop lever **3** of electronic governor ***** to engine stop position **A**.

CAUTION ⚠

When the engine is stopped by pulling engine stop button 1, set starter switch 2 to the ACC or LOCK position to reset the control unit computer.
Restarting the engine without resetting the computer results in unstable engine speed control.

Water Separator

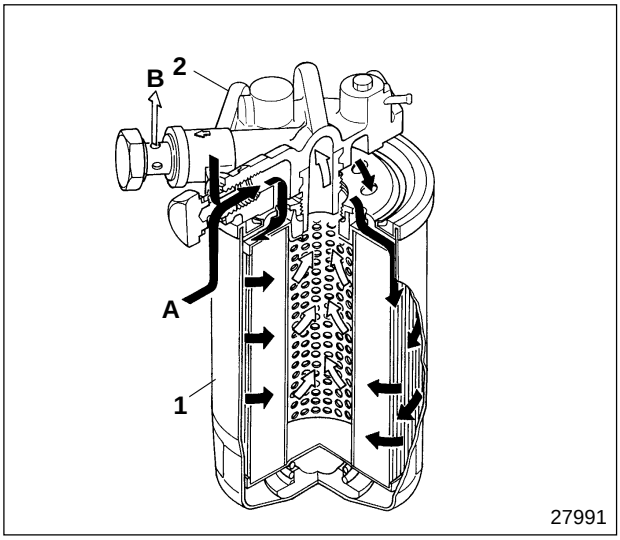


1 Water level ring

A : From fuel tank
B : To feed pump

The water separator is installed between the fuel tank and the feed pump. Any water present in the fuel is separated by the baffle plate and the screen assembly.

Fuel Filter

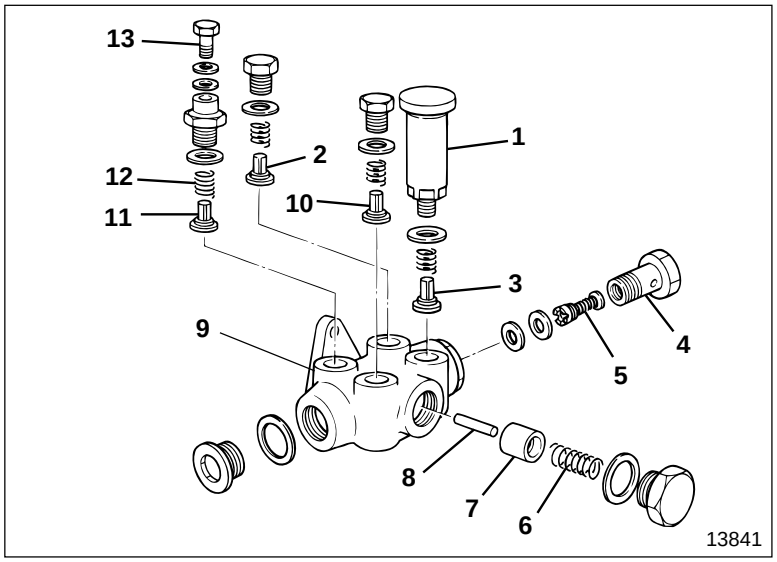


1 Fuel filter
2 Fuel filter head

A : From feed pump
B : To injection pump

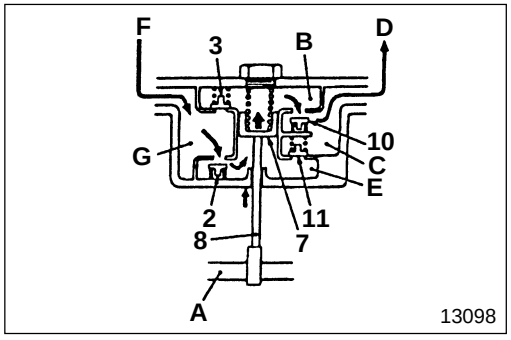
Pressurized fuel is delivered from the feed pump of the injection pump to the fuel filter which separates water from the fuel. Dirt and other foreign particles are removed from the fuel by fuel filter **1**.

Feed Pump

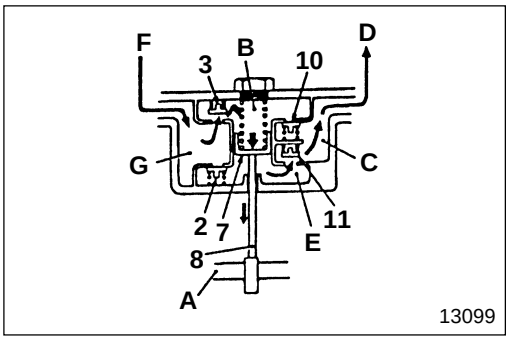


1 Priming pump
2 Check valve
3 Check valve
4 Eye bolt on fuel inlet side
5 Gauze filter
6 Piston spring
7 Piston
8 Push rod
9 Feed pump housing
10 Check valve
11 Check valve
12 Check valve spring
13 Eye bolt on fuel outlet side

- The feed pump is a double-action type pump which, with four check valves operating, sucks and discharges fuel during both strokes of pistons **7**.
- Push rod **8** makes contact with the injection pump camshaft directly, moving piston **7**.
- Priming pump **1** can be manually operated, when the injection pump is not operating, to suck up fuel and thus can be used for air bleeding.
- Gauze filter **5** eliminates large foreign particles from the fuel sucked up from the fuel tank to prevent clogging of the feed pump. This gauze filter must be cleaned with diesel fuel periodically.

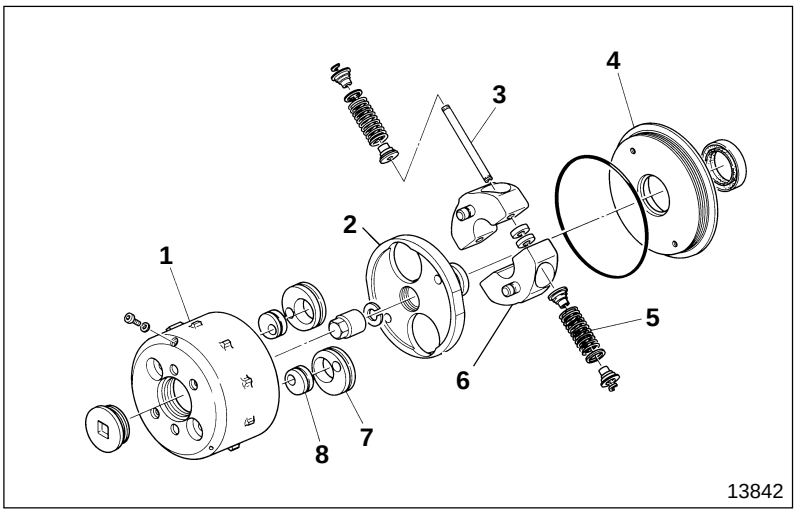


The rotation of injection pump camshaft **A**, pushes up push rod **8** and piston **7**, and the pressure in inner chamber **B** increases. This closes check valve **3**, and check valve **10** opens to let the fuel in inner chamber **B** flow through outer chamber **C** to fuel filter **D**.
When the pressure in inner chamber **E** decreases, check valve **11** closes, and check valve **2** opens to let fuel flow from fuel tank **F** through outer chamber **G** to inner chamber **E**.



When injection pump camshaft **A** rotates further, it pushes down push rod **8** and piston **7**, and the pressure in inner chamber **E** increases. This closes check valve **2**, and check valve **11** opens to let the fuel in inner chamber **E** flow through outer chamber **C** to fuel filter **D**.
When the pressure in inner chamber **B** decreases, check valve **10** closes, and check valve **3** opens to let fuel from fuel tank **F** flow through outer chamber **G** to inner chamber **B**.

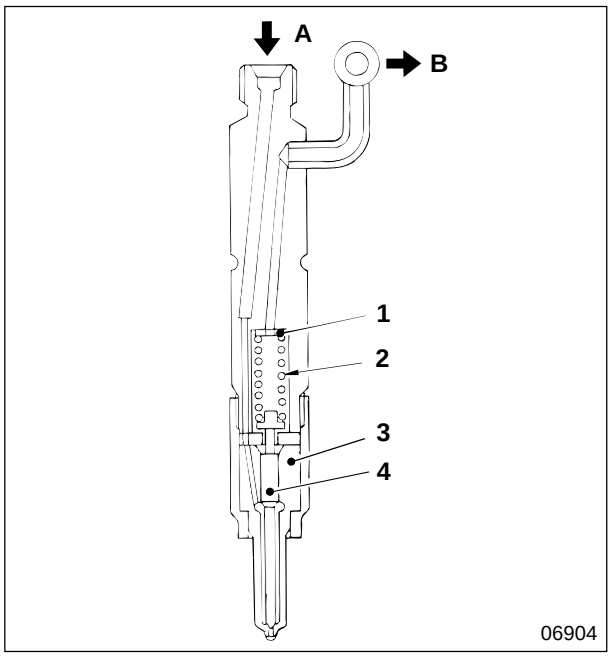
Automatic Timer



1 Timer housing
2 Timer holder
3 Pilot pin
4 Cover
5 Timer spring
6 Flyweight
7 Eccentric cam (Large)
8 Eccentric cam (Small)

- The mechanical type automatic timer changes fuel injection timing automatically when the engine revolution reaches the specified rate.
- The automatic timer controls the retard of fuel injection timing. The pre-stroke control unit controls the advance of fuel injection timing.

Injection Nozzle



1 Washer
2 Spring
3 Nozzle tip
4 Needle valve

A : From injection pump
B : To fuel tank

- As the pressure of the fuel delivered from the injection pump overcomes the repercussive force of spring **2**, needle valve **4** is pushed up to allow the fuel to spray out the opening at the tip of the nozzle.

- Injection pressure can be adjusted by increasing or decreasing the number of washers **1**.

M E M O

TROUBLESHOOTING

Possible causes \ Symptoms		Engine will not start	Engine difficult to start	Engine knocks	Unstable engine output	Insufficient engine output	Engine maximum speed too high	Unstable engine idling	Engine stops soon after starting	Engine does not reach maximum speed	Engine will not stop	Accelerator pedal too stiff	Defective fuel supply	Warning lamp illuminates	Remarks
Defective pre-stroke injection pump system														○	
Injection pump proper	Defective injection pump proper	○	○	○	○	○	○	○	○	○	○				*
	Defective mounting (poorly adjusted injection timing)		○		○	○		○							
	Defective overflow valve operation	○	○			○		○					○		
Defective pre-stroke actuator				○	○	○		○							
Fuel feed pump	Gauze filter clogged	○	○			○		○	○				○		
	Check valve not operating	○											○		
	Sticky piston	○											○		
	Sticky push rod	○											○		
	Defective check valve operation	○	○		○			○					○		
	Piston worn		○		○			○					○		
Defective governor				○	○	○	○	○	○	○	○				*
Injection nozzles	Sticky needle valve	○													
	Valve opening pressure too low	○								○					
	Blocked injection orifice	○		○		○		○		○					
	Poor airtightness in nozzle	○		○		○		○		○					
	Valve opening pressure too high			○											
	Broken spring				○	○									
	Defective sliding action in needle valve				○										
	Defective valve opening pressure				○										
	Weakness/deterioration in spring							○							
Fuel filter	Clogged filter	○			○			○	○						
Fuel tank empty		○													
Fuel pipes blocked and/or fuel leaking from connections		○													
Air or water in fuel system		○			○			○	○						
Low-quality fuel in use			○	○		○		○							

* : Must be serviced by BOSCH AUTOMOTIVE SYSTEMS service station.

Possible causes \ Symptoms		Engine will not start	Engine difficult to start	Engine knocks	Unstable engine output	Insufficient engine output	Engine maximum speed too high	Unstable engine idling	Engine stops soon after starting	Engine does not reach maximum speed	Engine will not stop	Accelerator pedal too stiff	Defective fuel supply	Warning lamp illuminates	Remarks
Engine control	Incorrect accelerator pedal stopper bolt adjustment					○				○					
	Rusted accelerator pedal arm											○			
	Defective accelerator pedal position sensor													○	
Cracked fuel pipe													○		
Leaky fuel tank													○		
Incorrect oil viscosity			○												Gr 12B
Incorrect valve clearance			○					○							Gr 11B
Defective cylinder head gasket			○					○							Gr 11B
Wear and/or carbon deposits on valve and valve seat			○					○							Gr 11B
Weakness/deterioration in valve spring			○					○							Gr 11B
Worn/damaged piston ring(s)			○					○							Gr 11B
Worn/damaged piston ring groove(s)			○					○							Gr 11B
Worn piston and cylinder liner			○												Gr 11B
Cooling system malfunctioning			○					○							Gr 14B
Defective starter switch			○												Gr 54B

ON-VEHICLE INSPECTION AND ADJUSTMENT

Checking and Adjusting Injection Timing

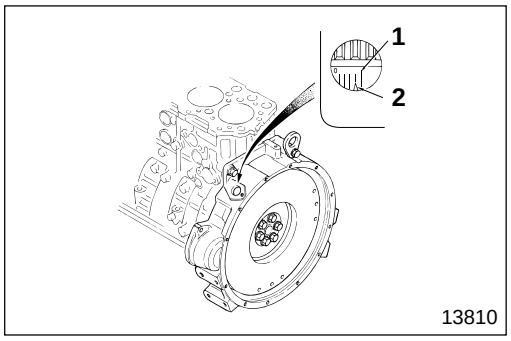
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Fuel injection timing (BTDC)	3°±0.5°	—	Adjust

Tightening torque

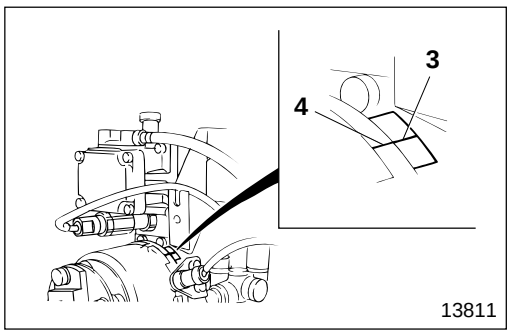
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Adjusting bolt	59 to 64 {43 to 47, 6 to 6.5}	—

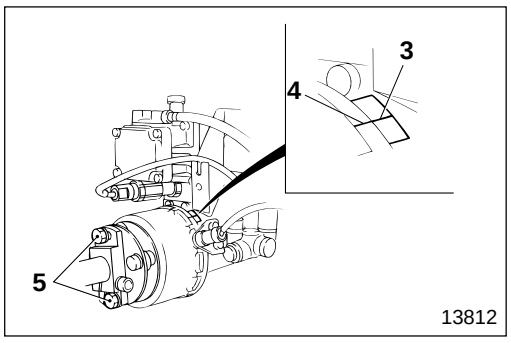


[Inspection]

- Turn the crankshaft more than 180° in the direction of engine rotation. Check if notch **1** on the flywheel and pointer **2** on the flywheel housing show the standard fuel injection timing.



- When pointer **3** on the injection pump and notch **4** on the automatic timer align, the fuel injection timing is standard.
- If the fuel injection timing is not standard, adjust as follows.



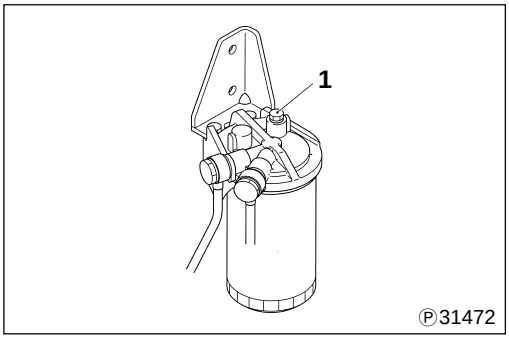
[Adjustment]

- Loosen adjusting bolts **5** and turn the automatic timer to align pointer **3** and notch **4**.
- Tighten adjusting bolts **5** at specified torque.
- Reinspect the fuel injection timing.

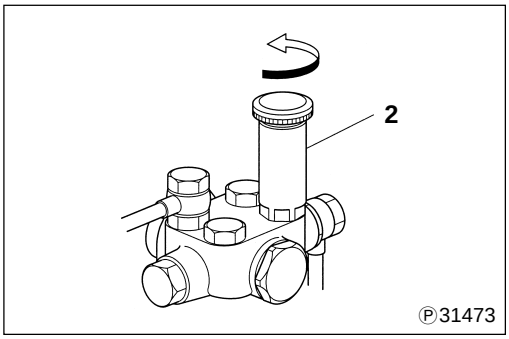
CAUTION ⚠

Do not loosen any bolts other than adjusting bolts 5.

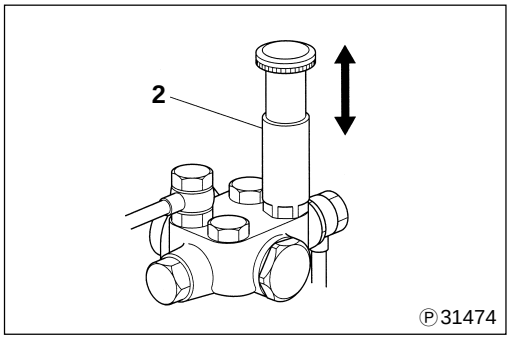
Bleeding Air from Fuel System



- Loosen the fuel filter air plug **1**.



- Turn the priming pump knob **2** counterclockwise until it pops up.
- Move the priming pump knob **2** up and down to feed fuel through the fuel filter.
- When fuel emerging from the fuel filter air plug **1** no longer contains air bubbles, tighten the air plug securely.

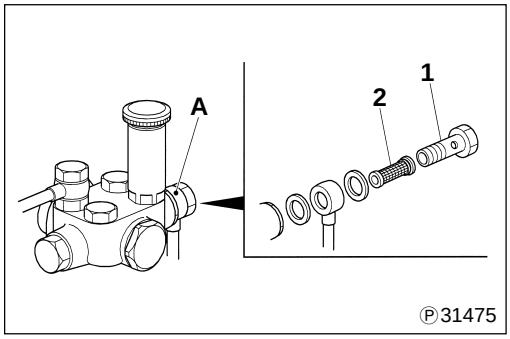


- Move the priming pump knob **2** up and down five or six more times. Then, press the knob down and screw it clockwise to lock it in position.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

WARNING⚠

- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**

Cleaning Gauze Filter



- Remove the eyebolt **1** from the suction port side **A** of the fuel feed pump.
- Remove the gauze filter **2** from the eyebolt **1**.
- Clean the gauze filter **2** in diesel fuel.
- Refit the gauze filter **2** and eyebolt **1** in the opposite order to that in which they were removed.
- Bleed all air out of the fuel system. 🕮 P13B-13
- Start the engine and check that no fuel leakage occurs.

WARNING⚠

- **To minimize the risk of fire, wipe up any spilled fuel.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After refitting the gauze filter, check that no fuel leakage occurs.**

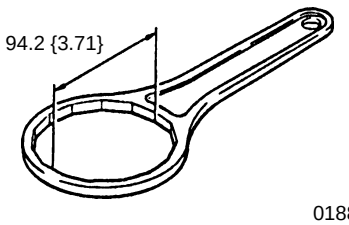
Replacing Fuel Filter

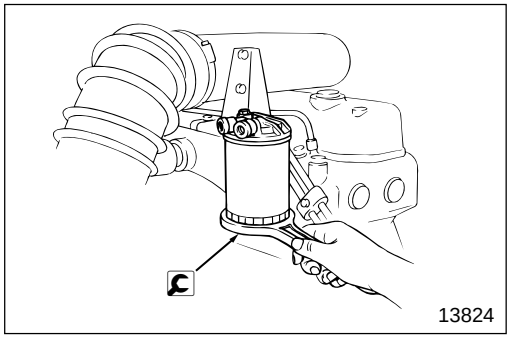
Lubricant

Location	Points of application	Specified lubricant	Quantity
1	Gasket between fuel filter and fuel filter head	Engine oil	As required

Special tool

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Filter wrench  01882	MH061572	Fuel filter removal


13824

[Removal]

: Filter Wrench

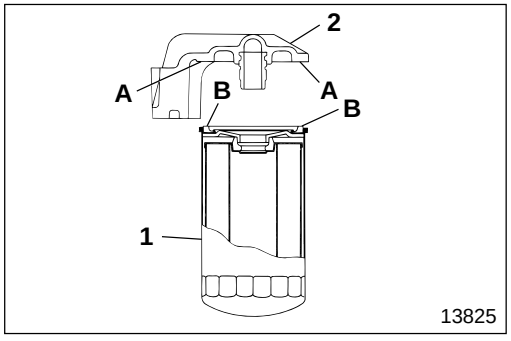
WARNING

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To minimize the risk of fire, wipe up any spilled fuel.**

[Installation]

WARNING

Use of an unsuitable fuel filter 1 can lead to fuel leaks and fires. Be sure to use a genuine filter.



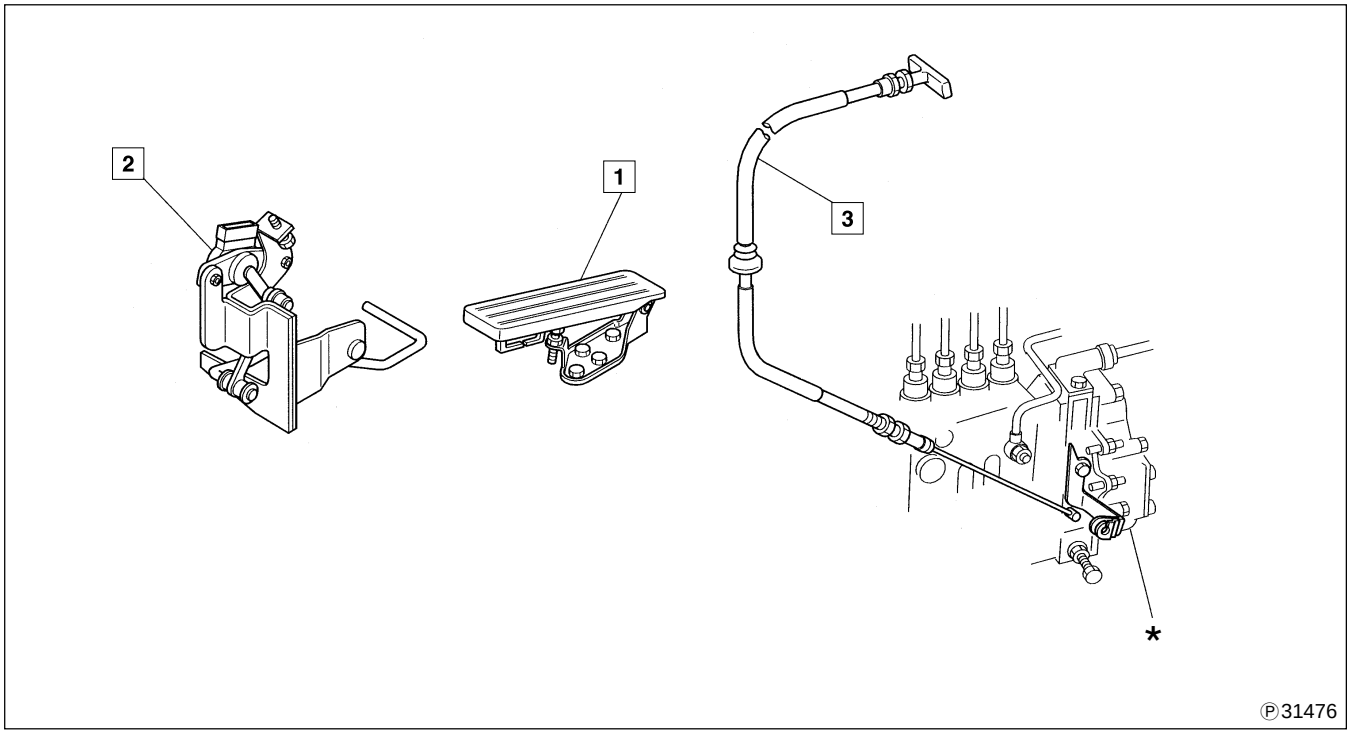
13825

- To fit the fuel filter **1**, turn it until the gasket **B** touches surface **A** of the fuel filter head **2**. Then, tighten the filter by 1 to $1\frac{1}{8}$ turn. Be sure to turn the filter by hand.
- Bleed all air out of the fuel system. P13B-13

WARNING

After fitting the fuel filter 1, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.

M E M O



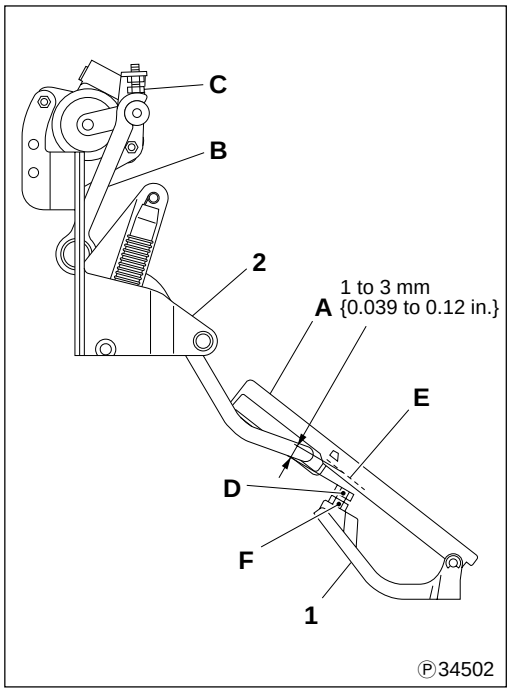
● **Removal sequence**

1 Accelerator pedal assembly
2 Accelerator pedal position sensor assembly
3 Emergency engine stop cable

***** : Injection pump assembly

● **Installation sequence**

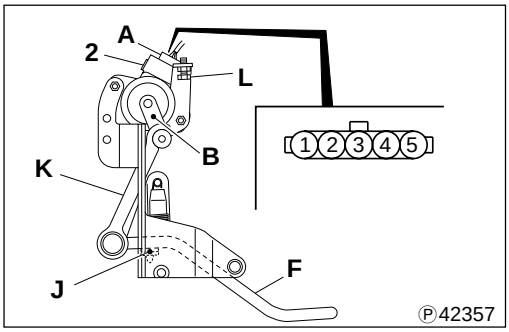
Follow the removal sequence in reverse.



◆ Service procedure

1 **Installation of accelerator pedal assembly**

- Fit the accelerator pedal assembly **1** onto the accelerator pedal position sensor assembly **2**.
- Depress the accelerator pedal **A** until the accelerator control extension **B** touches the stopper bolt **C** of the accelerator pedal position sensor assembly **2**.
- Check that the clearance between the stopper bolt **D** and the stopper bolt contact surface **E** of the accelerator pedal **A** is as shown in the illustration.
- Adjust the stopper bolt **D**, if necessary, to achieve the illustrated clearance. Lock the stopper bolt with the nut **F** after adjustment.



2 **Inspect the accelerator pedal position sensor**

[Inspection]

- Set the starter switch to ON.
- Measure the output voltage of the accelerator position sensor **2** from the back side of harness connector **A** according to the following table.

Lever **B** position		Accelerator Position Sensor I		Accelerator Position Sensor II		Accelerator Switch	
		②	①	②	⑤	②	③
		⊕	⊖	⊕	⊖	⊕	⊖
Standard value	Idling position **C**	0.85±0.1 V		0.85±0.1 V		4V or more	
	Accelerator switch operating position **D**	1.0±0.24 V		1.0±0.24 V		1V or less	
	Full load position **E**	4.15±0.1 V		4.15±0.1 V			

○——○ : There must be continuity between the pins.

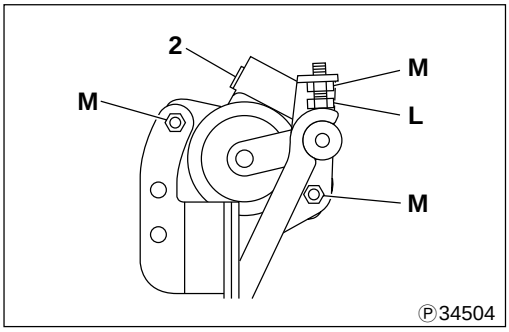
⊕ , ⊖ : Polarity when voltage is measured

C: Where accelerator control arm **F** is in contact with stopper **J**

D: Where voltage across pins ② and ③ is reduced to 1V or less by slowly depressing the accelerator pedal

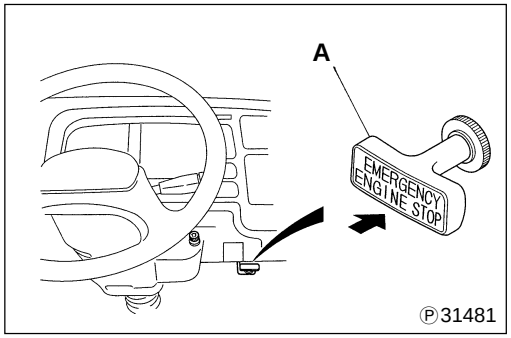
E: Where accelerator control extension **K** is in contact with stopper bolt **L**

- If the output voltage is out of the standard value range, adjust by the following procedures.



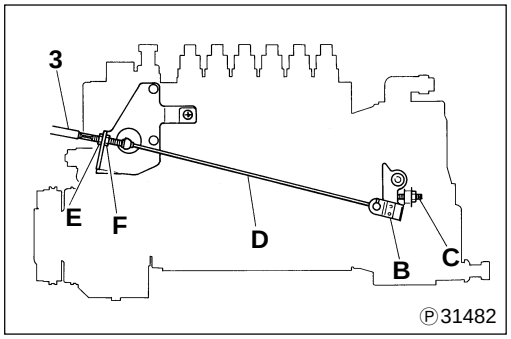
[Adjustment]

- Adjust the output voltage at the idling position **C** by loosening the screw **M** and moving the accelerator position sensor **2**.
  After the adjustment, retighten the screw.
- Adjust the output voltage at the full load position **E** by loosening the nut **M** and adjusting the stopper bolt **L**.
  After the adjustment, lock the bolt with the nut.



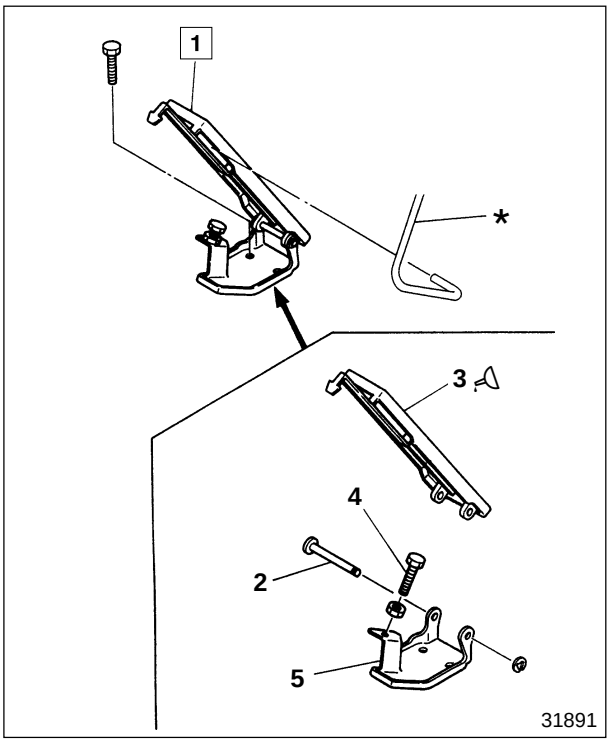
3 **Installation of emergency engine stop cable**

- Mount stop button **A** on emergency engine stop cable **3** and press the button firmly in position.



- With stop lever **B** of the governor contacting stopper bolt **C**, adjust nut **E** so that inner cable **D** of emergency stop cable **3** is taut. Then, tighten nut **F** to secure it in place.
- After installation, start the engine. Pull the stop button to make sure that the engine stops operating.

Accelerator Pedal Assembly



● **Disassembly sequence**

1 Accelerator pedal assembly
2 Clevis pin
3 Accelerator pedal
4 Stopper bolt
5 Accelerator pedal bracket

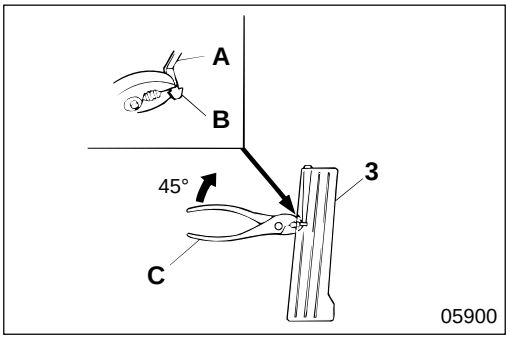
***** : Accelerator pedal position sensor assembly 🕮 P13B-20

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Specified lubricant	Quantity
3	Slide-contacting surfaces of accelerator pedal and bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required



◆ Service procedure

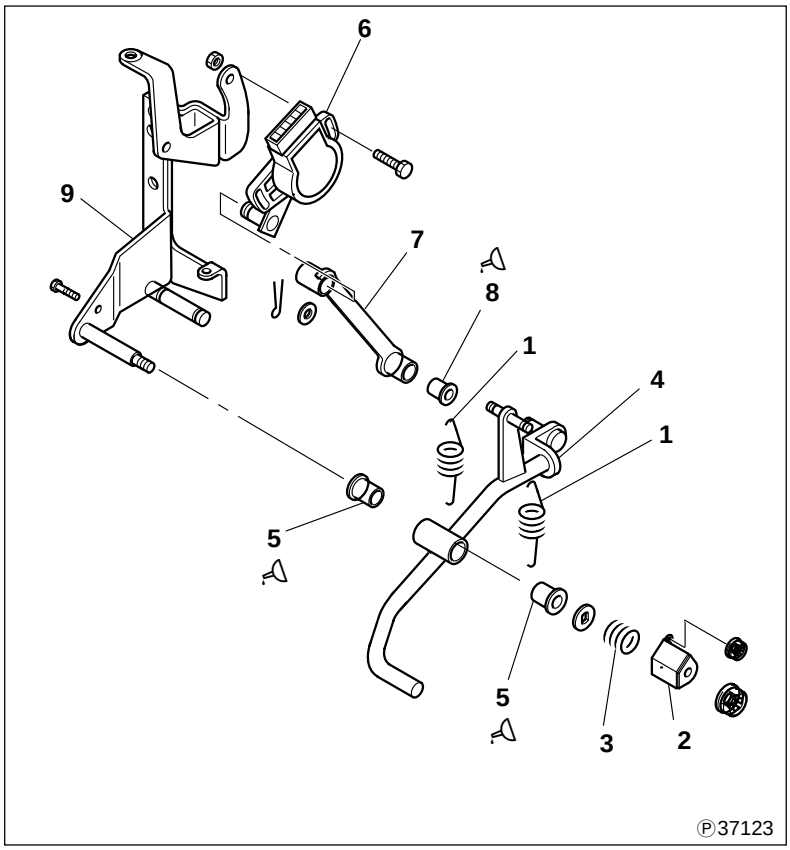
1 **Removal of accelerator pedal assembly**

Pinch hook **B** of stopper **A** of accelerator pedal **3** using pliers **C** and rotating approximately 45° pull out the stopper towards the front of the vehicle.

CAUTION ⚠

Take care not to damage stopper A itself during removal, do not pull it out too forcibly.

Accelerator Pedal Position Sensor Assembly



● **Removal sequence**

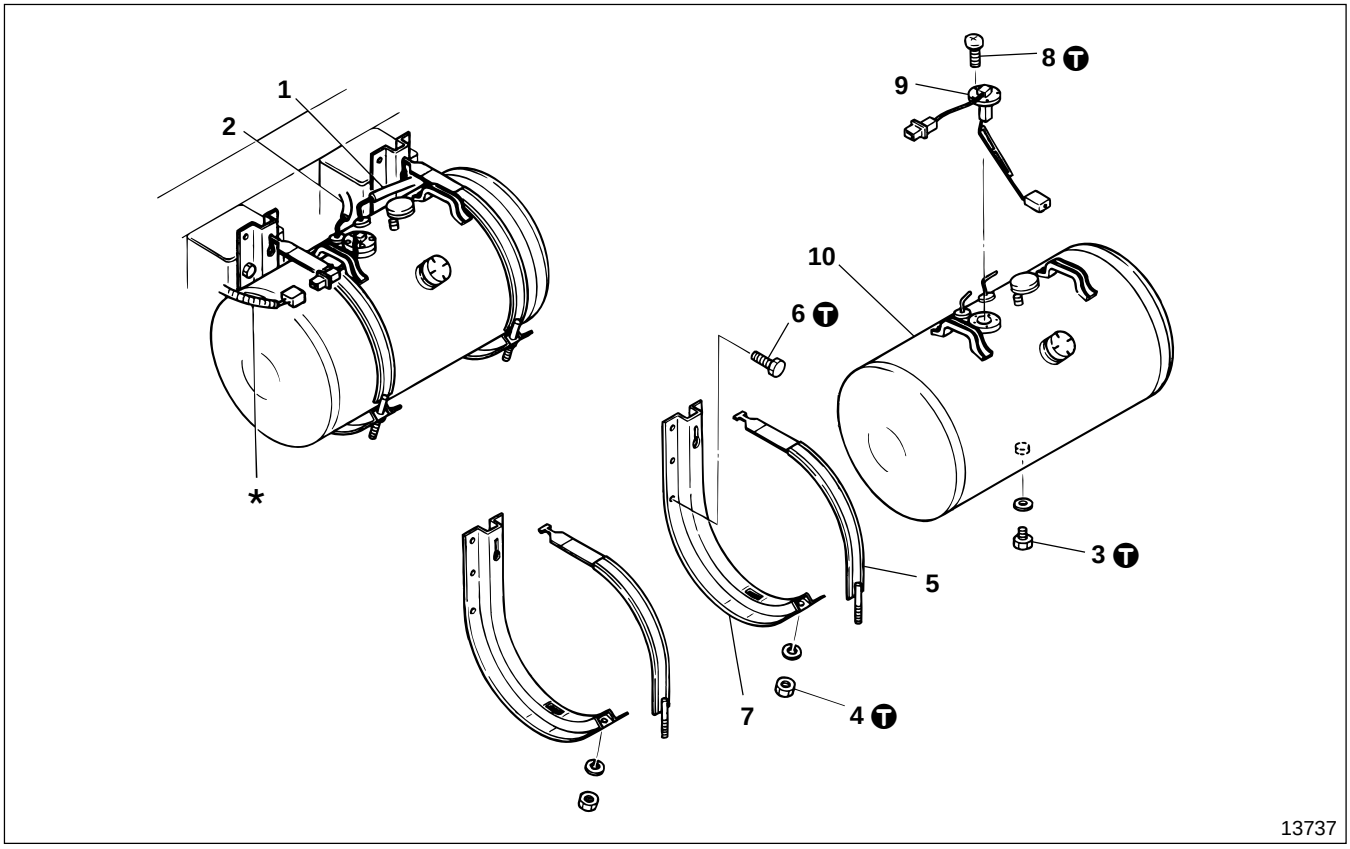
1 Return spring
2 Shaft cover
3 Spring
4 Accelerator control arm
5 Bushing
6 Throttle position sensor
7 Accelerator control extension
8 Bushing
9 Bracket

● **Installation sequeence**

Follow the removal sequence in reverse.

Lubricant

Location	Points of application	Specified lubricant	Quantity
5, 8	Slide-contacting surfaces of bushing and support assembly	Chassis grease [NLGI No.1 (Ca soap)]	As required



● **Work before removal**

WARNING ⚠

- **Keep drop lights away because of the risk of explosion.**
- **Wipe up any spilled fuel because it can cause a fire.**

NOTE

Drain fuel before working on the job.

● **Removal sequence**

1 Suction hose
2 Return hose
3 Drain plug
4 Nut
5 Fuel tank band
6 Bolt
7 Fuel tank bracket
8 Screw
9 Fuel gauge sending unit Gr 54
10 Fuel tank

***** : Chassis harness Gr 54

● **Installation sequence**

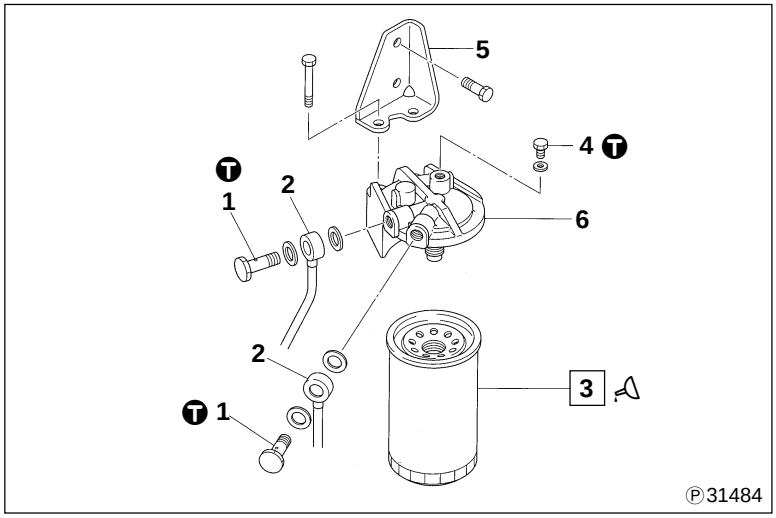
Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain plug	59 to 98 {43 to 72, 6 to 10}	—
4	Nut (Fuel tank band mounting)	5.9 to 9.8 {4.3 to 7.2, 0.6 to 1.0}	—
6	Bolt (Fuel tank bracket mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—
8	Screw (Fuel gauge sending unit mounting)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	—

FUEL FILTER



● **Disassembly sequence**

1 Eye bolt
2 Fuel feed pipe
3 Fuel filter
4 Air vent plug
5 Bracket
6 Fuel filter head

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

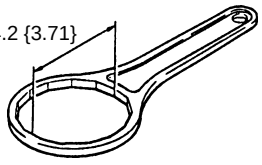
Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt	25 to 34 {18 to 25, 2.5 to 3.5}	—
4	Air vent plug	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—

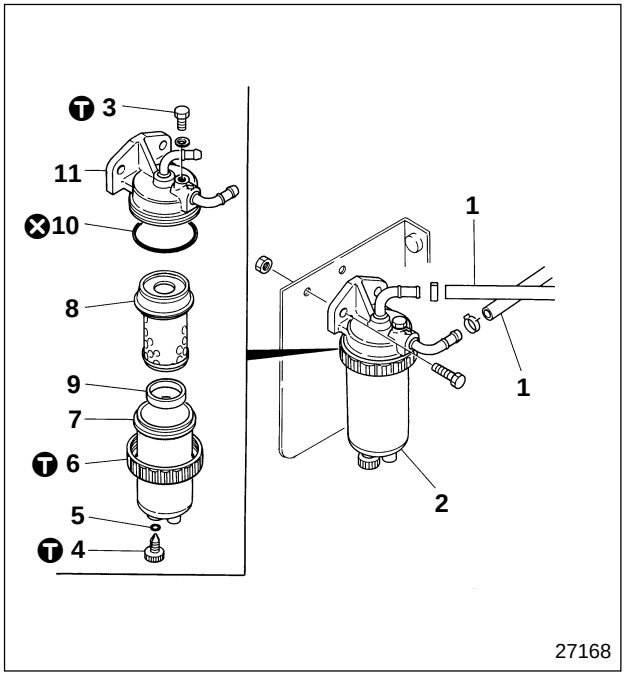
Lubricant

Location	Points of application	Specified lubricant	Quantity
3	Gasket contact surfaces of fuel filter and fuel filter head	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Filter wrench  01882	MH061572	Removal of fuel filter



● **Disassembly sequence**

1 Fuel hose
2 Water separator assembly
3 Air vent plug
4 Drain plug
5 O-ring
6 Ring nut
7 Case
8 Screen assembly
9 Water level ring
10 O-ring
11 Head

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Operations after assembly**

Bleed all air out of the fuel system. 🕮 P13B-13

WARNING ⚠

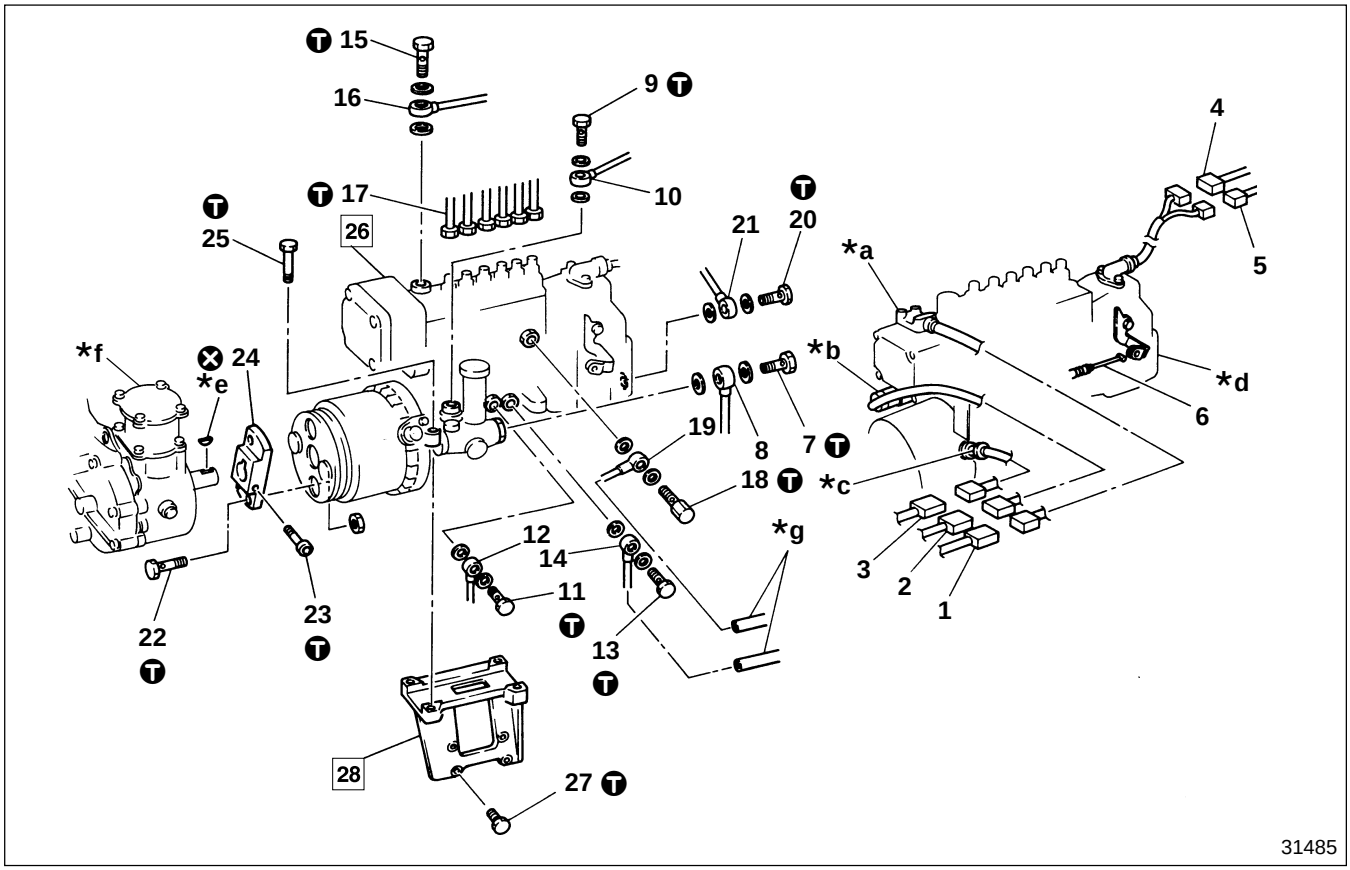
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After assembling the water separator, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.**

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Air vent plug	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—
4	Drain plug	3 to 4 {2.2 to 2.9, 0.3 to 0.4}	—
6	Ring nut	23 to 27 {17 to 20, 2.3 to 2.8}	—

INJECTION PUMP



● **Removal sequence**

1 Harness (6 pin)
2 Harness (4 pin)
3 Harness (3 pin)
4 Harness (10 pin)
5 Harness (3 pin)
6 Emergency engine stop cable 🕮 P13B-16
7 Eye bolt
8 Fuel suction pipe
9 Eye bolt
10 Fuel feed pipe
11 Eye bolt
12 Oil feed pipe
13 Eye bolt
14 Oil return pipe
15 Eye bolt
16 Fuel feed pipe
17 Injection pipe
18 Overflow valve
19 Fuel return pipe
20 Eye bolt
21 Oil return pipe
22 Bolt
23 Cotter bolt
24 Driving coupling
25 Bolt
26 Injection pump assembly
27 Bolt
28 Injection pump bracket

***a** : Pre-stroke actuator 🗀 Gr 13EB
***b** : Sub control rod position sensor 🗀 Gr 13EB
***c** : Engine speed sensor 🗀 Gr 13EB
***d** : Electronic governor 🗀 Gr 13EB
***e** : Key
***f** : Injection pump drive case 🕮 P13B-30
***g** : Fuel hose
⊗ : Non-reusable parts

WARNING ⚠

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any spilled fuel because it can cause a fire.**

CAUTION ⚠

- **Be sure to protect all openings by covering them after removal of hoses and pipes because the engine performance is adversely affected if dirt and foreign particles enter injection pump assembly 26.**
- **Do not hold the control lever when lifting injection pump assembly 26. Also, do not remove the control lever because removal of the lever might cause poor performance of the pump.**
- **Do not remove injection pump bracket 28 unless it is faulty.**
- **Make sure you connect fuel hose *g at a high position because fuel in the fuel tank would leak out if the end of the fuel hose were at a position lower than the tank.**

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
28	Injection pump bracket (eccentricity of injection pump centering tool to air compressor crankshaft)	0.2 {0.0079} or less	—	Adjust

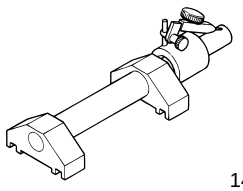
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

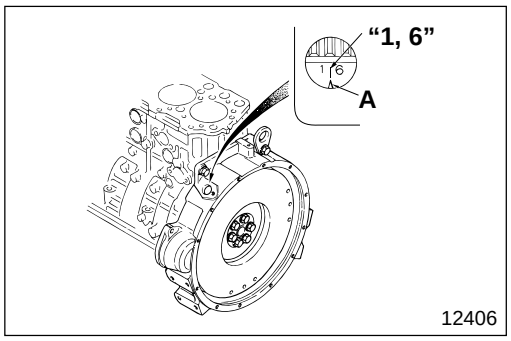
Location	Parts to be tightened		Tightening torque	Remarks
7, 9, 15	Eye bolt (Fuel suction pipe and fuel feed pipe mounting)		25 to 29 {18 to 22, 2.5 to 3}	—
11, 20	Eye bolt (Oil feed pipe and Oil return pipe mounting)		12 to 15 {8.7 to 11, 1.2 to 1.5}	—
13	Eye bolt (Oil return pipe mounting)		20 to 29 {14 to 22, 2 to 3}	—
17	Injection pipe mounting		29 to 49 {22 to 36, 3 to 5}	—
18	Overflow valve mounting		20 to 29 {14 to 22, 2 to 3}	—
22	Bolt (Driving coupling mounting)		59 to 64 {43 to 47, 6 to 6.5}	—
23	Cotter bolt		83 to 93 {61 to 69, 8.5 to 9.5}	—
25	Bolt (Injection pump assembly mounting)	Primary tightening	4.9 {3.6, 0.5}	—
		Secondary tightening	25 {18, 25}	—
27	Bolt (Injection pump bracket mounting)		33 to 55 {25 to 41, 3.4 to 5.6}	—

Special tools

Unit : mm {in.}

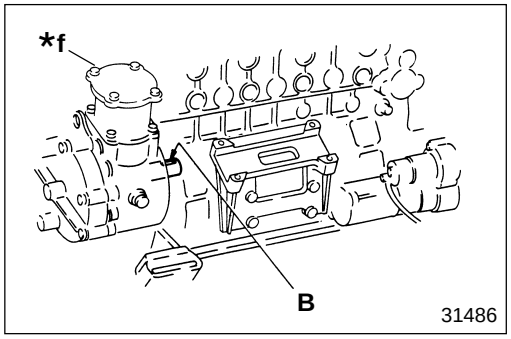
Location	Tool name and shape	Part No.	Application
28	Injection pump centering tool  14311	MH063336	Positioning of injection pump bracket

◆ Service procedure

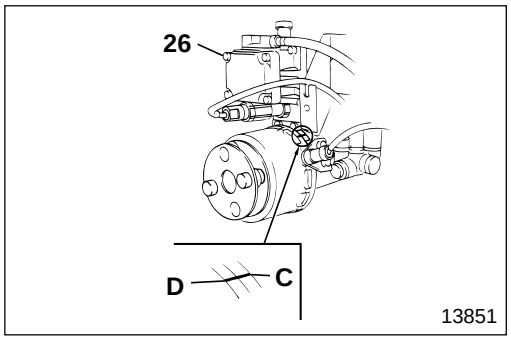


26 **Installation of injection pump assembly**

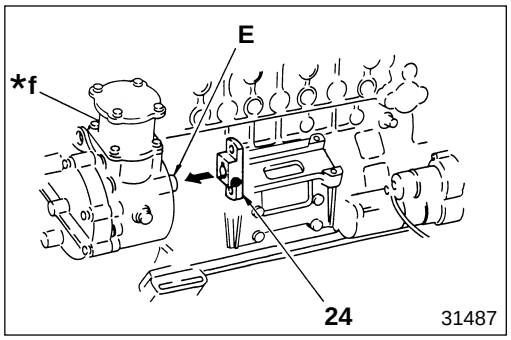
- Turn the engine to bring No.1 cylinder piston to top dead center in the compression cycle, and align mark "**1, 6**" of the flywheel with pointer **A** on the flywheel housing.



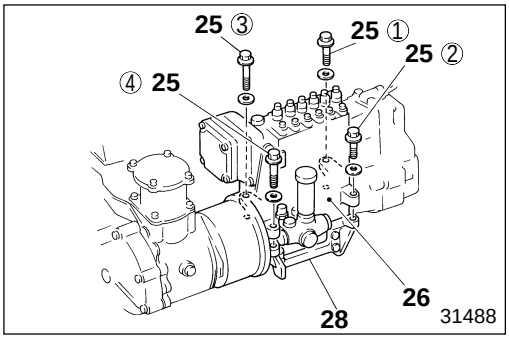
- In this state, make sure that keyway **B** in the crankshaft of injection pump drive case ***f** faces upward.
- If keyway **B** is not facing upward, turn the engine crankshaft by one turn.



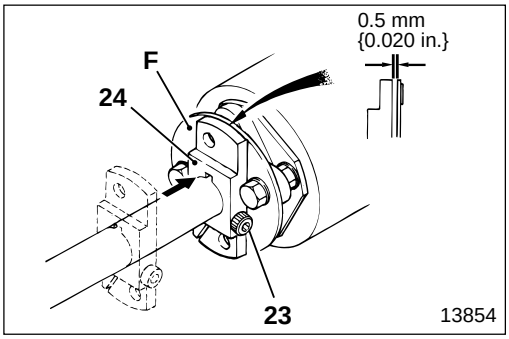
- Align pointer **C** on injection pump assembly **26** with notch **D** on the automatic timer.



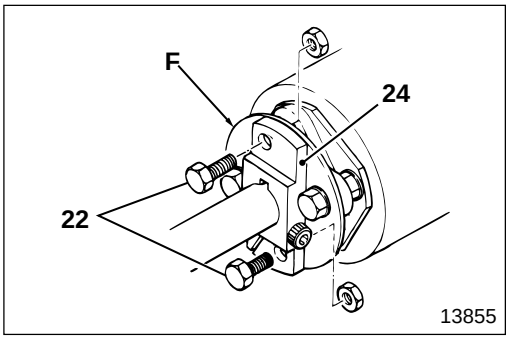
- Install driving coupling **24** to crankshaft **E** of injection pump drive case ***f** and place the driving coupling on the air compressor side.
- Install injection pump assembly **26** on the injection pump bracket.



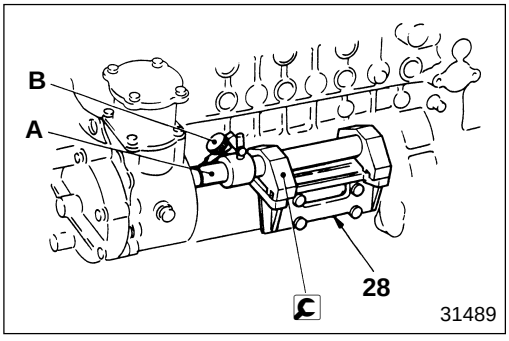
- Install injection pump assembly **26** on injection pump bracket **28**.
- Tighten bolts **25** in the order as illustrated at specified torque for primary tightening.
- Retighten bolts **25** in the order as illustrated at specified torque for secondary tightening.



- Move driving coupling **24** to adjust the clearance between the driving coupling and coupling plate **F** as illustrated, then tighten cotter bolt **23** at specified torque.



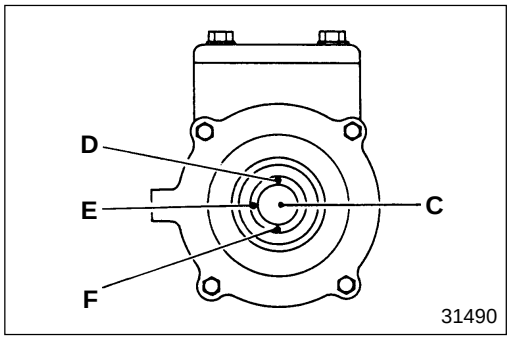
- Attach driving coupling **24** and coupling plate **F** using bolts **22** and tighten the bolts temporarily.
- In this state, adjust the fuel injection timing.
  Adjustment of fuel injection timing : P13B-12
  After adjusting the fuel injection timing, tighten bolts **22** at specified torque.



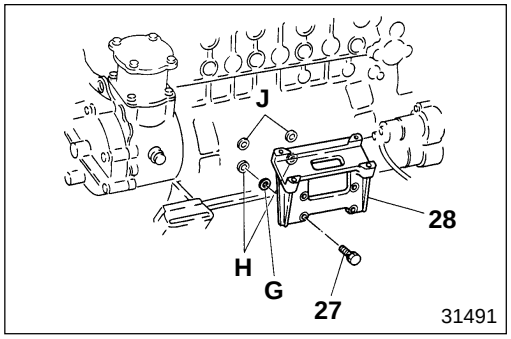
28 **Injection pump bracket**

[Inspection]

- Attach dial gauge **B** to arbor **A** of injection pump centering tool and adjust to gauge to zero setting.



- Slide dial gauge **B** toward injection pump drive case ***f** and measure the eccentricity of crankshaft **C** against arbor **A** at points **D**, **E** and **F**.
- If the measured value is higher than the standard value, adjust as follows.



[Adjustment]

- When the measured value at point **E** is higher than the standard value:
  Insert shims **G** into four points equally.
- When the measured value at point **D** is higher than the standard value:
  Insert shims **G** into lower side **H**.
- When the measured value at point **F** is higher than the standard value:
  Insert shims **G** into upper side **J**.

CAUTION ⚠

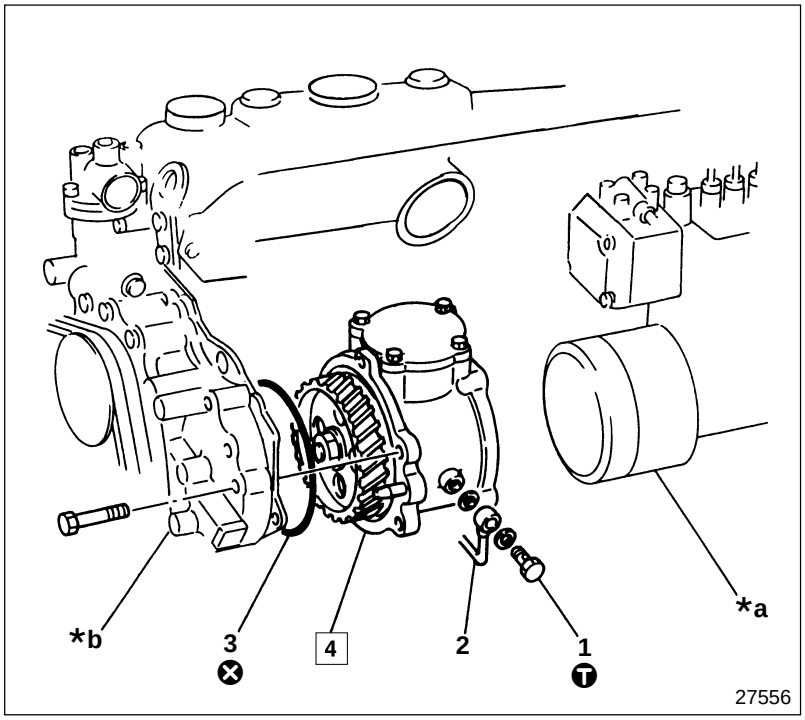
Insert shims G observing the following conditions:

- **Number of shims per point is three or less.**
- **The same number of shims should be used for the front and the rear.**
- **The difference in number of shims used for bottom and top is none or one.**

- Tighten bolt **27** at specified torque, then reinspect.

M E M O

INJECTION PUMP DRIVE CASE



● **Removal sequence**

1 Eye bolt
2 Oil pipe
3 O-ring
4 Injection pump drive case assembly 📖 P13B-32

***a** : Injection pump assembly 📖 P13B-24
***b** : Timing gear case Gr 11B
⊗ : Non-reusable parts

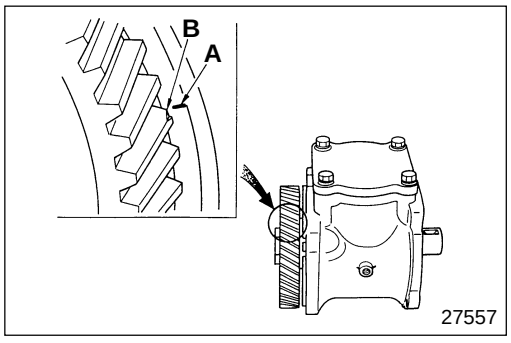
● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt	21 {15, 2.1}	—



◆ Service procedure

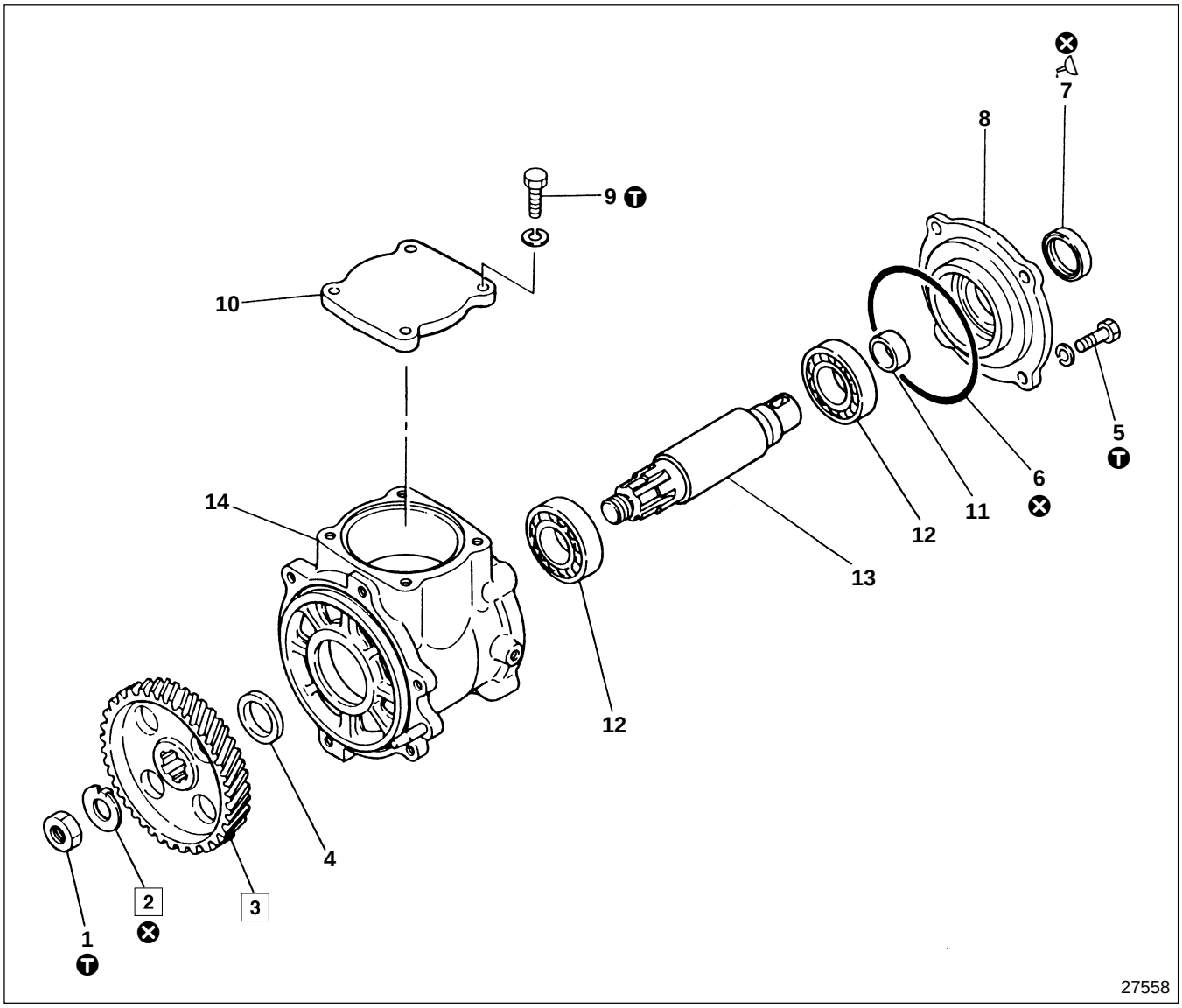
4 **Installation of injection pump drive case assembly**

- Position No.1 cylinder of the engine at top dead center in the compression cycle. Gr 11B
- Align marking line **A** with notch **B**, then install injection pump drive case assembly **4** on timing gear case ***b**.

M E M O

INJECTION PUMP DRIVE CASE

Injection Pump Drive Case Assembly



● **Disassembly sequence**

1 Nut
2 Lock washer
3 Drive gear
4 Collar
5 Bolt
6 O-ring
7 Oil seal
8 Bearing holder
9 Bolt
10 Cover
11 Sleeve
12 Bearing
13 Shaft
14 Crankcase

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

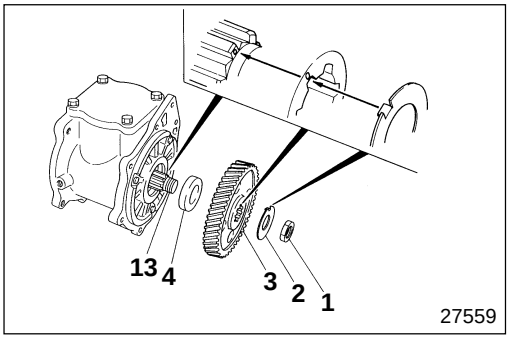
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drive gear mounting)	166.7 to 210.8 {120 to 155, 17.0 to 21.5}	—
5	Bolt (Bearing holder mounting)	13.7 to 17.7 {10 to 13, 1.4 to 1.8}	—
9	Bolt (Cylinder head assembly mounting)	24.5 to 29.4 {18 to 22, 2.5 to 3.0}	—

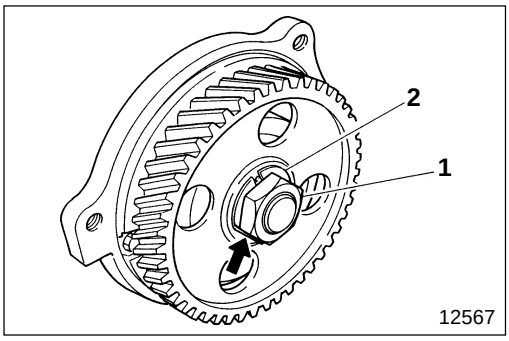
Lubricant

Location	Points of application	Specified lubricant	Quantity
7	Oil seal lip	Engine oil	As required

◆ Service procedure

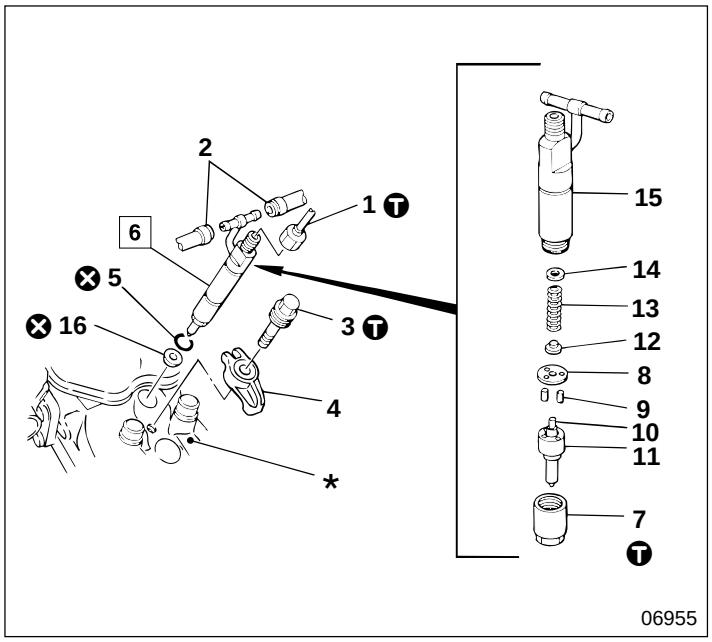


2 **3** **Installation of lock washer and drive gear**



After installation, bend lock washer **2** to nut **1** side.

INJECTION NOZZLE



● **Inspection before disassembly**

P13B-35

● **Disassembly sequence**

1 Injection pipe
2 Leak-off pipe
3 Bolt
4 Bridge
5 O-ring
6 Injection nozzle assembly
7 Retaining nut
8 Tip packing
9 Straight pin
10 Needle valve
11 Nozzle
12 Pressure pin
13 Spring
14 Adjusting shim
15 Nozzle holder
16 Nozzle gasket

* : Cylinder head Gr 11B
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

Wipe up any spilled fuel because it can cause a fire.

CAUTION ⚠

- **Be sure not to touch slide-contact area of needle valve 10 because any scratches or corrosion might spoil the airtightness of nozzle 11. It must be handled with utmost care.**
- **Never change the combination of needle valve 10 and nozzle 11 for each cylinder.**
  Be sure to protect all openings by covering them after removal of hoses and pipes because the engine performance is adversely affected if dirt and foreign particles enter injection nozzle assembly 6.

NOTE

Remove carbon deposits and clean injection nozzle assembly 6 before working on it, then test the injection pressure and jet spray condition, and check for fuel leakage before disassembly. If no fault is found, do not disassemble.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
6	Valve opening pressure	21.6 MPa {3130 lbf/in^2, 220 kgf/cm^2}	—	Adjust

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Union nut (Injection pipe mounting)	25 {18, 2.5}	—
3	Bolt (Bridge mounting)	25 {18, 2.5}	—
7	Retaining nut	34 to 44 {25 to 33, 3.4 to 4.5}	—

Special tools

Location	Tool name and shape	Part No.	Application
—	Nozzle cleaning tool	★105789-0010	Cleaning of injection nozzle assembly

★ BOSCH AUTOMOTIVE SYSTEMS code number

◆ Service procedure

● Inspection before disassembly

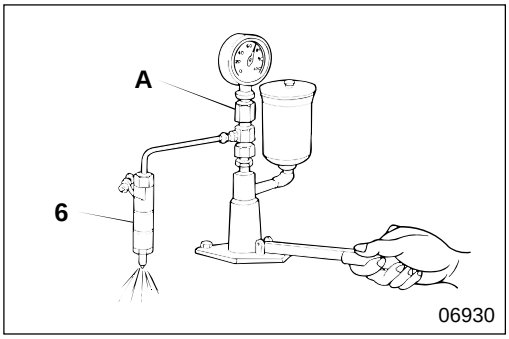
Attach injection nozzle assembly **6** to nozzle tester **A**, and conduct the following inspection.

WARNING ⚠

Never touch the spray from nozzle 11 or let your hands get too close to the spray point during the test.

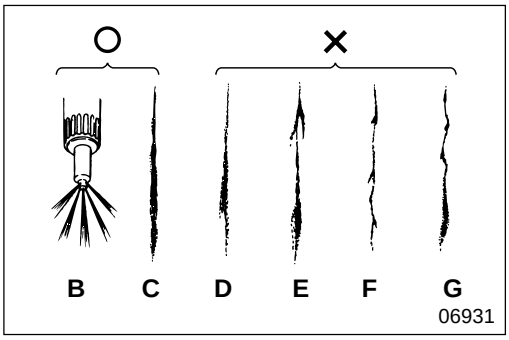
NOTE

Before inspection, bleed the air out in a couple of bursts by pressing nozzle tester A lever.



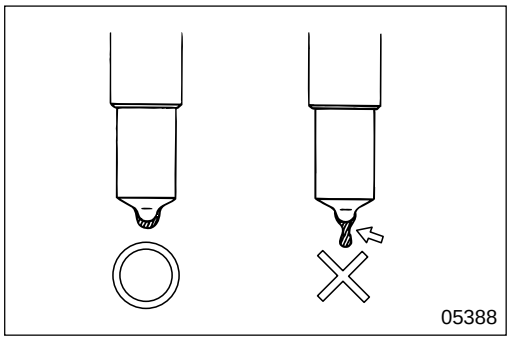
(1) Valve opening pressure

- Raise the pressure of nozzle tester **A** by operating the lever, and measure the pressure that the gauge registers when the pressure is released which will be observed by the sudden movement of the gauge indicator.
- If the measured value deviates from the standard value, disassemble the nozzle and clean, and adjust it using adjusting shims **14**.
- Variation of 0.05 mm {0.0020 in.} thickness in adjusting shims **14** causes a difference of 735 kPa {105 lbf/in^2, 7.5 kgf/cm^2} of pressure, for example, to alter the pressure for 98 kPa {14 lbf/in^2, 1 kgf/cm^2}, a thickness of 0.0067 mm {0.00026 in.} is required.
- If the performance cannot reach the standard value even after adjustment, replace injection nozzle assembly **6**.



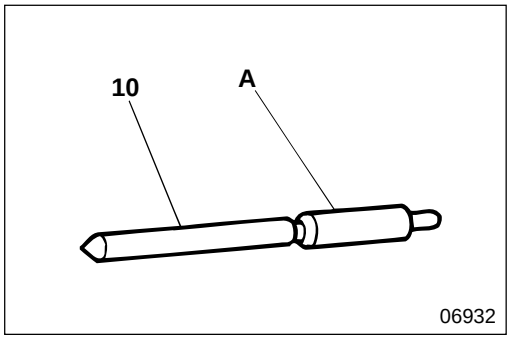
(2) Spray condition

- Test injection spray condition by quick lever actions of nozzle tester **A**, 4 to 6 actions per second.
  - **B** : Even spray from all five orifices (Good)
  - **C** : Even and symmetrical spray (Good)
  - **D** : Asymmetrical spray (Faulty)
  - **E** : Spray direction deviates from the nozzle axis line (Faulty)
  - **F** : Thin and insufficient spray (Faulty)
  - **G** : Irregular spray (Faulty)
- If faulty spray cannot be corrected, disassemble injection nozzle assembly **6** and clean every part and repeat the test.
  If faulty spray still occurs after repeating test, replace the injection nozzle assembly.
- Make sure that there is no post-spray dripping after injection.



(3) Fuel air tightness and leakage at related contact points

- Maintain interior pressure of nozzle at 1960 kPa {285 lbf/in^2, 20 kgf/cm^2} lower than the valve opening pressure, and check and see if any fuel seeps out of the nozzle tip within 10 seconds.
- If any fault is found, disassemble injection nozzle assembly **6** and clean every part and repeat the test. If any fault is still found, replace the injection nozzle assembly.

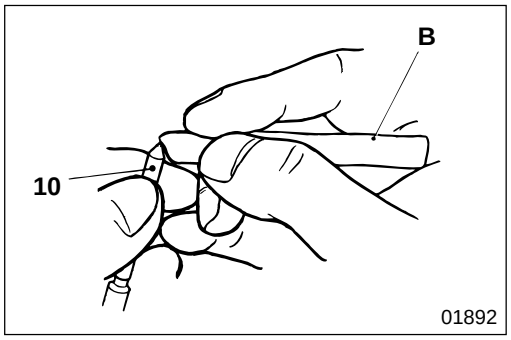


6 Injection nozzle assembly

[Disassembly]

CAUTION

- **Be sure not to touch sliding part A of needle valve 10 with your hands.**
- **Never change the combination of removed needle valve 10 and nozzle 11 for each cylinder.**



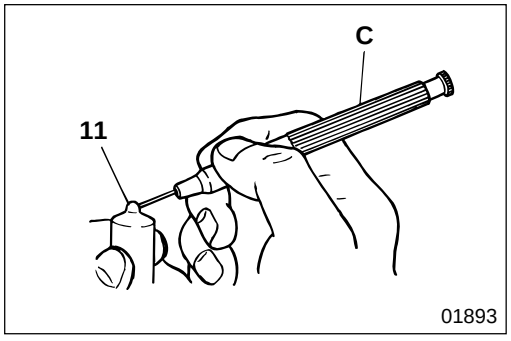
[Cleaning]

Clean needle valve **10** and nozzle **11** with diesel fuel (cleaning solvent). Remove carbon deposits with cleaning tool in the following manner:

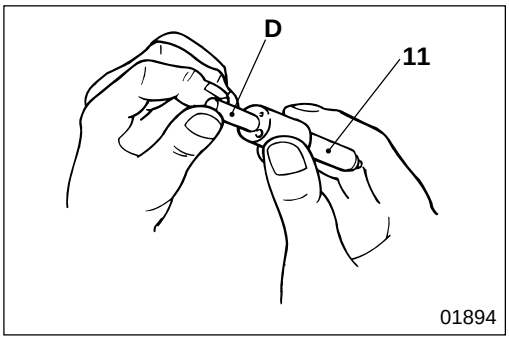
- Clean needle valve **10** by removing carbon deposits from its tip using cleaning bar **B** of cleaning tool.

CAUTION

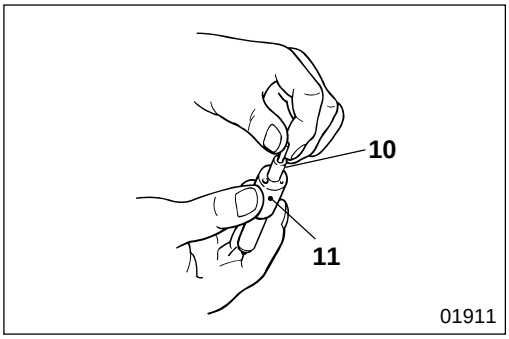
Never use a wire brush or hard steel for cleaning.



- To clean nozzle **11**, remove carbon deposits from the orifices of the nozzle using needle cleaner **C** of cleaning tool, by inserting it into the orifices and turning it.
  Needle cleaner diameter : ø0.25 mm {0.0098 in.} or less



- Clean the seat of nozzle **11** using cleaning needle **D** of [C] cleaning tool.
- Use FUSO carbon remover to remove hard-to-remove, burnt-on carbon deposits.



[Inspection]

- Immerse needle valve **10** and nozzle **11** in diesel fuel (cleaning solvent) and clean them thoroughly.
- Check and see if needle value **10** drops by its own weight into the nozzle from the position where a third of its length is pulled out. (Repeat this several times rotating the needle valve.)
- If needle valve **10** does not drop smoothly, repeat cleaning and repeat the test. If any fault is still found, replace both the needle valve and nozzle **11** together as a set.

MITSUBISHI
FUSO

Group 13EA

Electronically Controlled Fuel System

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWME0202-13EA

INDEX

SPECIFICATIONS 13EA- 2

STRUCTURE AND OPERATION
1. General 13EA- 3
2. Electronic Control System 13EA- 5
3. Pin Configuration of Engine Electronic Control Unit 13EA- 9

TROUBLESHOOTING
1. Inspection Procedures 13EA-14
2. Connection of Multi-Use Tester II 13EA-16
3. Reading and Erasing Diagnostic Trouble Codes 13EA-17
4. Diagnostic Trouble Codes and Check Items 13EA-19
5. Service Data of Multi-Use Tester II 13EA-28
6. Actuator Test by Mutil-Use Tester II 13EA-30
7. Checks at Connector of Electronic Control Unit 13EA-32
8. Checks on Intermittent Troubles 13EA-35

INSPECTION OF ELECTRICAL EQUIPMENT 13EA-36

LOCATIONS OF PARTS 13EA-44

ELECTRICAL WIRING DIAGRAM 13EA-49

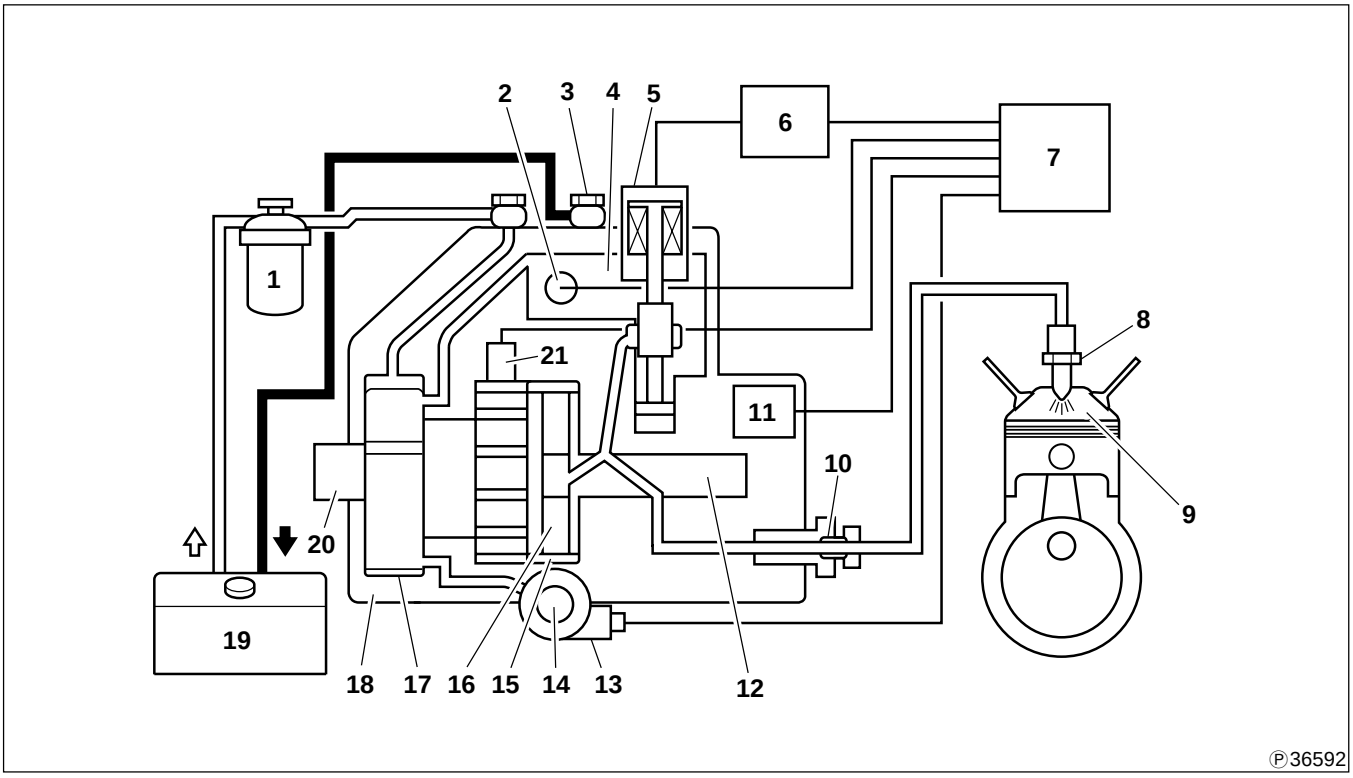
SPECIFICATIONS

Item			Specification
Injection pump assembly	Manufacturer		DENSO
	Model		V4
	Type		Distribution type electronically controlled pump
	Spill valve (Solenoid valve)		Electronically controlled type
	Timer	Control scheme	High pressure chamber control
		Drive method	Timer control valve (TCV)
	Overflow valve	Valve opening pressure kPa (psi, kgf/cm^2)	343 {49.8, 3.5}
	Feed pump	Type	Vane type
		Theoretical delivery rate cc {cu.in.}	6.4 {0.39} (per rotation)
	Fuel temperature sensor		Provided
	Engine speed sensor		Provided
Engine control unit	Manufacturer		DENSO
	Rated voltage V		12
Electrical drive unit	Manufacturer		DENSO
	Rated voltage V		12

1. GENERAL

The V4 system adopts a distribution type injection pump, which features small size and light weight and yet high speed, as well as an electronic control unit which controls the fuel injection rate, fuel injection timing, etc., thereby operating the engine in an optimum condition.

Theory of Operation

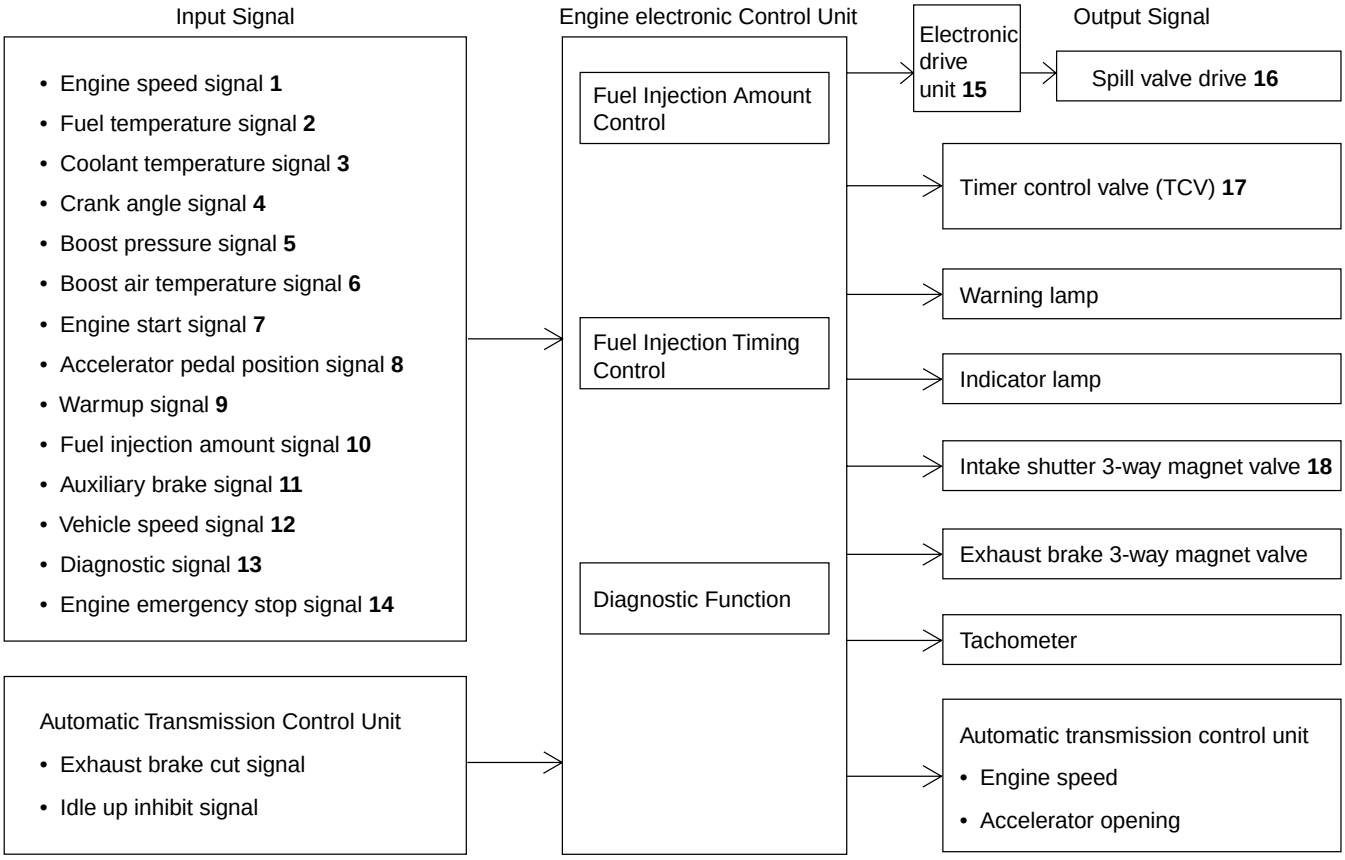


1 Fuel filter
2 Fuel temperature sensor
3 Overflow valve
4 Pump chamber
5 Spill valve
6 Electronic drive unit
7 Engine electronic control unit
8 Injection nozzle
9 Fuel chamber
10 Delivery valve
11 Injection rate adjusting read-only memory
12 Rotor
13 Timer control valve
14 Timer piston
15 Inner cam
16 Plunger
17 Feed pump
18 Injection pump proper
19 Fuel tank
20 Drive shaft
21 Engine speed sensor

- The feed pump **17** in the injection pump proper **18** pumps up the fuel from the fuel tank **19**, keeping the inside of the injection pump full of the fuel at all times.
- The rotor **12** rotates in the inner cam **15**.
- The electronic drive unit **6** converts the spill valve **5** drive signal delivered from the engine electronic control unit **7** into a high voltage signal to enhance the responsiveness of the spill valve.
- The fuel injection rate is increased or reduced by adjusting the opening time of the spill valve **5**.
- When the spill valve **5** is opened, the inside of the rotor **12** is filled with the fuel.
- After it has been filled, the spill valve **5** closes to confine the fuel in the rotor **12**. In this condition, as the drive shaft **20** rotates, the fuel is pressurized by the inner cam **15** and plunger **16** and fed through the delivery valve **10** to the injection nozzle **8** from which it is injected.
- Then the spill valve **5** opens, and a resultant decline in the fuel pressure in the rotor **12** causes the delivery valve **10** to close, thereby bringing the fuel injection to an end.
- The overflow valve **3** returns the fuel to the fuel tank **19** when the fuel pressure in the injection pump exceeds a predetermined value.
- The fuel injection timing is controlled by the timer control valve **13** which controls the fuel pressure acting on the timer piston **14**.
- The timer control valve **13** is activated by commands from the engine electronic control unit **7**.

2. ELECTRONIC CONTROL SYSTEM

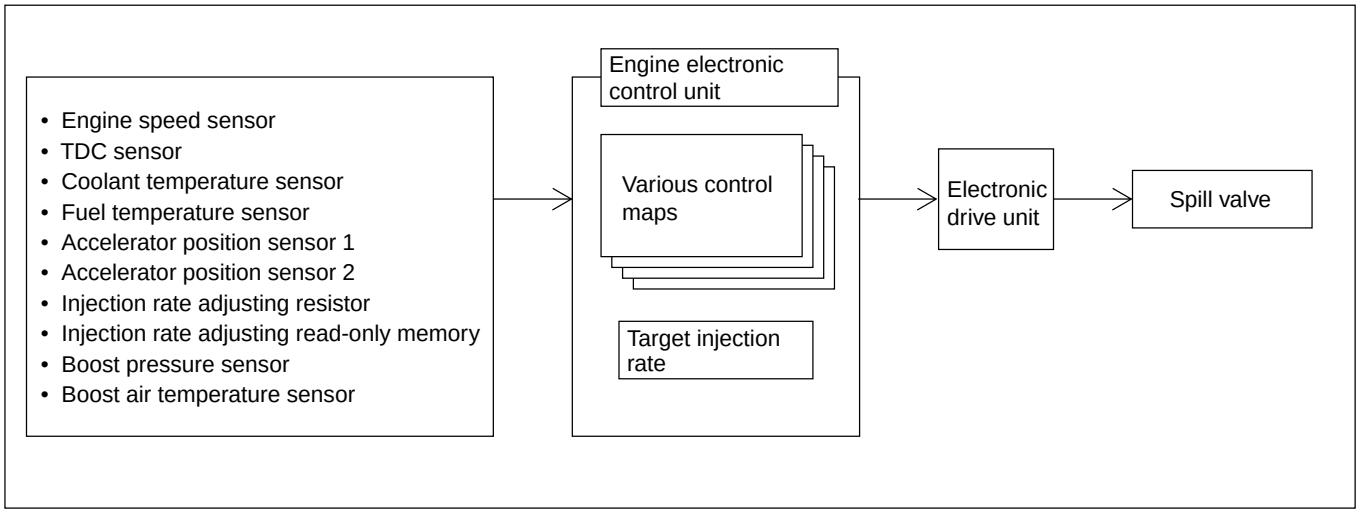
2.1 System Block Diagram



	Information Signal	Part Names	Major Function or Operation
1	Engine speed signal	Engine speed sensor	Detection of engine speed
2	Fuel temperature signal	Fuel temperature sensor	Detection of fuel temperature
3	Coolant temperature signal	Coolant temperature sensor	Detection of coolant temperature
4	Crank angle signal	TDC sensor	Detection of crank angle signal
5	Boost pressure signal	Boost pressure sensor	Detection of boost pressure
6	Boost air temperature signal	Boost air temperature sensor	Detection of boost air temperature
7	Engine start signal	Starter switch	Recognition of engine start when starter switch is placed at START position
8	Accelerator depressed signal	Accelerator position sensor	Detection of amount that accelerator pedal has been depressed
		Accelerator switch	Detection of released/depressed accelerator pedal
9	Warmup accelerating signal	Idle control variable resistor	Acceleration of warmup
		Warming switch	
10	Fuel injection amount adjustment signal	Injection amount adjusting ROM	Adjustment of fuel injection amount
11	Auxiliary brake signal	Exhaust brake switch	Control of auxiliary brake
		Exhaust brake cut relay	
12	Vehicle speed signal	Vehicle speed sensor	Detection of vehicle speed

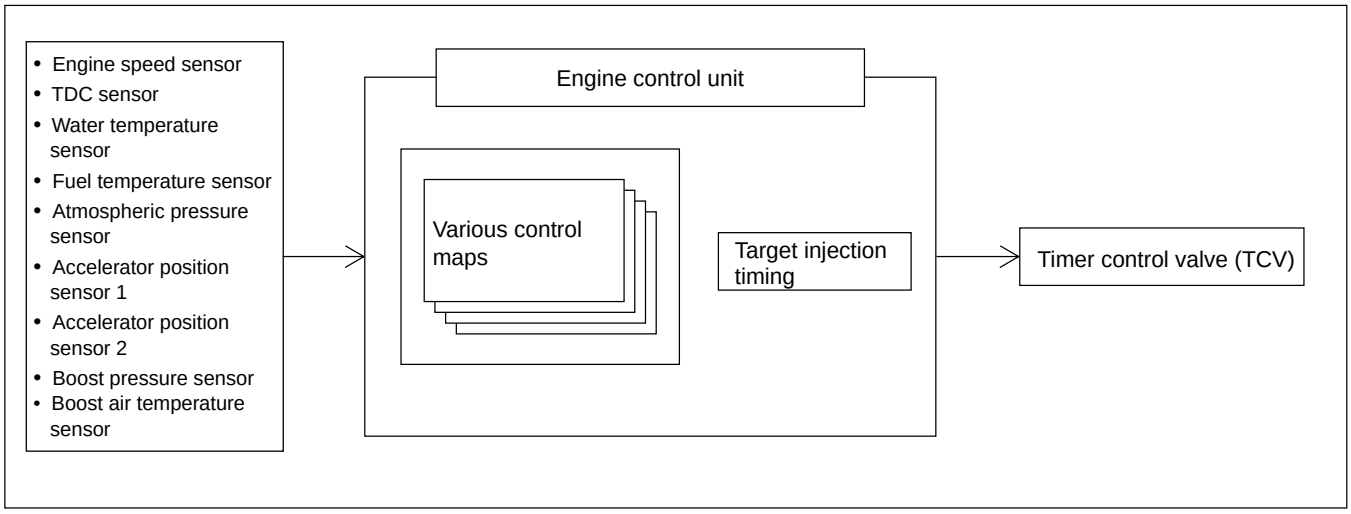
	Information Signal	Part Names	Major Function or Operation
13	Diagnostic signal	Diagnosis switch	Transmission of diagnosis signal
		Memory clear switch	Erasure of diagnostic trouble code Transmission of past diagnostic trouble code
14	Engine emergency stop signal	Emergency engine stop switch	Emergency shutdown of engine
15	–	Electronic drive unit	Assurance of high voltage for high speed drive of spill valve
16	–	Spill valve	Control of fuel injection amount and injection rate
17	Timer control valve operation signal	Timer control valve	Operation of timer piston
18	–	Intake shutter 3-way magnet valve	Operation of intake shutter 3-way magnet valve

2.2 Fuel Injection Rate Control



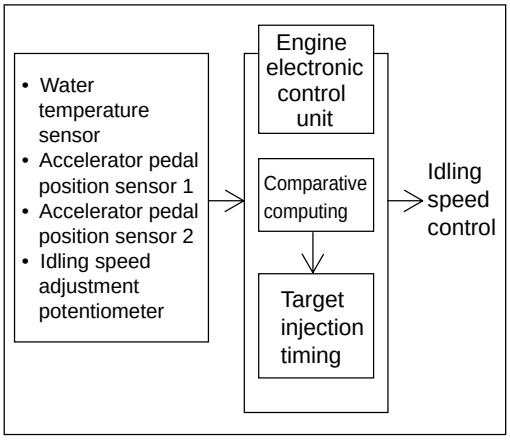
- During operation of the engine, the engine electronic control unit processes the individual information signals according to the control maps to select an appropriate injection mode from among the “basic”, “maximum” and “minimum”.
- After selection of the injection mode, the electronic control unit calculates the minimum value to ensure that the maximum injection rate is not exceeded and determines the target injection rate.
- Once the target injection rate has been determined, the engine electronic control unit outputs a signal to drive the spill valve.
- The signal to drive the spill valve is passed through the electronic drive unit so that its responsiveness for high speed driving will be enhanced.
- The electronic drive unit immediately converts the signal voltage delivered from the engine electronic control unit to a high voltage.

2.3 Fuel Injection Timing Control



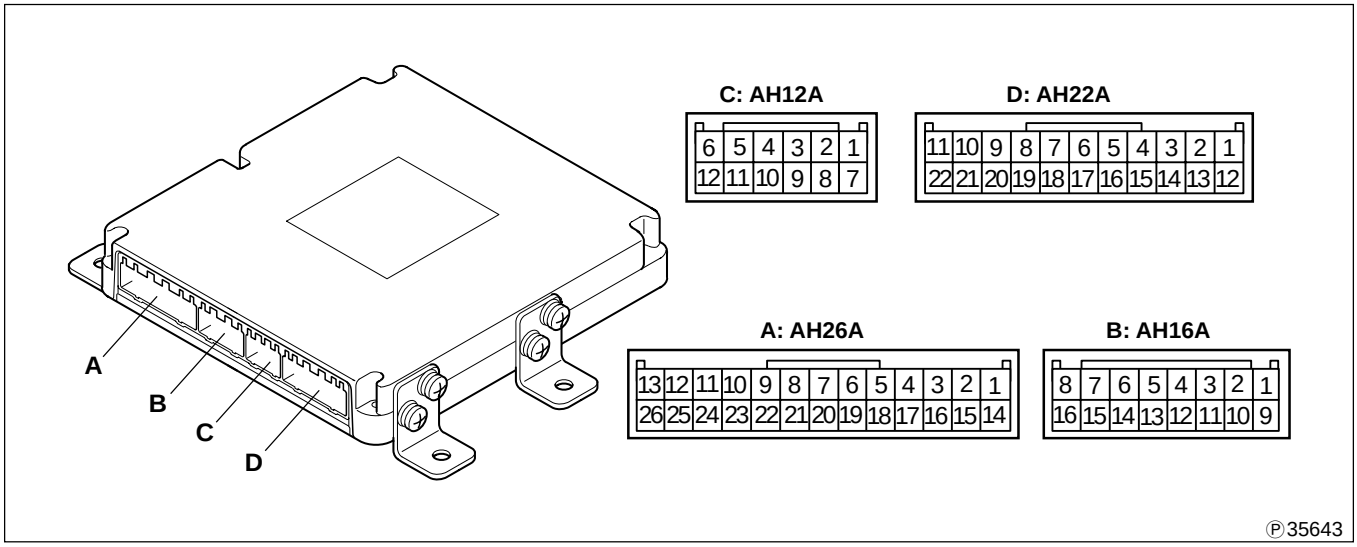
- During operation of the engine, the engine electronic control unit processes the individual information signals according to the control maps to calculate the target injection timing, and drives the timer control valve (TCV) in such a way that the real timing computed on the basis of the engine speed sensor and top dead center sensor will match the target timing.
- Controls at the time of an engine start are achieved by the start compensation map contained in each control map.

2.4 Warmup Accelerating Function



The warmup accelerating function varies the idling speed according to the engine coolant temperature to accelerate warmup. The function includes the automatic and manual modes. Either of the modes can be selected by pushing/pulling the idling speed adjustment potentiometer.

3. PIN CONFIGURATION OF ENGINE ELECTRONIC CONTROL UNIT



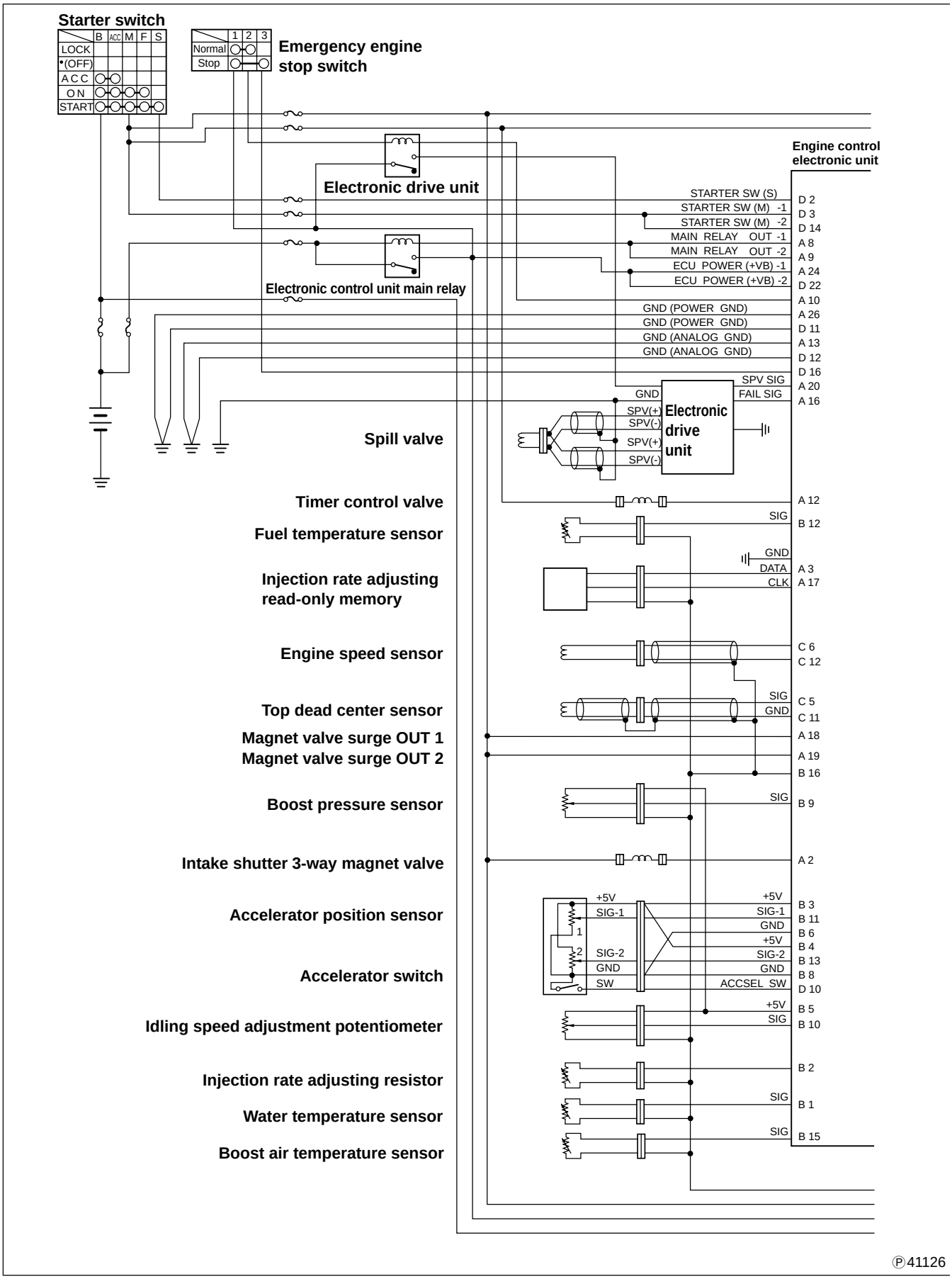
Connector A: AH26A	
Pin No.	Connected to
1	
2	Intake silencer 3-way magnet valve
3	Injection rate read-only memory
4	
5	
6	Pulse wedge modulator acceleration OUT (signal)
7	Vehicle speed sensor (signal)
8	Engine electronic control unit main relay 1
9	Engine electronic control unit main relay 2
10	Electronic drive unit relay
11	
12	Timer control valve
13	Ground (ANALOG)
14	
15	
16	Electronic drive unit (FAIL signal)
17	Injection rate adjusting read-only memory (CLK)
18	Magnet valve surge OUT 1
19	Magnet valve surge OUT 2
20	Electronic drive unit (Spill valve signal)
21	Warning lamp (Red)
22	Warning lamp (Amber)
23	
24	Engine electronic control unit POWER-1
25	Exhaust brake
26	Ground (POWER)

Connector B: AH16A	
Pin No.	Connected to
1	Water temperature sensor
2	Injection rate adjustment resistor (signal)
3	Accelerator pedal position sensor 1 (+5V)
4	Accelerator pedal position sensor 2 (+5V)
5	Sensor power supply (+5V)
6	Accelerator pedal position sensor (Ground-1)
7	—
8	Accelerator pedal position sensor (Ground-2)
9	Boost pressure sensor (signal)
10	Idling speed adjustment potentiometer (signal)
11	Accelerator pedal position sensor 1 (signal)
12	Fuel temperature sensor (signal)
13	Accelerator pedal position sensor 2 (signal)
14	—
15	Boost air temperature sensor
16	Sensor ground

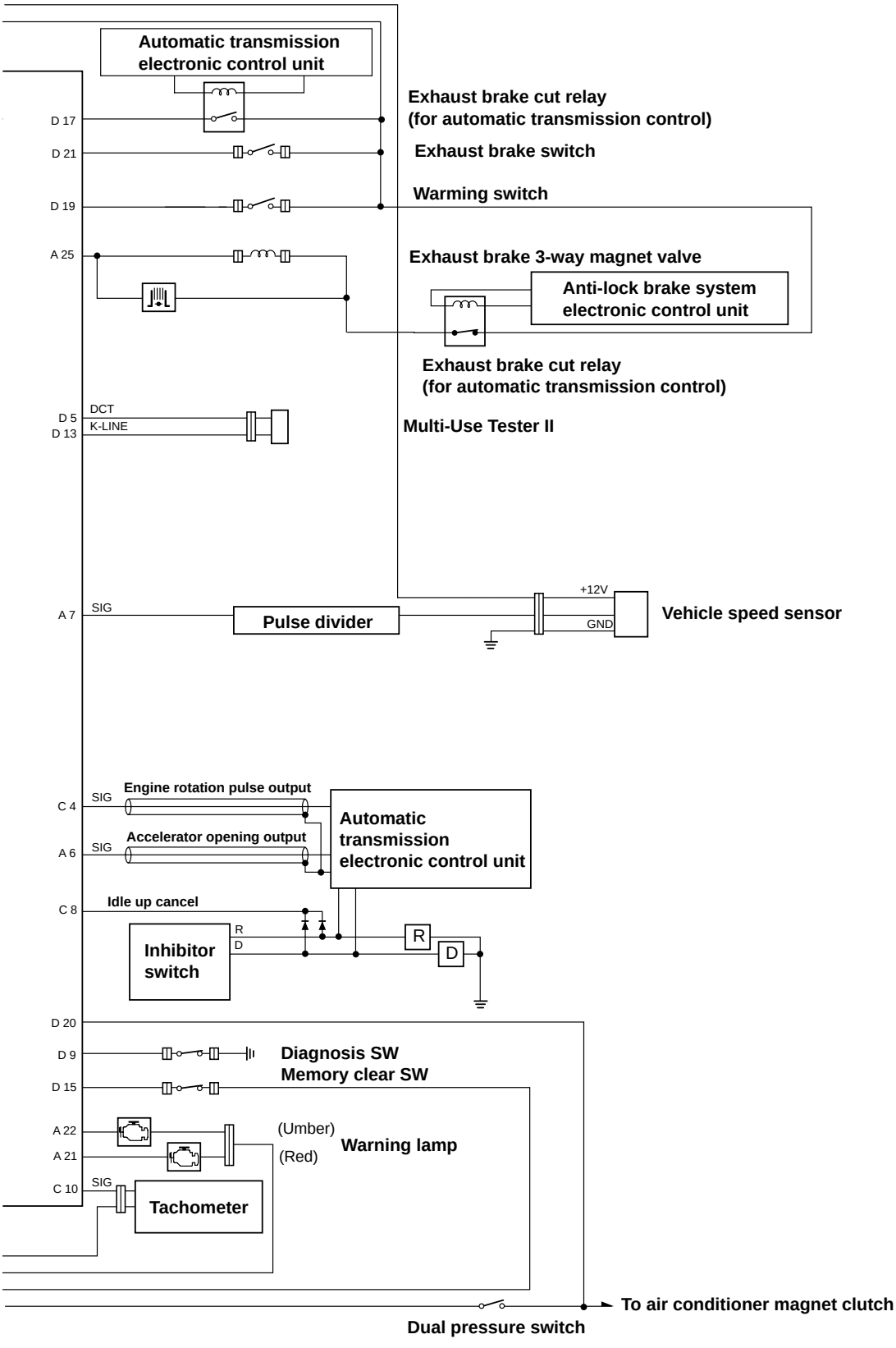
Connector C: AH12A	
Pin No.	Connected to
1	—
2	—
3	—
4	Engine speed OUT (signal)
5	TDC (Top dead center) sensor (signal)
6	Engine speed sensor (signal)
7	—
8	Idle up cancel
9	—
10	Tachometer output (signal)
11	TDC (Top dead center) sensor (ground)
12	Engine speed sensor (ground)

Connector D: AH22A	
Pin No.	Connected to
1	—
2	Starter switch (S terminal)
3	Starter switch (M terminal-1)
4	Power take-off switch
5	Multi-Use Tester II (DCT)
6	—
7	—
8	—
9	Diagnosis switch
10	Accelerator switch
11	Ground (POWER)
12	Ground (ANALOG)
13	Multi-Use Tester II (K-LINE)
14	Starter switch (M terminal-2)
15	Memory clear switch
16	Emergency engine stop switch
17	Auxiliary brake cut relay (for automatic transmission)
18	—
19	Warming switch
20	Cooler switch
21	Exhaust brake switch
22	Engine electronic control unit POWER-2

M E M O


Starter switch
B ACC M F S
LOCK
•(OFF)
ACC
ON
START
1 2 3
Normal
Stop
Emergency engine stop switch
Electronic drive unit
Electronic control unit main relay
Engine control electronic unit
STARTER SW (S) D 2
STARTER SW (M) -1 D 3
STARTER SW (M) -2 D 14
MAIN RELAY OUT -1 A 8
MAIN RELAY OUT -2 A 9
ECU POWER (+VB) -1 A 24
ECU POWER (+VB) -2 D 22
GND (POWER GND) A 10
GND (POWER GND) A 26
GND (ANALOG GND) D 11
GND (ANALOG GND) A 13
D 12
D 16
SPV SIG A 20
FAIL SIG A 16
GND
SPV(+)
SPV(-)
SPV(+)
SPV(-)
Electronic drive unit
Spill valve
Timer control valve A 12
Fuel temperature sensor SIG B 12
GND
DATA A 3
CLK A 17
Injection rate adjusting read-only memory
Engine speed sensor C 6 C 12
Top dead center sensor SIG C 5
GND C 11
Magnet valve surge OUT 1 A 18
Magnet valve surge OUT 2 A 19
B 16
Boost pressure sensor SIG B 9
Intake shutter 3-way magnet valve A 2
Accelerator position sensor
+5V
SIG-1
1
2
SIG-2
GND
SW
+5V B 3
SIG-1 B 11
GND B 6
+5V B 4
SIG-2 B 13
GND B 8
ACCSEL SW D 10
Accelerator switch
Idling speed adjustment potentiometer +5V B 5
SIG B 10
Injection rate adjusting resistor B 2
Water temperature sensor SIG B 1
Boost air temperature sensor SIG B 15

Ⓟ41126


Automatic transmission electronic control unit
Exhaust brake cut relay (for automatic transmission control)
D 17
D 21
Exhaust brake switch
D 19
Warming switch
A 25
Exhaust brake 3-way magnet valve
Anti-lock brake system electronic control unit
Exhaust brake cut relay (for automatic transmission control)
D 5
D 13
DCT
K-LINE
Multi-Use Tester II
A 7
SIG
Pulse divider
+12V
GND
Vehicle speed sensor
C 4
SIG
Engine rotation pulse output
A 6
SIG
Accelerator opening output
Automatic transmission electronic control unit
C 8
Idle up cancel
Inhibitor switch
R
D
D 20
D 9
Diagnosis SW
Memory clear SW
D 15
A 22
A 21
(Umber)
(Red)
Warning lamp
C 10
SIG
Tachometer
To air conditioner magnet clutch
Dual pressure switch

Ⓟ48679

TROUBLESHOOTING

1. INSPECTION PROCEDURES

Diagnostic Function

- Whenever the starter switch is placed at ON, the diagnostic function is activated to check all the sensors, etc. If any of them is found faulty, the warning lamp in the meter cluster is lit to alert the driver. At the same time, the fault location is stored in memory, and the system enters the backup mode.

Warning Lamp Indications

	(Red)	(Amber)
Safety-critical error (Vehicle must not be driven)	ON	OFF
Non-safety-critical error (Vehicle can be driven despite poor control feeling)	OFF	ON

- The stored fault location can be read as a diagnostic trouble code by the Multi-Use Tester II or the diagnosis switch.

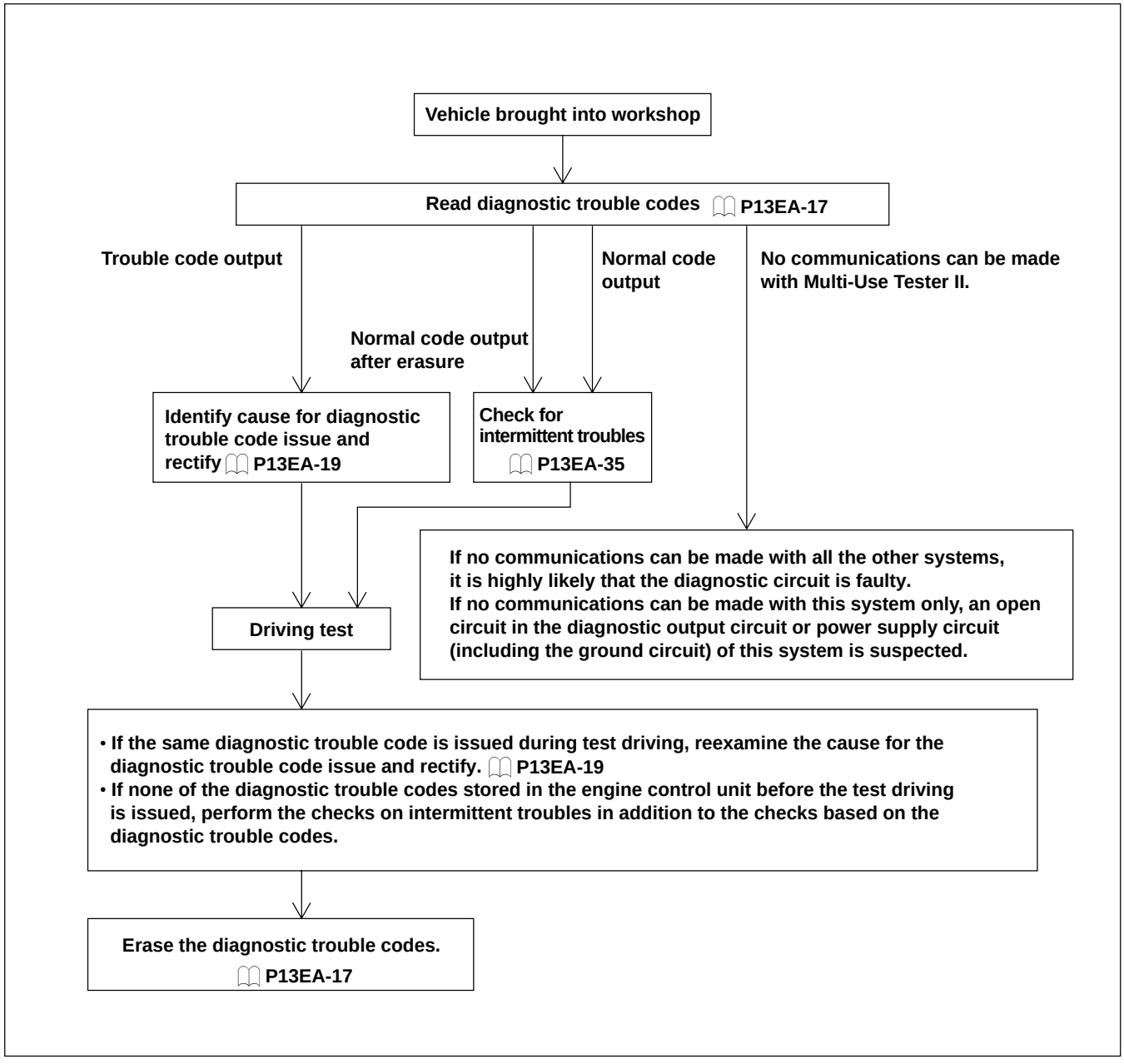
CAUTION ⚠

- **Check to ensure that the battery voltage is within the specified range.**
- **Check all the harness and device connectors for looseness. Always remove a connector at least 20 seconds after placing the starter switch at the LOCK position.**
- **Do not forget to clear the diagnostic trouble code by the Multi-Use Tester II or memory clear switch after a fault has been rectified.**
- **As a rule, inspection operations should be performed with the starter switch at the LOCK position. Some checks, however, may have to be made with the starter switch at the ON position. In such a case, use care to make sure that no short circuit develops between pins of the connectors or with the body.**
- **The resistance value of each component is affected by the temperature and the accuracy of the tester. The reading, therefore, does not always fall within the standard limits. Note that the check values shown in the text are the values obtained at normal temperature (10 to 35°C {58 to 95°F}).**
- **Whether or not the system automatically returns to normal from the backup mode after a fault has been removed depends on the diagnostic trouble code (fault location). When the system returns to normal, the warning lamp will be OFF.**
- **Even when the fault has been removed and the system has been automatically returned to the normal mode, the diagnostic trouble code of the fault remains stored in the engine control unit.**
- **When a fault occurs at a point where the system is not automatically reset, perform the memory clear procedure to let the system exit from the backup mode. 🕮 P13EA-17**

Inspection Flowchart

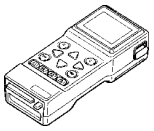
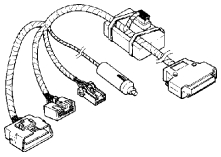
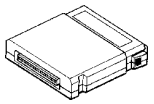
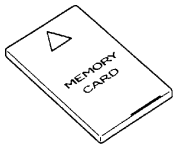
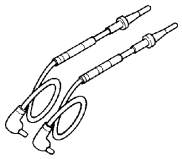
The system inspection can be performed effectively by use of the Multi-Use Tester II. The types of system inspections may be broadly divided as shown below in accordance with the trouble symptoms and diagnostic trouble code outputs.

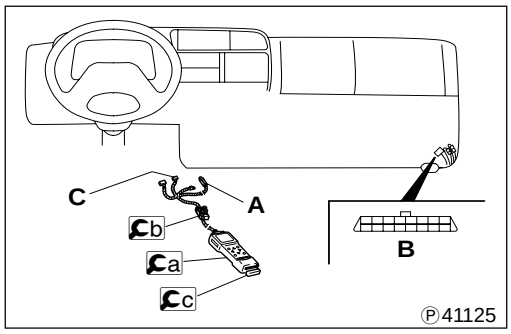
- Inspections based on diagnostic trouble codes stored in the engine electronic control unit
- Inspections of intermittent troubles



2. CONNECTION OF MULTI-USE TESTER II

Special Tools

Location	Name and Shape of Special Tool	Part No.	Application
—	Multi-Use Tester II  19492	MB991496	Inspection of system
—	Multi-Use Tester II harness (for communications)  19141	MK327601	To supply power to Multi-Use Tester II proper and communicate with vehicle side electrical devices
—	Read-only memory pack (MRT-E10)  19493	MH062867	Data for inspection and control of engine control unit
—	Memory card (set in Multi-Use Tester II proper)  20538	MB991500	To write data
—	Multi-Use Tester II harness  20536	MB991499	To use Multi-Use Tester II as a circuit tester



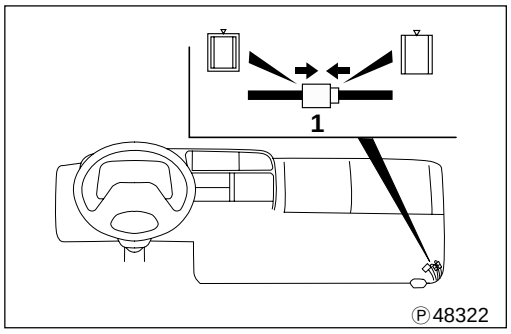
- Place the starter switch at the LOCK position.
- Connect the b Multi-Use Tester II harness to a Multi-Use Tester II and insert the c read-only memory in the tester.
- Connect the connector **A** to the cigar lighter socket.
- Connect the Multi-Use Tester II connector **C** (16 pins) to the data link connector **B** (16 pins).

NOTE

For the operating procedures for the Multi-Use Tester II, refer to the instruction manual for the Multi-Use Tester II.

3. READING AND ERASING DIAGNOSTIC TROUBLE CODES

Two types of methods are available for reading or erasing a diagnostic trouble code; one using the Multi-Use Tester II and one using the vehicle side diagnostic functions.

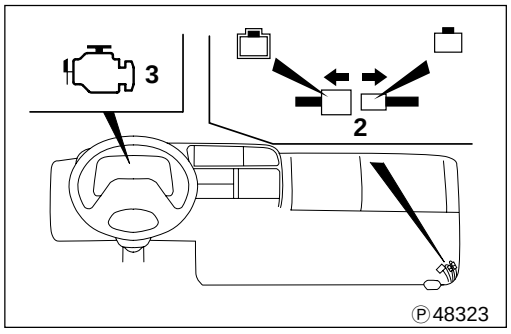


(1) Method using Multi-Use Tester II

● **Current Diagnostic Trouble Code**
- Check to see that the memory clear switch **1** is connected.
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to read the current diagnostic trouble code and determine the fault location.

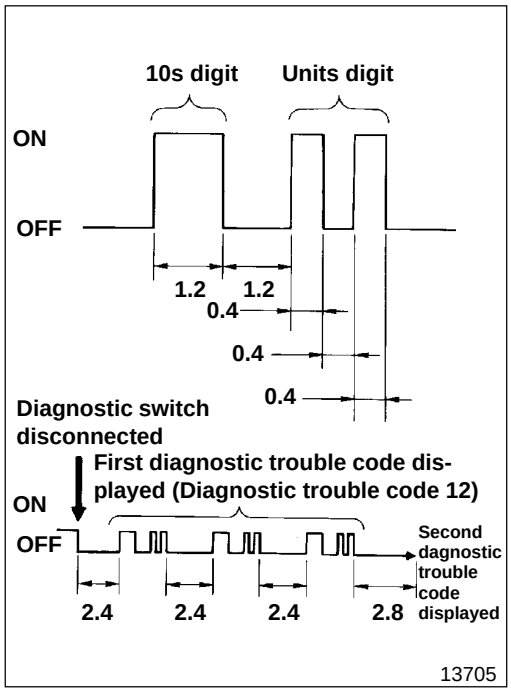
● **Past Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the memory clear switch **1**.
- Operate the Multi-Use Tester II to read the past registered diagnostic trouble codes and determine the fault location.

● **Erasing Diagnostic Trouble Codes**
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to erase all of the diagnostic trouble codes stored in the engine electronic control unit.



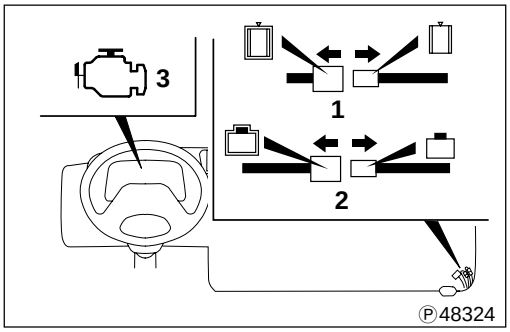
(2) Method Not Using Multi-Use Tester II (Method Using Diagnostic Switch and Memory Clear Switch)

● **Current Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the diagnostic switch **2**.
- The diagnostic trouble code is displayed by flashes of the warning lamp **3**.



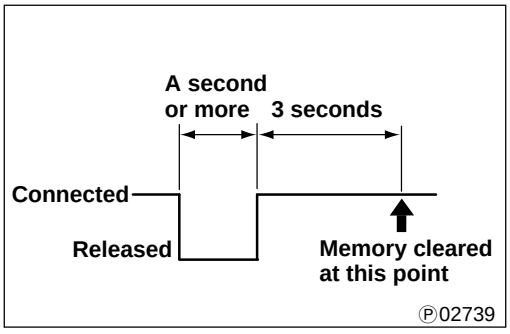
● **Reading Diagnostic Trouble Code**

- Diagnostic trouble codes are indicated by the number of times the warning lamp **3** flashes and their duration.
  - The flashing intervals also differ between the 10s digit and units digit.
  - 10s digit: 1.2 second interval
  - Units digit: 0.4 second interval
  - Each diagnostic trouble code is displayed from the 10s digit followed by the units digit. As for a code which has no 10s digit, units digit only is displayed.
- Each diagnostic trouble code is displayed three times in succession.
- If there is no more code stored, the sequence is then repeated from the beginning with each code indicated three times.
- When the diagnostic switch **2** is connected, the engine electronic control unit will immediately stop displaying codes.



● **Past Diagnostic Trouble Codes**

- After reading the current diagnostic trouble codes (with the diagnostic switch **2** disconnected), disconnect the memory clear switch **1**. Then the warning lamp **3** will restart flashing.
- This time, the warning lamp displays the past diagnostic trouble codes. Determine the fault locations based on the indicated codes.



● **Erasing Diagnostic Trouble Codes**

Disconnect the memory clear switch **1** and the diagnostic switch **2** then reconnect them. Then all the diagnostic trouble codes stored in the engine electronic control unit will be cleared.

CAUTION ⚠

- **If the contents of memory are not to be cleared after display of the stored codes, set the starter switch to OFF with the memory clear switch 1 disconnected. Thereafter, connect the memory clear switch.**
- **When you change the combination of the injection pump and engine electronic control unit, you must rewrite the pump data stored in the engine electronic control unit. For this purpose, be sure to perform the diagnostic trouble code erasing procedure.**
- **Whenever the engine electronic control unit has been replaced with a new one, be sure to erase the diagnostic trouble codes by disconnecting the memory clear switch 1 and diagnostic switch 2 after connecting all the connectors. Upon completing the procedure, confirm that no diagnostic trouble codes is stored.**

4. DIAGNOSTIC TROUBLE CODES AND CHECK ITEMS

4.1 Diagnostic Trouble Code List

Multi-Use Tester II Screen Display		Where Described
Diagnostic Trouble Code	Message	
06	EDU/SPV	🕮 P13EA-19
07	OVER REV	🕮 P13EA-20
14	TDC SNSR	
15	NE SNSR	
16	ACCEL SNSR-2	🕮 P13EA-21
19	AIR PRES SNSR	
21	WTR TEMP SNSR	
23	TCV	🕮 P13EA-22
24	ACCEL SNSR-1	
25	SPEED SNSR	🕮 P13EA-23
26	PUMP ROM	
27	SILENCER M/V	

Multi-Use Tester II Screen Display		Where Described
Diagnostic Trouble Code	Message	
31	IDL VOLUME	🕮 P13EA-24
32	BOOST PRES	
33	ECU SYSTEM	
34	Q RESISTOR	🕮 P13EA-25
41	FUEL TEMP	
44	BOOST TEMP	
45	FUEL CUT SW	🕮 P13EA-26
46	EDU RELAY	
65	ACCEL SW	🕮 P13EA-27
66	STARTER SW (S)	

4.2 Diagnostic Trouble Code Issued Conditions and Check Items

Perform service procedures taking the diagnostic trouble code issued conditions and the probable causes into consideration.

06 EDU/SPV		
Code issued condition [Reset condition]	Diagnostic trouble code **06** is intended for checking the electronic drive unit and spill valve for anything abnormal. The code is issued when the FAIL signal is not input the specified number of consecutive times from the electronic drive unit to the electronic control unit despite the fact that the battery voltage is normal, the engine is running at a speed higher than the idling speed, and the electrical drive unit is outputting the spill valve drive signal. [Starter switch OFF]	
Action taken by electronic control unit	Engine stopped	
Warning lamp illuminated	(Red)	
Probable cause and check item	• Open or short circuit between electronic control unit and electronic drive unit,or between electronic drive unit and spill valve • Faulty electronic drive unit • Faulty spill valve	• Check on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 83: Spill valve operation check • Test the actuator by the Multi-Use Tester II. 🕮 P13EA-30 No. 9B: Spill valve operation check • Check the electronic drive unit (Ask your DENSO service station to do the job.) • Check the spill valve. 🕮 P13EA-36: Inspection of Electrical Devices **536** • Check the circuit between the electronic control unit and electronic drive unit or the circuit between the electronic drive unit and spill valve. 🕮 P13EA-49: Electrical wiring Diagram

07 OVER REV		
Code issued condition [Reset condition]	Diagnostic trouble code **07** is intended for checking whether the engine speed has reached an overspeed. When the engine speed reaches an overspeed, the code is issued. (When the engine speed decreases to fall within the normal range, a reset is made.)	
Action taken by electronic control unit	Spill valve operation stopped	
Warning lamp illuminated	None	
Probable cause and check item	• Faulty spill valve of injection pump assembly • Overrevved engine during driving downhill • Faulty electronic control unit	Check the injection pump assembly (Ask your DENSO service station to do the job.)

14 TDC SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **14** is intended for checking the TDC sensor operation. It is issued when the TDC sensor signal is not input to the electronic control unit the specified number of consecutive times while the engine is running. [When normal TDC sensor signal input is restored, the system is reset.]	
Action taken by electronic control unit	Injection timing feedback control stopped and open-loop control executed	
Warning lamp illuminated	(Amber)	
Probable cause and check item	• Open or short circuit between control unit and TDC sensor • Faulty TDC sensor • Faulty electronic control unit	• Perform checks at electronic control unit connector. 📖P13EA-32 **01**: Measure resistance of TDC sensor. • Check TDC sensor. 📖 P13EA-36: Inspection of Electronic Devices **316** • Check circuit between electronic control unit and TDC sensor. 📖 P13EA-49: Electrical Writing Diagram

15 NE SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **15** is issued when the signal from the engine speed sensor is not input the specified number of times to the electronic control unit while the engine is in operation. [When the signal from the engine speed sensor returns to normal, a reset is made.]	
Action taken by electronic control unit	Synchronous control of spill valve with timer control valve interrupted	
Warning lamp illuminated	(Red)	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and engine speed sensor • Faulty engine speed sensor • Gap of engine speed sensor maladjusted • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 📖P13EA-28 No. 01: Measure engine speed. • Perform checks at control electronic unit connector. 📖P13EA-32 **02**: Measure resistance of engine speed sensor. • Check engine speed sensor. 📖 P13EA-36: Inspection of Electrical Devices **263** • Check circuit between electronic control unit and engine speed sensor. 📖P13EA-49: Electrical Wiring Diagram

16 ACCEL SNSR-2		
Code issued condition [Reset condition]	Diagnostic trouble code **16** is intended for checking the accelerator pedal position sensor 2 for an abnormal voltage. The code is issued when the voltage of the accelerator pedal position sensor 2 is out of the specified limits. When diagnostic trouble code **24** is also registered, the portion between the accelerator pedal position sensor is faulty. [When the voltage of the accelerator pedal position sensor 2 falls within the specified limits, a reset is made.]	
Action taken by electronic control unit	①: Ordinary controls are made by using only accelerator pedal position sensor 1 ②: When accelerator pedal position sensor 1 is also faulty, controls are made on the assumption that the pedal is depressed 30% when accelerator switch is OFF and 0% when accelerator switch is ON.	
Warning lamp illuminated	①: None ②: (Amber)	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and accelerator pedal position sensor 2 • Faulty accelerator pedal position sensor 2 • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 📖 P13EA-28 No. 0B: Accelerator pedal opening measurement. No. 0C: Measurement of accelerator pedal position sensor output voltage. • Perform checks at electronic control unit connector. 📖 P13EA-32 **03**: Measurement of accelerator pedal position sensor 2 output voltage • Check accelerator pedal position sensor 2. 📖 P13EA-36: Inspection of Electrical Devices **324** • Check circuit between electronic control unit and accelerator pedal position sensor 2. 📖 P13EA-49: Electrical Wiring Diagram

19 AIR PRES SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **19** is intended for checking the atmospheric pressure sensor (built into the electronic control unit) for anything abnormal. The code is issued when a voltage signal from the atmospheric pressure sensor is out of the specified limits. [When the output voltage of the atmospheric pressure sensor falls within the specified range, a reset is made.]	
Action taken by electronic control unit	Controls achieved on the assumption that atmospheric pressure is 100 kPa {29.9 in. Hg, 760 mmHg}.	
Warning lamp illuminated	None	–
Probable cause and check item	• Faulty atmospheric pressure sensor (built into control unit) • Faulty electronic control unit	Perform checks on the basis of the service data of the Multi-Use Tester II. 📖 P13EA-28 No. 14: Atmospheric pressure measurement.

21 WTR TEMP SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **21** is intended for checking for open or short circuit in the harness of the water temperature sensor or anything abnormal in water temperature sensor. The code is issued when the output voltage from the water temperature sensor is out of the specified limits. [When the output voltage of the water temperature sensor falls within the specified range, a reset is made.]	
Action taken by electronic control unit	Controls achieved on the assumption that the water temperature is 80°C {178°F}	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harness between electronic control unit and water temperature sensor • Faulty water temperature sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 📖 P13EA-28 No. 10: Engine water temperature measurement • Check water temperature sensor. 📖 P13EA-36: Inspection of Electrical Devices **262** • Check circuit between electronic control unit and water temperature sensor. 📖 P13EA-48: Electrical Wiring Diagram

23 TCV		
Code issued condition [Reset condition]	Diagnostic trouble code **23** is intended for checking the harness of the timer control valve for open or short circuit and checking the timer control valve for anomalies. The code is issued when the real advance angle position of the timer continues to be out of the specified limits under the condition that fuel injection timing feedback control is in progress after completion of engine warmup. [When the advance angle re-enters the specified range with the engine at a speed of less than 1200 rpm, a reset is made.]	
Action taken by electronic control unit	Controls are made on the assumption that the coolant temperature is 20°C {-4°F} when the engine is started, and 120°C {248°F} during operation.	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harness between electronic control unit and timer control valve • Faulty timer control valve • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 09: Timer advance angle measurement • Check timer control valve. 🕮 P13EA-36: Inspection of Electrical Devices **584** • Check circuit between electronic control unit and timer control valve. 🕮 P13EA-49: Electrical Wiring Diagram

24 ACCEL SNSR-1		
Code issued condition [Reset condition]	Diagnostic trouble code **24** is intended for checking the accelerator pedal position sensor 1 for abnormal voltage. The code is issued when the output voltage of the accelerator pedal position sensor 1 is out of the specified limits. When diagnostic trouble code 16 is also registered, the portion between the accelerator pedal position sensors is faulty. [When the output voltage of the accelerator pedal position sensor 1 re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	①: Ordinary controls are continued by using only the accelerator pedal position sensor 2. ②: When accelerator pedal position sensor 2 is also faulty, controls are made on the assumption that the pedal is depressed 30% when accelerator switch is OFF and 0% when accelerator switch is ON.	
Warning lamp illuminated	①: None ②: (Amber)	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and accelerator pedal position sensor 1 • Faulty accelerator pedal position sensor 1 • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 0B: Accelerator pedal opening measurement No. 0C: Measurement of accelerator pedal position sensor output voltage • Perform checks at electronic control unit connector. 🕮 P13EA-32 **04**: Measurement of accelerator pedal position sensor 1 output voltage • Check accelerator pedal position sensor 1. 🕮 P13EA-36: Inspection of Electrical Devices **324** • Check circuit between electronic control unit and accelerator pedal position sensor 1. 🕮 P13EA-49: Electrical Wiring Diagram

25 SPEED SNSR		
Code issued condition [Reset condition]	Diagnostic trouble code **25** is intended for checking the harness of the vehicle speed sensor for open/short circuit and checking the vehicle speed sensor for abnormalities. The code is issued when there are no pulse inputs from the vehicle speed sensor to the electronic control unit in the specified time duration. [When a pulse is input, a reset is made.]	
Action taken by electronic control unit	ISC (Idle Speed Control) disabled	
Warning lamp illuminated	None	
Probable cause and check item	• Open or short circuit in harness between electronic control unit and vehicle speed sensor • Faulty vehicle speed sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 📖 P13EA-28 No. 0D: Vehicle speed measurement. • Perform checks at electronic control unit connector. 📖P13EA-32 **05**: Measurement of vehicle speed signal voltage. • Check vehicle speed sensor. 📖P13EA-36: Inspection of Electrical Devices **265** • Check circuit between electronic control unit and vehicle speed sensor. 📖P13EA-49: Electrical Wiring Deagram

26 PUMP ROM		
Code issued condition [Reset condition]	Diagnostic trouble code **26** is intended for checking for an error in the loaded pump read-only memory data necessary for control of the injection rate. The code is issued when any of the following situations occurs. Loaded read-only memory has unmatched data. • Read-only memory data cannot be read. • Loaded data exceeds the upper limit of correction. • There is a mismatch between control unit backup data and loaded data. [No automatic reset takes place.]	
Action taken by electronic control unit	Initial values used	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and injection rate and adjusting read-only memory • Faulty injection rate adjusting read-only memory • Faulty electronic control unit	• Check injection rate adjusting read-only memory. (Ask your DENSO service station to do the job.) • Check circuit between electronic control unit and injection rate adjusting read-only memory. 📖P13EA-49: Electrical Wiring Diagram

27 SILENCER M/V		
Code issued condition [Reset condition]	Diagnostic trouble code **27** is intended for checking the harness of the intake silencer 3-way magnet valve for open/short circuit. [No automatic reset takes place.]	
Action taken by electronic control unit	Intake silencer control disabled	
Warning lamp illuminated	(Amber)	
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and injection rate and adjusting read-only memory • Faulty intake silencer 3-way magnet valve • Faulty electronic control unit	• Check intake silencer 3-way magnet valve. P13EA-36: Inspection of Electrical Devices **565** • Check circuit between electronic control unit and intake silencer 3-way magnet valve. P13EA-49: Electrical Wiring Diagram

31 IDL VOLUME		
Code issued condition [Reset condition]	Diagnostic trouble code **31** is intended for checking the harness of the idling speed adjustment potentiometer for open or short circuit and checking the idling speed adjustment potentiometer for abnormalities. The code is issued when the voltage of the idling speed adjustment potentiometer continues to be out of the specified limits for the predetermined period of time. [When the voltage of the idling speed adjustment potentiometer re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Operation mode fixed to auto idle	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harness between electronic control unit and idling speed adjustment potentiometer • Faulty idling speed adjustment potentiometer • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 0E: Measurement of idling speed adjustment potentiometer voltage. • Perform checks at electronic control unit connector. 🕮P13EA-32 **06**: Measurement of idling speed adjustment potentiometer output voltage. • Check idling speed adjustment potentiometer. 🕮 P13EA-36: Inspection of Electrical Devices **157** • Check circuit between electronic control unit and idling speed adjustment potentiometer. 🕮 P13EA-48: Electrical Wiring Diagram

32 BOOST PRES		
Code issued condition [Reset condition]	Diagnostic trouble code **32** is intended for checking the harness of the boost pressure sensor for open or short circuit and checking the boost pressure sensor for abnormalities. The code is issued when the output voltage of the boost pressure sensor continues to be out of the specified limits for the predetermined period of time. [When the voltage of the boost pressure sensor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Controls are made on the assumption that the boost pressure is 100 kPa {29.9 in. Hg, 760 mmHg}	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and boost pressure sensor • Faulty boost pressure sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮P13EA-28 No. 15: Boost pressure measurement • Check boost pressure sensor. 🕮 P13EA-36: Inspection of Electrical Devices **318** • Check circuit between electronic control unit and boost pressure sensor. 🕮P13EA-49: Electrical Wiring Diagram

33 ECU SYSTEM		
Code issued condition [Reset condition]	Diagnostic trouble code **33** is issued in the following cases. ①: Analog/Digital converter out of order [When Analog/Digital converter returns to normal, a reset is made.] ②: Mutual monitoring error, interruption processing error [When starter switch is turned OFF, a reset is made.]	
Action taken by electronic control unit	①: All Fail Safe functions against a faulty Analog/Digital input are activated. ②: Engine stopped	
Warning lamp illuminated	①: None ②: (Amber)	
Probable cause and check item	Faulty electronic control unit	—

34 Q RESISTOR		
Code issued condition [Reset condition]	Diagnostic trouble code **34** is intended for checking the harness of the injection rate adjustment resistor for open or short circuit and checking the injection rate adjustment resistor for abnormalities. The code is issued when the output voltage of the injection rate adjustment resistor continues to be out of the specified limits for the predetermined period of time. [When the voltage of the injection rate adjustment resistor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	The injection rate correction value is fixed to No. 1 value.	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harness between electronic control unit and injection rate adjustment resistor • Faulty injection rate adjustment resistor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 13: Resistor No. check of injection rate adjustment resistor. • Check circuit between electronic control unit and injection rate adjustment resistor. 🕮 P13EA-49: Electrical Wiring Diagram

41 FUEL TEMP		
Code issued condition [Reset condition]	Diagnostic trouble code **41** is intended for checking the harness of the fuel temperature sensor for open or short circuit and checking fuel temperature sensor for abnormalities. The code is issued when the output voltage of the fuel temperature sensor continues to be out of the specified limits for the predetermined period of time. [When the voltage of the fuel temperature sensor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Control is made on the assumption that fuel temperature is 40°C {104°F}	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and fuel temperature sensor • Faulty fuel temperature sensor • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 11: Fuel temperature measure. • Perform checks at electronic control unit connector. 🕮 P13EA-32 **12** : Measurement of fuel temperature sensor resistance. • Check fuel temperature sensor. 🕮 P13EA-36: Inspection of Electrical Devices **323** • Check circuit between electronic control unit and fuel temperature sensor. 🕮 P13EA-49: Electrical Wiring Diagram

44 BOOST TEMP		
Code issued condition [Reset condition]	Diagnostic trouble code **44** is intended for checking the harness of the boost air temperature sensor for open or short circuit and checking the boost air temperature sensor for abnormalities. [When the voltage of the boost air temperature sensor re-enters the specified range, a reset is made.]	
Action taken by electronic control unit	Control is made on the assumption that boost air temperature is 80°C {176°F}	
Warning lamp illunimated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and boost air temperature sensor • Faulty boost air temperature sensor • Faulty electronic control unit	• Check boost air temperature sensor. 🕮 P13EA-36 **304** : Inspection of Electrical Devices • Check circuit between electronic control unit and boost air temperature sensor. 🕮 P13EA-49: Electrical Wiring Diagram

45 FUEL CUT SW		
Code issued condition [Reset condition]	Diagnostic trouble code **45** is intended for checking the harness of the emergency engine stop switch for open or short circuit and checking the emergency engine stop switch for abnormalities. The code is issued when a fault is detected in the circuit with both emergency engine stop switch and starter switch at the ON position (without starting the engine). [When the emergency engine stop switch is set to OFF, a reset is made.]	
Action taken by electronic control unit	Engine start inhibited	
Warning lamp illuminated	(Red)	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and emergency engine stop switch • Faulty emergency engine stop switch • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 📖 P13EA-28 No. 42: Operation check of emergency engine stop switch. • Perform checks at electronic control unit connector. 📖 P13EA-32 **11**: Measurement of emergency engine stop switch operating voltage. • Check emergency engine stop switch. 📖 P13EA-36: Inspection of Electrical Devices **156** • Check circuit between electronic control unit and emergency engine stop switch. 📖 P13EA-49: Electrical Wiring Diagram

46 EDU RELAY		
Code issued condition [Reset condition]	Diagnostic trouble code **46** is issued in the following cases. ①: Electronic driveunit relay is not ON with electronic drive unit relay ON command issued. [When the electronic drive unit relay is not ON by the electronic drive unit relay ON command, and the voltage exceeds 16V, a reset is made.] ②: Electronic drive unit relay is not OFF with electronic drive unit relay OFF command issued. [Electronic drive unit relay is turned OFF by the electronic drive unit relay OFF command, and the voltage exceeds 16V, a reset is made.]	
Action taken by electronic control unit	①: Electronic drive unit relay OFF ②: Ordinary controls continued	
Warning lamp illuminated	①: (Amber) ②: None	
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and electronic drive unit. • Faulty electronic drive unit relay	• Check electronic drive unit relay. 📖 P13EA-36: Inspection of Electrical Devices **228** • Check circuit between electronic control unit and electronic drive unit relay. 📖 P13EA-49: Electrical Wiring Diagram

65 ACCEL SW		
Code issued condition [Reset condition]	Diagnostic trouble code **65** is intended for checking the harness of the accelerator switch for open or short circuit and checking the accelerator switch for abnormalities. The code is issued when the accelerator pedal position sensor 1 or 2 shows an opening of more than 20% with the accelerator switch ON. [If the accelerator switch turns OFF when the accelerator pedal position sensor shows an opening of more than 20%, a reset is made.]	
Action taken by electronic control unit	Ordinary controls continued	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and accelerator switch • Faulty accelerator switch • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮 P13EA-28 No. 43: Check of accelerator switch operating signal. Perform checks at electronic control unit connector. 🕮P13EA-32 **09**: Measurement of accelerator switch operating voltage. Check accelerator switch. 🕮P13EA-36: Inspection of Electrical Devices **324** Check circuit between electronic control unit and accelerator switch. 🕮P13EA-49: Electrical Wiring Diagram

66 STARTER SW (S)		
Code issued condition [Reset condition]	Diagnostic trouble code **66** is intended for checking the harness of the starter switch for open or short circuit and checking the starter switch for abnormalities. The code is issued when a start signal is input with the engine running at a speed higher than the specified speed. [When the start signal is no longer input, a reset is made.]	
Action taken by electronic control unit	Ordinary controls continued	
Warning lamp illuminated	None	–
Probable cause and check item	• Open or short circuit in harmess between electronic control unit and starter switch • Faulty starter switch • Faulty electronic control unit	• Perform checks on the basis of the service data of the Multi-Use Tester II. 🕮P13EA-28 No. 41: Start signal ON/OFF check. • Perform checks at electronic control unit connector. 🕮P13EA-32 **13**: Measurement of starter switch signal voltage. • Check starter switch. 🕮P13EA-36: Inspection of Electrical Devices **002** • Check circuit between electronic control unit and starter switch. 🕮P13EA-49: Electrical Wiring Diagram

5. SERVICE DATA OF MULTI-USE TESTER II

Screen Display of Multi-Use Tester II			Condition When Checking	Judging Criteria
No.	Item Name	Data		
01	ENGINE SPEED	■■■■. rpm	Racing (Engine running)	Synchronized with tachometer
03	INJ VOL	■■■. ■ %	Starter switch ON	0 %
09	TCV ANG DIFF	■■■. ■ deg	Warm engine running at idle	0 deg
0B	ACCEL (%)	■■■. ■ %	Accelerator pedal released	0 %
			Slowly depressed	Slowly increased
			Accelerator pedal fully depressed	100 %
0C	ACCEL (V)	■. ■■■ V	Accelerator pedal slowly depressed from released position	0.85 to 4.15 V
0D	VEHICLE SPEED	■■■. ■ MPH	During driving	Synchronized with speedometer
0E	IDL VOL SNSR	■. ■■■ V	Slow to fast	2.6 to 1.2 V
10	WATER TEMP	■■■. ■ °F	Engine cold	Equivalent to atmospheric temperature
			Engine warmup in progress	Slowly increased
			Engine stopped after warmup	Slowly decreased
11	FUEL TEMP	■■■. ■ °F	Engine cold	Equivalent to atmospheric temperature
			Engine warmup in progress	Slowly increased
			Engine stopped after warmup	Slowly decreased
12	AIR TEMP	■■■. ■ °F	Engine cold	Equivalent to atmospheric temperature
13	Q RESISTOR	■■■■	—	Matches No. marked on injection rate adjusting resistor.
14	AIR PRESS	■■■■. mmHg	Altitude 0 m	13.5 mmHg
			Altitude 600 m	12.7 mmHg
			Altitude 1200 m	11.7 mmHg
15	BOOST PRESS	■■■■. mmHg	Engine speed 3400 rpm	260 mmHg
16	BATT VOLTAGE	■■. ■■ V	Starter switch ON	Matches battery voltage.
17	PTO-ACCEL (%)	■■■. ■ %	When PTO is used (MIN-MAX)	0 to 100 %
18	PTO-ACCEL (V)	■. ■■■ V	When PTO is used (MIN-MAX)	1 to 3.0 V
19	PTO RESISTOR	■■■■	—	Matches No. marked on power take-off resistor.
41	START SIG	ON/OFF	Engine cranked by starter switch	ON
			Starter switch at any other position than S	OFF
42	FUEL CUT SW	ON/OFF	Switch ON	ON
			Switch OFF	OFF
43	ACCEL SW	ON/OFF	Accelerator pedal depressed	ON
			Accelerator pedal released	OFF
44	A/C SW	ON/OFF	When air conditioner compressor is in operation	ON
			When air conditioner compressor is idle	OFF

Screen Display of Multi-Use Tester II			Condition When Checking	Judging Criteria
No.	Item Name	Data		
45	COLD START SW	ON/OFF	Warming switch ON	ON
			Warming switch OFF	OFF
46	DIAGNOSIS SW	ON/OFF	Diagnostic switch ON	OFF
			Diagnostic switch OFF	ON
47	DIAG RESET SW	ON/OFF	Memory clear switch ON	OFF
			Memory clear switch OFF	ON
51	EXH.BRAKE SW	ON/OFF	Exhaust brake switch ON (when exhaust brake is active)	ON
			Exhaust brake switch OFF (when exhaust brake is inactive)	OFF
53	NEUTRAL SW	ON/OFF	Transmission at neutral	ON
			Transmission at any other position than neutral	OFF
55	IDL-UP CNCL	ON/OFF	Automatic transmission select lever at R, D, 2 or L	ON
			At any other position than mentioned above	OFF
61	SILENCER M/V	ON/OFF	At idling	ON
			At 2500 rpm	OFF
71	EXH. BRAKE M/V	ON/OFF	When exhaust brake is active	ON
			When exhaust brake is inactive	OFF
73	DIAG LAMP (R)	ON/OFF	Starter switch ON (engine not made to start)	ON
			No error generated after engine has started	OFF
74	DIAG LAMP (U)	ON/OFF	Starter switch ON (engine not made to start)	ON
			No error generated after engine has started	OFF
83	SPV	ON/OFF	When engine is running	ON (ON → OFF repeated)
			When engine is stationary	OFF

6. ACTUATOR TEST BY MULTI-USE TESTER II

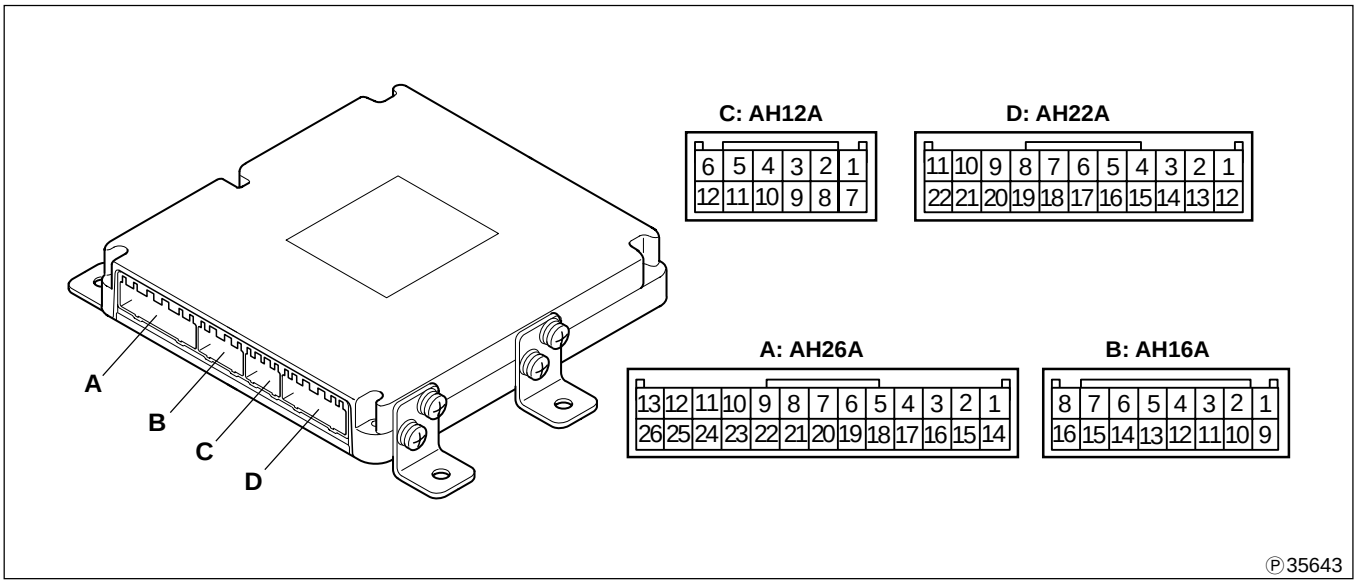
Screen Display of Multi-Use Tester II		Operation Check Procedures
No.	Item Name	
9B	SPV	Operating sound of solenoid valve
9C	TCV-OFF	No operating sound of solenoid valve
9D	TCV-ON	Operating sound of solenoid valve
91	SILENCER M/V	ON/OFF sound of magnetic valve
94	EXH. BRAKE M.V	ON/OFF sound of magnetic valve
97	DIAG LAMP (R)	ON/OFF state of warning lamp (Red)
98	DIAG LAMP (A)	Operating state of warning lamp (Amber)
99	A/C SIG	High idling speed
9A	IDL-UP CNCL	Low idling speed

MEMO

7. CHECKS AT CONNECTOR OF ELECTRONIC CONTROL UNIT

This method of checks is useful for checking whether all the signals of the electronic control unit are transmitted without any error through the vehicle side harness and connector.
The numbers in the table correspond to the call numbers used in “4. DIAGNOSTIC TROUBLE CODES AND CHECK ITEMS” for referencing this section.

Pin Configuration of Electronic Control Unit



No.	Item	Reference Page
01	Resistance of TDC (Top dead center) sensor	P13EA-33
02	Resistance of engine speed sensor	
03	Output voltage of accelerator position sensor 1	
04	Output voltage of accelerator position sensor 2	
05	Signal voltage of vehicle speed sensor	
06	Output voltage of idling speed adjustment potentiometer	P13EA-34
09	Voltage of accelerator switch	
11	Voltage of emergency engine stop switch	
12	Resistance of fuel temperature sensor	
13	Voltage of starter switch (start signal)	

Checking Procedures

CAUTION ⚠

Each item is checked by one of two methods; one by disconnecting the connectors and one by leaving the connectors connected.

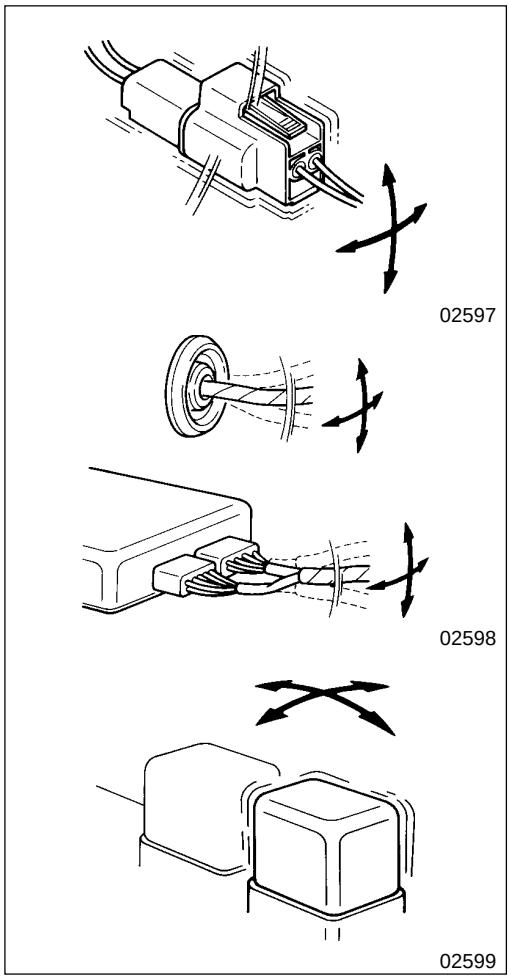
Pay heed to the following points.

- **Be sure not to touch any other pin than the one to be checked.**
  Especially, use utmost care that a short circuit is never produced between pins by the tester.
- **All the illustrations of the connectors in the table show the connectors on the electronic control unit side. Be careful not to confuse the pins with those to be checked.**

Check Item	Checking Procedure
01 Resistance of TDC (Top dead center) sensor	[Conditions] • Starter switch OFF • Disconnect connector and make checks at vehicle side harness connector (25°C {77°F}). [Judging Criteria] Between pins: C⑤ – C⑪ 1.5 ± 0.2 kΩ
02 Resistance of engine speed sensor	[Conditions] • Starter switch OFF • Disconnect connector and make checks at vehicle side harness connector. [Judging Criteria] Between pins: C⑥ – C⑫ 230 ± 25 Ω
03 Output voltage of accelerator pedal position sensor 2	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): B⑬ – B⑧ • When accelerator pedal is released: 0.85V • When accelerator pedal is depressed: 4.15V
04 Output voltage of accelerator pedal position sensor 1	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): B⑪ – B⑥ • When accelerator pedal is released: 0.85V • When accelerator pedal is depressed: 4.15V
05 Signal voltage of vehicle speed sensor	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of vehicle side connector). • Using chassis dynamometer or something else, slowly rotate wheels. [Judging Criteria] Between pins (⊕ — ⊖): A⑦ – A⑬ • High: Approx. 8V • Low : 0.5V or less

Check Item	Checking Procedure
06 Output voltage of idling speed adjustment potentiometer	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): B⑤ – B⑩ • When knob is pulled: Approx. 1 to 3V • When knob is pushed all the way: Approx. 3.6 to 4.3V
09 Voltage of accelerator switch	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): D⑩ – B⑧ • When accelerator pedal is depressed: 0V • When accelerator pedal is released: 5V
11 Voltage of emergency engine stop switch	[Conditions] • Starter switch ON • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins (⊕ — ⊖): D㉒ – D⑯ • Switch at stop position: 0V • Switch at normal position: 12V
12 Resistance of fuel temperature sensor	[Conditions] • Starter switch OFF • Leave vehicle side harness connected (make checks from back side of connector). [Judging Criteria] Between pins: B⑫ – B⑯ 2.5 ± 1.0 kΩ
13 Voltage of starter switch (starter signal)	[Conditions] • Leave vehicle side harness connected (make checks from back side of connector). • Starter switch (S position) [Judging Criteria] Between pins (⊕ — ⊖): D② – D⑪ 12V

8. CHECKS ON INTERMITTENT TROUBLES

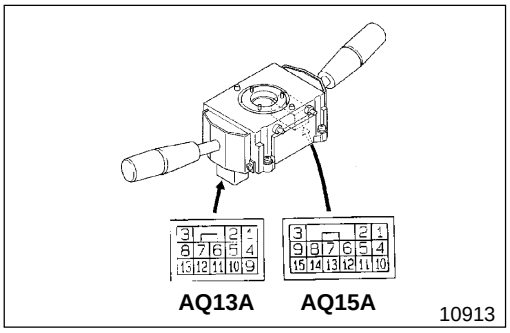


A intermittent trouble often occurs in a specific condition. Therefore, pinpointing the condition will make it easy to estimate the cause. To pinpoint the condition for a intermittent trouble, ask the customer in detail about the driving condition when the trouble occurs, weather, occurrence frequency and symptoms, and reproduce the symptoms of the trouble.
Depending on the condition where the trouble occurs, determine whether the cause of the trouble is vibration, temperature or any other factor.
If the probable cause is vibration, perform the following checks on the relevant connectors harnesses, etc. and check whether the symptoms of the trouble are reproduced.

- Lightly move the connector up and down and to the right and left.
- Lightly move the harness up and down and to the right and left.
- Lightly shake the sensors and other devices by hand.
- Lightly shake the wiring harness located in the moving components such as the suspension.

The connectors and other parts to be checked are identifiable from the descriptions in the Probable Causes or the Checking Procedures for the displayed diagnostic trouble code.

INSPECTION OF ELECTRICAL EQUIPMENT



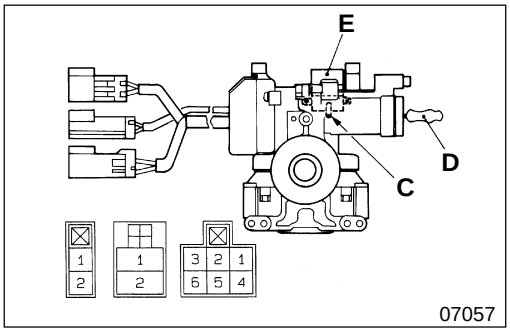
001 Checking Combination Switch

- Perform continuity checks according to the following table.
  AQ15A Connector Connection Table

		⑤	⑥
Exhaust brake switch	OFF		
	ON	○——○	

○——○ : There must be continuity between the pins.

- If there is anything wrong, replace the switch.



002 Checking Starter Switch

- Perform continuity checks according to the following table.
- If there is anything wrong, replace the starter switch. Gr 37

(1) Continuity Check

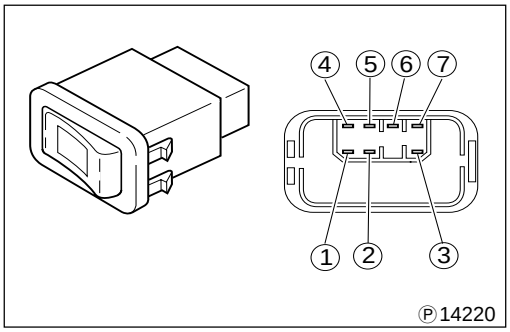
		AP2A		AN6A				
		②	①	③	④	②	⑥	⑤
LOCK	Key not in position							
	Key in position						○——○	
• (OFF)							○——○	
ACC		○———		○			○——○	
ON		○——○		○——○			○——○	
START		○——○		○——○		○	○——○	
		B	M	A	F/M	S	K1	K2

○——○ : There must be continuity between the pins.

(2) Checking Key Interlock Solenoid

	AN2A		LOCK	ACC	ON	START	Remarks
	①	②					
Rotating range of key **D**	⊕——⊖			←———		———→	Plunger **C** is locked and key **D** cannot be removed.
			←———			———→	Plunger **C** is free and key **D** can be removed.

⊕——⊖ : Apply voltage across these pins.
DC 12V
E: Key interlock solenoid



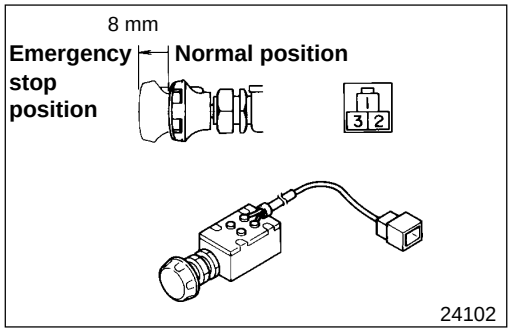
014 Checking Warming Switch

- Perform continuity checks according to the following table.

	①	⑤
ON	○——○	
OFF		

○——○ : There must be continuity between the pins.

- If there is anything wrong, replace the switch.



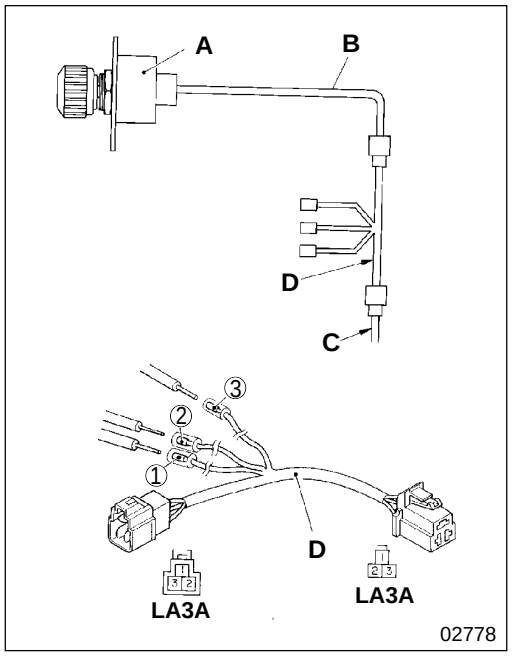
156 Checking Emergency Engine Stop Switch

- Perform continuity checks according to the following table.

	①	②	③
Normal position	○——○		
Emergency stop position	○		○

○——○ : There must be continuity between the pins.

- If there is anything wrong, replace the switch.
  Gr 13A

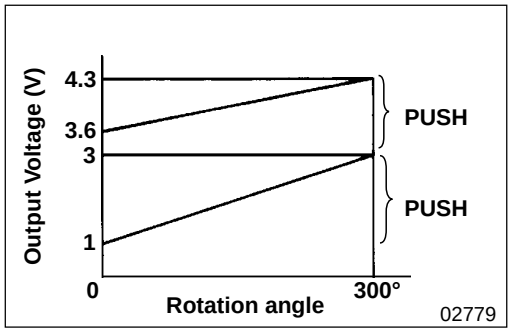


157 Checking Idling Speed Adjustment Potentiometer

- Disconnect the harness **B** of the idling speed adjustment potentiometer **A** from the vehicle side harness **C**, and connect the inspection harness **D** between them.
- Set starter switch to ON.
- Measure the output voltage of the idling speed adjustment potentiometer **A** according to the following table.

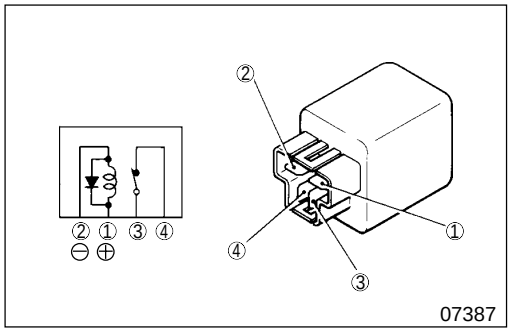
	②	③		
Standard value	⊖	⊕	Output voltage PULL (Knob in pulled position)	1 to 3 V
			Output voltage PUSH (Knob in pushed position)	3.6 to 4.3 V

- If the reading is out of the standard value range, replace the idling speed adjustment potentiometer **A**.



Output Characteristics

INSPECTION OF ELECTRICAL EQUIPMENT



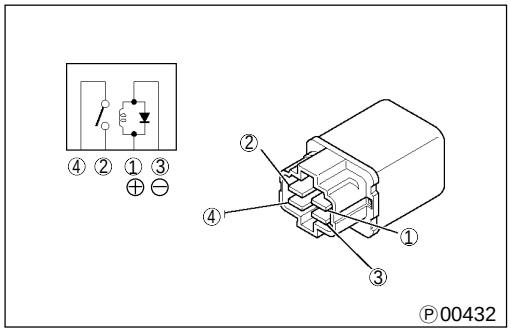
180 Checking Relay (Normally closed type 4-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④
When not energized	○	○	○	○
When energized	⊕	⊖	◌	◌

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12 V DC across these pins.
◌·····◌ : Continuity between these pins must be lost.

- If there is anything wrong, replace the relay.



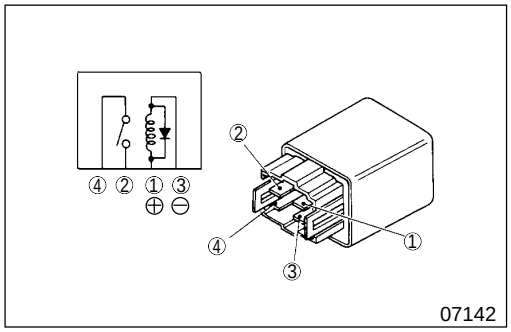
181 Checking Relay (Normally open type 4-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④
When not energized	○		○	
When energized	⊕		⊖	○

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12V DC across these pins.

- If there is anything wrong, replace the relay.



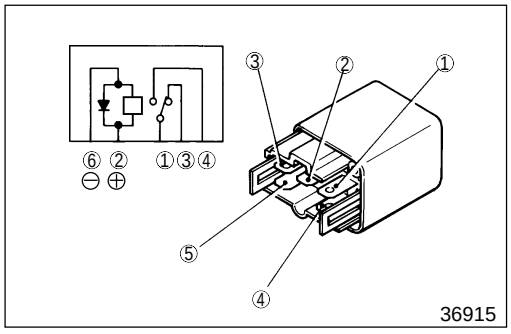
185 Checking Relay (Normally open type 4-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④
When not energized	○		○	
When energized	⊕		⊖	○

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12V DC across these pins.

- If there is anything wrong, replace the relay.



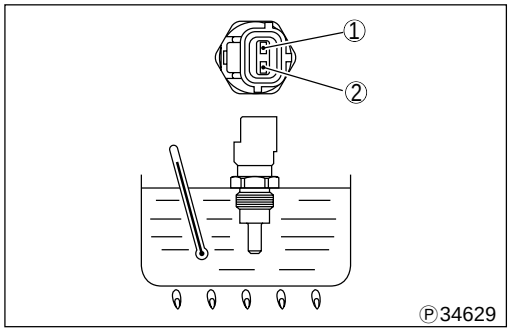
228 Checking Relay (Normally open type 6-pin)

- Perform continuity and operation checks according to the following table.

	①	②	③	④	⑥
When not energized	○		○		
		○			○
When energized	○			○	
		⊕			⊖

○——○ : There must be continuity between the pins.
⊕——⊖ : Apply a voltage of 12 V DC across these pins.

- If there is anything wrong, replace the relay.



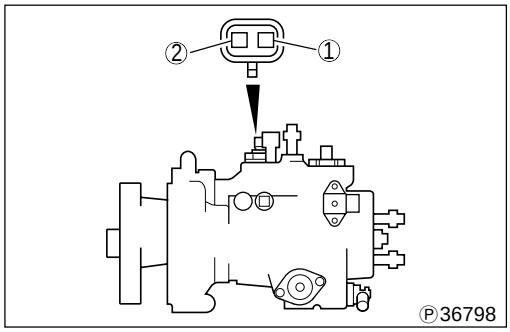
262 **Checking Water Temperature Sensor**

- Put the water temperature sensor in a container filled with engine oil.
- Heat the engine oil to various specified temperatures while stirring the engine oil.
- Measure the resistance value between pins ① and ② (body).

Standard value	20°C {68°F}	2.3 to 2.6 kΩ
	80°C {176°F}	0.30 to 0.34 kΩ

Reference value in parentheses

- If the reading is out of the standard value, replace the water temperature sensor. Gr14A

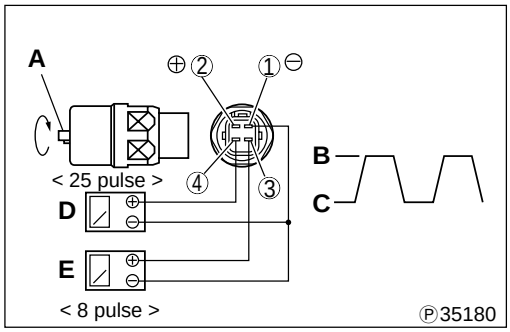


Checking Engine Speed Sensor

263 asure the resistance value between pins ① and ②.

Standard value (at 20°C {68°F})	230 ± 25 Ω

- If the reading is out of the standard value range, replace the engine speed sensor. Ask your DENSO service station to replace it.



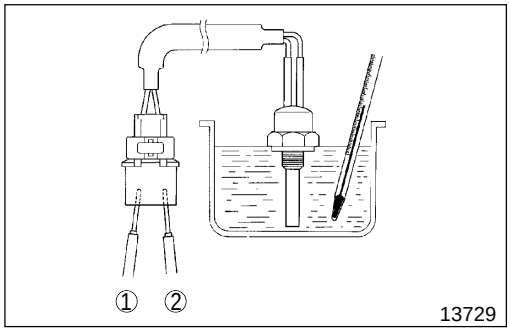
265 **Checking Vehicle Speed Sensor**

- Slowly rotate portion **A** of the vehicle speed sensor with a voltage of 12V DC applied across pins ① and ②.
- Measure the maximum value (high pulse voltage **B**) and minimum value (low pulse voltage **C**) of the voltage generated across following pins.

D: Tester

Standard value	Between pins ① and ③ of 8-pulse output	Low pulse	1.5 V or less
		High pulse	12 V — (0.5 V or less)
	Between pins ① and ④ of 25-pulse output	Low pulse	0.5 V or less
		High pulse	8 ± 1 V

- If the reading is out of the standard value, replace the vehicle speed sensor.

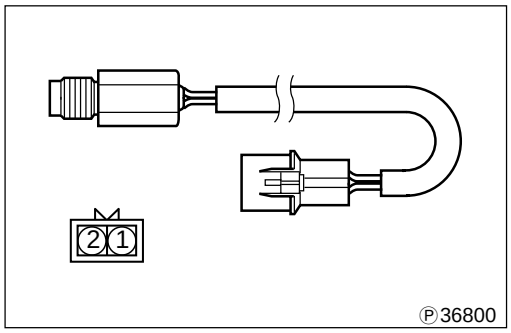


304 **Checking Boost Air Temperature Sensor**

- Place the boost air temperature sensor in glycerin in a container.
- Raise the glycerin temperature to the specified values and stir the glycerin.
- Measure the resistance between pins ① and ②.
- If the measured value deviates from the standard value, replace the boost air temperature sensor. Gr 15A

Standard value	0°C {32°F}	5880 ± 588 Ω
	20°C {68°F}	2450 ± 245 Ω
	80°C {176°F}	322 ± 48 Ω

INSPECTION OF ELECTRICAL EQUIPMENT

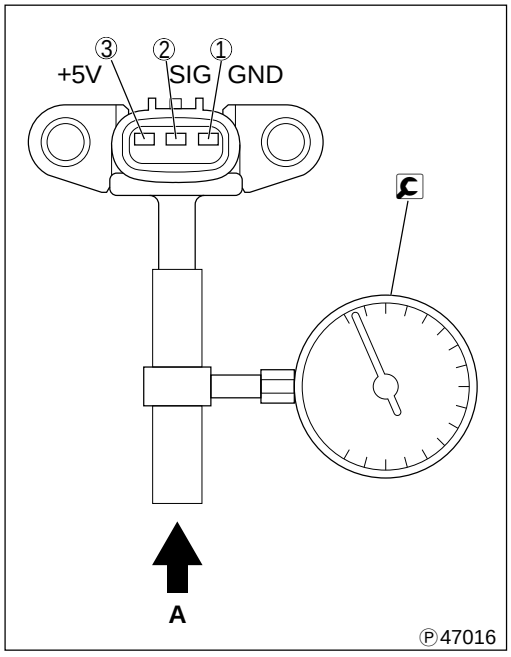


316 Checking TDC (Top dead center) Sensor

- Measure the resistance between pins ① and ②.

Standard value (at 25°C {77°F})	1.4 ± 0.2 kΩ

- If the reading is out of the standard value, replace the TDC (Top dead center) sensor.



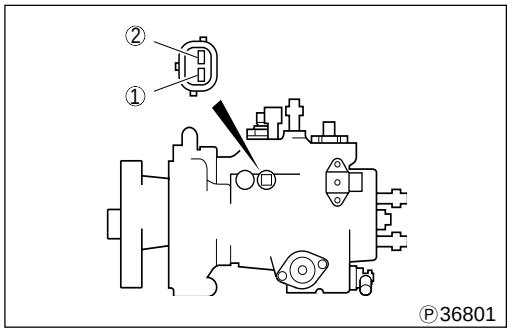
318 Checking Boost Pressure Sensor

- Apply 5V DC between terminals ① and ③.
- Increase air pressure A gradually and measure the voltage between terminals ② and ③.
  : Boost Pressure Gauge

Tool Name and Shape	Part No.
01524	MC061366

	Air pressure	Voltage
Standard value	99 kPa {740 mmHg, 1 kg/cm^2)	2.5V
	232 kPa {1738 mmHg, 2.4 kg/cm^2)	4.5V

- If the measurement deviates from the standard values, replace the boost pressure sensor.

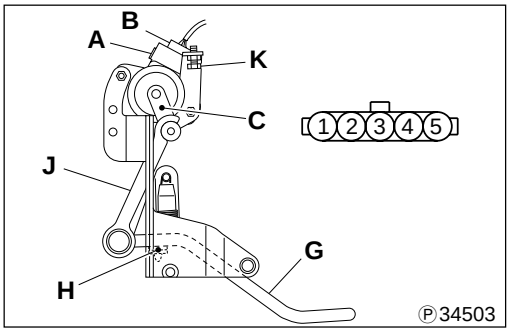


323 Checking Fuel Temperature Sensor

- Measure the resistance between pins ① and ②

Standard value (at 20°C {68°F})	2.5 ± 1.0 kΩ

- If the reading is out of the standard value range, replace the fuel temperature sensor. Ask your DENSO service station to replace it.



324 Checking Accelerator Position Sensor

[Inspection]

- Set the starter switch to ON.
- Measure the output voltage of the accelerator position sensor **A** from the back side of harness connector **B** according to the following table.

Lever **C** position		Accelerator Position Sensor 1		Accelerator Position Sensor 2		Accelerator Switch	
		②	①	②	⑤	②	③
		⊕	⊖	⊕	⊖	⊕	⊖
Standard value	Idling position **D**	0.85 ± 0.1 V		0.85 ± 0.1 V		4V or more	
	Accelerator switch operating position **E**	1.0 ± 0.24 V		1.0 ± 0.24 V		1V or less	
	Full load position **F**	4.15 ± 0.1 V		4.15 ± 0.1 V			

○——○ : There must be continuity between the pins.

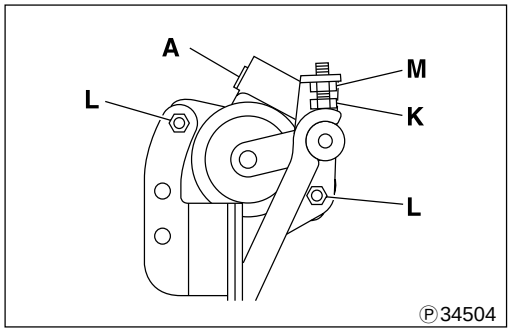
⊕ , ⊖ : Polarity when voltage is measured

D: Where accelerator control arm **G** is in contact with stopper **H**

E: Where voltage across pins ② and ③ is reduced to 1V or less by slowly depressing the accelerator pedal

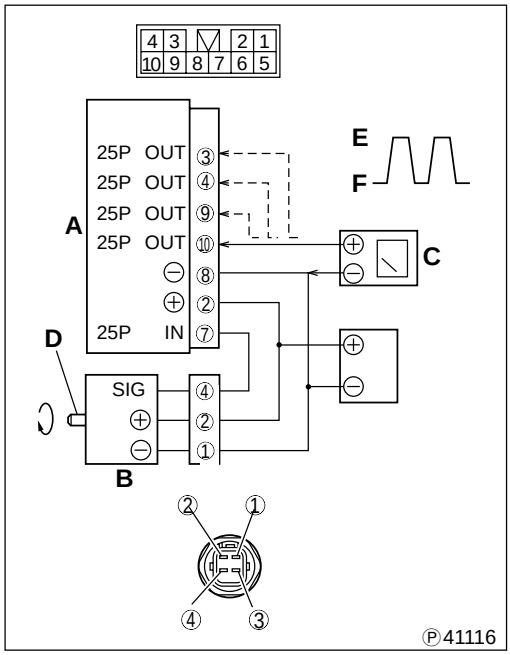
F: Where accelerator control extension **J** is in contact with stopper bolt **K**

- If the output voltage is out of the standard value range, adjust by the following procedures.



[Adjustment]

- Adjust the output voltage at the idling position **D** by loosening the screw **L** and moving the accelerator position sensor **A**.
  After the adjustment, retighten the screw.
- Adjust the output voltage at the full load position **F** by loosening the nut **M** and adjusting the stopper bolt **K**.
  After the adjustment, lock the bolt with the nut.

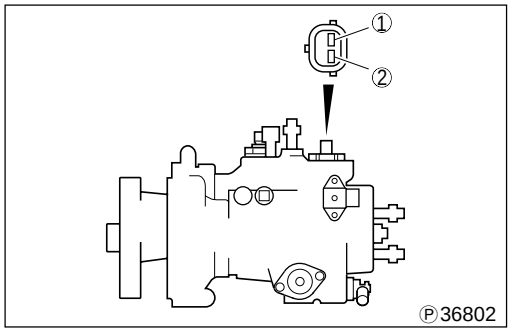


351 Checking Pulse Divider

- Wire the pulse divider **A** as shown.
  B: Vehicle speed sensor (Use 25-pulse pins.)
  C: Tester
- Slowly rotate the shaft **D** of the vehicle speed sensor **B** by hand and measure the maximum value (high pulse voltage **E**) and the minimum value (low pulse voltage **F**) of the voltage generated across each of the output pins (③, ④, ⑨, ⑩) and pin ⑧ of the pulse divider **A**.

Standard value	Low pulse voltage **F**	0.5V or less
	High pulse voltage **E**	8 ± 1 V

- If the reading is out of the standard value, replace the pulse divider **A**.

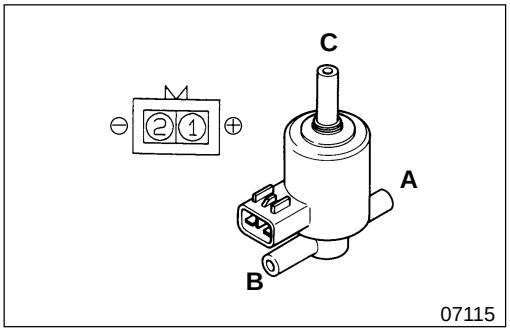


536 Checking Spill Valve

- Measure the resistance between pins ① and ②.

Standard value (at 20°C {68°F})	1.5 ± 0.5 Ω

- If the reading is out of the standard value range, replace the spill valve. Ask your DENSO service station to replace it.



565 Checking 3-Way Magnet Valve

Perform the following checks. If there is anything wrong, replace the 3-way magnet valve.

(1) Operation Check

- Apply DC voltage across pins ① and ② and slowly increase, beginning at 0V.
- Measure the voltage at the time when the 3-way magnet valve is operated.
  (Determine whether the magnet valve is ON or OFF on the basis of its operating sound.)

Standard value (Lowest operating voltage)	11 V or less

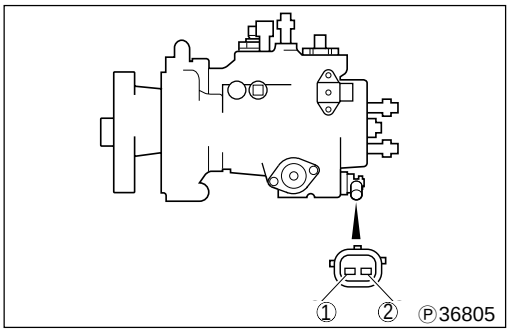
(2) Continuity and Air Tightness Checks

Perform continuity checks according to the following table.

	Input Port **A**	Output Port **B**	Exhaust Port **C**
ON	○———	———○	
OFF		○———	———○

○——○ : There must be continuity between the pins.

Negative pressure at the time of check: 100 kPa {30 in.Hg, 750 mmHg}



584 Checking Timer Control Valve

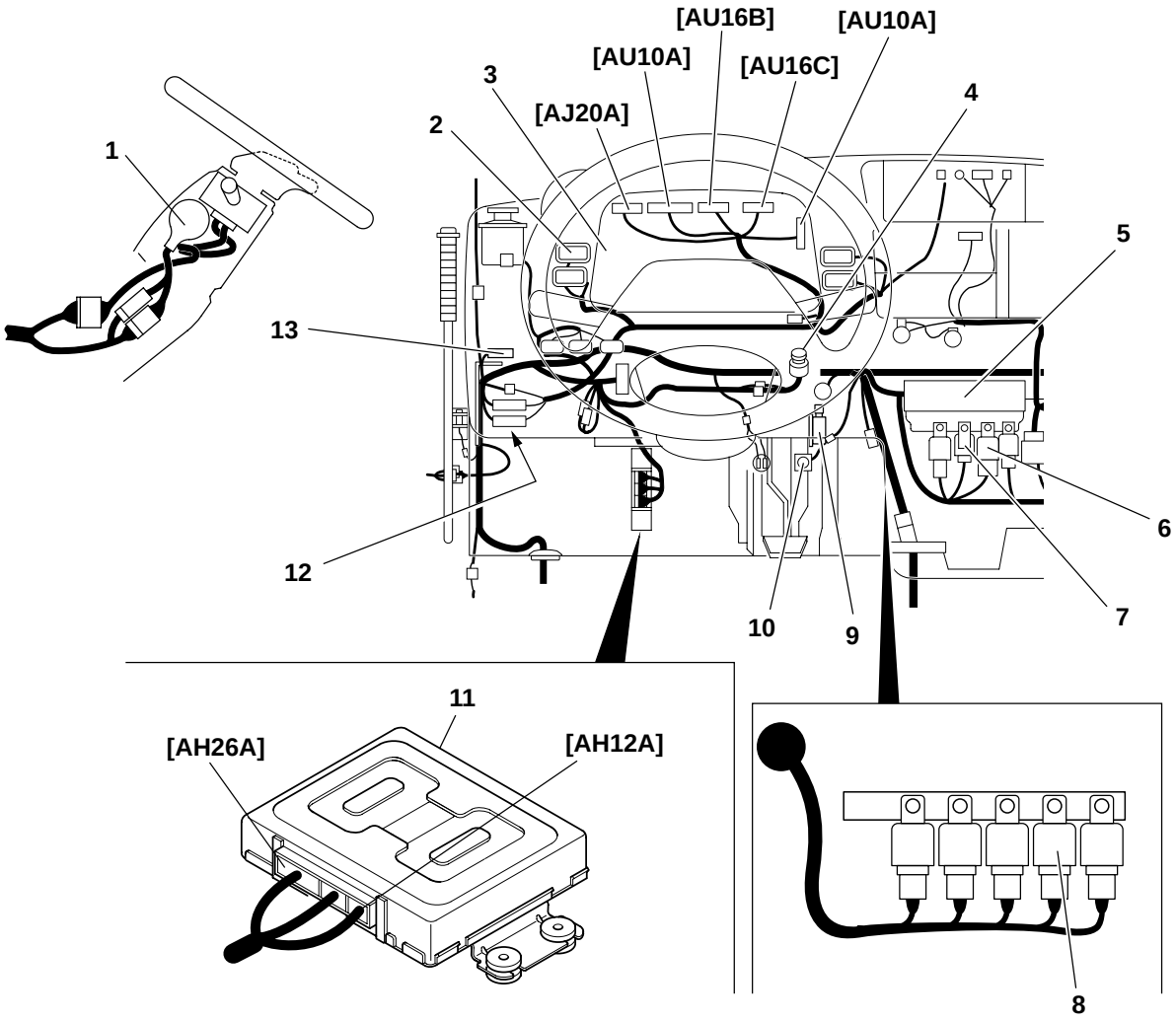
- Measure the resistance between pins ① and ②.

Standard value (at 20°C {68°F})	11.3 ± 3 Ω

- If the reading is out of the standard value range, replace the timer control valve. Ask your DENSO service station to replace it.

LOCATIONS OF PARTS

1 to 15

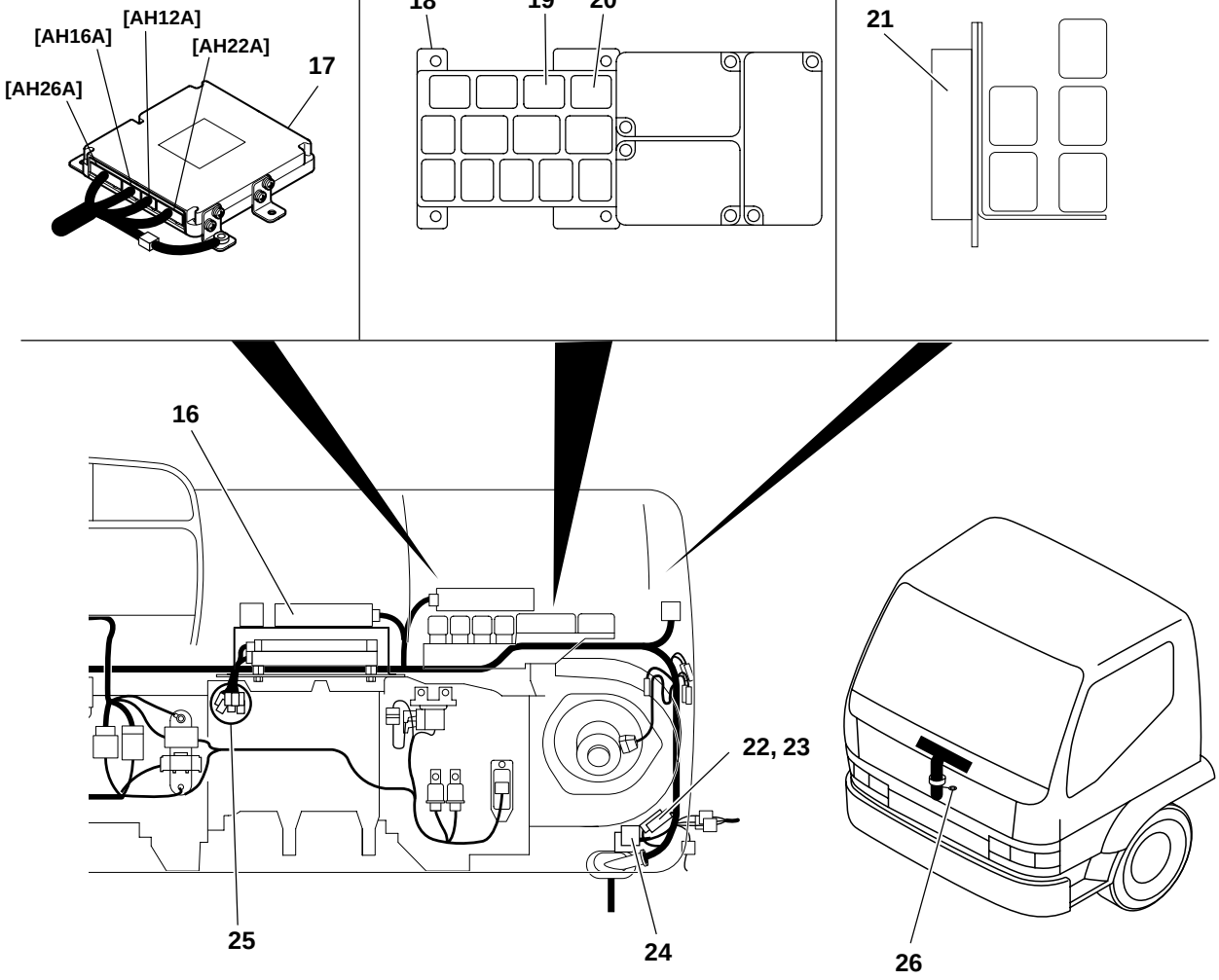


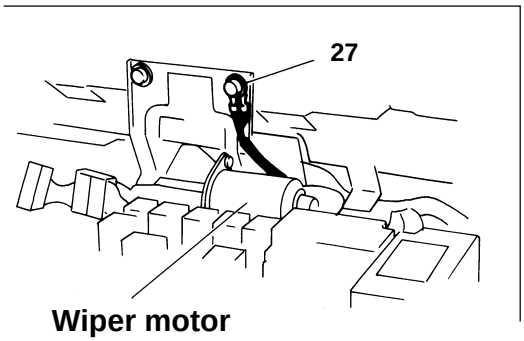
1 Starter switch
2 Warming switch
3 Meter cluster
4 Idling speed adjustment potentiometer
5 Fuse box
6 Electronic control unit main relay
7 Electronic drive unit relay
8 Exhaust brake cut relay
9 Accelerator pedal position sensor
10 Emergency engine stop switch
11 Automatic transmission electronic control unit
12 Connection of cab harness and meter harness
13 Fuel injection rate adjustment resistor

Indicate by connector type [ ]

Ⓟ48649

16 to 30





Wiper motor

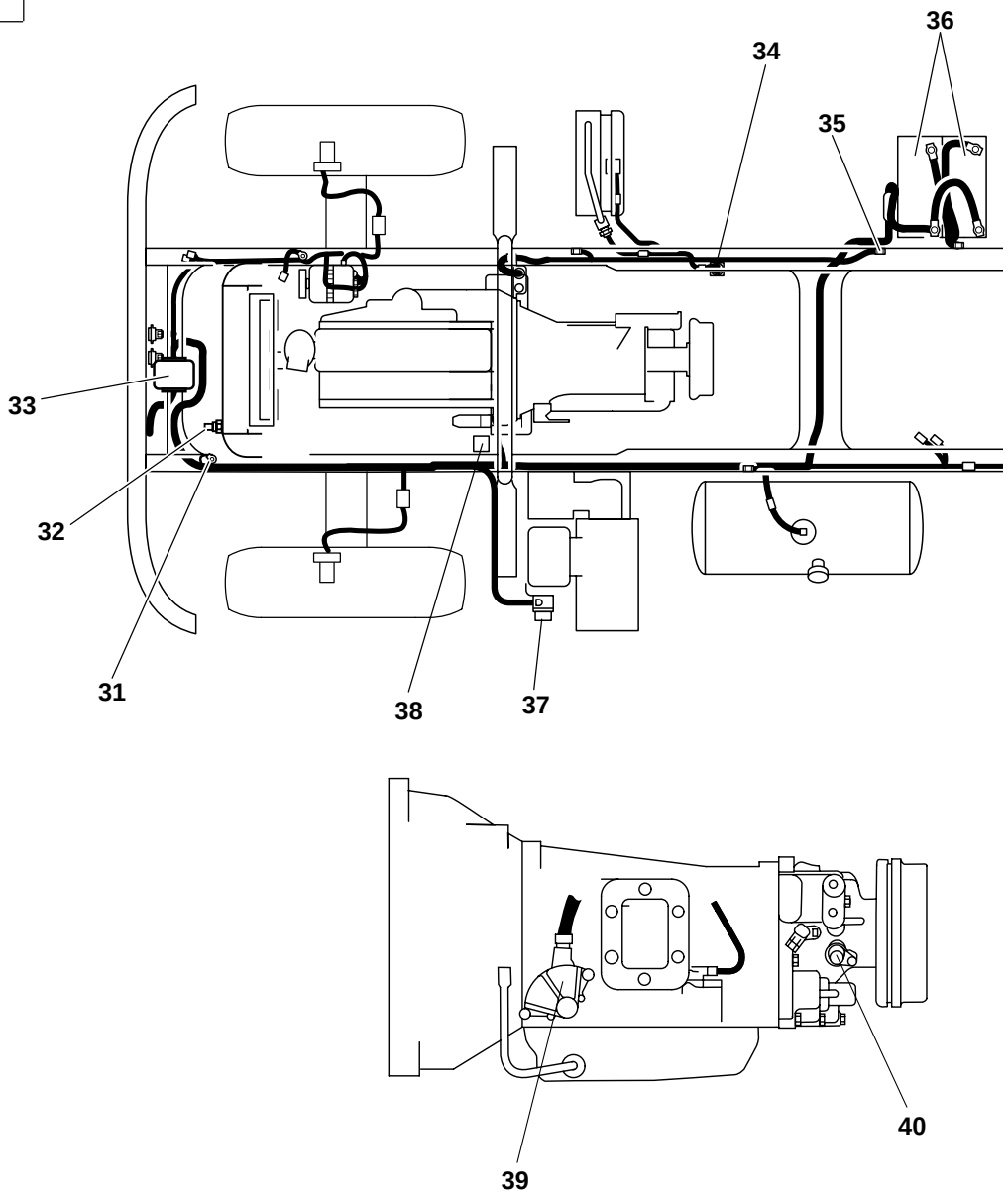
16 Pulse divider
17 Engine electronic control unit
18 Relay box
19 Exhaust brake cut relay(ABS)
20 Safety relay
21 Electronic drive unit
22 Diagnosis switch
23 Memory clear switch
24 Multi-use tester-II connector
25 Diode
26 Cab ground
27 Cab ground

A/T: Automatic transmission
ABS: Anti-lock brake system

Indicate by connector typ [ ]

Ⓟ48650

31 to 40

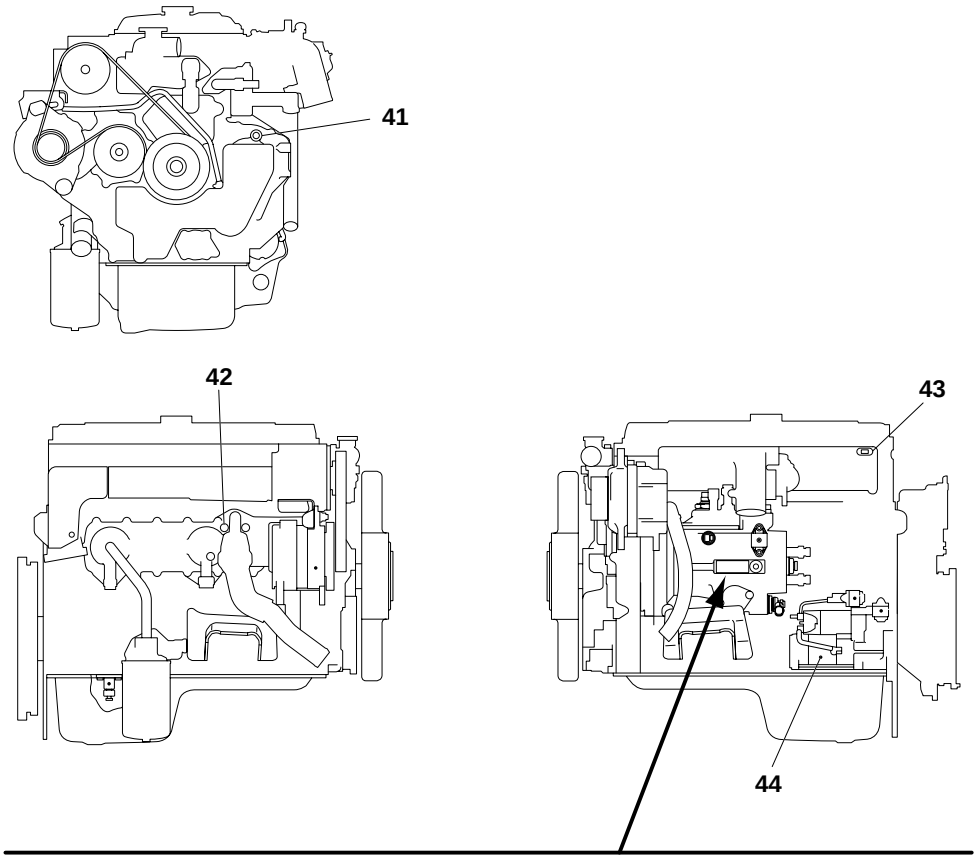


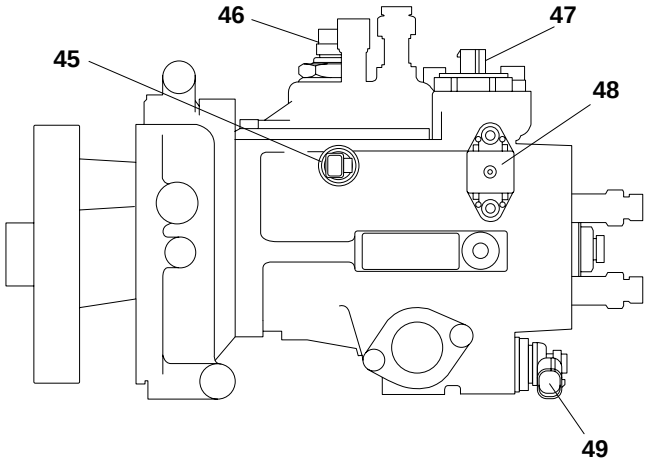
31 Ground
32 Boost temperature sensor
33 Connected of cab harness and chassis harness
34 Exhaust brake 3-way magnetic valve
35 Ground
36 battery
37 High current Fuse box
38 Intake silenser 3-way magnetic valve
39 Inhibitor switch
40 Vehicle speed sensor

Indicate by connector type [ ]

Ⓟ48651

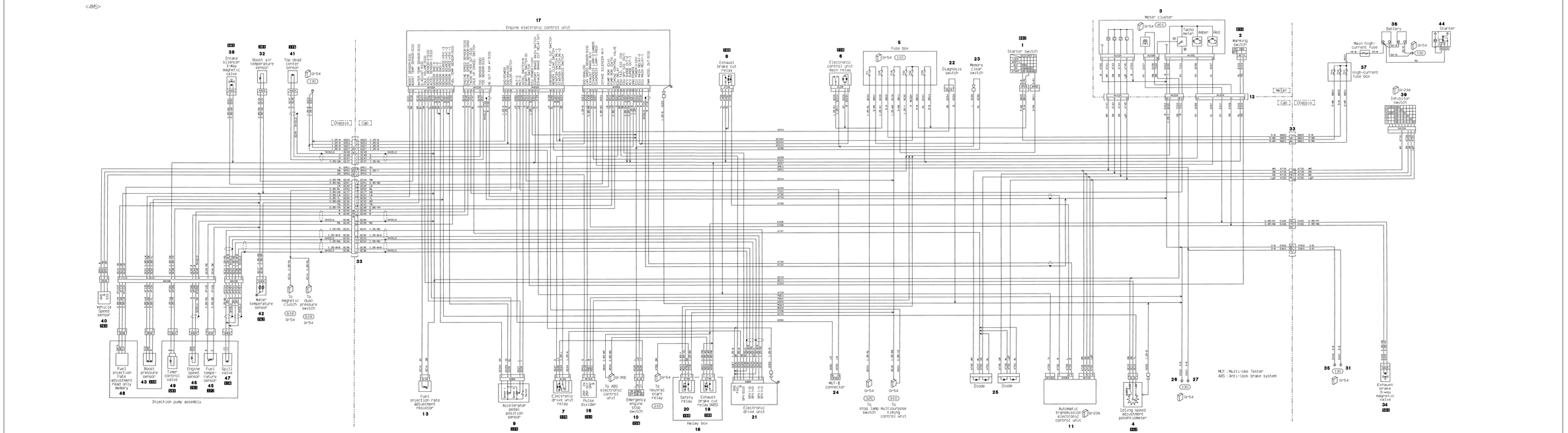
41 to 50





41 Top dead center (TDC) sensor
42 Water tenperature sensor
43 Boost pressure sensor
44 Starter
45 Fuel tenperature sensor
46 Engine speed sensor
47 Spill valve
48 Fuel injection rate adjusting read only memory
49 Timer control valve

Ⓟ48652


<4M5>
17
Engine electronic control unit
38
Intake silencer 3-way magnetic valve
32
Boost air temperature sensor
41
Top dead center sensor
8
Exhaust brake cut relay
6
Electronic control unit main relay
5
Fuse box
22
Diagnosis switch
23
Memory clear switch
1
Starter switch
3
Meter cluster
2
Warning switch
36
Battery
44
Starter
37
High-current fuse box
39
Inhibitor switch
33
Vehicle Speed sensor
40
Water temperature sensor
42
To magnetic clutch
To dual pressure switch
Fuel injection rate adjustment read only memory
48
Boost pressure sensor
43
Timer control valve
49
Engine speed sensor
46
Fuel temperature sensor
45
Spill valve
47
Injection pump assembly
Fuel injection rate adjustment resistor
13
Accelerator pedal position sensor
9
Electronic drive unit relay
7
Pulse divider
16
To ABS electronic control unit
Emergency engine stop switch
10
To neutral start relay
Safety relay
20
Exhaust brake cut relay (ABS)
19
Relay box
18
Electronic drive unit
21
Multi-connector
24
To stop lamp switch
To multipurpose timing control unit
Diode
25
Automatic transmission electronic control unit
11
Idling speed adjustment potentiometer
4
Main high-current fuse
Exhaust 3-way magnetic valve
34
Meter
Can
MUT : Multi-Use Tester
ABS : Anti-lock brake system

52784

MITSUBISHI
FUSO

Group 13EB

Electronically Controlled Fuel System

< 6D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWME0202-13EB

INDEX

STRUCTURE AND OPERATION 13EB- 2

TROUBLESHOOTING

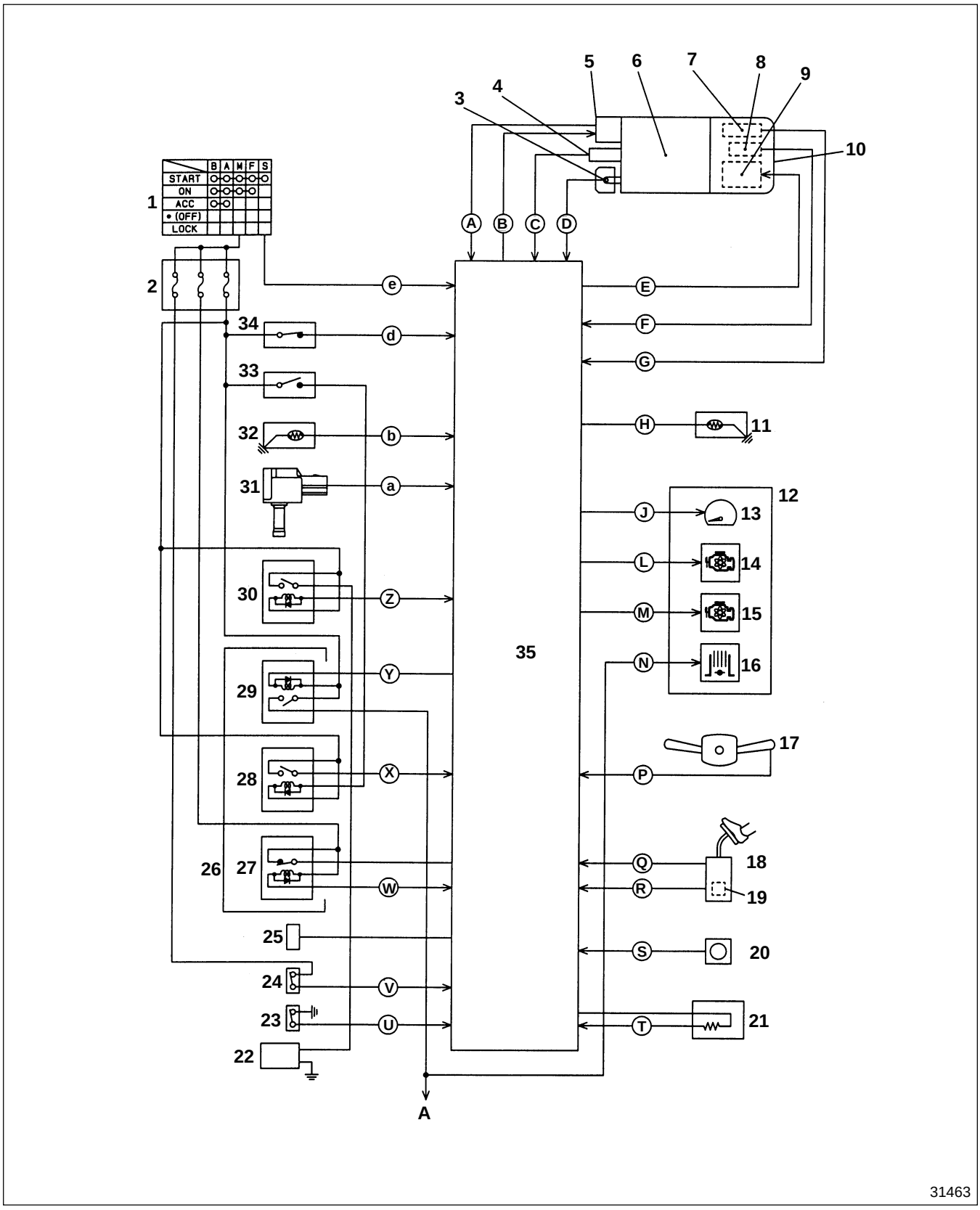
1. Inspection Procedures 13EB-20
2. Connection of Multi-Use Tester II 13EB-22
3. Reading and Erasing Diagnostic Trouble Codes 13EB-23
4. Diagnostic Trouble Codes and Check Items 13EB-25
5. Service Data of Multi-Use Tester II 13EB-30

INSPECTION OF ELECTRICAL EQUIPMENT 13EB-32

LOCATIONS OF PARTS 13EB-42

ELECTRICAL WIRING DIAGRAM 13EB-43

Configuration of Electronic Governor and Pre-stroke Control Injection Pump System



A : To exhaust brake 3-way magnetic valve Gr 54

Part		Main function/operation	Data signal
1	Starter switch	Sensing of start signal	ⓔ : Start signal
2	Fuse box	—	—
3	Engine speed sensor	Sensing of engine speed	Ⓓ : Engine speed signal
4	Sub control rack position sensor	Sensing of control rack position	Ⓒ : Control rack position signal (backup)
5	Pre-stroke actuator • Pre-stroke position sensor • Drive unit	— —	Ⓐ : Pre-stroke position signal Ⓑ : Actuator drive signal
6	Pre-stroke control type injection pump	Alteration of pre-stroke (advancement of fuel injection timing)	—
7	Control rack position sensor	Sensing of control rack position	Ⓖ : Control rack position signal
8	Backup engine speed sensor	Sensing of engine speed	Ⓕ : Engine speed signal (backup)
9	Linear DC motor	Activation of rack	Ⓔ : Linear DC motor drive signal
10	Electronic governor	—	—
11	Boost temperature sensor	Detection of engine intake air temperature	Ⓗ : Boost temperature signal
12	Meter cluster	—	—
13	Tachometer	—	Ⓙ : Tachometer drive signal
14	Warning lamp (Orange)	Indication of system faults and diagnosis codes	Ⓛ : Lamp illumination signal
15	Warning lamp (Red)		Ⓜ : Lamp illumination signal
16	Indicator lamp	—	Ⓝ : Lamp illumination signal
17	Auxiliary brake switch	ON/OFF switching of Exhaust brake	Ⓟ : Exhaust brake ON signal
18	Accelerator pedal position sensor	Sensing of accelerator pedal depression amount	Ⓠ : Accelerator pedal position signal
19	Accelerator pedal switch	Turns OFF when accelerator pedal is depressed	Ⓡ : Accelerator pedal depression signal
20	Idling speed adjustment potentiometer	Shortening of warmup time	Ⓢ : Warmup time shortening signal
21	Fuel injection rate adjustment resistor	Correction of fuel injection rate	Ⓣ : Injection volume correction signal
22	Modulator	—	—
23	Diagnosis switch	Generation of diagnosis codes	Ⓤ : Diagnosis code signal
24	Memory clear switch	Eraser of diagnosis codes	Ⓥ : Diagnosis code eraser signal
25	Multi-Use Tester II connector (16 pin)	Connection of Multi-Use Tester II	—
26	Relay box	—	—
27	Pre-stroke cut relay	Closes contacts upon plunger pre-stroke operation	Ⓦ : Pre-stroke operation signal
28	Transmission neutral relay	Contact closed when transmission is in neutral	Ⓧ : Transmission neutral signal
29	Exhaust brake relay	Closes contacts upon exhaust brake operation	Ⓨ : Exhaust brake operation signal
30	Accelerator relay	Contact closed when modulator is activated	Ⓩ : Modulator operation signal
31	Boost pressure sensor	Sensing of boost pressure	ⓐ : Boost pressure signal
32	Coolant temperature sensor	Sensing of engine coolant temperature	ⓑ : Coolant temperature signal
33	Transmission neutral switch	Turns OFF when transmission neutral is selected	—
34	Clutch pedal switch	Turns OFF when clutch pedal is depressed	ⓓ : Clutch pedal depression signal
35	Engine electronic control unit	Control of overall system	—

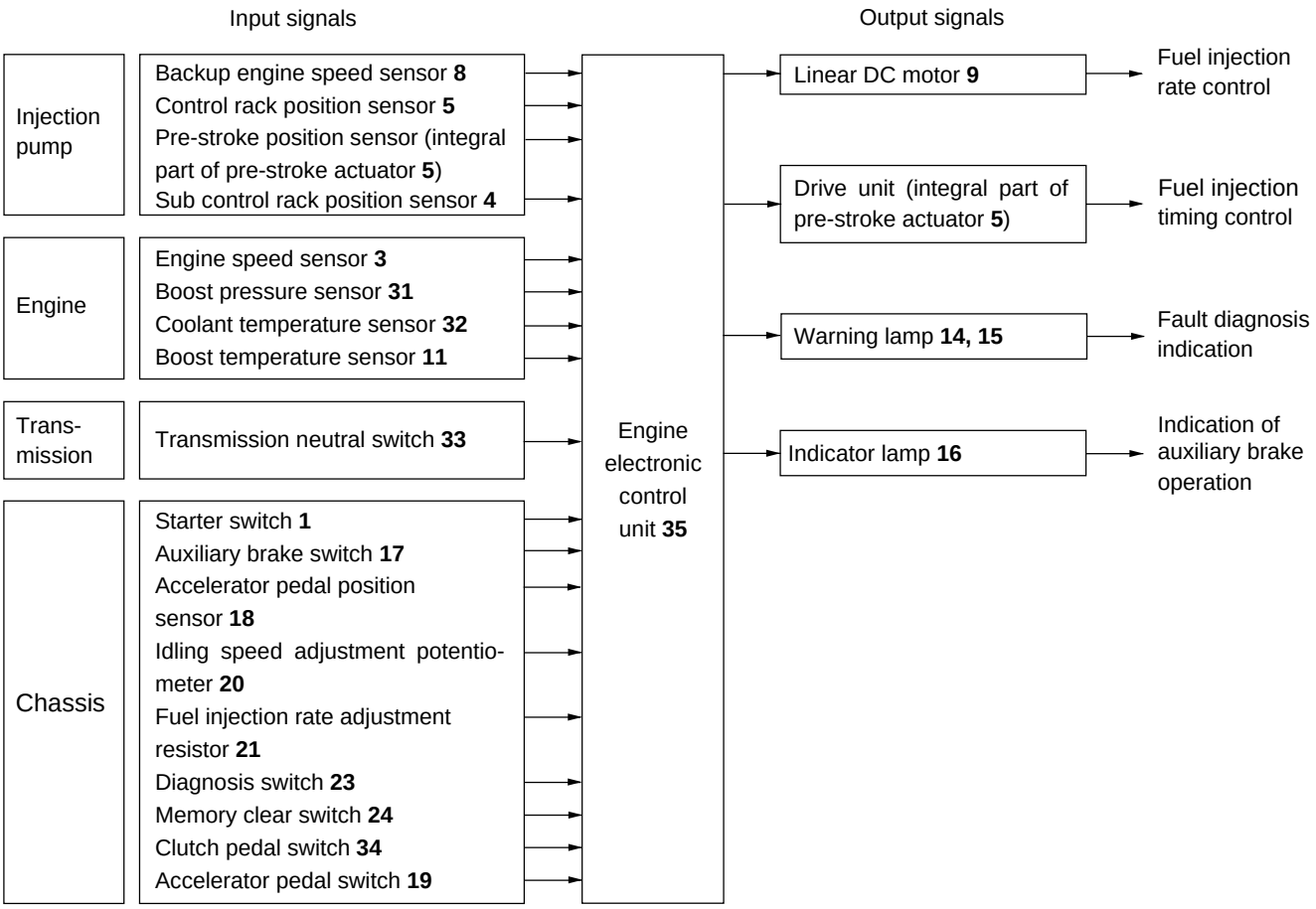
- The electronic governor and pre-stroke control injection pump system combines an electronic governor **10** with an injection pump **6** that has an electronically controlled pre-stroke adjustment feature.
- The injection pump's plunger lift speed varies in accordance with the engine speed, causing concomitant variations in the injection pipe pressure.
- Variations in the injection pipe pressure make it difficult to achieve an optimum spray from the injection nozzles and the optimum air/fuel mixture.
- To compensate for changes in the injection pipe pressure, the injection pump plunger pre-stroke is increased at low and mid- range speeds, thus ensuring that fuel injection takes place late in the cam lift, when plunger movement is relatively fast.
- At high speeds, the plunger pre-stroke is decreased, thus ensuring that fuel injection takes place in early in the cam lift, when plunger movement is relatively slow. Excessive increases in injection pipe pressure are thus prevented.
- By adjusting the plunger pre-stroke in this manner, the pre-stroke control injection pump **6** ensures that the spray and air/ fuel mixture are always optimally suited to combustion.
- The overall benefits are higher engine torque and cleaner exhaust emissions than are possible with a conventional injection pump.
- Control operations are performed by the engine electronic control unit **35**, which receives data from sensors on the engine and other vehicle components, processes them, and issues appropriate drive signals to the pre-stroke actuator **5** (located at the rear of the injection pump) and to the linear DC motor **9** (located inside the electronic governor).

The system's control functions (including auxiliary functions) are shown in the following table.

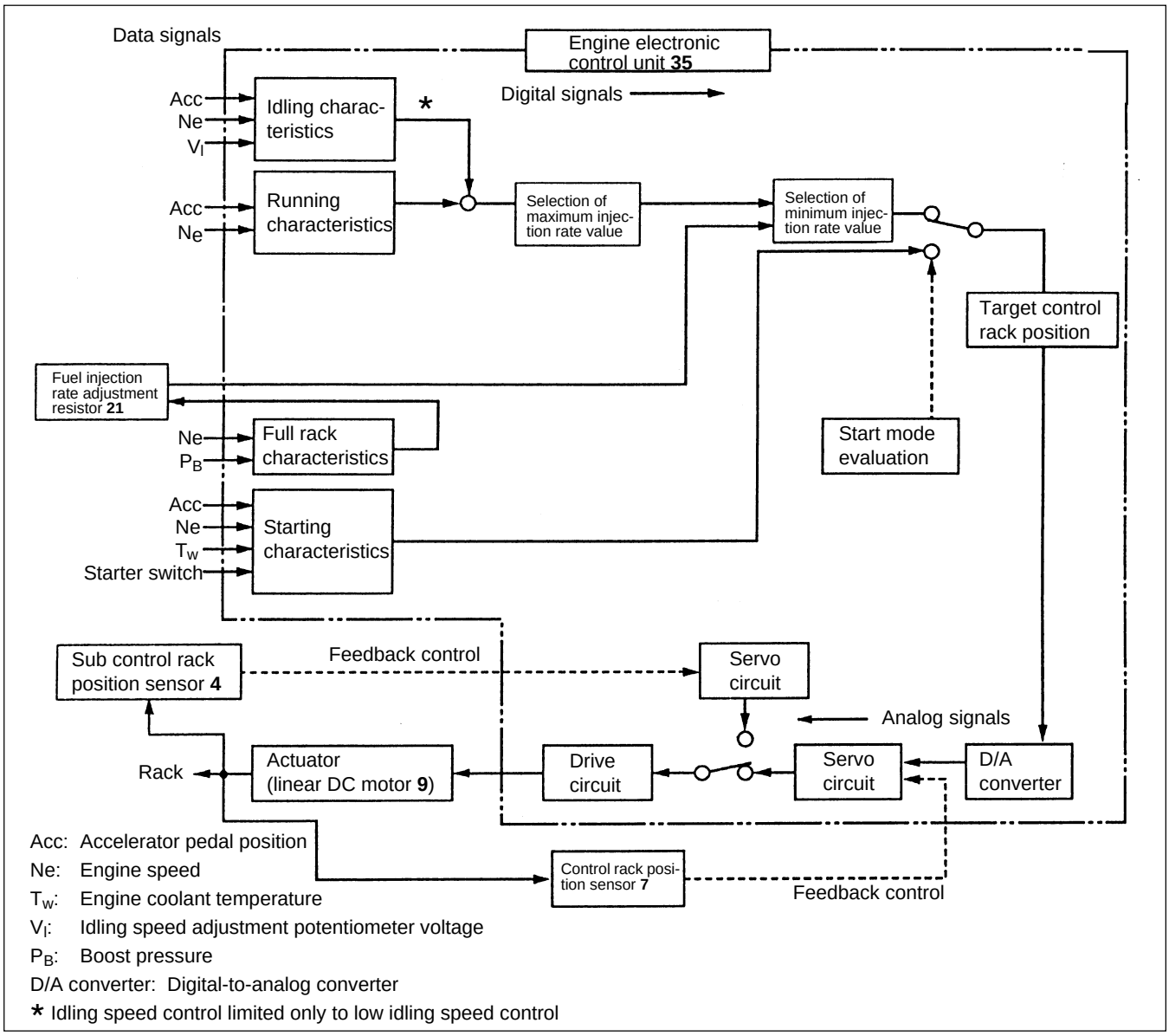
Item	Operation	Data source	
		Sensor(s)	Data signal(s)
Fuel injection rate control	The fuel injection rate is optimized to match engine operating conditions. P13EB-6	3, 7, 18, 19, 21, 31	Ⓓ , Ⓖ , Ⓠ , Ⓡ , Ⓣ , ⓐ
Pre-stroke control	The timing sleeve position is altered, thereby changing the pre-stroke and advancing the fuel injection timing. P13EB-7	3, 5, 7, 18, 32	Ⓓ , Ⓐ , Ⓑ , Ⓖ , Ⓠ , ⓑ
* Control rack preliminary operation	In cold weather and other conditions that are unfavorable for engine startup, the control rod is caused to move slightly in the fuel increase direction, thus enhancing startability. This operation takes place when the starter switch is turned ON.	1, 18, 19, 32	ⓔ , Ⓠ , Ⓡ , ⓑ
* Warmup time shortening function	In cold weather, the engine's idling speed is increased to shorten the time required for warmup. P13EB-8	18, 19, 20	Ⓠ , Ⓡ , Ⓢ
* Overrun prevention function	In the event of an abnormal increase in engine speed, the control rack is pulled in the fuel decrease direction to prevent the engine from overrunning.	3	Ⓓ
* Emergency vehicle operation function (used in event of control rack position sensor fault)	In the event of a fault in the control rack position sensor **7**, the control rack position is sensed by the sub control rack position sensor **4**. If both rack position sensors develop faults, thus preventing detection of the rack position and optimization of the fuel injection rate, the fuel injection rate is controlled in accordance with engine speed signals only. P13EB-10	3, 4, 7	D , C , G
* Auxiliary brake control function	The auxiliary braking devices (exhaust brake) are controlled by the engine electronic control unit **35**. (In a conventional system, the auxiliary braking devices are controlled by switches, relays, and dedicated controllers.) P13EB-11	3, 16, 18, 19, 28, 33, 34	Ⓓ , Ⓝ , Ⓠ , Ⓡ , Ⓧ , ⓓ
* Fault diagnosis function	The status of each system sensor is monitored continuously during engine operation. In the event of a fault, a warning lamp is illuminated to alert the driver and data related to the fault are stored in memory.	ALL	ALL
* Fail-safe function	In the event of a fault, a backup mode is selected and remedial action is taken in accordance with the type of fault.	ALL	ALL
* Reverse engine operation prevention function	In the event of reverse engine operation, the control rack is pulled in the fuel decrease direction to stop the engine	3	Ⓓ

* : Auxiliary function

System Block Diagram



● Fuel Injection Rate Control



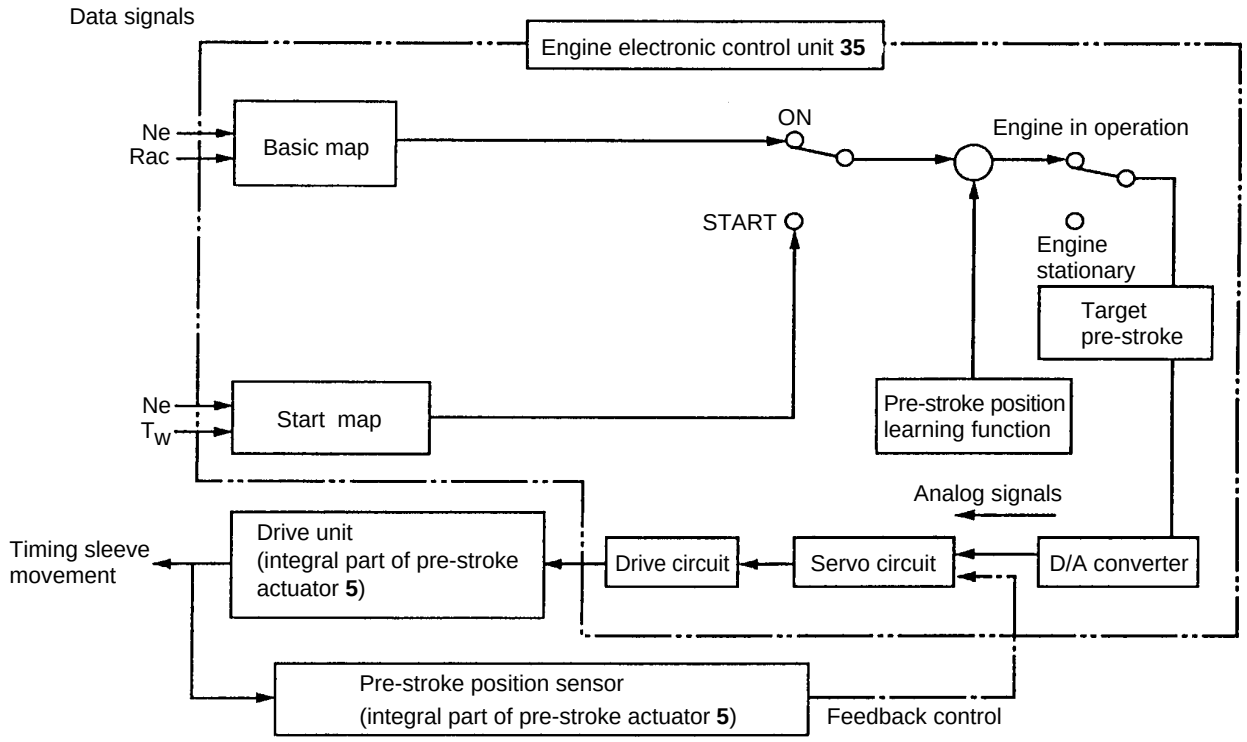
Operation of engine electronic control unit 35

- During engine operation, control is effected in accordance with the idling characteristics and running characteristics. The maximum fuel injection rate value is selected in accordance with the output signals.
- After this selection, the control unit calculates and determines the minimum injection rate to prevent the injection rate selected in accordance with the full rack characteristics from exceeding the maximum injection rate. The target control rack position is thus determined. (During engine startup, control is effected in accordance with the starting characteristics with the target rack position determined directly in accordance with the data signals.)
- The determined control rack position signal is converted into a continuous analog signal. By way of the servo circuit and drive circuit, the signal is applied to the linear DC motor **9**, which moves the rack.

Operation of control rack position sensor 7

- The control rack position sensor **7** monitors the operation of the linear DC motor **9**. In accordance with the position of the control rack, the sensor determines whether the linear DC motor is operating in accordance with the target, and it transmits feedback signals to the engine electronic control unit **35**.
- In accordance with the feedback signals, the engine electronic control unit **35** calculates the actual control rack position. If the actual position differs from the target, the control unit issues a correction command.
- Through repetition of this process, the system ensures that the control rack position complies with the target at all times.

● Pre-stroke control



Rac: Control rack position
Ne: Engine speed
T_W: Engine coolant temperature
D/A converter: Digital-to-analog converter

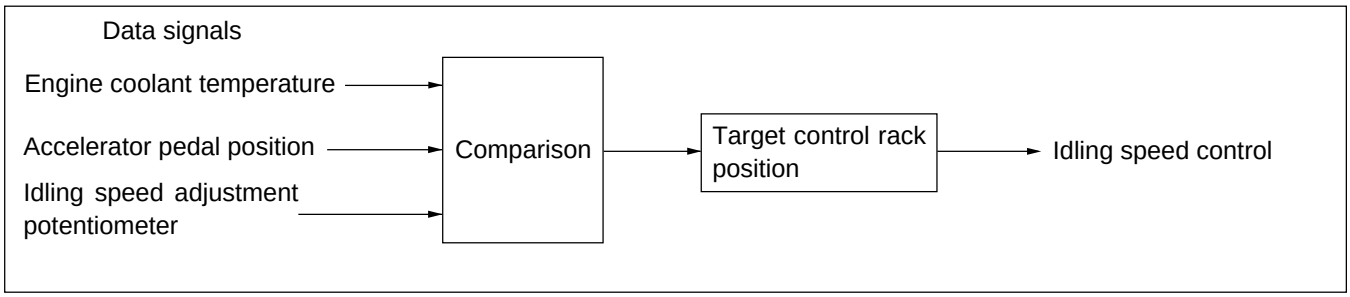
Operation of engine electronic control unit 35

- During engine operation, control is effected in accordance with the basic map.
- The pre-stroke position learning function compensates for pre-stroke position sensor adjustment errors and other injection pump errors using the pre-stroke position sensor output voltage, thereby enabling determination of the target pre-stroke.
- The determined target pre-stroke value is converted into a continuous analog signal. By way of the servo circuit and drive circuit, the signal is applied to the drive unit. The drive unit moves the timing sleeve to alter the pre-stroke.
- During engine startup, control is effected in accordance with the start map.

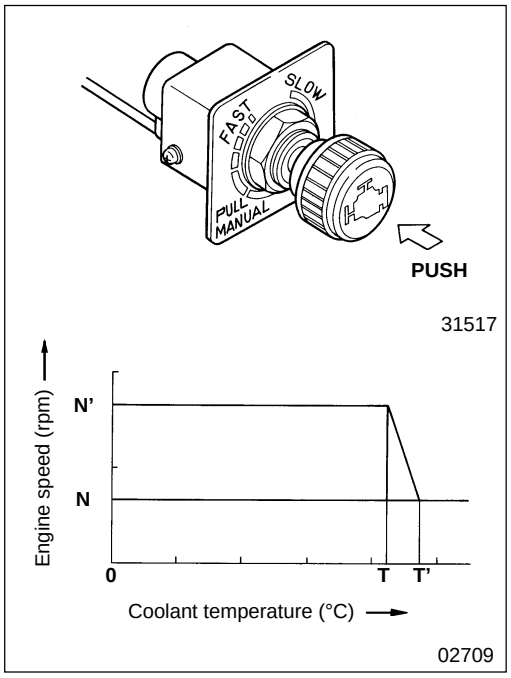
Operation of pre-stroke position sensor (integral part of pre-stroke actuator 5)

- The pre-stroke position sensor monitors the operation of the drive unit. In accordance with the position of the timing sleeve, the sensor determines whether pre-stroke control is being performed in accordance with the target, and it transmits feedback signals to the engine electronic control unit **35**.
- In accordance with the feedback signals, the engine electronic control unit **35** calculates the actual timing sleeve position. If the actual position differs from the target, the control unit issues a correction command.
- Through repetition of this process, the system ensures that the timing sleeve position complies with the target at all times. The appropriate pre-stroke is achieved as a result.

● Warmup time shortening function

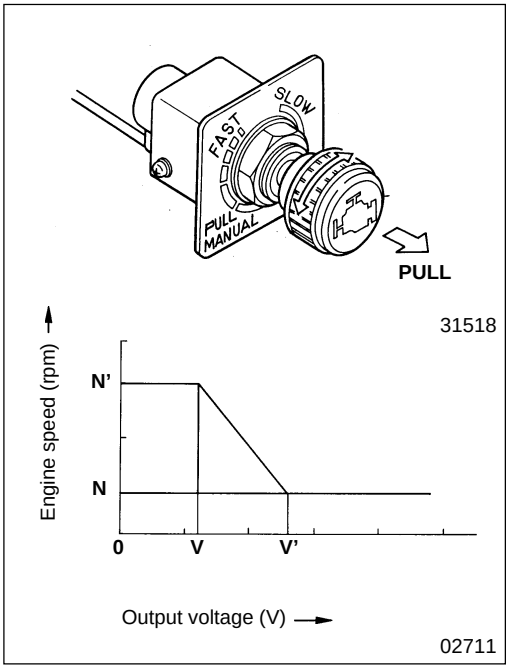


The warmup time shortening function increases the engine's idling speed in accordance with the coolant temperature, thereby shortening the time required for the engine to warm up. Control is effected automatically or manually in accordance with the position of the idling speed adjustment potentiometer **20**. Automatic control is selected by pushing the potentiometer, and manual control is selected by pulling it.



Automatic control (Potentiometer pushed)

- Automatic control is selected when the idling speed adjustment potentiometer **20** is pushed.
- When the coolant temperature is low, the engine's idling speed is automatically increased to shorten the time required for warmup.
- If the coolant temperature increases from **T** to **T'** (see the graph), the engine speed is decreased from **N'** to **N**, thus returning to its standard idling level.



Manual control (Potentiometer pulled)

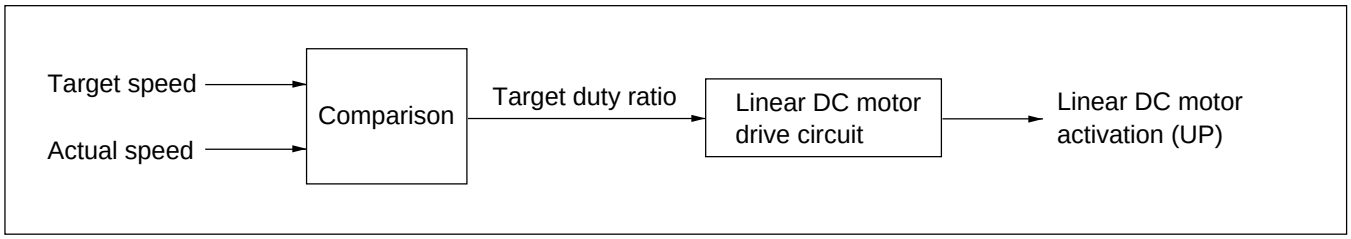
- When the idling speed adjustment potentiometer **20** is pulled, the automatic mechanism is deselected. The driver can then adjust the idling speed as desired by rotating the potentiometer. (Rotation of the potentiometer causes the potentiometer's output voltage to change accordingly.)
- With the output voltage between **0** and **V**, the engine speed stays at the **N** to **N'** level.
- If the output voltage is increased from **V** to **V'** (see the graph), the engine speed decreases from **N'** until it reaches its standard idling level **N**.

● Emergency vehicle operation function (Used of event in control rack position sensor fault)

Fault in Control rack position sensor 7

In the event of a fault in the control rack position sensor **7**, detection of the control rack position is performed using the sub control rack position sensor **4**. This enables more-or-less normal vehicle operation.

Fault in control rack position sensor 7 and sub control rack position sensor 4



In the event of faults in both the control rack position sensor **7** and sub control rack position sensor **4**, the position of the rack, which is controlled by the linear DC motor **9**, cannot be sensed directly. The fuel injection rate cannot be controlled normally with the engine in this condition. As an emergency measure, therefore, control operations are performed in accordance with engine speed data signals only. For this function, target engine speeds for given degrees of accelerator pedal depression are pre-programmed into the engine electronic control unit **35**. Control is effected as follows:

- The target engine speed is compared with the actual engine speed (this is indicated by the engine speed sensor **3**).
- The target duty ratio is determined in accordance with the result of the comparison. In accordance with the target duty ratio, a drive signal is transmitted to the UP-side (speed increasing side) circuit to effect control over the engine speed. If the target engine speed exceeds the actual engine speed or vice versa, the UP-side circuit's ON time period is altered such that the target engine speed is maintained.

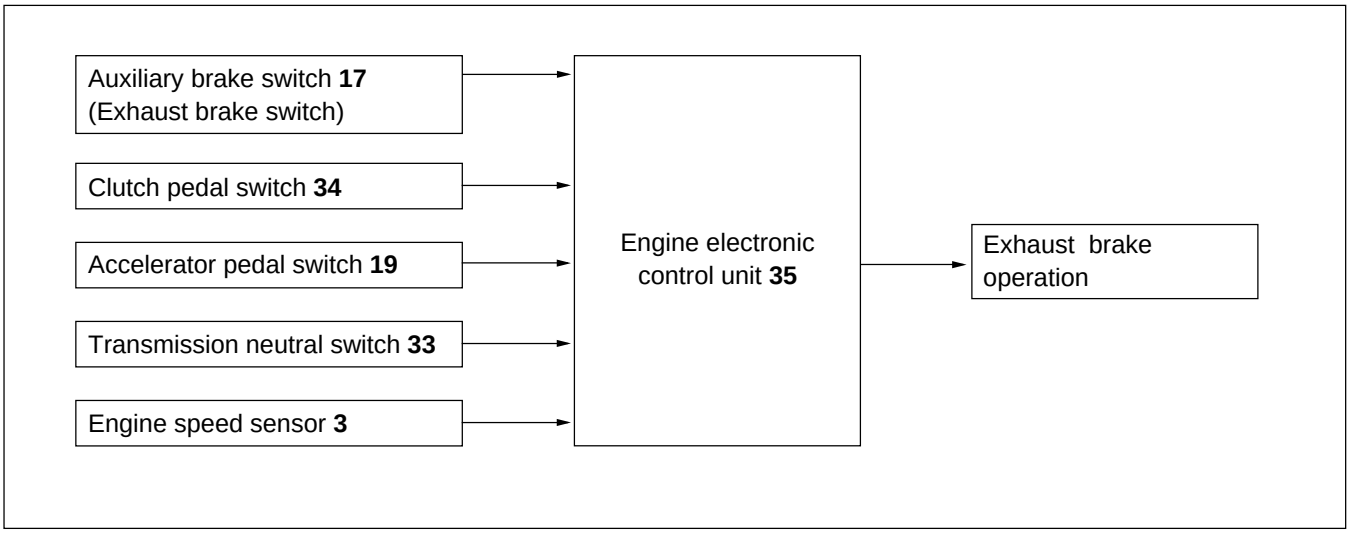
The target duty ratio is the ratio of the time periods during which the linear DC motor's UP-side and DOWN-side (speed decreasing side) circuits are energized. It is calculated as follows:

$$\text{Duty ratio} = \frac{\text{UP-side circuit ON time period}}{\text{UP-side circuit ON time period + DOWN-side circuit ON time period}} \times 100\%$$

CAUTION ⚠

When this function is activated, the warning lamp 14, 15 flashes to indicate that the engine must be inspected immediately. 🕮 **P13EB-20**

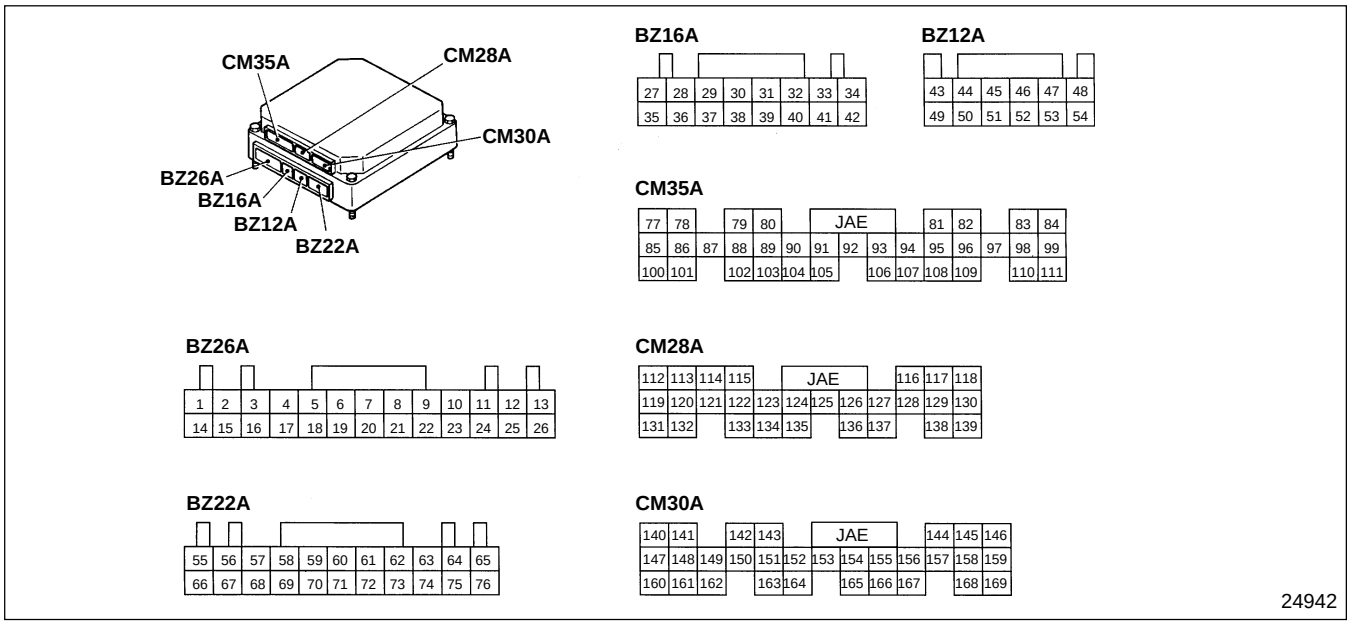
● Auxiliary brake control function



The auxiliary brake control function acts upon the auxiliary braking devices, i.e., the exhaust brake, when the following conditions are satisfied:

- Clutch pedal switch **34**: OFF (clutch pedal released)
- Accelerator pedal switch **19**: ON (accelerator pedal released)
- Transmission neutral switch **33**: ON (transmission not in neutral)

Engine electronic control unit



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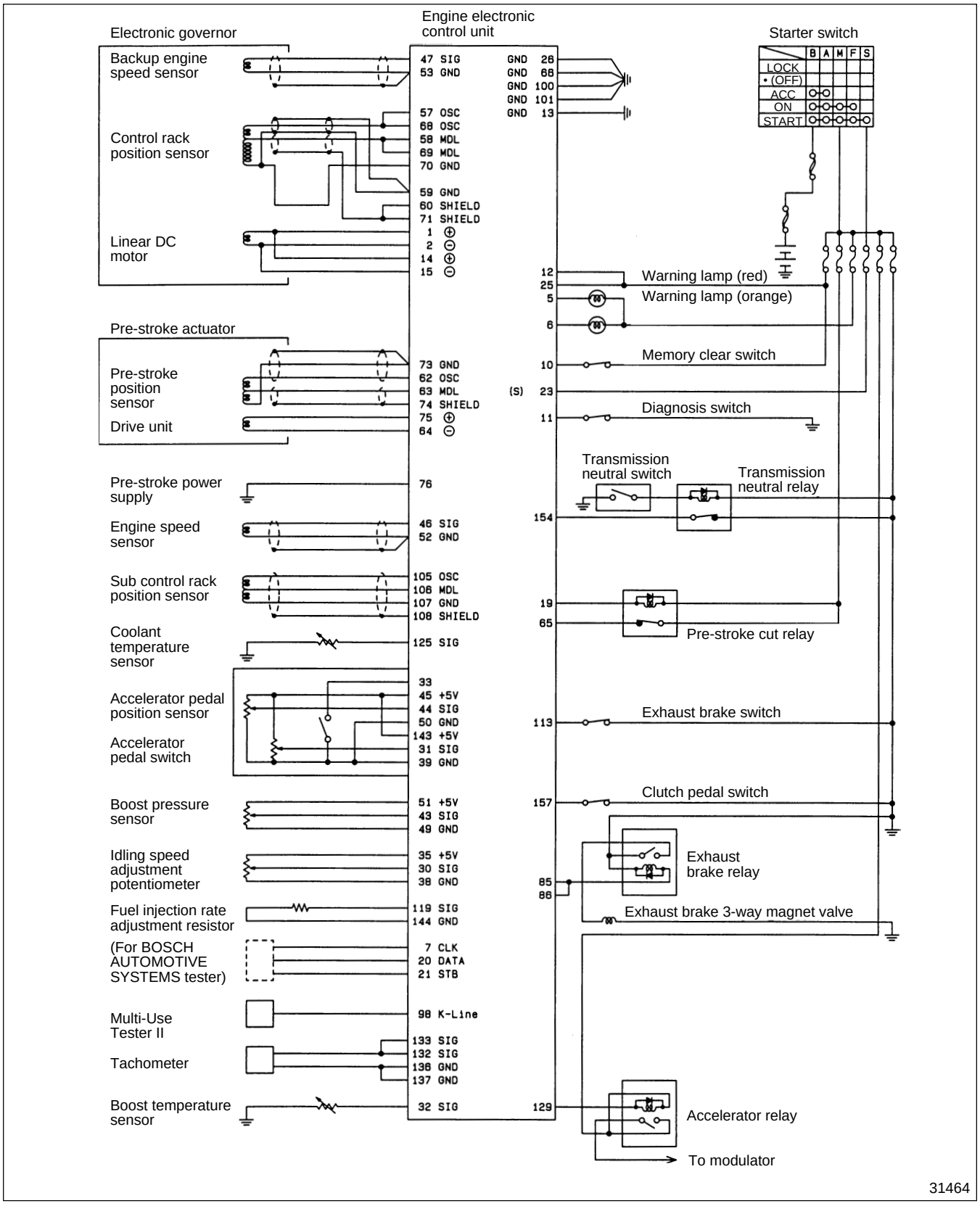
Connector	Terminal	Connected to		Connector	Terminal	Connected to		Connector	Terminal	Connected to	
BZ 26A	1	Linear DC motor	⊕	BZ 26A	19	Pre-stroke cut relay		BZ 16A	37	—	
	2		⊖		20	DDS-3	(DATA)		38	Idling speed adjustment potentiometer (GND)	
	3	—			21		(STB)		39	Accelerator pedal position sensor II (GND)	
	4				22	—			40	—	
	5	Warning lamp	(Red)		23	Start signal			41		
	6		(Orange)		24	—			42		
	7	DDS-3 (CLK)			25	Control unit power supply (starter switch terminal M)		BZ 12A	43	Boost pressure sensor (SIG)	
	8	—			26	Control unit GND			44	Accelerator pedal position sensor I	(SIG)
	9			BZ 16A	27	—			45		(+5V)
	10	Memory clear switch			28				46	Engine speed sensor (SIG)	
	11	Diagnosis switch			29				47	Backup engine speed sensor (SIG)	
	12	Control unit power supply (starter switch terminal M)			30	Idling speed adjustment potentiometer (SIG)			48	—	
	13	Control unit GND (analog GND)			31	Accelerator pedal position sensor II (SIG)			49	Boost pressure sensor (GND)	
	14	Linear DC motor	⊕		32	Boost temperature sensor (SIG)			50	Accelerator pedal position sensor I (GND)	
	15		⊖		33	Accelerator pedal switch			51	Boost pressure sensor (+5V)	
	16	—			34	—			52	Engine speed sensor (GND)	
	17				35	Idling speed adjustment potentiometer (+5V)			53	Backup engine speed sensor (GND)	
	18				36	—			54	—	

Connector	Terminal	Connected to	
BZ 22A	55	—	
	56		
	57	Control rack position sensor	(OSC)
	58		(MDL)
	59		(GND)
	60		(SHIELD)
	61	—	
	62	Pre-stroke position sensor	(OSC)
	63		(MDL)
	64	Pre-stroke actuator ⊖	
	65	Pre-stroke cut relay (+24V)	
	66	Control unit GND	
	67	—	
	68	Control rack position sensor	(OSC)
	69		(MDL)
	70		(GND)
	71		(SHIELD)
	72	—	
	73	Pre-stroke position sensor	(GND)
	74		(SHIELD)
	75	Pre-stroke actuator ⊕	
	76	Pre-stroke power supply (GND)	
CM 35A	77	—	
	78		
	79		
	80		
	81		
	82		
	83		
	84		
	85	Exhaust brake relay	
	86		
	87	—	
	88		
	89		
	90		
	91		
	92		
	93		

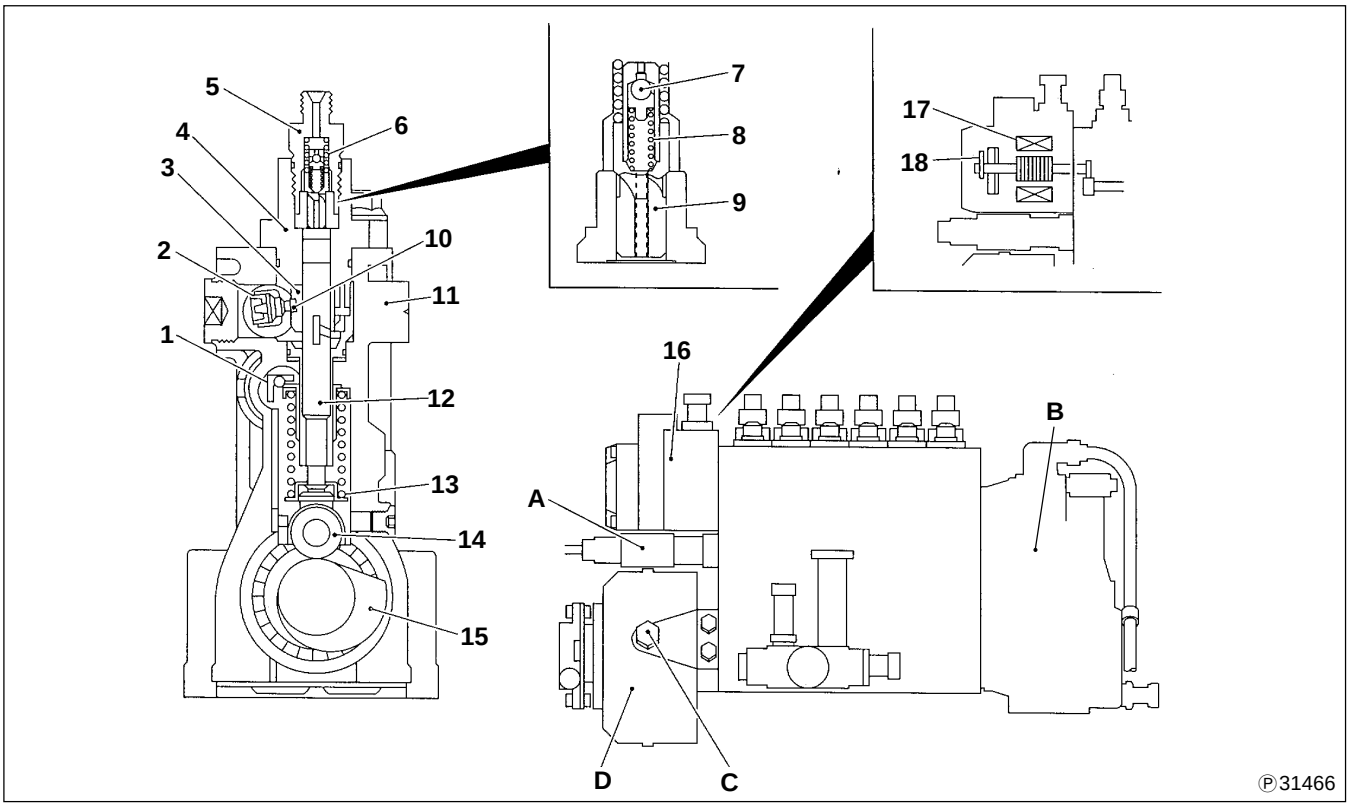
Connector	Terminal	Connected to	
CM 35A	94	—	
	95		
	96		
	97		
	98	Multi-Use Tester II (K-line)	
	99	—	
	100	Control unit GND (power GND)	
	101		
	102	—	
	103		
	104		
	105	Sub control rack position sensor	(OSC)
	106		(MDL)
	107		(GND)
	108		(SHIELD)
	109	—	
	110		
	111		
CM 28A	112	—	
	113	Exhaust brake switch	
	114	—	
	115		
	116		
	117		
	118		
	119	Fuel injection rate adjustment resistor (SIG)	
	120	—	
	121		
	122		
	123		
	124		
	125	Coolant temperature sensor (SIG)	
	126	—	
	127		
	128		
	129	Accelerator relay	
	130	—	
	131		

Connector	Terminal	Connected to	
CM 28A	132	Tachometer output	(SIG)
	133		(SIG)
	134	—	
	135		
	136	Tachometer output	(GND)
	137		(GND)
	138	—	
	139		
CM 30A	140		
	141		
	142		
	143	Accelerator pedal position sensor II (+5V)	
	144	Fuel injection rate adjustment resistor (GND)	
	145	—	
	146		
	147		
	148		
	149		
	150		
	151		
	152		
	153		
	154	Transmission neutral relay	
	155	—	
	156		
	157	Clutch pedal switch	
	158	—	
	159		
	160		
	161		
	162		
	163		
	164		
	165		
	166		
	167	Idle up prohibit switch	
	168	—	
	169		

Engine electronic control unit



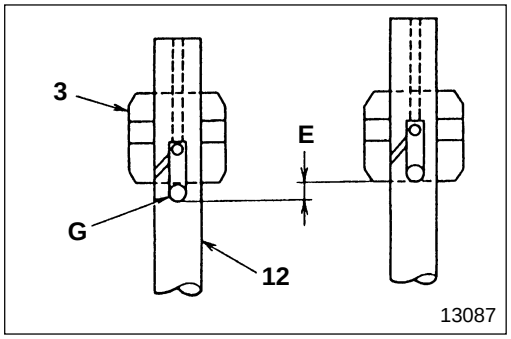
Pre-stroke Control Injection Pump Unit



1 Control rod
2 Timing rod
3 Timing sleeve
4 Plunger barrel
5 Delivery valve holder
6 Delivery valve spring
7 Ball
8 Spring
9 Delivery valve
10 Pin
11 Pump housing
12 Plunger
13 Plunger spring
14 Tappet
15 Camshaft
16 Pre-stroke actuator
17 Drive unit
18 Pre-stroke position sensor

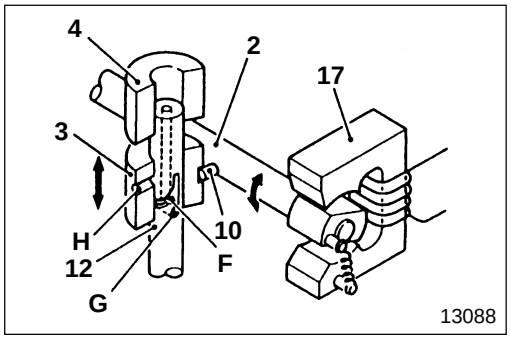
A : Sub-control rod position sensor
B : Electronic governor
C : Engine speed sensor
D : Mechanical timer

- The injection pump is provided with a mechanism that enables variation of the plunger pre-stroke.
- Variation of the plunger pre-stroke enables the creation of air/fuel mixture and spray conditions that are optimally suited to combustion. The overall benefits are higher engine torque and cleaner exhaust emissions than are possible with a conventional injection pump.



Pre-stroke

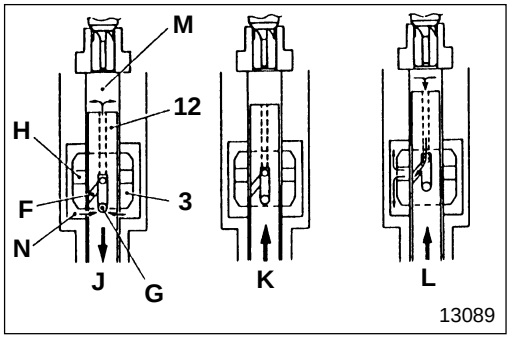
The term “pre-stroke” refers to the stroke dimension **E** of a plunger **12** from the plunger’s bottom dead center position to the point at which its fuel inlet hole **G** is closed by the timing sleeve **3** and fuel feed begins. This stroke dimension is constant in a conventional injection pump.



Variable pre-stroke mechanism

F : Lead
G : Inlet hole
H : Outlet hole

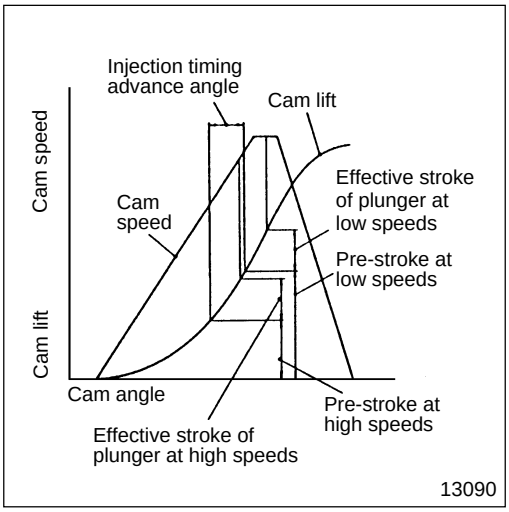
- In contrast to the fixed plunger barrel arrangement of a conventional injection pump, each plunger barrel **4** in the pre-stroke control type injection pump incorporates a vertically moveable timing sleeve **3**.
- Movement of the timing sleeve is effected by the timing rod **2**, pin **10**, and drive unit **17**.
- When the drive unit **17** rotates the timing rod **2**, the pin **10** moves the timing sleeve **3** up or down accordingly.
- Since the timing sleeve **3** incorporates a fuel outlet hole **H**, the pre-stroke changes in accordance with the movement of the timing sleeve.



Fuel feed action

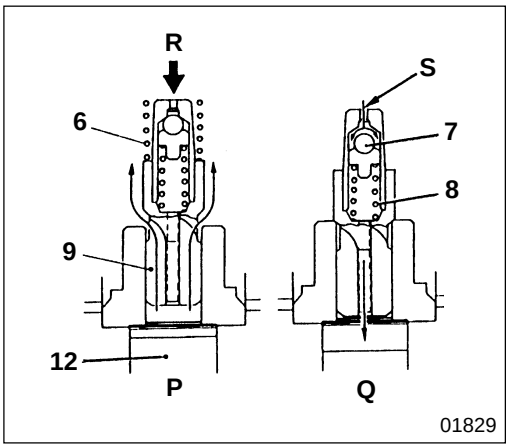
J : Fuel intake
K : Start of pressurization
L : End of pressure feed

- As the plunger **12** moves downward from its top dead center position and its inlet hole **G** opens, fuel flows into the pressure chamber **M** owing to the vacuum pressure created by the plunger’s downward movement and the fuel pressure produced by the feed pump.
- When the plunger **12** moves upward but its lift dimension is still small, the fuel in the pressure chamber **M** escapes into the sump **N** through the inlet hole **G** in the plunger. Thus, the pressure in the pressure chamber does not increase.
- As the plunger **12** moves further upward and the inlet hole **G** is closed by the timing sleeve **3**, the fuel starts to be pressurized. The pressure increases as the plunger moves upward, and the injection pump starts to feed the pressurized fuel to each injector.
- When the lead **F** in the plunger **12** becomes aligned with the outlet hole **H** in the timing sleeve **3**, the fuel in the pressure chamber **M** returns to the sump **N**, thus completing the pressure feed cycle.
- Adjustment of the injected fuel volume is achieved by rotation of the plunger **12**, which alters the position of the outlet hole **H** in the timing sleeve **3** relative to the lead **F** in the plunger.



Fuel injection timing and fuel injection characteristics

- Changes in the position of the timing sleeve **3** cause concomitant changes in the pre-stroke, which in turn alter the fuel injection timing.
- A decrease in the pre-stroke causes the fuel inlet hole **G** in the plunger **12** to close earlier such that the fuel injection timing is advanced.
- This arrangement provides highly responsive control over the injection timing and thus enhances the engine's cold startability.

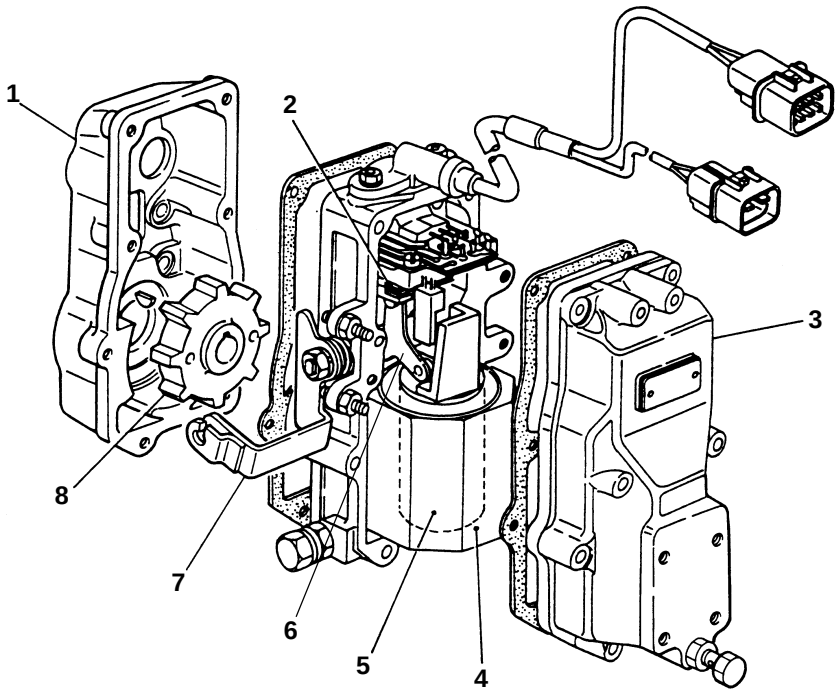


Delivery valve

P : Start of pressure feed
Q : End of pressure feed

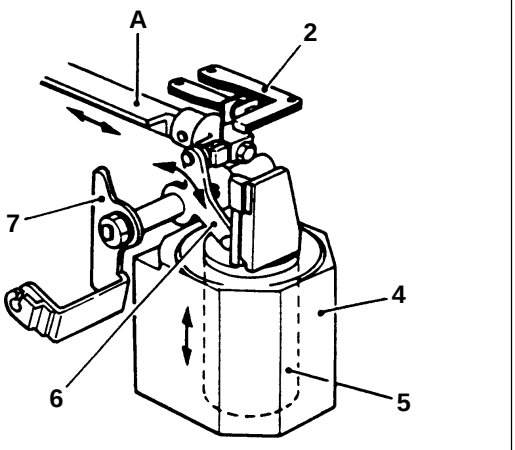
- The delivery valve **9** keeps constant the residual pressure **R** in the injection pipe at all engine speeds. This operation prevents the generation of bubbles in the fuel (this is known as "cavitation") and thus enables fuel injection at a high pressure.
- When the plunger **12** moves upward and the pressure of the fuel pushed by the plunger overcomes the residual pressure **R** in the injection pipe and the preset force of the delivery valve spring **2**, the delivery valve is pushed upward and delivery of the pressurized fuel begins.
- As soon as fuel delivery is complete, the fuel in the injection pipe rapidly returns to the plunger side and the delivery valve closes.
- Surplus fuel slowly returns through the orifice **S**, thus reducing the pressure in the injection pipe.
- When the preset force of the spring **8** in the delivery valve **9** is exactly offset by the pressure in the injection pipe, the ball **7** closes the orifice **S**, thus ensuring that the residual pressure **R** in the injection pipe remains constant.

Electronic Governor



31467

1 Housing
2 Control rack position sensor
3 Cover
4 Coil assembly
5 Linear DC motor
6 Link
7 Emergency engine stop lever
8 Sensing gear



31468

● Linear DC motor

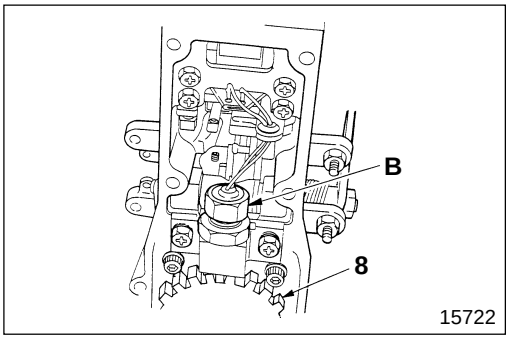
The linear DC motor **5** moves the coil assembly **4** vertically in accordance with signals from the engine electronic control unit. Via the link **6**, this movement is transmitted to the control rack **A**, which moves longitudinally to increase and decrease the fuel quantity.

● Control rack position sensor

The control rack position sensor **2** senses whether the control rack **A** is moved to the correct position by the linear DC motor **5**. In the event of a discrepancy between the actual control rack position and the target control rack position (this is determined by the engine electronic control unit), the control unit instructs the linear DC motor to perform a corrective movement.

● **Emergency engine stop lever**

The emergency engine stop lever **7** is connected to the link **6**. Via a cable, it enables the link to be moved from the driver's seat. In the event of a system fault that prevents the engine from being stopped normally, operation of the emergency engine stop lever forces the control rack **A** to move to the position at which fuel injection is terminated. This operation takes place irrespective of the position of the linear DC motor **5**.



● **Backup engine speed sensor**

The backup engine speed sensor **B** is fitted inside the governor. It converts the rotation speed of the sensing gear **8** into electric signals and feeds the signals to the engine electronic control unit to provide an indication of the engine speed.

TROUBLESHOOTING

1. INSPECTION PROCEDURES

Diagnostic Function

- Whenever the starter switch is placed at ON, the diagnostic function is activated to check all the sensors, etc. If any of them is found faulty, the warning lamp in the meter cluster is lit to alert the driver. At the same time, the fault location is stored in memory, and the system enters the backup mode.

Warning Lamp Indications

	(Red)	(Amber)
Safety-critical error (Vehicle must not be driven)	ON	OFF
Non-safety-critical error (Vehicle can be driven despite poor control feeling)	OFF	ON

- The stored fault location can be read as a diagnostic trouble code by the Multi-Use Tester II or the diagnosis switch.

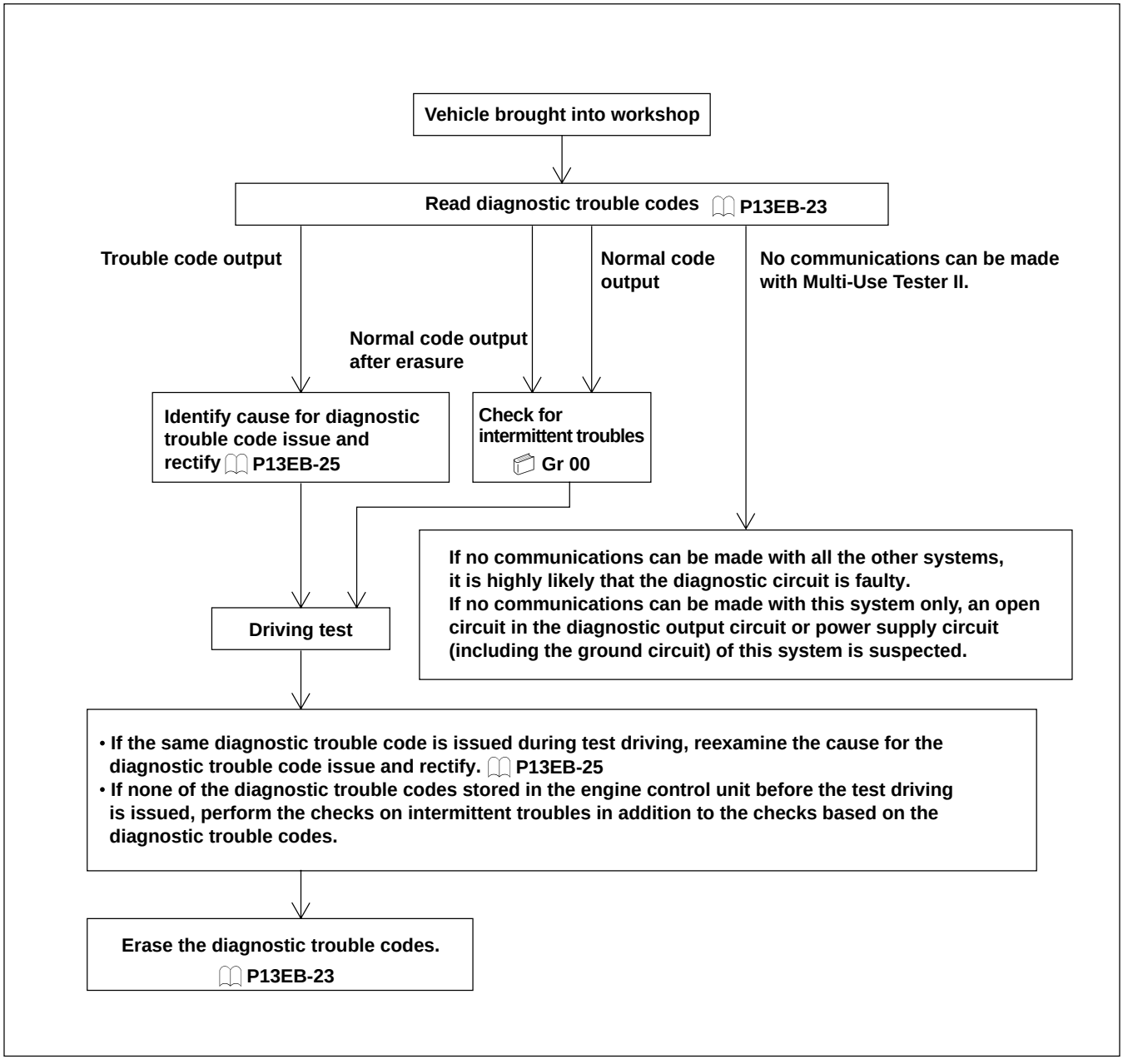
CAUTION ⚠

- **Check to ensure that the battery voltage is within the specified range.**
- **Check all the harness and device connectors for looseness. Always remove a connector at least 20 seconds after placing the starter switch at the LOCK position.**
- **Do not forget to clear the diagnostic trouble code by the Multi-Use Tester II or memory clear switch after a fault has been rectified.**
- **As a rule, inspection operations should be performed with the starter switch at the LOCK position. Some checks, however, may have to be made with the starter switch at the ON position. In such a case, use care to make sure that no short circuit develops between pins of the connectors or with the body.**
- **The resistance value of each component is affected by the temperature and the accuracy of the tester. The reading, therefore, does not always fall within the standard limits. Note that the check values shown in the text are the values obtained at normal temperature (10 to 35°C {58 to 95°F}).**
- **Whether or not the system automatically returns to normal from the backup mode after a fault has been removed depends on the diagnostic trouble code (fault location). When the system returns to normal, the warning lamp will be OFF.**
- **Even when the fault has been removed and the system has been automatically returned to the normal mode, the diagnostic trouble code of the fault remains stored in the engine control unit.**
- **When a fault occurs at a point where the system is not automatically reset, perform the memory clear procedure to let the system exit from the backup mode. 🕮 P13EB-25**

Inspection Flowchart

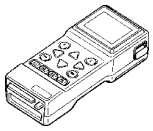
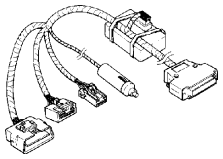
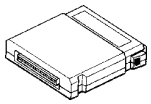
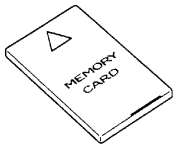
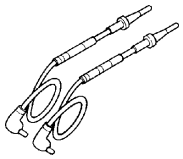
The system inspection can be performed effectively by use of the Multi-Use Tester II. The types of system inspections may be broadly divided as shown below in accordance with the trouble symptoms and diagnostic trouble code outputs.

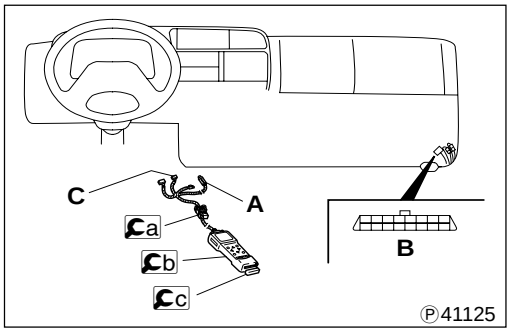
- Inspections based on diagnostic trouble codes stored in the engine control unit
- Inspections of intermittent troubles



2. CONNECTION OF MULTI-USE TESTER II

Special Tools

Location	Name and Shape of Special Tool	Part No.	Application
–	Multi-Use Tester II  19492	MB991496	Inspection of system
–	Multi-Use Tester II harness (for communications)  19141	MK327601	To supply power to Multi-Use Tester II proper and communicate with vehicle side electrical devices
–	Read-only memory pack (MRT-E9)  19493	MH062821	Data for inspection and control of engine control unit
–	Memory card (set in Multi-Use Tester II proper)  20538	MB991500	To write data
–	Multi-Use Tester II harness  20536	MB991499	To use Multi-Use Tester II as a circuit tester



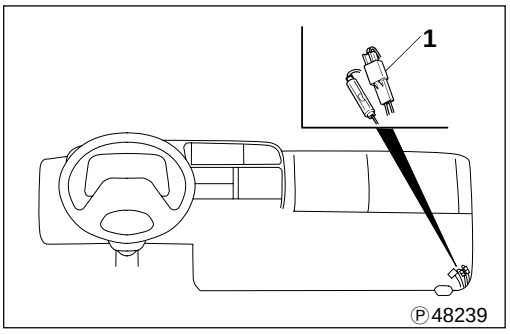
- Place the starter switch at the LOCK position.
- Connect the a Multi-Use Tester II harness to b Multi-Use Tester II and insert the c read-only memory in the tester.
- Connect the connector **A** to the cigar lighter socket.
- Connect the Multi-Use Tester II connector **C** (16 pins) to the data link connector **B** (16 pins).

NOTE

For the operating procedures for the Multi-Use Tester II, refer to the instruction manual for the Multi-Use Tester II.

3. READING AND ERASING DIAGNOSTIC TROUBLE CODES

Two types of methods are available for reading or erasing a diagnostic trouble code; one using the Multi-Use Tester II and one using the vehicle side diagnostic functions.

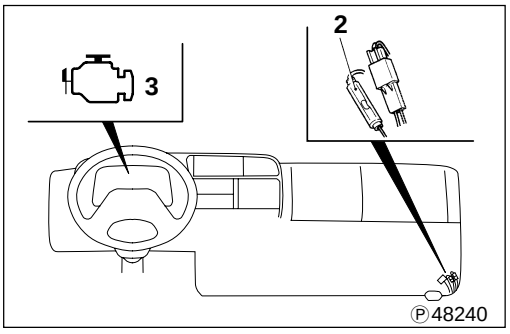


(1) Method using Multi-Use Tester II

● **Current Diagnostic Trouble Code**
- Check to see that the memory clear switch **1** is connected.
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to read the current diagnostic trouble code and determine the fault location.

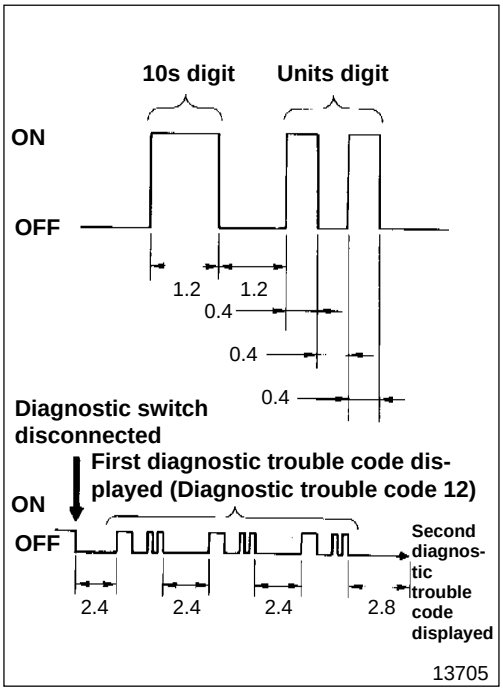
● **Past Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the memory clear switch **1**.
- Operate the Multi-Use Tester II to read the past registered diagnostic trouble codes and determine the fault location.

● **Erasing Diagnostic Trouble Codes**
- Set the starter switch to ON.
- Operate the Multi-Use Tester II to erase all of the diagnostic trouble codes stored in the engine control unit.



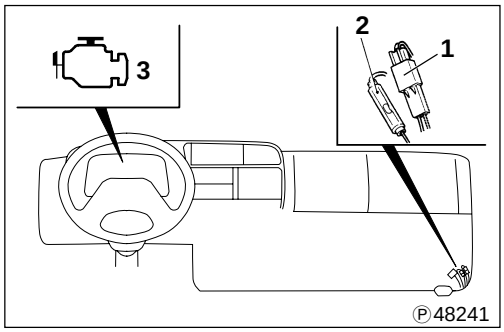
(2) Method Not Using Multi-Use Tester II (Method Using Diagnostic Switch and Memory Clear Switch)

● **Current Diagnostic Trouble Code**
- Set the starter switch to ON.
- Disconnect the diagnostic switch **2**.
- The diagnostic trouble code is displayed by flashes of the warning lamp **3**.



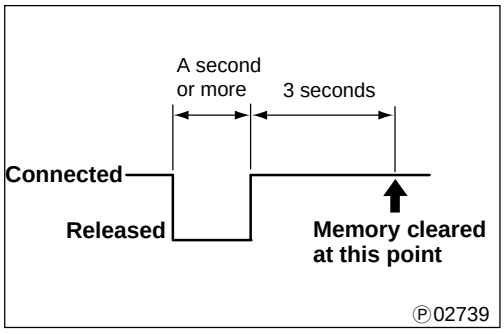
● **Reading Diagnostic Trouble Code**

- Diagnostic trouble codes are indicated by the number of times the warning lamp **3** flashes and their duration.
  - The flashing intervals also differ between the 10s digit and units digit.
  - 10s digit: 1.2 second interval
  - Units digit: 0.4 second interval
  - Each diagnostic trouble code is displayed from the 10s digit followed by the units digit. As for a code which has no 10s digit, units digit only is displayed.
- Each diagnostic trouble code is displayed three times in succession.
- If there is no more code stored, the sequence is then repeated from the beginning with each code indicated three times.
- When the diagnostic switch **2** is connected, the engine control unit will immediately stop displaying codes.



● **Past Diagnostic Trouble Codes**

- After reading the current diagnostic trouble codes (with the diagnostic switch **2** disconnected), disconnect the memory clear switch **1**. Then the warning lamp **3** will restart flashing.
- This time, the warning lamp displays the past diagnostic trouble codes. Determine the fault locations based on the indicated codes.



● **Erasing Diagnostic Trouble Codes**

Disconnect the memory clear switch **1** and the diagnostic switch **2** then reconnect them. Then all the diagnostic trouble codes stored in the engine control unit will be cleared.

CAUTION ⚠

- **If the contents of memory are not to be cleared after display of the stored codes, set the starter switch to OFF with the memory clear switch 1 disconnected. Thereafter, connect the memory clear switch.**
- **When you change the combination of the injection pump and engine control unit, you must rewrite the pump data stored in the engine control unit. For this purpose, be sure to perform the diagnostic trouble code erasing procedure.**
- **Whenever the engine control unit has been replaced with a new one, be sure to erase the diagnostic trouble codes by disconnecting the memory clear switch 1 and diagnostic switch 2 after connecting all the connectors. Upon completing the procedure, confirm that no diagnostic trouble codes is stored.**

4. DIAGNOSTIC TROUBLE CODES AND CHECK ITEMS

4.1 Diagnostic Trouble Code List

Diagnosis code	Fault location	Warning lamp	Electronic control unit countermeasure(s) in the case of failure (back-up mode)	Drive ability
01	Normal	—	—	○
03	Pre-stroke actuator learning function	Orange	Provides control with “0” as correction value.	○
06	Sub-control rack position sensor	Orange	Normal control using the main control rack position sensor	○
11	Governor servo	Red	*1 Engine stopped by the pull-down function.	×
12	Pre-stroke servo	Orange	Pre-stroke control stop engine revolution speed limit (approximately 1800 rpm)	△
13	Pre-stroke sensor	Orange	Pre-stroke control stop engine revolution speed limit (approximately 1800 rpm)	△
14	Back-up engine speed sensor	Orange	Control using the main engine speed sensor	○
15	Engine speed sensor	Orange	Calculate the engine revolution speed from the pulse count of the back-up engine speed sensor.	○
14+15	Both the back-up engine sensor and the main engine speed sensors are faulty upon start-up.	Red	Do not start the engine.	×
16	Accelerator pedal position sensor II	Orange	Control using the accelerator pedal sensor I	○
21	Water temperature sensor	Orange	Set the water temperature to 80 °C {176°F}.	○
22	Control rack position sensor	Orange	Switch to the sub-control rack position sensor control.	△
24	Accelerator pedal position sensor I	Orange	Control using the accelerator pedal position sensor II.	○
24+16	Both accelerator pedal position sensor I and accelerator pedal position sensor II are faulty	Red	Set the maximum accelerator depression angle to 30 degrees even if the accelerator pedal is depressed.	△
31	Idling adjustment volume	Orange	Set to auto idling.	○
32	Boost pressure sensor	Orange	Set the boost pressure to 0 kpa {0 mmHg, 0 in. Hg}.	△*2
33	RAM (ECU internal memory circuit)	Red	Do not start the engine.	×
41	Boost temperature sensor	Orange	Normal control assuming the boost temperature is 80 °C {176 °F}.	○
45	Reverse engine operation	Orange	*1 Engine stopped by the pull-down function.	×*2
65	Accelerator switch	Orange	Limited accelerator depressing angle (Approximately 30%)	○

*1 : The pull-down function indicates the rack pull-back action. In the event of an engine over-run or severe accident, the rack is pulled back immediately to the no-injection direction in order to protect the engine.

*2 : Driveable if the starter switch is turned OFF once and then restarted again.

○ : Driveable
△ : Back-up mode driving possible
× : Undriveable

4.2 Diagnostic Trouble Code Issued Conditions and Check Items

Perform service procedures taking the diagnostic trouble code issued conditions and the probable causes into consideration.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
03	Indicated that pre-stroke learning function has not been executed.	Faulty timing rod, timing sleeve or other parts in the injection pump assembly.	Repair or replace the injection pump assembly. *
		Faulty adjusment or pre-stroke position sensor	Repair or replace the injection pump.*
		Faulty engine electronic control unit	Replace the engine electronic control unit
06	Displayed if the output voltage of the control rack position sensor is less than 0.06 V or more than 3.5 V.	Open or short in harness wire or poor connector contact between the sub-control rack position sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open, short, or poor connector contact in the sub-control rack position sensor	Inspect the sub-control rack position sensor 🕮 P13EB-32
		Faulty engine electronic control unit	Replace the engine electronic control unit
11	Displayed if the difference between the target control rackposition and the actual control rack position is ±1mm {0.039 in.}.	Open or short in harness wire or poor connector contact between the linear DC motor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open or shorted wire in the linear DC motor connector	Inspect the linear DC motor 🕮 P13EB-32
		Poor adjustment of the emergency engine stop cable (The lever is pulled in the stop direction)	Inspect the emergency engine stop button 🕮 P13EB-32
		Faulty injection pump assembly rack movement or poor governor actuator link	Repair or replace the injection pump assembly. *
		Faulty engine electronic control unit	Replace the engine electronic control unit
12		Open or short in harness wire or poor connector contact between the pre-stroke actuator, pre-stroke cut relay, and engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open or shorted wire in the pre-stroke cut relay	Inspect the pre-stroke cut relay 🕮 P13EB-32
		Faulty pre-stroke actuator	Repair or replace the injection pump assembly. *
		Faulty timing rod, timing sleeve, etc. in the injection pump assembly	Repair or replace the injection pump assembly. *
		Faulty engine electronic control unit	Replace the engine electronic control unit

* : Contact your MFTA representative for current injection pump repair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
13	Displayed if the output voltage of the pre-stroke position sensor is less than 0.9 V or more than 3.4 V.	Open or short in harness wire or poor connector contact between the pre-stroke position sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open or shorted pre-stroke position sensor coil	Inspect the pre-stroke actuator 🕮 P13EB-32
		Faulty engine electronic control unit	Replace the engine electronic control unit
14	Displayed if the pulse count of the back-up engine speed sensor is less than that of the main engine speed sensor.	Open or short in harness wire or poor connector contact between the back-up engine speed sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Faulty back-up engine speed sensor	Repair or replace the injection pump assembly. *
		Faulty engine electronic control unit	Replace the engine electronic control unit
15	Displayed if the pulse count of the main engine speed sensor is less than that of the back-up engine speed sensor.	Open or short in harness wire or poor connector contact between the speed sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open or shorted wire or improperly assembled coil in the engine speed sensor main unit	Inspect the engine speed sensor main unit 🕮 P13EB-32
		Faulty engine electronic control unit	Replace the engine electronic control unit
16	Displayed if the output voltage of the accelerator pedal position sensor is less than 0.5 V or more	Open or short in harness wire or poor connector contact between the accelerator pedal position sensor II and the engine electronic control unit	• Inspect the accelerator position sensor using Multi-Use Tester II 🕮 P13EB-30 • Inspect the harness and the connector 🕮 P13EB-43
		Internal malfunction or faulty adjustment of the lever portion of the accelerator pedal position sensor II	• Inspect the accelerator pedal position sensor 🕮 P13EB-32 • Inspect the accelerator pedal position sensor using Multi-Use Tester II 🕮 P13EB-30
		Faulty engine electronic control unit	Replace the engine electronic control unit
21	—	Open or short in harness wire or poor connector contact between the coolant temperature sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Faulty coolant temperature sensor	• Inspect the coolant temperature sensor 🕮 P13EB-32 • Inspect the coolant temperature sensor using Multi-Use Tester II 🕮 P13EB-30
		Faulty engine electronic control unit	Replace the engine electronic control unit

* : Contact your MFTA representative for current injection pump repair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
22	Displayed if the output voltage of the control rack position sensor I is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the control rack position sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open or shorted wire in the coil or poor control rack position sensor contact	• Inspect the control rack position sensor 🕮 P13EB-32 • Inspect the control rack position sensor using Multi-Use Tester II 🕮 P13EB-30
		Faulty movement of the injection pump assembly control hook or poor governor actuator link.	Repair or replace the injection pump assembly. *
		Faulty engine electronic control unit	Replace the engine electronic control unit
24	Displayed if the output voltage of the accelerator pedal position sensor I is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the accelerator pedal position sensor and the engine control unit.	• Inspect the accelerator position sensor using Muti-Use Tester II 🕮 P13EB-30 • Inspect the harness and the connector 🕮 P13EB-43
		Internal malfunction or poor adjustment of the accelerator pedal position sensor I lever	• Inspect the accelerator position sensor I 🕮 P13EB-32 • Inspect the accelerator pedal position sensor using Multi-Use Tester II 🕮 P13EB-30
		Faulty engine electronic control unit	Replace the engine electronic control unit
31	Displayed if the output voltage of the idling adjustment volume is less than 0.6 V or more than 4.6 V.	Stuck idling speed adjustment potentiometer knob (between PUSH and PULL)	Reset the knob to PUSH or PULL
		Open or short in harness wire or poor connector contact between the idling speed adjustment potentiometer and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open wire in the switch portion of the idling speed adjustment potentiometer or faulty internal movement	Inspect the idling speed adjustment potentiometer 🕮 P13EB-32
		Faulty engine electronic control unit	Replace the engine control unit
32	Displayed if the output voltage of the boost pressure sensor is less than 0.5 V or more than 4.8 V.	Open or short in harness wire or poor connector contact between the boost pressure sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Internal malfunction of boost pressure sensor	• Inspect the boost pressure sensor using Multi-Use Tester II 🕮 P13EB-30 • Inspect the boost pressure sensor 🕮 P13EB-32
		Clogged boost hose or faulty assembly	Inspect the boost hose
		Faulty engine electronic control unit	Replace the engine electronic control unit

***** : Contact your MFTA representative for current injection pump repair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
33	Displayed if the electronic governor control unit is faulty.	Faulty electronic governor control main unit	In order to reset the engine electronic control unit, temporarily turn the starter switch OFF and erase the diagnostic codes by pressing the memory clear switch 🕮 P13EB-23 Replace the engine electronic control unit if the diagnostic codes persist after performing the above procedure
41	Displayed if the output voltage of the boost temperature sensor is more than 4.9 V.	Open or short in harness wire and poor connector contact between the boost temperature sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open or shorted wire or poor assembly of the boost temperature sensor coil	• Inspect the boost temperature sensor 🕮 P13EB-32 • Inspect the boost temperature sensor using Multi-Use Tester II 🕮 P13EB-30
		Faulty engine electronic control unit	Replace the engine electronic control unit
45	—	Faulty phase of engine speed sensor and backup engine speed sensor	• Inspect the engine speed sensor 🕮 P13EB-32 • Repair or replace the injection pump assembly. *
65	Faulty accelerator switch	Open or short in harness wire or poor connector contact between the accelerator switch and the electronic governor control unit	Inspect the harness and the connector 🕮 P13EB-43
		Open or shorted wire in the accelerator switch	Inspect the accelerator switch (Accelerator switch is built in the accelerator pedal position switch.) 🕮 P13EB-32
		Faulty engine electronic control unit	Replace the engine electronic control unit

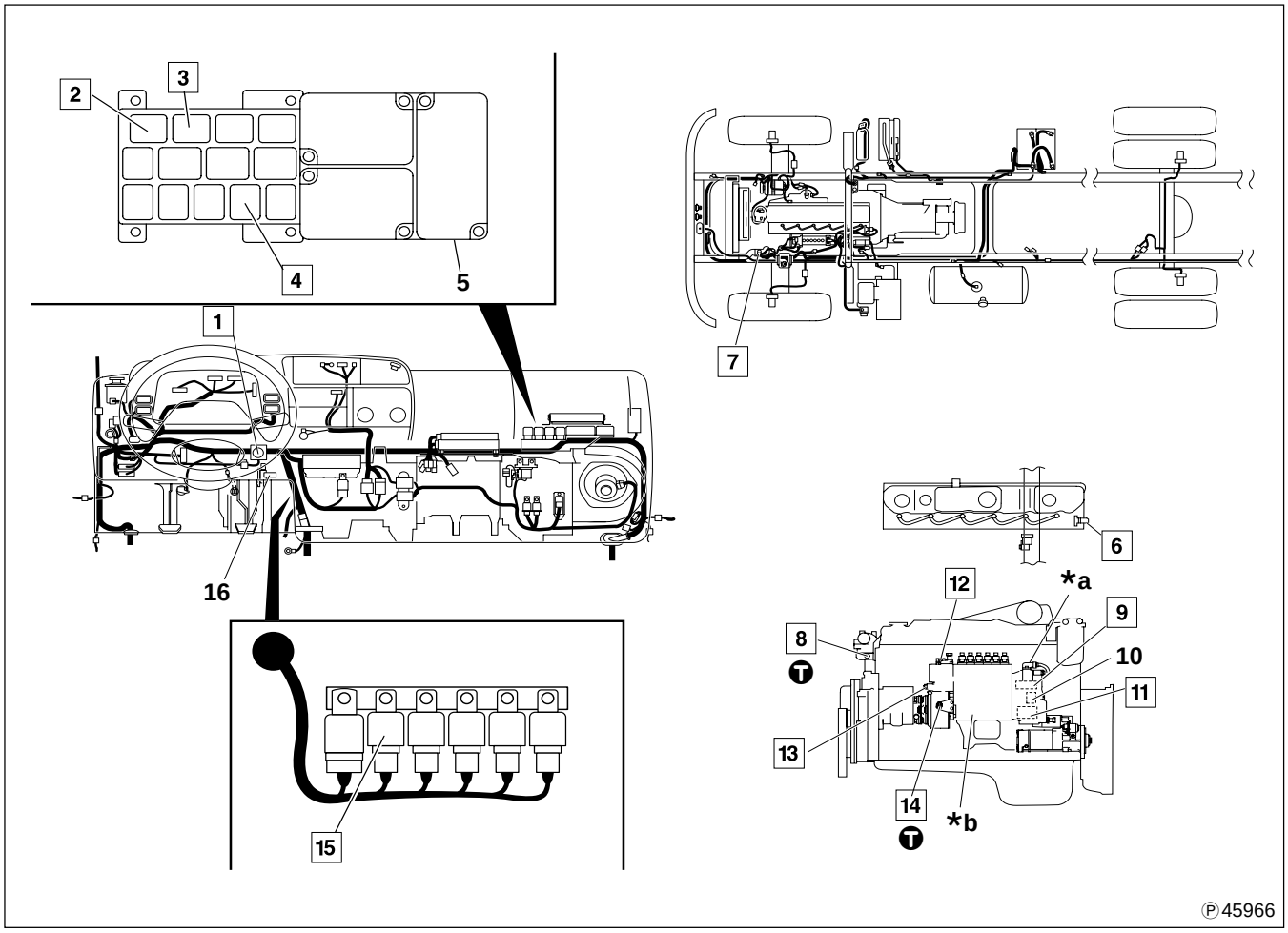
* : Contact your MFTA representative for current injection pump repair and replacement procedures.

5. SERVICE DATA OF MULTI-USE TESTER II

Multi-Use Tester II display			Inspection procedure	
No.	Data signal	Type of data	Inspection condition	Evaluation criterion
11	ENGINE SPEED	▮▮▮▮. rpm	Gradual acceleration (during engine operation)	Synchronization with tachometer
12	TARGET RACK	▮▮.▮▮ mm	Starter switch ON	3 mm
13	REAL RACK	▮▮.▮▮ mm	Starter switch ON	3 mm
14	ACCEL. VOLT	▮.▮▮▮ V	Accelerator pedal gradually depressed from throttle-fully-open to throttle-fully-closed position	1 to 3 V
15	WATER TEMP	▮▮▮.▮ °F	Engine cold Engine warming up Engine stopped after warmup	Same as ambient temperature Gradual increase Gradual decrease
16	BOOST PRESS	▮▮▮▮. mmHg	Engine running at high idling speed	270 mmHg or higher
17	PS ANG. DIFF.	▮▮.▮▮ deg	400 < Ne ≦ 2,000 Ne: Engine speed	–5.5° or greater 5.5° or smaller
18	SUPPLY VOLT	▮▮.▮▮ V	Starter switch ON	7 to 32 V
19	ACCEL. STROKE	▮▮▮.▮ %	Throttle completely closed Pedal gradually depressed Throttle completely open	0 % Gradual increase 100 %
20	BOOST TEMP	▮▮▮.▮ °F	Engine cold Engine warming up Engine stopped after warmup	Same as ambient temperature Gradual increase Gradual decrease
21	START SIG	ON/OFF	Engine cranked using starter switch	ON
33	ACCEL. SW	ON/OFF	Accelerator pedal depressed	OFF
34	DIAGNOSIS SW	ON/OFF	Diagnosis switch turned ON/OFF	ON/OFF
35	DIAG. RESET SW	ON/OFF	Memory clear switch turned ON/OFF	ON/OFF
37	CLUTCH SW	ON/OFF	Clutch pedal depressed	ON
38	NEUTRAL SW	ON/OFF	Transmission in neutral	OFF
42	EXH. BRAKE SW	ON/OFF	Switch ON	ON
51	A/C SW	ON/OFF	Air conditioner switch turned ON or OFF	ON/OFF
61	EXH. BRAKE SIG	ON/OFF	Exhaust brake operating	ON
71	RACK LIM. SW	ON/OFF	Automatic transmission oil temperature increase	ON
72	AT ACC RELAY	ON/OFF	Accelerator fully depressed	ON
75	IDLE UP CNCL	ON/OFF	Idle up prohibited (other than N range)	ON
81	CAR SPEED	▮▮▮.▮ MPH	Vehicle in driving operation	Synchronized with speedometer

M E M O

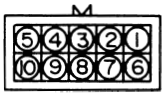
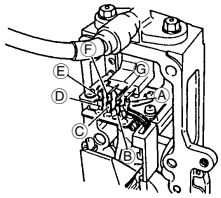
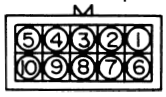
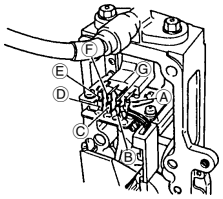
INSPECTION OF ELECTRICAL EQUIPMENT



1 Idling speed adjustment potentiometer
2 Pre-stroke cut relay
3 Transmission neutral relay
4 Exhaust brake relay
5 Relay box
6 Boost pressure sensor
7 Boost temperature sensor
8 Engine coolant temperature sensor
9 Control rack position sensor
10 Backup engine speed sensor
11 Linear DC motor
12 Pre-stroke actuator
13 Sub control rack position sensor
14 Engine speed sensor
15 Accelerator relay < A/T >
16 Emergency engine stop button

***a** : Electronic governor
***b** : Injection pump assembly
M/T : Manual transmission
A/T : Automatic transmission

Service standards

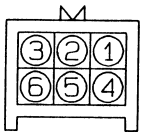
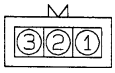
Location	Maintenance item			Standard value	Limit	Remedy
1	Output voltage of idling speed adjustment potentiometer 16184	②–③	Knob pulled	1 to 3 V	—	Replace
			Knob pushed	3.6 to 4.3 V	—	
7	Resistance value of boost temperature sensor		0°C {32°F}	5880±588 Ω	—	Replace
			20°C {68°F}	2455±245 Ω	—	
			80°C {176°F}	322±32 Ω	—	
8	Engine coolant temperature sensor	Between terminal and body	20°C {68°F}	(3.25 kΩ)	—	Replace
			40°C {104°F}	(1.5 kΩ)	—	
			60°C {140°F}	(620±62 kΩ)	—	
9	Resistances of control rack position sensor	< Connector : 3 pin > 16165	③ (3 pin)–④ (10 pin)	31.5 to 36.5 Ω	—	Repair or replace the injection pump assembly. *
			③(10 pin)–④(10 pin)			
			Ⓖ – Ⓒ			
		 16160	③ (3 pin)–⑨ (10 pin)		—	
		< Governor actuator >	③ (10 pin)–⑨ (10 pin)	18.0 to 21.0 Ω		
		 24816	Ⓖ – Ⓒ			
			④ (10 pin)–⑨ (10 pin)	13.5 to 15.5 Ω	—	
			Ⓒ – Ⓕ			
11	Resistances of linear DC motor	< Connector : 3 pin > 16165	②(3 pin)–①(3 pin)	9.0 to 9.8 Ω	—	Repair or replace the injection pump assembly. *
		< Connector : 10 pin >  16160	②(3 pin)–②(10 pin)			
			①(10 pin)–②(10 pin)			
		< Governor actuator >  24816	① (10 pin)–① (3 pin)			
			Ⓐ – Ⓑ			

The values in ( ) are reference values.

* : Contact your MFTA representative for current injection pump repair and replacement procedures.

INSPECTION OF ELECTRICAL EQUIPMENT

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
12	Resistances of pre-stroke actuator (measured at connector)  13714	②–③	5.5 to 6.1 Ω	—	Repair or replace the injection pump assembly. *
		①–③	11.0 to 12.2 Ω	—	
		①–②	5.5 to 6.1 Ω	—	
		④–⑤	0.9 to 1.3 Ω	—	
13	Resistances of sub control rack position sensor 13725	①–④	92.5 to 101.5 Ω	—	Repair or replace the injection pump assembly. *
		①–③	92.5 to 101.5 Ω	—	
		③–④	185 to 203 Ω	—	
14	Resistances of engine speed sensor (at 25°C {77°F})  14013	①–②	2.1 to 2.5 kΩ	—	Replace
	Gap between the engine speed sensor and timer housing protrusion		0.8 to 1 {0.031 to 0.039}	—	Adjust

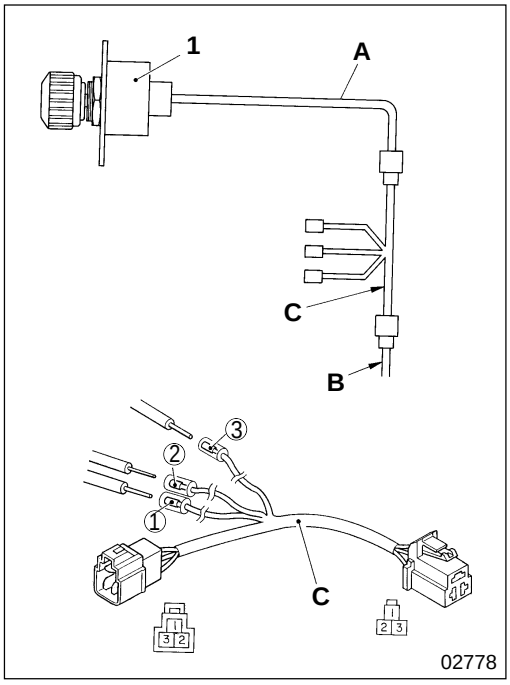
* : Contact your MFTA representative for current injection pump repair and replacement procedures.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Coolant temperature sensor	34±6.9 {25±5, 3.5±0.7}	—
14	Engine speed sensor lock nut	24 to 35 {17 to 26, 2.4 to 3.6}	—

◆ Service procedure

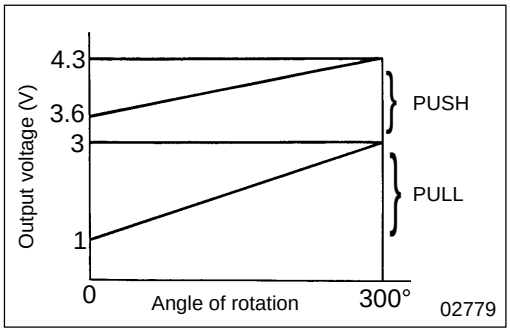


1 **Inspection of idling speed adjustment potentiometer**

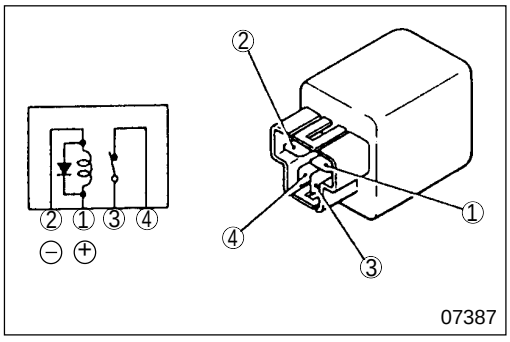
- Disconnect the harness **A** of the idling speed adjustment potentiometer **1** from the cab-side harness **B**. Then, connect an inspection harness **C** between harnesses **A** and **B.** (The inspection harness must be made specially for this procedure.)
- Turn the starter switch to the ON position.
- Check the output voltages of the idling speed adjustment potentiometer **1** in accordance with the following table.

Item	Connector terminal		
	Accelerator pedal position sensor inspection harness		
	①: Power supply (+)	②: GND (–)	③: Output (+)
Output voltage with knob pulled		⊖	⊕
Output voltage with knob pushed			

Output characteristics



- If the output voltages are out of specification, replace the idling speed adjustment potentiometer **1**.



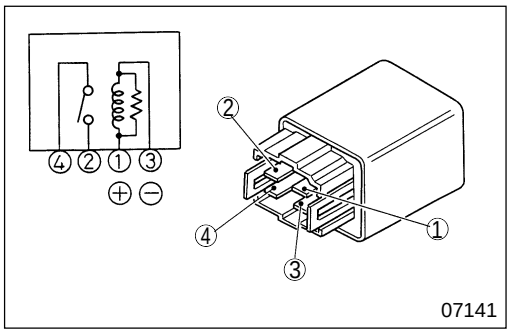
2 **3** **Inspection of pre-stroke cut relay and transmission neutral relay (normally-closed type with 4 pin connector)**

- Perform continuity checks in accordance with the following table.

	①	②	③	④
Not energized	○——○		○——○	
Energized	⊕——⊖		〔⊢ - - - - ⊣〕	

○——○ : Continuity exists between terminals.
⊕——⊖ : Terminals across which 12 V DC is applied
〔⊢ - - - ⊣〕 : Continuity no longer exists between terminals

- Replace the relay if any abnormality is evident.



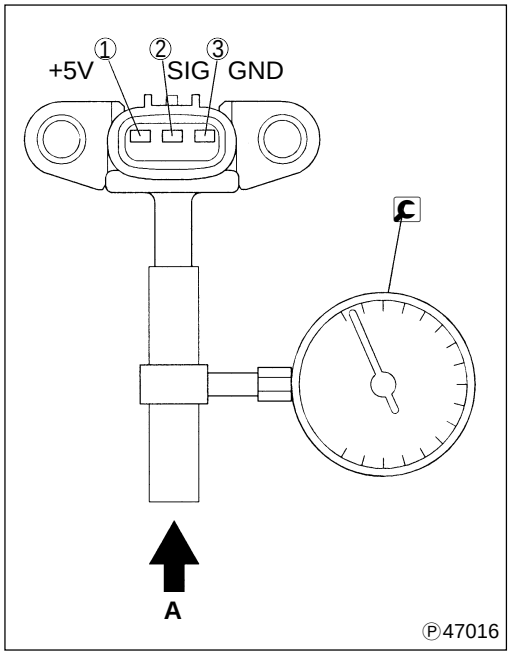
4 **15** **Inspection of exhaust brake relay and accelerator relay**

- Check the electrical conduction and operation according to the table below.

	①	②	③	④
Electric current not supplied	○		○	
Electric current supplied	⊕	○	⊖	○

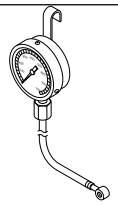
○—○ Electric conduction between terminals.
⊕—⊖ Terminals applied with 12 VDC.

- If an abnormality is found, replace the relay.



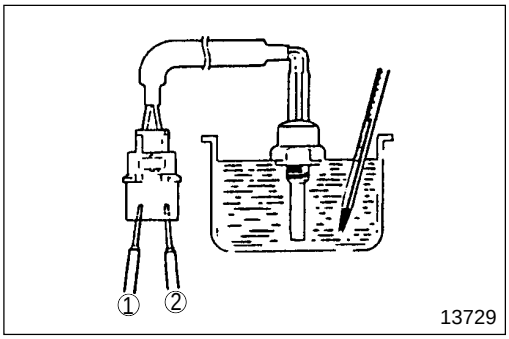
6 **Inspection of boost pressure sensor**

- Apply 5V DC between terminals ① and ③.
- Increase air pressure **A** gradually and measure the voltage between terminals ② and ③.
  : Boost Pressure Gauge

Tool Name and Shape	Part No.
 01524	MH061366

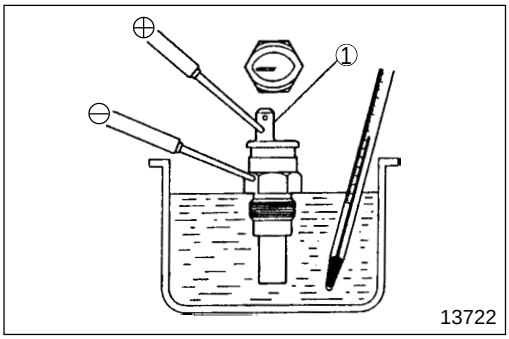
Standard value	Air pressure	Voltage
	99 kPa {740 mmHg, 1 kg/cm²}	2.5V
	232 kPa {1738 mmHg, 2.4 kg/cm²}	4.5V

- If the measurements deviate from the standard values, replace the boost pressure sensor.



7 Inspection of boost temperature sensor

- Place boost temperature sensor **7** in glycerin in a container.
- Raise the glycerin temperature to the specified values and stir the glycerin.
- Measure the resistance between terminals ① and ②.
- If the measured value deviates from the standard value, replace boost temperature sensor **7**. Gr 15B

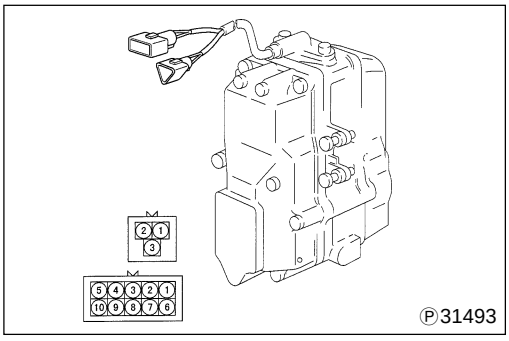


8 Inspection of engine coolant temperature sensor

- Put the engine coolant temperature sensor **8** in a container of engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil to ensure that it heats up evenly.
- At each of the specified temperatures, measure the resistance between the terminal ① and body of the engine coolant temperature sensor **8**.
- If the measurements are out of specification, replace the engine coolant temperature sensor **8**.

9 Inspection of control rack position sensor

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA.

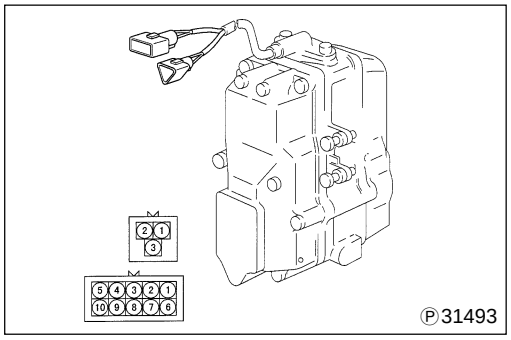


● **Measurements on connectors**

Measure the resistances between the following terminals: 3 pin connector's ③ and 10 pin connector's ④; 10 pin connector's ③ and ⑨; ④ and ⑨.

11 Inspection of linear DC motor

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA.



(1) Measurements on connectors

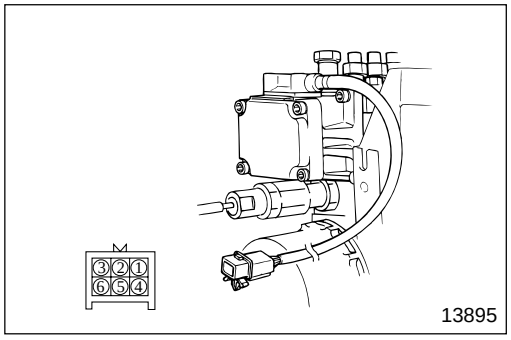
Measure the resistance between terminals ① and ② on each connector.

12 Inspection of pre-stroke actuator

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA.

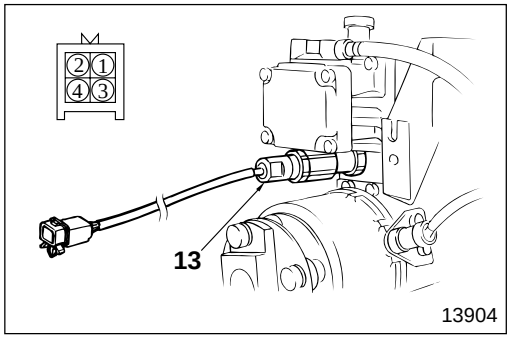
CAUTION ⚠

The pre-stroke actuator 12 must be inspected when the engine is cold.



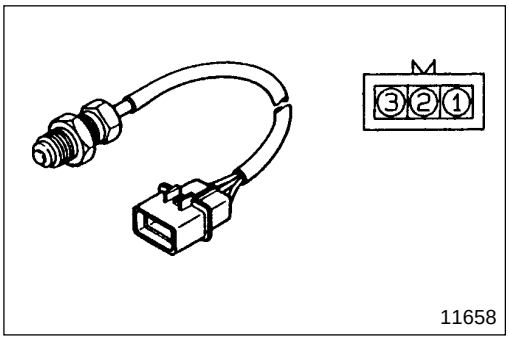
(1) Measurements on connectors

Measure the resistance between terminals ② and ③; ① and ③; ① and ②; ④ and ⑤.



13 Inspection of sub control rack position sensor

- Measure the resistances between the following terminals: ① and ④; ① and ③; ③ and ④.
- If any resistance is out of specification, replace the sub control rack position sensor **13**.
- Have replacement performed by the nearest MFTA.



14 Engine speed sensor

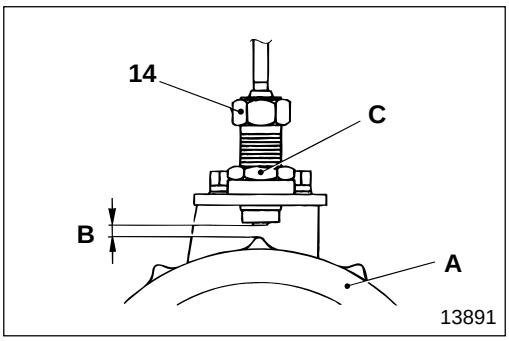
[Inspection]

(1) Main Unit

- Measure the resistance between terminals ① and ②.
- If the measured value deviates from the standard value, replace engine speed sensor **14**.

CAUTION

Be sure to check the tightening torque of engine speed sensor 14. If the tightening torque is insufficient, the sensor may not output a signal.



(2) Clearance between protrusions

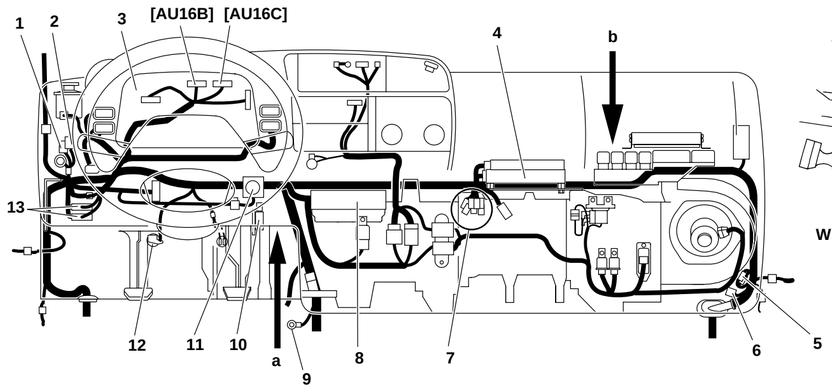
If the clearance between engine speed sensor **14** and timer housing protrusion **A** deviates from the standard value, adjust by following the procedure below.

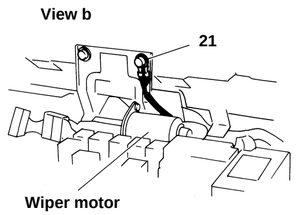
[Adjustment]

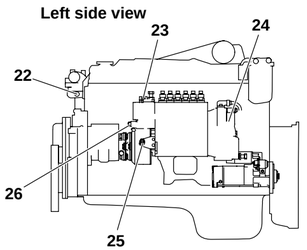
- Loosen lock nut **C**, and rotate engine speed sensor **14** to adjust the clearance.
- After adjustment, tighten lock nut **C** to the specified torque.

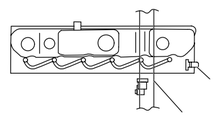
CAUTION

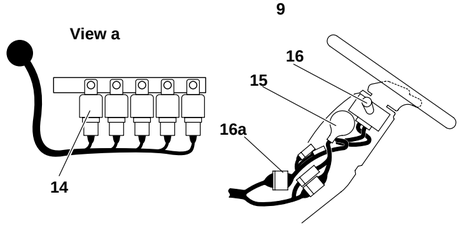
If clearance B between engine speed sensor 14 and timer housing protrusion A is too large, the sensor may not output a signal. If the clearance is too small, the sensor may contact the protrusions.

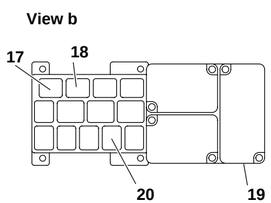


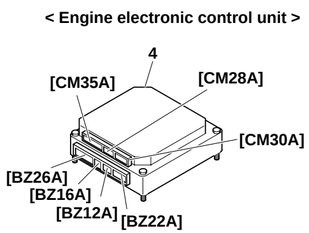


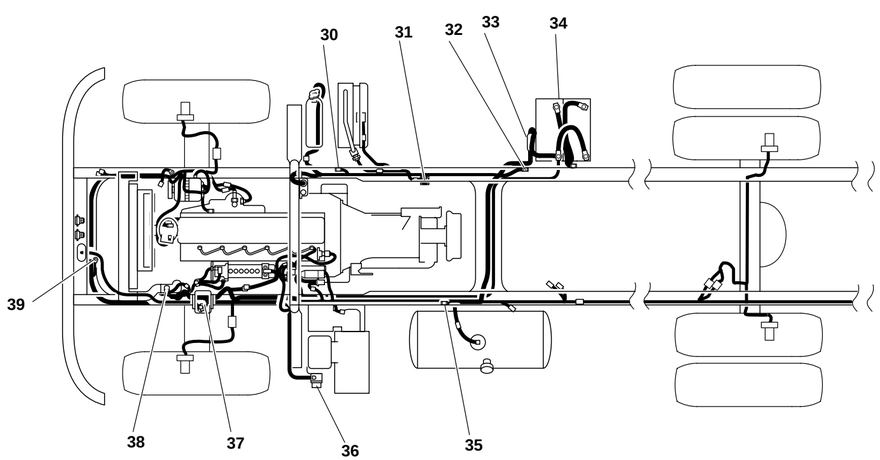


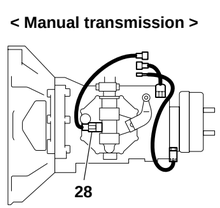


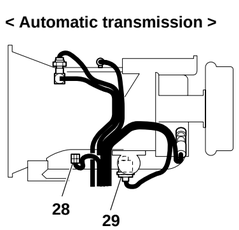






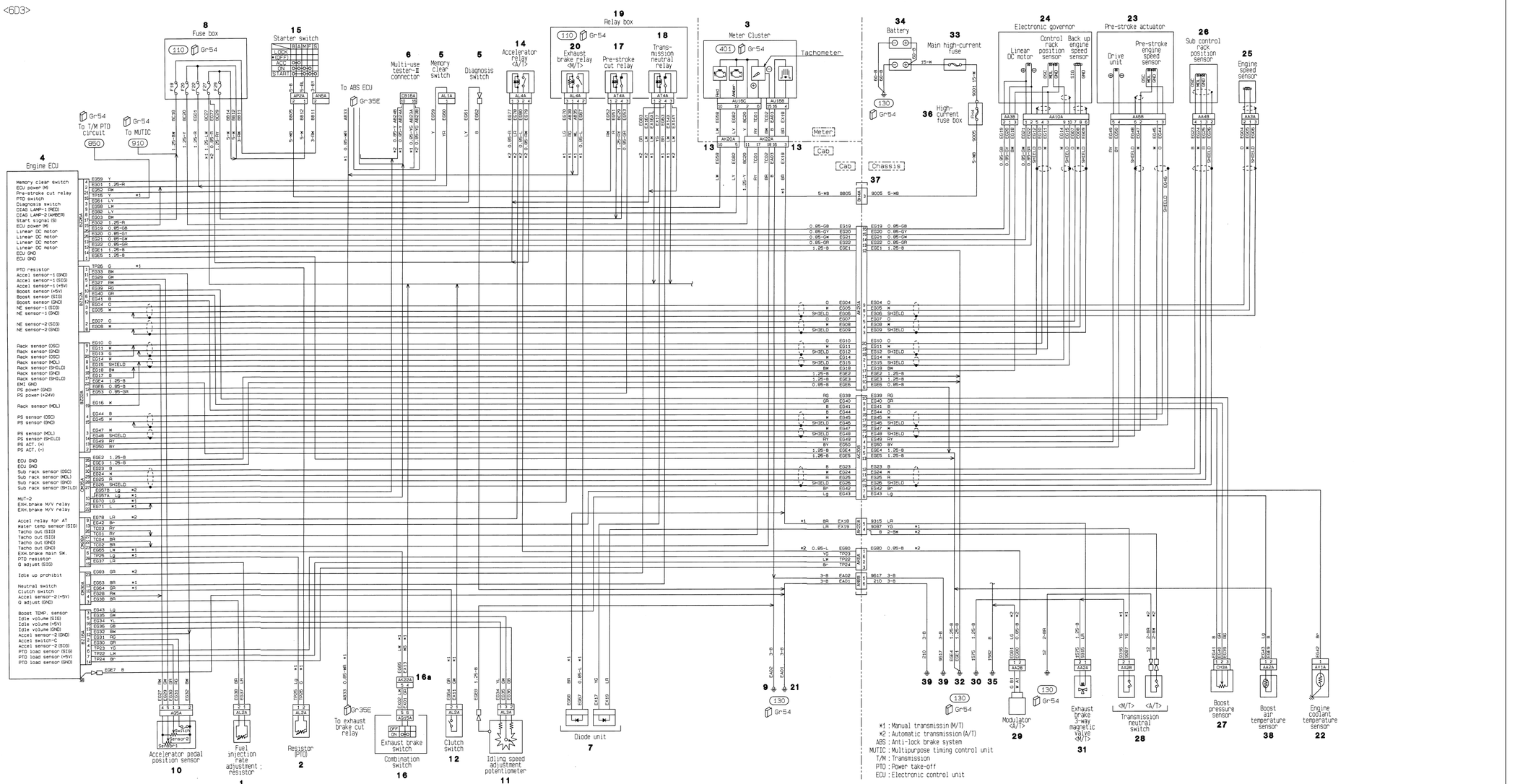






1 Fuel injection rate adjustment resistor
2 Resistor<Manual transmission>
3 Meter cluster
4 Engine electronic control unit
5 Diagnosis switch, memory clear switch
6 Multi use tester-II connector
7 Diode
8 Fuse box
9 Ground
10 Acceletor pedal position sensor
11 Idling speed adjustment potentiometer
12 Clutch switch
13 Connection of cab harness and meter harness
14 Acceletor relay<Automatic transmission>
15 Starter switch
16 Combination switch
16a Connection of cab harness and column harness
17 Pre-stroke relay
18 Transmission neutral relay
19 Relay box
20 Exhaust brake relay
21 Ground
22 Water temperature sensor
23 Pre-stroke actuator
24 Governor actuator
25 Engine speed sensor
26 Sub rack position sensor
27 Boost pressure sensor
28 Transmission neutral switch
29 Modulator
30 Ground
31 Exhaust brake 3-way magnetic valve
32 Ground
33 Main high-current fuse
34 Battery
35 Ground
36 High-current fuse box
37 Connection of cab harness and chassis harness
38 Boost air temperature sensor
39 Ground

Ⓟ45822


<6D3>
8 Fuse box
15 Starter switch
19 Relay box
20 Exhaust brake relay <M/T>
17 Pre-stroke cut relay
18 Trans-mission neutral relay
14 Accelerator relay <A/T>
6 Multi-use tester-III connector
5 Memory clear switch
5 Diagnosis switch
3 Meter Cluster
Tachometer
34 Battery
33 Main high-current fuse
36 High current fuse box
24 Electronic governor
Linear DC motor
Control rack position sensor
Back up engine speed sensor
23 Pre-stroke actuator
Drive unit
Pre-stroke engine speed sensor
26 Sub control rack position sensor
25 Engine speed sensor
4 Engine ECU
Memory clear switch
ECU power (M)
Pre-stroke cut relay
PTO switch
Diagnosis switch
DIAG LAMP-1 (RED)
DIAG LAMP-2 (AMBER)
Start signal (S)
ECU power (M)
Linear DC motor
Linear DC motor
Linear DC motor
Linear DC motor
ECU GND
ECU GND
PTO resistor
Accel sensor-1 (GND)
Accel sensor-1 (SIG)
Accel sensor-1 (+5V)
Boost sensor (+5V)
Boost sensor (SIG)
Boost sensor (GND)
NE sensor-1 (SIG)
NE sensor-1 (GND)
NE sensor-2 (SIG)
NE sensor-2 (GND)
Rack sensor (OSC)
Rack sensor (GND)
Rack sensor (OSC)
Rack sensor (MDL)
Rack sensor (SHIELD)
Rack sensor (GND)
Rack sensor (SHIELD)
EMI GND
PS power (GND)
PS power (+24V)
Rack sensor (MDL)
PS sensor (OSC)
PS sensor (GND)
PS sensor (MDL)
PS sensor (SHIELD)
PS ACT. (+)
PS ACT. (-)
ECU GND
ECU GND
Sub rack sensor (OSC)
Sub rack sensor (MDL)
Sub rack sensor (GND)
Sub rack sensor (SHILD)
MUT-2
EXH.brake M/V relay
EXH.brake M/V relay
Accel relay for AT
Water temp sensor (SIG)
Tacho out (SIG)
Tacho out (SIG)
Tacho out (GND)
Tacho out (GND)
EXH.brake main SW.
PTO resistor
Q adjust (SIG)
Idle up prohibit
Neutral switch
Clutch switch
Accel sensor-2 (+5V)
Q adjust (GND)
Boost TEMP. sensor
Idle volume (SIG)
Idle volume (+5V)
Idle volume (GND)
Accel sensor-2 (GND)
Accel switch-C
Accel sensor-2 (SIG)
PTO load sensor (SIG)
PTO load sensor (+5V)
PTO load sensor (GND)
To T/M PTO circuit
To MUTIC
To ABS ECU
Meter
Cab
Chassis
Accelerator pedal position sensor 10
Fuel injection rate adjustment resistor 1
Resistor PTO 2
To exhaust brake cut relay
Exhaust brake switch
Combination switch 16
Clutch switch 12
Idling speed adjustment potentiometer 11
Diode unit 7
Modulator <A/T> 29
Exhaust brake 3-way magnetic valve <M/T> 31
<M/T> <A/T>
Transmission neutral switch 28
Boost pressure sensor 27
Boost air temperature sensor 38
Engine coolant temperature sensor 22
*1 : Manual transmissin (M/T)
*2 : Automatic transmission (A/T)
ABS : Anti-lock brake system
MUTIC : Multipurpose timing control unit
T/M : Transmission
PTO : Power take-off
ECU : Electronic control unit
52781

MITSUBISHI
FUSO

Group 14A
Cooling

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-14A

INDEX

SPECIFICATIONS 14A- 2

STRUCTURE AND OPERATION 14A- 2

TROUBLESHOOTING 14A- 4

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Replacing Coolant and Cleaning Cooling System 14A- 6
- Air Bleeding of Cooling System 14A- 8
- Gas Leak Testing 14A- 8

RADIATOR AND FAN SHROUD 14A-10

COOLING FAN, V-RIBBED BELT, V-BELT AND WATER PUMP 14A-20

WATER HOSE & PIPE 14A-24

THERMOSTAT 14A-25

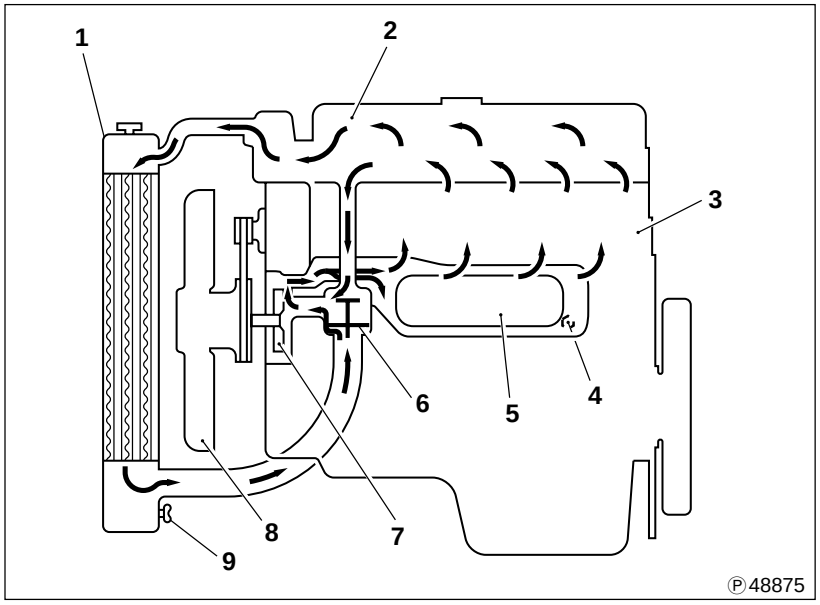
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item	Specifications
Kind of cooling system	Forced water circulation system
Water pump type	Belt-driven involute type
Thermostat type	Wax-pellet, bottom bypass type (with jiggling valve)
Automatic cooling fan coupling type	Continuous control type
Radiator type	Tube and corrugated fin type
Coolant capacity L {qts}	15 {15}

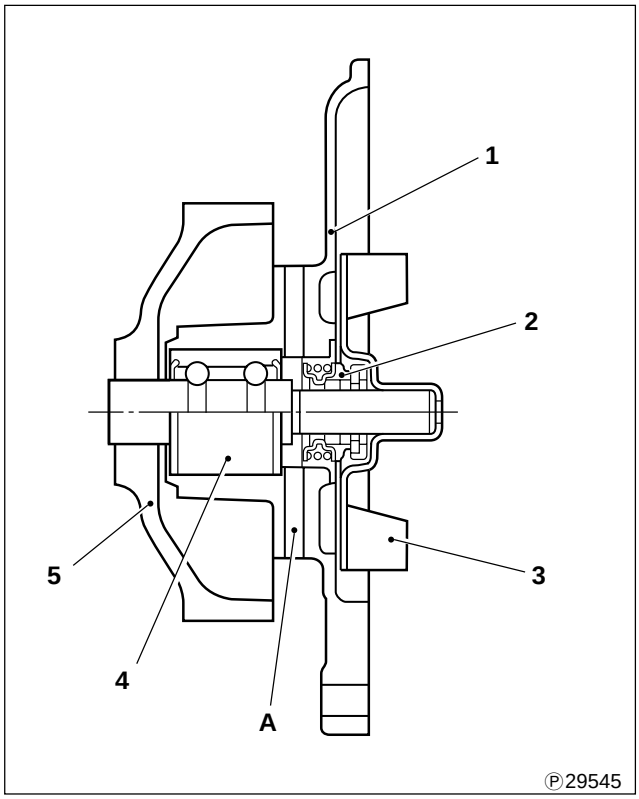
STRUCTURE AND OPERATION

Cooling System (Flow to Coolant)



1 Radiator
2 Cylinder head
3 Crankcase
4 Crankcase drain cock
5 Oil cooler
6 Thermostat
7 Water pump
8 Cooling fan
9 Radiator drain cock

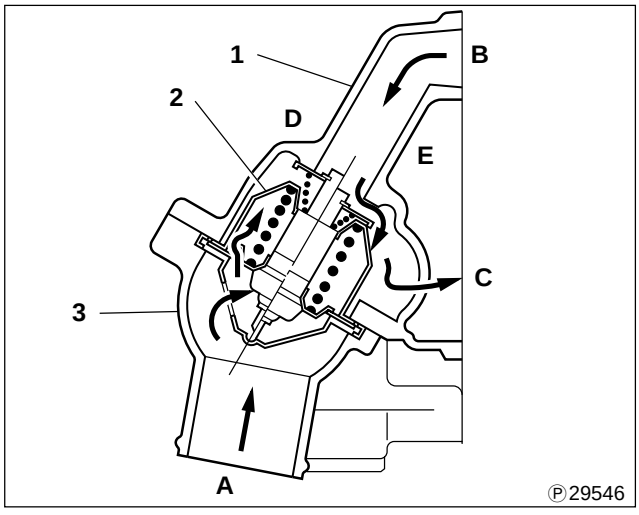
Water Pump



1 Case
2 Unit seal
3 Impeller
4 Unit bearing
5 Pulley

A : Drain hole

Thermostat



1 Oil cooler
2 Thermostat
3 Thermostat cover

A : From radiator
B : From cylinder head
C : To water pump
D : With high coolant temperature
E : With low coolant temperature

Thermostat **2** is a bottom bypass type that uses wax-charged pellets as its regulating element. As the wax changes from solid to liquid in with temperature increases, the total wax volume changes. As a result, the position of the valve, changed by the coolant temperature, regulates the flow of coolant from the radiator and cylinder head (by-pass side) before entering the engine to control the coolant temperature (inlet control type).

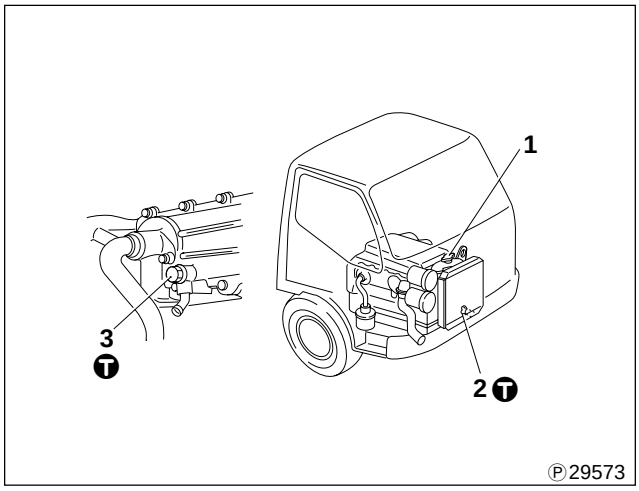
TROUBLESHOOTING

Possible causes \ Symptoms		Overheating (insufficient cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Remarks
V-ribbed belt	Loose or damaged	○		○		
	Excessive tension			○		
	Oil on belt	○				
Water pump	Water pump fitted poorly	○		○	○	
	Unit bearing defective	○		○		
	Impeller defective	○		○		
	Unit seal defective	○			○	
	Loose fit between unit bearing and flange and/or impeller	○		○		
Thermostat	Case fitted poorly	○			○	
	Valve opening temperature too high; valve remains closed	○				
	Valve opening temperature too low; valve remains open		○			
Radiator	Space between core and fins clogged	○				
	Core cracked and/or soldered joints separated	○			○	
Cooling fan	Fan shroud fitted poorly	○		○		
Automatic cooling fan coupling	Bearing defective	○		○		
	Bimetal damaged	○				
	Bimetal contaminated with foreign particles	○	○			
	Silicone oil leaking	○		○		
Oil cooler	Oil cooler fitted poorly	○			○	Gr 12A
	Gasket defective	○			○	
Cylinder head	Cylinder head fitted poorly	○			○	Gr 11A
	Gasket defective	○			○	
Coolant quantity insufficient		○				
Coolant passages dirty and/or clogged		○				
Hoses fitted poorly		○			○	
Ambient temperature extremely low			○			

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

Replacing Coolant and Cleaning Cooling System



1 Pressure cap
2 Drain cock
3 Water drain plug

T Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Drain cock	2 {14.5, 0.2}	—
3	Water drain plug	24.5±4.9 {18.1±3.6, 2.5±0.5}	—

Using the radiator for extended periods without cleaning the cooling system will cause overheating since rust and scale will accumulate. The cooling system must be cleaned periodically.

● **Draining the coolant**

Before draining the coolant, loosen the pressure cap **1** to reduce the pressure in the cooling system.

WARNING ⚠

- **To avoid being scalded, make sure the coolant has cooled sufficiently before loosening the pressure cap 1.**
- **Unless care is taken, opening the pressure cap 1 when the coolant is hot can cause the coolant to spray out. Cover the pressure cap with a cloth, and loosen the cap slowly to bleed off the pressure before opening it fully.**

● **Cleaning procedure**

- Run the engine and keep the coolant at a temperature of approximately 90°C {194°F} such that the thermostat valves remain open and the coolant circulates continuously in the radiator.
- To increase the coolant temperature quickly, cover the front of the radiator with cardboard or a similar material.
- If cleaning is carried out after a large amount of rust has accumulated, the radiator may start to leak. Carefully examine the radiator for leaks after cleaning the cooling system.
- Soft water to be used should have the following properties.

CAUTION ⚠

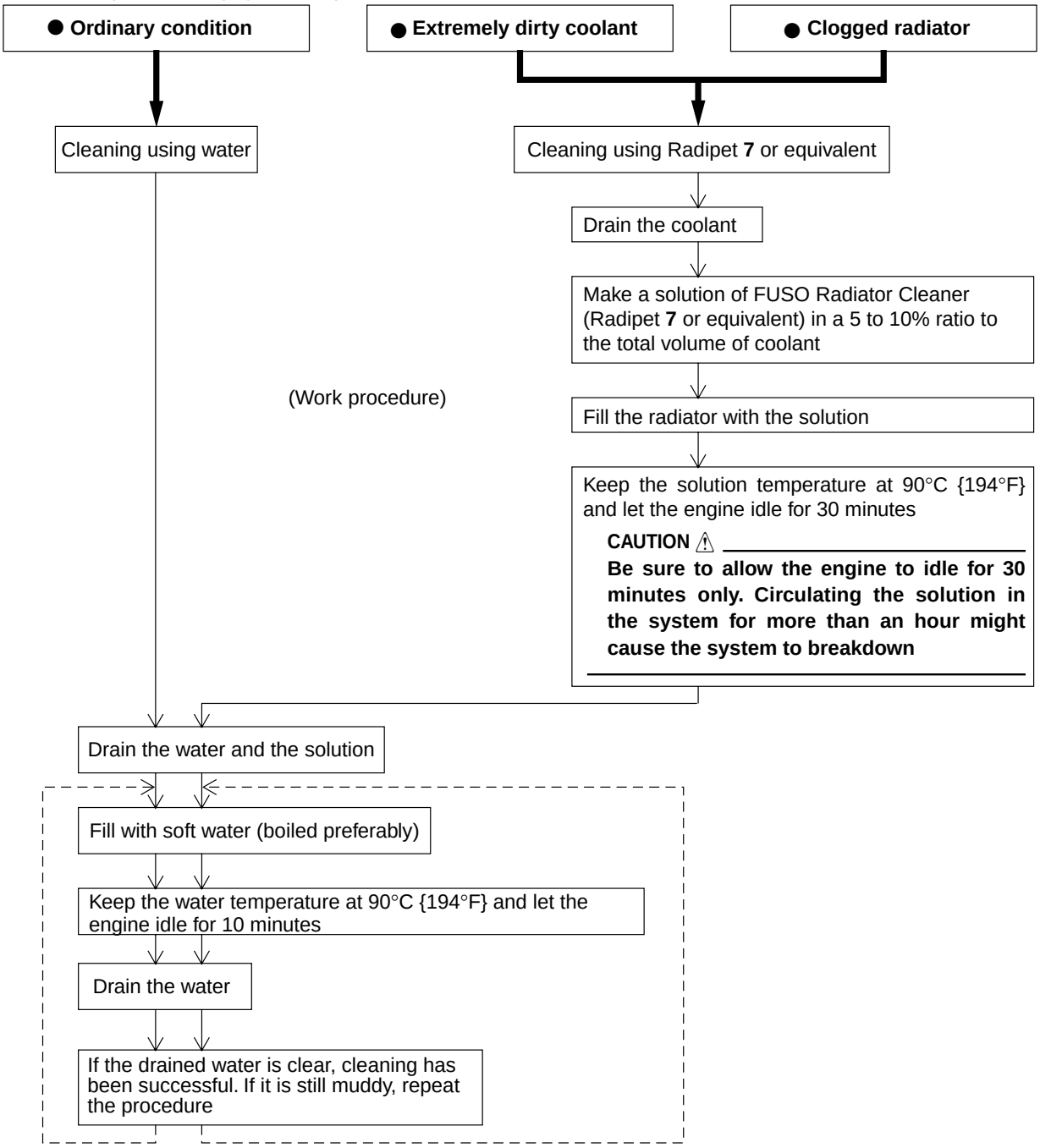
Do not use hard water as it causes scale and rust.

Required properties of soft water

Total hardness	300 ppm or less
Sulfate SO_4^-	100 ppm or less
Chloride Cl^-	100 ppm or less

Total dissolved solids	500 ppm or less
pH	6 to 8

Method of cleaning the cooling system depends on its condition.



DANGER ⚠

If FUSO DIESEL LONG LIFE COOLANT solution gets in your eyes accidentally, you must immediately rinse your eyes with copious amounts of water, and be sure to consult a doctor.

WARNING ⚠

FUSO DIESEL LONG LIFE COOLANT is inflammable. Do not put it near unprotected lights.

NOTE

- **After cleaning with solution, fill with coolant as quickly as possible.**
- **To prevent freezing of the coolant and corrosion of the cooling system, use specified coolant solution of FUSO DIESEL LONG LIFE COOLANT. (See the Owner's Handbook for use of these materials.)**

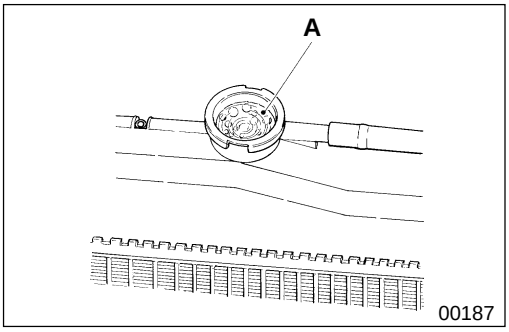
ON-VEHICLE INSPECTION AND ADJUSTMENT

Air Bleeding of Cooling System

- Remove the pressure cap. Then, introduce cooling water little by little up to the water outlet pipe neck. Do not pour water up to the outlet port brim, otherwise water would overflow out of the outlet port after the engine is started as water will expand due to temperature rise.
- With the pressure cap removed, run the engine at idle. While keeping temperature at 90°C {194°F}, bleed the cooling system completely.
- After bleeding the cooling system of air, add coolant to the water outlet pipe and reservoir tank as required.

Gas Leak Testing

The presence of air or exhaust gas in the coolant increases corrosion and rust in the cooling system. Check for air or exhaust gas in the coolant using the following procedure.



- Open the pressure cap.

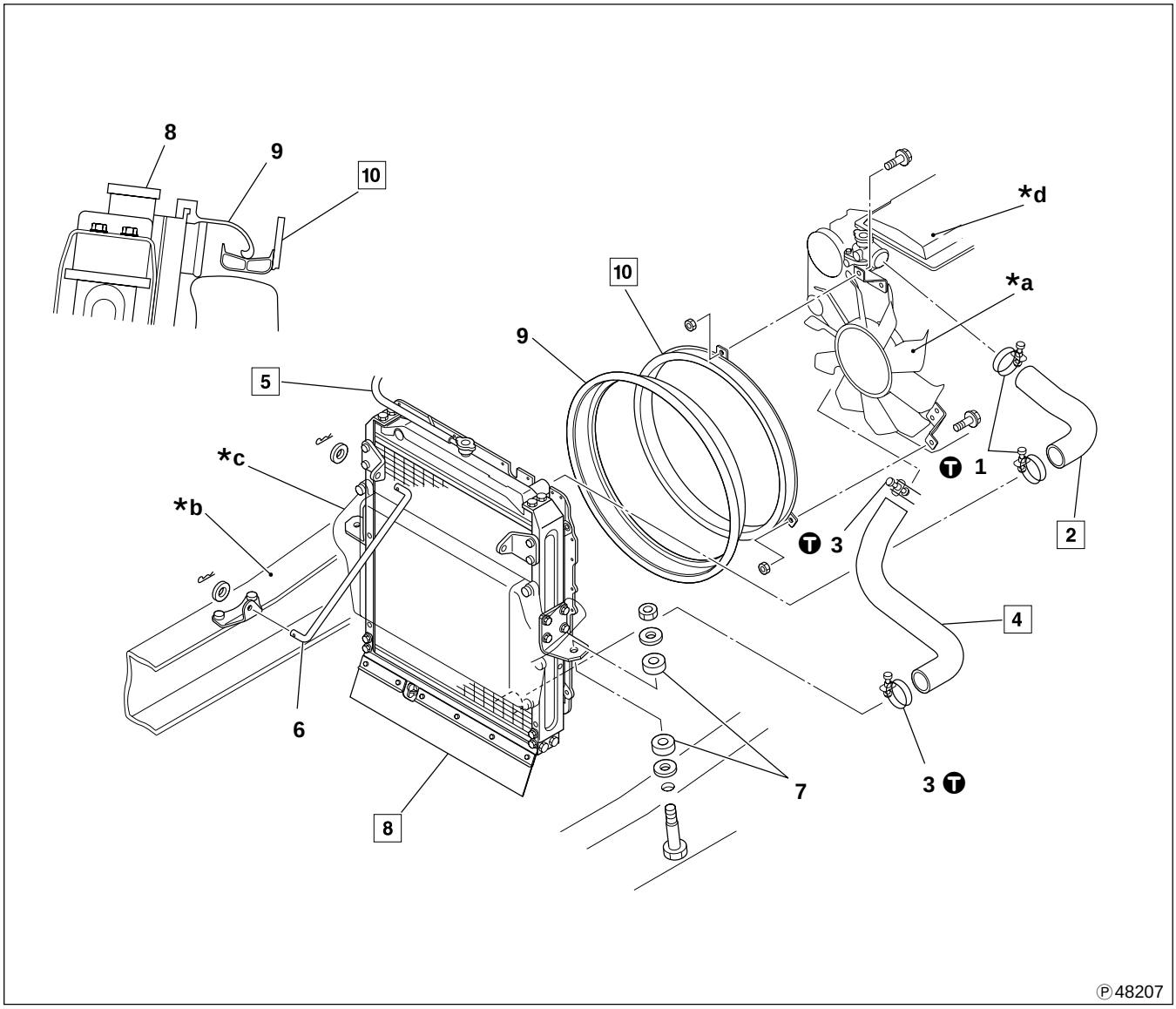
WARNING ⚠

Make sure the coolant is cool before loosening the pressure cap. If the coolant is hot, it may spray out.

- Run the engine and let the coolant temperature reach approximately 90°C {194°F}.
- If bubbles **A** appear continuously, there is air or exhaust gas in the coolant.
- If the coolant contains air, the cylinder head bolts, water pump mounting bolt, or hose connections may be loose. Alternatively, the hoses may be damaged.
- If the coolant contains exhaust gas, it is possible that the cylinder head gasket is damaged or that the cylinder head is cracked.

M E M O

RADIATOR AND FAN SHROUD



● **Disassembly sequence**

1 Hose clamp
2 Inlet hose
3 Hose clamp
4 Outlet hose
5 Reservoir hose
6 Support rod
7 Rubber seat
8 Radiator assembly 🕮 P14A-12
9 Shroud seal
10 Fan shroud

***a** : Cooling fan 🕮 P14A-14
***b** : Frame Gr 41
***c** : Intercooler Gr 15A
***d** : Engine assembly Gr 11A

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
10, *a	Tip clearance between fan shroud and cooling fan	7 to 11 {0.28 to 0.43}	—	Adjust

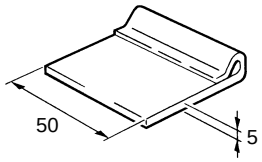
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

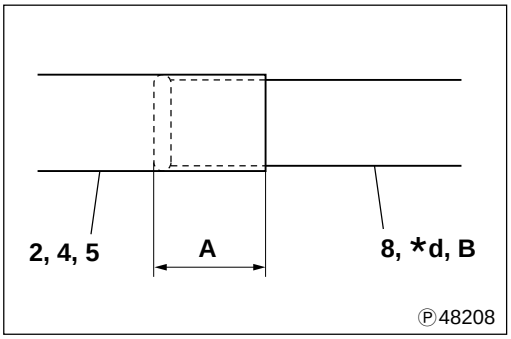
Location	Parts to be tightened	Tightening torque	Remarks
1, 3	Hose clamp	3.9±0.6 {2.9±0.4, 0.4±0.06}	—

Special tools

Unit : mm

Location	Tool name and shape	Part No.	Application
10	Tip Clearance Spacer  Ⓟ00189	MC019470	Adjustment of fan shroud to cooling fan tip clearance

◆ Service procedure



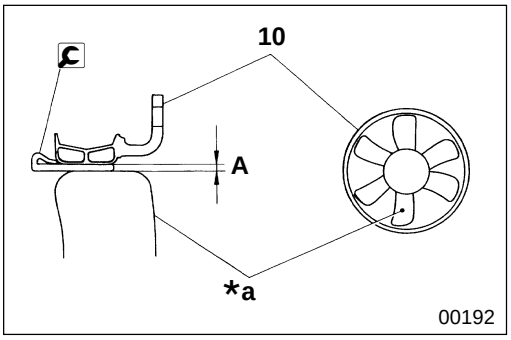
Ⓟ48208

2 **4** **5** **Hose installation**

Install inlet hose **2**, outlet hose **4** and reserver hose **5** with the diameter **A** as illustrated. Details of diameter are as follows.

Inlet hose **2**, outlet hose **4** : 40 mm {1.57 in.} (However, installing dimension of the engine side inlet hose **2** is 35 mm {1.38 in.})
Reservoir hose **5**: 25 mm {0.98 in.}

B : Reservoir tank



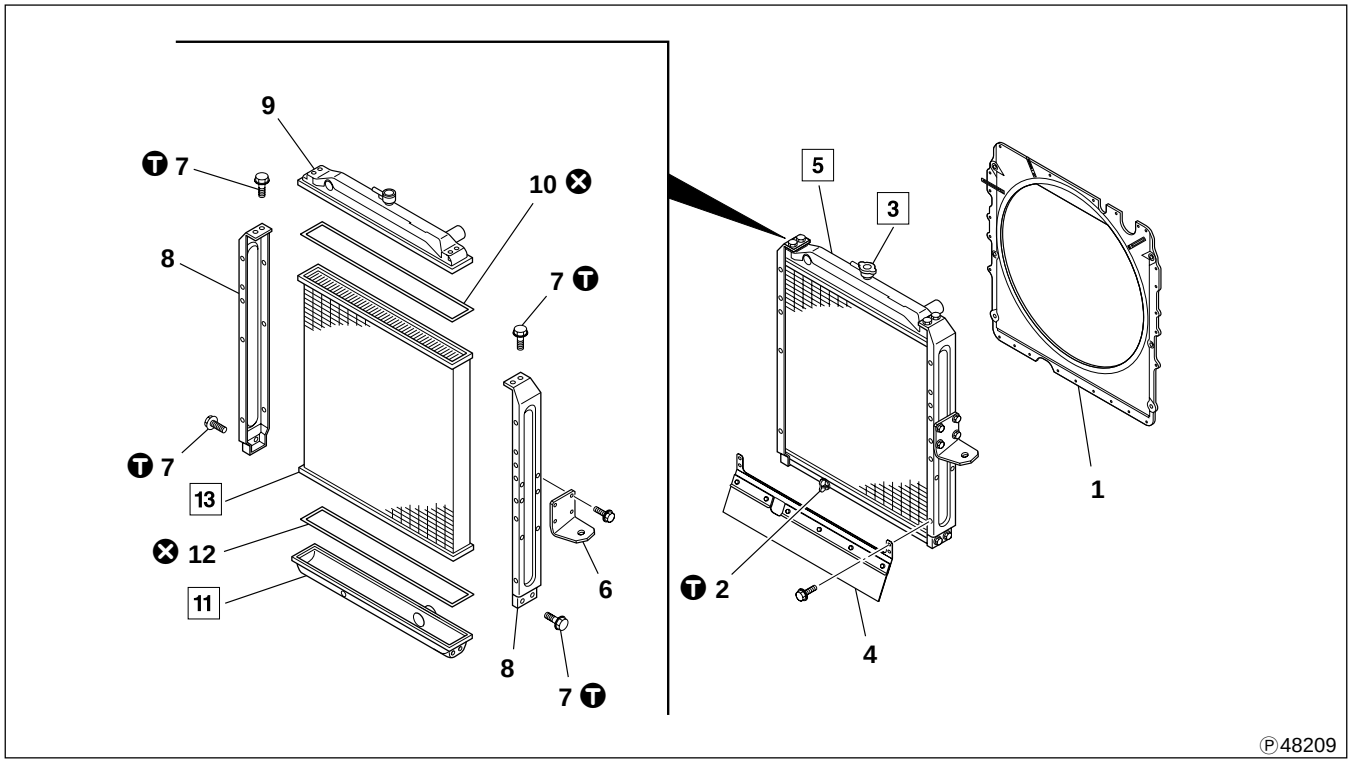
00192

10 **Fan shroud installation**

Use the Tip Clearance Spacer to achieve the specified clearance **A** around the entire periphery between the fan shroud **10** and cooling fan ***a**.

RADIATOR

Radiator Assembly



● **Disassembly sequence**

1 Radiator shroud
2 Drain cock
3 Pressure cap
4 Radiator apron
5 Radiator assembly
6 Bracket
7 Bolt
8 Side member
9 Upper tank
10 O-ring
11 Lower tank
12 O-ring
13 Core

⊗ : Non-reusable part

CAUTION ⚠

- **Do not disassemble the radiator assembly 5 unless defects are evident.**
- **The upper tank 9 and lower tank 11 are made of plastic and could crack if subjected to undue shock. Handle them with care.**
- **Replace the core 13 if the clinching tabs that hold the upper tank 9 or lower tank 11 have two paint marks, showing that the tabs have been back twice. 🕮 P14A-14**

NOTE

Pressure cap must be installed to the radiator in case 4M5 engine is installed.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
3	Pressure valve opening pressure	90±15 kPa {13±2.1 lbf/in^2, 0.92±0.15 kgf/cm^2}	—	Replace
5	Radiator air leakage (with air pressure of kPa {21 psi, 1.5 kgf/cm^2})	0 cm^3 {0 cu.in.}	—	Rectify or replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

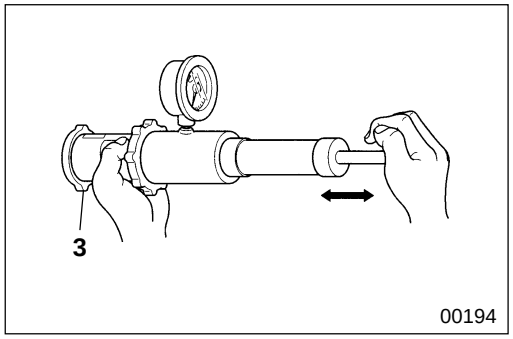
Location	Parts to be tightened	Tightening torque	Remarks
2	Drain cock	2 {1.4, 0.2}	—
7	Bolt (side member mounting)	13 {9.4, 1.3}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
9, 11	Lock & Break Tool	Obtain locally or use sublet repair	Upper tank, lower tank removal

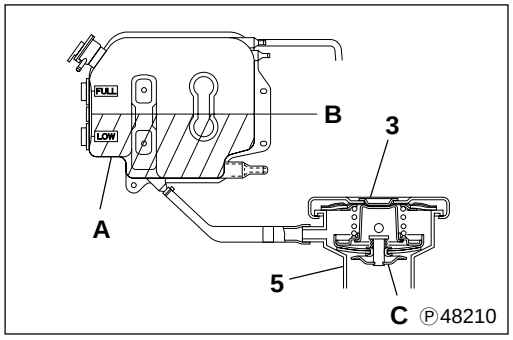
◆ Service procedure



3 **Pressure cap inspection**

(1) Pressure valve opening pressure

If the measurement does not comply with the standard value, replace the pressure cap **3**.

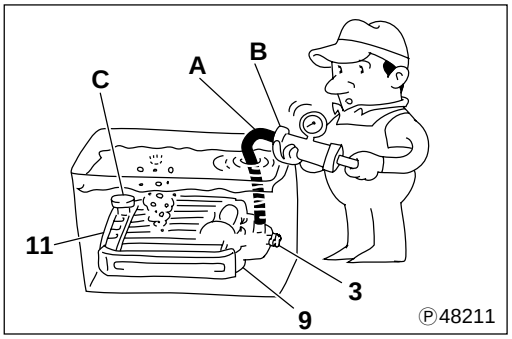


(2) Vent valve inspection

- Obeserve the water level **B** in the resorvoir tank **A**.
- Run the engine at a high speed. Stop then engine when a small amount of coolant has overflowed into the reservoir tank **A**.
- Wait for a while in this condition. When the coolant returns to the ambient temperature, check to see if the water level **B** in the reservoir tank **A** has returned to the level at which it was observed before the engine was started.
- If the water level **B** has not dropped, the vent valve **C** is defective; replace the pressure cap **3**.

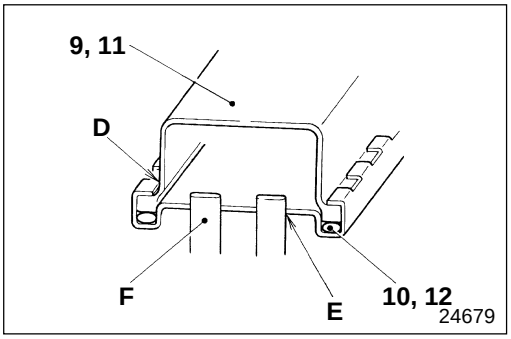
NOTE

If the pressure cap 3 is removed before the coolant has cooled down to the ambient temperature, the vacuum in the radiator 4 will be lost, preventing the coolant from returning to the reservoir tank A.



5 **Radiator inspection**

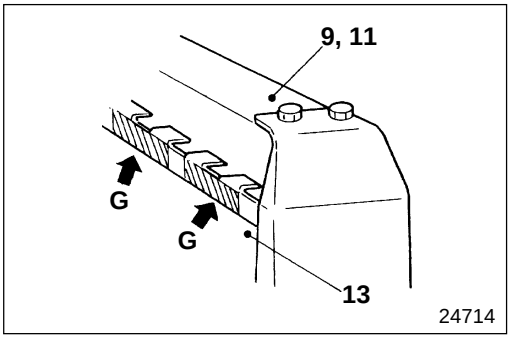
- Fit pressure cap **3**, hose **A**, and radiator cap tester **B** onto the radiator upper tank **9**.
- Fit a plug **C** onto the radiator lower tank **11**, then immerse the radiator in a tank of water.
- Using the radiator cap tester **B**, apply the specified air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2}, and check for air leakage.
- If air leakage is apparent, repair or replace the radiator assembly **5**.



- Replace the following parts according to the leaking locations.

Leaking location	Part to replace
Tank root **D**	O-ring **10** or **12**
Tank **9**	Tank **9**, O-ring **10**
Tank **11**	Tank **11**, O-ring **12**
Tube fitted area **E**	Core **13**, O-ring **10**, **12**
	* Tube **F** (TIG welded), O-ring **10**, **12**
Tube **F**	Core **13**, O-ring **10**, **12**

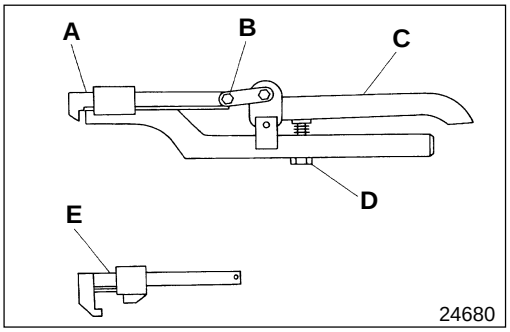
* : When repaired



CAUTION ⚠

Replace the core 13 if its clinching tabs that hold the upper tank 9 or lower tank 11 have two paint marks G, evidence of the tabs having been back twice.

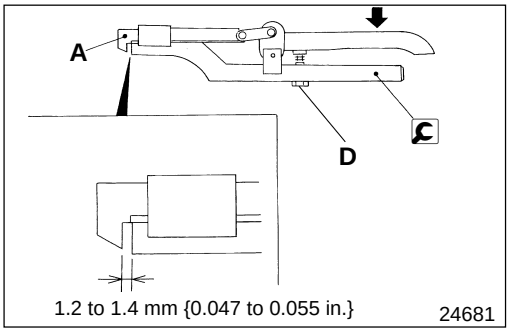
The tabs are provided with one paint mark each time they are bent back. Count the paint marks on each of upper and lower tabs separately.



9 **11** **Upper tank and lower tank**

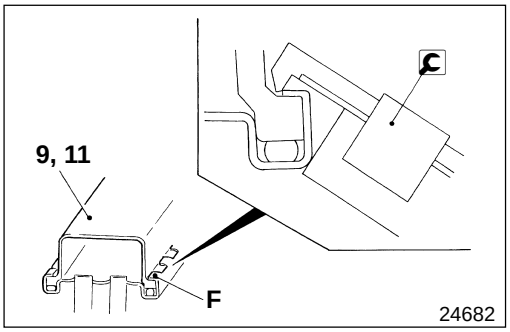
Remove and reinstall the tanks using the Lock and Break Tool.

A : Attachment (for tank removal)
B : Attachment locking bolt
C : Slide handle
D : Stopper/adjuster bolt
E : Attachment (for tank installation)

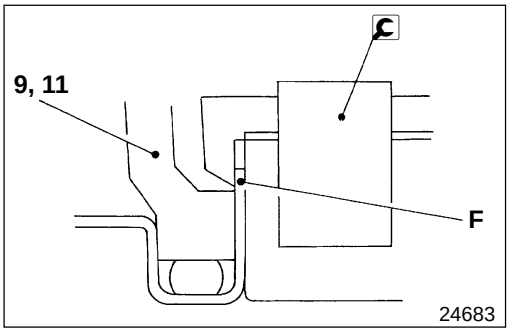


[Removal]

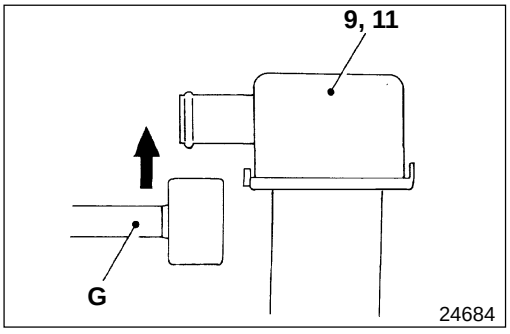
- Fit attachment **A** onto the end of the Lock and Break Tool, set it to the illustrated dimension and lock it in position with the stopper/adjuster bolt **D**.



- Using the Lock and Break Tool, bend up the tabs **F** of the core **13** that hold the tank **9, 11**.
- Straighten the tabs **F** completely as shown by gripping the Lock and Break Tool.

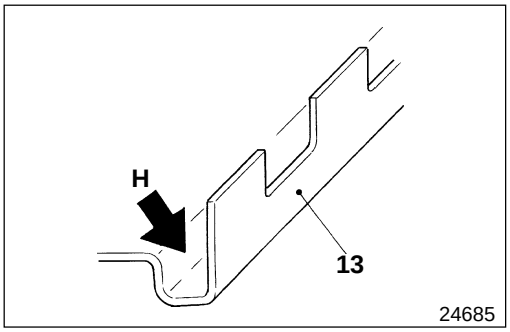


- After straightening all the tabs **F**, grasp the inlet or outlet pipe and remove the tank **9, 11**.
- If the tank **9, 11** is difficult to remove, tap it with a rubber or plastic hammer **G**.



CAUTION ⚠

The tanks 9 and 11 are made of plastic and may crack if subjected to undue shock. Handle them with care.

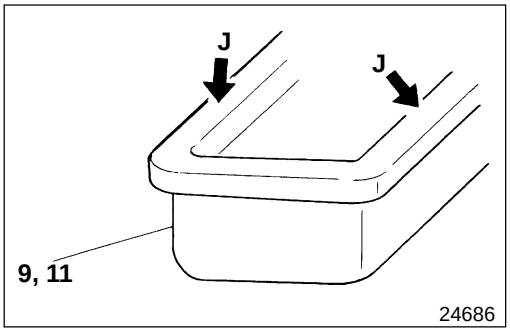


[Inspection]

- Check the tank mounting channels **H** of the core **13** for foreign matters.
- If foreign matter is stuck inside the mounting channels, rub them away with sandpaper (approximately #1000) or blow them out with compressed air.

CAUTION ⚠

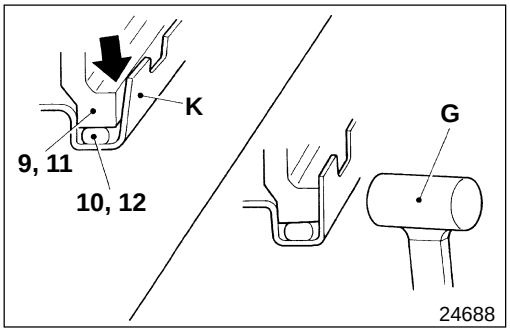
If any foreign matter (even a single hair) remains when the O-ring 10, 12 and tank 9, 11 are fitted, leakage can occur. Carefully inspect and clean each tank mounting channel H entirely.



- Clean the core contacting surface **J** of the tank **9, 11** and inspect it for damage. Replace the tank if any defect is evident.

CAUTION ⚠

Perform procedure with bare hands to prevent foreign matter from sticking to the surface J.

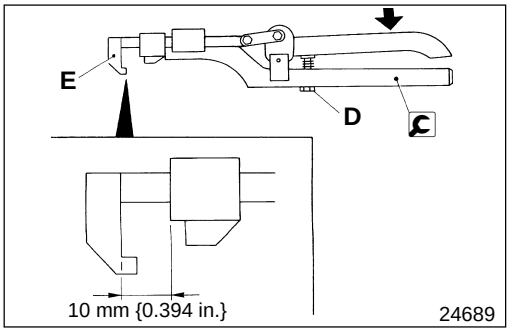


[Installation]

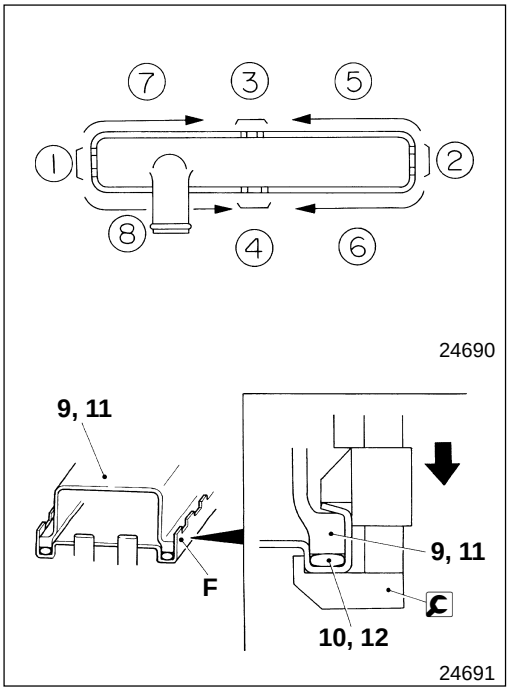
- Install the tank **9, 11** in position. Check that the sub-plate **K** of the core is in close contact with the tank. If there is any space, tap the sub-plate lightly with a rubber or plastic hammer to eliminate space.

CAUTION ⚠

Handle the parts with bare hands to prevent foreign matter from sticking to the O-ring 10, 12 and tank 9, 11.



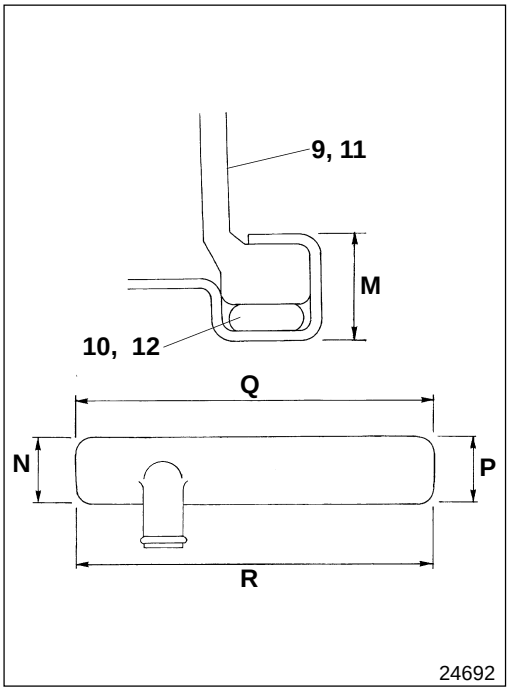
- Fit attachment **E** onto the end of the Lock and Break Tool, set it to the illustrated dimension and lock it in position with the stopper/adjuster bolt **D**.



- Clinch the tabs **F** of the core **13** to hold the tank **9, 11** in the illustrated order.
  ① to ④ : Two center tabs on each side
  ⑤ to ⑧ : Remaining tabs in illustrated sequence
  : Lock and Break Tool (with attachment **E**)

NOTE

The sides ① and ② do not allow the Lock and Break Tool to be used for clinching. Clinch these sides using a pair of pliers with tape wrapped around its jaws.

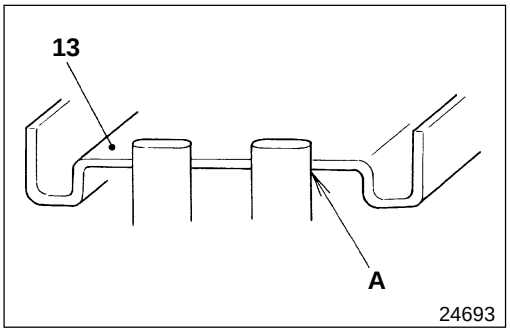


- Check that the tabs has been clinched to the following dimensions.
  M : 14.65 to 15.05 mm {0.576 to 0.592 in.} (Sides **N** and **P**)
  10.05 to 10.45 mm {0.395 to 0.411 in.} (Sides **Q** and **R**)

- Check for leaks. P14A-14
- Provide a paint mark to the sub-plate **K** of the core **13** to indicate that the tabs have been bent up and then down.

NOTE

Provide one paint mark after each removal of the tank.



13 Core

If water leaks from the tube fitted area **A**, replace the core **13** or repair it by the following method.

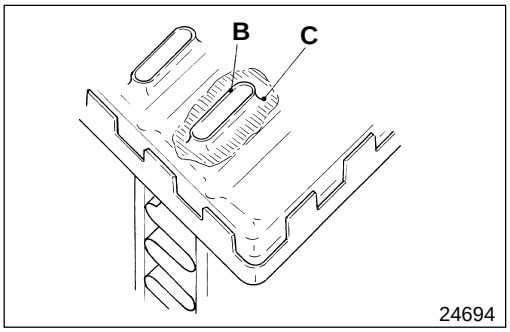
[Repair]

NOTE

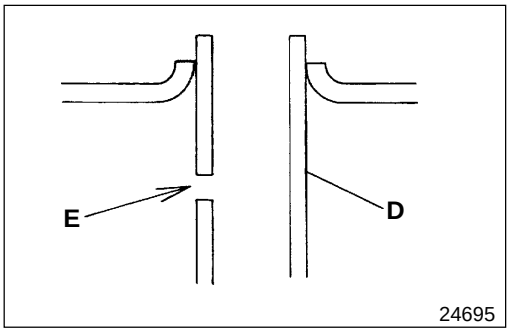
Repair is carried out by tungsten inert gas arc (TIG) welding, which requires the skill of a trained welder.

WARNING ⚠

To avoid danger, dry the core 13 completely before welding.



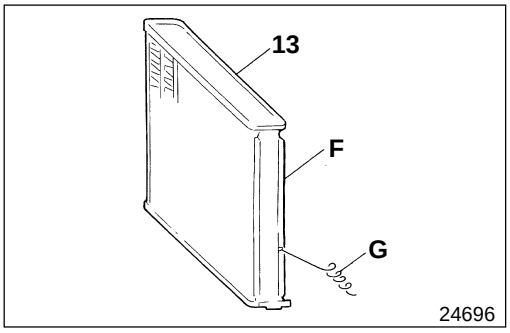
- Clean both edges **B** of the leaky tube and their surroundings **C** using a stainless steel wire brush. Scrub the surface until it glistens with exposed aluminum.



- Since both ends of the tube are covered with weld metal, make a small hole **E** in the tube **D** to allow air venting.

NOTE

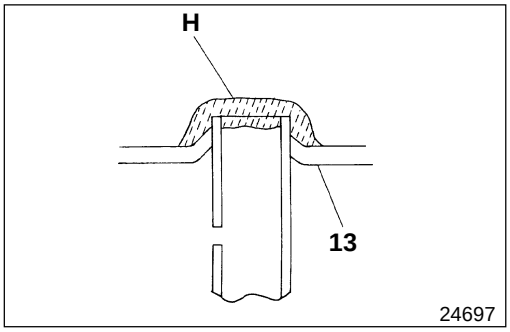
Absence of the small hole E causes escaping air to produce small pin holes in the weld.



- Connect a grounding wire **G** from the support **F** of the core **13** to an appropriate object.

CAUTION ⚠

Improper connection of the grounding wire G causes a short circuit during welding work and the core could be fused at the welded portion.



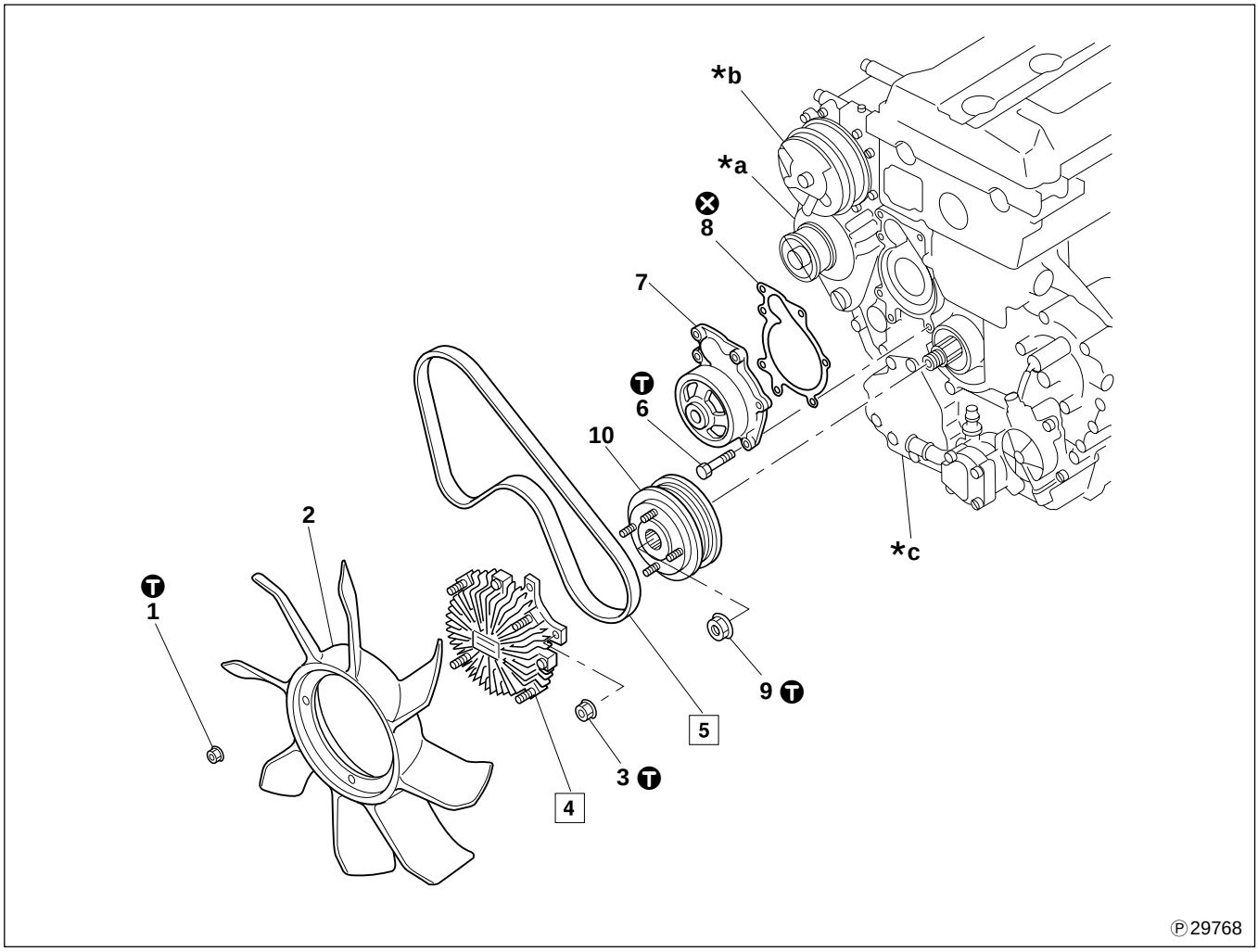
- Cover both ends of the tube with welding metal.
  H : Tungsten inert gas arc weld (TIG)
  Welding conditions:
  Welding rod: A4043 (approximately ϕ 2 mm {ϕ 0.0079 in.} in diameter)
  Welding current: 80A AC
- After welding, check for the following defects. Rectify the weld or replace the core **13** if any of the defects is evident.
  - Undercut
  - Bead crack
  - Crack in base metal

CAUTION ⚠

Weld with sufficient care. Poor welding may cause leakage to recur.

M E M O

COOLING FAN, V-RIBBED BELT, V-BELT AND WATER PUMP



● **Disassembly sequence**

1 Nut
2 Cooling fan
3 Nut
4 Automatic cooling fan coupling
5 V-ribbed belt (for water pump)
6 Bolt
7 Water pump assembly
8 Gasket
9 Nut
10 Fan pulley

***a :** Alternator Gr 54
***b :** Tension pulley
***c :** Front case Gr 11A
⊗ **:** Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standard

Unit: mm {in.}

Location	Maintenance item		Standard Value	Limit	Remedy
5	V-ribbed belt tension (for water pump)	When belt is new	9 to 11 {0.35 to 0.43}	—	Adjust
		When belt in use is re-tensioned	11 to 13 {0.43 to 0.51}	—	

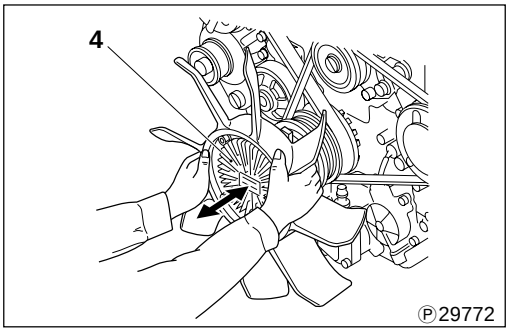
Tightening torque

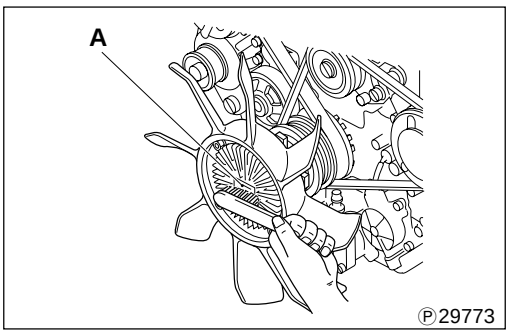
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (cooling fan mounting)	4.9 {3.6, 0.5}	—
3	Nut (for automatic cool fan coupling mounting)	12.7 {9.4, 1.3}	—
6	Bolt (for water pump assembly mounting)	23.5 {17.4, 2.4}	—
9	Nut (for fan pulley mounting)	196.1 {145, 20}	—

Special tools

Location	Tool name and shape	Part No.	Application
5	Belt Tension Gauge 03612	Obtain Locally	V-belt and V-ribbed belt tension measurement





◆ Service Procedure

4 Automatic cooling fan coupling

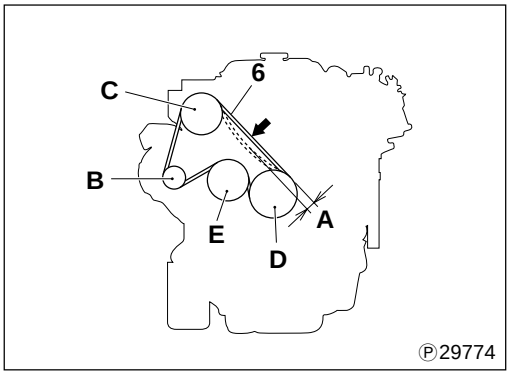
[Inspection]

Inspect the automatic cooling fan coupling **4** in accordance with the following procedure. If any defect is apparent, replace the unit.

- Check for leakage of oil from the coupling body.
- Rotate the automatic cooling fan coupling **4** by hand and check for irregular movement or abnormal noise caused by a defect in the bearing.
- Check for excessive axial play in the automatic cooling fan coupling **4** when the engine is cool.

[Cleaning]

If any foreign particles have adhered to the bimetal **A**, brush them off gently.



5 V-belt and V-ribbed belt tension

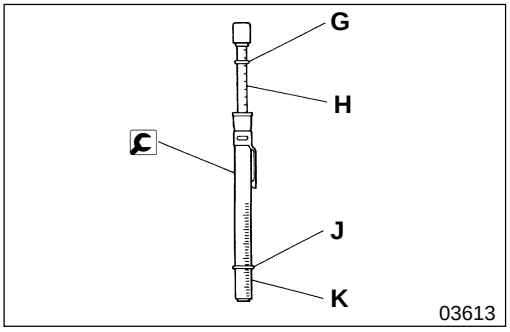
[Inspection]

NOTE

Before checking for tension, crank the engine one turn or more clockwise.

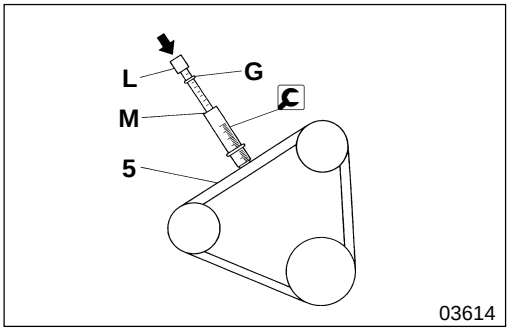
Apply force of approximately 98 N {22 lbf, 10 kgf} to the span center of the V-ribbed belt **5**, and measure the extent of belt deflection **A**.

B : Alternator pulley
C : Air conditioner compressor pulley or tention pulley
D : Fan pulley
E : Water pump pulley
F : Tension pulley

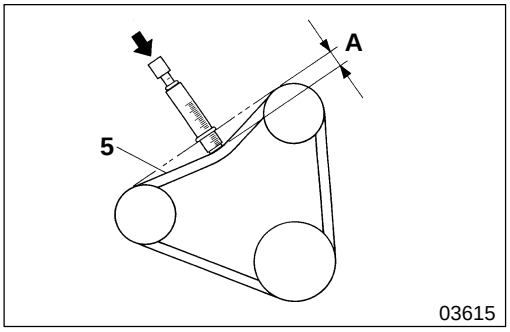


● **Use of belt tension gauge**

- Set the upper O-ring **G** of the 🔧 Belt Tension Gauge to a push load of 98 N {22 lbf, 10 kgf} on scale **H**.
- Set the lower O-RING **J** of the 🔧 Belt Tension Gauge to the belt's specified maximum deflection value on scale **K**.



- Apply the 🔧 Belt Tension Gauge to the center of the V-ribbed belt **5** and push **L** until the upper O-ring **G** reaches the flange **M**.

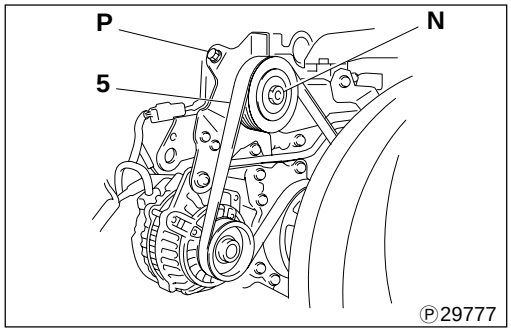


- Measure the deflection **A** of the V-ribbed belt **6**. If the measurement does not comply with the standard value, adjust the tension in accordance with the following procedure.

[Adjustment]

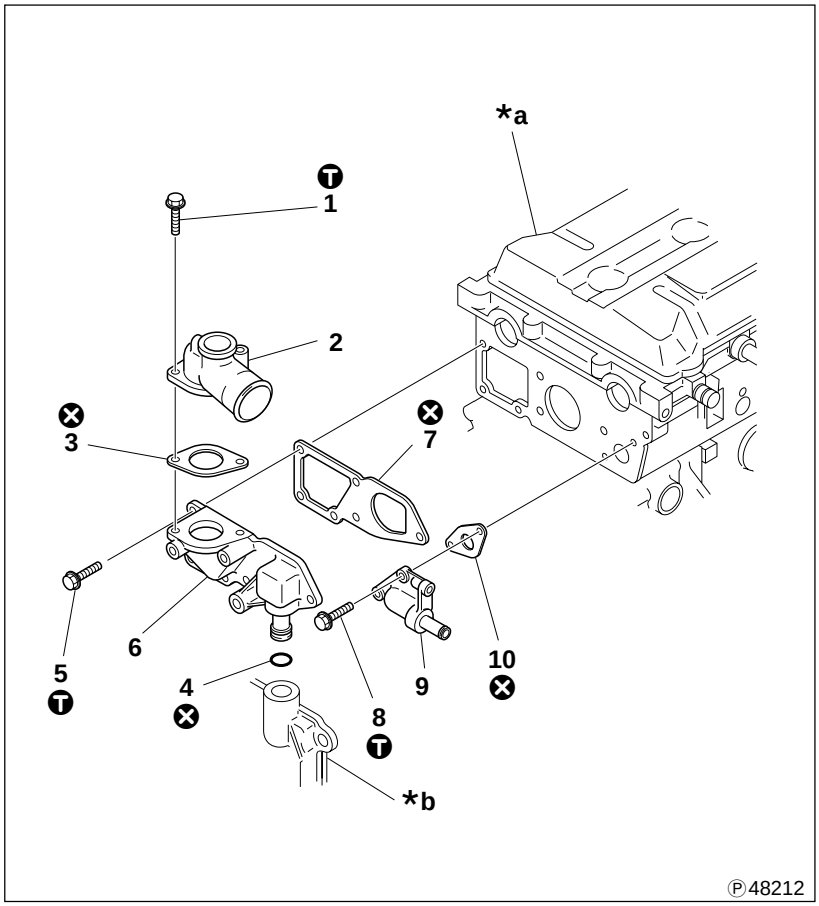
CAUTION ⚠

- **Excessive tension in the V-ribbed belt 5 may damage the belt and related bearings.**
- **Keep the V-ribbed belt 5 free of oil. If the belt becomes oily, it may slip, resulting in overheating of the engine and insufficient charging of the battery.**



- Loosen the tensioner pulley mounting sleeve **N**, then adjust the tension of the V-ribbed belt **5** using the adjustment bolt **P**.
- When the adjustment is completed, securely tighten the sleeve **N**.

WATER HOSE & PIPE



● **Disassembly sequence**

1 Belt
2 Water outlet pipe
3 Gasket
4 O-ring
5 Bolt
6 Water outlet case
7 Gasket
8 Bolt
9 Heater elbow
10 Gasket

***a** : Cylinder head Gr 11A
***b** : Breathe cover Gr 11A
⊗ : Non-reusable parts

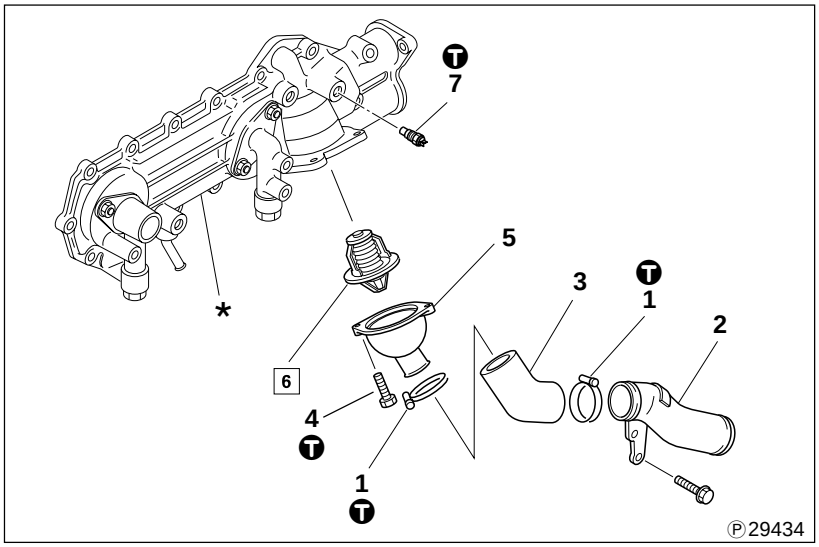
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (for water outlet pipe mounting)	23.5 {17.4, 2.4}	—
5	Bolt (for water outlet case mounting)	23.5 {17.4, 2.4}	—
8	Bolt (for heater elbow mounting)	23.5 {17.4, 2.4}	—



● **Disassembly sequence**

1 Clamp
2 Water pipe
3 Rubber hose
4 Bolt
5 Thermostat cover
6 Thermostat
7 Water temperature sensor
Gr 54

***:** Oil cooler Gr 12A

● **Assembly sequence**

Follow the disassembly sequence in reverse.

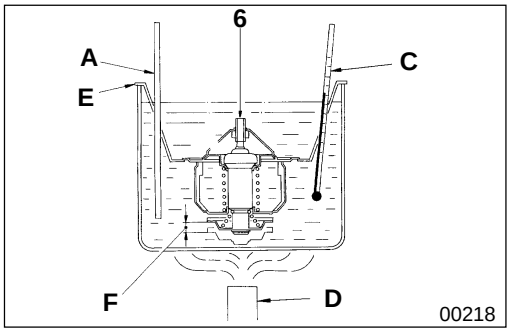
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
6	Thermostat	Valve opening temperature	82±2°C {180±3.6°F}	—	—
		Valve lift/temperature	10 mm or more/90° {194°F}	—	—

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Clamp	3.3 to 4.5 {2.46 to 3.33, 0.34 to 0.46}	—
4	Bolt (for thermostat cover mounting)	23.5 {17.4, 2.4}	—
7	Water temperature sensor	22.6 {16.6, 2.3}	—



◆ Service procedure

6 Thermostat

[Inspection]

Place the thermostat in a container of water. Then, carry out the following inspection procedure while stirring the water with a rod **A** to ensure that it is heated evenly. If the measurements do not comply with the standard values, replace the thermostat **6**.

(1) Valve opening temperature

- Support the thermostat **6** with wire **E** to keep it away from the heat source **D**.
- Gradually heat the water until it reaches the valve opening temperature.
- Maintain this temperature for approx five minutes and check that the valve **B** is open.
- When the water temperature drops below 65°C {149°F}, check the the valve **B** is completely closed.
  C : Thermometer

(2) Valve lift

Heat the water to slightly higher than the valve opening temperature. With the valve **B** fully open, maintain this water temperature for five minutes. Measure the extent of valve lift **F**.

MITSUBISHI
FUSO

Group 14B

Cooling

< 6D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-14B

INDEX

SPECIFICATIONS 14B- 2

STRUCTURE AND OPERATION 14B- 2

TROUBLESHOOTING 14B- 6

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Replacing Coolant and Cleaning Cooling System 14B- 8
- Air Bleeding of Cooling System 14B-10
- Gas Leakage Test 14B-10

RADIATOR AND FAN SHROUD 14B-12

SURGE TANK 14B-20

COOLING FAN AND V-BELT 14B-22

WATER PUMP 14B-25

THERMOSTAT 14B-26

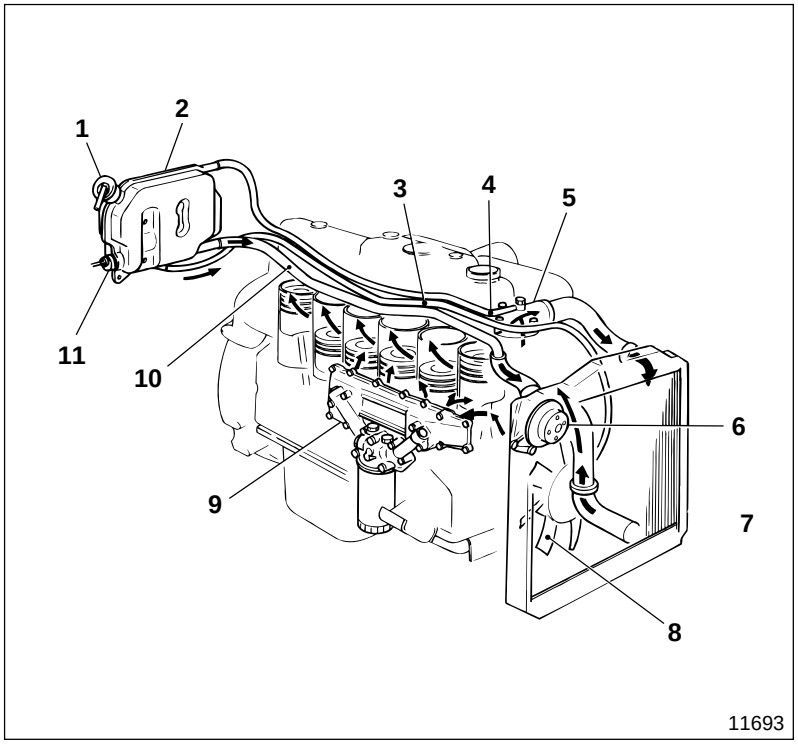
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item	Specifications
Kind of cooling system	Forced water circulation system
Water pump type	Belt-driven involute type
Thermostat type	Wax-pellet, bottom bypass type (with jiggling valve)
Automatic cooling fan coupling type	Continuous control type
Radiator type	Tube and corrugated fin type
Coolant capacity L {qts}	21 {22}

STRUCTURE AND OPERATION

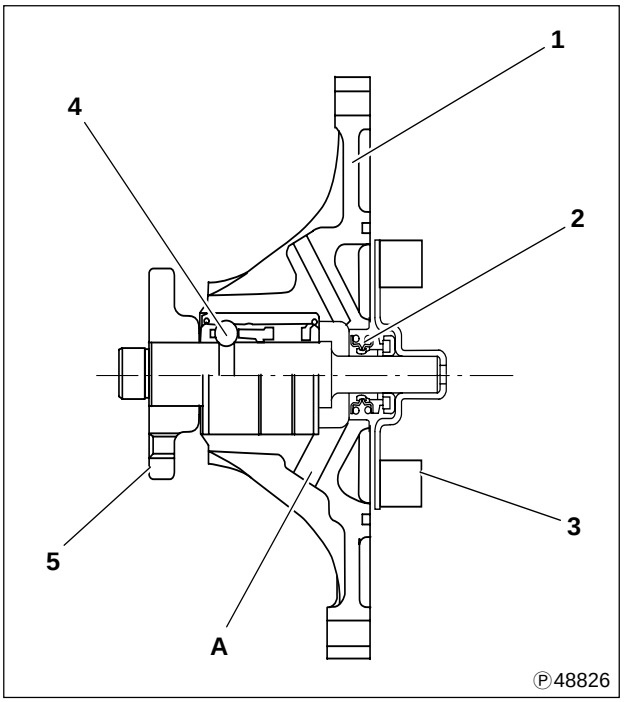
Cooling System (Flow of Coolant)



1 Pressure cap
2 Surge tank
3 Suction pipe
4 Air pipe
5 Thermostat
6 Water pump
7 Radiator
8 Cooling fan
9 Oil cooler
10 Water inlet pipe
11 Water level sensor

Surge tank **2** is installed at a higher position than radiator **7** and automatically adds coolant when the coolant level in the radiator drops.

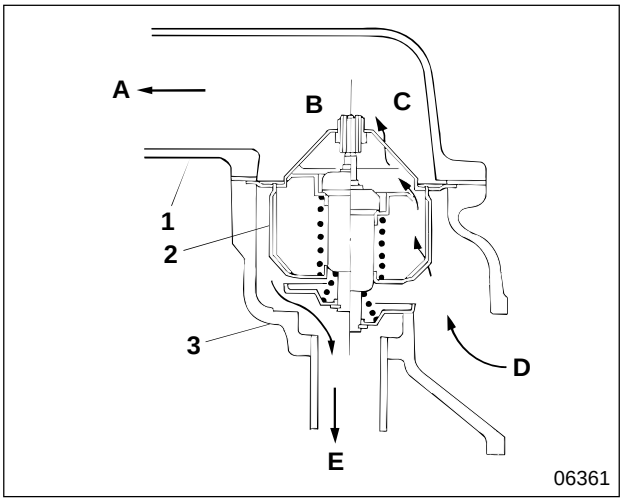
Water Pump



1 Case
2 Unit seal
3 Impeller
4 Ball bearing
5 Flange

A : Drain hole

Thermostat



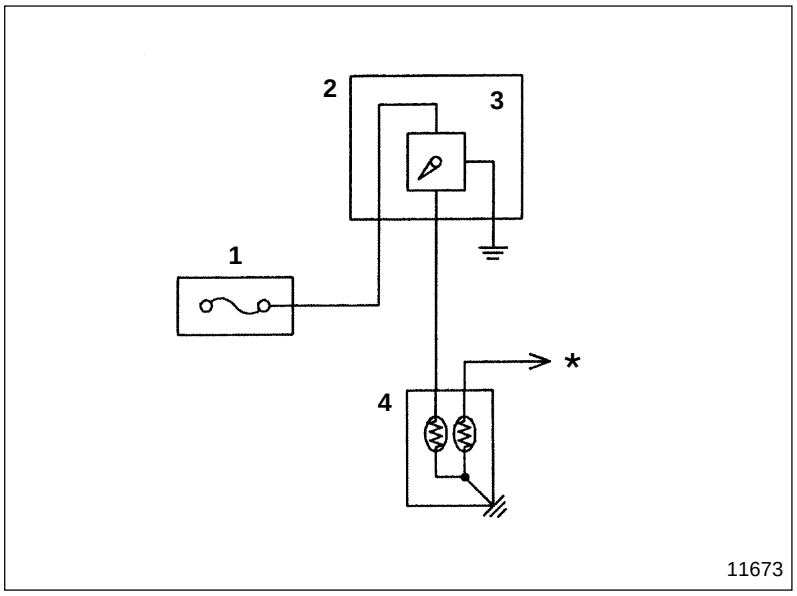
1 Thermostat cover
2 Thermostat
3 Thermostat case

A : To radiator
B : When low coolant temperature
C : When high coolant temperature
D : From cylinder head
E : To water pump

Thermostat **2** is a bottom bypass type that uses wax pellets as its regulating element. As the wax changes its form from solid to liquid according to changes in temperature, the volume of the wax changes. Therefore, the position of the valve, changed by the coolant temperature, regulates the flow of the coolant to the radiator and water pump (bypass side) and controls the coolant temperature.

Cooling System Electric Circuit

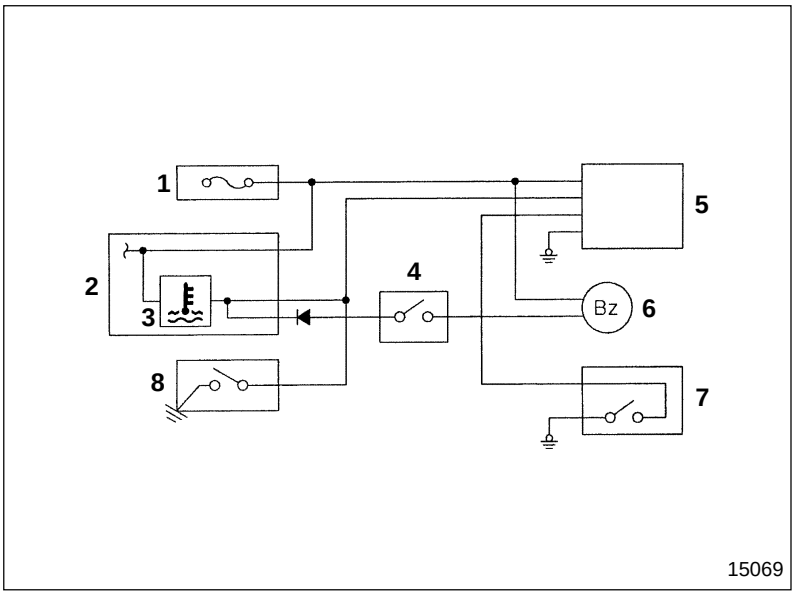
● Water temperature gauge circuit



1 Fuse box
2 Meter cluster
3 Water temperature gauge
4 Water temperature sensor

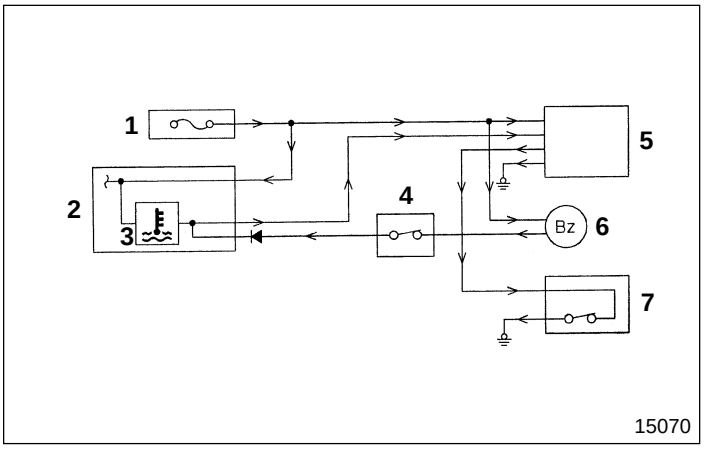
***** : To cold start switch

● Water level sensor and overheating circuit



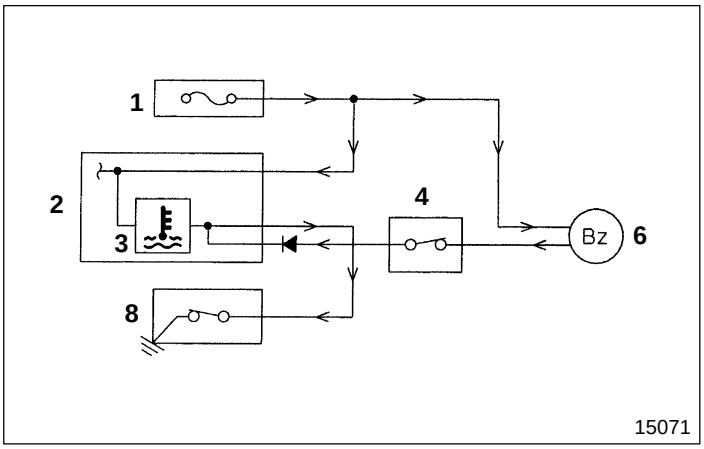
1 Fuse box
2 Meter cluster
3 Water level warning lamp
4 Parking brake switch
5 Water level control unit
6 Buzzer
(Buzzer does not work when the parking brake is engaged.)
7 Water level sensor
8 Overheating switch

When this circuit detects insufficient coolant or extremely high coolant temperature, it lights water level warning lamp **3** and sounds buzzer **6** to warn the driver of the abnormal conditions.



When water level sensor is activated

- **1**→**5**→**7**→Ground
- Water level control unit **5** detects insufficient coolant.
- **1** → **3** → **5** → Ground; **1** → **6** → **5** → Ground
- When the sensor is activated, water level warning lamp **3** lights up and buzzer **6** sounds.



When overheating switch is activated

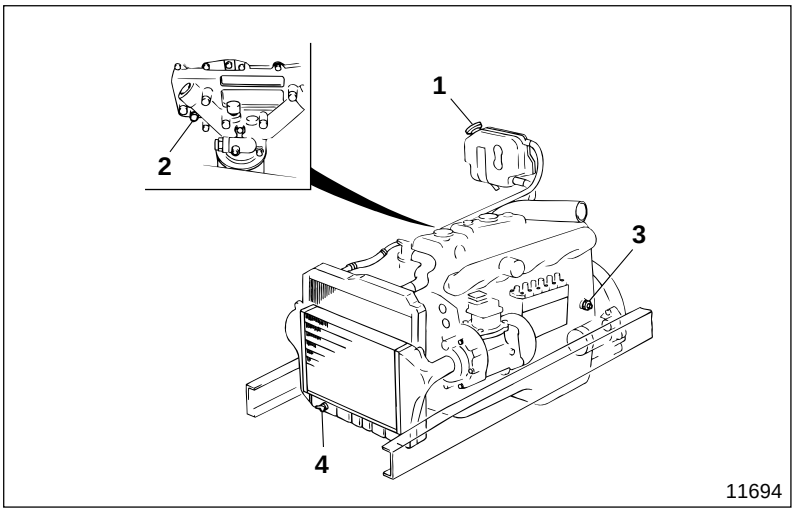
- **1** → **3** → **8** → Ground; **1** → **6** → **8** → Ground
- When the switch is activated, water level warning lamp **3** lights up and buzzer **6** sounds.

TROUBLESHOOTING

Possible causes \ Symptoms		Overheating (Low cooling effect)	Overcooling	Noise occurs	Coolant loss excessive	Remarks
V-belt	Loose or damaged	○		○		
	Tension excessive			○		
	Oily	○				
Water pump	Water pump installation faulty	○		○	○	
	Unit bearing faulty	○		○		
	Impeller faulty	○		○		
	Unit seal faulty	○			○	
	Unit bearing-to-flange and to-impeller fitting loose	○		○		
Thermostat	Case installation faulty	○			○	
	Valve opening temperature too high, valve remains closed	○				
	Valve opening temperature too low, valve remains open		○			
	Gasket faulty	○			○	
	Water level sensor leaking water	○			○	
Radiator	Space between core and fin clogged	○				
	Core cracked or soldered part separated	○			○	
Surge tank	Pressure cap airtightness poor	○				
	Water level sensor leaking water	○			○	
Cooling fan	Fan shroud installation faulty	○		○		
Automatic cooling fan coupling	Bearing faulty	○		○		
	Bimetal damaged	○				
	Bimetal contaminated with foreign particles	○	○			
	Silicon oil leaking	○		○		
Oil cooler	Oil cooler mounted incorrectly	○			○	Gr 12B
	Gasket faulty	○			○	Gr 12B
Cylinder head	Cylinder head mounted incorrectly	○			○	Gr 11B
	Gasket faulty	○			○	Gr 11B
Coolant quantity insufficient		○				
Coolant passage furred and clogged		○				
Water hose installation faulty		○			○	
Exterior temperature extremely cold			○			

M E M O

Replacing Coolant and Cleaning Cooling System



1 Pressure cap
2 Oil cooler drain plug
3 Crankcase drain plug
4 Radiator drain plug

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Oil cooler drain plug	34 to 39 {25 to 29, 3.5 to 4.0}	—
3	Crankcase drain plug	98 {12, 10}	—

Using the radiator for a long period of time without cleaning it will cause overheating because rust and scale deposits will accumulate inside the cooling system. Periodical cleaning is recommended.

● **Draining coolant**

First loosen pressure cap **1,** to lower the pressure in the cooling system, before draining coolant.

WARNING

- **You must make sure that the engine coolant is cold before draining it so as not to scald yourself.**
- **It is dangerous to open pressure cap 1, when the coolant temperature is high, without taking due care because the hot water would spray out. Be sure to cover the pressure cap with a cloth and loosen slowly to bleed the pressure before opening fully.**

● **Cleaning procedure**

- Keep the coolant temperature at approximately 90°C {194°F} so that the thermostat valve remains open and the coolant continues to circulate in the radiator.
- For the sake of convenience you can raise the coolant temperature quickly by covering the front of the radiator with corrugated cardboard or something similar.
- Set the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- In cases where a great amount of rust has accumulated it often happens that as a result of cleaning the radiator starts leaking. Conduct a thorough check for leakage after cleaning.
- Soft water to be used should have the following properties.

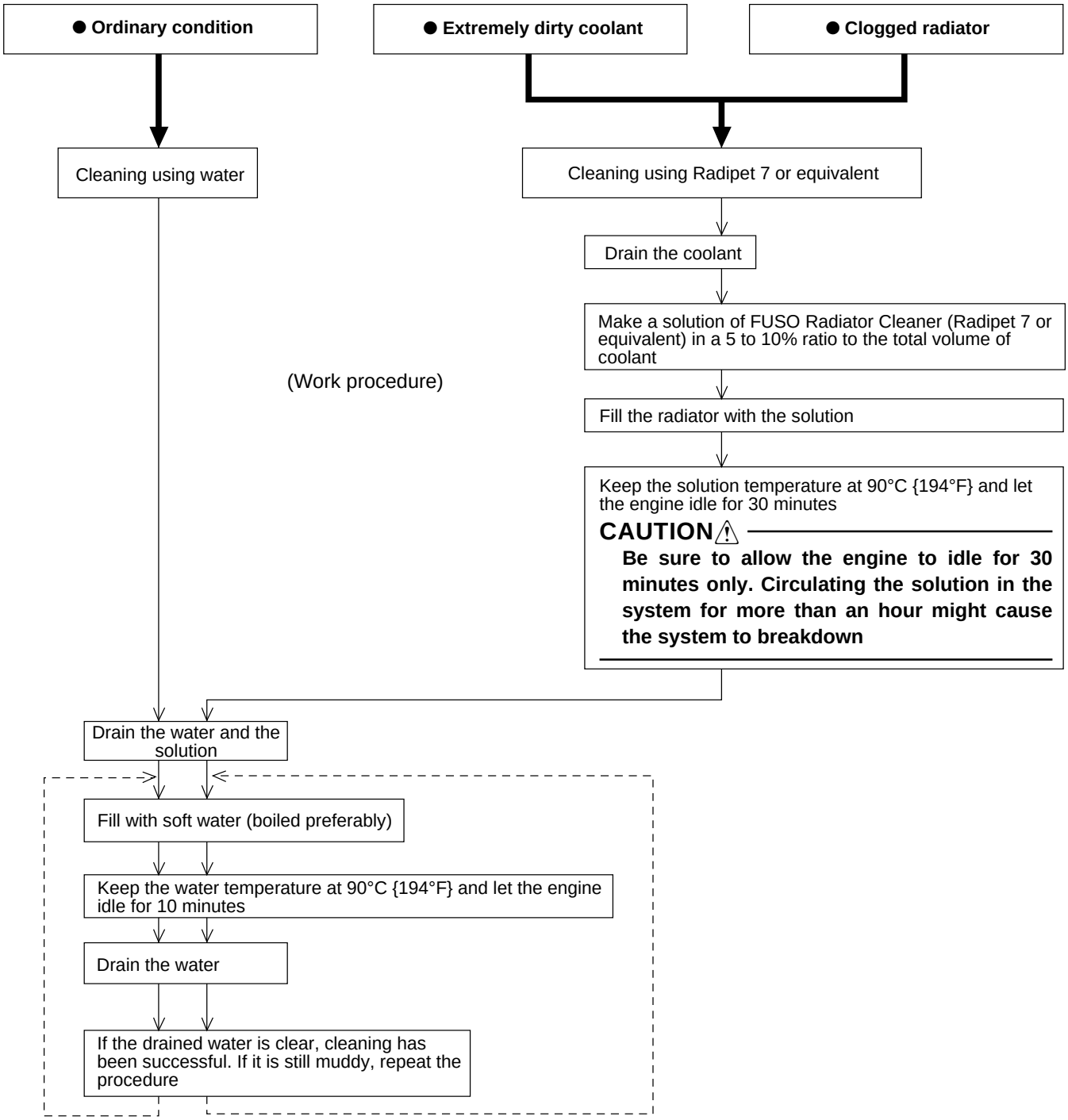
CAUTION

Do not use hard water as it causes scale and rust.

Required properties of soft water

Total hardness	300 ppm or less	Total dissolved solids	500 ppm or less
Sulfate SO_4^-	100 ppm or less	pH	6 to 8
Chloride Cl^-	100 ppm or less		

Method of cleaning the cooling system depends on its condition.



DANGER

If FUSO DIESEL LONG LIFE COOLANT solution gets in your eyes accidentally, you must immediately rinse your eyes with copious amounts of water, and be sure to consult a doctor.

WARNING

FUSO DIESEL LONG LIFE COOLANT is inflammable. Do not put it near naked lights.

NOTE

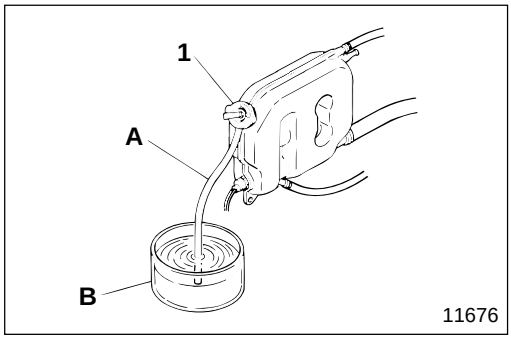
- **After cleaning with solution, fill with coolant as quickly as possible.**
- **To prevent freezing of the coolant and corrosion of the cooling system, use specified coolant solution of FUSO DIESEL LONG LIFE COOLANT. (See the Owner's Handbook for use of these materials.)**

ON-VEHICLE INSPECTION AND ADJUSTMENT

Air Bleeding of Cooling System

- Remove the pressure cap and keep the coolant temperature at 90°C {194°F} while letting the engine idle and bleed the air out completely. Keep the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- After completing adequate air bleeding of the cooling system, refill coolant sufficiently enough for the surge tank.

Gas Leakage Test

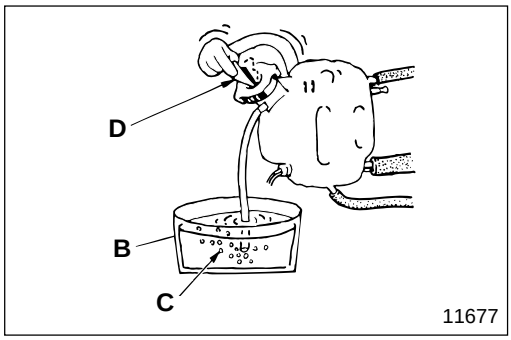


Air or exhaust gas in the coolant increases corrosion and rusting in the system. Therefore, carry out the following test:

- Remove surge tank pressure cap **1** and check if the coolant level comes up to the lip of the tank.
- Put the end of overflow pipe **A** into water tank **B**.

WARNING⚠

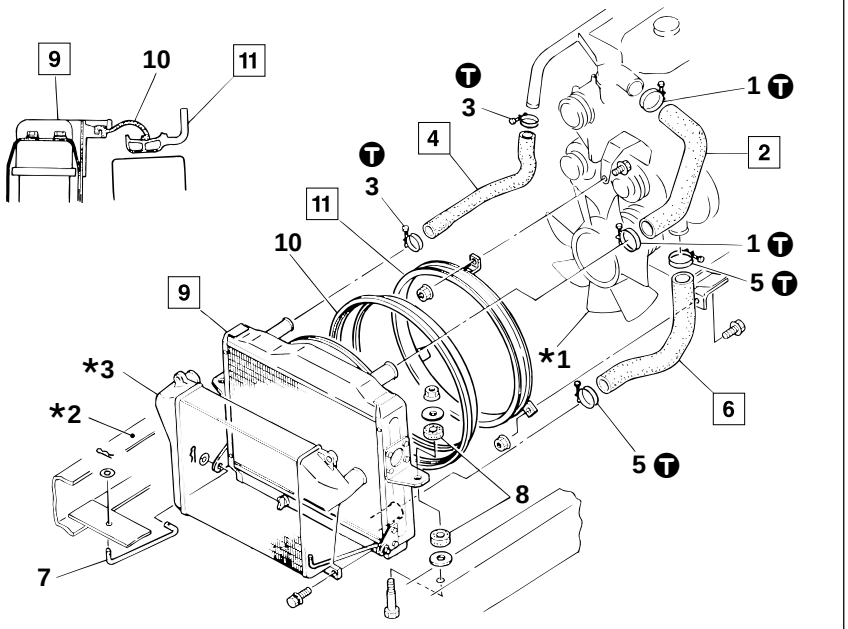
Be sure that the coolant temperature is low enough so that hot coolant does not spout out when you loosen pressure cap 1.



- Run the engine to bring the coolant temperature to approximately 90°C {194°F}.
- Lift lever **D** of pressure cap **1**.
- If air bubbles **C** continuously rise in water tank **B**, it is an indication that air or exhaust gas has gotten into the coolant.
- If it is air, it is possible that the cylinder head bolts, the water pump mounting bolts or the hose connections are loose, or that the hose is damaged.
- If it is exhaust gas, it is possible that the cylinder head gaskets are damaged, or that the cylinder head is cracked.

M E M O

RADIATOR AND FAN SHROUD



● **Removal sequence**

1 Hose clamp
2 Outlet hose
3 Hose clamp
4 Supply hose
5 Hose clamp
6 Inlet hose
7 Support rod
8 Rubber sheet
9 Radiator assembly
📖 P14B-14
10 Shroud seal
11 Fan shroud

***1** : Cooling fan
***2** : Frame
***3** : Intercooler Gr 15B

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
11, *1	Clearance between fan shroud and cooling fan tip	4.5 to 8.3 {0.18 to 0.33}	—	Adjust

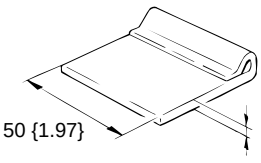
T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

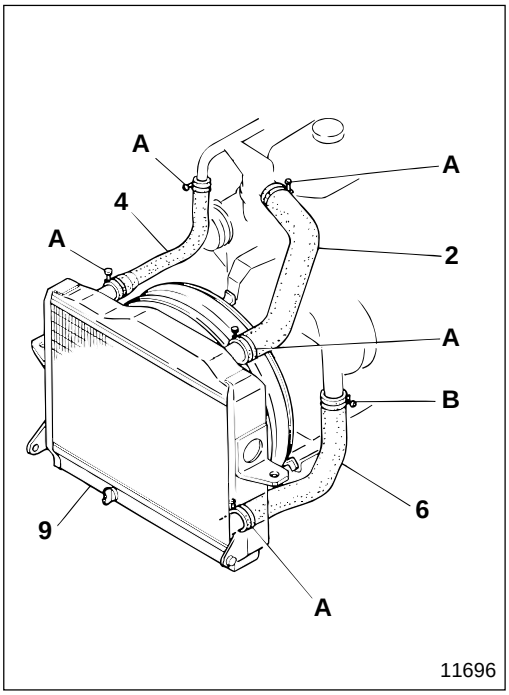
Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5	Hose clamp	3.9 {2.9, 0.4}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
11	Tip clearance spacer 	MC019470	Adjustment of clearance between fan shroud and cooling fan

◆ Service procedure

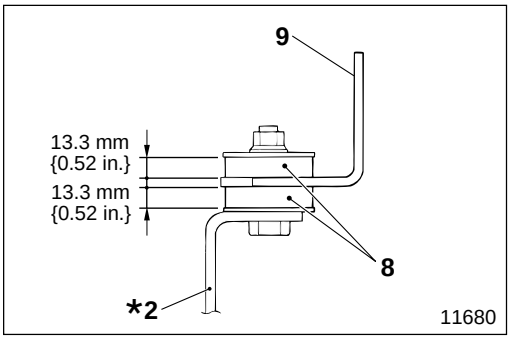


2 **4** **6** **Installation of hose**

The depth of hose installation is as follows.

A : 35 mm {1.38 in.}

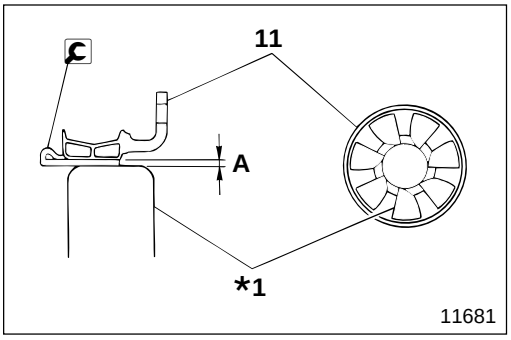
B : 40 mm {1.58 in.}



9 **Installation of radiator assembly**

Tighten nuts until the thickness of rubber sheet **8** conforms to the specified value.

***2** : Frame



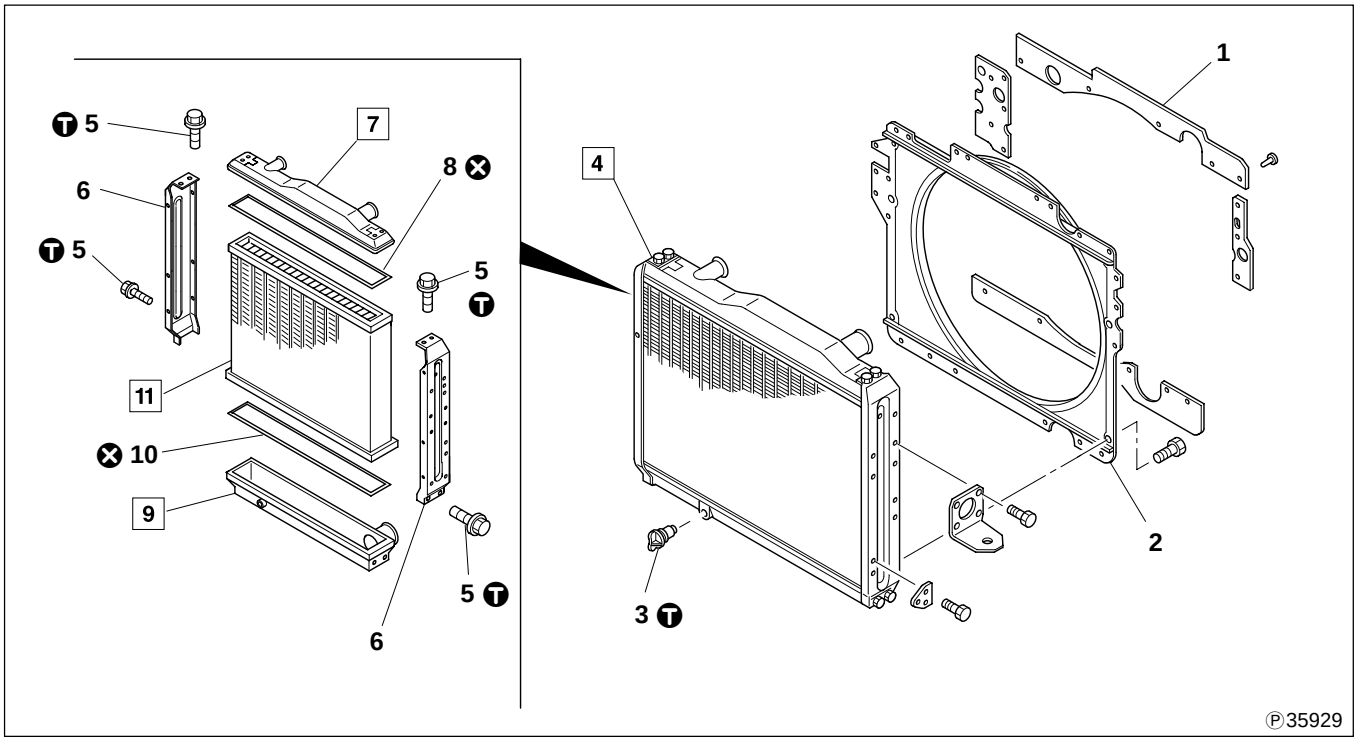
11 **Installation of fan shroud**

Adjust using 🔧 tip clearance spacer so that clearance **A** conforms to the standard value all around the periphery.

***1** : Cooling fan

RADIATOR AND FAN SHROUD

Radiator Assembly



● **Disassembly sequence**

1 Baffle plate
2 Radiator shroud
3 Drain cock
4 Radiator assembly
5 Bolt
6 Side member
7 Upper tank
8 O-ring
9 Lower tank
10 O-ring
11 Core

⊗ : Non-reusable part

CAUTION ⚠

- **Do not disassemble the radiator assembly 4 unless defects are evident.**
- **The upper tank 7 and lower tank 9 are made of plastic and could crack if subjected to undue shock. Handle them with care.**
- **Replace the core 11 if the clinching tabs that hold the upper tank 7 or lower tank 9 have two paint marks, showing that the tabs have been bent back twice. 🕮 P14B-15**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
4	Radiator assembly air leakage (with air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2})	0 cm^3 {0 cu. in.}	—	Rectify or replace

Tightening torque

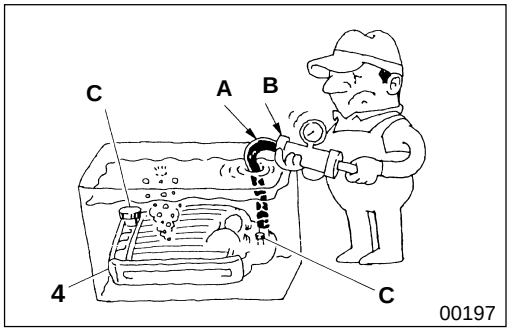
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain cock	2 {1.4, 0.2}	—
5	Bolt (side member mounting)	13 {9, 1.3}	—

Special tool

Location	Tool name and shape	Part No.	Application
7, 9	Lock & break tool	Obtain locally or use sublet repair	Upper tank, lower tank removal

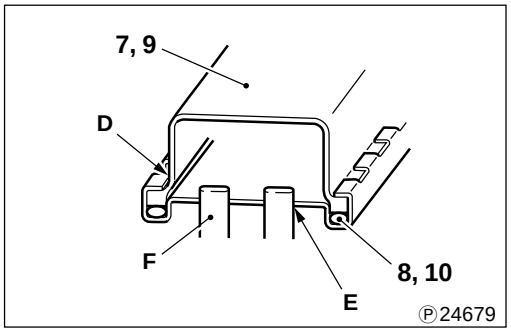
The part number given is Toyo Radiator's one.



Service procedure

4 Radiator inspection

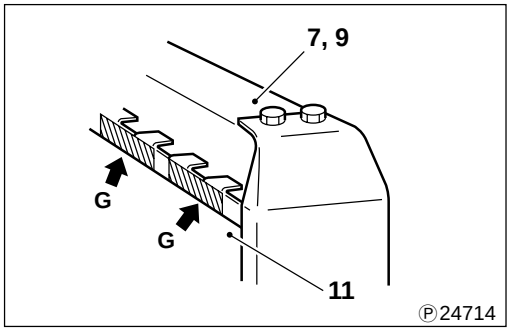
- Fit a hose **A**, radiator cap tester **B** and plug **C** onto the radiator upper tank **7**.
- Fit a plug **C** onto the radiator lower tank **9**, then immerse the radiator in a tank of water.
- Using the radiator cap tester **B**, apply the specified air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2}, and check for air leakage.
- If air leakage is apparent, repair or replace the radiator assembly **4**.



- Replace the following parts according to the leaking locations.

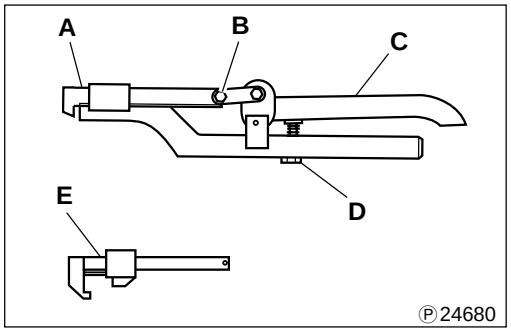
Leaking location	Part to replace
Tank root **D**	O-ring **8** or **10**
Tank **7**	Tank **7**, O-ring **8**
Tank **9**	Tank **9**, O-ring **10**
Tube fitted area **E**	Core **11**, O-ring **8**, **10**
	* Tube **F** (TIG welded), O-ring **8**, **10**
Tube **F**	Core **11**, O-ring **8**, **10**

* : When repaired



CAUTION ⚠

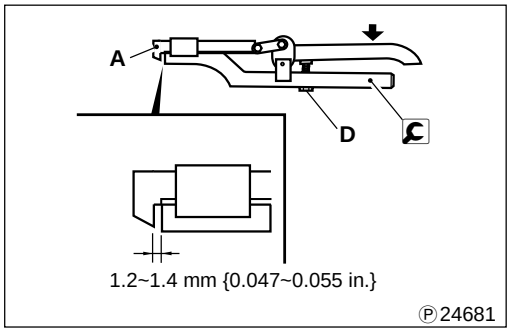
- **Replace the core 11 if its clinching tabs that hold the upper tank 7 or lower tank 9 have two paint marks G, evidence of the tabs having been bent back twice.**
- **The tabs are provided with one paint mark each time they are bent back. Count the paint marks on each of upper and lower tabs separately.**



7 **9** **Upper tank and lower tank**

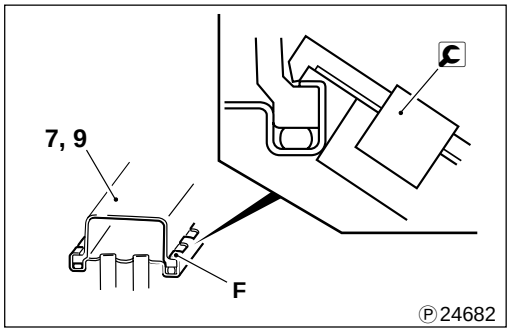
Remove and reinstall the tanks using the Lock and Break Tool.

- **A**: Attachment (for tank removal)
- **B**: Attachment locking bolt
- **C**: Slide handle
- **D**: Stopper/adjuster bolt
- **E**: Attachment (for tank installation)

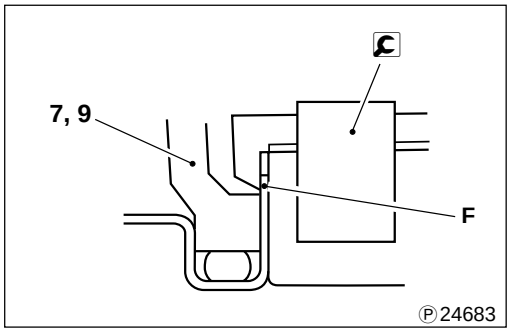


[Removal]

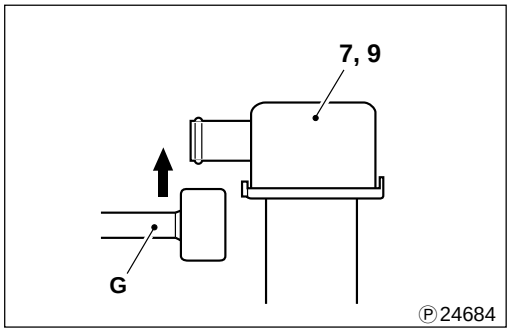
- Fit attachment **A** onto the end of the Lock and Break Tool, set it to the illustrated dimension and lock it in position with the stopper/adjuster bolt **D**.



- Using the Lock and Break Tool, bend up the tabs **F** of the core **11** that hold the tank **7**, **9**.



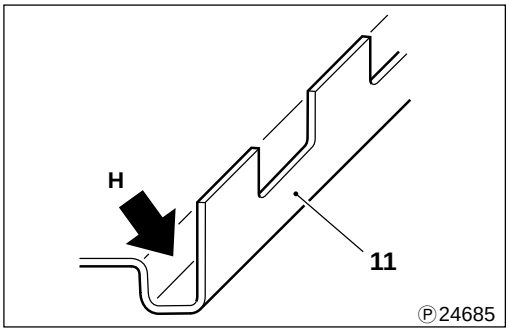
- Straighten the tabs **F** completely as shown by gripping the Lock and Break Tool.
- After straightening all the tabs **F**, grasp the inlet or outlet pipe and remove the tank **7**, **9**.



- If the tank **7**, **9** is difficult to remove, tap it with a rubber or plastic hammer **G**.

CAUTION ⚠

The tanks 7 and 9 are made of plastic and may crack if subjected to undue shock. Handle them with care.

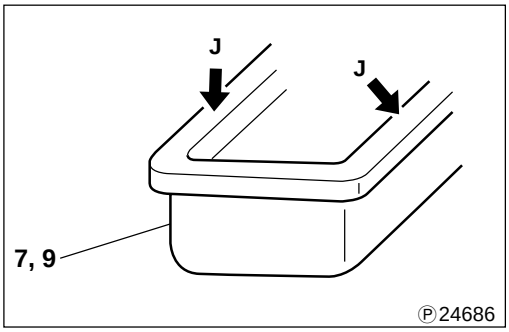


[Inspection]

- Check the tank mounting channels **H** of the core **11** for foreign matter.
- If foreign matter is stuck inside the mounting channels, rub it away with sandpaper (approx. #1000) or blow it out with compressed air.

CAUTION ⚠

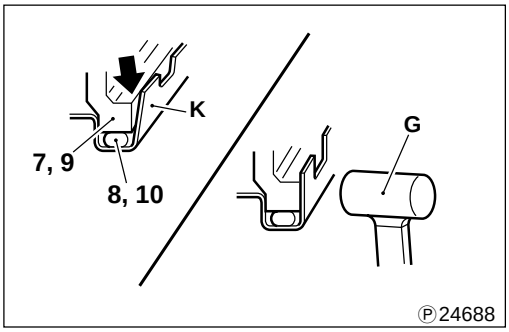
If any foreign matter (even a single hair) remains when the O-ring 8, 10 and tank 7, 9 are fitted, leakage can occur. Carefully inspect and clean each tank mounting channel H entirely.



- Clean the core contacting surface **J** of the tank **7**, **9** and inspect it for damage. Replace the tank if any defect is evident.

CAUTION ⚠

Perform works with bare hands to prevent foreign matter from sticking to the surface J.

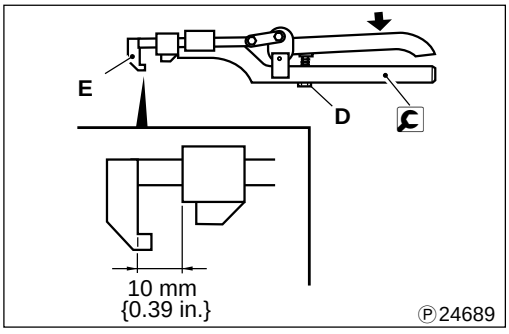


[Installation]

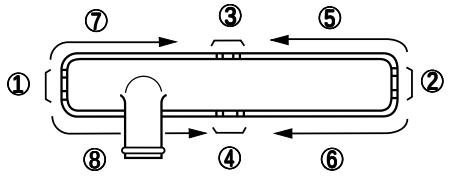
- Install the tank **7**, **9** in position. Check that the sub-plate **K** of the core is in close contact with the tank. If there is any space, tap the sub-plate lightly with a rubber or plastic hammer to eliminate space.

CAUTION ⚠

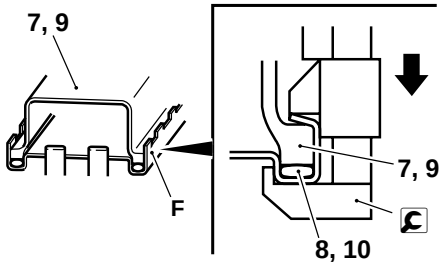
Handle the parts with bare hands to prevent foreign matter from sticking to the O-ring 8, 10 and tank 7, 9.



- Fit attachment **E** onto the end of the Lock and Break Tool, set it to the illustrated dimension and lock it in position with the stopper/adjuster bolt **D**.



Ⓟ24690



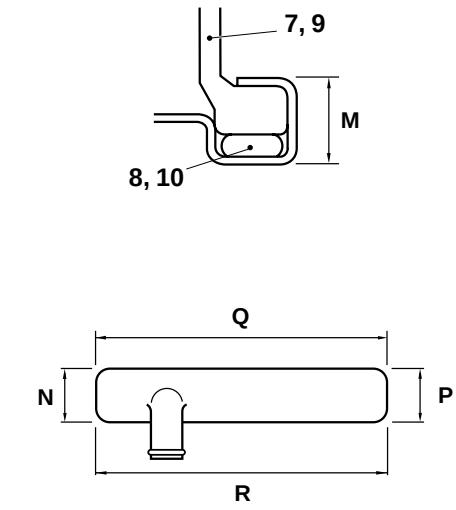
Ⓟ24691

- Clinch the tabs **F** of the core **11** to hold the tank **7**, **9** in the illustrated order.

  ①~④ :Two center tabs on each side
  ⑤~⑧ : Remaining tabs in illustrated sequence
  : Lock and Break Tool (with attachment **E**)

CAUTION ⚠

The sides ① and ② do not allow the Lock and Break Tool to be used for clinching. Clinch these sides using a pair of pliers with tape wrapped around its jaws.



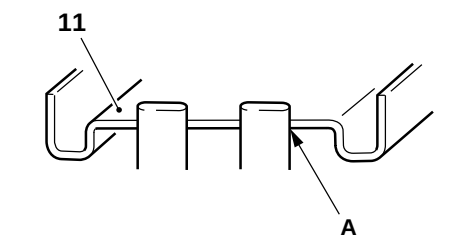
Ⓟ24692

- Check that the tabs have been clinched to the following dimensions.

  M : 14.65 ~ 15.05 mm {0.576 ~ 0.592 in.} (Sides **N** and **P**)
  10.05 ~ 10.45 mm {0.395 ~ 0.411 in.} (Sides **Q** and **R**)
- Check for leaks. 🕮 P14B-15
- Provide a paint mark to the sub-plate **K** of the core **11** to indicate that the tabs have been bent up and then down. 🕮 P14B-15

CAUTION ⚠

Provide one paint mark after each removal of the tank.



Ⓟ24693

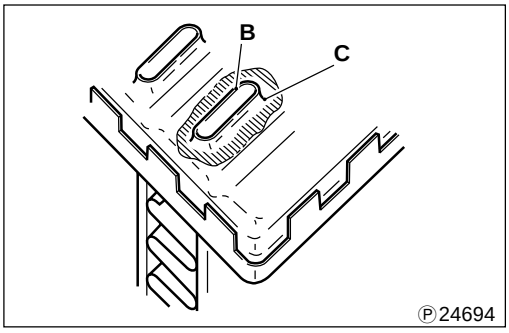
11 Core

If water leaks from the tube fitted area **A**, replace the core **11** or repair it by the following method.

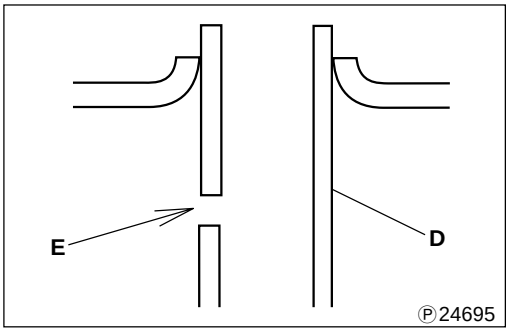
[Repair]

WARNING ⚠

- **Repair is carried out by tungsten inert gas arc (TIG) welding, which requires the skill of a trained welder.**
- **To avoid danger, dry the core 11 completely before welding.**



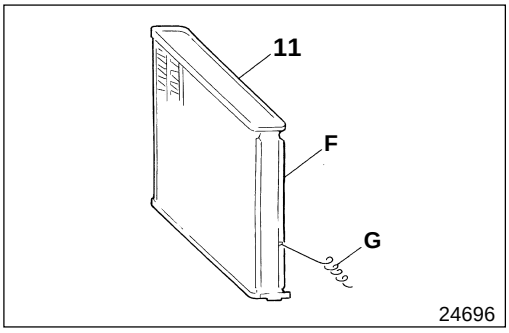
- Clean both edges **B** of the leaky tube and their surroundings **C** using a stainless steel wire brush. Scrub the surface until it glistens with exposed aluminum.



- Since both ends of the tube are covered with weld metal, make a small hole **E** in the tube **D** to allow air venting.

CAUTION ⚠

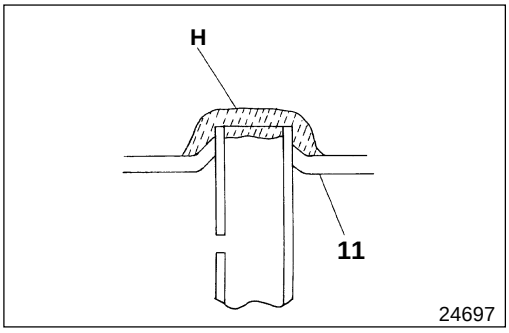
Absence of the small hole E causes escaping air to produce small pin holes in the weld.



- Connect a grounding wire **G** from the support **F** of the core **11** to an appropriate object.

CAUTION ⚠

Improper connection of the grounding wire G causes a short circuit during welding work and the core could be fused at the welded portion.

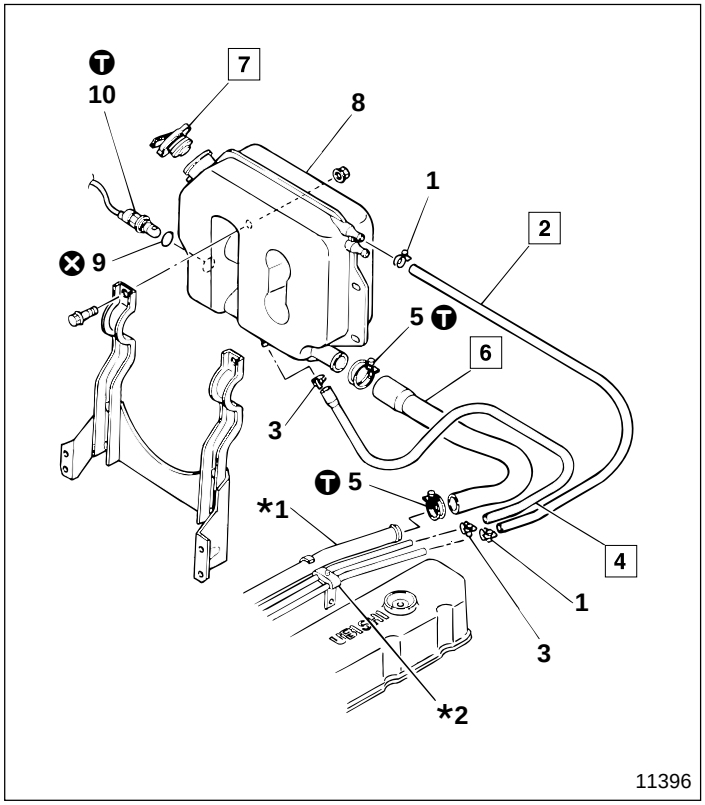


- Cover both ends of the tube with welding metal.
  H : Tungsten inert gas arc weld (TIG)
  Welding conditions:
  Welding rod: A4043 (approx. 2 mm {0.0079 in.} in diameter)
  Welding current: 80A AC
- After welding, check for the following defects. Rectify the weld or replace the core **11** if any of the defects is evident.
  - Undercut
  - Bead crack
  - Crack in base metal

CAUTION ⚠

Weld with sufficient care. Poor welding may cause leakage to reoccur.

SURGE TANK



11396

● **Disassembly sequence**

1 Clamp
2 Air hose
3 Clamp
4 Water hose
5 Clamp
6 Supply hose
7 Pressure cap
8 Surge tank
9 O-ring
10 Water level sensor Gr 54

***1** : Water inlet pipe
***2** : Air and water suction pipe
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

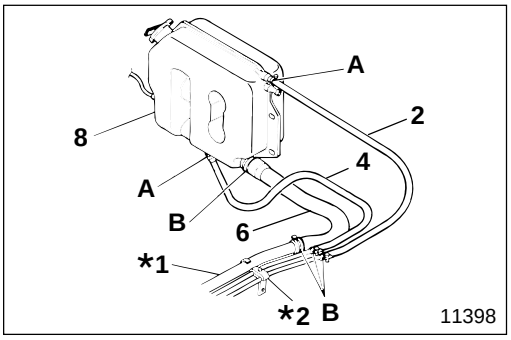
Location	Maintenance item	Standard value	Limit	Remedy
7	Pressure cap valve opening pressure	69±15 kPa {10±2.1 psi, 0.7±0.15 kgf/cm^2}	—	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Clamp	3.9 {2.9, 0.4}	—
10	Water level sensor	2.9 to 3.9 {2.2 to 2.9, 0.3 to 0.4}	—

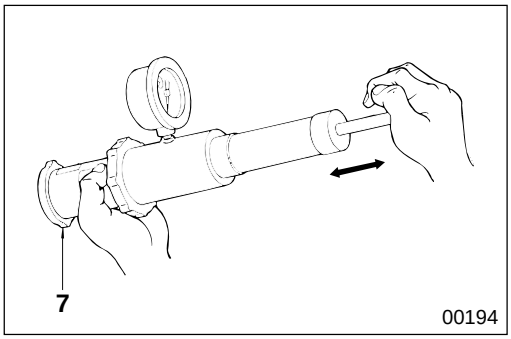
◆ Service procedure



2 4 6 Installation of hose

The depth of hose installation is as follows.

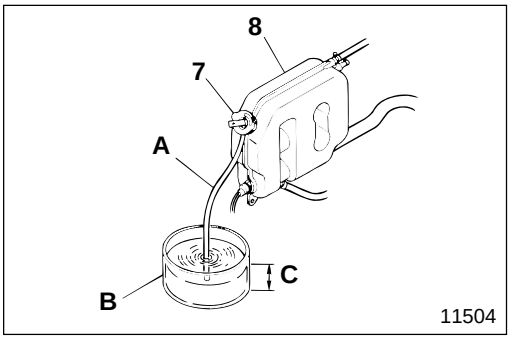
A : 15 mm {0.59 in.}
B : 30 mm {1.18 in.}



7 Inspection of pressure cap

(1) Pressure valve opening pressure

If the measured value deviates from the standard value, replace pressure cap **7**.



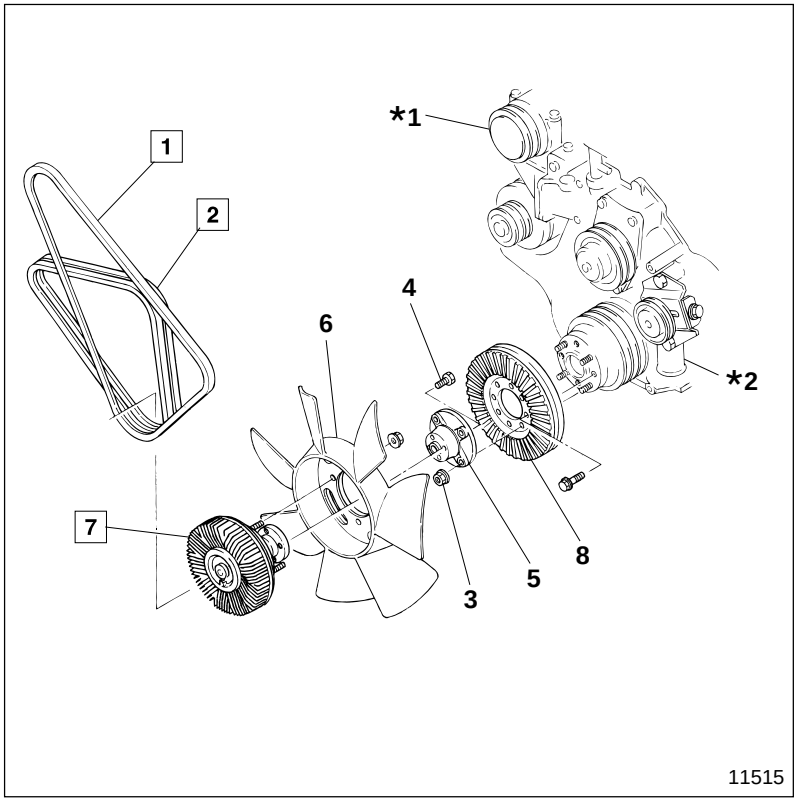
(2) Inspection of vent valve

- Check that the coolant level comes up to the lip of surge tank **8**. If the level is low, add coolant.
- Tighten pressure cap **7**.
- Put the end of overflow hose **A** into water tank **B**.
- Check coolant level **C** of water tank **B**.
- Run the engine at a high revolution to increase the coolant temperature.
- Stop the engine when some of the coolant in surge tank **8** has overflown into water tank **B**.
- Leave things for a while.
- Check the time it takes for the coolant temperature to return to the ambient temperature, and check whether coolant level **C** in the tank is the same as before running the engine.
- If the coolant level has not returned to that before running engine, replace pressure cap **7**.

NOTE

Do not remove pressure cap 7 before the coolant temperature decreases to the ambient temperature. If you do the coolant will not return to reservoir tank A because negative pressure in the radiator is lost.

COOLING FAN AND V-BELT



● **Removal sequence**

1 V-belt (Air-conditioner)
2 V-belt (Fan)
3 Nut
4 Bolt
5 Fan spacer
6 Cooling fan
7 Automatic cooling fan coupling
8 Torsional damper

***1** : Cooler compressor
***2** : Tension pulley

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION⚠

- **Be sure to replace automatic cooling fan coupling 7 as an assembly if it is faulty because it is a unit construction.**
- **Be sure to replace V-belts 2 as a set to maintain even tension between them.**

Service standards

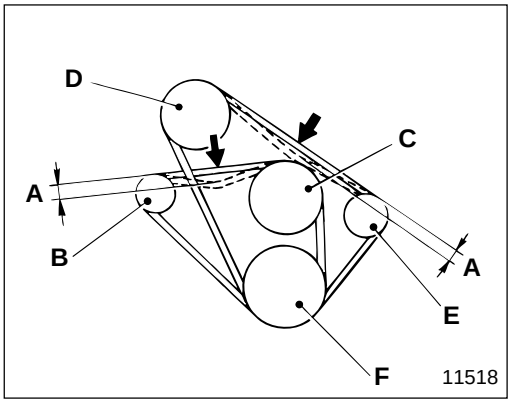
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	V-belt tension (Air-conditioner)	16 to 20 {0.63 to 0.79}	—	Adjust
2	V-belt tension (Fan)	12 to 16 {0.47 to 0.63}	—	Adjust

Special tools

Location	Tool name and shape	Part No.	Application
1, 2	Belt tension gauge 03612	MH062345	Measurement of tension of V-belt

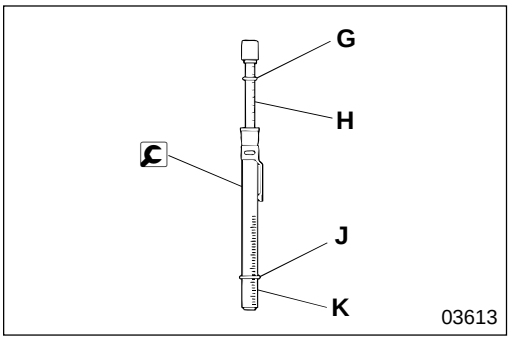
◆ Service procedure



1 **2** **V-belt**

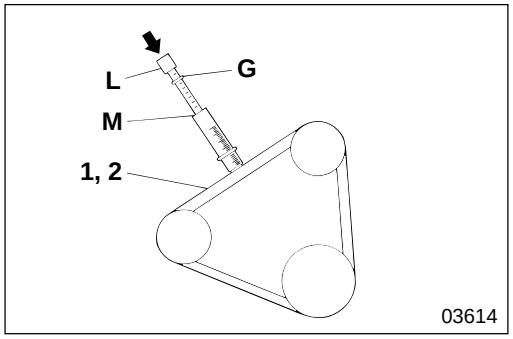
[Inspection]
Measure the extent of flex **A** when the center of V-belts **1**, **2** as illustrated is depressed with a force of approximately 98 N {72 lbf, 10 kgf}.

B : Alternator pulley
C : Water pump pulley
D : Cooler compressor pulley (Air-conditioner)
E : Tension pulley
F : Crankshaft pulley

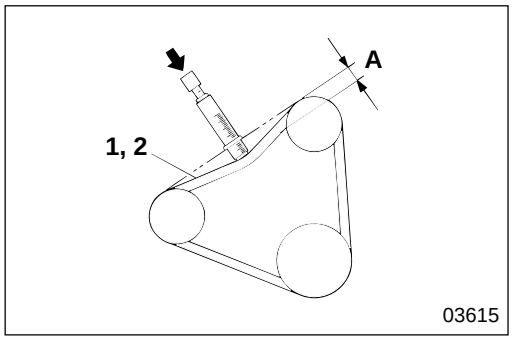


● **Use of special tool belt tension gauge**

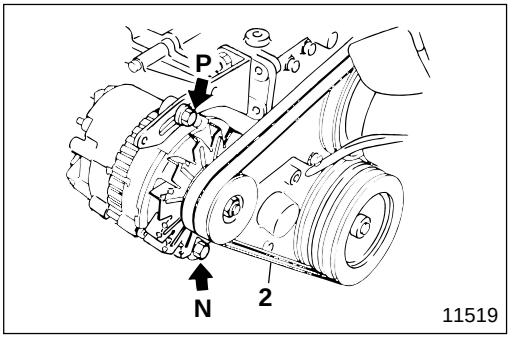
- Set upper O-ring **G** of belt tension gauge to 98 N {72 lbf, 10 kgf} (push load) on graduation **H**.
- Set lower O-ring **J** of belt tension gauge to graduation **K** (maximum flex of belt).



- Place belt tension gauge at the center of V-belts **1**, **2** perpendicularly as illustrated and push top **L** all the way down until upper O-ring **G** hits upper edge **M**.



- Measure the extent of flex **A** of V-belts **1**, **2** at this point, and if the measured value deviates from the standard value, adjust as follows.



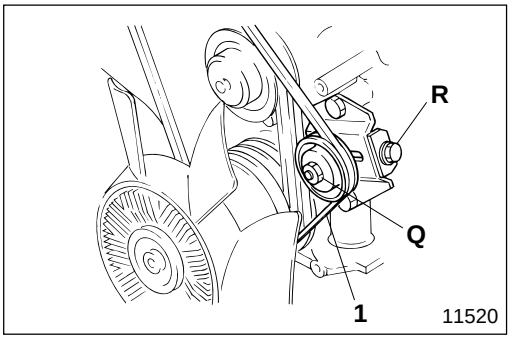
[Adjustment]

(1) Adjustment of V-belt tension for fan

- Loosen alternator mounting bolts **N** (two places), and adjust the tension of V-belts **2** using adjusting bolt **P**.
- After adjustment, tighten the bolts and nuts securely.

CAUTION

- **Bear in mind that excessive tension of V-belts 2 might damage the belts and bearings that engage with the V-belts.**
- **Be sure to replace V-belts 2 as a set to maintain even tension between them.**
- **Be careful not to let oil stick to V-belts 2, if oil gets onto the belts, it causes slipping, resulting in overheating and insufficient battery charging.**

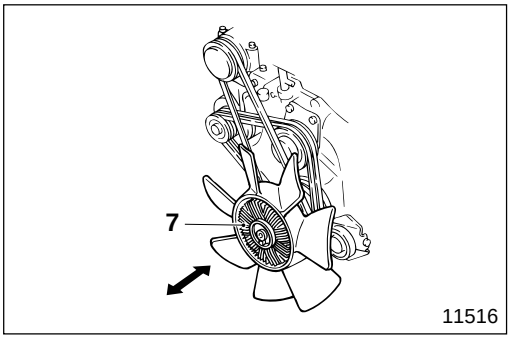


(2) Adjustment V-belt tension for air-conditioner

- Loosen tension pulley mounting nut **Q**, and adjust the tension of V-belt **1** using adjusting bolt **R**.
- After adjustment, tighten the bolt **R** and nut **Q** securely.

CAUTION

- **Bear in mind that excessive tension of V-belt 1 might damage the belt and bearings that engage with the V-belt.**
- **Be careful not to let oil stick to V-belt 1, if oil gets onto the belt, it causes slipping, resulting in poor performance of the air conditioner.**

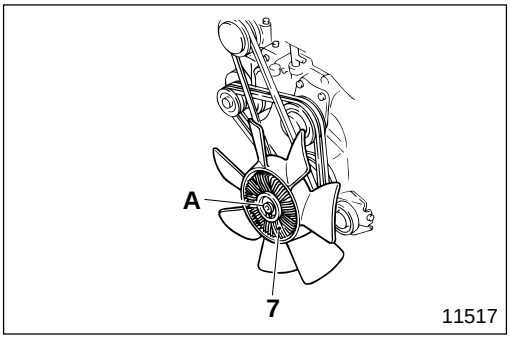


7 Automatic cooling fan coupling

[Inspection]

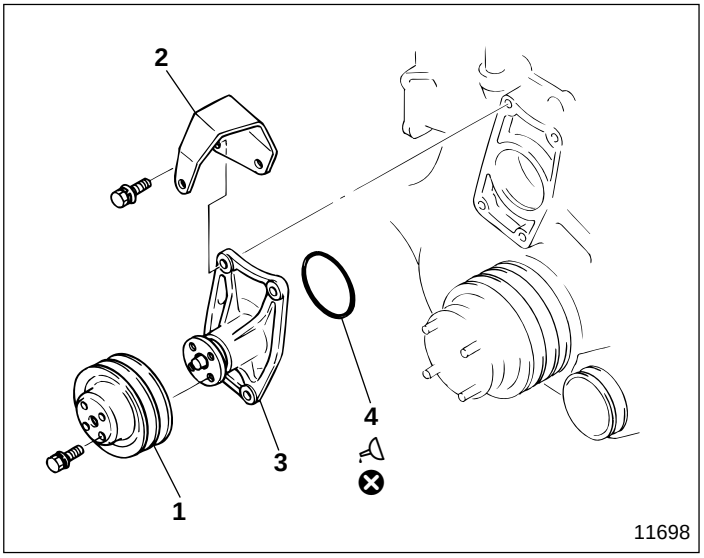
Carry out the following inspection of automatic cooling fan coupling **7** and if any fault is found, replace the unit.

- Check for any leakage of lubricating oil sealed in the coupling body.
- Rotate automatic cooling fan coupling **7** by hand, and check for any irregularity in rotation related to the coupling bearing or any abnormal noise.
- Check for any excessive play of automatic cooling fan coupling **7** in the axial direction when the engine is cool.



[Cleaning]

- If there are any foreign particles sticking to bimetal **A**, remove them by brushing lightly.



● **Removal sequence**

1 Water pump pulley
2 Upper shroud stay
3 Water pump
4 O-ring

⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

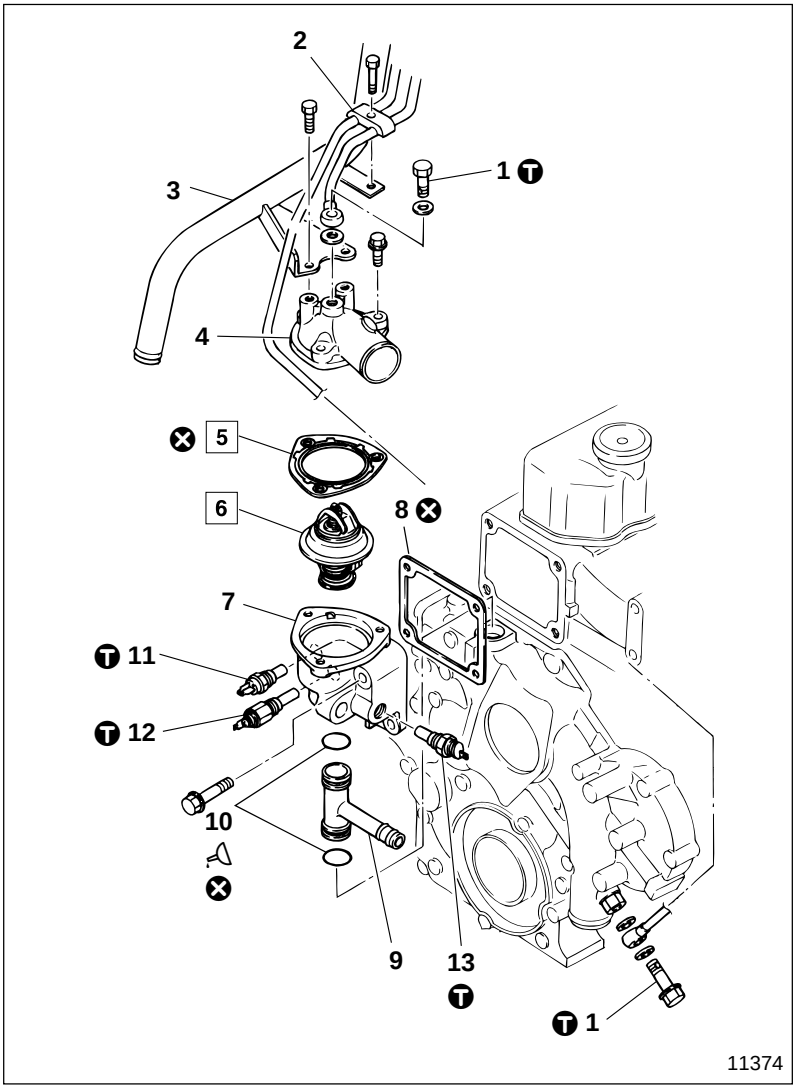
CAUTION

- **Be sure to replace water pump 3 as an assembly if it is faulty because it is a unit construction.**
- **Never apply engine oil to the O-ring because it will cause the O-ring to swell.**

Lubricant

Location	Points of application	Kinds	Quantity
4	Periphery of O-ring	Soapy water	As required

THERMOSTAT



● **Disassembly sequence**

1 Eye bolt
2 Air and water suction pipe
3 Water inlet pipe
4 Thermostat cover
5 Thermostat cover gasket
6 Thermostat
7 Thermostat case
8 Thermostat case gasket
9 Bypass pipe
10 O-ring
11 Water temperature sensor (Water temperature gauge and multi-purpose timing control unit) Gr 54
12 Overheating switch Gr 54
13 Water temperature sensor (Pre-stroke control type injection pump) Gr 54

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

Never apply engine oil to O-ring 10 because it will cause the O-ring to swell.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
6	Thermostat	Valve opening temperature	82±2°C {180±3.6°F}	—	Replace
		Extent of valve lift (95°C {203°F})	10 {0.39} or more	—	Replace

T Tightening torque

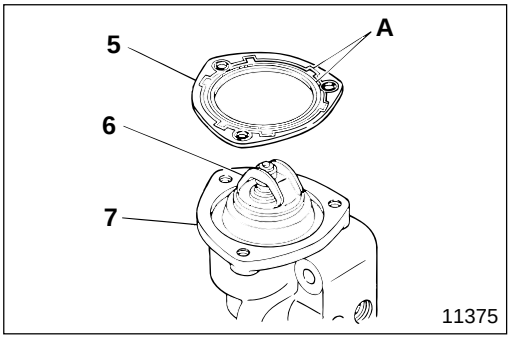
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt	25 {19, 2.6}	—
11	Water temperature sensor	34±6.9 {25±5.1, 3.5±0.7}	—
12	Overheating switch	27 to 41 {20 to 30, 2.8 to 4.2}	—
13	Water temperature sensor	34±6.9 {25±5.1, 3.5±0.7}	—

Lubricant

Location	Points of application	Kinds	Quantity
10	O-ring	Soapy water	As required

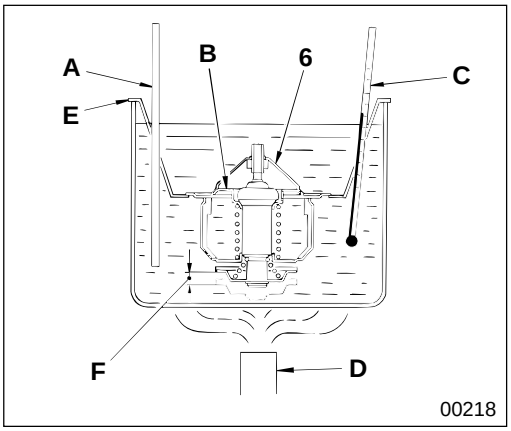
◆ Service procedure



5 **Mounting of thermostat cover gasket**

Mount thermostat cover gasket **5** on thermostat case **7** in the direction as illustrated.

A : Sealant application surface



6 **Thermostat**

[Inspection]

Stir the water using stick **A** to maintain an even water temperature in the container, then carry out the following tests. If the measured value deviates from the standard value, replace thermostat **6**.

(1) Valve opening temperature

- Hold thermostat **6** with wire **E** so as not to get the thermostat too close to heat **D**.
- Heat the water gradually to raise the temperature to the valve opening temperature.
- Maintain this temperature for five minutes and make sure that valve **B** has opened.
- Make sure that valve **B** has closed when the water temperature has dropped to 65°C {149°F}.

  C : Water temperature gauge

(2) Extent of valve lift

Measure valve lift **F**, while maintaining the water temperature a little higher than the valve opening temperature, with valve **B** fully open for five minutes.

MITSUBISHI
FUSO

Group 15A
Intake and Exhaust

< 4M5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-15A

INDEX

SPECIFICATIONS / STRUCTURE AND OPERATION 15A- 2
1. Air Cleaner 15A- 2
2. Turbocharger Assembly 15A- 3
3. Muffler 15A- 4

TROUBLESHOOTING 15A- 5

ON-VEHICLE INSPECTION AND ADJUSTMENT
Measurement of Turbocharger Boost Pressure 15A- 6

AIR DUCT AND AIR CLEANER 15A- 8

TURBOCHARGER 15A-12

INTERCOOLER 15A-17

INTAKE MANIFOLD 15A-18

EXHAUST MANIFOLD 15A-20

EXHAUST PIPE AND MUFFLER 15A-22

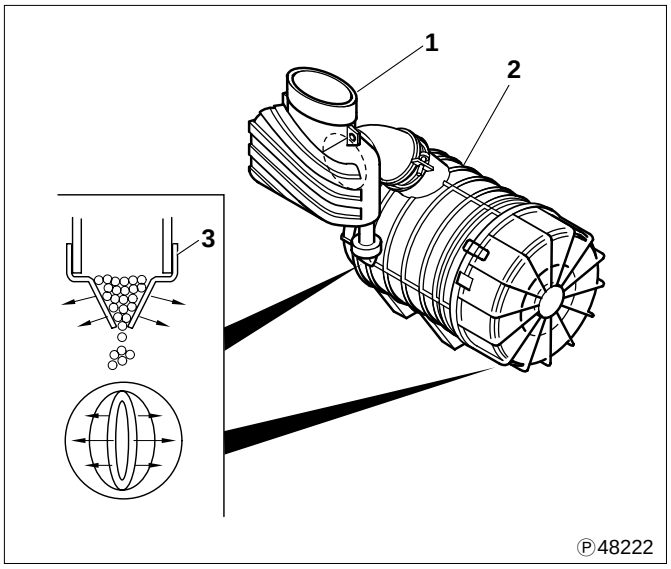
SPECIFICATIONS / STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Air cleaner element		Cyclone paper filter type
Dust indicator type		Mechanical
Turbocharger	Model	TD05
	Manufacturer	Mitusubishi Heavy Industries
Intercooler type		Tube and corrugated fin (air cooled)

STRUCTURE AND OPERATION

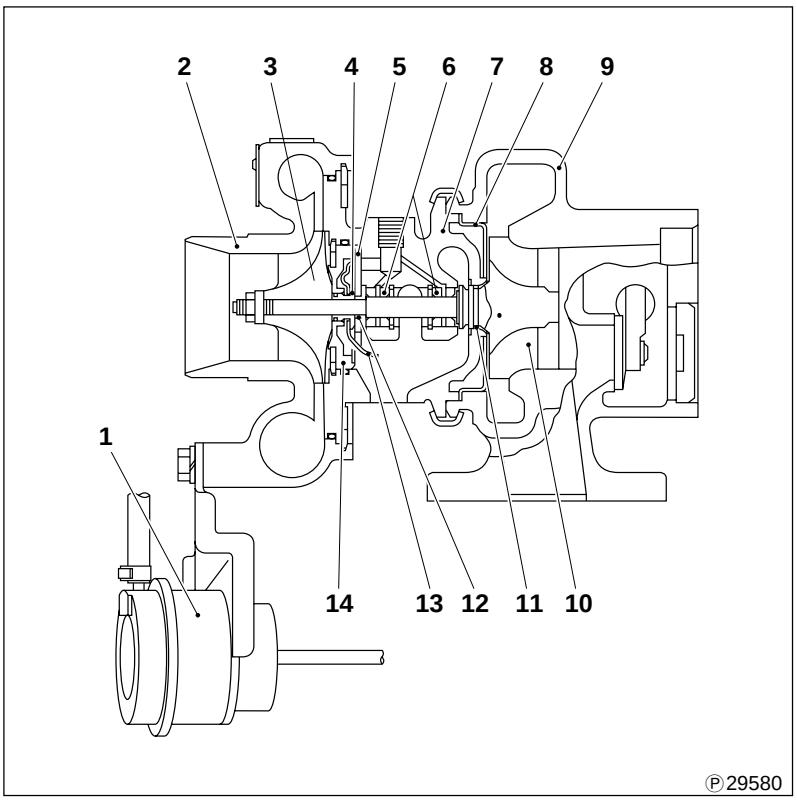
1. Air Cleaner



1 Air lower duct
2 Air cleaner assembly
3 Vacuator valve

- Air cleaner assembly **2** uses a single element.
- Vacuator valves **3** are fitted with air lower duct **1** and air cleaner assembly **2**.
- Vacuator valves **3** automatically vent dust and dirt by the repercussive force of the rubber of the valve that overcomes the inner negative pressure when the engine revolution falls below the specified revolution.

2. Turbocharger Assembly

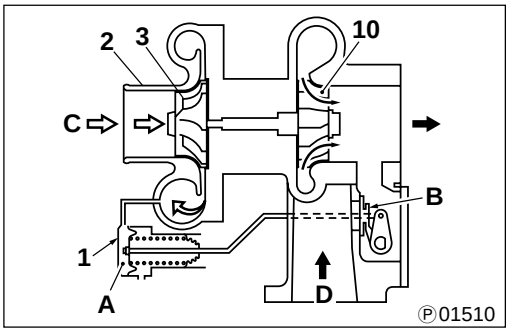


1 Actuator
2 Compressor cover
3 Compressor wheel
4 Thrust sleeve
5 Thrust bearing
6 Bearing
7 Bearing housing
8 Turbine back plate
9 Turbine housing
10 Shaft and turbine wheel
11 Piston ring
12 Thrust ring
13 Oil deflector
14 Insert

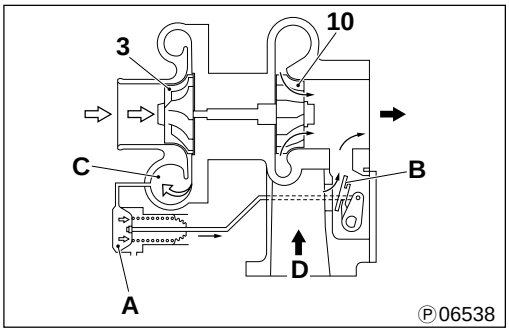
3 to 14: Cartridge assembly

● **Waste gate mechanism**

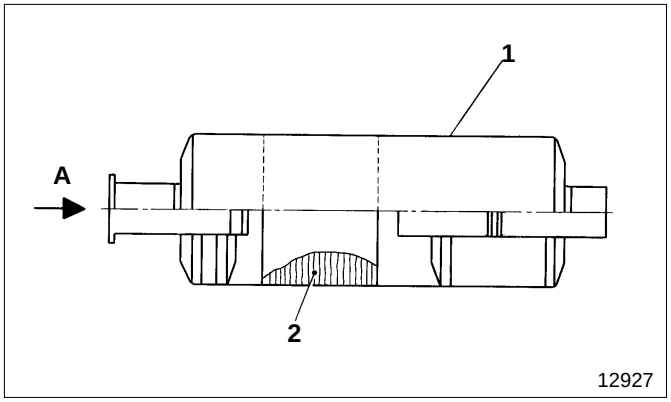
- The waste gate mechanism has actuator assembly **1** to let extra exhaust gas escape. By so doing, the boost pressure is properly controlled to prevent the turbine wheel from overrunning and prevent an excessive pressure in the intake manifold.
- The boost pressure is led from compressor cover **2** through a rubber hose to chamber **A** of actuator assembly **1**. When the boost pressure **C** that acts on chamber **A** is below the setting, the actuator assembly does not operate, and the waste gate valve remains closed, and exhaust gas **D** is blown against turbine wheel **10**.



- When the boost pressure that acts on chamber **A** exceeds the setting, the waste gate valve is opened. As a result, the amout of exhaust gas blown against turbine wheel **10** decreases, the rotating speed of compressor wheel **3** also decreases, and the boost pressure falls.



3. Muffler



1 Muffler
2 Catalytic converter

A : Exhaust gas intake

Converter **2** is built into muffler **1** to decrease the amount of particulate matter (PM) in the exhaust gas.

Possible causes \ Symptoms			Engine hard to start	Black exhaust gas	White exhaust gas	Insufficient engine output	Excessive oil consumption	Strange sound or vibration in intake and exhaust system	Remarks
Clogged air cleaner element			○	○		○			
Deformed front pipe, muffler, tail pipe								○	
Improperly mounted front pipe, muffler, tail pipe								○	
Incorrect valve clearance				○					Gr 11A
Defective head gasket				○					Gr 11A
Worn valve and valve seat and deposited carbon				○					Gr 11A
Sagging valve spring				○					Gr 11A
Worn or damaged piston ring					○		○		Gr 11A
Worn or damaged piston ring groove of piston					○		○		Gr 11A
Malfunctioning cooling equipment				○		○			Gr 14A
Excessive engine oil					○				Gr 12A
Seizure of major moving parts				○					Gr 11A
Turbo-charger	Cartridge assembly	Defective bearing		○		○		○	
		Carbon deposited on shaft and turbine wheel		○		○			
		Shaft and turbine wheel interfering with turbine back plate		○		○			
		Shaft and turbine wheel interfering with turbine housing		○		○			
		Bent shaft and turbine wheel		○		○		○	
		Damaged shaft and turbine wheel		○		○		○	
		Compressor wheel interfering with compressor housing		○		○			
		Thrust sleeve and thrust bearing seizure		○		○		○	
		Damaged compressor wheel		○		○		○	
		Oil leaks due to worn piston ring and insert			○		○		
		Improperly mounted piston ring					○		
		Unsmooth sliding of internal parts due to clogged lubrication oil pipe and eyebolt		○		○			
		Damaged oil seals due to clogged oil return pipe			○		○		
	Improperly mounted compressor housing			○		○	○	○	
	Improperly mounted turbine housing					○		○	
Intercooler	Foreign substances deposited on intercooler front core					○			

ON-VEHICLE INSPECTION AND ADJUSTMENT

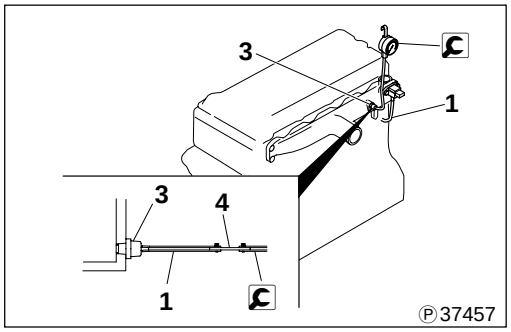
Measurement of Turbocharger Boost Pressure

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Boost pressure (at ambient temperature of 20°C {68°F} and atmospheric pressure of 100 kPa {29.9 in.Hg, 760 mmHg})	–	34.7 kPa {10.2 in.Hg, 260 mmHg}/ 3750 rpm 136 kPa {10.2+29.9 in.Hg, 260+760 mmHg} when measured by MUT	Inspect/ adjust

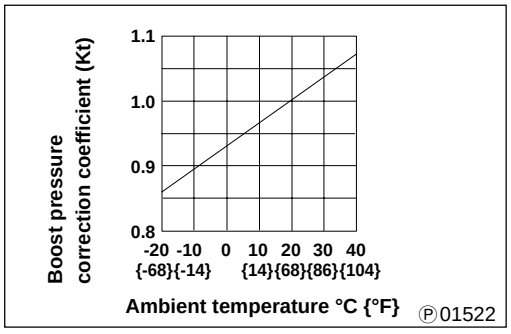
Special tool

Location	Tool name and shape	Part No.	Application
—	Boost pressure gauge Ⓟ01524	MH061366	Measurement of boost pressure



Ⓟ37457

- Before measuring the boost pressure, clean or replace the air cleaner element.
- Disconnect the vacuum hose **1** at the boost pressure sensor **2** side.
- Connect the pipe **4** (MH062049 [component part of MH062047]) between the vacuum hose **1** fitted to the gas filter assembly **3** and the Boost Pressure Gauge.
- Warm up the engine, then measure the boost pressure at the engine's maximum idling speed. At the same time, measure the engine speed and ambient temperature.

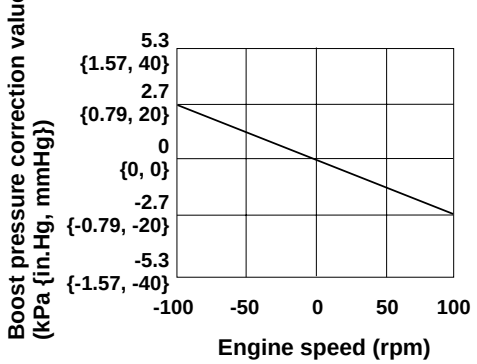


Ⓟ01522

- Correct the measurement to determine the boost pressure under standard conditions. (The boost pressure varies in accordance with the ambient temperature and engine speed.)

  [Correction for ambient temperature]

  From the graph, determine the boost pressure correction coefficient Kt for the ambient temperature.



(Difference between the median of the no-load maximum engine speed and the actual engine speed used for boost pressure measurement)

Ⓟ06165

[Correction for engine speed]

From the engine speed during boost pressure measurement, subtract the median of the maximum idling speed. From the result, determine the boost pressure correction value (**Pa**) in accordance with the graph.

Median**:** 3,750 rpm

[Calculation of corrected boost pressure]

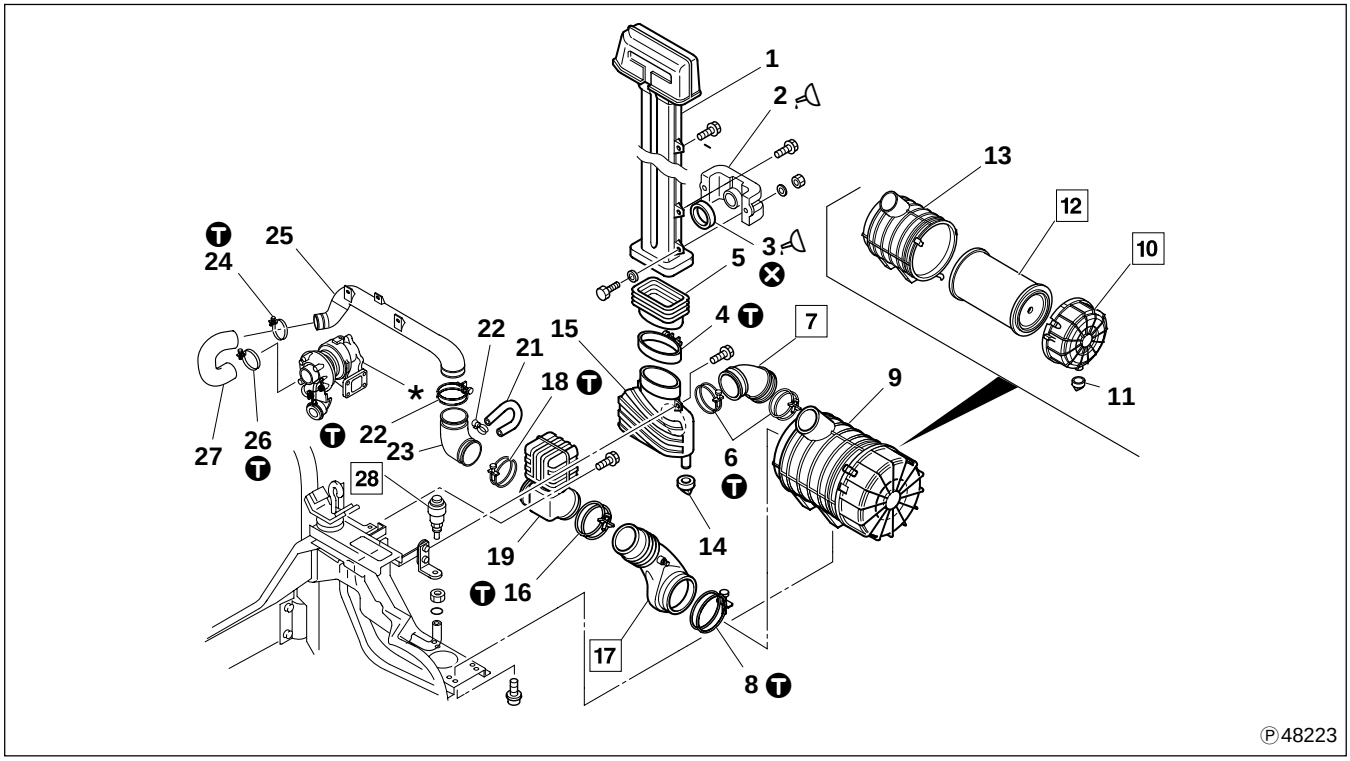
If the measured boost pressure is **P**, the corrected boost pressure **Pb** is determined as follows**:**

Pb = KtP + Pa

Pb : Corrected boost pressure
P : Measured boost pressure
Kt : Boost pressure correction coefficient for ambient temperature
Pa : Boost pressure correction value

If **Pb** is out of specification, the turbocharger must be inspected and adjusted.

AIR DUCT AND AIR CLEANER



● **Disassembly sequence**

1 Air upper duct
2 Resonator
3 Grommet
4 Clamp
5 Rubber boot
6 Clamp
7 Air intake hose
8 Clamp
9 Air cleaner assembly
10 Cover
11 Vacuator valve
12 Element
13 Body
14 Vacuator valve
15 Air lower duct
16 Clamp
17 Air duct
18 Clamp
19 Air duct
20 Clamp
21 Air suction hose
22 Clamp
23 Air intake hose
24 Clamp
25 Air duct
26 Clamp
27 Air hose
28 Dust indicator

*: Turbocharger 📖 P15A-12
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Do not remove evacuator valve 11, 14 unless it is faulty.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
28	Vacuum pressure at which dust indicator operates	7.5±0.6 kPa {2.20±0.17 in.Hg, 56±4.3 mmHg}	—	Replace

Ⓣ Tightening torque

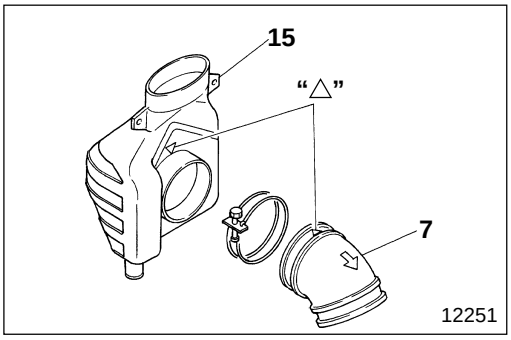
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4, 6, 8, 16, 18, 20, 22, 24, 26	Clamp	3.0 to 3.4 {2.2 to 2.5, 0.31 to 0.35}	—

Sealant

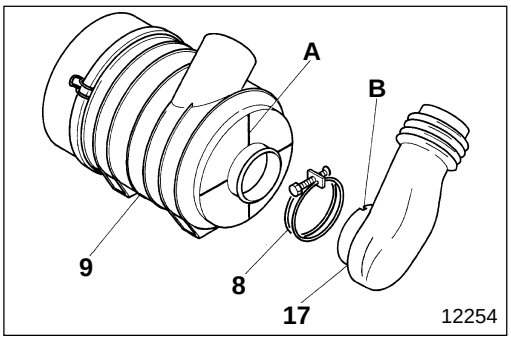
Location	Points of application	Kinds	Quantity
2	Apply sealant to the connecting part of grommet to the resonator	ThreeBond 1207C	As required
3	Apply sealant to grommet groove area	ThreeBond 1207C	As required

◆ Service procedure



7 **Installation of air intake hose**

△: Alignment mark

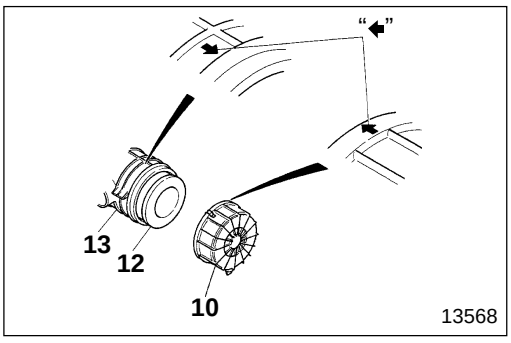


17 **Installation of air dust**

Install air duct **13** in the direction as illustrated to the air cleaner assembly **9**.

A : Protrusion

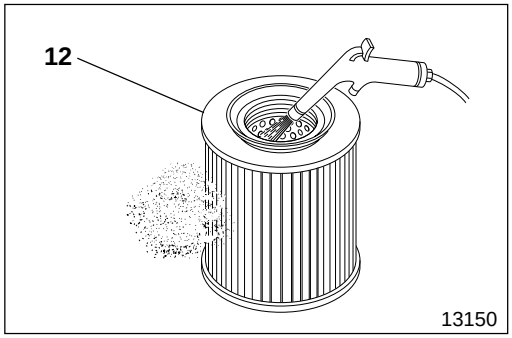
B : Indent



10 **Installation of cover**

➧ **:** Alignment mark

AIR DUCT AND AIR CLEANER



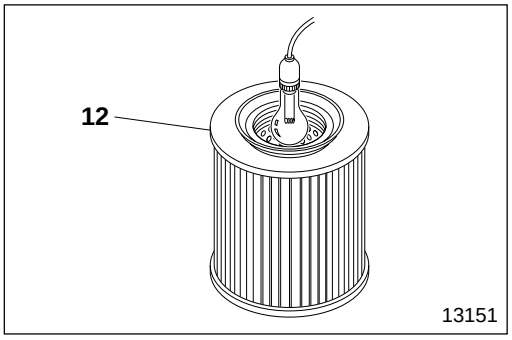
12 **Element**

[Cleaning]

- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **12** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of air cleaner element **12** evenly.

CAUTION

- **Do not tap or hit air cleaner element 12 to remove dust.**
- **Do not blow compressed air through air cleaner element 12 from the outside.**

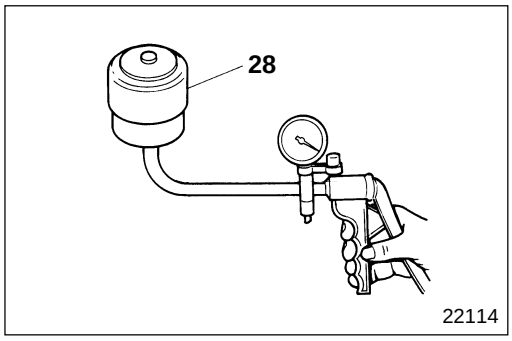


[Inspection]

- Illuminate the inside of air cleaner element **12**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of air cleaner element **12** is damaged, replace the air cleaner element.

NOTE

If the dust on air cleaner element 12 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.

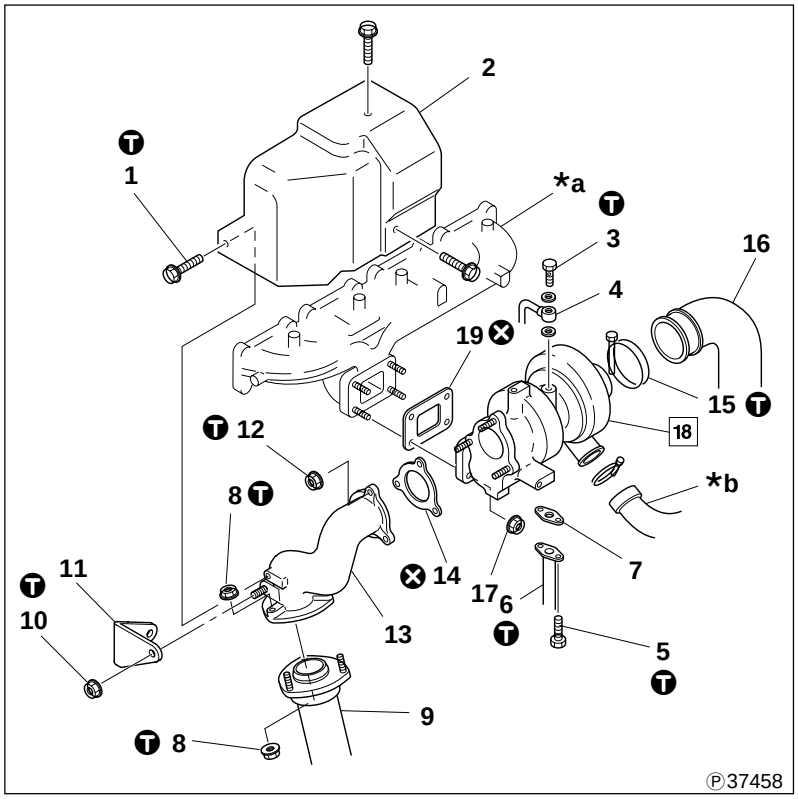


28 **Inspection of dust indicator**

- Apply the specified vacuum pressure (7.5±0.6 kPa {2.20±0.17 in.Hg, 56±4.3 mmHg}) on the dust indicator **28** and check that the red signal appears in the window,

M E M O

TURBOCHARGER



● **Disassembly sequence**

1 Bolt
2 Insulator
3 Eyebolt
4 Oil pipe
5 Bolt
6 Oil return pipe
7 Gasket
8 Nut
9 Front pipe
10 Nut
11 Exhaust pipe stay
12 Nut
13 Exhaust pipe
14 Coupler gasket
15 Clamp
16 Air inlet hose
17 Nut
18 Turbocharger assembly 📖 P15A-14
19 Gasket

***a:** Exhaust manifold 📖 P15A-20
***b:** Rubber hose 📖 P15A-17
⊗ **:** Non-reusable part

● **Reassembly sequence**

Follow the disassembly sequence in reverse.

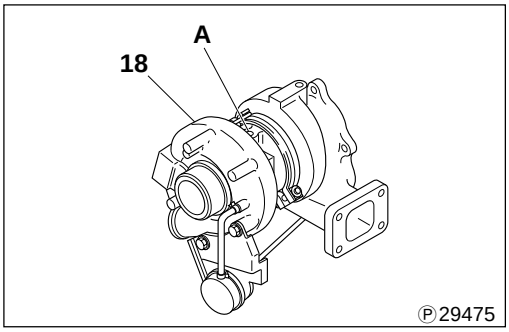
Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (for insulator mounting)	11.8 {8.7, 1.2}	–
3	Eyebolt (for oil pipe mounting)	23.5 {17, 2.4}	–
5	Bolt (for oil return pipe mounting)	4.9 {3.6, 0.5}	–
8	Nut (front pipe mounting)	25 to 30 {18 to 22, 2.5 to 3.0}	–
10, 12, 17	Nut (for exhaust pipe stay, exhaust pipe, turbocharger assembly mounting)	41.2 {30, 4.2}	–
15	Clamp	8.8 ± 0.98 {5.8 ± 0.7, 0.9 ± 0.1}	–

Lubricant

Location	Points of application	Specified lubricant	Quantity
18	Turbocharger assembly oil hole (supply at time of installation)	Engine oil	As required



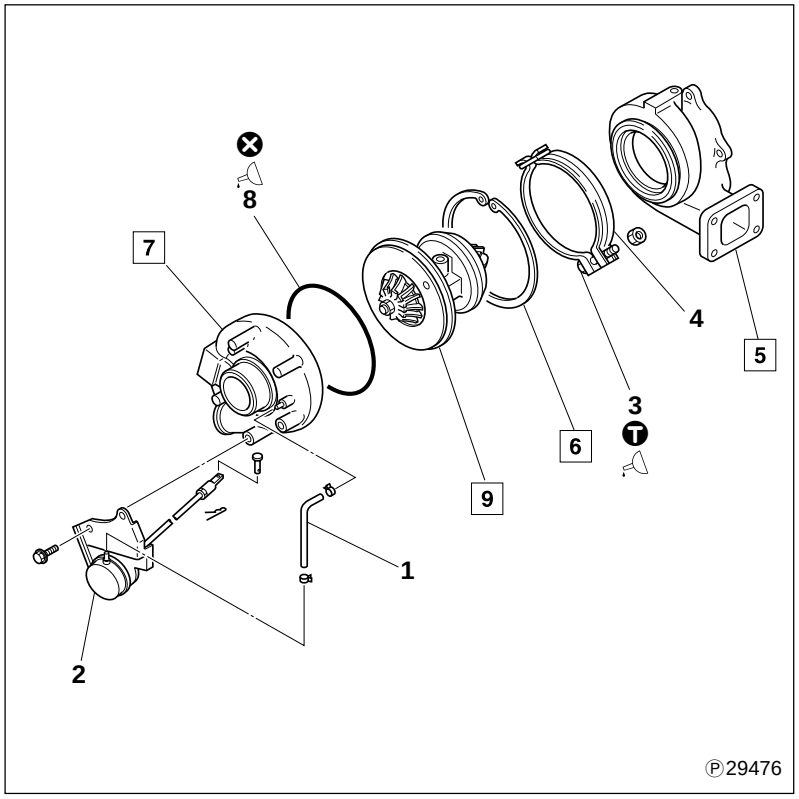
◆ Service procedure

18 Installation of turbocharger assembly

Before installing the turbocharger assembly **18**, pour engine oil into the oil hole **A** to ensure smooth operation of the internal parts.

TURBOCHARGER

Turbocharger assembly



● **Operation before disassembly**
P15A-15

● **Disassembly sequence**

1 Hose
2 Actuator
3 Bolt
4 Coupling
5 Turbine housing
6 Snap ring
7 Compressor cover
8 O-ring
9 Cartridge assembly

⊗ **:** Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**
P15A-15

NOTE

Cartridge assembly 9 cannot be disassembled. Replace the entire assembly if the turbine wheel or compressor wheel becomes damaged or if the assembly does not rotate smoothly or is otherwise defective.

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
9	Cartridge assembly	Axial play in shaft		0.05 to 0.09 {0.0020 to 0.0035}	0.1 {0.0039}	Replace
		Play at right angle to axial direction	Turbine wheel side	0.40 to 0.53 {0.016 to 0.021}	0.58 {0.023}	Replace
			Compressor wheel side	0.55 to 0.66 {0.022 to 0.026}	0.72 {0.028}	

Ⓣ Tightening torque

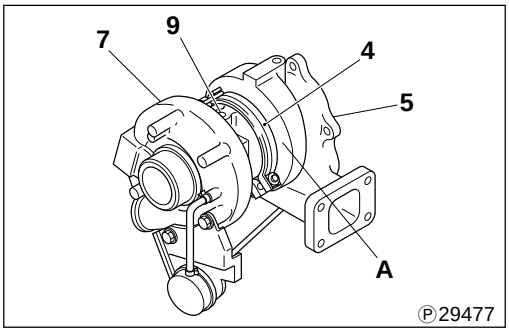
Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Coupling securing)	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	Wet

Lubricant and sealant

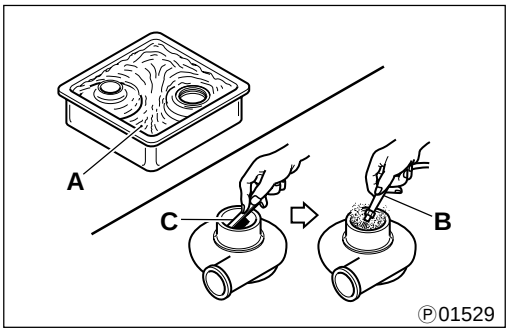
Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Threads of bolt	Molybdenum disulfide grease	As required
8	Entire periphery of O-ring	Engine oil	As required

◆ Service procedure



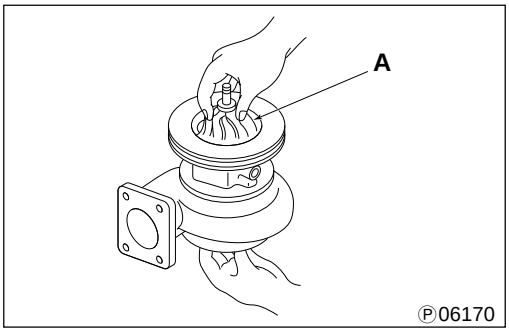
● **Operation before disassembly**

Make alignment marks **A** on the coupling **4**, turbine housing **5**, compressor cover **7**, and cartridge assembly **9**.



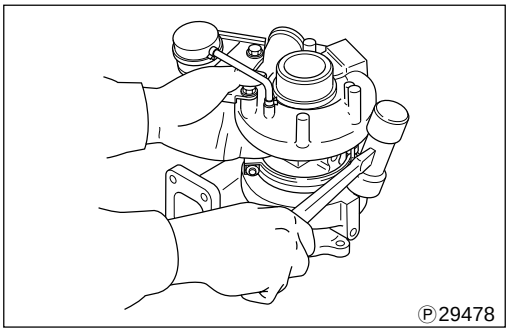
● **Cleaning after disassembly**

- Visually check the disassembled parts for scorches, abrasion, and other marks that may be difficult to see after cleaning. Replace any part that appears defective.
- Immerse the disassembled parts in a non-flammable solvent **A** and remove the parts from the solvent and blow them dry with compressed air **B**. Before this procedure, remove adhering matter if any using a plastic scraper on a wire brush **C**.
- Immerse the parts in the solvent **A** again.
- Blow the parts dry with compressed air **B**.



● **Inspection after assembly**

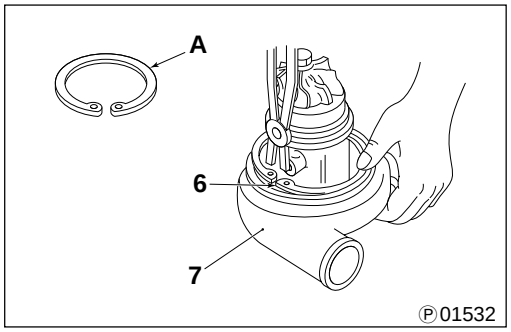
Manually rotate the wheel **A** of the cartridge assembly **9** to check that it turns smoothly.



5 **Removal of turbine housing**

CAUTION ⚠

- **While using care to prevent damage to the turbine housing, lightly strike its entire circumference with a rubber hammer or similar tool.**
- **Since the blades of the turbine wheel are easily bent, use care to make sure that they do not hit turbine housing 5.**

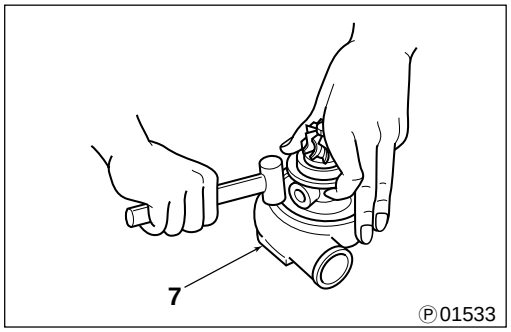


6 **Installing snap ring**

- Fit snap ring **6** onto compressor cover **7** with its tapered surface **A** facing upward.

WARNING ⚠

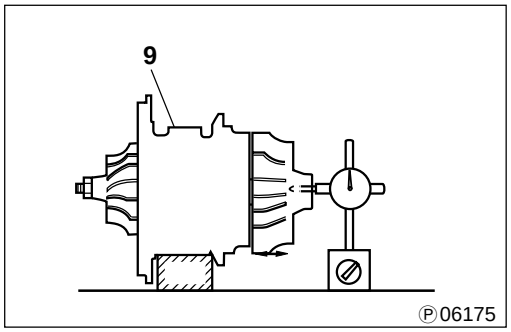
When fitting snap ring 6, hold it down to prevent it from flying off.



7 **Removal of compressor cover**

CAUTION ⚠

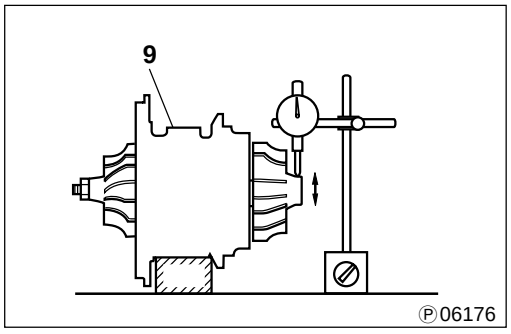
- **While using care to prevent damage to compressor cover 7, lightly strike its entire circumference with a rubber hammer or similar tool.**
- **Since the blades of the compressor wheel are easily bent, use care to make sure that they do not hit the compressor cover.**



9 **Inspection of cartridge assembly**

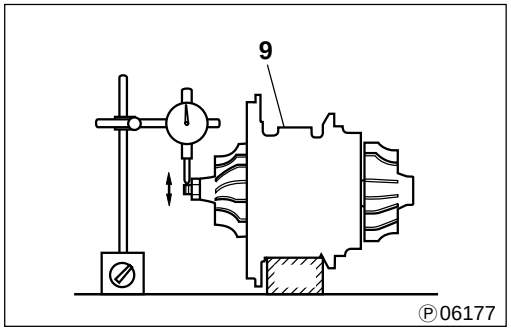
(1) Axial play in shaft and turbine wheel assembly

If the measurement exceeds the specified limit, replace cartridge assembly **9**.

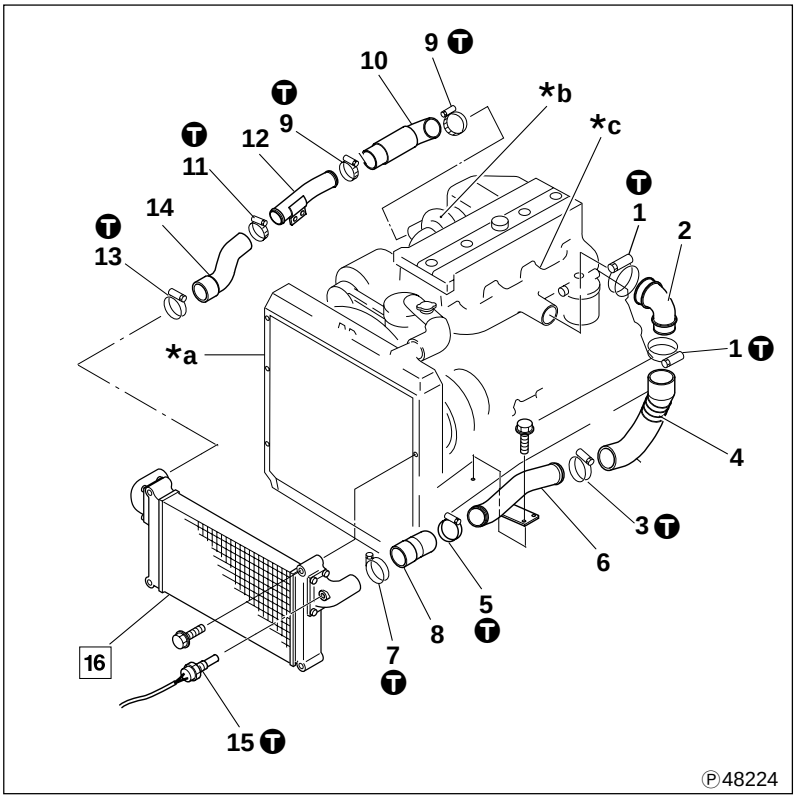


(2) Play at right angle to shaft direction in shaft and turbine wheel assembly

- Play on turbine wheel side
  If the measurement exceeds the specified limit, replace cartridge assembly **9**.



- Play on compressor wheel side
  If the measurement exceeds the specified limit, replace cartridge assembly **9**.



● **Disassembly sequence**

1 Clamp
2 Air inlet pipe
3 Clamp
4 Air inlet hose
5 Clamp
6 Air inlet pipe
7 Clamp
8 Air inlet hose
9 Clamp
10 Rubber hose
11 Clamp
12 Air inlet pipe
13 Clamp
14 Air inlet hose
15 Boost air temperature sensor
Gr 13EA
16 Intercooler

***a :** Radiator Gr 14A
***b :** Intake manifold P15A-18
***c :** Turbocharger assembly P15A-14

● **Reassembly sequence**

Follow the disassembly sequence in reverse.

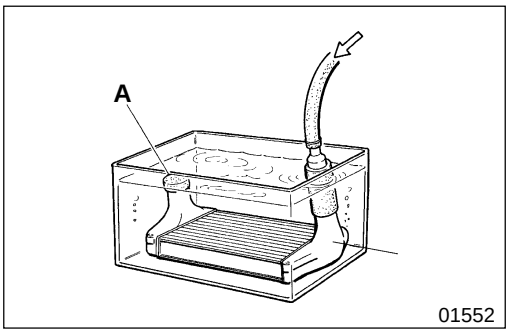
Service standard

Location	Maintenance item	Standard value	Limit	Remedy
16	Intercooler air leakage (at air pressure of 150 kPa {21 psi, 1.5 kgf/cm²})	0 cm³ {0 cu.in.}	–	Replace

Ⓣ Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5, 7, 11, 13	Clamp	2.9 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	–
9	Clamp	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	–
15	Boost air temperature sensor	14.7±2 {11±1.4, 1.5±0.2}	–

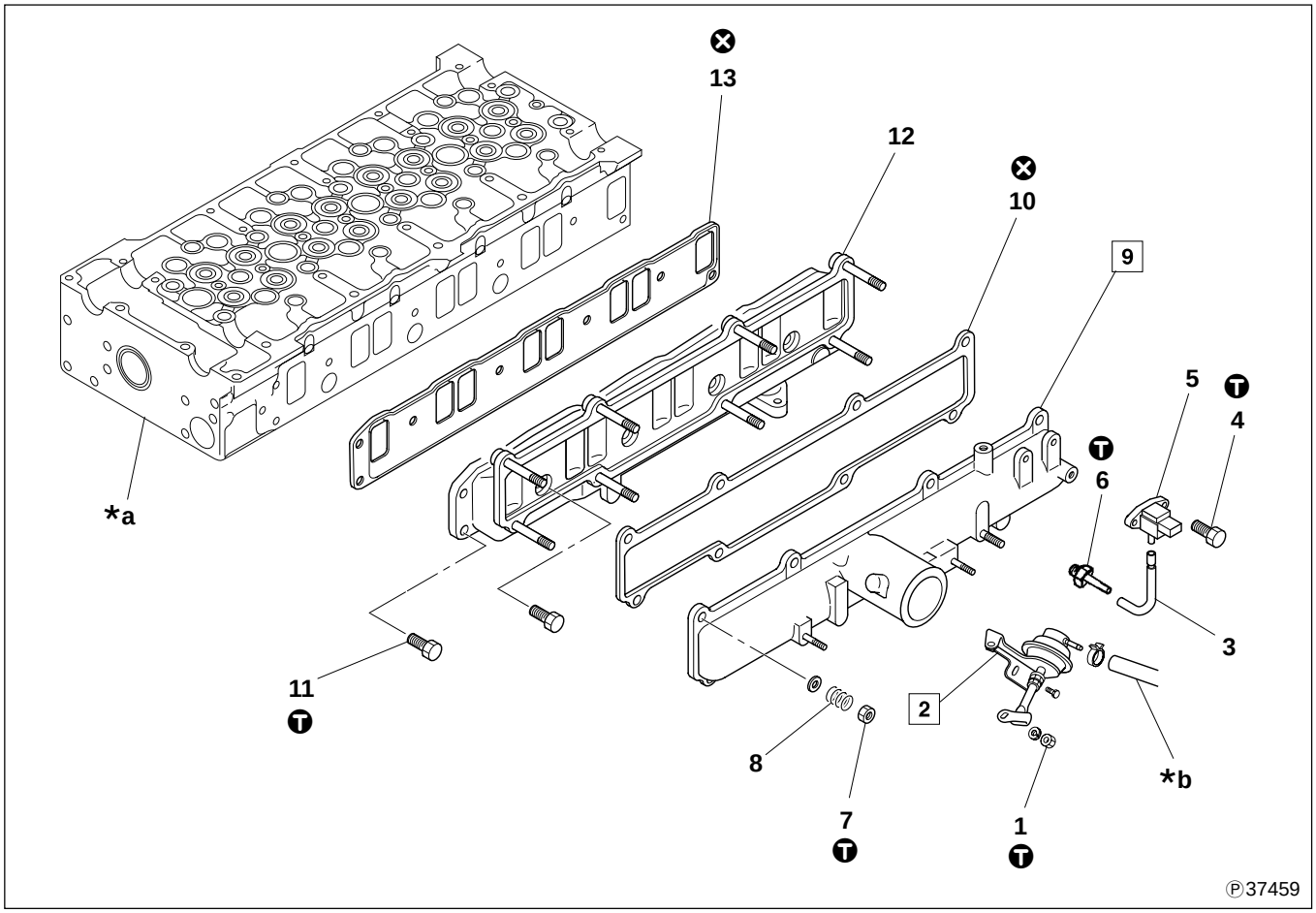


◆ Service procedure

16 Inspection of intercooler

Fit a cap over one of the air ports **A** on the intercooler **16**, connect a hose to the other port, and immerse the intercooler in a tank of water. Then, apply the specified air pressure (150 kPa {21 psi, 1.5 kgf/cm²}) via the hose and check for air leakage.
If leakage is apparent, replace the intercooler **16**.

INTAKE MANIFOLD



● **Disassembly sequence**

1 Nut
2 Actuator assembly
3 Pressure hose
4 Bolt
5 Boost pressure sensor
6 Pressure hose fitting
7 Nut
8 Spring
9 Intake manifold B
10 Gasket B
11 Bolt
12 Intake manifold A
13 Gasket A

***a:** Cylinder head Gr 11A
***b:** Vacuum hose
⊗ **:** Non-reusable part

● **Reassembly sequence**

Follow the disassembly sequence in reverse.

Service standards

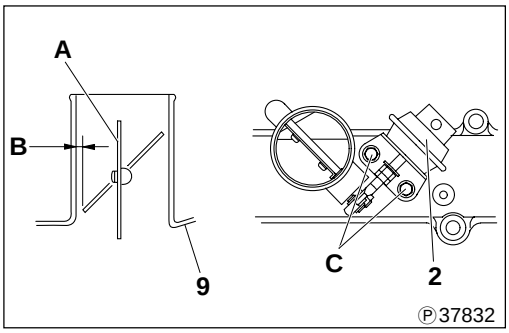
Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2, 9	Butterfly valve intake manifold clearance	Clearance B	$4.0^{+0.5}_{0}$ {$0.16^{+0.02}_{0}$}	–	Replace

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (actuator assembly mounting)	8 {5.8, 0.8}	–
4	Bolt (boost pressure sensor mounting)	4.9 {3.6, 0.5}	–
6	Pressure hose fitting	14.7 to 19.6 {11.0 to 14.0, 1.5 to 2.0}	–
7	Nut (intake manifold B mounting)	10.8 {8.0, 1.1}	–
11	Bolt (intake manifold A mounting)	44.1 {33.0, 4.5}	–

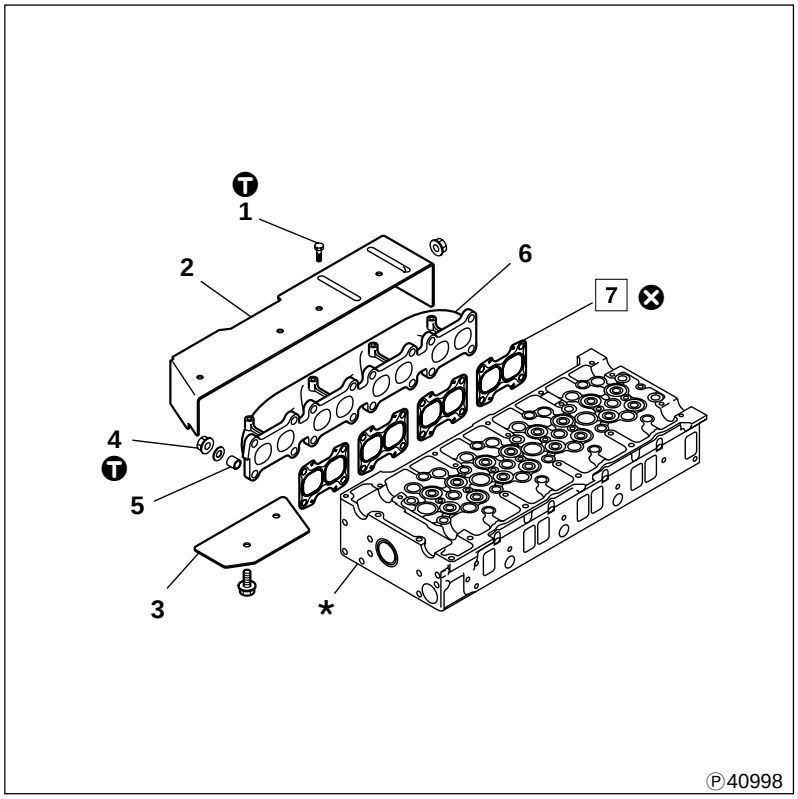


◆ Service procedure

2 **9** **Clearance between butterfly valve and intake manifold B**

Apply a vacuum of more than 67 kPa {19.7 in.Hg, 500 mmHg} to the actuator assembly **2** to bring the double nut into contact with its bracket. While keeping this condition, adjust the clearance **B** between the butterfly valve **A** and the intake manifold B **9** for the specified standard value using the oblong holes **C** in the actuator assembly bracket.

EXHAUST MANIFOLD



● **Disassembly sequence**

1 Bolt
2 Insulator
3 Lower insulator
4 Nut
5 Spacer
6 Exhaust manifold
7 Gasket

***** : Cylinder head Gr 11A
⊗ : Non-reusable part

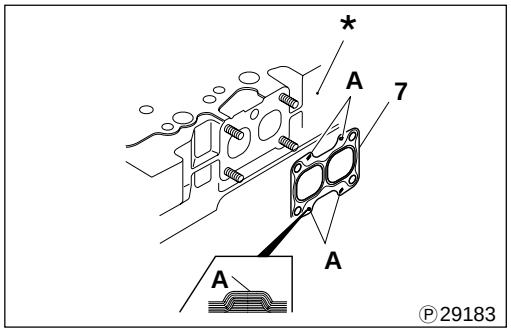
● **Reassembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (insulator manifold mounting)	18.0 {13.0, 1.8}	–
4	Nut (exhaust manifold mounting)	41.2 {30.0, 4.2}	–



◆ Service procedure

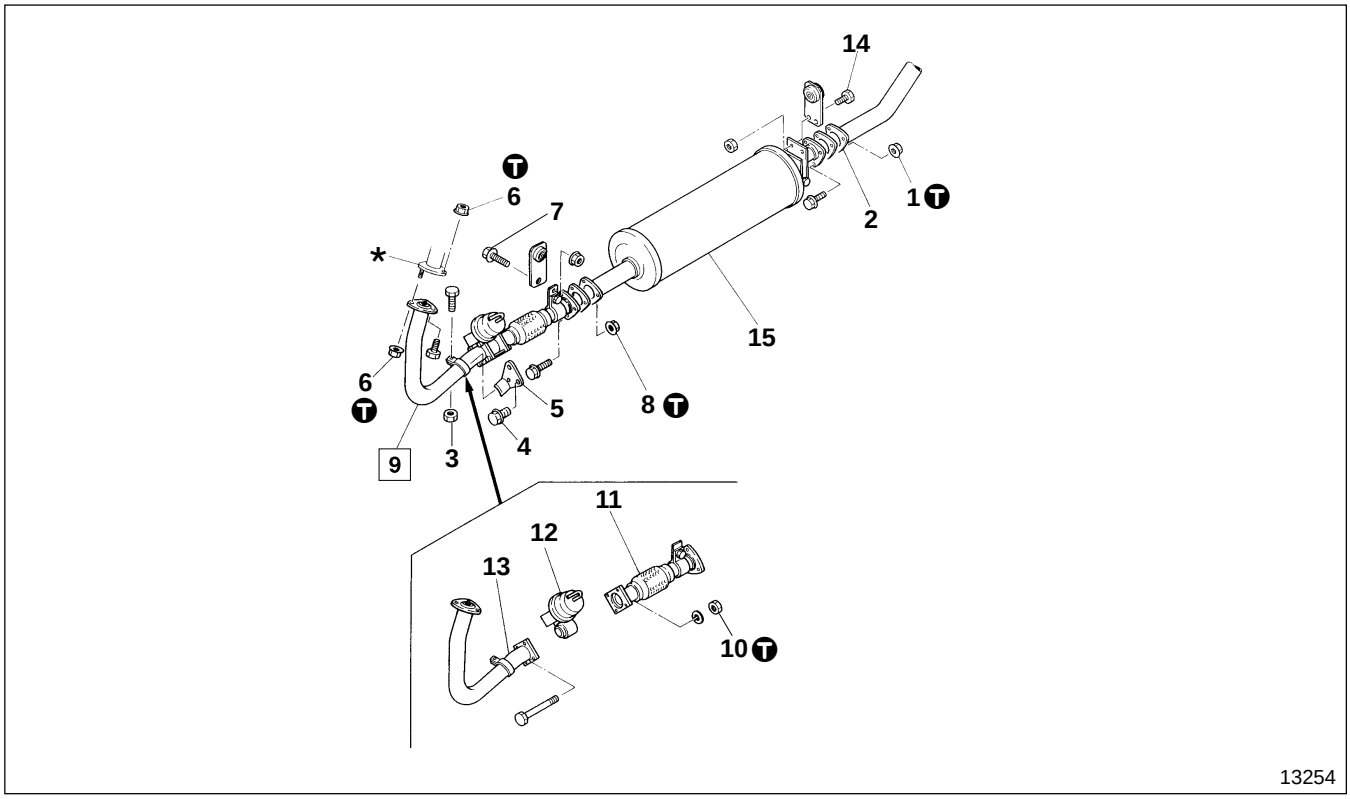
7 Installation of gasket

Fit the gasket **7** with the side having projections **A** facing the cylinder head *****.

A : Projections

M E M O

EXHAUST PIPE AND MUFFLER



● **Disassembly sequence**

1 Nut
2 Tail pipe
3 Nut
4 Bolt
5 Exhaust pipe bracket
6 Nut
7 Bolt
8 Nut
9 Front pipe assembly
10 Nut
11 Front pipe
12 Exhaust brake unit Gr 35A
13 Front pipe
14 Bolt
15 Muffler

***** : Exhaust manifold

● **Assembly sequence**

Follow the disassembly sequence in reverse.

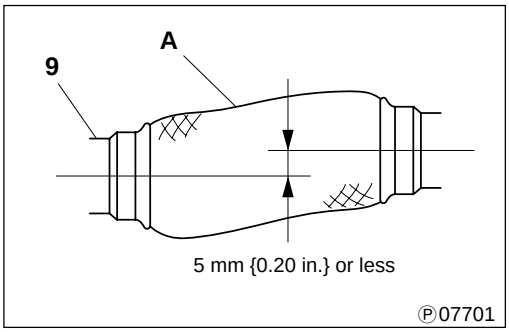
WARNING ⚠

- **Never hit or kick muffler 15, or the catalyst in the muffler will be damaged.**
- **A small amount of water sometimes collects inside muffler 15. Never touch this water, if you do by mistake, wash it off immediately with clean water.**

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 8	Nut (Tail pipe, center pipe and muffler mounting)	26 to 33 {20 to 25, 2.7 to 3.4}	–
6	Nut (Front pipe assembly mounting)	25 to 30 {18 to 22, 2.5 to 3.0}	–
10	Nut (Exhaust brake unit mounting)	27 {20, 2.75}	–



◆ Service procedure

9 Installation of front pipe assembly

Install front pipe assembly **9** so that the offset tolerance in the vertical and horizontal sections between the front and back of bellows **A** conforms to the specified value.

CAUTION ⚠

Be sure when installing front pipe assembly 9, that bellows A are not bent or stretched, since the bellows are designed to reduce the external noise of the vehicle but not to absorb dimensional errors in the installation of pipes.

MITSUBISHI
FUSO

Group 15B

Intake and Exhaust

< 6D3 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-15B

INDEX

SPECIFICATIONS 15B- 2

STRUCTURE AND OPERATION 15B- 2

TROUBLESHOOTING 15B- 5

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Measurement of Turbo Boost Pressure 15B- 6

AIR DUCT AND AIR CLEANER 15B- 8

TURBOCHARGER 15B-12

INTERCOOLER 15B-17

INTAKE MANIFOLD 15B-18

EXHAUST MANIFOLD 15B-19

EXHAUST PIPE AND MUFFLER 15B-20

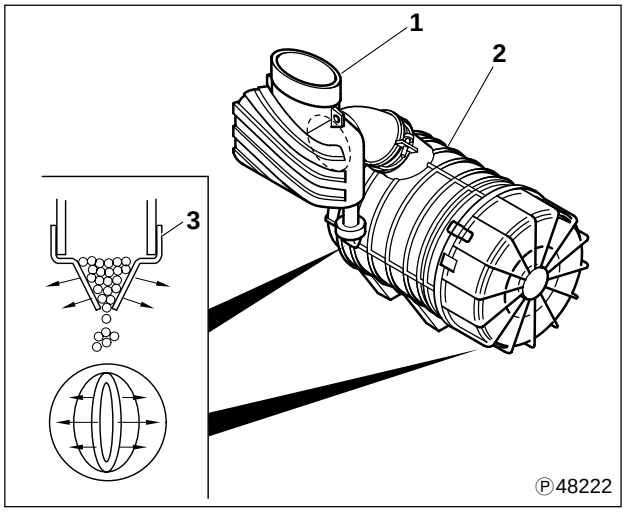
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Items		Specifications
Air cleaner element		Cyclone paper filter type
Dust indicator type		Mechanical
Turbocharger	Model	TD06
	Manufacturer	MITSUBISHI HEAVY INDUSTRIES
Intercooler type		Tube and corrugated fin (air cooled)

STRUCTURE AND OPERATION

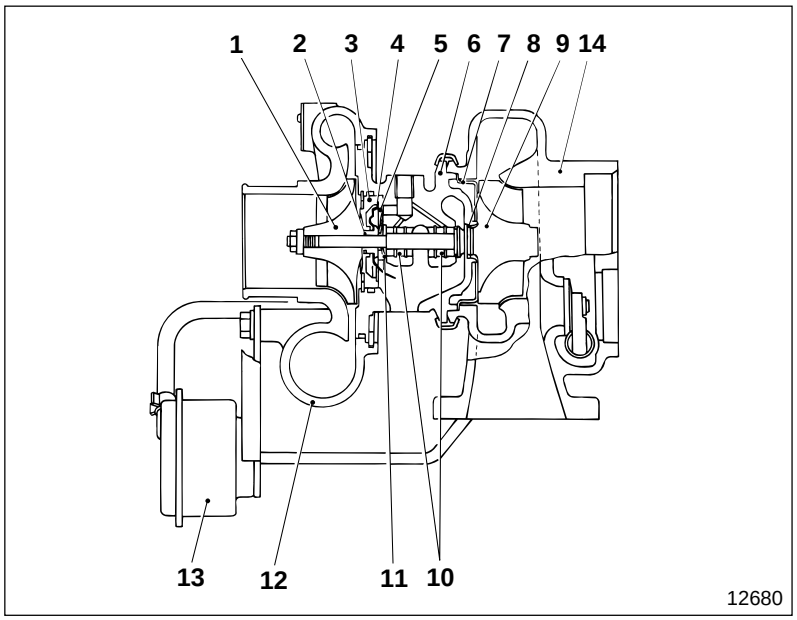
Air Cleaner



1 Air lower duct
2 Air cleaner assembly
3 Vacuator valve

- Air cleaner assembly **2** uses a single element.
- Vacuator valves **3** are fitted with air lower duct **1** and air cleaner assembly **2**.
- Vacuator valves **3** automatically vent dust and dirt by the repercussive force of the rubber of the valve that overcomes the inner negative pressure when the engine revolution falls below the specified revolution.

Turbocharger

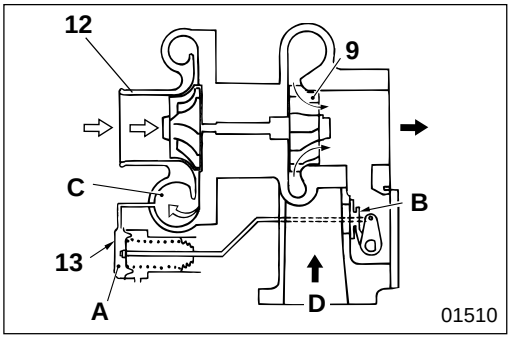


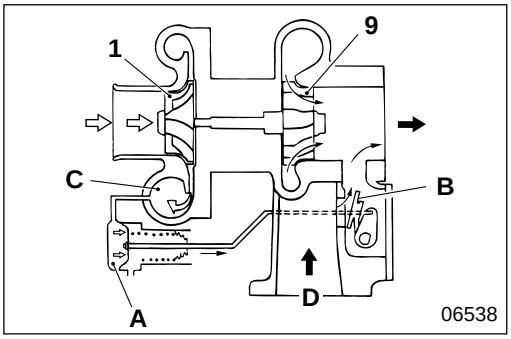
1 Compressor wheel
2 Thrust sleeve
3 Insert
4 Oil deflector
5 Thrust bearing
6 Bearing housing
7 Turbine backplate
8 Piston ring
9 Shaft and turbine wheel
10 Bearing
11 Thrust bearing
12 Compressor cover
13 Actuator
14 Turbine housing assembly

1 to **11** : Cartridge assembly

Waste gate mechanism

- The waste gate mechanism relieves the boost pressure of excess exhaust gas using actuator **13**. This controls the boost pressure appropriately and prevents the turbocharger from overrunning, and prevents excessive pressure in the intake manifold.
- The boost pressure is fed into chamber **A** of actuator **13** from compressor cover **12** via a rubber hose. When boost pressure **C**, acting on the chamber, is lower than the preset value, the actuator does not operate and waste gate valve **B** remains closed, therefore exhaust gas **D** is blown against shaft and turbine wheel **9**.

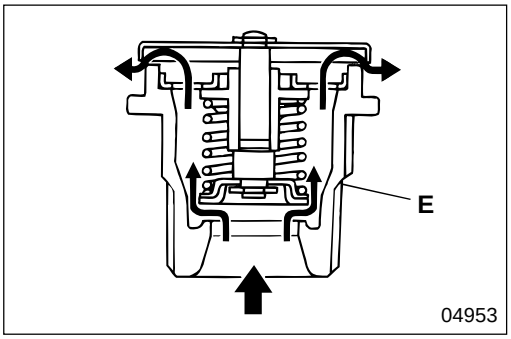


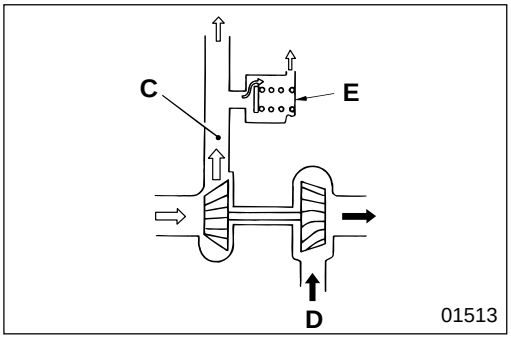


- As the boost pressure acting on chamber **A** increases to become higher than the preset value, waste gate valve **B** is opened and the exhaust gas blown against shaft and turbine wheel **9** decreases. Therefore the rotation of compressor wheel **1** decreases, causing the boost pressure to decrease.

Operation of over-boost valve

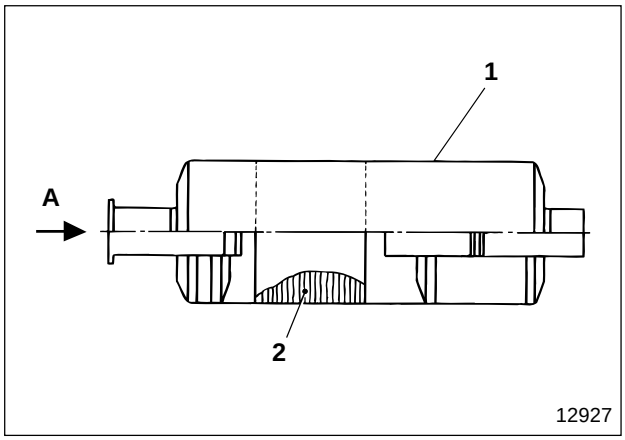
- Over-boost valve **E** operates when the boost pressure increases abnormally because of faulty operation of the waste gate mechanism.





- If boost pressure **C** of over-boost valve **E** increases to become higher than the preset value, the excessive boost pressure is discharged into the atmosphere, protecting the engine from excessive boost pressure. When the valve is operating, a pipe-blowing sound is generated.

Muffler



1 Muffler
2 Catalytic converter

A : Exhaust gas intake

Converter **2** is built into muffler **1** to decrease the amount of particulate matter (PM) in the exhaust gas.

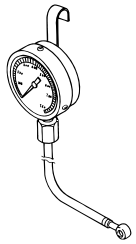
Possible causes \ Symptoms			Engine hard to start	Exhaust gas dark	Exhaust gas whitish	Engine output insufficient	Oil consumption excessive	Noise and vibration in intake/exhaust systems	Remarks
Air cleaner	Air cleaner element clogged		○	○		○			
Turbocharger	Cartridge assembly	Bearing faulty		○		○		○	
		Carbon deposits on shaft and turbine wheel		○		○			
		Shaft and turbine wheel interfering with turbine backplate		○		○			
		Shaft and turbine wheel interfering with turbine housing		○		○			
		Shaft and turbine wheel bent		○		○		○	
		Shaft and turbine wheel broken		○		○		○	
		Compressor wheel interfering with compressor housing		○		○			
		Thrust sleeve and thrust bearing seized		○		○		○	
		Compressor wheel broken		○		○		○	
		Engine oil leaking because piston ring and inserter worn		○	○		○		
		Piston rings installation faulty					○		
		Parts not sliding smoothly because oil lubrication pipe and eye bolt clogged		○		○			
		Oil seals damaged because oil return pipe clogged			○		○		
	Compressor housing installation faulty			○		○	○	○	
	Turbine housing installation faulty					○		○	
Intercooler	Foreign particles on intercooler front core					○			
Actuator	Butterfly valve does not open			○	○	○			
	Butterfly valve opening and closing adjusted incorrectly			○	○	○			
Front pipe, muffler and tail pipe deformed								○	
Front pipe, muffler and tail pipe installation faulty								○	
Valve clearance faulty				○					Gr 11B
Head gasket faulty				○					Gr 11B
Valve and valve seat worn and carbon deposits				○					Gr 11B
Valve spring fatigued				○					Gr 11B
Piston ring worn and damaged				○					Gr 11B
Piston ring groove worn and damaged				○					Gr 11B
Cooling system malfunctioning				○					Gr 14B
Engine oil excessive				○					Gr 12B
Main moving parts seized				○					Gr 11B
Fuel injection quantity uneven or excessive				○					Gr 13B

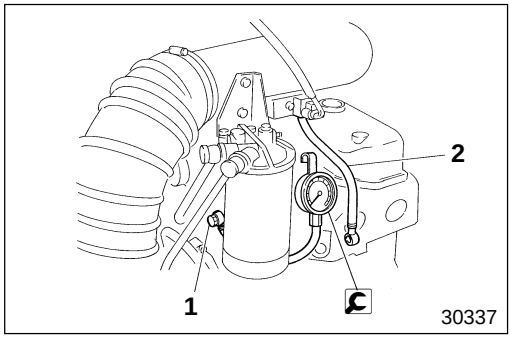
Measurement of Turbo Boost Pressure

Service standards

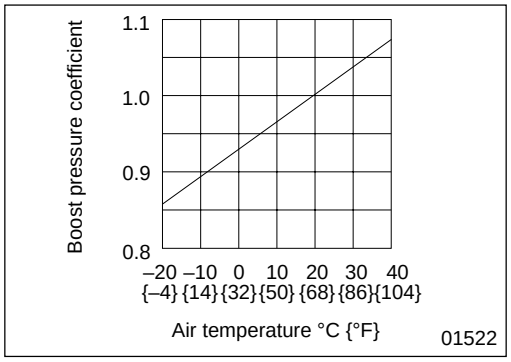
Location	Maintenance item	Standard value	Limit	Remedy
—	Boost pressure (Air temperature 20°C {68°F}, Atmospheric pressure 100 kPa {29.9 in. Hg, 760 mmHg})	—	32 kPa {9.45 in. Hg, 240 mmHg}/ 3700 rpm	Inspect and adjust

Special tools

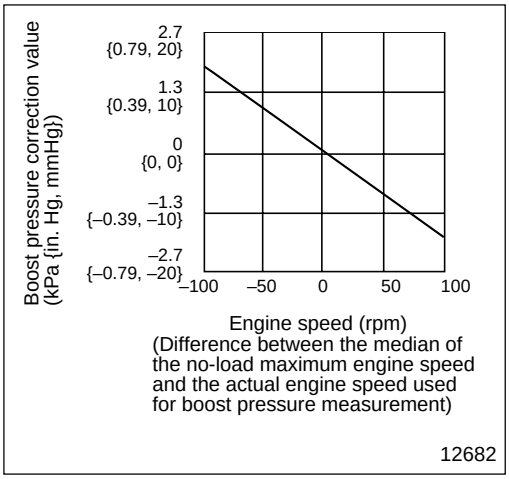
Location	Tool name and shape	Part No.	Application
—	Boost pressure gauge  01524	MH061366	Measurement of turbo boost pressure



- Before measuring the turbo boost pressure, clean or replace the air cleaner element.
- Slacken off eye bolt **1** of boost compensator and remove boost compensator pipe **2**, then attach boost pressure gauge.
- After warming up the engine, measure the boost pressure at the no-load maximum engine speed. Also, measure the engine speed and the air temperature.



- Correct the boost pressure at standard conditions. (Since the boost pressure varies depending on the air temperature and engine speed.)
  [Correction for air temperature]
  Identify boost pressure coefficient depending on the air temperature from the graph.



[Correction for engine speed]
Subtract the engine speed actually used for measuring the boost pressure from the median of the no-load maximum engine speed. Identify the boost pressure correction value (**Pa**) according to the graph.
Median value : 3700 rpm

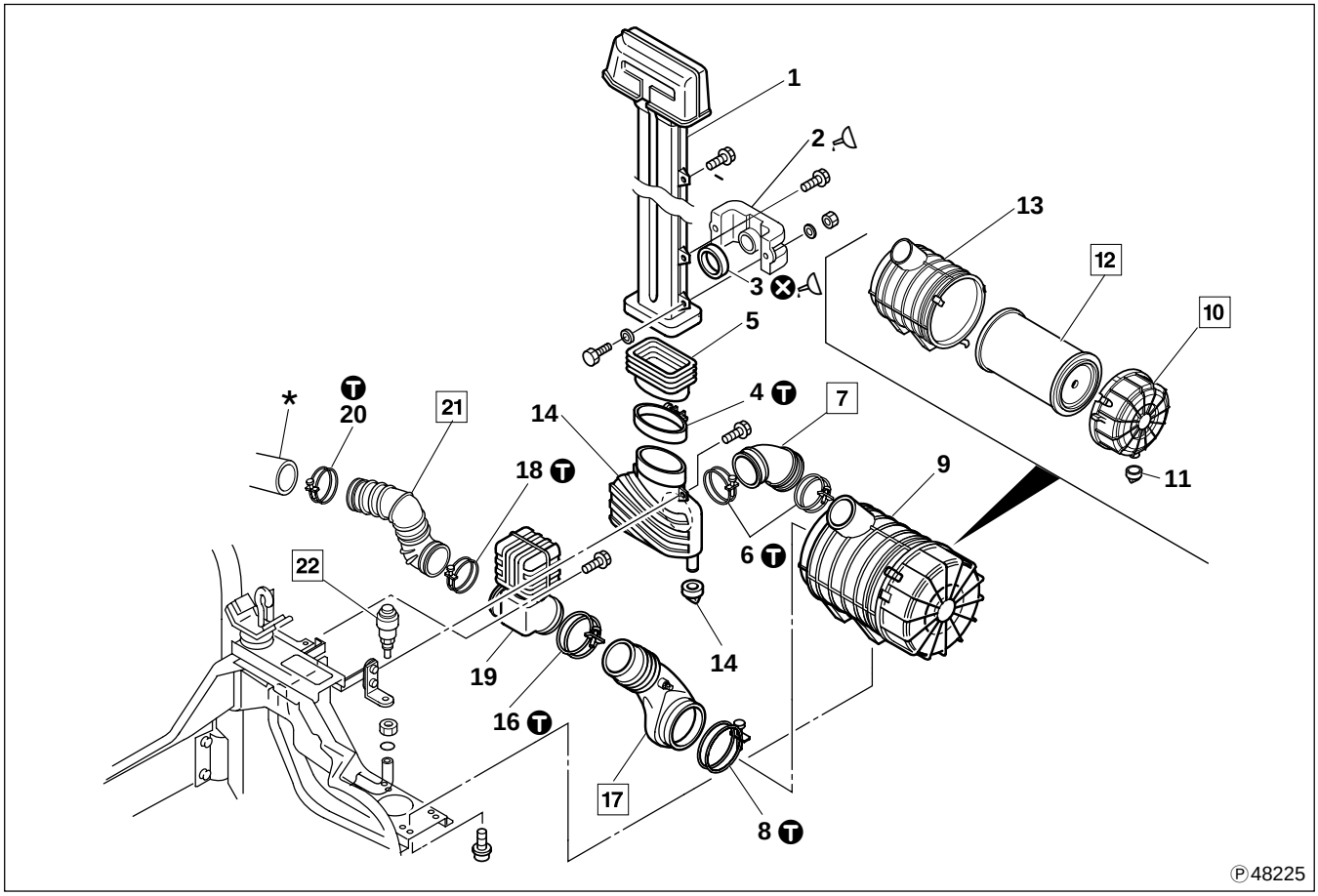
[Calculation of corrected boost pressure]
Given the measured boost pressure to be **P**, corrected boost pressure **Pb** can be calculated from the following equation:

Pb = ktP + Pa

- **Pb** : Corrected boost pressure
- **P** : Measured boost pressure
- **kt** : Boost pressure correcting coefficient depending on air temperature
- **Pa** : Boost pressure correction value

If **Pb** is lower than the limit, the turbocharger must be inspected and adjusted.

AIR DUCT AND AIR CLEANER



● **Disassembly sequence**

1 Air upper duct
2 Resonator
3 Grommet
4 Clamp
5 Rubber boot
6 Clamp
7 Air intake hose
8 Clamp
9 Air cleaner assembly
10 Cover
11 Vacuator valve
12 Element
13 Body
14 Vacuator valve
15 Air lower duct
16 Clamp
17 Air duct
18 Clamp
19 Air duct
20 Clamp
21 Air intake hose
22 Dust indicator

*: Air inlet pipe P15B-10
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Do not remove evacuator valve 11, 14 unless it is faulty.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
22	Vacuum pressure at which dust indicator operates	7.5±0.6 kPa {2.20±0.17 in.Hg, 56±4.3 mmHg}	—	Replace

Ⓣ Tightening torque

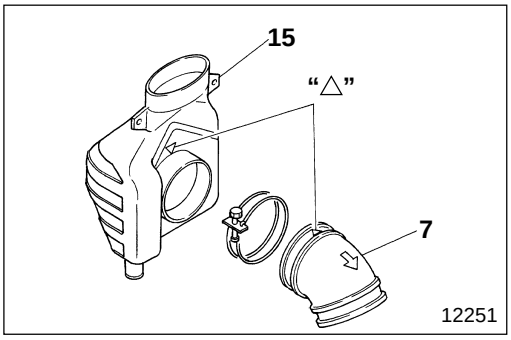
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4, 6, 8 16, 18, 20	Clamp	3.0 to 3.4 {2.2 to 2.5, 0.31 to 0.35}	—

Sealant

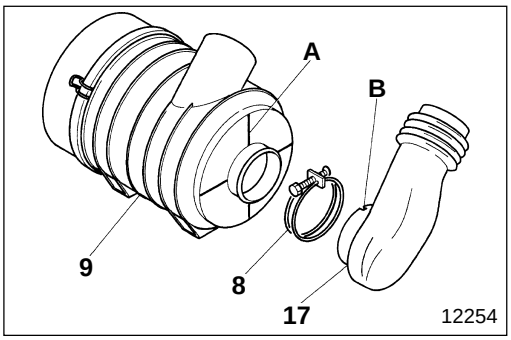
Location	Points of application	Kinds	Quantity
2	Apply sealant to the connecting part of grommet to the resonator	ThreeBond 1207C	As required
3	Apply sealant to grommet groove area	ThreeBond 1207C	As required

◆ Service procedure



7 **Installation of air intake hose**

△ : Alignment mark

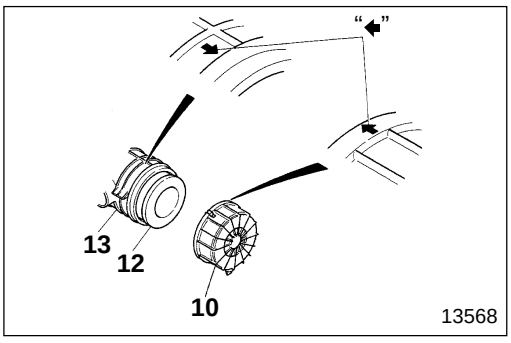


17 **Installation of air dust**

Install air duct **13** in the direction as illustrated to the air cleaner assembly **9**.

A : Protrusion

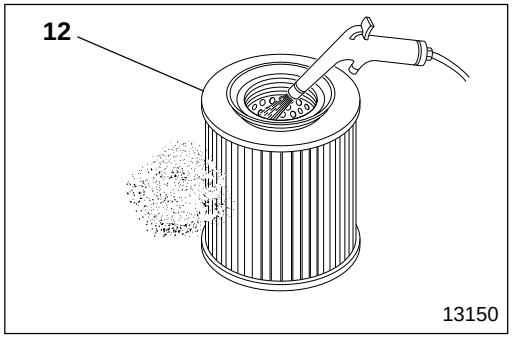
B : Indent



10 **Installation of cover**

➧ **:** Alignment mark

AIR DUCT AND AIR CLEANER



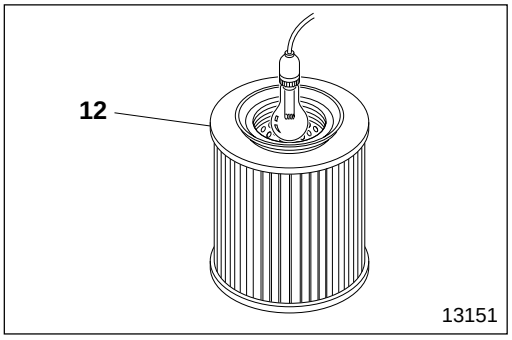
12 **Element**

[Cleaning]

- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **12** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of air cleaner element **12** evenly.

CAUTION ⚠

- **Do not tap or hit air cleaner element 12 to remove dust.**
- **Do not blow compressed air through air cleaner element 12 from the outside.**

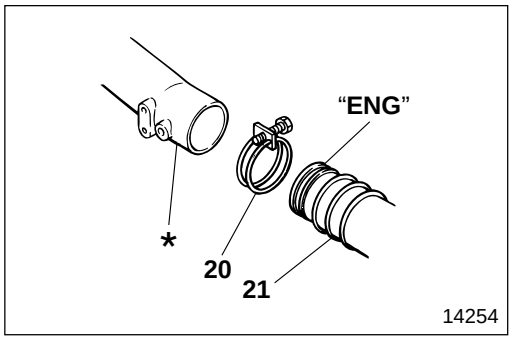


[Inspection]

- Illuminate the inside of air cleaner element **12**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of air cleaner element **12** is damaged, replace the air cleaner element.

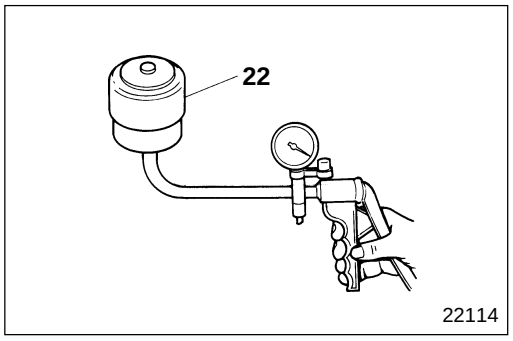
NOTE

If the dust on air cleaner element 12 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.



21 **Installation of air intake hose**

ENG : Alignment mark

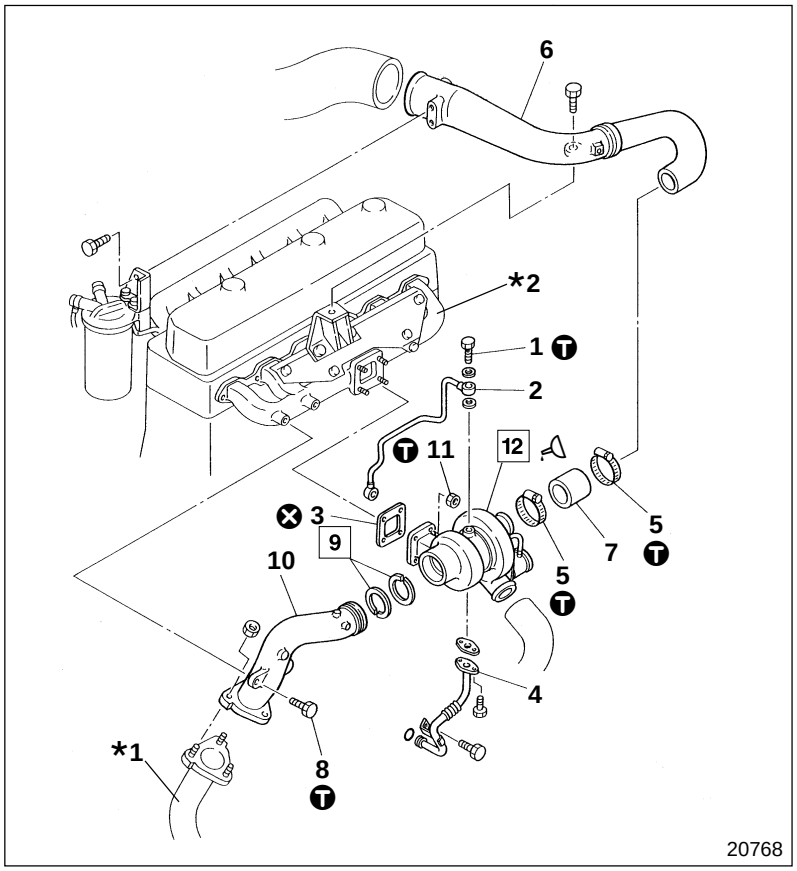


22 **Inspection of dust indicator**

- Check to verify that when a specified vacuum pressure of 7.5±0.6 kPa {2.20±0.17 in.Hg, 56±4.3 mmHg} is applied to the dust indicator **28**, a red signal appears in its window area.

M E M O

TURBOCHARGER



● **Removal sequence**

1 Eye bolt
2 Oil pipe
3 O-ring
4 Oil return pipe
5 Clamp
6 Air inlet pipe assembly Gr 35A
7 Rubber hose
8 Bolt
9 Seal ring
10 Exhaust pipe
11 Nut
12 Turbocharger assembly P15B-14
13 Gasket

***1** : Front pipe P15B-20
***2** : Exhaust manifold P15B-19
⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

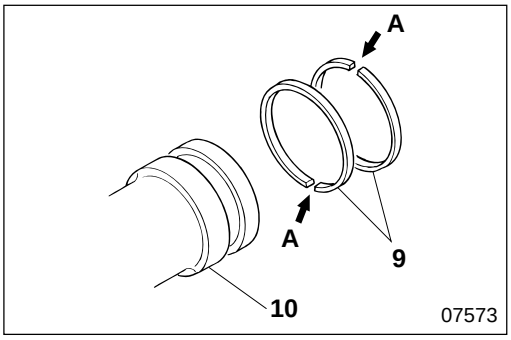
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt	21 {15, 2.1}	—
5	Clamp	4.9 {3.6, 0.5}	—
8	Bolt (Exhaust pipe mounting)	53 {39, 5.4}	—
11	Nut (Turbocharger assembly mounting)	41 {30, 4.2}	—

Lubricant

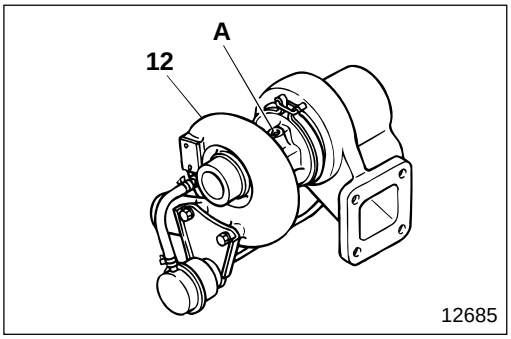
Location	Points of application	Kinds	Quantity
12	Supply when installing turbocharger assembly	Engine oil	As required

◆ Service procedure



9 **Installation of seal ring**

Offset splits **A** of seal rings **9** at 180°.

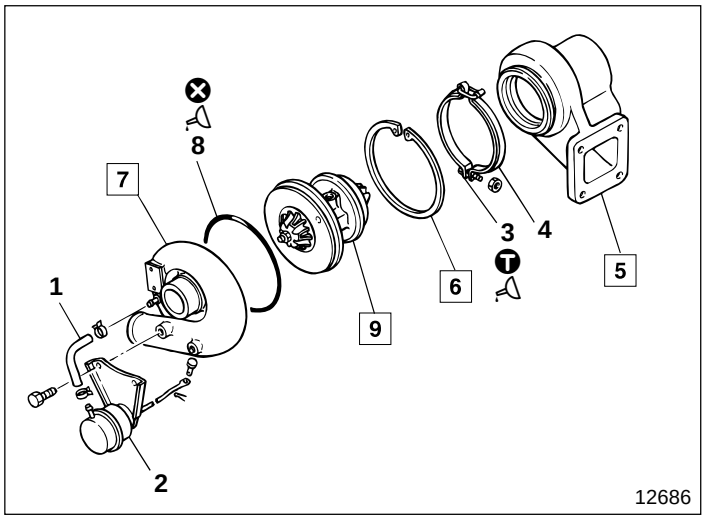


12 **Installation of turbocharger assembly**

When installing turbocharger assembly **12**, supply engine oil via oil port **A** as required to ensure that parts move smoothly.

TURBOCHARGER

Turbocharger Assembly



● **Work before disassembly**

P15B-15

● **Disassembly sequence**

1 Hose
2 Actuator
3 Bolt
4 Coupling
5 Turbine housing
6 Snap ring
7 Compressor cover
8 O-ring
9 Cartridge assembly

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

P15B-15

NOTE

Since cartridge assembly 9 is a unit construction, if the turbine wheel or the compressor wheel is damaged, or the cartridge assembly does not revolve smoothly, or any other fault is found, replace the assembly as a unit.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
9	Cartridge assembly	Play in the shaft direction		0.05 to 0.09 {0.0020 to 0.0035}	0.1 {0.0039}	Replace
		Play at right angles to the shaft	Turbine wheel side	0.40 to 0.53 {0.016 to 0.021}	0.58 {0.023}	Replace
			Compressor wheel side	0.55 to 0.66 {0.022 to 0.026}	0.72 {0.028}	Replace

Ⓣ Tightening torque

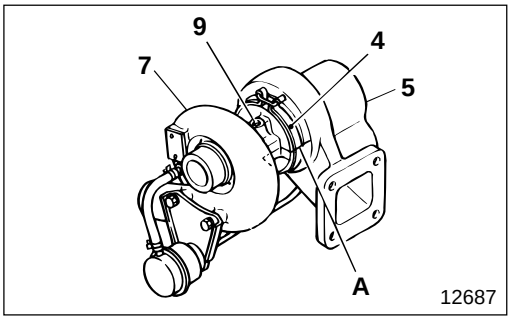
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Coupling mounting)	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	—

Lubricant

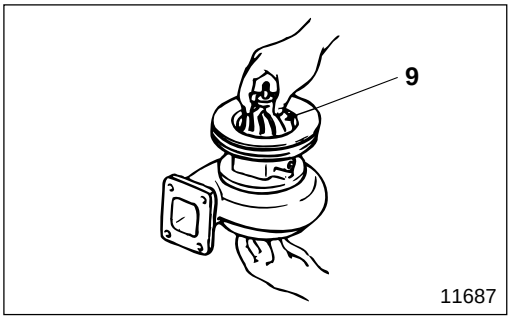
Location	Points of application	Kinds	Quantity
3	Thread area of bolt	Molybdenum disulfide grease	As required
8	Periphery of O-ring	Engine oil	As required

◆ Service procedure



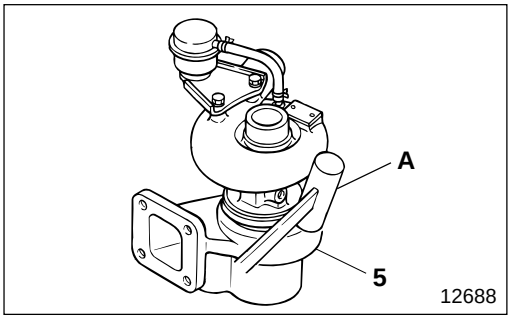
● Work before disassembly

Put alignment marks **A** on coupling **4**, turbine housing **5**, compressor cover **7** and cartridge assembly **9**.



● Inspection after assembly

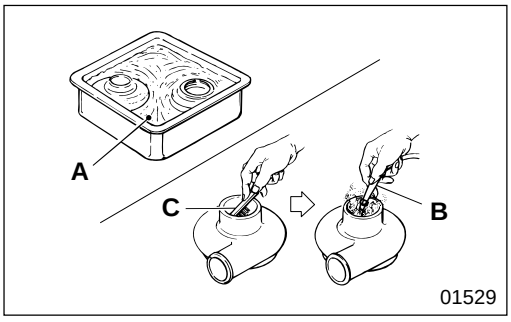
Turn the turbine wheel and the compressor wheel of cartridge assembly **9** to make sure that they turn smoothly.



5 Removal of turbine housing

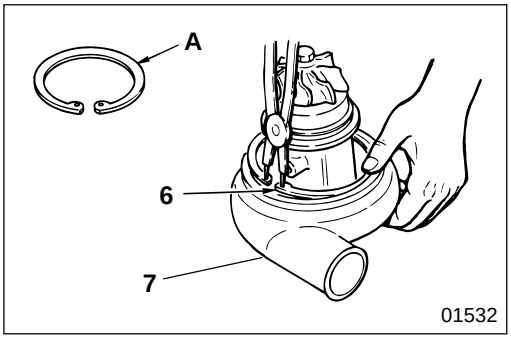
CAUTION

- **When removing turbine housing 5, tap all around the circumference lightly using rubber-headed hammer A so as not to damage the turbine housing.**
- **Do not hit the turbine wheel near turbine housing 5, since the blade of the turbine wheel can be easily bent.**



5 7 Cleaning of turbine housing and compressor cover

- Visually inspect related parts before cleaning to check if there are any burns or scratches as these would not be seen after cleaning. If any fault is found, replace the faulty parts.
- Remove any foreign particles before cleaning by scraping them off using plastic scraper or bristle-headed brush **C**. Immerse the disassembled parts in nonflammable solvent **A** (DAIDO KAGAKU KOGYO DAICLEANER T-30), then take them out and blow compressed air **B** on them.

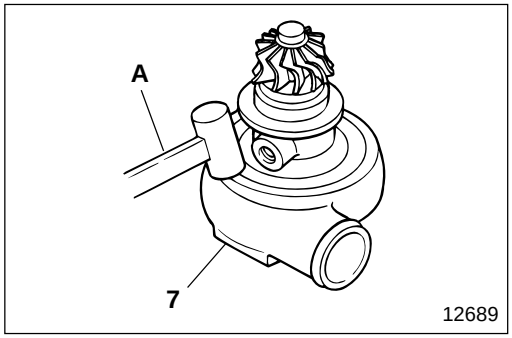


6 Installation of snap ring

Install snap ring **6** into compressor cover **7** with taper surface **A** upward.

WARNING

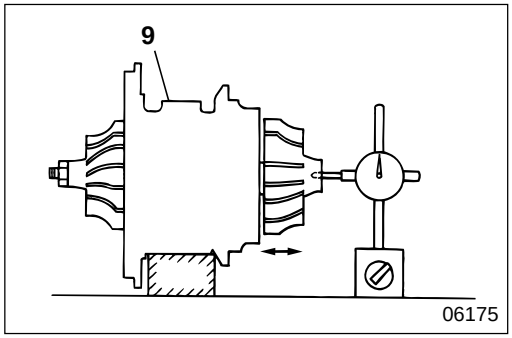
Use your hand to hold snap ring 6 in place to prevent it from springing out.



7 **Removal of compressor cover**

CAUTION

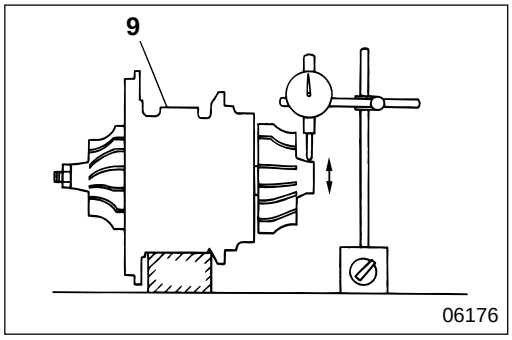
- **When removing compressor cover 7, tap all around the circumference lightly so as not to damage the compressor cover.**
- **Avoid hitting the compressor wheel near compressor cover 7, since the blade of the compressor wheel can be easily bent.**



9 **Inspection of cartridge assembly**

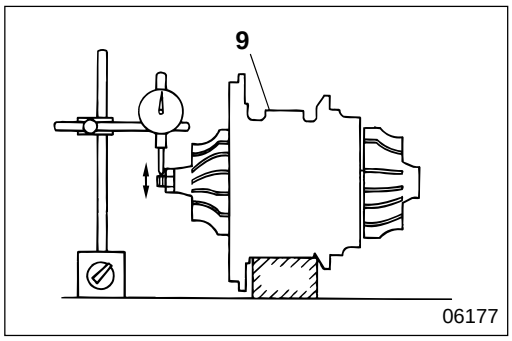
(1) Play in the shaft direction of the shaft and turbine wheel assembly

If the measured value deviates from the standard value, replace cartridge assembly **9**.

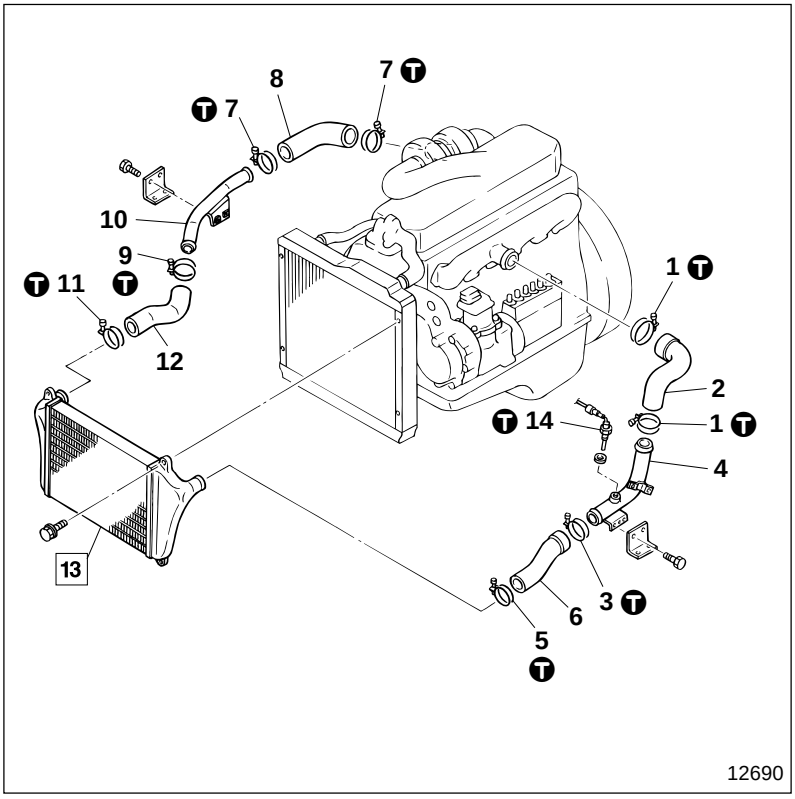


(2) Play at right angles to the shaft of the shaft and turbine wheel assembly

- Play on turbine wheel side
  If the measured value is higher than the limit, replace cartridge assembly **9**.



- Play on compressor wheel side
  If measured value is higher than the limit, replace cartridge assembly **9**.



● **Disassembly sequence**

1 Clamp
2 Air inlet hose
3 Clamp
4 Air inlet pipe
5 Clamp
6 Air inlet hose
7 Clamp
8 Air inlet hose
9 Clamp
10 Air inlet pipe
11 Clamp
12 Air inlet hose
13 Intercooler
14 Boost air temperature sensor Gr 13EB

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

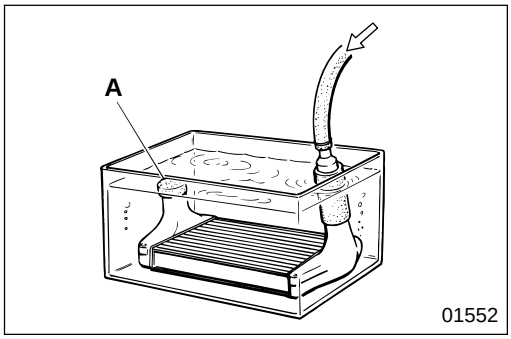
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
13	Air leakage from intercooler (Air pressure : 150 kPa {21 psi, 1.5 kg/cm²)	0 cm³ {0 cu. in.}	—	Replace

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5, 7, 9, 11	Clamp	2.9 to 3.4 {2.2 to 2.5, 0.3 to 0.35}	—
14	Boost air temperature sensor	14.7±2 {11±1.4, 1.5±0.2}	—

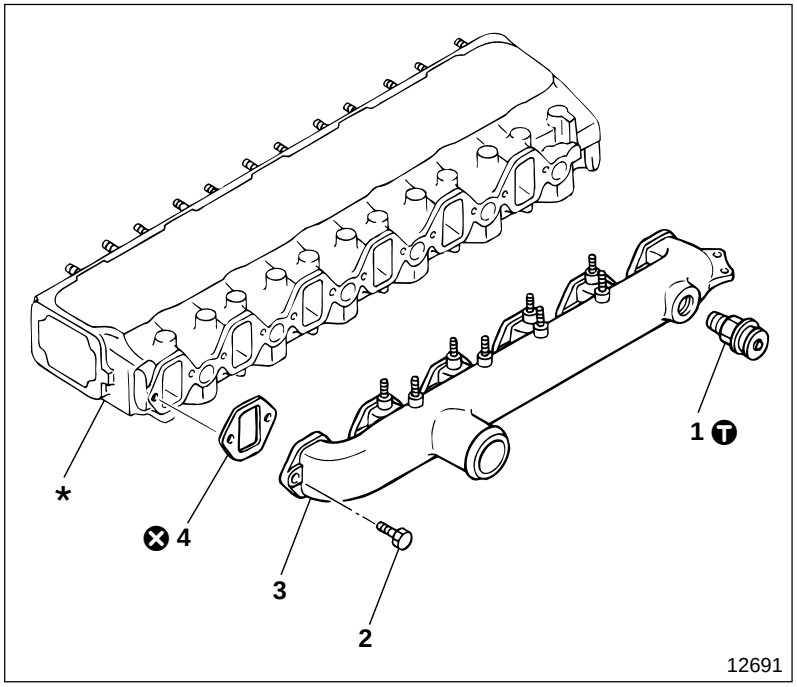


◆ Service procedure

13 **Inspection of intercooler**

- Fit plug **A** on one of the air inlets of intercooler **13** and connect a hose to the other, then lower the intercooler into the water tank. Apply air at the specified pressure (150 kPa {21 psi, 1.5 kgf/cm²}) from the hose side and check for air leaks.
- If air leaks, replace intercooler **13**.

INTAKE MANIFOLD



● **Disassembly sequence**

1 Over-boost valve
2 Bolt
3 Intake manifold
4 Gasket

* : Cylinder head Gr 11B
⊗ : Non-reusable parts

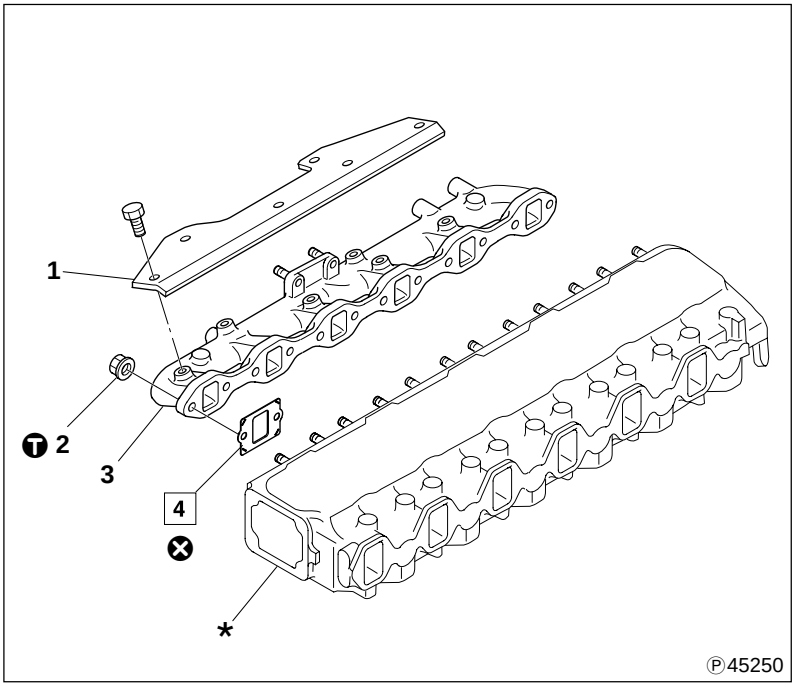
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Over-boost valve	49 {36, 5}	—



● **Disassembly sequence**

1 Insulator
2 Nut
3 Exhaust manifold
4 Gasket

* : Cylinder head Gr 11B
⊗ : Non-reusable parts

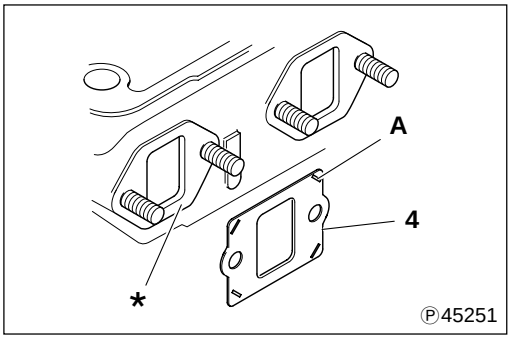
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Exhaust manifold mounting)	58 {43,5.9}	—

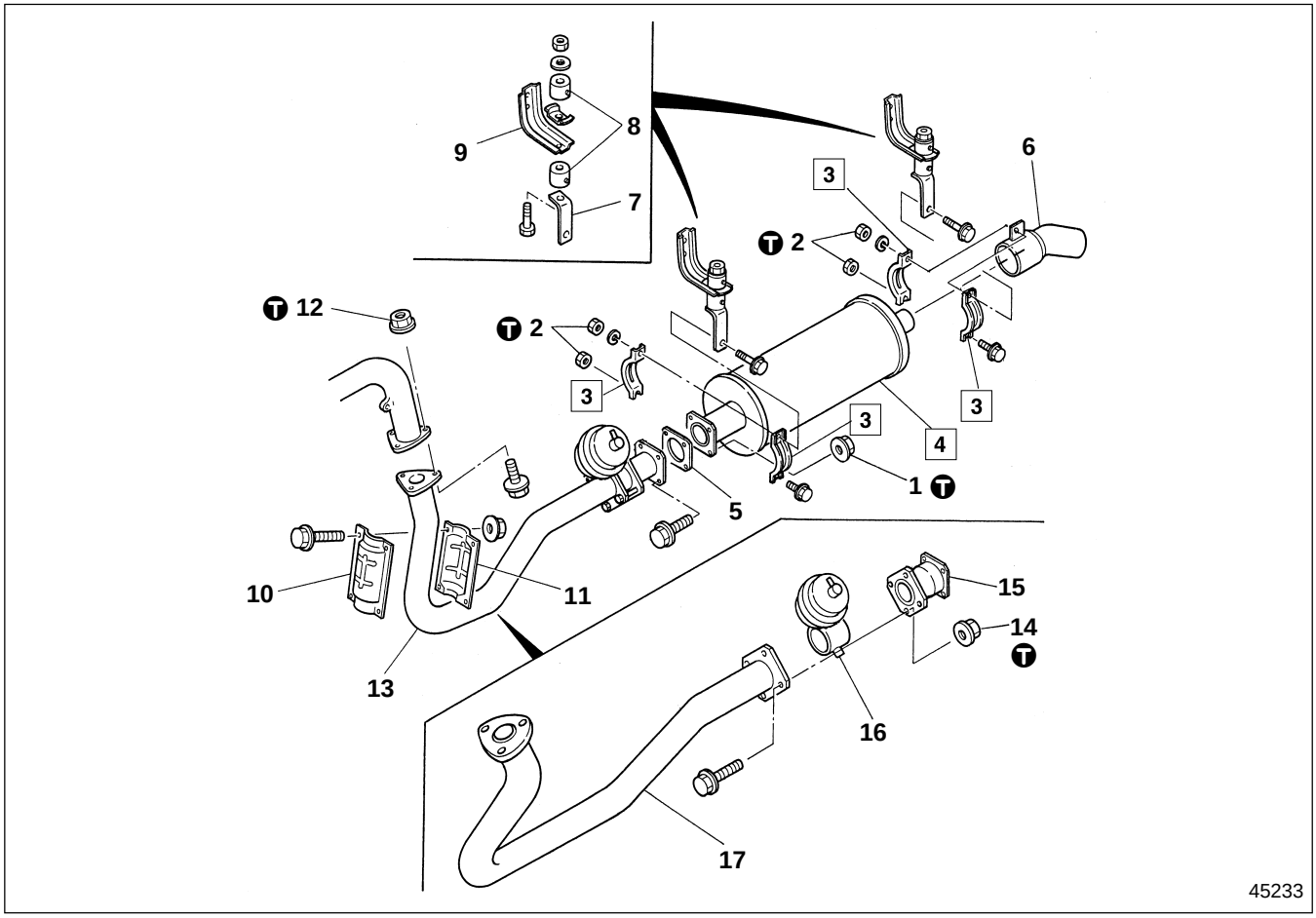


◆ Service procedure

4 **Installation of gasket**

Install gasket **4** on cylinder head * in the direction as illustrated.
A : Protrusion

EXHAUST PIPE AND MUFFLER



● **Disassembly sequence**

1 Nut
2 Nut
3 Clamp
4 Muffler
5 Gasket
6 Tail pipe
7 Pipe clamp stay
8 Rubber cushion
9 Exhaust pipe hanger
10 Exhaust pipe insulator
11 Exhaust pipe cover
12 Nut
13 Front pipe assembly
14 Nut
15 Center pipe
16 Exhaust brake unit Gr 35A
17 Front pipe

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

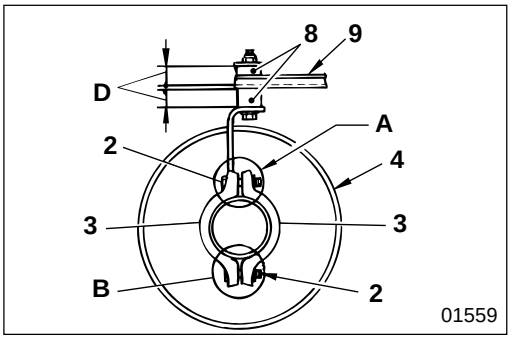
- **Never hit or kick muffler 4, or the catalyzer in the muffler will be damaged.**
- **A small amount of water sometimes collects inside muffler 4. Never touch this water, if you do by mistake, wash it off immediately with clean water.**

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

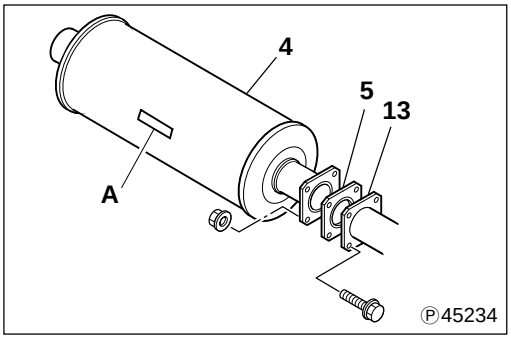
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Muffler mounting)	43 {32, 4.4}	—
2	Nut (Clamp tightening)	20 {14, 2}	—
12	Nut (Front pipe assembly mounting)	58 {43, 5.9}	—
14	Nut (Exhaust brake unit mounting)	58 {43, 5.9}	—

◆ Service procedure



3 **8** **Installation of clamp and rubber cushion**

- Tighten bolt **2** temporally to let clamp **3** move slightly.
- Tighten bolt **2** until it makes contact with area **A** of clamp **3**.
- After tightening area **A**, tighten area **B** using bolt **2**.
- Tighten until dimension **D** of rubber cushion **8** is as follows:
  D : Before tightening 25 mm {0.98 in.}
  After tightening 23 mm {0.91 in.}



4 **Installation of muffler**

Install muffler **4** on front pipe assembly **13** in the direction as illustrated.
A : Part No. marked position

MITSUBISHI
FUSO

Group 21

Clutch

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-21

INDEX

SPECIFICATIONS 21- 2

STRUCTURE AND OPERATION 21- 2

TROUBLESHOOTING 21- 5

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Clutch Fluid (Brake Fluid) Replacement and Air Bleeding 21- 6
- Clutch Pedal Free Play 21- 8

CLUTCH PEDAL 21-10

CLUTCH MASTER CYLINDER 21-14

CLUTCH POWER CYLINDER 21-16

WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY 21-18

CLUTCH BODY 21-20

CLUTCH CONTROL 21-30

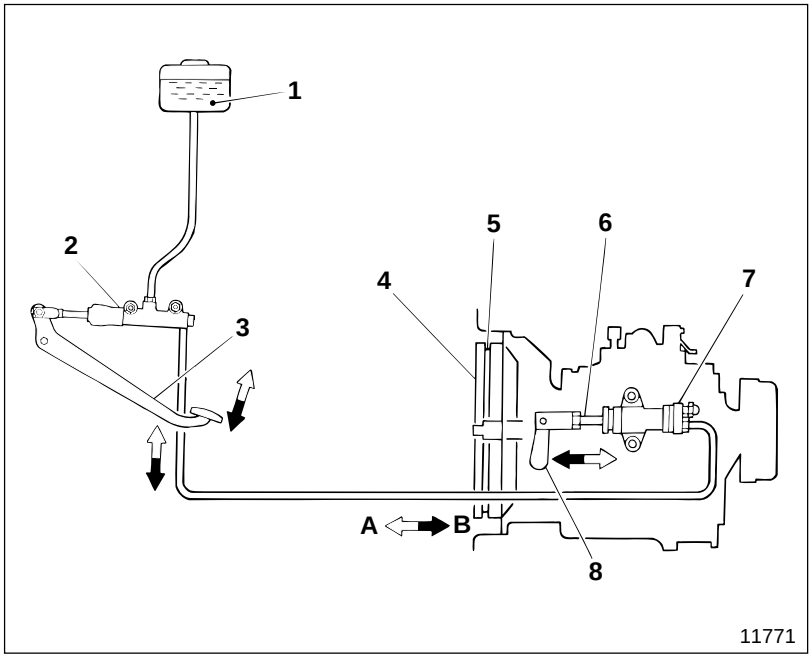
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Clutch	Model	C5M33
Drive type		Strap drive
Clutch disc	Type	Dry, single plate type
Pressure plate	Type	Coil spring type
Control system		Hydraulic pressure type
Clutch master cylinder	Manufacturer	NABCO
Clutch power cylinder	Manufacturer	NABCO

STRUCTURE AND OPERATION

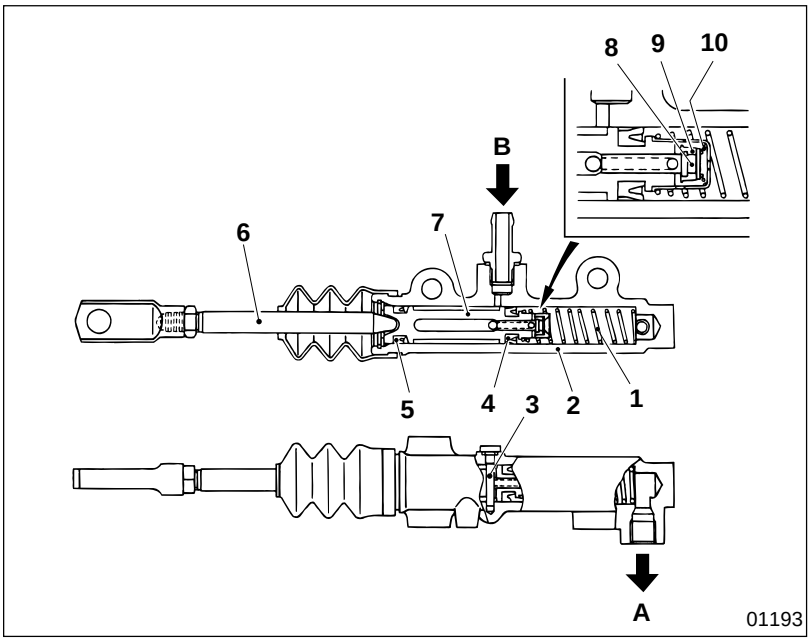
Clutch Control



1 Fluid tank
2 Clutch master cylinder
3 Clutch pedal
4 Flywheel
5 Clutch disc
6 Push rod
7 Clutch power cylinder
8 Release fork shaft

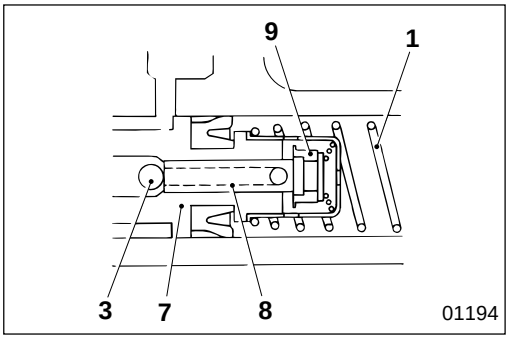
A : Engine power transmitted
B : Engine power cut off

Clutch Master Cylinder



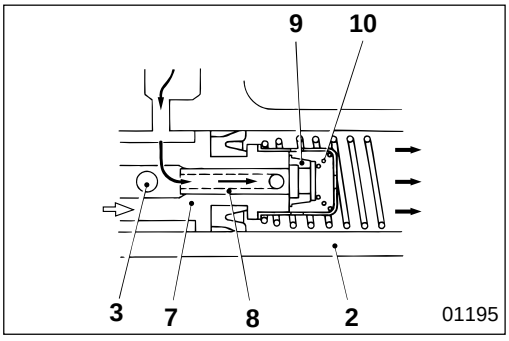
1 Return spring
2 Cylinder
3 Supply valve stopper
4 Primary cup
5 Secondary cup
6 Push rod
7 Piston
8 Supply valve rod
9 Supply valve
10 Supply valve spring

A : To clutch power cylinder
B : From fluid tank



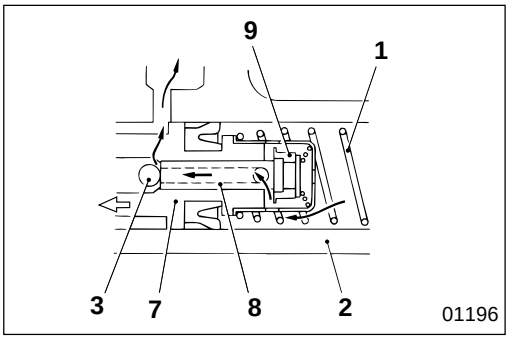
Before clutch pedal is depressed

- As piston **7** is pressed towards the push rod side by return spring **1**, supply valve rod **8** rests against supply valve stopper **3**, and supply valve **9** remains open.
- Thus, the passage between the fluid tank and the clutch is open.



When clutch pedal is depressed

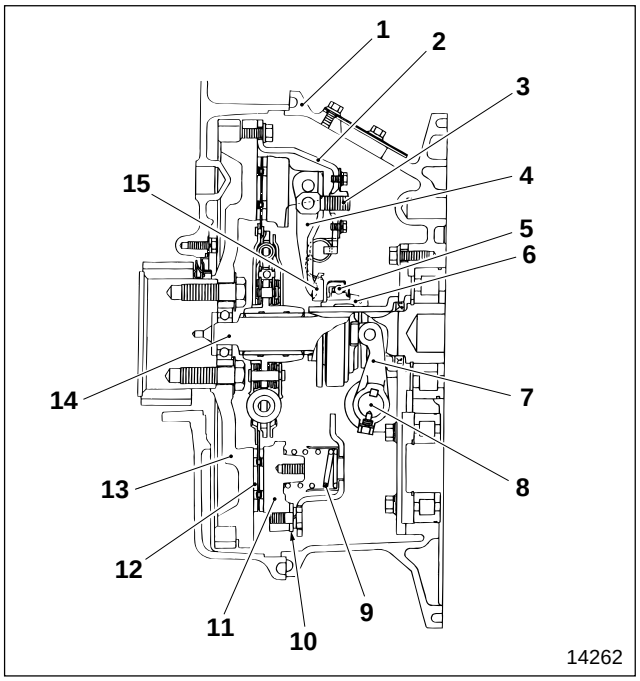
- As push rod **6** pushes piston **7**, supply valve rod **8** moves away from supply valve stopper **3**, and supply valve **9** is closed by the repercussive force of supply valve spring **10**.
- As piston **7** is pressed further, the hydraulic pressure generated within cylinder **2** actuates the clutch power cylinder.
- This results in fluid being supplied in direct proportion to the movement of piston **7**.



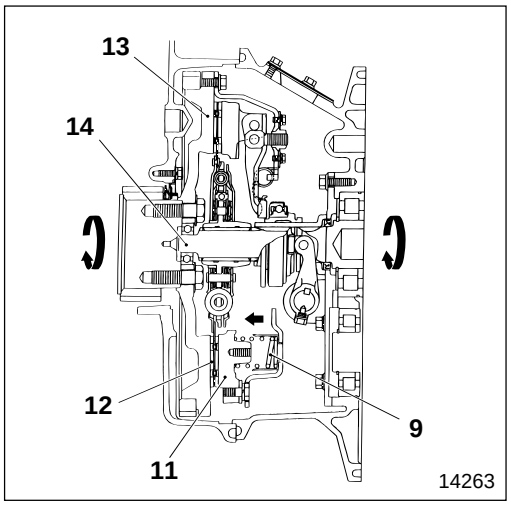
When clutch pedal is released

- As piston **7** is pushed back by the hydraulic pressure from cylinder **2** and the repercussive force of return spring **1**, supply valve rod **8** hits valve stopper **3** and supply valve **9** opens.
- Thus, the fluid in the clutch power cylinder side returns to the fluid tank and the hydraulic pressure drops to zero.

Clutch

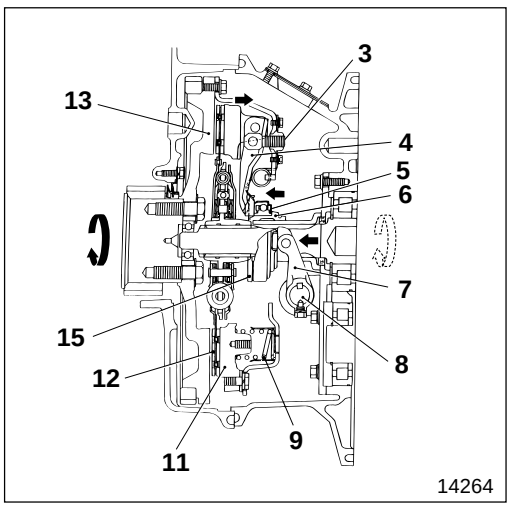


1 Clutch housing
2 Clutch cover
3 Support lever
4 Release lever
5 Release bearing
6 Clutch shifter
7 Release fork
8 Release fork shaft
9 Pressure spring
10 Strap plate
11 Pressure plate
12 Clutch disc
13 Flywheel
14 Drive pinion
15 Release lever plate



When clutch pedal is released

- Pressure plate **11**, activated by pressure spring **9**, presses clutch disc **12** firmly against flywheel **13**.
- Clutch disc **12** forced against flywheel **13** runs together with the flywheel and transmits power from the engine to transmission drive pinion **14**.



When clutch pedal is depressed

- Hydraulic pressure generated within the clutch master cylinder activates the clutch power cylinder. Thus, release fork shaft **8** actuates release fork **7**, pushing forward release bearing **5** and clutch shifter **6**, which in turn push release lever plate **15** and release lever **4**.
- Release lever **4**, using support lever **3** as a fulcrum, compresses pressure spring **9** and retracts pressure plate **11**, creating a clearance between clutch disc **12** and flywheel **13**, cutting off the transmission of engine power.

Possible causes \ Symptoms		Clutch disengaged but drags	Clutch slips	Clutch does not engage smoothly	Clutch makes noise on disengagement	Clutch makes noise on engagement	Judder when vehicle starting	Remarks
Pressure plate and lever assembly	Release bearing faulty	○			○			
	Release lever heights uneven	○	○	○			○	
	Pressure plate warped or faulty	○	○	○			○	
	Pressure spring fatigued		○	○		○		
	Strap bolts loose						○	
	Strap plate bent				○			
Clutch disc	Disc deformed	○		○			○	
	Disc rivets loose			○			○	
	Disc torsion spring fatigued or fractured		○	○	○	○	○	
	Spline worn	○			○	○	○	
	Spline rusted	○		○				
	Facing worn		○					
	Facing surface hardened		○	○			○	
	Facing oily or greasy		○	○			○	
Clutch pedal	Pedal free play inadequate		○					
	Pedal free play excessive	○						
	Pedal stroke inadequate	○						
	Return spring fatigued		○					
	Pedal friction surfaces faulty			○			○	
Clutch master cylinder	Piston and piston cup sliding movement faulty	○	○	○				
	Spring fatigued	○	○	○				
	Brake fluid port clogged	○	○	○				
Clutch power cylinder	Return spring fatigued	○	○	○				
	Piston and piston cup sliding movement faulty	○	○	○				
	Brake fluid port clogged	○	○	○				
Clutch control	Release bearing faulty						○	
	Clutch shifter sliding movement faulty						○	
	Clutch shifter lubricated incorrectly						○	
	Clutch release fork deformed						○	
Transmission drive pinion spline area worn		○				○		Gr 22
Engine idling speed too slow						○		Gr 13A, B
Engine mounting fatigued							○	
Flywheel warped, deformed or stepped wear		○	○	○			○	Gr 11A, B
Flywheel pilot bearing faulty		○			○			Gr 11A, B
Air mixed in clutch hydraulic system		○						
Clutch hydraulic system leaking		○						

ON-VEHICLE INSPECTION AND ADJUSTMENT

Clutch Fluid (Brake Fluid) Replacement and Air Bleeding

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

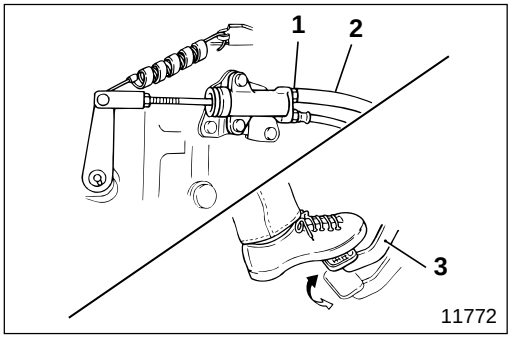
Location	Parts to be tightened	Tightening torque	Remarks
1	Air bleeder	25 to 34 {18 to 25, 2.5 to 3.5}	—

Fluid

Location	Points of application	Kinds	Quantity
4	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

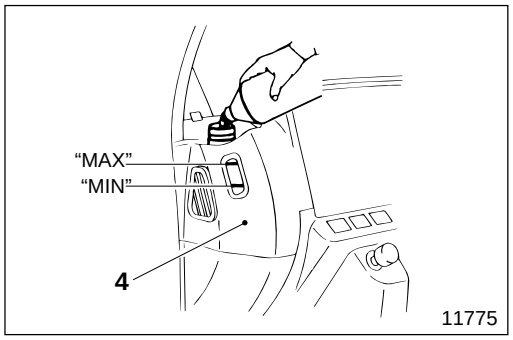
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system to swell, resulting in faulty clutch operation.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will cause faulty clutch operation.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**

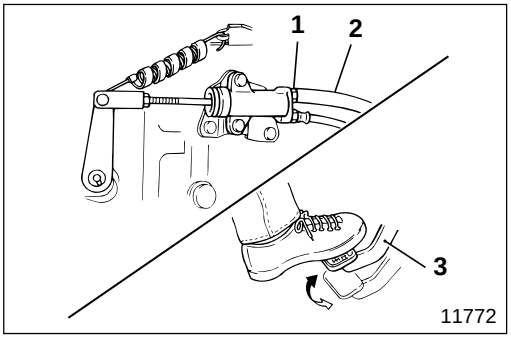


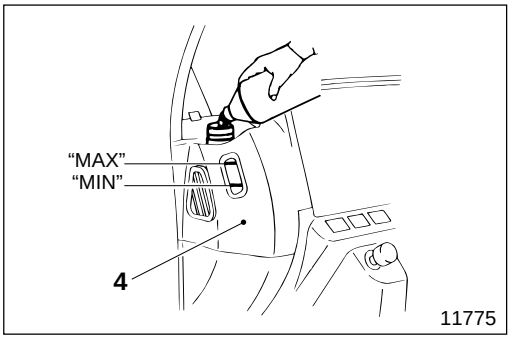
(1) Replacement of brake fluid

- Attach vinyl pipe **2** to air bleeder **1** of the clutch power cylinder.
- Loosen air bleeder **1** and depress clutch pedal **3** several times to drain brake fluid completely.



- Supply new brake fluid to the "MAX" level of fluid tank **4**. Depress clutch pedal **3** repeatedly until the old brake fluid discharged from vinyl pipe **2** is replaced by the new brake fluid.





(2) Air bleeding of clutch system

NOTE

Carry out this operation maintaining the brake fluid level in fluid tank 4 between "MAX" and "MIN".

- Attach vinyl pipe **2** to air bleeder **1** of the clutch power cylinder as in the replacement procedure.
- Fill fluid tank **4** with brake fluid, and loosen air bleeder **1** of the clutch power cylinder, then depress clutch pedal **3** continuously.
- Keep depressing clutch pedal **3**, and tighten air bleeder **1** when air is bled completely.
- Depress clutch pedal **3** several times again, then keep it depressed at its fullest extent.
- With the clutch pedal depressed, loosen air bleeder **1** to drain brake fluid containing air. Release the pedal after tightening the air bleeder.
- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten air bleeder **1** at specified torque.
- Check that brake fluid is at the "MAX" level of fluid tank **4**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **3** depressed.

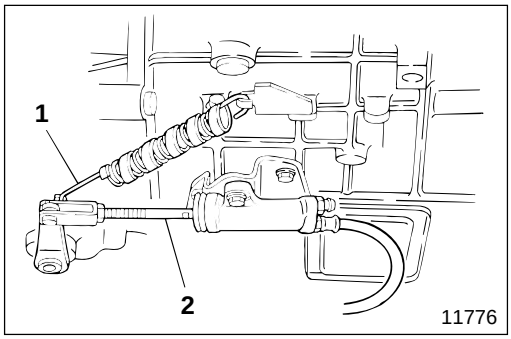
Clutch Pedal Free Play

Service standards

Unit : mm {in.}

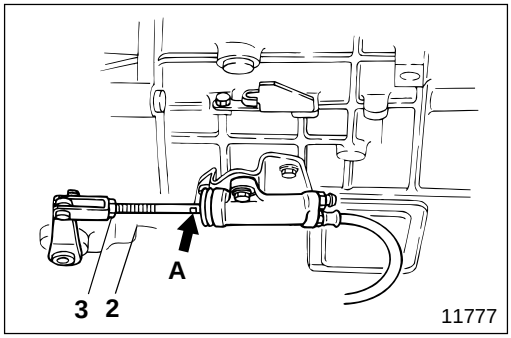
Location	Maintenance item	Standard value	Limit	Remedy
2	Push rod stroke	3.6 {0.14}	—	Adjust or replace
4	Clutch pedal free play	37 to 52 {1.46 to 2.05}	—	Adjust or replace

Inspect and adjust the free play of the clutch pedal, by noting the stroke of the clutch power cylinder push rod, after the clutch pedal has been correctly adjusted.



[Inspection]

- Bleed air from the clutch system. P21-7
- Adjust the clutch pedal. P21-11
- Disconnect return spring **1** and check the free play of push rod **2** by hand. If the measured value deviates from the standard value, adjust as follows:

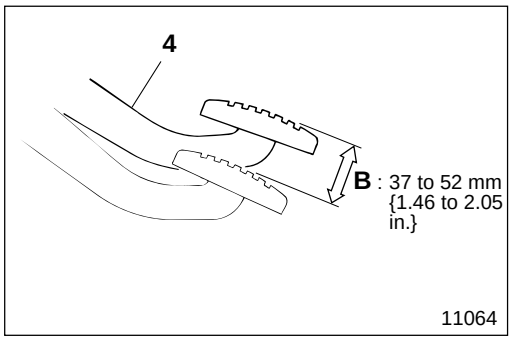


[Adjustment]

- Loosen nut **3** and turn head **A** of push rod **2** to extend the push rod until it stops.
- Then, slacken off head **A** of push rod **2** by the following value and retighten nut **3**.

  Amount of slackening off : Approximately three turns

- If push rod **2** does not return by the above amount, replace the clutch disc because it is worn beyond the limit.



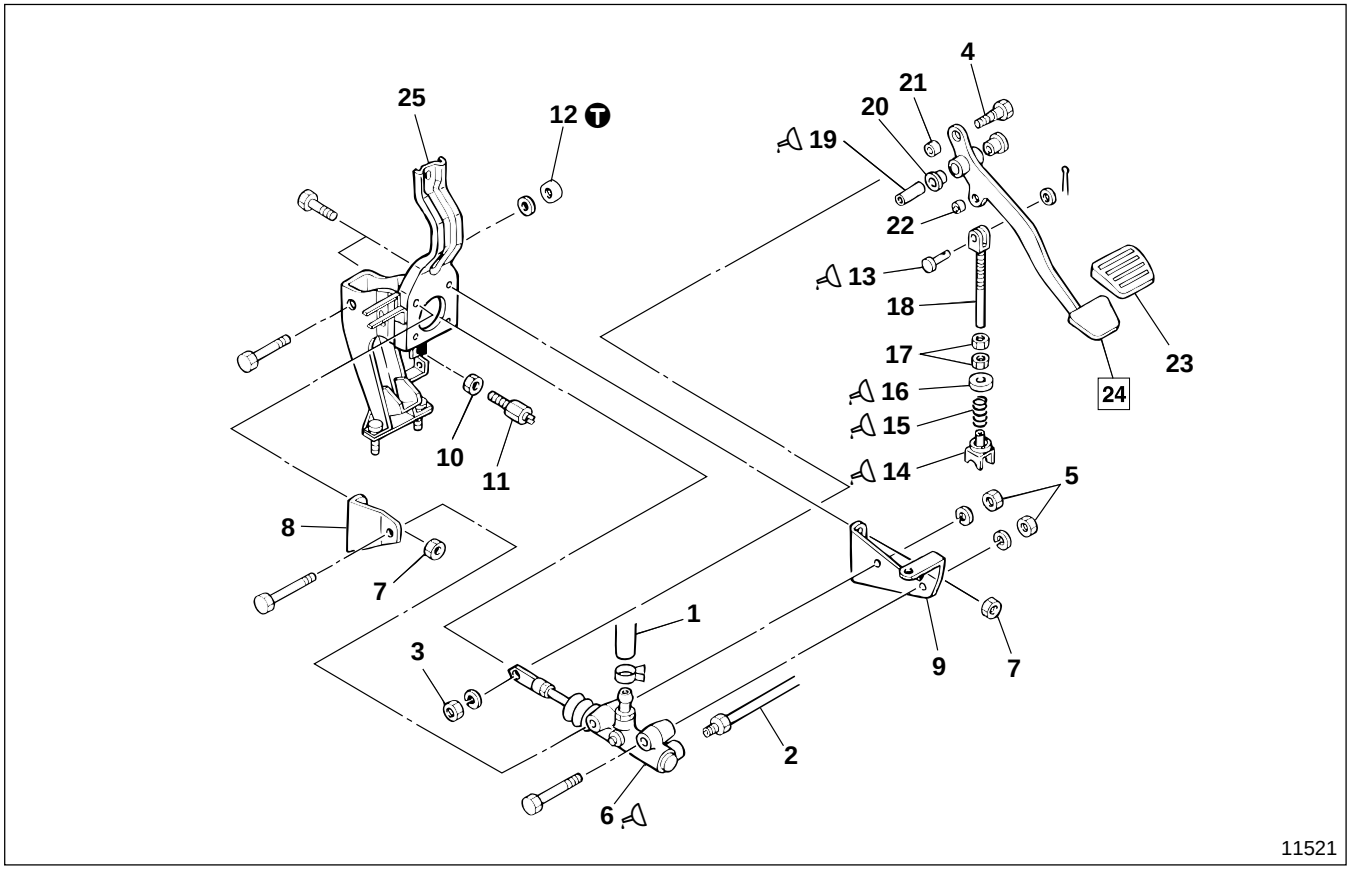
[Confirmation]

Push clutch pedal **4** with your hand until you feel a resistance and measure free play **B**.

If the measured value deviates from the standard value, readjust or replace the clutch disc.

M E M O

CLUTCH PEDAL



● **Disassembly sequence**

1 Fluid hose
2 Fluid pipe
3 Nut
4 Offset bolt
5 Nut
6 Clutch master cylinder
P21-14
7 Nut
8 Clutch master cylinder bracket, LH
9 Clutch master cylinder bracket, RH
10 Nut
11 Clutch switch
Gr 54
12 Nut
13 Clevis pin
14 Spring holder
15 Return spring
16 Plate
17 Nut
18 Spring assist rod
19 Collar
20 Bushing
21 Bushing
22 Bushing
23 Pedal pad
24 Clutch pedal
25 Clutch pedal support

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly**

P21-11

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
4, 21	Clearance between offset bolt and bushing	[18] 0.06 to 0.36 {[0.71] 0.0024 to 0.014}	—	Replace
15	Installed load of return spring (Installed length 37 {1.46})	185 N {41 lbf, 18.7 kgf}	160 N {36 lbf, 16.5 kgf}	Replace
19, 20	Clearance between collar and bushing	[14] 0.02 to 0.26 {[0.55] 0.00079 to 0.010}	0.3 {0.012}	Replace

Tightening torque

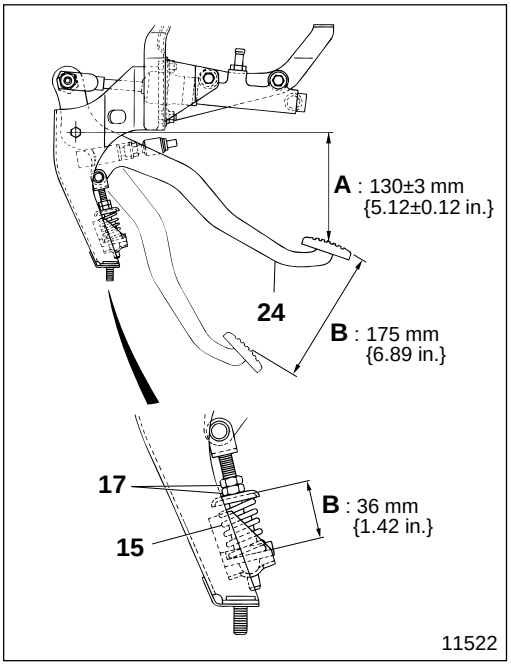
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
12	Nut (Clutch pedal mounting)	16.7 to 25.5 {12 to 19, 1.7 to 2.6}	—

Lubricant

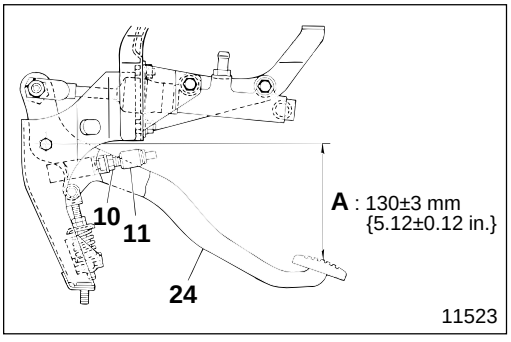
Location	Points of application	Kinds	Quantity
6	Offset bolt mounting area	Chassis grease [NLGI No.1 (Ca soap)]	As required
13	Clevis pin	Chassis grease [NLGI No.1 (Ca soap)]	As required
14 to 16	Friction surfaces of spring holder, return spring and plate	Chassis grease [NLGI No.1 (Ca soap)]	As required
19	External surface of collar	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



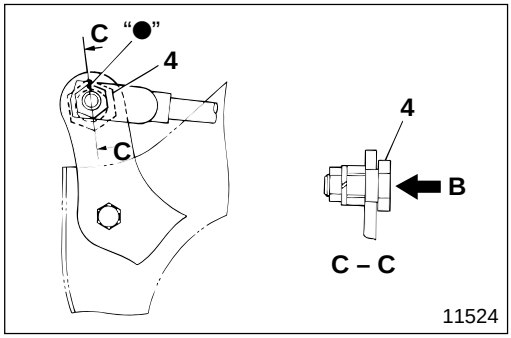
● **Adjustment after assembly**

Adjust return spring **15** to the installed dimension **C** using lock nut **17**, maintaining the installed dimensions **A**, **B** for clutch pedal **24**.

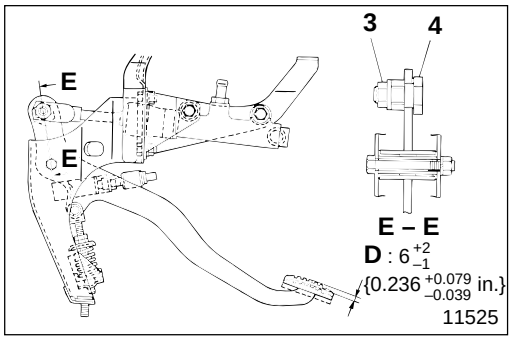


24 **Adjustment of clutch pedal**

- Turn clutch switch **11** to obtain the illustrated dimension **A**, and tighten nut **10**.



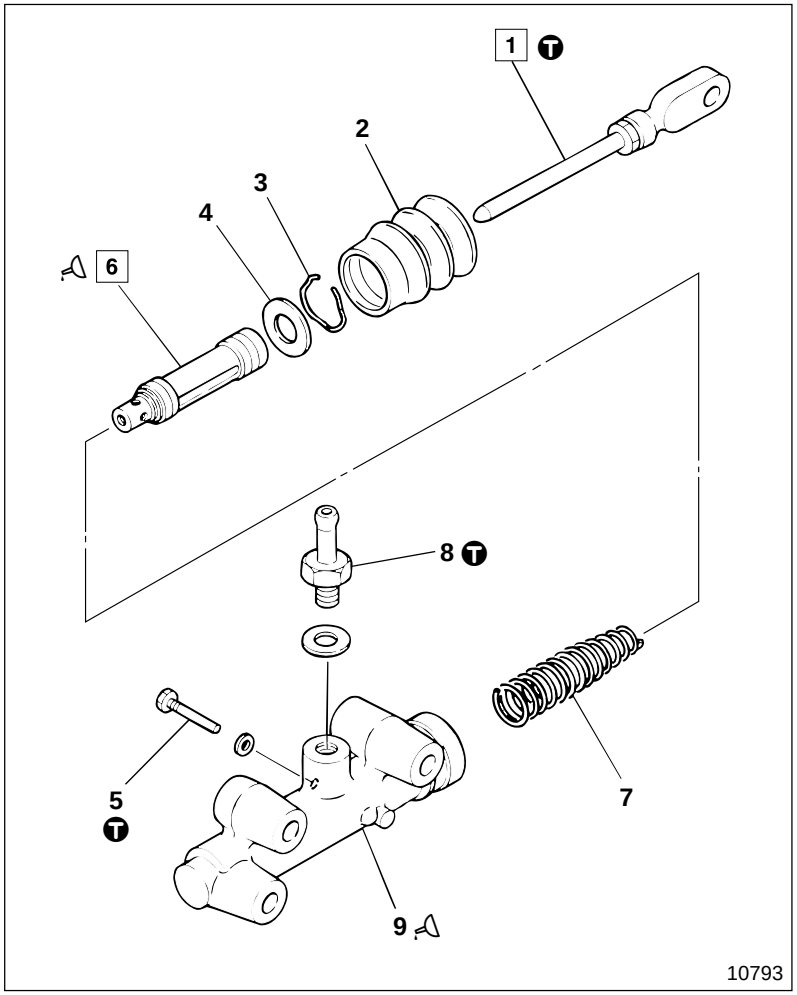
- At this time, temporarily tighten offset bolt **4** at the illustrated position.
  B : "●" Marked side



- Then, turn offset bolt **4** to adjust free play **D** of the clutch pedal top to conform to the dimension as illustrated, and tighten using nut **3**.

M E M O

CLUTCH MASTER CYLINDER



● **Disassembly sequence**

1 Push rod
2 Boot
3 Piston stop ring
4 Piston stop plate
5 Supply valve stopper
6 Piston assembly
7 Return spring
8 Nipple
9 Cylinder

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Piston and boot kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6, 9	Clearance between piston assembly and cylinder	[19.05] 0.020 to 0.105 {[0.750] 0.00079 to 0.0041}	0.2 {0.0079}	Replace
7	Free length of return spring	97 {3.82}	92 {3.62}	Replace

Tightening torque

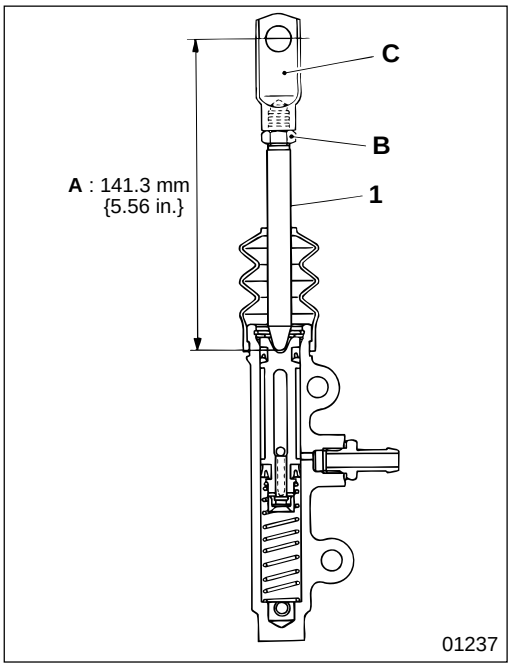
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Push rod (Lock nut tightening)	9.8 to 14.7 {7.2 to 11, 1.0 to 1.5}	—
5	Supply valve stopper	1.47 to 2.94 {1.1 to 2.2, 0.15 to 0.3}	—
8	Nipple	24.5 to 34.3 {18 to 25, 2.5 to 3.5}	—

Lubricant

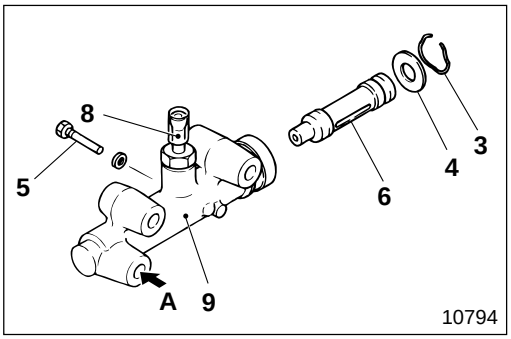
Location	Points of application	Kinds	Quantity
6, 9	Friction surfaces of piston assembly and cylinder body	Rubber grease	As required

◆ Service procedure



1 Adjustment of push rod length

If dimension **A**, as illustrated, deviates from the standard value, loosen lock nut **B** of push rod **1**, and adjust the length by turning head **C**.
After adjustment, tighten the lock nut at specified torque.



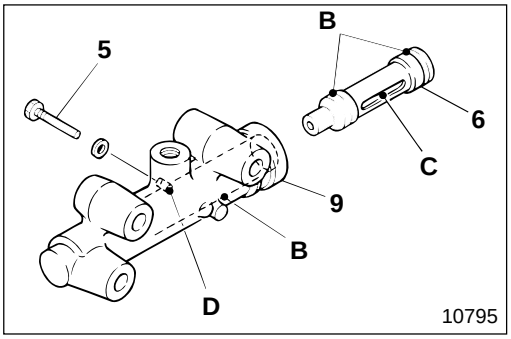
6 Piston assembly

[Removal]

- Remove piston stop ring **3**, piston stop plate **4** and supply valve stopper **5**.
- Block nipple **8** of cylinder **9**, and apply compressed air from **A** as illustrated to remove piston assembly **6**.

WARNING⚠

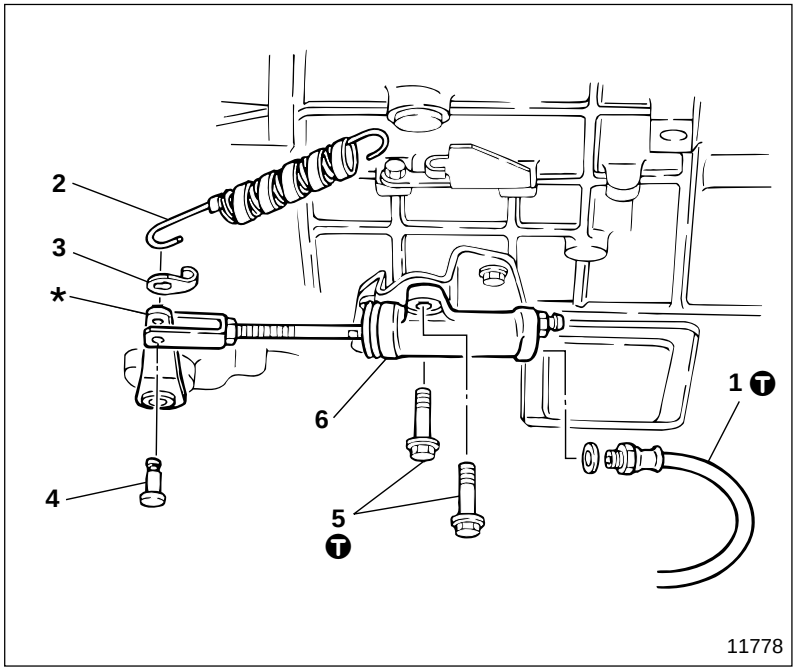
You must apply compressed air gradually when you remove piston assembly 6. If you applied compressed air strongly at one time, the piston assembly would be violently ejected.



[Installation]

- Before installing the assembly, apply rubber grease to friction surface **B** of piston assembly **6** and cylinder **9**.
- To install the piston, align groove **C** of piston assembly **6** with hole **D** of cylinder **9**, then insert valve stopper **5** to hold the piston in place.

CLUTCH POWER CYLINDER



● **Removal sequence**

1 Fluid hose
2 Return spring
3 Return spring claw
4 Clevis pin
5 Bolt
6 Clutch power cylinder assembly
📖 P21-17

***** : Clutch release fork shaft

CAUTION⚠

Make sure you plug the hose opening after disconnection to prevent fluid from running out.

● **Installation sequence**

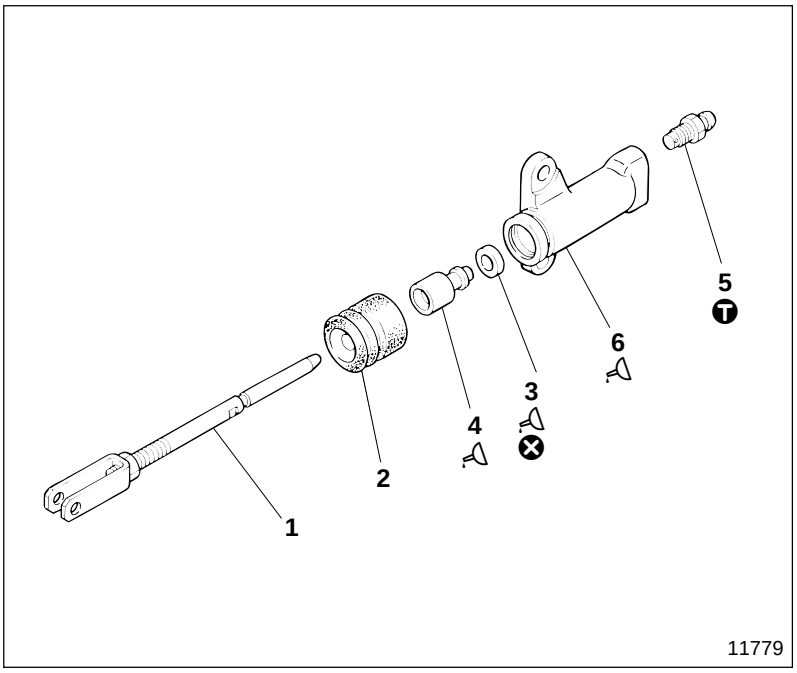
Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Tightness of fluid hose connection	21 to 31 {15 to 23, 2.1 to 3.2}	—
5	Bolt (Clutch power cylinder assembly mounting)	47 {35, 4.8}	—

Clutch Power Cylinder Assembly



● **Disassembly sequence**

1 Push rod
2 Boot
3 Piston cup
4 Piston
5 Air bleeder
6 Cylinder

⊗ : Non-reusable parts

● **Assembly sequence**

4→3→6→5→2→1

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
4, 6	Clearance between cylinder and piston	[20.64] 0.04 to 0.125 {[0.81] 0.0016 to 0.0049}	0.24 {0.0094}	Replace

Ⓣ Tightening torque

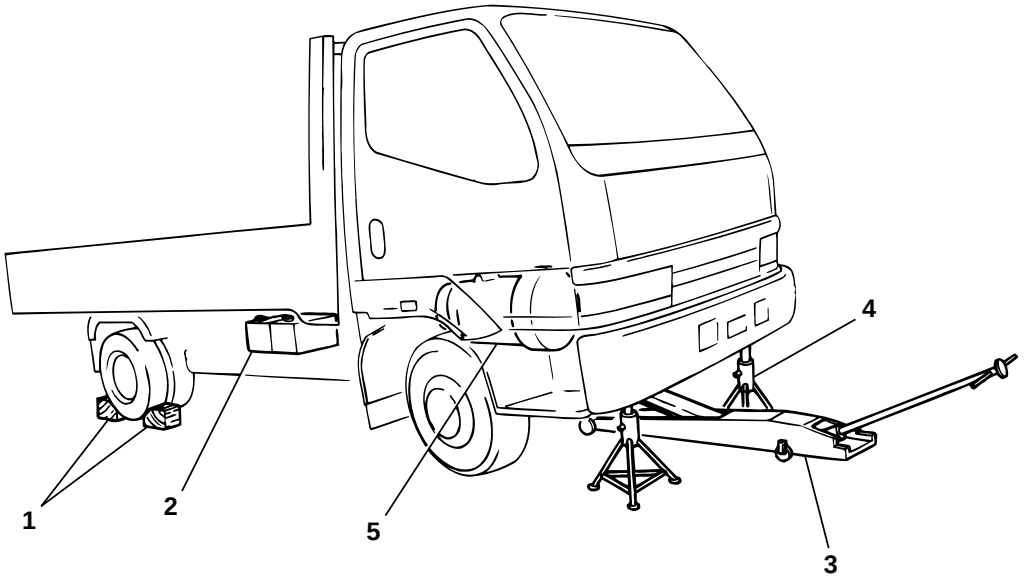
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Air bleeder	25 to 34 {18 to 25, 2.5 to 3.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
3	Piston cup circumference	Rubber grease	As required
4	Friction surface of piston	Rubber grease	As required
6	Cylinder bore	Rubber grease	As required

WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY



14118

● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the front axle using a garage jack.
4 Support the front frame on rigid racks.
5 Remove the transmission. Gr 22

WARNING

- **Since the parking brake will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Keep the transmission in neutral throughout the operation.

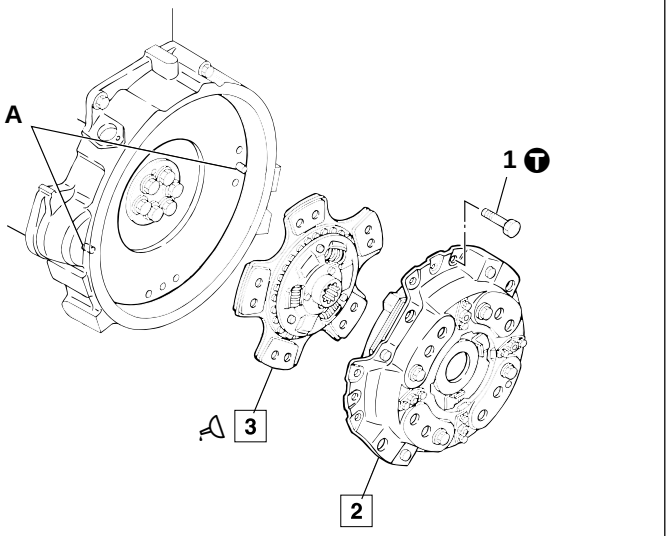
● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

CLUTCH BODY

Clutch Disc



● **Removal sequence**

1 Bolt
2 Pressure plate and lever assembly
P21-24
3 Clutch disc

A : Positioning pins (two points)

WARNING

Be careful when you handle pressure plate and lever assembly 2 because it is rather heavy.

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Be careful not to get oily substances on clutch disc 3 surfaces because this will cause the clutch to slip.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Clutch disc	Lateral runout	1.2 {0.047} or less	—	Replace
		Vertical runout	1.2 {0.047} or less	1.8 {0.071}	Replace
		Play in revolving direction at spline	0.06 to 0.21 {0.0024 to 0.0083}	0.5 {0.02}	Replace
		Depth from facing surface to cup	0.79 to 1.43 {0.031 to 0.056}	0.2 {0.0079}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

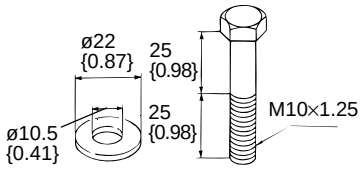
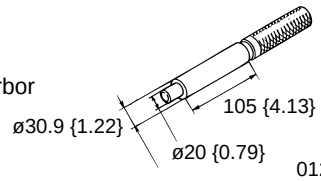
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Pressure plate and lever assembly mounting)	32 to 49 {24 to 36, 3.3 to 5.0}	—

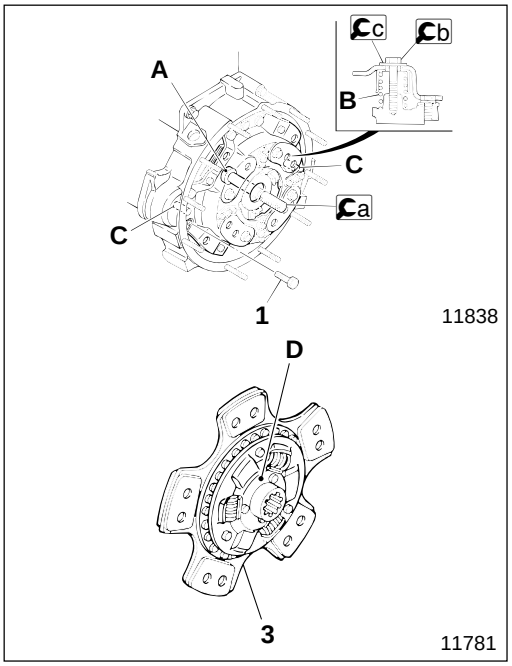
Lubricant

Location	Points of application	Kinds	Quantity
3	Spline of clutch disc	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	3.2 to 4.2 g {0.11 to 0.15 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Stopper bolt Washer  02378	ME521425 < Stopper bolt > ME521426 < Washer >	Removal and installation of pressure plate and lever assembly
3	Clutch alignment arbor  01270	MH061986	Holding of clutch disc



◆ Service procedure

2 Removal and installation of pressure plate and lever assembly

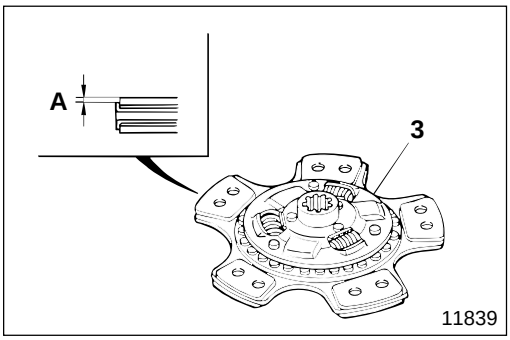
- Insert a clutch alignment arbor into flywheel pilot bearing **A** to hold clutch disc **3**.
- Compress pressure springs **B** using b stopper bolt and c washer, then remove bolt **1**.
- For installation, follow the removal sequence in reverse.
- Install clutch disc **3** so that part No. **D** is visible.
- Tighten bolts **1** gradually, in diagonal order, to specified torque.

CAUTION

- **Make sure you use b stopper bolts and c washers (four points) when you remove bolt 1. If you do not, pressure springs B might force up pressure plate and lever assembly 2, damaging the strap plate, and separate and fall off knock pin C.**
- **Remember to remove b stopper bolts and c washers after installation (four points). If the stopper bolts and washers are left on, the clutch will not engage.**

NOTE

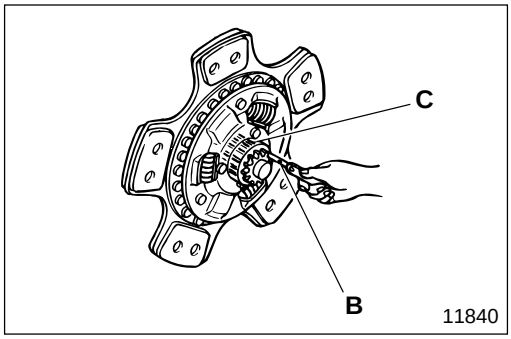
Clean flywheel contact surface of clutch disc 3 before installing pressure plate and lever assembly 12.



3 Clutch disc

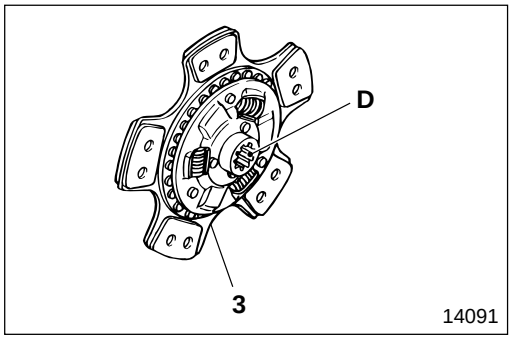
(1) Height of facing

Measure illustrated dimension **A** of clutch disc **3**. If the measured value is lower than the limit, replace the clutch disc.



(2) Play in direction of revolution

- First, reshape feeler gauge **B** for insertion into drive pinion spline **C**, and measure play at the spline.
- If the measured value is higher than the limit, replace clutch disc **3** or the drive pinion.
- Carry out the same measurement on new clutch disc **3**. If the measured value is higher than the limit, replace the drive pinion.



(3) Applying grease

Apply grease evenly to spline **D** and the entire tooth surface of clutch disc **3**. Apply grease to the grease groove of spline up to its large diameter.

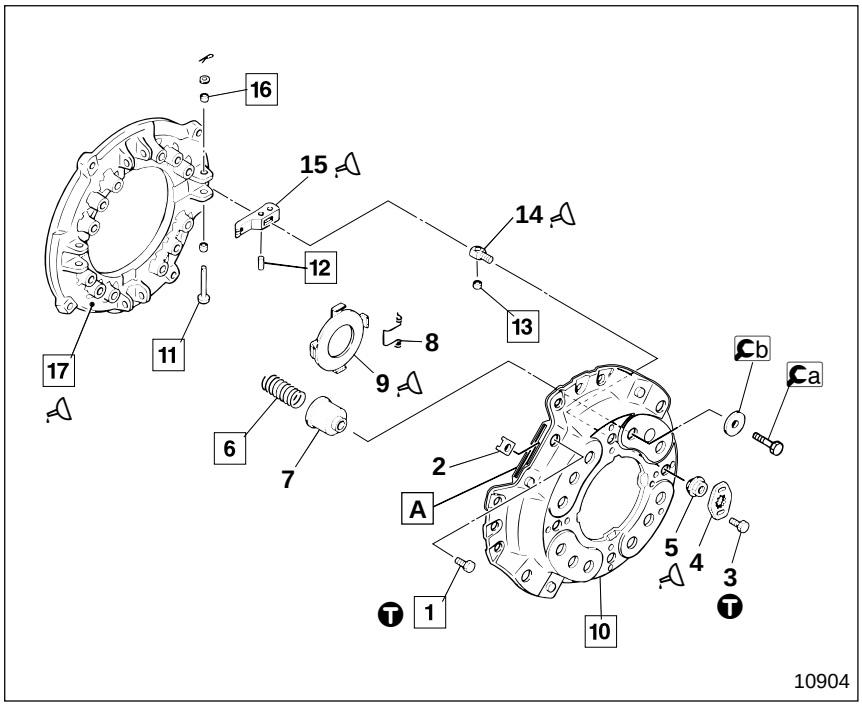
CAUTION

Be careful not to apply too much grease because excessive grease causes grease leakage from the spline D and makes the clutch slippery.

M E M O

CLUTCH BODY

Pressure Plate and Lever Assembly



● **Work before disassembly**

P21-26

● **Disassembly sequence**

1 Strap bolt
2 Washer
3 Bolt
4 Lock plate
5 Support nut
6 Pressure spring
7 Pressure spring cap
8 Return spring
9 Release lever plate
10 Clutch cover
11 Release lever pin
12 Support lever pin
13 Bushing
14 Support lever
15 Release lever
16 Bushing
17 Pressure plate

A : Strap plate
a : Stopper bolt
b : Washer

NOTE

Do not remove bushings 13, 16 unless they are faulty.

● **Assembly Sequence**

Follow the disassembly sequence in reverse.
Repair kit : Clutch release lever kit

● **Inspection and adjustment after assembly**

P21-26

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1, A	Clearance between strap bolt and strap plate		0.01 to 0.16 {0.00039 to 0.0063}	0.3 {0.012}	Replace
6	Pressure spring	Installed load (Installed length 49.1 {1.93})	885 N {200 lbf, 90.2 kgf}	750 N {170 lbf, 76.7 kgf}	Replace
		Tilt	2.9 {0.11} or less	5.0 {0.20}	Replace
9	Height of release lever plate		53.8±0.7 {2.12±0.028}	Difference between any two: 0.5 {0.020} or less	Adjust
11, 16	Clearance between release lever pin and bushing		[10] 0.02 to 0.11 {[0.39] 0.00079 to 0.0043}	0.4 {0.016}	Replace
12, 13	Clearance between support lever pin and bushing		[10] 0.02 to 0.12 {[0.39] 0.00079 to 0.0047}	0.4 {0.016}	Replace
17	Pressure plate	Thickness	23.6±0.1 {0.93±0.0039}	21 {0.83}	Replace
		Flatness	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Inner diameter of strap bolt fitting hole	10.2 to 10.25 {0.402 to 0.404}	10.5 {0.41}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

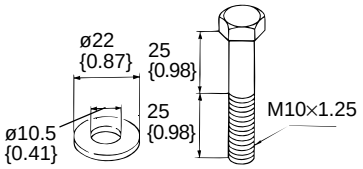
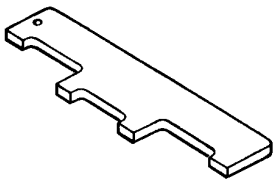
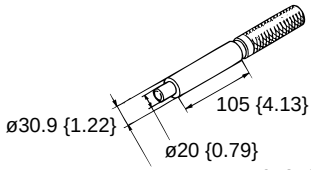
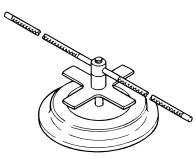
Location	Parts to be tightened	Tightening torque	Remarks
1	Strap bolt (Strap plate mounting)	39 to 59 {29 to 43, 4 to 6}	—
3	Bolt (Lock plate mounting)	5.9 to 7.8 {4.3 to 5.8, 0.6 to 0.8}	—

Lubricant

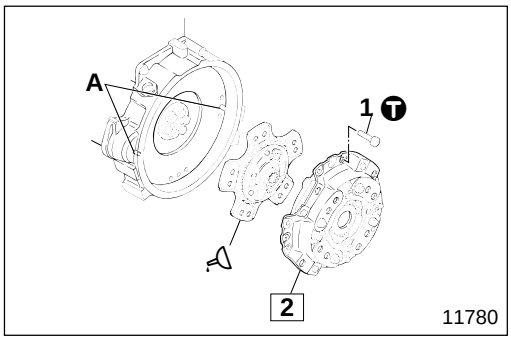
Location	Points of application	Kinds	Quantity
5	Thread area and spherical surfaces of support nut	Anti-seizure compound	As required
9, 15	Friction surfaces of release lever plate and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
14, 15	Friction surfaces of support lever and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
15, 17	Friction surfaces of release lever and pressure plate	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Stopper bolt Washer  02378	(Obtain Locally) ME521425 < Stopper bolt > ME521426 < Washer >	Disassembly and assembly of pressure plate and lever assembly
9	Clutch release Lever aligner 	315560 (chrome)	Adjust release lever heights
	Clutch alignment arbor  01270	MH061986	Holding of clutch disc
10	Clutch installer  01277	N/A MH061051	Removal and installation of clutch cover

◆ Service procedure



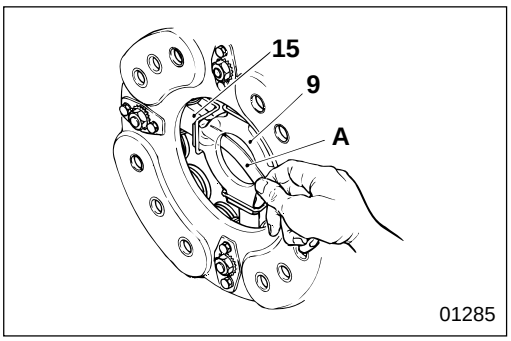
● **Work before disassembly**

Put alignment marks on all parts before disassembly.

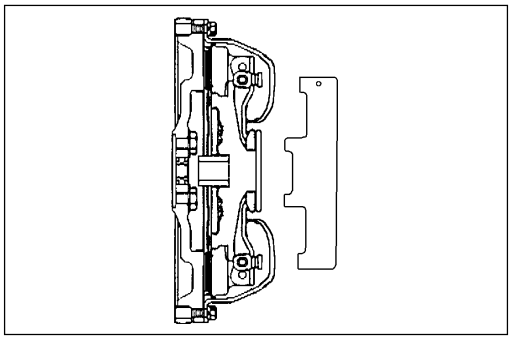
● **Inspection and adjustment after assembly**

(1) Measurement of release lever height

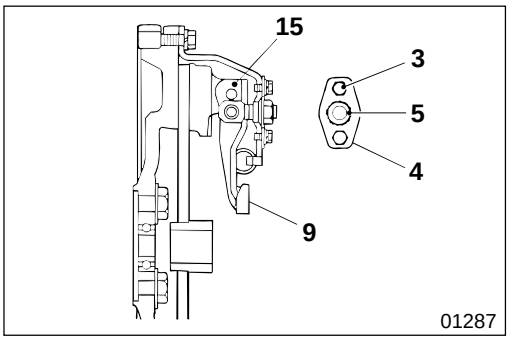
- Install the pressure plate assembly and clutch disc.



- Make certain that the clearance between release lever **15** and release lever plate **9** is such that a 0.05 mm {0.0020 in.} feeler gauge **A** cannot be inserted between them.
  If there is excessive clearance, press in strongly using your fingers, and return slowly to lessen the clearance.

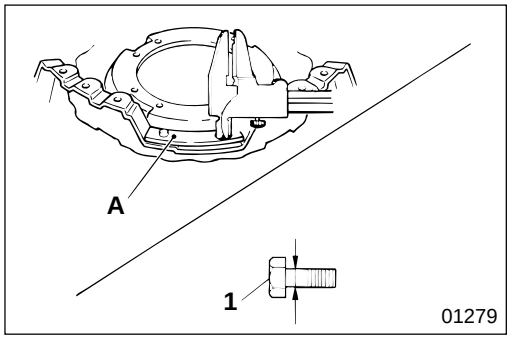


- Check clutch release lever height by using 09 clutch release lever aligner to upper surface of release lever plate **9** (at four points).
  If the measured value does not conform to the gauge, adjust as explained below. Note that even if the measured value is within the standard value, adjustment is necessary if the difference between any two points is higher than 0.5 mm {0.020 in.}.



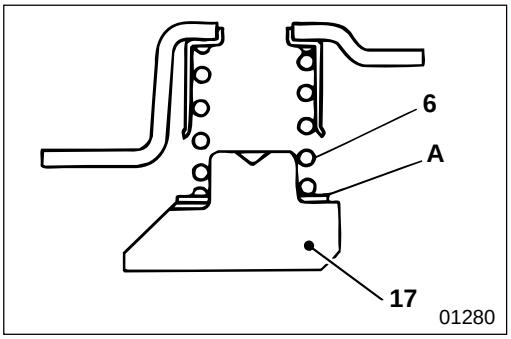
(2) Adjustment of release lever height

Remove bolt **3** and lock plate **4**, then turn support nut **5** to adjust.
After adjustment, install lock plate **4**, then lock support nut **5**, and check the height of release lever plate **9**.



1 **A** **Clearance between strap bolt and strap plate**

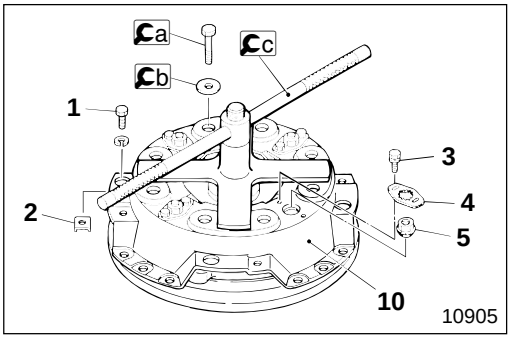
If the measured value is higher than the limit, replace the faulty parts.
A : Strap plate



6 **Installation of pressure spring**

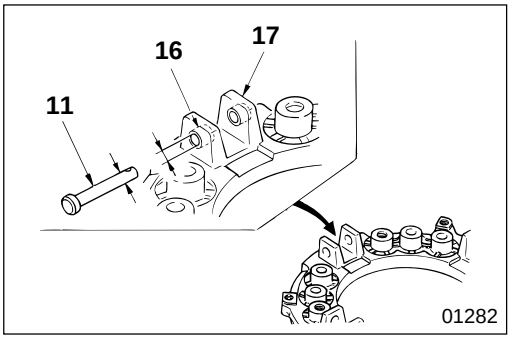
When pressure plate **17** has been corrected by grinding, place adjusting washer **A** equivalent to the correction depth between the plate and pressure spring **6**.

Amount of correction made	Thickness of washers and quantity
Less than 1 mm {0.039 in.}	Not required
1 to 2 mm {0.039 to 0.079 in.}	1×1.2 mm {0.047 in.}
2 to 3 mm {0.079 to 0.12 in.}	2×1.2 mm {0.047 in.}, or 1×2.3 mm {0.091 in.}



10 **Removal and installation of clutch cover**

- Compress pressure spring **6** using Cc clutch installer, and remove Ca stopper bolt, Cb washer, strap bolt **1**, washer **2**, bolt **3**, lock plate **4** and support nut **5**.
- Gradually loosen Cc clutch installer until pressure spring **6** is fully extended, then remove clutch cover **10**.
- For installation, follow the removal procedure in reverse.

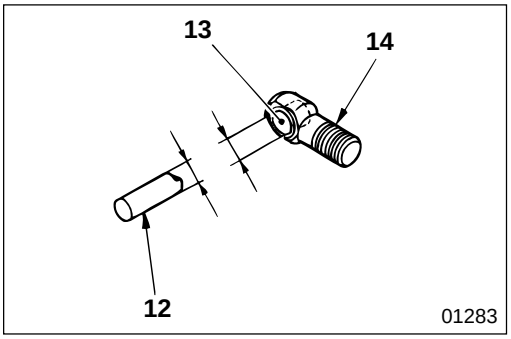


11 **16** **Clearance between release lever pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

Measure the bore of bushing 16 as press-fitted in pressure plate 17.

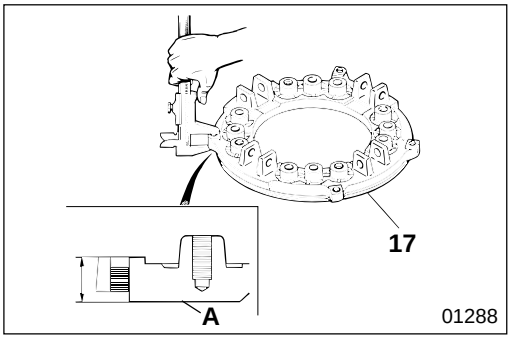


12 **13** **Clearance between support lever pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

Measure the bore of bushing 13 as press-fitted in support lever 14.

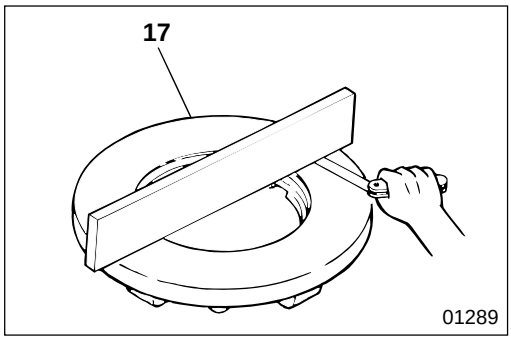


17 **Pressure plate**

(1) Thickness

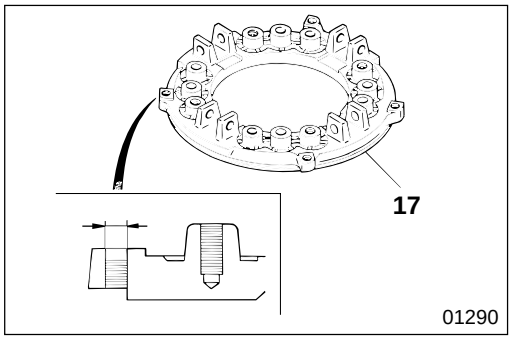
Measure friction surface **A** of pressure plate **17** (measuring position must be within the maximum and minimum diameters), and if the measured value is lower than the limit, replace the pressure plate.

Maximum diameter	320 mm {12.6 in.}
Minimum diameter	220 mm {8.66 in.}



(2) Flatness

If the measured value is higher than the limit, replace pressure plate **17**.

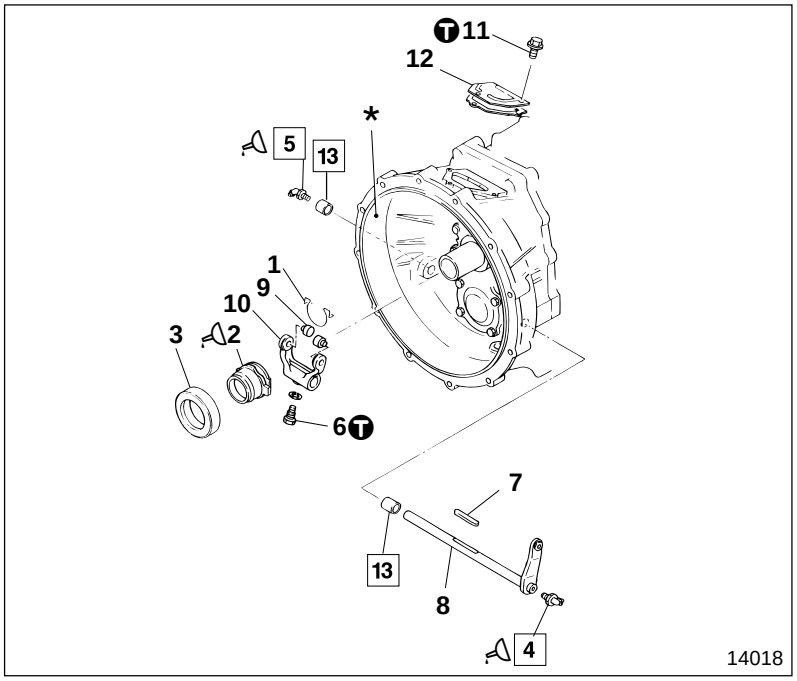


(3) Strap bolt fitting hole inner diameter

If the measured value is higher than the limit, replace pressure plate **17**.

M E M O

CLUTCH CONTROL



● **Disassembly sequence**

1 Return spring
2 Clutch shifter
3 Release bearing
4 Grease nipple
5 Grease nipple
6 Set screw
7 Key
8 Release fork shaft
9 Cam follower
10 Release fork
11 Bolt
12 Cover
13 Needle roller bearing

***** : Clutch housing
Gr 22

NOTE

Do not remove release bearing 3 or needle roller bearing 13 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

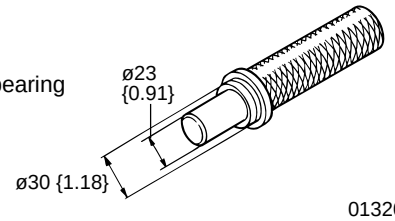
Location	Parts to be tightened	Tightening torque	Remarks
6	Set screw	21 {15, 2.1}	—
11	Bolt (Clutch housing cover mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—

Lubricant

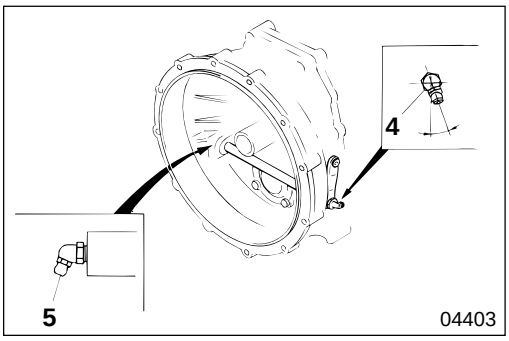
Location	Points of application	Kinds	Quantity
2	Pack the clutch shifter	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4, 5	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
13	Needle roller bearing installer 	03726-83000	Installation of needle roller bearing

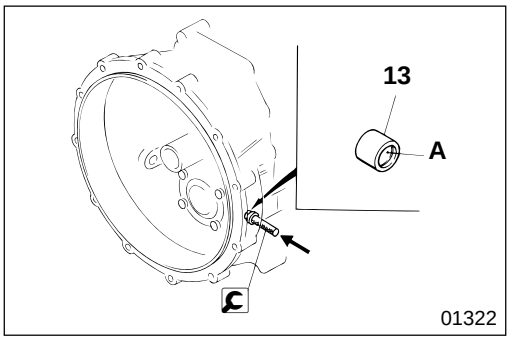
◆ Service procedure



4 **5** **Installation of grease nipple**

NOTE

Install grease nipple 4, 5 so that it faces the direction as illustrated.



13 **Installation of needle roller bearing**

Install needle roller bearing **13** with yellow sticker **A** facing outside.

CAUTION

Do not damage the bearing by hitting it directly with a hammer during installation.

MITSUBISHI
FUSO

Group 22

Manual Transmission

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-22

INDEX

SPECIFICATIONS 22- 2

STRUCTURE AND OPERATION 22- 3

TROUBLESHOOTING 22- 9

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22-10

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22-12

GEAR SHIFTER UPPER AND INTERLOCK PLATE 22-15

EXTENSION HOUSING, REAR COVER AND PARKING BRAKE ASSEMBLY 22-20

6TH GEAR < S6 > AND REVERSE IDLER GEAR 22-24

TRANSMISSION BODY 22-32

DRIVE PINION ASSEMBLY 22-46

MAINSHAFT ASSEMBLY 22-48

COUNTERSHAFT ASSEMBLY 22-56

TRANSMISSION CONTROL 22-60

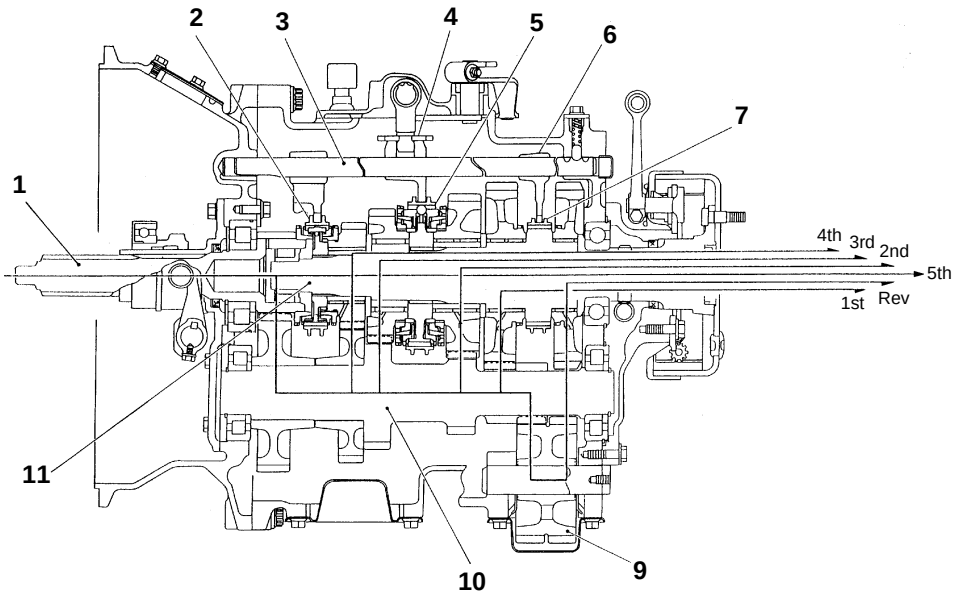
PULLER AND INSTALLER KIT 22-65

SPECIFICATIONS

Item		Specifications	
Mode of control		Floor shift remote control	
Transmission model		M050S5	M050S6
Gear ratio	1st	6.875	6.523
	2nd	4.189	3.975
	3rd	2.311	2.193
	4th	1.409	1.336
	5th	1.000	1.000
	6th	—	0.803
	Reverse	6.875	6.523
Oil	Gear oil	General: API GL-3 SAE80 Warm region: API GL-3 SAE90 Tropical region: API GL-4 SAE90	
	Eingine oil	Long period of high-speed driving : API CC SAE30 or SAE40 : API CC/SF SAE30 or SAE40	
	Quantity L {qts}	5.4 {5.7}	6.5 {6.9}
Mass	kg {lb}	122 {270}	137 {300}

Transmission

< S5 >



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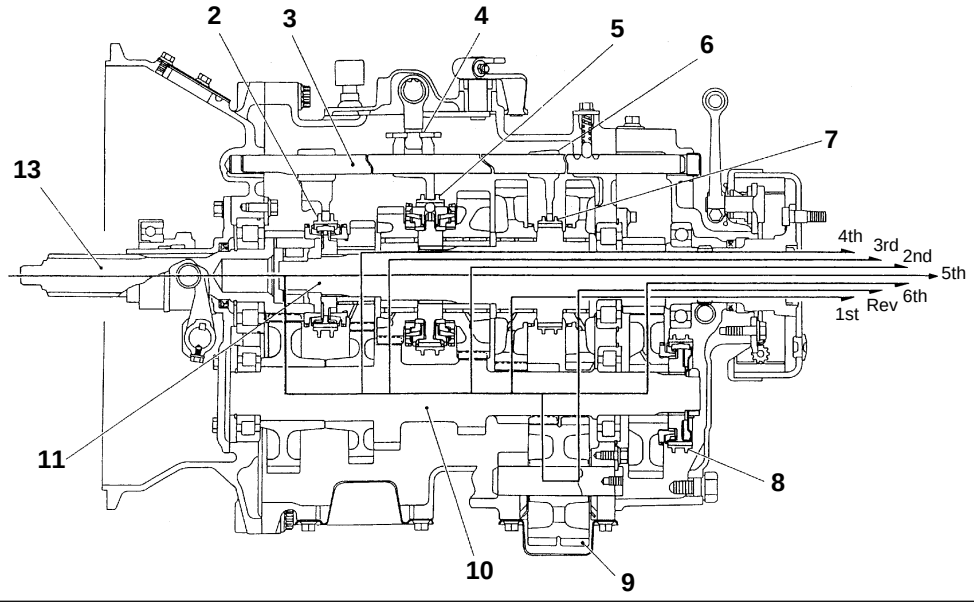
< S6 >



36021

1 Drive pinion
2 4th and 5th synchronizer assembly
3 Shift rail
4 Interlock mechanism
5 2nd and 3rd synchronizer assembly
6 Shift fork
7 1st and reverse constant mesh assembly
8 6th synchronizer assembly < S6 >
9 Reverse idler gear
10 Countershaft
11 Mainshaft

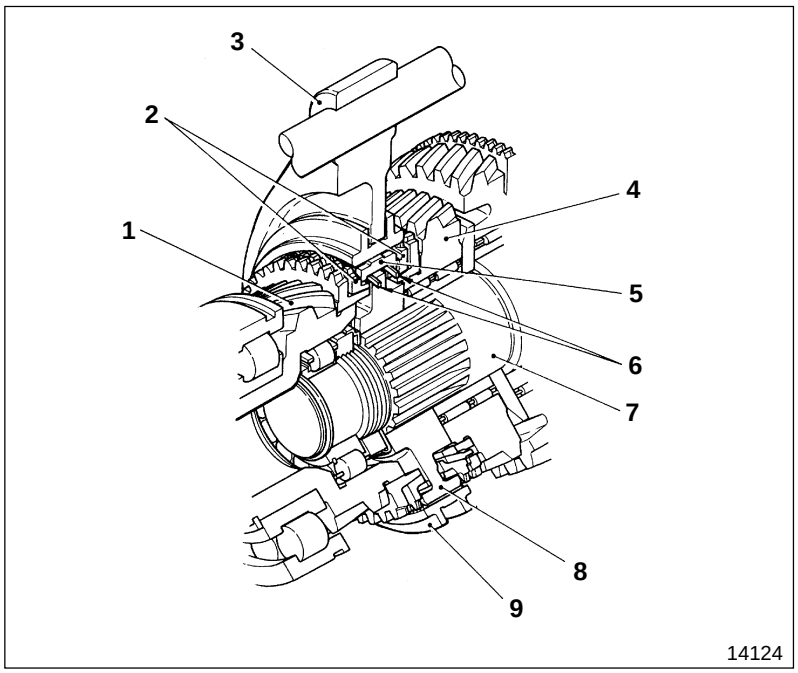
The transmission changes revolution and torque generated by the engine into those that match the vehicle's power requirement (driving force). Revolution and torque are increased or decreased by making a selection from several sets of engaged gears. The transmission uses an interlock mechanism to avoid double engagement.

Synchromesh Mechanism

This vehicle has two synchromesh mechanisms, a single cone type, and a double cone type, and uses the key system. The single or double cone type is used depending on the gear positions as shown below:

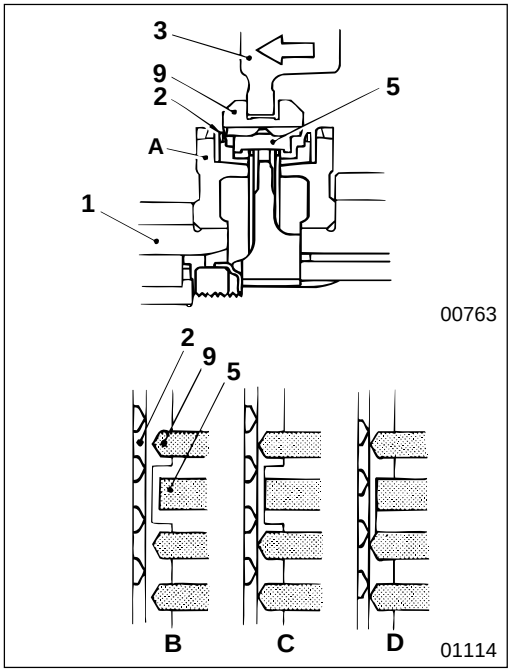
Synchromesh type	Parts used
Single cone type	4th, 5th, 6th
Double cone type	2nd and 3rd

Single Cone Type

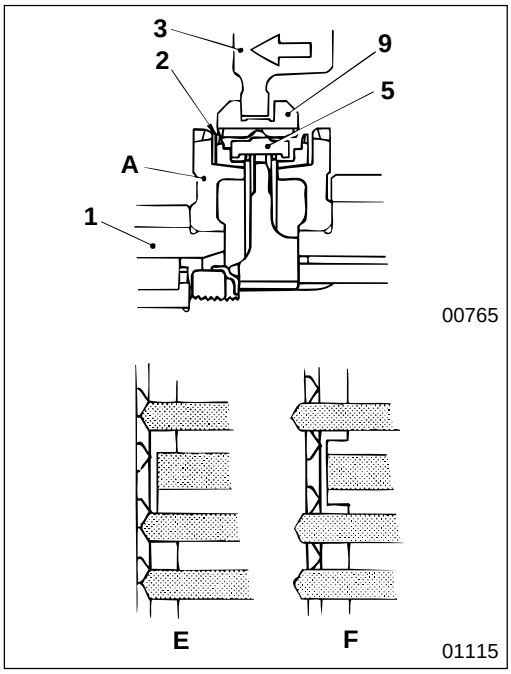


1 Drive pinion
2 Synchronizer ring
3 4th and 5th shift fork
4 4th gear
5 Shifting key
6 Shifting key spring
7 Mainshaft
8 Synchronizer hub
9 Synchronizer sleeve

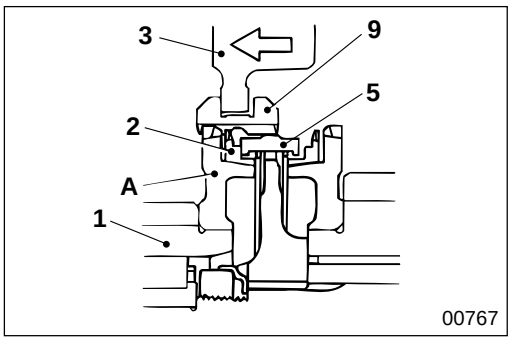
- The following descriptions are for 4th and 5th gear
  The inside of synchronizer hub **8** engages the spline of mainshaft **7** and rotates with it. The outside of the synchronizer hub has a spline that engages synchronizer sleeve **9** and three keyways.
- Shifting keys **5** are inserted into these keyways. When the gear shift is in neutral, a protrusion in the center of each shifting key engages a groove inside the synchronizer sleeve and the shifting keys are pressed against the inside of the synchronizer sleeve by shifting key springs **6**.
- Synchronizer rings **2** are inserted into drive pinions **1** in the front and rear of synchronizer hub **8**, and the taper cone of 4th gear **4**.
- The internal tapers of synchronizer rings **2** have fine threads, and the outer splines engage synchronizer sleeve **9**. On the hub side of the synchronizer rings are three keyways in which the ends of shifting keys **5** are inserted. These keyways are wider than the width of the shifting keys.
- Synchronizer rings **2** rotate relative to synchronizer sleeve **9** by the amount of play of the keyways.



- When the gear shift is in neutral (Figure **B**), moving shift fork **3** in the direction of the arrow as illustrated, moves synchronizer sleeve **9** slightly to the left. At the same time, shifting key **5**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer rings **2** against taper cone **A** of drive pinion **1**. (Figure **C**)
- When the taper surfaces of synchronizer rings **2** make contact with the taper cone of the drive pinion, the taper surfaces of the synchronizer rings act as cone clutches. This frictional torque rotates the synchronizer rings in the rotating direction of the drive pinion by the amount of play between shifting key **5** and the synchronizer rings. The spline chamfers of the synchronizer rings and the spline chamfer of synchronizer sleeve **9** are offset from each other. (Figure **D**)
- The disengagement direction of synchronizer rings **2** is defined by the speed of rotation of the synchronizer—sleeve **9**, and the synchronized—drive pinion **1**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.

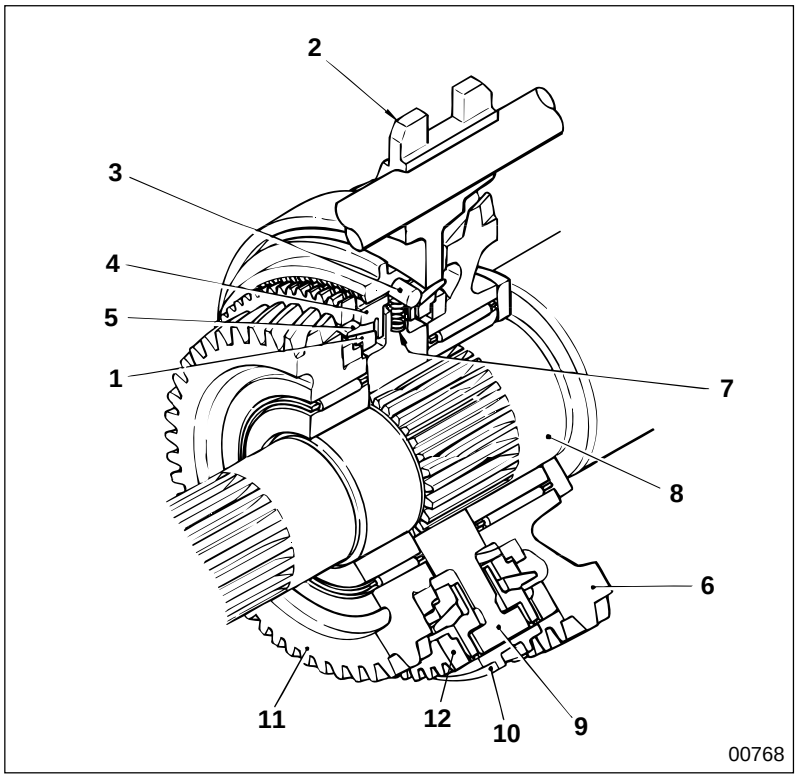


- When synchronizer sleeve **9** moves further to the left, synchronizer rings **2** prevent shifting key **5** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer rings **2** remain disengaged, the spline chamfer of synchronizer sleeve **9** presses the spline chamfers of the synchronizer rings, which in turn press the synchronizer rings against taper cone **A** of drive pinion **1**.
- As the frictional torque increases on the taper surfaces, the relative speed of the synchronizer and the synchronized gradually decreases.
  E : In synchronization
  F : After synchronization



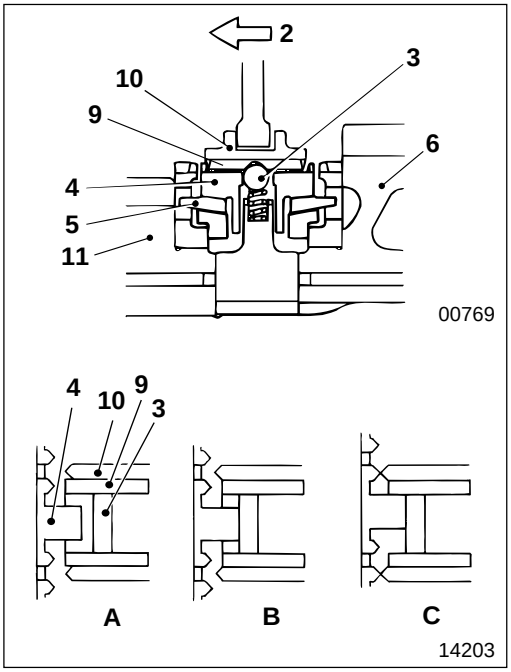
- When synchronizer sleeve **9** and drive pinion **1** rotate at the same speed, synchronizer rings **2** no longer prevent the synchronizer sleeve from moving, and the synchronizer sleeve moves further to the left and smoothly engages the spline of taper cone **A** of drive pinion **1**, transmitting the driving force.

Double Cone Type

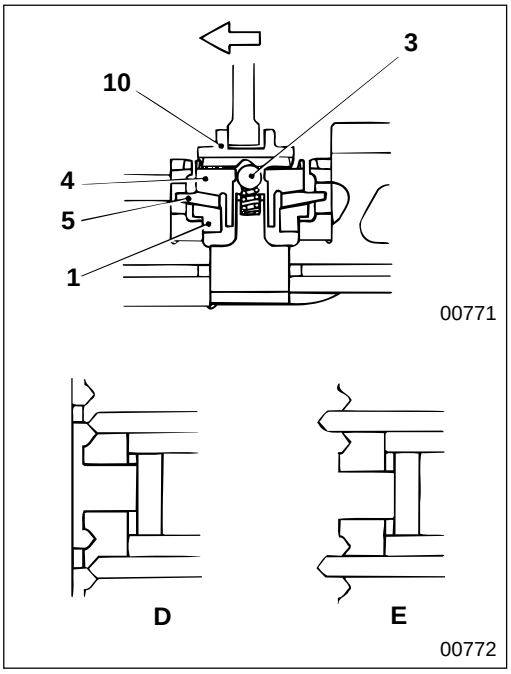


1 Synchronizer inner ring
2 2nd and 3rd shift fork
3 Shifting key
4 Synchronizer outer ring
5 Synchronizer center cone
6 2nd gear
7 Shifting key spring
8 Mainshaft
9 Synchronizer hub
10 Synchronizer sleeve
11 3rd gear
12 Dog clutch

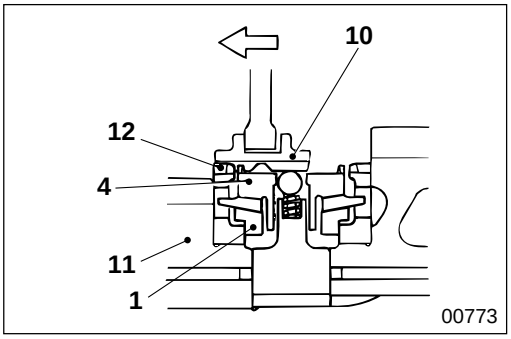
- The following descriptions are for 2nd and 3rd gear
  The synchromesh structure and operation of the double cone type are basically the same as for the single cone type.
- Synchronizer center cone **5** is a taper cone independent of 2nd gear **6** and 3rd gear **11**, (both the inside and outside surfaces are tapered). The synchronizer center cone is between synchronizer inner ring **1** and synchronizer outer ring **4** to increase the synchronization capacity.
- Six protrusions on the outside of center cone **5** fit into corresponding gear holes, in the same manner as the taper cone of the single cone type. The center cone and the gear are installed as if integrated.
  Shifting key **3** is a cylinder installed so that the lengthwise direction of the cylinder is at right angles to the diameter direction of synchronizer hub **9**. Shifting key spring **7** is a coil spring inserted in a hole in the synchronizer hub, this spring presses the shifting key against the inside of synchronizer sleeve **10**.



- When the gear shift is in neutral (Figure **A**), moving shift fork **2** in the direction of the arrow as illustrated, moves synchronizer sleeve **10** slightly to the left. At the same time, shifting key **3**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer outer ring **4** against synchronizer center cone **5**. (Figure **B**)
- When the taper surface of synchronizer outer ring **4** makes contact with the taper cone of synchronizer center cone **5**, the taper surface of the synchronizer outer ring acts as a cone clutch. This frictional torque rotates the synchronizer outer ring in the rotating direction of 3rd gear **11** by the amount of play between the synchronizer outer ring and synchronizer hub **9**. The spline chamfer of the synchronizer outer ring and the spline chamfer of synchronizer sleeve **10** are offset from each other. (Figure **C**)
- The disengagement direction of synchronizer outer ring **4** is defined by the speed of rotation of the synchronizer—the sleeve, and the synchronized—3rd gear **11**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.

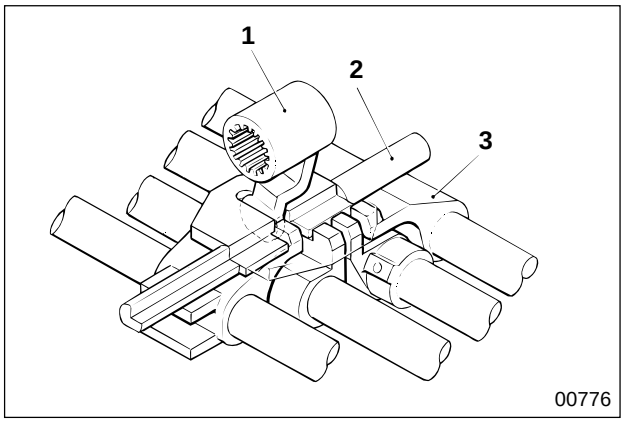


- When synchronizer sleeve **10** moves further to the left, synchronizer outer ring **4** prevents shifting key **3** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer outer ring **4** remains disengaged, the spline chamfer of synchronizer sleeve **10** presses the spline chamfer of the synchronizer outer ring, which in turn presses the synchronizer outer ring against the taper cone of synchronizer center cone **5**, and the frictional torque acts on the taper surface.
- As the frictional torque increases on the taper surface of synchronizer inner ring **1**, the relative speed of the synchronizer and the synchronized gradually decreases. The frictional torque acts on both sides of the synchronizer center cone. The double cone type has greater capacity for synchronization than the single cone type.
  D : In synchronization
  E : After synchronization



- When synchronizer sleeve **10** and 3rd gear **11** rotate at the same speed, synchronizer outer ring **4** no longer prevents the synchronizer sleeve from moving and the synchronizer sleeve moves further to the left and smoothly engages the spline of dog clutch **12** of the 3rd gear, transmitting the driving force.

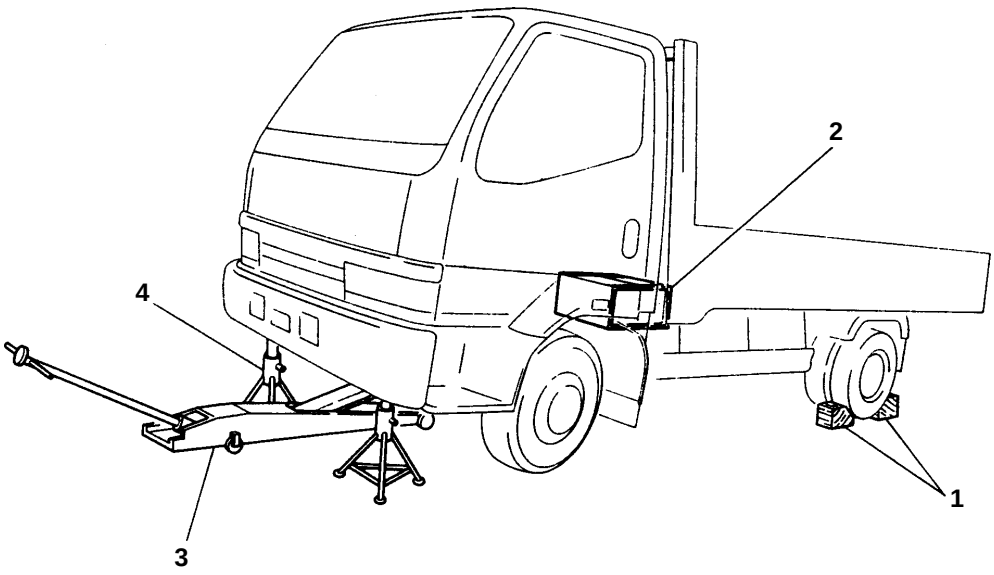
Interlock Mechanism



In the interlock mechanism, the rail beneath interlock plate **2** locks jaws **3**, (apart from the jaws shifted by gear shift slide lever **1**), preventing double engagement of gears.

Possible causes \ Symptoms		Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise while cruising	Noise when changing gear
Transmission body faulty	Mainshaft rear lock nut loose	○	○			
	Mainshaft thrust washer worn	○	○			
	Mainshaft bearing worn or damaged	○	○			
	Synchronizer ring and synchronizer sleeve spline worn	○				
	Synchronizer ring and gears taper cone area worn		○			
	Mainshaft pilot bearing worn or damaged			○	○	
	Drive pinion bearing worn or damaged			○		
	Countershaft bearing worn or damaged			○		
	Needle bearings of gears worn or damaged			○	○	
	Mainshaft and countershaft bearings worn or damaged				○	
	Mainshaft and countershaft gears backlash excessive				○	
	Spline of gears worn					○
	Gears damaged				○	
	Gear oil insufficient				○	
Control mechanisms faulty	Control cable joint play	○	○			
	Set board assembly bushings worn	○				
	Shift rail steel ball and groove worn	○				
	Shift rail poppet spring fatigued or damaged	○				
	Shift rail sliding movement faulty		○			
	Shift fork jaws worn		○			
	Shift fork bent		○			
Clutch faulty	Clutch disengagement faulty		○			○
	Clutch pedal play faulty (Gr 21)		○			
Synchronizer faulty	Contacting surfaces of synchronizer ring and gear taper cone worn					○
	Shifting key worn					○
	Shifting key spring deteriorated or damaged					○
	Synchronizer sleeve worn or damaged				○	○

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



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● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect negative battery cable. Gr 54
3 Jack up the front axle on a garage jack.
4 Support the front frame on rigid racks.

WARNING

- **Since the parking brake will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Keep the transmission in neutral throughout the operation.

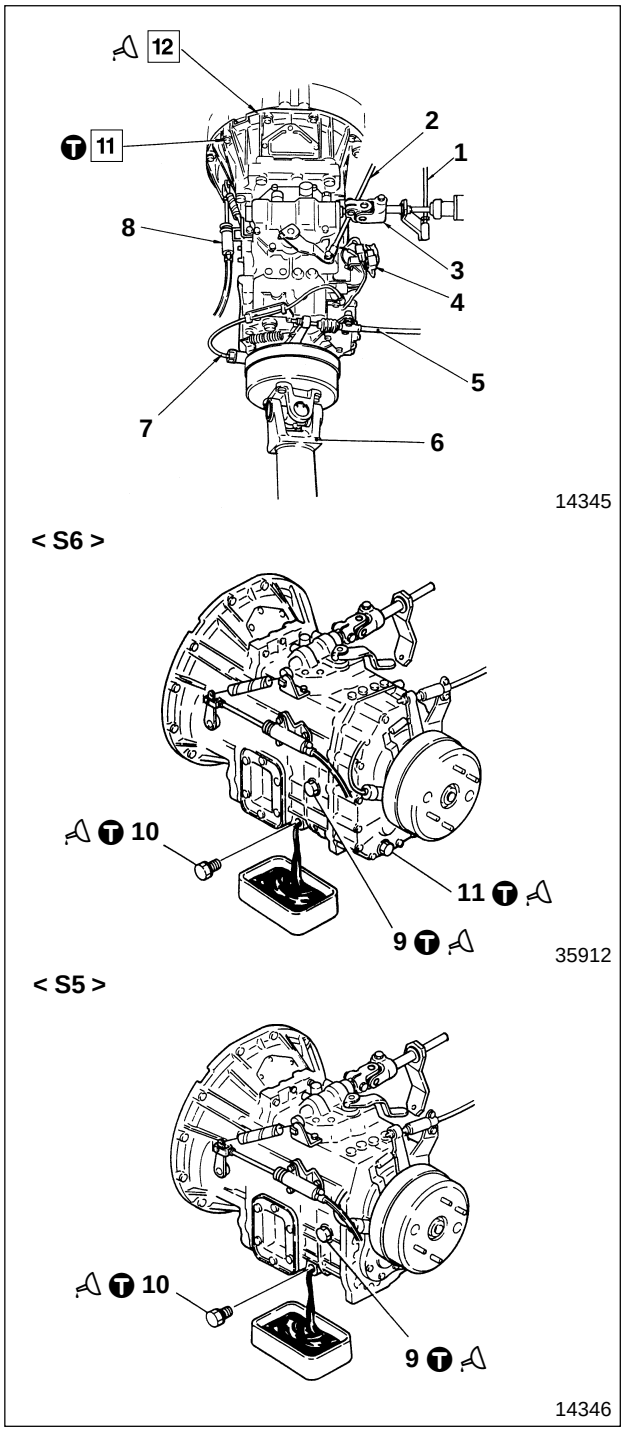
● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY

Removal and Installation



● **Disassembly sequence**

1 Shift cable P22-60
2 Selector cable P22-60
3 Cross shaft P22-64
4 Harness connector
5 Parking brake cable Gr 36
6 Propeller shaft Gr 25
7 Speed sensor Gr 54
8 Clutch power cylinder Gr 21
9 Inspection plug
10 Drain plug (on transmission case)
11 Drain plug (on extension housing)
12 Nut or bolt
13 Transmission assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

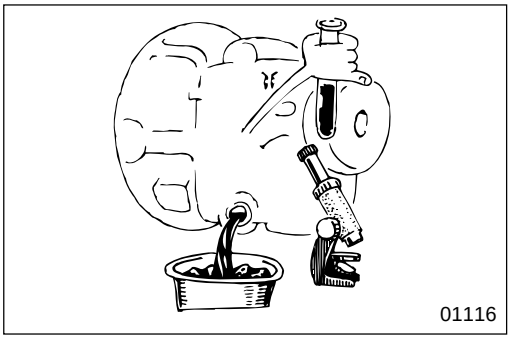
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Power shift hose connector	20 {14.8, 2}	—
9	Inspection plug	69±15 {51±11, 7±1.5}	—
10, 11	Drain plug	69±15 {51±11, 7±1.5}	—
12	Nut or bolt (Transmission mounting)	40 {30, 4.1}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
9	Thread area of inspection plug	THREEBOND 1105D	As required
10, 11	Thread area of drain plug	THREEBOND 1105D	As required
13	Spline of drive pinion	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

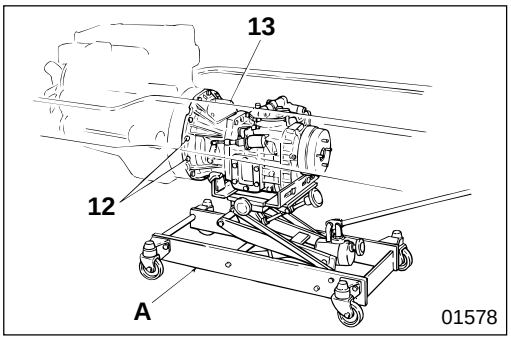
◆ Service procedure



● Oil change

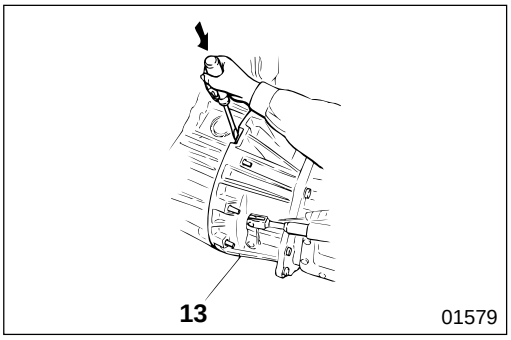
[Draining]
- When draining oil, check the quantity and quality of oil, especially for small pieces of metal and metal dust.
- Clean drain plug **9** before reinstalling it because it is magnetic.

[Filling]
- Check that drain plugs **10**, **11** are tightened at specified torque.
- Pour in gear oil until the oil overflows from the inspection hole. (For oil quantity, see specifications.)



12 Removal of transmission mounting nut or bolt

- Support transmission assembly **13** on transmission jack **A**.
- Tighten transmission mounting nuts or bolts **12**.

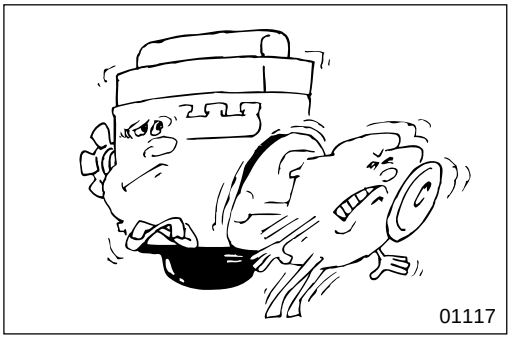


13 Transmission assembly

[Removal]
- Insert a screwdriver into the three removal grooves and pry transmission assembly **13** from the engine.

CAUTION⚠

Make sure that you remove hoses and cables before starting service operations.

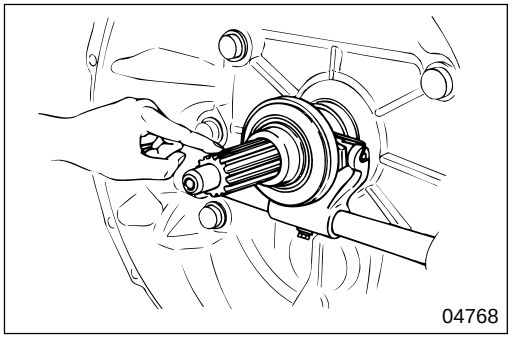


- Move transmission assembly **13** backward until the spline of the drive pinion is detached from the clutch.

CAUTION⚠

Make sure that you pull transmission assembly 13 out in a straight line. If you seesaw the transmission assembly violently, you will damage the spline that connects the drive pinion and the clutch.

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY

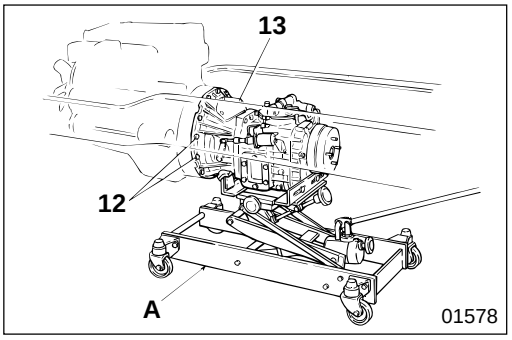


[Installation]

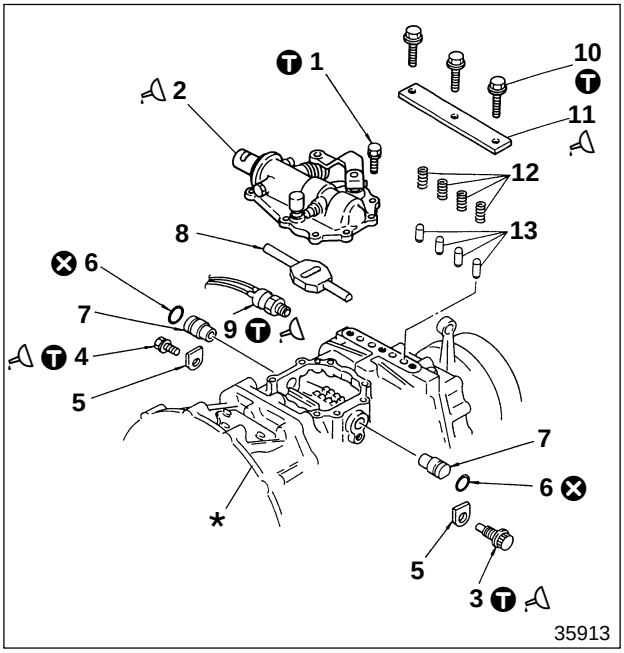
- Check the spline of the drive pinion for rust.
- If rust is found, remove it using a wire brush.
- Rub grease onto the clutch disc sliding surfaces of the drive pinion using your hand.

CAUTION

Make sure that you apply only the necessary amount of grease because too much grease would drip and cause clutch slip.



- Support transmission assembly **13** on transmission jack **A**, and insert the transmission assembly into the pilot bearing of the flywheel paying attention to the drive pinion spline.
- Tighten transmission mounting nuts or bolts **12** at specified torque.



● **Disassembly sequence**

1 Bolt
2 Gear shifter upper assembly P22-16
3 Jaw set bolt
4 Bolt
5 Lock plate
6 O-ring
7 Bushing
8 Interlock plate
9 Backup lamp switch Gr 54
10 Bolt
11 Poppet spring plate
12 Poppet spring
13 Interlock pin

* : Transmission body
⊗ : Non-reusable parts

● **Assembly sequence**

6→7
8
→5→4→3→9→2→1→13→12→11→10

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
7, 8	Clearance between interlock plate axis and bushing	[12 {0.47}] 0.14 to 0.19 {0.0055 to 0.0075}	0.4 {0.016}	Replace
12	Poppet spring load (Installed length 29 {1.14})	78 N {18 lbf, 8 kgf}	67 N {15 lbf, 68 kgf}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

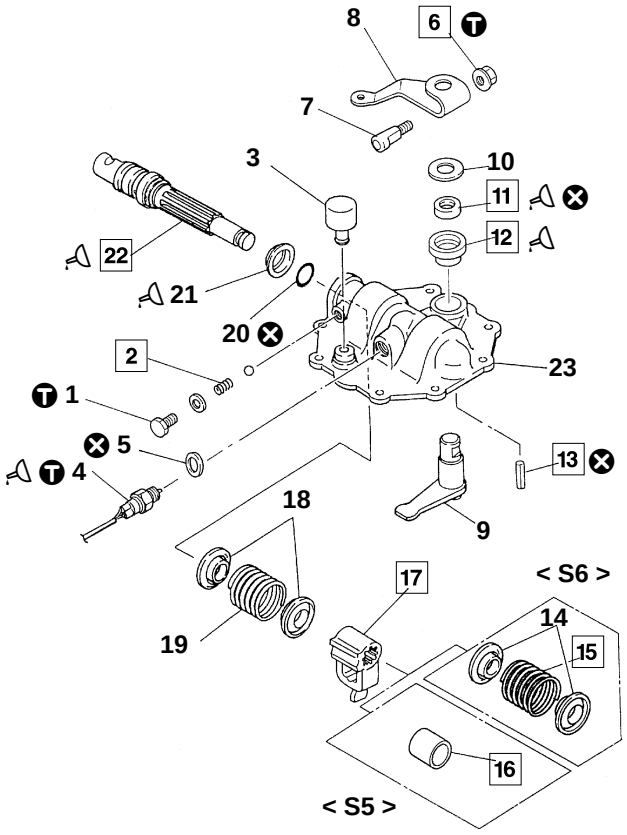
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Gear shifter upper mounting)	23 {17, 2.3}	—
3	Jaw set bolt	135 {98, 13.6}	—
4	Bolt (Lock plate mounting)	40 {30, 4.1}	—
9	Backup lamp switch	49 {36, 5.0}	—
10	Bolt (Poppet spring plate mounting)	49 {36, 5.0}	—

Sealant

Location	Points of application	Specified sealant	Quantity
2	Contact surface with transmission case	THREEBOND 1215	As required
3	Thread area of jaw set bolt	THREEBOND 1104J	As required
4	Thread area of bolt	THREEBOND 1104J	As required
9	Thread area of backup lamp switch	THREEBOND 1105D	As required
11	Contact surface with transmission case	THREEBOND 1215	As required

GEAR SHIFTER UPPER AND INTERLOCK PLATE

Gear Shifter Upper Assembly



37109

● **Disassembly sequence**

1 Plug
2 Torsion shaft spring
3 Air breather
4 Neutral switch Gr 54
5 Gasket
6 Nut
7 Lock pin
8 Gear selector lever B
9 Gear selector lever A
10 Washer
11 Oil seal
12 Bushing
13 Spring pin
14 Return spring B retainer < S6 >
15 Return spring B < S6 >
16 Gear selector stopper < S5 >
17 Gear shift slide lever
18 Return spring A retainer
19 Return spring A
20 O-ring
21 Dust seal
22 Gear shift lever
23 Selector lever case

⊗ : Non-reusable parts

NOTE

Do not remove bushing 12 except for replacement.

● **Assembly sequence**

23→12→11
21→22→20
→18→19→18→17→14→15→16→14→13→9→10→8→7→6→3→2→1
5→4

CAUTION ⚠

Be sure when assembling gear selector lever A 9, that you turn the lever so you do not damage the lip area of oil seal 11.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Torsion shaft spring load (Installed length 16.2 {0.64})	50 N {11 lbf, 5.1 kgf}	42 N {9.48 lbf, 4.3 kgf}	Replace
9	Play in axial direction of gear selector lever A	0.3 to 0.6 {0.012 to 0.024}	—	Replace
15	Return spring B load (Installed length 23.6 {0.93})	92 N {21 lbf, 9.4 kgf}	78 N {18 lbf, 8.0 kgf}	Replace
19	Return spring A load (Installed length 27.6 {1.09})	94 N {21 lbf, 9.6 kgf}	80 N {18 lbf, 8.2 kgf}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

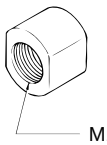
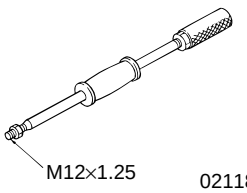
Location	Parts to be tightened	Tightening torque	Remarks
1	Plug	23 {17, 2.3}	—
4	Neutral switch	34 to 39 {25 to 29, 3.5 to 4.0}	—
6	Nut (Lock pin mounting)	17 {12, 1.7}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
4	Thread area of neutral switch	THREEBOND 1104J	As required
11	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
12	Inner surface of gear selector lever A axis bushing and its friction surface	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Contact surfaces between bushing outer surface and case	THREEBOND 1215	As required
21	Pack dust seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Gear shift lever O-ring groove	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

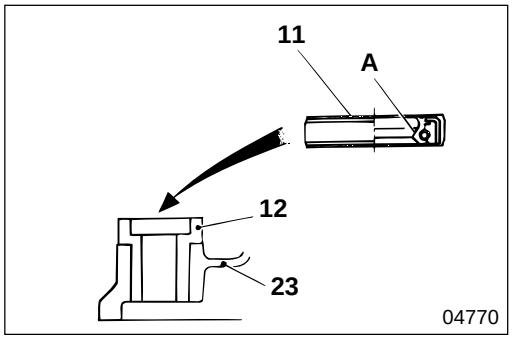
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
13	Spring pin puller  02399	MH062445	Removal of spring pin
	Reverse shaft puller  02118	03726-82000	

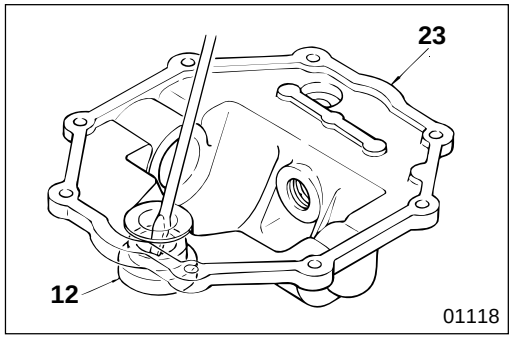
GEAR SHIFTER UPPER AND INTERLOCK PLATE

◆ Service procedure



11 Installation of oil seal

- Apply grease to lip area **A** of oil seal **11**.
- Press-fit oil seal **11** into bushing **12** in the direction as illustrated.



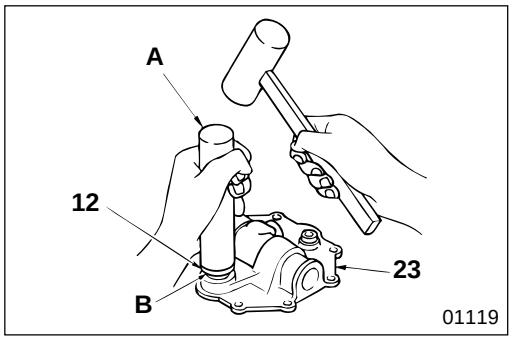
12 Bushing

[Removal]

Remove bushing **12** from selector lever case **23** using a screwdriver.

CAUTION

Be careful not to damage selector lever case 23.

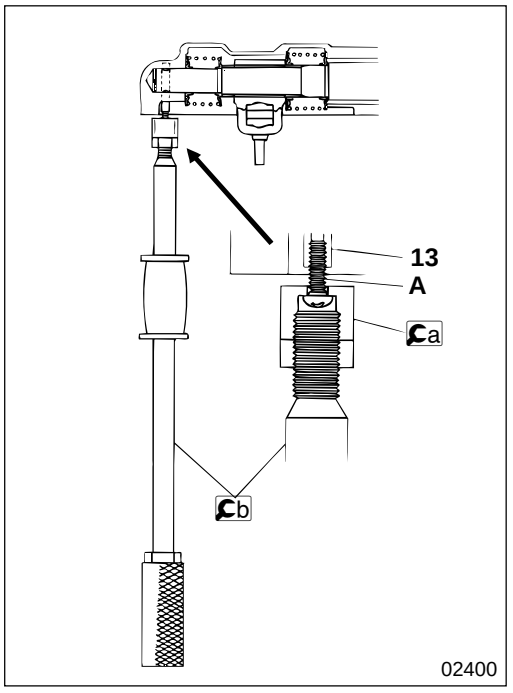


[Installation]

- Clean the inner surface of selector lever case **23**.
- Press-fit bushing **12** into selector lever case **23** using bar **A** (approximately ø40 mm {1.57 in.}).
- When press-fitting bushing **12**, take care not to damage selector lever case **23**.
- After press-fitting, apply sealant to press-fitted side **B** of bushing **12**.

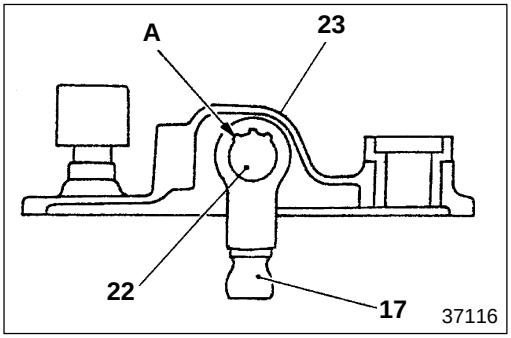
CAUTION

Prevent sealant from sticking to the inner surface of bushing 12.



13 Removal of spring pin

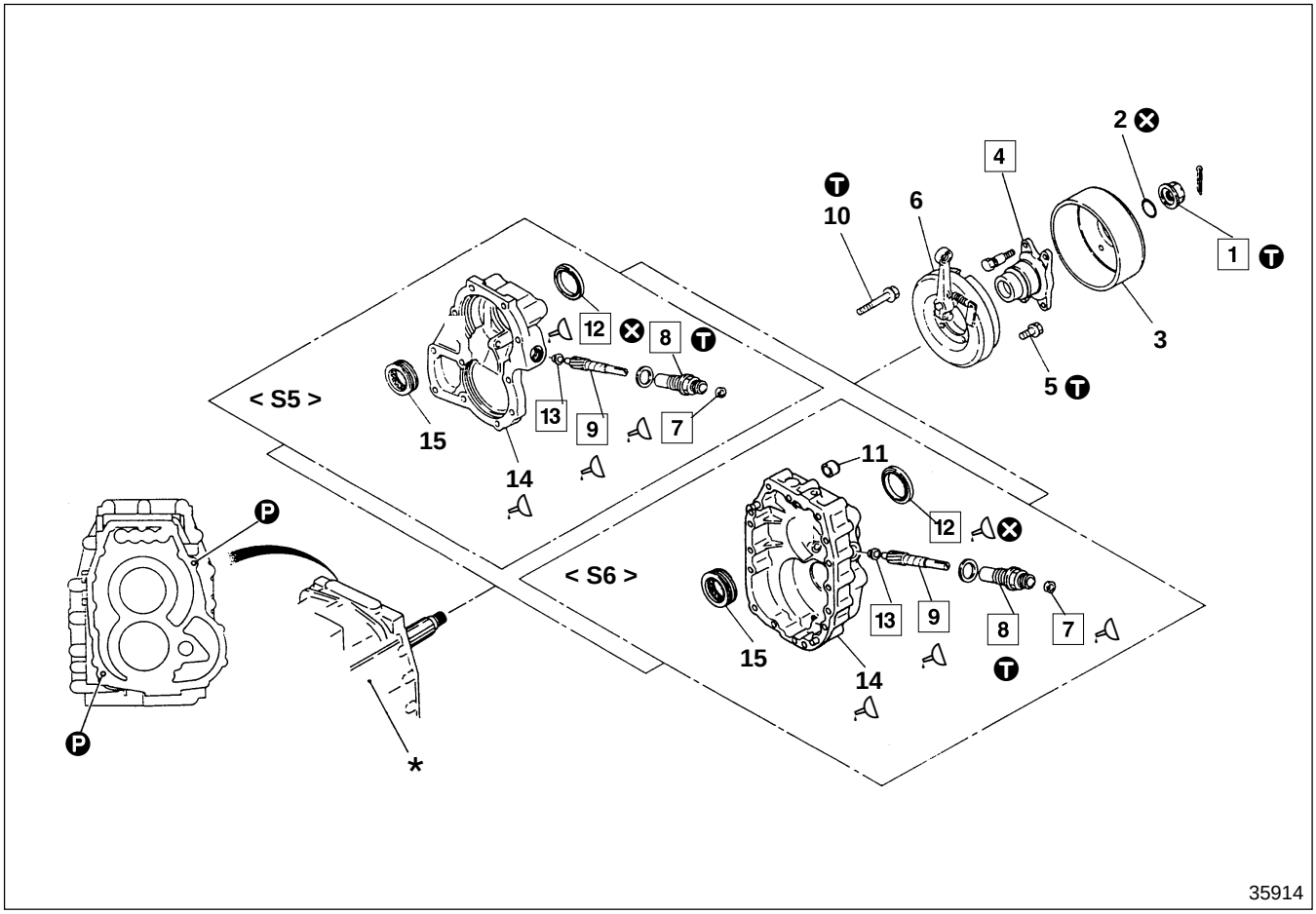
- Tap spring pin **13** using an M4 tap.
- Insert Ca spring pin puller with an M4 thread **A** of appropriate length into spring pin **13**.
- Position Cb reverse shaft puller on Ca spring pin puller.
- Remove spring pin **13** from selector lever case **23** using Ca spring pin puller and Cb reverse shaft puller.



17 **Installation of gear shift slide lever**

When you install gear shift slide lever **17** in gear shift lever **22**, position spline **A** is as illustrated.

EXTENSION HOUSING, REAR COVER AND PARKING BRAKE ASSEMBLY

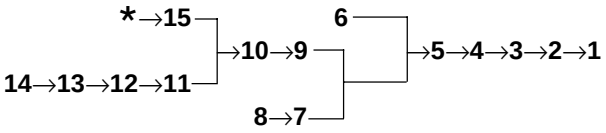


● **Disassembly sequence**

1 Lock nut
2 O-ring
3 Parking brake drum
4 Companion flange
5 Bolt
6 Support plate and shoe assembly Gr 36
7 Oil seal
8 Speedometer gear bushing
9 Speedometer gear
10 Bolt
11 Dust plug < S6 >
12 Oil seal
13 Speedometer gear bushing A
14 Rear cover < S5 >
Extension housing < S6 >
15 Speedometer worm

* : Transmission body
Ⓟ : Positioning pins
⊗ : Non-reusable parts

● **Assembly sequence**



NOTE

Inspect play of speedometer gear 9 before disassembly.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
8, 9	Clearance between speedometer gear bushing and speedometer gear	[12] 0.02 to 0.07 {[0.47] 0.00079 to 0.0028}	0.15 {0.0059}	Replace
9, 15	Play between speedometer gear and speedometer worm	0.13 to 0.29 {0.0051 to 0.011}	0.36 {0.014}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

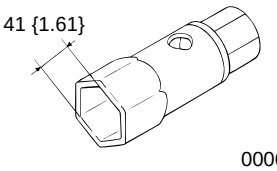
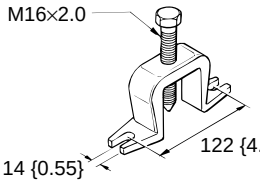
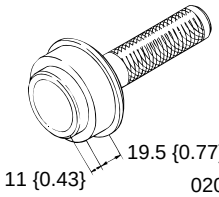
Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut	245 to 345 {180 to 255, 25 to 35}	—
5	Bolt (Support plate and shoe assembly mounting)	40 {30, 4.1}	—
8	Speedometer gear bushing	145 {110, 15}	—
10	Bolt (Extension housing or rear cover mounting)	40 {30, 4.1}	—

Lubricant and/or sealant

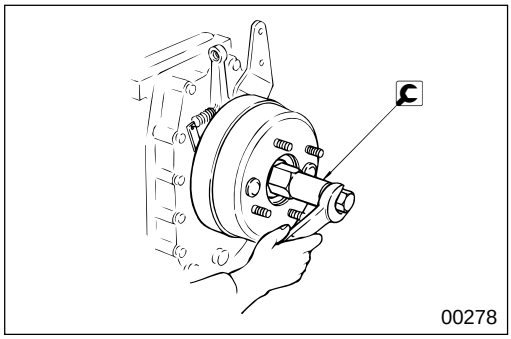
Location	Points of application	Specified lubricant and/or sealant	Quantity
7, 12	Interior and lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Friction surface with speedometer gear bushing	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
14	Contact surfaces between rear cover or extension housing and transmission case	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

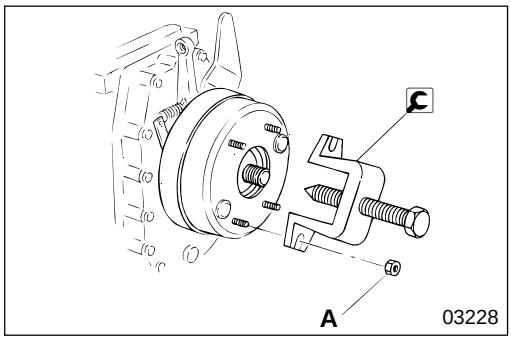
Location	Tool name and shape	Part No.	Application
1	Socket wrench 	MH061532	Removal and installation of mainshaft rear lock nut
4	Flange puller 	MC881524	Removal of flange at rear of mainshaft
12	Oil seal installer 	ME624242	Installation of oil seal in rear cover or extension housing

◆ Service procedure



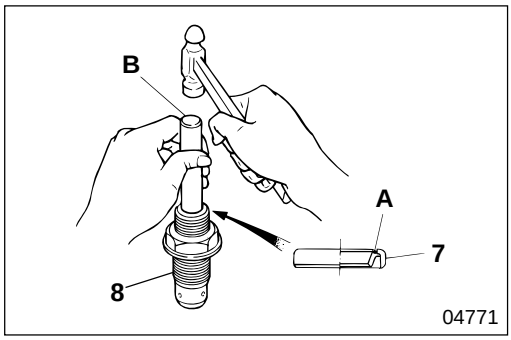
1 **Removal and installation of lock nut**

: Socket wrench



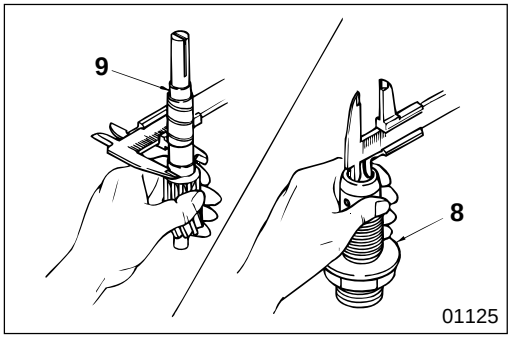
4 **Removal of companion flange**

A : Propeller shaft mounting nut
: Flange puller



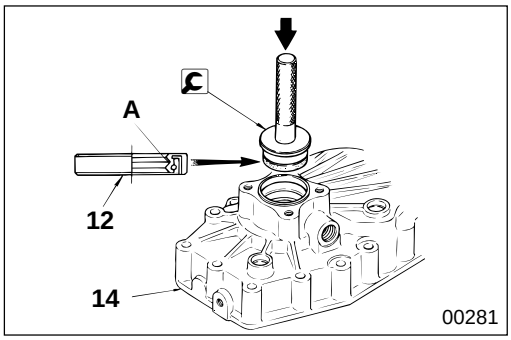
7 **Press-fitting of oil seal**

- Apply grease to inside of oil seal **7** packing **A**.
- Press-fit oil seal **7** into speedometer gear bushing **8** in the direction as illustrated using bar **B** (approximately ø15 mm {0.59 in.}).



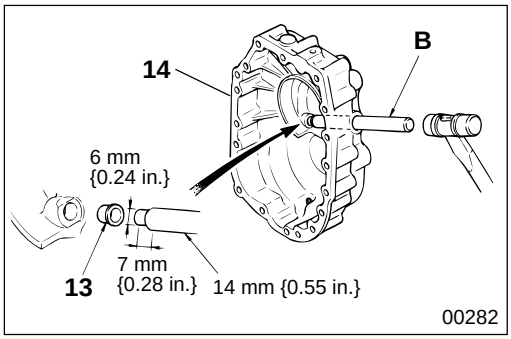
8 **9** **Clearance between speedometer gear bushing and speedometer gear**

If the clearance is higher than the limit, replace the faulty parts.



12 **Installation of oil seal**

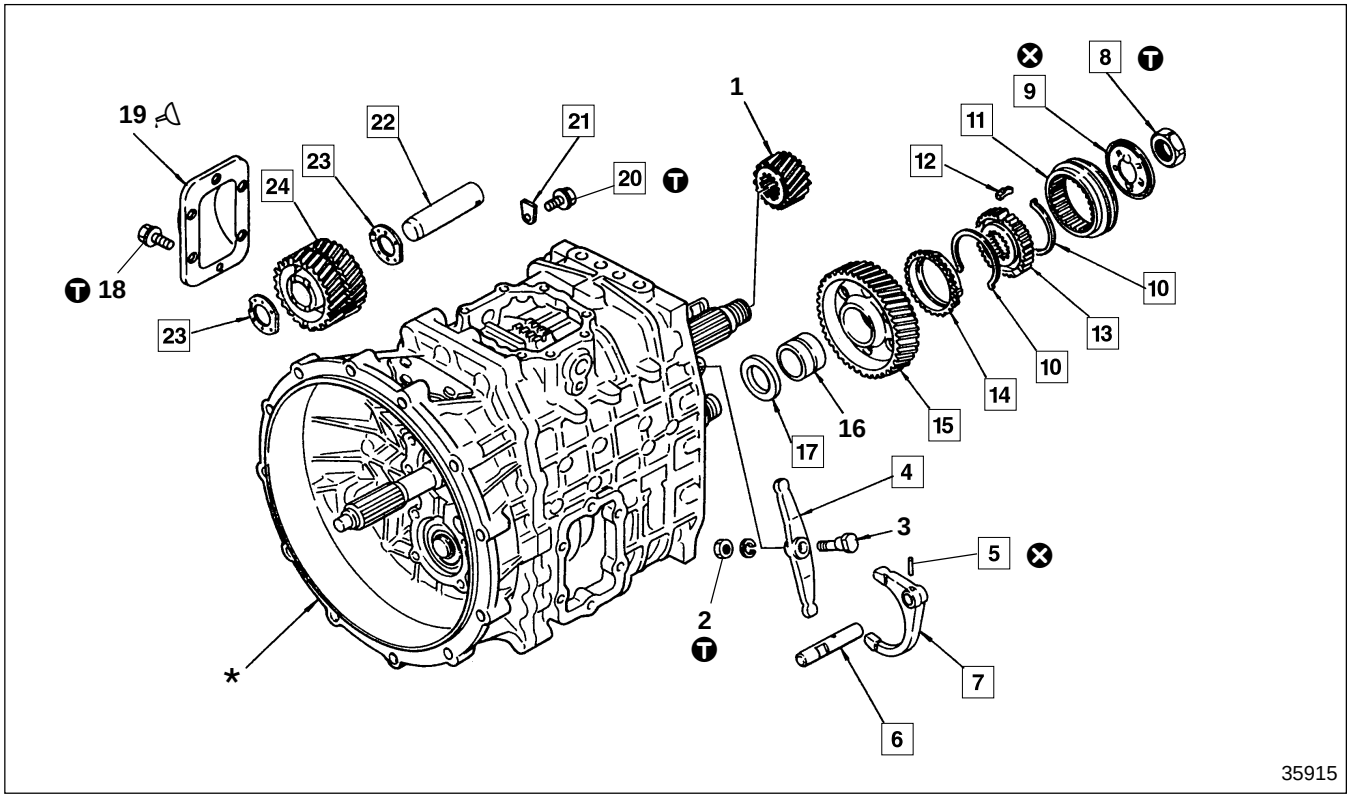
- Apply grease to lip area **A** of oil seal **12**.
- Press-fit oil seal **12** into extension housing or rear cover **14** in the direction as illustrated using oil seal installer.



13 **Installation of speedometer gear bushing A**

Press-fit speedometer gear bushing A **13** into extension housing or rear cover **14** using bar **B**, turned to the dimensions as illustrated.

6TH GEAR < S6 > AND REVERSE IDLER GEAR



● **Inspection before disassembly**

P22-26

● **Disassembly sequence**

1 Mainshaft O/D gear
2 Nut
3 O/D shift shaft
4 O/D shift lever
5 Spring pin
6 O/D shift rail C
7 O/D gear shift fork
8 Countershaft rear lock nut
9 Shifting Key retainer
10 Shifting key spring
11 Synchronizer sleeve
12 Shifting key
13 Synchronizer hub
14 Synchronizer ring
15 Countershaft O/D gear assembly
16 O/D gear sleeve
17 Thrust washer
18 Bolt
19 Reverse idler gear cover
20 Bolt
21 Reverse shaft lock piece
22 Reverse idler shaft
23 Reverse shaft gear side washer
24 Reverse idler gear

* : Transmission body
1 to **17** is applicable only to S6.
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
3, 4	Clearance between O/D shift and O/D shift lever	[16 {0.63}] 0.02 to 0.07 {0.00079 to 0.0028}	0.15 {0.0059}	Replace
4	Bend of O/D shift lever	0.05 {0.0020} or less	0.1 {0.0039}	Replace
6	Bend of O/D shift rail C	0.02 {0.00079} or less	0.04 {0.0016}	Replace
7	Tilt of O/D gear shift fork claw	0.1 {0.0039} or less	0.2 {0.0079}	Replace
7, 11	Clearance between gear shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace
11, 13	Play to rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
12, 13	Clearance between shifting key and synchronizer hub	0.05 to 0.20 {0.0020 to 0.0079}	0.5 {0.020}	Replace
12, 14	Clearance between shifting key and synchronizer ring	4.75 to 4.95 {0.187 to 0.195}	5.8 {0.228}	Replace
13, *	Fitness to revolving direction of synchronizer hub and countershaft	–0.006 to 0.088 {–0.00024 to 0.0035}	0.2 {0.0079}	Replace
14, 15	Clearance between synchronizer ring and countershaft O/D gear assembly	1.45 to 1.85 {0.057 to 0.073}	0.2 {0.0079}	Replace
15	End play of countershaft O/D gear	0.25 to 0.40 {0.0098 to 0.016}	0.5 {0.020}	Replace
15, 16	Diameter direction after assembling countershaft O/D gear	0.105 to 0.150 {0.0041 to 0.0059}	0.3 {0.012}	Replace
22, 24	Diameter direction after assembling reverse idler gear	—	0.12 {0.0047}	Replace
24	End play of reverse idler gear	0.2 to 0.9 {0.0079 to 0.0035}	1.2 {0.047}	Replace side washer

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

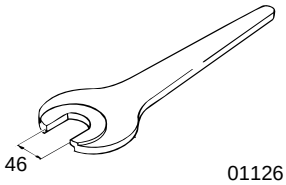
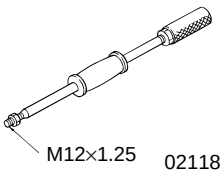
Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (O/D shift shaft and O/D shift lever mounting)	42 {31, 4.3}	—
8	Countershaft rear lock nut	345±49 {253±36, 35±5}	—
18	Bolt (Reverse idler gear cover mounting)	19 {14, 1.9}	—
20	Bolt (Reverse shaft lock piece mounting)	40 {30, 4.1}	—

Sealant

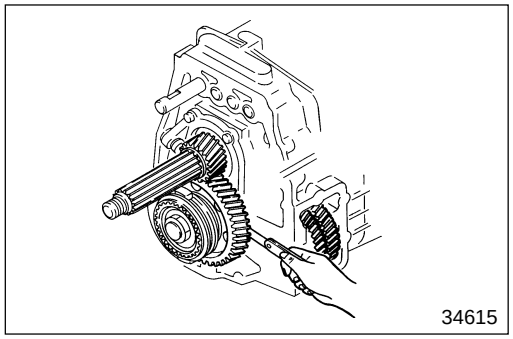
Location	Points of application	Specified sealant	Quantity
19	Reverse idler gear cover installation surface	THREEBOND 1215	As required

6TH GEAR < S6 > AND REVERSE IDLER GEAR

Special tools

Location	Tool name and shape	Part No.	Application
8	Single spanner  01126	MH061555 < S6 >	Removal and istallation of countershaft rear lock nut
22	Drive pinion and reverse shaft puller  02118	03726-82000	Removal of reverse ilder shaft

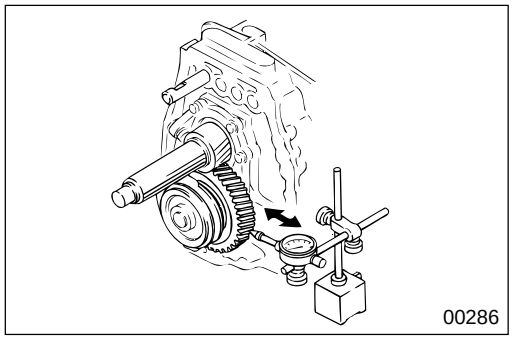
◆ Service procedure


34615

● Inspection before disassembly

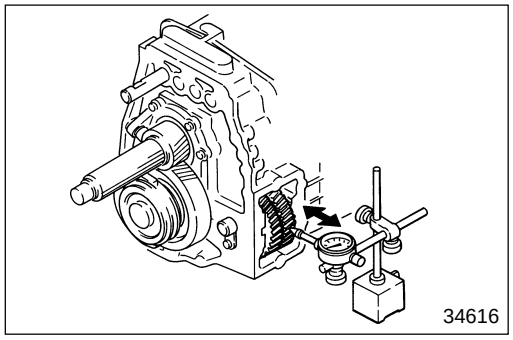
(1) End play of various gears < S6 >

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.


00286

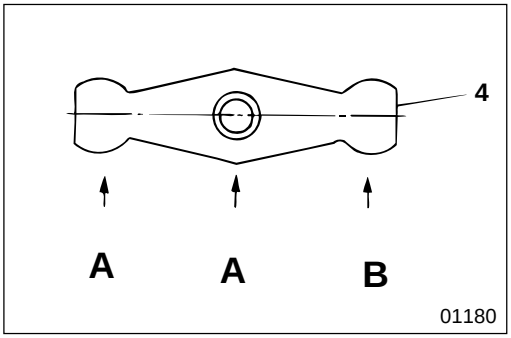
(2) Play of countershaft O/D gear in the diameter direction < S6 >

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.


34616

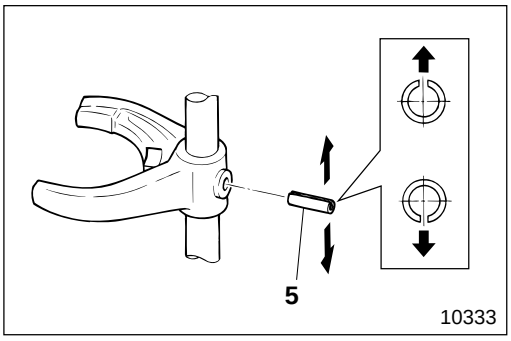
(3) Play of reverse ilder gear in the diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



4 **Bend of O/D shift lever**

If bend **B** exeeds the limit on the basis of illustrated **A - A**, replace O/D shift lever **4**.

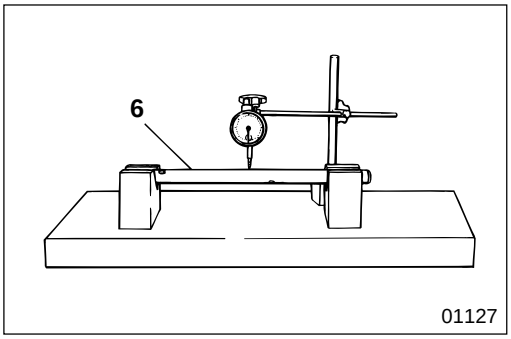


5 **Installation of spring pin**

Install spring pin **5** in O/D gear shift fork **7** in the direction as illustrated.

CAUTION

Make sure you do not drive in spring pin 5 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.

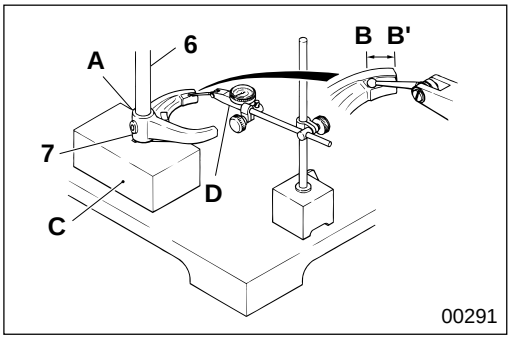


6 **Bend of O/D shift rail C**

If the measured value is higher than the limit, correct or replace O/D shift rail **C6**.

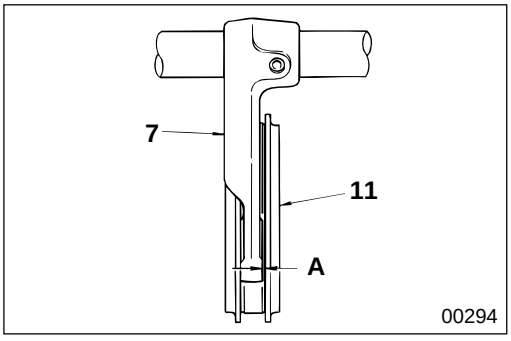
NOTE

Read the dial gauge after turning O/D shift rail C6 one full revolution. The bend is one half of the indicated value.



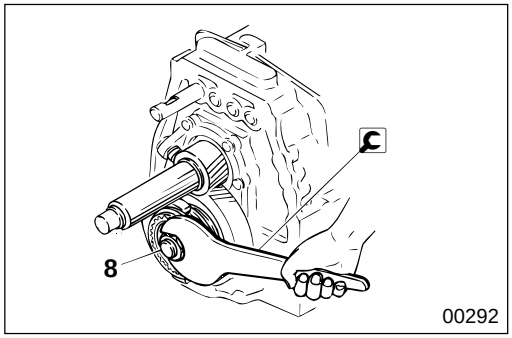
7 **Tilt of O/D gear shift fork claw**

- Measure the tilt (difference between **B** and **B'**) of claw **B-B'** against hole **A** of O/D shift rail C**6** of O/D gear shift fork **7** with the shift rail upright.
- If the measured value is higher than the limit, replace gear shift fork **7**.
  C: V-block
  D: Dial gauge



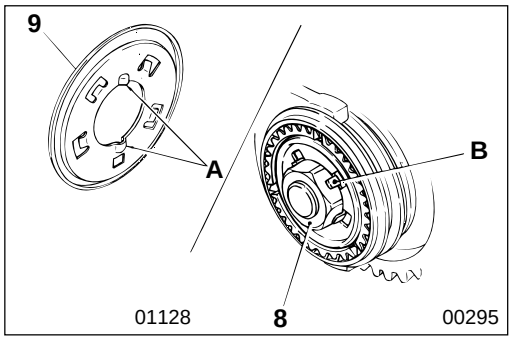
7 **11** **Clearance between O/D gear shift fork and synchronizer sleeve**

- Measure clearance **A** between O/D gear shift fork **7** and synchronizer sleeve **11**.
- If the measured value is higher than the limit, replace the faulty parts.



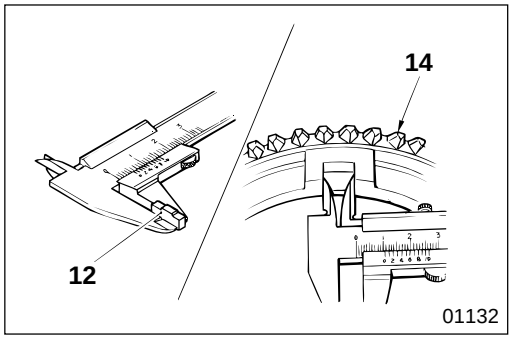
8 **Removal and installation of countershaft rear lock nut**

Have transmissions engaged in double to lock countershaft for this work.
: Single spanner



9 **Installation of shifting key retainer**

- Install so that shifting key retainer **9** protrusions **A** (at 2 places) rest in recessions provided on synchronizer hub.
- After tightening of lock nut, caulk the areas with slits **B** at 4 places of shifting retainer, toward lock nut **8**.

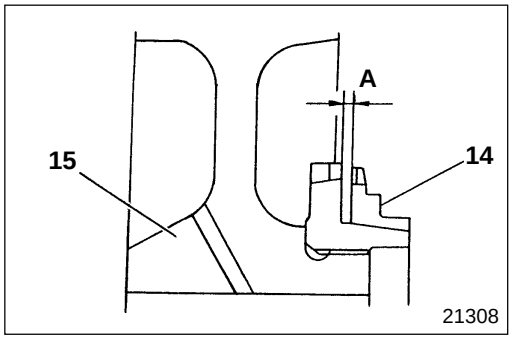


10 **to** **15** **Synchromesh mechanism and countershaft O/D gear assembly**

[Inspection]

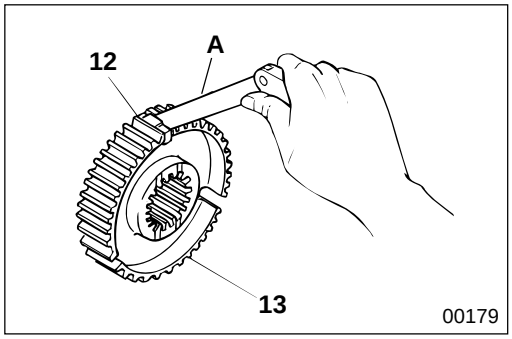
(1) Clearance between synchronizer ring 14 and shifting key 12.

If the measured value is higher than the limit, replace the faulty parts.



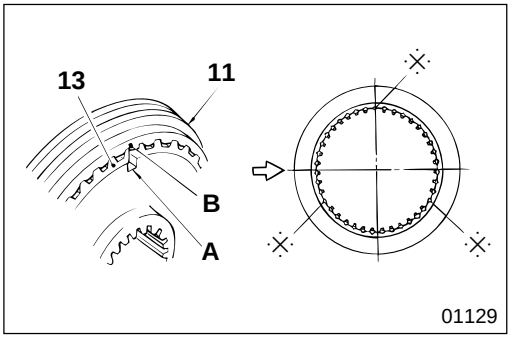
(2) Clearance between synchronizer ring 14 and countershaft O/D gear assembly 15

- Measure clearance **A** between synchronizer ring **14** and the gear cone of countershaft O/D gear assembly **15**.
- When measuring this value, press synchronizer ring **14** evenly, and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



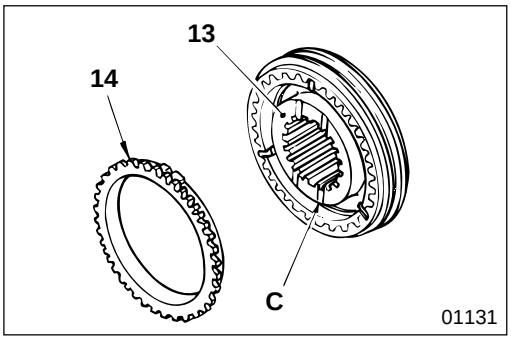
(3) Clearance between shifting key 12 and synchronizer hub 13

If the measured value is higher than the limit, replace the faulty parts.
A : Feeler gauge

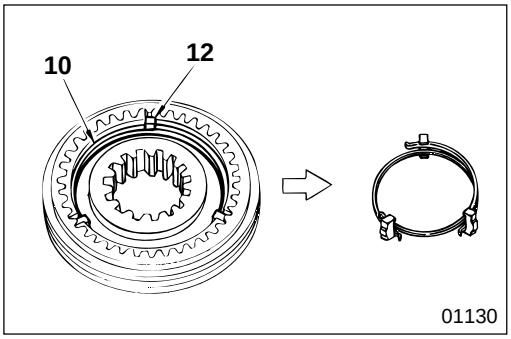


[Installation]

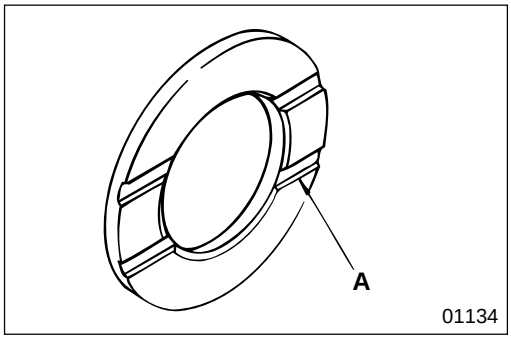
- Align the three keyways **A** of synchronizer hub **13** with the three stub teeth **B** (illustrated by ⋇ mark) of synchronizer sleeve **11** to install the synchronizer hub.
- To reassemble synchronizer hub **13** and synchronizer sleeve **11**, align the alignment marks made during disassembly.



- Assemble synchronizer ring **14** on synchronizer hub **13** with the keyway aligned to the side where oil groove **C** is located.

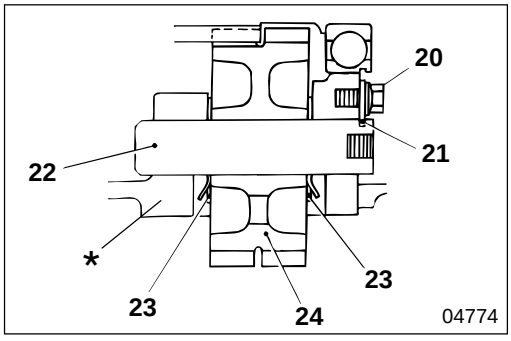


- Insert shifting **12** into the keyway.
- Install shifting key spring **10** so that its opening is offset from the one of the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.



17 Installation of thrust washer

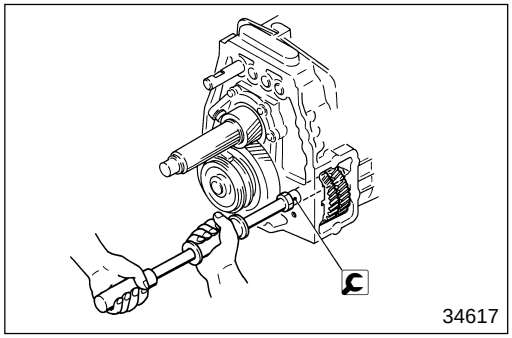
Install with the side having oil grooves **A** facing the side of gear.



20 to 24 Assembly of reverse idler gear

- Install reverse shaft gear side washer **23** and reverse idler gear **24** in trasmission body *****.
- Install reverse ilder shaft **22** in transmission body ***** using a plastic-headed mallet.
- Install reverse shaft lock piece **21** in transmission body ***** with mounting bolt **20**.

6TH GEAR < S6 > AND REVERSE IDLER GEAR

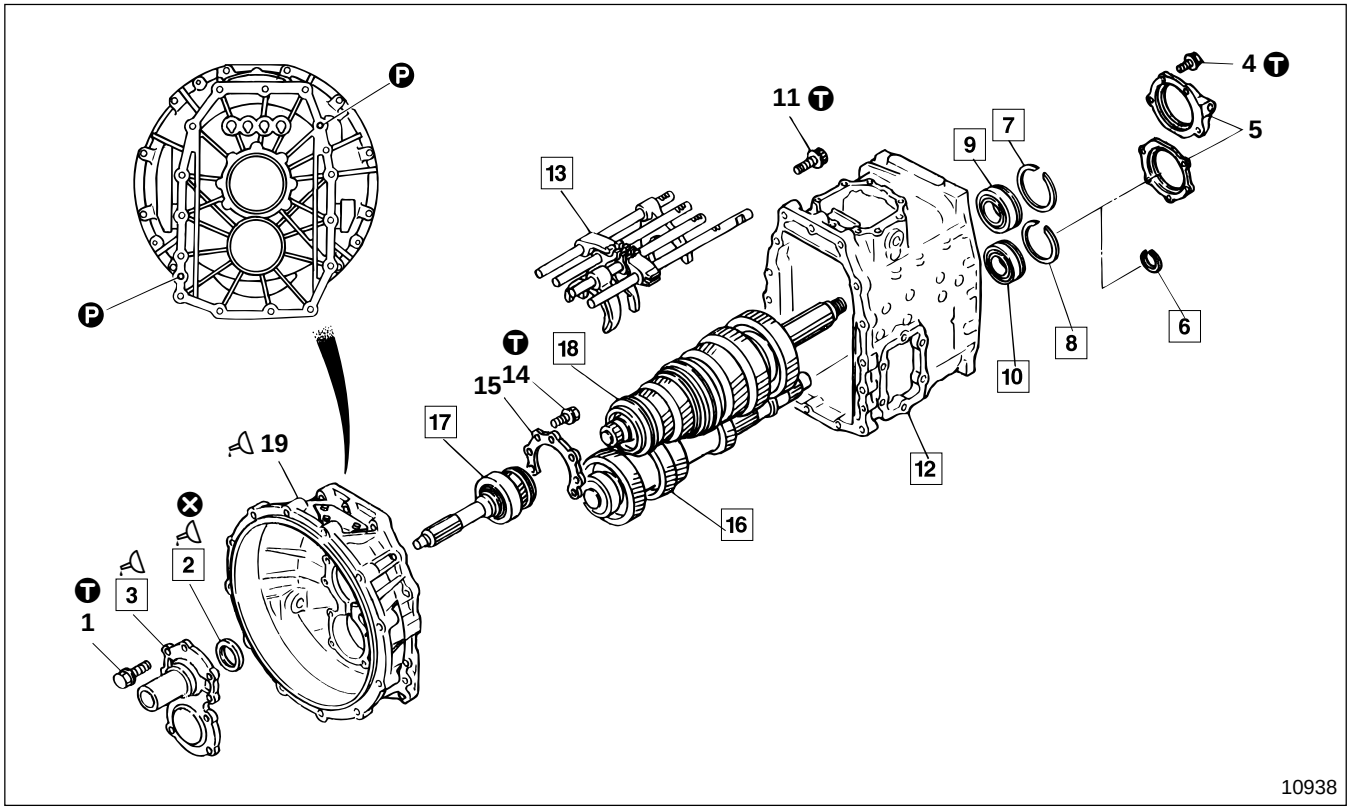


22 **Removal of reverse ilder shaft.**

: Drive pinion and reverse shaft puller

M E M O

TRANSMISSION BODY



● **Disassembly sequence**

1 Bolt
2 Oil seal
3 Front bearing retainer
4 Bolt < S6 >
5 Rear bearing retainer < S6 >
6 Snap ring < S5 >
7 Snap ring
8 Snap ring
9 Mainshaft rear bearing
10 Countershaft rear bearing
11 Bolt
12 Transmission case
13 Shift rail and shift fork 📖 P22-42
14 Bolt
15 Drive pinion bearing retainer
16 Countershaft assembly 📖 P22-56
17 Drive pinion assembly 📖 P22-46
18 Mainshaft assembly 📖 P22-48
19 Clutch housing assembly

Ⓟ : Positioning pins
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

- **After removing parts 1 to 3, disassemble the transmission assembly with the body laid vertically on its clutch housing side.**
- **Remove parts 13, and 16 to 18 as a group. However, shift rail and shift fork 13 can be disassembled on its own if you are not going to disassemble parts 16 to 18. 📖 P22-42**

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

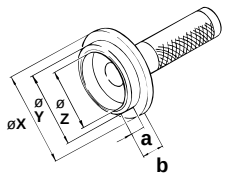
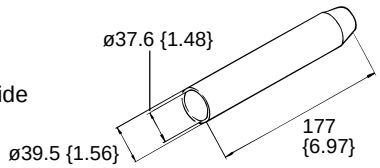
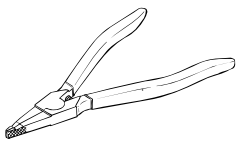
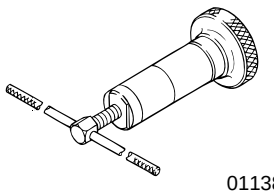
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front bearing retainer mounting)	40 {30, 4.1}	—
4	Bolt (Rear bearing retainer mounting)	40 {30, 4.1}	—
11	Bolt (Transmission case mounting)	120 {90, 12.4}	—
14	Bolt (Drive pinion retainer mounting)	40 {30, 4.1}	—

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
2	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
3	Contact surface between front bearing retainer and clutch housing assembly	THREEBOND 1215	As required
19	Contact surface between clutch housing assembly and transmission case	THREEBOND 1215	As required

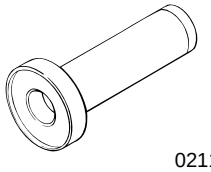
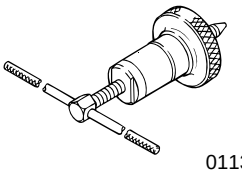
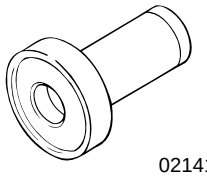
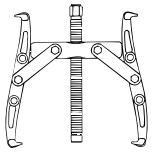
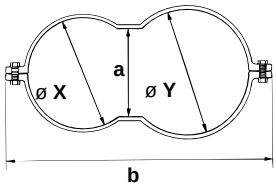
Special tools

Unit : mm {in.}

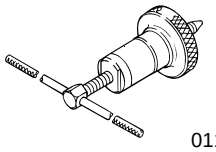
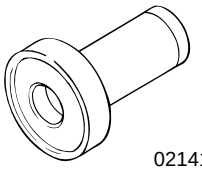
Location	Tool name and shape	Part No.	Application
2	Oil seal installer **X** 62 {2.44} **Y** 40 {1.57} **Z** 30 {1.18} **a** 10 {0.39} **b** 10 {0.39}  01135	ME624241	Installation of front bearing retainer oil seal
3	Oil seal front guide  01136	MH061990	Installation of front bearing retainer
6, 7, 8, 12	Snap ring expander  01137	MH061268	Removal of snap rings from mainshaft rear bearing and countershaft front and rear bearings
9	Mainshaft bearing puller  01138	*MH061732	Removal of mainshaft rear bearing

* components of puller and installer kit P22-65

Unit : mm {in.}

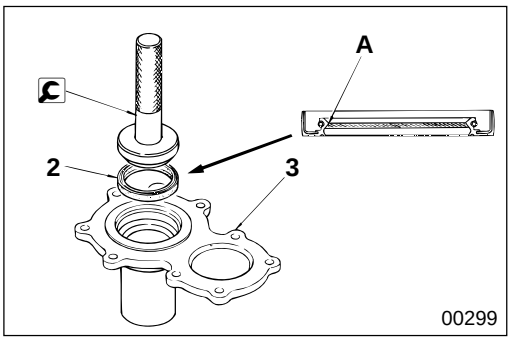
Location	Tool name and shape	Part No.	Application
9	Mainshaft bearing installer  02115	*MH624234	Installation of mainshaft rear bearing
10	Countershaft bearing puller  01139	*ME061731	Removal of countershaft rear bearing
	Countershaft bearing installer  02141	*ME624233	Installation of countershaft bearing
12	Eye bolt 01140	MH062340	Lifting of transmission case
	Gear puller  01148	MH062308	Removal of transmission case
16 to 18	Steel lifting band X: 87 {3.43} Y: 175 {6.89} a: 80 {3.15} b: 336 {13.2}  01141	MH062343	Removal and installation of mainshaft assembly, countershaft assembly and drive pinion assembly
	Eye nut 01142	MH062341	

* components of puller and installer kit. P22-65

Location	Tool name and shape	Part No.	Application
16	Countershaft bearing puller  01139	*MH062426	Removal of countershaft front bearing
	Countershaft bearing installer  02141	*ME624233	Installation of countershaft front bearing

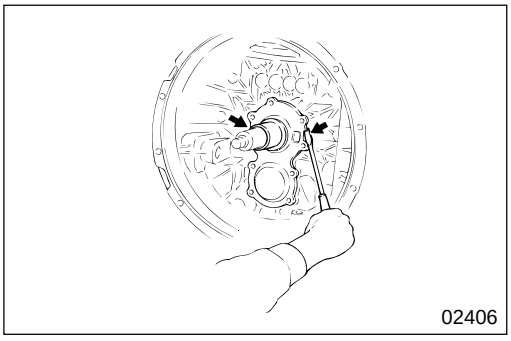
* components of puller and installer kit. P22-65

◆ Service procedure



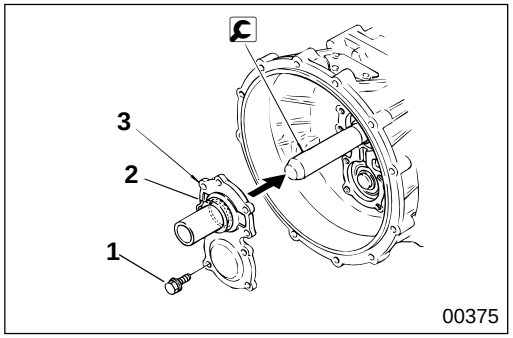
2 Installation of oil seal

- Apply grease to lip area **A** of oil seal **2**.
- Press-fit oil seal **2** into front bearing retainer **3** in the direction as illustrated using oil seal installer.



3 Front bearing retainer

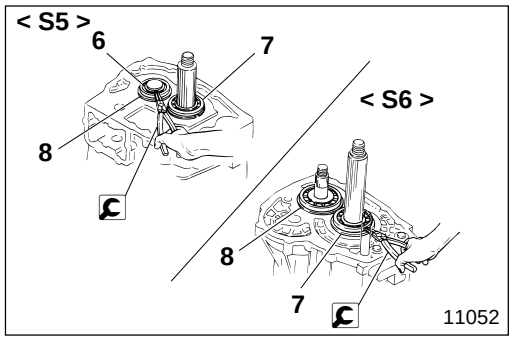
[Removal]



[Installation]
Press-fit front bearing retainer **3** into clutch housing assembly **19** using oil seal front guide.

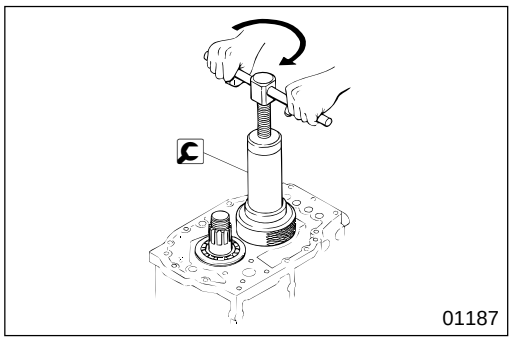
CAUTION

Be careful when installing front bearing retainer 3, that you do not damage oil seal 2 installed on the front bearing retainer.



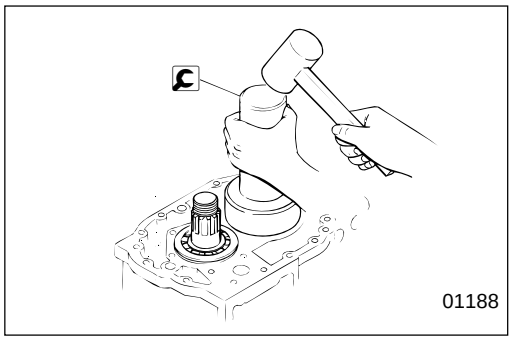
6 to 8 Removal and installation of snap ring

: Snap ring expander

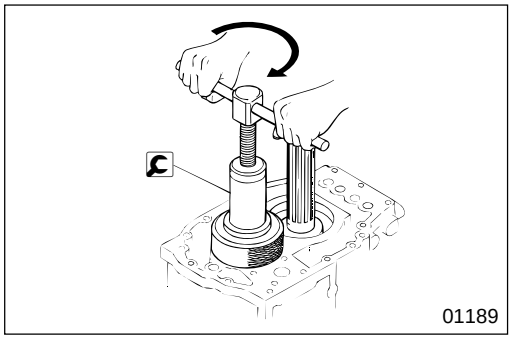


9 Mainshaft rear bearing

[Removal]
: Mainshaft bearing puller

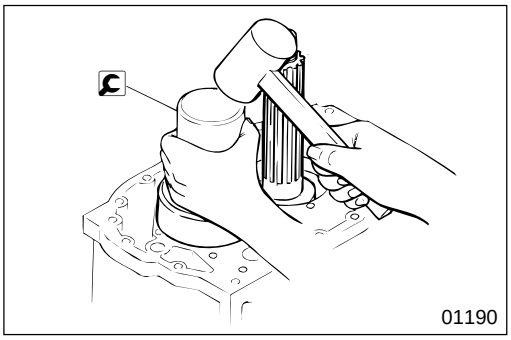


[Installation]
: Mainshaft bearing installer



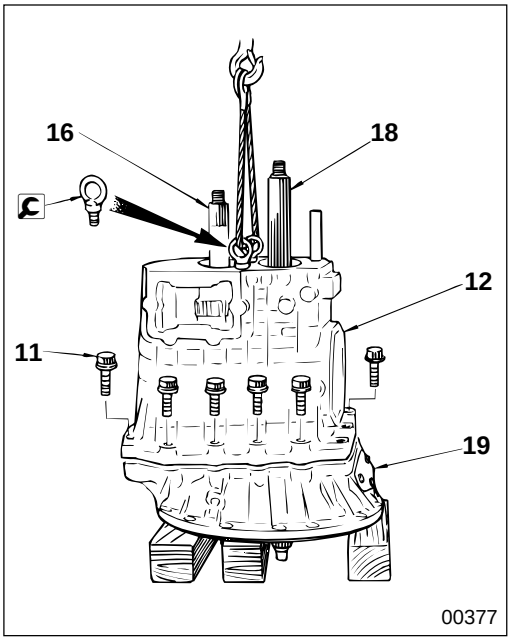
10 Countershaft rear bearing

[Removal]
: Countershaft bearing puller



[Installation]

: Countershaft bearing installer



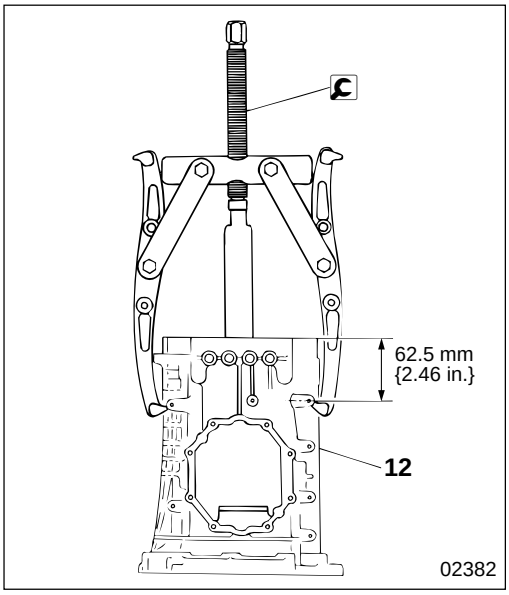
12 Removal and installation of transmission case

[Removal]

● **Remove transmission case 12.**

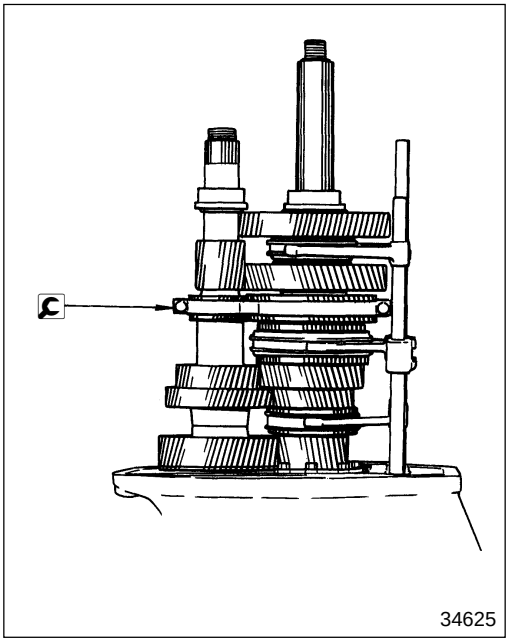
Method 1

- When lifting up with a crane, install eye bolts on transmission case **12** and pass a steel sling through them.
- After removing bolts **11**, lift transmission case **12** up with a crane and keep hitting the rear ends of clutch housing assembly **19**, mainshaft assembly **18** and countershaft assembly **16**. Use a plastic-headed or copper-headed mallet to remove the transmission case.



Method 2

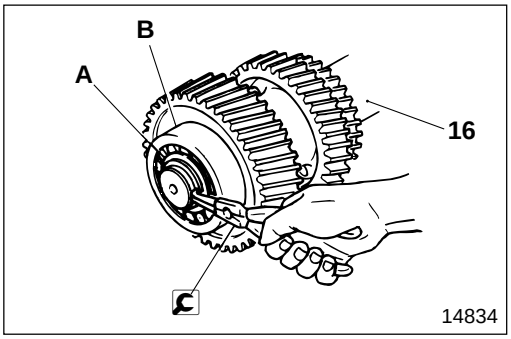
- A gear puller can be used instead of a crane.
  Puller installation position



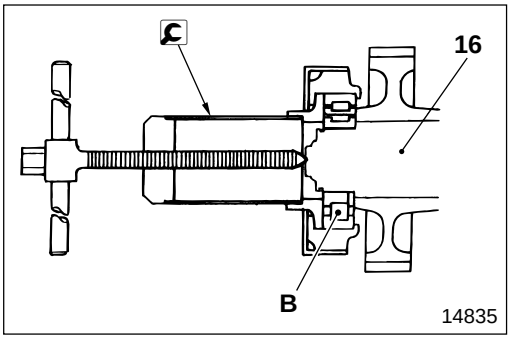
- After removing transmission case **12**, fit the 2nd gear unit using 🔧 steel lifting band to ensure safety.

CAUTION ⚠

Be sure to tighten 🔧 steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.



- Remove snap ring **A** from countershaft assembly **16**.
  B : Countershaft front bearing
  🔧 : Snap ring expander

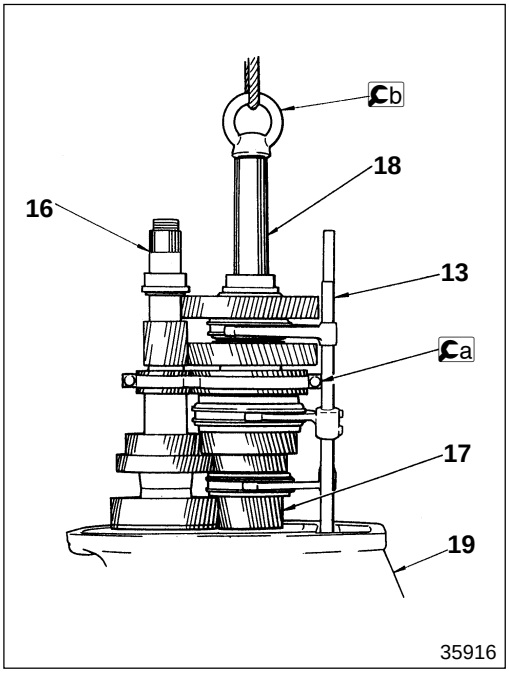


- Remove countershaft bearing **B** from countershaft assembly **16**.
  🔧 : Countershaft bearing puller

[Installation]
Follow the removal sequence in reverse.

CAUTION ⚠

Be careful not to damage mainshaft assembly 18, or rear bearings 9, 10 of countershaft assembly 16 during installation.



13 **16** **to** **18** **Shift rail and shift fork, countershaft assembly, drive pinion assembly, and mainshaft assembly**

[Removal]
Remove or install shift rail and shift fork **13**, countershaft assembly **16**, drive pinion assembly **17**, and mainshaft assembly **18** as a group.

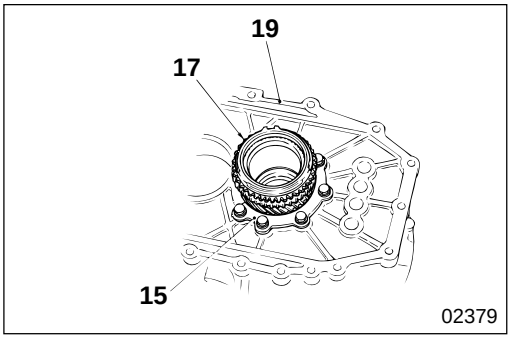
- Before lifting, after removing the case, install b eye nut at the end of mainshaft **18**, fitted with a steel lifting band.
- Fix shift rail and shift fork **13** to mainshaft assembly **18** with a rubber band.
- Fix a piece of wood to clutch housing assembly **19**, and use a crane to lift the clutch housing together with drive pinion assembly **17** up, at the same time hitting them with a plastic-headed mallet to remove them.

CAUTION

- **Be sure to tighten a steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.**
- **Make sure, when lifting mainshaft assembly 18 or other parts, that you support drive pinion assembly 17 with your hand in order to prevent it from falling when the mainshaft assembly and countershaft assembly 16 come apart.**

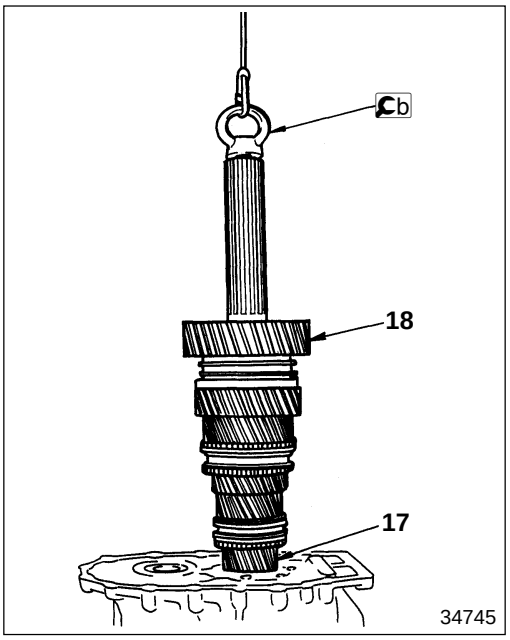
[Installation]
Method 1

- Follow the removal sequence in reverse.



Method 2

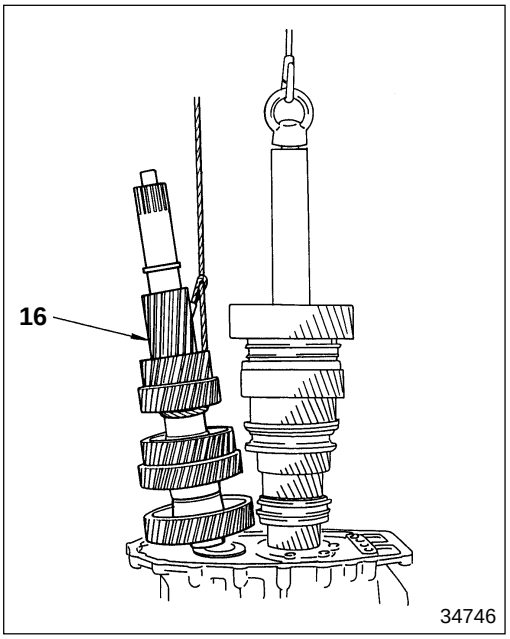
- After installing drive pinion assembly **17** in clutch housing assembly **19**, install drive pinion bearing retainer **15**.



- Install b eye nut at the end of mainshaft assembly **18**.
- Lift mainshaft assembly **18** up using a crane and install the mainshaft assembly on drive pinion assembly **17**.

CAUTION

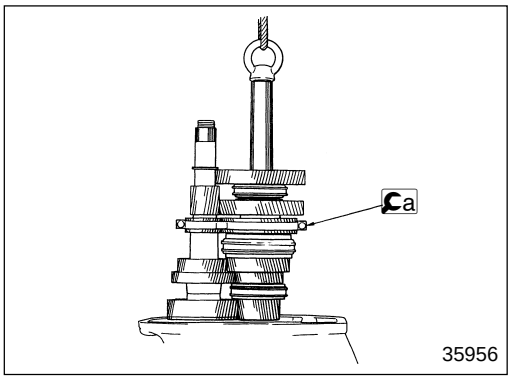
To prevent mainshaft assembly 18 from falling, support it using a crane.



- Install countershaft assembly **16** in clutch housing assembly **19**.

CAUTION

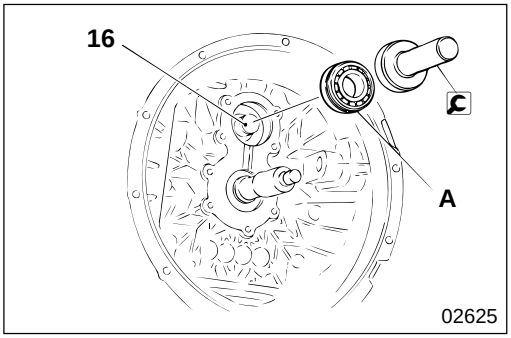
If you use this method of installation, first remove the countershaft front bearing. P22-56



- Fit the 2nd gear unit using a steel lifting band to ensure safety.

CAUTION

Be sure to tighten a steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.

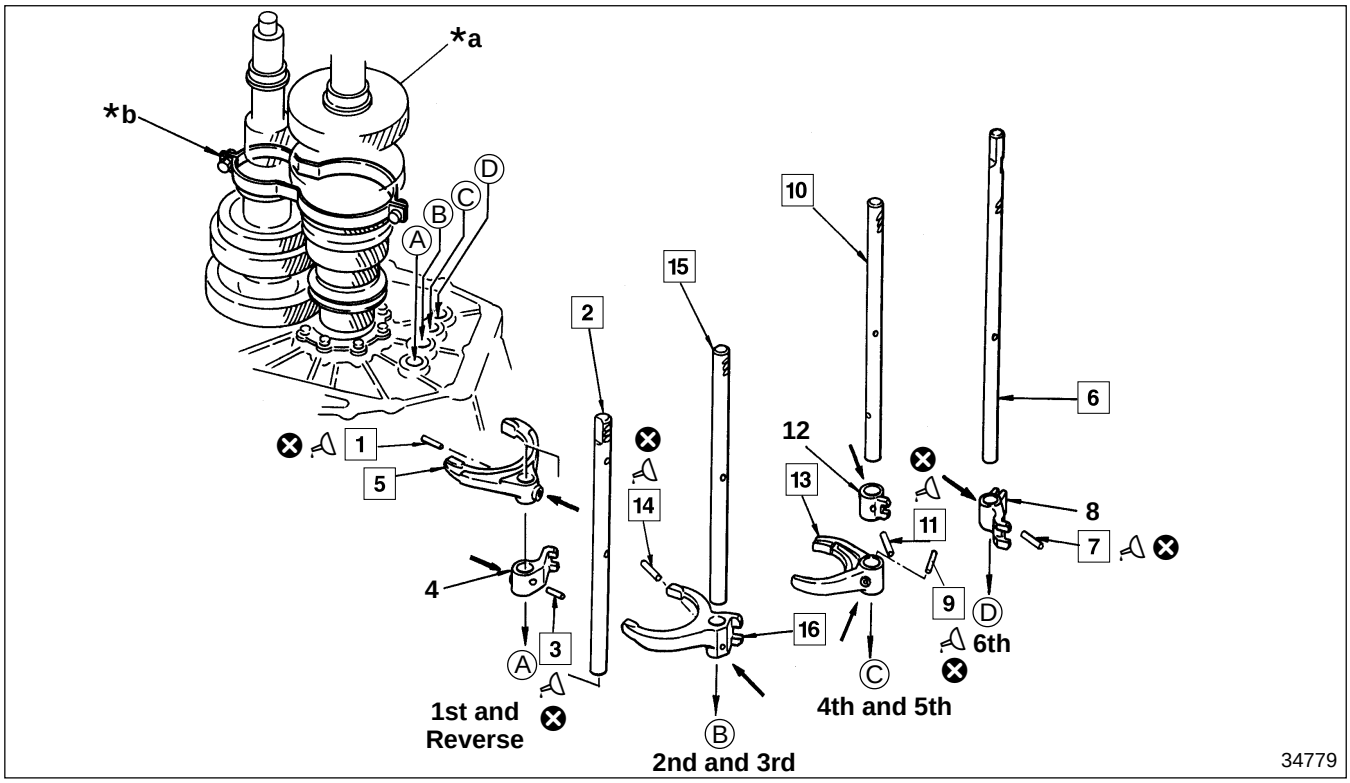


- Install shift rail and shift fork **13** and transmission case **12** in clutch housing assembly **19**.
- Place cluch housing assembly **19** horizontally so that countershaft assembly **16** is uppermost.
- Install the countershaft front bearing **A** into clutch housing assembly **19** using countershaft bearing installer.

CAUTION

Be sure to install the snap ring of the countershaft front bearing.

Shift Rail and Shift Fork



Arrow mark : Removal and installation direction for spring pin

● **Disassembly sequence** (When the mainshaft assembly is not removed or installed and only the shift rail and shift fork is disassembled)

1 Spring pin
2 1st and reverse shift rail
3 Spring pin
4 1st and reverse shift rail jaw
5 1st and reverse shift fork
6 6th shift rail < S6 >
7 Spring pin < S6 >
8 6th shift rail jaw < S6 >
9 Spring pin
10 4th and 5th shift rail
11 Spring pin
12 4th and 5th shift rail jaw
13 4th and 5th shift fork
14 Spring pin
15 2nd and 3rd shift rail
16 2nd and 3rd shift fork

***a** : Mainshaft assembly
***b** : steel lifting band
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse. Remove steel lifting band after installing the shift rail and shift fork.

Service standards

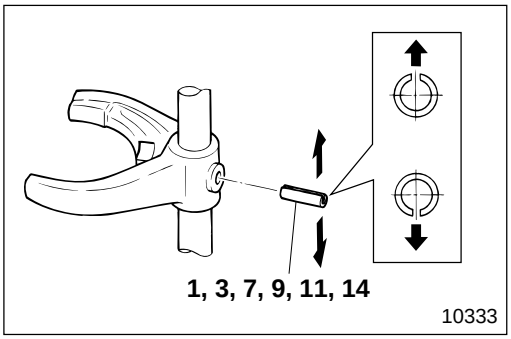
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2, 10, 15	Bend of shift rail	0.039 {0.0015} or less	0.08 {0.0031}	Correct or replace
5, 13, 16	Tilt of shift fork claw	0.1 {0.0039} or less	0.2 {0.0079}	Replace
5, *a	Clearance between 1st and reverse shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace
6	Bend of 6th shift rail	0.047 {0.0019} or less	0.09 {0.0035}	Correct or replace
13, *a	Clearance between 4th and 5th shift fork and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
16, *a	Clearance between 2nd and 3rd shift fork and synchronizer sleeve	0.2 to 0.4 {0.0079 to 0.016}	1.0 {0.039}	Replace

Sealant

Location	Points of application	Specified sealant	Quantity
1, 3, 7, 9, 11, 14	Spring pin	LOCTITE 601	As required

◆ Service procedure

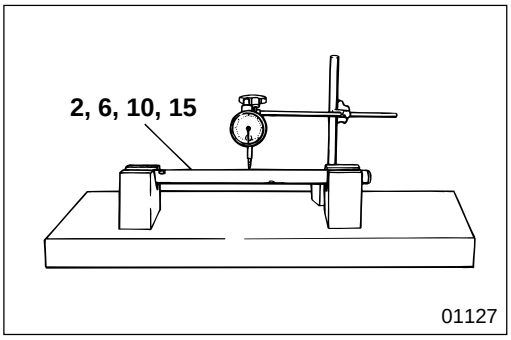


1 **3** **7** **9** **11** **14** **Installation of spring pin**

Install spring pins **1**, **3**, **7**, **9**, **11, 14** in the direction as illustrated.

CAUTION

- **Make sure you do not drive in spring pins 1, 3, 7, 9, 11, 14 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.**
- **Do not remove spring pin 9 for 4th and 5th shift fork 13 (made of aluminum), except when replacing shift fork 13 or shift rail 10.**
- **Note that the length of spring pin 9 differs from that of spring pins 1, 3, 7, 11, 14.**
- **Be careful when driving in spring pins 1, 3, 7, 9, 11, 14 that you do not subject shift rails 2, 6, 10, 15 to excessive strain, because this would cause faults such as bent shift rails.**

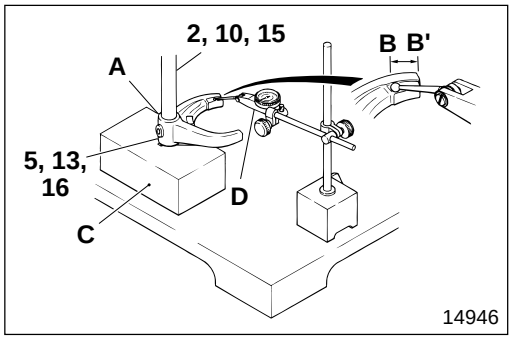


2 **6** **10** **15** **Bend of shift rail**

If the measured value is higher than the limit, correct or replace shift rail **2**, **6**, **10** or **15**.

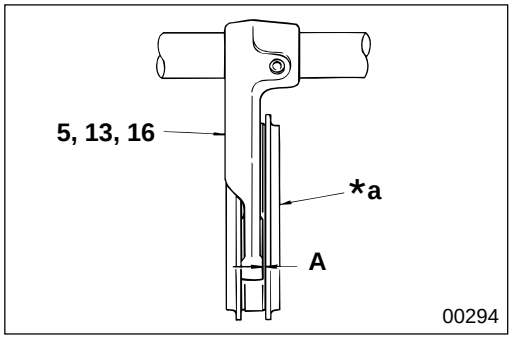
NOTE

Read the dial gauge after turning shift rails 2, 6, 10, 15 one full revolution. The bend is one half of the indicated value.



5 13 16 Tilt of shift fork claws

- Measure the tilt (difference between **B** and **B'**) of claw **B**–**B'** against hole **A** of shift rails **2, 10, 15** of shift forks **5, 13, 16** with the shift rails upright.
- If the measured value is higher than the limit, replace shift fork **5**, **13**, or **16**.
  C : V-block
  D : Dial gauge

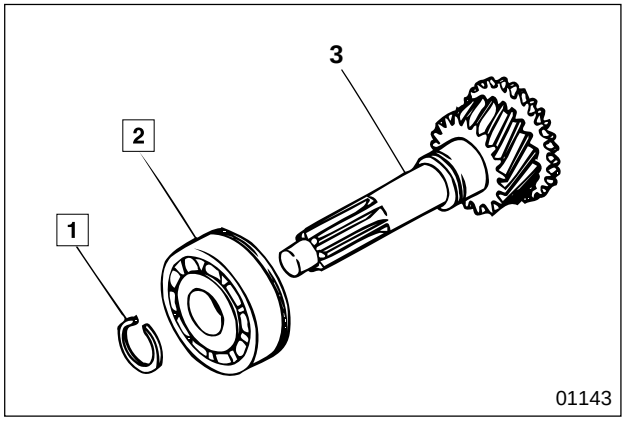


5 13 16 *a Clearance between gear shift fork and synchronizer sleeve of mainshaft

If clearance **A** is higher than the limit, replace the faulty parts.
***a** : Synchronizer ring of mainshaft assembly

M E M O

DRIVE PINION ASSEMBLY



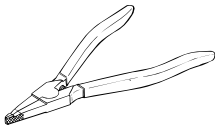
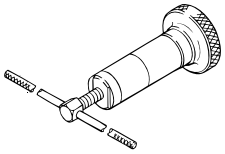
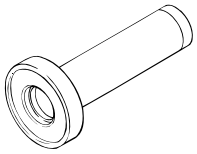
● **Disassembly sequence**

1 Snap ring
2 Drive pinion bearing
3 Drive pinion

● **Assembly sequence**

Follow the disassembly sequence in reverse.

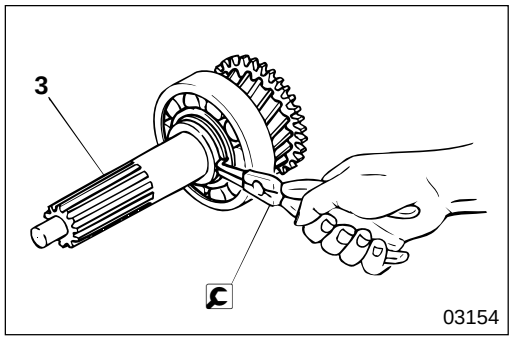
Special tools

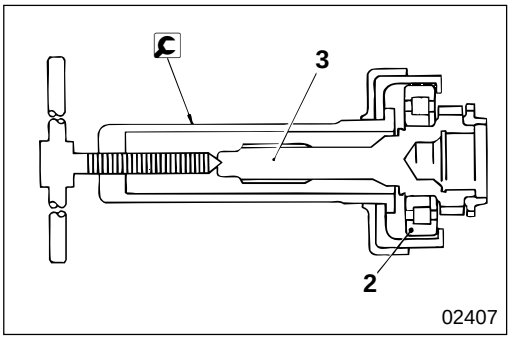
Location	Tool name and shape	Part No.	Application
1	Snap ring expander  01137	MH061268	Removal and installation of snap ring of drive pinion bearing
2	Drive pinion bearing puller  01138	*MH062440	Removal of drive pinion bearing
	Drive pinion bearing installer  02142	*ME624235	Installation of drive pinon bearing

* components of puller and installer kit P22-65

◆ Service procedure

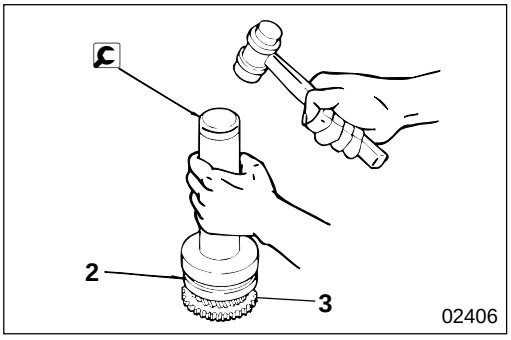
1 **Removal and installation of snap ring**





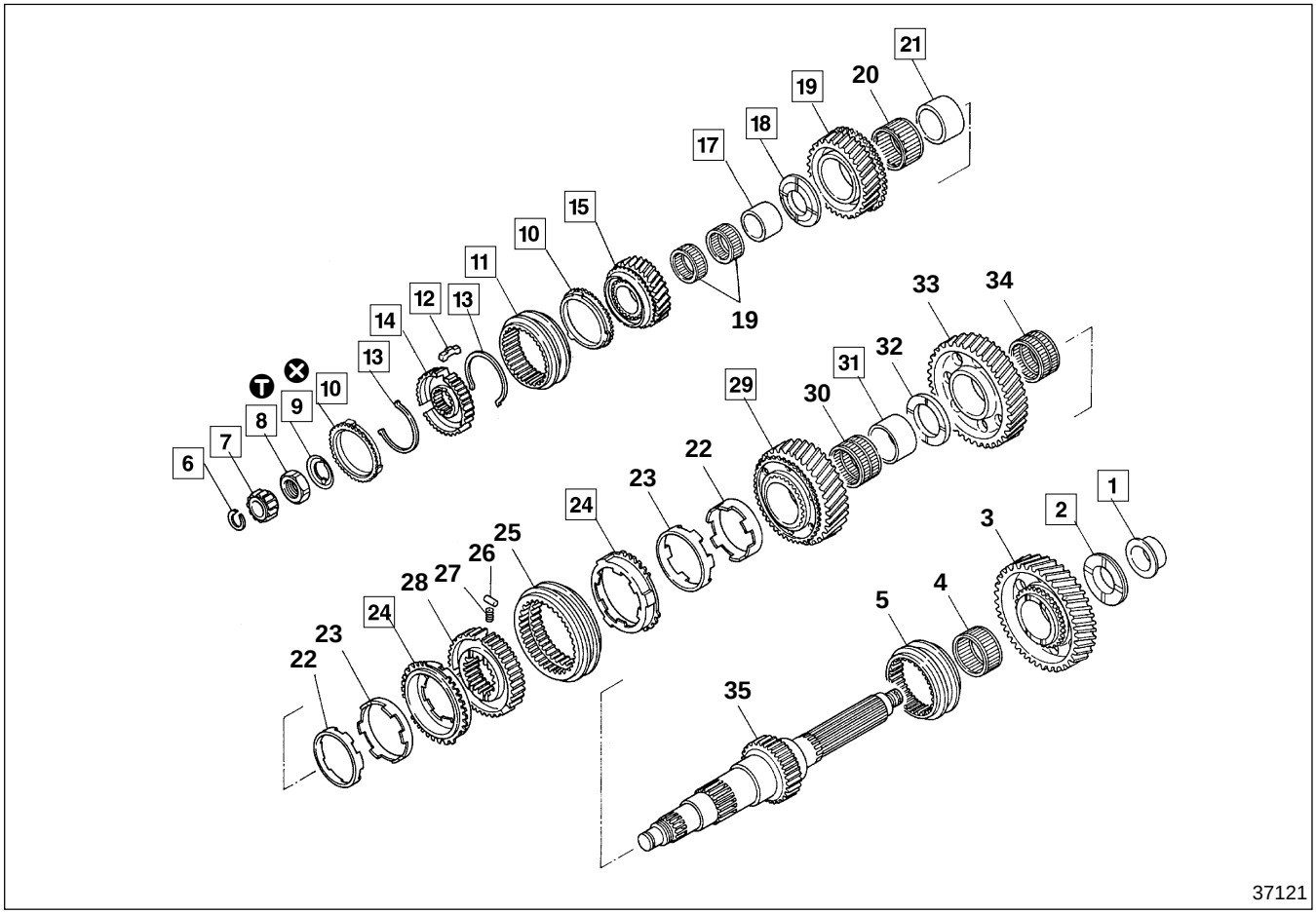
2 Drive pinion bearing

[Removal]



[Installation]

MAINSHAFT ASSEMBLY



● **Work before disassembly**

P22-51

● **Disassembly sequence**

1 Mainshaft rear bearing inner race < S6 >
2 Reverse gear thrust washer
3 Reverse gear
4 Needle bearing
5 Sleeve
6 Snap ring
7 Pilot bearing
8 Lock nut
9 Lock washer
10 Synchronizer ring
11 Synchronizer sleeve
12 Shifting key
13 Shifting key spring
14 Synchronizer hub
15 4th gear assembly
16 Needle bearing
17 4th gear bearing sleeve
18 3rd and 4th gear thrust washer
19 3rd gear assembly
20 Needle bearing
21 3rd gear bearing sleeve
22 Synchronizer inner ring
23 Synchronizer center cone
24 Synchronizer outer ring
25 Synchronizer sleeve
26 Shifting key
27 Synchronizer spring
28 Synchronizer hub
29 2nd gear assembly
30 Needle bearing
31 2nd gear bearing sleeve
32 1st and 2nd gear thrust washer
33 1st gear
34 Needle bearing
35 Mainshaft

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	End play of reverse gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
3, 4, 35	Play in the diameter direction after assembling reverse gear	—	0.12 {0.0047}	Replace
5, 35	Play in the rotating direction of sleeve and spline of mainshaft	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
7, 35	Play in the diameter direction after assembling pilot bearing	—	0.12 {0.0047}	Replace
10	Clearance between synchronizer ring and cone of drive pinion assembly	1.48 to 1.77 {0.058 to 0.070}	0.2 {0.0079}	Replace
10, 12	Clearance between synchronizer ring keyway and shifting key	4.75 to 4.95 {0.187 to 0.195}	5.8 {0.23}	Replace
10, 15	Clearance between synchronizer ring and cone of 4th gear	1.48 to 1.77 {0.058 to 0.070}	0.2 {0.0079}	Replace
11, 14	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
12, 14	Clearance between shifting key and synchronizer hub keyway	0.05 to 0.2 {0.0020 to 0.0079}	0.5 {0.020}	Replace
15	End play of 4th gear	0.25 to 0.4 {0.0098 to 0.016}	0.5 {0.020}	Replace gear or thrust washer
15, 16, 17, 35	Play in the diameter direction after assembling 4th gear	—	0.12 {0.0047}	Replace
17	Outer diameter of 4th gear bearing sleeve	$[54]^{-0.030}_{-0.043}$ {$[2.12]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
19	End play of 3rd gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
19, 24	Clearance between cone area of 3rd gear and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
19, 20, 21, 35	Play in the diameter direction after assembling 3rd gear	—	0.12 {0.0047}	Replace
21	Outer diameter of 3rd gear bearing sleeve	$[68]^{-0.030}_{-0.043}$ {$[2.68]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
24, 29	Clearance between synchronizer outer ring and cone area of 2nd gear	1.21 to 1.79 {0.048 to 0.070}	0.5 {0.020}	Replace
29	End play of 2nd gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
29, 30, 31, 35	Play in the diameter direction after assembling 2nd gear	—	0.12 {0.0047}	Replace
31	Outer diameter of 2nd gear bearing sleeve	$[71]^{-0.030}_{-0.043}$ {$[2.8]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
33	End play of 1st gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
33, 34, 35	Play in the diameter direction after assembling 1st gear	—	0.12 {0.0047}	Replace

MAINSHAFT ASSEMBLY

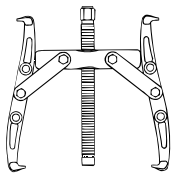
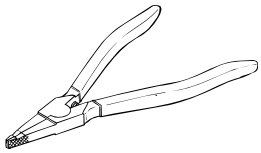
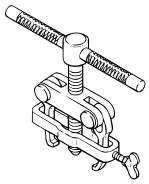
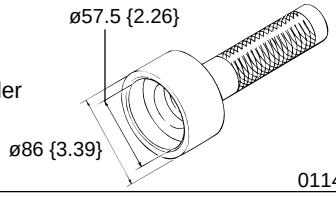
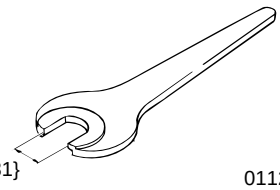
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Lock nut	245 {180, 25}	—

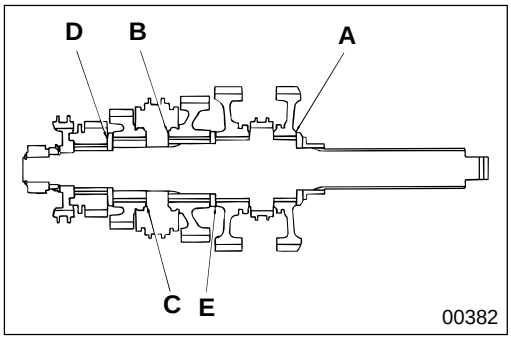
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1, 17, 21, 31	Gear puller  01148	MH062308	Removal of bearing sleeve
6	Snap ring expander  01137	MH061268	Removal and installation of snap ring
7	Pilot bearing puller  01146	MH061043	Removal of pilot bearing
	Pilot bearing installer  01147	*ME624236	Installation of pilot bearing
8	Single spanner  01126	MH061555	Removal and installation of lock nut

* components of puller and installer kit P22-65

◆ Service procedure



● Work before disassembly

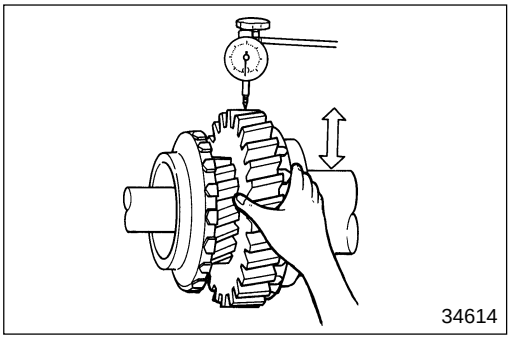
[Inspection]

(1) End play of gears

A : Reverse gear
B : 2nd gear
C : 3rd gear
D : 4th gear
E : 1st gear

If the measured value is higher than the limit, replace the faulty parts.

Also inspect this item after assembly and make sure that the measured value is within the limit.

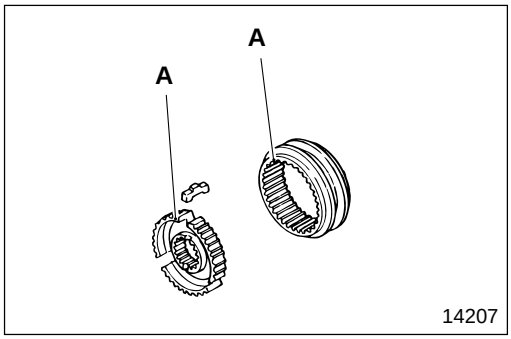


(2) Play of gears in diameter direction

If the measured value is higher than the limit, replace the faulty parts. Also inspect this item after assembly and make sure that the measured value is within the limit.

CAUTION⚠

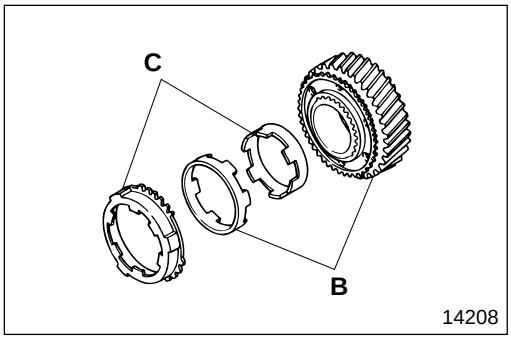
Be sure when you replace the two needle bearings of a gear, that both needle bearings are from the same color package.



[Alignment marks]

(1) Synchronizer sleeve and synchronizer hub

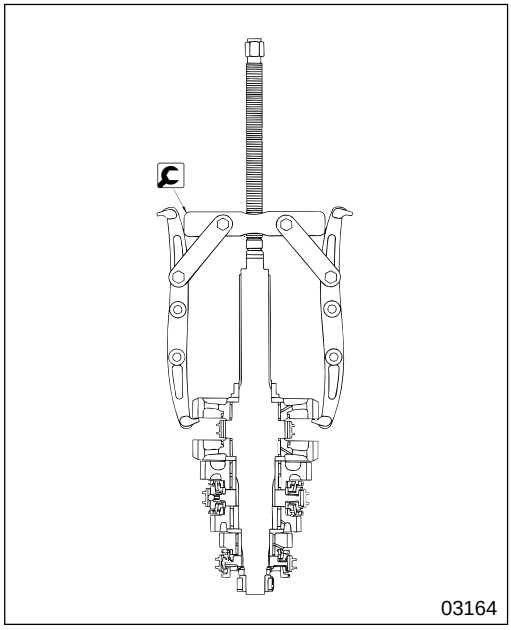
Before disassembling the synchronizer sleeve and the synchronizer hub, put alignment marks **A** on the places where the shifting keys are installed. When reusing parts, align the alignment marks to assemble.



(2) Ring, cone and gear assembly of double cone synchronizer

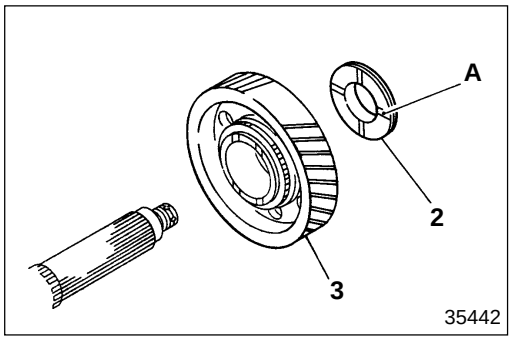
Before disassembling synchronizer center cone and gear assembly (**B**), and synchronizer center ring and synchronizer outer ring (**C**), put alignment marks on them. When reusing parts, align the alignment marks to assemble.

MAINSHAFT ASSEMBLY



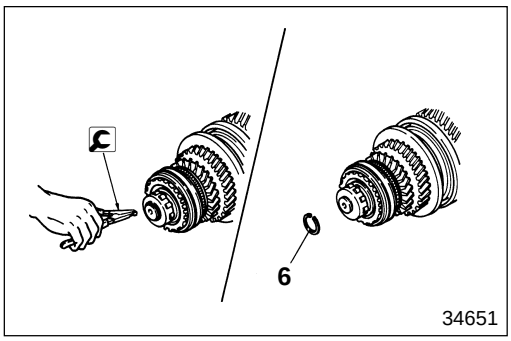
1 **Removal of mainshaft rear bearing inner race < S6 >**

: Gear puller



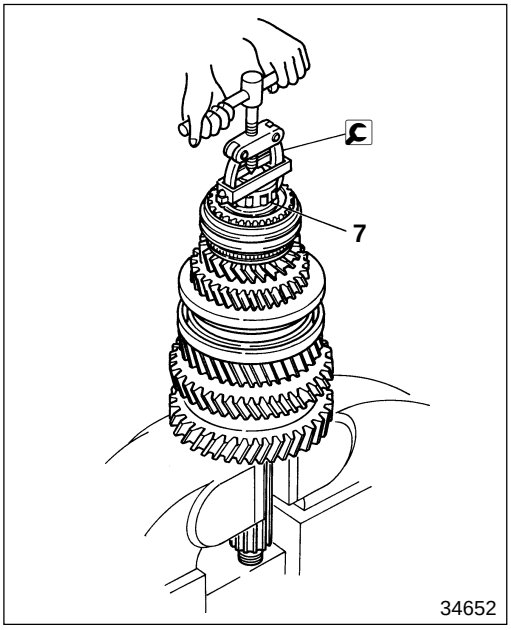
2 **Installation of reverse gear thrust washer**

A : Oil groove



6 **Removal and installation of snap ring**

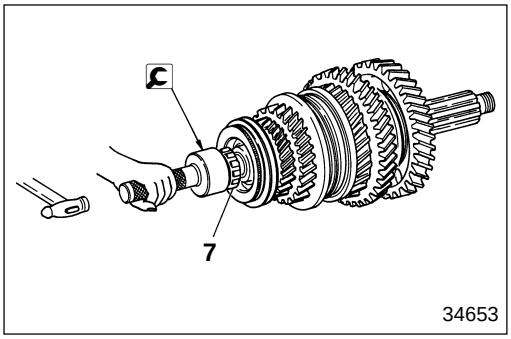
: Snap ring expander



7 **Pilot bearing**

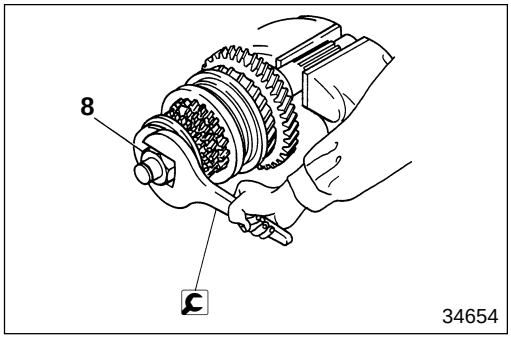
[Removal]

: Pilot bearing puller



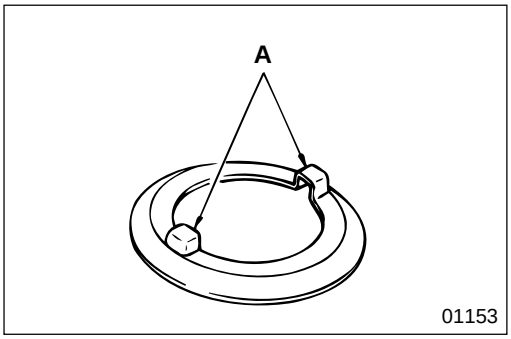
[Installation]

: Pilot bearing installer



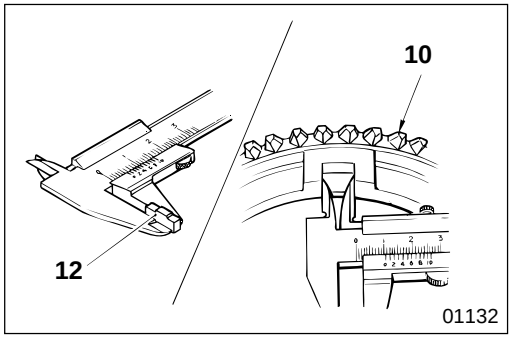
8 **Removal and installation of lock nut**

: Single spanner



9 **Installation of lock washer**

Install so that protrusions **A** (two points as illustrated) fit into the grooves of synchronizer hub **14**.

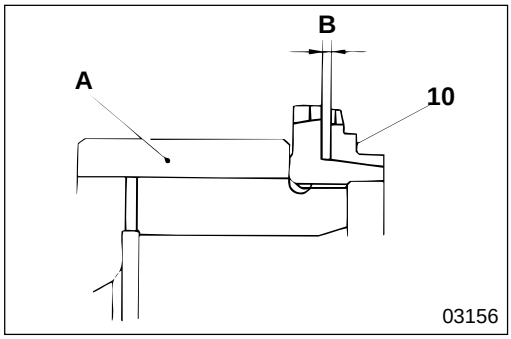


10 to **15** **Synchromesh mechanism and 4th gear**

[Inspection]

(1) Clearance between synchronizer ring 10 and shifting key 12

If the measured value is higher than the limit, replace the faulty parts.

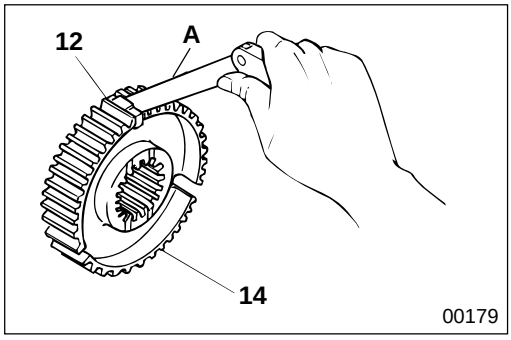


(2) Clearance between synchronizer ring 10 and drive pinion

- Measure clearance **B** between synchronizer ring **10** and the gear cone of drive pinon **A**.
- When measuring this value, press synchronizer ring **10** evenly, and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.

(3) Clearance between synchronizer ring and 4th gear

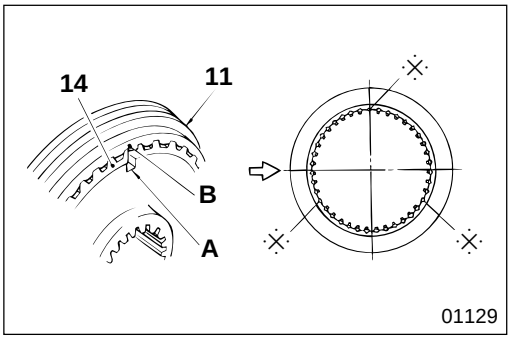
- According to the procedure described in (2), measure clearance between synchronizer ring **10** and the gear cone of 4th gear **15**.



(4) Clearance between shifting key 12 and synchronizer hub 14

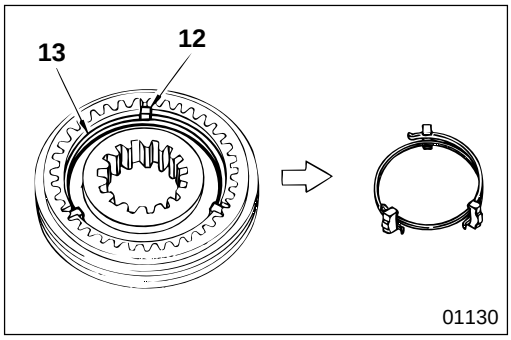
If the measured value is higher than the limit, replace the faulty parts.

A : Feeler gauge

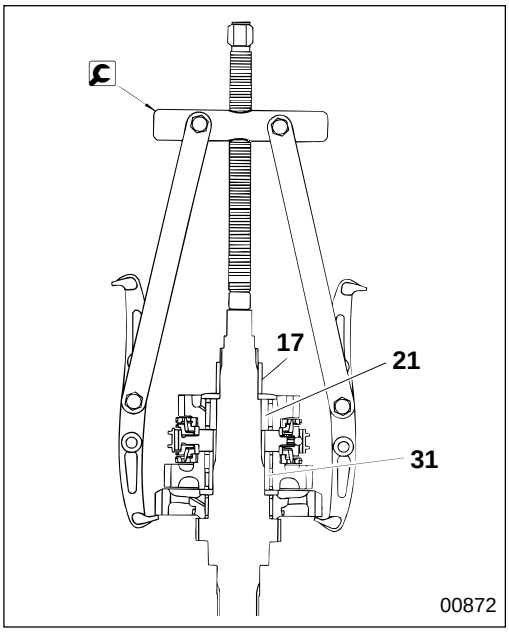


[Installation]

- Align the three keyways **A** of synchronizer hub **14** with the three stub teeth **B** (illustrated by ·⁜· mark) of synchronizer sleeve **11** to install the synchronizer hub.
- To reassemble synchronizer hub **14** and synchronizer sleeve **11**, align the alignment marks made during diassembly.

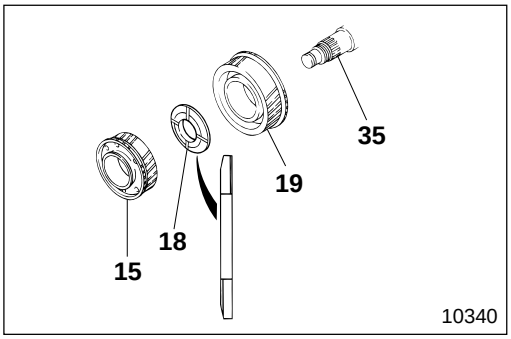


- Insert shifting key **12** into the keyway.
- Install shifting key spring **13** so that its opening is offset from the one of the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.

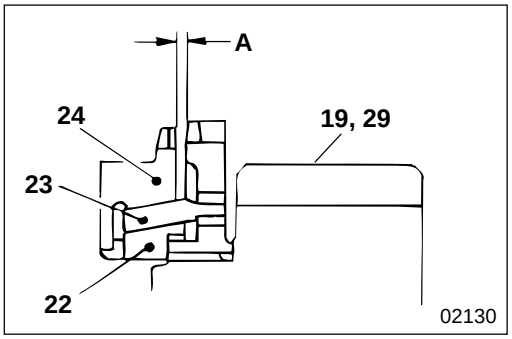


17 **21** **31** **Removal of 4th, 3rd, 2nd gear bearing sleeves**

: Gear puller



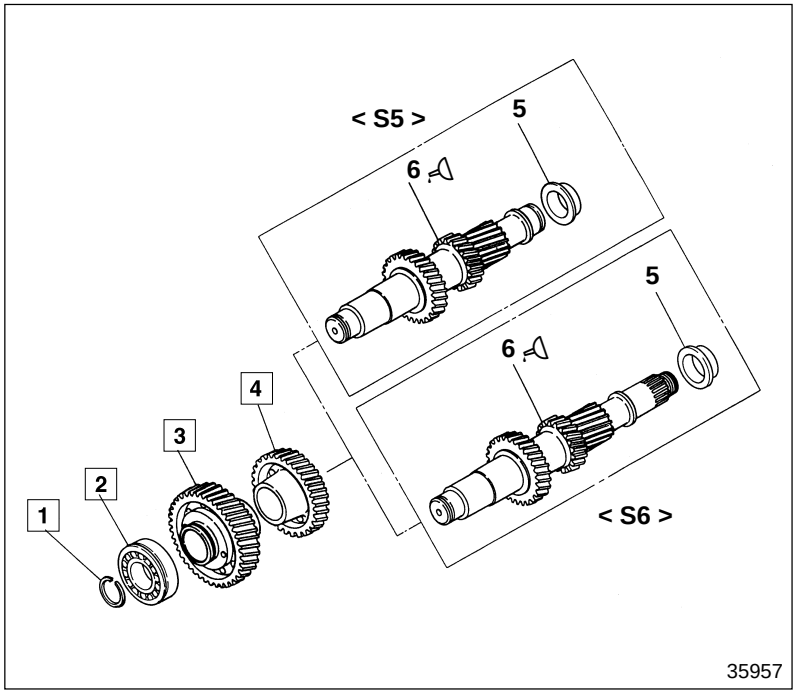
18 **Installation of 3rd and 4th gear thrust washer**



19 **24** **29** **Clearance between synchronizer outer ring and 3rd gear assembly or 2nd gear assembly**

- Measure clearance **A** between synchronizer outer ring **24** and the cone of 3rd gear assembly **19** or 2nd gear assembly **29**.
- When measuring this value, press synchronizer inner ring **22**, synchronizer outer ring **24** and synchronizer center ring **23** evenly and measure all around the circumference.
- If the measured value is higher than the limit, replace the faulty parts.

COUNTERSHAFT ASSEMBLY



● **Disassembly sequence**

1 Snap ring
2 Countershaft front bearing
3 Countershaft constant mesh gear
4 Countershaft 4th gear
5 Countershaft rear bearing inner race
6 Countershaft

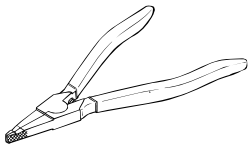
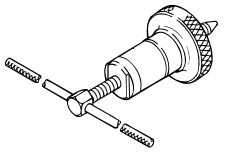
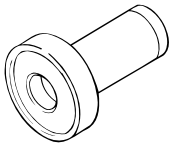
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Sealant

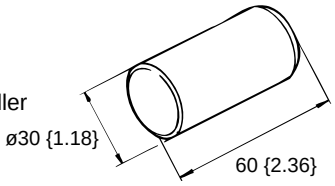
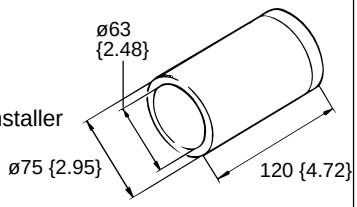
Location	Points of application	Specified sealant	Quantity
6	Gear installation area of countershaft	THREEBOND 1375B	As required

Special tools

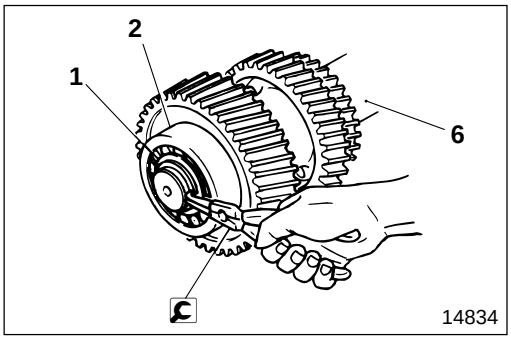
Location	Tool name and shape	Part No.	Application
1	Snap ring expander  01137	MH061268	Removal and installation of snap rings of countershaft bearing
2	Countershaft bearing puller  01139	*MH062426	Removal of countershaft front bearing
	Countershaft bearing installer  02141	*ME624233	Installation of countershaft front bearing

* components of puller and installer kit P22-65

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3, 4	Countershaft gear puller 	ME624243	Removal of countershaft gear
	Countershaft gear installer 	MH061740	Press-fitting of countershaft gear

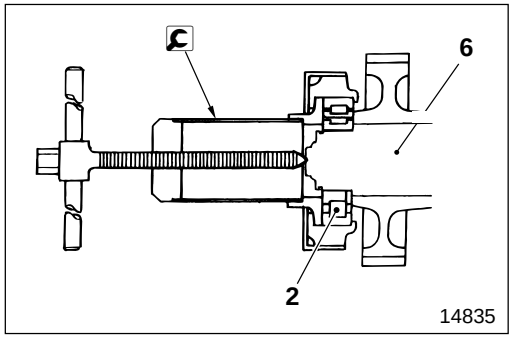
◆ Service procedure



1 Removal and installation of snap ring

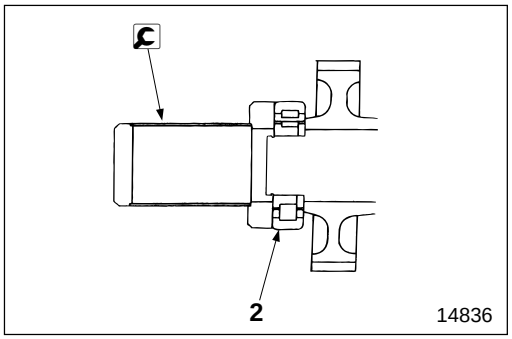
: Snap ring expander

COUNTERSHAFT ASSEMBLY

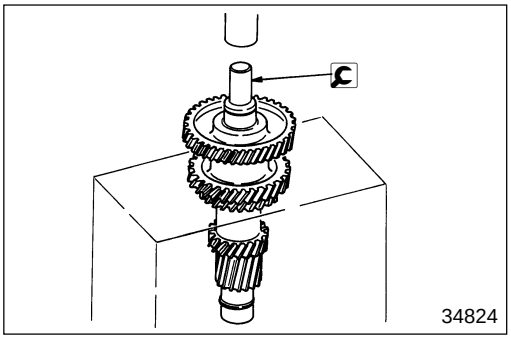


2 Countershaft front bearing

[Removal]
: Countershaft bearing puller

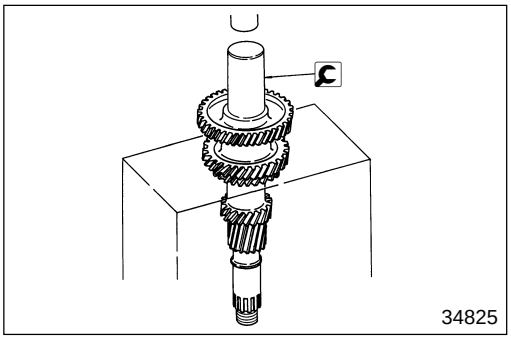


[Installation]
: Countershaft bearing installer



3 4 Countershaft constant mesh gear and countershaft 4th gear

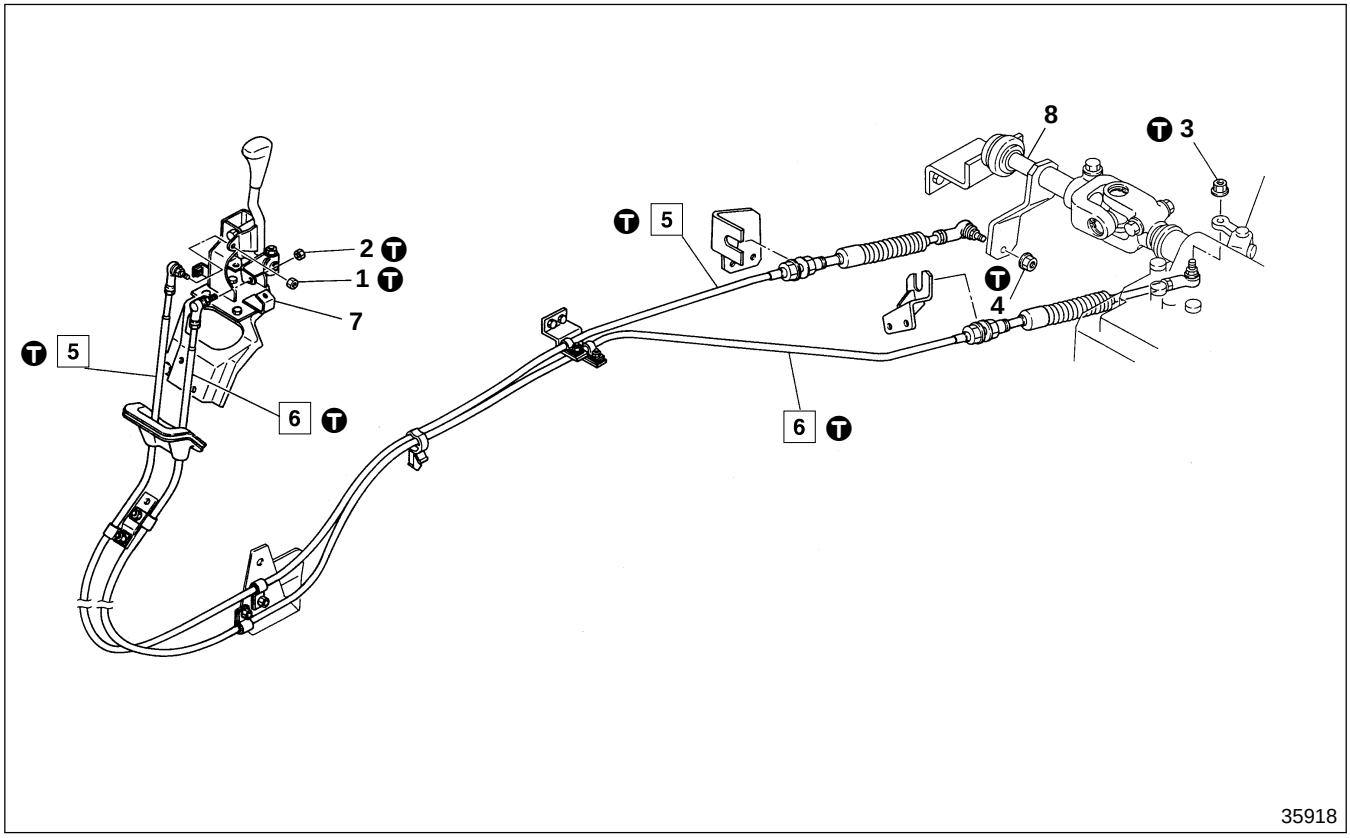
[Removal]
Use a press.
: Countershaft gear puller



[Installation]
Use a press.
: Countershaft gear installer

M E M O

TRANSMISSION CONTROL



● **Disassembly sequence**

1 Nut
2 Nut
3 Nut
4 Nut
5 Shift cable
6 Selector cable
7 Transmission control lever assembly 🕮 P22-63
8 Cross shaft 🕮 P22-64

● **Assembly sequence**

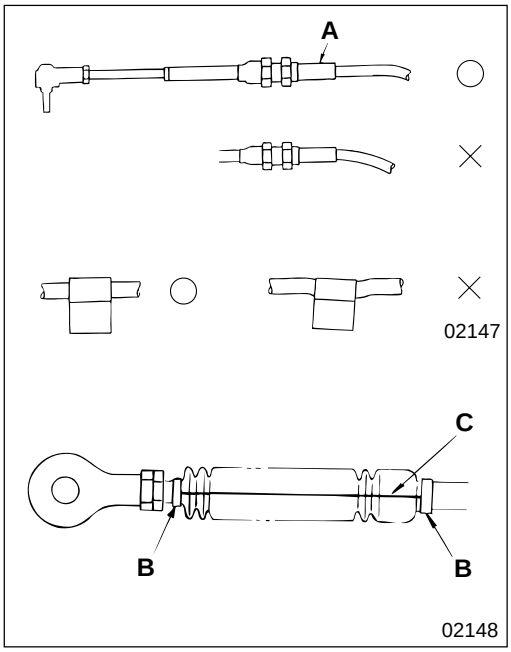
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1 to 4	Nut (Ball joint or rubber damper mounting)	19 to 24 {14 to 17, 1.9 to 2.4}	—
5, 6	Cable lock nut tightening	59 to 83 {43 to 61, 6 to 8.5}	—

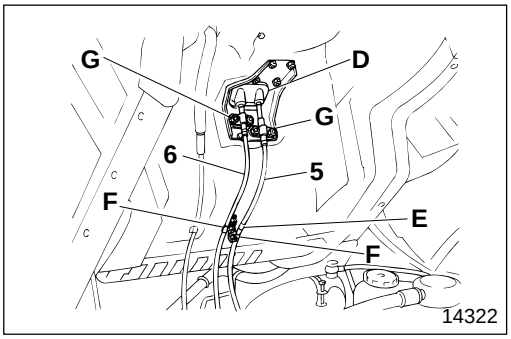
◆ Service procedure



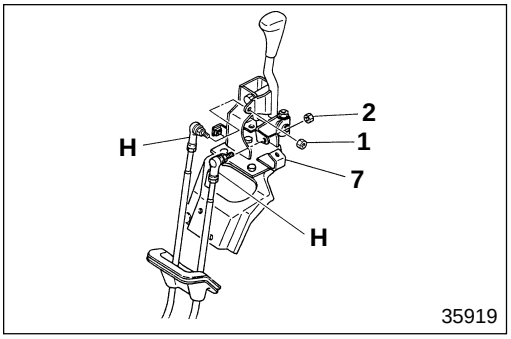
5 **6** **Installation of shift cable and selector cable**

CAUTION

- **Be sure to install casing cap A lengthwise.**
- **Make sure the radius of the bend is 200 mm {7.87 in.} or more.**
- **Make sure the cable operates smoothly.**
- **Be sure to install the clamps vertically against the cable.**
- **Make sure you do not twist clamps B at both ends of the boot. Make sure that white line C on the boot is aligned.**
- **Make sure the identification marks on the cable, the ball joint and the rubber damper point in the right direction when you install the cables. Installing the cables with the identification marks in the wrong direction can remarkably reduce the durability of the cables.**



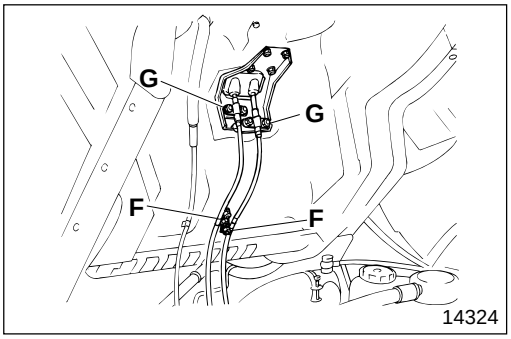
- Install shift cable **5** and selector cable **6** to the frame after having temporarily installed all the clamps.
- Insert shift cable **5** and selector cable **6** through grommet **D** of the cab floor into the inside of the cab, then install clip **F** and clip **G** temporarily by making identification mark **E** on the shift cable come to clip **F** position. (The selector cable has no identification mark.)



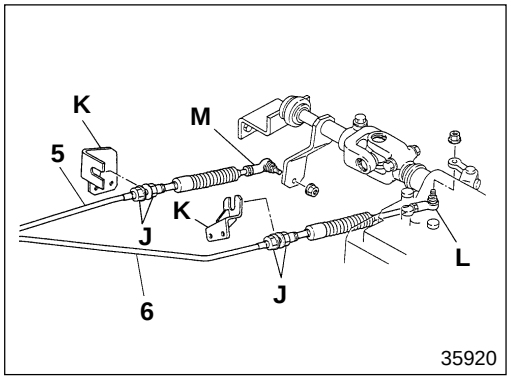
- Lower the cab.
- Install ball joint **H** of the cable to the shift lever and selector lever of transmission control lever assembly **7**.

CAUTION

Make sure that ball joint H faces the correct direction.



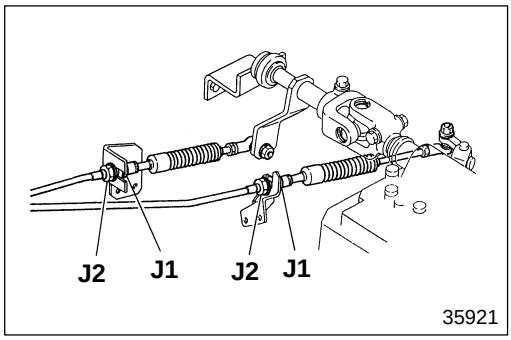
- Tilt the cab up and tighten clip **F** and clip **G** permanently without applying force to the cables.



- Install lock nut **J** to bracket **K** temporarily and connect ball joint **L** or rubber damper **M** to the shift lever and selector lever.
- Tighten lock nut **J** permanently without applying force to the cables.

CAUTION ⚠

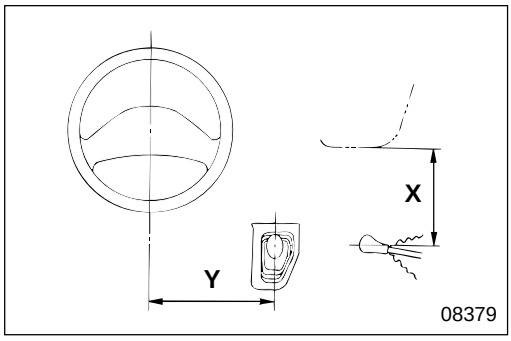
Make sure that ball joint L and rubber damper M face the correct direction.



CAUTION ⚠

Make sure not to move lock nut J1 of the transmission side when tightening lock nut J. Tighten lock nut J2.

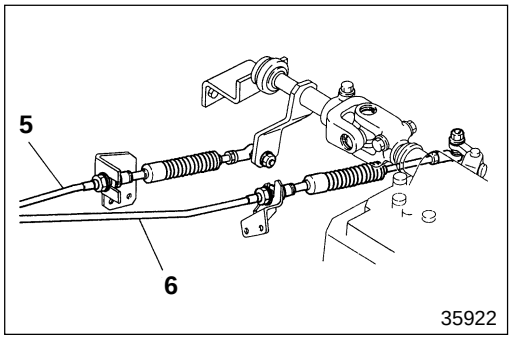
- Check when you operate the gear shift lever that it shifts and selects each position smoothly.



- If the gear shift lever leans to the front or rear, or to the left or right, excessively, adjust the length of the cable.
- When adjusting the gear shift lever, use the distance from the center of the steering wheel or from the instrument panel as the reference distance.

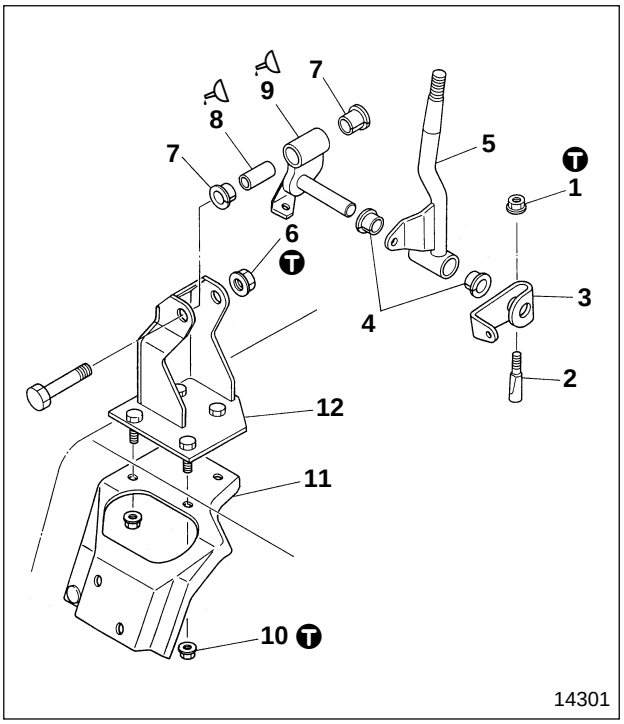
Unit : mm {in.}

Front and rear direction X (Distance from the instrument panel)	Left and right direction Y (Distance from the steering wheel center)
309 {12.17}	350 {13.78} (4th and 5th gear position)



	Shift cable **5**	Selector cable **6**
To front	Shorten	—
To rear	Lengthen	—
To right	—	Lengthen
To left	—	Shorten

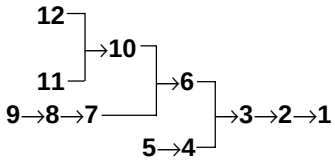
Transmission Control Lever Assembly



● **Disassembly sequence**

1 Nut
2 Lock pin
3 Select lever
4 Bushing
5 Lever
6 Nut
7 Bushing
8 Caller
9 Shaft assembly
10 Nut
11 Set board bracket
12 Set board

● **Assembly sequence**



T Tightening torque

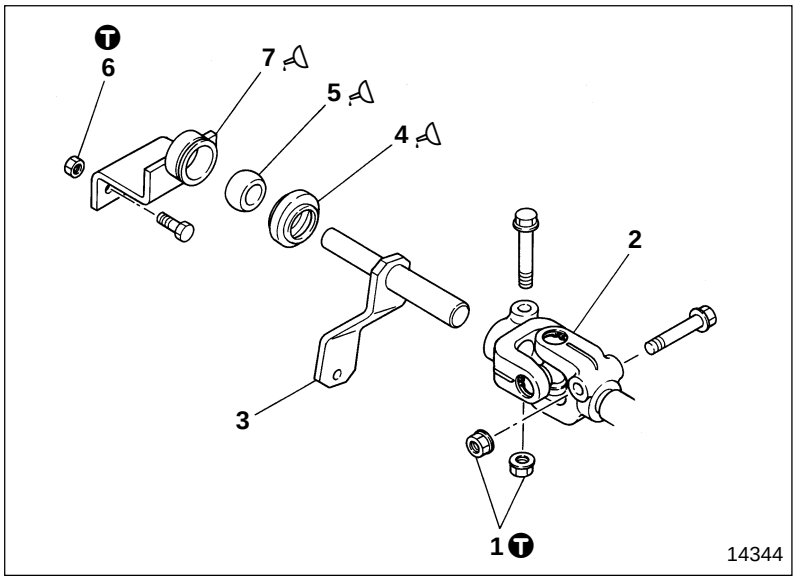
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Lock pin tightening)	10 to 15 {7.2 to 11, 1.0 to 1.5}	—
6	Nut (Shaft assembly mounting)	29 to 43 {22 to 32, 3.0 to 4.4}	—
10	Nut (Set board bracket and set board assembly mounting)	21 to 30 {15 to 22, 2.1 to 3.1}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
8	Friction surfaces of collar and bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required
9	Friction surfaces of shaft assembly and bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required

Cross shaft



● **Disassembly sequence**

1 Nut
2 Universal joint assembly
3 Cross shaft
4 Dust cover
5 Ball bushing
6 Nut
7 Cross shaft support

● **Assembly sequence**

7→6→1
2→3→4→5

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Universal joint assembly mounting)	85 to 110 {61 to 80, 8.5 to 11.0}	—
6	Nut (Cross shaft support mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
4	Pack into the interior of dust cover	Chassis grease [NLGI No.1 (Ca soap)]	As required
5	Friction parts inside and outside of ball bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required
7	Inner periphery of cross shaft support pipe	Chassis grease [NLGI No.1 (Ca soap)]	As required

Component	Name / Part No.	Puller and installer kit	Bearing puller for S5			Bearing puller for S6			
		MH062425	MH061731	MH061732	MH062426	MH062440	MH062429	MH062432	MH062433
MH062428	Protector	○			○	○	○		
MH062427	Claw	○			○				
ME624235	Installer	○							
ME624234	Installer	○							
ME624233	Installer	○							
ME624236	Installer	○							
MH061162	Handle	○	○	○	○	○	○	○	○
ME624232	Bolt	○	○	○	○	○	○	○	○
MH061735	Body	○		○		○			
MH061734	Body	○	○		○		○	○	
ME624229	Protector	○	○	○				○	
MH062430	Claw	○				○	○		
ME624227	Claw	○		○					
ME624226	Claw	○	○						
MH062436	Body								○
MH062435	Protector								○
MH062434	Claw								○
ME624228	Claw							○	

The puller and installer kit consists of principal bearing pullers and installers selected from the special tools used in this work group. For an installer use a component of this kit independently, and for a puller use the components of this kit in combination.

MITSUBISHI
FUSO

Group 23A
Automatic Transmission
< FH210 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-23A

INDEX

SPECIFICATIONS 23A- 2

STRUCTURE AND OPERATION 23A- 3

TROUBLESHOOTING PROCEDURES 23A-40

TROUBLESHOOTING 23A-42

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Stall Test 23A-52
- Time Lag Test 23A-53
- Line Pressure Test 23A-54
- Road Test 23A-56
- Inspection of Automatic Transmission Fluid 23A-57
- Changing Automatic Transmission Fluid 23A-58

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23A-60

OIL COOLER 23A-66

AUTOMATIC TRANSMISSION CONTROL 23A-68

REPLACEMENT OF AUTOMATIC TRANSMISSION PARTS 23A-78

INSPECTION AND ADJUSTMENT OF OTHER DEVICES 23A-84

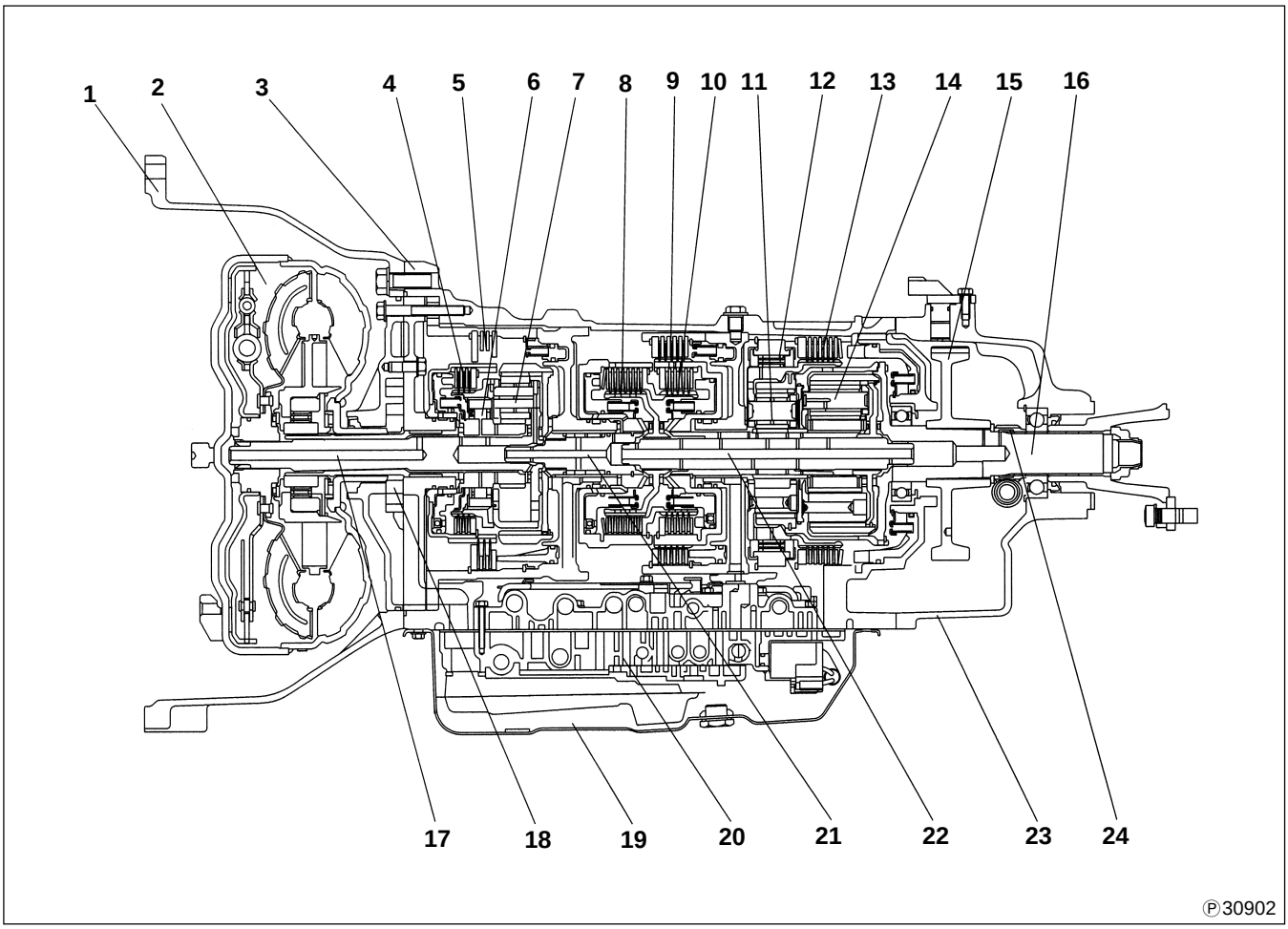
LOCATIONS OF PARTS 23A-86

ELECTRICAL WIRING DIAGRAM 23A-87

SPECIFICATIONS

Item			Specifications	
Manufacturer			Aisin Seiki Co., Ltd.	
Transmission type			M035A4	
Torque converter	Type		3-element, 1-stage, 2-phase (with lock-up clutch)	
	Stall torque ratio		1.82	
Automatic transmission	Type		Planetary gear type, 4 forward speeds, 1 reverse speed	
	Gear ratio	1st	3.018	
		2nd	1.548	
		3rd	1.000	
		4th	0.703	0.765
		Rev	2.678	
Range selector pattern			P - R - N - D - 2 - L (Engine starts in P and N positions only)	
Automatic transmission fluid	Oil type		DEXRON III type	
	Total oil capacity L {qts}		13 {14}	
	Quantity of oil required in automatic transmission fluid change L {qts}		Approximately 4.5 {4.8}	

Automatic Transmission Assembly



1 Converter housing
2 Torque converter
3 Transmission case
4 Overdrive direct clutch
5 Overdrive brake
6 Overdrive one-way clutch
7 Overdrive planetary gear
8 Front clutch
9 2nd brake
10 Rear clutch
11 Front planetary gear
12 No. 2 one-way clutch
13 1st and reverse brake
14 Rear planetary gear
15 Parking lock gear
16 Output shaft
17 Overdrive input shaft
18 Oil pump
19 Oil pan
20 Valve body
21 Input shaft
22 Intermediate shaft
23 Extension housing
24 Speedometer drive gear

The automatic transmission is comprised of a torque converter with a lock-up mechanism and a fully automatic 4-speed gear system.

● **Torque converter**

The torque converter is driven by the engine crankshaft, and functions as the input device for the transmission. The torque converter is a fluid coupling device that magnifies torque produced by the engine and absorbs shock that generates when the vehicle accelerates from a standstill or when the transmission shifts. At a cruising speed, the lock-up mechanism prevents slippage for improved power transmitting efficiency.

● **Transmission gear section**

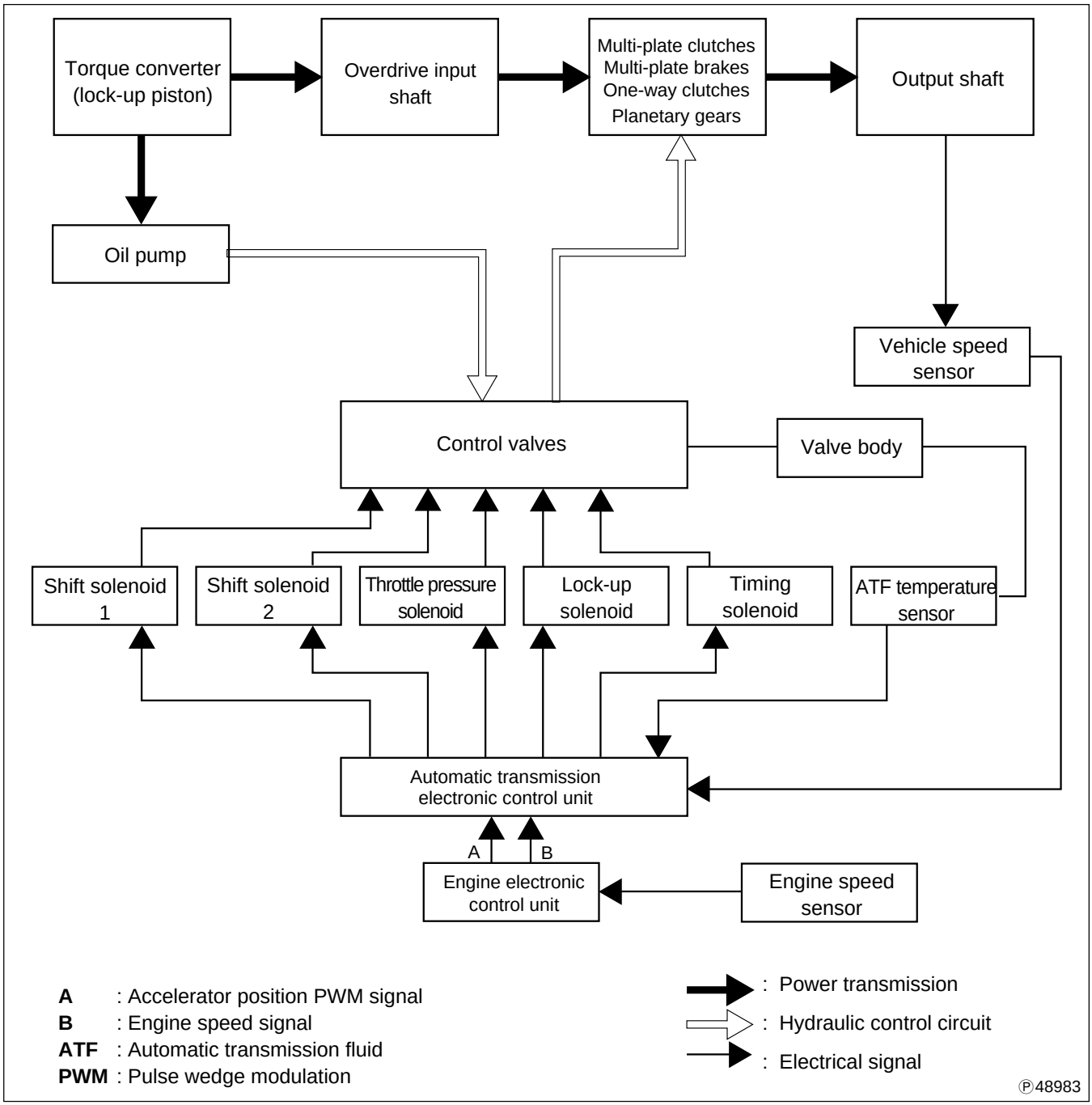
The gear system provides four forward speeds and one reverse speed. The gear section contains two one-way clutches, three sets of planetary gears, each comprised of a sun gear, pinion gears and a ring gear, three sets of hydraulic wet-type multi-plate clutches; and three sets of wet-type multi-plate brakes.

● **Hydraulic control section**

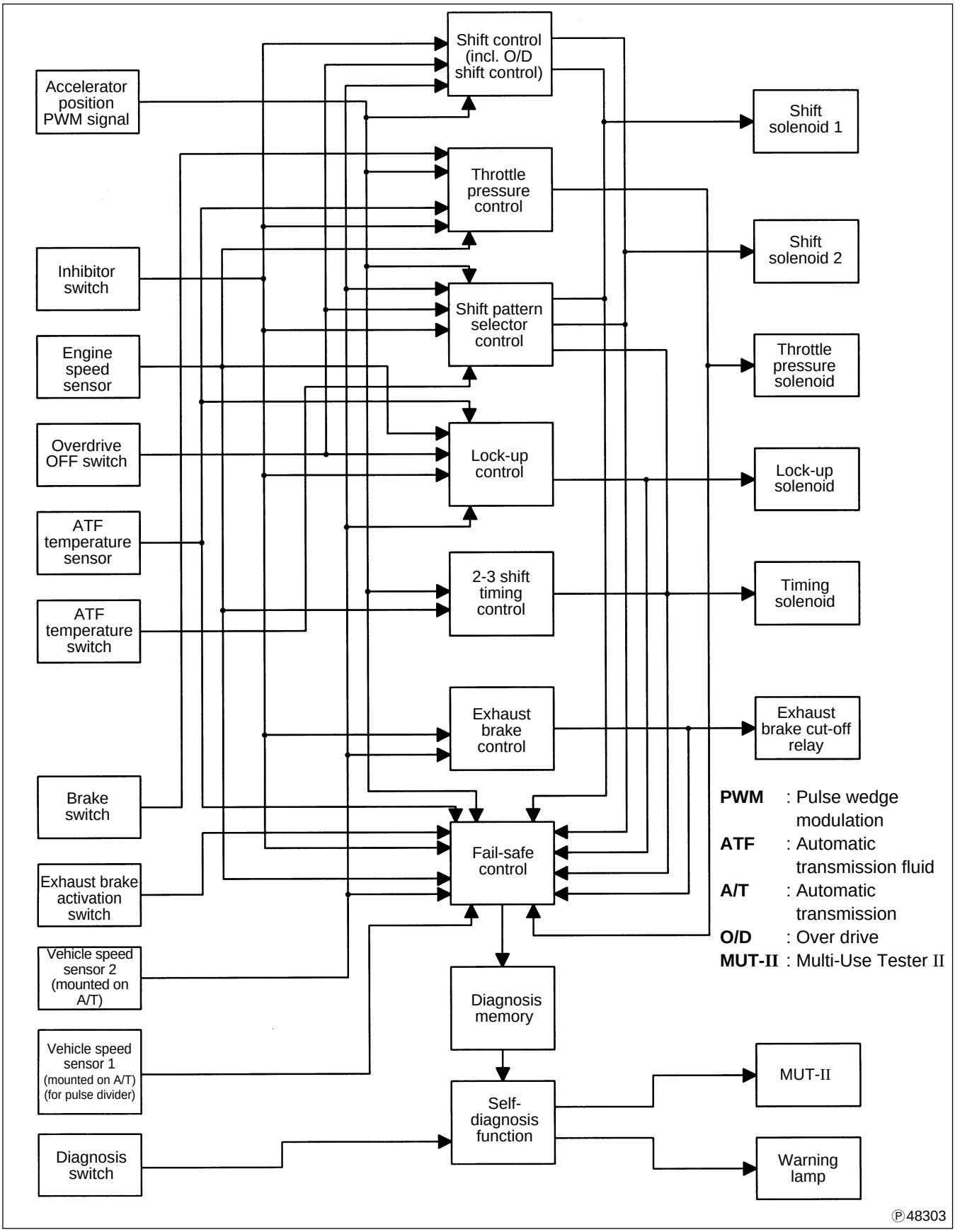
The electronic control system uses a microcomputer to regulate the mechanism operations for precise shifting.

Control Mechanisms

Control system



Control block diagram



The control functions can be roughly divided into shift control, lock-up control and 2-3 shift control. The electronic control unit electronically controls these functions precisely in accordance with driving conditions.

Chart of control items, inputs and outputs

Item \ Control item			Shift control (incl. overdrive control)	Shift pattern selector control	Throttle pressure control	Lock-up control	2-3 shift control	Exhaust brake control	Fail-safe control	Self-diagnosis control
Input	Vehicle speed sensor 2	Mounted on transmission (output shaft rotation sensor)		○	○	○		○	○ Note 1	○
	Vehicle speed sensor 1	Mounted on transmission	○ Note 3	○ Note 3	○ Note 3	○ Note 3		○ Note 3		
	Throttle position PWM signal		○	○	○	○	○	○	○ Note 1	○
	Engine speed sensor				○	○	○		○ Note 1	○
	Overdrive OFF switch		○	○		○				
	Inhibitor switch		○	○	○	○		○	○ Note 1	○
	Automatic transmission fluid temperature switch			○						
	Automatic transmission fluid temperature sensor				○	○			○	○
	Brake switch				○					
	Exhaust brake activation signal								○ Note 1	○
	Diagnosis switch									○ Note 2
Output	Shift solenoid 1		○	○					○ Note 1	○
	Shift solenoid 2		○	○					○ Note 1	○
	Timing solenoid			○			○		○ Note 1	○
	Lock-up solenoid					○			○ Note 1	○
	Throttle pressure solenoid				○				○ Note 1	○
	Exhaust brake cut-off relay							○	○ Note 1	○
	Warning lamp									○

Note 1 : The automatic transmission electronic control unit activates fail-safe functions when there is an abnormality in the input/output signals.
Note 2 : The self-diagnosis function actiates.
Note 3 : Backup for vehicle speed sensor 2 (mounted on transmission)
PWM : Pulse wedge modulation

● **Shift control**

Based on the accelerator operation signal transmitted from the throttle position PWM signal and the signal from the vehicle speed sensor, the automatic transmission electronic control unit outputs signals according to the predetermined shift curve. These signals are sent to shift solenoid 1, shift solenoid 2 and the timing solenoid mounted on the valve body, and automatically shift to the optimum gear.

● **Throttle pressure control**

The throttle position PWM signal detects the degree of throttle operation. This data is used to control the throttle pressure solenoid, and the hydraulic pressure supplied from the reducing valve is maintained at the optimum level (throttle pressure) according to the vehicle's operating condition.

● **2-3 shift control**

Based on the signal from the throttle position PWM signal and the signal from the engine speed sensor, the automatic transmission electronic control unit outputs a signal to the timing solenoid mounted on the valve body, and controls the discharge timing of automatic transmission fluid to reduce shift shock.

● **Lock-up control**

The lock-up mechanism eliminates slippage of the torque converter for improved power transmitting efficiency. Based on the accelerator operation signal transmitted from the throttle position PWM signal and the signal from the vehicle speed sensor, the automatic transmission electronic control unit outputs a signal according to the predetermined shift curve. This signal is sent to the lock-up solenoid mounted on the valve body, and engages or disengages the lock-up mechanism.

● **Fail-safe control**

The fail-safe functions minimize adverse effects to the vehicle operation caused by malfunctioning of the vehicle speed sensor, engine speed sensor, throttle position PWM signal, inhibitor switch or solenoids.

• Throttle position PWM signal

This sensor prohibits lock-up control change and 2-3 shift timing control by determining the shift-point vehicle speed at closed throttle position and the line pressure at maximum pressure, thus allowing vehicle operation.

• Inhibitor switch

If the inhibitor switch malfunctions in a stationary or moving vehicle and there is no signal input to the automatic transmission electronic control unit, the automatic transmission electronic control unit determines the transmission position setting as the D range and prohibits shifting from 3rd to 4th gear. If the automatic transmission electronic control unit receives two or more signals, the automatic transmission electronic control unit operates according to the following priority order for the range selector position and enables vehicle operation: L > R > 2 > D > N >P. Since the manual valve changes the hydraulic circuit in the valve body according to the range selector position, the vehicle operates as follows.

Range selector lever position	Inhibitor switch input signal	Vehicle operating condition
P	P and other selector signals	P
R	R and other selector signals	R
N	N and other selector signals	N
D	D and other selector signals (excludes R, L and 2 range signals)	$D_1 \leftrightarrow D_2 \leftrightarrow D_3 \leftrightarrow D_4$
↑	D and L range signals	$D_1 \leftrightarrow D_2 \leftarrow D_3$
↑	D and R range signals	D_4
↑	D and 2 range signals	$D_1 \leftrightarrow D_2 \leftrightarrow D_3$
2	2 and other selector signals (excludes R and L signals)	$2_1 \leftrightarrow 2_2 \leftarrow 2_3$
↑	2 and L range signals	$2_1 \leftrightarrow 2_2 \leftarrow 2_3$
↑	2 and R range signals	2_3
L	L and other selector signals	$L_1 \leftrightarrow L_2 \leftarrow L_3$

• Engine speed sensor

The 2-3 shift timing control becomes inactive to ensure proper vehicle operation.

• Shift solenoid 1 and shift solenoid 2

If a solenoid malfunction occurs when the transmission is in the D, 2 or L range, the operating conditions of the solenoids change as shown in the following table. The automatic transmission electronic control unit also deactivates the lock-up solenoid and timing solenoid to allow vehicle operation.

Range selector position	Normal				Malfunctioning of S1			Malfunctioning of S2			Malfunctioning of S1 and S2		
	S1	S2	ST	Gear	S1	S2	Gear	S1	S2	Gear	S1	S2	Gear
D range	○	×	×	1st	–	×→○	3rd	○	–	1st	–	–	4th
	○	○	×	2nd	–	○	3rd	○→×	–	4th	–	–	4th
	×	○	×	3rd	–	○	3rd	×	–	4th	–	–	4th
	×	×	×	4th	–	×	4th	×	–	4th	–	–	4th
2 range	○	×	×	1st–		×→○	3rd	○	–	1st	–	–	3rd
	○	○	×	2nd	–	○	3rd	○→×	–	3rd	–	–	3rd
	×	○	×	3rd	–	○	3rd	×	–	3rd	–	–	3rd
L range	○	×	×	1st	–	×	1st	○	–	1st	–	–	1st
	○	○	×	2nd	–	○	2nd	○	–	1st	–	–	1st
	×	○	○	3rd	–	○	2nd	×	–	1st	–	–	1st

○ : Electric current supplied ×: Electric current not supplied – : Malfunctioning → : Fail-safe function
S1 : Shift solenoid 1 S2 : Shift solenoid 2 ST : Timing solenoid

• Throttle pressure solenoid

The malfunctioning solenoid is deactivated to bring the line pressure to a maximum level, thus allowing vehicle operation.

• Timing solenoid and lock-up solenoid

The malfunctioning solenoid is deactivated to allow vehicle operation.

● Self-diagnosis function

The warning lamp lights when an abnormality occurs during vehicle operation.

- The warning lamp does not light if the abnormality causes minimum effect to vehicle operation.
- The warning lamp lights when the following parts are malfunctioning to indicate the abnormal condition since these malfunctions significantly reduce vehicle performance.
  - Vehicle speed sensor 1
  - Vehicle speed sensors 1 and 2
  - Shift solenoid 1
  - Shift solenoid 2
  - Accelerator sensor
  - Timing solenoid
  - Inhibitor switch
  - Throttle pressure solenoid

CAUTION ⚠

The warning lamp lights only when the malfunction prevents proper vehicle operation.

The indicator lamp provides self-diagnosis information.

- To facilitate the discovery of malfunctions that may not reproduce themselves frequently, the automatic transmission electronic control unit stores in the memory information of malfunctions that occur during vehicle operation.
- An input of a self-diagnosis start signal produces the output of the data from the memory, and causes the automatic transmission warning lamp to flash according to the data.

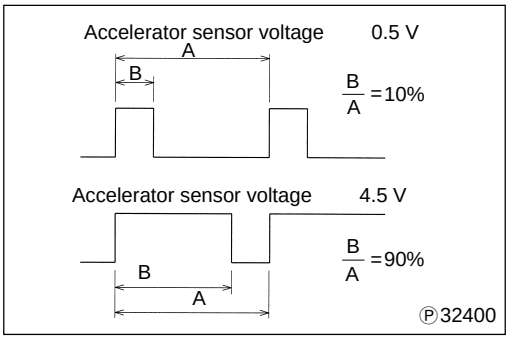
CAUTION ⚠

The automatic transmission electronic control unit stores information of all malfunctions that occur after the previous self-diagnosis operation.

Electronic Control Devices

● **Automatic transmission electronic control unit**

The automatic transmission electronic control unit is mounted near the brake booster on the driver's seat side. It determines the vehicle operating conditions based on signals sent from sensors, and outputs signals to solenoids to regulate shift control, lock-up control and other automatic transmission functions.
The automatic transmission electronic control unit is also equipped with a self-diagnosis function for the detection of malfunctions of main sensors and solenoids.



● **Throttle position PWM signal**

The accelerator sensor voltage detected by the electronic governor control unit is converted to a PWM signal and output to the automatic transmission electronic control unit. The PWM signal is a chopping wave with a duty ratio shown in the diagram at the left.

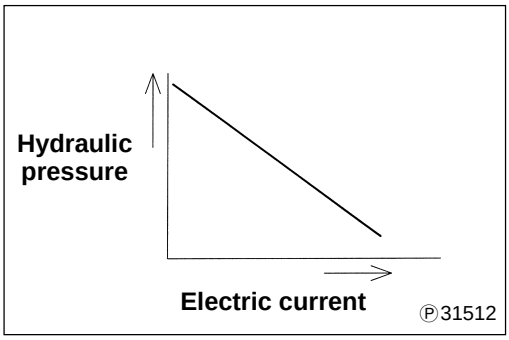
● **Vehicle speed sensor**

The vehicle speed monitoring system is composed of two sensor circuits; vehicle speed sensor **2** (output shaft rotation sensor) and vehicle speed sensor **1**. Accordingly, the normal driving mode is not disabled even when one of the vehicle speed sensor circuits is faulty.

● **Shift solenoids 1 and 2**

These solenoids are mounted on the valve body, and control shifting by turning ON and OFF in accordance with the signals sent from the automatic transmission electronic control unit.
The ON and OFF conditions of the two solenoids result in the following gear positions.

Shift solenoid 1	ON	ON	OFF	OFF
Shift solenoid 2	OFF	ON	ON	OFF
Gear position	1st gear	2nd gear	3rd gear	4th gear



● **Throttle pressure solenoid**

The throttle pressure solenoid is mounted on the valve body. It adjusts the throttle pressure based on the throttle opening signal sent from the automatic transmission electronic control unit. The throttle pressure adjustment characteristics are shown in the diagram.

● **Timing solenoid**

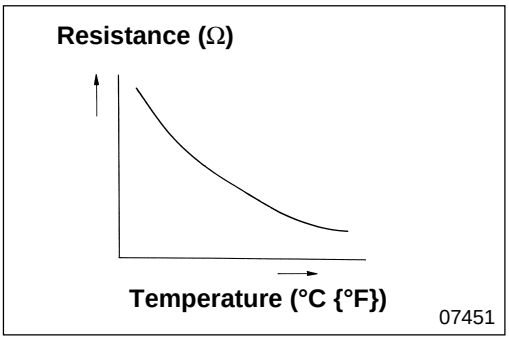
This solenoid is mounted on the valve body, and regulates the 2-3 shift timing control by turning ON and OFF in accordance with the signal sent from the automatic transmission electronic control unit.

● **Lock-up solenoid**

The lock-up solenoid is mounted on the valve body. According to the signal sent from the automatic transmission electronic control unit, the solenoid repeats ON and OFF operations, thereby opening and closing the drain circuit to control the hydraulic pressure at a predetermined level. The lock-up solenoid is a duty-cycle type that can control the ON and OFF time ratio in each cycle between 0 and 100%.

● **Automatic transmission fluid temperature switch**

This switch is mounted on the oil cooler outlet section of the transmission case. It detects abnormal temperatures of the automatic transmission fluid and turns on the warning lamp located on the meter cluster to indicate the abnormal condition.

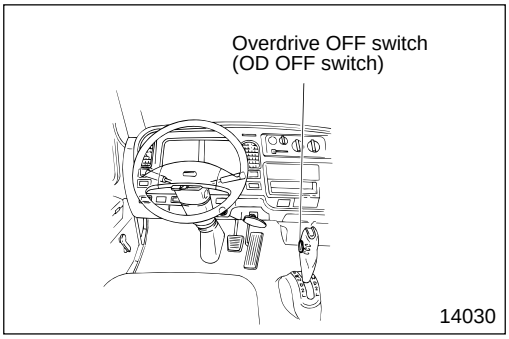


● **Automatic transmission fluid temperature sensor**

This sensor is mounted on the control valve in the transmission. It coverts temperature changes into continuous electric signals and sends to the automatic transmission electronic control unit. The characteristics of the sensor's electric output signal are shown at the left. Based on this output signal, the automatic transmission electronic control unit prohibits overdrive shifting and lock-up operation and also performs partial correction of line pressure control.

● **Engine speed sensor**

The sensor converts the engine revolution speed to a pulse signal, and outputs to the electronic governor control unit. This signal is then transmitted from the electronic governor control unit to the automatic transmission control unit.



● **Overdrive OFF switch**

This switch is mounted on the range selector lever. It is operated by the driver, and it allows switching between the 3-speed and 4-speed modes.

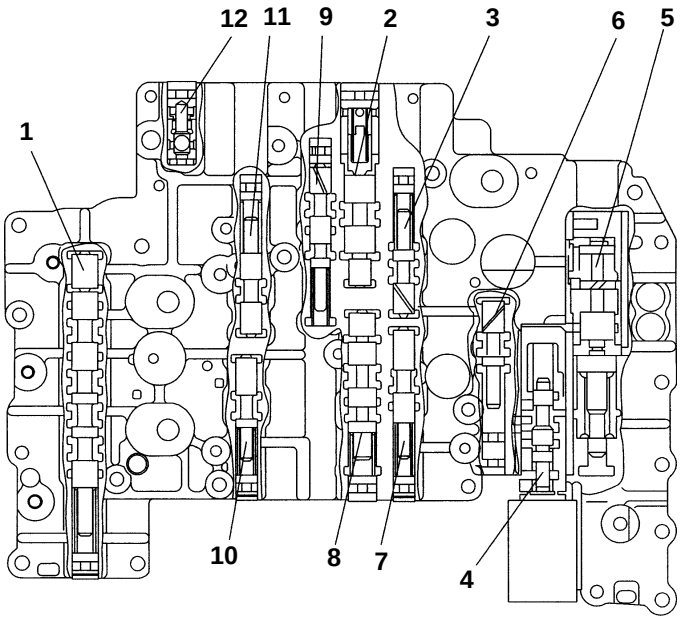
OFF : Transmission shifts to 4th gear for improved fuel efficiency.

ON : Transmission does not shift to 4th gear, thus increasing the engine brake effect and improving driveability on an up grade incline.

Hydraulic Control Devices

● **Valve Layout Diagram**

• **Upper valve body**



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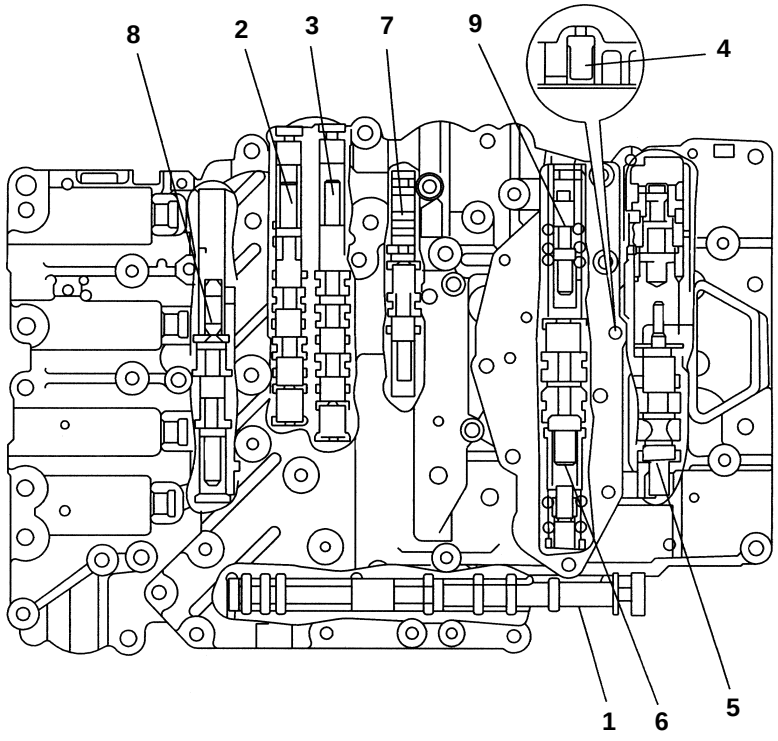
• **Lower valve body**



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● Valve Functions

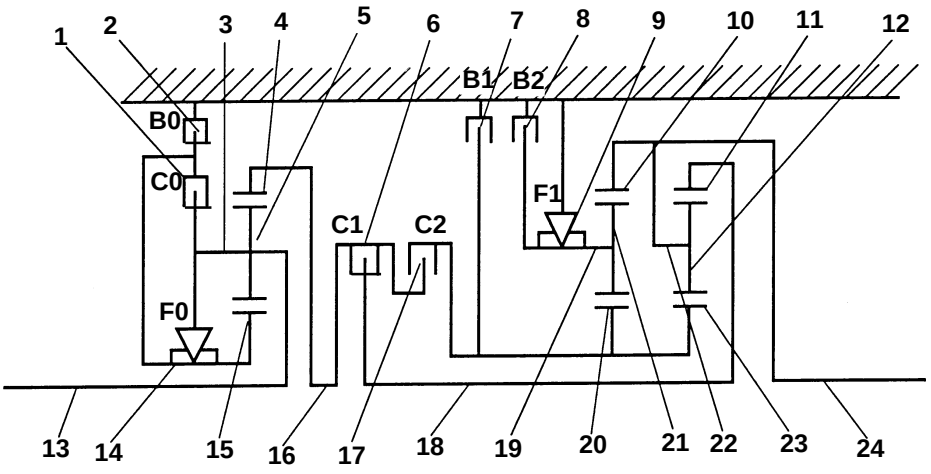
- **Upper valve body**

No.	Valve name	Description of function
1	2-3 Shift valve	Switches between 2nd and 3rd gears
2	Reverse inhibitor valve	When range selector is shifted to R range while vehicle is moving forward at moderate or high speed, this valve, operated by solenoid output, prevents shifting to reverse.
3	Modulator valve	Adjusts line pressure and supplies hydraulic pressure to lock-up signal valve and orifice control valve
4	Throttle valve	Adjusts signal pressure (throttle pressure) that is used to provide optimum line pressure in accordance with operating conditions
5	Secondary regulator valve	Controls pressure of automatic transmission fluid supplied from primary regulator valve to torque converter as well as lubricating oil pressure
6	Reducing valve	Reduces line pressure and feeds to throttle valve
7	Lock-up signal valve	Engages and disengages lock-up mechanism
8	Accumulator control valve	Lowers accumulator back pressure when throttle opening becomes smaller, and obtains accumulator control pressure from line pressure that is used to reduce shift shock
9	Low coast modulator valve	Lowers line pressure to reduce shift shock when range selector is shifted to L range
10	Orifice control valve	Switches orifices to reduce shock
11	Low inhibitor valve	When range selector is shifted to L range at high vehicle speed, this valve, operated by timing solenoid output, shifts to 3rd gear
12	Check valve	Switches fluid passage to rear clutch (C2) in D range and R ranges

- **Lower valve body**

No.	Valve name	Description of function
1	Manual valve	Switches fluid passage according to the position (P, R, N, D, 2, L) of range selector lever
2	1-2 Shift valve	Switches between 1st and 2nd gears
3	3-4 Shift valve	Switches between 3rd and overdrive gears
4	Pressure relief valve	Maintains pressure supplied to cooler at low level
5	Primary regulator valve	Regulates hydraulic pressure (line pressure) to devices
6	Lock-up control valve	Adjust flow rate of automatic transmission fluid to torque converter
7	C0 exhaust valve	Reduces shock in 3rd-to-2nd shifting
8	2-3 Timing valve	Adjusts hydraulic pressure switching timing in 3rd-to-2nd shifting to reduce shock
9	Cutback valve	Applies cutback pressure to throttle valve to reduce line pressure

Shift Function



1 Overdrive direct clutch (C0)
2 Overdrive brake (B0)
3 Overdrive planetary carrier
4 Overdrive planetary ring gear
5 Overdrive planetary pinion gears
6 Front clutch (C1)
7 2nd brake (B1)
8 1st and reverse brake (B2)
9 No. 2 one-way clutch (F1)
10 Front planetary ring gear
11 Rear planetary ring gear
12 Rear planetary pinion gears
13 Overdrive input shaft
14 Overdrive one-way clutch (F0)
15 Overdrive planetary sun gear
16 Input shaft
17 Rear clutch (C2)
18 Intermediate shaft
19 Front planetary carrier
20 Front planetary sun gear
21 Front planetary pinion gears
22 Rear planetary carrier
23 Rear planetary sun gear
24 Output shaft

• Clutch and brake functions

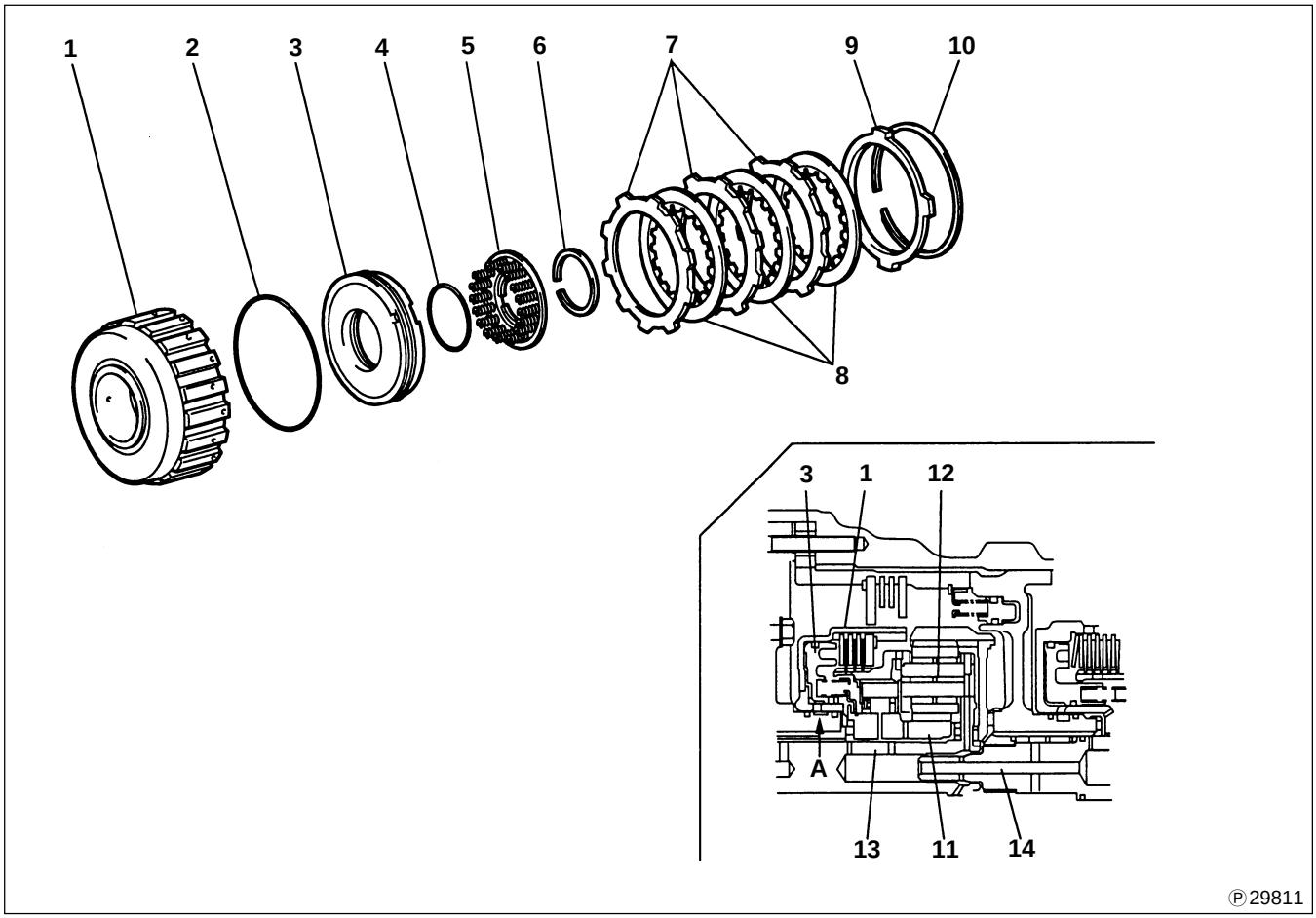
	Name	Function
1	Overdrive direct clutch (C0)	Interlocks overdrive sun gear and overdrive planetary carrier
2	Overdrive brake (B0)	Prevents rotation of overdrive sun gear
6	Front clutch (C1)	Interlocks input shaft and intermediate shaft
7	2nd brake (B1)	Prevents rotation of front and rear planetary sun gears
8	1st and reverse brake (B2)	Prevents rotation of front planetary carrier
9	No. 2 one-way clutch (F1)	Prevents counterclockwise rotation of front planetary carrier and allows only clockwise rotation
14	Overdrive one-way clutch (F0) direction relative to overdrive sun gear	Prevents overdrive planetary carrier from rotating in counterclockwise during driving
17	Rear clutch (C2)	Interlocks input shaft with front and rear planetary sun gears

● Clutch, Brake and Solenoid Operations

Shift position		C0	C1	C2	B0	B1	B2	F0	F1	S1	S2	Remarks
P	Parking				○					○		Parking
R	Reverse	○		○			○	●				Reverse
N	Neutral				○					○		Neutral
D	1st	○	○					●	●	○		Automatic shifting 1↔ 2↔ 3 ↔ 4 [Overdrive OFF mode 1↔ 2↔ 3 ↔ 4]
	2nd		○			○		●		○	○	
	3rd	○	○	○				●			○	
	Overdrive		○	○	○							
2	1st	○	○					●	●	○		Automatic shifting 1↔ 2 ↔ 3
	2nd	○	○			○		●		○	○	
	3rd	○	○	○				●			○	
L	1st	○	○				○	●	●	○		Locked in 1st gear 1← 2 ← 3 (3rd gear shifting occurs only when timing solenoid activates.)
	2nd	○	○			○		●		○	○	
	3rd	○	○	○				●			○	

S1 and S2 refer to shift solenoid 1 and shift solenoid 2, respectively ○: Activates ● : Activates only during driving
↔ : Overrun preventive control

● Overdrive Direct Clutch



1 Overdrive direct clutch drum
2 O-ring
3 Overdrive direct clutch piston
4 O-ring
5 Overdrive clutch return springs
6 Snap ring
7 Clutch plates
8 Clutch discs
9 Clutch flange
10 Snap ring
11 Overdrive planetary sun gear
12 Overdrive planetary carrier
13 Overdrive input shaft
14 Input shaft

A : Operating pressure

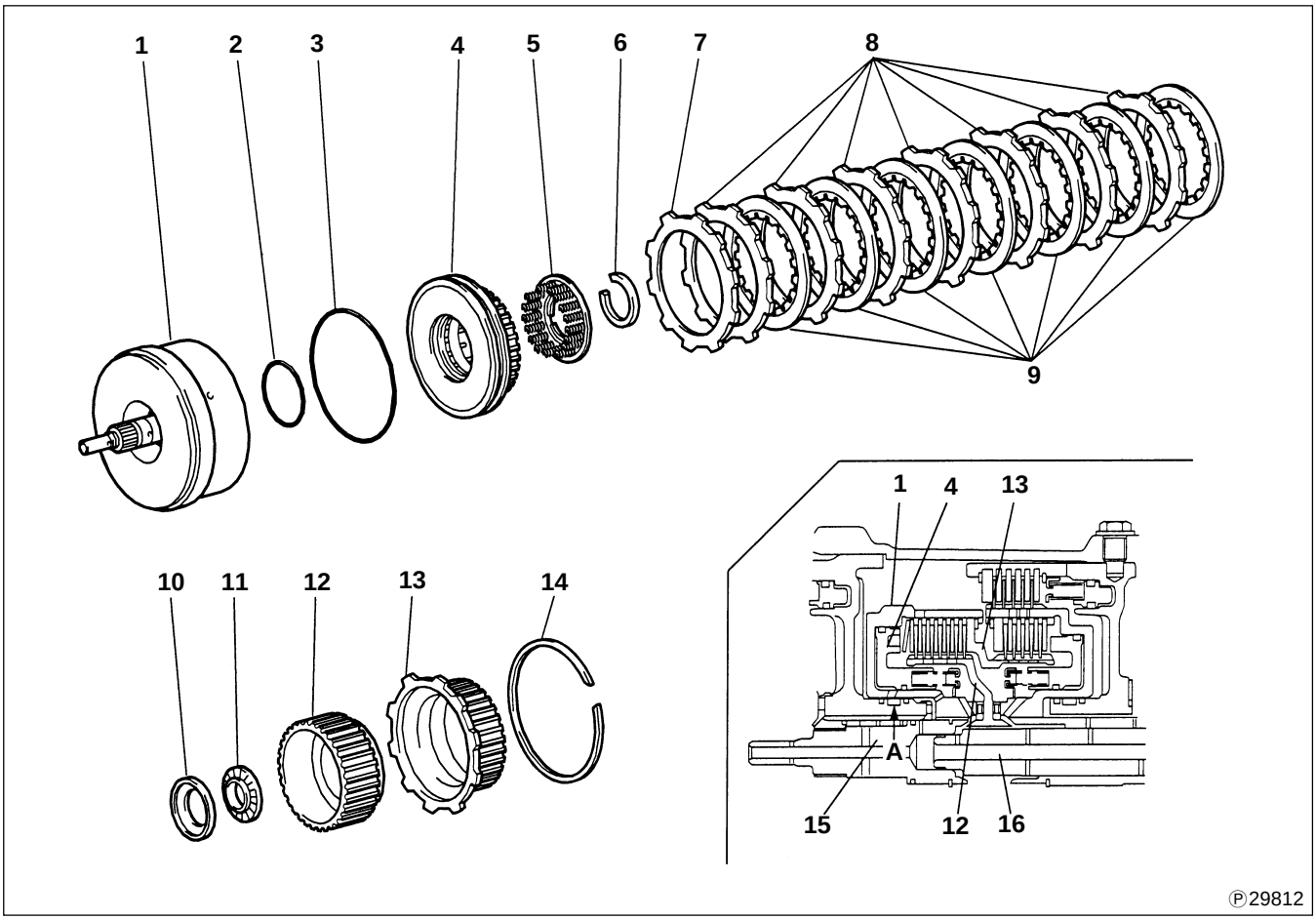
< Active condition >

The control valve supplies operating pressure **A** to overdrive direct clutch piston **3**, coupling clutch discs **8** and clutch plates **7**. This interlocks overdrive planetary sun gear **11** with overdrive planetary carrier **12**.
As a result, the entire overdrive planetary gear acts as a single unit to transmit the engine's driving power from overdrive input shaft **13** to input shaft **14**.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of overdrive clutch return springs **5** presses against overdrive direct clutch piston **3**.
As a result, clutch plates **7** are separated from clutch discs **8**, and the engine power is not transmitted.

● Front Clutch (C1)



1 Front clutch drum
2 O-ring
3 O-ring
4 Front clutch piston
5 Front clutch return springs
6 Snap ring
7 Clutch cushion plate
8 Clutch plates
9 Clutch discs
10 Thrust bearing lace
11 Thrust bearing
12 Front clutch hub
13 Rear clutch hub
14 Snap ring
15 Input shaft
16 Intermediate shaft

A : Operating pressure

< Active condition >

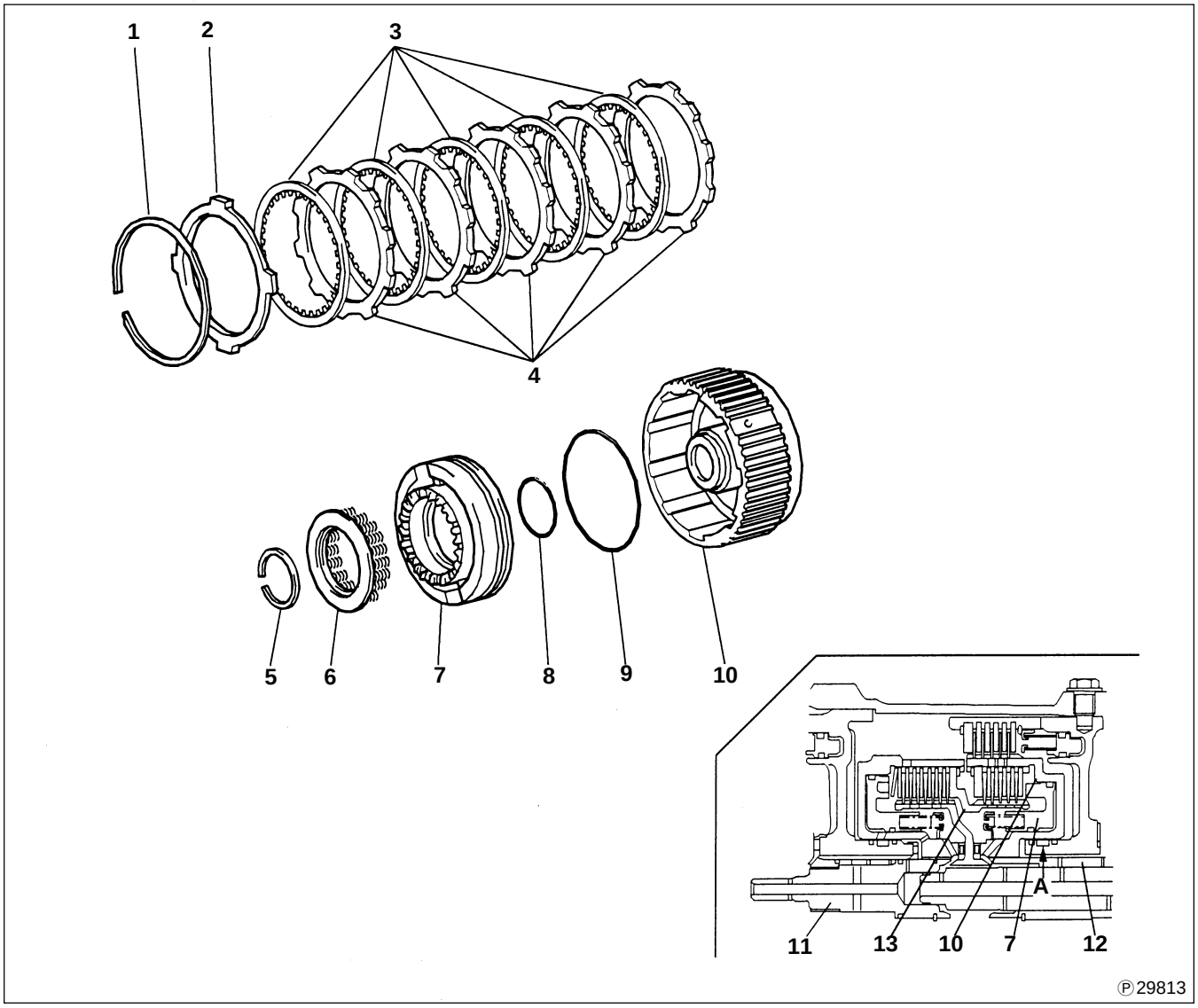
The control valve supplies operating pressure **A** to front clutch piston **4**, which causes the coupling of clutch discs **9** and clutch plates **8**, thus transmitting the engine's driving power from input shaft **15** to front clutch hub **12** and intermediate shaft **16**.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of front clutch return springs **5** presses against front clutch piston **4**.

As a result, clutch plates **8** are separated from clutch discs **9**, and the engine power is not transmitted.

● Rear Clutch (C2)



1 Snap ring
2 Clutch flange
3 Clutch discs
4 Clutch plates
5 Snap ring
6 Rear clutch piston return springs
7 Rear clutch piston
8 O-ring
9 O-ring
10 Rear clutch drum
11 Input shaft
12 Front and rear planetary sun gears
13 Rear clutch hub

A : Operating pressure

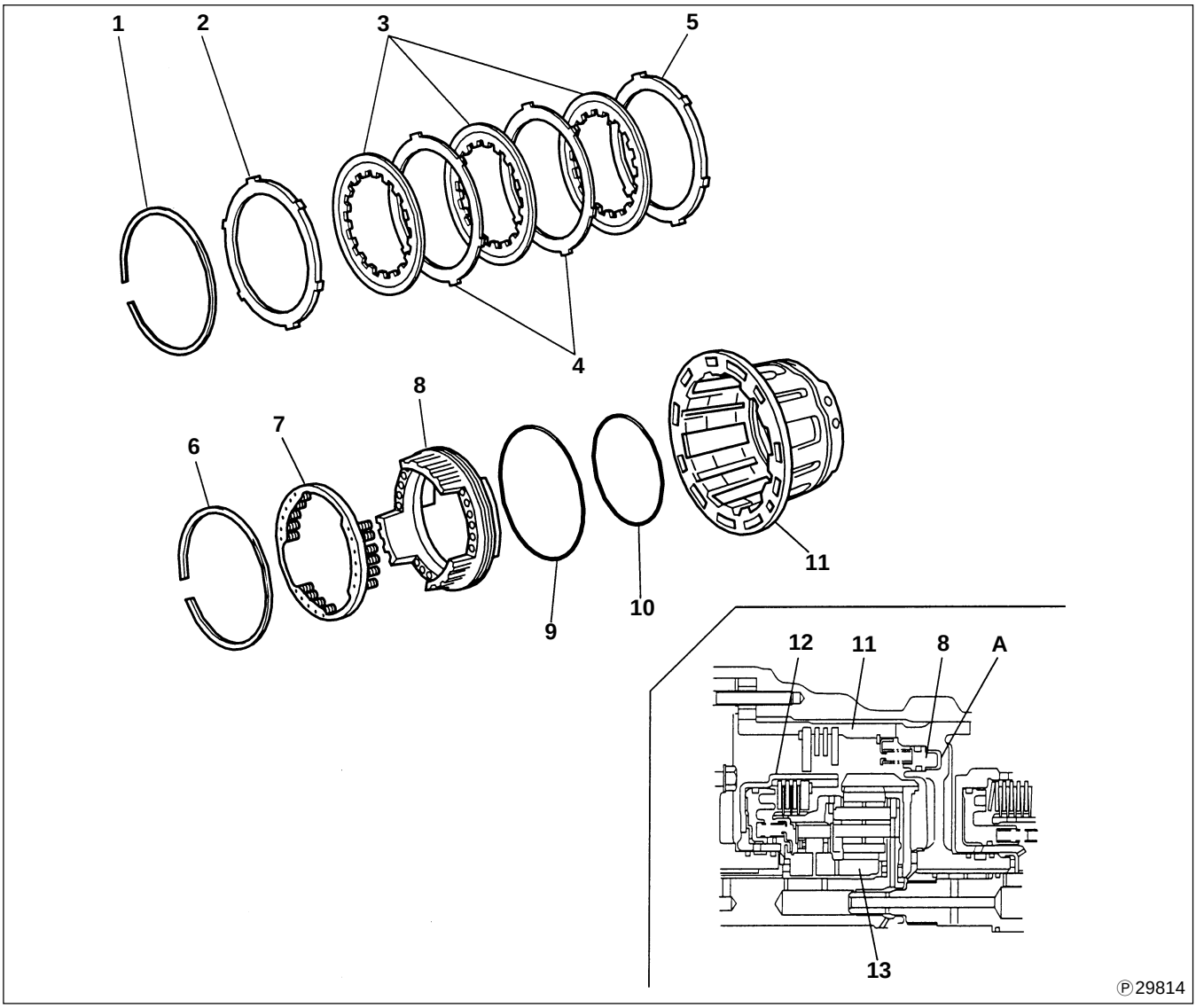
< Active condition >

The control valve supplies operating pressure **A** to rear clutch piston **7**, which causes the coupling of clutch discs **3** and clutch plates **4**, thus transmitting the engine's driving power from input shaft **11** and rear clutch hub **13** to rear clutch drum **10** and front and rear planetary sun gears **12**.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of rear clutch piston return springs **6** presses against rear clutch piston **7**.
As a result, clutch plates **4** are separated from clutch discs **3**, and the engine power is not transmitted.

● Overdrive Brake (B0)



1	Snap ring	**6**	Snap ring	**11**	Overdrive case
2	Brake flange	**7**	Overdrive brake return springs	**12**	Overdrive direct clutch
3	Clutch discs	**8**	Overdrive brake piston	**13**	Overdrive planetary sun gear
4	Brake plates	**9**	O-ring		
5	Brake plates	**10**	O-ring	**A**	: Operating pressure

< Active condition >

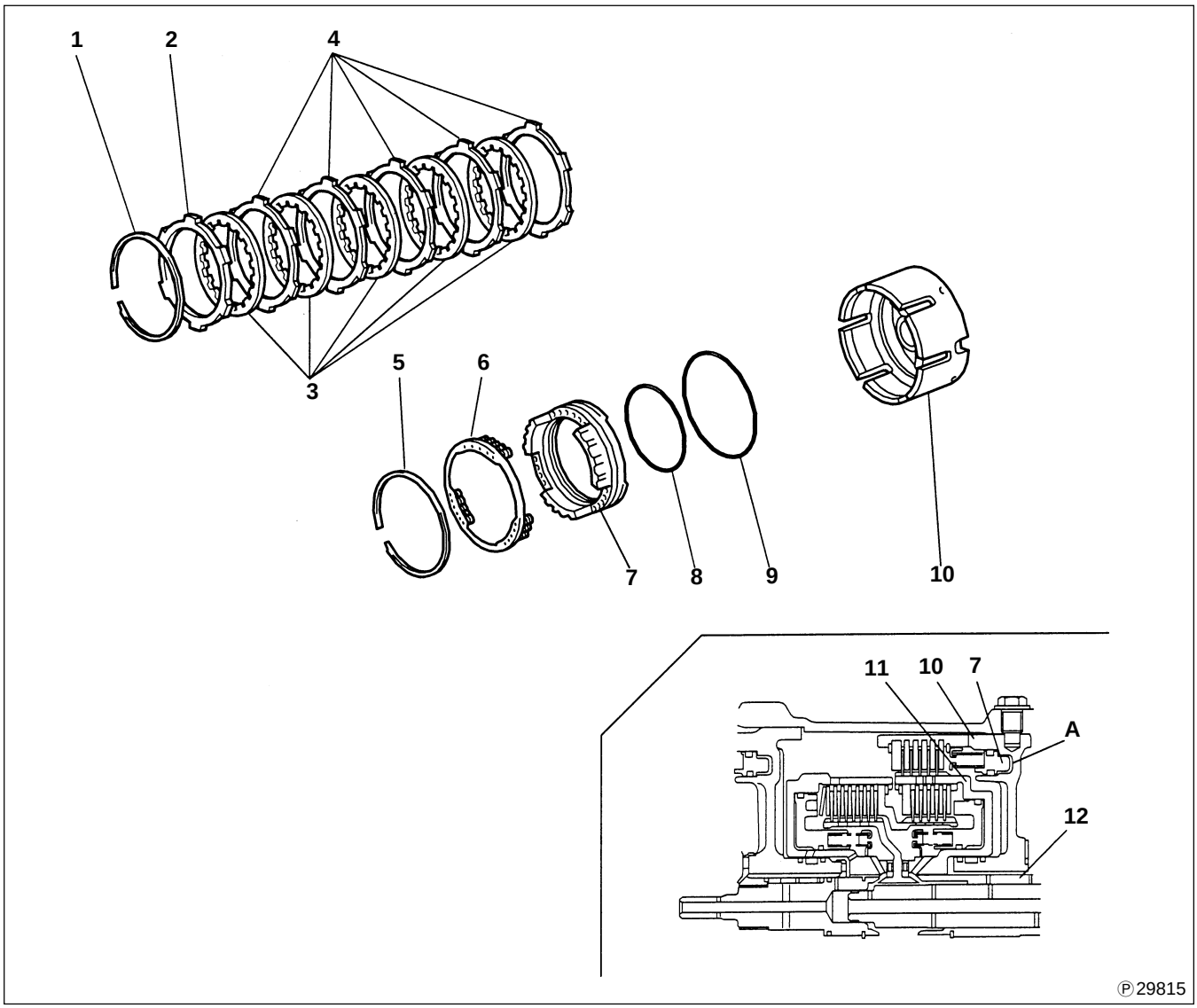
The control valve supplies operating pressure **A** to overdrive brake piston **8**, which causes the coupling of clutch discs **3** and brake plates **4**, **5**, thus interlocking overdrive direct clutch **12** with overdrive case **11**. This sets overdrive planetary sun gear **13** in locked condition.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of overdrive brake return springs **7** presses against overdrive brake piston **8**.

As a result, brake plates **4**, **5** are separated from clutch discs **3**, and the engine power is not transmitted.

● 2nd Brake (B1)



1 Snap ring
2 Brake flange
3 Clutch discs
4 Brake plates
5 Snap ring
6 2nd brake return springs
7 Brake piston No. 1
8 O-ring
9 O-ring
10 Center support
11 Rear clutch
12 Front and rear planetary sun gears

A : Operating pressure

< Active condition >

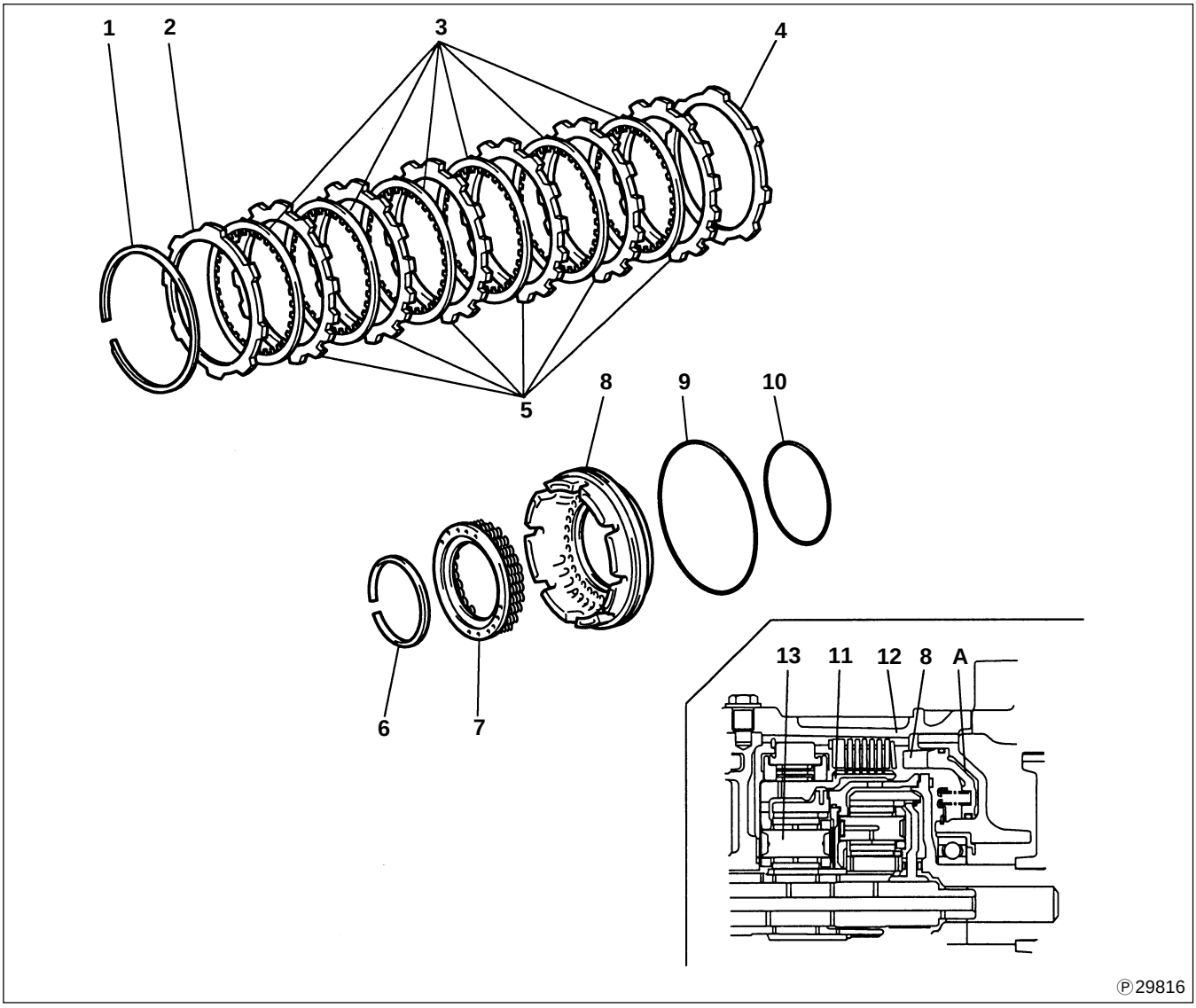
The control valve supplies operating pressure **A** to brake piston No.1 **7**, which causes the coupling of clutch discs **3** and brake plates **4**, thus interlocking rear clutch **11** with center support **10**. This sets front and rear planetary sun gears **12** in locked condition.

< Inactivate condition >

Since operating pressure **A** is not supplied, the force of 2nd brake return springs **6** presses against brake piston No.1 **7**.

As a result, brake plates **4** are separated from clutch discs **3**, and the engine power is not transmitted.

● 1st and Reverse Brake (B2)



1 Snap ring
2 Brake flange
3 Clutch discs
4 Brake cushion plate
5 Brake plates
6 Snap ring
7 1st and reverse brake return springs
8 1st and reverse brake piston
9 O-ring
10 O-ring
11 1st and reverse brake hub
12 Transmission case
13 Front planetary carrier

A : Operating pressure

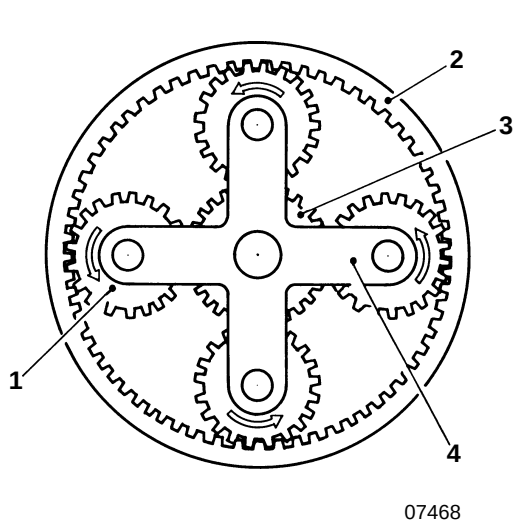
< Active condition >

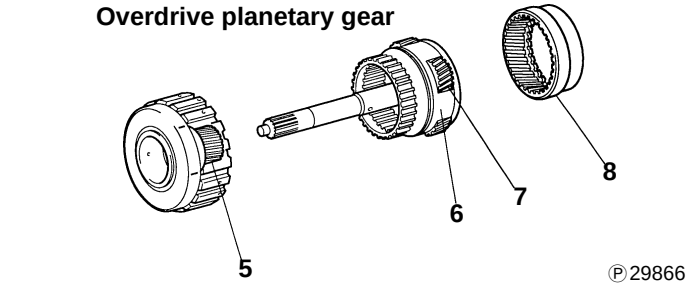
The control valve supplies operating pressure **A** to 1st and reverse brake piston **8**, which causes the coupling of clutch discs **3** and brake plates **5**, thus interlocking 1st and reverse brake hub **11** with transmission case **12**. This sets front planetary carrier **13** in locked condition.

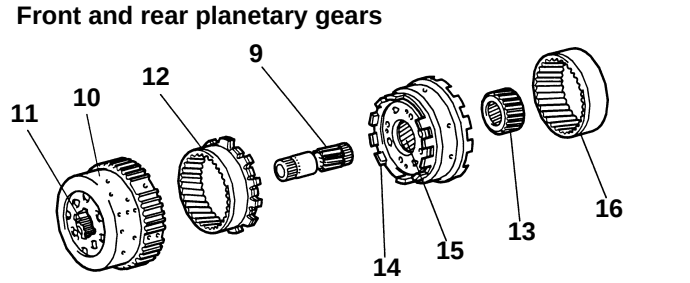
< Inactivate condition >

Since operating pressure **A** is not supplied, the force of 1st and reverse brake return springs **7** presses against 1st and reverse brake piston **8**.
As a result, brake plates **5** are separated from clutch discs **3**, and the engine power is not transmitted.

● Planetary Gears



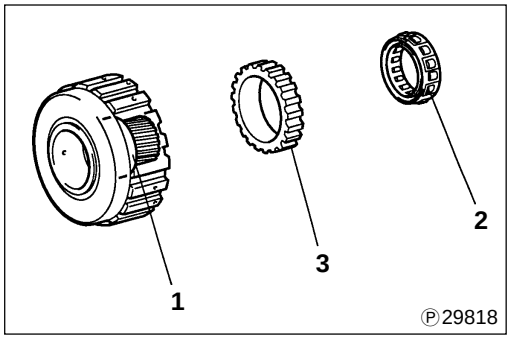




1 Pinion gear
2 Ring gear
3 Sun gear
4 Planetary carrier
5 Overdrive sun gear
6 Overdrive planetary carrier
7 Overdrive pinion gears
8 Overdrive ring gear
9 Front sun gear
10 Front planetary carrier
11 Front pinion gears
12 Front ring gear
13 Rear sun gear
14 Rear planetary carrier
15 Rear pinion gears
16 Rear ring gear

- Three sets of Simpson-type planetary gears provide a total of five gear ratios: four forward speeds and one reverse speed.
- Each planetary gear set consists of a sun gear **3** at the center and pinion gears **1** that revolve around the sun gear and on their axes. This set of gears are contained in a ring gear **2**. The pinion gears are attached to a planetary carrier **4**, so that all pinion gears rotate in the same direction and at the same rate. Gear shifting occurs when these four elements — sun gear, pinion gears, ring gear and planetary carrier — are provided with certain conditions. Clutches and brakes provide operating conditions to the planetary gears in accordance with shifting.

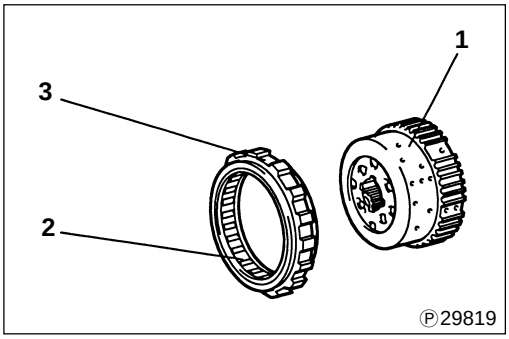
● Overdrive One-Way Clutch



1 Overdrive direct clutch drum and overdrive one-way clutch inner race
2 Overdrive one-way clutch
3 Overdrive one-way clutch outer race

- During acceleration in the 1st, 2nd and 3rd gears, the overdrive one-way clutch **2** engages and becomes interlocked with the overdrive sun gear and overdrive planetary carrier.
- In the 4th gear, the overdrive one-way clutch **2** rotates freely.

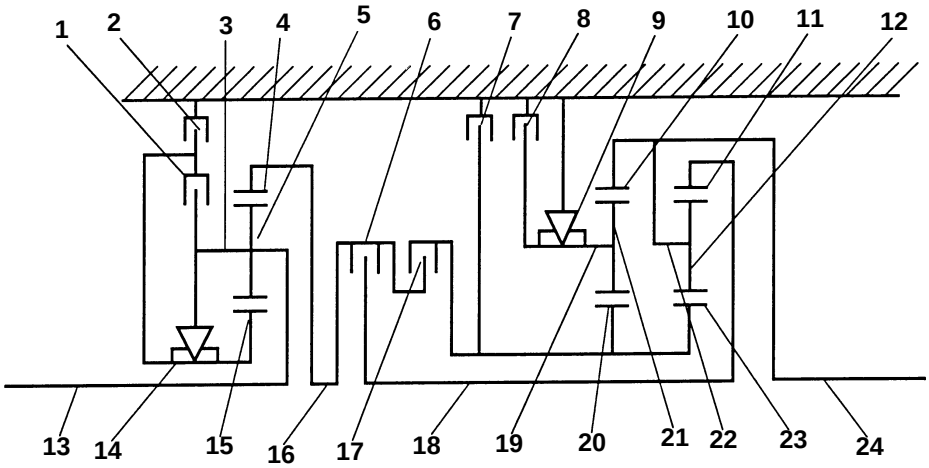
● No. 2 One-Way Clutch



1 Front planetary carrier and No. 2 one-way clutch inner race
2 No. 2 one-way clutch
3 No. 2 one-way clutch outer race

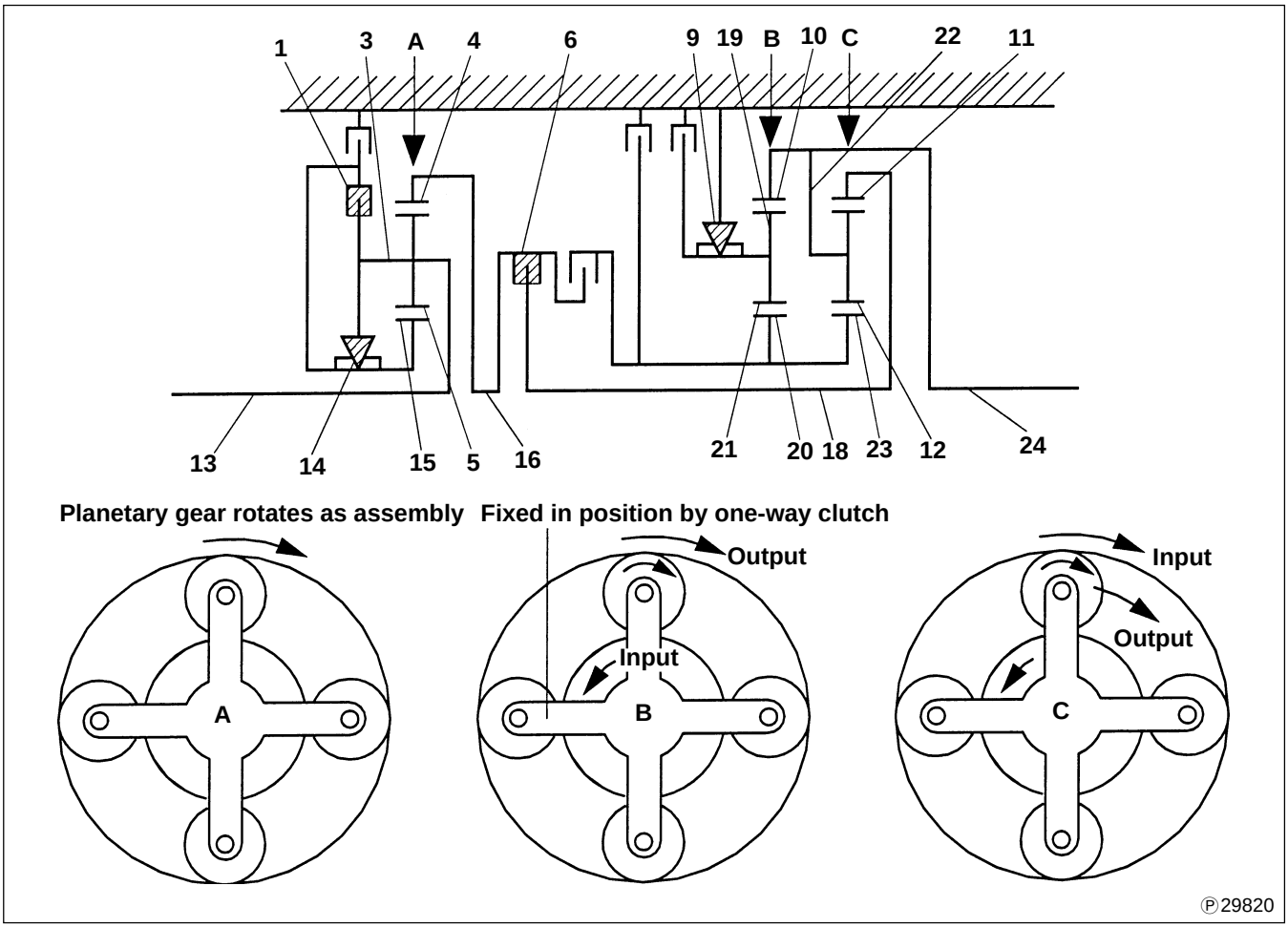
- During acceleration in the 1st gear, the No. 2 one-way clutch **2** engages and becomes interlocked with the front planetary carrier.
- In the 1st, 2nd and 3rd gears, the No. 2 one-way clutch **2** rotates freely.

Torque Transmission Process



1 Overdrive direct clutch
2 Overdrive brake
3 Overdrive planetary carrier
4 Overdrive planetary ring gear
5 Overdrive planetary pinion gears
6 Front clutch
7 2nd brake
8 1st and reverse brake
9 No. 2 one-way clutch
10 Front planetary ring gear
11 Rear planetary ring gear
12 Rear planetary pinion gears
13 Overdrive input shaft
14 Overdrive one-way clutch
15 Overdrive planetary sun gear
16 Input shaft
17 Rear clutch
18 Intermediate shaft
19 Front planetary carrier
20 Front planetary sun gear
21 Front planetary pinion gears
22 Rear planetary carrier
23 Rear planetary sun gear
24 Output shaft

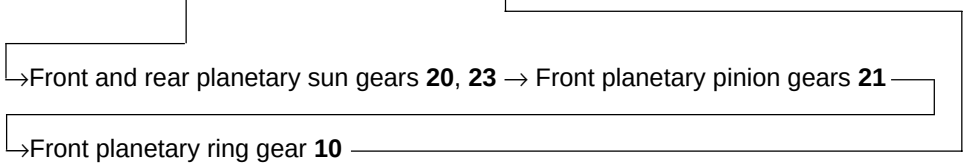
● D, and 2 Ranges (1st Gear)



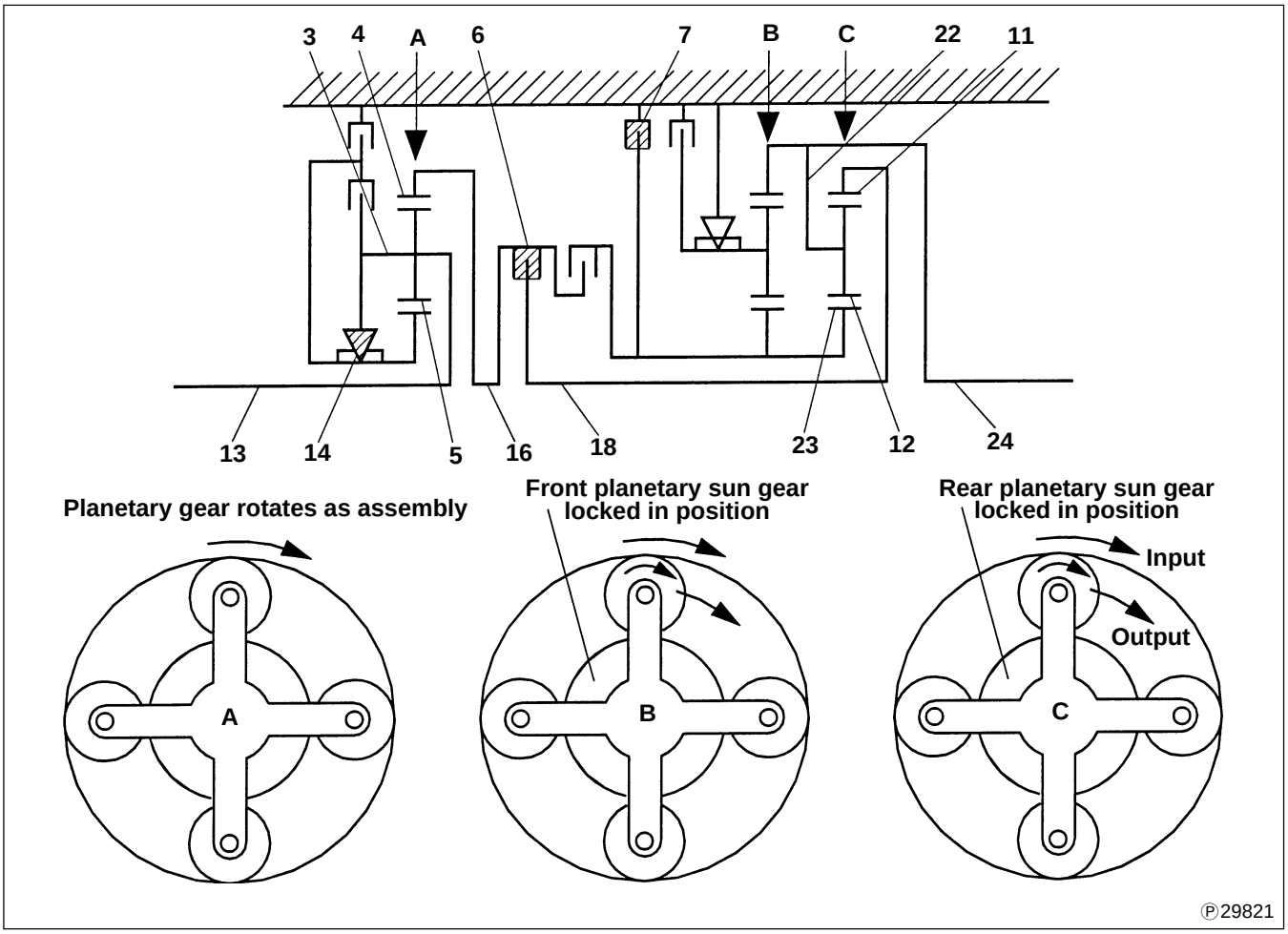
Overdrive direct clutch **1**, front clutch **6**, overdrive one-way clutch **14** and No. 2 one-way clutch **9** activate to provide the 1st gear. At overdrive planetary gear **A**, overdrive direct clutch **1** operates to interlock overdrive planetary carrier **3** (overdrive input shaft **13**) with overdrive planetary sun gear **15**. This disables overdrive planetary pinion gears **5** from rotating on their axes, and overdrive planetary carrier **3** becomes locked (direct coupling) in position with overdrive planetary ring gear **4**, thus transmitting driving force to input shaft **16**. Clockwise rotation of overdrive planetary carrier **3** results in a force that attempts to turn overdrive pinion gears **5** in a counterclockwise direction, producing clockwise rotating force for overdrive planetary sun gear **15**. However, since overdrive planetary sun gear **15** rotates faster than overdrive planetary carrier **3**, overdrive one-way clutch **14** activates, interlocking overdrive planetary carrier **3** with overdrive planetary sun gear **15**. This disallows overdrive planetary pinion gears **5** from rotating on their axes, in the same way as when overdrive direct clutch **1** activates. Therefore, overdrive planetary carrier **3** becomes locked (direct coupling) in position with overdrive planetary ring gear **4**, thus transmitting the driving force to input shaft **16**.
These two power transmitting systems reduce the load on overdrive direct clutch **1**.
The clockwise rotating force of input shaft **16** is transmitted to intermediate shaft **18** by the action of front clutch **6**, then turns rear planetary pinion gears **12** clockwise by means of rear planetary ring gear **11**. In this process, rear planetary carrier **22** is stationary due to vehicle weight. Therefore, rear planetary sun gear **23** receives counterclockwise rotating force and transmits this force to front planetary pinion gears **21**, exerting force to rotate front planetary carrier **19** in a counterclockwise direction. However, since No. 2 one-way clutch **9** prevents front planetary carrier **19** from rotating in a counterclockwise direction, pinion gears **12**, **21** cause front planetary ring gear **10** and rear planetary carrier **22** to rotate in a clockwise direction, thereby transmitting the rotating force to output shaft **24**. (Rotational directions are described as viewed from the torque converter side.)

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**



● D Range (2nd Gear)

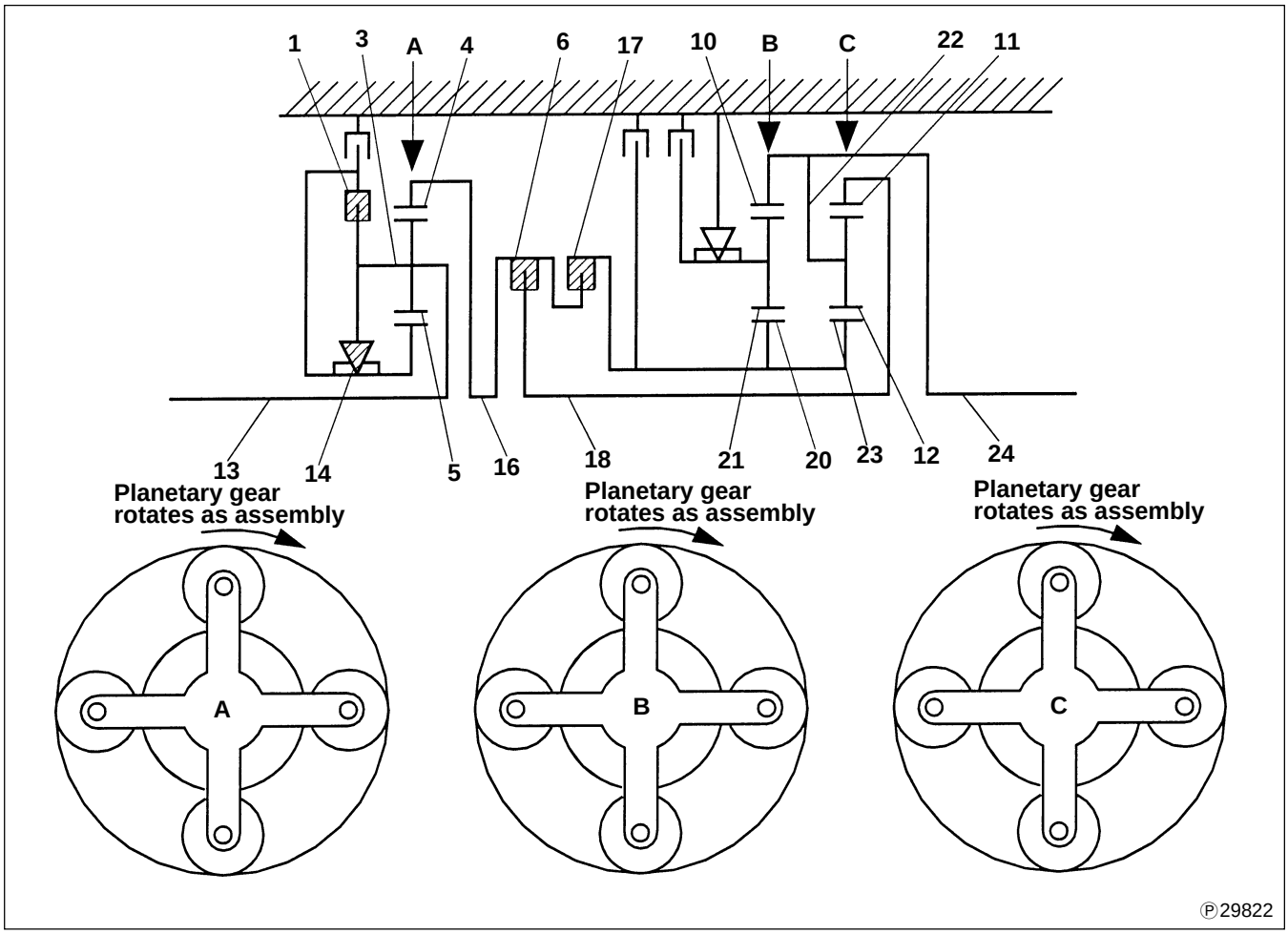


Front clutch **6**, 2nd brake **7** and overdrive one-way clutch **14** activate to provide the 2nd gear. In this gear, overdrive one-way clutch **14** transmits the rotating force of input shaft **16** to rear planetary pinion gears **12** by means of intermediate shaft **18** and rear planetary ring gear **11**. Although rear planetary sun gear **23**, which is meshed with pinion gears **12**, receives a counterclockwise rotating force, 2nd brake **7** prevents its rotation, disabling the transfer of the rotating force to front planetary gear **B**. As a result, the rotating force transmits to rear planetary carrier **22** via rear planetary pinion gears **12**, then to output shaft **24**.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**

● D, 2 and L Ranges (3rd Gear)



Overdrive direct clutch **1**, front clutch **6**, rear clutch **17** and Overdrive one-way clutch **14** activate to provide the 3rd gear. In this gear, front clutch **6** and rear clutch **17** cause intermediate shaft **18** and front and rear sun gears **20**, **23** to rotate in the same direction. Therefore, front and rear planetary pinion gears **12**, **21** become locked in position, thus the entire assemblies of planetary gears **A**, **B**, **C** rotate together to transmit the rotating force of input shaft **16** to output shaft **24** without reducing the rate of rotating speed.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** →Front clutch **6** → Intermediate shaft **18**

→Rear planetary ring gear **11** → Rear planetary pinion gears **12**

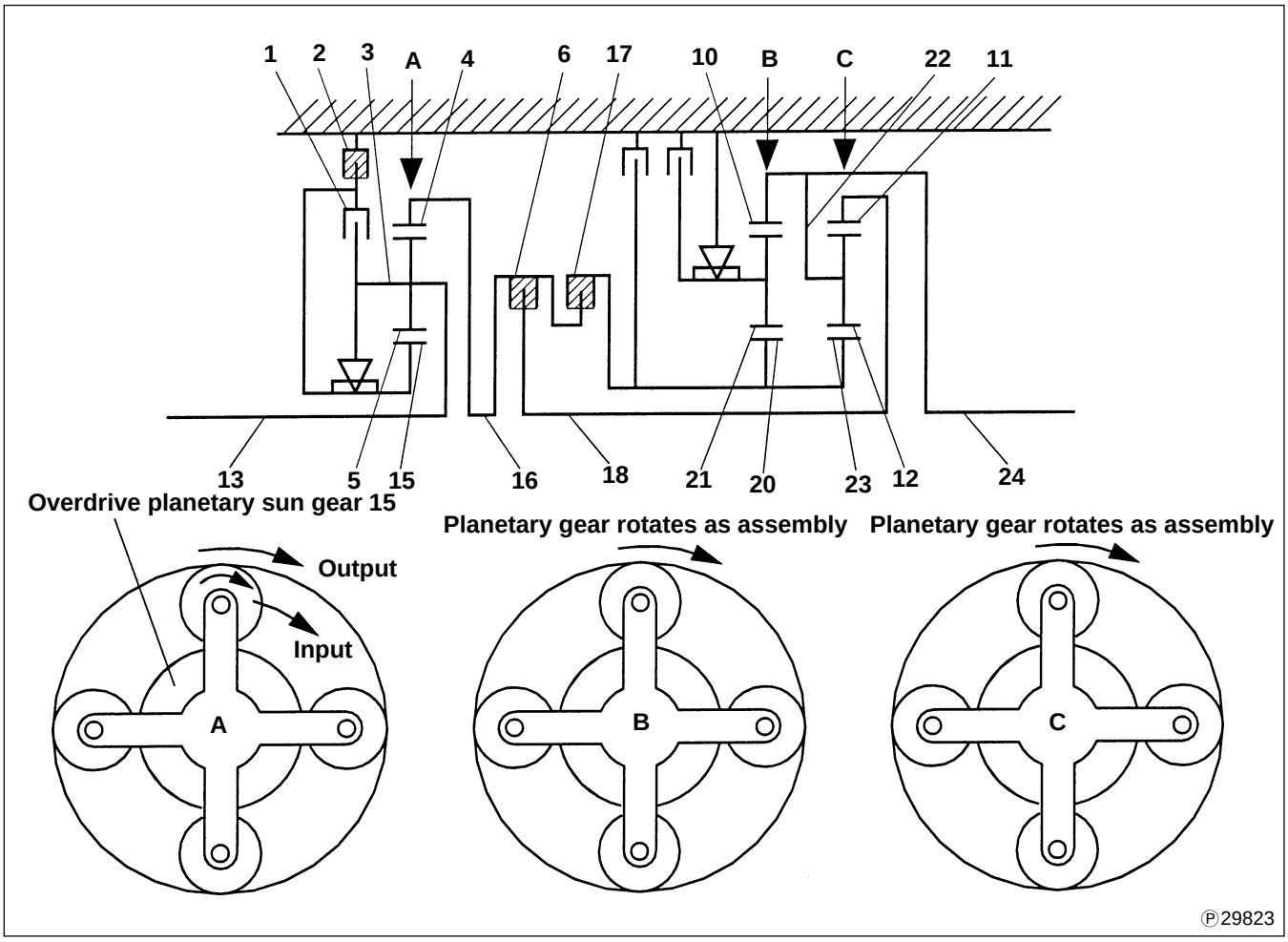
→Rear clutch **17**

→Rear planetary carrier **22** →Output shaft **24**

→Rear planetary sun gear **23** → Rear planetary pinion gears **12**

→Front planetary sun gear **20** → Front planetary pinion gears **21** → Front planetary ring gear **10**

● D Range (4th Gear)



If the overdrive conditions (see the table below) are fulfilled when the transmission is in 3rd gear, overdrive direct clutch **1** disengages, and overdrive brake **2** activates at the same time to provide the overdrive gear ratio. In the overdrive gear, overdrive brake **2** is in operation, thus locking overdrive planetary sun gear **15** in position. Therefore, the rotating force transmitted from overdrive input shaft **13** to overdrive planetary carrier **3** causes overdrive planetary pinion gears **5** to revolve around the sun gear and on their own axes, which results in an increased rotating speed of overdrive planetary ring gear **4** (input shaft **16**). The rotating force of input shaft **16** is transmitted to output shaft **24**, in the same way as in the 3rd gear.

Overdrive conditions

Shift position	D
Overdrive OFF SW	OFF
Temperature of oil in oil pan	Approximately 0°C {32°F} or higher

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18**

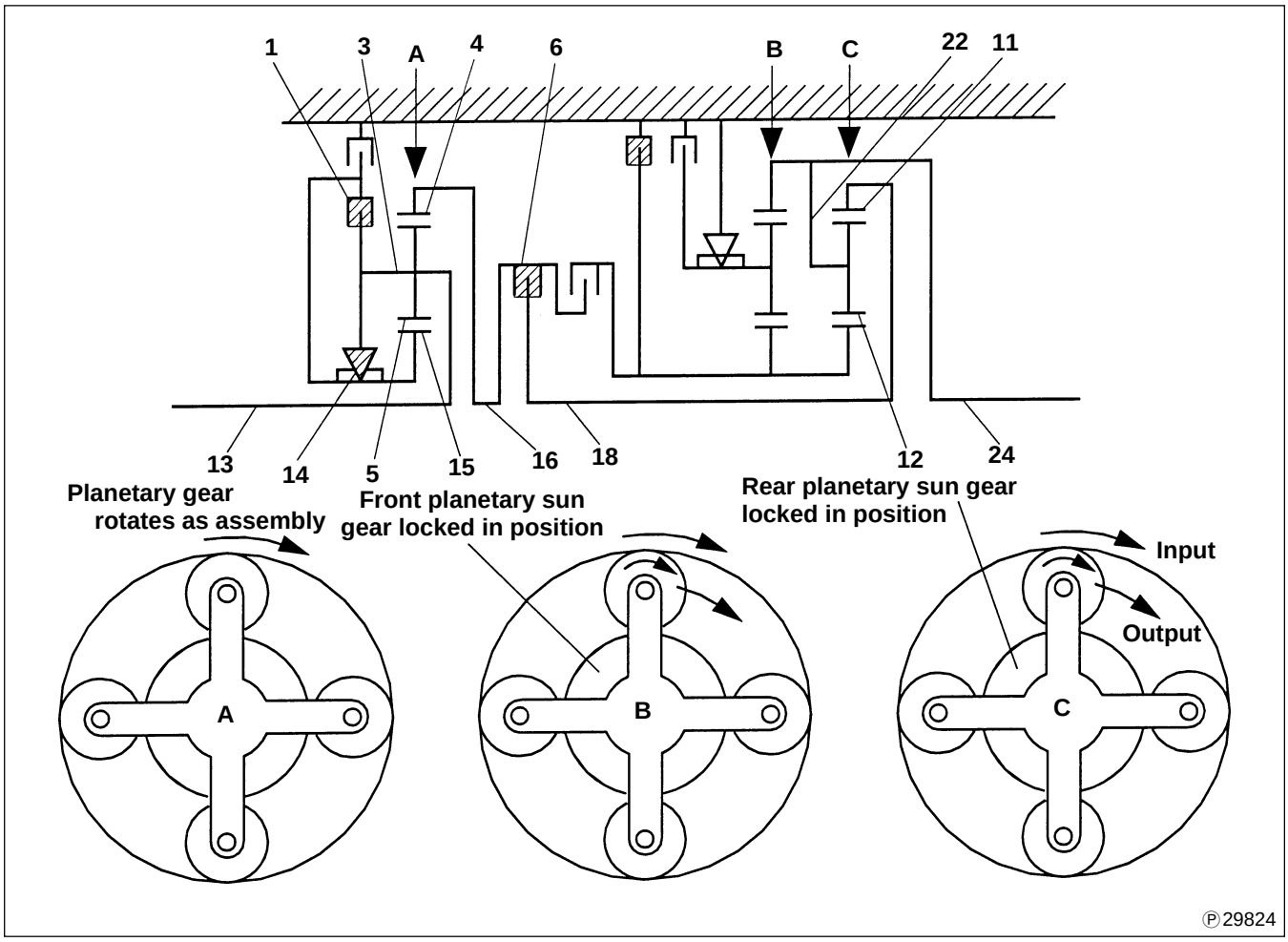
→ Rear planetary ring gear **11** → Rear planetary pinion gears **12**

→ Rear clutch **17** → Rear planetary carrier **22** → Output shaft **24**

→ Rear planetary sun gear **23** → Rear planetary pinion gears **12**

→ Front planetary sun gear **20** → Front planetary pinion gears **21** → Front planetary ring gear **10**

● 2 Range (2nd Gear)

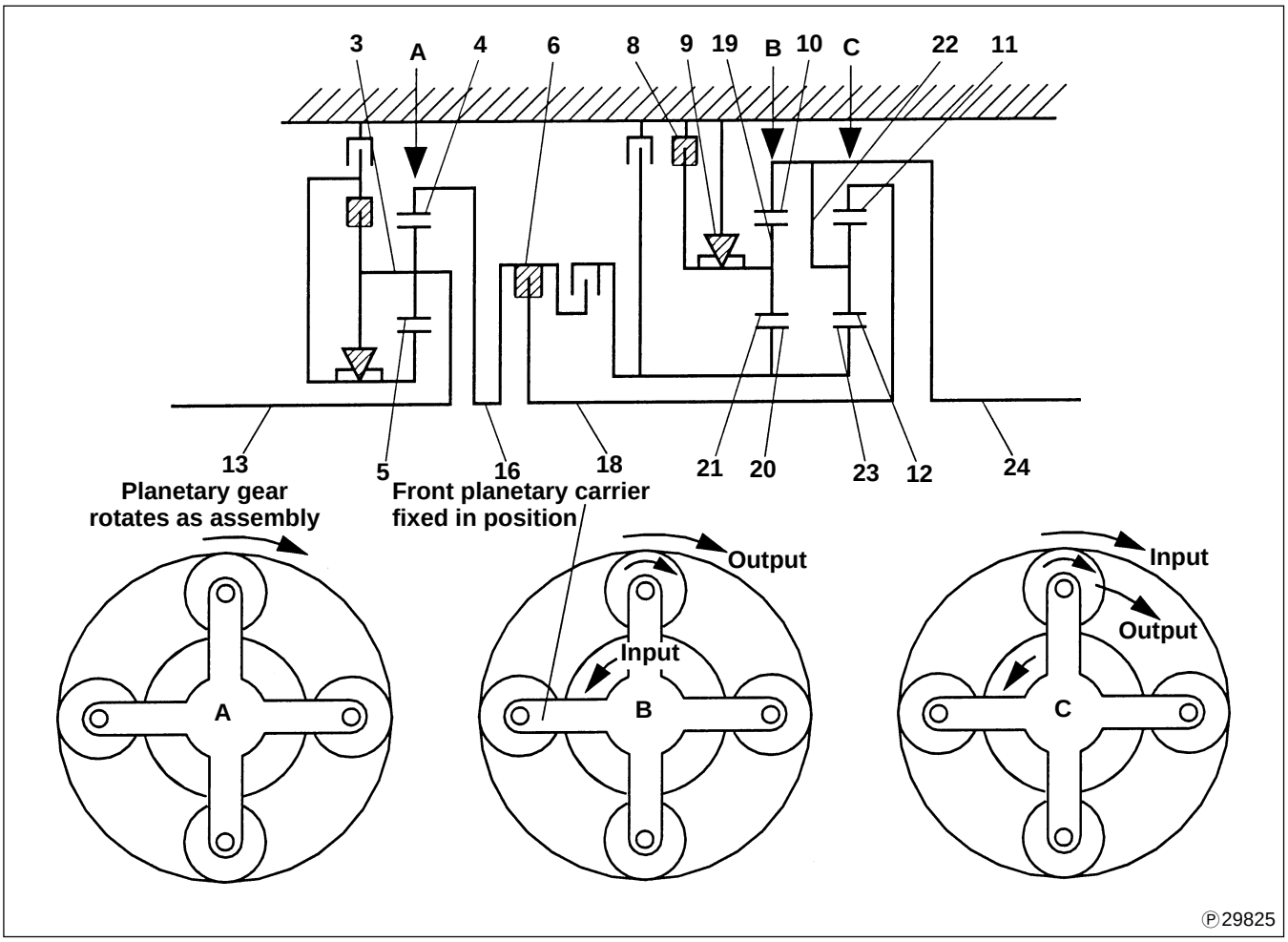


The rotating power is transmitted in the same way as in the previously described 2nd gear in the D range. However, when engine brake is applied, overdrive direct clutch **1** activates and prevents overdrive planetary sun gear **15** from rotating clockwise. In other words, when the transmission is in 2nd gear with the range selector in the D range, overdrive one-way clutch **14** transmits the rotating power to input shaft **16**. When the engine brake is applied, however, the counterclockwise rotating force of overdrive planetary sun gear **15** inactivates overdrive one-way clutch **14** and causes overdrive planetary sun gear **15** to spin freely. This disallows the transmission of the engine brake force. To properly transmit the engine brake force in the 2 range, overdrive direct clutch **1** is activated to interlock overdrive planetary sun gear **15** with overdrive planetary carrier **3**.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft**16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**

● L Range (1st Gear)



The rotating power is transmitted in the same way as in the previously described 1st gear in the D and L ranges. However, when the engine brake is applied, 1st and reverse brake **8** activates and prevents front planetary carrier **19** from rotating clockwise. In other words, when the transmission is in 1st gear with the range selector in the D or 2 range, No. 2 one-way clutch **9** prevents a counterclockwise rotation of front planetary carrier **19** and transmits the rotating power to output shaft **24**. When the engine brake is applied, however, a rotating force in the reverse direction is generated, inactivating No. 2 one-way clutch **9** and allowing front planetary carrier **19** to spin freely. This disallows the transmission of the engine brake force. To properly transmit the engine brake force in the L range, 1st and reverse brake **8** is activated to lock front planetary carrier **19** in position.

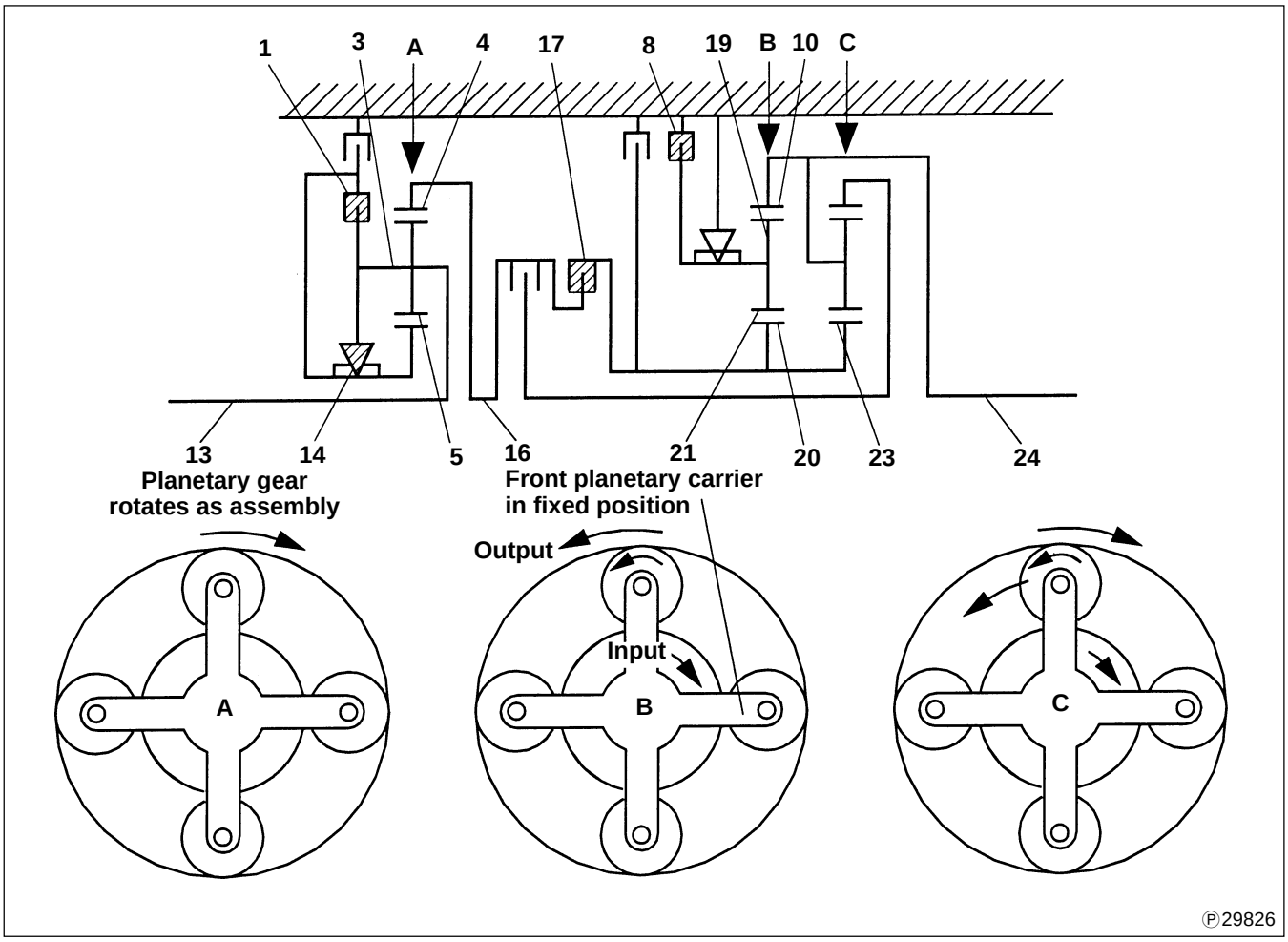
Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Front clutch **6** → Intermediate shaft **18** → Rear planetary ring gear **11** → Rear planetary pinion gears **12** → Rear planetary carrier **22** → Output shaft **24**

→Front and rear planetary sun gears **20**, **23** → Front planetary pinion gears **21**

→Front planetary ring gear **10**

● R Range

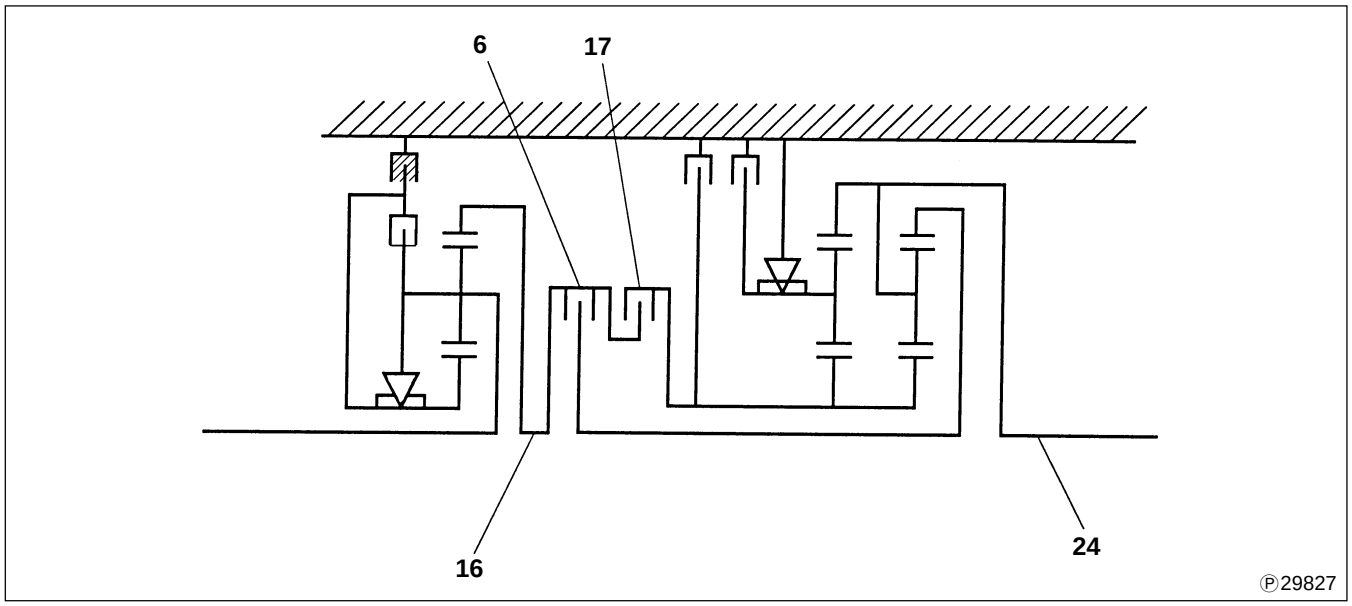


In the R range, overdrive direct clutch **1**, overdrive one-way clutch **14**, rear clutch **17** and 1st and reverse brake **8** activate to provide reverse gear. The rotating force of overdrive input shaft **13** is transmitted to input shaft **16** via direct coupling, in the same way as in the 1st gear in the D and 2 ranges. Since rear clutch **17** in operation, the rotating force of input shaft **16** is transmitted to pinion gears **21** of front planetary gear **B** by means of the sun gear. However, because front planetary carrier **19** is locked in position by 1st and reverse brake **8**, the rotating force of front planetary sun gear **20** is transmitted to the ring gear by means of front planetary pinion gears **21**, thus providing a counterclockwise rotating force to output shaft **24**.

Power transmitting process

Overdrive input shaft **13** → Overdrive planetary carrier **3** → Overdrive planetary pinion gears **5** → Overdrive planetary ring gear **4** → Input shaft **16** → Rear clutch **17** → Front planetary sun gear **20** → Front planetary pinion gears **12** → Front planetary ring gear **10** → Output shaft **24**

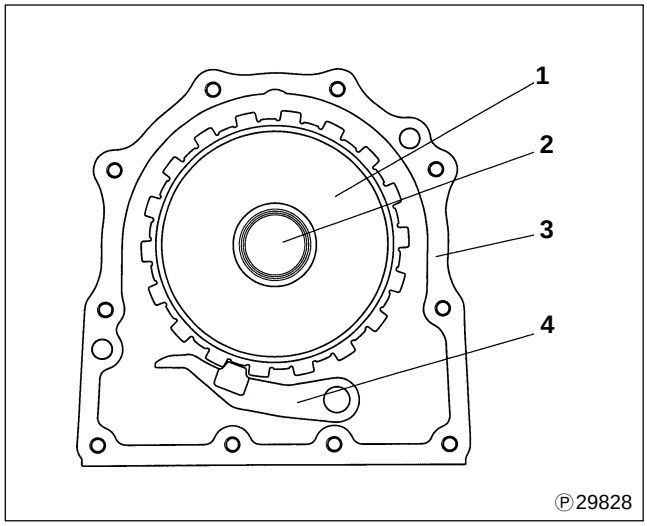
● N Range



- **N range**

  Since front clutch **6** and rear clutch **17** are disengaged, the driving force of input shaft **16** is not transmitted to output shaft **24**.

● P Range

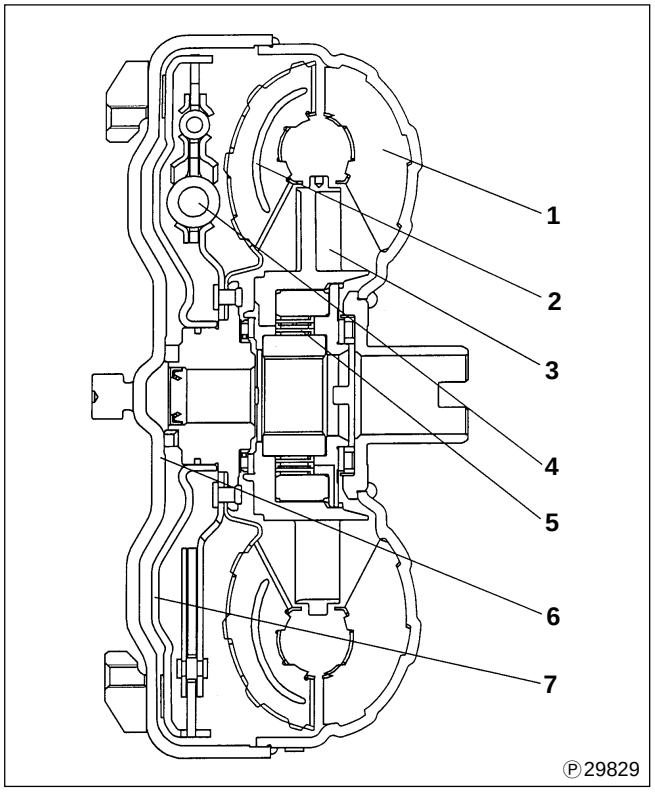


1 Parking lock gear
2 Output shaft
3 Transmission case
4 Parking lock pawl

- **P range**

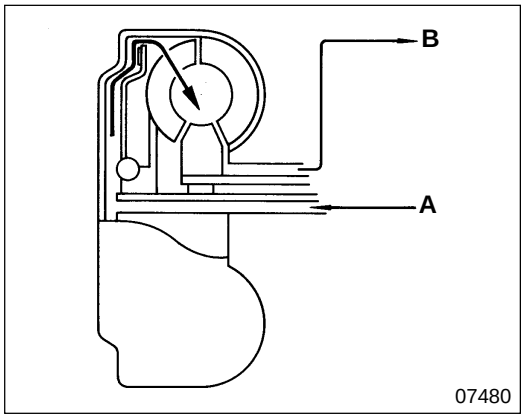
  In the same way as in the N range, the driving force of the input shaft is not transmitted to output shaft **2**. Parking lock pawl **4**, which is linked with the range selector lever, meshes with parking lock gear **1** which is directly connected to the output shaft, thus disallowing vehicle movement.

● Torque Converter



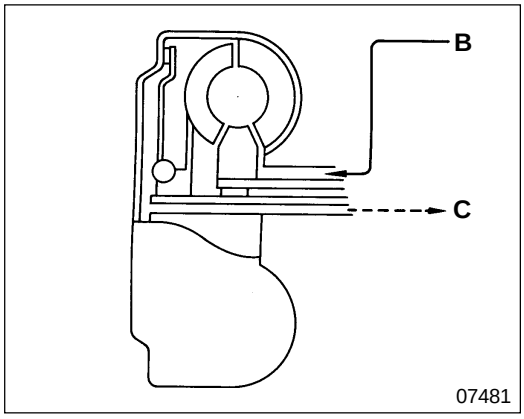
1 Pump impeller
2 Turbine liner
3 Stator
4 Lock-up damper
5 One-way clutch
6 Front converter cover
7 Lock-up piston

- The torque converter transfers engine torque to the transmission. It transmits engine torque by means of oil when it is not in a lock-up condition, and it transfers power via the lock-up piston when it is in a lock-up condition.
- The torque converter is a 3-element, 1-stage, 2-phase type.
- "1-stage" indicates that the torque converter has one turbine liner, which is an output element. "2-phase" means that it provides a torque converter function when the turbine liner speed is relatively slow as compared to the pump impeller speed, and acts as a fluid coupler when the turbine liner speed is high.



< Lock-up mechanism in inactive condition >

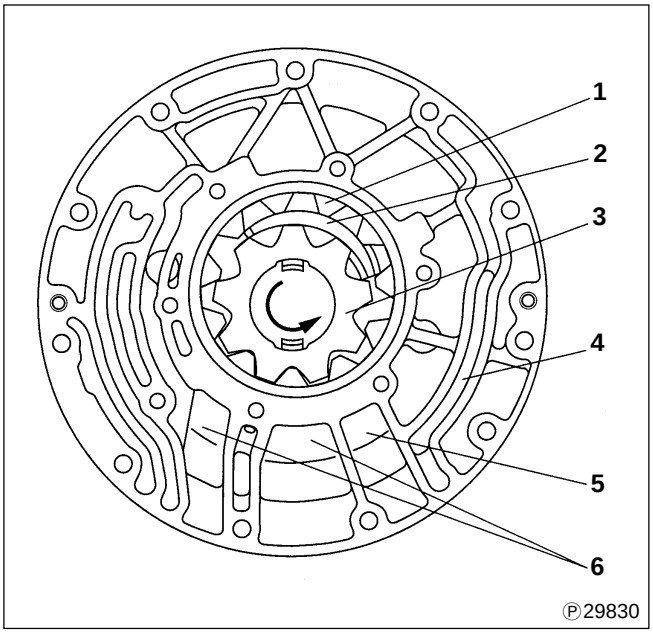
The lock-up control valve supplies the torque converter operating pressure through oil passage **A** to the space between the front converter cover and lock-up piston. This oil pressure separates the clutch facing of the lock-up piston from the front converter cover. As a result, the torque converter operating pressure supplied through oil passage **A** is released from oil passage **B**, and enters the oil cooler.



< Lock-up mechanism in active condition >

The lock-up control valve switches the operating oil passage. The torque converter operating pressure is supplied through oil passage **B** to the pump impeller, turbine liner and stator.
As a result, the oil pressure applied to the lock-up piston causes the clutch facing of the lock-up piston to engage with the front converter cover for improved power transmitting efficiency.
C : Drain

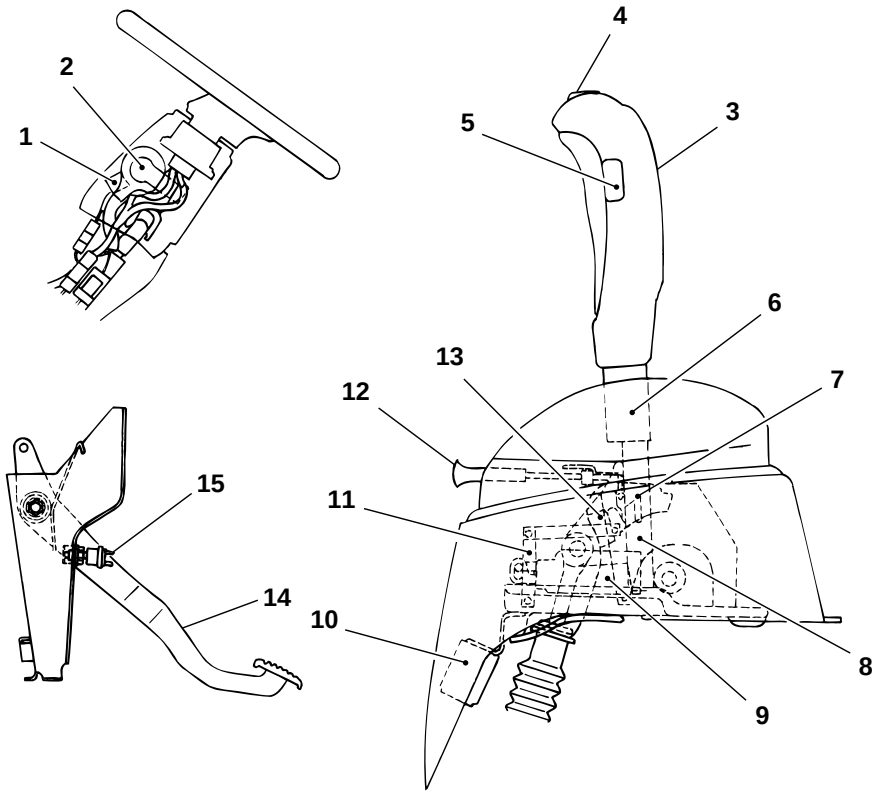
● Oil Pump



1 Driven gear
2 Crescent
3 Drive gear
4 Oil pump body
5 Outlet port
6 Inlet port

- Feature ..... The oil pump gears have a small number of gear teeth and features a special high-performance tooth profile.
- Operation ··· The drive gear is fitted to the extension sleeve of the torque converter, and rotates in the same direction (in the direction of the arrow) as the engine to compress and discharge the intake oil.

Operation Error Protection Device



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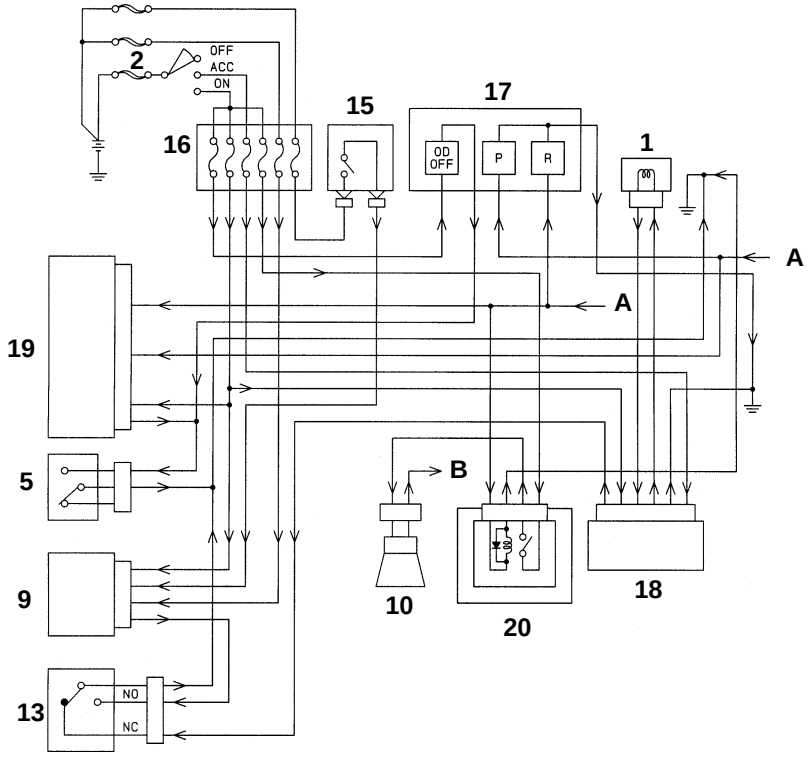


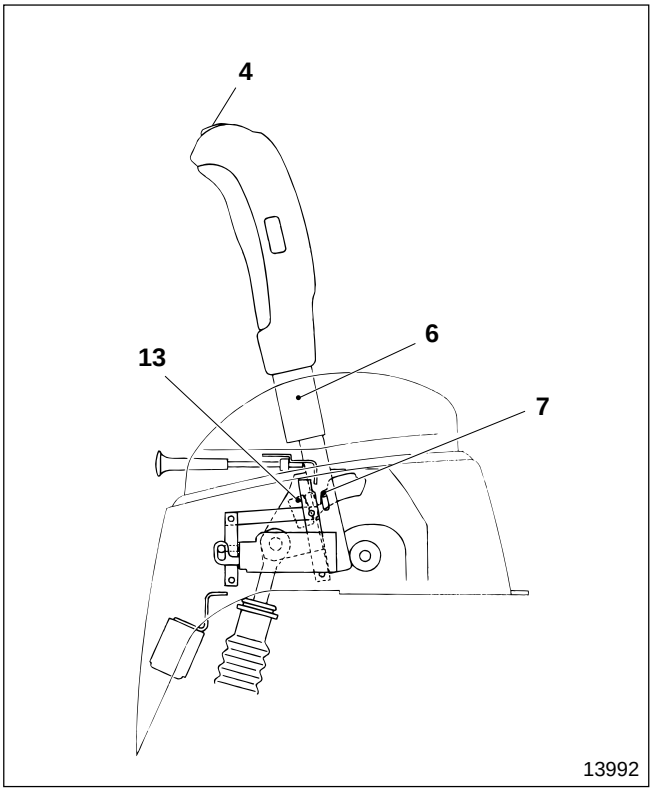
31559

1 Key interlock solenoid
2 Starter switch
3 Automatic transmission knob
4 Shift button
5 Overdrive OFF switch
6 Selector lever
7 Pin
8 Lever bracket
9 Shift lock actuator
10 Automatic transmission reverse buzzer
11 Shift lock link
12 Shift lock release knob
13 P range switch
14 Brake pedal
15 Stop lamp switch
16 Fuse box
17 Meter cluster
18 Key interlock electronic control unit
19 Automatic transmission electronic control unit
20 Backup lamp relay

A : From inhibitor switch
B : To backup buzzer

● **Parking Shift Lock Device with Key Interlock**

The key interlock device prevents the removal of the key unless selector lever **6** is in the P (Parking) range. The shift lock device disallows the selector lever from moving from the P range position unless brake pedal **15** is pressed, thereby preventing accidental vehicle movement caused by an unintended selector lever operation.



Key interlock device

< Lock condition >

Condition: When selector lever **6** is in a position other than the P range or when shift button **4** is pressed with the selector lever in the P range, pin **7** is not in contact with P range switch **13** (switch is set free). Therefore, the switch is ON.

↓

An electric current flows from key interlock electronic control unit **18** to key interlock solenoid **1** to activate the key interlock solenoid.

↓

Key interlock solenoid **1** turns ON to prevent starter switch **2** from being turned to the LOCK position, thus disabling the removal of the key.

< Unlock condition >

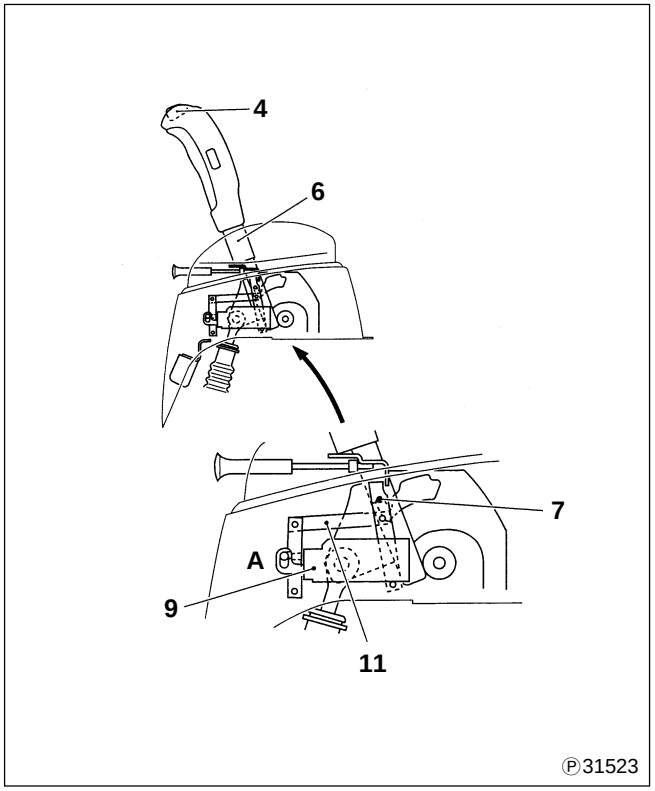
Condition: When selector lever **6** is in the P range and shift button **4** is not pressed, pin **7** presses again P range switch **13** (switch is activated). Therefore, the switch is OFF.

↓

No electric current flows from key interlock electronic control unit **18** to key interlock solenoid **1**. Therefore, the key interlock solenoid is OFF.

↓

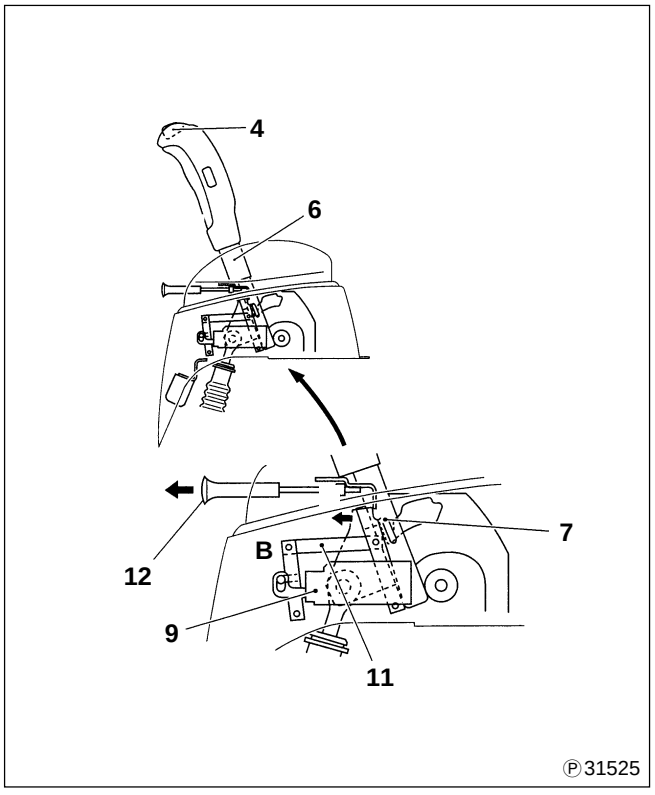
Key interlock solenoid **1** does not turn ON, thereby disengaging starter switch **2** and allowing the switch to turn to the LOCK position for the removal of the key.



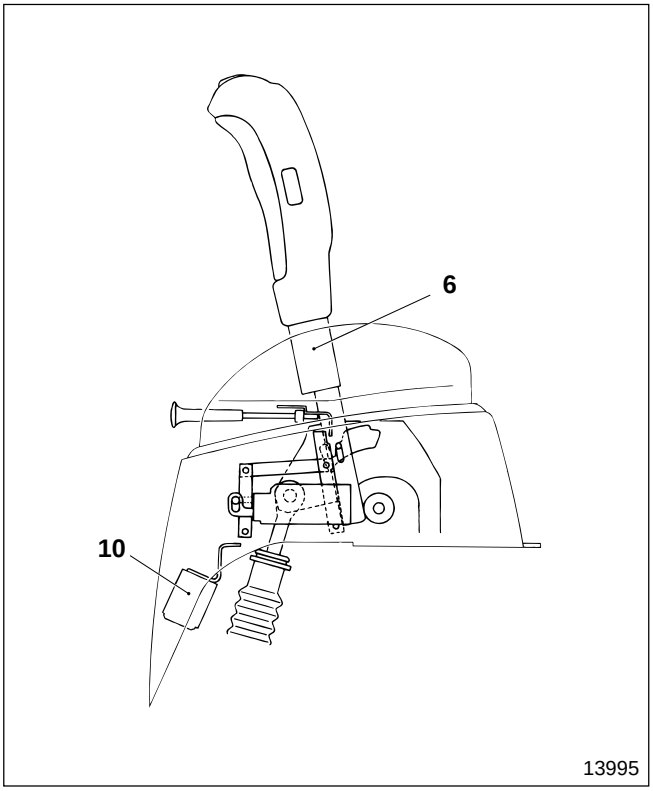
P shift lock device

- With selector lever **6** in the P range, when the electric current (see the table below) supplied to shift lock actuator **9** sets the shift lock actuator in lock position **A**, pin **7** is restrained by shift lock link **11** and disallows pressing of shift button **4**. Therefore, the selector lever cannot be moved from the P range.

Power supply		Switch		Operation mode	
IG	+B	Brake	P range	Unlock	Lock
○	○	○	○	○←	
○	○		○		→○
○	○	○		○	
○	○			○	
	○	○	○		→○
	○		○		→○
	○	○		○	
	○			○	



- With selector lever **6** in the P range, when the electric current (see the above table) supplied to shift lock actuator **9** sets the shift lock actuator in unlock position **B**, shift lock link **11** is in the forward position to set pin **7** free, thus allowing pressing of shift button **4**. Therefore, the selector lever can be moved from the P range to another range position.
- Should an electrical problem occur and hinder proper operation, pulling of shift lock release knob **12** deactivates the P shift lock.



● **Selector lever reverse position warning device**

When starter switch **2** is ON, moving selector lever **6** to the R (reverse) range activates the reverse position detecting switch (inhibitor switch: built into automatic transmission) and turns on automatic transmission reverse buzzer **10** to warn the driver that the selector lever is in the reverse position.

TROUBLESHOOTING PROCEDURES

Automatic transmission problems can be caused by the following malfunctions.

- Engine malfunction
- Improperly adjusted parts
- Faulty hydraulic system
- Faulty mechanical functions
- Faulty electrical system

When diagnosing the above abnormalities, be sure to inspect the following basic items.

- Engine condition
- Automatic transmission fluid level and condition: 🕮 P23A-57
- Range selector cable adjustment

In addition to the inspection of the above items, use the self-diagnosis function to locate the cause of the problem and take necessary measures.

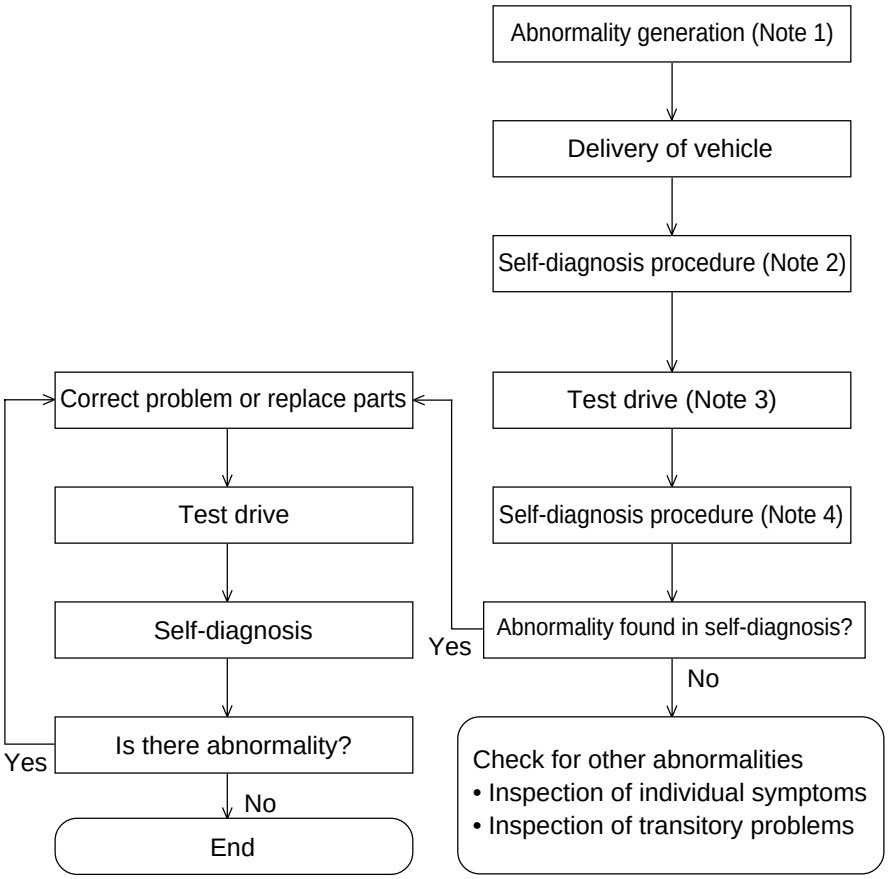
After repair is complete, test-drive the vehicle to determine whether the problem is corrected or further inspection is necessary.

If the cause of the problem cannot be located, or if repair work does not correct the problem, conduct a line pressure test and a stall test. 🕮 P23A-52, 54

It should be noted that special knowledge and tools are required to repair the automatic transmission unit or replace parts. Therefore, conduct an inspection for the purpose of evaluating the operating condition of the transmission. For maintenance or repair of the automatic transmission, contact your nearest authorized Mitsubishi dealer or distributor.

Use of the MUT-II allows efficient inspection of the automatic transmission system.

Self-diagnosis process



Note 1 : The following abnormalities significantly lower driving performance. In the case that these abnormalities generate during operation, the automatic transmission warning lamp lights.
- Faulty operation of vehicle speed sensors
- Faulty operation of solenoid other than lock-up solenoid
- Faulty operation of accelerator sensor
- Faulty operation of inhibitor switch
- Faulty throttle position PWM signal

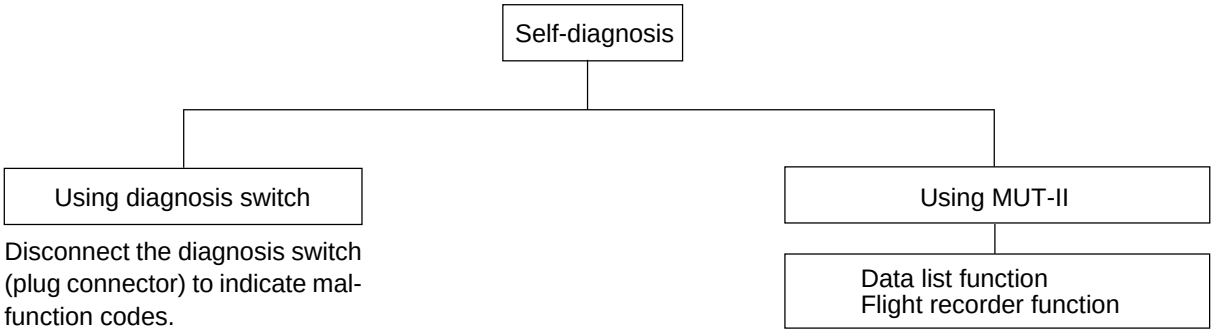
Note 2 : Inspect for malfunctions that occurred during user operation. Record inspection results.

Note 3 :
- Check abnormal conditions.
- In a test drive, operate the accelerator pedal in full range (from the released position to full throttle) with a vehicle speed of up to approximately 50 km/h {31.1 mph}.

Note 4 : Inspect problems that generate during a test drive. Record inspection results.

Types of Self-Diagnosis

The following two types of self-diagnosis function can be selected.



Disconnect the diagnosis switch (plug connector) to indicate malfunction codes.
Data of malfunctions stored in the memory can be deleted with the memory clear switch.

Connect the MUT-II to the automatic transmission electronic control unit with a test harness to download and display malfunction codes.
In addition to the self-diagnosis function, the MUT-II is equipped with a data list function that indicates sensor and switch values and a flight recorder function that records those data for a certain length of time before and after the triggering. These functions are useful in analyzing malfunctions.
(Refer to the MUT-II operation manual.)

Features of the two self-diagnosis methods

Item \ Self-diagnosis method	Use of diagnosis switch	Use of MUT-II
Convenience	○	◎
Number of self-diagnosis items	◎	◎
Data reading ease	○	◎
Data application range	×	◎

◎ : Good
○ : Fair
× : Bad

Using diagnosis switch to recall diagnosis codes and using memory clear switch to delete diagnosis codes

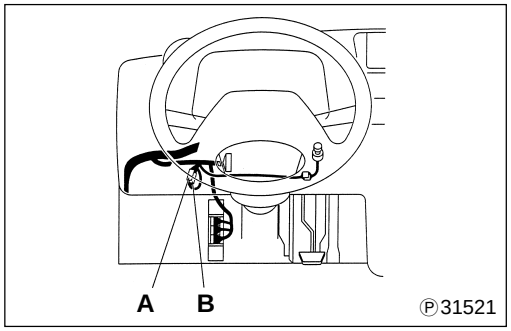
The diagnosis switch is used for the analysis of malfunction, and the memory clear switch allows deletion of stored diagnosis codes.

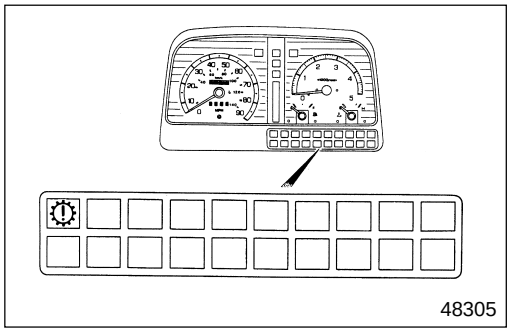
● **Recalling diagnosis code** 🕮 P23A-42

- Pull out the diagnosis switch to recall the diagnosis code of the current problem from the electronic control unit's memory.
- Pull out the diagnosis switch and memory clear switch to recall the diagnosis codes of the current and past problems from the electronic control unit's memory.

● **Deleting diagnosis codes** 🕮 P23A-43

Pull out and reinsert the memory clear switch to delete the diagnosis codes stored in the electronic control unit's memory.





● **Procedure for recalling diagnosis codes**

[Current diagnosis code]

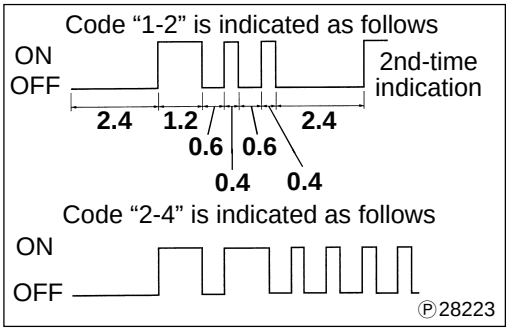
- Turn on the starter switch.
- Remove diagnosis switch **A** (plug connector). The warning lamp begins flashing. The flashing pattern indicates a diagnosis code. Check the code list to locate the problem location. 🕮 P23A-44

[Current and past diagnosis codes]

- Turn on the starter switch.
- Remove diagnosis switch **A** (plug connector) and memory clear switch **B** (1-pin connector). The warning lamp begins flashing to indicate diagnosis codes.
- The warning lamp indicates the diagnosis codes of past malfunctions and the diagnosis code of the current problem, if any.

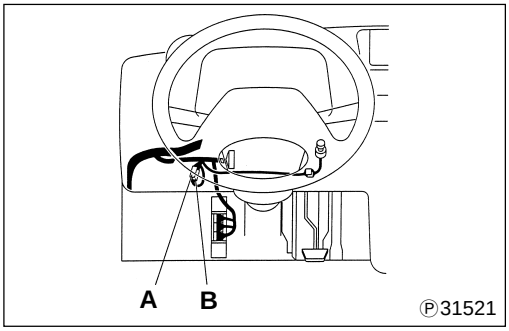
CAUTION ⚠

If diagnosis switch A is connected first, diagnosis codes in the electronic control unit's memory are deleted, and a "01" (normal) code is indicated.



● **Procedure for reading diagnosis codes**

- The automatic transmission electronic control unit’s memory is stored with the data of all malfunctions that occurred after the previous self-diagnosis operation.
- The warning lamp turns off for 2.4 seconds after the self-diagnosis operation starts, then indicates a code.
  - The tens digit is indicated by 1.2-second ON operation and 0.6-second OFF operation.
  - The ones digit is indicated by 0.4-second ON operation and 0.6-second OFF operation.
  - The lamp remains OFF for 2.4 seconds between codes.
- If there are two or more malfunction codes in the memory, they are output in an order from the smallest code number. Each malfunction code is indicated three times before the following code is output.
- After all malfunction codes in the memory are output, the indication process repeats from the beginning.



● **Procedure for deleting diagnosis codes**

- Keep diagnosis switch **A** (plug connector) connected.
- Turn on the starter switch.
- Disconnect memory clear switch **B** (1-pin connector). After more than one second, connect the memory clear switch. When the memory clear switch remains connected for more than three seconds, diagnosis codes in the electronic control unit are deleted.

● **Diagnosis Code Chart**

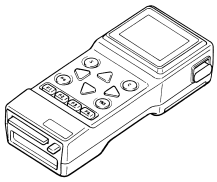
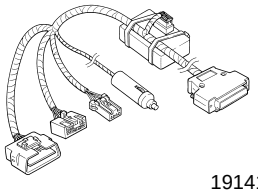
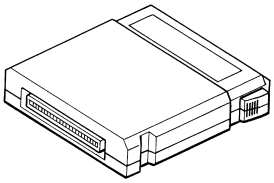
Diagnosis code	Problem location	Judgement criterion	Fail-safe measure
1	Normal		
11	Power supply voltage	Power supply voltage remains below 7.5 V for 1 second or longer with range selector in a position other than P or N range.	
12	Vehicle speed sensor 1	• Vehicle speed sensor 1 indicates sudden speed decrease.	• Maintains the gear selected immediately before malfunction. • Turns off shift solenoids 1, 2 when engine speed sensor detects a value or less than 1000 rpm.
13	Oil temperature sensor	When oil temperature of more than 135°C {275°F} or lower than -50°C{-58°F} is detected. Note that Multi-Use Tester II display is fixed at "40°C {104°F}" after fail-safe judgement result.	Maximum oil temperature
15	Engine speed sensor	Engine speed sensor detects a value of less than 300 rpm when range selector is in a position other than P or N range and when output shaft rotating speed is 1000 rpm or higher.	Prohibits 2-3 shift timing control.
24	Accelerator sensor	• When accelerator sensor signal input to engine Electronic Control Unit is faulty	• Shift-point is set at 0% throttle opening. • Prohibits 2-3 shift timing control. • Executes controls assuming that throttle pressure is at maximum. • Prohibits lock-up control (lock-up solenoid OFF) except during driving at high speeds.
25	Vehicle speed sensor 2	• Vehicle speed sensor 2 indicates sudden speed decrease.	• Maintains the gear selected immediately before malfunction detection. • Turns off shift solenoids 1, 2 when engine speed sensor detects a value of less than 1000 rpm.
31	Shift solenoid 1	• When solenoid output short-circuit occurs while solenoid is receiving current. • When solenoid output disconnection occurs while solenoid is not receiving current.	• Turns off malfunctioning shift solenoid. • Turns off lock-up solenoid and timing solenoid. • Refer to the chart on P23A-54 for gear selection.
32	Shift solenoid 2	• When solenoid output short-circuit occurs while solenoid is receiving current. • When solenoid output disconnection occurs while solenoid is not receiving current.	• Turns off malfunctioning shift solenoid. • Turns off lock-up solenoid and timing solenoid. • Refer to the chart on P23A-54 for gear selection.
34	Line pressure solenoid	When wire breakage or short-circuit occurs.	Turns off line pressure solenoid.
35	Lock-up solenoid	• When solenoid output short-circuit occurs while solenoid is receiving current. • When solenoid output disconnection occurs while solenoid is not receiving current.	Turns off lock-up solenoid.

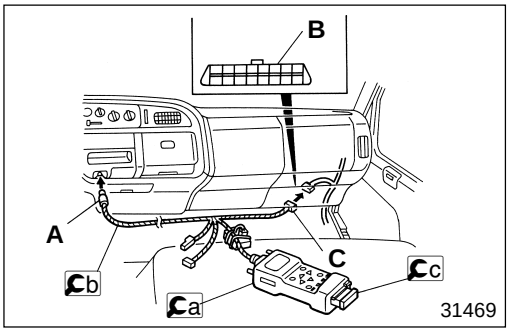
● **Diagnosis Code Chart**

Diagnosis code	Problem location	Judgement criterion	Fail-safe measure
43	Inhibitor switch	• No signal	Operates as D range and prohibits shifting to 4th gear.
		• Two or more signals	• Control function activates based on priority order of L > R > 2 > D > N (P). • Refer to P23A-54 for actual vehicle operation conditions.
50	PTO solenoid	When solenoid output short-circuit occurs while solenoid is receiving current.	Turns off PTO solenoid.
		When solenoid output is cut off while solenoid is not receiving current.	
51	Timing solenoid	• When solenoid output short-circuit occurs while solenoid is receiving current.	Turns off timing solenoid.
		• When solenoid output disconnection occurs while solenoid is not receiving current.	
54	Exhaust brake cut-off signal	Exhaust brake activates when exhaust brake cut-off signal is generated.	• Prohibits exhaust brake cut-off control • Allows lock-up only at high cruising speed.

Procedure for servicing with Multi-Use Tester II (MUT-II)

Special tools

Location	Tool name and shape	Part No.	Application
—	Multi-Use Tester II (MUT-II)  19492	MB991496	System inspection
—	Multi-Use Tester II (MUT-II) harness  19141	MK327601	
—	ROM (Read only memory) pack (MRT-E10)  19493	MH062867	



● **Connecting the MUT-II**

- Turn the starter switch to the LOCK position.
- Connect the b MUT-II Communication Harness to the a MUT-II, and insert the c ROM Pack.
- Plug connector **A** into the cigarette lighter socket.
- Fit connector **C** onto MUT-II connector **B** (16-pin) in the relay box.

NOTE

Instructions for operation of the MUT-II are given in the separate MUT-II Reference Manual.

● **Inspection using MUT-II**

①The MUT-II indicates diagnosis codes that provide information of malfunctioning items (devices that require inspection).

②The MUT-II indicates sensor signal conditions with numerical values (service data). Comparison of the service data with judgement criteria allows evaluation of the transmission operation. Diagnosis codes and service data codes can be effectively used for troubleshooting.

①		②				
Indicated by MUT-II		Indicated by MUT-II			Inspection procedure	
Diagno-sis code	Malfunctioning item (devices that require inspection)	Service data code	Signal name	Service data	Inspection condition	Judgement criterion
11	POWER VOLTAGE					
12	VEH SPD SNSR 1	12	VEH SPEED 1	□□□.□ MPH	Vehicle stationary in position	0 mph
					Vehicle in operation	Correspond with speedometer
13	OIL TEMPSNSR	13	A/T OIL TEMP	□□□□.°F	When engine is cold	Equivalent to outside air temperature
					When engine is in warm-up operation	Gradual increase
					Non-operating engine after warm-up operation	Gradual decrease
15	ENG SPD SNSR	15	ENGINE SPEED	□□□□. RPM	Idle after warm-up operation	650±25 rpm
					Racing	Corresponds with tachometer
		19	P POS. SW		Selector in P range	ON
					Selector in position other than P range	OFF
		20	R POS. SW		Selector in R range	ON
					Selector in position other than R range	OFF
		21	N POS. SW		Selector in N range	ON
					Selector in position other than N range	OFF
		22	D POS. SW		Selector in D range	ON
					Selector in position other than D range	OFF
24	ACCEL SNSR	24	ACCEL PERCENT	□□□.%	Release	0%
					Gradual pressing	Increases continuously
					Full throttle	100%
25	VEH SPD SNSR 2	25	VEH SPEED 2	□□□.□ MPH	Vehicle stationary in position	0 mph
					Vehicle in operation	Correspond with speedometer
		26	2 POS. SW		Selector in 2 range	ON
					Selector in position other than 2 range	OFF
		27	L POS. SW		Selector in L range	ON
					Selector in position other than L range	OFF
		28	OD-OFF SW		Overdrive OFF SW ON	ON
					Overdrive OFF SW OFF	OFF
		29	POWER S/W		In power mode	ON
					In economy mode	OFF
31	SHIFT VALVE 1	31	SHIFT VALVE 1		Driving in 1st and 2nd gears	ON
					Driving in 3rd and 4th gears	OFF

①		②				
Indicated by MUT-II		Indicated by MUT-II			Inspection procedure	
Diagno -sis code	Malfunctioning item (devices that require inspection)	Service data code	Signal name	Service data	Inspection condition	Judgement criterion
32	SHIFT VALVE 2	32	SHIFT VALVE 2		Driving in 2nd and 3rd gears	ON
					Driving in 1st and 4th gears	OFF
34	LINE PRESS. V	34	LINE PRESS	□□□.□ lbf/in^2	Idle	According to line pressure chart
					Stall	
35	LOCK UP VALVE	35	LOCK UP VALVE		Driving with consistent throttle opening	Turns ON according to lock-up vehicle speed chart during road test. 🕮 P23A-56
					Vehicle stationary in D range	OFF
		36	OIL TEMP SW		Abnormal oil temperature (ATF temperature lamp ON)	ON
					Normal oil temperature (ATF temperature lamp OFF)	OFF
		37	BRAKE SW		Brake pedal pressed	ON
					Brake not applied	OFF
		38	EXH. BRAKE SW		Exhaust brake activation during driving	ON
					Exhaust brake inactive	OFF
43	INHIBIT SIG.					
		47	ABS SW		ABS activation	ON
					ABS inactive	OFF
		48	M CLEAR SW		Connector disconnected	OPEN
					Connector in connection	CLOSE
		49	DIAGNOSIS SW		Plug connector disconnected	OPEN
					Plug connector in connection	CLOSE
50	PTO VALVE	50	PTO VALVE		PTO operation	ON
					PTO non-operation	OFF
51	TIMING VALVE	51	TIMING VALVE		2→3 shifting when accelerator pedal is released	ON
					Vehicle stationary in position	OFF
		53	DIAG LAMP		System malfunction (warming lamp ON)	ON
					System normal (warning lamp OFF)	OFF
54	EXB CUT SIG.	54	EXB CUT SIG.		Exhaust brake activation during driving	OFF
					Stopping using exhaust brake	OFF→ ON
		55	SELECTOR POS.	□·RANGE	Operate range selector from P to L in order.	Changes as follows: P→R→N→D→2→L
		56	GEAR POS.	1ST 2ND 3RD 4TH	Driving at constant speed Accelerating gradually from 0 km/h	According to lock-up vehicle speed chart during road test. 🕮 P23A-56 (1ST → 2ND → 3RD → 4TH)
				N	Selector in N range	N
				REV	Selector in R range	REV
		59	PTO SW		PTO SW ON	ON
					PTO SW OFF	OFF

M E M O

Symptoms and problems

Malfunction / Suspected problem factor	Abnormal movement						Abnormal shift operation												
	Vehicle runs in N range	Parking position is still engaged when selector is moved from P range	Vehicle moves in P range	Vehicle does not move in any range	Vehicle does not move in R range	Vehicle does not move in D, 2 or L range	Lock-up point extremely high or low	Does not lock up	No engine brake in 2 range	No engine brake in L range	Kick-down does not operate	Shift point extremely high or low	Engine revs up in 2-3 shift	Does not shift down from 2nd to 1st	Does not shift down from 3rd to 2nd	Does not shift down from 4th to 3rd	Does not shift up from 3rd to 4th	Does not shift up from 2nd to 3rd	Does not shift up from 1st to 2nd
Automatic transmission fluid level and condition				○															
Control linkage	○	○	○	○														○	○
Inhibitor switch																	○	○	○
Accelerator sensor							○	○			○	○	○						
Vehicle speed sensor							○				○	○		○	○	○	○	○	○
Engine speed sensor								○					○						
Engine idle speed																			
Line pressure				○				○											
Shift solenoid 1					○			○	○		○				○			○	
Shift solenoid 2					○			○	○	○	○			○		○	○		○
Timing solenoid													○						
Lock-up solenoid							○	○											
Starter circuit																			
Overdrive OFF switch																	○		
Exhaust brake switch								○											
Automatic transmission fluid temperature sensor								○									○		
Automatic transmission electronic control unit					○		○	○	○	○	○	○	○	○	○	○	○	○	○
Torque converter				○				○											
Automatic transmission unit malfunction	○	○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○

Malfunction / Suspected problem factor	Excess shock during shifting										Slippage						Others			
	During lock-up operation	When shifting from 3rd to 2nd	When shifting from 4th to 3rd	When shifting from 1st to 2nd, to 3rd, to 4th	When shifting from 3rd to 4th	When shifting from 2nd to 3rd	When shifting from 1st to 2nd	When shifting from N to D and from N to R	When shifting from N to D	When shifting from N to R	In 4th gear	In 3rd gear	In 2nd gear	In 1st gear	In reverse gear	In forward and backward	Transmission overheat and oil blow-off from breather	Engine stalls when range selector is moved to R, D, 2 or L, or when vehicle is stationary	Engine starts with range selector in position other than N or P range	Engine cannot be started with range selector in N or P range
Automatic transmission fluid level and condition																○	○			
Control linkage																			○	○
Inhibitor switch																			○	○
Accelerator sensor	○	○	○	○	○	○	○	○			○	○	○	○	○	○	○			
Vehicle speed sensor	○																			
Engine speed sensor						○														
Engine idle speed								○										○		
Line pressure								○								○	○			
Shift solenoid 1																				
Shift solenoid 2																				
Timing solenoid		○				○	○													
Lock-up solenoid																	○	○		
Starter circuit																				○
Overdrive OFF switch																				
Exhaust brake switch																				
Automatic transmission fluid temperature sensor				○																
Automatic transmission electronic control unit		○				○	○										○			
Torque converter	○															○	○	○		
Automatic transmission unit malfunction	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		

Stall Test

● **Purpose**

To check wearing of gears, slippage of one-way clutches, operation of torque converter and overall performance of the engine.

● **Measuring procedure**

Before the test, inspect the engine coolant, engine oil and automatic transmission fluid. Run the engine until the engine coolant temperature reaches an appropriate level. Also conduct a warm-up operation for the automatic transmission and bring the automatic transmission fluid temperature to an appropriate level.

- Place wheel chocks in front and back of all wheels, and apply the parking brake. When operating the accelerator pedal, be sure to press down firmly on the foot brake pedal.
- Shift the range selector lever to the D range.
- Press down on the accelerator pedal gradually to full throttle. When the engine speed stabilizes, quickly read the engine rpm (stall speed) and remove foot from the accelerator pedal.

CAUTION ⚠

- **Limit each measuring operation to five seconds. Extended testing causes automatic transmission fluid degradation and adverse effects to the internal parts.**
- **If the engine speed does not stabilize but continues to increase or suddenly jumps, stop the test immediately.**

- Shift the range selector lever to the N range, and let the engine run at approximately 1200 rpm for one minute or longer for cooling.
- Conduct tests in the same way with the range selector lever in each of the 2, L and R ranges.
- Stall speed : 2070±150 rpm

● **Diagnosis of test result**

Measuring result	Suspected abnormality
Lower than standard value in all ranges	Insufficient engine output power
	Faulty operation of one-way clutch in torque converter
Higher than standard value in D range	Slippage of front clutch
	Faulty operation of No. 2 one-way clutch
	Low line pressure
Higher than standard value in R range	Slippage of rear clutch
	Slippage of 1st and reverse brake
	Low line pressure
Higher than standard value in all range	Low line pressure
	Inappropriate automatic transmission fluid level
	Slippage of overdrive direct clutch
	Faulty operation of overdrive one-way clutch

Time Lag Test

● **Purpose**

To check the conditions of overdrive direct clutch, front clutch, rear clutch and 1st and reverse brake.

● **Measuring procedure**

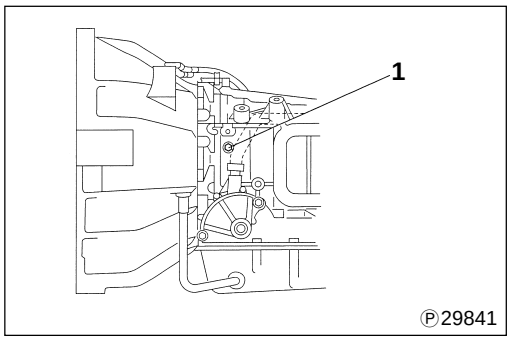
- Bring the oil temperature to normal operating level of between 50 and 80°C {122 and 176°F}.
- Start the engine and check the idle speed.
- Shift the range selector lever from the N range to the D range and use a stopwatch to measure the time it takes for shock to be felt.
- In the same way, measure the time lag by shifting the range selector lever from the N range to the R range.

	Standard value
N→D shifting	0.7 sec or less
N→R shifting	1.2 sec or less

● **Diagnosis of test result**

Measuring result	Suspected abnormality
Large time lag in N→D shift	Low line pressure
	Slippage of front clutch
	Faulty operation of overdrive one-way clutch
Large time lag in N→R shift	Low line pressure
	Slippage of rear clutch
	Slippage of 1st and reverse brake
	Faulty operation of overdrive one-way clutch

Line Pressure Test



● **Purpose**

To check the oil pump capacity, control valve functions and leaks in hydraulic circuit.

● **Measuring procedure**

CAUTION ⚠

The line pressure test requires two persons. One person must observe tire movement and wheel chocks from outside the vehicle, while the other person conducts the test.

- Apply the parking brake firmly.
- Place wheel chocks.
- Remove pressure detecting plug **1**, and mount the oil pressure gauge.
- Start the engine, and operate it until the automatic transmission fluid temperature reaches between 50 and 80°C {122 and 176°F}. Then, check the idle speed.
- While pressing the brake pedal firmly with the left foot, shift the range selector lever to the D range and measure the oil pressure while the engine is idling.
- Press the accelerator pedal all the way, and quickly measure the oil pressure at stall speed.

CAUTION ⚠

If the engine RPM do not reach stall speed and the rear wheels start rotating, release the accelerator pedal and stop the test.

- Measure the oil pressure with the range selector lever in the R range by following the above procedure.
- After the measurement, re-install pressure detecting plug **1** and tighten to the specified torque.

Pressure detecting plug	Bolt size	1/2-20UNF
	Tightening torque	7.5 N·m {5.5 ft.lbs, 0.76 kgf·m}

● **Line pressure** kPa {psi, kgf/cm^2}

Idle oil pressure	D range	529 to 784 {77 to 115, 5.4 to 8.0}
	R range	755 to 1127 {110 to 165, 7.7 to 11.5}
Stall oil pressure	D range	990 to 1480 {145 to 215, 10.1 to 15.1}
	R range	1401 to 2107 {205 to 305, 14.3 to 21.5}

● **Diagnosis of test result**

Measuring result	Suspected abnormality
Higher than standard value in all ranges	Faulty adjustment of throttle cable
	Sticking of regulator valve
	Sticking of throttle valve
Lower than standard value in all ranges	Faulty adjustment of throttle cable
	Sticking of regulator valve
	Sticking of throttle valve
	Excessive wear of oil pump
	Faulty overdrive direct clutch
Lower than standard value only in D range	Oil leak in D range system
	Faulty front clutch
Lower than standard value only in R range	Oil leak in R range system
	Faulty rear clutch
	Faulty 1st and reverse brake

ON-VEHICLE INSPECTION AND ADJUSTMENT

Road Test

● **Measuring procedure**

Before the road test, check the level and condition of the automatic transmission fluid. Also make sure that the range selector cable and the accelerator control cable are properly adjusted.
Operate the automatic transmission in every range position during the road test and check slippage and other operating conditions during shifting of gears.
Check to see if the shift feels too tight or too loose.
Check the shift points of up-shifting and downshifting.
Check shift-point vehicle speeds under various driving conditions.

● **Shift-point vehicle speeds**

Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	D1→D2	6.8 to 9.3 {4.2 to 5.8}
	D2→D3	20.1 to 22.7 {12.5 to 14.1}
	D3→D4	37.4 to 39.9 {23.2 to 24.8}
Full throttle	D1→D2	19.4 to 21.9 {12.0 to 13.6}
	D2→D3	41.5 to 44.1 {25.8 to 27.4}
	D3→D4	73.0 to 78.0 {45.4 to 48.5}
Closed throttle	D1→D2	5.0 to 7.6 {3.1 to 4.7}
	D2→D3	5.0 to 7.6 {3.1 to 4.7}
	D3→D4	27.2 to 29.7 {16.9 to 18.5}

● **Lock-up vehicle speeds**

Unit : km/h {mph}

Throttle opening	Shifting	Vehicle speed
Half throttle	2nd gear ON	34.0 to 36.5 {21.1 to 22.7}
	3rd gear ON	45.1 to 47.6 {28.0 to 29.6}
	4th gear ON	54.5 to 57.0 {33.9 to 35.4}
Full throttle	2nd gear ON	44.1 to 46.6 {27.4 to 28.9}
	3rd gear ON	45.1 to 47.6 {28.0 to 29.6}
	4th gear ON	73.0 to 78.0 {45.4 to 48.5}
Closed throttle	2nd gear OFF	34.0 to 36.5 {21.1 to 22.7}
	3rd gear OFF	44.1 to 46.6 {27.4 to 28.9}
	4th gear OFF	45.6 to 48.1 {28.3 to 29.9}

The above standard values are based on the following conditions.
- 5.571 differential gear ratio, 0.372 m {1.22 ft.} tire radius (215/75R17.5)

If the differential gear ratio and/or the tire radius are different from the above, proper standard values must be calculated based on the ratios of the differences and the above figures.

Inspection of Automatic Transmission Fluid (ATF)

If the automatic transmission has insufficient ATF, the pump draws air together with ATF. Air bubbles mixed in the ATF cause a “sponge” effect and lower the pressure. This can cause slipping of internal clutches.
On the other hand, if the ATF level is too high, excess air bubbles also result when rotating parts agitate the ATF, thus causing the same effect as when the ATF level is low.
In both cases, excess air bubbles lead to overheat, oxidation of oil and varnish generation, thereby hindering proper operation of the valves and clutches.
Excess air bubbles in the ATF also cause ATF to overflow from the vent hole and filler tube, which may be mistakenly diagnosed as an ATF leak.
To prevent these problems, read the ATF level accurately by following the procedure described below.

(1) Inspection of ATF condition

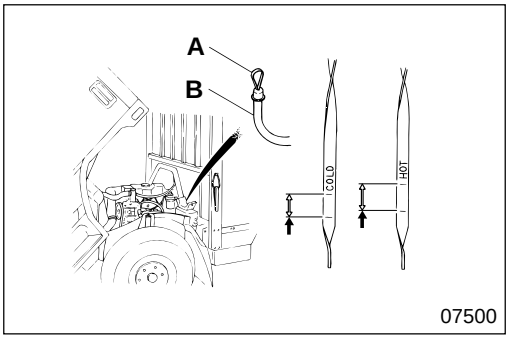
If ATF has a burned odor and contains metal shavings or particles, the automatic transmission needs an overhaul. Closely inspect the ATF adhered on level gauge **A**.
If ATF is suspected to be in poor condition, take out a sample and inspect closely.

(2) Inspection of ATF level

CAUTION

- **Inspection is conducted while the engine is running. Be careful of moving parts and hot areas to prevent personal injuries and burns.**
- **Before inspection, check the idle speed.**
- **Place the vehicle on level ground.**
- **Bring the transmission to normal operating temperature (70 to 80°C {158 to 176°F}) before inspection.**
- **Before pulling out level gauge A, clean the protective cap and the upper part of the filler tube B.**

- Apply the parking brake firmly, and place wheel chocks.
- With the engine idling, press down on the brake pedal and shift the range selector lever slowly from the P range to the L range, stopping at each position in between. Then return the range selector lever to the P range.
- With the engine idling, pull out level gauge **A**. Wipe the ATF from the level gauge and blow compressed air to remove lint and other particles. Insert the level gauge, and pull it out. Check to make sure that the ATF level is in the range marked “HOT.”

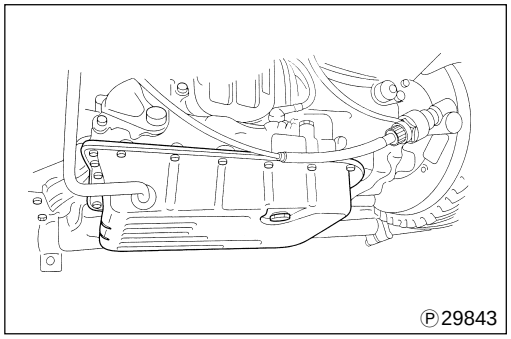


CAUTION

- **If the ATF temperature is low (20 to 30°C {68 to 86°F}), such as after an ATF change, bring the ATF level to the area on the level gauge marked “COLD.” Then, after the transmission temperature rises to normal operating level (70 to 80°C {158 to 176°F}), check to make sure that the ATF level is in the area on the level gauge marked “HOT.”**
- **If the markings on the front and back sides of the level gauge show different level indications, use the line that indicates the lower ATF level.**

- If the ATF level is low, add ATF from the filler tube **B** to the specified level on level gauge **A**.

Changing Automatic Transmission Fluid (ATF)



(1) Drain

- Place an ATF receiving tray under the automatic transmission oil pan. Remove the drain plug located at the back side of the pan to drain ATF.
  Tightening torque: 27 N·m {20 ft.lbs, 2.8 kgf·m}

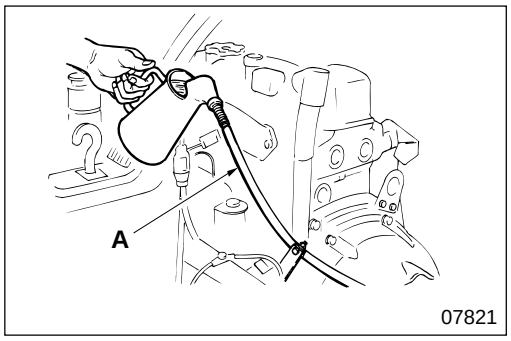
CAUTION ⚠

- **ATF is very hot immediately after the engine is turned off. Wait until the ATF temperature lowers sufficiently.**
- **For faster ATF drainage, warm up the engine.**
- **ATF in the hydraulic circuit, torque converter and oil cooler cannot be drained in the above process.**
- **Inspect the drained ATF for dirtiness and contamination such as metal shavings and particles.**

- After the above process, approximately 1 L {1.1 qts} of ATF remains in the oil pan. If you wish to drain this remaining ATF, remove the oil pan. 🕮 P23A-80

Amount of drained ATF

ATF drained by removing oil pan : Approximately 4.5 L {4.8 qts}
ATF drained by removing drain plug : Approximately 3.5 L {3.7 qts}



(2) Adding ATF

- Prepare new ATF.
- Re-install the oil pan drain plug and gasket.
- From filler tube **A**, add the same amount of ATF as drained.

CAUTION ⚠

Be careful not to let dust and other particles mix with ATF.

- Start the engine and let it idle for at least two minutes.
- Shift the range selector lever into every position, then back to the P range.

CAUTION ⚠

Do not rev up the engine in the above process.

- Check the ATF level. 🕮 P23A-57

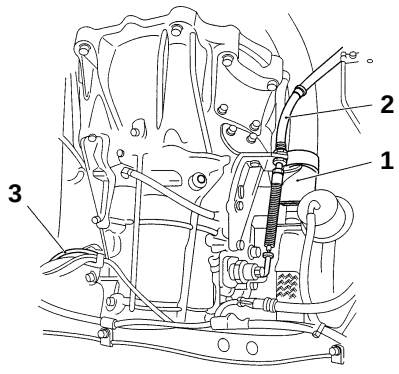
(3) ATF leaks

- Torque converter housing of the automatic transmission unit
- Check for leaking locations
  Since the torque converter and the surrounding area can be soiled with oil that leaks from the engine, inspect those areas carefully.
  ATF is red, so that it can be easily distinguished from engine oil.
- Before dismounting the automatic transmission, carefully examine if ATF leaks from the torque converter or the automatic transmission unit (oil seal of oil pump housing or connection of oil pump housing and case).

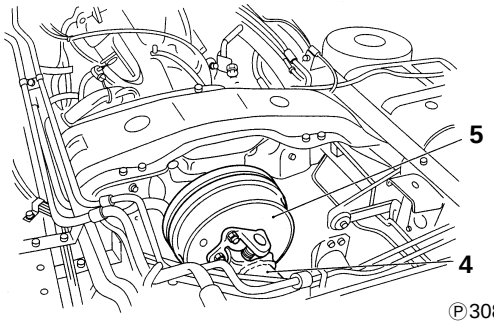
M E M O

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY

Preparation



Ⓟ31515



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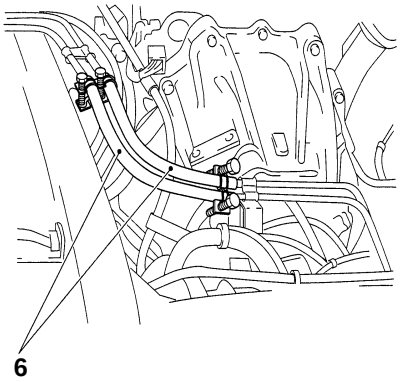

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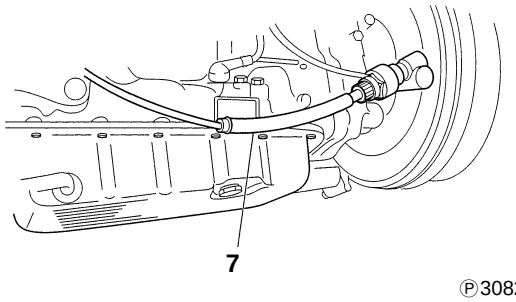


Ⓟ30822

● **Removal sequence**

1 Exhaust pipe Gr 15A
2 Selector cable P23A-75
3 Electrical harness
4 Propeller shaft Gr 25
5 Parking brake Gr 36
6 Oil cooler hose P23A-66
7 Speedometer cable

CAUTION

After removing propeller shaft 5, suspend the shaft at the same height as the installation position by securing it to the frame with a rope.

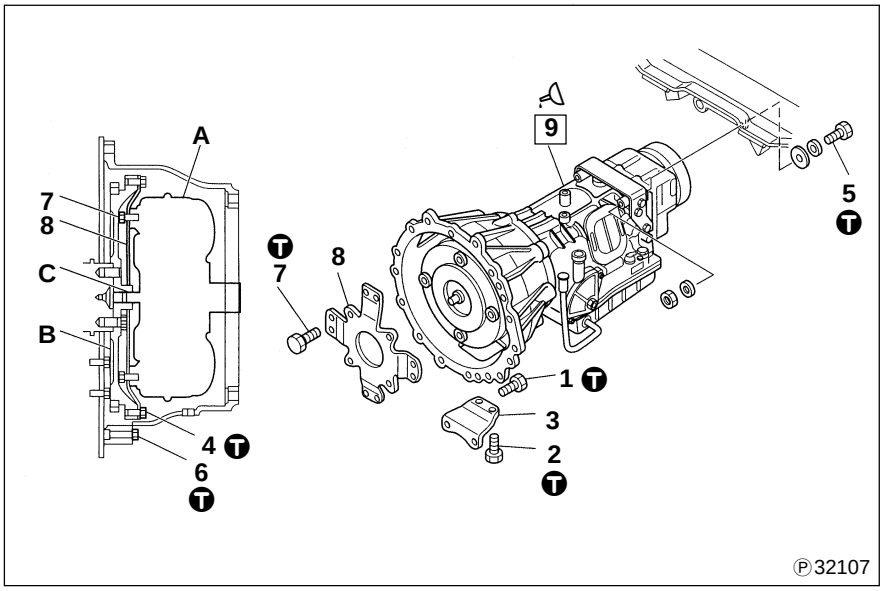
● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

If the automatic transmission unit is replaced due to a malfunction and if the automatic transmission fluid contains a large amount of impurities, conduct flushing of the oil cooler system. P23A-66

Removal



● **Removal sequence**

1 Bolt
2 Bolt
3 Dust cover
4 Bolt (8)
5 Bolt
6 Bolt
7 Bolt (4)
8 Drive plate
9 Automatic transmission assembly

A: Torque converter
B: Flywheel
C: Pilot section

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

Remove the automatic transmission assembly with drive plate 8 attached to torque converter A.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

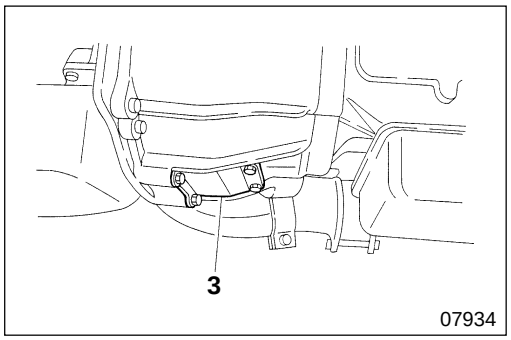
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Automatic transmission assembly mounting and dust cover mounting)	47 {35, 4.8}	—
2	Bolt (Dust cover mounting)	13 {9.4, 1.3}	—
4	Bolt (Flywheel and drive plate coupling)	32 {24, 3.3}	—
5	Bolt (Rear mounting)	83 to 105 {61 to 80, 8.5 to 11}	—
6	Bolt (Automatic transmission assembly mounting)	82 {61, 8.4}	M12
		47 {35, 4.8}	M10
	Bolt (Bracket mounting)	40 {30, 4.1}	—
7	Bolt (Drive plate mounting)	79±12 {59±8.7, 8.1±1.2}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
9	Pilot section C on torque converter A in automatic transmission assembly	Molybdenum disultide grease [NLGI No.2 (Li soap)]	As required

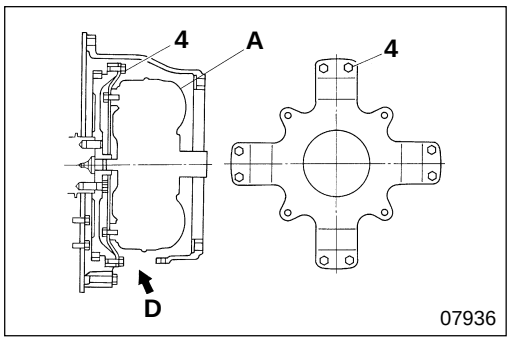
◆ Service procedure

9 Automatic transmission assembly

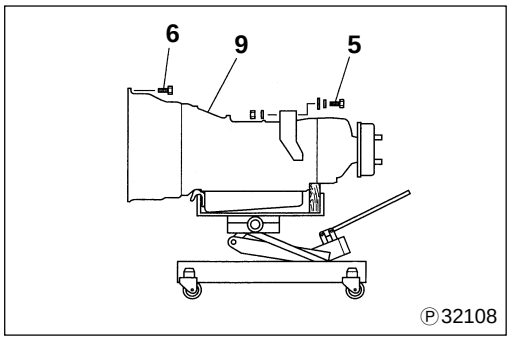


[Removal]

- Remove dust cover **3**.



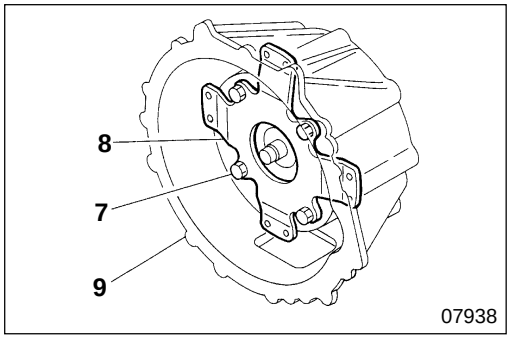
- Turn the engine so that bolt **4** is positioned at service window **D**.
- Remove eight bolts **4**. Remove two bolts at each of the four locations by turning the engine and stopping at the proper position.



- Support automatic transmission assembly **9** with a jack, then remove automatic transmission assembly mounting bolts **5**, **6**.
- Remove automatic transmission assembly **9** by pulling towards the back of the vehicle.

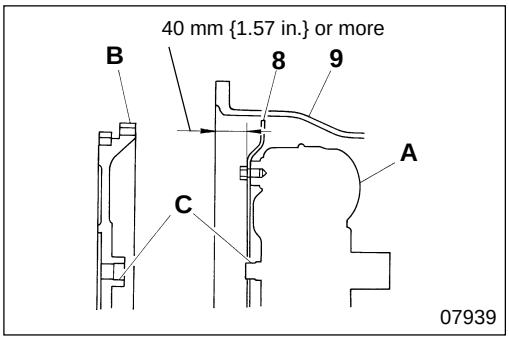
CAUTION ⚠

- **Do not support the automatic transmission by the oil pan, since it causes shape deformation of the oil pan and oil pan gasket.**
- **Since torque converter A can easily separate from the automatic transmission assembly, be careful not to drop the torque converter.**
- **Mounting bolts 6 are different in length. Record the length of each bolt when removing, so that bolts can be re-installed in the original locations.**

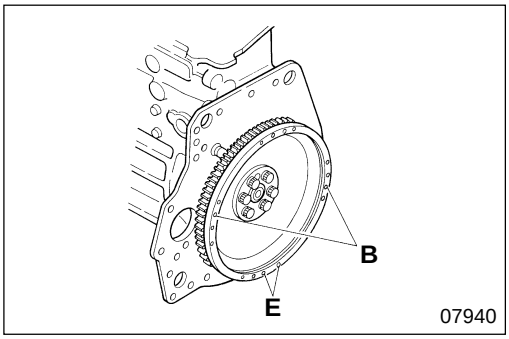


[Installation]

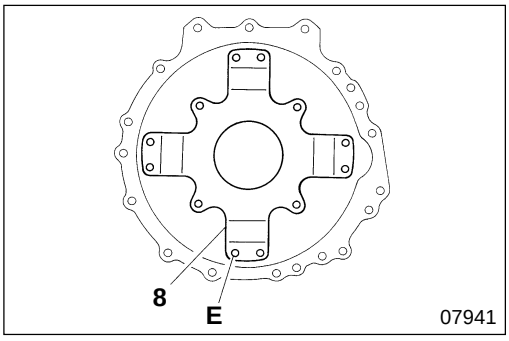
- Install drive plate **8** to torque converter **A** before installing the torque converter into automatic transmission assembly **9**.
  Tighten bolts **7** to the specified torque.



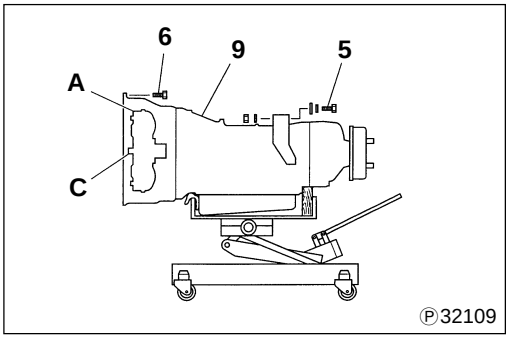
- Check to make sure that torque converter **A** is properly mounted in automatic transmission assembly **9**.
  When the torque converter is properly installed, the distance between the surface of drive plate **8** and the case mounting surface is as indicated in the diagram.
- Apply grease on pilot sections **C** of flywheel **B** and torque converter **A**.



- Turn flywheel **B** so that one of bolt holes **E** on the flywheel is located at the lowest position. Bolt holes are used to connect drive plate **8** to the flywheel.



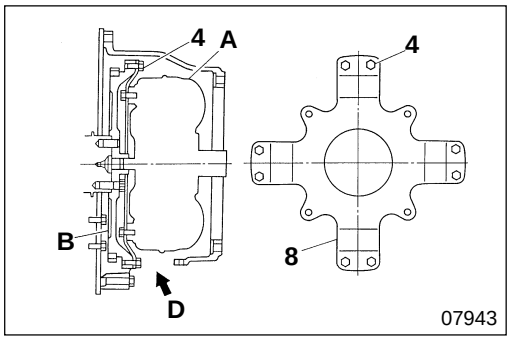
- Turn drive plate **8** so that one of bolt holes **E** is located at the lowest position.



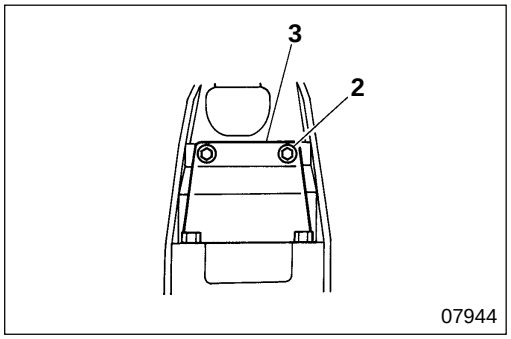
- Install automatic transmission assembly **9** into position slowly and carefully while aligning pilot section **C** and the dowel pin of the rear plate.
- Tighten several mounting bolts **6** on automatic transmission assembly **9** for temporary holding. Tighten bolts **5** to the specified torque to mount the automatic transmission assembly to the rear support.

CAUTION ⚠

- **Torque converter A can easily separate from the automatic transmission assembly 9. To keep the torque converter in place, set the back side of automatic transmission assembly slightly lower than the front part.**
- **Before mounting the automatic transmission assembly 9, wipe oil adhered on the internal wall of the torque converter housing.**



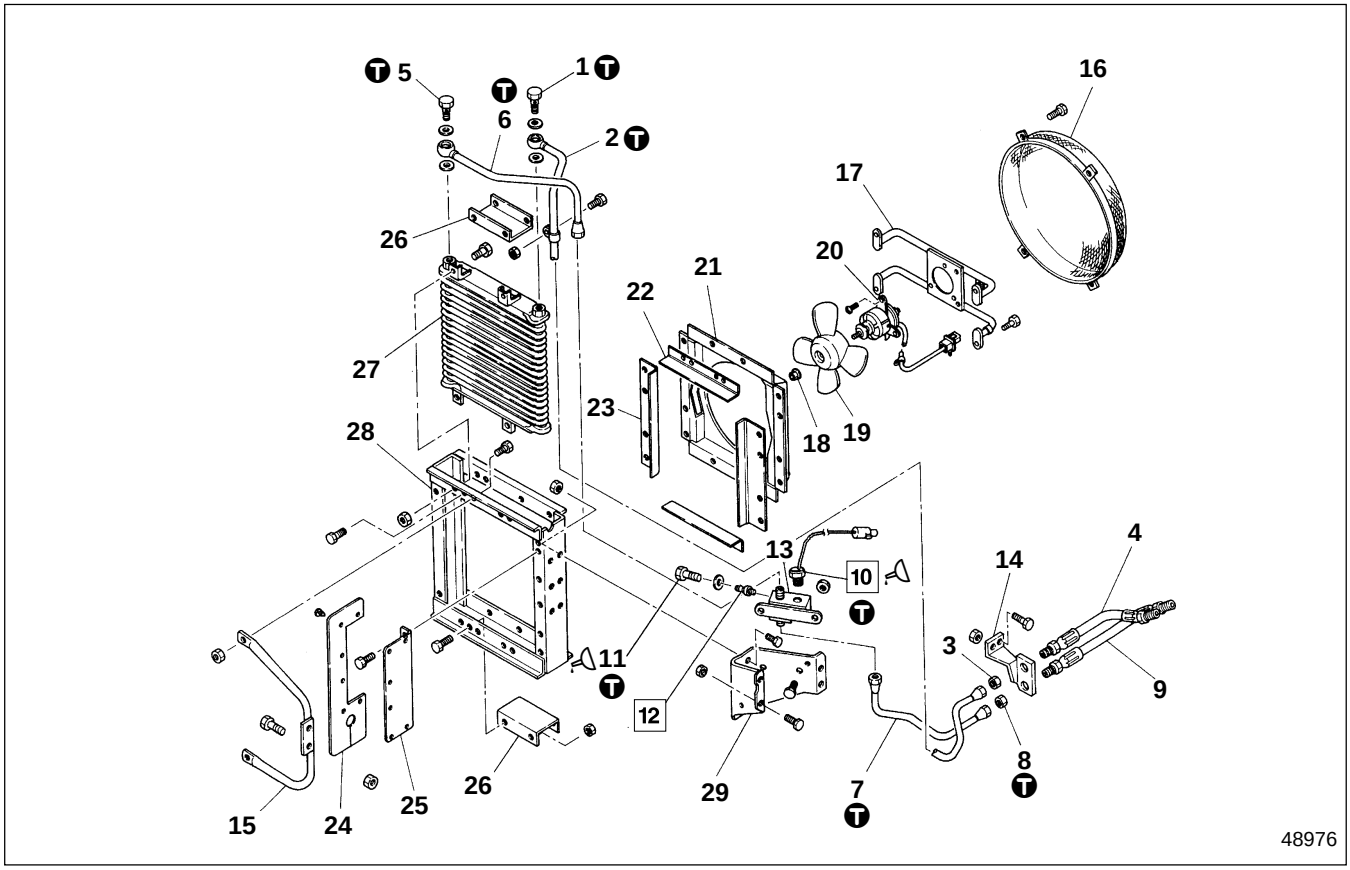
- Align the bolt holes of drive plate **8** and flywheel **B** by looking through service hole **D**, and mount bolts **4**.
- Temporarily tighten all eight bolts, two bolts at each of the four locations, by turning the engine and stopping at the proper position. Then, repeat the same process, and tighten the bolts to the specified torque.



- Tighten all automatic transmission assembly mounting bolts **6** to the specified torque.
- Tighten bolts **2** to the specified torque to secure dust cover **3** in place.

M E M O

OIL COOLER



● **Removal sequence**

1 Eye bolt
2 Oil pipe
3 Nut
4 Oil hose
5 Eye bolt
6 Oil pipe
7 Oil pipe
8 Nut
9 Oil hose
10 Automatic transmission fluid thermostat switch
11 Plug
12 Thermostat valve
13 Connector
14 Hose bracket
15 Oil cooler stay
16 Fan cover
17 Fan motor bracket
18 Nut
19 Fan assembly
20 Motor assembly Gr 54
21 Fan shroud
22 Fan shroud A
23 Fan shroud B
24 Baffle plate
25 Baffle plate bracket
26 Stay
27 Oil cooler
28 Oil cooler bracket
29 Oil cooler support

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
10	Operating temperature of automatic transmission fluid thermostat switch	When rising (OFF→ON)	97±3°C {207±5.4°F}	—	Replace
		When falling (ON→OFF)	90°C {194°F} MIN		
12	Thermostat valve	Starting operation temperature	76.5±3°C {170±5.4°F}	—	Replace
		Bypass opening temperature	83±2°C {181±3.6°F}	—	Replace

Tightening torque

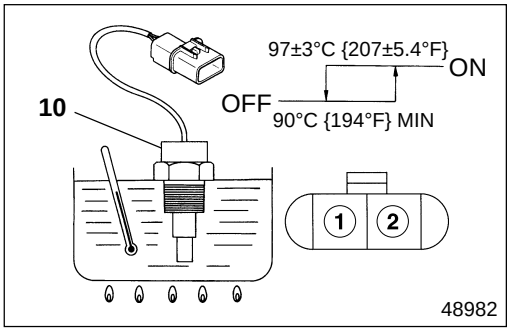
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 5	Eye bolt	2.94 to 34.3 {22 to 25, 3 to 3.5}	—
2, 6, 7	Oil pipe	29 to 30 {22 to 29, 3 to 4}	—
10	Automatic transmission fluid thermostat switch	29 to 39 {22 to 29, 3 to 4}	—
11	Plug	147 to 186 {110 to 139, 15 to 19}	—
17	Nut (Fan assembly mounting)	4.2 to 5.2 {3.1 to 3.8, 0.43 to 0.53}	—

Sealant

Location	Points of application	Specified sealant	Quantity
10	Automatic transmission fluid thermostat switch	THREEBOND 1110B	As required
11	Thread area of plug	THREEBOND 1110B	As required

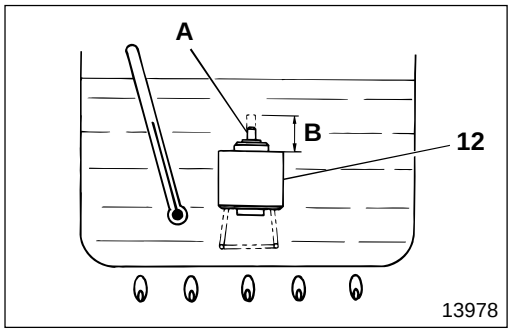
◆ Service procedure



10 **Inspection of automatic transmission fluid thermostat switch**

Carry out the following inspection and replace automatic transmission fluid thermostat switch **10** if there are any faults.

- Check that there is no continuity between terminals ① and ② at ambient temperature of 20±5°C {68±9°F}.
- Place automatic transmission fluid thermostat switch **10** in a container filled with automatic transmission fluid, and raise the temperature while stirring well.
  Measure the temperature when continuity has been achieved between terminals ① and ②, and check that the measured value conforms to the standard value.
- Lower and measure the temperature when continuity is lost between terminals ① and ②, and check that the measured value conforms to the standard value.



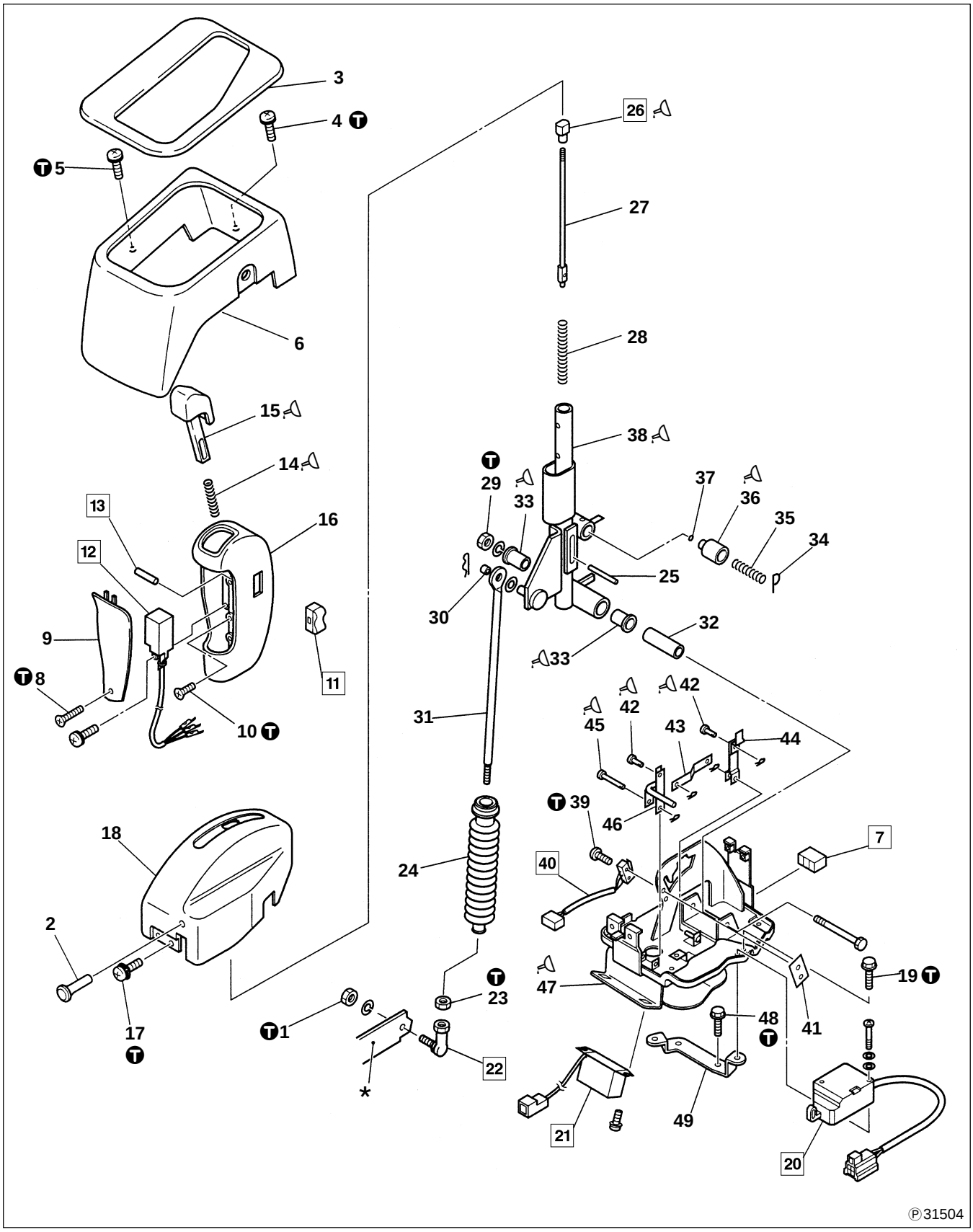
12 **Inspection of thermostat valve**

Carry out the following inspection. If any fault is found, replace thermostat valve **12**.

- Place thermostat valve **12** in a container filled with automatic transmission fluid and raise the fluid temperature while stirring the fluid.
  Make sure that end **A** starts stroking at a temperature of 76.5±3°C {170±5.4°F}.
- Raise the fluid temperature further and make sure that end **A** expands by 4.5 mm {1.18 in.} and dimension **B** in the illustration is 13.4 mm {0.53 in.} at a temperature of 83±2°C {181±3.6°F}.

AUTOMATIC TRANSMISSION CONTROL

Range Selector Lever



● **Disassembly sequence**

1 Nut
2 Shift lock release knob
3 Adapter
4 Screw
5 Screw
6 Range selector lever cover
7 Connector
8 Screw
9 Cover
10 Screw
11 Switch button
12 Overdrive OFF switch
13 Pin
14 Spring
15 Shift button
16 Automatic transmission knob
17 Screw
18 Indicator panel
19 Bolt
20 Shift lock actuator
21 Automatic transmission reverse buzzer
22 Ball joint
23 Lock nut
24 Grommet
25 Pin
26 Sleeve
27 Rod
28 Spring
29 Nut
30 Bushing
31 Rod
32 Pipe
33 Bushing
34 Pin
35 Ball spring
36 Ball support
37 Steel ball
38 Selector lever
39 Screw
40 P-range switch
41 Plate
42 Clevis pin
43 Shift lock link
44 Shift lock link
45 Clevis pin
46 Shift lock link
47 Lever bracket
48 Bolt
49 Base plate

***** : Lever assembly P23A-73

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

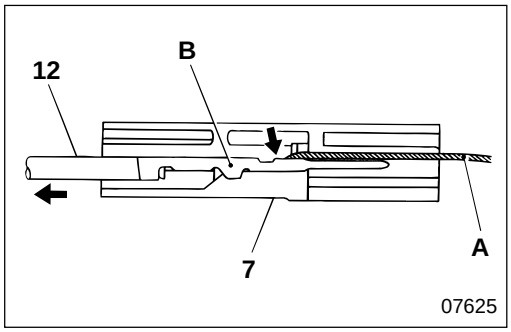
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Lever assembly mounting)	17 to 22 {12 to 16, 1.7 to 2.2}	—
4	Screw (Range selector lever cover mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
5	Screw (Range selector lever cover mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
8	Screw (Cover mounting)	2.0 {1.4, 0.2}	—
10	Screw (Automatic transmission knob mounting)	2.0 {1.4, 0.2}	—
17	Screw (Indicator panel mounting)	1 to 2 {0.7 to 1.4, 0.1 to 0.2}	—
19	Bolt (Lever bracket mounting)	9.8 to 15.0 {7.2 to 11.0, 1.0 to 1.5}	—
23	Lock nut (Ball joint mounting)	16 to 24 {12 to 17, 1.6 to 2.4}	—
29	Nut (Lever mounting)	9.8 to 14.0 {7.2 to 10.0, 1.0 to 1.4}	—
39	Screw (P-range switch mounting)	0.2 to 0.3 {0.1 to 0.2, 0.02 to 0.03}	—
48	Bolt (Base plate mounting)	9.8 to 15.0 {7.2 to 11.0, 1.0 to 1.5}	—

Lubricant

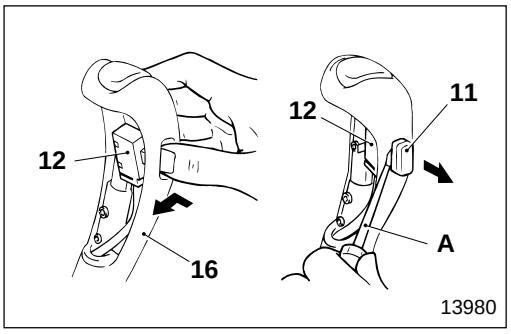
Location	Points of application	Specified lubricant	Quantity
14	Outside surface of spring	Multipurpose grease [NLGI No.2 (Li soap)]	As required
15	Sliding area of shift button	Multipurpose grease [NLGI No.2 (Li soap)]	As required
26	Sliding area of sleeve	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
33	Interior of bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required
36	Sliding area of ball support	Chassis grease [NLGI No.1 (Ca soap)]	As required
38	Sliding area of selector lever	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
42, 45	Sliding area of clevis pin	Chassis grease [NLGI No.1 (Ca soap)]	As required
47	Sliding area of lever bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



7 **Removal of connector**

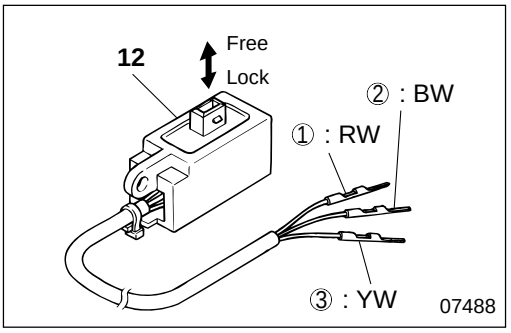
Using screwdriver **A**, pull out terminal **B** of overdrive OFF switch **12** from the inside of connector **7** and remove the connector.



11 **12** **Switch button, overdrive OFF switch**

[Removal]

- Using screwdriver **A**, remove switch button **11** from overdrive OFF switch **12**.
- Remove overdrive OFF switch **12** from automatic transmission knob **16** by pushing the switch out.

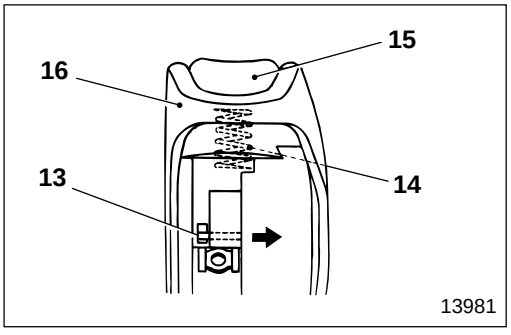


[Inspection of overdrive OFF switch **12**]

	① : RW	② : BW	③ : YW
Free	○——○		○
Lock	○	——○	

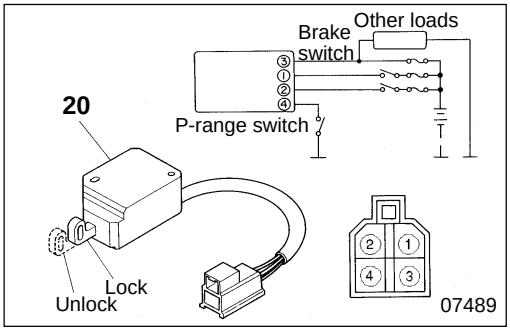
○——○ : There is continuity between terminals ○ and ○.

Replace overdrive OFF switch **12** if it is faulty.



13 **Removal of pin**

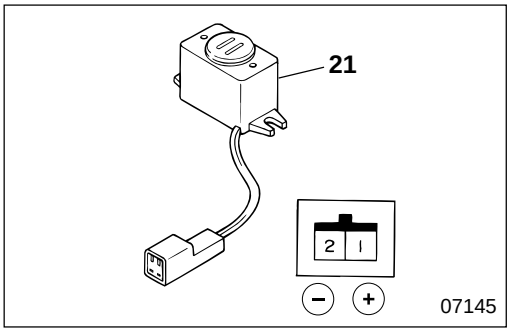
While keeping shift button **15** and spring **14** pressed down, remove pin **13** towards the inside (arrow direction) of automatic transmission knob **16**.



20 **Inspection of shift lock actuator**

Power supply		Switch		Operating mode	
IG	+B	Brake	P range	Unlock	Lock
○	○	○	○	○←	
○	○		○		→○
○	○	○		○	
○	○			○	
	○	○	○		→○
	○		○		→○
	○	○		○	
	○			○	

Check to make sure that shift lock actuator **20** is in operating mode under the above power supply and switch position.
Replace the shift lock actuator if it is faulty.

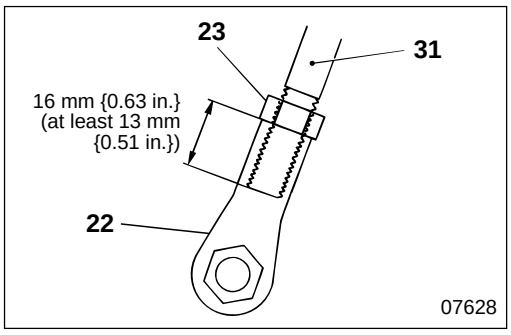


21 **Inspection of automatic transmission reverse buzzer**

- Check to make sure that the automatic transmission reverse buzzer sounds when 12 volts DC is loaded between terminals ① and ②.
- Replace automatic transmission reverse buzzer **21** if it is faulty.

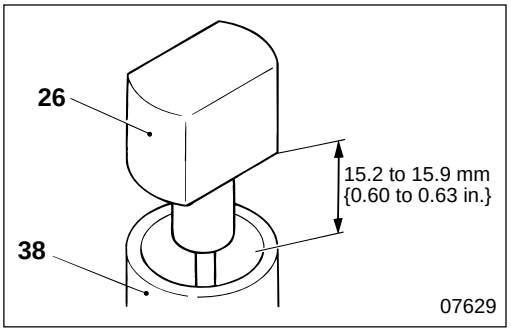
NOTE

- **Automatic transmission reverse buzzer 21 sounds continuously when you apply voltage.**
- **If you want to make automatic transmission reverse buzzer 21 sound intermittently, use the automatic transmission reverse buzzer and the back buzzer in combination.**



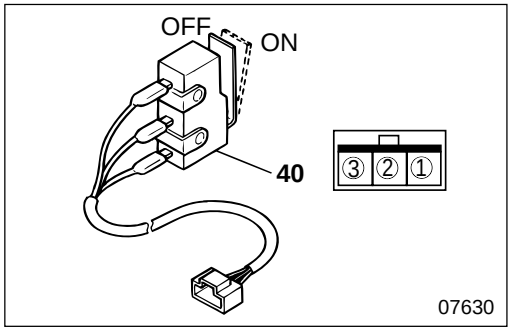
22 **Installation of ball joint**

Using ball joint **22** adjust rod **31** so that its thread ridge conforms to the dimensions as illustrated, then tighten with lock nut **23**.



26 **Installation of sleeve**

Shift range selector lever **38** to the P range. Install sleeve **26** by rotating it so that the dimension between the sleeve and the upper part of the lever conforms to the value as illustrated.



40 **P-range switch**

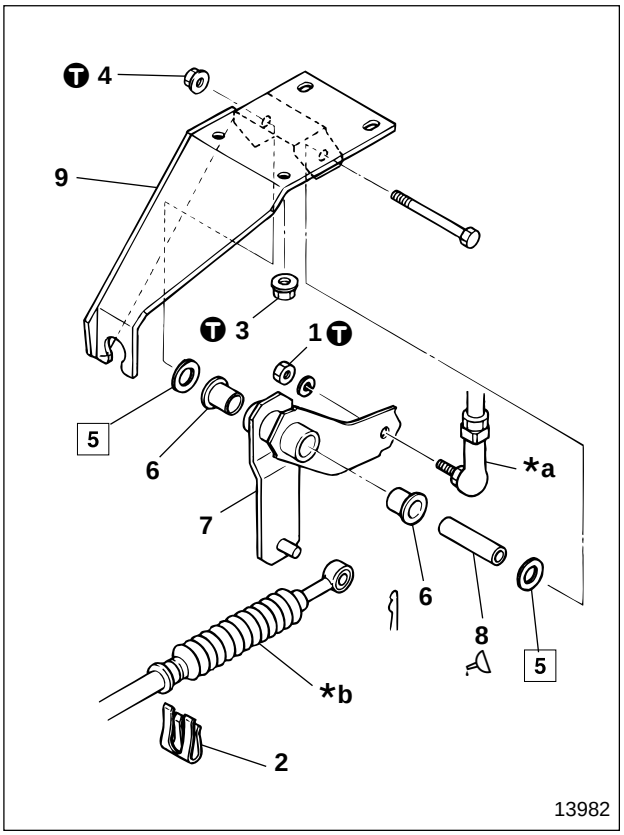
[Inspection]

	①	②	③
ON	○———		———○
OFF		○———	———○

○——○: There is continuity between terminals ○ and ○.
Replace P-range switch **40** if it is faulty.

[Installation]
Install P-range switch **40** so that it is OFF when the range selector lever is in the P range.

Lever Assembly

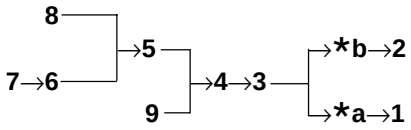


● **Disassembly sequence**

1 Nut
2 Clip
3 Nut
4 Nut
5 Spacer (for adjustment)
6 Bushing
7 Lever
8 Collar
9 Lever bracket

***a** : Range selector lever 🕮 P23A-68
***b** : Selector cable 🕮 P23A-74

● **Assembly sequence**



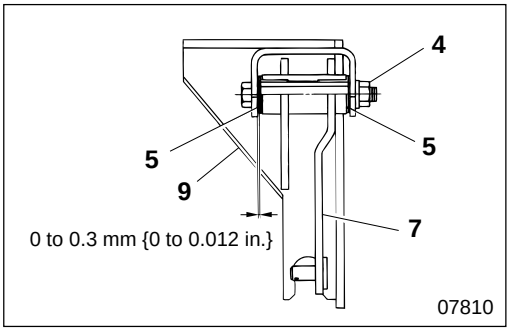
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Range selector lever mounting)	17 to 22 {12 to 16, 1.7 to 2.2}	—
3	Nut (Bracket mounting)	9.8 to 15.0 {7.2 to 11.0, 1.0 to 1.5}	—
4	Nut (Lever mounting)	17 to 22 {12 to 16, 1.7 to 2.2}	—

Lubricant

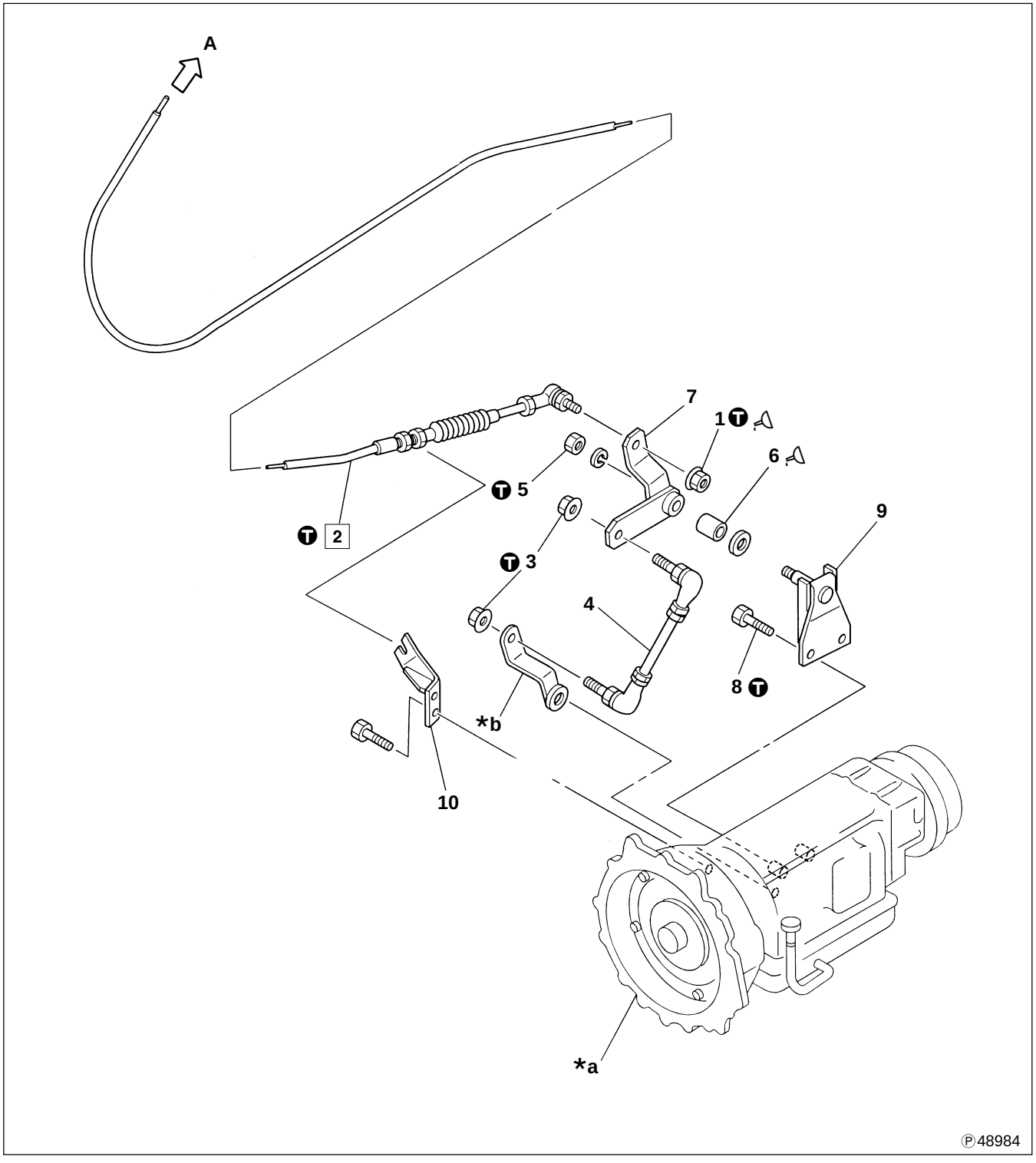
Location	Points of application	Specified lubricant	Quantity
8	Outside surface of collar	Chassis grease [NLGI No.1 (Ca soap)]	As required



◆ Service procedure

5 **Selection of spacer**

- Select the spacer so that when nut **4** is tightened at specified torque the clearance between lever bracket **9** and spacer **5** conforms to the dimensions as illustrated.
  There are two spacer thicknesses available : 0.3, 0.5 mm {0.012, 0.020 in.}
- After installation make sure lever **7** can be operated smoothly.


A
7
1 T
6
T 5
T 2
9
T 3
4
8 T
*b
10
*a
P48984

● **Removal sequence**

1 Nut
2 Selector cable
3 Nut
4 Rod
5 Nut
6 Bushing
7 Lever
8 Bolt
9 Bracket
10 Bracket

A : To range selector lever

***a** : Automatic transmission unit
***b** : Transmission control shift lever
🕮 P23A-78

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

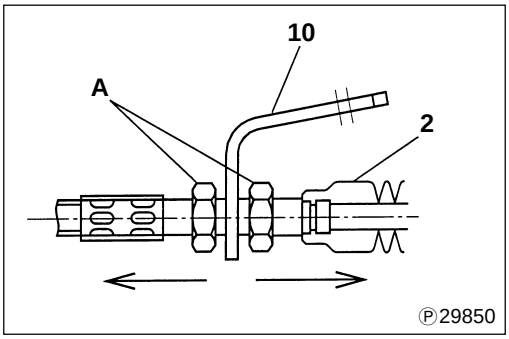
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Selector cable mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
2	Selector cable (For mounting on bracket)	60 to 85 {43.4 to 61.5, 6.0 to 8.5}	—
3	Nut (Rod mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
5	Nut (Lever mounting)	28 to 34 {20.3 to 25.3, 2.8 to 3.5}	—
8	Bolt (Bracket mounting)	69 to 93 {50.6 to 65, 7.0 to 7.5}	—

Lubricant

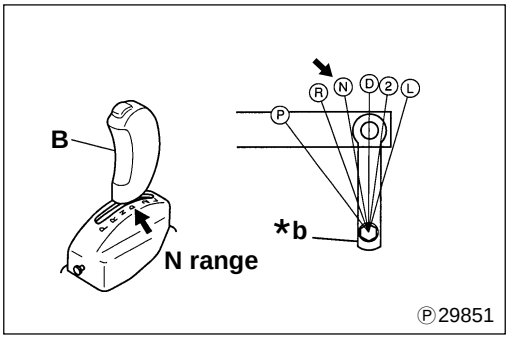
Location	Points of application	Specified lubricant	Quantity
6	Inside bushings	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure

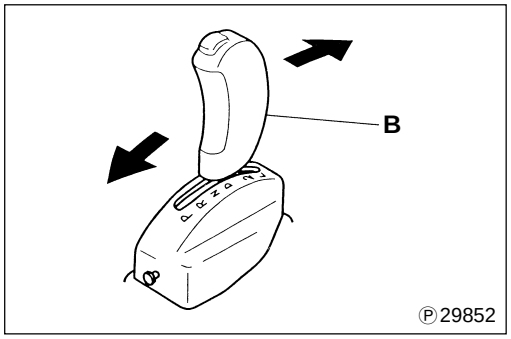


2 **Selector cable**

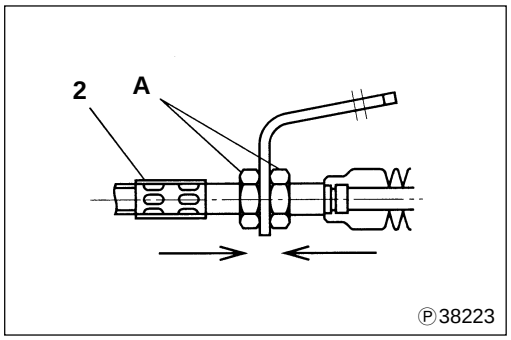
- Loosen nuts **A** on the selector cable **2** all the way to the ridges.



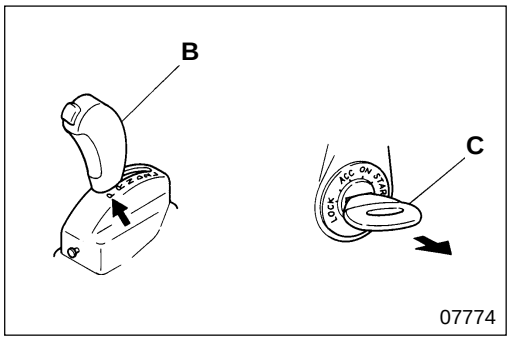
- Set automatic transmission lever knob **B** (located inside the cabin) and transmission control lever ***b** to the N range position.



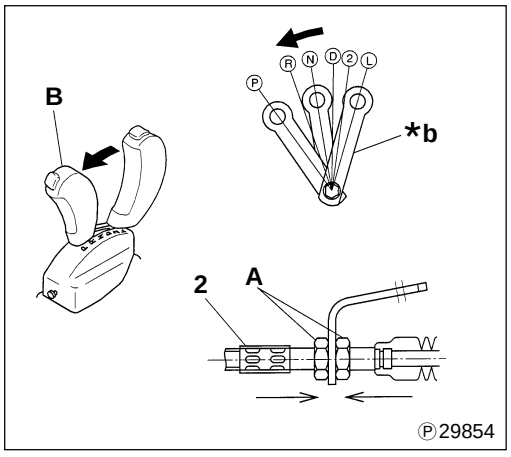
- Shake automatic transmission lever knob **B** back and forth.



- While ligthly pressing transmission control shift lever ***b** to R range position, tighten nut **A** of selector cable **2** to the specified torque.



- Make sure that starter key **C** can be removed with automatic transmission lever knob **B** in the P range.



[Adjustment]

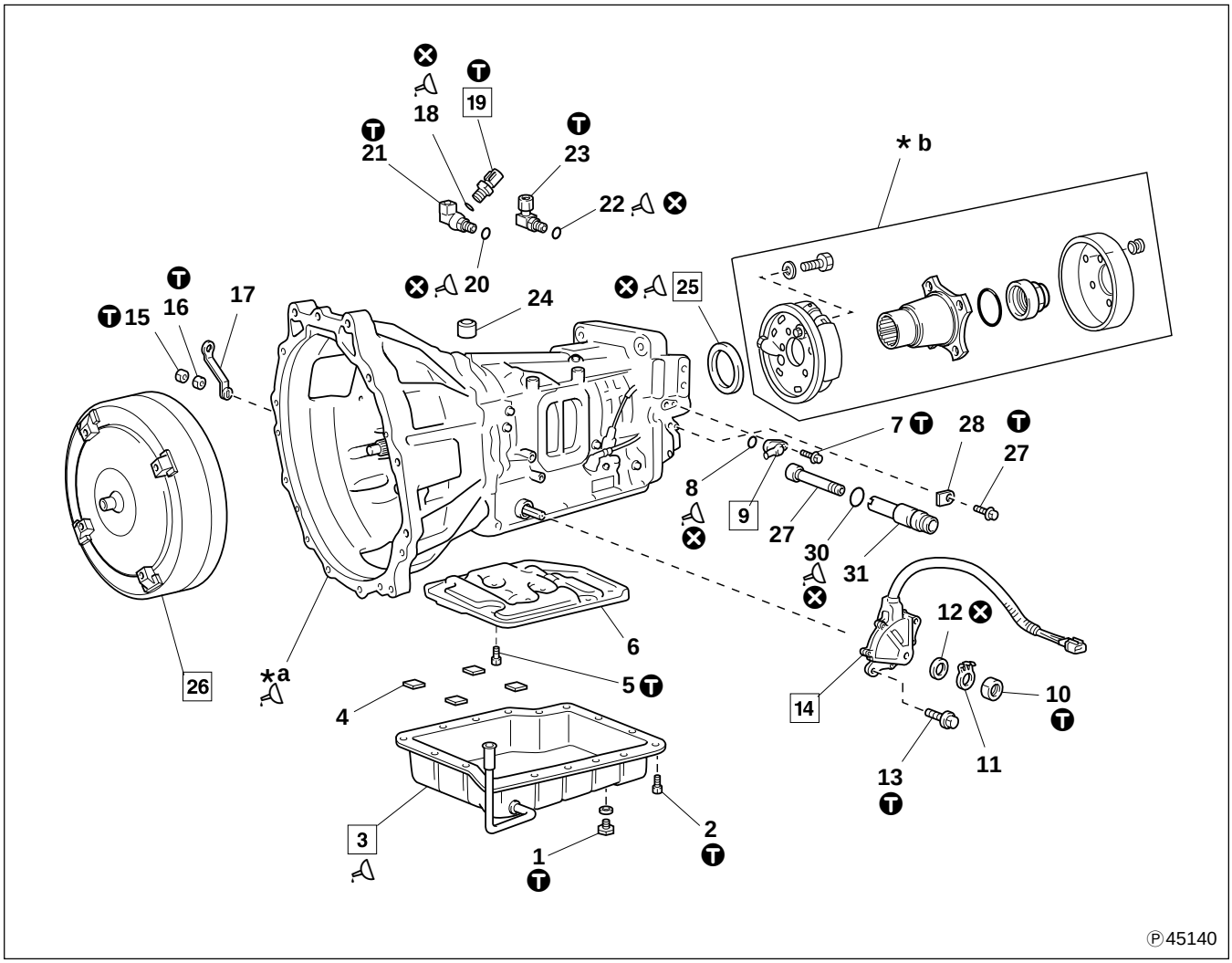
Adjust nuts **A** on selector cable **2** so that transmission control lever ***b** moves smoothly in the entire range when automatic transmission lever knob **B** is moved from the L range to P range.

CAUTION ⚠

If the adjustment of nuts A is improper, automatic transmission lever knob B produces resistance when it is moved to the L or P range. In some cases, the starter key cannot be removed with the automatic transmission lever knob in the P range.

M E M O

REPLACEMENT OF AUTOMATIC TRANSMISSION PARTS



● **Removal sequence**

1 Drain plug
2 Bolt
3 Oil pan
4 Oil cleaner magnet
5 Bolt
6 Oil strainer
7 Bolt
8 O-ring
9 Speed sensor
10 Nut
11 Lock washer
12 Gasket
13 Bolt
14 Inhibitor switch
15 Nut
16 Nut
17 Transmission control shift lever
18 O-ring
19 Oil temperature switch
20 O-ring
21 Elbow
22 O-ring
23 Elbow
24 Breather cap
25 Rear oil seal
26 Torque converter
27 Bolt
28 Speedometer sleeve lock plate
29 Speedometer driven gear
30 O-ring
31 Speedometer sleeve

***a** : Automatic transmission unit
***b** : Parking brake assembly
Gr 36
⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
9	Speed sensor resistance (at normal temperature)		560 to 680 Ω	—	Replace
19	Oil temperature switch activating temperature	OFF→ON	143 to 151°C {289 to 304°F}	—	Replace
		ON→OFF	Approximately 125°C {257°F}		

Tightening torque

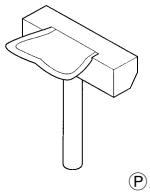
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	27 {21, 2.8}	With magnets
2	Bolt (Oil pan mounting)	7 {5.1, 0.7}	—
5	Bolt (Strainer mounting)	10 {7.2, 1.0}	—
7	Bolt (Speed sensor mounting)	8 {5.8, 0.8}	—
10	Nut (Inhibitor switch mounting)	7 {5.1, 0.7}	—
13	Bolt (Inhibitor switch mounting)	12.5 {9.4, 1.3}	—
15	Nut (Transmission control shift lever mounting)	12.5 {9.4, 1.3}	—
16	Nut (Transmission control shift lever mounting)	12.5 {9.4, 1.3}	—
19	Automatic transmission fluid temperature switch	24.5 {18, 2.5}	—
21	Elbow	32 {24, 3.3}	—
23	Elbow	32 {24, 3.3}	—
27	Bolt (Speedometer sleeve lock plate mounting)	12.5 {9.4, 1.3}	—

Lubricant and/or sealant

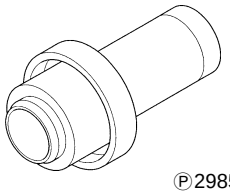
Location	Parts of application	Specified lubricant and/or sealant	Quantity
—	O-rings	Automatic transmission fluid	As required
3	Mounting surfaces of oil pan and automatic transmission unit	THREEBOND 1281B	As required
25	Lip section of oil seal	Wheel bearing grease [NLGI NO.2 (Li soap)]	As required
***a**	Perimeter of breather cap mounting pipe on automatic transmission unit	Cemendyne 540 Super X No. 8008	As required

Special tools

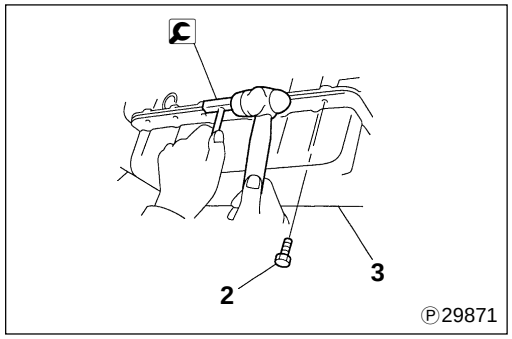
Location	Tool name and shape	Part No.	Application
3	Oil pan remover  Ⓟ29856	MD998727	Removal of oil pan

REPLACEMENT OF AUTOMATIC TRANSMISSION PARTS

Special tools

Location	Tool name and shape	Part No.	Application
25	Oil seal installer  Ⓟ29857	MH063608	Installation of oil seal

◆ Service procedure



Ⓟ29871

3 Oil pan

[Removal]

- Remove bolts **2**.

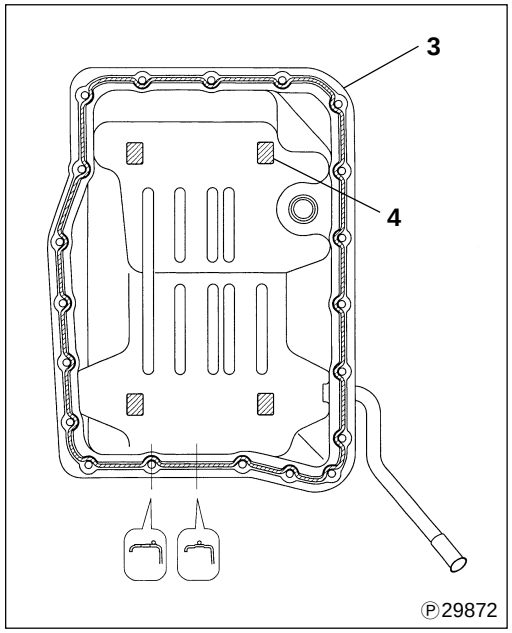
CAUTION

To prevent oil pan 3 from dropping when separating the sealant from the oil pan, keep several bolts (not tightened) mounted at intervals of three bolt holes.

- Insert oil pan remover at a corner of oil pan **3**, and separate the oil pan from the automatic transmission unit.

CAUTION

- **Be careful not to deform the shape of oil pan 3 when inserting oil pan remover.**
- **Do not tilt the oil pan during removal since the oil pan 3 contains oil.**



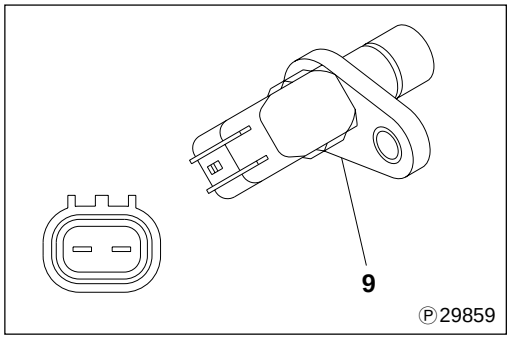
Ⓟ29872

[Installation]

- Remove the sealant from the mounting surfaces of the automatic transmission unit and oil pan **3**.
- Clean oil cleaner magnets **4**, and mount them in the oil pan.
- Apply sealant on oil pan **3**, and mount the oil pan on the automatic transmission unit.
- Tighten bolts **2** to the specified torque.

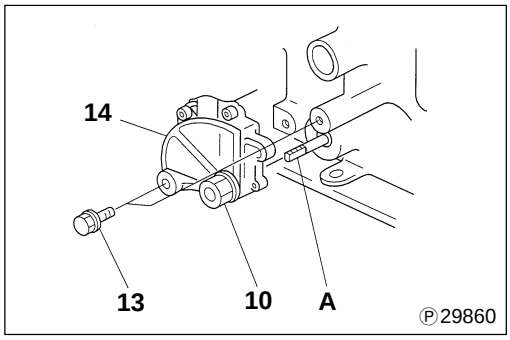
CAUTION

- **Do not allow automatic transmission fluid on the contact surfaces of oil pan 3 and the automatic transmission unit.**
- **Apply sealant continuously with a diameter of 2 or 3 mm {0.079 to 0.12 in.}, as shown in the diagram.**
- **Install the oil pan within 10 minutes after the application of the sealant.**
- **Tighten bolts 2 evenly by conducting the tightening operation for each bolt several times.**



9 Inspection of speed sensor

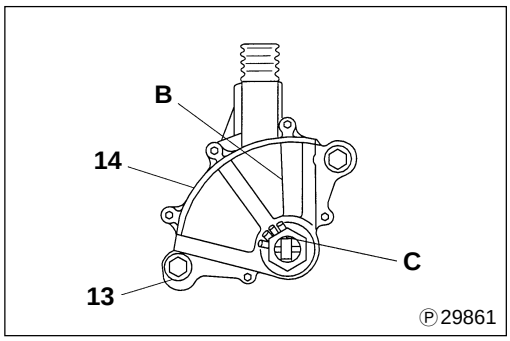
- Measure the resistance between the connector terminals shown in the diagram. If the measured value deviates from the standard value, the connector is defective.
- Standard resistance between terminals: 560 to 680 Ω (at normal temperature)



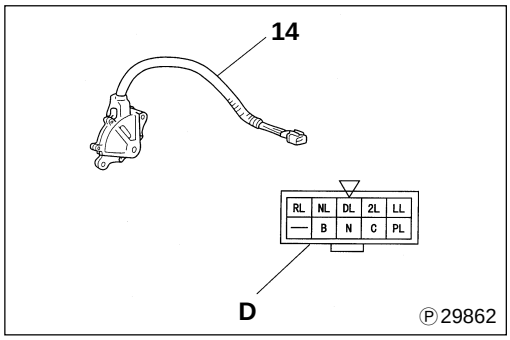
14 Inhibitor switch

[Installation]

- Set control shaft **A** to the N position.
- Mount inhibitor switch **14** on control shaft **A**.
- Tighten two bolts **13**.
- Tighten nut **10**.



- Loosen two bolts **13**, and position inhibitor switch **14** so that reference line **B** on the inhibitor switch aligns with groove **C**.
- While holding inhibitor switch **14** with one hand, tighten two bolts **13** to the specified torque with the other hand.
- Bend the two lock tabs on the nut of inhibitor switch **14**.



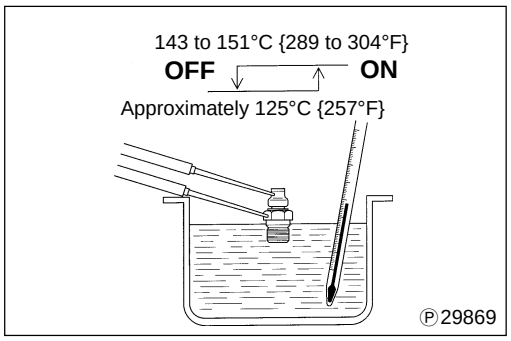
[Inspection]

Check the electric conduction at wire connector **D** of inhibitor switch **14** using a tester.

< Connection chart >

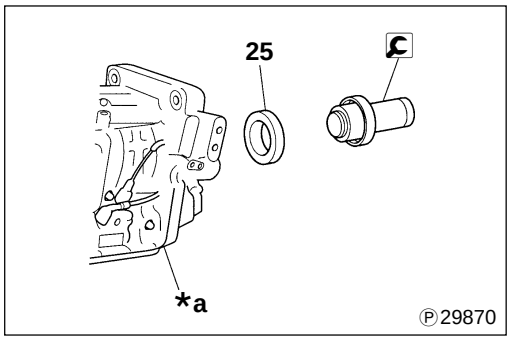
	B	N	C	PL	RL	NL	DL	2L	LL
P	○	○	○	○					
R			○		○				
N	○	○	○			○			
D			○				○		
2			○					○	
L			○						○

○——○ : Electric conduction between terminals



19 **Oil temperature switch**

Place oil temperature switch assembly **19** in a container filled with glycerin. Vary the temperature of the oil, and check to make sure that the switch operates (ON and OFF) at the specified temperatures.



25 **Installation of oil seal**

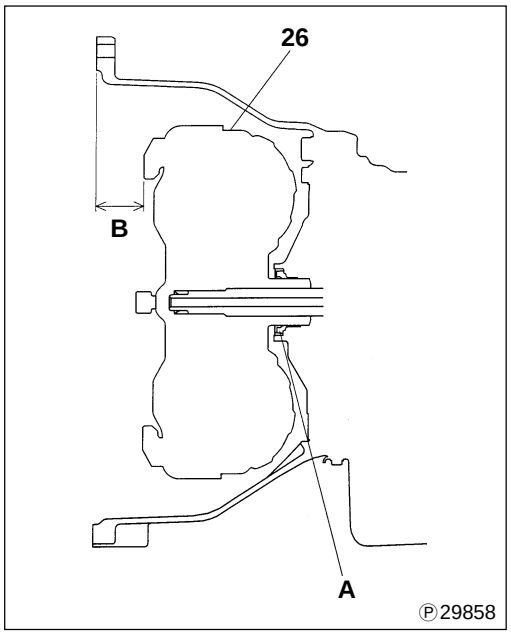
CAUTION

After the oil seal 25 is removed, clean the surface of the extension housing of automatic transmission unit *a to which oil seal is mounted.

- Apply grease on the lip section of oil seal **25**.
- Use oil seal installer to insert oil seal **25** all the way into the extension housing of automatic transmission unit ***a**.

CAUTION

- **Insert oil seal 25 evenly.**
- **Do not damage or deform the shape of oil seal 25.**



26 **Installation of torque converter**

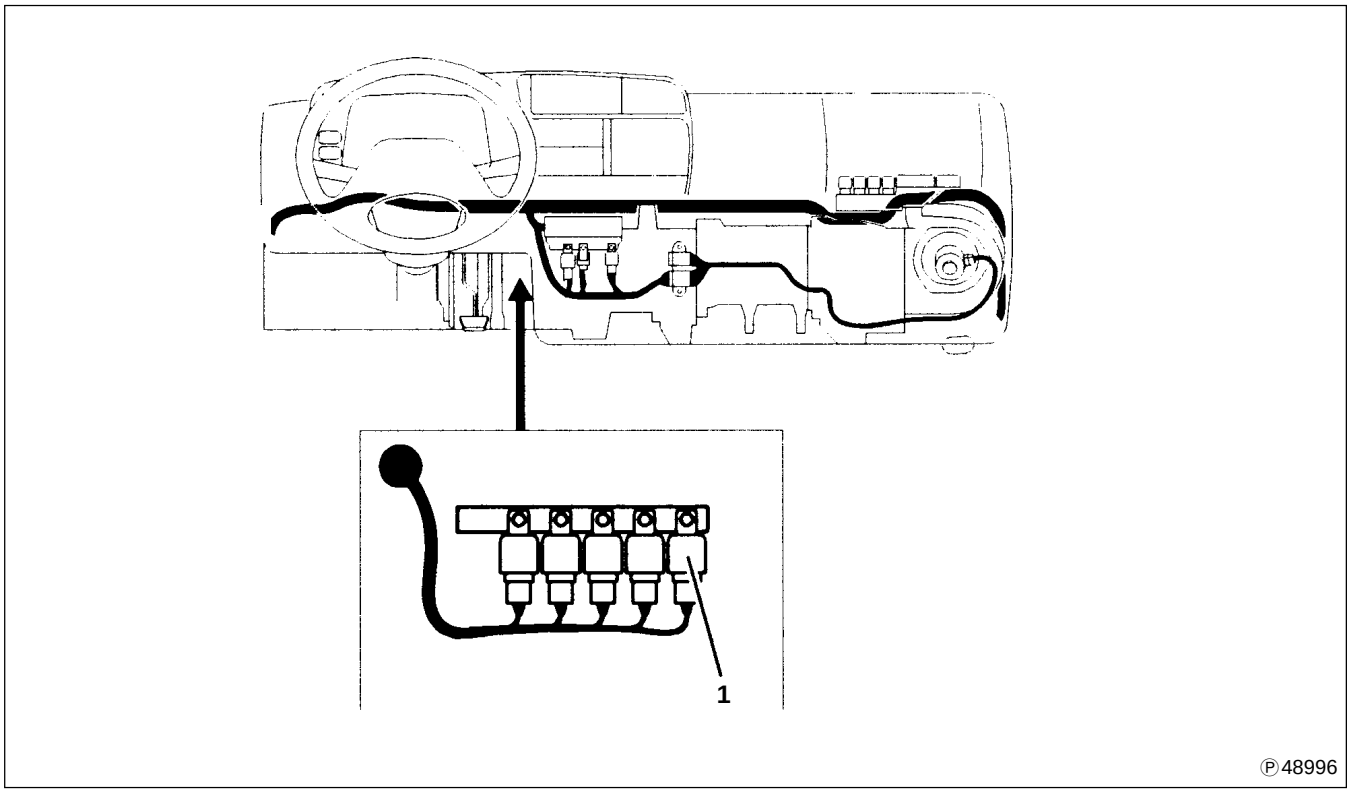
- Pour new automatic transmission fluid into torque converter **26** when the torque converter to be installed is new.
  Automatic transmission fluid quantity : Approximately 2 L {2.1 qts}
- Apply automatic transmission fluid on front oil seal **A**, and mount torque converter **26** on the oil pump.

CAUTION

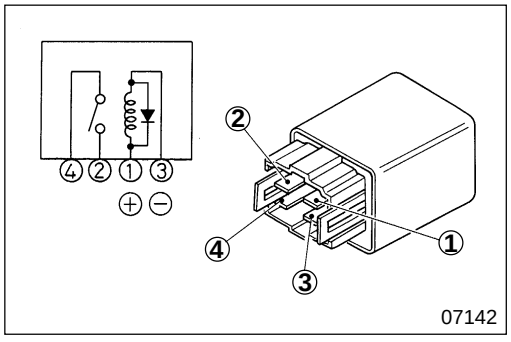
Be careful not to damage oil seal A when mounting torque converter 26.

- Measure dimension **B** between the torque converter housing and the set block of torque converter **26** to make sure that the torque converter is inserted into the proper position.
  Dimension **B** : 44 mm {1.73 in.} or more

M E M O



1 Automatic transmission fluid cooler fan relay

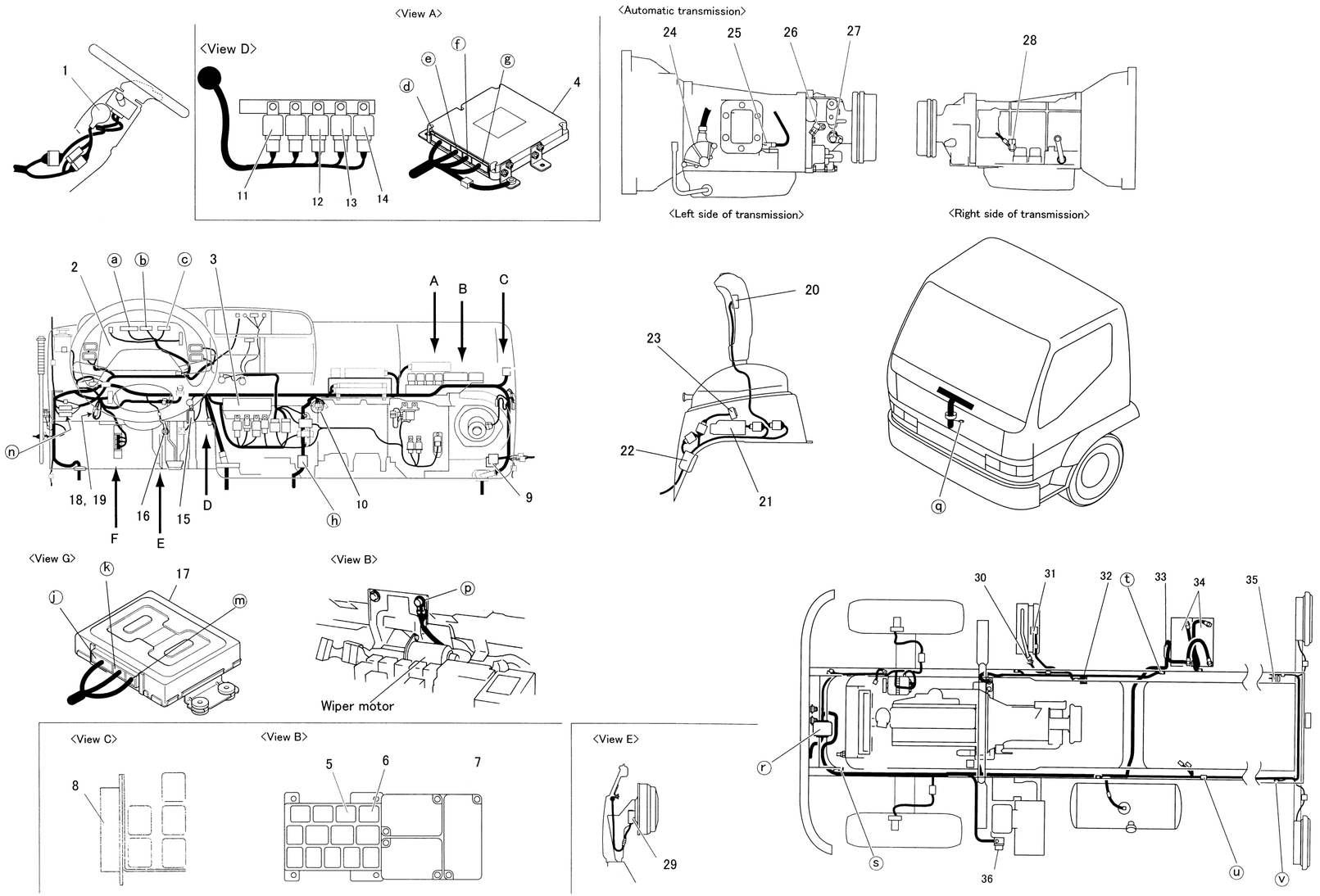


◆ Service procedure

1 **Inspection of relay (constant-open type, 4-pin)**

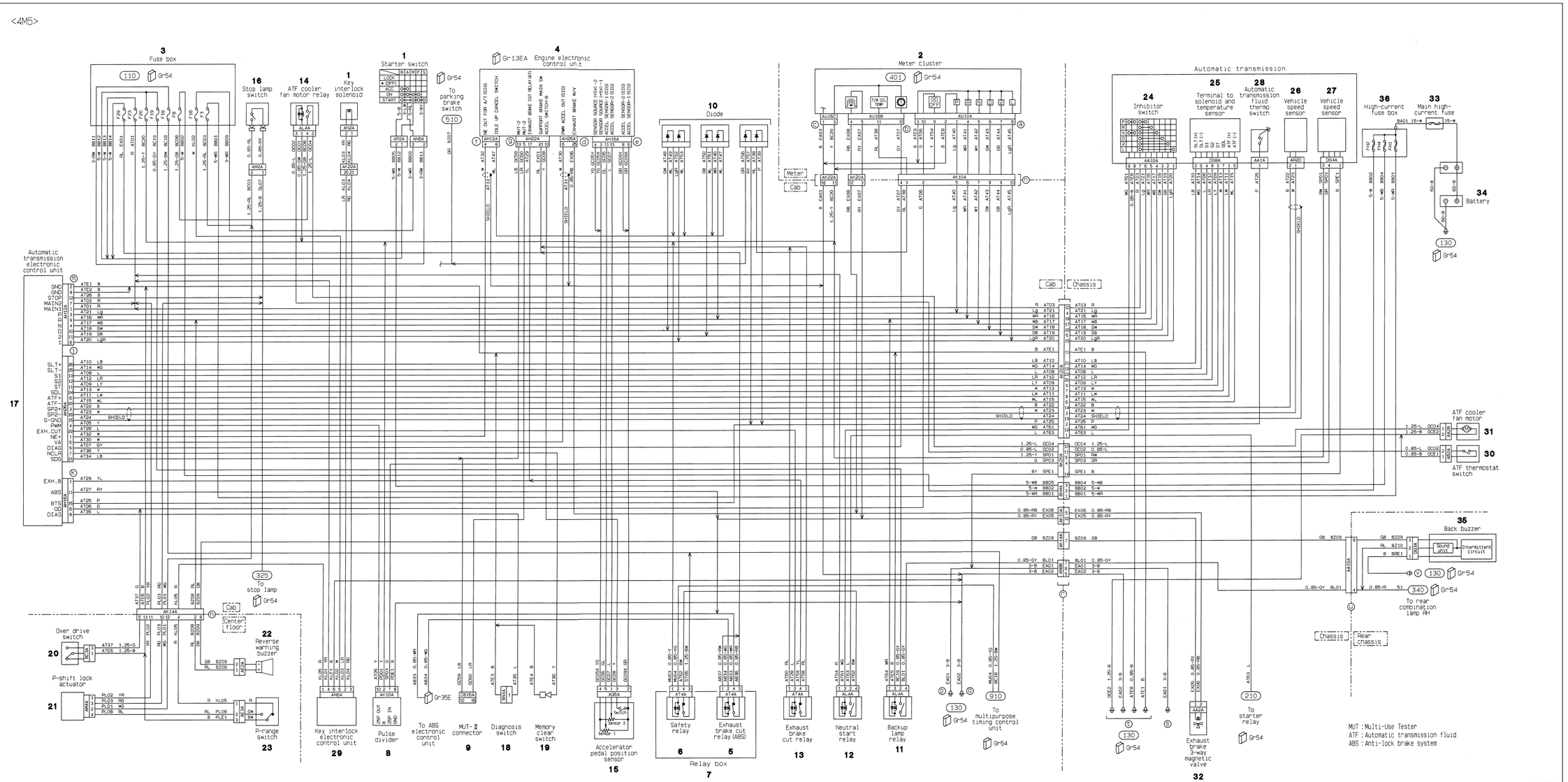
	①	②	③	④	Remarks
Electric current supplied	○	——	○		—
Electric current not supplied	⊕	○	⊖	○	Measure the voltage of electric current.

○——○ : Electric conduction between terminals
⊕ - - - ⊖ : Terminals applied with battery voltage
If an abnormality is found, replace the relay.



1 Starter switch (key interlock solenoid installed)
2 Meter cluster
3 Fuse box
4 Engine electronic control unit
5 Exhaust brake cut relay (ABS)
6 Safety relay
7 Relay box
8 Pulse divider
9 Multi-use tester II connector
10 Diode
11 Backup lamp relay
12 Neutral start relay
13 Exhaust brake cut relay (A/T)
14 Automatic transmission fluid cooler fan relay
15 Accelerator pedal position sensor
16 Stop lamp switch
17 Automatic transmission electronic control unit
18 Diagnosis switch
19 Memory clear switch
20 Over drive switch
21 P-shift lock actuator
22 Reverse warning buzzer
23 P-range switch
24 Inhibitor switch
25 Terminal to solenoid and temperature sensor
26 Vehicle speed sensor
27 Vehicle speed sensor
28 Automatic transmission fluid thermo switch
29 Key interlock control unit
30 Automatic transmission fluid cooler fan thermo switch
31 Automatic transmission fluid cooler fan motor
32 Exhaust brake 3-way magnetic valve
33 Main high current fuse box
34 Battery
35 Back buzzer
36 High current fuse box

Ⓟ48648


<4M5>
3 Fuse box
110
Gr54
16 Stop lamp switch
14 ATF cooler fan motor relay
1 Key interlock solenoid
1 Starter switch
LOCK
ACC
ON
START
To parking brake switch
510
4 Gr13EA Engine electronic control unit
2 Meter cluster
401
Meter
Cab
10 Diode
Automatic transmission
24 Inhibitor switch
25 Terminal to solenoid and temperature sensor
28 Automatic transmission fluid thermo switch
26 Vehicle speed sensor
27 Vehicle speed sensor
36 High-current fuse box
33 Main high-current fuse
34 Battery
130
Automatic transmission electronic control unit
17
Cab
Chassis
ATF cooler fan motor
31
ATF thermostat switch
30
35 Back buzzer
Sound unit
Intermittent circuit
To rear combination lamp RH
340
325
To stop lamp
Center floor
22 Reverse warning buzzer
Over drive switch
20
P-shift lock actuator
21
P-range switch
23
Key interlock electronic control unit
29
Pulse divider
8
To ABS electronic control unit
Gr35E
MUT-II connector
9
Diagnosis switch
18
Memory clear switch
19
Accelerator pedal position sensor
15
Sensor 1
Sensor 2
Relay box
7
6
5
Safety relay
Exhaust brake cut relay (ABS)
Exhaust brake cut relay
13
Neutral start relay
12
Backup lamp relay
11
To multipurpose timing control unit
910
210
To starter relay
Exhaust brake 3-way magnetic valve
32
Rear Chassis
MUT : Multi-Use Tester
ATF : Automatic transmission fluid
ABS : Anti-lock brake system
52780

MITSUBISHI
FUSO

Group 23B
Automatic Transmission
< FH211 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-23B

INDEX

SPECIFICATIONS 23B- 2

STRUCTURE AND OPERATION 23B- 3

TROUBLESHOOTING 23B- 6

ON-VEHICLE INSPECTION AND ADJUSTMENT 23B- 8

WORK BEFORE REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23B-11

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23B-12

OIL SEAL AND SPEEDOMETER WORM 23B-16

OIL PAN AND OIL FILTER 23B-19

AUTOMATIC TRANSMISSION CONTROL 23B-20

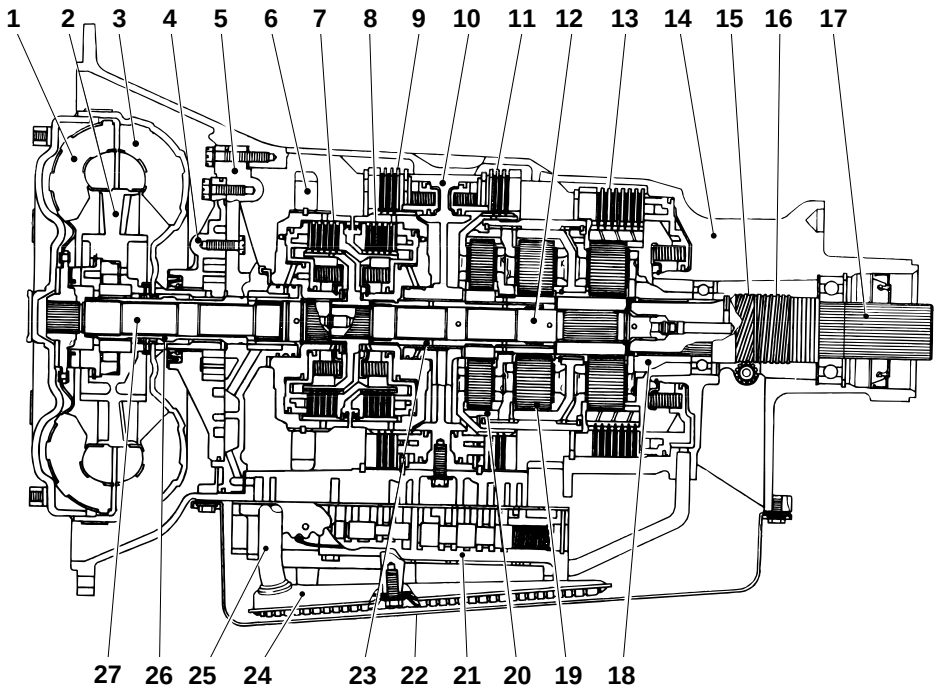
OIL COOLER 23B-25

OIL FILTER 23B-26

SPECIFICATIONS

Item			Specifications	
Type			M4A4 (Allison AT542)	M4A4 (Allison AT545)
Torque converter	Type Stall torque ratio		3-element, 1-stage, 2-phase 1.72	
Transmission	Type		Planetary gear type 4 forward speeds, 1 reverse speed	
	Gear ratio	1st	3.454	
		2nd	2.253	
		3rd	1.407	
		4th	1.000	
		Reverse	5.024	
Range selector pattern			R—(N)—D—3—2—1 (Engine can be started in (N) position only)	
Recommended fluid	Fluid quantity (except oil cooler piping L {qts}		Automatic transmission fluid (DEXRON or DEXRON II type) 14 {15} When oil is replaced: 8.5 {9.0}	Automatic transmission fluid (DEXRON or DEXRON II type) 20.8 {22} When oil is replaced: 15 {16}
Mass < Wet > kg {lb}			167 {368}	173 {381}
Transmission control			Floor shift remote control, cable type	

Automatic Transmission Assembly



1	Turbine	**10**	Center support	**19**	Center planetary gear set
2	Stator	**11**	2nd clutch	**20**	Front planetary gear set
3	Impeller	**12**	Mainshaft	**21**	Control valve assembly
4	Oil pump assembly	**13**	1st and reverse clutch	**22**	Oil pan
5	Front support	**14**	Transmission case	**23**	Sun gear shaft
6	Power take-off drive gear	**15**	Governor drive gear	**24**	Oil filter
7	Forward clutch	**16**	Speedometer sensor drive gear	**25**	Intake pipe
8	4th clutch	**17**	Output shaft	**26**	Stator shaft
9	3rd clutch	**18**	Rear planetary gear set	**27**	Turbine shaft

The automatic transmission consists of a torque converter and a fully automatic 4-speed gear system.

● **Torque converter**

The torque converter is driven by the engine crankshaft, and functions as the input device for the transmission. The torque converter also acts as the fluid coupling, absorbing shock during engine start up and gear shifting.

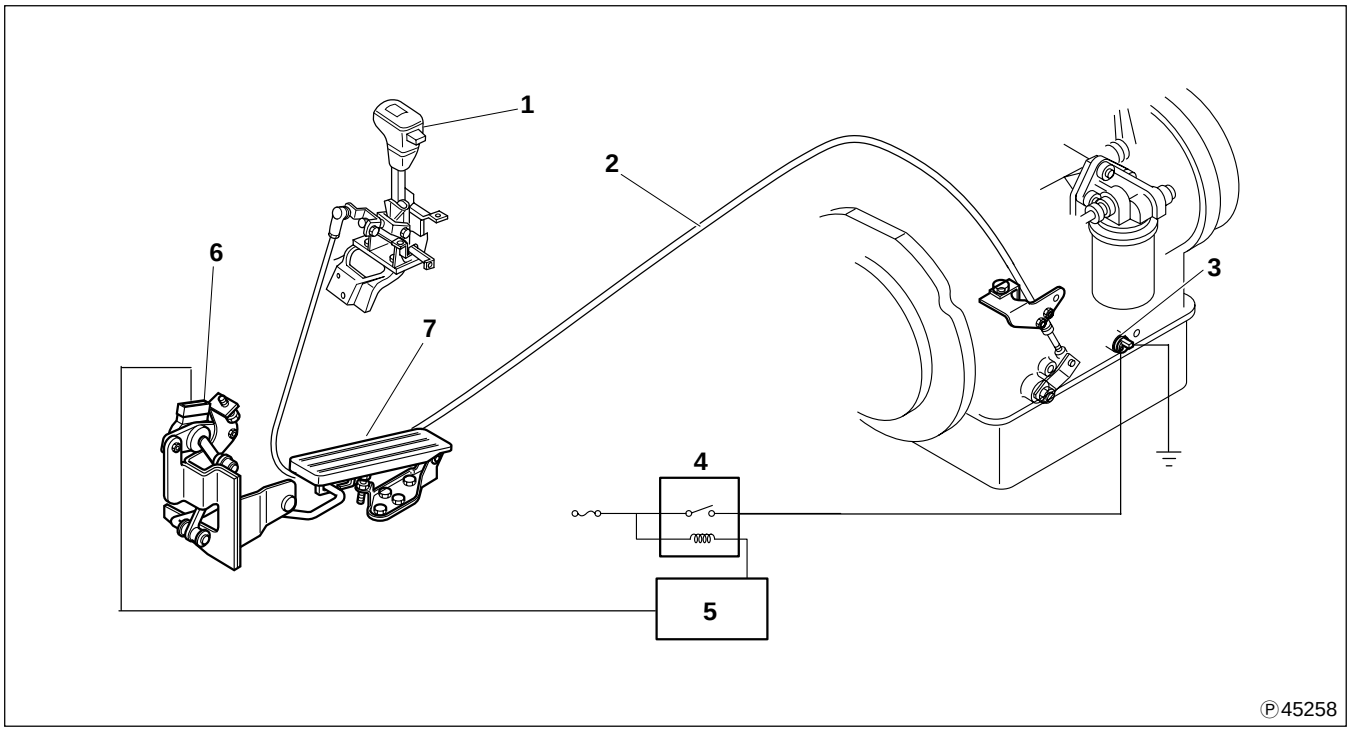
● **Transmission (4 forward speeds, 1 reverse speed)**

The transmission is accomplished by three sets of planetary gears **18**, **19**, **20** and five sets of oil pressure-operated, wet-type multiple disc clutches **7**, **8**, **9**, **11**, **13**. These oil-cooled clutch discs are self-adjusting to compensates for wear.

● **Oil pressure control area**

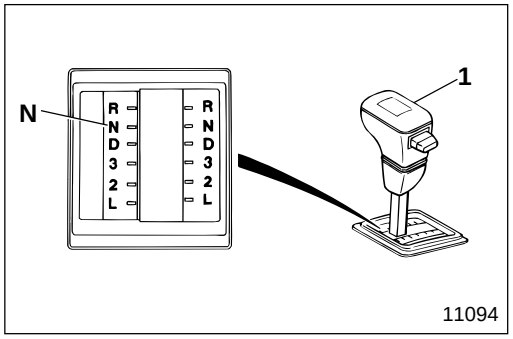
This oil pressure control area consists of oil pump **4**, control valve assembly **21** that controls the changeover between clutches **7**, **8**, **9**, **11**, and **13**, the modulator that monitors the amount the accelerator pedal is depressed, and the governor that monitors the vehicle speed. Gear shift is made automatically and depends on how much the accelerator pedal is depressed and how fast the vehicle is travelling.

Automatic Transmission Control



1 Range selector lever
2 Selector cable
3 Modulator
4 Relay
5 Engine control unit
6 Accelerator pedal position sensor
7 Accelerator pedal

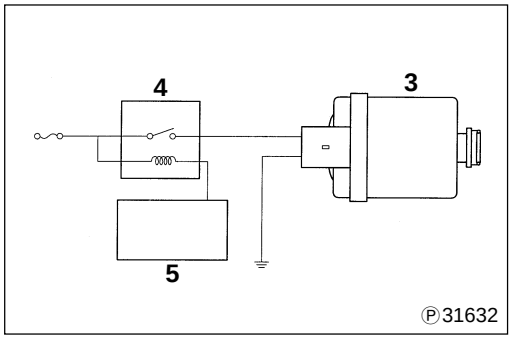
Selector Lever



Range selector lever **1** selects the most suitable range for the operating conditions, ensuring optimum service from the automatic transmission. Safety features are incorporated that make sure that the engine cannot be started when the range selector lever is in any position other than neutral (N).

N : Neutral

Modulator

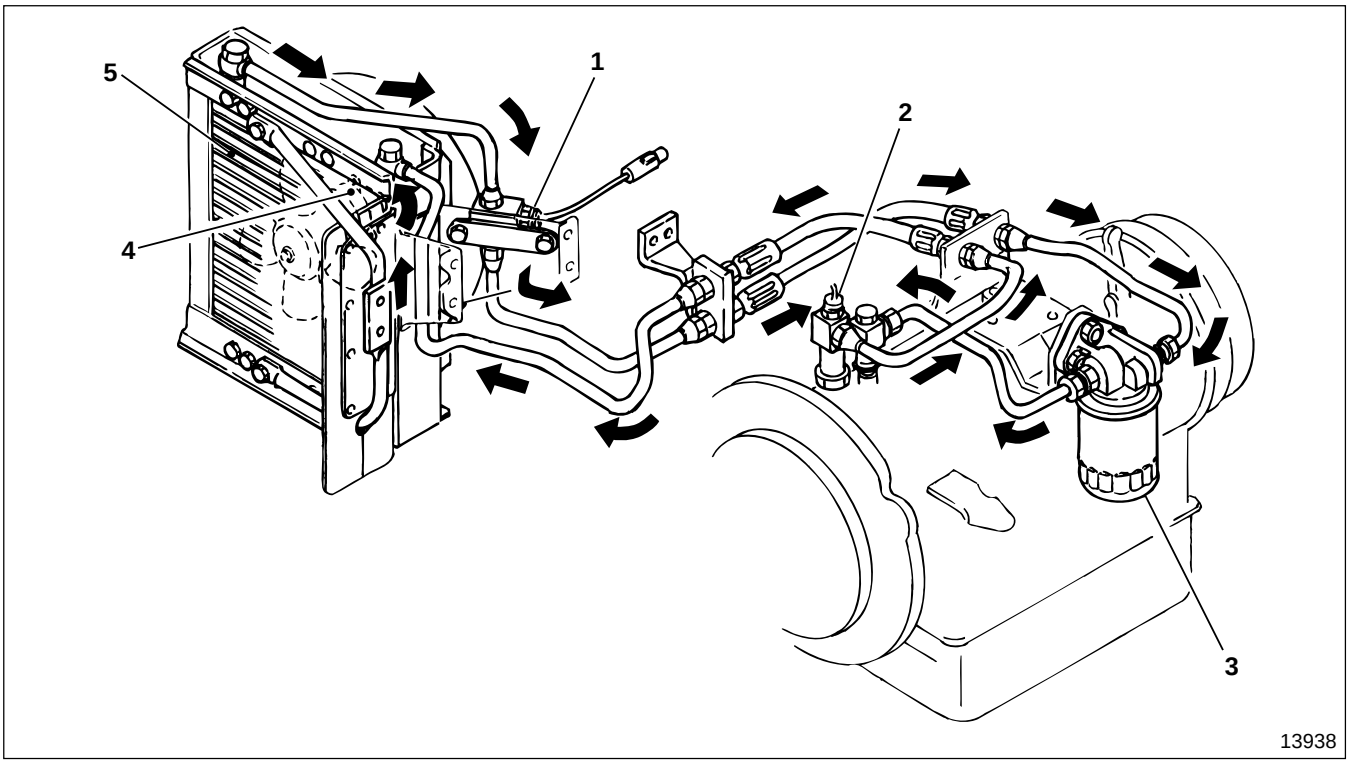


Modulator **3** converts the amount the accelerator pedal is depressed into hydraulic pressure.

- Outline of operating system
  Engine control unit **5** sends a signal via relay to modulator **3** for switching between closed-throttle shift and full-throttle shift.

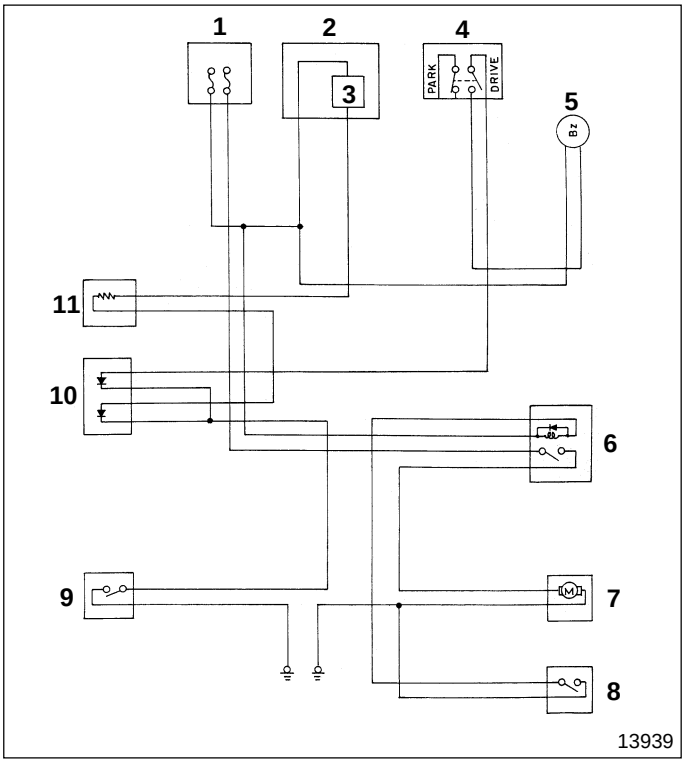
- Operating conditions
  Throttle opening of 80% or more : ON (Full-throttle shift)
  Throttle opening of 65% or less after ON : OFF (Closed-throttle shift)

Oil Cooler



1 Automatic transmission fluid thermostat switch (Oil cooler fan)
2 Automatic transmission fluid temperature switch (Warning lamp)
3 Oil filter
4 Blower assembly
5 Oil cooler

Oil Temperature Warning System



1 Relay and fuse box
2 Meter cluster
3 Indicator lamp
4 Parking brake switch
5 Warning buzzer
6 Automatic transmission fluid cooler fan relay
7 Automatic transmission fluid cooler fan motor
8 Automatic transmission fluid thermostat switch
9 Automatic transmission fluid temperature switch
10 Diode
11 Resistor

TROUBLESHOOTING

Possible causes	Symptoms	Excessive shock when shifting from Ⓝ to Ⓓ	Engagement interval too long when shifting from Ⓝ to Ⓓ	Engine races when shifting up	Does not shift up	Kick down impossible or shifting down abnormal	Abnormal shifting	Slips out of gear while driving forward	Slips out of gear in Ⓡ position
Engine faulty	Engine idling speed too fast	○							
	Engine idling speed too slow		○						
Incorrect adjustment of cables	Selector cable adjusted incorrectly		○		○		○	○	○
	Modulator faulty	○				○			
Automatic transmission fluid unsuitable situation	Fluid level too low		○	○	○		○	○	○
	Oil filter clogged		○	○			○	○	○
	Air mixed in fluid		○	○			○	○	
	Fluid level too high								
	Oil cooler pipe damaged or deteriorated								
	Oil cooler fan malfunctioning								
Internal malfunction of automatic transmission assembly	Fluid pressure too low		○	○	○		○	○	○
	Valve body abnormality or leakage	○	○	○	○	○	○	○	○
	Oil pump malfunctioning		○				○	○	○
	Output shaft bearing or bushing damaged								
	Governor abnormal				○	○	○		
	Clutch damaged or malfunctioning		○	○	○		○	○	○
	Breather clogged								
	Fluid pressure too high	○							
	Clutch plate clearance insufficient								
	Clutch dragging								
	Planetary gear damaged or stuck								

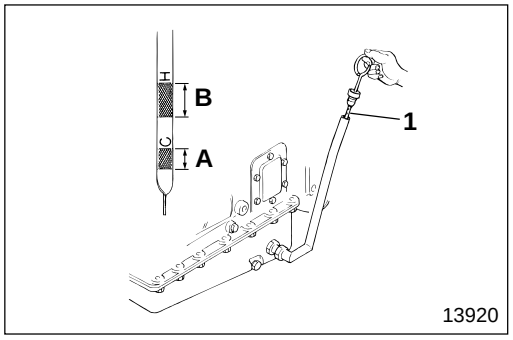
Possible causes \ Symptoms		Slips out of gear while in any position	Vehicle does not move irrespective of selector position	Vehicle does not move while selector in forward position	Vehicle does not move while selector in Ⓡ position	Vehicle moves while selector is in Ⓝ position	Scraping or squeaking noise	Humming noise	Trouble in fluid supply. Automatic transmission fluid spouting from filler tube	Excessive shock when shifting	Shift up too slow	Automatic transmission overheating
Engine faulty	Engine idling speed too fast											○
	Engine idling speed too slow											
Incorrect adjustment of cables	Selector cable adjusted incorrectly				○	○						○
	Modulator faulty									○	○	
Automatic transmission fluid unsuitable situation	Fluid level too low	○	○	○				○				○
	Oil filter clogged	○	○						○			
	Air mixed in fluid	○						○	○			
	Fluid level too high								○			
	Oil cooler pipe damaged or deteriorated											○
	Oil cooler fan malfunctioning											○
Internal malfunction of automatic transmission assembly	Fluid pressure too low	○	○	○	○					○		○
	Valve body abnormality or leakage	○	○	○	○	○		○		○	○	
	Oil pump malfunctioning	○	○									○
	Output shaft bearing or bushing damaged						○					
	Governor abnormal										○	
	Clutch damaged or malfunctioning			○	○						○	
	Breather clogged								○			
	Fluid pressure too high									○		
	Clutch plate clearance insufficient											○
	Clutch dragging					○						
	Planetary gear damaged or stuck		○	○	○		○					

ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspection of Automatic Transmission Fluid

(1) Inspection of characteristics

If the automatic transmission fluid smells burnt or if it contains metal particles or sludge as a result of internal friction and wear of metal or other material, the transmission assembly must be completely overhauled. Make sure you carefully examine the automatic transmission fluid on the dipstick. If you find the quality questionable, take a sample and examine it more closely.



(2) Inspection of automatic transmission fluid level

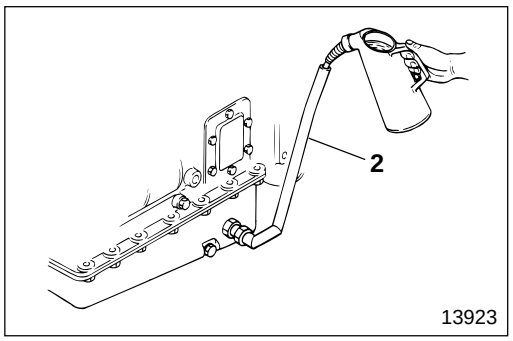
- Park the vehicle on level ground, make sure that the parking brake is fully activated and chock the wheels to keep them from rolling.
- Start the engine and let it idle. To fill the hydraulic circuit with automatic transmission fluid, shift the range selector lever from N → R → N → D → 2 → D → N. Repeat this process five times, finally shifting to N.
- While the engine is still idling, pull out dipstick **1** and wipe off the fluid sticking to it. Reinsert the dipstick, then pull it out again and check the fluid level.
- If the fluid level is inspected right after the engine is started and the fluid temperature is still low (approximately 15 to 49°C {60 to 120°F}), the level should be within area **A** marked COLD on the dipstick.
- If the fluid level is inspected after the vehicle has been driven and the fluid temperature is high (approximately 71 to 93°C {160 to 200°F}), the level should be within area **B** marked HOT on dipstick **1**.

WARNING⚠

Take care during the inspection because the engine will be running. Take sufficient care to avoid burns or injuries resulting from contact with moving parts.

NOTE

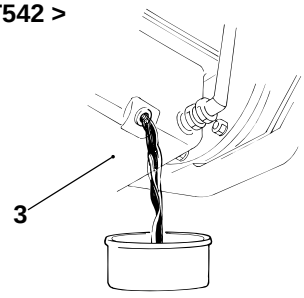
- **Make sure the vehicle is parked on level ground when you are checking the fluid level.**
- **Make sure the range selector lever is in the N position and the engine is idling when you are checking the fluid level. When the engine is stopped, the fluid level appears higher than it actually is.**
- **Be sure to wipe off the dust from the safety cap and the upper part of dipstick guide 2 before you pull out dipstick 1.**
- **To ensure the fluid is correct, reinspect the fluid level after an actual drive.**



- If the fluid level is low, add automatic transmission fluid (DEXRON or DEXRON II type) through dipstick guide **2** until the correct level on dipstick **1** is reached.

Replacement of Automatic Transmission Fluid

< AT542 >



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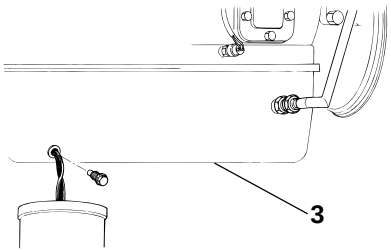
< AT545 >



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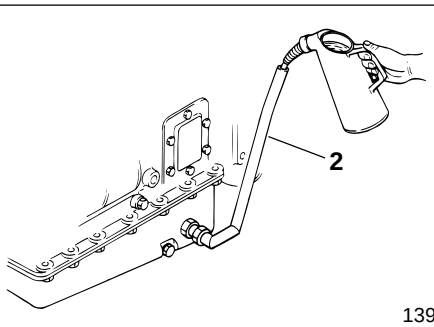

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(1) Draining

- Park the vehicle on level ground, chock the wheels and shift the range selector lever to the **N** position.
- Place a container under oil pan **3**, remove the drain plug and drain the fluid.
- Clean oil pan **3** and the drain plug. Replace the oil filter. P23B-19
- Replace the outer oil filter. P23B-26

WARNING

Take care because the fluid temperature immediately after the engine has stopped is very high. To avoid scalds, wait until a safe temperature has been reached before draining the fluid.

NOTE

- **The fluid will drain faster if the engine is first run to raise the fluid temperature.**
- **The fluid cannot be drained from the hydraulic circuit, the torque converter or the oil cooler.**
- **Check the drained fluid for dirt, metal particles and metal fragments.**

(2) Supply

- Install oil filter, oil pan **3** and drain plug. P23B-19
- Add automatic transmission fluid (DEXRON or DEXRON II type) through dipstick guide **2**.
  AT542 : 8.5 L {9.0 qts}
  AT545 : 15 L {16 qts}

CAUTION

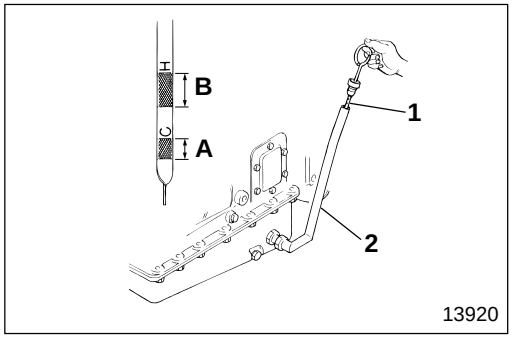
Make sure that dirt and foreign particles do not become mixed in with the fluid when it is added.

- Shift the range selector lever to the N position, start the engine and let it idle for about one minute.
- After shifting the lever through all positions once, shift it back to N position.

CAUTION

To prevent burning out the interior of the automatic transmission assembly, make sure that the engine is not allowed to race when you do the above.

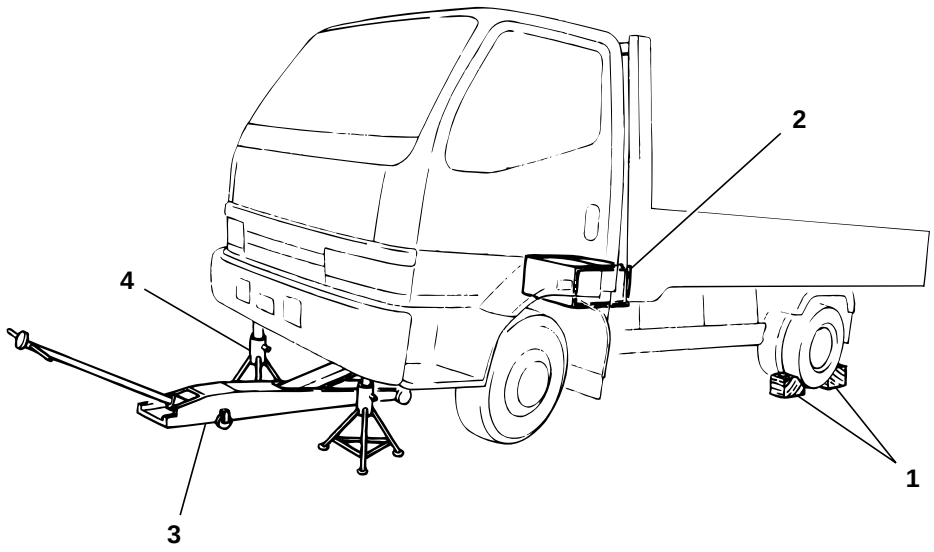
ON-VEHICLE INSPECTION AND ADJUSTMENT



- Check and adjust so that the fluid level is within the specified area on dipstick **1**.

NOTE

- **As the temperature of the fluid rises, so does the fluid level. If you add fluid while the temperature is still low (approximately 15 to 49°C {60 to 120°F}), make sure that the level stays within area A, marked COLD on dipstick 1.**
- **Let the engine idle and, while paying attention to the fluid level, pour in the fluid slowly.**
- **It is sometimes hard to check the fluid level, immediately after supplying fluid, because of the fluid adhering to the interior of dipstick guide 2. If this is the case, check the fluid level several times at intervals.**
- **Be careful not to supply too much fluid because you might mistake the fluid that overflows from the air breather for fluid leakage.**



14340

● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable Gr 54
3 Jack up the front axle with a garage jack.
4 Support the front frame on rigid racks.

WARNING⚠

- **The parking brake will be removed so naturally it cannot be used. Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

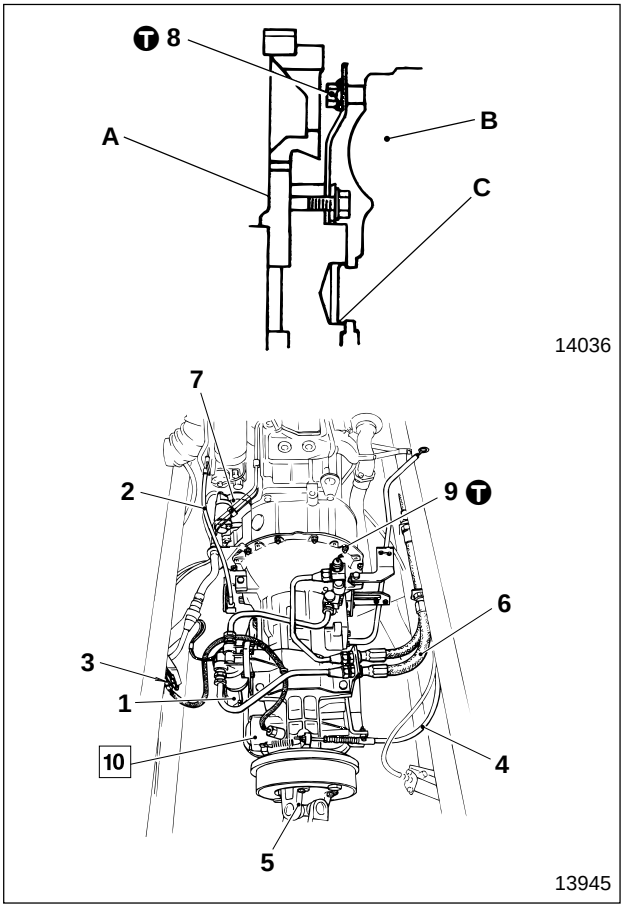
CAUTION⚠

Be sure to keep the automatic transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY



● **Removal Sequence**

1 Chassis harness (Modulator)
2 Selector cable
3 Harness connector
4 Parking brake cable Gr 36
5 Propeller shaft Gr 25
6 Oil cooler hose
7 Starter Gr 54
8 Bolt
9 Nut
10 Automatic transmission assembly

A : Flywheel
B : Torque converter
C : Torque converter pilot area

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

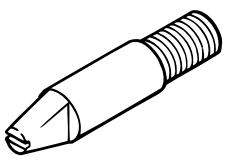
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Bolt (Torque converter and flywheel mounting)	51 to 61 {38 to 45, 5.20 to 6.22}	—
9	Nut (Automatic transmission assembly mounting)	39 to 58 {28 to 43, 3.9 to 6.0}	—

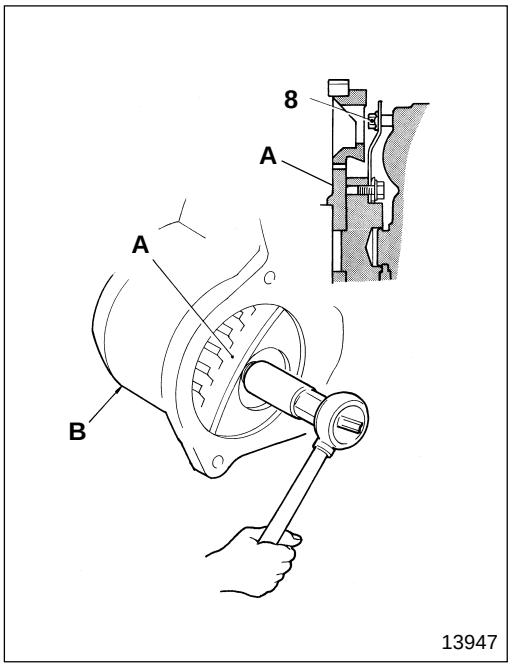
Lubricant

Location	Points of application	Kinds	Quantity
10	Torque converter pilot area (area C)	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
10	Converter installer  03726	ME633437	Automatic transmission assembly installation guide

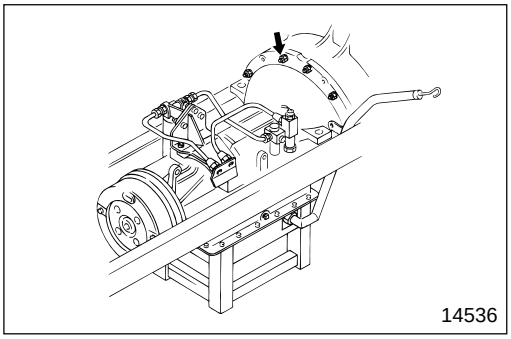
◆ Service procedure



10 **Automatic transmission assembly**

[Removal]

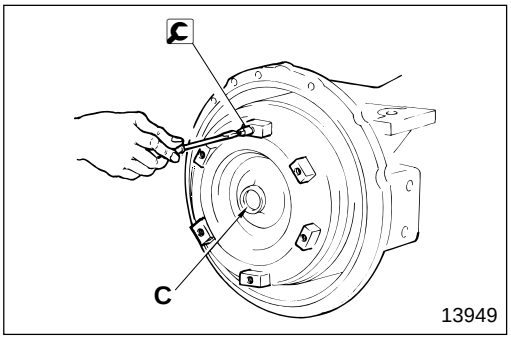
- Rotate flywheel **A** and remove bolts **8** in sequence.
  B : Starter housing



- Use a square bar or a similar object to support the oil pan of automatic transmission assembly **10**, then remove it by pulling it out backward.

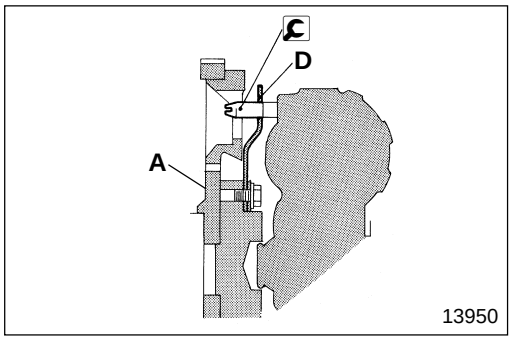
CAUTION

- **Be careful not to apply force unevenly to any of the oil pan parts.**
- **Be careful not to let the torque converter fall from the transmission body because as a single unit the torque converter can come loose easily.**

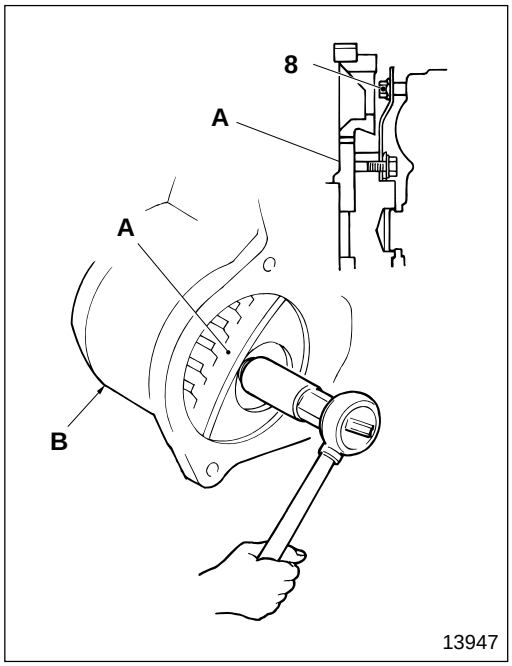


[Installation]

- Apply molybdenum disulfide grease to torque converter pilot area **C**.
- Mount torque converter installer in the tapped hole on the torque converter periphery.



- Install the automatic transmission assembly to the engine flywheel housing, by aligning torque converter installer with the hole in flexplate **D** of flywheel **A**.



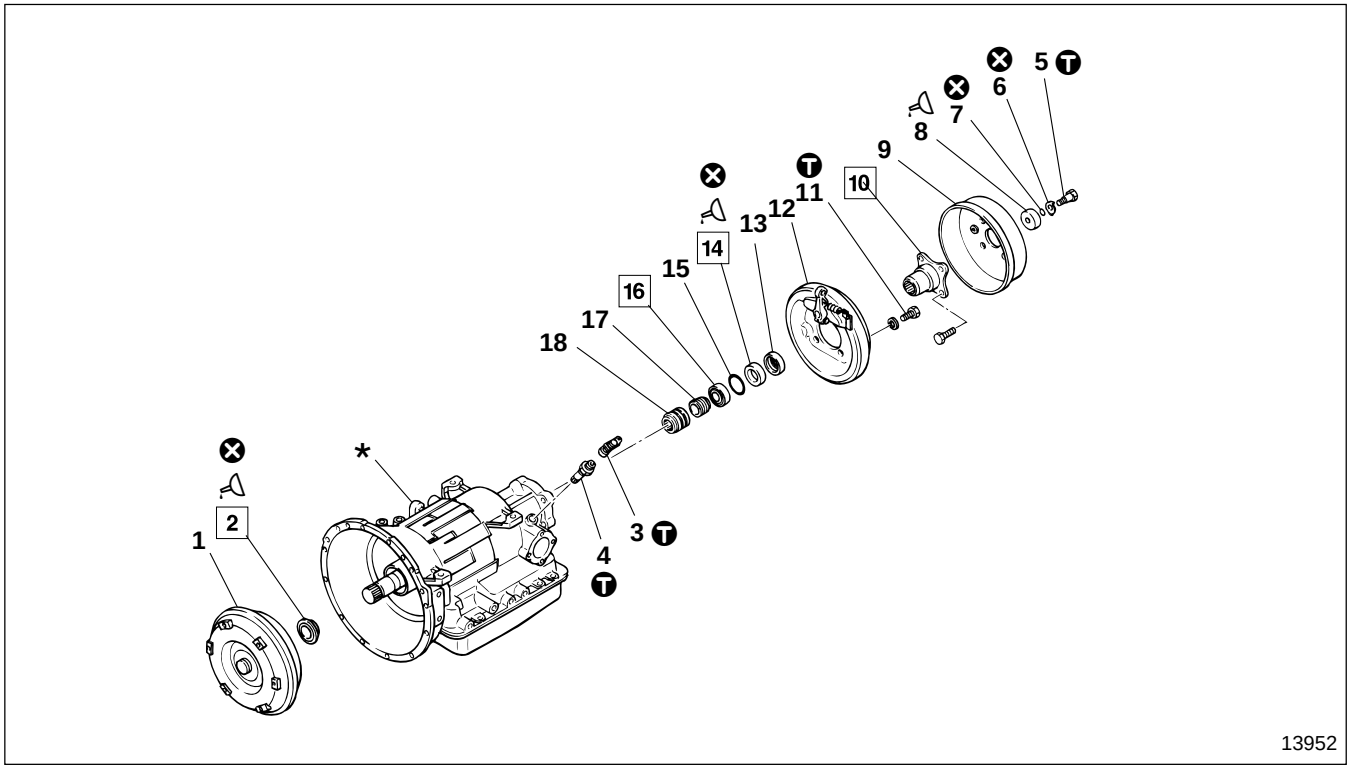
- Rotate flywheel **A** and tighten bolts **8**, in sequence, through the working hole of starter housing **B** (6 points).
- Remove the converter installer and replace it with bolt **8**.
- First tighten all six bolts **8** temporarily, then tighten at specified torque.

NOTE

Be careful not to drop bolts 8 into the gap between flywheel A and the torque converter.

M E M O

OIL SEAL AND SPEEDOMETER WORM



● **Disassembly sequence**

1 Torque converter
2 Oil seal
3 Speedometer gear adapter
4 Speedometer gear
5 Flange set bolt
6 Lock washer
7 O-ring
8 Retainer washer
9 Parking brake drum
10 Companion flange
11 Bolt
12 Support plate and shoe assembly
13 Seal plate
14 Oil seal
15 Snap ring
16 Bearing
17 Spacer
18 Speedometer worm

***** : Automatic transmission assembly
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
4, 18	Backlash between speedometer gear and speedometer worm	0.13 to 0.29 {0.0051 to 0.011}	0.36 {0.014}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

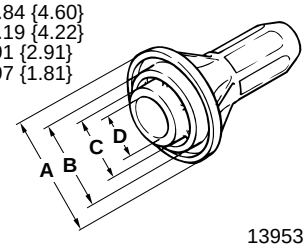
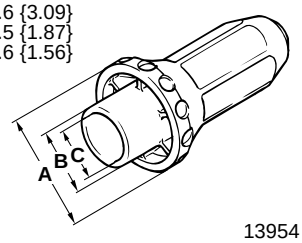
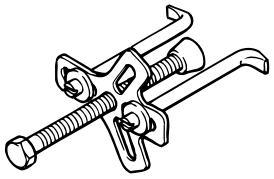
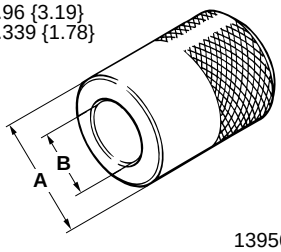
Location	Parts to be tightened	Tightening torque	Remarks
3	Speedometer gear adapter	55 to 82 {41 to 61, 5.6 to 8.4}	—
4	Speedometer gear	61 to 68 {45 to 50, 6.22 to 6.93}	—
5	Flange set bolt	140 to 160 {100 to 120, 14.1 to 16.72}	—
11	Bolt (Support plate and shoe assembly mounting)	110 to 130 {81 to 97, 11.22 to 13.46}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
2	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Oil seal periphery	THREEBOND 1215	As required
8	Retainer washer periphery	THREEBOND 1215	As required
14	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Oil seal periphery	THREEBOND 1215	As required

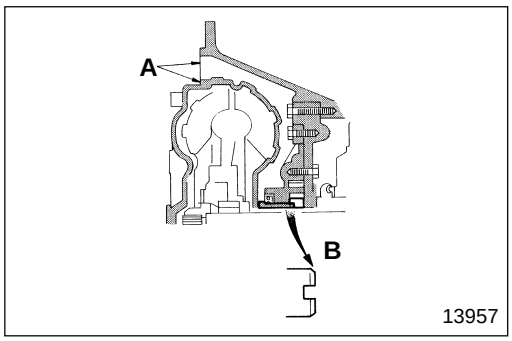
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	**A**=ø116.84 {4.60} **B**=ø107.19 {4.22} **C**=ø73.91 {2.91} **D**=ø45.97 {1.81} Pump seal installer  13953	ME633191	Installation of front side oil seal
14	**A**=ø78.6 {3.09} **B**=ø47.5 {1.87} **C**=ø39.6 {1.56} Rear oil seal installer  13954	ME633192	Installation of rear side oil seal
16	Bearing remover set  13955	ME633221	Removal of bearing
	A=ø80.96 {3.19} **B**=ø45.339 {1.78} Rear bearing installer  13956	ME633220	Installation of bearing

OIL SEAL AND SPEEDOMETER WORM

◆ Service procedure

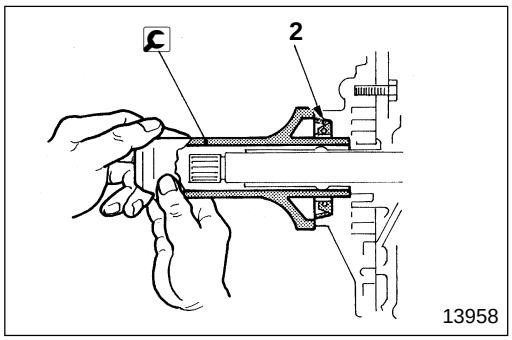


1 **Installation of torque converter**

Align the hub groove of torque converter **1** with the claw of the oil pump, then insert until the welded part on the converter periphery and the housing flange almost coincide.

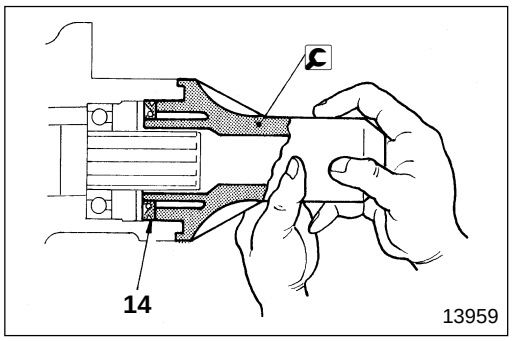
CAUTION
Be careful not to scratch the oil seal.

A : Guide to insertion position (Align faces)
B : Align claw position



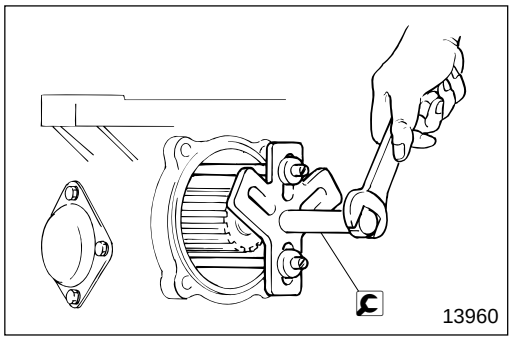
2 **Installation of oil seal**

- Apply grease to the lip area, and apply sealant to the periphery of oil seal **2**.
- Use 🔧 pump seal installer and install oil seal **2**.



14 **Installation of oil seal**

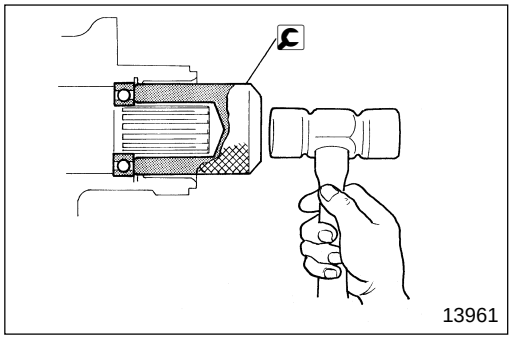
- Apply grease to the lip area, and apply sealant to the periphery of oil seal **14**.
- Use 🔧 rear oil seal installer and install oil seal **14**.



16 **Bearing**

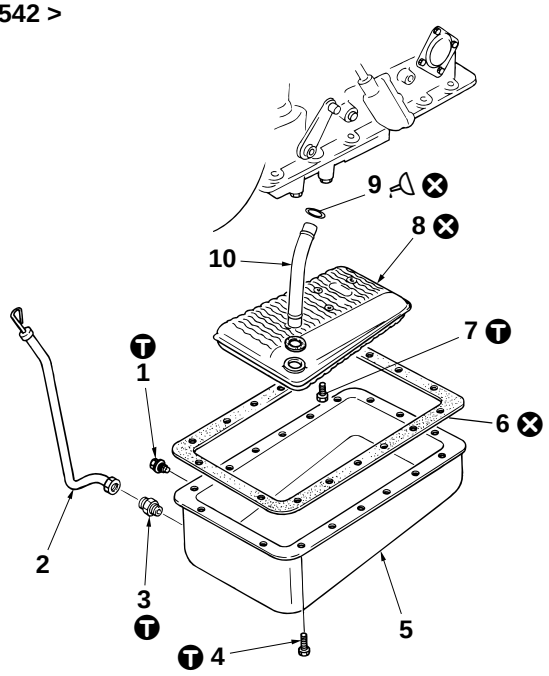
[Removal]

- Insert the claw on the tip of 🔧 bearing remover set rod between the bearing race of bearing **16**.
- Insert the bolt of 🔧 bearing remover set into the automatic transmission output shaft, then remove bearing **16** by tightening the bearing remover.



[Installation]

< AT542 >



13962

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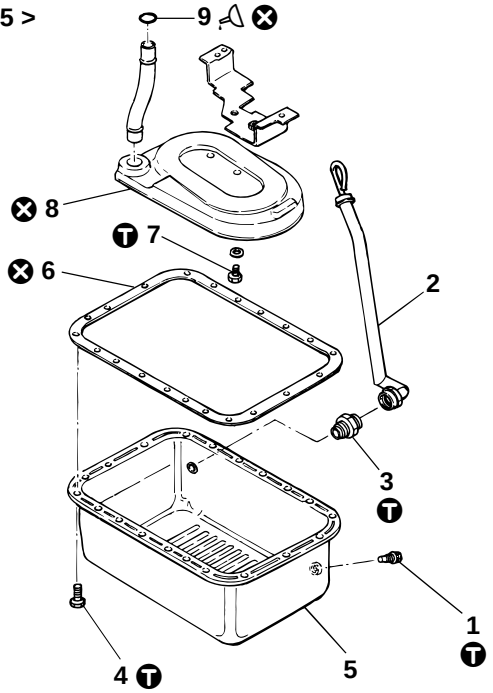


13963

● **Removal sequence**

1 Drain plug
2 Dipstick and dipstick guide
3 Dipstick guide connector
4 Bolt
5 Oil pan
6 Gasket
7 Bolt
8 Oil filter
9 Seal ring
10 Intake pipe

⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Repair kit : Oil filter and gasket kit

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

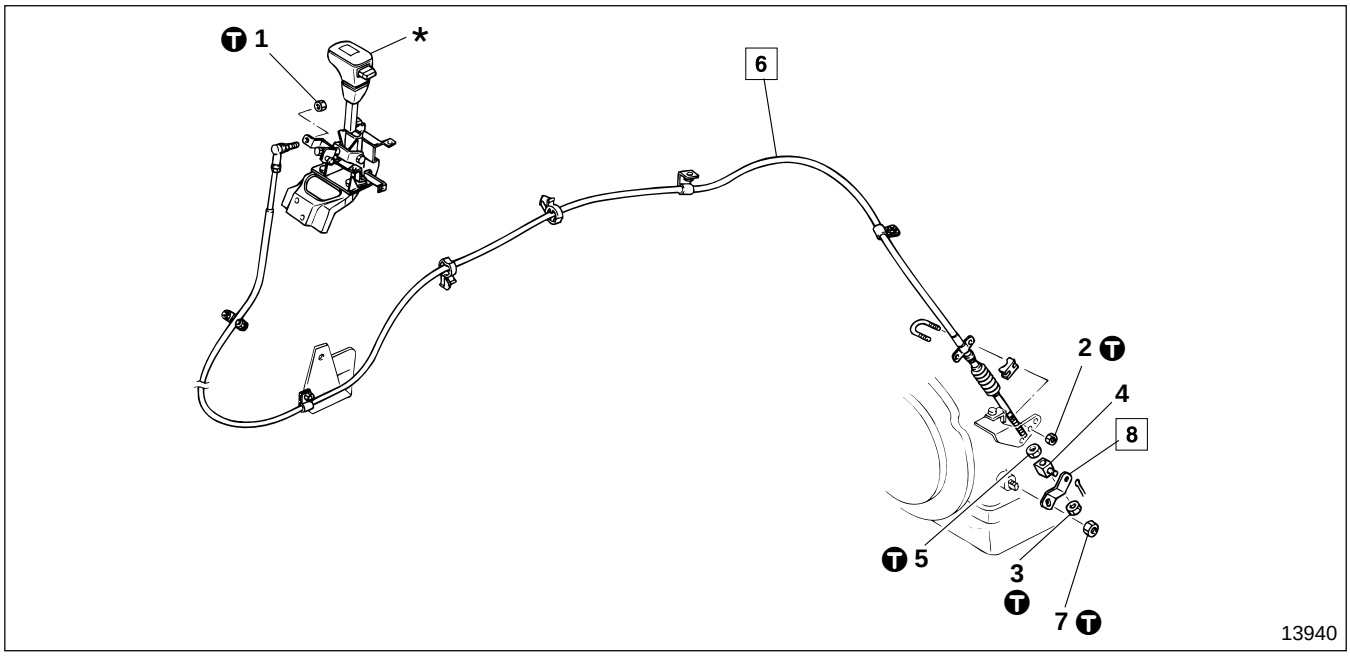
Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	20 to 27 {15 to 20, 2.05 to 2.75}	—
3	Dipstick guide connector	125 to 135 {91 to 100, 12.55 to 13.76}	—
4	Bolt (Oil pan mounting)	14 to 18 {10 to 13, 1.4 to 1.8}	—
7	Bolt (Oil filter mounting)	14 to 18 {10 to 13, 1.4 to 1.8}	—

Fluid

Location	Points of application	Kinds	Quantity
9	Seal ring	Automatic transmission fluid (DEXRON or DEXRON II type)	As required

AUTOMATIC TRANSMISSION CONTROL

Selector Cable



● **Removal sequence**

1 Nut
2 Nut
3 Nut
4 Adjuster
5 Nut
6 Selector cable
7 Nut
8 Selector lever

***** : Range selector lever 📖 P23B-22

● **Installation sequence**

***→6→1→5→4→3→2**
8→7→2

● **Inspection after installation**

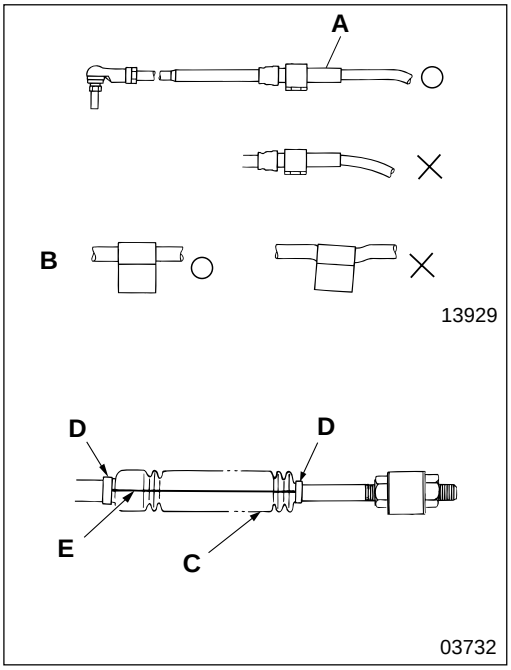
📖 P23B-21

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Selector cable mounting)	18.6 to 23.5 {14 to 17, 1.9 to 2.4}	—
2	Nut (U-bolt mounting)	21 to 30 {16 to 22, 2.15 to 3.05}	—
3, 5	Nut (Selector cable mounting)	4 to 6 {3.0 to 4.4, 0.41 to 0.61}	—
7	Nut (Selector lever mounting)	23.5±3.4 {17±2.5, 2.4±0.35}	—

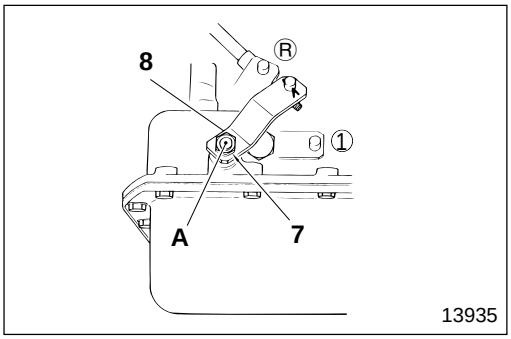
◆ Service procedure



6 Installation of selector cable

NOTE

- **Make sure casing cap A is installed in a straight line.**
- **Cable bend radius must be 20 cm {7.87 in.} or more.**
- **Make sure the cable is straight.**
- **Install the clamp at right angles to the cable. (Figure B)**
- **Do not twist clamps D at the ends of boot C. Install so that white line E on the boot is a straight line. (Figure E)**



8 Installation of selector lever

If selector lever **8** has been removed, rotate selector shaft **A** and move it to an intermediate position between, but other than, ① and Ⓡ, then tighten nut **7**.

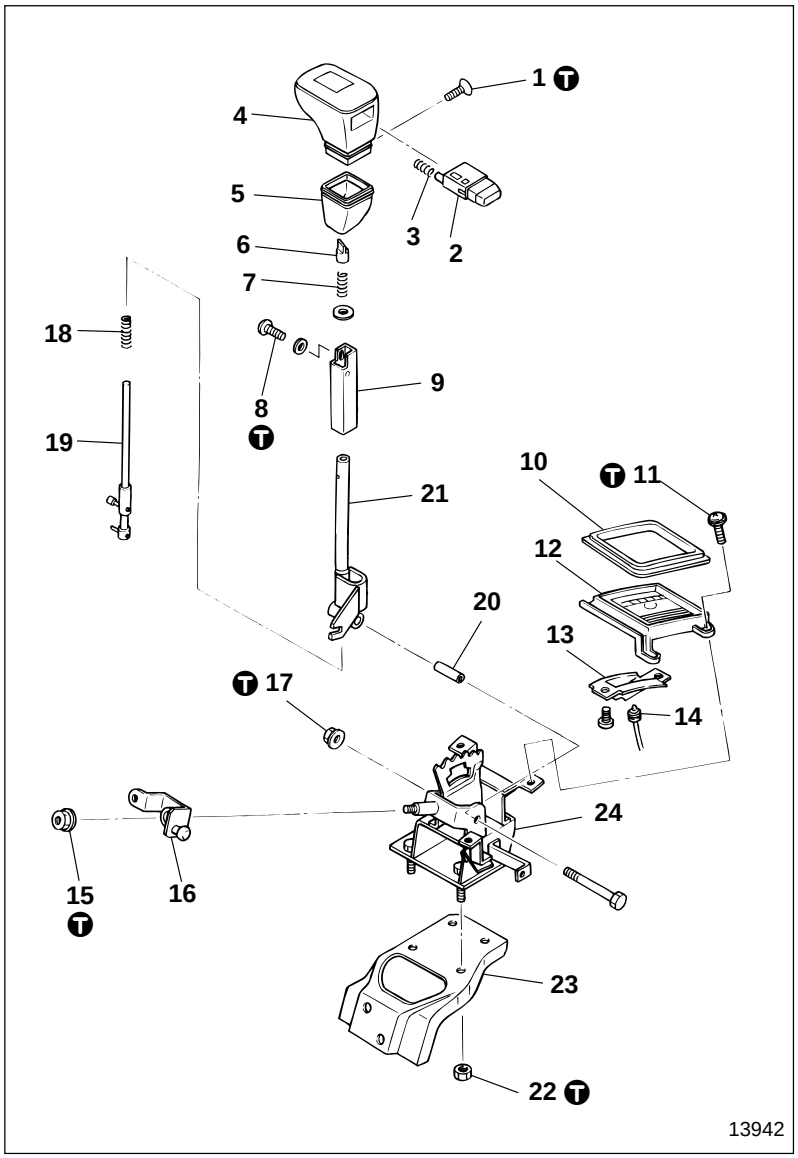
CAUTION ⚠

Be careful not to overtighten nut 7, it might cause the internal lever to malfunction.

● Inspection after installation

- Make sure that when the range selector lever * on the driver's side is operated, the detent positions of selector lever **8** on the automatic transmission side agree with the corresponding positions of the range selector lever on the driver's side. Also make sure that the range selector lever on the driver's side and the selector lever on the automatic transmission side are both operating smoothly.
- Make sure the modulator cable moves smoothly.
- Make sure the starter switch can be operated only in the neutral position, and is disabled for all other positions.
- Make sure the backup lamps light when the selector is in the reverse (R) position.
  (The lamps do not light when the engine is stopped.)

Range Selector Lever



● **Disassembly sequence**

1 Screw
2 Push button
3 Spring
4 Knob assembly
5 Cover
6 Sleeve
7 Spring
8 Screw
9 Pipe
10 Indicator rubber
11 Screw
12 Panel assembly
13 Holder
14 Indicator lamp
15 Nut
16 Range selector lever B
17 Nut
18 Spring
19 Rod assembly
20 Pipe
21 Range selector lever A
22 Nut
23 Set board bracket
24 Set board assembly

● **Assembly Sequence**

24→23→22→17→16→15→14→13→12→21→20→19→18→11→10→9→8→7→6→5→1→4→3→2

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

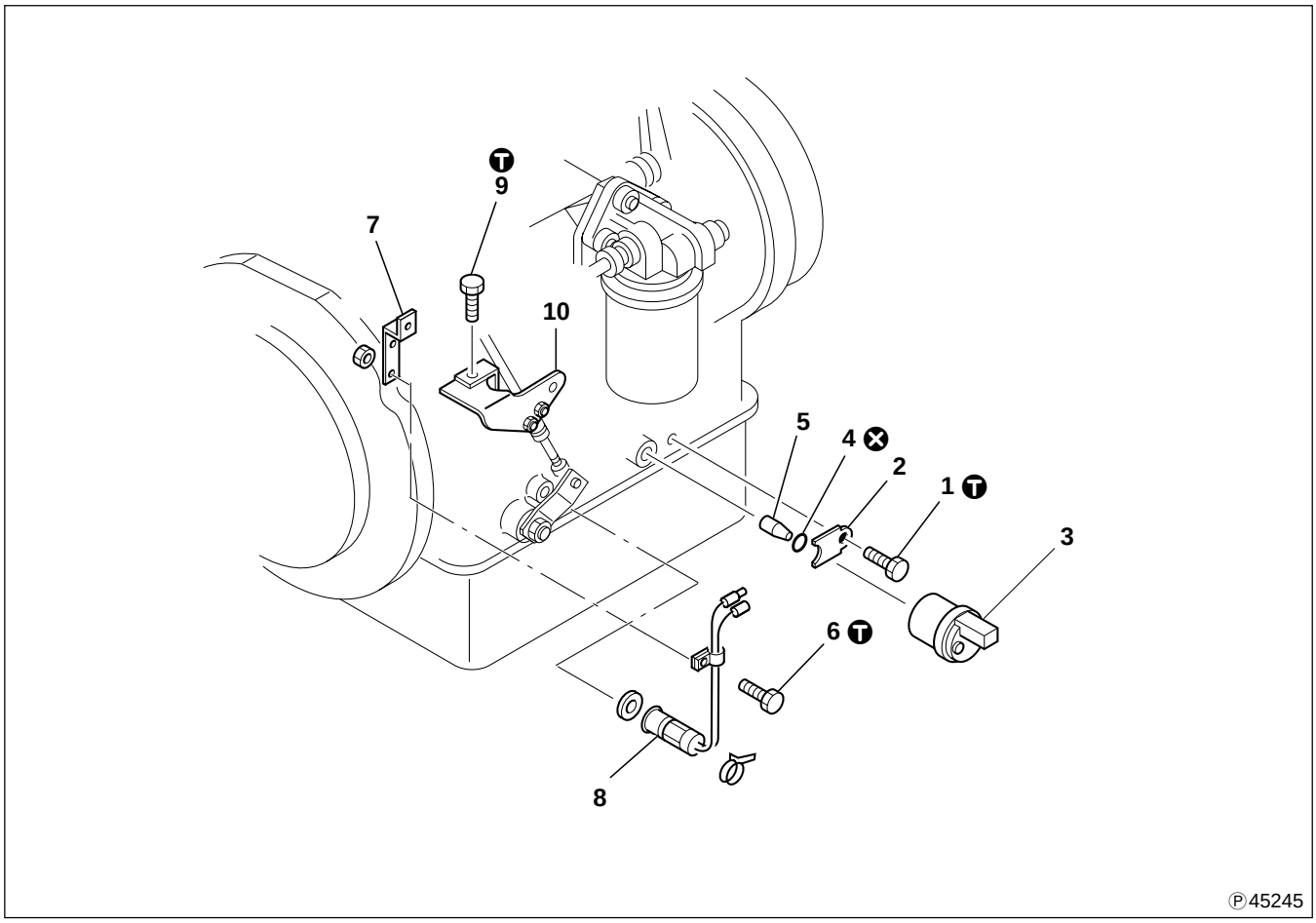
Location	Parts to be tightened	Tightening torque	Remarks
1	Screw (Knob assembly mounting)	2 {1.4, 0.2}	—
8	Screw (Pipe mounting)	2 {1.4, 0.2}	—
11	Screw (Panel assembly mounting)	2 {1.4, 0.2}	—
15	Nut (Range selector lever B mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
17	Nut (Range selector lever A mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
22	Nut (Setboard bracket mounting)	21 to 30 {16 to 22, 2.15 to 3.05}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	All sliding areas	Chassis grease [NLGI No.1 (Ca soap)]	As required

M E M O

Modulator Assembly and Neutral Start Switch



● **Removal sequence**

1 Bolt
2 Retainer
3 Modulator assembly
4 O-ring
5 Valve rod
6 Bolt
7 Backet
8 Neutral start switch Gr 54
9 Bolt
10 Bracket
⊗ : Non-reusable parts

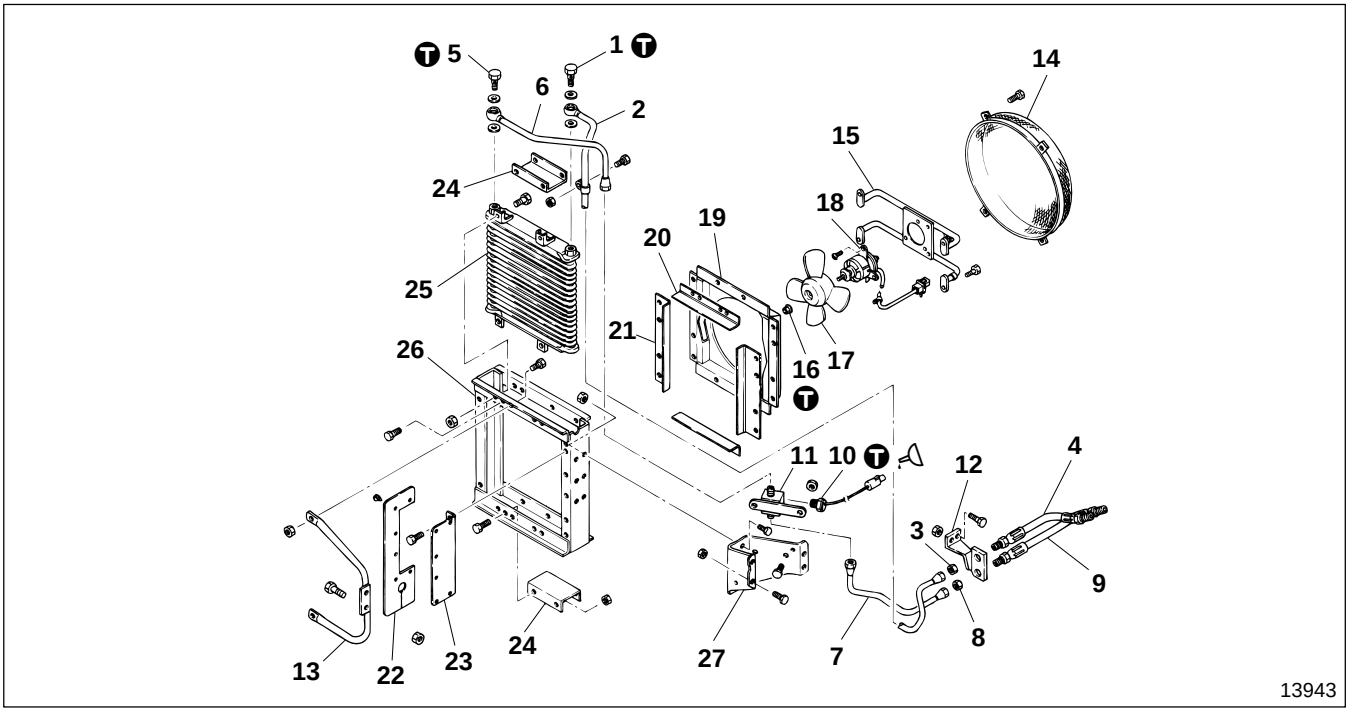
● **Installation sequence**

17→16→15→14→13→12→11→9→8→7→6→5→4→3→2→1
10

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Retainer mounting)	17±2.5 {13±1.8, 1.75±0.25}	—
6	Bolt (Clamp mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
9	Bolt (Bracket mounting)	59 to 83 {43 to 61, 6.0 to 8.5}	—



● **Removal sequence**

1 Eye bolt
2 Oil pipe
3 Nut
4 Oil hose
5 Eye bolt
6 Oil pipe
7 Oil pipe
8 Nut
9 Oil hose
10 Automatic transmission fluid thermostat switch Gr 54
11 Connector
12 Hose bracket
13 Oil cooler stay
14 Fan cover
15 Fan motor bracket
16 Nut
17 Fan assembly
18 Motor assembly Gr 54
19 Fan shroud
20 Fan shroud A
21 Fan shroud B
22 Baffle plate
23 Baffle plate bracket
24 Stay
25 Oil cooler
26 Oil cooler bracket
27 Oil cooler support

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

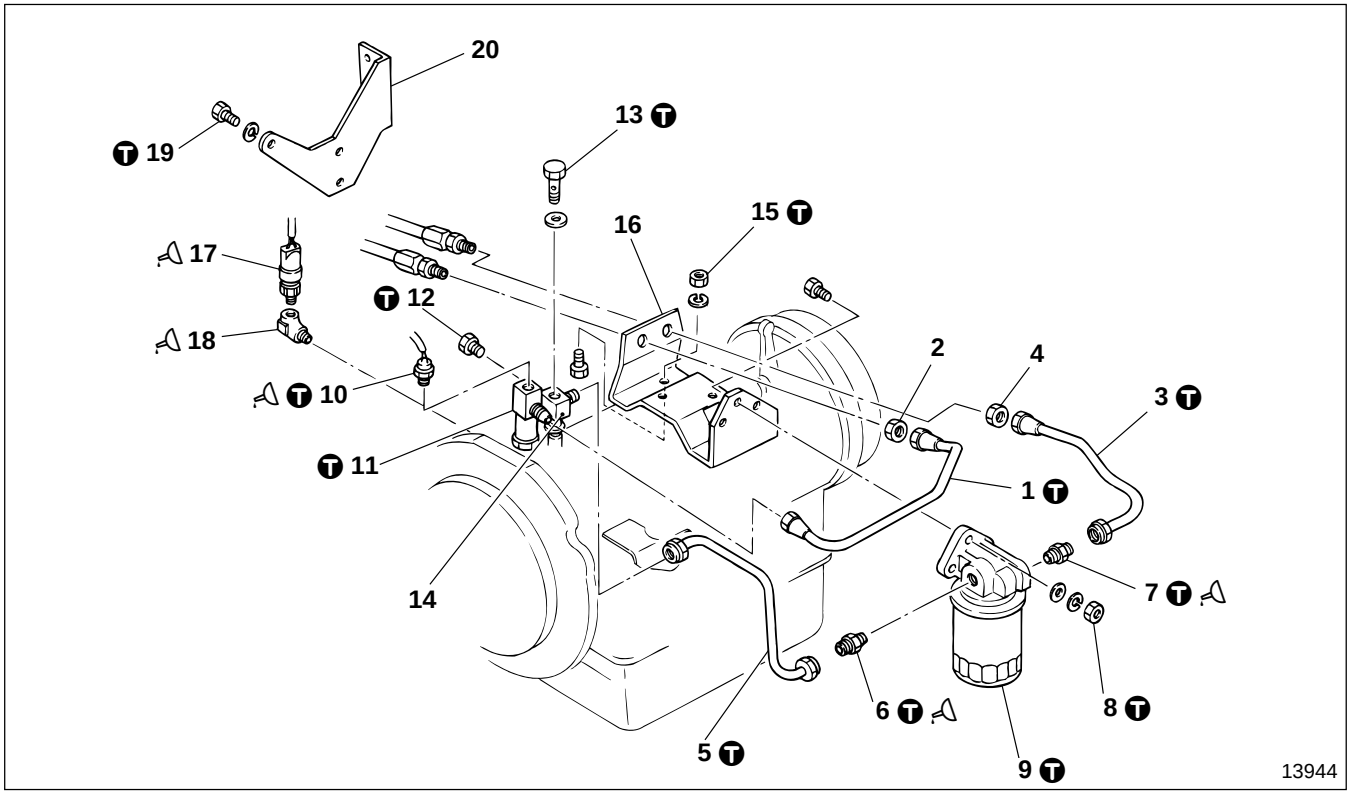
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 5	Eye bolt	59 to 88 {43 to 65, 6 to 9}	—
10	Automatic transmission fluid thermostat switch	29 to 39 {22 to 29, 3 to 4}	—
16	Nut (Fan assembly mounting)	4.2 to 5.2 {3.1 to 3.8, 0.43 to 0.53}	—

Sealant

Location	Points of application	Kinds	Quantity
10	Automatic transmission fluid thermostat switch	THREEBOND 1110B	As required

OIL FILTER



● **Removal sequence**

1 Oil pipe
2 Nut
3 Oil pipe
4 Nut
5 Oil pipe
6 Connector
7 Connector
8 Nut
9 Oil filter
10 Automatic transmission fluid temperature switch Gr 54
11 Connector
12 Plug
13 Eye bolt
14 Union joint
15 Nut
16 Oil filter bracket
17 Backup lamp switch Gr 54
18 Connector
19 Bolt
20 Hand brake cable bracket

● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5	Oil pipe	69 to 93 {51 to 69, 7.0 to 9.5}	—
6, 7	Connector	59 to 98 {43 to 72, 6 to 10}	—
8	Nut (Oil filter mounting)	21 {15, 2.13}	—
9	Oil filter (Cartridge mounting)	9.8 to 20 {7.2 to 14, 1 to 2}	—
10	Automatic transmission fluid temperature switch	29 to 39 {22 to 29, 3 to 4}	—
11	Connector	39 to 49 {29 to 36, 4 to 5}	—
12	Plug	34±7.8 {25±5.8, 3.5±0.8}	—
13	Eye bolt	74±15 {54±11, 7.5±1.5}	—
15	Nut (Oil filter bracket mounting)	115 to 155 {87 to 115, 12 to 16}	—
19	Bolt (Hand brake cable bracket mounting)	58 to 68 {43 to 50, 5.9 to 6.9}	—

Sealant

Location	Points of application	Kinds	Quantity
6, 7, 17, 18	Connector and thread area of backup lamp switch	THREEBOND 1207B	As required
10	Thread area of automatic transmission fluid temperature switch	THREEBOND 1110B	As required

MITSUBISHI
FUSO

Group 25
Propeller Shaft

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-25

INDEX

SPECIFICATIONS 25- 2

STRUCTURE AND OPERATION 25- 2

TROUBLESHOOTING 25- 3

REMOVAL AND INSTALLATION OF PROPELLER SHAFT 25- 4

REAR PROPELLER SHAFT 25- 6

FRONT PROPELLER SHAFT 25-10

BALANCING PROPELLER SHAFT 25-14

SPECIFICATIONS/STRUCTURE AND OPERATION

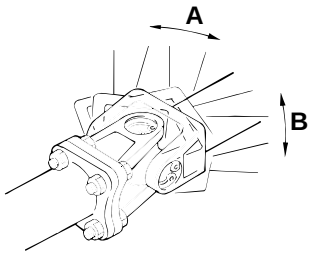
SPECIFICATIONS

Item			Specifications
Propeller shaft	Model		P4
Pipe	Outer diameter×Wall thickness	mm {in.}	90×2.6 {3.54×0.10}
Universal joint	Spider outer diameter	mm {in.}	26.7 {1.05}
Needle bearing	Outer diameter	mm {in.}	3.0 {0.12}
	Length of needle roller	mm {in.}	21.8 {0.86}
	Quantity of needle rollers		31
Slip yoke joint	Spline diameter	mm {in.}	48 {1.89}
Center bearing	Model No.		6209
	Inner diameter×Outer diameter	mm {in.}	45×85 {1.77×3.35}

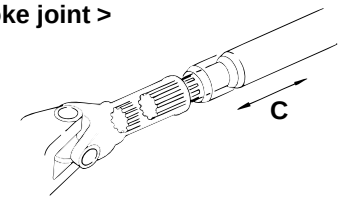
STRUCTURE AND OPERATION

Swing of Propeller Shaft

< Universal joint >



< Slip yoke joint >

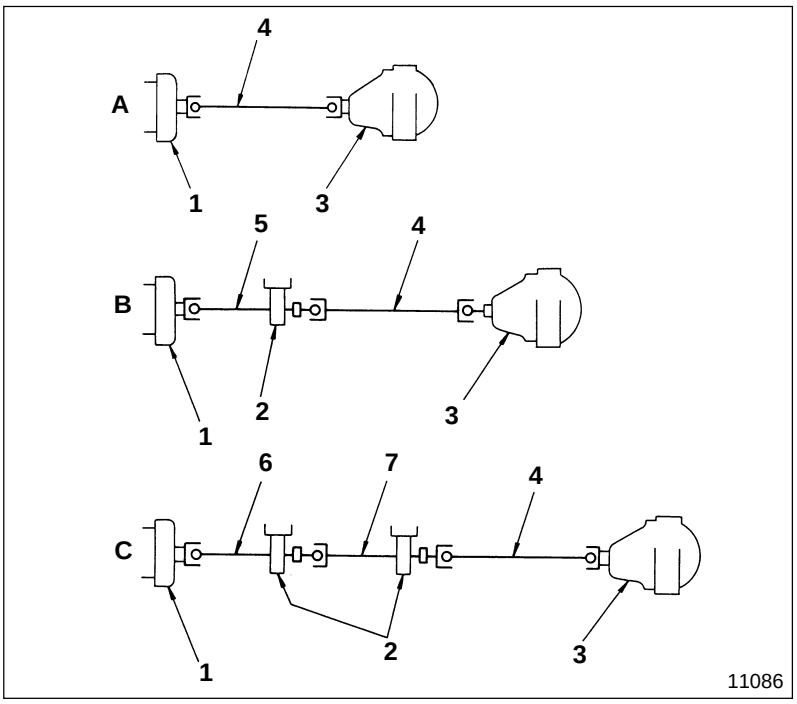


00815

A : Lateral swing
B : Longitudinal swing
C : Fore-and-aft movement

Relative positions of transmission and rear axle vary depending on the fluctuation of the road surface and load carried when operating the vehicle.
The universal joint and the slip yoke joint are provided to absorb these influences.

Configuration of Propeller Shaft Connection



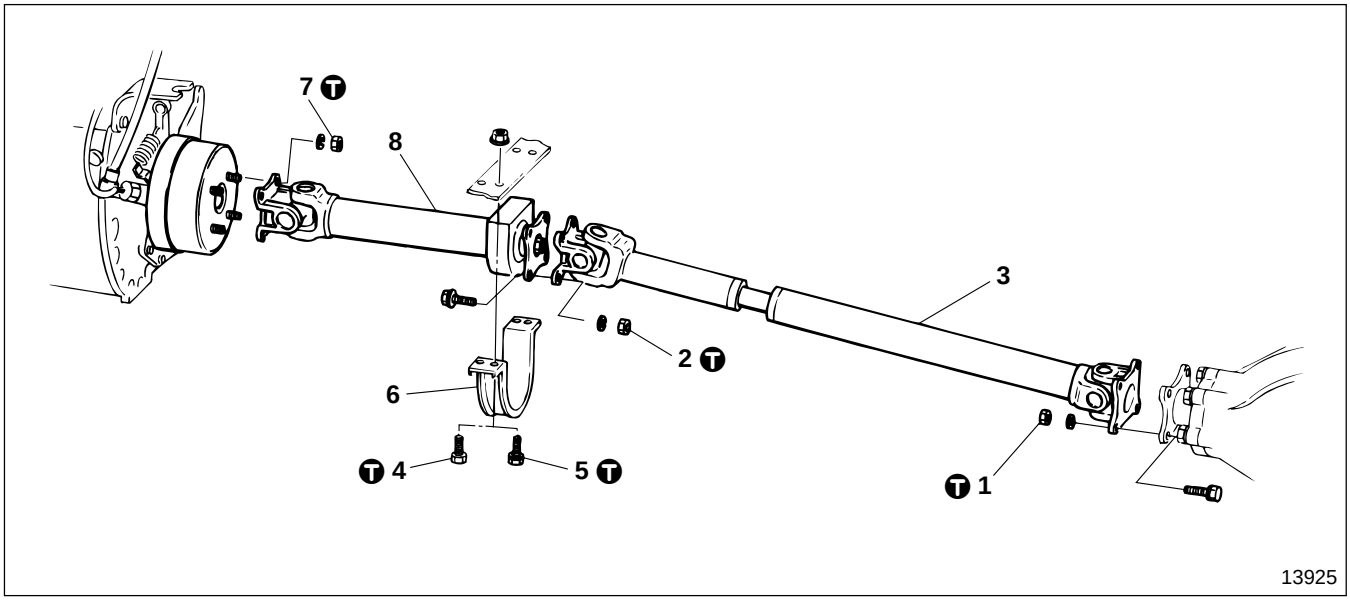
1 Parking brake drum
2 Center bearing
3 Rear axle
4 Rear propeller shaft
5 Front propeller shaft
6 Front propeller shaft No.1
7 Front propeller shaft No.2

A : Single-shaft connection
B : Twin-shaft connection
C : Triple-shaft connection

TROUBLESHOOTING

Possible causes \ Symptoms		Propeller shaft vibrating		Noise from propeller shaft		
		Vibration at high speed	Vibration at low speed	Noise when starting or while coasting	Noise while cruising	Clicking noise
Flange yoke assembly direction incorrect		○				
Companion flange tightening torque excessive						○
Slip yoke joint	Lubrication insufficient				○	
	Spline play excessive		○	○		
Universal joint	Clearance in spider axial direction excessive		○		○	
	Needle bearing lubricated insufficiently				○	
	Needle bearing worn	○		○	○	
Center bearing < Twin-shaft connection, Triple-shaft connection >	Lubrication insufficient				○	
	Seized, worn, or rotation faulty	○			○	
	Cushion rubber deteriorating or deformed			○		
	Bracket mounting bolt loose			○		
Propeller shaft	Mounting bolt loose	○		○		
	Bent	○				
	Dynamic balance adjusted incorrectly	○				
Transmission gear selection too high			○			

REMOVAL AND INSTALLATION OF PROPELLER SHAFT



● **Work before removal**

P25-4

● **Removal sequence**

1 Nut
2 Nut
3 Rear propeller shaft
P25-6
4 Bolt (without spring washer)
5 Bolt (with spring washer)
6 Center bearing bracket
7 Nut
8 Front propeller shaft
P25-10

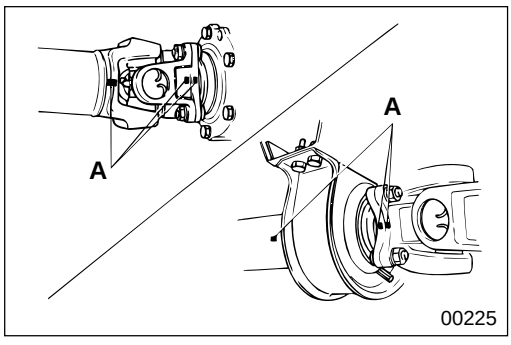
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Propeller shaft mounting at rear axle side)	85 {61, 8.5}	—
2	Nut (Propeller shaft mounting at center bearing side)	85 {61, 8.5}	—
4	Bolt (Center bearing bracket mounting)	39 to 59 {28 to 43, 3.9 to 6.0}	Without spring washer
5	Bolt (Center bearing bracket mounting)	36 to 52 {25 to 40, 3.5 to 5.5}	With spring washer
7	Nut (Propeller shaft mounting at propeller shaft side)	85 {61, 8.5}	—



◆ Service procedure

● **Work before removal**

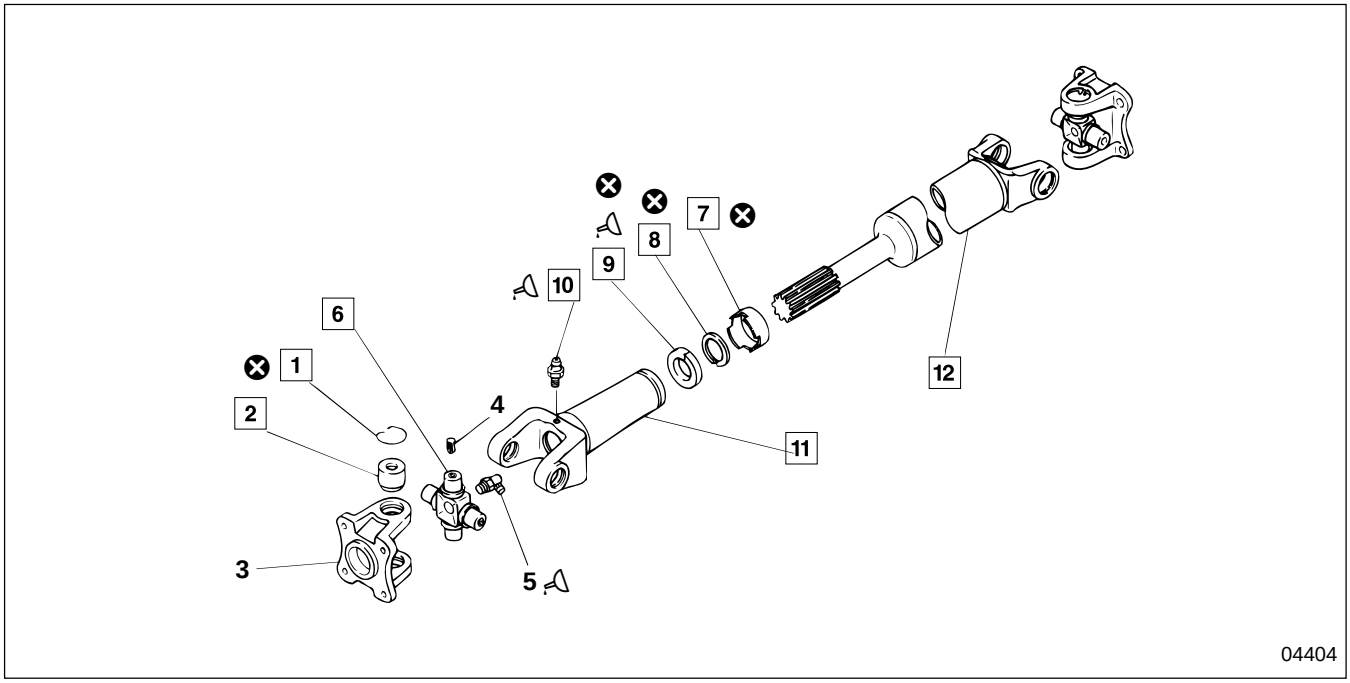
WARNING

- **Since the propeller shaft will be removed, the parking brake cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**

Remember to make alignment marks **A** before removal.

M E M O

REAR PROPELLER SHAFT



● **Inspection before disassembly**

P25-7

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease keeper
5 Grease nipple
6 Spider
7 Dust cap
8 Retainer
9 Cork seal
10 Grease nipple
11 Slip yoke joint
12 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

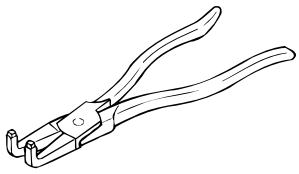
Unit : mm {in.}

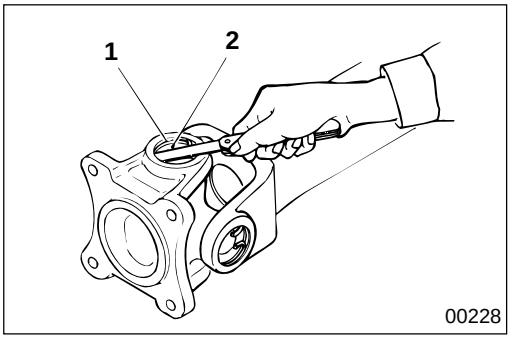
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 6	Clearance in axial direction of spider	0 to 0.25 {0 to 0.0098}	—	Adjust
2, 6	Clearance between needle bearing and spider	[26.7] 0.02 to 0.07 {[1.05] 0.00079 to 0.0028}	0.2 {0.0079}	Replace
11, 12	Play to revolving direction between slip yoke joint and rear propeller shaft	0.07 to 0.18 {0.0028 to 0.0071}	0.3 {0.012}	Replace
12	Bend of rear propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Lubricant

Location	Points of application	Kinds	Quantity
5	Supply via grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	Pack until grease overflows from spider dust cover
9	Inner surface of cork seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
10	Supply via grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	Pack until grease overflows from dust plug hole

Special tools

Location	Tool name and shape	Part No.	Application
1	Snap ring repressor  00227	MH061001	Removal and installation of snap ring



00228

◆ Service procedure

● **Inspection before disassembly**

Clearance in axial direction for spider

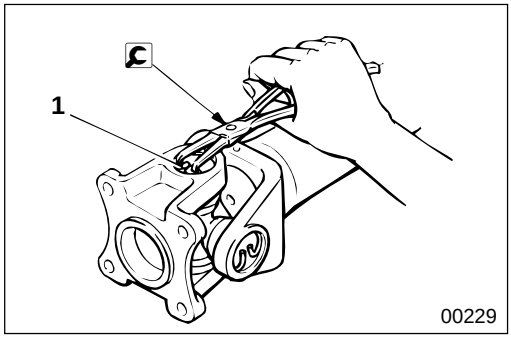
Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

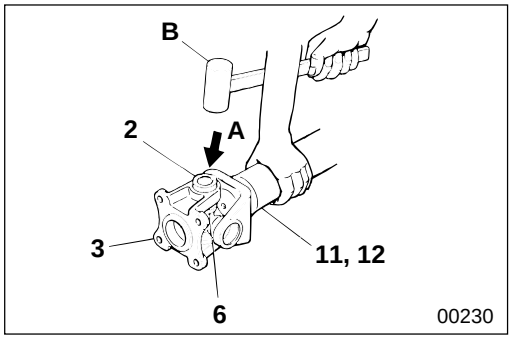
Part name	Thickness	Identification color
Snap ring A	2.5 mm {0.098 in.}	Green
Snap ring B	2.6 mm {0.10 in.}	Red

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.

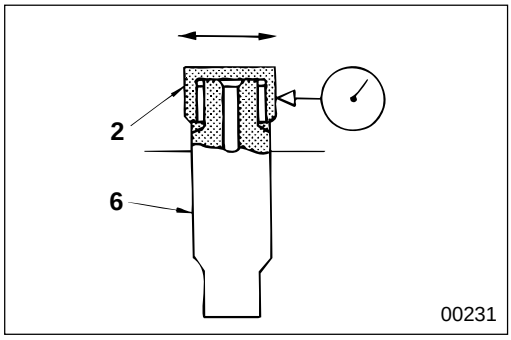


1 **Removal and installation of snap ring**



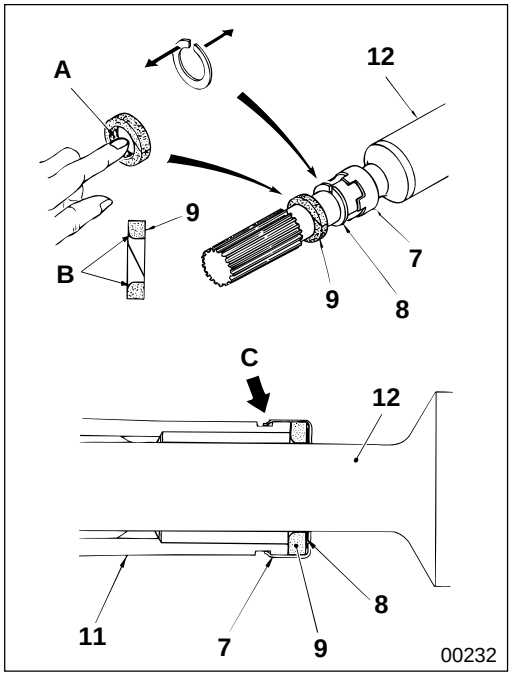
2 **Removal of needle bearing**

- Make alignment marks on needle bearing **2** and spider **6**.
- Make alignment marks across flange yoke **3**, slip yoke joint **11** and rear propeller shaft **12**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.
  B : Mallet



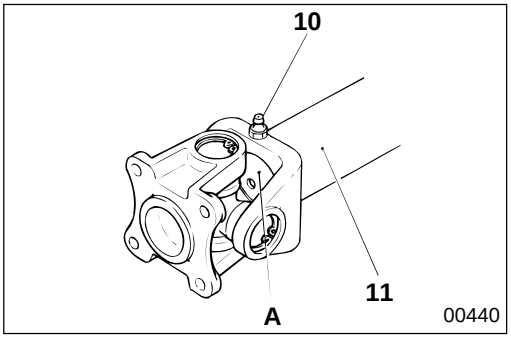
2 **6** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **2** and spider **6**. If the measured value is higher than the limit, replace with universal joint spider kit.



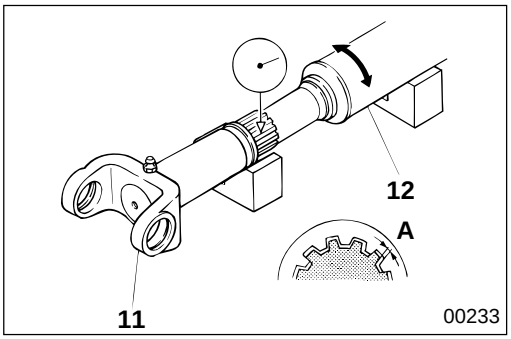
7 **to** **9** **Assembly of dust cap, retainer and cork seal**

- Insert dust cap **7** into rear propeller shaft **12** and expand retainer **8** carefully to mount it on the propeller shaft. Then, release the retainer and allow it to return to its original shape.
- Apply grease to inner surface **A** of cork seal **9**, face its chamfered side **B** towards the spline and mount in the same way as retainer **8**.
- Press cork seal **9**, compressing it by 1 to 2 mm {0.039 to 0.079 in.}, against slip yoke joint **11**, then caulk pawl area **C**.



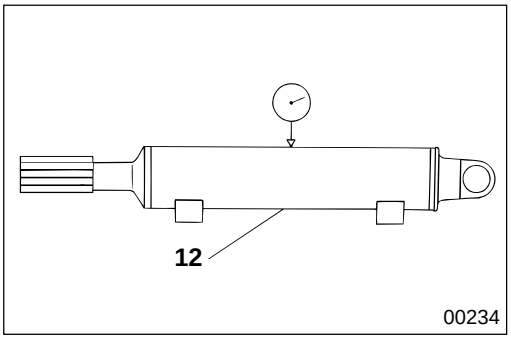
10 **Supply of grease via grease nipple**

Pack grease via grease nipple **10** until grease starts overflowing from the hole in dust plug **A** of slip yoke joint **11**.



11 **12** **Play between slip yoke joint and rear propeller shaft spline in rotaring direction**

Measure play **A** between slip yoke joint **11** and rear propeller shaft **12** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



12 **Bend of rear propeller shaft**

Measure bend of rear propeller shaft **12** at its center. If the measured value is higher than the limit, correct or replace it.

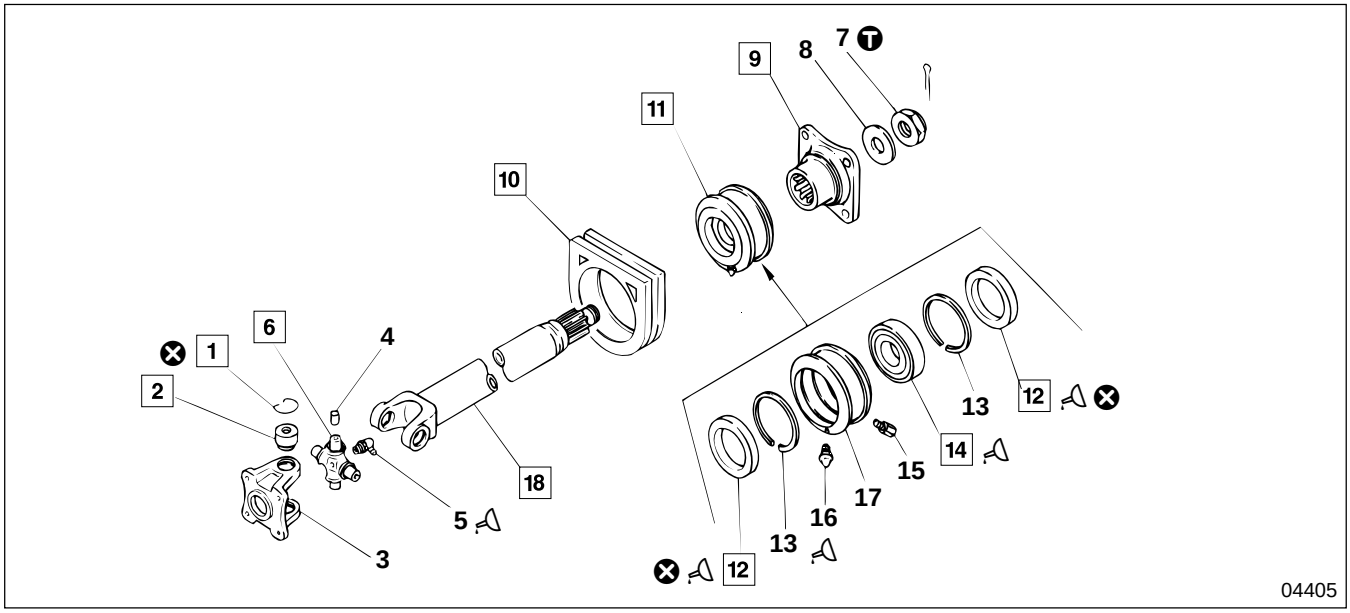
CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of rear propeller shaft 12, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

FRONT PROPELLER SHAFT



● **Inspection before disassembly**

P25-11

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease keeper
5 Grease nipple
6 Spider
7 Nut
8 Washer
9 Companion flange
10 Cushion rubber
11 Center bearing
12 Oil seal
13 Snap ring
14 Center bearing
15 Relief valve
16 Grease nipple
17 Center bearing case
18 Front propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 6	Clearance of spider is axial direction	0 to 0.25 {0 to 0.0098}	—	Adjust
2, 6	Clearance between needle bearing and spider	[26.7] 0.02 to 0.07 {[1.05] 0.00079 to 0.0028}	0.2 {0.0079}	Replace
18	Bend of front propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

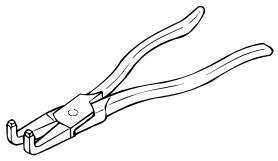
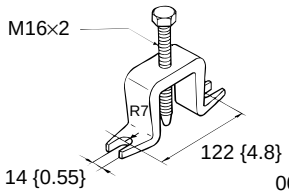
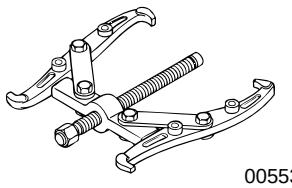
Location	Parts to be tightened	Tightening torque	Remarks
7	Nut (Companion flange mounting)	200 to 340 {145 to 255, 20 to 35}	—

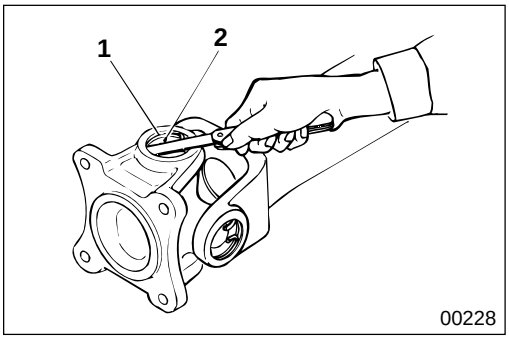
Lubricant

Location	Points of application	Kinds	Quantity
5	Supply via grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	Pack until grease overflows from spider dust cover
12	Lip area of oil seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
14	Pack area of center bearing assembly that houses ball bearings	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
16	Supply via grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	Pack until grease overflows from relief valve

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  00227	MH061001	Removal and installation of snap ring
9	Flange puller  00552	MC881524	Removal of companion flange
17	Gear puller  00553	MH061102	Removal of center bearing



00228

◆ Service procedure

● **Inspection before disassembly**

Clearance in axial direction for spider

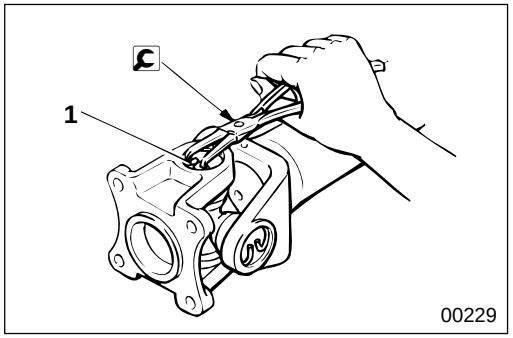
Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

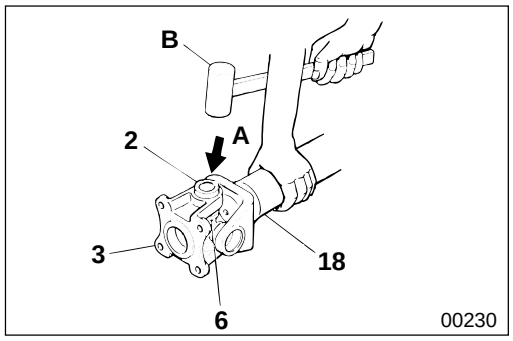
Part name	Thickness	Identification color
Snap ring A	2.5mm {0.098 in.}	Green
Snap ring B	2.6mm {0.10 in.}	Red

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.

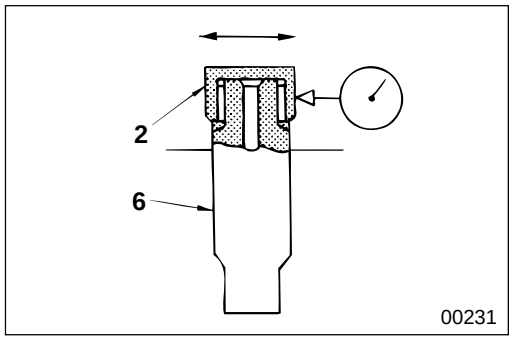


1 **Removal and installation of snap ring**



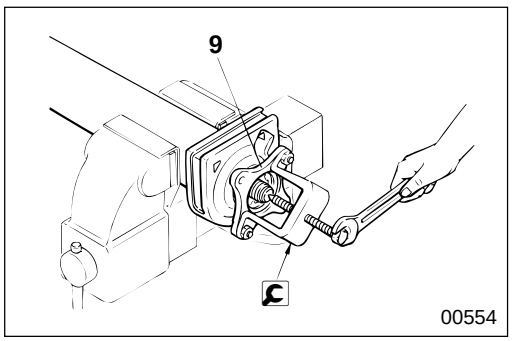
2 **Removal of needle bearing**

- Make alignment marks on needle bearing **2** and spider **6**.
- Make alignment marks across flange yoke **3** and front propeller shaft **18**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.
  B : Mallet

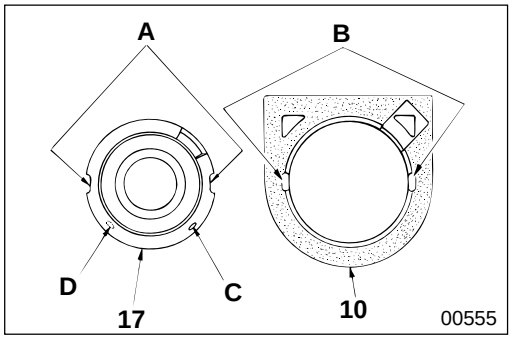


2 **6** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **2** and spider **6**. If the measured value is higher than the limit, replace with universal joint spider kit.



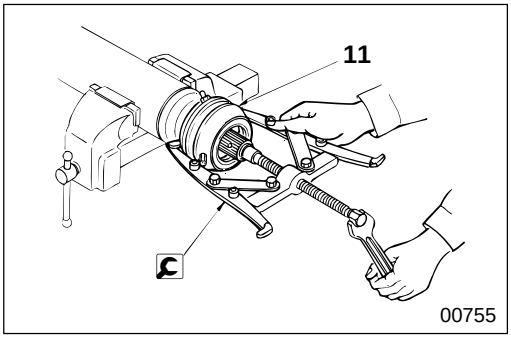
9 **Removal of companion flange**



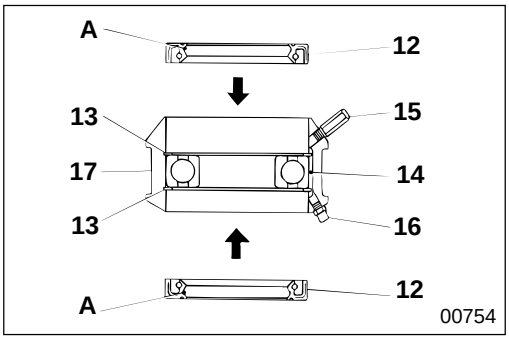
10 **Installation of cushion rubber**

- Align part **A** of center bearing case **17** to part **B** of cushion rubber **10**, and fit them together. When it is hard to fit them together, apply some soapy water to facilitate the fitting work.
- Assemble center bearing case **17** so that grease nipple mounting hole **D** faces downward.

C : Relief valve mounting hole
D : Grease nipple mounting hole

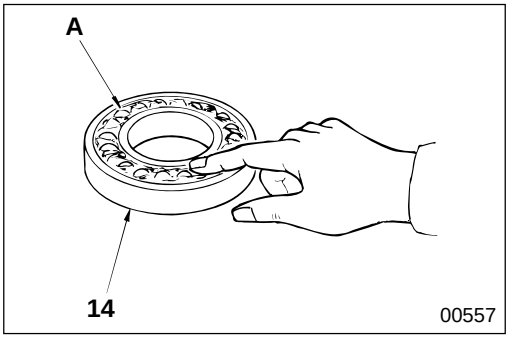


11 **Removal of center bearing assembly**



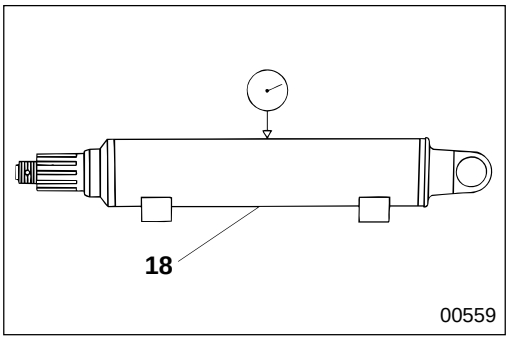
12 **Installation of oil seal**

- Apply grease to oil seal **12** lip area **A** and install to the direction as illustrated.
- Install oil seal **12** flush with center bearing case **17** end surface.



14 **Packing grease in center bearing**

Pack grease into the area that houses ball bearings **A** of center bearing **14**.



18 **Bend of front propeller shaft**

Measure bend of front propeller shaft **18** at its center. If the measured value is higher than the limit, connect or replace it.

CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of front propeller shaft 18, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

BALANCING PROPELLER SHAFT

Adjustment after Assembly

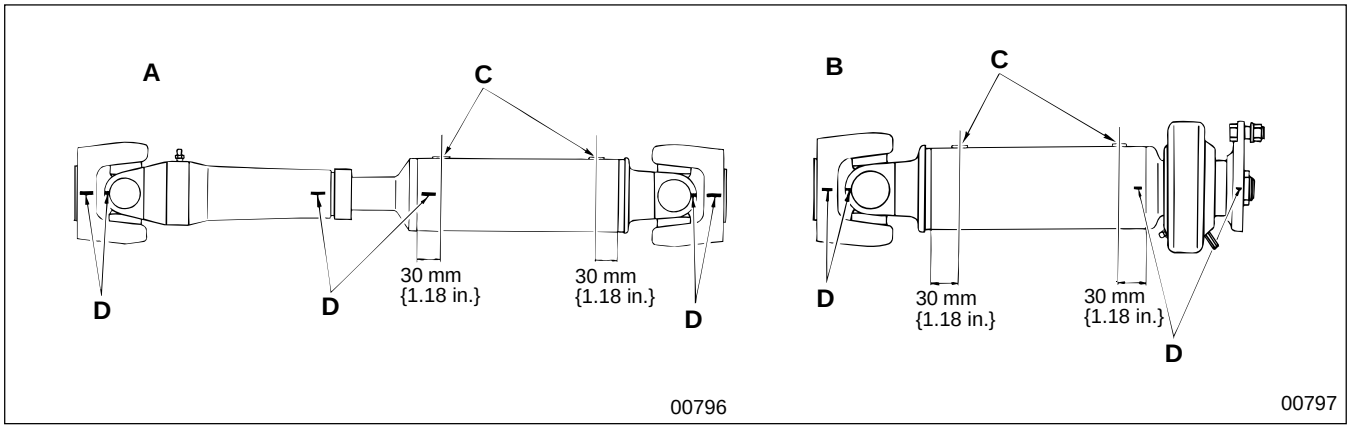
(1) After correction of propeller shaft deflection, or replacement of flange yoke and universal joint, adjust the amount of balance of the completed propeller shaft assembly on a balancing machine, and adjust by adding balance piece(s) so that the amount comes within the permissible limit.

(2) For correction of dynamic balance, use the polar coordination method.

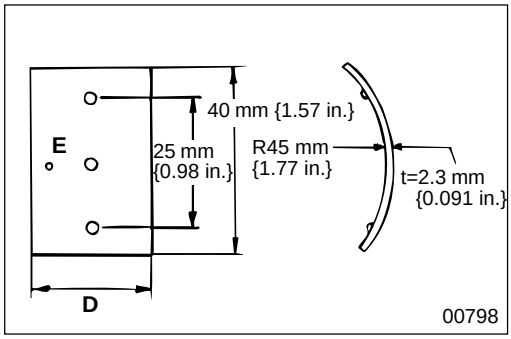
(3) Permissible amount of unbalance
0.49 N·cm {0.0036 ft.lbs, 50 gf·cm}/1600 rpm (Pipe outer periphery)

(4) Method of correction by way of the polar coordination method

• Balance piece attachment point



A : Rear propeller shaft
B : Front propeller shaft
C : Balance piece attachment point
D : Alignment mark



• Balance pieces available

Part name	Mass {oz}	Dimension D mm {in.}
Balance piece G	10 {0.35}	14 {0.55}
Balance piece A	20 {0.71}	28 {1.1}
Balance piece B	40 {1.41}	55.7 {2.19}
Balance piece C	60 {2.36}	83.5 {3.29}
Balance piece H	30 {1.06}	42 {1.65}

E : Mass punch mark

NOTE

- **Maximum balance piece allowed for one point is 120 g {4.23 oz}.**
- **Use a combination that keeps balance pieces to the minimum.**

MITSUBISHI
FUSO

Group 26

Front Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-26

INDEX

SPECIFICATIONS 26- 2

STRUCTURE AND OPERATION 26- 2

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Adjustment of Wheel Alignment 26- 4
- Adjustment of Steering Angle 26- 8
- Measurement of Side Slip 26- 8

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT AXLE 26- 9

WHEEL HUB AND BRAKE DRUM 26-10

FRONT AXLE, KNUCKLE AND KINGPIN 26-22

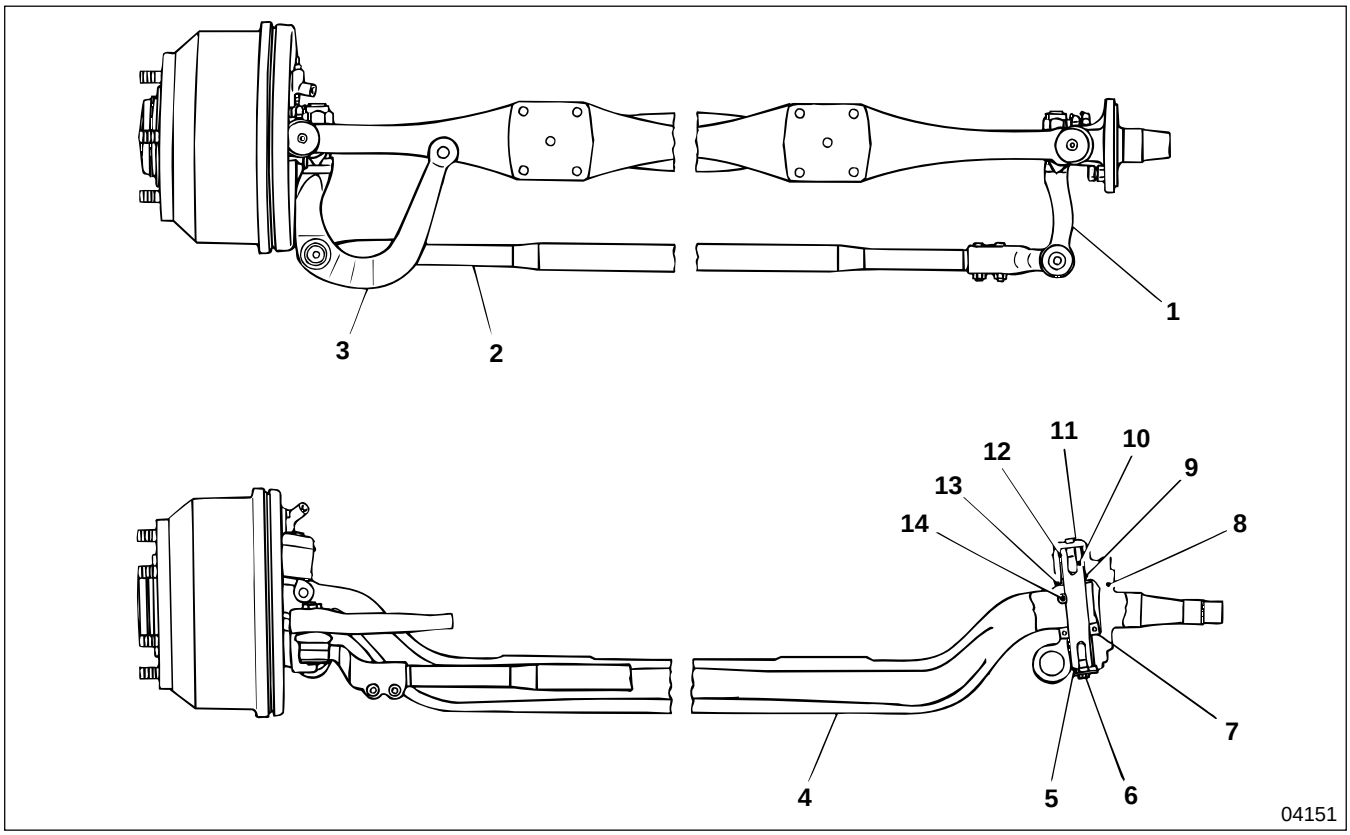
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Front axle	Model	F040T
	Type	I section, reverse Elliot type
Kingpin	Outer diameter × Length mm {in.}	35×195 {1.38×7.68}
Tread	mm {in.}	1785 {70.3}
Mass	kg {lb}	Approximately 185 {405}

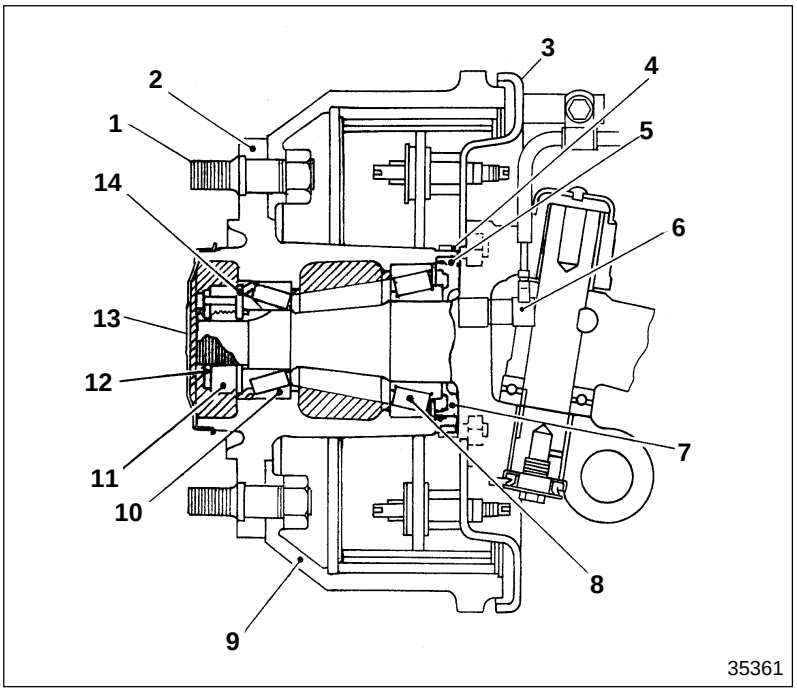
STRUCTURE AND OPERATION

Front Axle, Knuckle and Kingpin



1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Front axle
5 Dust seal
6 Lower kingpin cover
7 Bearing
8 Knuckle
9 Oil seal
10 Kingpin
11 Kingpin cap
12 Bushing
13 Thrust washer
14 Set bolt

Wheel Hub and Brake Drum



1 Hub bolt
2 Front wheel hub
3 Front brake assembly
4 Rotor
5 Oil seal
6 Wheel speed sensor
7 Knuckle retainer
8 Inner bearing
9 Front brake drum
10 Outer bearing
11 Lock nut
12 Lock plate
13 Wheel hub cap
14 Lock washer

ON-VEHICLE INSPECTION AND ADJUSTMENT

Adjustment of Wheel Alignment

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Wheel alignment	Toe-in (With tires on the ground)	0±1 {0±0.039}	—	Adjust
		Camber	1°30'±1°00'	—	—
		Caster	2°30' $^{+1°30'}_{-1°00'}$	—	Adjust
		Kingpin inclination angle	7°00'	7°00'±30'	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

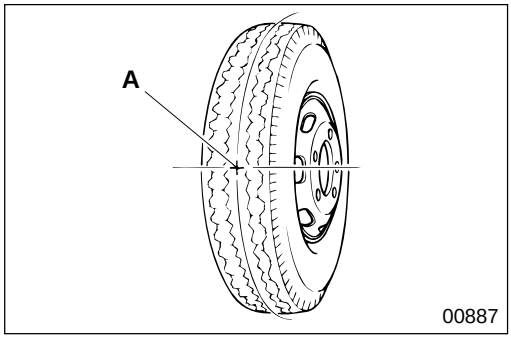
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Tie rod end clamp fastening)	78 {58, 8}	Wet

NOTE

- **Measure the wheel alignment when the vehicle is empty and level.**
- **Be sure that each part of the front axle has been serviced perfectly before adjusting the wheel alignment.**

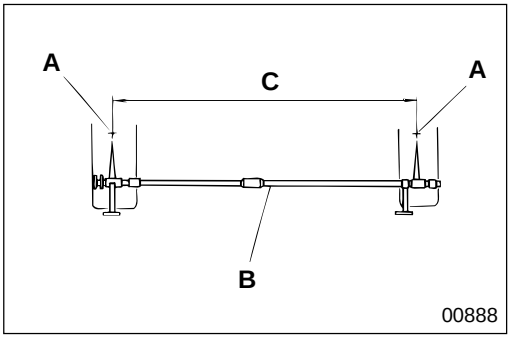
Before adjusting the wheel alignment, check for the following faults:

- Play in front wheel hub
- Play or looseness in kingpin
- Play or looseness in the joint between the tie rod and the knuckle arm
- Looseness of any fasteners
- Permanently set or damaged leaf springs
- Incorrect tire pressure
- Power steering booster backlash adjustment incorrect

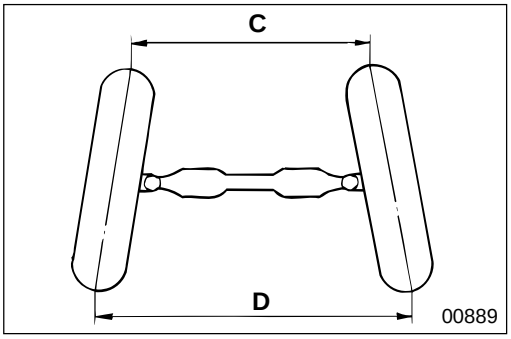


(1) Measurement and adjustment of toe-in

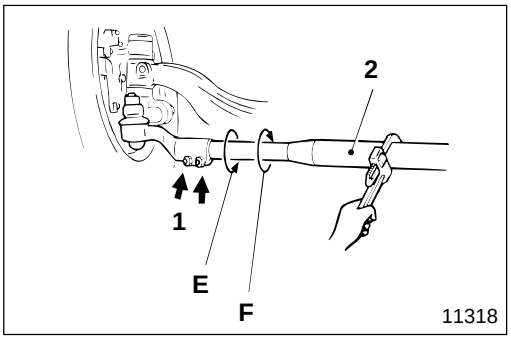
- Point the front wheels forward exactly in running order.
- Put mark **A** on the left and right front tires at the height of front wheel axis and in the middle of the tire width.



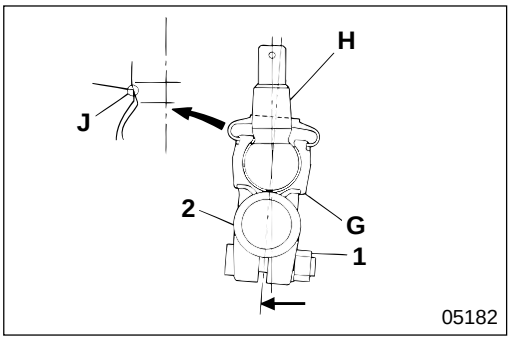
- Align the two points of toe-in gauge **B** to the respective marks **A** on the front tires. Measure the distance **C** between the marks at the front of the vehicle.



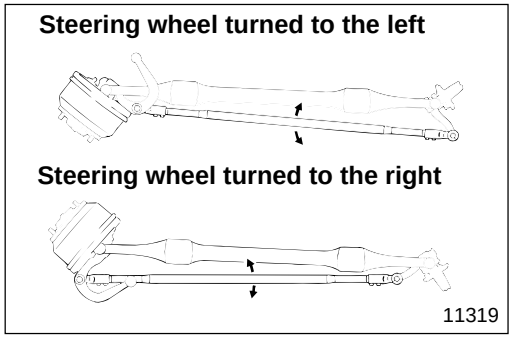
- Rotate the tires 180° and measure distance **D** between the marks at the rear of the vehicle with the tires on the ground.
- Check if the difference between distances **C** and **D** is within the standard value.



- If the measured value deviates from the standard value, with the tires pointed forward, loosen the left and right pairs of nuts **1**. (Total four nuts)
- Adjust the toe-in to the standard value by turning tie rod **2** with a pipe wrench.
  E : To adjust toe-in outward.
  F : To adjust toe-in inward.
  (★ : If tie rod **2** does not swing after the adjustment on 🕮 P26-6, redo from this item.)



- When tightening nuts **1**, push down and hold tie rod **2** backward or forward in the longitudinal direction of the vehicle so that left and right tie rod ends **G** are in contact (**J** as illustrated) with ball studs **H** at the same time.
- Tighten nuts **1** without allowing tie rod ends **G** to move backward or forward in the longitudinal direction of the vehicle.
- If you have to do the above work on your own; after you tighten nuts on one side of tie rod end **G**, when you tighten the nuts on the other end of the tie rod, make sure you keep the tie rod pushed down in the same direction.

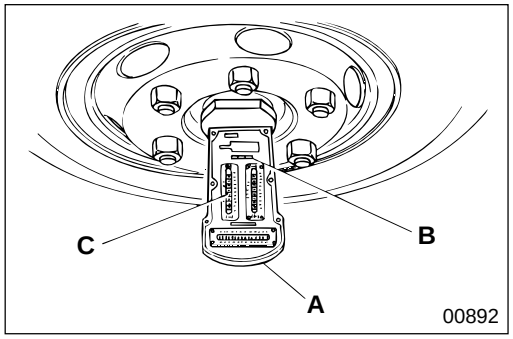


- After adjustment, turn the steering wheel to the left (until the knuckle stopper bolt is contacted), then shake tie rod **2** backward and forward in the longitudinal direction of the vehicle and see if the tie rod moves. Do the same with the steering wheel turned to the right.
  (If the tie rod can be moved, it means that tie rod end **G** and ball stud **H** are in simultaneous contact.)

WARNING⚠

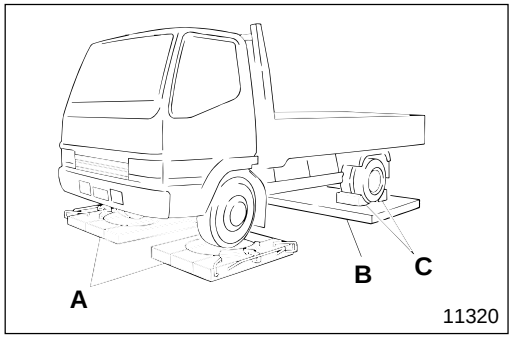
You must be careful not to catch your hand when turning the steering wheel to the left or right, since the tie rod moves.

- If tie rod **2** does not swing, redo the procedure from the item marked ★. 🕮 P26-5



(2) Measurement of camber

- Point the front wheels exactly forward.
- Remove the hub caps.
- Wipe off grease from the knuckle end, and attach camber/caster/kingpin gauge **A** to the knuckle.
- While keeping the bubble in level **B** centered, measure the camber angle by reading the scale mark at the center of the bubble on camber scale **C**.
  Follow this procedure to measure the camber angles on the left and right sides.

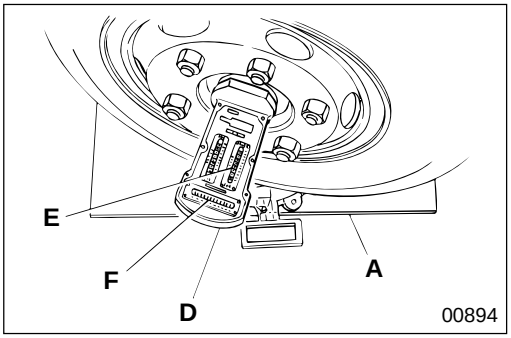


(3) Measurement of caster and kingpin inclination angle

- Prepare a platform **B** having the same height as turning radius gauges **A** and place the platform under the rear wheels so that the vehicle is kept level.
- Keep the turning radius gauges **A** locked.
- Jack up the vehicle and set the left and right wheels so that the ground contact area of both front tires and the turntables of turning radius gauges **A** meet at their respective centers.

WARNING⚠

- **After jacking up the vehicle, chock the rear wheels securely with chocks C.**
- **Do not remove chocks C until the entire operation is completed.**



- Unlock turning radius gauge **A**, and set the scale to 0°.
- As in measuring camber explained previously, attach camber/caster/kingpin gauge **D** tightly to the front wheel hub and keep the bubble centered.
- Apply the brake to the front wheels and turn the steering wheel slowly from the 0° point on the scale of turning radius gauge **A**, until direction changes 20° to the left for the left front wheel and 20° to the right for the right front wheel.

NOTE

It is not possible to obtain an exact reading of camber unless the brake is applied to the front wheels because the tires might rotate slightly.

- At the 20° point, align the bubbles in caster scale **E** and kingpin scale **F** to 0° by turning the adjuster.

NOTE

Kingpin scale F has scales for left and right; use the left scale when adjusting the left wheel, and the right scale when adjusting the right wheel.

- Turn the steering wheel slowly until the left front wheel changes its direction 20° to the right, or until the right front wheel changes its direction 20° to the left, past the 0° point of turning radius gauge **A** scale. At this point read the scale marks at the center of the bubbles on caster scale **E** and kingpin scale **F**. The scale marks indicate the caster and kingpin inclination angles.

Adjustment of Steering Angle

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Steering angle	Inside (Outside: reference)	54° (38°52´)	—	Adjust

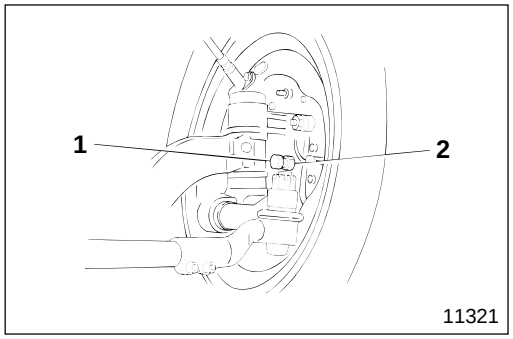
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (Knuckle stopper bolt fastening)	71±12 {52±9, 7.25±1.25}	—

NOTE

Be sure that wheel alignment is adjusted perfectly before adjusting the steering angle.

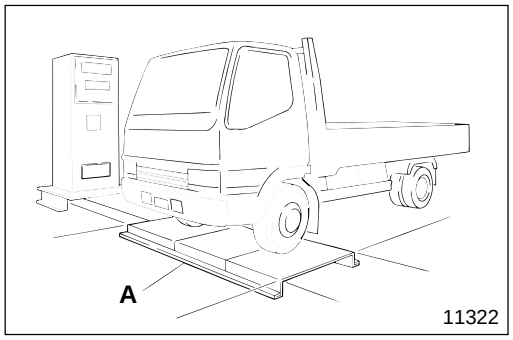


- To adjust the steering angle, set the turning radius gauges and platform in the same way as for caster and kingpin inclination angle measurement.
- Turn the steering wheel to the left or right completely, and from the position where the turning radius gauge is aligned to 0°, adjust knuckle stopper bolt **1**. Adjust so that the steering angle is within the standard inside steering angle value, to the left for the left front wheel, and to the right for the right front wheel. Then, tighten lock nut **2** at specified torque.

Measurement of Side Slip

NOTE

Be sure that wheel alignment is adjusted fully before measuring side slip.

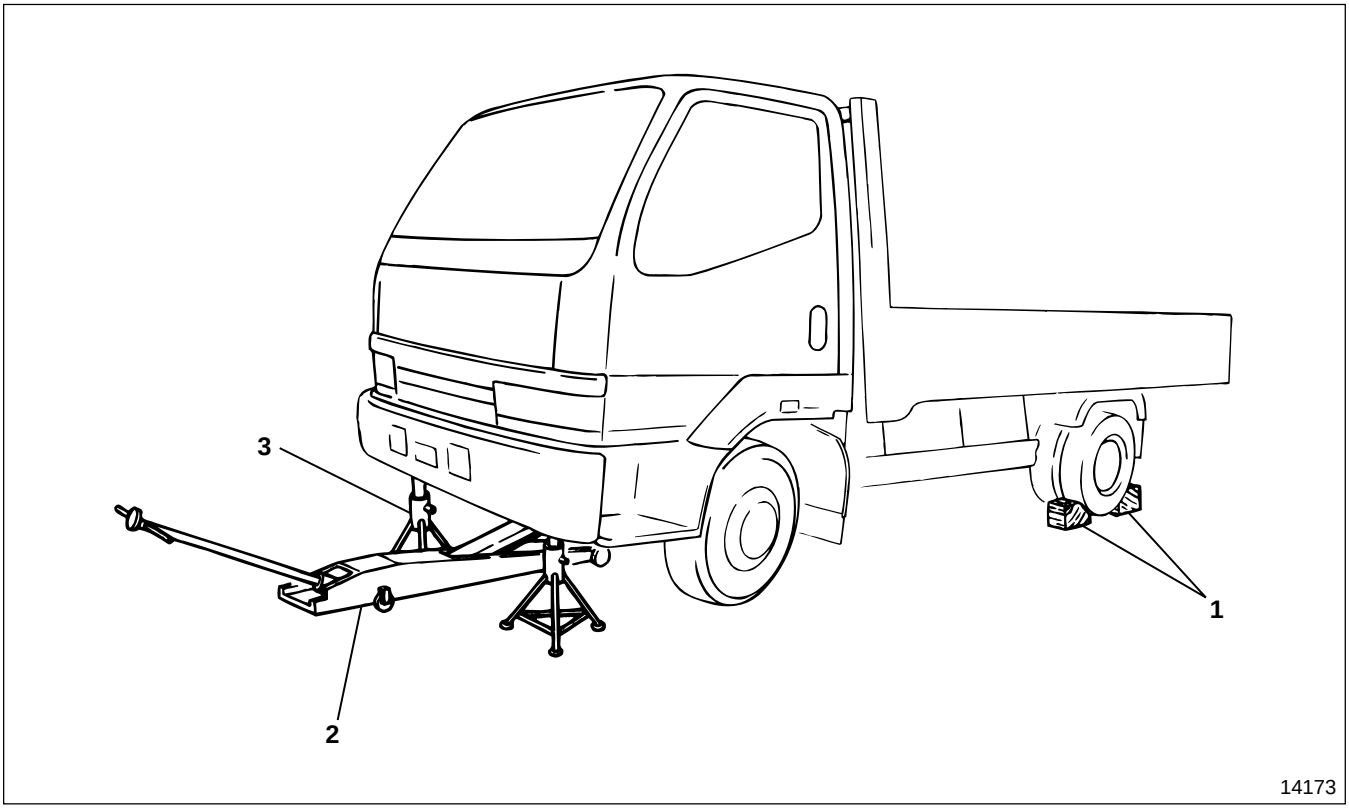


- Point the front wheels exactly forward.
- Maintain this position and slowly move vehicle forward, over side slip tester **A**, as slowly as possible.

NOTE

Make sure, when measuring side slip, that the wheels point exactly forward when the vehicle passes over side slip tester A. Do not allow the wheels to veer from side-to-side.

- The side slip is indicated by side slip tester **A** after the vehicle has passed through the tester. Readjust wheel alignment if slippage is 3 mm {0.12 in.} or more per meter {3.28 ft.}.



● **Work sequence before removal**

1 Place wheel chocks.
2 Jack up the front axle with a garage jack.
3 Support the front frame on rigid racks.

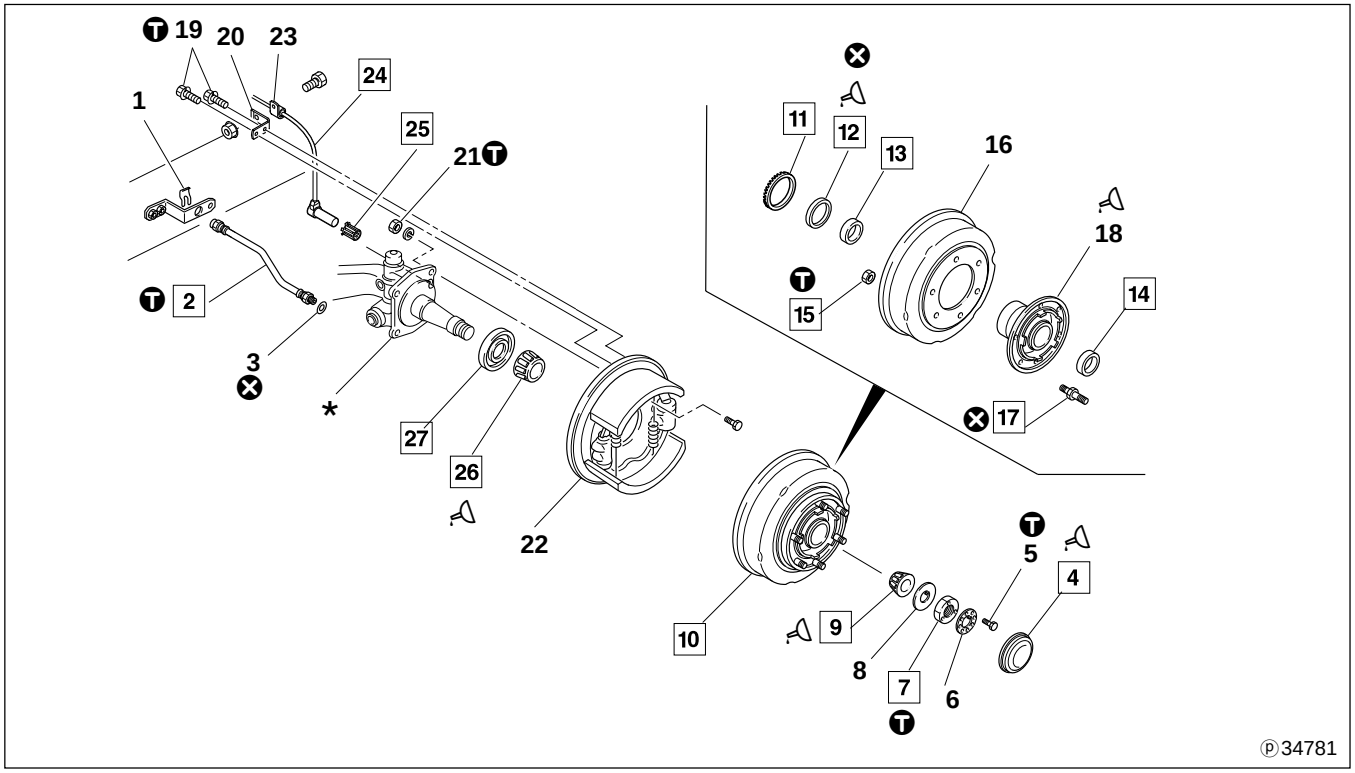
WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

WHEEL HUB AND BRAKE DRUM



● **Disassembly sequence**

1 Clip
2 Brake hose
3 Gasket
4 Wheel hub cap
5 Bolt
6 Lock plate
7 Lock nut
8 Lock washer
9 Outer bearing inner race
10 Wheel hub and brake drum assembly
11 Rotor
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Brake drum Gr 35A
17 Hub bolt
18 Wheel hub
19 Bolt
20 Clip bracket
21 Nut
22 Brake assembly Gr 35A
23 Clip
24 Wheel speed sensor
25 Spring spacer
26 Inner bearing inner race
27 Oil seal retainer

* : Knuckle P26-22
⊗ : Non-reusable parts

CAUTION⚠

Be sure to protect brake hose 2 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 16 and wheel hub 18 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 16.**
- **Be careful not to damage oil seal 12 and rotor 11 when installing wheel hub and brake drum assembly 10 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
9, 13, 14, 26	Starting torque of wheel hub bearing		1 to 4 N·m {0.72 to 2.89 ft.lbs, 0.1 to 0.4 kgf·m}	—	Tangential force at wheel hub bearing 9 to 35 N {1.98 to 7.94 lbf, 0.9 to 3.6 kgf}
11	Wobbling of rotor		0.1 {0.0039}	—	Replace
25	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1 MΩ or higher	—	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Brake hose (Brake side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
5	Bolt (Lock plate mounting)	7 to 11 {5.1 to 8, 0.7 to 1.1}	—
7	Lock nut	200 {145, 20}	Slackening off angle : 30° (one twelfth of a turn)
15	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
19	Bolt (Bracket mounting)	9.8 to 14.0 {7 to 10, 1.0 to 1.4}	—
21	Nut (Brake assembly mounting)	135 {100, 13.8}	—

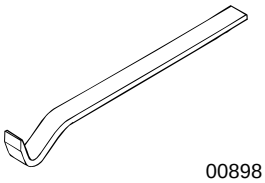
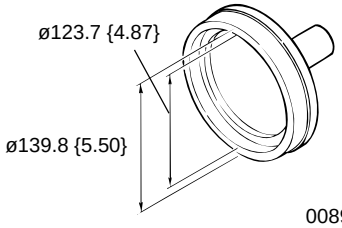
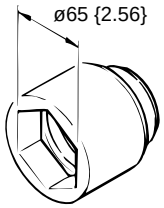
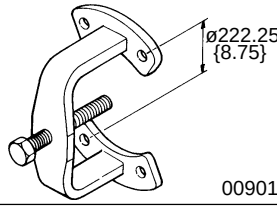
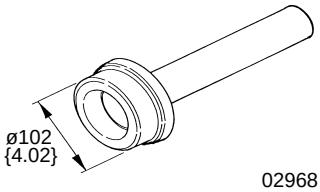
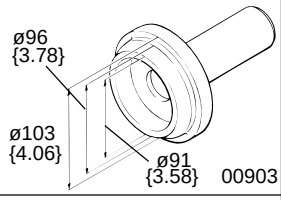
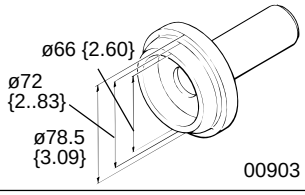
Lubricant and sealant

Location	Points of application	Kinds	Quantity
4	Pack wheel hub cap or wheel hub cover	Wheel bearing grease [NLGI No.2 (Li soap)]	120 g {4.23 oz}
	Mating area of wheel hub cap and wheel hub	THREEBOND 1104	As required
9, 26	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
12	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	250 g {8.82 oz}

WHEEL HUB AND BRAKE DRUM

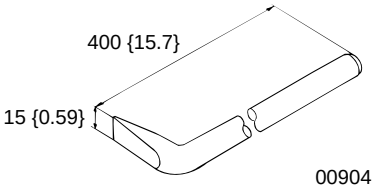
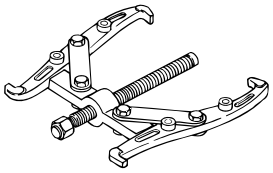
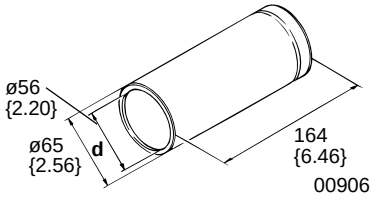
Special tools

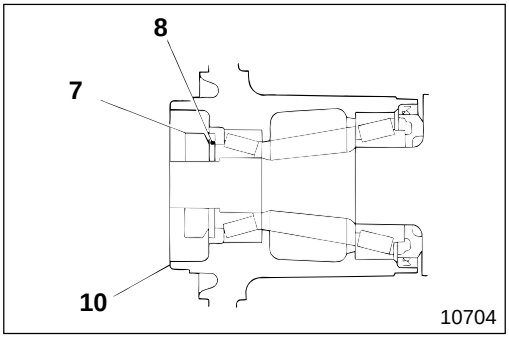
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4	Hub cap wrench  00898	MH061948	Removal of wheel hub cap
	Hub cap installer  00899	MH062204	Press-fitting of wheel hub cap
7	Socket wrench  00900	MH061531	Removal and installation of hub bearing lock nut
10	Wheel hub puller  00901	MH061966 or MH061017	Removal of hub and brake drum
12	ABS oil seal inataller  02968	MH062305	Press-fitting of oil seal
13	Inner bearing installer  00903	MH061974	Press-fitting of inner bearing outer race
14	Outer bearing installer  00903	MC881484	Press-fitting of outer bearing outer race

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26, 27	Lever 	MH061683	Prying lever for knuckle to oil seal
	Gear puller 	MH061102	Removal of oil seal and inner bearing inner race
	Inner bearing installer 	MH061475	Press-fitting of inner bearing inner race and oil seal

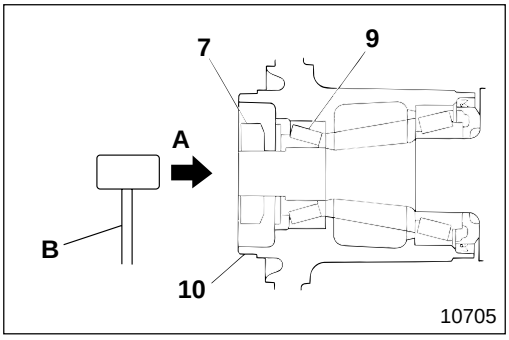


◆ Service procedure

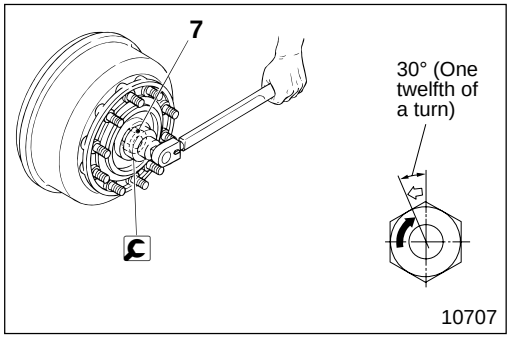
● Starting torque of wheel hub drum

[Adjustment]

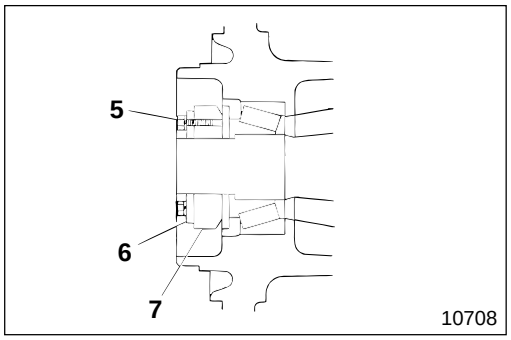
- Install lock washer **8** and lock nut **7**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **10** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **7** and lock washer **8**.



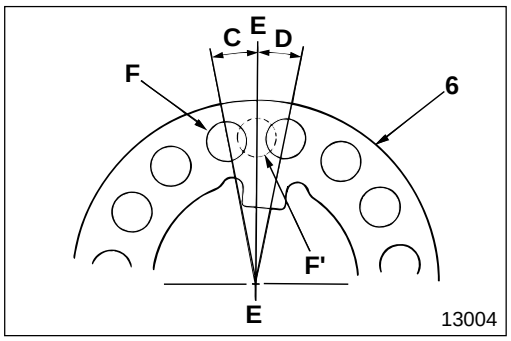
- Return outer bearing **9** toward lock nut **7** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **10** again.
  B : Copper-headed mallet



★ • After retightening lock nut **7** at specified torque, slacken it off by 30° (one twelfth of a turn)
(★ : If there is any deviation found when you measure the tangential force, carried out following the procedure on 🕮 P26-15, repeat the work.)

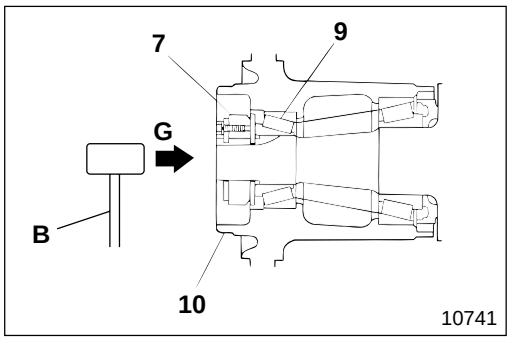


- Install lock plate **6**.
- Make sure that the bolt mounting holes of lock plate **6** and lock nuts **7** align.
- Tighten mounting bolts **5** at specified torque.



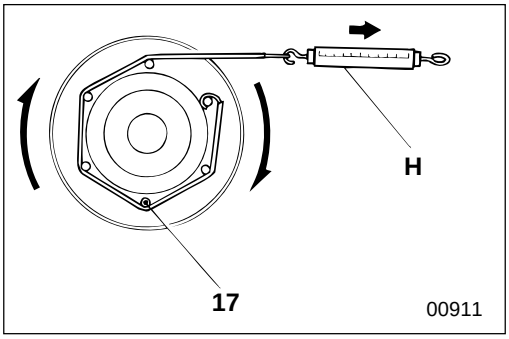
- If the mounting holes of lock plate **6** and lock nuts **7** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



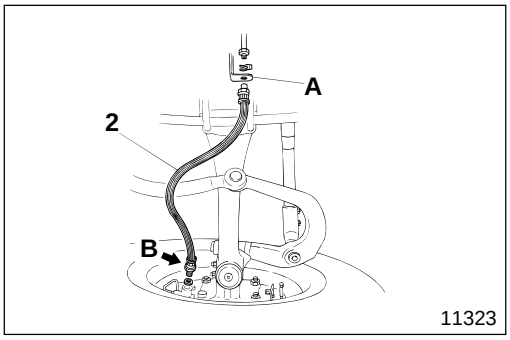
- To slide outer bearing **9** towards lock nut **7**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **10**.
B : Copper-headed mallet

- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.



[Measurement]
- Fasten spring balance **H** to hub bolt **17** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. 📖 P26-14
- If any fault is found after adjustment, replace outer bearings **9**, **14** and inner bearings **13**, **26**.

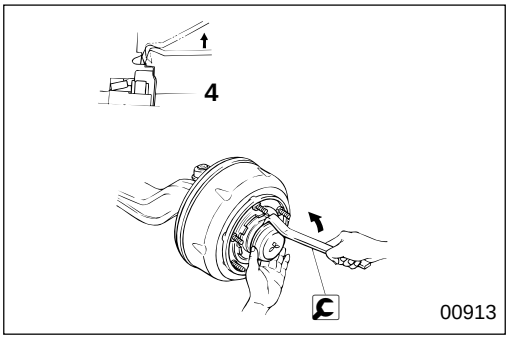
NOTE
- **Measure the starting torque when oil seal 12 has been installed.**
- **Make sure that the brake lining and brake drum 16 do not drag before measurement.**



2 Removal and installation of brake hose

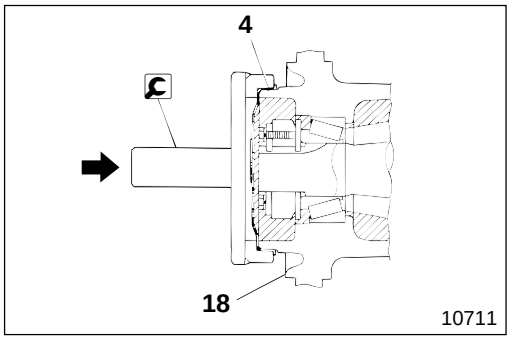
Remove the brake hose from frame side **A** first, then disconnect from wheel brake side **B**. For installation, connect the hose in a reverse order.

CAUTION ⚠
Make sure that brake hose 2 is not twisted when you install it.



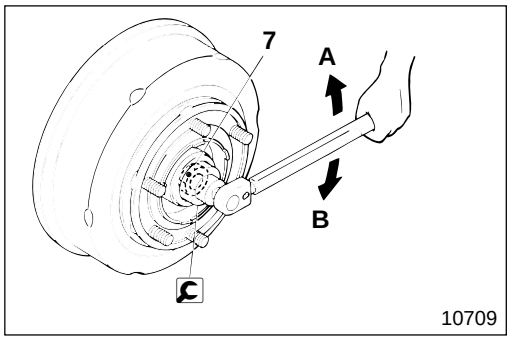
4 Wheel hub cap

[Removal]



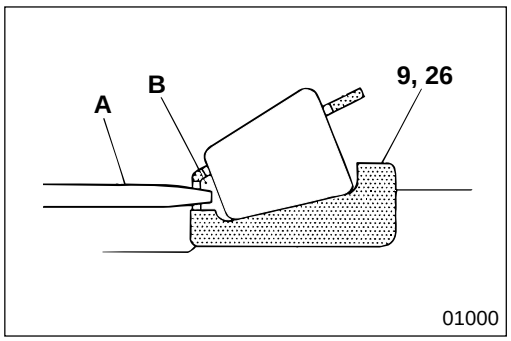
[nstallation]
Pack wheel hub cap **4** with grease, apply sealant to contact surfaces of wheel hub **18**, and press-fit it.

CAUTION
Do not use a hammer, etc. when you install wheel hub cap 4, or you might deform the mating surface, destroying watertightness.



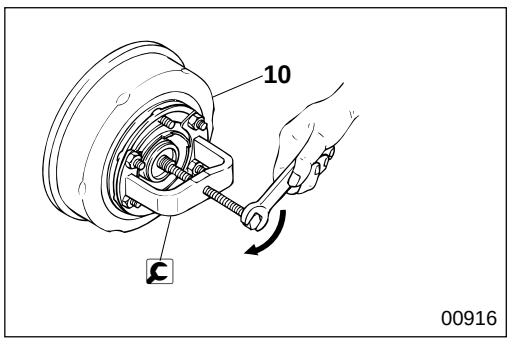
7 **Removal and installation of lock nut**

See adjustment of wheel hub bearing starting torque. P26-14
A : Removal
B : Installation



9 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

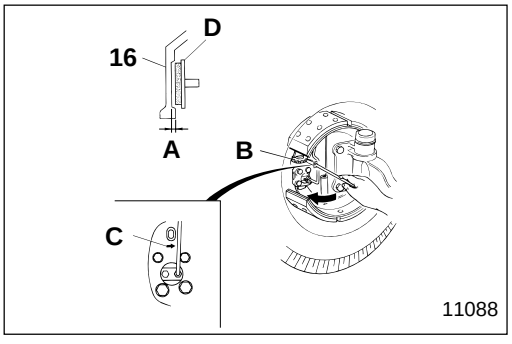
A : Grease pump nozzle
B : Between rollers



10 **Wheel hub and brake assembly**

[Removal]

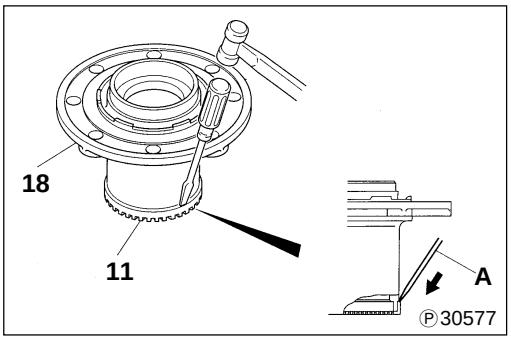
CAUTION
Make sure you remove wheel hub and brake drum assembly 10 in a straight line to prevent damage to oil seal 12.



- If it is hard to remove wheel hub and brake drum assembly **10** because brake drum **16** has stepped wear **A**, remove the wheel hub and brake drum assembly as follows:
- Turn adjuster **B** in the opposite direction to arrow **C** on the backing plate, and expand the clearance between brake drum **16** and brake shoe **D**. Then remove the brake drum.

CAUTION
If brake drum 16 is faulty, correct it. **Gr 35A**

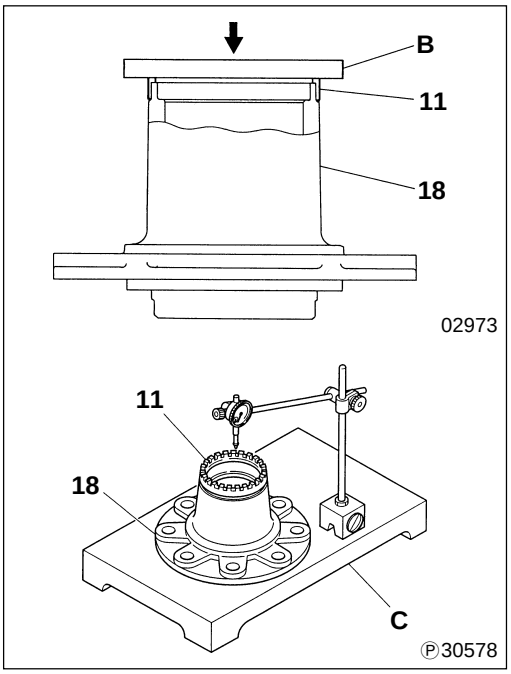
[Installation]
After installing wheel hub and brake drum assembly **10**, adjust the brake shoe clearnace.
Gr 35A



11 Rotor

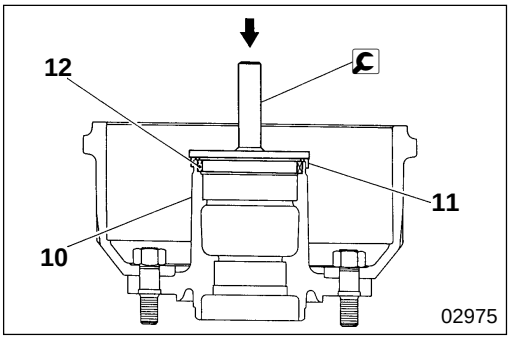
[Removal]
Strike the outer edge of rotor **11** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION ⚠
Be careful not to damage wheel hub 18.



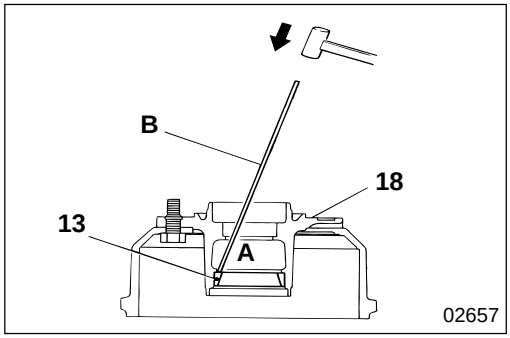
[Installation]
Heat rotor **11** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **18**. Make sure there is no space between the rotor and wheel hub.

[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



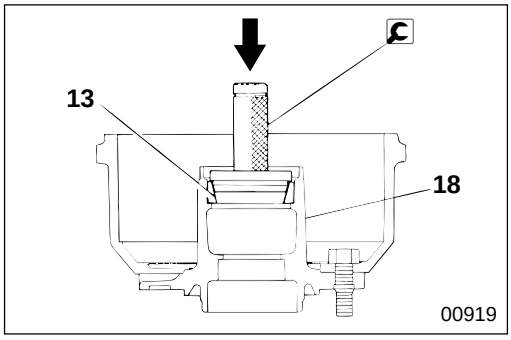
12 Installation of oil seal

CAUTION ⚠
When hub and brake drum assembly 10 is removed for a service operation and if rotor 11 is still mounted on the wheel hub, use 0 ABS oil seal installer to press-fit oil seal 12.

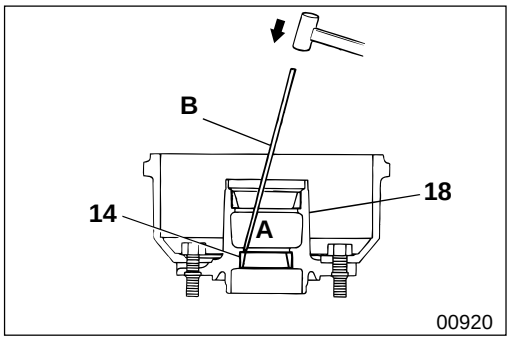


13 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **13** evenly from two indented parts **A** in wheel hub **18**.
B : Pin-punch

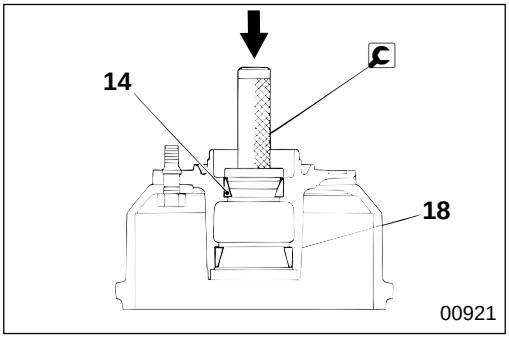


[Installation]

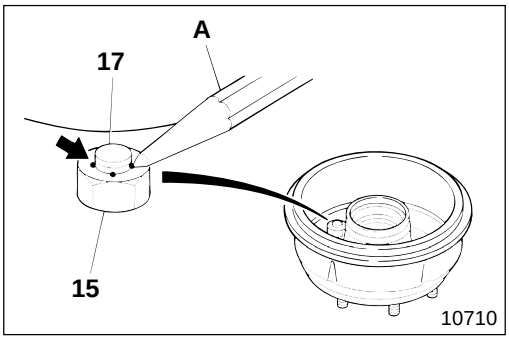


14 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **14** evenly from two indented parts **A** in wheel hub **18**.
B : Pin-punch

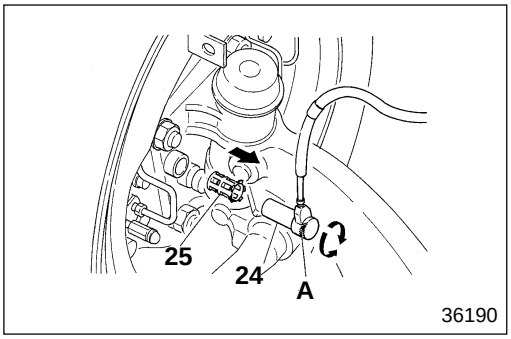


[Installation]



15 **17** **Installation of nut and hub bolts**

Tighten nut **15** at specified torque, then caulk hub bolt **17** evenly at four points.
A :Punch

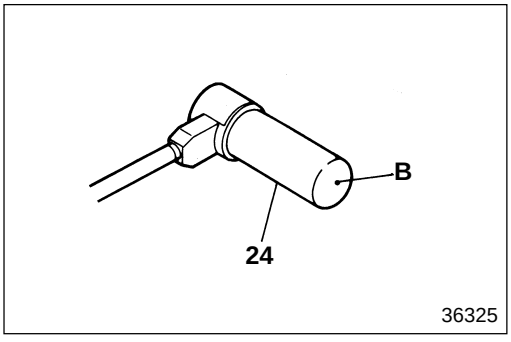


24 **Wheel speed sensor**

[Removal]
Hold shaded section **A** of wheel speed sensor **24** with pliers, and remove the sensor by twisting it slightly in left and right directions.

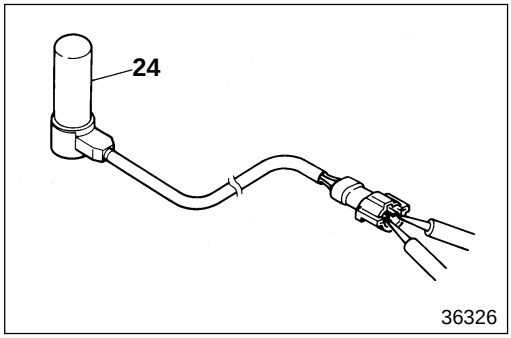
CAUTION

- **When holding wheel speed sensor 24 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 24 dismounts easily, replace spring spacer 25.**

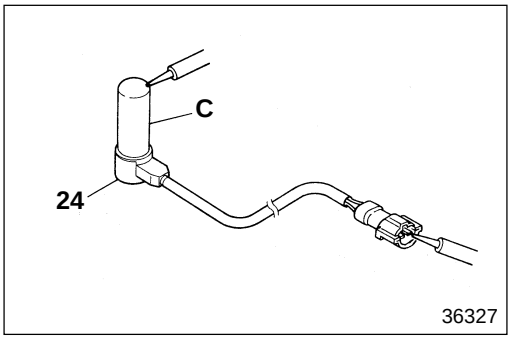


[Inspection]

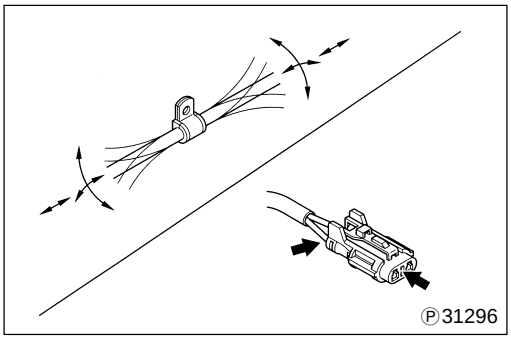
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **24**, it attracts metals. Do not allow the pole piece to collect metallic objects.



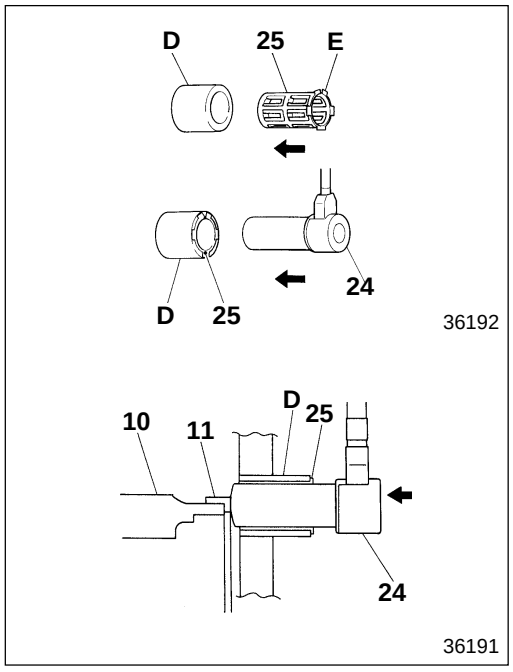
- Measure the resistance between the terminals of wheel speed sensor **24**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **24** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **24**.

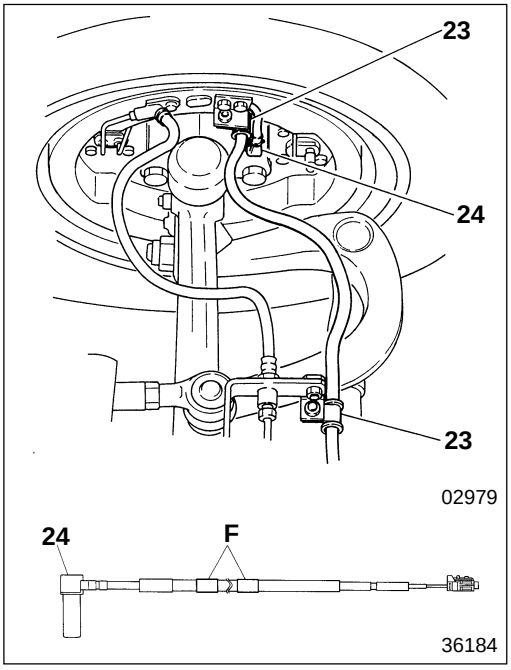


[Installation]

- Insert spring spacer **25** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **24**, and press until it contacts rotor **11**.
- Rotate hub and brake drum assembly **10** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION⚠

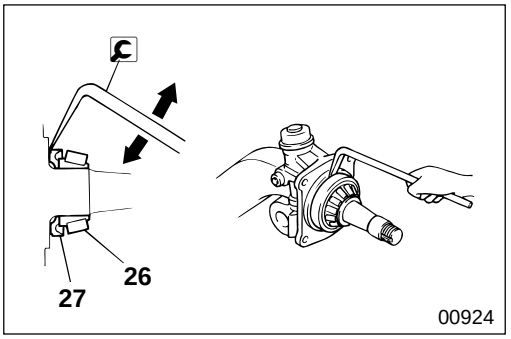
When installing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **24** in place using clip **23** on the wheel brake side and clip **23** on the frame side.

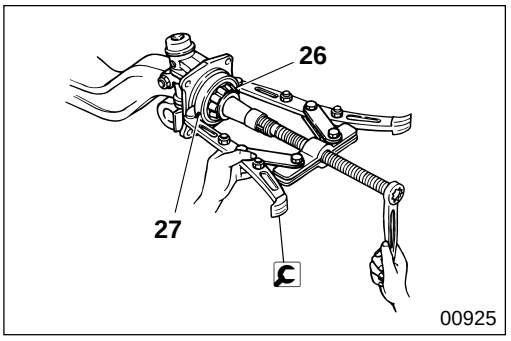
CAUTION⚠

Be sure to clamp the harness of wheel speed sensor 24 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.

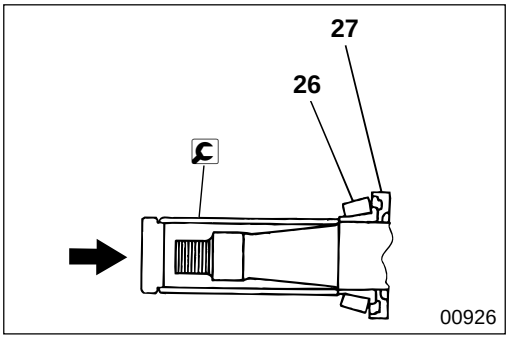


26 **27** **Inner bearing inner race and oil seal retainer**

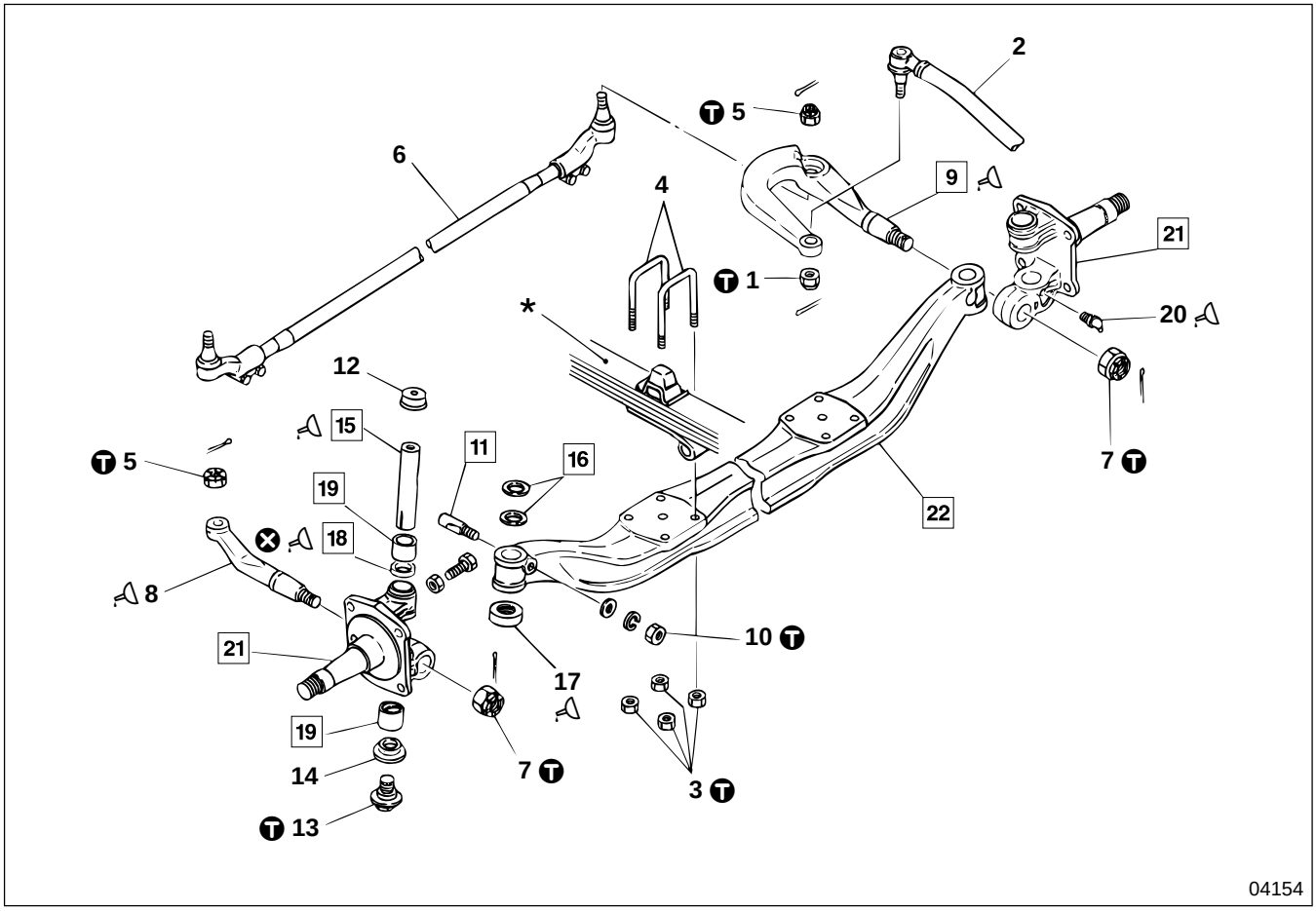
[Removal]



[Installation]



FRONT AXLE, KNUCKLE AND KINGPIN



● **Disassembly sequence**

1 Nut
2 Drag link 🗋 Gr 37
3 U-bolt nut 🗋 Gr 33
4 U-bolt
5 Nut
6 Tie rod 🗋 Gr 37
7 Nut
8 Tie rod arm
9 Knuckle arm
10 Nut
11 Set bolt
12 Kingpin cap
13 Lower kingpin cover
14 Dust seal
15 Kingpin
16 Thrust washer
17 Bearing
18 Oil seal
19 Bushing
20 Grease nipple
21 Knuckle
22 Front axle

*: Front leaf spring 🗋 Gr 33
⊗: Non-reusable parts

● **Assembly sequence**

21 → **20** → **19** → **18** →
22 → **17** → **16** →
→ **15** → **11** → **10** → **14** → **13** → **12** → **9** → **8** → **7** → **6** → **5** → **4** → **3** → **2** → **1**

Repair kit : Kingpin kit

● **Work after assembly**

🕮 P26-24

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
15	Kingpin	Outer diameter	[35] $^{-0.002}_{-0.015}$ {[1.38] $^{-0.000079}_{-0.00059}$}	34.9 {1.37}	Replace
		Inclination angle	7°	7°±30'	
19	Kingpin bushing	Inner diameter (after press-fitting into knuckle)	[35] $^{+0.045}_{+0.018}$ {[1.38] $^{+0.0018}_{+0.00071}$}	—	Replace
		Clearance between kingpin and kingpin bushing	0.02 to 0.06 {0.00079 to 0.0024}	0.15 {0.0059}	Replace
21, 22	Vertical clearance between knuckle and front axle		0.1 {0.0039} or less	0.2 {0.0079}	Adjust using thrust washer
22	Front axle	Bend in longitudinal direction	2.5 {0.098} or less	7 {0.28}	Replace
		Bend in vertical direction	3 {0.12} or less	7 {0.28}	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

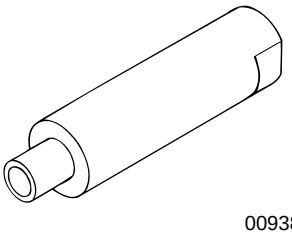
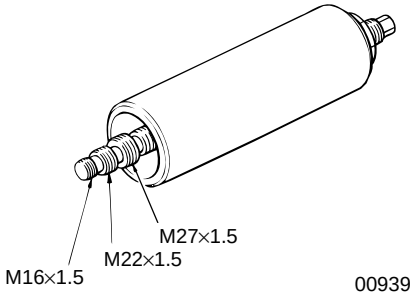
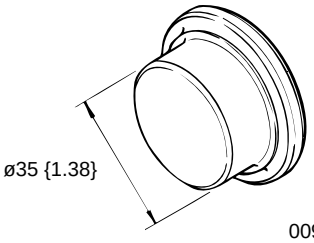
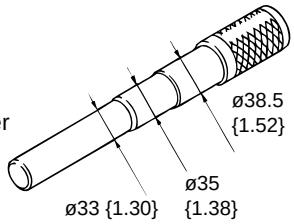
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drag link mounting)	190±47.5 {140±35, 19.4±4.85}	—
3	U-bolt nut (U-bolt mounting)	240±36 {175±27, 24.5±3.7}	Wet
5	Nut (Tie rod mounting)	190±48 {140±35, 19.4±4.85}	—
7	Nut (Tie rod arm and knuckle arm mounting)	686±98 {505±72, 70±10}	—
10	Nut (Set bolt tightening)	29 {22, 3}	—
13	Kingpin lower cover	39±10 {29±7, 4±1}	—

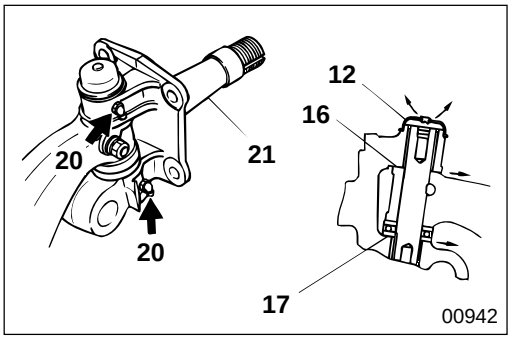
Lubricant

Location	Points of application	Kinds	Quantity
8, 9	Thread areas of knuckle arm and tie rod arm	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Periphery of kingpin and pack through hole	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack in bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
20	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
11	Kingpin set bolt remover  00938	MH061688	Removal of kingpin set bolt
15	Kingpin puller  00939	MH061684	Removal of kingpin
18	Oil seal installer  00940	MH062201	Installation of oil seal
19	Kingpin bushing remover  00941	MH061037	Removal and installation of kingpin bushing

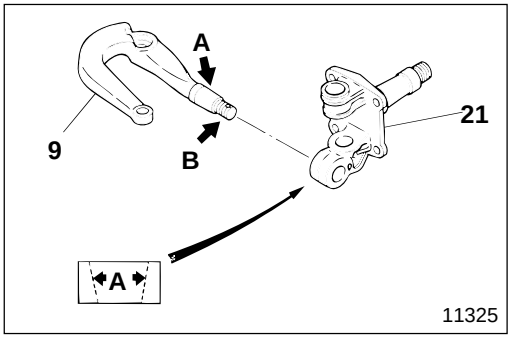


00942

◆ Service procedure

● Work after assembly

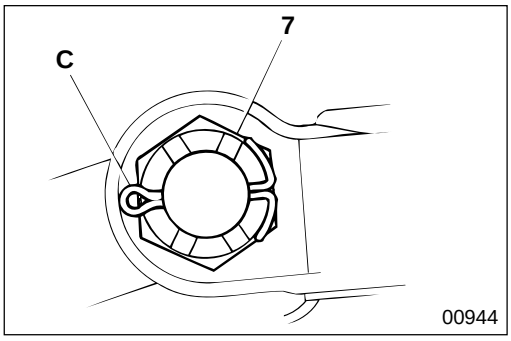
Pack knuckle **21** with grease via grease nipple **20**. Pack until grease starts overflowing from the dust cap of upper cap **12**, thrust washer **16**, and the press side of bearing **17**.



9 **21** **Installation of knuckle arm and knuckle**

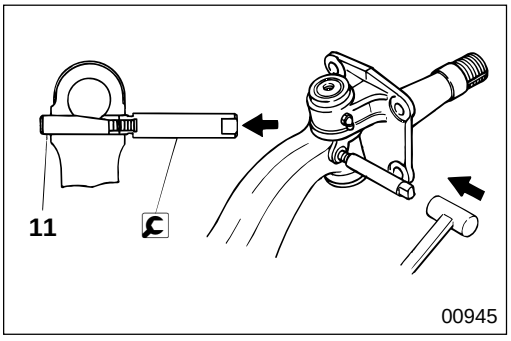
(1) Reassembly of existing knuckle arm 9 and/or knuckle 21

- Polish taper surfaces **A** of knuckle arm **9** and knuckle **21** with emery paper (120 grit or finer) uniformly, until abrasion traces left by the emery paper are only just visible. For new parts, polishing is not necessary.
- Clean taper surfaces **A** of knuckle arm **9** and knuckle **21**, and thread **B** of the knuckle arm. (Use a cleaning solvent for acetone color checking or other solvent.)
- Install knuckle arm **9** after applying grease to thread **B**. (Do not grease the taper surface of the knuckle arm and knuckle **21**.)
- Tighten new nut **7** at specified torque. Make sure you align the pin hole by turning in the tightening direction when you insert and fix split pin **C**.

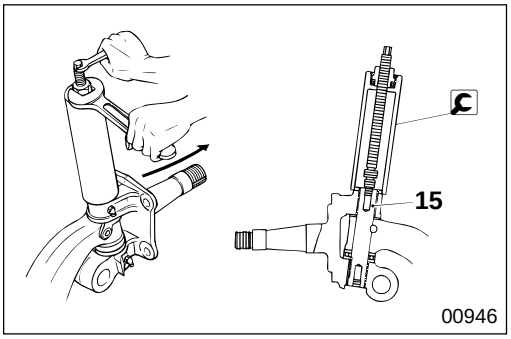


(2) Installation of new knuckle arm 9 and knuckle 21

- Clean taper surfaces **A** of knuckle arm **9**, knuckle **21**, and thread **B** of the knuckle arm, and install them without greasing.
- Tighten new nut **7** at specified torque. Make sure you align the pin hole by turning in the tightening direction when you insert and fix split pin **C**.

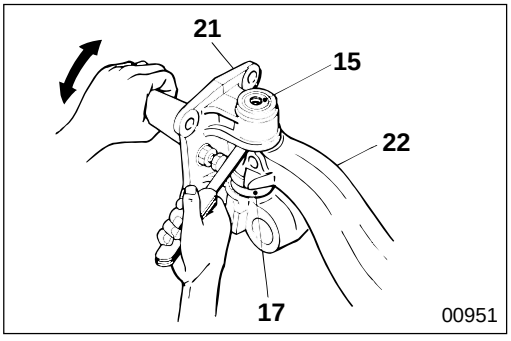


11 **Removal of set bolt**



15 **Removal of kingpin**

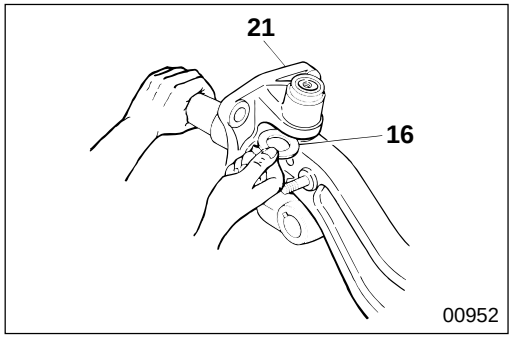
- Remove the kingpin cap; tighten kingpin puller bolt into the thread of kingpin **15** to remove the kingpin.



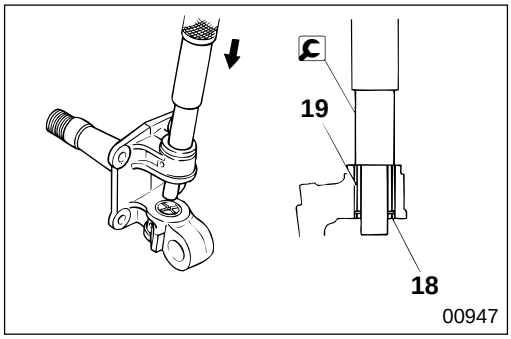
16 **21** **22** **Thrust washer, knuckle and front axle**

[Inspection]

- Assemble kingpin **15** and bearing **17** temporarily, and turn knuckle **21** a few times to smooth its operation.
- Measure the clearance between the upper surface of front axle **22** and the lower part of knuckle **21**.
- If the measured value is higher than the limit, adjust the clearance with thrust washer **16**.

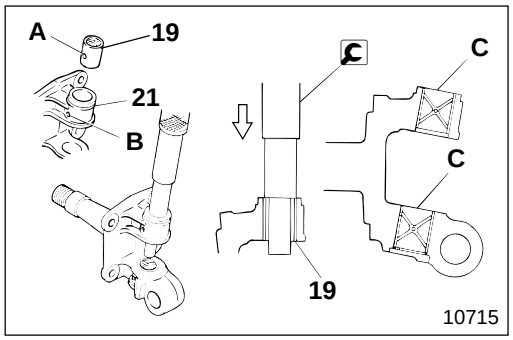


[Adjustment]
- Available adjusting thrust washer **16** thicknesses: 2.1 to 2.8 mm {0.083 to 0.11 in.} (8 thicknesses are available in 0.1 mm {0.0039 in.} increments.)
- Minimize the clearance by selecting appropriate thrust washer **16**.
- Check that knuckle **21** turns smoothly after assembly.

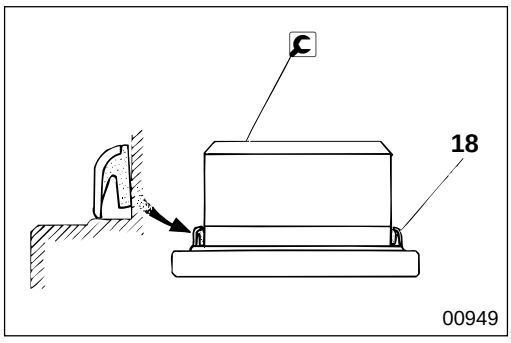


18 **19** **Oil seal and bushing**

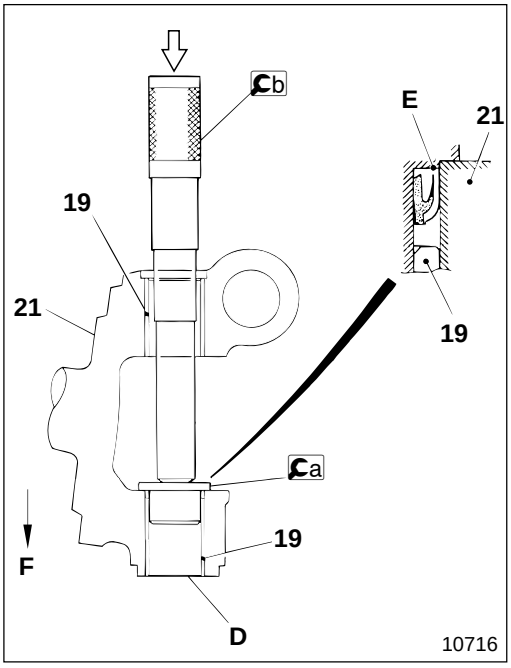
[Removal]



[Installation]
- Install bushing **19** so that the direction of oil hole **A** is aligned with oil hole **B** of knuckle **21** and the bushing end is set in the same plane with end **C**.

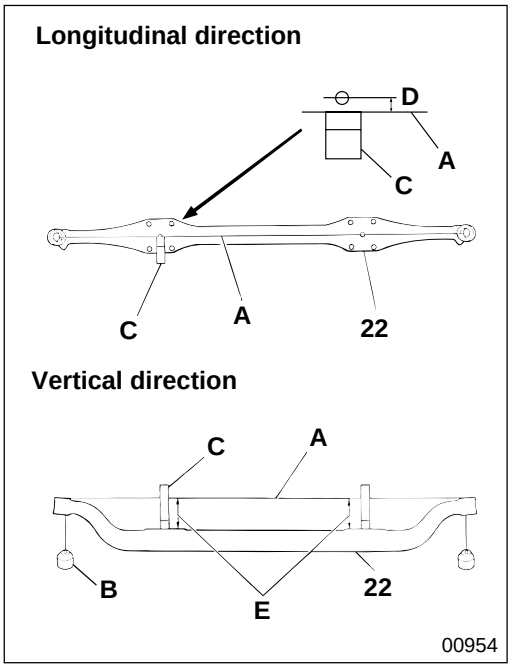


- Apply grease to the lip area of oil seal **18** and install it on oil seal installer.



- Next, install a oil seal installer on knuckle **21** in the direction as illustrated.
- Pass b kingpin bushing remover through kingpin hole until it makes contact with a oil seal installer.
- Drive the head of b kingpin bushing remover using a mallet until a oil seal installer makes contact with knuckle **21**.
- Check that end **D** of bushing **19** is aligned with knuckle **21**.
- Make sure that oil seal end **E** does not protrude from knuckle **21**.

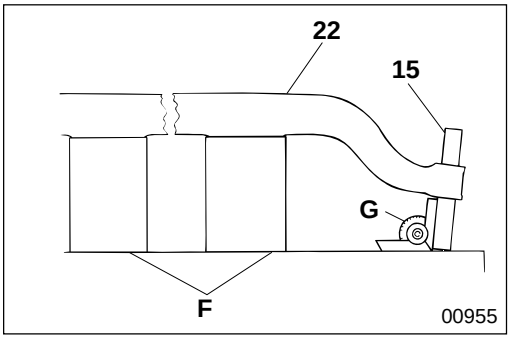
  F : Top of vehicle



22 Inspection of front axle

(1) Measurement of bend in front axle 22 in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **22** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **22**.



(2) Measurement of kingpin inclination angle

Mount kingpin **15** in front axle **22** as illustrated, and measure the kingpin inclination angle. If the measured value is higher the limit, replace the front axle.

F : Block gauge

G : Angle gauge

MITSUBISHI
FUSO

Group 27

Rear Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-27

INDEX

SPECIFICATIONS 27- 2

STRUCTURE AND OPERATION 27- 2

TROUBLESHOOTING 27- 4

WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE 27- 6

WHEEL HUB AND BRAKE DRUM 27- 8

AXLE HOUSING 27-22

REDUCTION AND DIFFERENTIAL 27-26

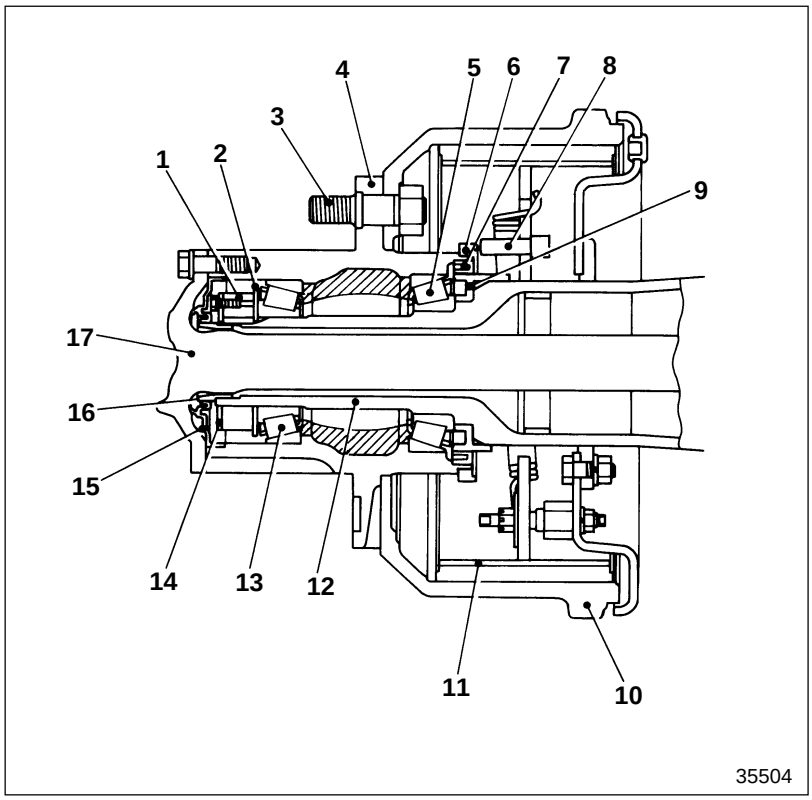
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Rear axle	Model	R040T
	Type	Banjo type, full floating
Reduction	Model	D040H
	Type	Single-reduction
	Tooth shape	Hypoid gear
	Speed reduction ratio	4.111, 4.625, 5.571
Differential	Tooth shape	Straight bevel gear
Gear oil	Grade	* Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot areas : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140
	Quantity L {qts}	4.5 {4.8}
Mass kg {lb}		Approximately 285 {630}

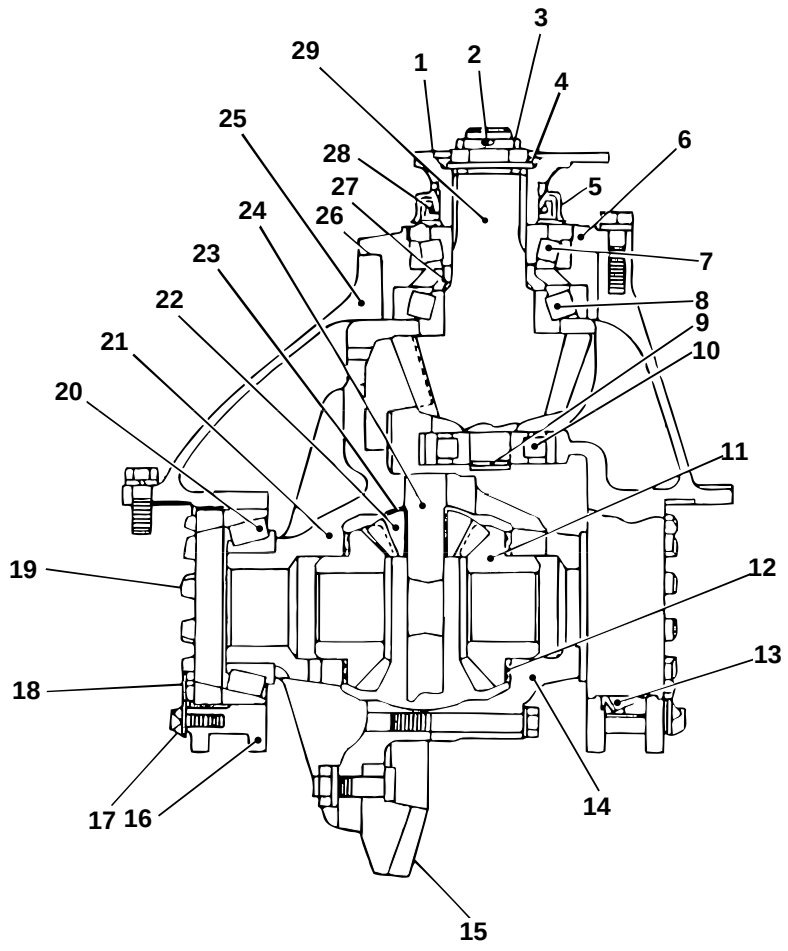
* : When used under heavily-loaded, severe conditions such as continuous driving on uphill grades, it is recommended that you use gear oil with a SAE viscosity grade of 140. However, the air temperature must be above 10°C {50°F}.

STRUCTURE AND OPERATION
Wheel Hub and Brake Drum



1 Lock nut
2 Lock washer
3 Hub bolt
4 Wheel hub
5 Inner bearing
6 Rotor
7 Oil seal
8 Wheel speed sensor
9 Oil seal retainer
10 Brake drum
11 Brake assembly
12 Axle tube
13 Outer bearing
14 Lock plate
15 Oil seal
16 Oil seal retainer
17 Axle shaft

Reduction and Differential



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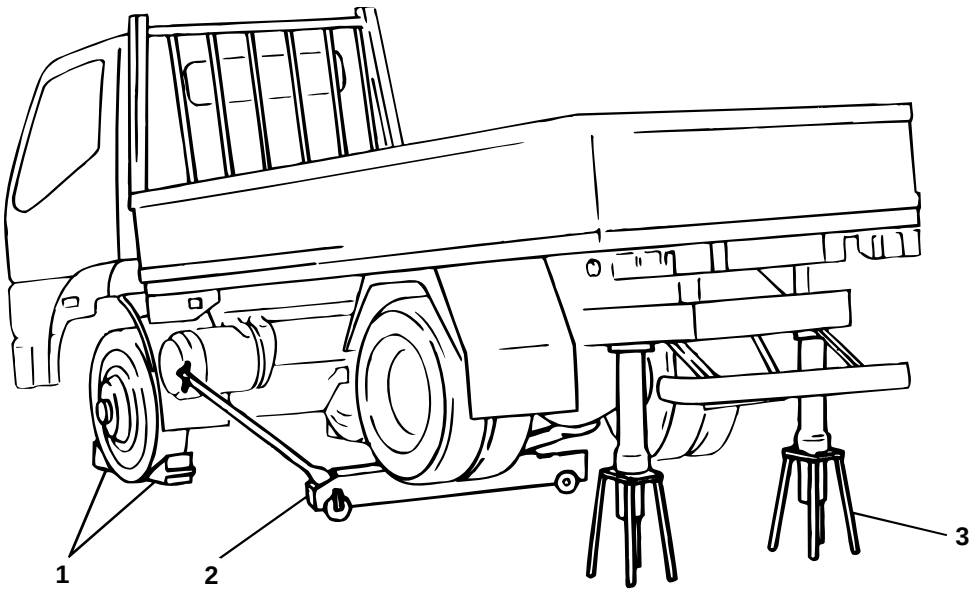
1 Companion flange
2 Split pin
3 Lock nut
4 Washer
5 Dust cover
6 Bearing retainer
7 Outer bearing
8 Inner bearing
9 Lock ring
10 Pinion pilot bearing
11 Differential gear
12 Differential gear washer
13 Lock plate
14 Differential case, RH
15 Reduction gear
16 Bearing cap
17 Lock sheet
18 Lock pawl
19 Adjusting screw
20 Side bearing
21 Differential case, LH
22 Differential pinion
23 Differential pinion washer
24 Pinion spider
25 Differential carrier
26 Shim
27 Collar
28 Oil seal
29 Reduction pinion

TROUBLESHOOTING

Possible causes	Symptoms	Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient: Propeller shaft turns but vehicle does not move	Noise when starting and changing speed	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Seizure	Damage
Wheel hub, axle housing	Axle shaft mounting bolt loose			○				○				
	Axle housing bent						○					
	Axle shaft bent						○					
	Axle shaft fractured				○							
	Axle shaft slips out of engagement				○							
	Oil seal faulty			○								
	Air breather clogged			○								
	Wheel hub bearing seized, worn or rotation faulty						○					
	Wheel hub bearing broken							○				
Reduction and differential	Gear oil excessive	○										
	Gear oil insufficient					○	○				○	
	Oil seal faulty	○										
	Sealant faulty		○									
	Side bearing seized, worn or rotation faulty						○		○			
	Side bearing broken							○				
	Side bearing preload adjusted incorrectly						○				○	
	Side bearing starting torque faulty					○	○		○			○
	Reduction and differential assembly mounting bolt and nut loose		○									
	Differential carrier cracked or damaged		○									
	Reduction gear and differential case tightening bolts loose					○		○				
	Reduction gear or reduction pinion broken				○	○	○	○	○			
	Reduction gear or reduction pinion worn						○		○			
	Reduction gear to reduction pinion backlash excessive					○						○
	Reduction gear to reduction pinion backlash insufficient						○				○	
	Reduction gear tooth contact adjusted incorrectly						○					

Symptoms / Possible causes		Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient							
					Propeller shaft turns but vehicle does not move	Noise when starting and changing speed	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Seizure	Damage
Reduction and differential	Reduction pinion assembly starting torque excessive					○	○				○	
	Reduction pinion assembly starting torque insufficient					○	○					
	Reduction pinion lock nut loose					○	○					
	Reduction pinion assembly inner bearing or outer bearing seized				○		○					
	Reduction pinion assembly inner bearing or outer bearing worn						○					
	Reduction pinion assembly inner bearing or outer bearing broken							○				
	Reduction pinion pilot bearing worn						○					
	Reduction pinion pilot bearing seized							○				
	Differential pinion spider broken				○							
	Differential gear or differential pinion broken				○			○	○	○		
	Differential gear or differential pinion seized				○					○		
	Differential gear or differential pinion worn								○	○		
	Differential gear washer worn or damaged							○	○	○		
	Differential gear backlash excessive					○						○
	Differential gear backlash insufficient								○		○	
	Play between differential gear and axle shaft spline excessive					○						○

WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE



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● **Work sequence before removal**

1 Place wheel chocks.
2 Jack up the rear axle using a garage jack.
3 Support the rear frame on rigid racks.

WARNING⚠

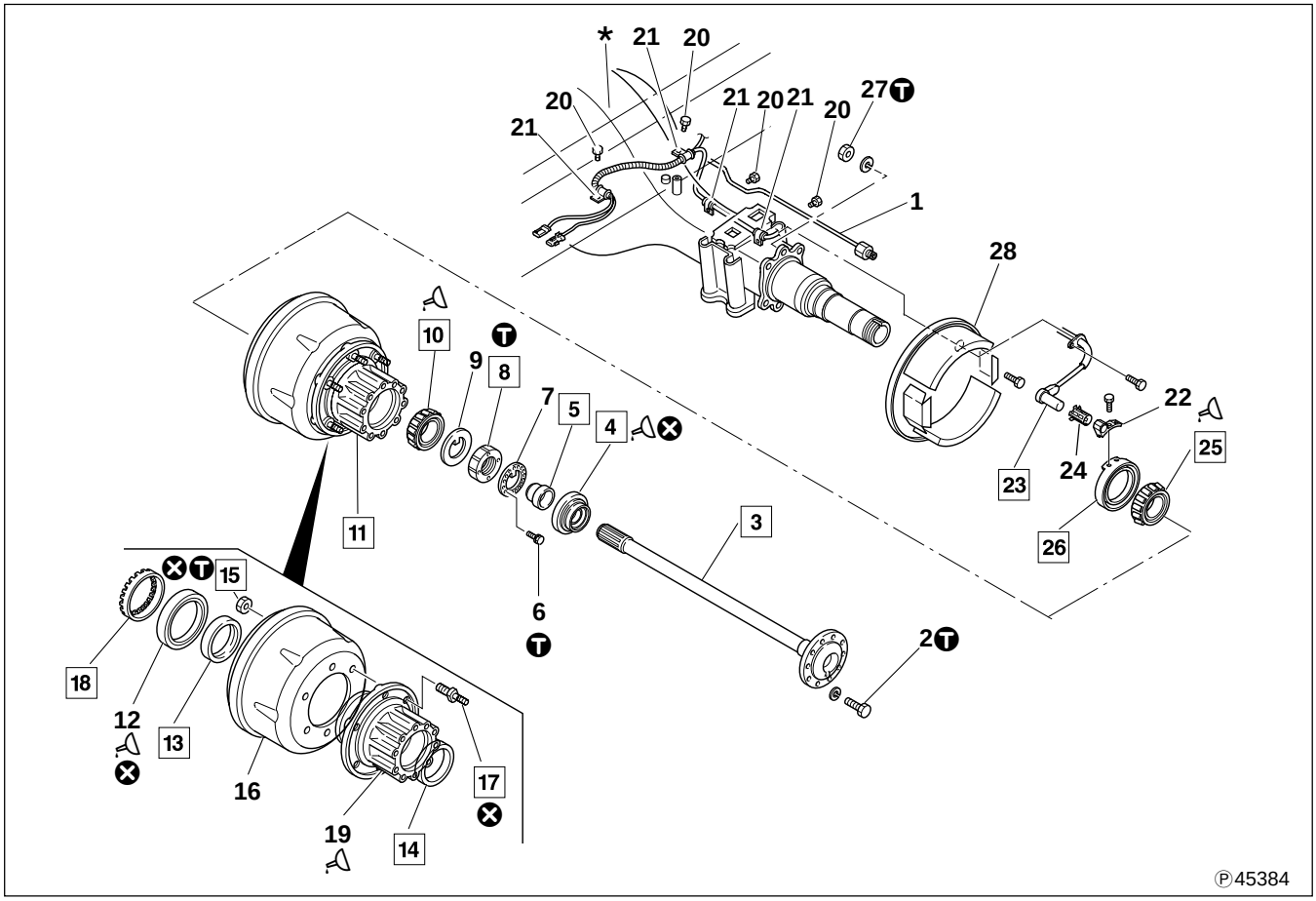
- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

WHEEL HUB AND BRAKE DRUM



● **Disassembly sequence**

1 Brake pipe
2 Bolt
3 Axle shaft
4 Oil seal
5 Oil seal retainer
6 Bolt
7 Lock plate
8 Lock nut
9 Lock washer
10 Outer bearing inner race
11 Wheel hub and brake drum assembly
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Brake drum
17 Hub bolt
18 Rotor
19 Wheel hub
20 Bolt
21 Clip
22 Sensor holder
23 Wheel speed sensor
24 Spring spacer
25 Inner bearing inner race
26 Oil seal retainer
27 Nut
28 Brake assembly
Gr 35A

* : Axle housing P27-22

⊗ : Non-reusable parts

CAUTION

Be sure to protect brake pipe 1, from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 16 and wheel hub 19 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

- **When removing or installing wheel hub and brake drum assembly 11, handle rotor 18 with care to prevent damage. Also, do not damage oil seal 12 during assembly.**
- **Keep oil and grease off lining surface of brake assembly 28 and the inner surface of brake drum 17.**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Axle shaft	Bend of shaft center	1.0 {0.039} or less	2.0 {0.079}	Replace
		Wobble of flange face	0.04 {0.0016}	0.5 {0.020}	Replace
10, 13, 14, 25	Starting torque of wheel hub bearing		2.5 to 5.4 N·m {1.8 to 4.0 lbf.ft, 0.25 to 0.55 kgf· m}	—	Tangential force at hub bolt position : 22 to 48 N {4.9 to 11 lbf, 2.2 to 4.9 kgf}
18	Wobbling of rotor		0.1 {0.0039}	—	Replace
23	Wheel speed sensor	Resistance between terminals	1570 to 1980Ω	—	Replace
		Insulation resistance	30 kΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Axle shaft mounting)	105 {80, 11}	—
6	Bolt (Lock plate mounting)	6.9 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
8	Lock nut	195 {145, 20}	Slackening off angle : 22.5° (0ne sixteenth of a turn)
15	Nut (Wheel hub and brake drum mounting)	320 {235, 32.8}	—
27	Nut (Brake assembly mounting)	76 {56, 7.8}	—

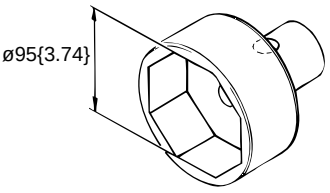
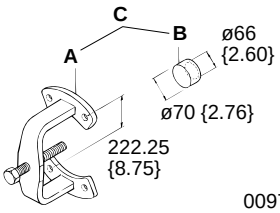
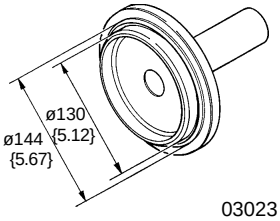
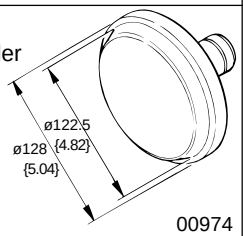
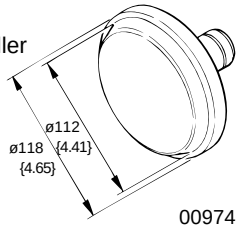
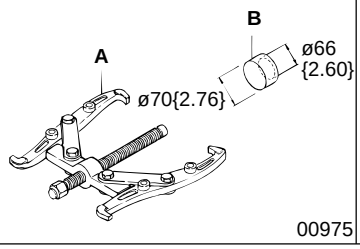
Lubricant

Location	Points of application	Kinds	Quantity
4, 13	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
10, 25	Pack the space between rollers of outer bearing inner race and inner bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	280 g {9.88 oz}

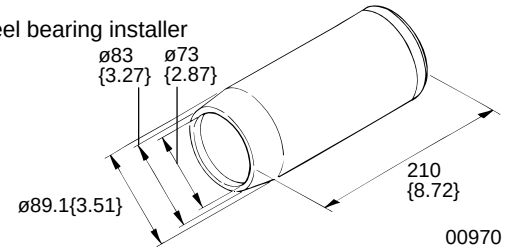
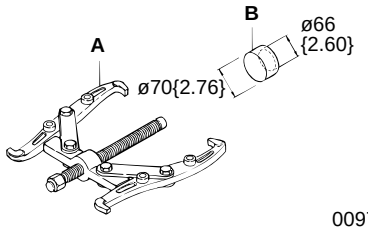
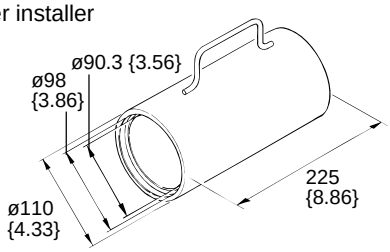
WHEEL HUB AND BRAKE DRUM

Special tools

Unit : mm {in.}

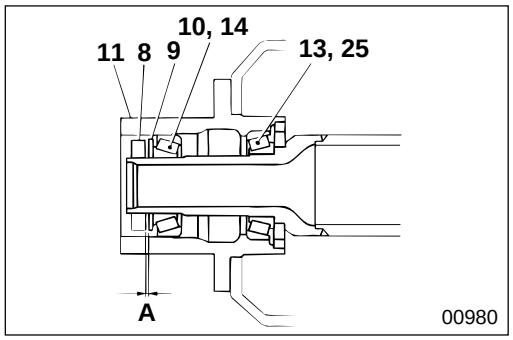
Location	Tool name and shape	Part No.	Application
8	Socket wrench  00969	MH061597	Removal and installation of lock nut
11	**A** : Wheel hub puller **B** : Adapter  00972	**A** : MH061966 **B** : MH061962 or **C** : MH061017	Removal of wheel hub and brake drum assembly
12	Anti-lock brake system oil seal installer  03023	MH062664	Press-fitting of oil seal
13	Wheel hub inner bearing installer  00974	MH061010	Press-fitting of inner bearing outer race
14	Wheel hub outer bearing installer  00974	MH061012	Press-fitting of outer bearing outer race
20	**A** : Gear puller **B** : Adapter  00975	**A** : MH061102 **B** : MH061962	Removal of inner bearing inner race

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
25	Wheel bearing installer 	MH061009	Press-fitting of inner bearing inner race
26	**A** : Gear puller **B** : Adapter 	**A** : MH061102 **B** : MH061962	Removal of oil seal retainer
	Oil seal retainer installer 	MH061008	Press-fitting of oil seal retainer

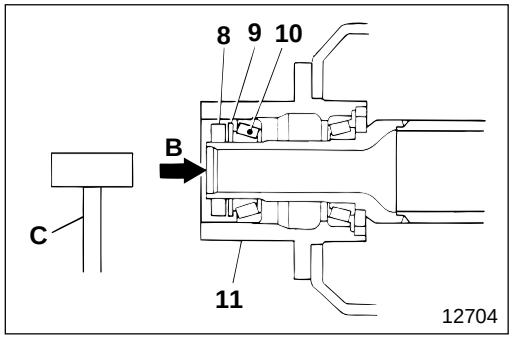
◆ Service procedure

● Starting torque of wheel hub bearing

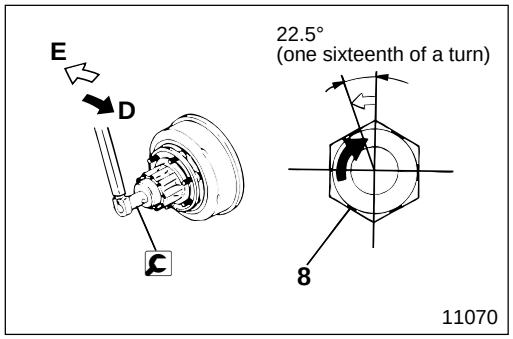


[Adjustment]

- Install lock washer **9** and lock nut **8**.
- Turn wheel hub and brake drum assembly **11** several times to smooth operation of outer bearings **10**, **14** and inner bearings **13**, **25**.
- Tighten lock nut **8** at specified torque.
- Slacken off lock nut **8** to obtain clearance **A** between the lock nut and lock washer **9**.



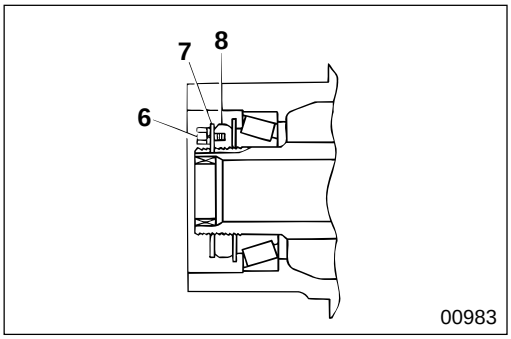
- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



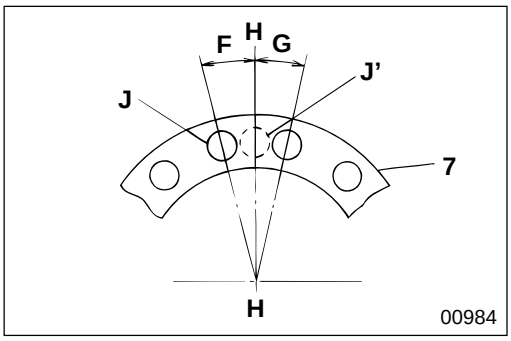
★ • Tighten lock nut **8** at specified torque.
  D : Tightening direction

- Slacken off lock nut **8** by 22.5° (one sixteenth of a turn).
  E : Slackening off direction

(★ : If any fault is found when measuring tangential force, redo from this item.)

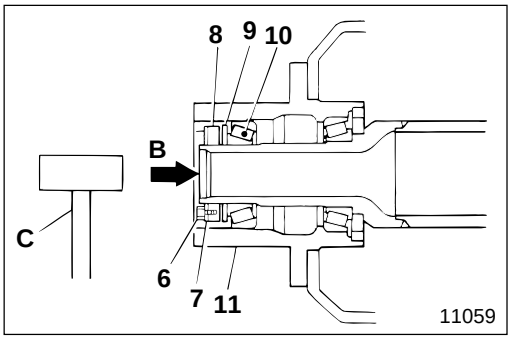


- Install lock plate **7**.
- Make sure that bolt **6** mounting holes of lock nut **8** and lock plate **7** align.
- Tighten bolt **6** at specified torque.

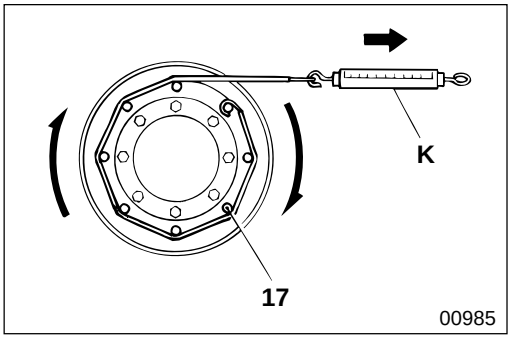


- If mounting holes of lock plate **7** and lock nut **8** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **F**	Loosen lock nut to align holes
Within range **G**	Turn over lock plate and loosen lock nut to align holes
On line **H-H**	Turn over lock plate to align holes (Hole position **J'** changes to **J**)



- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet

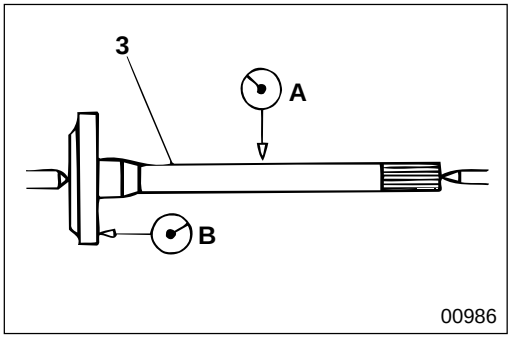


[Measurement]

- Install spring balance **K** on hub bolt **17**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the tangential force to become higher than the upper limit of the specified value.
- If the measured value deviates from the specified value, repeat from step ★. 📖 P27-12
- If the result is still not satisfactory, replace outer bearings **10, 14** and inner bearings **13, 25**.

NOTE

- **Make sure that there is no drag in brake lining and brake drum 16 before you measure the tangential force.**
- **Measure the starting torque when oil seal 12 has been installed.**



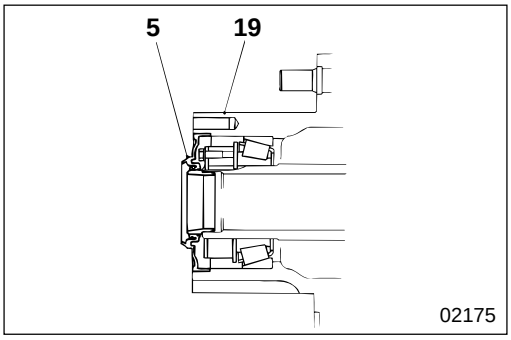
3 **Inspection of axle shaft**

A : Bend of shaft center

NOTE

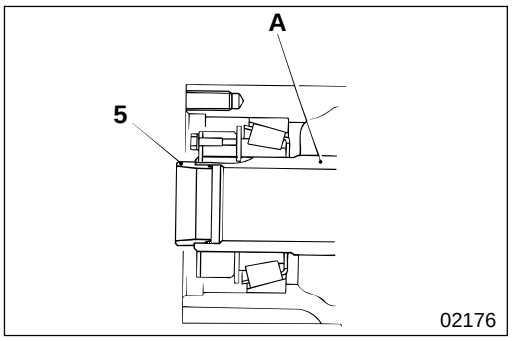
To measure the bend of axle shaft 3, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

B : Wobble of flange face



4 **Installation of oil seal**

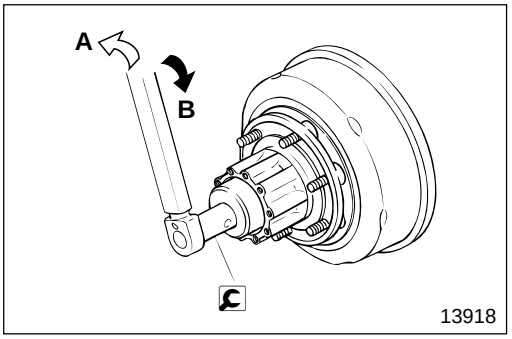
Press-fit oil seal **4** until it is flush with the end of wheel hub **19**.



5 **Oil seal retainer**

[Removal]
It is not necessary to remove oil seal retainer **5** other than for replacement of oil seal **4**.

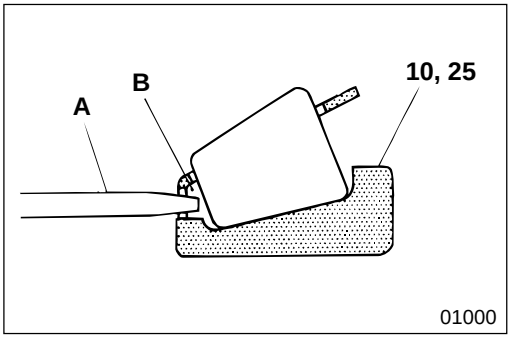
[Installation]
Press-fit oil seal retainer **5** until it is flush with the end of axle tube **A**.



8 **Removal and installation of lock nut**

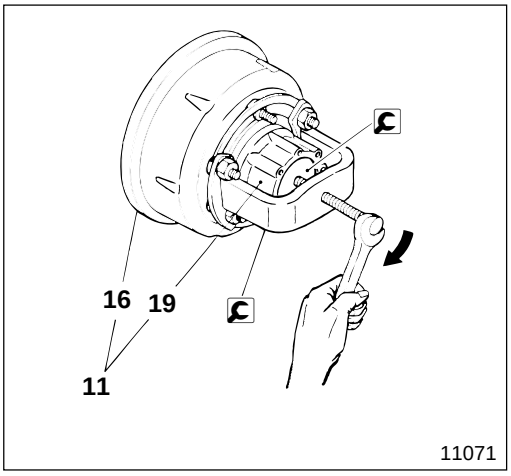
After installation, adjust the starting torque of the wheel hub bearing. See P27-12

A : Removal
B : Installation



10 **25** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Space between rollers

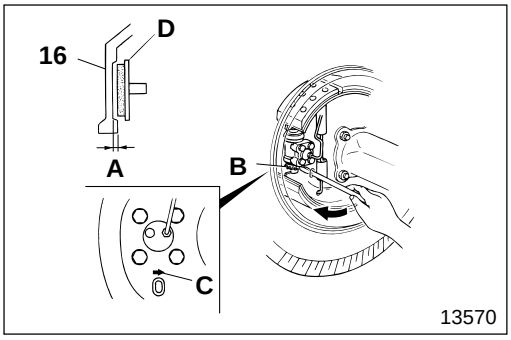


11 **Wheel hub and brake drum assembly**

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 11 in a straight line to prevent damage to oil seal 12.



- If wheel hub and brake drum assembly **11** cannot be removed because of stepped wear **A** in brake drum **16**, carry out the following:
- Turn adjuster **B** in the opposite direction to arrow **C** on the packing plate, and expand the clearance between brake drum **16** and brake shoe assembly **D**. Then remove wheel hub and brake drum assembly **11**.

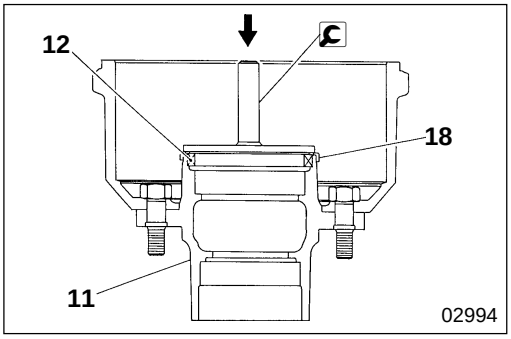
CAUTION

If brake drum 16 is faulty, correct it. Gr 35A

[Installation]

After installing wheel hub and brake drum assembly **11**, adjust the brake shoe clearance.

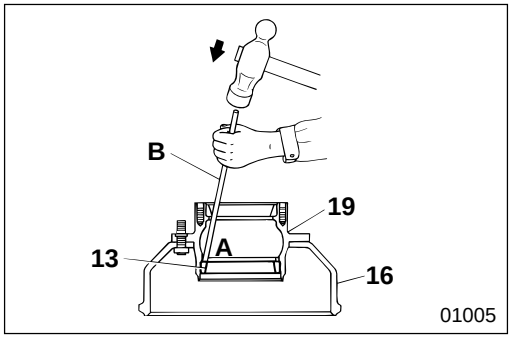
Gr 35A



12 **Installation of oil seal**

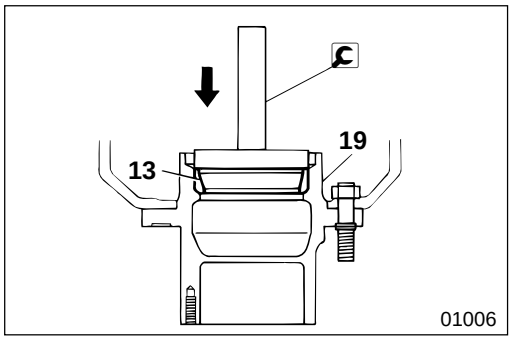
NOTE

When hub and brake drum assembly 11 is removed for a service operation and if rotor 18 is still mounted on the wheel hub, use Anti-lock brake system oil seal installer to press-fit oil seal 12.

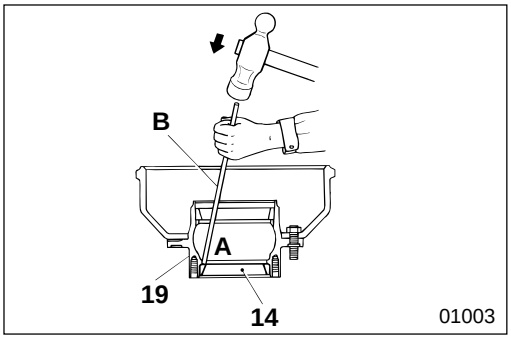


13 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **13** evenly from four indented parts **A** in wheel hub **19**.
B : Pin-punch

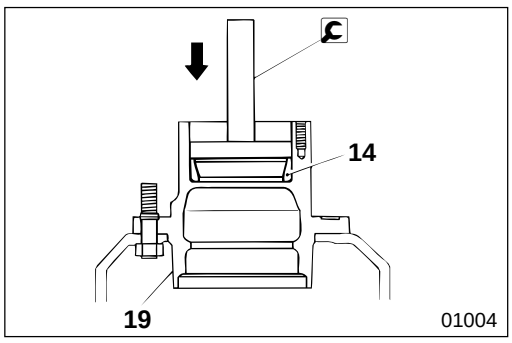


[Installation]

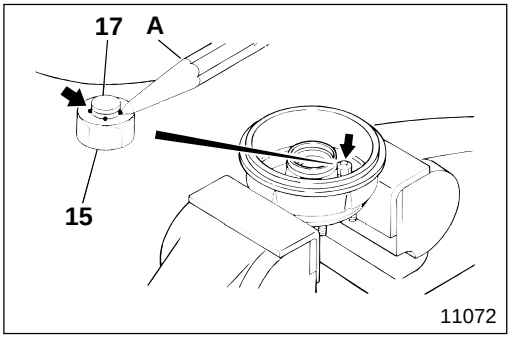


14 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **14** evenly from four indented parts **A** in wheel hub **19**.
B : Pin-punch

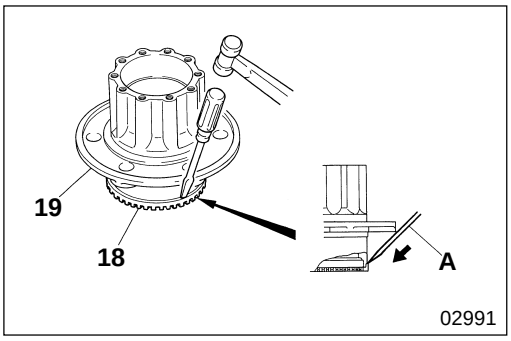


[Installation]



15 **17** **Installation of hub bolt and nut**

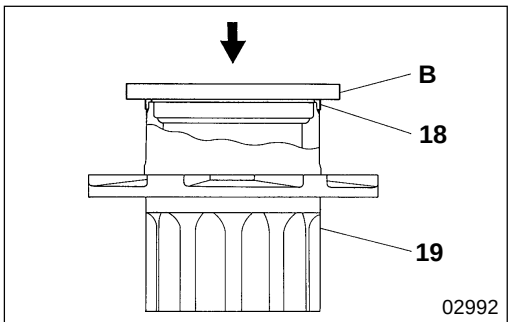
- Install hub bolt **17**.
- Tighten nut **15** at specified torque.
- Caulk nut **15** evenly at four points to keep it from turning.
  A : Pin-punch



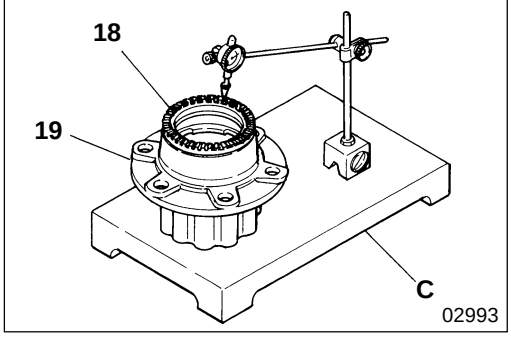
18 **Rotor**

[Removal]
Strike the outer edge of rotor **18** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

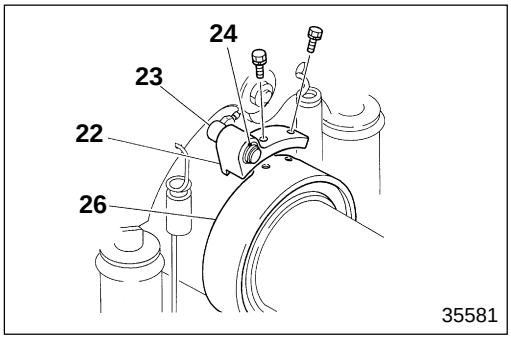
CAUTION
Be careful not to damage wheel hub 19.



[Installation]
Heat rotor **18** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **19**. Make sure there is no space between the rotor and wheel hub.

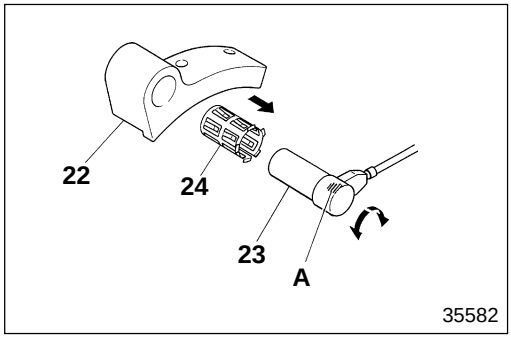


[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



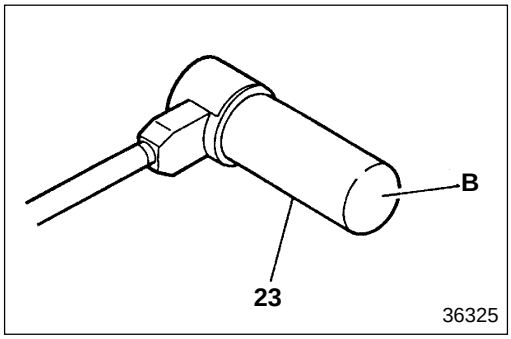
23 **Wheel speed sensor**

[Removal]
- With wheel speed sensor **23** and spring spacer **24** installed in sensor holder **22**, remove the sensor holder from oil seal retainer **26**.

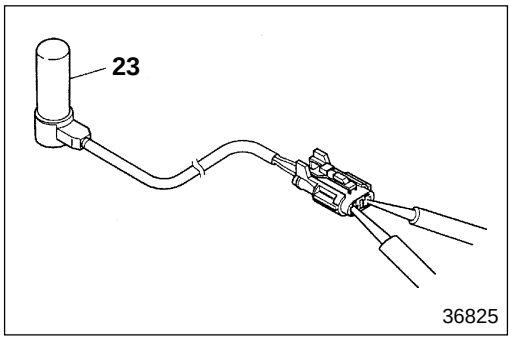


- Hold shaded section **A** of wheel speed sensor **23** with pliers, and remove the sensor by twisting it slightly in left and right directions.

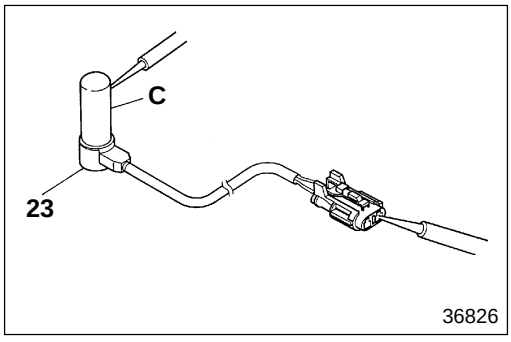
CAUTION
- **When holding wheel speed sensor 23 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 23, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 23 dismounts easily, replace spring spacer 24.**



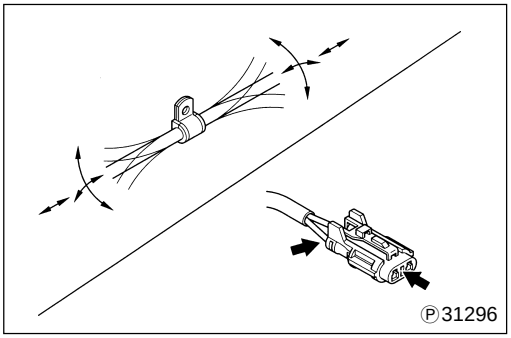
[Inspection]
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **23**, it attracts metals. Do not allow the pole piece to collect metallic objects.



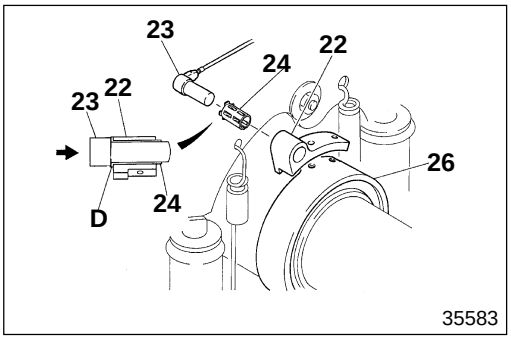
- Measure the resistance between the terminals of wheel speed sensor **23**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **23** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **23**.



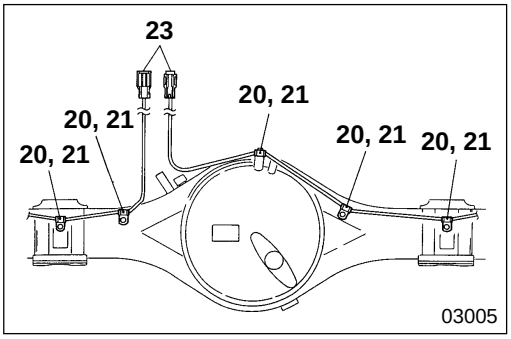
[Installation]

- Insert wheel speed sensor **23** from the back plate, and press until spring spacer **24** and stopper section **D** of the wheel speed sensor contacts sensor holder **22**.
- With wheel speed sensor **23** and spring spacer **24** installed in sensor holder **22**, mount the sensor holder on oil seal retainer **26**.

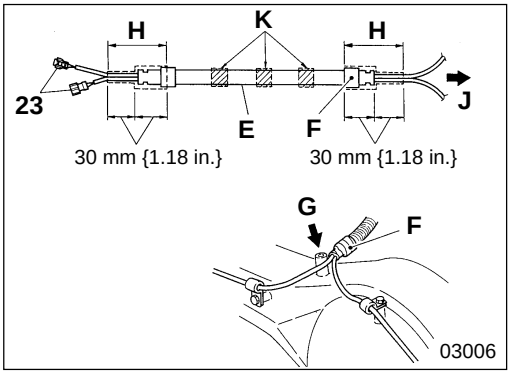
CAUTION⚠

- **When installing wheel speed sensor 23, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **Note that wheel speed sensor 23 is different for left and right wheels.**

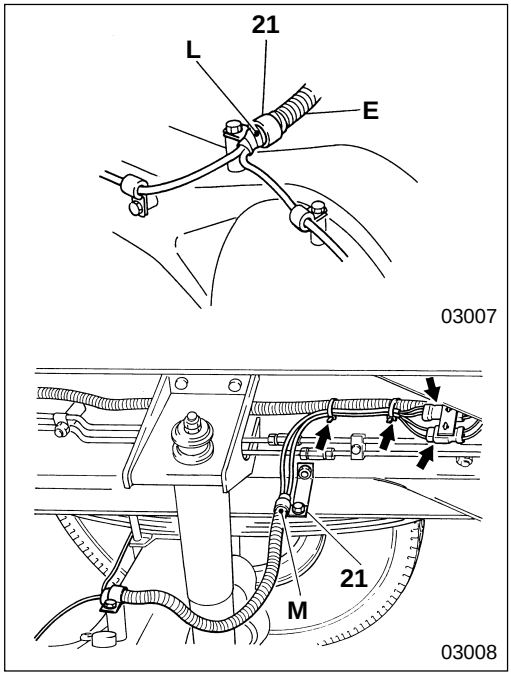
Location	Harness connector color	Harness connector shape
Left wheel	Gray	Male
Right wheel	Black	Female



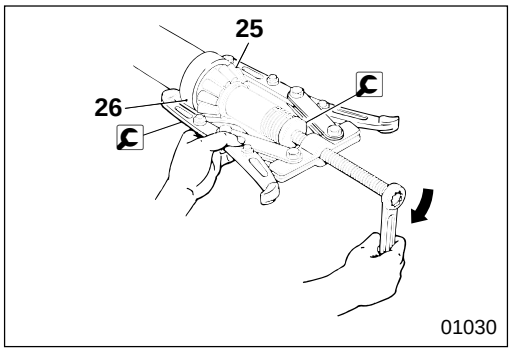
- Rear axle housing section
  Starting from the wheel brake side, secure the harness of wheel speed sensor **23** in place with clip **21** and bolt **20**. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



- Binding of harness
  - Gather the harnesses of left and right wheel speed sensors **23**, and bind with corrugated tube **E**.
  - Adjust the position of the corrugated tube **E** so that white tape section **F** is located at clip position **G** on the rear axle housing. Then, turn the corrugated tube so that the slit faces down. Wrap black tape (electric harness tape) on both ends **H** of the corrugated tube. The tape should be placed over the tube end and harness.
    J: Rear axle housing side
  - Wrap tape on the harnesses of wheel speed sensors **23** at sections **K** (three locations at equal intervals).

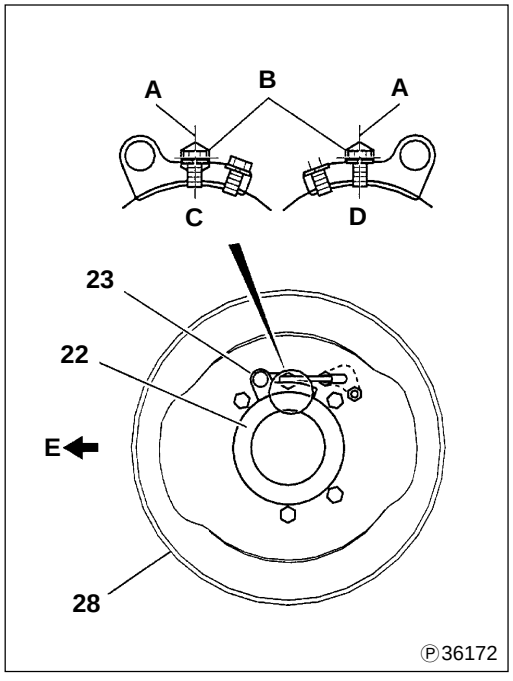


- Clamping of harness
  - Secure section **L** of corrugated tube **E** to the rear axle housing using clip **21**, and attach section **M** of the corrugated tube to the frame using clip **21**.
  - Connect the wheel speed sensor connector to the harness connector on the chassis side, and secure the connectors in place using the bracket.



25 **26** **Inner bearing inner race and oil seal retainer**

[Removal]



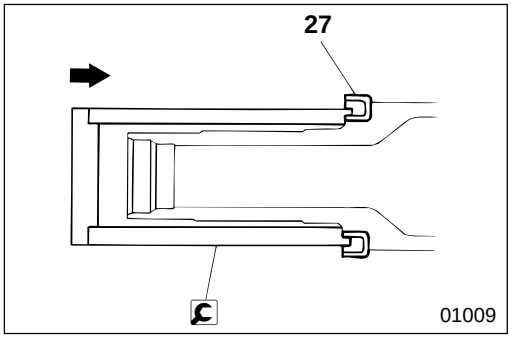
[Installation]

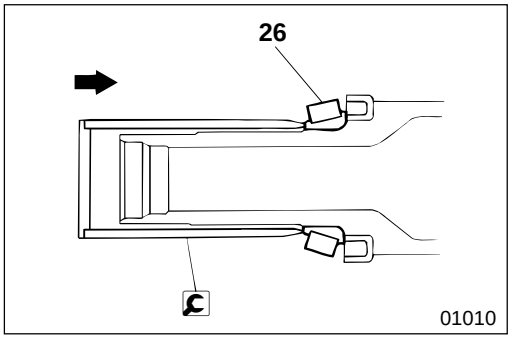
When installing oil seal retainer **26**, align mounting bolt center **A** of sensor holder **22** with the center line of mounting bolt **B** of brake assembly **28**.

C : For left wheel
D : For right wheel
E : Front of vehicle

NOTE

The brake assembly diagram shows a left wheel.


27
01009


26
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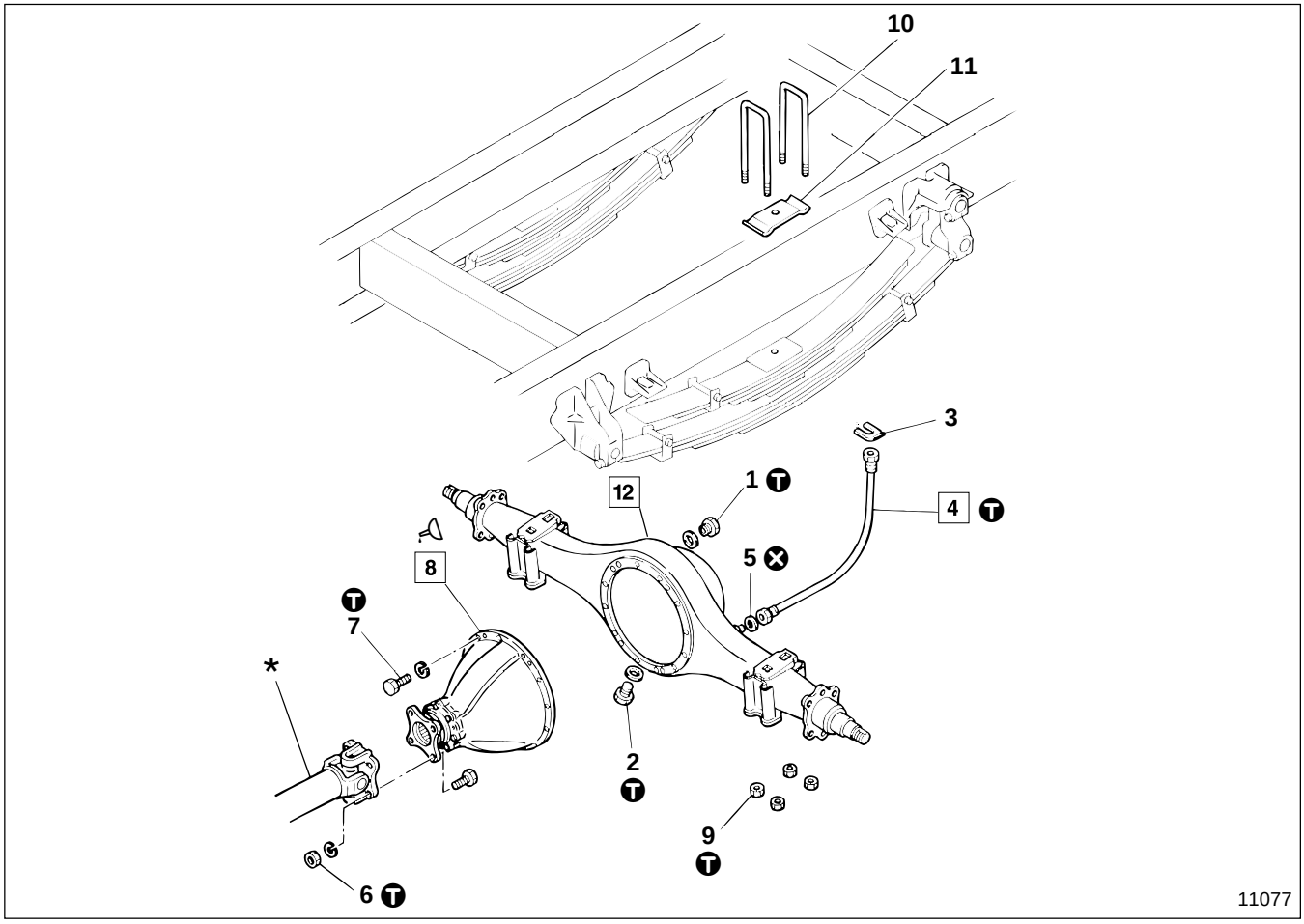
AXLE HOUSING



● **Work before removal** P27-23

● **Removal sequence**

1 Inspection plug
2 Drain plug
3 Clip
4 Brake hose
5 Packing
6 Nut
7 Bolt
8 Reduction and differential assembly P27-26
9 U-bolt nut
10 U-bolt
11 Spring upper pad
12 Axle housing

*: Propeller shaft Gr 25
⊗: Non-reusable parts

CAUTION

Be sure to protect brake hose 4 from dust by fitting blanking plugs after removal.

NOTE

Do not remove axle housing 12 unless it is faulty.

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Make sure that brake hose 4 is not twisted when you install it.

NOTE

Do not let sealant ooze from the mounting surfaces of reduction and differential assembly 8 and axle housing 12.

● **Work after installation** P27-23

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
12	Bend of axle housing (C-B)	0.2 {0.0079} or less	0.5 {0.020} or more	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

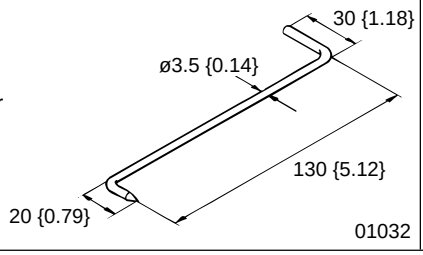
Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	98 to 115 {72 to 87, 10 to 12}	—
2	Drain plug	98 to 115 {72 to 87, 10 to 12}	—
4	Brake hose mounting (Axle housing side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
6	Nut (Propeller shaft mounting)	85 {61, 8.5}	—
7	Bolt (Reduction and differential assembly mounting)	120 {90, 12.5}	—
9	U-bolt nut (U-bolt mounting)	414±62 {305±46, 42.2±6.3}	Wet

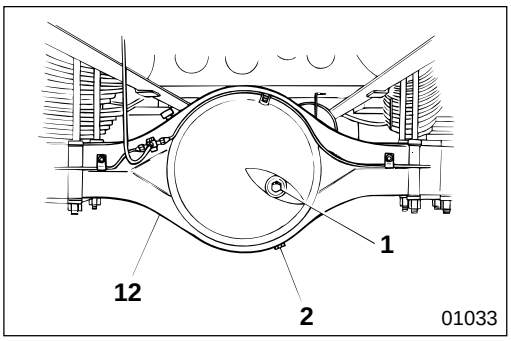
Sealant

Location	Points of application	Kinds	Quantity
8	Connecting surfaces of reduction and differential assembly and axle housing	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
12	Measuring bar 	MH061003	Measures bend of axle housing : Two required



◆ Service procedure

● **Work before removal**

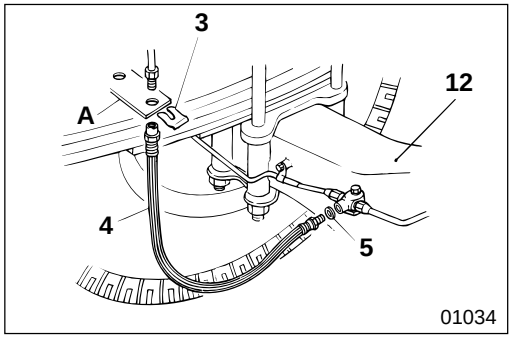
Remove drain plug **2** and drain the gear oil.

WARNING⚠

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

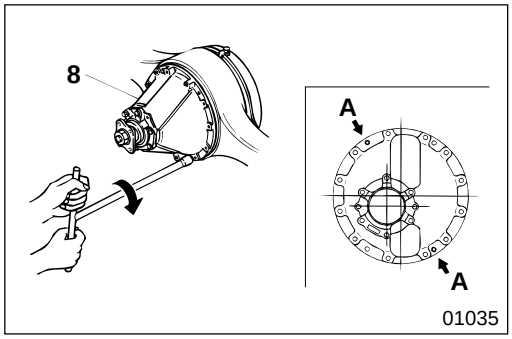
● **Work after installation**

Fill with the specified amount of gear oil via inspection plug **1**.



4 Removal and installation of brake hose

- Remove brake hose **4** from frame **A** side first, then from axle housing **12** side.
- For installation, follow the removal sequence in reverse.

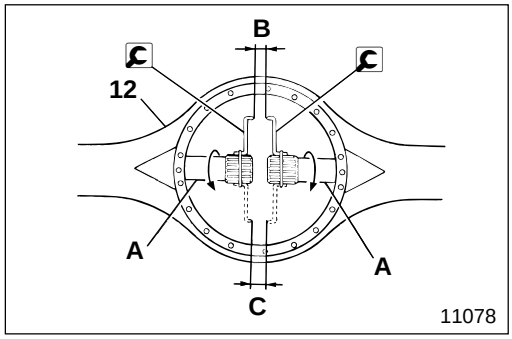


8 Removal of reduction and differential assembly

To remove reduction and differential assembly **8**, screw two M12×1.25 mm bolts evenly into two screw holes **A**.

NOTE

Completely remove adhered sealant from the mounting surfaces of reduction and differential assembly 8 and axle housing 12.



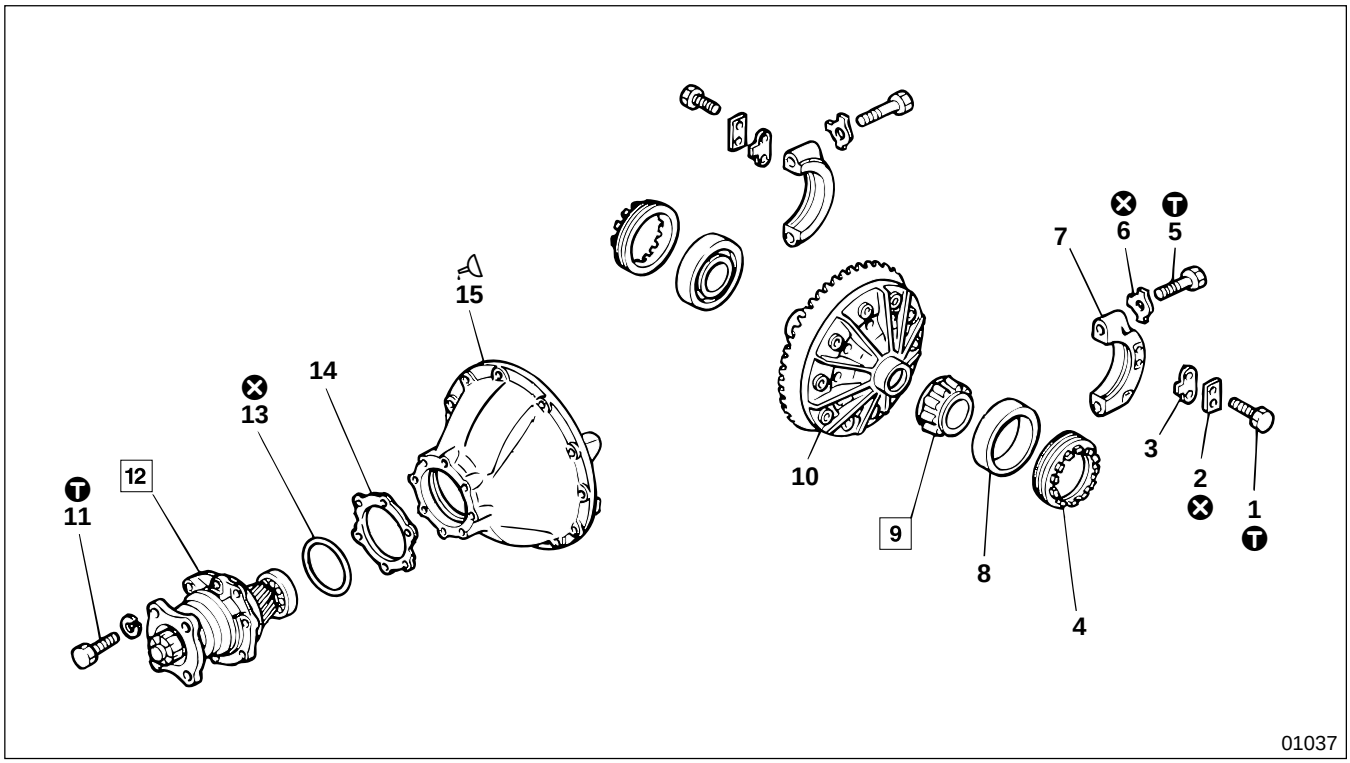
12 Bend of axle housing

- Leave axle shaft **A** installed in axle housing **12**.
- Install measuring bar on axle shaft **A**, and measure clearance **B**.
- Turn axle shaft **A** 180°, and measure clearance **C**.
- The difference between **B** and **C** is the amount of bend of axle housing **12**.
- If the bend of axle housing **12** is higher than the limit, replace the axle housing.

M E M O

REDUCTION AND DIFFERENTIAL

Reduction and Differential Assembly



- **Inspection before disassembly** **P27-28**
- **Work before disassembly** **P27-29**
- **Disassembly sequence**

1 Bolt
2 Lock seat
3 Lock pawl
4 Adjusting screw
5 Bolt
6 Lock plate
7 Bearing cap
8 Side bearing outer race
9 Side bearing inner race
10 Differential assembly P27-34
11 Bolt
12 Pinion assembly P27-38
13 O-ring
14 Shim
15 Differential carrier

⊗ : Non-reusable parts

CAUTION ⚠

- **Make sure you replace bearing caps 7, differential carrier 15 and bolt 5 as a differential carrier set.**
- **Make sure you replace the reduction gear of differential assembly 10 and the reduction pinion of pinion assembly 12 as a reduction gear set.**
- **Make sure you keep left and right side bearings 8, 9 separate after removal, and be careful not to mix them up when installing them.**

NOTE

Write down the thickness of shim 14 before disassembly to use it as reference when assembly.

- **Assembly sequence**

Follow the disassembly sequence in reverse.

- **Inspection and adjustment after assembly** **P27-29**

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
8, 9	Starting torque of side bearing	2.0 to 2.9 N·m {1.4 to 2.2 lbf.ft, 0.2 to 0.3 kgf·m}	—	• Adjust using adjusting screw • Tangential force at 170 {6.69} outer periphery point of differential case : 24 to 34 N {5.3 to 7.7 lbf, 2.4 to 3.5 kgf}
10	Wobble of reduction gear back face	0.15 {0.0059} or less	0.2 {0.0079}	• Adjust or replace as a gear set • Measure at the 145 {5.71} radial point from reduction gear center
10, 12	Backlash between reduction gear and reduction pinion	0.25 to 0.33 {0.0098 to 0.013}	0.6 {0.024}	Adjust or replace as a gear set

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

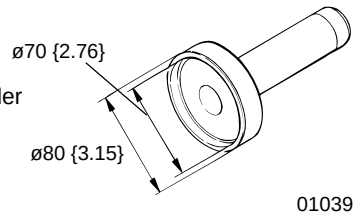
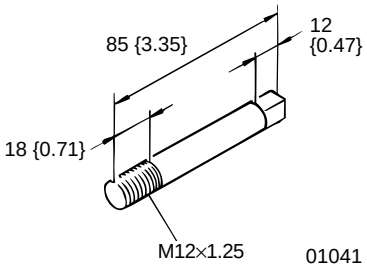
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock pawl mounting)	34 {25, 3.5}	—
5	Bolt (Bearing cap mounting)	235 {175, 24}	—
11	Bolt (Differential carrier and pinion assembly mounting)	78 {58, 8}	—

Sealant

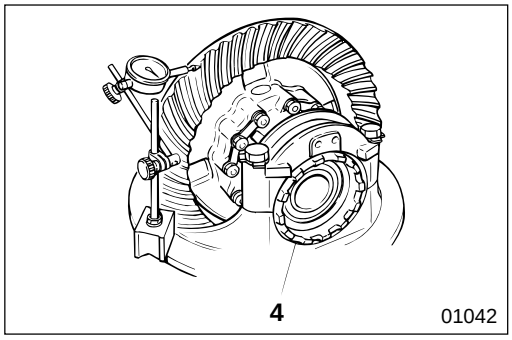
Location	Points of application	Kinds	Quantity
15	Mounting surface of pinion pilot bearing	LOCTITE 601	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
9	Side bearing installer 	MH061748	Press-fitting of side bearing inner race
12	Bearing retainer guide pin 	MH061745	Installation of pinion assembly : Two required

◆ Service procedure

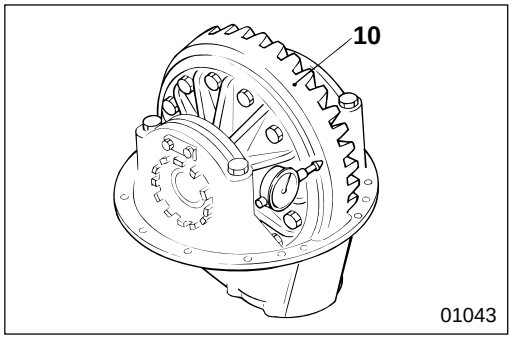


● Inspection before disassembly

Inspect for faulty parts before disassembly.

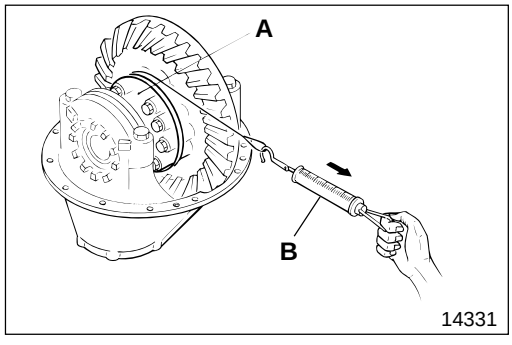
(1) Backlash of reduction gear and reduction pinion

If there is any fault, it is considered to be because of the amount adjusting screw **4** was tightened.



(2) Wobble of back face of reduction gear

Measure wobble at a point 145 mm {5.71 in.} (on the radius) from the center of the reduction gear, turning differential assembly **10** one full revolution.

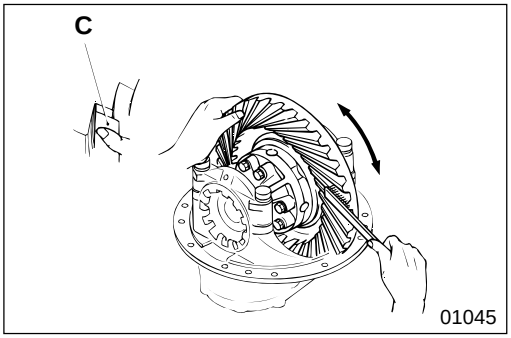


(3) Starting torque of side bearing

- Install spring balance **B** at 170 mm {6.69 in.} outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.

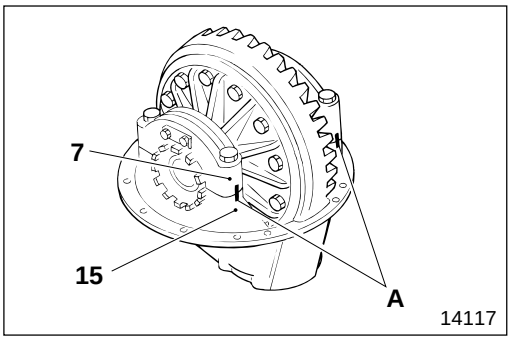
NOTE

Measure the starting torque within reduction gear and reduction pinion backlash range.



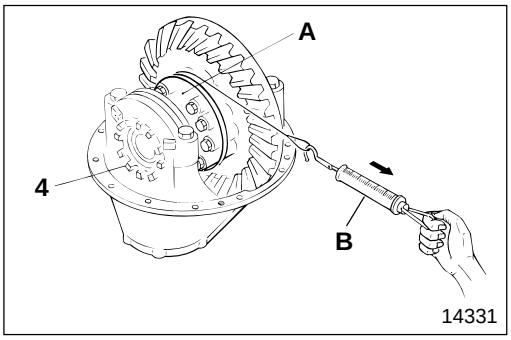
(4) Tooth contact of reduction gear

Apply red lead to three or four gear teeth, turn the gear a few times, and examine tooth contact with a piece of paper **C**.



● **Work before disassembly**

Put alignment marks **A** on bearing cap **7** and differential carrier **15** to identify left and right.



● **Inspection and adjustment after assembly**

(1) Starting torque of side bearing

[Inspection]

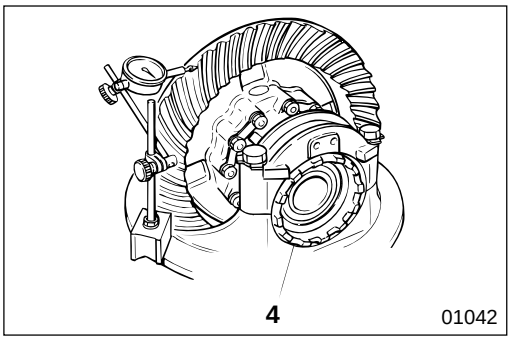
- Install spring balance **B** at 170 mm {6.69 in.} outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

[Adjustment]

If the measured value does not meet the specified value, adjust using left and right adjusting screws **4**.

CAUTION

- **Tighten left and right adjusting screws 4 the same amount.**
- **Adjust the starting torque within the reduction gear and reduction pinion backlash range.**

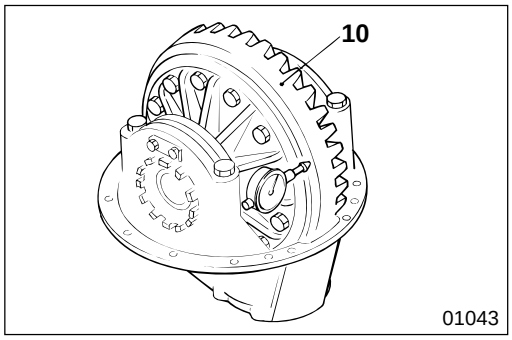


(2) Adjustment of backlash between reduction gear and reduction pinion

Adjust the starting torque of the side bearings using left and right adjusting screws **4**, taking care not to change the starting torque.

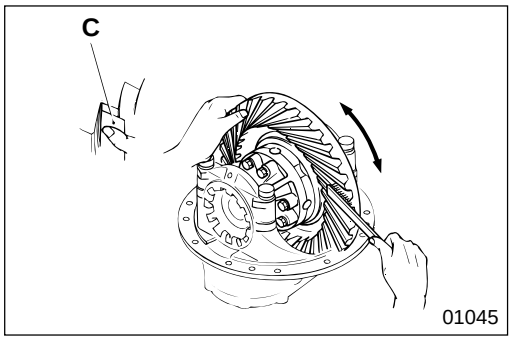
CAUTION

Make sure when you loosen one adjusting screw 4 that you tighten the other adjusting screw by the same amount, because the starting torque of the side bearing changes.



(3) Inspection of wobble of back face of reduction gear

Measure wobble at a point 145 mm {5.71 in.} (on the radius), from the center of the reduction gear, turning differential assembly **10** one full revolution.



(4) Tooth contact of reduction gear

[Inspection]

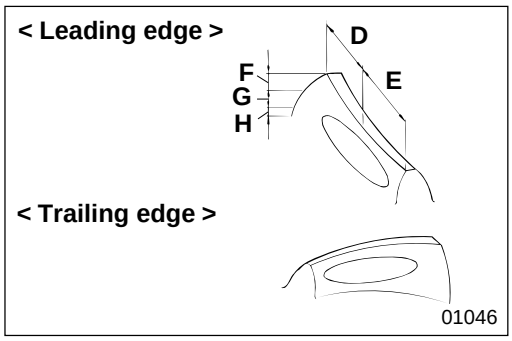
Apply red lead to three or four gear teeth, turn the gear a few times, and examine tooth contact with a piece of paper **C**.

[Adjustment]

If contact area is remarkably offset, adjust with reduction pinion mounting adjusting shims **14** to increase or decrease the backlash.

CAUTION ⚠

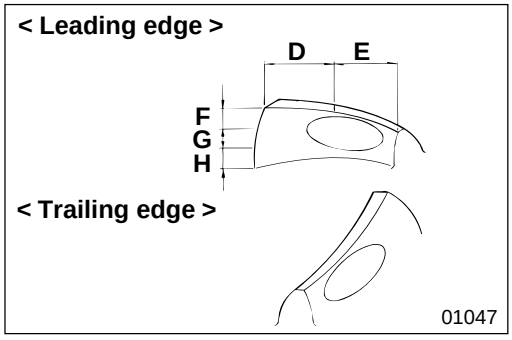
- **Make sure you replace as a reduction gear set (reduction gear and reduction pinion), when you replace the gear because of excessive teeth wear.**
- **When good tooth contact adjustment has been obtained, but backlash does not meet the standard value, tooth contact has priority. It is not necessary to adjust backlash to the standard value if it is less than 0.15 mm {0.0059 in.} out.**



● **Normal tooth contact at no load**

< Reduction gear >

D : Heel
E : Toe
F : Face
G : Flank
H : Clearance



< Reduction pinion >

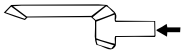
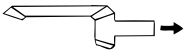
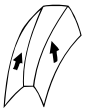
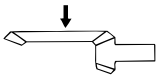
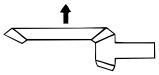
D : Heel
E : Toe
F : Face
G : Flank
H : Clearance

Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center toward toe
		Vertical direction	From center toward top of tooth for reduction gear and center of tooth for pinion
	Tooth contact shape	Length	About 50 to 70% of tooth width
		Width	About 50 to 70% of tooth depth
	Degree of tooth contact		Degree of tooth contact becomes weaker as it comes nearer to root or top

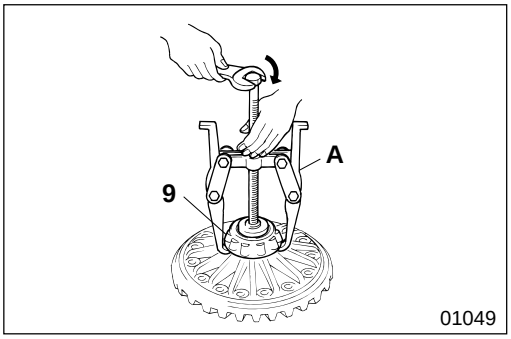
NOTE

When tooth contact area is nearer to toe at no load, it becomes middle area contact under load.

Adjustment of Tooth Contact

	Mode of adjustment	Moving direction
Adjustment by adding or reducing shims	Advances reduction pinion to reduction gear (Shims are reduced) 	< Leading edge > < Trailing edge > Tooth contact moves toward root of tooth
	Retards reduction pinion from reduction gear (Shims are added) 	 Tooth contact moves toward top of tooth
Adjustment using adjusting screw	Advance reduction gear to reduction pinion axis (Less backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard reduction gear from reduction pinion axis (More backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth

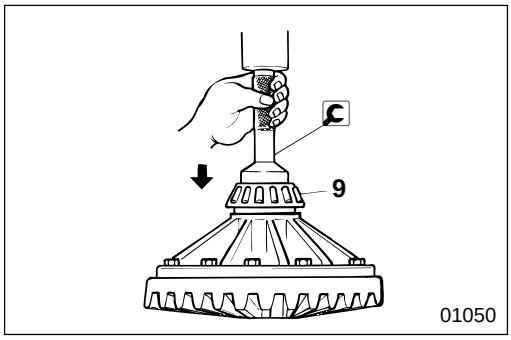
◆ Service procedure



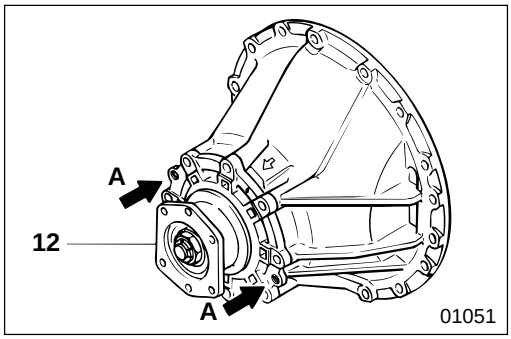
9 **Side bearing inner race**

[Removal]

A : Gear puller (General tool)



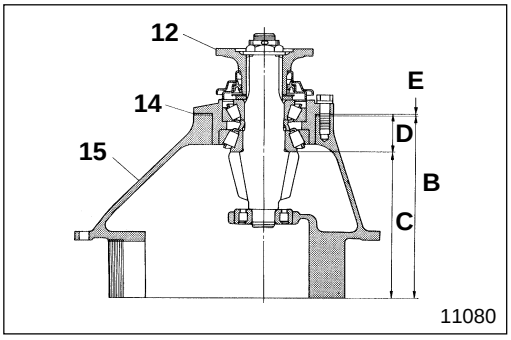
[Installation]



12 **Pinion assembly**

[Removal]

To remove pinion assembly **12**, screw two M12×1.25 mm bolts evenly into the two pinion assembly removal screw holes **A**.



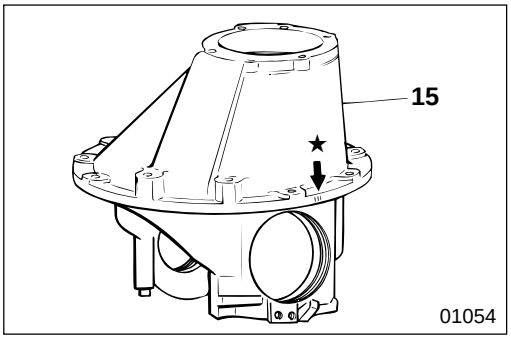
[Adjustment]

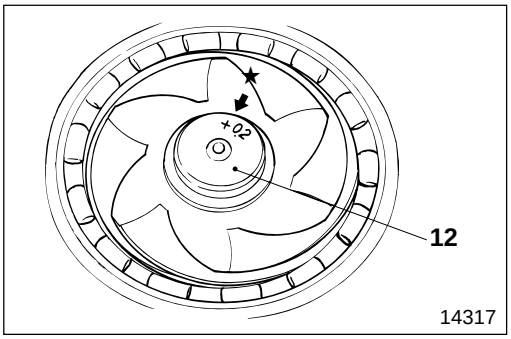
- Carry out the following procedure so that **B**, **C** and **D** conform to the standard dimension.
- Calculate shim thickness **E** according to the following formula based upon the machining error data stamped on pinion assembly **12** and differential carrier **15**.

Formula for calculation:

E = 0.5 {0.020}–b+c+d

b : Deviation from basic dimension **B**
c : Deviation from basic dimension **C**
d : Deviation from basic dimension **D**





Unit : mm {in.}

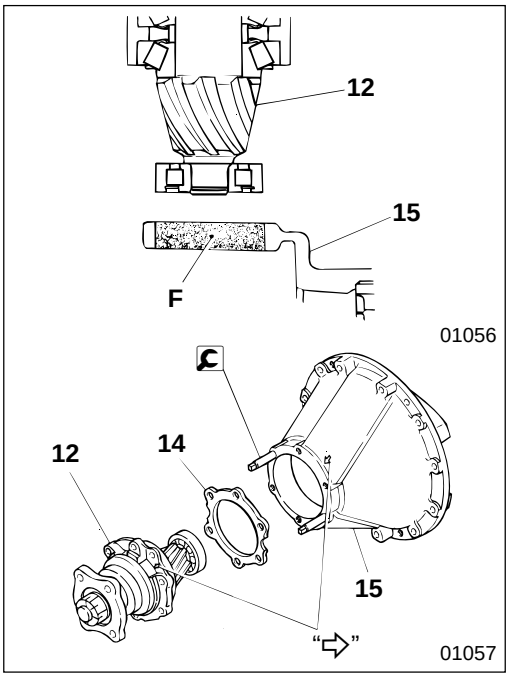
Location	Standard dimension	How to calculate deviation
Shim thickness	0.5 {0.020}	—
B	227 {8.94}	The basic dimension, multiplied by 100, is stamped on the periphery of differential carrier **15** flange
C	175 {6.89}	The basic dimension is stamped on the top of pinion assembly **12**
D	52 {2.05}	Measure the deviation from **D** using a dial gauge. However, If it is difficult to measure the actual deviation, assume a value from 0 to 0.2 {0 to 0.0079}

★ : Stamped number position

NOTE

Thickness is stamped in millimeters.

- Select shim **14** from shim thickness **E**.
  Available thicknesses of shim **14** : 0.1 mm {0.0039 in.} and 0.2 mm {0.0079 in.}



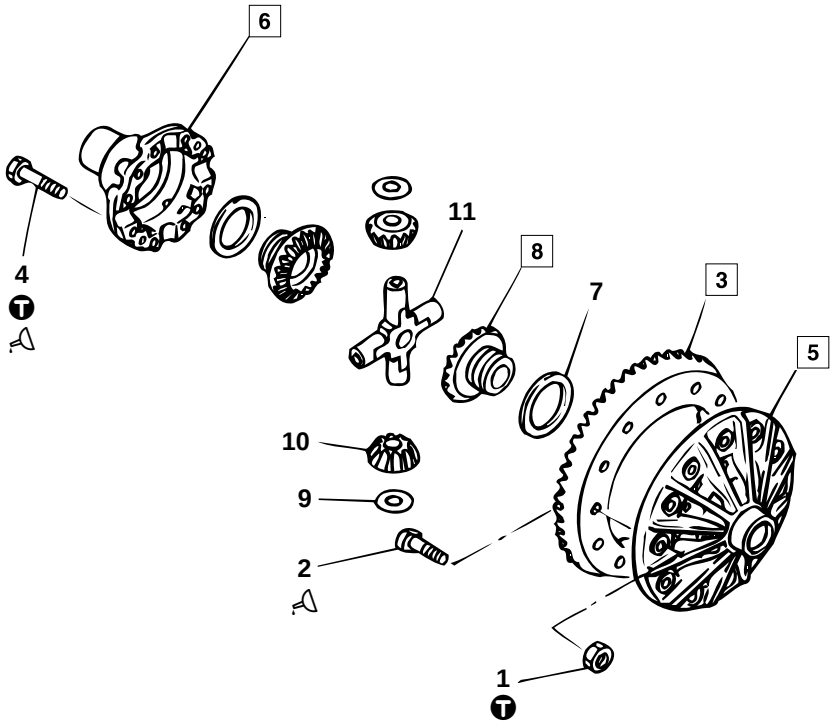
[Installation]

- Apply lock paint to pinion pilot bearing mounting surface **F** of differential carrier **15**.
- Install pinion assembly **12**.

CAUTION

- **Be sure to let the lock paint harden undisturbed for 30 minutes to two hours after installation.**
- **Be sure to wait at least three hours before running the vehicle, and if possible wait 24 hours to let the lock paint harden.**

Differential Assembly



● **Disassembly sequence**

1 Nut
2 Bolt
3 Reduction gear
4 Bolt
5 Differential case, LH
6 Differential case, RH
7 Differential gear washer
8 Differential gear
9 Differential pinion washer
10 Differential pinion
11 Pinion spider

CAUTION⚠

Make sure you replace differential case LH 5 and differential case RH 6 as a differential case set.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly** 🕮 P27-35

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
8	Play between differential gear and axle shaft spline	0.10 to 0.18 {0.0039 to 0.0071}	0.5 {0.020}	Replace
8, 10	Backlash between differential pinion and differential gear	0.19 to 0.25 {0.0075 to 0.0098}	0.5 {0.020}	Replace
10, 11	Clearance between differential pinion and pinion spider	[26] 0.17 to 0.27 {[1.02] 0.0067 to 0.011}	0.5 {0.020}	Replace

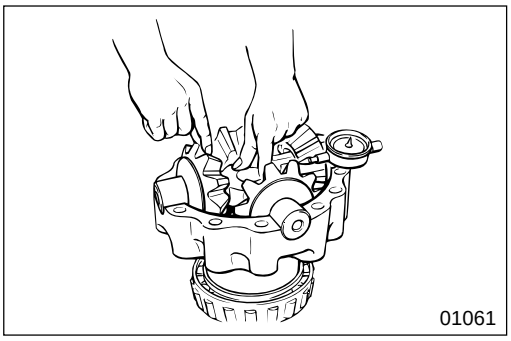
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Reduction gear and differential case LH mounting)	295 {215, 30}	—
4	Bolt (Differential case LH and differential case RH mounting)	180 {135, 18.5}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
2, 4	Entire bolt	Rust preventive	As required
	Thread area of bolt	LOCTITE 271	As required

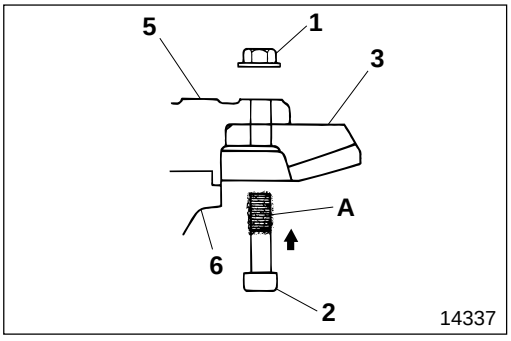


◆ Service procedure

● **Adjustment after assembly**

Backlash between differential gear and differential pinion

If the measured value deviates from the standard value, replace differential gear washer **7**.

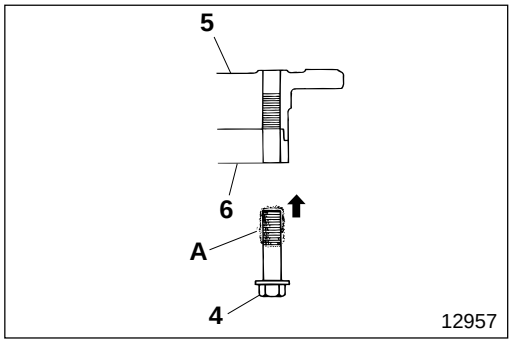


3 **5** **Installation of differential case LH and reduction gear**

- Apply rust preventive to entire surface of bolt **2**.
- Apply lock paint to thread area **A** of bolt **2**.
- Tighten nut **1** at specified torque.

CAUTION

- **Be sure to apply rust preventive to nut 1 because of the need to tighten it at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

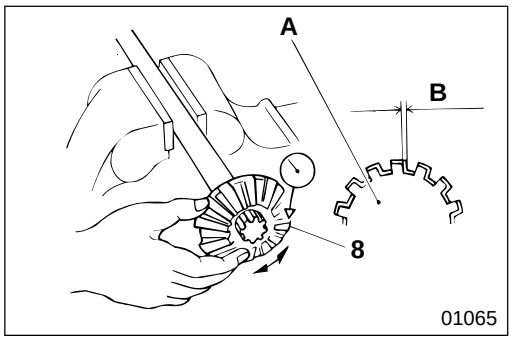


5 **6** **Installation of differential case LH and differential case RH**

- Apply rust preventive to entire surface of bolt **4**.
- Apply lock paint to thread area **A** of bolt **4**.
- Tighten bolt **4** at specified torque.

CAUTION

- **Be sure to apply rust preventive to bolt 4 because of the need to tighten it at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure no to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

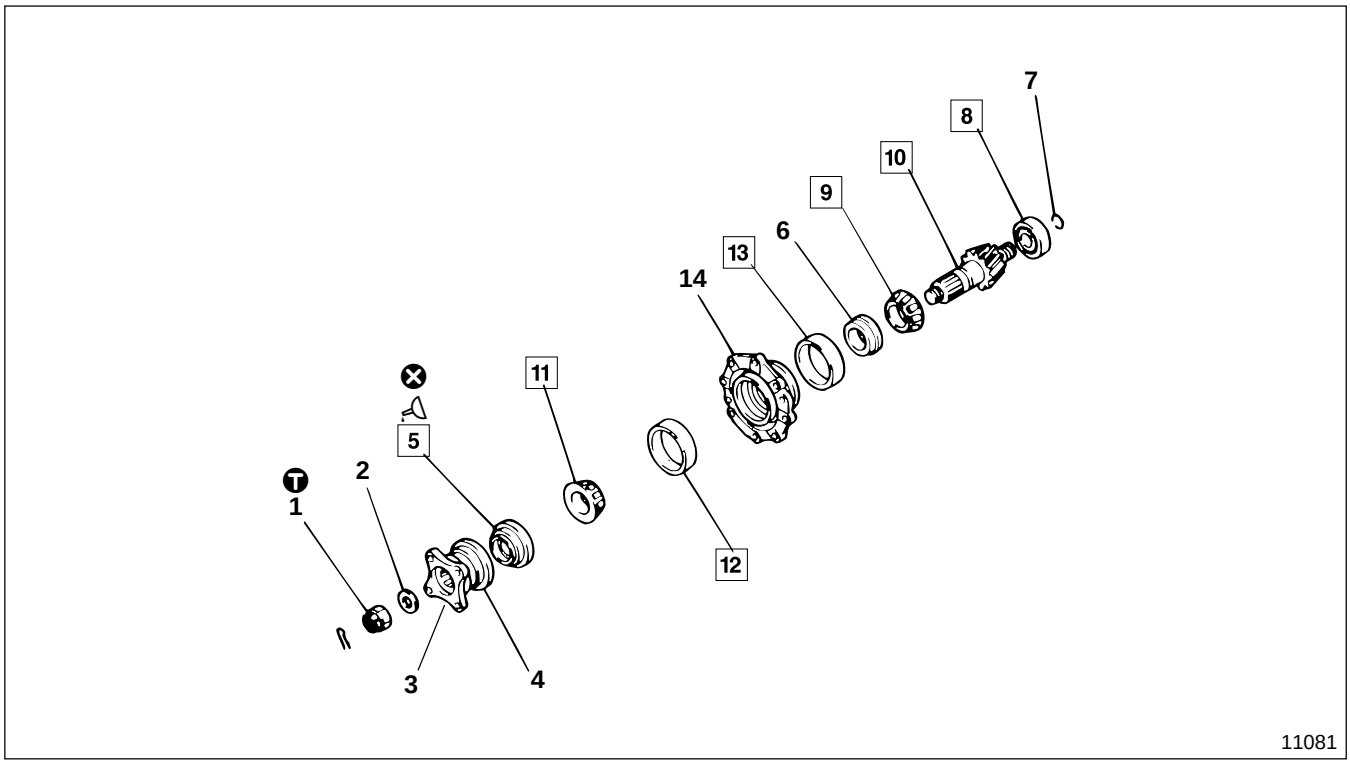


8 **Play between differential gear and axle shaft at the spline**

A : Axle shaft
B : Play

M E M O

Pinion Assembly



● **Disassembly sequence**

1 Lock nut
2 Washer
3 Companion flange
4 Dust cover
5 Oil seal
6 Collar
7 Lock ring
8 Pinion pilot bearing
9 Inner bearing inner race
10 Reduction pinion
11 Outer bearing inner race
12 Outer bearing outer race
13 Inner bearing outer race
14 Bearing retainer

⊗ : Non-reusable parts

NOTE

Record the thicknesses and number of collars 6 before disassembling for reference when assembling.

● **Assembly sequence**

14→13→12
10→8→7→9→6 → **11→5** → **4→3** → **2→1**

● **Inspection and adjustment after assembly** 📖 **P27-41**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
9, 11, 12, 13	Starting torque of pinion bearing	When new bearings are used	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using collar • Tangential force at 134 {5.28} outer periphery point of bearing retainer : 29.4 to 44.1 N {6.6 to 9.9 lbf, 3 to 4.5 kgf}
		When bearings are reused	1.6 to 2.4 N·m {1.2 to 1.7 ft.lbs, 0.16 to 0.24 kgf·m}	—	• Adjust using collar • Tangential force at 134 {5.28} outer periphery point of bearing retainer : 24 to 34 N {5.3 to 7.7 lbf, 2.4 to 3.5 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

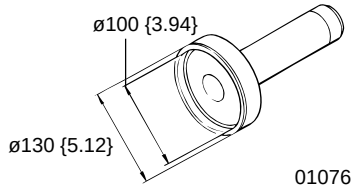
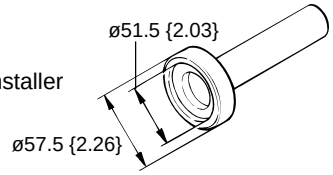
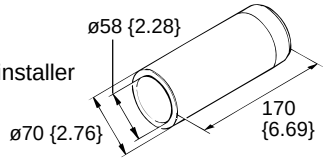
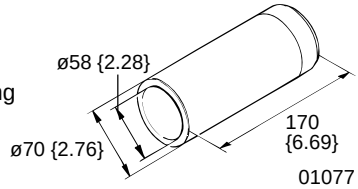
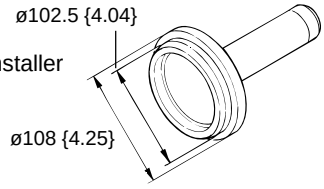
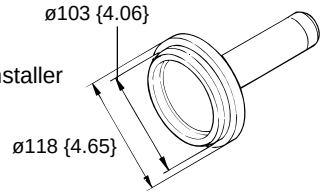
Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Companion flange and reduction pinion mounting)	195 to 345 {145 to 255, 20 to 35}	—

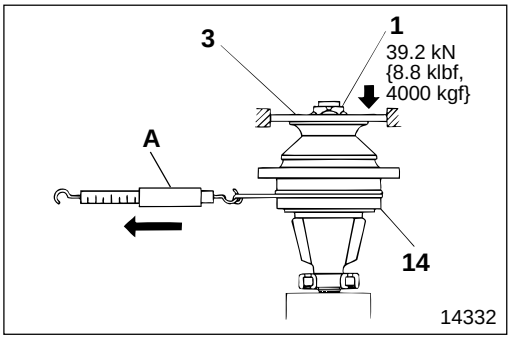
Lubricant

Location	Points of application	Kinds	Quantity
5	Lip area of oil seal	Chassis grease [NLGI No. 1 (Ca soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Oil seal installer 	MH061752	Press-fitting of oil seal
8	Pinion pilot bearing installer 	03723-27001	Press-fitting of pinion pilot bearing
9	Pinion inner bearing installer 	MH061004	Press-fitting of inner bearing inner race
11	Pinion outer bearing installer 	MH061004	Press-fitting of outer bearing inner race
12	Pinion outer bearing installer 	MH061007	Press-fitting of outer bearing outer race
13	Pinion inner bearing installer 	MH061006	Press-fitting of inner bearing outer race



◆ Service procedure

● Inspection and adjustment after assembly

Starting torque of pinion bearing

[Inspection]

- Apply load of approximately 39.2 kN {8.8 klbf, 4000 kgf} to companion flange **3** or tighten lock nut **1** at specified torque.
- Install spring balance **A** at 134 mm {5.28 in.} outer periphery point of bearing retainer **14**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

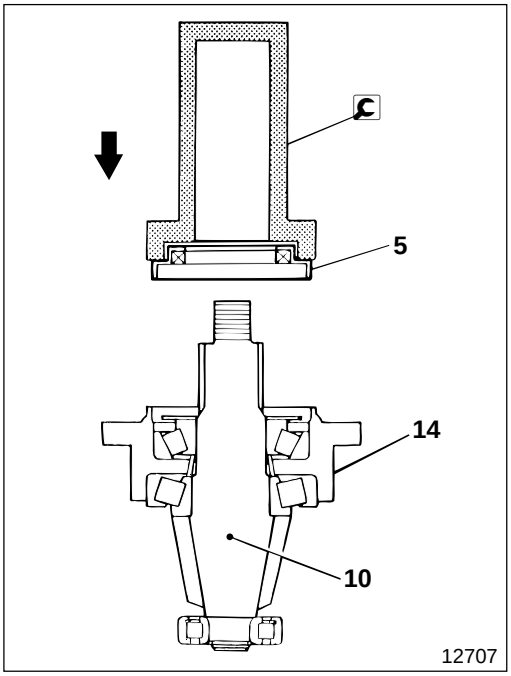
NOTE

- **Tighten companion flange 3 before measuring.**
- **Measure with oil seal 5 removed.**

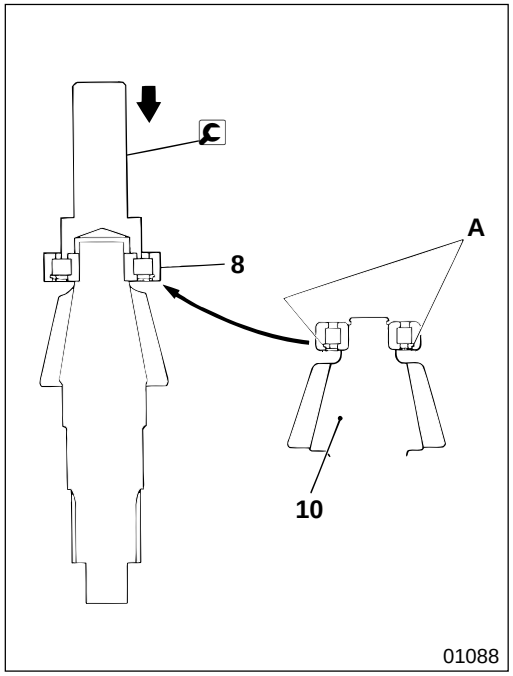
[Adjustment]

If the measured value does not conform to the specified value, adjust with collar **6** to obtain specified tangential force. Choose an appropriate collar by referring to the table below.

Thickness of collar : 15.875 to 16.475 mm {0.62 to 0.65 in.} (25 thicknesses in 0.025 mm {0.00098 in.} increments)



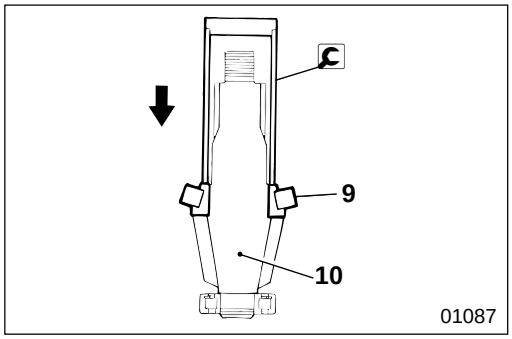
5 **Installation of oil seal**



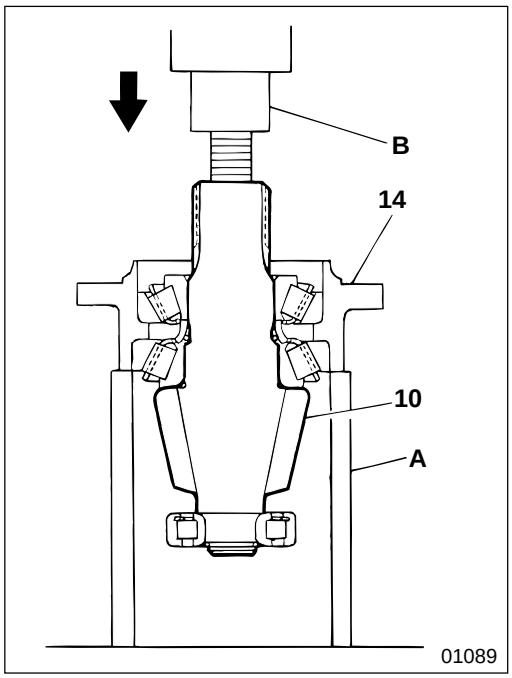
8 **Installation of pinion pilot bearing**

Press-fit pinion pilot bearing **8** in the direction as illustrated.

A : Lock ring



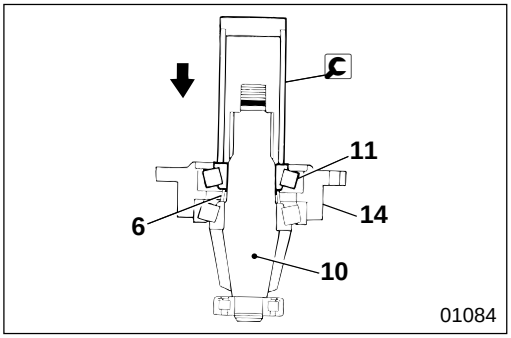
9 **Installation of inner bearing inner race**



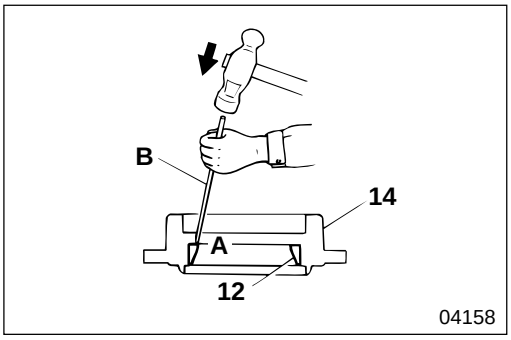
10 **Removal of reduction pinion**

A : Cylindrical guide

B : Press

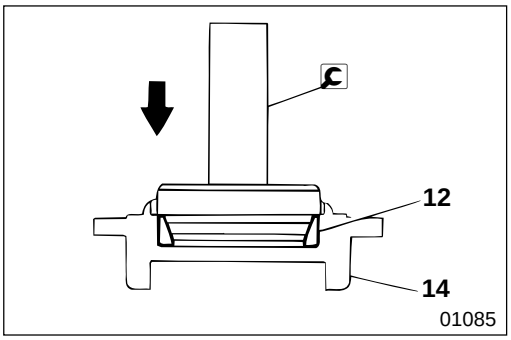


11 **Installation of outer bearing inner race**

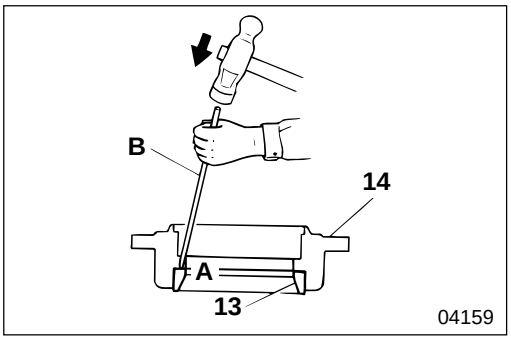


12 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **12** evenly from three indented parts **A** in bearing retainer **14**.
B : Pin-punch

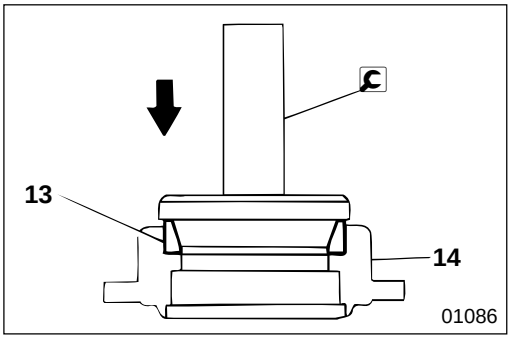


[Installation]



13 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **13** evenly from three indented parts **A** in bearing retainer **14**.
B : Pin-punch



[Installation]

MITSUBISHI
FUSO

Group 31

Wheel and Tire

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-31

INDEX

SPECIFICATIONS 31-2

TROUBLESHOOTING 31-2

WHEEL AND TIRE 31-3

SPECIFICATIONS/TROUBLESHOOTING

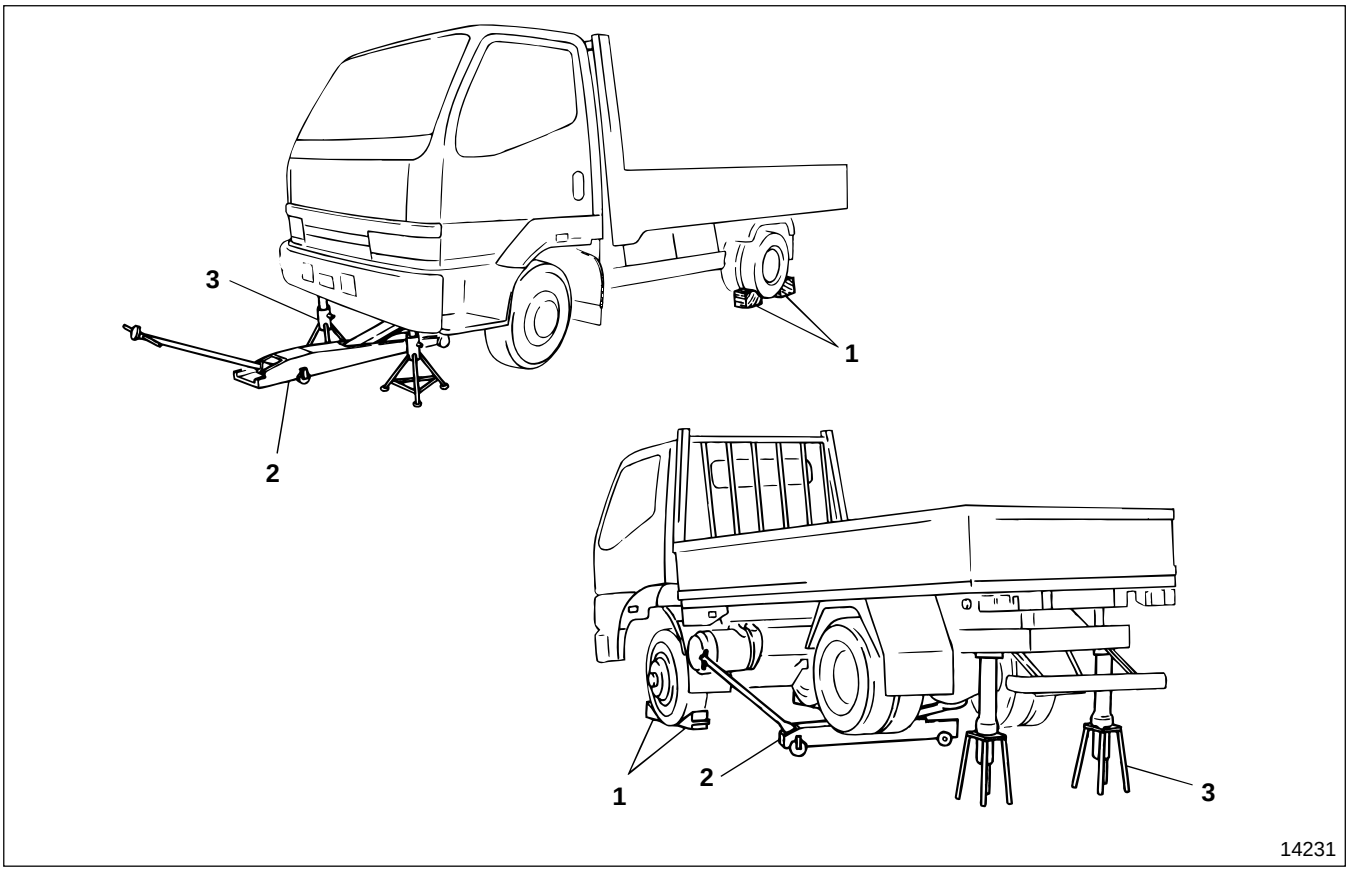
SPECIFICATIONS

Tire size	Air pressure kPa {psi, kgf/cm^2}		Application wheel
	Front	Rear	
215/75R17.5 124/123L	700 {100, 7.00}	700 {100, 7.00}	17.5×6.00-135-9t

TROUBLESHOOTING

Possible causes \ Symptoms			Tire tread worn										Remarks
			Both shoulders worn	Center worn	Outside worn	Inside worn	Feather-edged wear from outside to inside	Feather-edged wear from inside to outside	Wavy wear	Dished wear (one or more spots)	Pitted wear (dented) all around	Jagged wear	
Overloading			○										
Tire air pressure		Insufficient	○						○	○	○	○	
		Excessive		○									
Wheel alignment	Toe-in	Excessive			○		○						
Gr 26		Insufficient				○							
	Camber	Excessive			○								
		Insufficient				○							
	Toe-out excessive					○		○					
	Overall misalignment		○		○	○	○	○	○	○	○		
Knuckle arm bent					○	○	○	○					Gr 26
Left and right tie rod lengths different							○						Gr 26
Wheel balance incorrect									○	○	○	○	
Wheel bearing loose									○	○	○	○	Gr 26, 27
Ball joint loose										○			Gr 26
Tie rod end loose										○			Gr 37
Brake drum eccentric										○	○		Gr 35A
Axle bent									○	○			Gr 26, 27
Sudden starting, sudden braking or sharp turn										○	○		
Left and right front wheel turning radius incorrect												○	Gr 26
Road surface influence					○	○							

Work for Removal and Installation of Wheel and Tire



● **Work sequence**

1 Place wheel chocks.
2 Jack up the front or rear axle using a garage jack placed under the center of the axle.
3 Support the frame on rigid racks.

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after removal and installation**

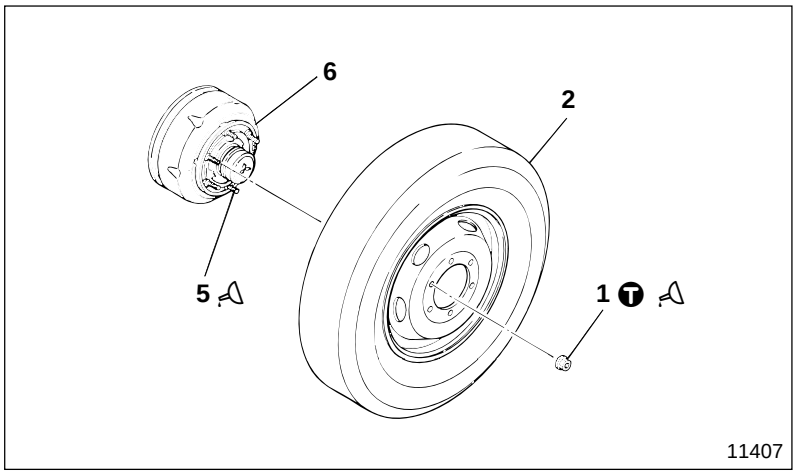
Follow the work sequence in reverse.

WHEEL AND TIRE

NOTE

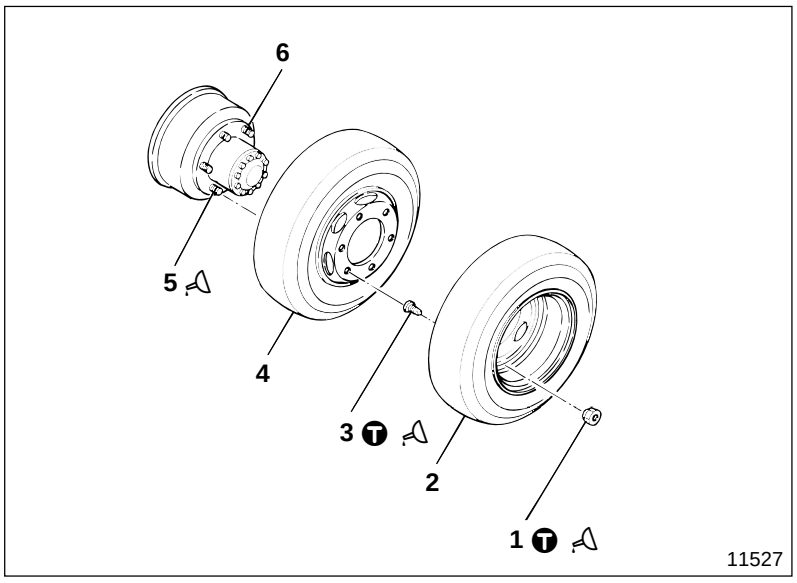
Use right-hand threaded wheel nuts marked “R” for right side wheel and left-hand threaded wheel nuts marked “L” for left side wheel.

< Single tire >



- **Removal sequence**
  - **1** Wheel nut
  - **2** Tire assembly P31-6
  - **5** Hub bolt
  - **6** Hub
- **Cleaning and applying grease before installation**
  P31-5
- **Installation sequence**
  Follow the removal sequence in reverse.

< Double tire >



- **Removal sequence**
  - **1** Wheel nut (outer)
  - **2** Tire assembly P31-6
  - **3** Wheel nut (inner)
  - **4** Tire assembly P31-6
  - **5** Hub bolt
  - **6** Hub
- **Cleaning and applying grease before installation**
  P31-5
- **Installation sequence**
  Follow the removal sequence in reverse.

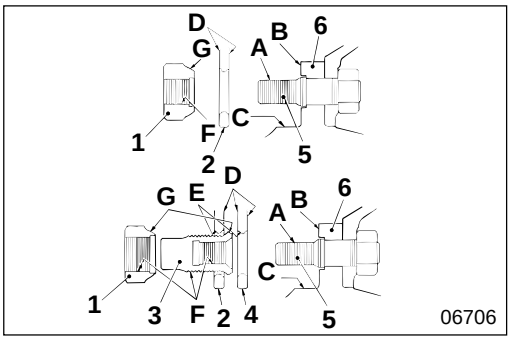
Tightening torque

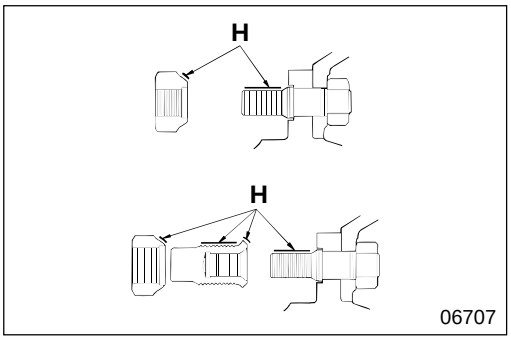
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3	Wheel nut	370 to 410 {275 to 305, 38 to 42}	Wet

Lubricant

Location	Points of application	Kinds	Quantity
1	Wheel nut spherical area	Chassis grease [NLGI No. 1 (Ca soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
3	Thread and spherical areas of wheel nut (inner)	Chassis grease [NLGI No. 1 (Ca soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
5	Thread area of hub bolt	Chassis grease [NLGI No. 1 (Ca soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required





◆ Service procedure

● Cleaning and applying grease before installation

[Cleaning]

To prevent wheel nuts **1** and **3** and hub bolt **5** from becoming loose and to prevent mounting parts (tire assemblies **2** and **4** and hub **6**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:

A : Hub bolt thread area
B : Wheel mounting surface of hub
C : Wheel alignment area of hub
D : Disc wheel mating surface
E : Disc wheel nut mounting surface
F : Wheel nut thread area
G : Wheel nut spherical area

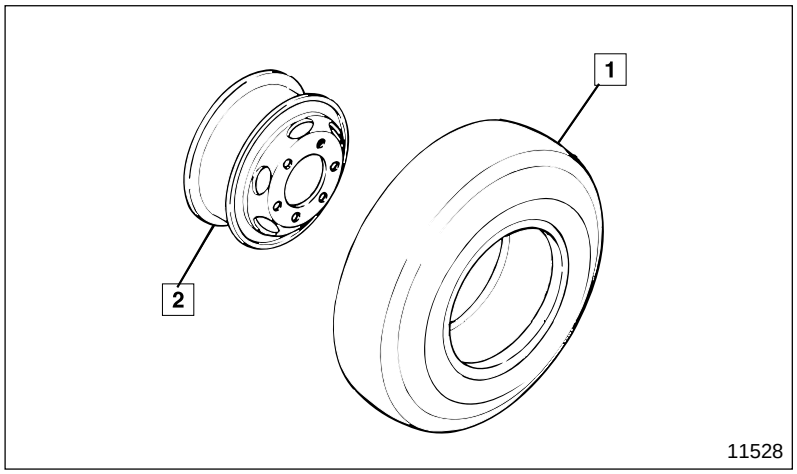
[Applying grease]

H : Grease application location

WARNING⚠

Never use grease containing molybdenum disulfide, since it can cause loosening of fitted screws.

Tire Assembly



● **Disassembly sequence**

1 Tire
2 Disc wheel

● **Assembly sequence**

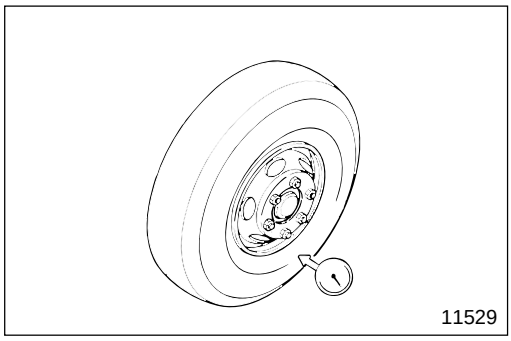
Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

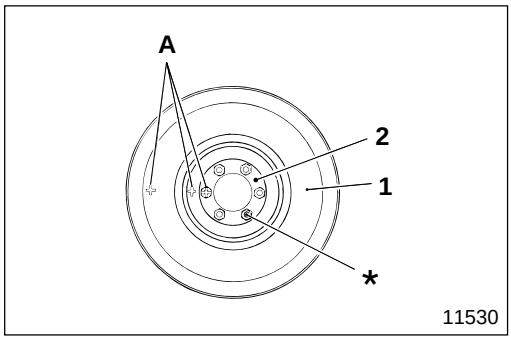
Location	Maintenance item		Standard value	Limit	Remedy
1	Horizontal deflection of tire (When assembled)		3.5 {0.14} or less	—	—
2	Disc wheel	Flatness	0.2 {0.0079} or less	—	—
		Horizontal deflection	1.5 {0.059} or less	—	—
		Vertical deflection	1.5 {0.059} or less	—	—

◆ Service procedure



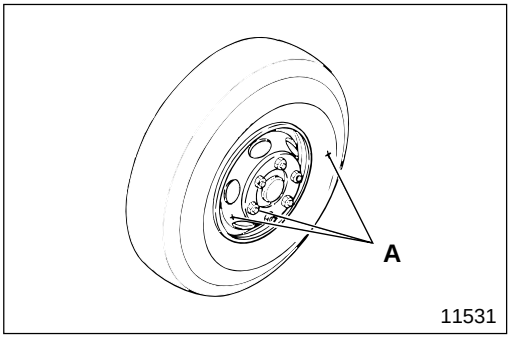
1 **Deflection of tire**

[Inspection]
If the measured value is higher than the limit, make corrections as follows.

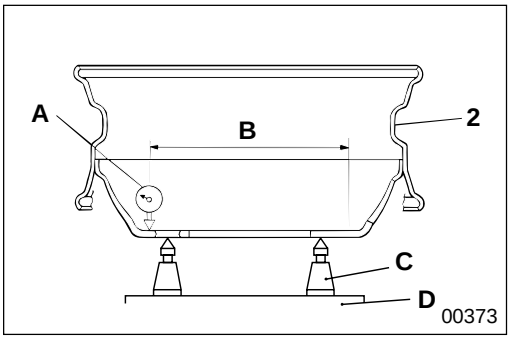


[Correction]

- Put chalk marks on tire **1**, disc wheel **2**, and hub bolt * (positions **A** as illustrated).
- Remove tire **1** from disc wheel **2**.



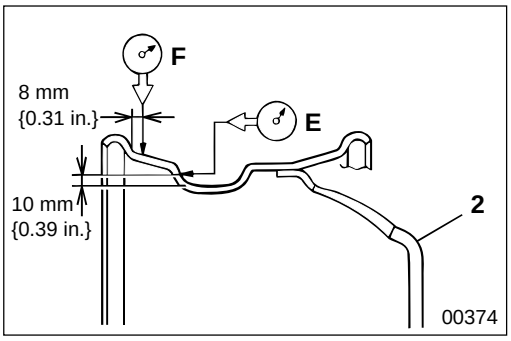
- Measure deflection of disc wheel **2**. If the most deflective position is near the chalk mark, reinstall tire **1** rotating it half a turn from the chalk mark and tighten nuts.
- Remeasure deflection of tire **1**.
- If the measured value is still higher than the limit, replace tire **1** and disc wheel **2** together as an assembly.



2 Inspection of disc wheel

(1) Flatness

- Measure flatness at specified position **B** from the center of disc wheel **2**.
  Measure flatness at six equidistant points (wheel with 6 studs) on the wheel.
  A : Dial gauge
  B : ø170 to 270 mm {6.69 to 10.6 in.}
  C : Portable screw jacks (× 4)
  D : Surface plate
- Replace disc wheel **2** if the measured value is higher than the limit.



(2) Deflection

Replace disc wheel **2** if the measured value is higher than the limit.
E : Horizontal deflection measuring point
F : Vertical deflection measuring point

MITSUBISHI
FUSO

Group 33

Front Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-33

INDEX

STRUCTURE AND OPERATION 33- 2

TROUBLESHOOTING 33- 3

WORK BEFORE REMOVAL AND INSTALLATION
OF FRONT SUSPENSION 33- 4

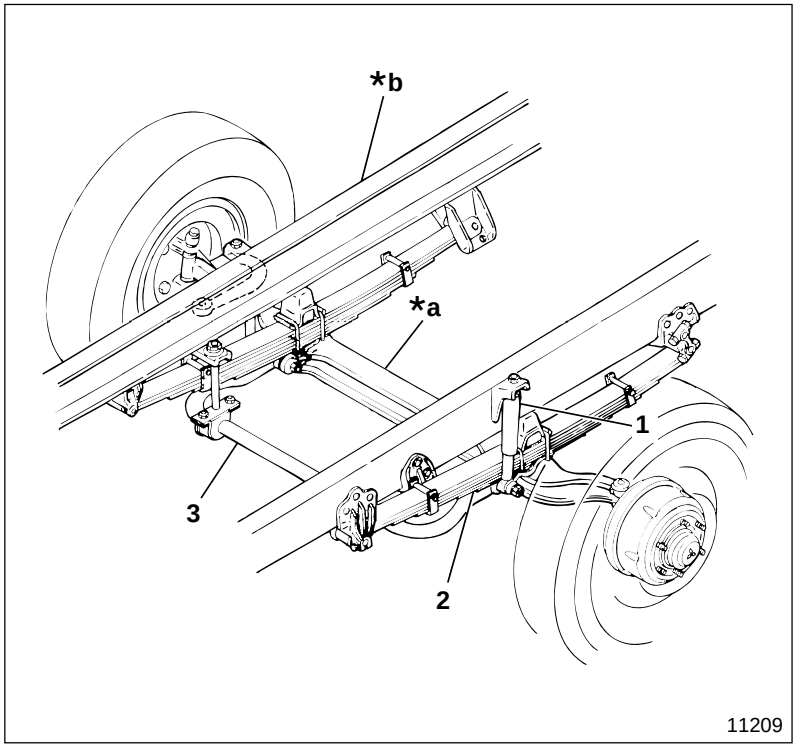
REMOVAL AND INSTALLATION
OF LEAF SPRING ASSEMBLY < FH210 > 33- 6

REMOVAL AND INSTALLATION
OF LEAF SPRING ASSEMBLY < FH211 > 33-10

LEAF SPRING ASSEMBLY 33-14

SHOCK ABSORBER 33-16

STABILIZER 33-17



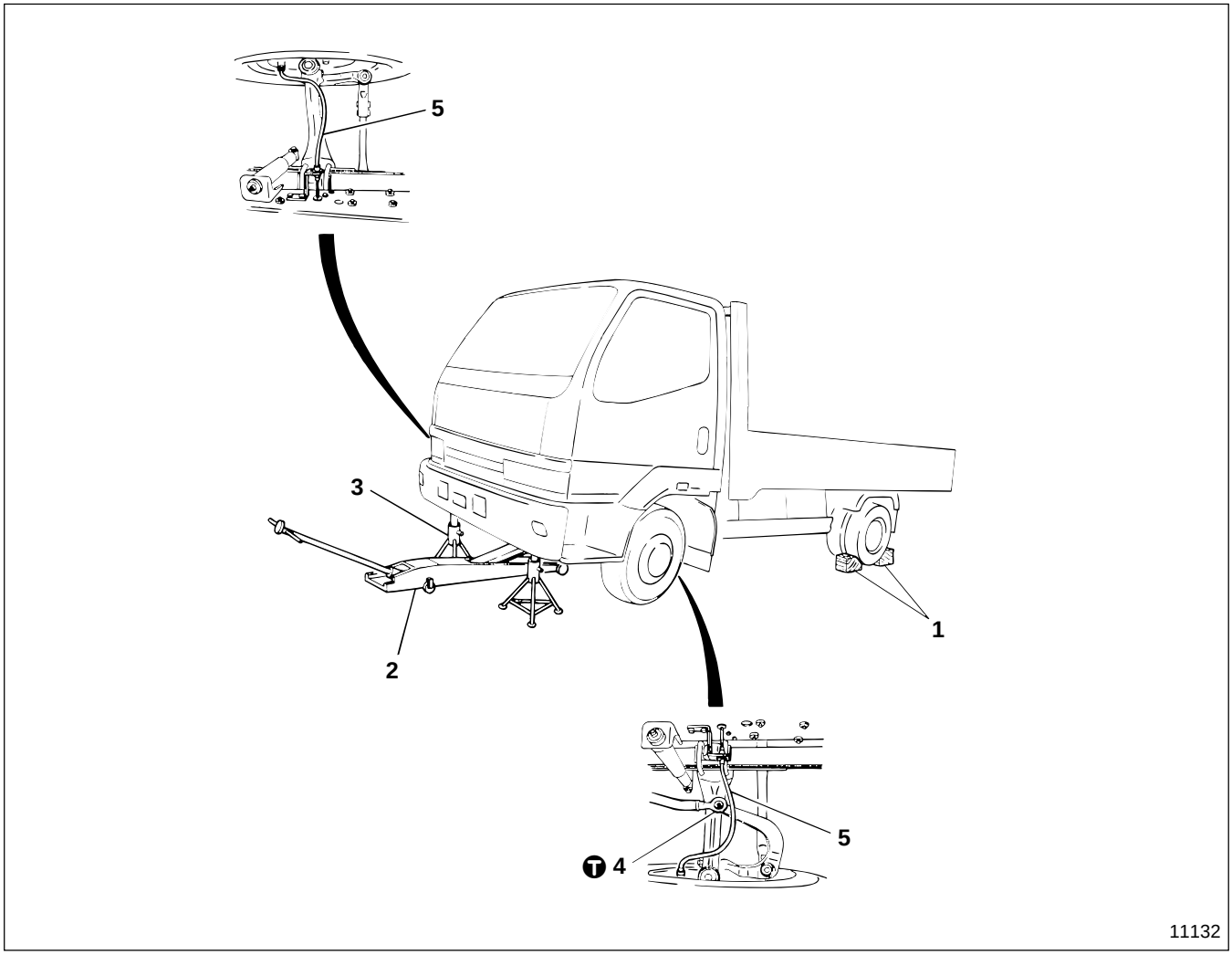
1 Shock absorber
2 Leaf spring assembly
3 Stabilizer

***a** : Front axle
***b** : Frame

Leaf spring assembly **2**, shock absorber **1** and stabilizer **3** are installed between frame ***b** and front axle ***a** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability.

Possible causes \ Symptoms		Ride soft with gentle swaying	Noise generated when vehicle is unloaded	Direct impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Excessive rolling while cruising	Periodic jolts received from the road surface	Remarks
Leaf spring	Cracked or damaged			○				
	Fractured		○					
	Spring brackets broken				○			
	U-bolts loose				○			
	Spring bushing worn		○					
Shackle pin play in thrust direction			○					
Bump stopper damaged or broken					○			
Shock absorber	Oil leaking noticeable or damping force decreased	○						
	Rubber bushing worn		○					
	Installation loose		○					
Stabilizer	Stabilizer deformed or bushing worn					○		
Tire	Tires worn unevenly						○	
	Tires and wheels unbalanced						○	Gr 31
	Air pressure excessive			○				

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT SUSPENSION



● **Removal sequence**

1 Place wheel chocks.
2 Jack up the front axle with a garage jack.
3 Support the front frame on rigid racks.
4 Remove the nut (that connect the knuckle arm and the drag link).
5 Disconnect the brake hose (on the frame side).

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame with rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION⚠

Be sure to protect the brake hose from dust by fitting blanking plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

WARNING⚠

You must bleed air from the brake system after connecting the brake hose, failure to do so would cause the brakes to malfunction. Gr 35A

CAUTION⚠

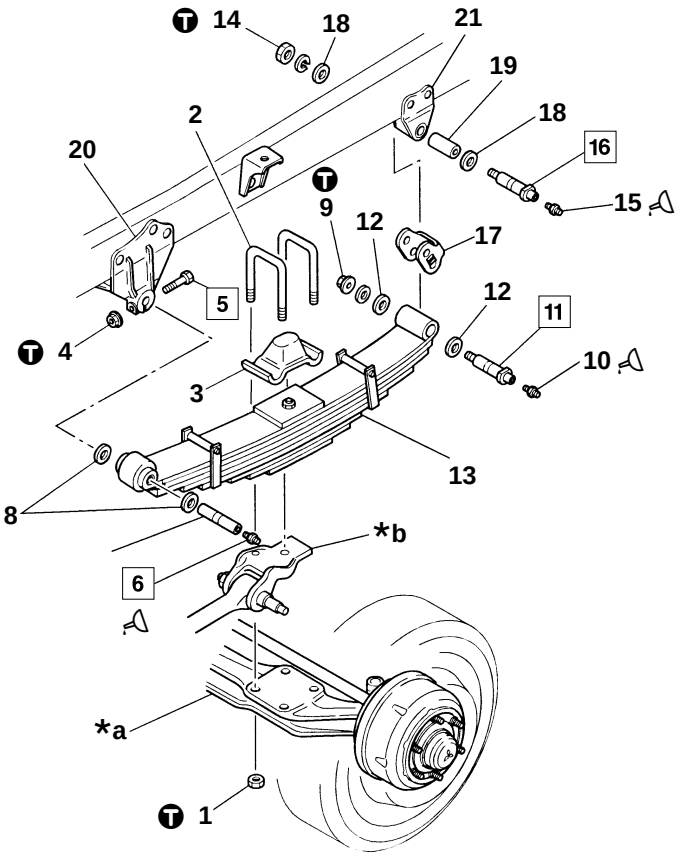
Be sure that the brake hose is not twisted when you connect it.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Nut (Knuckle arm and drag link connecting)	190±47.5 {140±35, 19.4±4.85}	—

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY < FH210 >



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● **Disassembly sequence**

1 U-bolt nut
2 U-bolt
3 Bump stopper
4 Nut
5 Bolt
6 Grease nipple
7 Shackle pin
8 Side washer
9 Shackle pin nut
10 Grease nipple
11 Shackle pin
12 Side washer
13 Leaf spring assembly P33-16
14 Shackle pin nut
15 Grease nipple
16 Shackle pin
17 Shackle link
18 Side washer
19 Bracket bushing
20 Front spring front bracket
21 Front spring rear bracket

***a** : Front axle Gr 26

***b** : Stabilizer P33-19

CAUTION

Do not remove front spring front bracket 20 and rear bracket 21 unless abnormalities are found. Gr 41

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

In leaf spring assembly 13, the spring unit camber is different for the right and left sides. If the leaf spring assemblies are reversed in installation position, the vehicle can tilt to one side.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
7, 11, 13	Clearance between shackle pin and bushing of leaf spring assembly	[28] 0 to 0.12 {[1.10] 0 to 0.0047}	0.3 {0.012}	Replace
7, 20	Clearance between shackle pin and front spring front bracket	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
11, 16, 17	Clearance between shackle pin and shackle link	[28] 0.02 to 0.24 {[1.10] 0.0008 to 0.0095}	0.3 {0.012}	Replace
13, 17	Clearance between leaf spring assembly and shackle link	0.35 to 2.2 {0.0138 to 0.0866}	2.5 {0.0984}	Replace side washer
13, 20	Clearance between leaf spring assembly and front spring front bracket	0.07 to 1.0 {0.0028 to 0.0394}	1.3 {0.0512}	Replace side washer
16, 19	Clearance between shackle pin and bracket bushing	[28] 0.02 to 0.14 {0.0008 to 0.0055}	0.3 {0.012}	Replace
17, 21	Clearance between shackle link and front spring rear bracket	0 to 1.7 {0 to 0.0669}	2.0 {0.0787}	Replace side washer

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

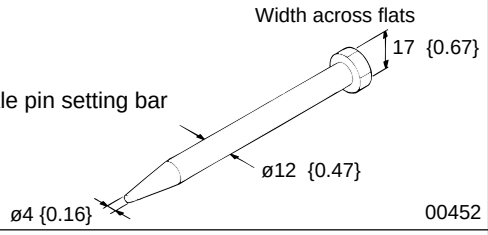
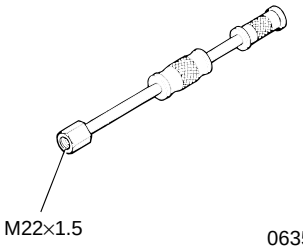
Location	Parts to be tightened	Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	240±36 {175±27, 24.5±3.7}	Wet
4	Nut (Shackle pin mounting)	80 to 110 {58 to 80, 8.0 to 11}	—
9, 14	Shackle pin nut (Shackle pin mounting)	190 to 260 {140 to 192, 19 to 26}	—

Lubricant

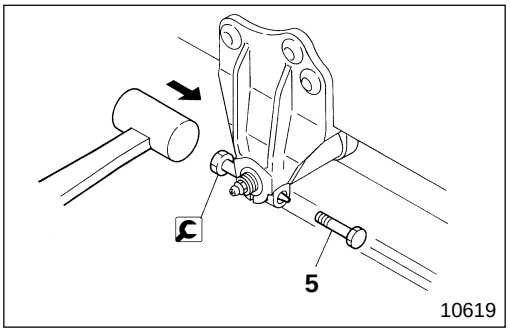
Location	Points of application	Kinds	Quantity
6, 10, 15	Supply from grease nipple	Mitsubishi chassis grease	As required

Special tools

Unit : mm {in.}

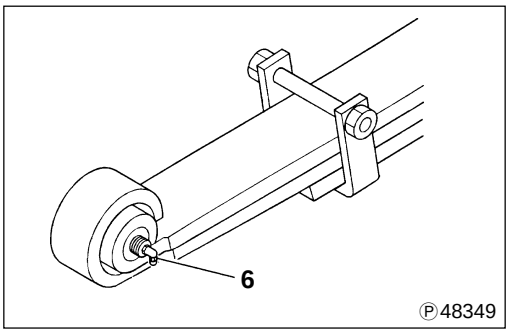
Location	Tool name and shape	Part No.	Application
5, 7, 11	Shackle pin setting bar 	MC023419	Removal of bolt (shackle pin mounting bolt) and aligning of shackle pin bolt groove
7, 11, 16	Shackle pin remover 	MB999112	Removal of shackle pin

◆ Service procedure



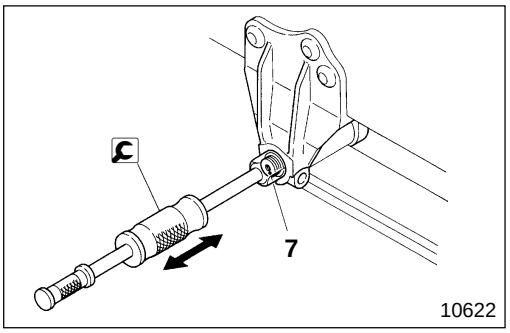
5 **Removal of bolt**

: Shackle pin setting bar



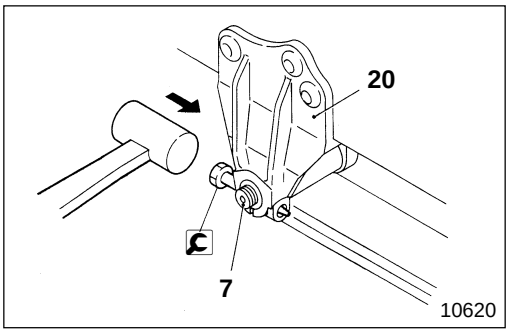
6 **Grease nipple**

Position grease nipple **6** on the driver's side (left front in a direction which allows easy supply of grease.
Grease nipples **10** and **15** use the straight type.

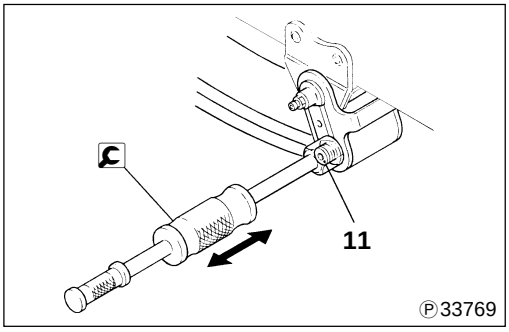


7 **Shackle pin**

[Removal]
: Shackle pin remover

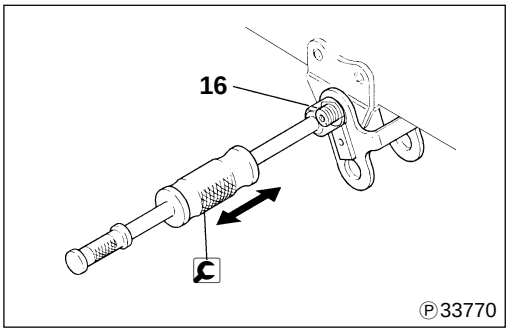


[Installation]
Using shackle pin setting bar, align the bolt hole of front spring front bracket **20** with the bolt groove of shackle pin **7**.



11 **Shackle pin**

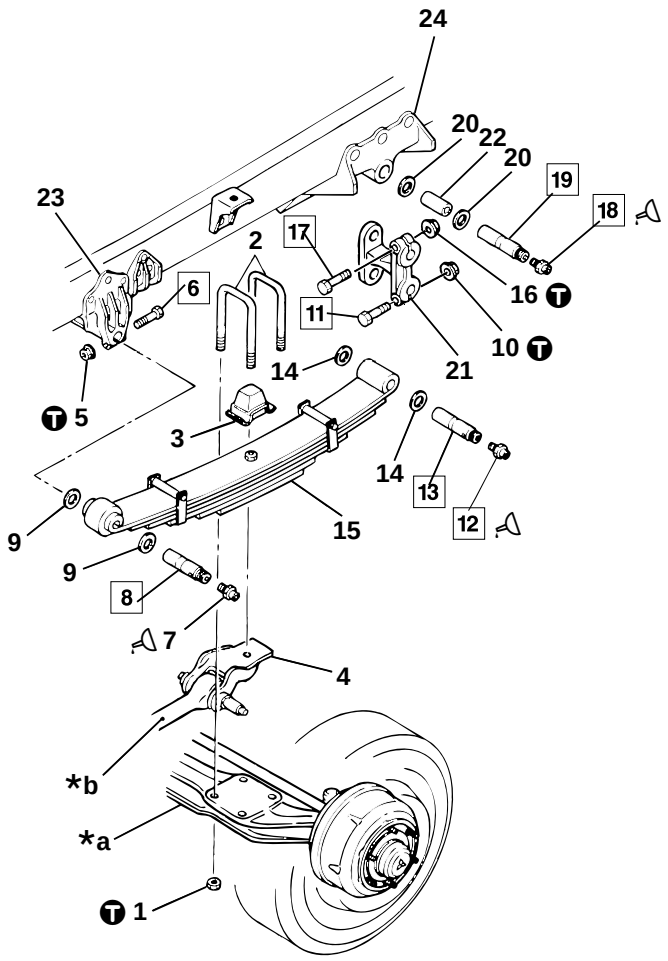
: Shackle pin remover



16 **Shackle pin**

: Shackle pin remover

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY < FH211 >



11133

● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Bump stopper
4 Stabilizer bracket
📖 P33-17
5 Nut
6 Bolt
7 Grease nipple
8 Shackle pin
9 Side washer
10 Nut
11 Bolt
12 Grease nipple
13 Shackle pin
14 Side washer
15 Leaf spring assembly
📖 P33-14
16 Nut
17 Bolt
18 Grease nipple
19 Shackle pin
20 Side washer
21 Shackle link
22 Bushing
23 Front spring front bracket
24 Front spring rear bracket

***a :** Front axle 📦 Gr 26
***b :** Stabilizer 📖 P33-17

NOTE

Do not remove front spring front bracket 23 and rear bracket 24 unless they are faulty. 📦 Gr 41

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

In leaf spring assembly 15, the spring unit camber is different for the right and left sides. If the leaf spring assemblies are reversed in installation position, the vehicle can tilt to one side.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
8, 13, 15	Clearance between shackle pin and leaf spring assembly bushing	[28} 0 to 0.12 {[1.10] 0 to 0.0047}	0.3 {0.012}	Replace
8, 23	Clearance between shackle pin and front spring front bracket	[28} 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
13, 19, 21	Clearance between shackle pin and shackle link	[28} 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
15, 21	Clearance between leaf spring assembly and shackle link	0.5 to 1.2 {0.020 to 0.047}	1.5 {0.059}	Replace side washer
15, 23	Clearance between leaf spring assembly and front spring front bracket	0.2 to 0.9 {0.0079 to 0.035}	—	Replace side washer
19, 22	Clearance between shackle pin and bushing	[28} 0.02 to 0.14 {[1.10] 0.00079 to 0.0055}	—	Replace
21, 24	Clearance between shackle link and front spring rear bracket	0.5 to 1.2 {0.020 to 0.047}	—	Replace side washer

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

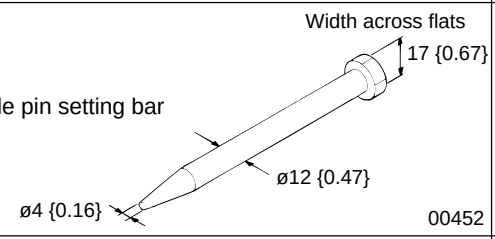
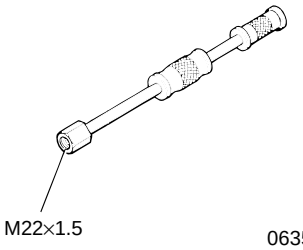
Location	Parts to be tightened	Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	240±36 {175±27, 24.5±3.7}	Wet
5, 10, 16	Nut (Shackle pin mounting)	80 to110 {58 to 80, 8.0 to 11}	—

Lubricant

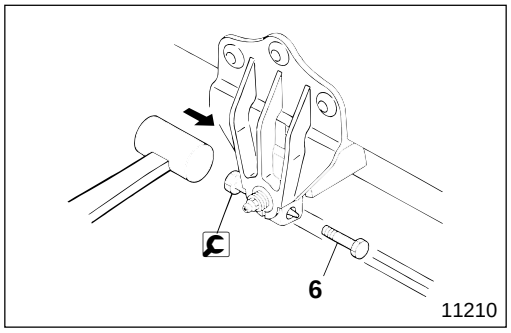
Location	Points of application	Kinds	Quantity
7, 12, 18	Grease nipple	Chassis grease [NLGI NO.1 (Ca soap)]	As required

Special tools

Unit : mm {in.}

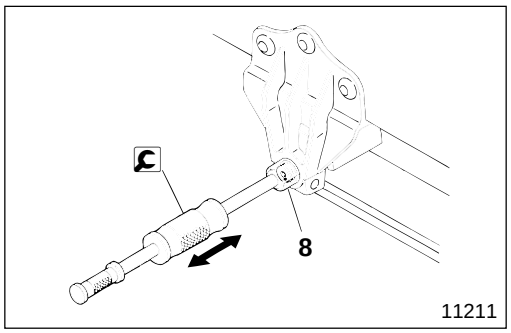
Location	Tool name and shape	Part No.	Application
6, 8, 11, 13, 17, 19	Shackle pin setting bar 	MC023419	Removal of bolt (installation of shackle pin), alignment of shackle pin bolt slot
8, 3, 19	Shackle pin remover 	MB999112	Removal of shackle pin

◆ Service procedure



6 **Removal of bolt**

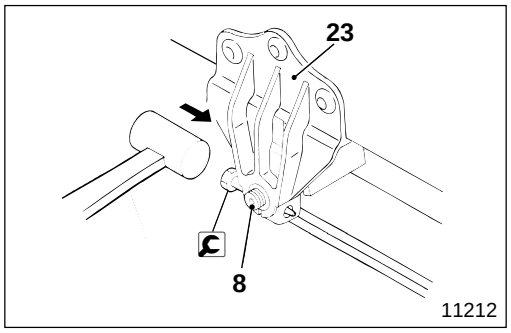
: Shackle pin setting bar



8 **Shackle pin**

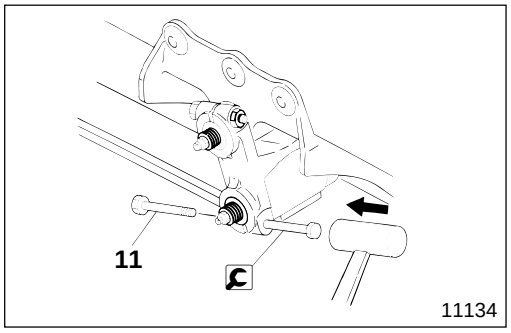
[Removal]

: Shackle pin remover



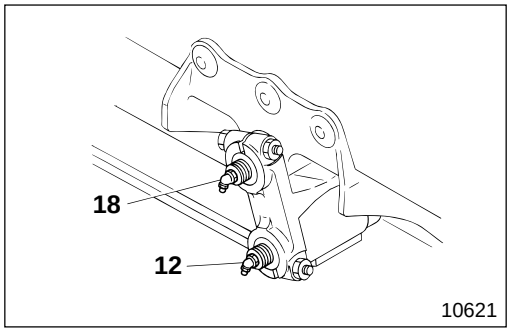
[Installation]

Align the bolt hole of front spring front bracket **23** and the bolt slot of shackle pin **8** using shackle pin setting bar.



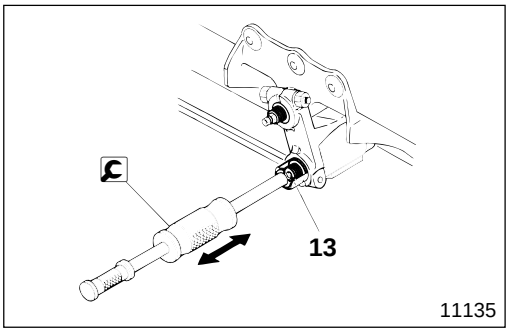
11 **Removal of bolt**

: Shackle pin setting bar



12 **18** **Installation of grease nipple**

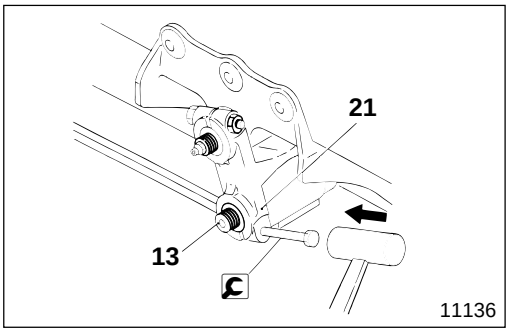
- Install grease nipples **12**, **18** on the driver's side (rear left) so that they face the most convenient side for supplying grease.
- For the automatic transmission model, also install grease nipples **12**, **18** on the passenger's side (rear right) so that they face the most convenient side for supplying grease.



13 Shackle pin

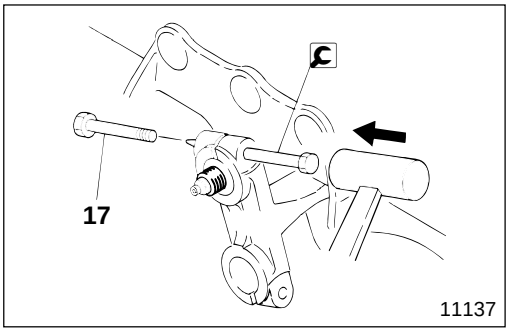
[Removal]

: Shackle pin remover



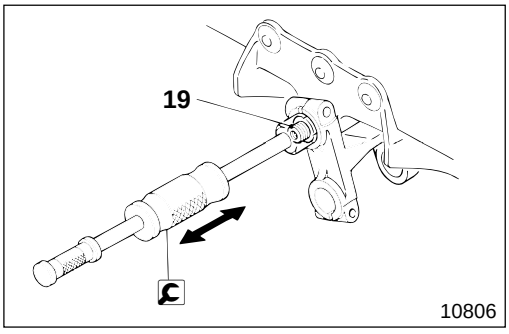
[Installation]

Align the bolt hole of shackle link **21** and the bolt slot of shackle pin **13** using shackle pin setting bar.



17 Removal of bolt

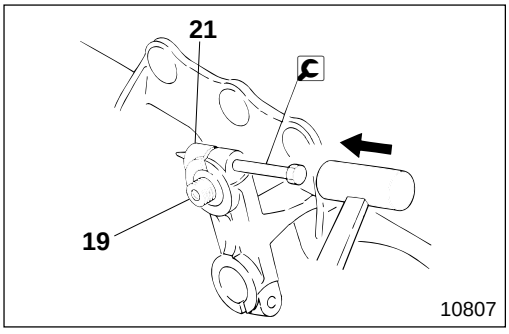
: Shackle pin setting bar



19 Shackle pin

[Removal]

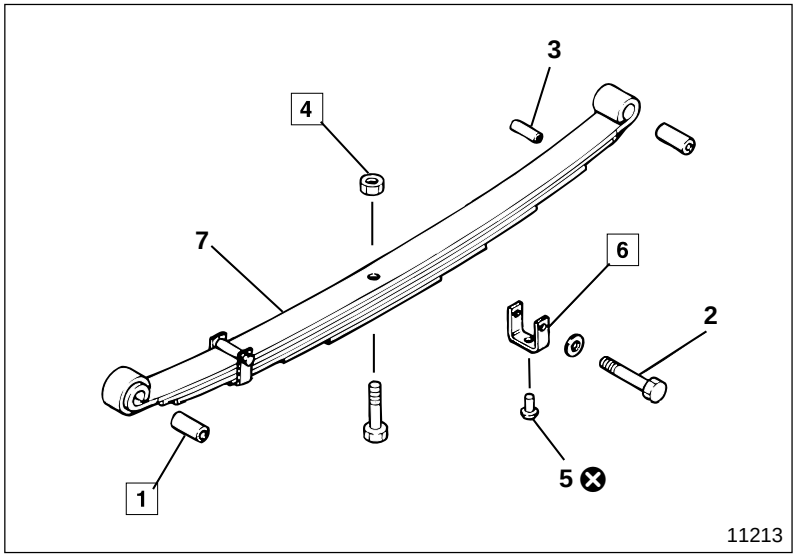
: Shackle pin remover



[Installation]

Align the bolt hole of shackle link **21** and the bolt slot of shackle pin **19** using shackle pin setting bar.

LEAF SPRING ASSEMBLY



● **Disassembly sequence**

1 Spring bushing
2 Clip bolt
3 Pipe
4 Center nut
5 Rivet
6 Clip
7 Leaf spring

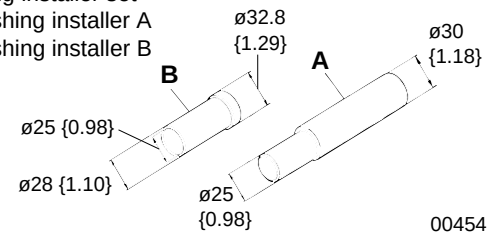
⊗ : Non-reusable parts

● **Assembly sequence**

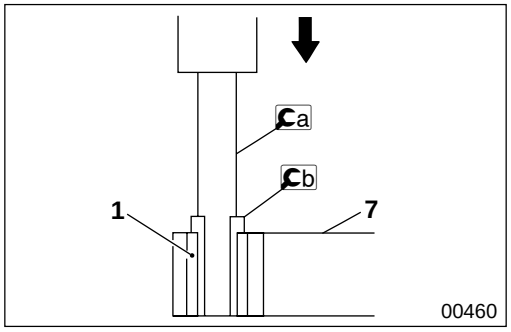
Follow the disassembly sequence in reverse.

Special tools

Unit : mm {in.}

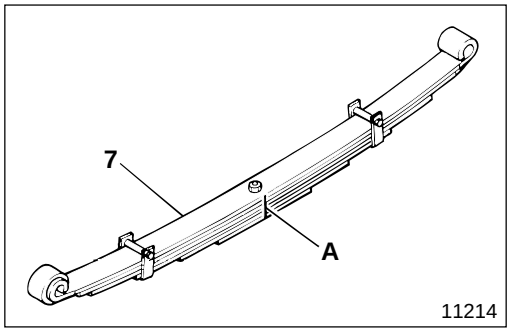
Location	Tool name and shape	Part No.	Application
1	Bushing installer set **A:** Bushing installer A **B:** Bushing installer B 	MB999066 **A:** MB999067 **B:** MB999068	Removal and installation of spring bushing

◆ Service procedure



1 **Removal and installation of spring bushing**

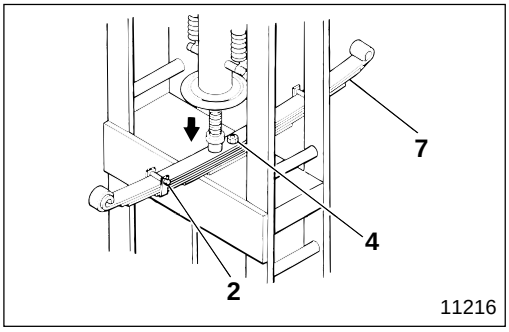
Remove spring bushing **1** from leaf spring **7** using a bushing installer **A** and b bushing installer **B**. For installation, follow the removal sequence in reverse.



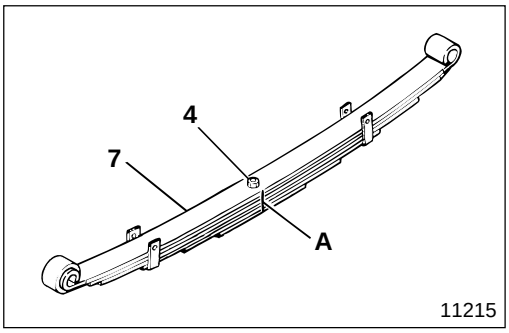
4 **Center nut**

[Removal]

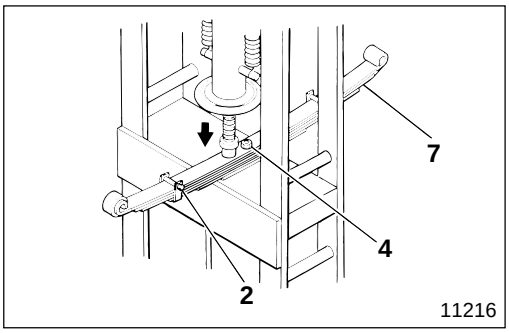
- Put alignment marks **A** on the side of leaf spring **7**.



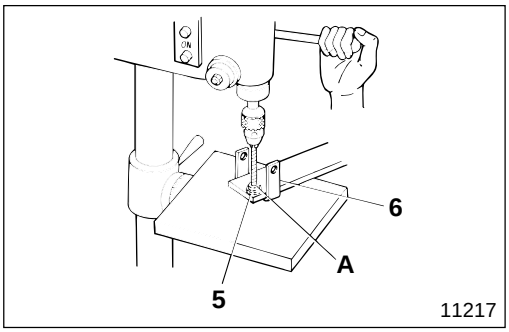
- Compress leaf springs **7** using a press, remove clip bolt **2** and center nut **4**.



[Installation]
- Align alignment marks **A** on leaf spring **7** and assemble.
- Tighten center nut **4** temporarily.

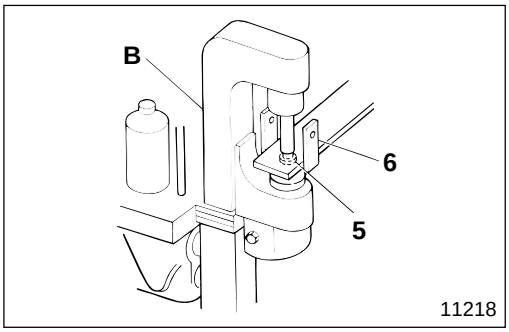


- Compress leaf spring **7** using a press, then install center nut **4**. After installation, caulk at three points using a punch.
- Tighten center clip bolt **2**.



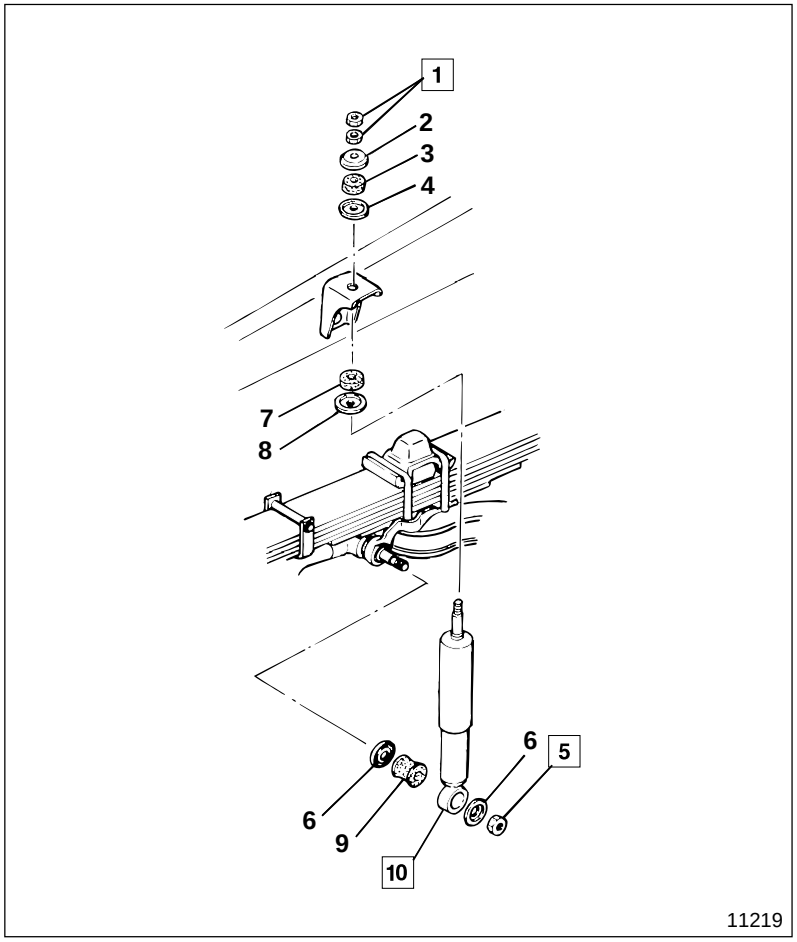
6 **Clip**

[Removal]
Drill out caulked end **A** of rivet **5** on a drill press, then remove clip **6**.



[Installation]
Using riveting machine **B**, install clip **6** by caulking rivet **5**.

SHOCK ABSORBER



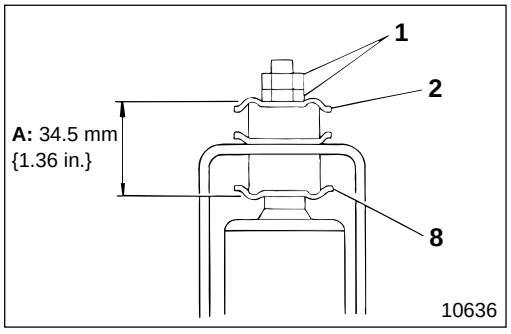
● **Removal sequence**

1 Nut
2 Washer
3 Rubber bushing
4 Centering washer
5 Nut
6 Washer
7 Rubber bushing
8 Washer
9 Rubber bushing
10 Shock absorber

● **Installation sequence**

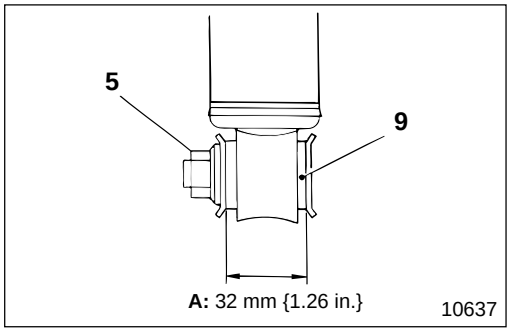
Follow the removal sequence in reverse.

◆ Service procedure



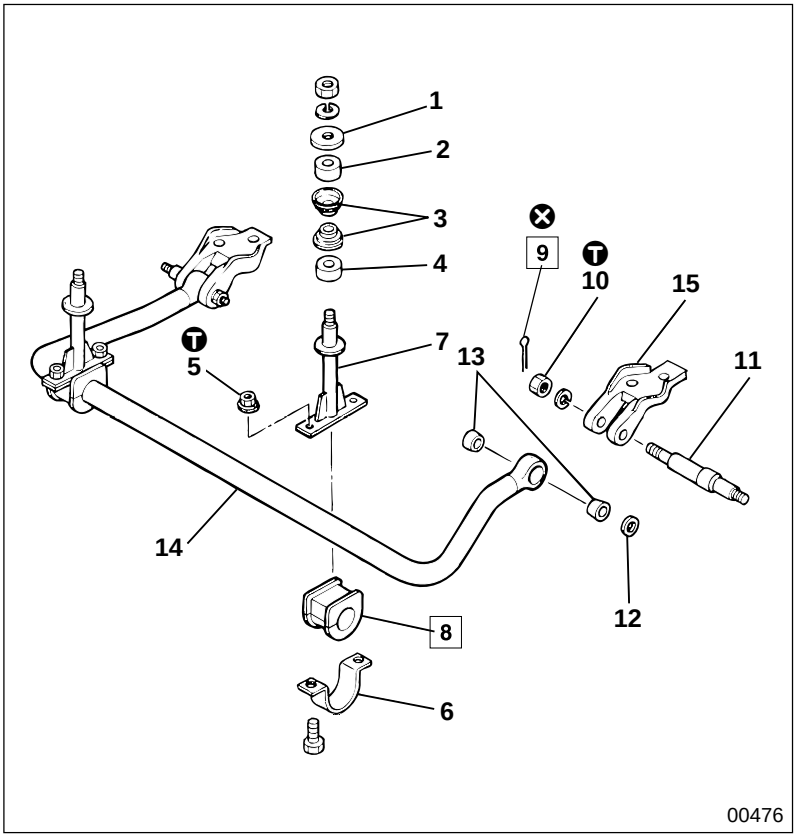
1 **Nut**

Install nut **1** so that the distance between washers **2**, **8** is **A**.



5 **Nut**

Install nut **5** so that dimension of rubber bushing **9** is **A**.



● **Removal sequence**

1 Sheet
2 Bushing
3 Holder
4 Bushing
5 Nut
6 Cap
7 Stabilizer rod
8 Stabilizer bushing
9 Split pin
10 Nut
11 Stabilizer pin
12 Side washer
13 Bushing
14 Stabilizer bar
15 Stabilizer bracket

⊗ : Non-reusable parts

● **Installation sequence**

15 → **11** → **8** → **7** → **6** → **5** → **4** → **3** → **2** → **1** → **10** → **9**
14 → **13** → **12**

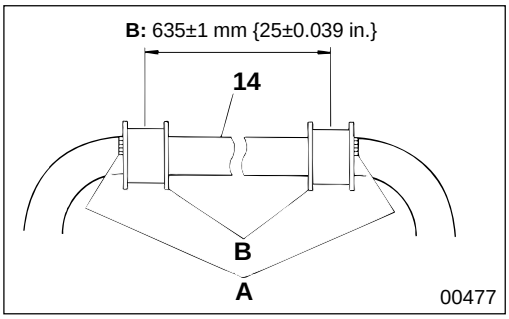
CAUTION ⚠
Be careful not to force in bushings 2, 4 and stabilizer rod 7 when installing them.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

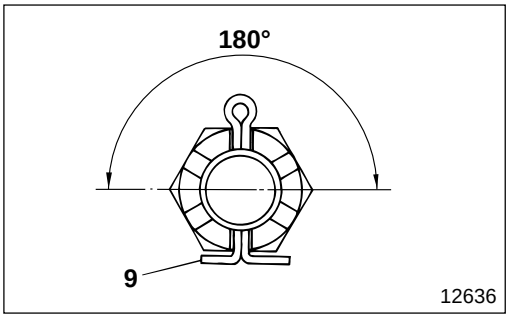
Location	Parts to be tightened	Tightening torque	Remarks
5	Nut (Cap installation)	80 to 110 {58 to 80, 8.0 to 11}	—
10	Nut (Stabilizer pin installation)	100 to 160 {72 to 115, 10 to 16}	—

◆ Service procedure



8 **Stabilizer bushing**

Install stabilizer bushing **8** with their end faces aligned with marks **A** on stabilizer bar **14** so that the distance between ends is **B**.



9 **Installation of split pin**

Insert split pin **9** so that its head is placed within the illustrated range, then bend the split pin securely.

MITSUBISHI
FUSO

Group 34

Rear Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-34

INDEX

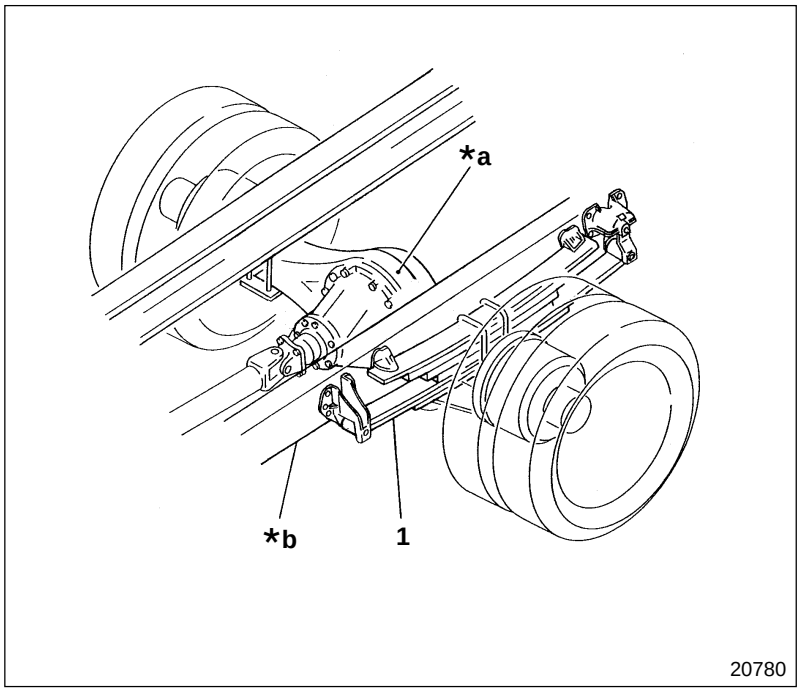
STRUCTURE AND OPERATION 34- 2

TROUBLESHOOTING 34- 3

WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION 34- 4

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY 34- 6

LEAF SPRING ASSEMBLY 34-12



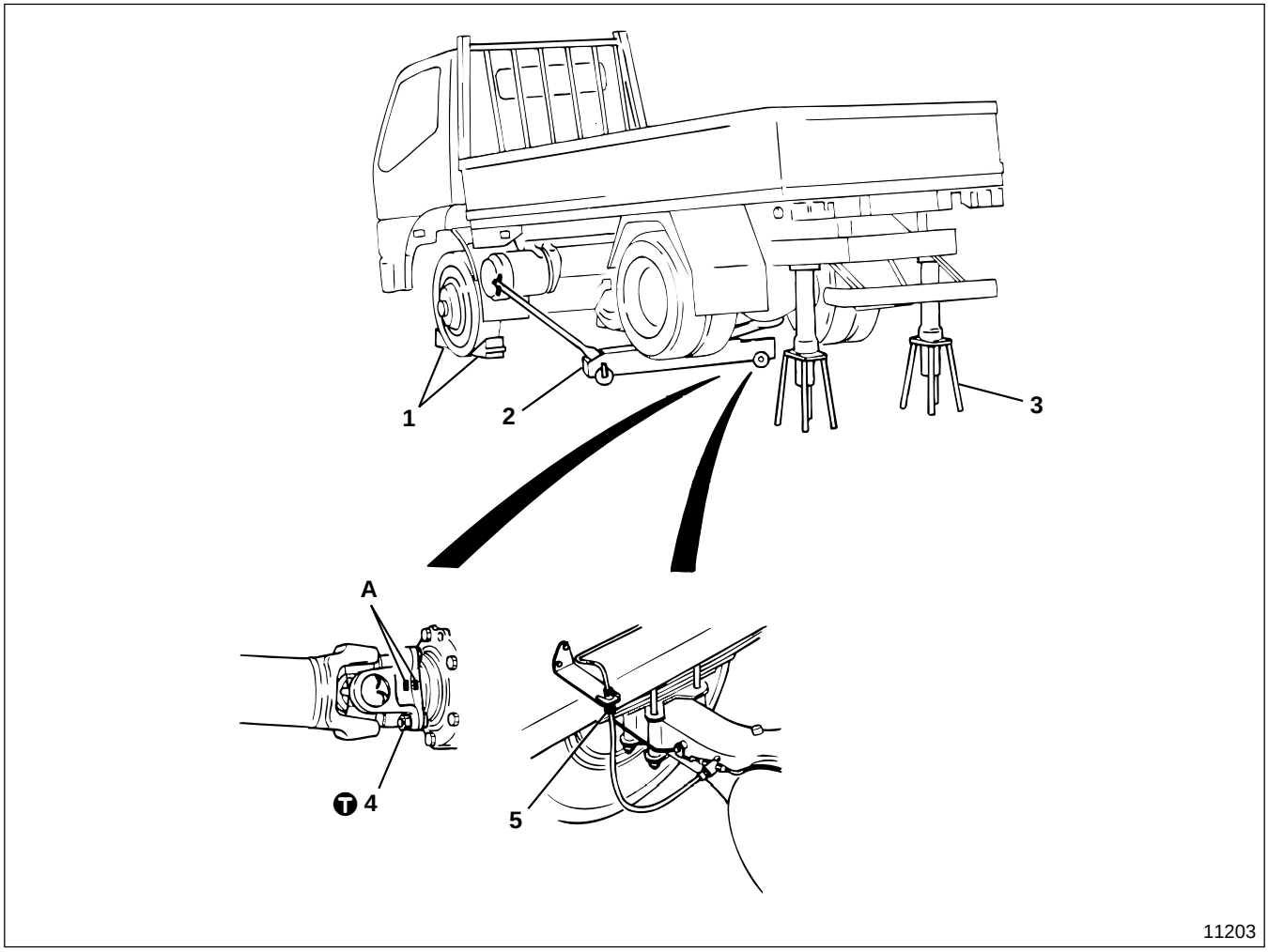
1 Leaf spring assembly

***a** : Rear axle
***b** : Frame

Leaf spring assembly **1** installed between frame ***b** and rear axle ***a** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability.

Possible causes \ Symptoms		Noise generated when vehicle is unloaded	Impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Periodic jolts caused by the road surface	Remarks
Leaf spring	Cracked or damaged		○			
	Damaged	○				
	Spring bracket broken			○		
	U-bolts loose			○		
	Spring bushing worn	○				
Shackle pins thrust play excessive		○				
Helper stopper damaged or broken				○		
Tire	Tires worn unevenly				○	
	Tires and wheels unbalanced				○	Gr 31
	Air pressure excessive		○			

WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION



● **Removal sequence**

1 Place wheel chocks.
2 Jack up the rear axle with a garage jack.
3 Support the rear frame on a rigid rack.
4 Put alignment marks **A** on the rear axle companion flange and the propeller shaft flange yoke, then remove the nuts (on the joint between the rear axle and the propeller shaft).
5 Remove the brake hose joint (on the frame).

WARNING ⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION ⚠

Be sure to protect the brake hose from dust by fitting blanking plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

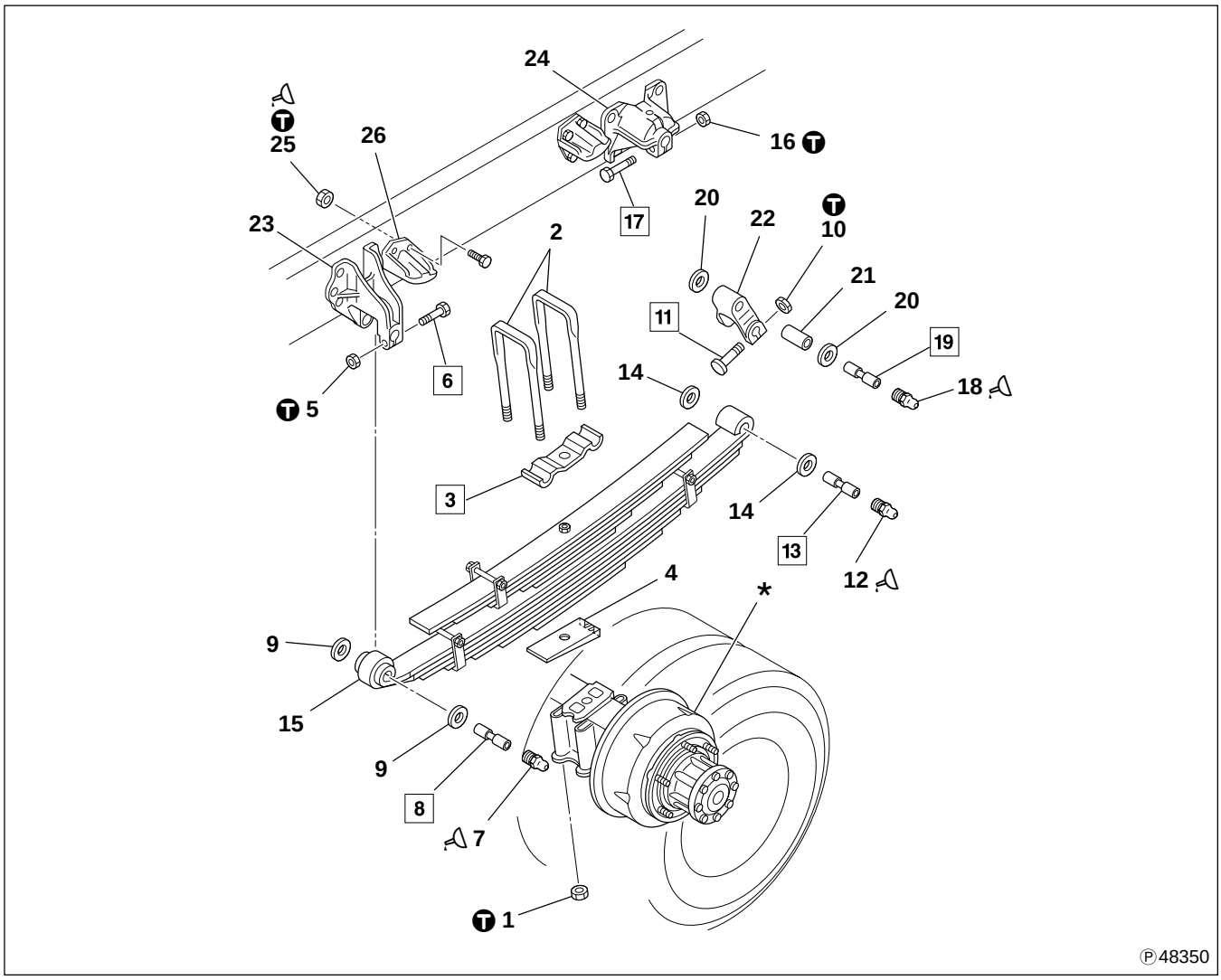
Be sure that the brake hose is not twisted when you install it.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Nut (Rear axle and propeller shaft connecting)	85 {61, 8.5}	—

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Spring pad
4 Shim < FH210E >
5 Nut
6 Bolt
7 Grease nipple
8 Shackle pin
9 Side washer
10 Nut
11 Bolt
12 Grease nipple
13 Shackle pin
14 Side washer
15 Leaf spring assembly
P34-8
16 Nut
17 Bolt
18 Grease nipple
19 Shackle pin
20 Side washer
21 Bushing
22 Shackle link
23 Rear spring front bracket
24 Rear spring rear bracket
25 Nut
26 Helper stopper

***** : Rear axle Gr 27

NOTE

Do not remove rear spring front bracket 23 or rear spring rear bracket 24 unless they are faulty. **Gr 41**

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
8, 13, 15	Clearance between shackle pin and bushing of leaf spring assembly	[28] 0 to 0.12 {[1.10] 0 to 0.0047}	0.3 {0.019}	Replace
19, 21	Clearance between shackle pin and bushing	[28] 0.02 to 0.14 {[1.10] 0.00079 to 0.0055}	0.3 {0.019}	Replace
23	Clearance between shackle pin and rear spring front bracket	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.019}	Replace
15, 22	Clearance between leaf spring assembly and shackle link	0.2 to 0.9 {0.0079 to 0.035}	—	Replace side washer
13, 22	Clearance between shackle pin and shackle link	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.019}	Replace
15, 23	Clearance between leaf spring assembly and rear spring front bracket	0.2 to 0.9 {0.0079 to 0.035}	—	Replace side washer
19, 24	Clearance between shackle pin and rear spring rear bracket	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	1.0 {0.039}	Replace
22, 24	Clearance between shackle link and rear spring rear bracketside washer	0.2 to 0.6 {0.0079 to 0.024}	—	Replace side washer

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

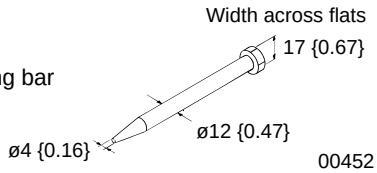
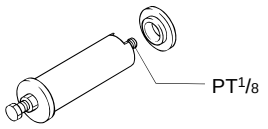
Location	Parts to be tightened	Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	414±62 {305±46, 42.2±6.3}	Wet
5, 10, 16	Nut (Shackle pin mounting)	80 to 110 {58 to 80, 8 to 11}	—
25	Nut (Helper stopper mounting)	103 to 132 {76 to 98, 10.5 to 13.5}	Wet

Lubricant

Location	Points of application	Kinds	Quantity
7, 12, 18	Supply via grease nipple	Chassis grease [NLGI No.1 (Ca soap)]	As required
25	Thread and contact surface of nut	Engine oil	As required

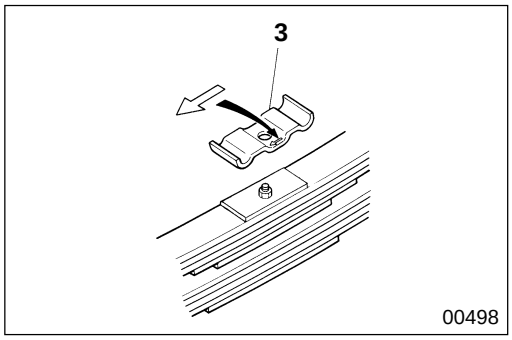
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
6, 8, 11, 13, 17, 19	Shackle pin setting bar 	MC023419	Removal of bolt (shackle pin installation), alignment of the shackle pin bolt groove
8, 13, 19	Shackle pin puller 	MH061452	Removal of shackle pin

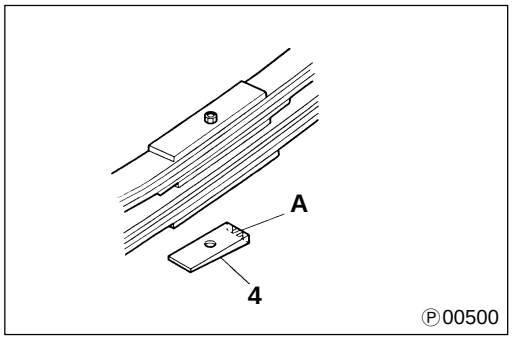
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY

◆ Service procedure



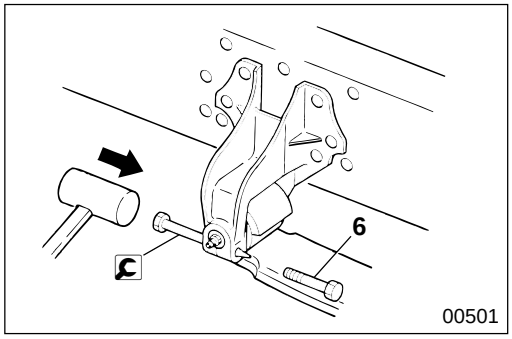
3 **Rear spring pad**

Align direction of arrow mark of the rear spring pad to front direction of vehicle.

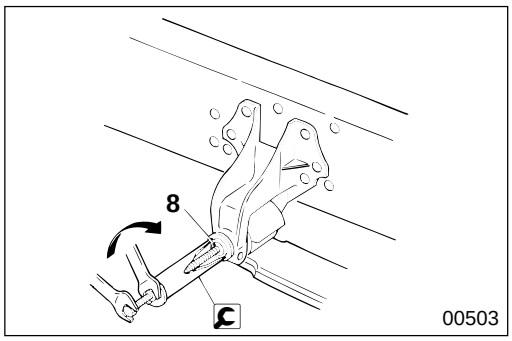


4 **Shim**

< FH210E >
White identification paint **A** should face toward the back of the vehicle.

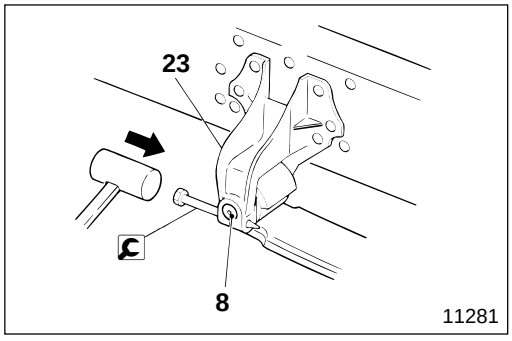


6 **Removal of bolt**

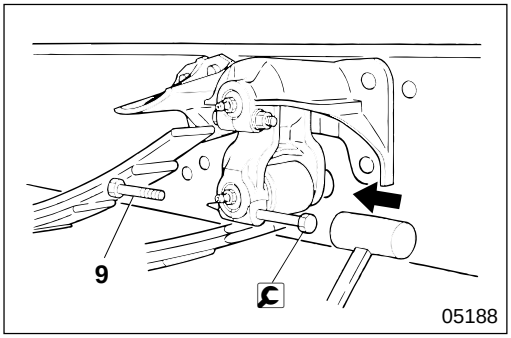


8 **Shackle pin**

[Removal]
: Shackle pin puller

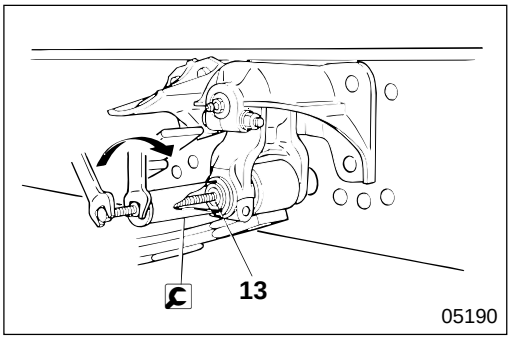


[Installation]
Align the bolt hole of rear spring front bracket **23** with the bolt groove of shackle pin **8** using shackle pin setting bar.



9 **Removal of bolt**

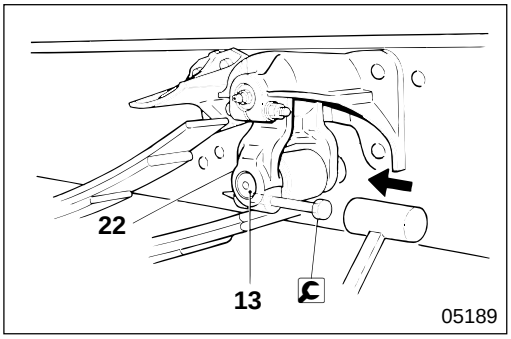
: Shackle pin setting bar



13 **Shackle pin**

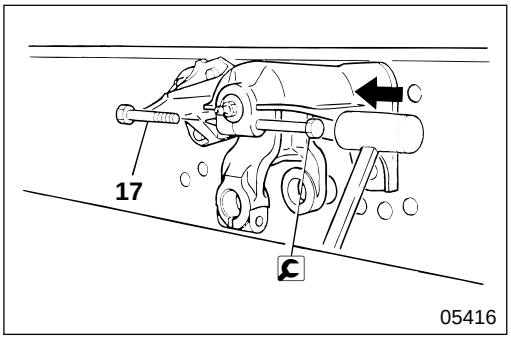
[Removal]

: Shackle pin puller



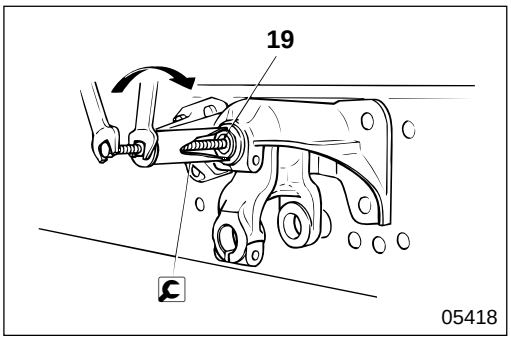
[Installation]

Align the bolt hole of shackle link **22** with the bolt groove of shackle pin **13** using shackle pin setting bar.



17 **Removal of bolt**

: Shackle pin setting bar

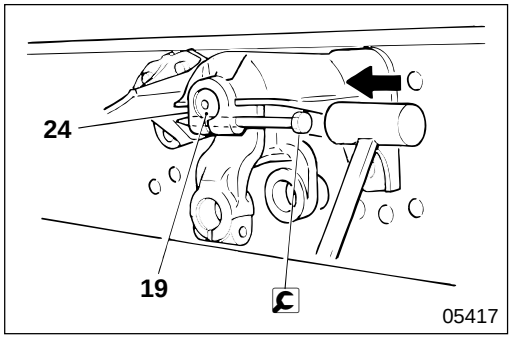


19 **Shackle pin**

[Removal]

: Shackle pin puller

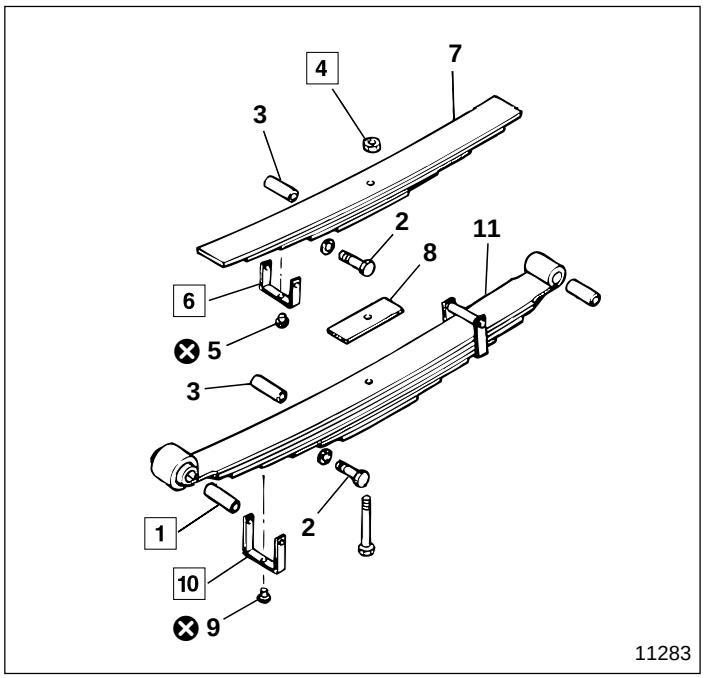
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



[Installation]
Align the bolt hole of rear spring rear bracket **24** and the bolt groove of shackle pin **19** using ◻ shackle pin setting bar.

M E M O

LEAF SPRING ASSEMBLY



● **Disassembly sequence**

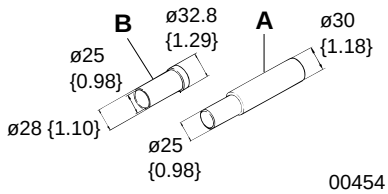
1	Spring bushing	**8**	Seat
2	Clip bolt	**9**	Rivet
3	Pipe	**10**	Clip
4	Center nut	**11**	Main spring
5	Rivet		
6	Clip	⊗	: Non-reusable parts
7	Helper spring		

● **Assembly sequence**

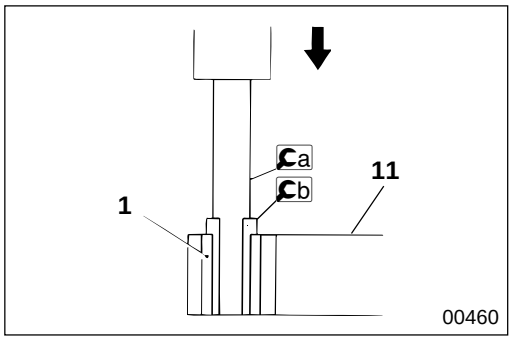
Follow the disassembly sequence in reverse.

Special tools

Unit : mm {in.}

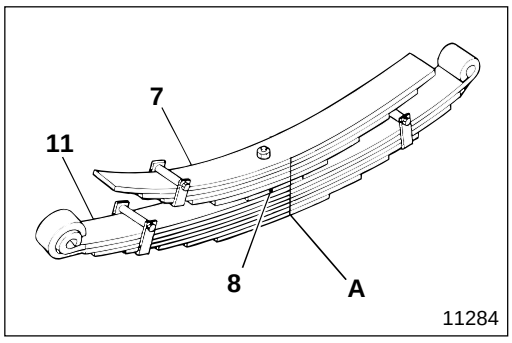
Location	Tool name and shape	Part No.	Application
1	Bushing installer set **A** : Bushing installer A **B** : Bushing installer B 	MB999066 **A** : MB999067 **B** : MB999068	Removal and installation of bushing

◆ Service procedure



1 **Removal and installation of spring bushing**

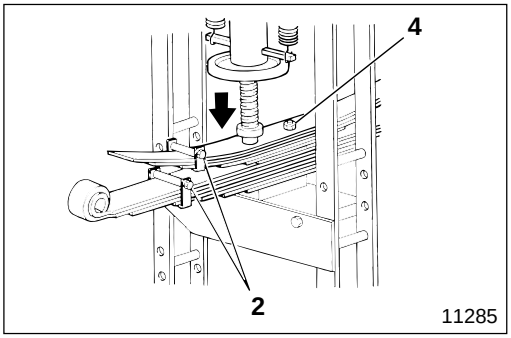
Remove spring bushing **1** from main springs **11** using a bushing installer **A** and b bushing installer **B**. For installation, follow the removal sequence in reverse.



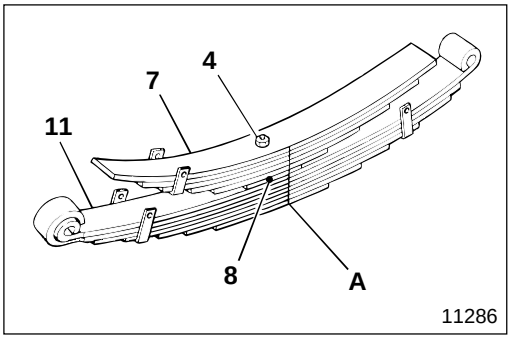
4 **Center nut**

[Removal]

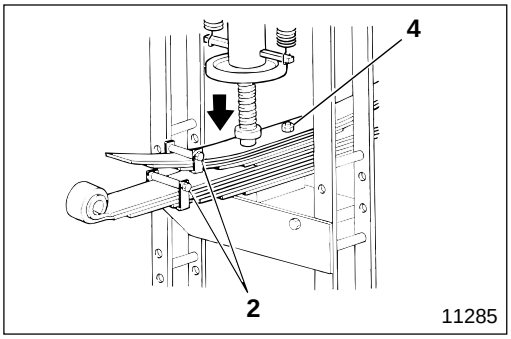
- Put alignment marks **A** on the sides of helper springs **7**, seat **8**, and main springs **11**.



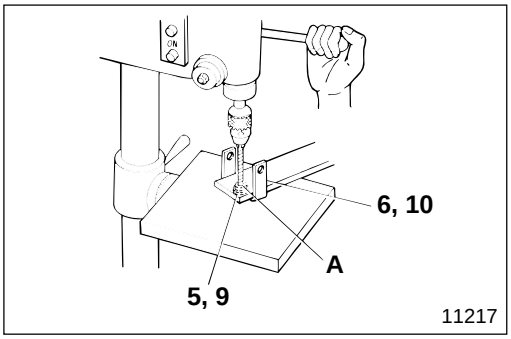
- Compress the leaf springs using a press to remove clip bolt **2** and center nut **4**.



[Installation]
- Align alignment marks **A** on helper springs **7**, seat **8**, and main springs **11** to assemble them.
- Tighten center nut **4** temporarily.

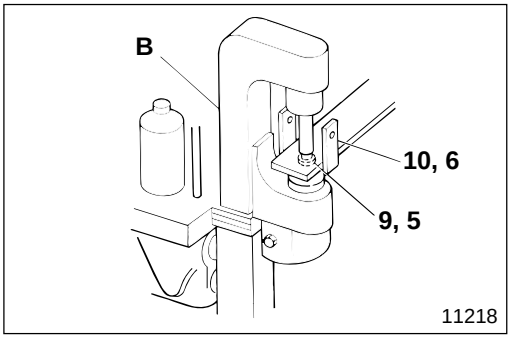


- Compress leaf springs using a press to install center nut **4**, then caulk it using a three-point punch.
- Install clip bolt **2**.



6 **10** **Clip**

[Removal]
Drill out caulked ends **A** of rivets **5**, **9** on a drill press to remove clips **6**, **10**.



[Installation]
Caulk rivets **9**, **5** using riveting machine **B** to install clips **10**, **6**.

MITSUBISHI
FUSO

Group 35A

Brake

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-35A

INDEX

SPECIFICATIONS 35A- 2

STRUCTURE AND OPERATION 35A- 4

TROUBLESHOOTING 35A-22

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Replacement of Brake Fluid 35A-28
- Air Bleeding of Brake System 35A-30
- Inspection and Adjustment of Brake Pedal Free Play 35A-34
- Inspection and Adjustment of Clearance between Brake Pedal and Floor Panel 35A-34
- Thickness Inspection and Replacement of Brake Lining 35A-35
- Inspection of Brake Shoe Clearance 35A-35
- Inspection of Brake Booster (Hydraulic Booster) 35A-36

BRAKE MASTER CYLINDER 35A-38

BRAKE PEDAL AND BRAKE BOOSTER (HYDRAULIC BOOSTER) 35A-40

BRAKE BOOSTER (HYDRAULIC BOOSTER) 35A-42

FRONT WHEEL BRAKE 35A-44

REAR WHEEL BRAKE 35A-52

VACUUM PUMP < FH210 > 35A-60

VACUUM PUMP < FH211 > 35A-61

EXHAUST BRAKE SYSTEM 35A-62

SPECIFICATIONS

< Equipment for Service Brake >

Item			Specifications
Brake booster (Hydraulic booster)	Booster		Hydraulic type
	Manufacturer		NABCO
Brake master cylinder	Cylinder	Inner diameter mm {in.}	ø41.28 {1.63}
	Piston stroke	Front mm {in.}	15.5 {0.61}
		Rear mm {in.}	19.0 {0.75}
	Manufacturer		NABCO

< Vacuum Pump >

Item	Specifications	
	FH210	FH211
Type	Vane type	
Delivery cm^3 {cu.in.}	60 {3.66}	120 {7.32}
Manufacturer	MITSUBISHI ELECTRIC	

< Wheel Brake >

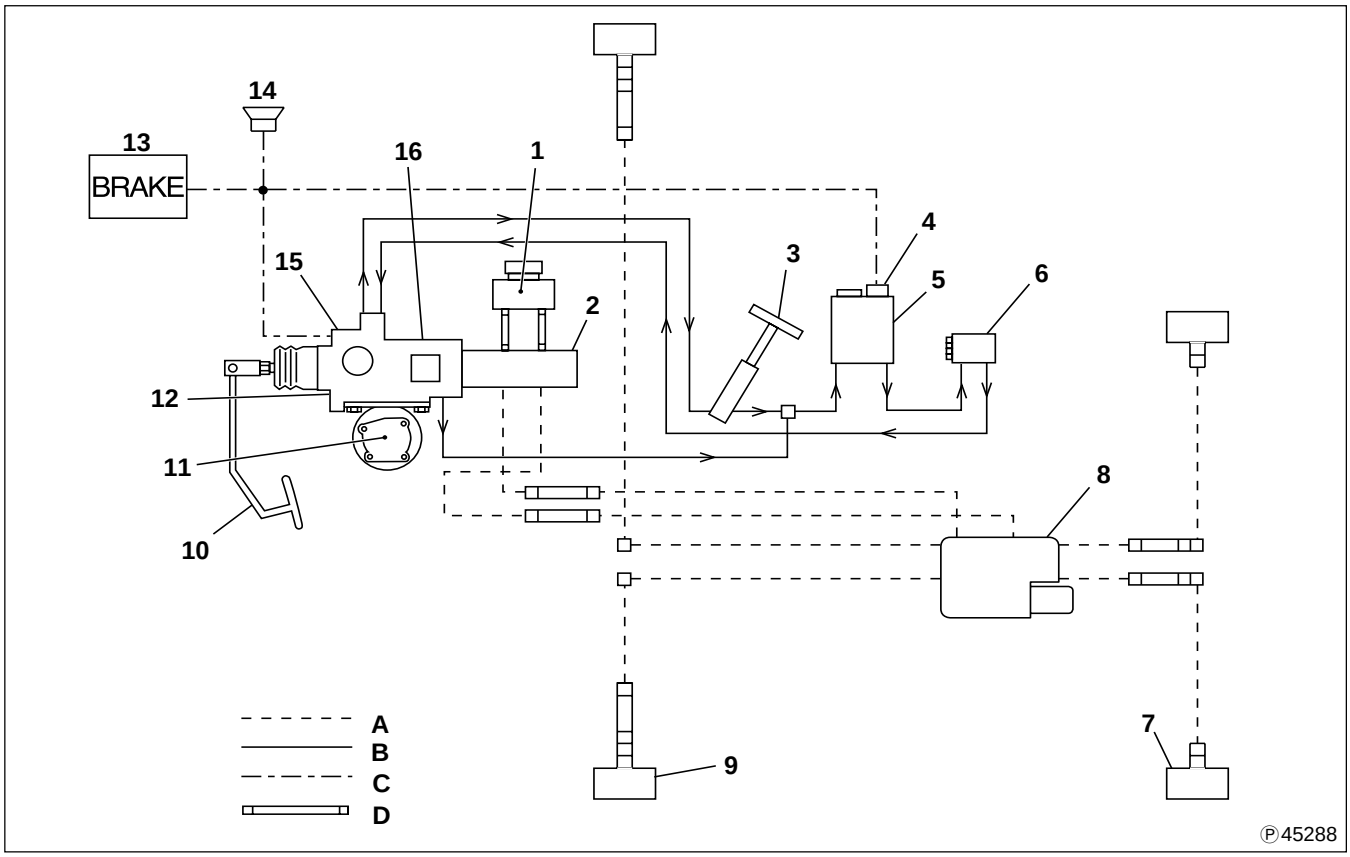
Item		Specifications
Brake type	Front	Drum brake (2-leading type)
	Rear	Drum brake (Dual 2-leading type)
Brake drum inner diameter mm {in.}		ø320 {12.6}
Wheel cylinder inner diameter	Front mm {in.}	ø34.93 {1.38}
	Rear mm {in.}	ø36.51 {1.44}
Brake lining Width×Thickness	Front mm {in.}	120×12 {4.72×0.47}
	Rear mm {in.}	140×12 {5.51×0.47}

< Exhaust Brake >

Item	Specifications
Control type	Combined electric and vacuum
Valve type	Butterfly valve

M E M O

Hydraulic booster brake system



1 Brake fluid tank
2 Brake master cylinder
3 Power steering booster
4 Power steering fluid level sensor
5 Power steering oil tank
6 Power steering oil pump
7 Rear wheel cylinder
8 Hydraulic unit
9 Front wheel cylinder
10 Brake pedal
11 Emergency pump motor
12 Brake booster (Hydraulic booster)
13 Brake warning lamp
14 Warning buzzer
15 Flow switch
16 Motor relay

A : Brake fluid line
B : Power steering fluid line
C : Electric line
D : Hose

- The brake system is a hydraulic booster brake type, all-wheel braking type consisting of separate front and rear systems.
- The servo system is fitted with brake booster (hydraulic booster) **12**.
- The hydraulic booster brake type uses the fluid pressure from power steering oil pump **6** to boost brake pedal **10** operating force.
- If fluid pressure stops being generated because of engine stoppage, power steering oil pump **6** failure, or fluid leakage from the power steering piping, it is detected by flow switch **15**. To ensure proper fluid pressure in an emergency, the emergency pump motor **11** rotates by the action of operating currents from motor relay **16**.

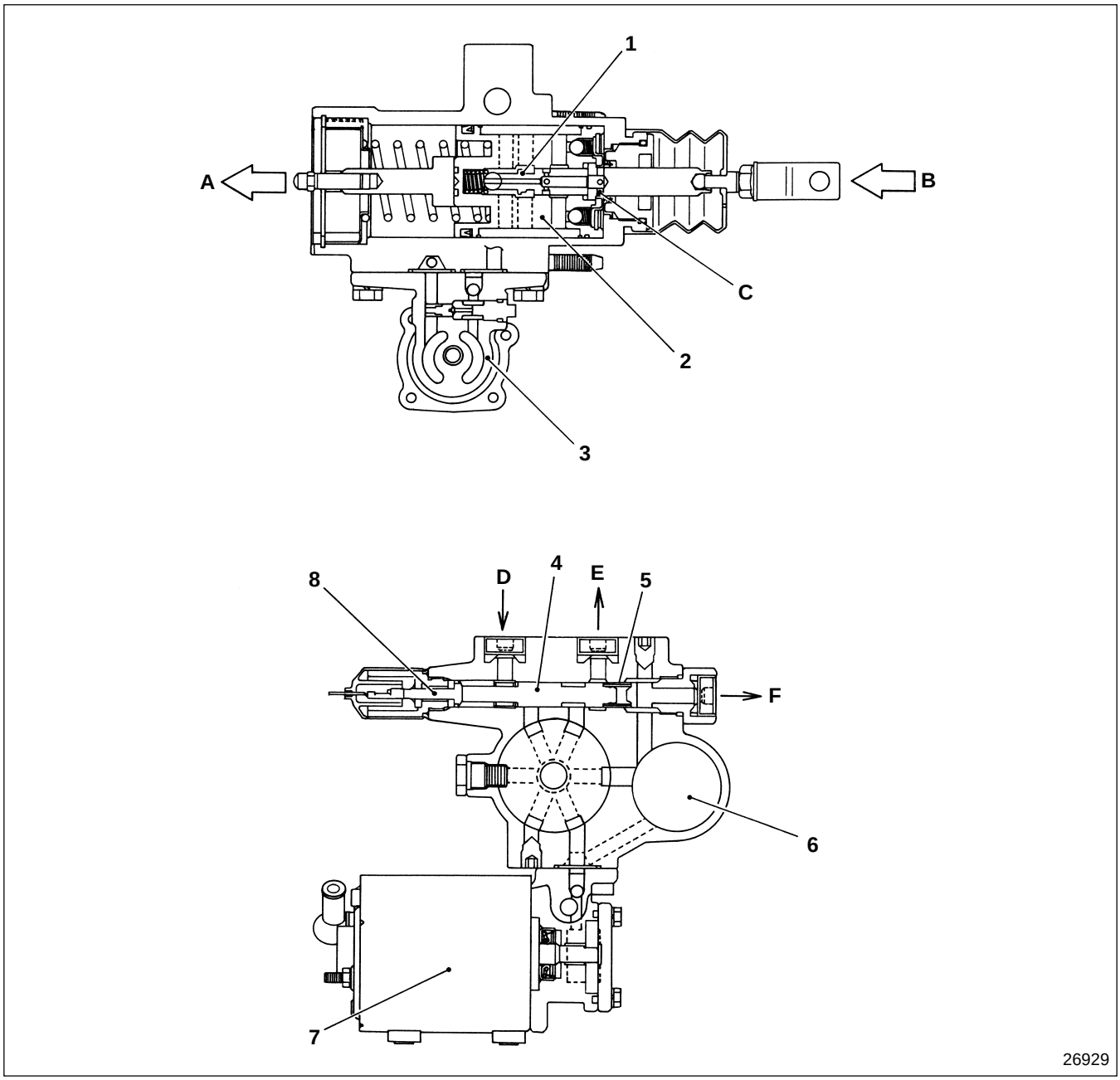
- Emergency pump **10** operates only when brake pedal **9** is depressed.
  Operation conditions details are as follows.

Starter switch	Engine	Parking brake switch	Alarms		Power steering fluid pressure	*1 Emergency pump motor	Vehicle condition
			Brake warning lamp ○ ··· Lit × ··· Not lit	Warning buzzer ○ ··· Sounding × ··· Silent		○ ··· Running × ··· Stopped	
ON	Running	ON (Pulled)	×	×	Present	×	When normal
			○	○	Absent	○	*2 Power steering piping fluid leakage
		OFF (Returned)	×	×	Present	×	When normal
			○	○		○	*2 Power steering piping fluid leakage
	ON (Pulled)	ON (Pulled)	○	○		○	When engine is started
						○	When engine stalls during take-off on a slope
		OFF (Returned)	○	○	Absent	○	When engine stalls
Stopped OFF			×	×		○	When vehicle starts moving right after being parked (when parking brake force is insufficient)
		OFF (Returned)	×	×		○	When engine is cut off right before the vehicle comes to a stop
ON	—	—	○	○	—	—	When fluid level in power steering oil tank is below “MIN” or above “MAX”
OFF	—	—	×	×	—	—	

*1 : The emergency pump motor operates when the brake pedal is depressed.

*2 : Fluid pressure is obtained by the action of the brake booster (hydraulic booster) fail-safe system which cuts off the flow of fluid to the power steering piping. 🕮 P35A-6

Brake Booster (Hydraulic Booster)



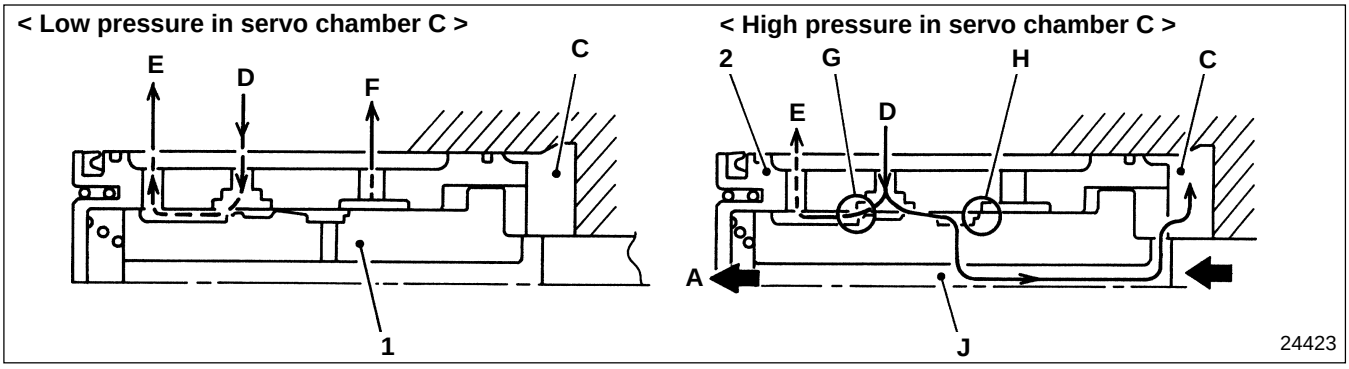
1 Spool valve
2 Hydraulic piston
3 Emergency pump
4 Piston
5 Spring
6 Reservoir
(Brake booster built-in)
7 Emergency pump motor
8 Flow switch

A : Brake master cylinder
B : Brake pedal
C : Servo chamber
D : Power steering oil pump
E : Power steering booster
F : Drain

- Spool valve **1** is an adjusting valve linked to brake pedal **B** that generates fluid pressure in accordance with the pedal operating force.
- Hydraulic piston **2** is linked to brake master cylinder **A**, by storing the fluid supplied via spool valve **1** in servo chamber **C** its force is boosted.

- In case there is fluid leaking from the power steering piping and fluid pressure is lost, piston **4** is depressed by the action of spring **5** and moves to the left, shutting off the flow of fluid to power steering oil pump **D** and power steering booster **E**. As a result fluid hydraulic circuit is created only inside the brake booster.
- When piston **4** moves to the left, flow switch **8** is turned ON and emergency pump motor **7** starts operating. By the action of emergency pump **3**, fluid pressure is generated within the fluid hydraulic circuit inside the brake booster.

● Spool valve



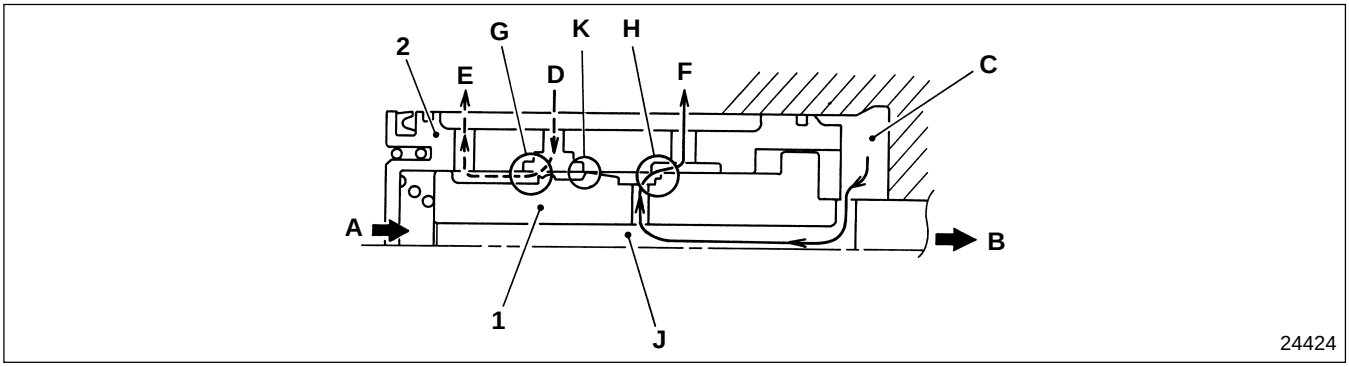
At operation

Through the action of brake pedal **B** spool valve **1** moves to the left, narrowing down land **G*** and closing off land **H** → Pressure of fluid coming from power steering oil pump **D** rises → High pressure fluid flows into servo chamber **C** via fluid groove **J**

↓

Hydraulic piston **2** is pushed to the left → Piston of brake master cylinder **A** is pushed and the brake is operated

***** : When the brake is operating, land **G** is not completely shut, therefore the power steering booster is not affected.



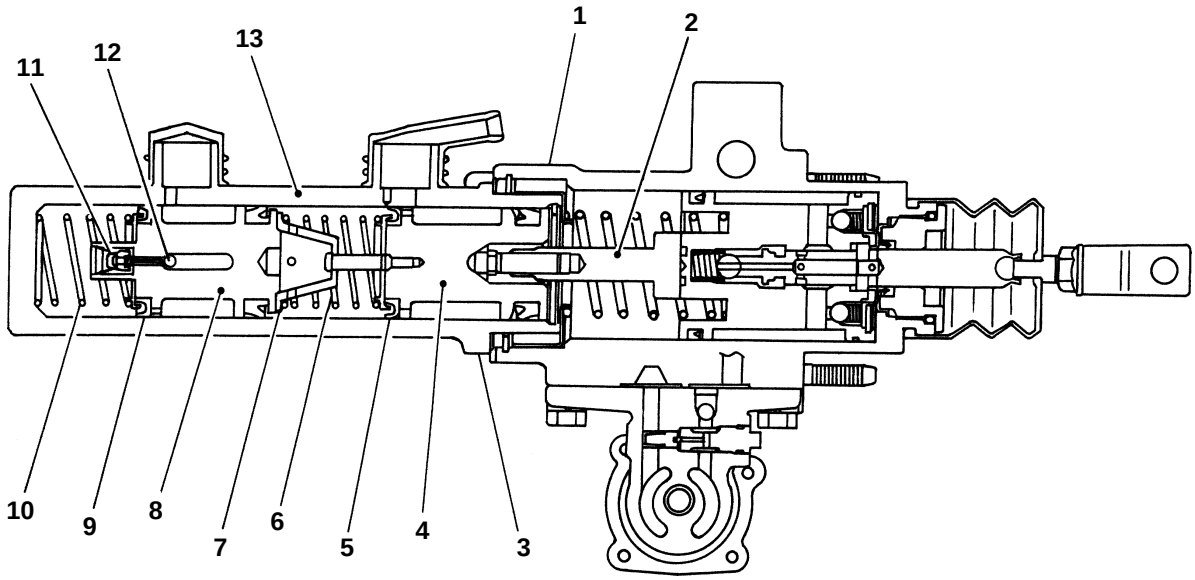
When released

Through the action of brake pedal **B** spool valve **1** moves to the right, opening lands **G** and **H** and closing fluid groove **K** → Pressure of fluid from power steering oil pump **D** falls → Fluid from servo chamber **C** flows into reservoir **4** and drain **F**

↓

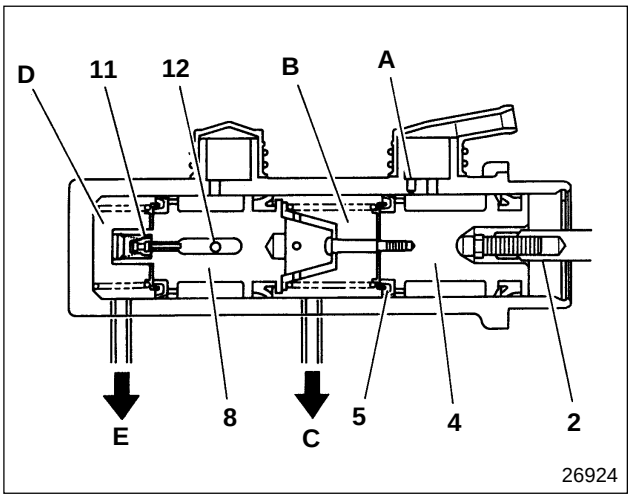
Hydraulic piston **2** moves to its original position → Brake master cylinder **A** piston is released

Brake Master Cylinder



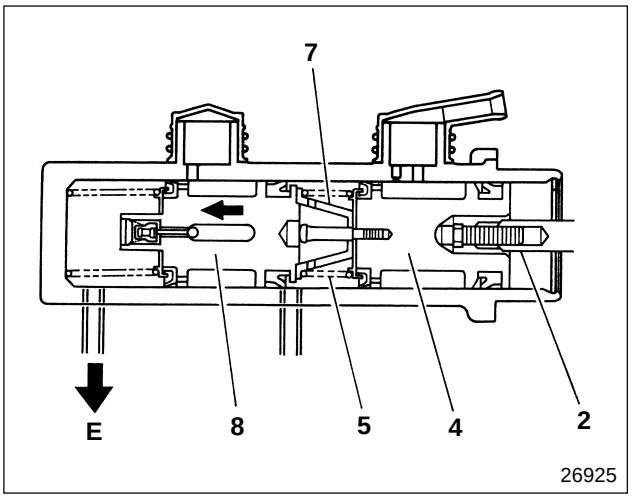
1 Brake booster (Hydraulic booster)
2 Hydraulic piston
3 Brake master cylinder
4 Primary piston
5 Packing cup
6 Primary piston return spring
7 Retainer
8 Secondary piston
9 Packing cup
10 Secondary piston return spring
11 Supply valve
12 Supply valve stopper
13 Cylinder

- Brake master cylinder **3** consists of separate and independent front and rear hydraulic systems. Therefore, if by chance there should be leakage in either the front or the rear hydraulic systems, the safety mechanism ensures that the other unaffected system can operate the brakes.



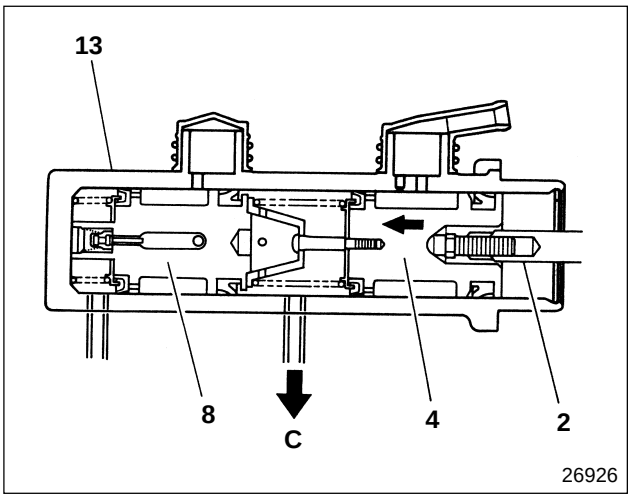
● **When brake pedal is depressed**

- Depressing the brake pedal makes brake booster (hydraulic booster) hydraulic piston **2** push in primary piston **4** and secondary piston **8**, packing cup **5** passes return port **A**, generates hydraulic pressure in chamber **B**, and feeds fluid to front brake system **C**.
- Supply valve **11** separates from supply valve stopper **12**, generates hydraulic pressure in chamber **D**, and feeds fluid to rear brake system **E**.



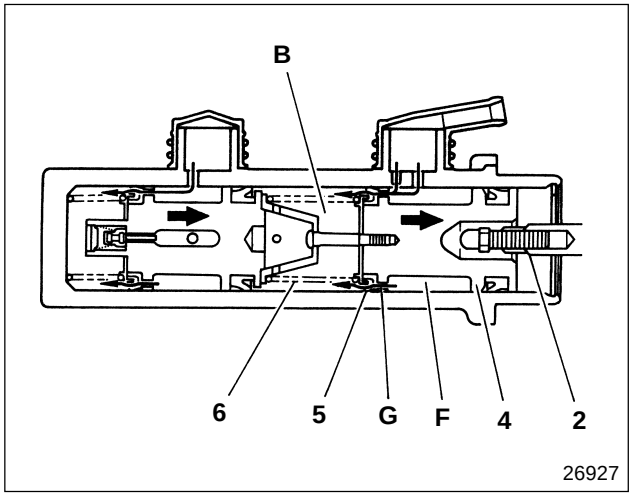
● **When there is fluid leakage in the front brake system**

- Depressing the brake pedal makes hydraulic piston **2** push in primary piston **4**. However, if the brake fluid in the front brake system leaks, hydraulic pressure is not generated in the front brake system.
- Depressing the brake pedal further makes primary piston **4** compress primary piston return spring **6** causing retainer **7** to push in secondary piston **8**, thus generating hydraulic pressure only in the rear brake system **E**.



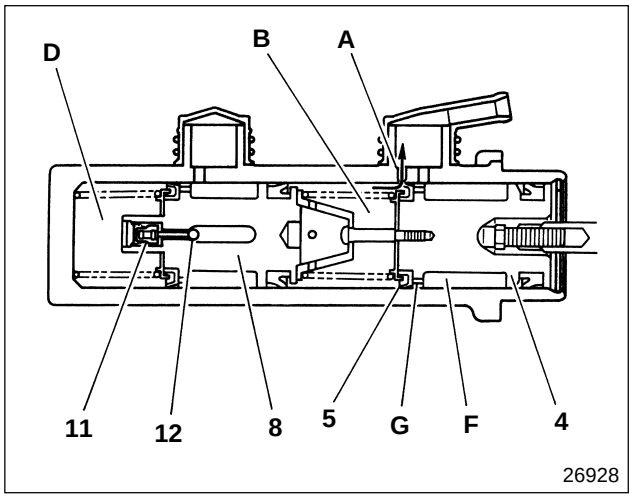
● **When there is fluid leakage in the rear brake system**

- Depressing the brake pedal makes hydraulic piston **2** push in primary piston **4** and secondary piston **8**. However, if the brake fluid in the rear brake system leaks, hydraulic pressure is not generated in the rear brake system.
- Depressing the brake pedal further makes the end of secondary piston **8** hit against cylinder **13**, pushing primary piston **4** and generating hydraulic pressure only in the front brake system **C**.



● **When the brake pedal is released**

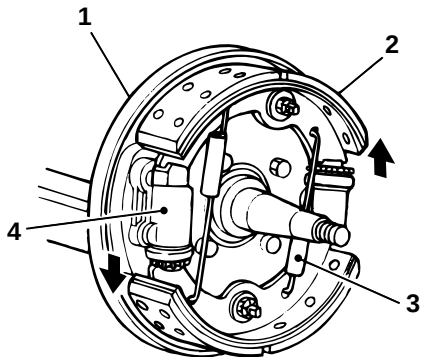
- When hydraulic piston **2** returns to its original position, as a result of the repercussive force of primary piston return spring **6**, primary piston **4** begins to return immediately. However, because of a lack of a pressure difference between chambers **B** and **F** brake fluid delivered from the brake master cylinder cannot return quickly.
- When primary piston **4** begins to return, hydraulic pressure in chamber **B** becomes lower than that in chamber **F**, the pressure difference causes packing cup **5** to deform opening up passage **G**. This causes brake fluid from chamber **F** to flow into chamber **B**.



- When primary piston **4** moves further and returns to its original position, the pressure in chambers **B** and **F** become the same, and packing cup **5** closes passage **G**. The hydraulic fluid in the brake pipe returns from chamber **B** to the reservoir tank via return port **A**.
- The same action also takes place in the secondary side. However, when secondary piston **8** is pushed back, supply valve **11** hits against supply valve stopper **12** and the supply valve opens.
- Therefore the hydraulic fluid in the brake pipe returns from chamber **D** to the reservoir tank via supply valve **11**.

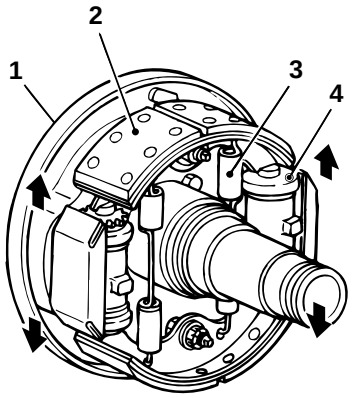
Wheel Brake

< Front >



12964

< Rear >

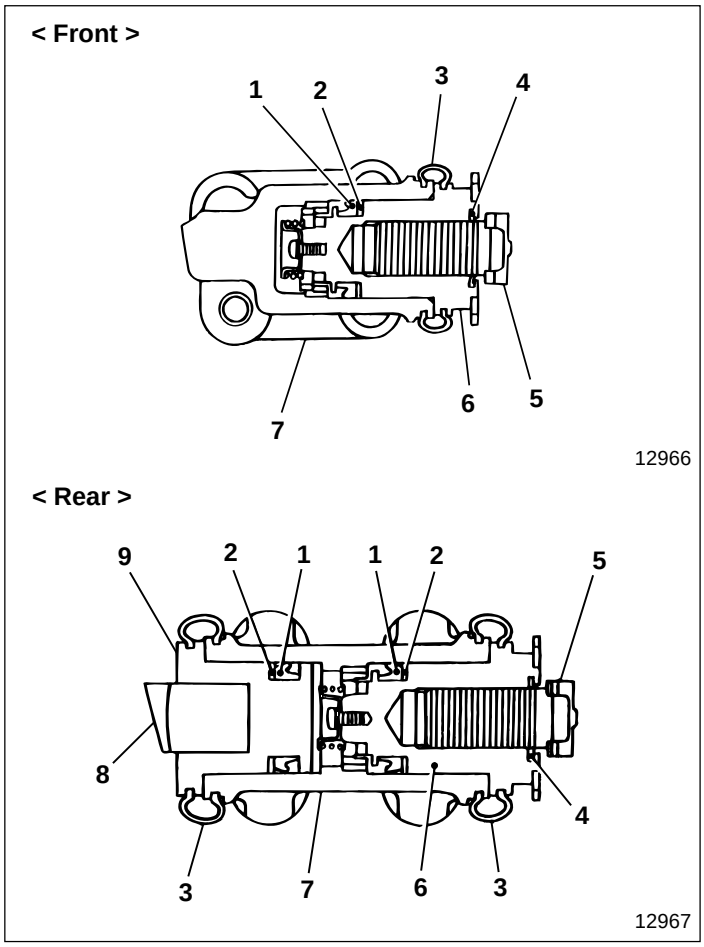


12965

1 Backing plate
2 Brake shoe assembly
3 Return spring
4 Wheel cylinder assembly

- The front wheel brake is an internal expanding 2-leading brake type.
- The rear wheel brake is an internal expanding dual 2-leading brake type.
- Front and rear wheel cylinder assemblies **4** have shoe clearance automatic adjusting mechanisms to adjust shoe clearance within a specific range.

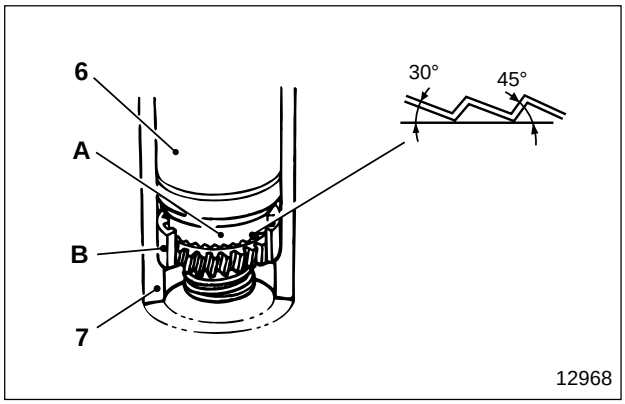
● Wheel cylinder assembly



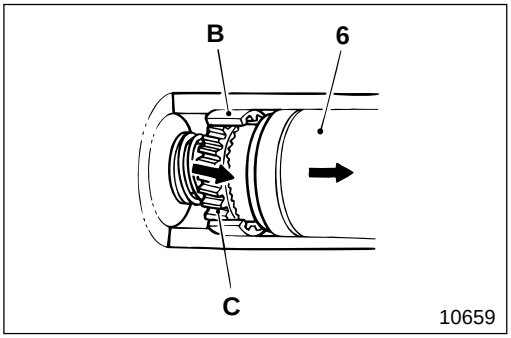
1 Piston cup
2 Backup ring
3 Boot
4 Seal
5 Screw
6 Piston
7 Cylinder body
8 Anchor piece < Rear >
9 Piston < Rear >

Even if the brake lining has worn to the extent that the brake shoe clearance is higher than the specified value, the brake shoe clearance automatic adjusting mechanism automatically adjusts the brake shoe clearance to maintain the appropriate brake shoe clearance when the vehicle is braked when moving forward.

● Operation of automatic shoe clearance adjusting mechanism (one-way clutch)

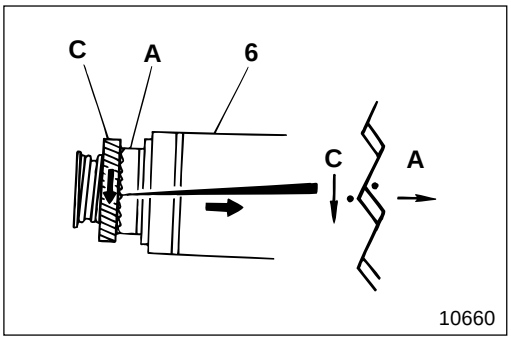


30° : When piston **6** appears, the double helical gear slides out easily.
45° : When turning piston **6**, the double helical gear receives and maintains the rotational force.
A : Clutch
B : Guide

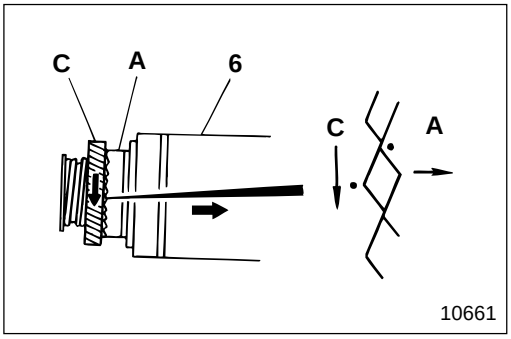


● **When braking starts**

- When hydraulic braking pressure acts on the wheel cylinder, it pushes piston **6** forward.
- Idler **C** of extended piston **6** is engaged with the diagonal gears cut in guide **B** of the cylinder body, so the idler advances while turning, in accordance with the travel of the piston.



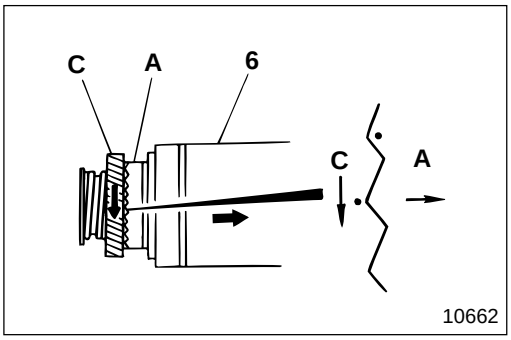
- The rotation of idler **C** slides out the double helical gear of clutch **A**.



● **When depressing brake pedal**

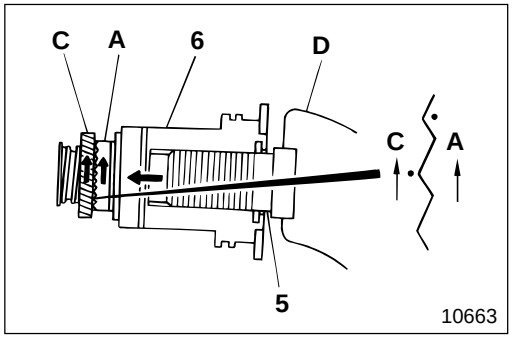
When the brake shoe clearance conforms to the specified value

- The amount of travel of idler **C** is proportional to the amount of travel of piston **6**. The amount of travel is not enough to make the double helical gear of clutch **A** climb over the opposite double helical gear when the brake shoe clearance is within the specified value.



When the brake shoe clearance is higher than the specified value

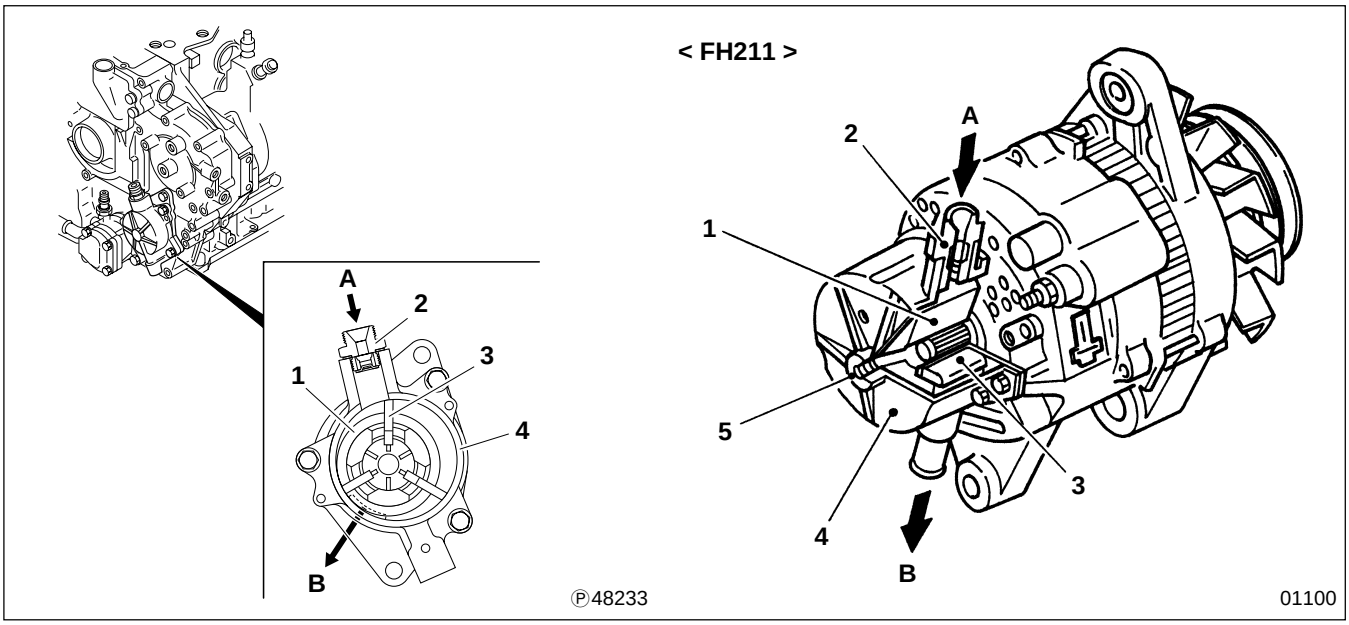
- When the brake shoe clearance is higher than the specified value, the amount of travel of idler **C** increases enough to make the double helical gear of clutch **A** climb over the opposite double helical gear.



● **When releasing brake pedal**

- As the brake fluid pressure decreases and piston **6** returns, idler **C** also returns, turning in the opposite direction along guide **B** of the cylinder body.
- When the brake shoe clearance is within the specified value, piston **6** returns to its original position without turning, because the double helical gear of clutch **A** has not climbed over the opposite double helical gear.
- When the brake shoe clearance is higher than the specified value, piston **6** returns while turning by one gear tooth, since the double helical gear of clutch **A** has climbed over the opposite gear. This lowers the brake shoe clearance to the specified value, because screw **5** of the piston is fixed by brake shoe **D** and does not turn.

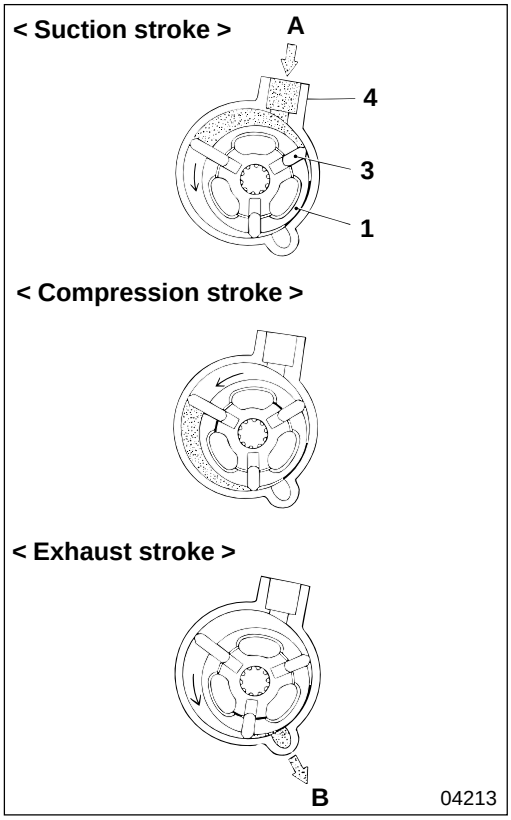
Vacuum Pump



1 Rotor
2 Check valve
3 Vane
4 Housing
5 Oil filler hole < FH211 >

A : Inlet
B : Outlet

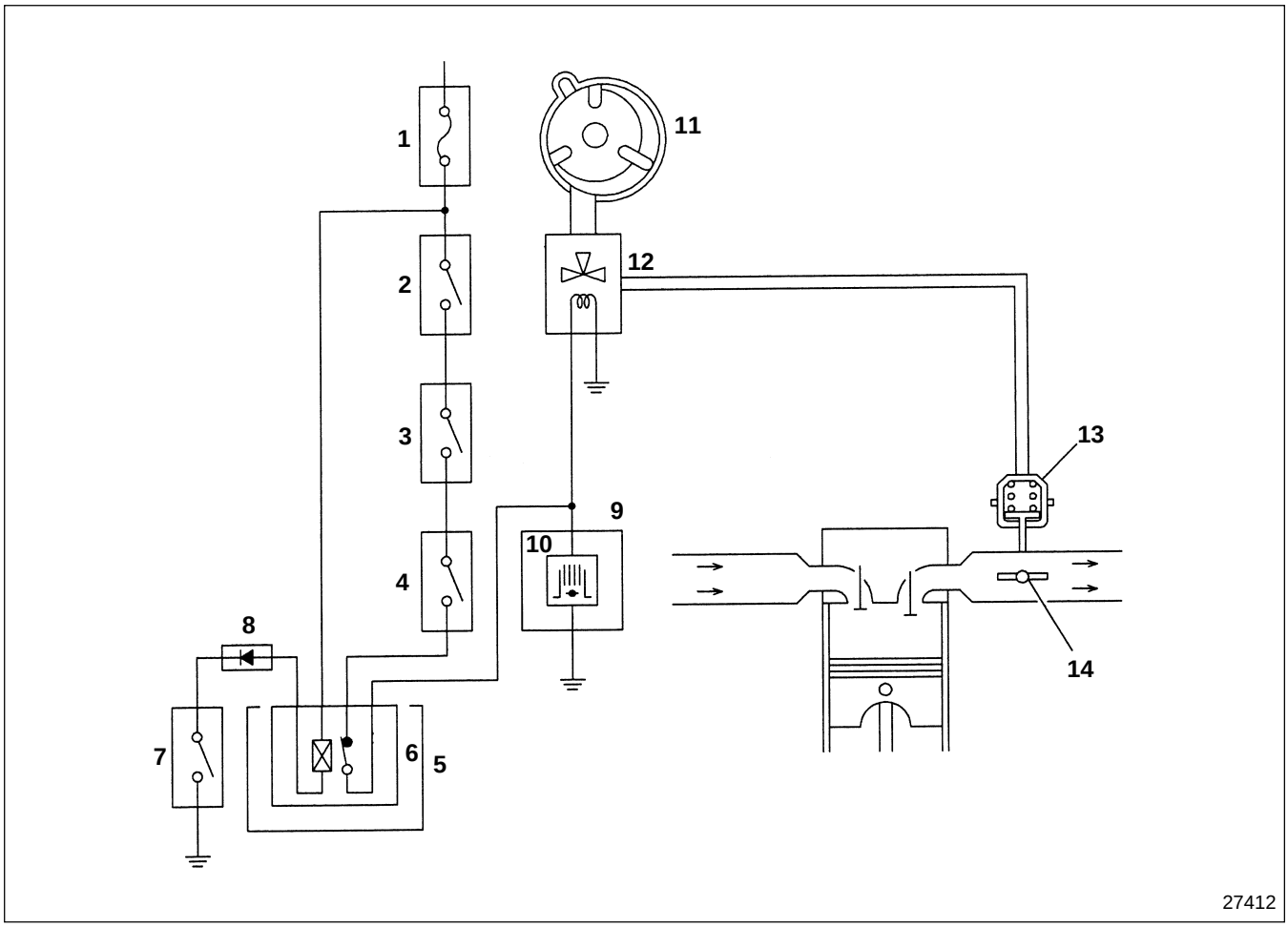
- The vacuum pump is installed on the rear part of alternator and is rotated by the V-belt.
- Check valve **2** is fitted to prevent the atmospheric pressure and the lubricating oil from flowing in reverse from the vacuum pump when the engine is stopped.



● **Operation**

- Inside cylindrical housing **4**, rotor **1** equipped with three vanes (movable blades) **3** rotates, pressing the vanes against the inside surface of the housing by centrifugal force.
- Since rotor **1** is eccentric with respect to housing **4**, as the rotor rotates, the atmospheric pressure of the exhaust brake unit is drawn in from inlet **A** and discharges from outlet **B** by the gradual compression of the air. This repetition of the suction, compression and exhaust strokes generates a vacuum, realizing a near-vacuum in the exhaust brake unit.
- The engine oil that lubricates and cools the inside of housing **4** is returned, along with air pressure, through outlet **B** to the oil pan.

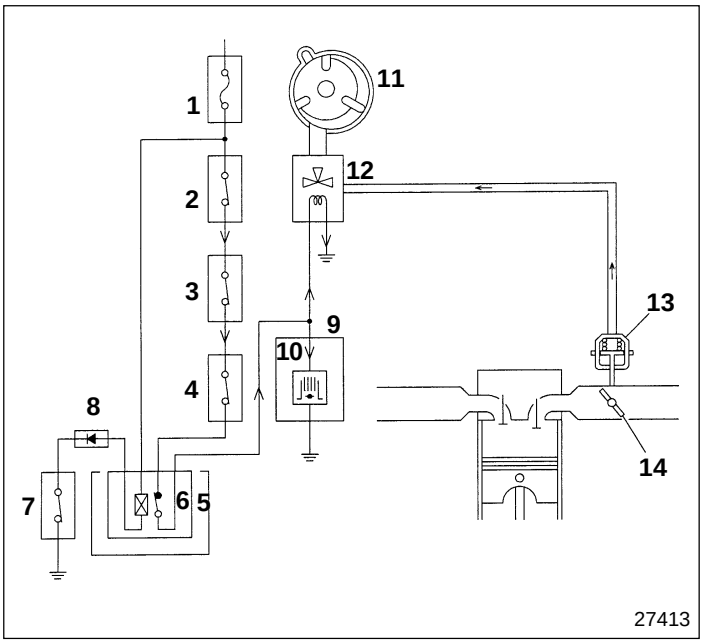
Exhaust Brake System



1 Fuse box
2 Clutch switch
3 Accelerator switch
4 Exhaust brake switch
5 Relay box
6 Exhaust brake cut relay
7 Transmission neutral switch
8 Diode
9 Meter cluster
10 Exhaust brake indicator lamp
11 Vacuum pump
12 3-way magnetic valve
13 Exhaust brake unit
14 Butterfly valve

- Excitation of the coil of 3-way magnetic valve **12** closes the atmospheric valve and opens the vacuum valve. This makes the vacuum pump **11** act on exhaust brake unit **13** which closes butterfly valve **14**, activating the exhaust brake.
- If the exhaust brake is activated while the vehicle is stationary, the coolant temperature can rise excessively, overheating the engine. To avoid this, when the transmission is in neutral, transmission neutral switch **7** turns ON, cutting the exhaust brake system.

● When exhaust brake system is activated

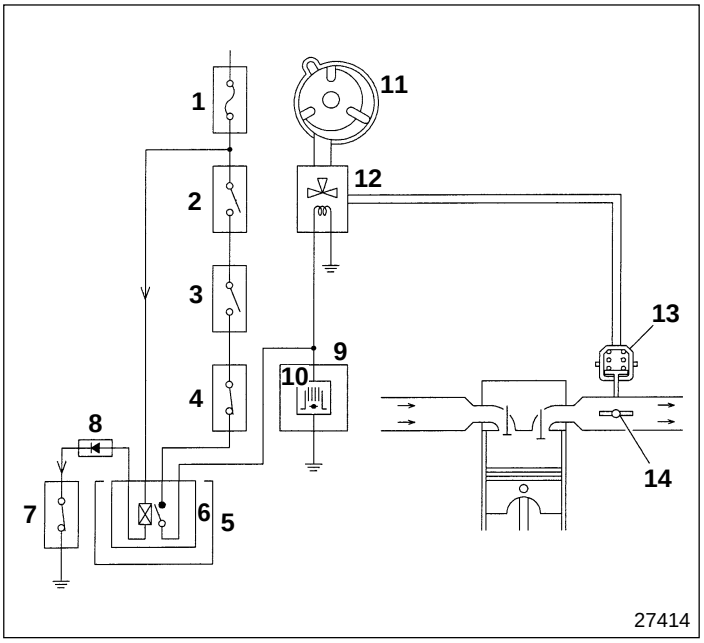


When exhaust brake switch **4** is turned on, the current flows as illustrated to activate the exhaust brake.

Fuse **1**→Clutch switch **2**→Accelerator switch **3**→Exhaust brake switch **4**→Exhaust brake cut relay **6**⟶→3-way magnetic valve **12**→Ground

⟶→Exhaust brake indicator lamp **10** (ON)→Ground

● When the exhaust brake system is released



When the accelerator pedal or clutch pedal is depressed while the exhaust brake is working, all switches **3**, **2** turn off, shutting off the current, releasing the exhaust brake.

● When clutch pedal is depressed

Fuse **1**→Clutch switch **2** (OFF)→Since no current flows, the circuit turns off and the exhaust brake is released.

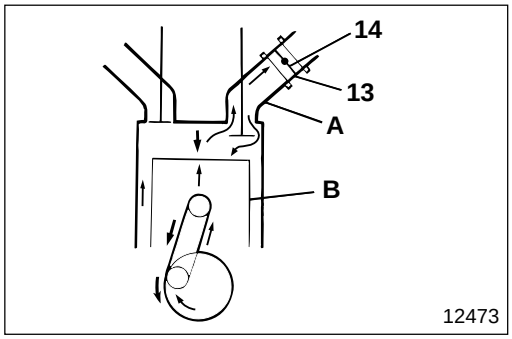
● When accelerator pedal is depressed

Fuse **1**→Clutch switch **2**→Accelerator switch **3** (OFF)→Since there is no grounding, current does not flow, so the exhaust brake is released.

● Releasing exhaust brake system by placing transmission in neutral

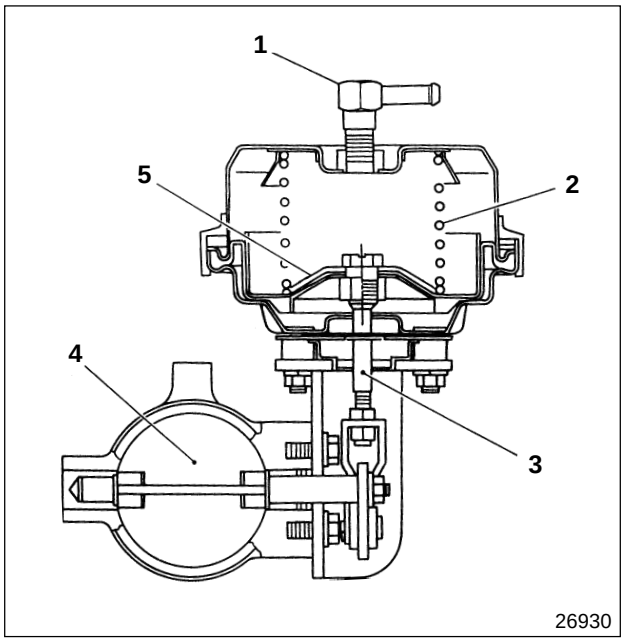
Fuse **1**→Exhaust brake cut relay **6** excitation→Transmission neutral switch **7**→Ground
Fuse **1**→Clutch switch **2**→Accelerator switch **3**→Exhaust brake switch **4**→Exhaust brake cut relay **6** (OFF)→Beyond this, current does not flow so the exhaust brake is released.

● Working principle of exhaust brake



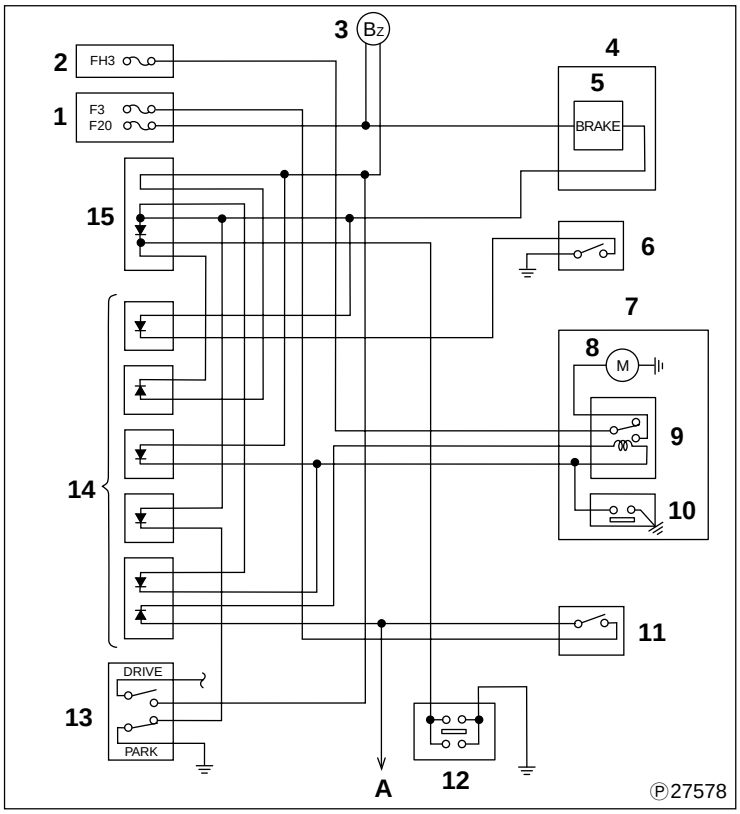
When butterfly valve **14** of exhaust brake unit **13**, in exhaust pipe **A**, is closed, the pressure in the exhaust pipe rises. The pressure rises further in the exhaust stroke, generating a force that pushes back piston **B**, the exhaust braking force.

● Exhaust brake unit



1 Connector
2 Spring
3 Push rod
4 Butterfly valve
5 Diaphragm

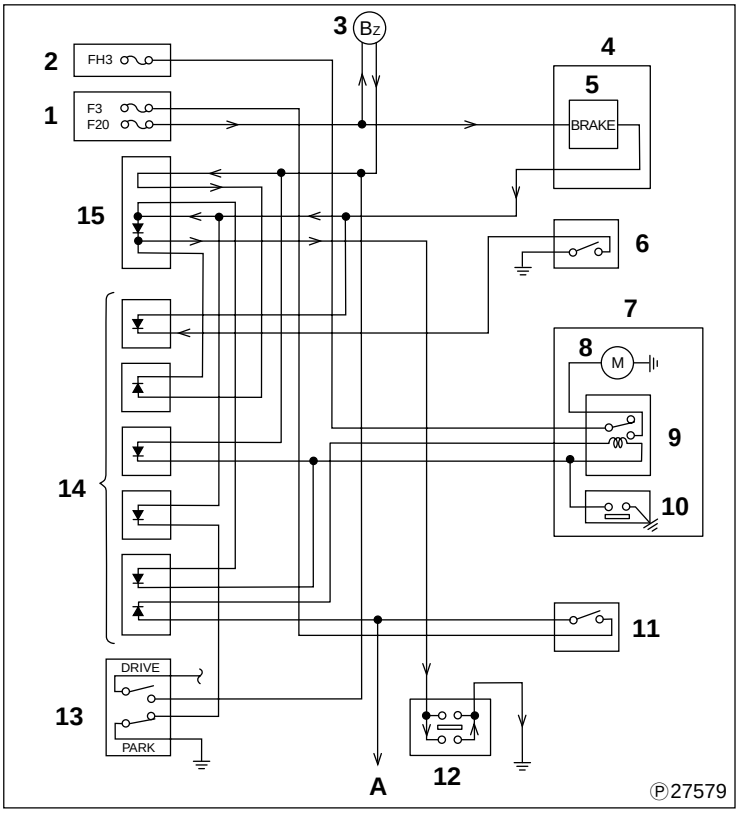
Brake Warning and Brake booster (Hydraulic Booster) Fail-Safe System



1 Fuse box
2 High current fuse box
3 Warning buzzer
4 Meter cluster
5 Brake warning lamp
6 Brake fluid level switch
7 Brake booster (Hydraulic booster)
8 Emergency pump motor
9 Motor relay
10 Flow switch
11 Stop lamp switch
12 Power steering fluid level sensor
Gr 37
13 Parking brake switch
14 Diode
15 Joint connector

A: To stop lamp

● Power steering fluid level warning circuit

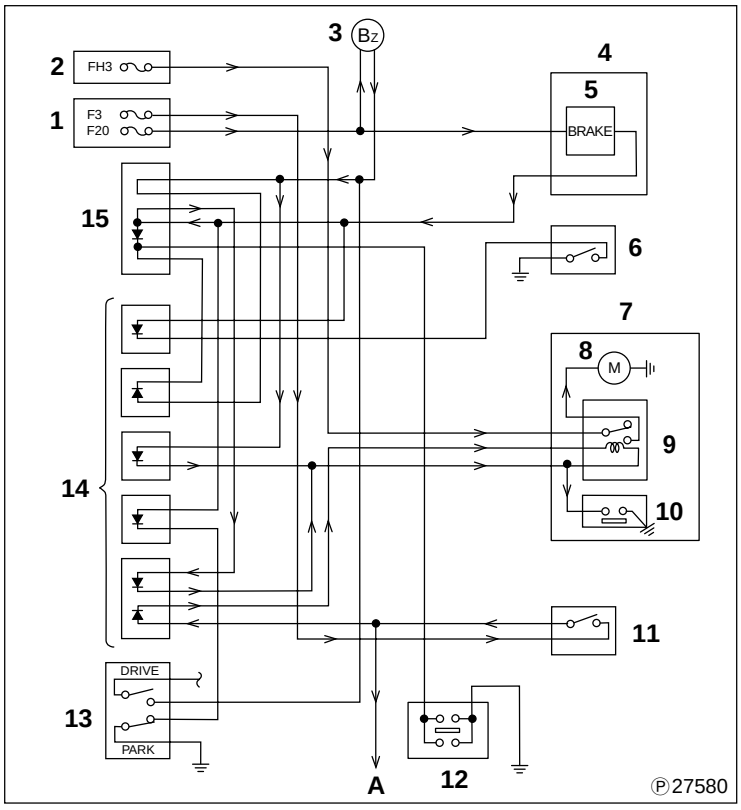


- Since the fluid pressure of the power steering fluid is also used for brake booster (hydraulic booster) **7**, the power steering fluid level warning circuit is connected to warning buzzer **3** and brake warning lamp **5**.
- When the power steering fluid level drops below the **"MIN"** level or rises above the **"MAX"** level of the power steering oil tank, power steering fluid level sensor **12** is turned ON, and the flow of current at such time is as follows.

Fuse **1** → Warning buzzer **3**
↓ ↓
Brake warning lamp **5** Joint connector **15**
↓
Diode **14**
↓
Joint connector **15**
↓
Power steering fluid level sensor **12**
↓
Ground

As a result warning buzzer **3** sounds and warning lamp **5** lights to warn the driver.

● **Brake booster (hydraulic booster) fail-safe system**



- If there is a fluid leakage in the power steering system piping and hydraulic pressure is lost, the brake booster (hydraulic booster) fail-safe system will act in the following manner.

  Flow switch **10** is turned ON and the flow of current is as follows.

  Fuse **1** → Warning buzzer **3**
  ↓ ↓
  Brake warning lamp **5** Diode **14**
  ↓ ↓
  Joint connector **15** → Flow switch **10**
  ↓ ↓
  Diode **14** Ground

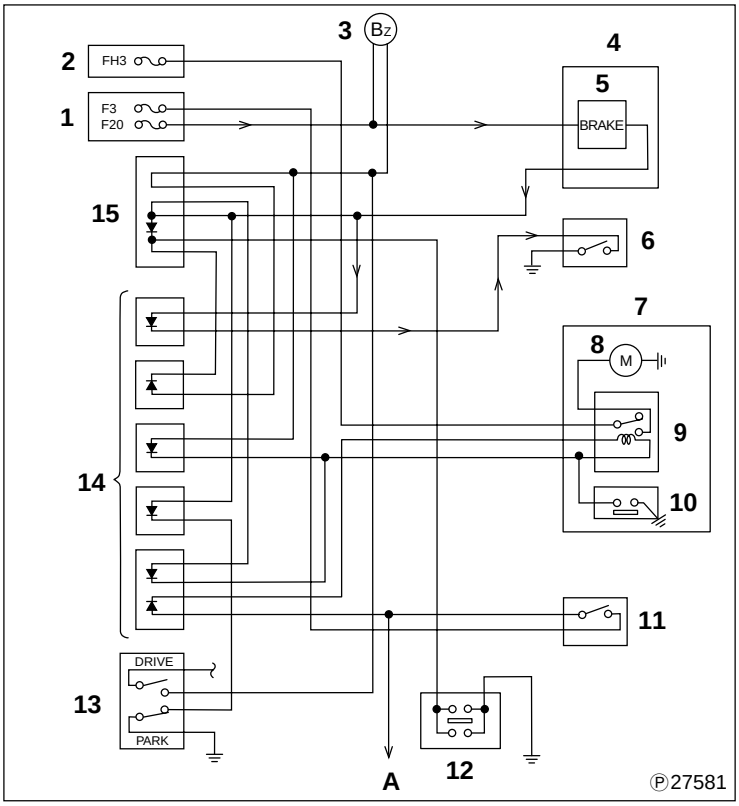
  As a result warning buzzer **3** sounds and brake warning lamp **5** lights.

  Depressing the brake pedal when flow switch **10** is ON, will cause the current to flow as follows.

  Fuse **1** → Stop lamp switch **11**
  ↓
  High current fuse **2** → Diode **14**
  ↓
  (Contact) → Motor relay **9** (coil)
  ↓
  Emergency pump motor **8** ← Flow switch **10**
  ↓ ↓
  Ground Ground

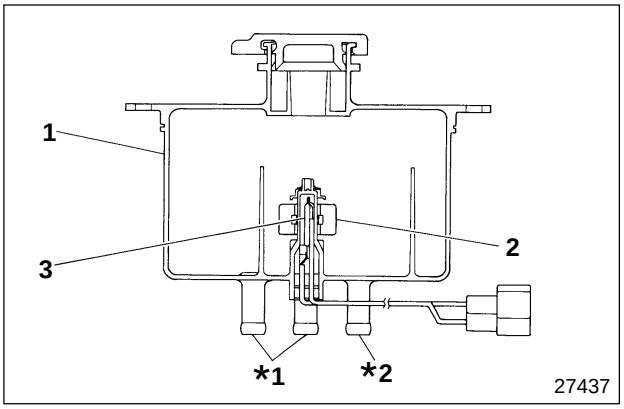
  As a result emergency pump motor **8** starts operating, maintaining the hydraulic pressure during an emergency.

● **Brake fluid warning circuit**



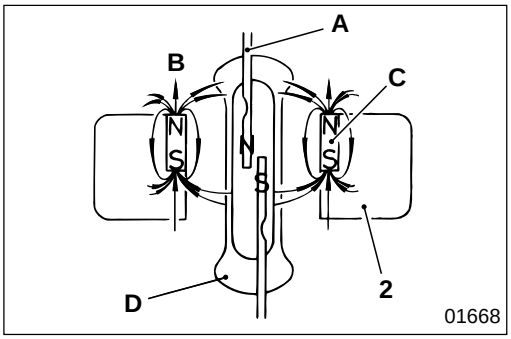
- When the brake fluid in the fluid tank drops below the specified level, brake fluid level switch **6** in the fluid tank turns on, brake warning lamp **5** lights.

● **Brake fluid level switch**



1 Fluid tank
2 Float
3 Brake fluid level switch
***1** : For brakes
***2** : For clutch

- Brake fluid level switch **3**, installed on fluid tank **1**, monitors the brake fluid level in the fluid tank. If the brake fluid level drops below the specified level, float **2** moves and lights up the warning lamp within the meter cluster to alert the driver.



- If the brake fluid level in fluid tank **1** drops and float **2** drops lower than level **L**, magnetic force **B** that passes through the contact point (ferromagnetic body **A**), increases generating north and south poles at the ends of the contact points. Therefore, the contact points pull each other and overcome the repercussive force of the springs of the contact points, forming an electric circuit.
  C : Permanent magnet
  D : Glass

● Wheel Brake

Possible causes / Symptoms		One-sided braking	One-sided braking: Braking shoe return slow after releasing brake pedal	One-sided braking: Braking force difference between left and right	One-sided braking: Braking force unstable	One-sided braking: Lock points difference	Braking force insufficient	Brake pedal stroke reduced	Noise and judder when brakes are applied	Noise and judder when brakes are applied: Noise generated when wheels are rotating, with vehicle jacked up	Noise and judder when brakes are applied: Continuous noise generated while braking (at low speed)
Tires	Air pressures uneven, etc. Gr 31	○									
	Left and right tire sizes different Gr 31	○									
Axle	Wheel hub bearing adjusted incorrectly Gr 26, 27	○									○
	Left and right wheelbase difference excessive Gr 26, 27	○									
	Wheel alignment incorrect Gr 26	○									
	Kingpin bushing worn Gr 26										
Wheel brakes	Backing plate ledge surface rough		○		○						
	Backing plate ledge surface not smooth										
	Backing plate deformed, mounted incorrectly				○						
	Oil or water on brake lining surfaces			○			○				
	Brake lining changed in quality or wrong material used		○								
	Brake lining unevenly worn or surface roughened			○							
	Brake lining fading (surface change in material)						○				
	Brake lining worn out completely										○
	Abrasive on brake lining										
	Brake lining worn										
	Brake lining contact incorrect			○		○	○				
	Brake lining ground radius irregular					○					
	Wheel cylinder malfunctioning		○	○				○		○	
	Wheel cylinder piston cup faulty										
	Shoe return spring fatigued or broken		○							○	
	Brake drum worn unevenly			○							
	Brake drum warped				○						
	Brake drum worn					○					
	Brake drum surface roughened						○				
	Brake drum roughness excessive								○		
	Brake drum glassy										

Possible causes / Symptoms		One-sided braking	One-sided braking							Noise and judder when brakes are applied	
		One-sided braking	Braking shoe return slow after releasing brake pedal	Braking force difference between left and right	Braking force unstable	Lock points difference	Braking force insufficient	Brake pedal stroke reduced	Noise and judder when brakes are applied	Noise generated when wheels are rotating, with vehicle jacked up	Continuous noise generated while braking (at low speed)
Wheel brakes	Brake drum cracked								○		
	Brake drum clogged by foreign particles										
	Brake drum deformed or eccentric									○	
	Brake shoe deformed or damaged							○			
	Brake shoe twisted or tilted										
	Moving parts greased insufficiently								○		
Brake pedal	Brake pedal stroke faulty (52 mm {2.05 in.} or more at 490 N {110 lbf, 50 kgf} foot pressure)						○				
	Brake pedal adjusted incorrectly, looseness excessive							○			
	Brake booster (Hydraulic booster) operating rod pushing up										
Brake fluid system	Brake fluid insufficient							○			
	Brake fluid leaking							○			
	Air lock in system							○			
	Vapor lock							○			
	Brake fluid return insufficient because brake pipe tightened excessively										
Power steering fluid system	Degree of power steering fluid line pressure reduced							○			
Brake booster (Hydraulic booster)	Brake booster (Hydraulic booster) defective						○	○			
Brake master cylinder	Piston cup faulty							○			
	Return port clogged										

TROUBLESHOOTING

Possible causes	Symptoms	Brake drums overheating			Brakes squeaking					Remarks
		All wheels overheating	One wheel overheating	Brakes squeaking	Squeaking in new vehicle or after brake lining replacement	Action too severe	Brake juddering	Brake pedal return faulty	Brake drags	
Tires	Air pressures uneven, etc.									Gr 31
	Left and right tire sizes different									Gr 31
Axle	Wheel hub bearing adjusted incorrectly		○	○			○			Gr 26, 27
	Left and right wheelbase difference excessive									Gr 26, 27
	Wheel alignment incorrect									Gr 26
	Kingpin bushing worn						○			Gr 26
Wheel brakes	Backing plate ledge surface rough								○	
	Backing plate ledge surface not smooth		○							
	Backing plate deformed, mounted incorrectly					○				
	Oil or water on brake lining surfaces									
	Brake lining changed in quality or wrong material used									
	Brake lining unevenly worn or surface roughened									
	Brake lining fading (surface change in material)					○				
	Brake lining worn out completely									
	Abrasive on brake lining			○						
	Brake lining worn			○						
	Brake lining contact incorrect				○					
	Brake lining ground radius irregular									
	Wheel cylinder malfunctioning		○						○	
	Wheel cylinder piston cup faulty		○						○	
	Shoe return spring fatigued or broken		○						○	
	Brake drum worn unevenly									
	Brake drum warped									
	Brake drum worn									
	Brake drum surface roughened									
	Brake drum roughness excessive									
	Brake drum glassy					○				

Possible causes / Symptoms		Brake drums overheating			Brakes squeaking						Remarks
		All wheels overheating	One wheel overheating	Brakes squeaking	Squeaking in new vehicle or after brake lining replacement	Action too severe	Brake juddering	Brake pedal return faulty	Brake drags	
Wheel brakes	Brake drum cracked										
	Brake drum clogged by foreign particle										
	Brake drum deformed or eccentric						○				
	Brake shoe deformed or damaged					○					
	Brake shoe twisted or tilted		○								
	Moving parts greased insufficiently										
Brake pedal	Brake pedal stroke faulty (52 mm {2.05 in.} or more at 490 N {110 lbf, 50 kgf} foot pressure)										
	Brake pedal adjusted, looseness excessive										
	Brake pedal return faulty	○									
	Brake pedal free play inadequate								○		
	Linkage rusted or deformed							○			
	Return spring fatigued or broken							○			
	Brake booster (Hydraulic booster) operating rod pushing up							○			
Brake fluid system	Brake fluid insufficient										
	Brake fluid leaking										
	Air lock in system										
	Vapor lock										
	Brake fluid return insufficient because brake pipe tightened excessively		○								
Power steering fluid system	Degree of power steering fluid line pressure reduced										
Brake booster (Hydraulic booster)	Brake booster (Hydraulic booster) defective	○							○		
Brake master cylinder	Piston cup faulty	○							○		
	Return port clogged	○							○		

● Exhaust Brake

Symptoms / Possible causes		Exhaust brake does not work	Exhaust brake does not release	Remarks
Vacuum system	Degree of vacuum insufficient	○		
	Pipe crushed	○		
3-way magnetic valve	Does not work	○	○	Gr 54
Exhaust brake unit	Valve assembly does not work	○	○	
	Valve assembly shaft stuck	○	○	
	Vacuum chamber does not work	○		
Electric system	Electric system faulty	○	○	Gr 54

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

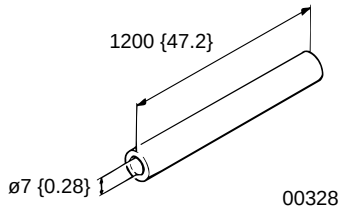
Replacement of Brake Fluid

Fluid

Location	Points of application	Specified fluid	Quantity
3	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Vinyl hose 	MH033102	Air bleeding

WARNING

- **The clutch fluid system and the brake fluid system use the fluid tank in common.**
- **You must use new brake fluid (SAE J17031 or FMVSS No. 116 DOT 3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in ineffective clutch and brake operations.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose.**

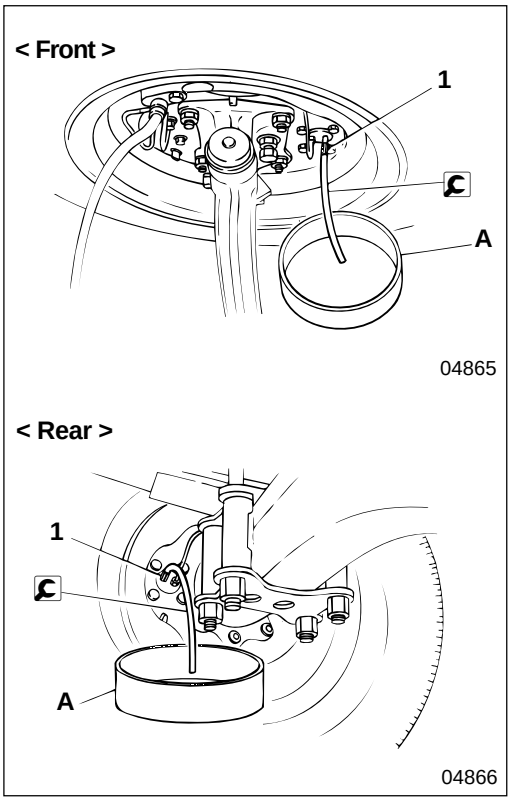
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

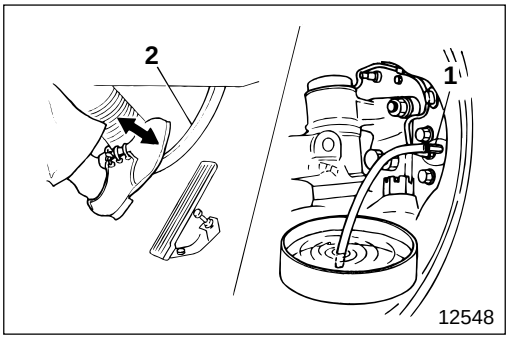
NOTE

Supply and maintain the brake fluid level to the "MAX" level of the fluid tank.

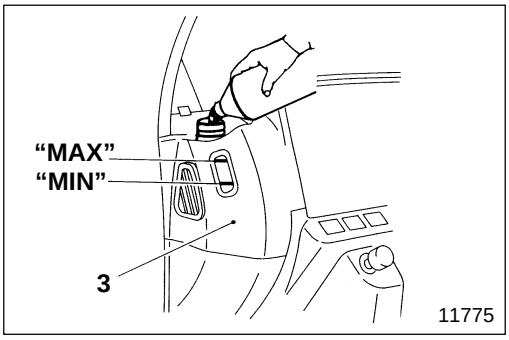
- Start engine and let it idle until brake fluid replacement is completed.



- Attach one end of vinyl hose to air bleeder **1** and place the other end in container **A**.



- Loosen air bleeder **1** and depress brake pedal **2** to drain brake fluid completely.



- Maintain a supply of new brake fluid up to the "**MAX**" level of fluid tank **3**, depress the brake pedal repeatedly until the old brake fluid of the brake system is replaced with new fluid.

- Bleed air from the brake system.
P35A-30

ON-VEHICLE INSPECTION AND ADJUSTMENT

Air Bleeding of Brake System

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

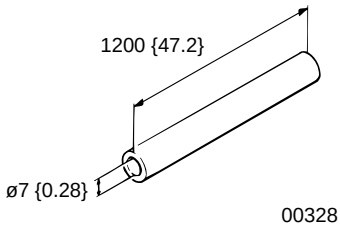
Location	Parts to be tightened	Tightening torque	Remarks
—	Air bleeder	7.8 to 12 {5.8 to 8.5, 0.8 to 1.2}	—

Fluid

Location	Points of application	Specified fluid	Quantity
—	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Vinyl hose 	MH033102	Air bleeding

WARNING

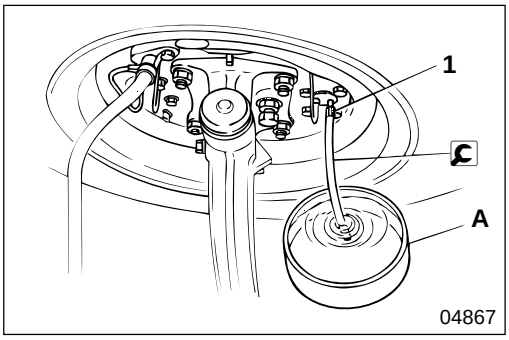
- **The clutch fluid system and the brake fluid system use the fluid tank in common.**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT 3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system and brake system to swell, resulting in faulty clutch operation, as well as ineffective braking and brake dragging.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will result in ineffective clutch and brake operations.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose.**

CAUTION ⚠

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

NOTE

- **Supply and maintain brake fluid to the "MAX" level of the fluid tank.**
- **Make sure you maintain brake fluid at the "MAX" level of the fluid tank since the brake fluid level drops during air bleeding.**



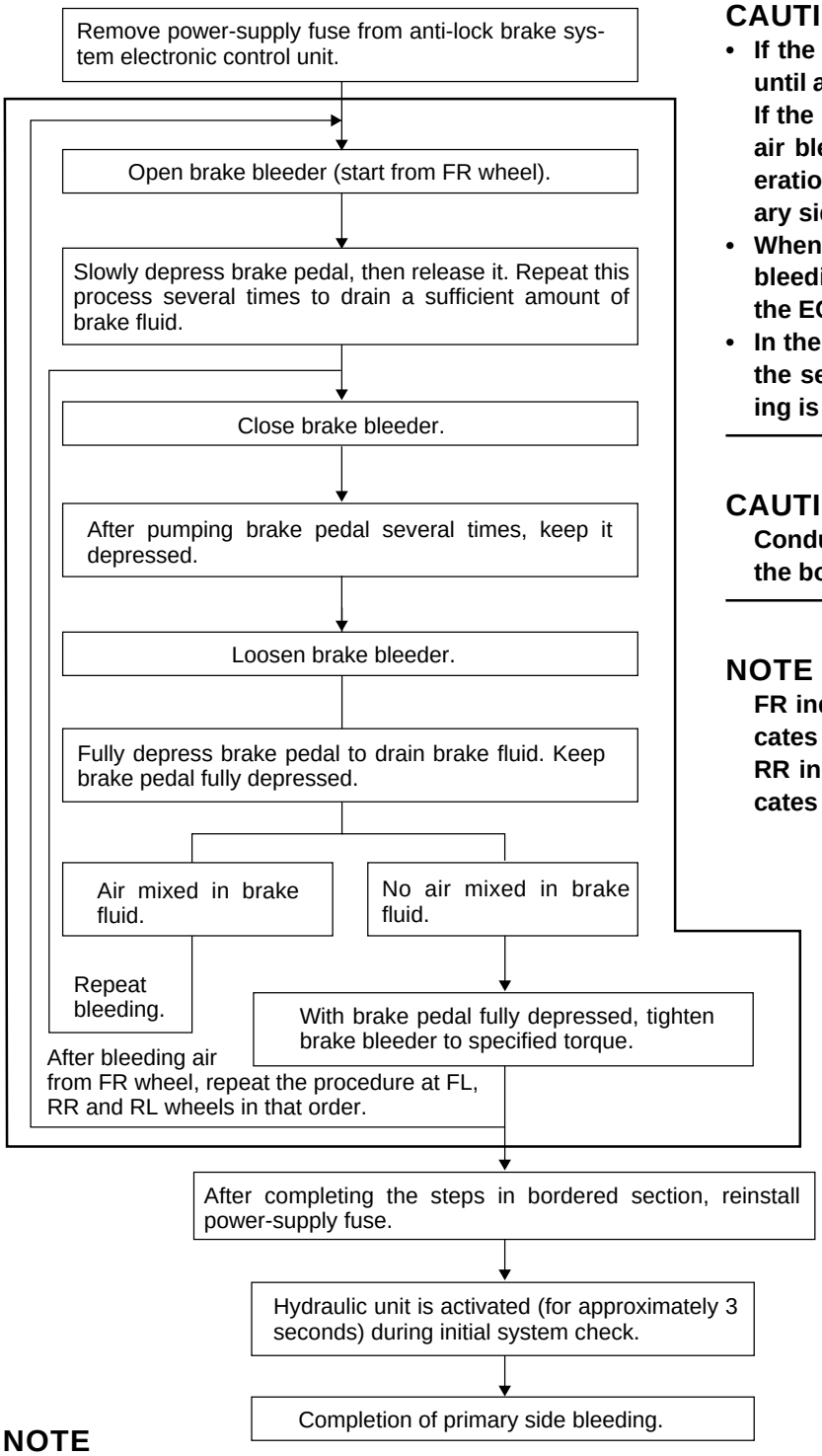
- Start engine and let it idle until brake fluid replacement is completed.
- Attach one end of 🔧 vinyl hose to air bleeder **1** of the wheel brake. Place free end in container **A** filled with brake fluid.
- Carry out air bleeding in the following sequence:

Front brake system	Rear brake system
Right-hand side wheel brake	Right-hand side wheel brake
↓	↓
Left-hand side wheel brake	Left-hand side wheel brake

ON-VEHICLE INSPECTION AND ADJUSTMENT

(1) Air bleeding during regular maintenance, and hydraulic unit replacement

When air bleeding is conducted during regular maintenance or when the hydraulic unit is replaced, brake fluid flows into the secondary side (operating circuit) of the hydraulic unit. Therefore, bleed the primary side (normal circuit) by following the procedures below. In the event air enters the secondary side, bleed air by following the procedures described in (2).



CAUTION

- **If the battery is disconnected, do not reconnect until air bleeding of the primary side is complete. If the battery is reconnected before primary side air bleeding is complete, the system check operation is activated and air can enter the secondary side.**
- **When the battery must be connected prior to air bleeding, remove the power-supply fuse from the ECU.**
- **In the event air enters the secondary side, bleed the secondary side after primary side air bleeding is complete.**

CAUTION

Conduct the air bleeding operation described in the bordered section at every wheel.

NOTE

FR indicates front-axle right wheel, and FL indicates front-axle left wheel.
RR indicates rear-axle right wheel, and RL indicates rear-axle left wheel.

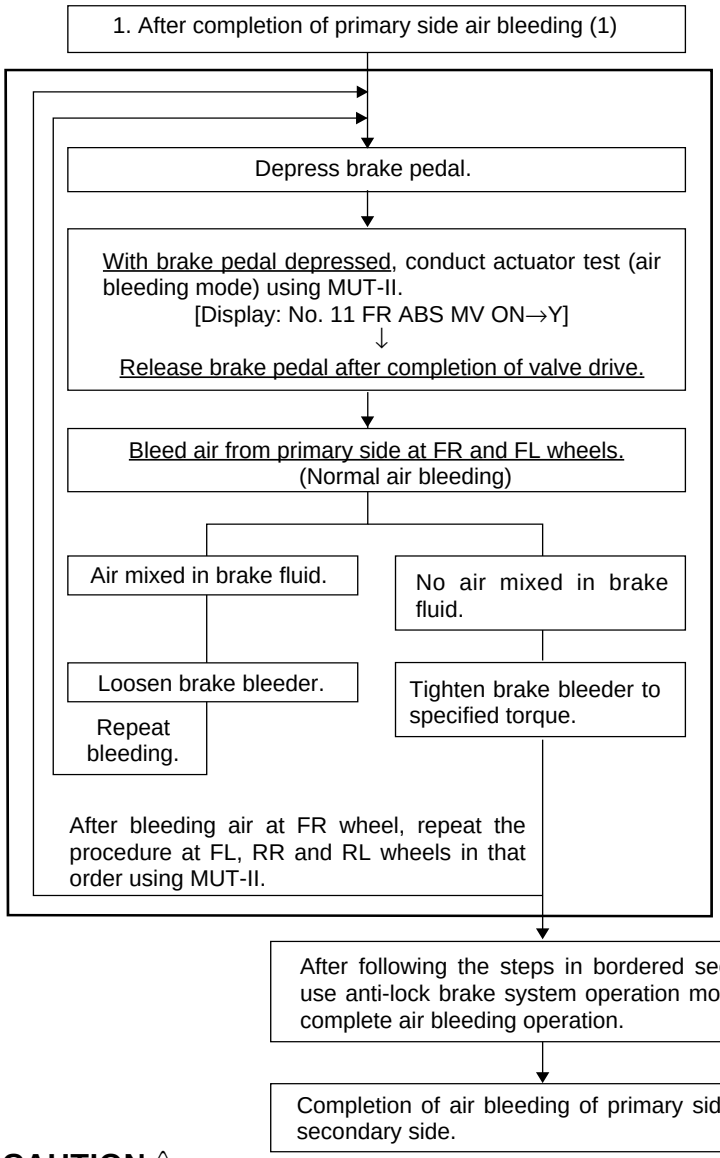
NOTE

- **The primary side (normal circuit) is a hydraulic circuit formed when the system is in non-operation.**
- **The secondary side (operating circuit) is a hydraulic circuit which connects with the primary side only when the system is in operation (when the system is in non-operation, the secondary side is disconnected from the primary side).**

(2) Air bleeding of secondary side

If the system starts operating before air bleeding of the primary side is complete, air can enter the secondary side. In the event the system accidentally starts before the completion of primary side air bleeding, follow the procedures below to bleed air. If air enters the secondary side, air flows into the primary side when the system starts, and this can extend the brake pedal stroke.
During air bleeding, use the MUT-II to conduct an actuator test (anti-lock brake system operation mode) at all wheels.

Use the MUT-II when bleeding air from the secondary side.



CAUTION⚠

Conduct air bleeding operation described in the bordered section at every wheel by using the anti-lock brake system operation mode.

CAUTION⚠

Bleed air from wheels other than FR according to the directions below.

(Refer to NOTE below)

For FL wheel
[Display: No. 12 FL ABS MV ON→Y]
↓
Bleed air from primary side at FR and FL wheels.

For RR wheel
[Display: No. 13 RR ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

For RL wheel
[Display: No. 14 RL ABS MV ON→Y]
↓
Bleed air from primary side at RR and RL wheels.

CAUTION⚠

- **Avoid continuous execution of the actuator test (anti-lock brake system drive) using the MUT-II; otherwise, excessive heating of the anti-lock brake system motor, valve and other parts can cause hydraulic unit damage.**
- **Do not conduct the actuator test with the MUT-II while bleeding air from the primary side; otherwise, air can enter the secondary side from the primary side.**
- **When mixing of air was found after air bleeding is conducted to correct an excessive brake pedal stroke, bleed air from the secondary side, too.**

NOTE

- **For the MUT-II operation for the actuator test during air bleeding, refer to section 4.**
- **If a drive operation is conducted for the FR and RL wheels at one time using the MUT-II, subsequent air bleeding of the primary side conducted at each wheel will not remove air from the secondary side.**

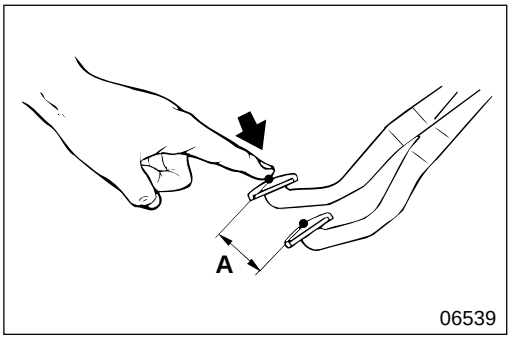
ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspection and Adjustment of Brake Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Free play of brake pedal	10 to 15 {0.39 to 0.59}	—	Adjust



[Inspection]
Check if brake pedal free play **A** confirms to the standard value. If the measured value deviates from the standard value, adjust the position of the brake pedal.

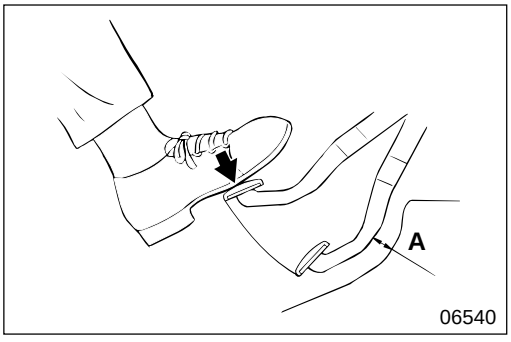
[Adjustment]
P35A-41

Inspection and Adjustment of Clearance between Brake Pedal and Floor Panel

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Clearance between brake pedal and floor panel (with pedal depressed at 490 N {110 lbf, 50 kgf})	34 {1.34} or more	—	Adjust



[Inspection]
Depress the brake pedal using 490 N {110 lbf, 50 kgf} when the engine is idling to check if clearance **A** between the brake pedal and the floor panel conforms to the standard value. If the measured value deviates from the standard value, adjust the position of the brake pedal.

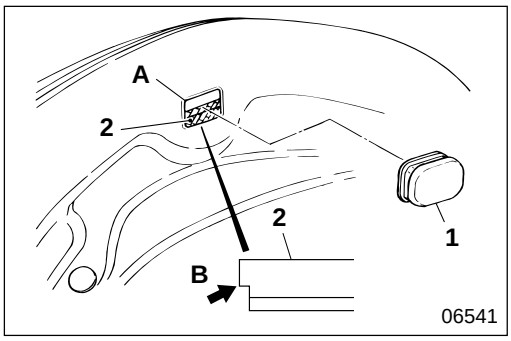
[Adjustment]
P35A-41

Thickness Inspection and Replacement of Brake Lining

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Thickness of brake lining	—	5.5 {0.22} (Side shoulder means wear limit)	Replace



[Inspection]

NOTE

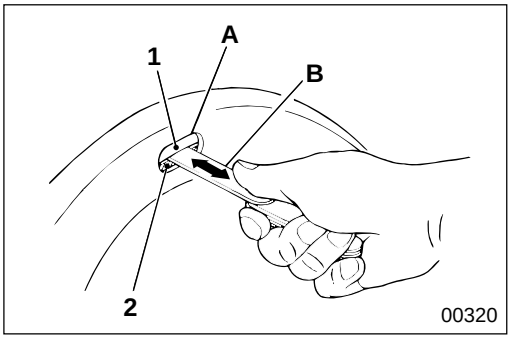
Be sure to inspect at two points for each wheel per side.

- Remove check hole plug **1** from the backing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall check hole plug **1**.

[Replacement]

P35A-44, 52

Inspection of Brake Shoe Clearance



NOTE

When the vehicle is jacked up and the wheel is being turned, make sure that there is no dragging.

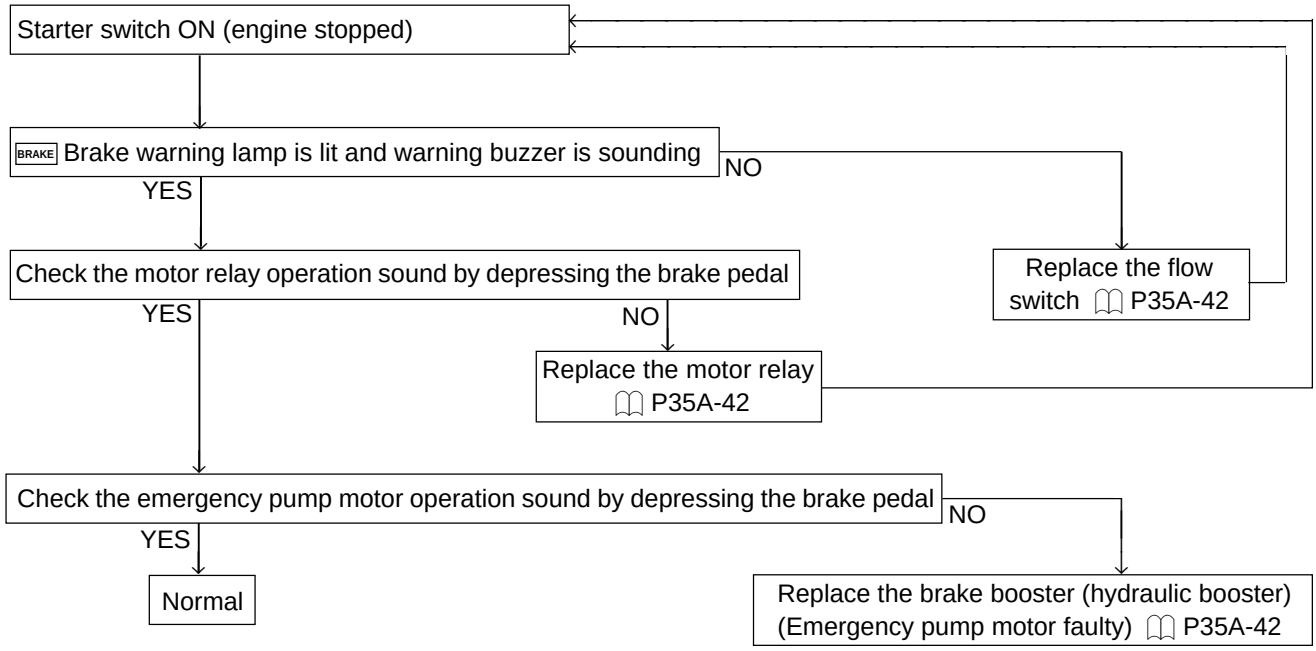
- Remove the check hole plug from the backing plate.
  A : Check hole
- Try to insert a 1 mm {0.039 in.} feeler gauge **B** between brake drum **1** and brake lining **2**. Check that the clearance is too small to let the feeler gauge enter.
  If feeler gauge **A** enters the clearance, disassemble the wheel cylinder and inspect.
  P35A-50, 58

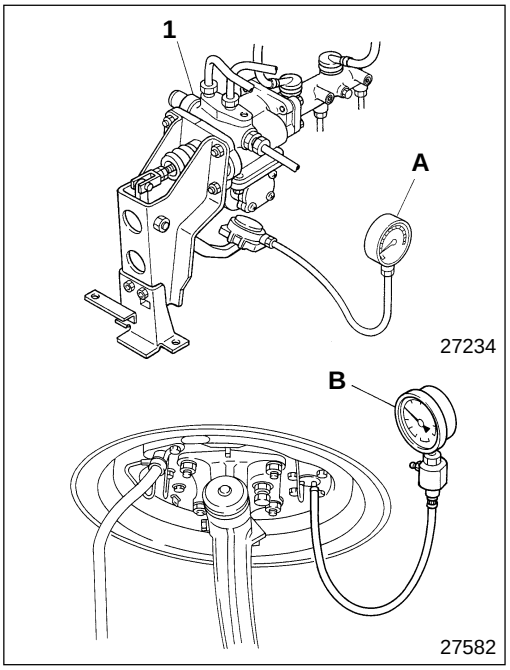
ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspection of Brake Booster (Hydraulic Booster)

(1) Inspection of electric equipment

Perform inspection in accordance with the flow-chart below. Make sure the power steering fluid level sensor is working properly and power steering oil tank fluid level is normal. Make sure the parking brake is working properly and the wheels are choked during inspection.

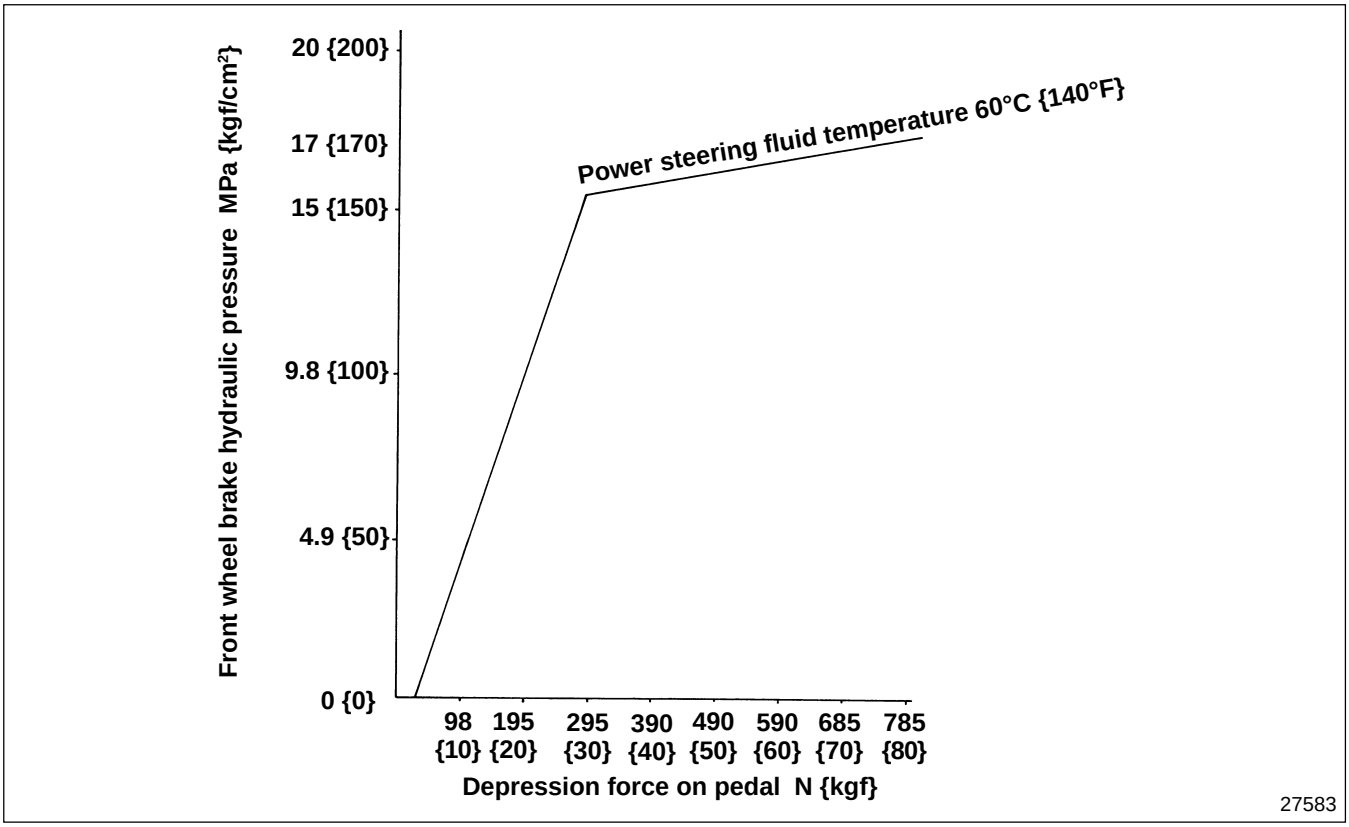




(2) Performance inspection

- Mount foot pressure meter **A** on the brake pedal, remove the front wheel brake air bleeder and after installing oil pressure gauge **B**, bleed the air from the pressure gauge.
- Carry out a performance evaluation test on the power steering system and make sure hydraulic pressure in the power steering fluid system is at a normal level. Gr 37
- If the above proves normal, check to make sure the hydraulic pressure of the front wheel brakes in response to foot pressure on the brake pedal is in conformity with the performance characteristics chart.
  If faulty, replace brake booster (hydraulic booster) **1**.
  Gr 35A-40

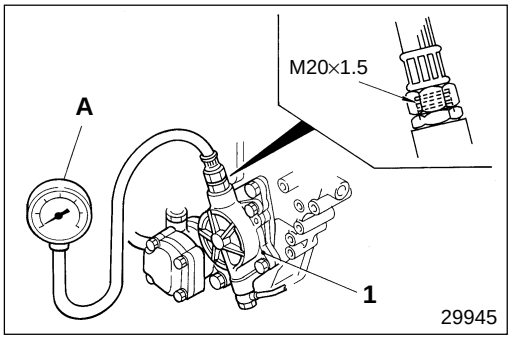
Performance characteristics chart



Inspection of Vacuum Pump Function

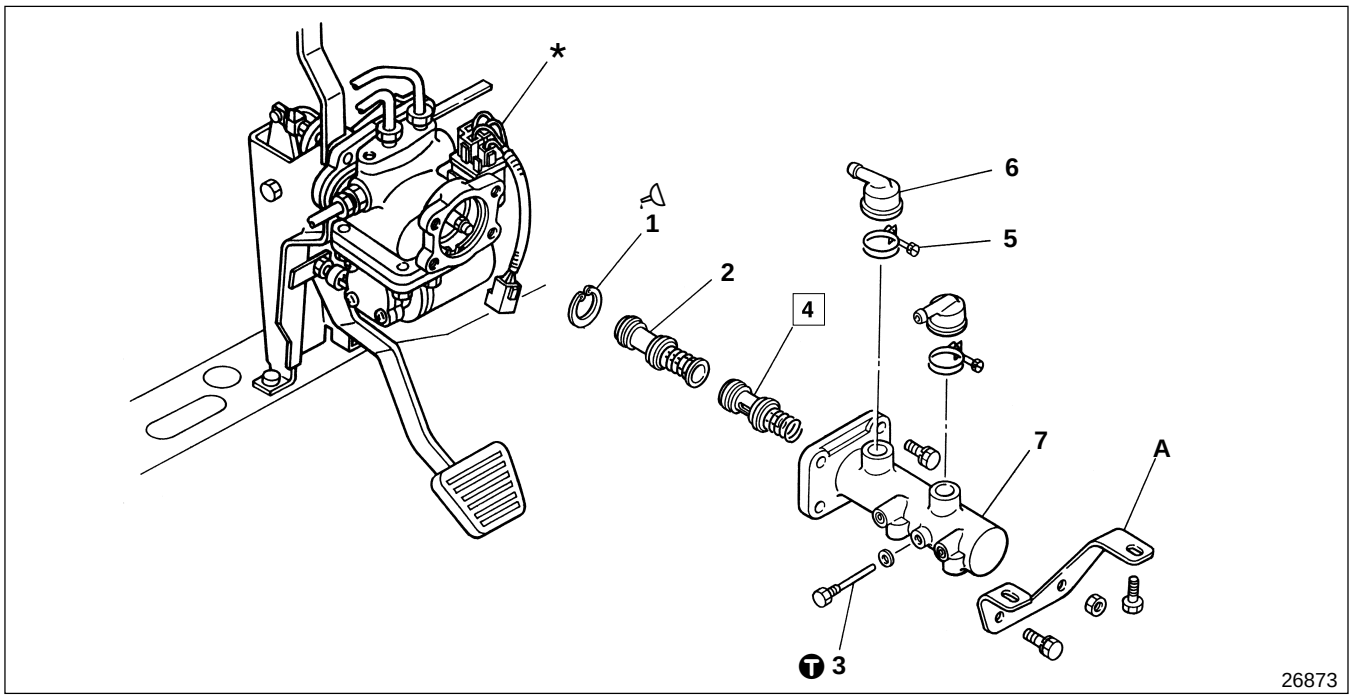
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
1	Ultimate vacuum	Less than 20 sec at 1500 rpm	93.3 kPa {27.6 in.Hg, 700 mmHg} or more	—	—
		Less than 12 sec at 3000 rpm			



- Attach vacuum gauge **A** to the inlet of vacuum pump **1**.
- Start the engine. Check to see if ultimate vacuum reaches the standard value in less than 20 seconds when the engine is operated at 1500 rpm, and less than 12 seconds at 3000 rpm.

BRAKE MASTER CYLINDER



● **Disassembly sequence**

1 Retaining ring
2 Primary piston assembly
3 Set bolt
4 Secondary piston assembly
5 Clamp
6 Connector
7 Cylinder body

A : Brake booster support
***** : Brake pedal and brake booster (hydraulic booster) 🕮 P35A-40

WARNING⚠

Be sure not to damage the inner surface of cylinder body 7, since it will cause air to get mixed in or will result in brake fluid leakage during the removal and installation of primary piston assembly 2 and secondary piston assembly 4.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
2	Primary piston assembly spring load (Installed length 35.1{1.38})	100 to 115 N {22 to 26 lbf, 10.2 to 11.7 kgf}	93 N {21 lbf, 9.5 kgf}	Replace
2, 4, 7	Clearance between primary and secondary piston assemblies and cylinder body	[41.28] 0.02 to 0.10 {[1.63] 0.00079 to 0.0039}	0.2 {0.0079}	Replace
4	Secondary piston assembly spring load (Installed length 34.1{1.34})	71 to 86 N {16 to 19 lbf, 7.2 to 8.8 kgf}	67 N {15 lbf, 6.8 kgf}	Replace

Tightening torque

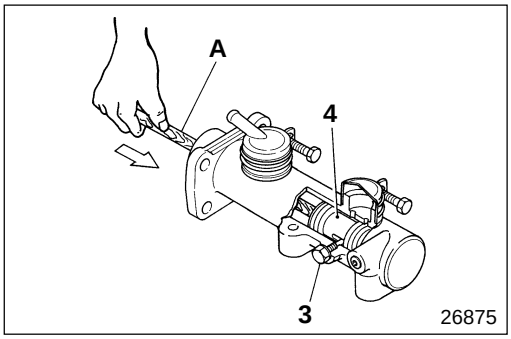
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Set bolt	6.86 to 8.82 {5.1 to 6.5, 0.7 to 0.9}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
1	Periphery of retaining ring	Rubber grease	As required

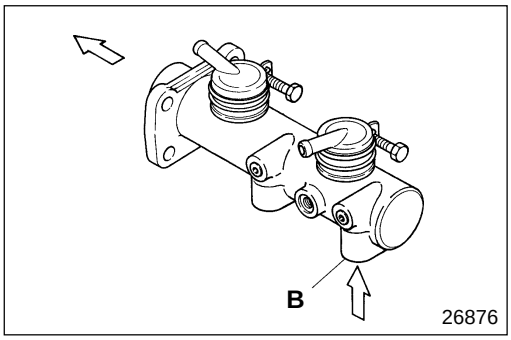
◆ Service procedure



4 Secondary piston assembly

[Removal]

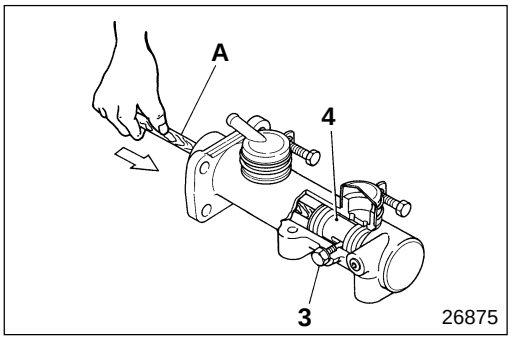
- Using rod **A**, push in secondary piston assembly **4**, then loosen set bolt **3**.



- Feed compressed air via discharge port **B** that leads to the rear wheel brake to extract secondary piston assembly **4**.

WARNING⚠

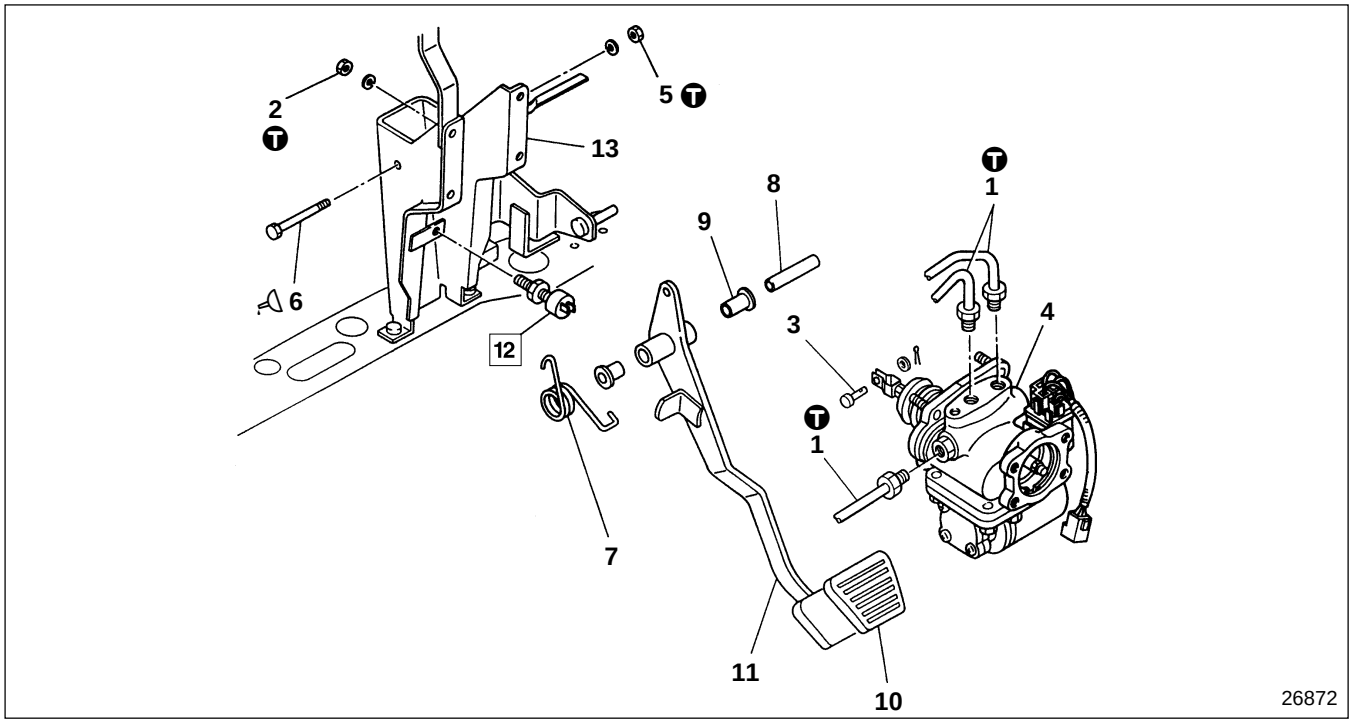
You must apply compressed air gradually when you remove secondary piston assembly 4. If you applied compressed air strongly at one time, the secondary piston assembly would be violently ejected.



[Installation]

Using rod **A**, push in secondary piston assembly **4**, then tighten set bolt **3** at specified torque.

BRAKE PEDAL AND BRAKE BOOSTER (HYDRAULIC BOOSTER)



● **Disassembly sequence**

1 Pipe 🗃 Gr 37
2 Nut
3 Clevis pin
4 Brake booster (Hydraulic booster) 🕮 P35A-42
5 Nut
6 Bolt
7 Spring
8 Collar
9 Bushing
10 Pedal pad
11 Brake pedal
12 Stop lamp switch 🗃 Gr 54
13 Support assembly

WARNING ⚠

Power steering fluid is a mineral fluid. Make sure it does not get mixed with brake fluid (vegetable fluid) during disassembly, because it causes the rubber parts of the brake equipment to expand resulting in brake dragging or malfunction.

NOTE

Do not disassemble brake booster (hydraulic booster) 4 because it is a non-disassemble type.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly** 🕮 P35A-41

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
8, 9	Clearance between collar and bushing		[16] 0.02 to 0.26 {0.00079 to 0.010}	0.5 {0.020}	Replace
11	Brake pedal	Height from pedal pad center to instrument panel underside	254 {10.0}	—	Adjust
		Full stroke	143 {5.63}	—	Adjust
11, 12	Clearance between brake pedal stopper and tip of stop lamp switch thread area		0 to 0.1 {0 to 0.0039}	—	Adjust

Tightening torque

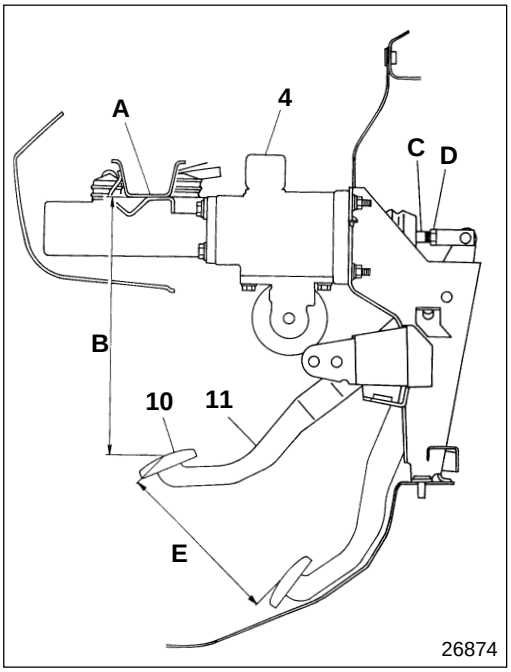
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Pipe (Brake booster connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
2	Nut (Brake booster mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—
5	Nut (Brake pedal mounting)	34.3 to 53.9 {25 to 40, 3.5 to 5.5}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
6	Friction surface of bolt bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



● Adjustment after assembly

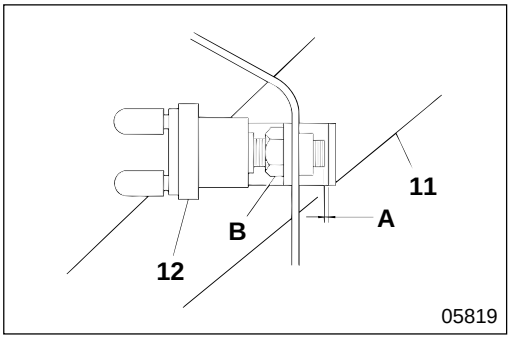
- Adjustment of brake pedal installation height
  By turning operating rod **C** of brake booster (hydraulic booster) **4**, adjust height **B** from the center of pedal pad **10** to the underside of instrument panel **A** to the standard value, then secure in place using nut **D**.

WARNING⚠

Make sure, when brake pedal 11 is depressed fully, that operating rod C of brake booster (hydraulic booster) 4 functions as the stopper and the pedal does not come to a stop by hitting against the floor panel, since this will reduce brake effectiveness.

- Inspection of brake pedal full stroke
  Make sure that full stroke **E** when brake pedal **11** is depressed fully conforms to the standard value.
  If there is any fault, adjust the installation height of the brake pedal.

- Inspection of play towards brake pedal 🕮 P35A-34



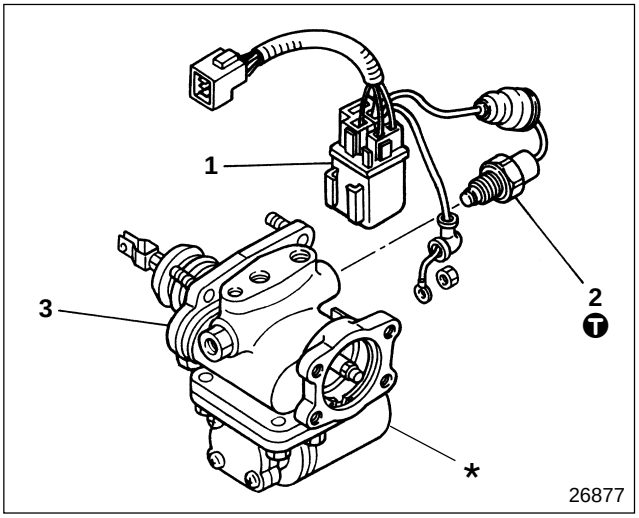
12 Adjustment of stop lamp switch

Turn stop lamp switch **12** to adjust clearance **A** between the top of the thread area of the stop lamp switch and the stopper of brake pedal **11** to the standard value, and fasten with lock nut **B**.

WARNING⚠

Make sure, when brake pedal 11 is released, that stop lamp switch 12 does not stop the pedal, since this will cause the brake to drag.

BRAKE BOOSTER (HYDRAULIC BOOSTER)



● **Disassembly sequence**

1 Motor relay
2 Flow switch
3 Brake booster (Hydraulic booster)

*: Emergency pump motor

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

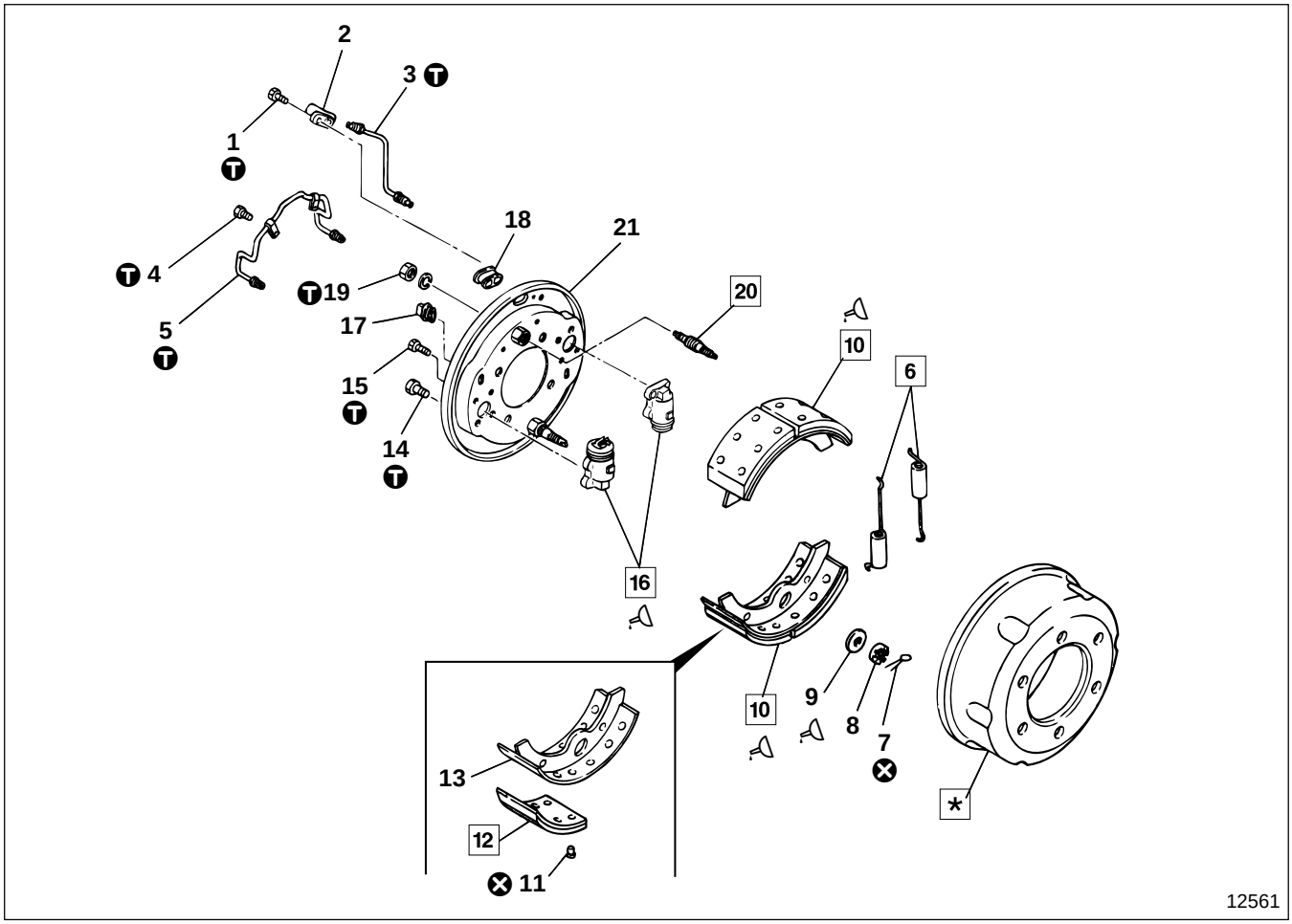
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Flow switch	24.5 to 34.3 {18 to 25, 2.5 to 3.5}	—

M E M O

FRONT WHEEL BRAKE

Front Wheel Brake Assembly



● **Disassembly sequence**

1 Bolt
2 Joint assembly
3 Pipe assembly
4 Bolt
5 Pipe assembly
6 Return spring
7 Split pin
8 Holder pin nut
9 Washer
10 Brake shoe assembly
11 Rivet
12 Brake lining
13 Brake shoe
14 Bolt
15 Bolt
16 Wheel cylinder assembly 🕮 P35A-50
17 Adjusting hole plug
18 Check hole plug
19 Nut
20 Holder pin
21 Backing plate

⊗ : Non-reusable parts

* : Brake drum 🗀 Gr 26

WARNING⚠

Do not leave grease or oil on the surface of brake lining 12 or inner surface of brake drum * because this reduces braking performance.

CAUTION⚠

Do not turn or remove holder pin 20 unless it is necessary, or the squareness of brake shoe assembly 10 can be influenced causing brake drag.

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Initial adjustment of brake shoe clearance after installation**

🕮 P35A-45

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
6	Return spring load (Installed length 192 {7.56})		325 N {73 lbf, 33 kgf}		Clearance between coils or coil and cover	Replace
12	Brake lining thickness		12.0 {0.47}		5.0 {0.20} (Side shoulder means wear limit)	Replace brake lining
*	Brake drum	Inner diameter	320 {12.5}	*321 {12.64}	322 {12.68}	Replace
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct or replace

* : Indicates correction limit.

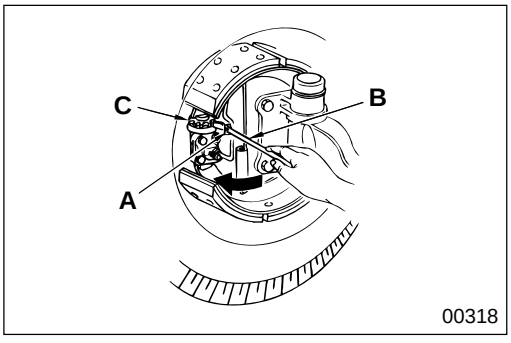
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Joint assembly mounting)	9.8±1.0 {7.2±1.4, 1.0±0.2}	—
3, 5	Flair nut (Pipe assembly mounting)	14±2.0 {10±1.4, 1.4±0.2}	—
4	Bolt (Pipe clamp mounting)	4.9±1.0 {3.6±0.7, 0.5±0.1}	—
14	Bolt (Wheel cylinder assembly mounting)	78±16 {58±12, 8.0±1.6}	—
15	Bolt (Wheel cylinder assembly mounting)	44±8.8 {33±6.5, 4.5±0.9}	—
19	Nut (Holder pin mounting)	29±5.9 {22±4.3, 3,0±0.6}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
9, 10, 16	Contact areas between washer and brake shoe assembly; and between brake shoe assembly and wheel cylinder assembly	Wheel bearing grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● **Initial adjustment of brake shoe clearance after installation**

- Jack up the front wheels, and make sure that there is no play in the hub bearings.
- Insert screwdriver **B** into adjusting hole **A** and turn adjuster **C** in the direction of the arrow marked on backing plate **21** until the wheel drags slightly when turned by hand.

NOTE

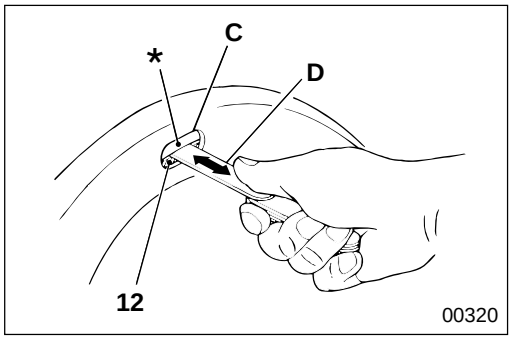
- **Be sure to adjust the clearance at two points for each wheel per side.**
- **The arrow mark on backing plate 21 is near adjusting hole A.**

- After depressing the brake pedal several times, release it and make sure that the wheel drags lightly when turned by hand. If the wheel turns without stress, repeat the above steps. Slacken off adjuster **B**, in the reverse direction to the arrow mark, by eight or nine notches.

NOTE

Be sure to adjust the clearance at two points for each wheel per side.

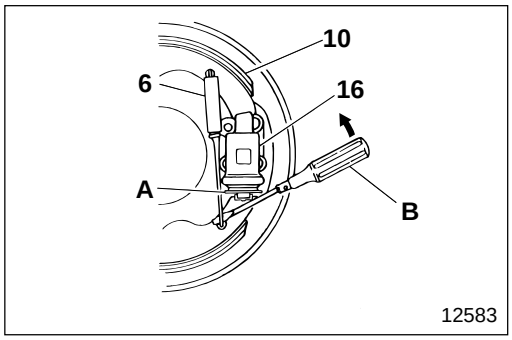
- Make sure that the wheel does not drag when turned by hand. If the wheel drags, repeat the above steps.



- Insert feeler gauge **D** between brake drum ***** and brake lining **12** through check hole **C**, and make sure that a little resistance is felt when the feeler gauge is pulled out or pushed in.

NOTE

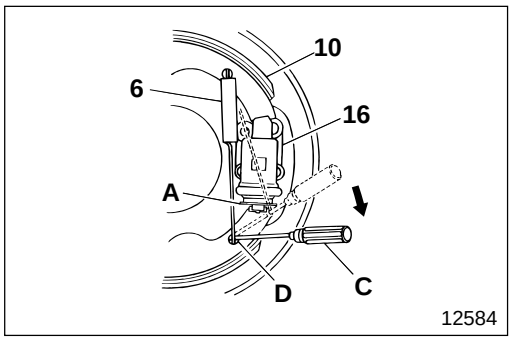
Be sure to adjust the clearance at two points for each wheel per side.



6 Return Spring

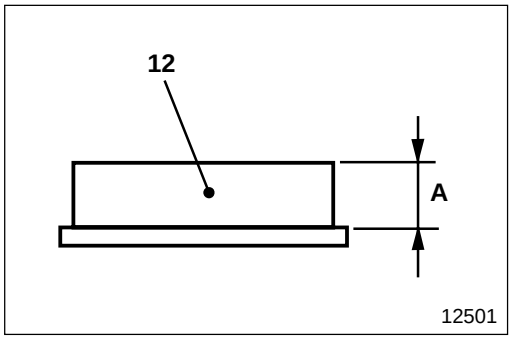
[Removal]

To remove return spring **6**, place screwdriver **B** on the hook of the return spring, then pry and remove the return spring making use of wheel cylinder assembly **16** adjuster **A** as a fulcrum.



[Installation]

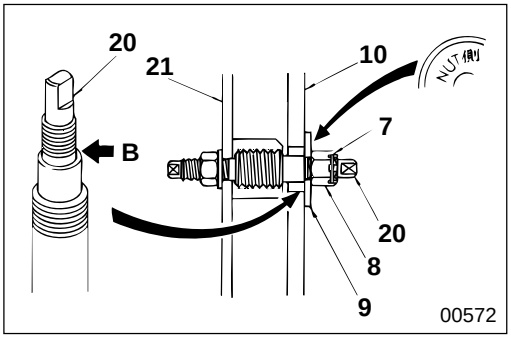
- Install the shorter hook end of return spring **6** in brake shoe assembly **10** at the side opposite to adjuster **A** of wheel cylinder assembly **16**.
- Insert a small Phillips screwdriver **C** into the hook of return spring **6**, insert the tip of the screwdriver into return spring installation hole **D** of the brake shoe assembly to pry on the return spring.



10 Brake shoe assembly

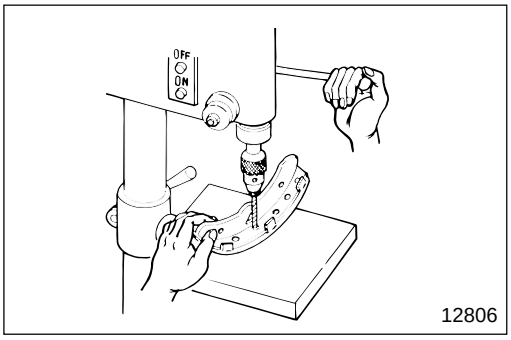
[Inspection]

If thickness **A** of brake lining **12** is lower than the limit replace the brake lining on the same axle as a unit.



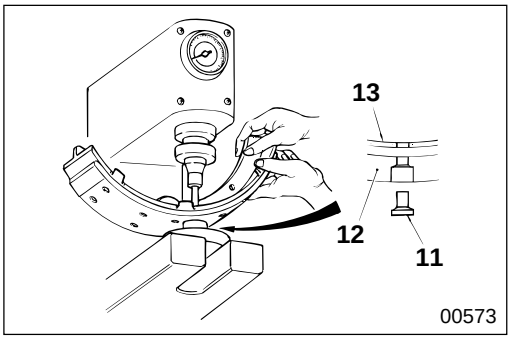
[Installation]

- Install brake shoe assembly **10**.
- Insert washer **9** with the side stamped “NUT 側” facing outside, screw down holder pin nut **8** until washer hits stepped area **B** of holder pin **20** gently, then slacken off the nut within the 0 to 60° limit until the nut is aligned with the first split pin hole.
- Insert split pin **7**, and bend it securely.



12 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **12** and brake shoe **13** with cleaning fluid and dry them.
- Insert rivets **11** from brake lining **12** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **13** and the brake lining.

  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

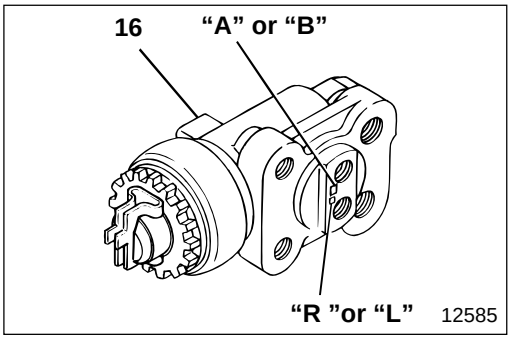
- Make sure that you inspect contact with the inner surface of brake drum ***** after you replace brake linings **12**. If contact is incorrect, correct with the brake assembled.

WARNING⚠

Do not leave lubricant on the surface of brake lining 12 because this reduces braking performance.

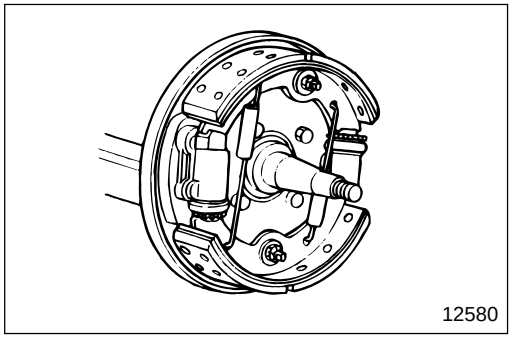
CAUTION⚠

Make sure that the type of brake linings 12 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.



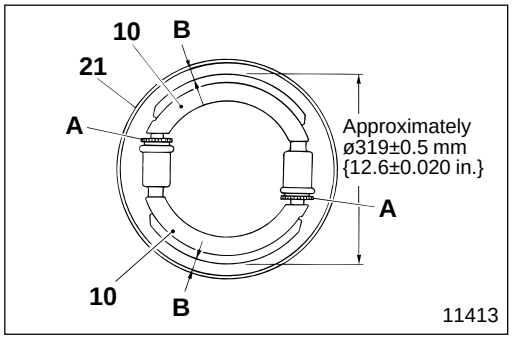
16 **Installation of wheel cylinder assembly**

Identification mark	Installation position
RA	Front of front axle right wheel
RB	Rear of front axle right wheel
LA	Front of front axle left wheel
LB	Rear of front axle left wheel

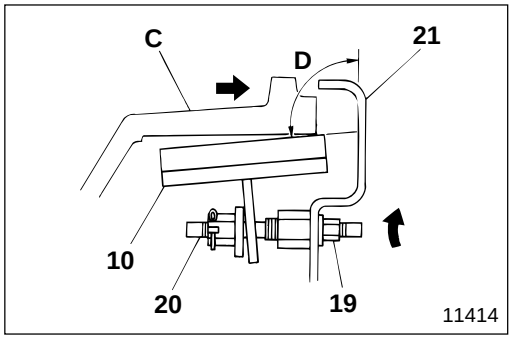


20 **Adjustment of holder pin**

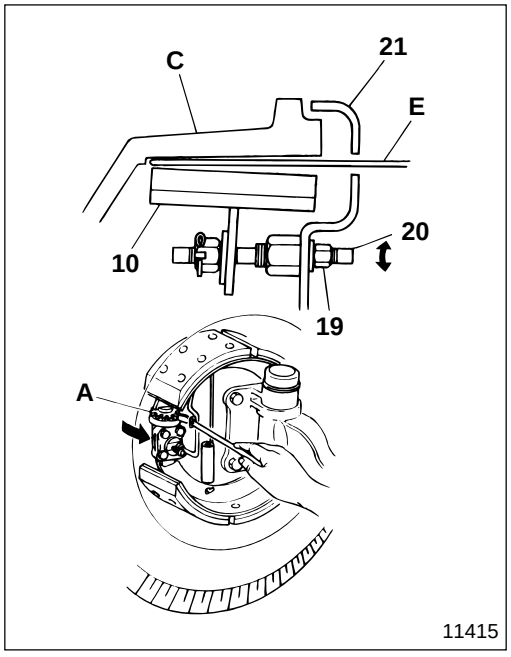
- Install the front wheel brake assembly on the front axle. Gr 26



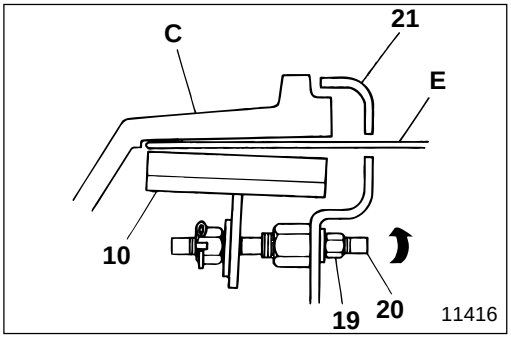
- Turn adjuster **A** to adjust the outer diameter to approximately ø319±0.5 mm {12.6±0.020 in.}.
- Then, move brake shoe assembly **10** to adjust clearance **B** evenly.



- Install hub and drum assembly **C** on the front wheel brake assembly. Gr 26
  At this time, the hub and drum assembly cannot be inserted in the specified position if squareness **D** is 90° or more, so loosen nut **19** and turn holder pin **20** to adjust the squareness to as close to 90° as possible.
- Bleed the brake system. P35A-30



★• Turn adjuster **A** to widen brake shoe assembly **10** until 0.2 mm {0.0079 in.} feeler gauge **E** cannot be pulled out easily.
★• Loosen nut **19** and turn holder pin **20** to the right or left so that feeler gauge **E** can be pushed in or pulled out easily.
- Repeat the above steps (marked ★) until feeler gauge **E** cannot be pushed in or pulled out easily.
- Depress the brake pedal a few times lightly to equalize clearance **B** (adjusted in the previous section).
- Repeat the above steps (marked ★) until feeler gauge **E** cannot be pushed in or pulled out easily.



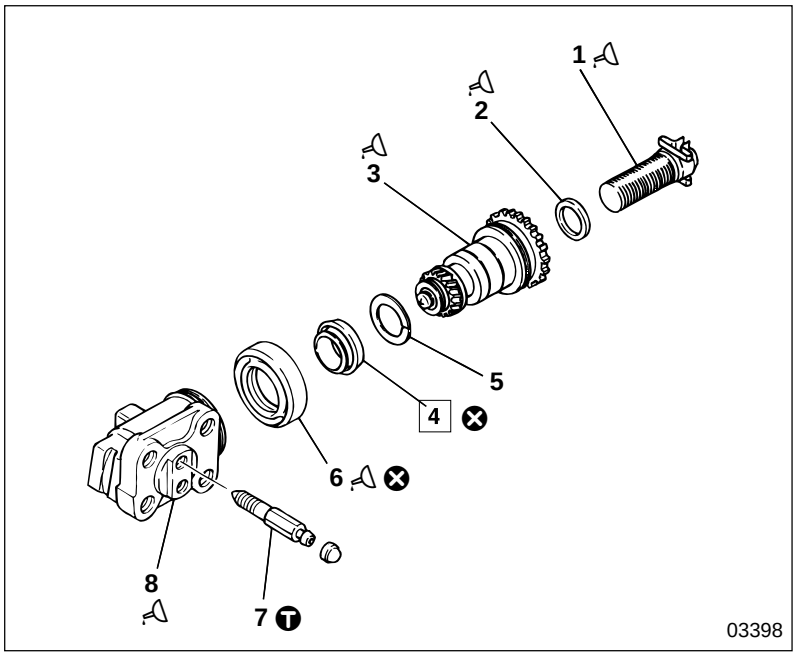
- If feeler gauge **E** cannot be pushed in or pulled out easily it is because it is making contact over the full width of brake shoe assembly **10**.
- Turn holder pin **20** so that when you pull out feeler gauge **E**, in the above condition, and reinsert the feeler gauge, pushing in or pulling out the feeler gauge at the rear is difficult.
- After adjustment, tighten nut **19** at specified torque.

* Correction of brake drum

If the cylindrical accuracy of brake drum * is higher than the limit, or there are seams, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

FRONT WHEEL BRAKE

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Screw
2 Seal
3 Piston
4 Piston cup
5 Backup ring
6 Boot
7 Air bleeder (only at the rear)
8 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3, 8	Clearance between piston and body	[34.93] 0.03 to 0.09 {[1.38] 0.0012 to 0.0035}	0.2 {0.0079}	Replace piston

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

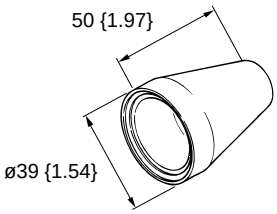
Location	Parts to be tightened	Tightening torque	Remarks
7	Air bleeder	9.8±2.0 {7.2±1.4, 1.0±0.2}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
1, 2, 3, 6, 8	Thread area of screw, outer periphery of seal, outer periphery of piston, mounting groove and thread area of boot, and inner surface of body	Rubber grease	As required

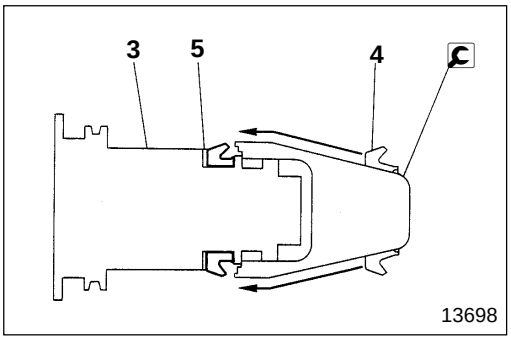
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4	Piston cup guide 	MC895722	Installation of piston cup

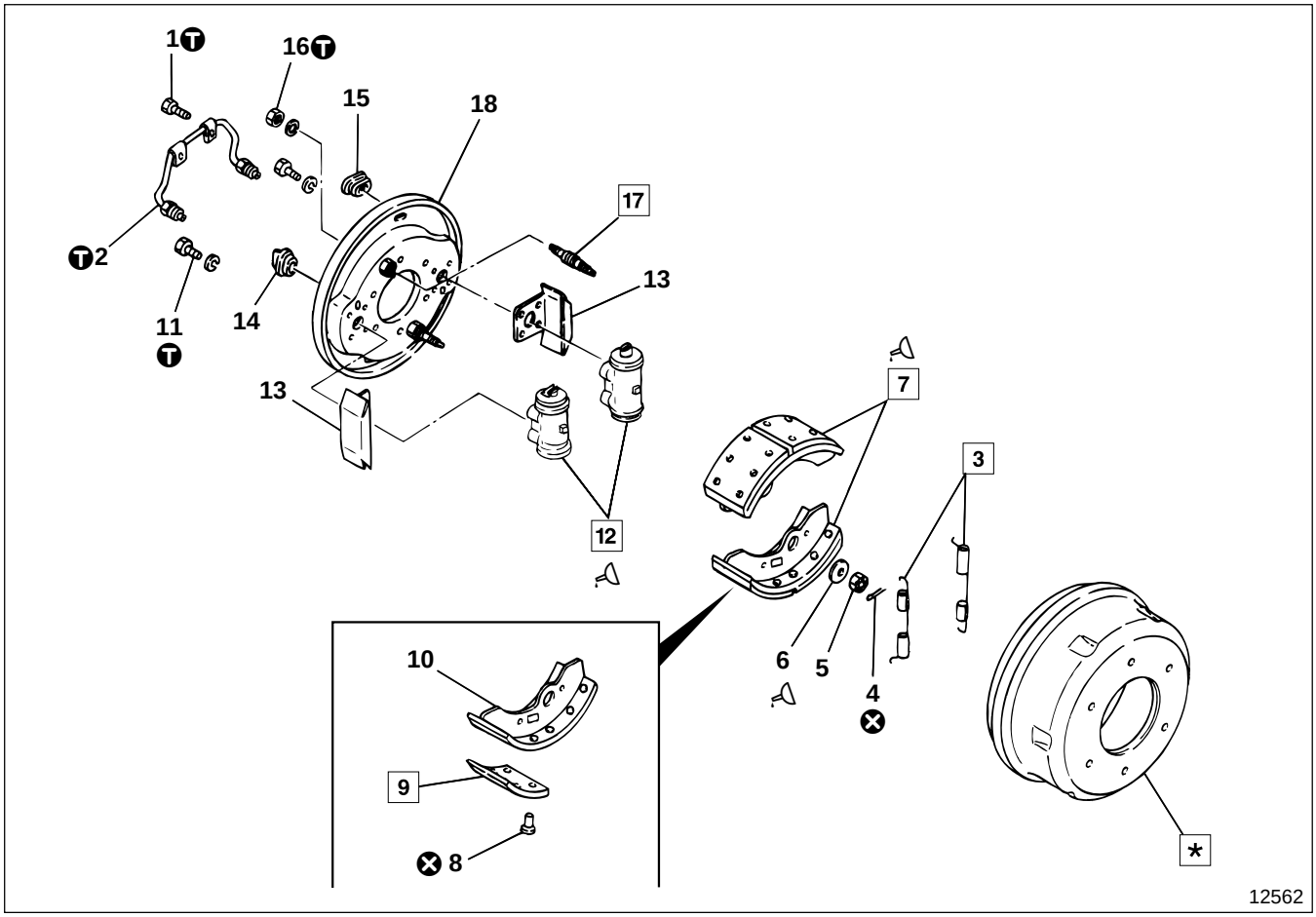
◆ Service procedure

4 **Installation of piston cup**



REAR WHEEL BRAKE

Rear Wheel Brake Assembly



● **Disassembly sequence**

1 Bolt
2 Pipe assembly
3 Return spring
4 Split pin
5 Holder pin nut
6 Washer
7 Brake shoe assembly
8 Rivet
9 Brake lining
10 Brake shoe
11 Bolt
12 Wheel cylinder assembly
📖 P35A-58
13 Wheel cylinder cover
14 Adjusting hole plug
15 Check hole plug
16 Nut
17 Holder pin
18 Backing plate

⊗ : Non-reusable parts
* : Brake drum Gr 27

WARNING⚠

Do not leave grease or oil on the surface of brake lining 9 or inner surface of brake drum * because this reduces braking performance.

CAUTION⚠

Do not turn or remove holder pin 17 unless it is necessary, or the squareness of brake shoe assembly can be influenced causing brake drag.

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Initial adjustment of brake shoe clearance after installation**

📖 P35A-53

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
3	Return spring load (Installed length 217 {8.54})		390 N {88 lbf, 40 kgf}		Clearance between coils or coil and cover	Replace
9	Brake lining thickness		12.0 {0.47}		5.0 {0.20} (Side shoulder means wear limit)	Replace lining
*	Brake drum	Inner diameter	320 {12.5}	*321 {12.64}	322 {12.68}	Replace
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct or replace

* : Indicates correction limit.

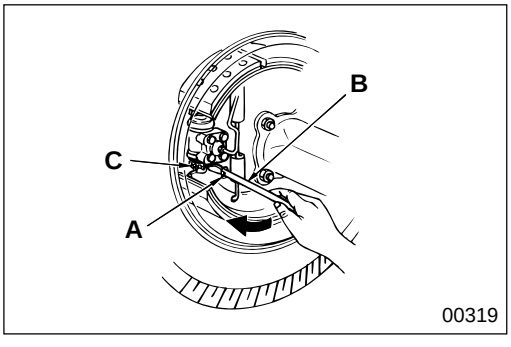
Tightening torque

Unit : N·m {lbf.ft, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Pipe clamp mounting)	4.9±1.0 {3.6±0.7, 0.5±0.1}	—
2	Flair nut (Pipe assembly mounting)	14±2.0 {10±1.4, 1.4±0.2}	—
11	Bolt (Wheel cylinder assembly mounting)	78±16 {58±12, 8.0±1.6}	—
16	Nut (Holder pin mounting)	29±5.9 {22±4.3, 3,0±0.6}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
6, 7, 12	Contact areas between washer and brake shoe assembly; and between brake shoe assembly and wheel cylinder assembly	Wheel bearing grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● Initial adjustment of brake shoe clearance after installation

- Jack up the front wheels, and make sure that there is no play in the hub bearings.
- Insert screwdriver **B** into adjusting hole **A** and turn adjuster **C** in the direction of the arrow marked on the back plate until the wheel drags slightly when turned by hand.

NOTE

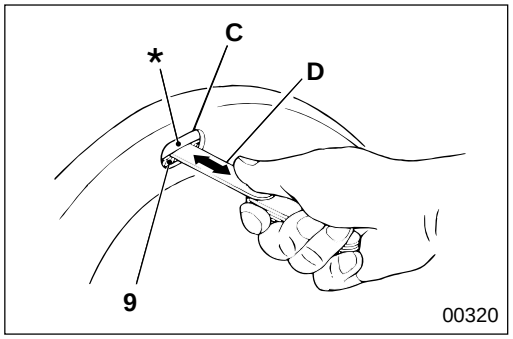
- **Be sure to adjust the clearance at two points for each wheel per side.**
- **The arrow mark on backing plate 18 is near adjusting hole A.**

- After depressing the brake pedal several times, release it and make sure that the wheel drags lightly when turned by hand. If the wheel turns without stress, repeat the above steps. Slacken off adjuster **B**, in the reverse direction to the arrow mark, by eight or nine notches.

NOTE

Be sure to adjust the clearance at two points for each wheel per side.

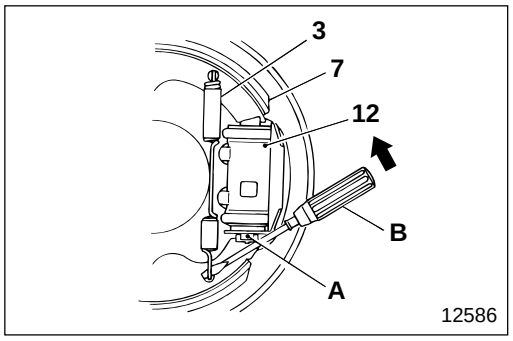
- Make sure that the wheel does not drag when turned by hand. If the wheel drags, repeat the above steps.



- Insert feeler gauge **D** between brake drum ***** and lining **9** through check hole **C**, and make sure that a little resistance is felt when the feeler gauge is pulled out or pushed in.

NOTE

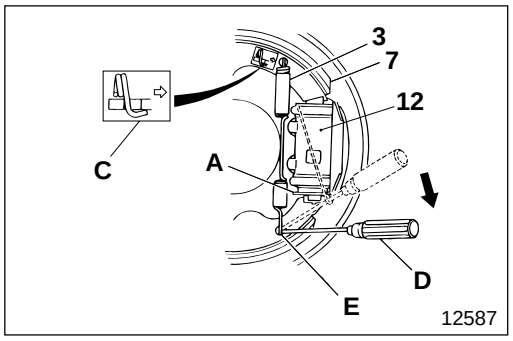
Be sure to adjust the clearance at two points for each wheel per side.



3 Return Spring

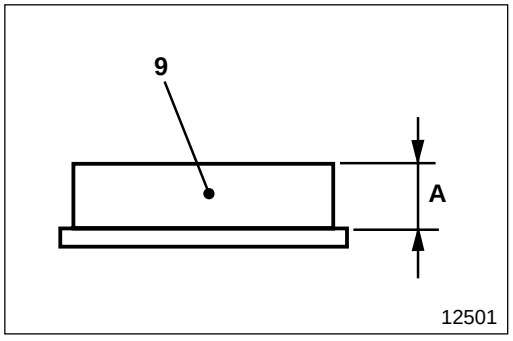
[Removal]

To remove return spring **3**, place screwdriver **B** on the hook of the return spring, then pry and remove the return spring making use of wheel cylinder assembly **12** adjuster **A** as a fulcrum.



[Installation]

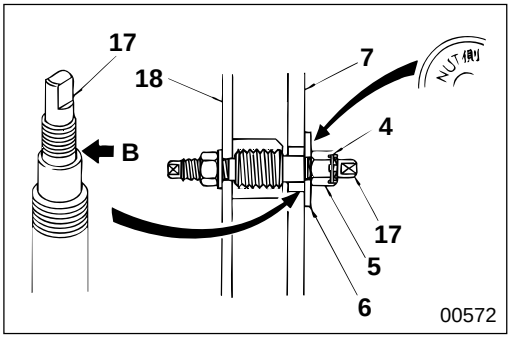
- Refer to the illustration on the caution plate fitted to brake shoe assembly **7** or marking **C**, and connect shorter hook end of return spring **3** to the brake shoe assembly at the side opposite the adjuster of wheel cylinder assembly **12**.
- Insert a small Phillips screwdriver **D** into the hook of return spring **3**, insert the tip of the screwdriver into return spring installation hole **E** of brake shoe assembly **7** to pry on the return spring.



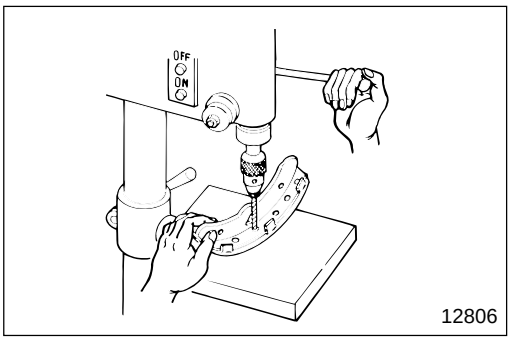
7 Brake shoe assembly

[Inspection]

If thickness **A** of brake lining **9** is lower than the limit replace the brake lining on the same axle as a unit.

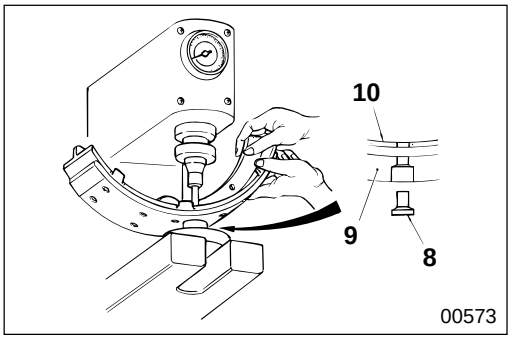


[Installation]
- Install brake shoe assembly **7**.
- Insert washer **6** with the side stamped “NUT 側” facing outside, screw down holder pin nut **5** until washer hits stepped area **B** of holder pin **17** gently, then slacken off the nut within the 0 to 60° limit until the nut is aligned with the first split pin hole.
- Insert split pin **4**, and bend it securely.



9 Brake lining

[Removal]



[Installation]
- Clean the mounting surfaces of brake lining **9** and brake shoe **10** with cleaning fluid and dry them.
- Insert rivets **8** from brake lining **9** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **10** and the brake lining.

  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

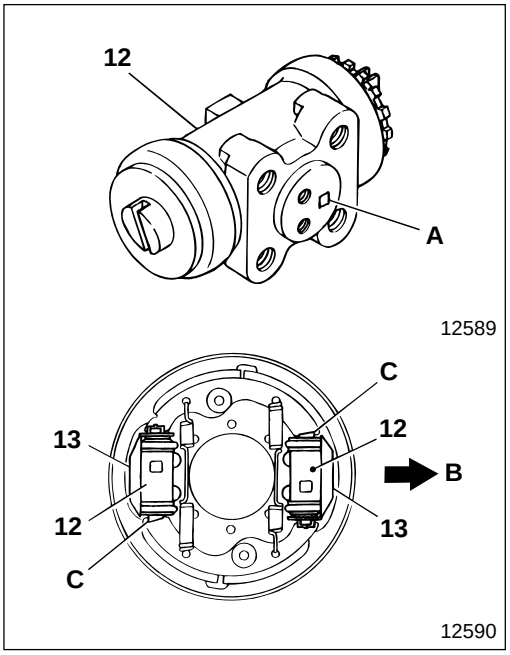
- Make sure that you inspect contact with the inner surface of brake drum ***** after you replace brake linings **9**. If contact is incorrect, correct with the brake assembled.

WARNING⚠

Do not leave lubricant on the surface of brake lining 9 because this reduces braking performance.

CAUTION⚠

Make sure that the type of brake linings 9 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.

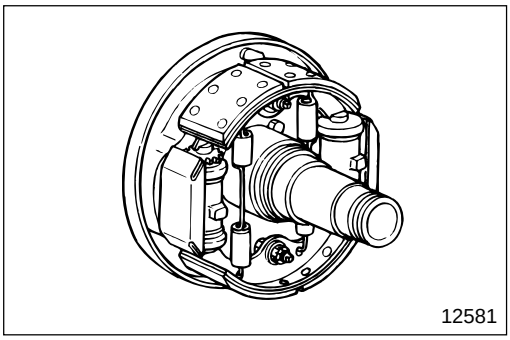


12 **Installation of wheel cylinder assembly**

A : Identification mark

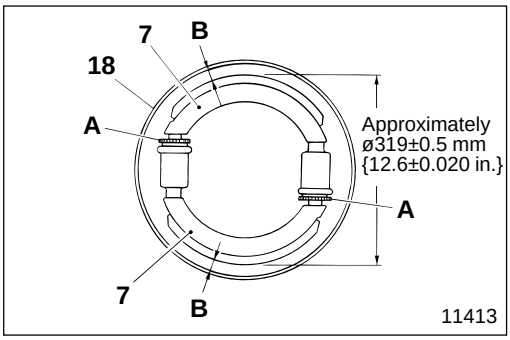
Identification mark	Installation position
R	Right wheel forward
L	Left wheel forward
No mark	Left and right wheel rearward

- Install anchor piece **C** so its recession is at the deeper side of the brake shoe at the outside.
  B : Front of the vehicle

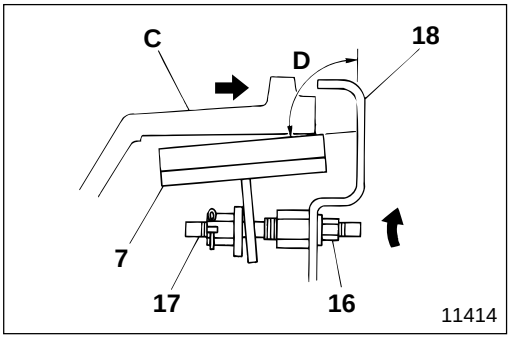


17 **Adjustment of holder pin**

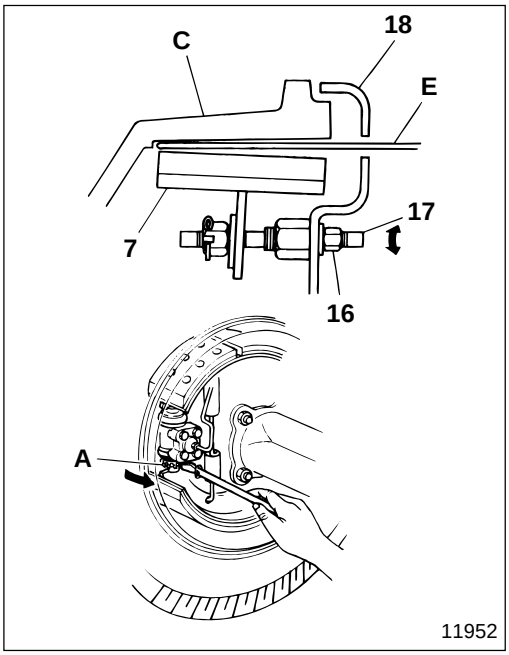
- Install the rear wheel brake assembly on the rear axle. Gr 27



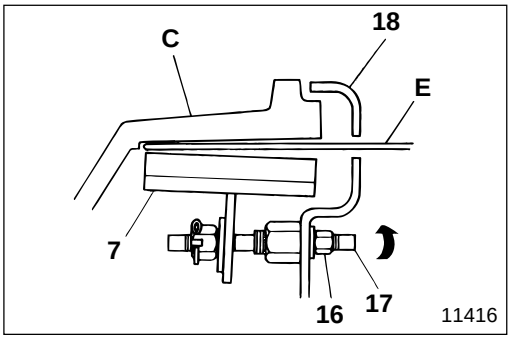
- Turn adjuster **A** to adjust the outer diameter to approximately ø319±0.5 mm {12.6±0.020 in.}.
- Then, move brake shoe assembly **7** to adjust clearance **B** evenly.



- Install hub and drum assembly **C** on the rear wheel brake assembly. Gr 27
  At this time, the hub and drum assembly cannot be inserted in the specified position if squareness **D** is 90° or more, so loosen nut **16** and turn holder pin **17** to adjust the squareness to as close to 90° as possible.
- Bleed the brake system. P35A-30



★ • Turn adjuster **A** to widen brake shoe assembly **7** until 0.2 mm {0.0079 in.} feeler gauge **E** cannot be pulled out easily.
★ • Loosen nut **16** and turn holder pin **17** to the right or left so that feeler gauge **E** can be pushed in or pulled out easily.
- Repeat the above steps (marked ★) until feeler gauge **E** cannot be pushed in or pulled out easily.
- Depress the brake pedal a few times lightly to equalize clearance **B** (adjusted in the previous section).
- Repeat the above steps (marked ★) until feeler gauge **E** cannot be pushed in or pulled out easily.



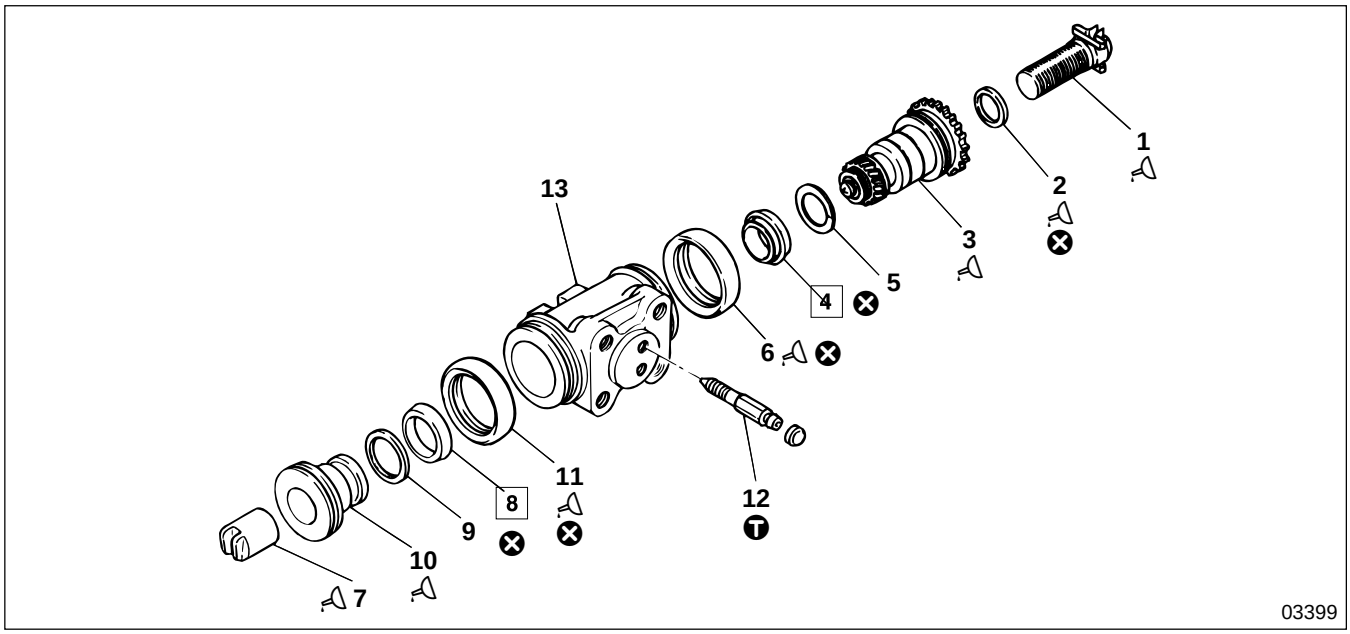
- If feeler gauge **E** cannot be pushed in or pulled out easily it is because it is making contact over the full width of brake shoe assembly **7**.
- Turn holder pin **17** so that when you pull out feeler gauge **E**, in the above condition, and reinsert the feeler gauge, pushing in or pulling out the feeler gauge at the rear is difficult.
- After adjustment, tighten nut **16** at specified torque.

✱ Correction of brake drum

If the cylindrical accuracy of brake drum ✱ is higher than the limit, or there are seams, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

REAR WHEEL BRAKE

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Screw
2 Seal
3 Piston
4 Piston cup
5 Backup ring
6 Boot
7 Anchor piece
8 Piston cup
9 Backup ring
10 Piston
11 Boot
12 Air bleeder
(Only identification marks L, R)
13 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3, 10, 13	Clearance between piston and body	[36.51] 0.03 to 0.09 {[1.44] 0.0012 to 0.0035}	0.2 {0.0079}	Replace piston

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

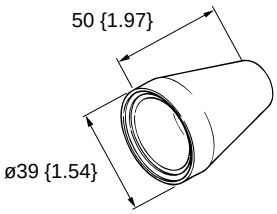
Location	Parts to be tightened	Tightening torque	Remarks
12	Air bleeder	9.8±2.0 {7.2±1.4, 1.0±0.2}	—

Lubricant

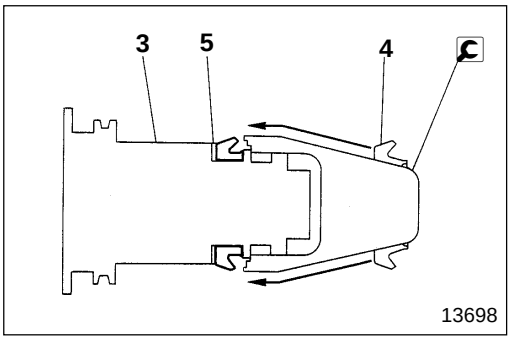
Location	Points of application	Specified lubricant	Quantity
1, 2, 3, 6, 10, 11	Thread area of screw, outer periphery of seal, outer periphery of piston, mounting groove and thread area of boot, and inner surface of body	Rubber grease	As required
7	Bottom surface of anchor piece	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

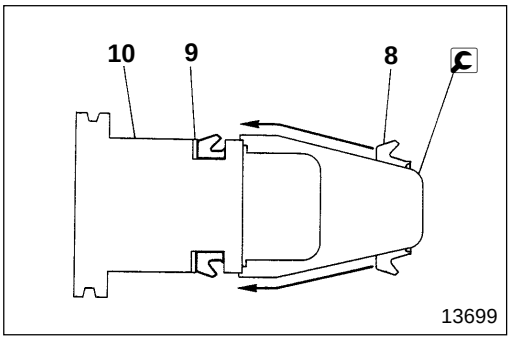
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4, 8	Piston cup guide 	MC895722	Installation of piston cup

◆ Service procedure

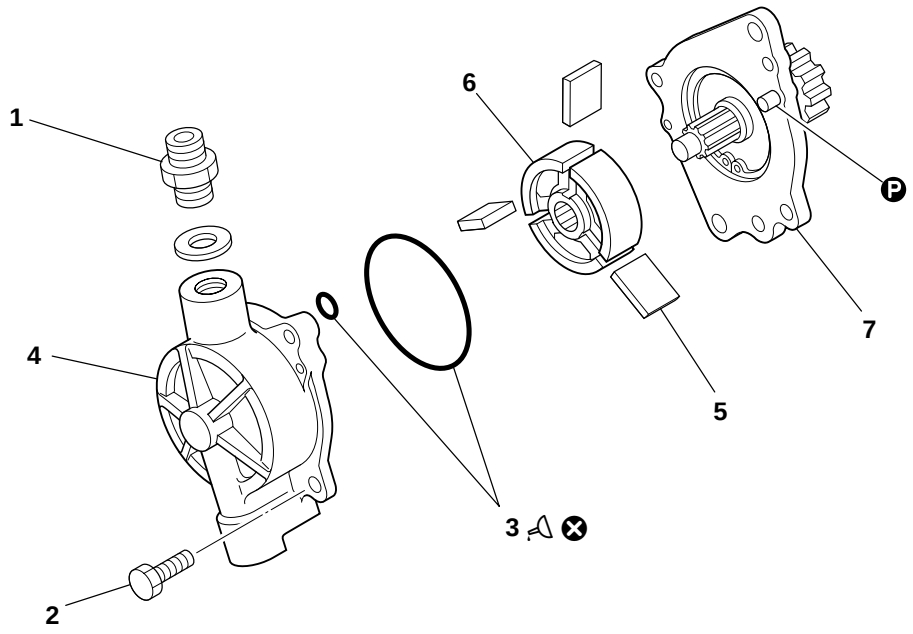


4 **Installation of piston cup**



8 **Installation of piston cup**

VACUUM PUMP < FH210 >



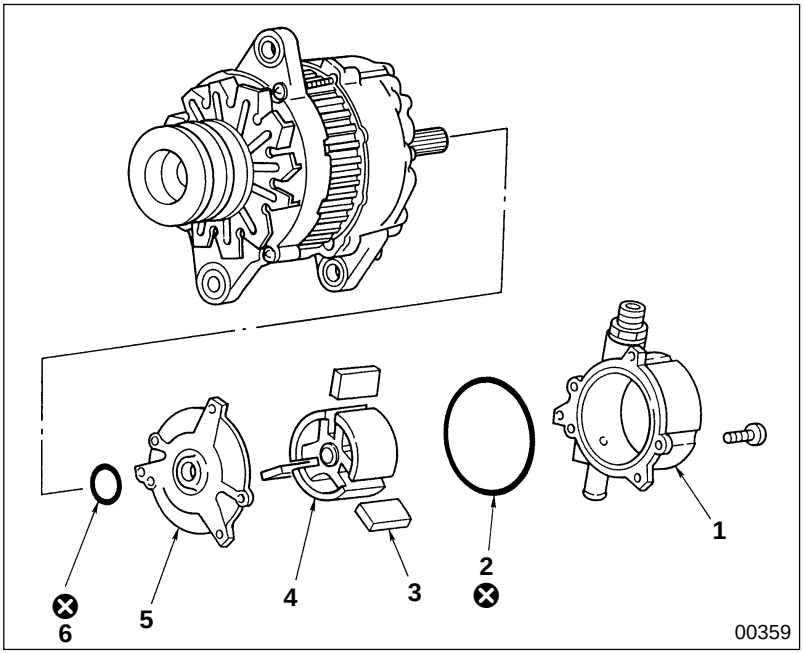
● **Disassembly sequence**

1 Check valve
2 Bolt
3 O-ring
4 Cylinder
5 Vane
6 Rotor
7 Flange

Ⓟ : Positioning pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Disassembly and reassembly of vacuum pump Gr 11A



● **Disassembly sequence**

1 Vacuum housing
2 O-ring
3 Vane
4 Rotor
5 Plate
6 O-ring

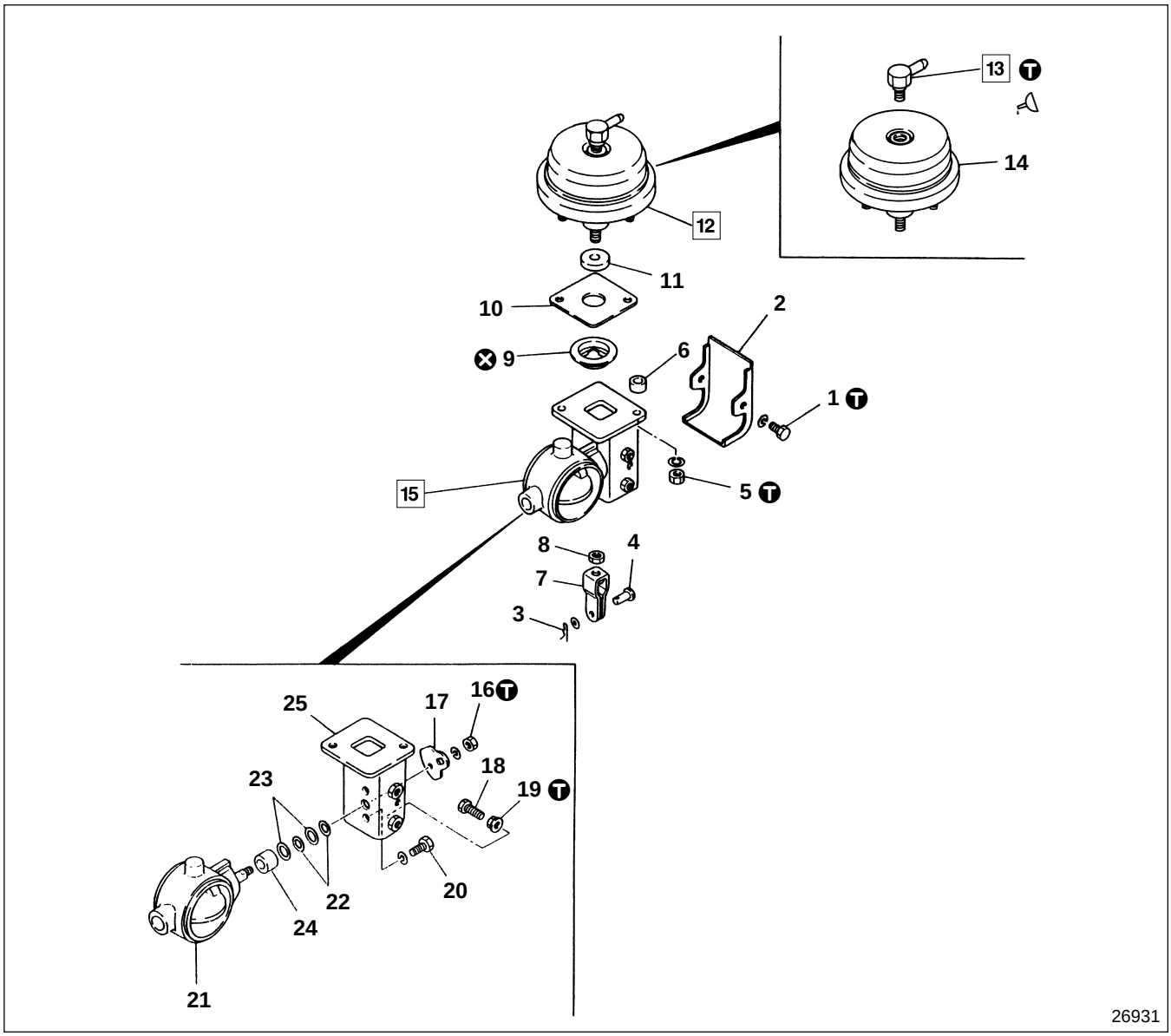
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

EXHAUST BRAKE SYSTEM

Exhaust Brake Unit



● **Disassembly sequence**

1 Bolt
2 Cover
3 Pin
4 Clevis pin
5 Nut
6 Collar
7 Clevis
8 Lock nut
9 Dust protector
10 Retainer
11 Bearing
12 Vacuum chamber assembly
13 Connector
14 Vacuum chamber 🕮 P35A-66
15 Valve and bracket assembly
16 Nut
17 Lever
18 Adjusting bolt
19 Lock nut
20 Bolt
21 Valve assembly
22 Seal ring (Small)
23 Seal ring (Large)
24 Bushing
25 Bracket assembly

⊗ : Non-reusable parts

● **Assembly sequence**

12 : **14→13**

15 : **21→24→23→22** (**25**) **→20→19→18→17→16**

15→ 9 / **12→11→10→6** **→5→8→7→4→3→2→1**

● **Adjustment after assembly**

P35A-64

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
12	Airtightness in vacuum chamber (Airtightness 15 seconds after applying negative pressure 67 kPa {19.7 in.Hg, 500 mmHg})	63 kPa {18.7 in.Hg, 475 mmHg} or more	—	Replace
—	Clearance between valve assembly butterfly valve and body when butterfly valve is fully closed (Degree of negative pressure in power chamber 87 to 93 kPa {25.6 to 27.6 in.Hg, 650 to 700 mmHg})	0.4 to 0.6 {0.016 to 0.023}	—	Adjust

Tightening torque

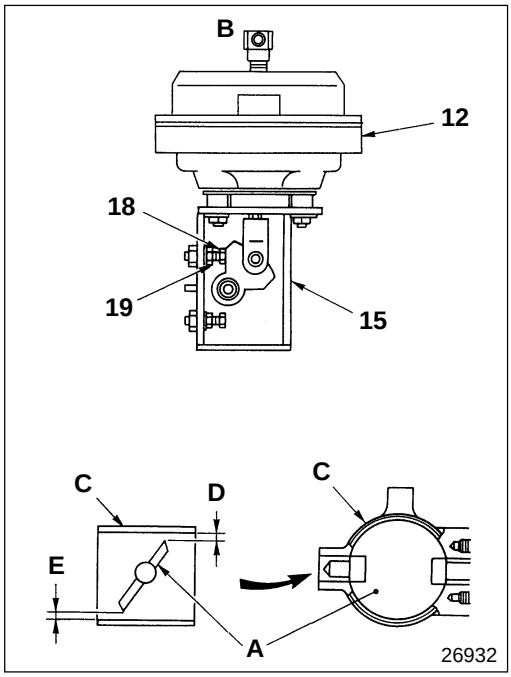
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Cover mounting)	4.9 to 6.9 {3.6 to 5.0, 0.5 to 0.7}	—
5, 16	Nut (Vacuum chamber and lever mounting)	9.8 to 16 {7.3 to 11.5, 1.0 to 1.6}	—
13	Connector	9.8 {7.3, 1} or more	—
19	Lock nut (Adjusting bolt mounting)	4.9 to 6.9 {3.6 to 5.0, 0.5 to 0.7}	—

Sealant

Location	Points of application	Specified sealant	Quantity
13	Thread area of connector	THREEBOND 1211	As required

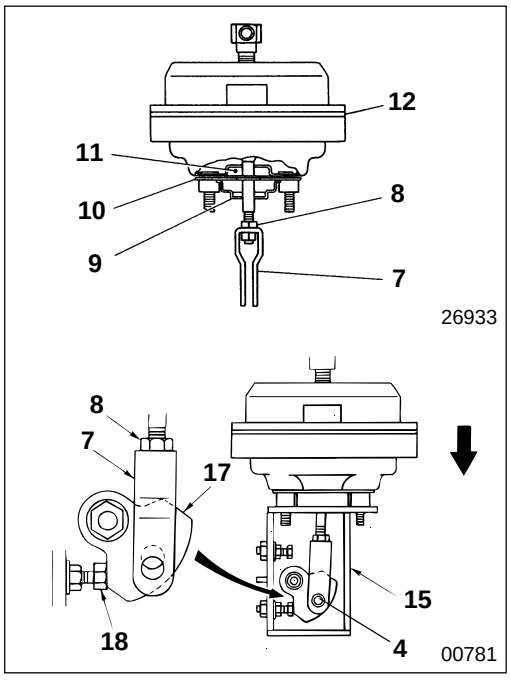
◆ Service procedure



● **Adjustment after assembly**

Adjustment of valve when fully-closed

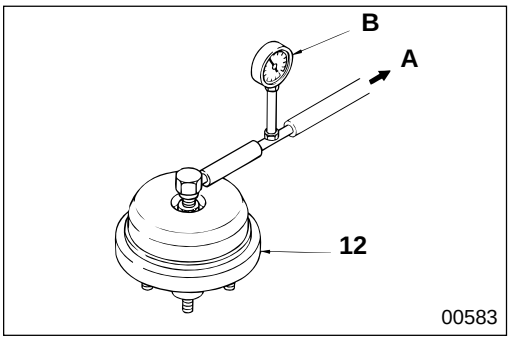
- While applying negative pressure **B** of 87 to 93 kPa {25.6 to 27.5 in.Hg, 650 to 700 mmHg} to vacuum chamber assembly **12**, adjust by turning adjusting bolt **18** so that clearance **D** and **E** between the butterfly valve and body **C** conforms to the standard value.
- After adjustment, tighten lock nut **19** at specified torque.
- Average value of clearance **D, E** = (**D + E**)/2.
- Fully-opened adjustment of butterfly valve **A** is done while valve and bracket assembly **15** is installed.



12 **Vacuum chamber assembly**

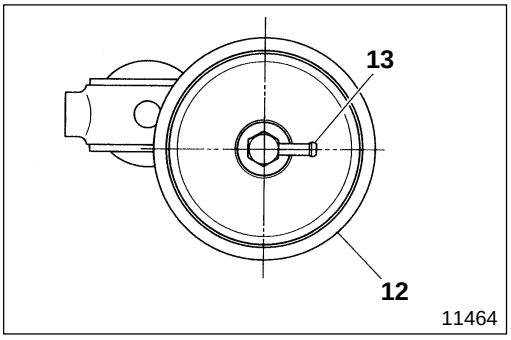
[Installation]

- Adjust valve and bracket assembly **15**. 🕮 P35A-65
- Adjust the hole of clevis **7** to position as illustrated.
- Fix clevis **7** using lock nut **8**.
- Push up and align clevis **7** with the hole of lever **17** and install using clevis pin **4**.

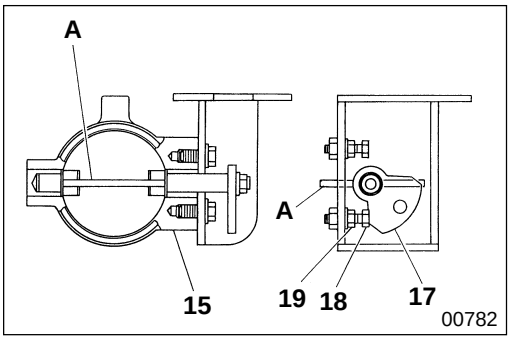


[Inspection]

Apply negative pressure **A** of 67 kPa {19.6 in.Hg, 500 mmHg} or more to vacuum chamber assembly **12**. Check to ensure that the value of negative pressure gauge **B** 15 seconds after indicating 67 kPa {19.6 in.Hg, 500 mmHg} conforms to the standard value.



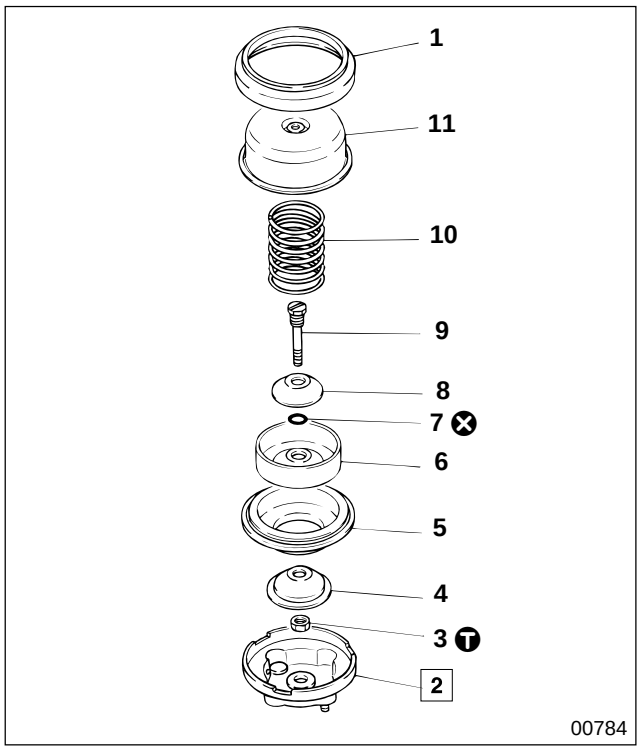
13 Installation of connector



15 Adjustment of valve and bracket assembly butterfly valve when fully-opened

- Adjust by turning adjusting bolt **18** so that lever **17** and the head of the adjusting bolt meet horizontally (butterfly valve **A** is fully opened at such time).
- After adjustment, tighten lock nut **19** at specified torque.

Vacuum Chamber



● **Disassembly sequence**

1 Dust cover
2 Rear shell
3 Nut
4 Diaphragm retainer
5 Diaphragm
6 Diaphragm plate
7 O-ring
8 Piston washer
9 Push rod
10 Spring
11 Front shell

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

P35A-67

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (Push rod mounting)	44 to 59 {32.6 to 43.3, 4.5 to 6}	—

Special tools

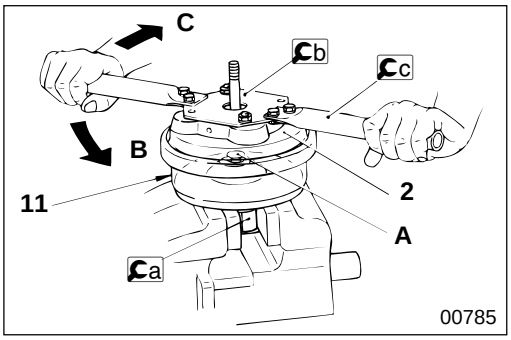
Location	Tool name and shape	Part No.	Application
2	Plate	*910-22060	Removal and installation of rear shell
	Lever	*910-22100	
11	Socket	*910-22110	Fixing of front shell

* : BOSCH BRAKING SYSTEMS part No.

◆ Service procedure

● **Inspection after assembly**

- Inspect the airtightness of the vacuum chamber assembly.
  📖 P35A-65
- If the measured value is higher than the limit, replace the vacuum chamber assembly.



2 **Rear shell**

[Removal]

- Fix a socket in a vice.
- Fix nut **A** of front shell **11** using a socket.
- Assemble b plate and c lever and install on rear shell **2**. Turn c lever in direction **B**.

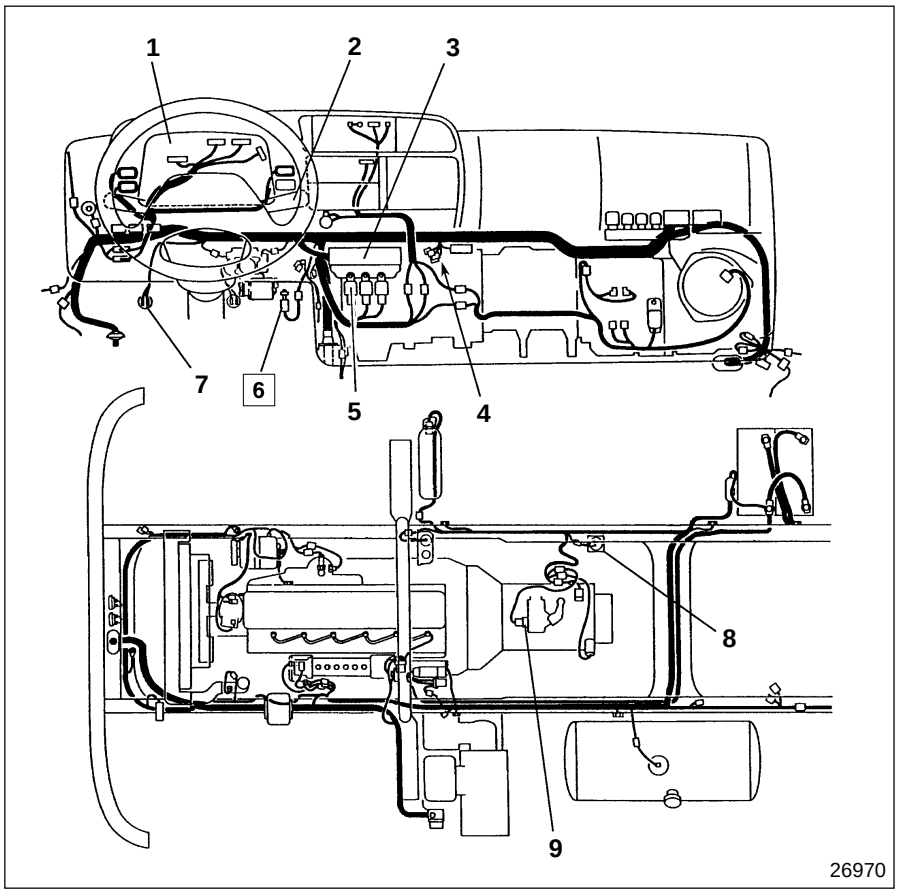
[Installation]

Set up as described above and turn c lever in direction **C**.

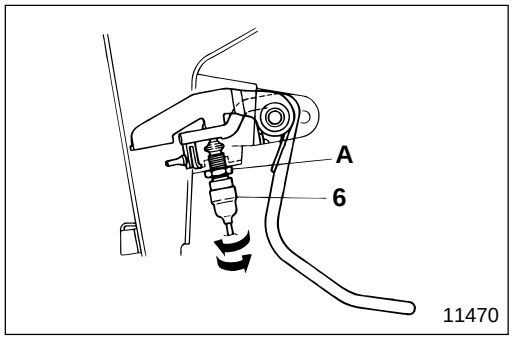
- After making sure the flange area of diaphragm **5** is fully inserted inside front shell **11**, turn rear shell **2**.

EXHAUST BRAKE SYSTEM

Exhaust Brake System Electric Equipment



1 Meter cluster
Gr 54
2 Exhaust brake switch
Gr 37, Gr 54
3 Fuse box
Gr 54
4 Diode
5 Exhaust brake cut relay
Gr 54
6 Accelerator switch
Gr 13, Gr 54
7 Clutch switch
Gr 21, Gr 54
8 3-way magnetic valve
Gr 54
9 Transmission neutral switch
Gr 22, Gr 54



◆ Service procedure

6 **Adjustment of accelerator switch**

- While the engine is idling, turn exhaust brake switch **2** ON, depress the accelerator gradually, and check the engine revolution when the exhaust indicator lamp within the meter cluster goes off.
- Adjust on the basis of the following chart using accelerator switch **6**.

Engine revolution	Adjusting direction of accelerator switch 6
800 rpm or less	↷
950 rpm or more	↶

- After adjustment, tighten nut **A** to fix accelerator switch **6**.

MITSUBISHI
FUSO

Group 35E

Anti-Lock Brake System (ABS)

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-35E

INDEX

SPECIFICATIONS 35E- 2

STRUCTURE AND OPERATION 35E- 2

ON-VEHICLE INSPECTION AND ADJUSTMENT

- **Periodic Inspection Procedures 35E-15**
- **Adjustment of Wheel Speed Sensor Clearance 35E-16**
- **Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope 35E-17**
- **Hydraulic Unit Operation Check 35E-18**

TROUBLESHOOTING

- **Troubleshooting Procedures 35E-20**
- **Diagnosis Code Indication 35E-21**
- **Diagnosis Code Chart 35E-24**
- **Actuator Drive Chart 35E-25**
- **Service Data 35E-25**

ELECTRIC CIRCUIT AND PART INSTALLATION LOCATIONS 35E-28

SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item	Specifications
Brake system	Hydraulic booster
Number of sensors/number of channels	4S/4K
Manufacturer	NIPPON ABS

STRUCTURE AND OPERATION
Anti-lock Brake System (ABS)

The anti-lock brake system (ABS) prevents tire slippage due to wheel lockup caused by sudden braking and braking on slippery road surfaces. The anti-lock brake system provides a driver with vehicle controllability and directional stability in braking.

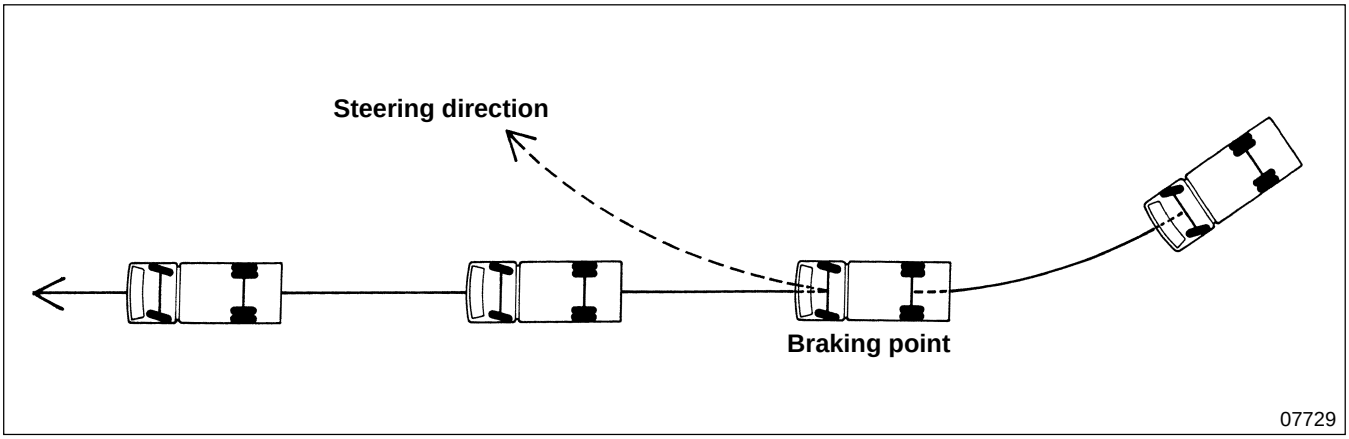
● Wheel lockup

Rotating tires of a moving vehicle have a tendency to continue traveling in the direction of tire rotation. Because of this characteristic, a driver can control the vehicle's traveling direction by moving the front wheels to a desired direction using the steering wheel.

In a vehicle not equipped with an anti-lock brake system, when a driver depresses the brake pedal with full force, the wheels can lock up under certain conditions. Tires in a wheel lockup condition lose the tendency to maintain directional characteristic, and the vehicle starts sliding in a direction of an externally applied force regardless of the tire direction. In other words, when wheel lockup occurs, the vehicle loses its directional stability, disallowing the driver to control the vehicle's movement.

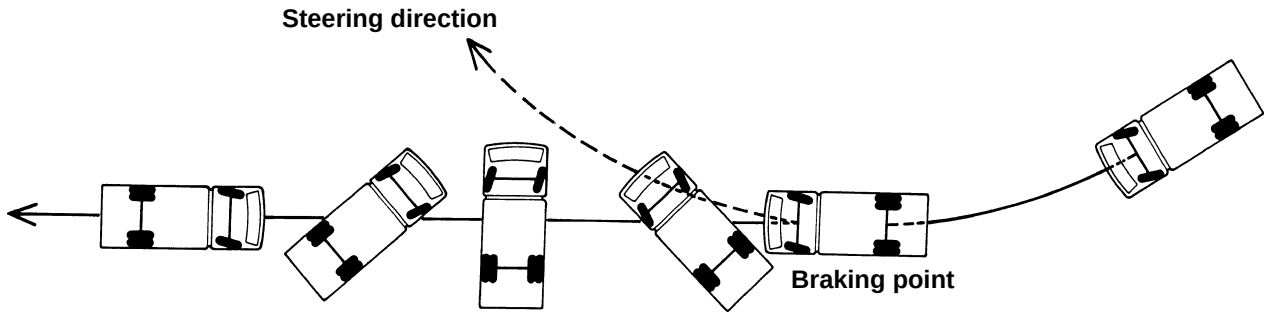
The following shows how a vehicle without anti-lock brake system loses its directional stability when different tires lock up on slippery road surfaces.

● Front wheel lockup (both front tires)



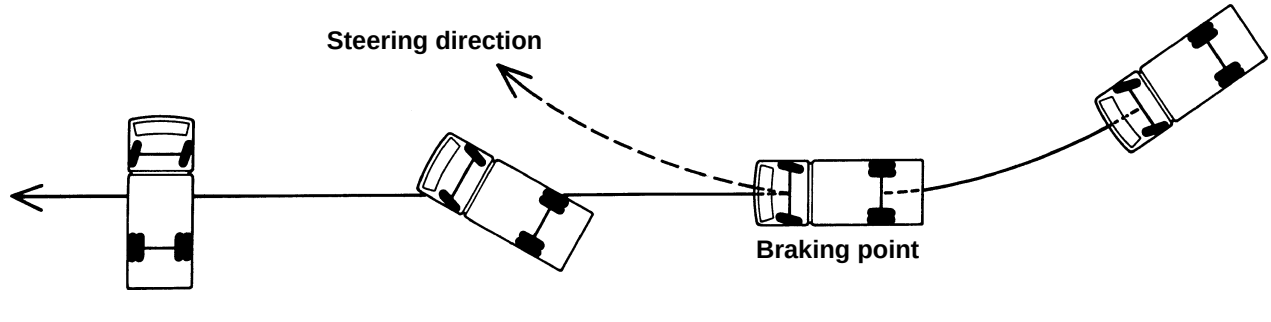
The front tires lose directional stability, but the rear tires try to travel in the direction of rotation since they are not locked up. Because of the front wheel lockup, a steering wheel operation does not change the vehicle's moving direction.

● **Rear wheel lockup (both rear tires)**



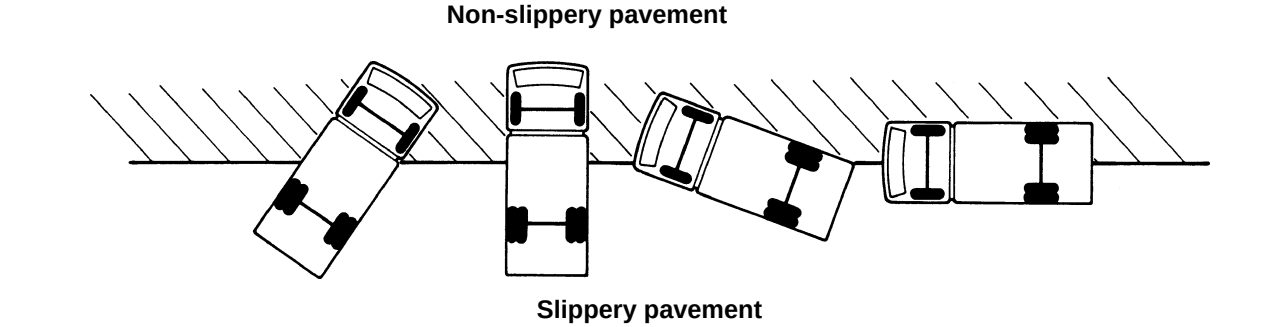
When the steering wheel is operated with the rear wheels in a lockup condition, the front tires try to change the vehicle's traveling direction, but the rear tires slide sideways, causing the vehicle to spin. If wheel lockup occurs in a vehicle traveling in a straight direction, the force of inertia continues to push the vehicle straight ahead from the back of the vehicle due to the lack of stopping force in the rear tires, and the vehicle can spin.

● **All wheel lock up (front and rear tires)**



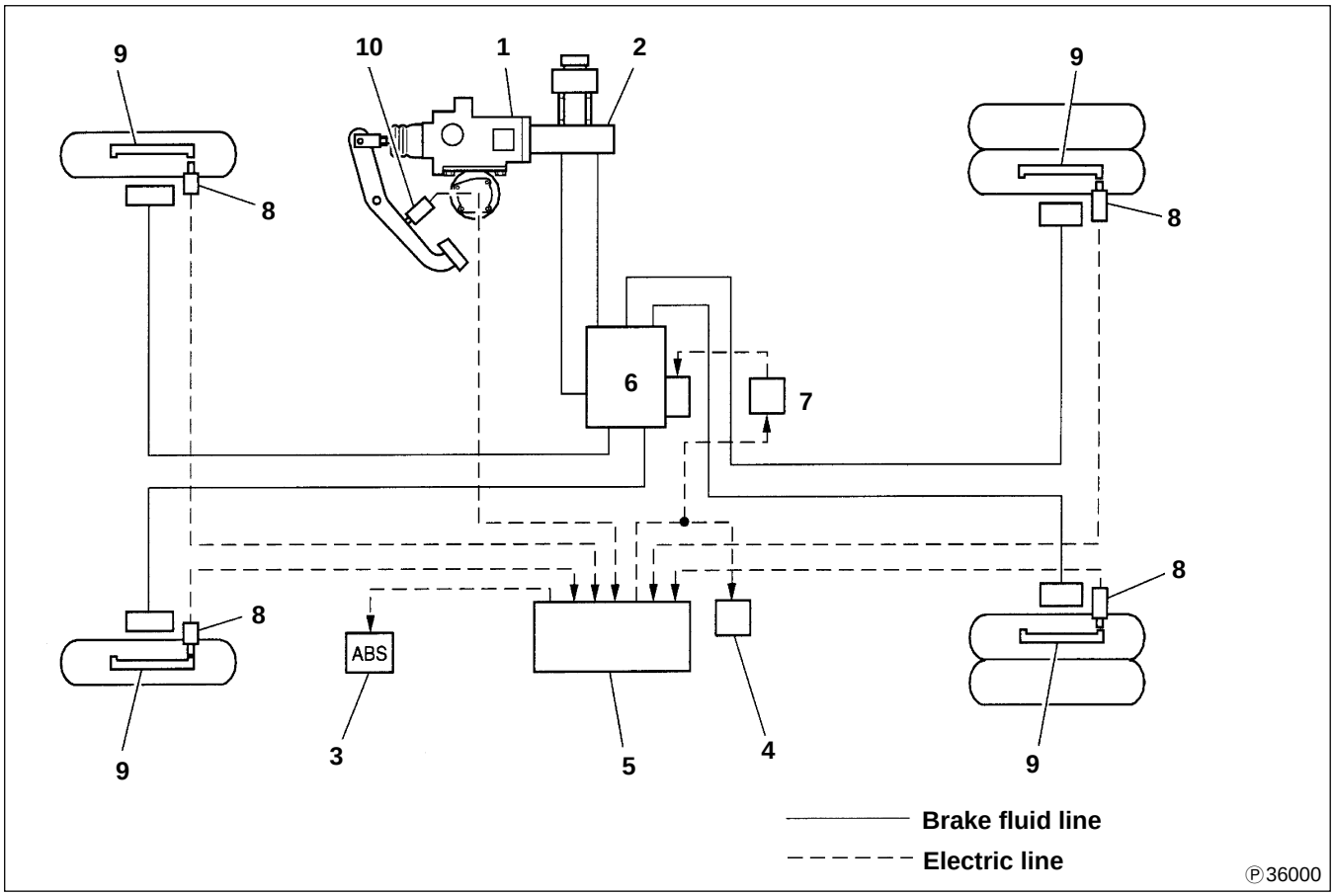
When wheel lockup occurs in both front and rear tires, all four tires lose directional stability. Therefore, the vehicle slips in the direction of inertia regardless of the steering direction.

● **Wheel lockup on surfaces with split μ factors (road surface with different friction coefficients for right and left tires)**



The tires on a surface with a lower friction coefficient lock up first. The tires in a lockup condition start sliding, thus failing to provide effective stopping force. Due to this imbalance in the stopping power between the right and left tires, one side of the vehicle slows down while the other side continues traveling, thus resulting in the loss of directional stability. When this happens during sudden braking, the vehicle spins.

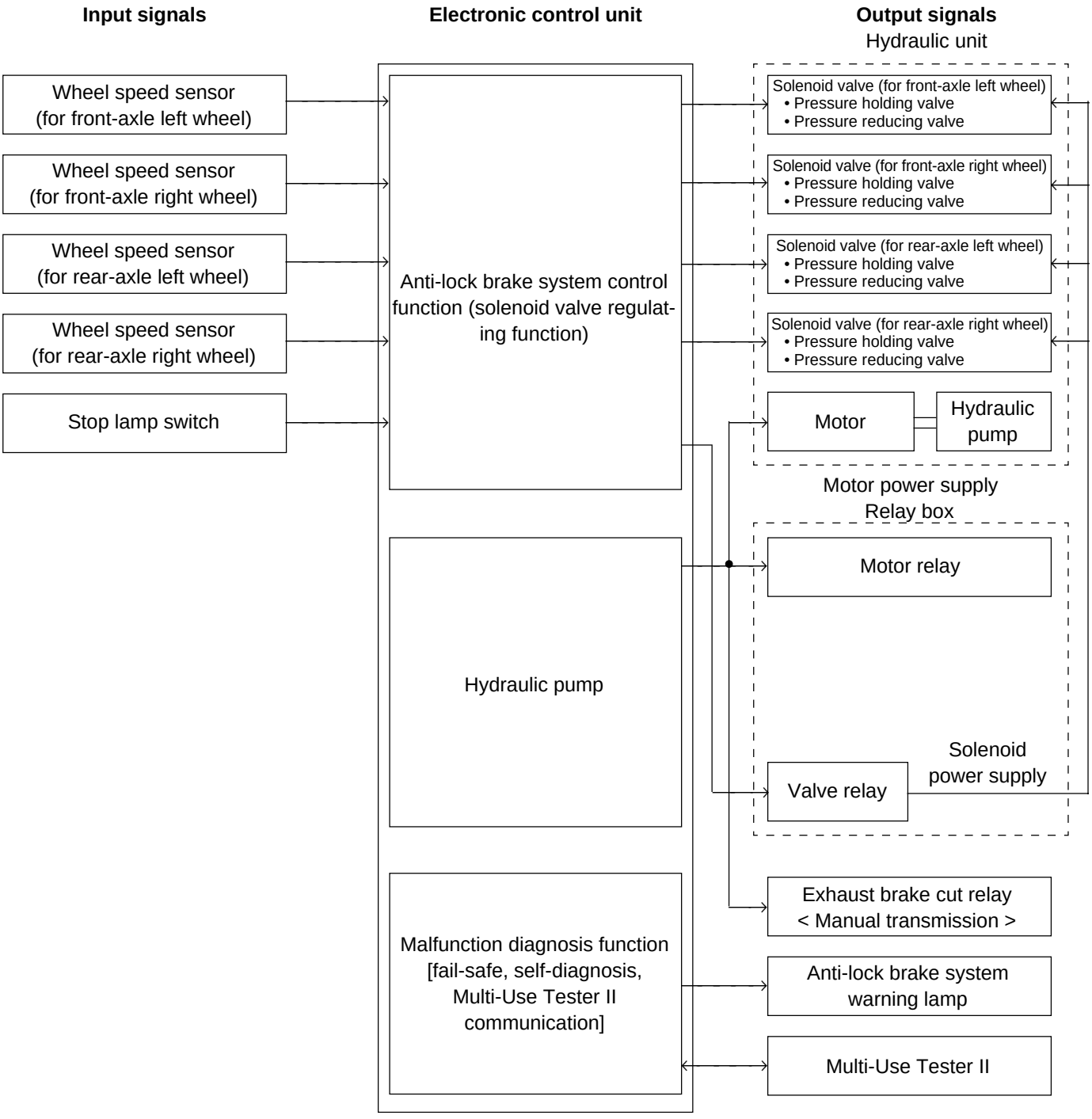
Structure of Anti-lock Brake System



1 Hydraulic booster
2 Brake master cylinder
3 Anti-lock brake system warning lamp
4 Exhaust brake cut relay
< Manual transmission >
5 Electronic control unit
6 Hydraulic unit
7 Relay box
8 Wheel speed sensor
9 Rotor
10 Stop lamp switch

The anti-lock brake system uses wheel speed sensors **8** and electronic control unit **5** to monitor the rotating speed of each wheel. When the wheel speed exceeds the preset deceleration speed or slip rate, the electronic control unit detects it as a tendency leading to wheel lockup, and sends control signals to hydraulic unit **6** and relay box **7**. The signals activate the solenoid valves to reduce the brake fluid pressure in the wheel brakes and ease the braking force to prevent wheel lockup. Then, when the wheel speed increases, wheel speed sensors **8** send signals to the solenoid valves in hydraulic unit **6** by way of electronic control unit **5** to increase the brake fluid pressure in the wheel brakes to augment the braking force. This control cycle is repeated to prevent wheel lockup on slippery pavements and ensure the vehicle's directional stability during braking. The 4-sensor 4-channel anti-lock brake system uses four wheel speed sensors **8**, which are located at the front and rear wheels, to control each of the four wheels.

● **Anti-lock brake system function**

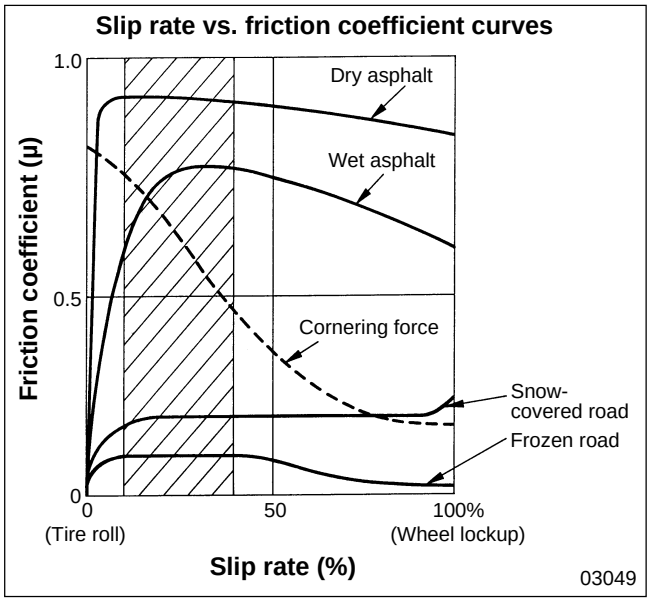


● **Anti-lock brake system control function**

To provide optimum stopping power, the anti-lock brake system controls the braking force based on the slip rate determined by the relationship between the wheel speed and the vehicle speed. When the brake is applied, the resulting force slows down the wheel rotation, thus reducing the vehicle speed. However, inertia acts on the vehicle and tries to maintain the vehicle's forward movement despite the stopping force applied by the tires. When there is a difference between the wheel speed and vehicle speed, slipping occurs. The degree of slippage is expressed by a slip rate.

$$\text{Slip rate (\%)} = \frac{\text{Vehicle speed} - \text{Wheel speed}}{\text{Vehicle speed}} \times 100$$

When the slip rate is 0%, there is no slippage between the tires and pavement. The slip rate of 100% refers to a wheel lockup condition.



The graph shows the time-based changes in the friction coefficient of a rolling tire during the process of wheel lockup. When the brake is applied gradually while the tires are rotating on pavement, the tires begin to slip while in rotation.

When the brake is applied harder, the tires stop rotating and start to slide on the pavement. This condition is called wheel lockup.

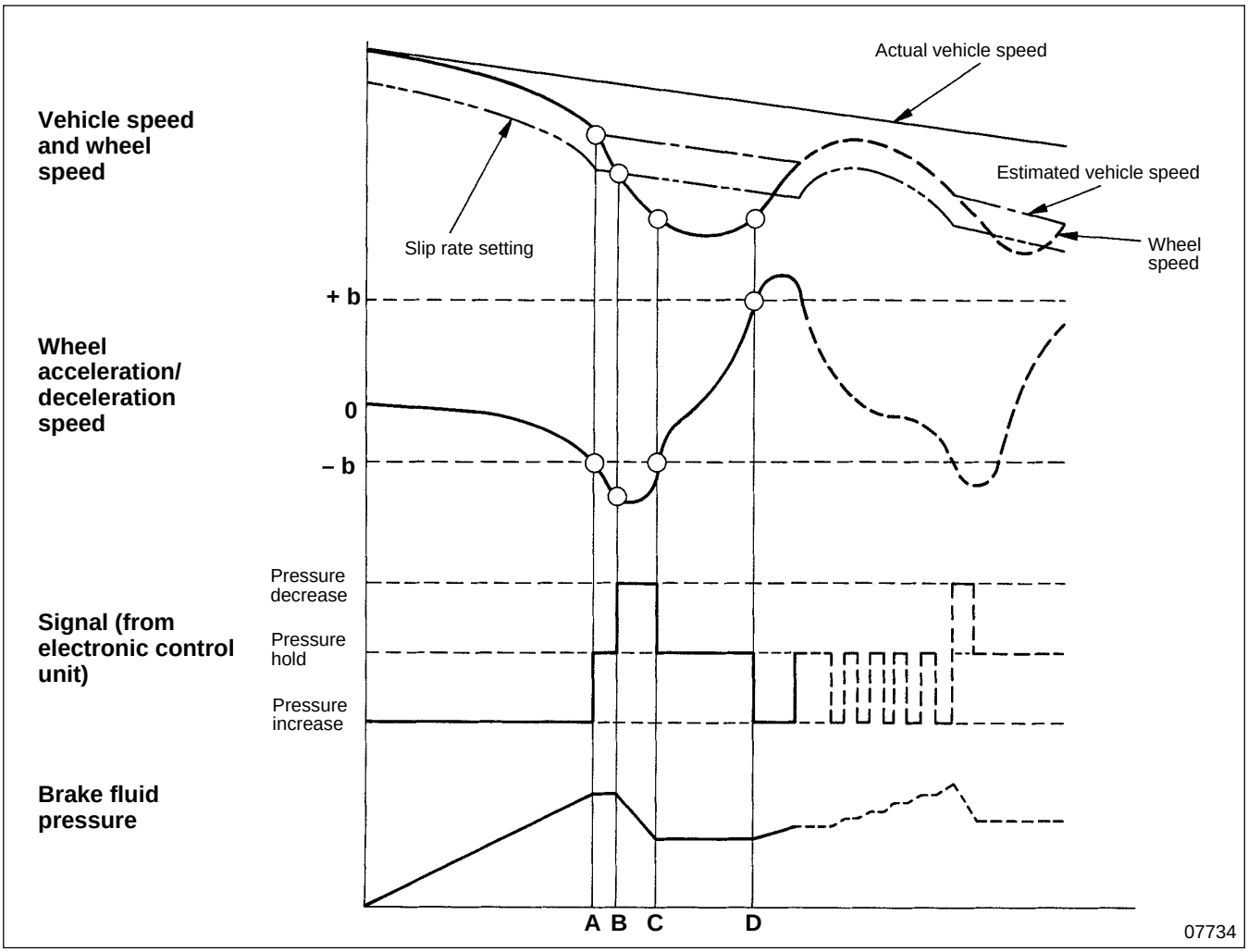
The friction coefficient is highest when the slip rate is within the shaded area on the graph.

In other words, tires provide maximum friction when the braking force is appropriately controlled to maintain the slip rate in the range indicated by the shaded area on the graph, rather than when the brake is applied at full force.

In a vehicle equipped with anti-lock brake system, the electronic control unit and hydraulic unit adjust the braking force and maintain it within the shaded area on the graph where the friction coefficient is high, thus preventing tire slippage and ensuring braking stability.

Anti-lock Brake System Operation

● **Anti-lock brake system control characteristic curve**



The above anti-lock brake system control characteristic graph shows the time-based changes in vehicle speed, wheel acceleration/deceleration speed and brake fluid pressure level during braking.

- When the wheel deceleration speed exceeds the speed setting **– b** at point **A**, the electronic control unit sends a signal to maintain the brake fluid pressure at the same level.
  At the same time, the electronic control unit estimates the vehicle speed according to a programmed calculation method.
- When the vehicle speed decreases further and the slip rate exceeds the setting at point **B**, the electronic control unit detects it as a tendency leading to wheel lockup, and sends a signal to reduce the brake fluid pressure.
- When the wheel speed increases because of the reduced brake fluid pressure and the wheel speed exceeds the setting **– b** at point **C**, the electronic control unit sends a signal to maintain the brake fluid pressure at the same level.
- When the wheel speed increases further and the wheel speed exceeds the setting **+ b** at point **D**, the electronic control unit determines that there is no risk of wheel lockup and sends a signal to increase the brake fluid pressure.

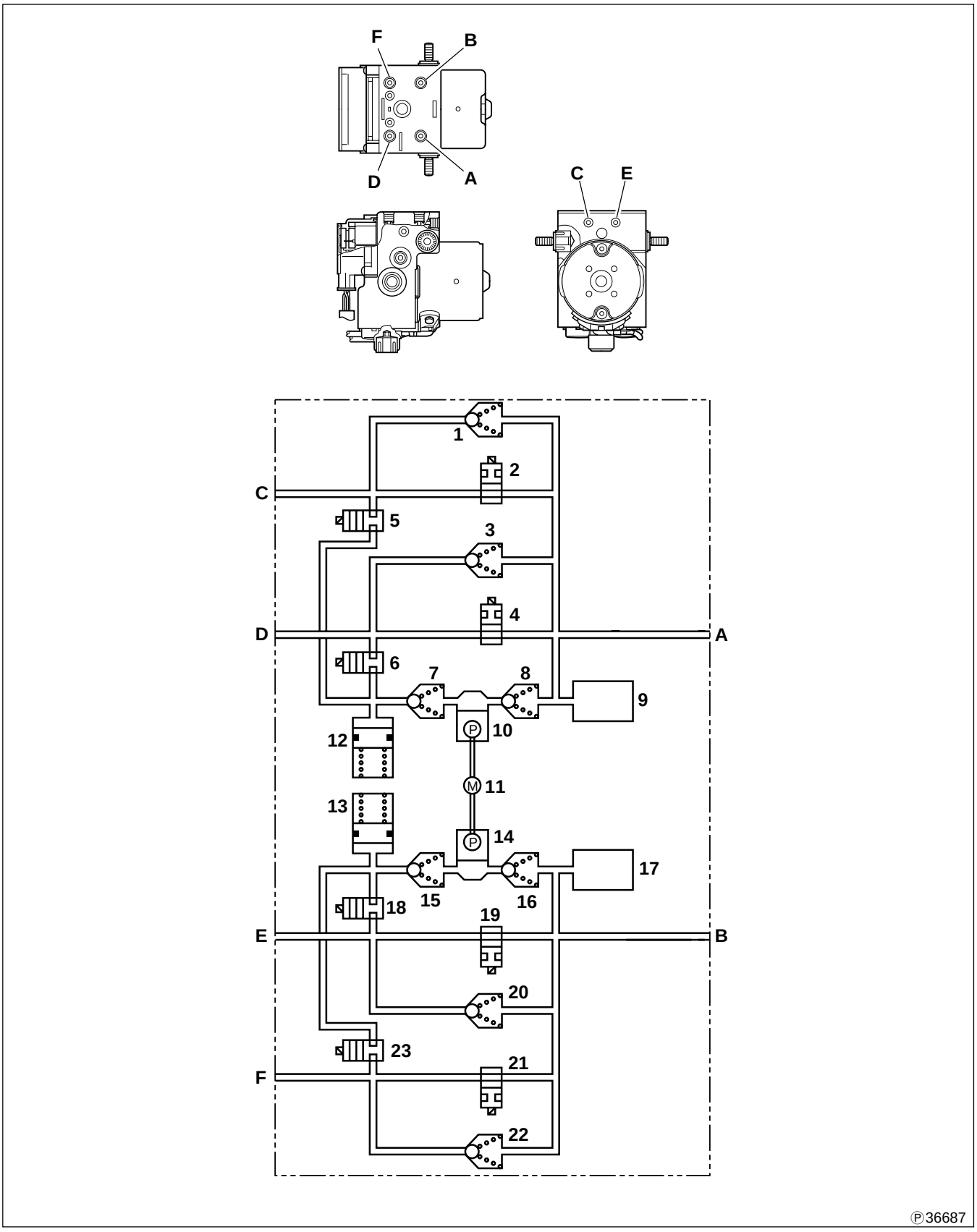
By repeating the above control cycle, the anti-lock brake system prevents wheel lockup and provides maximum friction between the tires and pavement to ensure high stability during braking.

● **Anti-lock brake system and exhaust brake system**

On slippery road surfaces, activation of the exhaust brake system can result in wheel lockup. If the exhaust brake activates during an anti-lock brake system braking operation, proper braking function cannot be provided by the anti-lock brake system.
To prevent this, the exhaust brake system is deactivated during anti-lock brake system operation even when the exhaust brake switch is turned ON.
When the anti-lock brake system stops providing its function, the exhaust brake system becomes operable if the exhaust brake switch is ON.

Hydraulic Unit

(1) Internal circuit



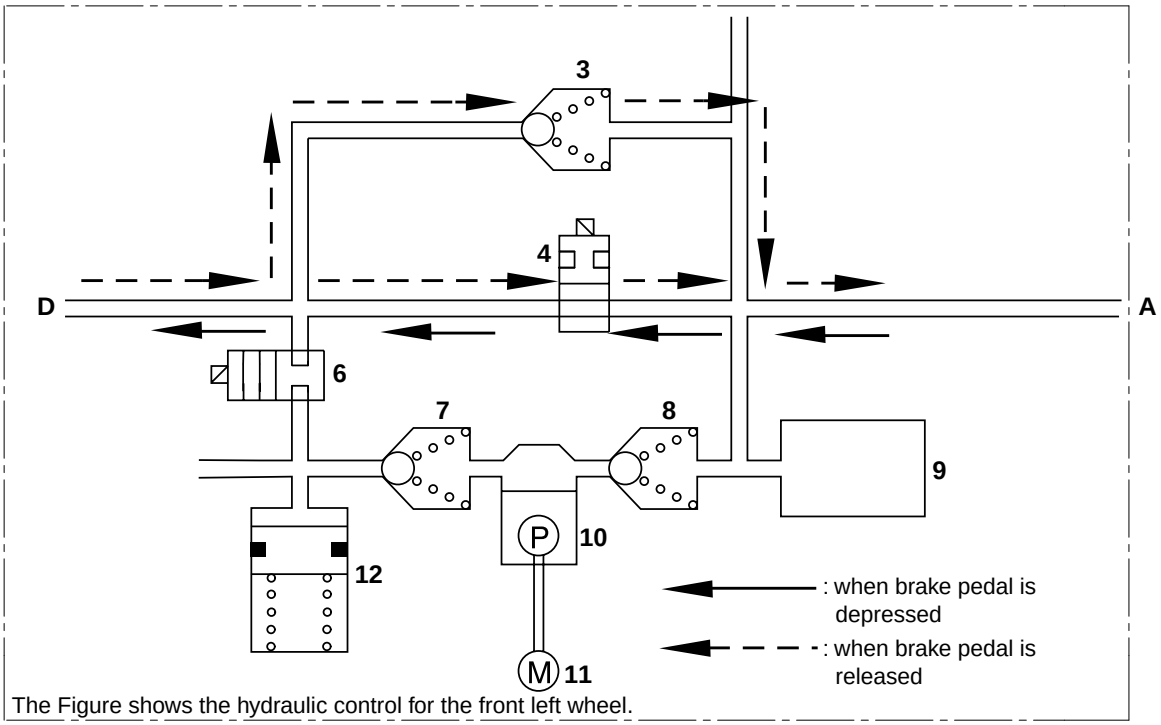
1 Check valve (front right wheel)
2 Solenoid valve (holding pressure for front right wheel)
3 Check valve (front left wheel)
4 Solenoid valve (holding pressure for front left wheel)
5 Solenoid valve (reducing pressure for front right wheel)
6 Solenoid valve (reducing pressure for front left wheel)
7 Inlet valve (front system)
8 Outlet valve (front system)
9 Damper (front system)
10 Plunger pump (front system)
11 Motor
12 Reservoir (front system)
13 Reservoir (rear system)
14 Plunger pump (rear system)
15 Inlet valve (rear system)
16 Outlet valve (rear system)
17 Damper (rear system)
18 Solenoid valve (reducing pressure for rear right wheel)
19 Solenoid valve (holding pressure for rear right wheel)
20 Check valve (rear right wheel)
21 Solenoid valve (holding pressure for rear left wheel)
22 Check valve (rear left wheel)
23 Solenoid valve (reducing pressure for rear left wheel)
A: From master cylinder (front system)
B: From master cylinder (rear system)
C: To wheel brake (front right wheel)
D: To wheel brake (front left wheel)
E: To wheel brake (rear right wheel)
F: To wheel brake (rear left wheel)

The hydraulic unit consists of various solenoid valves, a motor **11**, etc.
The solenoid valves and the motor are activated as shown in the following table by the control signal from the electronic control unit.

		Anti-lock brake system control											
		Front right wheel			Front left wheel			Rear right wheel			Rear left wheel		
		Pressure reduction	Pressure holding	Pressure increase	Pressure reduction	Pressure holding	Pressure increase	Pressure reduction	Pressure holding	Pressure increase	Pressure reduction	Pressure holding	Pressure increase
Solenoid valve	Reducing pressure for front right wheel **5**	○	×	×	–	–	–	–	–	–	–	–	–
	Holding pressure for front right wheel **2**	○	○	×	–	–	–	–	–	–	–	–	–
	Reducing pressure for front left wheel **6**	–	–	–	○	×	×	–	–	–	–	–	–
	Holding pressure for front left wheel **4**	–	–	–	○	○	×	–	–	–	–	–	–
	Reducing pressure for rear right wheel **18**	–	–	–	–	–	–	○	×	×	–	–	–
	Holding pressure for rear right wheel **19**	–	–	–	–	–	–	○	○	×	–	–	–
	Reducing pressure for rear left wheel **23**	–	–	–	–	–	–	–	–	–	○	×	×
	Holding pressure for rear left wheel **21**	–	–	–	–	–	–	–	–	–	○	○	×
Motor **11**		○											

○: ON
×: OFF

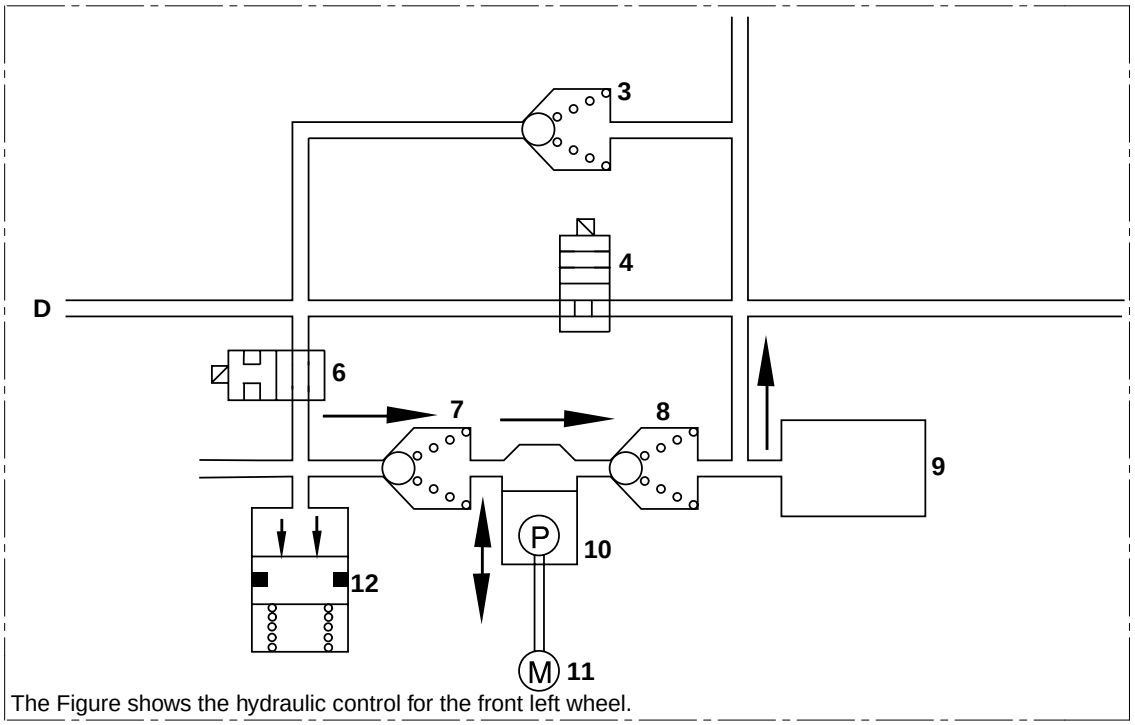
(2) Braking in normal conditions (Anti-lock brake system not activated)



Ⓟ36688

- In the conditions where the brake pedal is depressed but anti-lock brake system is not activated, no control signals are sent to the solenoid valve **6** (reducing pressure for front left wheel) and the solenoid valve **4** (holding pressure for front left wheel) in the hydraulic unit. Therefore, the solenoid valve **4** (holding pressure for front left wheel) is open and the solenoid valve **6** (reducing pressure for front left wheel) is closed.
- The brake fluid pressure **A** from the brake master cylinder is then fed to the wheel brake **D** through the solenoid valve **4** (holding pressure for front left wheel) without any modulation, braking the wheel.
- At that time, the brake fluid pressure is also applied to the damper **9** (front system), which is not activated with a normal brake fluid pressure.
- When the brake pedal is released, the brake fluid pressure **A** from the brake master cylinder is reduced. Therefore, the brake fluid pressure in the wheel brake **D** returns to the brake master cylinder through the solenoid valve **4** (holding pressure for front left wheel) and through the check valve **3** (front left wheel) whose ball is pressed off the seat by the pressure.

(3) When anti-lock brake system is activated (for reducing pressure)

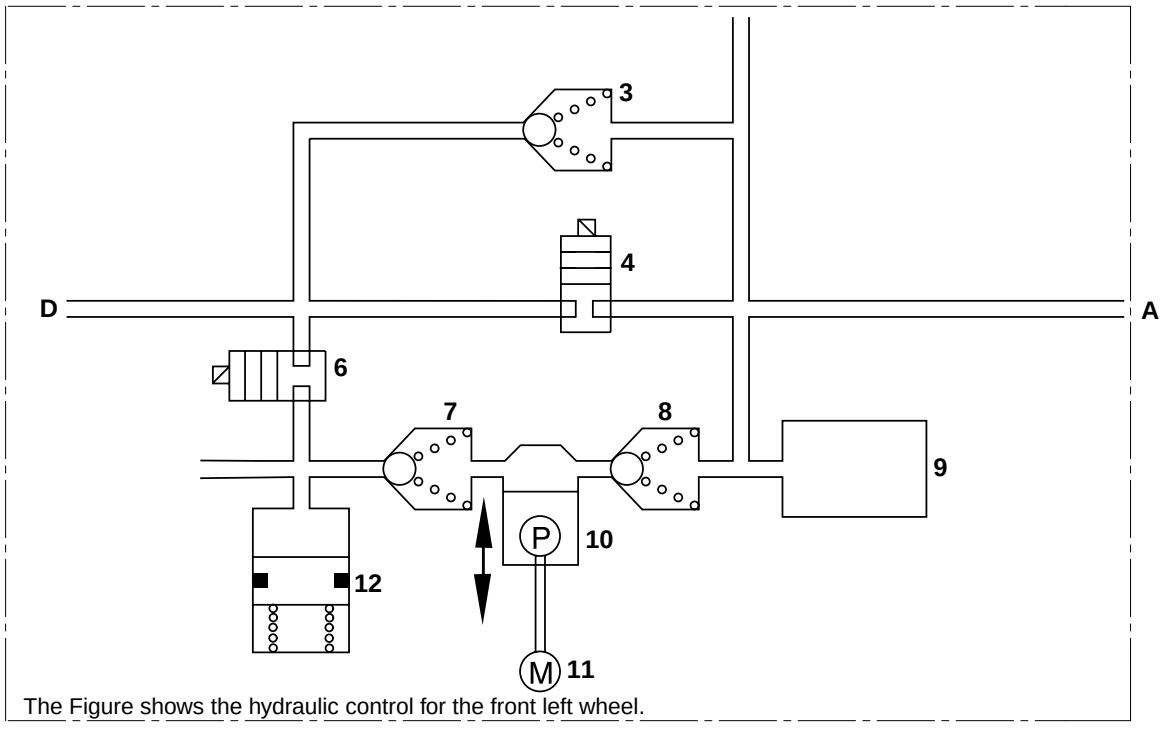


The Figure shows the hydraulic control for the front left wheel.

Ⓟ36689

- If the front left wheel shows signs of locking when the brake pedal is depressed, the electronic control unit sends the control signals to the solenoid valve **6** (reducing pressure for front left wheel) and the solenoid valve **4** (holding pressure for front left wheel). Then, the solenoid valve **6** (reducing pressure for front left wheel) opens and the solenoid valve **4** (holding pressure for front left wheel) closes.
- The brake fluid pressure in the wheel brake **D** is fed back into the reservoir **12** (front system) through the solenoid valve **6** (reducing pressure for front left wheel) and thereby it is reduced.
- Simultaneously with the control signals to the solenoid valve **6** (reducing pressure for front left wheel) and solenoid valve **4** (holding pressure for front left wheel), the electronic control unit also sends a control signal to the motor **11**, which operates the plunger pump **10** (front system). This causes the brake pressure in the reservoir to flow through the inlet valve **7** (front system) and outlet valve **8** (front system) into the damper **9** (front system).
- At this time, the check valve **3** (front left wheel) is closed by the brake fluid pressure **A** from the brake master cylinder. Accordingly, the brake fluid pressure is not fed from the brake master cylinder to the wheel brake.

(4) When anti-lock brake system is activated (for holding pressure)

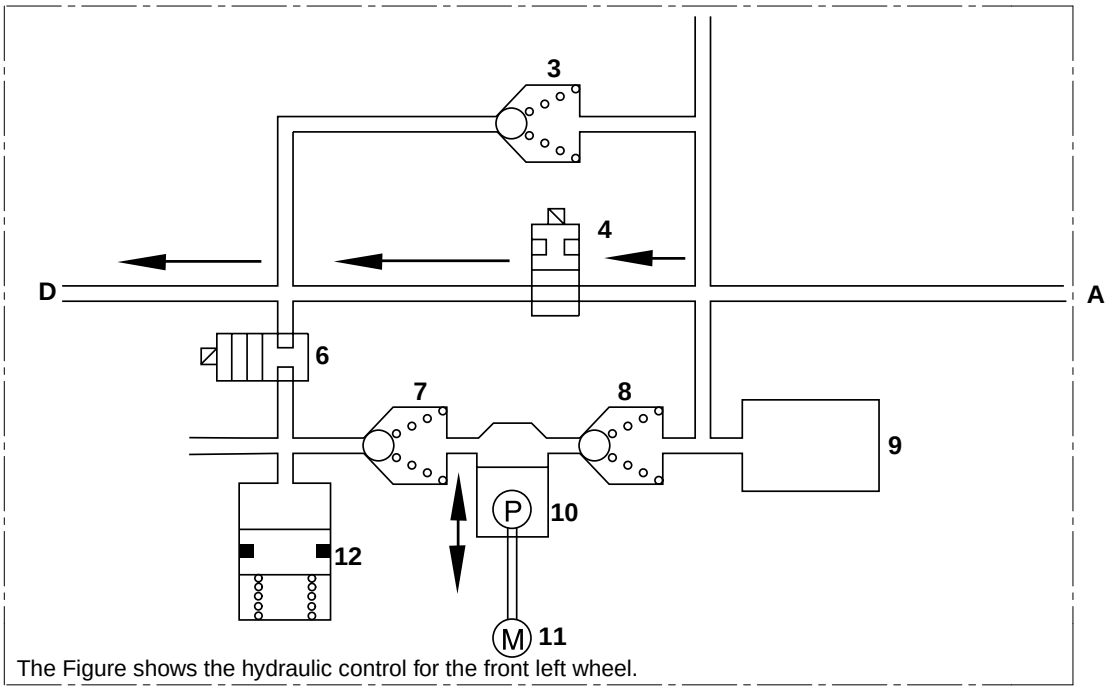


The Figure shows the hydraulic control for the front left wheel.

Ⓟ36690

If the brake fluid pressure **D** in the wheel brake should be maintained for sustained anti-lock brake system control, the electronic control unit sends the pressure holding signal to the solenoid valve **4** (holding pressure for front left wheel) and stops control signal to the solenoid valve **6** (reducing pressure for front left wheel). This causes both solenoid valve **4** (holding pressure for front left wheel) and solenoid valve **6** (reducing pressure for front left wheel) to close, thereby the brake fluid pressure being maintained.

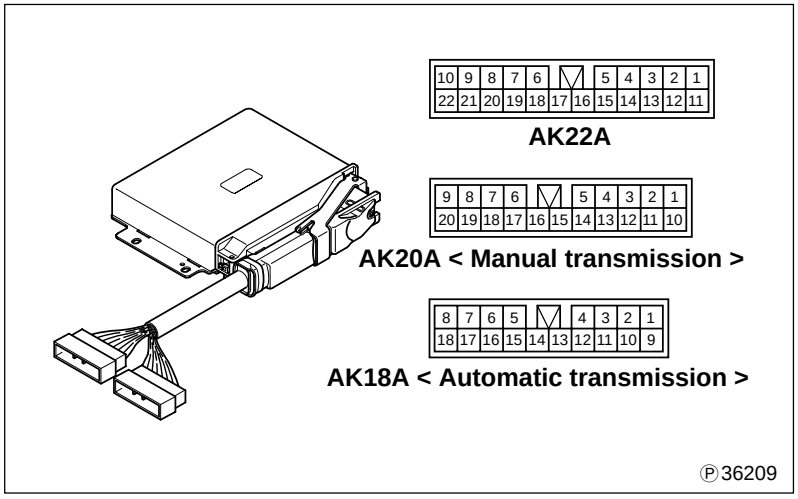
(5) When anti-lock brake system is activated (for increasing pressure)



The Figure shows the hydraulic control for the front left wheel.

Ⓟ36691

- If the brake fluid pressure **D** in the wheel brake should be increased, the electronic control unit stops sending control signals to the solenoid valve **4** (holding pressure for front left wheel) and solenoid valve **6** (reducing pressure for front left wheel) in the hydraulic unit.
- Then, the solenoid valve **4** (holding pressure for front left wheel) opens and the solenoid valve **6** (reducing pressure for front left wheel) closes. Namely, the same condition as where no anti-lock brake system control is provided brings about.
- At this time, the check valve **3** (front left wheel) is kept closed by the brake fluid pressure **A** from the brake master cylinder. Therefore, the brake fluid pressure **D** increased by the damper **9** (front system) is applied to the wheel brake irrespective of the brake fluid pressure in the brake master cylinder.



● **Electronic control unit**

This component calculates the wheel speed and estimates the vehicle speed based on signals sent from the wheel speed sensors. Based on the calculation results, it determines the degree of wheel lockup tendency, and sends brake fluid pressure control signals to the solenoid valves of the hydraulic unit to regulate brake fluid pressure accordingly.

The electronic control unit is equipped with a self-diagnosis function. Should an abnormality occur, the electronic control unit turns on the warning lamp on the instrument panel to indicate the system malfunction and deactivates the ABS control to set the brake system in normal condition (without anti-lock brake system control).

	AK22A	AK20A < Manual transmission >	AK18A < Automatic transmission >
Terminal No.	Connection destination		
1	Ground	–	–
2	Ground	–	–
3	–	–	Meter cluster (anti-lock brake system warning lamp)
4	Hydraulic unit (motor drive)	Meter cluster (anti-lock brake system warning lamp)	Starter switch terminal M (electronic control unit power supply)
5	Hydraulic unit (motor drive monitor)	Starter switch terminal M (electronic control unit power supply)	Wheel speed sensor (rear-axle right-wheel input)
6	–	Wheel speed sensor (rear-axle right-wheel input)	Wheel speed sensor (rear-axle left-wheel input)
7	Hydraulic unit (rear-axle right-wheel brake fluid pressure decrease)	Wheel speed sensor (rear-axle left-wheel input)	Wheel speed sensor (front-axle right-wheel input)
8	Hydraulic unit (rear-axle left-wheel brake fluid pressure decrease)	Wheel speed sensor (front-axle right-wheel input)	Wheel speed sensor (front-axle left-wheel input)
9	Hydraulic unit (front-axle right-wheel brake fluid pressure decrease)	Wheel speed sensor (front-axle left-wheel input)	–
10	Hydraulic unit (front-axle left-wheel brake fluid pressure decrease)	–	Multi-Use Tester II connector
11	Ground	–	Multi-Use Tester II connector
12	Ground	Multi-Use Tester II connector	Stop lamp switch
13	–	Multi-Use tester II connector	–
14	Relay box (valve relay drive)	Stop lamp switch	–
15	Relay box (valve relay and motor relay power supply)	–	Wheel speed sensor (rear-axle right-wheel grounding)
16	Exhaust brake cut relay < Manual transmission >	–	Wheel speed sensor (rear-axle left-wheel grounding)
17	Exhaust brake cut relay < Manual transmission >	Wheel speed sensor (rear-axle right-wheel grounding)	Wheel speed sensor (front-axle right-wheel grounding)
18	–	Wheel speed sensor (rear-axle left-wheel grounding)	Wheel speed sensor (front-axle left-wheel grounding)
19	Hydraulic unit (rear-axle right-wheel brake pressure hold)	Wheel speed sensor (front-axle right-wheel grounding)	
20	Hydraulic unit (rear-axle left-wheel brake pressure hold)	Wheel speed sensor (front-axle left-wheel grounding)	
21	Hydraulic unit (front-axle right-wheel brake pressure hold)		
22	Hydraulic unit (front-axle left-wheel brake pressure hold)		

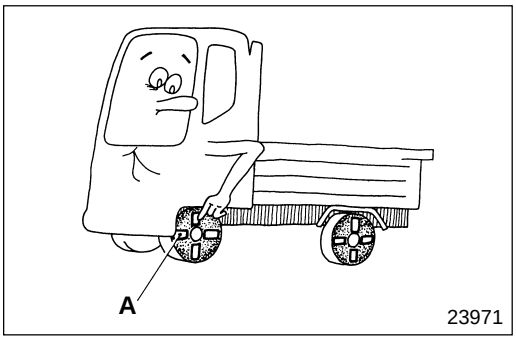
Periodic Inspection Procedures

(1) Periodic inspection of Anti-lock brake system

- Inspect the vehicle's Anti-lock brake system following the procedure below.
- If an abnormality is found in this inspection, further inspect the Anti-lock brake system using Multi-Use Tester II by referring to TROUBLESHOOTING section.
  P35E-21

- Inspection procedure
  ① With the vehicle stationary, press the brake pedal and inspect the hydraulic unit for fluid leaks.
  If fluid leaks from the hydraulic unit, replace the unit. If fluid leaks from the fluid pipe or connector, tighten the joint.
  ② Inspection using brake tester
  Check the braking force at each wheel with a brake tester by following the inspection procedure for ordinary vehicles.
  If an abnormality is found, inspect the wheel brake units, service brake system and hydraulic unit.
  ③ Drive the vehicle and check the operation of the Anti-lock brake system.
  - Conduct a test drive at an open area to ensure safety.
  - Conduct a test drive without cargo.

  Attach white tape **A** on the sides of tires, so that it is easy to observe the rotation of the front and rear wheels.
  - Turn the starter switch from the OFF position to the ON position, and make sure that the ABS warning lamp lights.
    Then, check that the ABS warning lamp turns off approximately two seconds after the starter switch is turned on.
  - Drive the vehicle at a speed of 20 to 30 km/h {12 to 19 mph}, and apply a sudden brake. Make sure that wheel lockup does not occur in any of the tires.



Adjustment of Wheel Speed Sensor Clearance

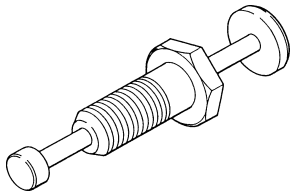
Tightening torque

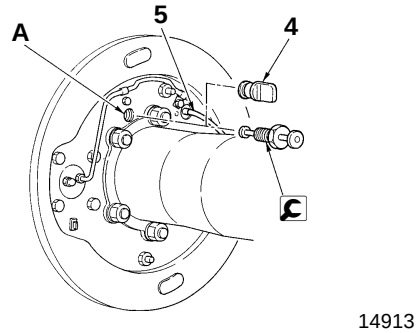
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Bolt (Anchor bracket mounting)	135 {100, 13.8}	—

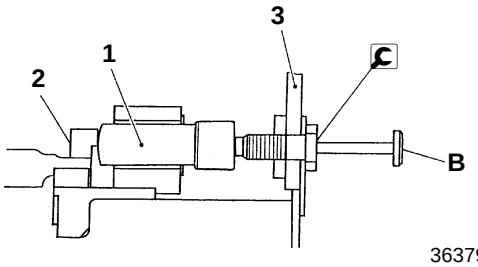
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Adjuster  14912	MH062080	Adjustment of wheel speed sensor clearance



14913



36379

Tighten adjuster to extend wheel speed sensor **1**, and adjust clearance between the sensor and rotor **2**.

- Remove plug **4** located on the back side of back plate **3**.
- Mount adjuster in adjustment hole **A**, and tighten the adjuster.
- Wheel speed sensor **1** contacts the rotor before adjuster is completely tightened. Therefore, do not press shaft **B**, and tighten the adjuster until resistance is felt.
- Be sure to reinstall plug **4** after adjustment.

5: Wheel speed sensor harness

Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope

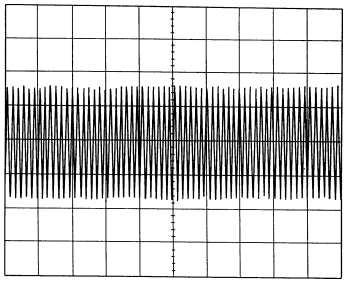
Inspect the rotor for dents using an oscilloscope, since the tester cannot be used for dent detection.

NOTE

Use an oscilloscope with a waveform recording function.

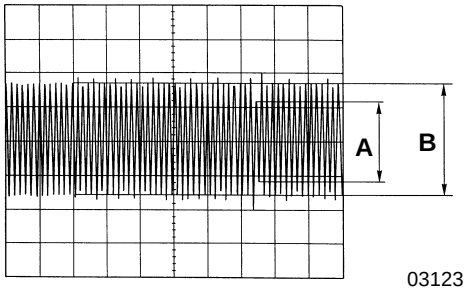
- Lift the wheel to be tested off the ground, and disconnect the connector at the wheel speed sensor.
- Connect the terminal of the oscilloscope to the terminal of the disconnected connector. Rotate the wheel at a constant speed. Check the waveform shown on the oscilloscope to check for dents on the rotor.

Normal waveform (no dent on rotor)



03122

Abnormal waveform (with dents on rotor)



03123

- Rotor dents are often made by the rotor press-fit on the hub end contacting the axle during installation of the hub and brake drum assembly on the axle. When installing the hub & brake drum assembly, pay close attention to prevent the rotor from contacting other parts.

A: Vmin (Minimum peak)
B: Vmean (Average of maximum peaks)

$$\frac{\text{Vmean} - \text{Vmin}}{\text{Vmean}} = 0.2 \text{ (20\% or lower)}$$

If more than 20%, replace the rotor.

Hydraulic Unit Operation Check

Operation check using Multi-Use Tester II

- Lift the vehicle using a jack and support it with rigid racks, or position the tires on brake tester rollers.

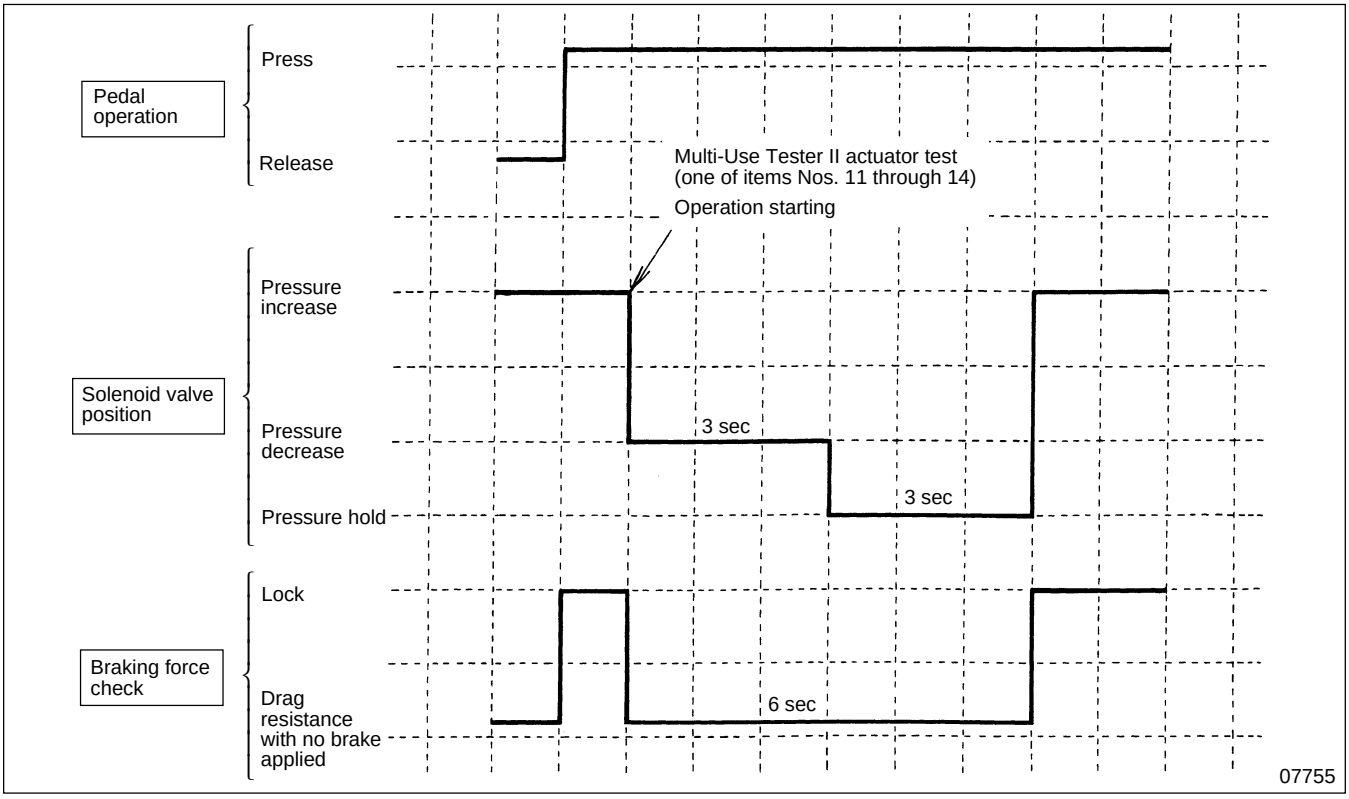
WARNING⚠

- **The brake tester rollers and tires must be dry during inspection.**
- **To test the front brakes, apply the parking brake. To test the rear brakes, place wheel chokes at the front tires to secure them in position.**

- Disengage the parking brake, and feel the drag resistance of the brake on each wheel.
  When using a brake tester, record the indicated drag resistance of the brake.
- Set the starter switch to the OFF position, then connect the Multi-Use Tester II.
- Set the testing equipment and system on the Multi-Use Tester II.
- After making sure that the transmission is in the neutral position, start the engine.

NOTE

- **When the engine is turned on, the anti-lock brake system switches to the Multi-Use Tester II mode and the anti-lock brake system warning lamp flashes.**
- **When the anti-lock brake system function is deactivated due to the electronic control unit fail-safe function, the actuator test cannot be performed with the Multi-Use Tester II.**



- If an abnormality is found during the inspection, take appropriate measures described in the following operating condition evaluation chart.

Operating condition evaluation chart

Item No.	Multi-Use Tester II indication	Operation	Judgment		Cause	Remedy
			Normal	Malfunction		
11	FR ABS MV ON	(1) Depress the brake pedal to lock wheels. (2) On the Multi-Use Tester II, select the wheel to be tested and forcibly drive the actuator. (3) Rotate the selected wheel using the brake tester or by hand, and check the change in braking power.	Braking force eases for 6 seconds from locked condition.	Wheel does not lock when brake pedal is depressed.	Clogging in brake line other than HU	Inspect and clean brake lines.
12	FL ABS MV ON				Clogging in hydraulic line inside HU	Replace HU assembly.
13	RR ABS MV ON			Braking force does not ease.	Erroneous HU brake tube connection	Correct tube connection.
14	RL ABS MV ON				Faulty HU solenoid valve	Replace HU assembly.

HU: Hydraulic unit • After inspection, set the starter switch to OFF before disconnecting the Multi-Use Tester II.

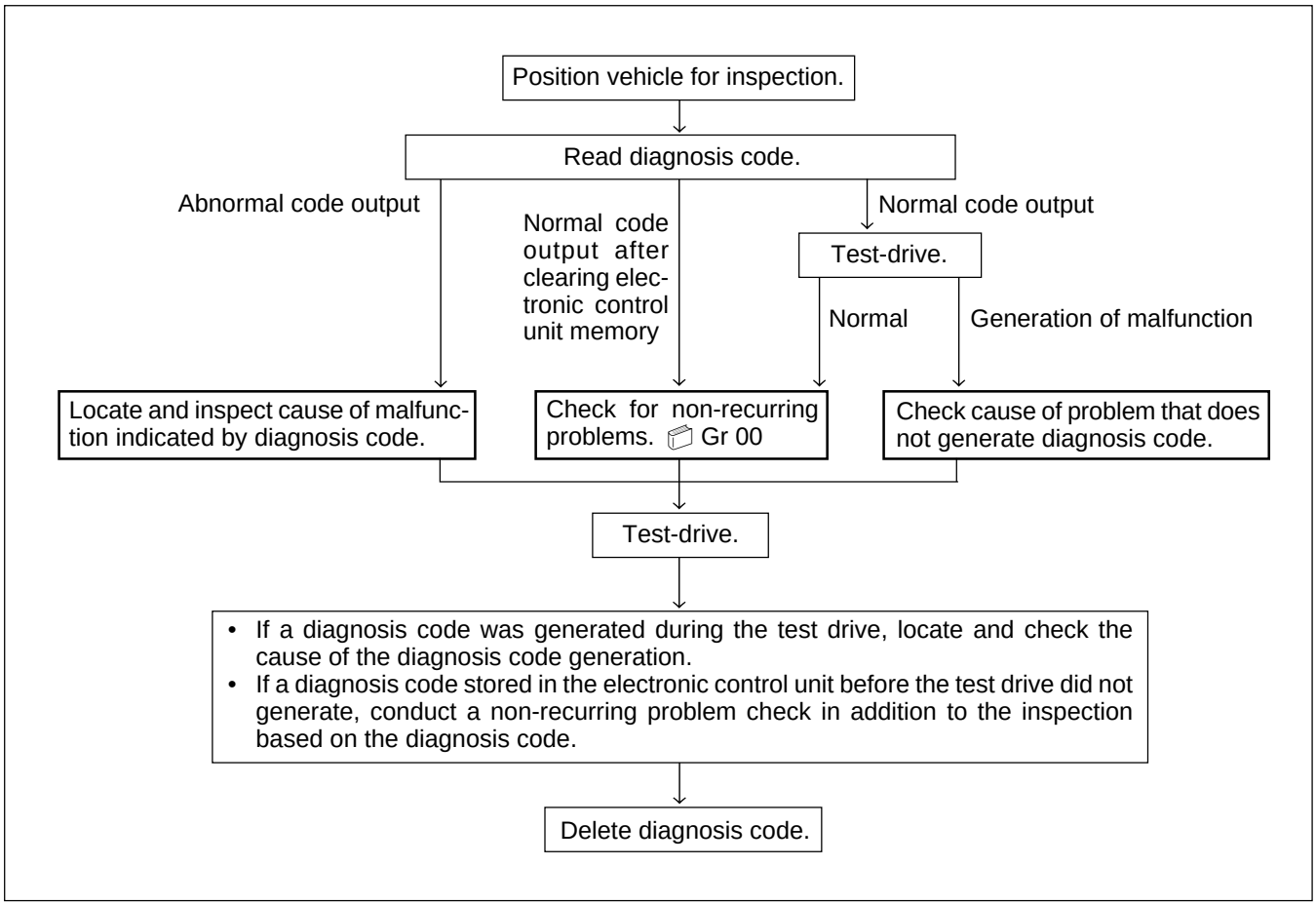
TROUBLESHOOTING

Troubleshooting Procedures

Inspection flow chart

The Multi-Use Tester II allows efficient inspection of the anti-lock brake system.
The types of system inspections can be roughly divided according to the malfunction condition and diagnosis code, as shown below.

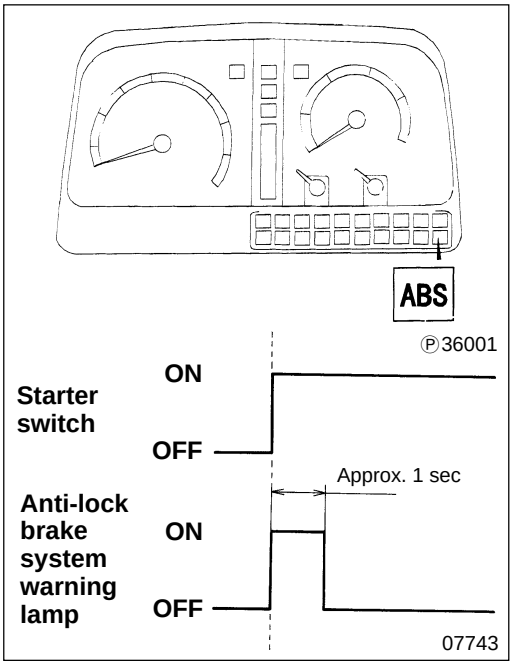
- Inspection based on individual malfunction diagnosis codes stored in the electronic control unit
- Inspection based on symptoms not indicated by diagnosis codes
- Correcting non-recurring problems



Cautions in malfunction diagnosis

- The anti-lock brake system uses electronic control to regulate the braking system. The following phenomena may occur during normal anti-lock brake system operation, but they do not denote a malfunction.

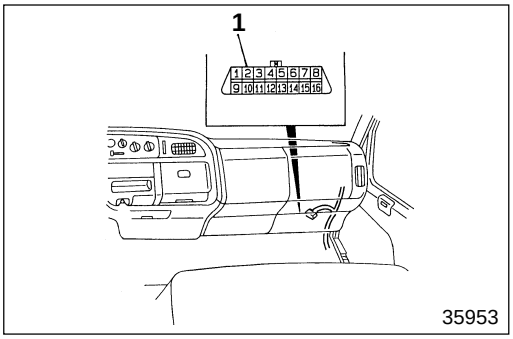
Phenomenon	Description
System checking sound	When the engine starts, a slight clunking sound may be generated in the left side of the frame near the cargo bed. This sound is produced by the system conducting an operation check, and does not denote a malfunction.
Anti-lock brake system operating sound	• Motor noise from the hydraulic unit (humming sound) • Noise generated as the brake pedal feel changes (grinding sound) • Noise from the chassis produced by repeated ON and OFF operations of the anti-lock brake system (wheels: short squeak, suspension: slight thud)
Anti-lock brake system operation effect (longer stopping distance)	On snow-covered surfaces and gravel roads, a vehicle equipped with anti-lock brake system may require a longer distance to come to a complete stop. Therefore, when driving on such road surfaces, reduce the speed sufficiently and drive carefully to minimize the use of brakes.



● **Inspection of anti-lock brake system warning lamp**

Check the anti-lock brake system warning lamp to make sure that the following operation turns on the lamp.

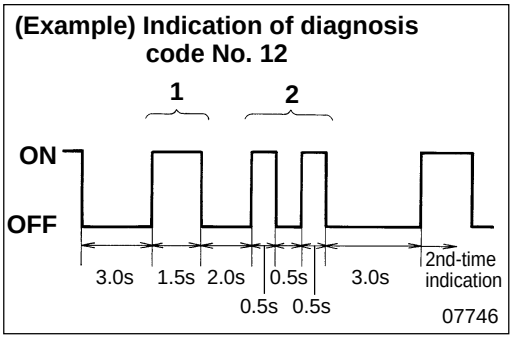
- Set the starter switch to the ON position, and check that the anti-lock brake system warning lamp lights for about 1 second and turns off.
- If the lamp does not light as described above, check diagnosis codes stored in the electronic control unit.



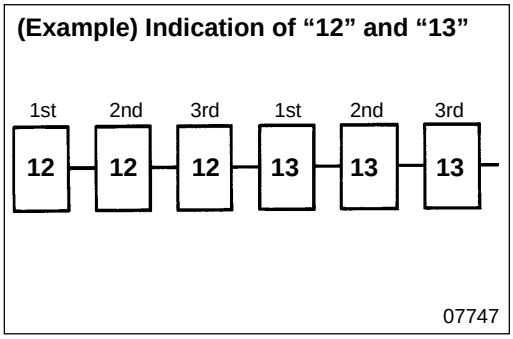
Diagnosis code indication

● **Without Multi-Use Tester II**

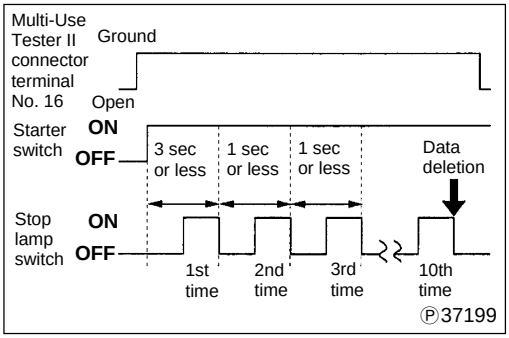
- With the vehicle stationary, ground terminal No. 16 of Multi-Use Tester II connector **1**, then turn the starter switch to the ON position. The anti-lock brake system warning lamp will flash to indicate a diagnosis code.
- The anti-lock brake system warning lamp starts flashing 3.0 seconds after the starter switch is turned ON. The flashing pattern of the warning lamp indicates a diagnosis code.



- A diagnosis code is indicated in the following manner.
  - To indicate the tens digit (left digit), the lamp remains ON for 1.5 seconds, then remains OFF for 0.5 seconds. To indicate the ones digit (right digit), the lamp remains ON for 0.5 second, then remains OFF for 0.5 second.
  - Each diagnosis code is indicated three consecutive times. When there is no other diagnosis code to indicate, the lamp repeats the diagnosis code indication from the beginning.
  - When there is no diagnosis code stored in the memory (normal condition), the anti-lock brake system warning lamp repeats On/Off in 0.25-second intervals.



- When two or more diagnosis codes are stored in the electronic control unit.



● **Deletion of diagnosis codes**

Connect terminal No. 16 of the Multi-Use Tester II connector to the chassis for grounding. Turn on the starter switch, and depress the brake pedal within 3 seconds and turn On and Off the stop lamp switch ten times in intervals of 1 second or less. This erases diagnosis codes from the memory.

● **Completion of diagnosis code check**

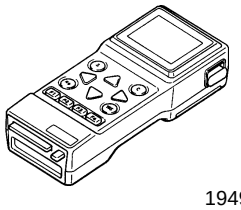
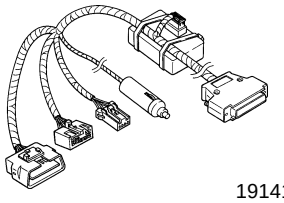
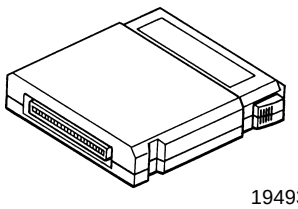
The diagnosis code check completes when diagnosis codes are erased from the electronic control unit of terminal No. 16 of the Multi-Use Tester II connector is disconnected.

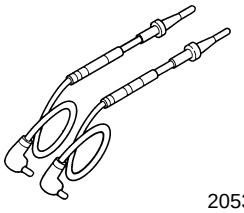
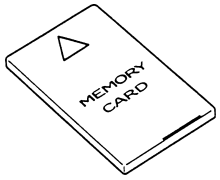
NOTE

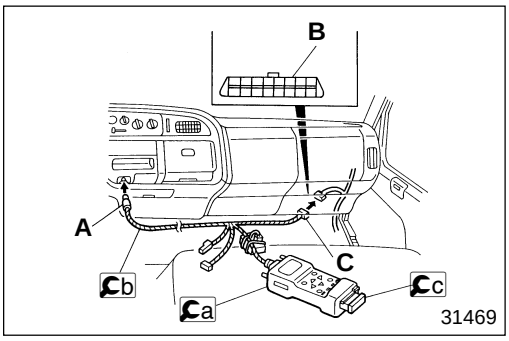
The diagnosis code check also ends when the vehicle moves from a stationary condition during the diagnosis code check.

With Multi-Use Tester II

Special tools

Tool name and shape	Part No.	Application
Multi-Use Tester II  19492	MB991496	Inspection of Anti-lock brake system
Multi-Use Tester II harness (for data communication)  19141	MK327601	
ROM pack (MRT-E9)  19493	MH062821	

Tool name and shape	Part No.	Application
Multi-Use Tester II harness (for circuit tester)  20536	MB991499	Inspection of Anti-lock brake system
Memory card (for Multi-Use Tester II)  20538	MB991500	



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Connecting the Multi-Use Tester II
- Turn the starter switch to the LOCK position.
- Connect the b MUT Communication Harness to the a Multi-Use Tester II, and insert the c ROM Pack.
- Plug connector **A** into the cigarette lighter socket.
- Fit connector **C** onto MUT connector **B** (16 pin) in the relay box.

NOTE

Instructions for operation of the Multi-Use Tester II are given in the separate Multi-Use Tester II Reference Manual.

Current diagnosis codes
- Turn the starter switch to the ON position.
- Determine the fault location(s) in accordance with the Multi-Use Tester II diagnosis code(s).

Past diagnosis codes
- Turn the starter switch to the ON position.
- Determine the fault location(s) in accordance with the past Multi-Use Tester II diagnosis code(s).

Diagnosis code erasure
- Turn the starter switch to the ON position.
- Using the Multi-Use Tester II, erase all diagnosis codes stored in the control unit.

Diagnosis Code Chart

Diagnosis codes can be read by using the Multi-Use Tester II or anti-lock brake system warning lamp.

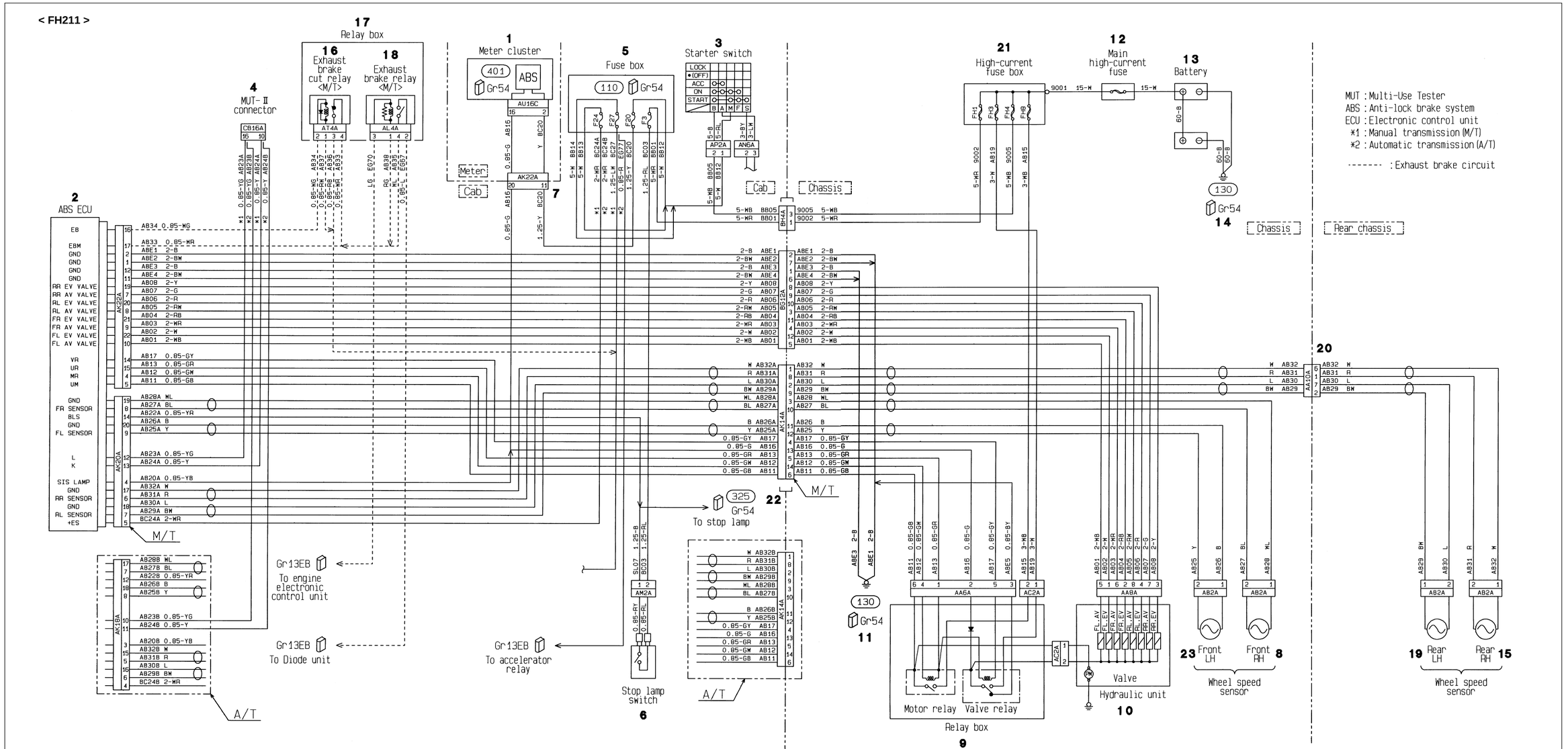
Diagnosis code	Malfunction location		
	Multi-Use Tester II display	Description of malfunction	
11	FR-SNSR OPEN	Wheel speed sensor	Broken wire to front-axle right-wheel speed sensor
12	FL-SNSR OPEN		Broken wire to front-axle left-wheel speed sensor
13	RR-SNSR OPEN		Broken wire to rear-axle right-wheel speed sensor
14	RL-SNSR OPEN		Broken wire to rear-axle left-wheel speed sensor
*a 15	ROTA OR SNSR		Broken wire
16	ECU VOLTAGE	Drop in power supply voltage	
21	FR-SNSR SHORT	Wheel speed sensor	No broken wire to front-axle right-wheel speed sensor
22	FL-SNSR SHORT		No broken wire to front-axle left-wheel speed sensor
23	RR-SNSR SHORT		No broken wire to rear-axle right-wheel speed sensor
24	RL-SNSR SHORT		No broken wire to rear-axle left-wheel speed sensor
*b 35	EXB RLY	Exhaust brake cut relay	
38	STOP LAMP SW	Stop lamp switch	
41	FR-EV VALVE	Hydraulic unit	Front-axle right-wheel solenoid valve (pressure decrease)
42	FL-EV VALVE		Front-axle left-wheel solenoid valve (pressure decrease)
43	RR-EV VALVE		Rear-axle right-wheel solenoid valve (pressure decrease)
44	RL-EV VALVE		Rear-axle left-wheel solenoid valve (pressure decrease)
45	FR-AV VALVE		Front-axle right-wheel solenoid valve (pressure hold)
46	FL-AV VALVE		Front-axle left-wheel solenoid valve (pressure hold)
47	RR-AV VALVE		Rear-axle right-wheel solenoid valve (pressure hold)
48	RL-AV VALVE		Rear-axle left-wheel solenoid valve (pressure hold)
51	VALVE RLY	Relay box	Valve relay
53	MOTOR RLY		Motor relay or motor
			Motor monitor line
63	ECU ERR	Anti-lock brake system electronic control unit	

Actuator Drive Chart

Multi-Use Tester II display	
Item No.	Item name
11	FR ABS MV ON
12	FL ABS MV ON
13	RR ABS MV ON
14	RL ABS MV ON

Service Data

Multi-Use Tester II display			Inspection condition	Criterion
11	FR SPEED	■■■. ■ MPH	Constant-speed driving	Same as speedometer indication
12	FL SPEED	■■■. ■ MPH		
13	RR SPEED	■■■. ■ MPH		
14	RL SPEED	■■■. ■ MPH		
15	ECU VOLTAGE	■■. ■ V	Starter switch ON	Same as battery voltage
30	STOP LAMP SW	ON/OFF	Brake pedal depressed	ON
			Brake pedal released	OFF


< FH211 >
17 Relay box
16 Exhaust brake cut relay <M/T>
18 Exhaust brake relay <M/T>
1 Meter cluster
5 Fuse box
3 Starter switch
21 High-current fuse box
12 Main high-current fuse
13 Battery
4 MUT-II connector
2 ABS ECU
7
14
11
6
9
10
23 Front LH
8
19 Rear LH
15
Wheel speed sensor
Hydraulic unit
Motor relay
Valve relay
Relay box
To engine electronic control unit
To Diode unit
To accelerator relay
To stop lamp
Stop lamp switch
Chassis
Rear chassis
Cab
Meter
M/T
A/T
MUT : Multi-Use Tester
ABS : Anti-lock brake system
ECU : Electronic control unit
*1 : Manual transmission (M/T)
*2 : Automatic transmission (A/T)
: Exhaust brake circuit
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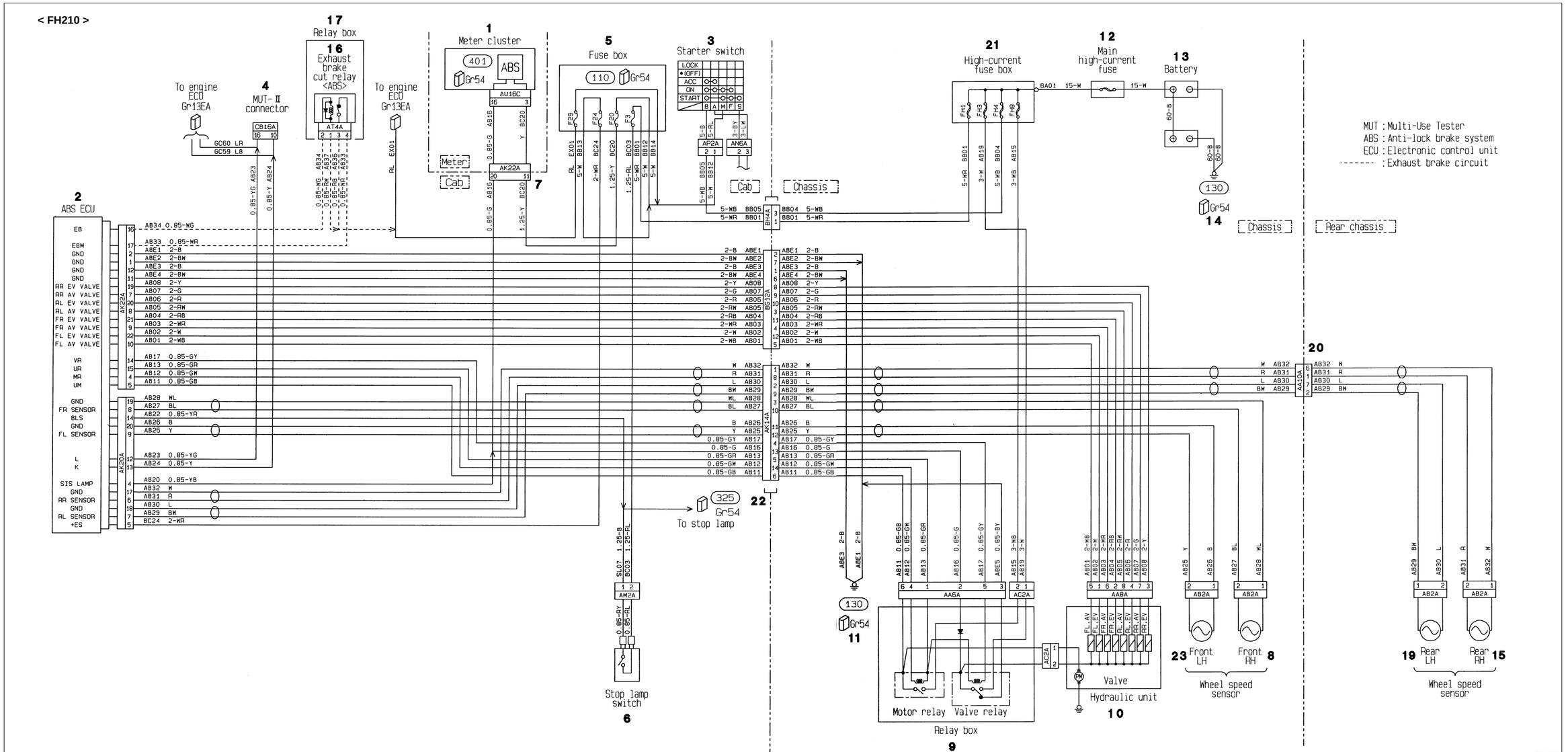
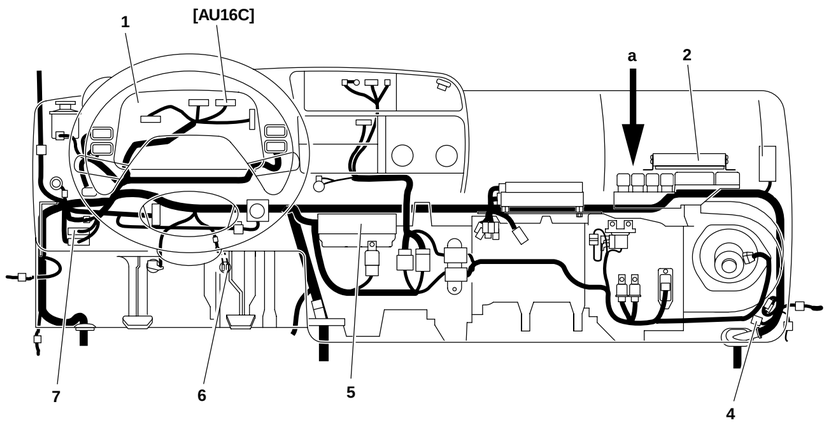
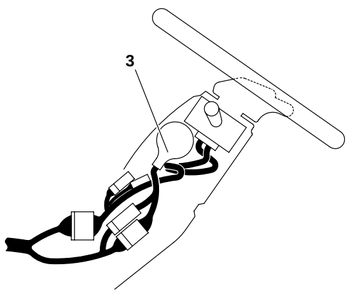
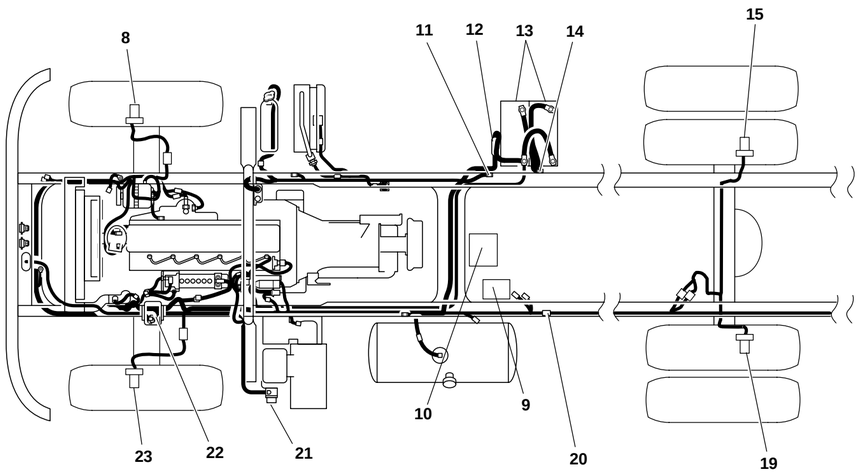
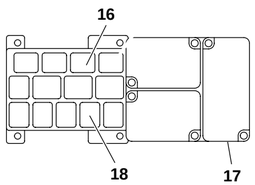

< FH210 >
MUT : Multi-Use Tester
ABS : Anti-lock brake system
ECU : Electronic control unit
------- : Exhaust brake circuit
2 ABS ECU
4 MUT-II connector
1 Meter cluster
3 Starter switch
5 Fuse box
7
16 Exhaust brake cut relay <ABS>
17 Relay box
21 High-current fuse box
12 Main high-current fuse
13 Battery
14
20
22
To engine ECU Gr13EA
To stop lamp
Stop lamp switch
6
11
Motor relay
Valve relay
Relay box
9
Valve
Hydraulic unit
10
23 Front LH
8 Front RH
Wheel speed sensor
19 Rear LH
15 Rear RH
Wheel speed sensor
Chassis
Rear chassis
52782



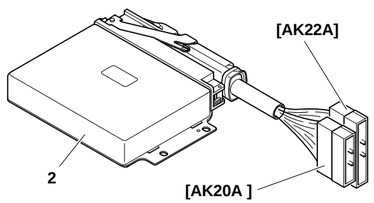




View a



< Anti-lock brake system electronic control unit >



1 Meter cluster
2 Anti-lock brake system electronic control unit
3 Starter switch
4 Multi-Use Tester II connector
5 Fuse box
6 Stop lamp switch
7 Connection of cab harness and meter harness
8 Front wheel speed sensor, RH
9 Relay box
10 Hydraulic unit
11 Ground
12 Main high current fuse
13 Battery
14 Ground
15 Rear wheel speed sensor, RH
16 Exhaust brake cut relay <Manual transmission>
17 Relay box
18 Exhaust brake relay
19 Rear wheel speed sensor, LH
20 Connection of chassis harness and rear chassis harness
21 High current fuse box
22 Connection of cab harness and chassis harness
23 Front wheel speed sensor, LH

Indicate by connector type [ ].

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MITSUBISHI
FUSO

Group 36A
Parking Brake
< FH210 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-36A

INDEX

SPECIFICATIONS 36A- 2

STRUCTURE AND OPERATION
1. Parking Brake Control 36A- 2
2. Parking Brake Lever 36A- 2
3. Parking Brake Assembly 36A- 3

TROUBLESHOOTING 36A- 4

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Adjustment of Parking Brake Shoe Clearance and Ratchet Bar Pulling Stroke 36A- 5

PARKING BRAKE CONTROL 36A- 6

PARKING BRAKE ASSEMBLY 36A- 8

BACKING PLATE AND SHOE ASSEMBLY 36A-10

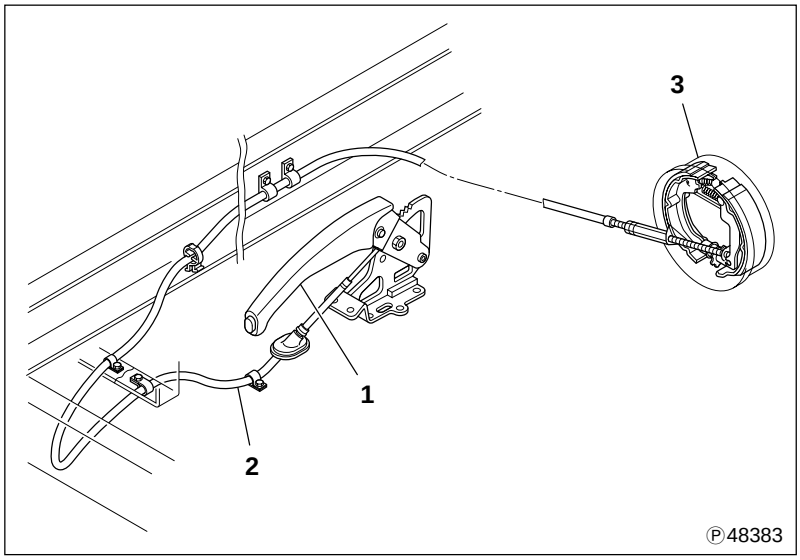
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item		Specifications
Brake	Type	Propeller shaft internal expanding type brake
	Operation type	Mechanical cable type
Parking brake assembly	Type	Duo-servo type
	Inner diameter of drum mm {in.}	ø190 {7.48}
	Lining width × Thickness mm {in.}	45×4.0 {1.77×0.16}

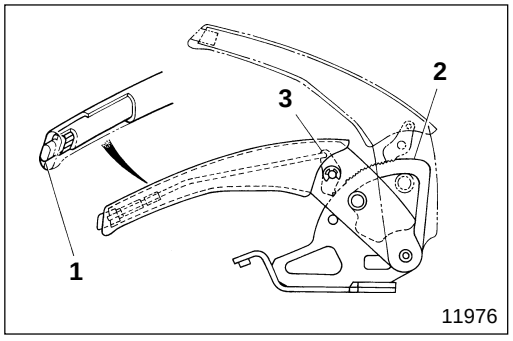
STRUCTURE AND OPERATION

1. Parking Brake Control



1 Parking brake lever
2 Parking brake cable
3 Parking brake assembly

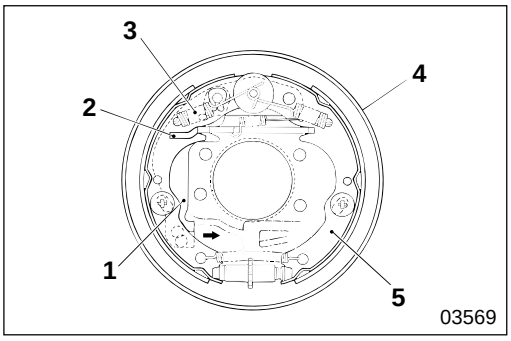
2. Parking Brake Lever



1 Release rod knob
2 Lever bracket
3 Locking latch

The parking brake has a built-in locking mechanism that prevents inadvertent release of the brake.
To release locking, push release rod knob **1** which will disengage from the serration of lever bracket **2** and the tooth of locking latch **3** freeing the parking brake lever and allowing it to return.

3. Parking Brake Assembly



1 Parking lever
2 Strut
3 Shoe return spring
4 Backing plate
5 Shoe and lining assembly

- Pulling the parking brake ratchet bar pulls the parking brake cable, which in turn pulls parking brake lever **1** installed in the parking brake body, operating shoe and lining assembly **5**.
- Activation of parking lever **1** expands one shoe and lining assembly **5** via strut **2**, the parking lever itself expands the other shoe and lining assembly. Therefore, both shoe and lining assemblies function as leading shoes.
- When the ratchet bar (parking lever) is returned, the repercussive force of shoe return spring **3** releases the brake.

TROUBLESHOOTING

Possible causes / Symptoms		Parking brake does not work	Parking brake does not release smoothly (dragging)	Remarks
Parking brake cable	Inner cable stretched or damaged	○	○	
	Inner cable rusted		○	
	Inner spring of cable deteriorated, fractured		○	
Parking brake lever	Locking latch and lever bracket engaging incorrectly	○		
	Pulling stroke insufficient	○	○	
	Pulling stroke excessive	○		
Parking brake assembly	Shoe clearance insufficient		○	
	Shoe clearance excessive	○		
	Parking brake drum inner surface deformed or distorted	○		
	Parking brake drum inner surface greasy or oily	○		
	Linings worn unevenly	○		
	Lining surface greasy or oily	○		
	Shoe return spring deteriorated, fractured		○	

1. Adjustment of Parking Brake Shoe Clearance and Ratchet Bar Pulling Stroke

Service standards

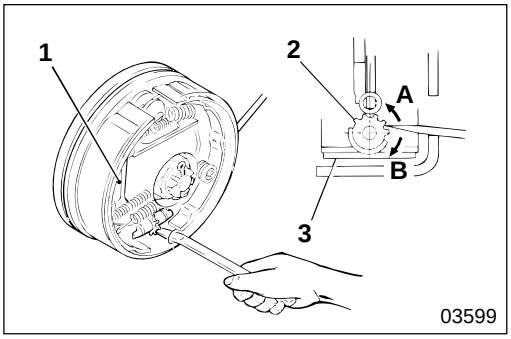
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Brake shoe clearance	0.2 to 0.25 {0.0079 to 0.0098}	—	Adjust
4	Ratchet bar pulling stroke (Operating force : 490 N {110 lbf, 50 kgf})	7 to 10 notches	—	Adjust

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Lock nut	19 to 27 {14 to 20, 1.9 to 2.8}	—

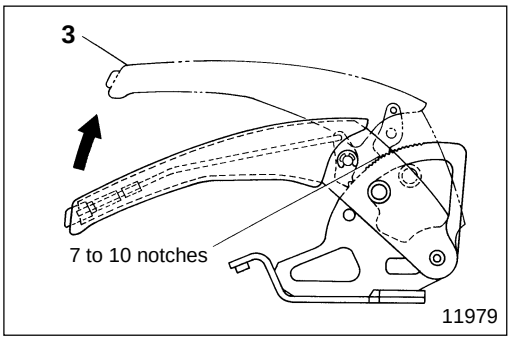


(1) Shoe clearance

When parking lever **1** is released, turn adjuster **2** in the expansion direction, using a screwdriver inserted through the shoe adjusting hole of the parking brake drum, and return 8 to 10 notches from the position where shoe **3** is in close contact with the drum. Then, the shoe clearance will be the standard value.

A : Contraction

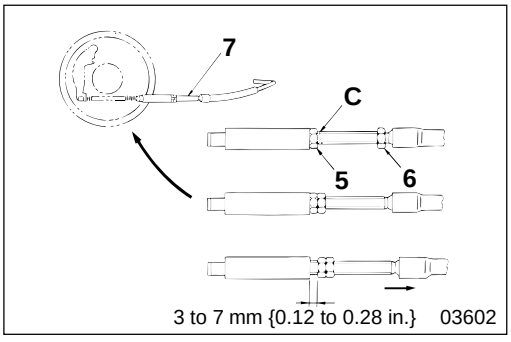
B : Expansion



(2) Ratchet bar pulling stroke

Adjust the adjusting nut of the parking brake cable so that the ratchet bar pulling stroke is the standard value when parking brake ratchet bar **4** is pulled from the released position by an operating force of 295 N {66 lbf, 30 kgf}.

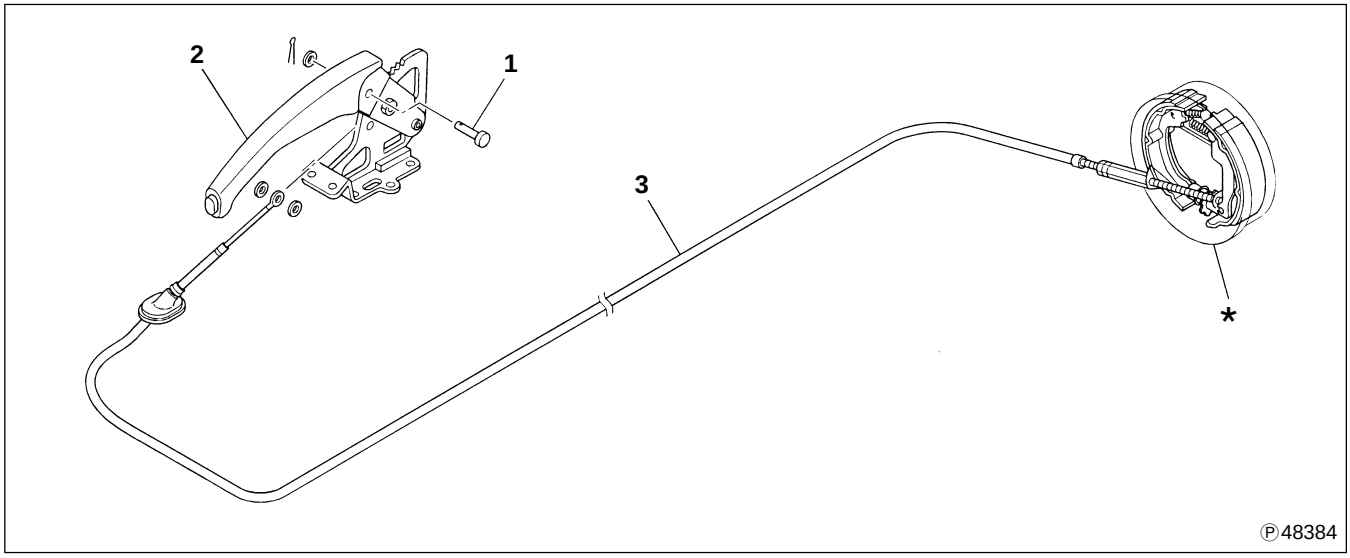
Operate ratchet bar two or three times after adjusting to verify the pulling stroke, to make sure that the parking brake is operating properly and that the parking brake drum does not drag when the parking brake is released.



[Adjustment]

- Tighten adjusting nut **5** until mark **C** can be seen.
- Tighten lock nut **6** to the position of adjusting nut **5**.
- Tighten lock nut **6** at specified torque.
- Check clearance when the outer cable of parking brake cable **7** is pulled by an operating force of 59 to 98 N {13 to 22 ft.lbs, 6 to 10 kgf·m}.

PARKING BRAKE CONTROL



● **Removal sequence**

1 Clevis pin
2 Parking brake lever assembly 🕮 P36A-7
3 Parking brake cable

***** : Parking brake assembly 🕮 P36A-8

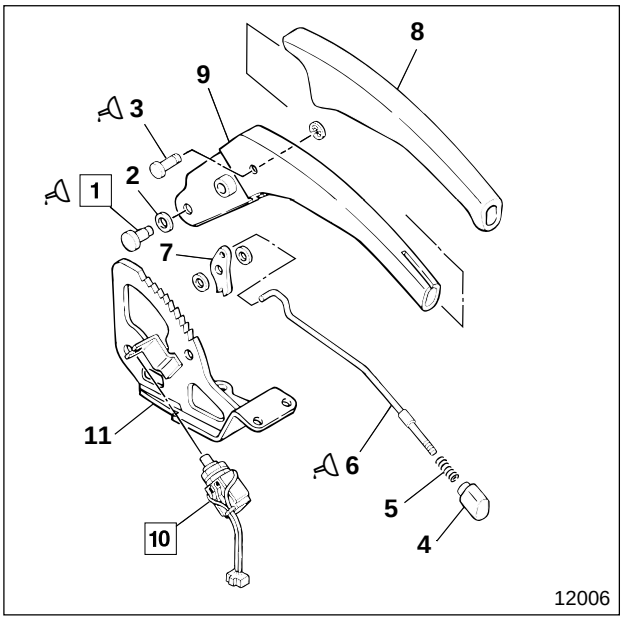
WARNING⚠

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Installation sequence**

Follow the removal sequence in reverse.

Parking Brake Lever Assembly



● **Disassembly sequence**

1 Pin
2 Spacer
3 Pin
4 Release rod knob
5 Return spring
6 Release rod
7 Locking latch
8 Grip
9 Parking brake lever
10 Parking brake switch Gr 54
11 Lever bracket

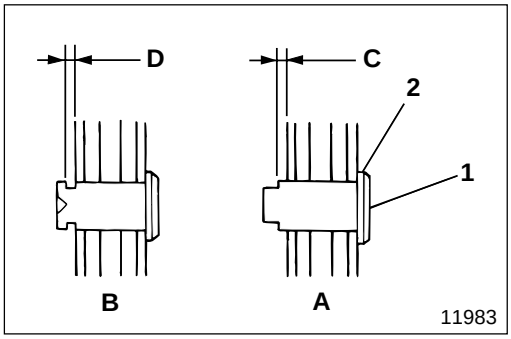
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Location	Points of application	Kinds	Quantity
1, 3	Rotating area and friction surface of pins	Chassis grease [NLGI No.1 (Ca soap)]	As required
6	Thread area of release rod	Cemedine 1500	As required

◆ Service procedure

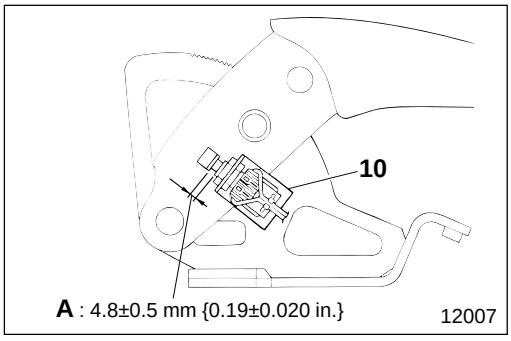


1 **Installation of pin**

A : Before caulking
B : After caulking

When clearance **C** (before caulking) is less than 0.6 mm {0.024 in.}, do not use spacer **2**.
Also, use the spacer to adjust if clearance is 0.6 to 0.96 mm {0.024 to 0.038 in.}.

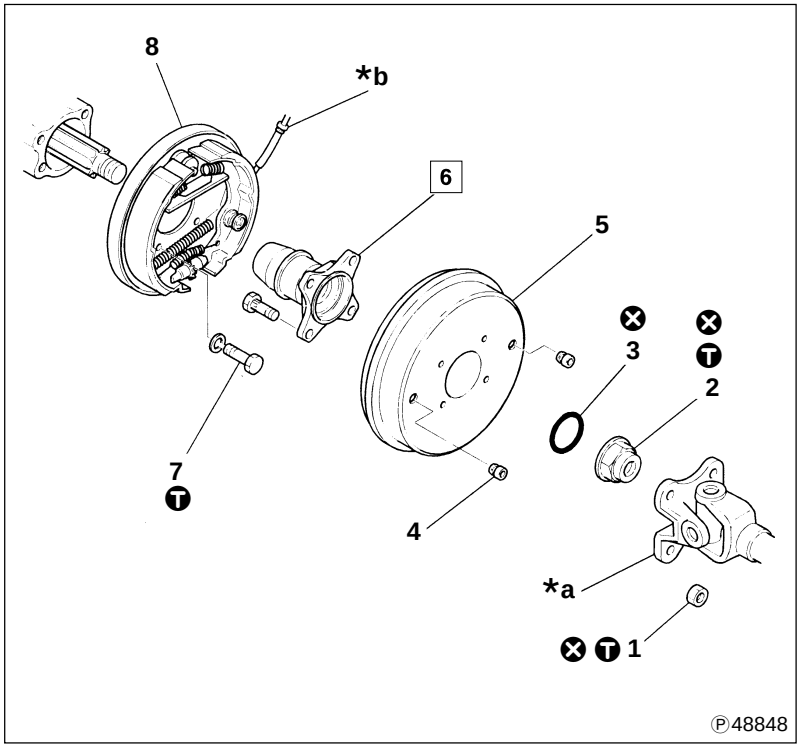
	Without spacer	With spacer
Dimension **D**	0.06 to 0.6 mm {0.0024 to 0.024 in.}	0 to 0.36 mm {0 to 0.014 in.}



10 **Installation of parking brake switch**

Install parking brake switch **10** so that the stroke equals **A**.

PARKING BRAKE ASSEMBLY



● **Disassembly sequence**

1 Nut
2 Lock nut
3 O-ring
4 Dust plug
5 Parking brake drum
6 Companion flange
7 Bolt
8 Backing plate and shoe assembly
📖 P36A-10

***a** : Propeller shaft 📦 Gr 25
***b** : Parking brake cable 📖 P36A-6
⊗ : Non-reusable parts

WARNING ⚠

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
5	Parking brake drum	Inner diameter	ø190 $^{+0.2}_{0}$ {7.48 $^{+0.0079}_{0}$}	ø191 {7.52}	Replace
		Squareness	0.05 {0.0020} or less	—	
		Concentricity	ø0.1 {0.0039} or less	—	
		Cylindrical accuracy	0.05 {0.0020} or less	—	
		Static rotation imbalance	0.49 N·cm {0.0036 lbf.ft, 50 gf·cm} or less	—	

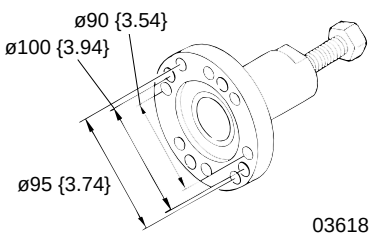
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

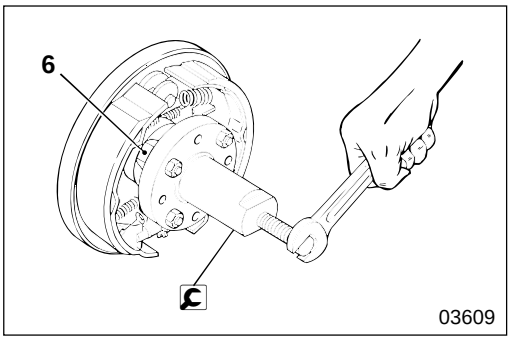
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Propeller shaft mounting)	98 to 120 {72 to 87, 10 to 12}	—
2	Lock nut (Companion flange mounting)	125 {94, 13}	—
7	Bolt (Backing plate and shoe assembly mounting)	52 to 67 {38 to 49, 5.3 to 6.8}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
6	Flange puller 	MH061848	Removal of companion flange

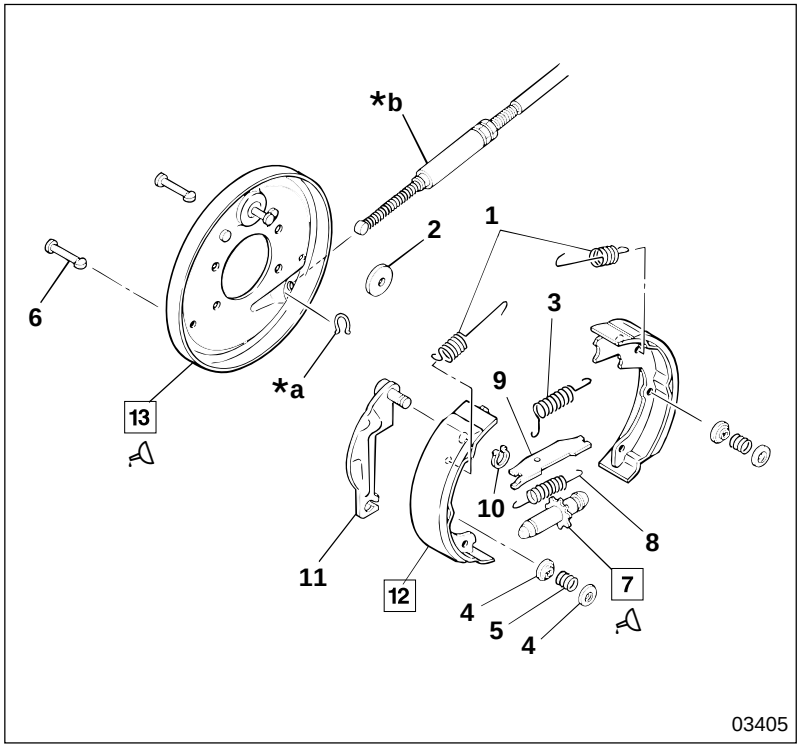
◆ Service procedure



6 Removal of companion flange

: Flange puller

BACKING PLATE AND SHOE ASSEMBLY



● **Disassembly sequence**

1 Shoe return spring
2 Washer
3 Strut spring
4 Shoe hold down cup
5 Shoe hold down spring
6 Shoe hold down pin
7 Adjuster
8 Adjuster spring
9 Strut
10 Retainer
11 Parking lever
12 Shoe and lining assembly
13 Backing plate

***a** : Retainer
***b** : Parking brake cable 🕮 P36A-6

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave grease or oil on the surface of shoe and lining assembly 12 because this reduces braking performance.

NOTE

If shoe and lining assembly 12 has been replaced with a new part, check correctness of contact with the parking brake drum.

Service standards

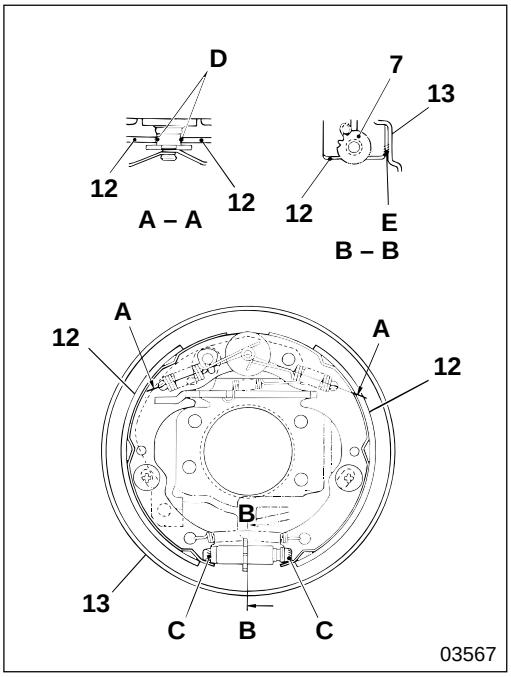
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (Installed length : 67.1 {2.64})	59±5.9 N {13±1.3 lbf.ft, 6±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace
3	Installed load of strut spring (Installed length : 49 {1.93})	29±2.9 N {6.6±0.7 lbf.ft, 3±0.3 kgf}	26 N {6 lbf, 2.7 kgf}	Replace
5	Installed load of shoe hold down spring (Installed length : 15.5 {0.61})	78±7.8 N {18±1.8 lbf.ft, 8±0.8 kgf}	71 N {16 lbf, 7.2 kgf}	Replace
8	Installed load of adjuster spring (Installed length : 78.2 {3.08})	59±5.9 N {13±1.3 lbf.ft, 6±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace
12	Thickness of lining	4 {0.16}	1.4 {0.055}	Replace

Lubricant

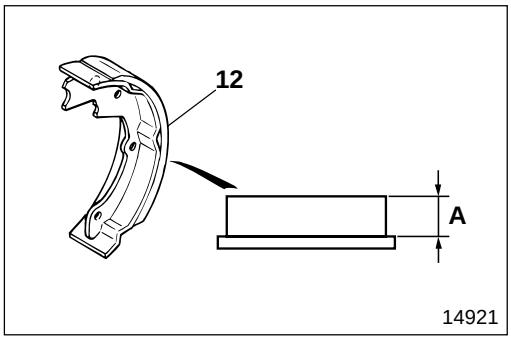
Location	Points of application	Kinds	Quantity
7	Contact surfaces of both ends of adjuster with shoe and lining assembly	Brake grease	As required
13	Anchor pin area and sliding face (6 points) of backing plate	Brake grease	As required

◆ Service procedure



7 **13** **Applying grease to adjuster and backing plate**

- Apply grease to contact surface **C** between both ends of adjuster **7** and shoe and lining assembly **12**.
- Apply grease to area **D** of the anchor pin and sliding face **E** (6 points) of backing plate **13**.



12 **Inspection of shoe and lining assembly**

Measure thickness **A** of the lining. If the measured value is lower the limit, replace shoe and lining assembly **12**.

MITSUBISHI
FUSO

Group 36B
Parking Brake
< FH211 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-36B

INDEX

SPECIFICATIONS 36B- 2

STRUCTURE AND OPERATION
1. Parking Brake Control 36B- 2
2. Parking Brake Lever 36B- 2
3. Parking Brake Assembly 36B- 3

TROUBLESHOOTING 36B- 4

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Adjustment of Parking Brake Shoe Clearance and Lever Stroke 36B- 5

PARKING BRAKE CONTROL 36B- 6

PARKING BRAKE ASSEMBLY 36B- 8

SUPPORT PLATE AND SHOE ASSEMBLY
< ø203.2 mm {8 in.} Drum > 36B-12
< ø254 mm {10 in.} Drum > 36B-14

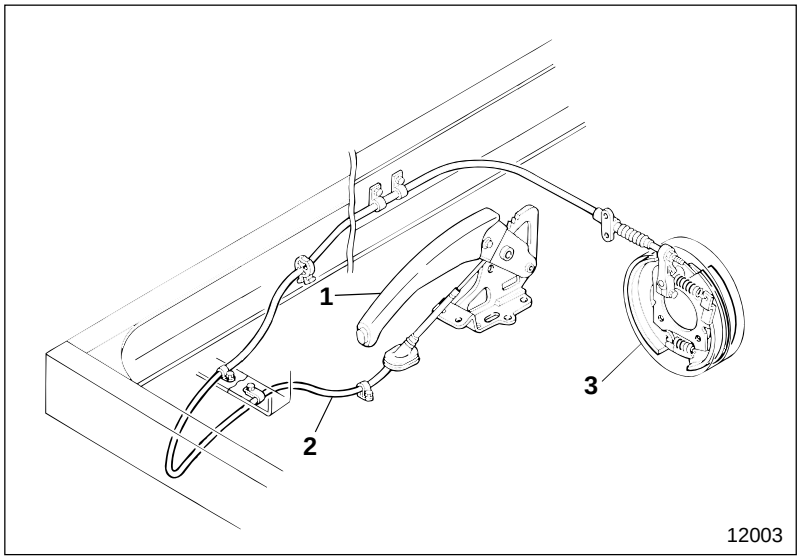
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item \ Vehicle model		FH211-A	FH211-B
		Manual transmission	Automatic transmission
Brake	Type	Propeller shaft internal expanding type brake	
	Operation type	Mechanical cable type	
Parking brake assembly	Type	Duo-servo type	
	Inner diameter of drum mm {in.}	ø203.2 {8}	ø254 {10}
	Lining width×Thickness mm {in.}	50×4.0 {1.97×0.16}	60×5.8 {2.36×0.23}

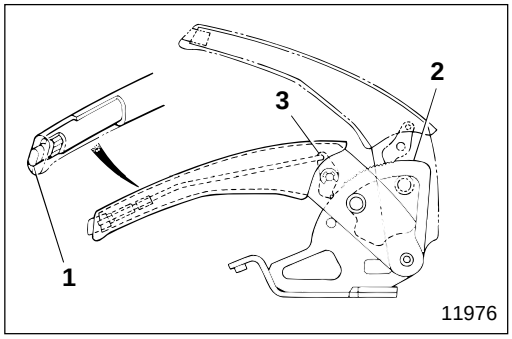
STRUCTURE AND OPERATION

1. Parking Brake Control



1 Parking brake lever
2 Parking brake cable
3 Parking brake assembly

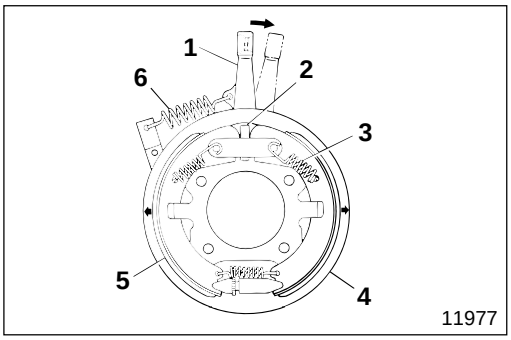
2. Parking Brake Lever



1 Release rod knob
2 Lever bracket
3 Locking latch

The parking brake has a built-in locking mechanism that prevents inadvertent release of the brake.
To release locking, push release rod knob **1** which will disengage from the serration of lever bracket **2** and the tooth of locking latch **3** freeing the parking brake lever and allowing it to return.

3. Parking Brake Assembly



1 Camshaft lever
2 Camshaft
3 Shoe return spring
4 Dust cover or support plate and cover assembly
5 Shoe and lining assembly
6 Camshaft lever return spring

Pulling the parking brake lever pulls the parking brake cable, which in turn pulls camshaft lever **1**. At the same time, camshaft **2** rotates in conjunction with the camshaft lever, and expands shoe and lining assembly **5** making it press against the brake drum. This frictional force locks the propeller shaft that is connected to the drum. When the brake lever is released, the repercussive force of shoe return spring **3** releases the brake.

TROUBLESHOOTING

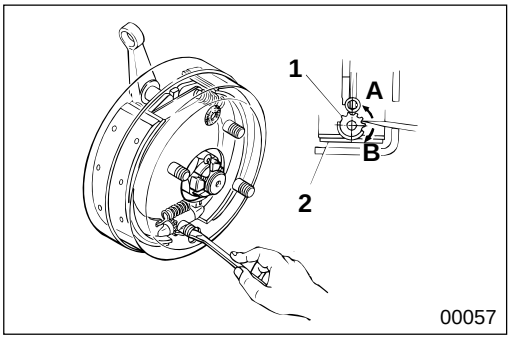
Possible causes / Symptoms		Parking brake does not work	Parking brake does not release smoothly (dragging)	Remarks
Parking brake cable	Inner cable stretched or damaged	○	○	
	Inner cable rusted		○	
Parking brake lever	Locking latch and lever bracket engaging incorrectly	○		
	Pulling stroke insufficient		○	
	Pulling stroke excessive	○		
Parking brake assembly	Shoe clearance insufficient		○	
	Shoe clearance excessive	○		
	Parking brake drum inner surface deformed or warped	○		
	Lining worn unevenly	○		
	Brake drum inner surface greasy or oily	○		
	Lining surface greasy or oily	○		
	Camshaft lever return spring fatigued or fractured		○	
	Shoe return spring fatigued or fractured		○	

1. Adjustment of Parking Brake Shoe Clearance and Lever Stroke

Service standards

Unit : mm {in.}

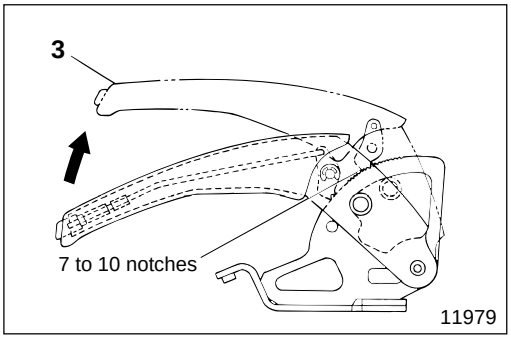
Location	Maintenance item	Standard value	Limit	Remedy
—	Brake shoe clearance	0.1 to 0.25 {0.0039 to 0.0098}	—	Adjust
3	Brake lever pulling stroke (at operating force of 490 N {110 lbf, 50 kgf})	7 to 10 notches	—	Adjust



(1) Shoe clearance

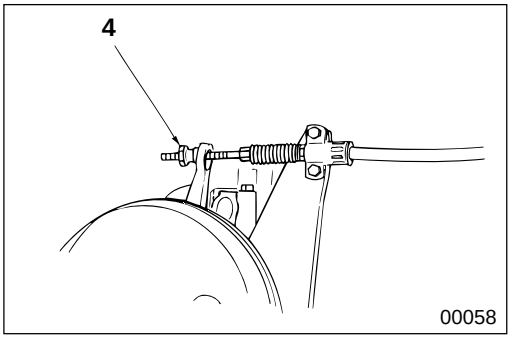
When the camshaft lever is released, turn adjusting screw **1** in the expansion direction, using a screwdriver inserted through the shoe adjusting hole of the brake drum, and return 8 notches from the position where shoe **2** is in close contact with the drum. Then, the shoe clearance will be the standard value.

A : Expansion
B : Contraction

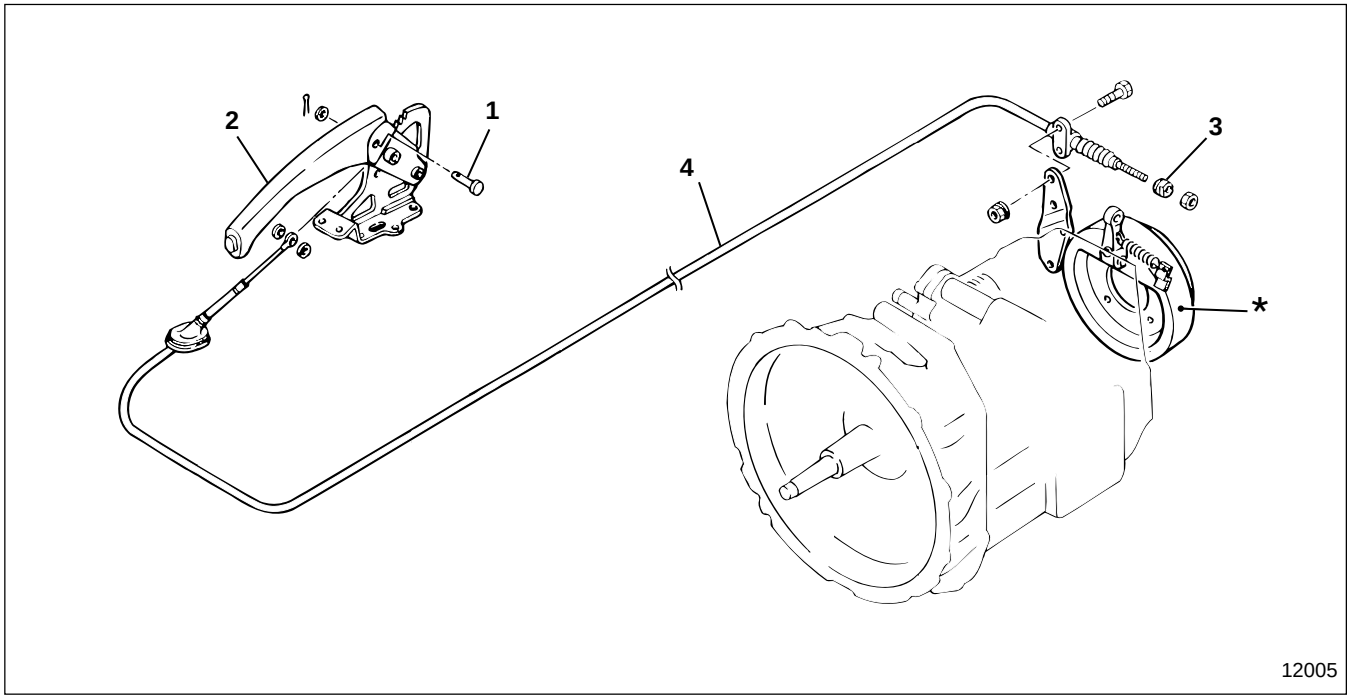


(2) Lever pulling stroke

Adjust camshaft lever lock nut **4** so that the number of notches (clicks heard) is the standard value when parking brake lever **3** is pulled from the released position by an operating force of 490 N {110 lbf, 50 kgf}. Operate the parking brake lever two or three times after adjusting to verify the pulling stroke, to make sure that the parking brake is operating properly and that the parking brake drum does not drag when the parking brake is released.



PARKING BRAKE CONTROL



● **Removal sequence**

1 Clevis pin
2 Parking brake lever assembly 🕮 P36B-7
3 Ball bushing
4 Parking brake cable

***** : Parking brake assembly 🕮 P36B-8

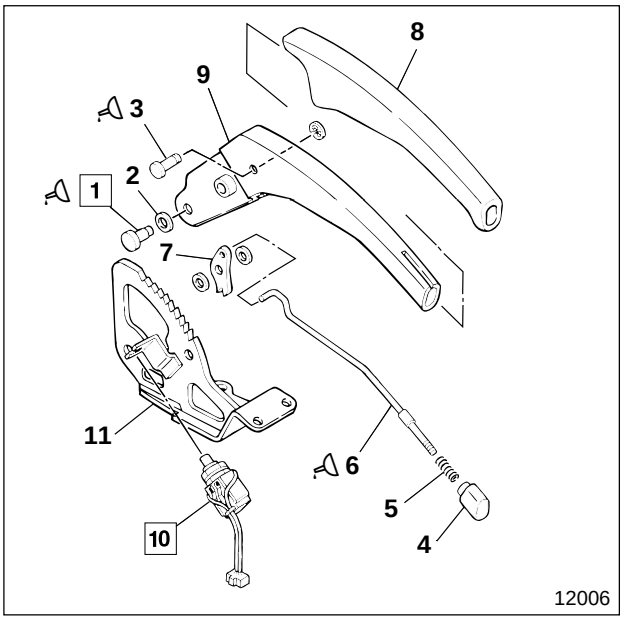
WARNING⚠

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Installation sequence**

Follow the removal sequence in reverse.

Parking Brake Lever Assembly



● **Disassembly sequence**

1 Pin
2 Spacer
3 Pin
4 Release rod knob
5 Return spring
6 Release rod
7 Locking latch
8 Grip
9 Parking brake lever
10 Parking brake switch Gr 54
11 Lever bracket

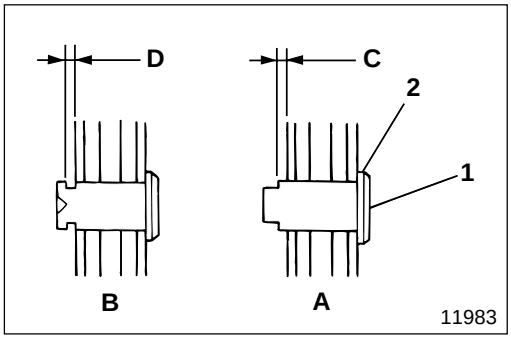
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Location	Points of application	Kinds	Quantity
1, 3	Rotating area and friction surface of pins	Chassis grease [NLGI No.1 (Ca soap)]	As required
6	Thread area of release rod	Cemedine 1500	As required

◆ Service procedure

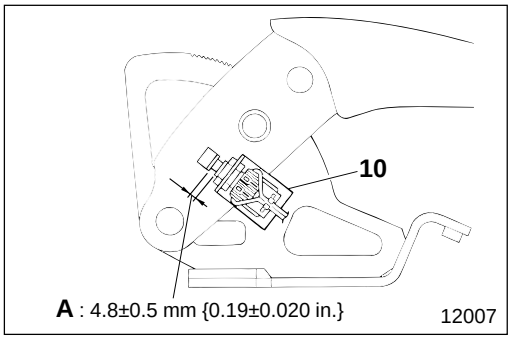


1 **Installation of pin**

A : Before caulking
B : After caulking

When clearance **C** (before caulking) is less than 0.6 mm {0.024 in.}, do not use spacer **2**.
Also, use the spacer to adjust if clearance is 0.6 to 0.96 mm {0.024 to 0.038 in.}.

	Without spacer	With spacer
Dimension **D**	0.06 to 0.6 mm {0.0024 to 0.024 in.}	0 to 0.36 mm {0 to 0.014 in.}

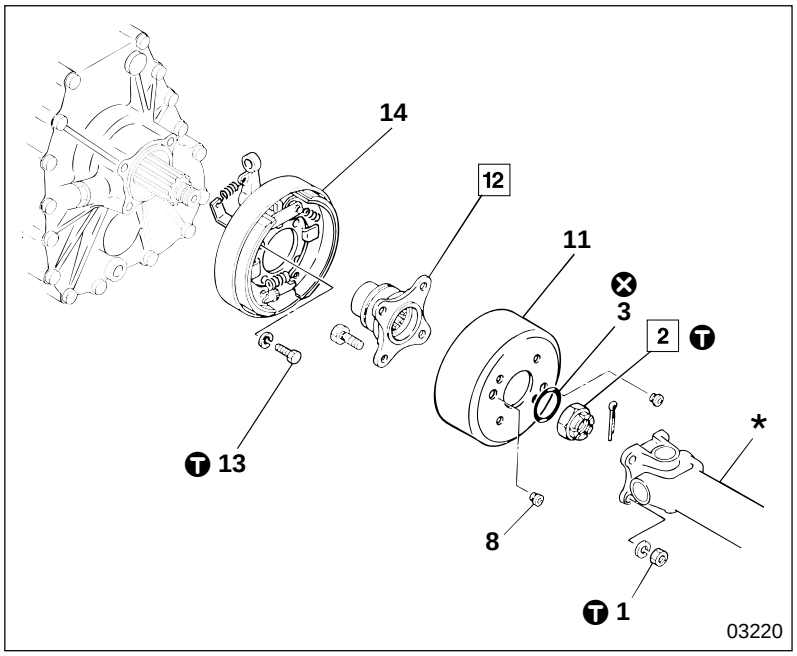


10 **Installation of parking brake switch**

Install parking brake switch **10** so that the stroke equals **A**.

PARKING BRAKE ASSEMBLY

< Manual Transmission >



● **Inspection before disassembly**

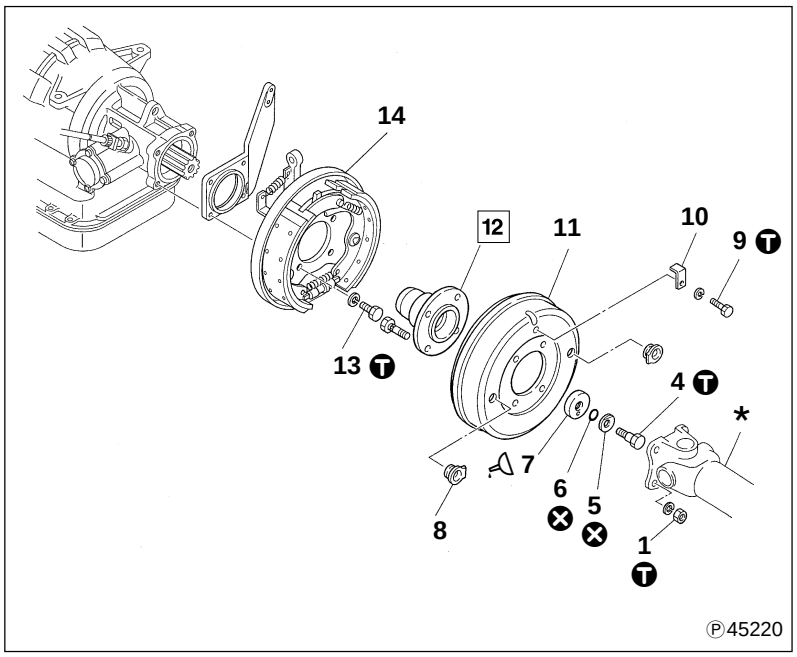
P36B-10

● **Disassembly sequence**

1 Nut
2 Lock nut
3 O-ring
4 Flange set bolt
5 Lock washer
6 O-ring
7 Retainer washer
8 Dust plug
9 Bolt
10 Drum plate
11 Parking brake drum
12 Companion flange
13 Bolt
14 Support plate and shoe assembly
P36B-12 or P36B-14

* : Propeller shaft Gr 25
⊗ : Non-reusable parts

< Automatic Transmission >



WARNING⚠

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

< Manual Transmission >

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
11	Parking brake drum	Deflection at mating area	0.15 {0.0059} or less	0.5 {0.020}	Replace
		Inner diameter	ø203.2 $^{+0.3}_{0}$ {8 $^{+0.012}_{0}$}	ø205 {8.07}	
		Squareness	0.05 {0.0020} or less	—	
		Concentricity	ø0.2 {0.0079} or less	—	
		Cylindrical accuracy	0.05 {0.0020} or less	—	
		Static rotation imbalance	0.88 N·cm {0.0065 ft.lbs, 90 gf·cm}	—	

< Automatic Transmission >

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
11	Parking brake drum	Deflection at mating area	0.15 {0.0059} or less	0.5 {0.020}	Replace
		Inner diameter	ø254.0 $^{+0.5}_{0}$ {10 $^{+0.020}_{0}$}	ø255.5 {10.1}	
		Squareness	0.05 {0.0020} or less	—	
		Concentricity	ø0.1 {0.0039} or less	—	
		Cylindrical accuracy	0.05 {0.0020} or less	—	
		Static rotation imbalance	0.88 N·cm {0.0065 ft.lbs, 90 gf·cm}	—	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Propeller shaft mounting)		85 {61, 8.5}	—
2	Lock nut (Companion flange mounting)		245 to 345 {180 to 235, 25 to 35}	—
4	Flange set bolt (Companion flange mounting)		140 to 160 {100 to 120, 14.10 to 16.72}	—
9	Bolt (Drum plate mounting)		20 {14, 2}	—
13	Bolt (Support plate and shoe assembly mounting)	Manual transmission	40 {30, 4.1}	—
		Automatic transmission	110 to 130 {81 to 97, 11.22 to 13.46}	

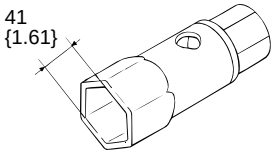
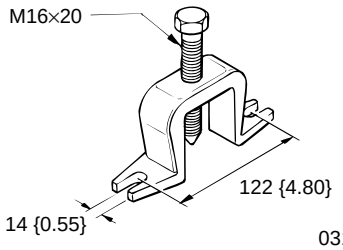
Sealant

Location	Points of application	Kinds	Quantity
7	Outer periphery of retainer washer	THREEBOND 1215	As required

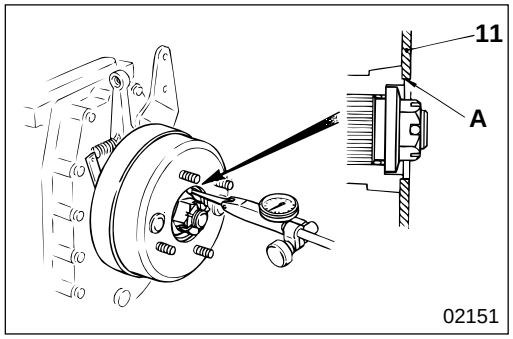
PARKING BRAKE ASSEMBLY

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Socket wrench  00069	MH061532	Removal and installation of main shaft rear lock nut < Manual transmission >
12	Flange puller  03159	MC881524	Removal of main shaft rear companion flange

◆ Service procedure



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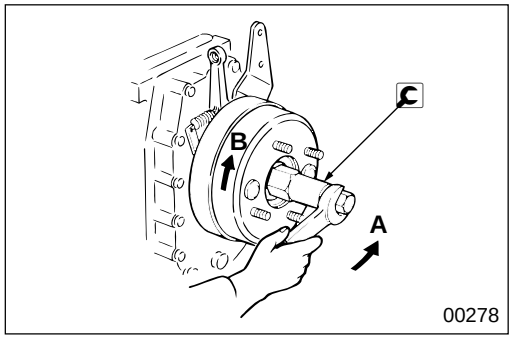
● **Inspection before disassembly**

Measure parking brake drum **11** at mating area **A**, and replace the brake drum if the measured valve is higher than the limit.



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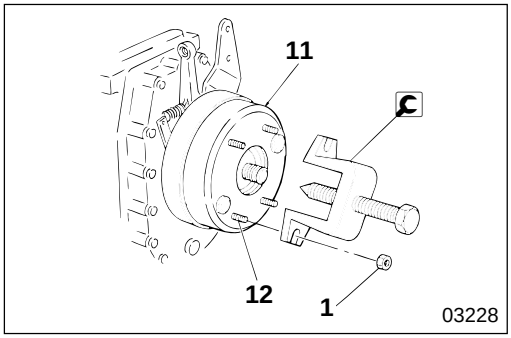
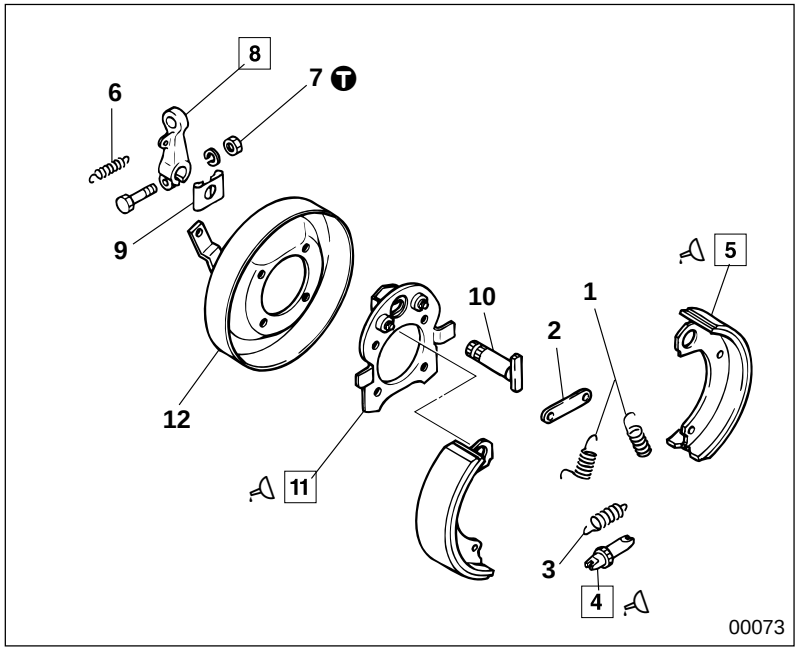
2 **Removal and installation of lock nut < Manual transmission >**

A : Removal
B : Installation



12 **Removal of companion flange**

SUPPORT PLATE AND SHOE ASSEMBLY < ø203.2 mm {8 in.} Drum >



● **Disassembly sequence**

1 Shoe return spring
2 Anchor pin brace
3 Adjusting wheel return spring
4 Adjusting screw
5 Shoe and lining assembly
6 Camshaft lever return spring
7 Nut
8 Camshaft lever
9 Spring spacer
10 Camshaft
11 Support plate
12 Dust cover

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave grease or oil on the surface of shoe and lining assembly 5 because this reduces braking performance.

NOTE

If shoe and lining assembly 5 has been replaced with a new part, check correctness of contact with the parking brake drum.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (Installed length 57.5 {2.26})	145±15 N {33±3.3 lbf, 15±1.5 kgf}	115 N {26 lbf, 12 kgf}	Replace
3	Installed load of adjusting wheel return spring (Installed length 59 {2.32})	78±7.8 N {18±1.8 lbf, 8±0.8 kgf}	63 N {14 lbf, 6.4 kgf}	Replace
5	Lining thickness of shoe and lining assembly	4.0 {0.16}	1.4 {0.055}	Replace
6	Installed load of camshaft lever return spring (Installed length 85 {3.35})	62±5.9 N {14±1.3 lbf, 6.3±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace

Ⓣ Tightening torque

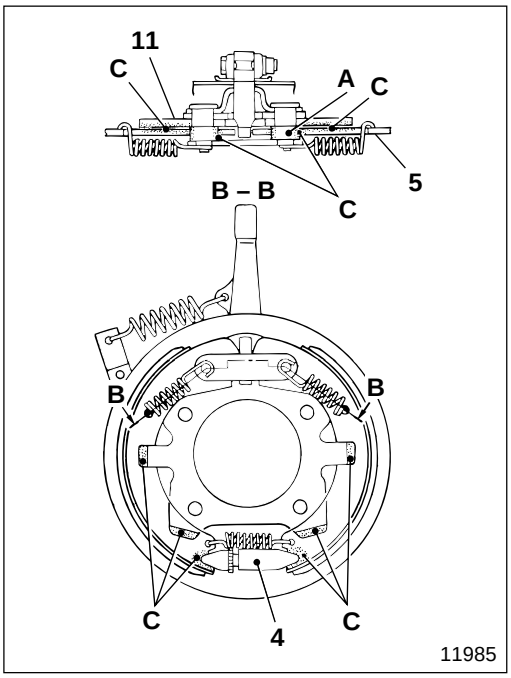
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Nut (Camshaft lever mounting)	6.9 to 13 {5.1 to 9.4, 0.7 to 1.3}	—

Lubricant

Location	Points of application	Kinds	Quantity
4, 5	Contact surfaces of both ends of adjusting screw with shoe and lining assembly	Brake grease (AKB100)	As required
5, 11	Contact surface of support plate and shoe and lining assembly	Brake grease (AKB100)	As required
	Contact surface of anchor pin area and support plate and shoe and lining assembly	Brake grease (AKB100)	As required

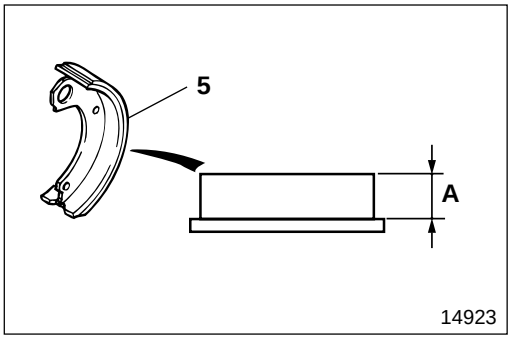
◆ Service procedure



4 **5** **11** **Applying grease to adjusting screw, shoe and lining assembly, and support plate**

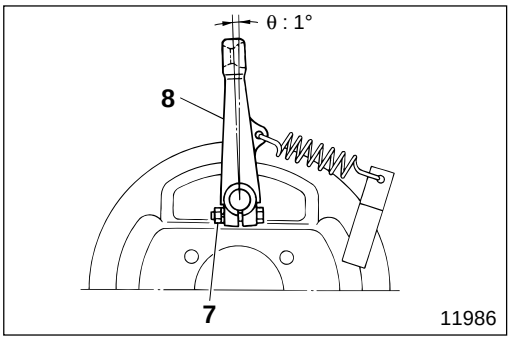
Apply grease to area **C**.

A : Anchor pin area



5 **Inspection of shoe and lining assembly**

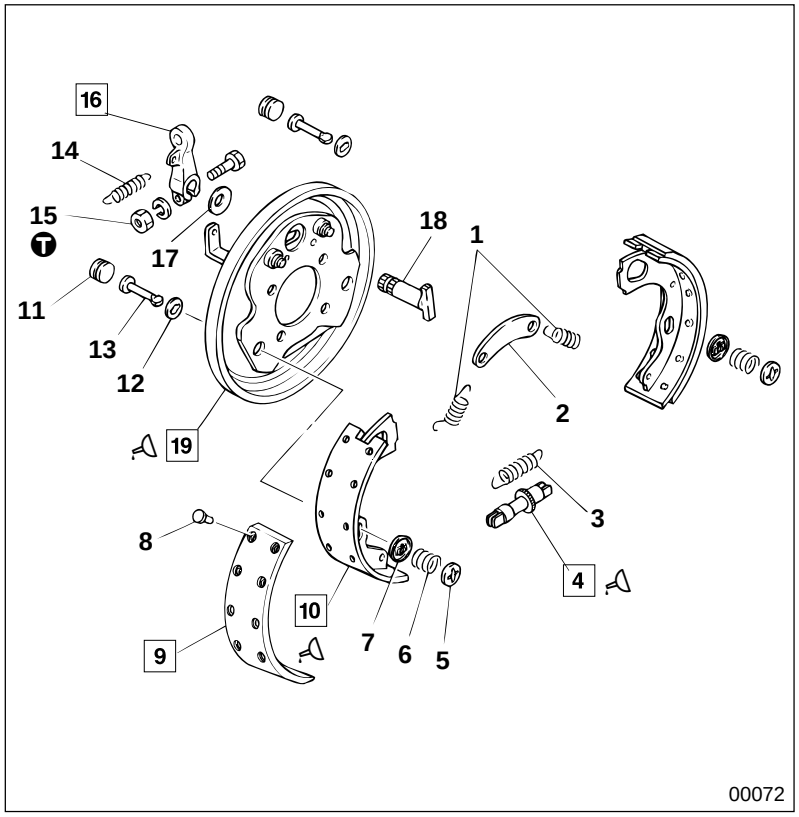
Measure thickness **A** of the lining. If the measured value is lower than the limit, replace shoe and lining assembly **5**.



8 **Installation of camshaft lever**

Install camshaft lever **8**, aligning the lever at the specified angle θ, then tighten nut **7** at specified torque.

SUPPORT PLATE AND SHOE ASSEMBLY < ø254 mm {10 in.} Drum >



● **Disassembly sequence**

1 Shoe return spring
2 Anchor pin brace
3 Adjusting wheel return spring
4 Adjusting screw
5 Shoe hold-down cup
6 Shoe hold-down spring
7 Shoe hold-down cup
8 Rivet
9 Lining
10 Brake shoe
11 Cover
12 Shoe hold-down washer
13 Shoe hold-down pin
14 Camshaft lever return spring
15 Nut
16 Camshaft lever
17 Spring spacer
18 Camshaft
19 Support plate and cover assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave grease or oil on the surface of lining 9 because this reduces braking performance.

NOTE

If lining 9 has been replaced with a new part, check correctness of contact with the parking brake drum.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (Installed length 75 {2.95})	180±18 N {41±4.0 lbf, 18.5±1.8 kgf}	145 N {33 lbf, 15 kgf}	Replace
3	Installed load of wheel return spring (Installed length 85 {3.35})	105±11 N {24±2.4 lbf, 11±1.1 kgf}	86 N {19 lbf, 8.8 kgf}	Replace
6	Installed load of shoe hold-down spring (Installed length 14 {0.55})	145±15 N {33±3.3 lbf, 15±1.5 kgf}	115 N {26 lbf, 12 kgf}	Replace
9	Lining thickness	5.8 {0.23}	3.5 {0.14}	Replace
14	Installed load of camshaft lever return spring (Installed length 85 {3.35})	62±5.9 N {14±1.3 lbf, 6.3±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace

Tightening torque

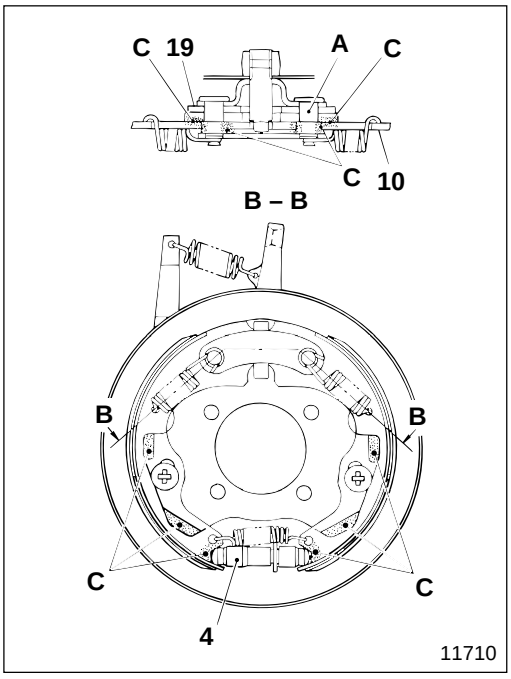
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
15	Nut (Camshaft lever mounting)	13.72 to 22.56 {10 to 17, 1.4 to 2.3}	—

Lubricant

Location	Points of application	Kinds	Quantity
4, 10	Contact surfaces of both ends of adjusting screw with shoe and lining assembly	Brake grease (AKB100)	As required
10, 19	Contact surface of support plate and shoe and lining assembly	Brake grease (AKB100)	As required
	Contact surface of anchor pin area and support plate and shoe and lining assembly	Brake grease (AKB100)	As required

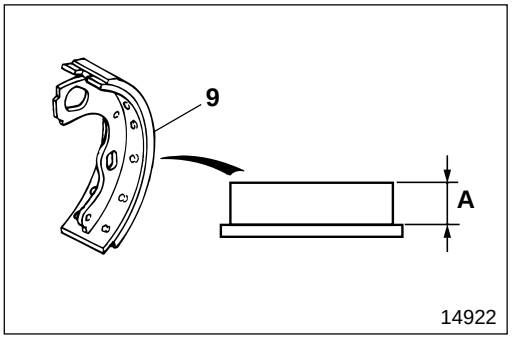
◆ Service procedure



4 **10** **19** **Applying grease to adjusting screw, shoe and lining assembly, and support plate**

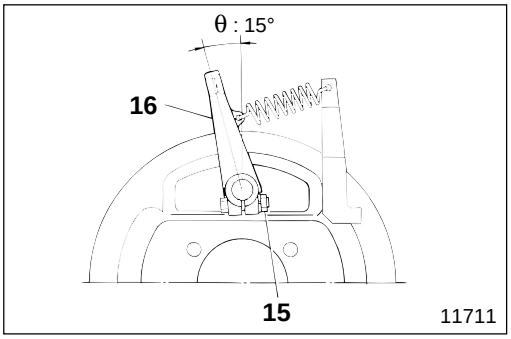
Apply grease to area **C**.

A : Anchor pin area



9 **Inspection of lining**

Measure thickness **A** of lining **9**. If the measured value is lower than the limit, replace the lining.



16 **Installation of camshaft lever**

Install camshaft lever **16**, aligning the lever at the specified angle θ, then tighten nut **15** at specified torque.

MITSUBISHI
FUSO

Group 37

Steering

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-37

INDEX

SPECIFICATIONS 37- 2

STRUCTURE AND OPERATION
- 1. Steering System 37- 3
- 2. Power Steering System 37- 4
- 3. Power Steering Booster 37- 4
- 4. Power Steering Oil Pump 37- 6

TROUBLESHOOTING 37-10

ON-VEHICLE INSPECTION AND ADJUSTMENT
- 1. Change of Power Steering Fluid 37-13
- 2. Bleeding of Power Steering System 37-13
- 3. Steering Wheel Play 37-14
- 4. Performance Verification Test of Power Steering System 37-15

STEERING SYSTEM 37-16

STEERING COLUMN SUBASSEMBLY 37-22

POWER STEERING BOOSTER 37-26

POWER STEERING OIL PUMP < KAYABA > 37-38

POWER STEERING OIL PUMP < Unisia JKC Steering System > ... 37-42

POWER STEERING OIL TANK 37-46

POWER STEERING FLUID LINE 37-48

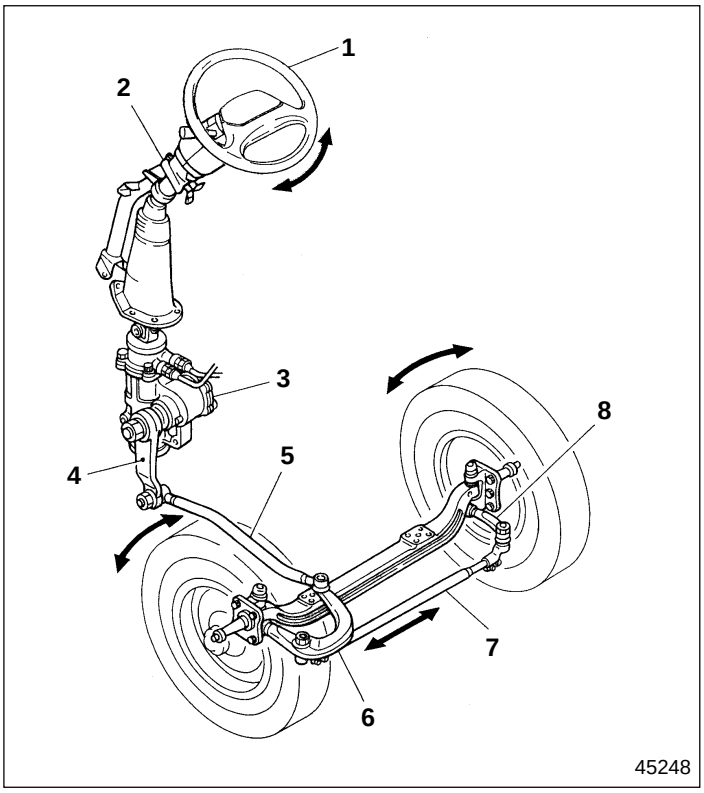
DRAG LINK 37-50

TIE ROD ASSEMBLY 37-52

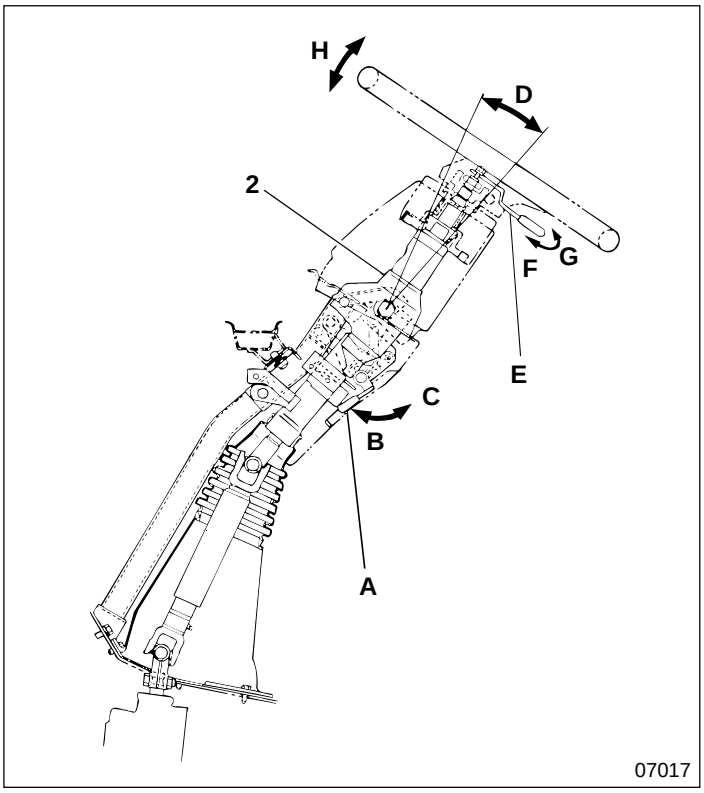
SPECIFICATIONS

Item		Specification	
		FH210	FH211
Steering wheel	Type	2-spoke type	
	Outer diameter mm {in.}	400 {15.7}	
Steering shaft	Type	Universal joint type (High tilt and telescopic type)	
Power steering booster	Manufacturer	Unisia JKC Steering Systems	
	Type	Ball nut type	
	Form	Integral type	
	Gear ratio	17.1 to 20	
	Cylinder diameter mm {in.}	85 {3.35}	
	Mass (without pitman arm and fluid) kg {lb}	21 {46}	
Power steering oil pump	Manufacturer	KAYABA	Unisia JKC Steering Systems
	Type	Vane type	
	Discharge amount cm^3 {cu. in.}/rotation	12.6 {0.77}	11.2 {0.68}
	Regulated flow amount L {qts}/min	12 {13}	
	Regulated pressure (relief valve) MPa {psi, kgf/cm^2}	11.8 {1706, 120}	12.3 {1780, 125}
	Permissible revolutions rpm	600 to 6500	600 to 4800
	Mass (without drive gear and fluid) kg {lb}	1.8 {4.0}	2.4 {5.3}

1. Steering System

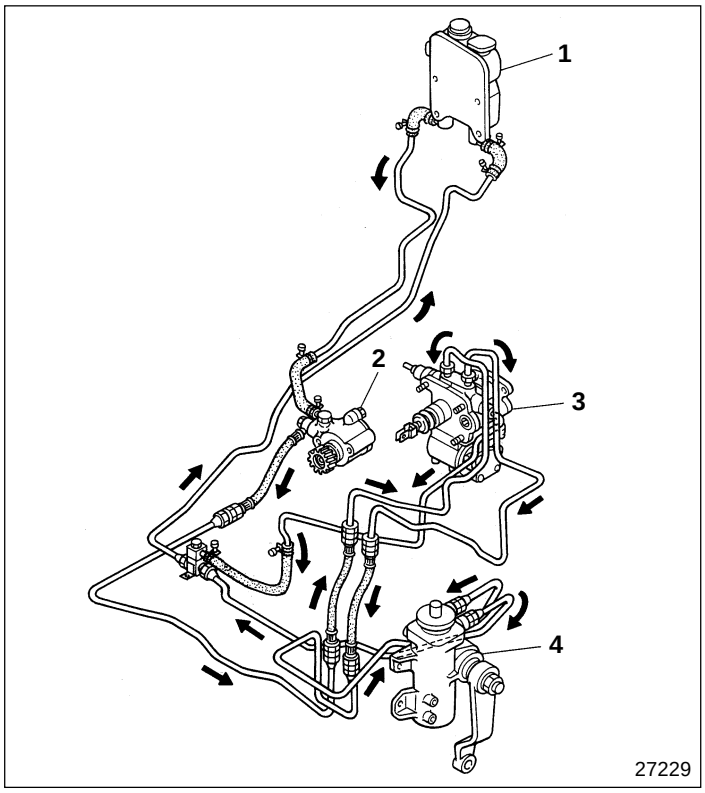


1 Steering wheel
2 Steering column subassembly
3 Power steering booster
4 Pitman arm
5 Drag link
6 Knuckle arm
7 Tie rod
8 Tie rod arm



Shifting lock lever **A** from lock position **B** to release position **C** produces high tilt **D**, and turning telescopic lever **E** (counterclockwise) from lock position **F** to release position **G** allows telescopic movement **H**. In this way, the structure of steering column subassembly **2** can be adjusted for optimum driving position.

2. Power Steering System

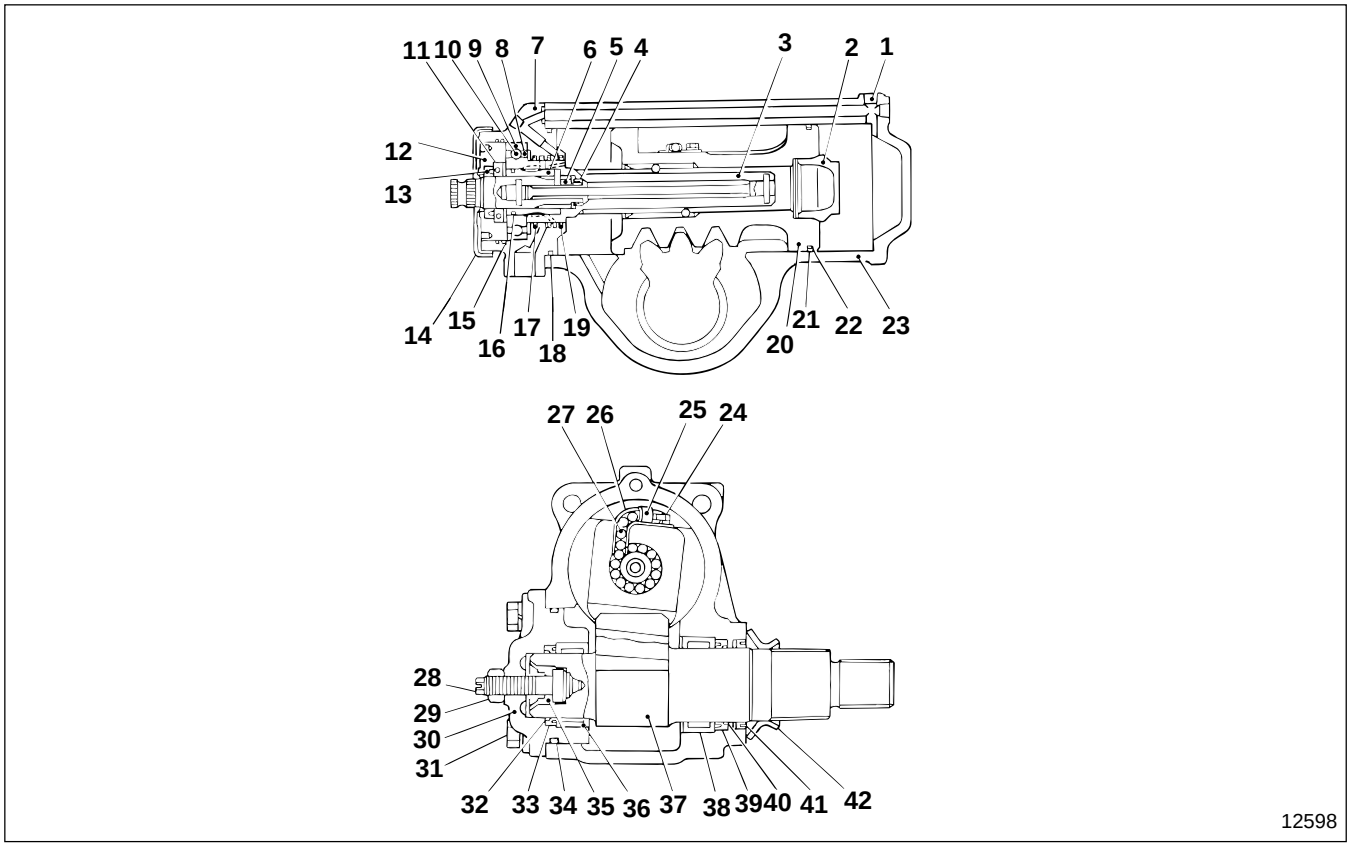


1 Power steering oil tank
2 Power steering oil pump
3 Brake booster (Hydraulic booster)
4 Power steering booster

⬅ : Fluid flow

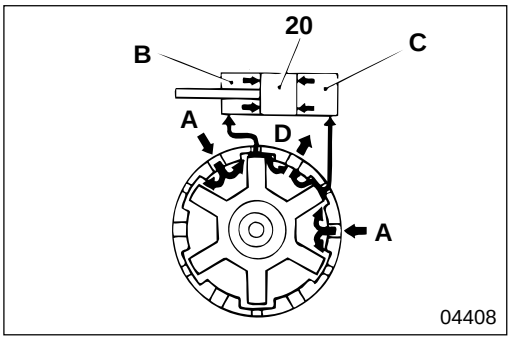
- In vehicles equipped with hydraulic booster brake, power steering oil pump **2** hydraulic pressure is also used for brake booster (hydraulic booster) **3** by the power steering system. Although the power steering pump is shared by both the power steering system and the brake system, the spool valve inside brake booster (hydraulic booster) ensures that power steering booster **4** and brake booster (hydraulic booster) operate without interfering with each other.
  (For information on brake booster operation, refer to Gr 35A.)

3. Power Steering Booster



1 Taper plug
2 Plug
3 Worm shaft
4 Needle bearing
5 Stub shaft
6 Rotor
7 Valve housing
8 Bearing cage
9 Side race
10 Steel ball
11 Ball bearing
12 Adjusting plug
13 Oil seal
14 Dust cover
15 O-ring
16 Seal ring
17 O-ring
18 O-ring
19 Seal ring
20 Piston
21 Seal ring
22 O-ring
23 Body
24 Screw
25 Ball tube clip
26 Ball tube
27 Steel ball
28 Adjusting screw
29 Nut
30 Side cover
31 Bolt
32 Backup ring
33 Y-packing
34 O-ring
35 Retainer
36 Needle bearing
37 Sector shaft
38 Needle bearing
39 Y-packing
40 Backup ring
41 Oil seal
42 Dust cover

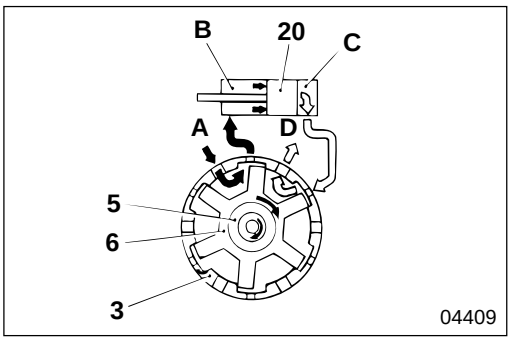
The rotary valve is the central part of the power steering booster. The torsion bar allows the steering reaction force and valve return to operate lightly and smoothly at low speed, and ensures stable steering feel even at high speed.



● **Straight-ahead operation**

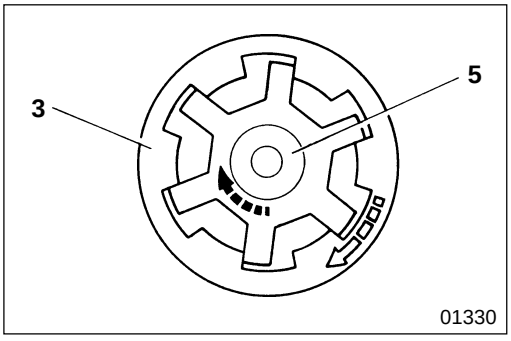
Piston **20** is in the neutral position as chambers **B** and **C** of the piston are under equal pressure.

A : From oil pump
D : To oil tank



● **Steering operation**

Turning the steering wheel rotates stub shaft **5**, causing rotor **6** to close the fluid feed passage to cylinder chamber **C**. This produces a pressure difference between cylinder chambers **B**, **C**, which causes piston **20** to move, and facilitates rotation of worm shaft **3**.

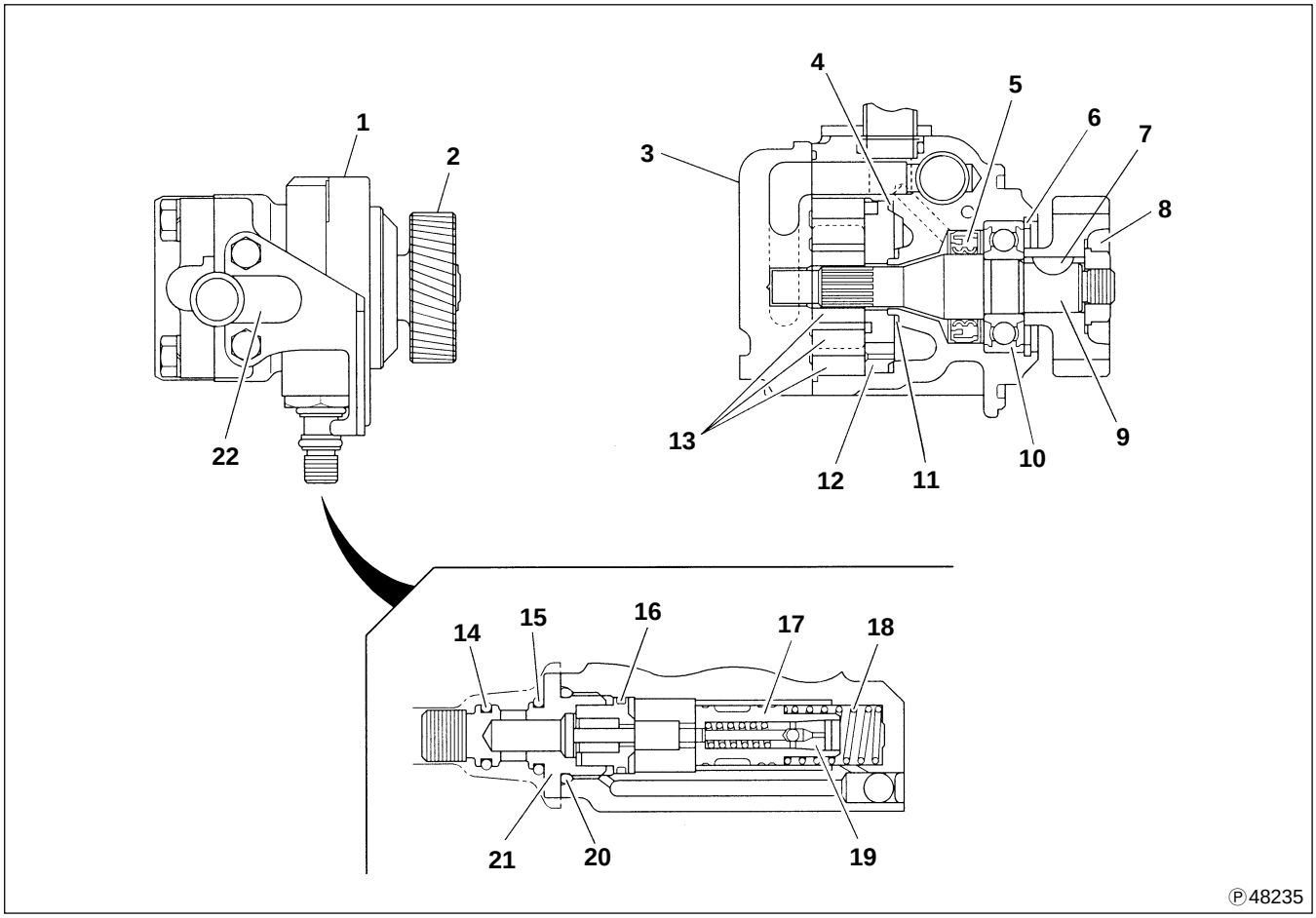


If the hydraulic circuit fails

The safety mechanism allows the vehicle to be steered manually, when the rotating force of stub shaft **5** alone directly turns worm shaft **3**, transmitting the steering force.

4. Power Steering Oil Pump

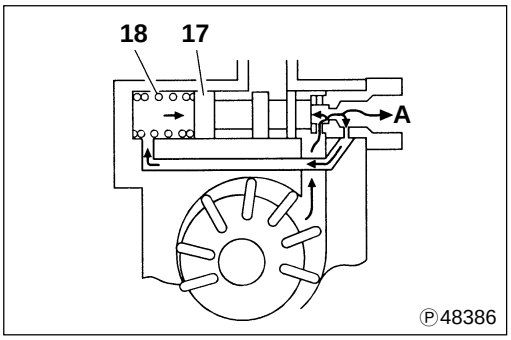
< KAYABA >



1	Body assembly	**9**	Shaft	**17**	Flow control valve assembly
2	Gear	**10**	Ball bearing	**18**	Flow control spring
3	Cover assembly	**11**	O-ring	**19**	Relief valve
4	O-ring	**12**	Side plate	**20**	O-ring
5	Oil seal	**13**	Cartridge assembly	**21**	Connector assembly
6	Retaining ring	**14**	O-ring	**22**	Suction connector
7	Key	**15**	O-ring		
8	Nut	**16**	O-ring		

- The power steering oil pump produces hydraulic pressure for the power steering system. Inside the pump, vanes are installed in the grooves of cartridge assembly **13**, and driving power is transmitted from the engine by means of gears.
- The power steering oil pump is comprised of an oil pump which discharges oil, a flow control valve that regulates the flow rate, and a relief valve which limits the pressure increase.
- Flow control valve assembly **17** maintains a constant flow of oil to the power steering booster when the steering wheel is operated.
  When the steering wheel is not operated, the relief valve built in the flow control valve assembly prevents the oil pressure from increasing inside the pump.

● Front Control Valve Assembly

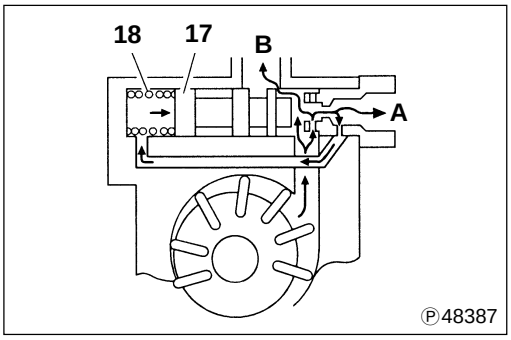


(1) Front control valve assembly

< When pump is rotating at low speed >

Because the force of flow control spring **18** is stronger than the oil pressure applied to front control valve assembly **17**, the flow control assembly remains in the same position, thus sending oil to the power steering booster.

A : To power steering booster

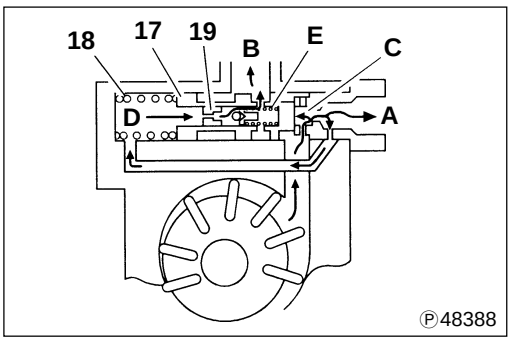


< When pump is rotating at low speed >

Because the force of flow control spring **18** is stronger than the oil pressure applied to front control valve assembly **17**, the flow control assembly remains in the same position, thus sending oil to the power steering booster.

A : To power steering booster

B : To pump section



(2) Relief valve section

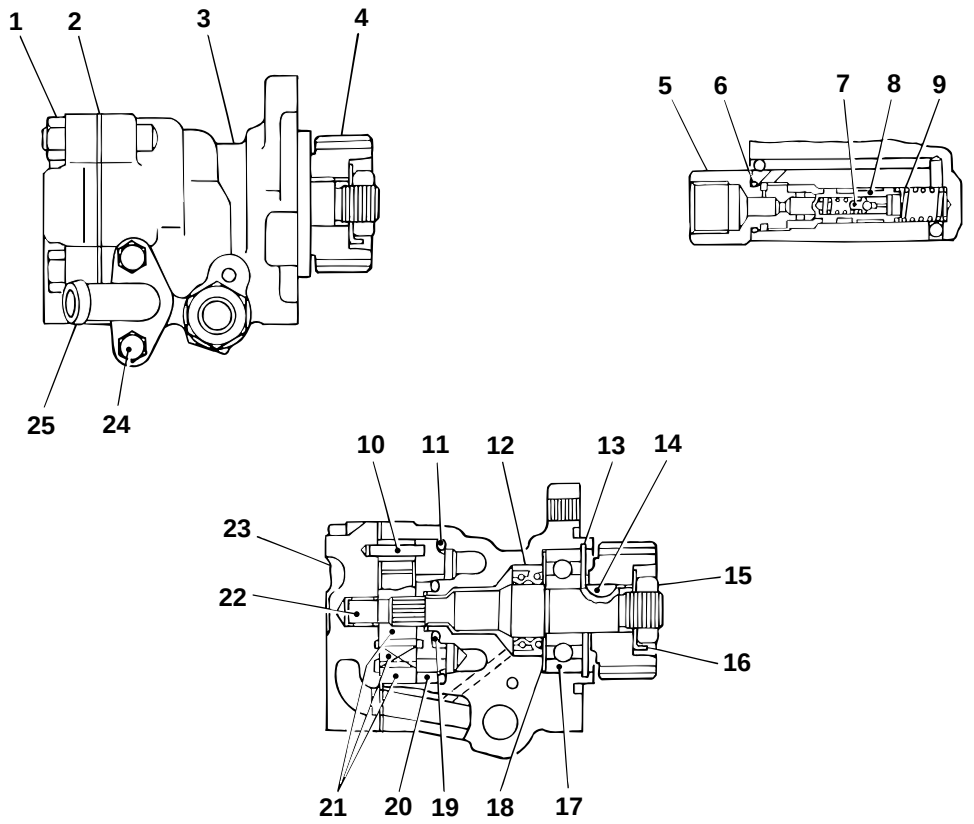
When the steering wheel is not operated, the pressure of oil between the power steering oil pump and power steering booster increases because the pump is rotating. In this condition, oil pressure is applied to passage **C** and chamber **D**. The oil pressure compresses relief valve spring **E**, thus moving relief valve **19** and returning oil to the pump section.

This reduces the oil pressure build up in the power steering pump.

A : To power steering booster

B : To pump section

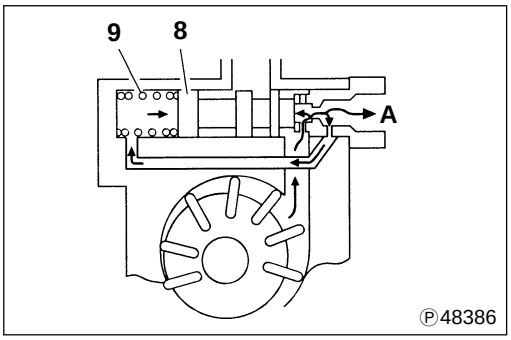
< Unisia JKC Steering Systems >



1	Bolt	**10**	Straight pin	**19**	O-ring
2	Gasket	**11**	O-ring	**20**	Pressure plate
3	Front body	**12**	Oil seal	**21**	Cartridge assembly
4	Gear	**13**	Retaining ring	**22**	Shaft
5	Connector	**14**	Key	**23**	Rear body
6	O-ring	**15**	Nut	**24**	Bolt
7	Relief valve	**16**	Lock washer	**25**	Suction pipe
8	Flow control valve assembly	**17**	Ball bearing		
9	Flow control spring	**18**	Retaining ring		

- The power steering oil pump produces hydraulic pressure for the power steering system. Inside the pump, vanes are installed in the grooves of cartridge assembly **21**, and driving power is transmitted from the engine by means of gears.
- The power steering oil pump is comprised of an oil pump which discharges oil, a flow control valve that regulates the flow rate, and a relief valve which limits the pressure increase.
- Flow control valve assembly **8** maintains a constant flow of oil to the power steering booster when the steering wheel is operated.
  When the steering wheel is not operated, the relief valve **7** built in the flow control valve assembly prevents the oil pressure from increasing inside the pump.

● Flow Control Valve Assembly

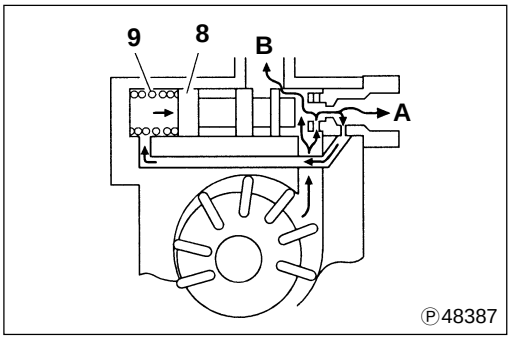


(1) Front control valve assembly

< When pump is rotating at low speed >

Because the force of flow control spring **9** is stronger than the oil pressure applied to front control valve assembly **8**, the flow control assembly remains in the same position, thus sending oil to the power steering booster.

A : To power steering booster

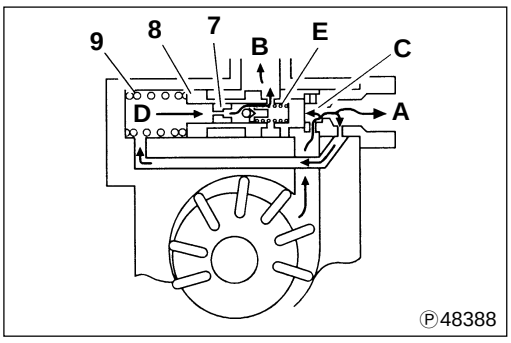


< When pump is operating at medium or high speed >

Increased rotating speed of the power steering oil pump causes the amount of oil that passes through the pump to exceed a certain level. When this happens, the oil pressure compresses flow control spring **9**, thus moving flow control assembly **8** and returning part of oil to the pump section. This results in the same amount of oil flow to the power steering booster as when the pump rotates at slow speed.

A : To power steering booster

B : To pump section



(2) Relief valve section

When the steering wheel is not operated, the pressure of oil between the power steering oil pump and power steering booster increases because the pump is rotating. In this condition, oil pressure is applied to passage **C** and chamber **D**. The oil pressure compresses relief valve spring **E**, thus moving relief valve **7** and returning oil to the pump section.

This reduces the oil pressure build up in the power steering pump.

A : To power steering booster

B : To pump section

Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure faulty	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Power steering mechanism faulty	Bearing damaged or worn	○			○	○								
	Ball or groove of ball screw worn	○	○		○									
	Air bled insufficiently	○												
	Fluid viscosity unsuitable	○												
	Power steering booster system faulty	○												
	Flow control valve malfunctioning	○												
	Ball screw unit rack and gear worn		○											
	Sector shaft bearing worn		○		○									
	Power steering booster mounting bolt loose		○											
	Ball screw unit and sector shaft play incorrect				○									
	Valve control edge damaged or control seal ring broken				○									
	Power steering system fluid unsuitable				○									
	Rack engagement starting torque adjusted incorrectly	○				○								
	Fluid circuit clogged	○				○								
	Sector shaft gear worn		○											
	Torsion shaft serration damaged or worn		○											
	Power steering booster body faulty			○	○									
	O-ring, oil seal faulty								○					
	Sealant applied incorrectly								○					
Steering column and linkage mechanism faulty	Universal joint worn abnormally, damaged, lubricated incorrectly	○	○											
	Linkage deformed	○												
	Drag link ball stud play		○		○									
	Tie rod end ball stud play		○		○									
	Tie rod bent						○							
	Pitman arm mounting position incorrect							○						
	Steering wheel turning center offset			○										

Possible causes / Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure faulty	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Front axle, etc. faulty	Kingpin lubricated incorrectly	○				○								
	Front wheel alignment (toe-in, camber, caster) incorrect	○		○	○	○								
	Thrust bearing damaged	○												
	Wheel hub bearing worn or damaged		○	○	○									Gr 26
	Kingpin or bushing worn or damaged		○	○	○									
	Front axle deformed			○										
	Knuckle arm, tie rod arm, or knuckle tightened incorrectly				○									
	U-bolt of front spring, nut, loose				○									Gr 33
	Front axle parts overtightened					○								
	Turning angle adjusted incorrectly						○	○						Gr 26
	Mounting parts, connection point loose		○											
	Knuckle stopper bolt adjusted incorrectly							○						
Oil pump faulty	Oil pump body faulty								○					
	O-ring or oil seal faulty								○					
	Bolt tightened incorrectly								○					
	Maximum generated fluid pressure insufficient									○				
	Fluid line crushed or clogged									○				
	Air lock in oil pump										○			
	Oil pump interior seized									○	○	○		
	Mounting bolt or nut loose												○	
	Pump body faulty												○	
	Valve malfunctioning									○				

TROUBLESHOOTING

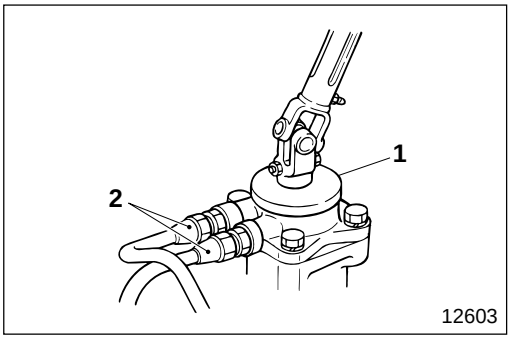
Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure faulty	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Oil tank faulty	Oil tank leaking due to overflowing								○					
	Oil tank leaking due to air lock								○					
	Fluid level insufficient	○												
Other malfunctions	Load too far forward of load-carrying platform	○												
	Load too far rearward of load-carrying platform		○											
	Load too far to one side of load-carrying platform			○										
	Wheelbase difference between left and right excessive			○										
	Propeller shaft runout excessive				○									Gr 25
	Front axle bent				○									Gr 26
	Rear axle housing bent			○										Gr 27
	Final drive gear and final drive pinion damaged or engaged incorrectly				○									
	Tire pressure insufficient	○												Gr 31
	Tire pressure excessive		○											
	Tire wear difference between left and right excessive			○										
	Tire outer diameter difference between left and right			○										
	Front tire radial and lateral runout, static balance and dynamic balance incorrect				○									
	One-sided braking			○										Gr 35A

1. Change of Power Steering Fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Oil pipe	66.69±12.75 {49±9.4, 6.8±1.3}	—



[Draining]
- Jack up the front wheels.
- Loosen oil pipe **2** connected to power steering booster **1**.
- Turn the steering wheel fully left and right repeatedly, and drain the fluid from power steering booster **1**.
- After draining the fluid, tighten oil pipe **2** at specified torque.

[Filling]
P37-13

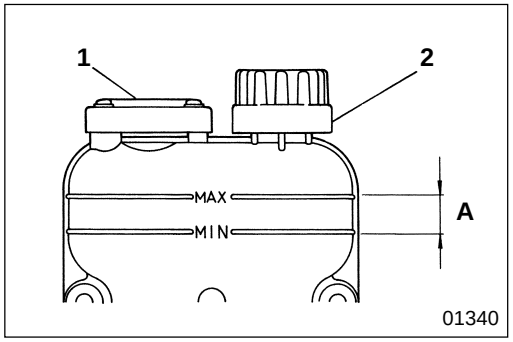
2. Bleeding of Power Steering System

Fluid

Location	Points of application	Specified fluid	Quantity
1	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Between the "MAX" and "MIN" levels in the power steering oil tank

WARNING

Because the brake booster (hydraulic booster) uses power steering fluid, do not let other fluids such as brake fluid, etc. get mixed with the power steering fluid inside the power steering oil tank.



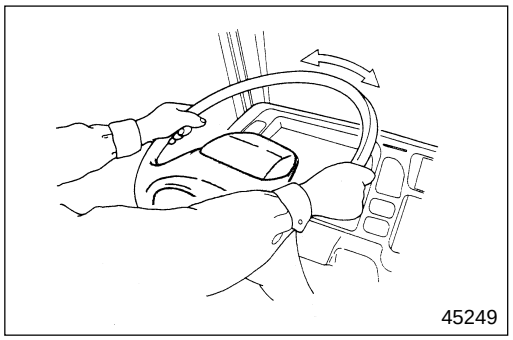
- Supply fluid into power steering oil tank **1** up to filler cap **2**.
- With the engine stopped, jack up the front wheels and turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.
- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- Depress the brake pedal fully several times repeatedly, until as in the case of the steering wheel, the fluid level does not drop anymore. (The steering wheel at such time does not need to be operated)
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times, next depress the brake pedal several times to raise the fluid temperature to approximately 60 to 80°C {140 to 176°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times to make sure there is no abnormal noise.
- With the engine stopped, depress the brake pedal several times, activate the brake booster (hydraulic booster) emergency pump and bleed air.
- When there is no abnormal noise after the above procedure has been performed, bleeding is completed. Check oil tank **1** fluid level, and pipe and hose connections for fluid leakage.
- After bleeding is completed, inspect brake booster (hydraulic booster) performance (input and output characteristics). Gr 35A

3. Steering Wheel Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering wheel play (Measure at the outer circumference of steering wheel)	10 to 40 {0.39 to 1.57}	—	Adjust

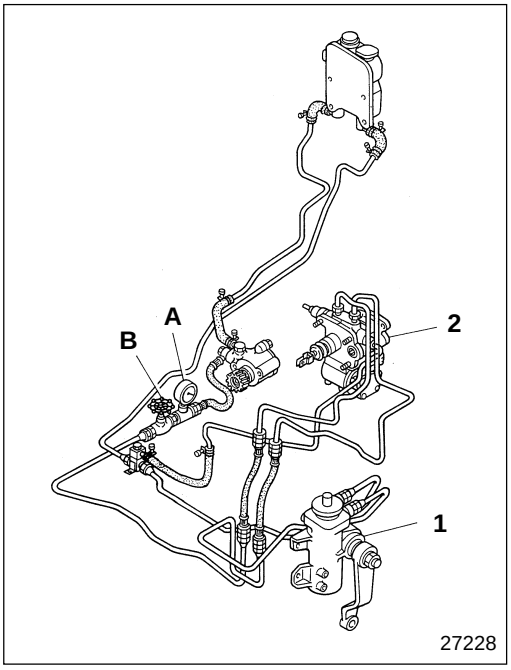


Point the wheels directly forward and gently turn the steering wheel left and right and measure the outer circumference play. If the play deviates from the standard value, adjust tightening points and power steering booster backlash. P37-31

4. Performance Verification Test of Power Steering System

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Steering system fluid pressure (With hands off steering wheel)		490 kPa {71 psi, 5 kgf/cm²}	—	Repair
—	Relief set pressure (Measure with engine speed at 1000 to 1500 rpm and the stop valve closed)	FH211	12.3 MPa {1780 psi, 125 kgf/cm²}	Maximum +490 kPa {71 psi, 5 kgf/cm²} Minimum –196 kPa {28 psi, 2 kgf/cm²}	Disassembly of power steering oil pump
		FH210	11.8 MPa {1706 psi, 120 kgf/cm²}		



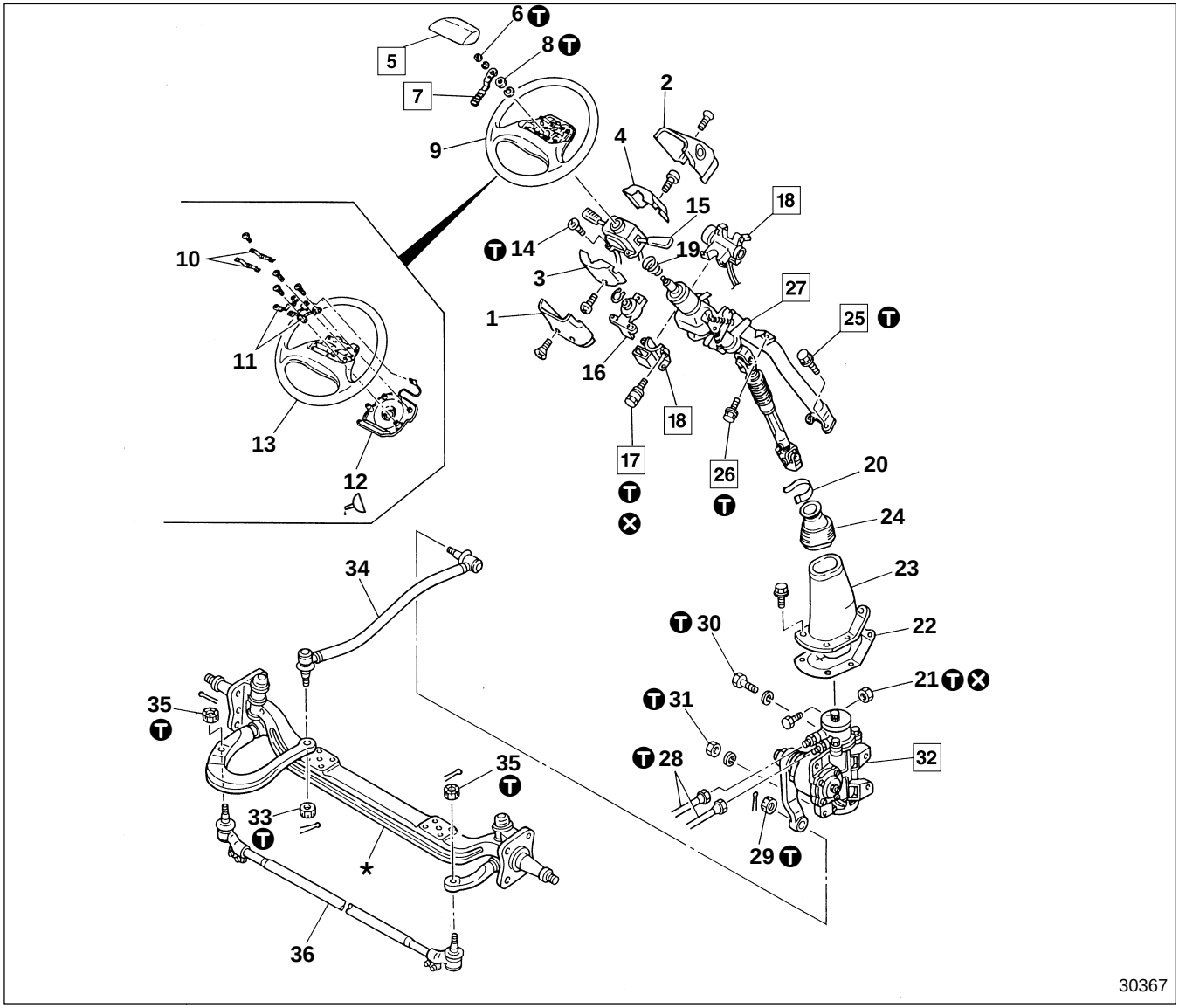
Verify that power steering booster **1** and the power steering oil pump are operating properly by testing the following items.

NOTE

If the fluid pressure is higher than 490 kPa {71 psi, 5 kgf/cm²} with engine idling and the steering wheel free, inspect power steering booster 1, brake booster (hydraulic booster) 2 and the fluid circuit for clogging.

Test item	Test procedure	Assembly standards
Verification of smooth operation	Jack up the front wheels and turn steering wheel fully left and right	Smooth operation throughout test
Measurement conditions	• Install oil pressure gauge **A** capable of measuring above 14.7 MPa {2130 psi, 150 kgf/cm²} and stop valve **B**, then bleed air • With engine idling, turn steering wheel left and right several times to raise fluid temperature to 50 to 60°C {122 to 140°F} • With the engine idling, open stop valve **B**	
Measurement of fluid pressure	• Measure fluid pressure with hands off steering wheel	490 kPa {71 psi, 5 kgf/cm²}
Measurement of relief pressure	• Gradually increase engine speed and maintain it at 1000 to 1500 rpm, and close stop valve **B** to measure maximum fluid pressure • Do not keep stop valve **B** closed for more than fifteen seconds	Relief set pressure 11.8 MPa {1706 psi, 120 kgf/cm²} < FH210 > 12.3 MPa {1780 psi, 125 kgf/cm²} < FH211 >

STEERING SYSTEM



● **Removal sequence**

1 Column cover outer lower
2 Column cover outer upper
3 Column cover inner lower
4 Column cover inner upper
5 Horn pad
6 Nut
7 Telescopic lever
8 Nut
9 Steering wheel assembly
10 Horn spring
11 Contact plate
12 Cover assembly
13 Steering wheel
14 Screw
15 Combination switch Gr 54
16 Bracket
17 Head cutting bolt
18 Starter switch Gr 54
19 Spring
20 Band
21 Nut
22 Dust cover
23 Dust cover
24 Dust cover
25 Bolt
26 Bolt
27 Steering column subassembly P37-22
28 Oil pipe P37-48
29 Nut
30 Bolt
31 Nut
32 Power steering booster P37-26
33 Nut
34 Drag link P37-50
35 Nut
36 Tie rod assembly P37-52

* : Front axle assembly Gr 26
⊗ : Non-reusable parts

CAUTION

Be sure to clean the port area of oil pipe 28 when disconnecting the oil pipe, so as to keep it free from dust and foreign particles.

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

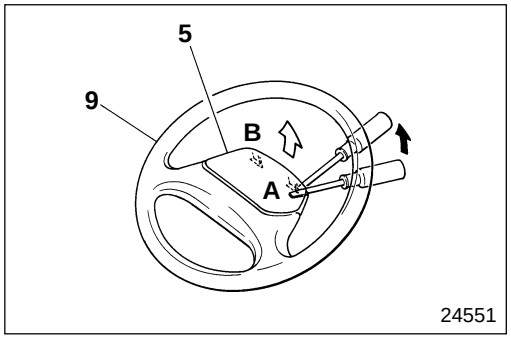
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Nut (Teletscopic lever mounting)	8.8 to 9.8 {6.5 to 7.2, 0.9 to 1.0}	—
8	Nut (Steering wheel assembly mounting)	39 to 49 {29 to 36, 4 to 5}	—
14	Screw (Combination switch mounting)	2.5±0.5 {1.8±0.36, 0.25±0.05}	—
17	Head cutting bolt (Starter switch mounting)	14.2±1.5 {10±1.1, 1.45±0.15}	—
21	Nut (Steering column subassembly and power steering booster mounting)	51.45±2.45 {38±1.8, 5.25±0.25}	—
25	Bolt (Steering column at floor side mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
26	Bolt (Steering column subassembly to instrument panel side mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
28	Oil pipe	66.69±12.75 {49±9.4, 6.8±1.3}	—
29	Nut (Drag link and power steering booster mounting)	190±47.5 {140±35,19.4±4.85}	—
30	Bolt (Power steering booster mounting)	175.4±26.5 {130±20, 17.9±2.7}	—
31	Nut (Power steering booster mounting)	175.4±26.5 {130±20, 17.9±2.7}	—
33	Nut (Drag link and front axle assembly mounting)	190±47.5 {140±35, 19.4±4.85}	—
35	Nut (Tie rod assembly and front axle assembly mounting)	190±47.5 {140±35, 19.4±4.85}	—

Lubricant

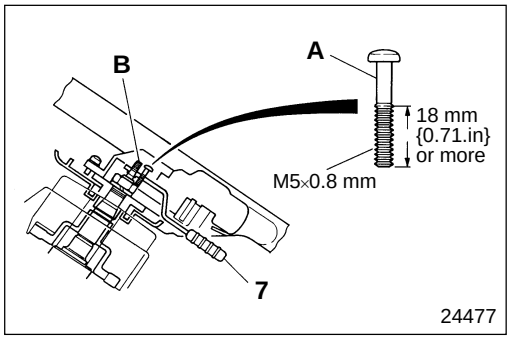
Location	Points of application	Specified lubricant	Quantity
12	Contact area between combination switch of cover assembly and horn contact	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



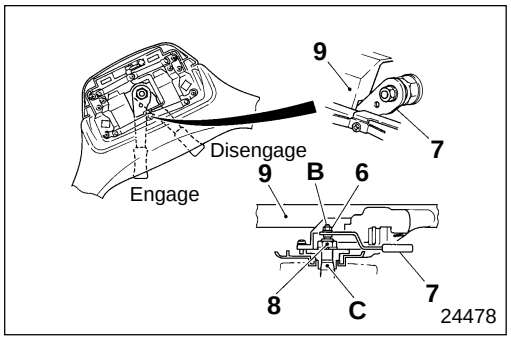
5 Removal of horn pad

- Insert a flat-tip screwdriver into the space between steering wheel assembly **9** and shoulder sections **A**, **B** of horn pad **5**, and disengage the latch by prying open the horn pad with the screwdriver until a clicking sound is produced.
- Insert a finger into the space behind horn pad **5** and remove the horn pad.



7 Telescopic lever

[Removal]
Secure screw **A** (M5×0.8 mm) in tapped hole in telescopic lever **7** and remove telescopic lever from telescopic shaft **B**.



[Installation]

- Make adjustment so that telescopic lever **7** positioned at the designated location applies the specified torque on telescopic shaft **B**.

CAUTION ⚠
Be careful not to damage the threads on the tip of telescopic shaft B.

C : Telescopic shaft assembly

Start procedure

Install steering wheel assembly **9**. Using a long socket wrench, tighten nut **8** at specified torque 39 to 49 N·m {29 to 36 ft.lbs, 4 to 5 kgf·m}

Rotate telescopic shaft **B** counterclockwise with your fingers and check for looseness

Looseness found

No looseeness

Using a flat-blade screwdriver turn telescopic shaft **B** clockwise and drive it in until it hits lightly with a “clunk”, but do not turn it any further

CAUTION

Be careful not to over tighten or you will crush the end of the telescopic shaft, requiring replacement of telescopic shaft assembly C

Install telescopic lever **7** at a location that allows easy tightening, then tighten nut **6** until the telescopic lever will not slip

Tighten telescopic shaft **B** at operating torque 6.9 to 7.8 N·m {5.1 to 5.8 ft.lbs, 0.7 to 0.8 kgf·m}. (Tighten telescopic bar **7** at torque 69 to 78 N {15 to 18 lbf, 7 to 8 kgf} at 100 mm {3.94 in.} from the center of steering wheel assembly **9**

To maintain lock, hold telescopic lever **7** clockwise, then loosen and remove lock nut **6**

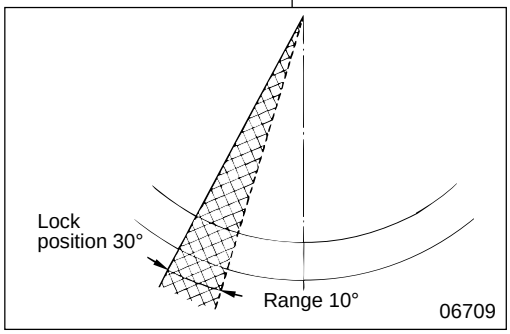
Remove telescopic lever **7**

NOTE

Remove telescopic lever 7 following the description under [Removal], taking care not to loosen telescopic shaft B.

Set telescopic lever **7** to specified lock position (within **10°** before the position at which telescopic lever contacts steering wheel assembly **9**).

Tighten nut **6** at specified torque 8.8 to 9.8 N·m {6.5 to 7.2 ft.lbs, 0.9 to 1.0 kgf·m}



When telescopic lever **7** is released, and telescopic shaft **B** is retightened at operating torque 6.9 to 7.8 N·m {5.1 to 5.8 ft.lbs, 0.7 to 0.8 kgf·m}, the telescopic lever should lock in the 10° range this side of specified lock position 30°

Out of the range

Within the range

Jiggle steering wheel assembly **9** up and down and check for looseness

Looseness found

No looseness

Remove nut **6**

Procedure is completed

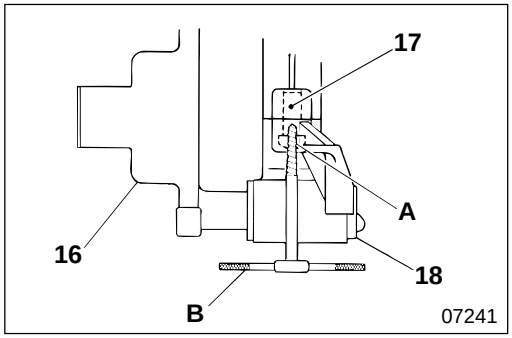
Remove telescopic lever **7**

CAUTION

Be sure not to operate telescopic shaft B while steering wheel assembly 9 is removed.

NOTE

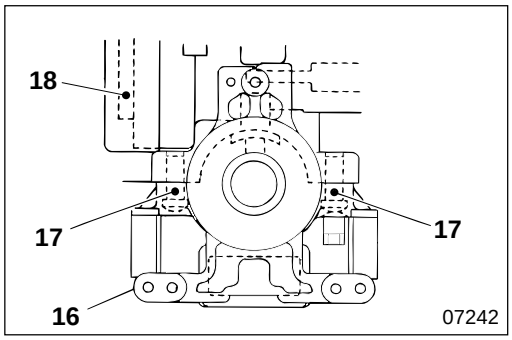
Be sure to assemble telescopic lever 7 only after steering wheel assembly 9 has been installed.



17 **18** **Head cutting bolt, starter switch**

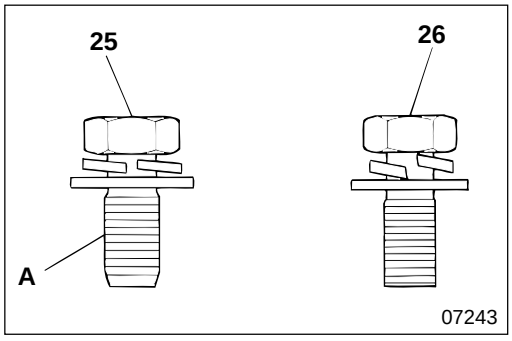
[Removal]

- After removing bracket **16**, drill a ø5.5 to 6.0 mm {0.22 to 0.24 in.} hole 10 to 15 mm {0.39 to 0.59 in.} deep in surface **A** of head cutting bolt **17** for mounting starter switch **18**.
- Screw in screw extractor **B** counterclockwise, then remove head cutting bolt **17**.



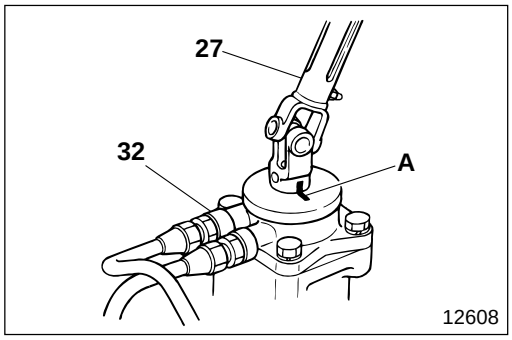
[Installation]

- With new head cutting bolt **17**, tighten starter switch **18** at specified torque to cut the head off the bolt.
- After installing bracket **16**, verify operation of the steering lock function of starter switch **18**.



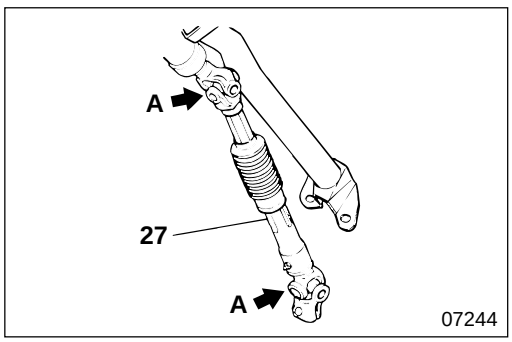
25 **26** **Installation of bolt**

- Bolts **25** and **26**, differ in shape. Do not mix them up when installing.
- Thread area **A** of bolt **25** is elliptical to facilitate grounding of the horn circuit.



27 **32** **Removal and installation of steering column subassembly, and power steering booster**

Before removing steering column subassembly **27** or power steering booster **32**, be sure to make alignment mark **A**.

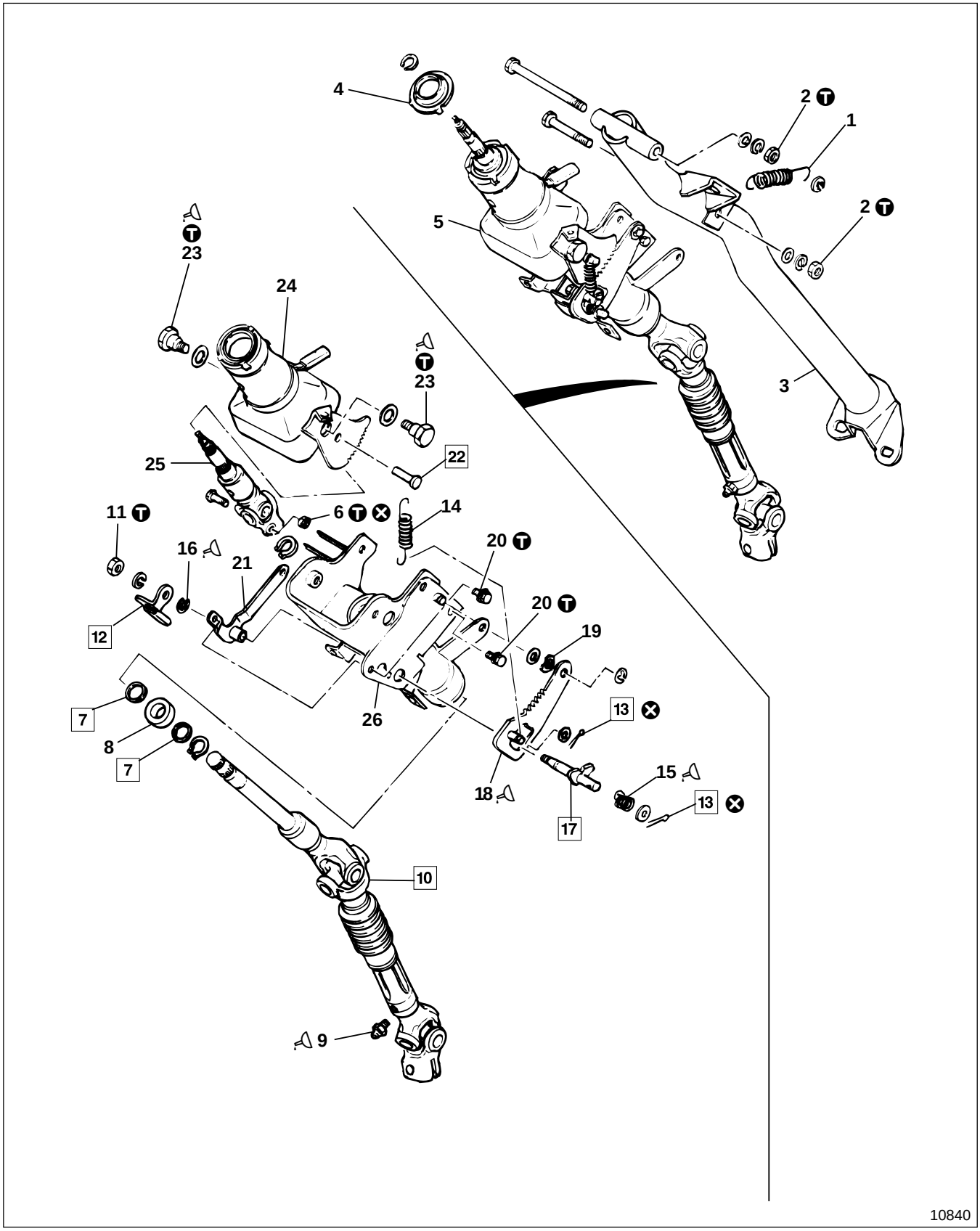


27 **Steering column subassembly**

When the spline of steering column subassembly **27** has been disconnected, align marks **A** on the yokes to face the same direction.

M E M O

STEERING COLUMN SUBASSEMBLY



● **Disassembly sequence**

1 Return spring
2 Nut
3 Support bracket
4 Spring seat
5 Steering column assembly
6 Nut
7 Stopper
8 Bearing spacer
9 Grease nipple
10 Steering shaft assembly
11 Nut
12 Lock lever
13 Split pin
14 Return spring
15 Return spring
16 Snap ring
17 Cam
18 Lock plate
19 Wave washer
20 Bolt
21 Lever support
22 Clevis pin
23 Bolt
24 Column support upper
25 Telescopic shaft assembly
26 Column support lower

⊗ : Non-reusable parts

● **Assembly sequence**

5 → **4** → **3** → **2** → **1**

5 : **25** → **24** → **26** → **23** → **22** → **21** → **20** → **19** → **18** → **17** → **16** → **15** → **14** → **13** → **12** → **11** → **10** → **9** → **8** → **7** → **6**

Ⓣ Tightening torque

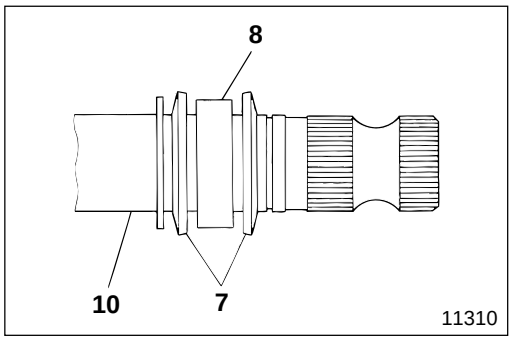
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Support bracket mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
6	Nut (Steering shaft assembly and telescopic shaft assembly mounting)	53 to 65 {39 to 48, 5.4 to 6.6}	—
11	Nut (Lock lever mounting)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
20	Bolt (Lever support mounting)	7 to 10 {5.1 to 7.2, 0.7 to 1.0}	—
23	Bolt (Column support upper and column support lower mounting)	15 to 20 {11 to 14, 1.5 to 2.0}	—

Lubricant and/or sealant

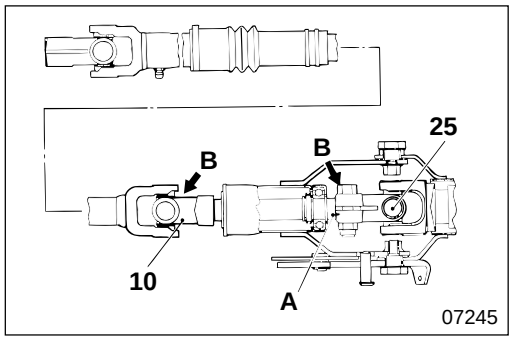
Location	Points of application	Specified lubricant and/or sealant	Quantity
9	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Friction surfaces of return spring and washer	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
16	Friction surfaces of lever support and snap ring	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Friction surfaces of cam and lock plate return spring clevis pin	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
23	Thread area of bolt	THREEBOND thread lock super 103Q or LOCTITE 271	As required
	Friction surfaces of column support upper and bolt	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



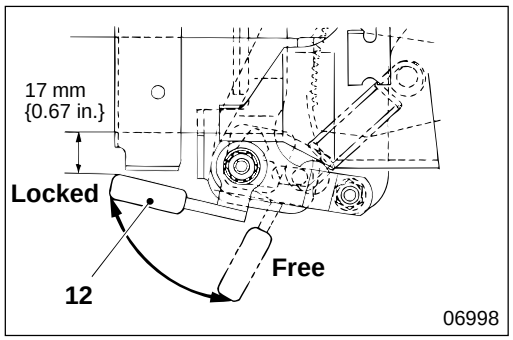
7 **Installation of stopper**

Install stoppers **7** on steering shaft assembly **10** in the direction as illustrated so that they straddle bearing spacer **8**.



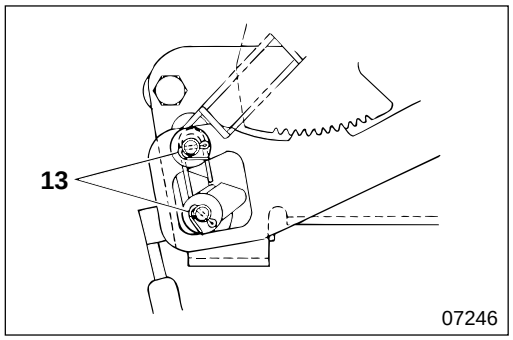
10 **Steering shaft assembly**

- Before removing steering shaft assembly **10**, be sure to make alignment mark **A**.
- Install the steering shaft with direction **B** of the telescopic shaft assembly **25** yoke and steering shaft assembly **10** yoke aligned or at phase angle of 90°.



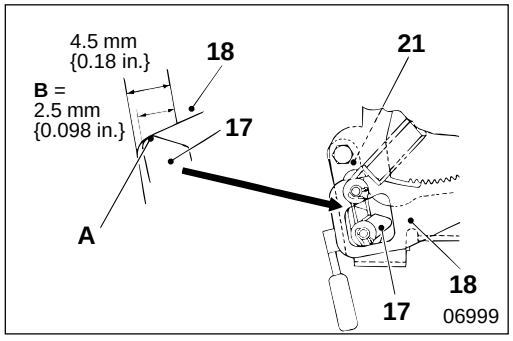
12 **Installation of lock lever**

- Install lock lever **12** so it is within the working angle when locked.
- After installing lock lever **12**, make sure that the lever operates smoothly (operating force less than 49 N {11 lbf, 5 kgf}). With the lever free, make sure that high tilt operates smoothly.



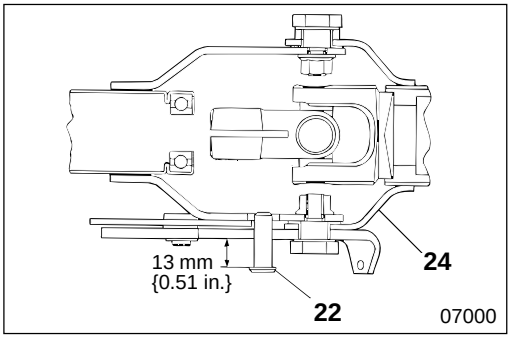
13 **Installation of split pin**

Bend split pin **13** to face outwards as illustrated.



17 **Installation of cam**

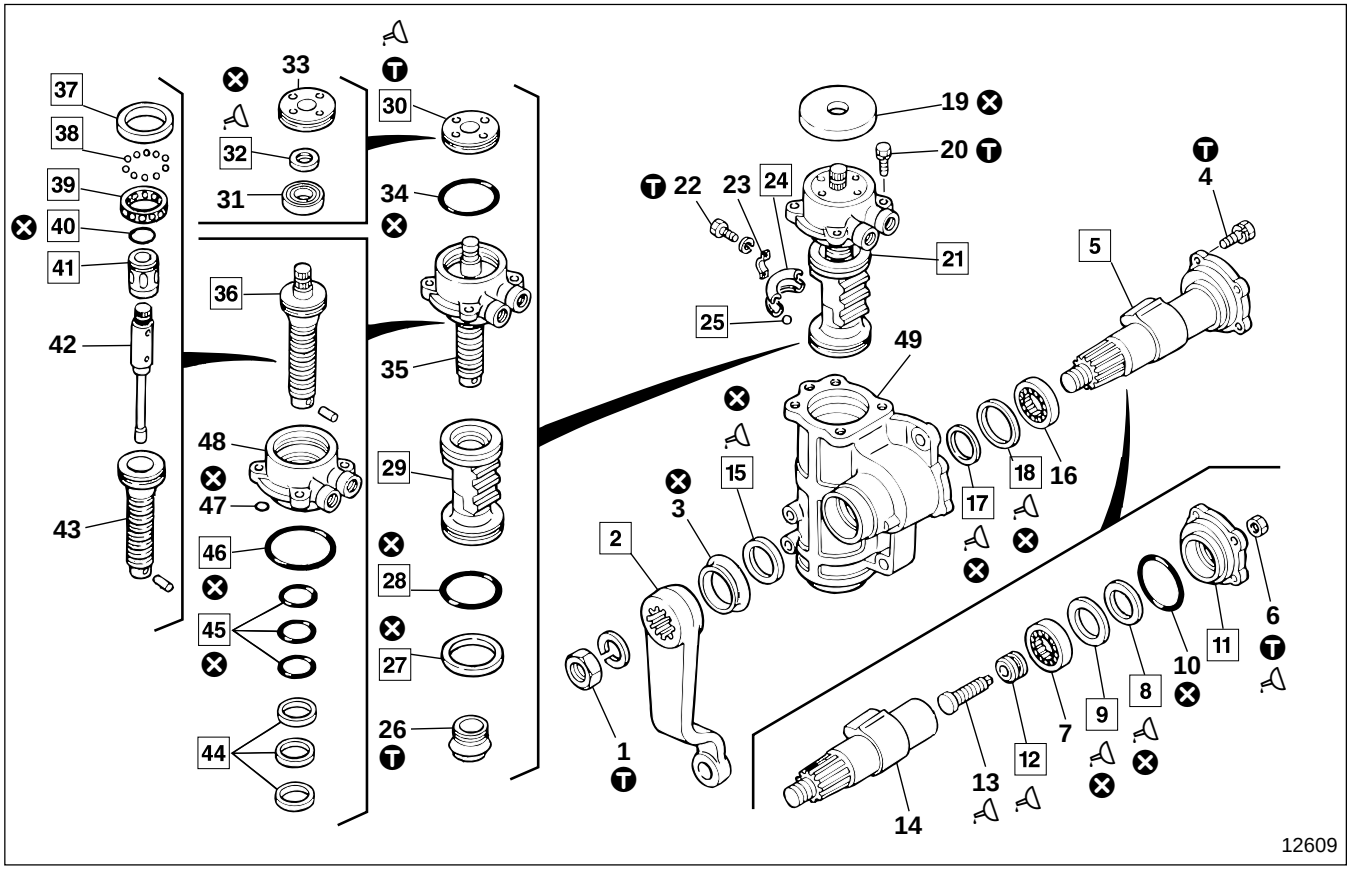
Adjust lever support **21** so that the top surface **A** of cam **17** is within dimension **B** of lock plate **18** to install the cam.



22 **Installation of clevis pin**

Drive clevis pin **22** into column support upper **24** so that the drive dimension is obtained.

POWER STEERING BOOSTER



● **Work before disassembly**

P37-30

● **Disassembly sequence**

1 Lock nut
2 Pitman arm
3 Dust cover
4 Bolt
5 Sector shaft assembly and side cover assembly
6 Nut
7 Needle bearing
8 Backup ring
9 Y-packing
10 O-ring
11 Side cover
12 Retainer
13 Adjusting screw
14 Sector shaft
15 Oil seal
16 Needle bearing
17 Backup ring
18 Y-packing
19 Dust cover
20 Bolt
21 Ball screw assembly
22 Screw
23 Ball tube clip
24 Ball tube
25 Steel ball
26 Plug
27 Seal ring
28 O-ring
29 Piston
30 Adjusting plug assembly
31 Ball bearing
32 Oil seal
33 Adjusting plug
34 O-ring
35 Worm shaft assembly and valve housing assembly
36 Worm shaft assembly
37 Side race
38 Steel ball
39 Bearing cage
40 Seal ring
41 Rotor
42 Stub shaft
43 Worm shaft
44 Seal ring
45 O-ring
46 O-ring
47 O-ring
48 Valve housing
49 Body (Cylinder)

⊗ : Non-reusable parts

NOTE

- **Do not remove needle bearing 7 or 16 unless they are faulty.**
- **Do not remove retainer 12 or adjusting screw 13 unless they are faulty.**
- **Have a tray or box ready to catch steel balls 25, 38.**

● **Assembly sequence**

49 → **21** → **20** → **19** → **18** → **17** → **16** → **15** → **5** → **4** → **3** → **2** → **1**

36 : **43** → **42** → **41** → **40** → **39** → **38** → **37**

35 : **48** → **47** → **46** → **45** → **44** → **36**

30 : **33** → **32** → **31**

21 : **35** → **34** → **30** → **29** → **28** → **27** → **26** → **25** → **24** → **23** → **22**

5 : **14** → **13** → **12**, **11** → **10** → **9** → **8** → **7** → **6**

● **Adjustment after assembly**

P37-31

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy	
5, 21	Backlash between sector shaft and ball screw (Measure at the end of pitman arm)		0.2 {0.0079}	0.5 {0.020}	ℓ= 250 {9.84}	Adjust (Measure with applied load of ±15 N {3.3 lbf, 1.5 kgf})
12	Retainer		Tighten the retainer then slacken off by 180°, retighten at 39 N·m {29 lbf.ft, 4 kgf·m}, then slacken off by 20°. Make sure that the adjusting screw turns smoothly, then caulk it	—	—	
13, 14	Axial play of adjusting screw and sector shaft		0.01 to 0.10 {0.00039 to 0.0039}	0.2 {0.0079}	Replace	
14	Outer diameter of sector shaft	Adjusting screw side	ø39.975 {1.574}	ø39.875 {1.570}	Replace	
		Pitman arm side	ø44.975 {1.771}	ø44.875 {1.767}	Replace	
29, 43	Play of piston and worm shaft in axial direction		—	0.5 {0.02} or more	Replace	
29, 49	Clearance between outer diameter of piston and inner diameter of body (Cylinder)		[85 {3.3}] 0.11 {0.0043}	0.16 {0.0063}	Replace	
41, 43	Clearance between outer diameter of rotor and worm shaft		[35.5 {1.4}] 0.02 {0.00079}	0.03 {0.0012}	Replace	

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Pitman arm mounting)	270±25 {200±18, 27.5±2.5}	—
4	Bolt (Side cover mounting)	53.9 to 63.7 {40 to 47, 5.5 to 6.5}	—
6	Nut (Adjusting screw tightening)	63.7 to 73.5 {47 to 54, 6.5 to 7.5}	—
20	Bolt (Valve housing tightening)	98.1 to 107.9 {72 to 80, 10 to 11}	—
22	Screw (Ball tube clip mounting)	4.41 to 5.39 {3.3 to 4.0, 0.45 to 0.55}	—
26	Plug	246 to 274 {180 to 200, 25 to 28}	—
30	Adjusting plug assembly	177 to 196 {130 to 145, 18 to 20}	—

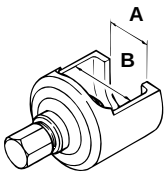
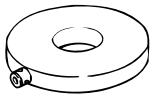
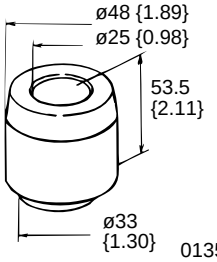
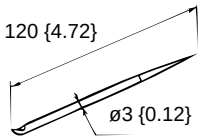
POWER STEERING BOOSTER

Lubricant and/or sealant

Location	Points of application	Kinds	Quantity
6	Contact surfaces of nut and side cover	Hermetic seal 101Y or THREEBOND 1102	As required
8, 17	Backup ring inner periphery	Multipurpose grease [NLGI No.2 (Li soap)]	As required
9, 18	Pack interior of Y-packing	Multipurpose grease [NLGI No.2 (Li soap)]	As required
12	Pack interior of retainer	Multipurpose grease [NLGI No.2 (Li soap)]	As required
13	Contact surfaces of adjusting screw and sector shaft	Multipurpose grease [NLGI No.2 (Li soap)]	As required
	Thread area of adjusting screw	Hermetic seal 101Y or THREEBOND 1102	As required
15, 32	Pack interior of oil seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required
30	Adjusting plug assembly outer periphery	Hermetic seal 101Y or THREEBOND 1102	As required

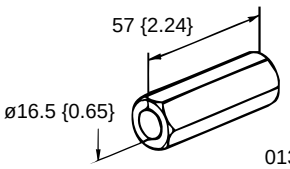
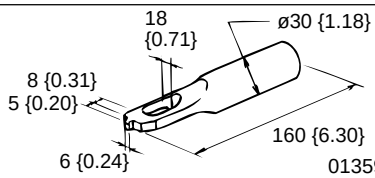
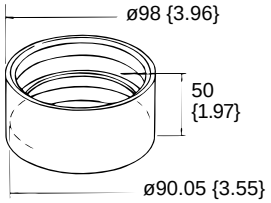
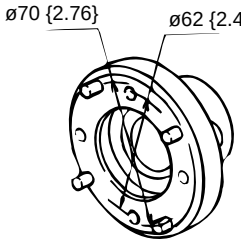
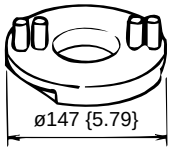
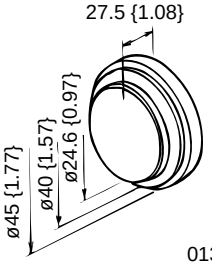
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Pitman arm puller Part No. / **A** / **B** MH061687 *910-00183 / 59 {2.32} / ø92 {3.62} *910-00184 / 59 {2.32} / ø100 {3.94}  01355	MH061687 *910-00183 *910-00184	Removal of pitman arm
8,15, 17	Inserting tool assembly  01356	MC811971 *910-11001	Forming of backup ring and press-fitting of oil seal
8,17	Inserting tool  01358	MC811974 *910-21715	Forming of backup ring
10, 27, 28, 34, 40, 44, 45, 46, 47	Needle  02288	MC811948 *910-21200	Removal of O-ring and seal ring

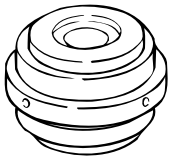
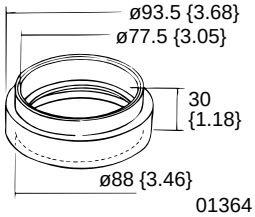
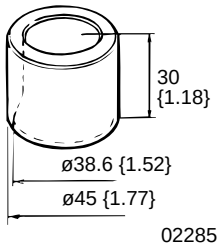
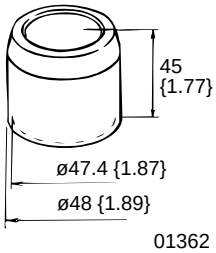
* Unisia JKC Steering Systems part No.

Unit : mm {in.}

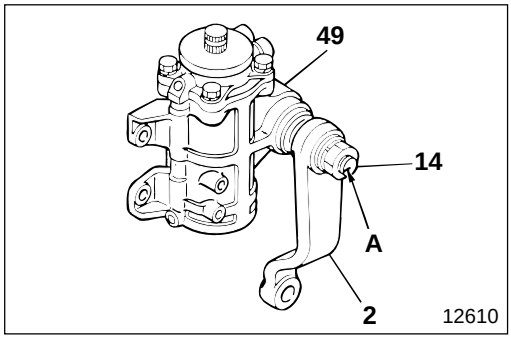
Location	Tool name and shape	Part No.	Application
12	Bar 	MC811955 *910-22811	Turning of retainer
	Squeeze tool 	MC811950 *910-21801	Caulking of retainer
27	Inserting tool 	MC813516 *910-21718	Forming of piston seal ring
30	Wrench assembly 	MC811970 *910-10743	Removal and installation of adjusting plug assembly
	Attachment (**A** : Adapter) (**B** : Bolt) 	MC811969 *910-10671 (**A** : *910-23581) (**B** : *910-23194)	Holding down of valve housing
32	Press-fitting tool 	MC811972 *910-20404	Press-fitting of oil seal

* Unisia JKC Steering Systems part No.

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
37 to 39	Tool assembly  01363	MC811968 *910-10611	Assembly of thrust bearing
	Guide assembly  01364	MC090148 *910-23033	
40	Inserting tool  02285	*910-22777	Forming of rotor seal ring
44	Inserting tool  01362	MC811975 *910-22722	Forming of valve housing seal ring

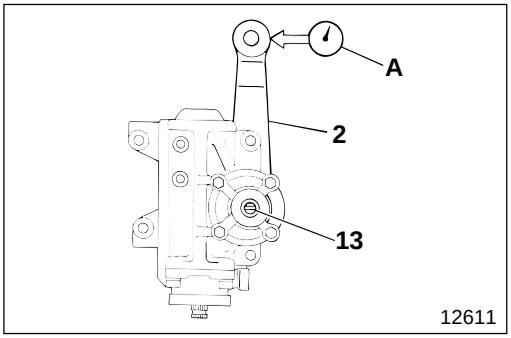
* Unisia JKC Steering Systems part No.



◆ Service procedure

● Work before disassembly

Move pitman arm **2**, and align slit **A** of the V-groove of sector shaft **14** to the center of body **49** so that the gears are in neutral position.

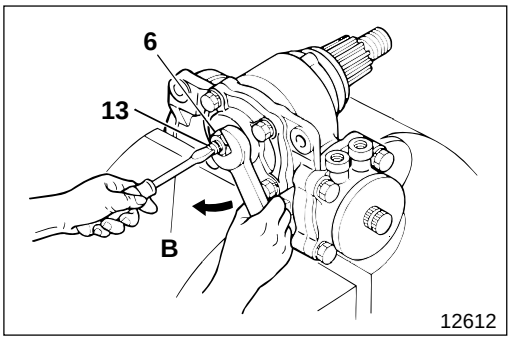


● **Adjustment after assembly**

Adjustment of backlash

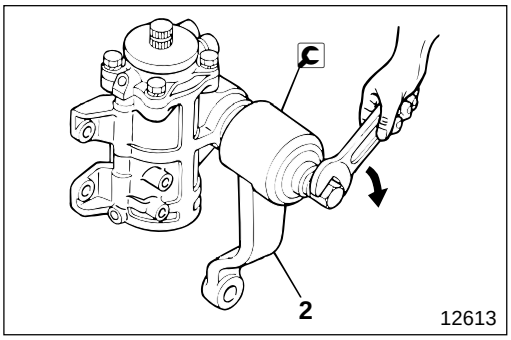
- (Carry out this work with the gears in neutral position.)
  Measure play at the end of pitman arm **2** with dial gauge **A**, and adjust adjusting screw **13** so that the reading meets the standard value.

  Measuring load : ±15 N {3.3 lbf, 1.5 kgf}



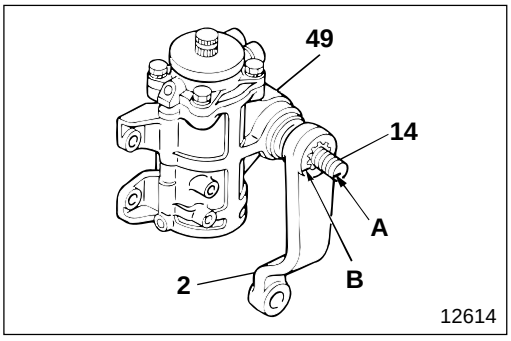
Tightening nut

- After adjusting backlash, apply sealer to thread area of adjusting screw **13**. Hold it in place with screwdriver **B** and tighten nut **6** at specified torque.



2 **Pitman arm**

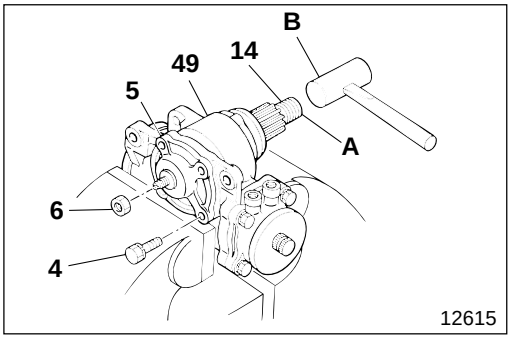
[Removal]



[Installation]
Align slit **A** of the V-groove of sector shaft **14** to the center of body **49**, and align slit **B** of the V-groove of pitman arm **2** on the same line.

NOTE

Have pitman arm 2 make a full stroke of the piston to make sure that the piston moves smoothly.

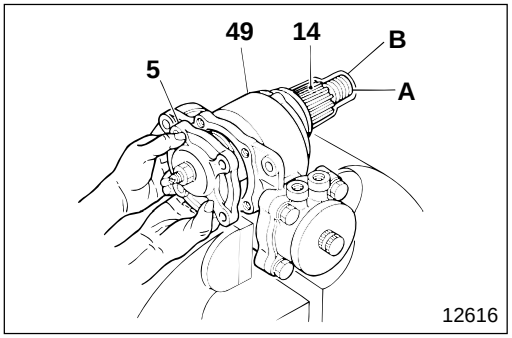


5 **Sector shaft assembly and side cover assembly**

[Removal]

- Make sure that the piston is in the neutral position (slit **A** of the V-groove at one end of sector shaft **14** is aligned with the center of body **49**).
- Tap the end of sector shaft **14** and pull out sector shaft assembly and side cover assembly **5**.

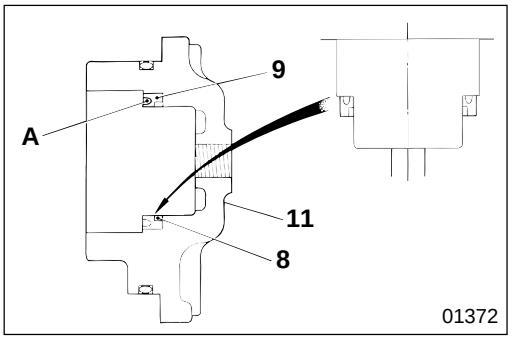
  B : Plastic-headed mallet



[Installation]
Position sector shaft **14** of sector shaft assembly and side cover assembly **5** so that slit **A** of its V-groove is aligned with the center of body **49**, and the piston gear and sector shaft gear engage at their centers.

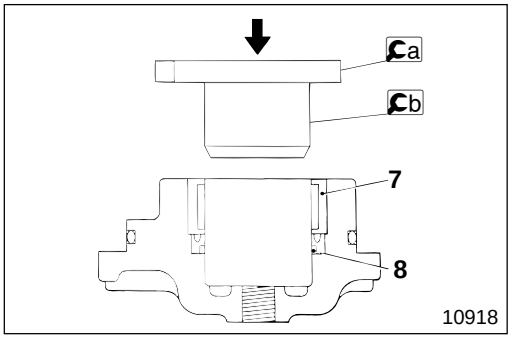
CAUTION

Before installation, apply tape B to the Y-packing to prevent it being damaged by the threads of sector shaft 14.

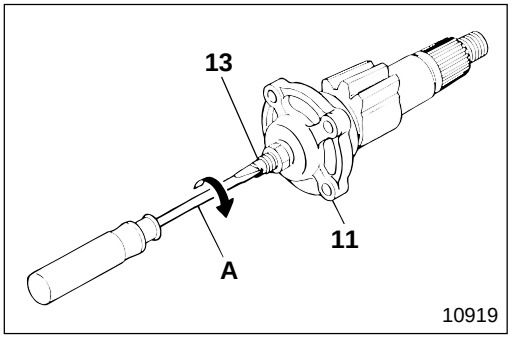


8 **9** **Backup ring, Y-packing**

[Installation]
- Install Y-packing **9** into side cover **11** in the direction as illustrated.
- After installing backup ring **8**, pack groove **A** of Y-packing **9** with grease.

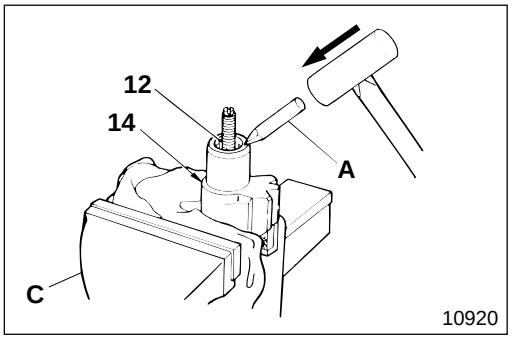


- After installing needle bearing **7** into backup ring **8**, form the bent up part of the backup ring using ca insert tool assembly and cb insert tool.



11 **Removal of side cover**

Screw in adjusting screw **13** and remove side cover **11**.
A : Screwdriver

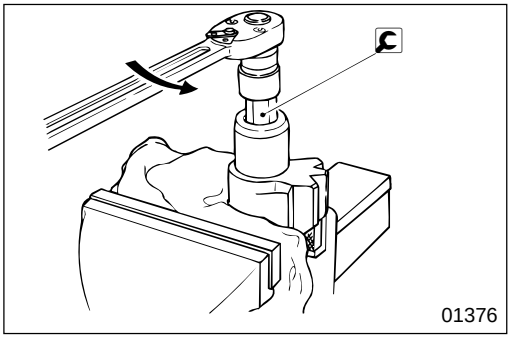


12 **Retainer**

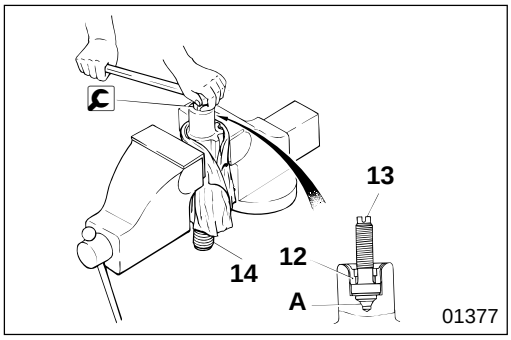
Disassemble sector shaft **14**, as follows, only if it is faulty :
[Removal]
- Pry up (2 points) of retainer **12**.
  A : Chisel

CAUTION

Make sure you use a cloth when you grip sector shaft 14 in vise C to prevent damage.

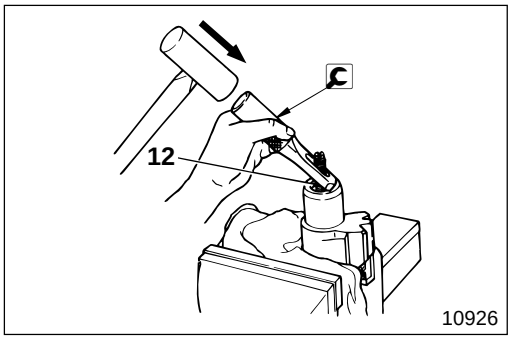


- Remove retainer **12** using [f] bar.

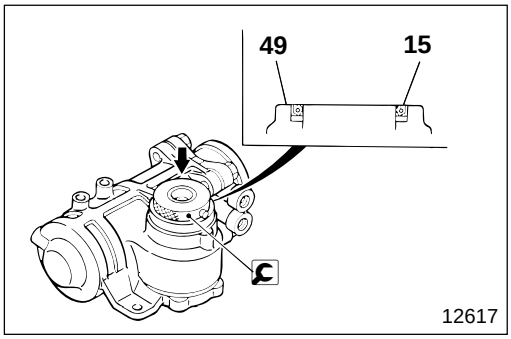


[Installation]

- Pack adjusting screw **13** mounting hole **A** of sector shaft **14** with grease.
- Install adjusting screw **13** into sector shaft **14**.
- Install retainer **12** into sector shaft **14** using [f] bar.
- After installation, slacken off by 180°, retighten at 39 N·m {29 ft.lbs, 4 kgf·m}, then slacken off by 20°.
- Make sure that adjusting screw **13** turns smoothly.

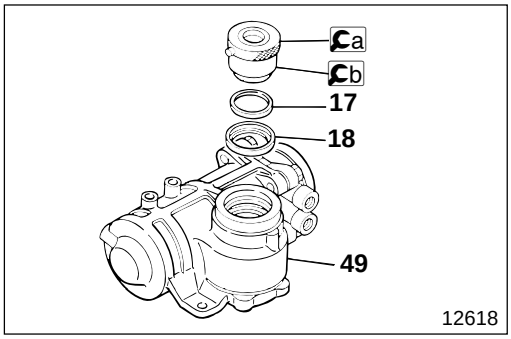


- After installing retainer **12**, caulk the retainer (2 points) using [f] squeeze tool.



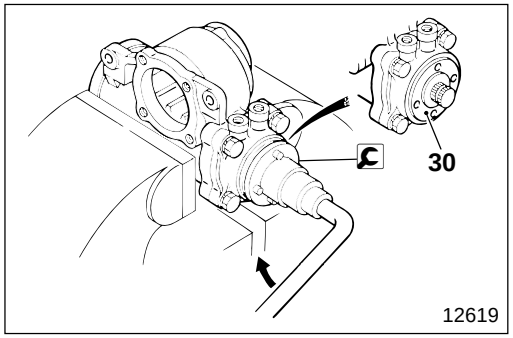
15 **Installation of oil seal**

Install oil seal **15** into body **49** in the direction as illustrated.



17 **18** **Installation of backup ring and Y-packing**

- Install Y-packing **18** and backup ring **17** to body **49**.
- Pack the groove of Y-packing **18** with grease.
- Form the shape of backup ring **17** using [fa] insert tool assembly and [fb] insert tool.



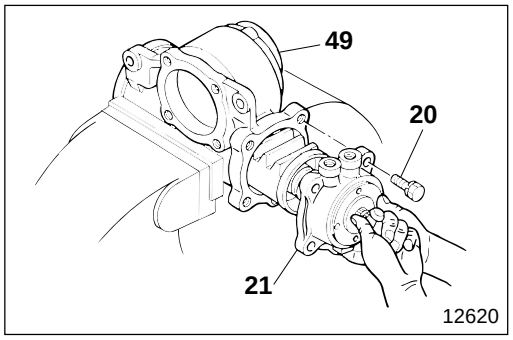
21 **Ball screw assembly**

[Removal]

- Loosen adjusting plug assembly **30** by approximately 180° using wrench assembly.

CAUTION

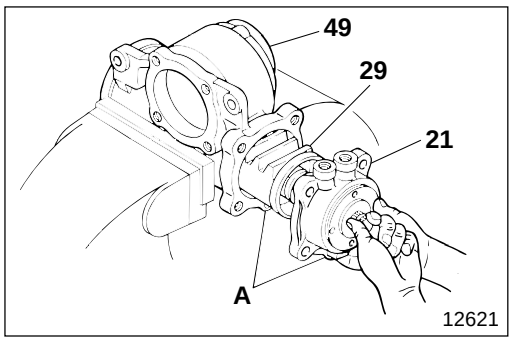
Make sure you only loosen adjusting plug assembly 30, do not undo it completely because the bearing inside the valve housing might spring out.



- Loosen bolt **20** and remove ball screw assembly **21** from body **49**.

CAUTION

- **Make sure that the balls of the ball screw do not spring out.**
- **Be careful not to damage the piston or the interior of body 49.**



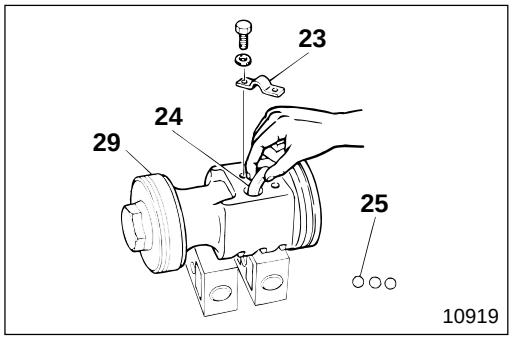
[Installation]

- Install ball screw assembly **21** into body **49**, holding piston **29** so it will not turn.

CAUTION

Be careful not to damage the piston seal ring or the interior of body 49.

- Align oil passage ports **A** of ball screw assembly **21** and body **49**, then tighten.

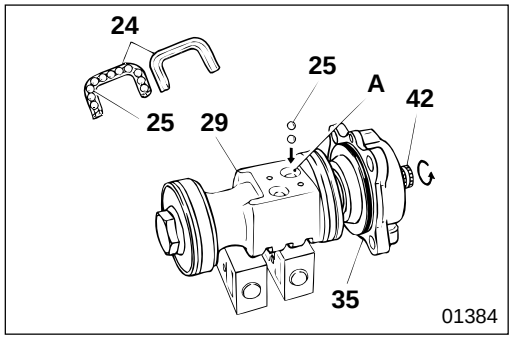


24 **25** **Ball tube and steel ball**

First remove steel balls **25** from piston **29** and place them in the receiving tray, remove ball clip **23**, grip ball tube **24** with your fingers and pull it out gently.

CAUTION

Be careful not to loose any steel balls 25 (×30).

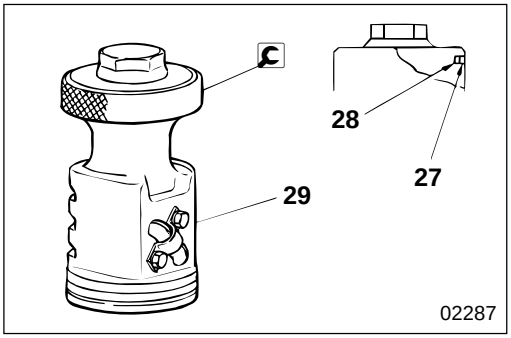


[Installation]

- Pack the interior of ball tube **24** with grease, lay 10 or 11 steel balls **25** in place, then mount the other side of the ball tube.
- Place piston **29** on a level surface, align assembled worm shaft assembly and valve housing assembly **35** and the piston ball race, then drop the steel balls through ball tube hole **A** while turning stub shaft **42**.

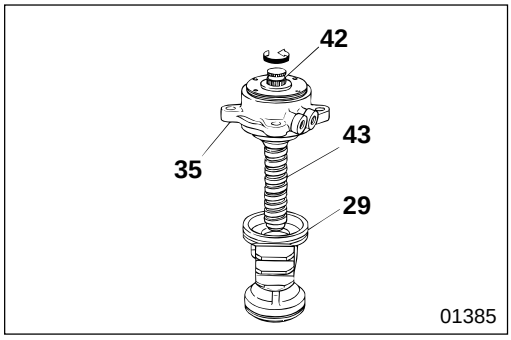
CAUTION

Make sure that you do not pull out worm shaft assembly and valve housing assembly 35 too far, or steel balls 25 will drop out of the ball race.



27 **28** **Installation of O-ring and seal-ring**

Install O-ring **28** and seal ring **27** in the outside grooves of piston **29**, then form the shape of the seal ring with 🔧 inserting tool.

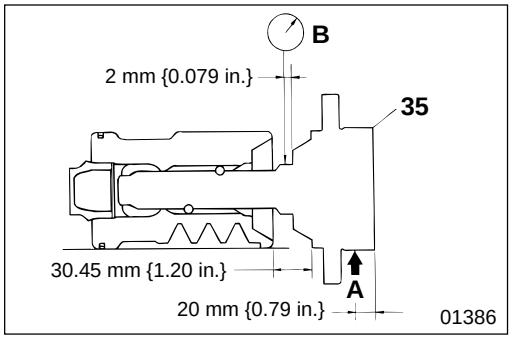


29 **Piston**

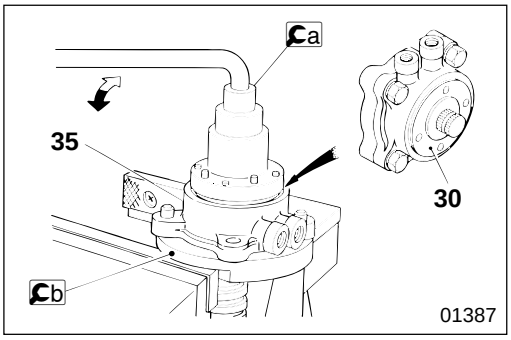
[Removal]
Holding worm shaft assembly and valve housing assembly **35** so that piston **29** is at the bottom, turn stub shaft **42** and remove the piston.

CAUTION ⚠

Be careful not to tilt piston 29 when you do this, otherwise steel balls 25 in the races of the piston and worm shaft 43, will drop into the piston.

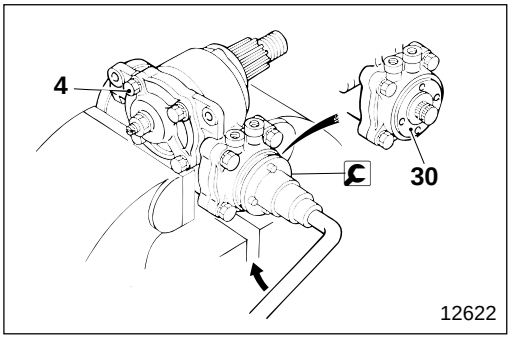


[Inspection]
Measure side play (play in axial direction) **B** of worm shaft assembly and valve housing assembly **35** when 49 N {11 lbf, 5 kgf} is applied to **A** as illustrated.

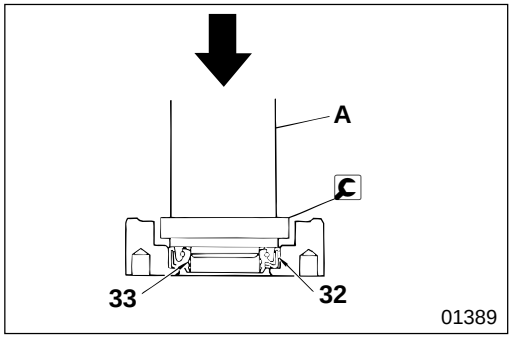


30 **Installation of adjusting plug assembly**

- After tightening adjusting plug assembly **30** of worm shaft assembly and valve housing assembly **35** at specified torque, slacken off by approximately 180°.

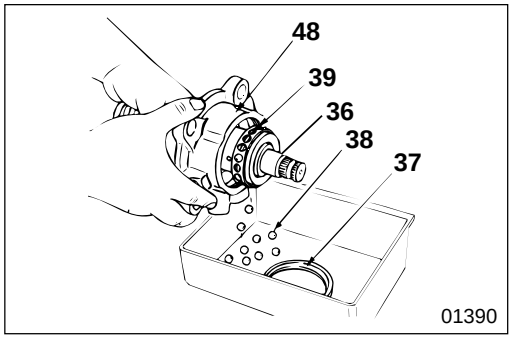


- Tighten bolt **4** at specified torque, then retighten adjusting plug assembly **30** at specified torque using 🔧 wrench assembly.



32 **Installation of oil seal**

Install oil seal **32** into adjusting plug **33** in the direction as illustrated.
A : Hand press



36 **Worm shaft assembly**

[Removal]
Push out worm shaft assembly **36** from valve housing **48** by pushing out the side of the worm shaft assembly where the piston is assembled.

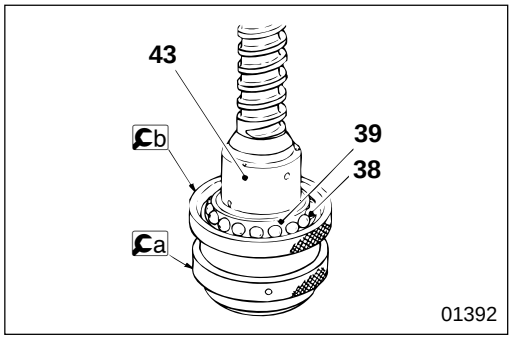
NOTE

Have a tray or box ready to catch side race 37, steel balls 38, and bearing cage 39 as these items separate on removal.

[Installation]

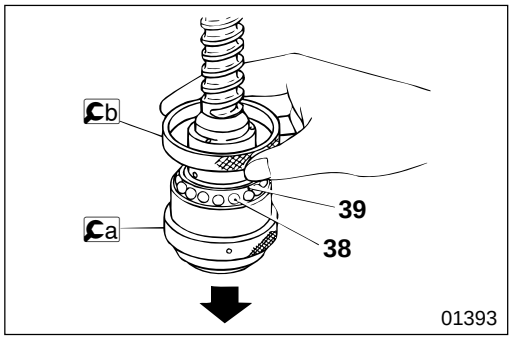
CAUTION

Be careful that worm shaft assembly 36 ball race does not damage seal ring 44.

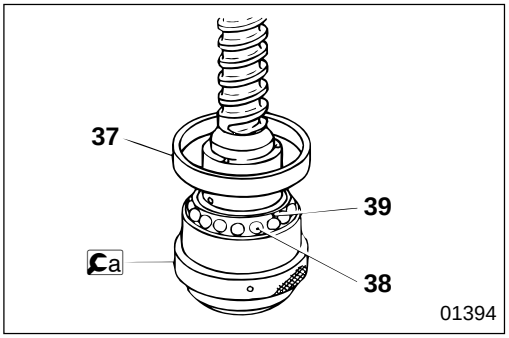


37 **to** **39** **Installation of side race, steel ball, and bearing cage**

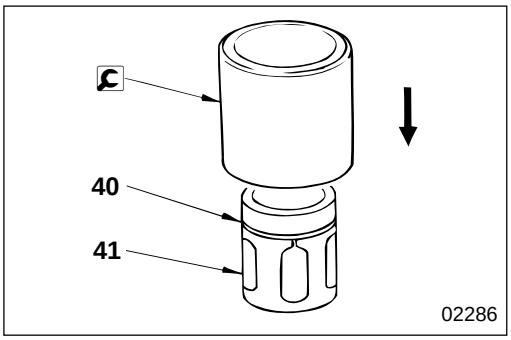
- Install b guide assembly on a tool assembly, and insert worm shaft **43** in the direction as illustrated.
- Assemble bearing cage **39** and steel balls **38** on worm shaft **43**.



- Hold down b with your hand and slide a downward, so that you can position steel balls **38** as specified.

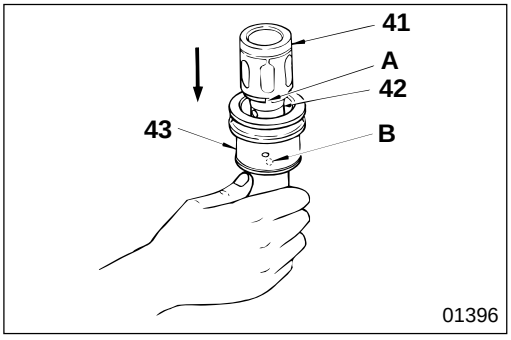


- Install side race **37** on top of steel balls **38** and bearing cage **39**.



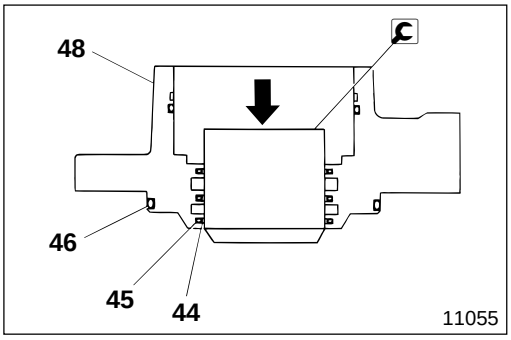
40 **Installation of seal ring**

- Install seal ring **40** onto rotor **41**.
- Form seal ring **40** using insert tool.



41 **Installation of rotor**

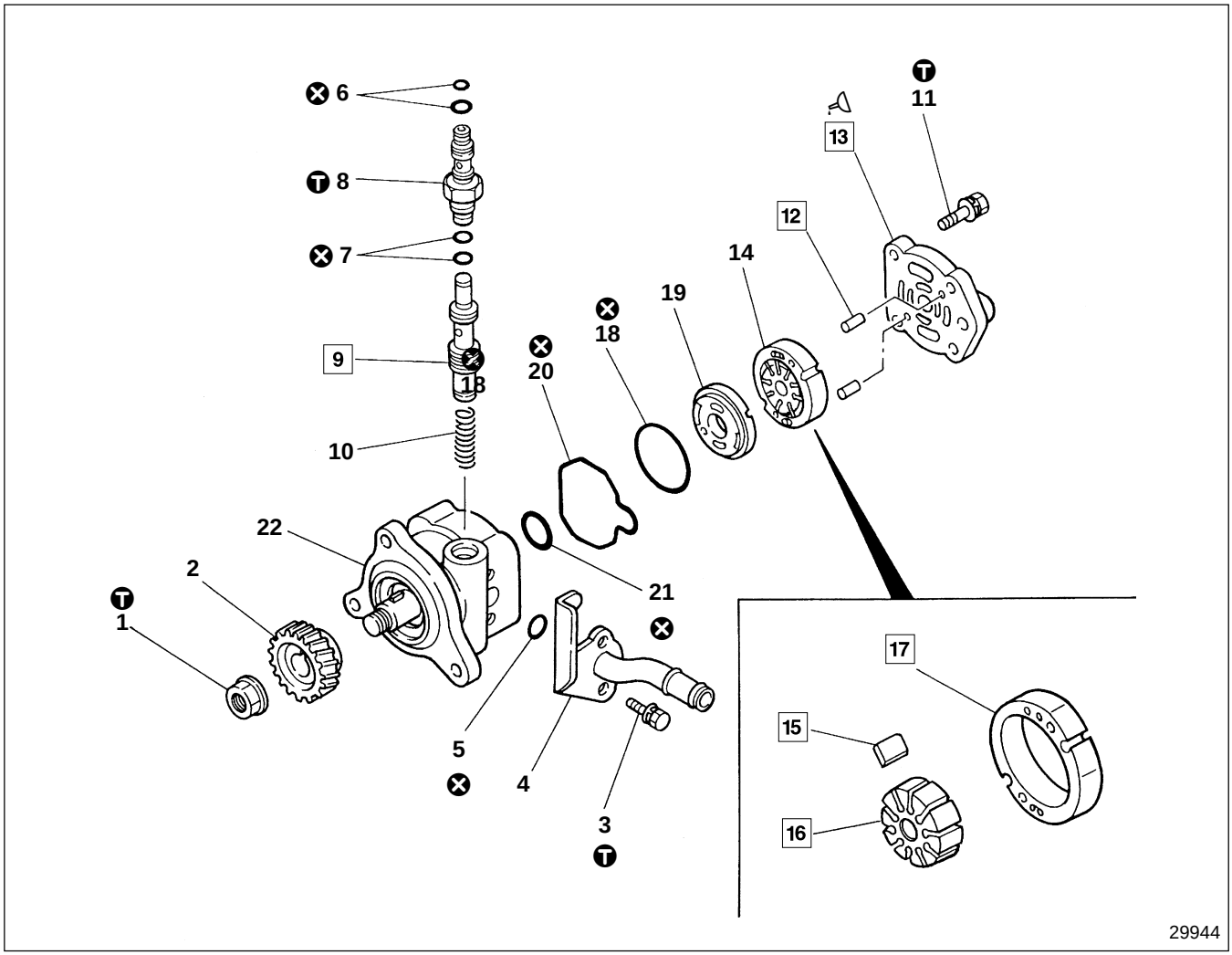
Install rotor **41** between stub shaft **42** and worm shaft **43** so that indent **A** of the rotor fits positioning pin **B** of the worm shaft.



44 **to** **46** **Installation of seal ring and O-ring**

- Install seal ring **44** and O-ring **45**, **46** into valve housing **48**.
- Form seal ring **44** using insert tool.

POWER STEERING OIL PUMP < KAYABA >



● **Disassembly sequence**

1 Lock nut
2 Gear
3 Bolt
4 Suction connector
5 O-ring
6 O-ring
7 O-ring
8 Connector
9 Flow control valve assembly
10 Flow control spring
11 Bolt
12 Pin
13 Cover
14 Cartridge assembly
15 Vane
16 Rotor
17 Cam ring
18 O-ring
19 Side plate
20 O-ring
21 O-ring
22 Body and shaft assembly

⊗ : Non-reusable parts

● **Assembly sequence**

19→18 — **13→12** — **8→7→6**
22→21→20 → **14** → **11→10→9** → **5→4→3→2→1**

14 : 15→16→17

Repair kit : Seal kit, Cartridge assembly kit

Inspection after reassembly

P37-15

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
9, 22	Clearance between relief valve assembly and body and shaft assembly	[14] 0.01 to 0.02 {[0.55] 0.00039 to 0.00079}	0.03 {0.0012}	—
10	Flow control spring free length	36.5 {1.44}	33.5 {1.32}	Replace
13	Wear of cover	—	0.05 {0.0020}	—
15, 16	Clearance between vane and rotor	0.01 {0.00039}	0.06 {0.0024}	—
19	Wear of side plate	—	0.05 {0.0020}	—

Tightening torque

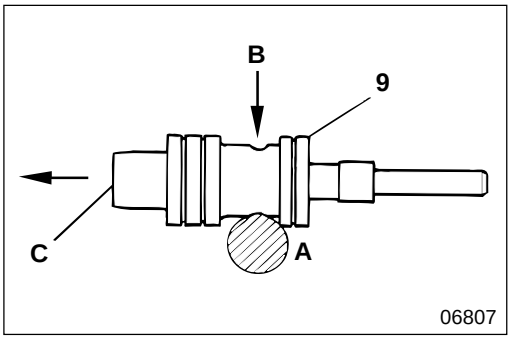
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Gear mounting)	34 to 45 {25 to 33, 3.5 to 4.6}	Wet
3	Bolt (Suction connector mounting)	6 to 10 {4.3 to 7.2, 0.6 to 1.0}	—
8	Connector	49 to 69 {36 to 51, 5 to 7}	—
11	Bolt (Cover mounting)	18 to 22 {13 to 16, 1.8 to 2.2}	—

Lubricant

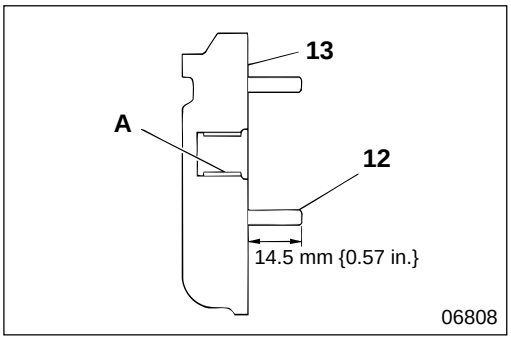
Location	Points of application	Specified lubricant	Quantity
13	Bushing of cover	Automatic transmission fluid (DEXRON or DEXRON II type)	As required

◆ Service procedure



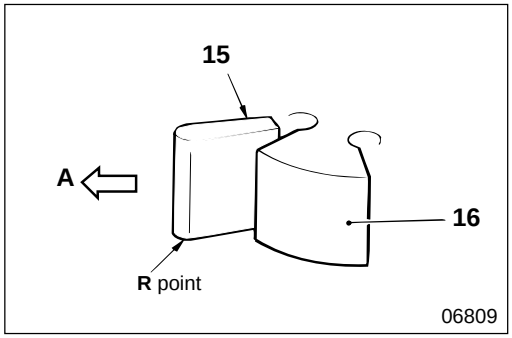
9 **Inspection of air-tightness of relief valve section in flow control valve assembly**

- Cover port **A** of flow control valve assembly **9** with a finger.
- Apply air pressure of 390 to 490 kPa {57 to 71 psi, 4 to 5 kgf/cm²} to port **B**.
- Check port **C** for air leakage.
- If abnormalities are found, replace body & shaft assembly **22**.



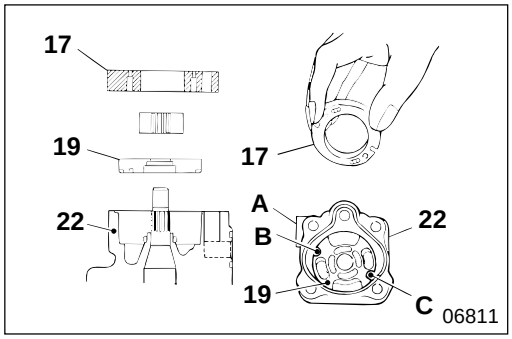
12 **13** **Installation of pin and cover**

- Press-fit pin **12** into cover **13**, to the press-fitting height.
- Apply hydraulic oil to bushing area **A** of the cover.



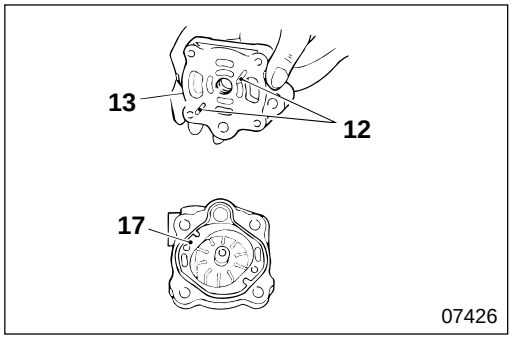
15 **Installation of vane**

With **R** point of vane **15** facing outside **A**, install it on rotor **16** and make sure that the vane moves smoothly. If it is faulty, replace cartridge **14**.



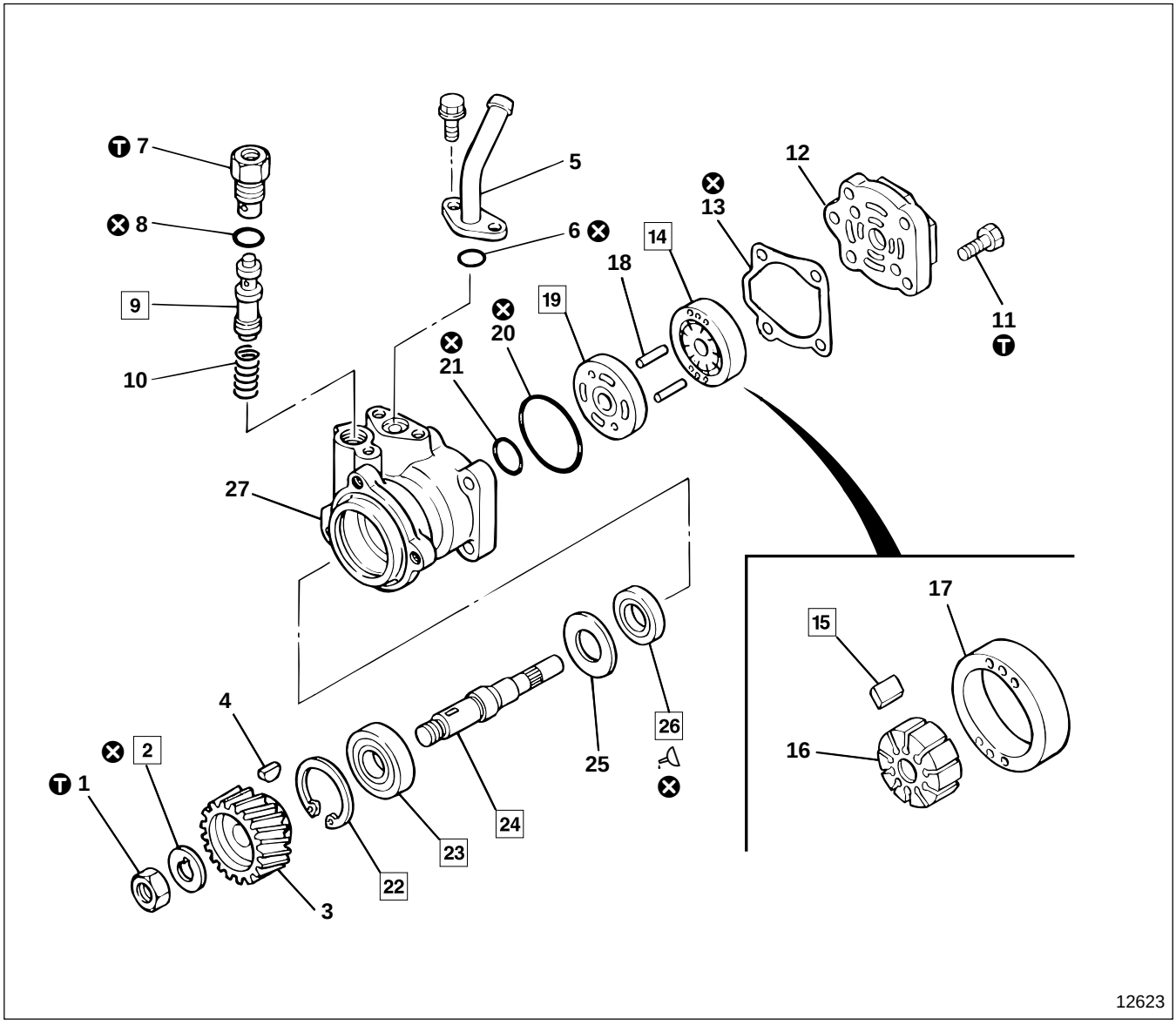
17 **19** **Installation of cam ring and side plate**

- Since the mounting direction of side plate **19** is determined, mount the side plate, so that relief valve side **A** is aligned with round hole **B** (standard pin side) and slotted hole **C** is located on a diagonal.



- Align cam ring **17** with pin **12** of cover **13**, then install the cam ring.

M E M O



● **Disassembly sequence**

1 Nut
2 Lock washer
3 Gear
4 Key
5 Suction pipe
6 O-ring
7 Connector
8 O-ring
9 Flow control valve assembly
10 Flow control spring
11 Bolt
12 Rear body
13 Gasket
14 Cartridge assembly
15 Vane
16 Rotor
17 Cam ring
18 Straight pin
19 Pressure plate
20 O-ring
21 O-ring
22 Retaining ring
23 Ball bearing
24 Shaft
25 Retaining ring
26 Oil seal
27 Front body assembly

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Seal kit, Cartridge assembly kit

Inspection after reassembly

📖 P37-15

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
9, 27	Clearance between flow control valve assembly and front body	—	0.03 {0.0012}	*1
12, 19	Stepped wear on rear body and pressure plate where it is subject to friction against rotor and vane	—	0.01 {0.00039}	*2

*1 No seizure, wear, or scoring sufficient to catch a finger nail. Replace flow control valve assembly or front body.
*2 No seizure, wear, or scoring sufficient to catch a finger nail. Replace rear body or pressure plate.

Tightening torque

Unit : N·m {lbf.ft, kgf·m}

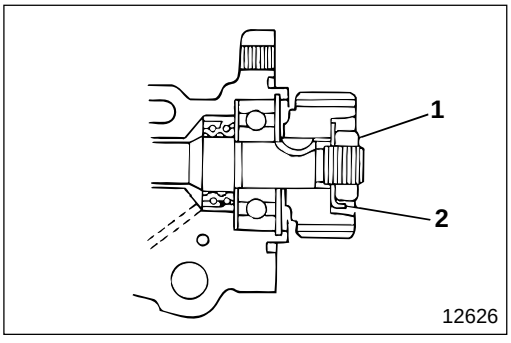
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Gear mounting)	68.8 to 88.2 {51 to 65, 7 to 9}	—
7	Connector	49 to 58.8 {36 to 43, 5 to 6}	—
11	Bolt (Rear body mounting)	49 to 58.8 {36 to 43, 5 to 6}	—

Special tools

Location	Tool name and shape	Part No.	Application
22	Pliers	*910-22570	Removal and installation of retaining ring
23	Press-fitting tool	*910-23061	Removal and installation of ball bearing, and installation of shaft
26	Stick	*910-21632	Driving out of oil seal
	Press-fitting tool	*910-23062	Press-fitting of oil seal

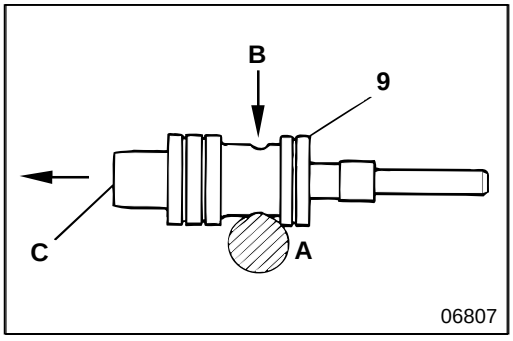
* Unisia JKC Steering Systems part No.

◆ Service procedure



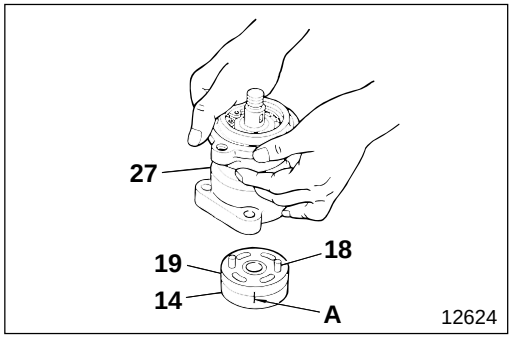
2 Installation of lock washer

After installing nut **1**, bend up one lug on the circumference of lock washer **2**.



9 Inspection of air-tightness of relief valve section in flow control valve assembly

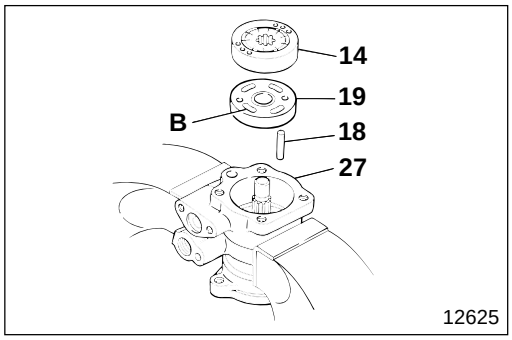
- Cover port **A** of flow control valve assembly **9** with a finger.
- Apply air pressure of 390 to 490 kPa {57 to 71 psi, 4 to 5 kgf/cm^2} to port **B**.
- Check port **C** for air leakage.
- If abnormalities are found, replace front body assembly **27**.



14 **Removal and installation of cartridge assembly**

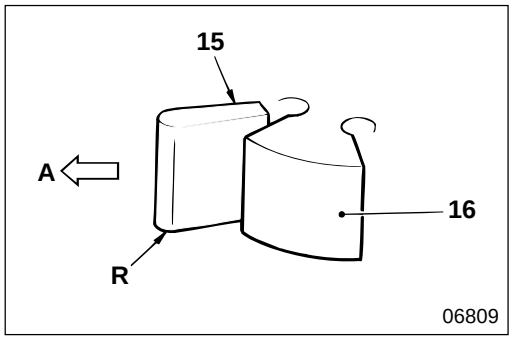
[Removal]

- Remove cartridge assembly **14**, pressure plate **19** and straight pin **18** together from front body **27**.
- Put alignment marks **A** around the outer circumferences of cartridge assembly **14** and pressure plate **19**.



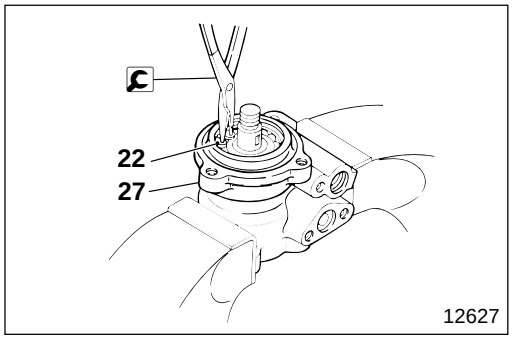
[Installation]

- Install straight pin **18** into front body **27**.
- Install pressure plate **19** onto front body **27**, so that groove **B** of the pressure plate faces the direction as illustrated.
- Align cartridge assembly **14** with straight pin **18**, then install the cartridge assembly.



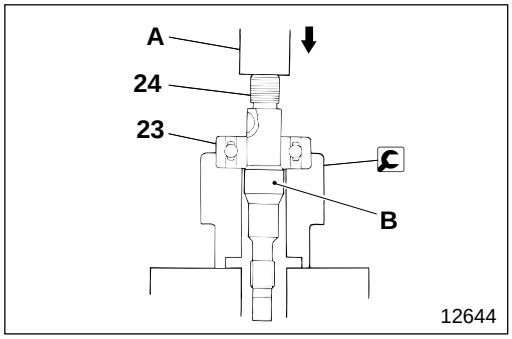
15 **Installation of vane**

With point **R** of vane **15** facing outside **A**, install it into rotor **16** and make sure that the vane moves smoothly. If it is faulty, replace the cartridge assembly.



22 **Removal of retaining ring**

Remove retaining ring **22** using 🔧 pliers.



23 **Removal and installation of ball bearing**

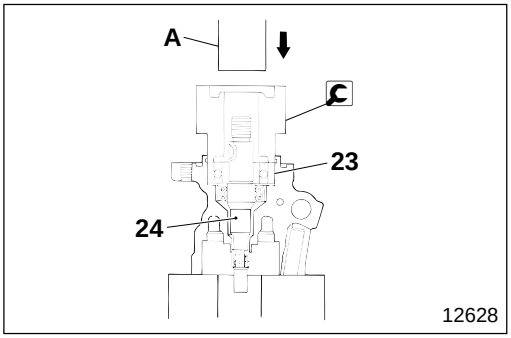
Remove ball bearing **23** from shaft **24** using 🔧 press-fitting tool.

A : Hand press

For installation, follow the removal sequence in reverse.

CAUTION

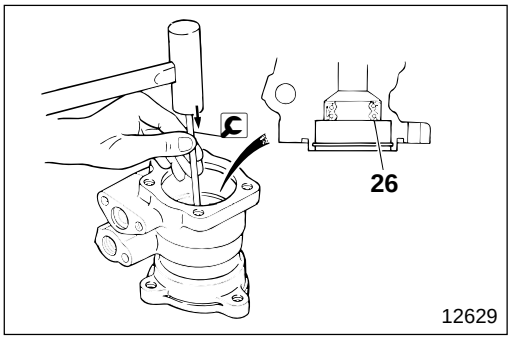
Be careful not to damage oil seal contact surface B.



23 **24** **Installation of ball bearing and shaft**

Install ball bearing **23** and shaft **24** using 🔧 press-fitting tool.

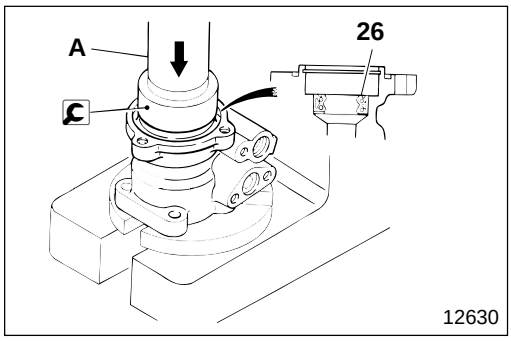
A : Hand press



26 **Oil seal**

[Removal]

Remove oil seal **26** using 🔧 stick.

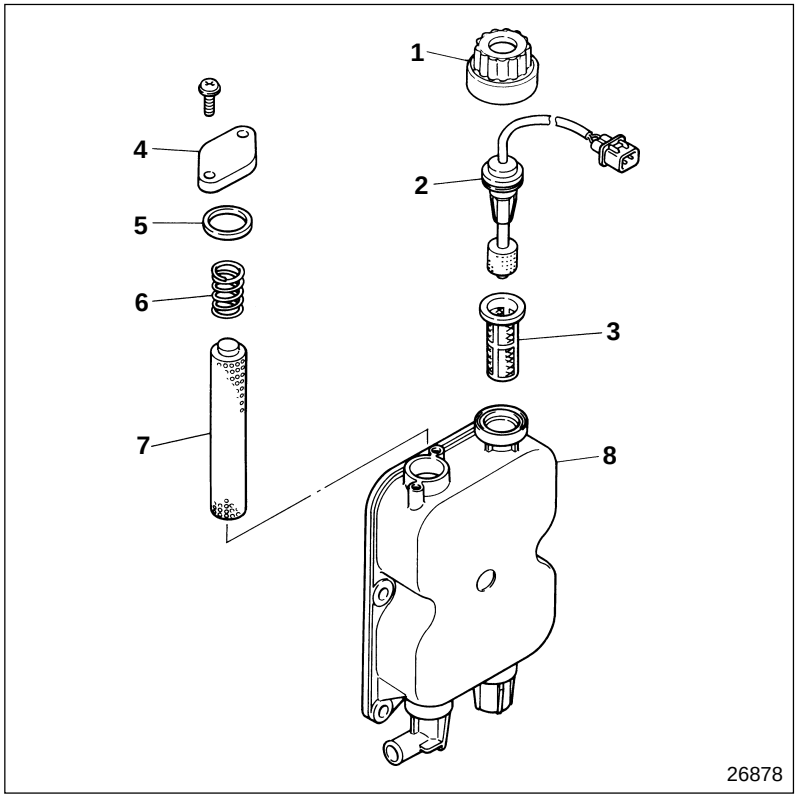


[Installation]

Install oil seal **26** in the direction as illustrated using 🔧 press-fitting tool.

A : Hand press

POWER STEERING OIL TANK



● **Disassembly sequence**

1 Cap (with packing)
2 Power steering fluid level sensor (with packing) Gr 54
3 Strainer
4 Filter cap
5 Packing
6 Spring
7 Return filter
8 Tank body assembly

● **Assembly sequence**

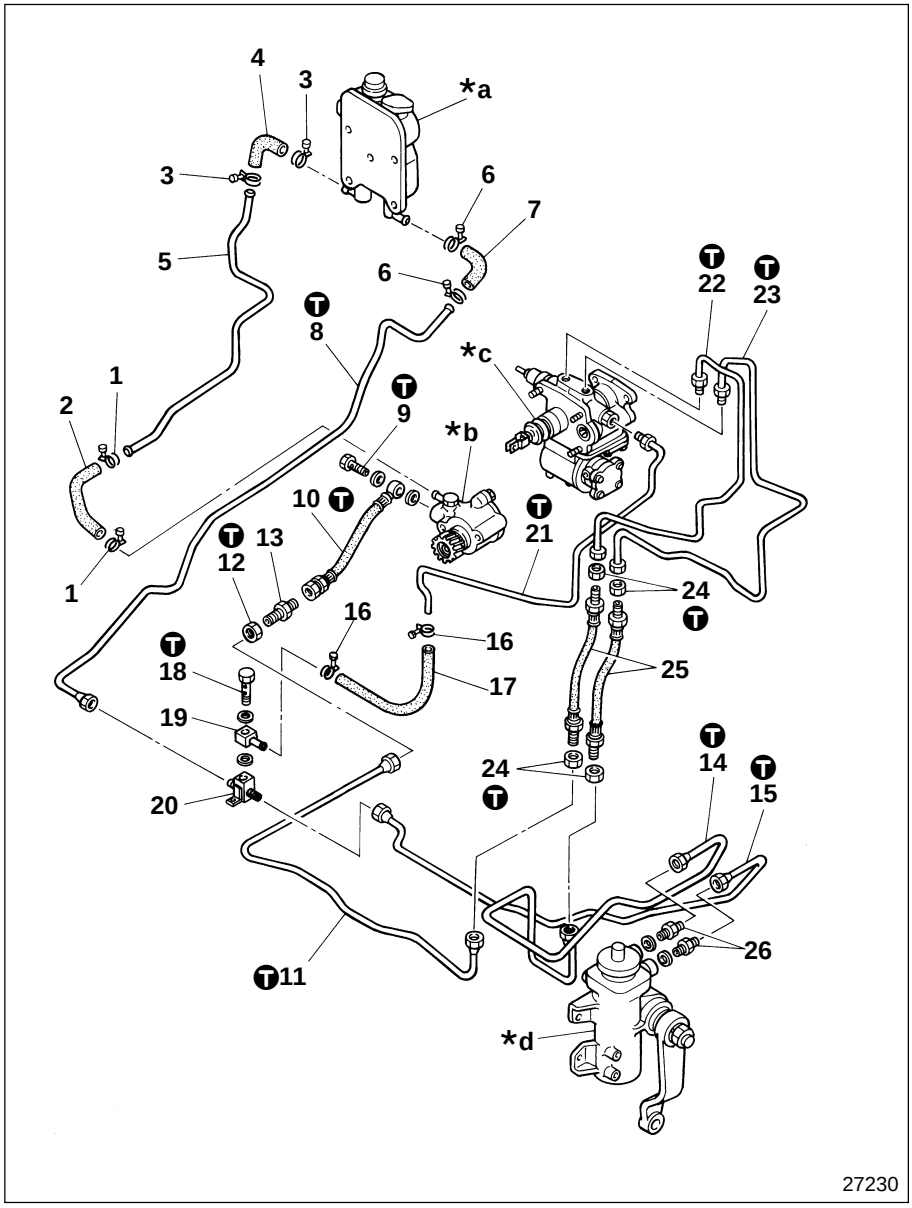
Follow the disassembly sequence in reverse.

CAUTION⚠

Because the oil tank is made of resin make sure you do not hit the tank or let it suffer any other kind of shock.

M E M O

POWER STEERING FLUID LINE



● **Removal sequence**

1 Clamp
2 Oil hose
3 Clamp
4 Oil hose
5 Oil pipe
6 Clamp
7 Oil hose
8 Oil pipe
9 Bolt
10 Oil hose
11 Oil pipe
12 Nut
13 Connector
14 Oil pipe
15 Oil pipe
16 Clamp
17 Oil hose
18 Bolt
19 Connector
20 Connector
21 Oil pipe
22 Oil pipe
23 Oil pipe
24 Nut
25 Oil hose
26 Connector

***a** : Power steering oil tank
***b** : Power steering oil pump
***c** : Brake booster (Hydraulic booster) Gr 35A
***d** : Power steering booster

● **Installation sequence**

Follow the removal sequence in reverse.

WARNING

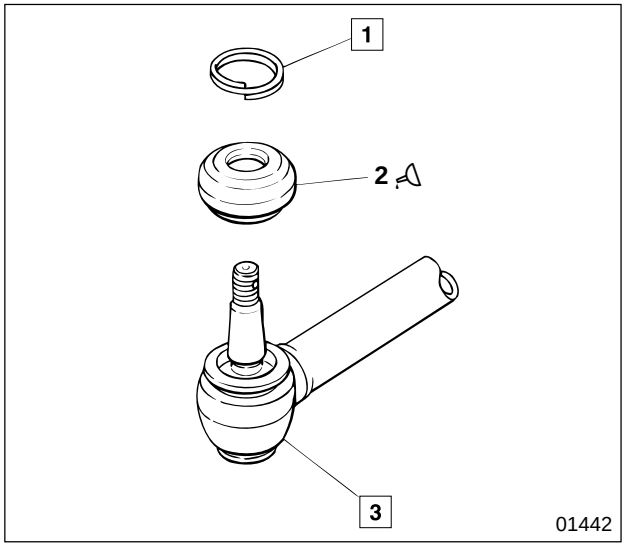
Be sure to bleed air after removing the fluid line, failure to do so would cause the brake and power steering to malfunction. **P37-13**

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8, 15	Oil pipe (Connector connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
9	Bolt (Oil hose mounting)	125 {94, 13}	—
10	Oil hose (Connector connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
11	Oil pipe (Oil hose and connector connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
12, 24	Nut	66.69±12.75 {49±9.4, 6.8±1.3}	—
14	Oil pipe (Oil hose and connector connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
18	Bolt (Connector mounting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
21	Oil pipe (Brake booster connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
22, 23	Oil pipe (Oil hose and brake booster connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—

DRAG LINK



● **Disassembly sequence**

1 Clip
2 Dust cover
3 Drag link

NOTE

- **Do not remove clip 1 or dust cover 2 unless they are faulty.**
- **Do not disassemble drag link 3 because it is a unit construction.**

● **Assembly sequence**

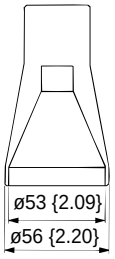
Follow the disassembly sequence in reverse.

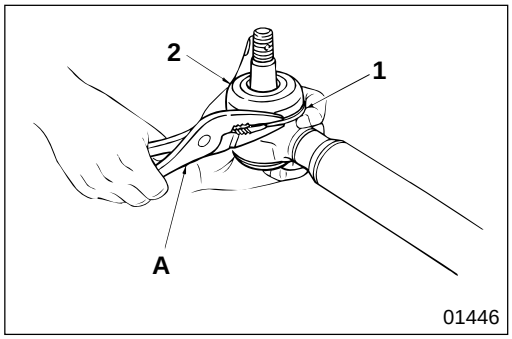
Lubricant

Location	Points of application	Kinds	Quantity
2	Lip area of dust cover	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
	Pack interior of dust cover	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	11 g {0.39 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Clip guide 	MH061831	Installation of clip



◆ Service procedure

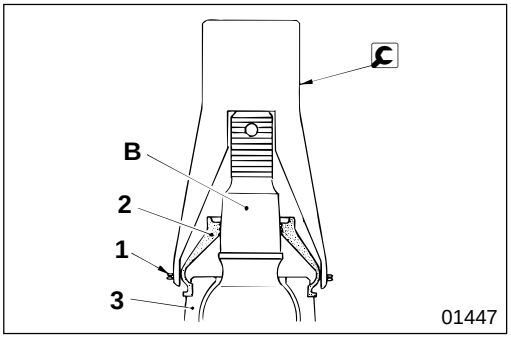
1 Clip

[Removal]

A : Long nose pliers

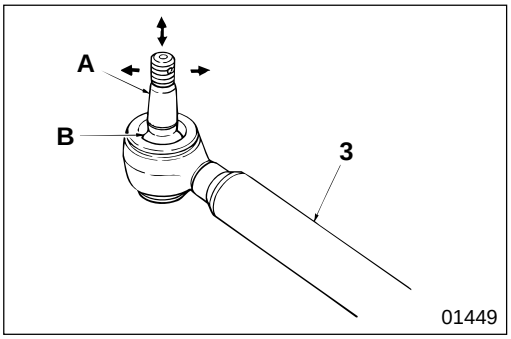
CAUTION

- **Be careful not to damage clip 1 or dust cover 2 when you remove the clip.**
- **If clip 1 is deformed, do not reuse it.**



[Installation]
- Position the assembly so ball stud **B** is vertical.
- Place clip guide on drag link **3**.
- Install clip **1** into the groove of dust cover **2**.

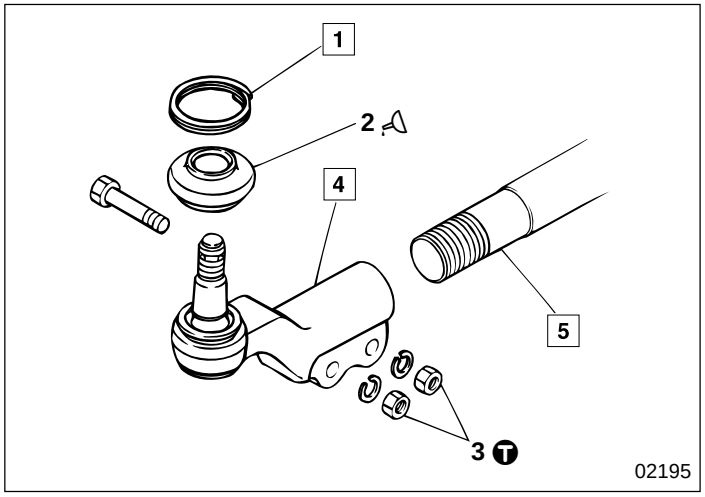
CAUTION
- **Be careful that clip guide end does not dig into dust cover 2.**
- **Be especially careful that clip 1 end does not damage dust cover 2.**



3 Inspection of drag link

Move ball stud area **A** of drag link **3** vertically and horizontally to make sure that there is no play. Also, check that ball section **B** moves evenly. If any fault is found, replace the tie rod assembly.

TIE ROD ASSEMBLY



● **Disassembly sequence**

1 Clip
2 Dust cover
3 Nut
4 Tie rod end assembly
5 Tie rod

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Do not attempt to disassemble tie rod end assembly 4 because it is a unit construction.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
5	Bend of tie rod	1 {0.039} or less	1 {0.039}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

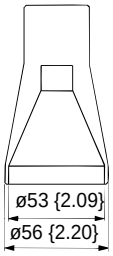
Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (Tie rod end assembly fastening)	78 {58, 8}	Wet

Lubricant

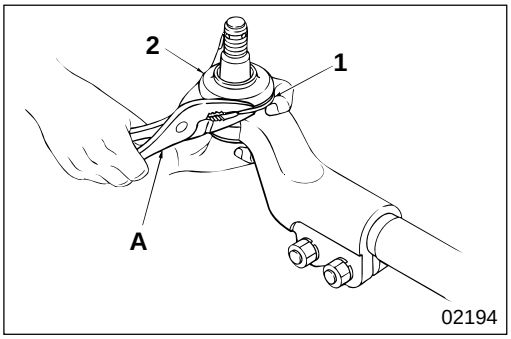
Location	Points of application	Kinds	Quantity
2	Lip area of dust seal	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
	Pack into dust cover	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	11 g {0.39 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Clip guide 	MH061831	Installation of clip

◆ Service procedure



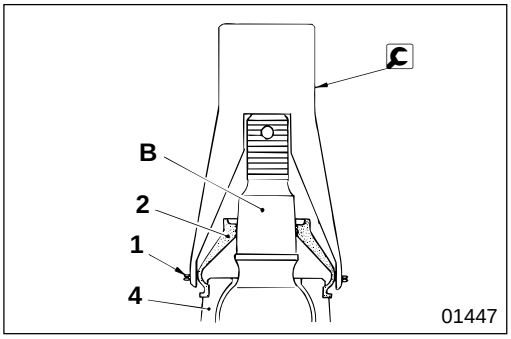
1 Clip

[Removal]

A : Long nose pliers

CAUTION

- **Be careful not to damage clip 1 or dust cover 2 when you remove the clip.**
- **If clip 1 is deformed, do not reuse it.**

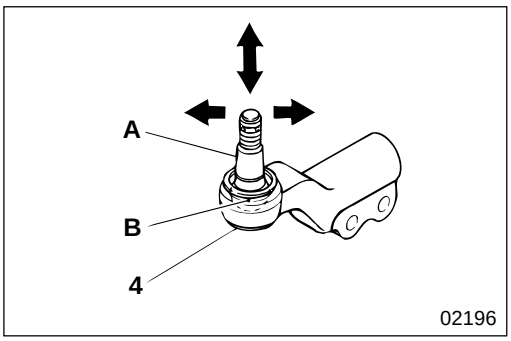


[Installation]

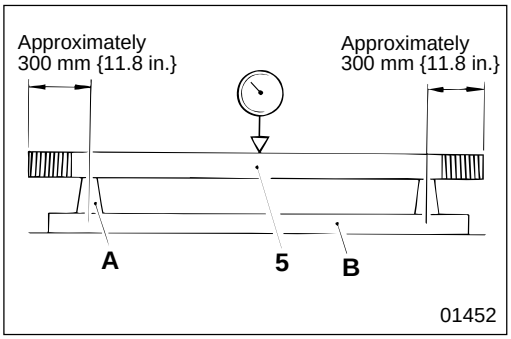
- Position so ball stud **B** is vertical.
- Place clip guide on tie rod end assembly **4**.
- Install clip **1** into the groove of dust cover **2**.

CAUTION

- **Be careful that clip guide end does not dig into dust cover 2.**
- **Be especially careful that clip 1 end does not damage dust cover 2.**



Move ball stud area **A** of tie rod end assembly **4** vertically and horizontally to make sure that there is no play. Also, check that ball section **B** moves evenly. If any fault is found, replace the tie rod end assembly.



5 Bend of tie rod

Measure the bend of tie rod **5** at the center point. If the measured value exceeds the limit, correct or replace the tie rod.

NOTE

To measure the deflection of tie rod 5, turn it one full rotation and read the dial gauge indicator. The deflection is one half of the indicated value.

A : V-block
B : Surface plate

MITSUBISHI
FUSO

Group 41

Frame

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-41

INDEX

SPECIFICATIONS 41-2

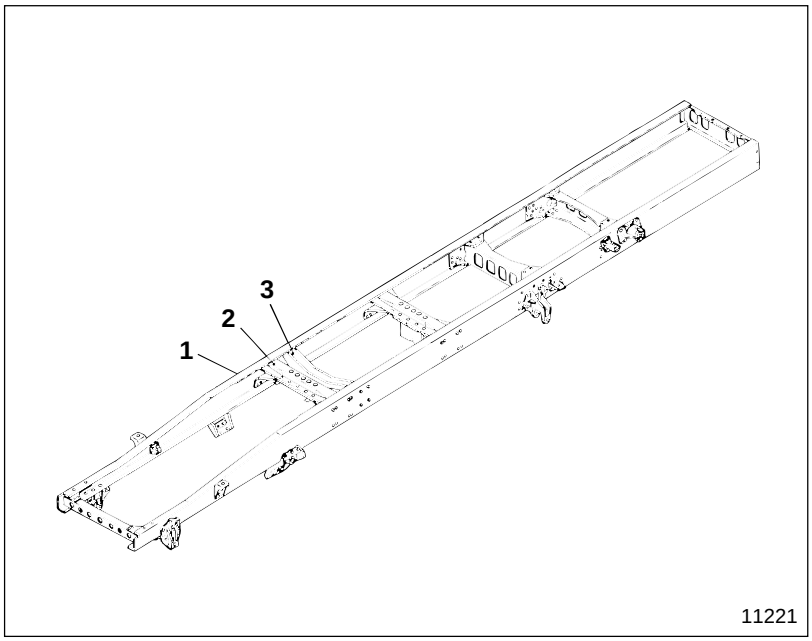
STRUCTURE AND OPERATION 41-2

INSPECTION AND REPAIR OF FRAMES 41-2

SPECIFICATIONS

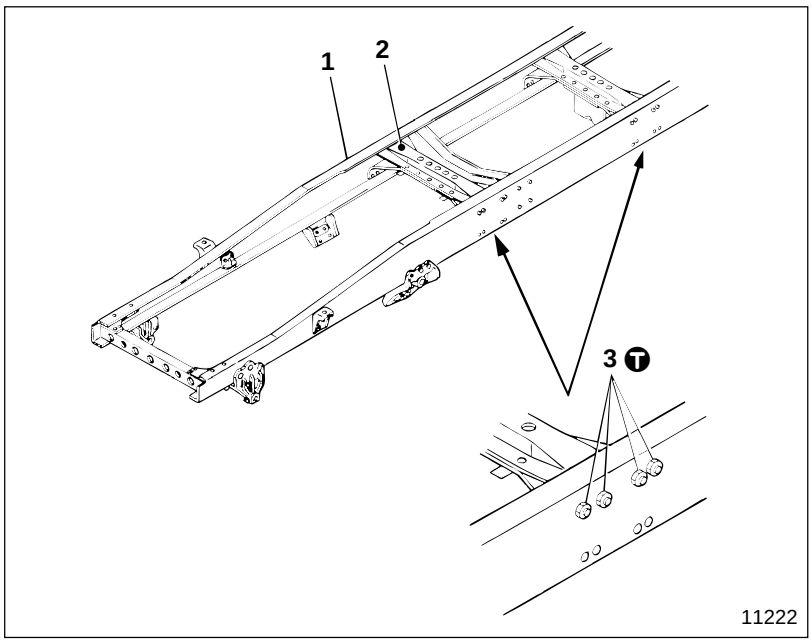
Item	Specifications
Frame type	Ladder type
Cross section configuration of side rail	⊐ shape channel section

STRUCTURE AND OPERATION



1 Side rail
2 Cross member
3 Center bearing bracket

INSPECTION AND REPAIR OF FRAMES



1 Side rail
2 Cross member
3 Nut

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (Cross member to side rail side wall mounting)	85 to 110 {61 to 80, 8.5 to 11}	—

◆ Service procedure

● Cleaning of frame

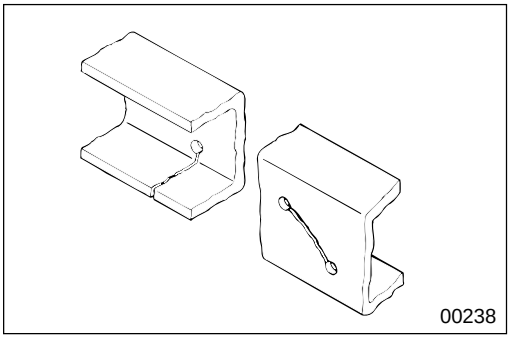
Carefully remove mud, grease, rust, etc. that is stuck to the outer and inner surfaces of the frame.

● Inspection for frame deformation

If any fault such as deformation is found, repair the frame.

● Inspection for cracks in frame

- Remove paint from any areas that are seemingly faulty and carefully inspect.
- If visual inspection is difficult, inspect using color contrast penetrant examination or other methods.
  If a crack is found, repair as follows.

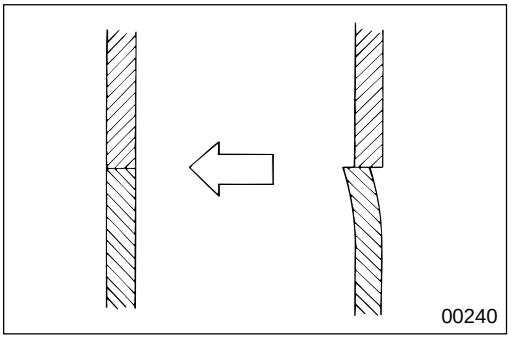


● Repair of crack in frame

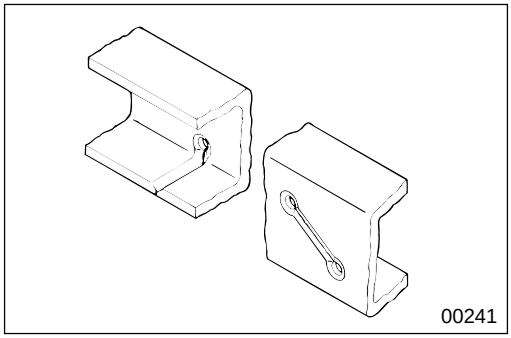
- With the vehicle unloaded, level the frame.
- Drill a hole, about twice the thickness of the frame, 10 mm {0.39 in.} from the end of the crack.

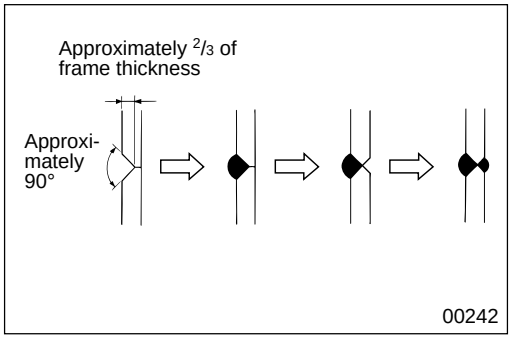
NOTE

If a crack is found inside the frame, drill holes at both ends of the crack.



- If the edges of the crack are not flush, make them flush with each other.





- Using a grinder, etc., grind a 90° V-section channel, two-thirds of the frame thickness, then weld.

WARNING

You must cover any inflammable materials, such as pipelines, wiring harnesses, rubber parts, and the fuel tank, that are near the welding site.

CAUTION

- **Do not use gas welding because the high temperature produced alters the material properties and weakens the welded area. Be sure, therefore, to use electric welding.**
- **Be sure to remove the negative terminal of the battery, then ground the welder near the area to be welded to prevent reversed flow of current from the welder which might burn out electrical components.**
- **Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.**

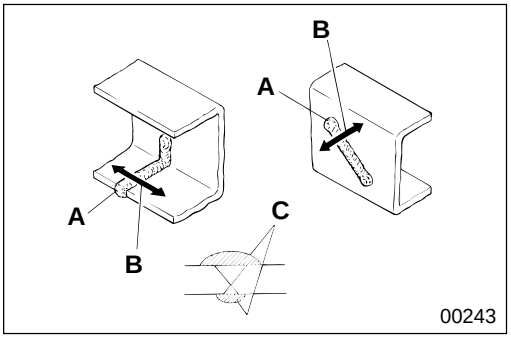
NOTE

- **Use low-hydrogen type coated CO_2 and arc welding electrodes for welding to prevent harmful defects such as undercutting, blow holes, etc.**
- **Preheat the area to be welded to approximately 50 to 350°C {122 to 662°F} before welding when the workshop temperature is below 0°C {32°F}.**

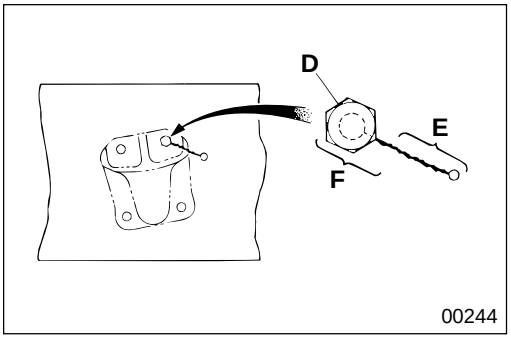
- Next, grind a V-section channel, as described above, on the opposite side of the weld and weld. At the same time, fill the holes at both ends of the crack by welding.

NOTE

In cold districts, heat the welded area to approximately 200°C {392°F} after welding.

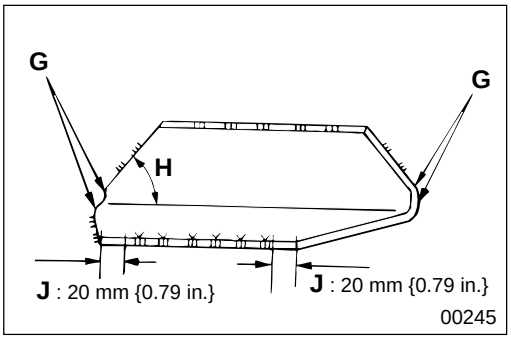


- After welding, grind bead **A** at right angles **B** to remove shaded area **C** as illustrated and grind the area flat.
- Finish the surface so that the frame thickness is identical to the original thickness.



[Repairing cracks caused by rivets or bolt holes]

- To make the edges of the holes flush at the cracked area, temporarily tighten bolt **D** in the hole.
- Weld cracked point **E** at least 20 mm {0.79 in.} from the center of the bolt.
  For welding method refer to the above-mentioned procedures for repairing cracks. P41-3
- After removing the bolt and making the edges flush, weld remaining area **F** and fill the hole.
- After drilling a hole in the filled area, install a rivet or bolt.

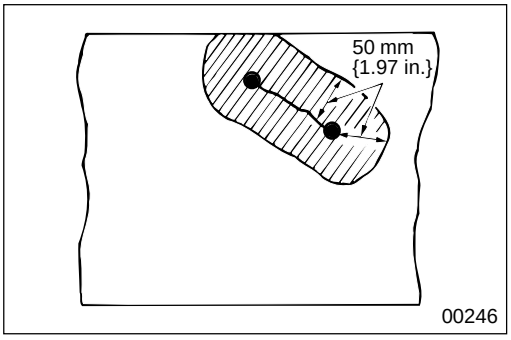


[Repairing using reinforcement plate]

- To prevent concentrated stress being produced at ends **G** of the reinforcement plate, weld the plate with angle **H** at both ends opened 30° or less.
  Do not weld area **J**.
- The reinforcement plate must have enough strength for the cracked area.

NOTE

- **Thickness of reinforcement plate : same as frame thickness**
- **Reinforcement plate material : HTP540 (high tensile strength steel) or equivalent strength.**

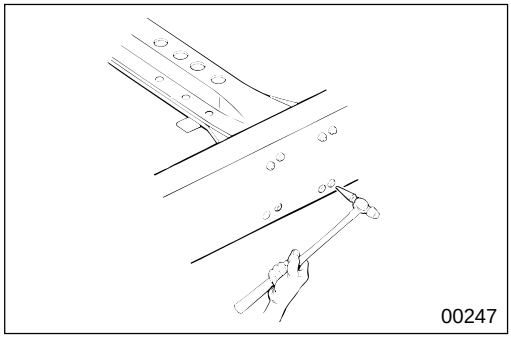


- After welding, heat the shaded area to 600 to 700°C {1112 to 1292°F}.

CAUTION

Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.

INSPECTION AND REPAIR OF FRAMES

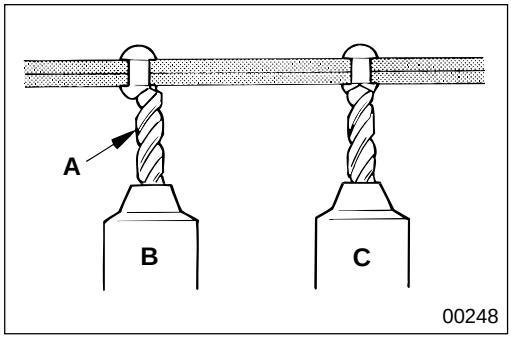


● **Inspection for loose rivets**

- Gently tap the rivet head using an inspection hammer and judge the condition by checking the vibration using the tip of your finger, or by listening to the sound.
- Rust between rivet and frame indicates that the rivet is loose.

CAUTION

Be sure to replace loose rivets because they can break or cause cracking of the frame in the area around the rivet hole, causing accidents.

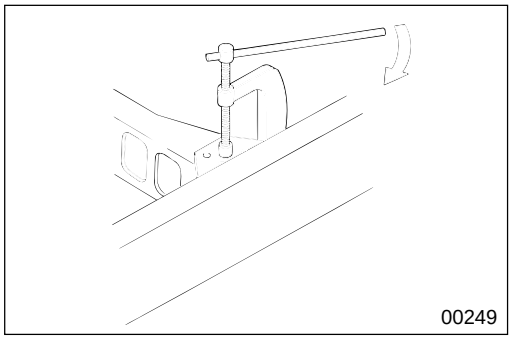


● **Repair of rivet**

- When removing rivets, use a center punch to make an indent in the center of the rivet head; then, drill out using drill **A** or grind.
  B : Incorrect
  C : Correct

CAUTION

Make sure that you do not damage the rivet hole.



- When rivetting, first clamp both plates tightly near the rivet hole using a clamp to eliminate gaps between plates.

- Using a rivetting machine, insert the rivet (cold rivet).
- If rivetting is impossible, ream the rivet hole, drive in a reamer bolt, fully tightening the nut, then weld it in place.
  A flange bolt and flange nut should be used for the reamer bolt and nut.

● **Inspection for loose bolts and nuts**

- Inspect the mounting bolts of the cross member and the helper stopper for looseness. Loosened bolts should be tightened at specified torque. P41-2, Gr 34

NOTE

Tighten the nut side when working on the helper stopper mounting bolts.

MITSUBISHI
FUSO

Group 42

Cab

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-42

INDEX

SPECIFICATIONS 42- 2

STRUCTURE AND OPERATION 42- 3

TROUBLESHOOTING 42-14

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Adjustment of Cab Tilt 42-19
- Adjustment of Door Fitting 42-20

REMOVAL AND INSTALLATION OF CAB 42-22

FRONT CAB MOUNTING 42-30

REAR CAB MOUNTING 42-32

CAB TILT LINK 42-34

DOOR 42-37

CAB EXTERIOR FITTING 42-42

MIRROR 42-46

WIPER AND WASHER 42-48

CAB INTERIOR FITTING 42-51

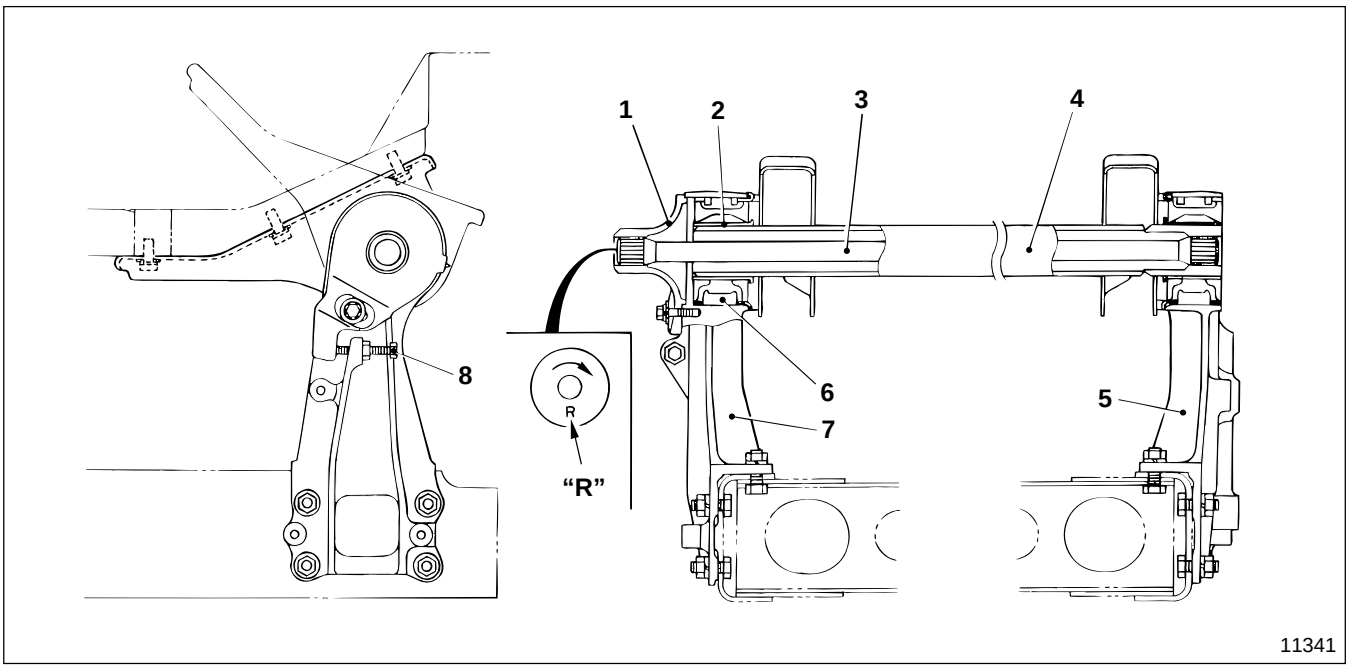
INSTRUMENT PANEL 42-53

WINDOW GLASS 42-56

SPECIFICATIONS

Item		Specifications
Cab assembly	Type	Cab over type (Forward control type)
	Mass kg {lb}	Approximately 390 {860}
Cab tilt	Type	Torsion bar type
	Tilt angle	45°
Cab mounting Type		Fixed type
Windshield		Laminated glass
Glass other than windshield		Tempered glass
Door glass opening and closing mechanism		Manual control type (Cable driven)

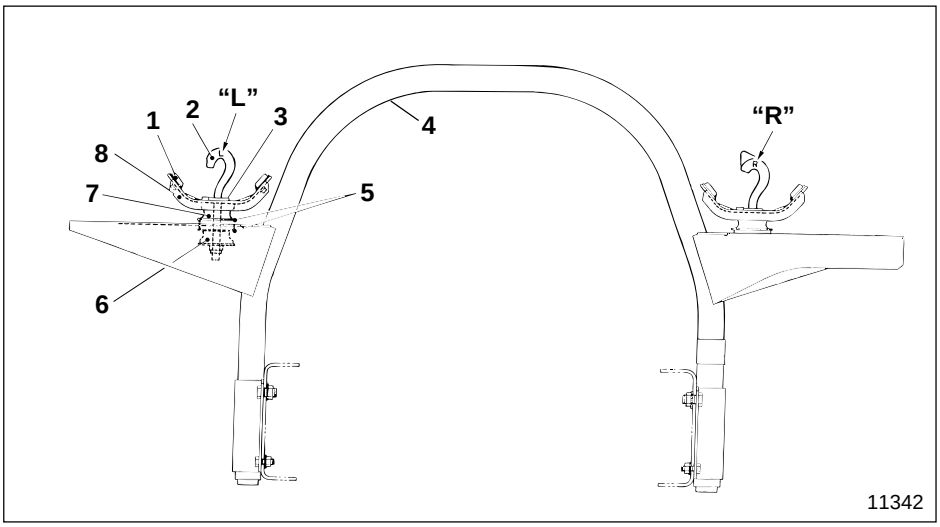
Front Cab Mounting



1 Anchor lever
2 Bushing
3 Torsion bar
4 Front floor cross member assembly
5 Front cab mounting bracket, LH
6 Front rubber assembly
7 Front cab mounting bracket, RH
8 Adjusting bolt

Since torsion bar **3** has torsional direction, it is marked **"R"** on its right end to indicate the torsional direction, preventing mistaken installation.

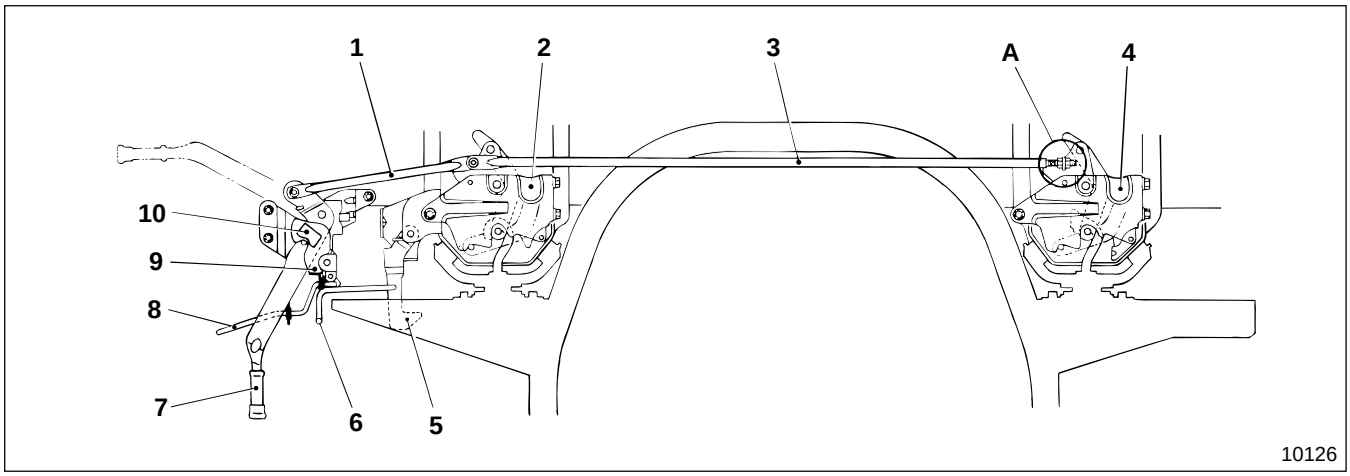
Rear Cab Mounting



1 Side rubber
2 Anchor hook
3 Spacer
4 Rear mounting post
5 Metal fixture
6 Lower rubber
7 Upper rubber
8 Cab hold bracket

- Anchor hooks **2** are marked **"L"** and **"R"** to identify left and right.
- Between anchor hook **2** and cab hold bracket **8** is spacer **3**. By increasing or decreasing the number of spacers, the cab tilt operating force can be adjusted.

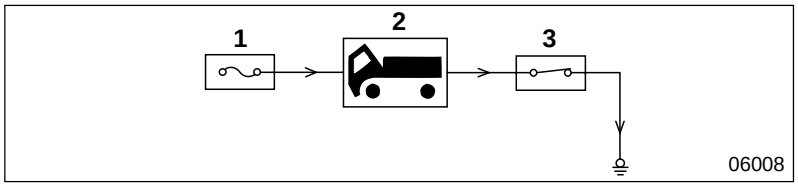
Cab Tilt Link



1 Lock handle rod
2 Link assembly, LH
3 Center rod
4 Link assembly, RH
5 L-lever
6 L-lever rod
7 Lock handle
8 Lock latch lever
9 Lock latch
10 Cab tilt lock switch
A : Center rod adjusting point

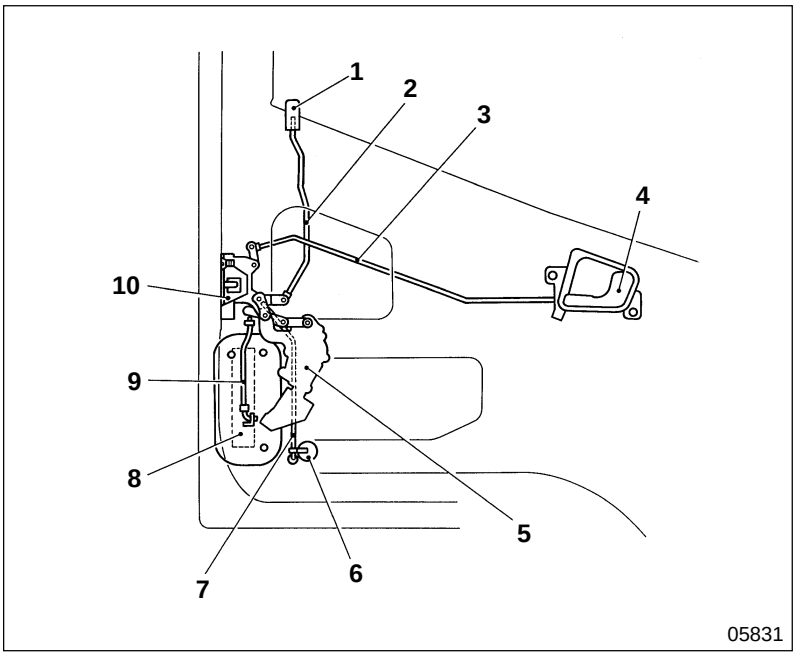
- The length of center rod **3** can be adjusted at mounting part **A** (center rod adjusting point) of link assembly RH **4**.
- Cab tilt lock switch **10**, mounted on lock latch **9**, detects whether lock handle **7** is locked securely.

Cab Tilt Warning Electric Circuit



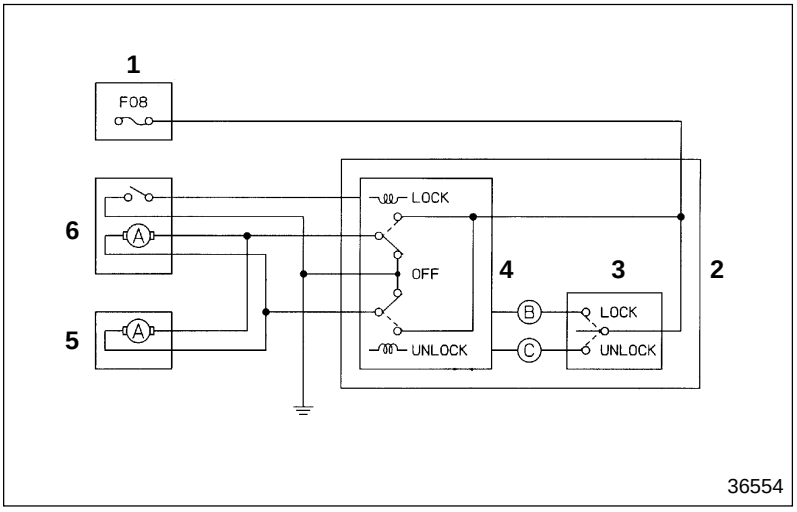
1 Fuse box
2 Cab tilt warning lamp
3 Cab tilt lock switch

Door Locking System



1 Door lock knob
2 Door lock rod
3 Door opening rod
4 Inside handle
5 Door lock actuator
6 Door lock cylinder
7 Door lock cylinder rod
8 Outside handle
9 Door opening rod
10 Door lock latch

Auto Door Lock Electric Circuit



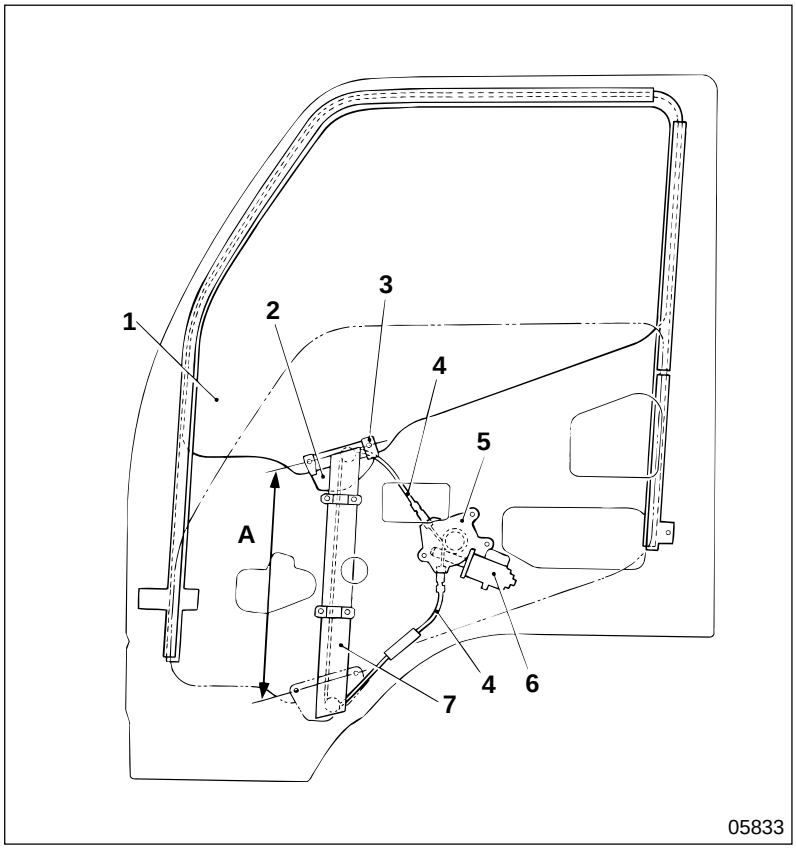
1 Fuse box
2 Driver's side power window switch
3 Auto door lock switch
4 Door lock relay
5 Driver's side door lock actuator
6 Assistant driver's side door lock actuator

A : Actuator

Ⓑ : Lock signal
Ⓒ : Unlock signal

From the driver's side, the doors can be locked and unlocked by auto door lock switch **3** as well as by door lock actuator **6**.

Door Glass Opening System

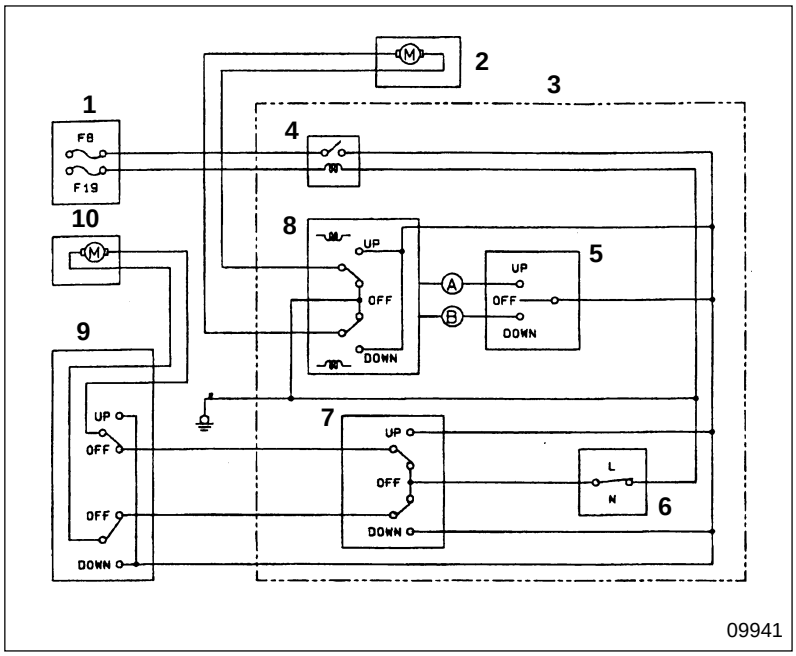


1 Door glass
2 Carrier plate
3 Glass holder
4 Cable
5 Regulator
6 Power window motor
7 Rail

A : Carrier plate moving range

- Both ends of cable **4** are secured to carrier plate **2**, and regulator **5** is installed to the wire at a midpoint.
- Regulator **5** rotates, thus winding cable **4** and moving carrier plate **2** in a vertical direction to raise or lower door glass **1**.

Power Window Electric Circuit



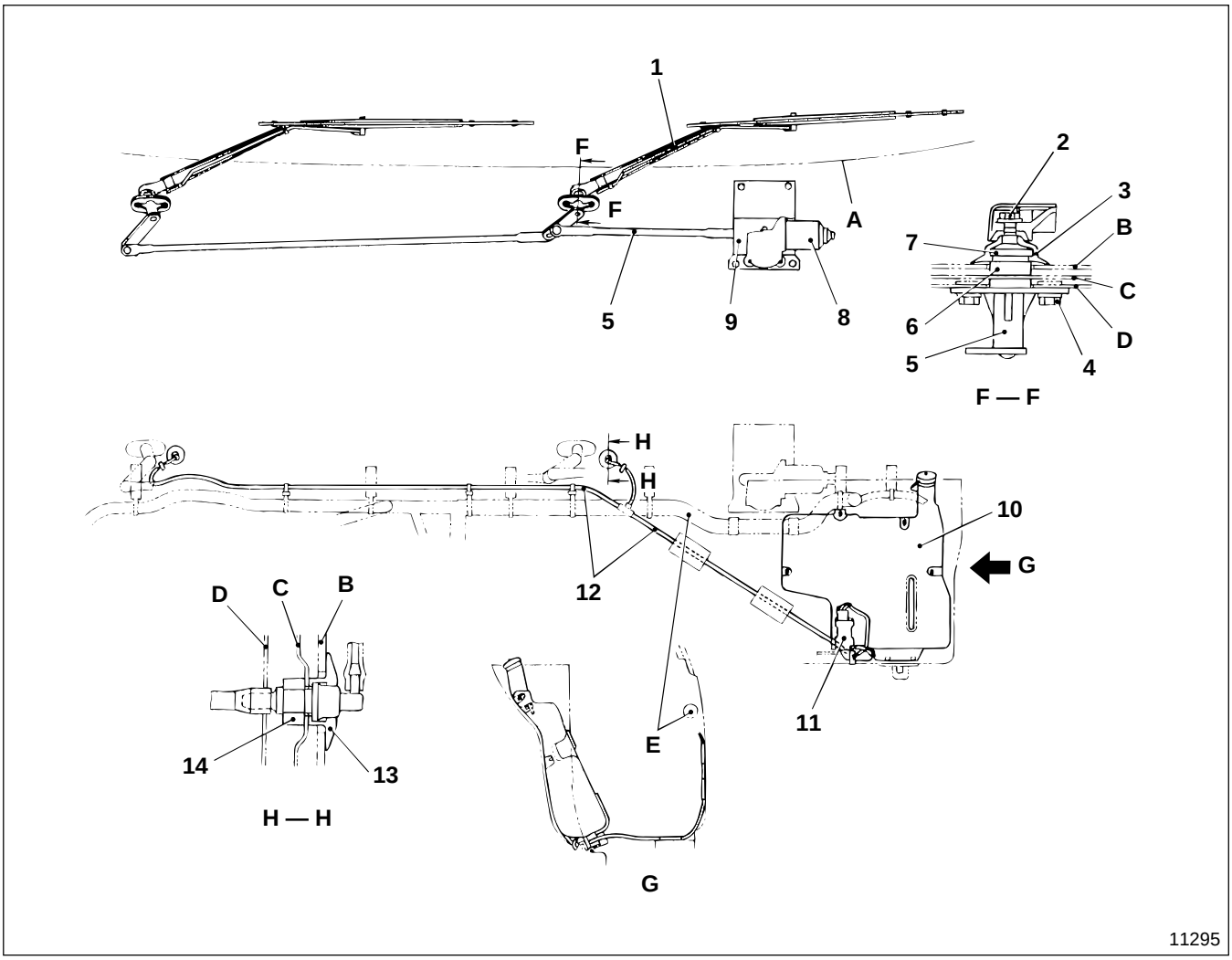
1 Fuse box
2 Driver's side power window motor
3 Driver's side power window switch assembly
4 Relay
5 Driver's side power window switch
6 Power window lock switch
7 Driver's side power window switch (for opening and closing assistant driver's side door glass)
8 Power window relay
9 Assistant driver's side power window switch
10 Assistant driver's side power window motor

M : Motor

Ⓐ : UP signal
Ⓑ : DOWN signal

- Power window switch assembly **3** on the driver's side is integrated with power window switches **5**, **7** and power window lock switch **6**.
- When power window lock switch **6** is set to the LOCK position, the door glass on the assistant driver's side cannot be operated by power window switches **7**, **9**.

Wiper and Washer

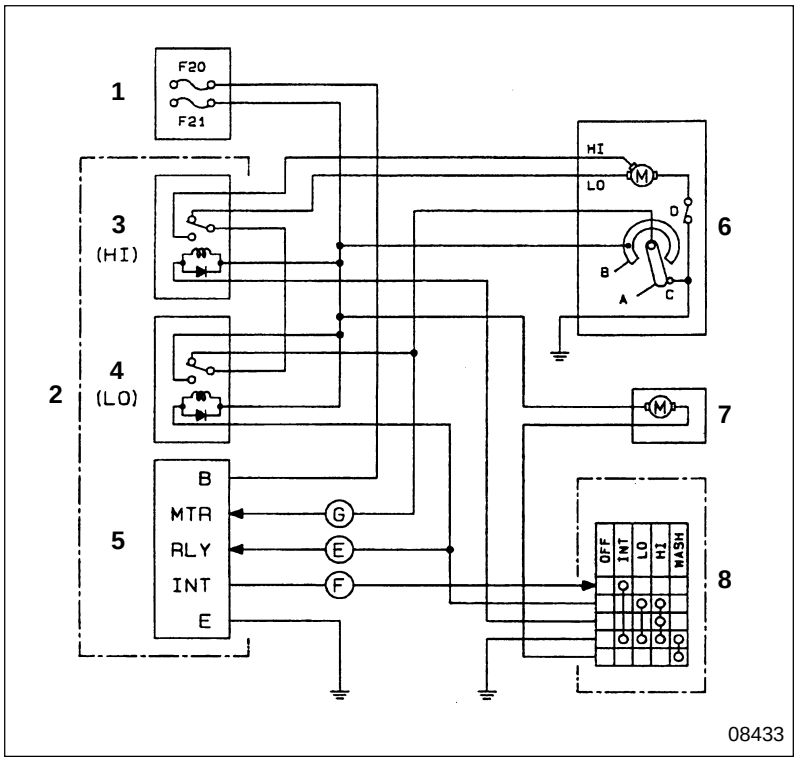


1 Wiper arm and blade assembly
2 Nut
3 Pivot cap
4 Nut
5 Wiper link assembly
6 Packing washer
7 Nut
8 Wiper motor
9 Wiper motor bracket
10 Washer tank
11 Washer motor
12 Washer hose
13 Hose joint
14 Nut

A : Weatherstrip ends
B : Front garnish
C : Front panel
D : Front rail
E : Cab harness

The viewpoint of this illustration is from inside the cab.

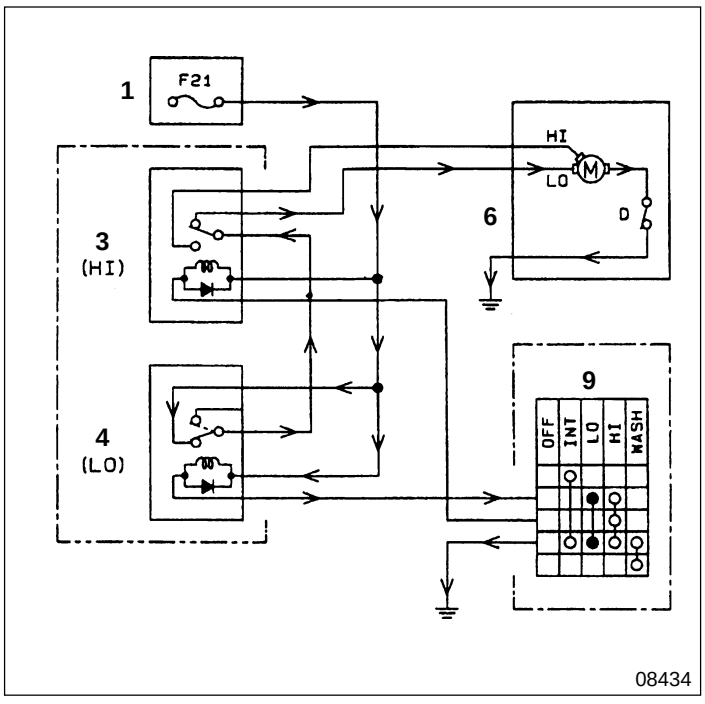
Wiper and Washer Electric Circuit



1 Fuse box
2 Relay box
3 Wiper relay (HIGH)
4 Wiper relay (LOW)
5 Multipurpose timing control unit
6 Wiper motor
7 Washer motor
8 Combination switch
9 Wiper and washer switch

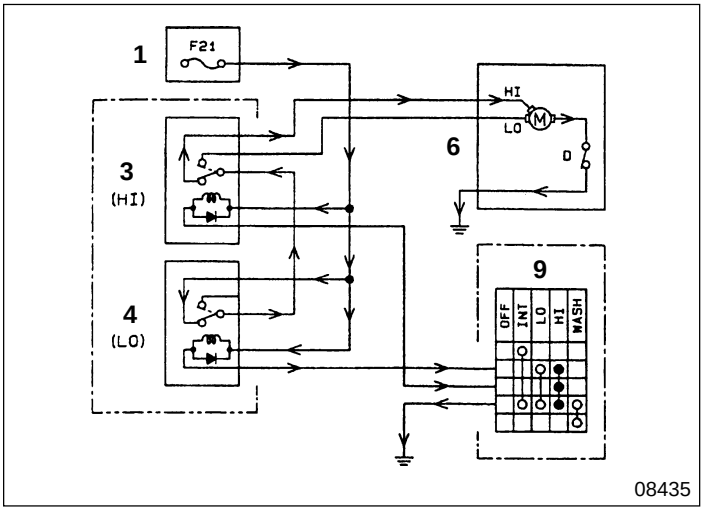
Wiper motor **6** section
A : Cam
B : Plate
C : Contact point
D : Circuit breaker

Ⓔ : Wiper motor driving signal (when wiper operating intermittently)
Ⓕ : Intermittent switch signal (when wiper operating intermittently)
Ⓖ : Cam signal (when wiper stops)
Ⓗ : Washer switch signal



When wiper operating at LOW speed

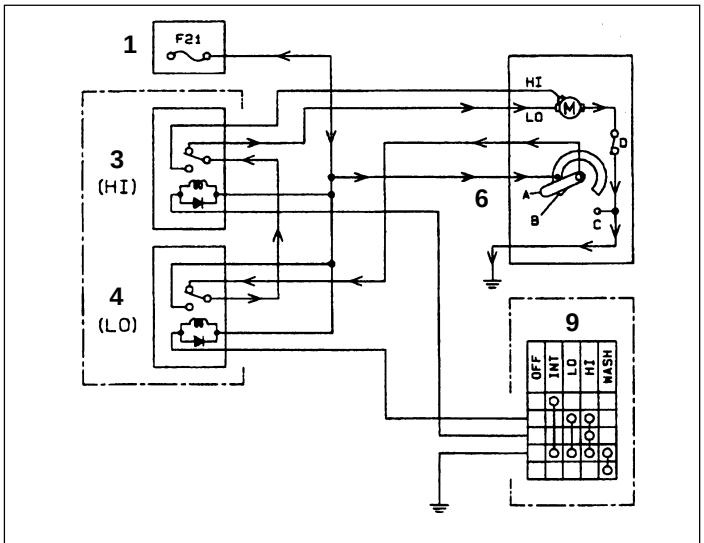
Position of wiper and washer switch **9** : LO
- **1** (F21) → **4** (coil) → **9** (LO) → Ground
- **1** (F21) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** rotates at low speed.



When wiper operating at HIGH speed

Position of wiper and washer switch **9** : HI

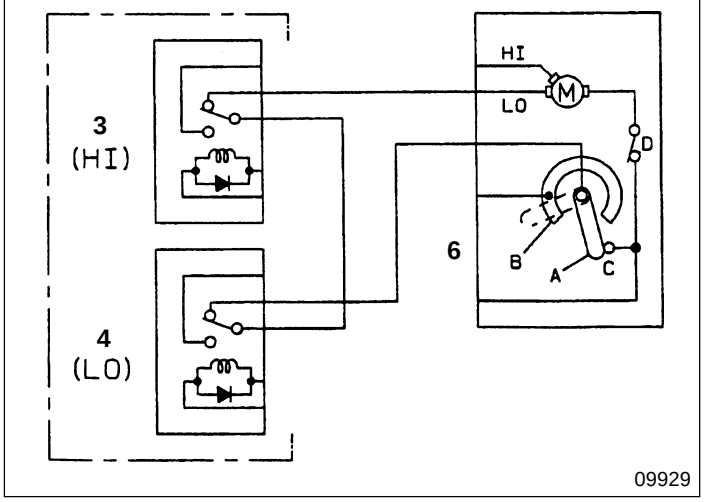
- **1** (F21) → **3** (coil) → **9** (HI) → Ground
  → **4** (coil) → **9** (HI) → Ground
- **1** (F21) → **4** (contact point) → **3** (contact point) → **6** (HI) → **6** (D) → Ground
  Wiper motor **6** rotates at high speed.



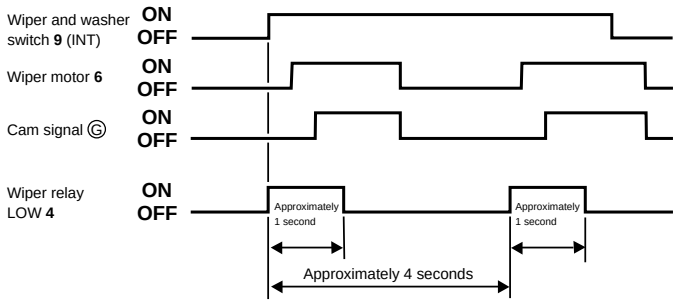
When wiper stops

Position of wiper and washer switch **9** : OFF

- **1** (F21) → **6** (B) → **6** (A) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** continues to rotate at low speed.



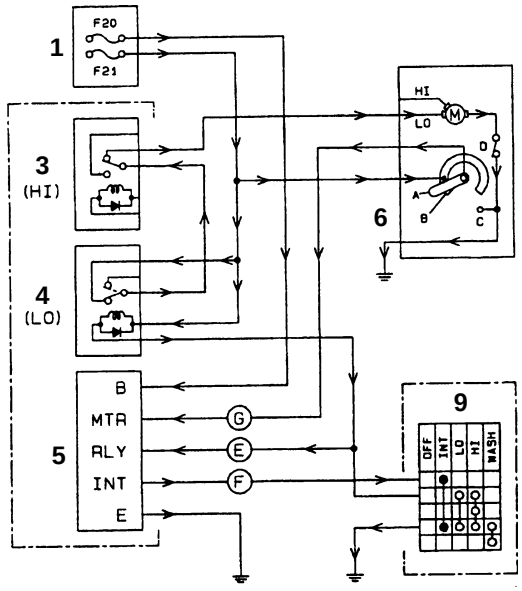
- When cam **A** is separated from plate **B** by rotation of wiper motor **6**, the current to the motor is cut off.
- Wiper motor **6** continues to rotate due to the inertia force of the motor and the wiper link.
- When cam **A** of wiper motor **6** makes contact with contact point **C**, the following ungrounded circuit is formed.
  → **6** (LO) → **6** (D) → **6** (C) → **3** (contact point) ← **4** (contact point) ← **6** (A) ←
- Wiper motor **6** stops by dynamic (electric) braking because of this circuit.



08654

When wiper operating intermittently

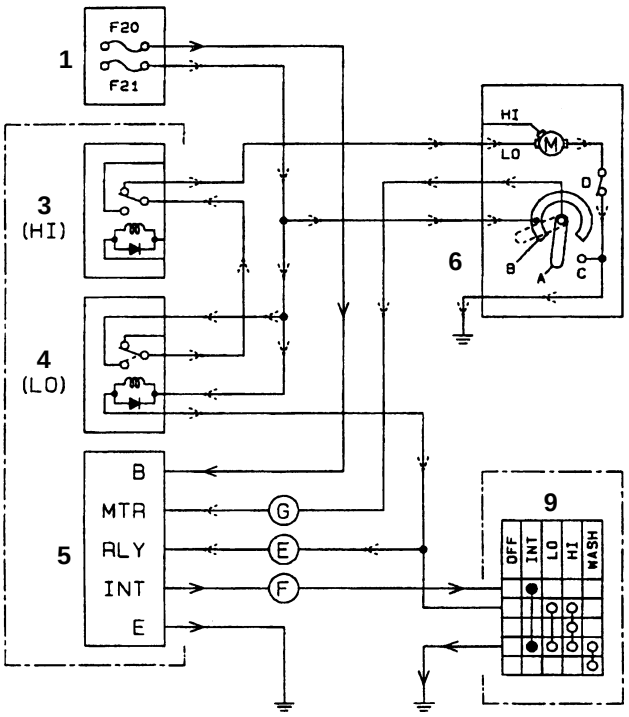
Operation mode with multipurpose timing control unit **5**



09931

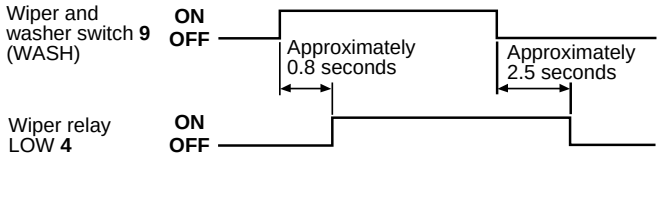
Position of wiper and washer switch **9** : INT

- **1** (F20) → **5** (B) → Ground
- **5** (INT) —Ⓕ→ **9** (INT) → Ground
- Multipurpose timing control unit **5** sends wiper motor driving signal Ⓔ when it receives intermittent switch signal Ⓕ.
  1 (F21) → **4** (coil) —Ⓔ→ **5** (RLY)
- **1** (F21) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** rotates at low speed.
- Multipurpose timing control unit **5** sends wiper motor driving signal Ⓔ, then sends cam signal Ⓖ.
  1 (F21) → **6** (B) → **6** (A) —Ⓖ→ **5** (MTR)

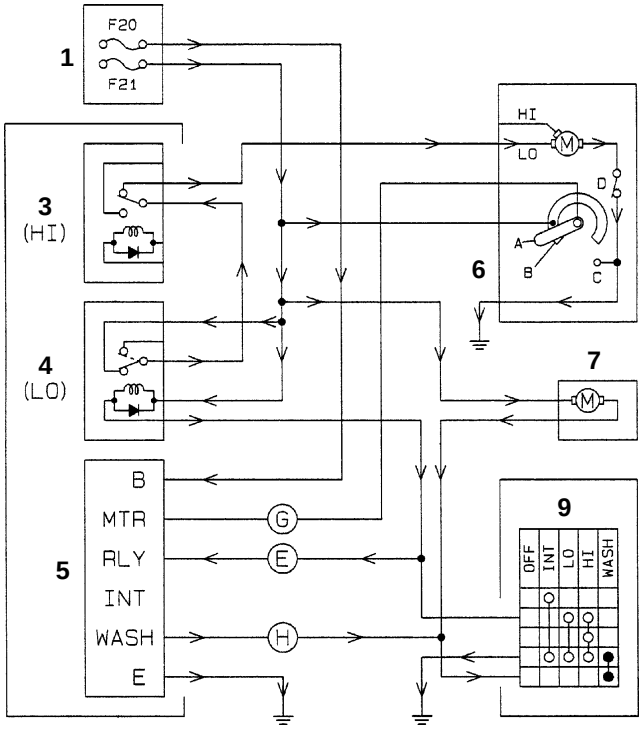


09932

- When cam **A** of wiper motor **6** is separated from plate **B**, cam signal Ⓖ turns OFF.
- When cam signal Ⓖ is turned OFF, multipurpose timing control unit **5** turns wiper motor driving signal Ⓔ OFF for specified time.
  The illustrated part ⊣⊢ of the circuit turns OFF.
- Wiper motor **6** stops. 🕮 Gr 42-9
- After specified time has passed, multipurpose timing control unit **5** sends wiper motor driving signal Ⓔ again.
- Wiper motor **6** rotates at low speed.



11125



11126

When washer operating

Operation mode with multipurpose timing control unit **5**

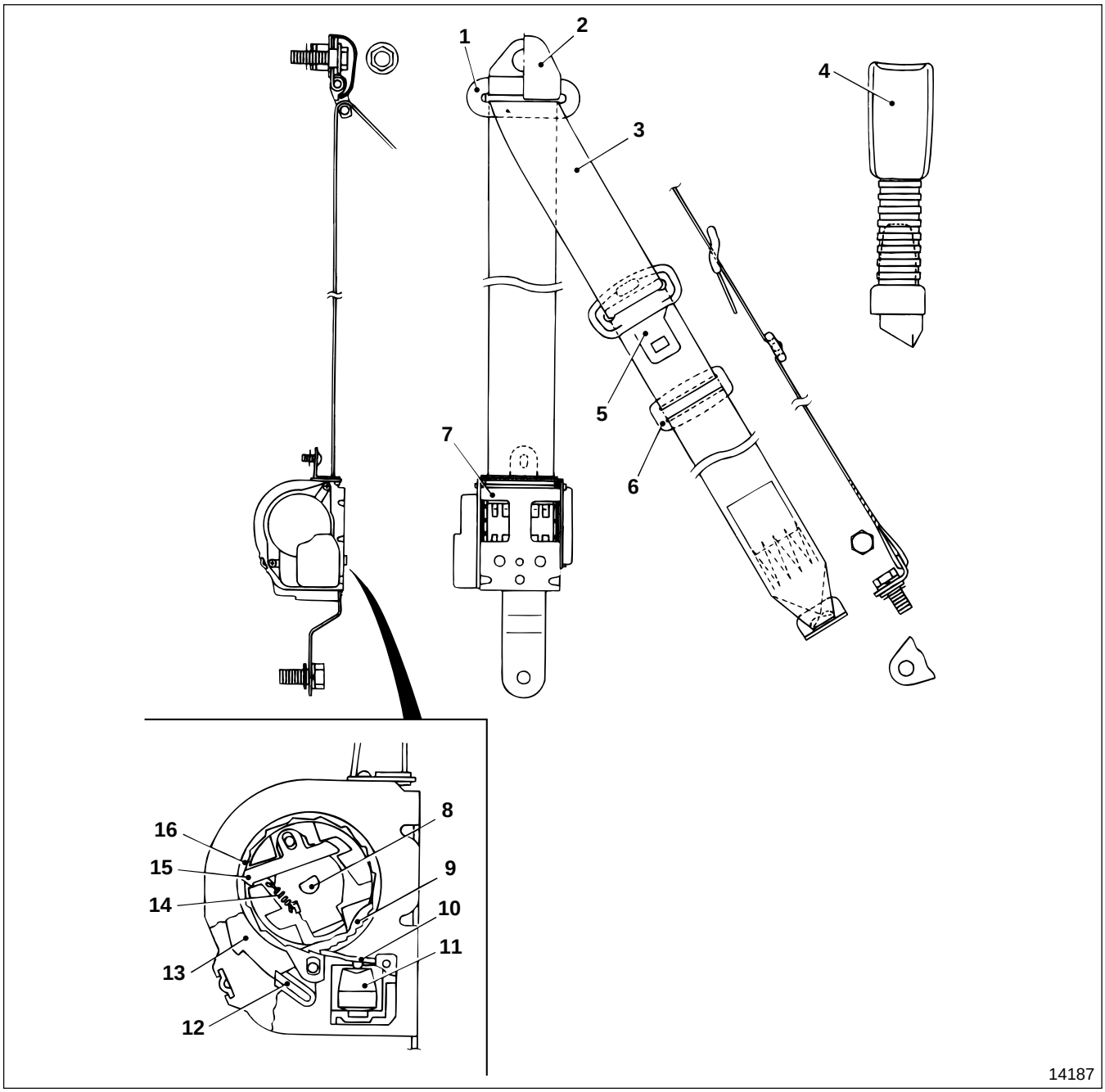
Position of wiper and washer switch **9** : WASH

- **1** (F20) → **5** (B) → Ground
- **1** (F21) → **7** → **9** → Ground
  5 (WASH)-Ⓗ

When washer motor **7** operates to spray washer fluid, multipurpose timing control unit **5** transmits washer switch signal Ⓗ.

- **1** (F21) → **4** (coil) —Ⓔ→ **5** (RLY)
  Washer switch signal Ⓗ makes multipurpose timing control unit **5** input wiper motor drive signal Ⓔ.
- **1** (F21) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** operates at LOW speed.
- When wiper and washer switch **9** is turned to OFF, washer motor **7** stops.
- Then, washer switch signal Ⓗ is turned off and multipurpose timing control unit **5** turns off wiper motor drive signal Ⓔ after specified time.
- Wiper motor **6** automatically stops.
  P42-9

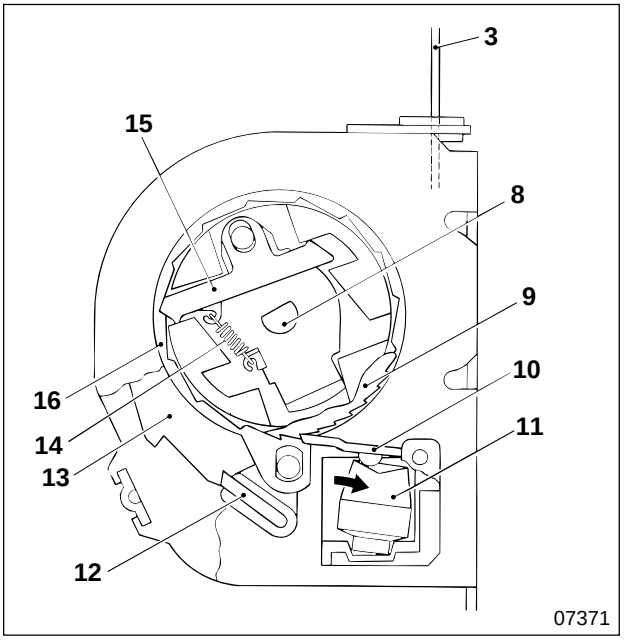
Emergency Locking Retractor (ELR) Type Seat Belt



1 Sash guide
2 Cover
3 Webbing
4 Buckle assembly
5 Tongue plate
6 Tongue stopper
7 Emergency locking retractor assembly
8 Spindle
9 Locking gear
10 Mechanism lever
11 Mechanism weight
12 Pawl
13 Ratchet gear
14 Sensor spring
15 Lock arm
16 Clutch

CAUTION⚠

Do not disassemble emergency locking retractor assembly 7, or malfunctions might occur.



Webbing detecting lock

- When the vehicle is subjected to a sudden impact, such as a crash, webbing **3** retracts according to the movement of passengers, and spindle **8** rotates.
- As the rotation of spindle **8** is higher than the specified value, the repercussive force of sensor spring **14** can no longer retain lock arm **15**. Then, the arm is pulled out from the specified position and is locked by clutch **16**.
- If spindle **8** further rotates, clutch **16** lifts pawl **12** to lock with ratchet gear **13**, making spindle rotation impossible.

Body detecting lock

- When the body is tilted excessively, mechanism weight **11** is tilted, engaging mechanism lever **10** with locking gear **9**, locking it.
- If spindle **8** further rotates, clutch **16** operates as described above, and the spindle cannot rotate.

Cab as a Whole

Possible causes / Symptoms		Cab shimmy (pitching and rolling vibration)	Cab or steering wheel high-frequency vibration (above 20 Hz) or noise	Cab cannot be tilted up	Cab cannot be locked to rear mounting post	Cab tilt warning lamp does not light	Cab tilt warning lamp does not go out	Remarks
Cab-related	Cab mounting loose or play	○						
	Front rubber, rear rubber deteriorated		○					
	Cab mounted incorrectly		○					
	Link assembly from anchor hook does not release			○				
	L-lever release faulty			○				
	Torsion bar damaged or fatigued			○				
	Torsion bar arm installation position incorrect			○				
	Link assembly not hooked to anchor hook				○			
	Link assembly contact with side cushion incorrect				○			
	Cab tilt lock switch adjusted incorrectly					○	○	
	Cab tilt lock switch faulty					○	○	
	Cab tilt warning lamp bulb burnt-out					○		
	Fuse, high-current fuse blown					○		
	Wiring broken or connection faulty					○		
Engine-related	Crossed axes angle of propeller shaft excessive due to increased tilt caused by deteriorated engine mounting		○					
	Engine installation faulty		○					Gr 11A, B
	Intake and exhaust system installation faulty		○					
Transmission-related	Transmission installation faulty		○					Gr 22, 23A, B
Propeller shaft-related	Propeller shaft run-out excessive		○					
	Universal joint worn excessively		○					
	Slip yoke joint spline play		○					
	Center bearing play excessive		○					Gr 25
	Crossed axes angle of mounting dimension excessive due to deteriorated center bearing cushion rubber, etc.			○				
	Crossed axes angle of propeller shaft excessive due to increased tilt of drive axis caused by overloading		○					

Possible causes / Symptoms		Cab shimmy (pitching and rolling vibration)	Cab or steering wheel high-frequency vibration (above 20 Hz) or noise	Cab cannot be tilted up	Cab cannot be locked to rear mounting post	Cab tilt warning lamp does not light	Cab tilt warning lamp does not go out	Remarks
Front axle-related	Axle seat resonance	○						Gr 26
Rear axle-related	Reduction gear engaged incorrectly		○					Gr 27
	Differential gear engaged incorrectly		○					
Wheel and tire-related	Wheel and tire run-out excessive	○						Gr 31
	Wheel and tire unbalanced	○						
	Size and kinds of tire unequal	○						
	Wheel mounting surface warped	○						
Front suspension-related	Leaf spring friction between leaves excessive	○						Gr 33
Brake-related	Brake drum unbalanced	○						Gr 35A
	Brake drum eccentric	○						
	Rotor of disc brake eccentric	○						

Door Lock

Symptoms / Possible causes	Door latch does not engage, and door does not close	Door does not lock when door lock knob is pressed	Door does not lock when key is turned	Remote door lock does not operate	Door does not open when outside door handle is operated	Door does not open when inside door handle is operated	Inside door handle does not return properly to original position	There is interference between door and cab	Remarks
Door installation faulty	○							○	
Striker installation faulty	○								
Faulty door locking mechanism of door latch	○	○	○		○	○			
Door latch rod deformed		○				○			
Door latch rod disconnected		○	○			○			
Door latch rod interference							○		
Door lock cylinder deformed			○						
Faulty auto door lock switch in power window & door lock switch				○					Gr 54
Door lock actuator faulty				○					
Fuse or high-current fuse blown				○					
Open circuit or faulty connection of wire				○					
Left-side outside door handle faulty					○				
Inside door handle installation faulty						○			
Spring fatigue in inside door handle							○		

Wiper and Washer

Symptoms / Possible causes	Wiper doe not work	Wiper does not stop	Wiper intermittent operation does not work	Wiper blade stop position incorrect	Wiper operation inadequate	Noise during wiper operation	Washer motor does not work	Washer fluid jetting insufficient	Washer fluid does not jet	Remarks
Wiper motor faulty	○	○		○		○				
Washer motor faulty							○	○	○	
Wiper and washer switch faulty	○	○	○				○			
Multipurpose timing control unit faulty			○							Gr 54
Wiper relay faulty	○						○			
Fuse, high-current fuse blown	○						○			
Wiring broken or connection faulty	○		○				○		○	
Wiper motor crank arm set position faulty				○						
Wiper link and wiper arm connection faulty						○				
Wiper blade faulty					○	○				
Wiper arm faulty					○					
Washer hose twisted								○		
Washer hose connected incorrectly									○	
Washer nozzle clogged								○	○	
Washer fluid insufficient									○	

Power Window

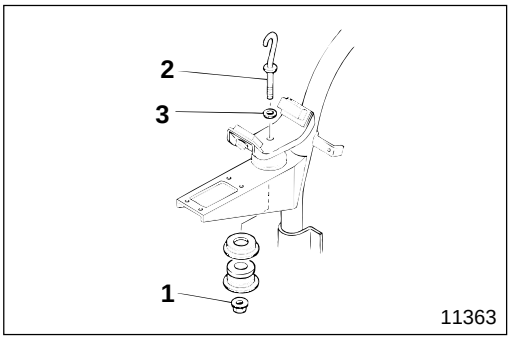
Symptoms / Possible causes	Door window glass drops of its own accord while cruising	Abnormal noise from power window regulator while cruising	Power window does not operate	Power window does not stop	Abnormal noise while power window operating	After the starter switch has been turned OFF the window does not operate within 30 seconds of the power window switch being operated	After the starter switch has been turned OFF and although the doors have been opened within 30 seconds, the window does not operate within 30 seconds of the power window switch being operated	Remarks
Power window switch faulty			○	○		○	○	
Power window regulator faulty	○		○	○	○			
Power window regulator mounting faulty					○			Gr 54
Fuse and high-current fuse burnt-out			○					
Wiring broken or connection faulty			○					
Power window glass and door belt line molding rattling		○						

Adjustment of Cab Tilt

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Lock nut (Anchor hook mounting)	83 to 98 {61 to 72, 8.5 to 10.0}	—
4	Bolt (Lock handle mounting)	29 to 39 {22 to 29, 3.0 to 4.0}	—



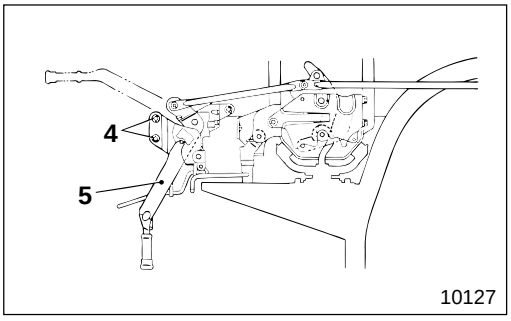
(1) Adjustment of lock handle operating force

Adjust the lock handle operating force by increasing or decreasing the number of spacers **3** as follows:

1 : Lock nut

2 : Anchor hook

	Number of spacers
Heavy operating force	Increased
Light operating force	Decreased



(2) Adjustment for unsmooth latch

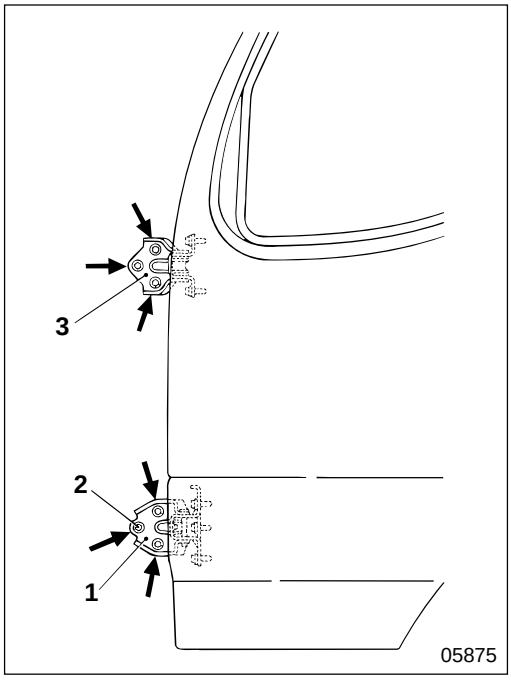
If latch operation is not smooth, loosen bolt **4**, and adjust installation of lock handle **5**.

Adjustment of Door Fitting

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Upper and lower hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
7	Screw (Striker mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—

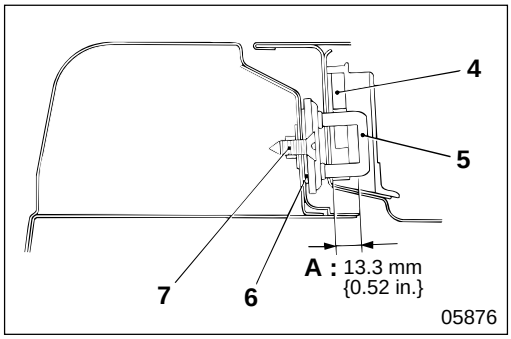


Adjust door fitting at hinge and striker.
(For door fitting dimensions: 🕮 P42-21.)

(1) Adjustment of hinge

For adjustment, use front-side bolt **2** of lower hinge **1** as the reference point.

3 : Upper hinge

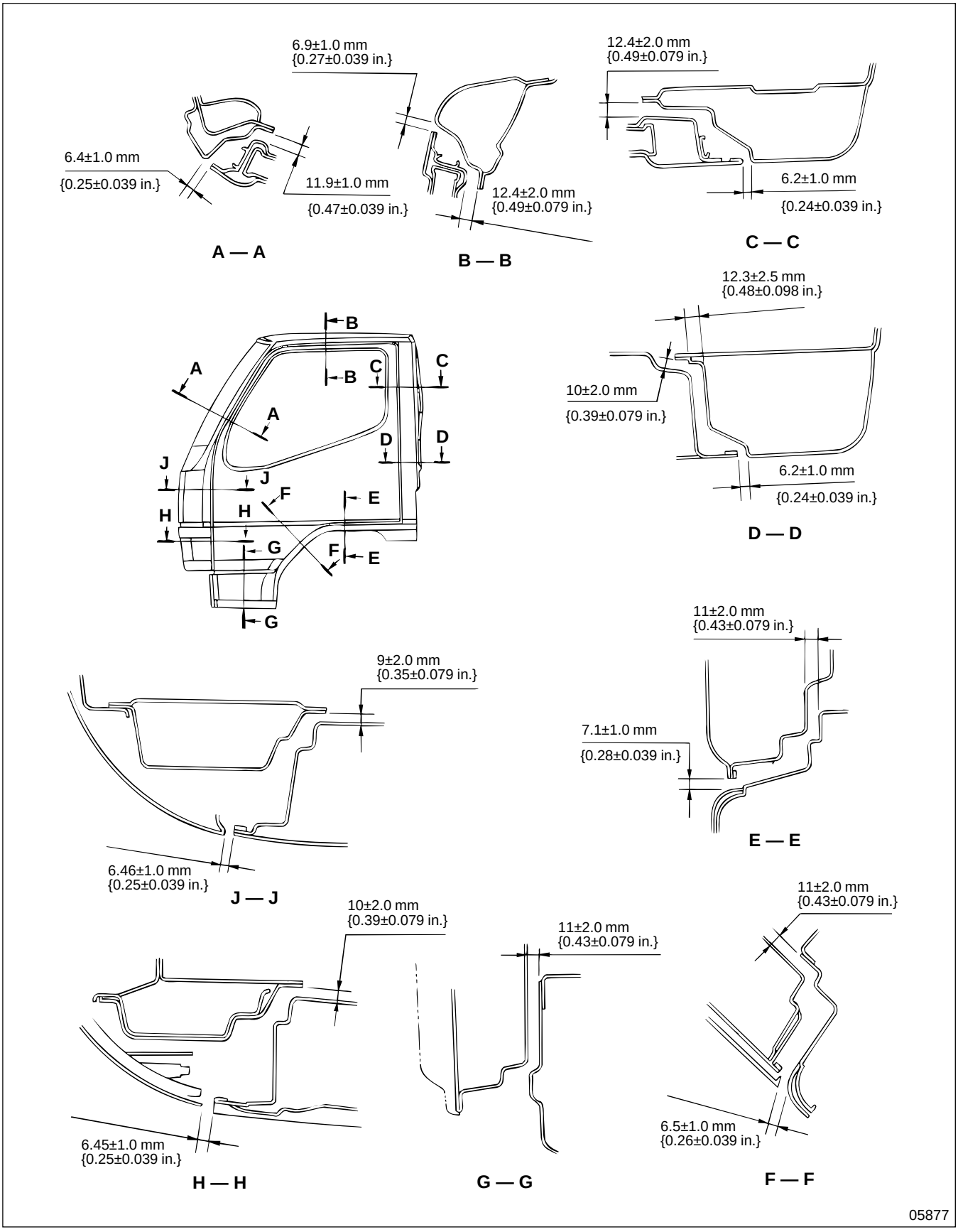


(2) Adjustment of striker

Engagement condition between door lock latch **4** and striker **5** should be adjusted with shim **6** within illustrated range **A**.

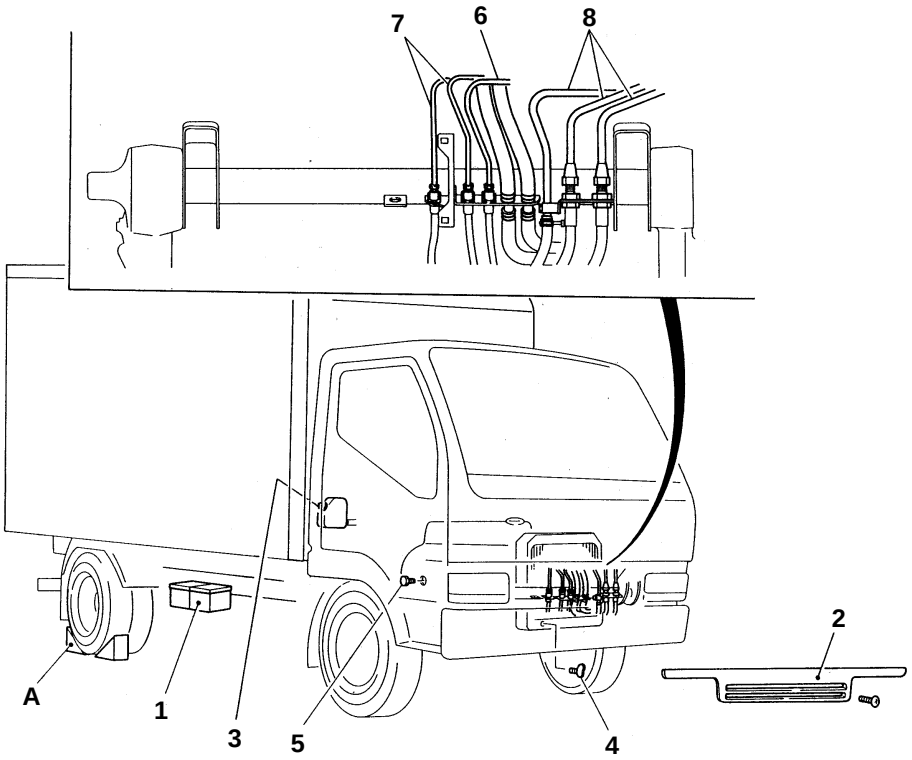
7 : Screw

Door Fitting Dimensions



REMOVAL AND INSTALLATION OF CAB

Preliminary Work



28301

● **Disassembly sequence**

1 Battery (negative terminal) Gr 54
2 Front grille P42-42
3 Pressure cap Gr 14A, B
4 Radiator drain plug Gr 14A, B
5 Crankcase drain plug Gr 14A, B
6 Clutch fluid pipe
< Manual transmission > Gr 21
7 Brake fluid pipe Gr 35A
8 Power steering oil pipe Gr 37

A : Wheel chock

Work items

- Draining, filling, and air bleeding of clutch fluid, brake fluid and power steering fluid Gr 21, Gr 35A, Gr 37
- Draining, filling, and air bleeding of coolant Gr 14A, B

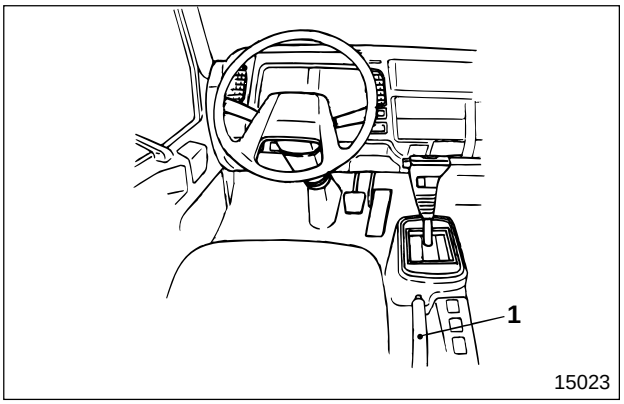
WARNING

- **Put chocks A securely because the vehicle cannot be maintained at a standstill just by using the parking brake during removal and installation of the cab.**
- **Do not remove chocks A until the entire operation is completed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Work Inside Cab



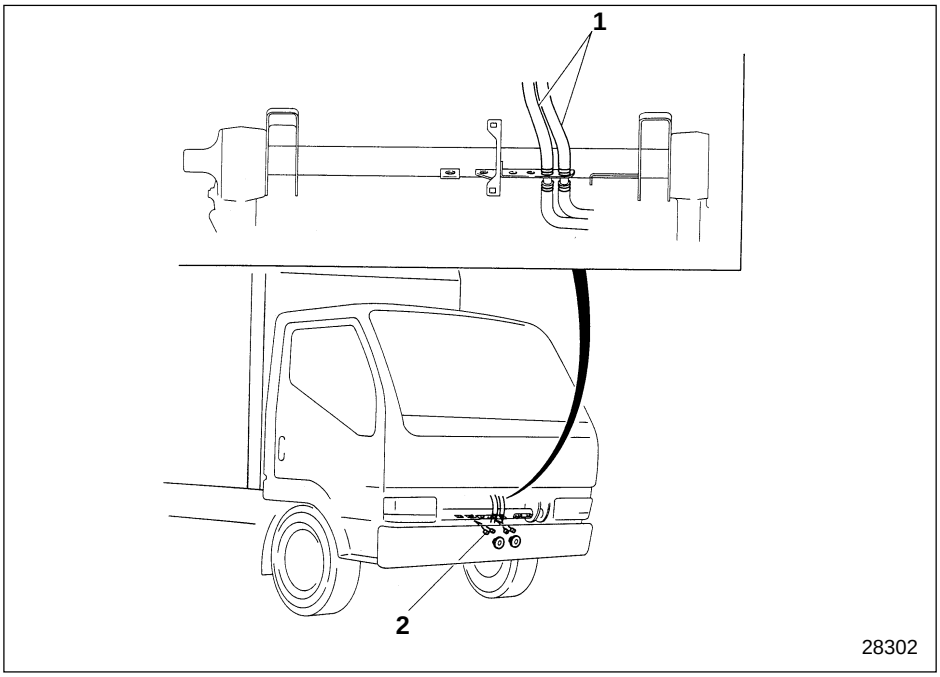
● **Disassembly sequence**

1 Parking brake cable Gr 36

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Work from Front of Cab



● **Disassembly sequence**

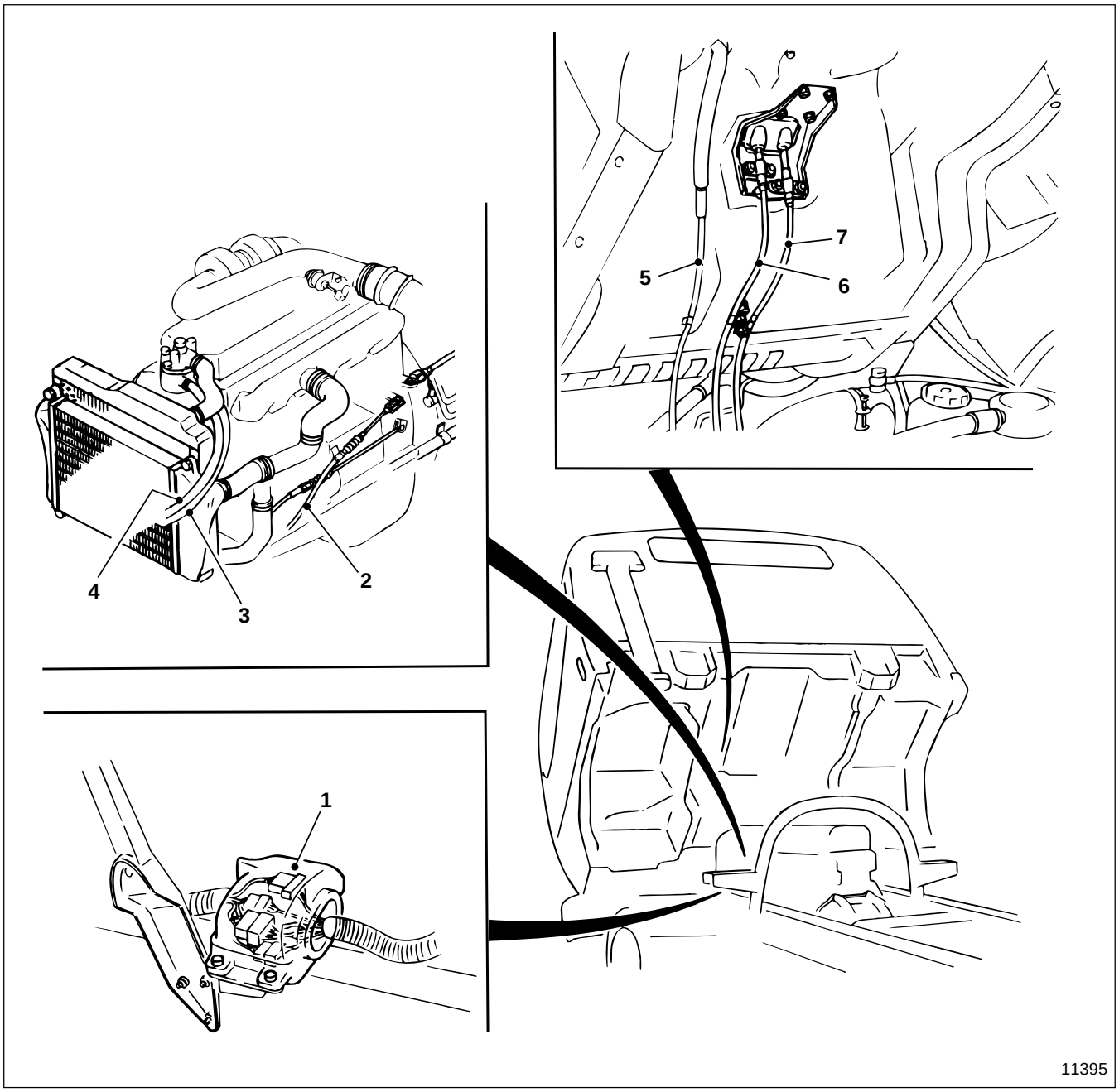
1 Heater hose Gr 55B
2 Horn harness

● **Assembly sequence**

Follow the disassembly sequence in reverse.

REMOVAL AND INSTALLATION OF CAB

Work with Cab Tilted Up



● **Disassembly sequence**

1 Cab harness and chassis harness connection
2 Accelerator control cable Gr 13A, B
3 Heater hose (Engine in)
4 Heater hose (Engine out)
5 Parking brake cable Gr 36A, B
6 Shift cable < Manual transmission > Gr 22
7 Selector cable < Manual transmission > Gr 22
Range selector cable < Automatic transmission > Gr 23A, B

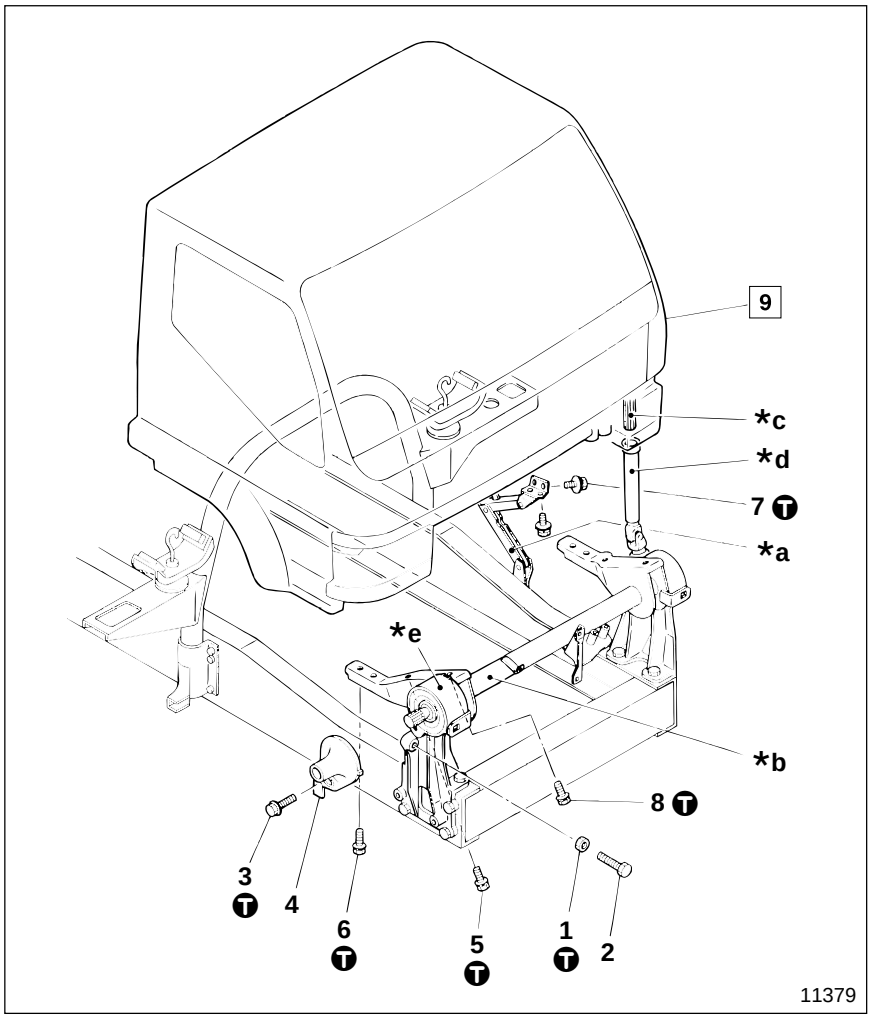
● **Assembly sequence**

Follow the disassembly sequence in reverse.

M E M O

REMOVAL AND INSTALLATION OF CAB

Removal and Installation of Tilt Cab Body



● **Disassembly sequence**

1 Nut
2 Bolt
3 Bolt
4 Anchor lever
5 Bolt
6 Bolt
7 Bolt
8 Bolt
9 Cab assembly

***a** : Cab stay
***b** : Front floor cross member
***c** : Steering yoke
***d** : Steering shaft
***e** : Front cab mounting bracket

● **Assembly sequence**

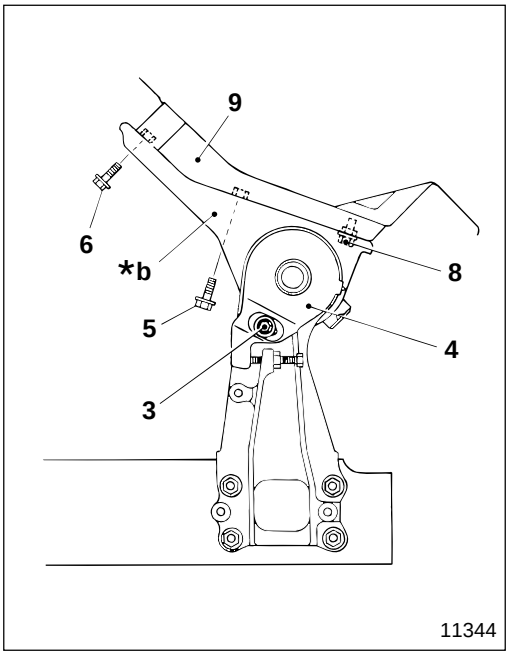
Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Anchor lever adjusting bolt locking)	59 to 83 {43 to 60, 6 to 8.5}	—
3	Bolt (Anchor lever mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—
5, 6, 8	Bolt (Front floor cross member mounting)	70 to 95 {51 to 70, 7.1 to 9.7}	—
7	Bolt (Cab stay mounting)	19 to 27 {14 to 21, 1.9 to 2.8}	—

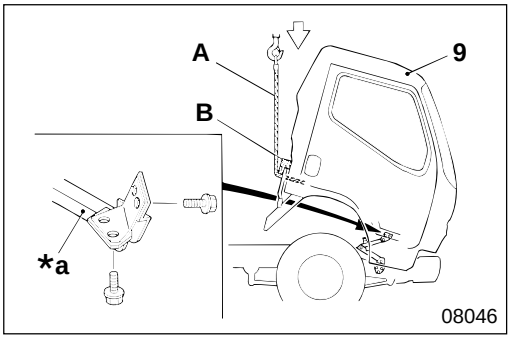
◆ Service procedure



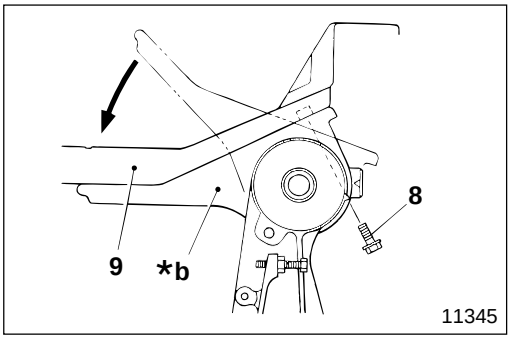
9 **Cab assembly**

[Removal]

- Tilt cab assembly **9** and lock cab stay ***a** securely.
- Remove bolt **3**, and remove anchor lever **4**.
- Of the three bolts that retain front floor cross member ***b**, remove bolts **5**, **6** at rear side, leaving bolt **8** at front side.

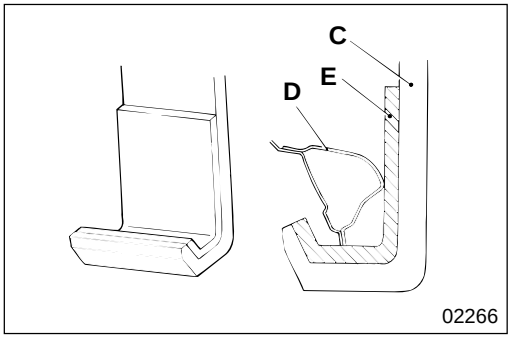


- To separate cab stay ***a** from cab assembly **9**, support the cab securely using crane **A** that is capable of lifting the cab.
  B : Use a wood block for protecting the rear of the cab
- Using crane **A**, lower cab assembly **9** until cab stay ***a** can be removed, then remove it.



- Fully lower cab assembly **9** to remove remaining bolt **8** that retains front floor cross member ***b**.

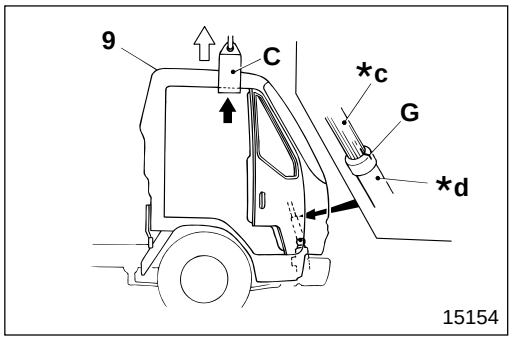
REMOVAL AND INSTALLATION OF CAB



- Set up hoist attachment **C** for the cab as illustrated.

CAUTION

- **Make sure when you set up hoist attachment C that it is capable of lifting cab assembly 9 which weighs approximately 390 kg {860 lb}.**
- **Make sure you install rubber E on hoist attachment C to prevent cab roof D being deformed when the cab is lifted.**



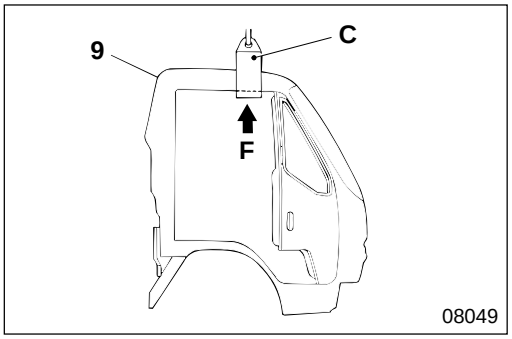
- Mount hoist attachment **C** at center-of-gravity point **F** of cab assembly **9**. Verify the position at which the cab can be lifted horizontally when the cab is lifted slightly.
- Slowly lift cab assembly **9** straight up, and finish lifting when steering yoke ***c** is pulled out from steering shaft ***d**. Make alignment mark **G** before the steering yoke is pulled out from the steering shaft.

WARNING

Never get under cab assembly 9 when it is being lifted.

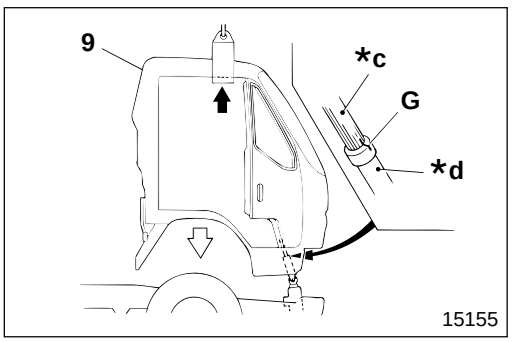
CAUTION

Make sure, when lifting cab assembly 9, that the wiring harness, cable, hoses, etc. are completely disconnected when the cab is lifted slightly.

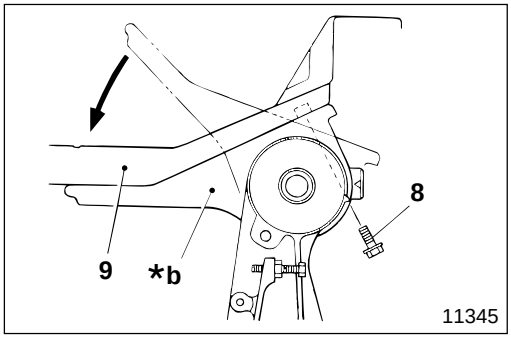


[Installation]

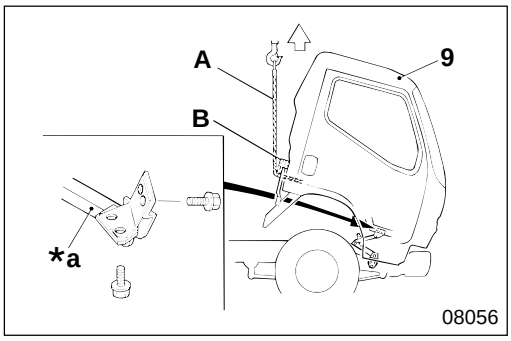
- Mount hoist attachment **C** at center-of-gravity point **F** of cab assembly **9**.



- Slowly lower cab assembly **9** horizontally to insert steering yoke ***c** into steering shaft ***d**, aligning alignment mark **G**.



- Slowly lower cab assembly **9** further, and remove hoist attachment **C** after it comes down fully.
- Tighten front bolt **8**, one of the three bolts used for installing front floor cross member ***b**.

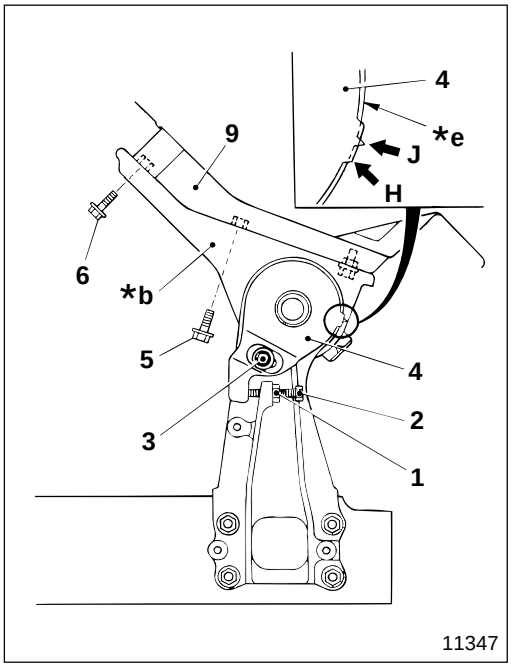


- Securely support cab on crane **A** to tilt cab assembly **9**.
  B : Use a wood block for protecting the rear of the cab
- Using crane **A** tilt cab assembly **9**, and install cab stay ***a**.

WARNING

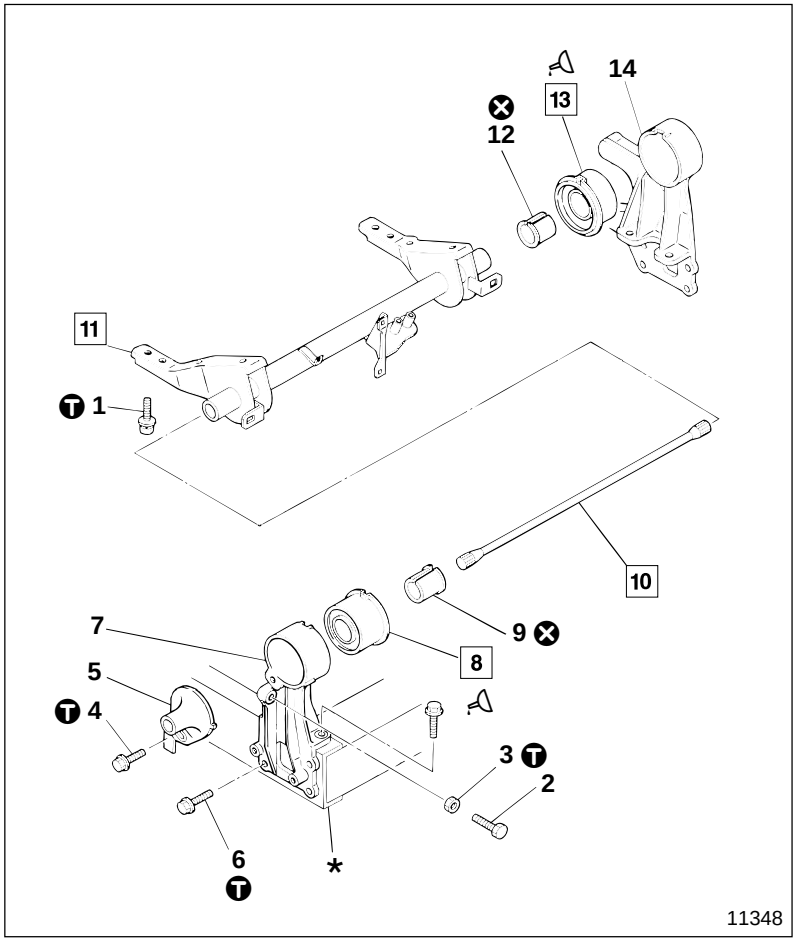
You must pay close attention to the tilt angle when tilting cab assembly 9 using crane A. It is very dangerous to tilt the cab excessively because it will topple over.

- After installing cab stay ***a**, tilt cab assembly **9** slowly until it is completely tilted, securely lock cab stay, then detach the cab from crane **A**.



- Tilt cab assembly **9**, and securely lock cab stay ***a**.
- Tighten bolts **5**, **6** to install front floor cross member ***b**.
- Position and install pointer **J** of front cab mounting bracket ***e** in convex area **H** of anchor lever **4** and fix it with bolt **3**.
- Position bolt **2** on anchor lever **4** and lock it with nut **1**.
- After mounting cab assembly **9**, check and adjust the operating force required for the lock handle. P42-19

FRONT CAB MOUNTING



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Nut
4 Bolt
5 Anchor lever
6 Bolt
7 Front cab mounting bracket, RH
8 Front rubber assembly, RH
9 Bushing, RH
10 Torsion bar
11 Front floor cross member assembly
12 Bushing, LH
13 Front rubber assembly, LH
14 Front cab mounting bracket, LH

⊗ : Non-reusable parts
* : Frame

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Since the following parts are assembled at the time the cab is mounted, see removal and installation of cab (P42-22) for assembly procedure.
1 : Bolt (Connection of front floor cross member assembly and cab assembly)
2 : Bolt (Adjustment of anchor lever)
3 : Nut
4 : Bolt (Installation of anchor lever)
5 : Anchor lever

Ⓣ Tightening torque

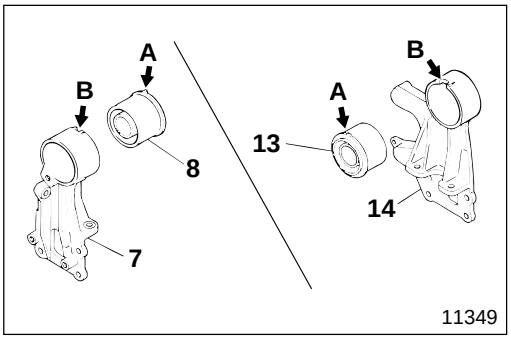
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front floor cross member assembly and cab assembly mounting)	70 to 95 {51 to 70, 7.1 to 9.7}	—
3	Nut (Lock of anchor lever adjustment bolt)	59 to 83 {43 to 61, 6 to 8.5}	—
4	Bolt (Anchor lever mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—
6	Bolt (Front cab mounting bracket mounting)	70 to 85 {51 to 63, 7.1 to 8.7}	—

Lubricant

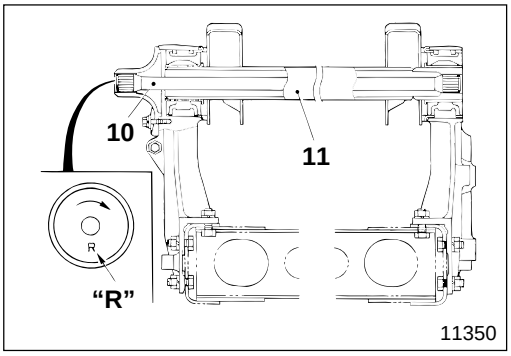
Location	Points of application	Kinds	Quantity
8, 13	Contact area between front rubber assemblies and front floor cross member assembly	Rubber grease	As required

◆ Service procedure



8 **13** **Installation of front rubber assembly**

Install front rubber assembly RH **8** and LH **13** fitting protrusions **A** to the indents **B** of mounting bracket RH **7** and LH **14** respectively.

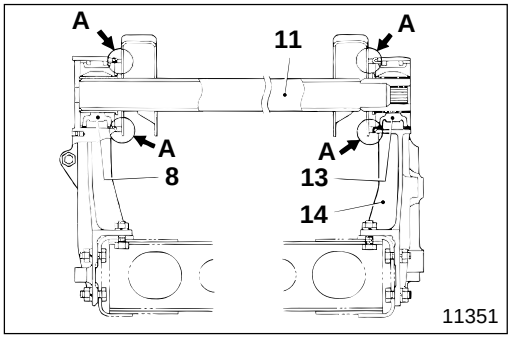


10 **Installation of torsion bar**

Install torsion bar **10** to front floor cross member assembly **11** in the direction as illustrated.

CAUTION⚠

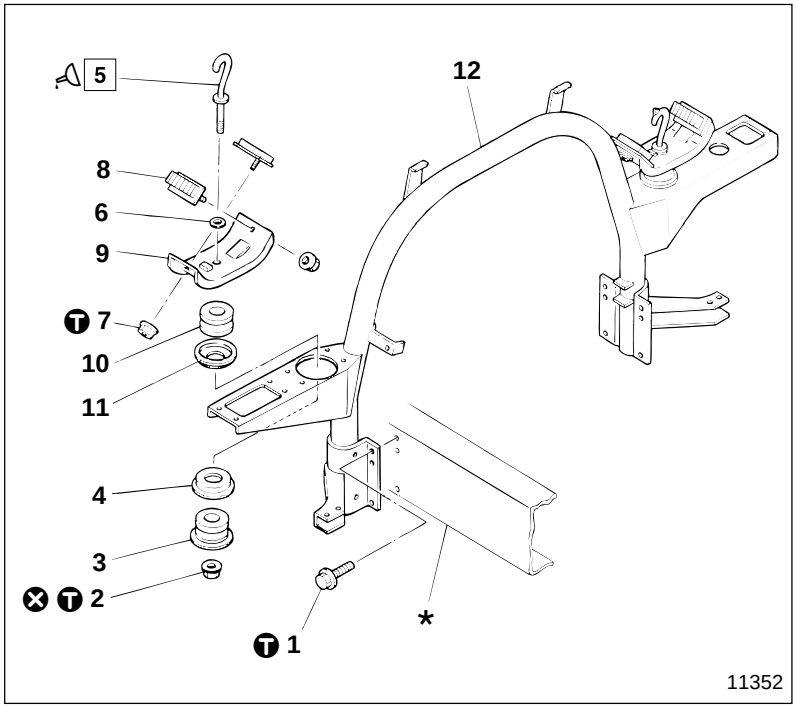
Be sure not to mistake the left side for the right side, when installing torsion bar 10, because the torsion bar will be damaged if its torsion direction is reversed.



11 **Installation of front floor cross member assembly**

Install front floor cross member assembly **11**, adjusting front cab mounting bracket LH **14** so there is no gap between the front floor cross member assembly and front rubber assembly RH **8** and LH **13** at points **A**.

REAR CAB MOUNTING



● **Disassembly sequence**

1 Bolt
2 Nut
3 Lower rubber
4 Metal fixture
5 Anchor hook
6 Spacer
7 Nut
8 Side rubber
9 Cab hold bracket
10 Upper rubber
11 Metal fixture
12 Rear mounting post

⊗ : Non-reusable parts
* : Frame

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

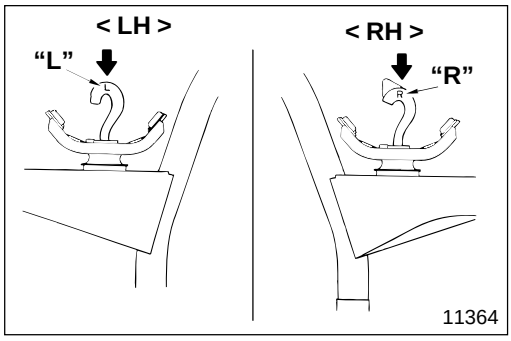
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Rear mounting post mounting)	78 to 105 {58 to 80, 8 to 11}	—
2	Nut (Anchor hook mounting)	83 to 98 {61 to 72, 8.5 to 10.0}	—
7	Nut (Side rubber mounting)	16 to 20 {12 to 14, 1.6 to 2.0}	—

Lubricant

Location	Points of application	Lubricant or sealant	Quantity
5	Anchor hook top section (lock handle stopper contacting section)	Chassis grease [NLGI No.1 (Ca soap)]	—

◆ Service procedure

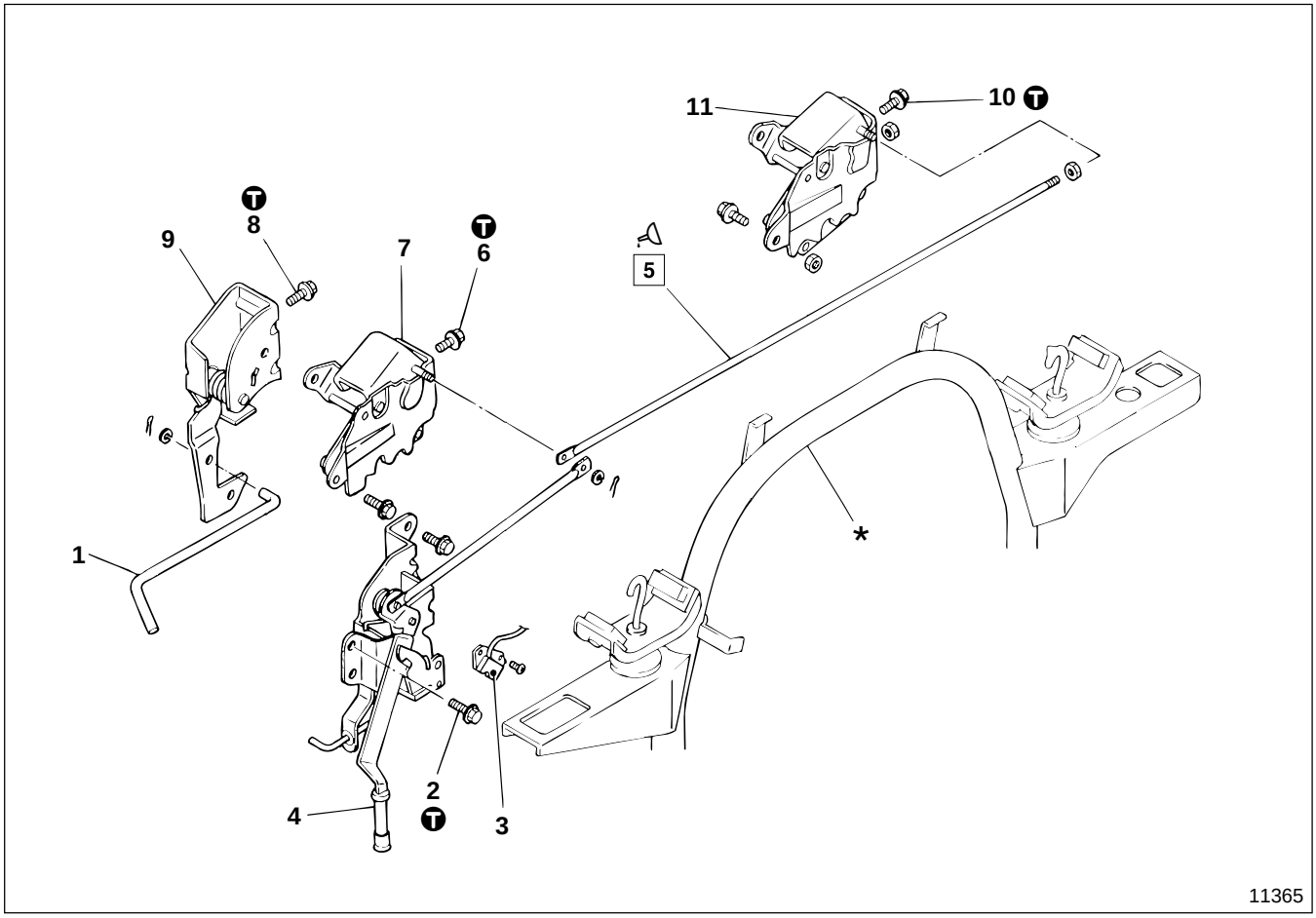


5 **Installation of anchor hook**

Check the "**L**" and "**R**" identification marks on anchor hooks **5** for proper installation locations. Install anchor hooks **5** with their open sections facing toward the left side of the vehicle.
Be sure to apply grease to the top section (indicated by ⬇) of each anchor hook.
L : Left identification mark
R : Right identification mark

M E M O

CAB TILT LINK



● **Disassembly sequence**

1 L-lever rod
2 Bolt
3 Cab tilt lock switch Gr 54
4 Lock handle assembly
5 Center rod
6 Bolt
7 Link assembly, LH
8 Bolt
9 L-lever assembly
10 Bolt
11 Link assembly, RH

* : Rear mounting post

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Lock handle assembly mounting)	29 to 39 {22 to 29, 3 to 4}	—
6	Bolt (Link assembly, LH mounting)	29 to 39 {22 to 29, 3 to 4}	—
8	Bolt (L-lever assembly mounting)	29 to 39 {22 to 29, 3 to 4}	—
10	Bolt (Link assembly, RH mounting)	29 to 39 {22 to 29, 3 to 4}	—

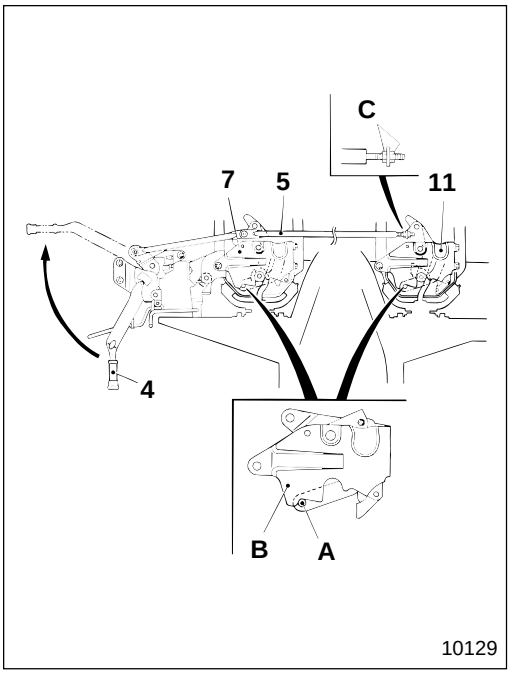
Lubricant

Location	Points of application	Kinds	Quantity
5	Connecting area between center rod link assembly, LH and lock handle assembly	Wheel bearing grease [NLGI No2 (Li soap)]	As required

◆ Service procedure

● Inspection after assembly

Make sure that operating force for lock handle assembly **4** is correct. If it is too heavy or too light, adjust. P42-19



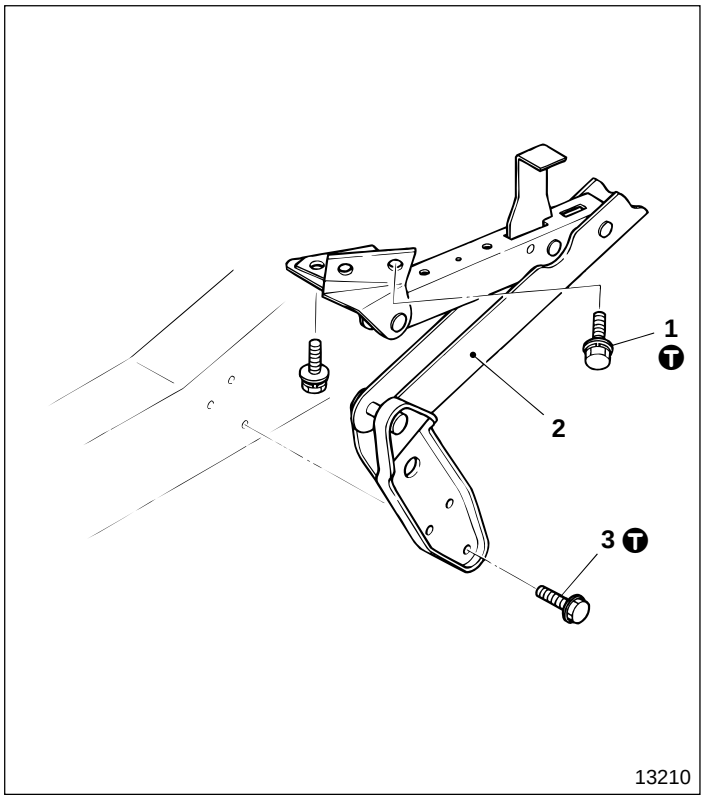
5 **Installation of center rod**

Adjust the length of center rod **5** using lock nut **C** to optimize locking and unlocking of rear cab mounting.

- Raise lock handle assembly **4** all the way, unlocking it.
- Turn and adjust lock nut **C** so that shafts **A** of link assembly LH **7** and RH **11** contact brackets **B**.

CAB TILT LINK

Cab Stay



● **Removal sequence**
1 Bolt
2 Cab stay assembly
3 Bolt

WARNING⚠
You must use a hoist to support the cab when you remove the cab stay assembly.

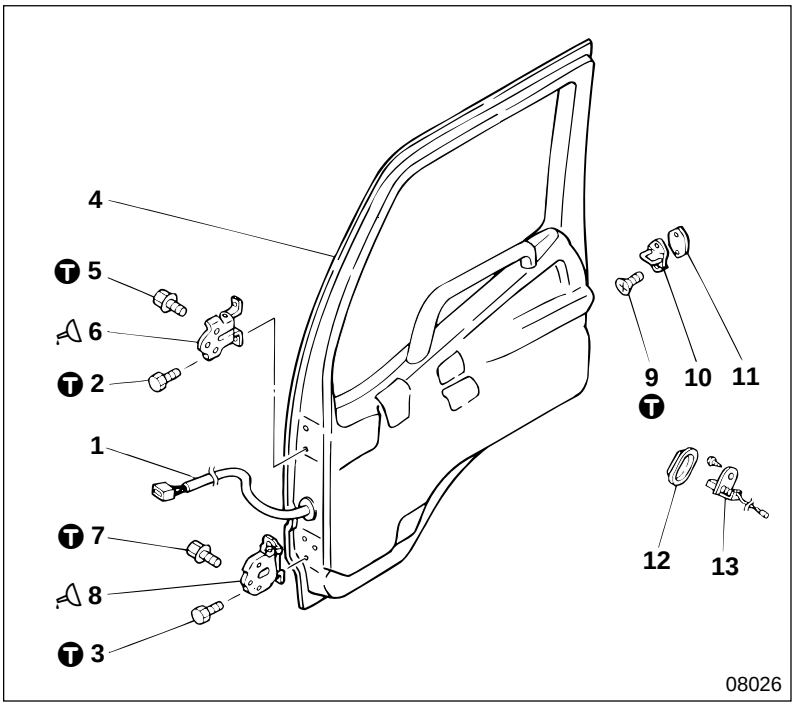
● **Installation sequence**
Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Cab stay mounting)	19 to 27 {14 to 20, 1.9 to 2.8}	—
3	Bolt (Cab stay mounting)	59 to 78 {43 to 65, 6 to 8}	—

Door Hinge and Striker



● **Disassembly sequence**

1 Door harness
2 Bolt
3 Bolt
4 Door assembly P42-38
5 Bolt
6 Upper hinge
7 Bolt
8 Lower hinge
9 Screw
10 Striker
11 Shim
12 Grommet
13 Door switch Gr 54

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection and adjustment after assembly**

P42-20

NOTE

For adjustment of door fit: P42-20.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

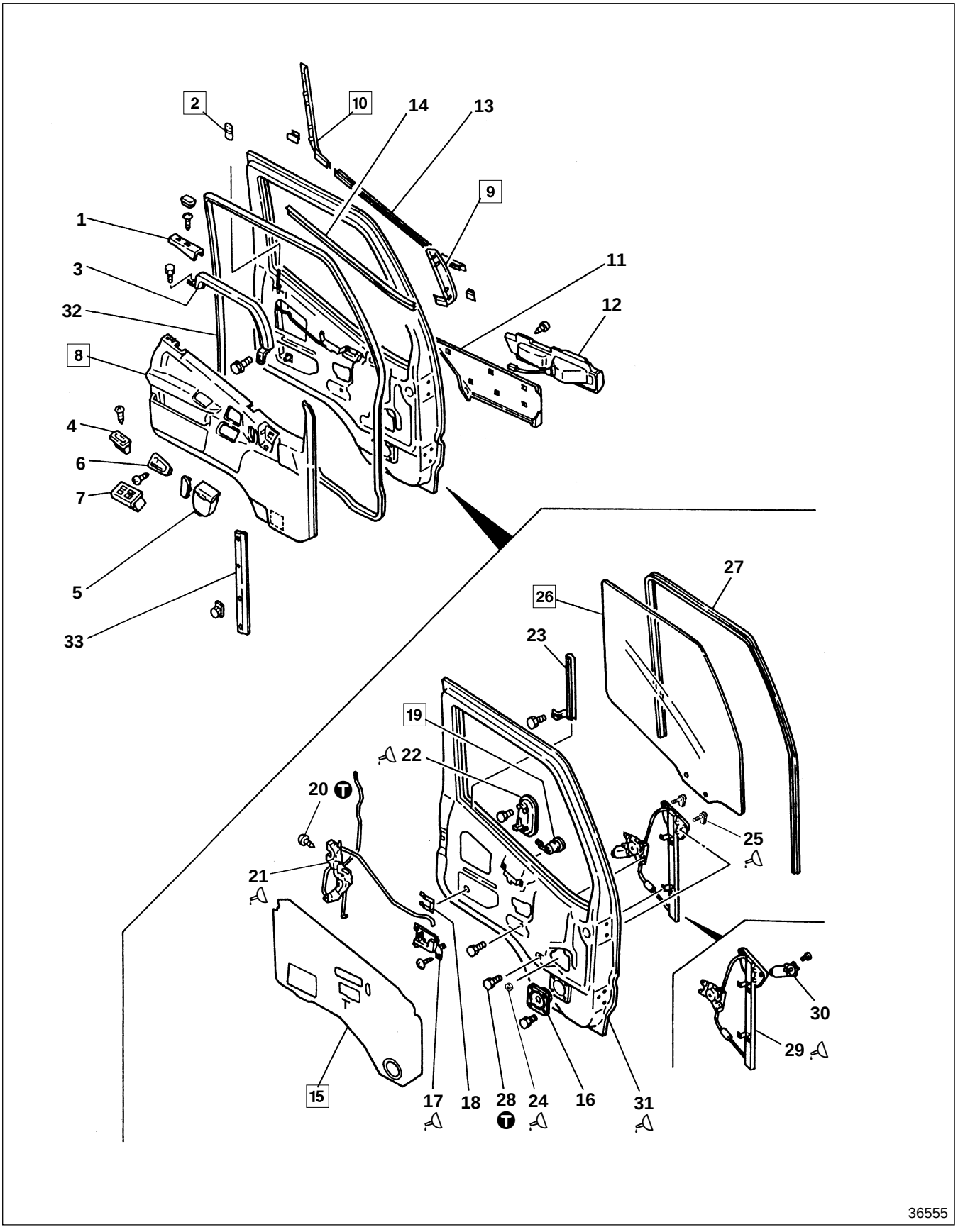
Location	Parts to be tightened	Tightening torque	Remarks
2, 3	Bolt (Door assembly mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
5	Bolt (Upper hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
7	Bolt (Lower hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
9	Screw (Striker mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—

Lubricant

Location	Points of application	Kinds	Quantity
6	Upper hinge checker pin roller	Chassis grease [NLGI No.1 (Ca soap)]	As required
8	Lower hinge checker pin roller	Chassis grease [NLGI No.1 (Ca soap)]	As required

DOOR

Door Assembly



● **Disassembly sequence**

1 Cover
2 Door lock knob
3 Guard bar
4 Pull handle cover
5 Ashtray
6 Inside handle cover
7 Power window switch 🕮 Gr 54
8 Door trim
9 Front garnish
10 Rear garnish
11 Outer garnish
12 Side combination lamp 🕮 Gr 54
13 Outer weather strip
14 Inner weather strip
15 Waterproof cover
16 Speaker
17 Inside handle
18 Clip
19 Door lock cylinder
20 Screw
21 Door lock actuator 🕮 Gr 54
22 Outside handle
23 Lower sash
24 Nut
25 Glass holder
26 Door glass
27 Run channel
28 Bolt
29 Regulator & rail assembly
30 Power window motor 🕮 Gr 54
31 Door panel
32 Weather strip
33 Weather strip

Tightening torque

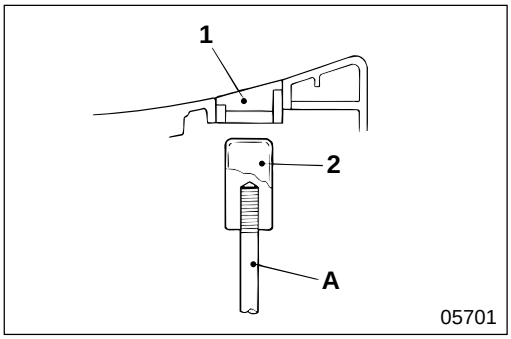
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
20	Screw (Door lock actuator mounting)	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
28	Bolt (Regulator & rail assembly mounting)	6.9 to 10.8 {5.1 to 8.0, 0.7 to 1.1}	—

Lubricant and/or sealant

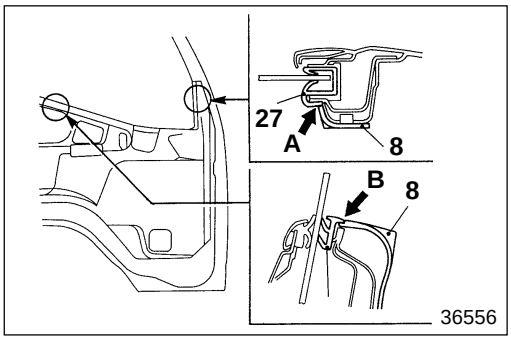
Location	Points of application	Specified lubricant and/or sealant	Quantity
17	Rotating surface of inside handle	Multipurpose grease [NLGI No.2 (Li soap)]	As required
21	Sliding surface of door lock actuator	Multipurpose grease [NLGI No.2 (Li soap)]	As required
22	Sliding surface of outside handle	Multipurpose grease [NLGI No.2 (Li soap)]	As required
24	Threads of nut	Loctite (Japan) Drylock No. 203	As required
25	Threads of glass holder bolt	Loctite (Japan) Drylock No. 203	As required
29	Sliding surfaces of regulator & rail assembly	Multipurpose grease [NLGI No.1 (Li soap)]	As required
31	Waterproof cover installation surface of door panel	Butyl tape	As required

◆ Service procedure



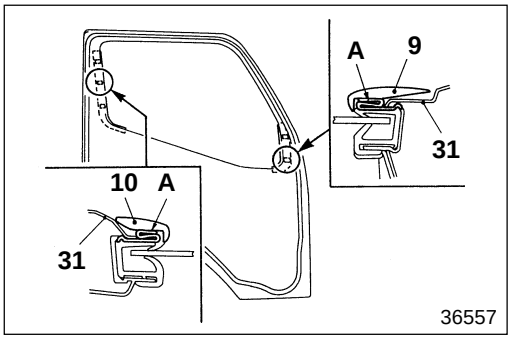
2 **Installation of door lock knob**

- Install door lock knob **2** to door lock rod A of door lock actuator **21**, and turn the knob fully in clockwise direction.
- Back off door lock knob **2** by turning it 1 or 2 turns in counterclockwise direction.
- Position cover **1** to prevent door lock knob **2** from turning.



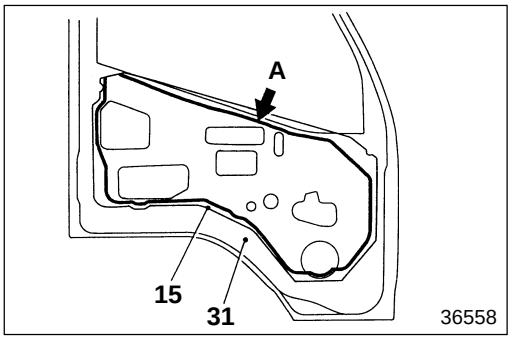
8 **Installation of door trim**

- On the front pillar section, install door trim **8** by pressing it to lip section **A** of run channel **27**.
- On the belt line section, install door trim **8** by pressing it to lip section **B** of inner weather strip **14**.



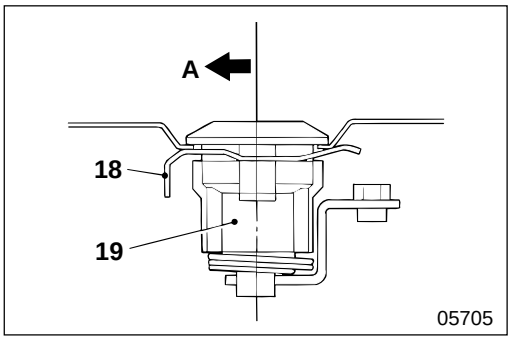
9 **10** **Installation of front and rear garnishes**

- Install clips **A** to door panel **31** prior to the installation of the garnishes.
- Install front garnish **9** and rear garnish **10** to clips **A**.



15 **Installation of waterproof cover**

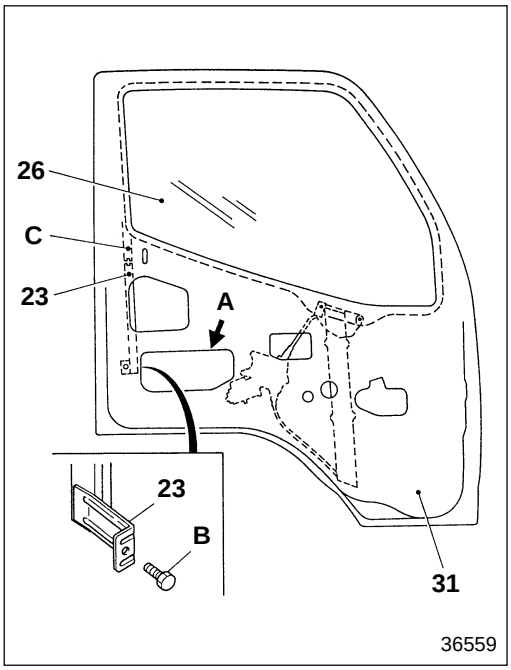
- Apply butyl tape **A** to door panel **31**, as indicated in the illustration.
- Install waterproof cover **15** by pasting onto butyl tape **A**.



19 **Installation of door lock cylinder**

Install door lock cylinder **19** to clip **18** in the direction indicated in the illustration.

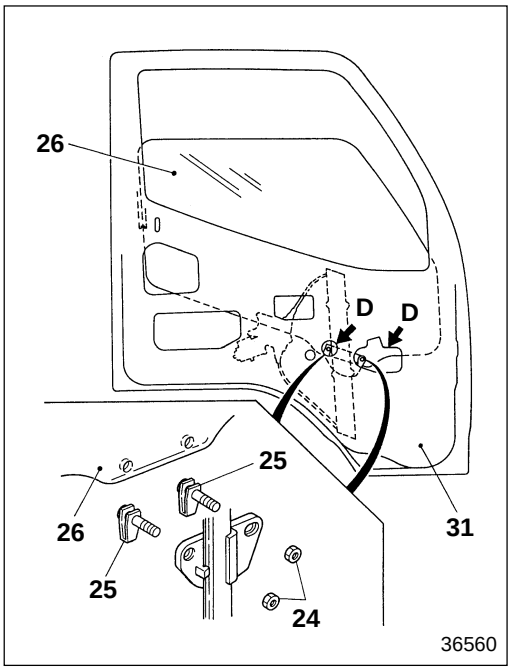
A : Vehicle front side



26 **Removal and installation of door glass**

Remove all parts supporting door glass **26**, then remove the door glass through the open space in the door.

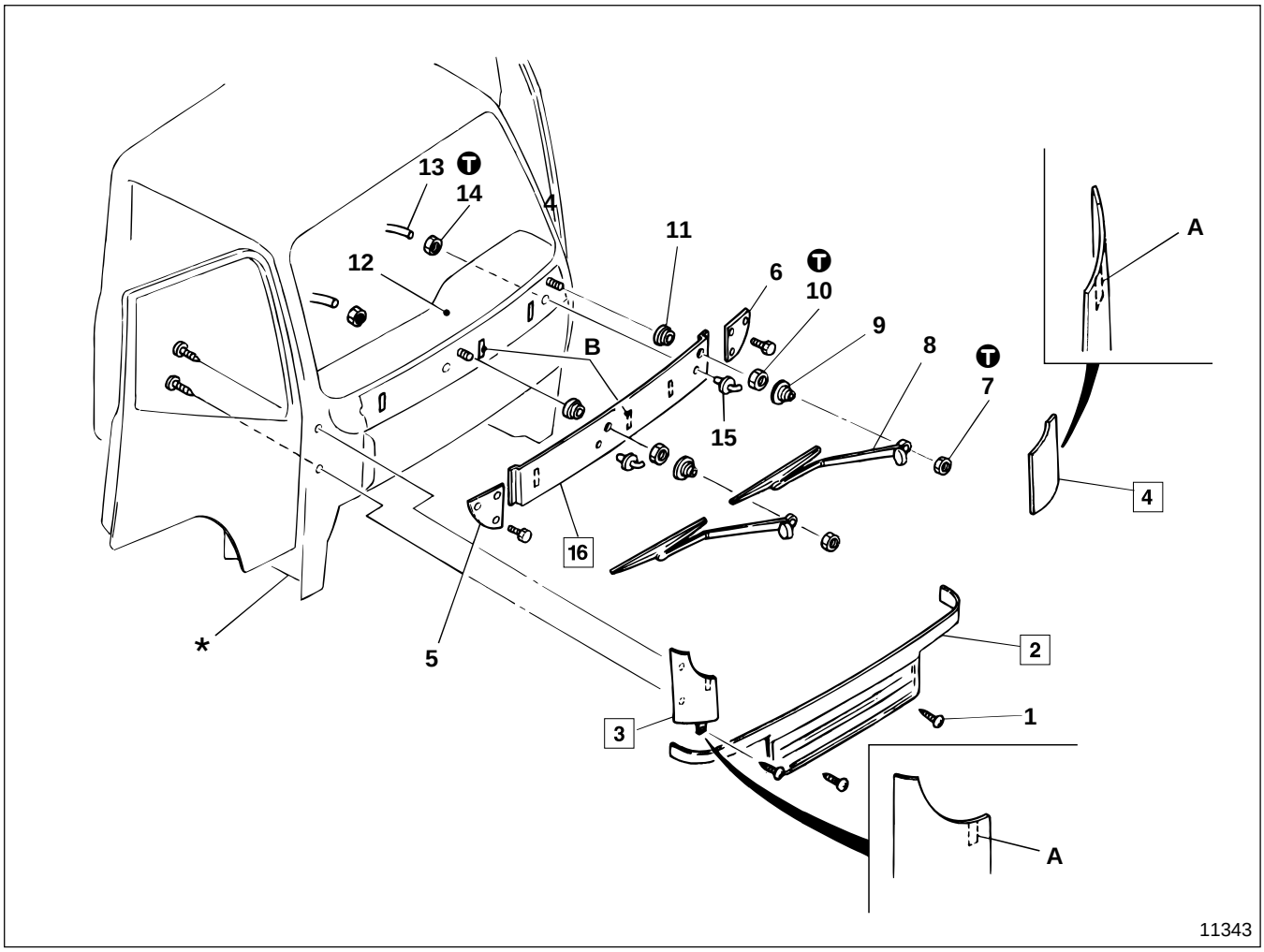
- Pull door glass **26** all the way to the top.
- Remove bolt **B** through hole **A** in door panel **31**, and remove lower sash **23**.
  Note that the lower sash is inserted in upper sash **C**.



- Lower door glass **26** until nut **24** becomes visible through hole **D** in door panel **31**.
- Support door glass **26** by hand, then remove glass holder **25**.
- Remove door glass **26** through the open space in the door.
- To install door glass **26**, follow the removal procedure in reverse.

CAB EXTERIOR FITTING

Front Panel



● **Disassembly sequence**

1 Screw
2 Front grille
3 Front side panel, RH
4 Front side panel, LH
5 Side garnish, RH
6 Side garnish, LH
7 Nut
8 Wiper arm and blade assembly 🕮 P42-48
9 Pivot cap
10 Nut
11 Packing washer 🕮 P42-48
12 Instrument panel 🕮 P42-53
13 Washer hose
14 Nut
15 Hose joint
16 Front garnish

***** : Cab assembly
A : Pawl (Front side panel)
B : Magic tape

● **Assembly sequence**

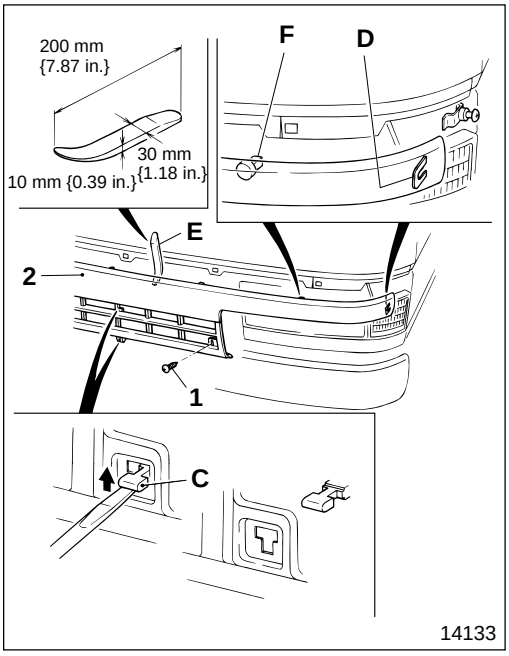
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7	Nut (Wiper arm and blade assembly mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
10	Nut (Packing washer mounting)	14 to 20 {10 to 14, 1.4 to 2.0}	—
14	Nut (Hose joint connecting)	0.59 to 0.88 {0.43 to 0.65, 0.06 to 0.09}	—

◆ Service procedure



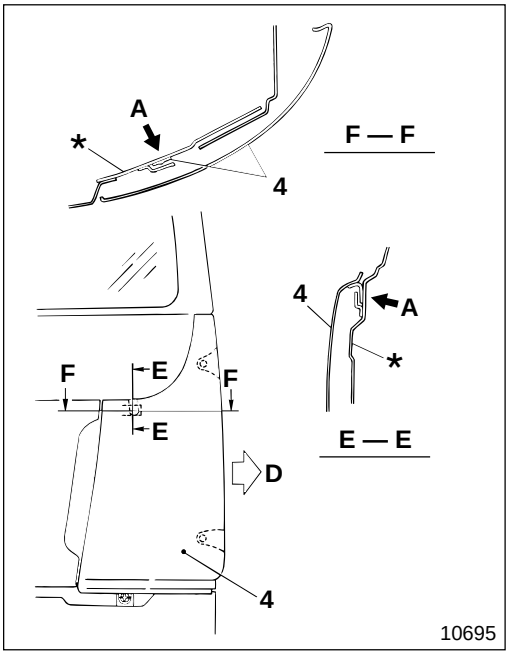
2 **Removal and installation of front grille**

- Remove screws **1** (two points) from front grilles **2**.
- Lift up the ends of clips **C** (two points), located in the center of front grilles **2**, using a screwdriver, and unlock them from the clips.
- Pull out front grilles **2** horizontally, in the vehicle forward running direction, to remove them.

CAUTION

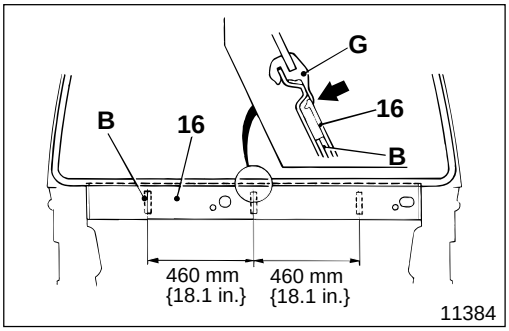
- **Be careful not to apply too much force to front grilles 2, because this would damage them. Be especially careful to avoid applying force to clips D at both sides, support the clips using your hands. If it is hard to remove the front grilles, remove them using nylon jig E as illustrated.**
- **Be careful not to use force when you pull out clips F (five points) from the tops of front grilles 2, because this would damage them.**

- For installation, follow the removal sequence in reverse.



3 **4** **Installation and removal of front side panels RH, LH**

- Move front side panels RH **3**, LH **4** to the outside of the vehicle to remove them from the cab assembly *.
  A : Pawl
  (The illustration shows front side panel LH **4**.)
- For installation, follow the removal sequence in reverse.



16 **Installation of front garnish**

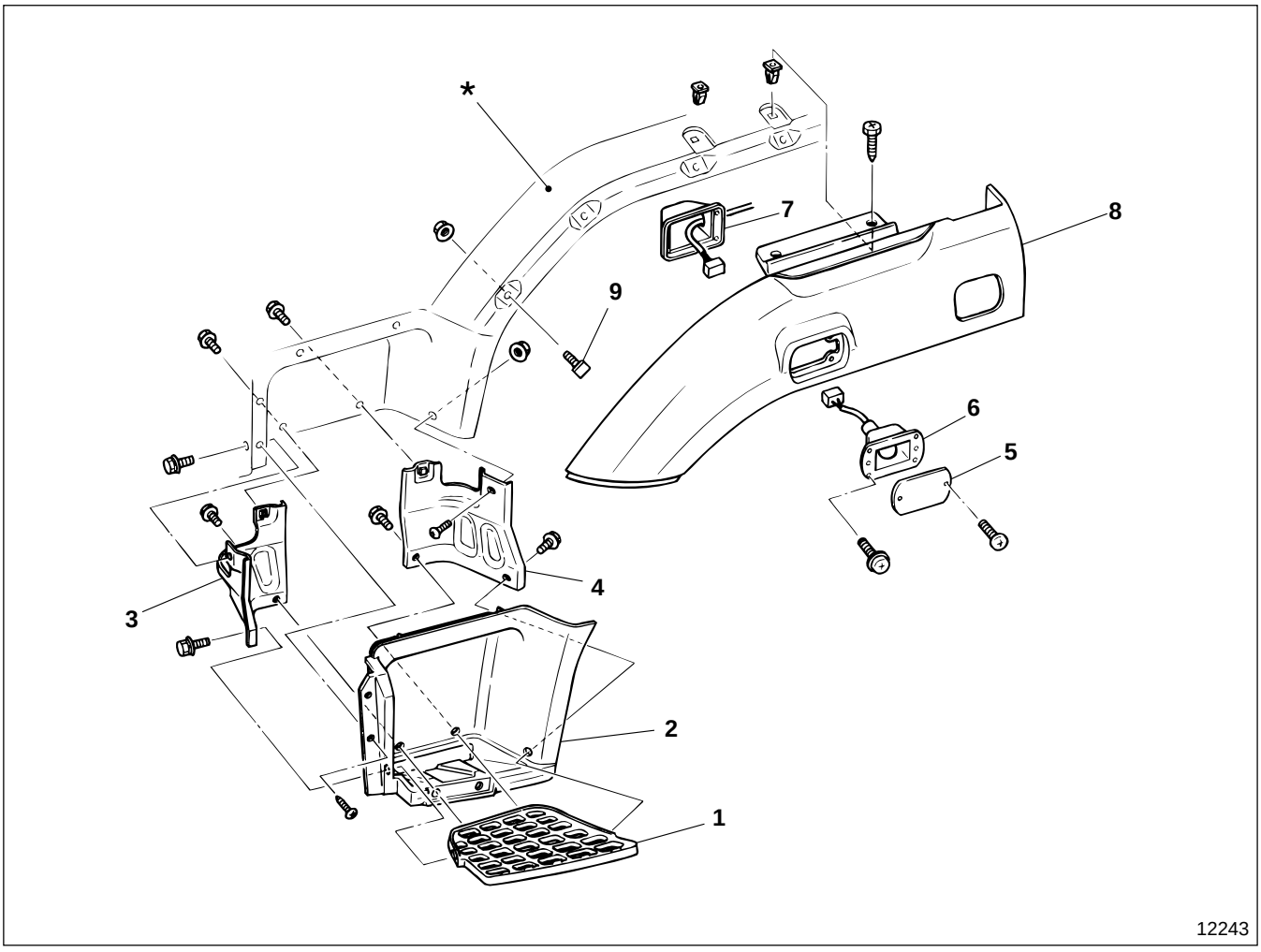
NOTE

When installing front garnish 16, be careful not to catch weather-strip G of the windshield.

B : Magic tape (3 points)

CAB EXTERIOR FITTING

Step and Fender



● **Removal sequence**

1 Step
2 Step garnish
3 Front step bracket
4 Rear step bracket
5 Lens
6 Side turn signal lamp
7 Side turn signal lamp cover
8 Fender garnish
9 Set bolt

***** : Cab assembly

● **Installation sequence**

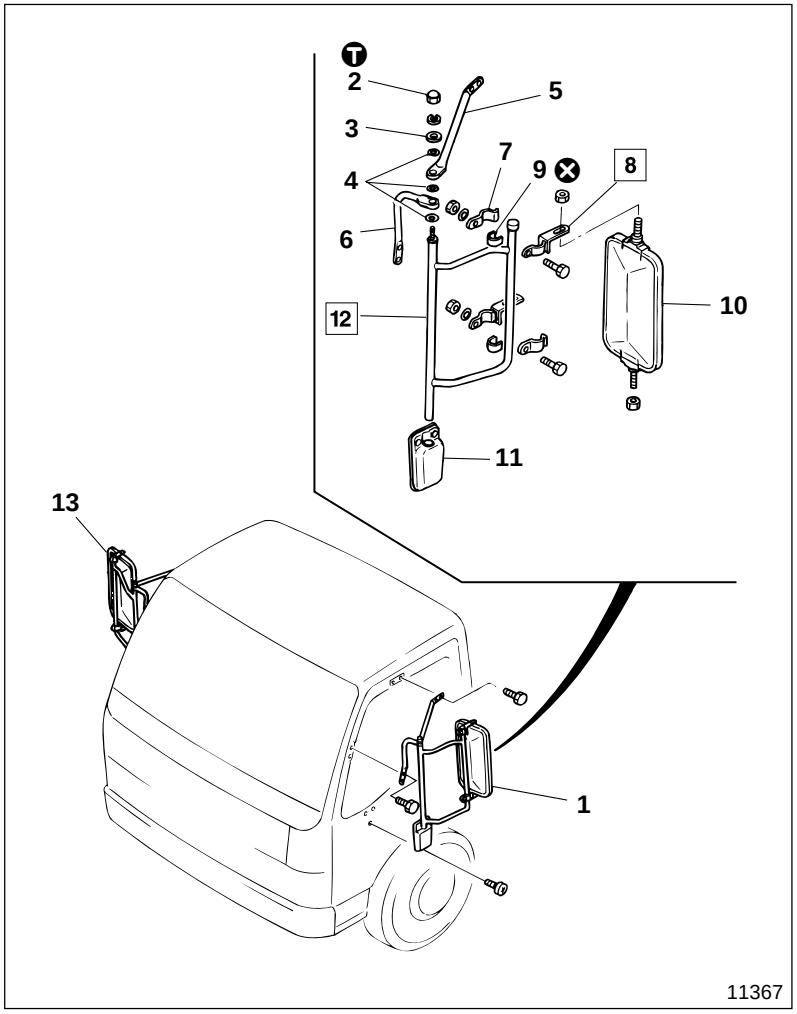
Follow the removal sequence in reverse.

NOTE

This illustration only shows the step and fender for the left side; the same service procedure described above is used for the right side.

M E M O

MIRROR



● **Removal sequence**

1 Outside mirror stay assembly, LH
2 Nut
3 Washer (Stainless)
4 Washer
5 Sub mirror stay
6 Sub mirror stay
7 Mirror holder B
8 Mirror holder
9 Packing
10 Outside mirror
11 Lower bracket
12 Main mirror stay
13 Outside mirror stay assembly, RH

⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

NOTE

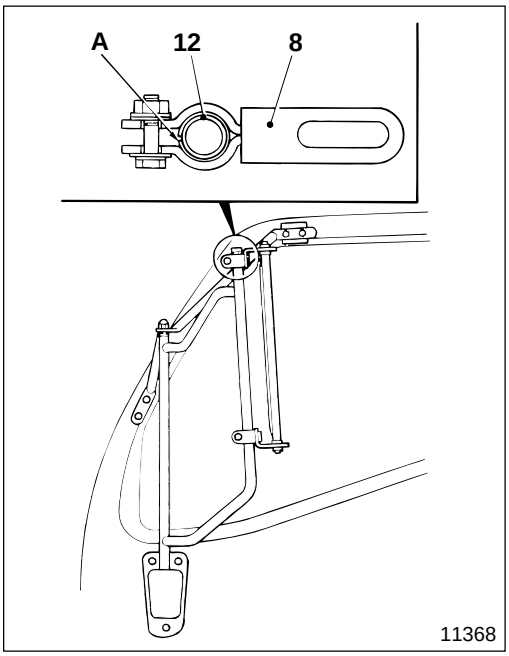
For outside mirror stay assembly RH 13, follow the same service procedure as for outside mirror stay assembly LH 1.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Sub mirror stay and main mirror stay mounting)	24.5 to 29.4 {18 to 22, 2.5 to 3.0}	—

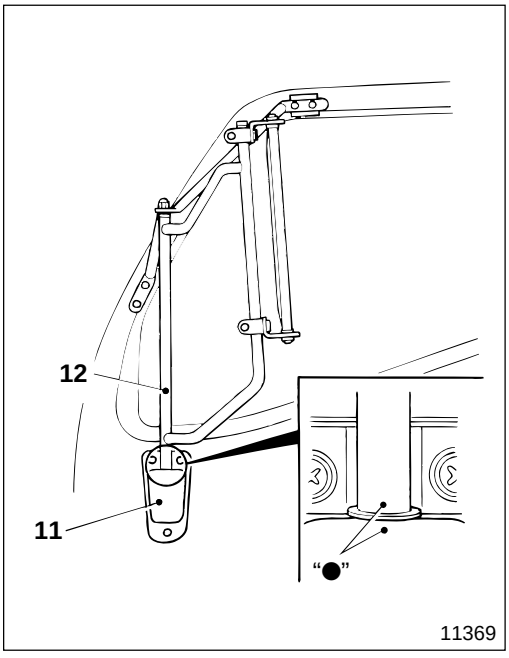
◆ Service procedure



8 **Installation of mirror holder**

Install mirror holder **8** onto main mirror stay **12** in the direction as illustrated.

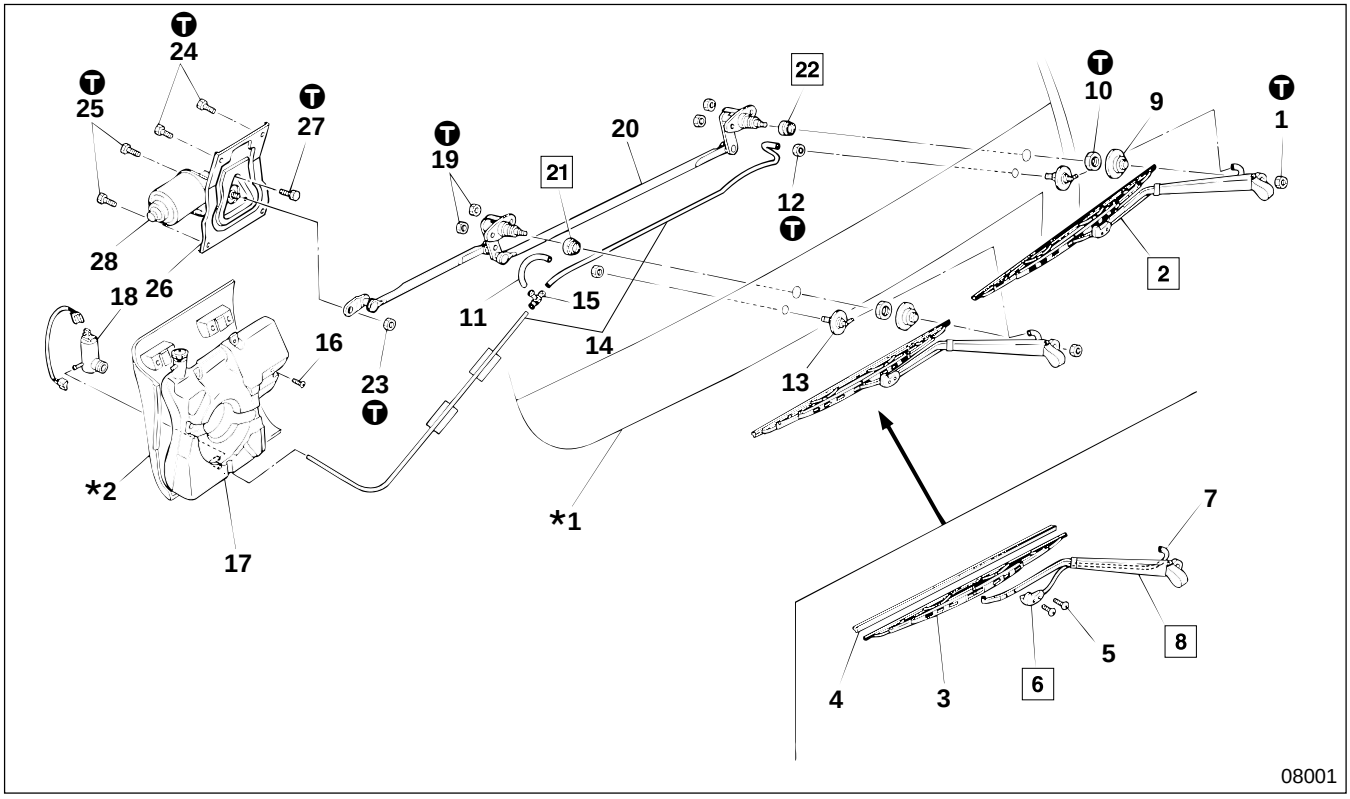
A : Indent of main mirror stay **12**.



12 **Installation of main mirror stay**

Install main mirror stay **12** and lower bracket **11** so that alignment marks "●" are aligned.

WIPER AND WASHER



● **Disassembly sequence**

1 Nut
2 Wiper arm and blade assembly
3 Wiper blade
4 Blade rubber
5 Screw
6 Washer nozzle assembly
7 Hose
8 Wiper arm
9 Pivot cap
10 Nut
11 Washer hose
12 Nut
13 Hose joint
14 Washer hose
15 Joint
16 Screw
17 Washer tank
18 Washer motor Gr 54
19 Nut
20 Wiper link assembly
21 Packing washer
22 Packing washer
23 Nut
24 Bolt (L : 16 mm {0.63 in.})
25 Bolt (L : 12 mm {0.47 in.})
26 Wiper motor bracket
27 Bolt
28 Wiper motor Gr 54

***1** : Front garnish P42-42
***2** : Assistant driver's side lower panel P42-53

NOTE

Before disassembling parts 11 to 28, remove the instrument panel to allow access to them. P42-53

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

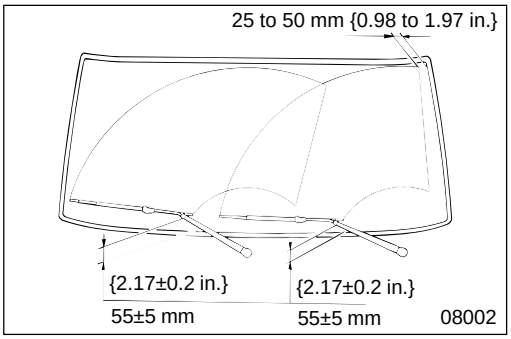
Location	Maintenance item	Standard value	Limit	Remedy
2	Wiping force of wiper arm	5.7±0.49 N {1.28±0.11 lbf, 0.58±0.05 kgf}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

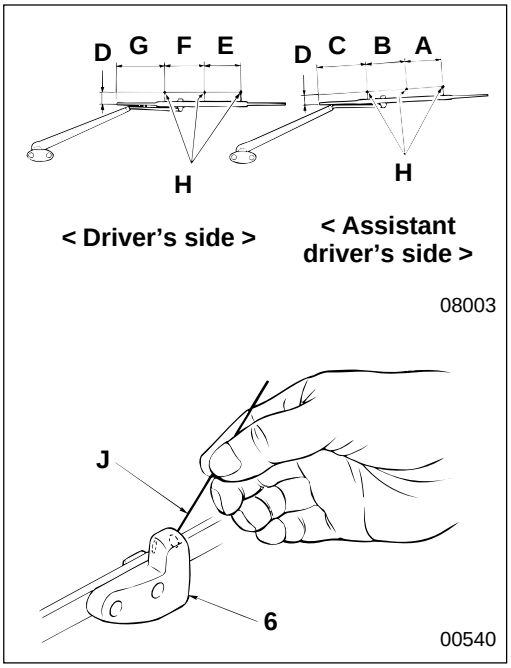
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Wiper arm and blade assembly mounting)	9.8 to 15 {7.2 to 11, 1 to 1.5}	—
10	Nut (Packing washer mounting)	14 to 20 {10 to 14, 1.4 to 2}	—
12	Nut (Hose joint mounting)	0.6 to 0.9 {0.4 to 0.7, 0.06 to 0.09}	—
19	Nut (Wiper link mounting)	9.8 to 15 {7.2 to 11, 1 to 1.5}	—
23	Nut (Wiper motor and wiper link mounting)	1.7 to 2.4 {1.2 to 1.7, 0.17 to 0.24}	—
24, 25	Bolt (Wiper motor bracket mounting)	9.8 to 15 {7.2 to 11, 1 to 1.5}	—
27	Bolt (Wiper motor mounting)	5.4 {4, 0.55}	—

◆ Service procedure



2 **Installation of wiper arm and blade assembly**

Install wiper arm and blade assembly **2** so that dimensions from the edges of the weatherstrip are as illustrated.



6 **Inspection of washer nozzle assembly**

Make sure that washer fluid spreading target positions **H** are within dimensions **A** to **G**. (Illustration shows the view from inside cab.)

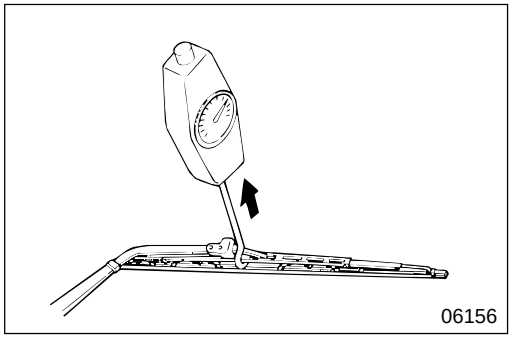
Unit : mm {in.}

		H
Assistant driver's side	A	110 {4.33}
	B	90 {3.54}
	C	170 {6.69}
Driver's side	D	15 {0.59}
	E	90 {3.54}
	F	90 {3.54}
	G	160 {6.30}

If washer fluid spreading target positions **H** deviate from these dimensions, adjust the jet hole angle of washer nozzle assembly **6** using wire **J**.

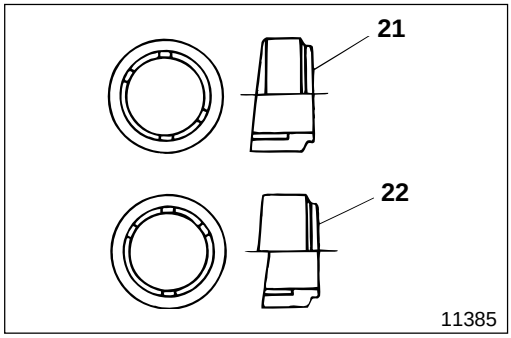
CAUTION⚠

Be careful not to damage the jet hole of washer nozzle assembly 6 with wire J when adjusting the angle.



8 **Inspection of wiper arm**

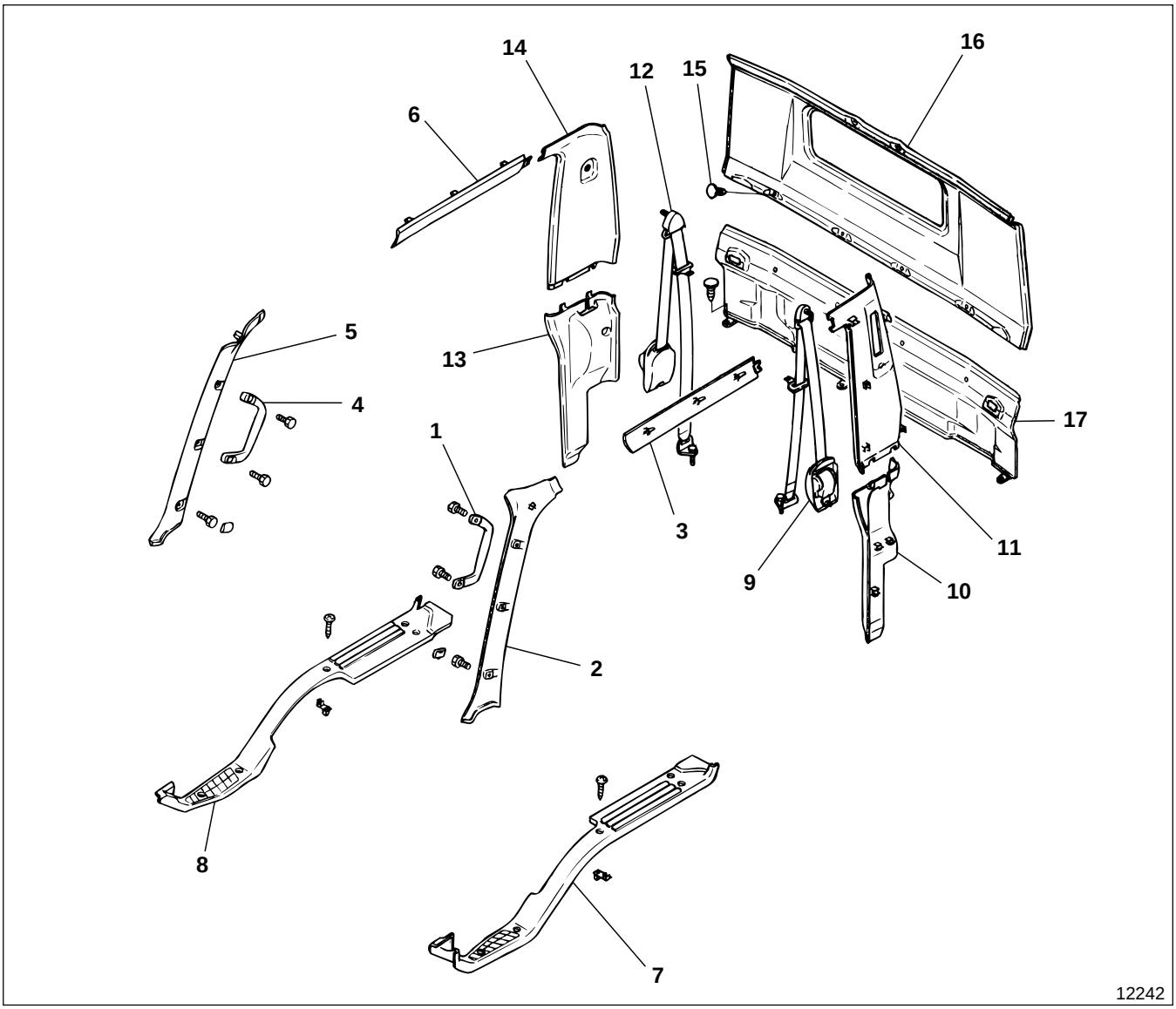
If the measured value deviates from the standard value, replace wiper arm **8**.



21 **22** **Packing washer**

Because the shape of packing washer **21** for the assistant driver's side and packing washer **22** for the driver's side are different, be careful not to mix them up during assembly.

Trim



● **Removal sequence**

1 Front pillar grip, LH
2 Front pillar trim, LH
3 Roof side trim, LH
4 Front pillar grip, RH
5 Front pillar trim, RH
6 Roof side trim, RH
7 Scuff plate, LH
8 Scuff plate, RH
9 Seat belt assembly, LH
10 Lower rear pillar trim, LH
11 Upper rear pillar trim, LH
12 Seat belt assembly, RH
13 Lower rear pillar trim, RH
14 Upper rear pillar trim, RH
15 Rear trim clip
16 Upper rear trim
17 Lower rear trim

CAUTION⚠

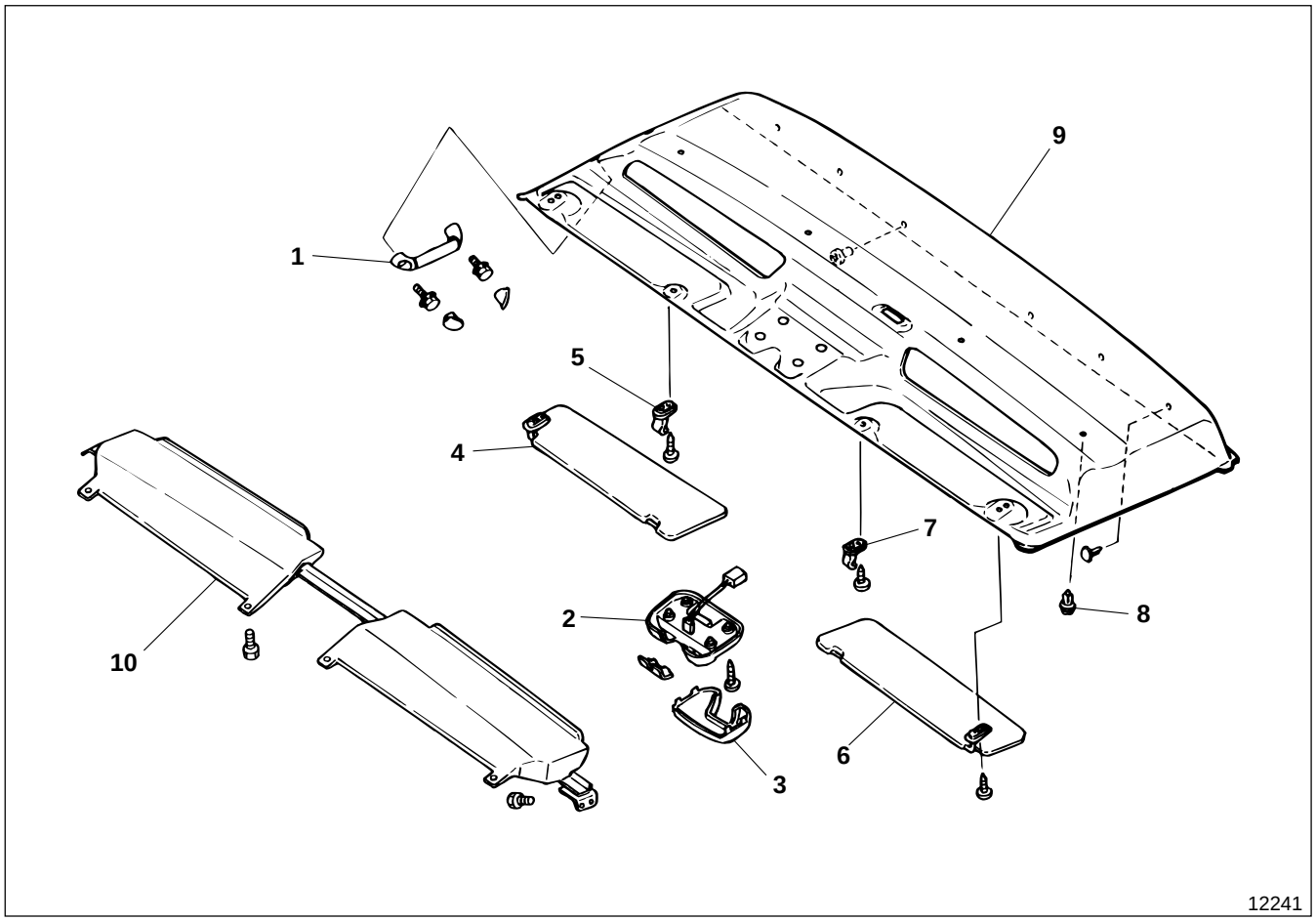
Do not disassemble seat belt assemblies 9, 12 because this might cause malfunction of the emergency locking retractor.

● **Installation sequence**

Follow the removal sequence in reverse.

CAB INTERIOR FITTING

Headlining



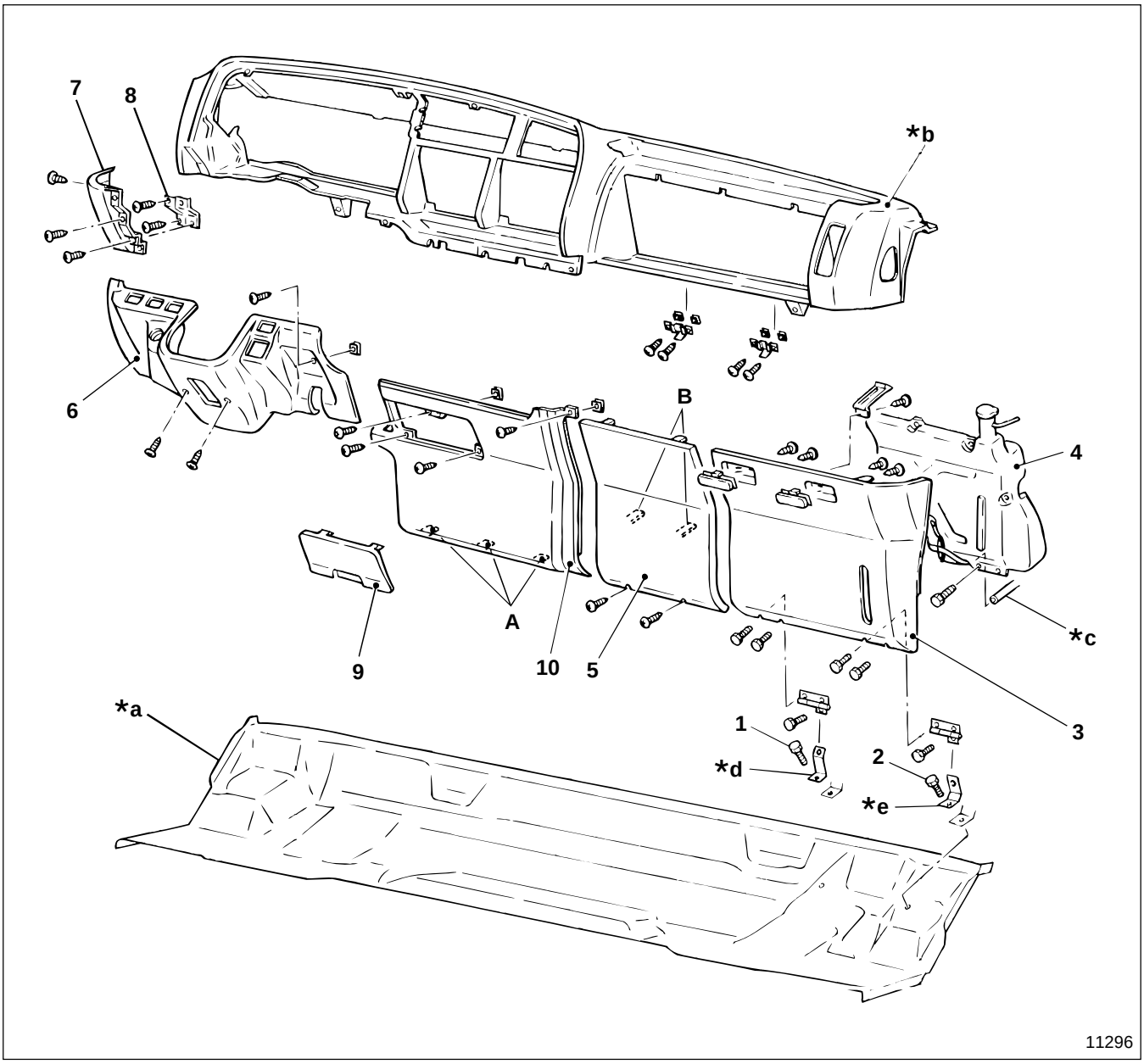
● **Removal sequence**

1 Grip
2 Lens
3 Cab lamp assembly Gr 54
4 Sun visor, RH
5 Hook
6 Sun visor, LH
7 Hook
8 Headlining clip
9 Headlining
10 Shelf assembly

● **Installation sequence**

Follow the removal sequence in reverse.

Lower Panel



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Assistant driver's side lower panel
4 Window washer tank
5 Center lower panel
6 Driver's side lower panel
7 Side panel
8 Side panel bracket
9 Fuse box lid
10 Center lower panel
***a** : Front floor
***b** : Instrument panel 🕮 P42-55
***c** : Water hose
***d** : Cooling unit
***e** : Blower unit

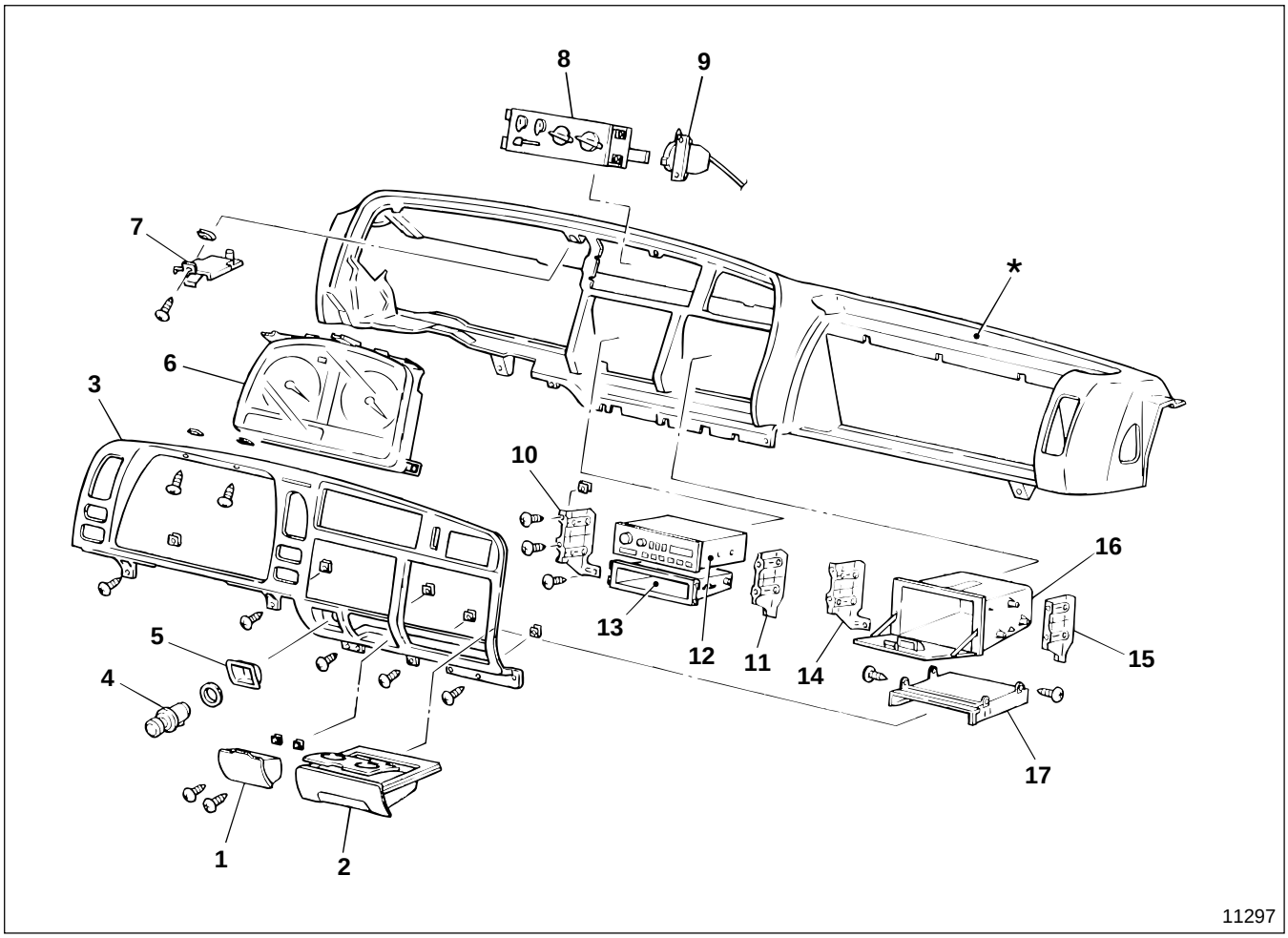
A : Fixed on heater unit
B : Fixed on joint duct

● **Assembly sequence**

Follow the disassembly sequence in reverse.

INSTRUMENT PANEL

Meter Bezel



● **Disassembly sequence**

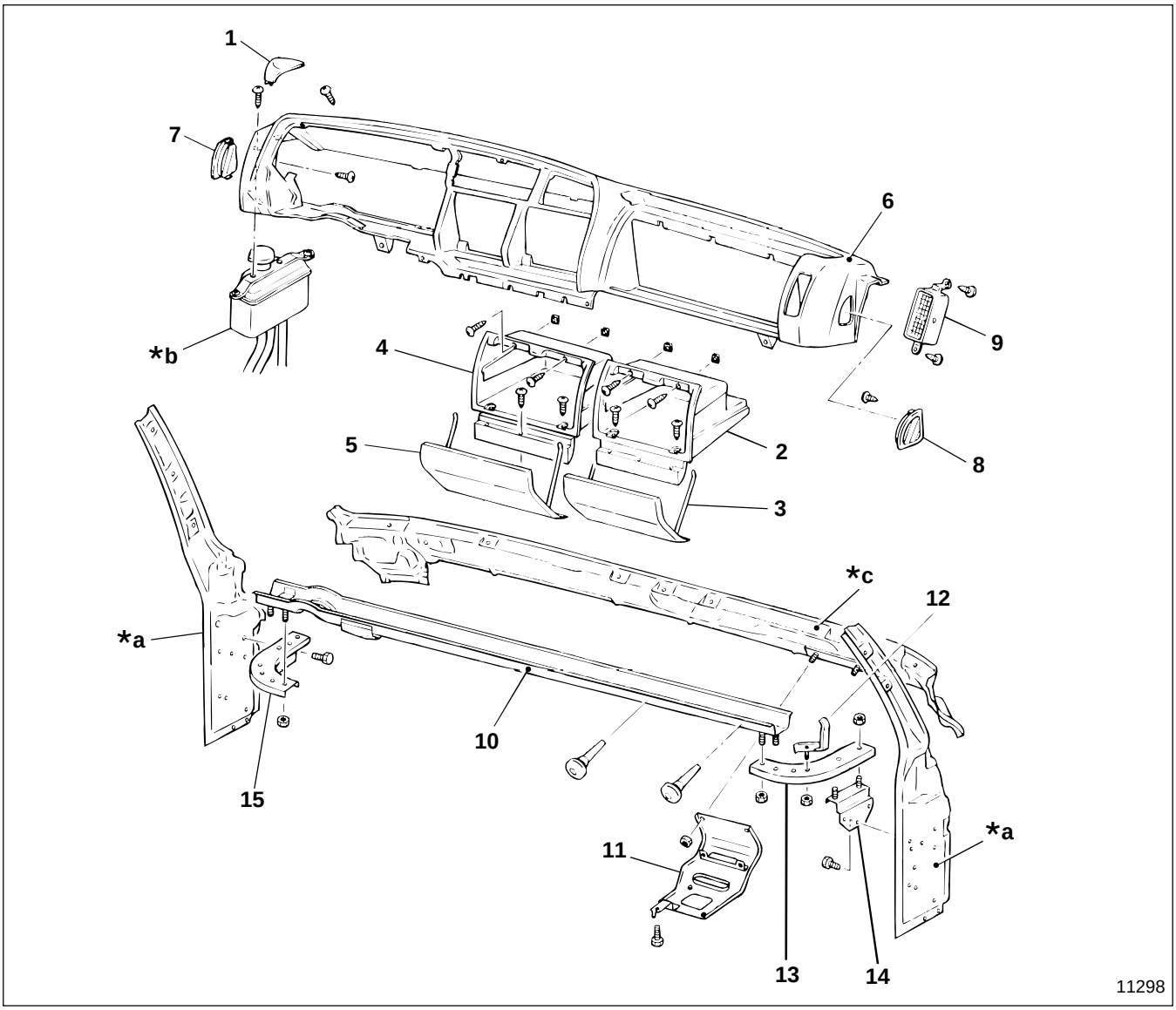
1 Ashtray
2 Cup holder
3 Meter bezel
4 Cigarette lighter Gr 54
5 Protector
6 Meter cluster Gr 54
7 Card holder
8 Heater control assembly Gr 55B
9 Cool air bypass control assembly Gr 55B
10 Bracket, LH
11 Bracket, RH
12 Radio < Option >
13 Box
14 Bracket, LH
15 Bracket, RH
16 Glove compartment
17 Cup holder base

* : Instrument panel P42-55

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Instrument Panel



● **Disassembly sequence**

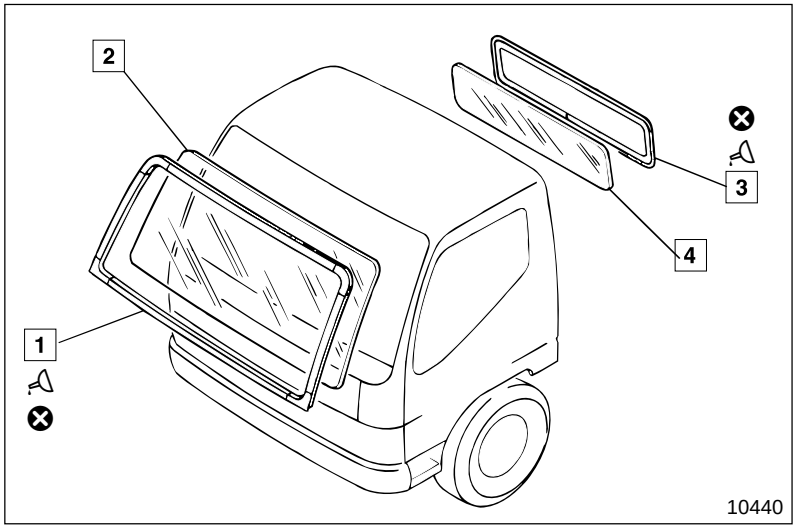
1 Fluid tank lid
2 Glove compartment
3 Glove compartment lid
4 Glove compartment
5 Glove compartment lid
6 Instrument panel
7 Side demister grille
8 Side demister grille
9 Air outlet grille
10 Instrument panel frame
11 Relay bracket
12 Instrument panel support
13 Instrument panel bracket
14 Instrument panel bracket
15 Instrument panel bracket

***a** : Upper front inner pillar
***b** : Fluid tank Gr 21
***c** : Front window rail

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WINDOW GLASS



● **Disassembly sequence**

1 Weatherstrip
2 Windshield
3 Weatherstrip
4 Rear window glass

⊗ : Non-reusable parts

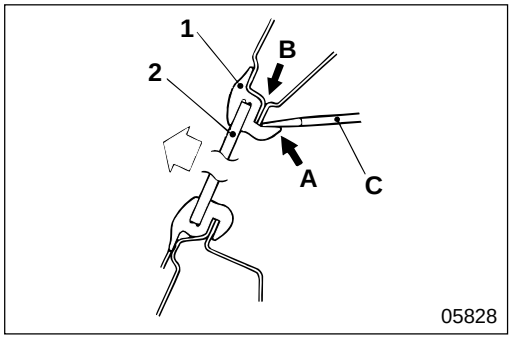
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Kinds	Quantity
1, 3	Lip area of weatherstrip	Soapy water	As required

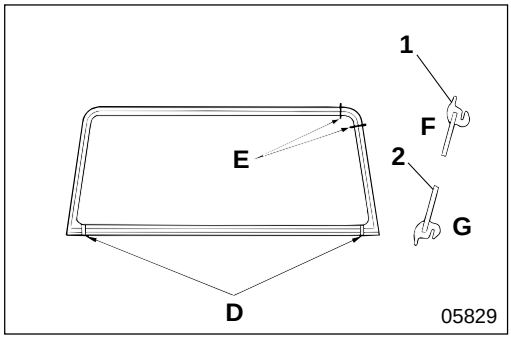
◆ Service procedure



1 **2** **Weatherstrip and windshield**

[Removal]

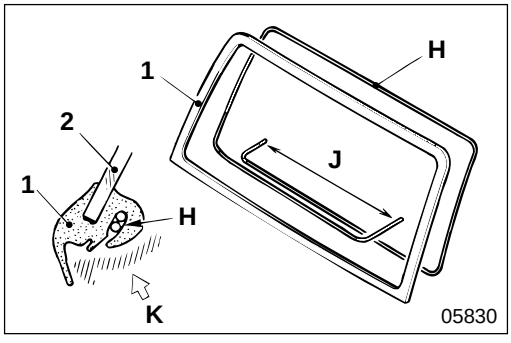
- From the inside of the cab, separate lip **A** of weatherstrip **1** from flange lip **B** of the cab.
  C : Screwdriver
- Push windshield **2** outward to remove it from the cab.



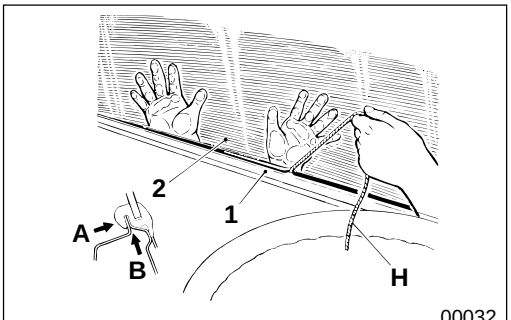
[Installation]

When installing the windshield, pull cord **H** attached to weatherstrip **1** and turn over lip **A**, following the procedure below:

- Position drain hole **D** and joint part **E** of weatherstrip **1** as illustrated and install them on windshield **2**.
  F : Outside
  G : Inside



- Lay cord **H** in the cab mounting groove of weatherstrip **1** as illustrated, and overlap the cord at the lower side of the glass by the specified length, see **J**.
- Apply soapy water **K** to weatherstrip **1**.
- Align windshield **2** with the cab.



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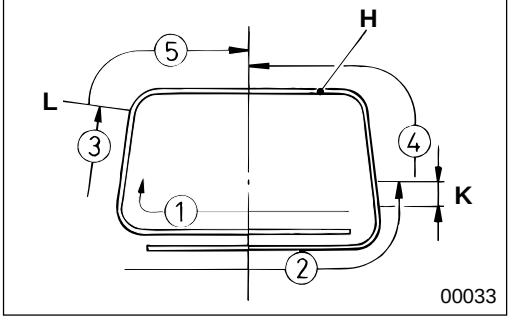
- Push windshield **2** inward from the outside of the cab firmly.
- Inside the cab, pull one end of cord **H** to install lip **A** of weatherstrip **1** into flange lip **B** of the cab.



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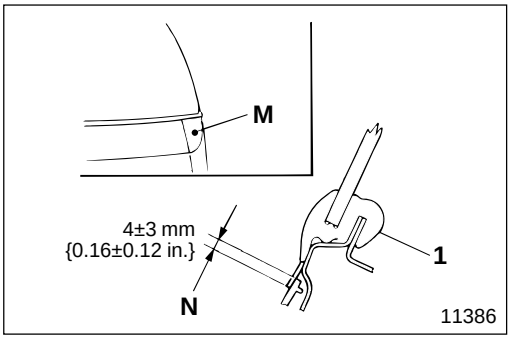
- Pull cord **H** in the numbered order as illustrated and at the same time have someone push windshield **2** into weatherstrip **1**, tapping the windshield with a rubber-headed mallet.
  K : approximately 100 mm {3.94 in.} from the starting point of straight line
  L : up to the end of straight line

CAUTION⚠

Make sure that windshield 2 is installed correctly into the cab before hitting the windshield with the rubber-headed mallet, otherwise the windshield might be broken.



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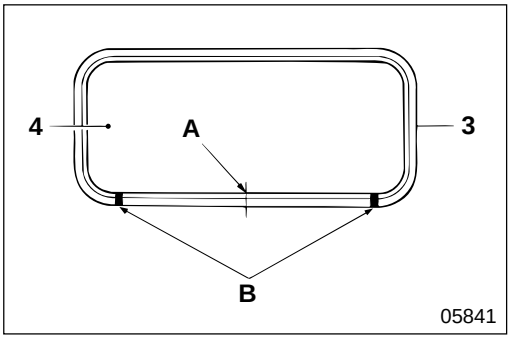
- Provide an overlapped margin **N** on weatherstrip **1** and side garnish **M** to prevent water flowing backwards from the water drain hole.



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3 **4** **Weatherstrip, rear window glass**

- Install so that joint **A** of weatherstrip **3** is at the center of rear window **4**.
  B : Water drain hole
- Except for the point mentioned above, follow the same service procedure as for installation of windshield. 🕮 P42-56

MITSUBISHI FUSO

Group 54

Electrical

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-54

GROUP 54 ELECTRICAL

HOW TO READ THIS GROUP

HOW THIS GROUP IS STRUCTURED 2

0 GENERAL

SPECIFICATIONS 54-0-2

STRUCTURE AND OPERATION

1. Starter 54-0-6
2. Alternator 54-0-8
3. Lamp 54-0-13
4. MUTIC (Multipurpose Timing Control Unit) 54-0-16

TROUBLESHOOTING

Power and charging 54-0-32

Enging starting, preheating and stopping 54-0-33

Lighting 54-0-34

Meter 54-0-37

Cigarette lighter and Audio 54-0-38

Accessory noise generation source 54-0-38

Horn 54-0-39

1 POWER, CHARGE AND GROUND CIRCUIT

(110) POWER CIRCUIT 54-1-2

(115) RESERVE POWER CIRCUIT 54-1-11

(125) BATTERY CHARGING CIRCUIT 54-1-12

(130) GROUND 54-1-14

2 STARTING AND PREHEATING CIRCUIT

(210) ENGINE STARTING CIRCUIT 54-2-2

(215) ENGINE STOPPING CIRCUIT ..... Gr 13E

(220) ENGINE PREHEATING CIRCUIT 54-2-5

(225) ENGINE WARM-UP CIRCUIT ..... (710)

3 LIGHTING CIRCUIT

(310) HEADLAMP CIRCUIT 54-3-2

(313) DAYTIME RUNNING LIGHT CIRCUIT 54-3-4

(320) TAIL, CLEARANCE AND LICENSE PLATE LAMP CIRCUIT 54-3-6

(325) STOP LAMP CIRCUIT 54-3-7

(330) TURN SIGNAL AND HAZARD LAMP CIRCUIT 54-3-8

(340) BACKUP LAMP CIRCUIT 54-3-9

(345) CAB LAMP CIRCUIT 54-3-11

(348) ILLUMINATION LAMP CIRCUIT 54-3-12

(349) MARKER AND IDENTIFICATION LAMP CIRCUIT 54-3-13

(352) VAN BODY DOME LIGHT CIRCUIT 54-3-14

4 METER CIRCUIT

(401) METER CLUSTER INTERNAL CIRCUIT 54-4-2

(410) TACHOMETER CIRCUIT 54-4-6

(412) SPEEDOMETER CIRCUIT 54-4-8

(420) FUEL GAUGE CIRCUIT 54-4-10

(425) WATER TEMPERATURE GAUGE CIRCUIT 54-4-11

5 INDICATOR AND WARNING LAMP CIRCUIT

(510) PARKING BRAKE INDICATOR CIRCUIT 54-5-2

(515) BRAKE WARNING CIRCUIT 54-5-4

(530) WATER LEVEL WARNING CIRCUIT 54-5-5

(535) ENGINE OIL LEVEL AND PRESSURE WARNING CIRCUIT 54-5-6

(536) ENGINE OIL PRESSURE WARNING CIRCUIT ... 54-5-7

(537) OVERHEATING WARNING CIRCUIT 54-5-9

(547) ATF TEMPERATURE WARNING CIRCUIT 54-5-10

(549) POWER STEERING FLUID LEVEL WARNING CIRCUIT 54-5-11

(550) CAB TILT WARNING CIRCUIT 54-5-12

(566) FUEL FILTER WARNING CIRCUIT 54-5-13

⑥ CAB SIDE ELECTRICAL CIRCUIT

610 CIGARETTE LIGHTER CIRCUIT 54-6-2

612 AUDIO CIRCUIT 54-6-3

614 WIPER AND WASHER CIRCUIT 54-6-4

616 HORN CIRCUIT 54-6-5

618 HEATER CIRCUIT 54-6-6

622 POWER WINDOW AND AUTO DOOR LOCK CIRCUIT 54-6-7

629 MIRROR HEATER CIRCUIT 54-6-8

⑦ CHASSIS SIDE ELECTRICAL CIRCUIT

710 EXHAUST BRAKE CIRCUIT 54-7-2

⑧ ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

850 TRANSMISSION POWER TAKE-OFF CIRCUIT .. 54-8-2

⑨ OTHERS CIRCUIT

910 MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT 54-9-2

ELECTRONICALLY CONTROLED FUEL SYSTEM CIRCUIT ..... Gr 13E

AUTOMATIC TRANSMISSION CIRCUIT ..... Gr 23

ANTI-LOCK BRAKE SYSTEM CIRCUIT ..... Gr 35E

⑩ PARTS INSTALLATION POSITION

Cab side

A SWITCH 54-10-2

B RELAY AND ELECTRONIC CONTROL UNIT 54-10-4

C FUSE, METER, SENSOR AND MOTOR 54-10-6

D HEATER 54-10-8

E DOOR 54-10-9

F ROOF 54-10-10

J JOINT OF MAIN HARNESS CONNECTORS 54-10-12

Engine and transmission side

R ENGINE 54-10-14

S TRANSMISSION 54-10-16

Chassis side

T SWITCH AND SENSOR 54-10-18

U BATTERY, FUSE AND CONNECTOR 54-10-19

V MAGNETIC VALVE, MOTOR 54-10-19

W HORN AND BUZZER 54-10-19

⑫ INSPECTION OF PARTS

001 to 179 SWITCH 54-11-2

180 to 249 RELAY 54-11-9

250 to 349 SENSOR 54-11-12

350 to 409 CONTROL UNIT 54-11-15

410 to 509 MOTOR 54-11-18

510 to 559 ACTUATOR 54-11-19

560 to 609 MAGNETIC VALVE 54-11-20

610 to 649 BUZZER AND HORN 54-11-21

650 to 699 LAMP 54-11-22

750 to 859 OTHER 54-11-23

860 BATTERY 54-11-25

870 to 889 FUSE 54-11-28

890 METER CLUSTER 54-11-32

⑫ STARTER AND ALTERNATOR

930 STARTER 54-12-2

940 ALTERNATOR 54-12-30

950 INSPECTION OF ALTERNATOR 54-12-46

951 INSPECTION OF REGULATOR 54-12-47

⑬ ON-VEHICLE INSPECTION AND ADJUSTMENT

955 INSPECTION OF PREHEATING SYSTEM 54-13-2

960 HEADLAMP AIMING 54-13-4

965 INSPECTION OF BRAKE FLUID LEVEL SWITICH 54-13-6

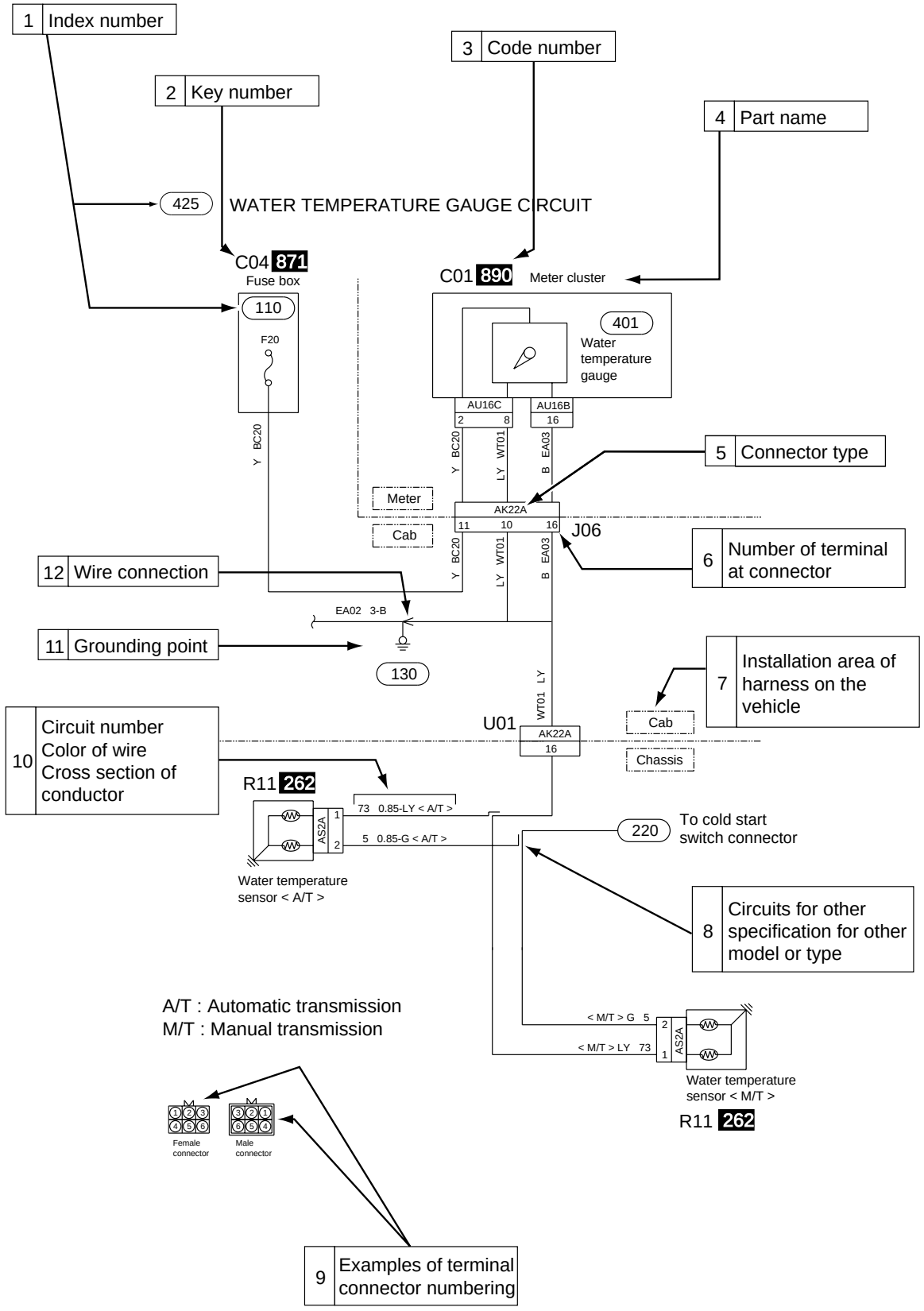
966 INSPECTION OF POWER STEERING FLUID LEVEL SENSOR 54-13-7

HOW TO READ THIS GROUP

HOW THIS GROUP IS STRUCTURED 2

HOW TO READ THIS GROUP

HOW TO READ CIRCUITS (GROUP 54)



Ⓟ48699

1 Index number: (110)

Each circuit has its own Index number respectively and has three digits ((110)).
How to read index number

- By proper using of the index number, it is possible to locate right place immediately since the circuit drawing of this manual book are classified as function by function. (including “POWER CIRCUIT” (110) and “GROUND” (130) .)
- How to check the location of circuit drawing in each part
  The circuit drawing which can not be diagramed in one page due to its complicated structure (such as meter cluster and electronic control unit etc.), has its remarked index number to be connected to other circuit drawing. ((401) , (910) , etc.)

2 Key number: A01~

Key number is the number to indicate the installation position of the parts, and is shown by A01 ~ Z.
The details of the installation position are described in GROUP 10.

3 Code number: **001** ~

Code number is the number to indicate the one portion of the parts to be checked and has three digits (**001**).
The details of the parts to be checked are described in GROUP 11.

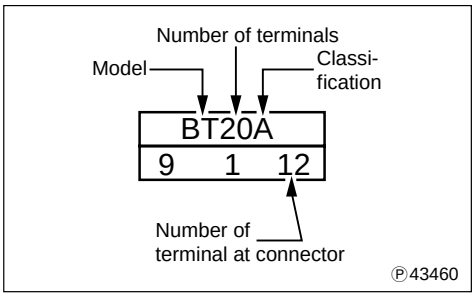
4 Part name

5 Connector type

Connectors are shown by □ without mentioning Male or Female and in the box it is described model of connector, number of terminals and its classification, etc.
Table of connectors is described in GROUP 14.

6 Number of terminal at connector

Terminal numbers of connector are shown by figures in the box.



7 Installation area of harness on the vehicle

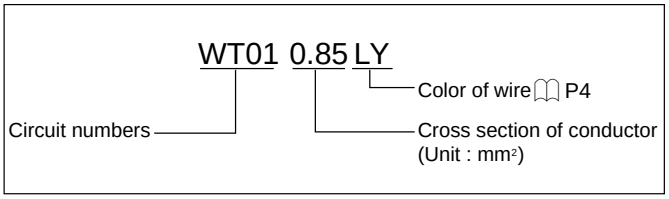
The location and boundary of the harnesses in the vehicle are shown in each circuit drawing and it may help to check mounting position of connectors.

8 Circuits for other specification for other model or type

9 Examples of terminal connector numbering

As it is shown, for female connectors, with placing the lock upward then starting to put numbers from the upper left. And when it is male connector, put numbers from the upper right, also with placing the lock upward.

10 Circuit number, color of wire, and cross section of conductor are shown in circuit drawings.



Except for 0.5mm², Wire thickness is described in the circuit drawing. The reason why only wire thickness, 0.5 mm² is not described in the drawings is 0.5mm² is so common and so that the circuit drawing can be seen more easily.
(Examples) 0.5mm²: Y
0.85mm²: 0.85 — LY
3mm²: 3 — B

11 Grounding point

The actual locations of grounding points on the vehicle are shown. Refer to (130) for detailed information.

12 Wire connection

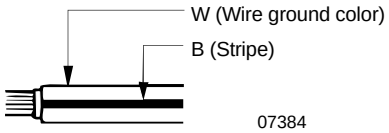
When the wires are connected into one point of the harnesses, the circuit drawing shows “Arrow mark”.

CAUTION !
Be careful that direction of the arrow does not show the direction of the electric current flow.

HOW TO READ THIS GROUP

● Wire Colors

Example: WB means a wire whose ground color is white and whose stripe is black.

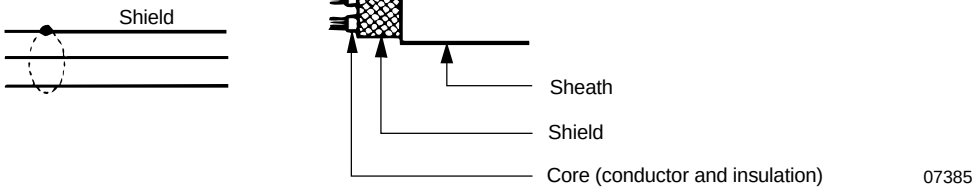


Wire ground color		Wire ground color + Stripe							
W	White	WR	White red	WB	White black	WL	White blue	WG	White green
B	Black	BW	Black white	BY	Black yellow	BR	Black red		
R	Red	RW	Red white	RB	Red black	RY	Red yellow	RG	Red green
Y	Yellow	YR	Yellow red	YB	Yellow black	YG	Yellow green	YL	Yellow blue
G	Green	GW	Green white	GR	Green red	GY	Green yellow	GB	Green black
Br	Brown	BrW	Brown white						
L	Blue	LW	Blue white	LR	Blue red	LY	Blue yellow	LB	Blue black
		LG	Blue green						
Lg	Yellow green	LgR	Yellow green red	LgY	Yellow green yellow	LgB	Yellow green black	LgW	Yellow green white
O	Orange								
P	Pink	PB	Pink black						

● Shield Wire

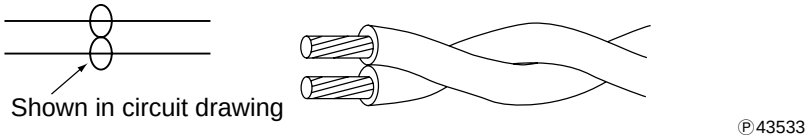
A shield wire is clearly identified as follows:

Example



● Twist wire

Twist wires are made by twisting the core of wires by the constant pitch.
Example:



0 GENERAL

SPECIFICATIONS

Battery

Item	Specifications
Model	115E41R
Voltage × Quantity	12 × 2 (Parallel connection)
Capacity (5-hour rating)	88

Alternator

Item	Specifications		
Manufacturer	MITSUBISHI ELECTRIC		
Type	Alternator with built-in regulator (without brush external fan)		
Engine (Vacuum pump)	6D3 (without)	6D3 (with)	4M5 (without)
Model	A4TU0888	A4TU0988	A4TU1081
Output V-A	12-100		12-100

Engine starter, Glow

Item			Specifications	
Starter	Manufacturer		MITSUBISHI ELECTRIC	
	Reduction gear system		Planetary gear	
			6D3	4M5
	Model		M8T55171	M8T55371
	Out put	V-kW	12-3.5	12-3
	Magnetic switch operating voltage	V	8 or less	8 or less
Starter relay	Model		U1X15072	U1X11079
	Excitation current	V-A	12-4	12-4
	Closing voltage	V	8 or less	8 or less
	Operating voltage	V	3.5 or less	3.5 or less
	Allowable cutoff current	A	200	200
Glow plug	Model		Sheathed type	Sheathed type
	Rated voltage current	V-A	11-5.5	11-8.5
Glow relay	Model		U1T11373	U1T11473
	Excitation current	V-A	12-4	
	Closing voltage	V	8 or less	
	Operating voltage	V	3.5 or less	
	Allowable cutoff current	A	200	60
	Temperature fuse capacity	A	127	

SPECIFICATIONS

Lighting

Item			Specifications
Headlamp	Model		Seald beam
	Main beam	W	50
	Dipped beam	W	40/60 (Main/Dipped)
Front turn signal lamp (serving also as hazard warning lamp)		W	21 × 2
Clearance lamp		W	7.5
Side turn signal lamp (serving also as hazard warning lamp)		W	10
Clearance and side marker lamp		W	7.5
Rear combination lamp	Stop/Tail lamp	W	27/8
	Backup lamp	W	27
	Turn signal lamp (serving also as hazard warning lamp)	W	27
Cab lamp		W	10
License plate lamp		W	7.5
Identification lamp		W	7.5
Back buzzer	Rated voltage	V	12
	Rated current	mA	50 or less
	Sound pressure	dB	85 ± 10 (at 1 m {3.3ft.})
	Intermittent frequency	frequency per minute	85 ± 15

All bulbs of the lamps shown above have voltage rating of 12 V.

Meter

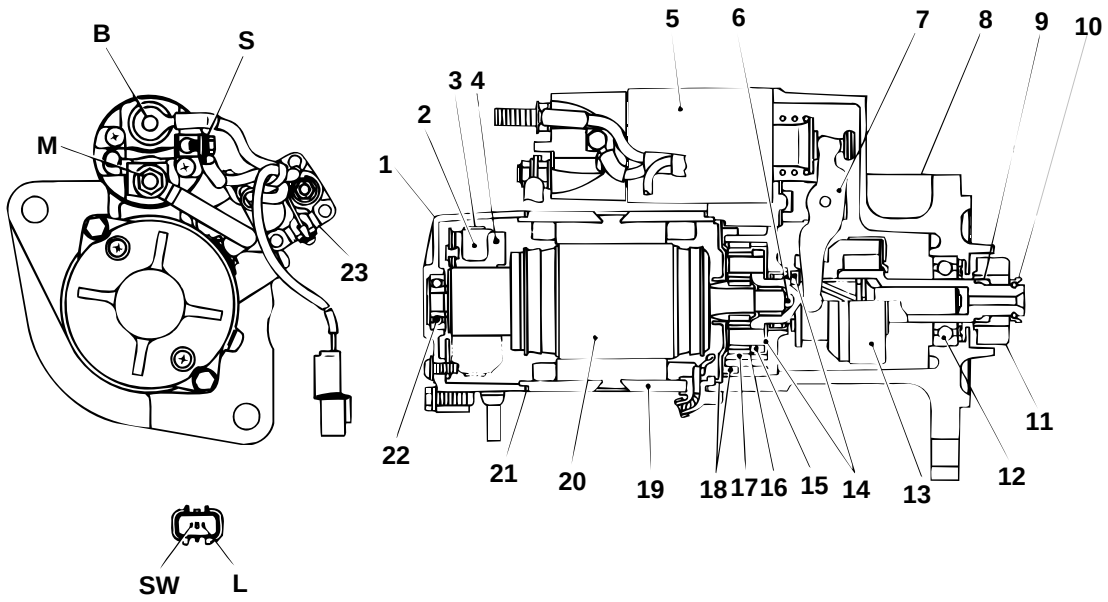
Item			Specifications
Meter cluster	Manufacturer		DENSO CORPORATION
	Rated voltage	V	12
	Lighting bulb	W	3.4
	Indicator lamp bulb	W	1.4
	Warning lamp bulb	W	1.4

Relay, Motor, Horn, Buzzer

Item			Specifications
Relay	Rated voltage	V	12
	Minimum operating voltage	V	8 or less
Speaker	Rated input	W	15
	Maximum input	W	25
	Impedance	Ω	4 ± 0.6
Power window motor	Rated voltage	V	13.5
	Rated current	A	9 or less < UP > 7 or less < Down >
Door lock actuator	Rated voltage	V	12
	Bound current	A	6 or less
Electric horn	Rated voltage	V	12
	Current consumption	A	3 ± 0.5
	Sound pressure	dB	110 ± 5 (at 2 m {6.6ft.})
	Standard frequency	Hz	390 ± 20 (High), 330 ± 20 (Low)
Wiper motor	Rated voltage	V	12
	Non-load current	A	3.7 or less
	Bound current	A	27 or less
Windshield washer motor	Rated voltage	V	12
	Rated current	A	3.8 or less
Reverse warning buzzer	Rated voltage	V	12
	Current consumption	mA	66 or less
	Sound pressure	dB	80 ± 10 (at 1 m {3.3 ft.})
Warning buzzer	Rated voltage	V	12
	Current consumption	mA	150 or less
	Sound pressure	dB	75 ± 10 (at 1 m {3.3 ft.})

1. Starter

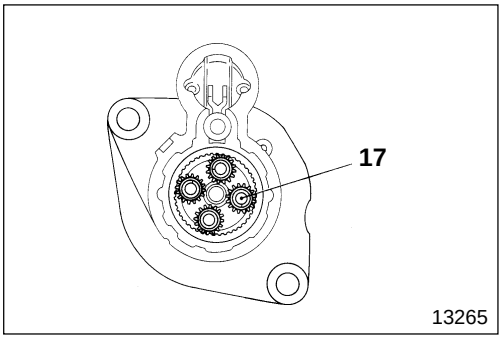
< 6D3 >



52936

1 Rear bracket
2 Brush
3 Brush spring
4 Brush holder
5 Magnetic switch
6 Ball
7 Lever
8 Front bracket
9 Spring
10 Pinion stopper
11 Pinion
12 Front bearing
13 Overrunning clutch
14 Washer
15 Gear shaft
16 Internal gear
17 Planetary gear
18 Rubber packing
19 Yoke assembly
20 Armature
21 Rubber packing
22 Rear bearing
23 Starter relay

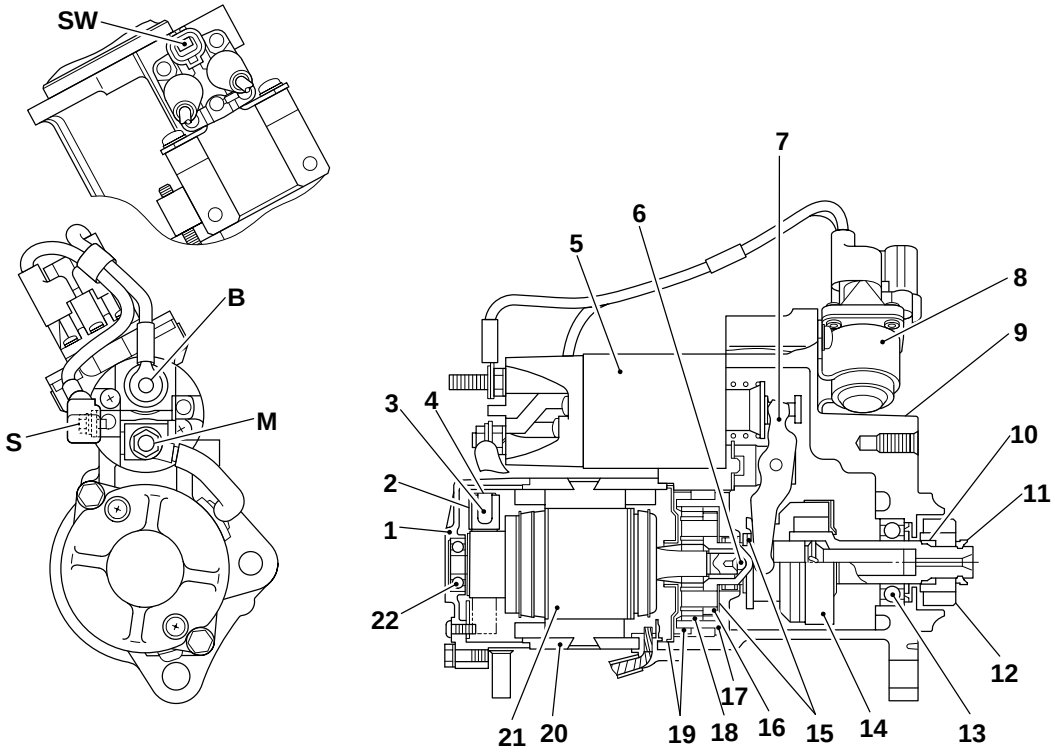
B : Terminal B
L : Terminal L
M : Terminal M
S : Terminal S
SW : Terminal SW



13265

This starter installs planetary gear **17** in a deceleration gear mechanism.

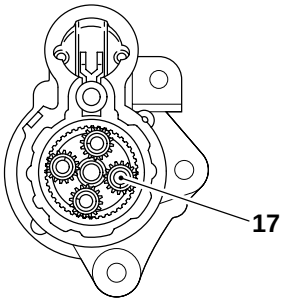
< 4M5 >



Ⓟ48017

1 Rear bracket
2 Brush holder
3 Brush
4 Brush spring
5 Magnetic switch
6 Ball
7 Lever
8 Starter relay
9 Front bracket
10 Spring
11 Pinion stopper
12 Pinion
13 Front brearing
14 Overrunning clutch
15 E-ring
16 Gear shaft assembly
17 Internal gear assembly
18 Planetary gear
19 Rubber packing
20 Yoke assembly
21 Armature assembly
22 Rear bearing

B : Terminal B
M : Terminal M
S : Terminal S
SW : Terminal switch

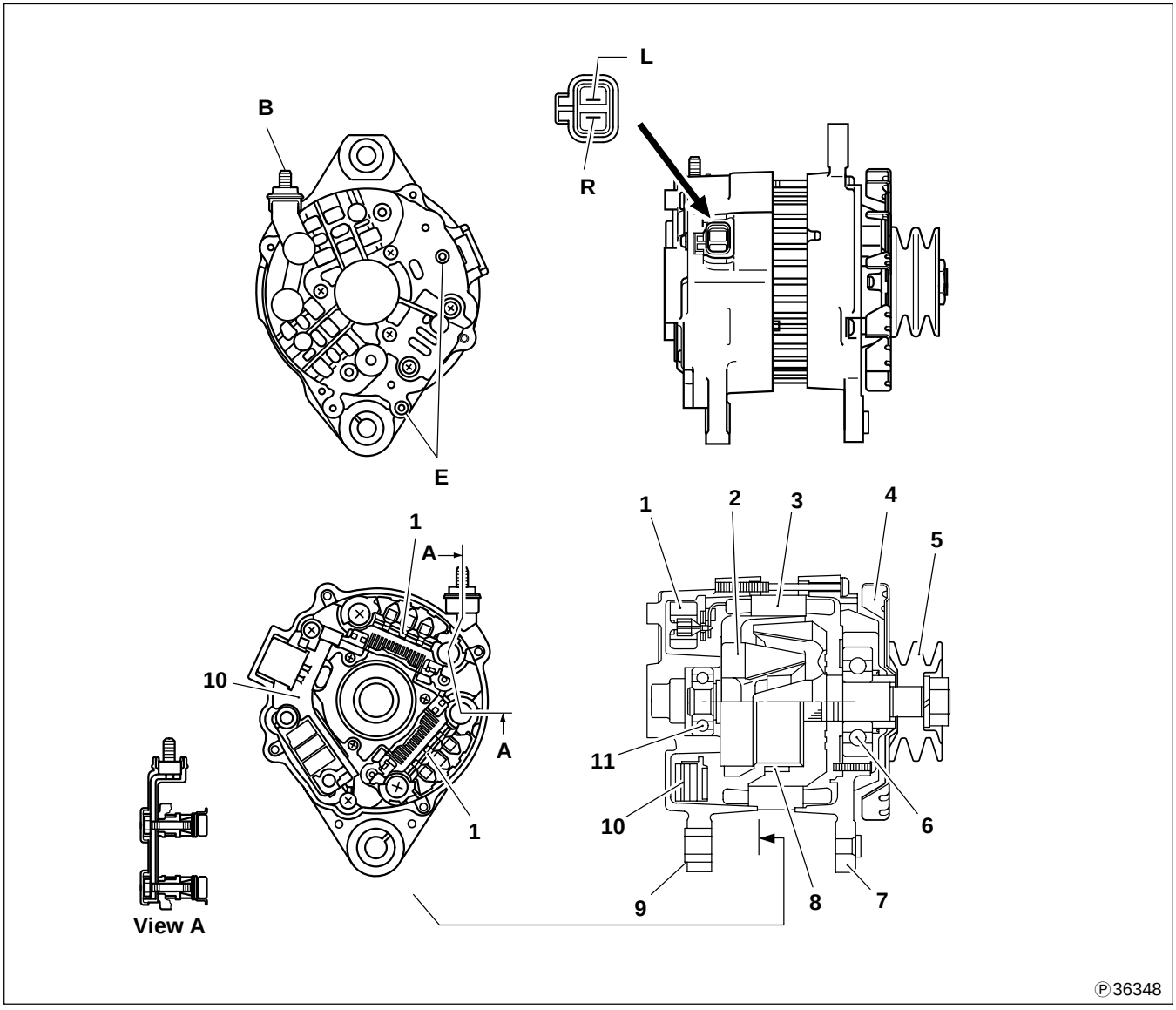


Ⓟ48018

This starter installs planetary gear **17** in a deceleration gear machanism.

2. Alternator

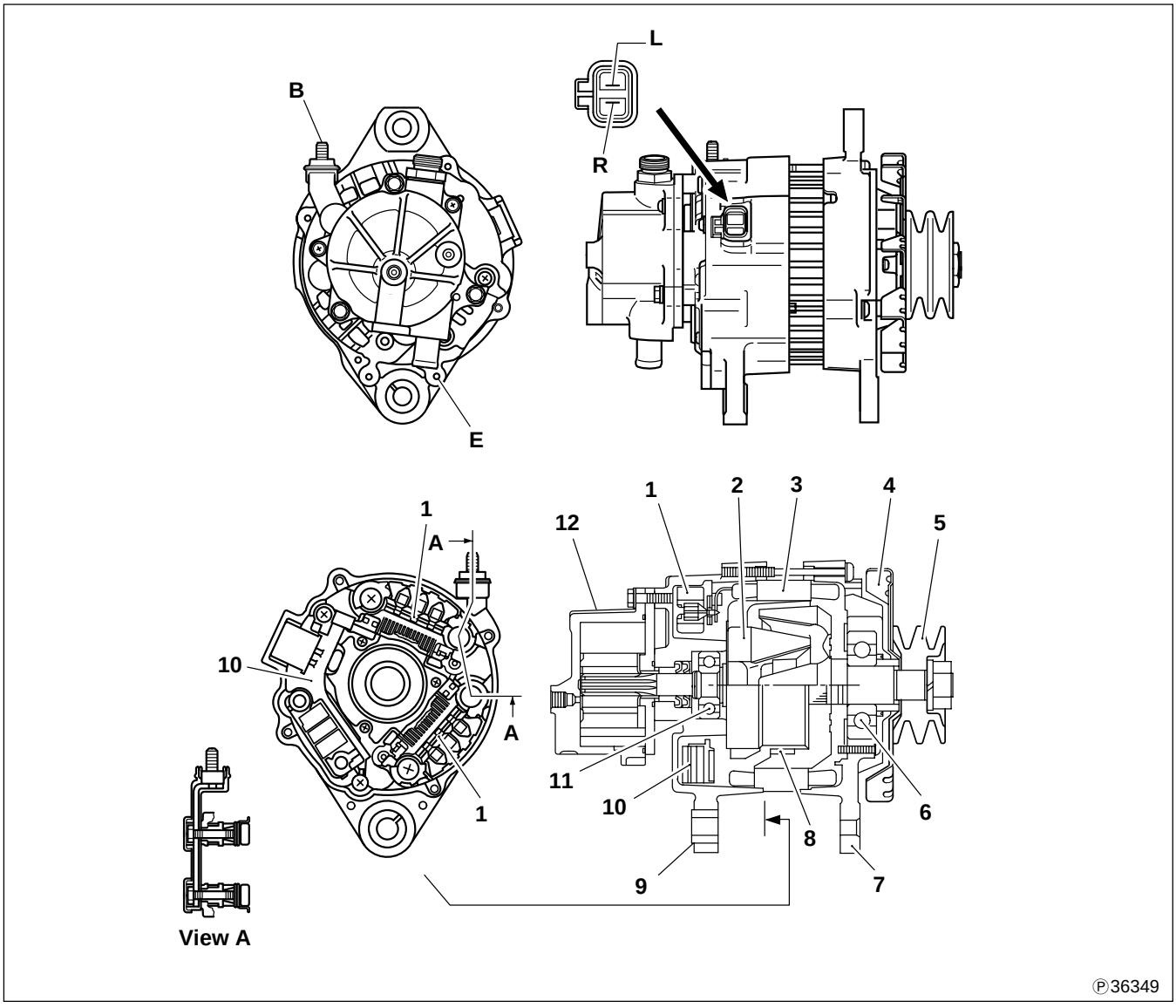
< A4TU0888 >



1 Rectifier
2 Rotor assembly
3 Stator assembly
4 Fan
5 Pulley
6 Front bearing
7 Front bracket
8 Field coil
9 Rear bracket
10 Regulator
11 Rear bearing

B : Terminal B
E : Terminal E
L : Terminal L
R : Terminal R

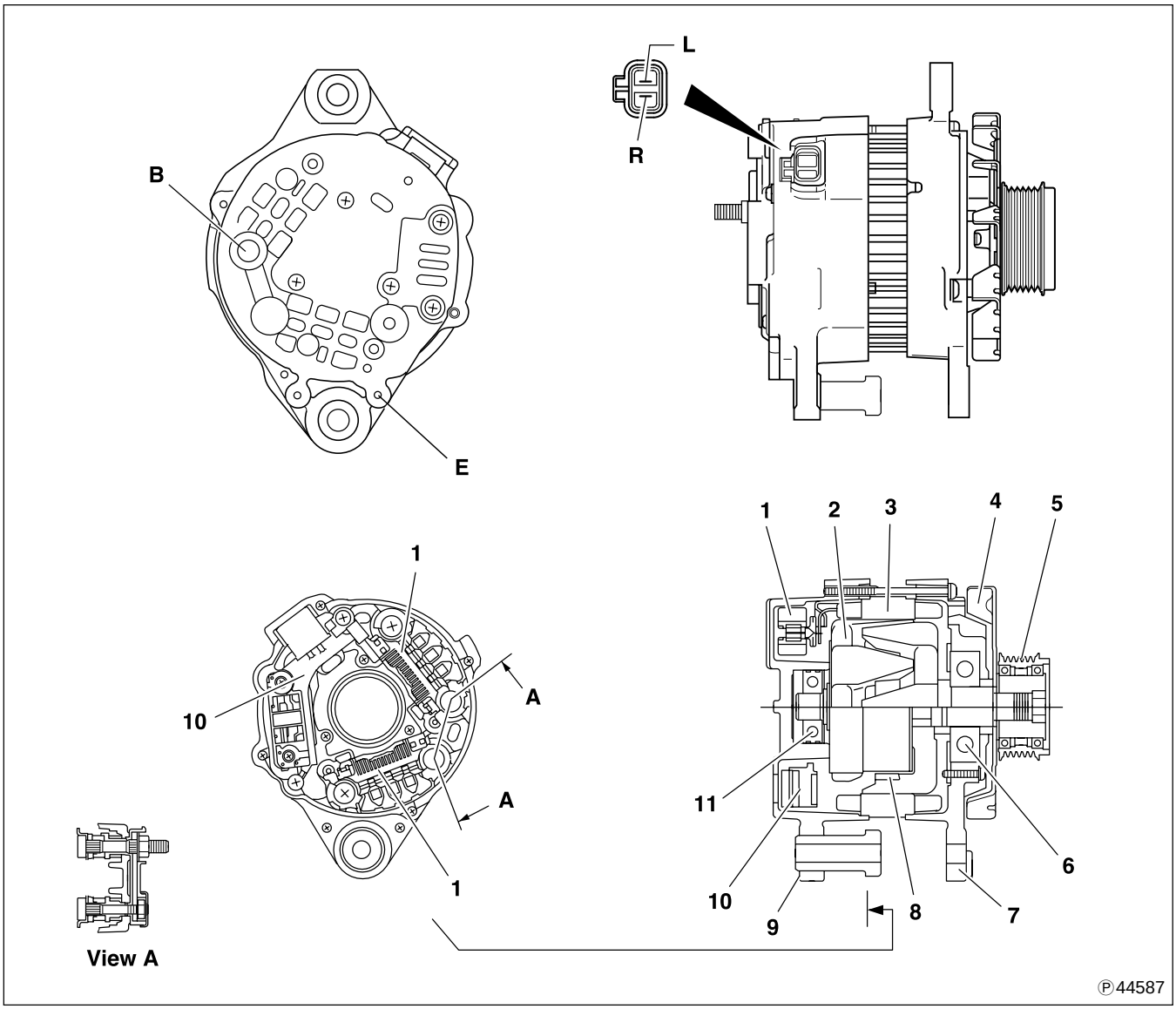
< A4TU0988 >



1 Rectifier
2 Stator assembly
3 Rotor assembly
4 Fan
5 Pulley
6 Front bearing
7 Front bracket
8 Field coil
9 Rear bracket
10 Regulator
11 Rear bearing
12 Vacuum pump

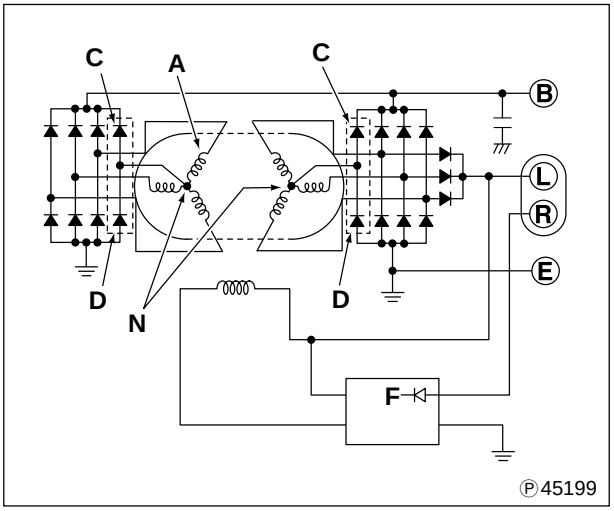
B : Terminal B
E : Terminal E
L : Terminal L
R : Terminal R

< A4TU1081 >



1 Rectifier
2 Rotor assembly
3 Stater assembly
4 Fan
5 Pulley
6 Front bearing
7 Front bracket
8 Field coil
9 Rear bracket
10 Regulator
11 Rear bearing

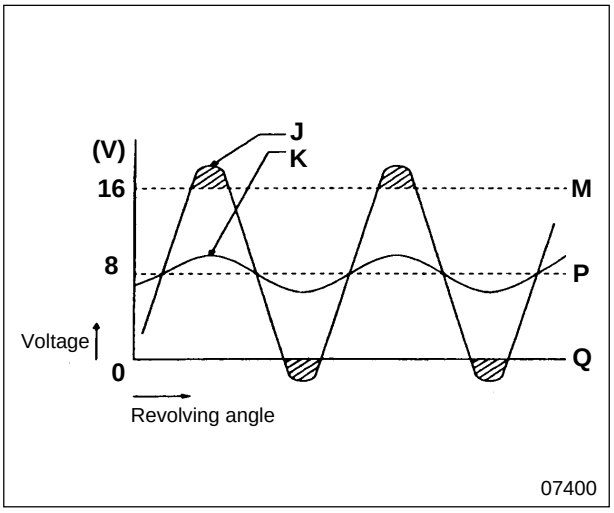
B : Terminal B
E : Terminal E
L : Terminal L
R : Terminal R



Features of alternator with neutral diodes

- The alternator is the same as the current alternator except neutral diodes **C** and **D** added.
- These neutral diodes **C** and **D** enable this alternator to provide higher DC output during operation at high speeds than the alternator without neutral diodes.

A : Stator coil
B : Alternator terminal B
E : Alternator terminal E
F : IC regulator
L : Alternator terminal L
N : Neutral point
R : Alternator terminal R



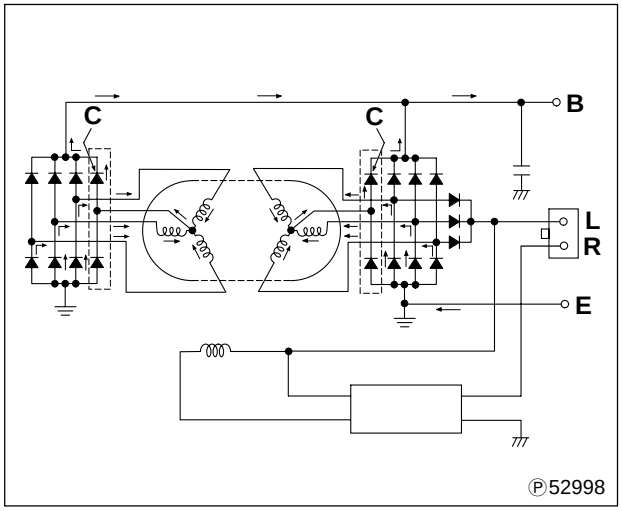
Variations of voltage at neutral point and operation of neutral diodes

- The potential at the neutral point **N** varies up and down with the neutral point DC voltage **P** as a center as shown.
- When alternator is operated at high speeds, the voltage at the neutral point **N** can increase to exceed the output voltage **M** (16 volts) and decrease to become lower than the ground voltage **Q** (0 volt). To adjust these over-voltage and under-voltage (shaded portions of diagram) the current from the excess voltages is taken by neutral diodes **C** and **D** and added to the DC output.

J : Voltage waveform at neutral point during high speed operation
K : Voltage waveform at neutral point during low speed operation
M : Output voltage
P : Average voltage at neutral point (1/2 of output voltage)
Q : Ground potential

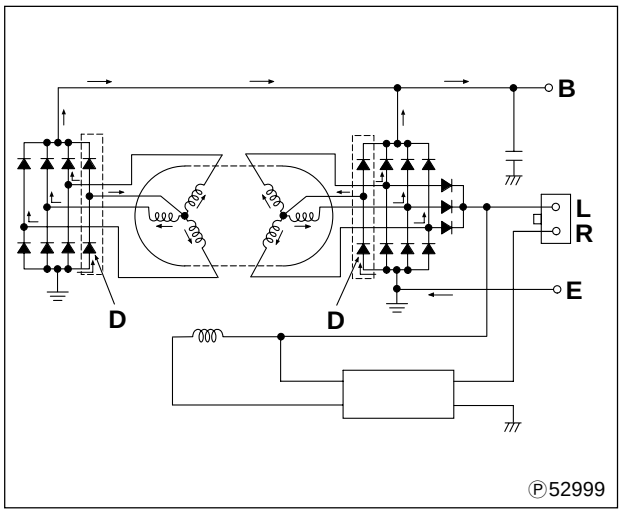
The operation of neutral diodes **C** and **D** for each voltage and potential is as follows.

- When the voltage at neutral point is in the range from 0 to 16 volts, the other 6 diodes are operated. Neutral diodes are not operated.



● **When the voltage at neutral point exceeds 16 volts**

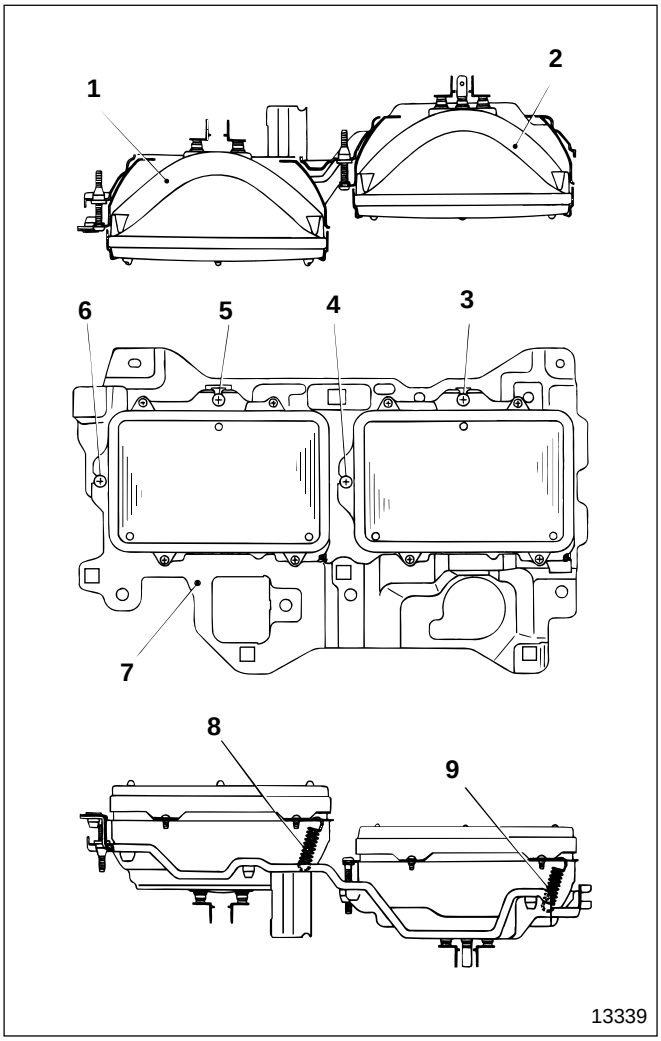
The positive diode **C** adds extra output to the DC output for supply to each electric equipment.



● **When the voltage at neutral point drops below 0 volt**

The negative diode **D** supplies the output from neutral point through other 3 diodes.

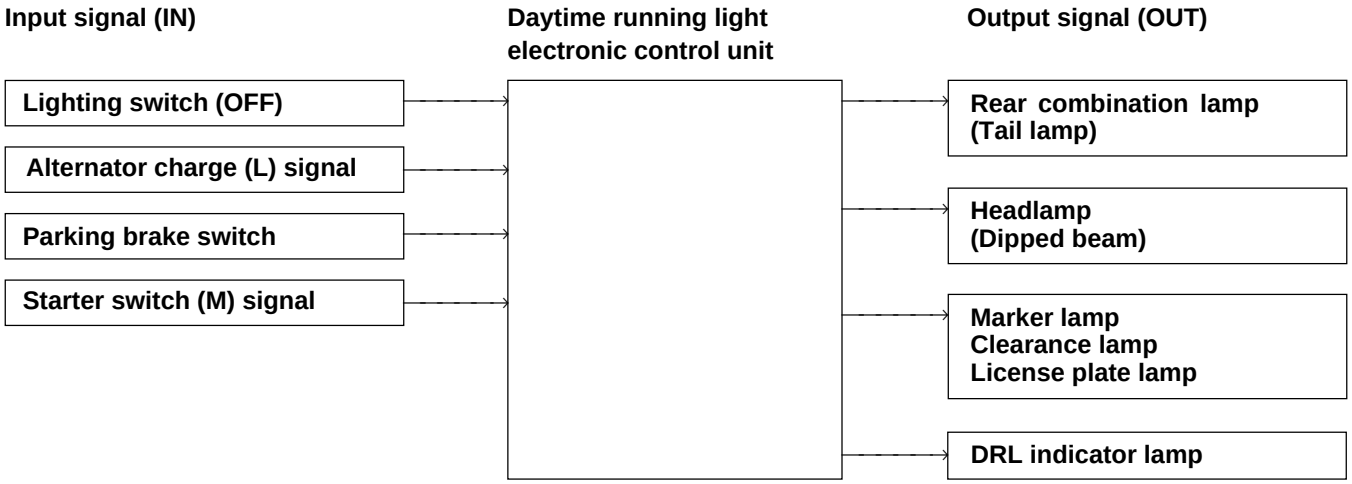
3. Lamp
Headlamp



1 Sealed beam unit (Main beam)
2 Sealed beam unit (Dipped beam)
3 Screw (Dipped beam, vertical adjustment)
4 Screw (Dipped beam, horizontal adjustment)
5 Screw (Main beam, vertical adjustment)
6 Screw (Main beam, horizontal adjustment)
7 Housing
8 Extension spring
9 Extension spring

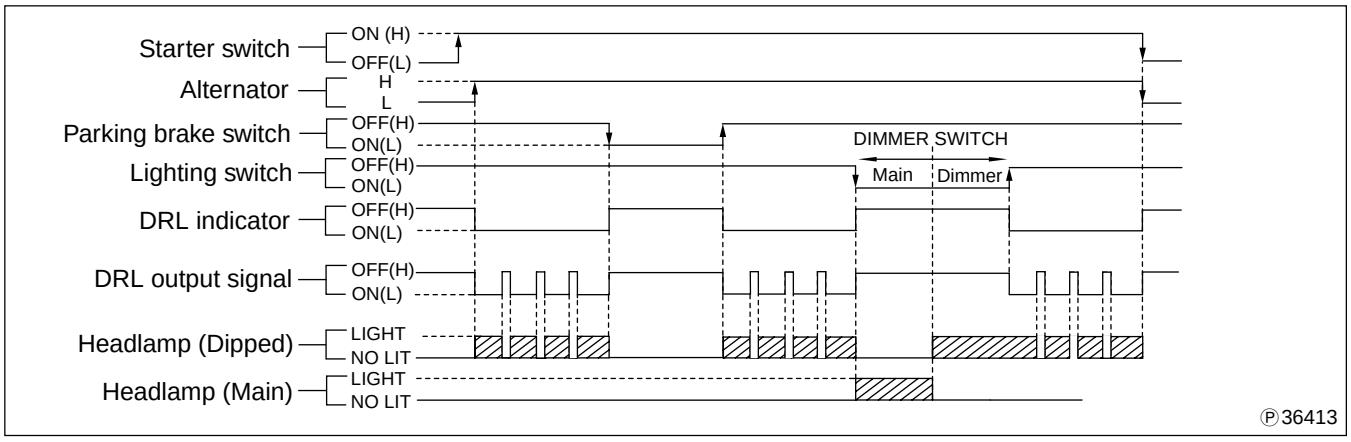
- The headlamp unit consists of sealed beam units **1, 2** separately installed in housing **7**. Sealed beam unit **1** is for Main beam, and sealed beam unit **2** is for Dipped beam.
- The headlamp aiming can be adjusted by changing the installation angle of sealed beam units **1, 2**.
- To adjust the installation angle of sealed beam unit **1**, turn screws **5, 6**. Extension spring **8** sets the angle of the sealed beam unit.
- To adjust the installation angle of sealed beam unit **2**, turn screws **3, 4**. Extension spring **9** sets the angle in the same way as for sealed beam unit **1**.

Daytime running light system



- In a daytime running light system, regardless the position of lighting switch while engine is running, the dipped beam of the headlamp and the tail lamp of the rear combinations, position lamp, license plate lamp will light on.
- Except for that the lighting switch is OFF or when the passing switch is ON, the same lamps as usual switch operation will light.

• Timing chart

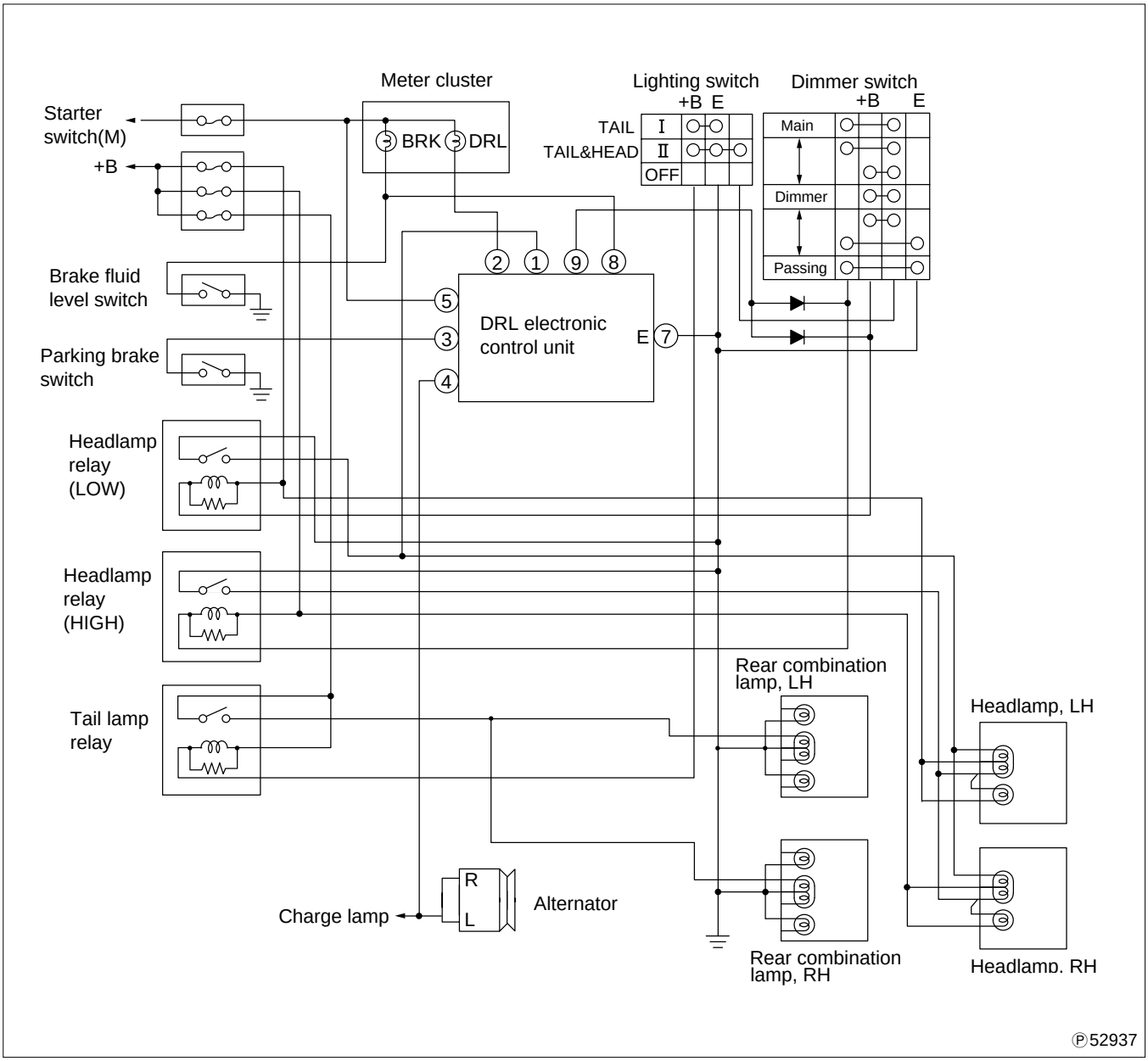


Headlamps repeat ON/OFF operations at 120 Hz according to the above timing chart. Because of the cyclic ON/OFF operations, the headlamps are dimmer than when the headlamp switch is ON.

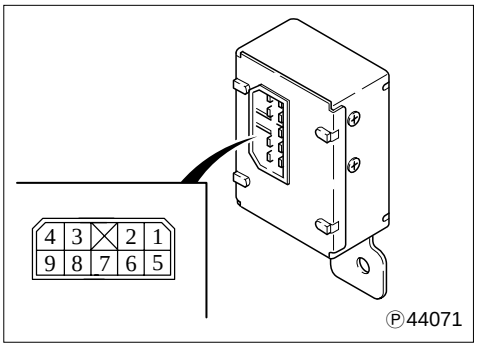
Explanation of timing chart

- After the engine starts, when alternator begins generating electricity with starter switch in the ON position, headlamps light.
- When parking brake switch is ON, the DRL turns off to switch off the headlamps.

• Daytime running light electronic control unit circuit diagram



• DRL electronic control unit



Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Head lamp (Dipped)	6	—
2	DRL indicator lamp	7	Ground
3	Parking brake switch	8	Parking brake indicator lamp
4	Alternator L terminal	9	Lighting switch
5	Starter switch M terminal	—	—

4. MUTIC (Multipurpose Timing Control Unit)

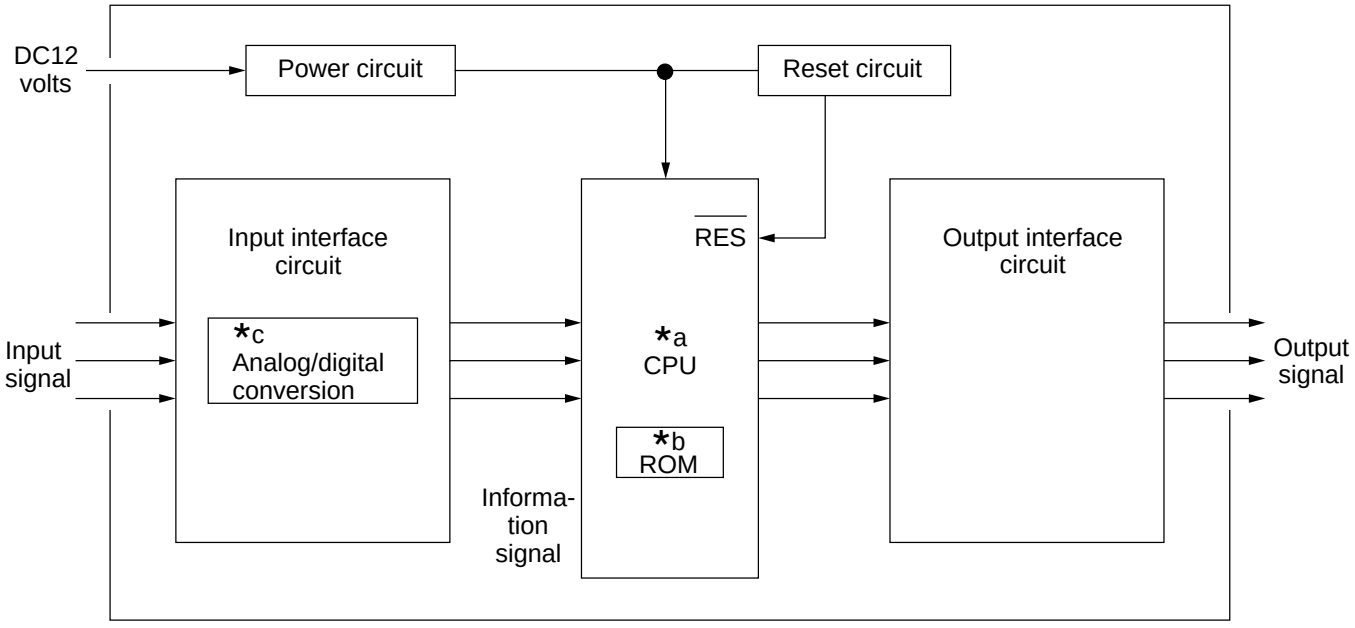
< FH211 >

- This control unit is an integrated control unit for controlling the following functions.

Preheating function	P54-0-20
Intermittent wiper activation function	Gr 42
Wiper activation function (Even if the wiper switch is OFF, this function automatically activates the wiper when the window washer works)	Gr 42
Water level warning function	Gr 14
Starter continuous-ON prevention function	P54-0-22

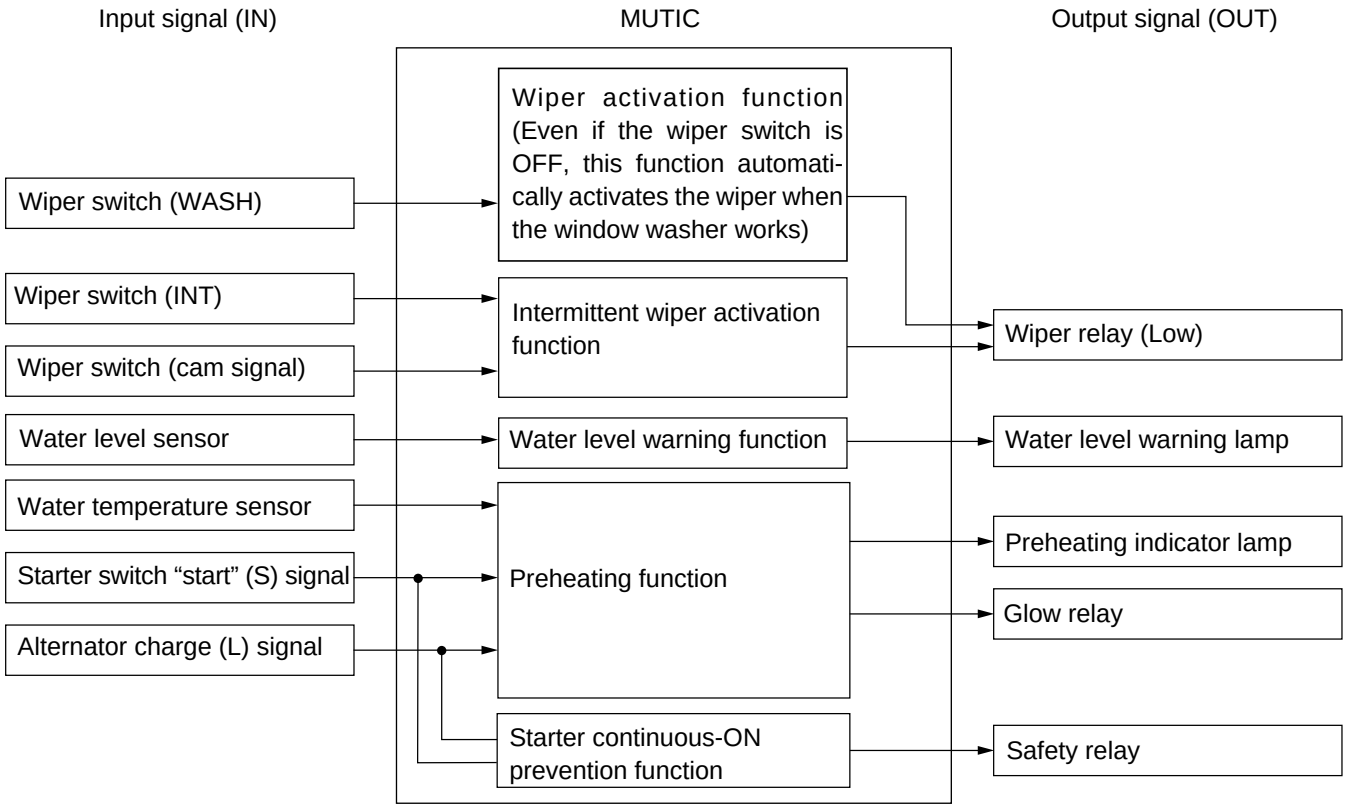
- For controlling each function, sensors and switches are needed as sources of information, and they are provided for respective systems.
- Based on the information provided by the sensors and switches, the MUTIC controls above functions by means of the circuits inside itself.

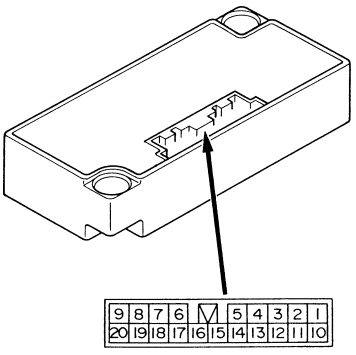
● **Internal structure of MUTIC**



- The MUTIC is internally made up roughly of the input interface circuit, CPU*a, ROM*b, and output interface circuit.
  *a: An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM and makes a decision and sends commands to the outputs.
  *b: An abbreviation for Read-Only Memory. It is an element used exclusively to have its contents read. It stores fixed data and program, and such retained information is not deleted even after power is cut off.
- Information sources such as sensor, switch send input signal to the input interface circuit.
- The input interface circuit performs A/D conversion*c of the input signals, and the converted signals are transmitted to the CPU as information signals.
  *c: An abbreviation for Analog/Digital conversion. It is a conversion from analog to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

System function schematic

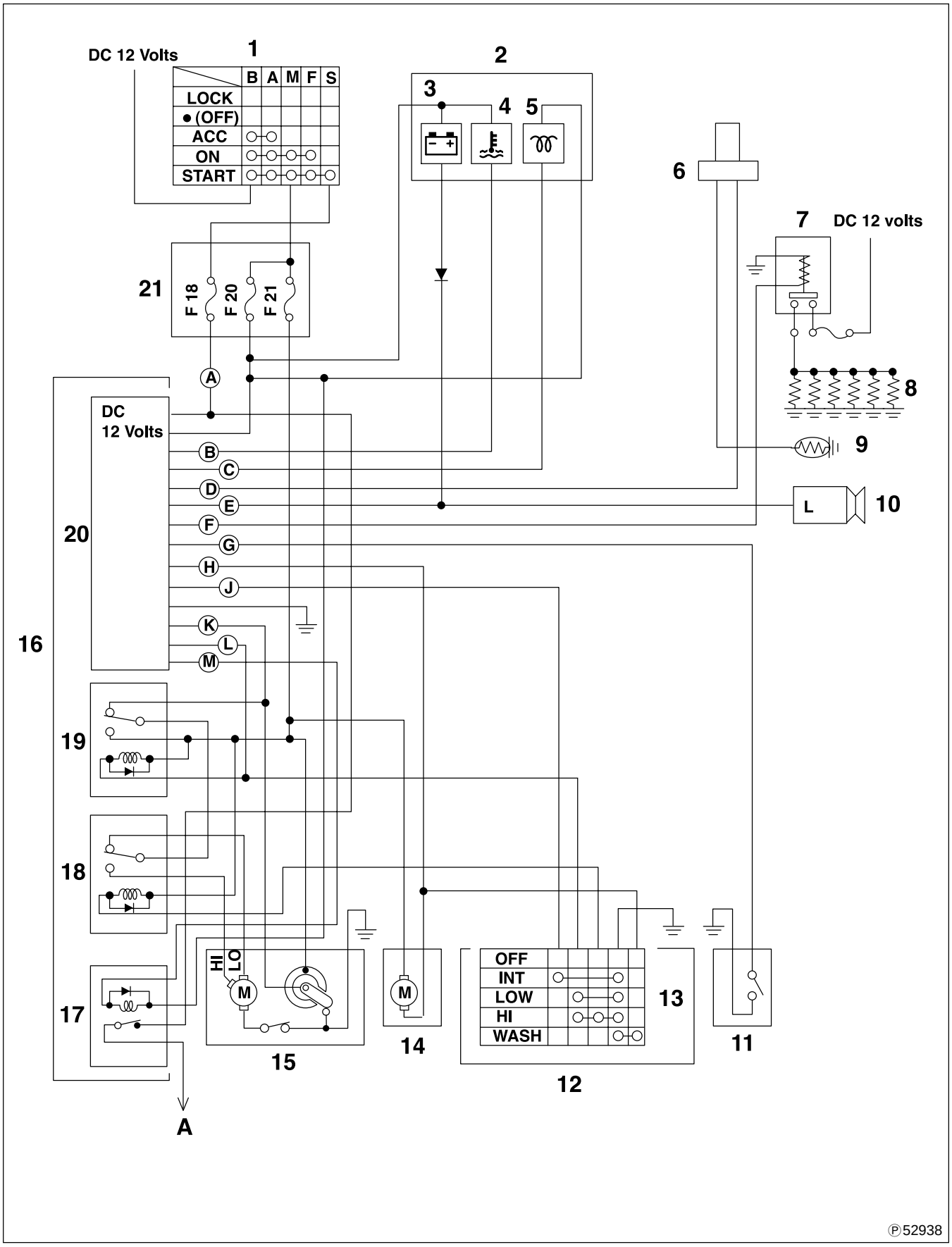




07504

Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Glow relay	11	—
2	Wiper cam switch	12	Water level warning lamp
3	Glow indicator lamp	13	Safety relay
4	Wiper relay	14	Ground
5	—	15	—
6	—	16	Alternator L terminal
7	Washer switch	17	—
8	—	18	Starter switch S terminal
9	Water temperature sensor	19	Wiper switch (INT)
10	+Va (starter switch M terminal)	20	Water level sensor

MUTIC (Multipurpose Timing Control Unit) Functional Circuit Diagram

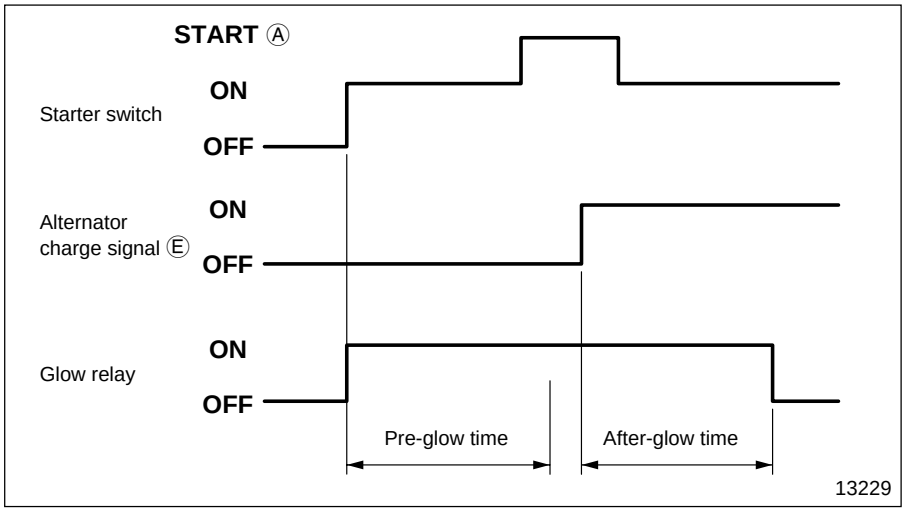


No.	Part name	Principal function sensors	Information signal
1	Starter switch	Start position detection	Ⓐ : Start signal
2	Meter cluster	—	—
3	Battery charge indicator lamp	—	—
4	Water level warning lamp	—	Ⓑ : Lamp ON signal
5	Enging preheating indicator lamp	—	Ⓒ : Lamp ON signal
6	Cold start switch connector	—	—
7	Glow relay	—	Ⓕ : Glow relay activation signal
8	Glow plug	—	—
9	Water temperature sensor	Detection of engine coolant temperature	Ⓓ : Engine coolant temperature signal
10	Alternator	Output of alternator charge signal	Ⓔ : Alternator charge signal
11	Water level sensor	Detection of engine coolant level	Ⓖ : Engine coolant level signal
12	Combination switch	—	—
13	Wiper and washer switch	—	Ⓙ : Intermittent wiper swich signal
14	Washer motor	—	Ⓗ : Washer switch signal
15	Wiper motor	—	Ⓚ : Wiper motor cam signal
16	Relay box	—	—
17	Safety relay	—	Ⓜ : Starter continuous-ON cancellation signal
18	Wiper relay (HIGH)	—	—
19	Wiper relay (LOW)	Intermittent wiper operation	Ⓛ : Wiper relay activation signal
20	MUTIC	—	—
21	Fuse box	—	—

A : To neutral start relay

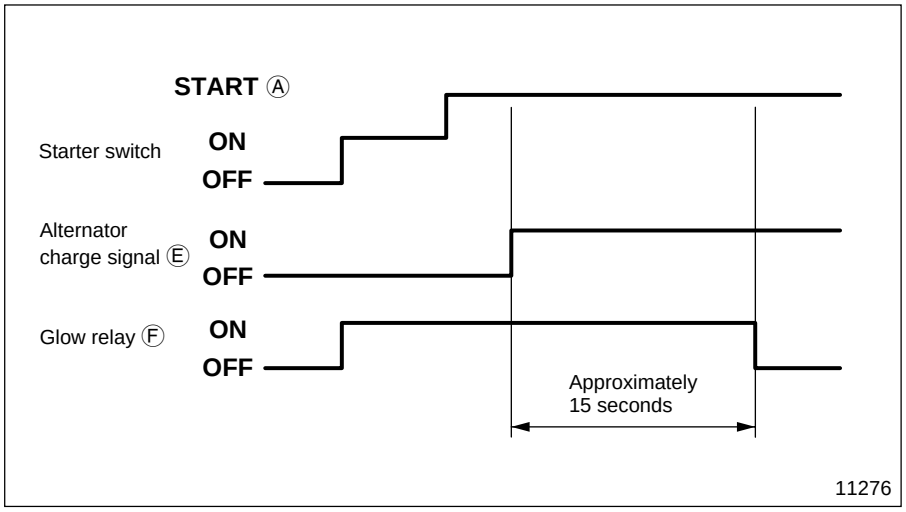
Preheating Function

This preheating function aims to enhance the engine start up when the engine coolant is low in cold weather or temperature.
MUTIC (Multipurpose Timing Control Unit) controls the entire function as follows:



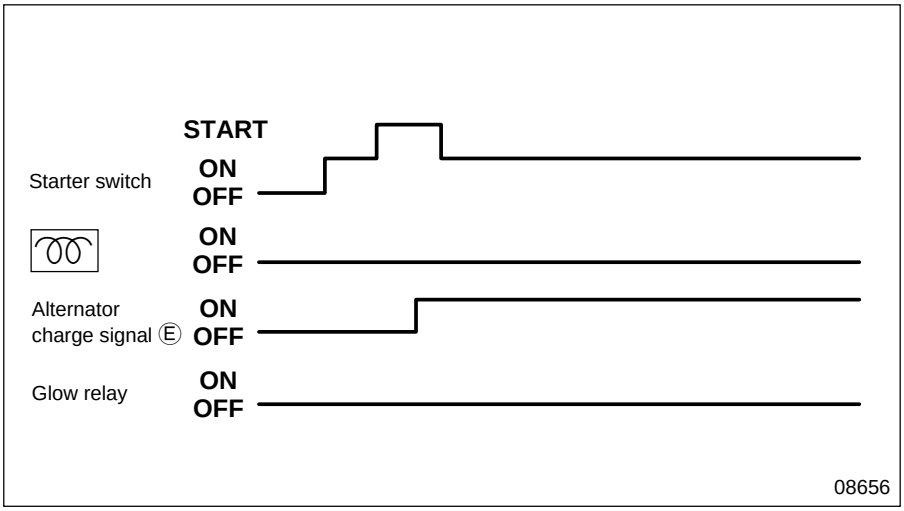
Pre-glow and After-glow

The preheating is operated with a pre-glow before the engine starting and an after-glow after the engine starting, which are controlled by the starter switch (S terminal) signal Ⓐ and the alternator (L terminal) signal Ⓔ.



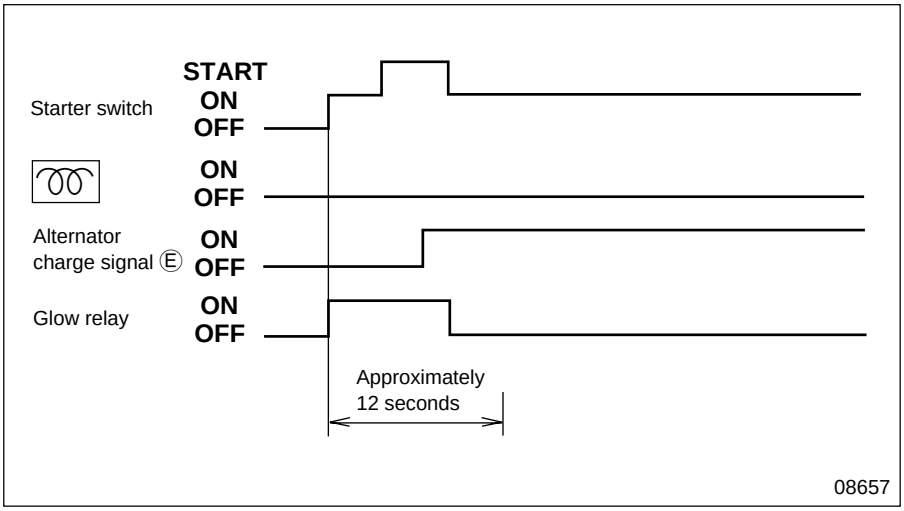
Fail Safe

- In case the contact point operating the glow relay in MUTIC has melted, the preheating indicator lamp flashes to warn this abnormality.
- Operation mode turns glow relay activation signal Ⓕ to OFF only after all the following conditions are met.
  - Where the engine coolant temperature is 60°C {140°F} or less.
  - Alternator (L terminal) signal Ⓔ is ON for 15 seconds continuously.
  - Starter switch (S terminal) signal Ⓐ is ON.

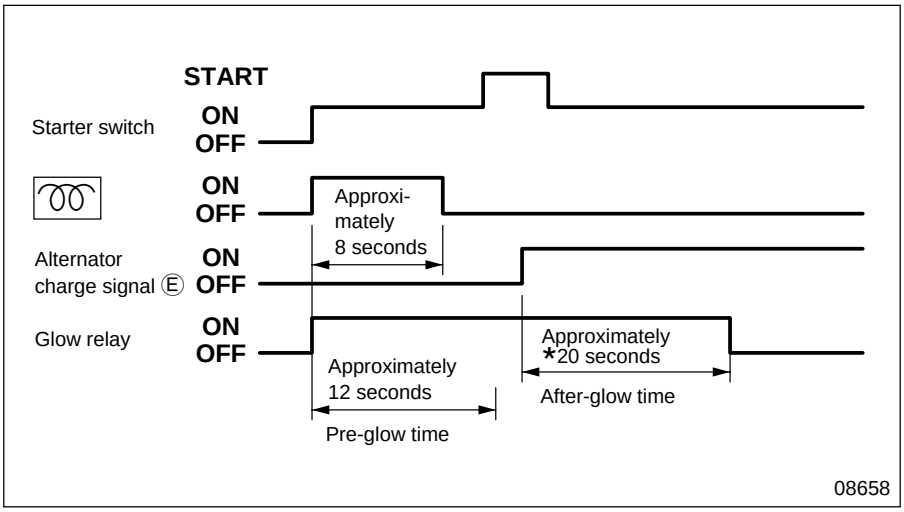


Operation mode

- Where the engine coolant temperature is 60°C {140°F} or more.



- Where the engine coolant temperature is 0 to 60°C {32 to 140°F}.
- Where the engine coolant temperature is aproximately 15 to 60°C {59 to 140°F} for production dated September 2002 onward.



- Where the engine coolant temperature is 0°C {32°F} or less.
- Where the engine coolant temperature is aproximately 15°C {59°F} or less for production dated September 2002 onward.

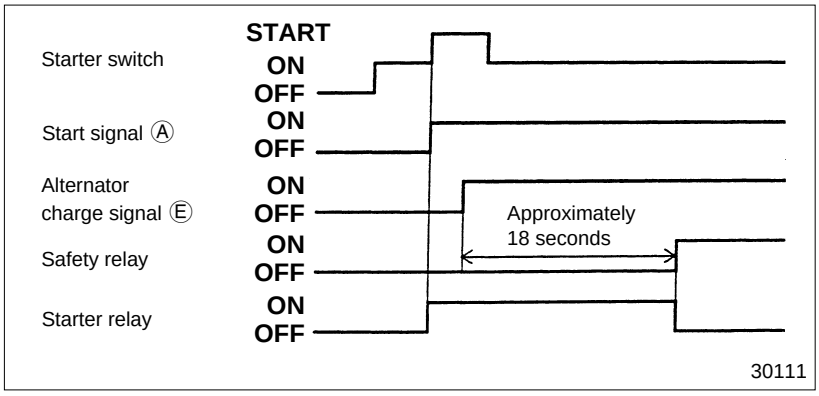
*: Approximately 180 seconds for production dated September 2002 onward.

Starter Continuous-ON Prevention Function

- This function prevents a starter overrun.
- If the starter continues to operate for more than a preset time after the engine starts, the MUTIC detects a starter continuous-ON condition, and stops the current to the starter and starter relay to prevent the starter from seizing.

When a preset time elapses after the engine starts, the safey relay is activated (opening of contact) by signal Ⓔ from the alternator (terminal L).

Operation mode



M E M O

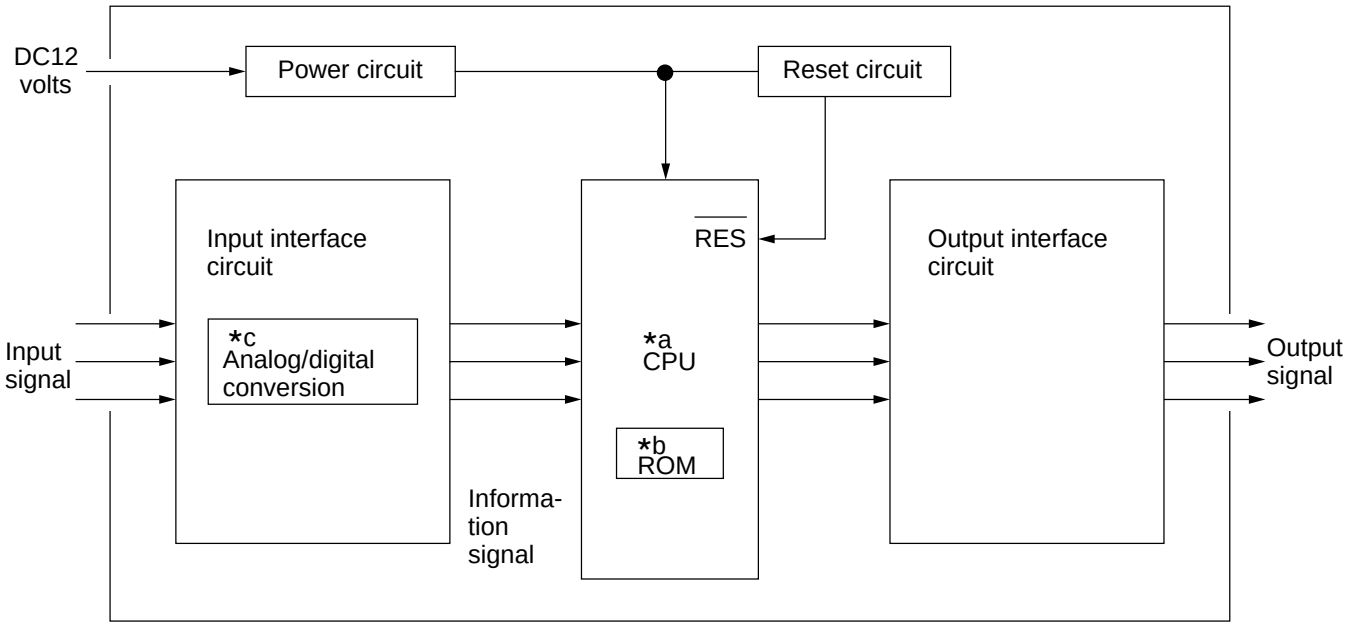
< FH210 >

- This control unit is an integrated control unit for controlling the following functions.

Preheating function	P54-0-28
Intermittent wiper activation function	P54-0-27
Starter continuous-ON prevention function	P54-0-30

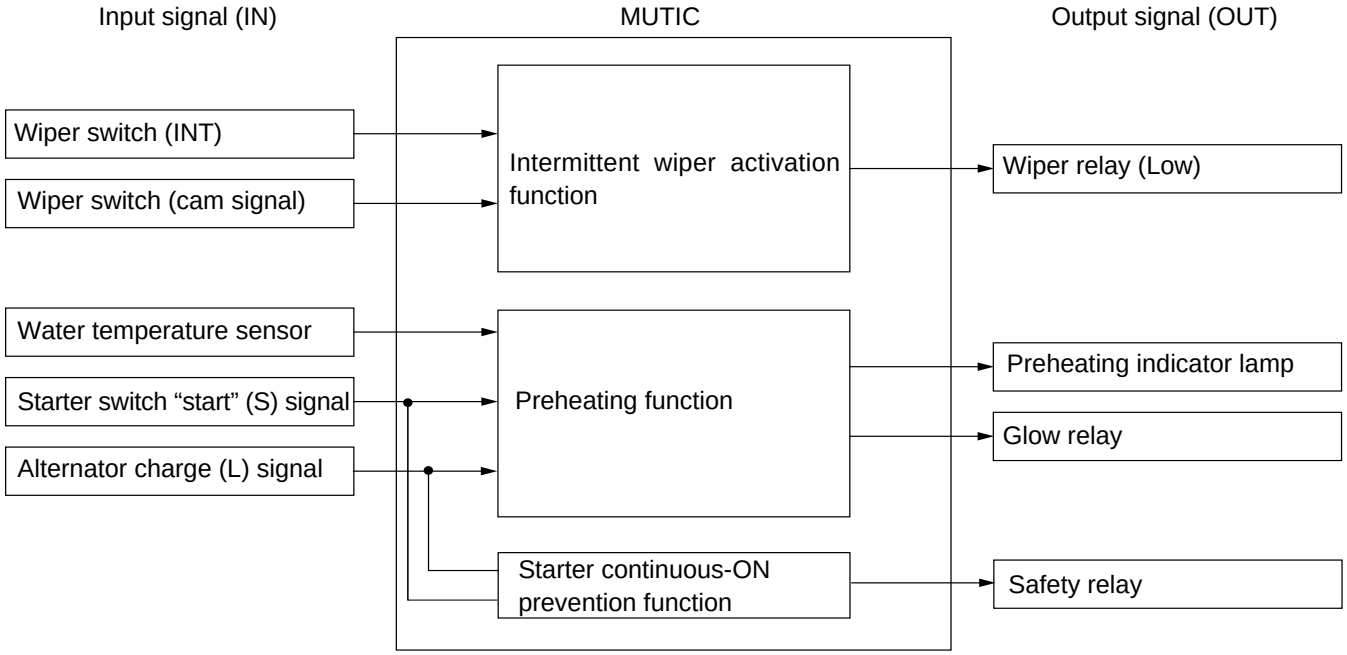
- For controlling each function, sensors and switches are needed as sources of information, and they are provided for respective systems.
- Based on the information provided by the sensors and switches, the MUTIC controls above functions by means of the circuits inside itself.

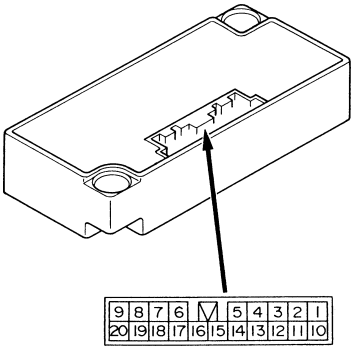
● **Internal structure of MUTIC**



- The MUTIC is internally made up roughly of the input interface circuit, CPU*a, ROM*b, and output interface circuit.
  *a: An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM and makes a decision and sends commands to the outputs.
  *b: An abbreviation for Read-Only Memory. It is an element used exclusively to have its contents read. It stores fixed data and program, and such retained information is not deleted even after power is cut off.
- Information sources such as sensor, switch send input signal to the input interface circuit.
- The input interface circuit performs A/D conversion*c of the input signals, and the converted signals are transmitted to the CPU as information signals.
  *c: An abbreviation for Analog/Digital conversion. It is a conversion from analog to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

System function schematic

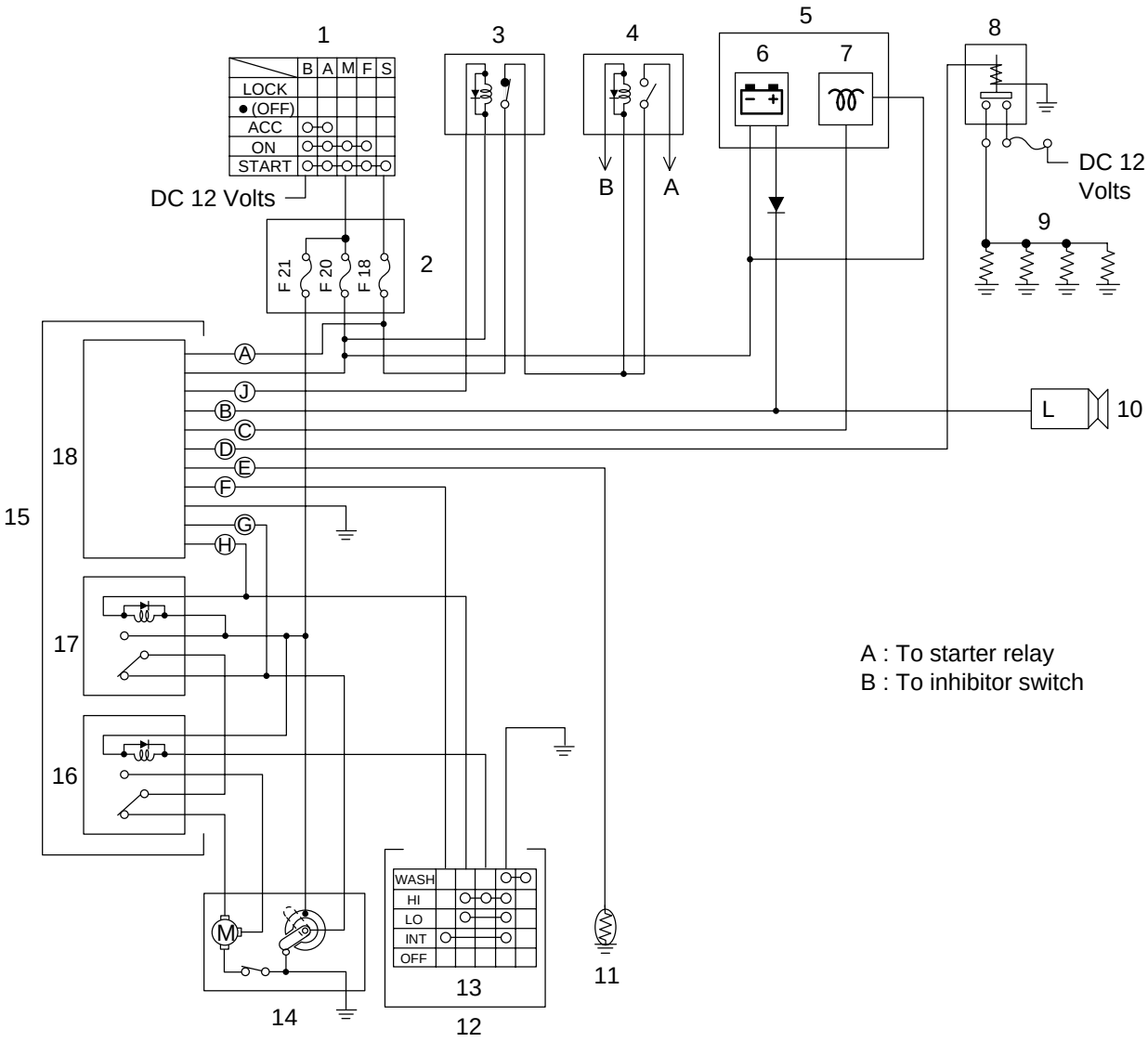




07504

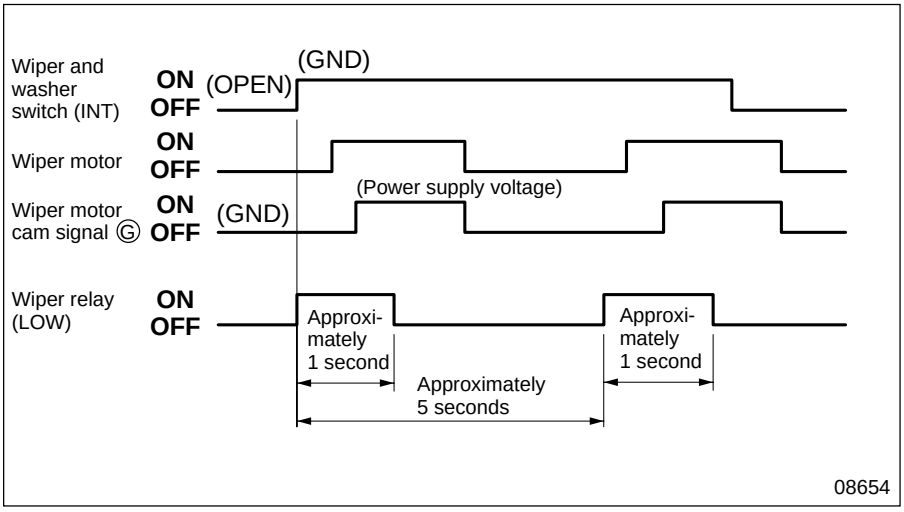
Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Glow relay	11	—
2	Wiper cam switch	12	—
3	Glow indicator lamp	13	Safety relay
4	Wiper relay	14	Ground
5	—	15	—
6	—	16	Alternator L terminal
7	Washer switch	17	—
8	—	18	Starter switch S terminal
9	Water temperature sensor	19	Wiper switch (INT)
10	+Va (starter switch M terminal)	20	—

MUTIC (Multipurpose Timing Control Unit) Functional Circuit Diagram



No.	Part name	Principal function sensors	Information signal
1	Starter switch	Start position detection	Ⓐ : Start signal
2	Fuse box	—	—
3	Safety relay	—	Ⓙ : Starter continuous-ON cancellation signal
4	Neutral start relay	—	—
5	Meter cluster	—	—
6	Battery charge indicator lamp	—	—
7	Engine preheating indicator lamp	—	Ⓒ : Lamp ON signal
8	Glow relay	—	Ⓓ : Glow relay activation signal
9	Glow plug	—	—
10	Alternator	Output of alternator charge signal	Ⓑ : Alternator charge signal
11	Water temperature sensor	Engine water temperature	Ⓔ : Engine water temperature signal
12	Combination switch	—	—
13	Wiper and washer switch	—	Ⓕ : Wiper interval switch signal
14	Wiper motor	—	Ⓖ : Wiper motor cam signal
15	Relay box	—	—
16	Wiper relay (HIGH)	—	—
17	Wiper relay (LOW)	Wiper intermittent operation	Ⓗ : Wiper relay activation signal
18	MUTIC	—	—

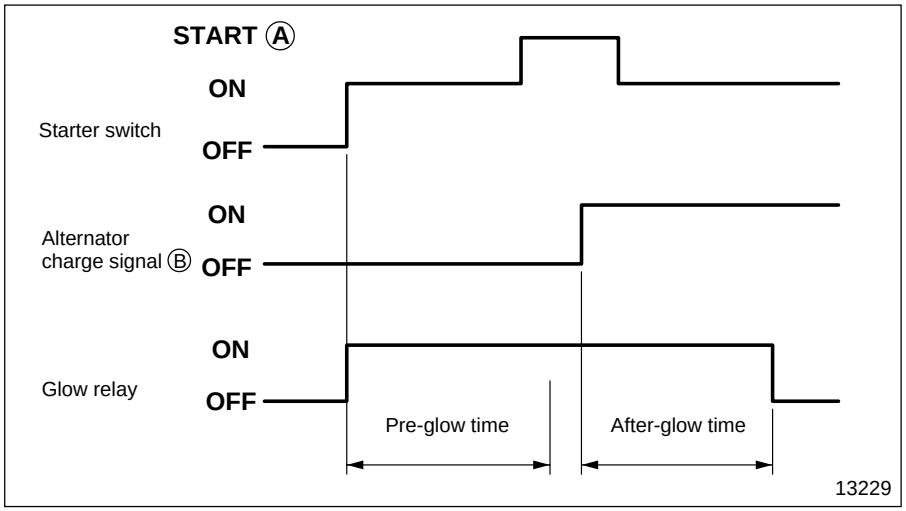
Intermittent Wiper Activation Function



The operation of intermittent wiper is controlled by MUTIC in a mode as shown.

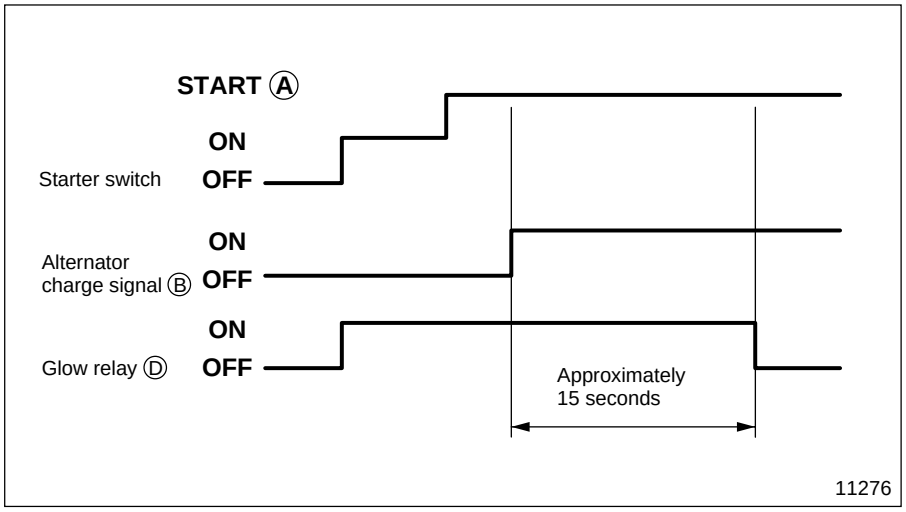
Preheating Function

This preheating function aims to enhance the engine start up when the engine coolant is low in cold weather or temperature.
MUTIC (Multipurpose Timing Control Unit) controls the entire function as follows:



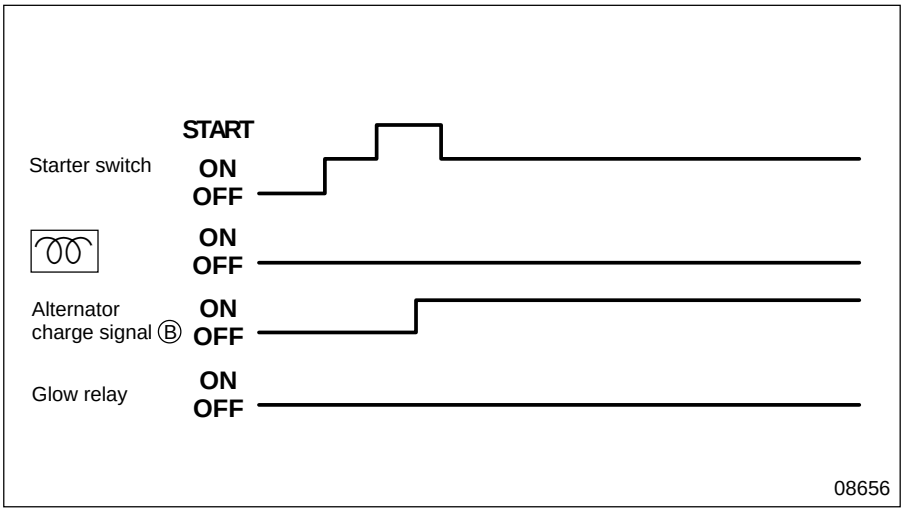
Pre-glow and After-glow

The preheating is operated with a pre-glow before the engine starting and an after-glow after the engine starting, which are controlled by the starter switch (S terminal) signal Ⓐ and the alternator (L terminal) signal Ⓑ.



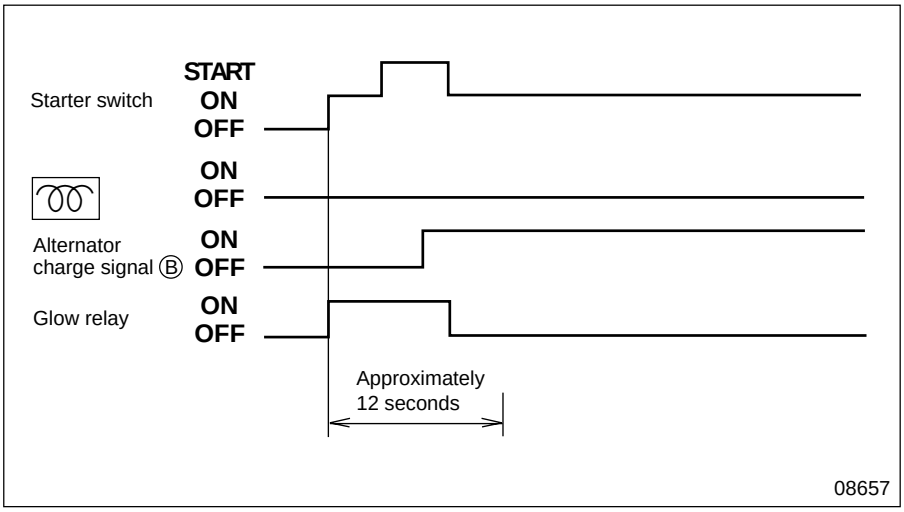
Fail Safe

- In case the contact point operating the glow relay in MUTIC has melted, the preheating indicator lamp flashes to warn this abnormality.
- Operation mode turns glow relay activation signal Ⓓ to OFF only after all the following conditions are met.
  - Where the engine coolant temperature is 60°C {140°F} or less.
  - Alternator (L terminal) signal Ⓑ is ON for 15 seconds continuously.
  - Starter switch (S terminal) signal Ⓐ is ON.

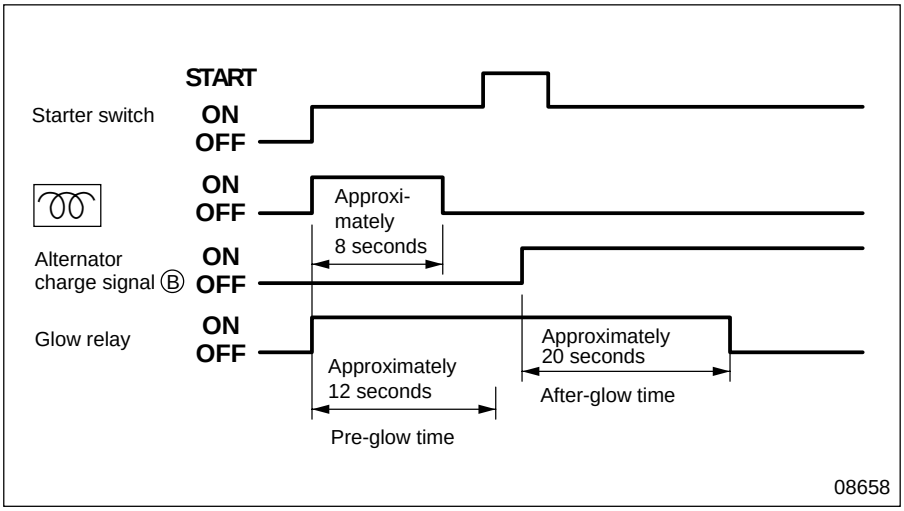


Operation mode

- Where the engine coolant temperature is 60°C {140°F} or more.



- Where the engine coolant temperature is 0 to 60°C {32 to 140°F}.



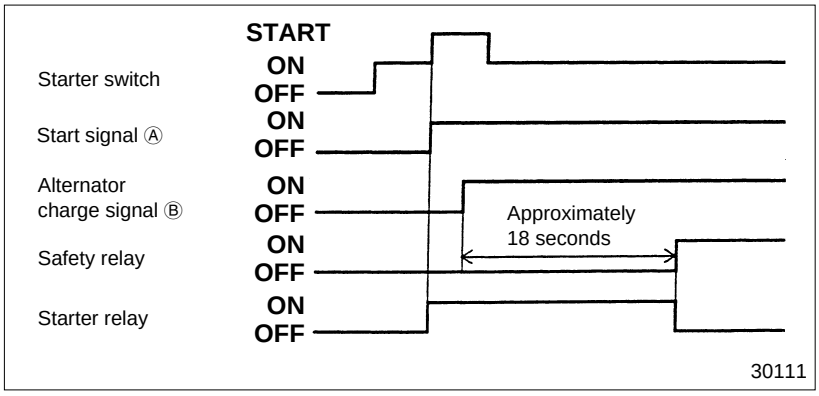
- Where the engine coolant temperature is 0°C {32°F} or less.

Starter Continuous-ON Prevention Function

- This function prevents a starter overrun.
- If the starter continues to operate for more than a preset time after the engine starts, the MUTIC detects a starter continuous-ON condition, and stops the current to the starter and starter relay to prevent the starter from seizing.

When a preset time elapses after the engine starts, the safey relay is activated (opening of contact) by signal Ⓑ from the alternator (terminal L).

Operation mode



M E M O

TROUBLESHOOTING

Power and charging

Symptoms / Possible causes		Battery electrolyte decreases too early	Battery overheating	Battery is normal but overdischarged	Charge warning lamp does not light when starter switch is turned ON, with engine stopped	Alternator is normal but battery overdischarged	Remarks
Defective connector connection, harness open/short circuit, defective grounding				○		○	
Fuse blown				○	○	○	
V-belts loose				○		○	Gr 14
V-belts damaged				○		○	Gr 14
Battery faulty		○				○	
Alternator	Stator coil broken			○			
	Stator coil short-circuited with core			○			
	Field coil faulty			○			
	Rectifier faulty			○			
	Regulator faulty		○	○	○		
	Wiring faulty			○			
Meter cluster faulty					○		

Engine starting, preheating and stopping

Symptoms / Possible causes		Starter does not operate	Starter operates but engine does not start: Pinion does not engage with ring gear	Starter operates but engine does not start: Pinion engages with ring gear but does not rotate	Starter operates but engine does not start: Flywheel rotates but engine does not start	Engine does not stop	Engine cannot be preheated	Engine is hard to start	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○			○	○	○		
High-current fuse blown		○							
Fuse blown		○				○	○		
Battery insufficiently charged		○		○					
Starter	Magnetic switch contacts stuck or fused together	○							
	Open circuit in magnetic switch coil	○							
	Overrunning clutch malfunctioning			○					
	Pinion worn or damaged		○						
Starter relay defective		○							
Starter switch defective		○				○			
Flywheel ring gear worn or damaged			○						Gr 11
Glow plugs defective							○	○	
Glow relay defective							○	○	
Water temperature sensor defective							○	○	
MUTIC (control unit) defective		○					○	○	
Faulty connection of connecting plate							○	○	Gr 11
Transmission neutral switch faulty < M/T >		○							
Transmission neutral relay faulty < M/T >		○							
Neutral start relay faulty		○							
Inhibitor switch faulty < A/T (4M5) >		○							
Safety relay faulty		○							
Engine electronic control unit faulty									Gr 13E

A/T : Automatic transmission
M/T : Manual transmission

TROUBLESHOOTING

Lighting

Symptoms / Possible causes		Headlamp: Does not light	Headlamp: Dim	Headlamp: Does not switch to main beam	Headlamp: Does not switch to dipped beam	Tail lamp does not light	Stop lamp does not light	Clearance lamp does not light	License plate lamp does not light	Backup lamp does not light	Back buzzer does not sound	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○				○	○	○	○	○	○	
Fuse blown		○				○	○	○	○	○	○	
Battery capacity insufficient			○									
Alternator output insufficient			○									
Bulb burnt-out		○				○	○	○	○	○	○	
Power (wattage) of bulb is lower than specified value												
Power (wattage) of bulb is higher than specified value												
Combination switch	Lighting switch faulty	○				○		○	○	○		
	Turn signal lamp switch faulty											
	Dimmer switch faulty			○	○							
	Hazard warning lamp switch faulty											
Relay box	Headlamp relay (HIGH, LOW) faulty	○		○	○							
	Tail lamp relay faulty					○		○	○	○		
	Flasher unit faulty											
Stop lamp switch faulty							○					
Backup lamp switch faulty										○	○	
Back buzzer faulty											○	
Cab lamp switch faulty												
Cab lamp faulty												
Door switch faulty												
Rheostat switch faulty												
Tail lamp bulb burnt-out											○	

Symptoms / Possible causes		Turn signal lamp (also used as hazard)					Cab lamp does not light	Interior illumination lamps for meters, heater control panel, etc. cannot be adjusted	Marker lamp does not light	Remarks
		Does not blink	Stays ON	Blinks too slowly	Blinks too quickly	Blinks irregularly				
Defective connector connection, harness open/short circuit, defective grounding		○					○	○	○	
Fuse blown		○					○		○	
Battery capacity insufficient			○							
Alternator output insufficient			○							
Bulb burnt-out		○			○			○	○	
Power (wattage) of bulb is lower than specified value					○					
Power (wattage) of bulb is higher than specified value				○						
Combination switch	Lighting switch faulty								○	
	Turn signal lamp switch faulty									
	Dimmer switch faulty									
	Hazard warning lamp switch faulty	○	○							
Relay box	Headlamp relay (HIGH, LOW) faulty									
	Tail lamp relay faulty							○	○	
	Flasher unit faulty	○	○	○	○	○				
Stop lamp switch faulty										
Backup lamp switch faulty										
Back buzzer faulty										
Cab lamp switch faulty							○			
Cab lamp faulty						○				
Door switch faulty							○			
Rheostat switch faulty								○		

Lighting

Symptoms / Possible causes		Van body dome light does not light	Daytime running light system does not operate after engine starts, and headlamps do not light	Identification lamp does not light	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○	○	
Fuse blown		○		○	
Battery capacity insufficient					
Alternator output insufficient			○		
Bulb burnt-out		○	○	○	
Power (wattage) of bulb is lower than specified value					
Power (wattage) of bulb is higher than specified value					
Combination switch	Lighting switch faulty	○			
	Turn signal lamp switch faulty				
	Dimmer switch faulty				
	Hazard warning lamp switch faulty				
Relay box	Headlamp relay (HIGH, LOW) faulty	○	○		
	Tail lamp relay faulty			○	
	Flasher unit faulty				
Van body dome light relay faulty		○			
Van body dome light switch faulty		○			
Daytime running light electronic control unit faulty			○		

Meter

Possible causes \ Symptoms		Pointer does not move	Pointer movement unstable	Indication error large	Abnormal noise from meter	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○			
Fuse blown		○				
Internal circuits of meter cluster faulty		○	○	○		
Printed wiring board of meter cluster faulty		○				
Tachometer	Engine speed sensor coil open-circuited	○				
	Engine speed sensor improperly mounted	○	○			Gr 11, 13E
	Tachometer faulty	○	○	○	○	
	Engine electronic control unit faulty	○	○	○		Gr 13E
Speedometer	Vehicle speed sensor faulty	○				
	Vehicle speed sensor improperly mounted		○			
	Specified tires not used			○		Gr 31
	Tires worn or inflation pressure incorrect			○		Gr 31
	Specified L-joint of transmission not used (Different in gear ratio)			○		Gr 22
	Specified speedometer gear of transmission not used (Different in gear ratio)			○		Gr 22
	Installation angle of speedometer gear bushing on transmission incorrect (Not set at correct gear ratio position)			○		Gr 22
	Speedometer faulty	○	○	○	○	
Water temperature gauge	Water temperature sensor faulty	○		○		
	Water temperature gauge faulty	○		○		
	Thermostat does not close	○				Gr 14
Fuel gauge	Fuel level sensor faulty	○		○		

Cigarette lighter and Audio

Symptoms / Possible causes	Cigarette lighter			Audio					Remarks
	Does not glow	Does not return	Night lamp does not light up	Specific frequency band does not work	Spurious noise generated	Sound quality poor	Sound from one side only	Left and right volume different	
Defective connector connection, harness open/short circuit, defective grounding	○		○		○		○		
Fuse blown	○		○						
Cigarette lighter faulty	○	○							
Tail lamp relay faulty			○						
Antenna and antenna cable connection faulty					○				
Speaker faulty				○	○	○	○	○	
Left and right speaker impedance different								○	

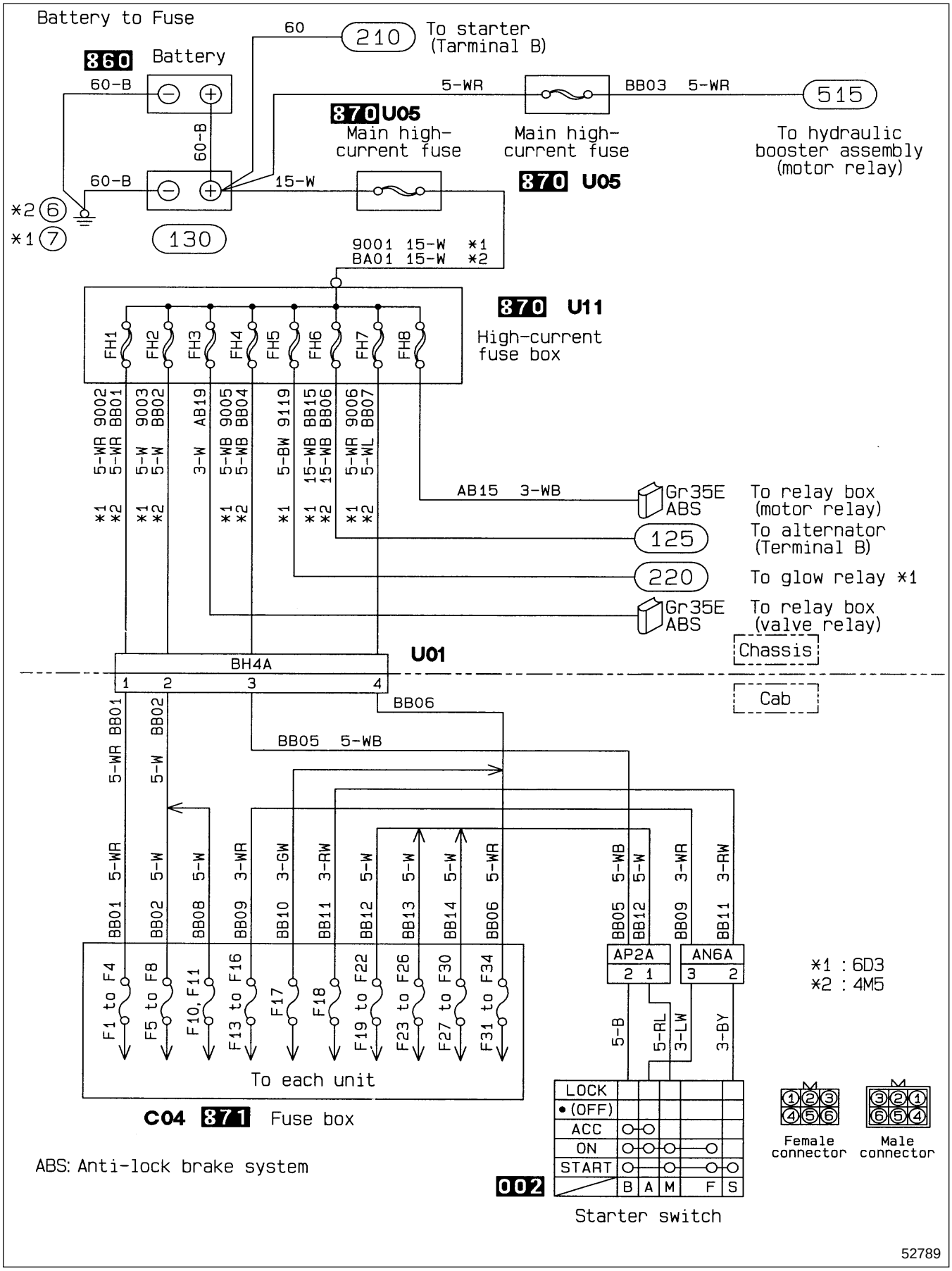
Accessory noise generation source

Accessory	Noise	Symptoms
Alternator	Whistling	High pitch sound when accelerator pedal suddenly depressed (Stops soon after engine stopped)
Water temperature gauge	Scratching	Occurs when engine running (Continues for a while after engine stops)
Engine oil pressure switch	Rattling	Depends on engine speed (Does not occur during idling)
Fuel level sensor	Scratching	Occurs when engine suddenly revved, while running on rough roads, or starter switch turned ON
Flasher unit	Banging	When turn signal blinks
Horn	Hissing	Occurs when horn button pressed or released
Wiper motor	Whining	Depends on wiper speed
Windshield washer motor	Whining	When windshield washer operates

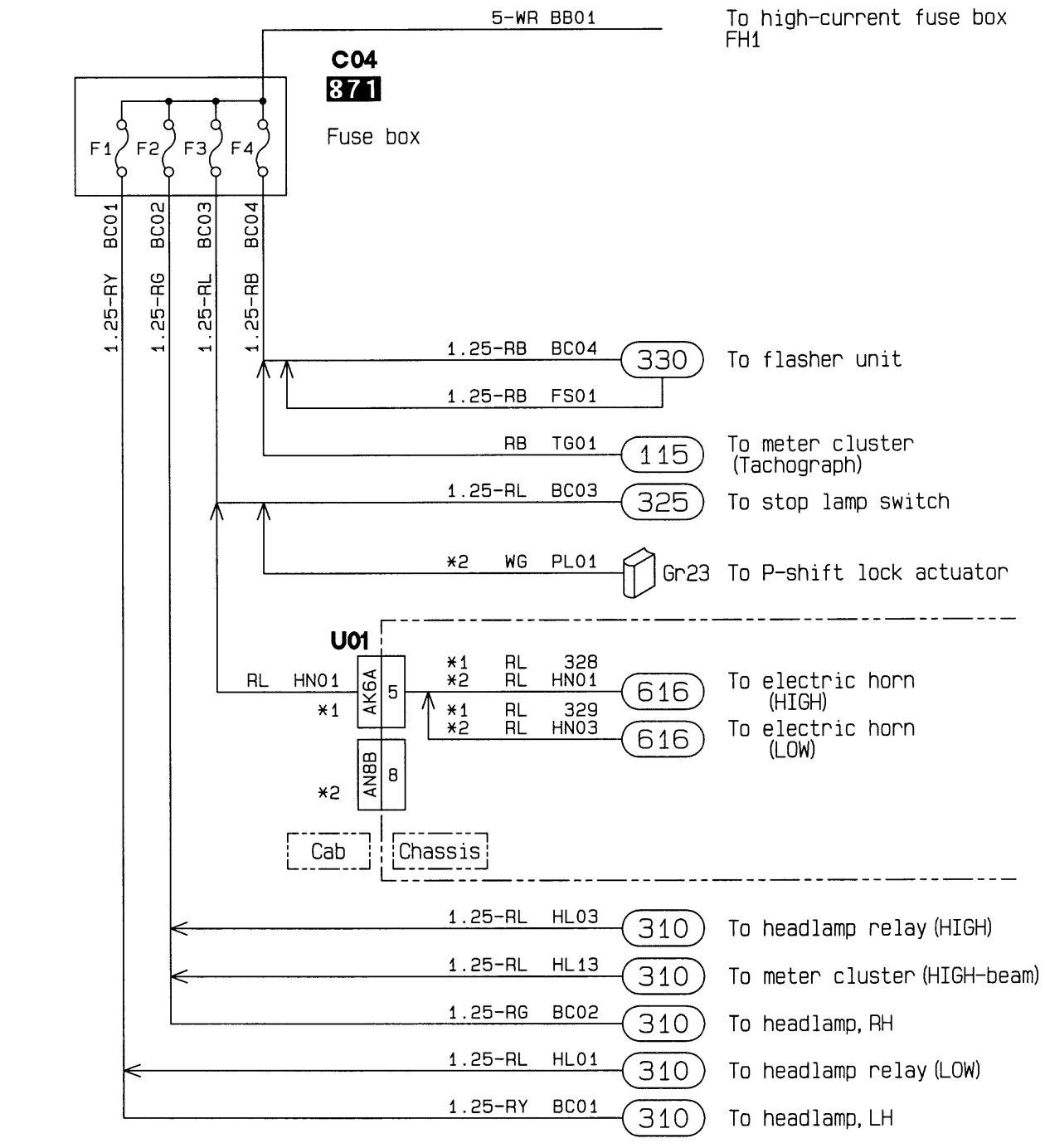
Horn

Symptoms / Possible causes	Horn				Remarks
	No Sound	Continuous sound	Small sound	Sound quality poor	
Defective connector connection, harness open/short circuit, defective grounding	○				
Fuse blown	○				
Horn switch faulty	○	○			
Horn faulty	○		○	○	
Horn stay warped			○	○	
Battery voltage insufficient	○		○		

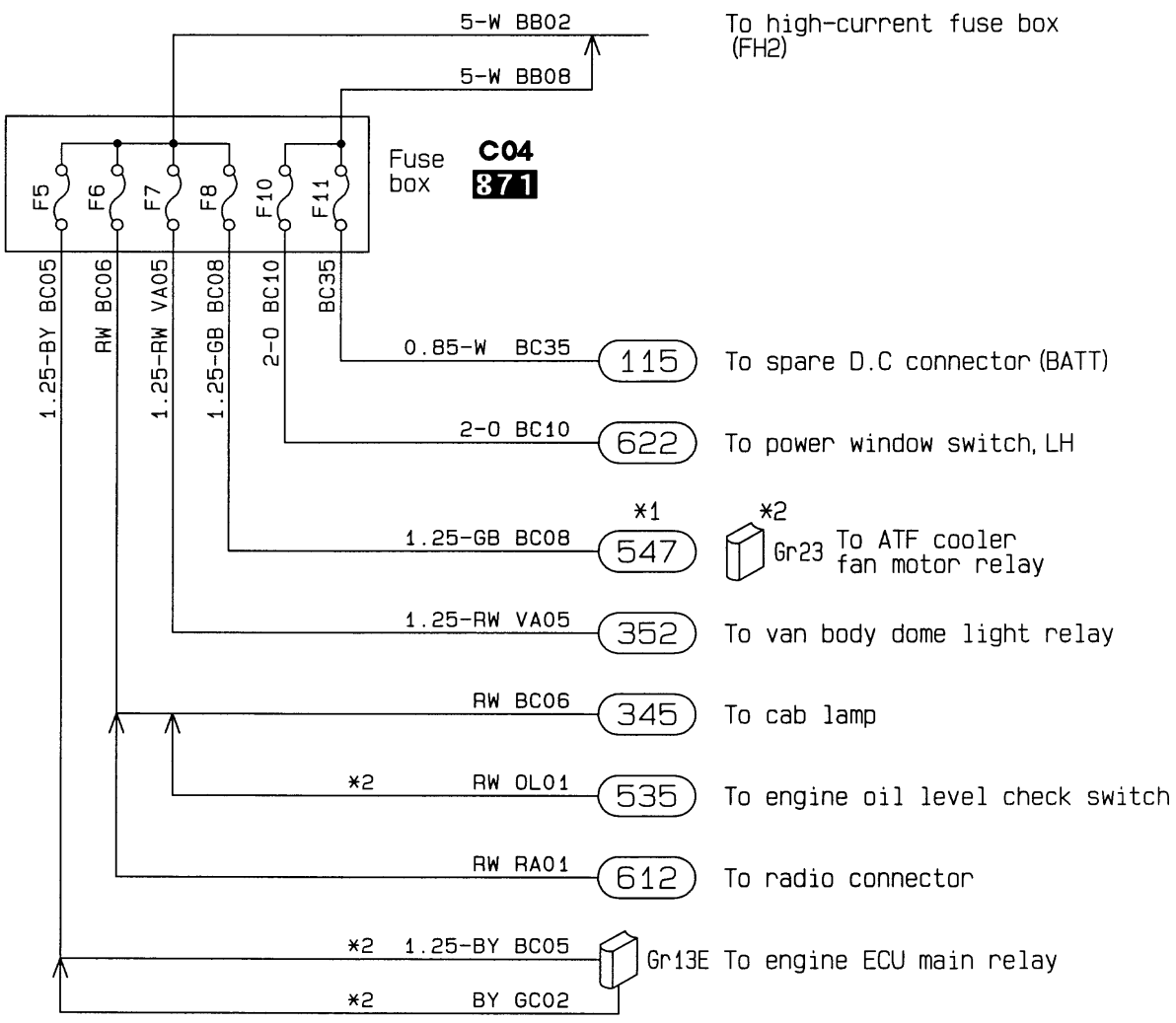
1 POWER, CHARGE AND GROUND CIRCUIT


Battery to Fuse
60
210
To starter
(Tarminal B)
860
Battery
60-B
5-WR
BB03 5-WR
515
870 U05
Main high-current fuse
Main high-current fuse
To hydraulic booster assembly (motor relay)
870 U05
60-B
15-W
*2 6
*1 7
130
9001 15-W *1
BA01 15-W *2
870 U11
High-current fuse box
FH1
FH2
FH3
FH4
FH5
FH6
FH7
FH8
5-WR 9002 *1
5-WR BB01 *2
5-W 9003 *1
5-W BB02 *2
3-W AB19 *1
5-WB 9005 *1
5-WB BB04 *2
5-BW 9119 *1
15-WB BB15 *1
15-WB BB06 *2
5-WR 9006 *1
5-WL BB07 *2
AB15 3-WB
Gr35E ABS
To relay box (motor relay)
125
To alternator (Terminal B)
220
To glow relay *1
Gr35E ABS
To relay box (valve relay)
Chassis
U01
BH4A
1 2 3 4
Cab
BB06
BB05 5-WB
5-WR BB01
5-W BB02
BB01 5-WR
BB02 5-W
BB08 5-W
BB09 3-WR
BB10 3-GW
BB11 3-RW
BB12 5-W
BB13 5-W
BB14 5-W
BB06 5-WR
BB05 5-WB
BB12 5-W
BB09 3-WR
BB11 3-RW
AP2A
2 1
AN6A
3 2
*1 : 6D3
*2 : 4M5
F1 to F4
F5 to F8
F10, F11
F13 to F16
F17
F18
F19 to F22
F23 to F26
F27 to F30
F31 to F34
To each unit
5-B
5-RL
3-LW
3-BY
C04 871 Fuse box
LOCK
• (OFF)
ACC
ON
START
B A M F S
002
Starter switch
Female connector
Male connector
ABS: Anti-lock brake system
52789

Fuse F1 to F4


5-WR BB01
To high-current fuse box FH1
C04
871
Fuse box
F1
F2
F3
F4
1.25-RY BC01
1.25-RG BC02
1.25-RL BC03
1.25-RB BC04
1.25-RB BC04
330
To flasher unit
1.25-RB FS01
RB TG01
115
To meter cluster (Tachograph)
1.25-RL BC03
325
To stop lamp switch
*2 WG PL01
Gr23
To P-shift lock actuator
U01
RL HN01
*1
AK6A
5
*1 RL 328
*2 RL HN01
616
To electric horn (HIGH)
*1 RL 329
*2 RL HN03
616
To electric horn (LOW)
AN8B
8
*2
Cab
Chassis
1.25-RL HL03
310
To headlamp relay (HIGH)
1.25-RL HL13
310
To meter cluster (HIGH-beam)
1.25-RG BC02
310
To headlamp, RH
1.25-RL HL01
310
To headlamp relay (LOW)
1.25-RY BC01
310
To headlamp, LH
Female connector
Male connector
*1 : 6D3
*2 : 4M5
52790

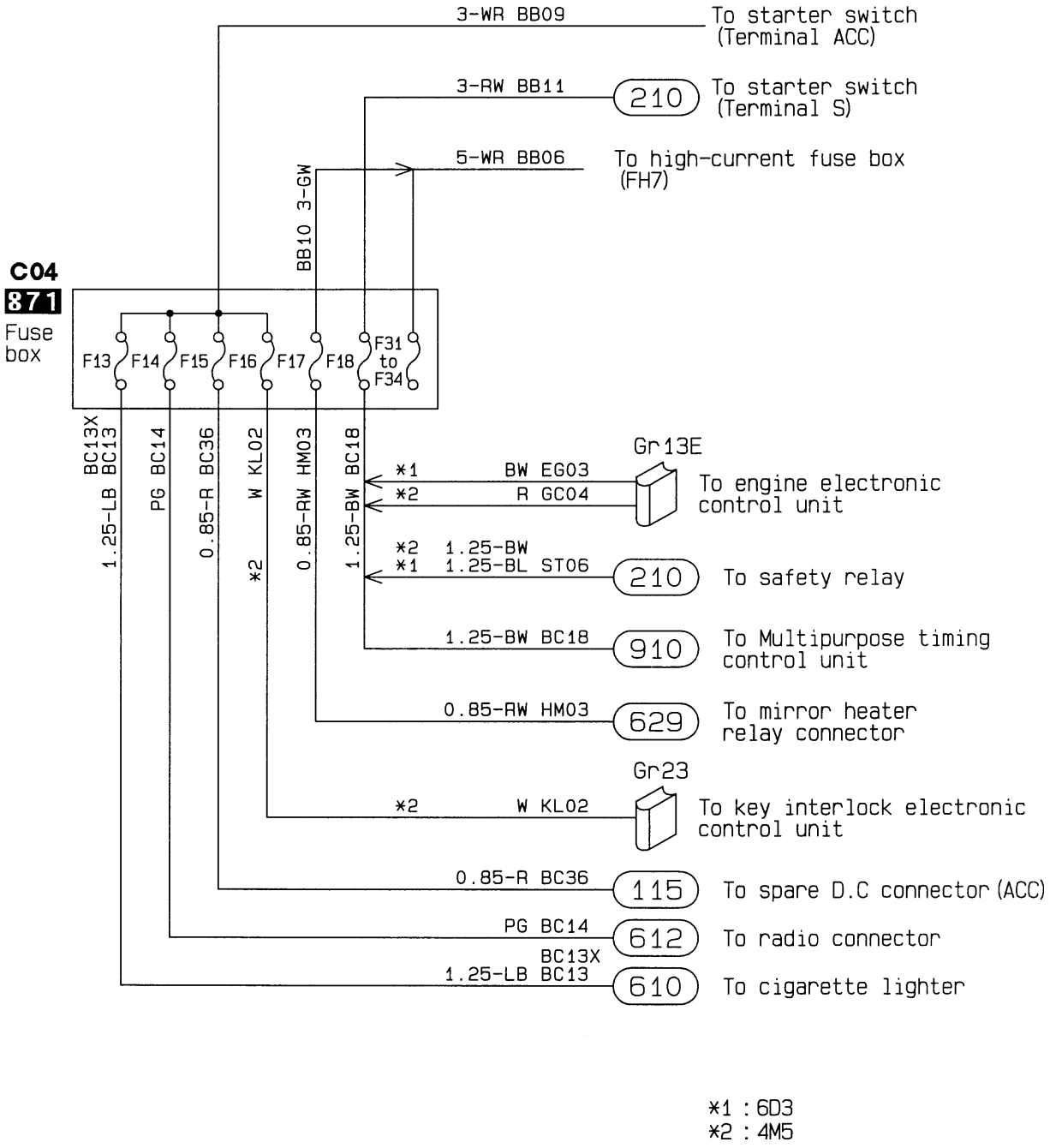
Fuse F5 to F11



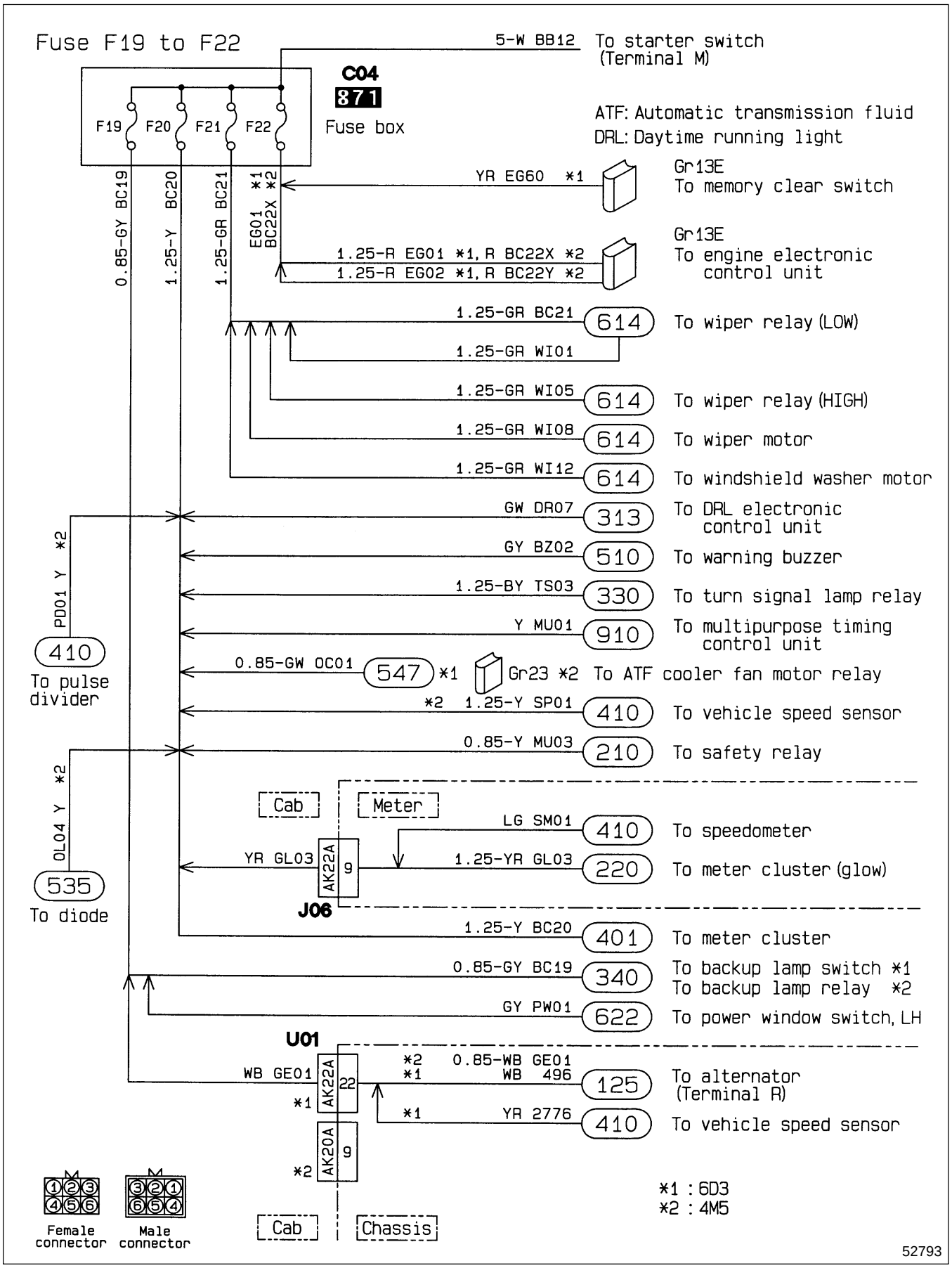
ATF : Automatic transmission fluid
ECU : Electronic control unit
*1 : 6D3
*2 : 4M5

52791

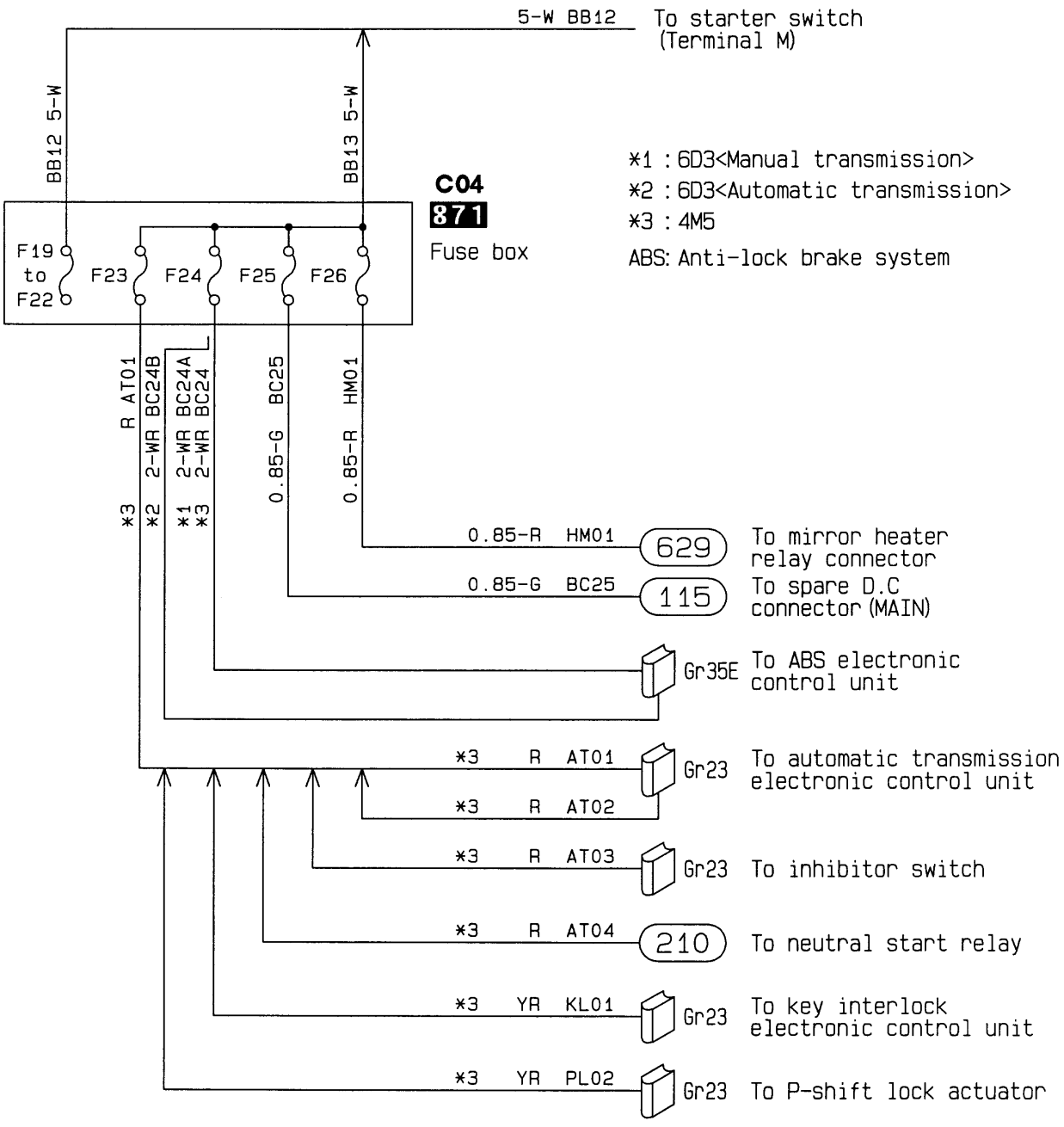
Fuse F13 to F18



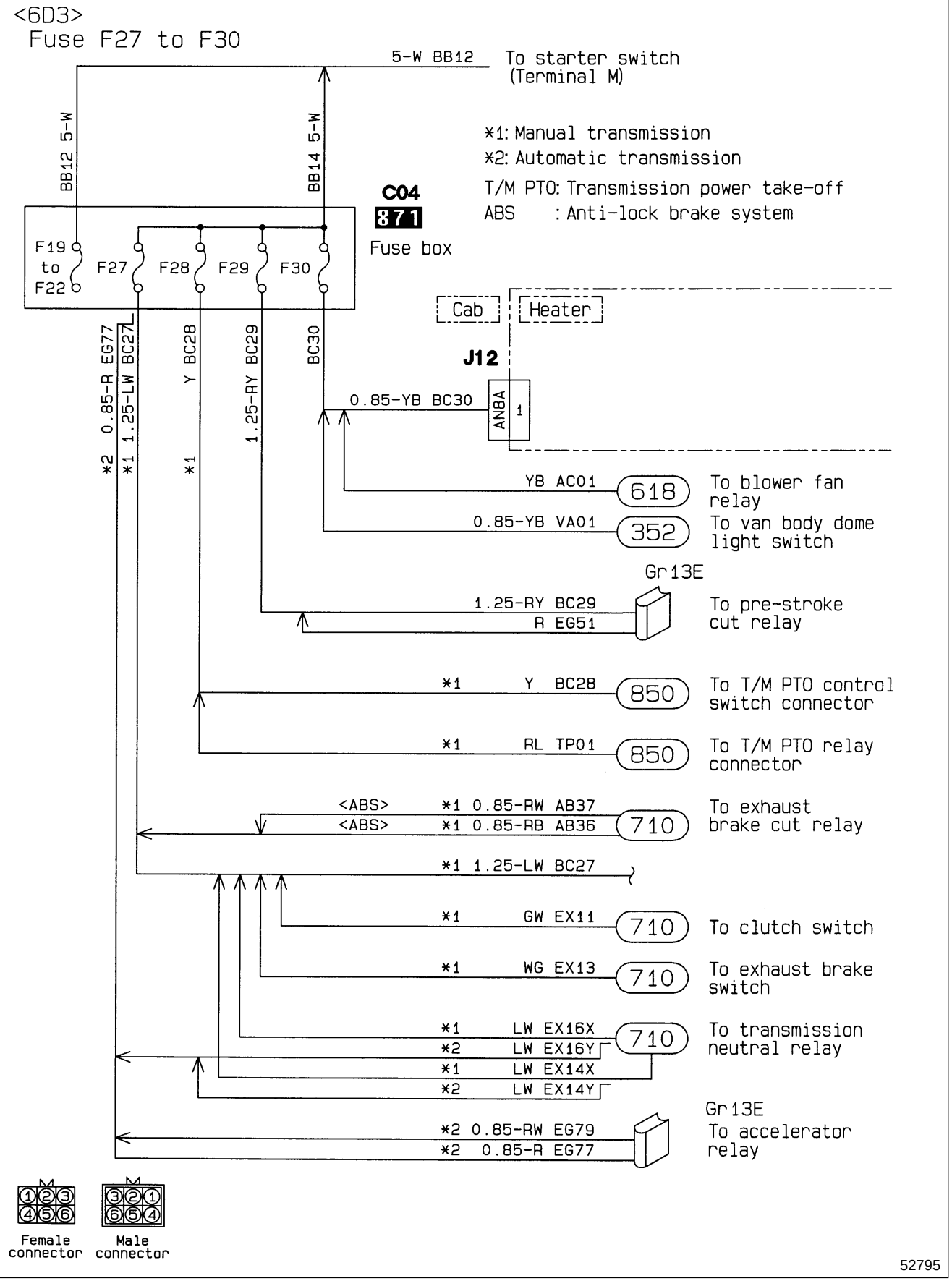
52792


Fuse F19 to F22
5-W BB12
To starter switch (Terminal M)
C04
871
Fuse box
F19
F20
F21
F22
ATF: Automatic transmission fluid
DRL: Daytime running light
0.85-GY BC19
1.25-Y BC20
1.25-GR BC21
EG01 *1 BC22X *2
YR EG60 *1
Gr13E
To memory clear switch
1.25-R EG01 *1, R BC22X *2
1.25-R EG02 *1, R BC22Y *2
Gr13E
To engine electronic control unit
1.25-GR BC21
614
To wiper relay (LOW)
1.25-GR WI01
1.25-GR WI05
614
To wiper relay (HIGH)
1.25-GR WI08
614
To wiper motor
1.25-GR WI12
614
To windshield washer motor
GW DR07
313
To DRL electronic control unit
GY BZ02
510
To warning buzzer
1.25-BY TS03
330
To turn signal lamp relay
Y MU01
910
To multipurpose timing control unit
PD01 Y *2
410
To pulse divider
0.85-GW OC01
547
*1
Gr23 *2
To ATF cooler fan motor relay
*2 1.25-Y SP01
410
To vehicle speed sensor
0.85-Y MU03
210
To safety relay
OL04 Y *2
535
To diode
Cab
Meter
LG SM01
410
To speedometer
YR GL03
AK22A
9
1.25-YR GL03
220
To meter cluster (glow)
J06
1.25-Y BC20
401
To meter cluster
0.85-GY BC19
340
To backup lamp switch *1
To backup lamp relay *2
GY PW01
622
To power window switch, LH
U01
WB GE01
AK22A
22
*2 0.85-WB GE01
*1 WB 496
125
To alternator (Terminal R)
*1
*1 YR 2776
410
To vehicle speed sensor
AK20A
9
*2
*1 : 6D3
*2 : 4M5
Female connector
Male connector
Cab
Chassis
52793

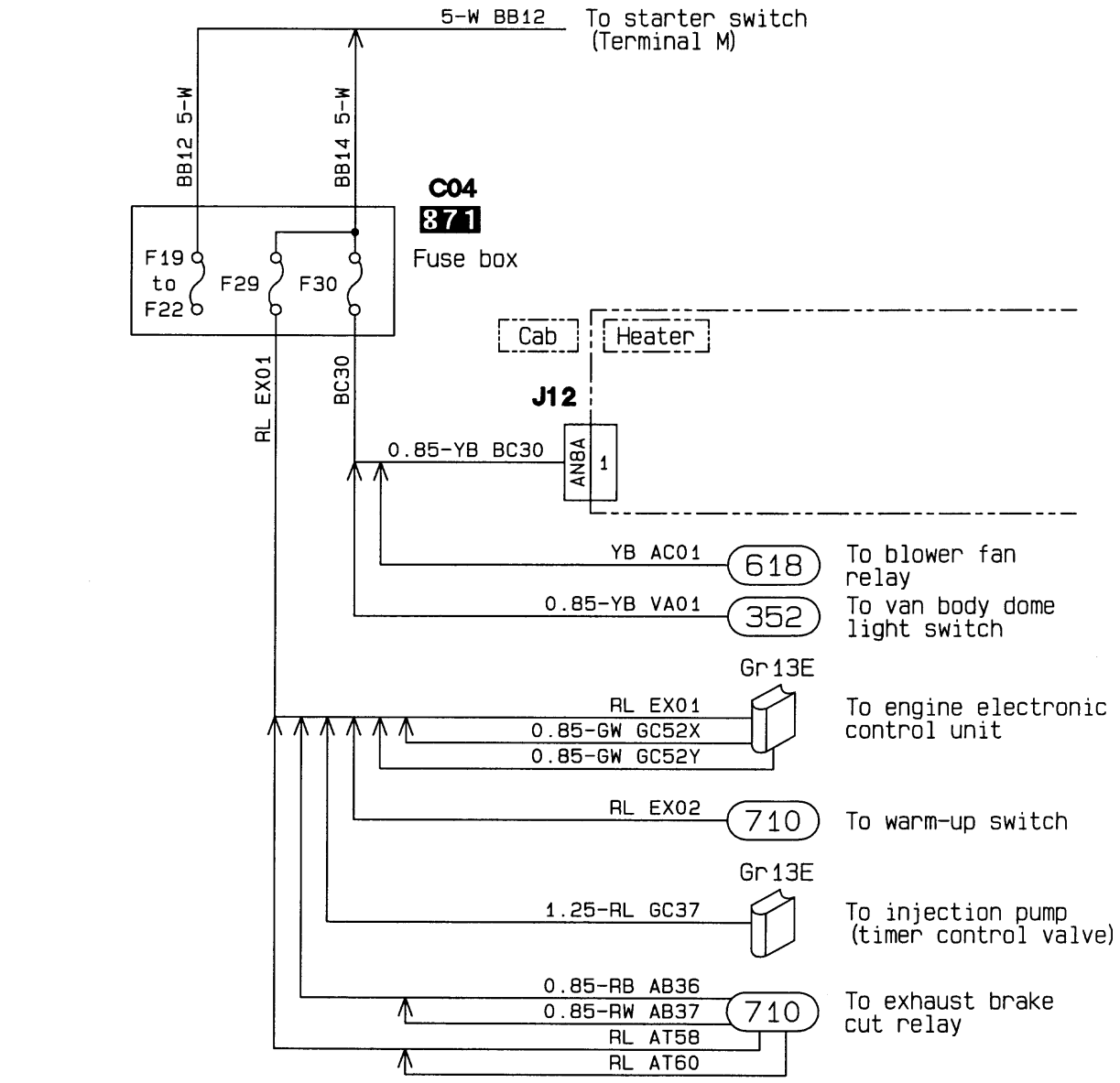
Fuse F23 to F26

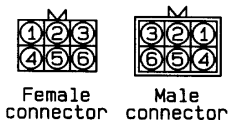


52794

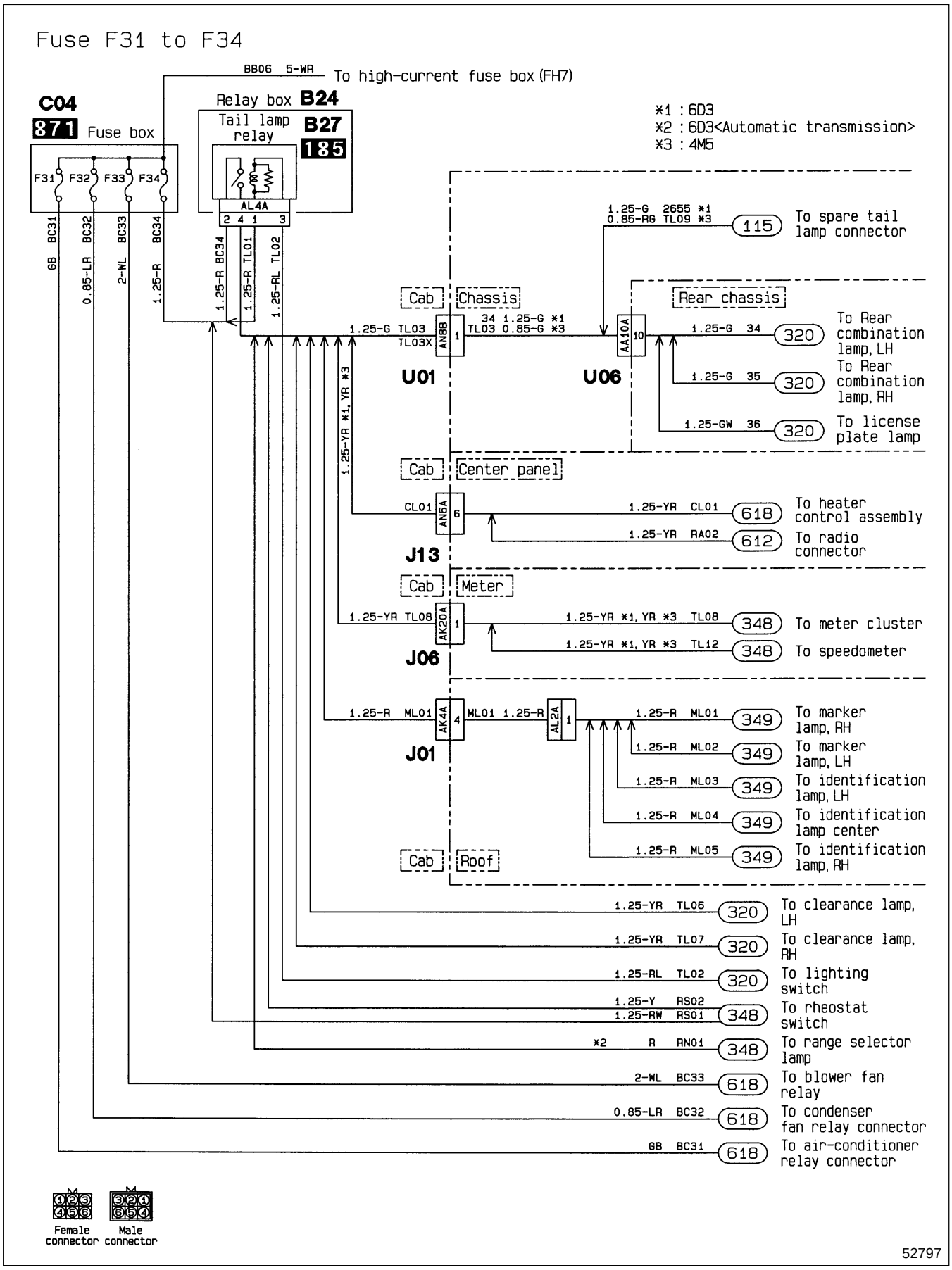

<6D3>
Fuse F27 to F30
5-W BB12
To starter switch (Terminal M)
BB12 5-W
BB14 5-W
*1: Manual transmission
*2: Automatic transmission
T/M PTO: Transmission power take-off
ABS : Anti-lock brake system
C04
871
Fuse box
F19 to F22
F27
F28
F29
F30
Cab
Heater
J12
ANBA
1
0.85-YB BC30
*2 0.85-R EG77
*1 1.25-LW BC27
Y BC28
1.25-RY BC29
BC30
YB AC01
618
To blower fan relay
0.85-YB VA01
352
To van body dome light switch
Gr13E
1.25-RY BC29
R EG51
To pre-stroke cut relay
*1 Y BC28
850
To T/M PTO control switch connector
*1 RL TP01
850
To T/M PTO relay connector
<ABS> *1 0.85-RW AB37
<ABS> *1 0.85-RB AB36
710
To exhaust brake cut relay
*1 1.25-LW BC27
*1 GW EX11
710
To clutch switch
*1 WG EX13
710
To exhaust brake switch
*1 LW EX16X
*2 LW EX16Y
*1 LW EX14X
*2 LW EX14Y
710
To transmission neutral relay
Gr13E
*2 0.85-RW EG79
*2 0.85-R EG77
To accelerator relay
Female connector
Male connector
52795

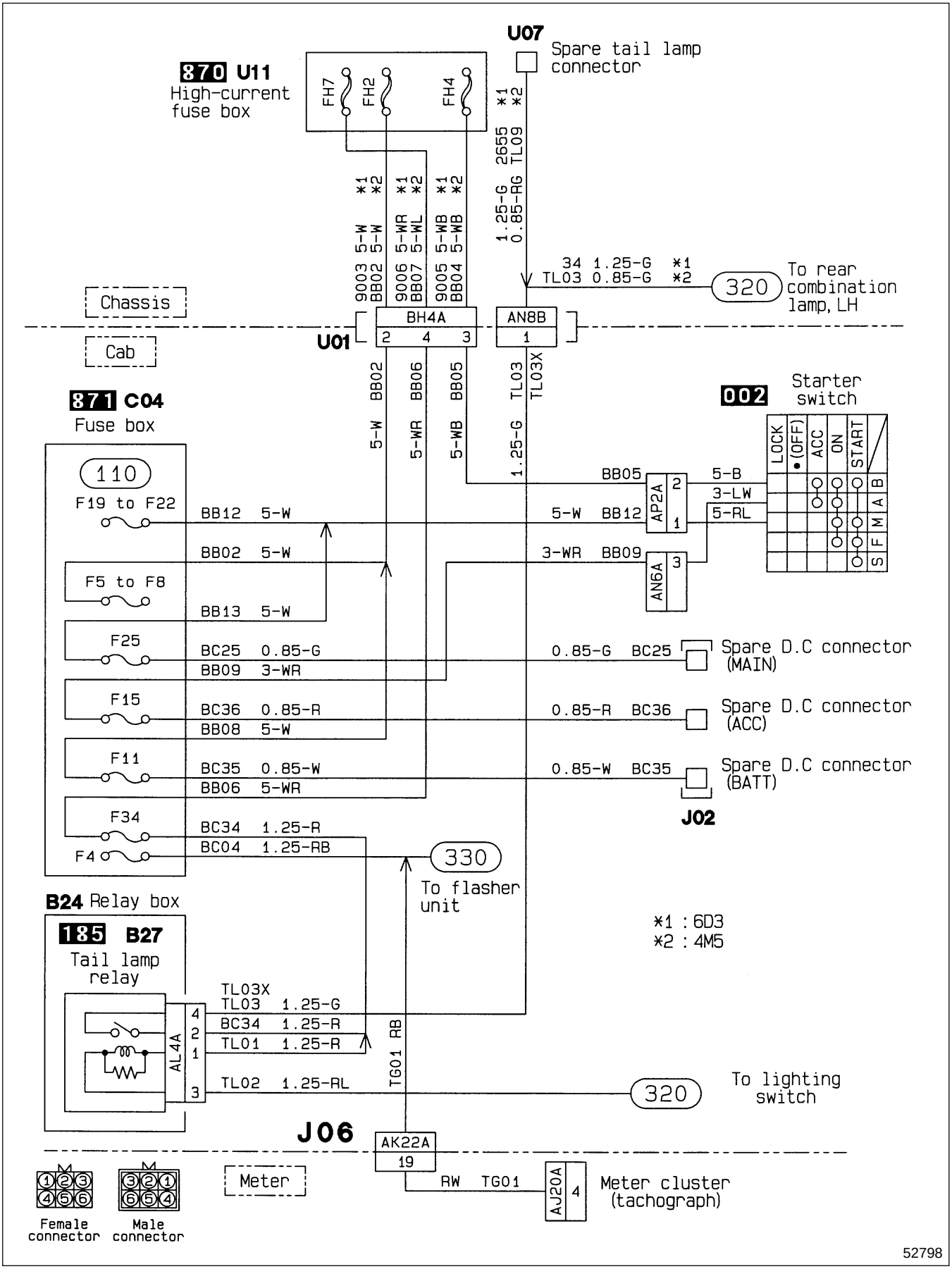
<4M5>
Fuse F29 to F30



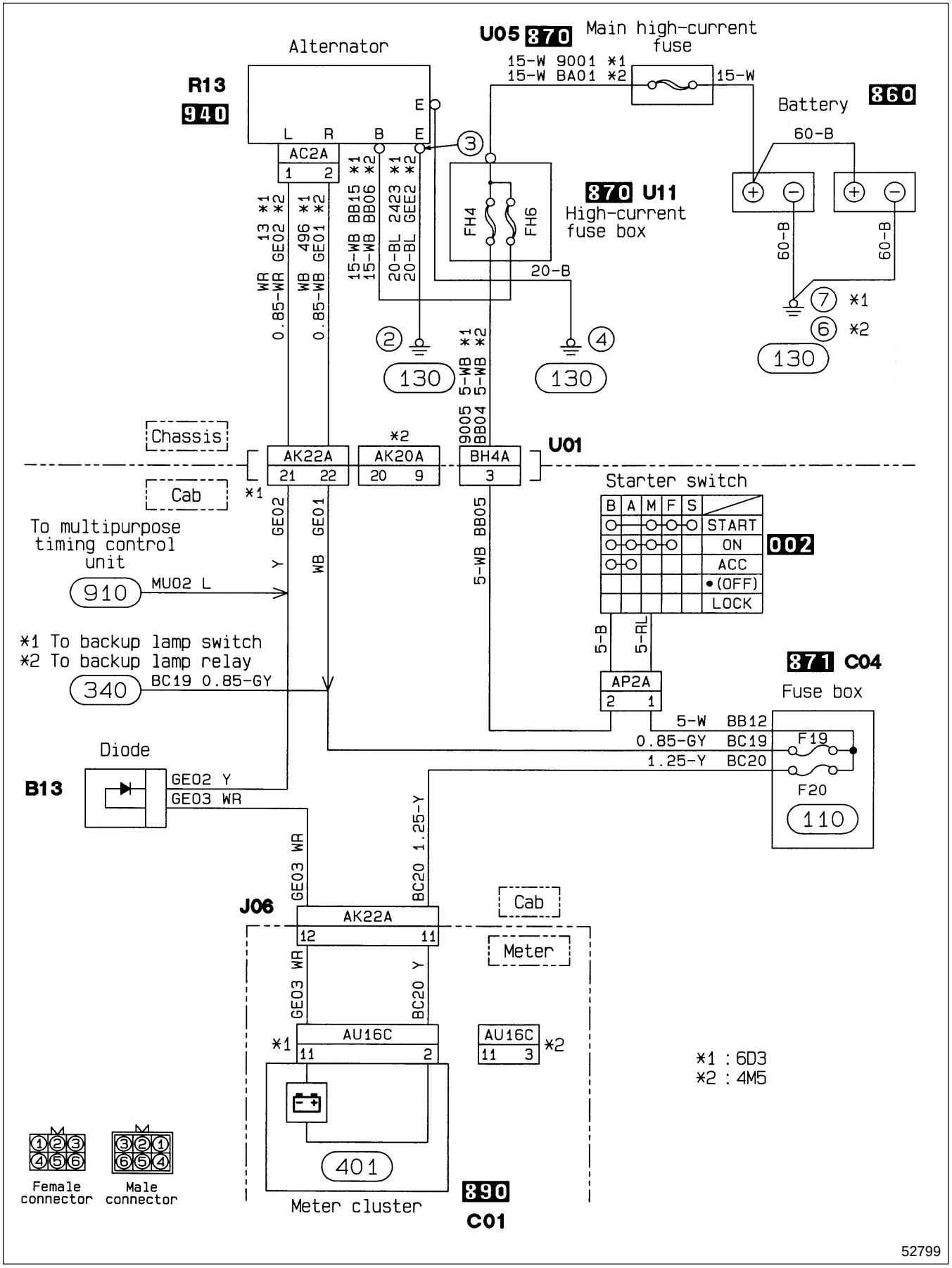


52796


Fuse F31 to F34
BB06 5-WR
To high-current fuse box (FH7)
C04
871
Fuse box
F31
F32
F33
F34
Relay box B24
Tail lamp relay B27
185
AL4A
2 4 1 3
*1 : 6D3
*2 : 6D3<Automatic transmission>
*3 : 4M5
GB BC31
0.85-LR BC32
2-WL BC33
1.25-R BC34
1.25-R BC34
1.25-R TL01
1.25-RL TL02
1.25-G 2655 *1
0.85-RG TL09 *3
115
To spare tail lamp connector
Cab
Chassis
Rear chassis
1.25-G TL03
TL03X
AN8B
1
34 1.25-G *1
TL03 0.85-G *3
U01
U06
AA10A
10
1.25-G 34
320
To Rear combination lamp, LH
1.25-G 35
320
To Rear combination lamp, RH
1.25-GW 36
320
To license plate lamp
1.25-YR *1, YR *3
Cab
Center panel
CL01
AN6A
6
1.25-YR CL01
618
To heater control assembly
1.25-YR RA02
612
To radio connector
J13
Cab
Meter
1.25-YR TL08
AK20A
1
1.25-YR *1, YR *3 TL08
348
To meter cluster
1.25-YR *1, YR *3 TL12
348
To speedometer
J06
1.25-R ML01
AK4A
4
ML01 1.25-R
AL2A
1
1.25-R ML01
349
To marker lamp, RH
1.25-R ML02
349
To marker lamp, LH
1.25-R ML03
349
To identification lamp, LH
1.25-R ML04
349
To identification lamp center
1.25-R ML05
349
To identification lamp, RH
J01
Cab
Roof
1.25-YR TL06
320
To clearance lamp, LH
1.25-YR TL07
320
To clearance lamp, RH
1.25-RL TL02
320
To lighting switch
1.25-Y RS02
1.25-RW RS01
348
To rheostat switch
*2 R RN01
348
To range selector lamp
2-WL BC33
618
To blower fan relay
0.85-LR BC32
618
To condenser fan relay connector
GB BC31
618
To air-conditioner relay connector
Female connector
Male connector
52797


870 U11
High-current fuse box
FH7
FH2
FH4
U07
Spare tail lamp connector
*1 *2
2655 TL09
1.25-G 0.85-R6
9003 5-W BB02
9006 5-WR BB07
9005 5-WB BB04
34 1.25-G *1
TL03 0.85-G *2
320
To rear combination lamp, LH
Chassis
Cab
U01
BH4A
2 4 3
AN8B
1
871 C04
Fuse box
002
Starter switch
LOCK (OFF) ACC ON START
S F M A B
110
F19 to F22
BB12 5-W
BB02 5-W
F5 to F8
BB13 5-W
F25
BC25 0.85-G
BB09 3-WR
F15
BC36 0.85-R
BB08 5-W
F11
BC35 0.85-W
BB06 5-WR
F34
BC34 1.25-R
F4
BC04 1.25-RB
BB05
AP2A
5-B
3-LW
5-RL
5-W BB12
3-WR BB09
AN6A
0.85-G BC25
Spare D.C connector (MAIN)
0.85-R BC36
Spare D.C connector (ACC)
0.85-W BC35
Spare D.C connector (BATT)
J02
330
To flasher unit
*1 : 6D3
*2 : 4M5
B24 Relay box
185 B27
Tail lamp relay
AL4A
TL03X
TL03 1.25-G
BC34 1.25-R
TL01 1.25-R
TL02 1.25-RL
TG01 RB
320
To lighting switch
J06
AK22A
19
RW TG01
AJ20A
4
Meter cluster (tachograph)
Meter
Female connector
Male connector
52798

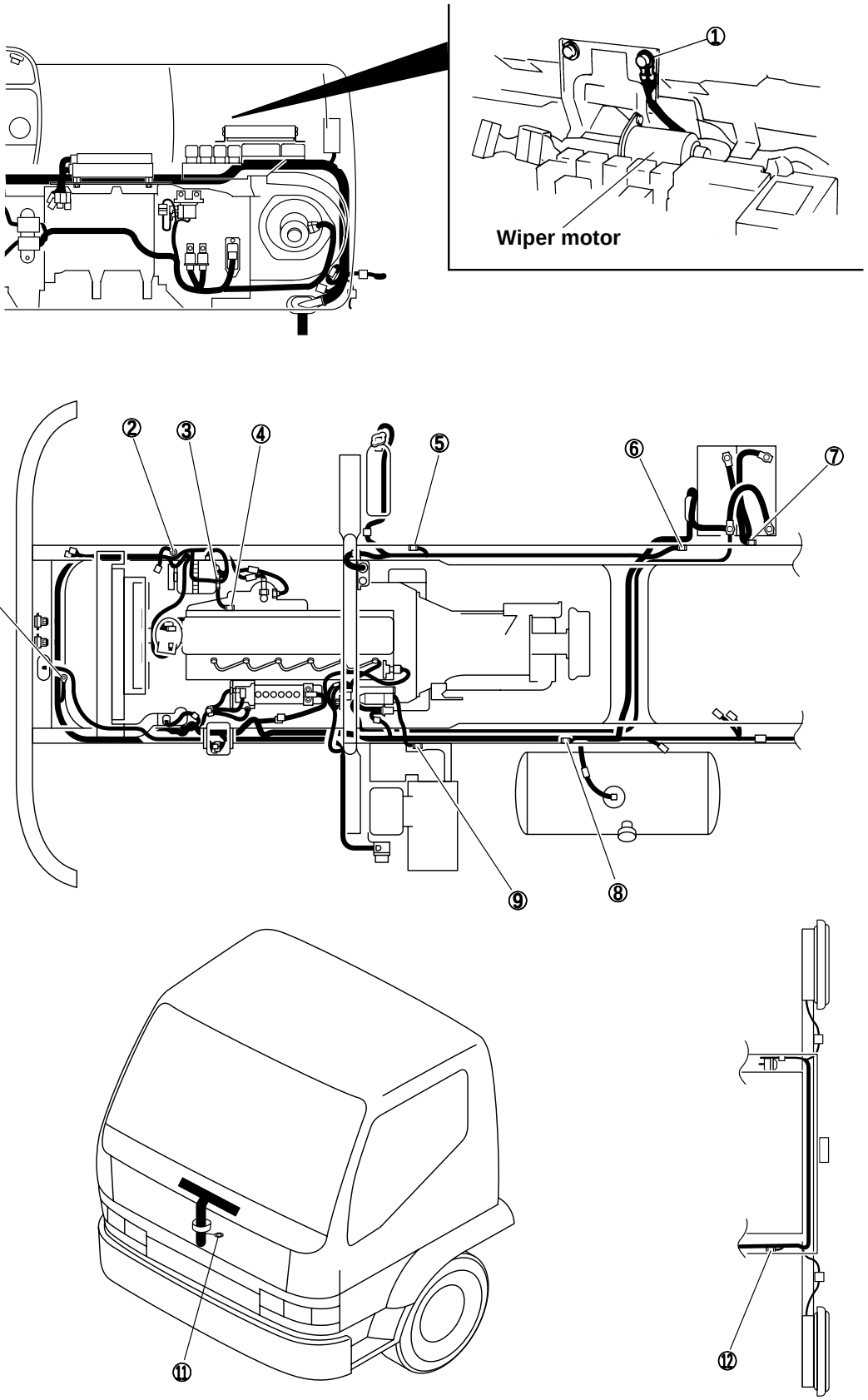
125 BATTERY CHARGING CIRCUIT



52799

M E M O

< 6D3 >

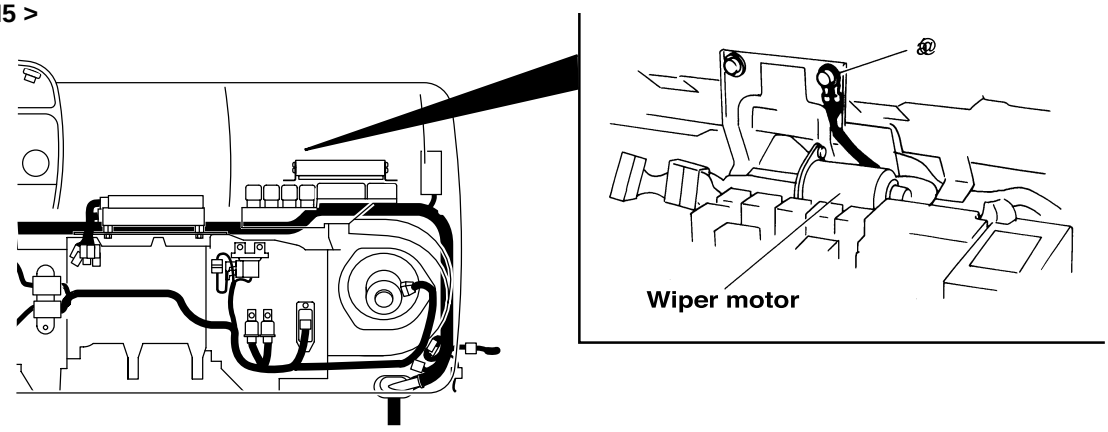


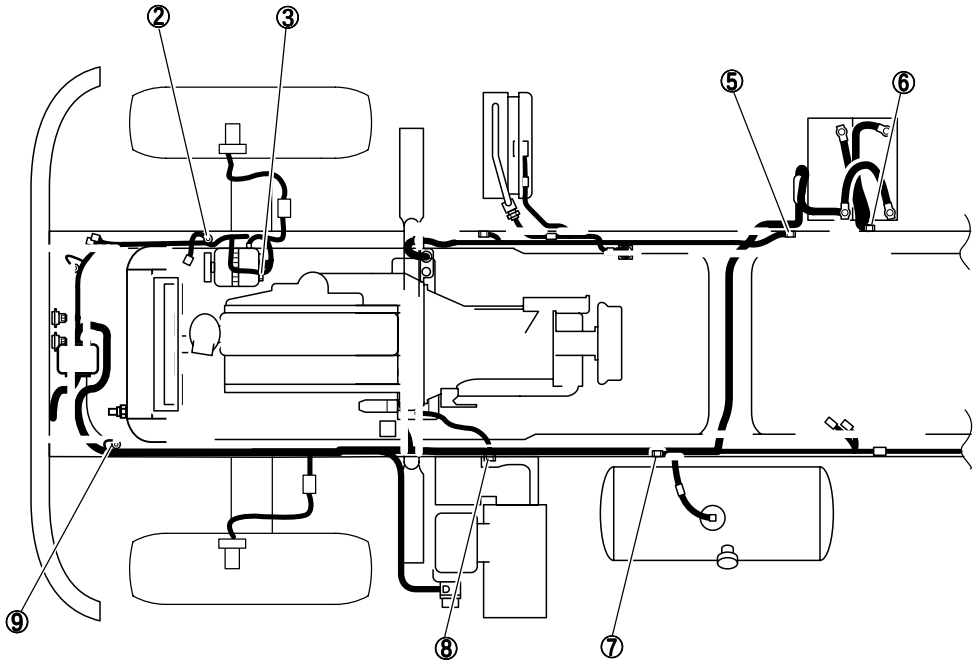
Ⓟ26887

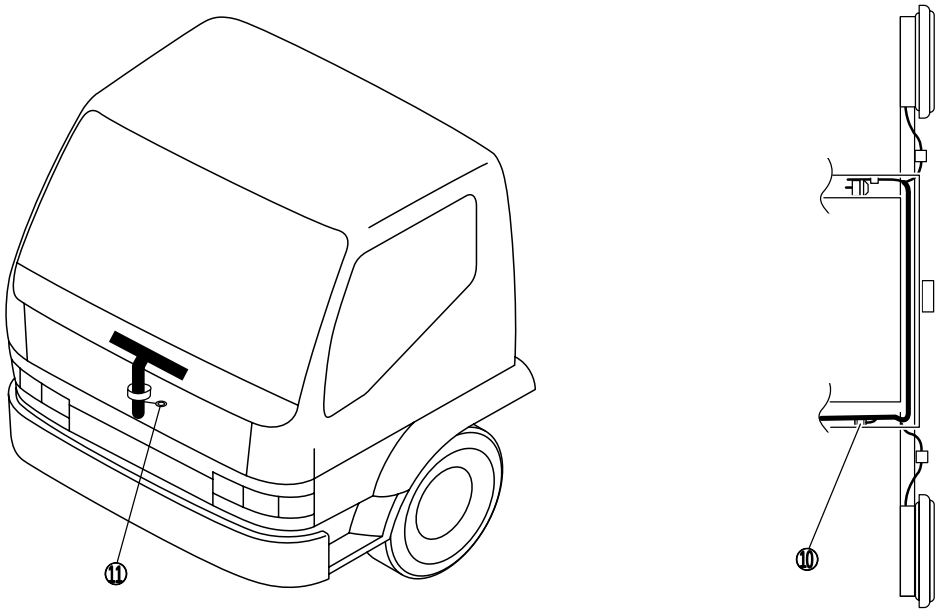
Location	Circuit No.	Wire diameter-wire color	Remarks
①	EA01	3-B	
②	2423	20-BL	
	6	20-B	
③	2423	20-BL	
④	—	5-B	
⑤	1575	1.25-B	
	1600	1.25-B	A/T
	12	2-BR	A/T
⑥	EGE1	1.25-B	
	EGE4	1.25-B	
	ABE1	2-B	
	ABE3	2-B	
⑦	—	60-B	
⑧	74	B	
	1582	B	A/T
⑨	—	—	Engine ground
⑩	19	1.25-B	
	210	3-B	
	9617	3-B	
⑪	EA02	3-B	
⑫	38	0.85-B	
	39	0.85-B	

A/T : Automatic transmission

< 4M5 >







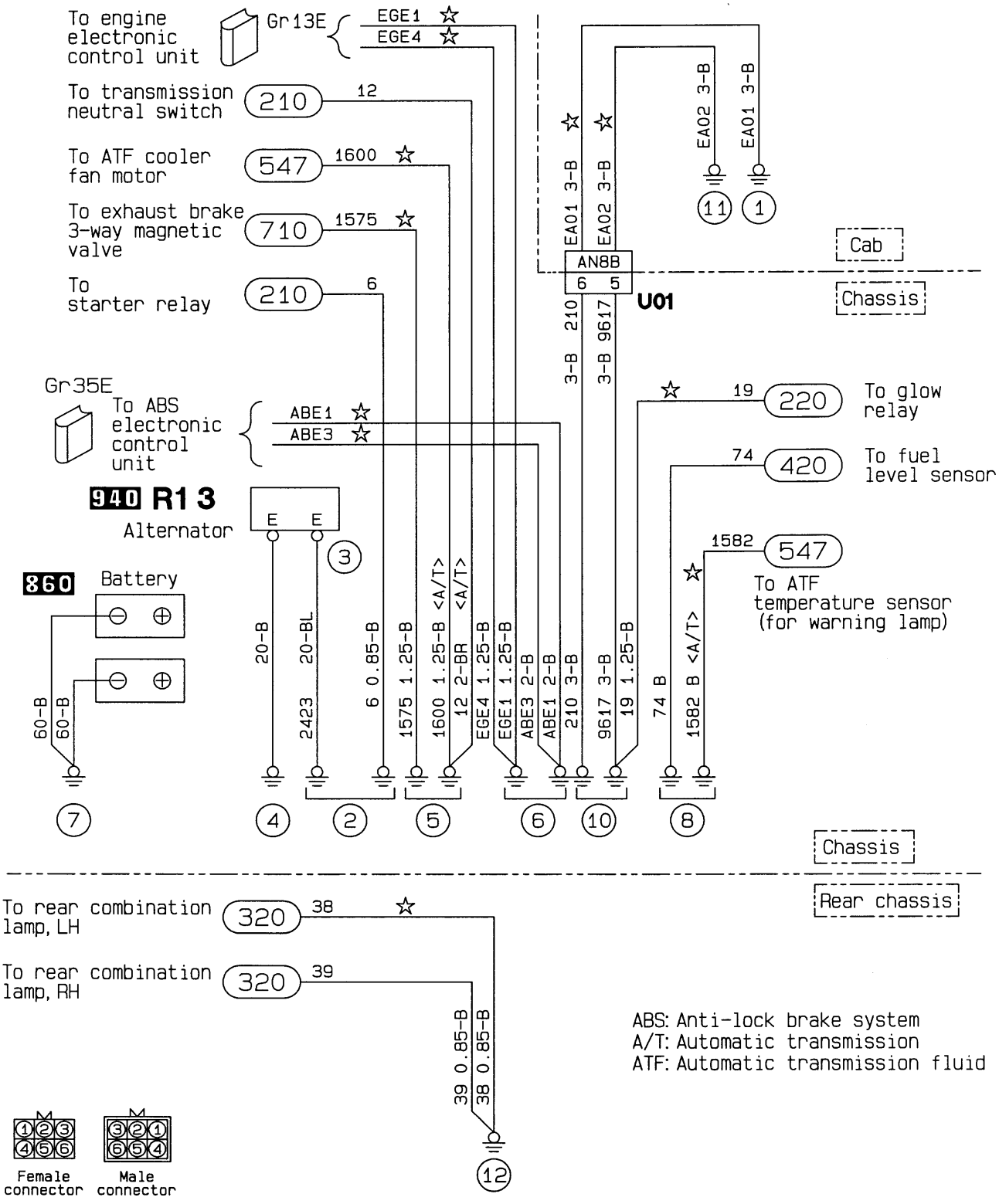
Ⓟ52976

Location	Circuit No.	Wire diameter-wire color	Remarks
①	EA01	3-B	
②	GEE2	20-BL	
③	GEE2	20-BL	
⑤	ABE1	2-B	
	ABE3	2-B	
	ATE1	B	
	ATE8	0.85-B	
	EA02	3-B	
	OCE2	1.25-B	
⑥	—	60-B	
⑦	FEE1	B	
⑧	—	60-BR	Engine ground
⑨	EA01	3-B	
	GCE1	1.25-B	
	GCE3	1.25B	
⑩	38	0.85-B	
	39	0.85-B	
	BRE1	B	
⑪	EA02	3-B	

Location number ④ is not existing.

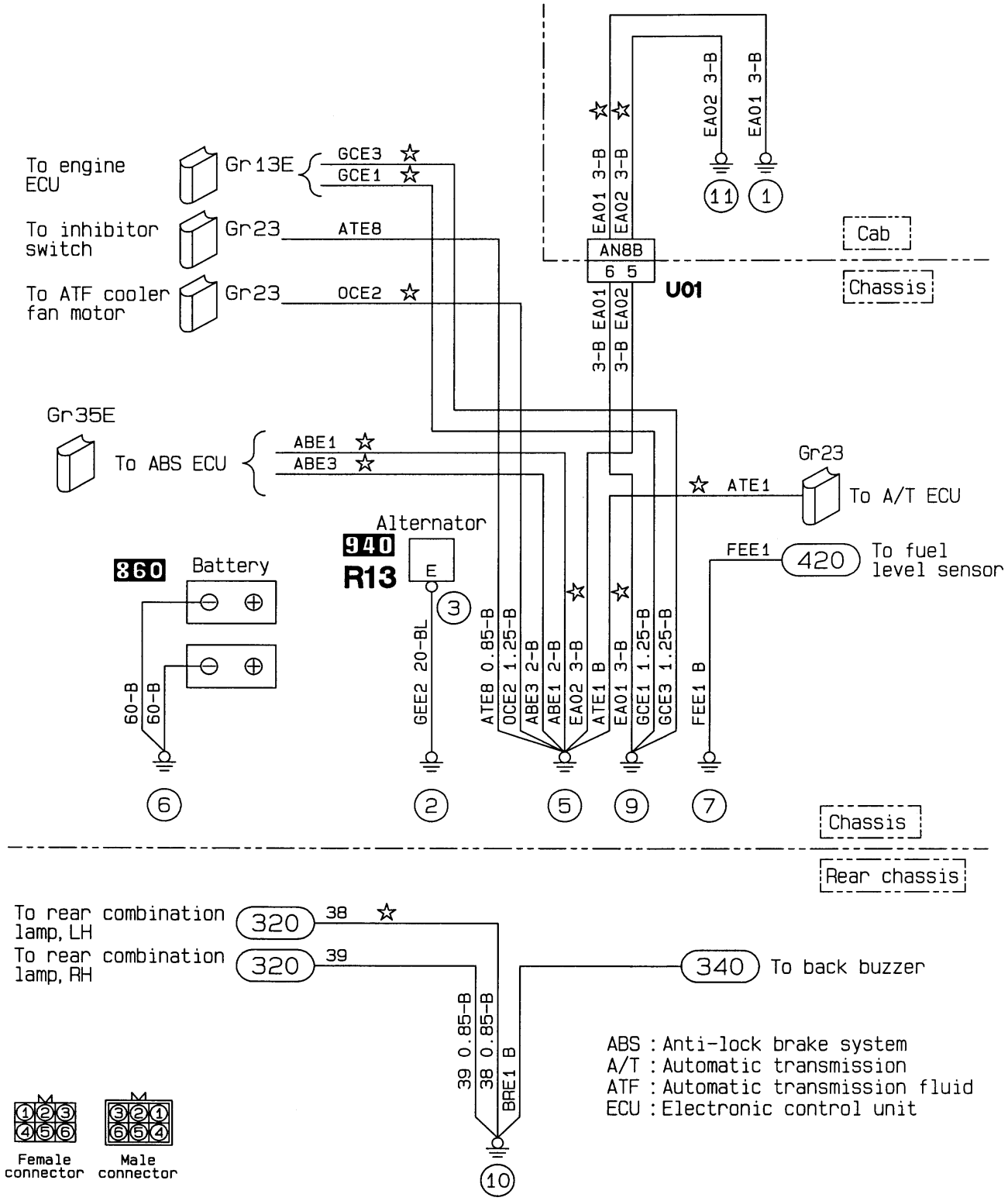
<6D3>

Entire ground
·This diagram indicates grounding points.
·See the following pages for branching of grounding (wire for ☆). (In circuit No. order)



<4M5>

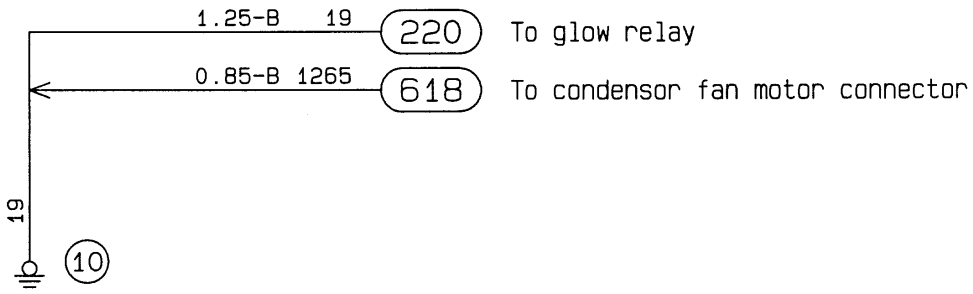
Entire ground
·This diagram indicates grounding points.
·See the following pages for branching of grounding (wire for ☆). (In circuit No.order)



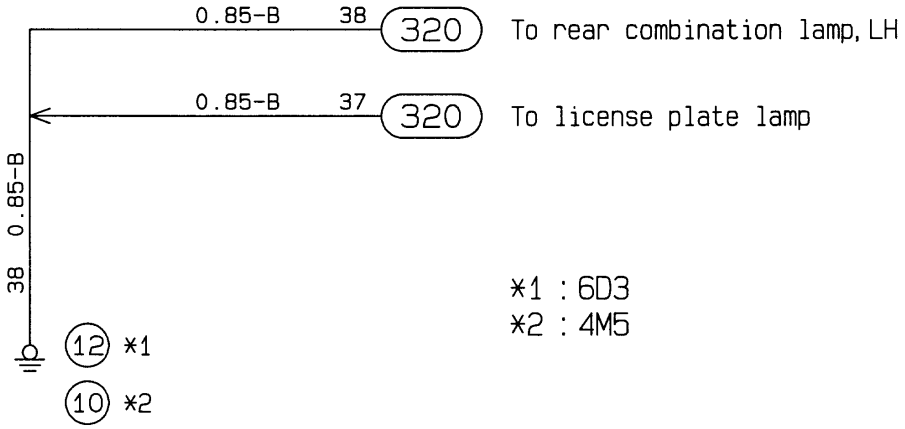
52801

Circuit No. 19, 38 ground

<Chassis ground (6D3) >



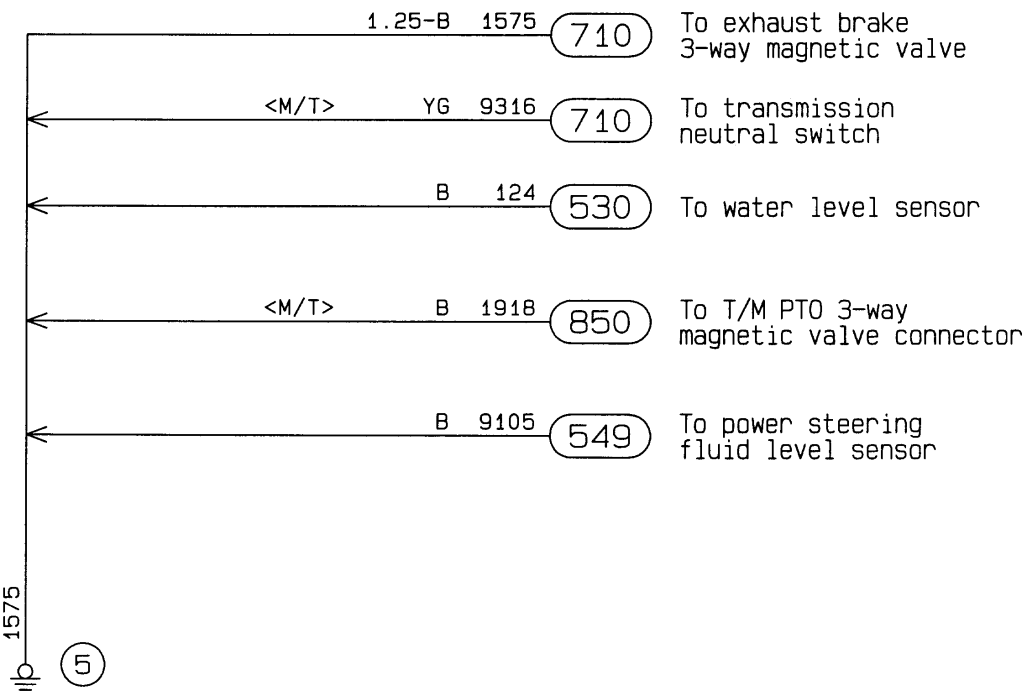
<Rear chassis ground>



52802

<6D3>

Circuit No.1575 Chassis Ground



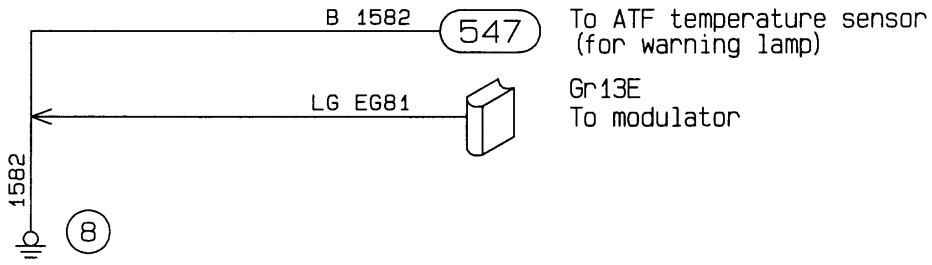
M/T: Manual transmission

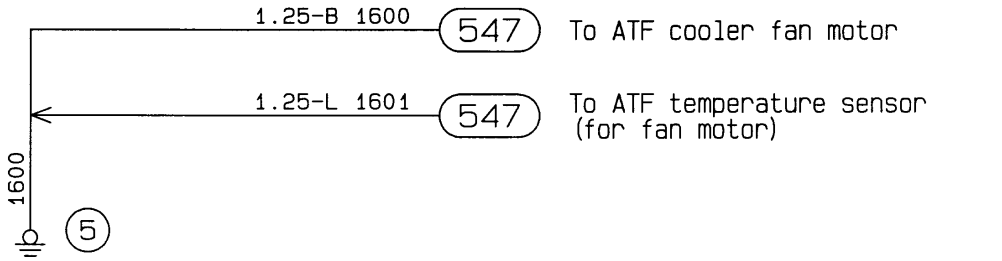
T/M PTO: Transmission power take-off

52803

<6D3>

Circuit No.1582, 1600 Chassis Ground <Automatic transmission>

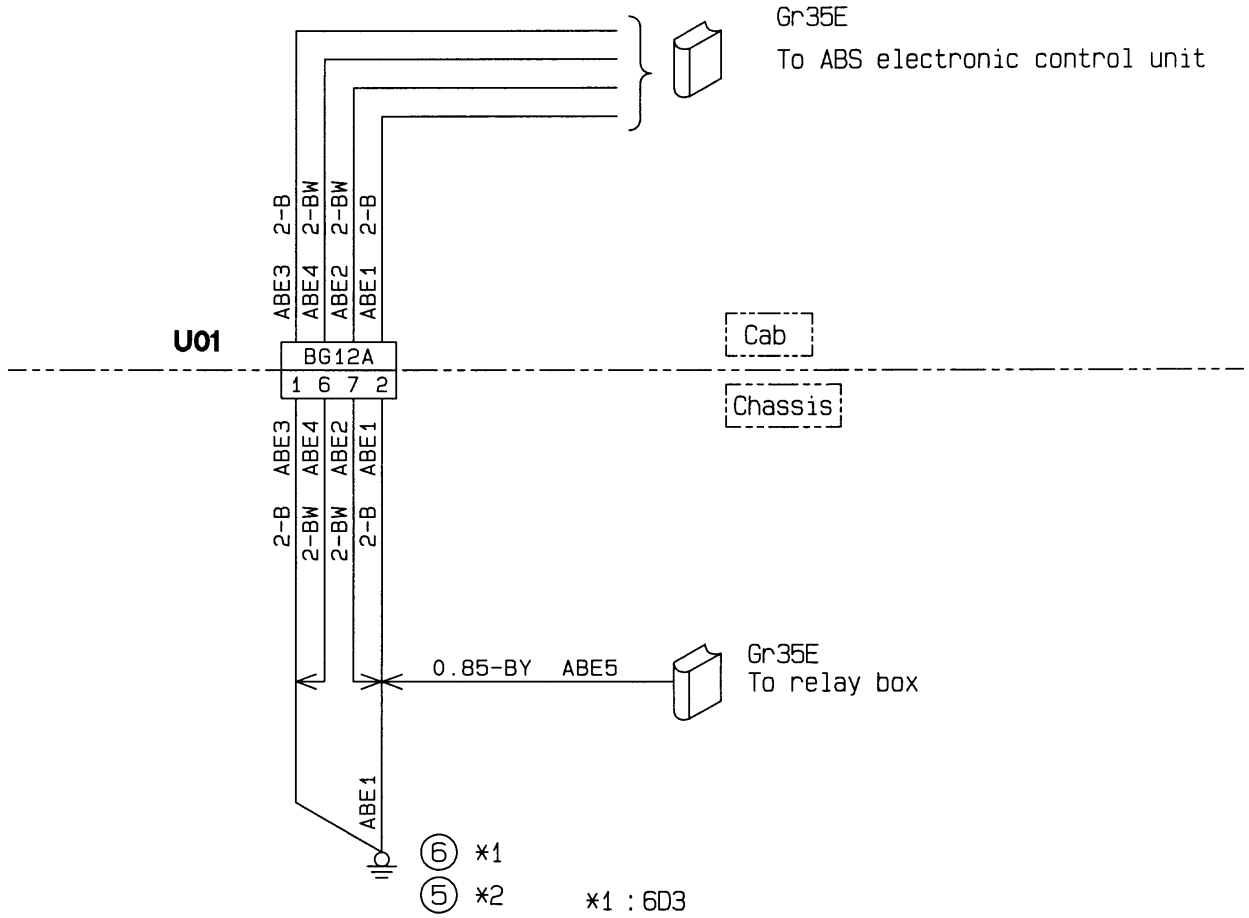


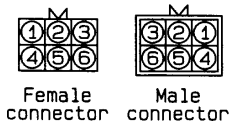


ATF: Automatic transmission fluid

52804

Circuit No.ABE1, ABE3 Chassis Ground <Anti-lock brake system>

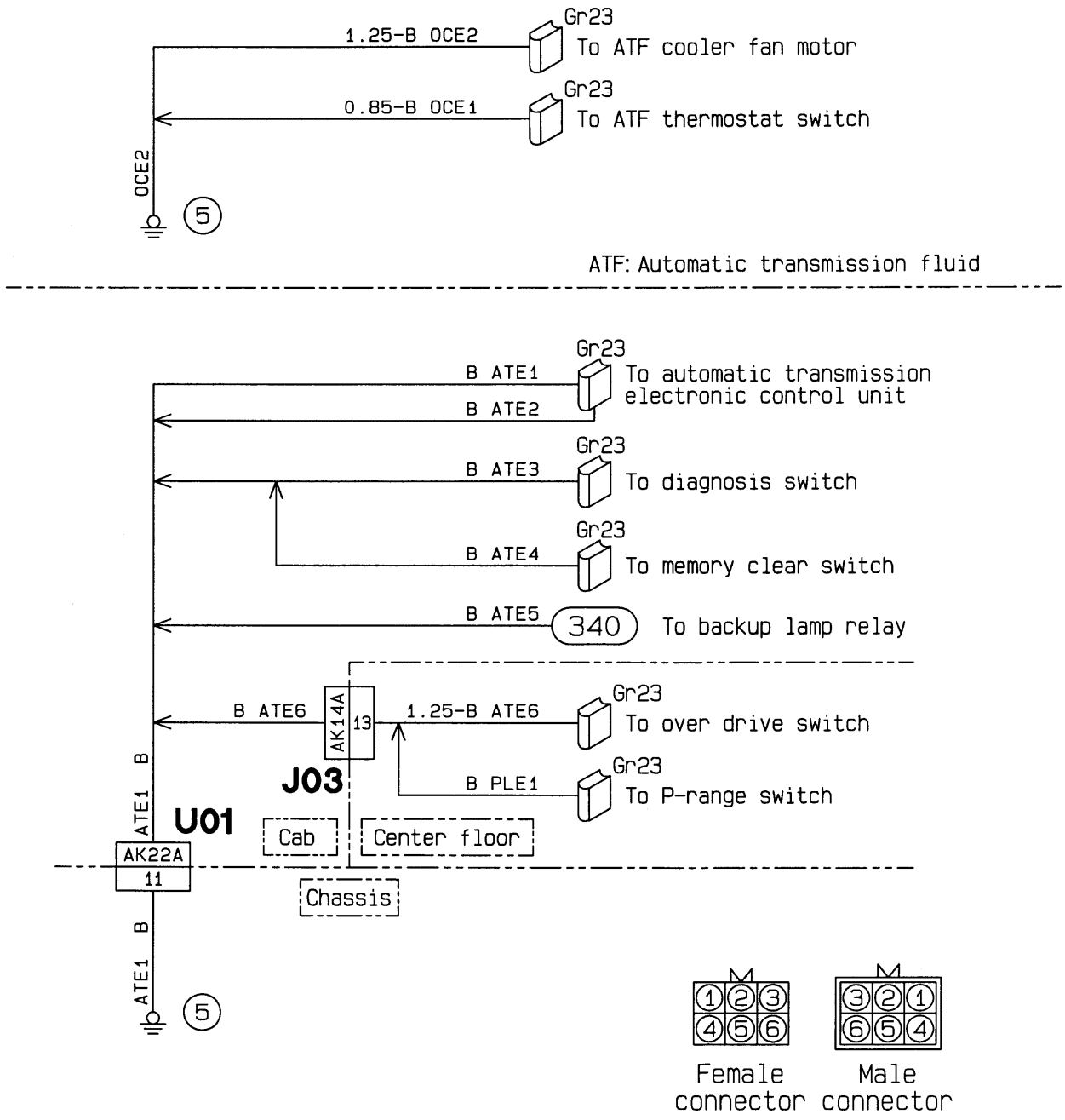


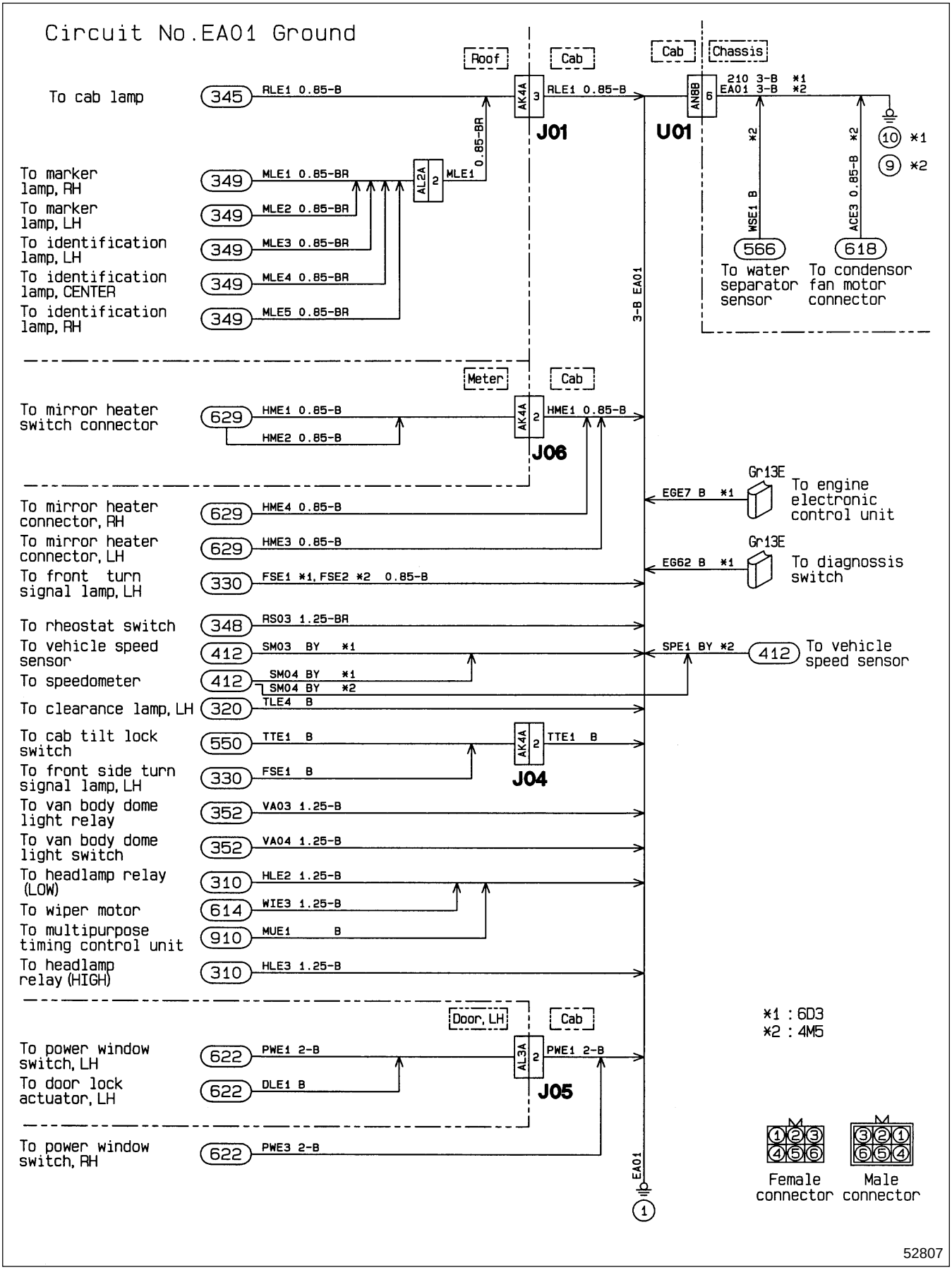


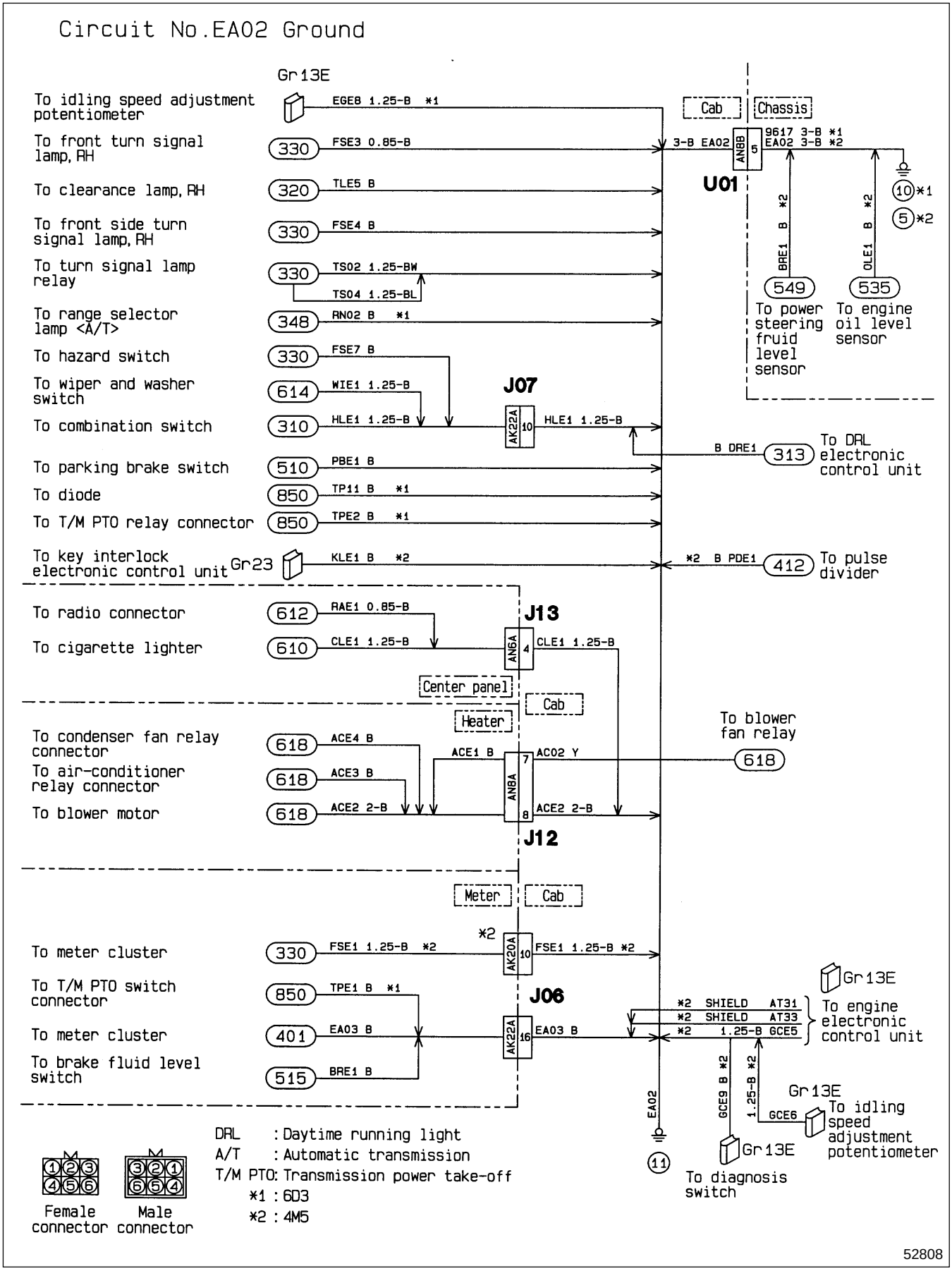
52805

<4M5>

Circuit No.ATE1, OCE2 Chassis Ground

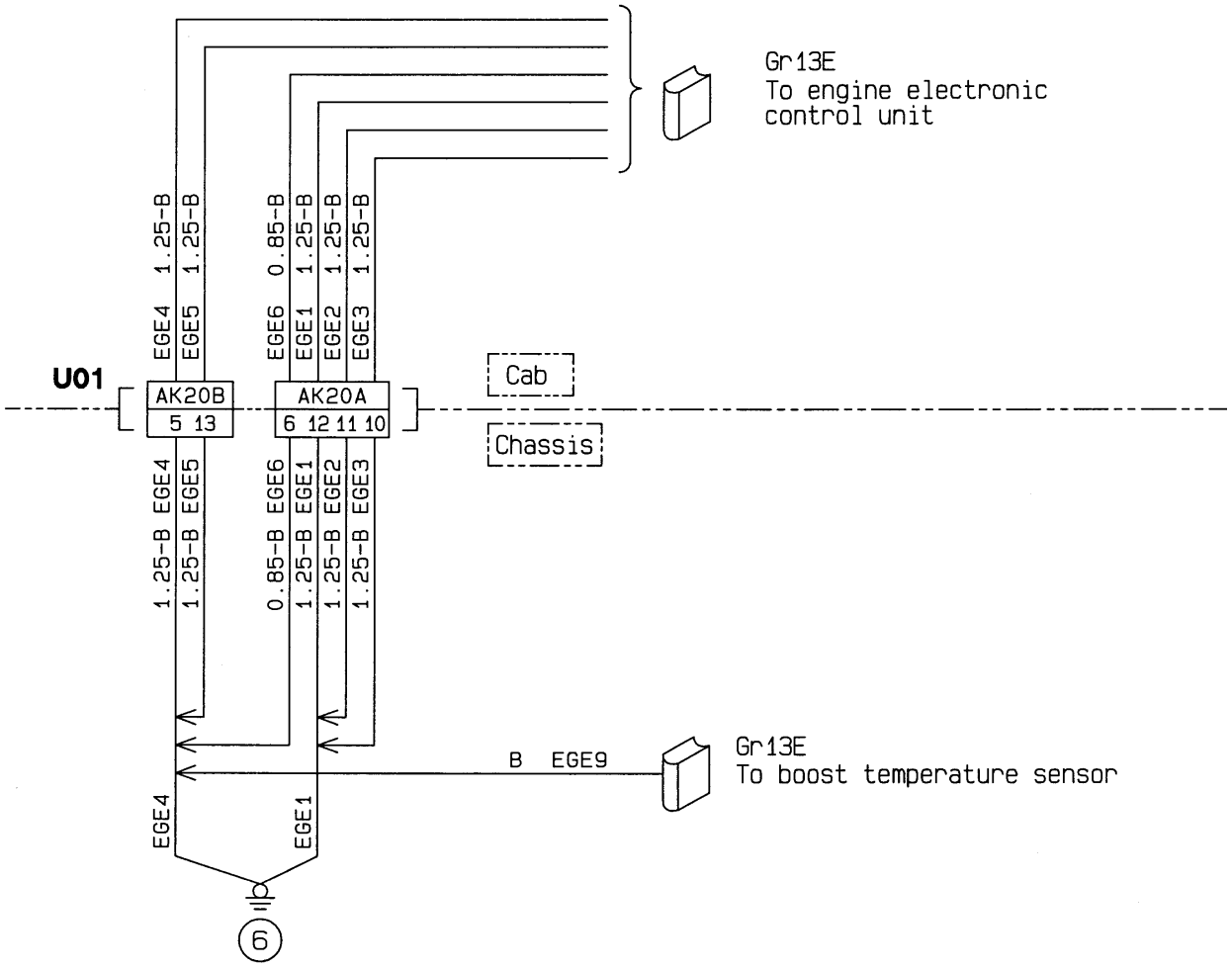


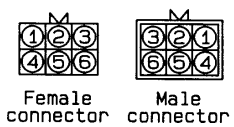

Circuit No.EA01 Ground
Roof
Cab
Cab
Chassis
To cab lamp
345
RLE1 0.85-B
AK4A 3
RLE1 0.85-B
J01
ANBB 6
U01
210 3-B *1
EA01 3-B *2
10 *1
9 *2
0.85-BR
*2
WSE1 B
ACE3 0.85-B
*2
To marker lamp, RH
349
MLE1 0.85-BR
AL2A 2
MLE1
To marker lamp, LH
349
MLE2 0.85-BR
To identification lamp, LH
349
MLE3 0.85-BR
To identification lamp, CENTER
349
MLE4 0.85-BR
To identification lamp, RH
349
MLE5 0.85-BR
566
To water separator sensor
618
To condensor fan motor connector
3-B EA01
Meter
Cab
To mirror heater switch connector
629
HME1 0.85-B
HME2 0.85-B
AK4A 2
HME1 0.85-B
J06
Gr13E
EGE7 B *1
To engine electronic control unit
To mirror heater connector, RH
629
HME4 0.85-B
To mirror heater connector, LH
629
HME3 0.85-B
Gr13E
EG62 B *1
To diagnosis switch
To front turn signal lamp, LH
330
FSE1 *1, FSE2 *2 0.85-B
To rheostat switch
348
RS03 1.25-BR
To vehicle speed sensor
412
SM03 BY *1
SPE1 BY *2
412
To vehicle speed sensor
To speedometer
412
SM04 BY *1
SM04 BY *2
To clearance lamp, LH
320
TLE4 B
To cab tilt lock switch
550
TTE1 B
AK4A 2
TTE1 B
J04
To front side turn signal lamp, LH
330
FSE1 B
To van body dome light relay
352
VA03 1.25-B
To van body dome light switch
352
VA04 1.25-B
To headlamp relay (LOW)
310
HLE2 1.25-B
To wiper motor
614
WIE3 1.25-B
To multipurpose timing control unit
910
MUE1 B
To headlamp relay (HIGH)
310
HLE3 1.25-B
Door, LH
Cab
To power window switch, LH
622
PWE1 2-B
AL3A 2
PWE1 2-B
To door lock actuator, LH
622
DLE1 B
J05
To power window switch, RH
622
PWE3 2-B
EA01
1
*1 : 6D3
*2 : 4M5
Female connector
Male connector
52807


Circuit No.EA02 Ground
Gr13E
To idling speed adjustment potentiometer
EGE8 1.25-B *1
To front turn signal lamp, RH
330
FSE3 0.85-B
To clearance lamp, RH
320
TLE5 B
To front side turn signal lamp, RH
330
FSE4 B
To turn signal lamp relay
330
TS02 1.25-BW
TS04 1.25-BL
To range selector lamp <A/T>
348
RN02 B *1
To hazard switch
330
FSE7 B
To wiper and washer switch
614
WIE1 1.25-B
To combination switch
310
HLE1 1.25-B
J07
AK22A
10
HLE1 1.25-B
To parking brake switch
510
PBE1 B
To diode
850
TP11 B *1
To T/M PTO relay connector
850
TPE2 B *1
To key interlock electronic control unit
Gr23
KLE1 B *2
To radio connector
612
RAE1 0.85-B
To cigarette lighter
610
CLE1 1.25-B
J13
AN6A
4
CLE1 1.25-B
Center panel
Cab
Heater
To condenser fan relay connector
618
ACE4 B
To air-conditioner relay connector
618
ACE3 B
To blower motor
618
ACE2 2-B
ACE1 B
AN8A
7
8
ACO2 Y
ACE2 2-B
J12
To blower fan relay
618
Meter
Cab
*2
To meter cluster
330
FSE1 1.25-B *2
AK20A
10
FSE1 1.25-B *2
To T/M PTO switch connector
850
TPE1 B *1
J06
To meter cluster
401
EA03 B
AK22A
16
EA03 B
To brake fluid level switch
515
BRE1 B
Cab
Chassis
3-B EA02
AN8B
5
9617 3-B *1
EA02 3-B *2
U01
10 *1
5 *2
BRE1 B *2
OLE1 B *2
549
535
To power steering fruid level sensor
To engine oil level sensor
B DRE1
313
To DRL electronic control unit
*2 B PDE1
412
To pulse divider
Gr13E
*2 SHIELD AT31
*2 SHIELD AT33
*2 1.25-B GCE5
To engine electronic control unit
GCE9 B *2
1.25-B *2
GCE6
Gr13E
To idling speed adjustment potentiometer
EA02
11
Gr13E
To diagnosis switch
DRL : Daytime running light
A/T : Automatic transmission
T/M PTO: Transmission power take-off
*1 : 6D3
*2 : 4M5
Female connector
Male connector
52808

<6D3>

Circuit No.EGE1, EGE4 Chassis Ground

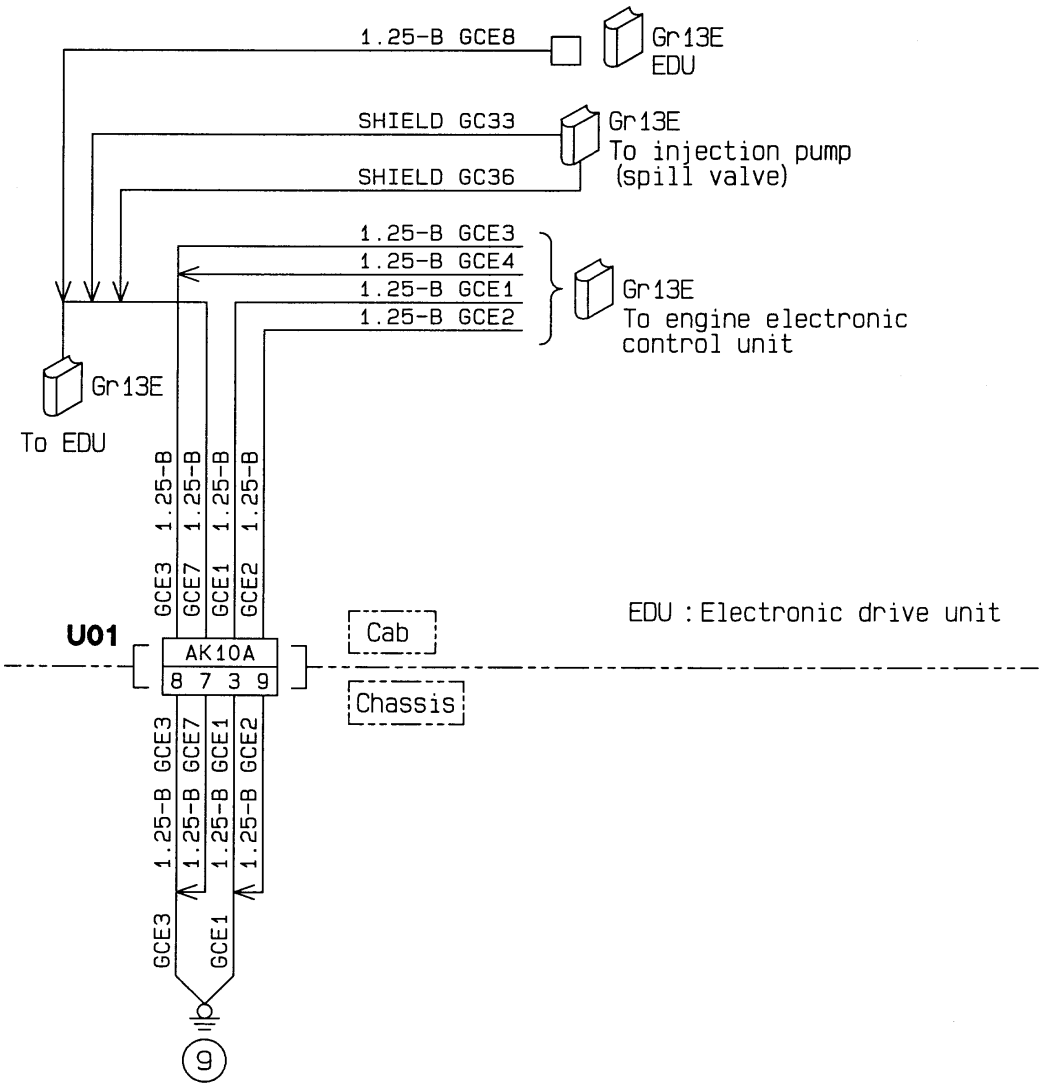


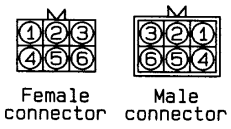


52809

<4M5>

Circuit No.GCE1, GCE3 Chassis Ground



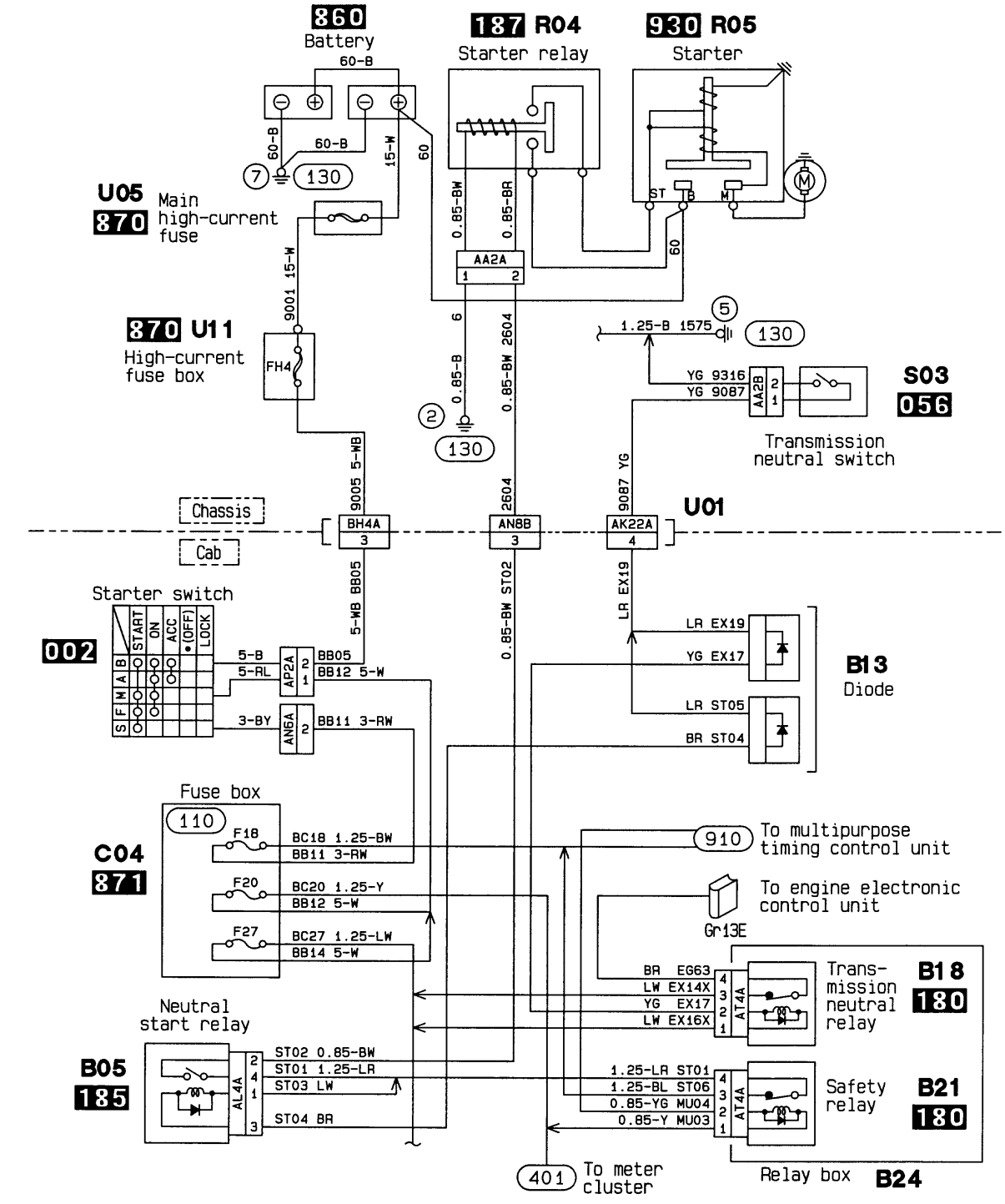


Female connector Male connector

52810

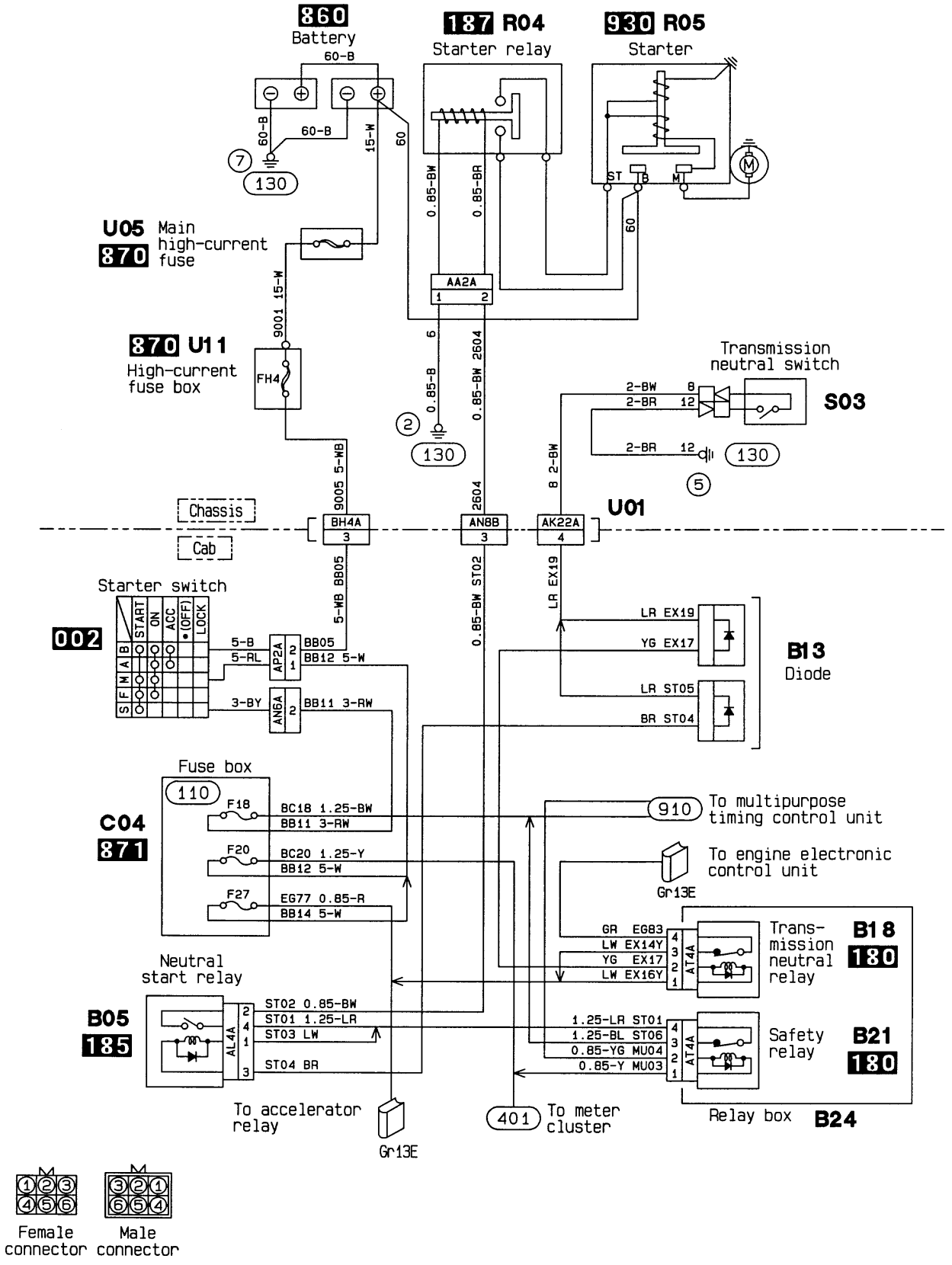
2 STARTING AND PREHEATING CIRCUIT

<6D3 (Manual transmission)>



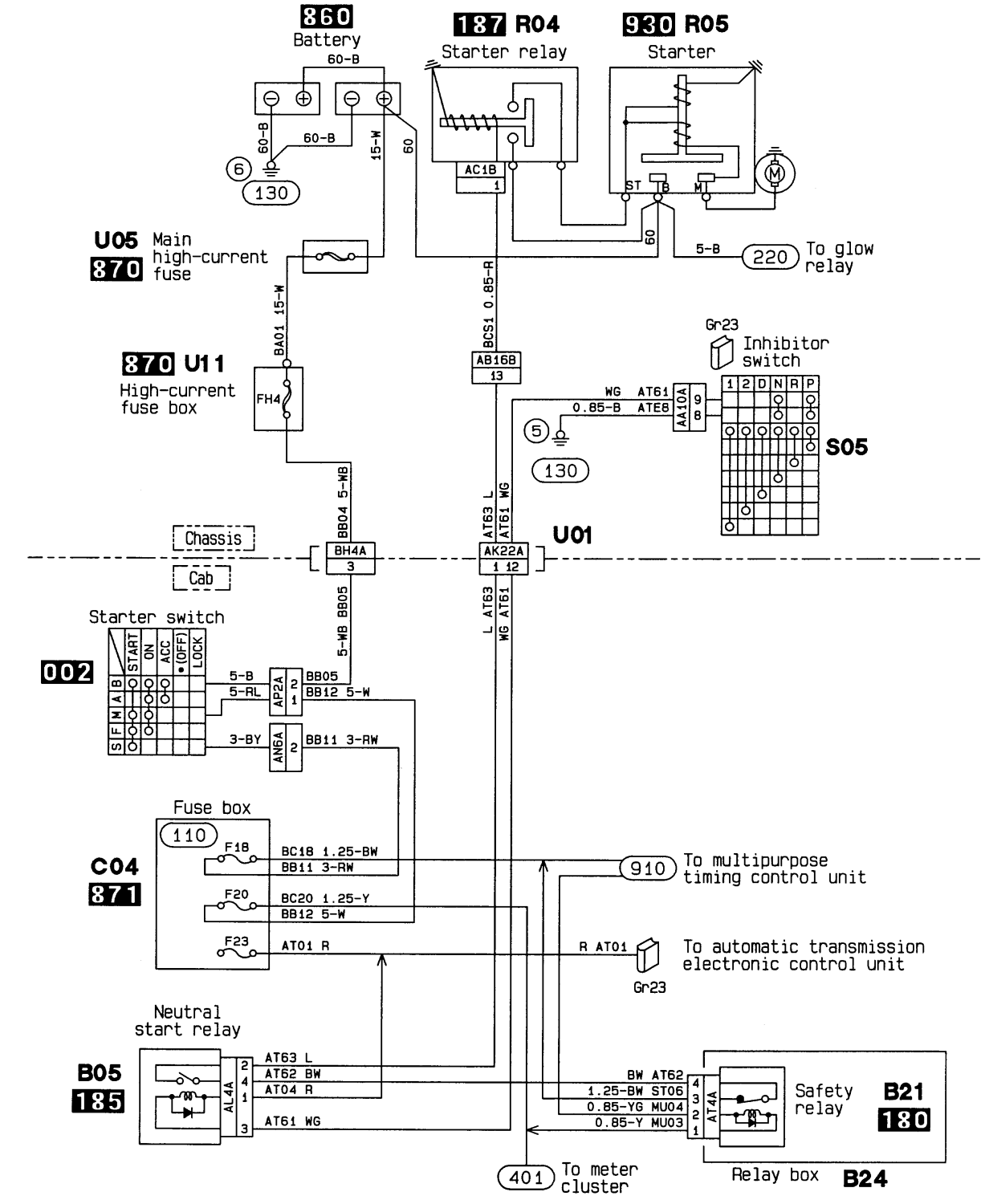
52811

<6D3 (Automatic transmission)>



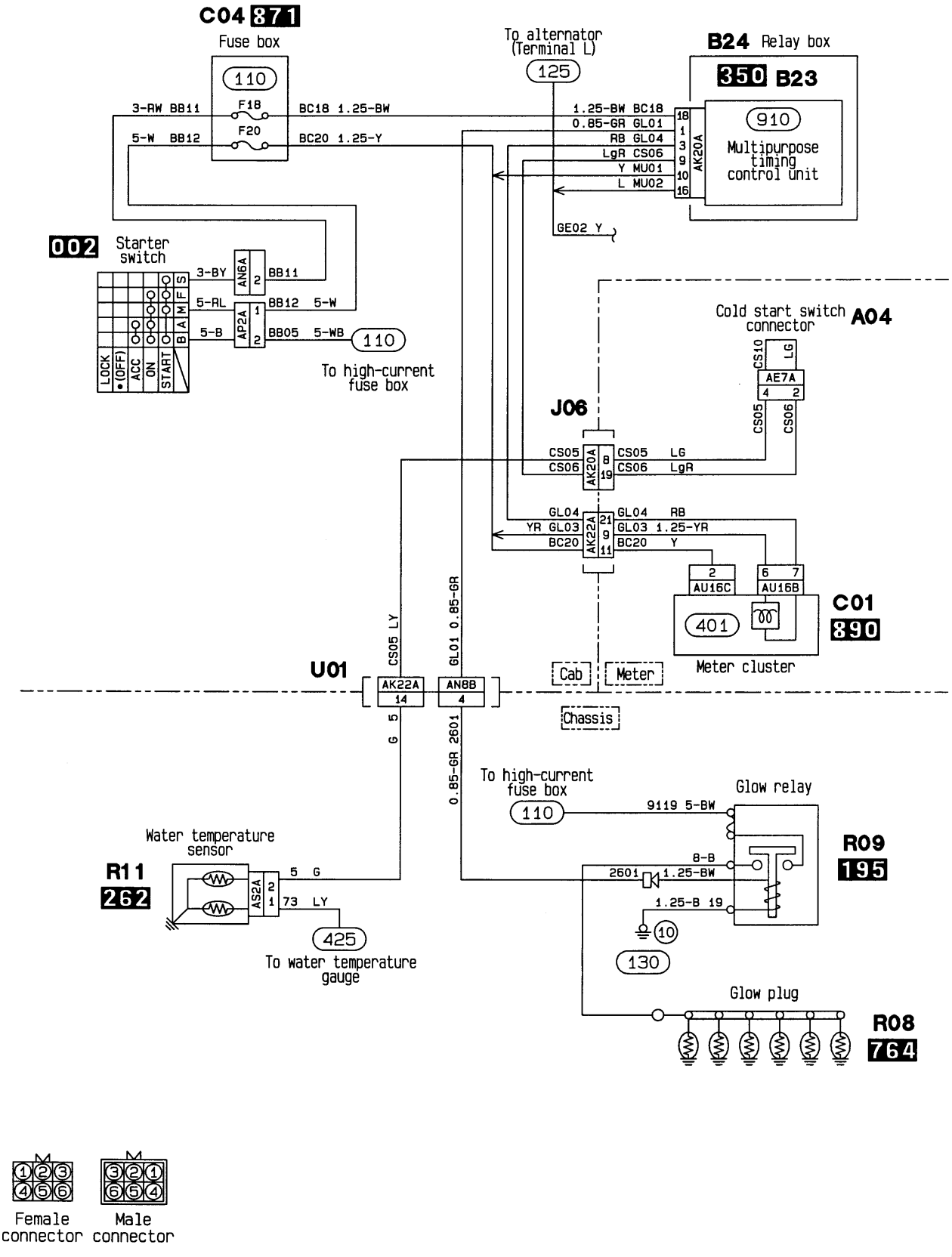
52812

<4M5>


860 Battery
60-B
187 R04 Starter relay
930 R05 Starter
AC1B
1
ST
B
M
6
130
60-B
15-W
60
U05 Main high-current fuse
870
5-B
220 To glow relay
BA01 15-W
BC51 0.85-R
AB16B
13
870 U11 High-current fuse box
FH4
Gr23 Inhibitor switch
1 2 D N R P
WG AT61
0.85-B AT68
AA10A
9
8
5
130
S05
BB04 5-WB
AT63 L
AT61 WG
U01
Chassis
Cab
BH4A
3
AK22A
1 12
Starter switch
002
START
ON
ACC
(OFF)
LOCK
B
A
M
F
S
5-B
5-RL
AP2A
2
1
BB05
BB12 5-W
5-WB BB05
3-BY
AN6A
2
BB11 3-RW
L AT63
WG AT61
Fuse box
110
C04
871
F18
BC18 1.25-BW
BB11 3-RW
910 To multipurpose timing control unit
F20
BC20 1.25-Y
BB12 5-W
F23
AT01 R
R AT01
Gr23
To automatic transmission electronic control unit
Neutral start relay
B05
185
AL4A
2
4
1
3
AT63 L
AT62 BW
AT04 R
AT61 WG
BW AT62
1.25-BW ST06
0.85-YG MU04
0.85-Y MU03
AT4A
4
3
2
1
Safety relay
B21
180
Relay box B24
401 To meter cluster
Female connector
Male connector

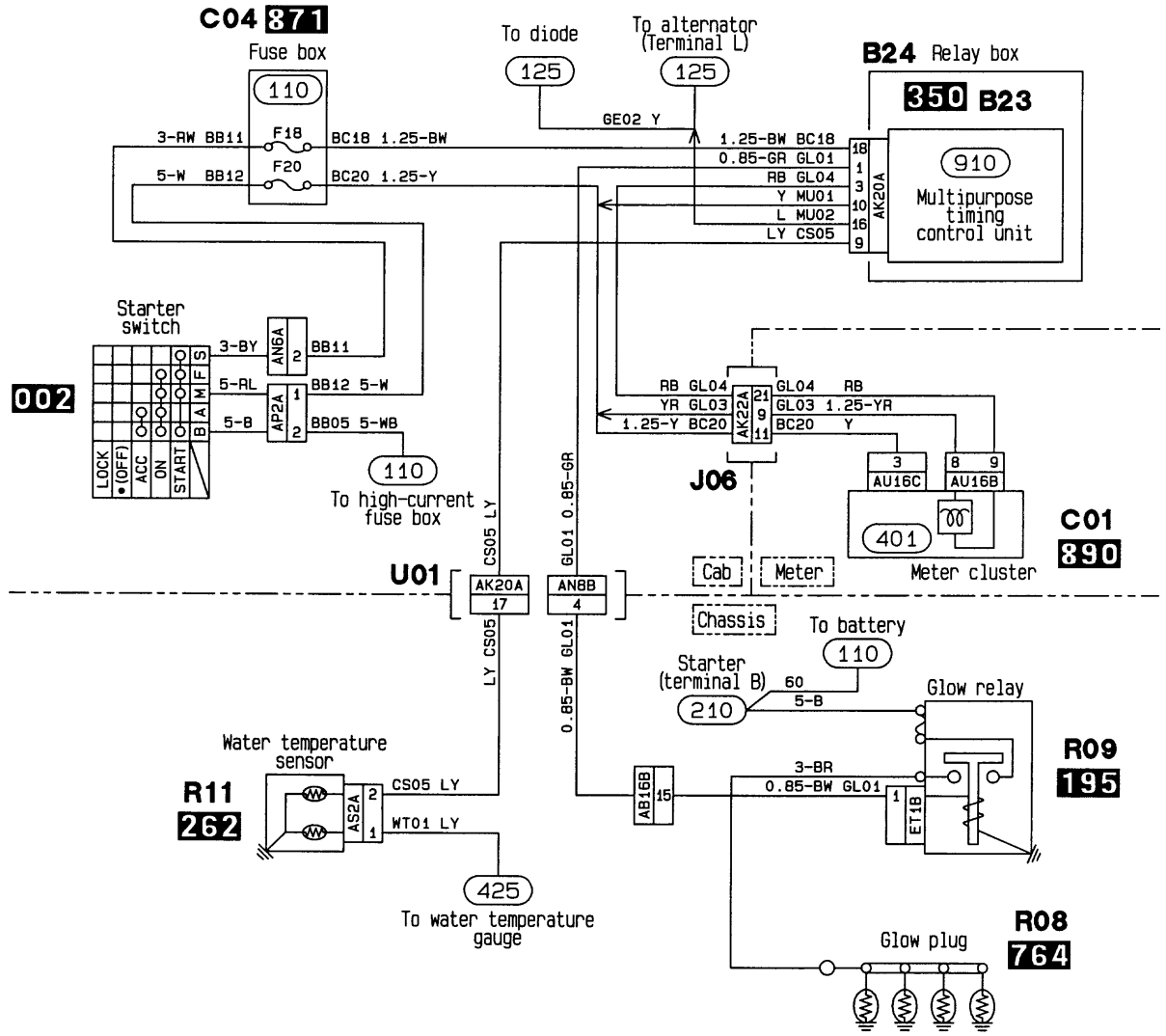
52813

<6D3>


C04 871
Fuse box
110
F18
F20
3-RW BB11
5-W BB12
BC18 1.25-BW
BC20 1.25-Y
To alternator (Terminal L)
125
B24 Relay box
350 B23
910
Multipurpose timing control unit
AK20A
1.25-BW BC18
0.85-GR GL01
RB GL04
LgR CS06
Y MU01
L MU02
GE02 Y
002 Starter switch
LOCK (OFF)
ACC
ON
START
B A M F S
3-BY
5-RL
5-B
AN6A
AP2A
BB11
BB12 5-W
BB05 5-WB
110
To high-current fuse box
Cold start switch connector A04
AE7A
CS10
LG
CS05
CS06
J06
AK20A
CS05 LG
CS06 LgR
AK22A
GL04 RB
GL03 1.25-YR
BC20 Y
AU16C
AU16B
401
C01
890
Meter cluster
U01
AK22A
AN8B
CS05 LY
GL01 0.85-GR
Cab
Meter
Chassis
G 5
0.85-GR 2601
To high-current fuse box
110
9119 5-BW
Glow relay
R09
195
8-B
2601
1.25-BW
1.25-B 19
10
130
Glow plug
R08
764
Water temperature sensor
R11
262
AS2A
5 G
73 LY
425
To water temperature gauge
Female connector
Male connector

52814

<4M5>



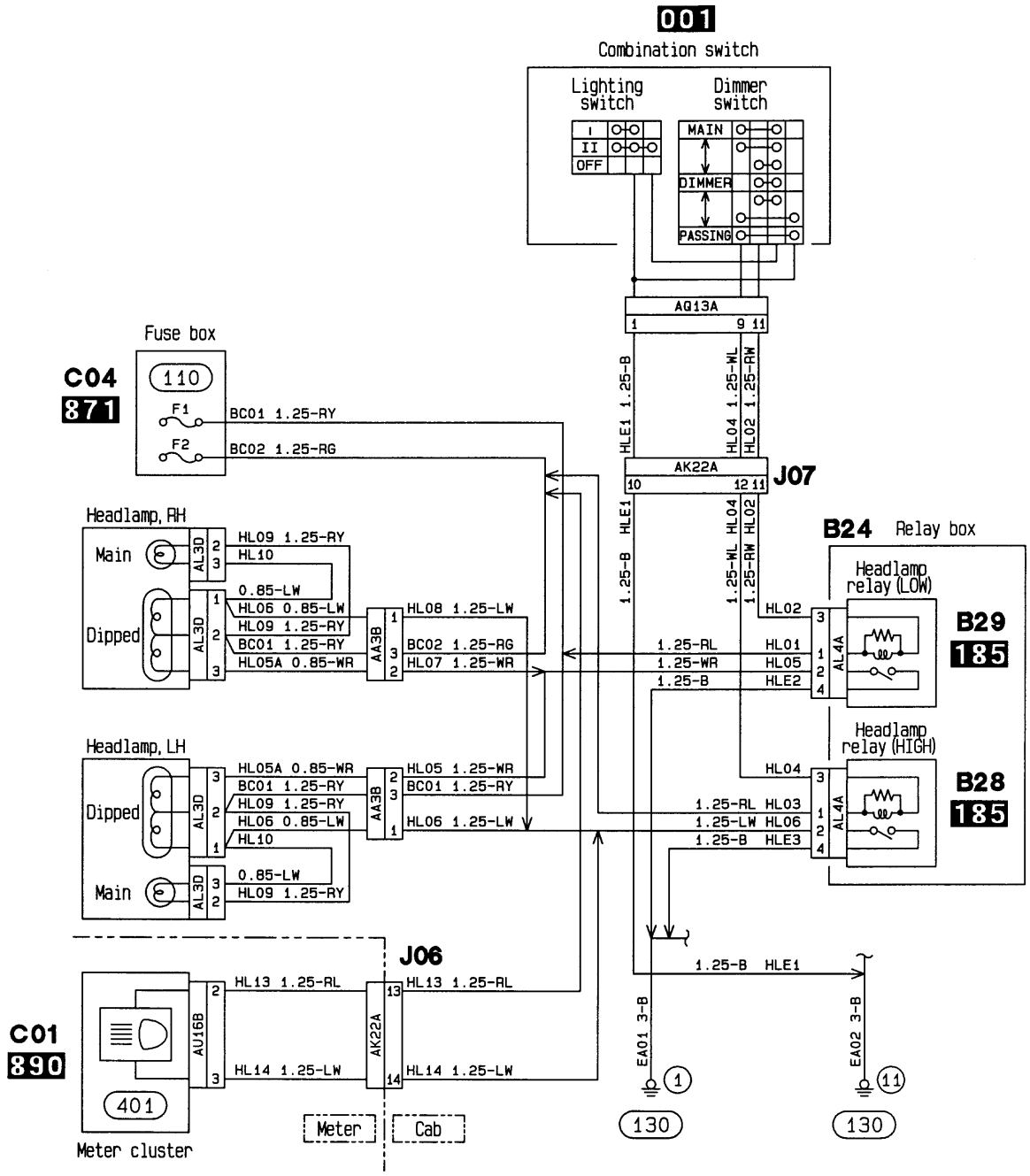
Female connector

Male connector

52815

M E M O

3 LIGHTING CIRCUIT



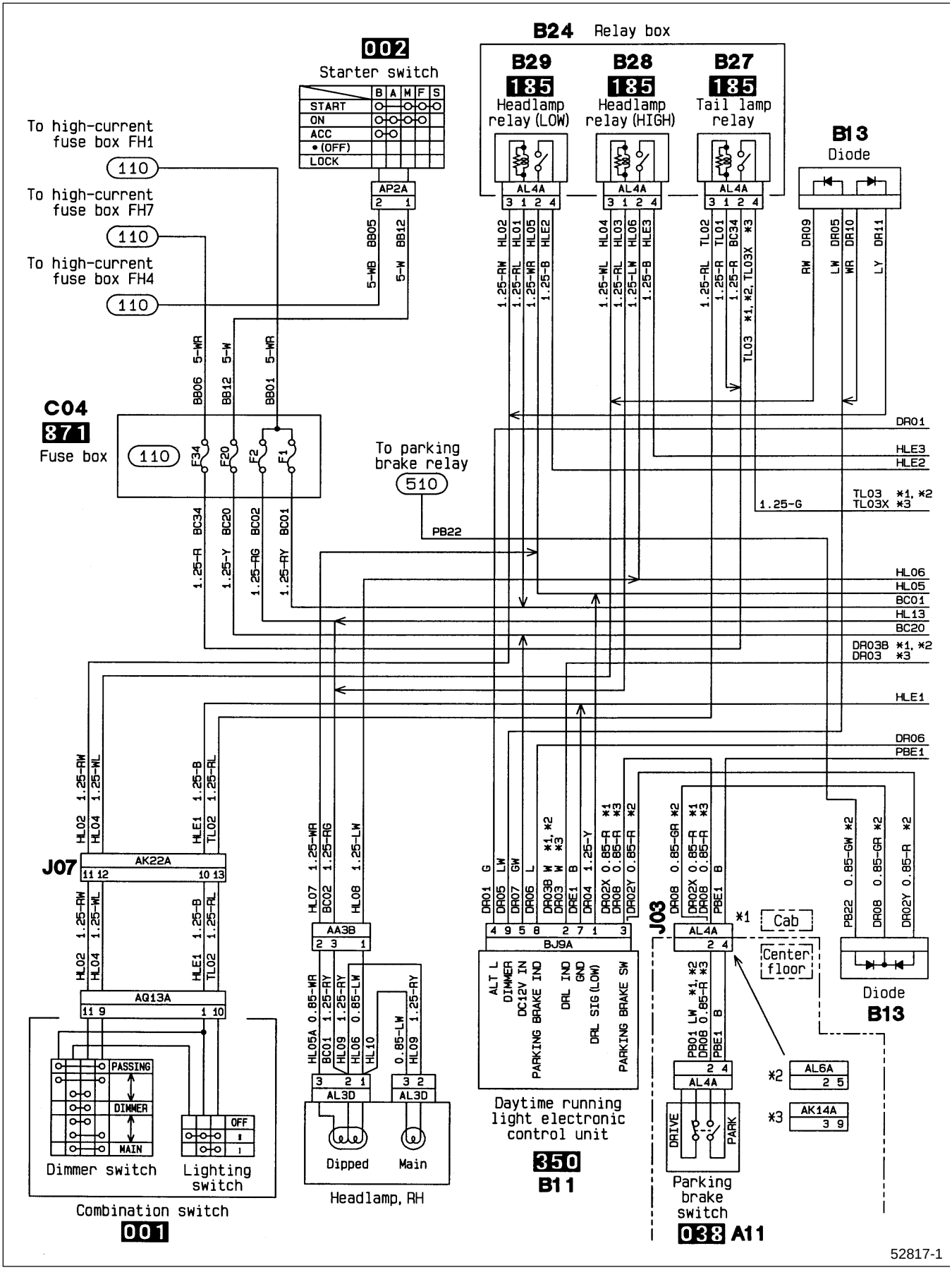
Female connector

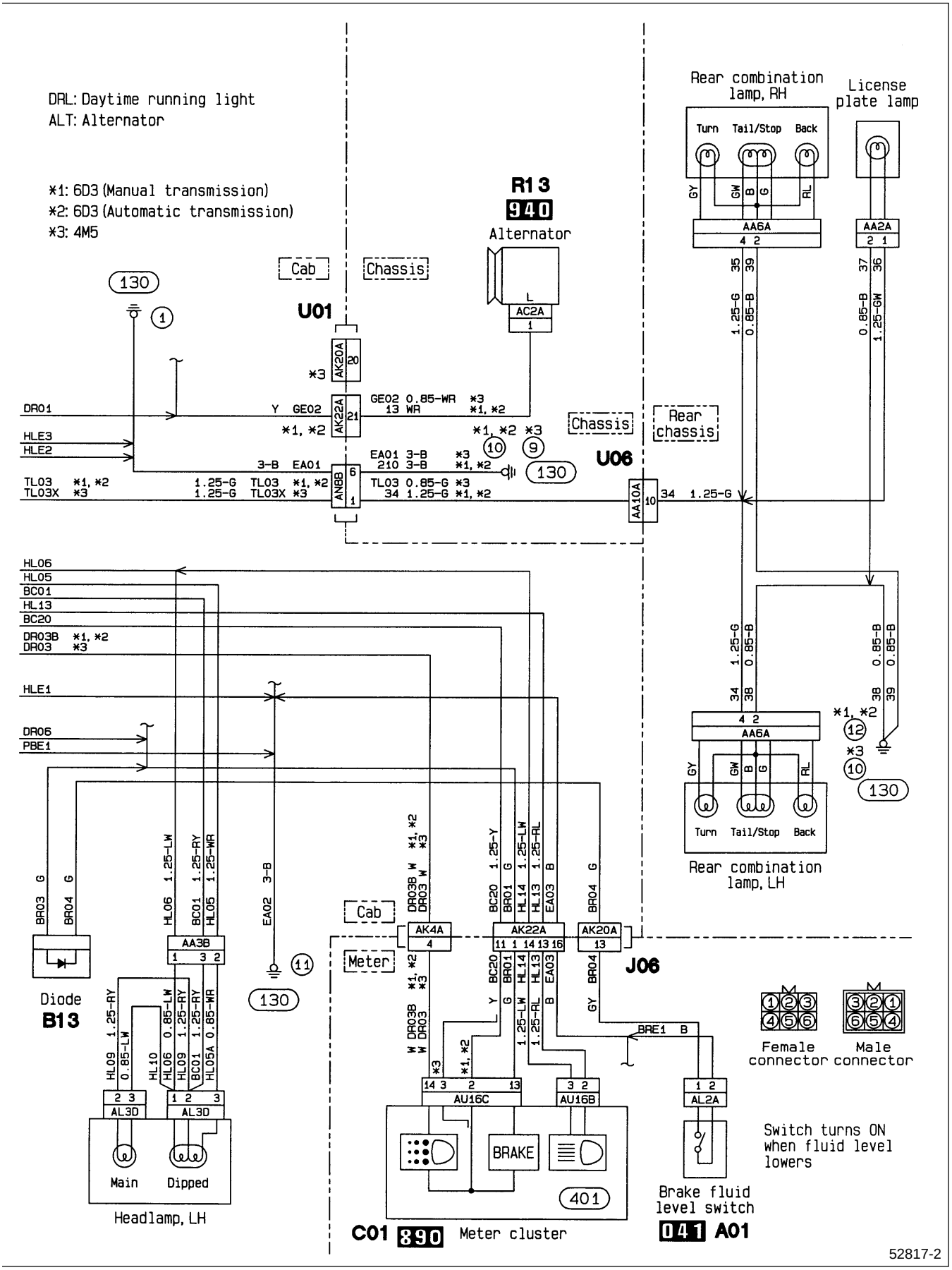
Male connector

52816

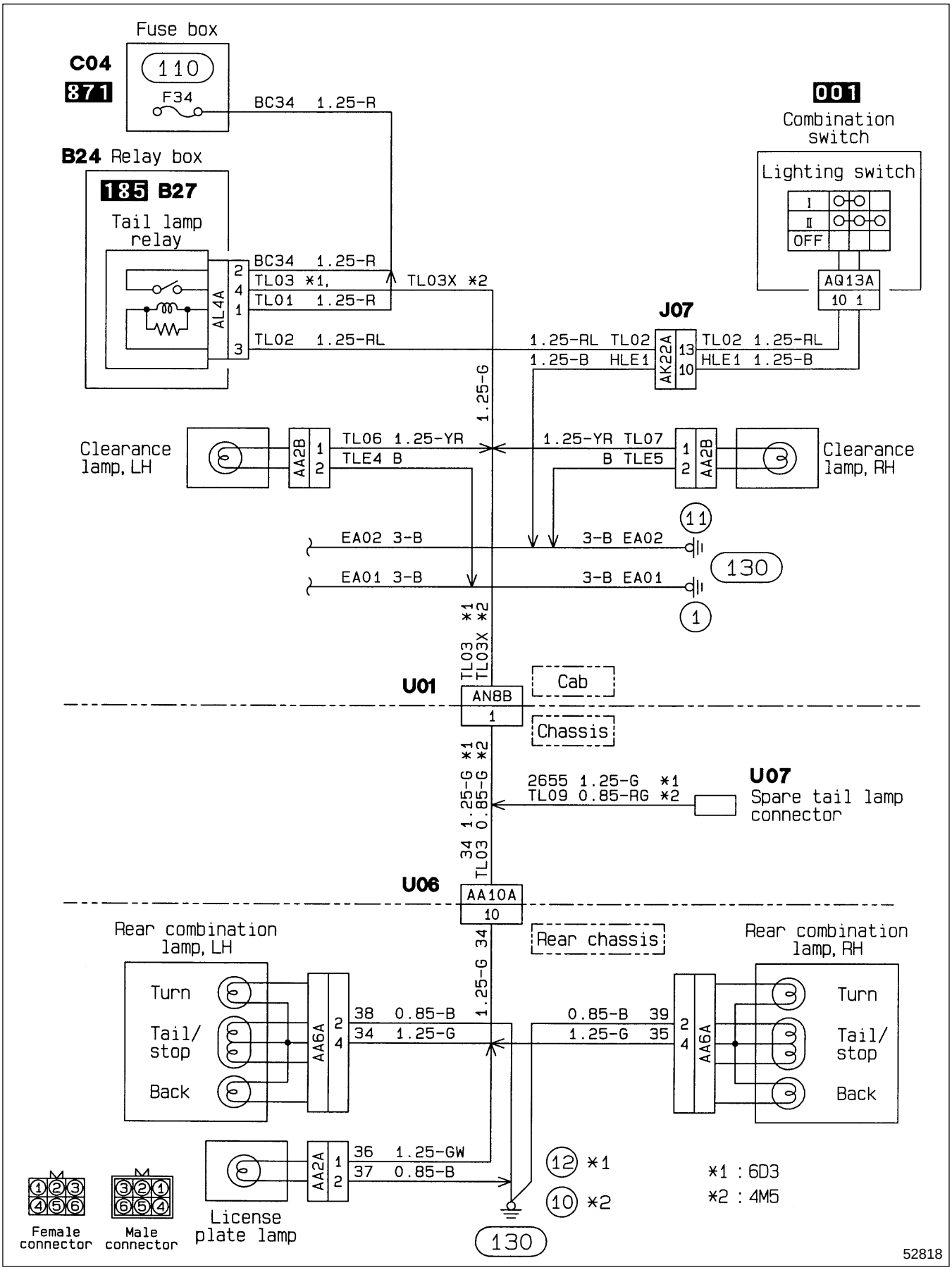
M E M O

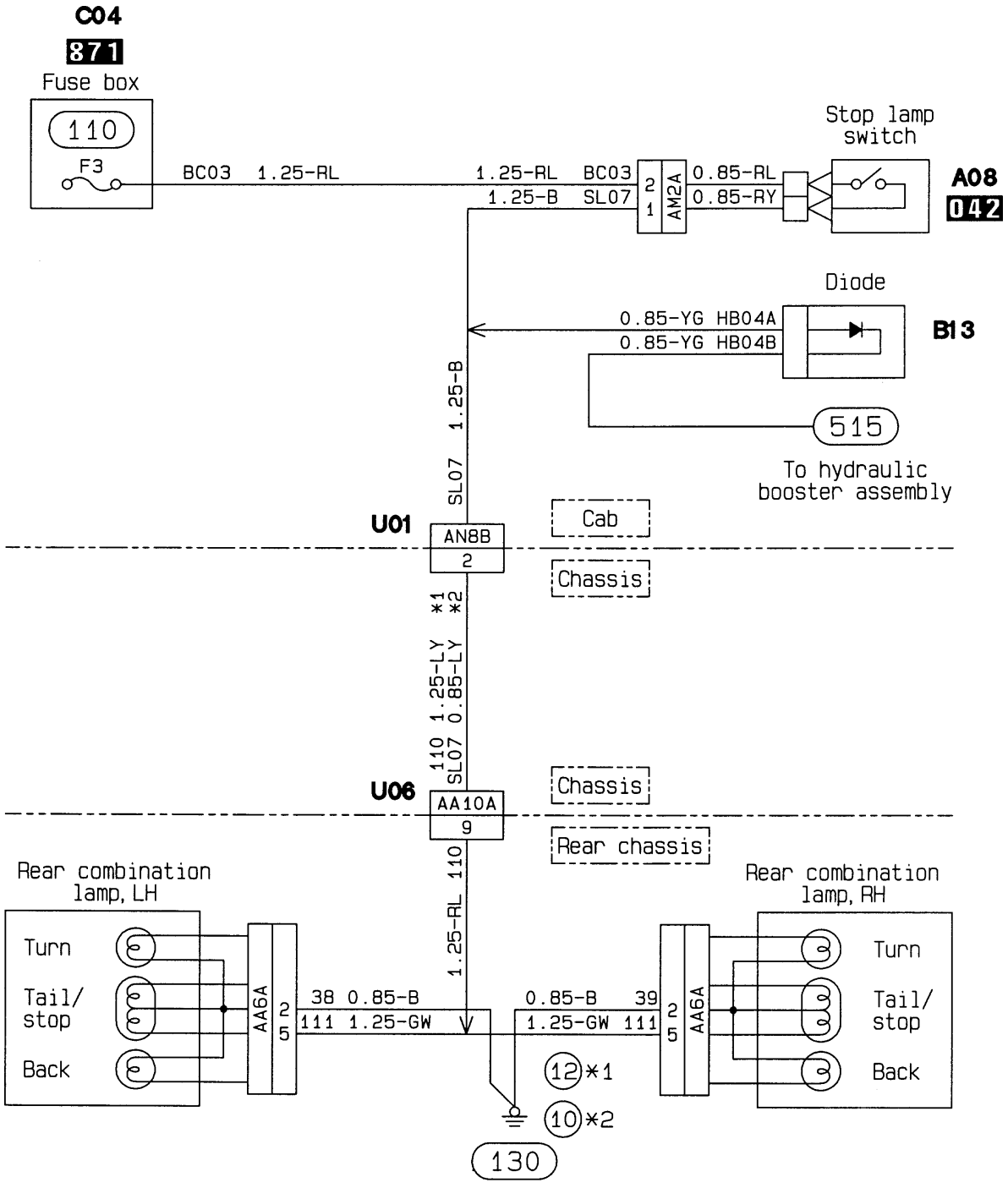
313 DAYTIME RUNNING LIGHT CIRCUIT




DRL: Daytime running light
ALT: Alternator
*1: 6D3 (Manual transmission)
*2: 6D3 (Automatic transmission)
*3: 4M5
R13 940
Alternator
Cab
Chassis
U01
130
DR01
HLE3
HLE2
TL03 *1, *2
TL03X *3
AK20A
AK22A
ANBB
AC2A
GE02 0.85-WR *3
13 WR *1, *2
EA01 3-B *3
210 3-B *1, *2
TL03 0.85-G *3
34 1.25-G *1, *2
Chassis
Rear chassis
U06
AA10A
Rear combination lamp, RH
License plate lamp
Turn
Tail/Stop
Back
AA6A
AA2A
GY
GW
B
G
RL
1.25-G
0.85-B
0.85-GW
Rear combination lamp, LH
HL06
HL05
BC01
HL13
BC20
DR03B *1, *2
DR03 *3
HLE1
DR06
PBE1
BR03 G
BR04 G
HL06 1.25-LW
BC01 1.25-RY
HL05 1.25-WR
EA02 3-B
AA3B
Diode
B13
Cab
Meter
AK4A
AK22A
AK20A
DR03B W *1, *2
DR03 W *3
BC20 1.25-Y
BR01 G
HL14 1.25-LW
HL13 1.25-RL
EA03 B
BR04 G
J06
BRE1 B
AU16C
AU16B
AL2A
BRAKE
401
C01 890 Meter cluster
Brake fluid level switch
041 A01
Switch turns ON when fluid level lowers
Female connector
Male connector
AL3D
Main
Dipped
Headlamp, LH
52817-2

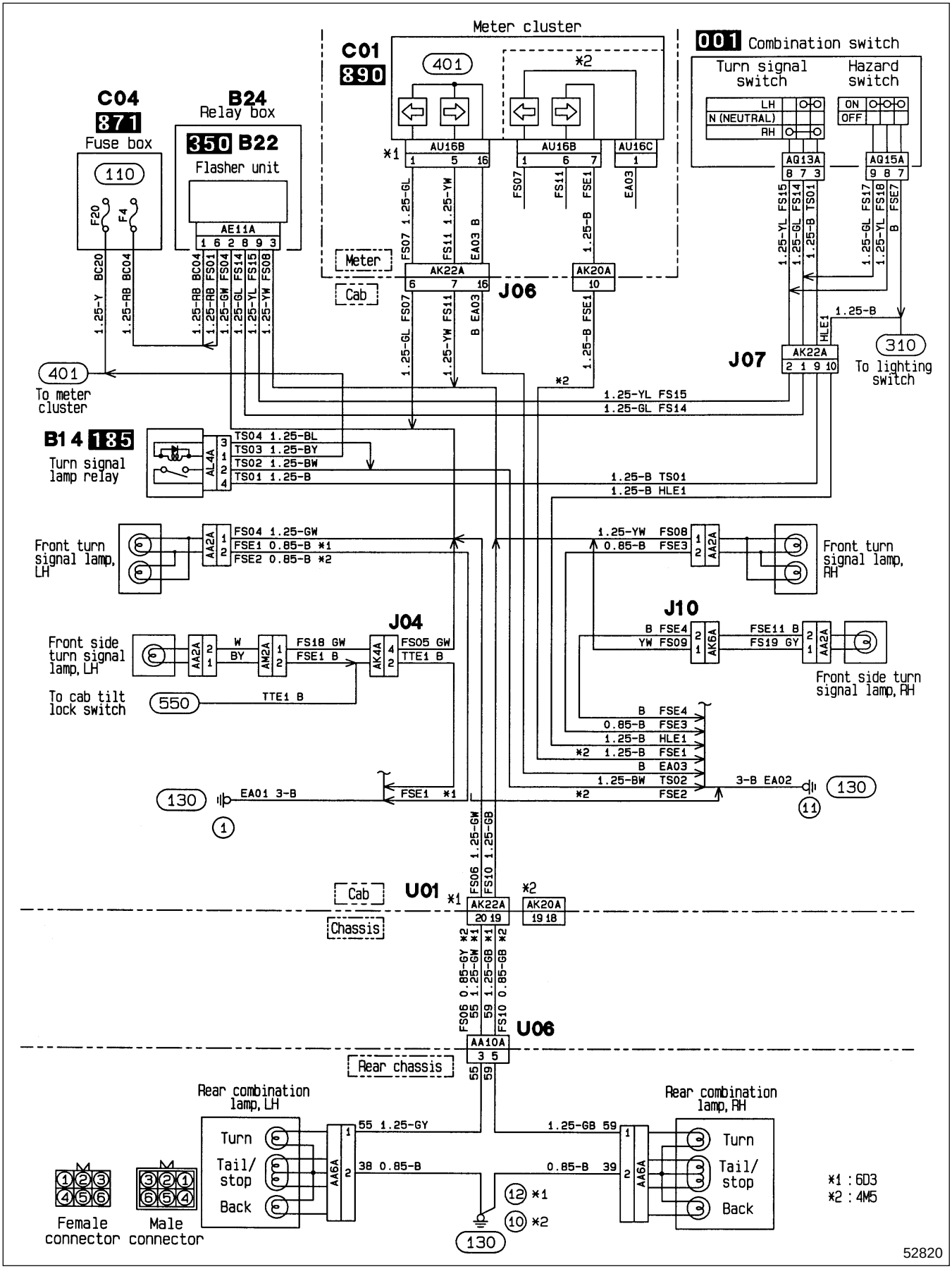
320 TAIL, CLEARANCE AND LICENSE PLATE LAMP CIRCUIT

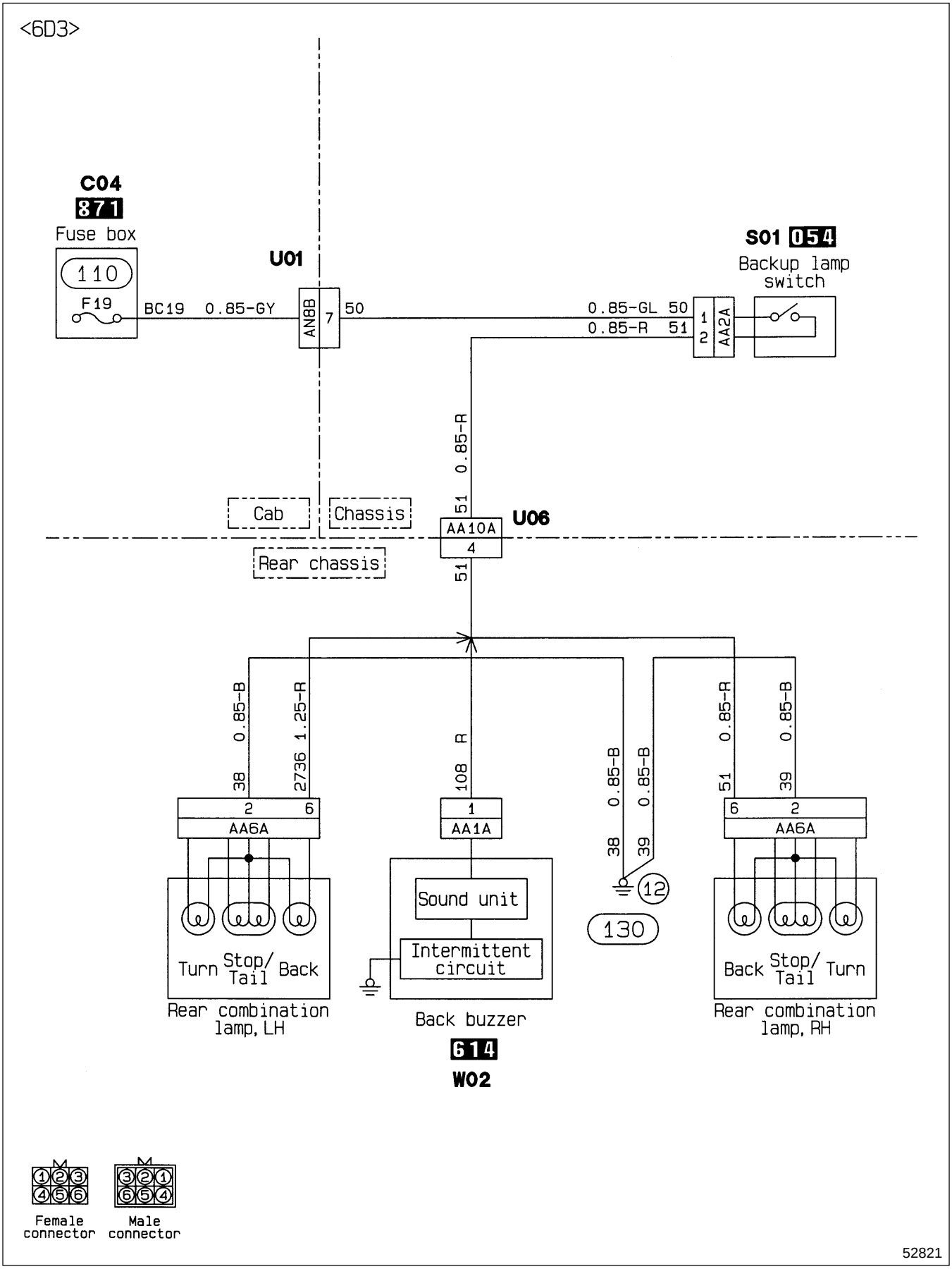



C04
871
Fuse box
110
F3
BC03 1.25-RL
1.25-RL BC03
1.25-B SL07
2
1
AM2A
0.85-RL
0.85-RY
Stop lamp switch
A08
042
Diode
0.85-YG HB04A
0.85-YG HB04B
B13
515
To hydraulic booster assembly
SL07 1.25-B
U01
AN8B
2
Cab
Chassis
*1
*2
110 1.25-LY 0.85-LY
SL07
U06
AA10A
9
Chassis
Rear chassis
110 1.25-RL
Rear combination lamp, LH
Turn
Tail/ stop
Back
AA6A
2
5
38 0.85-B
111 1.25-GW
0.85-B 39
1.25-GW 111
12 *1
10 *2
130
Rear combination lamp, RH
Turn
Tail/ stop
Back
*1 : 6D3
*2 : 4M5
Female connector
Male connector

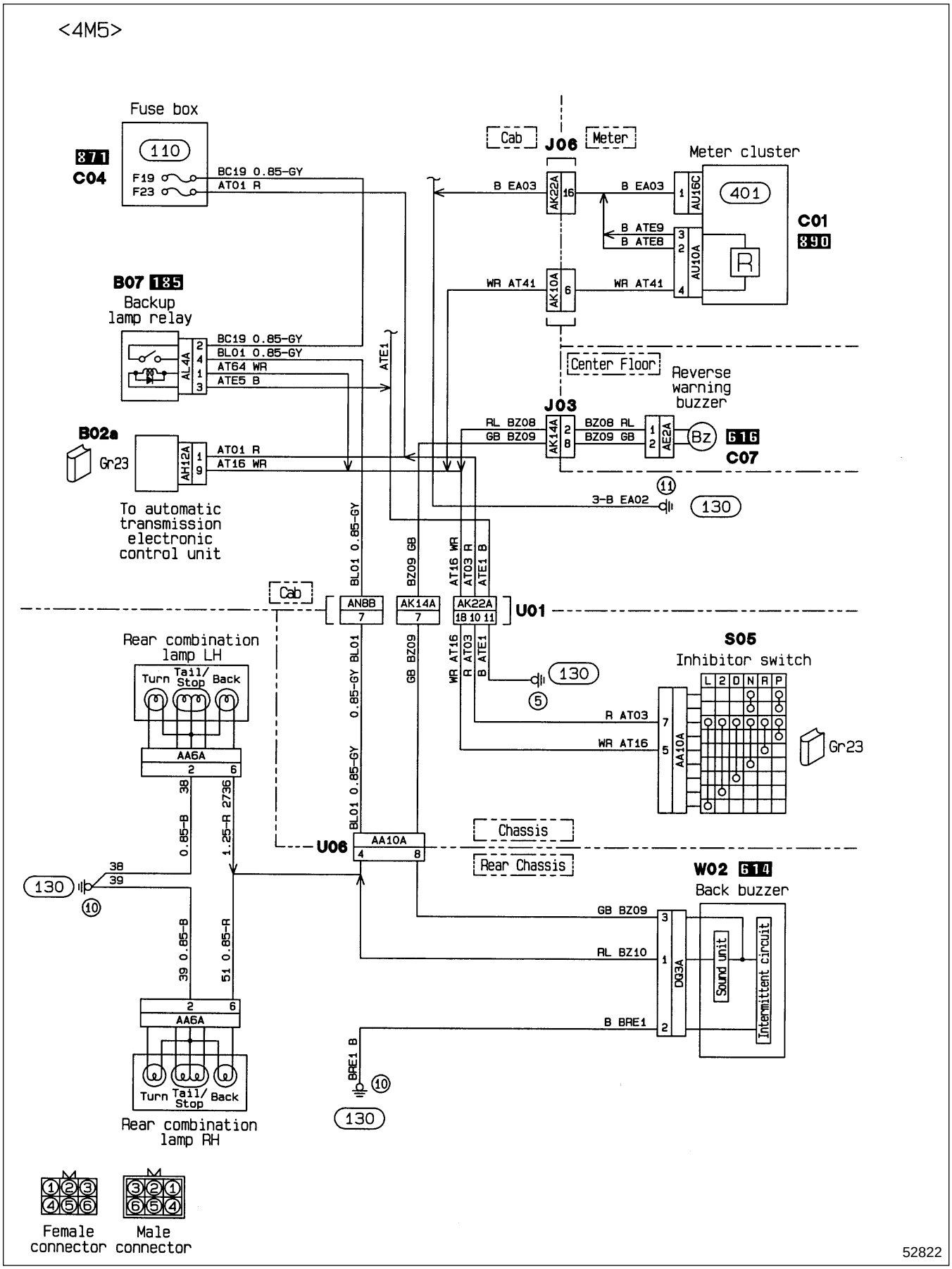
52819

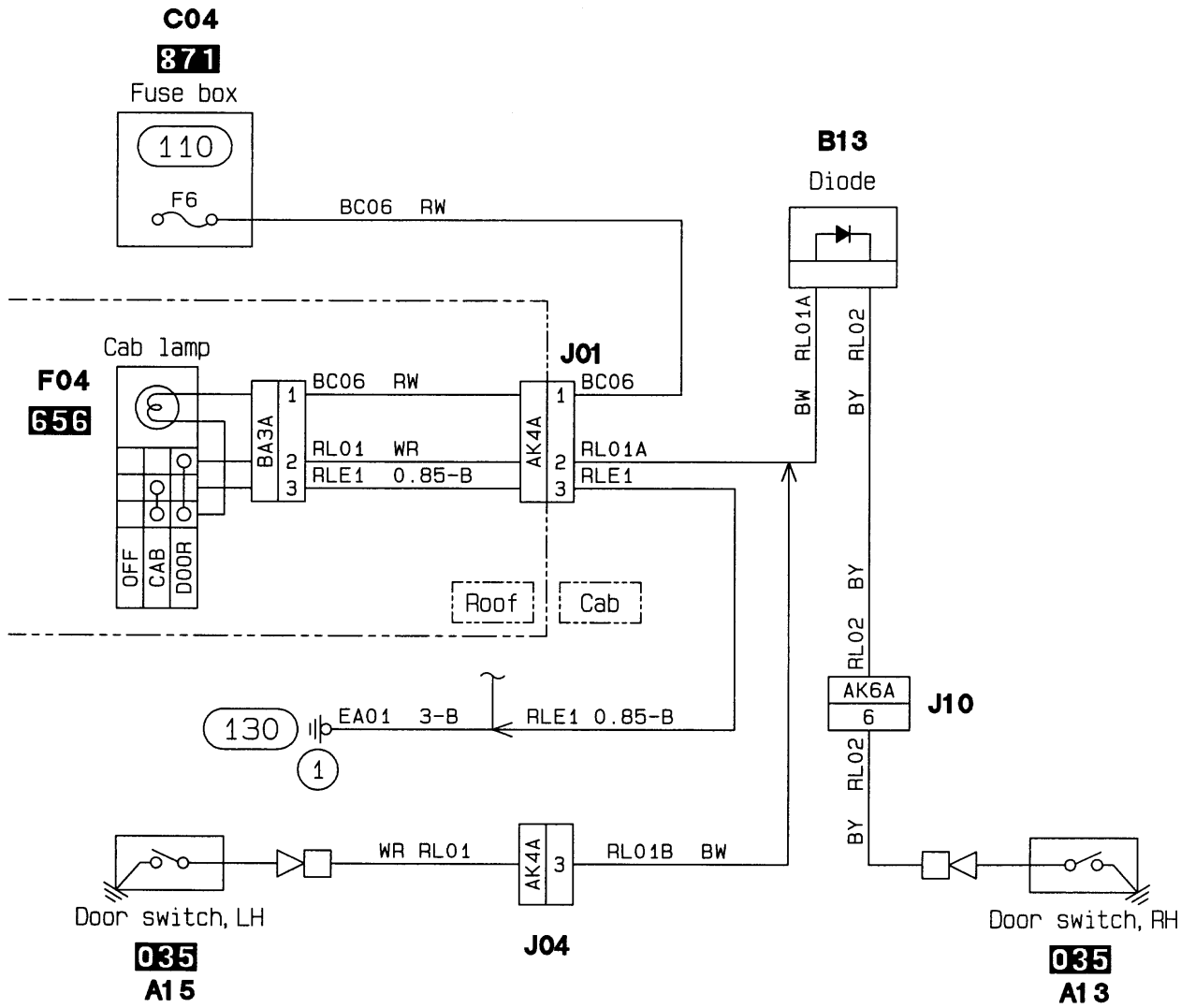
330 TURN SIGNAL AND HAZARD LAMP CIRCUIT

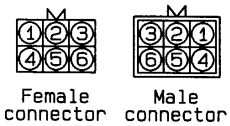



<6D3>
C04
871
Fuse box
110
F19
BC19 0.85-GY
U01
AN8B
7
50
0.85-GL 50
0.85-R 51
S01 054
Backup lamp switch
AA2A
1
2
0.85-R
51
Cab
Chassis
Rear chassis
U06
AA10A
4
51
38 0.85-B
2736 1.25-R
108 R
38 0.85-B
39 0.85-B
51 0.85-R
39 0.85-B
2 6
AA6A
1
AA1A
6 2
AA6A
Sound unit
Intermittent circuit
12
130
Turn Stop/ Tail Back
Rear combination lamp, LH
Back buzzer
614
W02
Back Stop/ Tail Turn
Rear combination lamp, RH
Female connector
Male connector
52821

340 BACKUP LAMP CIRCUIT

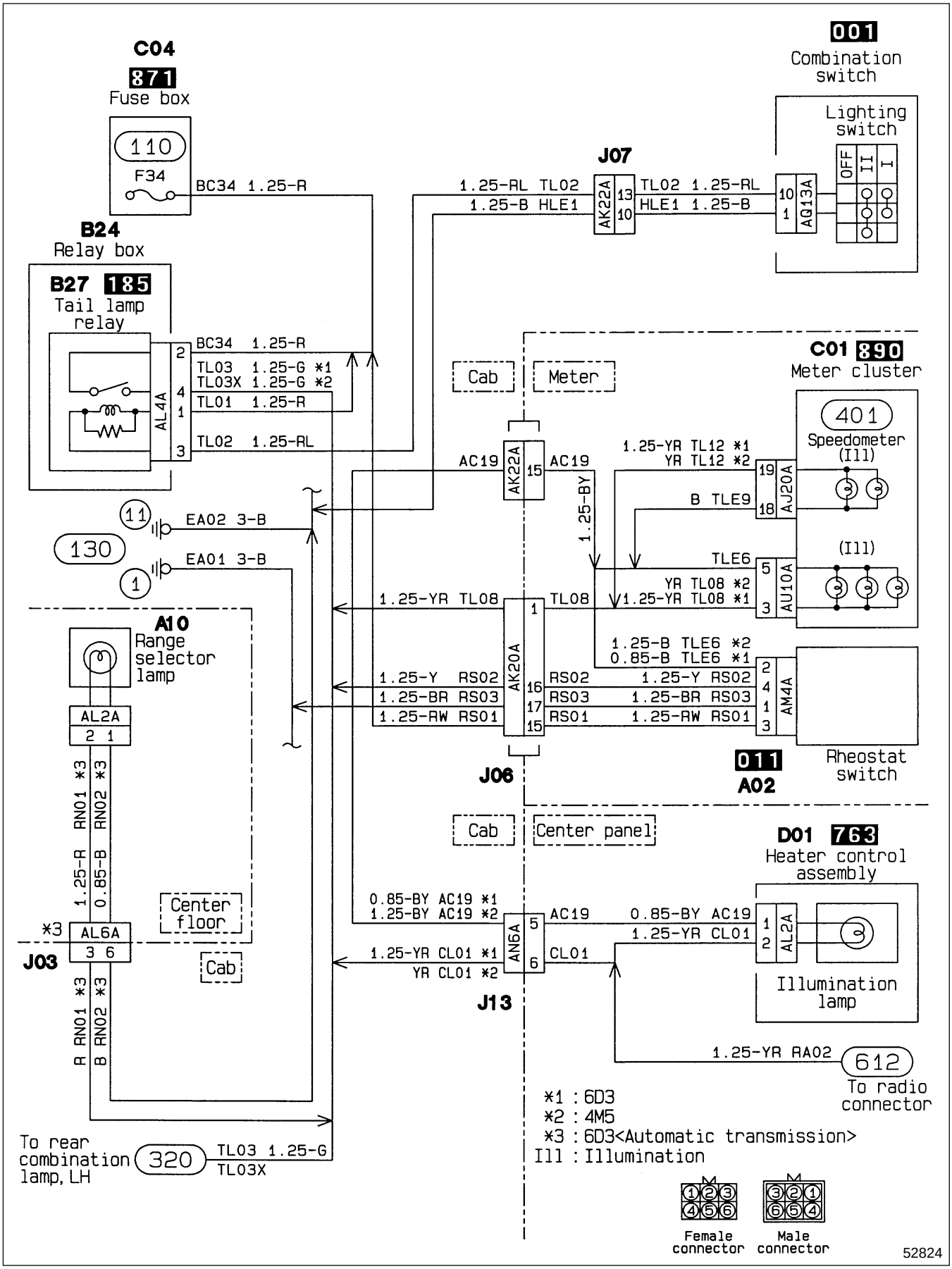


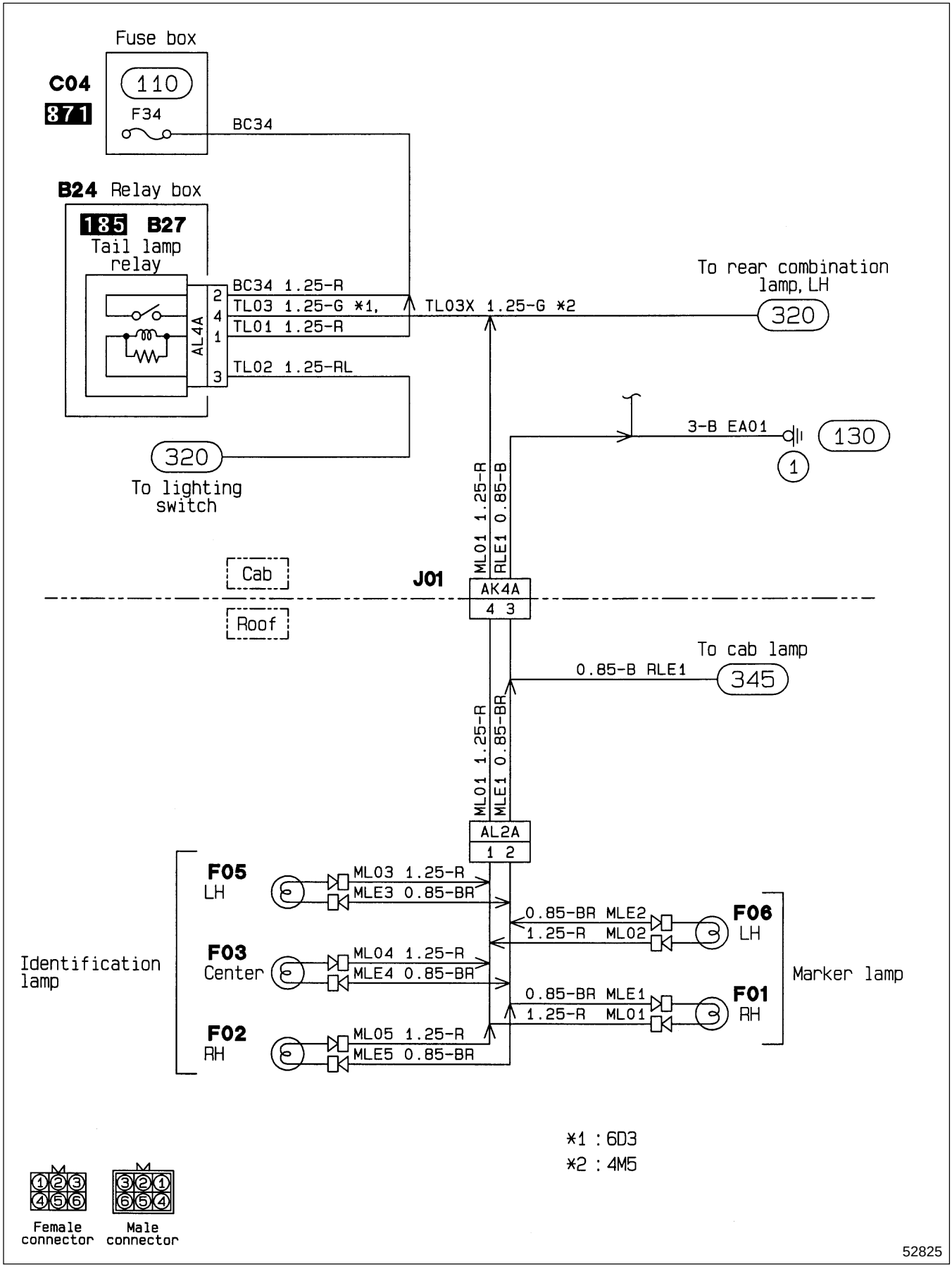

C04
871
Fuse box
110
F6
BC06 RW
B13
Diode
BW RL01A
BY RL02
Cab lamp
F04
656
J01
BA3A
AK4A
BC06 RW
RL01 WR
RLE1 0.85-B
BC06
RL01A
RLE1
OFF
CAB
DOOR
Roof
Cab
130
EA01 3-B
RLE1 0.85-B
AK6A
6
J10
WR RL01
AK4A
3
RL01B BW
Door switch, LH
035
A15
J04
Door switch, RH
035
A13


Female connector
Male connector

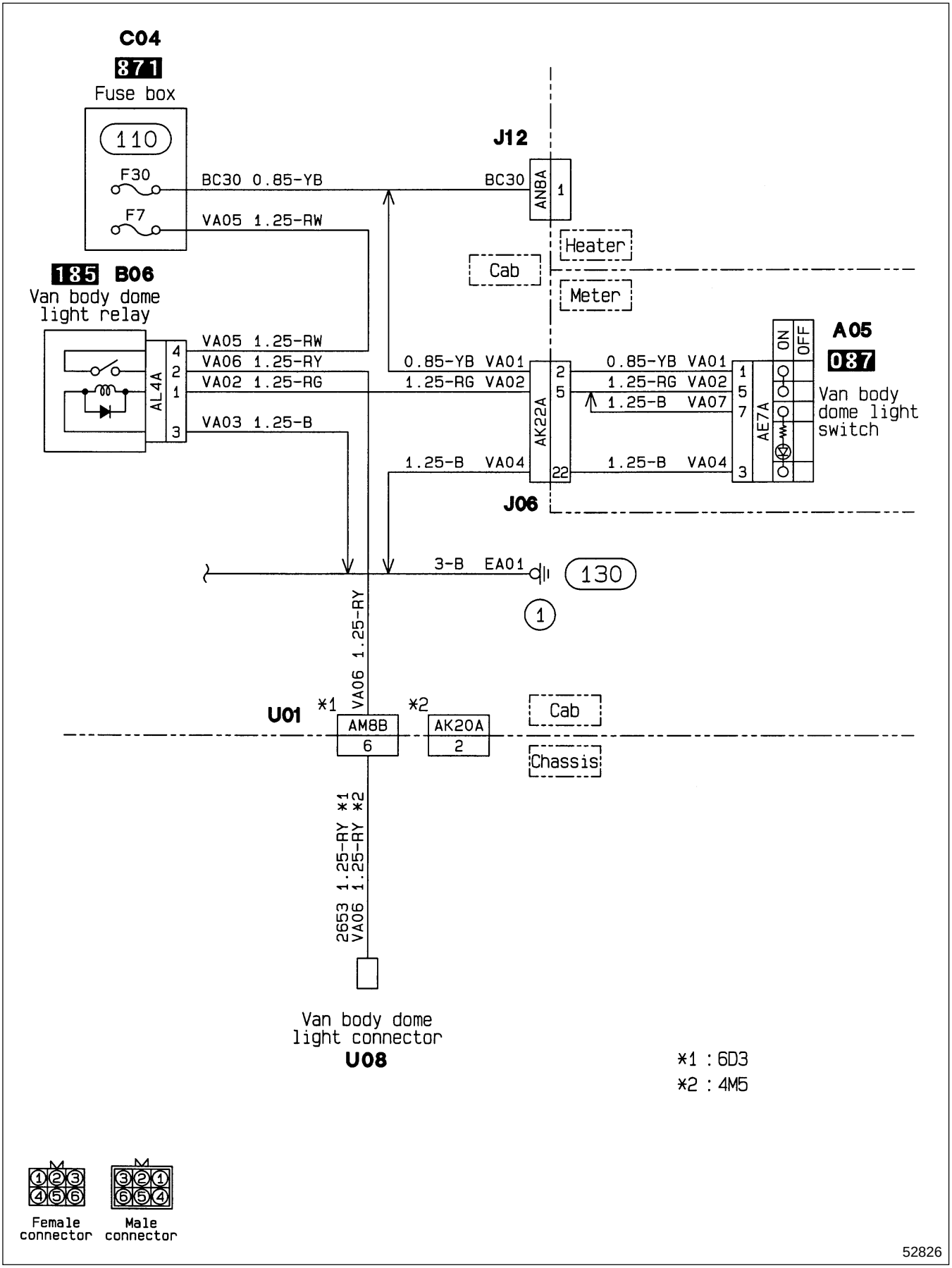
52823

348 ILLUMINATION LAMP CIRCUIT




Fuse box
C04
871
110
F34
BC34
B24 Relay box
185 B27
Tail lamp relay
AL4A
2
4
1
3
BC34 1.25-R
TL03 1.25-G *1,
TL01 1.25-R
TL02 1.25-RL
TL03X 1.25-G *2
To rear combination lamp, LH
320
320
To lighting switch
3-B EA01
130
1
ML01 1.25-R
RLE1 0.85-B
Cab
Roof
J01
AK4A
4 3
To cab lamp
0.85-B RLE1
345
ML01 1.25-R
MLE1 0.85-BR
AL2A
1 2
F05
LH
ML03 1.25-R
MLE3 0.85-BR
F03
Center
ML04 1.25-R
MLE4 0.85-BR
F02
RH
ML05 1.25-R
MLE5 0.85-BR
Identification lamp
0.85-BR MLE2
1.25-R ML02
F06
LH
0.85-BR MLE1
1.25-R ML01
F01
RH
Marker lamp
*1 : 6D3
*2 : 4M5
Female connector
Male connector
52825

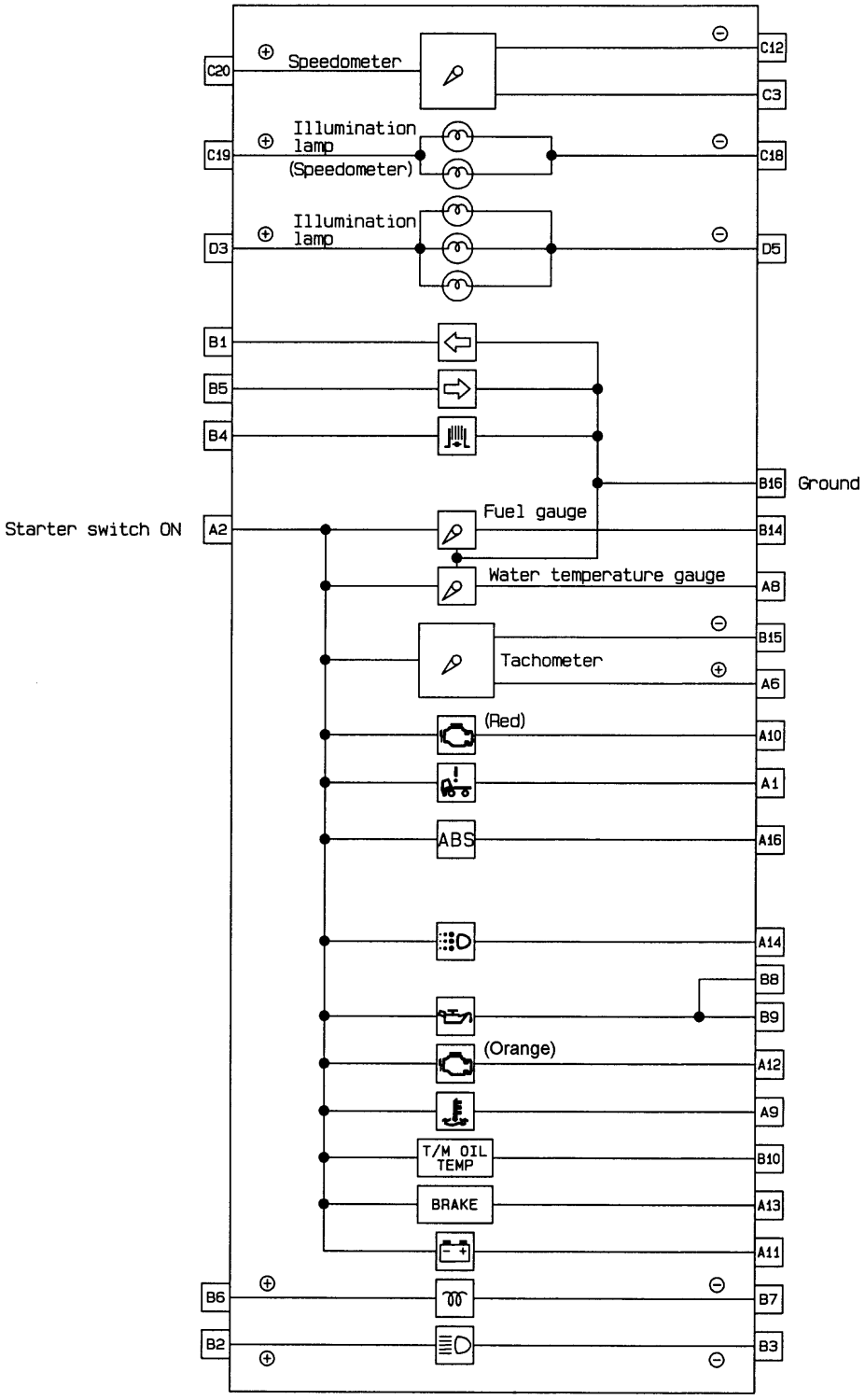
352 VAN BODY DOME LIGHT CIRCUIT



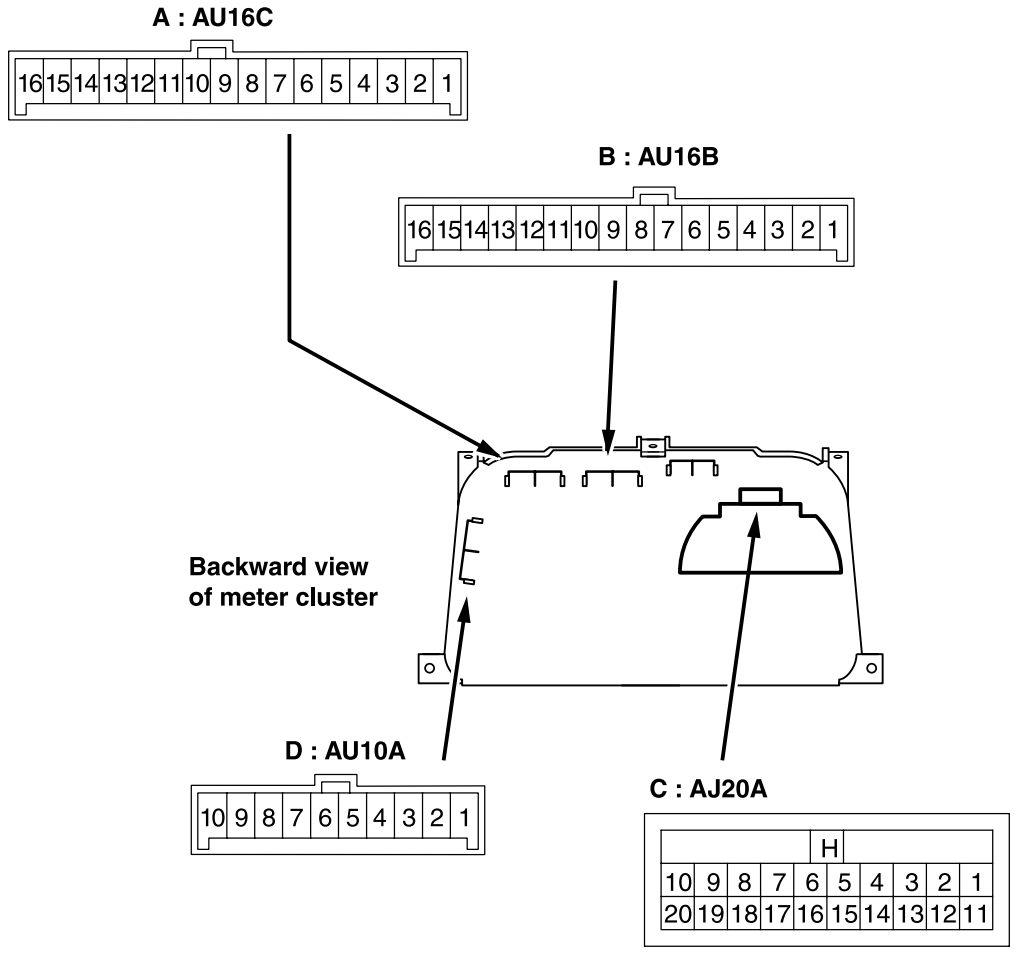
M E M O

4 METER CIRCUIT

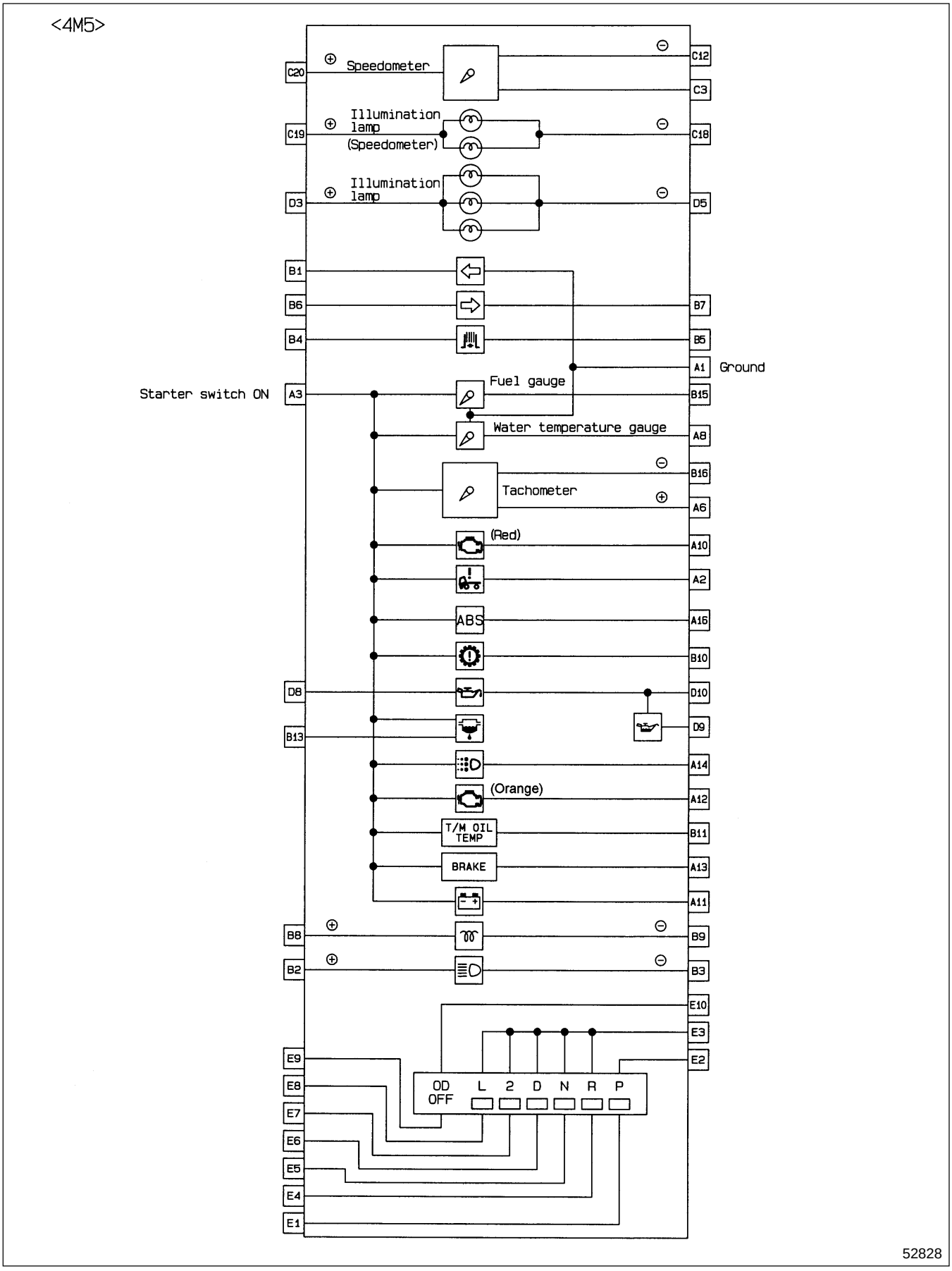
<6D3>

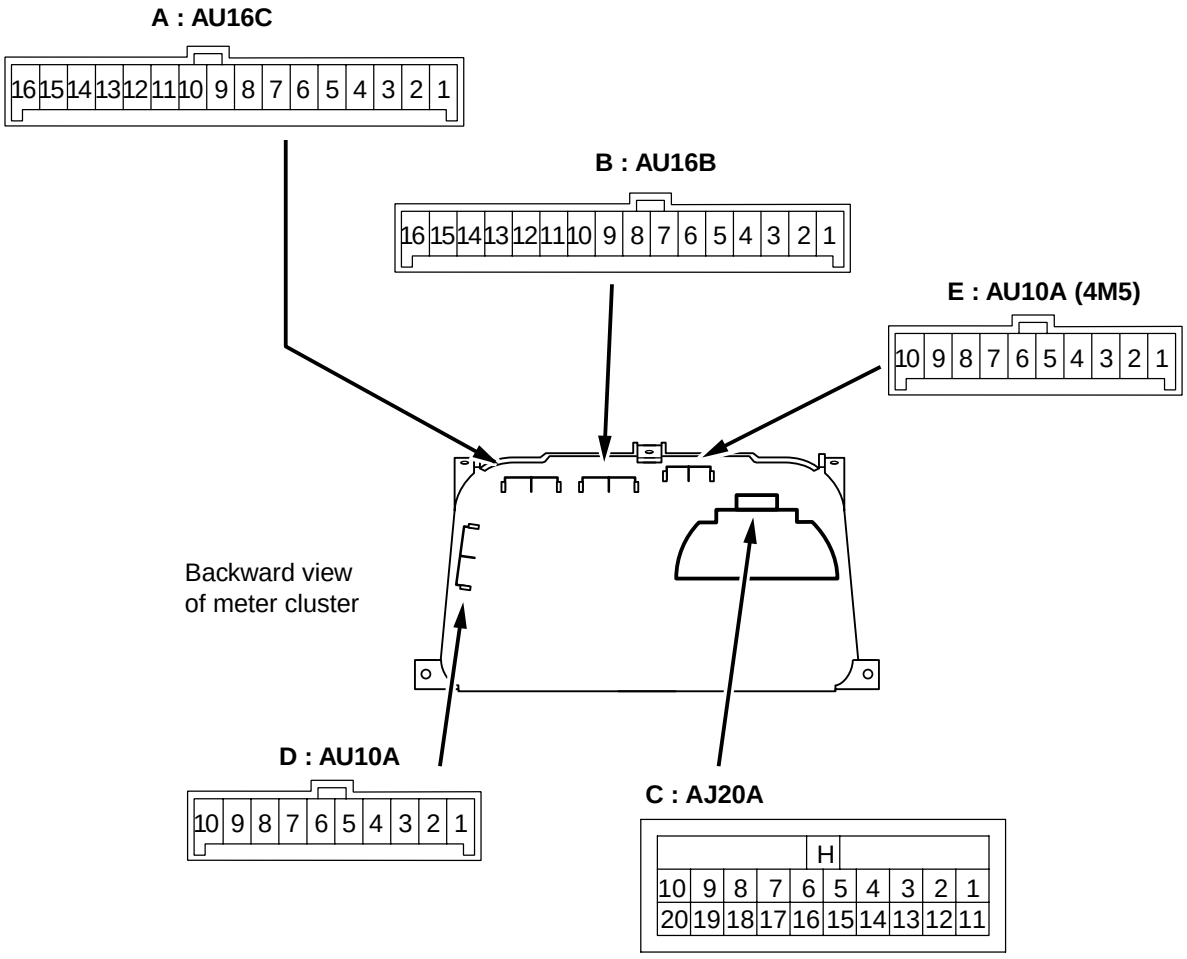

C20
Speedometer
C12
C3
C19
Illumination lamp
(Speedometer)
C18
D3
Illumination lamp
D5
B1
B5
B4
B16
Ground
Starter switch ON
A2
Fuel gauge
B14
Water temperature gauge
A8
B15
Tachometer
A6
(Red)
A10
A1
ABS
A16
A14
B8
B9
(Orange)
A12
A9
T/M OIL TEMP
B10
BRAKE
A13
A11
B6
B7
B2
B3

52827

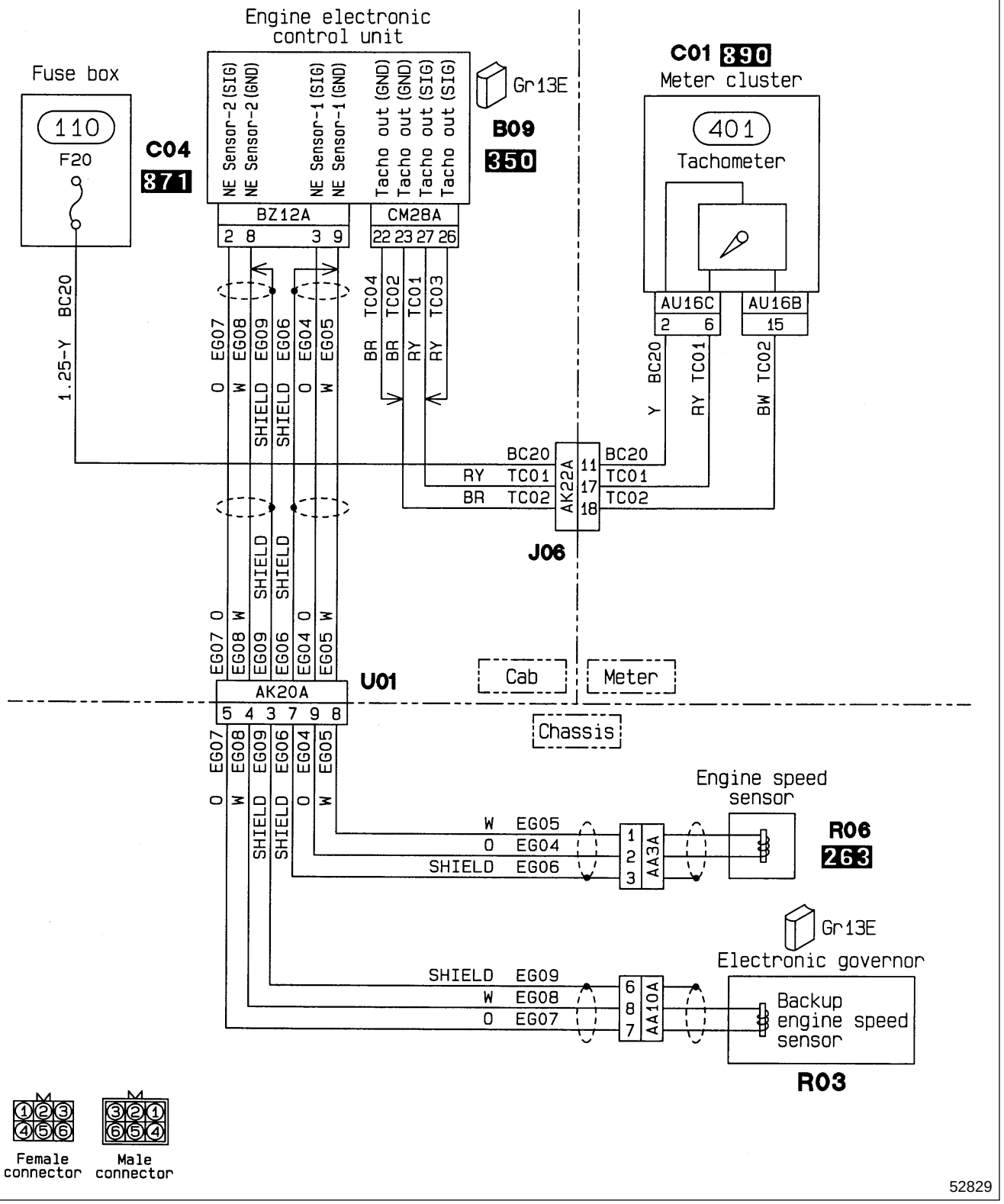

A : AU16C
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
B : AU16B
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
Backward view
of meter cluster
D : AU10A
10 9 8 7 6 5 4 3 2 1
C : AJ20A
H
10 9 8 7 6 5 4 3 2 1
20 19 18 17 16 15 14 13 12 11

Ⓟ45373

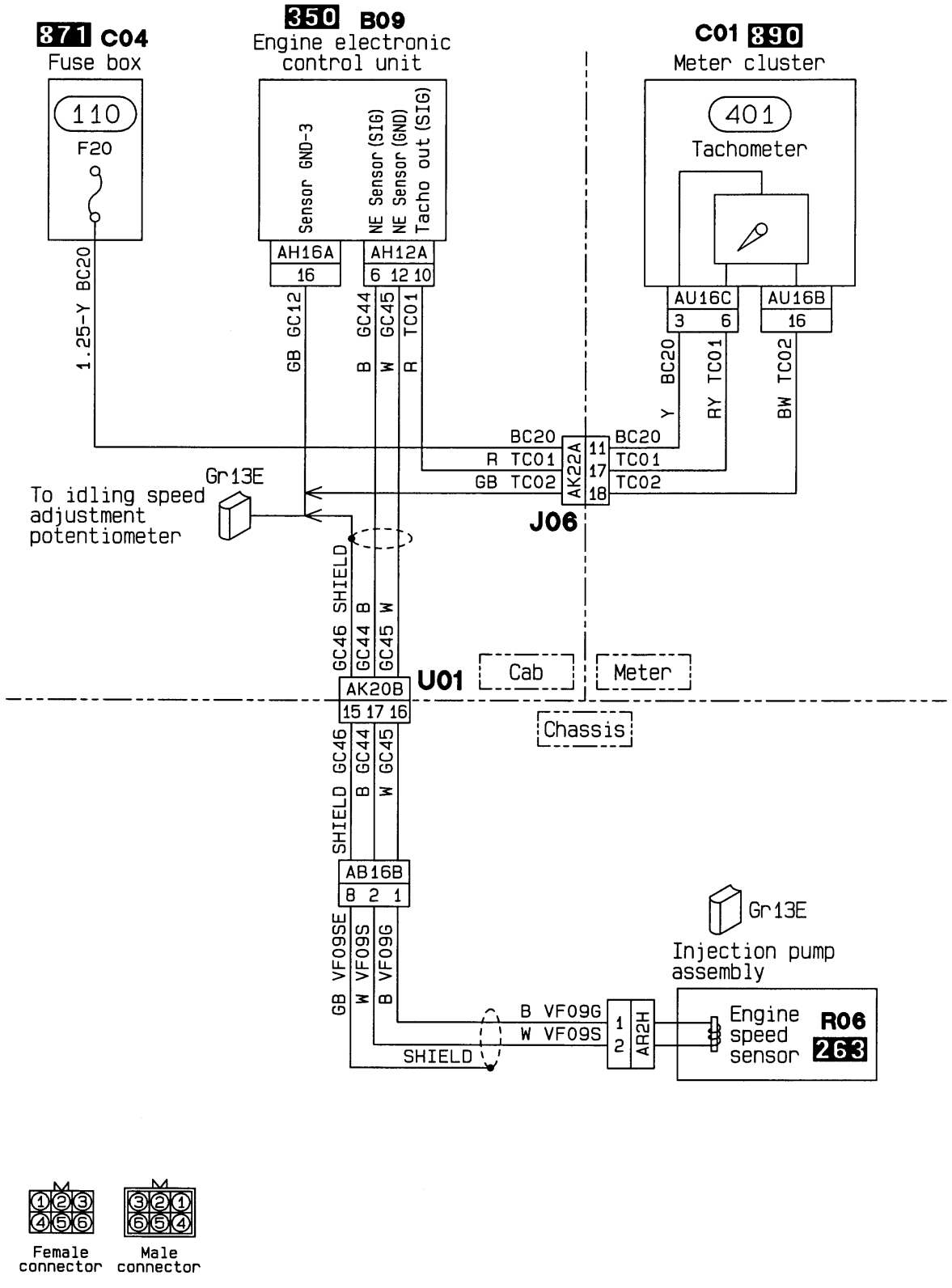

<4M5>
C20
Speedometer
C12
C3
C19
Illumination lamp (Speedometer)
C18
D3
Illumination lamp
D5
B1
B6
B4
B7
B5
A1
Ground
Starter switch ON
A3
Fuel gauge
B15
Water temperature gauge
A8
B16
Tachometer
A6
(Red)
A10
A2
ABS
A16
B10
D8
D10
D9
B13
A14
(Orange)
A12
T/M OIL TEMP
B11
BRAKE
A13
A11
B8
B9
B2
B3
E10
E3
E2
E9
E8
E7
E6
E5
E4
E1
OD OFF
L
2
D
N
R
P
52828


A : AU16C
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
B : AU16B
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
E : AU10A (4M5)
10 9 8 7 6 5 4 3 2 1
Backward view
of meter cluster
D : AU10A
10 9 8 7 6 5 4 3 2 1
C : AJ20A
H
10 9 8 7 6 5 4 3 2 1
20 19 18 17 16 15 14 13 12 11

Ⓟ48457

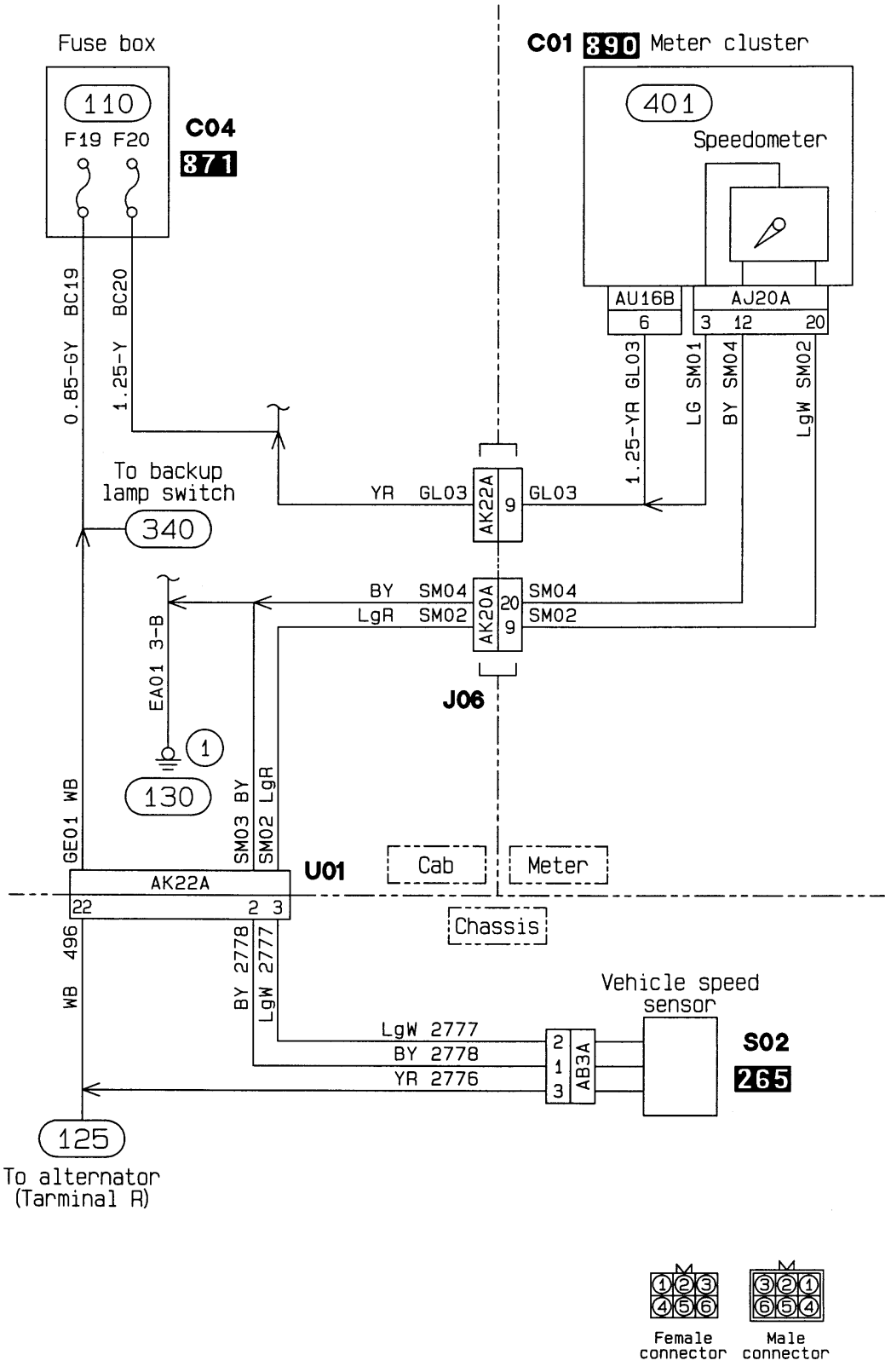

<6D3>
Engine electronic control unit
Fuse box
110
F20
C04
871
NE Sensor-2 (SIG)
NE Sensor-2 (GND)
NE Sensor-1 (SIG)
NE Sensor-1 (GND)
Tacho out (GND)
Tacho out (GND)
Tacho out (SIG)
Tacho out (SIG)
Gr13E
B09
350
BZ12A
2 8 3 9
CM28A
22 23 27 26
C01 890
Meter cluster
401
Tachometer
AU16C
2 6
AU16B
15
1.25-Y BC20
O EG07
W EG08
SHIELD EG09
SHIELD EG06
O EG04
W EG05
BR TC04
BR TC02
RY TC01
RY TC03
Y BC20
RY TC01
BW TC02
BC20
RY TC01
BR TC02
AK22A
11
17
18
J06
U01
AK20A
5 4 3 7 9 8
Cab
Meter
Chassis
Engine speed sensor
W EG05
O EG04
SHIELD EG06
AA3A
1
2
3
R06
263
Gr13E
Electronic governor
SHIELD EG09
W EG08
O EG07
AA10A
6
8
7
Backup engine speed sensor
R03
Female connector
Male connector
52829

<4M5>

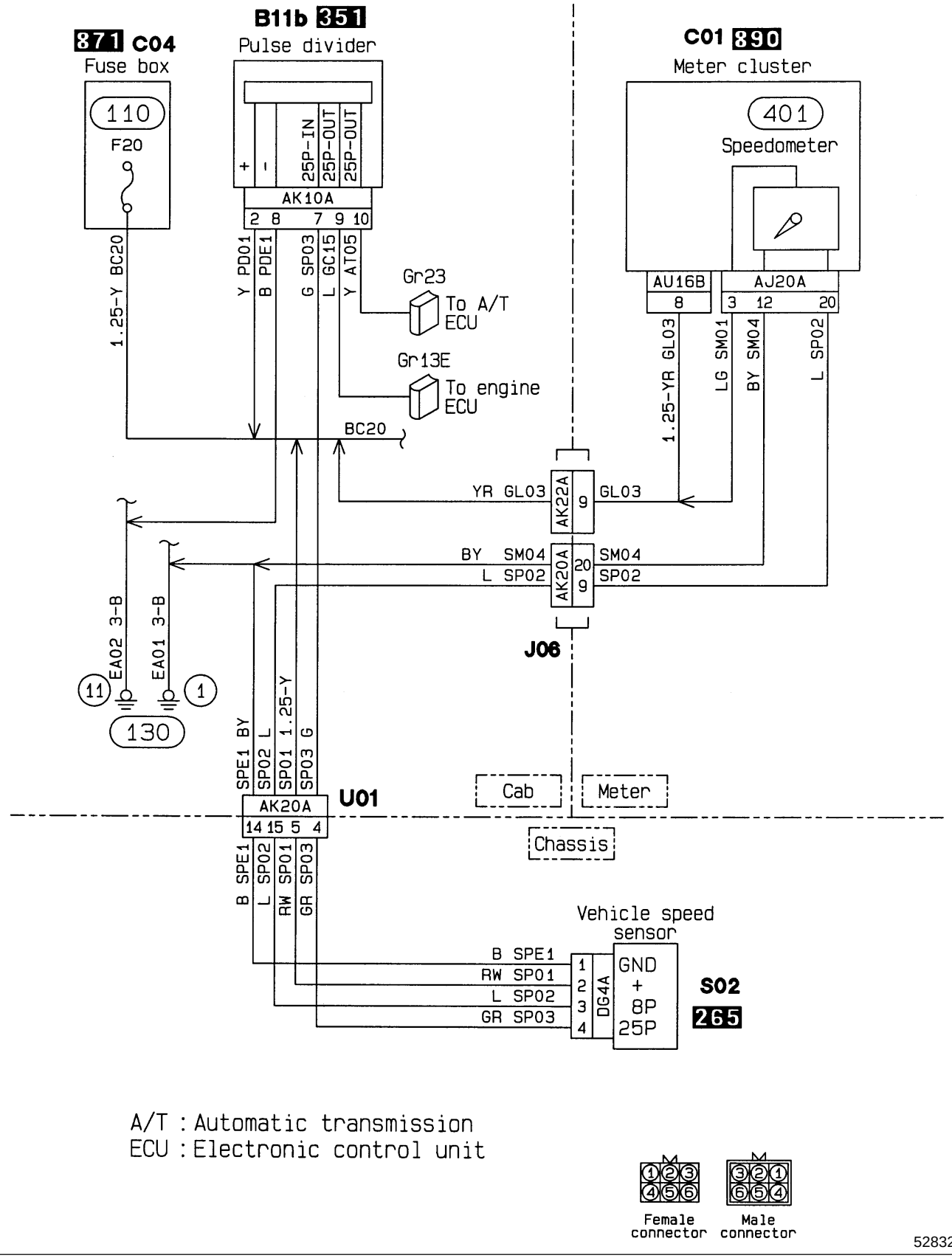

871 C04
Fuse box
110
F20
1.25-Y BC20
350 B09
Engine electronic control unit
Sensor GND-3
NE Sensor (SIG)
NE Sensor (GND)
Tacho out (SIG)
AH16A
16
AH12A
6 12 10
GB GC12
B GC44
W GC45
R TC01
C01 890
Meter cluster
401
Tachometer
AU16C
3 6
AU16B
16
Y BC20
RY TC01
BW TC02
BC20
R TC01
GB TC02
AK22A
11
17
18
BC20
TC01
TC02
J06
Gr13E
To idling speed adjustment potentiometer
GC46 SHIELD
GC44 B
GC45 W
U01
AK20B
15 17 16
Cab
Meter
Chassis
SHIELD GC46
B GC44
W GC45
AB16B
B 2 1
GB VF09SE
W VF09S
B VF09G
Gr13E
Injection pump assembly
B VF09G
W VF09S
SHIELD
1
2
AR2H
Engine speed sensor
R06
263
Female connector
Male connector

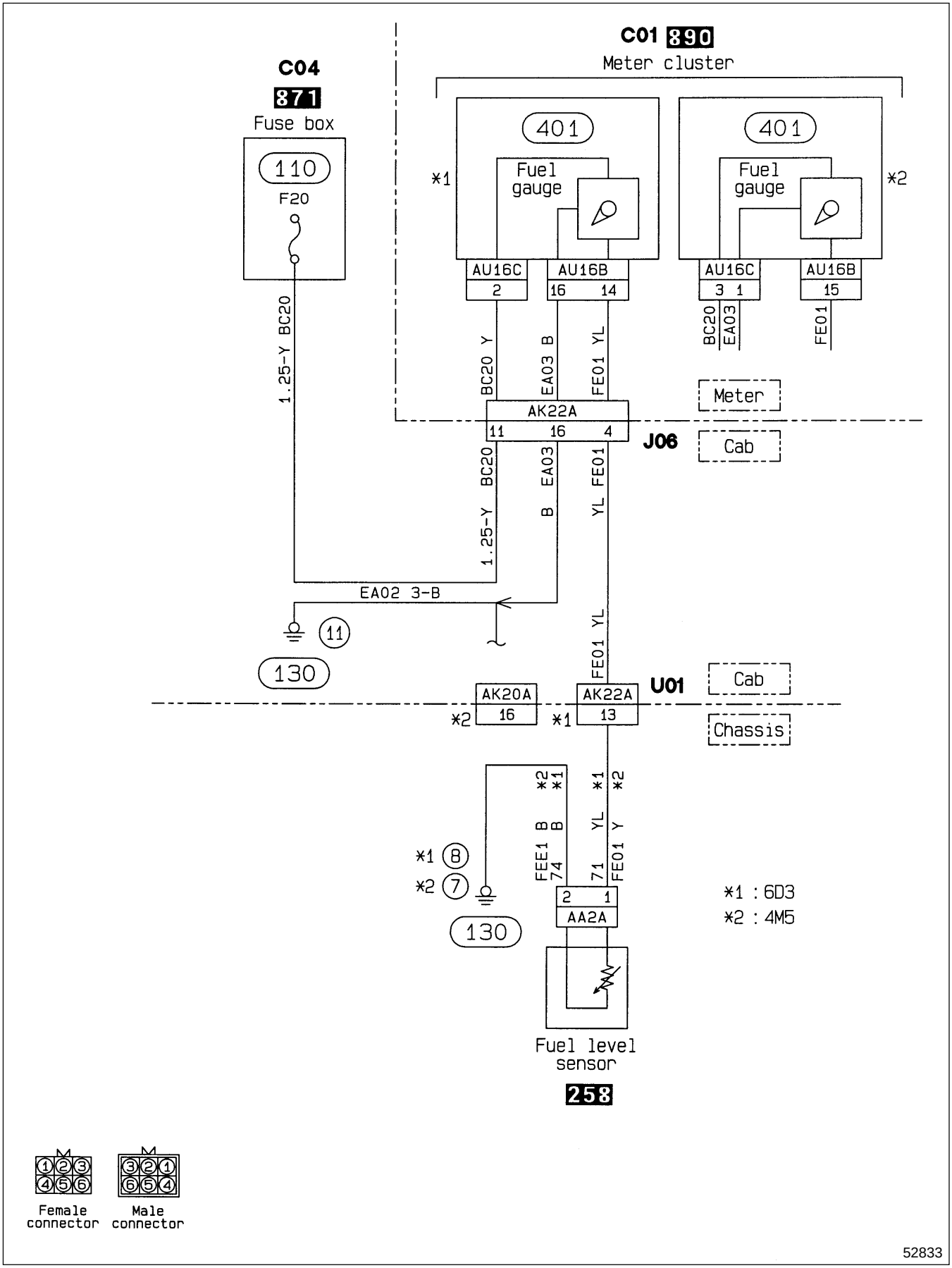
52830

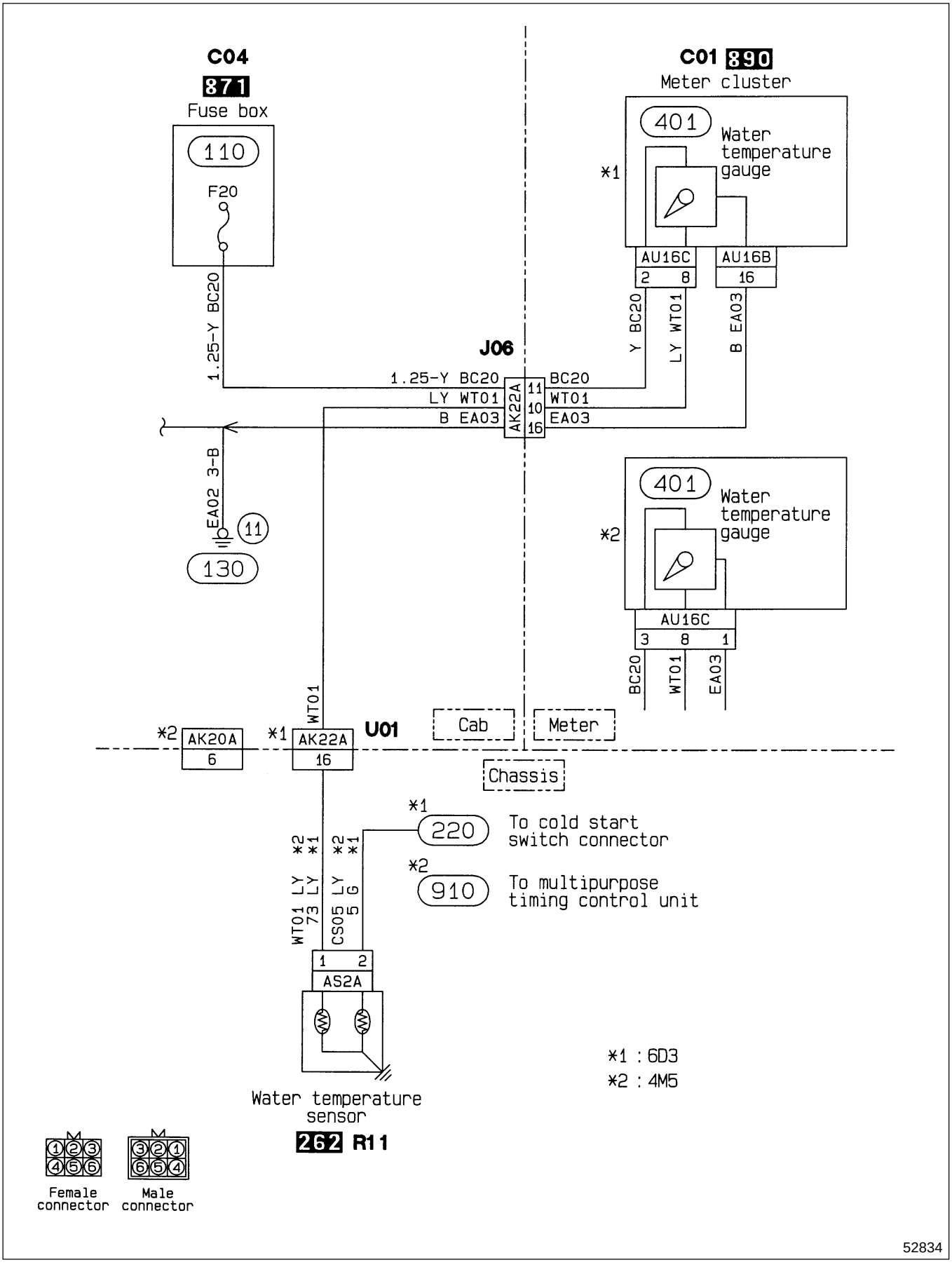
<6D3>


Fuse box
110
F19 F20
C04
871
C01 890 Meter cluster
401
Speedometer
AU16B
6
AJ20A
3 12 20
0.85-GY BC19
1.25-Y BC20
1.25-YR GL03
LG SM01
BY SM04
LgW SM02
To backup
lamp switch
340
YR GL03
AK22A
9
GL03
BY SM04
LgR SM02
AK20A
20
9
SM04
SM02
J06
EA01 3-B
1
130
GE01 WB
SM03 BY
SM02 LgR
U01
Cab
Meter
AK22A
22
2 3
Chassis
WB 496
BY 2778
LgW 2777
Vehicle speed
sensor
LgW 2777
BY 2778
YR 2776
2
1
3
AB3A
S02
265
125
To alternator
(Tarminal R)
Female
connector
Male
connector
52831

<4M5>

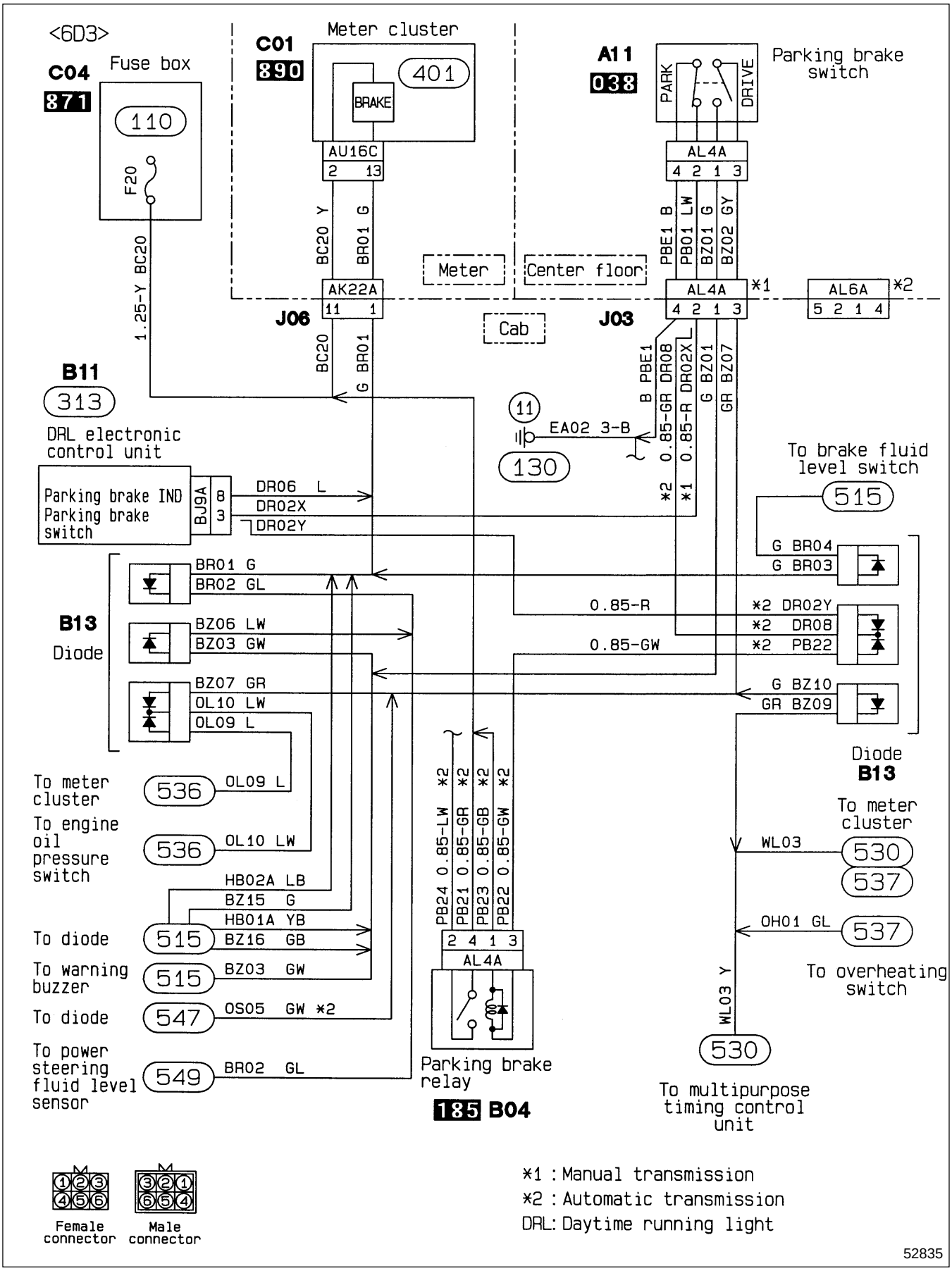

871 C04
Fuse box
110
F20
1.25-Y BC20
B11b 351
Pulse divider
+
-
25P-IN
25P-OUT
25P-OUT
AK10A
2 8 7 9 10
Y PD01
B PDE1
G SP03
L GC15
Y AT05
Gr23
To A/T ECU
Gr13E
To engine ECU
BC20
C01 890
Meter cluster
401
Speedometer
AU16B
8
AJ20A
3 12 20
1.25-YR GL03
LG SM01
BY SM04
L SP02
YR GL03
AK22A
9
GL03
BY SM04
L SP02
AK20A
20
9
SM04
SP02
J06
EA02 3-B
EA01 3-B
11
1
130
SPE1 BY
SP02 L
SP01 1.25-Y
SP03 G
U01
AK20A
14 15 5 4
Cab
Meter
Chassis
B SPE1
L SP02
RW SP01
GR SP03
Vehicle speed sensor
B SPE1
RW SP01
L SP02
GR SP03
1
2
3
4
DG4A
GND
+
8P
25P
S02
265
A/T : Automatic transmission
ECU : Electronic control unit
Female connector
Male connector
52832


C01 890
Meter cluster
C04
871
Fuse box
110
F20
401
401
*1
*2
Fuel gauge
Fuel gauge
AU16C
2
AU16B
16 14
AU16C
3 1
AU16B
15
1.25-Y BC20
BC20 Y
EA03 B
FE01 YL
BC20
EA03
FE01
Meter
AK22A
11 16 4
J06
Cab
1.25-Y BC20
B EA03
YL FE01
EA02 3-B
11
130
FE01 YL
U01
Cab
AK20A
16
*2
AK22A
13
*1
Chassis
*2 *1
FEE1 B
74 B
*1 YL
71
*2
FE01 Y
*1 8
*2 7
2 1
AA2A
130
*1 : 6D3
*2 : 4M5
Fuel level sensor
258
Female connector
Male connector
52833

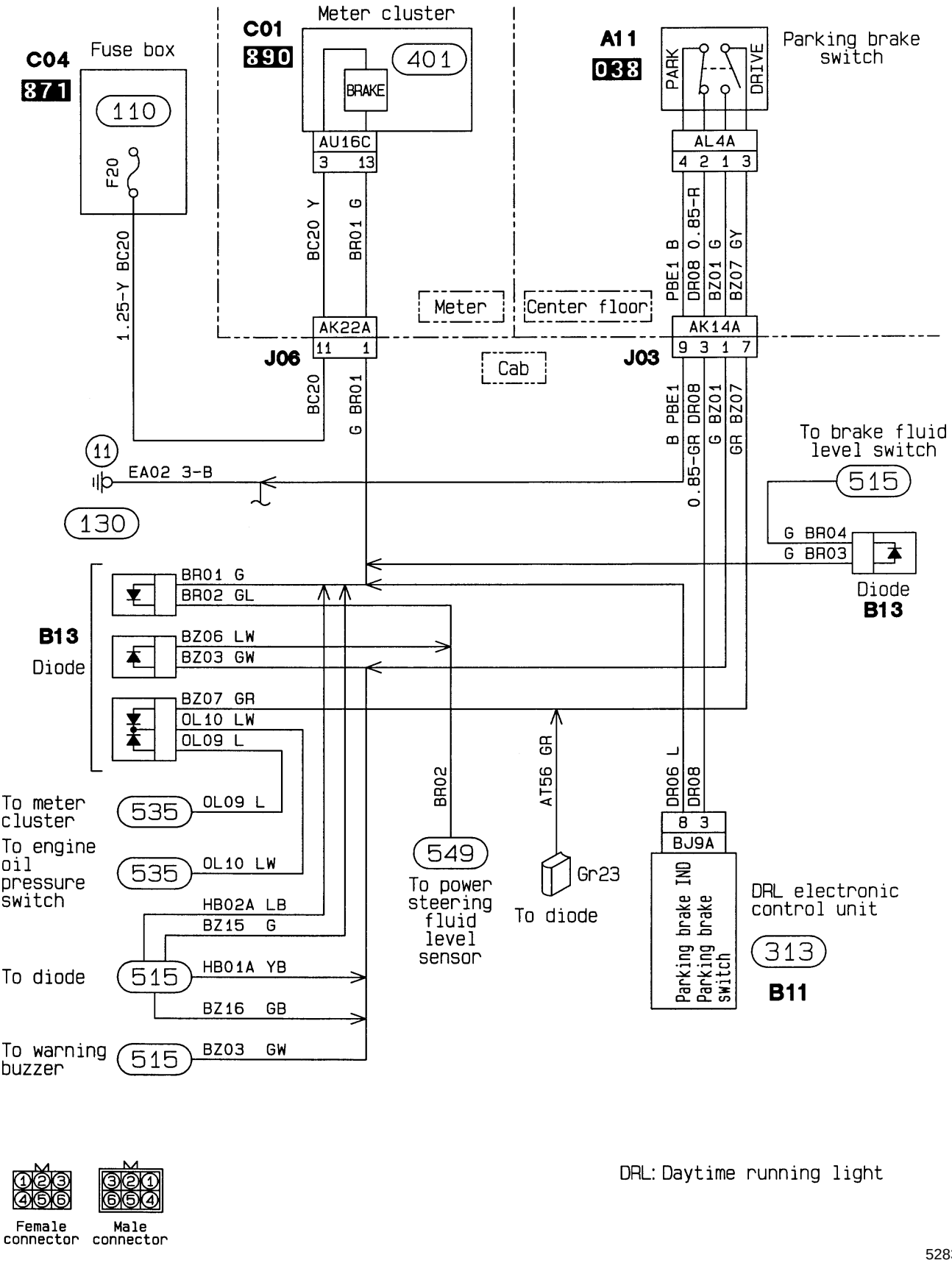

C04
871
Fuse box
110
F20
1.25-Y BC20
C01 890
Meter cluster
401
Water temperature gauge
*1
AU16C
2 8
AU16B
16
Y BC20
LY WT01
B EA03
J06
1.25-Y BC20
LY WT01
B EA03
AK22A
11
10
16
BC20
WT01
EA03
EA02 3-B
11
130
401
Water temperature gauge
*2
AU16C
3 8 1
BC20
WT01
EA03
WT01
*2 AK20A 6
*1 AK22A 16
U01
Cab
Meter
Chassis
*1
220
To cold start switch connector
*2
910
To multipurpose timing control unit
WT01 LY 73
CS05 LY 5
1 2
AS2A
Water temperature sensor
262 R11
*1 : 6D3
*2 : 4M5
Female connector
Male connector
52834

5 INDICATOR AND WARNING LAMP CIRCUIT

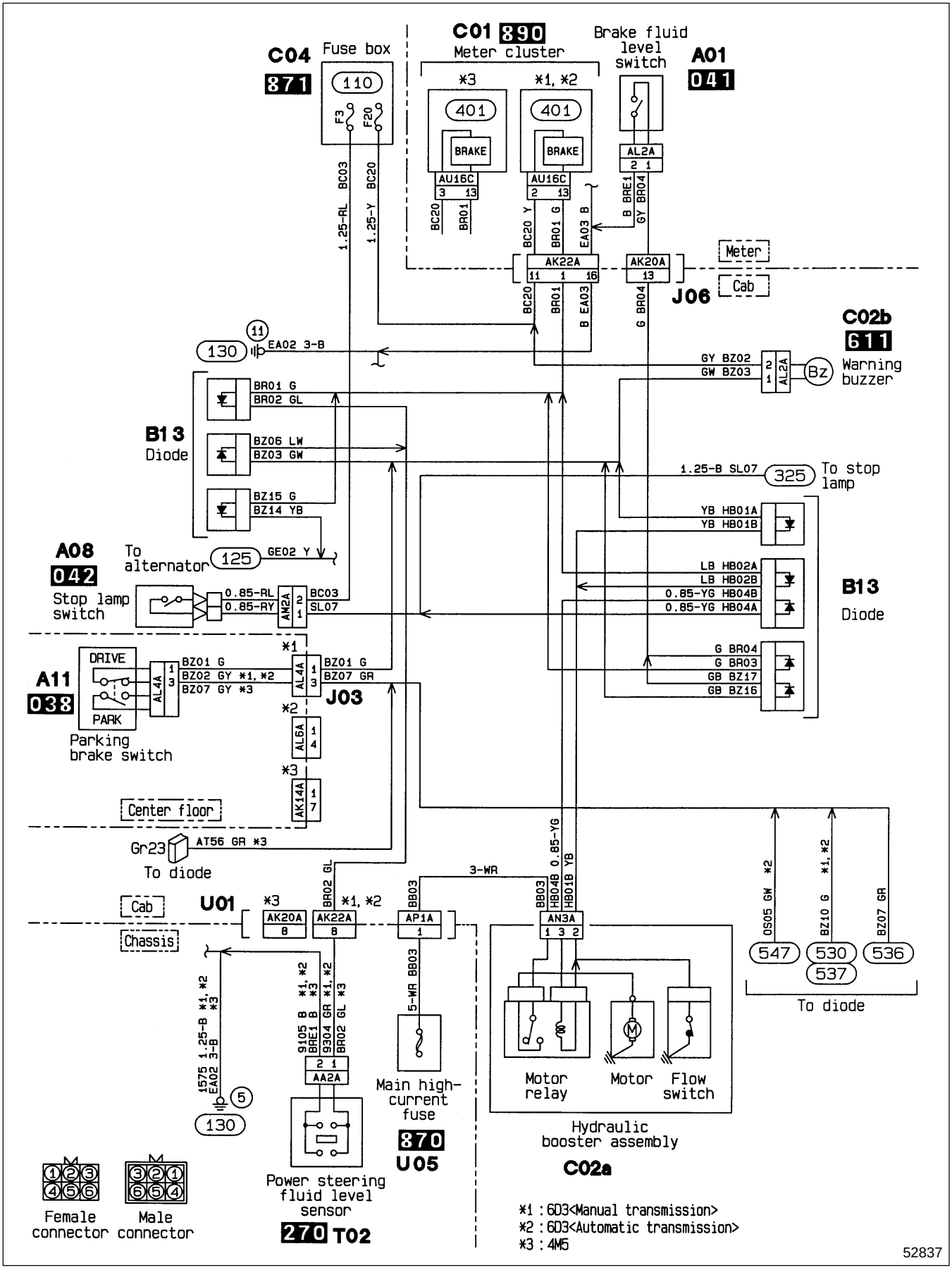
510 PARKING BRAKE INDICATOR CIRCUIT

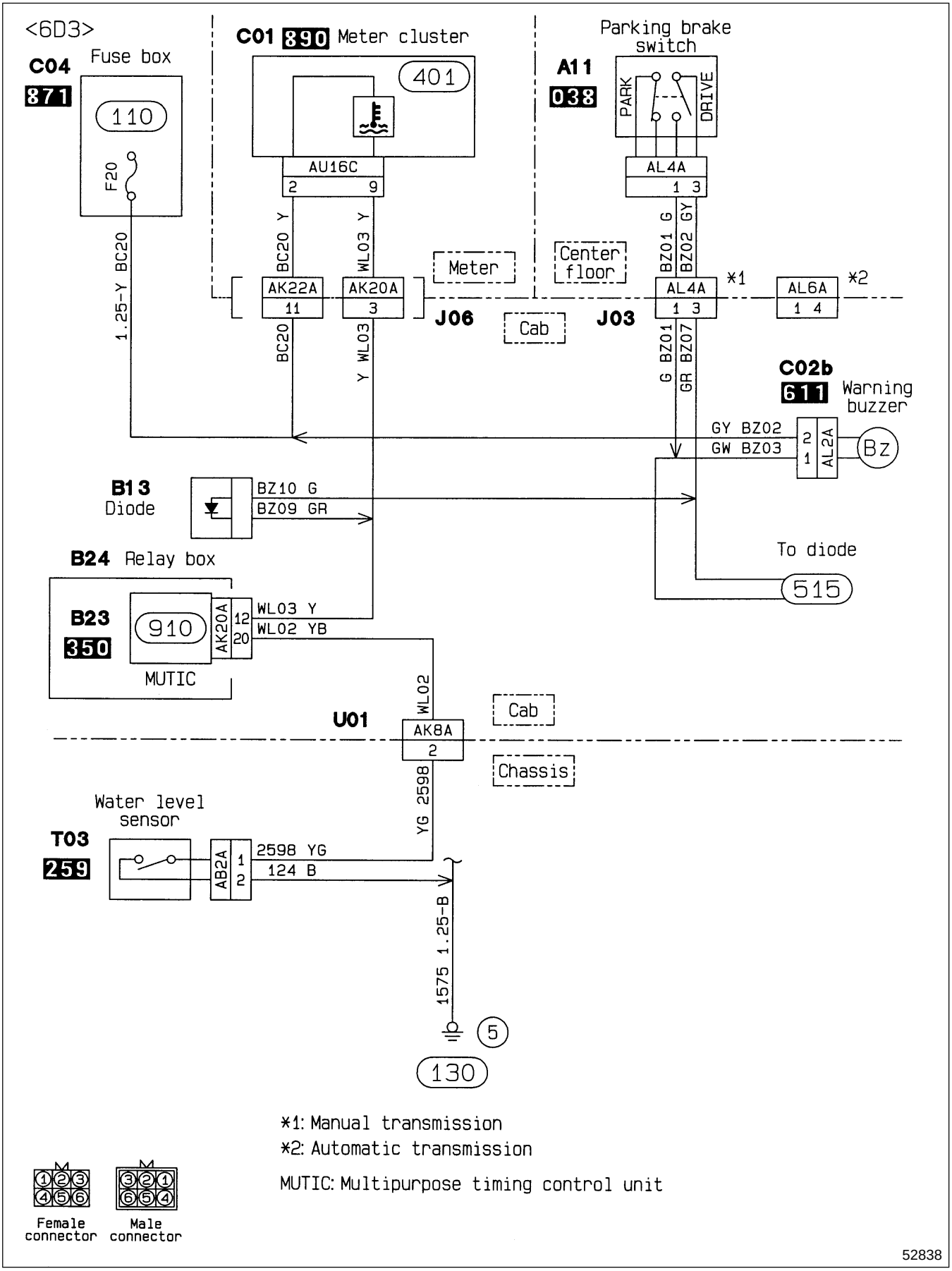


<4M5>

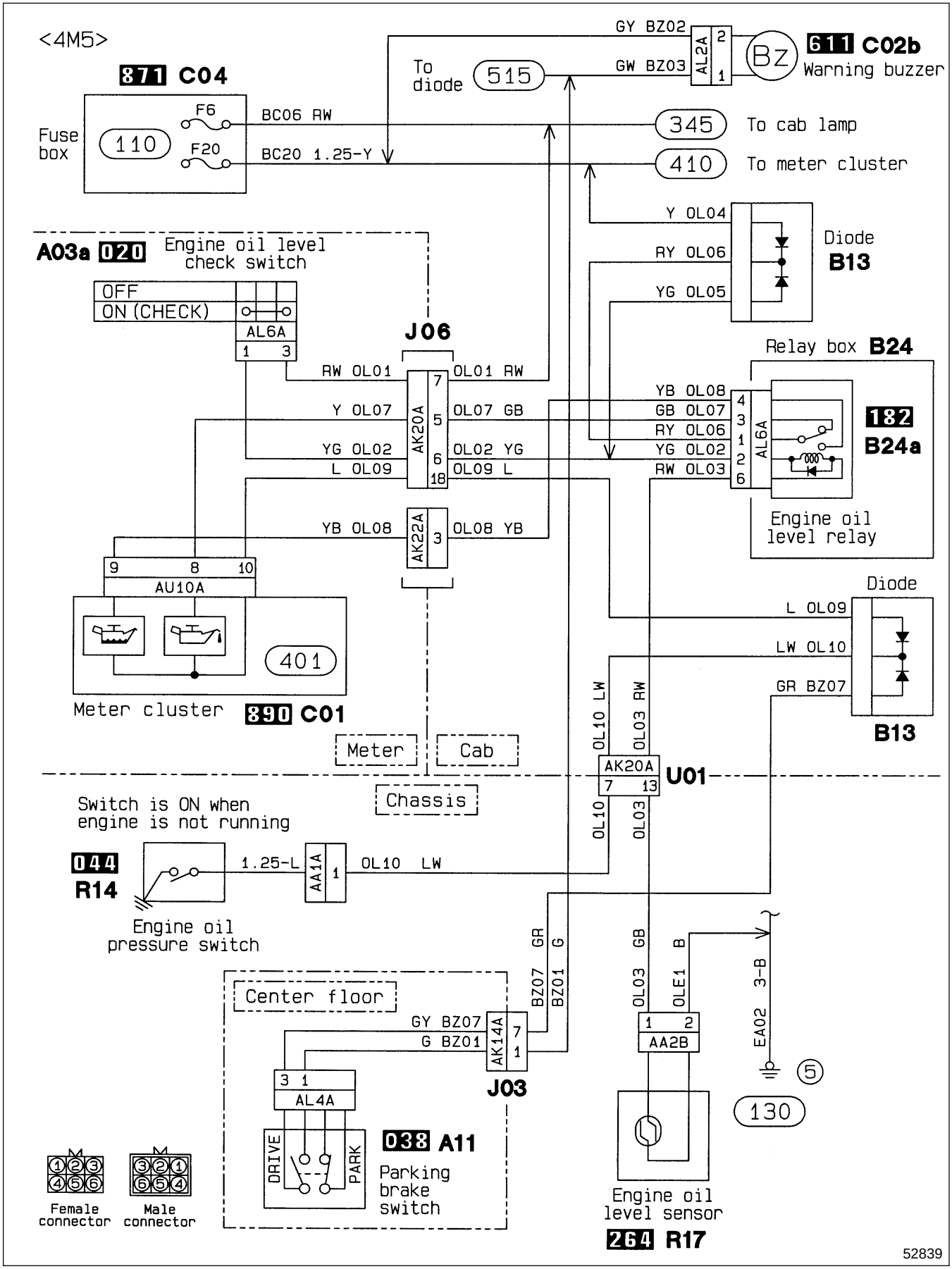

Meter cluster
C01
890
401
BRAKE
AU16C
3 13
C04
871
Fuse box
110
F20
1.25-Y BC20
BC20 Y
BR01 G
Meter
Center floor
A11
038
Parking brake switch
PARK
DRIVE
AL4A
4 2 1 3
PBE1 B
DR08 0.85-R
BZ01 G
BZ07 GY
AK22A
11 1
J06
AK14A
9 3 1 7
J03
Cab
BC20
G BR01
B PBE1
0.85-GR DR08
G BZ01
GR BZ07
11
EA02 3-B
130
To brake fluid level switch
515
G BR04
G BR03
Diode
B13
B13
Diode
BR01 G
BR02 GL
BZ06 LW
BZ03 GW
BZ07 GR
OL10 LW
OL09 L
To meter cluster
535
OL09 L
To engine oil pressure switch
535
OL10 LW
HB02A LB
BZ15 G
To diode
515
HB01A YB
BZ16 GB
To warning buzzer
515
BZ03 GW
BR02
549
To power steering fluid level sensor
AT56 GR
Gr23
To diode
DR06 L
DR08
8 3
BJ9A
Parking brake IND
Parking brake switch
DRL electronic control unit
313
B11
Female connector
Male connector
DRL: Daytime running light
52836

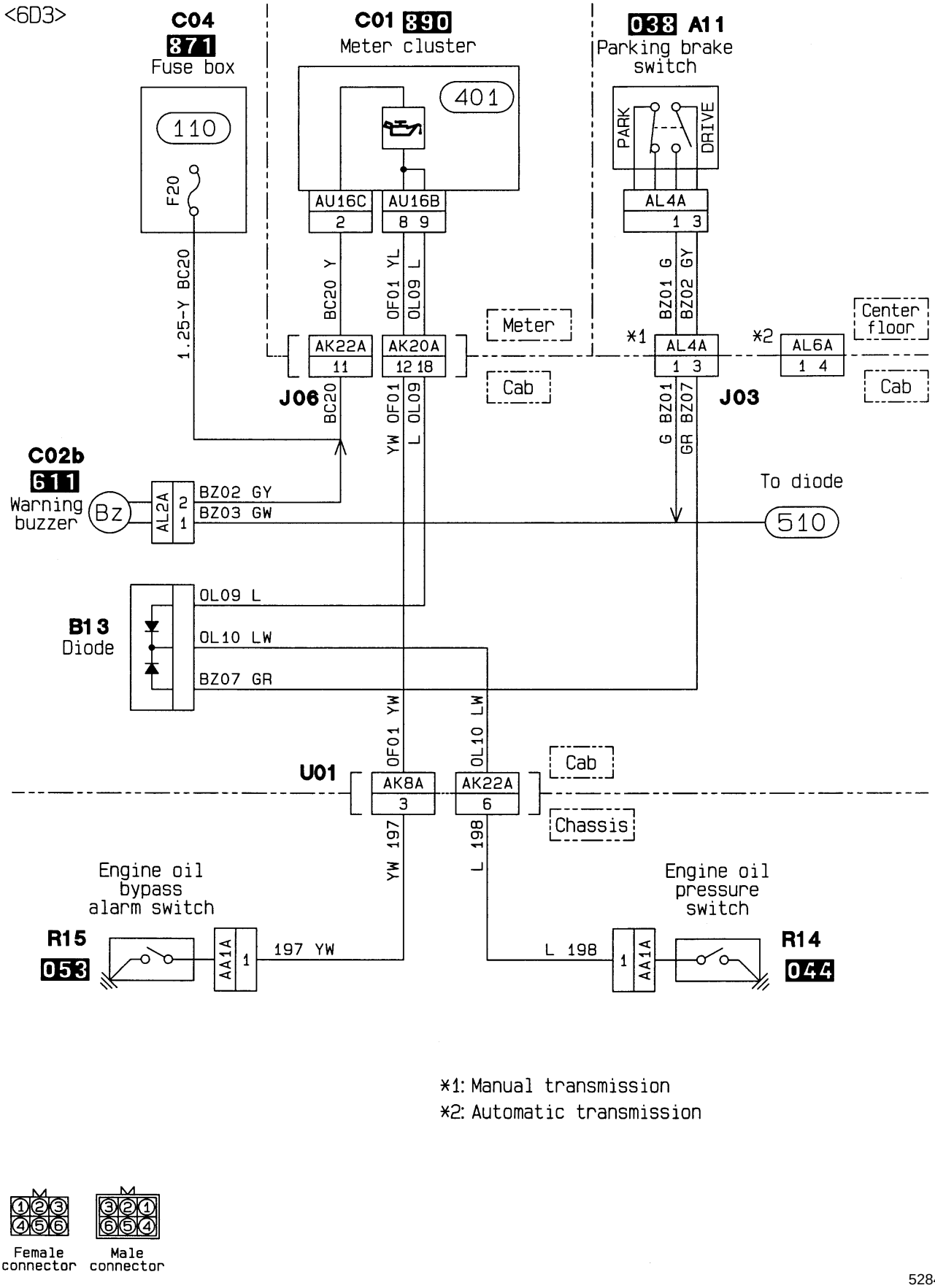
515 BRAKE WARNING CIRCUIT




<6D3>
C04 871 Fuse box
110
F20
1.25-Y BC20
C01 890 Meter cluster
401
AU16C
2 9
BC20 Y
WL03 Y
Meter
AK22A 11
AK20A 3
J06
BC20
Y WL03
Cab
Parking brake switch
A11 038
PARK
DRIVE
AL4A 1 3
BZ01 G
BZ02 GY
Center floor
AL4A 1 3
*1
AL6A 1 4
*2
J03
G BZ01
GR BZ07
C02b 611 Warning buzzer
GY BZ02
GW BZ03
2 1 AL2A
Bz
B13 Diode
BZ10 G
BZ09 GR
To diode
515
B24 Relay box
B23 350
910
MUTIC
AK20A 12 20
WL03 Y
WL02 YB
U01
WL02
AK8A 2
Cab
Chassis
YG 2598
Water level sensor
T03 259
AB2A 1 2
2598 YG
124 B
1575 1.25-B
5
130
*1: Manual transmission
*2: Automatic transmission
MUTIC: Multipurpose timing control unit
Female connector
Male connector
52838

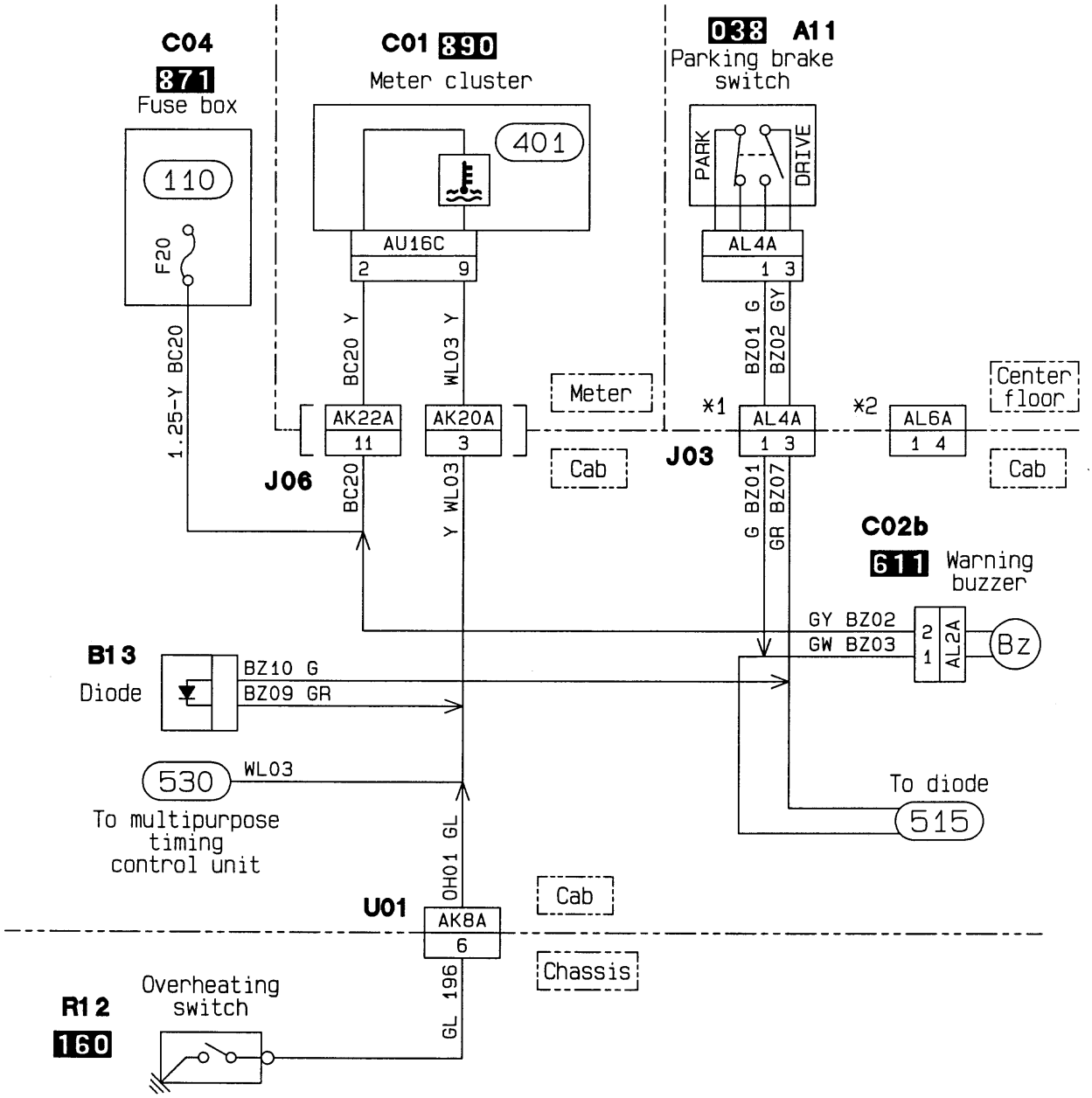
(535) ENGINE OIL LEVEL AND PRESSURE WARNING CIRCUIT



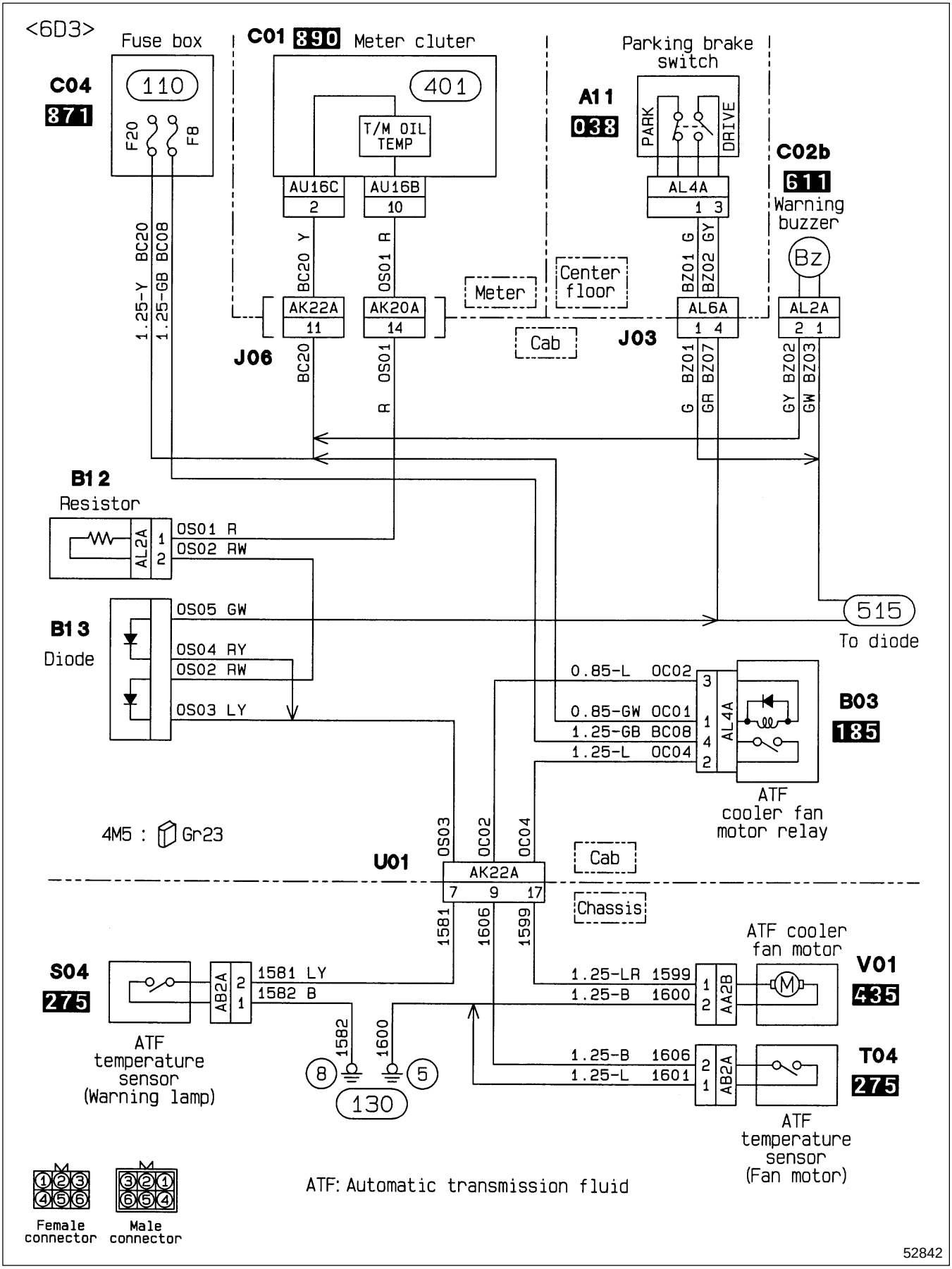

<6D3>
C04
871
Fuse box
110
F20
1.25-Y BC20
C01 890
Meter cluster
401
AU16C
2
AU16B
8 9
BC20 Y
OF01 YL
OL09 L
AK22A
11
AK20A
12 18
J06
BC20
YW OF01
L OL09
Meter
Cab
038 A11
Parking brake switch
PARK
DRIVE
AL4A
1 3
BZ01 G
BZ02 GY
*1
*2
AL6A
1 4
Center floor
Cab
J03
G BZ01
GR BZ07
C02b
611
Warning buzzer
Bz
AL2A
2
1
BZ02 GY
BZ03 GW
To diode
510
B13
Diode
OL09 L
OL10 LW
BZ07 GR
OF01 YW
OL10 LW
U01
AK8A
3
AK22A
6
Cab
Chassis
YW 197
L 198
Engine oil bypass alarm switch
R15
053
AA1A
1
197 YW
L 198
Engine oil pressure switch
R14
044
*1: Manual transmission
*2: Automatic transmission
Female connector
Male connector
52840

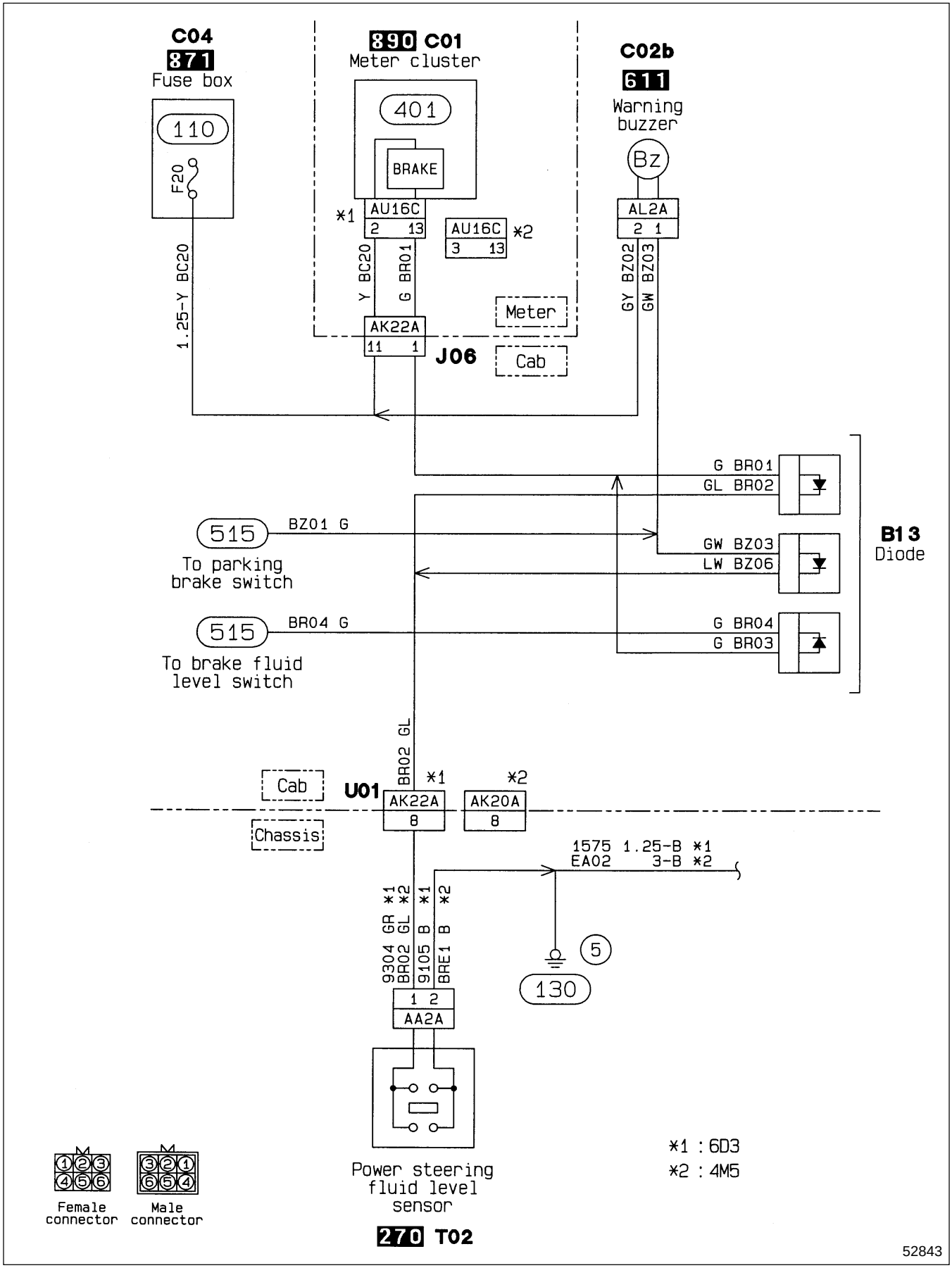
M E M O

<6D3>

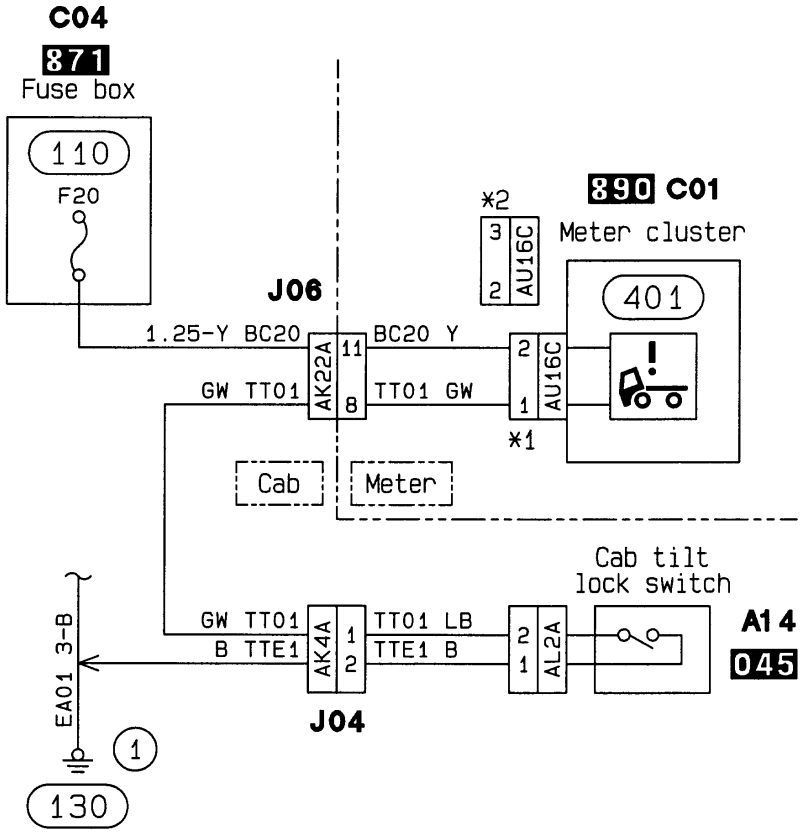

C04
871
Fuse box
110
F20
1.25-Y BC20
C01 890
Meter cluster
401
AU16C
2 9
BC20 Y
WL03 Y
038 A11
Parking brake switch
PARK
DRIVE
AL4A
1 3
BZ01 G
BZ02 GY
Meter
Cab
AK22A
11
AK20A
3
J06
BC20
Y WL03
*1
AL4A
1 3
J03
*2
AL6A
1 4
Center floor
Cab
G BZ01
GR BZ07
C02b
611 Warning buzzer
GY BZ02
GW BZ03
2
1
AL2A
Bz
B13
Diode
BZ10 G
BZ09 GR
530
WL03
To multipurpose timing control unit
To diode
515
OH01 GL
U01
AK8A
6
Cab
Chassis
GL 196
R12
160
Overheating switch
*1: Manual transmission
*2: Automatic transmission
Female connector
Male connector
52841

547 ATF TEMPERATURE WARNING CIRCUIT

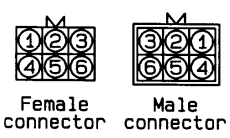



C04
871
Fuse box
110
F20
1.25-Y BC20
890 C01
Meter cluster
401
BRAKE
*1
AU16C
2 13
AU16C *2
3 13
Y BC20
G BR01
AK22A
11 1
J06
Meter
Cab
C02b
611
Warning buzzer
Bz
AL2A
2 1
GY BZ02
GW BZ03
G BR01
GL BR02
515
BZ01 G
To parking brake switch
GW BZ03
LW BZ06
515
BR04 G
To brake fluid level switch
G BR04
G BR03
B13
Diode
BR02 GL
Cab
U01
*1
*2
AK22A
8
AK20A
8
Chassis
1575 1.25-B *1
EA02 3-B *2
9304 GR *1
BR02 GL *2
9105 B *1
BRE1 B *2
5
130
1 2
AA2A
Power steering fluid level sensor
270 T02
Female connector
Male connector
*1 : 6D3
*2 : 4M5
52843

550 CAB TILT WARNING CIRCUIT

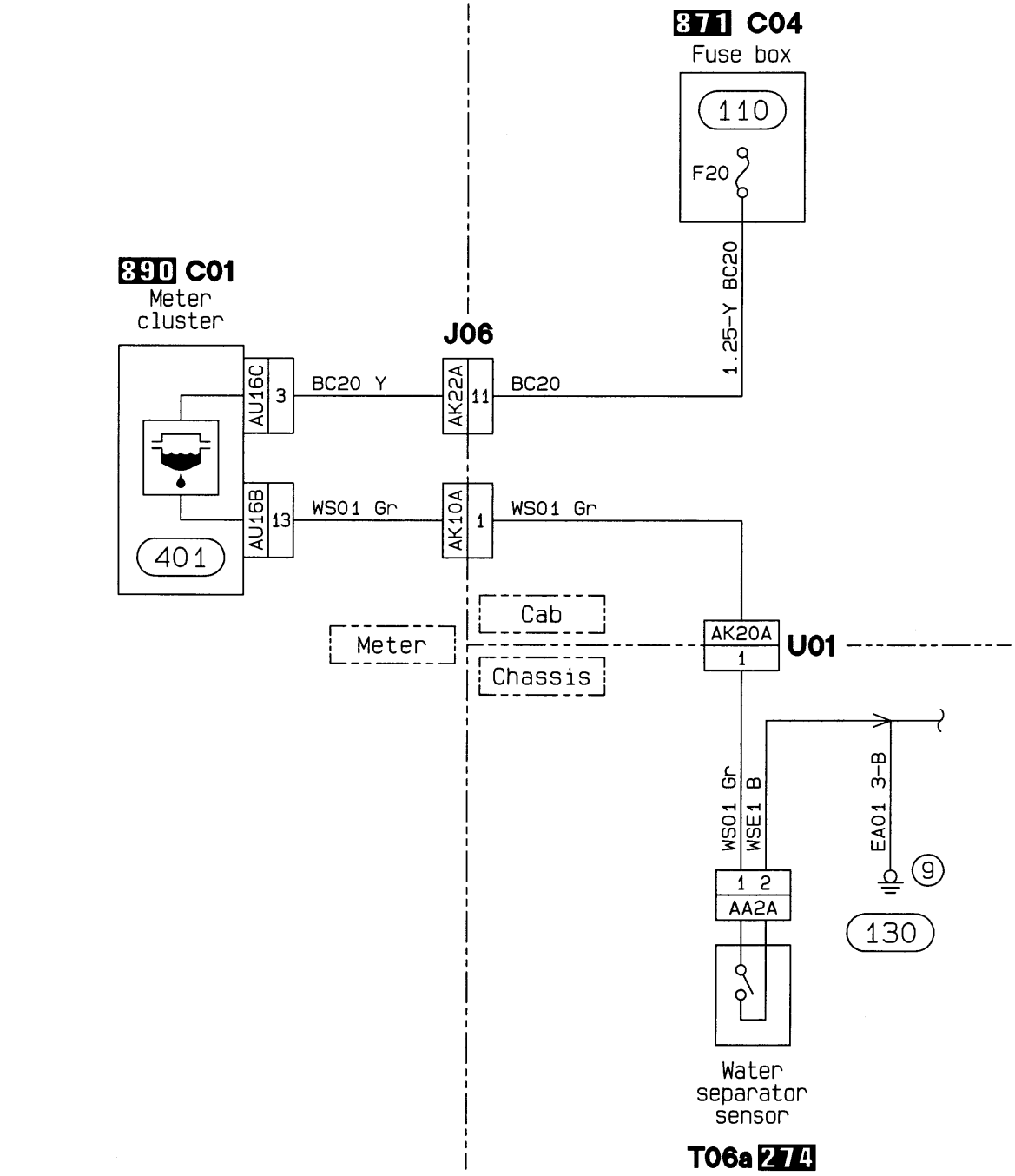


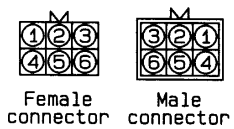
*1 : 6D3
*2 : 4M5



52844

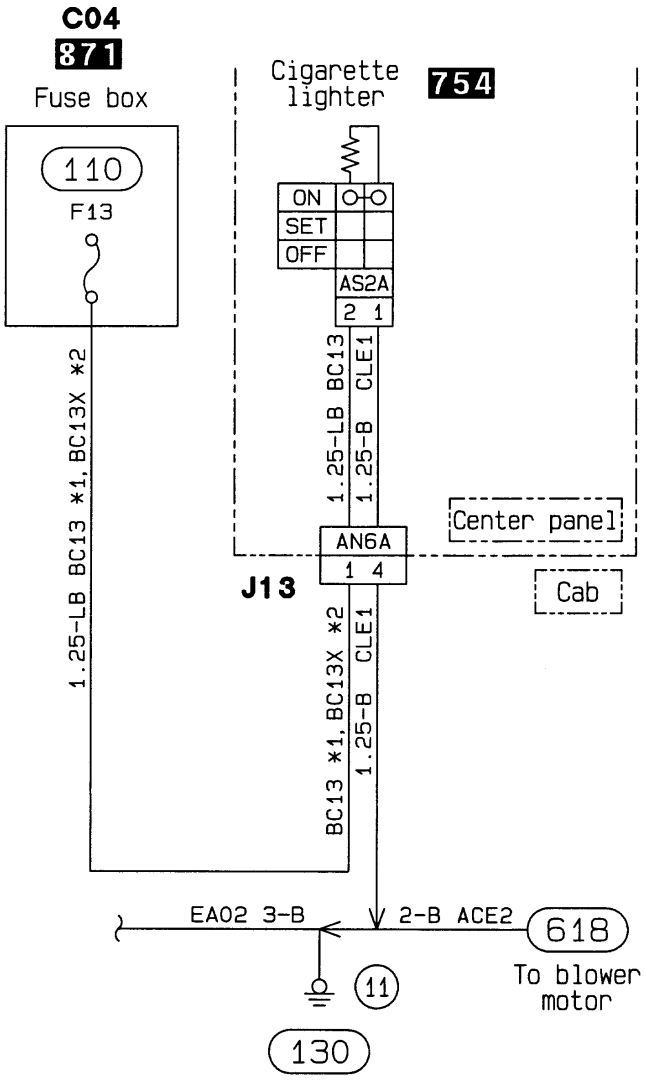
<4M5>

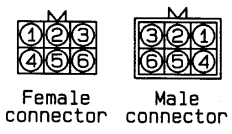

871 C04
Fuse box
110
F20
1.25-Y BC20
890 C01
Meter cluster
J06
AU16C
3
BC20 Y
AK22A
11
BC20
AU16B
13
WS01 Gr
AK10A
1
WS01 Gr
401
Cab
Meter
Chassis
AK20A
1
U01
WS01 Gr
WSE1 B
EA01 3-B
9
1 2
AA2A
130
Water separator sensor
T06a 274


Female connector
Male connector

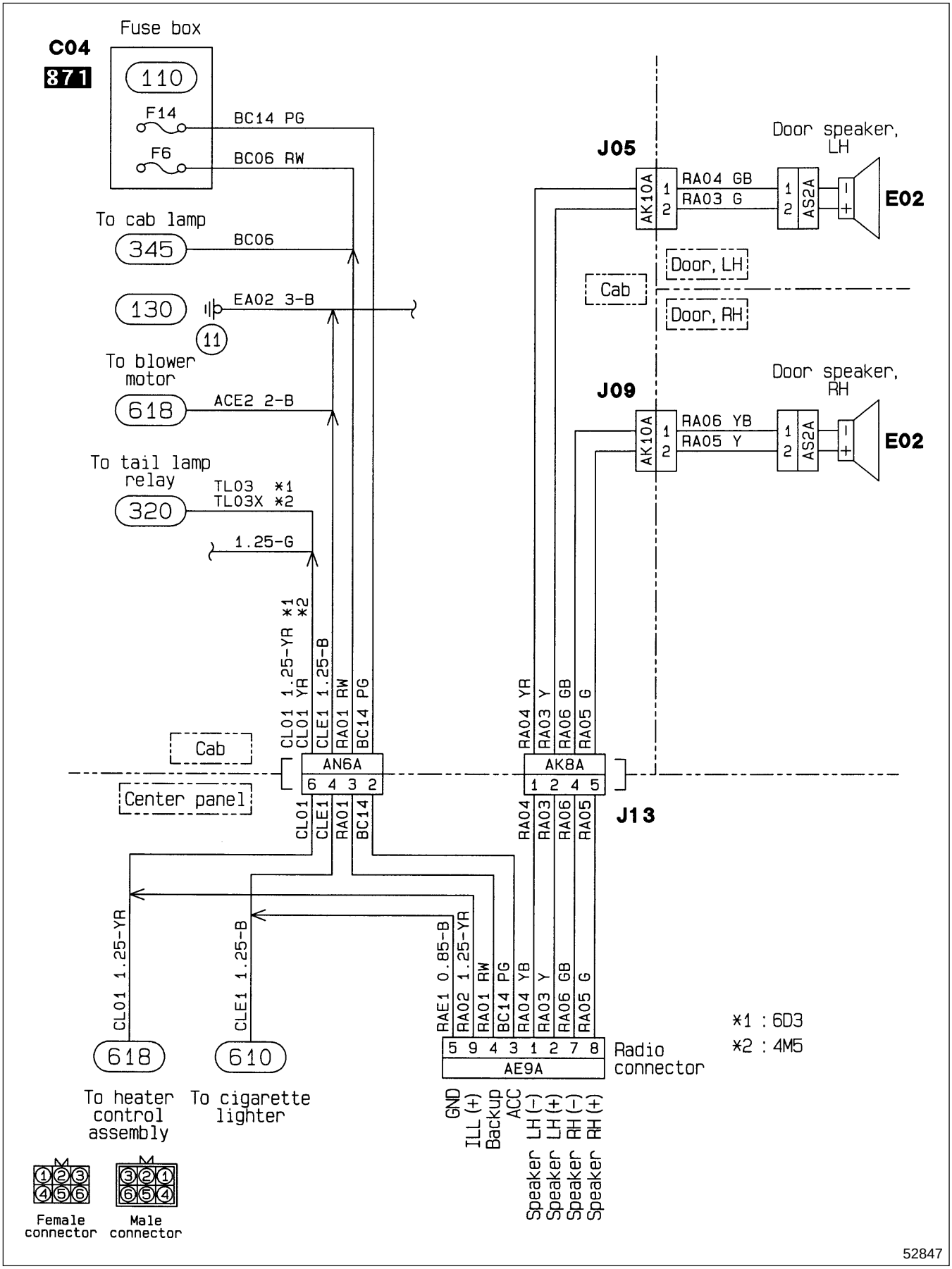
52845

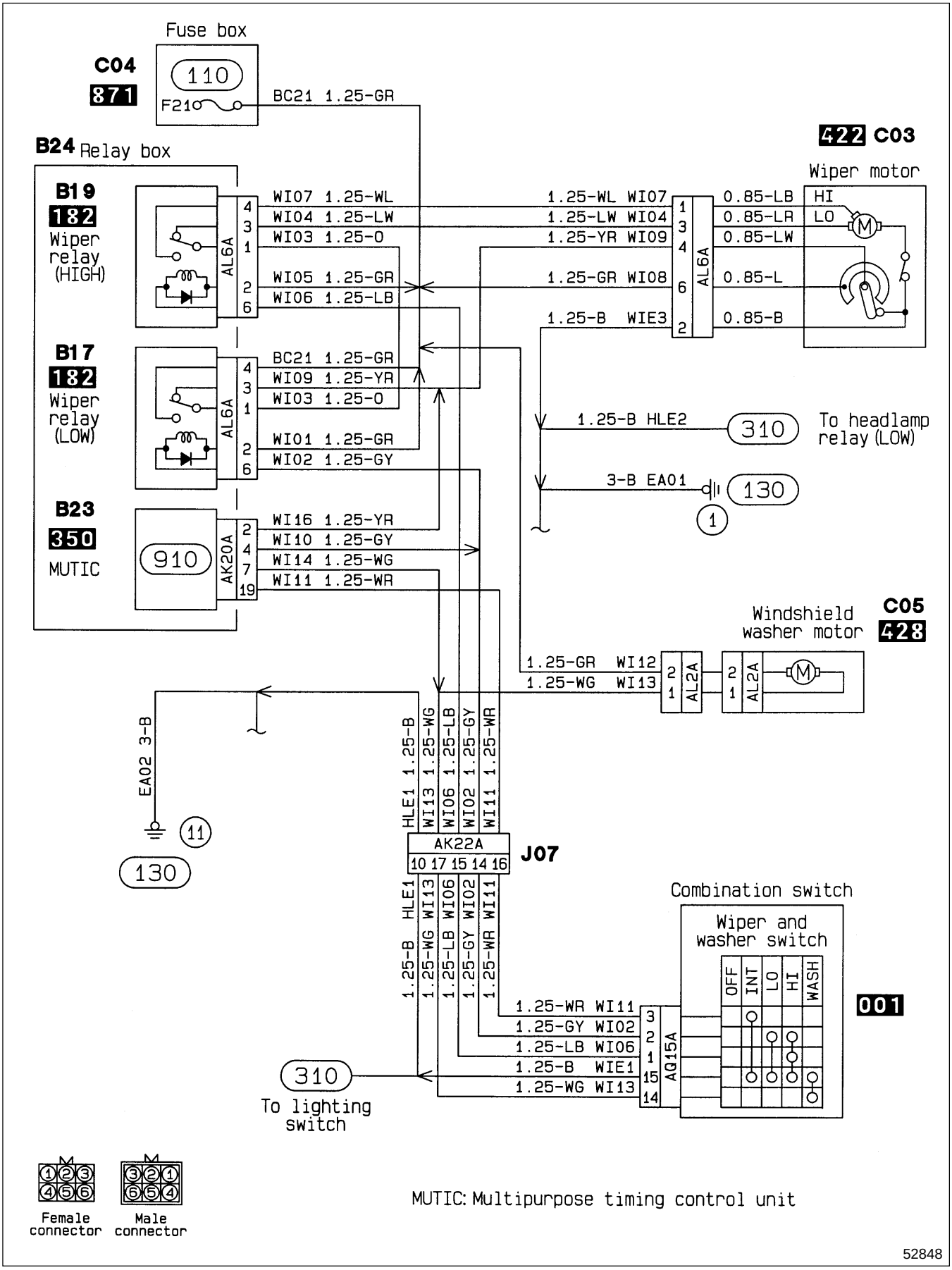
⑥ CAB SIDE ELECTRICAL CIRCUIT

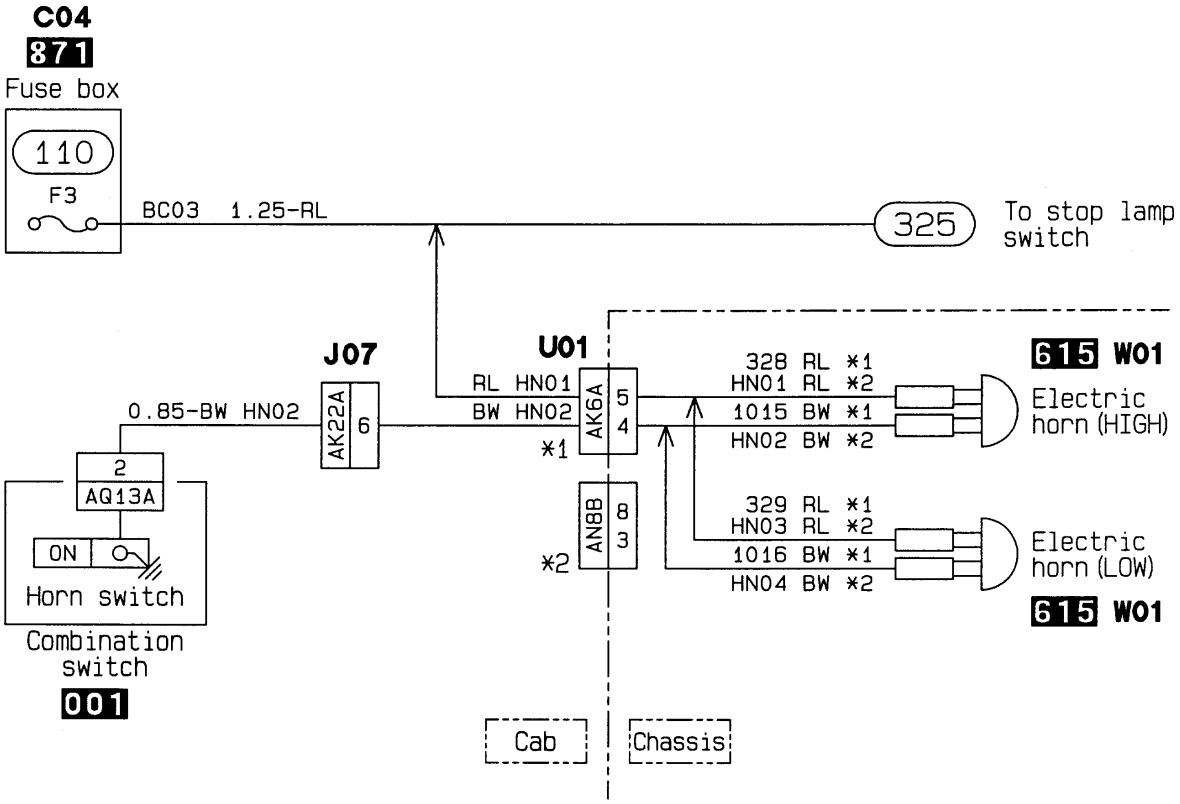

C04
871
Fuse box
110
F13
1.25-LB BC13 *1, BC13X *2
Cigarette lighter
754
ON
SET
OFF
AS2A
2 1
1.25-LB BC13
1.25-B CLE1
Center panel
AN6A
1 4
J13
Cab
BC13 *1, BC13X *2
1.25-B CLE1
EA02 3-B
2-B ACE2
618
To blower motor
11
130
*1 : 6D3
*2 : 4M5


Female connector
Male connector

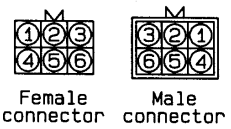
52846


Fuse box
C04
87 1
110
F14
BC14 PG
F6
BC06 RW
To cab lamp
345
BC06
130
EA02 3-B
11
To blower motor
618
ACE2 2-B
To tail lamp relay
320
TL03 *1
TL03X *2
1.25-G
CL01 1.25-YR *1 *2
CL01 YR
CLE1 1.25-B
RA01 RW
BC14 PG
Cab
Center panel
AN6A
6 4 3 2
CL01
CLE1
RA01
BC14
J05
AK10A
1 2
RA04 GB
RA03 G
1 2
AS2A
Door speaker, LH
E02
Door, LH
Door, RH
J09
RA06 YB
RA05 Y
Door speaker, RH
RA04 YR
RA03 Y
RA06 GB
RA05 G
AK8A
1 2 4 5
J13
RA04
RA03
RA06
RA05
CL01 1.25-YR
CLE1 1.25-B
RAE1 0.85-B
RA02 1.25-YR
RA01 RW
BC14 PG
RA04 YB
RA03 Y
RA06 GB
RA05 G
5 9 4 3 1 2 7 8
AE9A
Radio connector
*1 : 6D3
*2 : 4M5
618
610
To heater control assembly
To cigarette lighter
GND
ILL (+)
Backup
ACC
Speaker LH (-)
Speaker LH (+)
Speaker RH (-)
Speaker RH (+)
Female connector
Male connector
52847

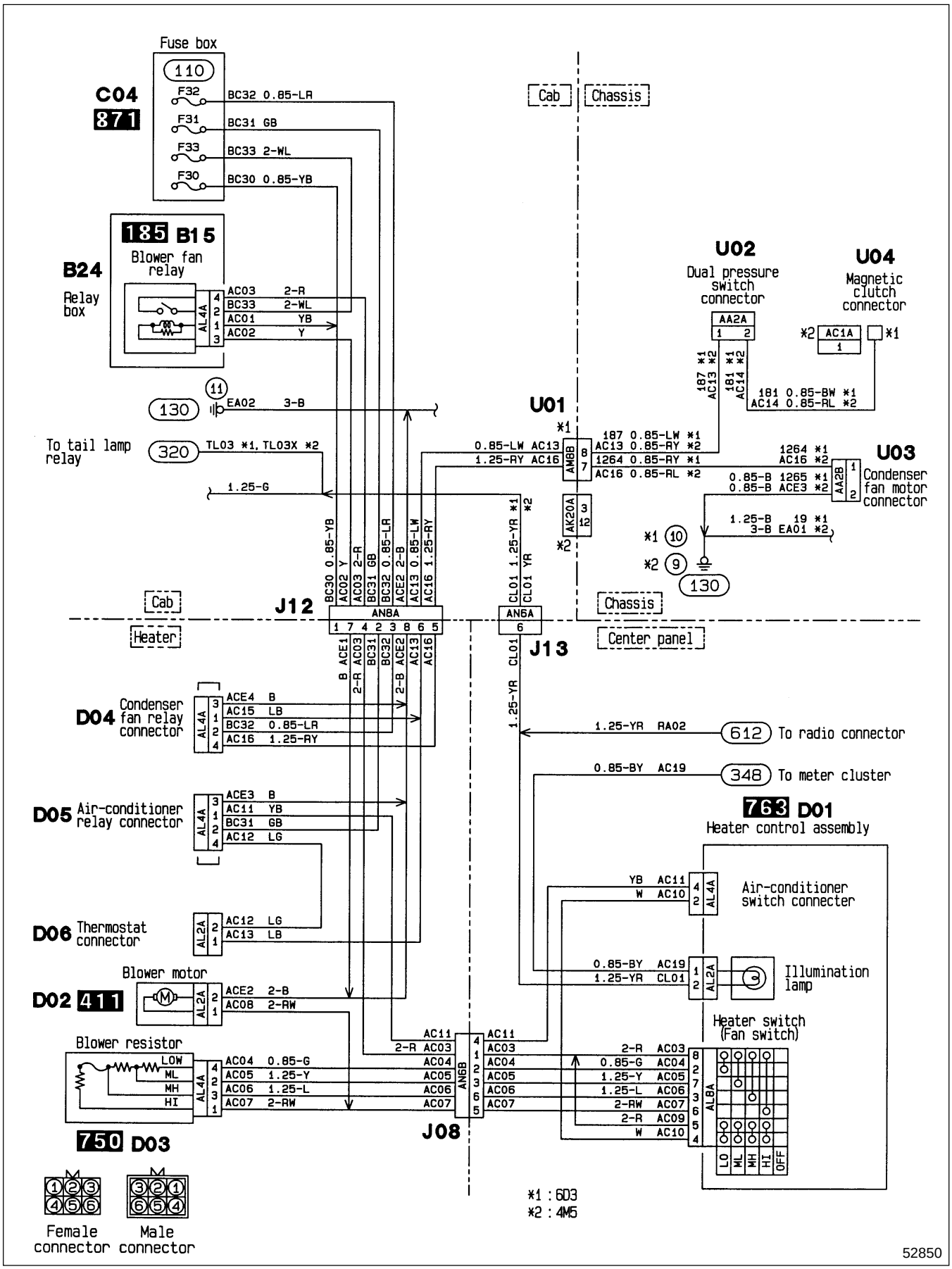

Fuse box
C04
871
110
F21
BC21 1.25-GR
B24 Relay box
B19
182
Wiper relay (HIGH)
AL6A
WI07 1.25-WL
WI04 1.25-LW
WI03 1.25-O
WI05 1.25-GR
WI06 1.25-LB
B17
182
Wiper relay (LOW)
BC21 1.25-GR
WI09 1.25-YR
WI03 1.25-O
WI01 1.25-GR
WI02 1.25-GY
B23
350
MUTIC
910
AK20A
WI16 1.25-YR
WI10 1.25-GY
WI14 1.25-WG
WI11 1.25-WR
422 C03
Wiper motor
HI
LO
1.25-WL WI07
1.25-LW WI04
1.25-YR WI09
1.25-GR WI08
1.25-B WIE3
0.85-LB
0.85-LR
0.85-LW
0.85-L
0.85-B
1.25-B HLE2
310
To headlamp relay (LOW)
3-B EA01
130
1
Windshield washer motor
C05
428
1.25-GR WI12
1.25-WG WI13
AL2A
EA02 3-B
11
130
HLE1 1.25-B
WI13 1.25-WG
WI06 1.25-LB
WI02 1.25-GY
WI11 1.25-WR
AK22A
10 17 15 14 16
J07
Combination switch
Wiper and washer switch
OFF
INT
LO
HI
WASH
001
1.25-WR WI11
1.25-GY WI02
1.25-LB WI06
1.25-B WIE1
1.25-WG WI13
AG15A
310
To lighting switch
Female connector
Male connector
MUTIC: Multipurpose timing control unit
52848

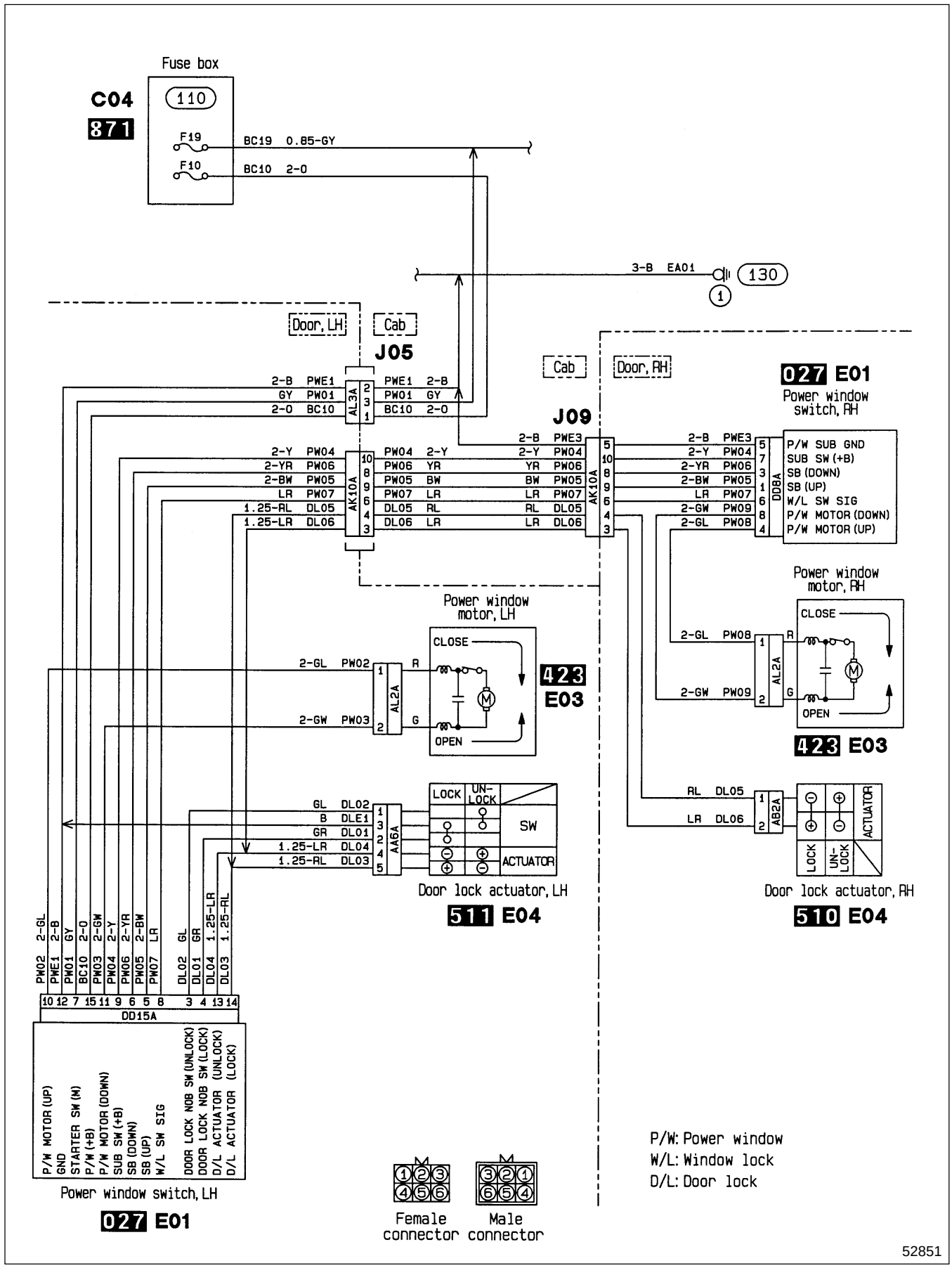


*1 : 6D3
*2 : 4M5

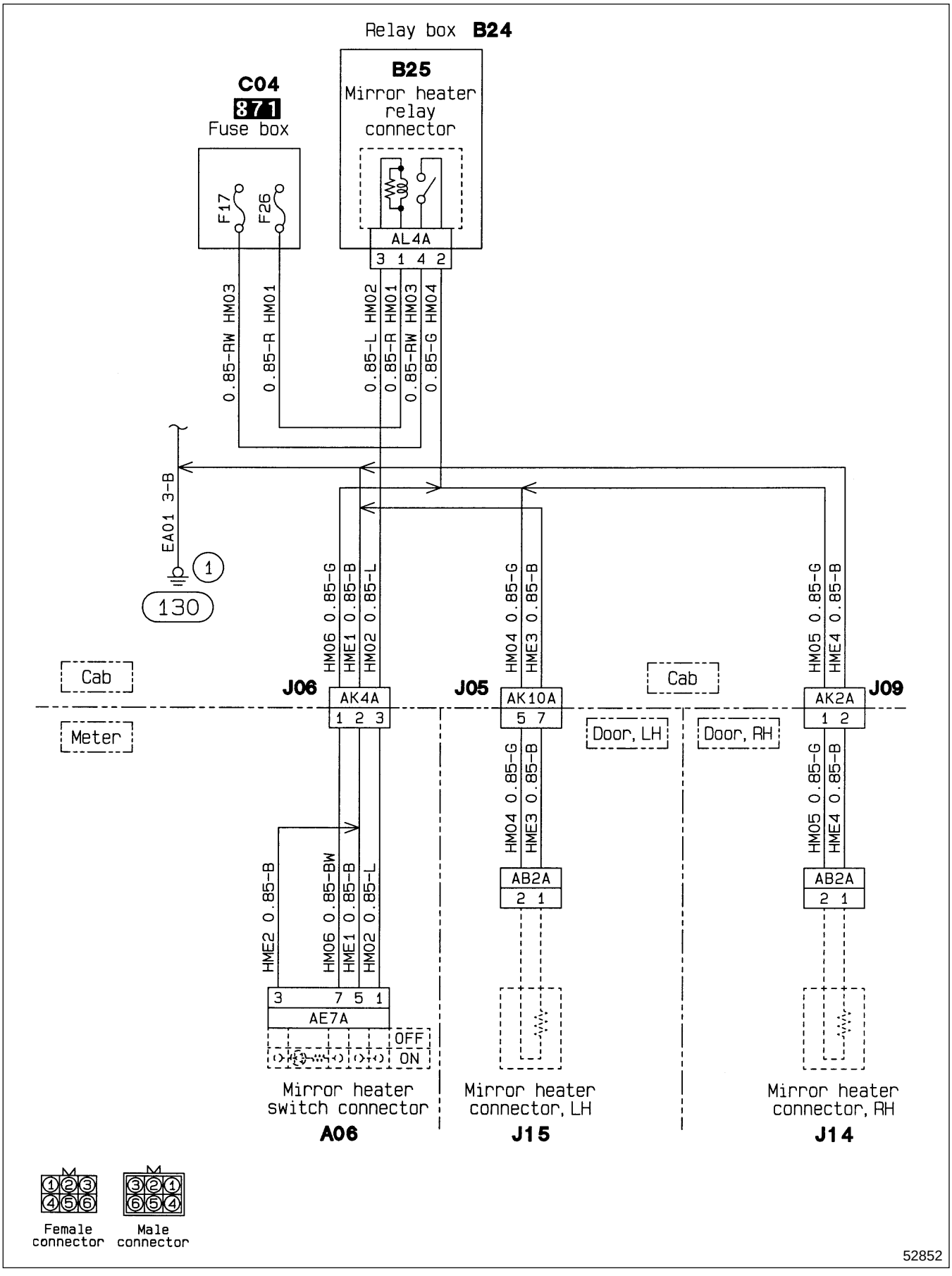


52849


Fuse box
110
C04
871
F32
F31
F33
F30
BC32 0.85-LR
BC31 GB
BC33 2-WL
BC30 0.85-YB
185 B15
Blower fan relay
B24
Relay box
AL4A
AC03 2-R
BC33 2-WL
AC01 YB
AC02 Y
130
11
EA02 3-B
To tail lamp relay
320
TL03 *1, TL03X *2
1.25-G
U02
Dual pressure switch connector
AA2A
U04
Magnetic clutch connector
AC1A
187 *1 AC13 *2
181 *1 AC14 *2
181 0.85-BW *1
AC14 0.85-RL *2
U01
*1
187 0.85-LW *1
AC13 0.85-RY *2
1264 0.85-RY *1
AC16 0.85-RL *2
0.85-LW AC13
1.25-RY AC16
AM8B
1264 *1 AC16 *2
U03
Condenser fan motor connector
AA2B
0.85-B 1265 *1
0.85-B ACE3 *2
1.25-B 19 *1
3-B EA01 *2
AK20A
*1 10
*2 9
130
BC30 0.85-YB
AC02 Y
AC03 2-R
BC31 GB
BC32 0.85-LR
ACE2 2-B
AC13 0.85-LW
AC16 1.25-RY
CL01 1.25-YR *1 *2
CL01 YR
Cab
J12
AN8A
1 7 4 2 3 8 6 5
AN6A
6
Chassis
Heater
J13
Center panel
B ACE1
2-R AC03
BC31
BC32
2-B ACE2
AC13
AC16
CL01
1.25-YR
D04
Condenser fan relay connector
ACE4 B
AC15 LB
BC32 0.85-LR
AC16 1.25-RY
1.25-YR RA02
612
To radio connector
0.85-BY AC19
348
To meter cluster
763 D01
Heater control assembly
D05
Air-conditioner relay connector
ACE3 B
AC11 YB
BC31 GB
AC12 LG
YB AC11
W AC10
Air-conditioner switch connecter
AL4A
D06
Thermostat connector
AL2A
AC12 LG
AC13 LB
0.85-BY AC19
1.25-YR CL01
Illumination lamp
Blower motor
D02 411
ACE2 2-B
AC08 2-RW
Heater switch (Fan switch)
Blower resistor
LOW
ML
MH
HI
AC04 0.85-G
AC05 1.25-Y
AC06 1.25-L
AC07 2-RW
AC11
2-R AC03
AC04
AC05
AC06
AC07
AN6B
J08
2-R AC03
0.85-G AC04
1.25-Y AC05
1.25-L AC06
2-RW AC07
2-R AC09
W AC10
AL8A
LO
ML
MH
HI
OFF
750 D03
Female connector
Male connector
*1 : 6D3
*2 : 4M5
52850


Fuse box
C04
871
110
F19
F10
BC19 0.85-GY
BC10 2-O
3-B EA01
130
1
Door, LH
Cab
J05
Cab
Door, RH
J09
027 E01
Power window switch, RH
P/W SUB GND
SUB SW (+B)
SB (DOWN)
SB (UP)
W/L SW SIG
P/W MOTOR (DOWN)
P/W MOTOR (UP)
Power window motor, LH
CLOSE
OPEN
423 E03
Power window motor, RH
CLOSE
OPEN
423 E03
LOCK
UN-LOCK
SW
ACTUATOR
Door lock actuator, LH
511 E04
Door lock actuator, RH
510 E04
DD15A
P/W MOTOR (UP)
GND
STARTER SW (M)
P/W (+B)
P/W MOTOR (DOWN)
SUB SW (+B)
SB (DOWN)
SB (UP)
W/L SW SIG
DOOR LOCK NOB SW (UNLOCK)
DOOR LOCK NOB SW (LOCK)
D/L ACTUATOR (UNLOCK)
D/L ACTUATOR (LOCK)
Power window switch, LH
027 E01
Female connector
Male connector
P/W: Power window
W/L: Window lock
D/L: Door lock
52851

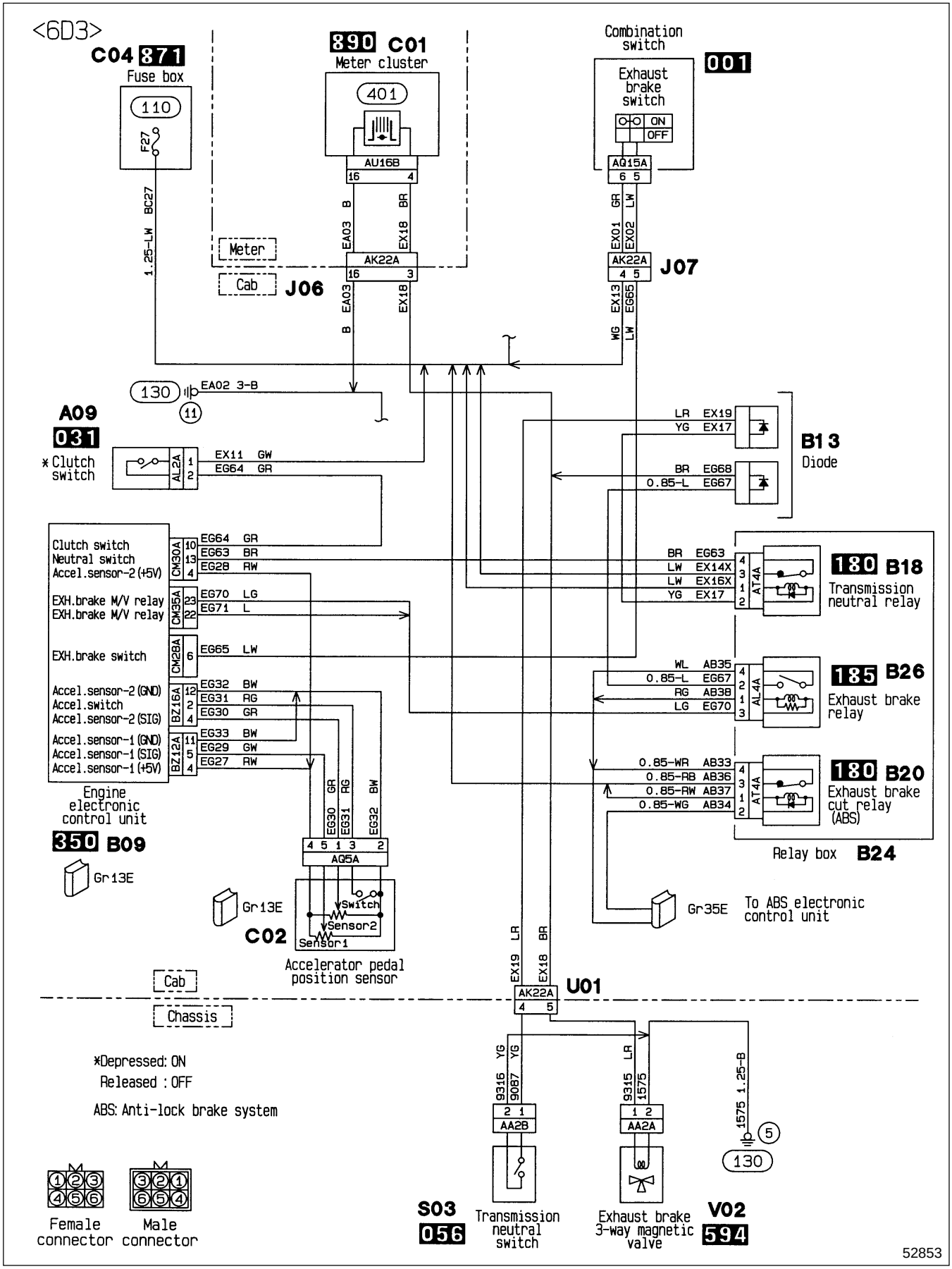
629 MIRROR HEATER CIRCUIT



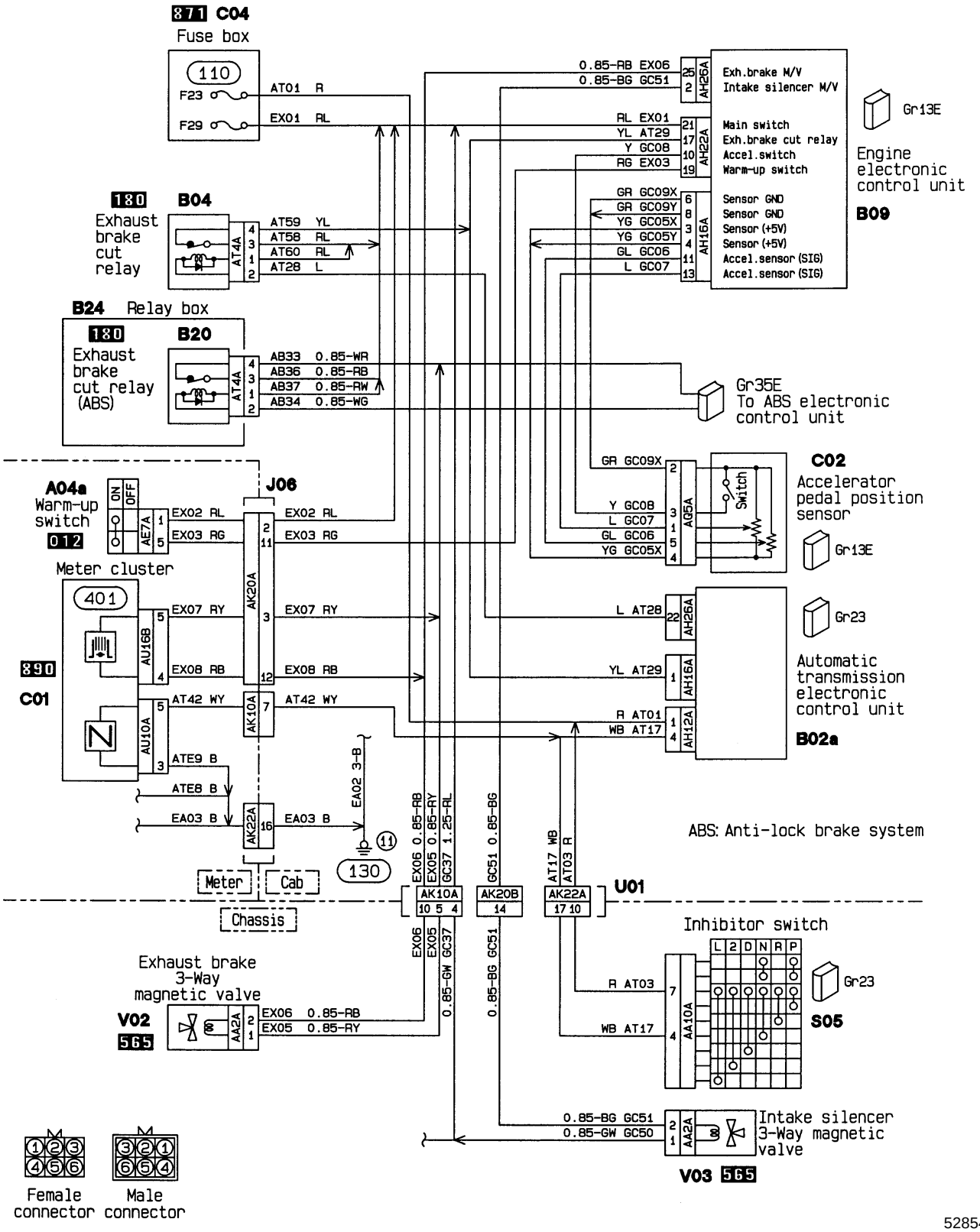
M E M O

7 CHASSIS SIDE ELECTRICAL CIRCUIT

710 EXHAUST BRAKE CIRCUIT



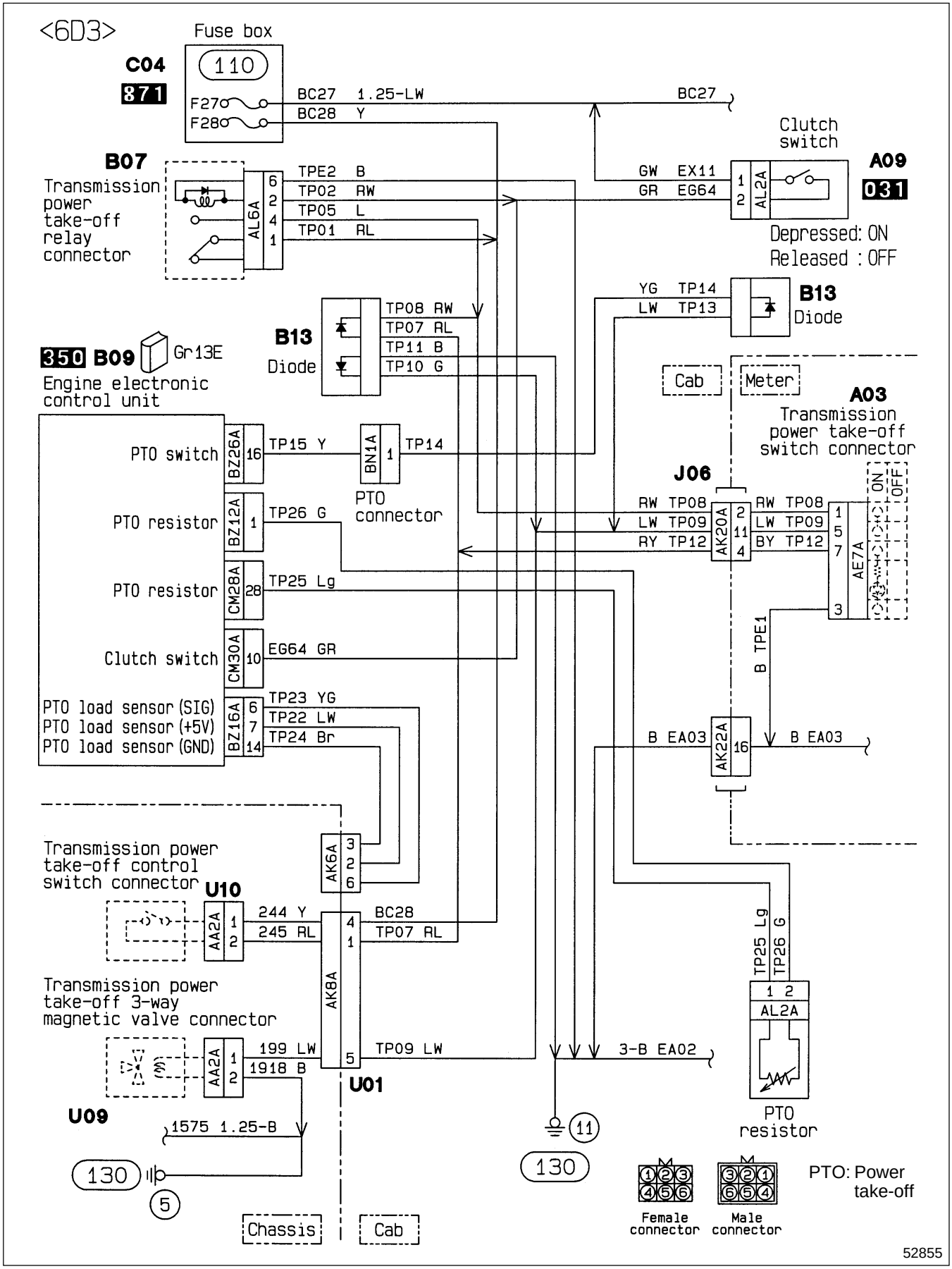
<4M5>


871 C04
Fuse box
110
F23
F29
AT01 R
EX01 RL
180 B04
Exhaust brake cut relay
AT4A
AT59 YL
AT58 RL
AT60 RL
AT28 L
B24 Relay box
180 B20
Exhaust brake cut relay (ABS)
AT4A
AB33 0.85-WR
AB36 0.85-RB
AB37 0.85-RW
AB34 0.85-WG
0.85-RB EX06
0.85-BG GC51
AH26A
Exh.brake M/V
Intake silencer M/V
RL EX01
YL AT29
Y GC08
RG EX03
AH22A
Main switch
Exh.brake cut relay
Accel.switch
Warm-up switch
GR GC09X
GR GC09Y
YG GC05X
YG GC05Y
GL GC06
L GC07
AH16A
Sensor GND
Sensor GND
Sensor (+5V)
Sensor (+5V)
Accel.sensor (SIG)
Accel.sensor (SIG)
Gr13E
Engine electronic control unit
B09
Gr35E
To ABS electronic control unit
A04a
Warm-up switch
012
ON
OFF
AE7A
EX02 RL
EX03 RG
J06
AK20A
EX02 RL
EX03 RG
GR GC09X
Y GC08
L GC07
GL GC06
YG GC05X
A05A
Switch
C02
Accelerator pedal position sensor
Gr13E
Meter cluster
401
AU16B
EX07 RY
EX08 RB
AK20A
EX07 RY
EX08 RB
L AT28
AH26A
Gr23
YL AT29
AH16A
Automatic transmission electronic control unit
B02a
R AT01
WB AT17
AH12A
890
C01
AU10A
AT42 WY
AK10A
AT42 WY
ATE9 B
ATE8 B
EA03 B
AK22A
EA03 B
EA02 3-B
ABS: Anti-lock brake system
Meter
Cab
130
EX06 0.85-RB
EX05 0.85-RY
GC37 1.25-RL
GC51 0.85-BG
AT17 WB
AT03 R
AK10A
AK20B
AK22A
U01
Chassis
Inhibitor switch
L 2 D N R P
R AT03
WB AT17
AA10A
Gr23
S05
Exhaust brake 3-Way magnetic valve
V02
565
AA2A
EX06 0.85-RB
EX05 0.85-RY
0.85-GW GC37
0.85-BG GC51
0.85-BG GC51
0.85-GW GC50
Intake silencer 3-Way magnetic valve
V03 565
Female connector
Male connector

52854

⑧ ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

850 TRANSMISSION POWER TAKE-OFF CIRCUIT

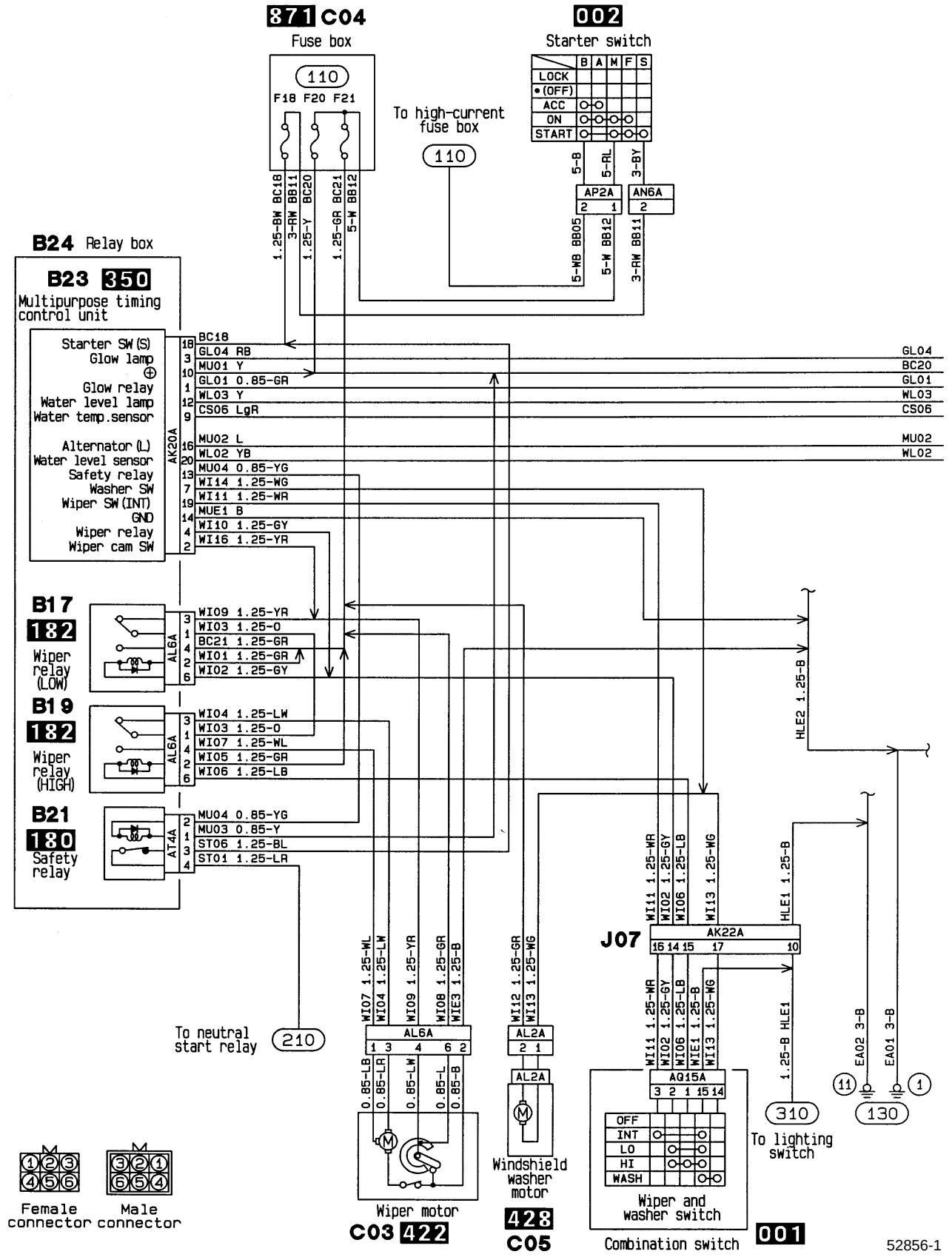


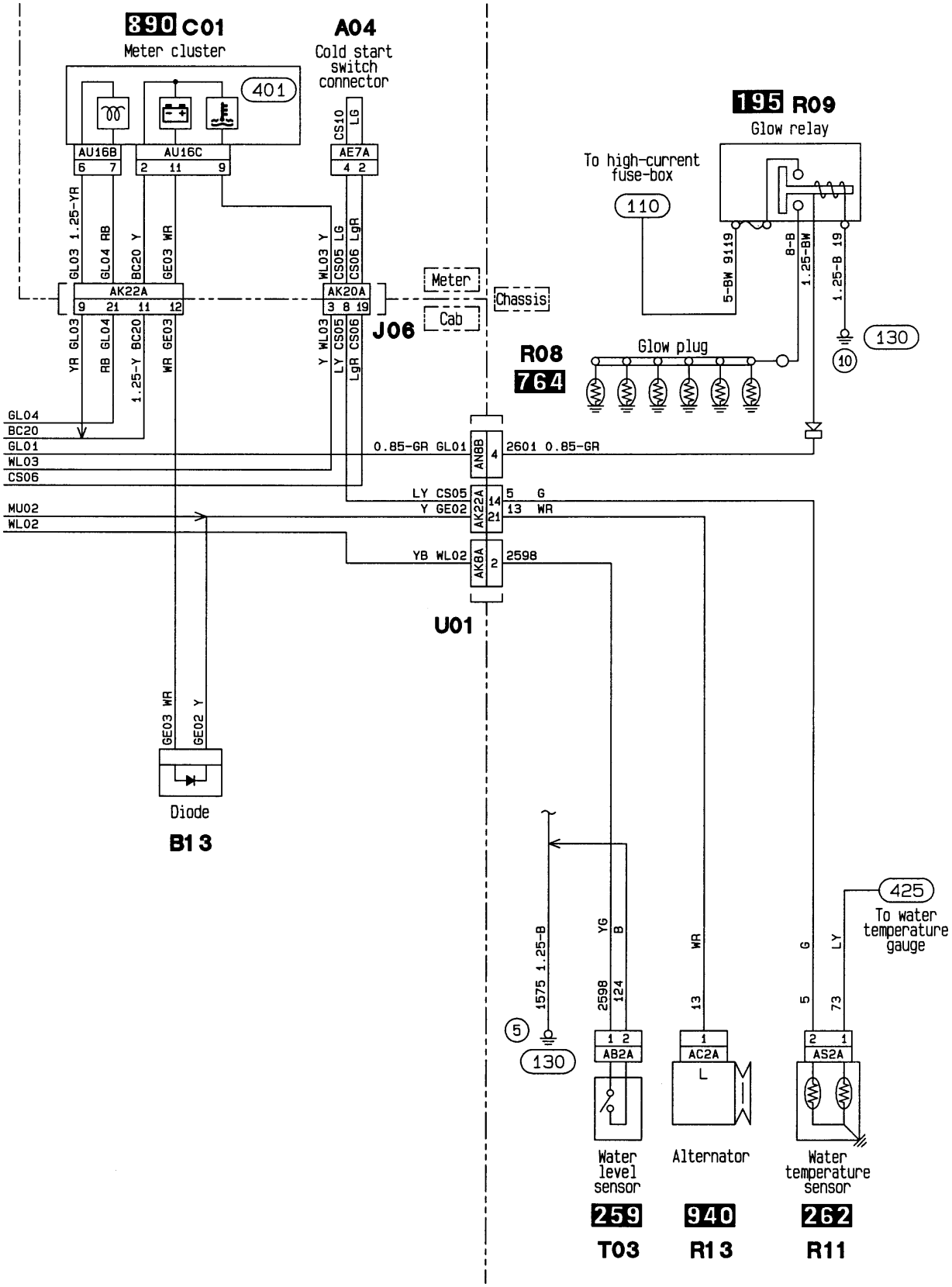
M E M O

9 OTHERS CIRCUIT

910 MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT

<6D3>

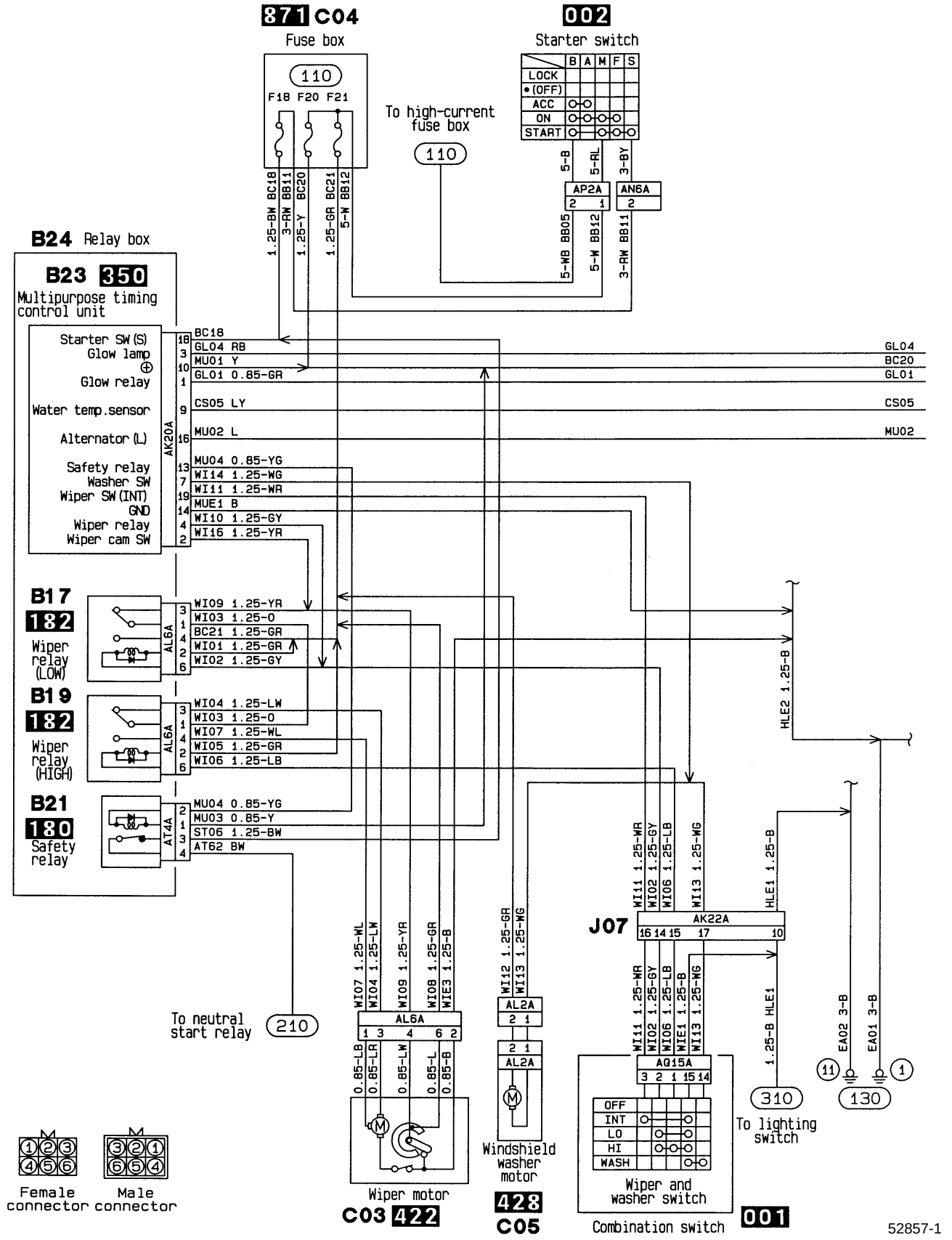


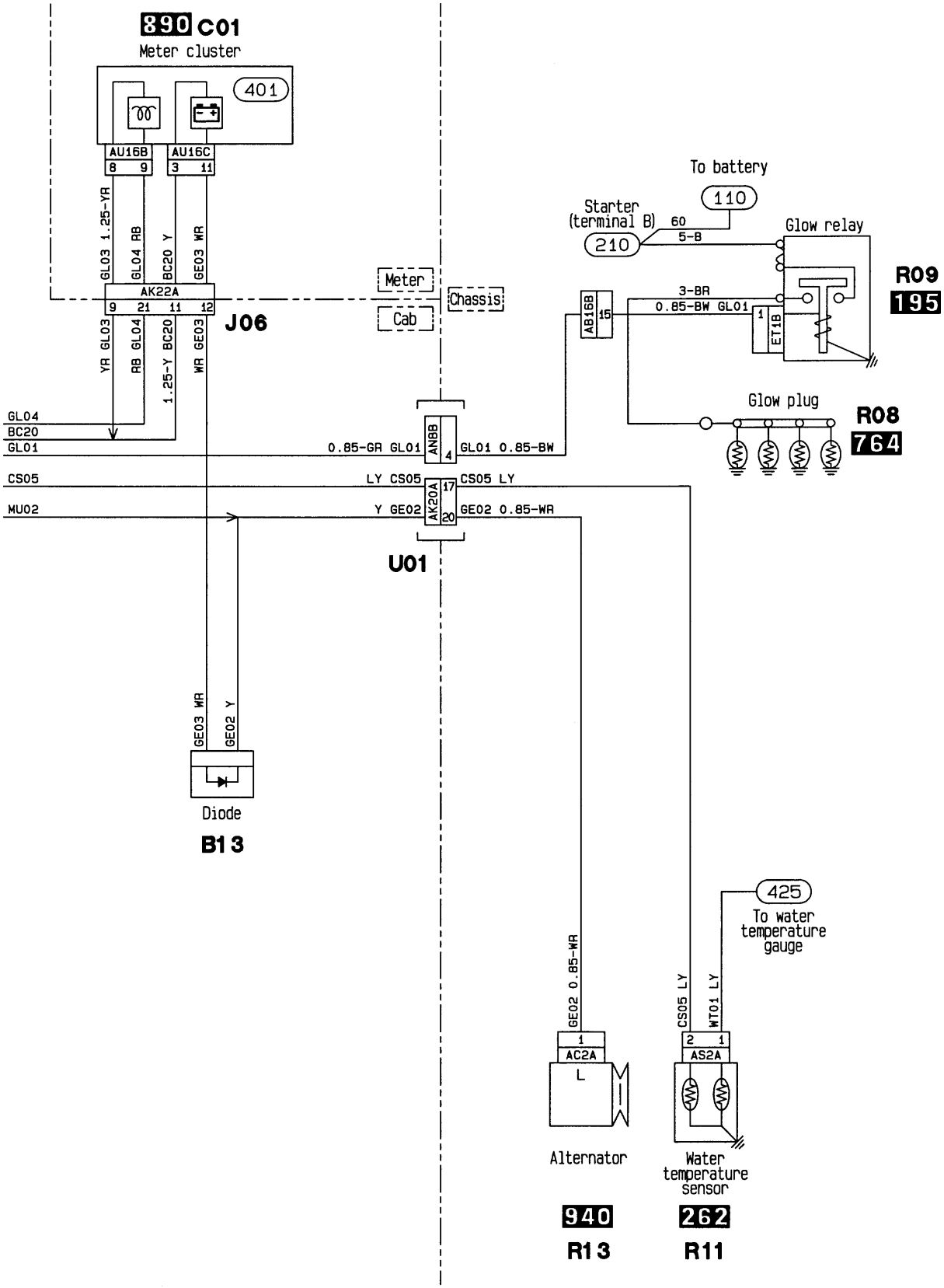

890 C01
Meter cluster
401
AU16B
6 7
AU16C
2 11 9
A04
Cold start switch connector
CS10 LG
AE7A
4 2
195 R09
Glow relay
To high-current fuse-box
110
5-BW 9119
8-B
1.25-BW
1.25-B 19
130
10
Glow plug
R08
764
GL03 1.25-YR
GL04 RB
BC20 Y
GE03 WR
WL03 Y
CS05 LG
CS06 LgR
AK22A
9 21 11 12
AK20A
3 8 19
Meter
Chassis
Cab
J06
YR GL03
RB GL04
1.25-Y BC20
WR GE03
Y WL03
LY CS05
LgR CS06
GL04
BC20
GL01
WL03
CS06
0.85-GR GL01
AN8B
4
2601 0.85-GR
LY CS05
Y GE02
AK22A
14
21
5 G
13 WR
MU02
WL02
YB WL02
AK8A
2
2598
U01
GE03 WR
GE02 Y
Diode
B13
1575 1.25-B
YG
B
2598
124
13
WR
5
G
LY
73
425
To water temperature gauge
5
130
1 2
AB2A
1
AC2A
L
2 1
AS2A
Water level sensor
259
T03
Alternator
940
R13
Water temperature sensor
262
R11

52856-2

910 MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT

<4M5>



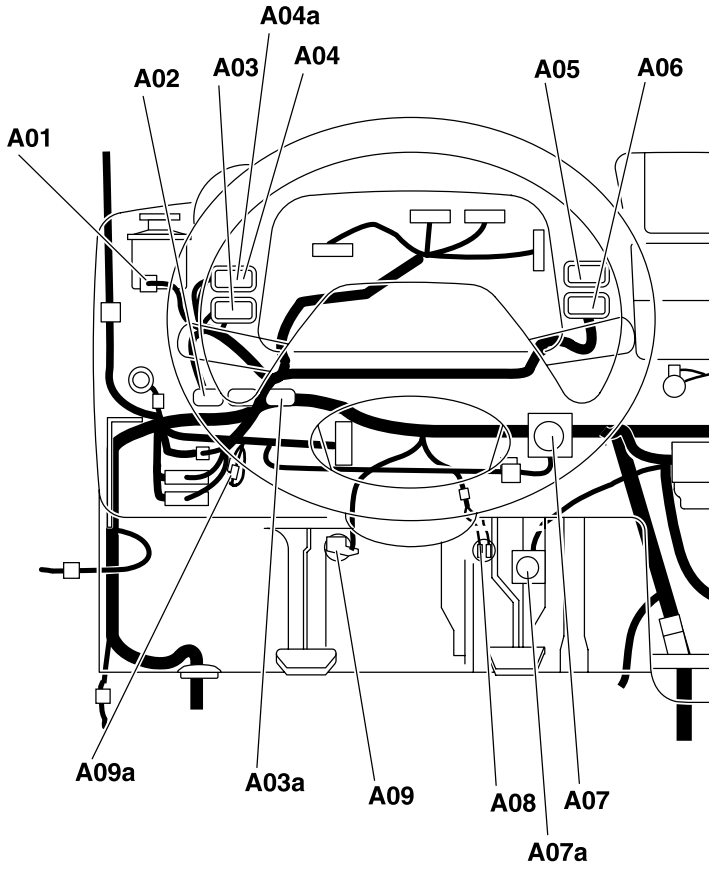

890 C01
Meter cluster
401
AU16B
8 9
AU16C
3 11
GL03 1.25-YR
GL04 RB
BC20 Y
GE03 WR
AK22A
9 21 11 12
J06
Meter
Cab
Chassis
To battery
110
Starter
(terminal B)
60
210
5-B
Glow relay
R09
195
AB16B
15
3-BR
0.85-BW GL01
1
ET1B
Glow plug
R08
764
GL04
BC20
GL01
0.85-GR GL01
AN8B
4
GL01 0.85-BW
CS05
LY CS05
AK20A
17
CS05 LY
MU02
Y GE02
20
GE02 0.85-WR
U01
GE03 WR
GE02 Y
Diode
B13
425
To water
temperature
gauge
GE02 0.85-WR
CS05 LY
WT01 LY
1
AC2A
L
2 1
AS2A
Alternator
Water
temperature
sensor
940
R13
262
R11

52857-2

10 PARTS INSTALLATION POSITION

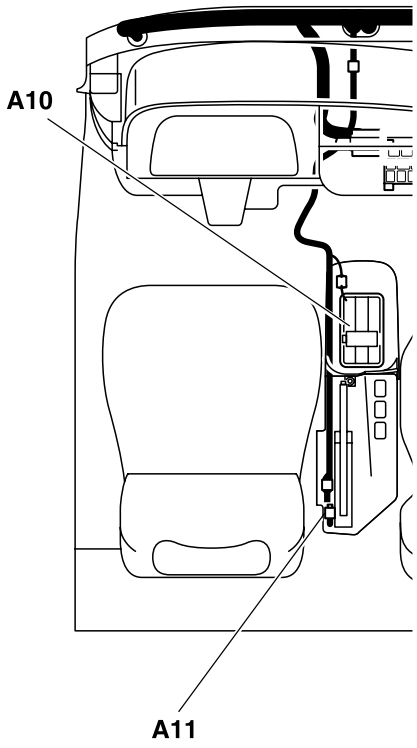
A SWITCH

A 01 to 11



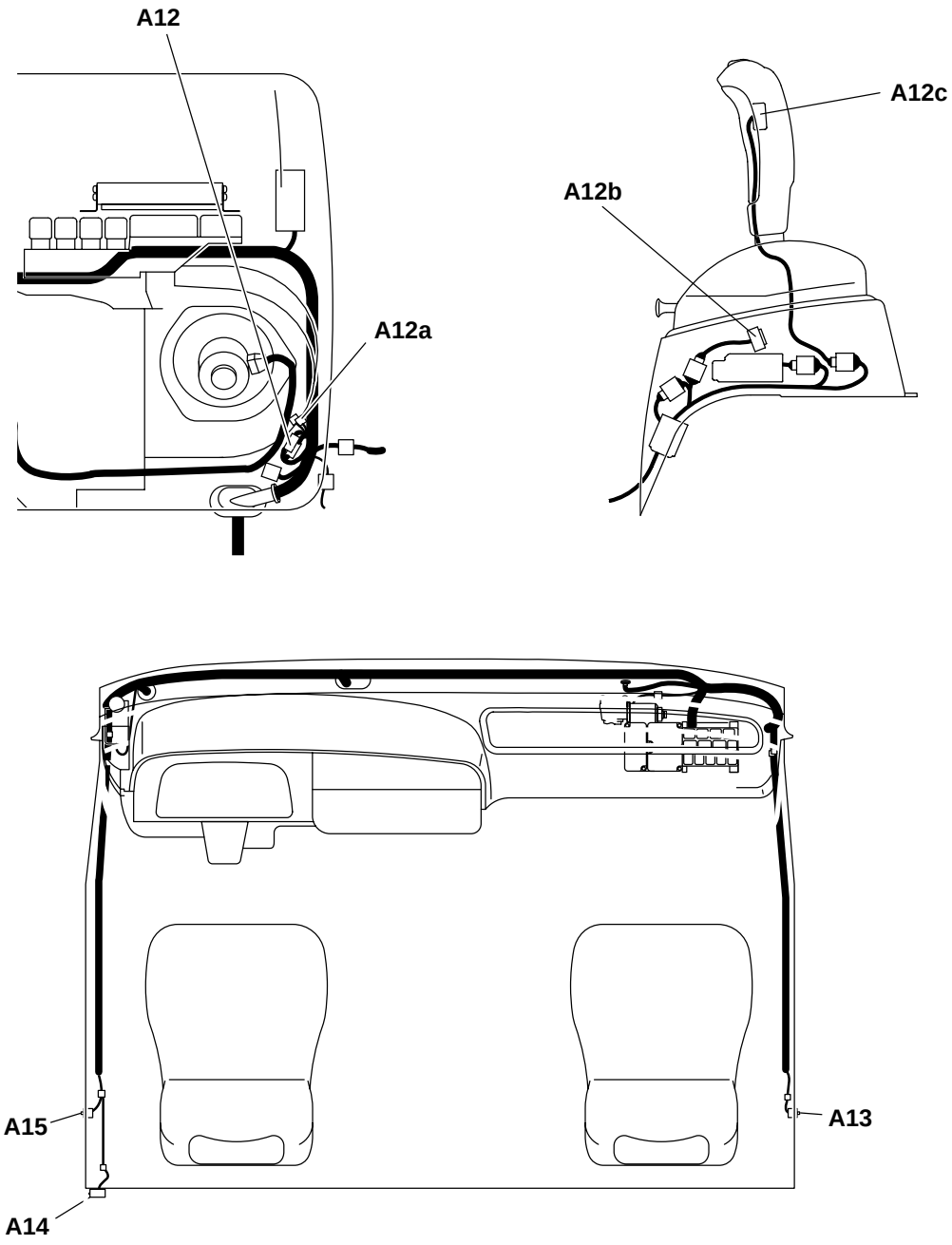
A01 Brake fluid level switch
A02 Rheostat switch
A03 Transmission power take-off switch connector <6D3(M/T)>
A03a Engine oil level check switch <4M5>
A04 Cold start switch connector <6D3>
A04a Warm-up switch <4M5>
A05 Van body dome light switch
A06 Mirror heater switch connector
A07 Idling speed adjustment potentiometer
A07a Emergency engine stop switch <4M5>
A08 Stop lamp switch
A09 Clutch switch <6D3(M/T)>
A09a Diagnosis switch <4M5>
Memory clear switch <4M5>
A10 Range selector lamp <6D3(A/T)>
A11 Parking brake switch

M/T : Manual transmission
A/T : Automatic transmission



Ⓟ52900

A 12 to 15



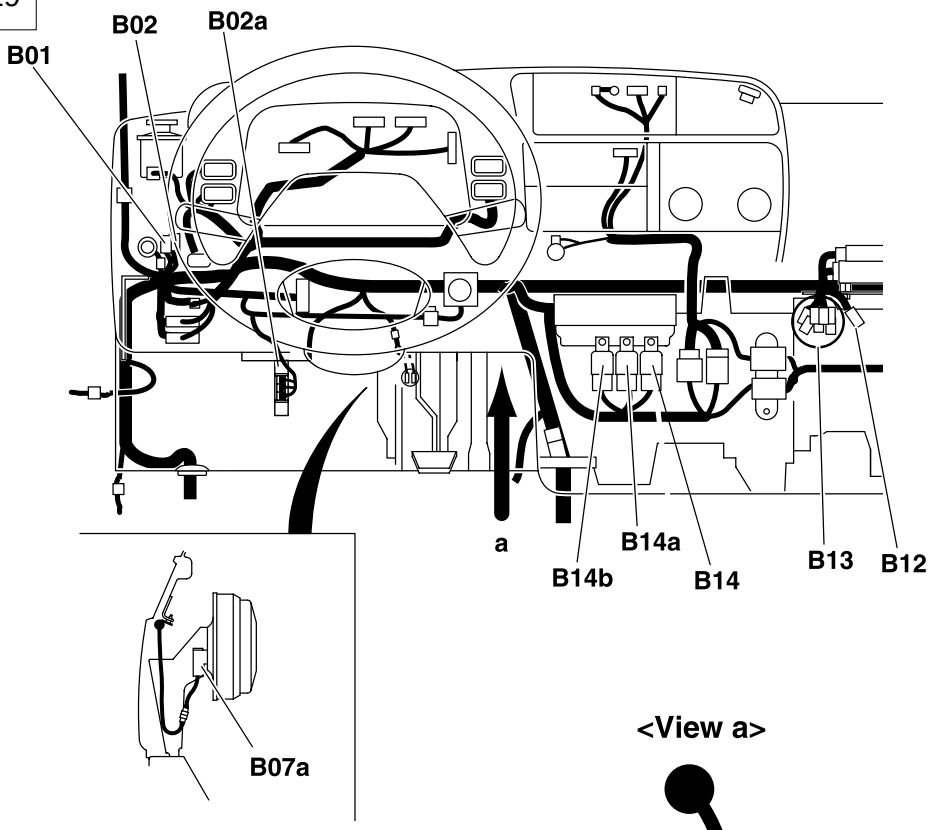
A12 Diagnosis switch
Memory clear switch
A12a Power take-off connector <6D3(M/T)>
A12b P-range switch <4M5>
A12c Over drive switch <4M5>
A13 Door switch, RH
A14 Cab tilt lock switch
A15 Door switch, LH

M/T : Manual transmission

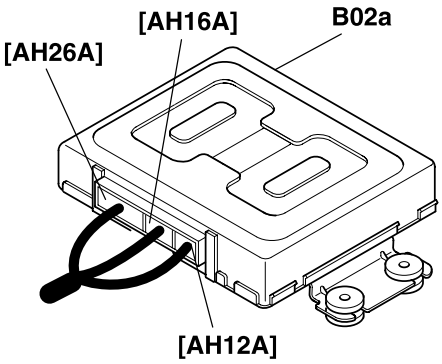
Ⓟ52901

B RELAY AND ELECTRONIC CONTROL UNIT

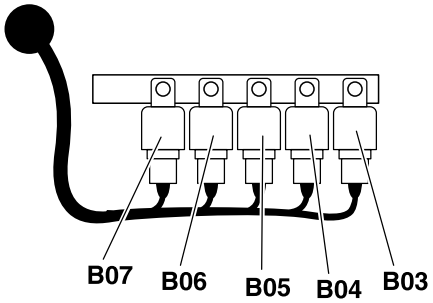
B 01 to 29



<A/T electronic control unit>



<View a>



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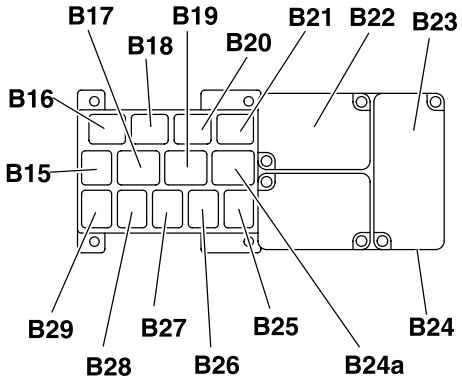
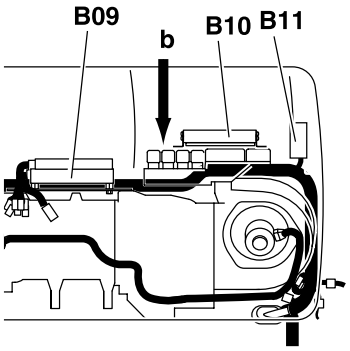


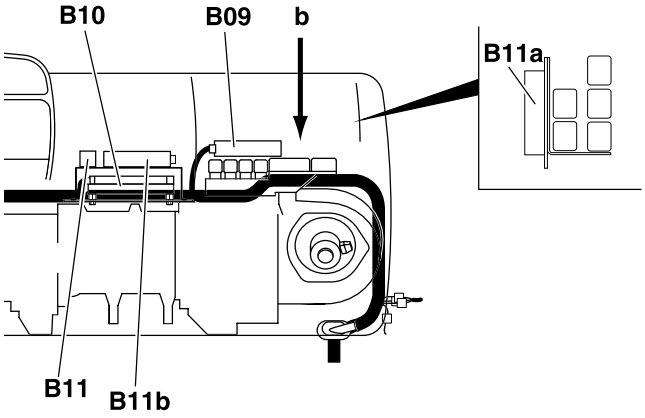
B01 Fuel injection rate adjustment resistor
B02 PTO resistor <6D3(M/T)>
B02a A/T electronic control unit <4M5>
B03 ATF cooler fan motor relay
B04 Parking brake relay <6D3(A/T)>
Exhaust brake cut relay <4M5>
B05 Neutral start relay
B06 Van body dome light relay
B07 Accelerator relay <6D3(M/T)>
Transmission power take-off relay connector <6D3(M/T)>
Backup lamp relay <4M5>
B07a Key interlock electronic control unit <4M5>

Ⓟ52902

<6D3>



<4M5>



No relevant part in a missing number

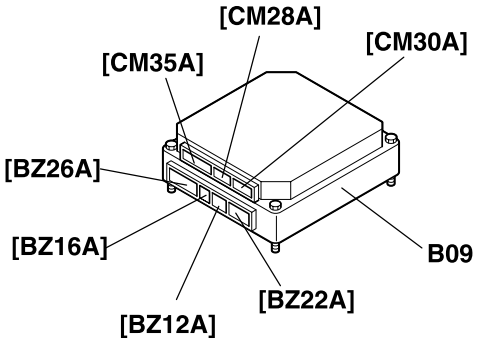
B09 Engine electronic control unit
B10 ABS electronic control unit
B11 Daytime running light electronic control unit
B11a Electronic drive unit <4M5>
B11b Pulse divider <4M5>
B12 Resistor <6D3(A/T)>
B13 Diode
B14 Turn signal lamp relay
B14a Engine electronic control unit main relay <4M5>
B14b Electronic drive unit relay <4M5>
B15 Blower fan relay
B16 Pre-stroke cut relay <6D3>
B17 Wiper relay (LOW)
B18 Transmission neutral relay <6D3>
B19 Wiper relay (HIGH)
B20 Exhaust brake cut relay <ABS>
B21 Safety relay
B22 Flasher unit
B23 Multipurpose timing control unit
B24 Realy box
B24a Engine oil level relay <4M5>
B25 Mirror heater relay connector
B26 Exhaust brake relay <6D3>
B27 Tail lamp relay
B28 Headlamp relay (HIGH)
B29 Headlamp relay (LOW)

ABS : Anti-lock brake system
ATF : Automatic transmission fluid
A/T : Automatic transmission
M/T : Manual transmission
PTO : Power take-off

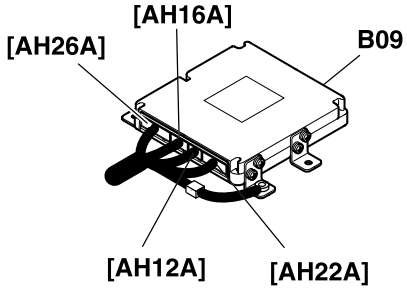
Indicate by connector type [ ].

<Engine electronic control unit>

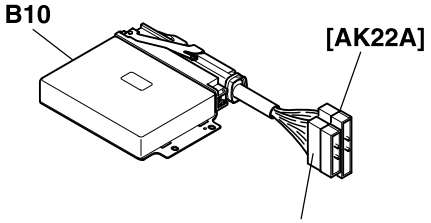
<6D3>



<4M5>



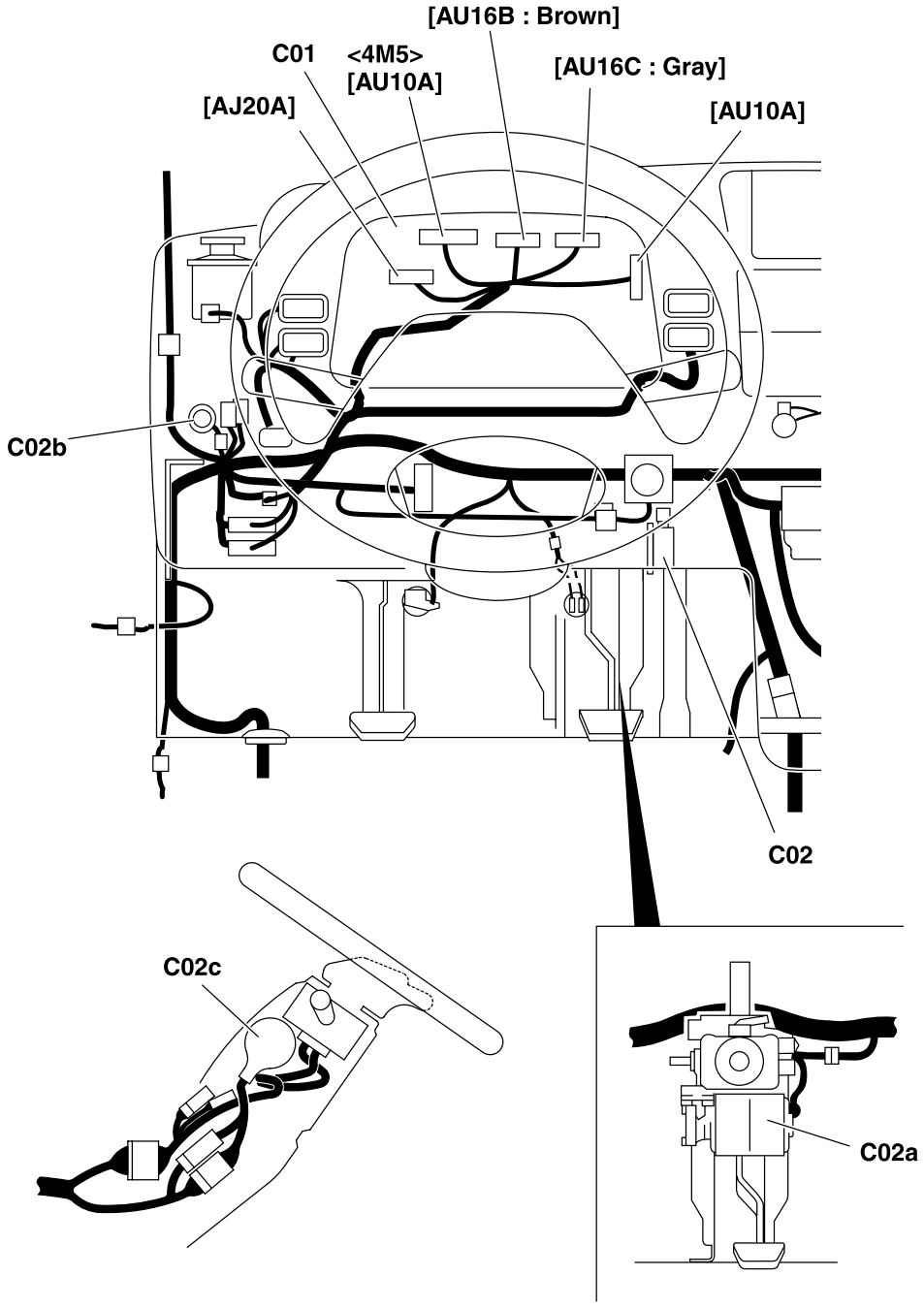
<ABS electronic control unit>



[AK20A] <6D3(M/T) , 4M5>
or
[AK18A] <6D3(A/T)>

Ⓟ52903

C 01 to 02

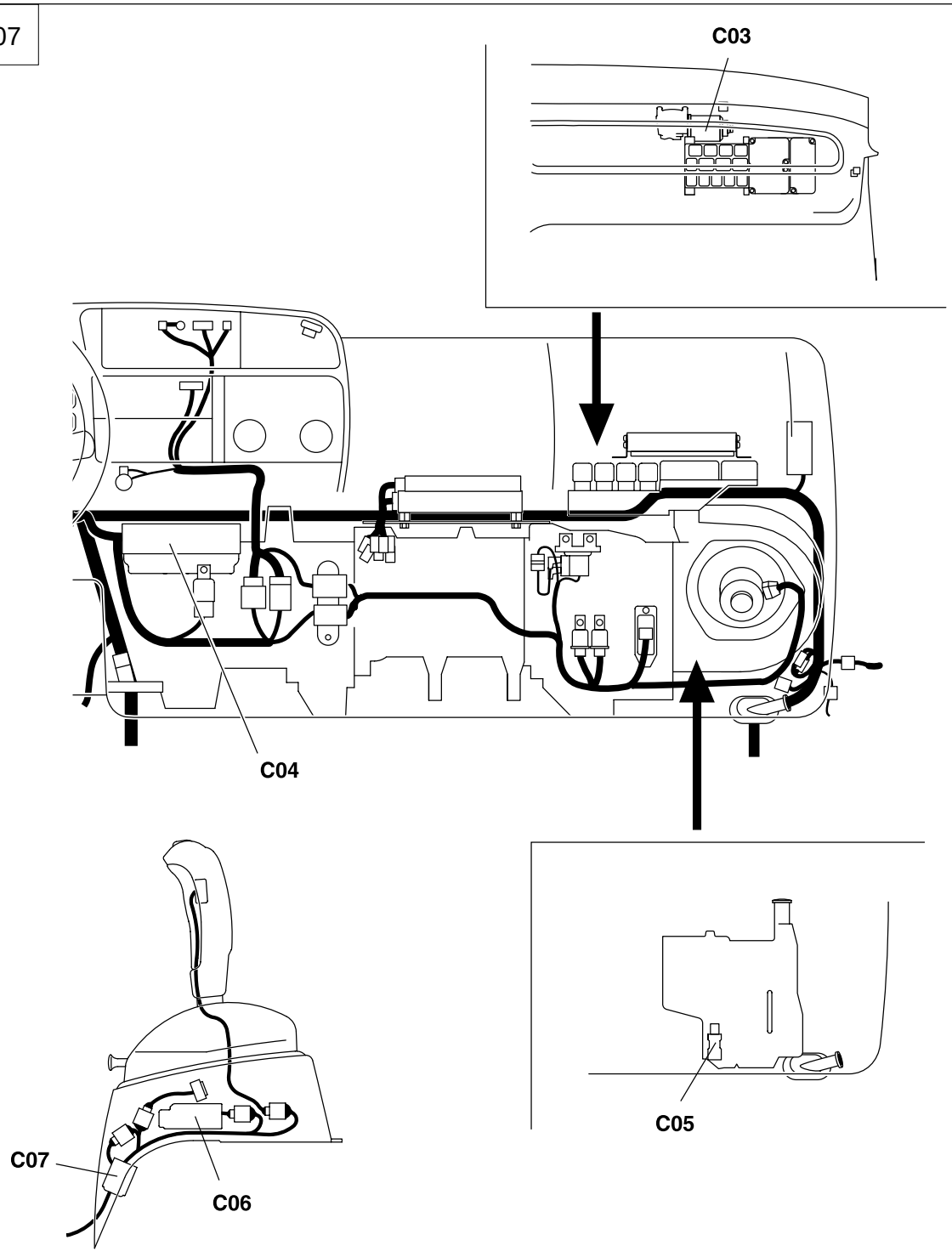


C01 Meter cluster
C02 Accelerator pedal position sensor
C02a Hydraulic booster assembly
C02b Warning buzzer
C02c Key interlock solenoid <4M5>

Indicate by connector and color [ ].
[connector type : connector color]

Ⓟ52904

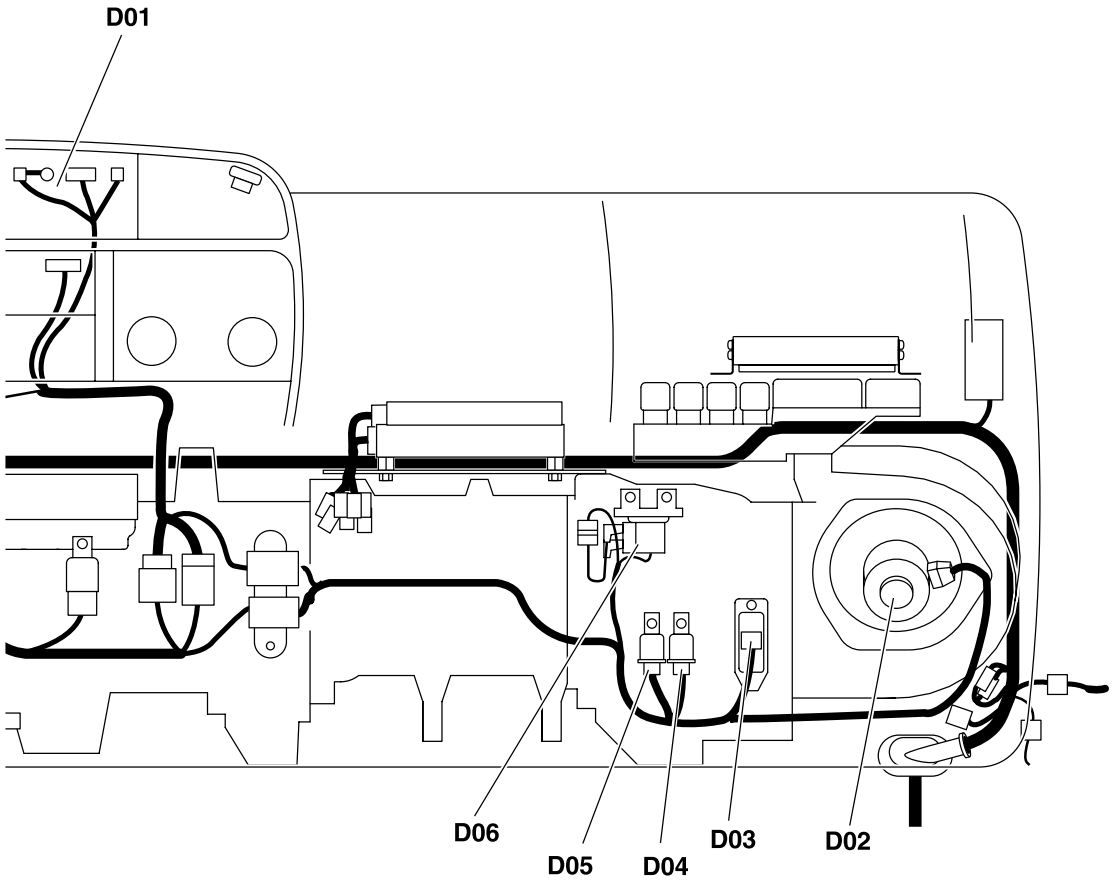
C 03 to 07



C03 Wiper motor
C04 Fuse box
C05 Windshield washer motor
C06 P-shift lock actuator <4M5>
C07 Reverse warning buzzer <4M5>

Ⓟ52905

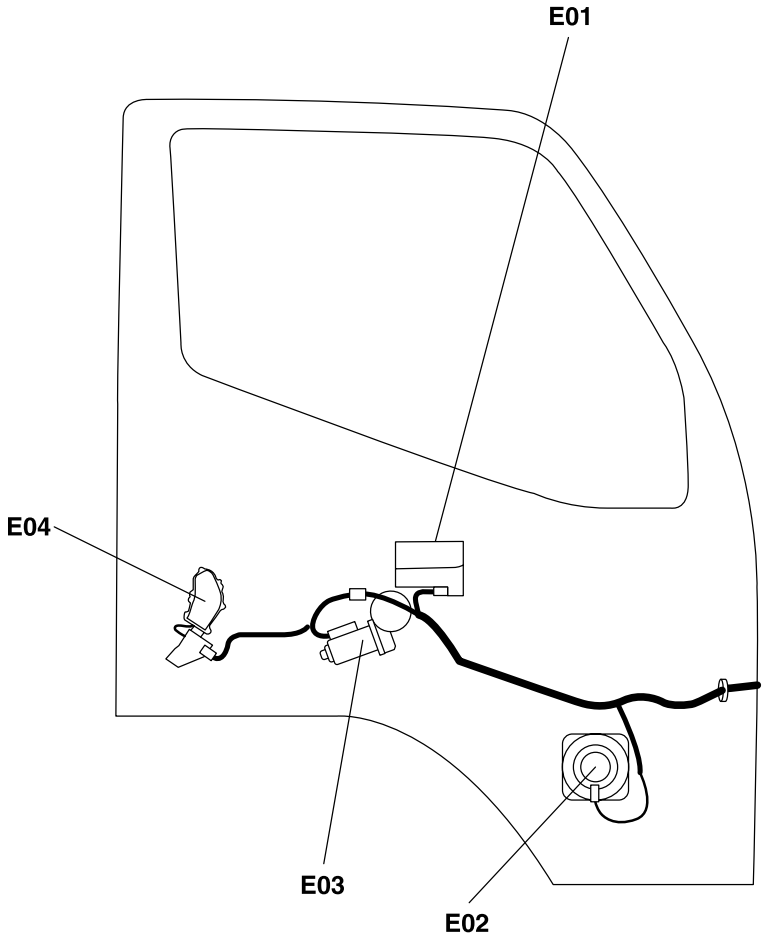
D 01 to 06



D01 Heater control assembly
D02 Blower motor
D03 Blower resistor
D04 Condenser fan relay connector
D05 Air-conditioner relay connector
D06 Thermostat connector

Ⓟ52906

E 01 to 04

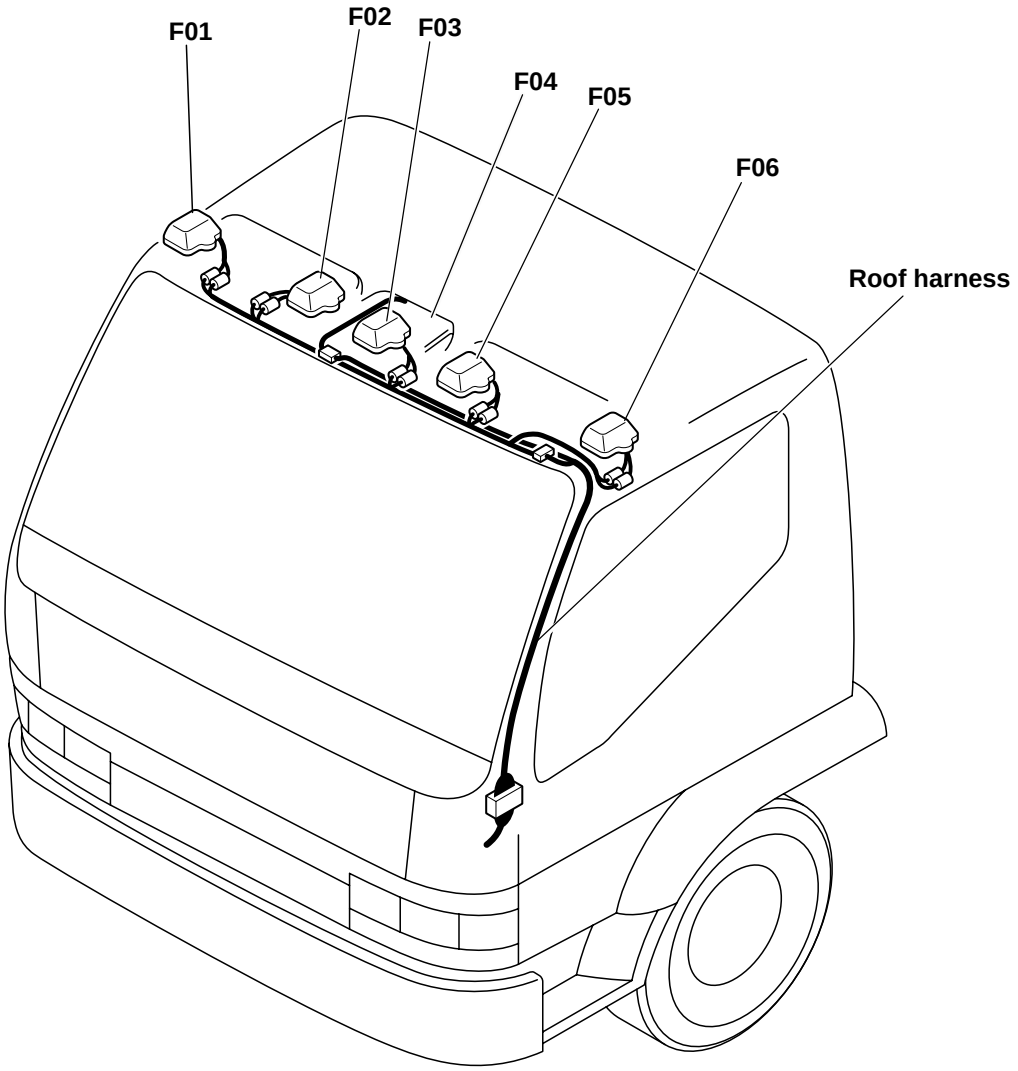


E01 Power window switch
E02 Door speaker
E03 Power window motor
E04 Door lock actuator

This illustrations show the left side door , the right side door is symmetrical .

Ⓟ44122

F 01 to 06



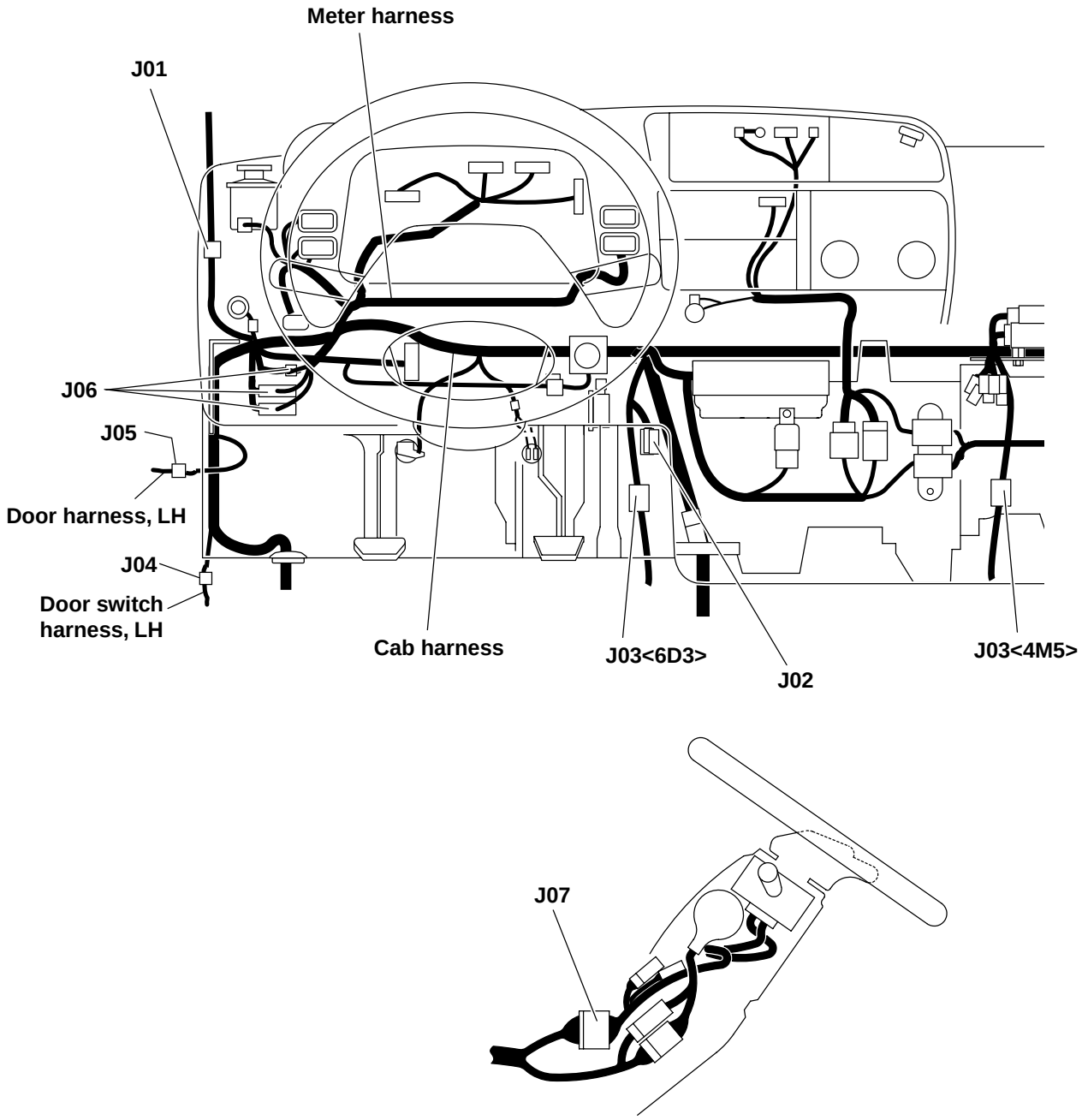
F01 Marker lamp, RH
F02 Identification lamp, RH
F03 Identification lamp, CENTER
F04 Cab lamp
F05 Identification lamp, LH
F06 Marker lamp, LH

Ⓟ 44125

M E M O

J JOINT OF MAIN HARNESS CONNECTORS

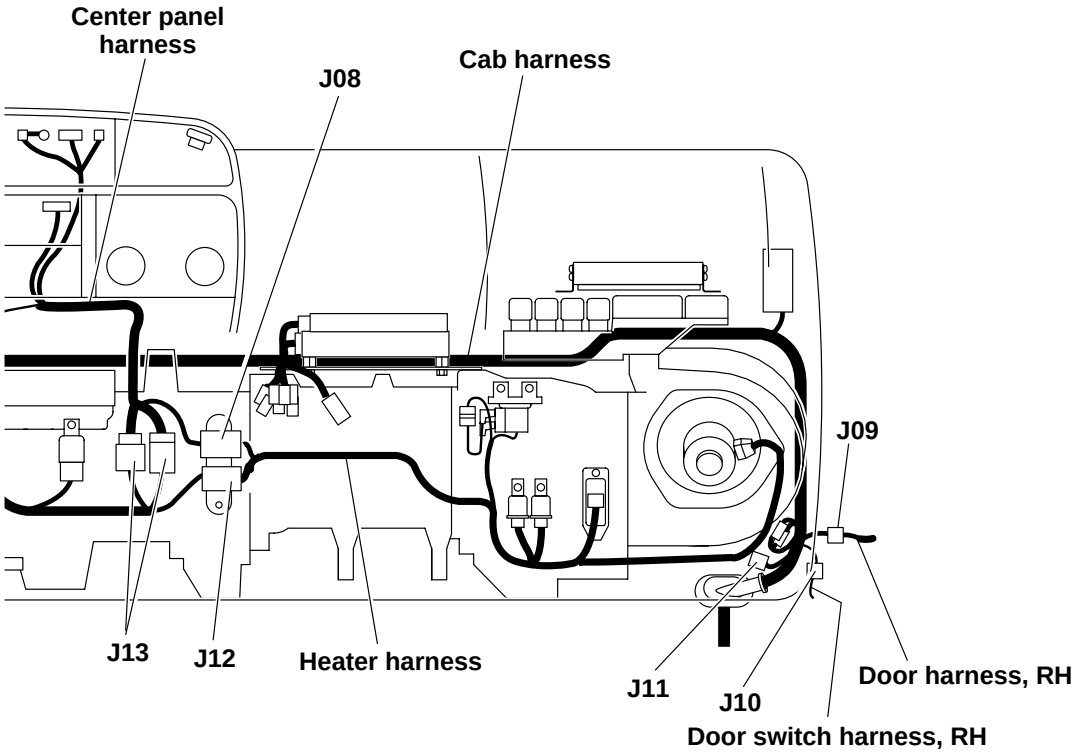
J 01 to 07

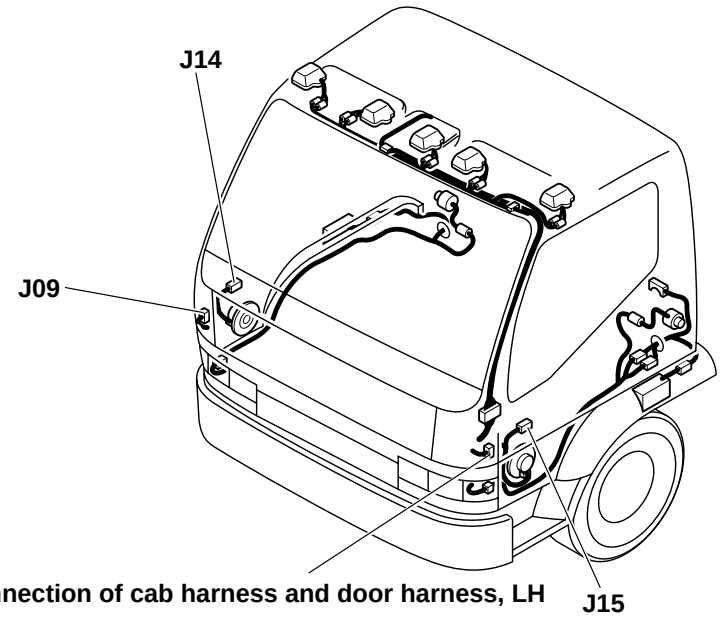


J01 Connection of cab harness and roof harness
J02 Spare D.C connector
J03 Connection of cab harness and center floor harness
J04 Connection of cab harness and door switch harness, LH
J05 Connection of cab harness and door harness, LH
J06 Connection of cab harness and meter harness
J07 Connection of cab harness and column harness

Ⓟ48296

J 08 to 15

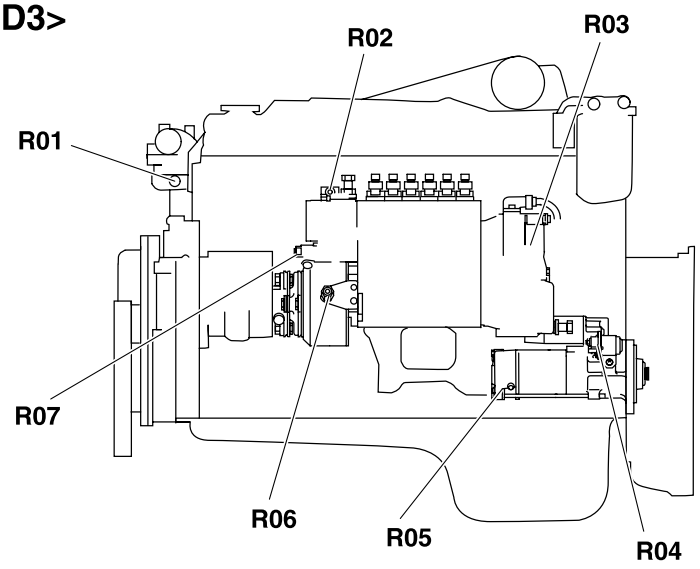


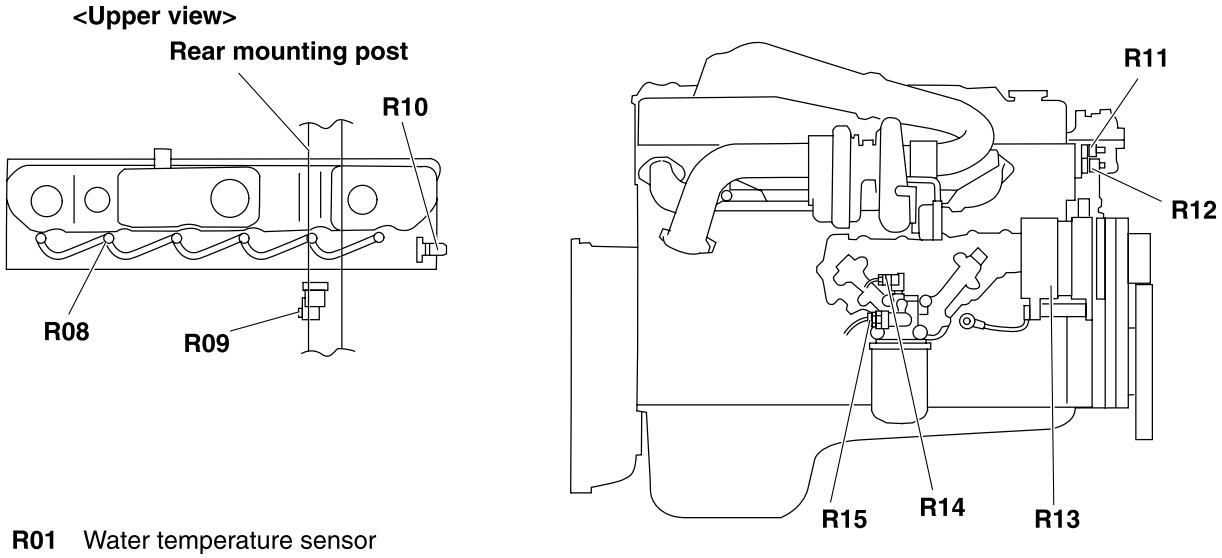


J08 Connection of center panel harness and heater harness
J09 Connection of cab harness and door harness, RH
J10 Connection of cab harness and door switch harness, RH
J11 Multi use tester-II connector
J12 Connection of cab harness and heater harness
J13 Connection of cab harness and center panel harness
J14 Mirror heater connector, RH
J15 Mirror heater connector, LH

Ⓟ44153

R 01 to 15 **<6D3>**



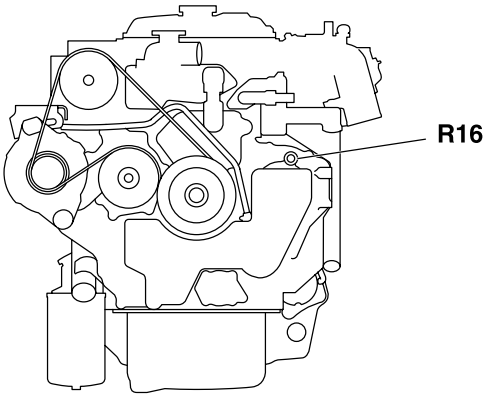


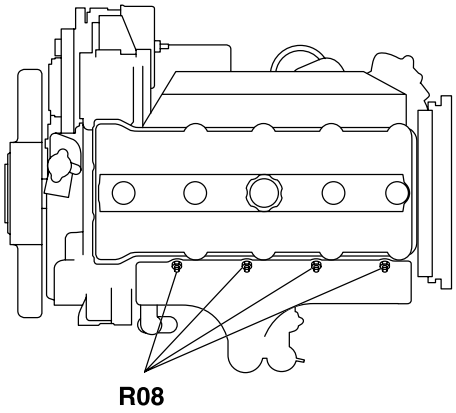
R01 Water temperature sensor
(connects to engine electronic control unit)
R02 Pre-stroke actuator
R03 Electronic governor
R04 Starter relay
R05 Starter
R06 Engine speed sensor
R07 Sub control rack position sensor
R08 Glow plug
R09 Glow relay
R10 Boost pressure sensor
R11 Water temperature sensor
(connects to water temperature gauge and multipurpose timing control unit)
R12 Overheating switch
R13 Alternator
R14 Engine oil pressure switch
R15 Engine oil bypass alarm switch

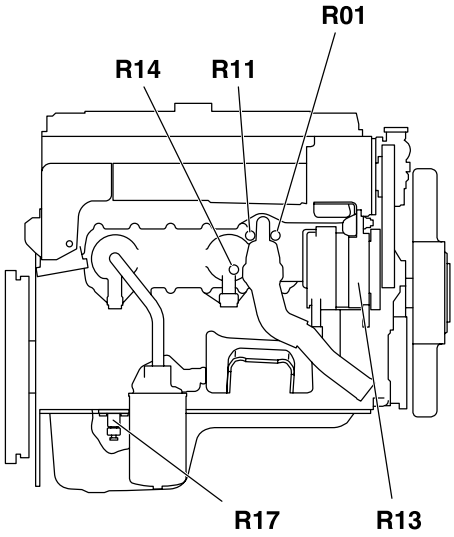
Ⓟ52908

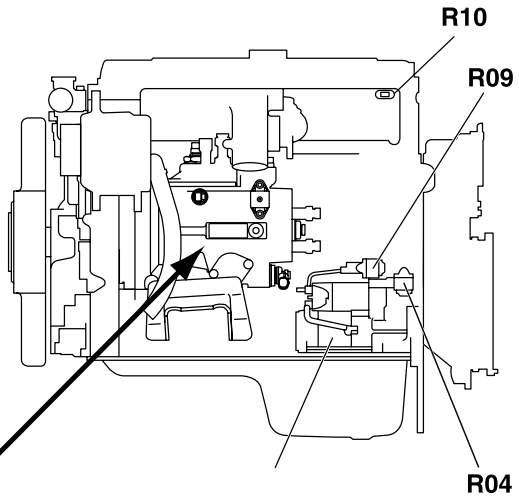
R 01 to 21

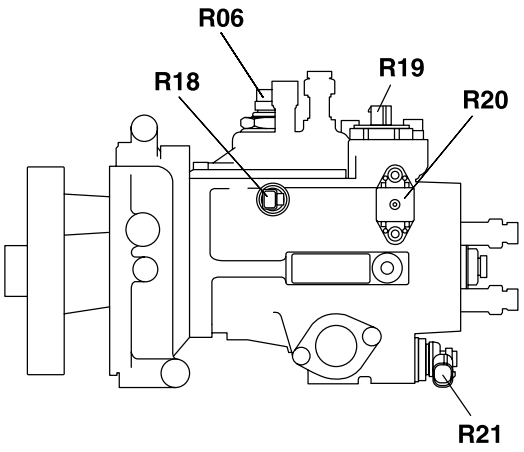
<4M5>











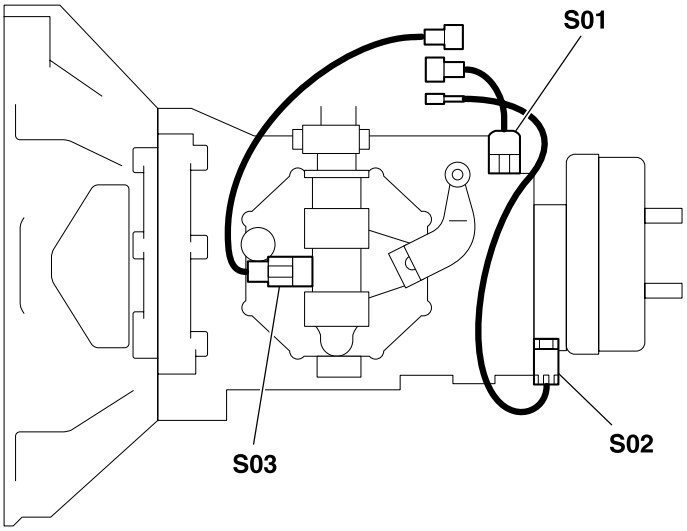
No relevant part in a missing number

R01 Water temperature sensor
(connects to engine electronic control unit)
R04 Starter relay
R05 Starter
R06 Engine speed sensor
R08 Glow plug
R09 Glow relay
R10 Boost pressure sensor
R11 Water temperature sensor
(connects to water temperature gauge and multipurpose timing control unit)
R13 Alternator
R14 Engine oil pressure switch
R16 Top dead center (TDC) sensor
R17 Engine oil level sensor
R18 Fuel temperature sensor
R19 Spill valve
R20 Fuel injection rate adjusting read only memory
R21 Timer control valve

Ⓟ52909

S 01 to 03

<Manual transmission>

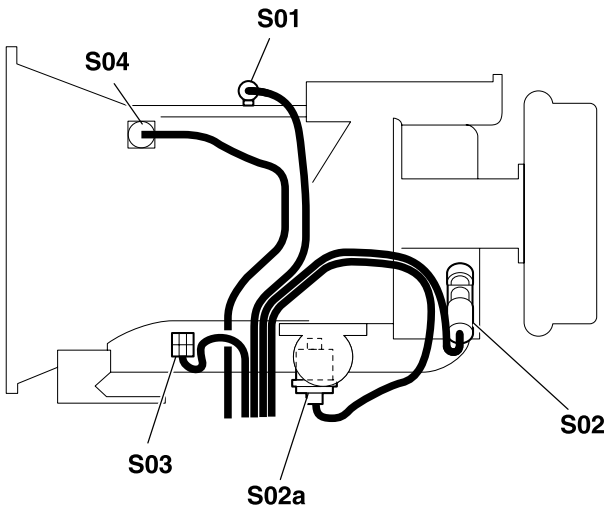


S01 Backup lamp switch
S02 Vehicle speed sensor
S03 Transmission neutral switch

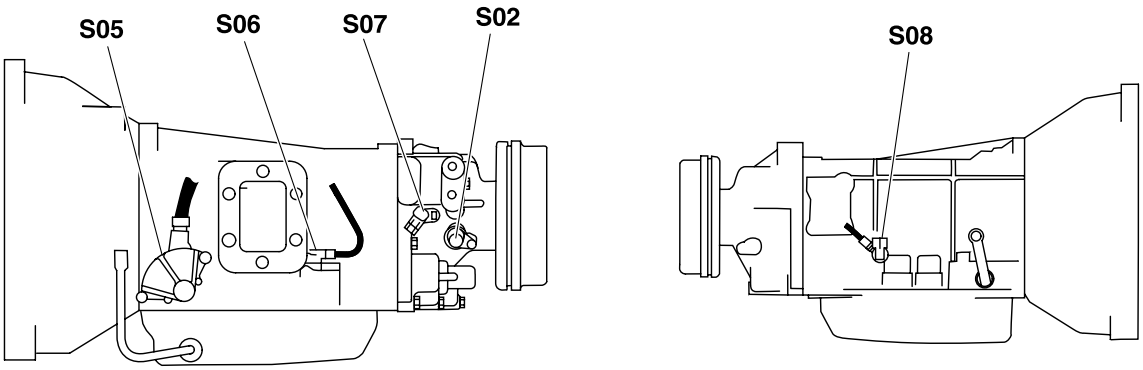
Ⓟ52910

S 01 to 08 **<Automatic transmission>**

<6D3>



<4M5>

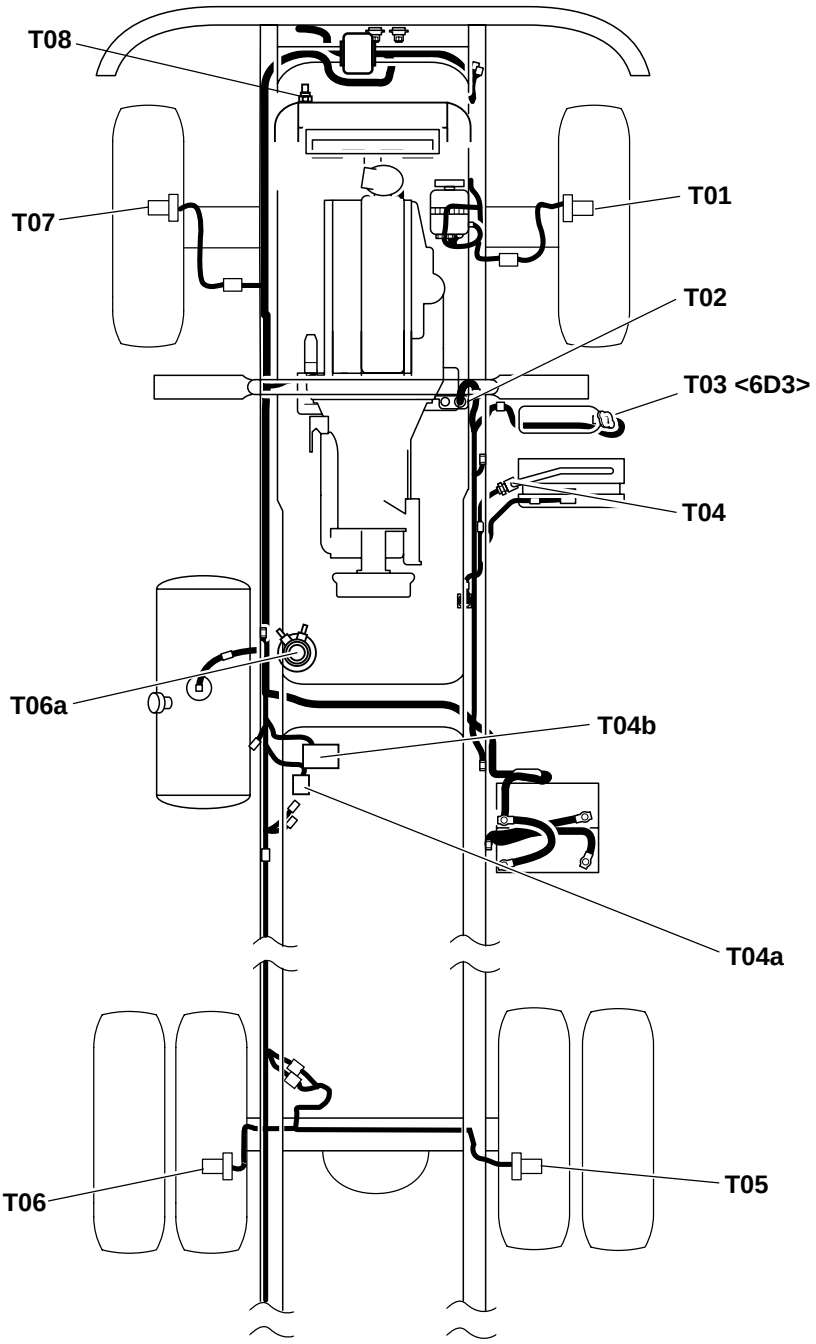


S01 Backup lamp switch
S02 Vehicle speed sensor
S02a Modulator <6D3>
S03 Transmission neutral switch
S04 ATF temperature sensor (for warning lamp) <6D3>
S05 Inhibitor switch <4M5>
S06 A/T terminal to solenoid and temperature sensor <4M5>
S07 Vehicle speed sensor <4M5>
S08 ATF thermo switch

ATF : Automatic transmission fluid
A/T : Automatic transmission

Ⓟ52911

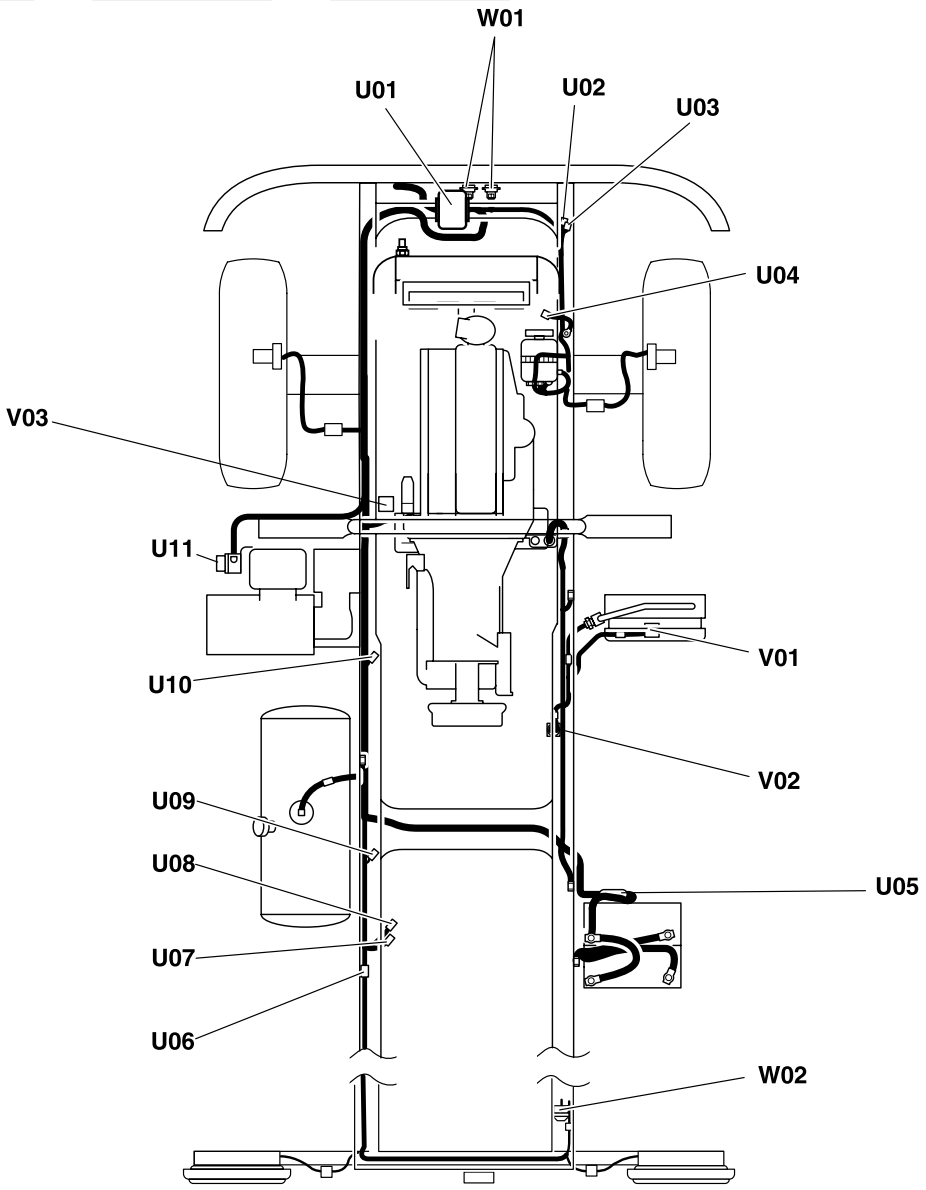
T 01 to 08



T01 Front wheel speed sensor, RH
T02 Power steering fluid level sensor
T03 Water level sensor <6D3>
T04 Automatic transmission fluid temperature sensor (for fan motor)
T04a Relay box <Anti-lock brake system>
T04b Hydraulic unit <Anti-lock brake system>
T05 Rear wheel speed sensor, RH
T06 Rear wheel speed sensor, LH
T06a Water separator sensor <4M5>
T07 Front wheel speed sensor, LH
T08 Boost air temperature sensor

Ⓟ52912

U 01 to 11 V 01 to 02 W 01 to 02



U

U01 Connection of cab harness and chassis harness
U02 Dual pressure switch connector
U03 Condenser fan motor connector
U04 Magnetic clutch connector
U05 Main high-current fuse
U06 Connection of chassis harness and rear chassis harness
U07 Spare tail lamp connector
U08 Van body dome light connector
U09 T/M PTO 3-way magnetic valve
U10 T/M PTO control switch connector
U11 High-current fuse box

V

V01 Automatic transmission fluid cooler fan motor
V02 Exhaust brake 3-way magnatic valve
V03 Intake silencer 3-way magnatic valve <4M5>

W

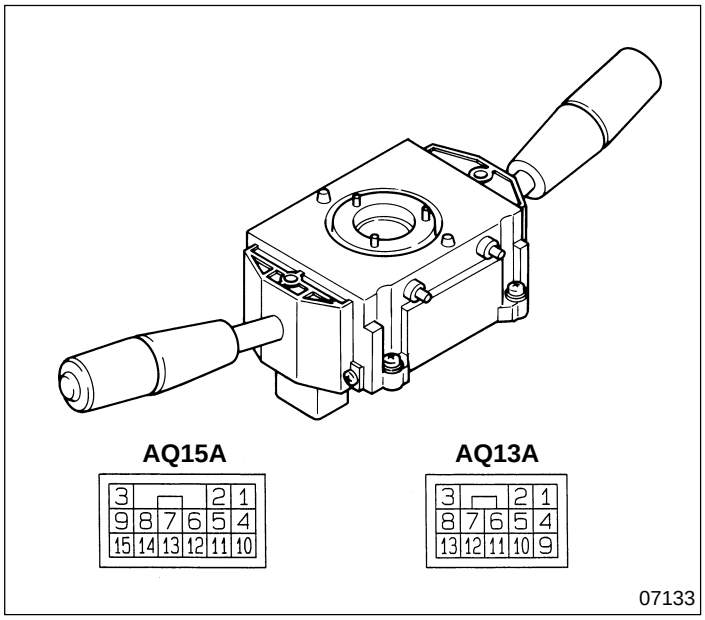
W01 Electric horn
W02 Back buzzer

T/M PTO : Transmission power take-off

Ⓟ52913

11 INSPECTION OF PARTS

001 to 179 SWITCH



001 Inspection of combination switch

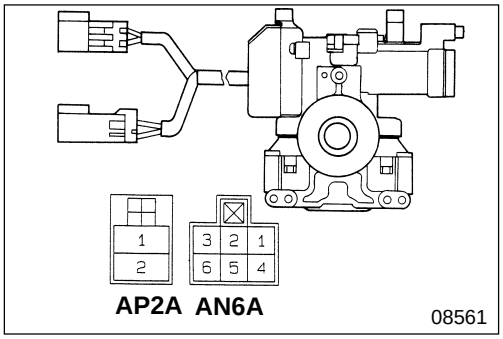
- Follow the table below to check for continuity.
  ○—○ : There is continuity between terminals.
- If any fault is found, replace the switch.

AQ13A Connector connection table

		①	②	③	⑦	⑧	⑨	⑩	⑪	Body ground	Internal connection
Lighting switch	OFF										
	I	○						○			
	II	○						○			○
Dimmer switch	Main						○				○
	↕						○		○		○
	Dimmer								○		○
	↕	○					○		○		○
	Passing	○					○				
Turn signal switch	LH			○	○						
	N (neutral)										
	RH			○		○					
Horn switch	OFF										
	ON		○							○	

AQ15A Connector connection table

		①	②	③	⑤	⑥	⑦	⑧	⑨	⑭	⑮
Wiper switch	OFF										
	INT (intermittent)			○							○
	LO (LOW)		○								○
	HI (HIGH)	○	○								○
	WASH (washer)									○	○
Exhaust brake switch	OFF										
	ON				○	○					
Hazard switch	OFF										
	ON						○	○	○		



002 **Inspection of starter switch**

- Follow the table below to check for continuity.

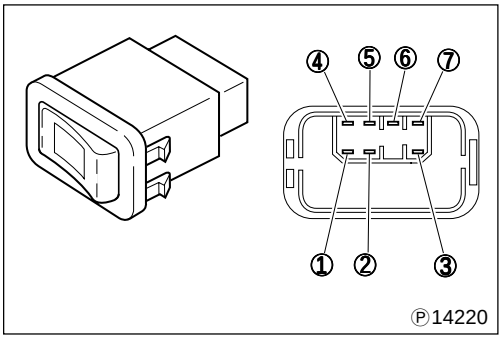
	AP2A		AN6A		
	②	①	③	④	②
LOCK					
• (OFF)					
ACC	○		○		
ON	○	○	○	○	
START	○	○		○	○
	B	M	A	F	S

○——○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 37

011 **Inspection of rheostat switch**

- Rheostat switch contains a control circuit, because of this it is difficult to inspect rheostat switch independently, therefore you should inspect the rheostat switch indirectly, by inspecting the system harness and the related parts.
- If no fault is found in the related parts but the system is faulty, replace the switch.



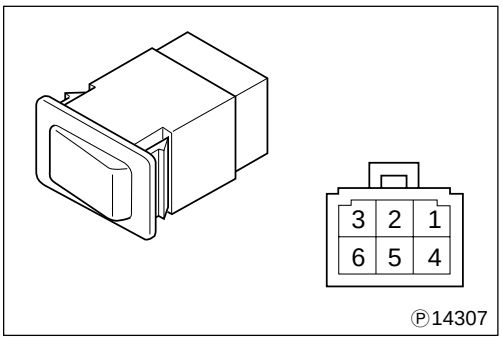
012 **Inspection of warm-up switch**

- Follow the table below to check for continuity.

	①	⑤
ON	○	○
OFF		

○——○ : There is continuity between terminals.

- If any fault is found, replace the switch.



020 **Inspection of engine oil level check switch**

- Follow the table below to check for continuity.

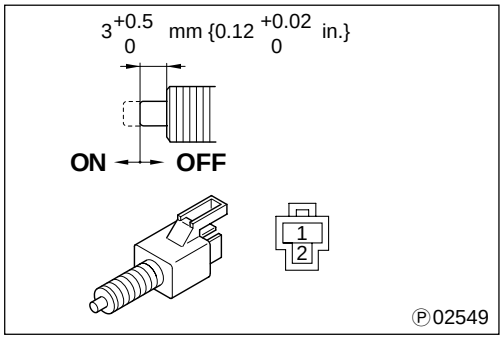
	①	③
ON (CHECK)	○	○
OFF		

○——○ : There is continuity between terminals.

- If any fault is found, replace the switch.

027 Inspection of power window switch, and power window and auto door lock switch

- Switches contains a control circuit, because of this it is difficult to inspect switches independently, therefore you should inspect the system harness, power window motor, door lock actuator etc. the related parts.
- If no fault is found in the related parts but the system is faulty, replace switches.



031 Inspection of clutch switch

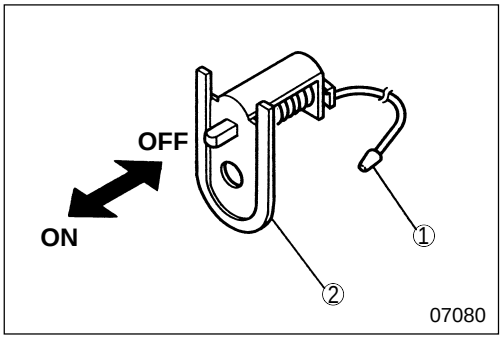
- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 21

M E M O



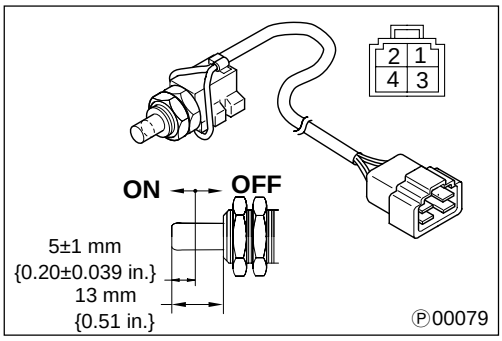
035 Inspection of door switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 42



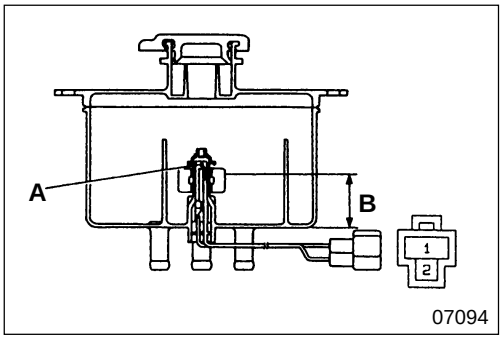
038 Inspection of parking brake switch

- Follow the table below to check for continuity.

	①	②	③	④
ON (PARK)		○		○
OFF (DRIVE)	○		○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 36



041 Inspection of brake fluid level switch

- Remove brake fluid slowly from fluid tank assembly.

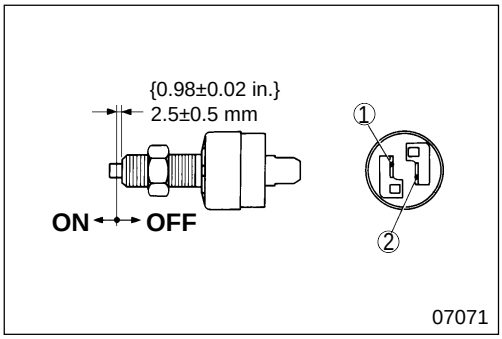
CAUTION

If brake fluid gets on a painted surface it will dissolve the paint, so wipe it off immediately.

- Measure the height **B** of switch **A** when the continuity is detected between terminals ① and ②.

Standard value	41.0 ± 3 mm {1.61 ± 0.12 in.} (equivalent to 120cm³ {7.32 cu.in., 0.12L})

- If the measured value deviates from the standard value, replace the brake fluid tank assembly. Gr 42



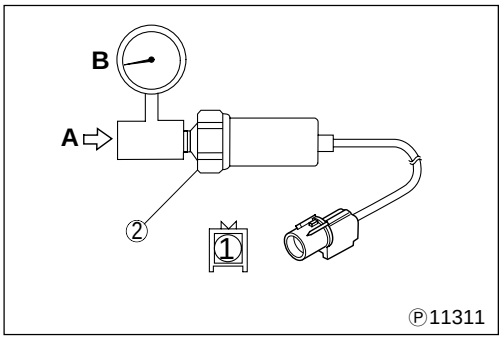
042 Inspection of stop lamp switch

- Follow the table below to check for continuity.

	①	②
ON	○	○
OFF		

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 35A



044 Inspection of engine oil pressure switch

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying air pressure

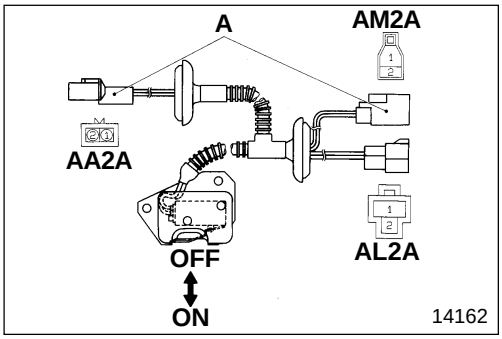
Make sure that there is continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	49 ± 9.8 kPa {7.1 ± 1.4 psi, 0.5 ± 0.1 kgf/cm²}



045 Inspection of cab tilt lock switch

- Follow the table below to check for continuity.

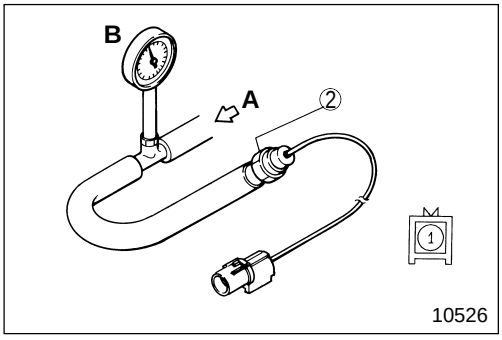
AL2A

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

A : Side turn signal lamp harness (AA2A, AM2A)

- If any fault is found, replace the switch. Gr 42



053 Inspection of engine oil bypass alarm switch < 6D3 >

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying air pressure

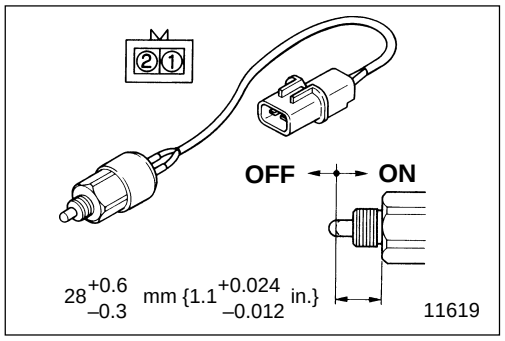
Make sure that there is no continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	190^{+60}_{0} kPa {$27^{+8.5}_{0}$ psi, $1.9^{+0.6}_{0}$ kgf/cm²}



054 Inspection of backup lamp switch

< Manual transmission >

- Follow the table below to check for continuity.

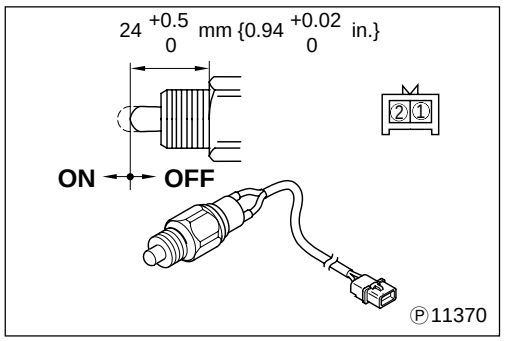
	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.

< 6D3 Automatic transmission >

For questions, contact Allison Transmission.



056 Inspection of transmission neutral switch

- Follow the table below to check for continuity.

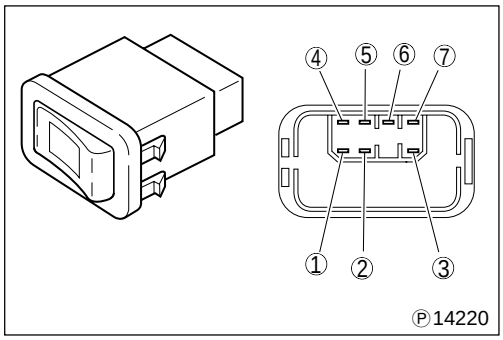
	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 22

< 6D3 Automatic transmission >

For questions, contact Allison Transmission.



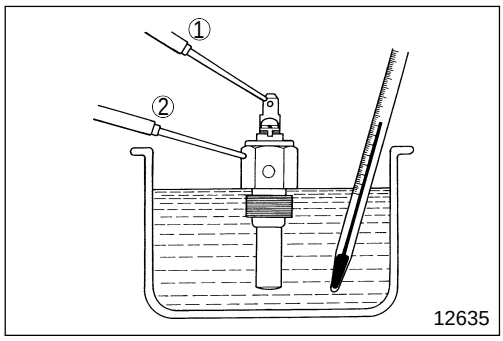
087 Inspection of van body dome light switch

- Follow the table below to check for continuity.

	①	⑤	⑦	LED (Operation indication light)	③
ON	○	○	○	—⧸\/\/\—▷—	○
OFF					

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.

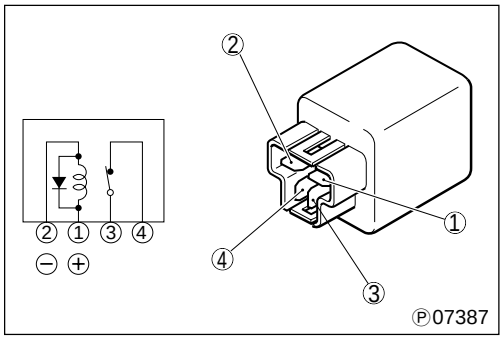


160 Inspection of overheating switch

- Place the switch in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the operating temperature between terminals ① and ② (body) respectively.

Standard Value	When temperature increase (ON→OFF)	110±2°C {230±36°F}
	When temperature decrease (OFF→ON)	110°C±4°C {230±39°F}

- If the measured value deviates from the standard value, replace the switch. Gr 14



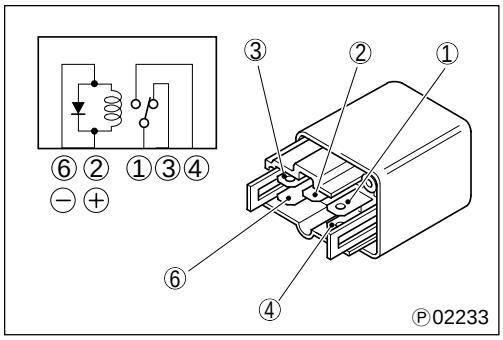
180 Inspection of relay (Close type 4-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④
No current	○	○	○	○
Current	⊕	⊖	○	○

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.
○—○ : Indicates the terminals across which there is no continuity.

- If any fault is found, replace the relay.



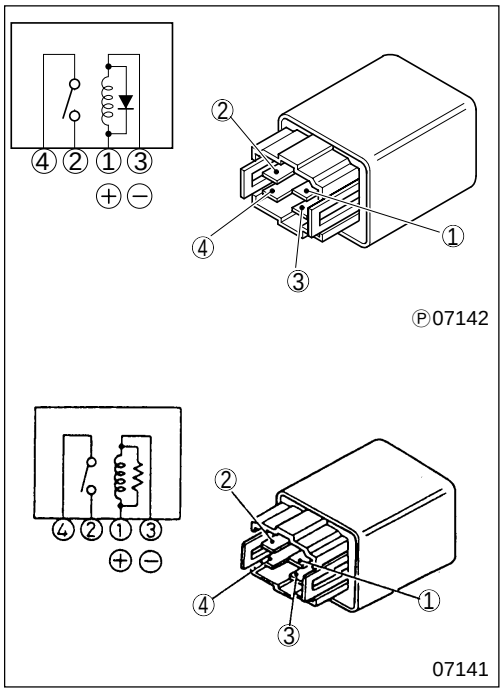
182 Inspection of relay (Open type 6-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④	⑥
No current	○	○	○		○
Current	○	⊕	○	○	⊖

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



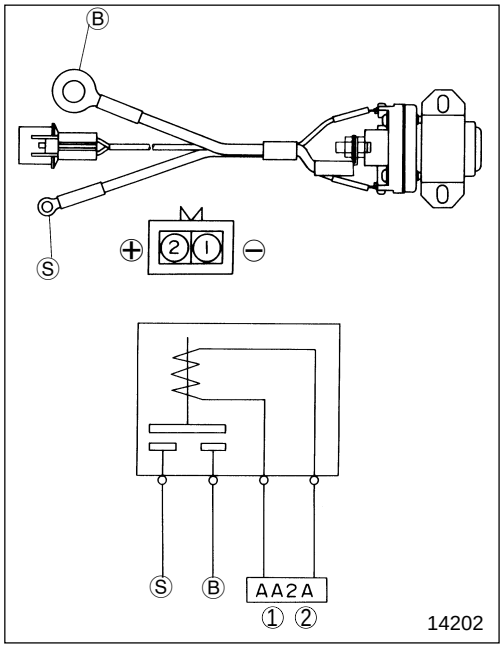
185 Inspection of relay (Open type 4-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④
No current	○		○	
Current	⊕	○	⊖	○

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



187 Inspection of starter relay

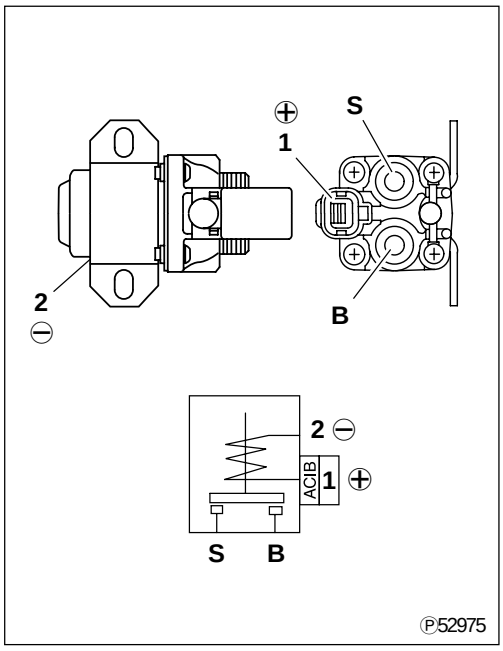
< 6D3 >

- Follow the table below to check for continuity and operation.

	B	S	①	②
No current			○	○
Current	○	○	⊖	⊕

○—○ : There is continuity between terminals.
⊖—⊕ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



< 4M5 >

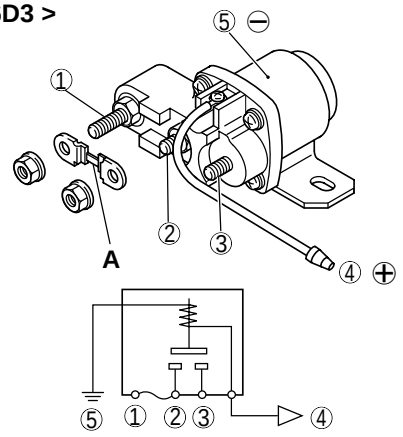
- Follow the table below to check for continuity and operation.

	B	S	①	②
No current			○	○
Current	○	○	⊕	⊖

○—○ : There is continuity between terminals.
⊖—⊕ : Indicates the terminals where battery voltage is to be applied.

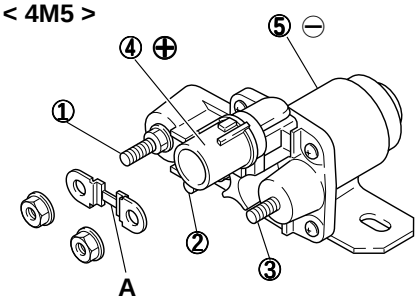
- If any fault is found, replace the relay.

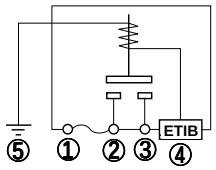
< 6D3 >



Ⓟ43907

< 4M5 >





Ⓟ33889

195 Inspection of glow relay

(1) Inspection of fuse

If any fault is found, replace the fuse **A** (127 ampere).

(2) Inspection of main body

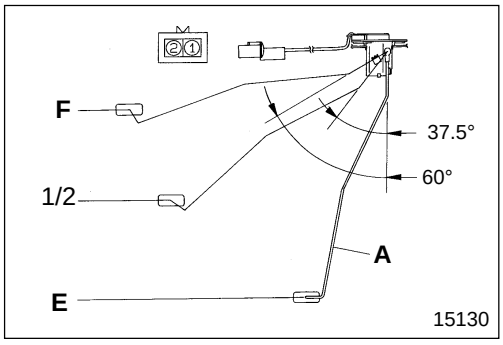
- Follow the table below to check for continuity and operation.

	①	②	③	④	⑤ (Body)
OFF	○——○			○——○	
ON	○——○——○			⊕——⊖	

○——○ : There is continuity between terminals.

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.

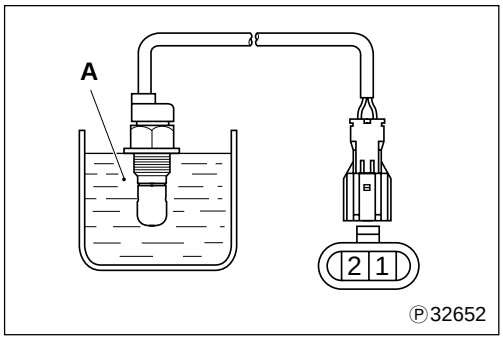


258 Inspection of fuel level sensor

- Measure the resistance between terminals ① and ② when float arm **A** contacts to both stoppers (positions **E** and **F**) and also 1/2 position.

Standard value	F (FULL position)	$0\ ^{+2}_{0}\ \Omega$
	1/2	50 ± 3 Ω
	E (EMPTY position)	150 ± 10 Ω

- If the measured value deviates from the standard value, replace the sensor. Gr 13



259 Inspection of water level sensor

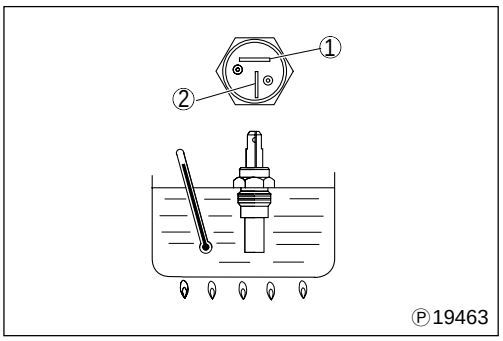
- Follow the table below to check for continuity.

	①	②
When water level sensor is out of the water		
When water level sensor is in the water	○	○

○——○ : There is continuity between terminals.

- If any fault is found, replace the sensor. Gr 14

A : Engine coolant



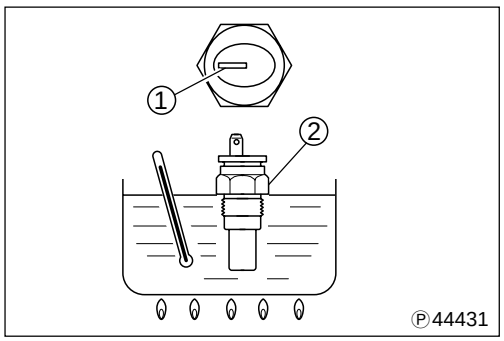
262 Inspection of water temperature sensor

< For multipurpose timing control unit >

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ②, and the body respectively.
  Terminal ① : Water temperature gauge connection
  Terminal ② : Multipurpose timing control unit connection

Standard Value	①—Body (connection side of water temperature sensor)	50°C {122°F}	153.9 Ω (Reference value)
		80°C {176°F}	$51.9\ ^{+4.9}_{-4.4}\ \Omega$
		100°C {212°F}	$27.4\ ^{+1.9}_{-1.2}\ \Omega$
	②—Body (connection side of multipurpose timing control unit)	20°C {68°F}	3.25 ± 0.33 kΩ
		60°C {140°F}	620 Ω (Reference value)
		80°C {176°F}	300 Ω (Reference value)

- If the measured value deviates from the standard value, replace the sensor. Gr 14

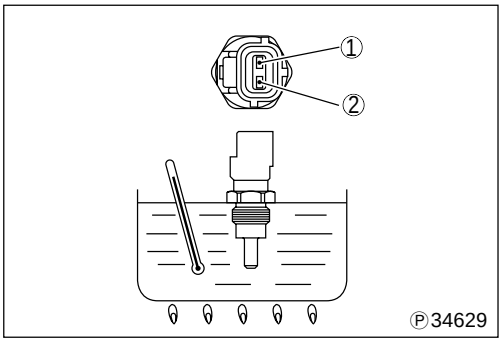


< For engine control (6D3)>

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ② (body).

Standard value	20°C {68°F}	3.25 kΩ (Reference value)
	60°C {140°F}	620±62 Ω
	80°C {176°F}	300 Ω (Reference value)

- If the measured value deviates from the standard value, replace the sensor. Gr 14

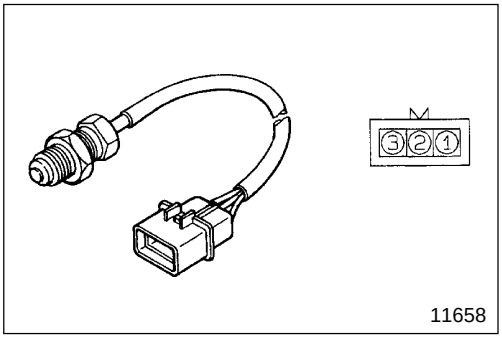


< For engine control (4M5)>

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ②.

Standard value	20°C {68°F}	2.3 to 2.6 kΩ
	80°C {176°F}	0.30 to 0.34 kΩ

- If the measured value deviates from the standard value, replace the sensor. Gr 14



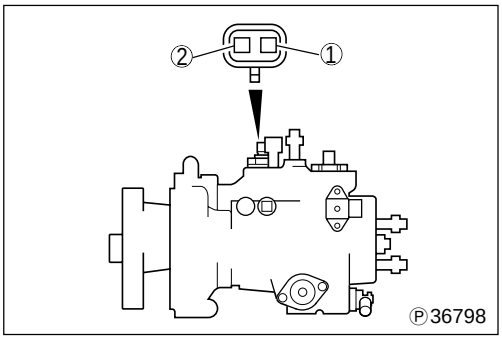
263 Inspection of engine speed sensor

< 6D3 >

- Measure the resistance between terminals ① and ②.

Standard value (at 25°C {77°F})	2.1 to 2.5 kΩ

- If the measured value deviates from the standard value, replace the sensor.

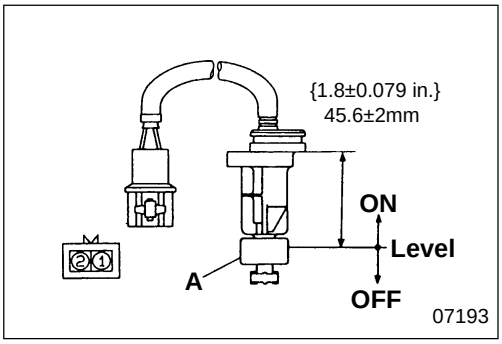


< 4M5 >

- Measure the resistance between terminals ① and ②.

Standard value (at 20°C {68°F})	230 ± 25 Ω

- If the measured value deviates from the standard value, replace the sensor.



264 Inspection of engine oil level sensor

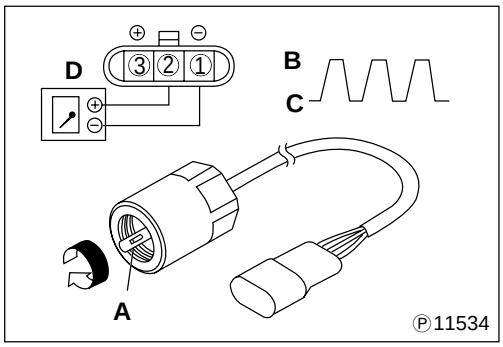
- Follow the table below to check for continuity.

	①	②
ON	○—○	
OFF		

○—○ : There is continuity between terminals.

A : Float

- If any fault is found, replace the sensor. Gr 12



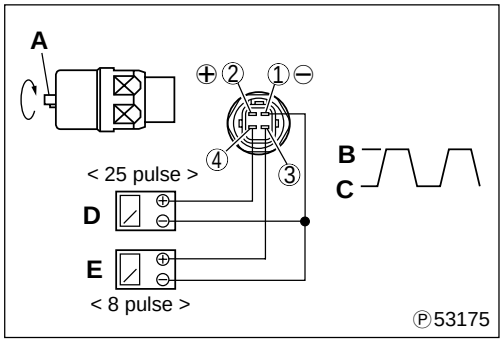
265 Inspection of vehicle speed sensor

<6D3>

Perform the following checks, and if any fault is found, replace the sensor. Gr 22

- Turn slowly the portion **A** of the sensor with battery voltage applied between terminals ① and ③.
- Measure the maximum value (high level **B**) and minimum value (low level **C**) of the voltages generated between terminals ① and ②.
  D : Tester

Standard value	Low level of pulse	1.5 V or less
	High level of pulse	13 V – (0.5 V or less)

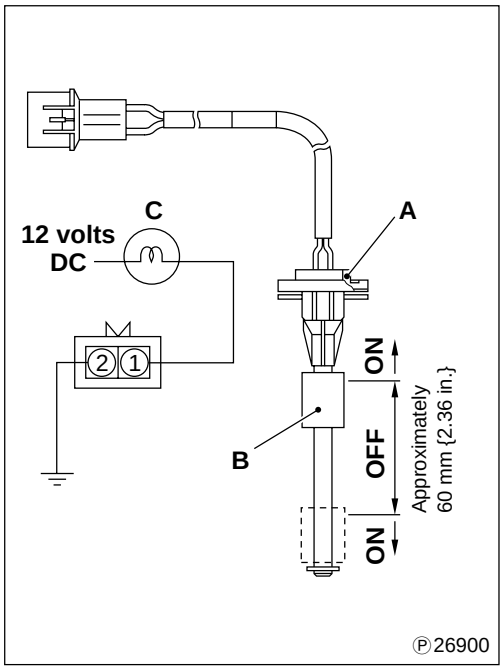


<4M5>

Perform the following checks, and if any fault is found, replace the sensor. Gr 23A

- Turn slowly the portion **A** of the sensor with battery voltage applied between terminals ① and ②.
- Measure the maximum value (high level **B**) and minimum value (low level **C**) of the voltages generated between following terminals.
  D : Tester

Standard Value	Between terminals ① and ③ of 8-pulse output	Low pulse	1.5 V or less
		High pulse	12 V - (0.5 V or less)
	Between terminals ① and ④ of 25-pulse output	Low pulse	0.5 V or less
		High pulse	8 ± 1 V

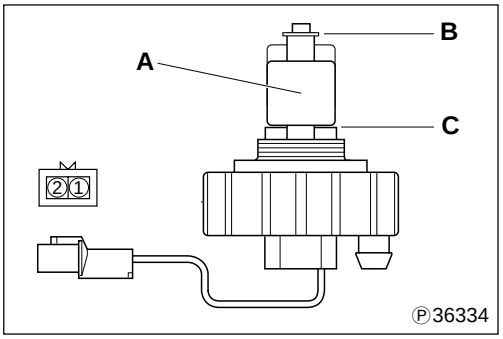


270 Inspection of power steering fluid level sensor

Perform the following checks, and if any fault is found, replace the sensor.

- Wire the sensor **A** as illustrated.
  C : Inspection lamp
- Make sure inspection lamp **A** lights when float **B** is in ON position.
  Resistance between terminals ① and ②

Standard value	Read SW : ON	0.5 Ω or less
	Read SW : OFF	10 M Ω or more



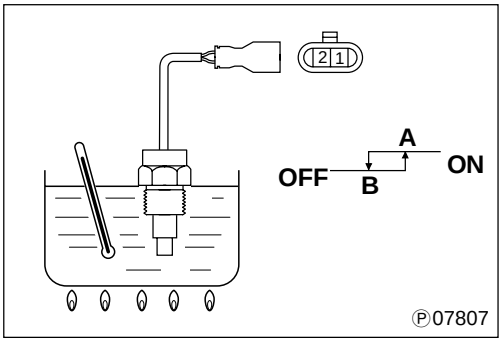
274 Inspection of water separator sensor

- Move float **B** to the specified positions to check continuity.

	①	②
B (maximum water level)	○—○	
C (minimum water level)		

○—○ : There is continuity between terminals.

- If any fault is found, replace the sensor.



275 Inspection of automatic transmission fluid temeperature sensor

Perform the following checks, and if any fault is found, replace the sensor. Gr 23

- Make sure that there is no continuity between terminals ① and ② at room temperature (20±5°C {68±41°F}).
- Place the sensor in a container filled with engine oil and raise the oil temperature while stirring the oil.
  Mesure the temperature when there is continuity between terminals ① and ②, and make sure that the measured value conforms to the standard value.
- Lower the oil temperture and measure the temperature when continuity is lost between terminals ① and ②, and make sure that the measured value conforms to the standard value.

A : When temperature is increase (OFF → ON)
B : When temperature is decrease (ON → OFF)

- Sensor for fan motor

Standard value	**A**	108±3°C {226±37°F}
	B	101°C {214°F} or more

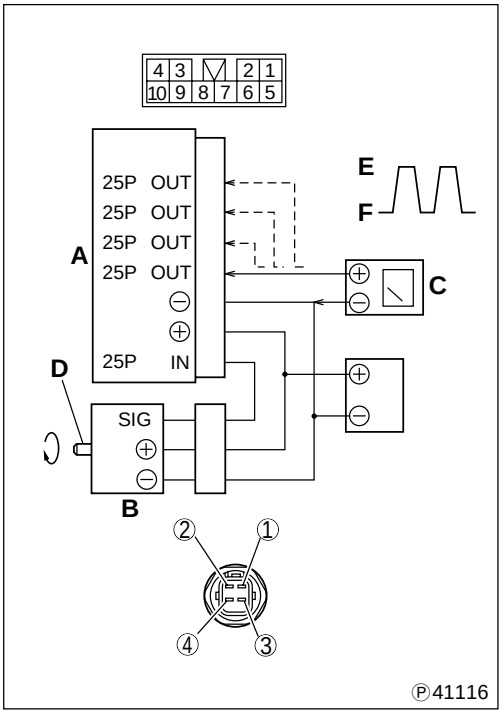
- Sensor for warning lamp

Standard value	**A**	140±3°C {284±37°F}
	B	133°C {271°F} MIN

Sensor for 4M5 Gr 23A

350 Inspection of control units and other units

- Since the units alone cannot be readily checked in the off-vehicle state, check the harness, switch and other related parts in each system.
- If any fault is not found in the related parts, and the problem still remains in the system, replace the control units or other units.



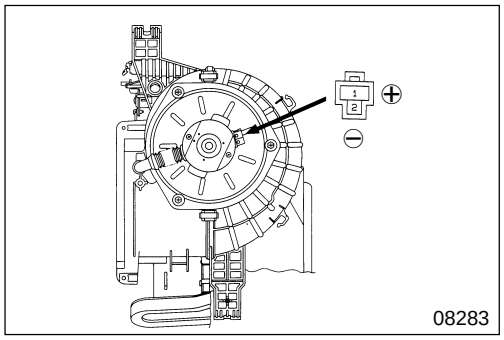
351 Inspection of Pulse Divider

Perform the following checks, and if any fault is found, replace the pulse divider.

- Wire the pulse divider **A** as shown.
  B: Vehicle speed sensor (Use 25-pulse terminals.)
  C: Tester
- Slowly rotate the shaft **D** of the vehicle speed sensor **B** by hand and measure the maximum value (high pulse voltage **E**) and the min imum value (low pulse voltage **F**) of the voltage generated across each of the output terminals (③, ④, ⑨, ⑩) and terminal ⑧ of the pulse divider **A**.

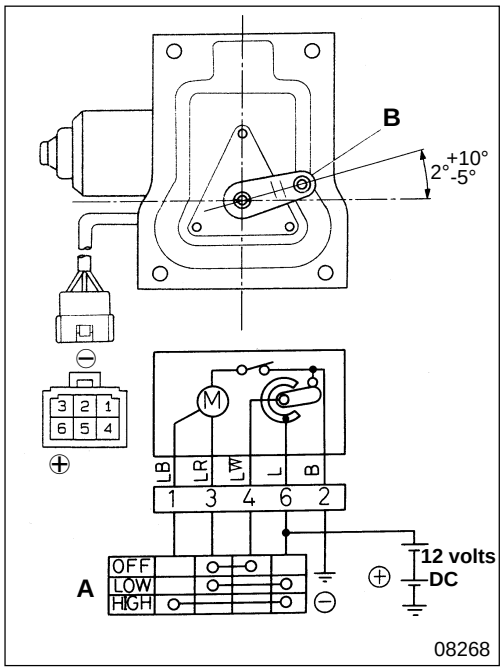
Standard value	Low pulse voltage **F**	0.6 V or less
	High pulse voltage **E**	8 ± 1 V

M E M O



411 Inspection of blower motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 55



422 Inspection of wiper motor

- Connect a switch to the motor as shown.

  A : Switch

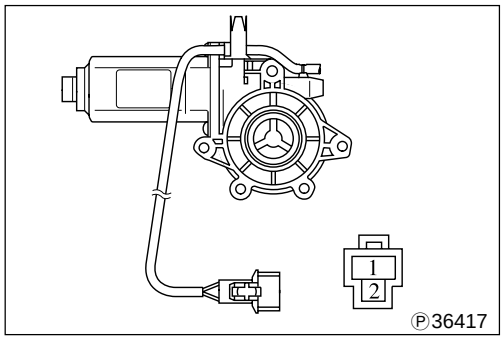
- Check the motor for correct operation as follows. If any fault is found, replace the motor. Gr 42

(1) Inspection of motor operation

- Set switch **A** in HIGH position to check that the motor rotates at high speed.
- Set switch **A** in LOW position to check that the motor rotates at low speed.

(2) Inspection of automatic stop position

- Set switch **A** in LOW position to let the motor rotates at low speed.
- When crank arm **B** is at a position other than the automatic stop position (outside the angles shown), set switch **A** in OFF position.
- Check to see the crank arm **B** stops at the automatic stop position (within the angles range shown).



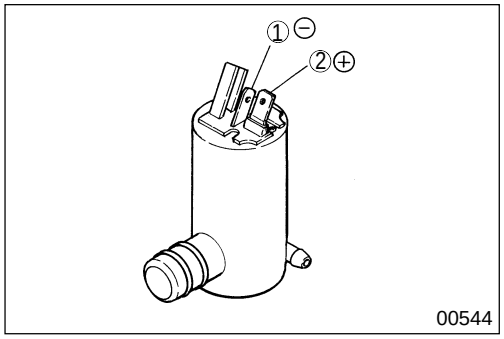
423 Inspection of power window motor

- Follow the table below to check for operation.

	①	②
UP	⊕	⊖
DOWN	⊖	⊕

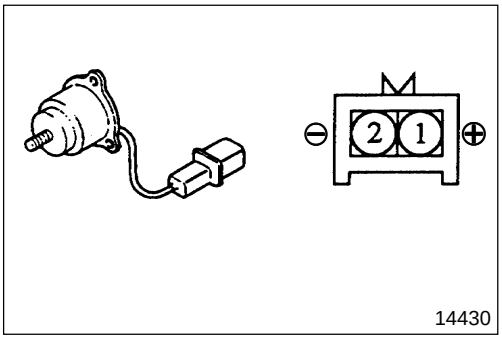
⊕——⊖: Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the motor. Gr 42



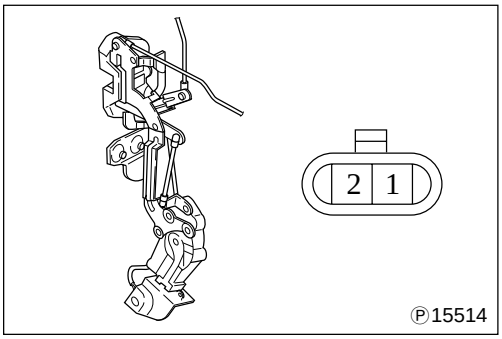
428 Inspection of windshield washer motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 42



435 Inspection of automatic transmission fluid cooler fan motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor.



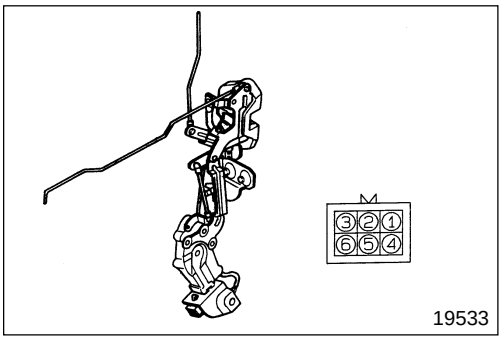
510 Inspection of door lock actuator (Assistant driver's seat side)

- Follow the table below to check for operation.

	①	②
LOCK	⊖	⊕
UNLOCK	⊕	⊖

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42



511 Inspection of door lock actuator (Driver's seat side)

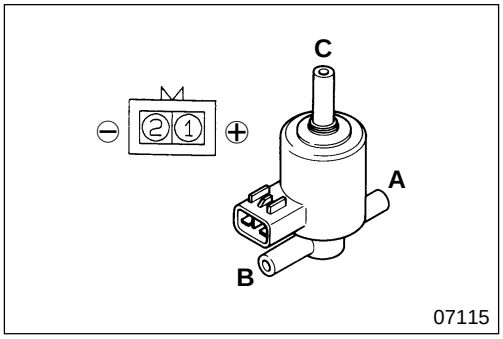
- Follow the table below to check for continuity and operation.

	①	③	②	④	⑤
LOCK		○	○	⊖	⊕
UNLOCK	○	○		⊕	⊖

○——○ : There is continuity between terminals. (OFF in LOCK position)

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42



565 Inspection of exhaust brake 3-way magnetic valve <FH210>

Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation test

- Gradually apply battery voltage to between terminals ① and ② from 0 volt.
- Measure the voltage (minimum operating voltage) at the moment when the 3-way magnetic valves starts operating. (The OFF to ON operating can be noticed from a sound the magnetic valve generates.)

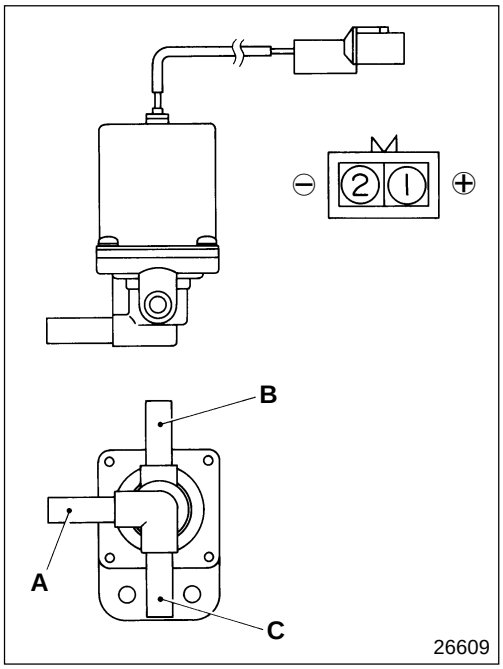
Standard value (Minimum operating voltage)	11V or less

(2) Continuity and airtightness test

Follow the table below to check for continuity.

	Input port A	Output port B	Exhaust port C
ON	○———	———○	
OFF		○———	———○

Air circuit table (○———○ : Air passage is open between ports.)
Negative pressure at the time of check : –100kpa
{–29.5in.Hg,–750mmHg}



594 Inspection of exhaust brake 3-way magnetic valve <FH211>

Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation test

- Gradually apply battery voltage to between terminals ① and ② from 0 volt.
- Measure the voltage (minimum operating voltage) at the moment when the 3-way magnetic valves starts operating. (The OFF to ON operating can be noticed from a sound the magnetic valve generates.)

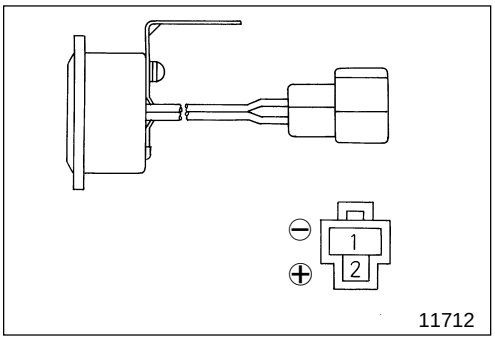
Standard value (Minimum operating voltage)	10 V or less

(2) Continuity and airtightness test

Follow the table below to check for continuity.

	Input port A	Output port B	Exhaust port C
ON	○———	———○	
OFF		○———	———○

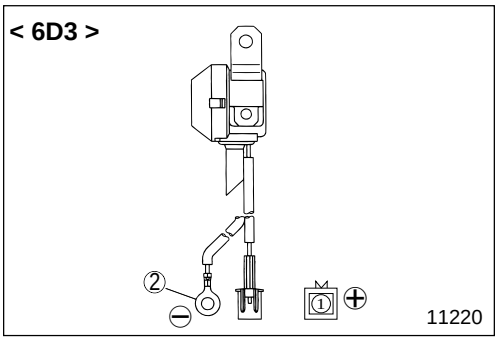
Air circuit table (○———○ : Air passage is open between ports.)
Negative pressure at the time of check : –99.99 kPa
{–29.5 in.Hg, –750 mmHg}



611 Inspection of warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.

< 6D3 >

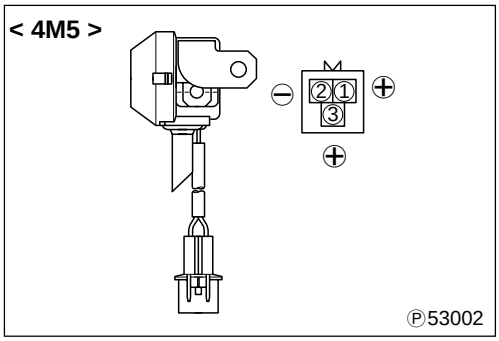


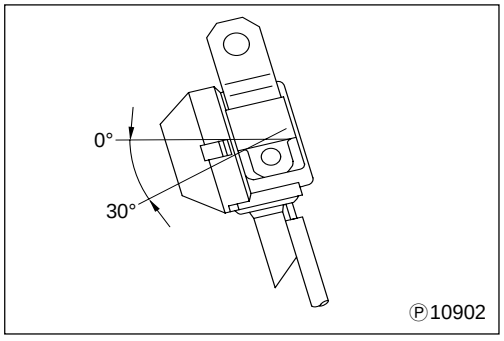
614 Back buzzer

[Inspection]

- Make sure that the buzzer sounds intermittently when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.

< 4M5 >





[Installation]

Attach the buzzer to the frame at an angle within the range shown.

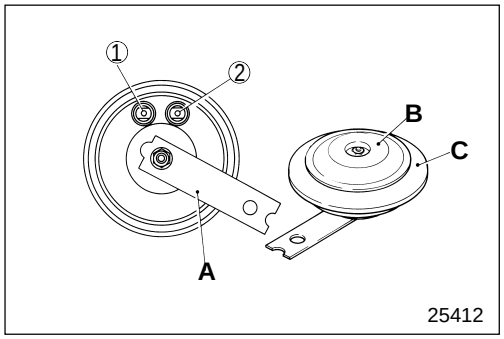
CAUTION⚠

Be careful to install the buzzer within the illustrated angle range or the buzzer will not be drained normally.

615 Inspection of electric horn

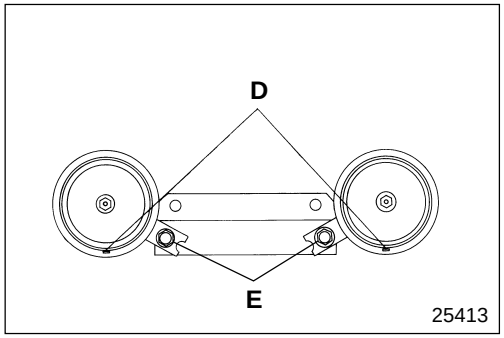
CAUTION⚠

Do not bend or damage stay A or the sound quality of electric horn may be changed and the horn capacity can deteriorate.



[Inspection]

- Apply battery voltage between terminals ① and ② (No polarity) to make sure that the horn sounds.
- If any fault is found, replace the horn.
- Remove foreign particles from resonator **B** or vibration plate **C**, if any.

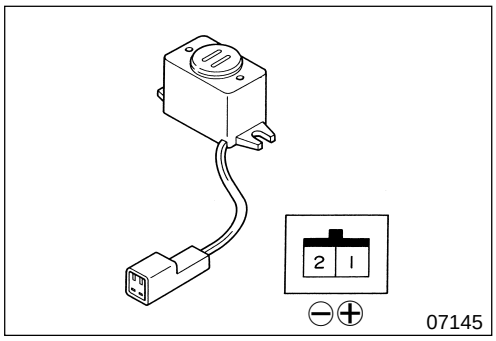


[Installation]

D : Water drain hole

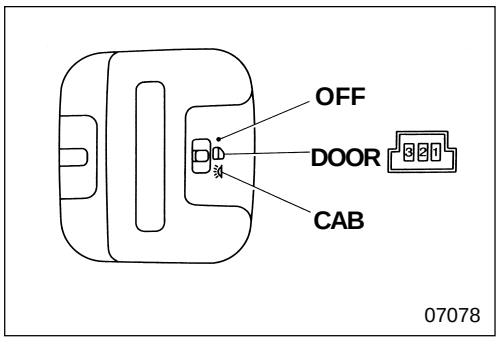
E : Bolt

Tightening torques : Bolt (N·m {ft.lbs, kgf·m})	11.8 to 15.6 {8.7 to 12, 1.2 to 1.6}



616 Inspection of reverse warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.



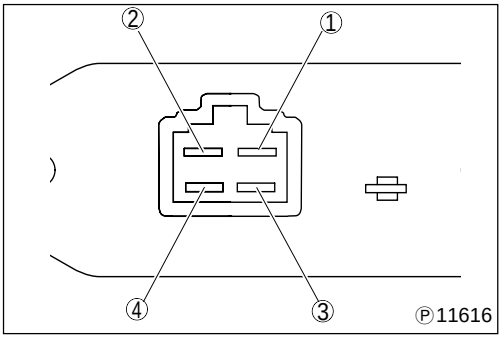
656 Inspection of cab lamp

- Follow the table below to check for continuity.

	①	②	③
OFF			
DOOR	○	○	
CAB	○		○

○—○ : There is continuity between the terminals. (when bulb is installed).

- If any fault is found, replace the lamp.

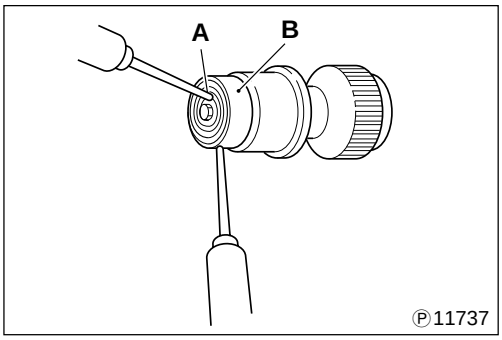


750 Inspection of blower resistor

- Follow the table below to check for resistance of between terminals.

Standard value	MIDDLE LOW	①—②	0.81 Ω
	MIDDLE HIGH	①—③	0.28 Ω
	LOW	①—④	1.94 Ω

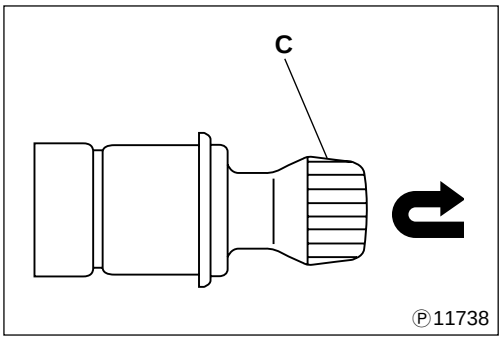
- If the measured value deviates from the standard value, replace the blower resistor.



754 Inspection of cigarette lighter

Perform the following checks, and if any fault is found, replace the cigarette lighter.

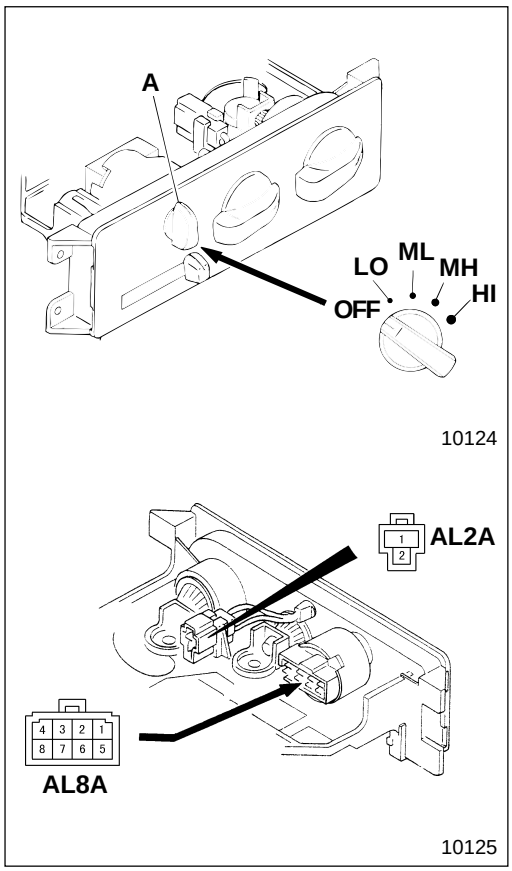
- Make sure that there is continuity between heater element **A** and body **B**.



- Make sure that when plug **C** is pushed in by hand, it immediately returns to its original position.
- Turn the starter switch at ACC or ON position.
- Push plug **C** into the socket in the cab.
- Measure the time required for plug **C** automatically returns.

Standard value	15 ± 5 seconds

- Check to see that heater element **A** is red-hot.



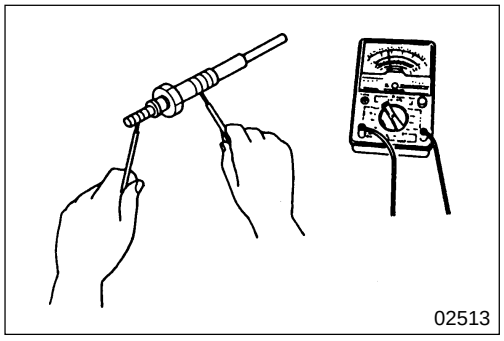
763 Inspection of heater control assembly

- Follow the table below to check for continuity.

	AL8A							AL2A	
	⑧	②	⑦	③	⑥	⑤	④	①	②
OFF									
LO (LOW)	○—○					○—○			
ML (MIDDLE LOW)	○—	—○				○—○			
MH (MIDDLE HIGH)	○—	—	—○			○—○			
HI (HIGH)	○—	—	—	—○		○—○			

○—○ :There is continuity between terminals.

- If any fault is found, replace the switch **A** or heater control assembly.
- If the illumination lamp has blown out, replace the bulb.



764 Inspection of glow plug

- Measure the resistance of glow plug as shown.

Standard value (Cold resistance of glow plug)	4M5	1.0 Ω (Reference value)
	6D3	0.6 Ω (Reference value)

- If the measured value deviates from the standard value, replace the glow plug. Gr 11

DANGER⚠

- **Because flammable hydrogen gas is generated from battery, be sure to obey the following:**
  - **Never attempt to short-circuit the positive and negative terminals of battery, and generate sparks, or smoke a cigarette near it.**
  - **Do not wear metal objects on your arms or do not lean over battery.**
- **Sulfuric acid of the electrolyte is very corrosive. Whenever handling battery, wear safety goggles and rubber gloves to protect your eyes and hands.**
- **Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.**

WARNING⚠

- **When you disconnect battery cables, disconnect the negative battery cable ⊖ first.**

CAUTION⚠

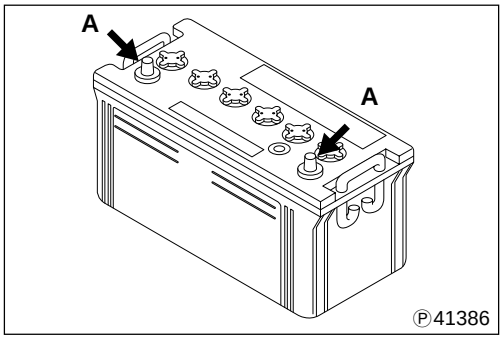
- **Make sure that all electrical switches of the vehicle are off before connecting battery cables.**
- **Be sure to connect the positive battery cable ⊕ first before you connect the negative battery cable ⊖.**
- **To prevent a short-circuit, take care that disconnected battery cables may not accidentally touch the battery terminals.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Specific gravity of battery electrolyte (20°C {68°F})	1.220 to 1.290	—	Charge or replace

◆ Service procedure

Inspection of battery

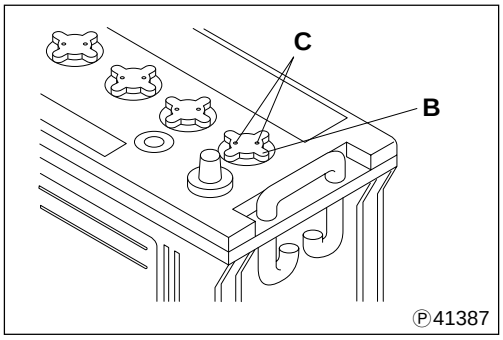


(1) Visual inspection

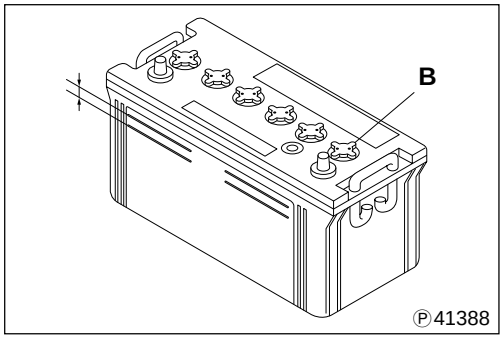
- If terminal **A** is corroded, scrub off the corrosion from it using a wire brush.
- If cracks or defects are found on battery, replace it since the cracks or defects can cause liquid spills.

CAUTION⚠

Make sure you grease the ⊕ side of terminal A because it is easily corroded.

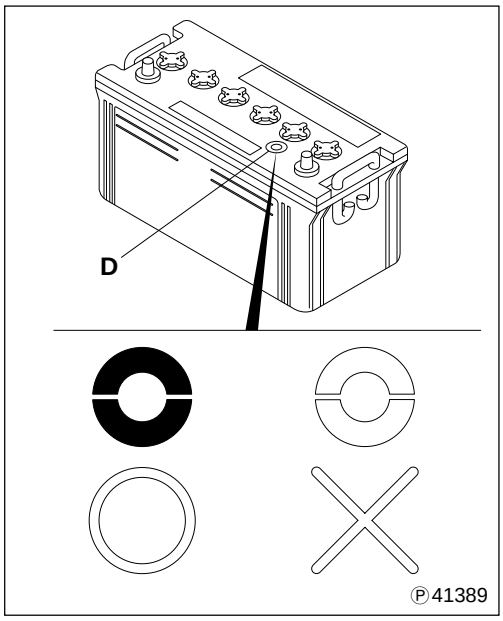


- If bleed hole **C** of vent plug **B** is clogged, clean the hole.



(2) Inspection of fluid level

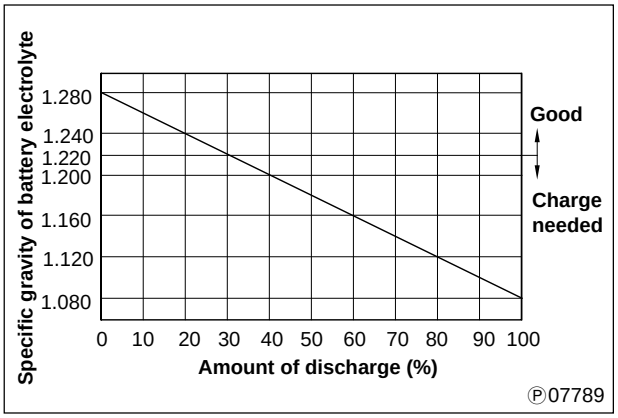
- Make sure that the battery electrolyte level is between UPPER and LOWER.
- If the level is below LOWER, remove vent plug **B** and fill the battery with distilled water or battery replenisher to UPPER.



(3) Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator **D**.

Blue : Good
White : Charge or replace



(4) Charging

- Although, as a rule, battery charging should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect battery cable ⊖.
- Remove vent plug before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	$\frac{\text{Value of 5-hour rating capacity}}{10}$	$\frac{\text{*Amount of discharge (Ah)}}{\text{Charge current (A)}} \times 1.2$ (to 1.5)	45 {113}
Quick charge	$\frac{\text{Value of 5-hour rating capacity}}{1.5}$	0.5	55 {131}

* Amount of discharge (Ah)=5-hour rating capacity (Ah) $\times \frac{\text{Amount of discharge (\%)}}{100}$

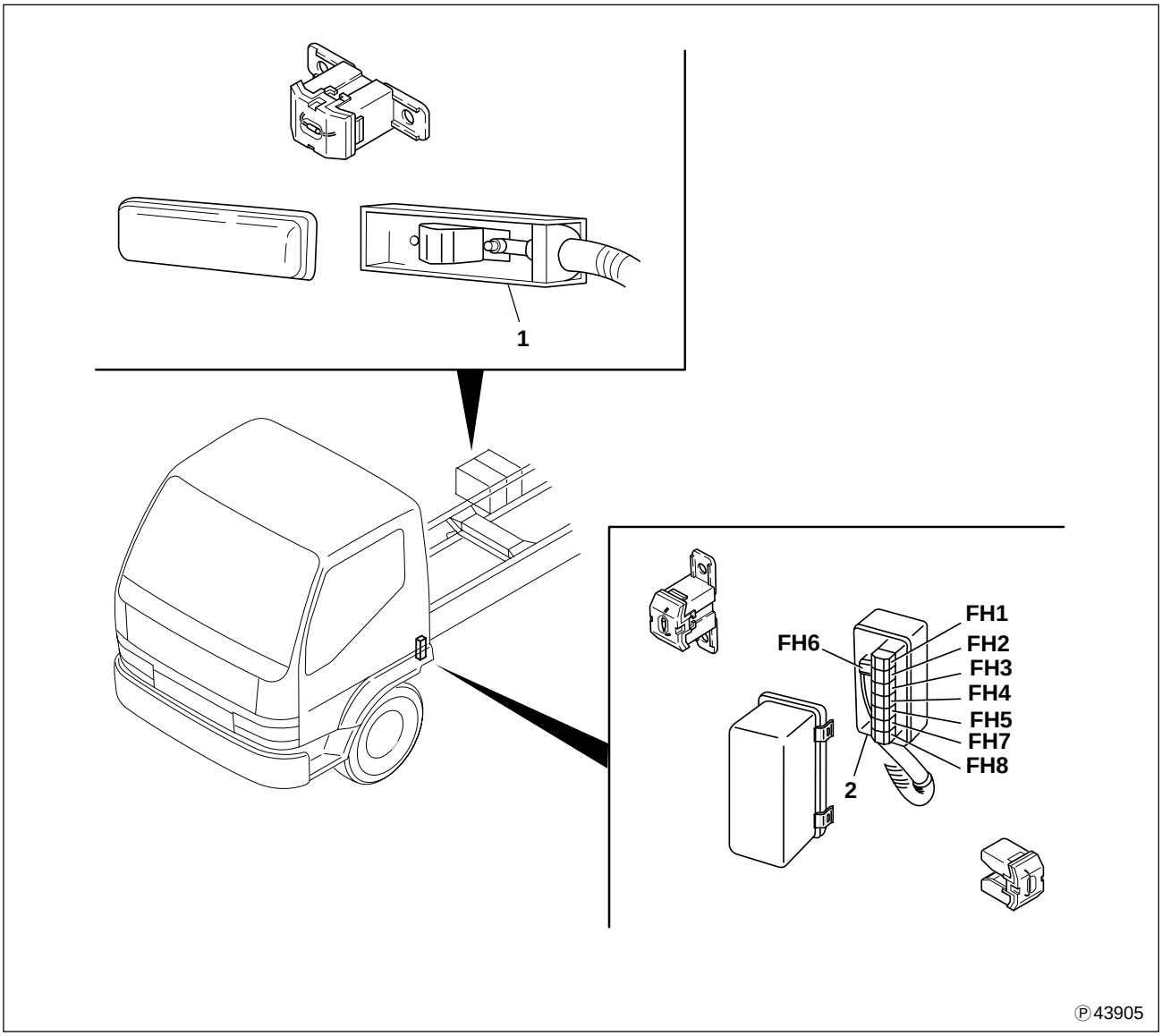
- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.
- The specific gravity of fully-charged battery electrolyte is 1.280 with the temperature at 20°C {68°F}.

DANGER⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **Keep open flame away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it is dangerous.**
- **After charging the battery, tighten the vent plugs, wash away sulfuric acid from the battery using water, and dry the surface.**
- **Be sure to check the electrolyte level before charging the battery. Charging with the electrolyte level below the lower limit (LOWER LEVEL) can cause premature deterioration, heat generation and explosion of the battery.**

870 to 889 FUSE

870 High-current fuse box



1 Main high-current fuse
2 High-current fuse box

WARNING ⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing high-current fuses (FH1 to FH8). 🕮 860

With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:
Always (directly connected to the battery): FH1 to FH8

CAUTION ⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use a fuse of the specified ampere.**

Main high-current fuse

Fuse No.	Main load	Capacity
—	High-current fuse box	140A
—	ABS	50A

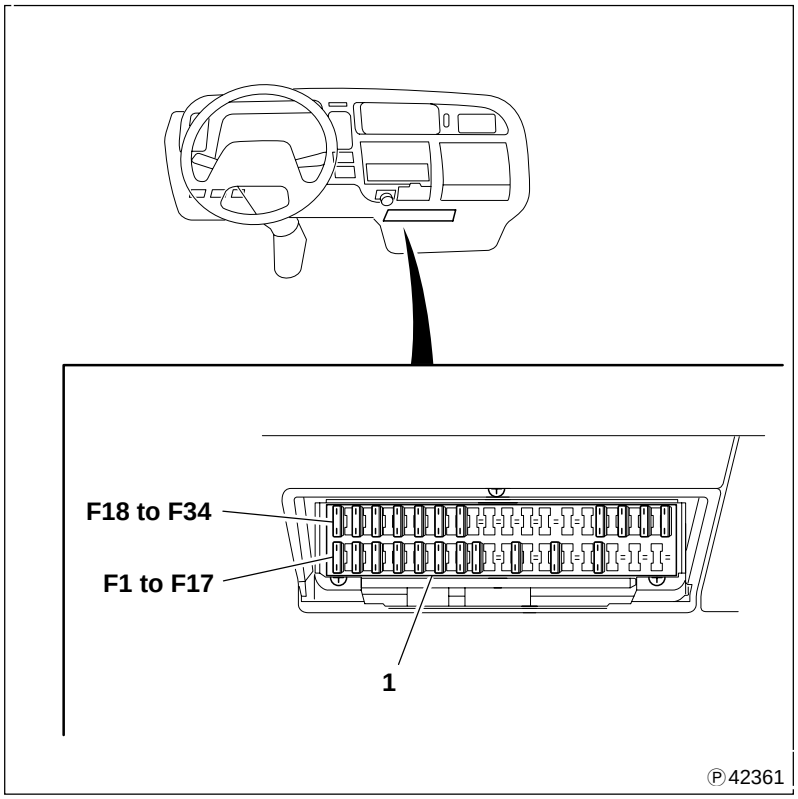
High-current fuse box

Fuse No.	Main load	Capacity
FH1	Fuse box (F1 to F4)	50A
FH2	Fuse box (F5 to F11)	40A
FH3	ABS	30A
FH4	Starter switch (Terminal B)	50A
FH5	Glow relay	50A
FH6	Alternator	140A
FH7	Fuse box (F17, F31 to F34)	40A
FH8	ABS	40A

ABS : Anti-lock brake system

870 to 889 FUSE

871 Fuse box



1 Fuse box

WARNING

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing fuses (F1 to F34). 📖 860

With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:

- **Always (directly connected to the battery): F1 to F11, F17, F31 to F34**
- **When starter switch is in ON position : F19 to F30**
- **When starter switch is in ACC position : F13 to F15**
- **When starter switch is in START position : F18**

CAUTION

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use a fuse of the specified ampere.**

Fuse box < FH211 >

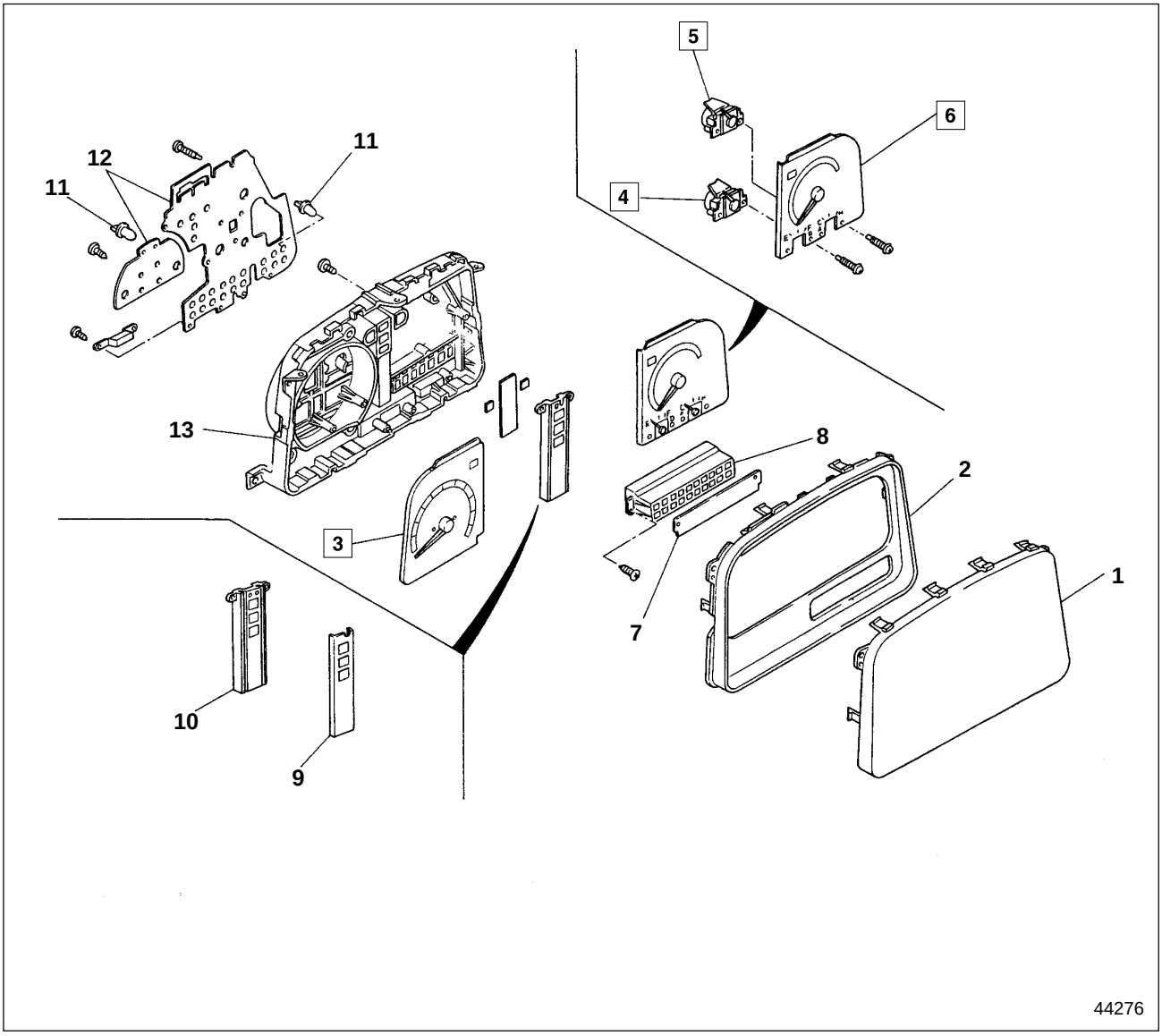
Fuse No.	Main load	Capacity
F1	Headlamp, LH	15A
F2	Headlamp, RH	15A
F3	Stop lamp, horn	15A
F4	Turn signal lamp	15A
F5	—	—
F6	Cab lamp	10A
F7	Van body dome light	10A
F8	A/T cooler fan motor	20A
F9	—	—
F10	Power window	25A
F11	Reserve power (BATT)	10A
F12	—	—
F13	Cigarette lighter	15A
F14	Radio	10A
F15	Reserve power (ACC)	10A
F16	—	—
F17	Mirror heater	10A
F18	Engine start (MUTIC)	10A
F19	Backup lamp	10A
F20	Meter cluster, DRL	10A
F21	Wiper	10A
F22	Engine control (ECU)	10A
F23	—	—
F24	ABS	10A
F25	Reserve power (MAIN)	10A
F26	Mirror heater	10A
F27	Exhaust brake, A/T	10A
F28	Transmission power take-off	10A
F29	Engine control (ACT)	10A
F30	Heater (A/C control)	10A
F31	Heater (A/C compressor)	10A
F32	Heater (A/C condenser fan)	15A
F33	Blower motor	25A
F34	Tail lamp	20A

Fuse box < FH210 >

Fuse No.	Main load	Capacity
F1	Headlamp, LH	15A
F2	Headlamp, RH	15A
F3	Stop lamp, horn	15A
F4	Turn signal lamp	15A
F5	Engine control (ECU)	20A
F6	Cab lamp	10A
F7	Van body dome light	10A
F8	A/T cooler fan motor	20A
F9	—	—
F10	Power window	25A
F11	Reserve power (BATT)	10A
F12	—	—
F13	Cigarette lighter	15A
F14	Radio	10A
F15	Reserve power (ACC)	10A
F16	A/T	10A
F17	Mirror heater	10A
F18	Engine start (MUTIC)	10A
F19	Backup lamp	10A
F20	Meter cluster, DRL	10A
F21	Wiper	10A
F22	Engine control (ECU)	10A
F23	A/T	10A
F24	ABS	10A
F25	Reserve power (MAIN)	10A
F26	Mirror heater	10A
F27	—	—
F28	—	—
F29	Engine control (ACT), exhaust brake	10A
F30	Heater (A/C control)	10A
F31	Heater (A/C compressor)	10A
F32	Heater (A/C condenser fan)	15A
F33	Blower motor	25A
F34	Tail lamp	20A

ABS : Anti-lock brake system
ACT : Actuator
A/C : Air-conditioner
A/T : Automatic transmission
BATT : Battery
MUTIC : Multipurpose timing control unit
DRL : Daytime running light
ECU : Electronic control unit

890 METER CLUSTER



● **Disassembly sequence**

1 Meter glass
2 Window plate
3 Speedometer
4 Fuel gauge
5 Water temperature gauge
6 Tachometer
7 Indicator plate
8 Indicator case
9 Plate cover
10 Indicator case
11 Bulb
12 Printed board
13 Meter case

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Removal and installation of meter cluster Gr 42

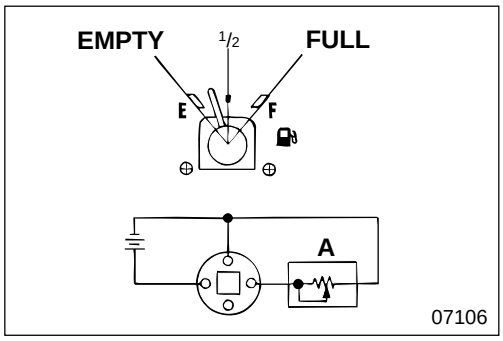
Service standards

Location	Maintenance item				Standard value	Limit	Remedy
3	Indication area of speedometer assembly			At 10 mph	16.1 ± 3.2 km/h {10 ± 2 mph}	—	Replace
				At 20 mph	32.2 $^{+3.2}_{-2.4}$ km/h {20 $^{+2}_{-1.5}$ mph}		
				At 40 mph	64.4 $^{+4}_{-1.6}$ km/h {40 $^{+2.5}_{-1}$ mph}		
				At 50 mph	80.5 $^{+4.8}_{0}$ km/h {50 $^{+3}_{0}$ mph}		
				At 60 mph	96.6 $^{+4.8}_{0}$ km/h {60 $^{+3}_{0}$ mph}		
4	Resistance of fuel gauge	Needle position		FULL	4 Ω	—	Replace
				1/2	50 Ω		
				EMPTY	135 Ω		
5	Resistance of water temperature gauge	Needle position	FH211	65°C {149°F}	81.8 Ω	—	Replace
				100°C {212°F}	26.6 Ω		
			FH210	50°C {112°F}	131 Ω		
				83°C {181.4°F}	39.3 Ω		
				105°C {221°F}	21.6 Ω		
				120°C {248°F}	14.7 Ω		
6	Indication range of tachometer 20 ± 2°C {68 ± 36°F} 13.5 ± 0.1V		FH211	At 550 rpm	550 ± 35 rpm	—	Replace
				At 1000 rpm	1000 ± 50 rpm		
				At 1500 rpm	1500 ± 60 rpm		
				At 2000 rpm	2000 ± 65 rpm		
				At 2500 rpm	2500 ± 70 rpm		
				At 3000 rpm	3000 ± 75pm		
			FH210	At 550 rpm	550 ± 50 rpm	—	Replace
				At 1000 rpm	1000 ± 70 rpm		
				At 1500 rpm	1500 ± 110 rpm		
				At 2000 rpm	2000 ± 110 rpm		
				At 2500 rpm	2500 ± 110 rpm		
				At 3000 rpm	3000 ± 110 rpm		

◆ Service procedure

3 Inspection of speedometer

- Use the speedometer tester to check that the indication area of speedometer **3** does not deviate from the standard value at each speed.
- If the measured value deviates from the standard value, replace the speedometer.



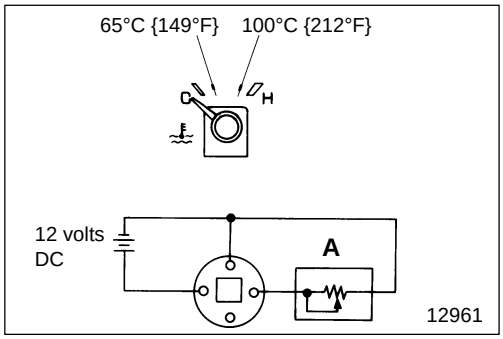
4 Inspection of fuel gauge

- Connect a variable resistor to fuel gauge **4** as shown.
  A : Variable resistor
- Measurement order
  FULL → 1/2 → EMPTY

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of fuel gauge **4** indicates FULL, 1/2, and EMPTY.
- If the measured value deviates from the standard value, replace fuel gauge **4**.



5 Inspection of water temperature gauge

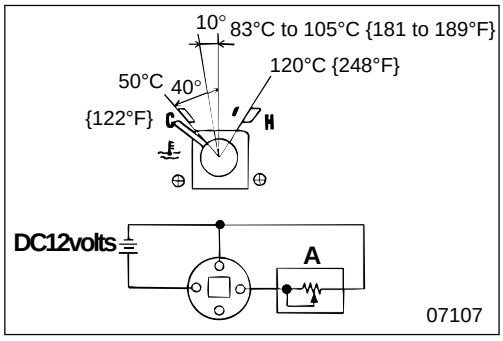
< FH211 >

- Connect a variable resistor to water temperature gauge **5** as shown.
  A : Variable resistor
- Measurement order
  65°C {149°F}→ 100°C {212°F}

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of water temperature gauge **5** indicates 65°C {149°F}, and 100°C {212°F}.
- If the measured value deviates from the standard value, replace water temperature gauge **5**.



< FH210 >

- Connect a variable resistor to water temperature gauge **5** as shown.
  A : Variable resistor
- Measurement order
  50°C {122°F}→ 120°C {248°F}

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of water temperature gauge **5** indicates 50°C {122°F}, 83°C {181°F} to 105°C {189°F}, and 120°C {248°F}.
- If the measured value deviates from the standard value, replace water temperature gauge **5**.

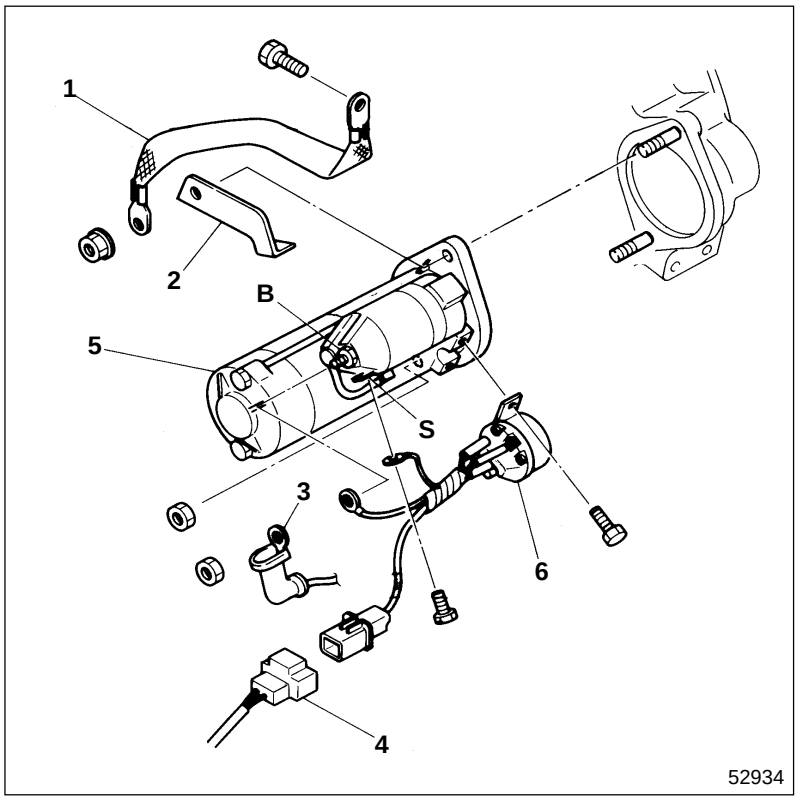
6 Inspection of tachometer

- Use the engine revolution counter to check that the indication area of tachometer **6** is in the standard value at each revolution.
- If the measured value deviates from the standard value, replace tachometer **6.**

M E M O

12 STARTER AND ALTERNATOR

< 6D3 >



● **Removal sequence**

1 Ground strap
2 Bracket
3 Starter cable
4 Chassis harness
5 Starter 🕮 P54-12-4
6 Starter relay 🕮 187
B : Connect to terminal B
S : Connect to terminal S

WARNING⚠

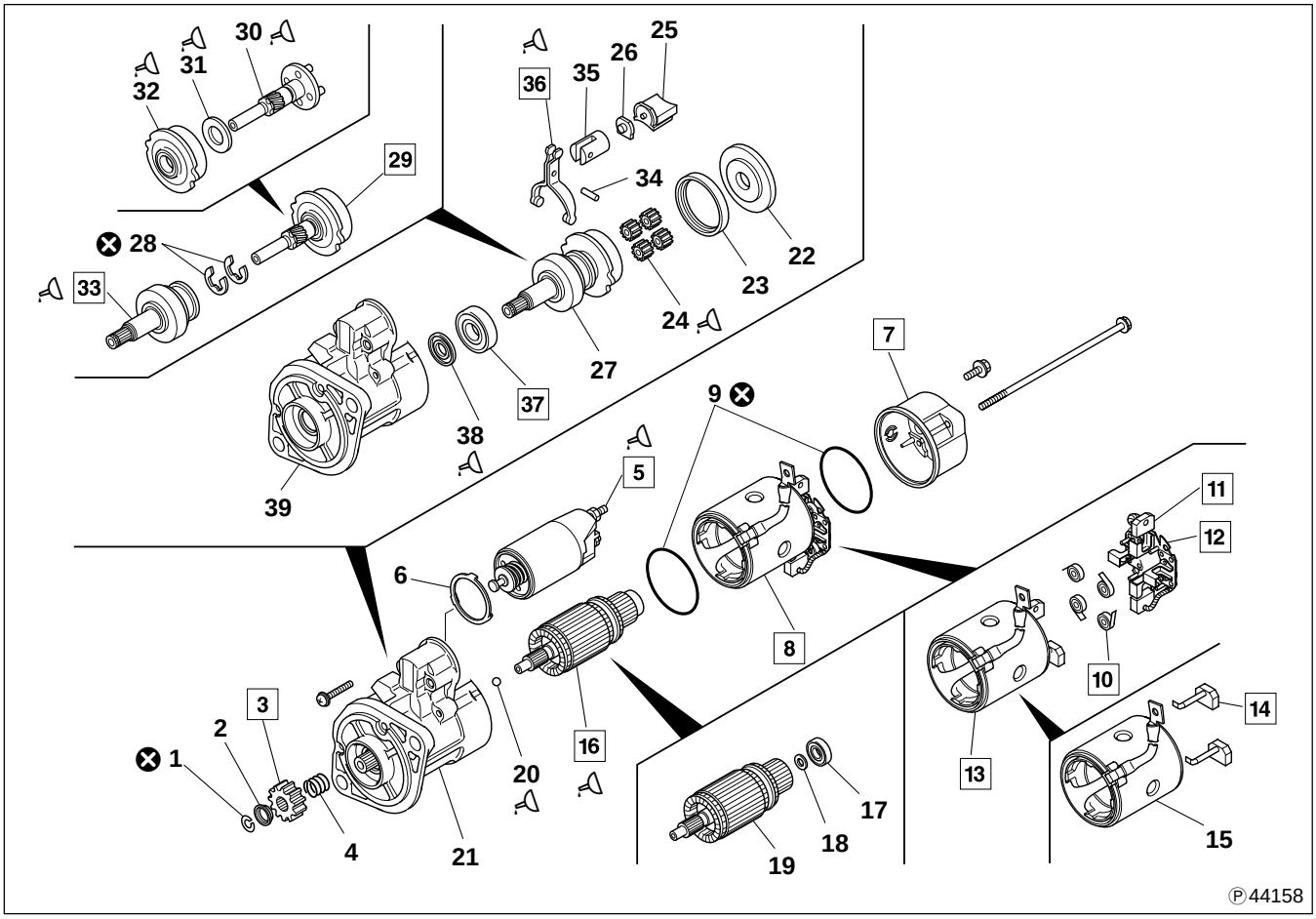
Never touch the starter 5 with tools when you remove the harness from terminal B. This is because voltage is always supplied to it from starter cable 3, and you will short-circuit the starter. Before removing the harness from terminal B, remove the ⊖ battery terminal and tape it up to insulate it.

● **Installation sequence**

Follow the removal sequence in reverse.

M E M O

Starter < 6D3 >



● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch assembly
6 Shim
7 Rear bracket
8 Yoke and brush holder assembly
9 Rubber packing
10 Brush spring
11 Brush ⊖
12 Brush holder assembly
13 Yoke assembly
14 Brush ⊕
15 Yoke
16 Armature assembly
17 Rear bearing
18 Washer
19 Armature
20 Ball
21 Front bracket assembly
22 Cover
23 Rubber packing
24 Planetary gear
25 Rubber packing
26 Plate
27 Gear shaft and overrunning clutch assembly
28 E-ring
29 Gear shaft and internal gear assembly
30 Gear shaft assembly
31 Washer
32 Internal gear
33 Overrunning clutch
34 Pin
35 Holder
36 Lever
37 Front bearing
38 Oil seal
39 Front bracket

⊗ : Non-reusable parts

CAUTION⚠

- **Do not remove bearings 17, 37 unless they are faulty.**
- **Be careful not to lose ball 20, since it might come out together with armature assembly 16 when you remove it.**

NOTE

- **You do not have to remove pinion 3 when you disassemble or inspect only the motor assembly, for example: when inspection of the brush assembly is required.**
- **Except for the above, make sure you remove pinon 3 before disassembling any parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Whenever magnetic switch assembly 5 has been replaced, be sure to adjust the pinion gap.

● **Inspection after assembly**

🕮 P54-12-6

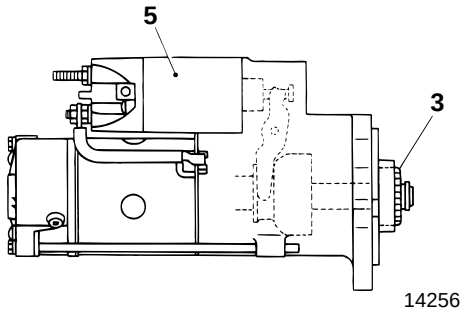
Service standards

Unit : mm {in.}

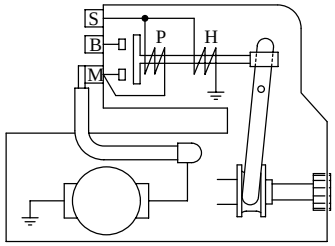
Location	Maintenance item			Standard value	Limit	Remedy
—	Pinion gap			0.5 to 2.0 {0.02 to 0.079}	—	Adjust
—	No-load characteristic	With current of 11 V	Current	180 A or less	—	Inspect
			Revolutions per minute	3800 rpm or more	—	
10	Pressure of brush spring			29.2 to 39.4 N {6.6 to 8.9 lbs, 2.98 to 4.02 kgf}	13.7 N {3.1 lbs, 1.4 kgf}	Replace
11, 14	Length of brush			18 {0.71}	11 {0.43}	Replace
16	Outer diameter of commutator			32 {1.26}	31.4 {1.24}	Replace
	Deflection of commutator periphery			—	0.1 {0.0039} or more	Replace
	Mold depth between segments			—	0.2 {0.0079} or less	Correct or replace

Lubricant

Location	Points of application	Specified lubricant	Quantity
5	Lever contact surface of magnetic switch assembly	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Teeth of armature assembly gear	MOLYKOTE ® AG650	As required
16, 30	Sliding surface of armature assembly and gear shaft assembly	MOLYKOTE ® AG650	As required
20	Ball	MOLYKOTE ® AG650	As required
24, 32	Teeth of internal gear and planetary gear	MOLYKOTE ® AG650	As required
30, 33	Friction surfaces of gear shaft assembly and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
31	Washer	MOLYKOTE ® AG650	As required
33	Spline of overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
36	Friction surfaces of lever and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
38	Oil Seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required



14256



Ⓟ14257

◆ Service procedure

● Inspection after assembly

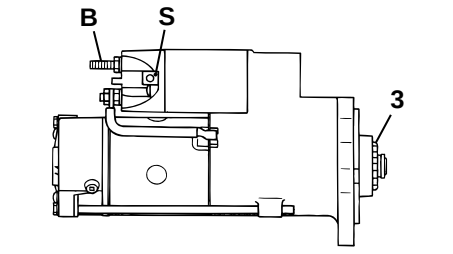
Inspection after assembling the starter should be carried out with current fed to the starter.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot during inspection.**

CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits the coil might burn due to overheating.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



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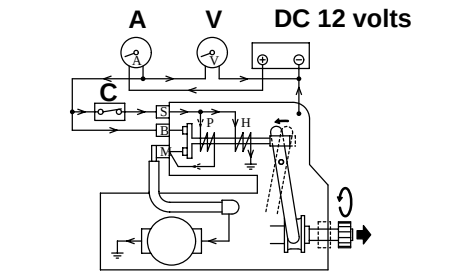


Ⓟ14258

(1) Performance test

- Connect the starter as shown.
  A : Ammeter
  B : Terminal B of starter
  C : Switch
  S : Terminal S of starter
  V : Voltmeter
- Set the voltage to 11 volts DC.

CAUTION⚠

Up to 12 volts can be loaded.

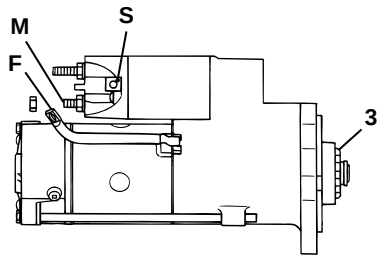
- The following work should be done with current fed to the starter. You must complete measurement of the current and the number of revolutions within 30 seconds.
  - Turn switch **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

CAUTION⚠

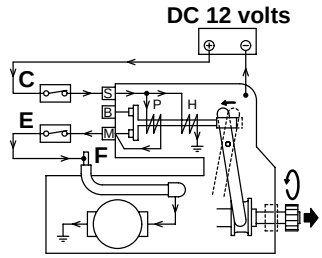
When switch C is turned ON, current is fed both to pull-in coil P and holding coil H. When a large amount of current is fed into terminal M from DC 12 volts, via terminal B of the starter, the current stops flowing into the pull-in coil but continues to flow into the holding coil.

To avoid burning the holding coil, be sure to carry out the performance test within 30 seconds.

  - Measure the current and the number of revolutions of the starter. Train a strobe light on pinion **3** to measure the number of revolutions.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, disassemble the starter again and inspect it.



13297



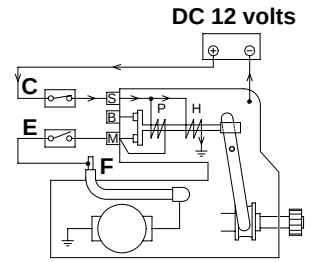
Ⓟ14259

(2) Pinion gap

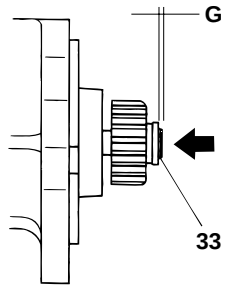
[Inspection]

- Connect the starter as shown.
  C : Switch
  E : Switch
  F : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete measurement of the pinion gap within 30 seconds.
  - Turn switches **C** and **E** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



Ⓟ14260



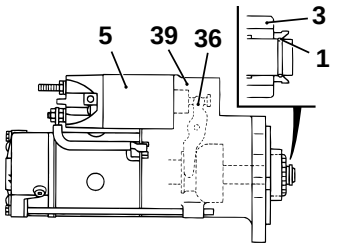
13314

  - Within 5 seconds of pinion **3** rotating, turn switch **E** OFF to stop rotation of the pinion.

CAUTION⚠

When switches C and E are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.
To avoid burning the pull-in coil, be sure to turn switch E OFF within 5 seconds of the pinion rotating.

  - Hold the end of overrunning clutch **33** with fingers, and pull it. Measure the distance **G** (pinion gap) in the shaft direction that the overrunning clutch moves when it is lightly pushed back by hand.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, replace lever **36**.



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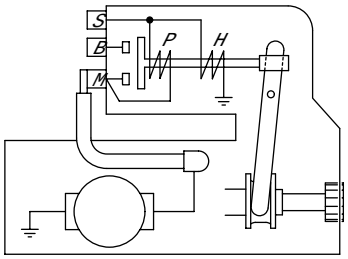


Ⓟ14257

3 Pinion

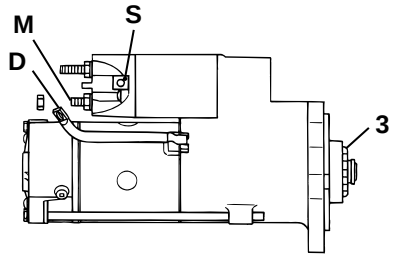
[Removal]
Feed current to the starter and protrude pinion **3** to remove the pinion.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot after inspection.**

CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits, the coil might burn due to overheating.**
- **Before making pinion 3 jump out, be sure to feed current to the starter to obtain the correct state. If current is not fed to the starter and lever 36 is pulled to protrude the pinion, front bracket 39 or the lever might be damaged due to the shock produced on removal of stopper ring 1.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



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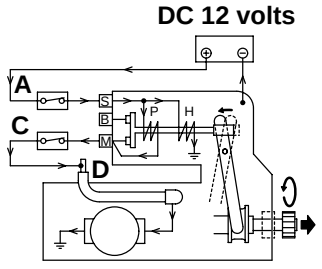
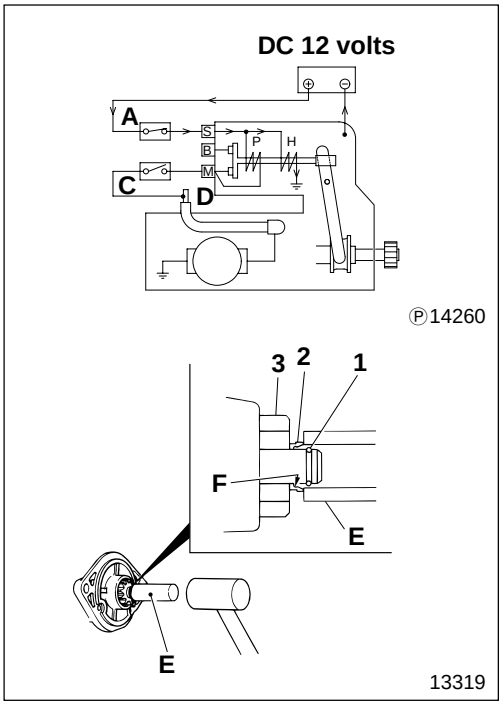


Ⓟ14259

- Connect the starter as shown.
  A : Switch
  C : Switch
  D : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete removal of pinion **3** within 30 seconds.
  - Turn switches **A** and **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



- Within 5 seconds of pinion **3** rotating, turn switch **C** OFF to stop rotation of the pinion**.**

CAUTION

When switches A and C are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.

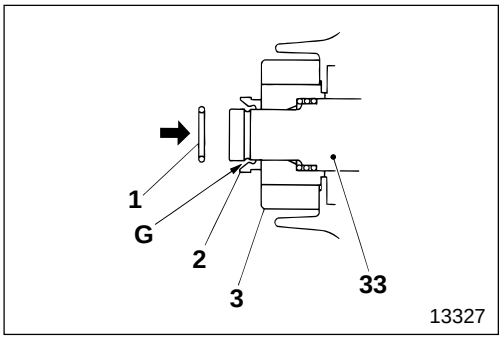
To avoid burning pull-in coil P, be sure to turn switch C OFF within 5 seconds after the pinion rotates.

- Apply pipe-shaped tool **E** onto pinion stopper **2**.
- Hit tool **E** lightly using a mallet to remove stopper ring **1** from ring groove **F** of pinion stopper **2**.
- Remove stopper ring **1** and pinion **3**.
- Turn switch **A** OFF to stop current to the starter.

NOTE

When the current to the starter is stopped, stopper ring 1 might fall back into ring groove F of pinion stopper 2 because pinion 3 is pushed inside.

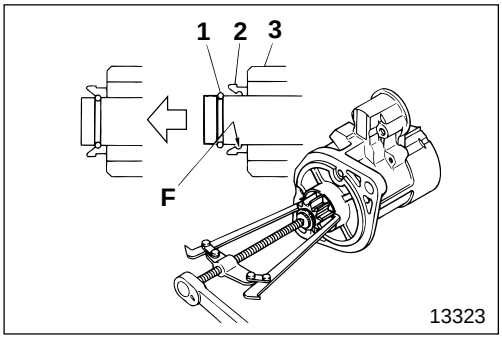
If this occurs, feed current to the starter again and carry out the work.



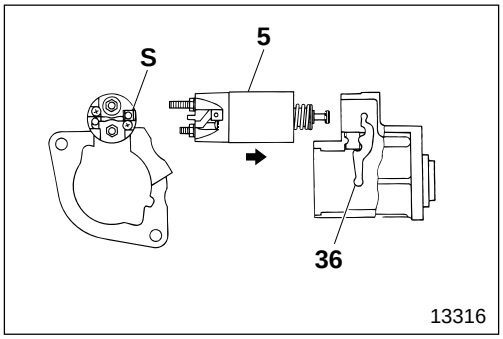
[Installation]

When installing pinion **3**, it is not necessary to feed current to the starter.

- Install pinion stopper **2** and pinion **3** onto overrunning clutch **33** in the direction as shown.
- Fit stopper ring **1** into ring groove **G** of overrunning clutch **33**.

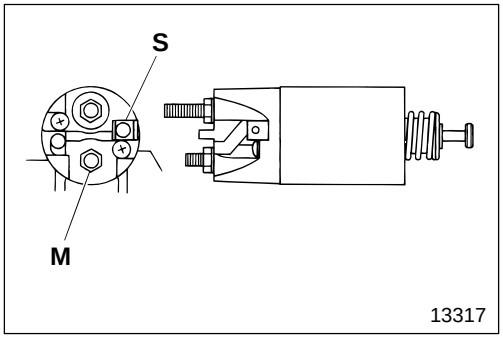


- Pull pinion **3** firmly and set stopper ring **1** on groove **F** of pinion stopper **2** securely.



5 Magnetic switch assembly

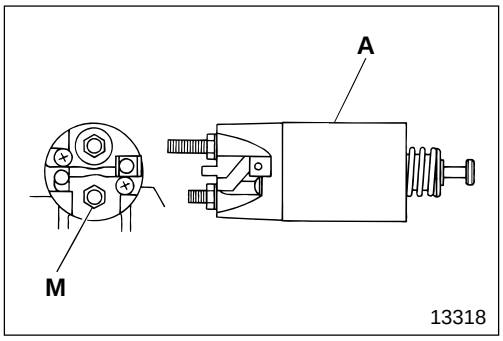
[Installation]
Install magnetic switch assembly **5** to lever **36**, with terminal **S** facing the direction as shown.



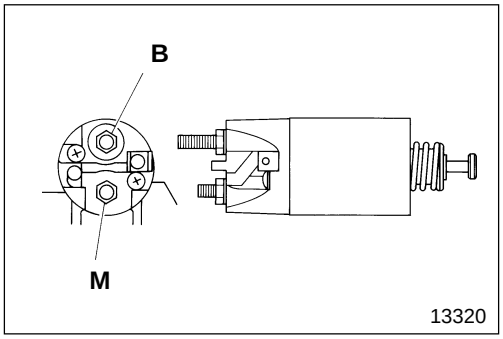
[Inspection]

(1) Testing for coil breakage

- Make sure that there is continuity between terminals **S** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.

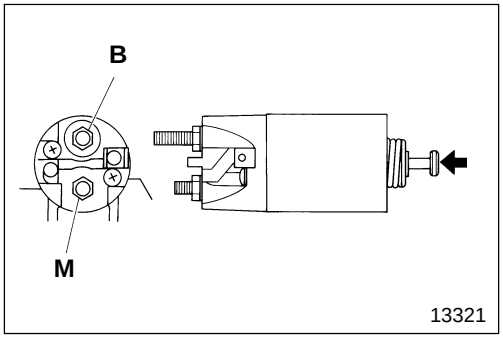


- Make sure that there is continuity between terminal **M** and body **A**.
- If there is no continuity, replace magnetic switch assembly **5**.



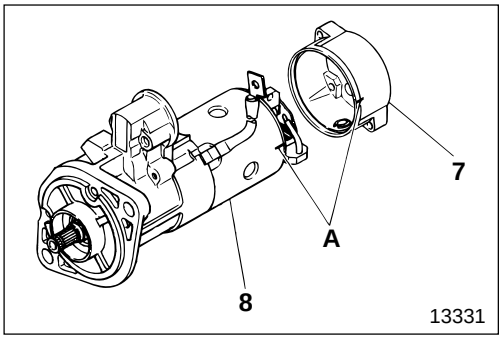
(2) Inspection of welded connections

- Make sure that there is no continuity between terminals **B** and **M**.
- If there is continuity, replace magnetic switch assembly **5**.



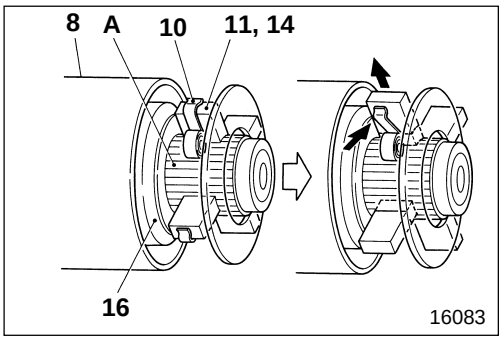
(3) Inspection of connections

- Push the tip of magnetic switch assembly **5** to close the internal connection.
  Make sure that there is continuity between terminals **B** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.



7 **Installation of rear bracket**

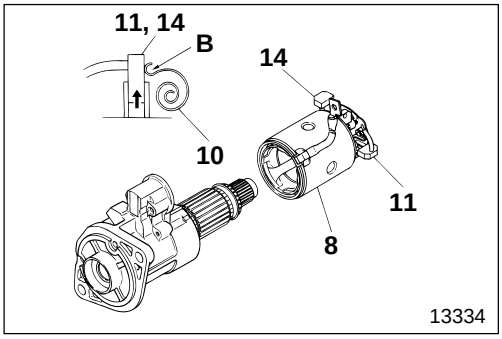
A : Alignment mark



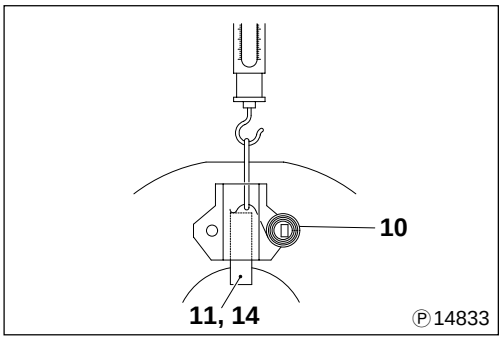
8 **Removal and installation of yoke and brush holder assembly**

Use the following method to remove the yoke and brush holder assembly **8** in order to prevent the commutator **A** of the armature assembly **16** from being damaged by the brushes **11** and **14**.

- Lift the brushes **11** and **14** away from the commutator **A** and hold them lifted by applying the brush springs **10** against the sides of the brush springs.

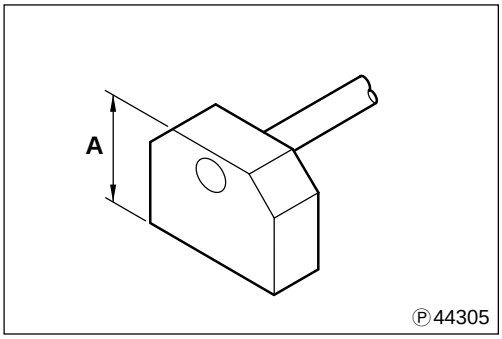


- Pull part **B** of each brush spring **10** and pull up the brushes **11** and **14**.
- Hold the brushes **11** and **14** in position with brush spring **10** as shown.
- Remove yoke and brush holder assembly **8**.
- To reinstall the yoke and brush holder assembly **8**, follow the removal instructions in, reverse.



10 **Inspection of brush spring**

- Use new brushes **11, 14** and measure the load when brush spring **10** is detached from the brushes.
- If the measured value is lower than the limit, replace brush spring **10**.



11 **14** **Inspection of brush**

(1) Length of brush

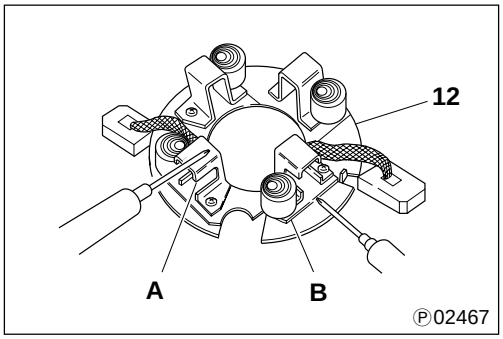
If the measured value **A** is lower than the limit, replace brushes **11, 14**.

NOTE

To replace brush ⊖ 11, replace entire brush holder assembly 12.

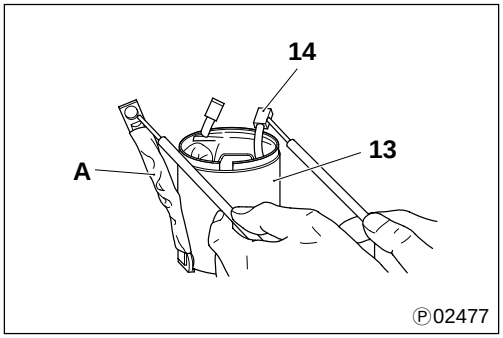
(2) Contact surface with commutator

If the surface where the brushes contact the commutator is rough or is worn unevenly, polish the surface with emery paper (300 to 500 grit).



12 Inspection of brush holder assembly

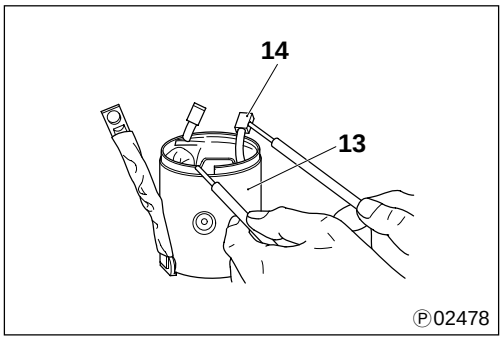
- Cleaning the brush holder **A** and holder plate **B**.
- Make sure that there is no continuity between the ⊕ side of the brush holder **A** and the ⊖ side of the holder plate **B**.
- If there is continuity between them, they are short-circuited. Replace brush holder assembly **12**.



13 Inspection of yoke assembly

(1) Testing for coil breakage

- Make sure that there is continuity between cable **A** and brush ⊕ **14**.
- If there is no continuity, they are broken. Replace brush ⊕ **14** or yoke assembly **13**.

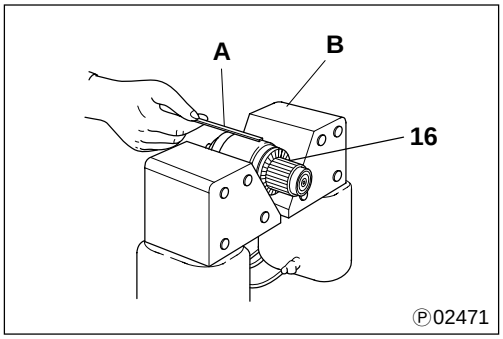


(2) Testing for coil grounding

- Make sure that there is no continuity between yoke assembly **13** and brush ⊕ **14**.
- If there is continuity, they are short-circuited. Inspect the insulated point. If it is hard to repair, replace brush ⊕ **14** or yoke assembly **13**.

NOTE

The coil may be short-circuited to the yoke assembly 13 due to the accumulation of worn-off metal particles from the brushes and/or armature.



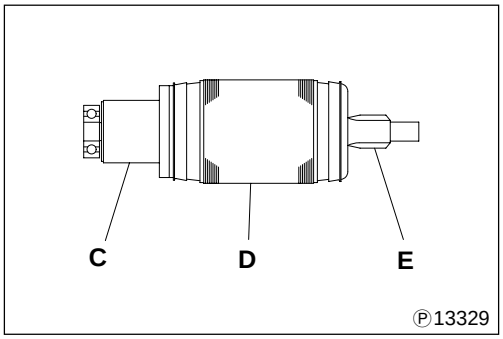
16 Inspection of armature assembly

(1) Testing for coil short-circuit

- Hold an iron rod **A** parallel with the armature assembly **16**.

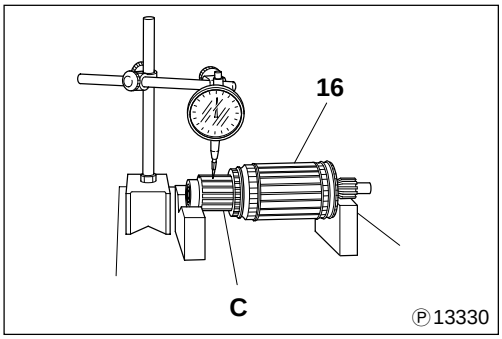
B : Armature tester

- Slowly rotate the armature assembly **16** by hand.
- If the iron rod **A** vibrates or is pulled toward the armature assembly **16**, the coil is short-circuited and the armature assembly must be replaced.



(2) Testing for coil grounding

- Make sure that there is no continuity between commutator **C** and core **D** (or shaft **E**).
- If there is continuity between them, they are short-circuited. Replace armature assembly **16**.

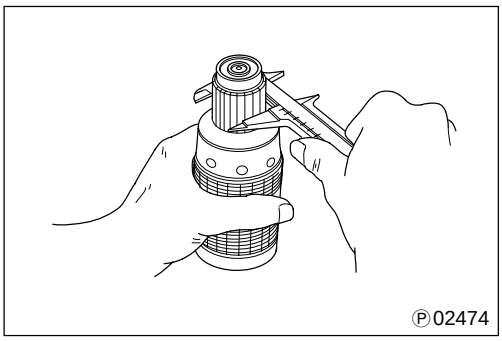


(3) Deflection of commutator

If the measured value is higher than the limit, correct the outer diameter of commutator **C** within the limit.

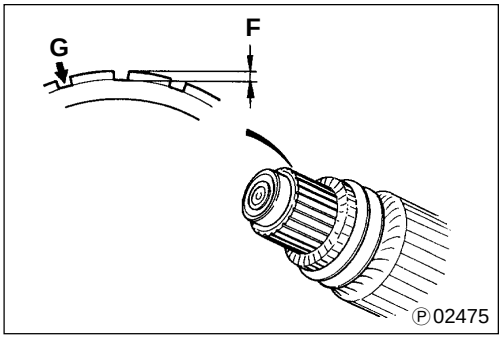
(4) Condition of the surface of commutator

- If the surface is rough or has stepped wear, polish the surface with emery paper (300 to 500 grit).
- After polishing, check deflection of commutator **C**.



(5) Outer diameter of commutator

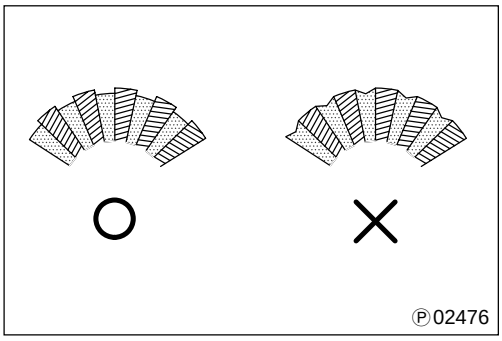
If the measured value is higher than the limit, replace armature assembly **16**.



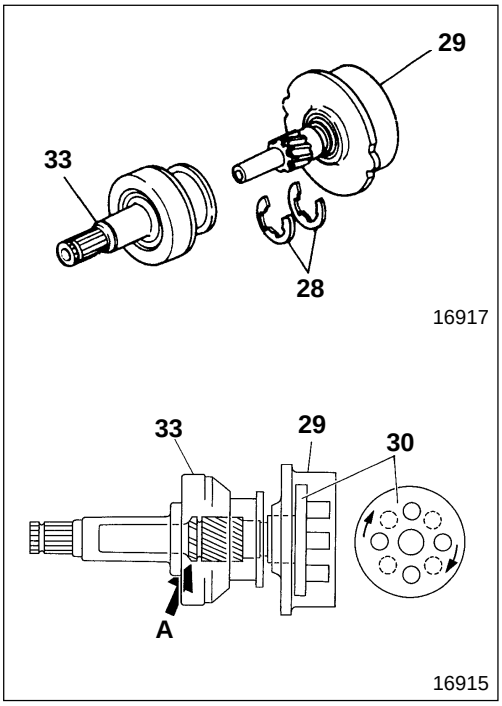
(6) Mold depth between segments

- If the measured value is lower than the limit, replace armature assembly **16**.
  F : Mold depth

- To rectify the armature assembly **16**, grind the shown portions **G**.



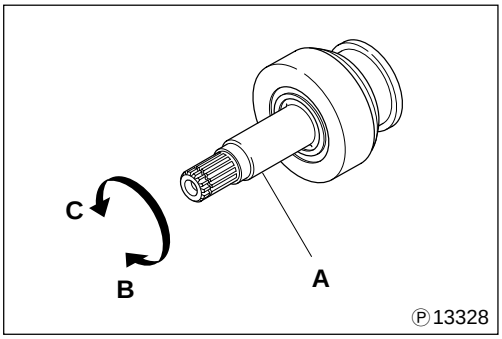
- If the mold is worn as shown, correct or replace armature assembly **16**.
  ○ : Good
  × : Faulty



29 Removal of gear shaft and internal gear assembly

Remove the E-rings **28** and then the gear shaft and internal gear assembly **29** from the overrunning clutch **33**.
Proceed as follows if the gear shaft and internal gear assembly **29** cannot be removed due to interference of the splined section **A** of gear shaft assembly **30** with internal parts of the overrunning clutch **33**.

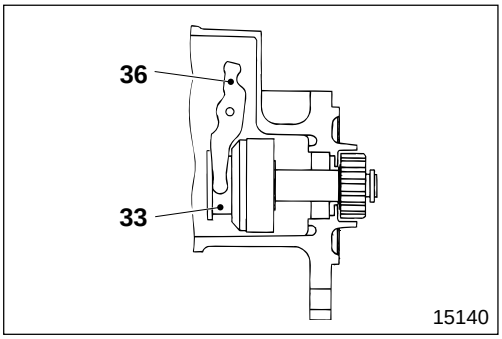
- Press the gear shaft assembly **30** against the overrunning clutch **33**.
- Turn the gear shaft assembly **30** approx. 1/8 of a turn to change the position of splined section **A**.



33 Inspection of overrunning clutch

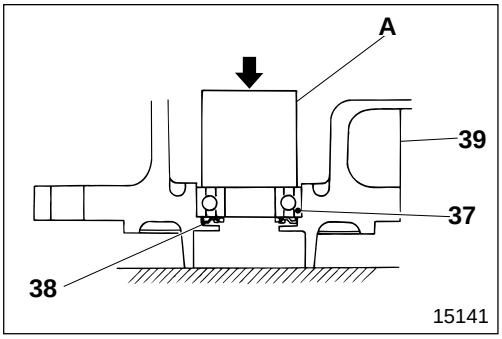
Perform the following checks, and if any fault is found, replace the overrunning clutch **33**.

- Make sure that shaft **A** turns smoothly when turned in direction **B**.
- Make sure that shaft **A** locks when turned in direction **C**.



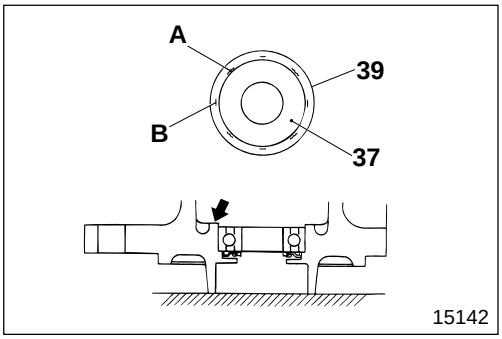
36 Installation of lever

Install lever **36** onto overrunning clutch **33** in the direction as shown.



37 Installation of front bearing

- Install oil seal **38** before press-fitting front bearing **37**.
- Press-fit front bearing **37** into front bracket **39** using pipe-shaped tool **A**.



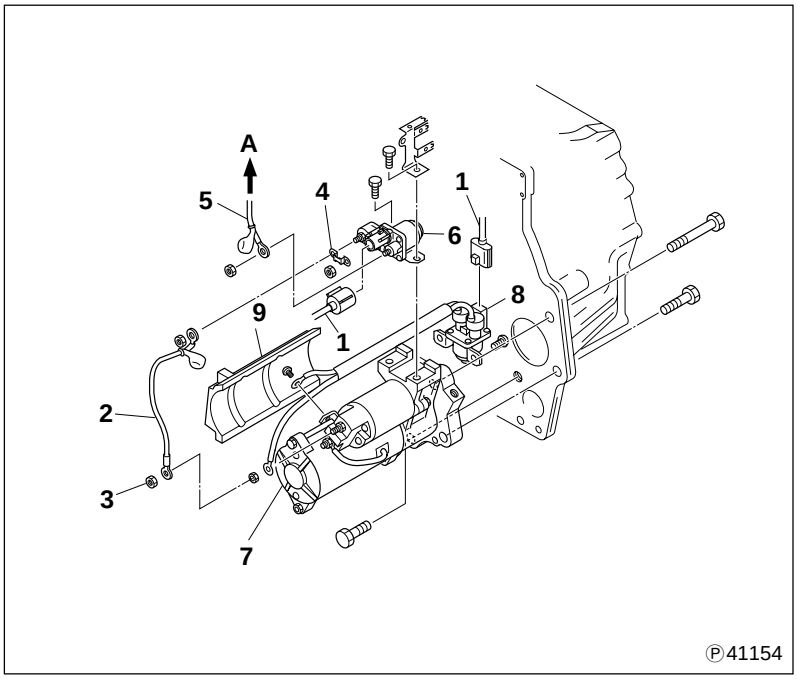
- Re-caulk the side of front bracket **39**.

NOTE

Do not re-caulk previously caulked points B.

A : Caulking points (4 points)

< 4M5 >



● **Removal sequence**

1 Chassis harness
2 Starter cable
3 Nut (connect to terminal B)
4 Fuse
5 Glow cable
6 Glow relay 🕮 **187**
7 Starter 🕮 P54-12-18
8 Starter relay 🕮 **187**
9 Rubber spacer
B : Connect to terminal B
S : Connect to terminal S

WARNING⚠

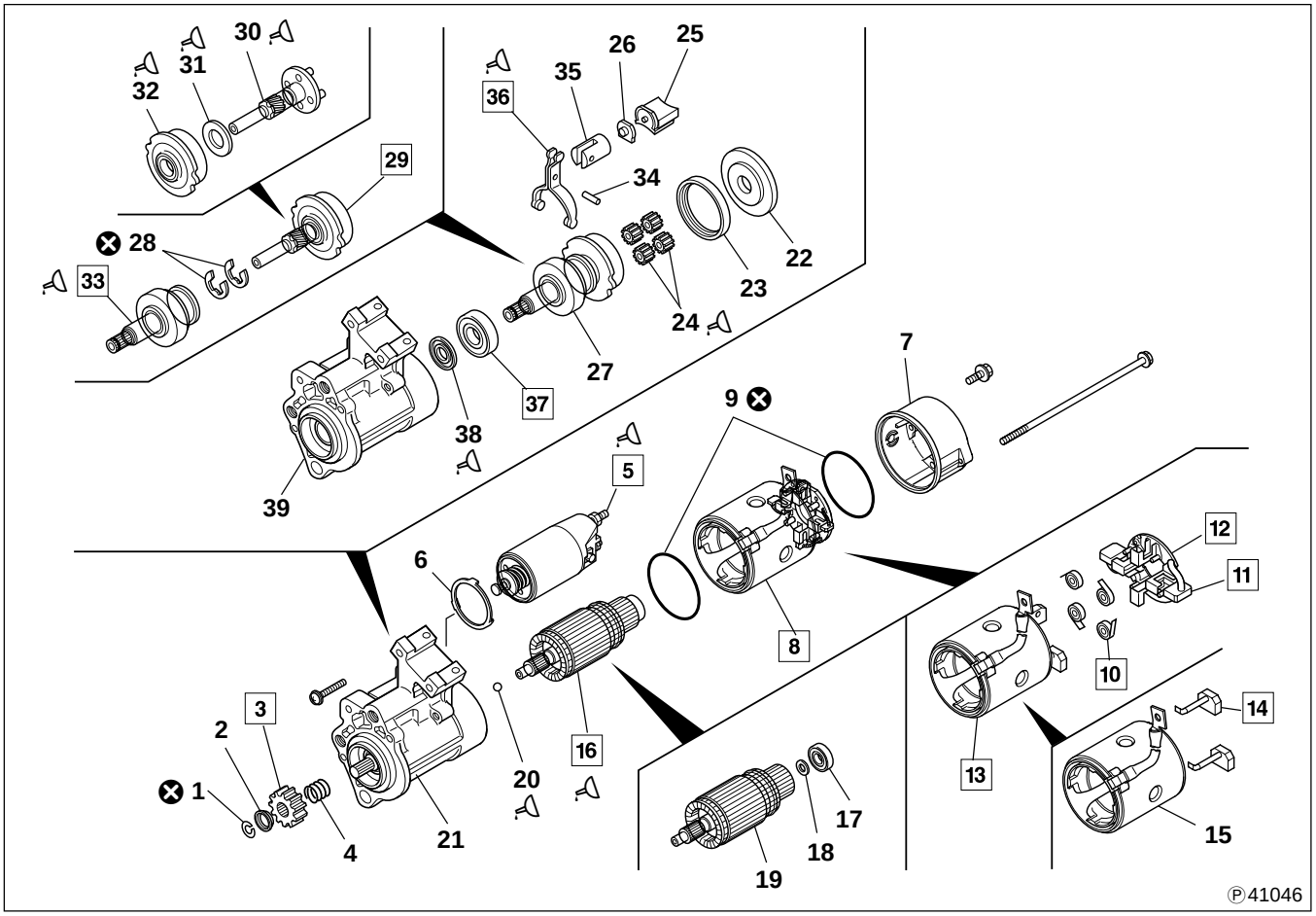
Never touch the starter 7 with tools when you remove the harness from terminal B. This is because voltage is always supplied to it from starter cable 2, and you will short-circuit the starter. Before removing the harness from terminal B, remove the ⊖ battery terminal and tape it up to insulate it.

● **Installation sequence**

Follow the removal sequence in reverse.

M E M O

Starter < 4M5 >



● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch assembly
6 Shim
7 Rear bracket
8 Yoke and brush holder assembly
9 Rubber packing
10 Brush spring
11 Brush ⊖
12 Brush holder assembly
13 Yoke assembly
14 Brush ⊕
15 Yoke
16 Armature assembly
17 Rear bearing
18 Washer
19 Armature
20 Ball
21 Front bracket assembly
22 Cover
23 Rubber packing
24 Planetary gear
25 Rubber packing
26 Plate
27 Gear shaft and overrunning clutch assembly
28 E-ring
29 Gear shaft and internal gear assembly
30 Gear shaft assembly
31 Washer
32 Internal gear
33 Overrunning clutch
34 Pin
35 Holder
36 Lever
37 Front bearing
38 Oil seal
39 Front bracket

⊗ : Non-reusable parts

CAUTION⚠

- **Do not remove bearings 17, 37 unless they are faulty.**
- **Be careful not to lose ball 20, since it might come out together with armature assembly 16 when you remove it.**

NOTE

- **You do not have to remove pinion 3 when you disassemble or inspect only the motor assembly, for example: when inspection of the brush assembly is required.**
- **Except for the above, make sure you remove pinion 3 before disassembling any parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Whenever magnetic switch assembly 5 has been replaced, be sure to adjust the pinion gap.

● **Inspection after assembly**

🕮 P54-12-20

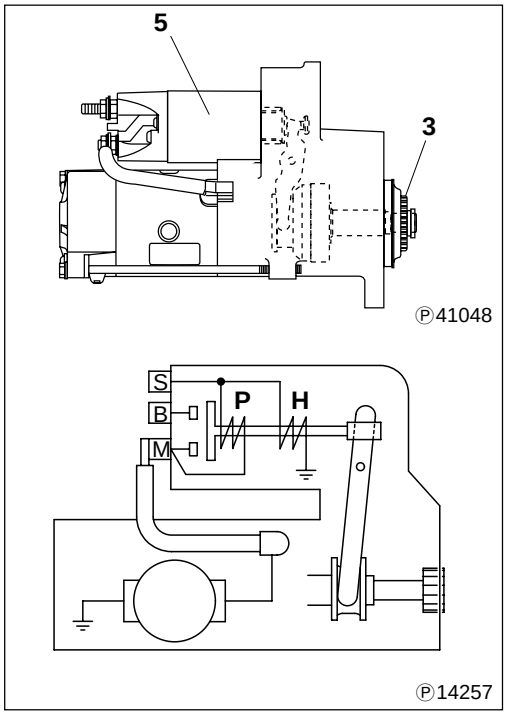
Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
—	Pinion gap			0.5 to 2.0 {0.02 to 0.079}	—	Adjust
—	No-load characteristic	With current of 11 V	Current	180 A or less	—	Inspect
			Revolutions per minute	3800 rpm or more	—	
10	Pressure of brush spring			29.2 to 39.4 N {6.6 to 8.9 lbs, 2.98 to 4.02 kgf}	13.7 N {3.1 lbs, 1.4 kgf}	Replace
11, 14	Length of brush			18 {0.71}	11 {0.43}	Replace
16	Outer diameter of commutator			32 {1.26}	31.4 {1.24}	Replace
	Deflection of commutator periphery			—	0.1 {0.0039} or more	Replace
	Mold depth between segments			—	0.2 {0.0079} or less	Correct or replace

Lubricant

Location	Points of application	Specified lubricant	Quantity
5	Lever contact surface of magnetic switch assembly	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Teeth of armature assembly gear	MOLYKOTE ® AG650	As required
16, 30	Sliding surface of armature assembly and gear shaft assembly	MOLYKOTE ® AG650	As required
20	Ball	MOLYKOTE ® AG650	As required
24, 32	Teeth of internal gear and planetary gear	MOLYKOTE ® AG650	As required
30, 33	Friction surfaces of gear shaft assembly and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
31	Washer	MOLYKOTE ® AG650	As required
33	Spline of overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
36	Friction surfaces of lever and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
38	Oil Seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

● Inspection after assembly

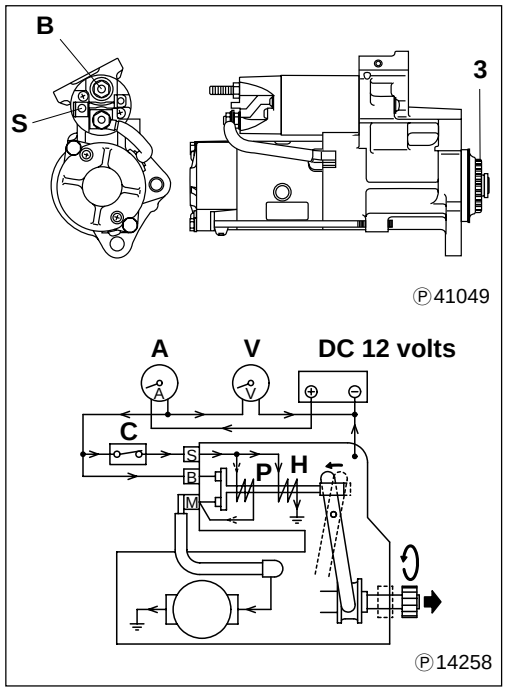
Inspection after assembling the starter should be carried out with current fed to the starter.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot during inspection.**

CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits the coil might burn due to overheating.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



(1) Performance test

- Connect the starter as shown.
  A : Ammeter
  B : Terminal B of starter
  C : Switch
  S : Terminal S of starter
  V : Voltmeter
- Set the voltage to 11 volts DC.

CAUTION⚠

Up to 12 volts can be loaded.

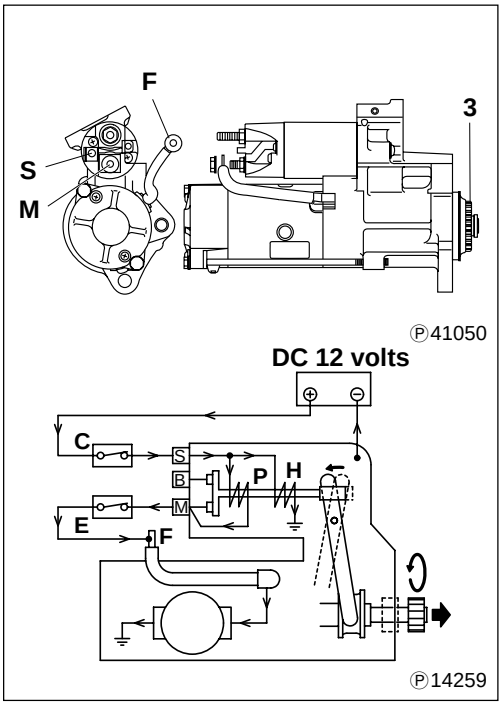
- The following work should be done with current fed to the starter. You must complete measurement of the current and the number of revolutions within 30 seconds.
  - Turn switch **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

CAUTION⚠

When switch C is turned ON, current is fed both to pull-in coil P and holding coil H. When a large amount of current is fed into terminal M from DC 12 volts, via terminal B of the starter, the current stops flowing into the pull-in coil but continues to flow into the holding coil.

To avoid burning the holding coil, be sure to carry out the performance test within 30 seconds.

  - Measure the current and the number of revolutions of the starter. Train a strobe light on pinion **3** to measure the revolutions.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, disassemble the starter again and inspect it.

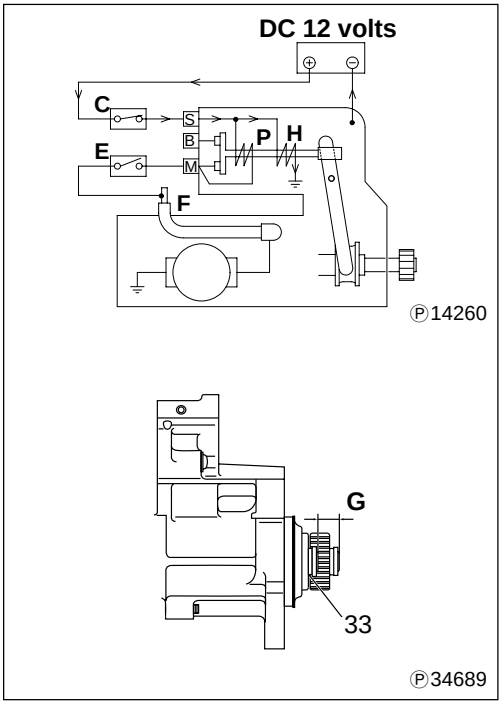


(2) Pinion gap

[Inspection]

- Connect the starter as shown.
  C : Switch
  E : Switch
  F : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete measurement of the pinion gap within 30 seconds.
  - Turn switches **C** and **E** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

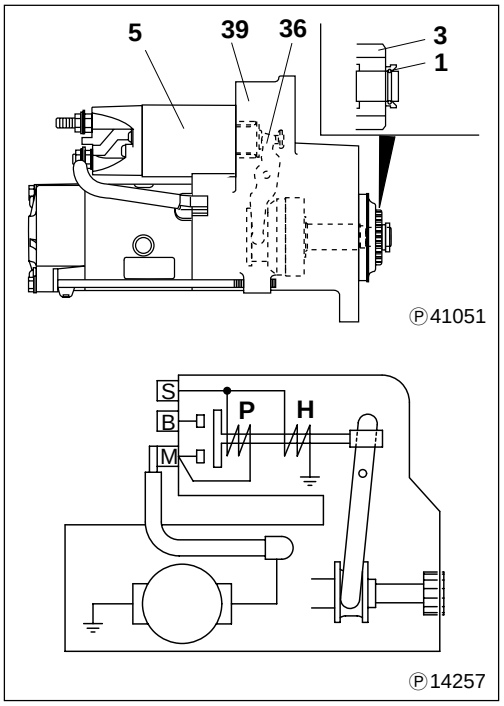


  - Within 5 seconds of pinion **3** rotating, turn switch **E** OFF to stop rotation of the pinion.

CAUTION⚠

When switches C and E are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.
To avoid burning the pull-in coil, be sure to turn switch E OFF within 5 seconds of the pinion rotating.

  - Hold the end of overrunning clutch **33** with fingers, and pull it. Measure the distance **G** (pinion gap) in the shaft direction that the overrunning clutch moves when it is lightly pushed back by hand.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, replace lever **36**.



3 **Pinion**

[Removal]

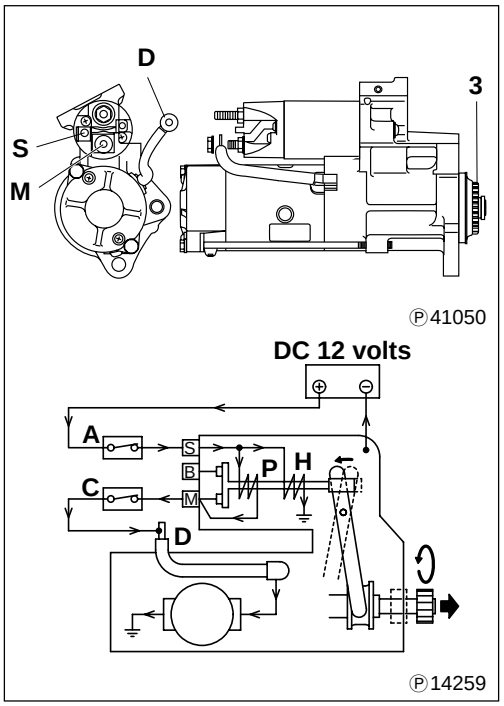
Feed current to the starter and protrude pinion **3** to remove the pinion.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot after inspection.**

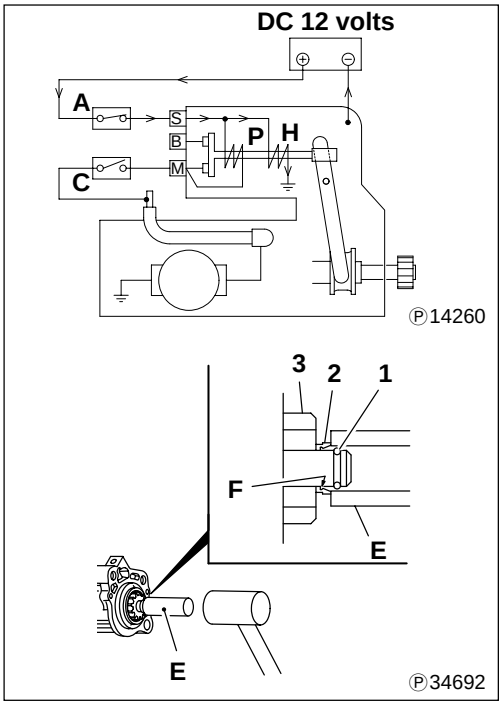
CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits, the coil might burn due to overheating.**
- **Before making pinion 3 jump out, be sure to feed current to the starter to obtain the correct state. If current is not fed to the starter and lever 36 is pulled to protrude the pinion, front bracket 39 or the lever might be damaged due to the shock produced on removal of stopper ring 1.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



- Connect the starter as shown.
  A : Switch
  C : Switch
  D : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete removal of pinion **3** within 30 seconds.
  - Turn switches **A** and **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



- Within 5 seconds of pinion **3** rotating, turn switch **C** OFF to stop rotation of the pinion**.**

CAUTION

When switches A and C are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.

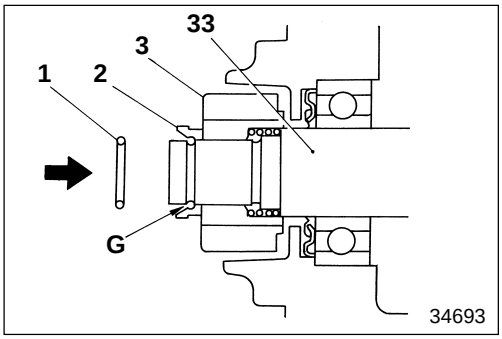
To avoid burning pull-in coil P, be sure to turn switch C OFF within 5 seconds after the pinion rotates.

- Apply pipe-shaped tool **E** onto pinion stopper **2**.
- Hit tool **E** lightly using a mallet to remove stopper ring **1** from ring groove **F** of pinion stopper **2**.
- Remove stopper ring **1** and pinion **3**.
- Turn switch **A** OFF to stop current to the starter.

NOTE

When the current to the starter is stopped, stopper ring 1 might fall back into ring groove F of pinion stopper 2 because pinion 3 is pushed inside.

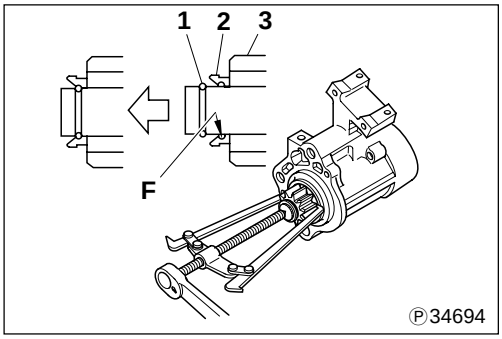
If this occurs, feed current to the starter again and carry out the work.



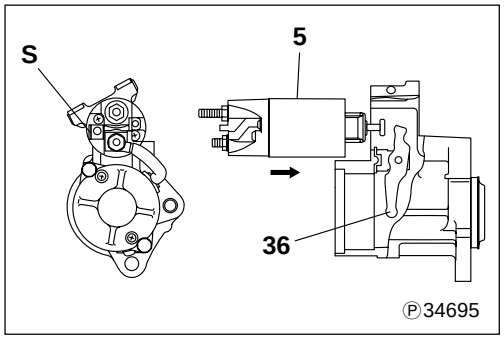
[Installation]

When installing pinion **3**, it is not necessary to feed current to the starter.

- Install pinion stopper **2** and pinion **3** onto overrunning clutch **33** in the direction as shown.
- Fit stopper ring **1** into ring groove **G** of overrunning clutch **33**.

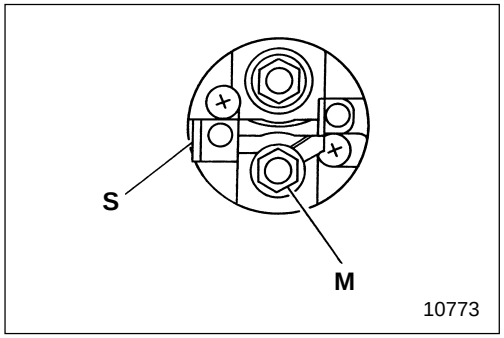


- Pull pinion **3** firmly and set stopper ring **1** on groove **F** of pinion stopper **2** securely.



5 Magnetic switch assembly

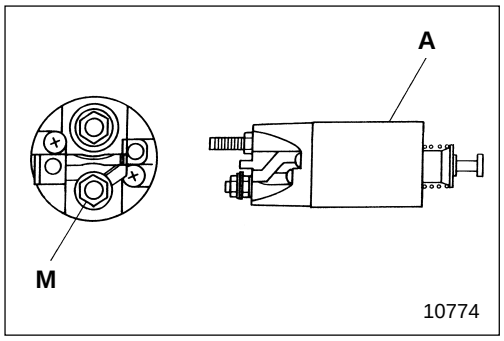
[Installation]
Install magnetic switch assembly **5** to lever **36**, with terminal **S** facing the direction as shown.



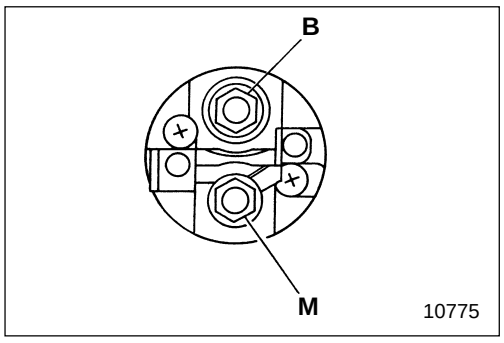
[Inspection]

(1) Testing for coil breakage

- Make sure that there is continuity between terminals **S** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.

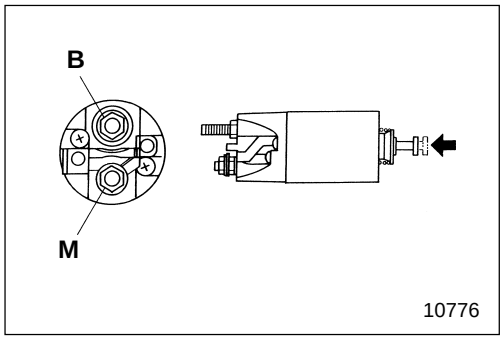


- Make sure that there is continuity between terminal **M** and body **A**.
- If there is no continuity, replace magnetic switch assembly **5**.



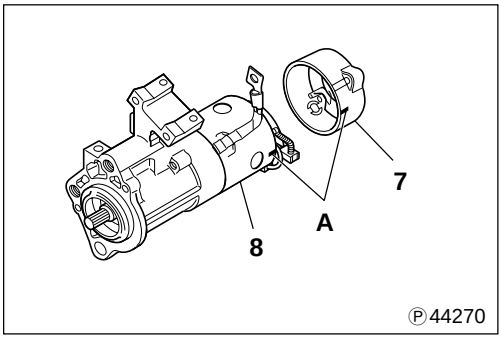
(2) Inspection of welded connections

- Make sure that there is no continuity between terminals **B** and **M**.
- If there is continuity, replace magnetic switch assembly **5**.



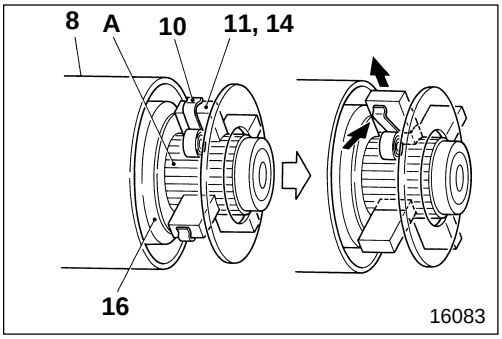
(3) Inspection of connections

- Push the tip of magnetic switch assembly **5** to close the internal connection.
  Make sure that there is continuity between terminals **B** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.



7 **Installation of rear bracket**

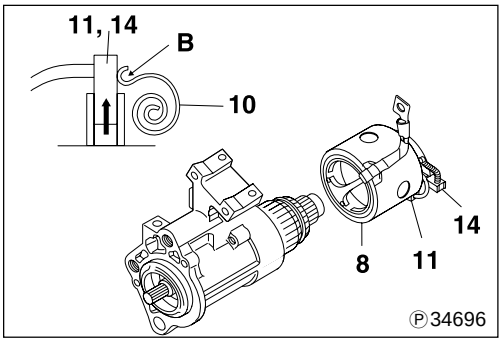
A : Alignment mark



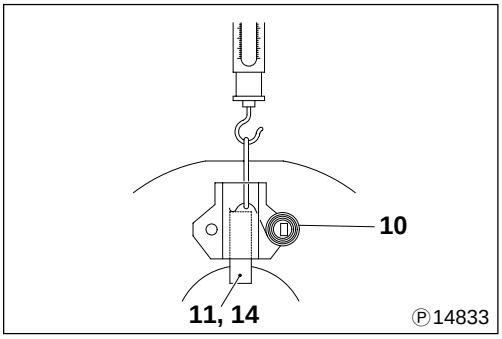
8 **Removal and installation of yoke and brush holder assembly**

Use the following method to remove the yoke and brush holder assembly **8** in order to prevent the commutator **A** of the armature assembly **16** from being damaged by the brushes **11** and **14**.

- Lift the brushes **11** and **14** away from the commutator **A** and hold them lifted by applying the brush springs **10** against the sides of the brush springs.

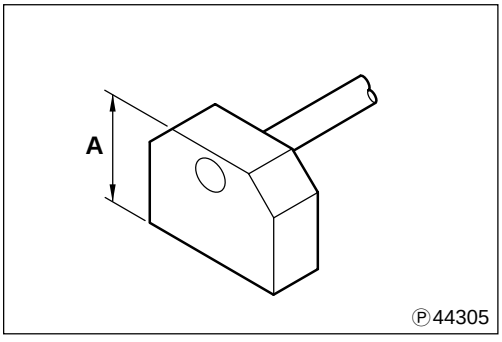


- Pull part **B** of each brush spring **10** and pull up the brushes **11** and **14**.
- Hold the brushes **11** and **14** in position with brush spring **10** as shown.
- Remove yoke and brush holder assembly **8**.
- To reinstall the yoke and brush holder assembly **8**, follow the removal instructions in, reverse.



10 **Inspection of brush spring**

- Use new brushes **11, 14** and measure the load when brush spring **10** is detached from the brushes.
- If the measured value is lower than the limit, replace brush spring **10**.



11 **14** **Inspection of brush**

(1) Length of brush

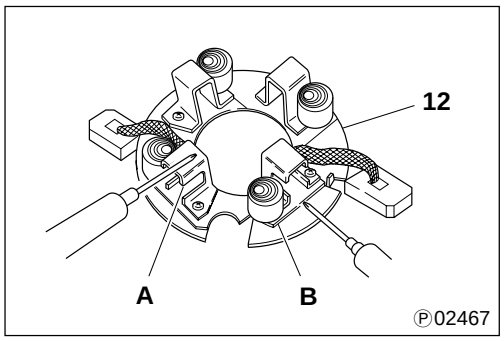
If the measured value **A** is lower than the limit, replace brushes **11, 14**.

NOTE

To replace brush ⊖ 11, replace entire brush holder assembly 12.

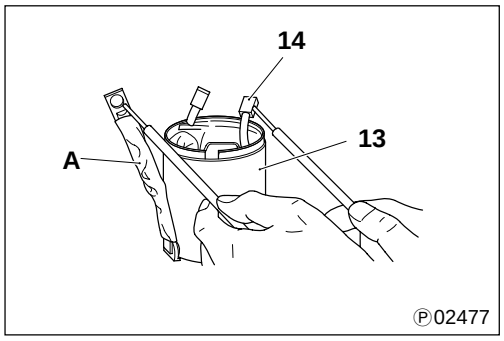
(2) Contact surface with commutator

If the surface where the brushes contact the commutator is rough or is worn unevenly, polish the surface with emery paper (300 to 500 grit).



12 Inspection of brush holder assembly

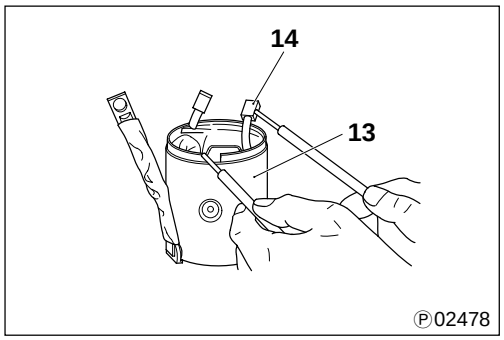
- Clearing the brush holder **A** and holder plate **B**.
- Make sure that there is no continuity between the ⊕ side of the brush holder **A** and the ⊖ side of the holder plate **B**.
- If there is continuity between them, they are short-circuited. Replace brush holder assembly **12**.



13 Inspection of yoke assembly

(1) Testing for coil breakage

- Make sure that there is continuity between cable **A** and brush ⊕ **14**.
- If there is no continuity, they are broken. Replace brush ⊕ **14** or yoke assembly **13**.

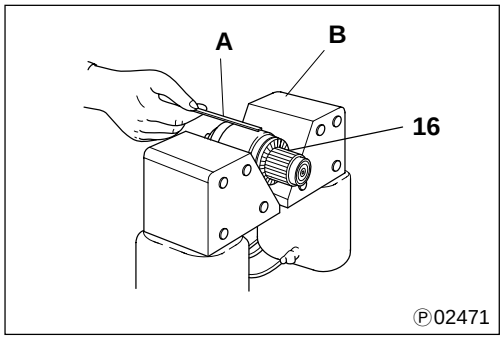


(2) Testing for coil grounding

- Make sure that there is no continuity between yoke assembly **13** and brush ⊕ **14**.
- If there is continuity, they are short-circuited. Inspect the insulated point. If it is hard to repair, replace brush ⊕ **14** or yoke assembly **13**.

NOTE

The coil may be short-circuited to the yoke assembly 13 due to the accumulation of worn-off metal particles from the brushes and/or armature.



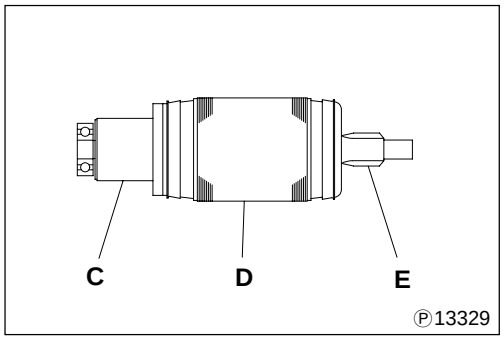
16 Inspection of armature assembly

(1) Testing for coil short-circuit

- Hold an iron rod **A** parallel with the armature assembly **16**.

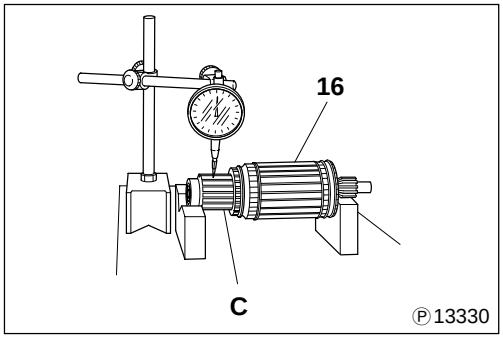
B : Armature tester

- Slowly rotate the armature assembly **16** by hand.
- If the iron rod **A** vibrates or is pulled toward the armature assembly **16**, the coil is short-circuited and the armature assembly must be replaced.



(2) Testing for coil grounding

- Make sure that there is no continuity between commutator **C** and core **D** (or shaft **E**).
- If there is continuity between them, they are short-circuited. Replace armature assembly **16**.

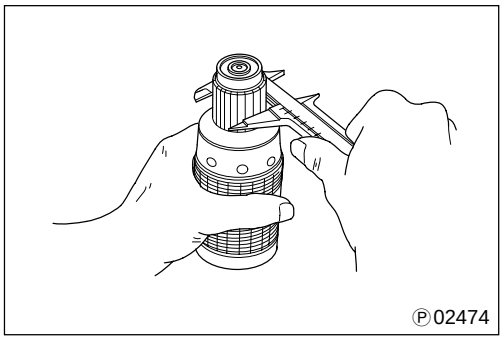


(3) Deflection of commutator

If the measured value is higher than the limit, correct the outer diameter of commutator **C** within the limit.

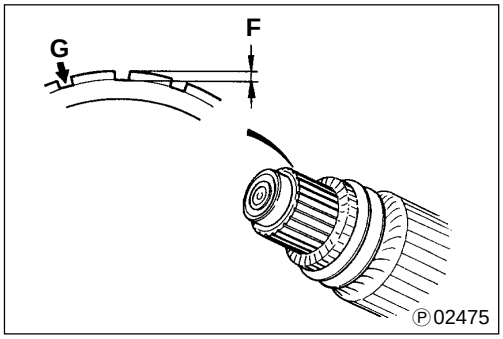
(4) Condition of the surface of commutator

- If the surface is rough or has stepped wear, polish the surface with emery paper (300 to 500 grit).
- After polishing, check deflection of commutator **C**.



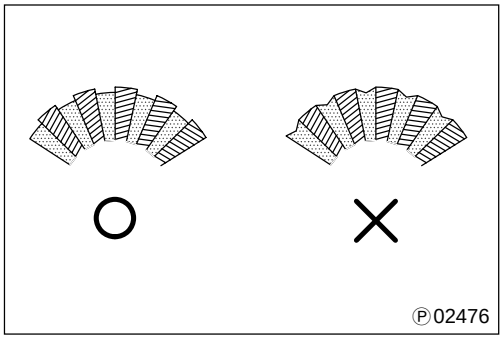
(5) Outer diameter of commutator

If the measured value is higher than the limit, replace armature assembly **16**.

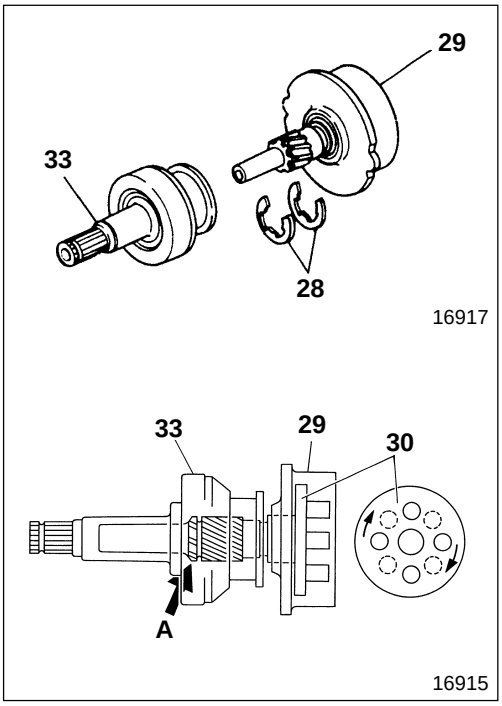


(6) Mold depth between segments

- If the measured value is lower than the limit, replace armature assembly **16**.
  F : Mold depth
- To rectify the armature assembly **16**, grind the shown portions **G**.



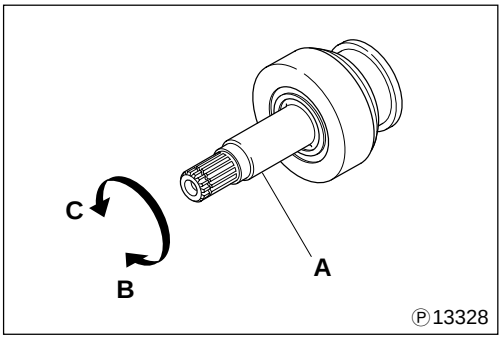
- If the mold is worn as shown, correct or replace armature assembly **16**.
  ○ : Good
  × : Faulty



29 Removal of gear shaft and internal gear assembly

Remove the E-rings **28** and then the gear shaft and internal gear assembly **29** from the overrunning clutch **33**.
Proceed as follows if the gear shaft and internal gear assembly **29** cannot be removed due to interference of the splined section **A** of gear shaft assembly **30** with internal parts of the overrunning clutch **33**.

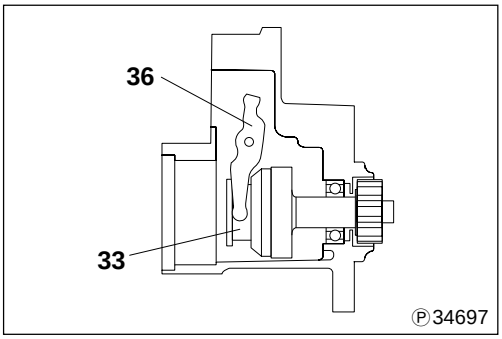
- Press the gear shaft assembly **30** against the overrunning clutch **33**.
- Turn the gear shaft assembly **30** approx. 1/8 of a turn to change the position of splined section **A**.



33 Inspection of overrunning clutch

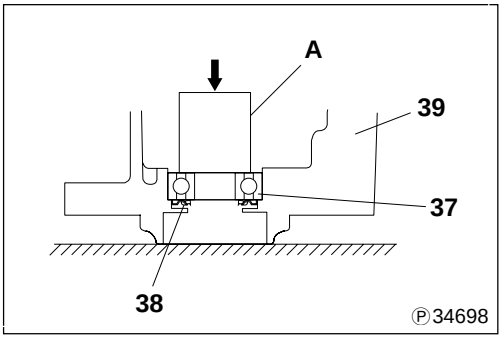
Perform the following checks, and if any fault is found, replace the overrunning clutch **33**.

- Make sure that shaft **A** turns smoothly when turned in direction **B**.
- Make sure that shaft **A** locks when turned in direction **C**.



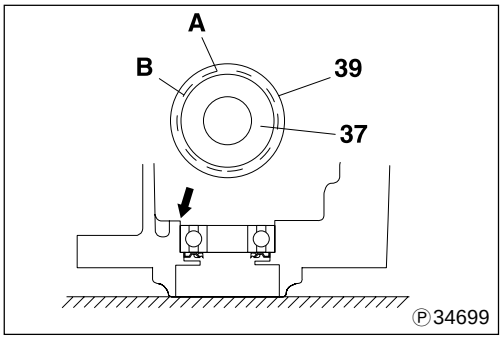
36 Installation of lever

Install lever **36** onto overrunning clutch **33** in the direction as shown.



37 Installation of front bearing

- Install oil seal **38** before press-fitting front bearing **37**.
- Press-fit front bearing **37** into front bracket **39** using pipe-shaped tool **A**.



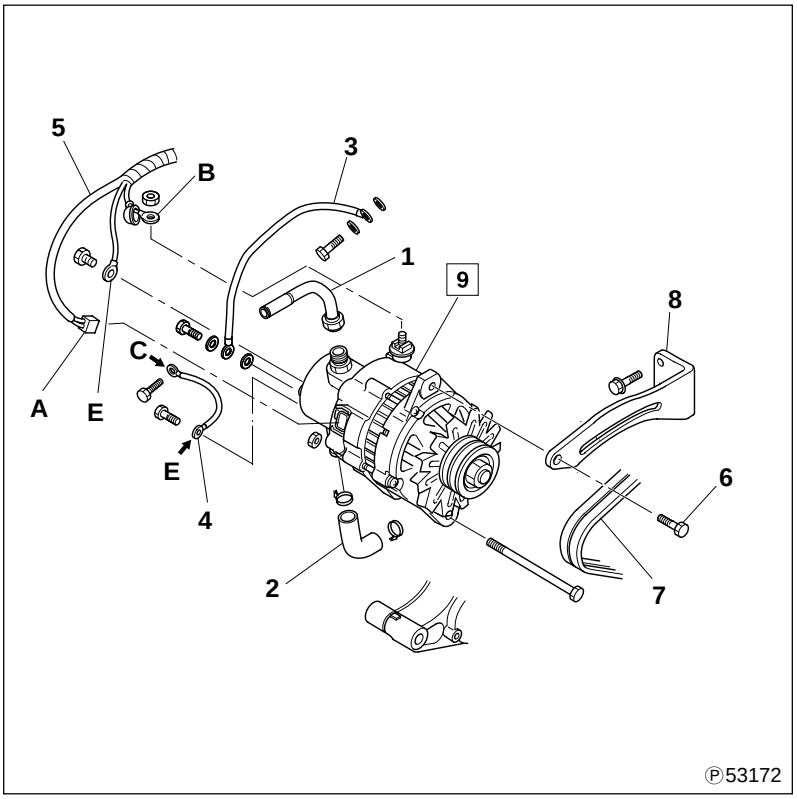
- Re-caulk the side of front bracket **39**.

NOTE

Do not re-caulk previously caulked points B.

A : Caulking points (4 points)

< 6D3 >



● **Removal sequence**

1 Vacuum pipe < V/P >
2 Oil return hose < V/P >
3 Oil inlet hose < V/P >
4 Ground cable
5 Chassis harness
6 Adjusting bolt
7 V-belts
8 Adjusting plate
9 Alternator < with V/P > 🕮 P54-12-32
Alternator < without V/P > 🕮 P54-12-36

A : To terminals L and R
B : To terminal B
C : To crankcase
E : To terminal E
V/P : Vacuum pump

WARNING ⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing alternator 9.
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.

● **Installation sequence**

Follow the removal sequence in reverse.

● **Adjustment after installation**

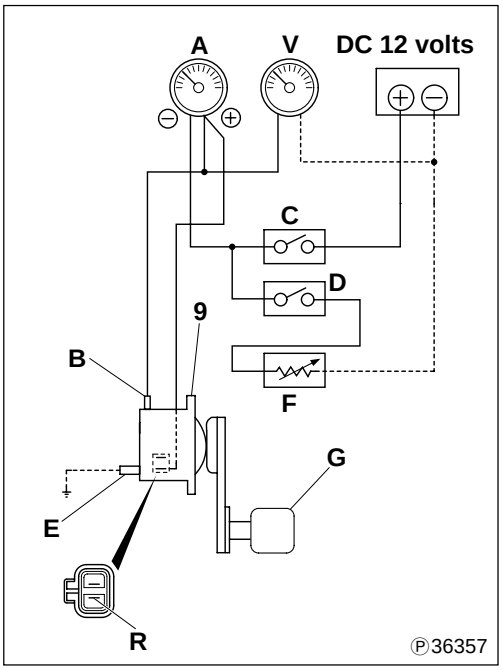
For adjustment of V-belt **7** tension
Gr 14

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
9	Alternator output current (*When alternator is hot and producing 13.5V)	Without vacuum pump	At 1500 rpm	53 A or more	—	Inspect
			At 2500 rpm	84 A or more	—	
			At 5000 rpm	102 A or more	—	
		With vacuum pump	At 1500 rpm	51 A or more	—	Inspect
			At 2500 rpm	81 A or more	—	
			At 5000 rpm	98 A or more	—	
	Adjustment voltage of regulator (At 5000 rpm, 5A or less load)			14.7 ± 0.3V	—	Replace

*The hot condition is the one after the alternator has been run at normal ambient temperature with 5000 rpm and maximum output for 30 minutes.

◆ Service procedure



9 Inspection of alternator

(1) Alternator performance check (bench test)

- Connect the alternator **9** as shown.

CAUTION ⚠

Sufficiently thick wires should be used for wiring and each connection should be securely fastened.

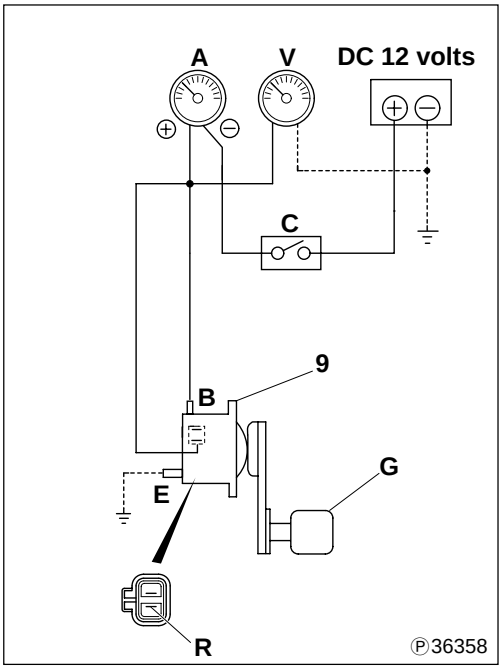
A : Ammeter
B : Alternator terminal B
C : Switch
D : Switch
E : Alternator terminal E
F : Load resistance (variable resistance)
G : Alternator drive motor
R : Alternator terminal R
V : Voltmeter

- Increase load resistance **F** to the maximum (condition which the load current hardly flow).
- Turn switches **C** and **D** ON.
- Run alternator at 5000 rpm for 30 minutes by adjusting load resistance **F** so that electric current can conform to the specified standard.

  Alternator nominal current

12V-100A

- Measure the current at each specified revolution of alternator **9**.
- If the measured value deviates from the standard value, disassemble and check alternator **9**. < with vacuum pump > 🕮 P54-12-32, < without vacuum pump > 🕮 P54-12-36



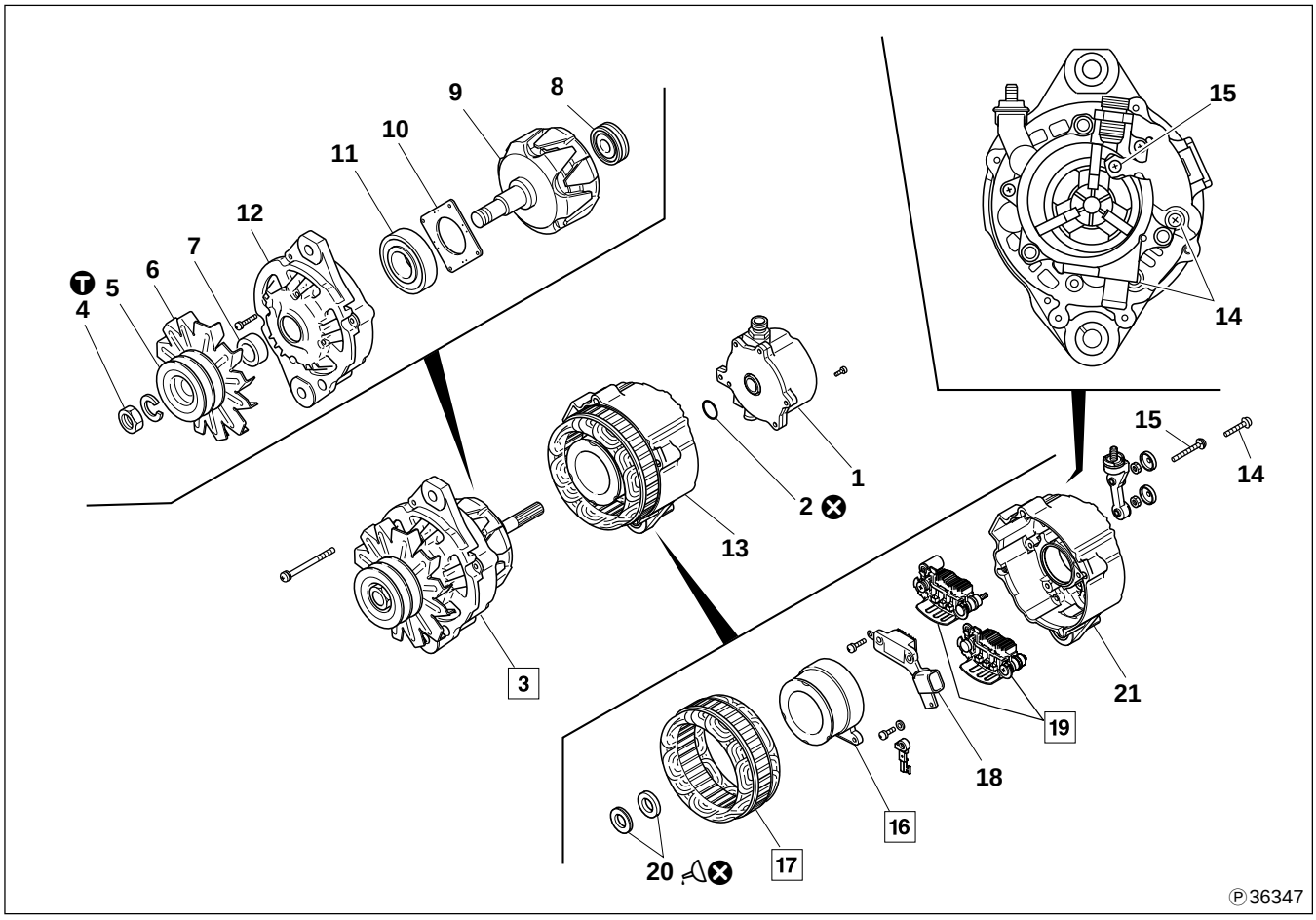
(2) Regulator performance check (bench test)

- Connect the alternator **9** as shown.

A : Ammeter
B : Alternator terminal B
C : Switch
E : Alternator terminal E
G : Alternator drive motor
R : Alternator terminal R
V : Voltmeter

- Turn switches **C** ON.
- Run alternator **9** at low speeds.
- Increase the speed of alternator **9** to 5000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 5 amperes or less at 5000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If follow than the standard value: Inspect the alternator related parts before replacing the regulator.

< With vacuum pump >



● **Disassembly sequence**

1 Vacuum pump Gr 35
2 O-ring
3 Rotor and front bracket assembly
4 Nut
5 Pulley
6 Fan
7 Spacer
8 Rear bearing
9 Rotor assembly
10 Cover
11 Front bearing
12 Front bracket
13 Stator and rear bracket assembly
14 Screw
15 Screw
16 Field coil
17 Stator assembly
18 Regulator
19 Rectifier
20 Oil seal
21 Rear bracket

⊗ : Non-reusable parts

CAUTION ⚠

When removing field coil 16, support the field coil by hand or with a stand to prevent it from falling due to its own weight.

NOTE

Do not remove parts 8, 11, 17 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
16	Field coil resistance (20°C {68°F})	2.0 to 2.4 Ω	—	Replace

Tightening torque

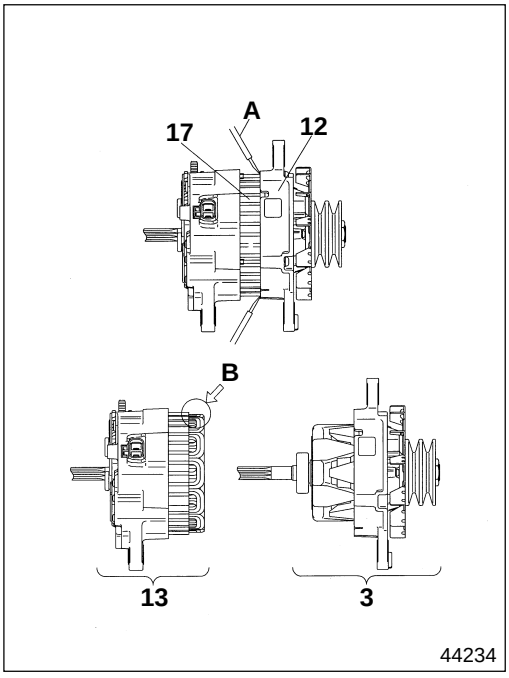
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Nut (Pulley mounting)	143 to 181 {105 to 135, 14.6 to 18.5}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
20	Oil seal lip area	Idemitsu Autolux or lubricant supplied with oil seal	As required

◆ Service procedure



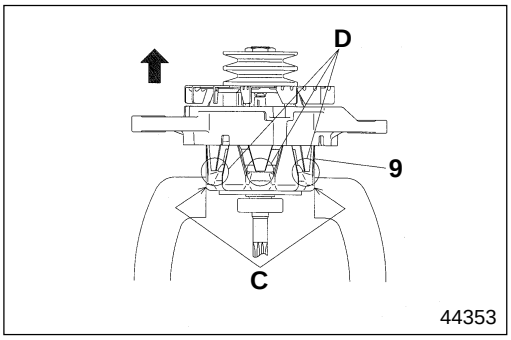
3 **Rotor and front bracket assembly**

[Removal]

- Insert screwdriver **A** between front bracket **12** and stator assembly **17**.
- Use the screwdriver **A** to pry rotor and front bracket assembly **3** away from stator and rear bracket assembly **13**.

CAUTION

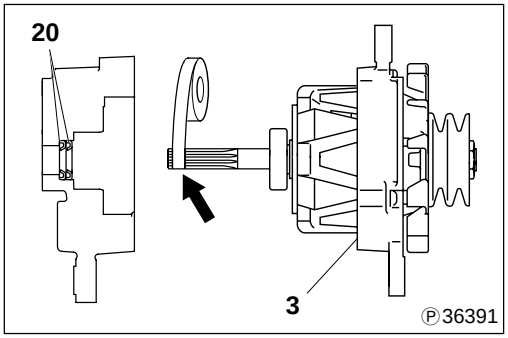
Be careful not to insert the screwdriver A too deep or it will damage coil B of stator assembly 17 and might cause a short-circuit.



[Disassembly]

CAUTION

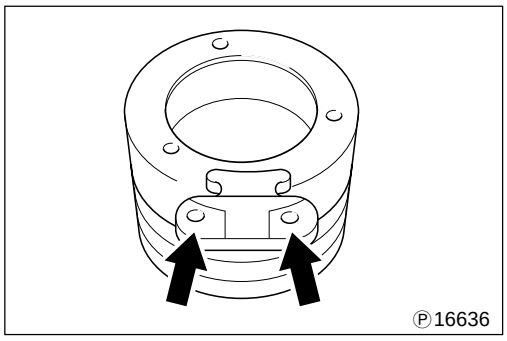
Make sure, when you hold rotor assembly 9 in a vise, to grip root C of the core claws. Gripping claws D can damage them.



[Installation]

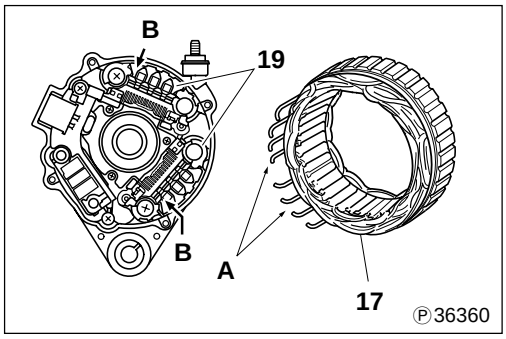
CAUTION⚠

To prevent damaging oil seal 20 during assembly, cover spline area E of the shaft of rotor and front bracket assembly 3 with tape.



[Inspection]

- Measure the resistance between the terminals of field coil **16**.
- If the measured value deviates from the standard value, replace field coil **16**.



17 Stator assembly

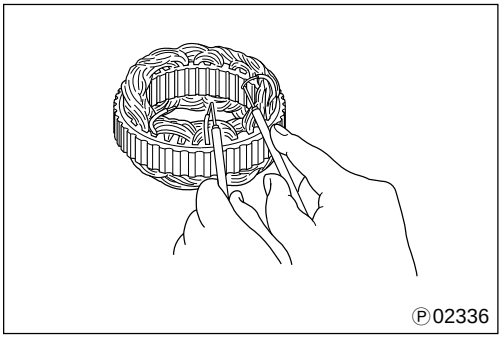
[Removal and installation]

- Disconnect lead **A** of stator assembly **17** from rectifier **19**. The lead is soldered to diode **B** of the rectifier at 8 places. (Each of the 2 rectifiers has 4 soldered sections.)

CAUTION⚠

Unsolder within as short a time as possible (within 5 seconds), or diode can be easily damaged by heat.

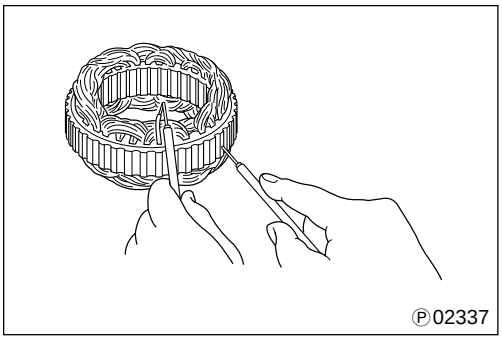
- To install, follow the removal sequence in reverse.



[Inspection]

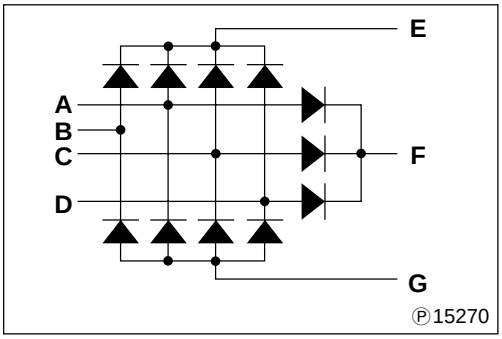
(1) Continuity between each lead wire

- Check that there is continuity between each stator lead.
- If there is no continuity, the lead is broken. Replace stator assembly **17**.



(2) Continuity between each lead wires and the core

- Check that there is no continuity between lead wires and the core.
- If there is continuity, the lead wires is short-circuited. Replace the stator assembly **17**.

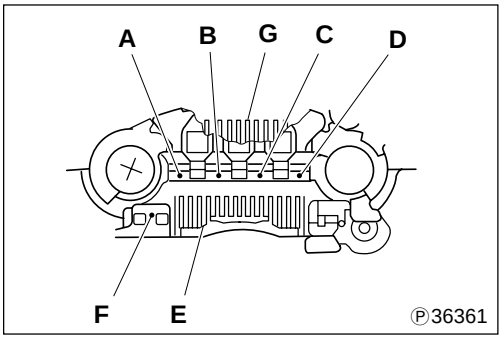


19 Inspection of rectifier

- Check the function of diodes within rectifier **19** properly. If any fault is found, replace the rectifier.

  If resistance is infinite in both cases, the diode is open.
  If resistance is close to 0Ω in both cases, the diode is shorted

  A, **B**, **C**, **D** : Lead connecting area of stator coil
  E, **G** : Heat sink area
  F : Regulator connecting area

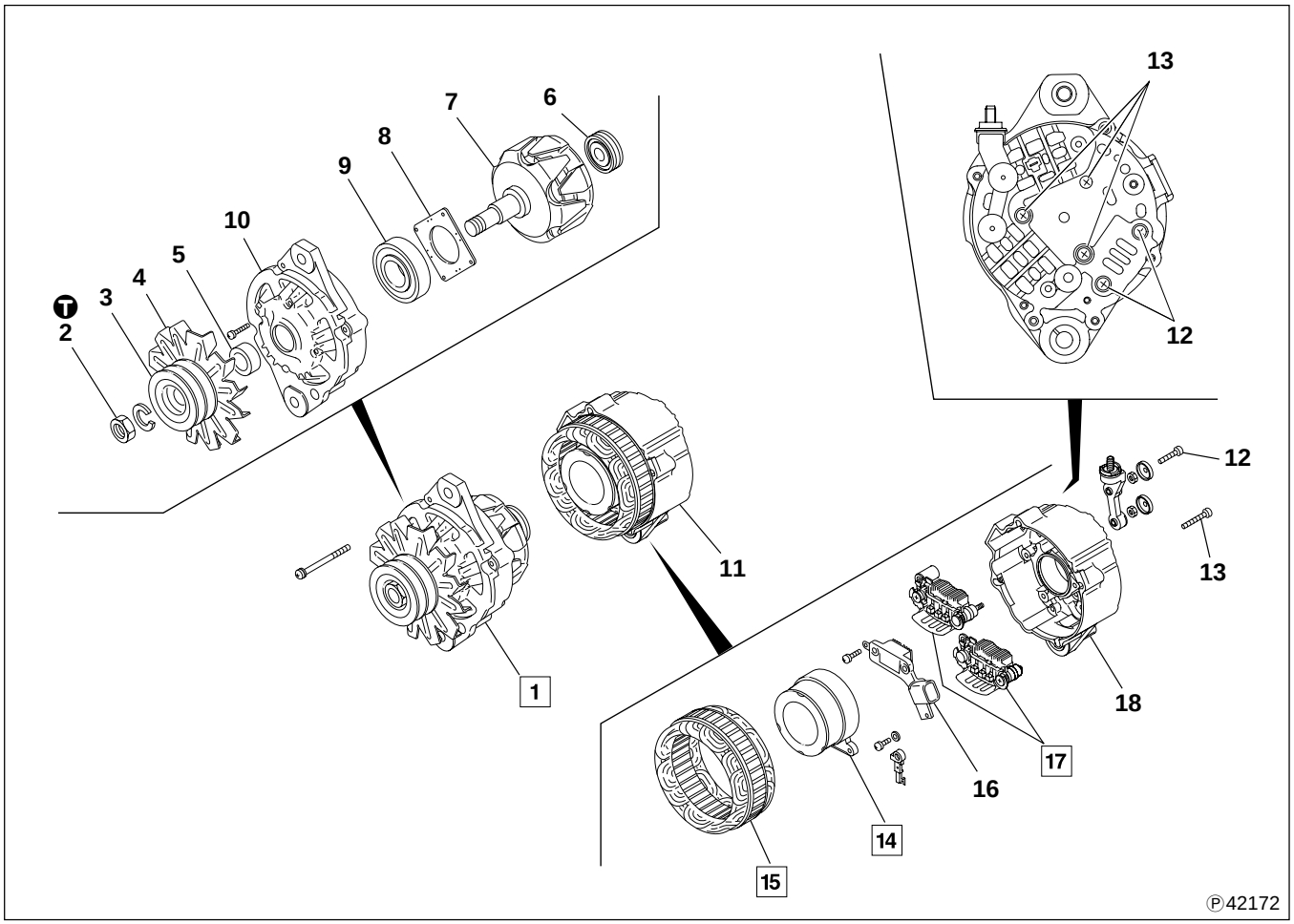


- Inspection should be repeated with the positive probe and the negative probe of the tester changed over.

CAUTION ⚠

When inspecting using a tester, the current flowing through rectifier 19 is smaller than usual. Therefore, an incorrect resistance value might be indicated on the tester.
Also, incorrect indication become larger as the range of the tester gets smaller. Set the tester to a largest possible scale.

< Without vacuum pump >



● **Disassembly sequence**

1 Rotor and front bracket assembly
2 Nut
3 Pulley
4 Fan
5 Spacer
6 Rear bearing
7 Rotor assembly
8 Cover
9 Front bearing
10 Front bracket
11 Stator and rear bracket assembly
12 Screw
13 Screw
14 Field coil
15 Stator assembly
16 Regulator
17 Rectifier
18 Rear bracket

CAUTION ⚠

When removing field coil 14, support the field coil by hand or with a stand to prevent it from falling due to its own weight.

NOTE

Do not remove parts 6, 9, 15 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

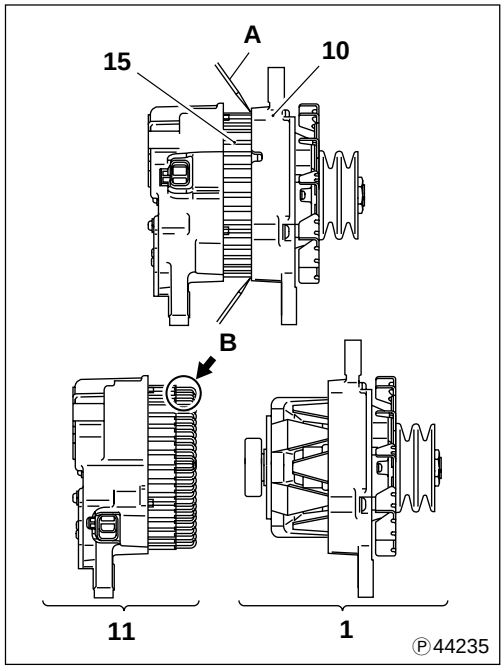
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
14	Field coil resistance (20°C {68°F})	2.0 to 2.4 Ω	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Pulley mounting)	143 to 181 {105 to 135, 14.6 to 18.5}	—



◆ Service procedure

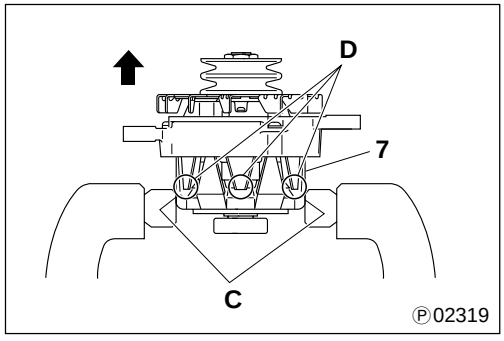
1 Rotor and front bracket assembly

[Removal]

- Insert a screwdriver **A** between front bracket **10** and stator assembly **15**.
- Use the screwdriver **A** to pry rotor and front bracket assembly **1** away from stator and rear bracket assembly **11**.

CAUTION

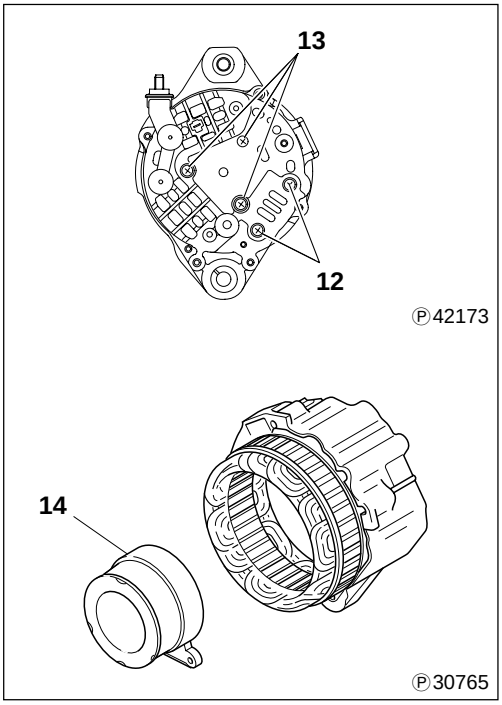
Be careful not to insert the screwdriver A too deep or it will damage coil B of stator assembly 15 and might cause a short-circuit.



[Disassembly]

CAUTION

Make sure, when you hold rotor assembly 7 in a vise, to grip root C of the core claws. Gripping claws D can damage them.



14 Field coil

[Removal]

- Remove screw **12** (2 places).

CAUTION

If screw 13 are removed first, the weight of field coil 14 may be placed on the joining portion with regulator 16 which is fixed with screw 12, causing break of the joining portion. To avoid this, remove screw 12 first.

- Remove screw **13** (3 places).

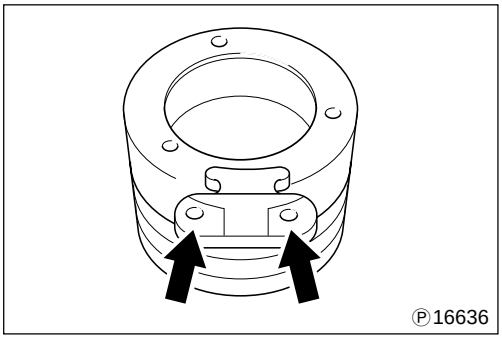
CAUTION

If screw 13 are removed, field coil 14 falls under its own weight. Keep the field coil supported by your hand.

- Remove field coil **14**.

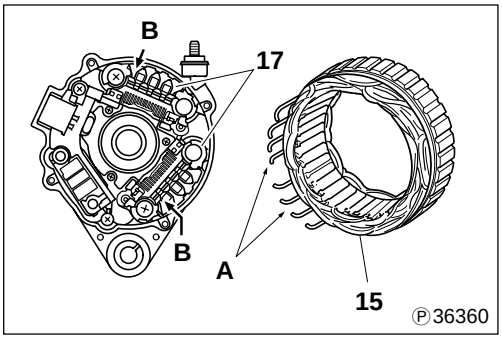
CAUTION

Do not take out field coil 14 forcibly. Otherwise the joining portion with regulator 16 may be caught by the stator coil.



[Inspection]

- Measure the resistance between the terminals of field coil **14**.
- If the measured value deviates from the standard value, replace field coil **14**.



15 Stator assembly

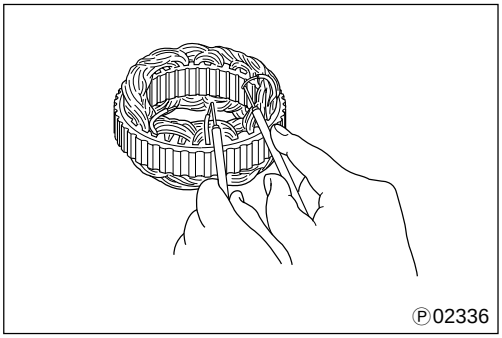
[Removal and installation]

- Disconnect lead **A** of stator assembly **15** from rectifier **17**. The lead is soldered to diode **B** of the rectifier at 8 places. (Each of the 2 rectifiers has 4 soldered sections.)

CAUTION

Unsolder within as short a time as possible (within 5 seconds), or diode can be easily damaged by heat.

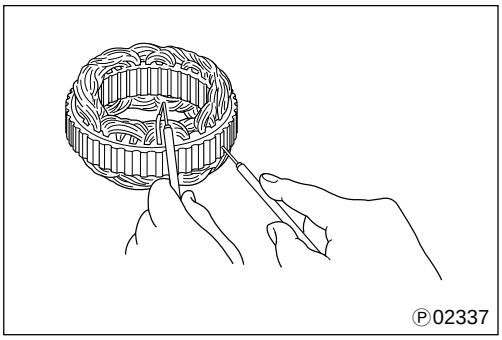
- To install, follow the removal sequence in reverse.


Ⓟ02336

[Inspection]

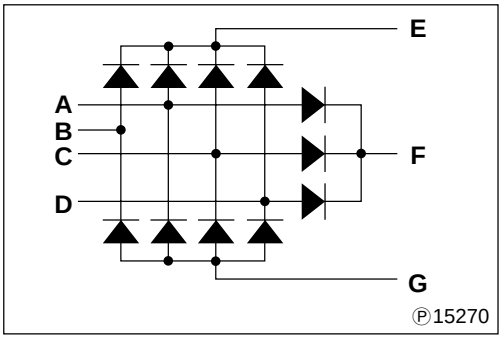
(1) Continuity between each lead wire

- Check that there is continuity between each stator lead.
- If there is no continuity, the lead is broken. Replace stator assembly **15**.


Ⓟ02337

(2) Continuity between each lead wires and the core

- Check that there is no continuity between lead wires and the core.
- If there is continuity, the lead wires is short-circuited. Replace the stator assembly **15**.



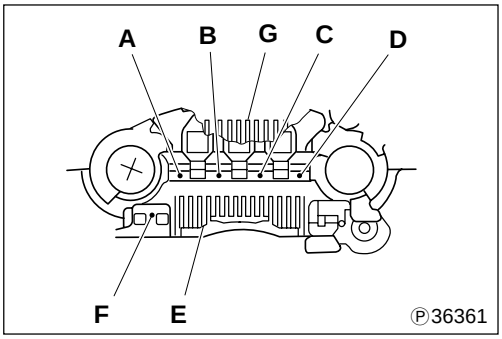
Ⓟ15270

17 Inspection of rectifier

- Check the function of diodes within rectifier **17** function properly. If any fault is found, replace the rectifier.

  If resistance is infinite in both cases, the diode is open.
  If resistance is close to 0Ω in both cases, the diode is shorted

  A, **B**, **C**, **D** : Lead connecting area of stator coil
  E, **G** : Heat sink area
  F : Regulator connecting area



Ⓟ36361

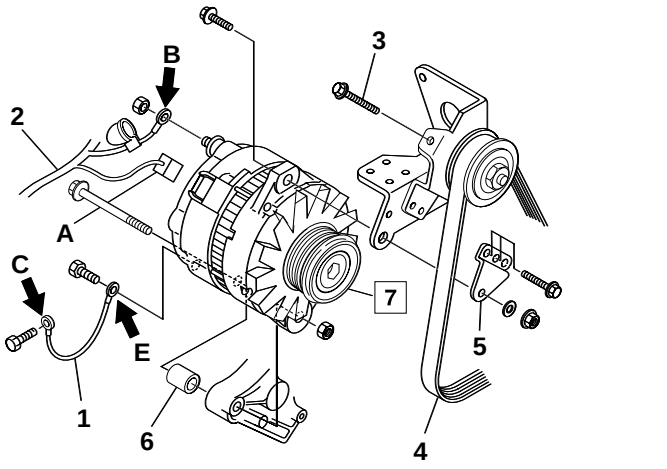
- Inspection should be repeated with the positive probe and the negative probe of the tester changed over.

CAUTION ⚠

When inspecting using a tester, the current flowing through rectifier 17 is smaller than usual. Therefore, an incorrect resistance value might be indicated on the tester.
Also, incorrect indication become larger as the range of the tester gets smaller. Set the tester to a largest possible scale.

940 ALTERNATOR

< 4M5 >



Ⓟ34708

● **Removal sequence**

1 Ground cable
2 Chassis harness
3 Adjusting bolt
4 V-belts
5 Adjusting plate
6 Spacer
7 Alternator 🕮 P54-12-42

A : To terminals L and R
B : To terminal B
C : To crankcase
E : To terminal E

WARNING ⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing alternator 7.
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.

● **Installation sequence**

Follow the removal sequence in reverse.

● **Adjustment after installation**

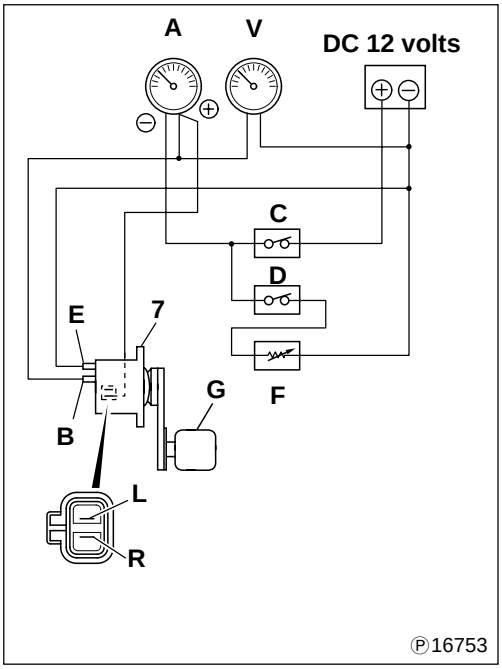
For adjustment of V-belt 4 tension
🗀 Gr 14

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
7	Alternator output current (*When alternator is hot and producing 13.5V)	At 1500 rpm	53A or more	—	Inspect
		At 2500 rpm	84A or more	—	
		At 5000 rpm	102A or more	—	
	Adjustment voltage of regulator (At 5000 rpm, 5A or less load)		14.7±0.3V	—	Replace

*The hot condition is the one after the alternator has been run at normal ambient temperature with 5000 rpm and maximum output for 30 minutes.

◆ Service procedure



7 Inspection of alternator

(1) Alternator performance check (bench test)

- Connect the alternator **7** as shown.

CAUTION⚠

Sufficiently thick wires should be used for wiring and each connection should be securely fastened.

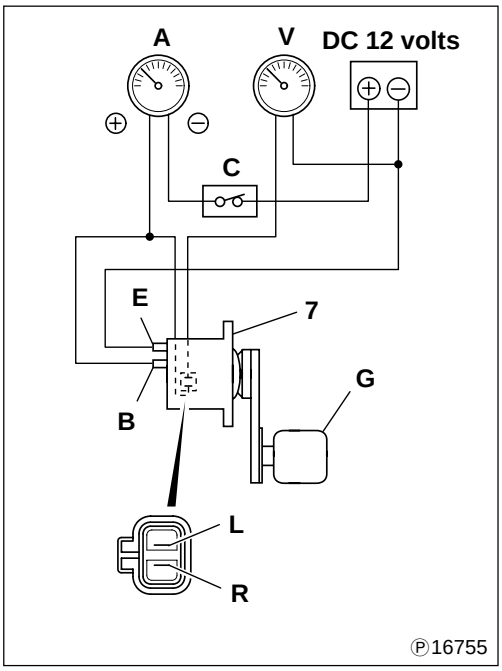
A : Ammeter
B : Alternator terminal B
C : Switch
D : Switch
E : Alternator terminal E
F : Load resistance (variable resistance)
G : Alternator drive motor
L : Alternator terminal L
R : Alternator terminal R
V : Voltmeter

- Increase load resistance **F** to the maximum (condition which the load current hardly flow).
- Turn switches **C** and **D** ON.
- Run alternator at 5000 rpm for 30 minutes by adjusting load resistance **F** so that electric current can conform to the current specified in the service standard.

  Alternator nominal current

12V-100A

- Measure the current at each specified revolution of alternator **7**.
- If the measured value deviates from the standard value, disassemble and check alternator **7**. 📖 P54-12-42



(2) Regulator performance check (bench test)

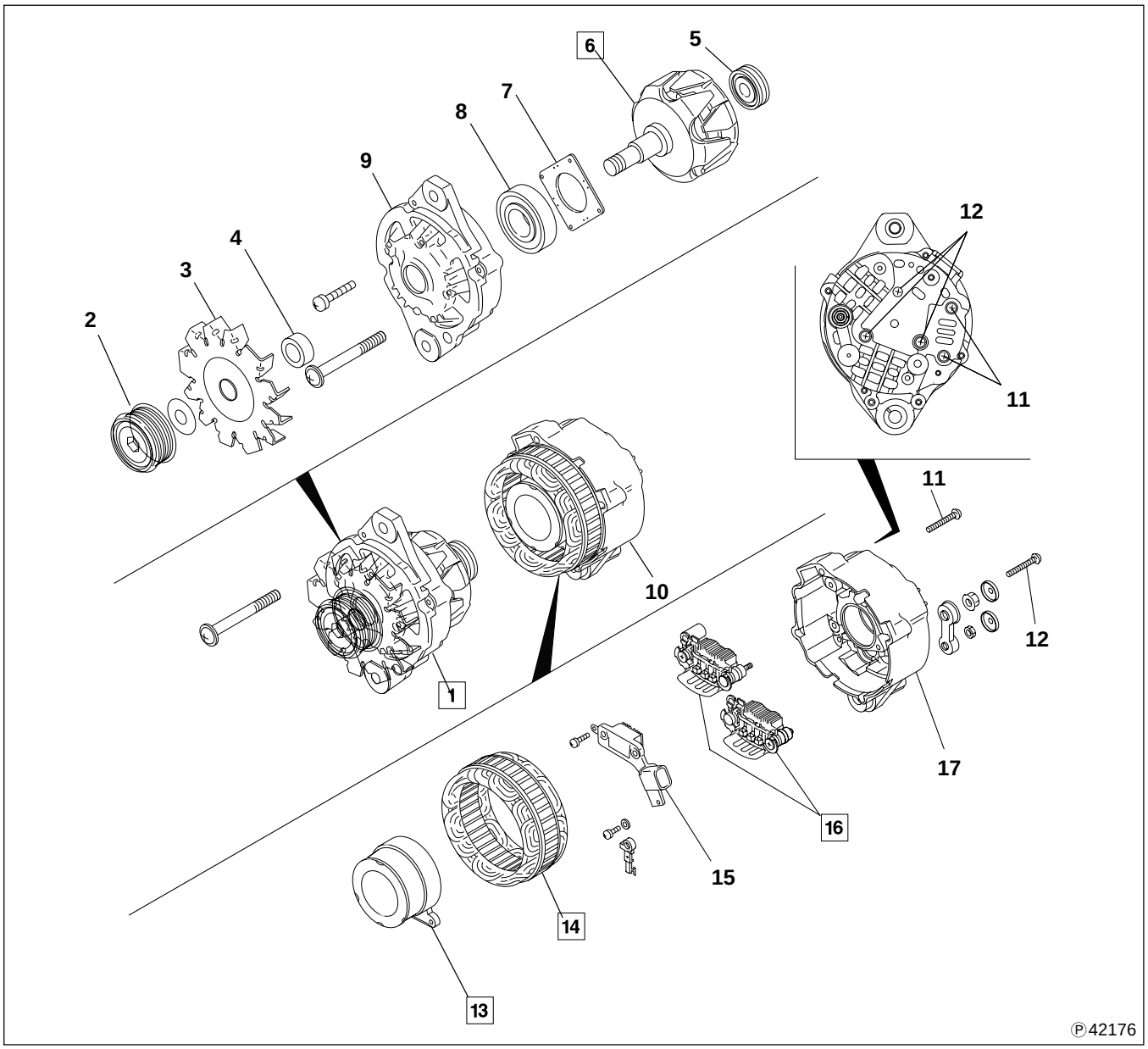
- Connect the alternator **7** as shown.

A : Ammeter
B : Alternator terminal B
C : Switch
E : Alternator terminal E
G : Alternator drive motor
L : Alternator terminal L
R : Alternator terminal R
V : Voltmeter

- Turn switches **C** ON.
- Run alternator **7** at low speeds.
- Increase the speed of alternator **7** to 5000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 5 amperes or less at 5000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If lower than the standard value: Inspect the alternator related parts before replacing the regulator.

940 ALTERNATOR

< 4M5 >



● **Disassembly sequence**

1 Rotor and front bracket assembly
2 Pulley
3 Fan
4 Spacer
5 Rear bearing
6 Rotor assembly
7 Cover
8 Front bearing
9 Front bracket
10 Stator and rear bracket assembly
11 Screw
12 Screw
13 Field coil
14 Stator assembly
15 Regulator
16 Rectifier
17 Rear bracket

NOTE

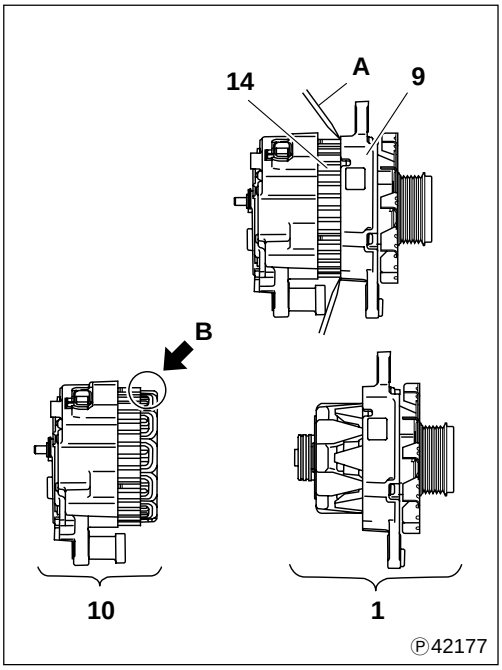
Do not remove parts 5, 8, 14 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
13	Field coil resistance (20°C {68°F})	2.0 to 2.4 Ω	—	Replace



◆ Service procedure

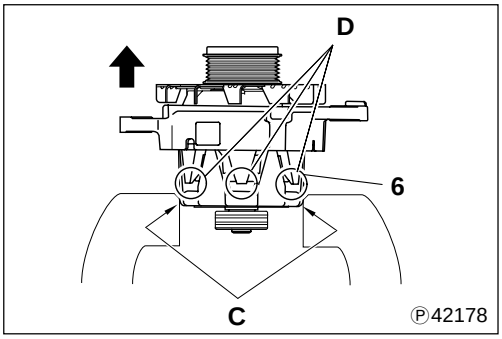
1 Rotor and front bracket assembly

[Removal]

- Insert a screwdriver **A** between front bracket **9** and stator assembly **14**.
- Use the screwdriver **A** to pry rotor and front bracket assembly **1** away from stator and rear bracket assembly **10**.

CAUTION ⚠

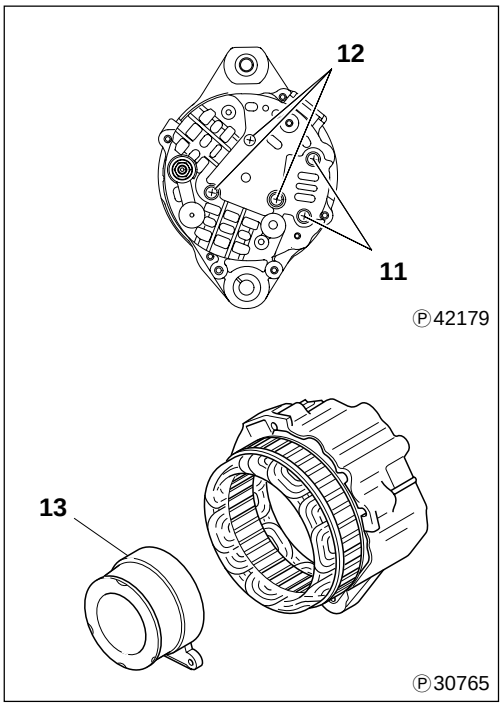
Be careful not to insert the screwdriver A too deep or it will damage coil B of stator assembly 14 and might cause a short-circuit.



[Disassembly]

CAUTION ⚠

Make sure, when you hold rotor assembly 6 in a vise, to grip root C of the core claws. Gripping claws D can damage them.



13 Field coil

[Removal]
- Remove screw **11** (2 places).

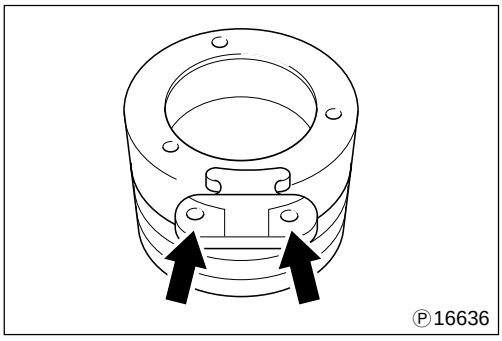
CAUTION
If screw 12 are removed first, the weight of field coil 13 may be placed on the joining portion with regulator 15 which is fixed with screw 11, causing break of the joining portion. To avoid this, remove screw 11 first.

- Remove screw **12** (3 places).

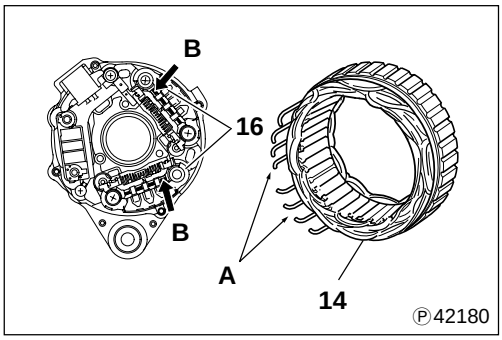
CAUTION
If screw 12 are removed, field coil 13 falls under its own weight. Keep the field coil supported by your hand.

- Remove field coil **13**.

CAUTION
Do not take out field coil 13 forcibly. Otherwise the joining portion with regulator 15 may be caught by the stator coil.



[Inspection]
- Measure the resistance between the terminals of field coil **13**.
- If the measured value deviates from the standard value, replace field coil **13**.

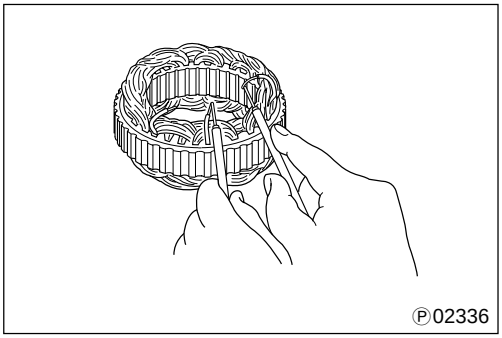


14 Stator assembly

[Removal and installation]
- Disconnect lead **A** of stator assembly **14** from rectifier **16**. The lead is soldered to diode **B** of the rectifier at 8 places. (Each of the 2 rectifiers has 4 soldered sections.)

CAUTION
Unsolder within as short a time as possible (within 5 seconds), or diode can be easily damaged by heat.

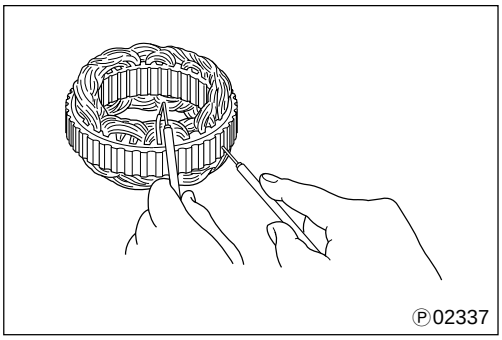
- To install, follow the removal sequence in reverse.



[Inspection]

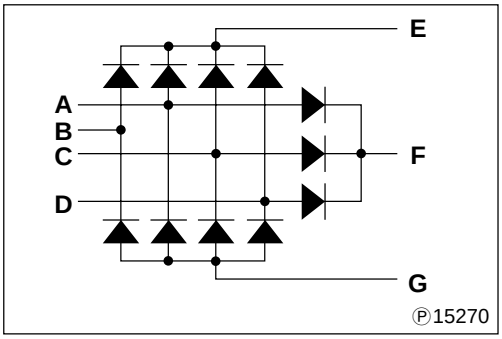
(1) Continuity between each lead wire

- Check that there is continuity between each stator lead.
- If there is no continuity, the lead is broken. Replace stator assembly **14**.



(2) Continuity between each lead wires and the core

- Check that there is no continuity between lead wires and the core.
- If there is continuity, the lead wires is short-circuited. Replace the stator assembly **14**.

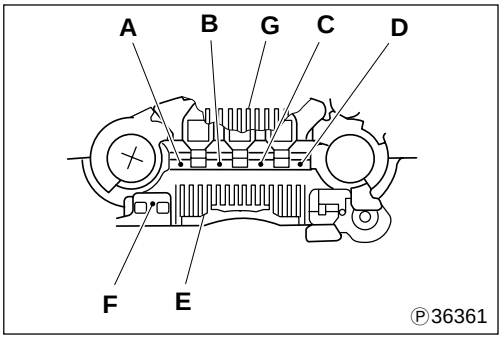


16 Inspection of rectifier

- Check the function of diodes within rectifier **16** properly. If any fault is found, replace the rectifier.

  If resistance is infinite in both cases, the diode is open.
  If resistance is close to 0Ω in both cases, the diode is shorted

  A, **B**, **C**, **D** : Lead connecting area of stator coil
  E, **G** : Heat sink area
  F : Regulator connecting area



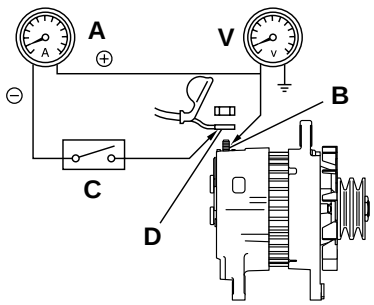
- Inspection should be repeated with the positive probe and the negative probe of the tester changed over.

CAUTION ⚠

When inspecting using a tester, the current flowing through rectifier 16 is smaller than usual. Therefore, an incorrect resistance value might be indicated on the tester.
Also, incorrect indication become larger as the range of the tester gets smaller. Set the tester to a largest possible scale.

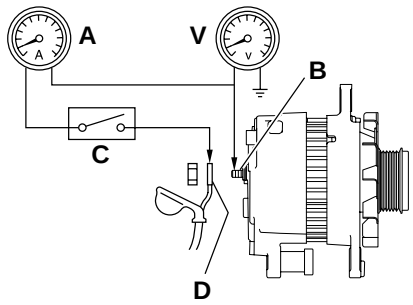
950 INSPECTION OF ALTERNATOR

< 6D3 >



Ⓟ42489

< 4M5 >



Ⓟ42490

Performance test

- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn on switch **C** and make sure that voltmeter **V** indicates battery voltage.
- Start the engine.
- Immediately turn on the switches for all lamps on the vehicle.
- Immediately accelerate the engine to 2300 rpm < 6D3 >, 2100 to 2400 rpm < 4M5 >, and measure the intensity of the current.

- The alternator is considered to be good if the measured value is 70% or more of the nominal output current.
  Alternator nominal output

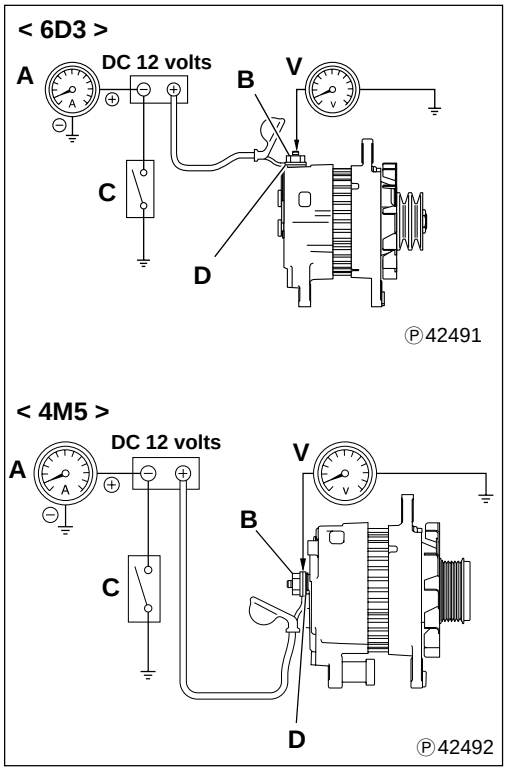
Voltage	Output current
12V	100A

NOTE

The on-vehicle inspection is only a simplified check. Use a test bench for accurate checking. 940

Service standards

Location	Check item	Standard value	Limit	Remedy
—	Regulator adjusting voltage	14.7 ± 0.3V	—	Replace



- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING⚠

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn off the switches for lamps, heater, etc. so that electric loads may not be applied during the inspection.
- Turn on switch **C** and then start the engine.
- If the output current is 5 amperes or less when the engine speed is approx. 2300 rpm < 6D3 >, 2400 rpm <4M5 >, measure the voltage at terminal **B**.
- If the output current is 5 amperes or more, do one of the following:
  - Run the engine for a while to charge the battery.
  - Replace the battery with a fully-charged one.
- If the measured value deviates from the standard value, conduct checking again on the test bench.

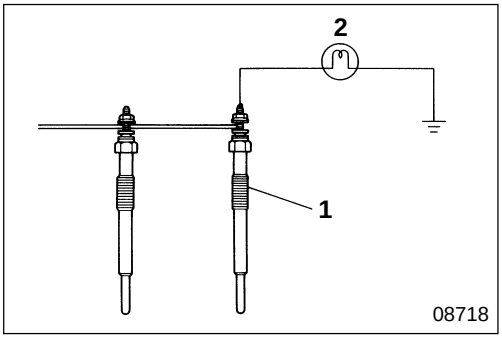
13 ON-VEHICLE INSPECTION AND ADJUSTMENT

955 INSPECTION OF PREHEATING SYSTEM

Service standards

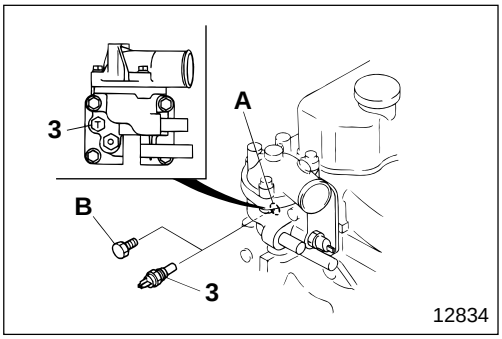
Location	Maintenance item			Standard value	Limit	Remedy
—	Pre-glow time	Coolant temperature	60°C {140°F} or more	Does not pre-glow	—	Inspect
			0 to 60°C {32 to 140°F}	About 12 seconds	—	
			*15 to 60°C {59 to 140°F}			
			0°C {32°F} or less	About 12 seconds	—	
			*15°C {59°F} or less			
	After-glow time	Coolant temperature	60°C {140°F} or more	Does not after-glow	—	
			0 to 60°C {32 to 140°F}	Does not after-glow	—	
			*15 to 60°C {59 to 140°F}			
			0°C {32°F} or less	About 20 seconds	—	
			*15°C {59°F} or less	*About 180 seconds	—	
	Indicator lamp ON time	Coolant temperature	60°C {140°F} or more	Does not illuminate	—	
			0 to 60°C {32 to 140°F}	Does not illuminate		
			*15 to 60°C {59 to 140°F}			
			0°C {32°F} or less	About 8 seconds	—	
			*15°C {59°F} or less			

* FH211 Produced September 2002 onward.

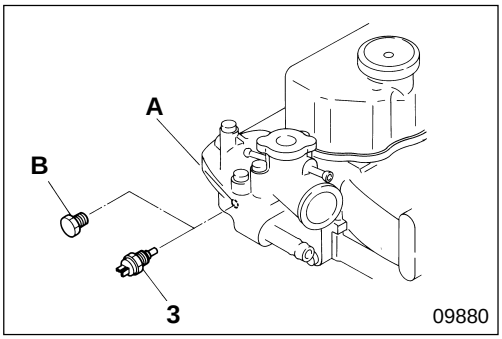


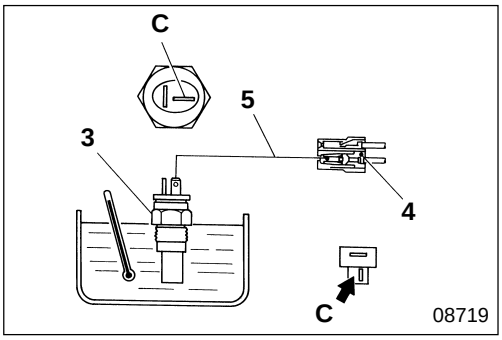
- Turn the starter switch to OFF.
- Connect a check lamp **2** to the glow plug **1** as shown.

< 6D3 >



< 4M5 >





- Remove the water temperature sensor **3** from the engine, and close the sensor mounting hole **A** with the plug **B** (M16 × 1.5 mm).
  Removal and installation of the water temperature sensor **3** Gr 14.

- Connect the extension harness **5** between the water temperature sensor **3** and connector **4**.

NOTE

Connect the extension harness 5 to the terminal C on the MUTIC (multipurpose timing control unit).

- Put water temperature sensor **3** into a container filled with water.
- Carry out the following inspection while changing the water temperature in the container. If any fault is found, inspect each unit.

(1) Inspection of pre-glow time and indicator lamp lighting time

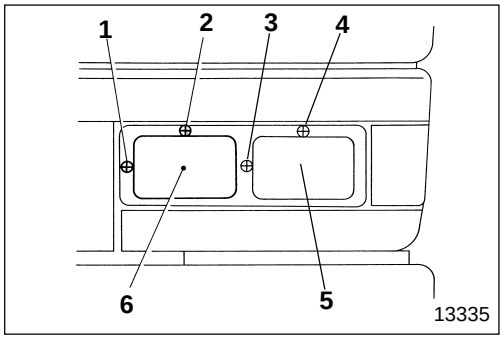
Turn the starter switch ON but do not start the engine. Make sure that the pre-glow time and the indicator lamp lighting time at each water temperature conform to the standard value.

- For pre-glow time inspection, measure the lighting time of inspection lamp **2**.
- For indicator lamp lighting time inspection, measure the lighting time of lamp within the meter cluster directly.

(2) Inspection of after-glow time

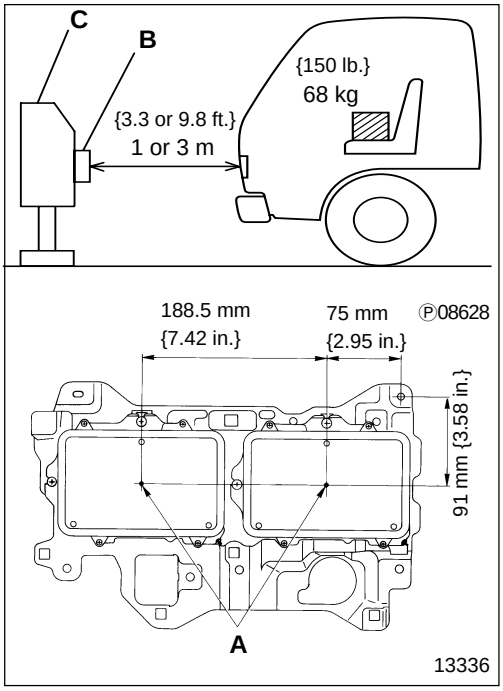
Start the engine and measure the lighting time of inspection lamp **2** from the point lamp within the meter cluster goes off, and make sure that the after-glow time conforms to the standard value.

960 HEADLAMP AIMING



1 Screw (Main beam, horizontal adjustment)
2 Screw (Main beam, vertical adjustment)
3 Screw (Dipped beam, horizontal adjustment)
4 Screw (Dipped beam, vertical adjustment)
5 Dipped beam

To adjust the headlamp move the optical axis of Main beam **6** by turning screws **1, 2** and move the optical axis of Dipped beam **5** by turning screws **3, 4**. You need to adjust the aiming of both the Main and the Dipped beams on both the left and right headlamps.



(1) Preparation before adjustment

- Park the vehicle on a level place.

WARNING

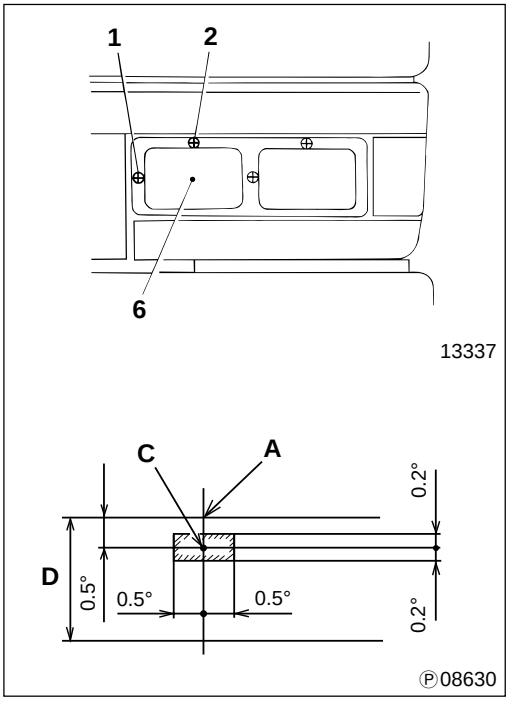
Be sure to put tire chocks securely in place.

- Unload the vehicle and make sure no one is in it.
- Inflate the tires to the specified pressure. Gr 31
- Seat one person of an equivalent mass (68 kg {150 lb.}) in the vehicle.
- Start the engine and check that the battery is being charged.
- Place convergent headlamp tester **C** in line with Main beam 6 or Dipped beam **5** of either the left or right headlamp at a distance of 1 m {3.3 ft.} or 3 m {9.8 ft.}.
- Align the center of convergent lens **B** of convergent headlamp tester **C** with lamp center **A** of Main beam **6** or Dipped beam **5**. (The illustration shows a left headlamp.)
- When adjusting one headlamp, mask the other to avoid light leakage.

(2) Adjustment

WARNING

Do not mask a lit headlamp for more than 10 minutes or the heat generated might cause a fire.



● **Adjustment of Main beam unit**

- Turn on Main beam **6**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Main beam **6** is located as shown:
  - Vertical adjustment: Turn screw **2** to adjust.
  - Horizontal adjustment: Turn screw **1** to adjust.

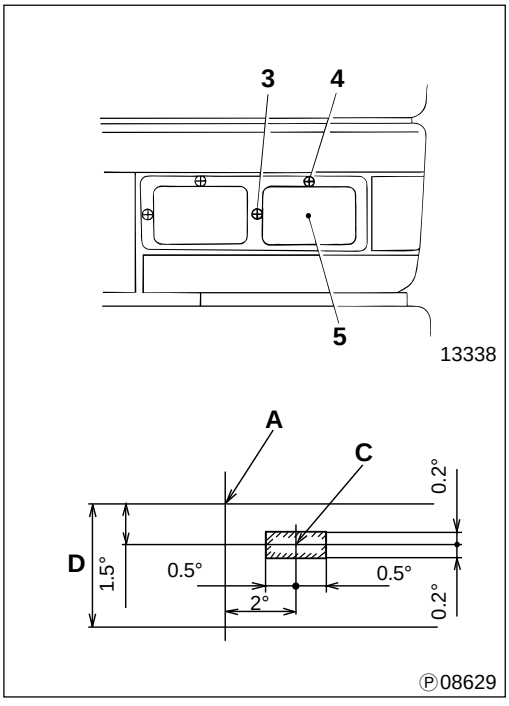
  The aiming of both left and right Main beams **6** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of headlamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 1	—	—	(Counter-clockwise)	(Clockwise)
Screw 2	(Clockwise)	(Counter-clockwise)	—	—

Turning direction of the screws in the table is as viewed from the front.



● **Adjustment of Dipped beam unit**

- Turn on the Low beam of Dipped beam **5**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Dipped beam is located as shown:
  - Vertical adjustment: Turn screw **4** to adjust.
  - Horizontal adjustment: Turn screw **3** to adjust.

  The aiming of both left and right Dipped beams **5** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of lamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 3	—	—	(Counter-clockwise)	(Clockwise)
Screw 4	(Clockwise)	(Counter-clockwise)	—	—

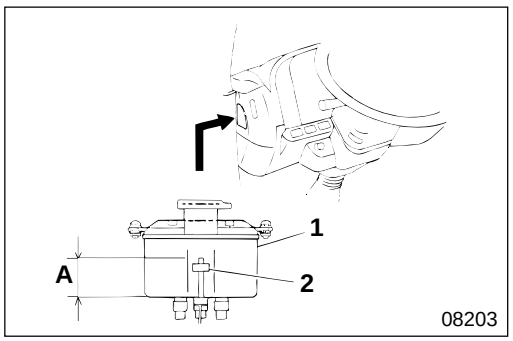
Turning direction of the screws in the table is as viewed from the front.

965 INSPECTION OF BRAKE FLUID LEVEL SWITCH

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Warning lamp lighting position for brake fluid level switch	41.0 ± 3 {1.61 ± 0.12}	—	Replace



- Start engine.
- Drain the brake fluid gradually from fluid tank assembly **1**.

CAUTION

If brake fluid is spilt on any part of the vehicle, wipe it off immediately, since the solvent in the fluid can damage the paintwork.

- Measure height **A** of brake fluid level switch **2** when BRAKE warning lamp within the meter cluster lights.
- If the measured value deviates from the standard value, remove and check fluid tank assembly **1**.

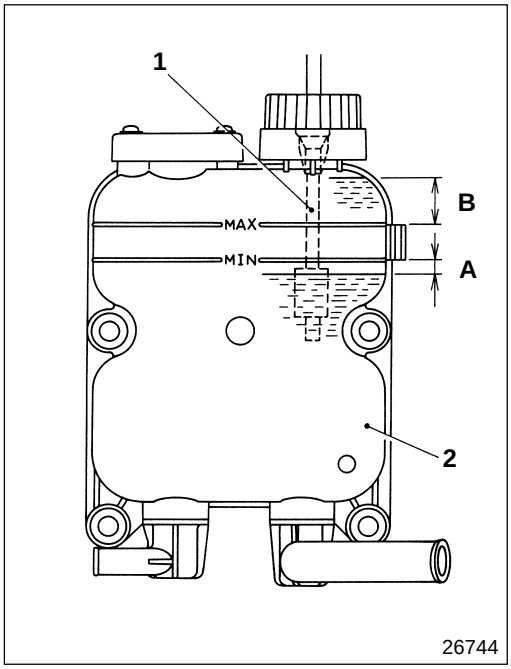
Removal and installation : Gr 42

Inspection : 041

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Warning lamp lighting position for power steering fluid level sensor	Height from oil tank MIN level to fluid surface	15 {0.59}	—	Replace
		Height from oil tank MAX level to fluid surface	25 {0.98}	—	



Perform the following check and if any fault is found, remove and inspect power steering fluid level sensor **1**.

Removal and installation : Gr 37

Inspection : **270**

Perform inspection by turning the starter switch ON and determining the power steering fluid level when BRAKE warning lamp within the meter cluster lights (buzzer sounds at the same time).

(1) Inspection procedure when the power steering fluid level is low

- Drain the power steering fluid gradually from power steering oil tank **2**.
- Inspect to make sure that, when BRAKE warning lamp is lit, height **A** from power steering fluid surface to the **"MIN"** level of power steering oil tank **2**, is within the standard value.

(2) When power steering fluid level is too high

- Supply power steering fluid gradually into power steering oil tank **2**.
- Inspect to make sure that, when BRAKE warning lamp is lit, height **B** from power steering fluid surface to the **"MAX"** level of power steering oil tank **2**, is within the standard value.

MITSUBISHI
FUSO

Group 55A
Air-conditioner
< 6D34 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-55A

FOREWORD

This service manual describes the maintenance deta consisting of constructive & outline, inspection, and repair service of MITSUBISHI FUSO GENUINE TRUCK CAB AIR CONDITIONER

Table of contents

1. SPECIFICATIONS ---- 1
2. OUTLINES OF REFRIGERATION SYSTEM ---- 2
3. CONSTRUCTION ---- 4
4. TROUBLE SHOOTING ---- 12
5. REMOVAL AND INSTALLATION ---- 19
6. TREATMENT AFTER INSTALLATION ---- 22
7. MAINTENANCE ---- 28
8. COOLING UNIT ASSEMBLY ---- 29
9. COMPRESSOR & CLUTCH ASSEMBLY ---- 31

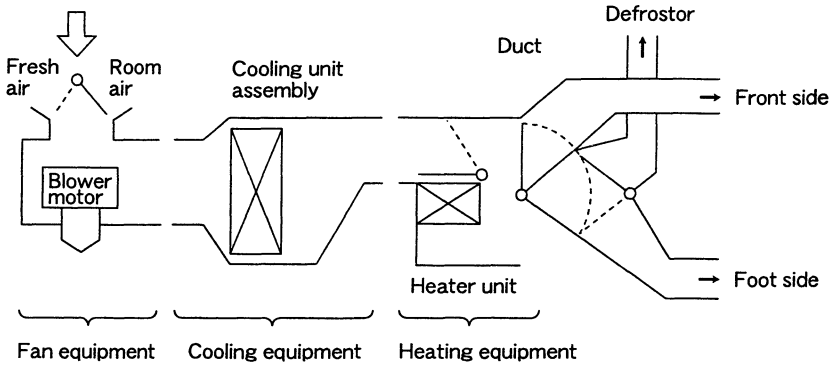
1. SPECIFICATIONS

Item			Specification
Vehicle model			FH 2003
* Cooling capacity (on JIS conditions)			4,200W
Compressor	Model		MSC90T
	Displacement		90cm³
	Maximum revolution		MAX 9,000min^{-1}
	Compressor oil		SUN PAG 56, 120cm³
Magnetic clutch	Type		Dry single disc magnet
	Voltage & input		DC12V, 38W
Cooling unit assembly	Type		Laminated fin type
Controls	Air flow control		Rotary switch, Four step type
	Temperature control		Air mix control
Condenser	Type		Corrugate fin type
Receiver assembly			Cylinder type, approx 350cm³
Protective equipment	Frost prevention (Thermostat)		OFF : 0.5℃ ON : 3.5℃
	Releif valve		Open : 3.50~4.10MPa Close : 2.94MPa
	Dual pressure switch	Low pressure switch	OFF : 0.2MPa ON : 0.22MPa
		High pressure switch	OFF : 2.94MPa ON : 2.35MPa
	Fuse (Fan equipmemt) Fuse (Magnetic clutch)		10A 10A
Refrigerant and quantity			HFC-134a, 23oz

- The * marked cooling capacity is based on JIS conditions.
- Compressor speed : 1,800min^{-1}
- Condensing temperature : 55℃
- Cooling unit inlet air dry bulb temperature : 27℃
- Cooling unit inlet air wet bulb temperature : 19.5℃
- Terminal voltage :DC24V

2. OUTLINES OF REFRIGERATION SYSTEM

2.1 Air system



Cooling operation

Fresh air is induced to the cooling unit assembly by a blower fan, where it is cooled down and dehydrated, charged at the front side outlet through a duct.

Heating operation

Fresh air is induced to the heater unit by a blower fan through the cooling unit assembly, where it is heated, then discharged at the foot side outlet through a duct.

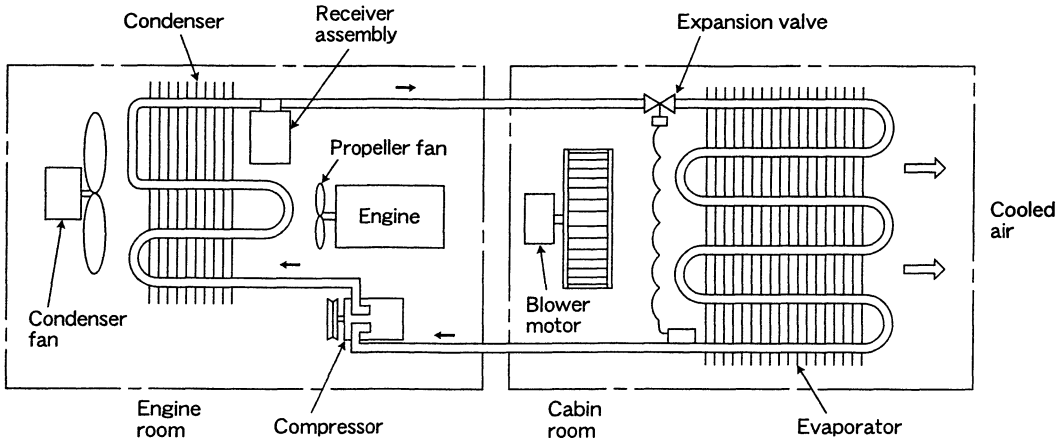
Dehumidifying operation

Fresh air is induced to the cooling by a blower fan, where it is cooled down and dehydrated, and succeedingly to the heater unit for warming, then discharged at the front side outlet through a duct.

Temperature control

Cooled air and warmed air are mixed for temperature control of the room inside.

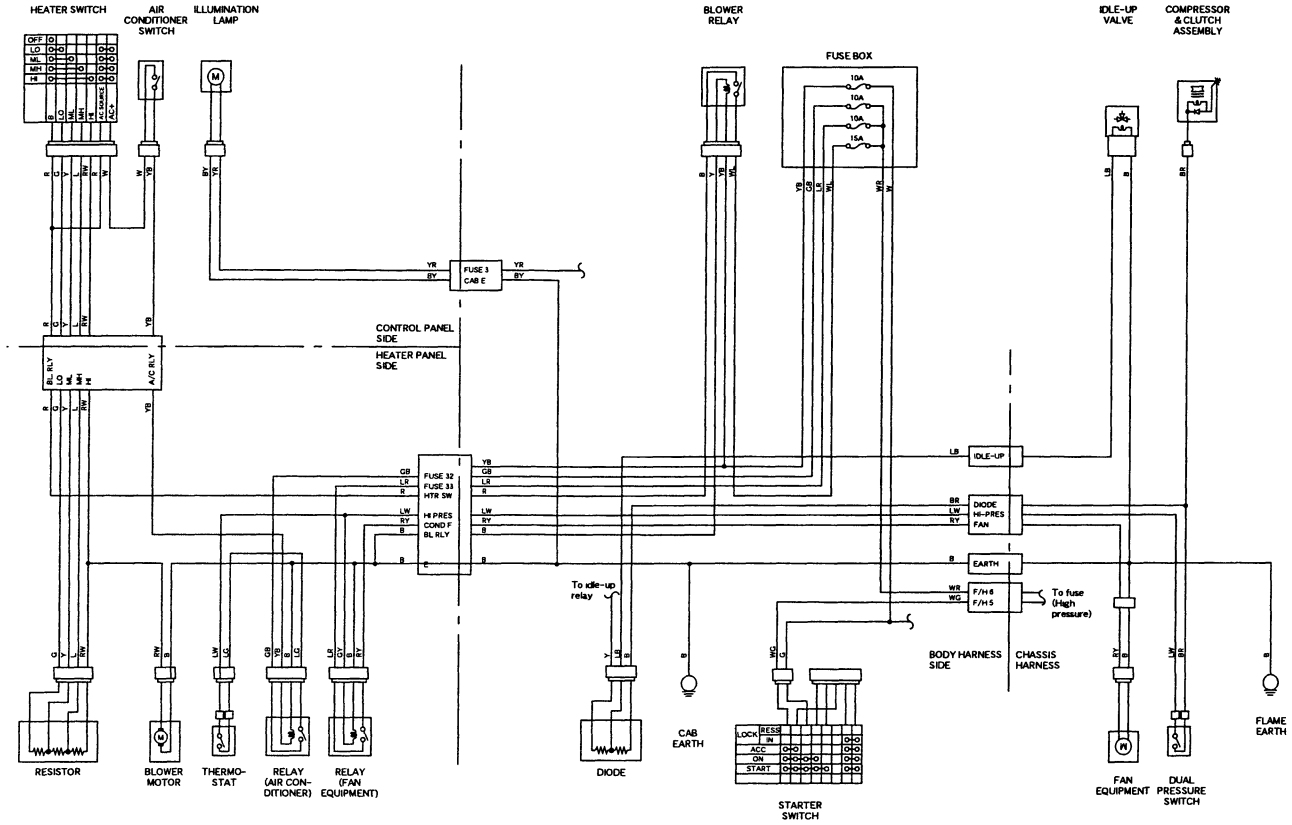
2.2 Refrigerating circuit



While the refrigerant, HFC-134a is cooling the air drawn into the evaporator, it evaporates and becomes a gas. This gas is compressed to high pressure and temperature in the compressor, and sent into the condenser, where it is cooled and becomes liquid.
This cooling in the condenser is carried out by the open air passing through the condenser sucked by radiator fan and vehicle motion of the vehicle.
The liquid refrigerant flows through the receiver assembly where water and dirt are removed, and then it enters the expansion valve. Here the liquid refrigerant is throttled and changed to a mixture of liquid and gas in low temperature and low pressure, and is sent to the evaporator.

In the evaporator, the refrigerant absorbs heat from the surroundings and becomes a gas. That is, because the evaporator it self is cooled at this time, the return air to the cooling unit assembly is cooled,
and the interior of the vehicle becomes cool. In this way the refrigerant flow makes a complete circuit.

2.3 Electrical system



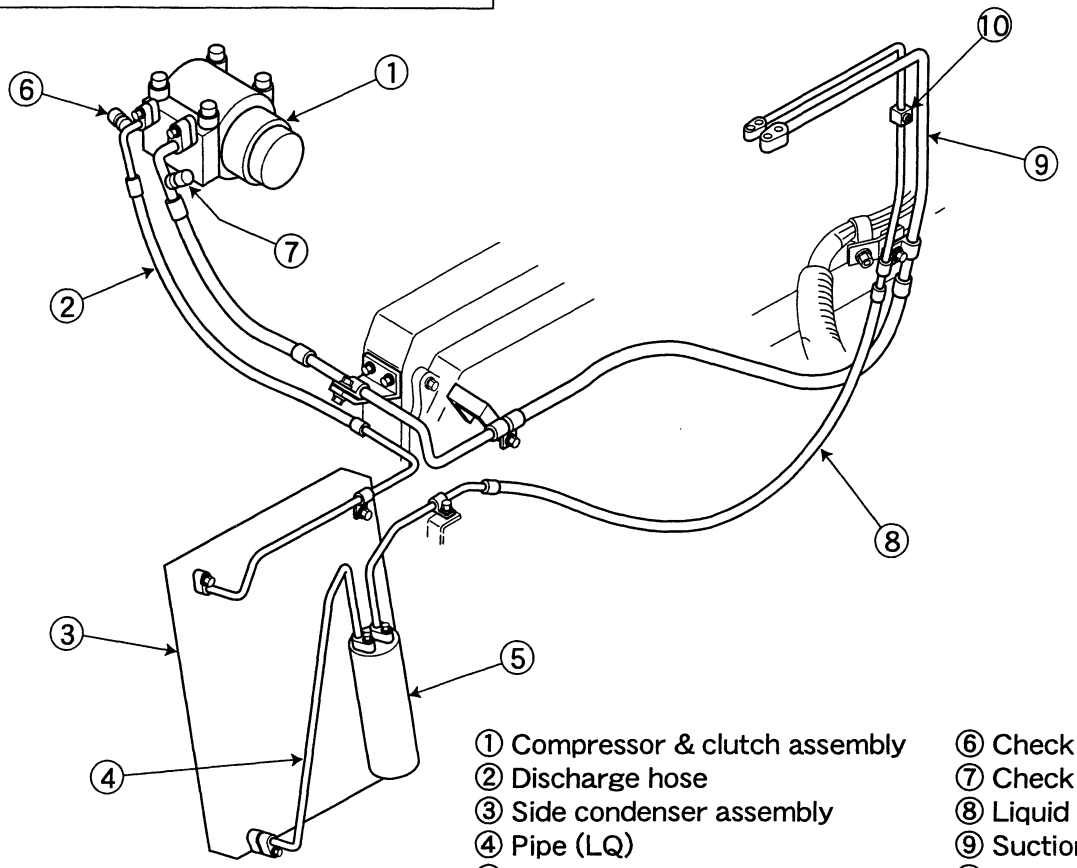
The power source is supplied from the TRUCK battery. When the blower switch is put ON, the power relay becomes ON, and electricity is connected to the magnetic clutch of the compressor. The magnetic clutch switches ON or OFF by air conditioner switch, fin thermo, and low pressure switch as the controls for operation service, or safety protection.

The cabin room air temperature is set to a preset point by adjusting the temperature control lever, and the opening degree of the air mix damper.

3. CONSTRUCTION

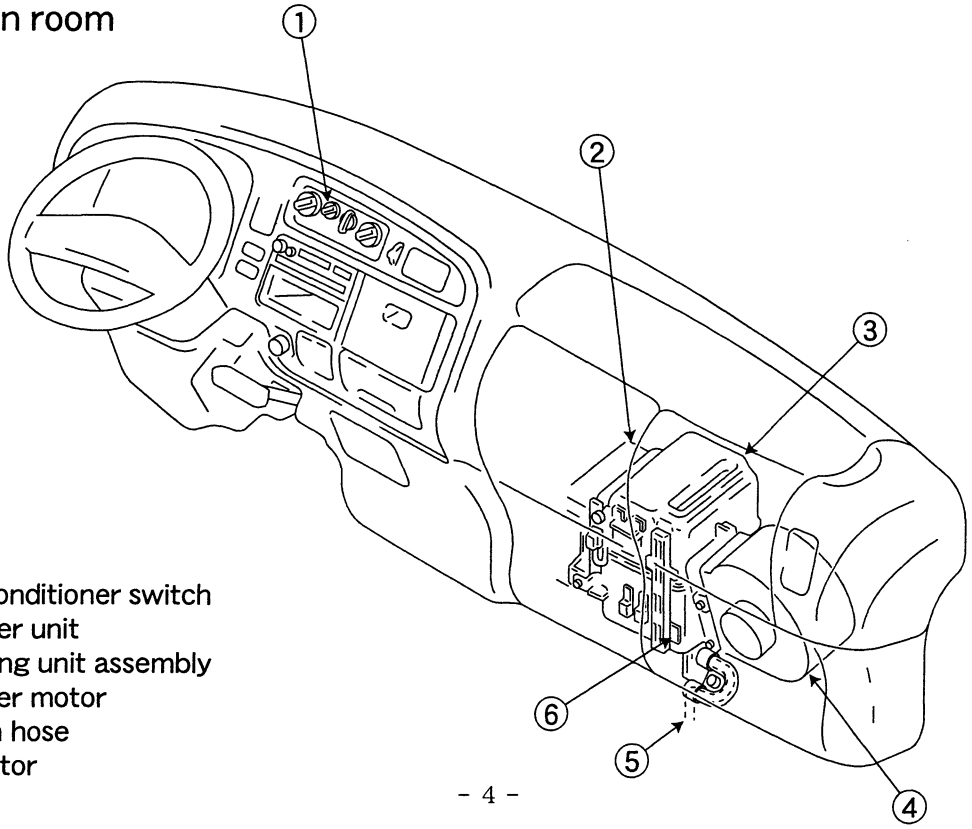
3.1 Engine room

A figure is a 6D34 engine loading car.



① Compressor & clutch assembly
② Discharge hose
③ Side condenser assembly
④ Pipe (LQ)
⑤ Receiver assembly
⑥ Check valve (HP)
⑦ Check valve (LP)
⑧ Liquid hose
⑨ Suction hose
⑩ Sight glass

3.2 Cabin room



① Air conditioner switch
② Heater unit
③ Cooling unit assembly
④ Blower motor
⑤ Drain hose
⑥ Resistor

3.3 Control system

(1) Control in panel

Do not run the air conditioner when it is child.

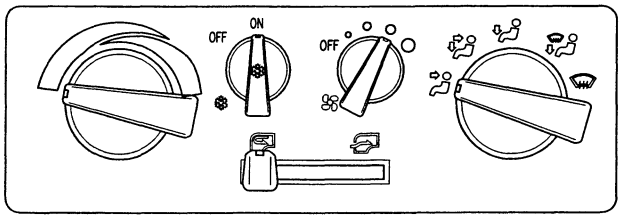
☐ Air conditioner switch
By select the air conditioner switch initially in cooling or drying operation, the compressor starts running.

☐ Fan switch
The air flow is selectable, out of the below four volume.

OFF	No air flow
◦	Gentle
o	Low
o	Medium
O	High

☐ Air outlet mode select switch
The air outlet is selected by positioning in cooling and heating operation.

- ----- The conditioned air is discharged at the center and both side outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the center and both side and foot outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the foot outlets directed by the louvers as reguired.
- ----- The conditioned air for dehumidifying is discharged at the foot outlets and to the front glass.
- ----- The conditioned air for dehumidifying is discharged to the front glass.



☐ Temperature control switch
The discharged air temperature is controllable by selecting the position of the control lever in cooling, heating or drying operation.

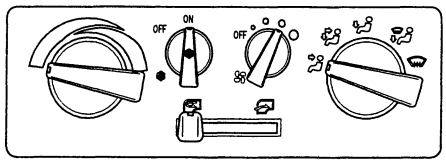
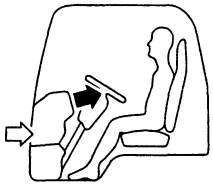
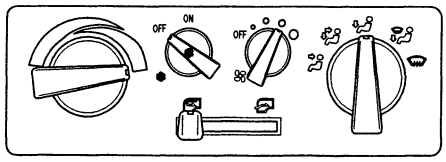
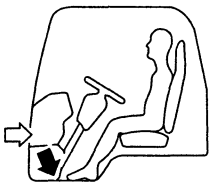
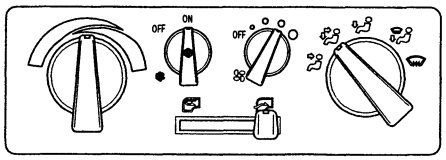
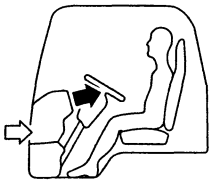
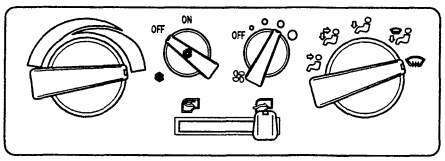
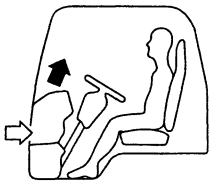
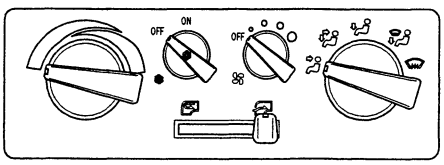
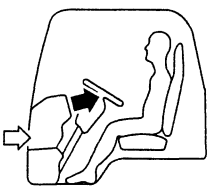
BLUE ZONE ------ For cool air flow
RED ZONE ------- For warm air flow

By turning the switch toward the BLUE and RED ZONE sides, the supply air temperature becomes more cooler and warmer respectively.

☐ Shift lever, air circulation
The recirculation air is selectable out of the below circulation modes.

- ----- Room circulation
- ----- Fresh air intake

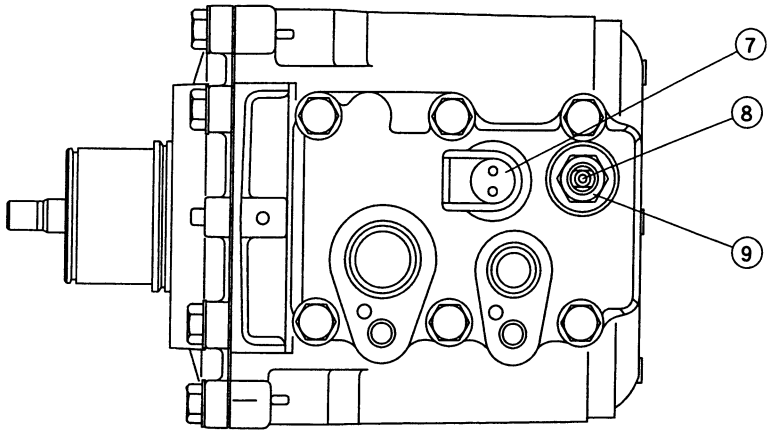
(2) Operation control

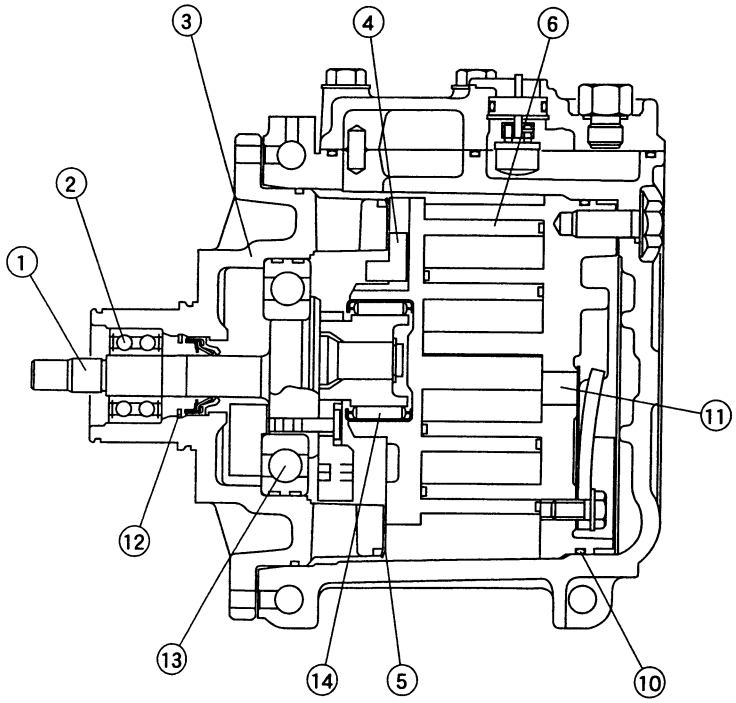
Operation mode	Setting control lever	Air delivery	Remarks
COOL			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation
HEAT			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation Air outlet mode select switch
DEHUMIDIFY			Wetty conditioning in head cooled, and foot warmed : Shift lever : Air outlet Air outlet mode select switch
DEFROST			
VENTILATION			

3.4 Compressor and clutch assembly

3.4.1 Compressor

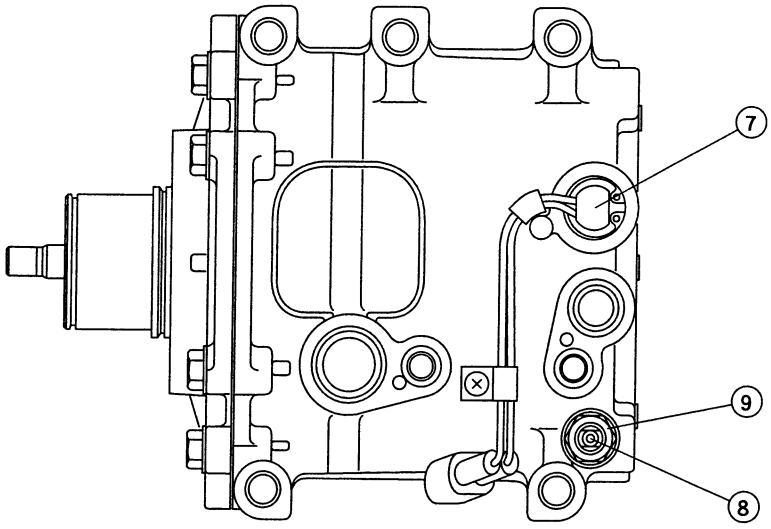
FOR 6D34

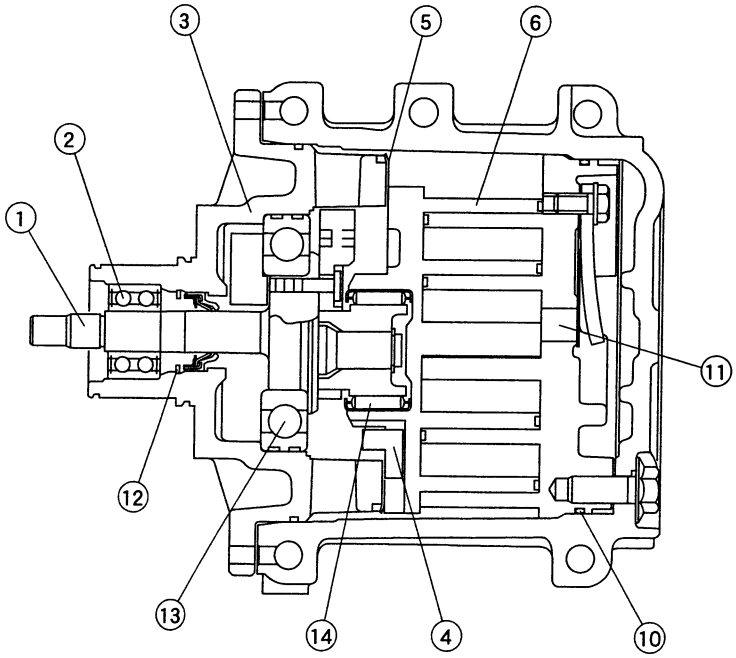




① Crankshaft
② Bearing
③ Front case assembly
④ Housing assembly
⑤ Thrust plate
⑥ Orbit scroll assembly
⑦ Thermostat
⑧ Dust seal
⑨ H/P relief valve
⑩ O-ring
⑪ Port hole
⑫ Shaft seal
⑬ Bearing
⑭ Needle bearing

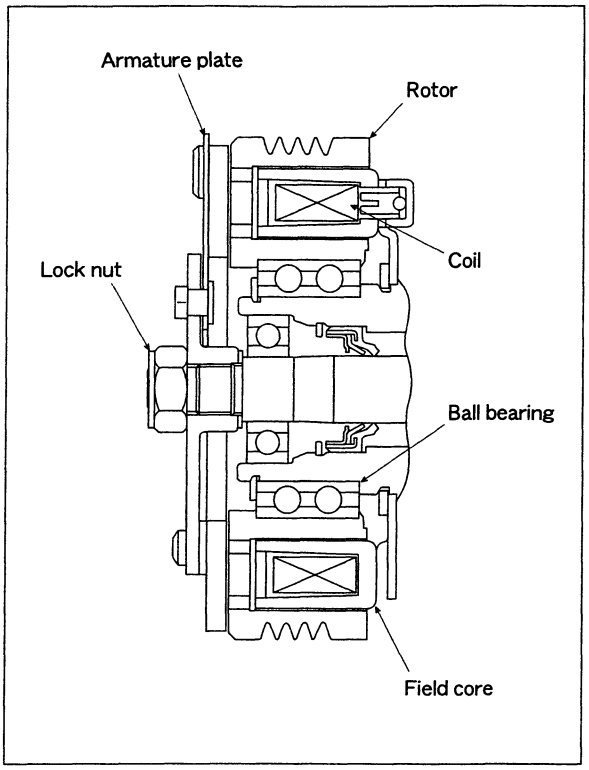
FOR 4M50T





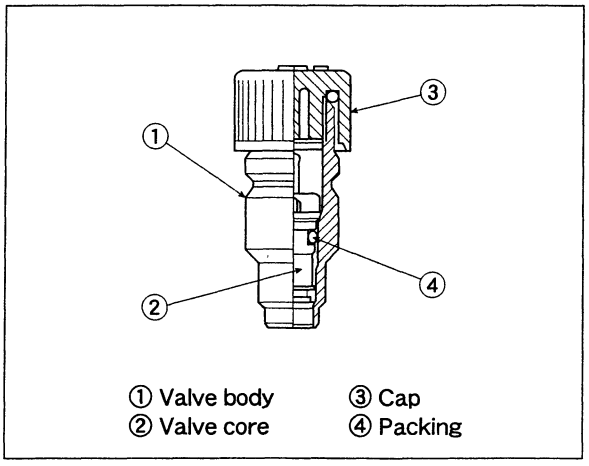
① Crankshaft
② Bearing
③ Front case assembly
④ Housing assembly
⑤ Thrust plate
⑥ Orbit scroll assembly
⑦ Thermostat
⑧ Dust seal
⑨ H/P relief valve
⑩ O-ring
⑪ Port hole
⑫ Shaft seal
⑬ Bearing
⑭ Needle bearing

3.4.2 Magnetic clutch



The magnetic clutch is mounted on the compressor crankshaft to start and stop the compressor.
This means that the magnetic clutch is actuated to control the compressor operation electrically by the thermostat.

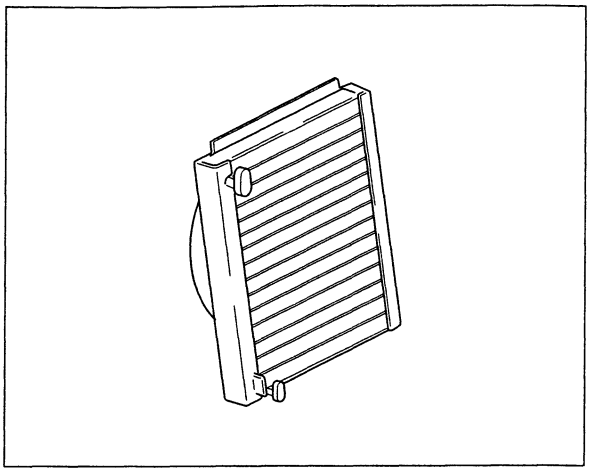
3.5 Check valve



① Valve body ③ Cap
② Valve core ④ Packing

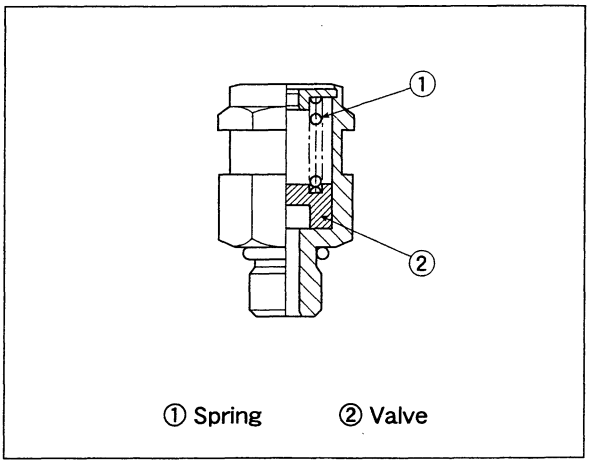
The suction hose and discharge hose are provided with check valve, and designed for gas evacuation and charging service. (shown above)
In the valves, a valve rubber tube, as in automobile tire tubes, is provided as shown in the figure.
Stackening the flare nut on the gauge manifold causes the passege to close automatically by the spring force, and tightening the flare nut causes the passege to open while pressing the compressed spring.

3.6 Side condenser assembly



The condenser is a means to liquefy the refrigerant gas. As the condenser is cooled by the air pulled in by the condenser fan, the refrigerant in the condenser is cooled into liquid. Therefore, when any obstacle prevents the air from flowing evenly to the condenser or the air flow is short circuited, the cooling effect is reduced, with a decrease in the performance of the condenser. When the vehicle is driven at a high speed, the air flow increases resulting in an increase of the cooling effect, and performance of the condenser.

3.7 Relief valve



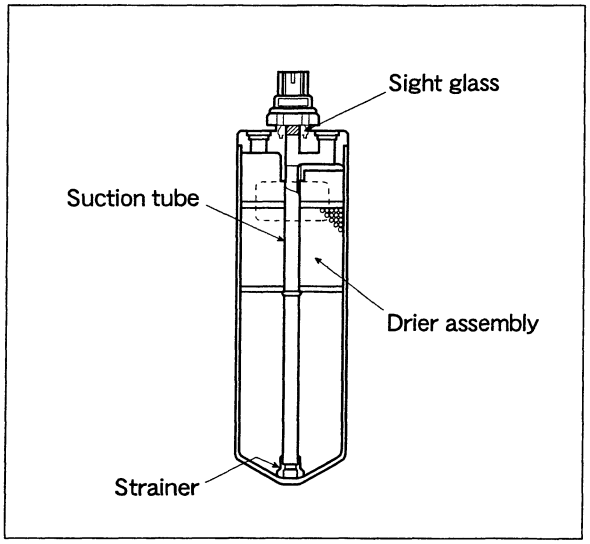
① Spring ② Valve

The relief valve is mounted to the compressor & clutch assembly. The relief valve is usually closed by spring. If pressure of refrigerant in air conditioner system is higher than spring pressure, refrigerant is discharged from relief valve. The pressure drop due to discharge refrigerant, and relief valve is closed again.

Unit : MPa

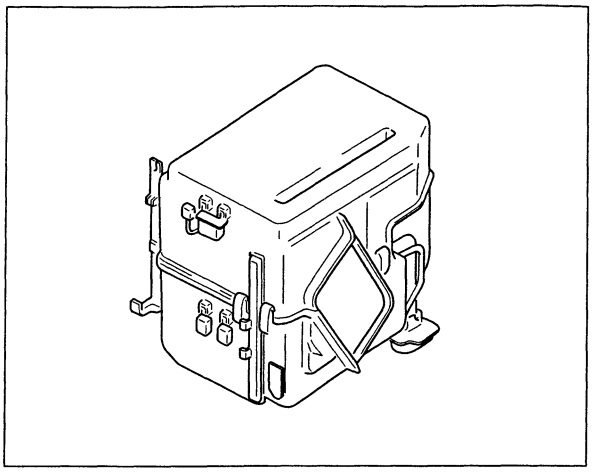
Open	3.50~4.10
Close	2.94

3.8 Receiver assembly



The receiver assembly is served as a refrigerant reservoir located between the condenser and expansion valve. The receiver assembly consists of a filter and a sight glass. The filter is used to remove dust , the drier is used to remove moisture from the refrigerant in the circuit, and the sight glass is used to check the refrigerant charge. Any moisture in the refrigerant may not only corrode metal surfaces in the refrigerant circuit, but also cause the throttle of the expansion valve to be frosted, resulting in the interruption of refrigerant circulation.
Therefore, the receiver assembly must be handled very carefully. When storing or installing it, care should be taken to protect it from the deterioration of drying performance due to exposure to the air.
The retardation of heat exchange, or any fire around the refrigerant circuit will cause excessive pressurization or heating of the refrigerant. Should such an accident occur, the refrigerant in the circuit must be expelled to the outside to prevent the above hazards.
The sight glass is a sort of peep window used to check the refrigerant flow in the refrigerant circuit.
The sight glass appears clear when the refrigerant flow is enough, and shows bubbles flowing when the refrigerant flow is short.

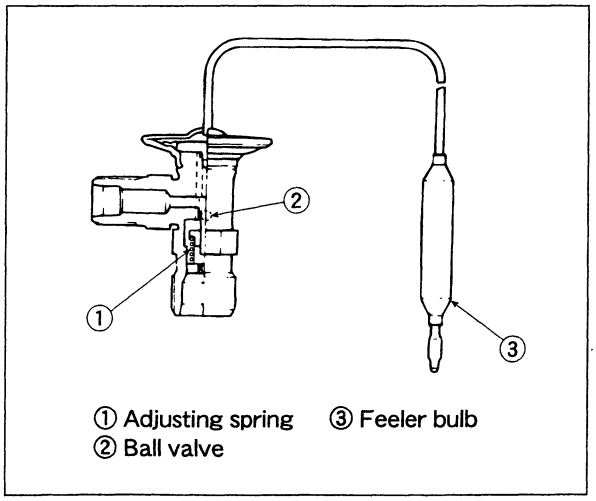
3.9 Cooling unit assembly



The evaporator core is a type of corrugated fin and tube. The tube is arranged in zigzag to achieve high effciency, and to make the core system compact.
A thicker reinforced plastic plate is used as the enclosure to inclease heat and shock resistance, and to protect the core from humidity. This case is a split type, and in a simple design to facilitate installation on the floor panel and the instrument panel frame of the vehicle.

3.10 Expansion valve

The expansion valve is mounted at the inlet of the cooling unit. The liquid refrigerant from the receiver is led to it through a narrow passage (for throttle action), where-in, the liquid refrigerant is condensed with pressure dropping and at the same time the flow rate is adjusted before the refrigerant is sent to the cooling unit.
The refrigeration load in the cooling unit is not constant, but usually fluctuates over a certain range. So the refrigerant flow should under go the control in design.
An automatic expansion valve performs this function automatically. The air condenser uses a thermal type automatic expansion valve.



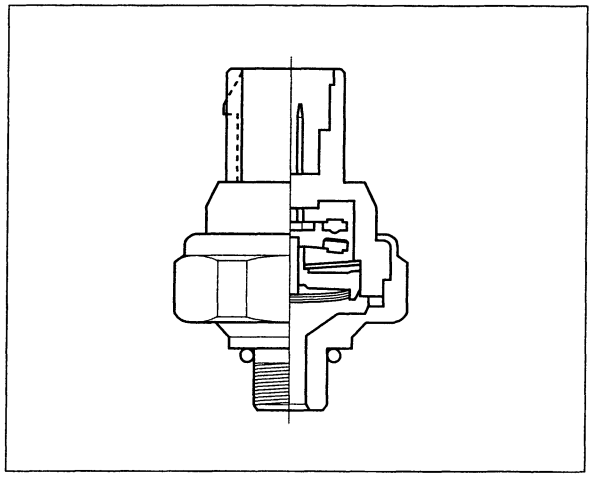
① Adjusting spring ③ Feeler bulb
② Ball valve

3.11 Dual pressure switch

The dual pressure switch, fixed to the receiver functions as a protector for stopping the compressor (OFF) at a preset value of pressure in the refrigerant circuit.

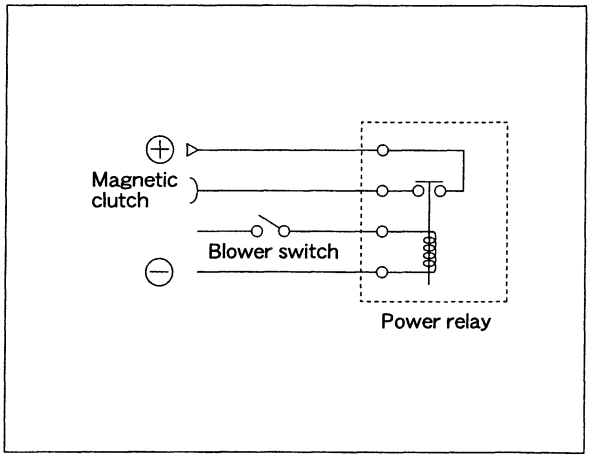
Unit : MPa

	LP side	HP side
OFF	0.2	2.94
ON	0.22	2.35



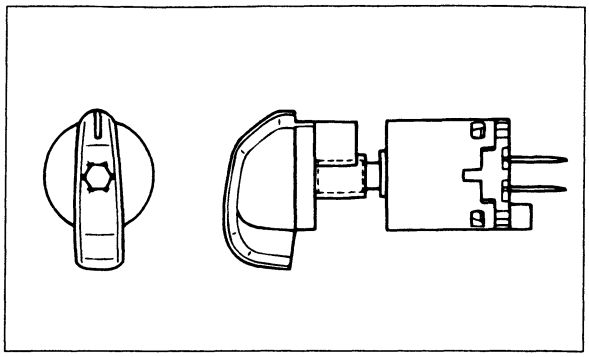
3.12 Power relay

The power relay is excited at a closed position of the micro switch and enables the magnetic clutch to be ready for engaging electically.



3.13 Air conditioner switch

The air conditioner switch function as an operation controller for starting or stopping the compressor in cooling and dehumidifying.
Set the it to the "ON" position, the magnetic clutch becomes engaged and the compressor starts.
Set the it to the "OFF" position, the magnetic clutch becomes disengaged and the compressor stops.

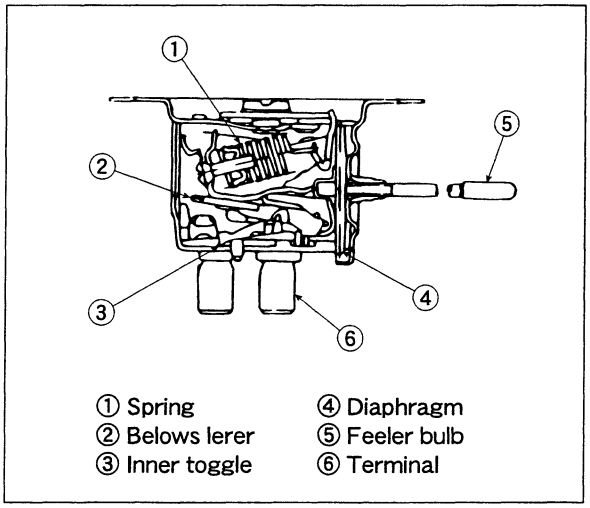


3.14 Thermostat

The thermostat is mounted on the evaporator case. It senses the temperature of evaporator fins, and controls the compressor operation for ON or OFF as specified below.

Unit : ℃

OFF	33
ON	38



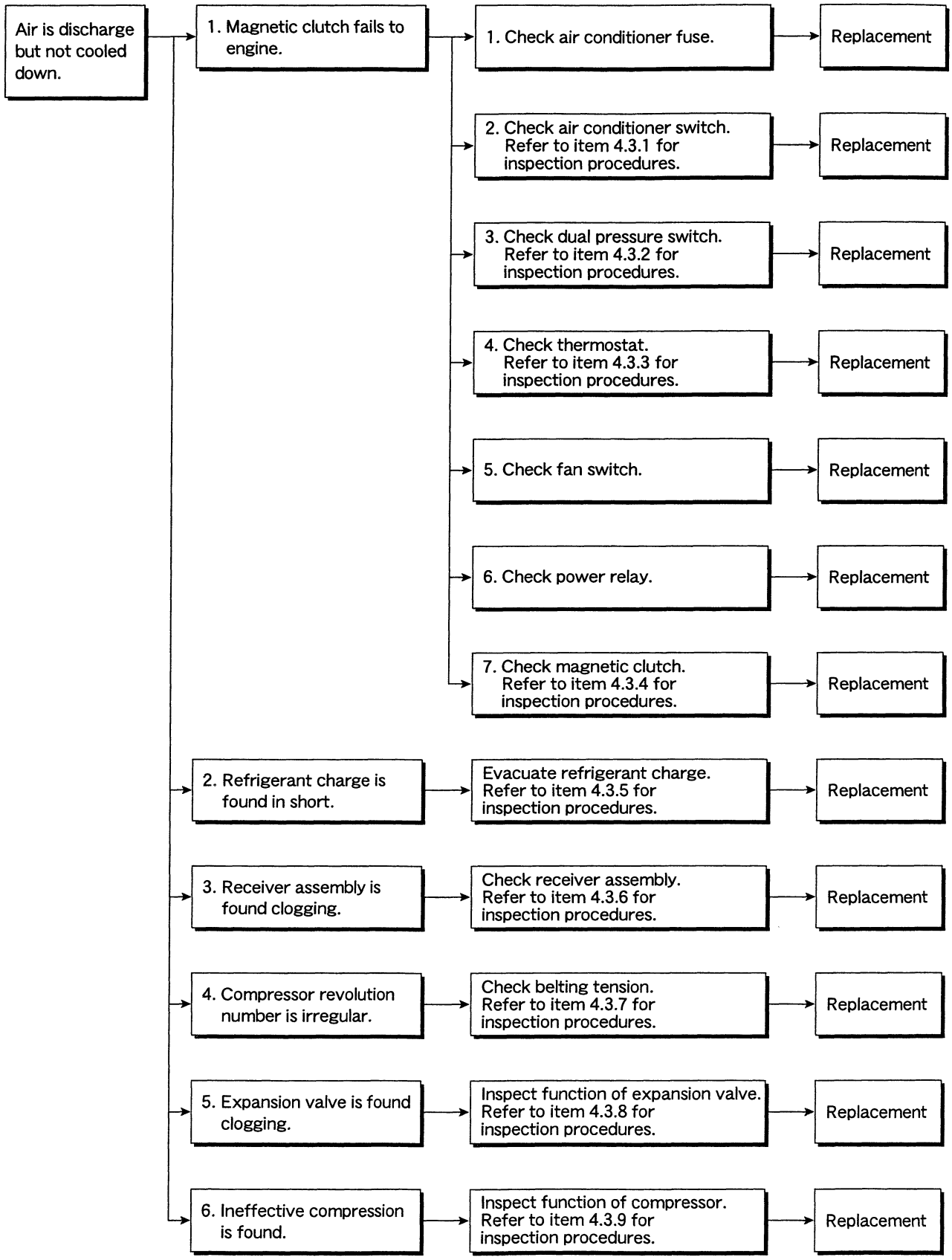
4 . TROUBLE SHOOTING

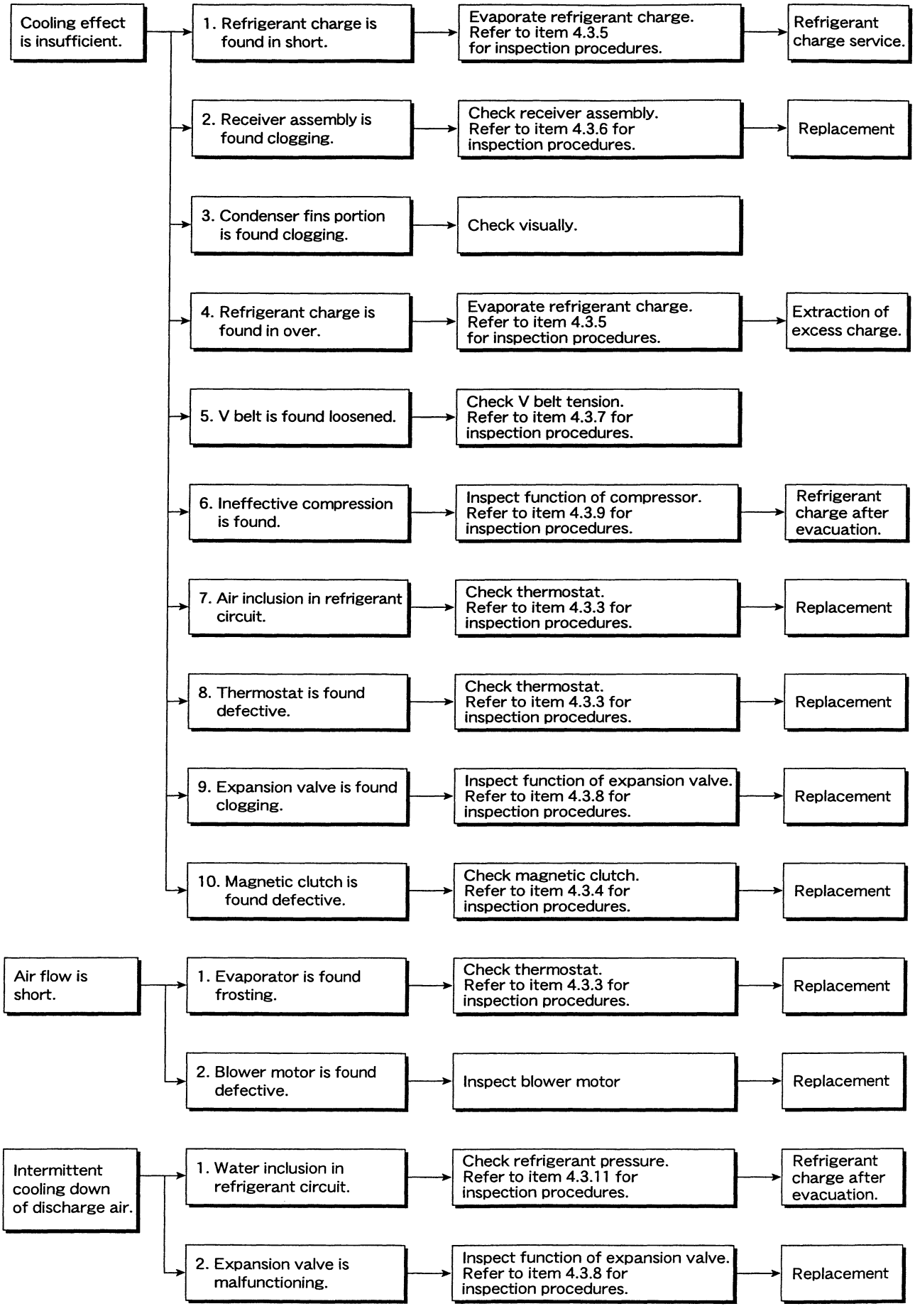
4.1 General precaution

(1) When handling refrigerant (HFC-134a), the following precautions must be observed.
   a. Allways wear eye protection and a pair of gloves which handling refrigerant.
   b. Be careful the liquid refrigerant dose not contact the skin.
   c. Keep the refrigerant container blow 40 degrees C.
   d. Do not handle the refrigerant in an enclosed area having an open flame. The refrigerant may produce a poisonous gas.
   e. When dumping the refrigerant from the system, release it slowly so as not to expell all the compressor oil.

(2) If liquid refrigerant strikes eye or skin.
   a. Do not rub eye or skin.
   b. Splash large quantities of cool water on the eye or skin.
   c. Rush to a physician or hospital for immediate professional treatment.

4.2 Trouble cause and remedy




Cooling effect is insufficient.
1. Refrigerant charge is found in short.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Refrigerant charge service.
2. Receiver assembly is found clogging.
Check receiver assembly. Refer to item 4.3.6 for inspection procedures.
Replacement
3. Condenser fins portion is found clogging.
Check visually.
4. Refrigerant charge is found in over.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Extraction of excess charge.
5. V belt is found loosened.
Check V belt tension. Refer to item 4.3.7 for inspection procedures.
6. Ineffective compression is found.
Inspect function of compressor. Refer to item 4.3.9 for inspection procedures.
Refrigerant charge after evacuation.
7. Air inclusion in refrigerant circuit.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
8. Thermostat is found defective.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
9. Expansion valve is found clogging.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement
10. Magnetic clutch is found defective.
Check magnetic clutch. Refer to item 4.3.4 for inspection procedures.
Replacement
Air flow is short.
1. Evaporator is found frosting.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
2. Blower motor is found defective.
Inspect blower motor
Replacement
Intermittent cooling down of discharge air.
1. Water inclusion in refrigerant circuit.
Check refrigerant pressure. Refer to item 4.3.11 for inspection procedures.
Refrigerant charge after evacuation.
2. Expansion valve is malfunctioning.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement

4.3 Inspection procedure

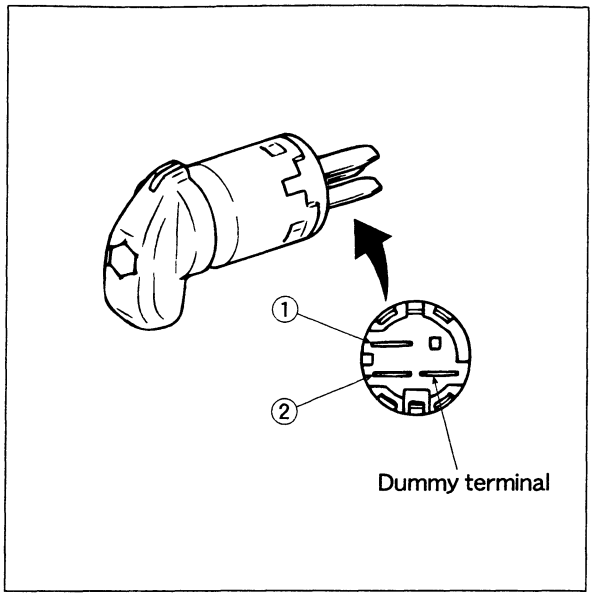
4.3.1 Air conditioner switch

(1) Unplug the air conditioner switch.
(2) Check the continuity between terminals of the air conditioner switch with a tester.

Continuity

Switch position	Terminal's number	Result, in normal
OFF	①-②	No
ON	①-②	Yes

Switch position \ Terminal's number	1	2
OFF	○	
ON	○	○

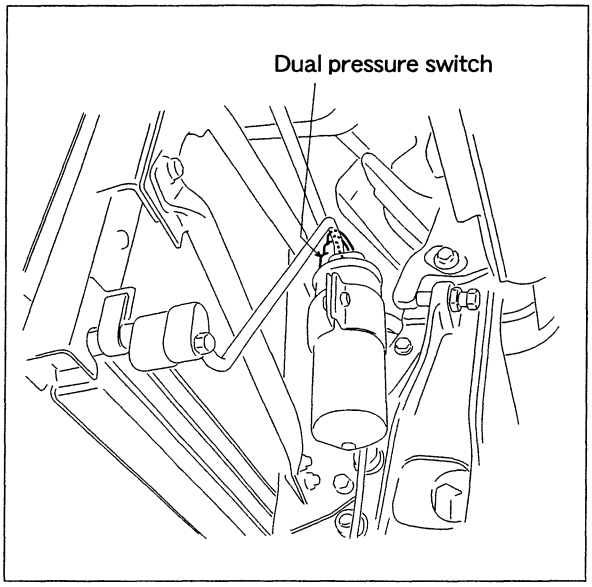


4.3.2 Dual pressure switch

The dual pressure switch is attached to the receiver assembly for controlling the operation of the air conditioner by checking the inside pressure of the receiver assembly.

Unit : MPa

	LP side	HP side
OFF	0.2	2.94
ON	0.22	2.35



(1) Unplug the connector at the receiver assembly.
(2) Check the continuity between terminals of the connector with a tester.
(3) When electric continuity is found, connect the connector to the high pressure switch.
(4) Attach the high pressure gauge and low pressure gauge.
(5) Operate the air conditioner.
(6) Cover the surface of the condenser by using a piece of paper.
(7) When the high pressure exceeds 2.94 MPa, if the magnetic clutch is turned off, the switch is normal.
(8) If the magnetic clutch is not turned off, replace pressure switch with new one.
(9) Check the accuracy of the preset as below.
  (a) Stop the air conditioner.
  (b) Purge the air conditioner of refrigerant slowly starting at over 0.22 MPa.
  (c) At reading the pressure 0.2 MPa, the switch opens.
  (d) Here, stop the purging, then turn it to charging.
  (e) At reading the pressure 0.22 MPa, the switch closes.

If the dual pressure switch does not meet specifications, replace the switch.

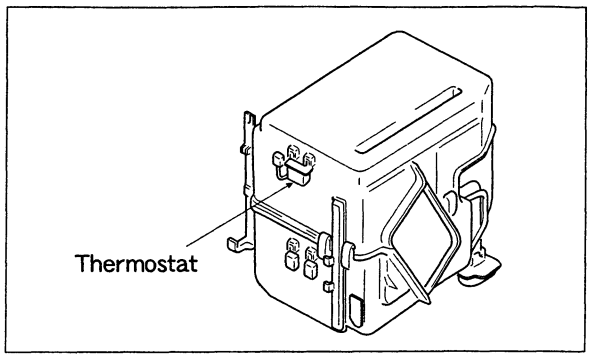
4.3.3 Thermostat

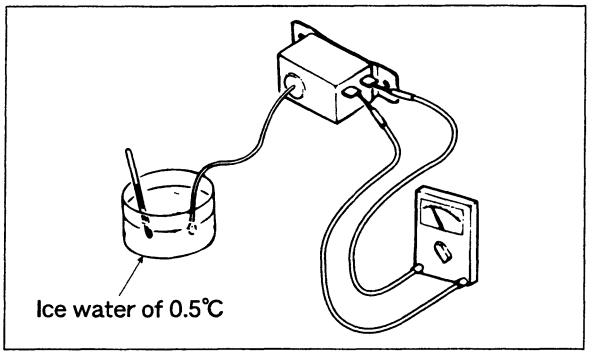
The thermostat is mounted on the evaporator case. It controls the operation of the air conditioner by sensing the temperature of the evaporator fins.

Unit : ℃

OFF	0.5
ON	3.5

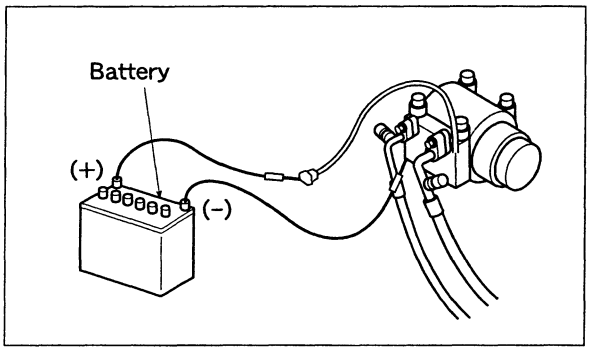
(1) Check the accuracy of the preset as below.
  (a) Soak the sensor of the thermostat in ice-water of below 0.5℃.
  (b) Check the continuity between the switch terminals.
  (c) Pull the senser out of the ice-water, and check the continuity at over 3.5℃ of the senser.





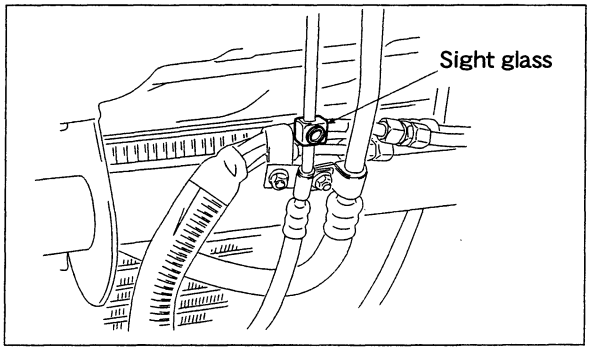
4.3.4 Magnetic clutch

(1) Disconnect the wiring to the magnetic clutch.
(2) Apply a positive side power voltage to the magnetic clutch through the wiring.
(3) In the case of regular functioning, the pulley and magnetic clutch are engaged with a clicking sound. The falling means any malfunction of the magnetic clutch.



4.3.5 Refrigerant charge

(1) Set the temperature control lever at the cool position.
(2) Open doors of the room.
(3) Set the blower switch at the ON position.
(4) Adjust the engine revolution at 1500min^{-1}.
(5) Operation the air conditioner switch for comp. ON.
(6) Watch the sight glass of the liquid hose at the inside of the engine room.
  (a) If judged insufficient refrigerant charging, repair the leaks, then charge it additionally.
  (b) If judged as over charging of refrigerant, extract an excess refrigerant.
(7) Diagnosis by pressure reading.
  (a) Short of refrigerant:
    Lower pressure for both LP and HP reading.
  (b) Express of refrigerant:
    Higher pressure for LP and HP reading.

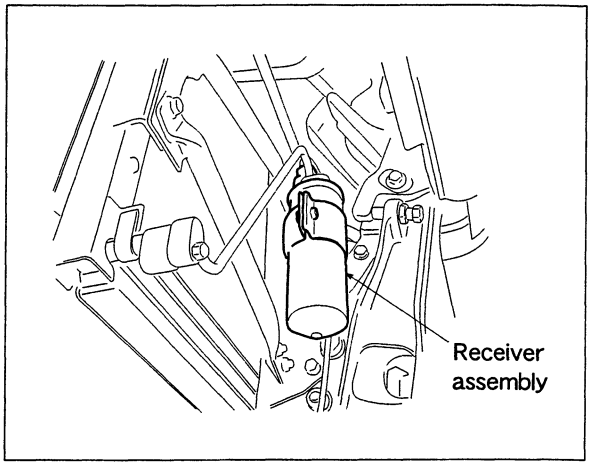


Sight glass		Remarks
Proper refrigerant level	Bubble	1. Bubble occasionally appears. 2. Bubble disappear if speed is a little increased.

Sight glass		Remarks
Insufficient refrigerant	Bubble	Considerable bubbles appear. If the system is extremely short of refrigerant, the sight glass appear white.
Excessive refrigerant		1. No bubbles appear. 2. Slight bubbles appear if speed is decreased.

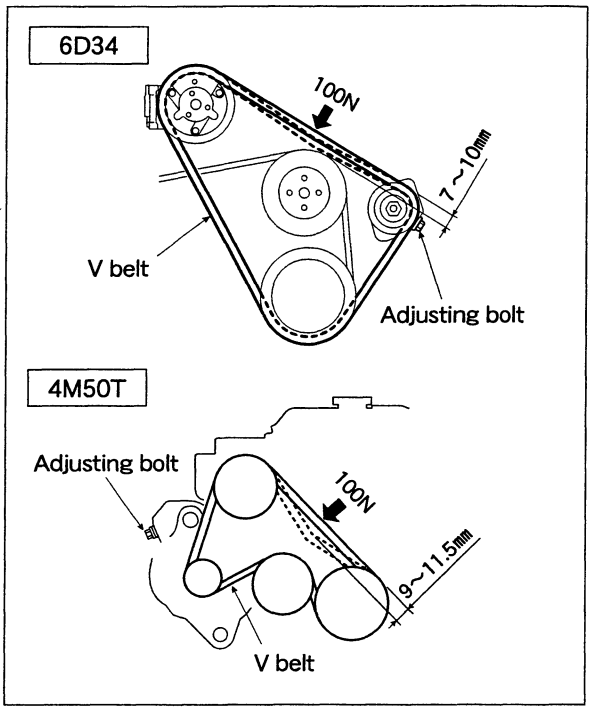
4.3.6 Receiver assembly

(1) While operating the air conditioner, touch the refrigerant piping with a hand at the inlet and outlet portions.
  (a) Sensed temperature difference:
    It is possible that clogging is happening at the inside, liquid receiver assembly is to be replaced with a new one.



4.3.7 Belt tension

(1) Depress the V belt with a thumb at the ⬅ marked position, and adjust the stretching as below.
  Stretching degree : 6D34 / 7～10 ㎜
    4M50T / 9～11.5 ㎜
(2) Adjustment
  (a) Loosen the nut of the tension pulley.
  (b) Control the belting tension by the adjusting bolt.
  (c) After finishing, retighten the nut as before.

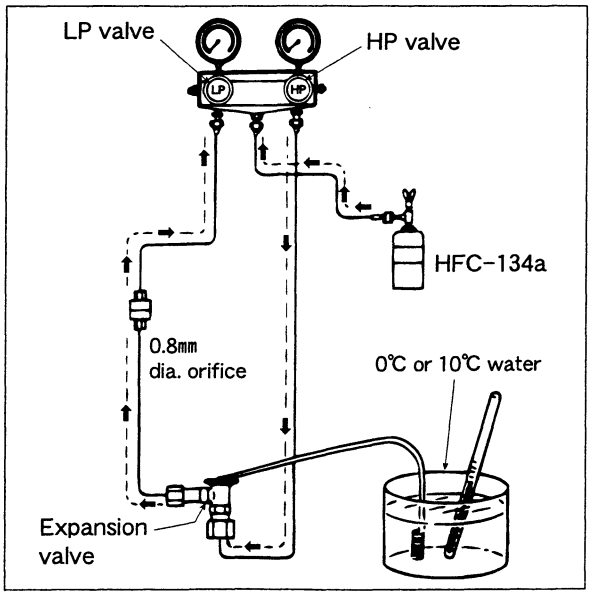


4.3.8 Expansion valve

⚠ CAUTION

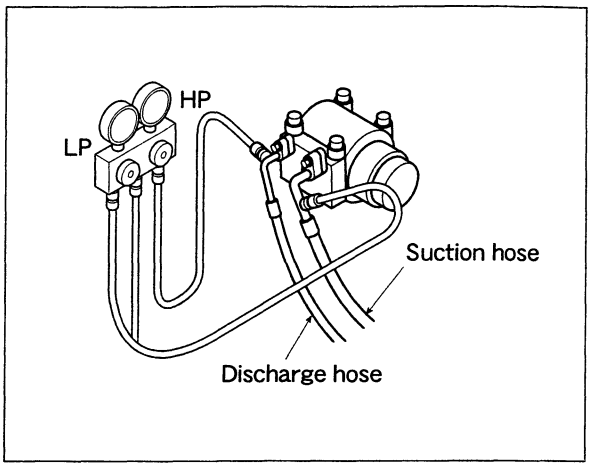
The test should be applied to only the case of the other components being free from troubles, and the expansion malfunctioning singly.

(1) Build up the test circuit with a gauge manifold.
(2) Soak the sensor bulb in ice water of 0℃, and of 10℃ respectively.
(3) Pressurize the HP side with dry nitrogen gas of 1.03MPa.
(4) Check the reading of the LP side pressure gauge for the standard range.
  At 0℃ ····0.127MPa
  At 10℃ ····0.23MPa



4.3.9 Pressure check

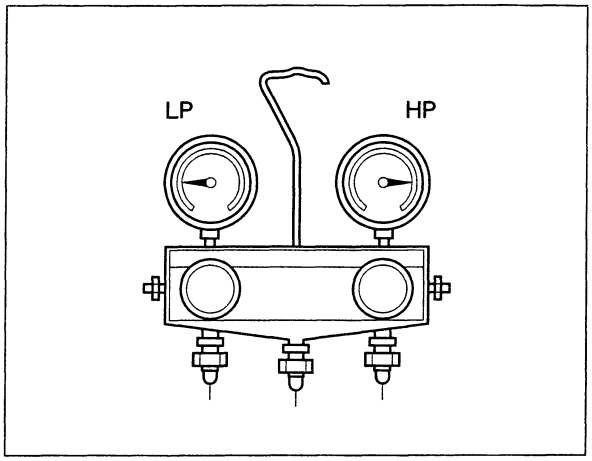
(1) Mount a low pressure gauge hose and a high pressure gauge hose on the check valve.
(2) Drive the air conditioner.
(3) Showing of higher LP side pressure and lower HP side pressure evidences ineffective compression.
Standard pressure
LP side pressure About 0.26MPa
HP side pressure About 1.42MPa



4.3.10 Air inclusion in ref.circuit

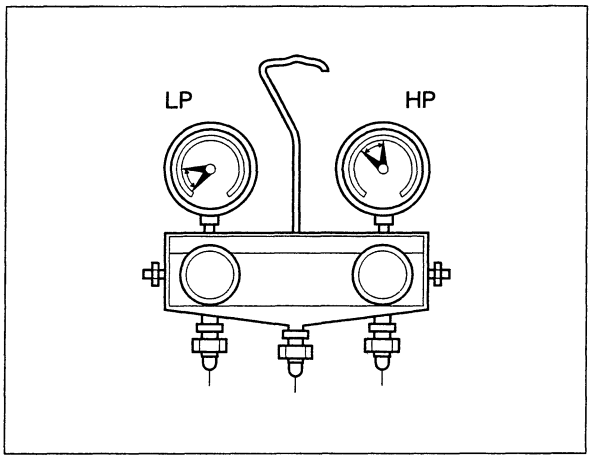
The abnormal reading of refrigerant circuit evidences afraid air inclusion.

A little higher LP side pressure. Noticeably higher HP side pressure.



4.3.11 Moisture inclusion in ref.circuit

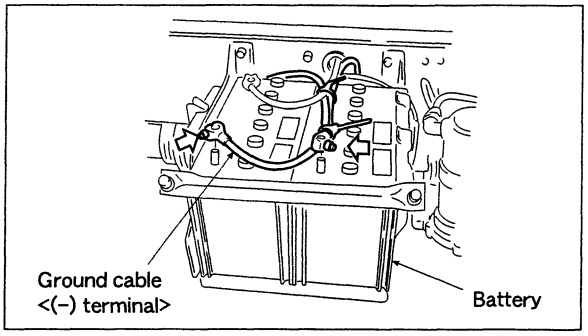
(1) During the operation, cooled air supply is interrupted periodically with a time interval.
This phenomenon evidences afraid water inclusion.
(2) Check the refrigerant pressure at a stop of the cooled air supply to make sure of the water inclusion.
LP side pressure ····Almost vacuum
HP side pressure ····Noticeably low



5. REMOVAL AND INSTALLATION

5.1 Precaution for removal and installation

(1) Disconnect the (-) ground cable from the battery, and place a cover on the battery.



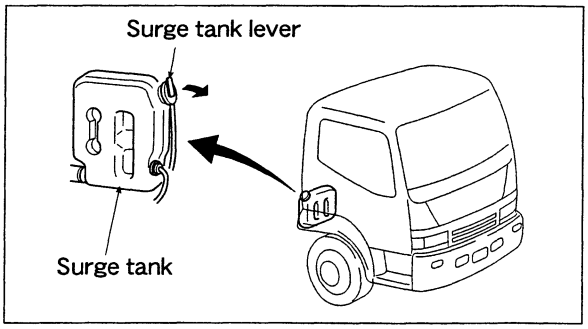
(2) Make certain all the openings are covered with caps in order to prevent entry of foreign substances such as dust and dirt.
(3) Never tamper with the brake and fuel systems, including the brake tubes and hoses.
(4) Avoid doing the work in a dusty place or outdoors in rainy weather. If tubes or functional parts are removed, put a cap in position immediately in order to prevent entry of dust and moisture.
(5) Connect the charging hose of the gauge manifold to the check valves (suction and discharge) of the suction hose and discharge hose, and recover the refrigerant by refrigerant recovery unit until its pressure is reduced to 0 kPa.
(Make sure that there is no internal pressure in the equipment.)
About discharging might result in the discharge of the refrigerant oil from the compressor.
(6) When coupling the flared tube, coat the flared portion with the compressor oil at the inner side.
(7) Make sure to use the wheel chocks.

5.2 Removal

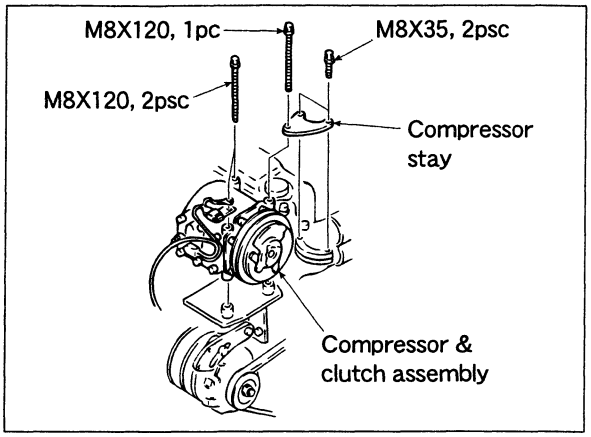
5.2.1 Inside engine room

(1) Compressor & clutch assembly

6D34

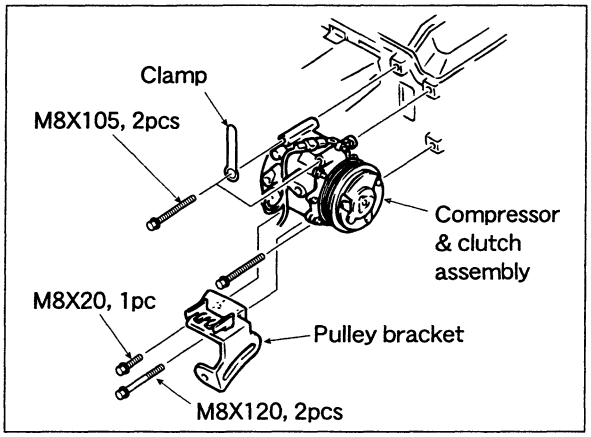


(a) Erect the pressure reducing lever of the radiator coolant surge tank cap to relieve the pressure from inside the radiator.
(b) Withdraw the wiring of magnetic clutch at the compressor.
(c) Remove the V belt by loosening fixture of the tension pulley.
(d) Take off the fixing bolts and anchor bolt : M8X35, 2pcs and M8X120, 1pc.
(e) Dismount the compressor stay.
(f) Take off the anchor bolts : M8X120, 2pcs.
(g) Dismount the compressor & clutch assembly.

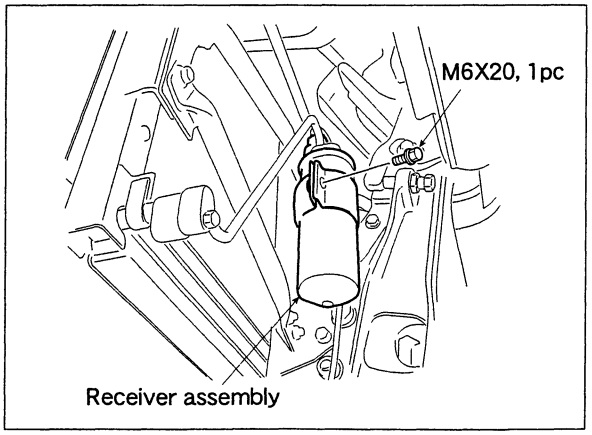


4M50T

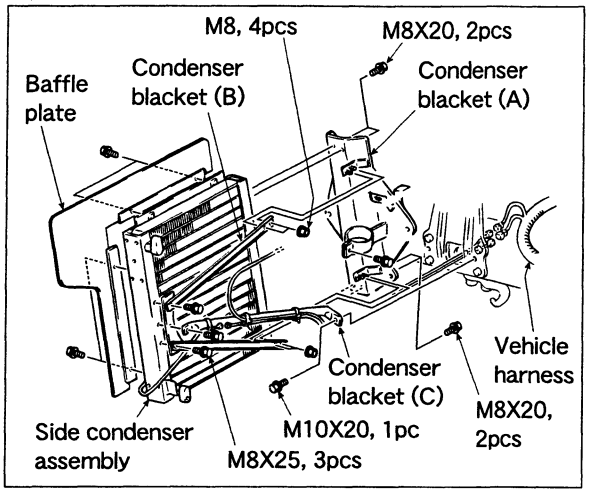
(a) Withdraw the wiring of the magnetic clutch at the connector.
(b) Remove the V belt by loosening fixature of the tension pulley
(c) Take off the fixing bolts : M8X105, 2pcs and M8X 120, 2pcs. (with clamp) and M8X20, 1pc.
(d) Dismount the compressor.



(2) Reciever assembly
(a) Unplug the dual pressure switch at the connector.
(b) Separete the interconnecting refrigerant pipe of the receiver assembly.
(c) Take off the fixing bolt : M6X20, 1pc.
(d) Dismount the receiver assembly.

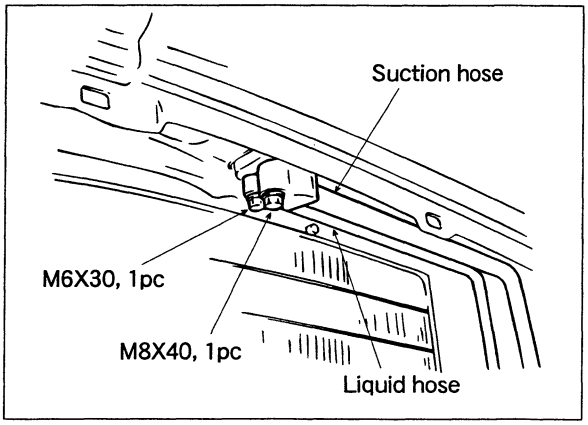


(3) Side condenser assembly
(a) Unplug the condenser fan harness at the vehicle side harness.
(b) Take off the fixing bolt : M8X25, 3pcs and M10X20, 1pc.
(c) Take off the fixing nut : M8, 4pcs.
(d) Dismount the condenser blacket (A), (B), (C).
(e) Take off the fixing bolt : M8X20, 4pcs.
(d) Dismount the side condenser assembly (and baffle plate).

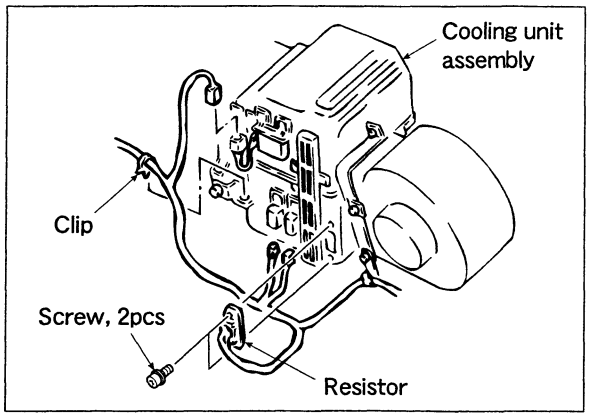


5.2 Cabin room

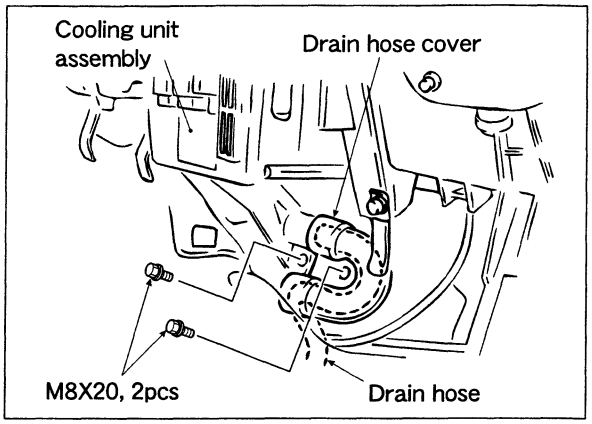
(1) Cooling unit assembly
(a) Separate the interconnecting refrigerant pipes of the cooling unit assembly.



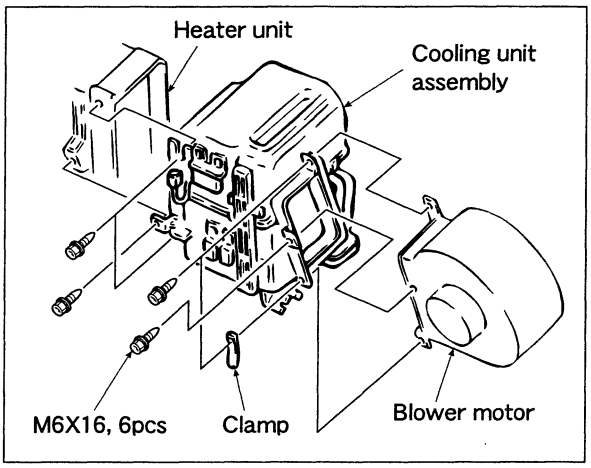
(b) Withdraw the wiring of the cooling unit assembly at the connectors.



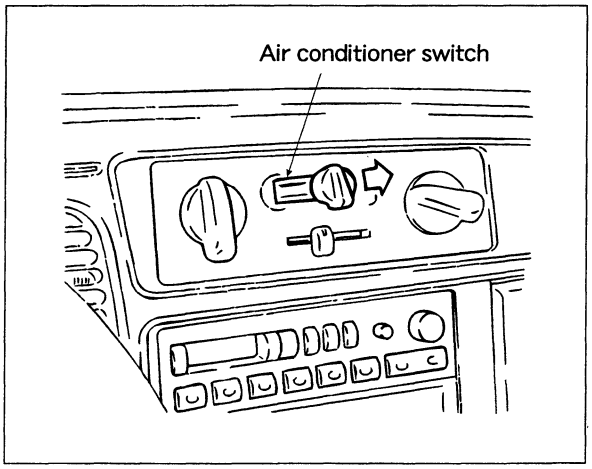
(c) Take off the fixing bolt : M8X20, 2pcs.
(d) Dismount the drain hose cover.
(e) Reconnect the drain hose from the cooling unit assembly.



(f) Take off the fixing screws : M6X16, 6pcs.
(g) Dismount the cooling unit assembly.



(2) Air conditioner switch
Pull out the air conditioner switch.



5.3 Installation

Installation is performed in the opposite sequence of removal.

○ Torque for tightening coupler of refrigerant tubing.

Unit : N • m

Compressor suction hose	29~34
Compressor discharge hose	20~25
Condenser inlet hose	20~25
Condenser outlet hose	12~14
Liquid receiver assembly inlet and outlet hoses	12~14
Cooling unit inlet hose	12~14
Cooling unit outlet hose	29~34

○ Torque for tightening general bolt and nut

Unit : N • m

Nominal size	Pitch	Tightening torque		
		Head mark 4	Head mark 7	Head mark 8
M5	0.8	3~4	5~6	5~7
M6	1.0	5~6	9~11	8~12
M8	1.25	12~14	19~24	19~29
M10	1.25	24~29	38~48	43~58
M10	1.5	17~26	32~48	41~58
M12	1.25	34~43	58~77	82~106
M14	1.5	72~82	115~134	125~173

NOTE

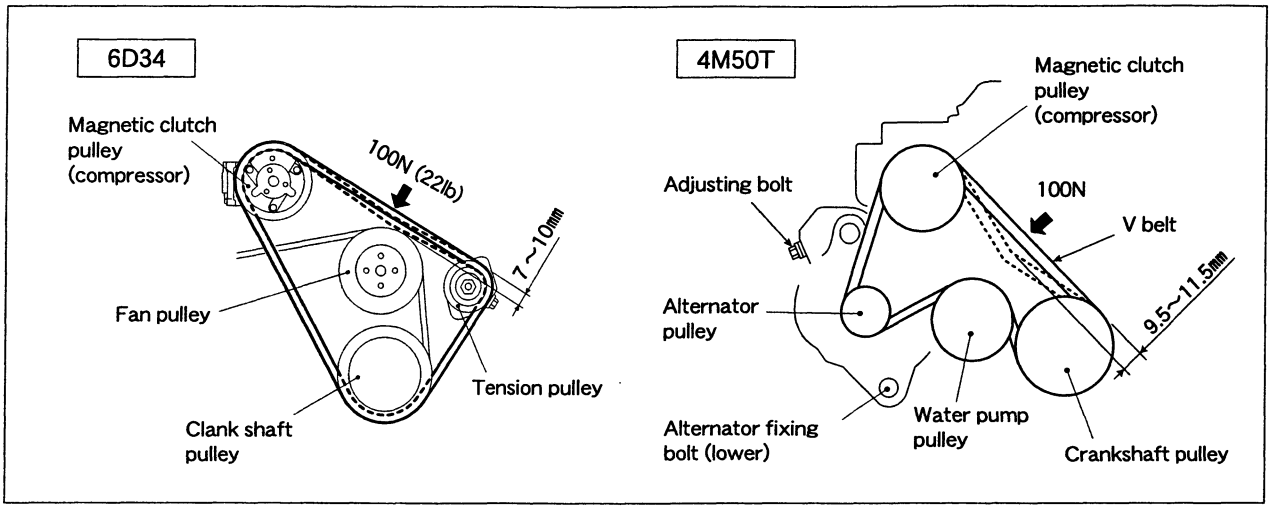
For the cases of spring washer seated, and thread or seating surface coated with oil, the value shall be reduced down to 85 percent of the data listed.

6. TREATMENT AFTER INSTALLATION

6.1 Check and adjustment

After installation, check the following points and confirm that everything is normal, then charge the gas, and do the performance and operation tests.

(1) Check if any abnormal vehicle performance, happens or not by installing the air conditioner.
(2) Check the operation of the magnetic clutch. (with the compressor disengaged)
(3) Check if any parts left unmounted or any tool left in the vehicle.
(4) Check to ensure that the temperature control lever operates properly.
(5) Check the tension of the belt.



6.2 Leak test

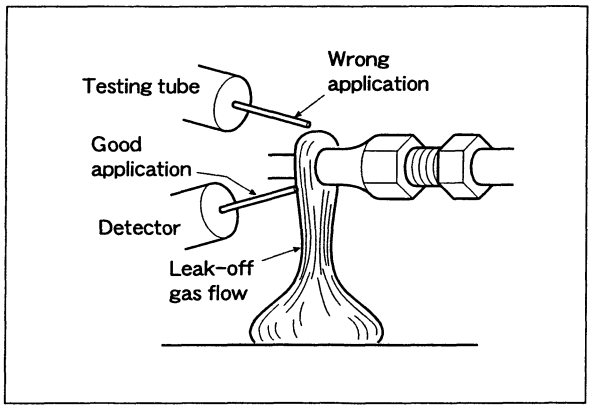
After all the piping works are completed, conduct an leak test by the following procedure to check any leaks at the flare coupling, etc. and then evacuate the system. If this leak test is omited and evacuation is immediately started, there is no way of detecting possible leak. If there are leaks, the specified vacuum cannot be attained. In order to save the service time be sure to conduct the leak test before evacuation.

6.2.1 Test point

(1) All pipe joint.
(2) Shaft seal and check valve on the compressor.

6.2.2 Test procedure

(1) For the gas leak test, the use of an electric gas leak detector is recommended. (HFC-134a SAE Approved)
(2) Perform the test at a place as in free from air flowing.
(3) The refrigerant is heavier than air. Leaks will concentrate at the bottom. Make certain that the testing tube is applied below the check point.



(4) The test should be performed patiently. Make certain that testing tube is moved slowly [approx. 10mm/sec].
(5) The high pressure side refrigerant circuit should be tested for gas leaks during operation. Those areas which are dangerous or hard to test during operation (including areas around the compressor and condenser) should be tested direct after shutdown.

(6) The low pressure side refrigerant circuit should be tested during shutdown after the gas pressure has balanced.
(7) The test should be performed on the basis of the following standards:

Gas leak test standards

test point / Instrument	Compressor shaft seal	Other parts
Electric gas leak detector	Pointer shall not swing more than 0.1mA at the low sensitivility.	Pointer shall not swing more than 0.1mA at the low sensitivility.
handle torch gas leak detector	Flame colour (moss green) shall not change.	

⚠ WARNING

- Smoking should be forbidden if a gas leak is detected.
- If a flame is applied to the refrigerant, toxic phosgene gas will be produced. Do not keep the detector in contact with a leaky point for a long time.

- Leak test procedure

1. Attach refrigerant supply and gauge set as shown with all valves closed. Open refrigerant supply valve on can.
2. Loosen the center charging hose fitting at the gauge manifold end to blow any air from the hose until it hisses for a few seconds, then refrigerant.
3. Open both gauge valves to partially charge the system and then close both valves.
4. The system can then be checked for leaks using an electronic leak detector.
5. If leaks are found that require the system to be opened (to repair or replace hoses, fittings, etc.), release any charge in the system.
6. After checking and repairing leaks, system must be evacuated.

6.3 System charging

GENERAL PRECAUTIONS

⚠ WARNING

When handling refrigerant (HFC-134a), the following precautions must be observed.

- Always wear eye protection and gloves while handling refrigerant.
- Be careful that liquid refrigerant does not contact the skin.
  If liquid refrigerant strikes eye or skin:
  - Do not rub on skin.
  - Splash large quantities of cool water on the eye or skin.
  - Flush eyes or skin with cool water for 5 minutes.
  - Rush to a physician or hospital for immediate professional treatment.
  - Do not attempt to treat it yourself.
- Keep the refrigerant (HFC-134a) container below 40℃.
- Do not handle the refrigerant in an enclosed area having an open flame; the refrigerant may produce a poisonous gas.
- Use approved recovery equipment to recover HFC-134a refrigerant before attempting service of this or any other HFC-134a system.
- Do not attempt to leak test an HFC-134a system with high pressure air or nitrogen. Mixing HFC-134a with a concentrated quantity of air may be combustible in the presence of ignition.

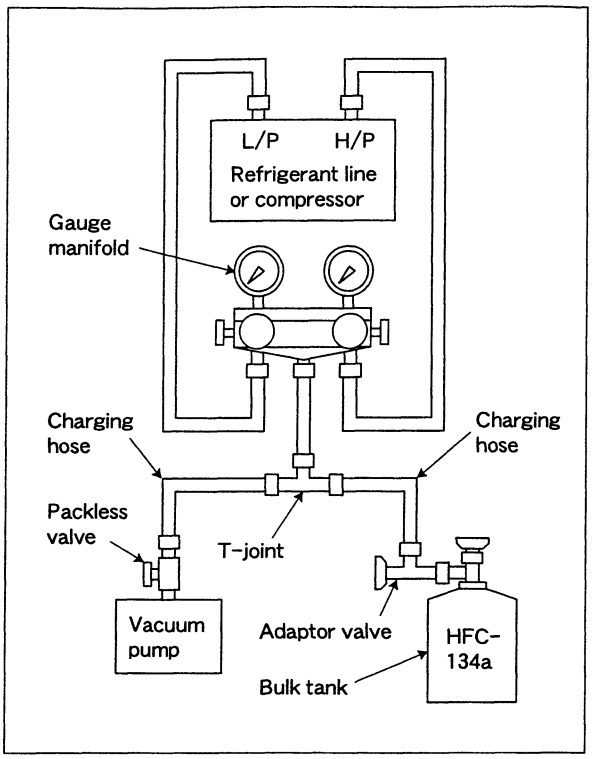
6.3.1 Evacuation

INSTALLATION OF CHARGE EQUIPMENT

(1) Connect the gauge manifold to the service valves.
(2) Connect the packless valve to the vacuum pump.
(3) With the charge valve handle turned back all the way, install the bulk tank.
(4) Connect each charge equipment as illustrated.

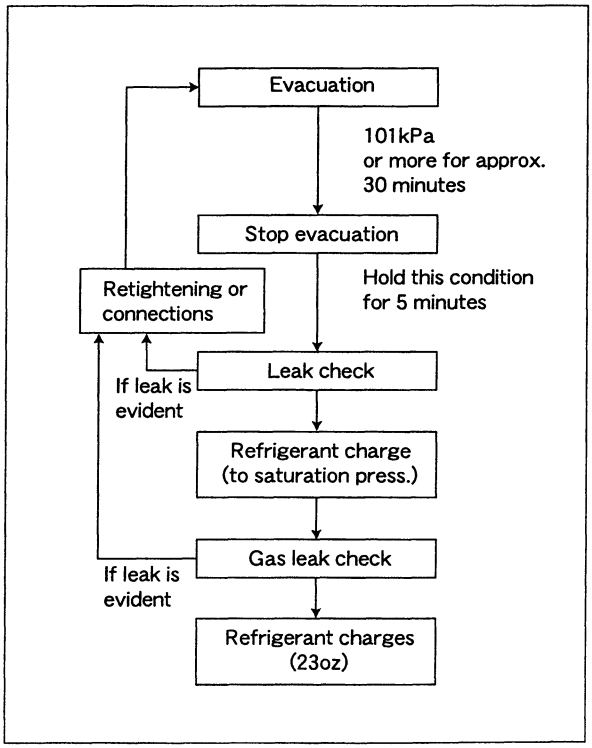
⚠ CAUTION

1. Do not connect the high and low pressure sides adversely. (Connect high pressure side to the condenser and low pressure side to the cooling unit.)
2. The indications "DIS" and "SUC" on the compressor indicate high and low pressure sides respectively.



6.3.2 Evacuate the system

The refrigerant system must have been evacuated using the previous procedure before charging. Charge using only HFC-134a refrigerant. HFC-134a is available in bulk tank. Follow the safety precautions for handling HFC-134a as listed in this section.
Follow the evacuation procedure below and at right.
This procedure assumes no HFC-134a refrigerant has been introduced into the system. If evacuating a charged system, it is necessary to recover the existing HFC-134a refrigerant before continuing with these instructions.
Refer to the recover equipment manufacture's instructions for proper refrigerant recovery.



CHARGING WITH BULK TANK

When using disposable cans of this type, follow carefully the tank manufactures instructions.

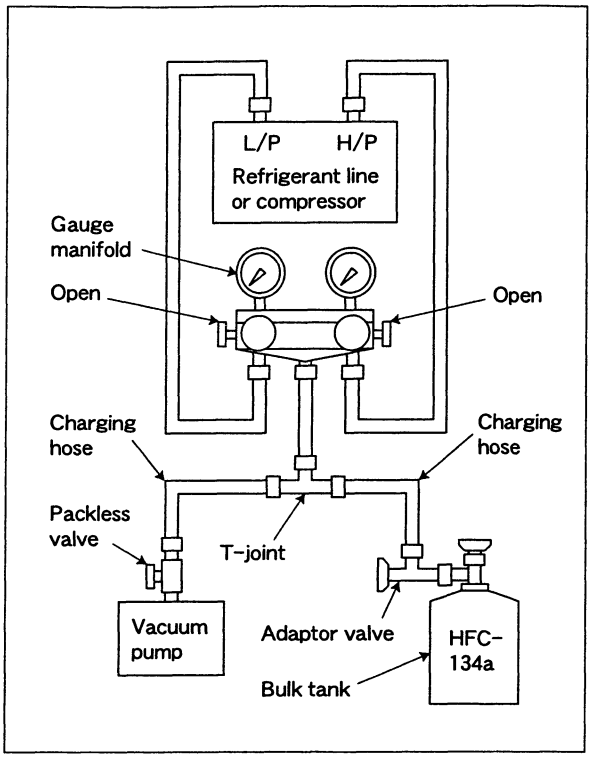
(1) Start up the vacuum pump.

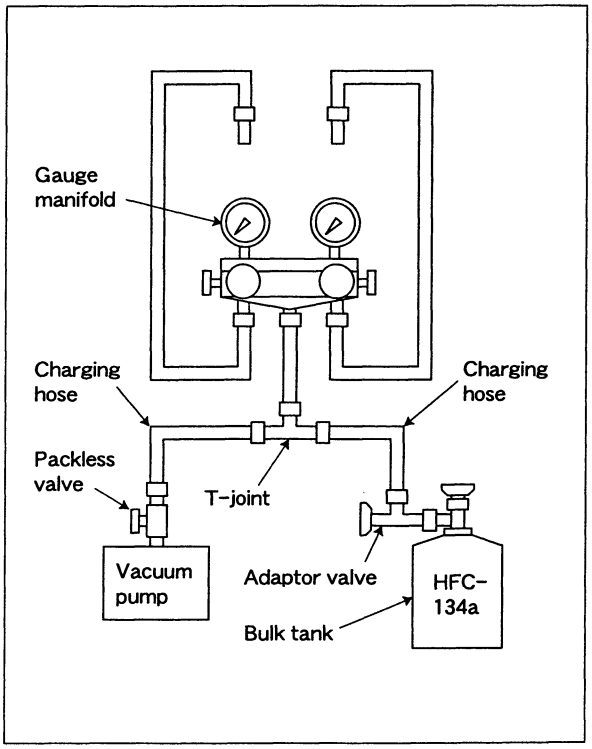
> ⚠ CAUTION
>
> 1. Do not use the compressor for evacuation.
> 2. Do not operate the compressor in the vacuum condition; damage may occur.

(2) Open the gauge manifold handles and the packless valve.
(3) Evacuate to a vacuum reading of 101kPa higher (approx.30 minutes).
(4) Turn back the packless valve all the way and close the bulk tank.
(5) Stop the vacuum pump and allow to stand for 5 minutes.
(6) Check for leak. (Good if the vacuum is held.)
(7) Tighten the charge valve handle to puncture the bulk tank.
(8) Open the charge valve to charge the system with refrigerant.
(9) When the refrigerant is no longer drawn in, turn back the high pressure side gauge manifold handles.
(10)Check for gas leaks using a leak detector.
(11)Start the engine.
(12)Operate the air conditioner and set at the lowest temperature (MAX. COOL).
(13)Fix the engine speed at 1500min^{-1}.
(14)Continue charging system until proper refrigerant quantity is introduced into the system.

> ⚠ CAUTION
>
> If the bulk tank is inverted, liquid refrigerant may be drawn into the compressor damaging it by liquid compression. Keep the bulk tank upright to ensure that refrigerant is charged in gas state.

(15)Upon completion of charging, turn back the low pressure side gauge manifold handles.





6.3.3 Removal of charge equipment

(1) Close the charge valve.
(2) Remove the gauge manifold from each service valves.

> ⚠ CAUTION
> Do not remove the bulk tank, T-joints and adaptor valves but keep them connected for next charge operation.

OPERATING LOW REFRIGERANT LEVEL

Locate the souce of the low refrigerant level, recover system, repair system, evacuate system, charge ststem, check for leaks.

> ⚠ CAUTION
> If the bulk tank is not emptied completely, keep the charge valve connected to the tank for next charging.

6.3.4 Discharging system

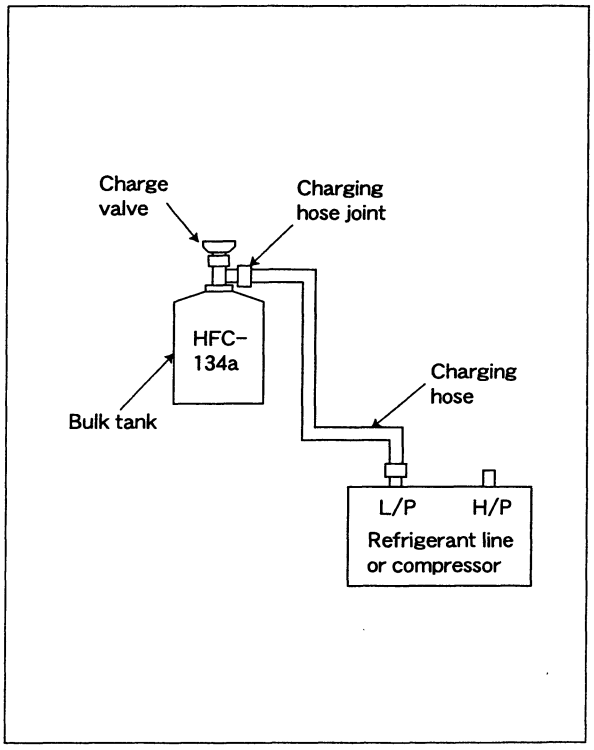
Use the refrigerant recovery unit which can be purchased in local market to discharge refrigerant gas from the system.

> ⚠ CAUTION
> Refer to that Refrigerant Recovery Unit Instruction Manual for operation which is attached on the unit.

LIQUID CHARGE, through high side using charging station:

> ⚠ CAUTION
> Do not run engine when performing liquid charge; compressor will be damage.

(1) After the system is evacuated, close gauge valves, connect center hose to refrigerant supply. Loosen center fitting at gauge to blow any air out of the hose and then retighten.
(2) Following charging station manufacture's instructions charge the system until 23oz of refrigerant is pumped into the system.
(3) When system is fully charged, close high gauge valve and refrigerant supply valve, then quickly disconnect gauge hoses from service
(4) After charging the system, refer to pre-delivery inspection.



6.4 Performance test

6.4.1 Preparation

Reinstall all vehicle parts that were removed for installation of the air conditioner at their original positions, adjust the mounting, and test the following items.

(1) Installation of grommets.

Install the specified grommets.

6.4.2 Stationary performance test

(1) Operating conditions

(a) Place the vehicle in the shade with doors open.

(b) Keep the return air temperature between 25 to 30℃, (Adjust by changing the opening degree of the doors).

(c) Set the fan switch to the max position.

(d) Turn the thermostat control lever to the cool position.

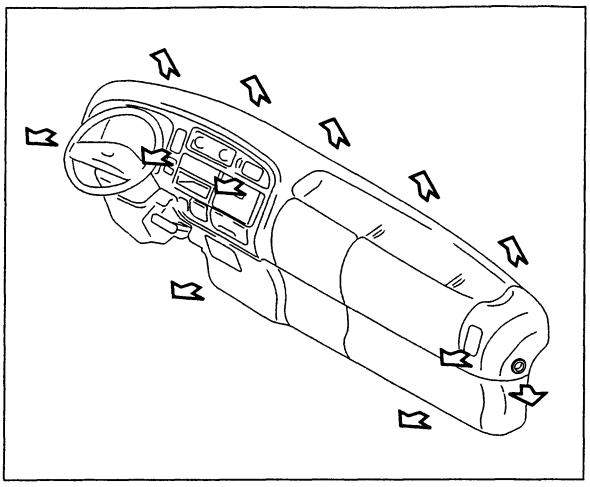
(e) Set the engine speed to approx. 1500min^{-1}.

(f) Set the high pressure at 1.17 to 1.37 MPa.

(If the high side pressure does not rise up, place paper or the like in front of the condenser.)

(2) Test procedure

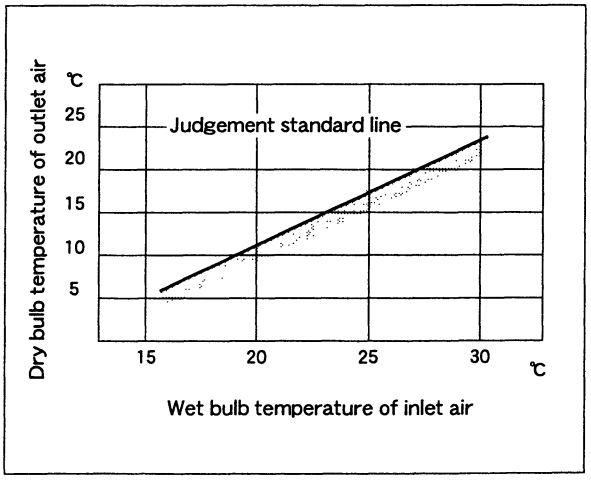
Operate the air conditioner for more than 10 minutes under the above operating conditions in order to stabilize the high and low pressures. Then perform the test by the following procedure:



(a) Measure the outlet air temperature at the inside space of the outlet grille.

(b) Measure the air conditioner intake air temperature, humidity, etc, and the items shown in the Table of Measuring Items at a position free from the effects of cool outlet air.

(c) The intersecting point of the plotted line perpendicular to the point which corresponds to the air conditioner intake and outlet air temperature difference and the plotted line perpendicular to the relative humidity of intake air should be between the oblique lines in figure.



7. MAINTENANCE

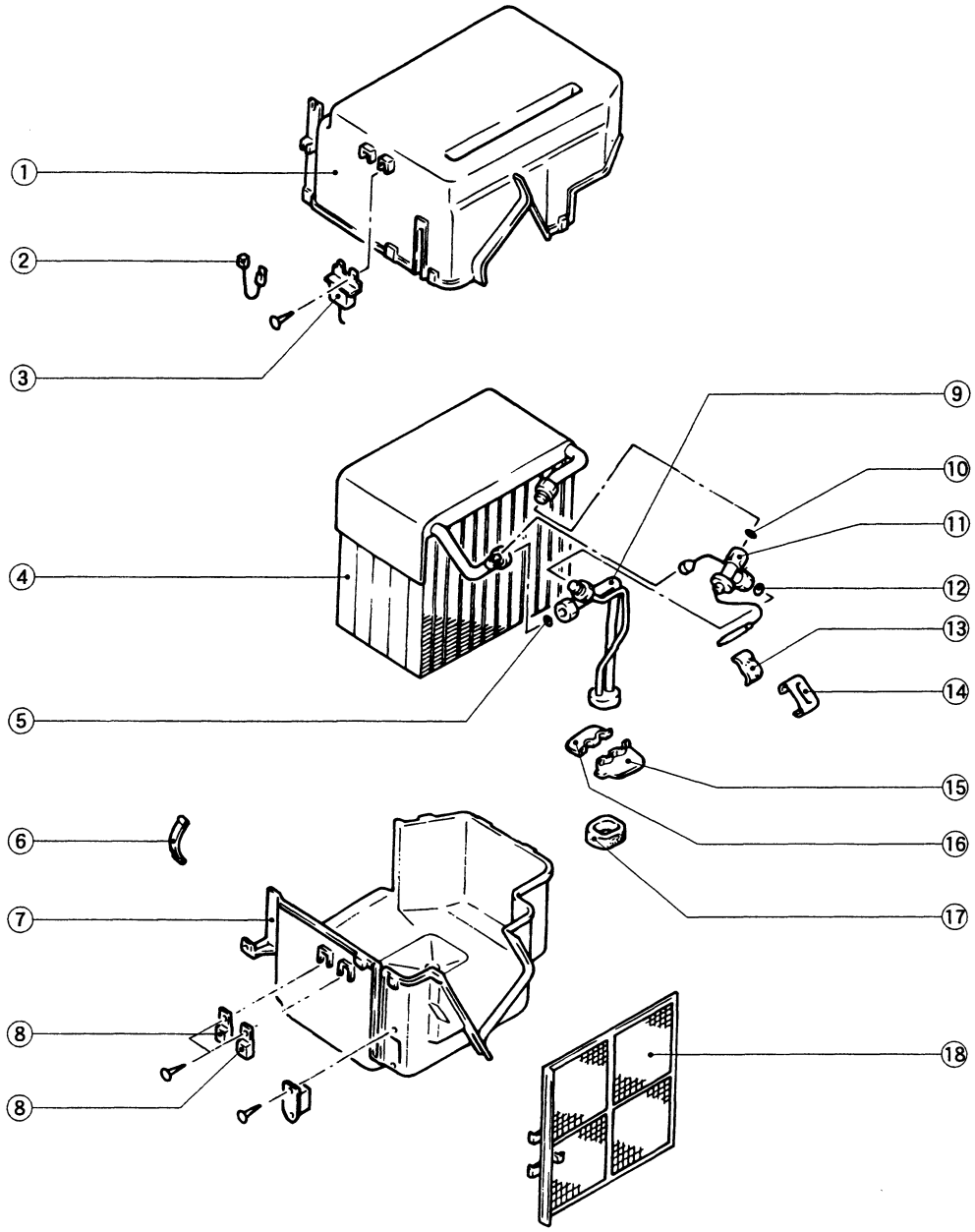
No.	Check point	Service and inspection intervals				
		When used only in summer (approx. for three months)		When used in all seasons		
		At the beginning or season	At the end of season	Every 5,000km (3,000miles)	Every 10,000km (6,000miles)	Every 20,000km (12,000miles)
1	Check condenser and radiator fin for clogging.	○	○	○		
2	Retighten all bolts.	○			○	
3	Check for refrigerant leaks.	○			○	
4	Check refrigerant level.	○		○		
5	Check V-belt tension.	○		○		
6	Check operation of magnetic clutch.	○			○	
7	Check operation of thermostat.	○				○
8	Cooling unit assembly performance test.	○		○		
9	Compressor overhaul.			Every four years		Every 40,000km (24,000miles)

⚠ WARNING

Even after the hot season is over, the air conditioner should be kept ready for operation all year round. Do not remove the V-belt or other parts.
This is because the air conditioner must be operated once a week for several minutes regardless of the season in order to prevent gas leaks caused by drying of the compressor shaft seal, and also to maintain the compressor itself in the best condition.

8. COOLING UNIT ASSEMBLY

8.1 Components



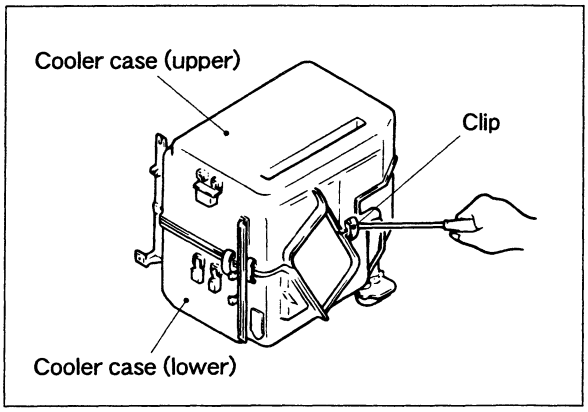
① Cooler case (upper)
② Joint harness
③ Thermostat
④ Evaporator
⑤ O-ring
⑥ Clip
⑦ Cooler case (lower)
⑧ Power relay
⑨ Pipe assembly
⑩ O-ring
⑪ Expansion valve
⑫ O-ring
⑬ Insulation rubber
⑭ Clip
⑮ Baffle plate
⑯ Baffle plate
⑰ Insulation rubber
⑱ Air filter

8.2 Cautions in disassembling

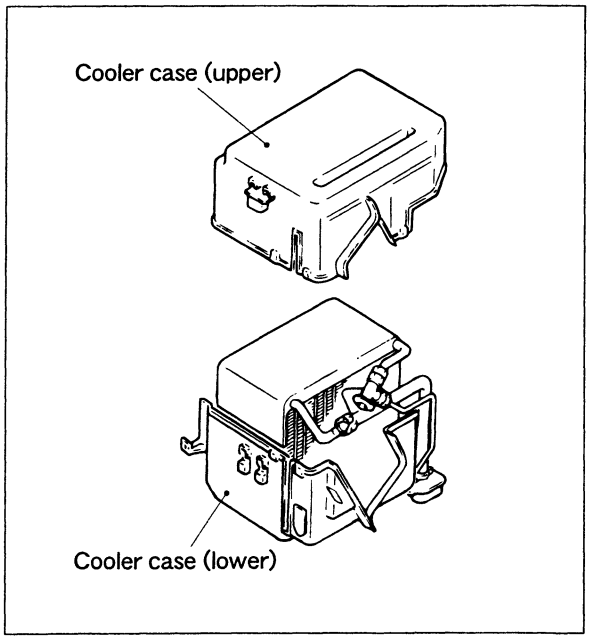
(1) Direct after disconnecting the refrigerant piping blind the opening to prevent dust and moisture etc. from eatering in it.
(2) When disconnecting the expansion valve, surely apply two spanners to prevent unstable twisting from applyng with the one for supporting and the other for torquing at the connection.
(3) Pipings in the cooling unit assembly should be handled gently. Particularly, the ingress and egress portions should be from any bending trouble in carrying it.
(4) If the cooling unit assembly is stored, or transported on disassembled condition, be careful not to deform the fins.
(5) When disconnecting the wiring, avoid pulling it with the insulation cover catched, but apply force by pinching the terminals or by catching the connectors.

8.3 Disassembling

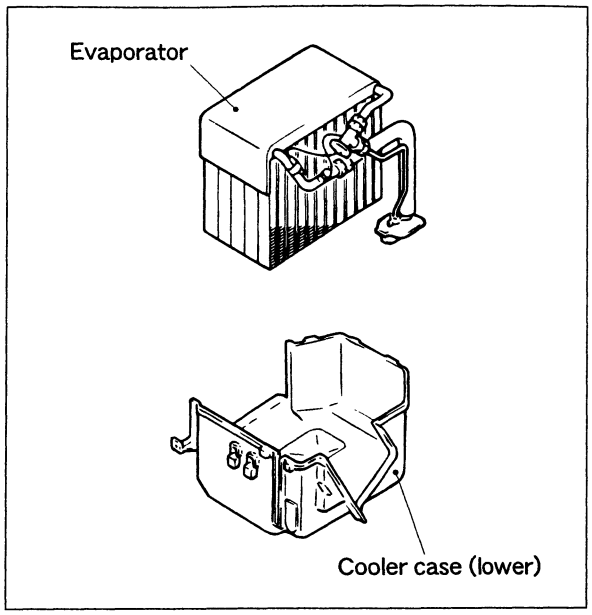
(1) Remove the clips for jointings the upper & lower side cooler case with a flat type screwdriver.



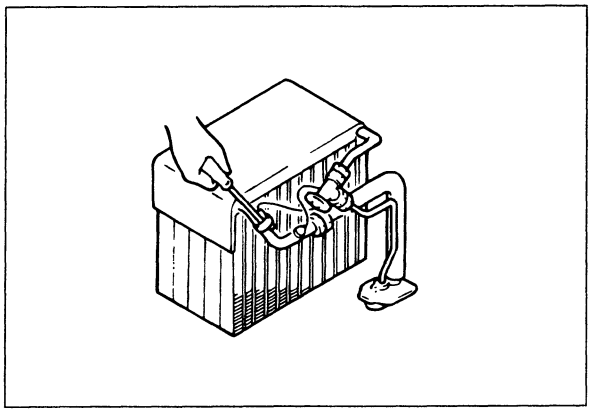
(2) Dismount the cooler case (upper).



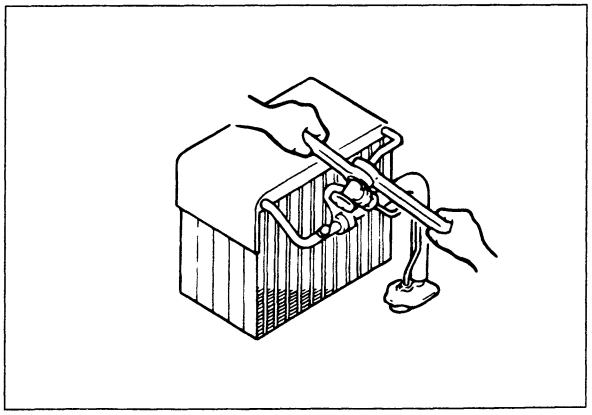
(3) Dismount the evaporator.



(4) Separate the expansion valve.
Dismount the feeler bulb at the suction side.

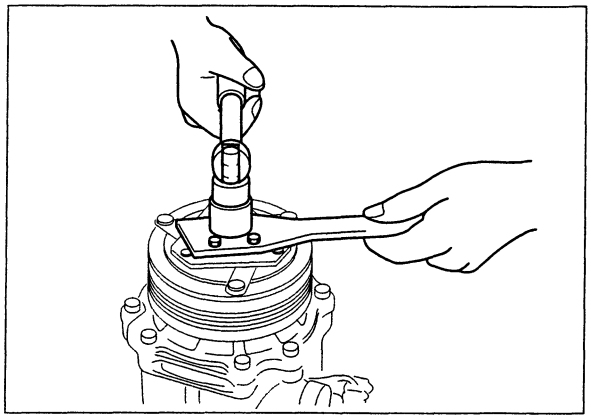


(5) Dismount the expansion valve from the circuit.

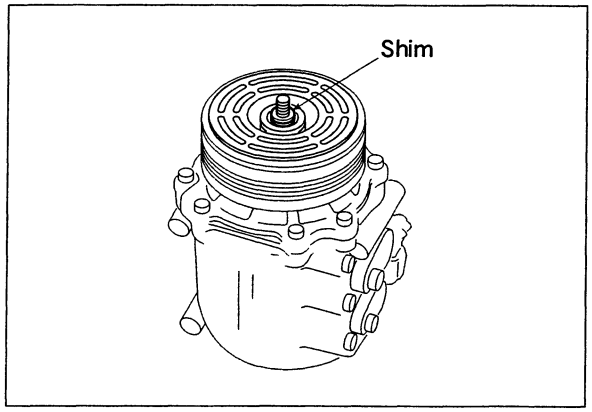


9. COMPRESSOR & CLUTCH ASSEMBLY

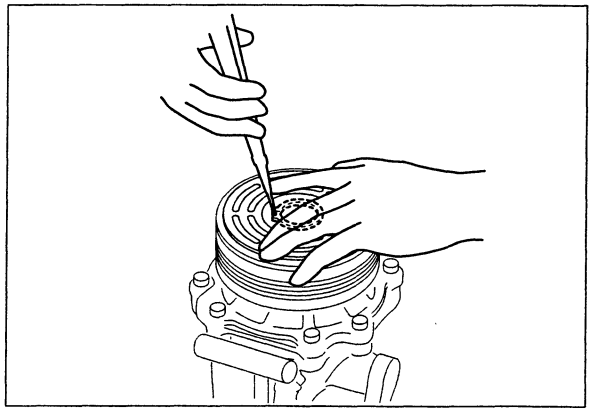
9.1 Disassembling the clutch



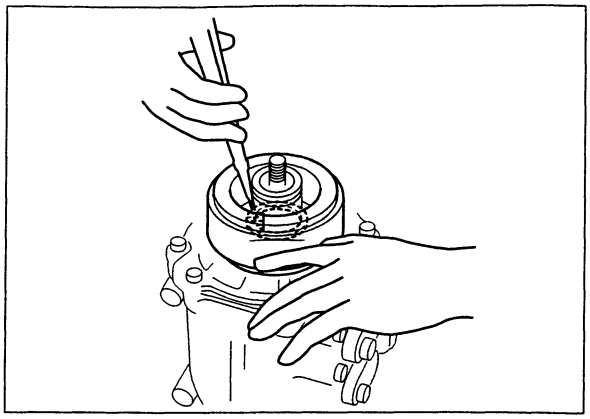
(1) Removal of armature plate.
  (a) Lock up the armature plate with a armature plate fixture and remove the lock nut.
  (b) Remove the armature plate.



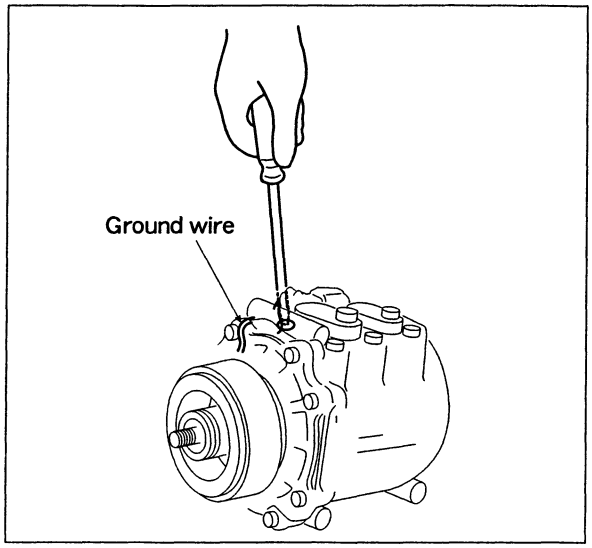
(2) Remove the shim.



(3) Withdrawing rotor.
  (a) Remove the snap ring at the front case side with snap ring pliers.
  (b) Withdraw the rotor toward you and remove it from the front case.

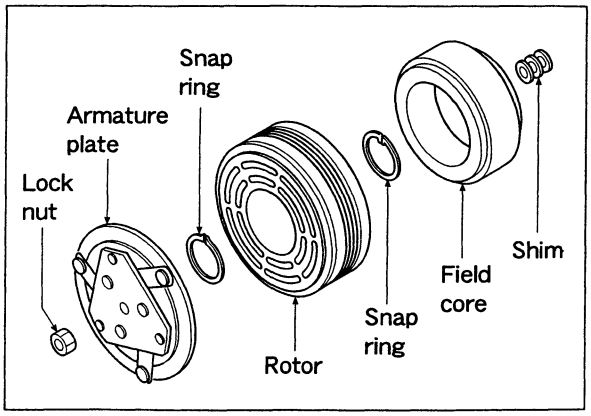


(4) Removal of field core.
  (a) Remove the snap ring for fixing the field core with snap ring pliers.



  (b) Remove the ground wire with a cross point screwdriver and withdraw the field core toward you to remove it from the crank case.

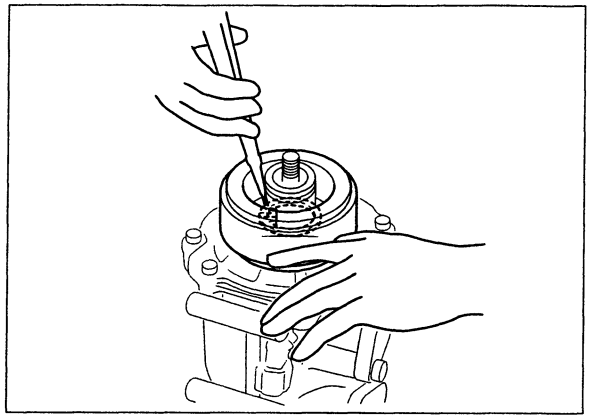
(5) Removal of key.
  Remove the key from the shaft using the top of a flat type screwdriver.



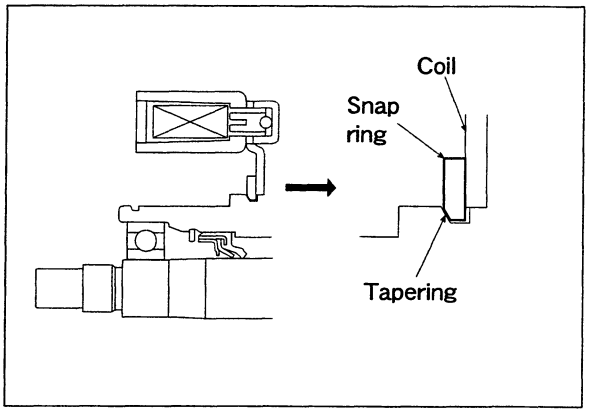
(6) Components of magnetic clutch.

9.2 Reassembly the clutch

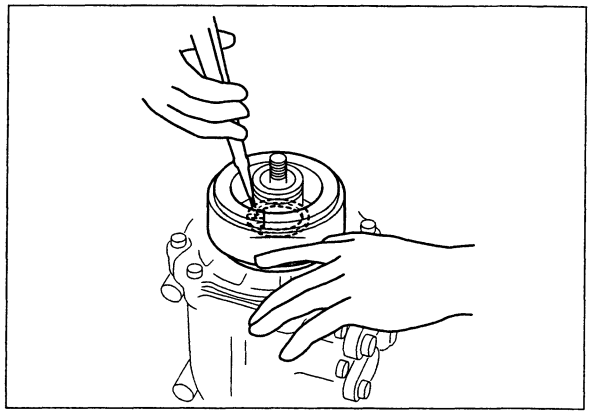
(1) Insert the key into the clankshaft.
(2) Insert the field core.



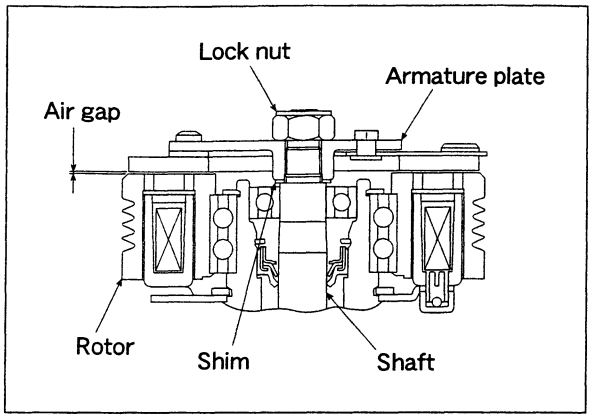
(a) Insert the field core into the front case and position it with a knock pin.
(b) Insert the snap ring for fixing field core into the groove and fix it with snap ring pliers as shown the below.



(c) Connect the ground wire.
(3) Insert the rotor into the front case.



(4) Insert the snap ring for the front case side into the groove with snap ring pliers.



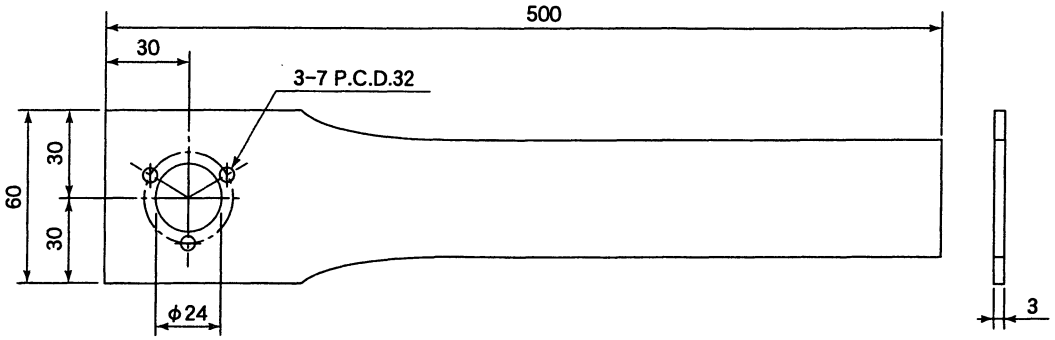
(5) Insert the armature plate.
(a) Place a shim on the end of the shaft and insert the armature plate, adjusting to the key.
(b) Tighten the center bolt to the specified torque, 15.7N.m, with in between plain washer.
(c) Measure the air gap.
The air gap should be within 0.4 to 0.65 ㎜.
Adjust it by shim if it is not within the specifications.
Adjusting shim : 0.1, 0.3, 0.5, or 0.8 ㎜.

9.3 Special tool figure

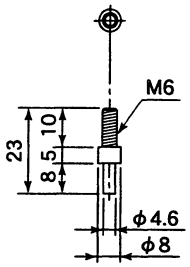
The dimension are in millimeter

(1) Armature plate fixture

① Material S45C



② Material S45C(3個)



MITSUBISHI
FUSO

Group 55A
Air-conditioner
< 4M50 >

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-55A1

FOREWORD

This service manual describes the maintenance deta consisting of constructive & outline, inspection, and repair service of MITSUBISHI FUSO GENUINE TRUCK CAB AIR CONDITIONER

Table of contents

1. SPECIFICATIONS ---- 1
2. OUTLINES OF REFRIGERATION SYSTEM ---- 2
3. CONSTRUCTION ---- 4
4. TROUBLE SHOOTING ---- 12
5. REMOVAL AND INSTALLATION ---- 19
6. TREATMENT AFTER INSTALLATION ---- 22
7. MAINTENANCE ---- 28
8. COOLING UNIT ASSEMBLY ---- 29
9. COMPRESSOR & CLUTCH ASSEMBLY ---- 31

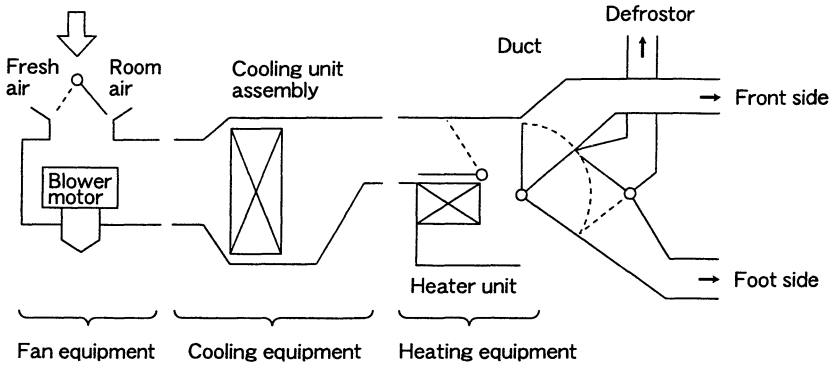
1. SPECIFICATIONS

Item			Specification
Vehicle model			FH 2003
* Cooling capacity (on JIS conditions)			4,200W
Compressor	Model		MSC90T
	Displacement		90cm³
	Maximum revolution		MAX 9,000min^{-1}
	Compressor oil		SUN PAG 56, 120cm³
Magnetic clutch	Type		Dry single disc magnet
	Voltage & input		DC12V, 38W
Cooling unit assembly	Type		Laminated fin type
Controls	Air flow control		Rotary switch, Four step type
	Temperature control		Air mix control
Condenser	Type		Corrugate fin type
Receiver assembly			Cylinder type, approx 350cm³
Protective equipment	Frost prevention (Thermostat)		OFF : 0.5℃ ON : 3.5℃
	Releif valve		Open : 3.50~4.10MPa Close : 2.94MPa
	Dual pressure switch	Low pressure switch	OFF : 0.2MPa ON : 0.22MPa
		High pressure switch	OFF : 2.94MPa ON : 2.35MPa
	Fuse (Fan equipmemt) Fuse (Magnetic clutch)		10A 10A
Refrigerant and quantity			HFC-134a, 23oz

- The * marked cooling capacity is based on JIS conditions.
- Compressor speed : 1,800min^{-1}
- Condensing temperature : 55℃
- Cooling unit inlet air dry bulb temperature : 27℃
- Cooling unit inlet air wet bulb temperature : 19.5℃
- Terminal voltage :DC24V

2. OUTLINES OF REFRIGERATION SYSTEM

2.1 Air system



Cooling operation

Fresh air is induced to the cooling unit assembly by a blower fan, where it is cooled down and dehydrated, charged at the front side outlet through a duct.

Heating operation

Fresh air is induced to the heater unit by a blower fan through the cooling unit assembly, where it is heated, then discharged at the foot side outlet through a duct.

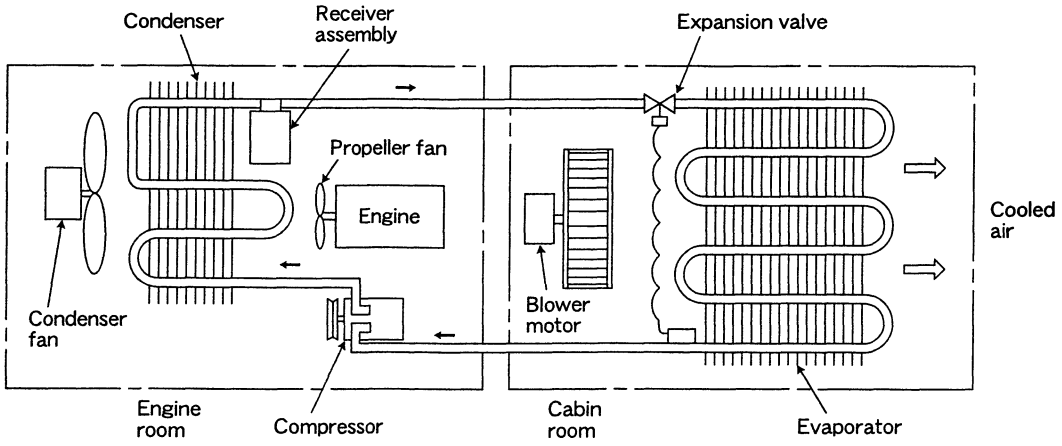
Dehumidifying operation

Fresh air is induced to the cooling by a blower fan, where it is cooled down and dehydrated, and succeedingly to the heater unit for warming, then discharged at the front side outlet through a duct.

Temperature control

Cooled air and warmed air are mixed for temperature control of the room inside.

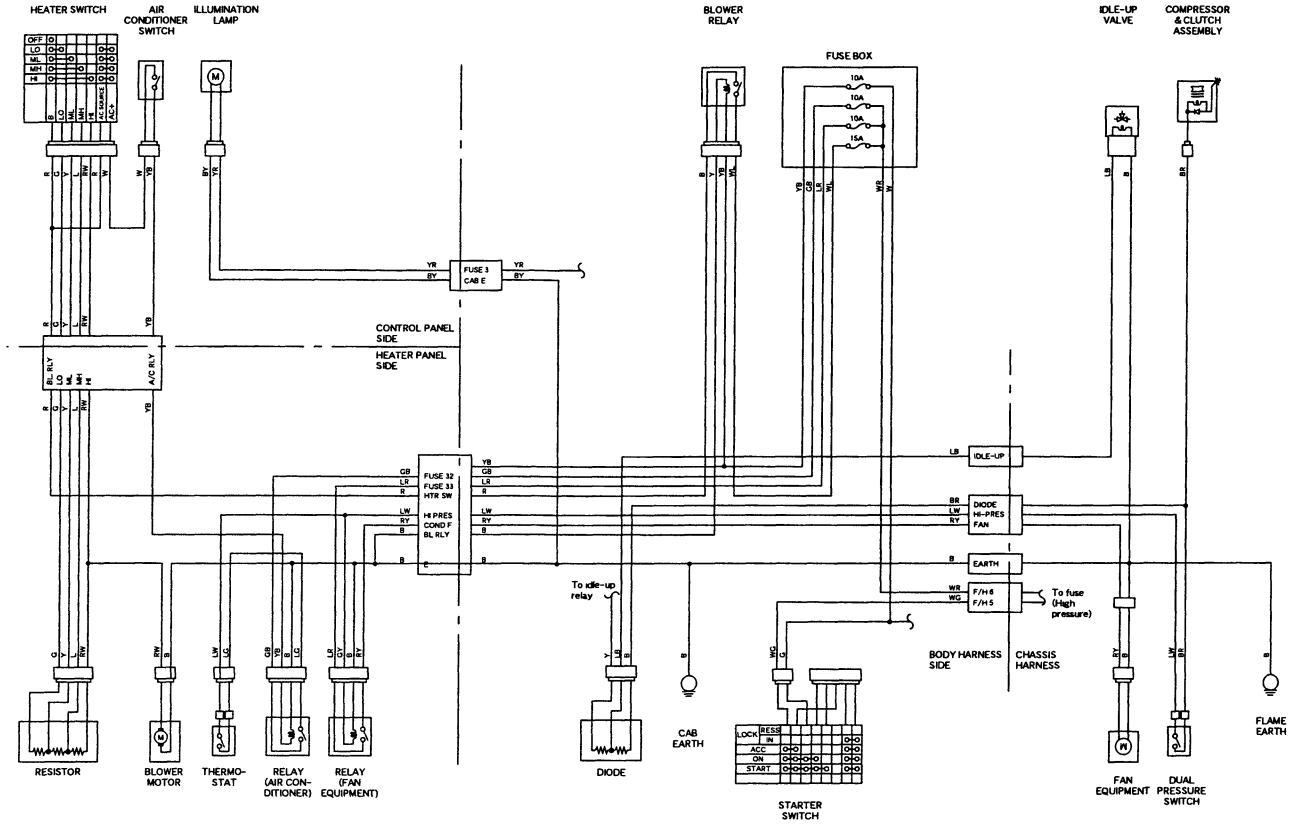
2.2 Refrigerating circuit



While the refrigerant, HFC-134a is cooling the air drawn into the evaporator, it evaporates and becomes a gas. This gas is compressed to high pressure and temperature in the compressor, and sent into the condenser, where it is cooled and becomes liquid.
This cooling in the condenser is carried out by the open air passing through the condenser sucked by radiator fan and vehicle motion of the vehicle.
The liquid refrigerant flows through the receiver assembly where water and dirt are removed, and then it enters the expansion valve. Here the liquid refrigerant is throttled and changed to a mixture of liquid and gas in low temperature and low pressure, and is sent to the evaporator.

In the evaporator, the refrigerant absorbs heat from the surroundings and becomes a gas. That is, because the evaporator it self is cooled at this time, the return air to the cooling unit assembly is cooled,
and the interior of the vehicle becomes cool. In this way the refrigerant flow makes a complete circuit.

2.3 Electrical system



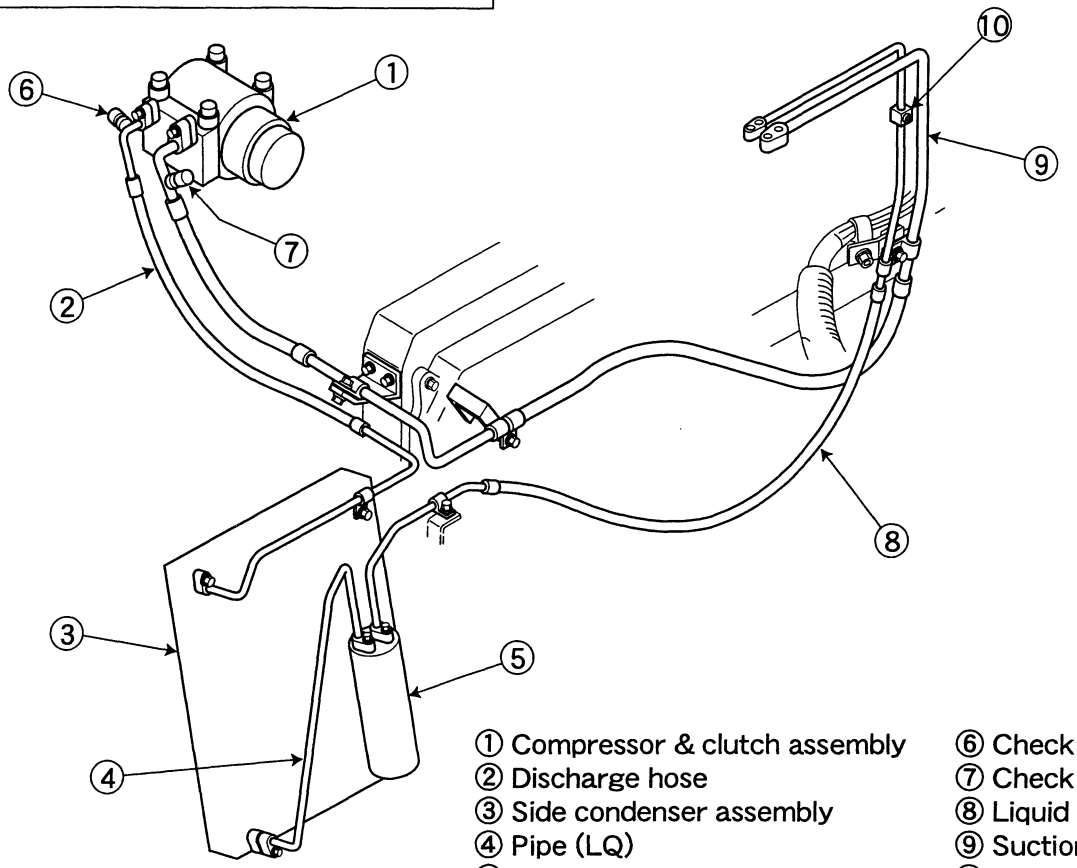
The power source is supplied from the TRUCK battery. When the blower switch is put ON, the power relay becomes ON, and electricity is connected to the magnetic clutch of the compressor. The magnetic clutch switches ON or OFF by air conditioner switch, fin thermo, and low pressure switch as the controls for operation service, or safety protection.

The cabin room air temperature is set to a preset point by adjusting the temperature control lever, and the opening degree of the air mix damper.

3. CONSTRUCTION

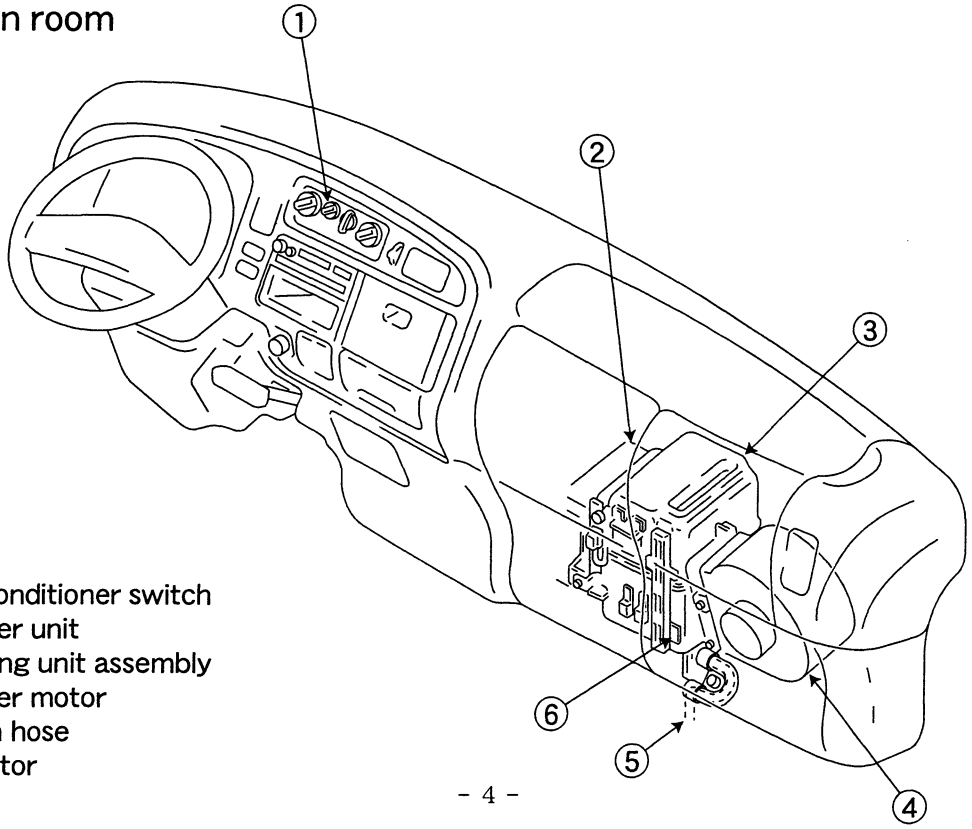
3.1 Engine room

A figure is a 6D34 engine loading car.



① Compressor & clutch assembly
② Discharge hose
③ Side condenser assembly
④ Pipe (LQ)
⑤ Receiver assembly
⑥ Check valve (HP)
⑦ Check valve (LP)
⑧ Liquid hose
⑨ Suction hose
⑩ Sight glass

3.2 Cabin room



① Air conditioner switch
② Heater unit
③ Cooling unit assembly
④ Blower motor
⑤ Drain hose
⑥ Resistor

3.3 Control system

(1) Control in panel

Do not run the air conditioner when it is child.

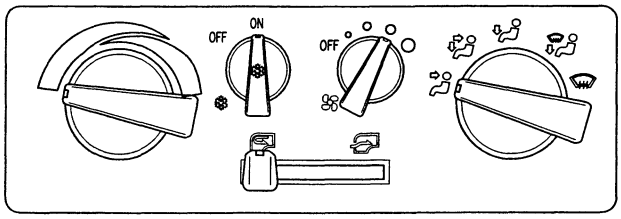
☐ Air conditioner switch
By select the air conditioner switch initially in cooling or drying operation, the compressor starts running.

☐ Fan switch
The air flow is selectable, out of the below four volume.

OFF	No air flow
◦	Gentle
o	Low
o	Medium
O	High

☐ Air outlet mode select switch
The air outlet is selected by positioning in cooling and heating operation.

- ----- The conditioned air is discharged at the center and both side outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the center and both side and foot outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the foot outlets directed by the louvers as reguired.
- ----- The conditioned air for dehumidifying is discharged at the foot outlets and to the front glass.
- ----- The conditioned air for dehumidifying is discharged to the front glass.



☐ Temperature control switch
The discharged air temperature is controllable by selecting the position of the control lever in cooling, heating or drying operation.

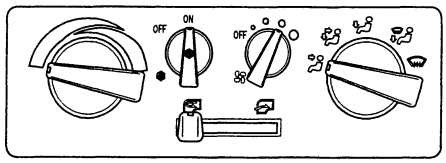
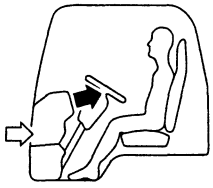
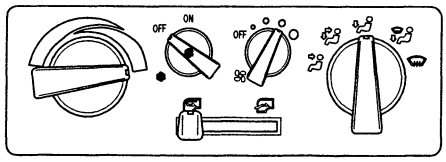
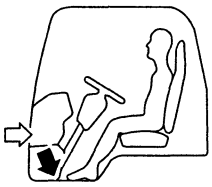
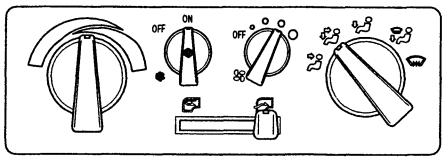
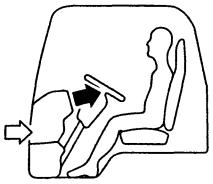
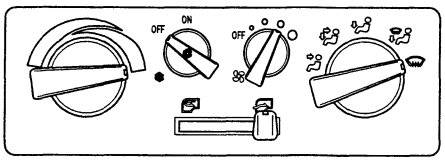
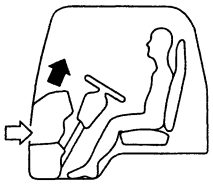
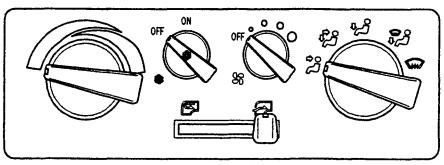
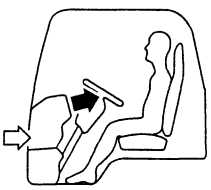
BLUE ZONE ------ For cool air flow
RED ZONE ------- For warm air flow

By turning the switch toward the BLUE and RED ZONE sides, the supply air temperature becomes more cooler and warmer respectively.

☐ Shift lever, air circulation
The recirculation air is selectable out of the below circulation modes.

- ----- Room circulation
- ----- Fresh air intake

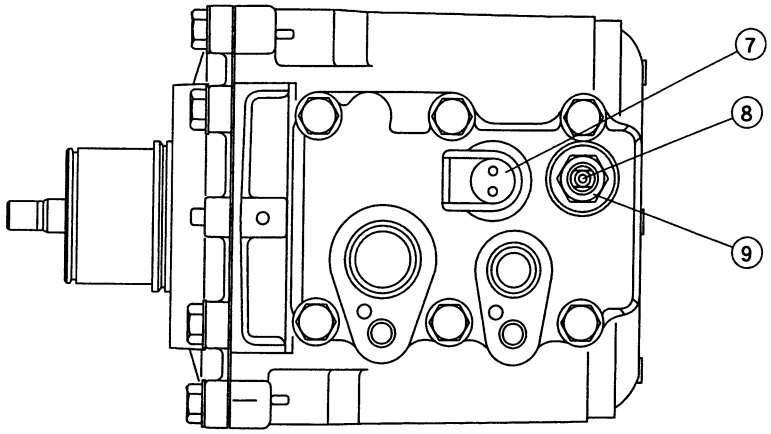
(2) Operation control

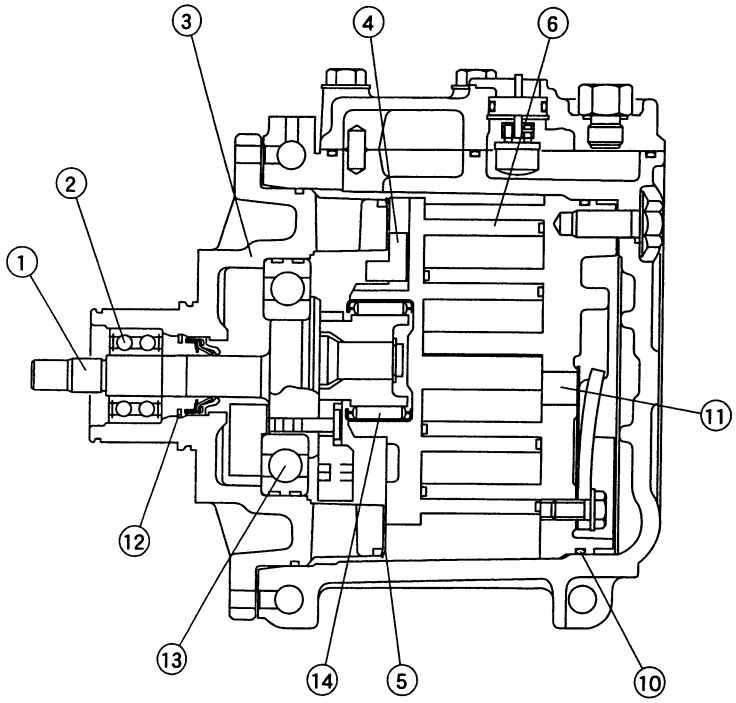
Operation mode	Setting control lever	Air delivery	Remarks
COOL			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation
HEAT			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation Air outlet mode select switch
DEHUMIDIFY			Wetty conditioning in head cooled, and foot warmed : Shift lever : Air outlet Air outlet mode select switch
DEFROST			
VENTILATION			

3.4 Compressor and clutch assembly

3.4.1 Compressor

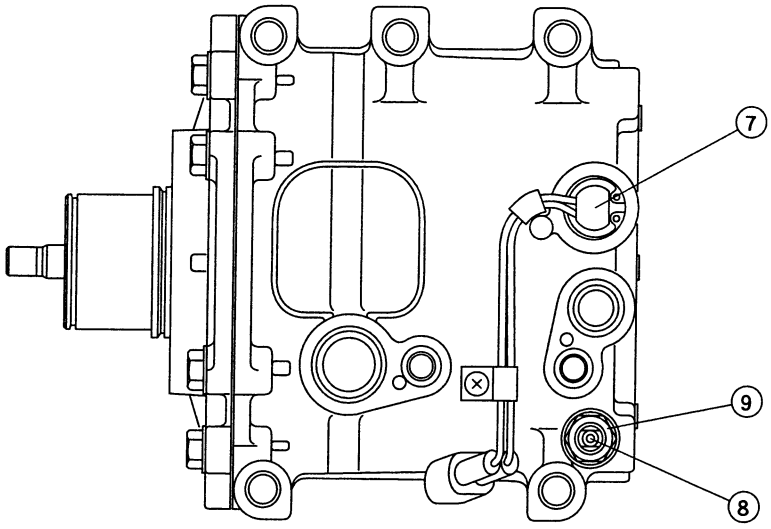
FOR 6D34

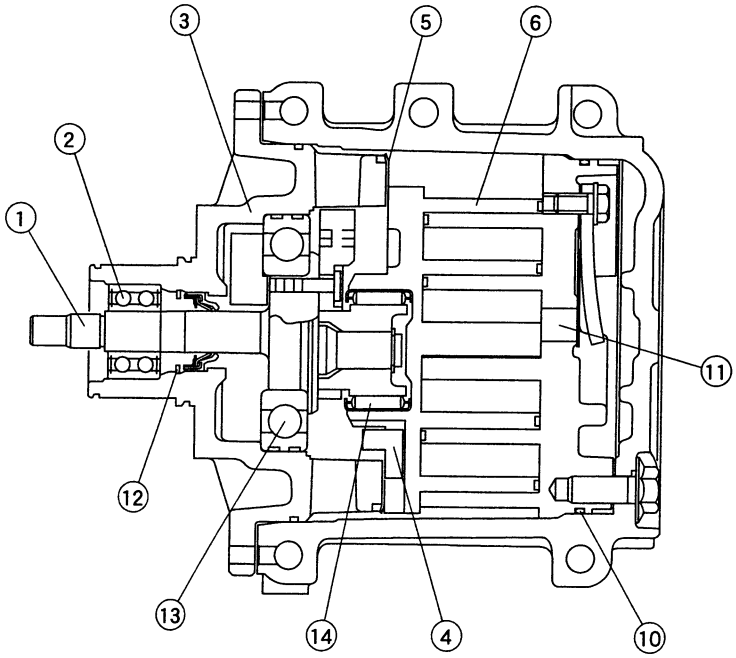




① Crankshaft
② Bearing
③ Front case assembly
④ Housing assembly
⑤ Thrust plate
⑥ Orbit scroll assembly
⑦ Thermostat
⑧ Dust seal
⑨ H/P relief valve
⑩ O-ring
⑪ Port hole
⑫ Shaft seal
⑬ Bearing
⑭ Needle bearing

FOR 4M50T





① Crankshaft
② Bearing
③ Front case assembly
④ Housing assembly
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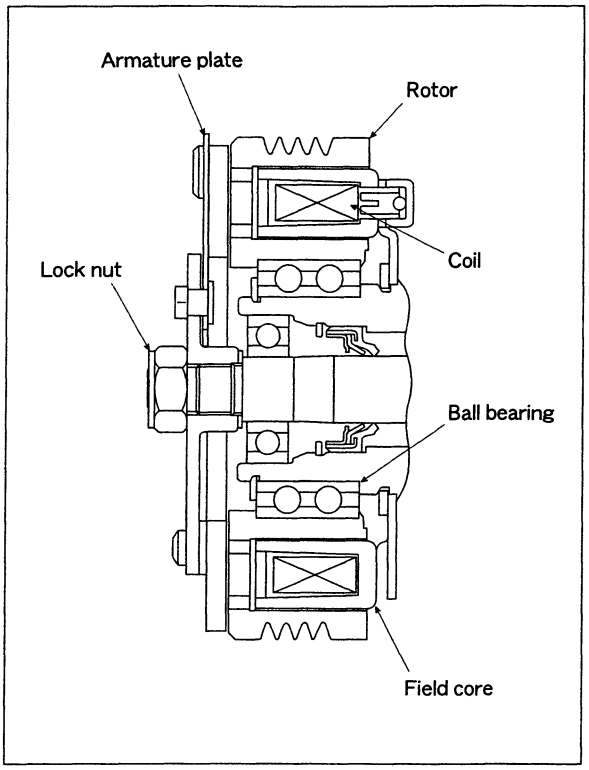
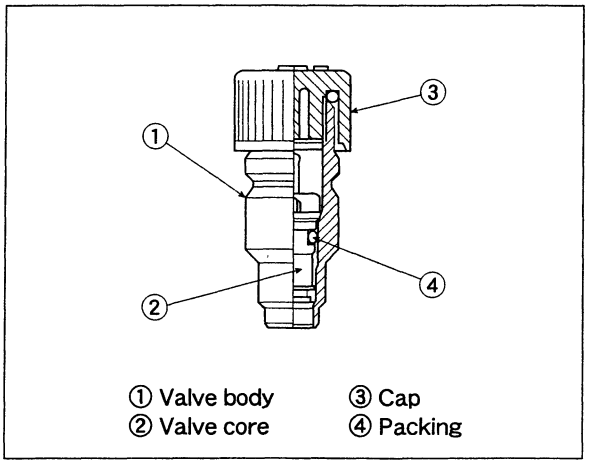
⑥ Orbit scroll assembly
⑦ Thermostat
⑧ Dust seal
⑨ H/P relief valve
⑩ O-ring
⑪ Port hole
⑫ Shaft seal
⑬ Bearing
⑭ Needle bearing

3.4.2 Magnetic clutch



The magnetic clutch is mounted on the compressor crankshaft to start and stop the compressor.
This means that the magnetic clutch is actuated to control the compressor operation electrically by the thermostat.

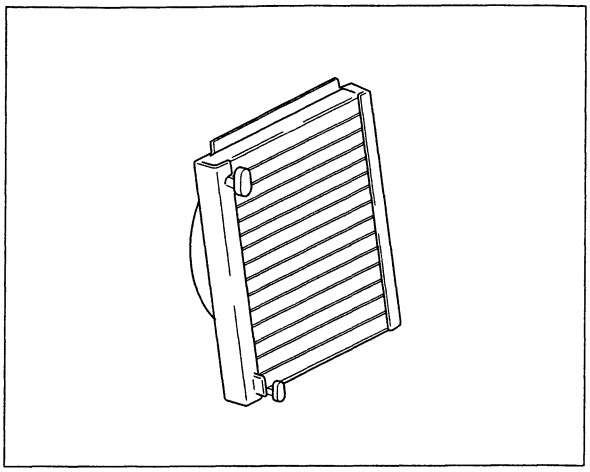
3.5 Check valve



① Valve body ③ Cap
② Valve core ④ Packing

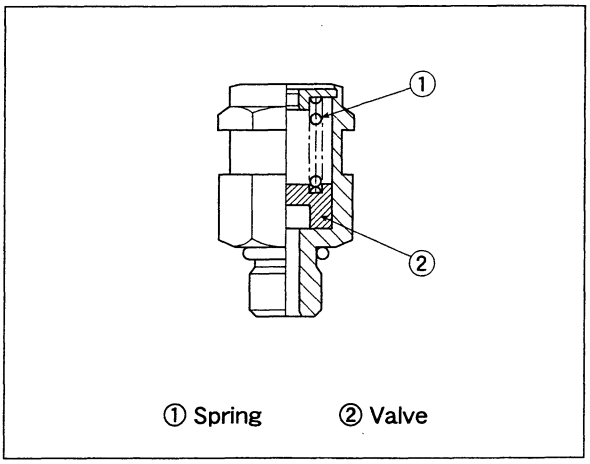
The suction hose and discharge hose are provided with check valve, and designed for gas evacuation and charging service. (shown above)
In the valves, a valve rubber tube, as in automobile tire tubes, is provided as shown in the figure.
Stackening the flare nut on the gauge manifold causes the passege to close automatically by the spring force, and tightening the flare nut causes the passege to open while pressing the compressed spring.

3.6 Side condenser assembly



The condenser is a means to liquefy the refrigerant gas. As the condenser is cooled by the air pulled in by the condenser fan, the refrigerant in the condenser is cooled into liquid. Therefore, when any obstacle prevents the air from flowing evenly to the condenser or the air flow is short circuited, the cooling effect is reduced, with a decrease in the performance of the condenser. When the vehicle is driven at a high speed, the air flow increases resulting in an increase of the cooling effect, and performance of the condenser.

3.7 Relief valve



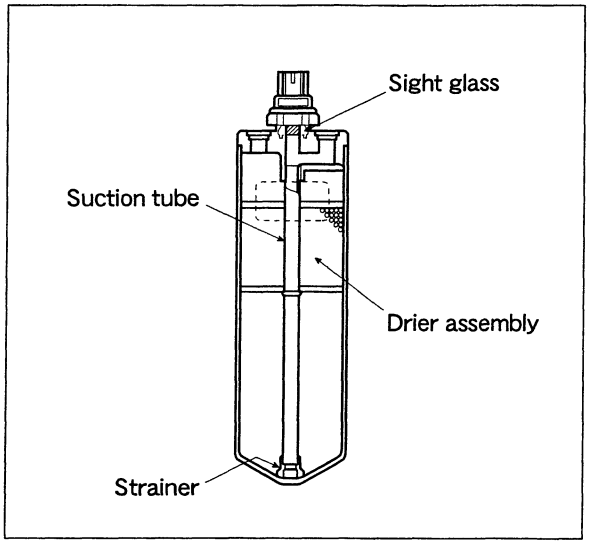
① Spring ② Valve

The relief valve is mounted to the compressor & clutch assembly. The relief valve is usually closed by spring. If pressure of refrigerant in air conditioner system is higher than spring pressure, refrigerant is discharged from relief valve. The pressure drop due to discharge refrigerant, and relief valve is closed again.

Unit : MPa

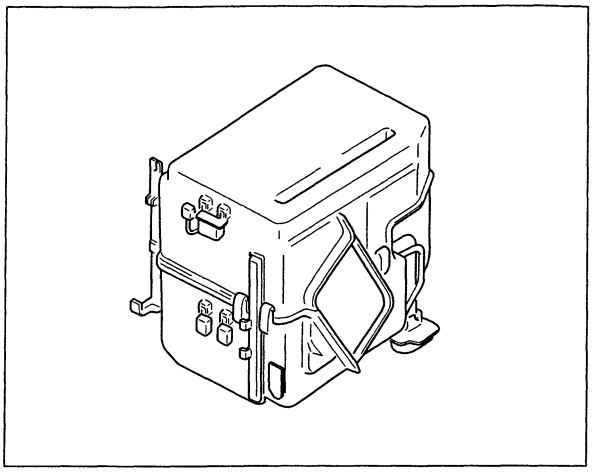
Open	3.50~4.10
Close	2.94

3.8 Receiver assembly



The receiver assembly is served as a refrigerant reservoir located between the condenser and expansion valve. The receiver assembly consists of a filter and a sight glass. The filter is used to remove dust , the drier is used to remove moisture from the refrigerant in the circuit, and the sight glass is used to check the refrigerant charge. Any moisture in the refrigerant may not only corrode metal surfaces in the refrigerant circuit, but also cause the throttle of the expansion valve to be frosted, resulting in the interruption of refrigerant circulation.
Therefore, the receiver assembly must be handled very carefully. When storing or installing it, care should be taken to protect it from the deterioration of drying performance due to exposure to the air.
The retardation of heat exchange, or any fire around the refrigerant circuit will cause excessive pressurization or heating of the refrigerant. Should such an accident occur, the refrigerant in the circuit must be expelled to the outside to prevent the above hazards.
The sight glass is a sort of peep window used to check the refrigerant flow in the refrigerant circuit.
The sight glass appears clear when the refrigerant flow is enough, and shows bubbles flowing when the refrigerant flow is short.

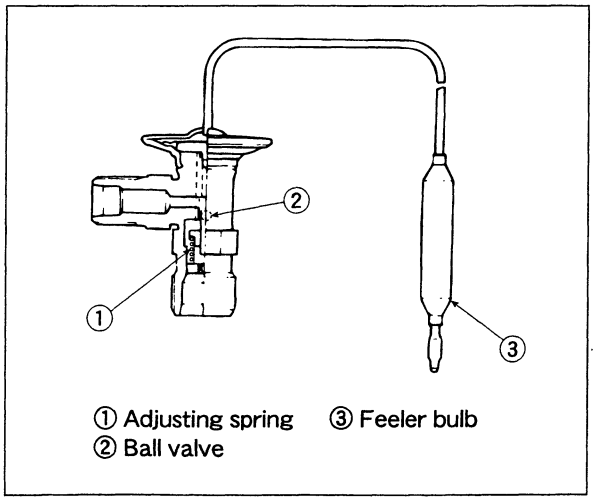
3.9 Cooling unit assembly



The evaporator core is a type of corrugated fin and tube. The tube is arranged in zigzag to achieve high effciency, and to make the core system compact.
A thicker reinforced plastic plate is used as the enclosure to inclease heat and shock resistance, and to protect the core from humidity. This case is a split type, and in a simple design to facilitate installation on the floor panel and the instrument panel frame of the vehicle.

3.10 Expansion valve

The expansion valve is mounted at the inlet of the cooling unit. The liquid refrigerant from the receiver is led to it through a narrow passage (for throttle action), where-in, the liquid refrigerant is condensed with pressure dropping and at the same time the flow rate is adjusted before the refrigerant is sent to the cooling unit.
The refrigeration load in the cooling unit is not constant, but usually fluctuates over a certain range. So the refrigerant flow should under go the control in design.
An automatic expansion valve performs this function automatically. The air condenser uses a thermal type automatic expansion valve.



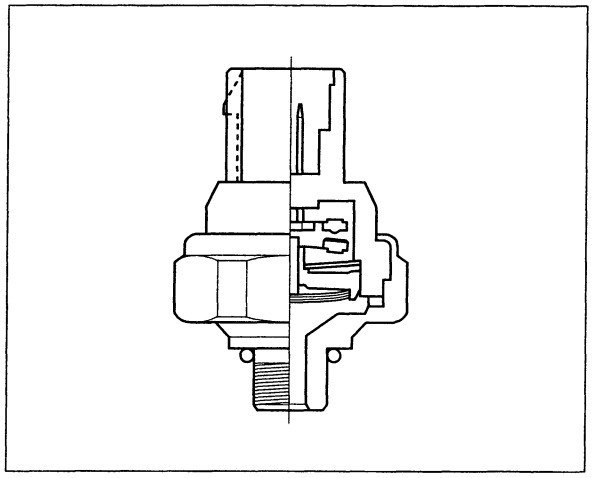
① Adjusting spring ③ Feeler bulb
② Ball valve

3.11 Dual pressure switch

The dual pressure switch, fixed to the receiver functions as a protector for stopping the compressor (OFF) at a preset value of pressure in the refrigerant circuit.

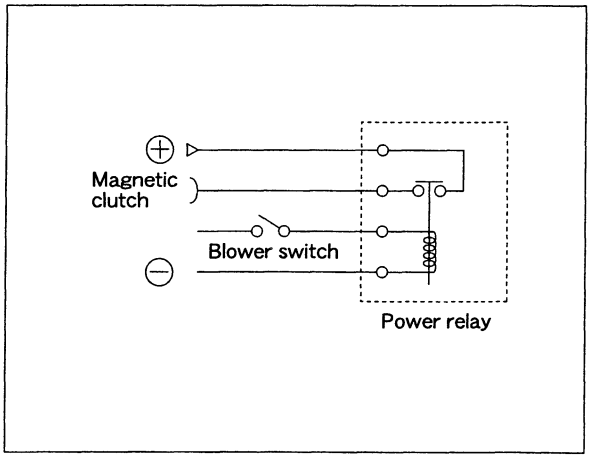
Unit : MPa

	LP side	HP side
OFF	0.2	2.94
ON	0.22	2.35



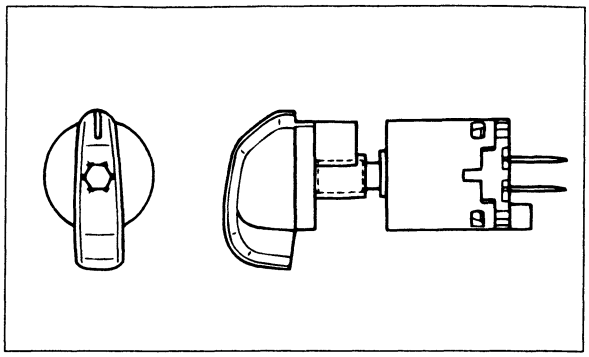
3.12 Power relay

The power relay is excited at a closed position of the micro switch and enables the magnetic clutch to be ready for engaging electically.



3.13 Air conditioner switch

The air conditioner switch function as an operation controller for starting or stopping the compressor in cooling and dehumidifying.
Set the it to the "ON" position, the magnetic clutch becomes engaged and the compressor starts.
Set the it to the "OFF" position, the magnetic clutch becomes disengaged and the compressor stops.

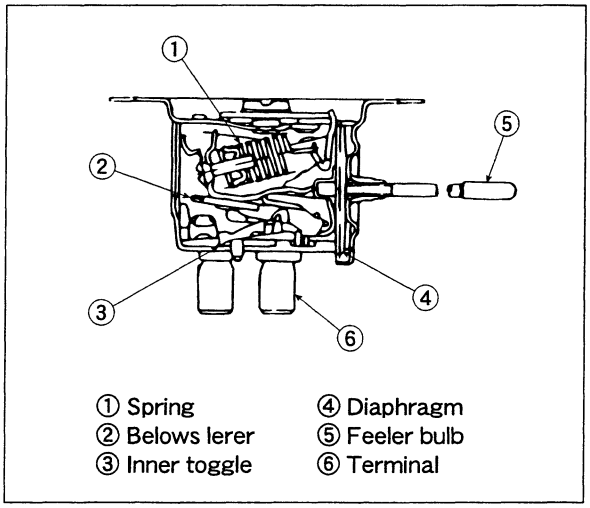


3.14 Thermostat

The thermostat is mounted on the evaporator case. It senses the temperature of evaporator fins, and controls the compressor operation for ON or OFF as specified below.

Unit : ℃

OFF	33
ON	38



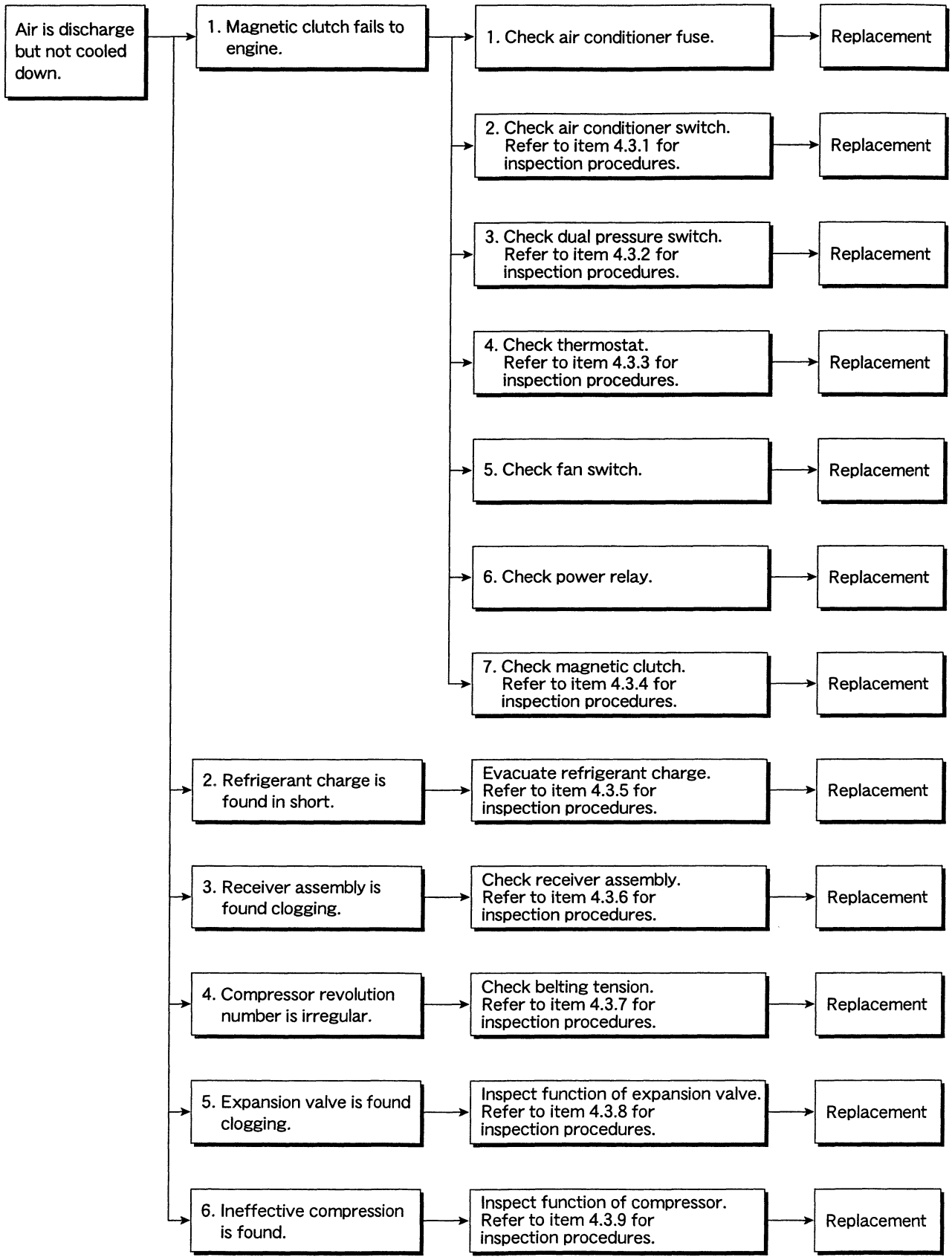
4 . TROUBLE SHOOTING

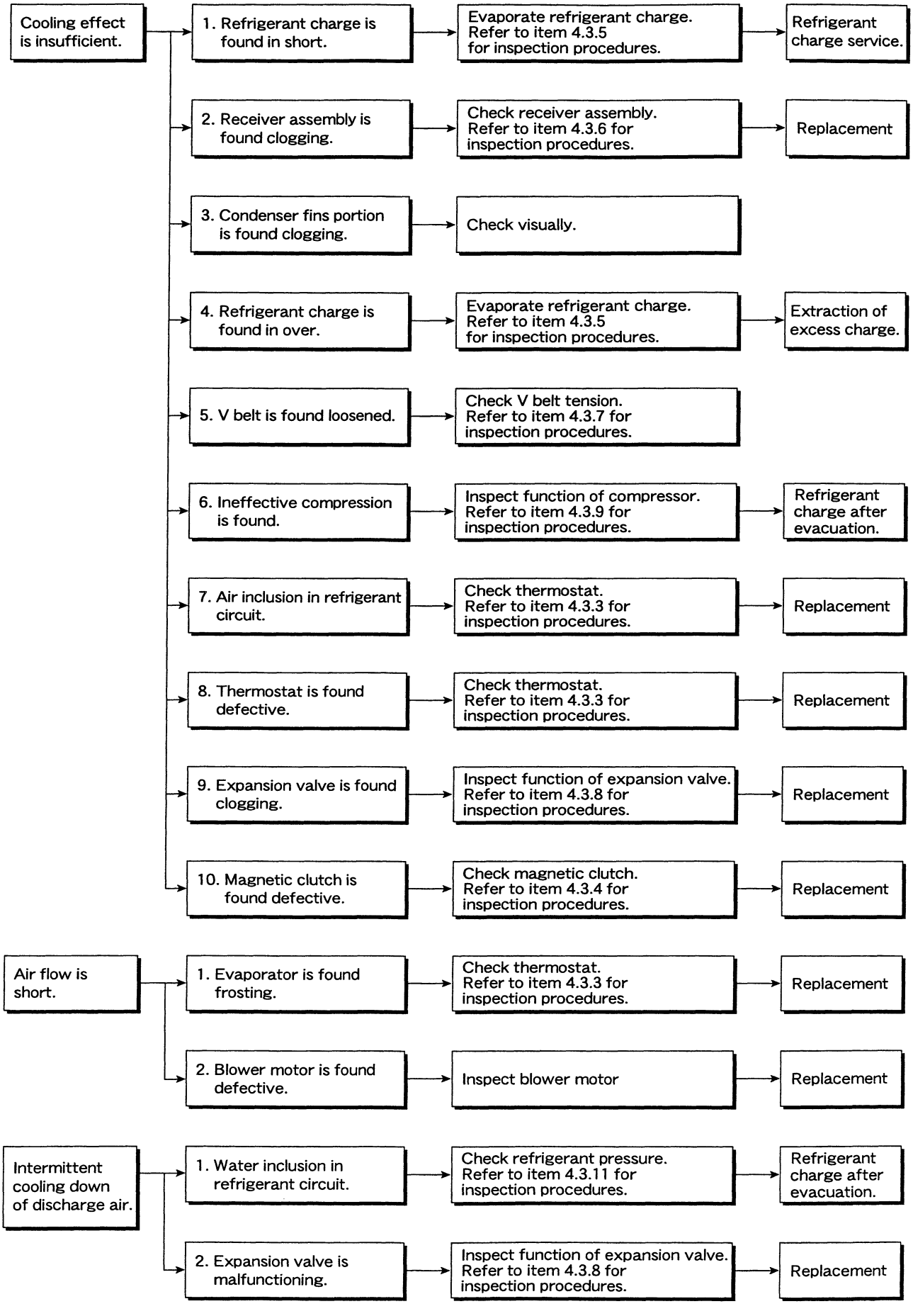
4.1 General precaution

(1) When handling refrigerant (HFC-134a), the following precautions must be observed.
   a. Allways wear eye protection and a pair of gloves which handling refrigerant.
   b. Be careful the liquid refrigerant dose not contact the skin.
   c. Keep the refrigerant container blow 40 degrees C.
   d. Do not handle the refrigerant in an enclosed area having an open flame. The refrigerant may produce a poisonous gas.
   e. When dumping the refrigerant from the system, release it slowly so as not to expell all the compressor oil.

(2) If liquid refrigerant strikes eye or skin.
   a. Do not rub eye or skin.
   b. Splash large quantities of cool water on the eye or skin.
   c. Rush to a physician or hospital for immediate professional treatment.

4.2 Trouble cause and remedy




Cooling effect is insufficient.
1. Refrigerant charge is found in short.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Refrigerant charge service.
2. Receiver assembly is found clogging.
Check receiver assembly. Refer to item 4.3.6 for inspection procedures.
Replacement
3. Condenser fins portion is found clogging.
Check visually.
4. Refrigerant charge is found in over.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Extraction of excess charge.
5. V belt is found loosened.
Check V belt tension. Refer to item 4.3.7 for inspection procedures.
6. Ineffective compression is found.
Inspect function of compressor. Refer to item 4.3.9 for inspection procedures.
Refrigerant charge after evacuation.
7. Air inclusion in refrigerant circuit.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
8. Thermostat is found defective.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
9. Expansion valve is found clogging.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement
10. Magnetic clutch is found defective.
Check magnetic clutch. Refer to item 4.3.4 for inspection procedures.
Replacement
Air flow is short.
1. Evaporator is found frosting.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
2. Blower motor is found defective.
Inspect blower motor
Replacement
Intermittent cooling down of discharge air.
1. Water inclusion in refrigerant circuit.
Check refrigerant pressure. Refer to item 4.3.11 for inspection procedures.
Refrigerant charge after evacuation.
2. Expansion valve is malfunctioning.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement

4.3 Inspection procedure

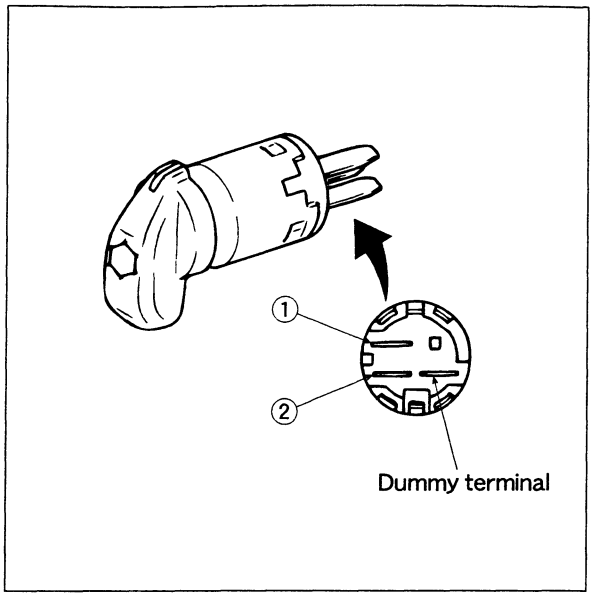
4.3.1 Air conditioner switch

(1) Unplug the air conditioner switch.
(2) Check the continuity between terminals of the air conditioner switch with a tester.

Continuity

Switch position	Terminal's number	Result, in normal
OFF	①-②	No
ON	①-②	Yes

Switch position \ Terminal's number	1	2
OFF	○	
ON	○	○

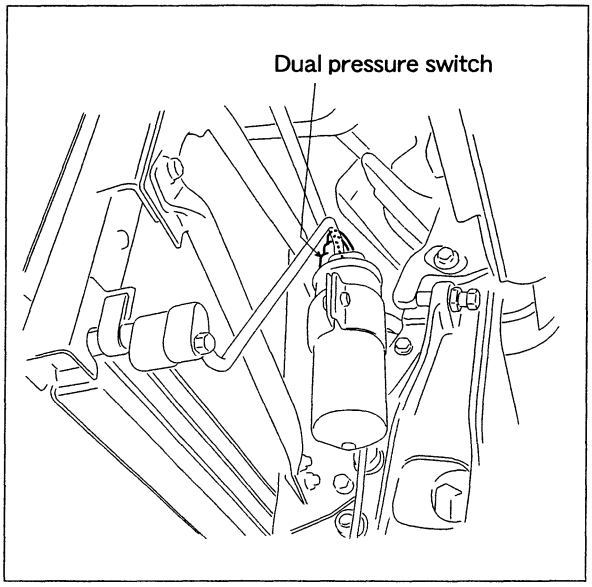


4.3.2 Dual pressure switch

The dual pressure switch is attached to the receiver assembly for controlling the operation of the air conditioner by checking the inside pressure of the receiver assembly.

Unit : MPa

	LP side	HP side
OFF	0.2	2.94
ON	0.22	2.35



(1) Unplug the connector at the receiver assembly.
(2) Check the continuity between terminals of the connector with a tester.
(3) When electric continuity is found, connect the connector to the high pressure switch.
(4) Attach the high pressure gauge and low pressure gauge.
(5) Operate the air conditioner.
(6) Cover the surface of the condenser by using a piece of paper.
(7) When the high pressure exceeds 2.94 MPa, if the magnetic clutch is turned off, the switch is normal.
(8) If the magnetic clutch is not turned off, replace pressure switch with new one.
(9) Check the accuracy of the preset as below.
  (a) Stop the air conditioner.
  (b) Purge the air conditioner of refrigerant slowly starting at over 0.22 MPa.
  (c) At reading the pressure 0.2 MPa, the switch opens.
  (d) Here, stop the purging, then turn it to charging.
  (e) At reading the pressure 0.22 MPa, the switch closes.

If the dual pressure switch does not meet specifications, replace the switch.

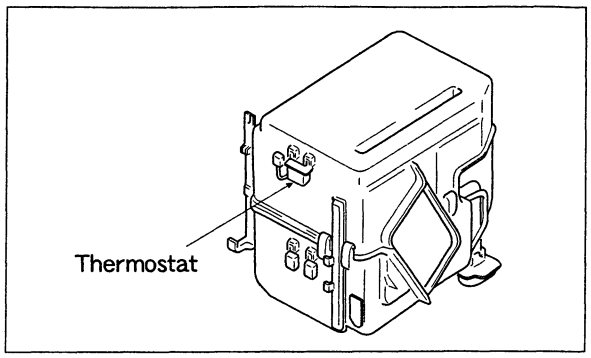
4.3.3 Thermostat

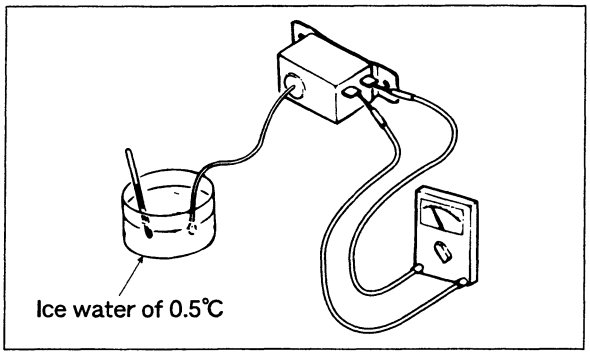
The thermostat is mounted on the evaporator case. It controls the operation of the air conditioner by sensing the temperature of the evaporator fins.

Unit : ℃

OFF	0.5
ON	3.5

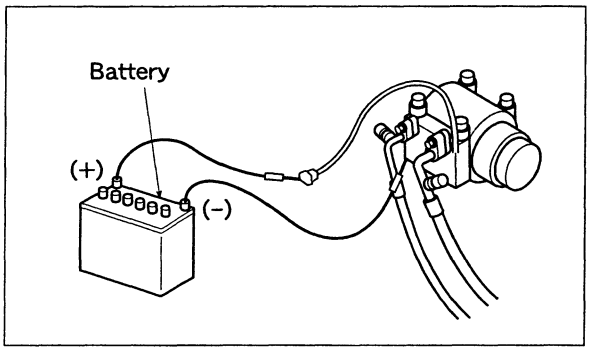
(1) Check the accuracy of the preset as below.
  (a) Soak the sensor of the thermostat in ice-water of below 0.5℃.
  (b) Check the continuity between the switch terminals.
  (c) Pull the senser out of the ice-water, and check the continuity at over 3.5℃ of the senser.





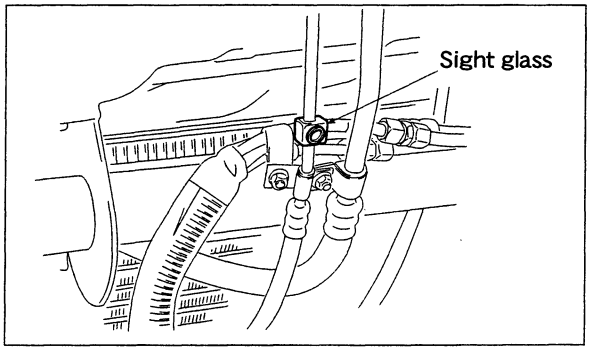
4.3.4 Magnetic clutch

(1) Disconnect the wiring to the magnetic clutch.
(2) Apply a positive side power voltage to the magnetic clutch through the wiring.
(3) In the case of regular functioning, the pulley and magnetic clutch are engaged with a clicking sound. The falling means any malfunction of the magnetic clutch.



4.3.5 Refrigerant charge

(1) Set the temperature control lever at the cool position.
(2) Open doors of the room.
(3) Set the blower switch at the ON position.
(4) Adjust the engine revolution at 1500min^{-1}.
(5) Operation the air conditioner switch for comp. ON.
(6) Watch the sight glass of the liquid hose at the inside of the engine room.
  (a) If judged insufficient refrigerant charging, repair the leaks, then charge it additionally.
  (b) If judged as over charging of refrigerant, extract an excess refrigerant.
(7) Diagnosis by pressure reading.
  (a) Short of refrigerant:
    Lower pressure for both LP and HP reading.
  (b) Express of refrigerant:
    Higher pressure for LP and HP reading.

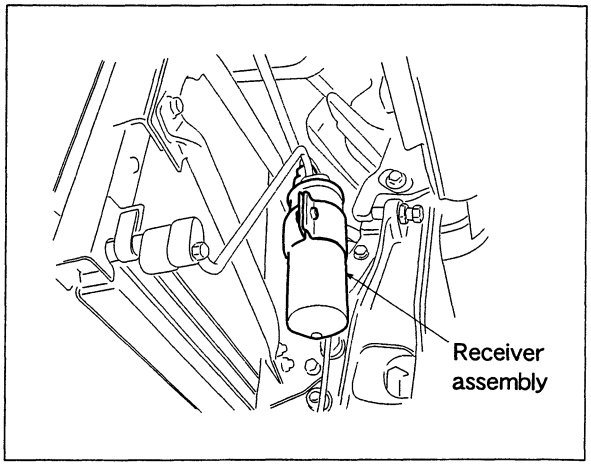


Sight glass		Remarks
Proper refrigerant level	Bubble	1. Bubble occasionally appears. 2. Bubble disappear if speed is a little increased.

Sight glass		Remarks
Insufficient refrigerant	Bubble	Considerable bubbles appear. If the system is extremely short of refrigerant, the sight glass appear white.
Excessive refrigerant		1. No bubbles appear. 2. Slight bubbles appear if speed is decreased.

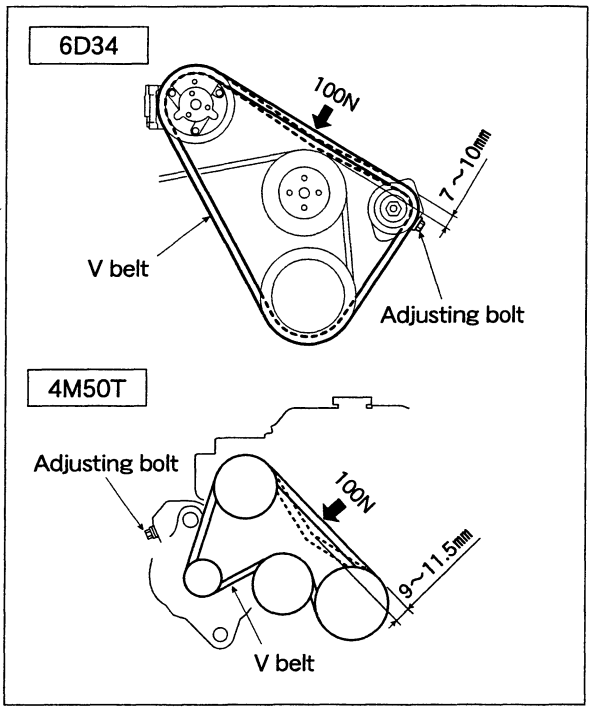
4.3.6 Receiver assembly

(1) While operating the air conditioner, touch the refrigerant piping with a hand at the inlet and outlet portions.
  (a) Sensed temperature difference:
    It is possible that clogging is happening at the inside, liquid receiver assembly is to be replaced with a new one.



4.3.7 Belt tension

(1) Depress the V belt with a thumb at the ⬅ marked position, and adjust the stretching as below.
  Stretching degree : 6D34 / 7～10 ㎜
    4M50T / 9～11.5 ㎜
(2) Adjustment
  (a) Loosen the nut of the tension pulley.
  (b) Control the belting tension by the adjusting bolt.
  (c) After finishing, retighten the nut as before.

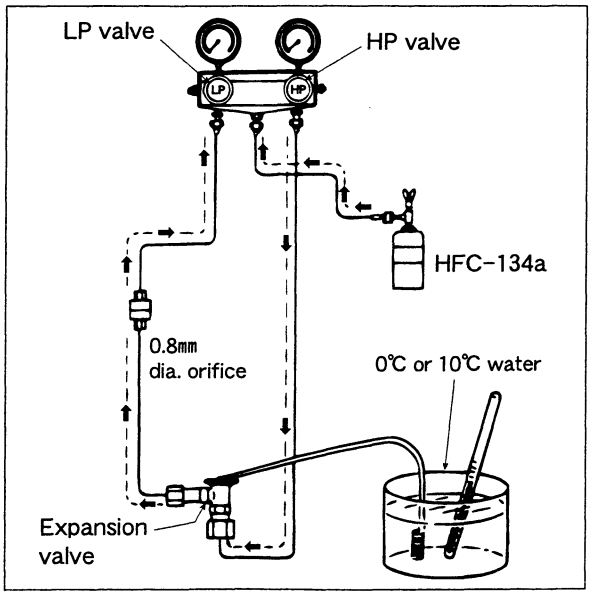


4.3.8 Expansion valve

⚠ CAUTION

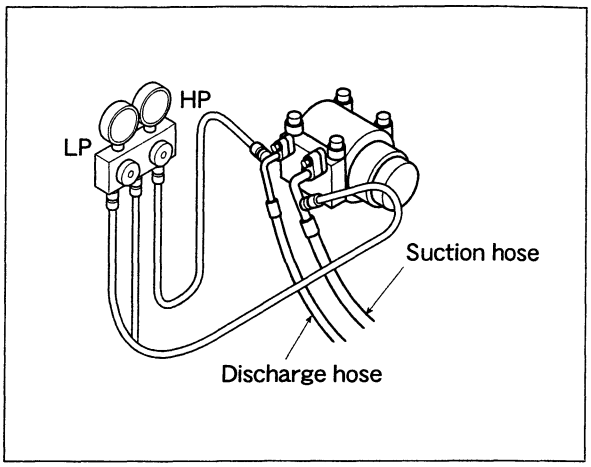
The test should be applied to only the case of the other components being free from troubles, and the expansion malfunctioning singly.

(1) Build up the test circuit with a gauge manifold.
(2) Soak the sensor bulb in ice water of 0℃, and of 10℃ respectively.
(3) Pressurize the HP side with dry nitrogen gas of 1.03MPa.
(4) Check the reading of the LP side pressure gauge for the standard range.
  At 0℃ ····0.127MPa
  At 10℃ ····0.23MPa



4.3.9 Pressure check

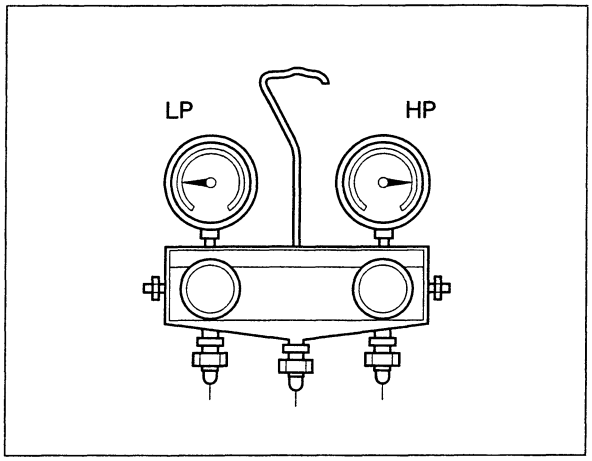
(1) Mount a low pressure gauge hose and a high pressure gauge hose on the check valve.
(2) Drive the air conditioner.
(3) Showing of higher LP side pressure and lower HP side pressure evidences ineffective compression.
Standard pressure
LP side pressure About 0.26MPa
HP side pressure About 1.42MPa



4.3.10 Air inclusion in ref.circuit

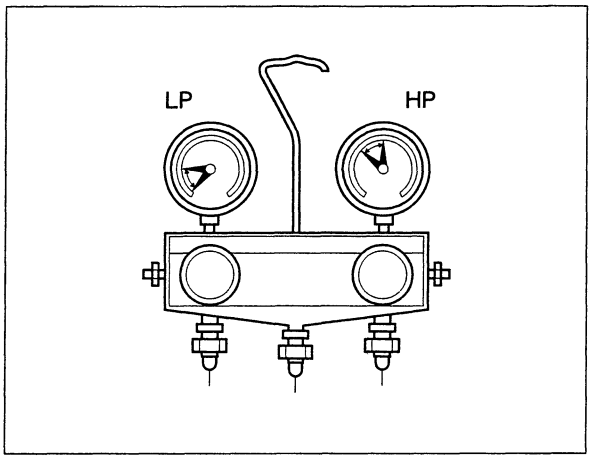
The abnormal reading of refrigerant circuit evidences afraid air inclusion.

A little higher LP side pressure. Noticeably higher HP side pressure.



4.3.11 Moisture inclusion in ref.circuit

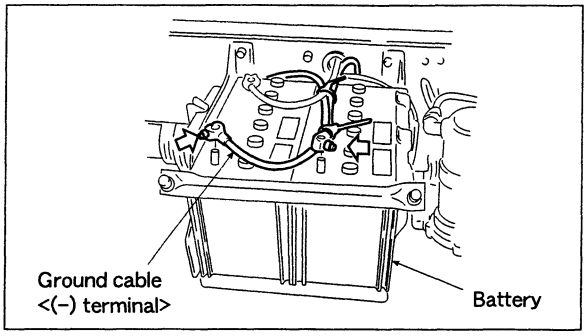
(1) During the operation, cooled air supply is interrupted periodically with a time interval.
This phenomenon evidences afraid water inclusion.
(2) Check the refrigerant pressure at a stop of the cooled air supply to make sure of the water inclusion.
LP side pressure ····Almost vacuum
HP side pressure ····Noticeably low



5. REMOVAL AND INSTALLATION

5.1 Precaution for removal and installation

(1) Disconnect the (-) ground cable from the battery, and place a cover on the battery.



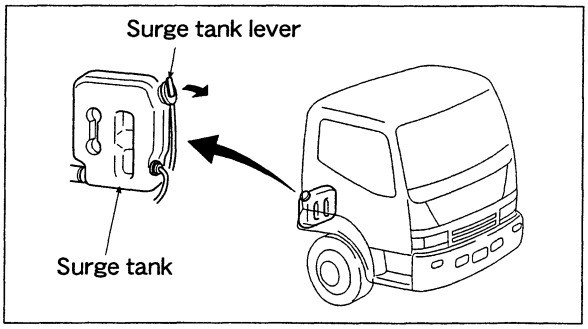
(2) Make certain all the openings are covered with caps in order to prevent entry of foreign substances such as dust and dirt.
(3) Never tamper with the brake and fuel systems, including the brake tubes and hoses.
(4) Avoid doing the work in a dusty place or outdoors in rainy weather. If tubes or functional parts are removed, put a cap in position immediately in order to prevent entry of dust and moisture.
(5) Connect the charging hose of the gauge manifold to the check valves (suction and discharge) of the suction hose and discharge hose, and recover the refrigerant by refrigerant recovery unit until its pressure is reduced to 0 kPa.
(Make sure that there is no internal pressure in the equipment.)
About discharging might result in the discharge of the refrigerant oil from the compressor.
(6) When coupling the flared tube, coat the flared portion with the compressor oil at the inner side.
(7) Make sure to use the wheel chocks.

5.2 Removal

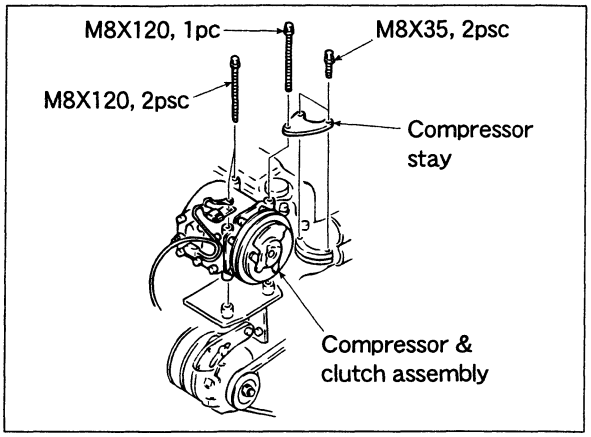
5.2.1 Inside engine room

(1) Compressor & clutch assembly

6D34

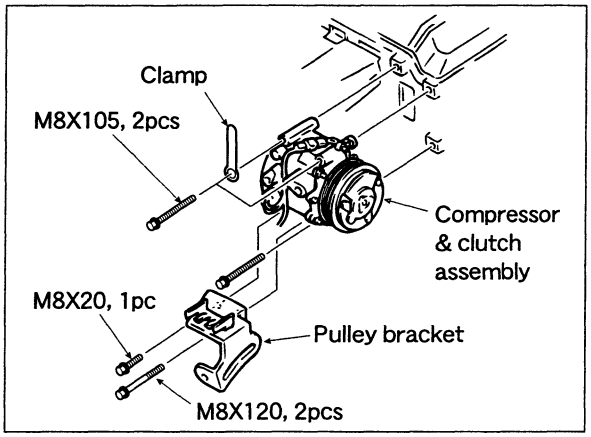


(a) Erect the pressure reducing lever of the radiator coolant surge tank cap to relieve the pressure from inside the radiator.
(b) Withdraw the wiring of magnetic clutch at the compressor.
(c) Remove the V belt by loosening fixture of the tension pulley.
(d) Take off the fixing bolts and anchor bolt : M8X35, 2pcs and M8X120, 1pc.
(e) Dismount the compressor stay.
(f) Take off the anchor bolts : M8X120, 2pcs.
(g) Dismount the compressor & clutch assembly.

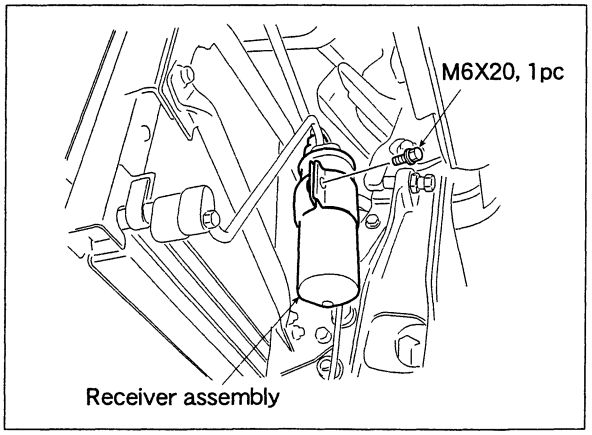


4M50T

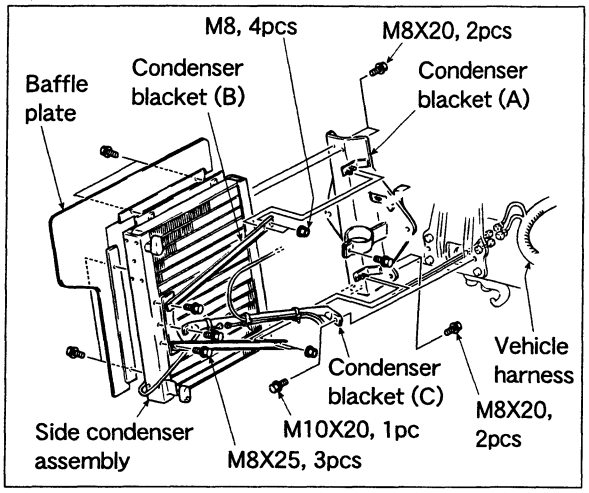
(a) Withdraw the wiring of the magnetic clutch at the connector.
(b) Remove the V belt by loosening fixature of the tension pulley
(c) Take off the fixing bolts : M8X105, 2pcs and M8X 120, 2pcs. (with clamp) and M8X20, 1pc.
(d) Dismount the compressor.



(2) Reciever assembly
(a) Unplug the dual pressure switch at the connector.
(b) Separete the interconnecting refrigerant pipe of the receiver assembly.
(c) Take off the fixing bolt : M6X20, 1pc.
(d) Dismount the receiver assembly.

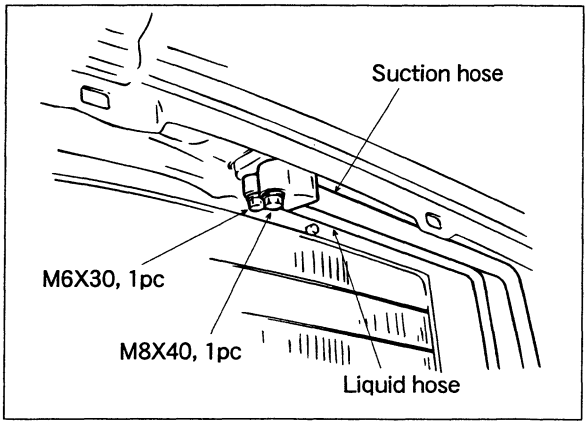


(3) Side condenser assembly
(a) Unplug the condenser fan harness at the vehicle side harness.
(b) Take off the fixing bolt : M8X25, 3pcs and M10X20, 1pc.
(c) Take off the fixing nut : M8, 4pcs.
(d) Dismount the condenser blacket (A), (B), (C).
(e) Take off the fixing bolt : M8X20, 4pcs.
(d) Dismount the side condenser assembly (and baffle plate).

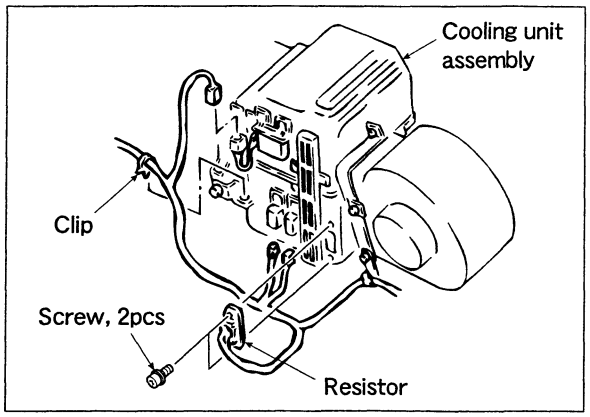


5.2 Cabin room

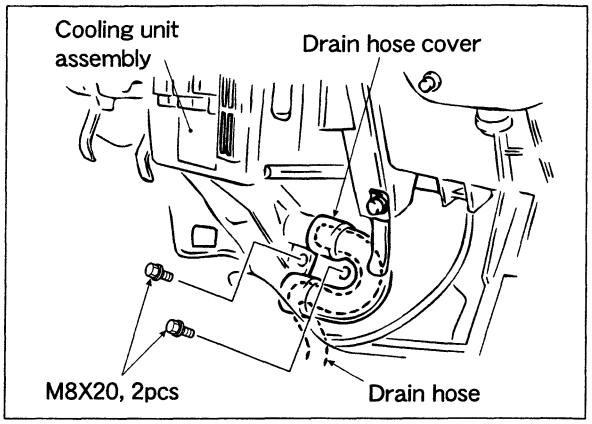
(1) Cooling unit assembly
(a) Separate the interconnecting refrigerant pipes of the cooling unit assembly.



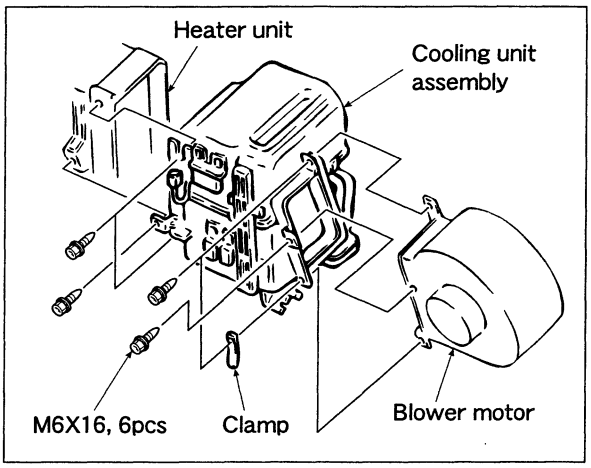
(b) Withdraw the wiring of the cooling unit assembly at the connectors.



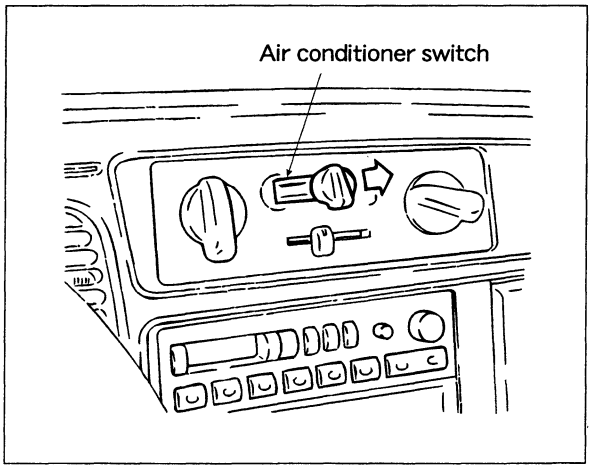
(c) Take off the fixing bolt : M8X20, 2pcs.
(d) Dismount the drain hose cover.
(e) Reconnect the drain hose from the cooling unit assembly.



(f) Take off the fixing screws : M6X16, 6pcs.
(g) Dismount the cooling unit assembly.



(2) Air conditioner switch
Pull out the air conditioner switch.



5.3 Installation

Installation is performed in the opposite sequence of removal.

○ Torque for tightening coupler of refrigerant tubing.

Unit : N • m

Compressor suction hose	29~34
Compressor discharge hose	20~25
Condenser inlet hose	20~25
Condenser outlet hose	12~14
Liquid receiver assembly inlet and outlet hoses	12~14
Cooling unit inlet hose	12~14
Cooling unit outlet hose	29~34

○ Torque for tightening general bolt and nut

Unit : N • m

Nominal size	Pitch	Tightening torque		
		Head mark 4	Head mark 7	Head mark 8
M5	0.8	3~4	5~6	5~7
M6	1.0	5~6	9~11	8~12
M8	1.25	12~14	19~24	19~29
M10	1.25	24~29	38~48	43~58
M10	1.5	17~26	32~48	41~58
M12	1.25	34~43	58~77	82~106
M14	1.5	72~82	115~134	125~173

NOTE

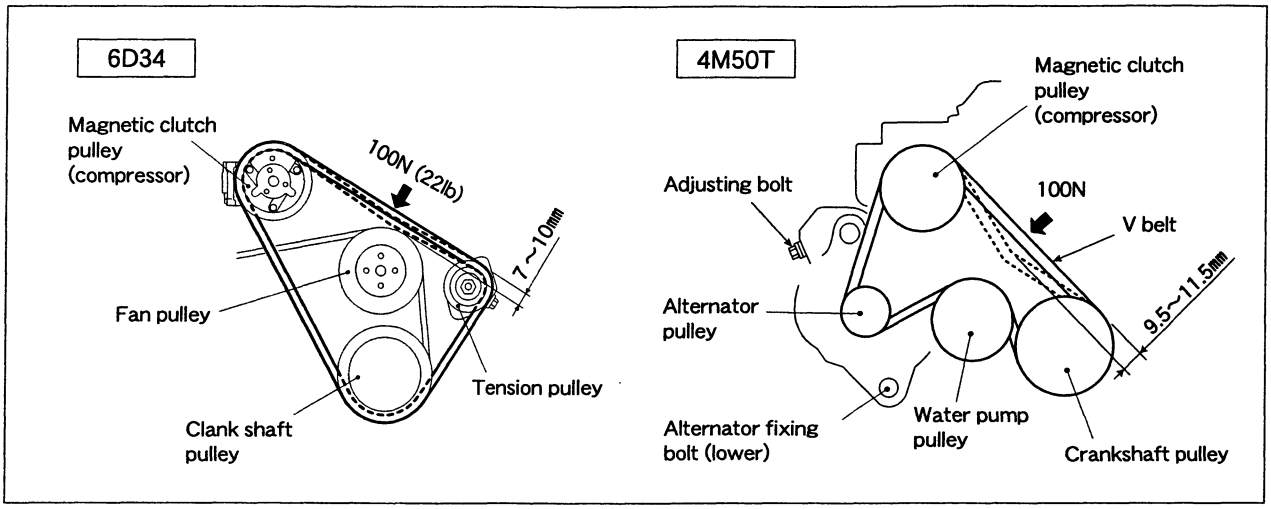
For the cases of spring washer seated, and thread or seating surface coated with oil, the value shall be reduced down to 85 percent of the data listed.

6. TREATMENT AFTER INSTALLATION

6.1 Check and adjustment

After installation, check the following points and confirm that everything is normal, then charge the gas, and do the performance and operation tests.

(1) Check if any abnormal vehicle performance, happens or not by installing the air conditioner.
(2) Check the operation of the magnetic clutch. (with the compressor disengaged)
(3) Check if any parts left unmounted or any tool left in the vehicle.
(4) Check to ensure that the temperature control lever operates properly.
(5) Check the tension of the belt.



6.2 Leak test

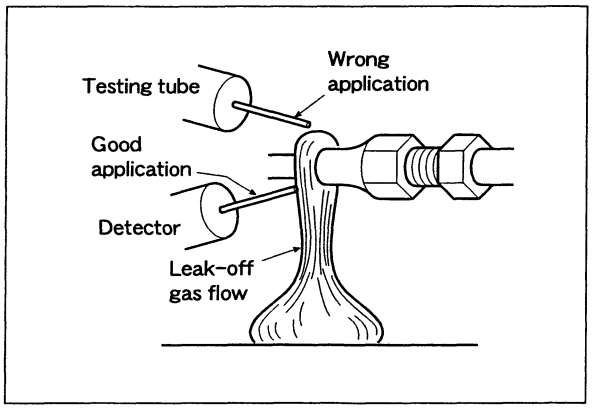
After all the piping works are completed, conduct an leak test by the following procedure to check any leaks at the flare coupling, etc. and then evacuate the system. If this leak test is omited and evacuation is immediately started, there is no way of detecting possible leak. If there are leaks, the specified vacuum cannot be attained. In order to save the service time be sure to conduct the leak test before evacuation.

6.2.1 Test point

(1) All pipe joint.
(2) Shaft seal and check valve on the compressor.

6.2.2 Test procedure

(1) For the gas leak test, the use of an electric gas leak detector is recommended. (HFC-134a SAE Approved)
(2) Perform the test at a place as in free from air flowing.
(3) The refrigerant is heavier than air. Leaks will concentrate at the bottom. Make certain that the testing tube is applied below the check point.



(4) The test should be performed patiently. Make certain that testing tube is moved slowly [approx. 10mm/sec].
(5) The high pressure side refrigerant circuit should be tested for gas leaks during operation. Those areas which are dangerous or hard to test during operation (including areas around the compressor and condenser) should be tested direct after shutdown.

(6) The low pressure side refrigerant circuit should be tested during shutdown after the gas pressure has balanced.
(7) The test should be performed on the basis of the following standards:

Gas leak test standards

test point / Instrument	Compressor shaft seal	Other parts
Electric gas leak detector	Pointer shall not swing more than 0.1mA at the low sensitivility.	Pointer shall not swing more than 0.1mA at the low sensitivility.
handle torch gas leak detector	Flame colour (moss green) shall not change.	

⚠ WARNING

- Smoking should be forbidden if a gas leak is detected.
- If a flame is applied to the refrigerant, toxic phosgene gas will be produced. Do not keep the detector in contact with a leaky point for a long time.

- Leak test procedure

1. Attach refrigerant supply and gauge set as shown with all valves closed. Open refrigerant supply valve on can.
2. Loosen the center charging hose fitting at the gauge manifold end to blow any air from the hose until it hisses for a few seconds, then refrigerant.
3. Open both gauge valves to partially charge the system and then close both valves.
4. The system can then be checked for leaks using an electronic leak detector.
5. If leaks are found that require the system to be opened (to repair or replace hoses, fittings, etc.), release any charge in the system.
6. After checking and repairing leaks, system must be evacuated.

6.3 System charging

GENERAL PRECAUTIONS

⚠ WARNING

When handling refrigerant (HFC-134a), the following precautions must be observed.

- Always wear eye protection and gloves while handling refrigerant.
- Be careful that liquid refrigerant does not contact the skin.
  If liquid refrigerant strikes eye or skin:
  - Do not rub on skin.
  - Splash large quantities of cool water on the eye or skin.
  - Flush eyes or skin with cool water for 5 minutes.
  - Rush to a physician or hospital for immediate professional treatment.
  - Do not attempt to treat it yourself.
- Keep the refrigerant (HFC-134a) container below 40℃.
- Do not handle the refrigerant in an enclosed area having an open flame; the refrigerant may produce a poisonous gas.
- Use approved recovery equipment to recover HFC-134a refrigerant before attempting service of this or any other HFC-134a system.
- Do not attempt to leak test an HFC-134a system with high pressure air or nitrogen. Mixing HFC-134a with a concentrated quantity of air may be combustible in the presence of ignition.

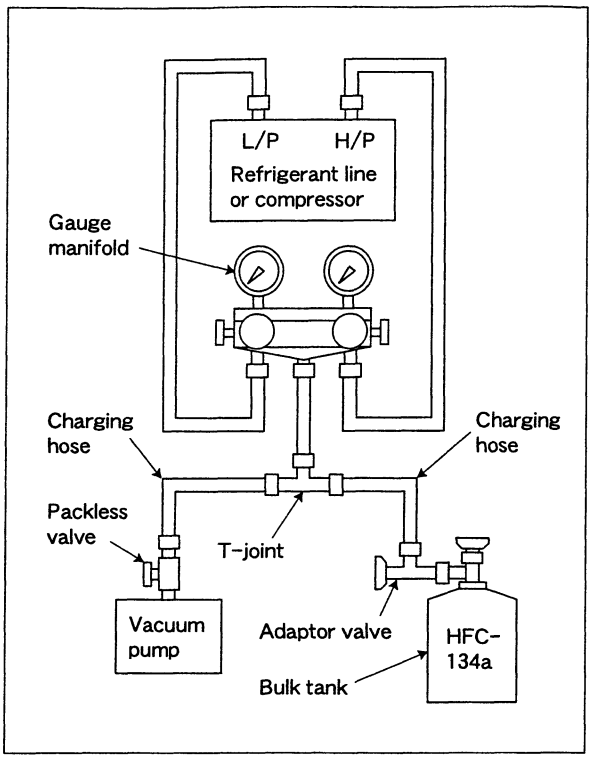
6.3.1 Evacuation

INSTALLATION OF CHARGE EQUIPMENT

(1) Connect the gauge manifold to the service valves.
(2) Connect the packless valve to the vacuum pump.
(3) With the charge valve handle turned back all the way, install the bulk tank.
(4) Connect each charge equipment as illustrated.

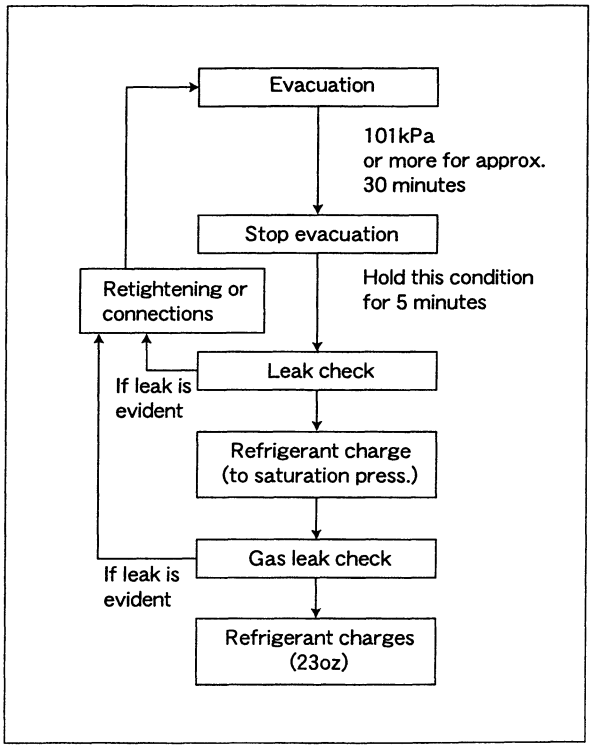
⚠ CAUTION

1. Do not connect the high and low pressure sides adversely. (Connect high pressure side to the condenser and low pressure side to the cooling unit.)
2. The indications "DIS" and "SUC" on the compressor indicate high and low pressure sides respectively.



6.3.2 Evacuate the system

The refrigerant system must have been evacuated using the previous procedure before charging. Charge using only HFC-134a refrigerant. HFC-134a is available in bulk tank. Follow the safety precautions for handling HFC-134a as listed in this section.
Follow the evacuation procedure below and at right.
This procedure assumes no HFC-134a refrigerant has been introduced into the system. If evacuating a charged system, it is necessary to recover the existing HFC-134a refrigerant before continuing with these instructions.
Refer to the recover equipment manufacture's instructions for proper refrigerant recovery.



CHARGING WITH BULK TANK

When using disposable cans of this type, follow carefully the tank manufactures instructions.

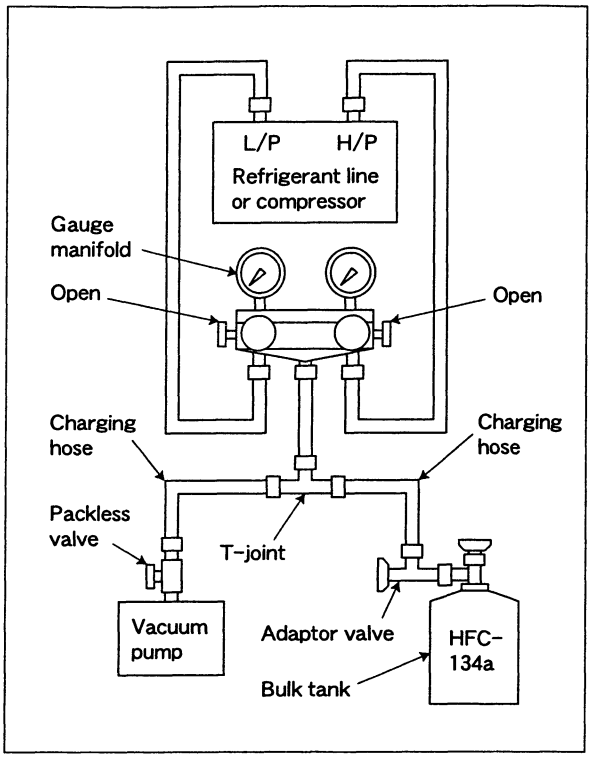
(1) Start up the vacuum pump.

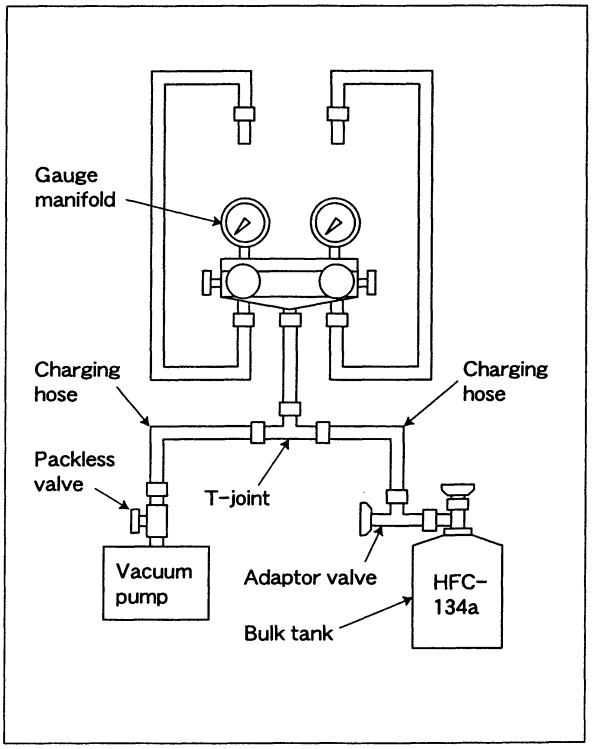
> ⚠ CAUTION
>
> 1. Do not use the compressor for evacuation.
> 2. Do not operate the compressor in the vacuum condition; damage may occur.

(2) Open the gauge manifold handles and the packless valve.
(3) Evacuate to a vacuum reading of 101kPa higher (approx.30 minutes).
(4) Turn back the packless valve all the way and close the bulk tank.
(5) Stop the vacuum pump and allow to stand for 5 minutes.
(6) Check for leak. (Good if the vacuum is held.)
(7) Tighten the charge valve handle to puncture the bulk tank.
(8) Open the charge valve to charge the system with refrigerant.
(9) When the refrigerant is no longer drawn in, turn back the high pressure side gauge manifold handles.
(10)Check for gas leaks using a leak detector.
(11)Start the engine.
(12)Operate the air conditioner and set at the lowest temperature (MAX. COOL).
(13)Fix the engine speed at 1500min^{-1}.
(14)Continue charging system until proper refrigerant quantity is introduced into the system.

> ⚠ CAUTION
>
> If the bulk tank is inverted, liquid refrigerant may be drawn into the compressor damaging it by liquid compression. Keep the bulk tank upright to ensure that refrigerant is charged in gas state.

(15)Upon completion of charging, turn back the low pressure side gauge manifold handles.





6.3.3 Removal of charge equipment

(1) Close the charge valve.
(2) Remove the gauge manifold from each service valves.

> ⚠ CAUTION
> Do not remove the bulk tank, T-joints and adaptor valves but keep them connected for next charge operation.

OPERATING LOW REFRIGERANT LEVEL

Locate the souce of the low refrigerant level, recover system, repair system, evacuate system, charge ststem, check for leaks.

> ⚠ CAUTION
> If the bulk tank is not emptied completely, keep the charge valve connected to the tank for next charging.

6.3.4 Discharging system

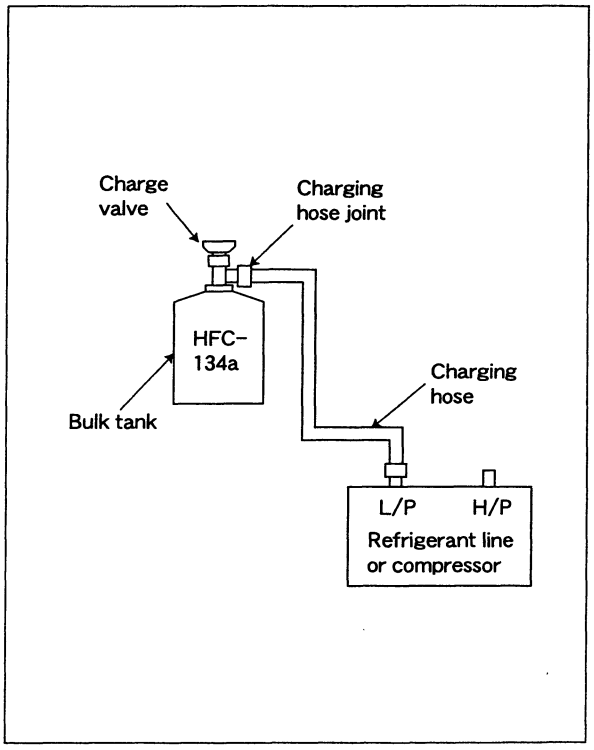
Use the refrigerant recovery unit which can be purchased in local market to discharge refrigerant gas from the system.

> ⚠ CAUTION
> Refer to that Refrigerant Recovery Unit Instruction Manual for operation which is attached on the unit.

LIQUID CHARGE, through high side using charging station:

> ⚠ CAUTION
> Do not run engine when performing liquid charge; compressor will be damage.

(1) After the system is evacuated, close gauge valves, connect center hose to refrigerant supply. Loosen center fitting at gauge to blow any air out of the hose and then retighten.
(2) Following charging station manufacture's instructions charge the system until 23oz of refrigerant is pumped into the system.
(3) When system is fully charged, close high gauge valve and refrigerant supply valve, then quickly disconnect gauge hoses from service
(4) After charging the system, refer to pre-delivery inspection.



6.4 Performance test

6.4.1 Preparation

Reinstall all vehicle parts that were removed for installation of the air conditioner at their original positions, adjust the mounting, and test the following items.

(1) Installation of grommets.

Install the specified grommets.

6.4.2 Stationary performance test

(1) Operating conditions

(a) Place the vehicle in the shade with doors open.

(b) Keep the return air temperature between 25 to 30℃, (Adjust by changing the opening degree of the doors).

(c) Set the fan switch to the max position.

(d) Turn the thermostat control lever to the cool position.

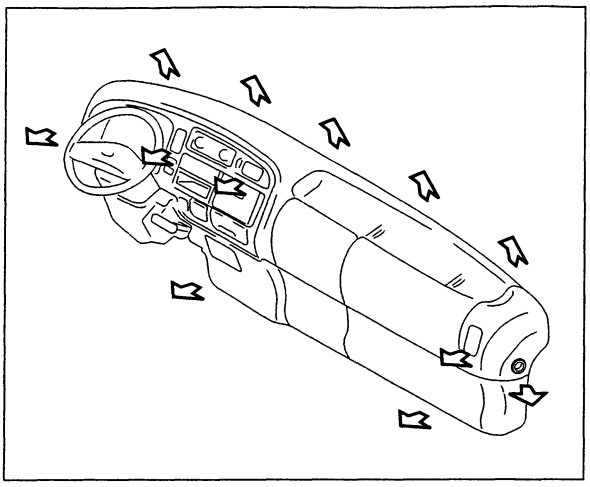
(e) Set the engine speed to approx. 1500min^{-1}.

(f) Set the high pressure at 1.17 to 1.37 MPa.

(If the high side pressure does not rise up, place paper or the like in front of the condenser.)

(2) Test procedure

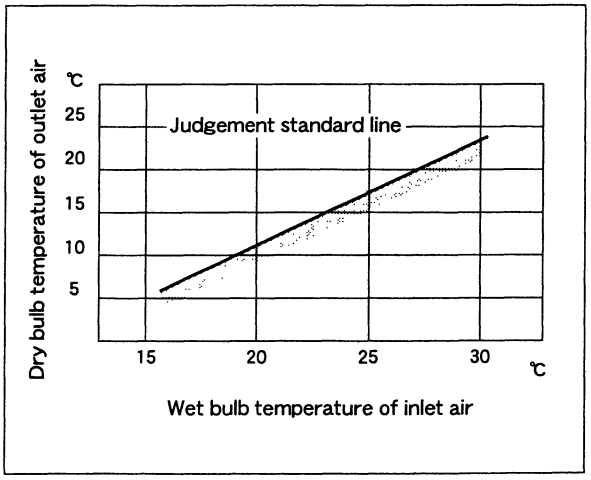
Operate the air conditioner for more than 10 minutes under the above operating conditions in order to stabilize the high and low pressures. Then perform the test by the following procedure:



(a) Measure the outlet air temperature at the inside space of the outlet grille.

(b) Measure the air conditioner intake air temperature, humidity, etc, and the items shown in the Table of Measuring Items at a position free from the effects of cool outlet air.

(c) The intersecting point of the plotted line perpendicular to the point which corresponds to the air conditioner intake and outlet air temperature difference and the plotted line perpendicular to the relative humidity of intake air should be between the oblique lines in figure.



7. MAINTENANCE

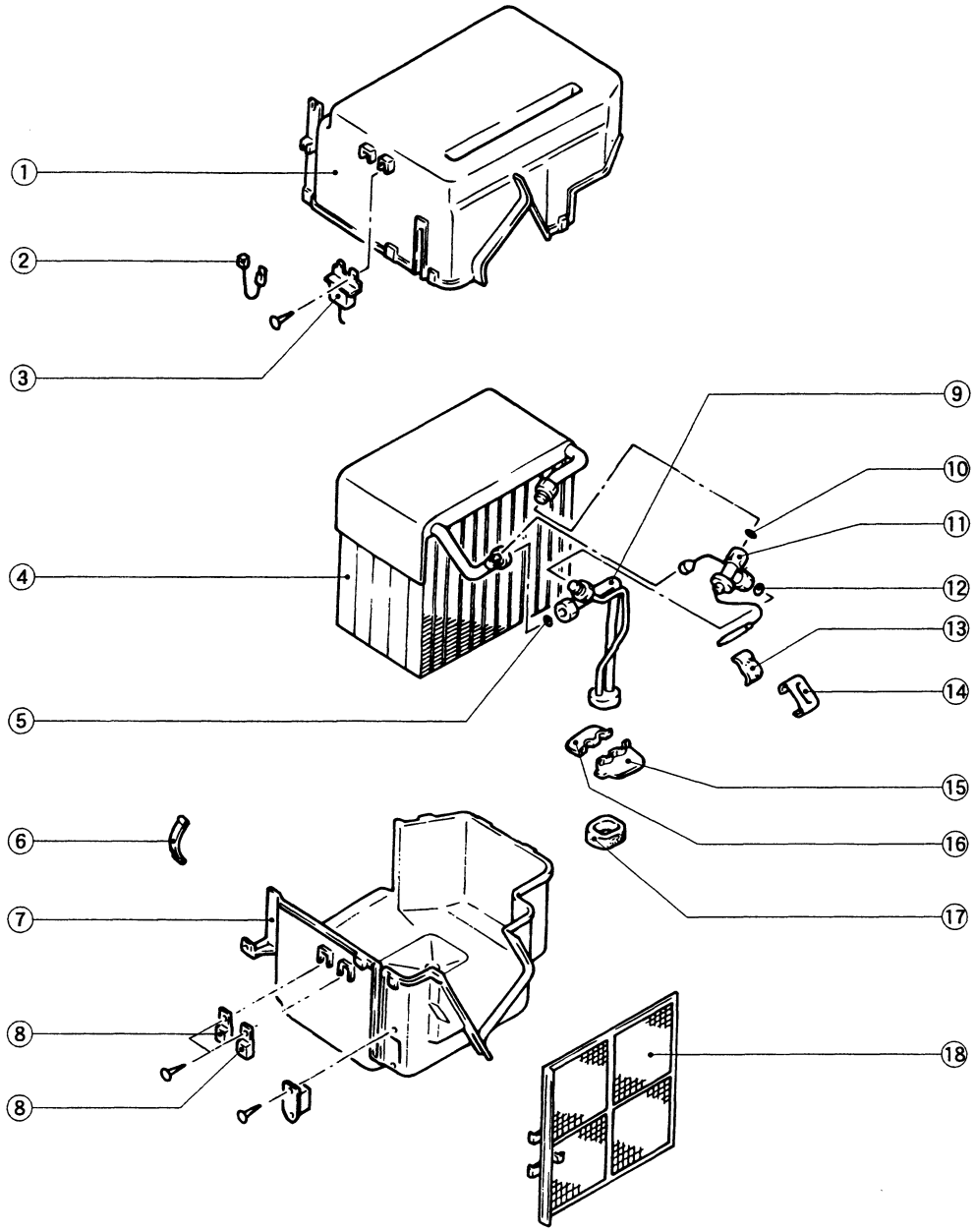
No.	Check point	Service and inspection intervals				
		When used only in summer (approx. for three months)		When used in all seasons		
		At the beginning or season	At the end of season	Every 5,000km (3,000miles)	Every 10,000km (6,000miles)	Every 20,000km (12,000miles)
1	Check condenser and radiator fin for clogging.	○	○	○		
2	Retighten all bolts.	○			○	
3	Check for refrigerant leaks.	○			○	
4	Check refrigerant level.	○		○		
5	Check V-belt tension.	○		○		
6	Check operation of magnetic clutch.	○			○	
7	Check operation of thermostat.	○				○
8	Cooling unit assembly performance test.	○		○		
9	Compressor overhaul.			Every four years		Every 40,000km (24,000miles)

⚠ WARNING

Even after the hot season is over, the air conditioner should be kept ready for operation all year round. Do not remove the V-belt or other parts.
This is because the air conditioner must be operated once a week for several minutes regardless of the season in order to prevent gas leaks caused by drying of the compressor shaft seal, and also to maintain the compressor itself in the best condition.

8. COOLING UNIT ASSEMBLY

8.1 Components



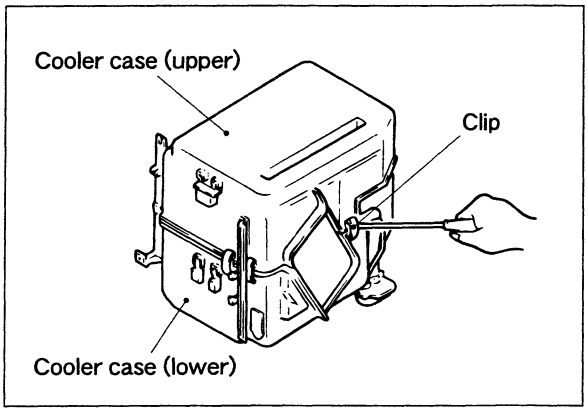
① Cooler case (upper)
② Joint harness
③ Thermostat
④ Evaporator
⑤ O-ring
⑥ Clip
⑦ Cooler case (lower)
⑧ Power relay
⑨ Pipe assembly
⑩ O-ring
⑪ Expansion valve
⑫ O-ring
⑬ Insulation rubber
⑭ Clip
⑮ Baffle plate
⑯ Baffle plate
⑰ Insulation rubber
⑱ Air filter

8.2 Cautions in disassembling

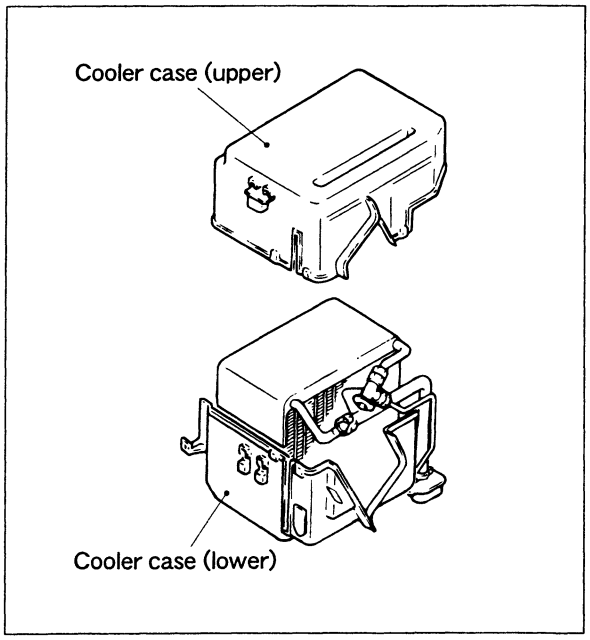
(1) Direct after disconnecting the refrigerant piping blind the opening to prevent dust and moisture etc. from eatering in it.
(2) When disconnecting the expansion valve, surely apply two spanners to prevent unstable twisting from applyng with the one for supporting and the other for torquing at the connection.
(3) Pipings in the cooling unit assembly should be handled gently. Particularly, the ingress and egress portions should be from any bending trouble in carrying it.
(4) If the cooling unit assembly is stored, or transported on disassembled condition, be careful not to deform the fins.
(5) When disconnecting the wiring, avoid pulling it with the insulation cover catched, but apply force by pinching the terminals or by catching the connectors.

8.3 Disassembling

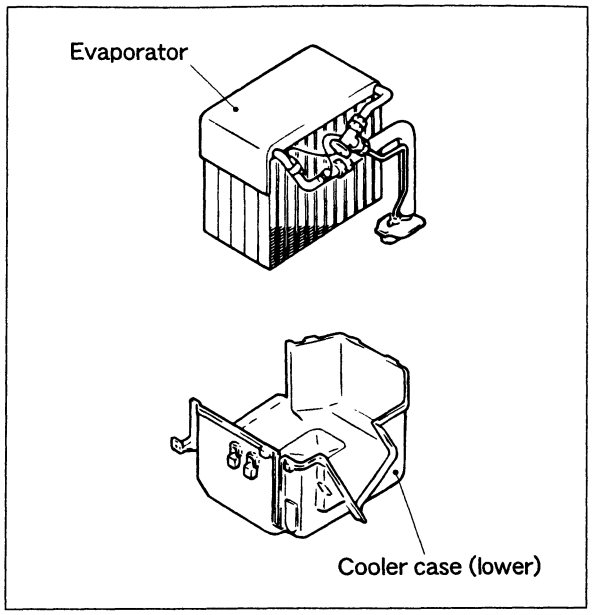
(1) Remove the clips for jointings the upper & lower side cooler case with a flat type screwdriver.



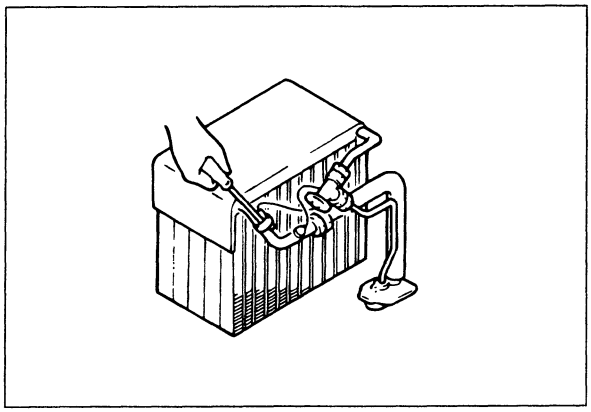
(2) Dismount the cooler case (upper).



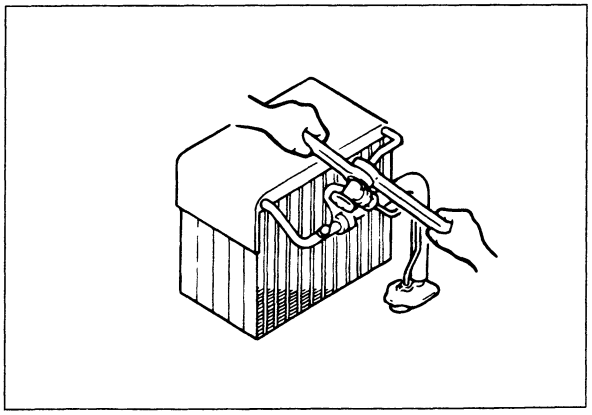
(3) Dismount the evaporator.



(4) Separate the expansion valve.
Dismount the feeler bulb at the suction side.

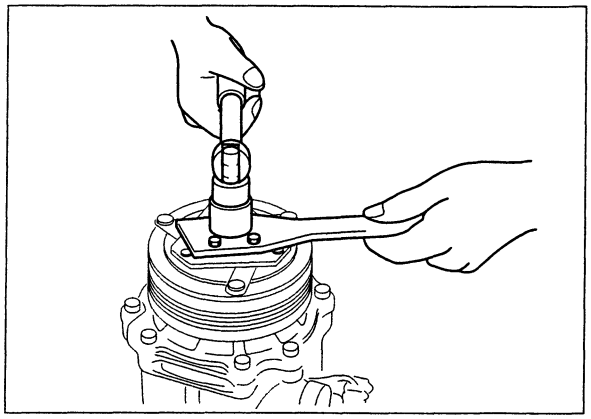


(5) Dismount the expansion valve from the circuit.

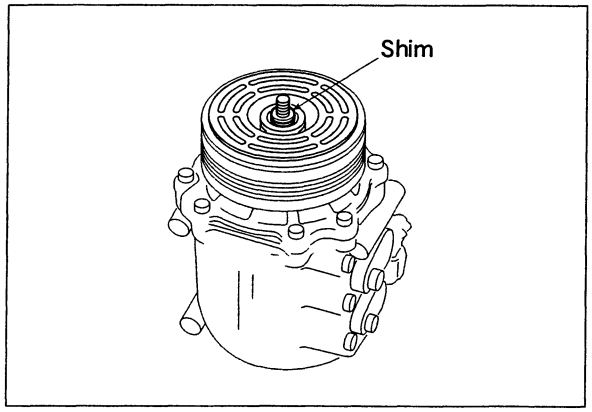


9. COMPRESSOR & CLUTCH ASSEMBLY

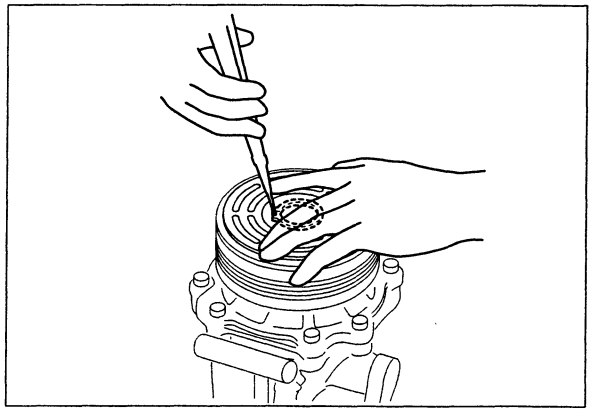
9.1 Disassembling the clutch



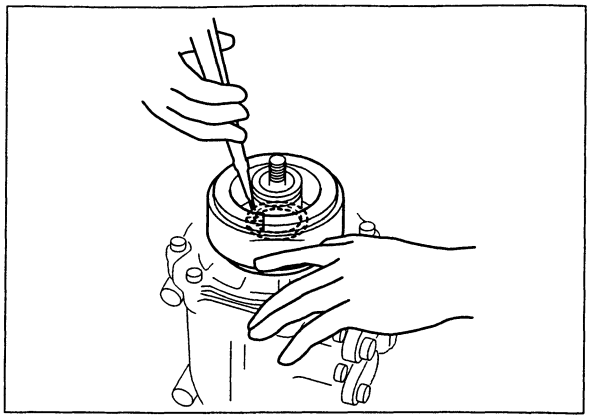
(1) Removal of armature plate.
  (a) Lock up the armature plate with a armature plate fixture and remove the lock nut.
  (b) Remove the armature plate.



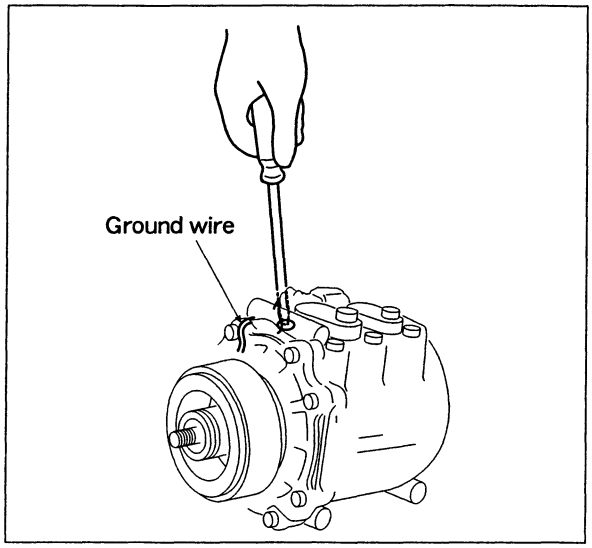
(2) Remove the shim.



(3) Withdrawing rotor.
  (a) Remove the snap ring at the front case side with snap ring pliers.
  (b) Withdraw the rotor toward you and remove it from the front case.

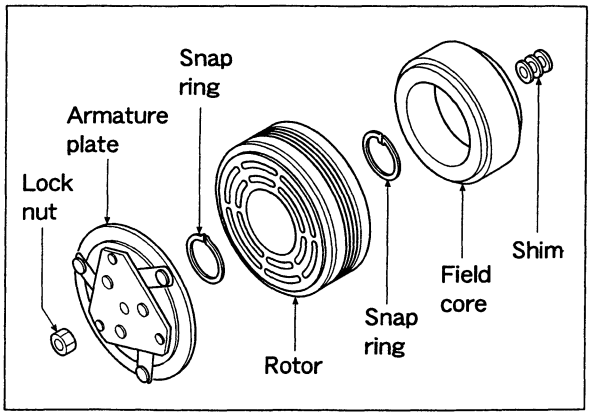


(4) Removal of field core.
  (a) Remove the snap ring for fixing the field core with snap ring pliers.



  (b) Remove the ground wire with a cross point screwdriver and withdraw the field core toward you to remove it from the crank case.

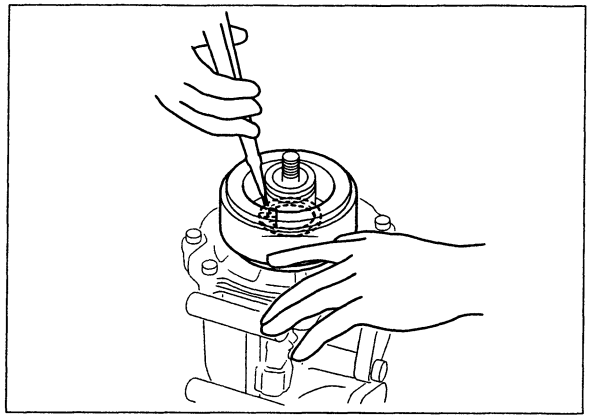
(5) Removal of key.
  Remove the key from the shaft using the top of a flat type screwdriver.



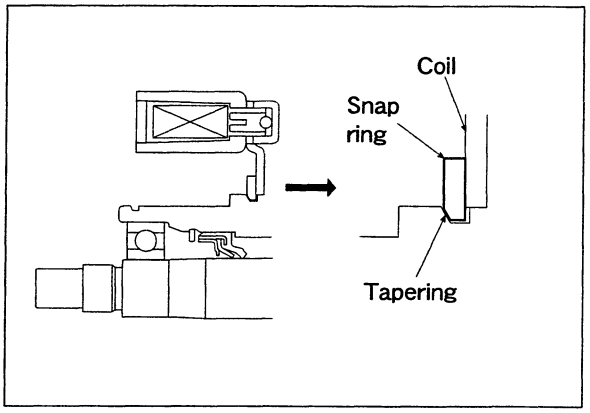
(6) Components of magnetic clutch.

9.2 Reassembly the clutch

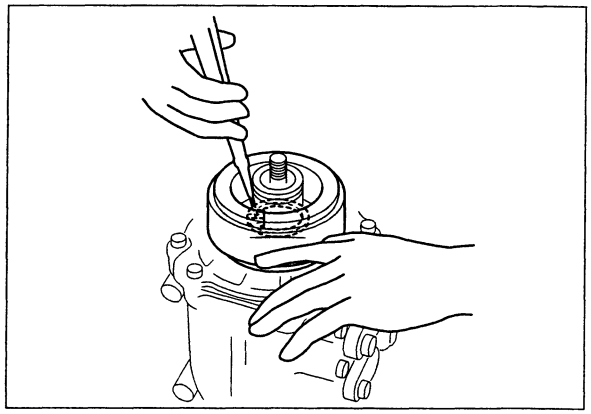
(1) Insert the key into the clankshaft.
(2) Insert the field core.



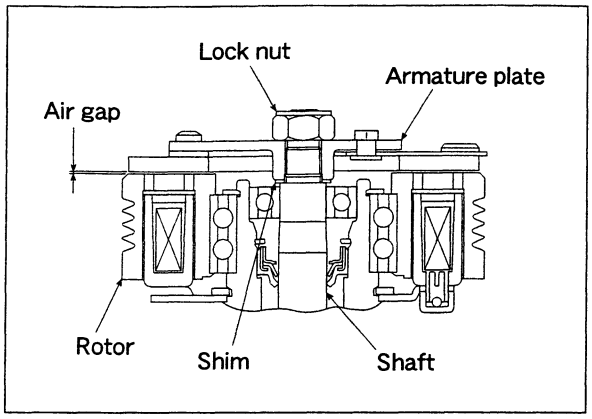
(a) Insert the field core into the front case and position it with a knock pin.
(b) Insert the snap ring for fixing field core into the groove and fix it with snap ring pliers as shown the below.



(c) Connect the ground wire.
(3) Insert the rotor into the front case.



(4) Insert the snap ring for the front case side into the groove with snap ring pliers.



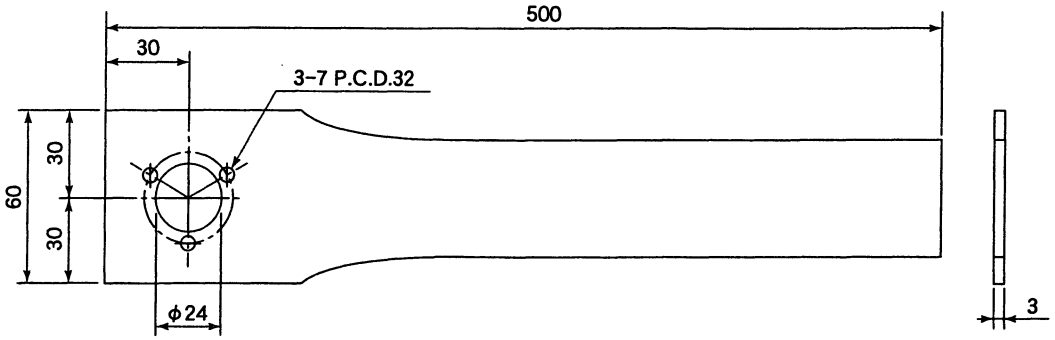
(5) Insert the armature plate.
(a) Place a shim on the end of the shaft and insert the armature plate, adjusting to the key.
(b) Tighten the center bolt to the specified torque, 15.7N.m, with in between plain washer.
(c) Measure the air gap.
The air gap should be within 0.4 to 0.65 ㎜.
Adjust it by shim if it is not within the specifications.
Adjusting shim : 0.1, 0.3, 0.5, or 0.8 ㎜.

9.3 Special tool figure

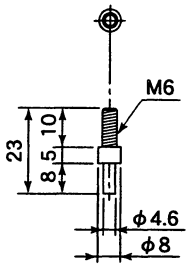
The dimension are in millimeter

(1) Armature plate fixture

① Material S45C



② Material S45C(3個)



MITSUBISHI
FUSO

Group 55B

Heater

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0202-55B

INDEX

SPECIFICATIONS 55B- 2

STRUCTURE AND OPERATION 55B- 3

TROUBLESHOOTING 55B- 9

HEATER HOSE 55B-10

HEATER CONTROL 55B-12

AIR DUCT 55B-15

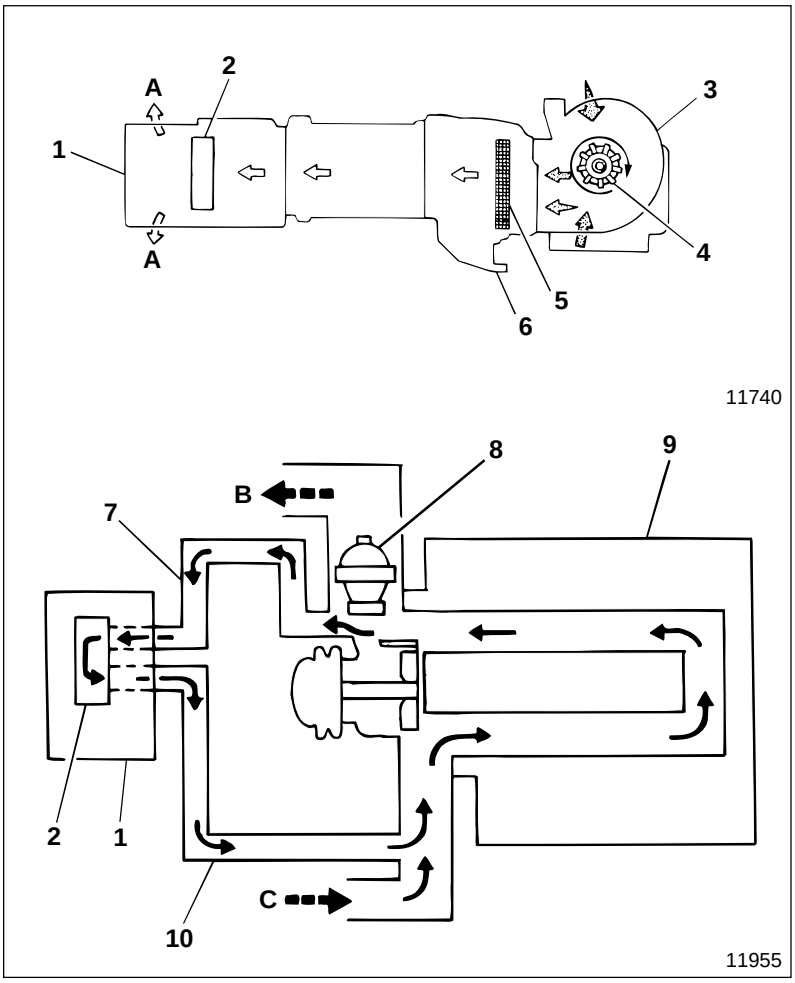
HEATER UNIT AND BLOWER ASSEMBLY 55B-16

SPECIFICATIONS

Items		Specifications
System	Type	Inside/outside air combining, hot-water type heating system
	Standard voltage V	12
	Damper changeover system	Manual cable type
Blower assembly	Manufacturer	NIPPONDENSO
	Power consumption W	170
	Maximum rotation rpm	3450
Heater unit assembly	Manufacturer	NIPPONDENSO
	Temperature control system	Air mixing type
	* Heating performance kW {BTU/h, kcal/h}	*3.53 {12060, 3040}

* : Heating performance is shown under the following conditions.
Temperature difference : 65°C {119°F}
Water flow : 6 L/min {0.0035 ft³/s}
Voltage : 12 V DC

Heater



1 Heater unit
2 Heater core
3 Blower assembly
4 Fan
5 Air filter
6 Duct assembly
7 Heater hose (Heater in)
8 Thermostat
9 Engine
10 Heater hose (Heater out)

A : To duct
B : To radiator
C : From radiator

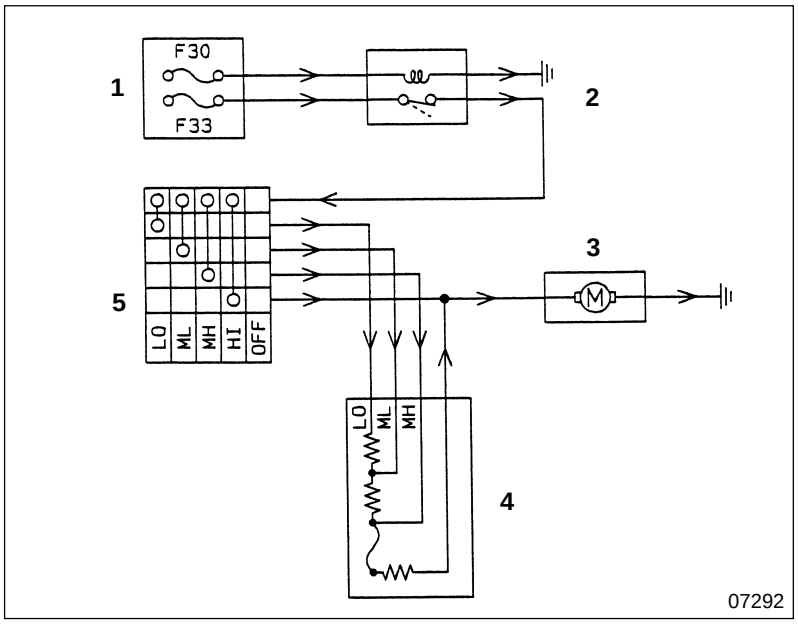
Outside air (Intake)

Inside air (Circulation)

Filtered air

- Warm engine coolant that has absorbed heat from engine **9** does not flow through thermostat **8** but circulates as follows:
  7→**2**→**10**→**9**
- Air sent to heater unit **1** from blower assembly **3** is warmed by heater core **2** (heat exchanger). Then the ducts deliver the warmed air to the cab.

Heater Electric Circuit



1 Fuse box
2 Blower fan relay
3 Blower motor
4 Blower resistor
5 Fan switch (Heater switch)

- The resistance of blower resistor **4** controls blower motor **3**, which in turn controls the air flow, except when the air flow is set to HI (high speed). When the air flow is set to HI, the current does not flow through the blower resistor.

Fan switch 5 set to LO position

- **1** (F30)→**2** (coil)→Ground
- **1** (F33)→**2** (contact point)→**5** (LO)→**4** (LO)→**3**→Ground

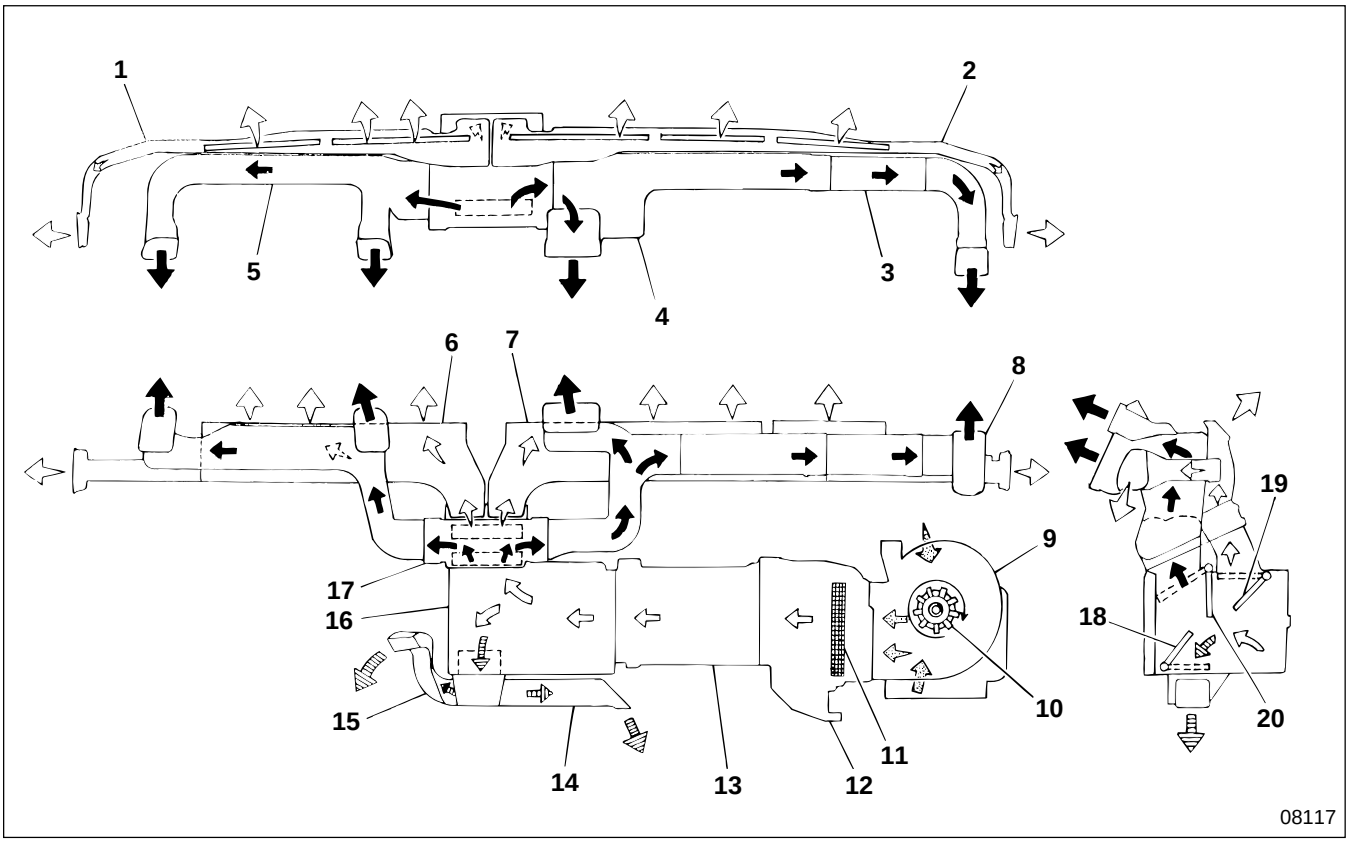
Fan switch 5 set to HI position

- **1** (F30)→**2** (coil)→Ground
- **1** (F33)→**2** (contact point)→**5** (HI)→**3**→Ground

Fan switch 5 set to either ML or MH position

The current flows through blower resistor **4** in the same way as when set to LO position, routing ML or MH respectively instead of LO.

Air Duct

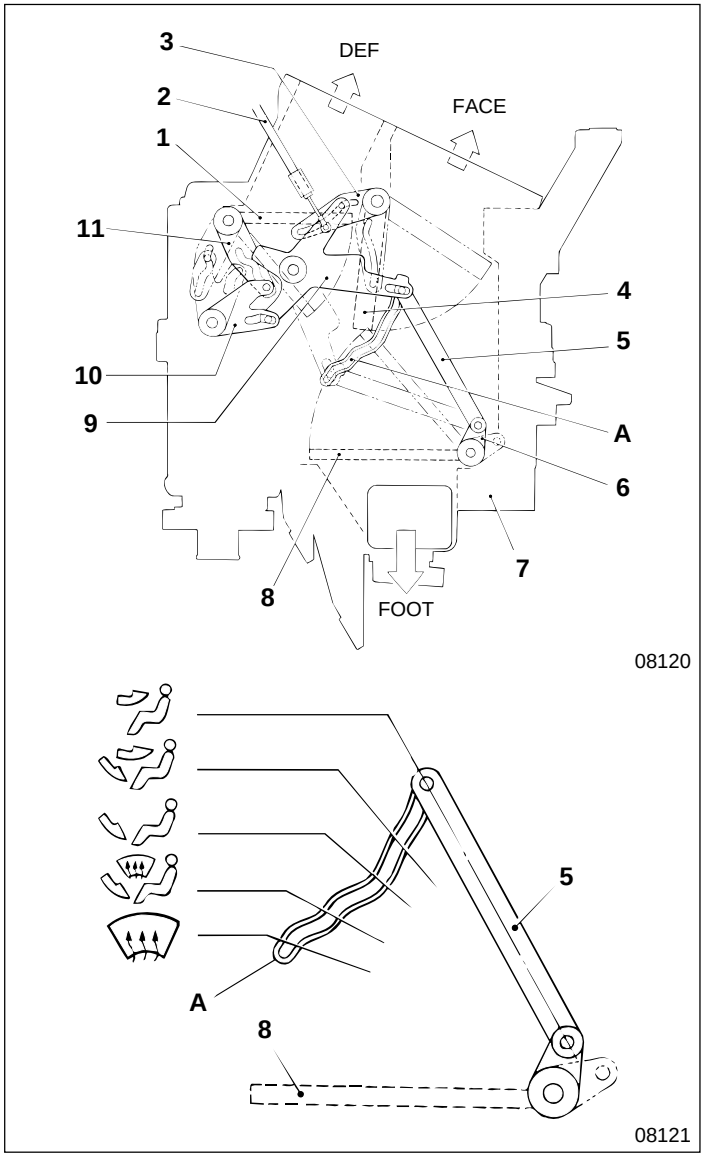


1 Defroster side duct, LH
2 Defroster side duct, RH
3 Face duct B
4 Center face duct
5 Face duct, LH
6 Front defroster, LH
7 Front defroster, RH
8 Face duct A
9 Blower assembly
10 Fan
11 Air filter
12 Duct assembly < without air-conditioner >
Cooling unit < with air-conditioner : option >
13 Joint duct
14 Foot duct, RH
15 Foot duct, LH
16 Heater unit
17 Center duct
18 Damper (FOOT)
19 Damper (DEF)
20 Damper (FACE)

Outside air (Intake) Inside air (Circulation) Filtered air (in heater and cooling unit)

Air (FACE) ( )Air (DEF) Air (FOOT)

Since dampers **18**, **19, 20** of heater unit **16** are opened and shut by the switching operation of the heater control assembly, the outside air and inside air coming from blower assembly **9** flow as illustrated.



● **Mode changeover system**

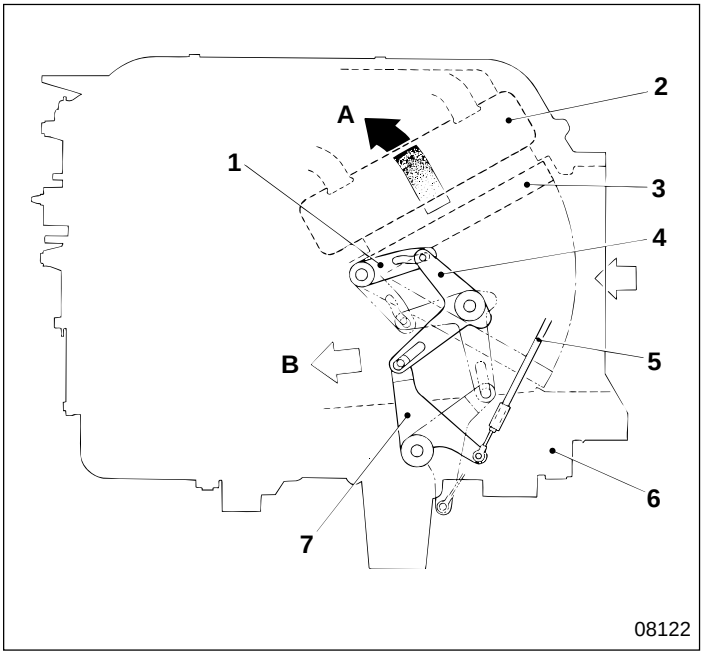
1 Damper (DEF)
2 Mode changeover control cable
3 Lever
4 Damper (FACE)
5 Lever
6 Lever
7 Heater unit
8 Damper (FOOT)
9 Lever
10 Lever
11 Lever

A : Rail

- The opening and closing of dampers **1**, **4**, **8** is mechanically controlled by the movement of mode changeover control cable **2**, transmitted as follows:
  2→**9**→**3**→**4** (FACE)
  →**5**→**6**→**8** (FOOT)
  →**10**→**11**→**1** (DEF)

  Levers **3**, **5**, **6**, **10**, **11** move together with lever **9**. Dampers **1**, **4** , **8** move together with levers **3**, **6**, **11**, the degree of opening is determined by the shape of the lever grooves.

- Lever **5** is connected to rail **A**. Since the lever moves along the groove of the rail, damper **8** (FOOT) can be opened and closed in combination with other modes to activate bi-level mode.

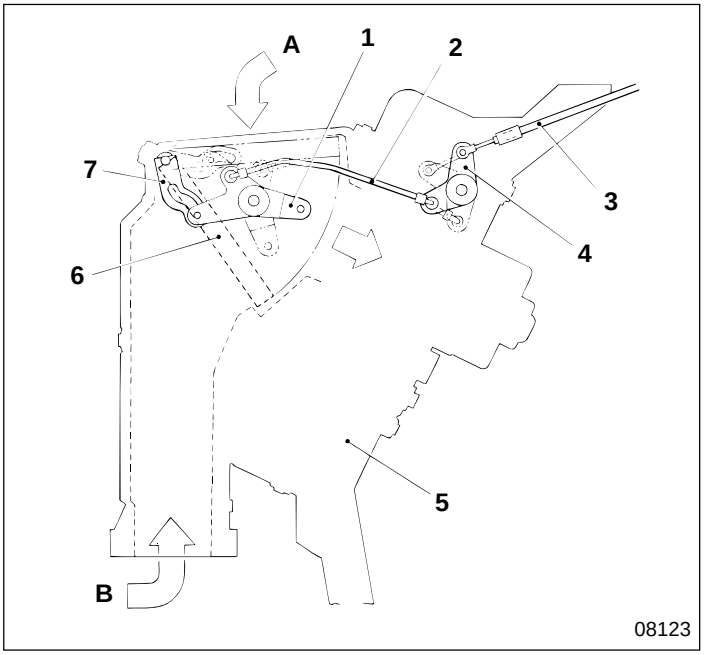


● **Air mixing control**

1 Lever
2 Heater core
3 Damper
4 Lever
5 Air mixing control cable
6 Heater unit
7 Lever

A : Warm air
B : Unwarmed air

- The degree of opening of damper **3** controls the flow of both air **A** that has passed through and been warmed by heater core **2**, and air **B** that has not been warmed.
- Damper **3** is mechanically operated by the movement of air mixing control cable **5**, transmitted as follows:
  5→7→4→1→3
  Lever **1** moves together with damper **3**.

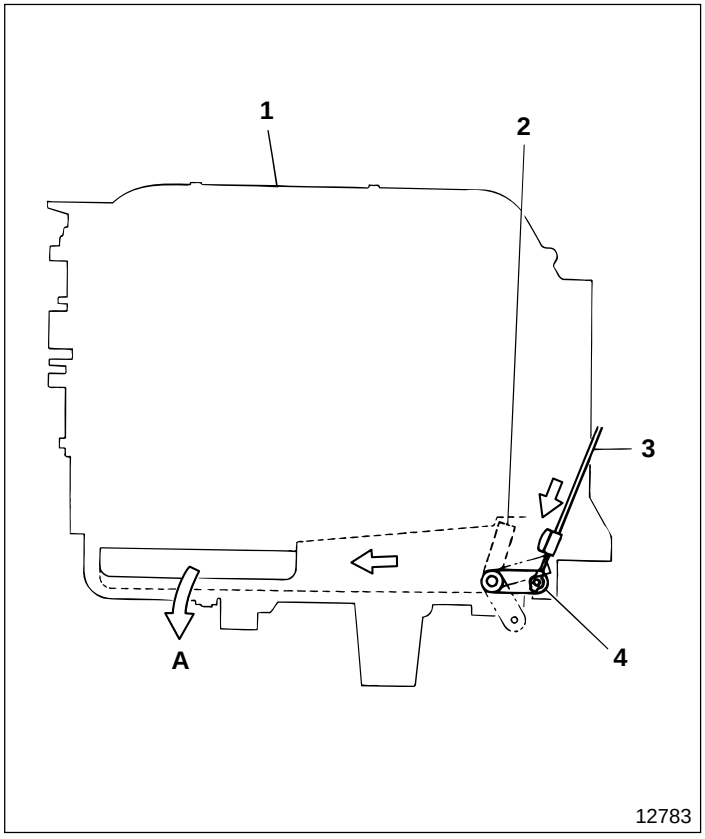


● **Air intake control**

1 Lever
2 Rod
3 Inside/outside air changeover control cable
4 Lever
5 Blower assembly
6 Damper
7 Lever

A : Inside air
B : Outside air

- Changeover of air intake from inside to outside is controlled by the opening and closing of damper **6**.
- Damper **6** is mechanically operated by the movement of inside/outside air changeover control cable **3**.
  3→4→2→1→7→6
  Lever **7** moves together with damper **6**.



● **Air flow bypass changeover**

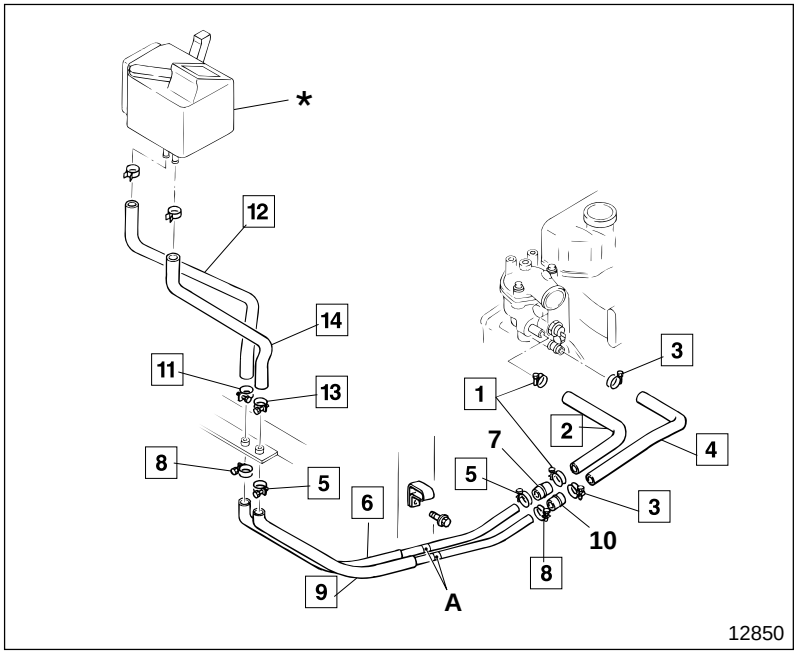
1 Heater unit
2 Damper
3 Air flow bypass changeover control cable
4 Lever

A : Air not warmed by heater core

- Damper **2** is opened and closed to change the air flow from warm air to air that has not passed through and been warmed by heater core **2**.
- Damper **2** is mechanically operated by the movement of air flow bypass changeover control cable **3**, transmitted as follows:
  3→**4**→**2**
  Lever **4** moves together with damper **2**.

Symptoms / Possible causes	Air does not flow from vents	Heater does not work well	Airflow control setting cannot be changed	Drafts from vents	Temperature control setting cannot be adjusted	Outside/inside air control cannot be changed	Air volume from vents unstable	Control switches operation heavy	Air flow bypass cannot be changed	Remarks
Blower motor coil broken or short-circuited	○									
Blower motor relay contact point melted, coil broken or short-circuited	○									
Blower resistor operation malfunctioning							○			
Mode damper opening and closing faulty			○	○				○		
Air mixing damper opening and closing faulty				○	○			○		
Inside/outside air changeover damper opening and closing faulty				○		○		○		
Heater control assembly faulty	○	○	○	○	○	○				
Thermostat does not close		○								Gr 14A, B
Coolant amount insufficient		○								Gr 14A, B
Connector connection faulty, harness broken or grounding faulty	○		○	○	○	○				
Fuse blown	○									
Heater pipes clogged, loose or connection faulty		○								
Duct connection faulty				○						
Heater unit clogged		○								
Control cable sliding movement faulty, installation faulty			○	○		○		○		
Control cable connecting lever of units bent			○	○		○		○		
Control cable connecting lever sliding parts of units worn or lubricated insufficiently			○	○		○		○		
Air flow bypass changeover damper opening and closing faulty									○	

HEATER HOSE



● **Disassembly sequence**

1 Hose clamp
2 Heater hose (Engine out)
3 Hose clamp
4 Heater hose (Engine in)
5 Hose clamp
6 Heater hose (Engine out)
7 Water pipe
8 Hose clamp
9 Heater hose (Engine in)
10 Water pipe
11 Hose clamp
12 Heater hose (Heater in)
13 Hose clamp
14 Heater hose (Heater out)

***** : Heater unit
A : White mark

NOTE

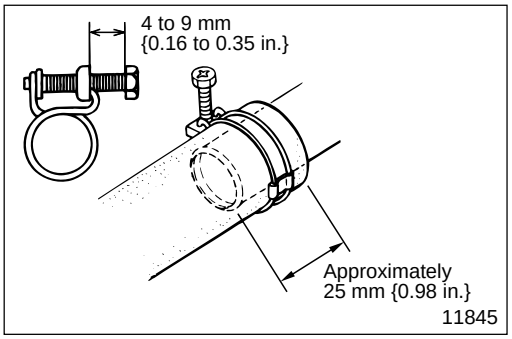
- **Drain engine coolant from radiator before removing hoses.** **Gr 14A, B**
- **Make sure that white mark A on heater hoses 6, 9 are clearly visible before removing parts. If there are no marks, make identification marks before removing parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Be sure that hoses are inserted securely to prevent coolant leaking.**
- **Make sure not to mix up heater hoses 2, 4, 6, 9, 12, 14 when connecting them because mistaken connection would damage the heater unit.**



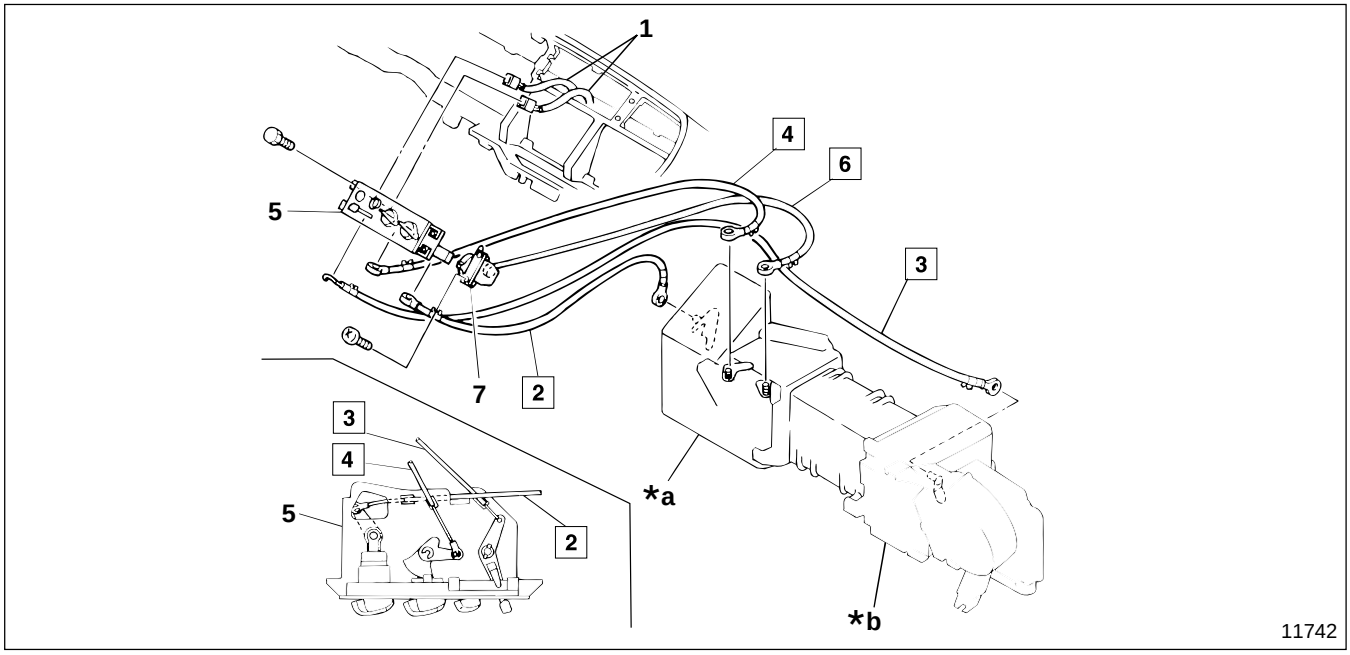
◆ Service procedure

1 **to** **6** **8** **9** **11** **to** **14** **Installation of heater hose and hose clamp**

- Install heater hoses **2**, **4**, **6**, **9**, **12**, **14** conform to the dimension as illustrated.
- Tighten hose clamps **1**, **3**, **5**, **8**, **11**, **13** to conform to the dimension as illustrated.

M E M O

HEATER CONTROL



● **Disassembly sequence**

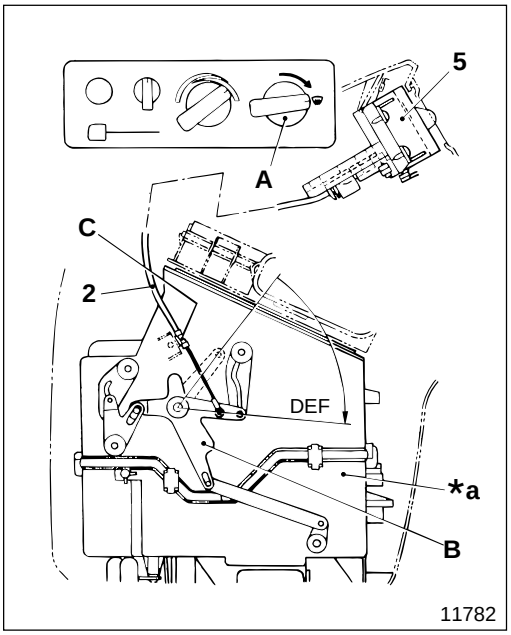
1 Harness
2 Mode changeover control cable
3 Inside/outside air changeover control cable
4 Air mixing control cable
5 Heater control assembly Gr 54
6 Air bypass changeover control cable
7 Air bypass control lever

***a** : Heater unit assembly P55B-16
***b** : Blower assembly P55B-16

● **Assembly sequence**

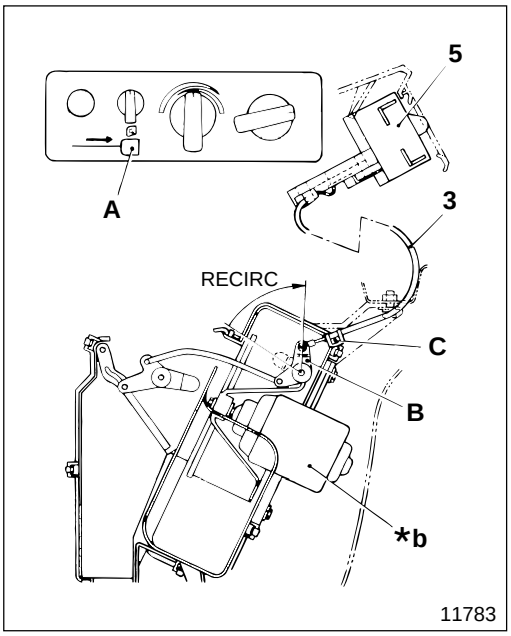
Follow the disassembly sequence in reverse.

◆ Service procedure



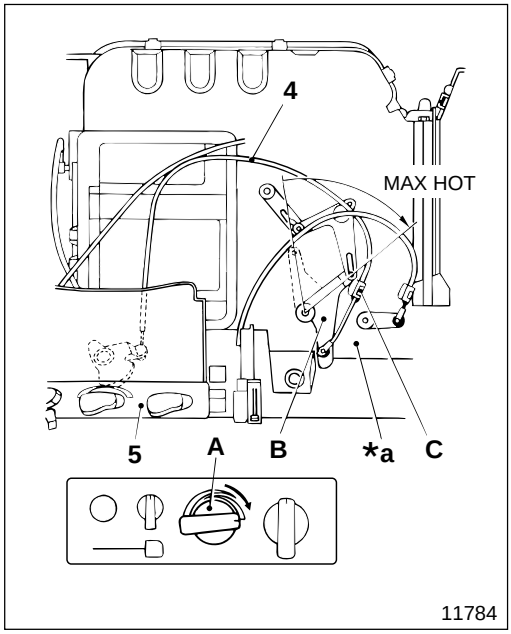
2 Installation of mode changeover control cable

- Turn mode changeover control dial **A** of heater control assembly **5** to (DEF).
- Turn mode changeover damper lever **B** of heater unit assembly ***a** to DEF.
- Under these conditions, install mode changeover control cable **2** onto mode changeover damper lever **B** and fasten it with clip **C**.



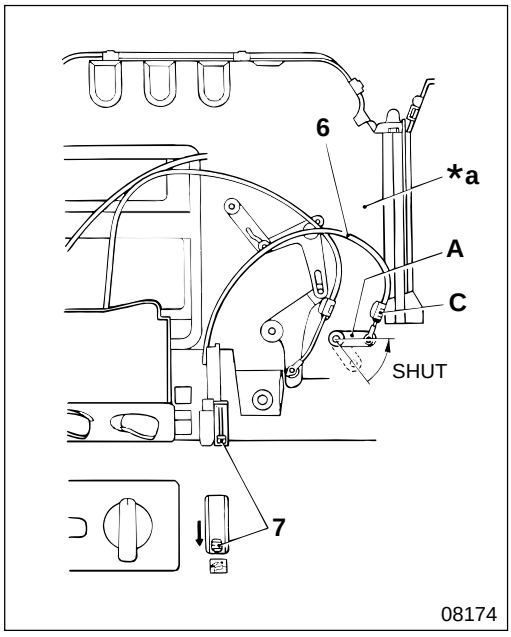
3 Installation of inside/outside air changeover control cable

- Set inside/outside changeover lever **A** of heater control assembly **5** to (RECIRC : Inside air).
- Turn inside/outside air changeover damper lever **B** of blower assembly ***b** to RECIRC.
- Under these conditions, install inside/outside air changeover control cable **3** onto inside/outside air changeover damper lever **B** and fasten it with clip **C**.



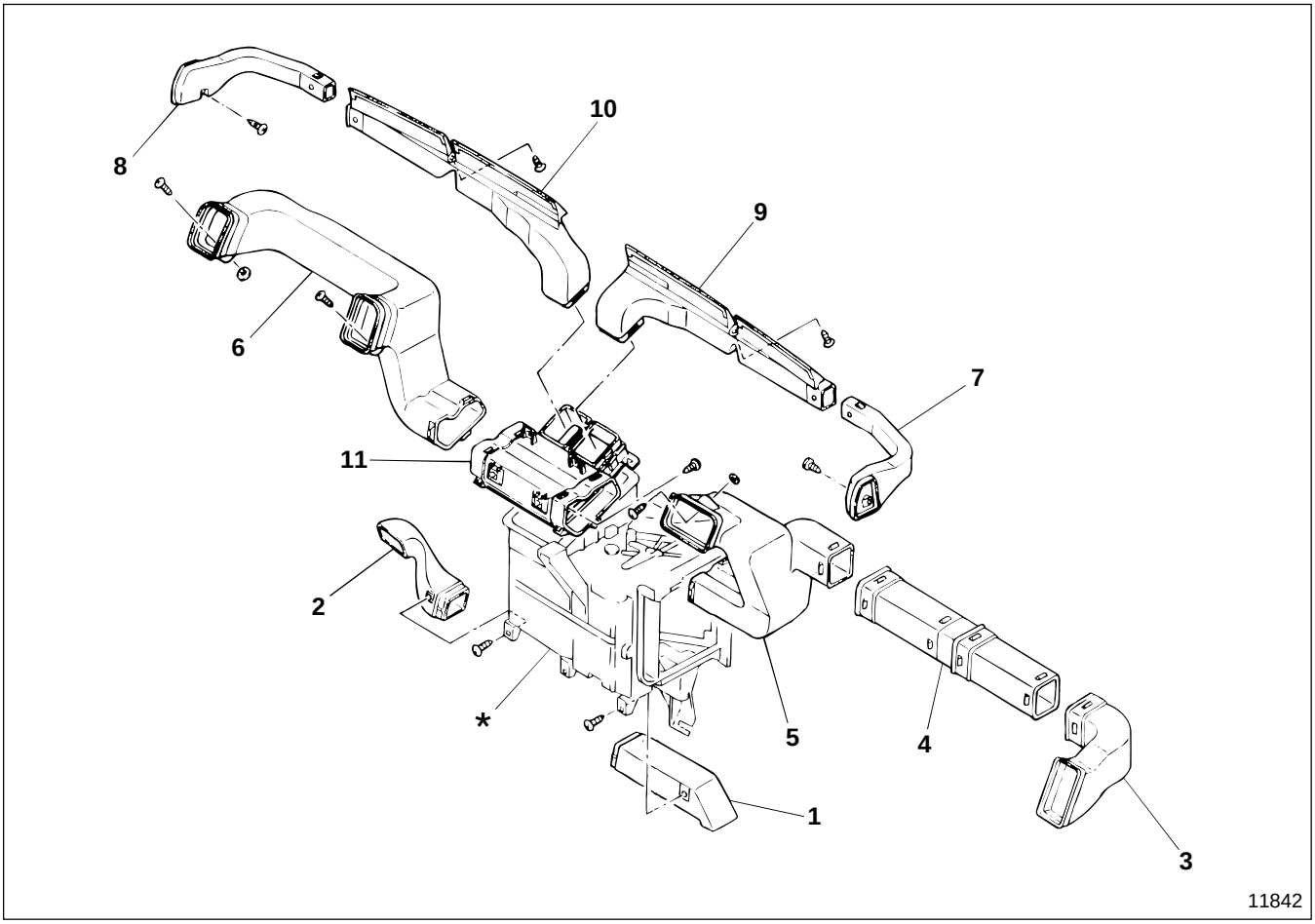
4 Installation of air mixing control cable

- Fully turn temperature control dial **A** of heater control assembly **5** clockwise to MAX HOT (maximum heating).
- Turn air mixing damper lever **B** of heater unit assembly ***a** to MAX HOT (maximum heating).
- Under these conditions, install air mixing control cable **4** onto air mixing damper lever **B** and fasten it with clip **C**.



6 Installation of air bypass changeover control cable

- Set air bypass changeover control lever **7** to SHUT.
- Set air bypass lever **A** of heater unit assembly ***a** to SHUT.
- Under these conditions, install air bypass changeover control cable **6** onto air bypass lever **7** and fasten it with clip **C**.



● **Disassembly sequence**

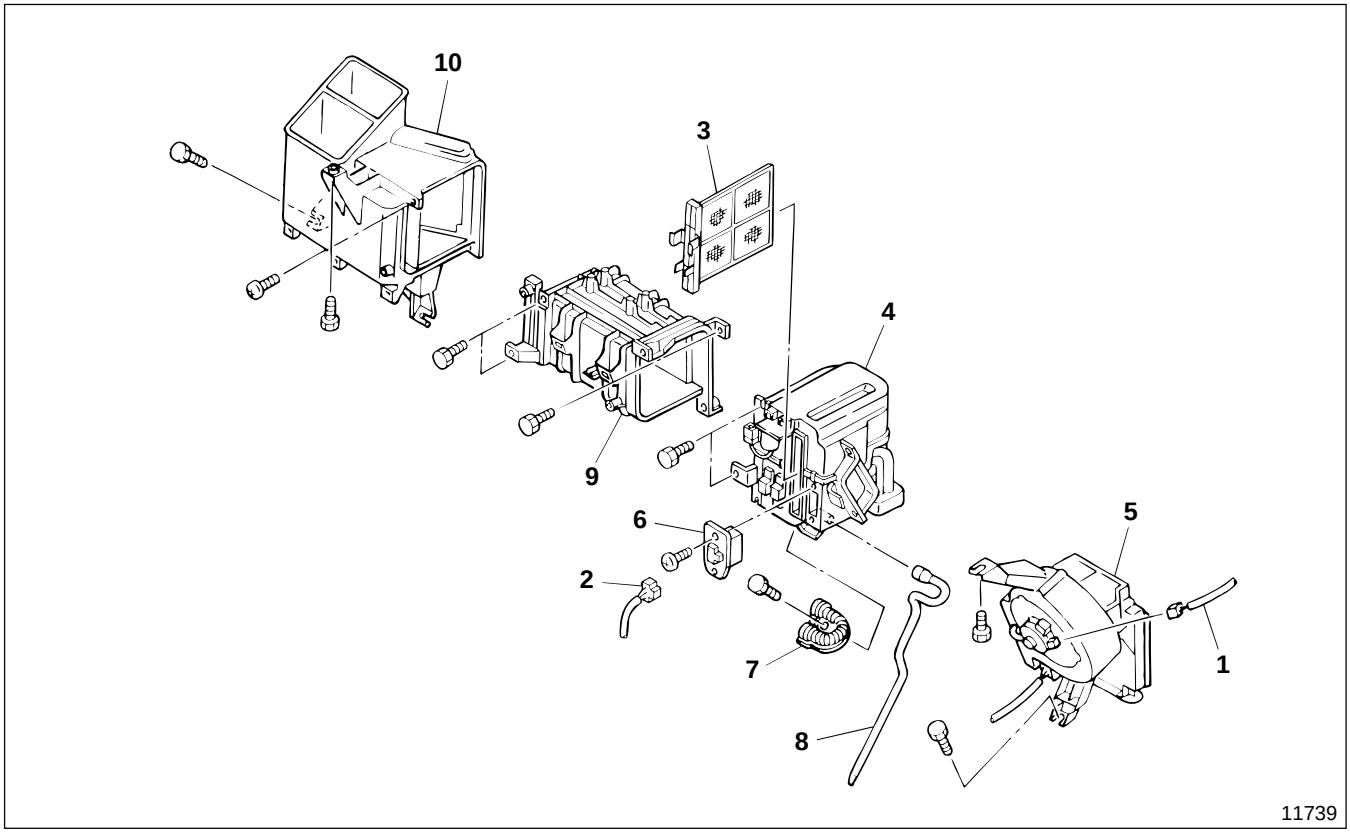
1 Foot duct, RH
2 Foot duct, LH
3 Face duct A
4 Face duct B
5 Center face duct
6 Face duct, LH
7 Defroster side duct, RH
8 Defroster side duct, LH
9 Front defroster duct, RH
10 Front defroster duct, LH
11 Center duct

***** : Heater unit

● **Assembly sequence**

Follow the disassembly sequence in reverse.

HEATER UNIT AND BLOWER ASSEMBLY



● **Disassembly sequence**

1 Harness
2 Harness
3 Air filter
4 Duct assembly
5 Blower assembly Gr 54
6 Blower resistor Gr 54
7 Cover
8 Drain hose
9 Joint duct
10 Heater unit assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

FK.FM

SERVICE MANUAL
2002 Model

FOREWORD

This Service Manual contains maintenance and repair methods for the Mitsubishi Fuso Truck FH Series. Read this manual carefully as an aid in providing correct, efficient maintenance. Please note that the information and specifications contained within this manual may change without notice. This is due to product modifications and contined vehicle improvements that are made throughout the model years. Should you encounter any discrepancy in the information provided, please do not hesitate to contact your nearest Mitsubishi Fuso Dealer or Mitsubishi Fuso Truck of America, Inc.

April 2001

HOME

GROUP INDEX

HOW TO READ THIS MANUAL
GENERAL 00
MAINTENANCE SCHEDULE 01
ENGINE 11
LUBRICATION 12
FUEL AND ENGINE CONTROL 13
COOLING 14
INTAKE AND EXHAUST 15
CLUTCH 21
MANUAL TRANSMISSION
< M060S6, M070S6 > 22A
< M8S2x5 > 22B
AUTOMATIC TRANSMISSION
< FK617, FM617 > 23A
< FM657 > 23B
PROPELLER SHAFT 25
FRONT AXLE 26
REAR AXLE 27
WHEEL AND TIRE 31
FRONT SUSPENSION 33
REAR SUSPENSION 34
BRAKE
< AIR OVER HYDRAULIC BRAKE > 35A
< FULL AIR BRAKE > 35B
ANTI-LOCK BRAKE SYSTEM 35E
PARKING BRAKE
< CENTER PARKING BRAKE > 36A
< WHEEL PARKING BRAKE > 36B
STEERING 37
FRAME 41
CAB 42
ELECTRICAL 54
AIR-CONDITIONER 55A
HEATER 55B

MITSUBISHI
FUSO

How to Read this Manual

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

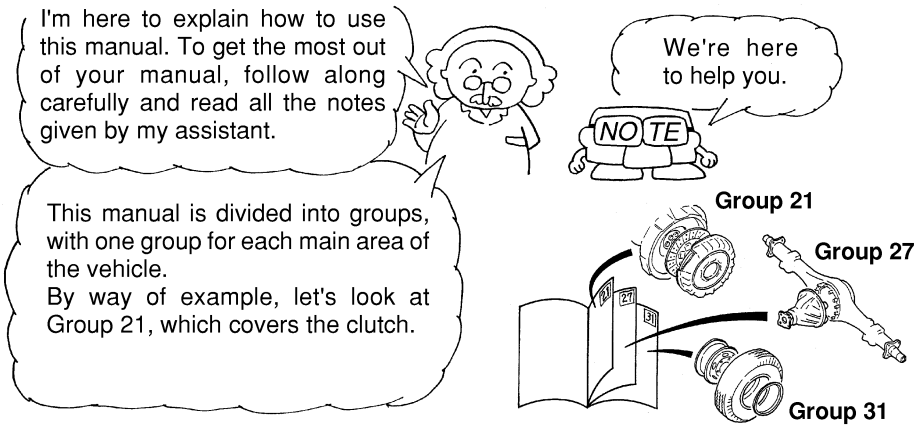
Pub No. TWME0103-H

INDEX

HOW THIS MANUAL IS STRUCTURED **2**

TERMS **15**

HOW THIS MANUAL IS STRUCTURED



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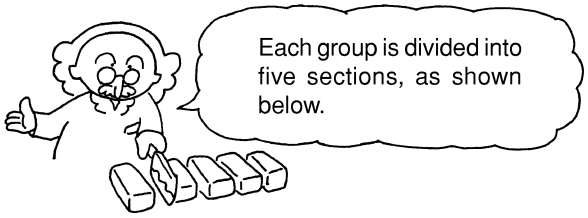


23916

Specifications
Specifications, oil quantities, and other information pertaining to system components.

Structure and Operation
Information on the structure and operation of the overall system and its components.

Troubleshooting
An item-by-item guide to fault symptoms and their probable causes.

On-Vehicle Inspection and Adjustment
Instructions for on-vehicle inspection and adjustment operations.

Service Instructions
(See the next and subsequent pages.)

INDEX

SPECIFICATIONS .....

STRUCTURE AND OPERATION .....

TROUBLESHOOTING .....

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Clutch Fluid Replacement and Air Bleeding .....
2. Inspection of Clutch Booster Functionality .....
3. Clutch Pedal Play .....

CLUTCH PEDAL .....

CLUTCH MASTER CYLINDER .....

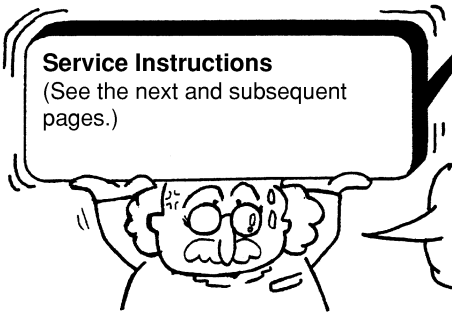
CLUTCH BOOSTER AND CLUTCH MASTER CYLINDER .....

CLUTCH POWER CYLINDER .....

CLUTCH-PROPER .....

CLUTCH HOUSING .....

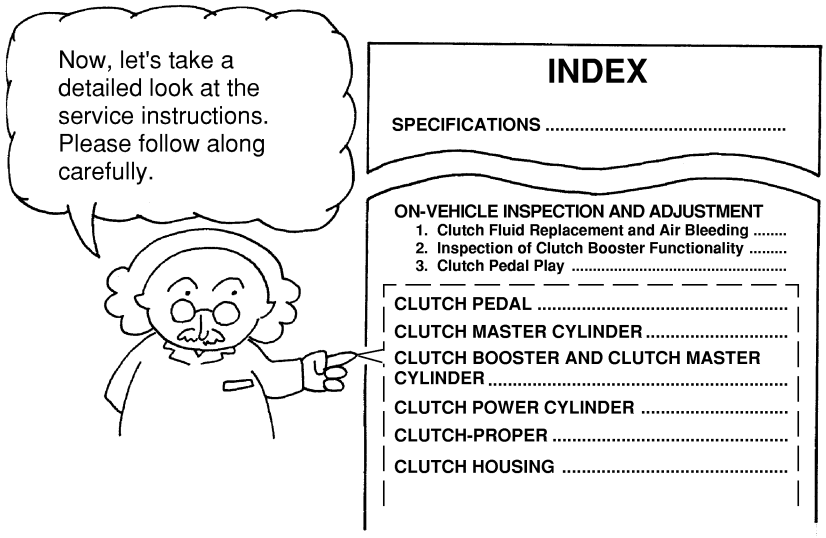
CLUTCH DISC WEAR INDICATOR SWITCH .....



23917

Service procedures

1



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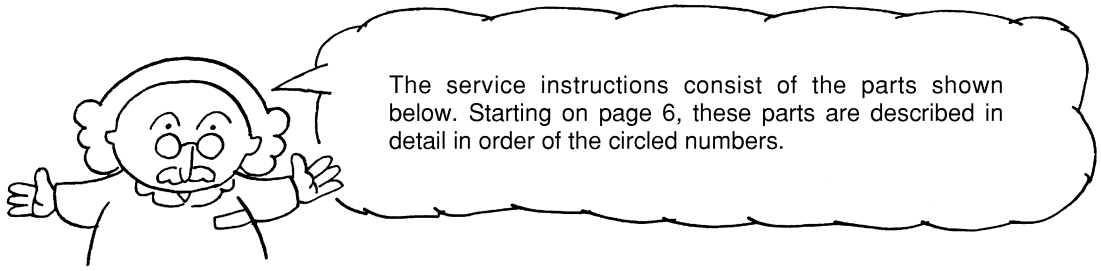

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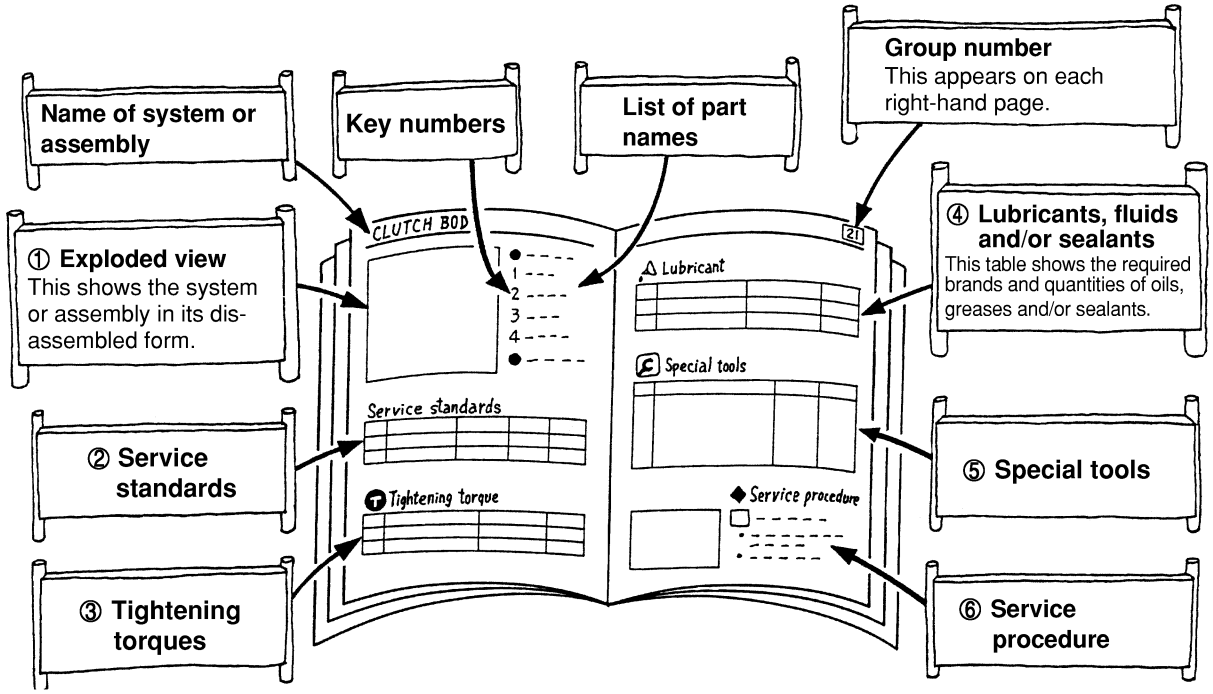

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HOW THIS MANUAL IS STRUCTURED

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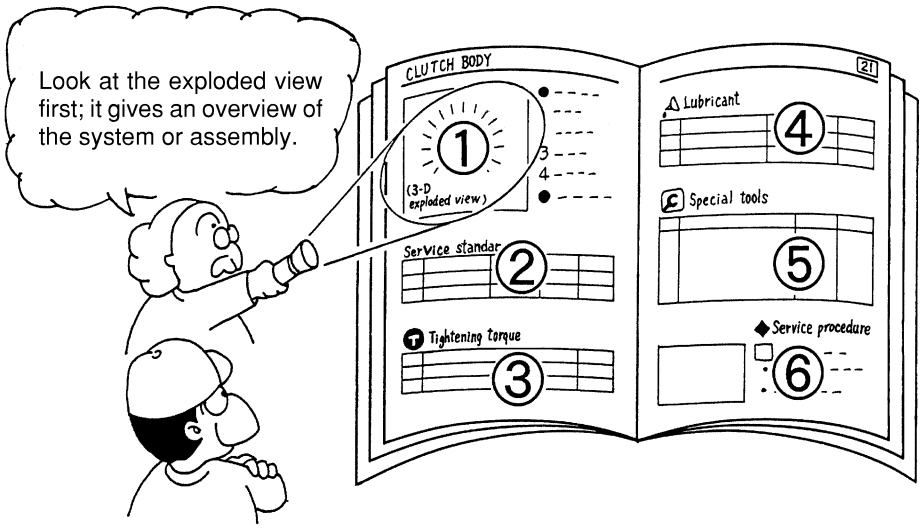

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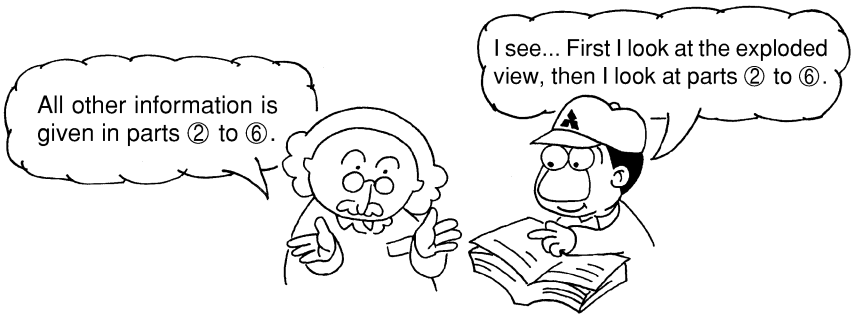

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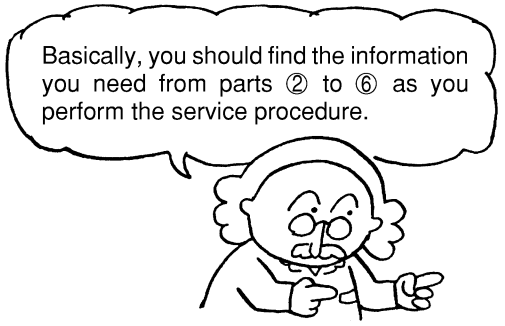

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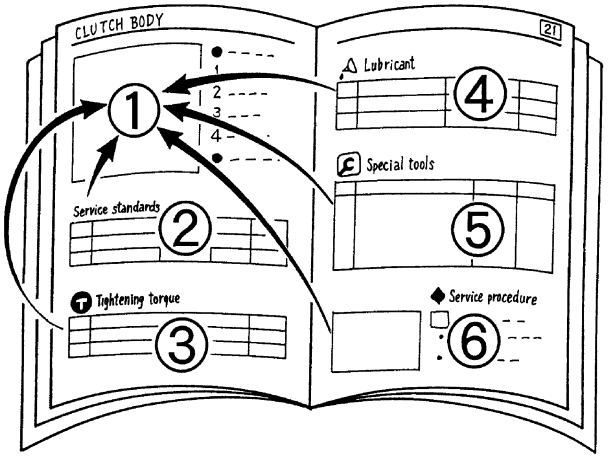

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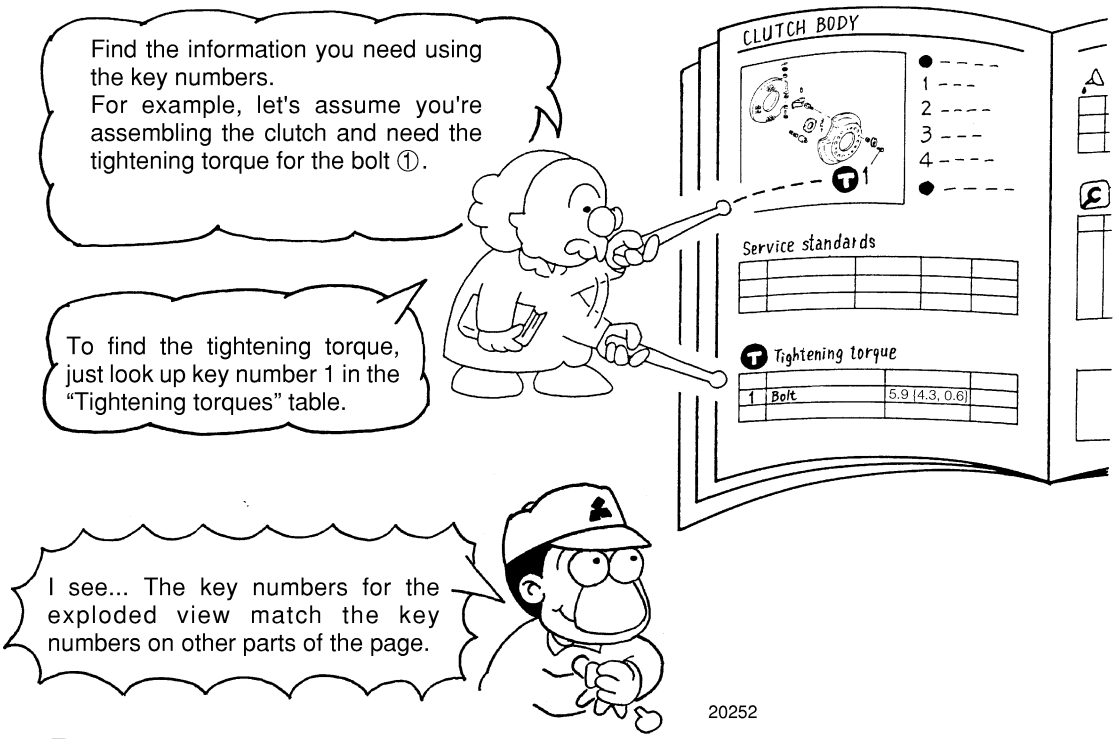
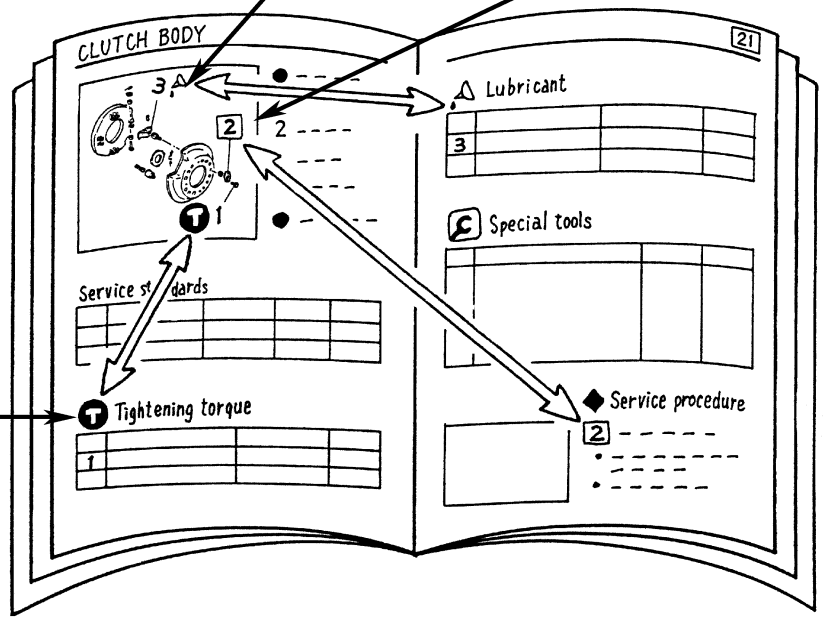
23922

6



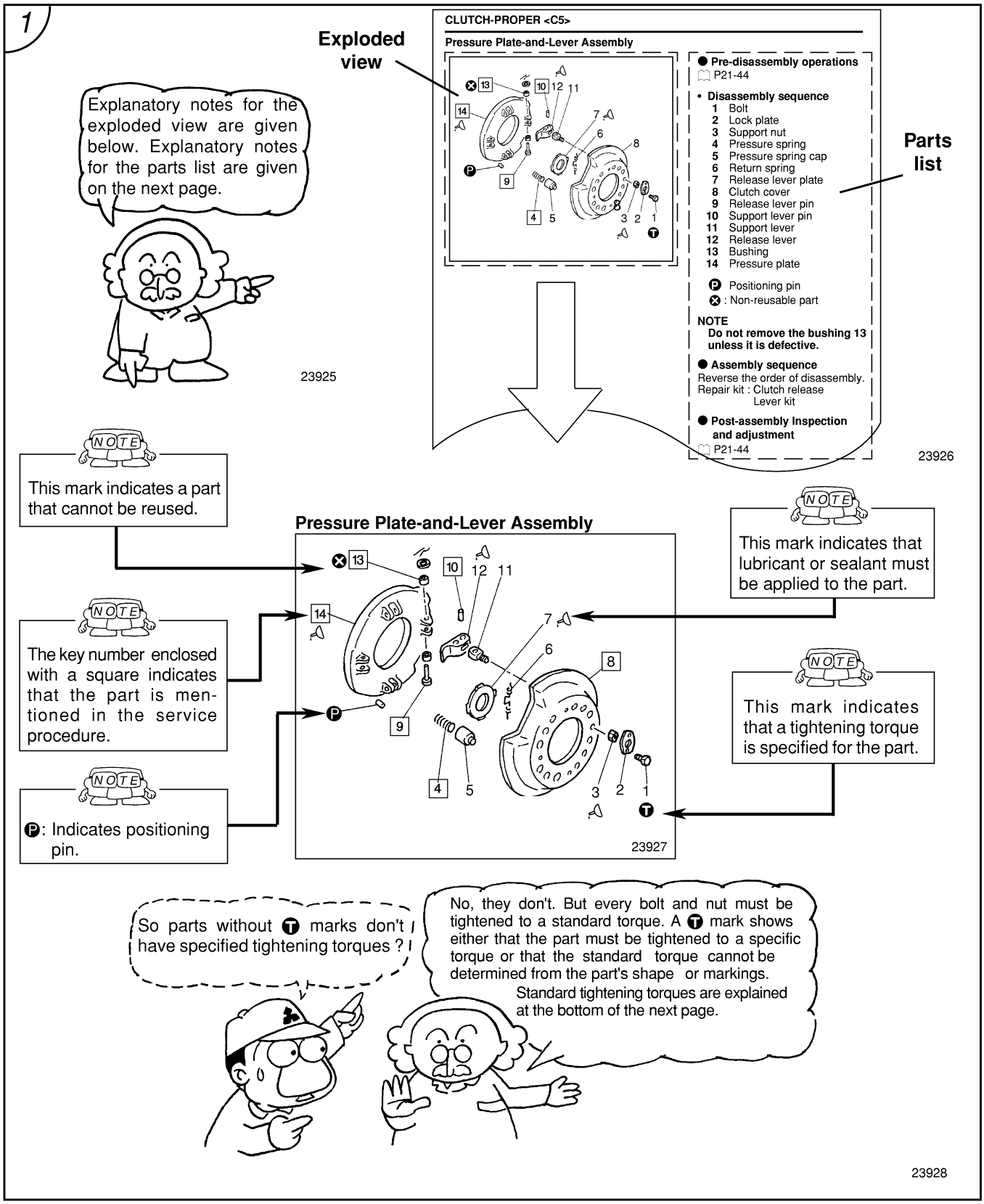
NOTE

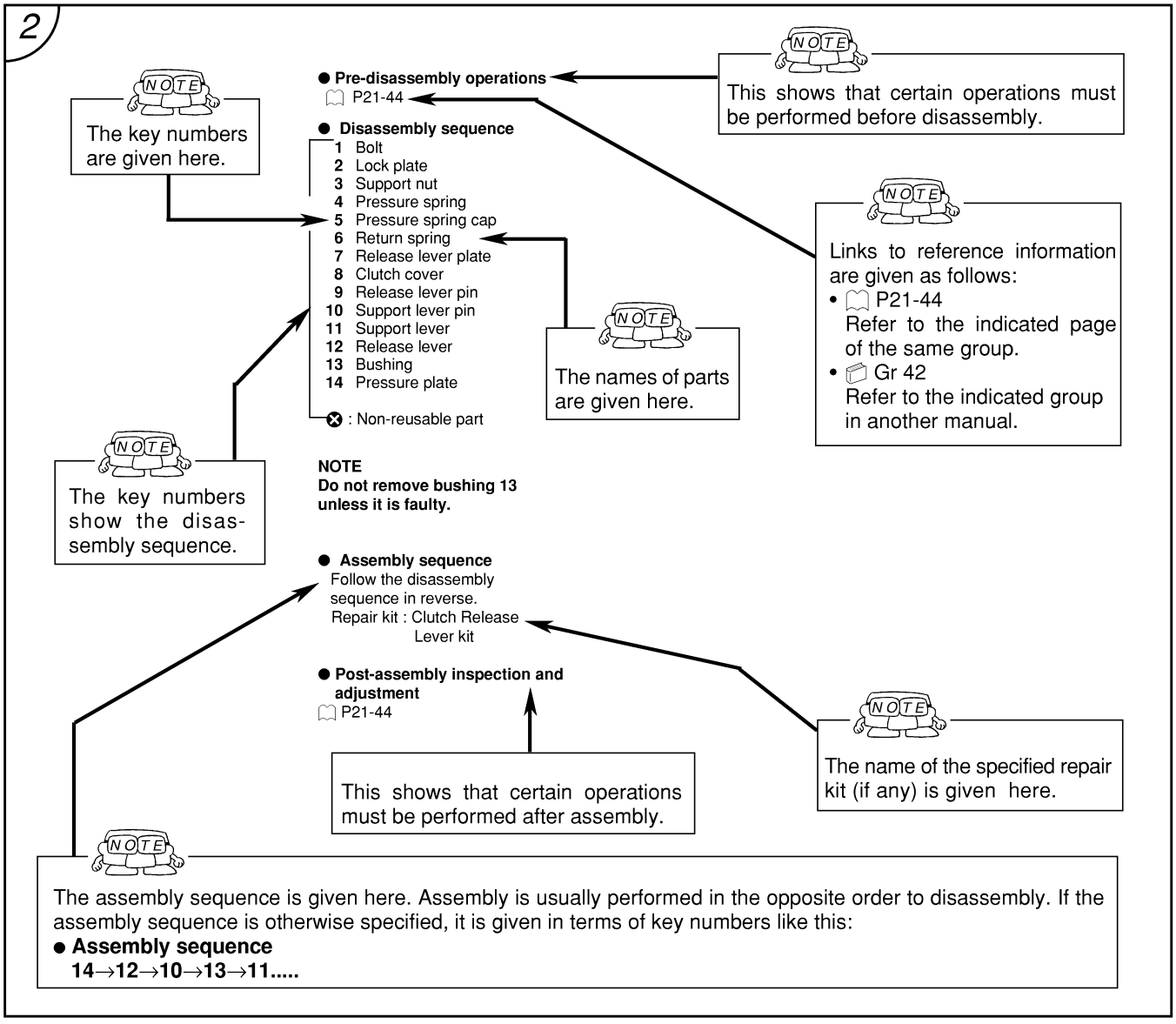
To help you find information quickly:
Tightening torques are marked with T.
Lubricants, fluids and sealants are marked with △.
And every key number that appears in the service procedure is enclosed with a square.

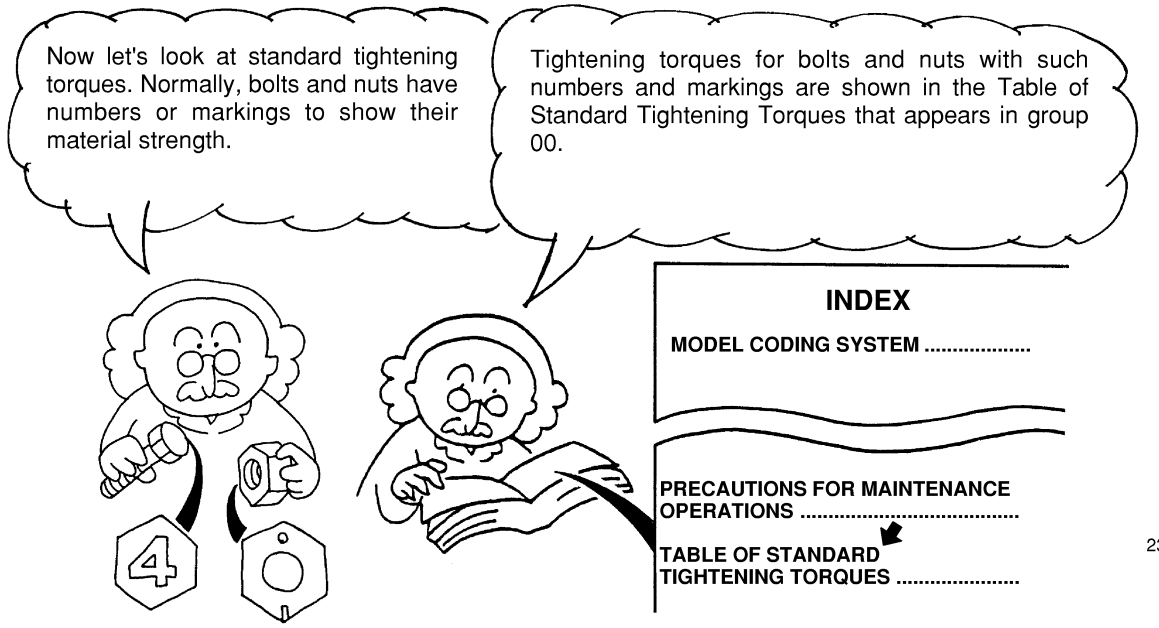


HOW THIS MANUAL IS STRUCTURED

① Exploded view




2
NOTE
The key numbers are given here.
● Pre-disassembly operations
P21-44
● Disassembly sequence
1 Bolt
2 Lock plate
3 Support nut
4 Pressure spring
5 Pressure spring cap
6 Return spring
7 Release lever plate
8 Clutch cover
9 Release lever pin
10 Support lever pin
11 Support lever
12 Release lever
13 Bushing
14 Pressure plate
⊗ : Non-reusable part
NOTE
This shows that certain operations must be performed before disassembly.
NOTE
Links to reference information are given as follows:
• P21-44
Refer to the indicated page of the same group.
• Gr 42
Refer to the indicated group in another manual.
NOTE
The names of parts are given here.
NOTE
The key numbers show the disassembly sequence.
NOTE
Do not remove bushing 13 unless it is faulty.
● Assembly sequence
Follow the disassembly sequence in reverse.
Repair kit : Clutch Release Lever kit
● Post-assembly inspection and adjustment
P21-44
NOTE
The name of the specified repair kit (if any) is given here.
This shows that certain operations must be performed after assembly.
NOTE
The assembly sequence is given here. Assembly is usually performed in the opposite order to disassembly. If the assembly sequence is otherwise specified, it is given in terms of key numbers like this:
● Assembly sequence
14→12→10→13→11.....


Now let's look at standard tightening torques. Normally, bolts and nuts have numbers or markings to show their material strength.
Tightening torques for bolts and nuts with such numbers and markings are shown in the Table of Standard Tightening Torques that appears in group 00.
INDEX
MODEL CODING SYSTEM .....
PRECAUTIONS FOR MAINTENANCE OPERATIONS .....
TABLE OF STANDARD TIGHTENING TORQUES .....
23930

HOW THIS MANUAL IS STRUCTURED

② Service standards

Service standards Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
4	Pressure spring	Installed load (Installed length 49.1 {1.93})	885 N {200 lbf, 90.2 kgf}	750 N {170 lbf,76.7 kgf}	Replace
		Squareness	2.9 {0.11} or less	5.0 {0.20}	Replace
7	Release lever plate height		53.8±0.7 {2.12±0.028}	Relative difference 0.5 {0.020} maximum	Adjust
10, 13	Clearance between release lever pin and bushing		[10 {0.39}] 0.02 to 0.11 {0.00079 to 0.0043}	0.4 {0.016}	Replace
14	Pressure plate	Thickness	23.6±0.1 {0.93±0.0039}	21 {0.83}	Replace
		Flatness	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Strap bolt hole I.D.	10.2 to 10.25 {0.40 to 0.40}	10.5 {0.41}	Replace

NOTE
Number(s) in this column match the key number(s) on the exploded view ①.

③ Tightening torques

T Tightening torque Unit : N·m {ft.lbs, kgf.m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	5.9 to 7.8 {4.3 to 5.8, 0.6 to 0.8}	—

NOTE
Number(s) in this column match the key number(s) on the exploded view ①.

NOTE
If oil or grease must be applied to threads before tightening, the word "Wet" appears in this column.

	Remarks
	Wet

④ Lubricants, fluids and/or sealants

Lubricant

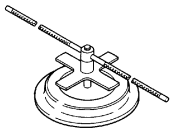
Location	Points of application	Specified lubricant	Quantity
3	Threads and spherical surface of support nut	Anti-seizure compound	As required
7, 12	Sliding surfaces of release lever plate and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
11, 12	Sliding surfaces of support lever and release lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
11, 14	Sliding surfaces of support lever and pressure plate	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

NOTE
Number(s) in this column match the key number(s) on the exploded view ①.

NOTE
The specified types/brand are shown here.

⑤ Special tools

Special tools Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Clutch Installer  01277	MH061051	Removal and installation of clutch cover

NOTE
Number(s) in this column match the key number(s) on the exploded view ①. For any special tool that is not a Mitsubishi genuine part, no illustration is shown; only the part number is given, as shown below.

Special tools

Location	Tool name and shape	Part No.	Application
21	Insertion Tool	*910-24461	Installation of O-ring
32	Retainer	*910-24590	Retention of primary piston

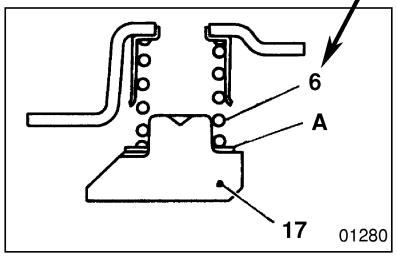
* BOSCH BRAKING SYSTEMS Co. Ltd. product number

⑥ Service procedure

1

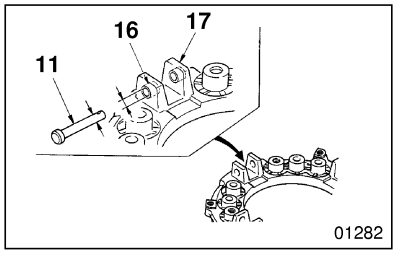
NOTE
Number(s) is this column match the key number(s) exploded view ①.

NOTE
The service procedure gives instructions in order of key numbers.



6 **Installation of pressure spring**
If the pressure plate **17** has been reqround, insert between the pressure plate and pressure spring **6** an adjusting washer **A** whose thickness matches that of the ground off material.

Regrind amount	Thickness and number of washer(s)
Less than 1 mm {0.039 in.}	Not required
1 mm {0.039 in.} (or more) to less than 2 mm {0.079 in.}	1.2 mm {0.047 in.}×1
2 mm {0.079 in.} (or more) to less than 3 mm {0.12 in.}	1.2 mm {0.047 in.}×2 or 2.3 mm {0.091 in.}×1



G L **Clearance between release lever pin and bushing**
If the measurement exceeds the specified limit, replace the defective part(s).

NOTE
Perform this check with the bushing 16 press-fitted into the pressure plate 17.

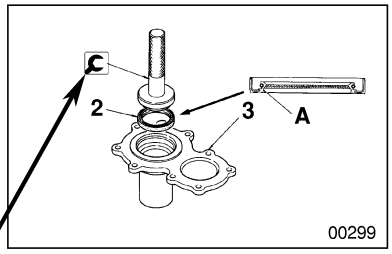
2

Service procedures contain a variety of symbols and other indications. Let's look at some examples.

23931

Key number

[Example 1: Special tools]



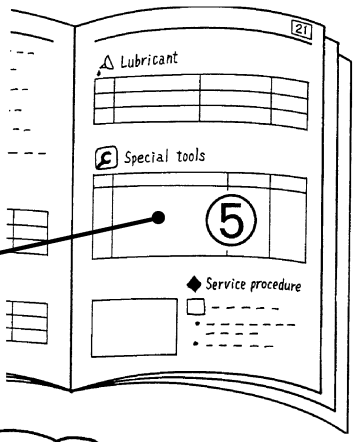
2 Installation of oil seal

- Apply grease to the lip **A** of the oil seal **2**.
- Using the Oil Seal Installer, fit the oil seal **2** into the front bearing retainer **3**. Make sure the oil seal is aligned as illustrated.

Name of special tool

Every special tool is indicated by a symbol. The text of the service procedure also includes the special tool's name. To see the part number and shape of a special tool, find the tool's key number and name in the "Special tools" table ⑤.

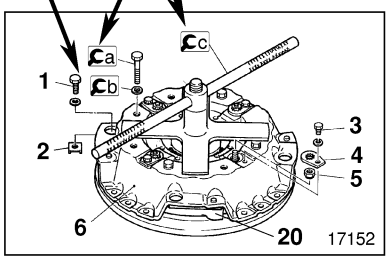
23932



26315

If more than one special tool is used, the symbols are supplemented by letters (for example, a, b and c) to enable cross-referencing between the exploded view and service procedure.

20277



6 Removal and installation of clutch cover

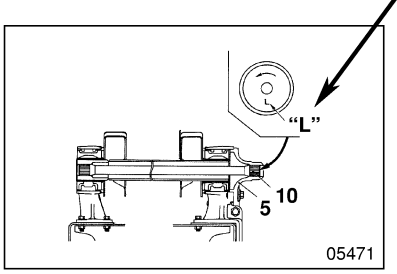
[Removal]

- Compress the pressure spring **8** using the c Clutch Installer, then remove the a Stopper Bolt, b Washer, strap bolt **1**, washer **2**, bolt **3**, lock plate **4** and support nut **5**.
- Gradually loosen the c Clutch Installer until the pressure spring **8** is ineffective, then remove the clutch cover **6**.

3

[Example 2: Identification or mating marks]

NOTE Any mark on an actual part is given in quotation marks “ ” in the service procedure.

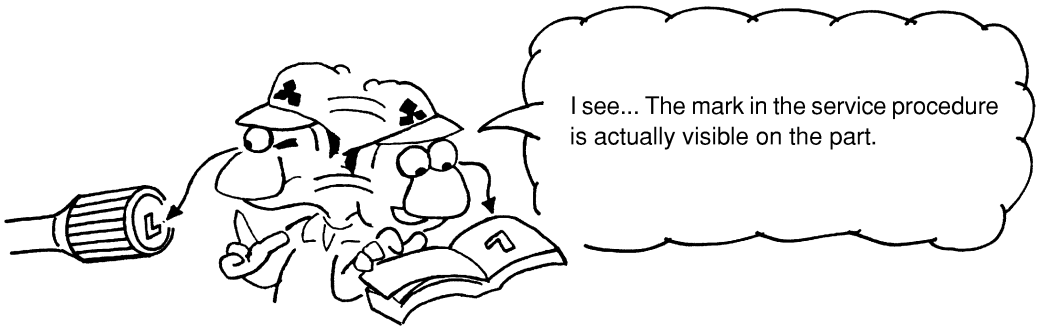


F Installation of torsion bar

Fit the torsion bar **10** such that the "**L**" identification mark is on the side of the anchor lever **5**.

CAUTION ⚠

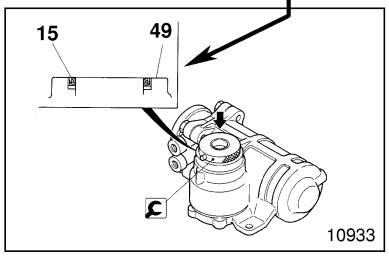
Make sure the torsion bar 10 aligned as specified. If the torsion bar is installed the wrong way around, the torsion direction will be reversed, resulting in damage.



4

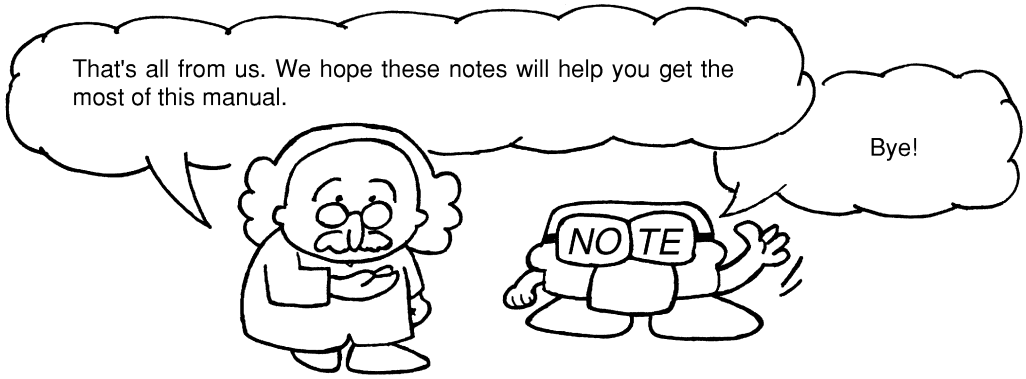
[Example 3 : Alignment of parts]

NOTE All illustrations show the correct alignment/direction of parts relative to each other. Provided the alignment/direction is shown clearly in the exploded view ①, no further explanation is given in the text of the service procedure.



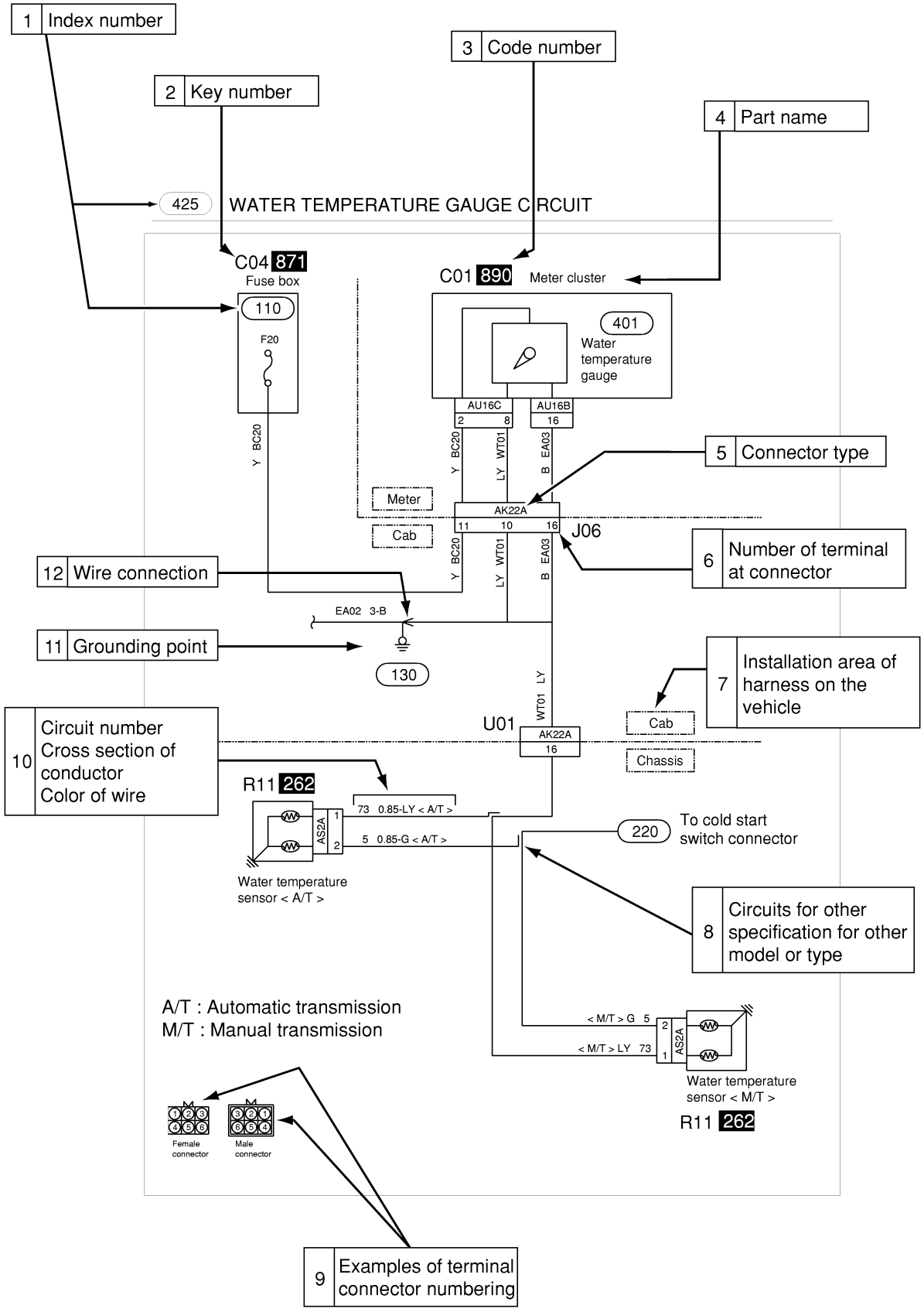
K Installation of oil seal

Fit the oil seal **15** into the body **49,** making sure it is aligned as illustrated.



HOW THIS MANUAL IS STRUCTURED

HOW TO READ CIRCUITS (GROUP 54)



Ⓟ45405

1 Index number: (110)

Each circuit has its own three digit Index number identified with three digits ((110)).

- How to read index number
  By proper using of the index number, it is possible to easily locate the circuit drawing in this manual as they are classified by function. (including "POWER CIRCUIT" (110) and "GROUND " (130) .)
- How to check the location of circuit drawing in each part
  The circuit drawing which can not be diagramed in one page due to its complicated structure (such as meter cluster and electronic control unit etc.), has its remarked index number to be connected to other circuit drawing. ((401) , (910) , etc.)

2 Key number: A01~

Key number is the number to indicate the installation position of the parts, and is shown by A01 ~ Z.
The details of the installation position are described in GROUP 10 .

3 Code number: **001** ~

Code number is the number to indicate an inspeciton procedure or detail exists and has three digits (**001**).
The details of the parts to be checked are described in GROUP 11 .

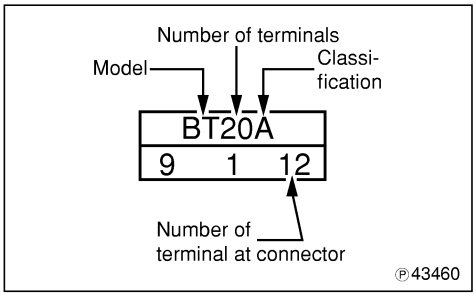
4 Part name

5 Connector type

Connectors are shown by □ without reference to Male or Female. In the box is a description of connector, number of terminals and its classification, etc.
Table of connectors is described in GROUP 00.

6 Number of terminal at connector

Terminal numbers of connector are shown by figures in the box.



7 Installation area of harness on the vehicle

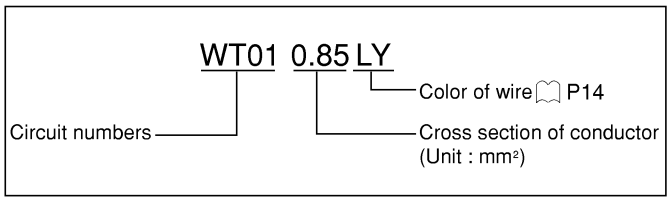
The location and boundary of the harnesses in the vehicle are shown in the each circuit drawing and it may help to check mounting position of connectors.

8 Circuits for other specification for other model or type

9 Examples of terminal connector numbering

As it is shown, for female connectors, with placing the lock upward then starting to put numbers from the upper left. And when it is male connector, put numbers from the upper right, also with placing the lock upward.

10 Circuit number, color of wire, and cross section of conductor are shown in circuit drawings.



Except for 0.5mm², Wire thickness is described in the circuit drawing. The reason why only wire thickness, 0.5 mm² is not described in the drawings is 0.5mm² is so common and so that the circuit drawing can be seen more easily.
(Examples) 0.5mm²: Y
0.85mm²: 0.85 — LY
3mm²: 3 — B

11 Grounding point

The actual locations of grounding points on the vehicle are shown. Refer to (130) for detailed information.

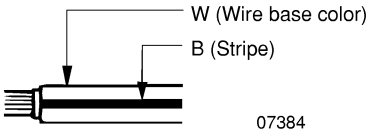
12 Wire connection

When the wires are connected into one point of the harnesses, the circuit drawing shows "Arrow mark".

CAUTION !
Be careful as the direction of the arrow does not show the direction of the electric current flow.

● Wire Colors

Example: WB means a wire whose base color is white and whose stripe is black.

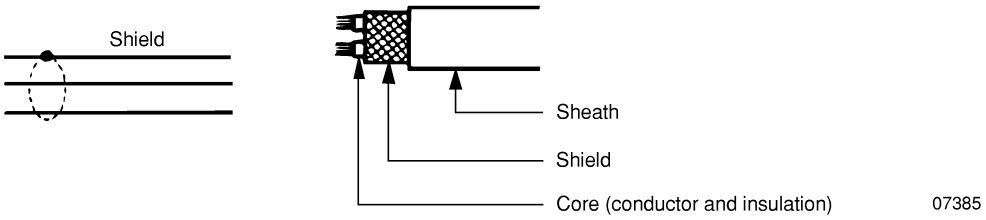


Wire base color		Wire base color + Stripe									
W	White	WR	White red	WB	White black	WL	White blue	WG	White green		
B	Black	BW	Black white	BY	Black yellow	BR	Black red				
R	Red	RW	Red white	RB	Red black	RY	Red yellow	RG	Red green	RL	Red blue
Y	Yellow	YR	Yellow red	YB	Yellow black	YG	Yellow green	YL	Yellow blue	YW	Yellow white
G	Green	GW	Green white	GR	Green red	GY	Green yellow	GB	Green black	GL	Green blue
Br	Brown	BrW	Brown white								
L	Blue	LW	Blue white	LR	Blue red	LY	Blue yellow	LB	Blue black	LO	Blue orange
Lg	Yellow green	LgR	Yellow green red	LgY	Yellow green yellow	LgB	Yellow green black	LgW	Yellow green white		
O	Orange										
P	Pink	PB	Pink black								

● Shield Wire

A shield wire is clearly identified as follows:

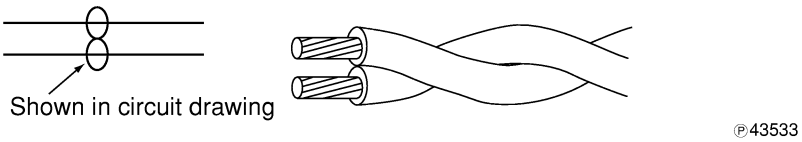
Example



● Twisted wire

Twisted wires are identified as follows:

Example:



TERMS

The terms in this manual are defined as follows.

● This service manual contains important precautionary instructions and supplementary information under the following four headings which identify the nature of the instructions and information:

DANGER⚠	Precautions that should be taken in handling potentially dangerous substances such as battery fluid and coolant additives.
WARNING⚠	Precautionary instructions, which, if not observed, could result in serious injury or death.
CAUTION⚠	Precautionary instructions, which, if not observed, could result in damage to or destruction of equipment or parts.
NOTE	Suggestions or supplementary information for more efficient use of equipment or a better understanding.

● **Front and rear**

The term “front” is the fan side and “rear” the flywheel side of the engine.

● **Left and right**

The terms “right” and “left” shall be used to indicate the side as viewed from the flywheel side of the engine.

● **Terms of service standards**

(1) Standard value

Standard value specifications indicate the design dimensions of individual new parts, the standard clearance between assembled parts, or a standard value for an assembled part, whichever applies.

The figure in [ ] is the basic diameter.

(2) Wear limit

When the value of a part exceeds this wear limit it is no longer serviceable with respect to performance and strength and must be replaced or repaired.

● **Tightening torque**

Appropriate fastener tightening torque has particular importance with respect to performance. Tightening torque is specified in locations where applicable.

Where there is no specified figure for tightening torque, follow the table covering standard tightening torques. (See Group 00).

When the item is to be tightened in a “wet” state, it is indicated in the remarks column. Where there is no indication, assume it is to be assembled dry, and tighten to specified torque.

MITSUBISHI
FUSO

Group 00

General

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-00

INDEX

MODEL CODING SYSTEM 00- 2

POWER TRAIN TABLE 00- 3

CHASSIS NUMBER AND ENGINE NUMBER 00- 4

POWER TRAIN LABEL 00- 4

VEHICLE IDENTIFICATION NUMBER 00- 5

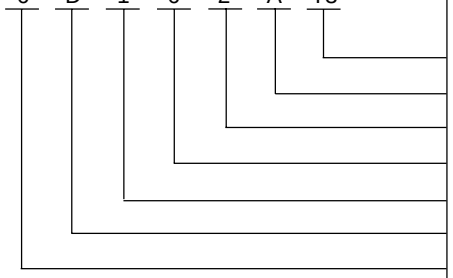
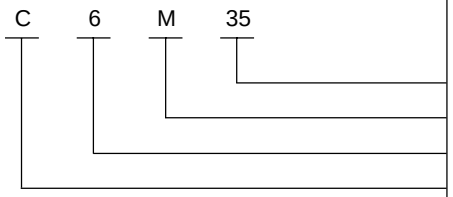
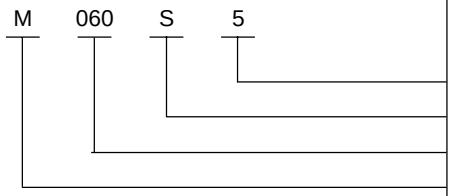
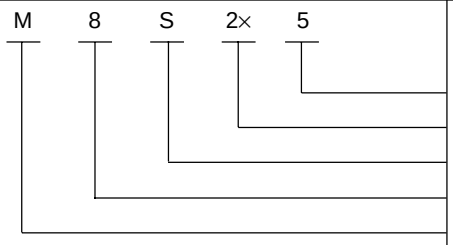
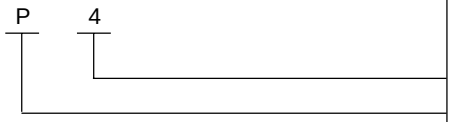
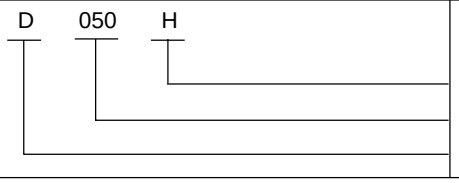
PRECAUTIONS FOR MAINTENANCE OPERATION 00- 6

TABLE OF STANDARD TIGHTENING TORQUES 00-18

CONNECTOR CONFIGURATION CHART 00-22

MODEL CODING SYSTEM

Equipment Model Code

Equipment name	Model description	Code description
Engine		With turbocharger Stands for automotive Remodeling sequence Version number Series number Stands for diesel engine No. of cylinders (6 : Six cylinders) } These are omitted in the Service Manual
Clutch		Disc outer diameter (x10 m.m.) Facing material (M : Cera-metallic) Loading capacity of major type (tonnage) Stands for clutch
Transmission		No. of forward speeds Meshing (S : Synchromesh, A : Automatic) Loading capacity of major type (tonnage) Stands for transmission
		No. of forward speeds High-and-low two step selection Meshing (S : Synchromesh) Typical weight of vehicle in which the transmission is installed Stands for transmission
Propeller shaft		Loading capacity of major type (tonnage) Stands for propeller shaft
Reduction and differential		Teeth shape (H : hypoid gear) Loading capacity of major type (tonnage) Stands for reduction and differential

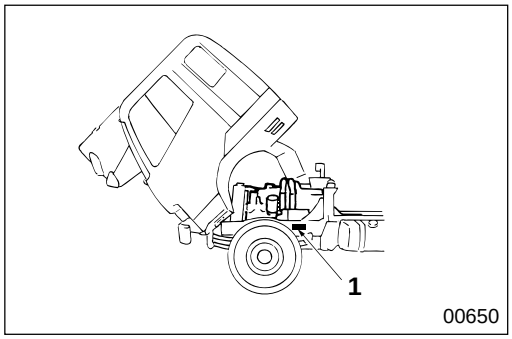
POWER TRAIN TABLE

Model	Engine model	Clutch model	Transmission model	Propeller shaft	Rear axle model	Final reduction and gear ratio
FK617 G. V. W. 10430 kg {23000 lb}	6D16T3 200 HP/2600 rpm 434 ft.lbs/1600 rpm (SAE, Gross)	C6M35	M060S6 6.875/0.786	P4	R050T	D050H 4.875
		Torque converter (TC290-1.72)	M4A4 (Allison AT542) 3.454/1.000			D050H 4.625
FM617 G. V. W. 11790 kg {25995 lb}	6D16T3 200 HP/2600 rpm 434 ft.lbs/1600 rpm (SAE, Gross)	C6M35	M060S6 6.875/0.786	P8	R060T	D8H 5.857
		Torque converter (TC290-1.72)	M4A4 (Allison AT545) 3.454/1.000			D8H 4.875
FM617 G. V. W. 13610 kg {30000 lb}	6D16T3 200 HP/2600 rpm 434 ft.lbs/1600 rpm (SAE, Gross)	C6M35	M060S6 6.875/0.786	P8	R060T	D8H 6.166
		Torque converter (TC290-1.72)	M4A4 (Allison AT545) 3.454/1.000			D8H 5.571
FM657 G. V. W. 14920 kg {32900 lb}	6D16T3 200 HP/2600 rpm 434 ft.lbs/1600 rpm (SAE, Gross)	C6M35	M060S6 6.875/0.786	P8	R060T	D8H 6.166
	6D16T2 230 HP/2600 rpm 521 ft.lbs/1600 rpm (SAE, Gross)	C7M38	M070S6 8.064/1.000	P10		D8H 4.625
			M8S2×5 10.060/1.000			
		Torque converter (TC415-2.35)	M100A6 (Allison) MD3060 3.487/0.652			D8H 6.666

CHASSIS NUMBER AND ENGINE NUMBER/POWER TRAIN LABEL

CHASSIS NUMBER AND ENGINE NUMBER

The serial numbers for chassis and engines are assigned to the respective vehicles and engines in manufacturing sequence: each vehicle and engine has its own number. These numbers are required for registration and incidental inspection of the vehicle. Please do not fail to mention these numbers to the dealers when ordering spare parts.



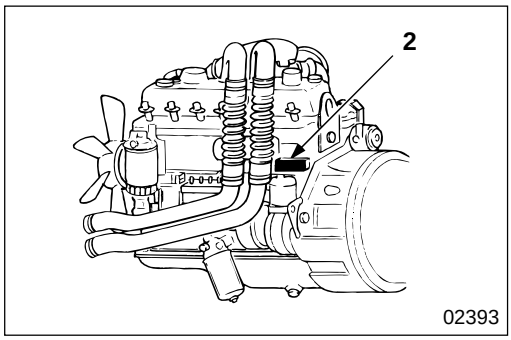
Chassis number

Chassis number **1** is punch-marked on the frame by the left-side front wheel.

Example : FK617H–□□□□□□

Vehicle model

Chassis number



Engine number

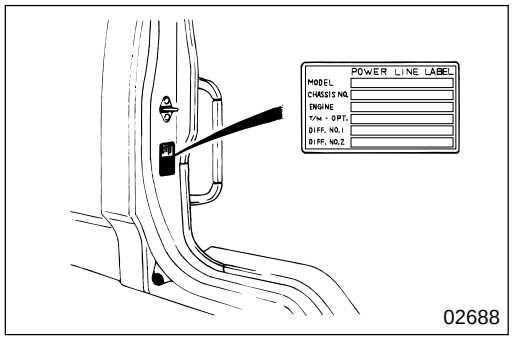
Engine number **2** is punch-marked on the left of the crankcase.

Example : 6D16–□□□□□□

Engine number

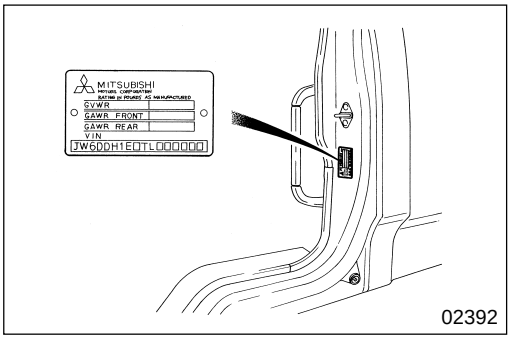
Engine model

POWER TRAIN LABEL



Power train label **1** located in the position illustrated indicates the vehicle model, chassis number and information relevant to the vehicle's power transmission components.

VEHICLE IDENTIFICATION NUMBER



The vehicle identification number is punch-marked on the plate, which is attached in the position as illustrated.
The vehicle identification number consists of a 17-digit set of alphanumeric characters. Each digit represents the following specifications.

J W 6 D D H 1 E □ 2 L □□□□□□
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫

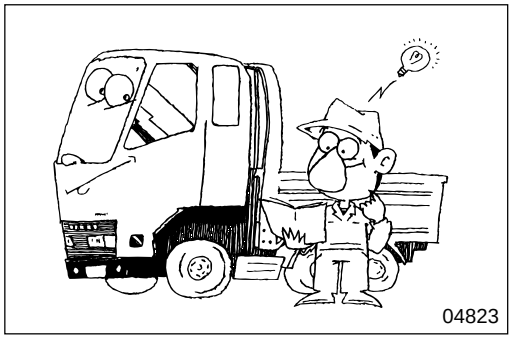
①	Country	J : Japan
②	Make	W : Mitsubishi Fuso
③	Vehicle type	6 : Incomplete Vehicle
		7 : Truck
④	Gross vehicle weight/Brake system	D : 19501 to 26000 lbs/Air over hydraulic
		E : 26001 to 33000 lbs/Air over hydraulic
		F : 26001 to 33000 lbs/Full air
⑤	Line	D : FK617
		E : FM617
		F : FM657
⑥	Series (Wheelbase)	F : 3.5 to 3.79 m {11.48 to 12.43 ft.}
		H : 4.1 to 4.39 m {13.45 to 14.40 ft.}
		J : 4.4 to 4.69 m {14.43 to 15.38 ft.}
		K : 4.7 to 4.99 m {15.41 to 16.37 ft.}
		L : 5.0 to 5.29 m {16.40 to 17.35 ft.}
		M : 5.3 to 5.59 m {17.38 to 18.33 ft.}
		P : 5.9 to 6.19 m {19.35 to 20.30 ft.}
⑦	Cab chassis type	1 : Chassis cab
		3 : Mixer
⑧	Engine	E : 7.545 ℓ Diesel turbocharged and charge air cooled
⑨	Check digit	
⑩	Model year	2 : 2002
⑪	Plant	K : Kawasaki-1
		L : Kawasaki-2
		M : Kawasaki-3
⑫	Plant sequential number	

PRECAUTIONS FOR MAINTENANCE OPERATION

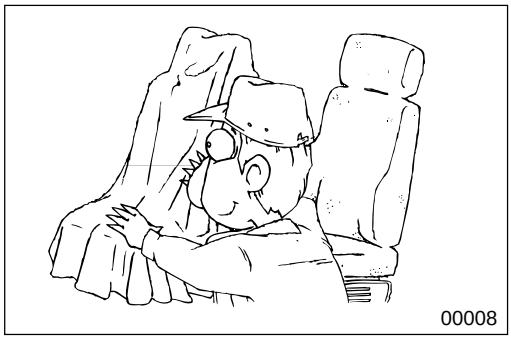
DANGER ⚠

This product contains or emits chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

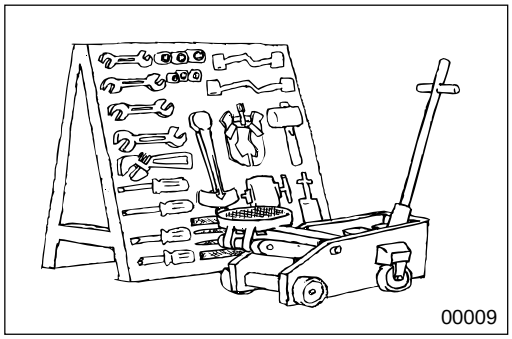
In order to determine the condition of the vehicle adequately, examine the vehicle beforehand to record the accumulated mileage, operating condition, customer's complaint, and other information that may be necessary. Prepare the steps to be taken and perform an efficient maintenance procedure.


04823

Determine where the fault exists and check for the cause to see whether removal or disassembly of the part is necessary. Then follow the procedure specified by this manual.


00008

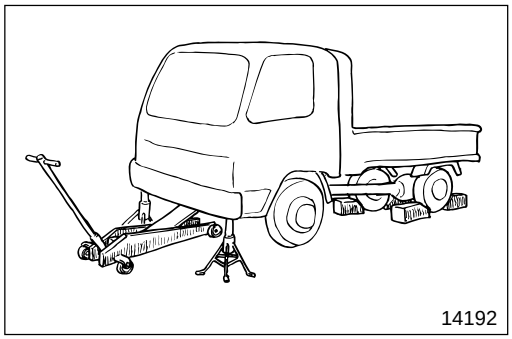
Perform maintenance work in a level area.
Prepare the following.
- To prevent the seats, upholstery, floor and bodywork from being spoiled or scratched, cover with workshop sheet cover(s).


00009

- Prepare general and special tools necessary for the maintenance work.

WARNING ⚠

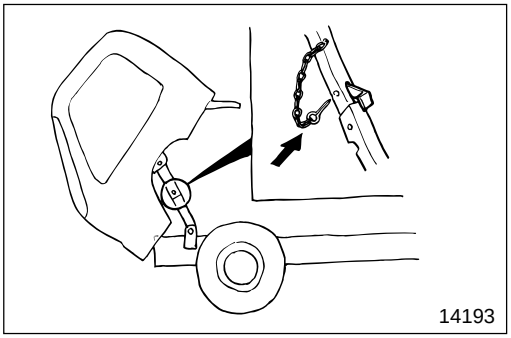
Do not attempt to use tools other than special tools where use of special tools is specified in this manual. This will avoid injury or damage.


14192

When jacking up the vehicle to work under the vehicle, carry out the following preparatory work:
- Chock the wheels on both sides.
- Jack up the vehicle using an appropriately rated jack.
- Support the frame on jack stands.

WARNING ⚠

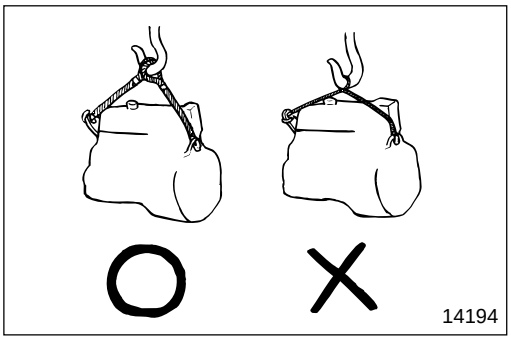
- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on jack stands.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**



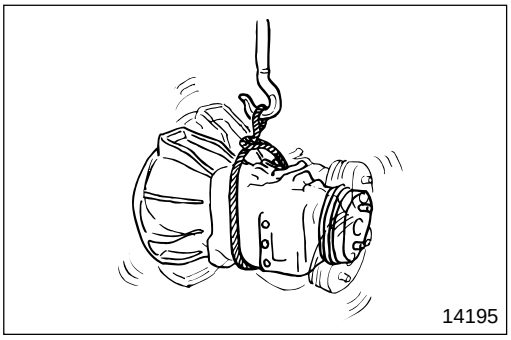
When tilting the cab, be sure to insert the safety pin into the cab stay so that the cab stay remains locked and cannot be released when the cab is tilted.

Pay special attention to safety when removing or installing heavy items such as engines, transmissions and axles.

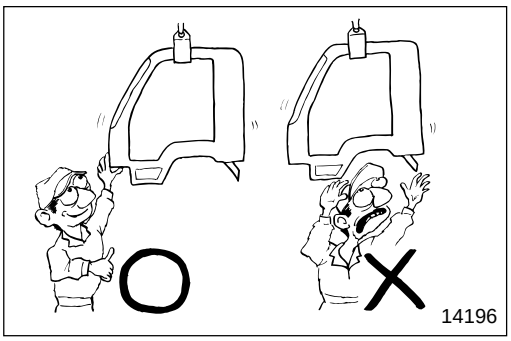
When lifting up heavy items using cables, pay special attention to the following points:



- Check the mass of the item to be lifted and use a cable capable of lifting that mass.



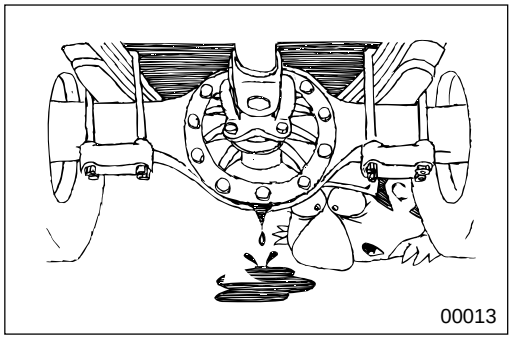
- If you do not have the specified lifting hanger, secure the item using cable taking the point-of-balance of the item into consideration.



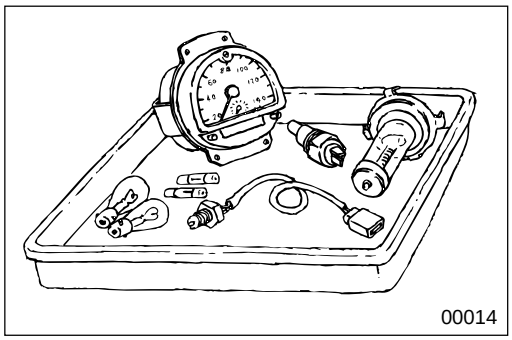
- You must work in a position where you will not be injured even if the cable comes undone and the lifted item falls.

PRECAUTIONS FOR MAINTENANCE OPERATION

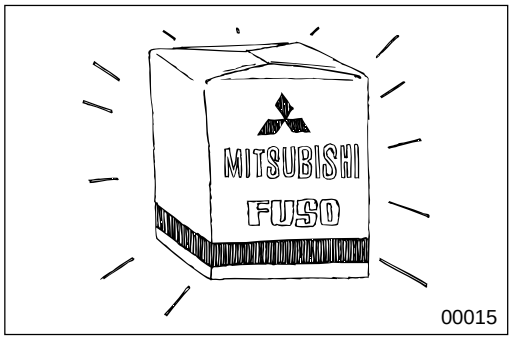
Be particularly careful not to work in shoes that have oily soles and are slippery. When working as a team of two or more, arrange signals in advance and keep confirming safety. Be careful not to accidentally bump switches or levers.



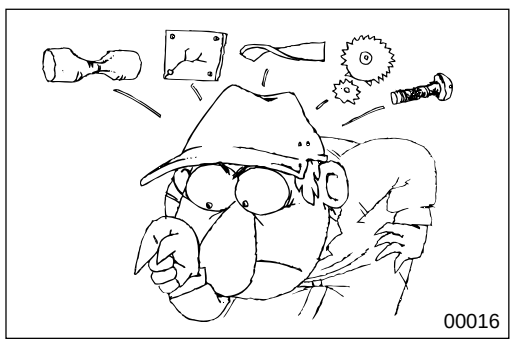
Check for oil leakage before cleaning the area having the fault otherwise you might miss detecting the leakage.



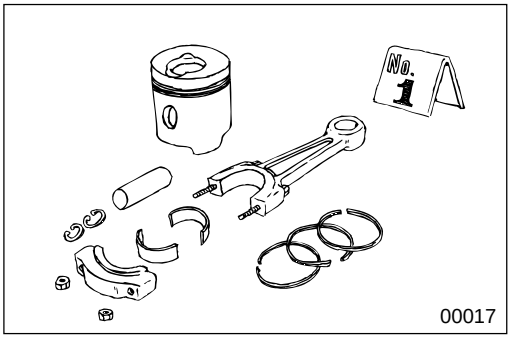
Prepare replacement part(s) beforehand.



Replace oil seals, packing, O-rings and other rubber parts; gaskets and split pins with new parts whenever any of them has been removed. Use only genuine MITSUBISHI replacement parts.



On disassembly, visually inspect all parts for wear and tear, cracks, damage, deformation, degradation, rust, corrosion, smoothness in rotation, fatigue, clogging and any other possible defect.

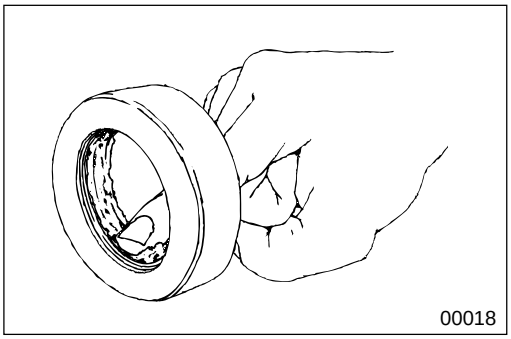


00017

Put alignment marks on part combinations before disassembly and arrange the disassembled parts neatly. This will help avoid mismating of the parts later.
Put the alignment marks, punch marks, etc. where performance and appearance will not be affected.
Cover the area left open after removal of parts to keep it free from dust.

CAUTION⚠

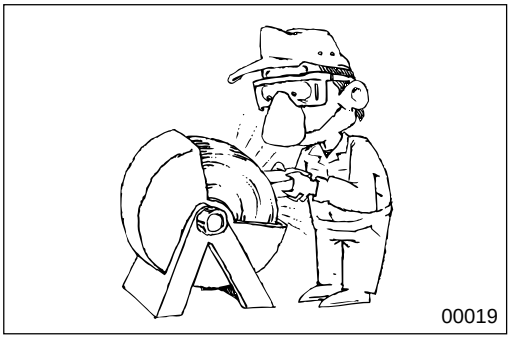
- **Take care to avoid mixing up numerous parts, similar parts, left and right, etc.**
- **Keep new parts for replacement and original (removed) parts separate.**


00018

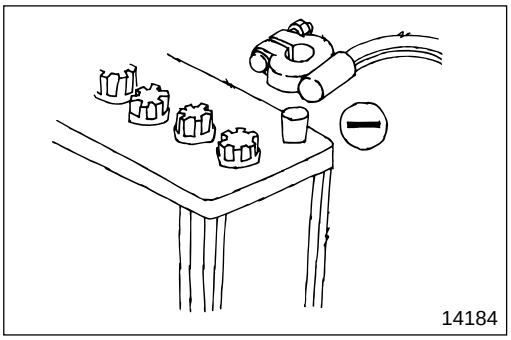
Apply the specified oil or grease to U-packings, oil seals, dust seals and bearings during assembly.
Use only the specified oil, grease, etc. for lubricant, remove the excess immediately after application with a piece of waste, etc.

CAUTION⚠

When the specified lubricant, fluid and sealant is not available, you may use an equivalent.


00019

Wear goggles when using a grinder or welder. Pay full attention to safety by wearing gloves when necessary. Watch out for sharp edges, etc. that might injure your hands or fingers.

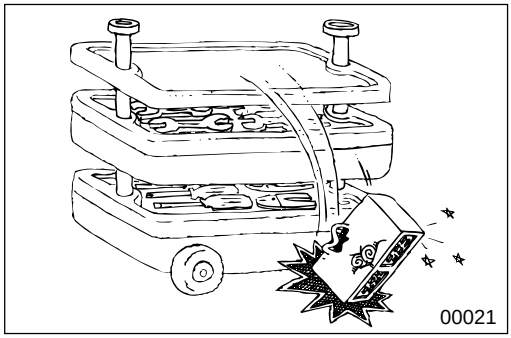

14184

Before carrying out maintenance work on the electric system, disconnect the negative terminals of the batteries to prevent them from short-circuiting and burning-out.

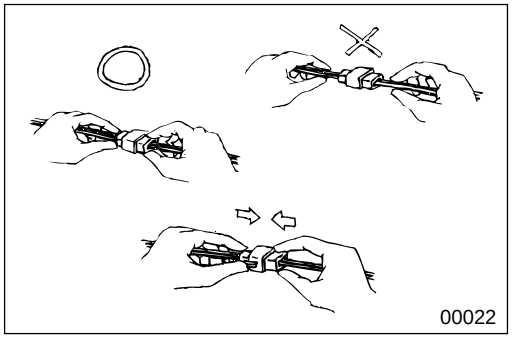
CAUTION⚠

Be sure to turn starter and lighting switches, etc. off before disconnecting or connecting battery terminals, because the semiconductors can be damaged.

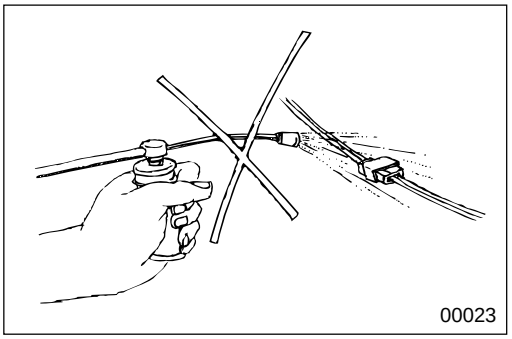
PRECAUTIONS FOR MAINTENANCE OPERATION



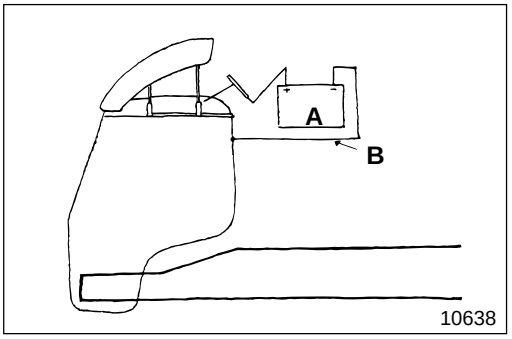
Take care when handling sensors, relays, etc. which are vulnerable to shock and heat. Do not attempt to remove the cover from, or apply paint to, the electronic control unit.



Pull the connector, and not the harness lead, to separate connectors. To separate a lock-type connector, first push toward arrow mark. To reconnect a lock-type connector, press the separated parts until they click together.



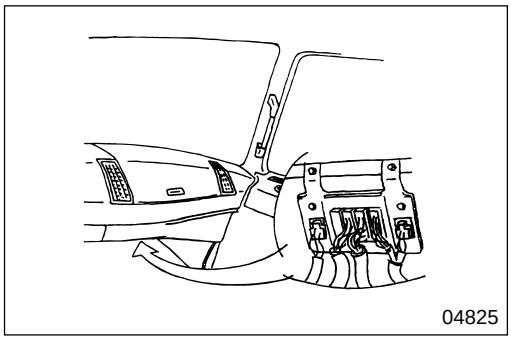
When washing the vehicle, cover the electric system parts and instruments with waterproof material beforehand (Cover with vinyl sheet or the like). Keep water away from harness wire connectors and sensors. If any of them should get wet, wipe them off immediately.



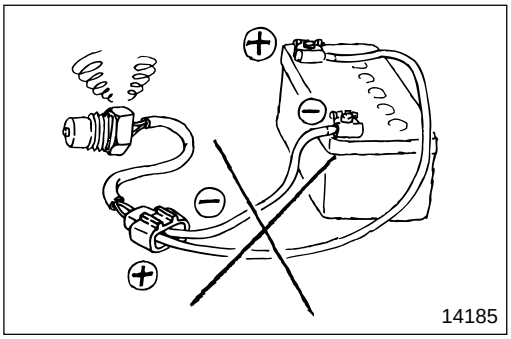
When using an electric welder, such electronic parts that are directly connected to the batteries might be damaged due to the flow of current from the welder that flows through the negative circuit. Parts that have switches might be subject to the same danger if the switches are left on. Therefore, do not fail to observe the following.

A : Welder

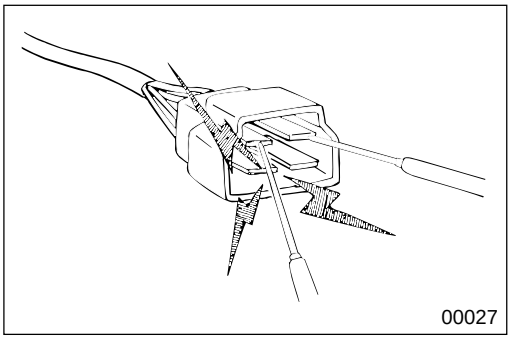
B : Connect the negative terminal of the welder as near as possible to the area that is to be welded.



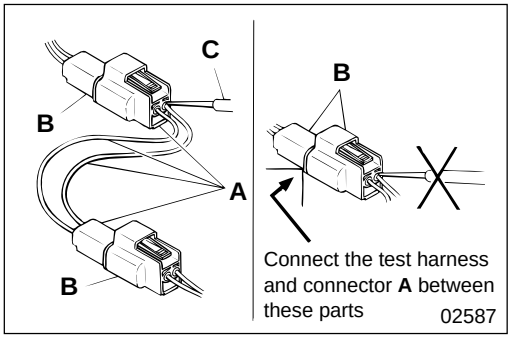
- Disconnect the negative terminals of batteries.
- Disconnect connections between the cab harness wires and the chassis harness wires.



To apply voltage for testing, check that the positive and negative cables are connected properly, then increase voltage gradually from 0 volt. Do not apply voltage higher than the specified value.
In particular, pay close attention to the electronic control unit and sensors, since they are not always fed the battery voltage.



When using testers or the like for continuity tests, be careful not to allow test probes to touch the wrong terminals.



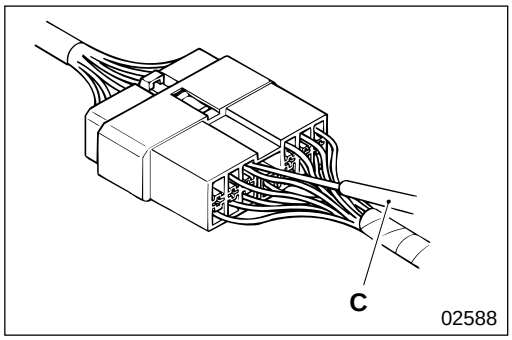
Measurement procedures using connectors

- **Test with connectors engaged (continuity through circuit obtained)**

  < Waterproof connector >

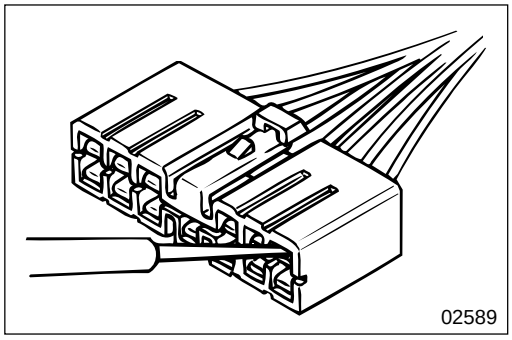
  Prepare a test harness and connectors **A**, then connect if between the two parts of harness **B** that is to be tested. Check the circuit by touching test probe **C** to the test connector.

  Never insert the test probe from the harness side of the waterproof connection, or waterproof performance might be diminished causing corrosion of the connector.



< Non-waterproof connector >

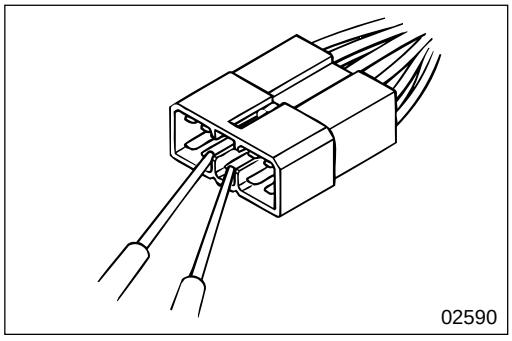
Insert test probe **C** from the harness side of the connector. Where control units, etc. have connectors that are too small to accept the test probe, do not force the test probe into them.



- **Test with connectors disengaged**

  Using female pins

  Insert a test probe into a terminal. However, do not force the probe into the terminal, or it will cause a poor contact.

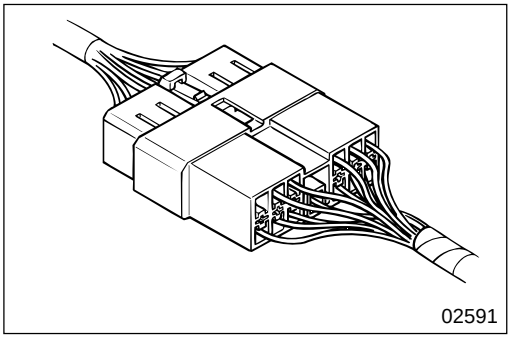


Using male pins

Touch the pins directly using test probes.

CAUTION⚠

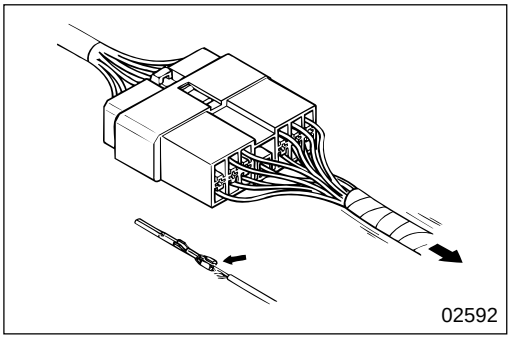
Be sure that you do not short circuit the connector pins when you use the test probe because this could damage the internal circuit of the electronic control unit.



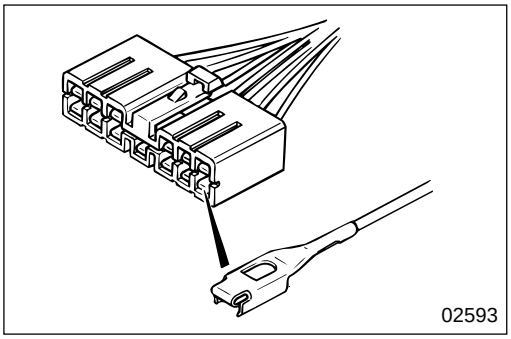
Connector inspection procedures

- **Visual inspection**

  Check for loose connection and poor engagement.

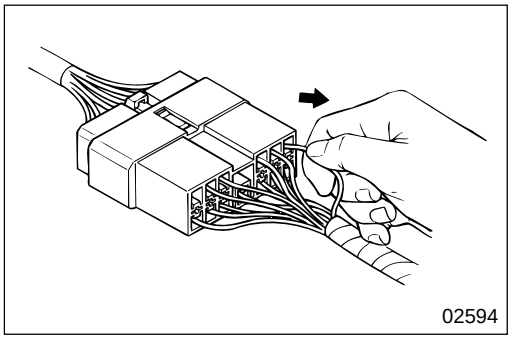


Check if harnesses are broken by pulling gently around the terminals.



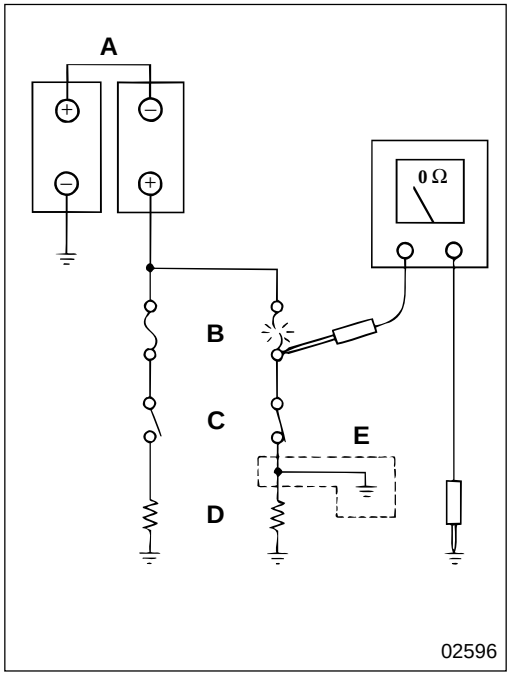
Check for a decrease in contact pressure between the male and female terminals.

Check for poor contact caused by connector pins having fallen out, rusted terminals or foreign particles.



- **Connector pin fall out inspection**

  Damaged connector pin stoppers can cause poor engagement of the terminals (male and female pins) even if the connector body is secured, and might cause some pins to fall out. Check if the pins have fallen out from the connector by pulling each harness gently.



Inspection procedures for blown fuses

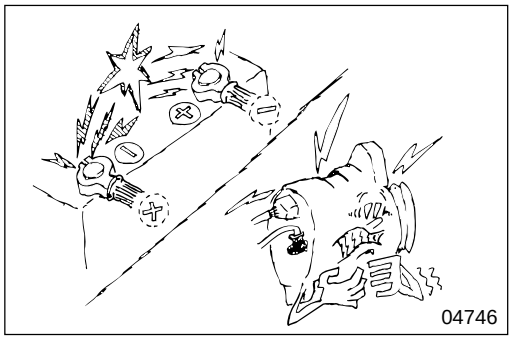
Remove fuse **B** and measure resistance between the loaded side of the fuse and ground.

Turn on all circuit switches (connected to the fuse). If the resistance value reading is approximately 0 Ω, a short has occurred between the switch and the loaded point. A value of other than zero may indicate that the fuse was blown by a temporary short but the short is no longer present.

The major causes of a short circuit are as follows:

- Harness stuck onto the vehicle body.
- Harness sheath damaged by friction or heat.
- Water in connectors or circuits.
- Mistakes (accidental short circuits)

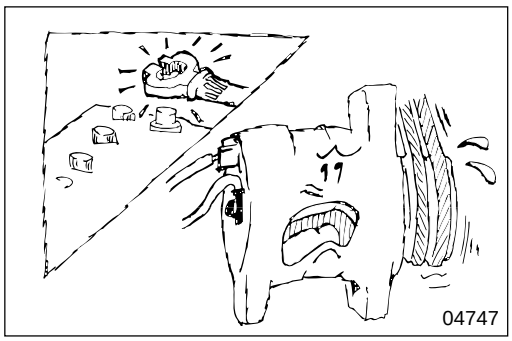
A : Battery
B : Fuse
C : Loaded switch
D : Load
E : Short circuit



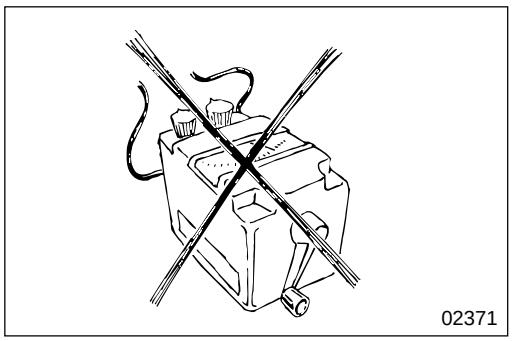
Precautions for handling alternator

When servicing the alternator, pay attention to the following :

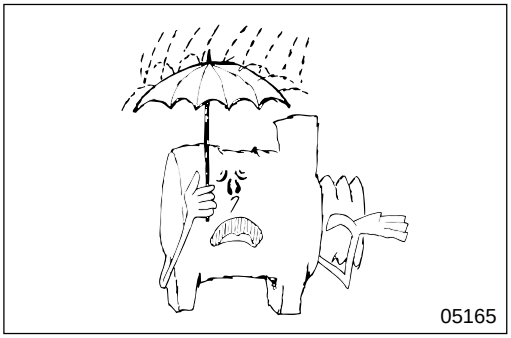
- Do not connect the alternator with battery polarities reversed.
  If the alternator is connected with reversed polarities, a large current flow from the battery to the alternator occurs, and the diode or regulator might be damaged.



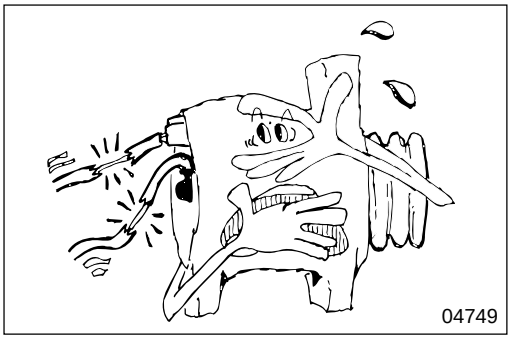
- While the engine is running, do not remove the battery terminals. If the battery terminals are removed at that time, a surge voltage is generated and the diode or regulator might be weakened.



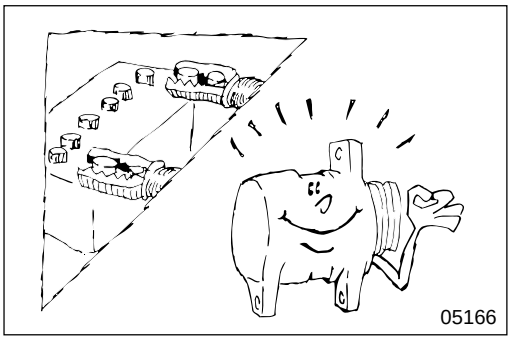
- Do not use a high-voltage tester for inspection.
  If a high-voltage tester is used, the diode or regulator might be destroyed.



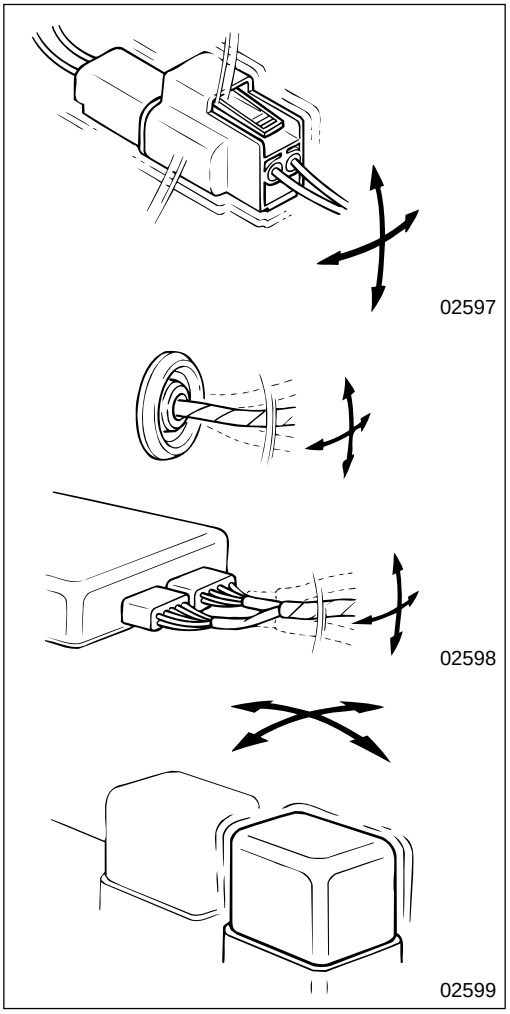
- Do not splash water over the alternator.
  If water is directly splashed over the alternator, individual components will be short-circuited and might be destroyed.



- Do not short-circuit terminal B and terminal L while running the alternator.
  If the terminals are short-circuited while the alternator is running, the diode trio might be destroyed.



- Disconnect the battery terminals before quick-charging the battery. Quick-charging without disconnecting the battery terminals might damage the diode or regulator.



Measures for temporary faults

Temporary faults often occur under certain conditions. So identifying those conditions helps to find possible causes. To find the conditions under which temporary faults occurred, you need to reproduce the faults after interviewing customers in detail about actual driving conditions, weather, frequency of occurence and fault phenomena.
Then determine if the faults were caused by vibration, temperature or other possible elements depending on the actual conditions identified.
If vibration is suspected as a possible cause, inspect individual connectors as follows to check if the fault will occur:

- Shake the connector gently in all four directions of the arrows as illustrated.
- Shake the wiring harness gently in all four directions of the arrows as illustrated.
- Wiggle each sensor or piece of equipment by hand.
- Gently shake the wiring harnesses near movable parts such as suspensions.

The inspection subjects include possible causes related to the diagnosis code outputs and faults, as well as the connectors and other parts in the inspection procedure.

M E M O

TABLE OF STANDARD TIGHTENING TORQUES

- Use specified bolts and nuts and tighten them at specified torques according to the following table, unless otherwise specified.
- Threads and contact seats shall be dry.
- Where there is a difference in strength classification between the nut and bolt (or stud bolt), the torque specified for the bolt shall apply.

Hex-head Bolt and Stud Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Repre-sentation / Diameter symbol	(Stud)		(Stud)		(Stud)	
M 5	2 to 3 {1.4 to 2.2, 0.2 to 0.3}	—	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	5 to 7 {3.6 to 5.1, 0.5 to 0.7}	—
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	7 to 11 {5.1 to 8.0, 0.7 to 1.1}	—	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—
M 8	9 to 14 {6.5 to 10, 0.9 to 1.4}	—	17 to 26 {12 to 19, 1.7 to 2.6}	—	20 to 29 {14 to 22, 2.0 to 3.0}	—
M 10	19 to 28 {14 to 20, 1.9 to 2.8}	18 to 26 {13 to 20, 1.8 to 2.7}	36 to 52 {25 to 40, 3.5 to 5.5}	33 to 49 {25 to 36, 3.5 to 5.0}	45 to 60 {33 to 43, 4.5 to 6.0}	41 to 59 {31 to 50, 4.3 to 6.9}
M 12	35 to 50 {25 to 36, 3.4 to 5.0}	31 to 46 {22 to 34, 3.1 to 4.7}	70 to 95 {51 to 69, 7.0 to 9.5}	65 to 85 {47 to 61, 6.5 to 8.5}	85 to 110 {61 to 80, 8.5 to 11}	75 to 100 {54 to 72, 7.5 to 10}
M 14	60 to 85 {43 to 61, 6.0 to 8.5}	55 to 75 {40 to 54, 5.5 to 7.5}	120 to 160 {87 to 115, 12 to 16}	110 to 140 {80 to 100, 11 to 14}	130 to 180 {94 to 130, 13 to 18}	120 to 160 {87 to 120, 12 to 17}
M 16	90 to 130 {69 to 94, 9.5 to 13}	90 to 120 {65 to 87, 9.0 to 12}	180 to 240 {130 to 175, 18 to 24}	160 to 220 {115 to 160, 16 to 22}	200 to 270 {145 to 195, 20 to 27}	190 to 260 {135 to 190, 19 to 26}
M 18	140 to 190 {100 to 135, 14 to 19}	120 to 160 {87 to 115, 12 to 16}	260 to 340 {180 to 255, 25 to 35}	220 to 290 {160 to 215, 22 to 30}	290 to 390 {215 to 290, 30 to 40}	260 to 340 {190 to 255, 26 to 35}
M 20	190 to 260 {135 to 190, 19 to 26}	170 to 230 {120 to 165, 17 to 23}	350 to 470 {260 to 345, 36 to 48}	320 to 420 {230 to 310, 32 to 43}	410 to 550 {295 to 405, 41 to 56}	370 to 490 {265 to 360, 37 to 50}
M 22	260 to 340 {190 to 255, 26 to 35}	230 to 300 {165 to 225, 23 to 31}	470 to 640 {345 to 470, 48 to 65}	430 to 570 {310 to 420, 43 to 58}	550 to 740 {405 to 540, 56 to 75}	490 to 670 {360 to 490, 50 to 68}
M 24	340 to 450 {255 to 330, 34 to 46}	290 to 390 {210 to 290, 29 to 40}	630 to 840 {455 to 620, 63 to 86}	540 to 730 {395 to 535, 55 to 74}	730 to 980 {535 to 725, 74 to 100}	630 to 840 {460 to 620, 64 to 86}

Hex-head Flange Bolt

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		7 T		8 T	
Repre-sentation / Diameter symbol						
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—	9 to 14 {6.5 to 10, 0.9 to 1.4}	—
M 8	10 to 15 {7.0 to 11, 1.0 to 1.5}	—	19 to 28 {14 to 20, 1.9 to 2.8}	—	22 to 32 {16 to 24, 2.2 to 3.3}	—
M 10	21 to 30 {15 to 22, 2.1 to 3.1}	20 to 28 {14 to 21, 1.9 to 2.9}	39 to 58 {28 to 43, 3.9 to 6.0}	37 to 53 {26 to 39, 3.6 to 5.4}	50 to 65 {36 to 47, 5.0 to 6.5}	45 to 65 {33 to 47, 4.5 to 6.5}
M 12	38 to 54 {27 to 40. 3.8 to 5.5}	35 to 51 {25 to 38, 3.4 to 5.2}	80 to 110 {58 to 80, 8.0 to 11}	70 to 95 {51 to 69, 7.0 to 9.5}	90 to 120 {65 to 87, 9.0 to 12}	85 to 110 {61 to 80, 8.5 to 11}

Hex-head Nut

Unit : N·m {ft.lbs, kgf·m}

Strength classification	4 T		6 T	
Representation / Diameter symbol				
	Standard screw	Coarse screw	Standard screw	Coarse screw
M 5	2 to 3 {1.4 to 2.2, 0.2 to 0.3}	—	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—	7 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
M 8	9 to 14 {6.5 to 10, 0.9 to 1.4}	—	17 to 26 {12 to 19, 1.7 to 2.6}	—
M 10	19 to 28 {14 to 20, 1.9 to 2.8}	18 to 26 {13 to 20, 1.8 to 2.7}	36 to 52 {25 to 40, 3.5 to 5.5}	33 to 49 {25 to 36, 3.5 to 5.0}
M 12	35 to 50 {25 to 36, 3.4 to 5.0}	31 to 46 {22 to 34, 3.1 to 4.7}	70 to 95 {51 to 69, 7.0 to 9.5}	65 to 85 {47 to 61, 6.5 to 8.5}
M 14	60 to 85 {43 to 61, 6.0 to 8.5}	55 to 75 {40 to 54, 5.5 to 7.5}	120 to 160 {87 to 115, 12 to 16}	110 to 140 {80 to 100, 11 to 14}
M 16	90 to 130 {69 to 94, 9.5 to 13}	90 to 120 {65 to 87, 9.0 to 12}	180 to 240 {130 to 175, 18 to 24}	160 to 220 {115 to 160, 16 to 22}
M 18	140 to 190 {100 to 135, 14 to 19}	120 to 160 {87 to 115, 12 to 16}	260 to 340 {180 to 255, 25 to 35}	220 to 290 {160 to 215, 22 to 30}
M 20	190 to 260 {135 to 190, 19 to 26}	170 to 230 {120 to 165, 17 to 23}	350 to 470 {260 to 345, 36 to 48}	320 to 420 {230 to 310, 32 to 43}
M 22	260 to 340 {190 to 255, 26 to 35}	230 to 300 {165 to 225, 23 to 31}	470 to 640 {345 to 470, 48 to 65}	430 to 570 {310 to 420, 43 to 58}
M 24	340 to 450 {255 to 330, 34 to 46}	290 to 390 {210 to 290, 29 to 40}	630 to 840 {455 to 620, 63 to 86}	540 to 730 {395 to 535, 55 to 74}

Hex-head Flange Nut Unit : N·m {ft.lbs, kgf·m}

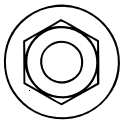
Strength classification	4 T	
Representation / Diameter symbol		
	Standard screw	Coarse screw
M 6	4 to 6 {2.9 to 4.3, 0.4 to 0.6}	—
M 8	10 to 15 {7.0 to 11, 1.0 to 1.5}	—
M 10	21 to 30 {15 to 22, 2.1 to 3.1}	20 to 28 {14 to 21, 1.9 to 2.9}
M 12	38 to 54 {27 to 40, 3.8 to 5.5}	35 to 51 {25 to 38, 3.4 to 5.2}

TABLE OF STANDARD TIGHTENING TORQUES

Tightening torque for flair nut for general purpose

Unit : N·m {ft.lbs, kgf·m}

Pipe diameter	ø4.76 mm {0.19 in.}	ø6.35 mm {0.25 in.}	ø8 mm {0.31 in.}	ø10 mm {0.39 in.}	ø12 mm {0.47 in.}	ø15 mm {0.59 in.}
Tightening torque	17 {12, 1.7}	25 {19, 2.6}	39 {29, 4.0}	59 {43, 6.0}	88 {65, 9.0}	98 {72, 10.0}

Tightening torque for air piping nylon tube for general purpose {DIN type}

Unit : N·m {ft.lbs, kgf·m}

Standard diameter	6×1 mm {0.24×0.039 in.}	10×1.25 mm {0.39×0.049 in.}	12×1.5 mm {0.47×0.059 in.}	15×1.5 mm {0.59×0.059 in.}
Tightening torque	$20^{+5.9}_{-0}$ {$14^{+4.3}_{-0}$, $2.0^{+0.6}_{-0}$}	$29^{+9.8}_{-0}$ {$22^{+7.2}_{-0}$, $3.0^{+1.0}_{-0}$}	$49^{+9.8}_{-0}$ {$36^{+7.2}_{-0}$, $5.0^{+1.0}_{-0}$}	$54^{+4.9}_{-0}$ {$40^{+7.2}_{-0}$, $5.5^{+1.0}_{-0}$}

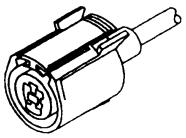
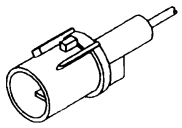
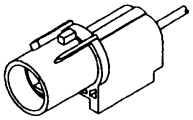
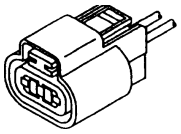
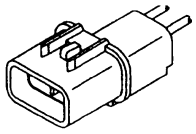
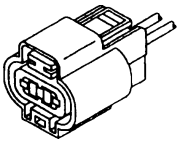
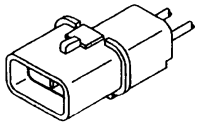
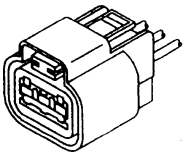
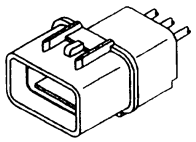
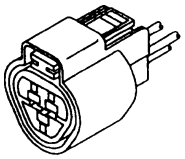
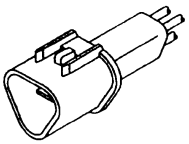
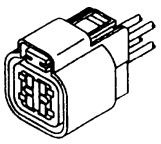
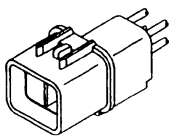
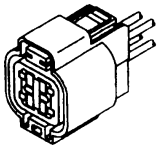
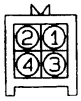
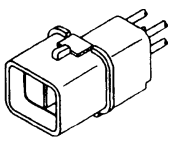
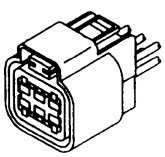
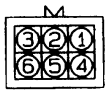
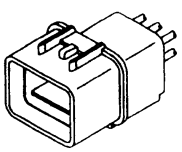
Tightening torque for air piping nylon tube for general purpose {SAE type}

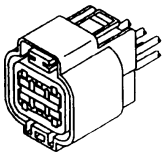
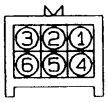
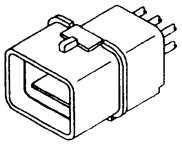
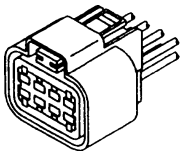
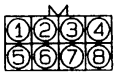
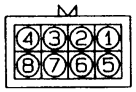
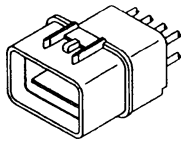
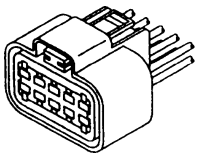
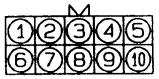
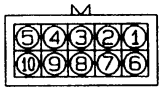
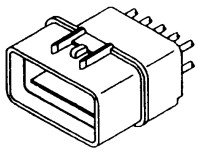
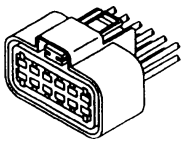
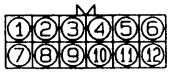
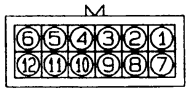
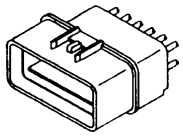
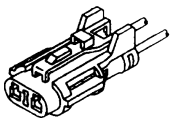
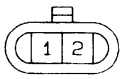
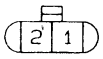
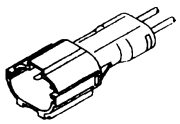
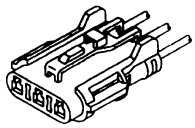
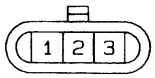
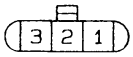
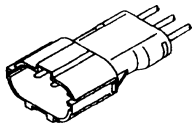
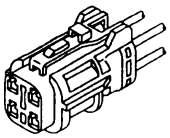
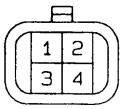
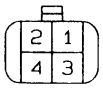
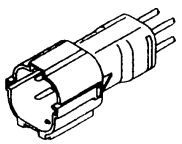
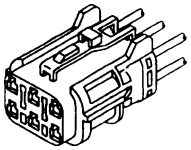
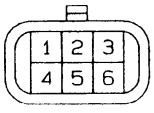
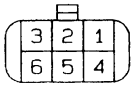
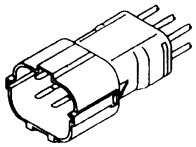
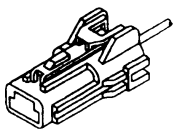
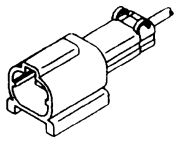
Unit : N·m {ft.lbs, kgf·m}

Standard diameter	1/4 in.	3/8 in.	1/2 in.	5/8 in.
Tightening torque	$13^{+3.9}_{-0}$ {$9.4^{+2.9}_{-0}$, $1.3^{+0.4}_{-0}$}	$29^{+4.9}_{-0}$ {$22^{+3.6}_{-0}$, $3.0^{+0.5}_{-0}$}	$49^{+4.9}_{-0}$ {$36^{+3.6}_{-0}$, $5.0^{+0.5}_{-0}$}	$64^{+4.9}_{-0}$ {$47^{+3.6}_{-0}$, $6.5^{+0.5}_{-0}$}

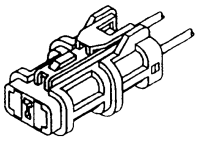
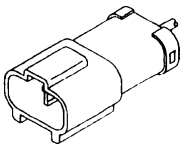
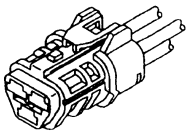
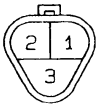
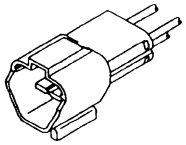
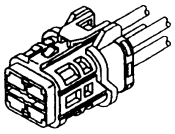
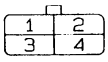
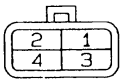
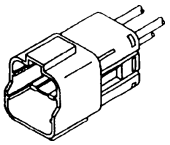
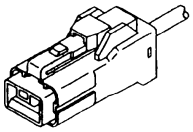
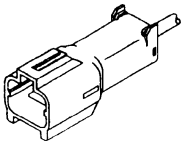
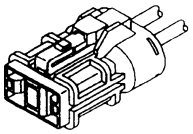
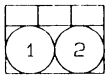
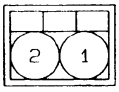
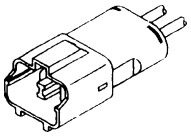
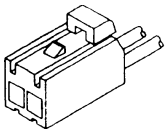
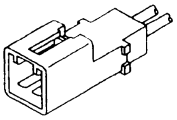
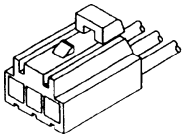
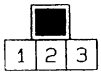
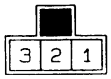
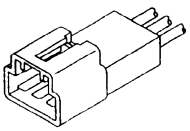
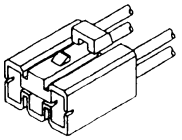
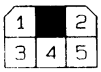
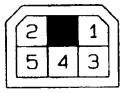
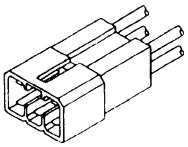
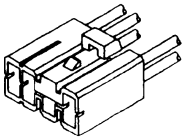
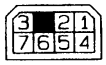
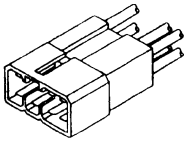
M E M O

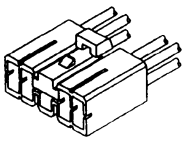
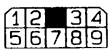
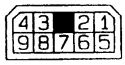
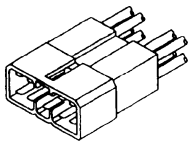
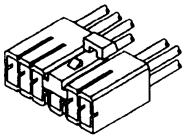
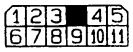
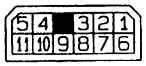
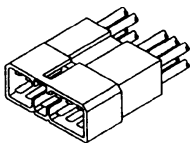
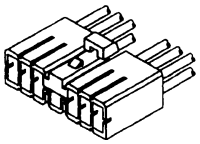
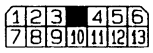
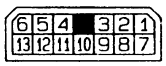
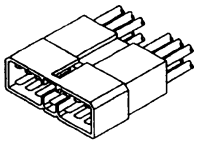
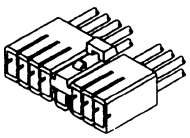
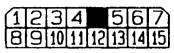
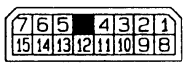
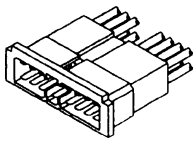
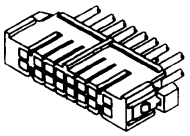
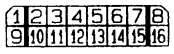
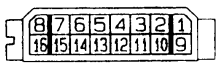
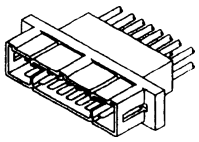
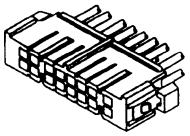
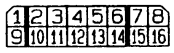
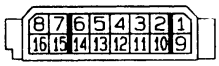
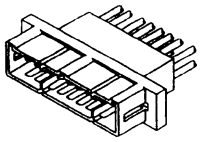
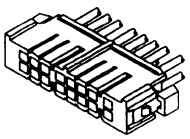
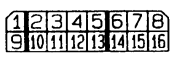
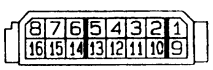
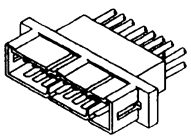
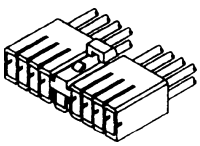
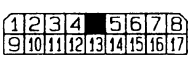
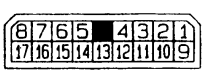
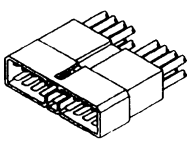
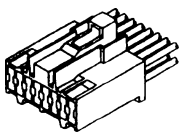
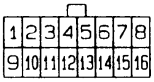
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AA	AA 1 A				
					
	AA 2 A				
	AA 2 B				
	AA 3 A				
	AA 3 B				
	AA 4 A				
	AA 4 B				
	AA 6 A				

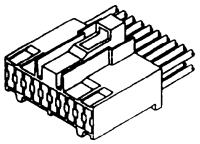
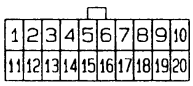
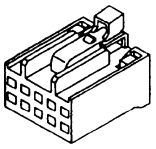
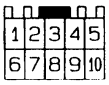
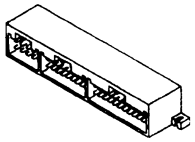
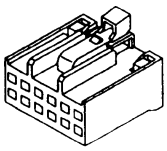
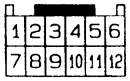
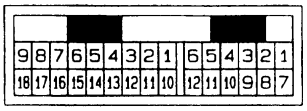
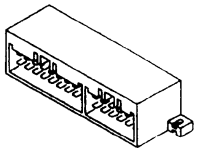
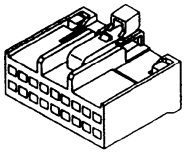
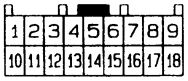
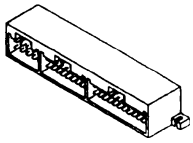
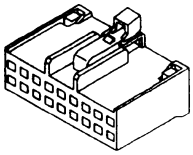
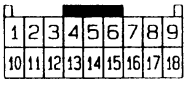
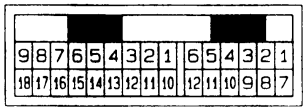
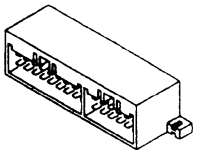
Model (Number shows number of pins)		Connection			
AA	AA 6 B				
	AA 8 A				
	AA10A				
	AA12A				
AB	AB 2 A				
	AB 3 A				
	AB 4 A				
	AB 6 A				
AC	AC 1 A				

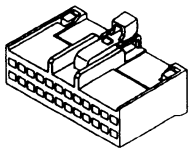
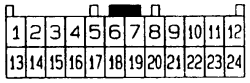
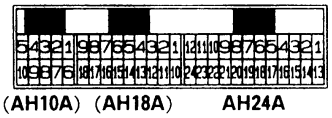
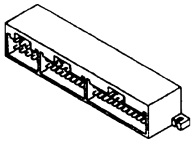
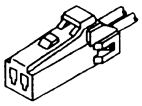
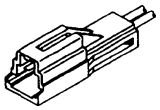
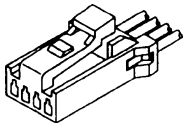
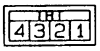
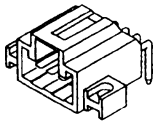
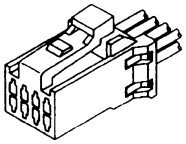
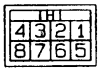
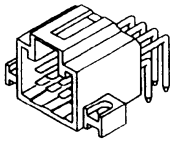
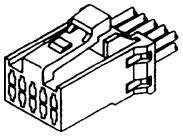
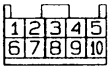
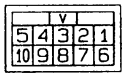
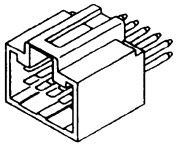
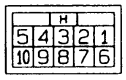
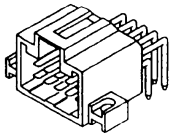
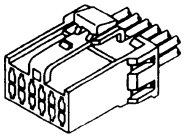
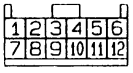
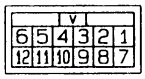
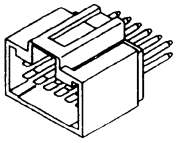
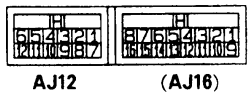
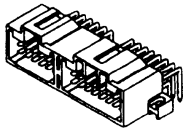
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AC	AC 2 A				
	AC 3 A				
	AC 4 A				
AD	AD 1 A				
	AD 2 A				
AE	AE 2 A				
	AE 3 A				
	AE 5 A				
	AE 7 A				

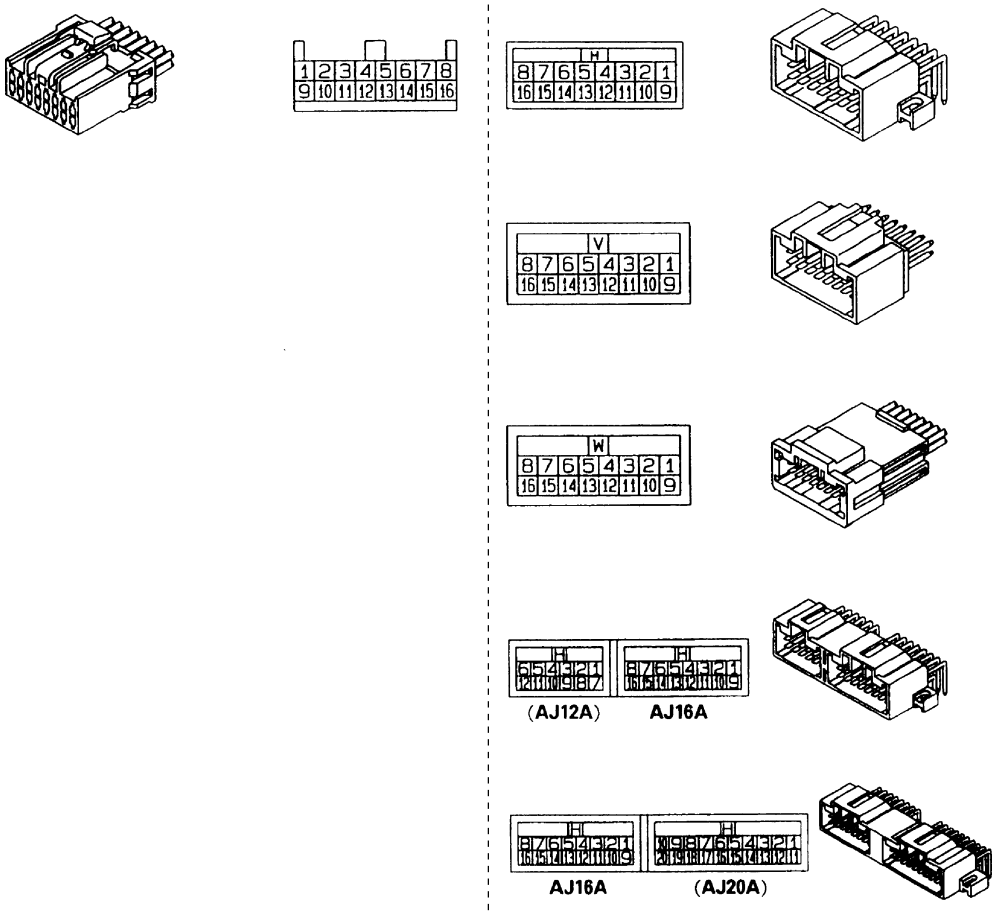
Model (Number shows number of pins)		Connection			
AE	AE 9 A				
	AE11A				
	AE13A				
	AE15A				
	AE16A (White, Gray, Black)				
	AE16B (Green)				
	AE16C (Blue)				
	AE17A				
AG	AG16A				

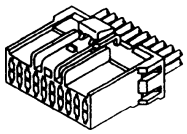
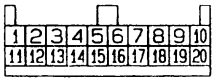
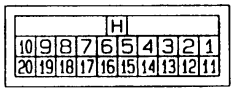
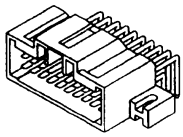
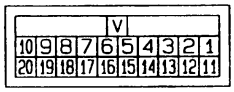
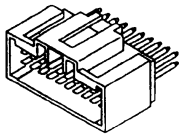
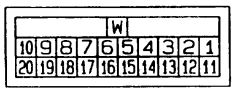
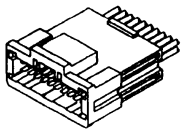
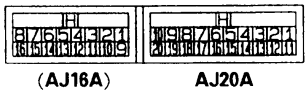
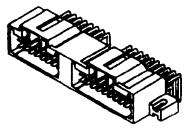
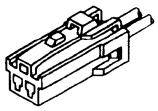
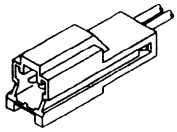
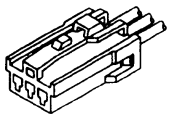
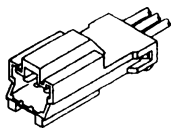
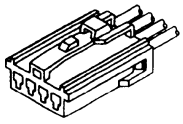
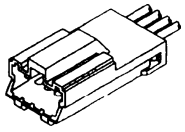
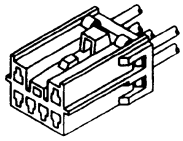
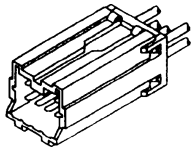
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AG	AG20A	 
AH	AH10A	  AH10A (AH18A) (AH24A) 
	AH12A	   (AH18A) AH12A 
	AH18A	  (AH10A) AH18A AH24A 
	AH18B	   AH18A (AH12A) 

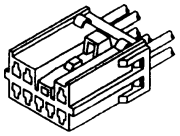
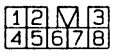
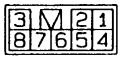
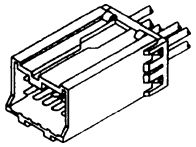
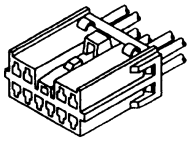
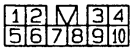
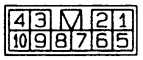
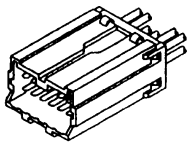
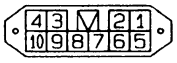
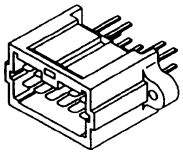
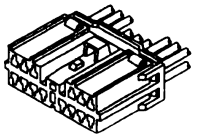
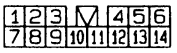
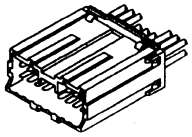
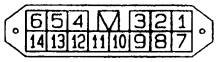
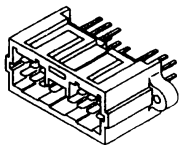
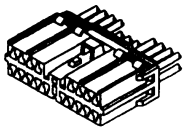
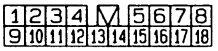
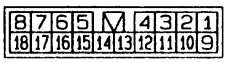
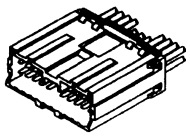
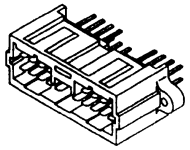
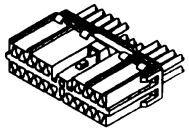
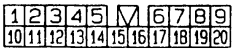
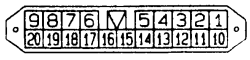
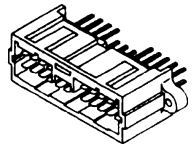
Model (Number shows number of pins)		Connection
AH	AH24A	   
AJ	AJ 2 A	 
	AJ 4 A	  
	AJ 8 A	  
	AJ10A	     
	AJ12A	     

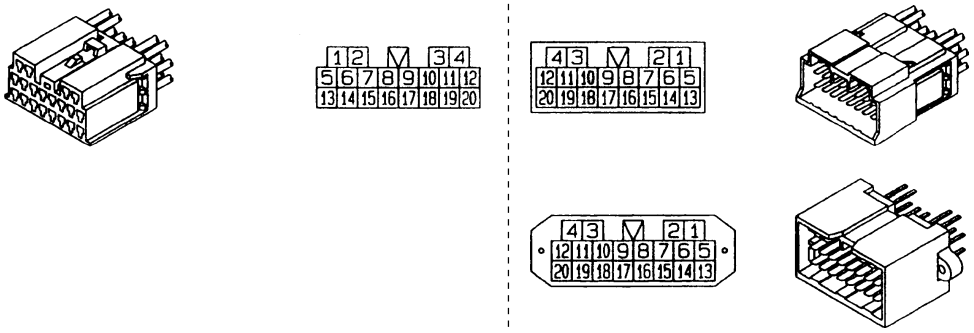
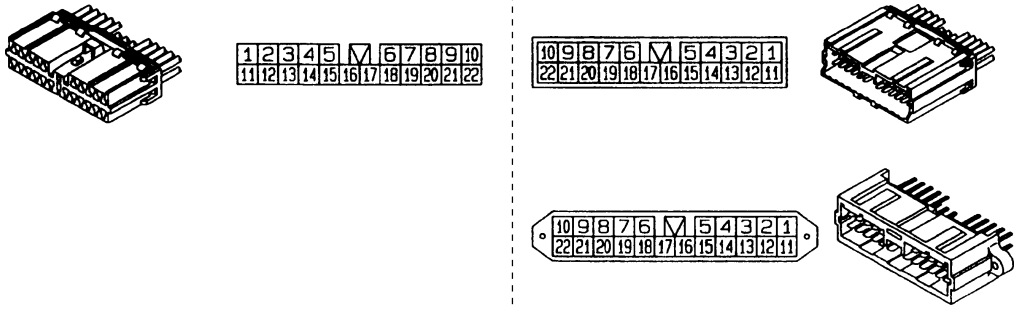
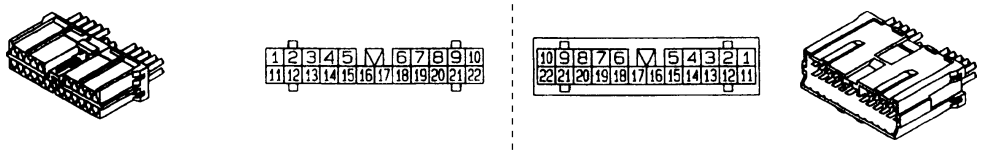
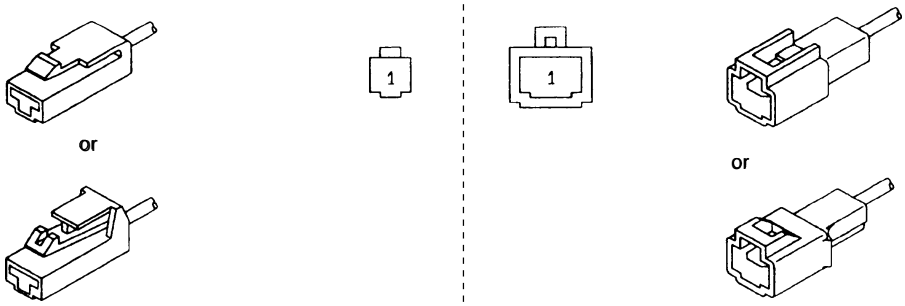
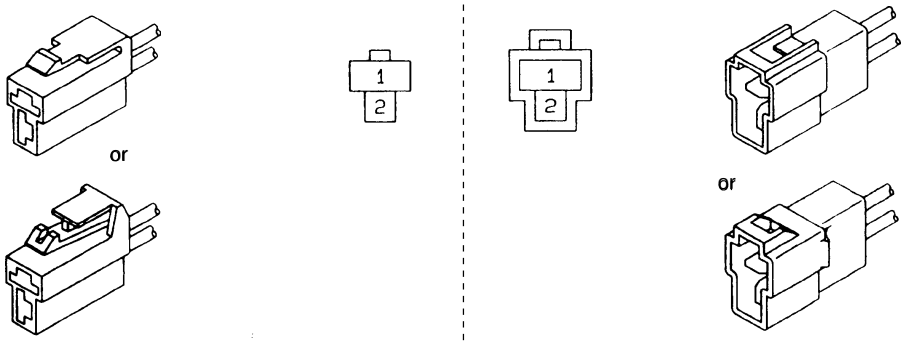
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AJ	AJ16A	

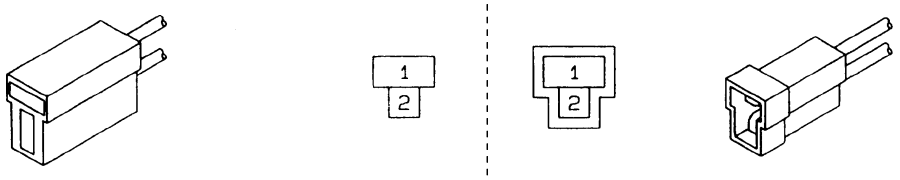
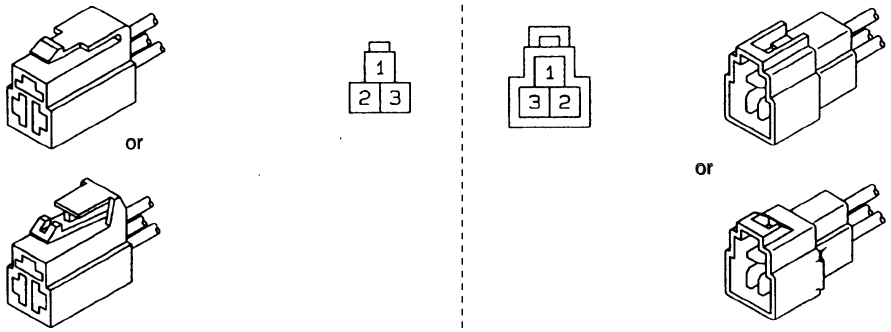
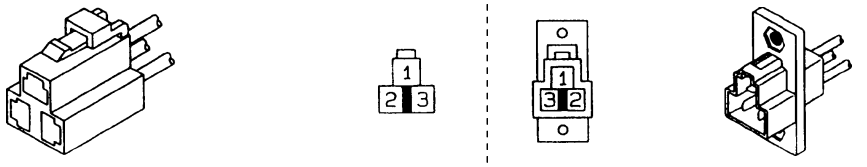
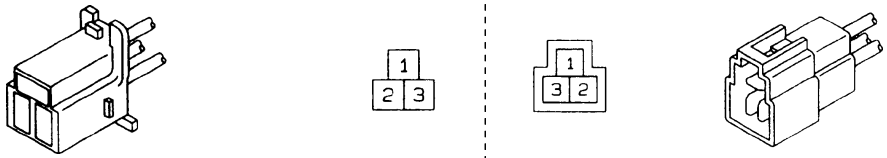
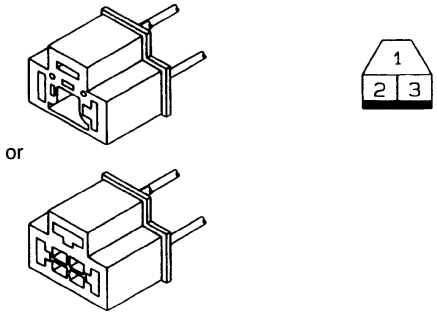
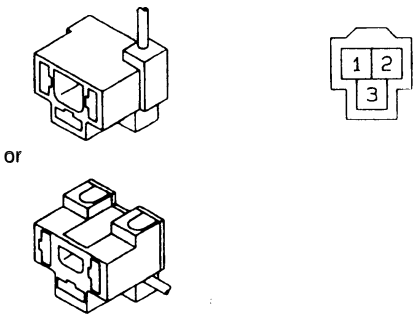
Model (Number shows number of pins)		Connection
AJ	AJ20A	         (AJ16A) AJ20A 
AK	AK 2 A	 
	AK 3 A	 
	AK 4 A	 
	AK 6 A	 

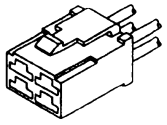
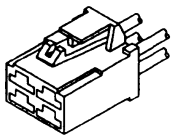
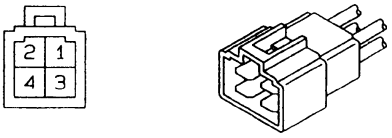
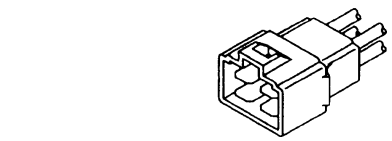
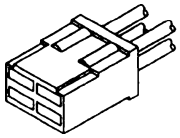
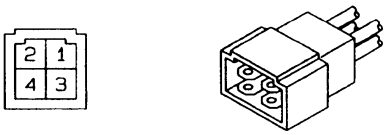
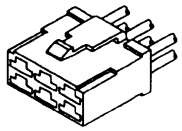
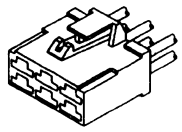
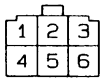
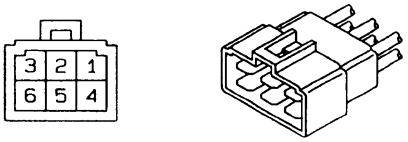
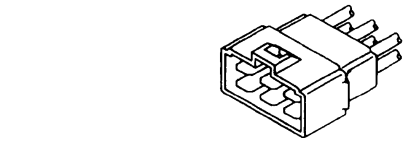
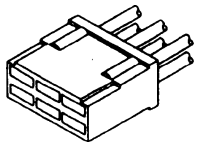
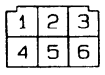
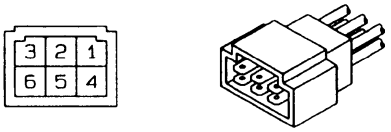
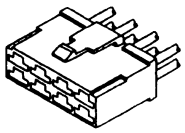
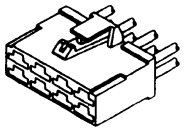
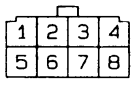
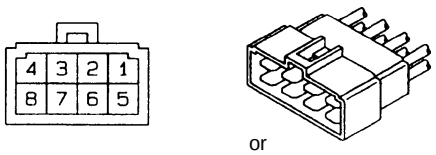
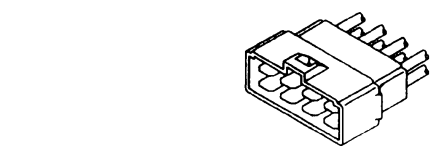
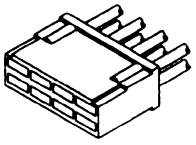
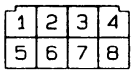
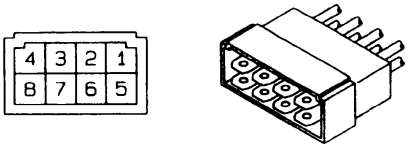
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AK	AK 8 A	   
	AK10A	     
	AK14A	    
	AK18A	    
	AK20A	   

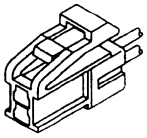
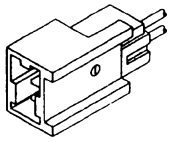
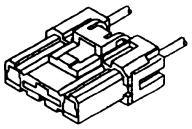
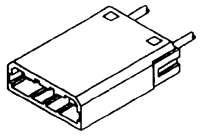
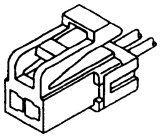
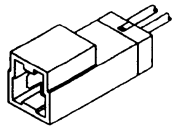
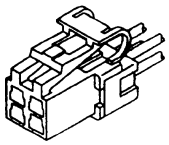
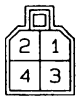
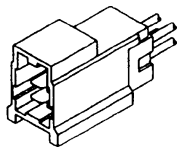
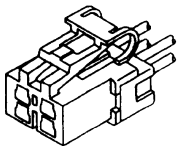
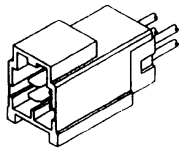
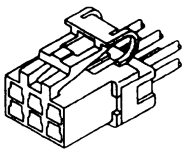
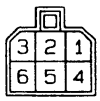
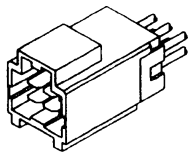
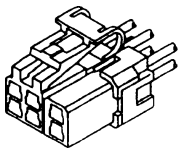
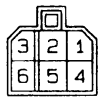
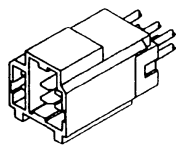
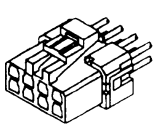
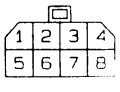
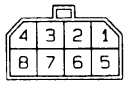
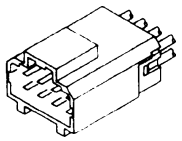
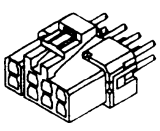
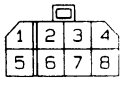
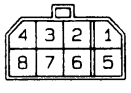
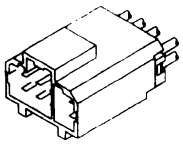
Model (Number shows number of pins)		Connection
AK	AK20B	
	AK22A	
	AK22B	
AL	AL 1 A	
	AL 2 A	

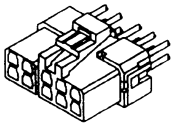
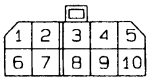
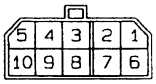
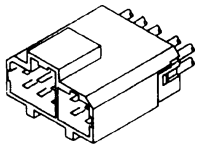
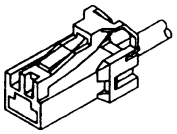
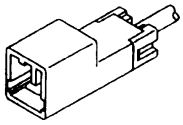
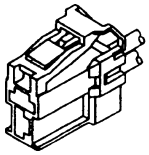
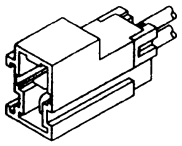
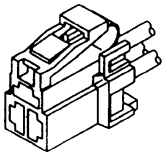
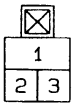
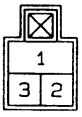
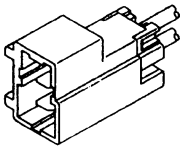
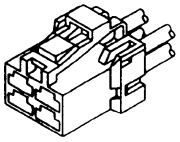
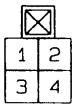
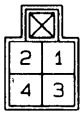
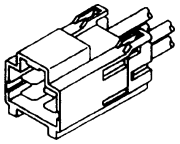
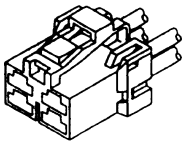
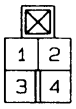
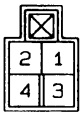
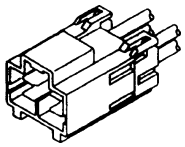
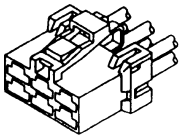
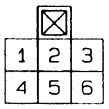
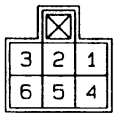
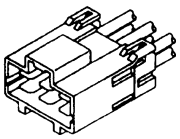
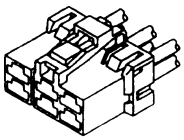
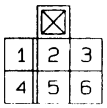
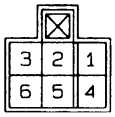
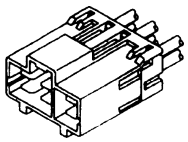
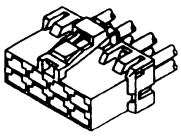
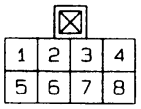
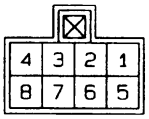
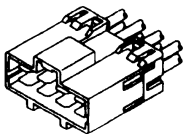
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AL	AL 2 B	
	AL 3 A	
	AL 3 B	
	AL 3 C	
	AL 3 D	
	AL 3 E	

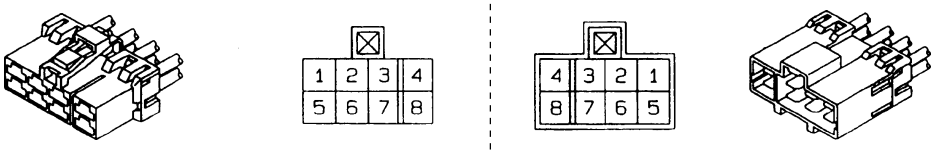
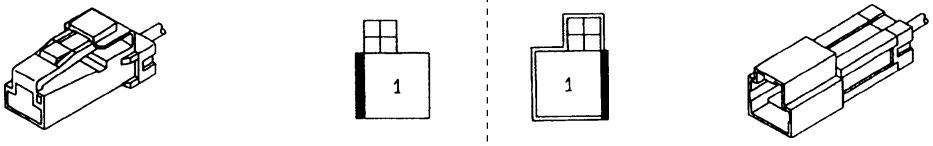
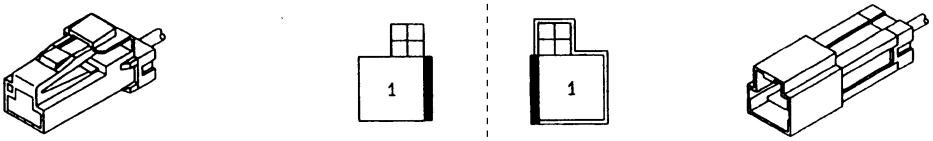
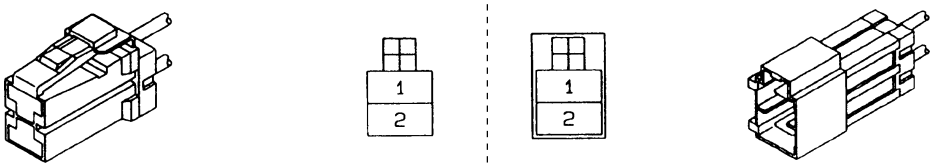
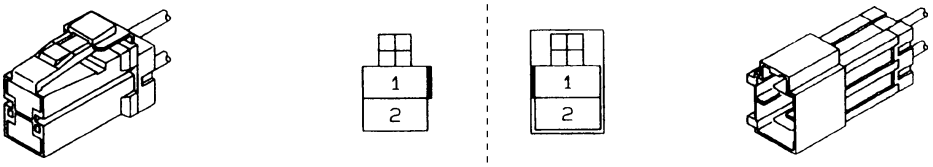
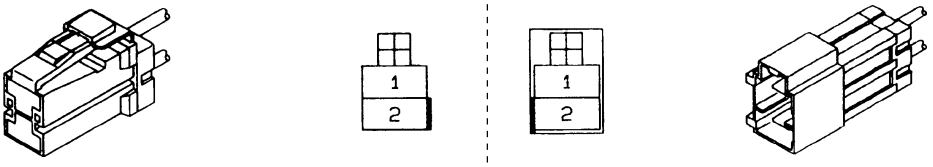
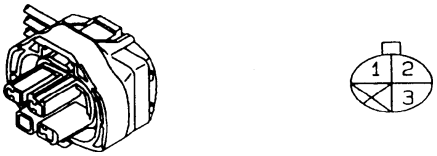
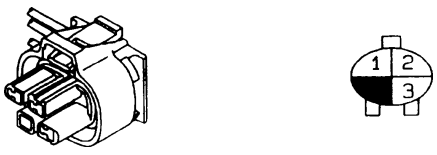
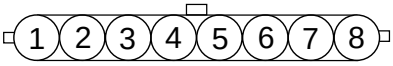
Model (Number shows number of pins)		Connection			
AL	AL 4 A	 or 		 or 	
	AL 4 B				
	AL 6 A	 or 			 or 
	AL 6 B				
	AL 8 A	 or 			 or 
	AL 8 B				

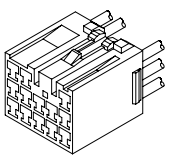
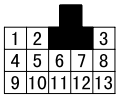
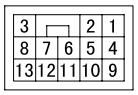
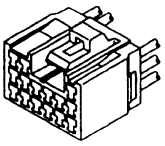
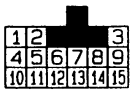
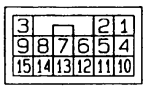
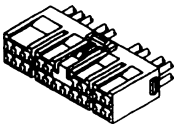
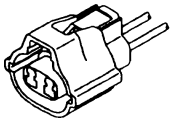
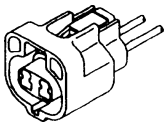
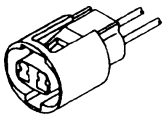
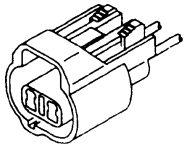
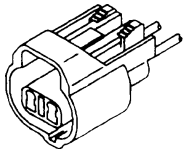
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AM	AM 2 A	 
	AM 2 B	 
	AM 2 C	 
	AM 4 A	  
	AM 4 B	 
	AM 6 A	  
	AM 6 B	  
	AM 8 A	   
	AM 8 B	   

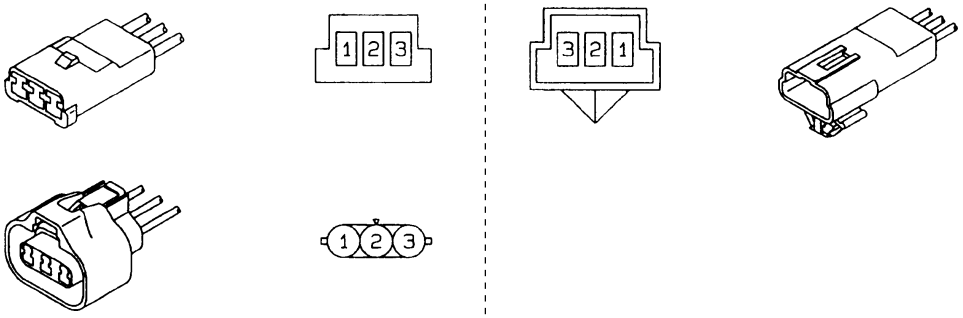
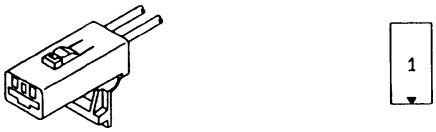
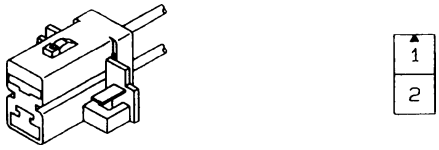
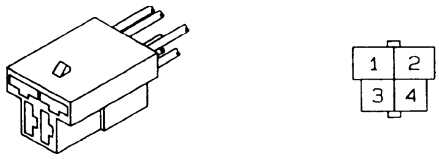
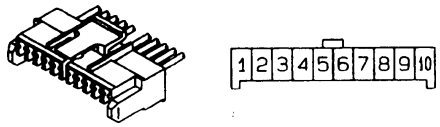
Model (Number shows number of pins)		Connection			
AM	AM10A				
AN	AN 1 A				
	AN 2 A				
	AN 3 A				
	AN 4 A				
	AN 4 B				
	AN 6 A				
	AN 6 B				
	AN 8 A				

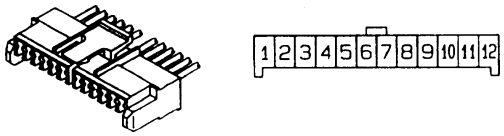
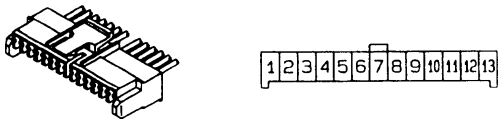
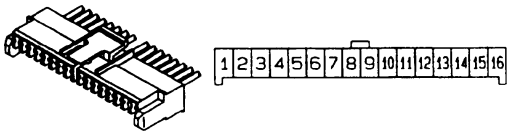
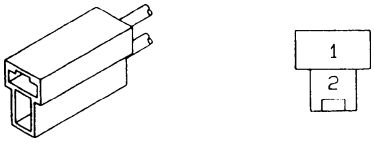
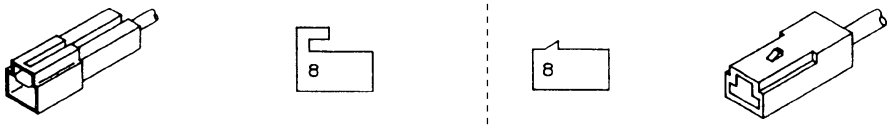
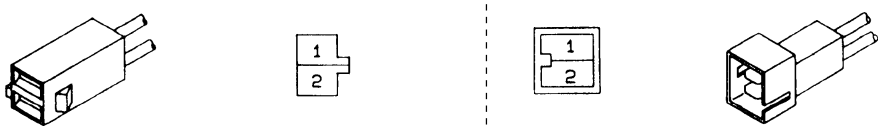
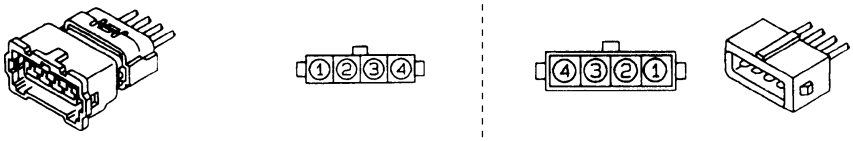
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AN	AN 8 B	
AP	AP 1 A	
	AP 1 B	
	AP 2 A	
	AP 2 B	
	AP 2 C	
AQ	AQ 3 A	
	AQ 3 B	
	AQ 8 A	

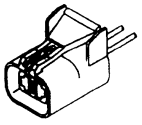
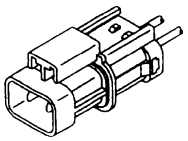
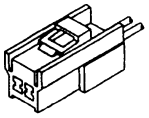
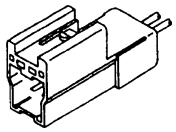
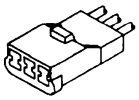
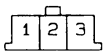
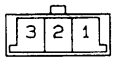
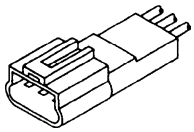
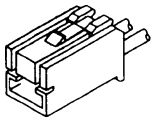
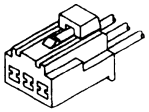
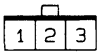
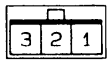
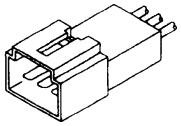
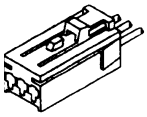
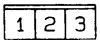
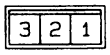
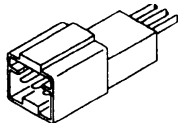
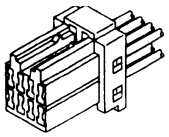
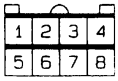
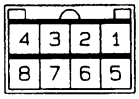
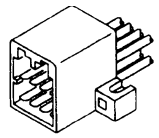
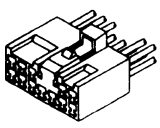
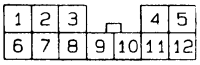
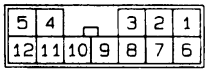
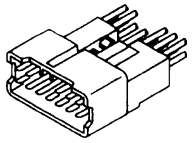
Model (Number shows number of pins)		Connection		
AQ	AQ13A			
	AQ15A			
	AQ20A			
AR	AR 2 A			
	AR 2 B			
	AR 2 C			
	AR 2 D			
	AR 2 E			
	AR 2 F			

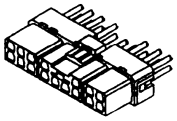
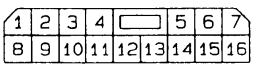
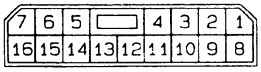
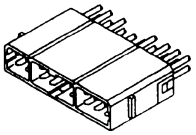
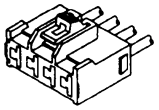
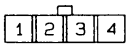
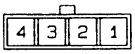
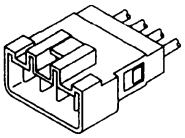
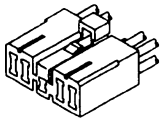
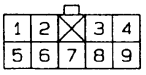
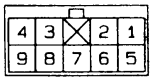
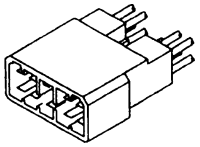
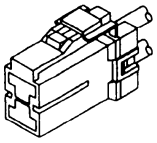
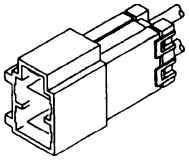
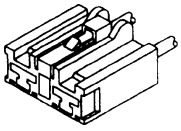
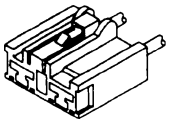
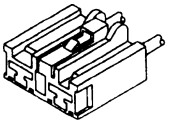
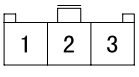
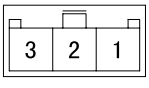
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
AR	AR 3 A	
AS	AS 1 A	
	AS 2 A	
	AS 2 B	
AT	AT 4 A	
AU	AU 6 A	
	AU 8 A	
	AU10A	

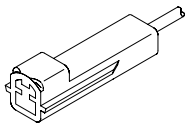
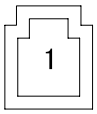
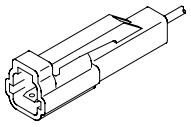
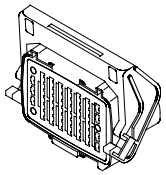
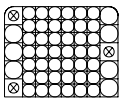
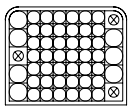
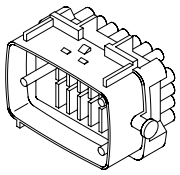
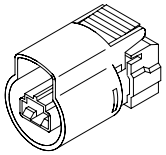
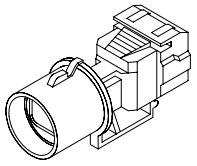
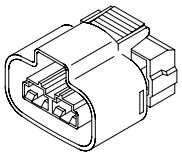
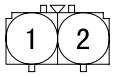
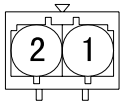
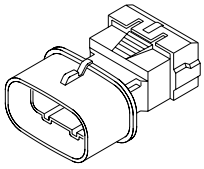
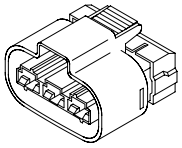
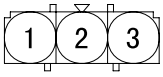
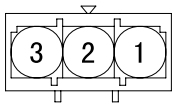
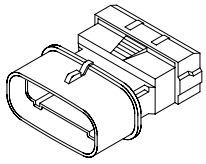
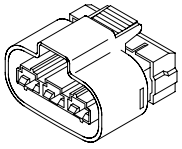
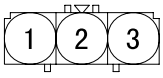
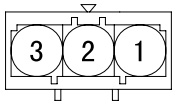
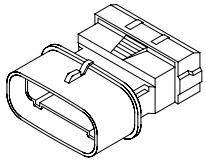
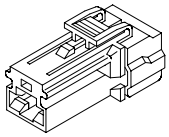
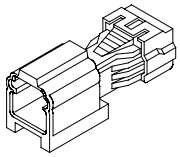
Model (Number shows number of pins)		Connection
AU	AU12A	
	AU13A	
	AU16C	
AV	AV 1 A	
	AV 2 A	
AW	AW 1 A	
	AW 1 B	
	AW 2 A	
AX	AX 4 A	

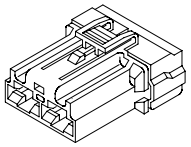
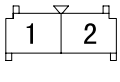
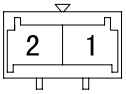
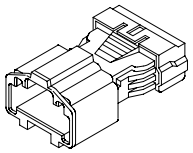
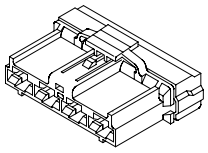
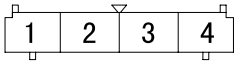
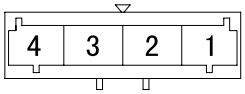
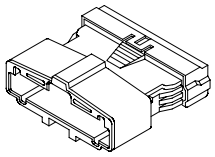
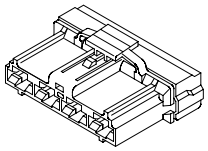
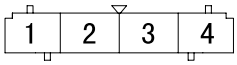
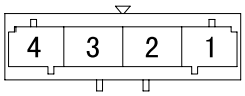
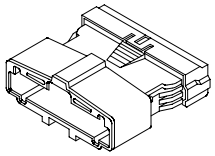
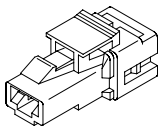
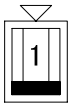
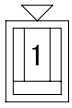
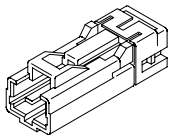
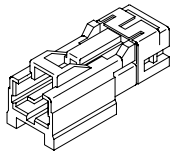
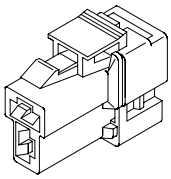
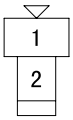
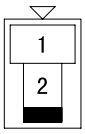
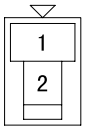
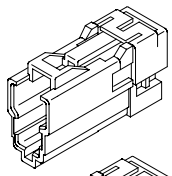
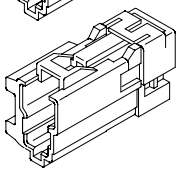
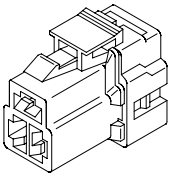
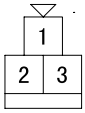
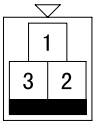
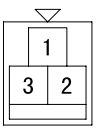
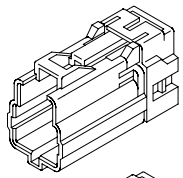
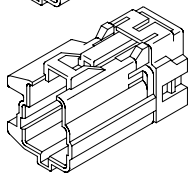
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
AY	AY 2 A				
AZ	AZ 2 A				
BA	BA 3 A				
BB	BB 2 A				
	BB 3 A				
BC	BC 3 A				
BD	BD 8 A				
BE	BE 6 A				
BF	BF12A				

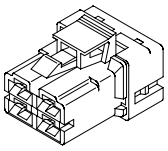
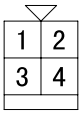
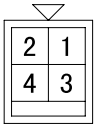
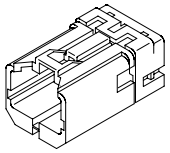
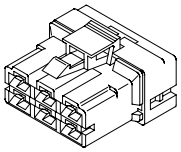
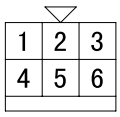
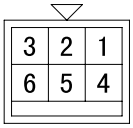
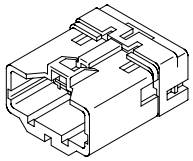
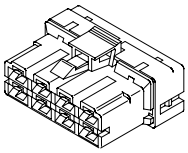
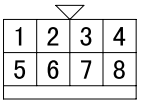
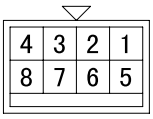
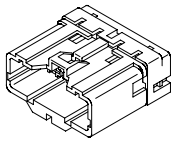
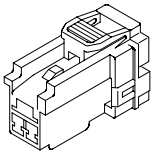
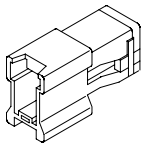
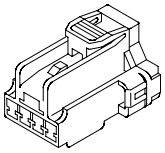
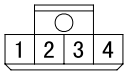
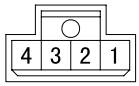
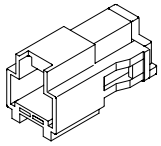
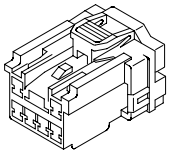
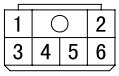
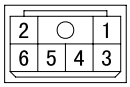
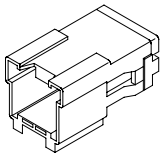
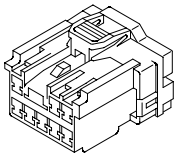
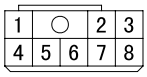
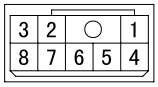
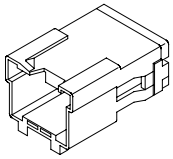
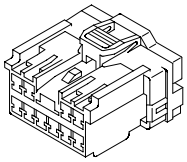
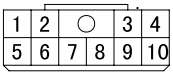
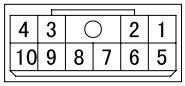
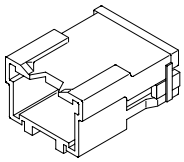
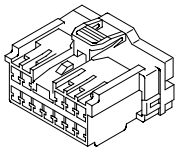
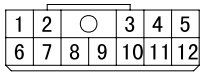
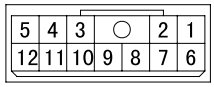
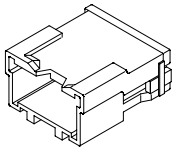
Model (Number shows number of pins)		Connection			
BG	BG16A				
BH	BH 4 A				
BJ	BJ 9 A				
BL	BL 2 A				
BM	BM 2 A				
	BM 2 B				
	BM 2 C				
	BM 3 A				

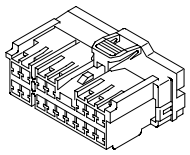
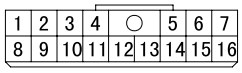
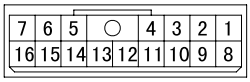
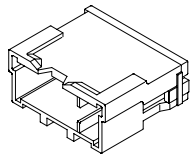
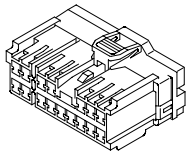
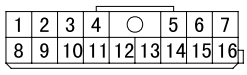
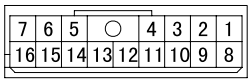
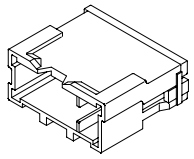
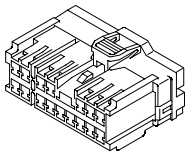
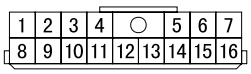
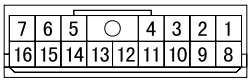
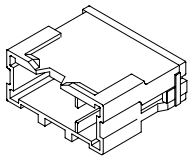
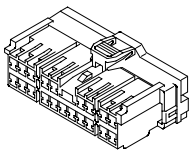
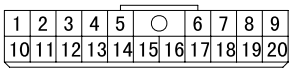
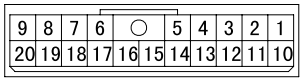
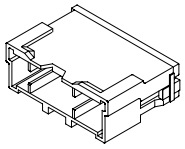
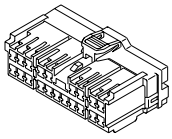
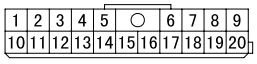
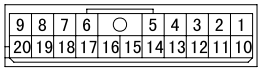
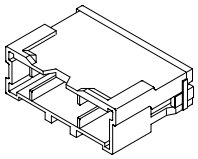
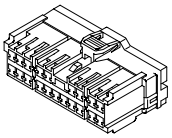
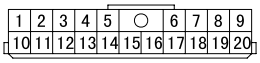
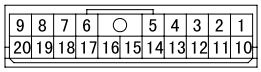
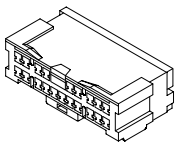
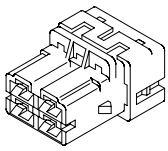
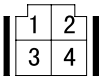
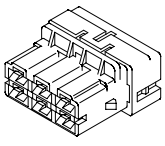
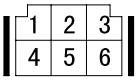
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BN	BN 1 A				
BP	BP49A				
BQ	BQ 1 A				
	BQ 2 A				
	BQ 3 A				
	BQ 3 B				
BR	BR 1 A				

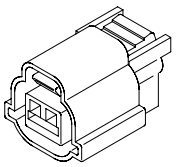
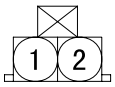
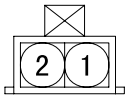
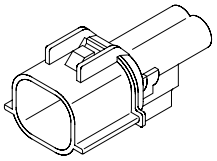
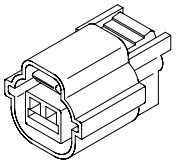
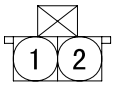
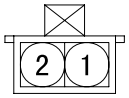
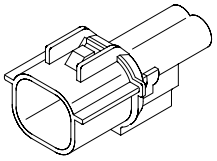
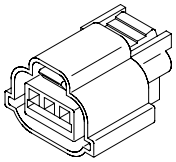
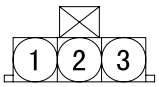
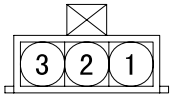
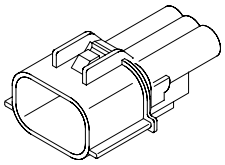
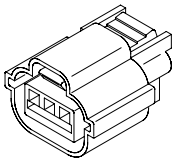
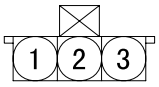
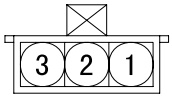
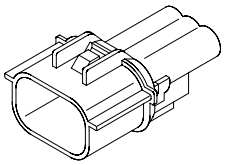
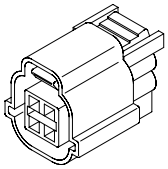
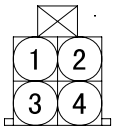
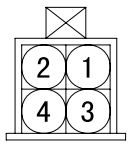
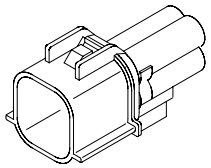
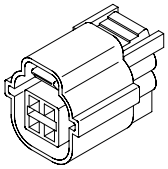
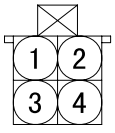
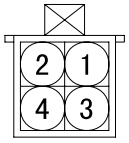
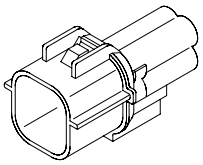
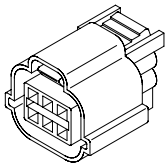
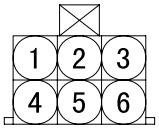
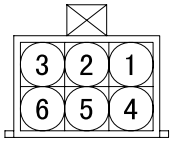
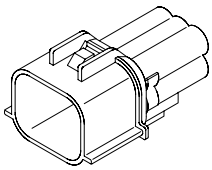
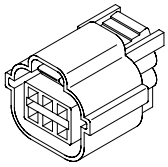
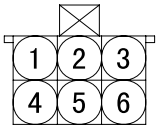
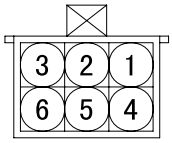
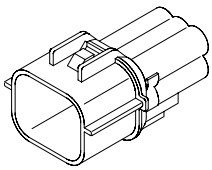
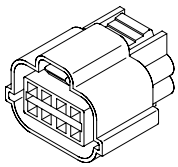
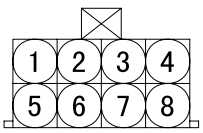
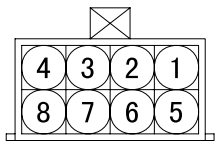
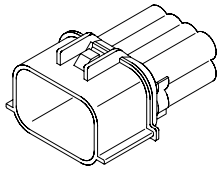
Model (Number shows number of pins)		Connection			
BR	BR 2 A				
	BR 4 A (Glay)				
	BR 4 B (Black)				
BS	BS 1 A			 	 
	BS 2 A			 	 
	BS 3 A			 	 

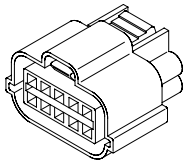
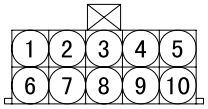
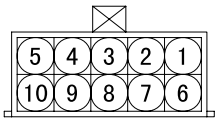
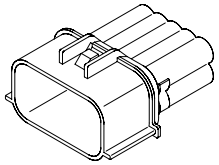
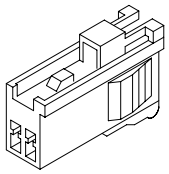
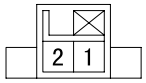
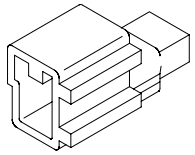
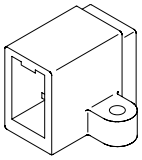
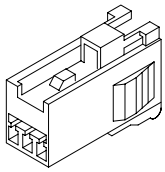
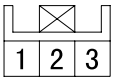
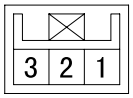
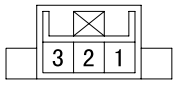
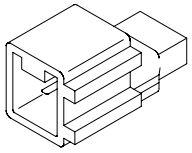
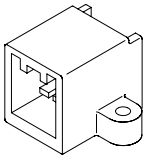
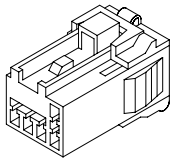
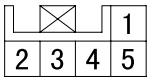
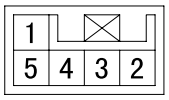
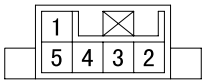
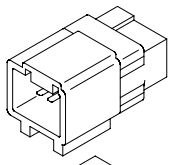
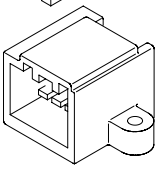
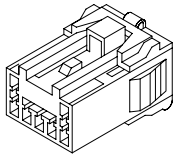
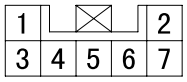
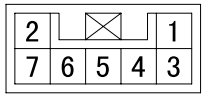
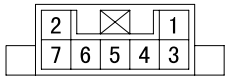
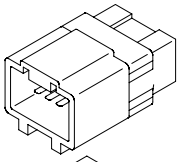
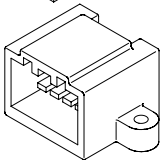
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BS	BS 4 A				
	BS 6 A				
	BS 8 A				
BT	BT 2 A				
	BT 4 A				
	BT 6 A				
	BT 8 A				
	BT10A				
	BT 12 A				

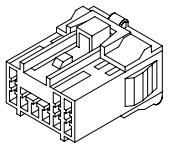
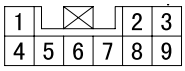
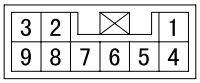
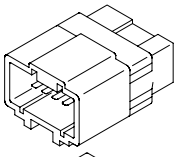
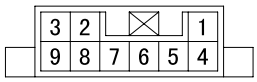
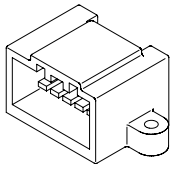
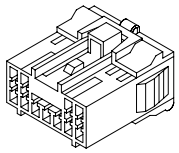
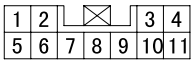
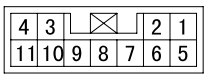
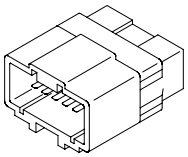
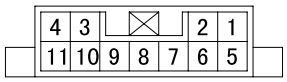
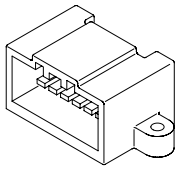
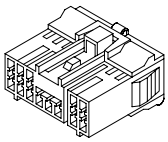
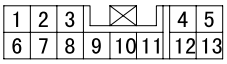
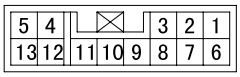
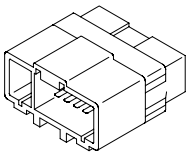
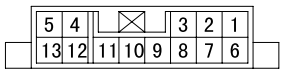
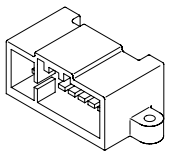
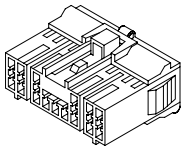
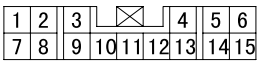
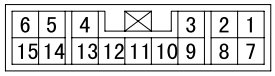
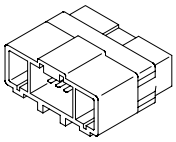
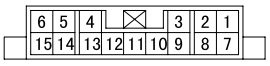
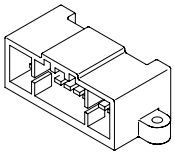
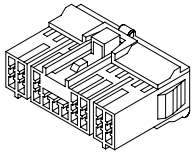
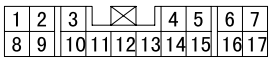
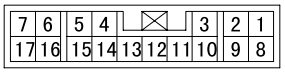
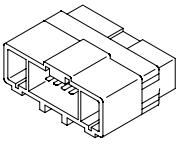
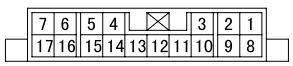
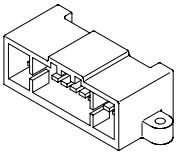
Model (Number shows number of pins)		Connection			
BT	BT16A				
	BT16B				
	BT16C				
	BT20A				
	BT20B				
	BT20C				
BU	BU 4 A				
	BU 6 A				

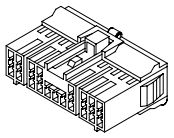
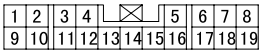
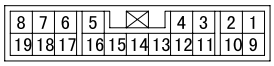
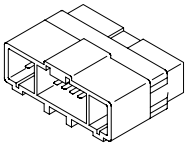
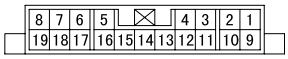
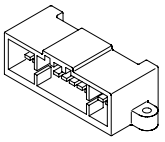
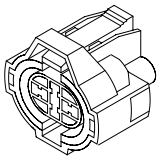
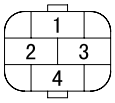
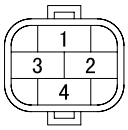
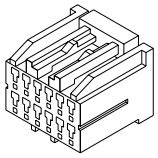
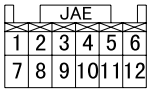
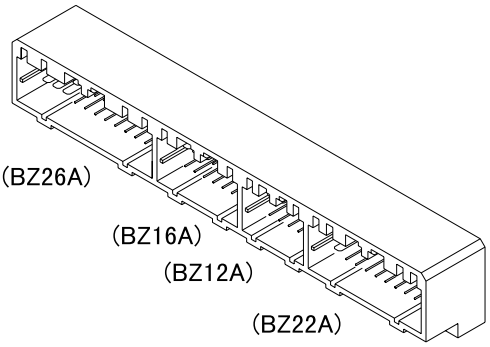
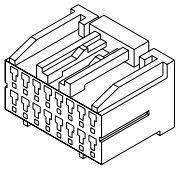
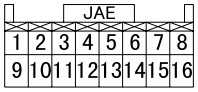
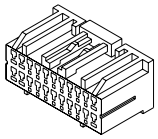
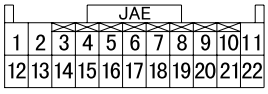
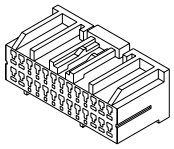
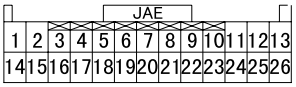
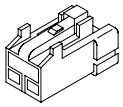
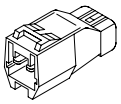
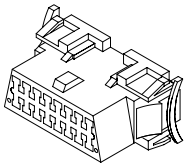
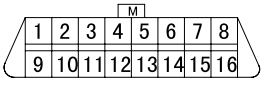
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection			
BW	BW 2 A				
	BW 2 B				
	BW 3 A				
	BW 3 B				
	BW 4 A				
	BW 4 B				
	BW 6 A				
	BW 6 B				
	BW 8 A				

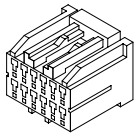
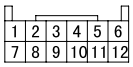
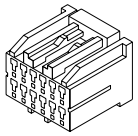
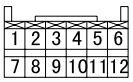
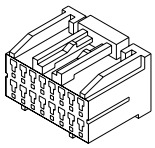
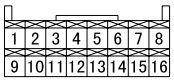
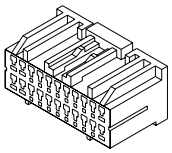
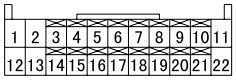
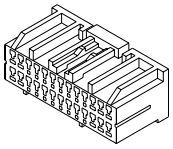
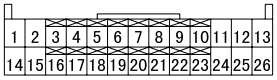
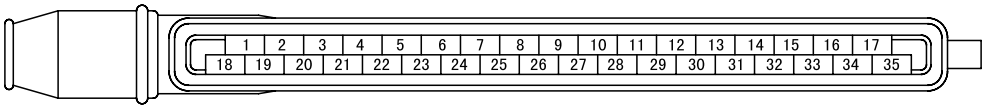
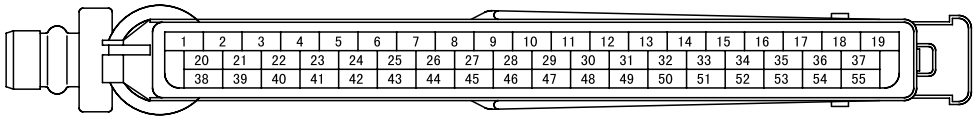
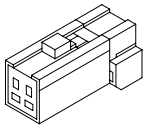
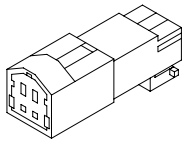
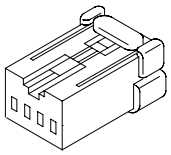
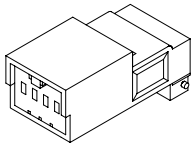
Model (Number shows number of pins)		Connection			
BW	BW10A				
BX	BX 2 A			 	 
	BX 3 A			 	 
	BX 5 A			 	 
	BX 7 A			 	 

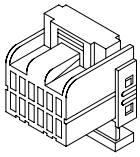
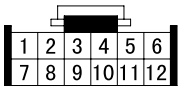
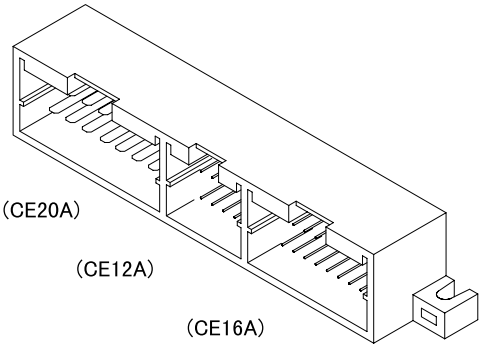
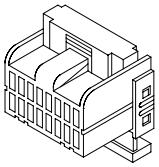
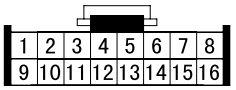
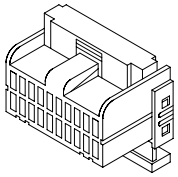
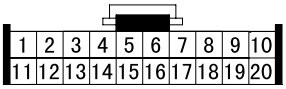
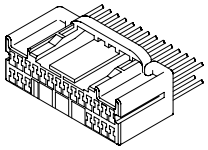
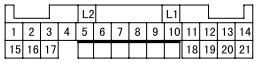
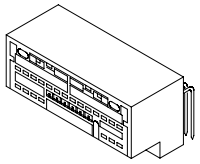
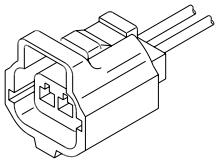
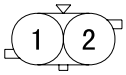
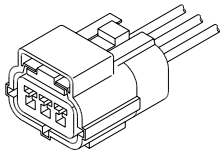
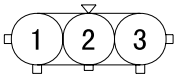
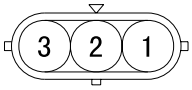
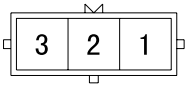
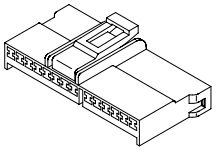
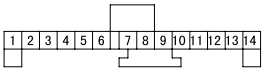
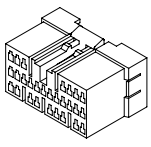
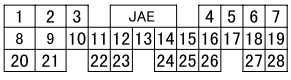
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
BX	BX 9 A	     
	BX11A	     
	BX13A	     
	BX15A	     
	BX17A	     

Model (Number shows number of pins)		Connection	
BX	BX19A	 	   
BY	BY 4 A	 	
BZ	BZ12A	 	 (BZ26A) (BZ16A) (BZ12A) (BZ22A)
	BZ16A	 	
	BZ22A	 	
	BZ26A	 	
CA	CA 2 A		
CB	CB16A	 	

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CC	CC12A	 
	CC12B	 
	CC16A	 
	CC22A	 
	CC26A	 
CD	CD35A	
	CD55A	
CE	CE 2 A	 
	CE 4 A	 

Model (Number shows number of pins)		Connection	
CE	CE12A	 	CE48A 
	CE16A	 	
	CE20A	 	
CF	CF21A	 	
CH	CH 2 A	 	
	CH 3 A	 	
CK	CK 3 A		
CL	CL14A	 	
CM	CM28A	 	

CONNECTOR CONFIGURATION CHART

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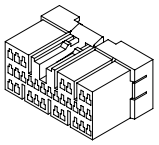
<tr><td rowspan="2">CM</td><td>CM30A</td><td> 
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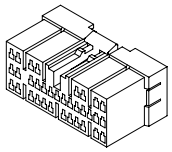
<tr><td>CM35A</td><td> 
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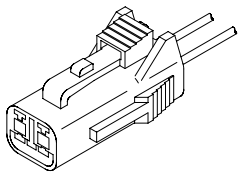
<tr><td rowspan="2">CN</td><td>CN 2 A</td><td> 
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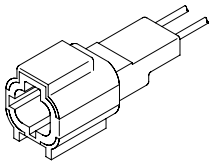
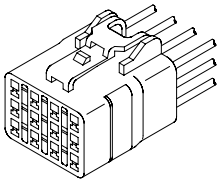
 </td></tr>
<tr><td>CN12A</td><td> 
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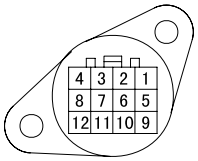
</table></td><td> 
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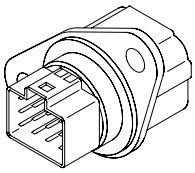
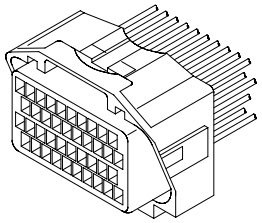
 </td></tr>
<tr><td rowspan="2">CP</td><td>CP40A</td><td> 
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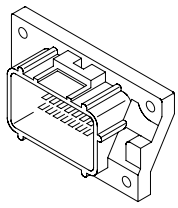
</table></td><td> 
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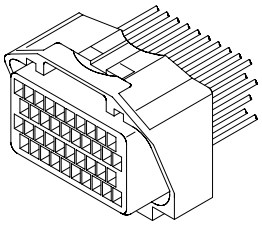
<tr><td>CP40B</td><td> 
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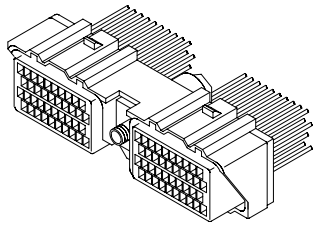
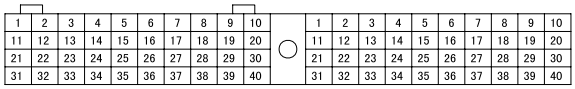
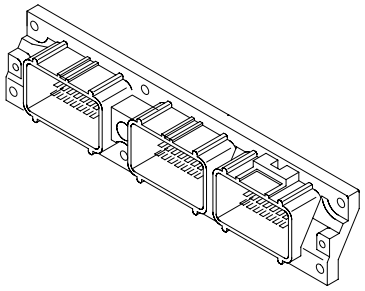
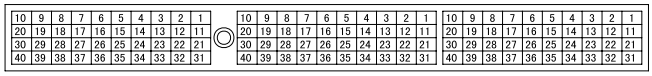
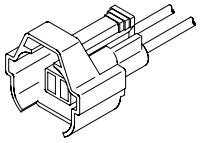
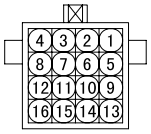
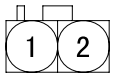
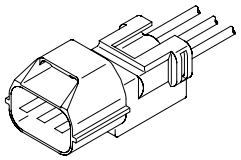
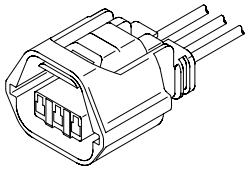
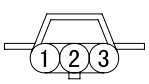
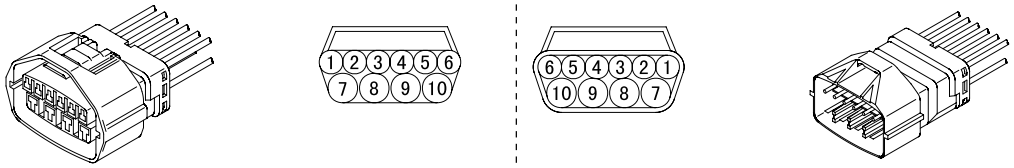
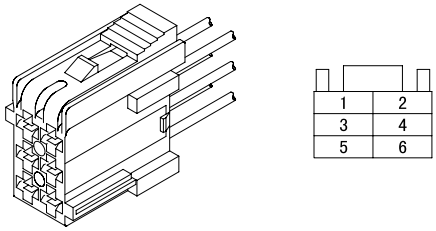
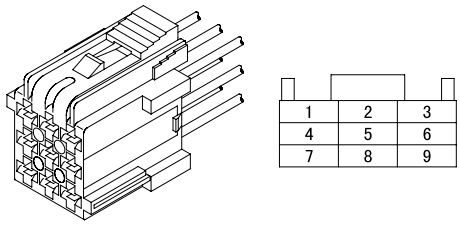
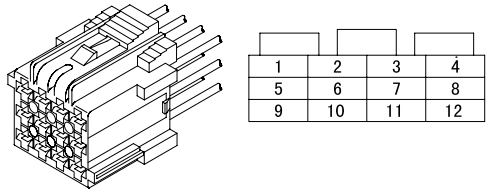
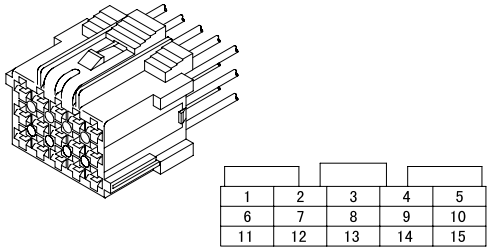
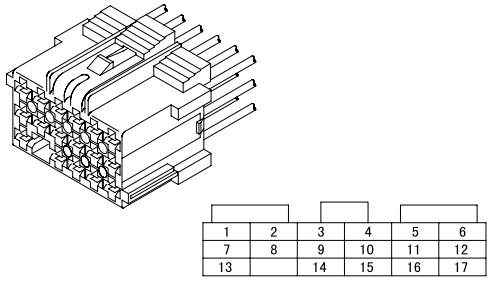
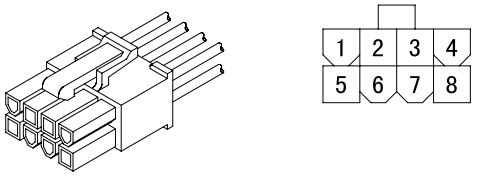
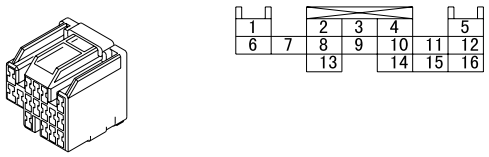
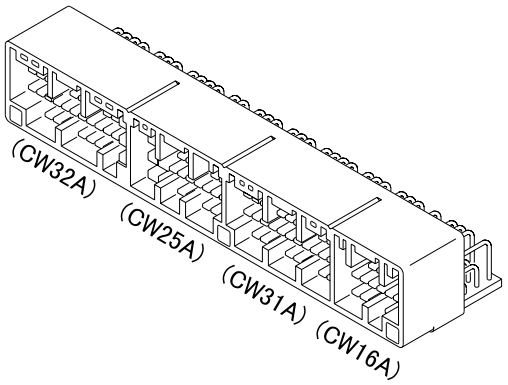
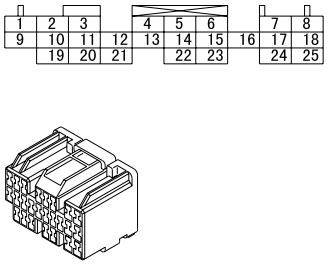
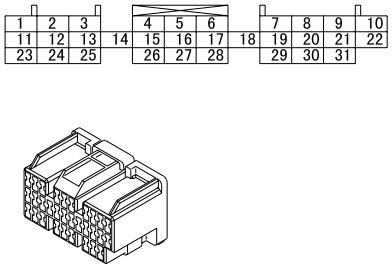
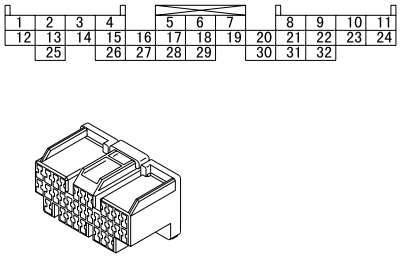
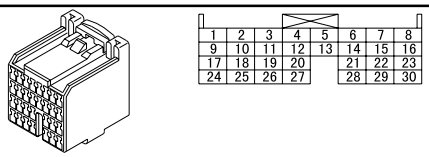
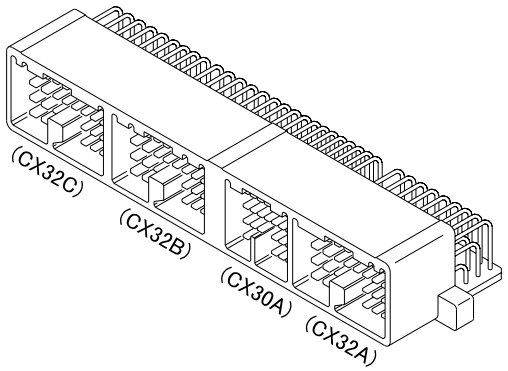
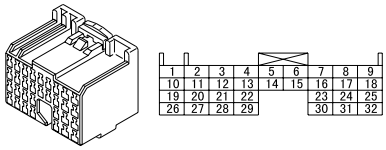
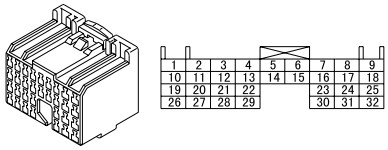
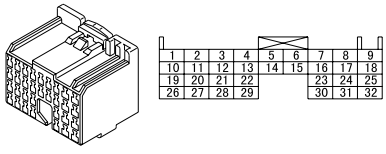
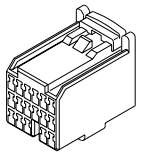
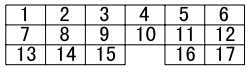
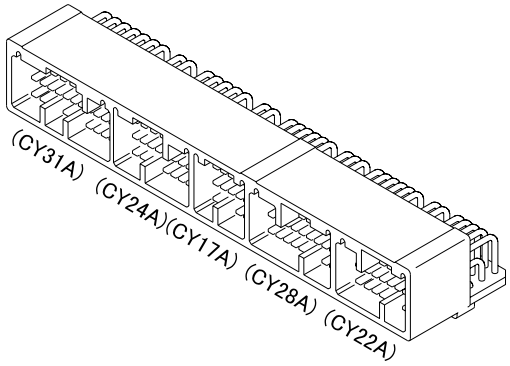
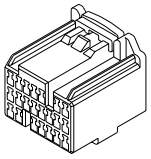
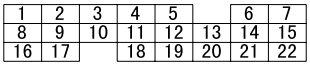
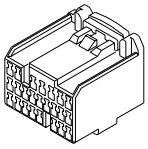
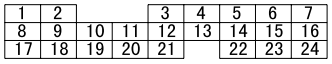
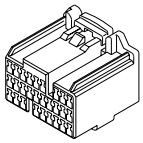
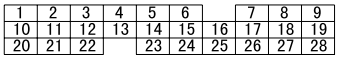
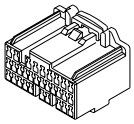
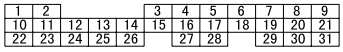
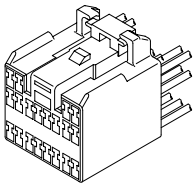
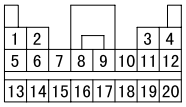
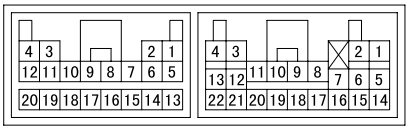
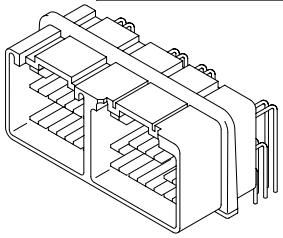
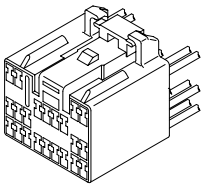
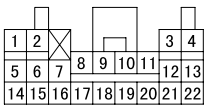
Model (Number shows number of pins)		Connection
CP	CP80A	 
	CP40B CP80A	  (CP80A) (CP40B)
CQ	CQ 2 A	
CR	CR16A	
CS	CS 2 A	
CT	CT 3 A	
	CT 3 B	 

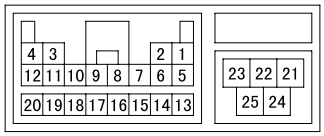
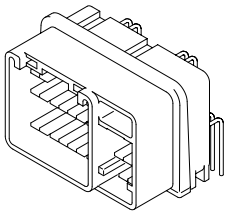
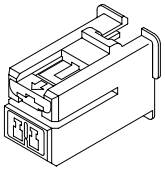
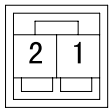
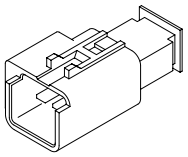
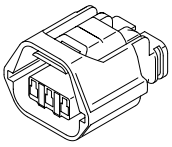
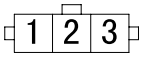
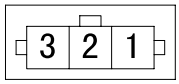
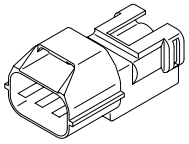
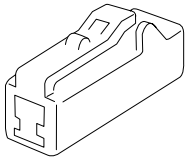
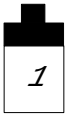
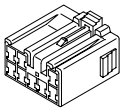
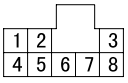
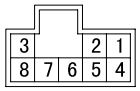
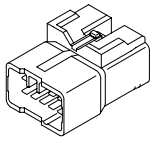
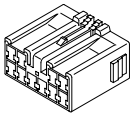
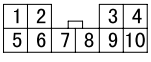
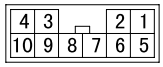
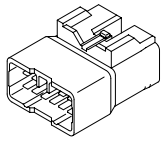
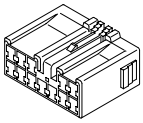
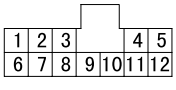
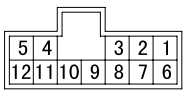
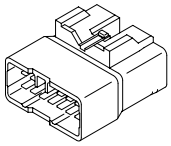
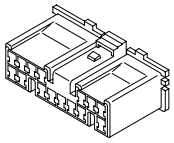
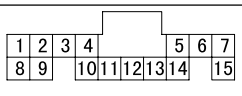
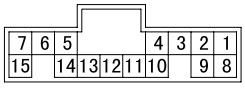
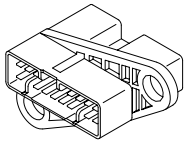
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CT	CT10A	
CU	CU 6 A	
	CU 9 A	
	CU12A	
	CU15A	
	CU17A	
CV	CV 8 A	

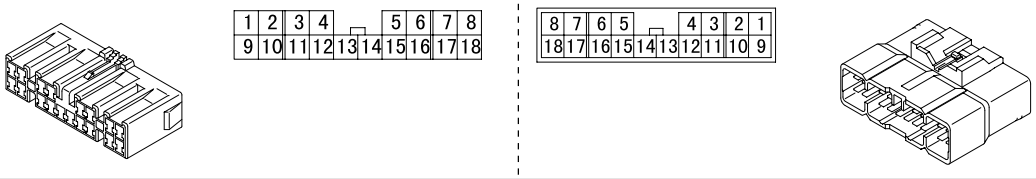
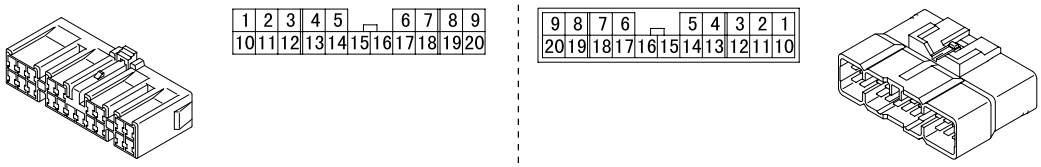
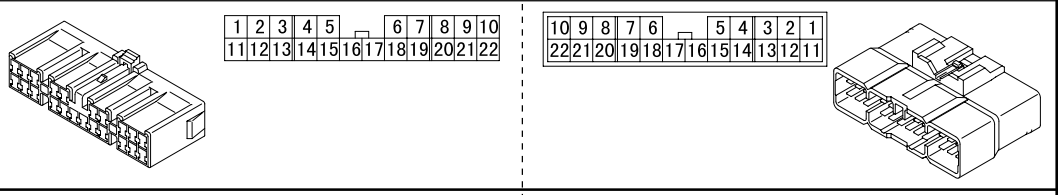
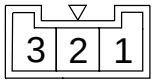
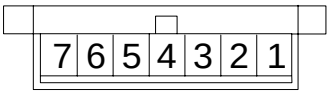
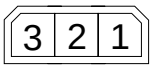
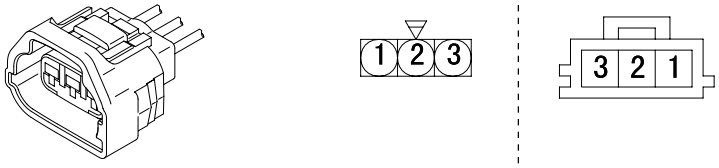
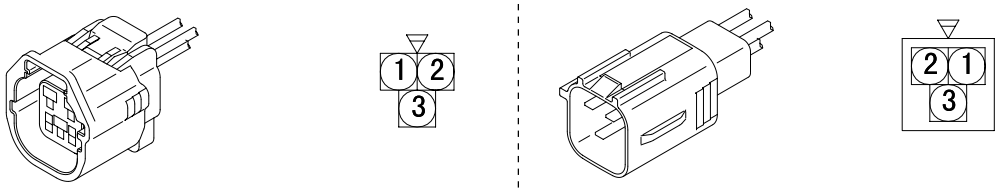
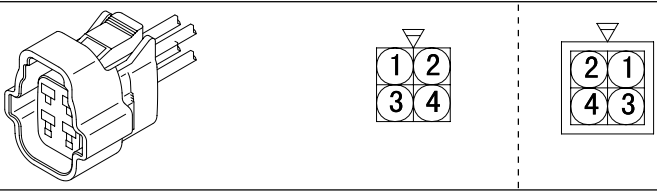
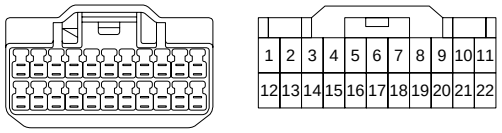
Model (Number shows number of pins)		Connection
CW	CW16A	 
	CW25A	
	CW31A	
	CW32A	
CX	CX30A	 
	CX32A	
	CX32B	
	CX32C	

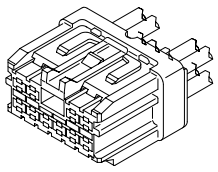
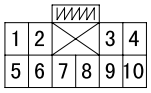
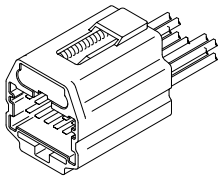
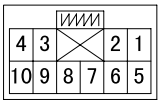
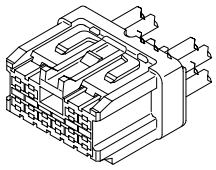
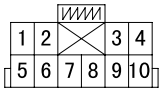
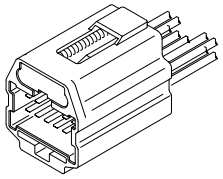
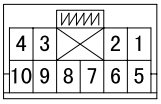
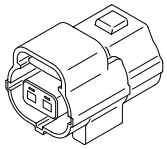
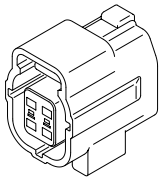
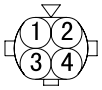
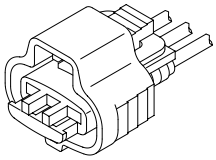
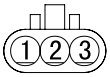
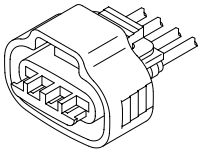
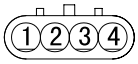
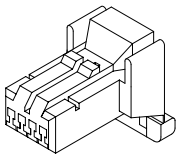
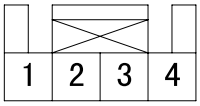
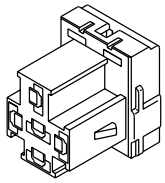
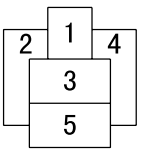
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
CY	CY17A	  
	CY22A	 
	CY24A	 
	CY28A	 
	CY31A	 
DA	DA20A	   
	DA22A	 

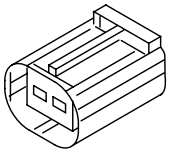
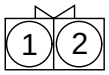
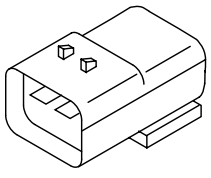
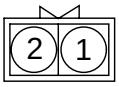
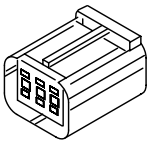
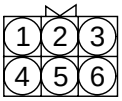
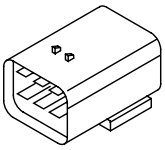
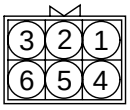
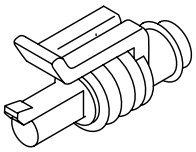
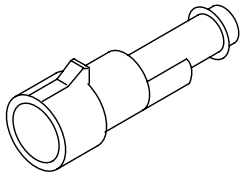
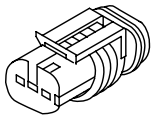
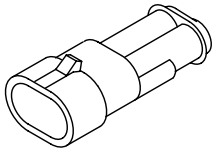
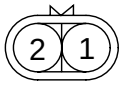
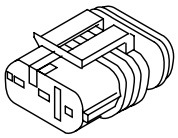
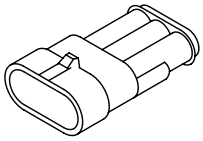
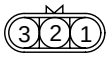
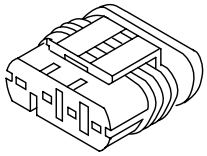
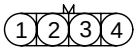
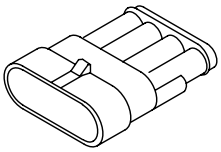
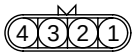
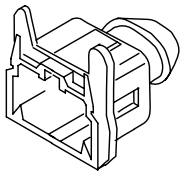
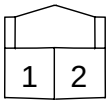
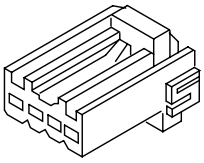
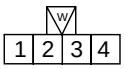
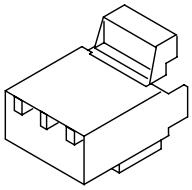
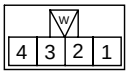
Model (Number shows number of pins)		Connection
DA	DA25A	 
DB	DB 2 A	  
DC	DC 3 A	   
DD	DD 1 A	 
	DD 8 A	   
	DD10A	   
	DD12A	   
	DD15A	   

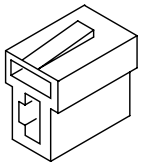
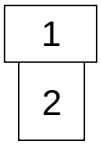
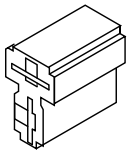
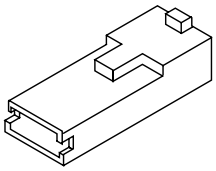
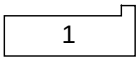
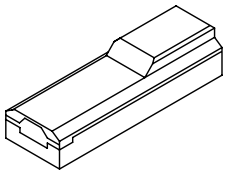
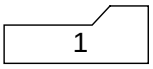
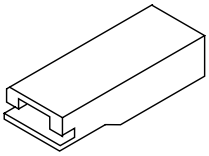
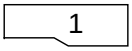
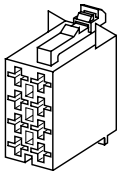
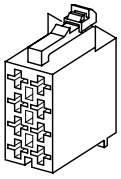
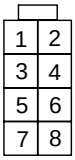
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
DD	DD18A	
	DD20A	
	DD22A	
DE	DE 3 A	
	DE 7 A	
DF	DF 3 A	
DG	DG 3 A	
	DG 3 B	
	DG 4 A	
DH	DH22A	

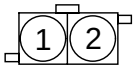
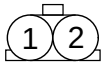
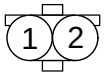
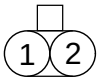
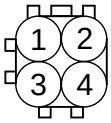
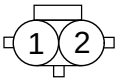
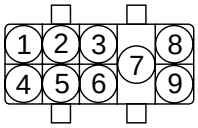
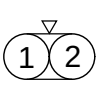
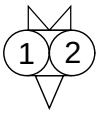
Model (Number shows number of pins)		Connection			
DJ	DJ10A				
	DJ10B				
DK	DK 2 A				
	DK 4 A				
DM	DM 3 A				
	DM 4 A				
DN	DN 4 A				
DP	DP 5 A				

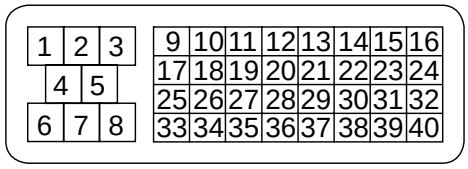
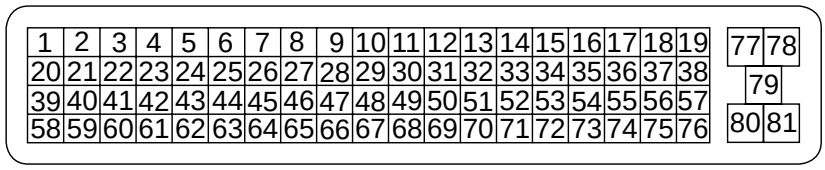
CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection	
DS	DS 2 A	 	 
	DS 6 A	 	 
DT	DT 1 A		
	DT 2 A		 
	DT 3 A		 
	DT 4 A	 	 
DU	DU 2 A	 	
DV	DV 4 A	 	 

Model (Number shows number of pins)		Connection
DW	DW 2 A	 
DX	DX 2 A	
DY	DY 2 A	 
	DY 2 B	 
DZ	DZ 1 A	 
EA	EA 8 A	
	EA 8 B	
EB	EB 8 A	

CONNECTOR CONFIGURATION CHART

Model (Number shows number of pins)		Connection
EC	EC 2 A	
ED	ED 2 A	
EE	EE 2 A	
EF	EF 2 A	
EG	EG 4 A	
EH	EH 2 A	
EJ	EJ 9 A	
EK	EK 2 A	
EL	EL 2 A	

Model (Number shows number of pins)		Connection
EM	EM40A	
	EM81A	

MITSUBISHI
FUSO

Group 01

Maintenance Schedule

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-01

INDEX

HOW TO READ THE MAINTENANCE SCHEDULE TABLES 01- 2

MAINTENANCE SCHEDULE TABLES 01- 3

MAINTENANCE OPERATIONS

- Replacement of Oil Filter 01- 7
- Replacement of Fuel Filter 01- 8
- Draining of Water Separator Condensation 01- 9
- Cleaning of Fuel Feed Pump Gauze Filter 01- 9
- Bleeding of Air from Fuel Line 01-10
- Adjustment of V-Belt Tension 01-11
- Cleaning and Replacement of Air Cleaner Element 01-13
- Inspection of Clutch Pedal Free Play 01-14
- Tire 01-15
- Inspection of Brake Lining Thickness 01-21
- Battery 01-21
- Fuse 01-24

LUBRICATION TABLES 01-26

LUBRICATION

- Engine Oil 01-27
- Clutch Fluid (Brake Fluid) 01-29
- Manual Transmission Gear Oil 01-31
- Automatic Transmission Fluid and Oil Filter 01-32
- Rear Axle Gear Oil 01-38
- Power Steering Fluid 01-39
- Brake Fluid 01-41
- Greasing Various Areas of Chassis 01-45

HOW TO READ THE MAINTENANCE SCHEDULE TABLES

Example Table :

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
*3 : FK617, FM617
*4 : FM657 (Manual transmission)
*5 : FM657 (Automatic transmission)
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

Inspection and maintenance (1)		Time of inspection and maintenance (2)					Working procedures (3)	Remarks (4)
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Every 30000 km/18000 miles *1	Every 60000 km/36000 miles *2		
ENGINE								
1	Air, fuel, oil or coolant leaks from engine			×			Check engine for air, fuel, oil and coolant leaks	Gr 11, 12, 13, 14
2	Ⓔ Ⓝ Engine starting performance, speed, noise and exhaust gas conditions			×			Check for engine starting performance, idling speed, abnormal engine noise, black smoke or other abnormal exhaust gas during idling and acceleration. Check engine speed on tachometer	Gr 11, 13, 15
3	Retightening of inlet and exhaust manifold bolts					×	Retighten, checking of the tightening torque is unnecessary.	Gr 15
4	Ⓔ Val…		×			×	Check valve clearance with fe…	
…	…			Every 20000 km/12000 miles			Replace element	

(1) This column contains the maintenance and inspection items.
(2) The periods between inspection and service are based on the assumption that the vehicle will be driven approximately 60000 kilometers (36000 miles) per year.
Inspections which must be made are indicated by an "×" or by the appropriate period between servicing.
(3) This column provides a simplified explanation of the operational procedures involved for each inspection or maintenance item.
(4) The Gr. No. refers to the "group number" in this vehicle Service Manual. For visual checks and simple inspections, see the sections labelled "Working Procedures".

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
*3 : FK617, FM617
*4 : FM657 (Manual transmission)
*5 : FM657 (Automatic transmission)
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

	Inspection and maintenance	Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Inspection interval: Every 30000 km/18000 miles *1	Inspection interval: Every 60000 km/36000 miles *2		
ENGINE								
1	Air, fuel, oil or coolant leaks from engine			×			Check engine for air, fuel, oil and coolant leaks	Gr 11, 12, 13, 14
2	Ⓔ Ⓝ Engine starting performance, speed, noise and exhaust gas conditions			×			Check for engine starting performance, idling speed, abnormal engine noise, black smoke or other abnormal exhaust gas during idling and acceleration. Check engine speed on tachometer	Gr 11, 13, 15
3	Retightening of inlet and exhaust manifold bolts					×	Retighten. Checking of the tightening torque is unnecessary	Gr 15
4	Ⓔ Valve clearance		×			×	Check valve clearance with feeler gauge	Gr 11
5	Ⓔ Oil filter replacement			Every 20000 km/12000 miles On new vehicle, also replace at the 10000 km/6000 miles			Replace element	P01-7
6	Ⓔ Ⓝ Check injection nozzles			Every 90000 km/54000 miles			Check and clean injection nozzles	Gr 13
7	Ⓔ Ⓝ Fuel injection pressure and spray pattern of injection nozzles			Every 250000 km/150000 miles			Remove injection nozzle and check with nozzle tester	Gr 13
8	Ⓔ Ⓝ Fuel injection timing					×	Turn crankshaft in normal running direction and check injection starting timing of No.1 cylinder	Gr 13
9	Ⓔ Cleaning fuel feed pump gauze filter					×	Remove connector from fuel feed pump inlet and clean filter inside connector with diesel fuel	P01-9
10	Ⓔ Fuel filter replacement				×		Replace element	P01-8
11	Ⓔ Water separator water discharge	×					Loosen water separator drain plug to discharge water	P01-9
12	Ⓔ Draining water and sediment in fuel tank			Every 24 months			Remove fuel tank drain plug and remove water and sediment	Gr 13
13	Retightening the fuel tank bracket bolts			×			Check mounting bolts for looseness and retighten to a torque of 69 to 93 N·m {51 to 69 ft.lbs, 7 to 9.5 kgf·m}	Gr 13
14	Ⓔ Replacing fuel hose in engine compartment			Every 24 months			Replace fuel hose in engine compartment	Gr 13
15	Ⓔ Check fuel line outside the engine compartment			Every 24 months			Check fuel line outside the engine compartment. Replace if necessary	Gr 13
16	Ⓔ Ⓝ V-belt tension and damage	×		×			Press midpoint of V-belt firmly with finger to measure deflection and check for belt damage	P01-11
17	Coolant level and leaks from cooling system	×					Check coolant level and if level is low, check for coolant leaks	Gr 14
18	Coolant replacement			Every 24 months			Replace with new coolant	Gr 14
19	Radiator cap condition			×			Check radiator cap for sealing and mounting condition	Gr 14
20	Ⓔ Cooling system hose clamp position and clamping condition			×			Check clamp position and clamping condition of cooling system hose	Gr 14
21	Ⓔ Turbocharger rotor play			Every 250000 km/150000 miles			Check rotor for excessive end play by using a dial indicator	Gr 15
22	Ⓔ Ⓝ Cleaning of air cleaner element	×		×			Check air cleaner dust indicator. If red signal appears, clean the element	P01-13
23	Ⓔ Ⓝ Air cleaner element replacement			Every 50000 km/30000 miles			Replace element	P01-13
24	Ⓔ Ⓝ Damage of air intake system, looseness of clamp and loss of parts			×			Check air intake system for damage and inspect all parts for installation	Gr 15
25	Ⓔ Ⓝ Exhaust system			×			Check the exhaust system for damage, corrosion and loose connection causing leakage	Gr 15
26	Starter function					×	Operate starter switch and check the switch for proper function	Gr 54
27	Alternator function					×	Check for function with a circuit tester	Gr 54

MAINTENANCE SCHEDULE TABLES

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
*3 : FK617, FM617
*4 : FM657 (Manual transmission)
*5 : FM657 (Automatic transmission)
Ⓔ : Exhaust emission items
Ⓝ : Noise control items

	Inspection and maintenance	Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Every 30000 km/18000 miles *1	Every 60000 km/36000 miles *2		
POWER TRAIN								
28	Air or oil leaks from power train			×			Check power train for air and oil leaks	
29	Clutch pedal play			×			Press clutch pedal lightly and check that its play is adequate	🕮 P01-14
30	Clutch function			×			(1) Press the clutch pedal to check for unusual noise or stiffness. Also check if gear engages quietly (2) Check the clutch does not slip and engages smoothly	🗀 Gr 21
31	Manual transmission gearshift control looseness				×		In NEUTRAL position, check gearshift lever for looseness. With gearshift lever in each gear position, check all gears engage smoothly without excessive looseness. Also check that control cable in not damaged	🗀 Gr 22A, B
	Automatic transmission range selector linkage and throttle (modulator) linkage condition				×		Shifting to each position must be correct and secure	🗀 Gr 23A, B
32	Propeller shaft couplings and bearings looseness		×	×			(1) Check flange yoke bolts and center bearing bolts for looseness (2) Turn propeller shaft manually to check for loose spline coupling (3) Check for looseness between spider and needle roller bearing On new vehicle inspection at 4000 km/2500 miles, check only the looseness of bolts	🗀 Gr 25
FRONT AND REAR AXLES								
33	Axle shaft torsion and cracks					×	Remove axle shaft and check for torsion, bend, and cracks	🗀 Gr 27
34	Front wheel hub bearing looseness				×		With front axle jacked up, move wheel up and down by holding tire's top and bottom to check for bearing looseness	🗀 Gr 26
35	Rear wheel hub bearing damage					×	Disassemble rear wheel and check for hub bearing wear and damage	🗀 Gr 27
36	Retightening wheel nuts		×	×			Check wheel nuts for looseness	🕮 P01-15
37	Disc wheel damage			×			Check disc wheel for corrosion, deformation and cracks	🗀 Gr 31
38	Tire inflation pressure, cracking, tread groove depth, abnormal wear, etc.	×		×			(1) Measure inflation pressure with tire pressure gauge, und check that tire tread groove is deep enough (2) Check tire tread and side walls for cracks, damage, uneven ridgy and other abnormal wear	🕮 P01-15
39	Tire rotation			×			Rotate all tires	🕮 P01-15
SUSPENSION SYSTEM								
40	Looseness, play and damage of suspension system				×		Check suspension system for looseness, play and damage	🗀 Gr 33, 34
41	Damage and looseness of leaf springs	×			×		Check leaf springs for damage and looseness	🗀 Gr 33, 34
42	Retightening U-bolts		×		×		Check U-bolts for looseness	🗀 Gr 33, 34
43	Oil leaks and damage of shock absorbers				×		Check for oil leaks from and damage of cylinders and other parts	🗀 Gr 33, 34
BRAKING SYSTEM								
44	Air pressure and its charging speed	×					After discharging air from air tank, start and run the engine at idle and measure time taken to charge air to specified pressure in air tank	🗀 Gr 35A, B
45	Air and fluid leaks from braking system			×			Check braking system for air and fluid leaks	🗀 Gr 35A, B
46	Looseness, play and damage of braking system parts			×			Check braking system parts for looseness, play and damage	🗀 Gr 35A, B
47	Condensation in air tank	×					Open drain cock and check for presence of condensation in air tank	🗀 Gr 35A, B

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Inspection and maintenance		Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Inspection interval: Every 10000 km/6000 miles	Inspection interval: Every 30000 km/18000 miles *1	Inspection interval: Every 60000 km/36000 miles *2		
48	Operation of brake pedal			×			Depress the brake pedal and release it, checking for the sound of air being released from the brake valve and to ensure that the pedal returns normally without cathing Press the brake pedal with a finger to the point where resistance is felt and meassure the distance (play) over which the pedal has moved	Gr 35A, B
49	Foot brake effectiveness	×		×			While driving the vehicle at low speed, check braking effect and check for uneven braking	Gr 35A, B
50	Operation of exhaust brake	×		×			Check exhaust brake operation	Gr 35A, B
51	Exhaust brake control cylinder packing replacement			Every 12 months			Check exhaust brake control cylinder packing; replace if necessary	Gr 35A, B
52	Operation of air dryer			×			Open drain cock of air tank and make sure there is no drainage.If there is a small amount of drainage from the FK series, remove the plug from the air dryer and check the color of the indicator. If it is pink, drying agent	Gr 35A, B
53	Check drain from air dryer exhaust port			×			Check to see that oil is not discharged abnormally from exhaust port of air dryer	Gr 35A, B
54	Air dryer disassembly and check					×	FK series : Remove plug from the air dryer and check color of indicator. If indicator is pink, disassemble and replace drying agent FM series : Disassemble air dryer and check every part of it. If more than 1/5 of the drying agent is discolored, replace drying agent	Gr 35A, B
55	Replacement of drying agent in air dryer			Every 24 months			Disassemble air dryer and replace drying agent and rubber parts	Gr 35A, B
56	Brake shoe clearance				×		Measure clearance with feeler gauge *3 *5	Gr 35A, B
							Measure brake chamber push rod stroke *4	
57	Brake lining wear				×		Check for lining wear	Gr 35A, B
58	Brake drum wear					×	Disassemble and check drum for wear, cracks and damage	Gr 35A, B
59	Slack adjuster cracking *4					×	Check slack adjuster for cracking and other damages	Gr 35B
60	Parking brake effectness			×			On a slope, check that vehicle can be held stationary	Gr 36A, B
61	Parking brake operation *4 *5	×		×			(1) Check for operation of parking brake control valve (2) Check operation when brake line air pressure is reduced	Gr 36B
62	Parking brake lever stroke *3	×		×			With lever full pulled, check that lever is locked completely and that there is allowance in pulling stroke	Gr 36A
63	Parking brake drum and lining wear *3					×	Disassemble and check drum for wear, cracks and damage and lining for wear	Gr 36A
64	Brake chamber expander boot inspection*5					×	Check expander boot for damage	Gr 35B
65	Wheel cylinder piston cup and dust seal replacement *3			Every 12 months			Check wheel cylinder piston cup and dust seal; replace if necessary	Gr 35A
66	Brake booster packing, cup and rubber parts replacement *3			Every 12 months			Check brake booster packing, cup and rubber parts; replace if necessary	Gr 35A
67	Brake hose replacement			Every 12 months			Check brake hose; replace if necessary	Gr 35A, B
68	Check valve packing and rubber parts replacement			Every 12 months			Check check valve packing and rubber parts; replace if necessary	Gr 35A, B
69	Brake valve packing and rubber parts replacement			Every 12 months			Check brake valve packing and rubber parts; replace if necessary	Gr 35A, B
70	Air compressor and pressure gauge hoses replacement			Every 24 months			Replace air compressor and pressure gauge hose	Gr 35A, B
71	Brake booster power cylinder packing replacement *3			Every 24 months			Replace brake booster power cylinder packing	Gr 35A
72	Brake fluid reservoir tank tube replacement *3			Every 24 months			Check and replace brake fluid reservoir tank tube	Gr 35A

MAINTENANCE SCHEDULE TABLES

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Inspection and maintenance		Time of inspection and maintenance					Working procedures	Remarks
		Pre-operation checks	New vehicle at 4000 km/ 2500 miles	Inspection interval: Every 10000 km/ 6000 miles	Every 30000 km/ 18000 miles *1	Every 60000 km/ 36000 miles *2		
73	Replacement of packings and rubber parts in brake chamber *4 *5			Every 24 months			Replace packings and rubber parts in brake chamber	Gr 35B
74	Replacement of rubber parts in wheel parking brake spring section and expander section of brake chamber *5			Every 36 months			Replace rubber parts in wheel parking brake spring section and expander section of brake chamber	Gr 35B
STEERING SYSTEM								
75	Fluid leaks from steering system			×			Check steering system for fluid leaks	Gr 37
76	Steering wheel play	×		×			Turn steering wheel right and left to measure play at steering wheel rim. Measure while engine is running	Gr 37
77	Steering operating condition	×		×			Check steering wheel to see if it vibrates, pulls to one side or requires unusual steering effort	Gr 37
78	Looseness and play of steering system (including hoses and pipes)			×			(1) Check steering system for looseness and play (2) Check power steering hoses and pipes for looseness	Gr 37
79	Wheel alignment					×	Measure toe-in, camber, caster and kingpin inclination angles	Gr 26
80	Right and left turning angles and power steering function					×	(1) Check that the stopper bolt is sufficiently tight, without damage, and that steering linkage operates smoothly until blocked by stopper bolt (2) Check that steering wheel does not contact other parts	Gr 26
81	Power steering booster and oil pump internal rubber parts replacement			Every 48 months			Replace internal rubber parts	Gr 37
82	Power steering hose replacement			Every 48 months			Replace power steering hose	Gr 37
CAB AND FRAME								
83	Looseness and damage of chassis and body			×			(1) Check the frame, cross members and other parts for cracks and damage, also check for loose rivets (2) Also check for body damage and loose mounting bolts	Gr 41, 42
84	Heater and defroster operation			×			Check operation and installation of defroster	Gr 55B
85	Reflection of rearview mirrors and reflectors	×					Check for reflecting condition, stains and damage	Gr 42
86	Door lock function			×			Check door lock mechanism functions properly	Gr 42
87	Seat belt mounting condition			×			Check seat belt for damage, buckle and retracting function and mounting condition	Gr 42
ELECTRICAL SYSTEM								
88	Looseness and damage of electrical wiring and connections			×			Check wiring, connectors and battery terminals for looseness and corrosion	Gr 54
89	Battery electrolyte level and specific gravity			Every 20000 km/ 12000 miles			(1) Check electrolyte level (2) Measure electrolyte specific gravity with hydrometer	Gr 54
90	Operation and damage of the lighting system and turn signal lamps	×		×			(1) Check operation, damage and installation of each lighting unit (2) Check that turn signal lamps are operated by the turn signal switch	Gr 54
91	Operation of horn	×		×			Check operation, damage and mounting condition	Gr 54
92	Operation and fluid level of windshield wiper and washer	×		×			Check operation, damage and mounting condition Check if fluid level in washer tank is okay	Gr 42
93	Gauges and pilot lamps function	×		×			Check function of gauges and pilot lamps	Gr 54
94	Switch function					×	Check operation, damage and installation of each switch	Gr 54
OTHER								
95	Road test of vehicle			×			Drive the vehicle to check for overall vehicle operating condition	

This section explains simple maintenance procedures. See the relevant Group in this manual for further details.

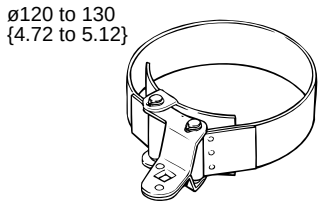
Replacement of Oil Filter

Lubricant

Location	Points of application	Kinds	Quantity
2	Inside oil filter	Engine oil	Approximately 2.3 L {2.4 qts}
	Gasket area of oil filter with thin application	Engine oil	As required

Special tools

Unit : mm {in.}

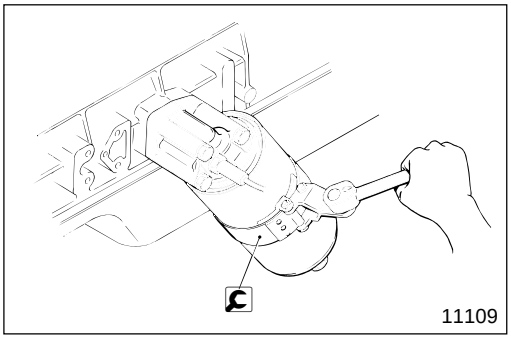
Location	Tool name and shape	Part No.	Application
2	Oil filter wrench  01503	MH061537 (Obtain Locally)	Removal of oil filter

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**

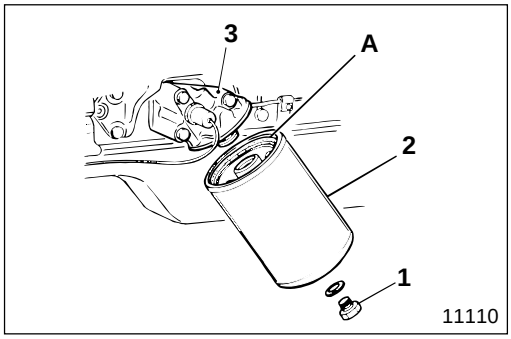
CAUTION

Take care not to spill engine oil on the V-belts, because this would cause them to slip, reducing service life.


11109

[Removal]

: Oil filter wrench



11110

[Installation]

- Clean the surface of oil filter head **3** that makes contact with oil filter **2**.
- Apply engine oil thinly and evenly to gasket area **A** of oil filter **2**.
- Screw in oil filter **2** to oil filter head **3** until gasket area **A** sits on the filter head. From this position, tighten further by rotating by one and one eighth to one and three eighths of a turn.
- After installation, run the engine and check that there is no oil leakage from gasket area **A**.
- Check the oil level and if it is low, top it up.

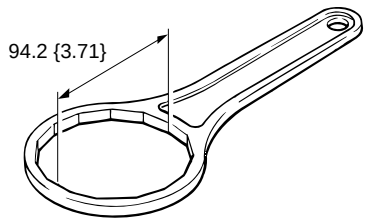
Replacement of Fuel Filter

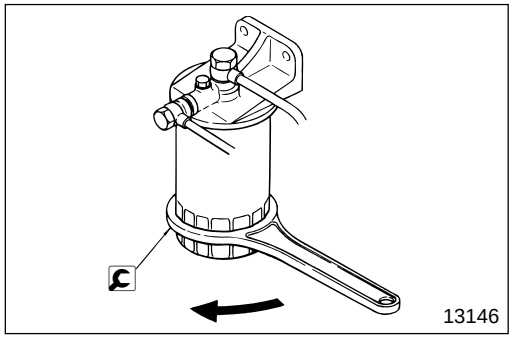
Lubricant

Location	Points of application	Kinds	Quantity
2	Gasket contact surfaces of fuel filter and fuel filter head	Engine oil	As required

Special tools

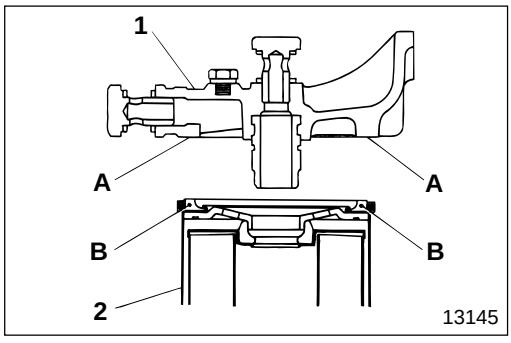
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Filter wrench  01882	MH061572 (Obtain Locally)	Removal of fuel filter


13146

WARNING
- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any gas oil that has been spilled because it can cause a fire.**
- **Do not use an unsuitable filter because it can cause a fire.**

[Removal]
: Filter wrench



13145

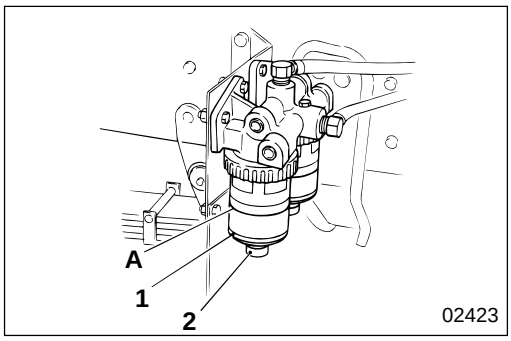
[Installation]
- Install by tightening by three quarters to one full turn after contact surface **A** of fuel filter head **1** contacts gasket **B** of fuel filter **2**. Be sure to tighten by hand.
- After installation, run the engine and check for fuel leakage.

Draining of Water Separator Condensation

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Drain plug	2.9 to 3.9 {2.2 to 2.9, 0.3 to 0.4}	—



Visually inspect the water separator before driving.
When float **1** reaches red line **A**, drain the condensation as follows:

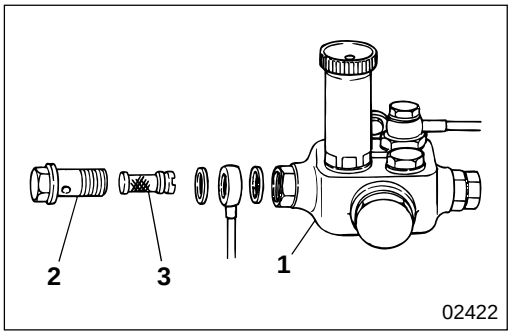
- Loosen drain plug **2** and drain out the condensation.
- When float **1** has dropped to the bottom, tighten drain plug **2**.
- Carefully wipe the water separator and the surrounding area.
- Check for fuel leakage.

Cleaning of Fuel Feed Pump Mesh Filter

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Eye bolt	25 to 29 {18 to 22, 2.5 to 3}	—



WARNING

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any gas oil that has been spilled because it can cause a fire.**
- **Do not use an unsuitable filter because it can cause a fire.**

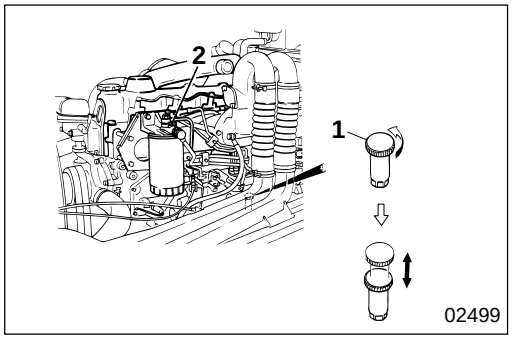
- Remove eye bolt **2** on the inlet side of fuel feed pump **1**.
- Remove mesh filter **3** from eye bolt **2**.
- Clean gauze filter **3** with gas oil.
- Follow the removal sequence in reverse and reinstall gauze filter **3**. Install eye bolt **2** in the fuel feed pump.
- Bleed the air from the fuel line.
- Start the engine and check for fuel leakage.

Bleeding of Air from Fuel Line

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Air vent plug	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—



WARNING

- **Fuel ignites easily. Do not get it near flame or heat.**
- **Wipe up any gas oil that has been spilled because it can cause a fire.**

- Turn the top of priming pump **1** of the injection pump counterclockwise and pull it up so the top protrudes.
- Loosen air vent plug **2** of the fuel filter and move the top part of priming pump **1** up and down.
- Move priming pump **1** up and down repeatedly until air bubbles are no longer present in the fuel drained from air vent plug **2**.
- When the fuel being drained is free of air bubbles, tighten air vent plug **2**.
- After moving priming pump **1** up and down another five or six times, push the top down and turn clockwise to drive it in fully.
- After bleeding the air, carefully wipe up spilled fuel and start the engine.
- Check for fuel leakage.

Adjustment of V-Belt Tension

Newly installed V-belts can stretch during their initial running-in period. To prevent this from becoming a problem, run the engine for several minutes after installing the V-belt, then readjust. Perform this cycle several times.

WARNING⚠

You must take special precautions to prevent the engine from rotating while a V-belt is being inspected or adjusted.

CAUTION⚠

- **Make sure that you turn off the engine before attempting to inspect or adjust the V-belts.**
- **Make sure that you fasten all bolts and nuts securely after adjusting the V-belts. Remember that too much tension can damage the V-belts and bearings.**
- **Do not grease V-belts. This causes them to slip, which reduce service life.**

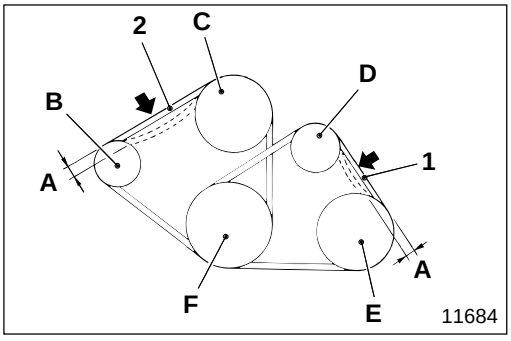
Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1, 2	V-belt Flex (Each)	Fan	10 to 15 {0.39 to 0.59}	—	Adjust
		Air-conditioner	7 to 10 {0.28 to 0.39}		

Special tools

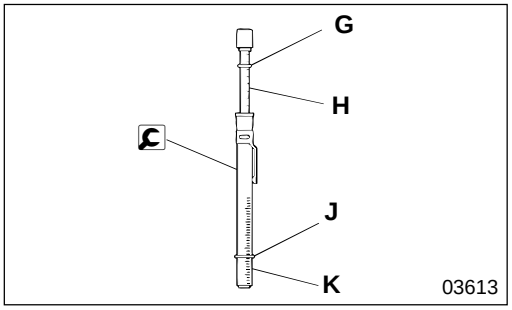
Location	Tool name and shape	Part No.	Application
1, 2	Belt tension gauge 03612	MH062345	Measurement of tension of V-belt



[Inspection]

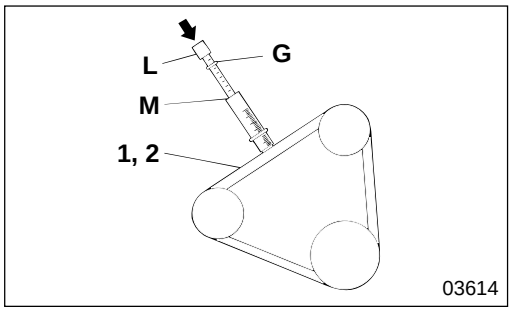
Measure the extent of flex **A** when the center of V-belts **1**, **2** as illustrated is depressed with a force of 98 N·m {72 ft.lbs, 10 kgf·m}.

B : Alternator pulley
C : Water pump pulley
D : Tension pulley
E : Cooler compressor pulley (Air-conditioner)
F : Crankshaft pulley

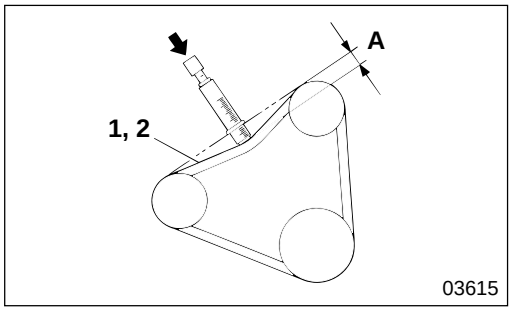


Use of special tool belt tension gauge

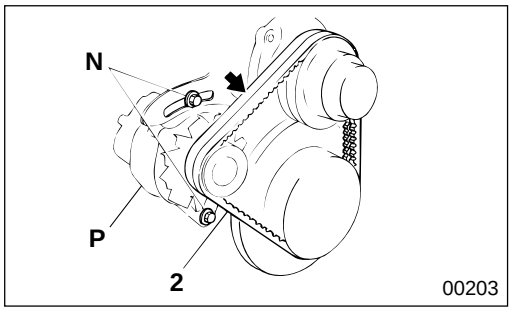
- Set upper O-ring **G** of 🔧 belt tension gauge to 98 N·m {72 ft.lbs, 10 kgf·m} (push load) on graduation **H**.
- Set lower O-ring **J** of 🔧 belt tension gauge to graduation **K** (maximum flex of belt).



- Place 🔧 belt tension gauge at the center of V-belts **1**, **2** perpendicularly as illustrated and push top **L** all the way down until upper O-ring **G** hits upper edge **M**.



- Measure the extent of flex **A** of V-belts **1**, **2** at this point, and if the measured value deviates from the standard value, adjust as follows:



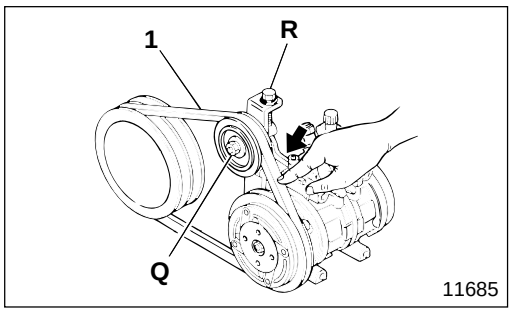
[Adjustment]

(1) Adjustment of tension of V-belts for fan

- Loosen alternator mounting bolts **N** (two points).
- Adjust the tension of V-belt **2** by rocking alternator **P** left and right.
- After adjustment, tighten mounting bolts **N** securely.

CAUTION⚠

- **Bear in mind that excessive tension of V-belts 2 might damage the belts and bearings that engage with the V-belts.**
- **Be sure to replace V-belts 2 as a set to maintain even tension between them.**
- **Be careful not to let oil stick to V-belts 2. If oil gets onto the belts, it causes slipping, resulting in overheating and insufficient battery charging.**



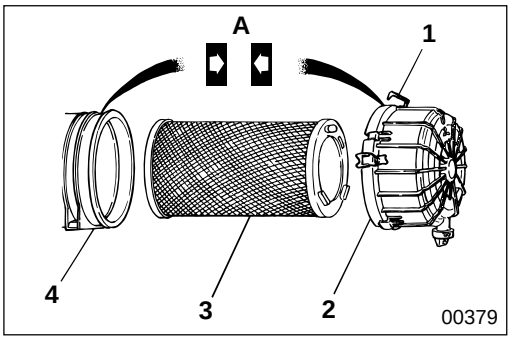
(2) Adjustment of tension of V-belt for air-conditioner

- Loosen tension pulley mounting nut **Q**, and adjust the tension of V-belt **1** moving adjusting bolt **R**.
- After adjustment, tighten mounting nut **Q** securely.

CAUTION⚠

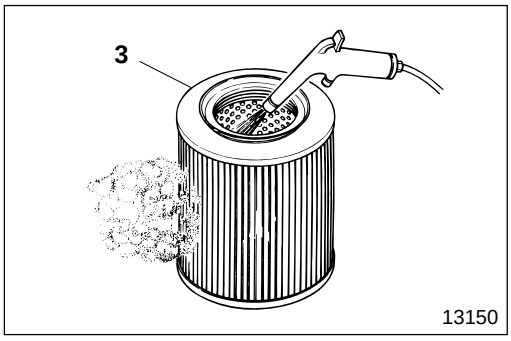
- **Bear in mind that excessive tension of V-belt 1 might damage the belt and bearings that engage with the V-belt.**
- **Be careful not to let oil stick to V-belt 1. If oil gets onto the belt, it causes slipping, resulting in poor performance of the air-conditioner.**

Cleaning and Replacement of Air Cleaner Element



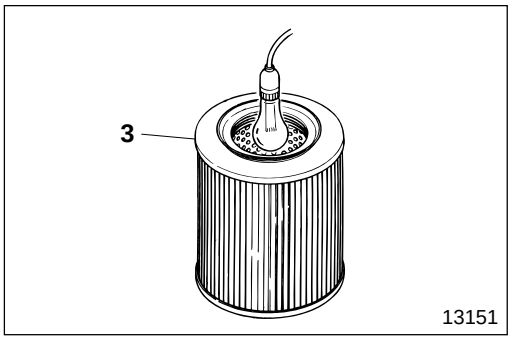
[Removal]
- Remove clamp **1** to remove cover **2**.
- Remove air cleaner element **3**.

[Installation]
Install case **4** and cover **2** by aligning arrows **A**.



[Cleaning]
- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through air cleaner element **3** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of air cleaner element **3** evenly.

CAUTION⚠
- **Do not tap or hit air cleaner element 3 to remove dust.**
- **Do not blow compressed air through air cleaner element 3 from the outside.**



[Inspection]
- Illuminate the inside of air cleaner element **3**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of air cleaner element **3** is damaged, replace the air cleaner element.

NOTE

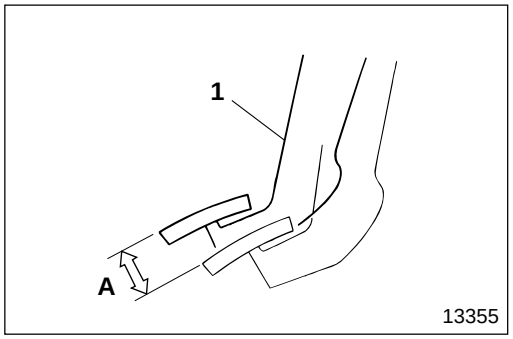
If the dust on air cleaner element 3 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.

Inspection of Clutch Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1	Clutch pedal free play	Except for FM657 (M8S2×5)	32 to 44 {1.26 to 1.73}	—	Adjust or replace
		FM657 (M8S2×5)	25 to 37 {0.98 to 1.46}	—	



[Confirmation]
Push clutch pedal **1** with your hand and measure the amount of movement **A** (free play) until you meet resistance. If the measured value does not conform to the standard value, adjust the stroke of the clutch power cylinder or the clutch booster push rod, or replace the clutch disc.

[Clutch operation]
- Check for unusual noises when clutch pedal **1** is pressed while the engine is idling, and also for abnormally heavy clutch operation. Also check to be certain that it is not difficult to shift the vehicle into first and reverse gears.
- Gradually release clutch pedal **1** to set the vehicle in motion.
  Check to be sure there is no slippage, and that the clutch engages smoothly.

Tire

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Depth of tire tread grooves	—	1.6 {0.063}	Replace

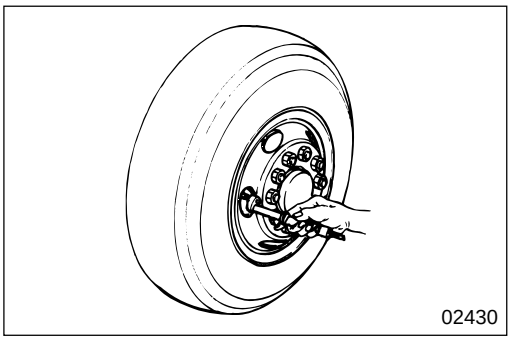
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Wheel nut	400 to 440 {295 to 325, 41 to 45}	Wet

Lubricant

Location	Points of application	Kinds	Quantity
2	Wheel nut spherical area	Chassis grease [NLGI No.1 (Ca soap)] or Wheel bearing grease [NLGI No.1 (Li soap)]	As required
4	Wheel nut (inner) at thread area and spherical area		
6	Thread area of hub bolt		



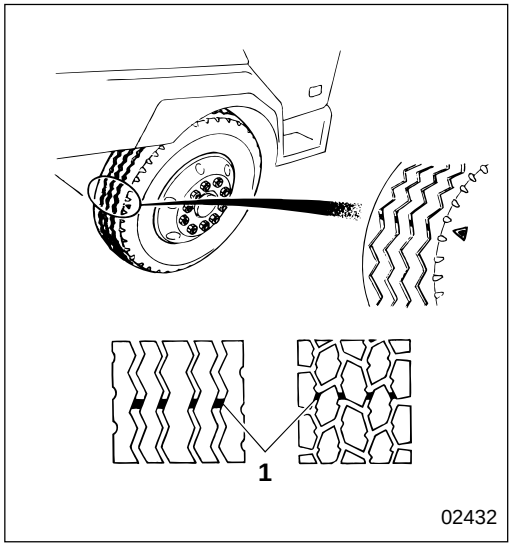
Air pressure

Tire air pressure should be checked before the vehicle is driven, while the tires are still cool.

Model	Tire size	Air Pressure kPa {psi, kgf/cm^2}
FK	9R 22.5-12PR	Front : 750 {105, 7.50} Rear : 675 {95, 6.75}
FM	11R 22.5-14PR	

CAUTION

- **Make certain that there is no difference in the air pressure between the inner and outer rear tires.**
- **Make certain you use valve caps on the air valves.**
- **It is not necessary to increase the air pressure for high-speed driving.**

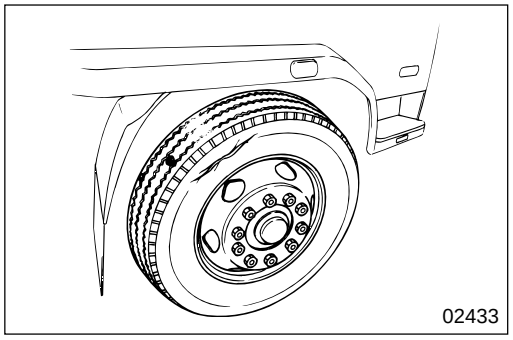


Checking tread depth

- Check the circumference of the tire to make sure that the depth of the tread grooves is above the wear limit.
- If the tread grooves are not deep enough, wear indicator **A** appears at the position of the ⚠ mark, where the tread groove has worn away.

WARNING⚠

If the depth of the tread grooves is not adequate, the tires will slip on wet roads and present a hazard. Such tires are also extremely dangerous because they are more susceptible to hydroplaning when the vehicle is running at high speeds in the rain. Such tires must be replaced with new ones as soon as possible.



Checking for cracks, damage, and objects embedded in the treads

- Check the tire treads and walls for cracks and damage.
- Check tire treads for uneven wear or other abnormal wear.
- Check if metal objects or nails have penetrated the tires.
- Check for stones embedded between double tires.

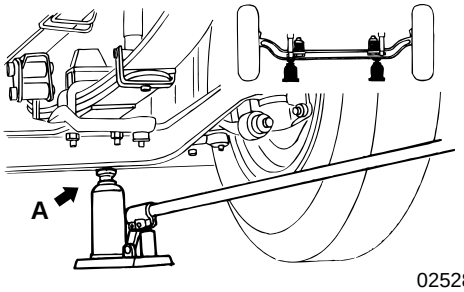
WARNING⚠

Badly damaged or worn tires are extremely dangerous, because they can be punctured more easily when the vehicle is running, they must be replaced with new ones as soon as possible.

Removing tires

- Jacking up point
  - For front wheels : Front axle bottom A
  - For rear wheels : Rear axle tube bottom B

< Front wheel >



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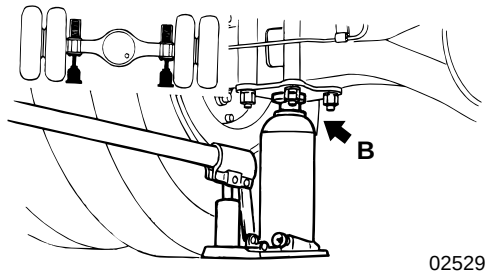
< Rear wheel >



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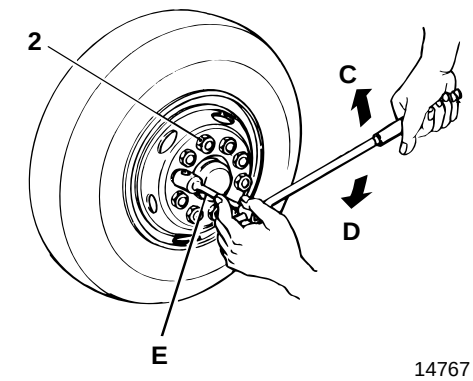
WARNING

- **The jack should be placed on flat, solid ground, and should not be used to raise the vehicle higher than necessary.**
- **Do not use the jack at vehicle locations other than those illustrated.**
- **Keep in mind the danger of a slipping jack. Never crawl under the vehicle while the jack is in use or rock the vehicle. Also, do not start the engine while the vehicle is jacked up.**
- **To increase safety, use supports for the vehicle when it is necessary to leave it jacked up for long periods.**
- **Chock both the tire to be removed and the tire diagonally opposite to it so that they will not rotate when you are removing the tire.**



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- Loosen wheel nuts **2** slightly. The wheel nuts for right tires **C** have right-hand threads "**R**", and the wheel nuts for left tires **D** have left-hand threads "**L**".

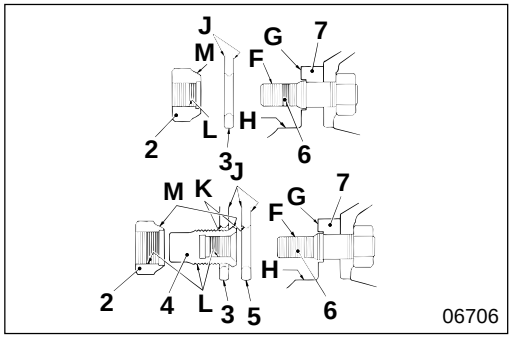
WARNING

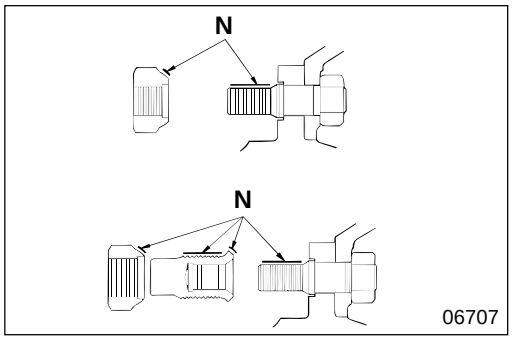
Make certain that wheel nut wrench E is fully engaged, all the way to the back of nuts 2. If it is not, it could slip.

CAUTION

Only loosen wheel nuts 2 slightly. Do not remove them.

- Jack up the vehicle carefully, until the tire is slightly off the ground. Remove wheel nuts **2**, then remove the tire.
- When working on the double tires at the rear of the vehicle, first remove the outside tire, then lower the vehicle and loosen the nuts on the inside tire. After doing this, jack the vehicle back up and remove the tire.



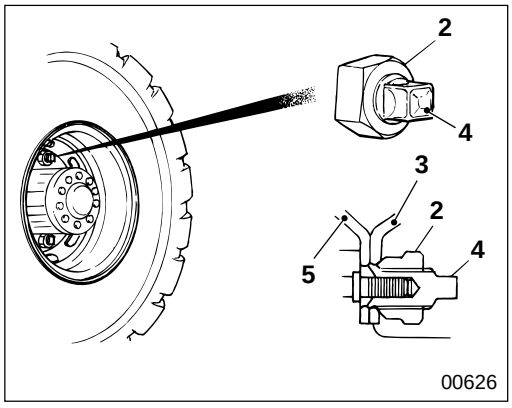


Mounting tires

- To prevent wheel nuts **2**, **4** and hub bolt **6** from becoming loose and to prevent mounting parts (tire assemblies **3**, **5** and hub **7**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:
  F : Hub bolt thread area
  G : Wheel mounting surface of hub
  H : Wheel alignment area of hub
  J : Disc wheel mating surface
  K : Disc wheel nut mounting surface
  L : Wheel nut thread area
  M : Wheel nut spherical area
  N : Grease application area

WARNING⚠

Never use grease containing molybdenum disulfide, because it would cause loosening of fitted screws.



- Put on the dual rear tires as follows:
  - After mounting inner tire **5** and fully tightening inner wheel nuts **4**, jack the vehicle up and mount on outer tire **3**, then tighten outer wheel nuts **2**.
  - Even if only outside tire **3** is to be changed, do not mount it until inner wheel nuts **4** have been fastened at the specified torque.
  - Slide the air valves on the inside and outside tires down when mounting the tires.

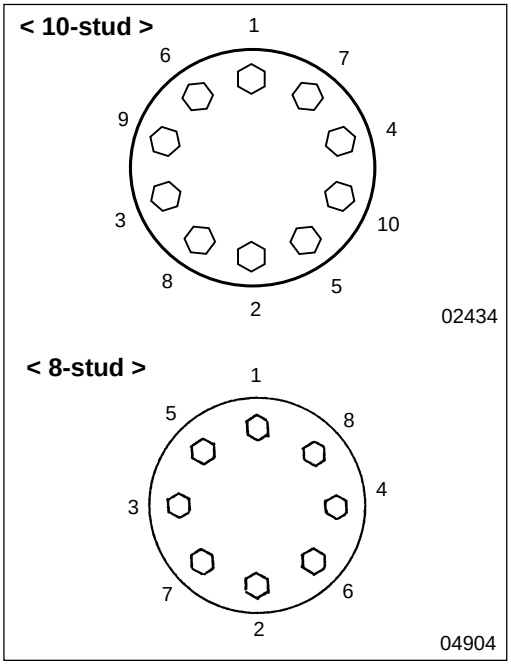
WARNING⚠

If the threads are scored, or the disc wheel is deformed or cracked, change bolts 6, nuts 2, 4 and disc. Driving the truck before correcting such problems can cause the tire in question to come loose, which could be the source of major accidents.

CAUTION⚠

Check hub bolt 6 threads carefully for scratches before putting the tire on.

- Place the tapered end of wheel nuts **2**, **4** towards the disc wheel and fasten temporarily. Center so that there is no eccentricity between bolts **6** and the disc wheel bolt holes.
- Lower the vehicle.



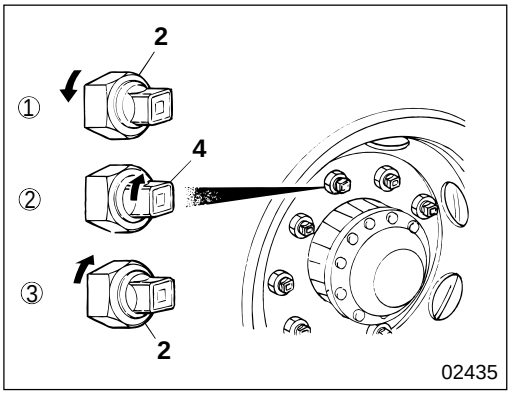
- Tighten the nuts in the order as illustrated, tightening each nut two or three times. To finish, tighten each nut at the specified torque.

WARNING⚠

Always use the specified torque when tightening the wheel nuts. If the wheel nuts are not tightened properly, the wheels could come loose while the vehicle is being driven, which could result in life threatening accidents or the truck being disabled.

CAUTION⚠

Over-tightening the wheel nuts can damage them.



Checking the wheel nuts for looseness

The wheel nuts should be checked for looseness every 10000 km (6000 miles). All the nuts should be tightened at specified torque.

- Check the double rear tires for looseness as follows:

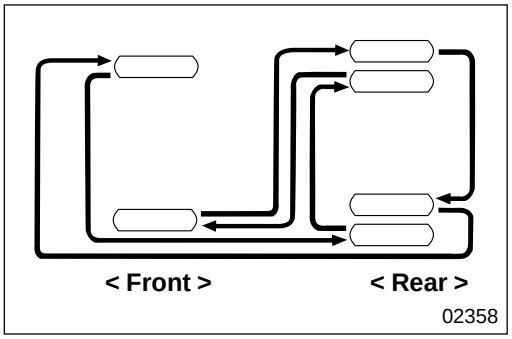
① Loosen outer wheel nuts **2**.
② Tighten inner wheel nuts **4** at specified torque.
③ Tighten outer wheel nuts **2** at specified torque.

CAUTION⚠

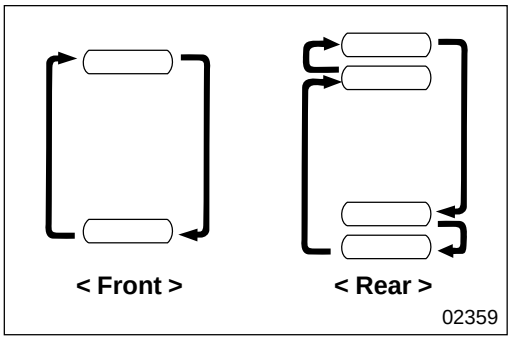
If outer wheel nuts 2 are tightened without first being loosened, it might not be possible to tighten them at the specified torque.

Tire rotation

Tires wear differently, according to the location where they are mounted. To make this wear uniform and prolong the life of your tires, they should be rotated every 10000 km (6000 miles) in the rotation order shown below:



- When the tread patterns for all tires are identical:



- When the tread patterns are different for the front and rear tires:

CAUTION ⚠

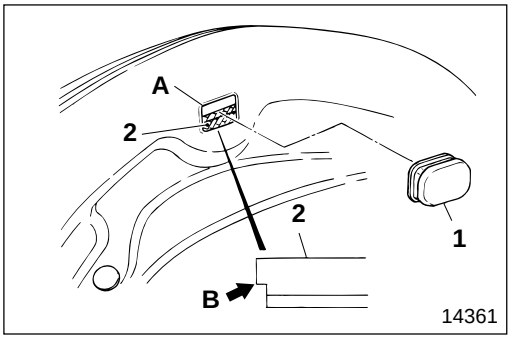
- **Always adjust air pressure after running-in new tires.**
- **When using tires of different tread patterns, use rib-type patterns for the front tires and traction type patterns for the rear tires.**
- **Avoid using both radial and biased tires on the same vehicle.**

Inspection of Brake Lining Thickness

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2	Thickness of brake lining	FK617, FM617	—	5.5 {0.22} (Side shoulder means wear limit)	Replace
		FM657	—	6 {0.24} (Side shoulder means wear limit)	Replace



NOTE

Be sure to inspect at two points for each wheel per side.

- Remove check hole plug **1** from the backing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder (wear indicator) **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on both sides of the axle.
- After inspection, be sure to reinstall check hole plug **1**.

Battery

DANGER ⚠

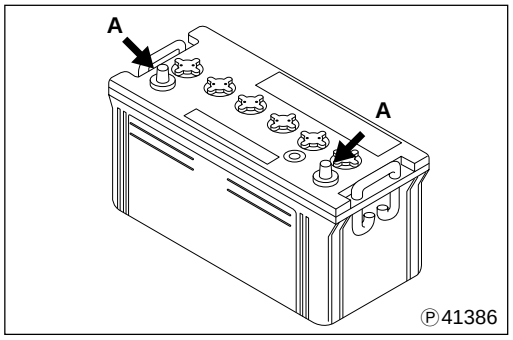
- **Since flammable hydrogen gas is generated by the battery, be sure to obey the following warnings:**
  - **Do not short-circuit the ⊕ and ⊖ terminals on the battery.**
  - **Keep sparks and lit cigarettes away from the battery.**
  - **Do not wear metal objects on your arms and lean over the bat tery.**
- **Because the battery electrolyte is diluted sulfuric acid and is corrosive when handling the battery wear safety glasses and rubber gloves to protect the eyes and hands.**
- **Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.**

WARNING ⚠

To prevent a short-circuit be sure that disconnected the battery cables do not accidentally touch the battery terminals.

CAUTION ⚠

- **Make sure that you disconnect the battery cable ⊖ first when you disconnect the battery cables.**
- **Make sure that all electrical switches of the vehicle are OFF before connecting the battery cables.**
- **Make sure that you connect the battery cables ⊕ before you connect the battery cable ⊖.**

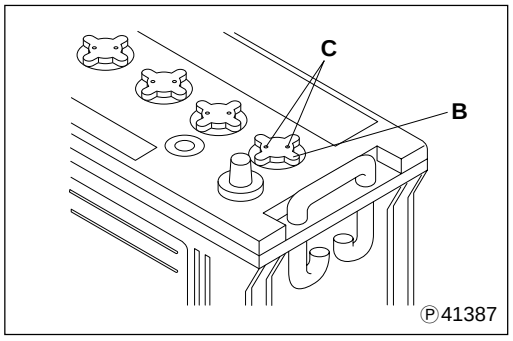


Visual inspection

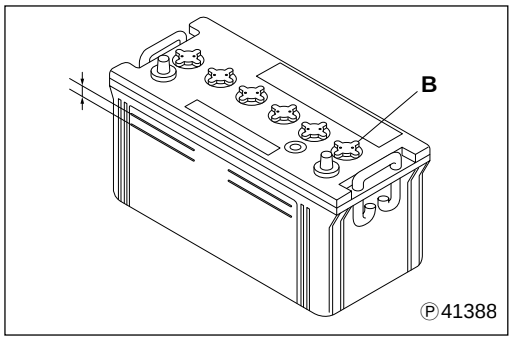
- If terminal **A** is corroded, scrub off the corrosion using a wire brush.
- If cracks or defects are found on the battery, replace it since the cracks or defects can cause liquid spills.

CAUTION⚠

Make sure you grease the ⊕ side of terminal A because it is easily corroded.

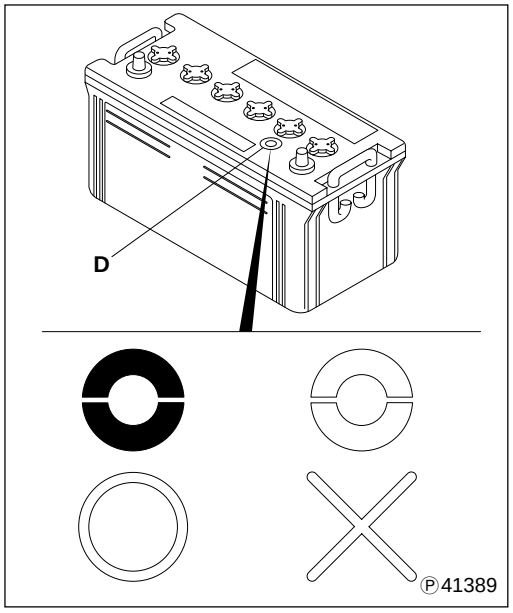


- If bleed hole **C** of vent plug **B** is clogged, clean the hole.



Inspection of fluid level

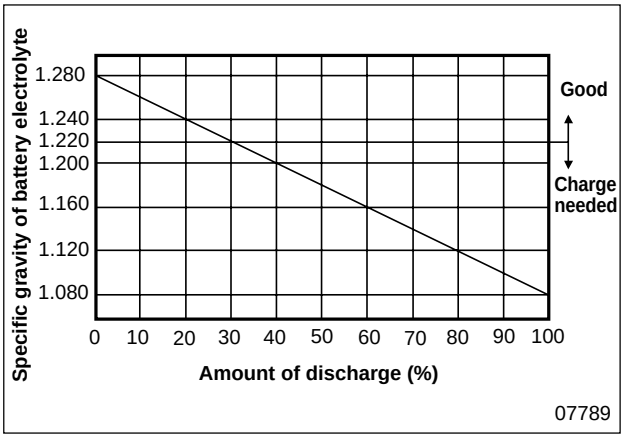
- Make sure that the battery electrolyte level is between the UPPER and LOWER level lines.
- If the level is below the LOWER level line, remove vent plug **B** and fill the battery with distilled water or battery replenisher to the UPPER level line.



Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator **D**.

Blue : Good
White : Charge or replace



Charging

- Although, as a rule, charging of the battery should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect the battery cable ⊖.
- Remove vent plug **B** before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	$\frac{\text{Value of 5-hour rating capacity}}{10}$	$\frac{*\text{Amount of discharge (Ah)}}{\text{Charge current (A)}} \times 1.2\text{(to 1.5)}$	45 {113}
Quick charge	$\frac{\text{Value of 5-hour rating capacity}}{1.5}$	0.5	45 {131}

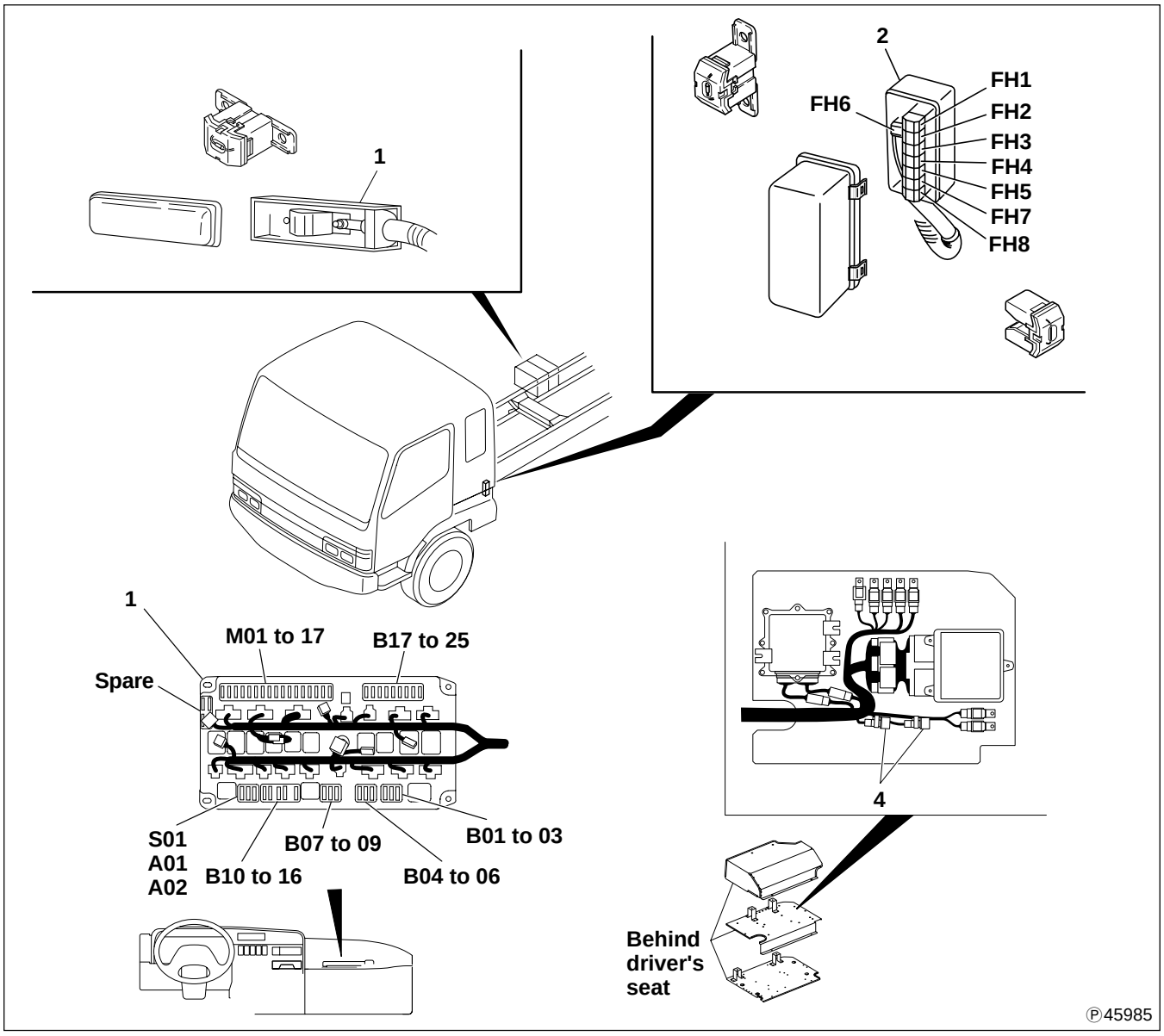
* Amount of discharge (Ah) = 5-hour rating capacity (Ah) × $\frac{\text{Amount of discharge (\%)}}{100}$

- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.
- The specific gravity of fully-charged battery electrolyte is 1.280 with the temperature at 20°C {68°F}.

DANGER⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **Keep work lights away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it is dangerous.**
- **After charging the battery, tighten vent plug B, wash away sulfuric acid from the battery using water, and dry the surface.**
- **Be sure to check the electrolyte level before charging the battery. Charging with the electrolyte level below the lower limit (LOWER LEVEL) can cause premature deterioration, heat generation and explosion of the battery.**

Fuse



1 Main high-current fuse
2 High-current fuse box
3 Relay and fuse box
4 Fuse holder

CAUTION ⚠

- **If a fuse blows, make sure you identify and remedy the cause, then replace the fuse.**
- **Make sure that you replace the fuse with one having the same rating.**
- **Make sure that you remove the ⊖ terminal of the battery cable before removing main high-current fuse 1 and high-current fuses FH1 to 8.**

Main high-current fuse

Fuse No.	Main load	Capacity
—	High-current fuse box	140 A

High-current fuse box

Fuse No.	Main load	Capacity
FH1	Starter switch (Terminal B)	50 A
FH2	Fuse (B07 to B16)	40 A
FH3	Fuse box (B18 to B24)	40 A
FH4	Fuse box (B01 to B04)	40 A
FH5	Glow relay (Terminal B)	50 A
FH6	Alternator (Terminal B)	140 A
FH7	Fuse box (B06)	40 A
FH8	A/T < FM657 >	60 A

A/T : Automatic transmission

Relay and fuse box

Fuse No.	Main load	Capacity
A01	Audio	10 A
A02	Cigarette lighter	15 A
B01	Reserve power (BATT)	10 A
B02	Reserve power (ACC)	10 A
B03	Van body dome light relay	15 A
B04	Socket connector	20 A
B05	Power window	25 A
B06	Automatic transmission	10 A
B07	Stop lamp	10 A
B08	Turn/hazard	15 A
B09	Tail lamp	20 A
B10	Headlamp relay	10 A
B11	—	—
B12	Headlamp RH	15 A
B13	—	—
B14	—	—
B15	Headlamp LH	15 A
B16	—	—
B17	Spare	—
B18	Heater	20 A
B19	—	—
B20	ABS	30 A
B21	—	—

Fuse No.	Main load	Capacity
B22	Cab lamp	10 A
B23	Mirror heater	10 A
B24	—	—
B25	Horn	15 A
M01	Automatic transmission	10 A
M02	Transmission power take-off	10 A
M03	—	—
M04	Reserve power (MAIN)	10 A
M05	Neutral switch	10 A
M06	Automatic transmission	20 A
M07	Mirror heater	10 A
M08	Pre-stroke cut relay	10 A
M09	Heater	20 A
M10	—	—
M11	Control unit	10 A
M12	ABS electronic control unit	10 A
M13	Turn/hazard	10 A
M14	Air dryer	15 A
M15	Meter, speed indicator, DRL	10 A
M16	Backup lamp	10 A
M17	Wiper	15 A
S01	Safety relay	10 A

ABS : Anti-lock brake system
DRL : Daytime running light

Fuse holder

Fuse No.	Main load	Capacity
—	A/T < FM657 >	30 A

A/T : Automatic transmission

LUBRICATION TABLES

*1 : 30000 km/18000 miles or 6 months, whichever occurs first.
*2 : 60000 km/36000 miles or 12 months, whichever occurs first.
*3 : FK617, FM617
*4 : FM657 (Manual transmission)
Ⓔ : Exhaust emission items

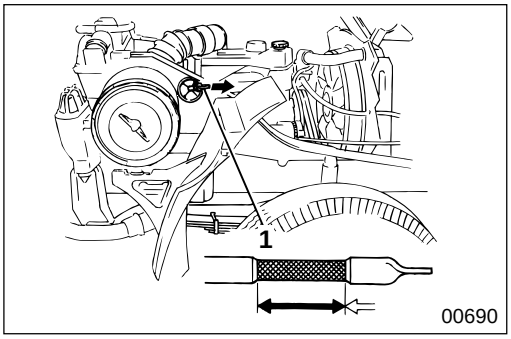
	Inspection and maintenance	Time of inspection and maintenance					Lubrication procedures	Remarks
				Inspection interval				
		Pre-operation checks	New vehicle at 4000 km/2500 miles	Every 10000 km/ 6000 miles	Every 30000 km/ 18000 miles *1	Every 60000 km/ 36000 miles *2		
1	Ⓔ Engine oil contamination and oil level	×					Engine oil API classification CD, CD/SF, CE, CE/SF or CF-4 Over 30°C {86°F} ..... SAE 40 40 to –5°C {104 to 23°F} ..... SAE 30 15 to -15°C {59 to 5°F} ..... SAE 20W-20 Over -15°C {5°F} ..... SAE 15W-40 Below 0°C {32°F} ..... SAE 10W-30	🕮 P01-27
	Ⓔ Engine oil replacement		×	×				
2	Clutch fluid tank fluid level	×		×			Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	🕮 P01-29
	Clutch fluid tank fluid replacement					×		
3	Lubrication of clutch fork shaft				×		Wheel bearing grease [NLGI No.2 (Li soap)]	🕮 P01-45
4	Lubrication of clutch shifter			When replacing clutch disc assembly				
5	Manual transmission oil level			×			Gear oil, API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region) Engine oil Long period of high-speed driving API classification CC or CC/SF SAE 30 or SAE 40	🕮 P01-31
	Manual transmission oil replacement		×	Every 50000 km/ 30000 miles				
6	Automatic transmission fluid level			×			Automatic transmission fluid (DEXRON or DEXRON II type)	🕮 P01-32
	Automatic transmission fluid and filter replacement			Every 40000 km/ 25000 miles				
			First change in new vehicle Models other than FM657: 10000 km/6000 miles FM657: 8000 km/5000 miles					
7	Axle housing gear oil level			×			Gear oil API classification GL-5 Below 40°C {104°F} ..... SAE 90 Over 40°C {104°F} ..... SAE 140 Use SAE 140 when operating vehicle at high load such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more	🕮 P01-38
	Axle housing gear oil replacement		×			×		
8	Hub bearing grease and oil seal replacement					×	Wheel bearing grease [NLGI No.2 (Li soap)]	🗀 Gr 26, 27
9	Brake fluid tank fluid level *3	×		×			Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	🕮 P01-41
	Brake fluid tank fluid replacement *3					×		
10	Power steering fluid level			×			Automatic transmission fluid (DEXRON, DEXRON II or DEXRON III type)	🕮 P01-39
	Power steering fluid replacement					×		
11	Lubrication of propeller shaft (universal joint, slip joint, center bearing)			×			Wheel bearing grease [NLGI No.2 (Li soap)]	🕮 P01-45
	Lubrication of slack adjuster and brake camshaft *4			×				
12	Lubrication of kingpins			×			Chassis grease [NLGI No.1 (Ca soap)]	🕮 P01-45
13	Lubrication of all chassis parts			×			Chassis grease [NLGI No.1 (Ca soap)]	
14	Lubrication of cab rear mount side cushion				×		Molybdenum disulfide grease [NLGI No.2 (Li soap)]	🕮 P01-45

Engine Oil

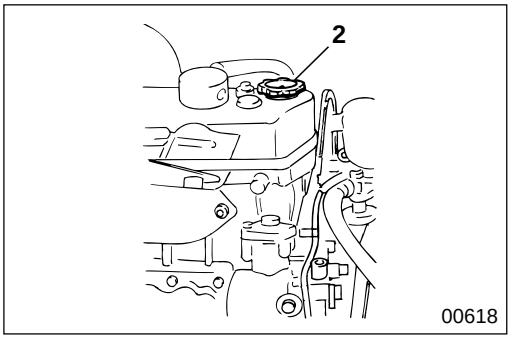
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Oil pan drain plug	69 {51, 7}	—



[Inspection]
- Pull out dipstick **1**, wipe off the oil with a cloth.
- Reinsert dipstick **1**, then pull it out carefully.
- Oil level is correct if there is oil sticking to dipstick **1** within the hatched area.
- If the level is low, top it up.
- Tilt the cab.

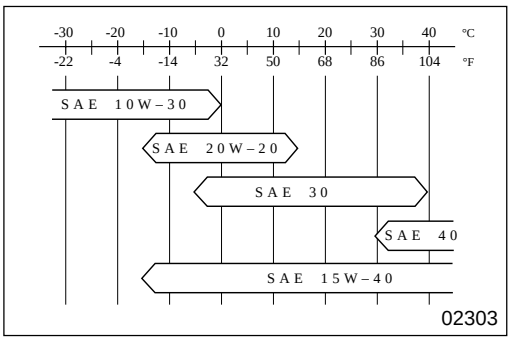


[Replenishment]
- Clean the area surrounding oil filler cap **2** and prevent dust from entering through the filler.
- Remove oil filler cap **2** and top up with engine oil.
- Wait five minutes before checking the oil level.
- Replace filler cap **2**.

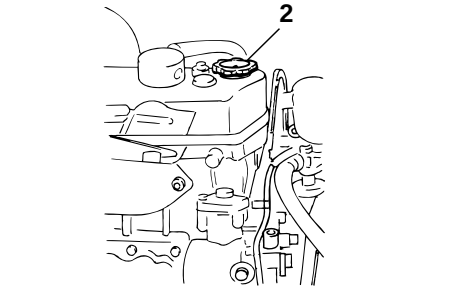
WARNING
- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**

CAUTION

Take care not to spill engine oil on the V-bells, because this would cause them to slip, reducing service life.



[Replacement]
Since engine oil greatly influences the performance, the life expectancy, and the ability to start the engine, use only oil of the specified grade and viscosity.
The chart illustrates the relationship between oil viscosity and the ambient air temperature.



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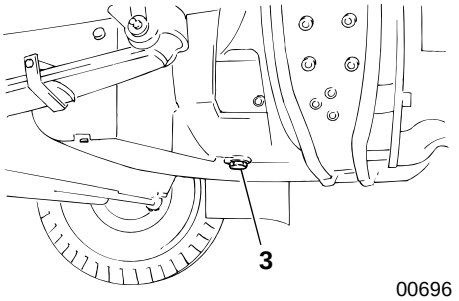

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- Clean the area surrounding oil filler cap **2** and prevent dust from entering through the filler.
- Remove oil filler cap **2**.
- Remove oil pan drain plug **3**, and drain the oil. At the same time replace the oil filter.
- After reinstalling drain plug **3**, slowly add engine oil through the oil filler.
- Using the dipstick, check the oil level after more than six minutes have passed.
- Start the engine and let it idle. When the oil has reached all parts, stop the engine. Let 30 minutes pass before checking the oil level again.

Clutch Fluid (Brake Fluid)

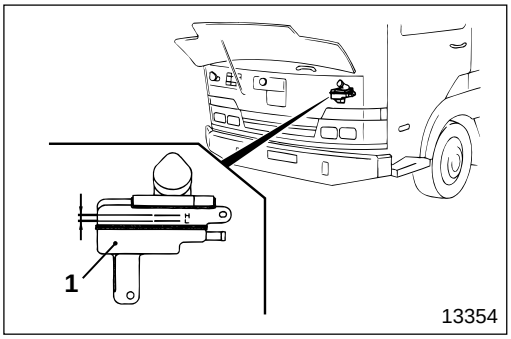
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Air bleeder (For air bleeding of clutch power cylinder)	25 to 34 {18 to 25, 2.5 to 3.5}	—

Fluid

Location	Points of application	Kinds	Quantity
1	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required



CAUTION

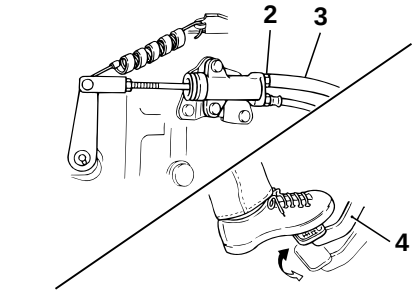
- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**
- **You must use new brake fluid (SAE J1703f or FMVSS No.116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system to swell, resulting in faulty clutch operation.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will cause faulty clutch operation.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**

[Inspection and replenishment]

Inspect the level of the brake fluid in fluid tank **1**. It should fall between the "**H**" and "**L**" levels.

If it is below the "**L**" level, lift up the lid flap and remove the cap from fluid tank **1**, then supply the specified brake fluid until the level has come up to the "**H**" level. Do not fill above the "**H**" level.

< Except for FM657 (M8S2×5) >



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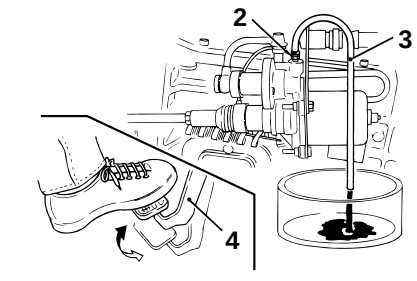
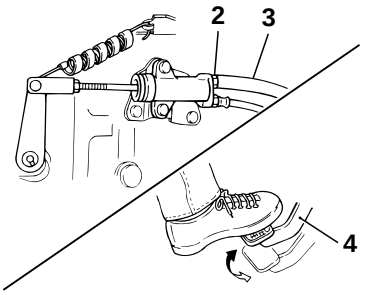


[Replacement]

- Attach vinyl pipe **3** to air bleeder **2** of the clutch power cylinder or the clutch booster.
- Loosen air bleeder **2** and depress clutch pedal 4 several times to drain brake fluid completely.
- Supply new brake fluid to the "**H**" level of fluid tank **1**. Depress clutch pedal **4** repeatedly until the old brake fluid discharged from vinyl pipe **3** is replaced by the new brake fluid.

< Except for FM657 (M8S2×5) >



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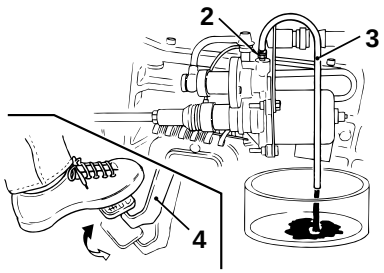

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[Air bleeding]

NOTE

Carry out this operation maintaining the brake fluid level in fluid tank 1 between "H" and "L".

- Attach vinyl pipe **3** to air bleeder **2** of the clutch power cylinder or the clutch booster as in the replacement procedure.
- Fill fluid tank **1** with brake fluid, and loosen air bleeder **2** of the clutch power cylinder or the clutch booster, then depress clutch pedal **4** continuously.
- Keep depressing clutch pedal **4**, and tighten air bleeder **2** when air is bled completely.
- Depress clutch pedal **4** several times again, then keep it depressed at its fullest extent.
- With clutch pedal **4** depressed, loosen air bleeder **2** to drain brake fluid containing air. Release the pedal after tightening the air bleeder.
- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten air bleeder **2** at specified torque.
- Check that brake fluid is at the "**H**" level of fluid tank **1**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **4** depressed.

Manual Transmission Gear Oil

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

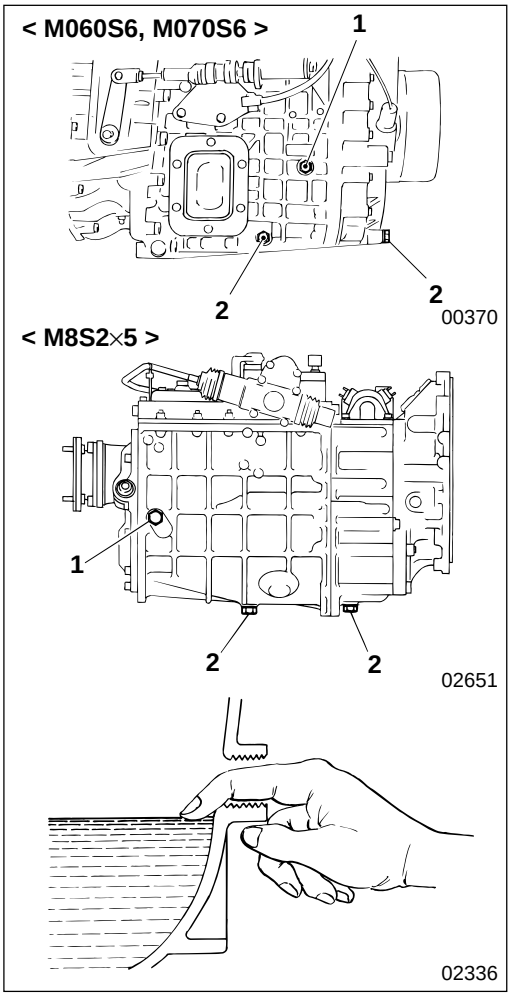
Location	Parts to be tightened	Tightening torque	Remarks
1	Inspection plug	69±15 {51±11, 7±1.5}	—
2	Drain plug	69±15 {51±11, 7±1.5}	—

Sealant

Location	Points of application	Kinds	Quantity
1	Thread area of inspection plug	THREEBOND 1105D	As required
2	Thread area of drain plug	THREEBOND 1105D	As required

WARNING

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.



[Inspection and replenishment]

- Remove inspection plug **1** and check whether the oil level is up to the edge of the entrance.
- If the level is low, add oil through the inspection plug hole until the level comes up to the edge of the entrance.

[Replacement]

- Drain the oil after removing inspection plug **1** and drain plug **2**.
- Remove any metal particles sticking to the magnetic part of drain plug **2** before reinstalling the plug.
- Add oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Reinstall inspection plug **1**.

Automatic Transmission Fluid and Oil Filter

< M4A4 >

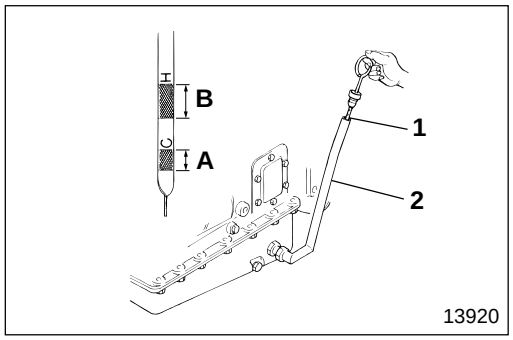
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Drain plug	20 to 27 {15 to 20, 2.05 to 2.75}	—
5	Dipstick guide connector	125 to 135 {91 to 100, 12.55 to 13.76}	—
6	Bolt (Oil pan mounting)	14 to 18 {10 to 13, 1.4 to 1.8}	—
8	Bolt (Oil filter mounting)	14 to 18 {10 to 13, 1.4 to 1.8}	—
12	Oil filter	9.8 to 20 {7 to 14, 1 to 2}	—

Fluid

Location	Points of application	Kinds	Quantity
11	Body of O-ring	Automatic transmission fluid (DEXRON or DEXRON II type)	As required
12	Gasket of oil filter with thin application	Automatic transmission fluid (DEXRON or DEXRON II type)	As required



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[Inspection and replenishment]

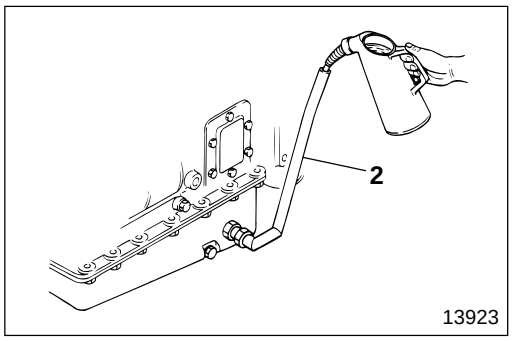
- Park the vehicle on level ground, make sure that the parking brake is fully activated and chock the wheels to keep them from rolling.
- Start the engine and let it idle. To fill the hydraulic circuit with automatic transmission fluid, shift the range selector lever from N → R → N → D → 2 → D → N. Repeat this process five times, finally shifting to N.
- While the engine is still idling, pull out dipstick **1** and wipe off the fluid sticking to it. Reinsert the dipstick, then pull it out again and check the fluid level.
- If the fluid level is inspected right after the engine is started and the fluid temperature is still low (approximately 15 to 49°C {60 to 120°F}), the level should be within area **A** marked COLD on dipstick **1**.
- If the fluid level is inspected after the vehicle has been driven and the fluid temperature is high (approximately 71 to 93°C {160 to 200°F}), the level should be within area **B** marked HOT on dipstick **1**.

WARNING

Take care during the inspection because the engine will be running. Take sufficient care to avoid burns or injuries resulting from contact with moving parts.

NOTE

- **Make sure the vehicle is parked on level ground when you are checking the fluid level.**
- **Make sure the selector lever is in the N position and the engine is idling when you are checking the fluid level. When the engine is stopped, the fluid level appears higher than it actually is.**
- **Be sure to wipe off the dust from the safety cap and the upper part of dipstick guide 2 before you pull out dipstick 1.**
- **To ensure the fluid is correct, reinspect the fluid level after an actual drive.**



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- If the fluid level is low, add automatic transmission fluid (DEXRON or DEXRON II type) through dipstick guide **2** until the correct level on dipstick **1** is reached.

[Replacement]

- Park the vehicle on level ground, chock the wheels and shift the range selector lever to the N position.
- Place a container under oil pan **3**, remove drain plug **4** and drain the fluid.

WARNING⚠

Take care because the fluid temperature immediately after the engine has stopped is very high. To avoid scalds, wait until a safe temperature has been reached before draining the fluid.

NOTE

- **The fluid will drain faster if the engine is first run to raise the fluid temperature.**
- **The fluid cannot be drained from the hydraulic circuit, the torque converter or the oil cooler.**
- **Check the drained fluid for dirt, metal particles and metal fragments.**

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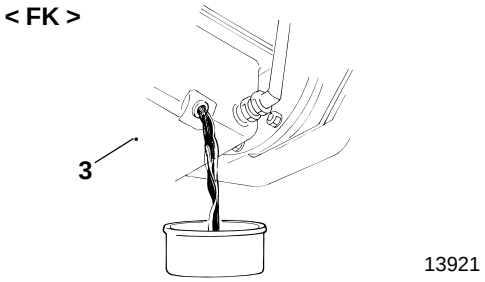

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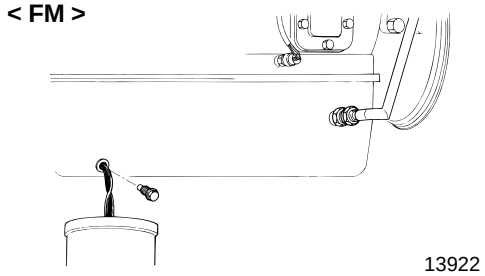

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- Remove oil pan **3**, intake pipe **10**, O-ring **11**, gasket **7** and oil filter **9**.
- Clean oil pan **3**.
- Replace O-ring **11**, gasket **7** and oil filter **9**.

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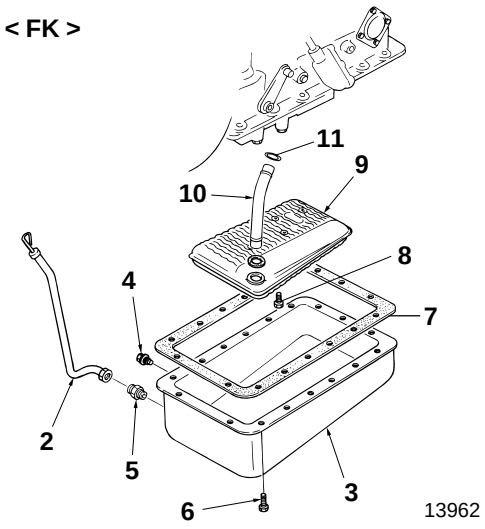

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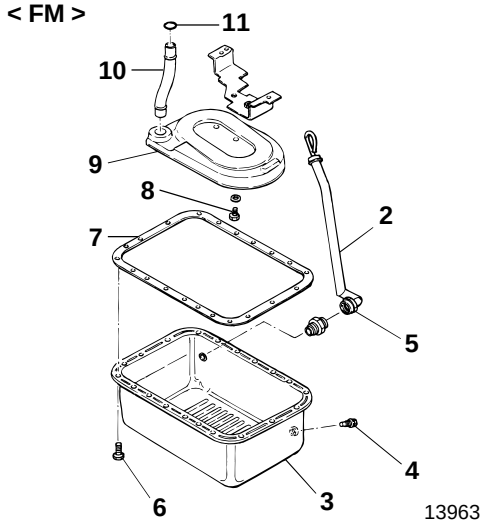

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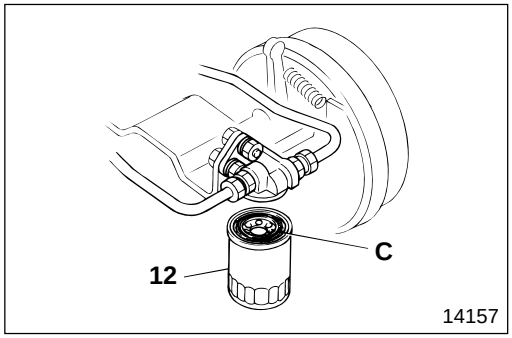
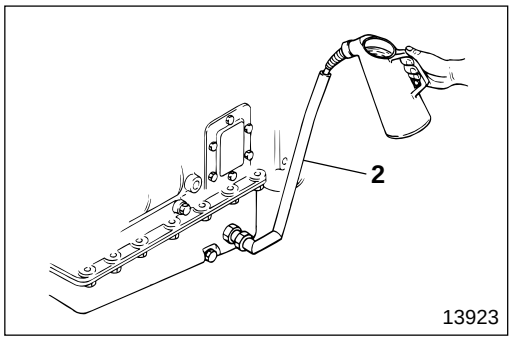


- Remove oil filter **12** (for oil cooler) by turning it counterclockwise.
- Lightly coat gasket **C** with the fluid before installing oil filter **12**. Then tighten the oil filter.



- Supply fluid through dipstick guide **2**.

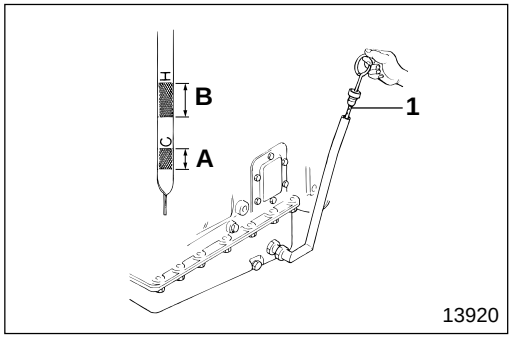
CAUTION

Make sure that dirt and foreign particles do not become mixed in with the fluid when it is added.

- Shift the range selector lever to the N position, start the engine and let it idle for about one minute.
- After shifting the lever through all positions once, shift it back to N position.

CAUTION

To prevent burning out the interior of the automatic transmission assembly, make sure that the engine is not allowed to race when you do the above.



- Check and adjust so that the fluid level is within the specified area on dipstick **1**.

NOTE

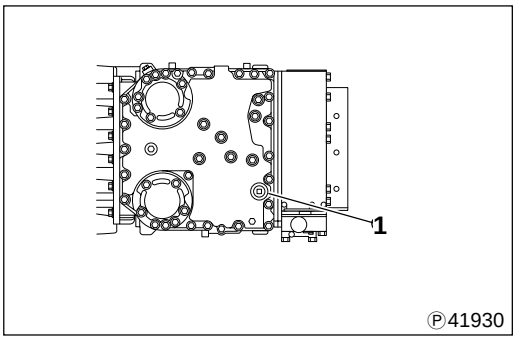
- **As the temperature of the fluid rises, so does the fluid level. If you add fluid while the temperature is still low (approximately 15 to 49°C {60 to 120°F}), make sure that the level stays within area A, marked COLD on dipstick 1.**
- **Let the engine idle and, while paying attention to the fluid level, pour in the fluid slowly.**
- **It is sometimes hard to check the fluid level, immediately after supplying fluid, because of the fluid adhering to the interior of dipstick guide 2. If this is the case, check the fluid level several times at intervals.**
- **Be careful not to supply too much fluid because you might mistake the fluid that overflows from the air breather for fluid leakage.**

< M100A6 >

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
—	Drain plug	25 to 32 {18 to 24, 2.6 to 3.3}	—



[Replacement of automatic transmission fluid]

(1) Draining

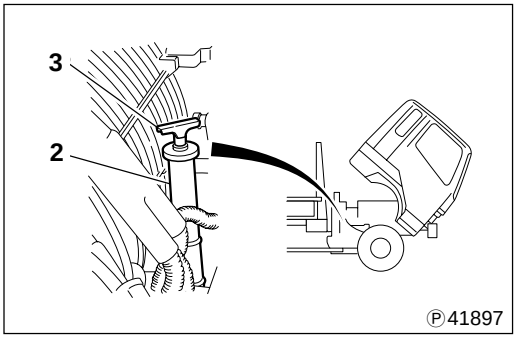
- Put the automatic transmission fluid drain pan under the transmission oil pan; then remove drain plug **1** behind the oil pan to drain automatic transmission fluid.

WARNING

Do not start any work for engine immediately after the engine is shut down. Wait until the engine cools to a safe temperature since a hot engine can cause burns.

NOTE

- **The draining can be performed more quickly by warming automatic transmission fluid to the operating temperature.**
- **It is impossible to drain automatic transmission fluid from the internal hydraulic circuit, the torque converter, or the oil cooler without disassembling the unit completely.**
- **Check for dirt in the drained automatic transmission fluid, and for existence of metallic powder or metal pieces.**



(2) Filling

- Prepare DEXRON III of 18 dm³ {18 L} (19 qts).
- Install oil pan drain plug **1** and tighten to specs.
- Fill with automatic transmission fluid through the filter tube **2**.

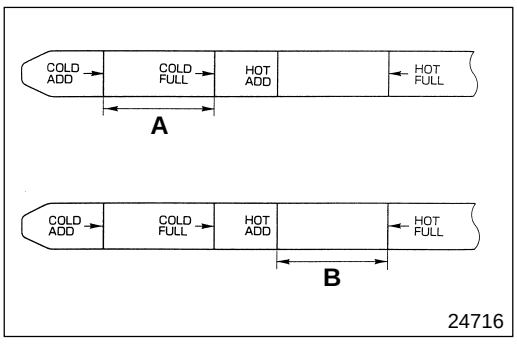
CAUTION

Be careful during filling so that dust or foreign particles do not enter.

- After starting the engine, run at idle RPM for approximately one (1) minute with the range selector to "N" position.
- After moving the range selector to each range, place it to "N" position again.

CAUTION

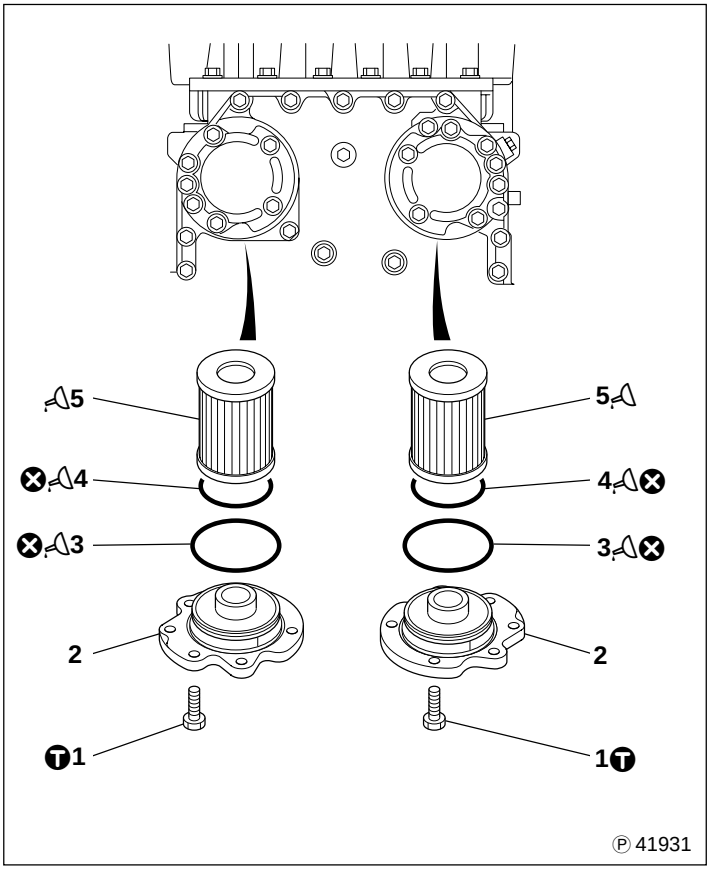
In this process, run engine at idle speed only — avoid running the engine at higher speeds.



- Add automatic transmission fluid until it reaches the low position of the specified range of dipstick **3**. Then, check the level of automatic transmission fluid. The level of automatic transmission fluid must be within the specified range of the dipstick.
  A: When temperature is low; 15 to 50°C {59 to 122°F}
  B: When temperature is high; 70 to 95°C {158 to 203°F}

NOTE

- **After filling the automatic transmission fluid, it may be difficult to see the level of automatic transmission fluid easily due to the automatic transmission fluid adhering to the inner wall of filler tube 2; therefore, recheck it after a short time.**
- **If the automatic transmission fluid is overfull, the automatic transmission fluid will overflow from the air breather. This might be misunderstood to be an automatic transmission fluid leak.**
- **Fill automatic transmission fluid gradually with letting the engine idle while paying a careful attention to the level of automatic transmission fluid.**



[Replacement of oil filter]

● **Disassembly sequence**

1 Bolt
2 Filter cover
3 Seal
4 O-ring
5 Filter

* : Automatic transmission assembly
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (installing filter cover)	51 to 61 {38 to 45, 5.2 to 6.2}	—

Lubricant

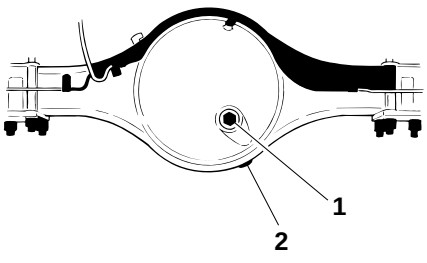
Location	Points of application	Specified fluid	Quantity
2	Seal	DEXRON III	As required
4	O-ring	DEXRON III	As required
5	Engagement part of filter	DEXRON III	As required

Rear Axle Gear Oil

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Inspection plug	FK	98 to 115 {72 to 87, 10 to 12}	—
		FM	175 to 195 {130 to 145, 18 to 20}	
2	Drain plug	FK	98 to 115 {72 to 87, 10 to 12}	—
		FM	175 to 195 {130 to 145, 18 to 20}	



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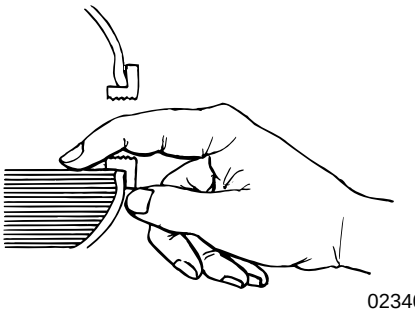

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[Inspection and replenishment]

WARNING

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

- Remove inspection plug **1**, check the oil level and make sure it is up to the edge of the entrance.
- If the oil level is low, add oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Insert inspection plug **1**.

[Replacement]

- Drain the oil after removing inspection plug **1** and drain plug **2**.
- Remove any metal particles sticking to the magnetic part of drain plug **2** before reinstalling the plug.
- Supply oil through the inspection plug hole until the level comes up to the edge of the entrance.
- Reinstall the inspection plug.

Power Steering Fluid

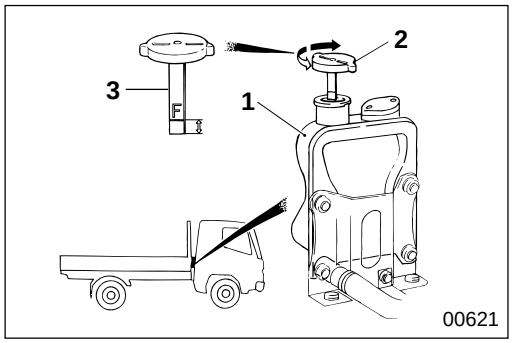
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Oil pipe	66.69±12.75 {49±9.4, 6.8±1.3}	—

Fluid

Location	Points of application	Kinds	Quantity
1	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Between end and "**F**" on filler cap dipstick



[Inspection and replenishment]

- Straighten the front wheels and stop the engine.
- Remove filler cap **2** of power steering oil tank **1** by turning the filler cap counterclockwise.
- Wipe off the fluid sticking to dipstick **3** on filler cap **2**. Replace the filler cap.

NOTE

Check the fluid level without screwing on filler cap 2.

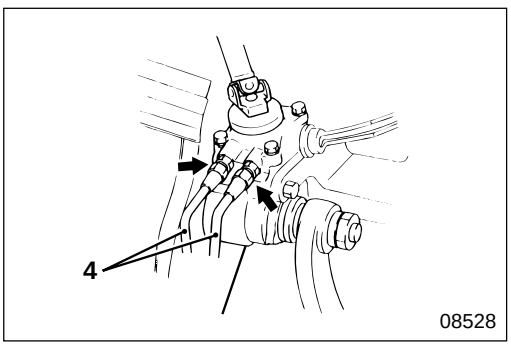
- Carefully lit up filler cap **2** and check the fluid sticking to dipstick **3** to make sure that the fluid is at a point between the end and "**F**" on the dipstick. If the level is low, add fluid.
- After inspection install filler cap **2** by turning it clockwise.

WARNING⚠

Close filler cap 2 firmly; otherwise power steering fluid will leak and could catch fire. Also wipe up spilled fluid.

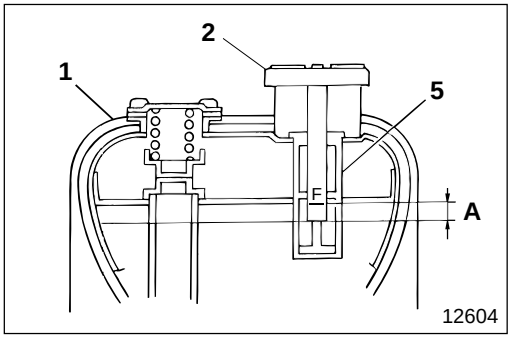
CAUTION⚠

If the fluid level is far below the recommended range, the fluid may be leaking.



[Replacement]

- Draining procedure
  - Jack up the front wheels.
  - Disconnect oil pipe **4** connected to the power steering booster.
  - Turn the steering wheel fully left and right repeatedly, and drain the fluid from the power steering booster.
  - After draining the fluid, tighten oil pipe **4** at specified torque.



- Refilling procedure
  - Pour fluid into power steering oil tank **1** up to the inner port of strainer **5**.
  - With the engine stopped, jack up the front wheels and turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.

NOTE

Check the fluid level without screwing on filler cap 2.

- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times to raise the fluid temperature to approximately 60 to 80°C {140 to 176°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise, bleeding is completed.
- When bleeding is finished, check fluid level of power steering oil tank **1**, and pipe and hose connections for fluid leakage.

Brake Fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

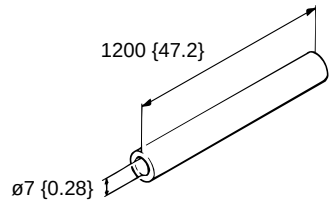
Location	Parts to be tightened	Tightening torque	Remarks
—	Air bleeder (Airmaster)	6.9 to 12.7 {5.1 to 9.4, 0.7 to 1.3}	—
—	Air bleeder (Wheel brake)	7.8 to 12 {5.8 to 8.5, 0.8 to 1.2}	—

Fluid

Location	Points of application	Kinds	Quantity
—	Fluid tank (reservoir)	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Vinyl hose 	MH033102 (Obtain Locally)	Air bleeding

WARNING

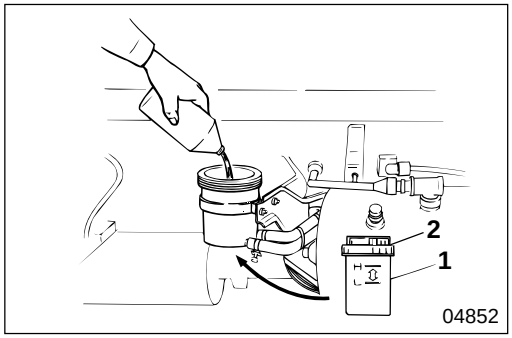
- **You must use new brake fluid (SAE J1703f or FMVSS No.116 DOT3).**
- **Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the brake system, because this will cause the rubber parts of the brake system to swell, resulting in brake dragging or ineffective braking.**
- **Be sure not to allow dirt or water to become mixed into brake fluid when refilling, because this will cause the brake to malfunction.**
- **If you use a cup for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**

CAUTION

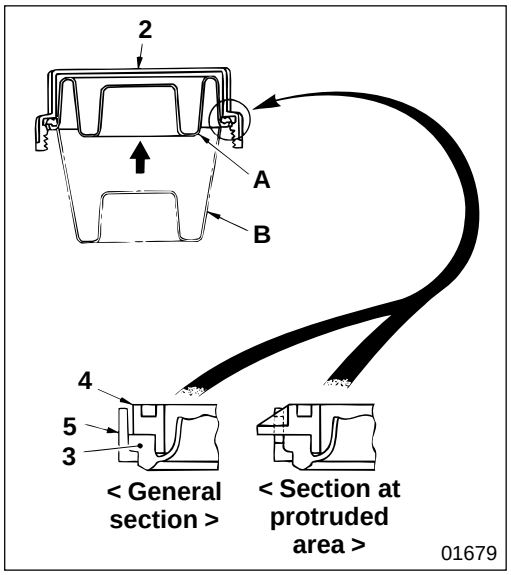
- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

NOTE

Supply brake fluid to maintain the "H" level of the brake fluid tank always.



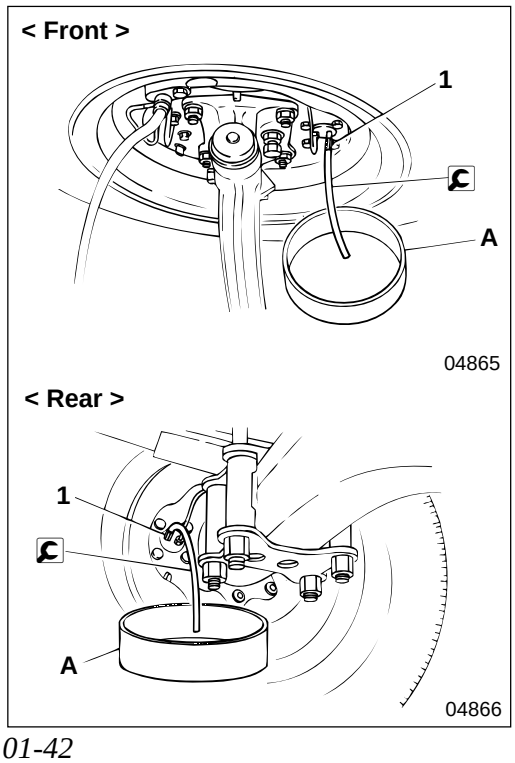
[Inspection and replenishment]
Inspect the level of the brake fluid in fluid tank **1**. It should fall between the "**L**" and "**H**" levels. If it is below the "**L**" level, remove cap **2** from the fluid tank, then supply the specified brake fluid until the level comes up to the "**H**" level. Do not fill above the "**H**" level.



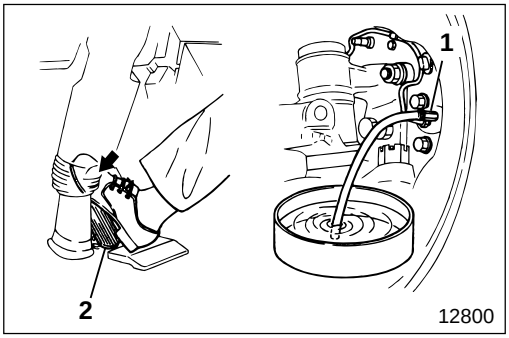
- If diaphragm **3** is not in its normal position when the brake fluid is supplied, correct it to its normal position, and install cap **2**. If brake fluid leaks from the cap area after you have supplied brake fluid, check whether the diaphragm is assembled as illustrated.

  4 : Slide ring
  5 : Ring cover
  A : Correct condition of diaphragm when brake fluid is being supplied
  B : Condition when diaphragm is extended when brake fluid has decreased

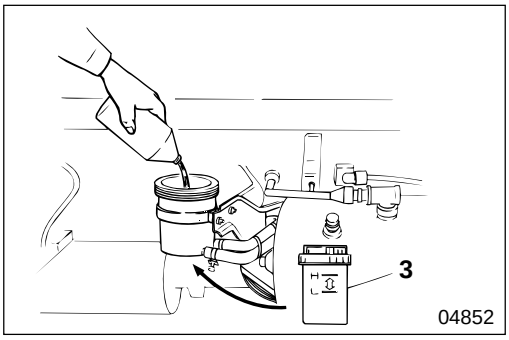
[Replacement]
- Start engine and let it idle during the brake fluid replacement procedure.



- Attach one end of vinyl hose to air bleeder **1** and place the other end in container **A**.

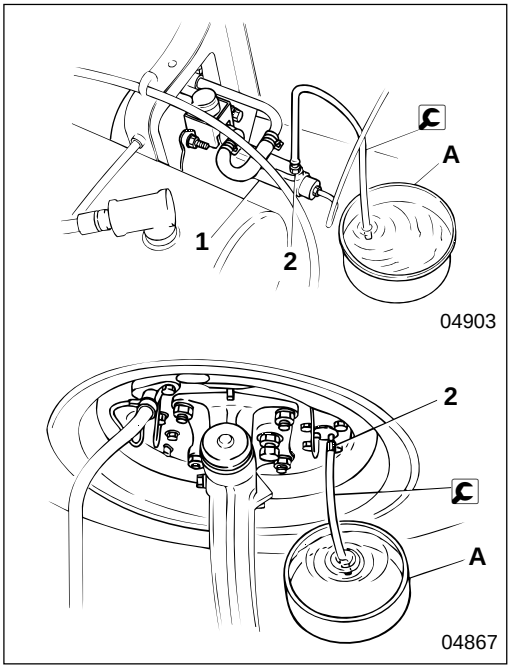


- Loosen air bleeder **1** and repeatedly depress brake pedal **2** to drain brake fluid completely.



- While maintaining a supply of new brake fluid up to the "**H**" level of fluid tank **3**, depress the brake pedal repeatedly until the old brake fluid of the brake system is replaced with new fluid.
- Carry out air bleeding of the brake system.

[Air bleeding]



- Start the engine and let it idle during the air bleeding procedure.
- Attach one end of 🔧 vinyl hose to front or rear airmaster **1**. Then, attach one end of another vinyl hose to air bleeder **2** of the wheel brake. Finally, place both open ends in container **A** filled with brake fluid.

- Carry out air bleeding in the following sequence:

Front brake system

Airmaster for front
↓
Right-hand side wheel brake
↓
Left-hand side wheel brake

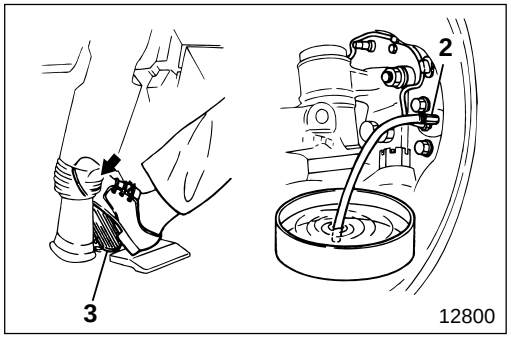
Rear brake system

< Right-hand side >

Airmaster for rear (right-hand side)
↓
Right-hand side wheel brake

< Left-hand side >

Airmaster for rear (left-hand side)
↓
Left-hand side wheel brake



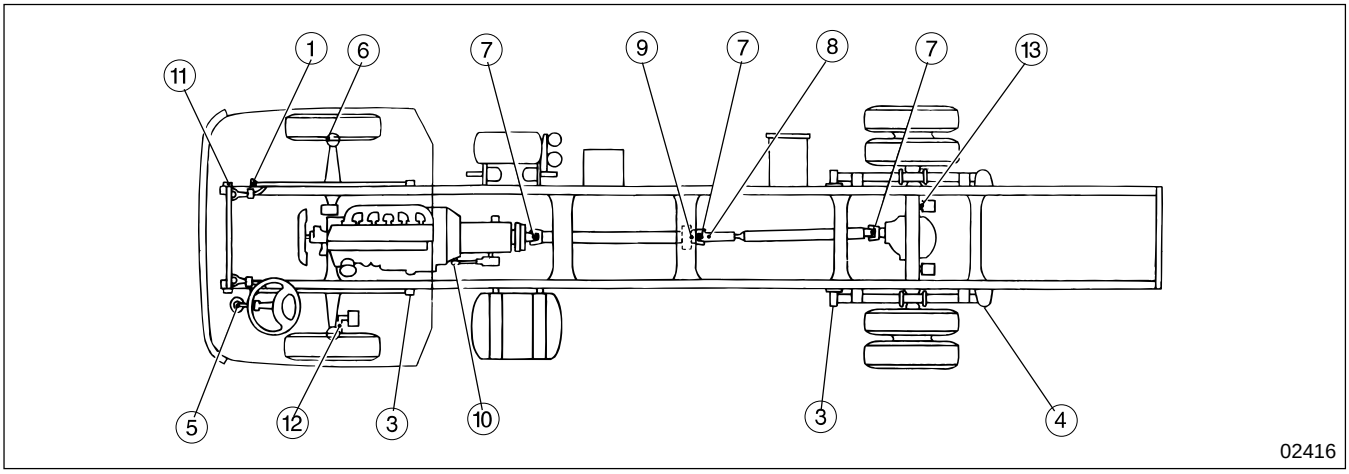
- Depress brake pedal **3** slowly a few times, and with the brake pedal depressed, loosen air bleeder **2** to drain brake fluid containing air.

- Tighten air bleeder **2**, and release brake pedal **3**.
- Repeat this service procedure until air is no longer present in the fluid being drained.
- Tighten air bleeder **2** at specified torque as soon as brake fluid flowing out is free of air bubbles.

- Adjust brake shoe clearance when you have finished air bleeding.
- Check that brake fluid comes up to level "**H**" of fluid tank. If it does not, refill with new brake fluid.
- Depress brake pedal **3** a few times and check for any leakage of brake fluid, then test the brakes.
- When you test the brakes, if the brake fluid warning lamp within the meter cluster lights, it means that air has not been bled completely. Repeat air bleeding procedure.

Greasing Various Areas of Chassis

Carefully clean away all dust and dirt from the grease nipples, and use the specified type of grease. The areas to be greased are shown in the following illustration.



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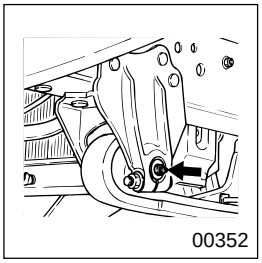
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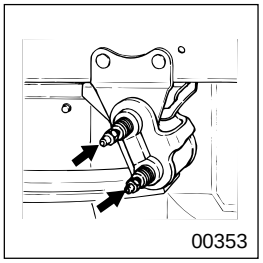
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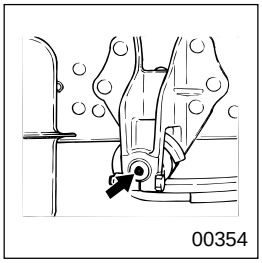
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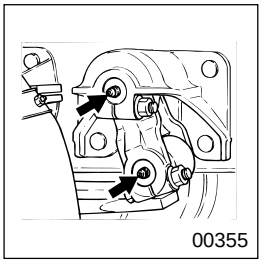
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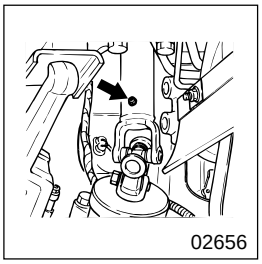
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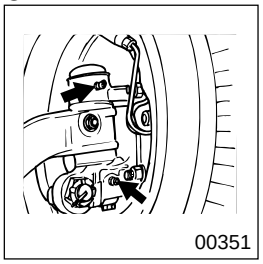
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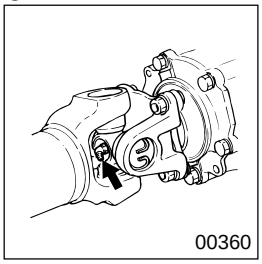
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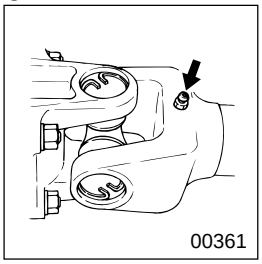
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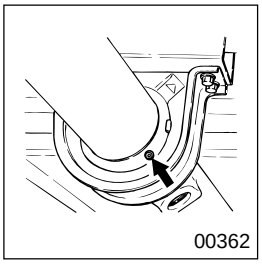
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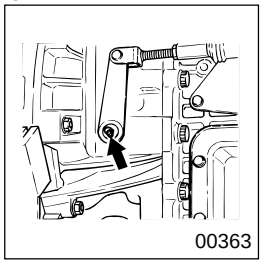
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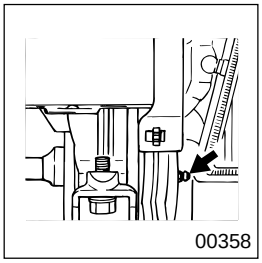
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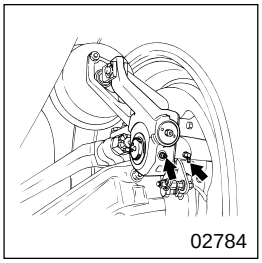
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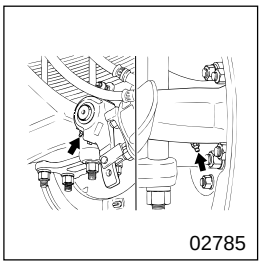
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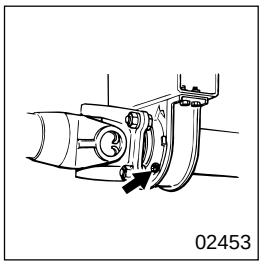
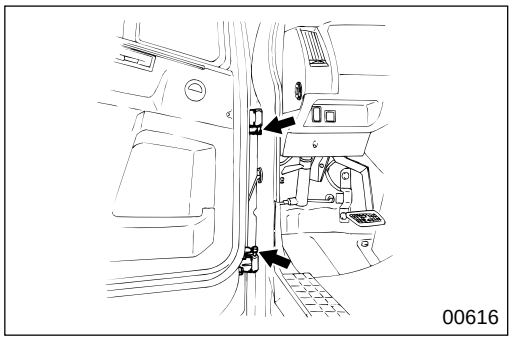

02453

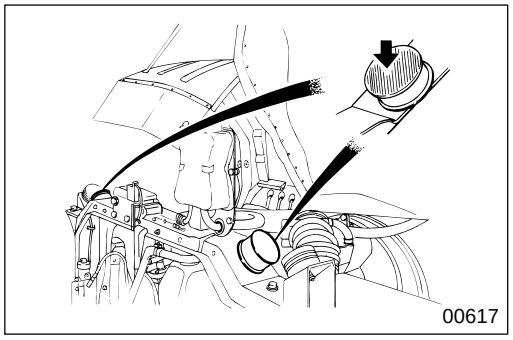
Supply grease to the center bearing until grease overflows from the escape valve at the back of the grease nipple.

LUBRICATION

① Front spring pin front (left and right, 2 points)
② Front spring pin rear (left and right, 4 points)
③ Rear spring pin front (left and right, 2 points)
④ Rear spring pin rear (left and right, 4 points)
⑤ Steering shaft
⑥ Kingpin bearing (left and right, 4 points)
⑦ Universal joint of propeller shaft
⑧ Slip joint of propeller shaft
⑨ Center bearing of propeller shaft
⑩ Clutch fork shaft (left and right, 2 points)
⑪ Cab hinge (left and right, two points)
⑫ Slack adjuster and camshaft (left and right, two points) < FM657 >
⑬ Slack adjuster and camshaft (left and right, two points) < FM657 >



● **Door hinge**



● **Cab rear mount side cushion**

MITSUBISHI
FUSO

Group 11

Engine

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-11

INDEX

SPECIFICATIONS 11- 2

STRUCTURE AND OPERATION 11- 3

TROUBLESHOOTING 11- 8

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Inspection of Engine Compression 11- 9
- Inspection and Adjustment of Valve Clearance 11-11

REMOVAL AND INSTALLATION OF ENGINE 11-12

CYLINDER HEAD AND VALVE MECHANISM 11-14

PISTON, CONNECTING ROD AND CYLINDER SLEEVE 11-28

FLYWHEEL POWER TAKE-OFF 11-42

FLYWHEEL 11-46

TIMING GEAR 11-52

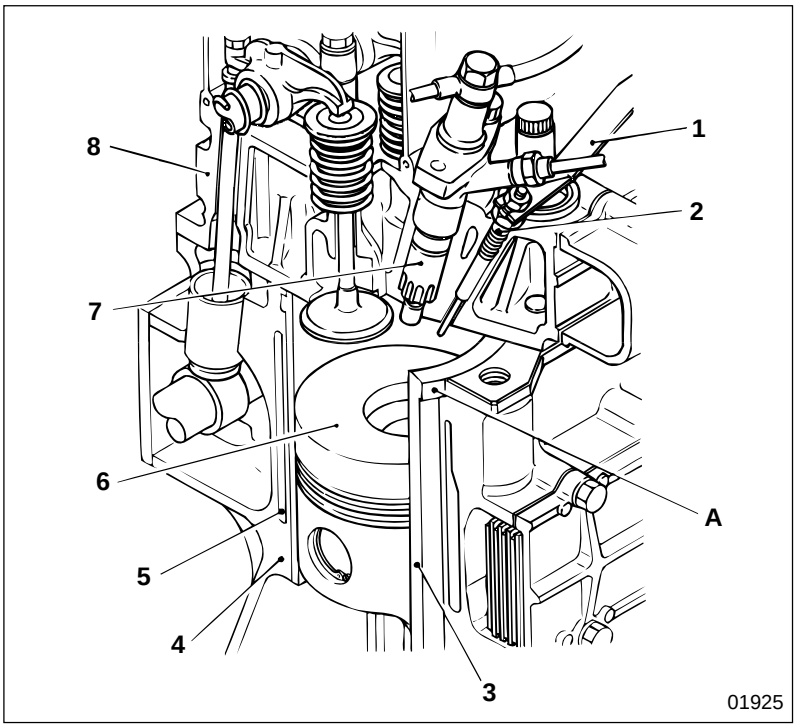
CAMSHAFT 11-56

CRANKSHAFT AND CRANKCASE 11-62

SPECIFICATIONS

Item		Specifications	
Engine model		6D16T2	6D16T3
Type		6-cylinder in-line, water-cooled 4-cycle diesel	
Combustion chamber type		Direct injection type	
Valve mechanism		Overhead valve (OHV) type	
Maximum output	HP/rpm (SAE Gross)	230/2600	200/2600
Maximum torque	lbf.ft/rpm (SAE Gross)	521/1600	434/1600
Bore×stroke	mm {in.}	ø118×115 {4.6×4.5}	
Total displacement	cm^3 {cu. in.}	7545 {460.4}	
Compression ratio		18.0	

Cylinder Head and Crankcase

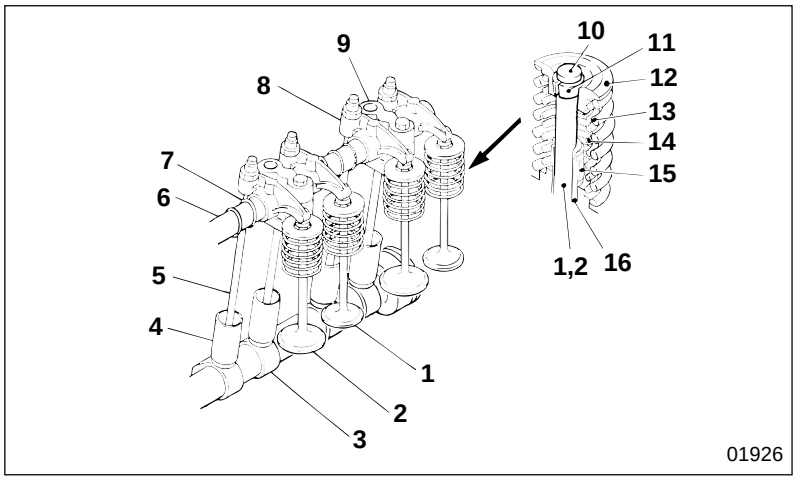


1 Connecting strap
2 Glow plug
3 Cylinder sleeve
4 Crankcase
5 Water jacket
6 Piston
7 Injection nozzle
8 Cylinder head

A: Cylinder size mark stamping
- Outer diameter size mark : 1, 2, or 3
- Inner diameter size mark : A, or B

Cylinder sleeve **4** is a dry type sleeve press-fitted into the crankcase **5**. Removal is easier than for a wet type sleeve.

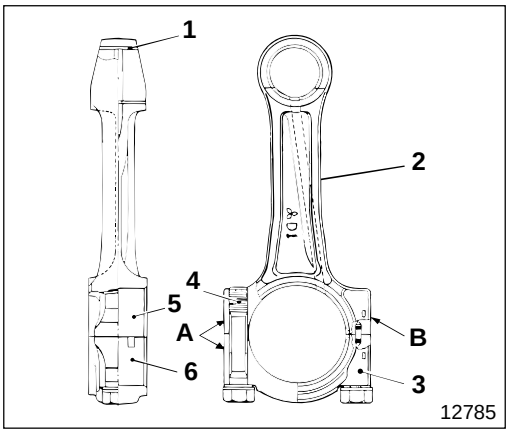
Valve Mechanism



1 Exhaust valve
2 Inlet valve
3 Camshaft
4 Tappet
5 Push rod
6 Rocker shaft
7 Rocker shaft spring
8 Rocker
9 Rocker bracket
10 Valve cap
11 Valve cotter
12 Upper retainer
13 Outer valve spring
14 Inner valve spring
15 Valve stem seal
16 Valve guide

- Valve stem seal **15** is fitted to valve **1, 2** to control the lubricant supplied to valves **1**, **2** and valve guide **16**.
- A combination of variable pitch springs is used for valve springs **13**, **14** to avoid abnormal vibration at high speed. The spiral direction of the two springs is opposite to avoid interference between the two springs.
- The front of the engine has smaller camshaft bearings, so removal and installation of the camshaft is easier from the rear of the engine.

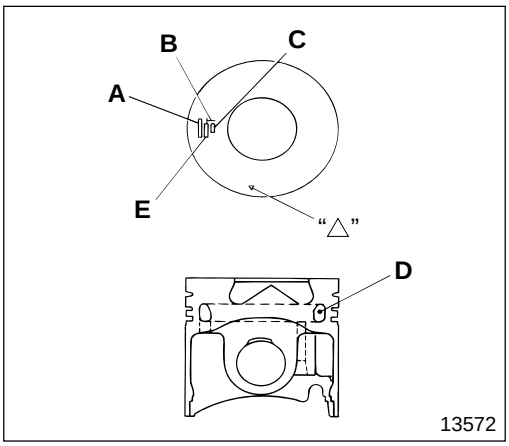
Connecting Rod



1 Connecting rod bushing
2 Connecting rod
3 Connecting rod cap
4 Connecting rod bolt
5 Upper connecting rod bearing
6 Lower connecting rod bearing

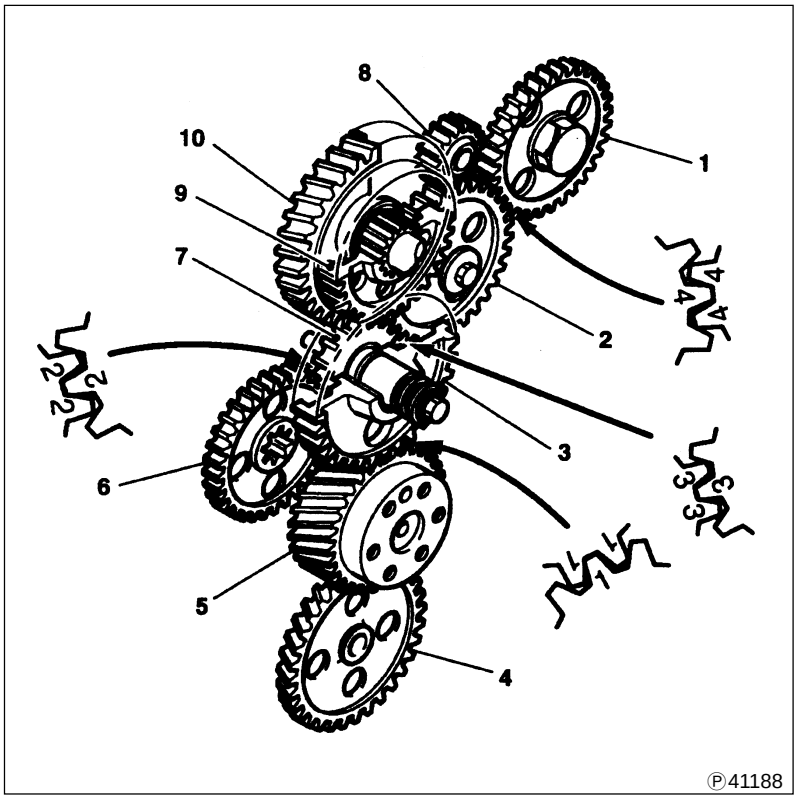
A : Alignment mark
B : Mass mark
(A, B, C, D, E, F, G, H, I, V, W, X, Y, or Z)

Piston



A : Part number
B : Stamped "T"
C : Size mark (A, or B)
D : Free space for piston cooling
E : Stamped mass
△ : Front mark

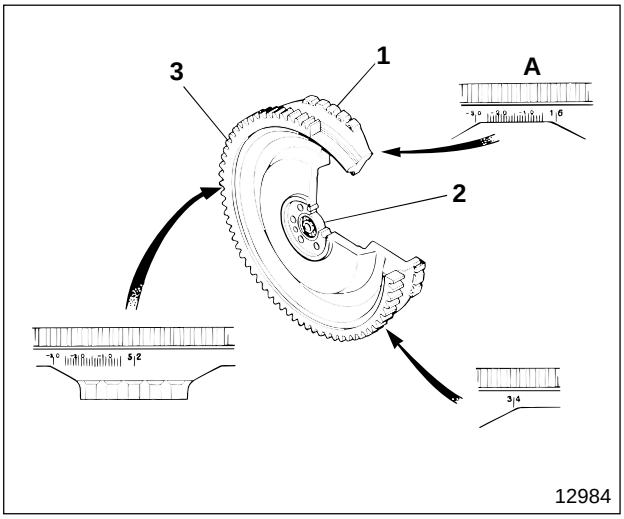
Timing Gears



1 Camshaft gear
2 No. 2 idler gear
3 No. 1 idler gear (outer)
4 Oil pump gear
5 Crankshaft gear
6 Air compressor drive gear
7 No. 1 idler gear (inner)
8 Power steering pump gear
9 Power take-off idler gear
10 Power take-off idler gear

Each gear is stamped with a timing gear alignment mark ("**1**", "**2**", "**3**", or "**4**",) to facilitate reassembly.

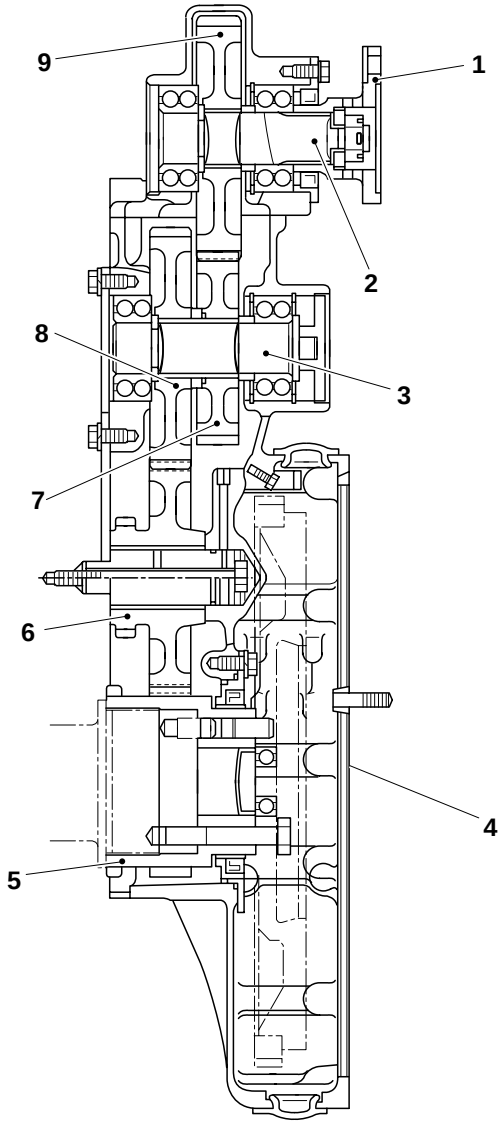
Flywheel



1 Flywheel
2 Pilot bearing < Manual transmission >
3 Ring gear

A : Angle scale and cylinder No.

Flywheel Power Take-Off



Ⓟ41189

1 Flange
2 Power take-off shaft
3 Power take-off idler shaft
4 Flywheel housing
5 Crankshaft gear
6 No. 1 idler gear
7 Power take-off idler gear
8 Power take-off idler gear
9 Power take-off gear

The flywheel power take-off is mounted on the upper part of the flywheel housing **4** and takes the power out through the crankshaft gear **5**.

TROUBLESHOOTING

Symptoms / Possible causes	Decrease of power	Engine noise abnormal	Remarks
Oil viscosity unsuitable	○		Gr 12
Fuel incorrect or unsuitable	○		Gr 13
Valve clearance faulty	○	○	
Head gasket faulty	○	○	
Valve and valve seat worn, and carbon deposits	○	○	
Valve spring fatigued	○	○	
Piston ring worn or damaged	○	○	
Piston ring grooves worn or damaged	○	○	
Injection timing faulty	○	○	Gr 13
Injection pump malfunctioning	○	○	Gr 13
Cooling system malfunctioning	○		Gr 14
Injection nozzle malfunctioning	○	○	Gr 13
Fuel system sucking air	○		Gr 13
Air cleaner mesh clogged	○		Gr 15
Muffler clogged	○		Gr 15
Pipe and hose installation faulty		○	
Ancillary equipment (injection pump, alternator, etc.) or installation faulty		○	Gr 13, 54
V-belt loose or damaged		○	Gr 14
Crankshaft pulley mounted incorrectly		○	
Air cleaner or muffler malfunctioning		○	Gr 15
Rocker shaft and bracket faulty		○	
Rocker shaft bracket lubrication faulty		○	
Timing gear backlash faulty		○	
Timing gear system and idler shaft lubrication faulty		○	
Connecting rod small end bushing worn and piston pin worn		○	
Crankshaft pin and big end bearing of connecting rod worn or damaged		○	
Crankshaft journal and main bearing worn or damaged		○	
Crankshaft and camshaft end play excessive		○	
Tappet and camshaft worn		○	

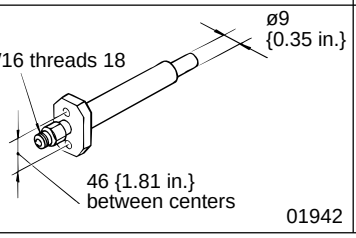
Inspection of Engine Compression

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Engine Compression	Each cylinder (200 rpm)	2550 kPa {370 psi, 26 kgf/cm^2} (dry)	1960 kPa {285 psi, 20 kg/cm^2}	Inspect
		Pressure difference between each cylinder	—	within 390 kPa {57 psi, 4 kgf/cm^2}	Inspect

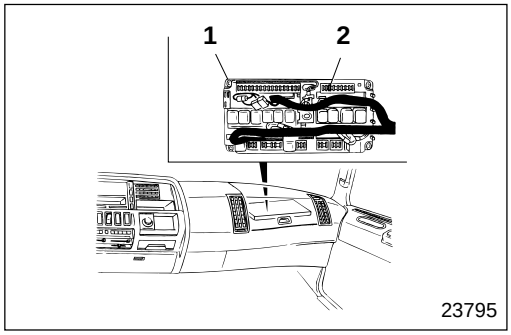
Special tools

Unit : mm {in.}

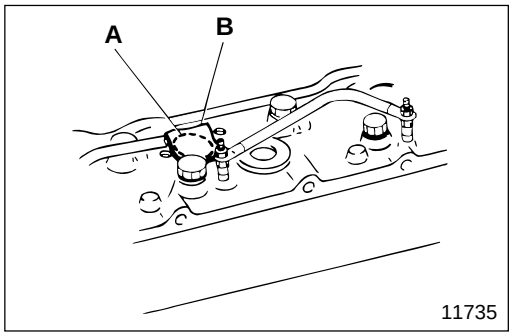
Location	Tool name and shape	Part No.	Application
—	Compression gauge adapter 	MH061461	Measurement of engine compression

A decrease of engine compression is a signal that it is time to overhaul the engine. It is strongly recommended that this item is inspected periodically and that you record the history of deterioration in engine performance as this will help you to diagnose causes of future irregularities.
When the vehicle is still new or immediately after installation of new parts, there may be a slight increase in engine compression, but normal values will be restored soon.

- Before inspection make sure that engine oil, starter and battery are in normal condition.
- Before inspecting the vehicle do the following:
  - Run the engine to bring the temperature of the coolant up to approximately 75 to 85°C {167 to 185°F}.
  - Turn all the lights and accessory equipment OFF.
  - Put transmission in neutral. (N range for automatic transmission)
  - Set the steering wheel at center and straight ahead position.



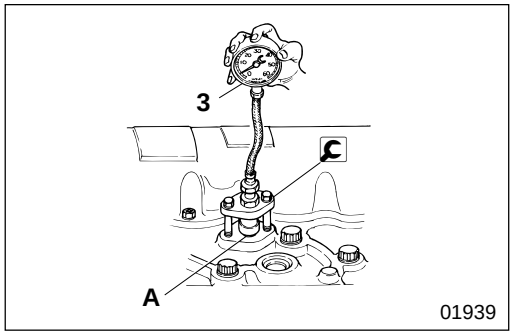
- Remove fuel-cut motor fuse **2** from fuse and relay box **1** in the driver's cab so that no injection of fuel takes place when cranking the engine using the starter.



- Remove all the injection nozzles. Gr 13
- Check that no foreign particles are sticking to waste cloth **B** covering injection nozzle mounting hole **A** after cranking the engine.

WARNING

You must stay clear of injection nozzle mounting hole A when you crank the engine during this inspection. Assume that all cylinders have cracked, and that coolant, engine oil, fuel, etc. have seeped into the cylinder chambers. If this is the state when the engine is cranked, there is an extreme danger of these substances being injected out of the injection nozzle mounting hole at high temperature.



- Install the nozzle gasket and compression gauge adaptor in injection nozzle mounting hole **A**, then attach compression gauge **3**.
- Measure engine compression while cranking the engine.
- Measure engine compression of each cylinder and calculate the difference between them.
- If the engine compression and pressure difference between each cylinder deviate from the limit, reinspect by pouring a small amount of engine oil into injection nozzle mounting hole **A**. Recheck compression.
  - If pressure increases : It is likely that either wear or damage of the piston ring and the cylinder sleeve surface has taken place.
  - If pressure remains low : It is likely that burning of the valve, faulty contact of valve surfaces and/or faults in the cylinder head gasket have developed.

Inspection and Adjustment of Valve Clearance

Service standards

Unit : mm {in.}

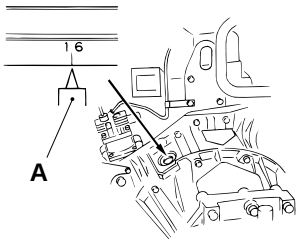
Location	Maintenance item	Standard value	Limit	Remedy
—	Valve clearance (When engine is cold)	0.4 {0.016}	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut	34 {25, 3.5}	—

< Flywheel without PTO >



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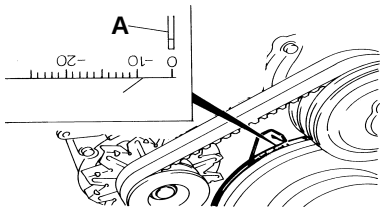
< Flywheel with PTO >



14583

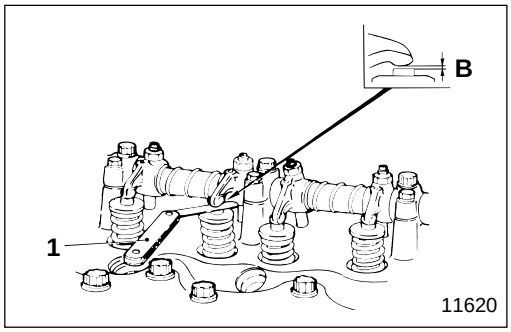
Inspect and adjust the valve clearance while the engine is cold in the following way.

[Inspection]

- Crank the engine to move No.1 or No.6 piston to top dead center of the compression stroke, aligning stamped mark "**1**", "**6**" on the flywheel with pointer **A** on the flywheel housing inspection window or aligning stamped mark on torsional damper with pointer **A**.

NOTE

The cylinder whose push rod is not pushing up the inlet/exhaust rocker is the one whose piston is at top dead center of the compression stroke.



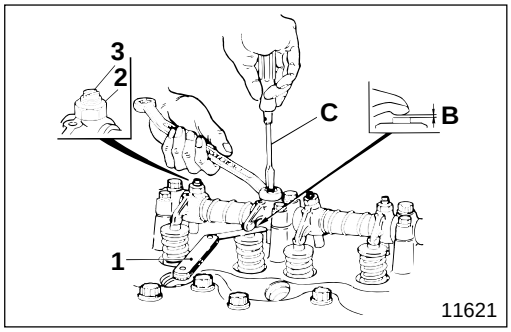
11620

- Measure valve clearance **B** when either No.1 or No.6 piston is at top dead center in accordance with the following table.
  x = adjust

Piston No.	1		2		3		4		5		6	
Valve arrangement	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust	In-take	Ex-haust
No.1 piston at top dead center	○	○	○	×	×	○	○	×	×	○	×	×
No.6 piston at top dead center	×	×	×	○	○	×	×	○	○	×	○	○

NOTE

Be sure when taking measurements using feeler gauge 1 that some resistance is felt when inserting the gauge. If the gauge can be inserted freely without any resistance, an accurate measurement cannot be obtained.



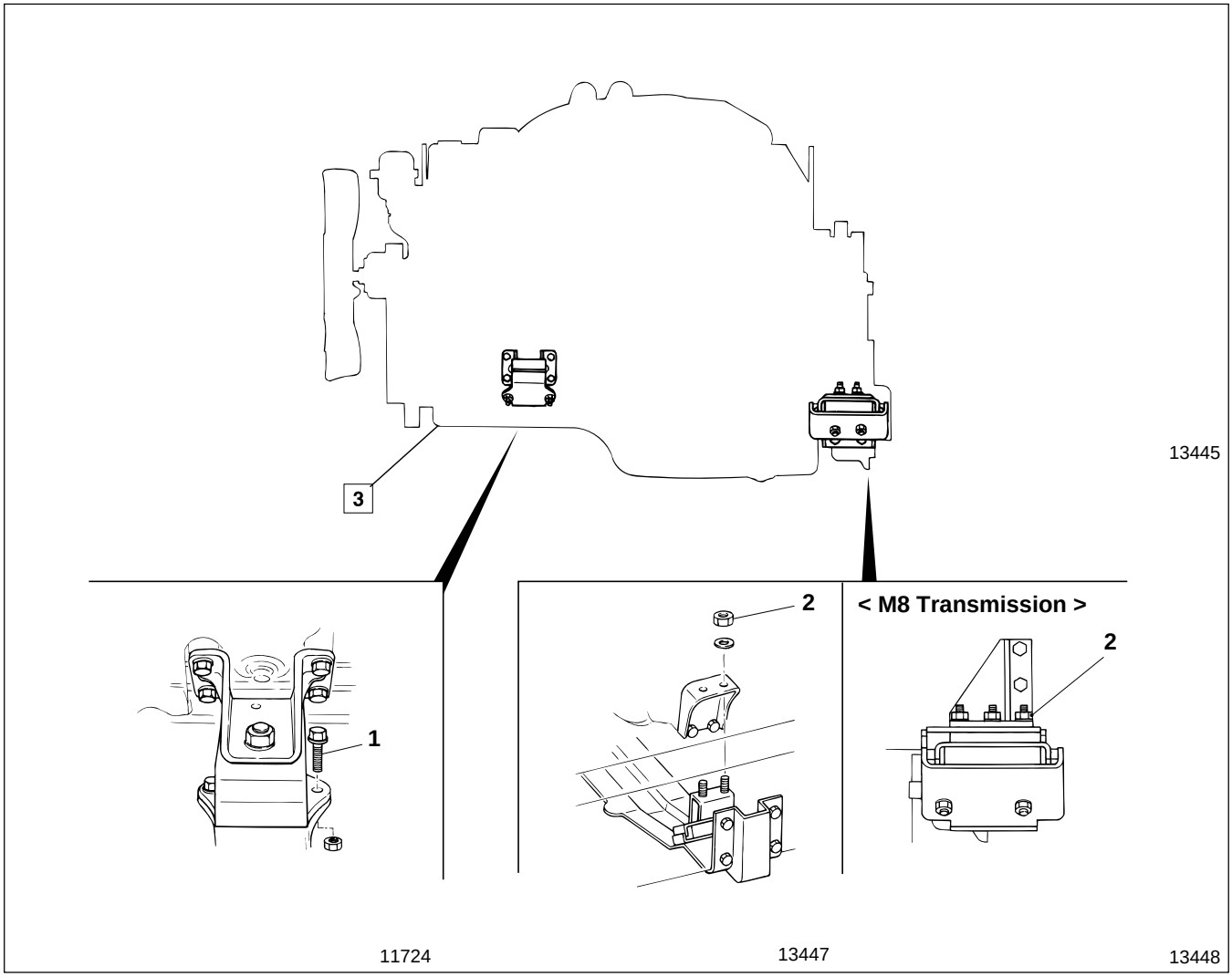
11621

- If the measured value deviates from the limit, adjust as follows:

[Adjustment]

- Adjust valve clearance **B** so that feeler gauge **1** encounters some resistance when it is inserted. Do this by loosening lock nut **2** and turning adjusting screw **3**.
- After adjusting, tighten adjusting screw **3** using screwdriver **C** and tighten lock nut **2**. Reinspect valve clearance **B** using feeler gauge **1**.

REMOVAL AND INSTALLATION OF ENGINE



● **Removal sequence**

1 Bolt
2 Nut
3 Engine assembly

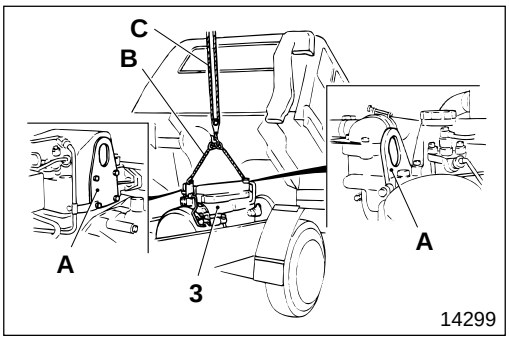
WARNING

When you lift engine assembly 3, you must use lifting gear that is strong enough to lift the mass of the engine (approximately 650 kg {1430 lb}).

● **Installation sequence**

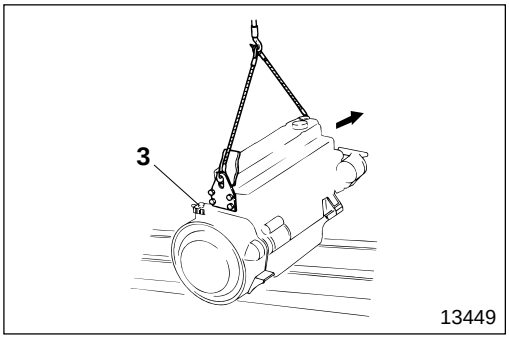
Follow the removal sequence in reverse.

◆ Service procedure



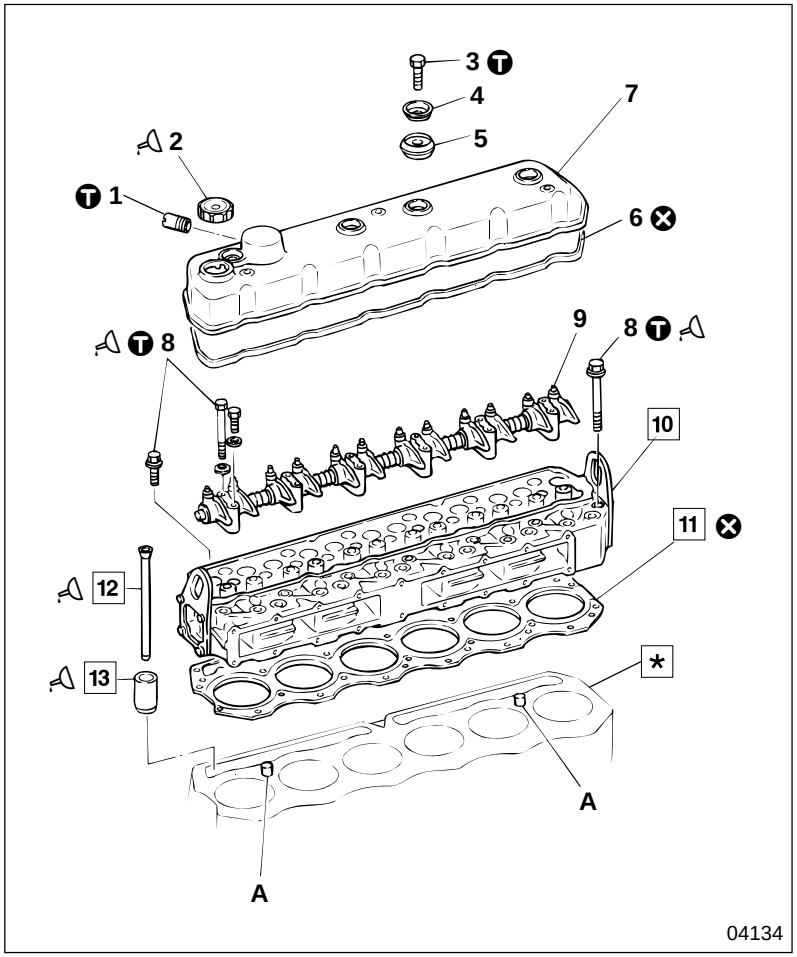
3 Removal of engine assembly

- Hook lifting gear **B** to two hangers **A** on engine assembly **3** and lift the engine using crane **C** until the lifting gear becomes taut.
- Make sure that wiring and hoses are disconnected.



- Lower engine assembly **3** slowly so that it does not hit the frame or cab.
- When the lower part of engine assembly **3** appears from the frame, turn the engine assembly 90° to remove it.

CYLINDER HEAD AND VALVE MECHANISM



● **Disassembly sequence**

1 Joint
2 Oil filler cap
3 Bolt
4 Plate
5 Rubber
6 Rocker cover gasket
7 Rocker cover
8 Cylinder head bolt
9 Rocker and bracket assembly
P11-18
10 Cylinder head and valve assembly
P11-20
11 Cylinder head gasket
12 Push rod
13 Tappet

* : Crankcase P11-62
A : Positioning pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
12	Push rod deflection	—	0.4 {0.016}	Replace
13	Clearance between tappet and crankcase tappet hole	[31] 0.06 to 0.1 {[1.22] 0.0024 to 0.0039}	0.2 {0.0079}	Replace

T Tightening torque

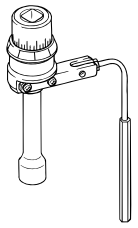
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Joint		29 {52, 3.0}	—
3	Bolt (Rocker cover mounting)		3.9 {2.9, 0.4}	—
8	Cylinder head bolt	M14 bolt	78 {58, 8}+180°	Wet Reuse up to three times
		M10 bolt	17 {13, 1.75}+34 {25, 3.5}	—

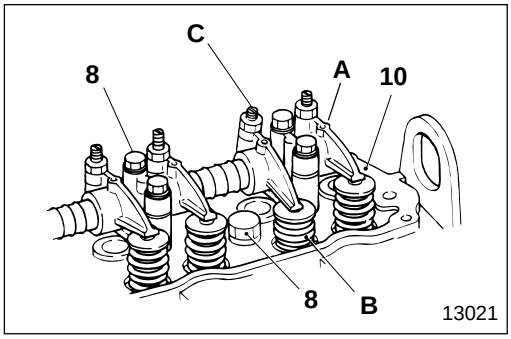
Lubricant

Location	Points of application	Kinds	Quantity
2	Oil filler cap rubber part	Engine oil	As required
8	Thread area of cylinder head bolt	Engine oil	As required
12	Both ends of push rod	Engine oil	As required
13	Outer periphery of tappet	Engine oil	As required

Special tools

Location	Tool name and shape	Part No.	Application
10	Socket wrench  01984	MH063388 (Obtain Locally)	Installation of cylinder head and valve assembly

◆ Service procedure



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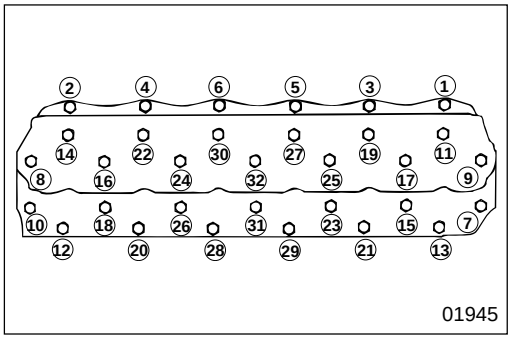
10 Cylinder head and valve assembly

[Removal]

- Before removing cylinder head bolts **8**, first loosen adjusting screw **C** of rockers **A** that push down valve springs **B**.



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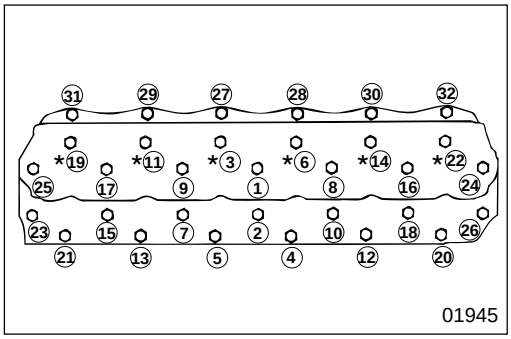
- Loosen cylinder head bolts **8** in the sequence as illustrated, then remove them.



01945

[Installation]

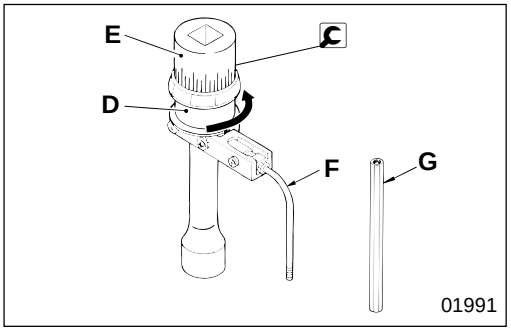
- Center punch the heads of cylinder head bolts **8** < M14 bolts > before each installation. Cylinder head bolts can be re-used a maximum of three times.

CAUTION⚠

If there are already three center-punch marks, replace the cylinder head bolt 8 with a new one.

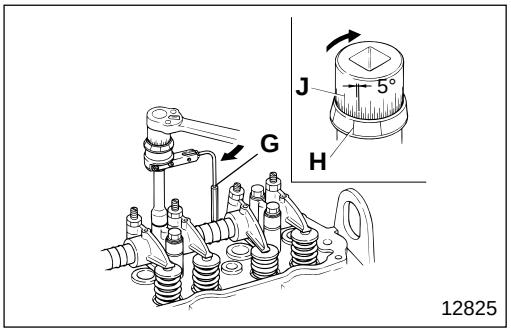
- Lubricate m14 bolts with engine oil.
- After tightening cylinder head bolts **8** at specified torque (M14 bolt : 78 N·m {58 ft.lbs, 8 kgf·m}, M10 bolt : 17 N·m {13 ft.lbs, 1.75 kgf·m}) in sequence as illustrated, tighten further as follows:
  ① to ㉖ : M14 bolt additional 180°
  ㉗ to ㉜ : M10 bolt additional 34 N·m {25 ft.lbs, 3.5 kgf·m}

***** :Tightened simultaneously with rocker and bracket assembly

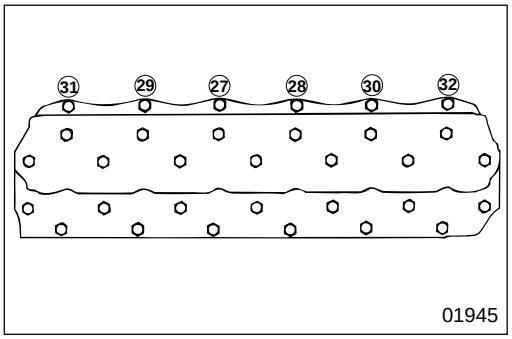


< M14 bolt >

- Using tool MH063388 turn socket wrench holder **D** counterclockwise and maintain spring tension in the wrench.
  E : Socket
  F : Rod
  G : Rod (for connection)



- Set socket wrench holder **D** so that extension rod **G** maintains contact against adjacent parts such as, rocker shaft bracket or the injection pipe.
- Select a scale that is convenient for reading graduation **H** on holder **D**.
- Tighten further by turning socket **H** clockwise by 180° (setting is in 5° increments), referring to graduation **J** on the selected scale.



< M10 bolt >

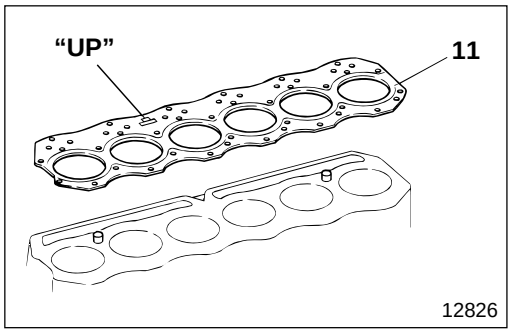
After tightening M14 bolts, tighten cylinder head bolts **8** (M10 bolt) at specified torque (34 N·m {25 ft.lbs, 3.5 kgf·m}) in the numbered order as illustrated.

11 **Cylinder head gasket**

[Removal]

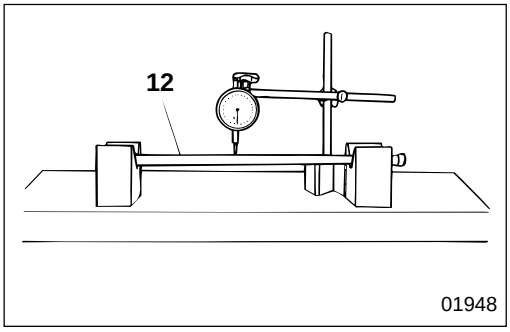
CAUTION

Be careful not to scratch the cylinder head or crankcase * when you remove cylinder head gasket 11.



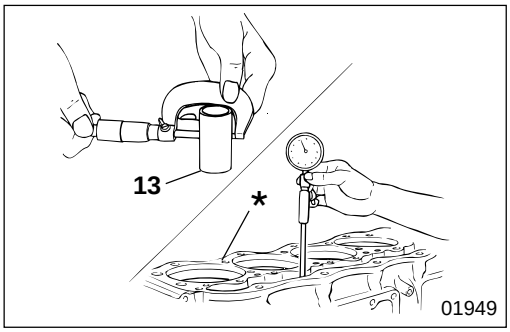
[Installation]

- Install cylinder head gasket **11** onto crankcase * in the direction as illustrated.



12 **Push rod deflection**

If the measured value is higher than the limit, replace push rod **12**.

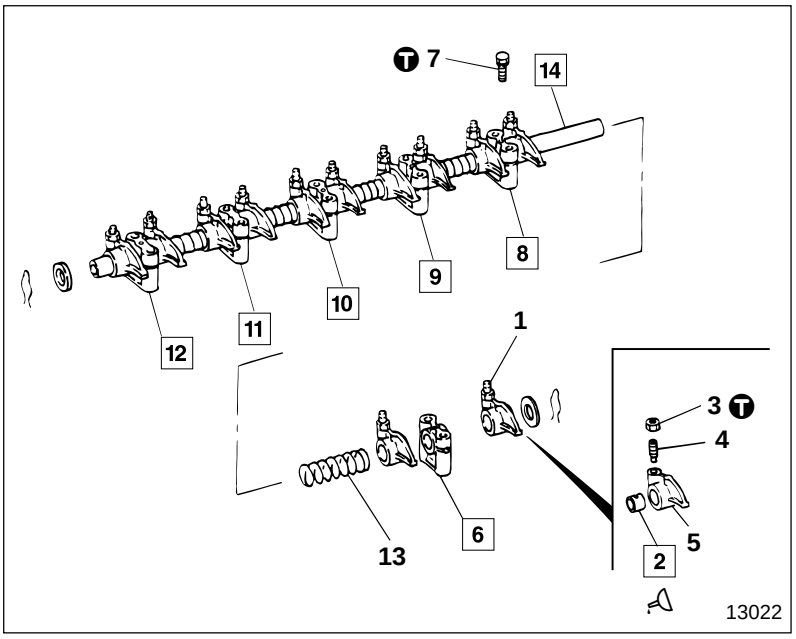


13 ***** **Clearance between tappet and crankcase tappet hole**

If the measured value is higher than the limit, replace the faulty parts.

CYLINDER HEAD AND VALVE MECHANISM

Rocker and Bracket Assembly



● **Disassembly sequence**

1 Rocker assembly
2 Rocker bushing
3 Lock nut
4 Adjusting screw
5 Rocker
6 No.6 rocker shaft bracket
7 Setting screw
8 No.5 rocker shaft bracket
9 No.4 rocker shaft bracket
10 No.3 rocker shaft bracket
11 No.2 rocker shaft bracket
12 No.1 rocker shaft bracket
13 Rocker shaft spring
14 Rocker shaft

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
2, 14	Clearance between rocker bushing and rocker shaft	[24] 0.01 to 0.08 {[0.94] 0.00039 to 0.0031}	0.12 {0.0047}	Replace rocker bushing

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

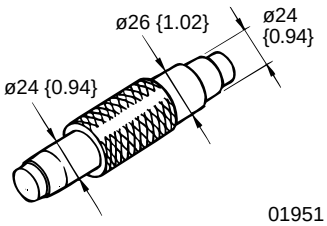
Location	Parts to be tightened	Tightening torque	Remarks
3	Lock nut (Adjusting screw mounting)	34 {25, 3.5}	—
7	Setting screw (Rocker shaft mounting)	3.9 {2.9, 0.4}	—

Lubricant

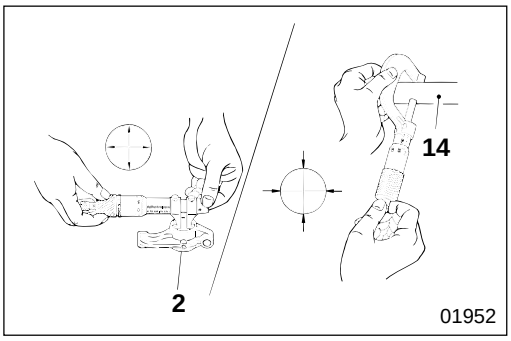
Location	Points of application	Kinds	Quantity
2	Inner surface of rocker bushing	Engine oil	As required

Special tools

Unit : mm {in.}

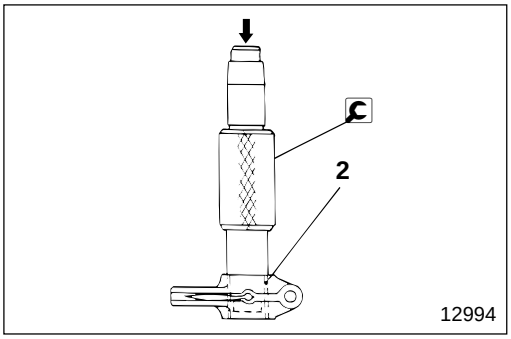
Location	Tool name and shape	Part No.	Application
2	Rocker bushing puller 	MH061777	Removal and installation of rocker bushing

◆ Service procedure



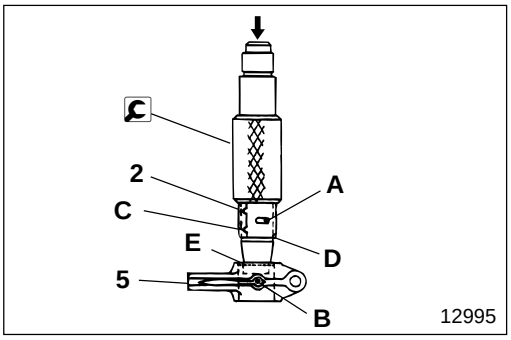
2 **14** **Rocker bushing and rocker shaft**

[Inspection]
If the clearance is higher than the limit, replace the faulty parts.

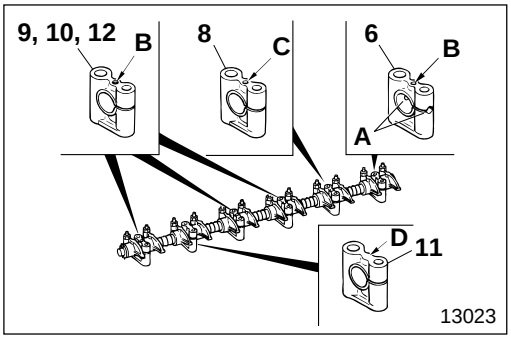


Rocker bushing

[Removal]



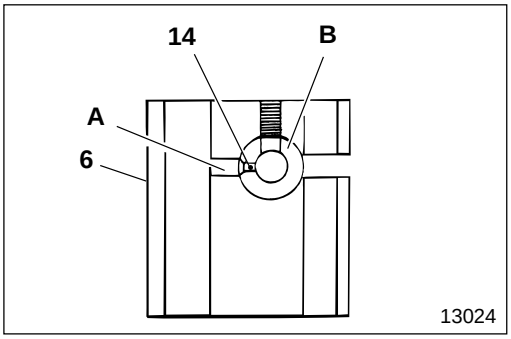
[Press-fitting]
- Align oil hole **A** of rocker bushing **2** with oil hole **B** of rocker **5**.
- Position clinch **C** and split **D** of rocker bushing **2** in the direction as illustrated.
- Press-fit rocker bushing **2** from chamfered side **E** of rocker **5**.



6 **8** **to** **12** **14** **Installation of rocker shaft bracket and rocker shaft**

Rocker shaft bracket

Be careful not to mix up rocker shaft brackets **6**, **8** to **12** when installing.
- **A** : Oil hole
- **B** : Screw hole (Rocker cover mounting bolt : M8)
- **C** : Screw hole (Set screw : M6)
- **D** : No screw hole

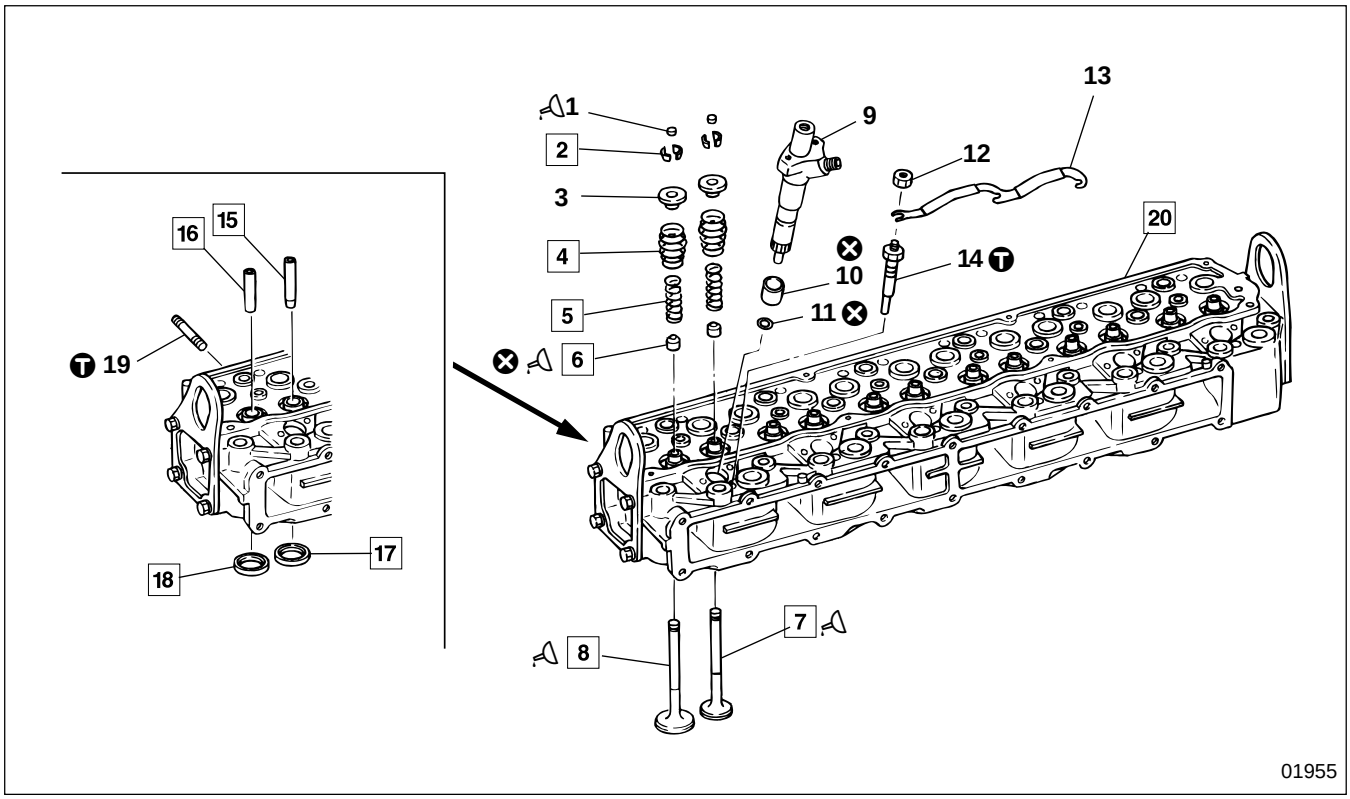


Rocker Shaft

Align oil hole **A** of No.6 rocker shaft bracket **6** with oil hole **B** of rocker shaft **14**.

CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head and Valve Assembly



● **Disassembly sequence**

1 Valve cap
2 Valve cotter
3 Upper retainer
4 Outer valve spring
5 Inner valve spring
6 Valve stem seal
7 Exhaust valve
8 Inlet valve
9 Injection nozzle Gr 13
10 Dust seal
11 Nozzle tip gasket
12 Nut
13 Connecting plate
14 Glow plug Gr 54
15 Exhaust valve guide
16 Inlet valve guide
17 Exhaust valve seat
18 Inlet valve seat
19 Stud
20 Cylinder head

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

Be careful of the protrusion of glow plug 14 and injection nozzle 9 from the bottom surface of cylinder head 20.

NOTE

When inlet valve 8 and exhaust valve 7 have been removed, replace valve stem seal 6.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
4	Outer valve spring	Free length	67.0 {2.64}	64.0 {2.52}	Replace
		Installed load (Installed length 47.8 {1.88})	330 N {74 lbf, 33.5 kgf}	290 N {65 lbf, 29.7 kgf}	Replace
5	Inner valve spring	Free length	55.1 {2.17}	52.1 {2.05}	Replace
		Installed load (Installed length 40.5 {1.59})	92 N {21 lbf, 9.4 kgf}	78 N {18 lbf, 8.0 kgf}	Replace
		Tilt	—	2.0 {0.079}	Replace
7	Exhaust valve	Stem diameter	ø8.93 to 8.94 {0.3515 to 0.3519}	ø8.85 {0.348}	Replace
		Valve recess from the cylinder head bottom surface	1.3 to 1.7 {0.051 to 0.067}	2.0 {0.079}	Inspect each part
		Valve margin	1.5 {0.059}	1.2 {0.047}	Correct or replace
		Valve seat angle	45°±15'	—	Correct or replace
7, 15	Clearance between exhaust valve stem and exhaust valve guide		[9] 0.07 to 0.10 {[0.35] 0.0028 to 0.0039}	0.2 {0.0079}	Replace
8	Inlet valve	Outer diameter of stem	ø8.96 to 8.97 {0.3527 to 0.3531}	ø8.85 {0.348}	Replace
		Valve recess from the cylinder head bottom surface	1.1 to 1.5 {0.043 to 0.059}	1.8 {0.071}	Inspect each part
		Valve margin	1.5 {0.059}	1.2 {0.047}	Correct or replace
		Valve seat angle	45°±15'	—	Correct or replace
8, 16	Clearance between inlet valve stem and inlet valve guide		[9] 0.04 to 0.06 {[0.35] 0.0016 to 0.0024}	0.15 {0.0079}	Replace
17	Seat width of exhaust valve seat		1.8 to 2.2 {0.071 to 0.087}	2.8 {0.11}	Correct or replace
18	Seat width of inlet valve seat		1.8 to 2.2 {0.071 to 0.087}	2.8 {0.11}	Correct or replace
20	Cylinder head	Distortion of bottom	0.08 {0.0031} or less	0.2 {0.0079}	Correct or replace
		Thickness	94.9 to 95.1 {3.74 to 3.74}	94.5 {3.72}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

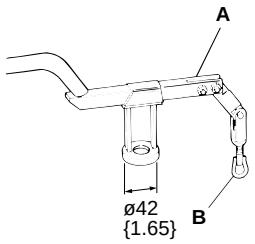
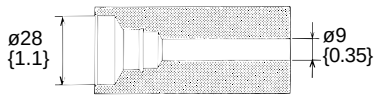
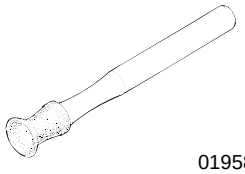
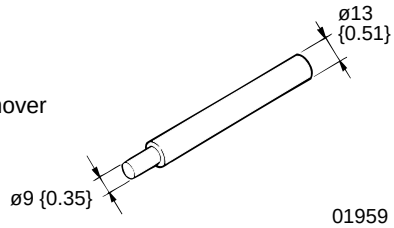
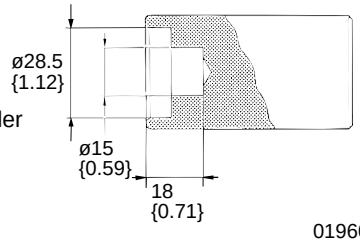
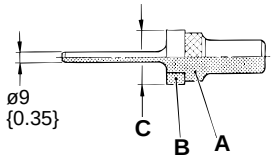
Location	Parts to be tightened	Tightening torque	Remarks
14	Glow plug	15 to 20 {11 to 14, 1.5 to 2.0}	—
19	Stud (Exhaust manifold mounting)	29 {22, 3}	—

Lubricant

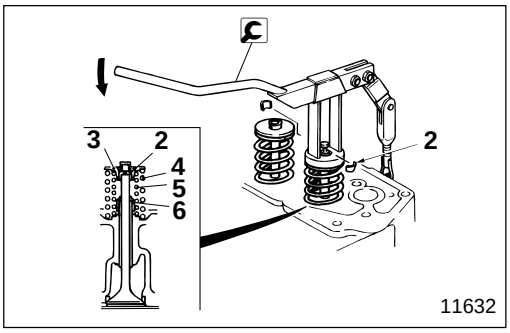
Location	Points of application	Kinds	Quantity
1	Slide contact areas of valve cap and rocker	Engine oil	As required
6	Lip of valve stem seal	Engine oil	As required
7, 8	Valve stem	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	**A** : Valve lifter **B** : Valve lifter hook  01956	**A** : MH061668 **B** : MH061679 (Obtain Locally)	Removal and installation of valve cotter
6	Valve stem seal installer  01957	MH061293	Installation of valve stem
7, 8	Valve lapper  01958	30091-07500 (Obtain Locally)	Fitting of valve and valve guide
15, 16	Valve guide remover  01959	MH061066	Removal of valve guide
	Valve guide installer  01960	MH061998	Press-fitting of valve guide
17, 18	**A** : Caulking tool body **B** : Caulking ring **C** dimension: Inlet ø49 {1.93}; Exhaust ø42 {1.65}  01961	(Obtain Locally) **A** : MH061067 **B** : MH061695 (Inlet) MH061696 (Exhaust)	Press-fitting of valve seat

◆ Service procedure



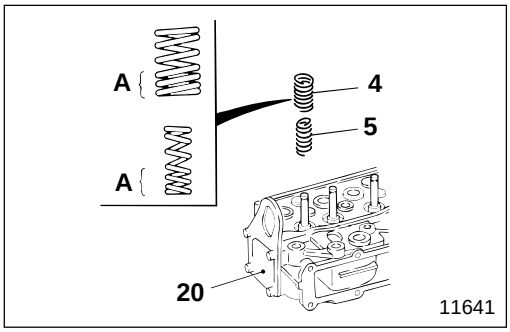
2 **Valve cotter**

[Removal]
Remove valve cotter **2** making sure that valve springs **4**, **5** are squarely and evenly pressed down by 🔧 valve lifter.

[Installation]
Follow the removal procedure in reverse.

CAUTION⚠

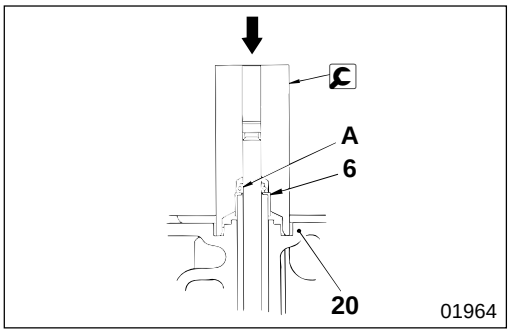
Be sure not to press down on valve springs 4, 5 too hard because this would cause upper retainer 3 to contact valve stem seal 6 and damage it.



4 **5** **Installation of outer and inner valve springs**

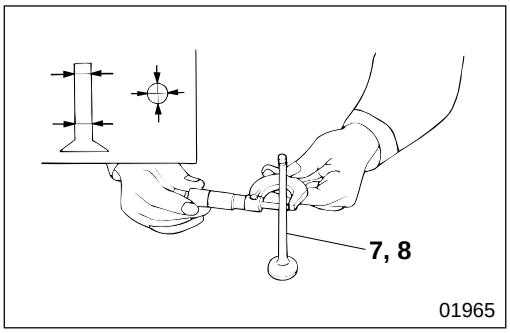
Install outer springs **4** and inner springs **5** in cylinder head **20** in the direction as illustrated.

A : Closely wound area



6 **Installation of valve stem seal**

- Apply engine oil to lip **A** of valve stem seal **6**.
- Tap down 🔧 valve stem seal installer until it hits cylinder head **20**.



7 **8** **Inlet valve and exhaust valve**

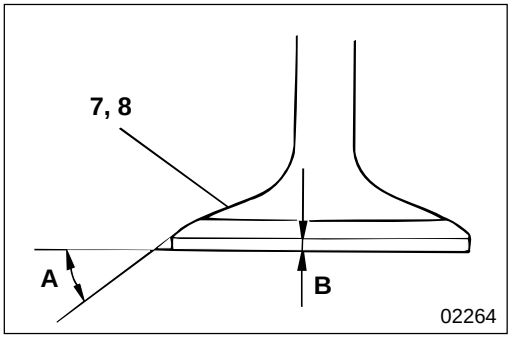
[Inspection]

(1) Inspection of stems

If the measured value is lower than the limit or in the case of excessive wear, replace valves **7**, **8**.

CAUTION⚠

Be sure to lap valve seats 17, 18 when valves 7, 8 are replaced with new ones. 🕮 **P11-25**

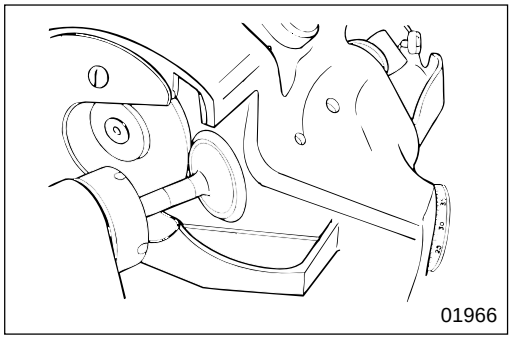


(2) Valve seat angle and valve margin

If the measured value is higher than the limit, correct or replace valves **7**, **8**.

A : Valve seat angle

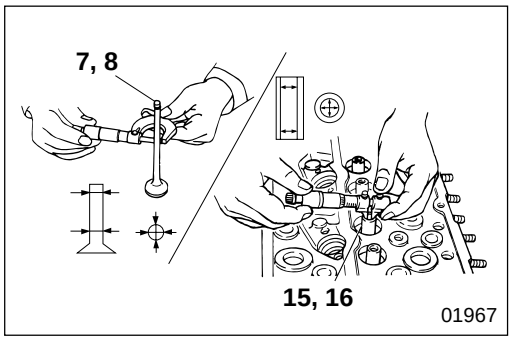
B : Valve margin



[Correction]

NOTE

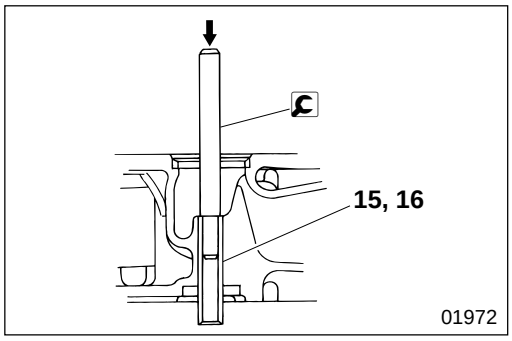
- **Be sure to keep the grinding work as light as possible.**
- **Be sure to replace valves 7, 8 after grinding if valve margin deviates from the limit.**
- **Be sure to lap valve 7, 8 and valve seats 17, 18 after grinding. P11-25**



7 **8** **15** **16** **Valve and valve guide**

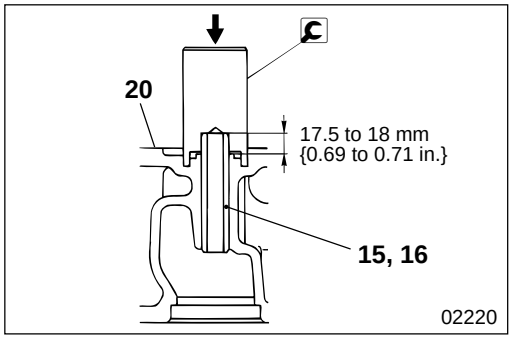
[Inspection]

When the clearance is higher than the limit, replace the faulty parts.



Valve guide

[Removal]

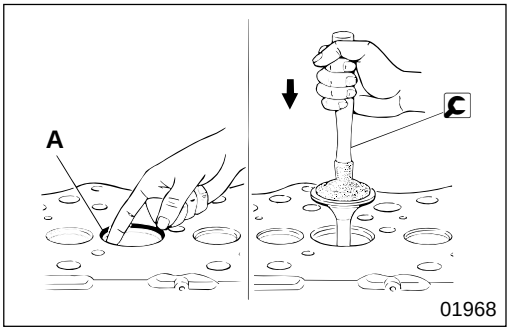


[Installation]

- Tap down valve guides **15**, **16** with 🔧 valve guide installer until it contacts cylinder head **20**.

CAUTION ⚠

- **The length of fit of valve guides 15, 16 is standardized. Be sure to use 🔧 valve guide installer.**
- **Be sure to distinguish between valve guides 15, 16. Exhaust valve guide 15 is longer.**



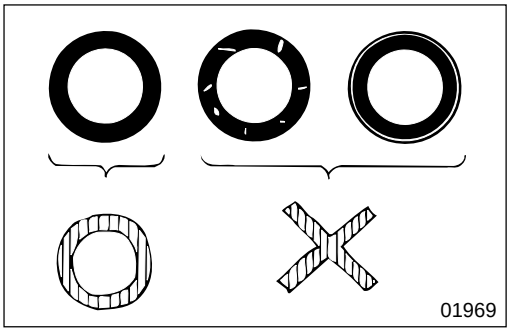
7 8 17 18 **Valve and valve seat**

[Inspection]

- Apply red lead evenly to entire surface **A** of valve seats **17**, **18** that contact valves **7**, **8**.
- Fit valves **7**, **8** to valve seats **17**, **18** and tap once without rotating.

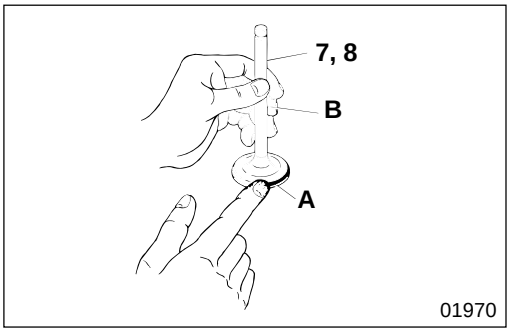
NOTE

Be sure to carry out inspection under the condition that valves 7, 8 and all parts of valve guides 15, 16 are normal.



- Check how much red lead has transferred to valves **7**, **8** to determine the contact of the valve and the seat. According to the degree of abnormality, take proper measures to correct it.

Contact conditions	Correction measures
Minor fault	Valve lapping
Major fault	Repair of valve and seat or replacement of both



[Correction]

Valve polishing is done in the following manner:

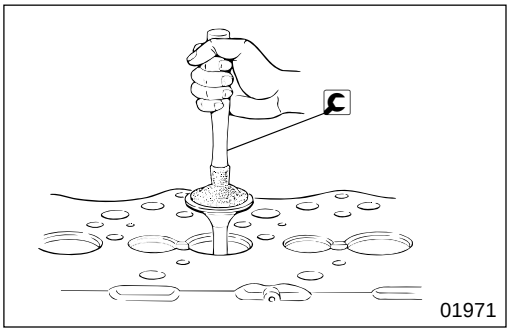
- Apply valve lapping compound thinly to contact surface **A** of valves **7**, **8** with valve seats **17**, **18**.

CAUTION ⚠

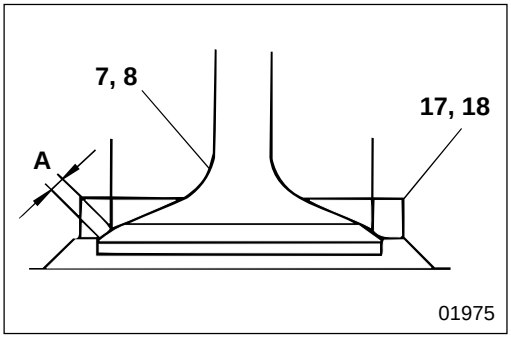
Take care not to smear stems B of valves 7, 8 with the compound.

NOTE

- **Start with medium grit compound (120 to 150 grit) and for finishing up, use finer grit (200 grit or finer).**
- **Mixing with a small amount of engine oil will make the compound consistent and make even application easier.**



- Tap valves **7**, **8** against valve seats **17**, **18** several times while rotating the valves slightly at each strike.
- Clean off the compound.
- Apply engine oil to contact surface **A** of valve seats **17**, **18** and smooth the surface.
- Check the contact of valves **7**, **8** and valve seats **17**, **18**.
- If contact does not take place completely around the seat, replace valve seats **17**, **18**.



17 **18** **Valve seat**

[Inspection]

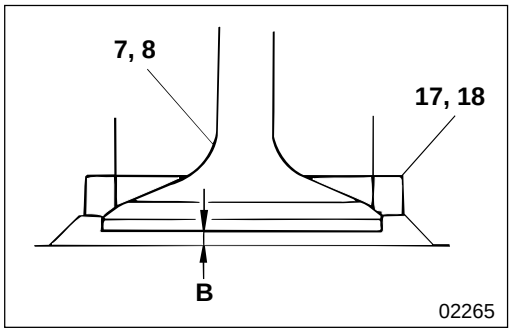
(1) Valve seat width

If the measured value is higher than the limit, replace valve seats **17**, **18**.

A : Valve seat width

NOTE

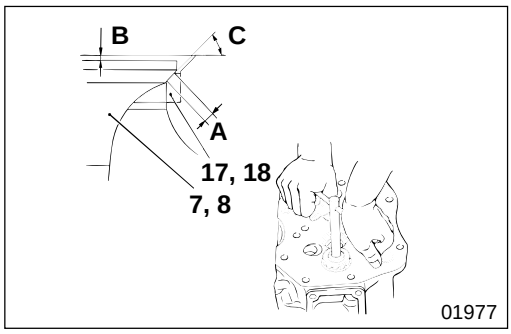
Be sure to lap and fit valves 7, 8 and valve seats 17, 18 after correction or replacement.



(2) Extent of valve recess from the bottom surface of cylinder head

If the measured value is higher than the limit, correct or replace the faulty parts.

B : Extent of valve recess



[Correction]

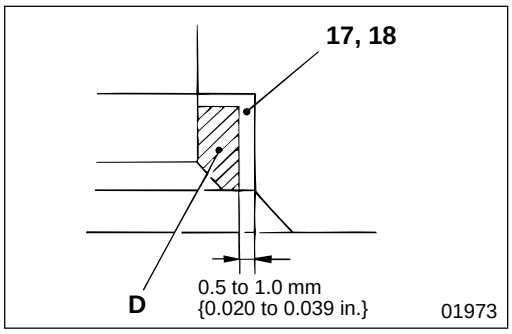
- Grind valve seats **17**, **18** using valve seat cutter or valve seat grinder.
- After grinding, do another light abrasion using 400 grit emery paper placed between the cutter and the seat.
- Adjust the seat width **A** of valves **7**, **8** using 15° or 75° cutter to make seat width conform to the standard value.

C : Valve seat angle

CAUTION ⚠

Be sure that as a result of grinding, recess B of valves 7, 8 does not become higher than the limit.

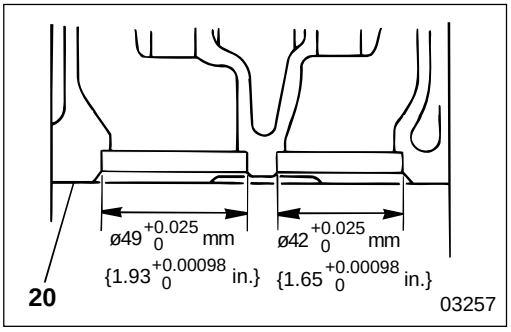
- After correction is done, be sure to carry out lapping and fitting on valves **7**, **8** and valve seats **17**, **18**.



[Removal]

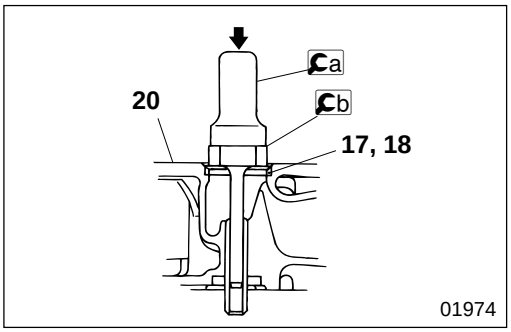
- Valve seats **17**, **18** have been set in by the cooling-off-process, and have to be thinned by grinding off the inner side for removal under normal temperature.

D : Part to be ground

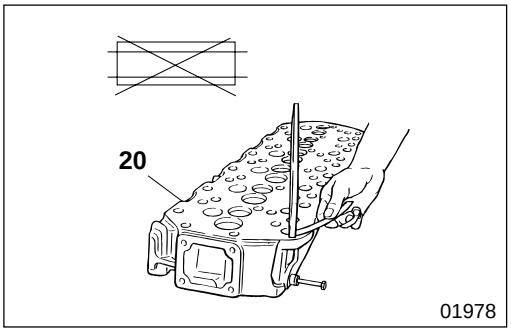


[Installation]

- Make sure that the diameter of valve seat hole of cylinder head **20** conforms to the standard value.
  E : Inlet valve seat hole diameter
  F : Exhaust valve seat hole diameter



- Immerse valve seats **17**, **18** in liquid nitrogen and cool them substantially. Press-fit into the cylinder head using Ca caulking tool body and Cb caulking rings inlet and exhaust.
- After installation of valve seats **17**, **18**, work until they contact valves **7**, **8** smoothly.



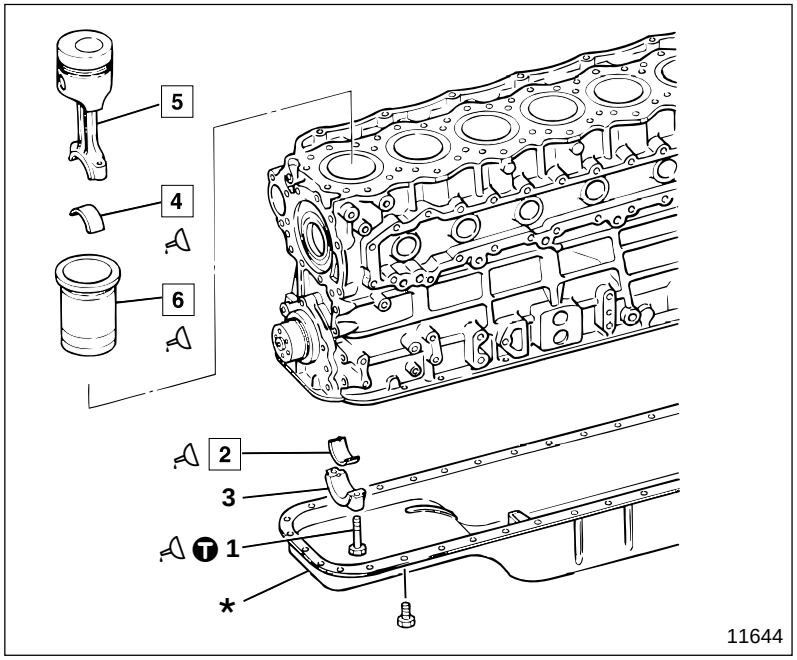
20 Inspection of cylinder head

Measure the extent of distortion of the bottom of cylinder head **20**, and if the measured value is higher than the standard value, grind using a surface grinder.

CAUTION

Be sure to keep the amount of grinding within the limit of the cylinder head thickness 20.

PISTON, CONNECTING ROD AND CYLINDER SLEEVE



● **Disassembly sequence**

1 Bolt
2 Lower connecting rod bearing
3 Connecting rod cap
4 Upper connecting rod bearing
5 Piston and connecting rod assembly
P11-36
6 Cylinder sleeve

***** : Oil pan Gr 12

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
—	Extent of piston protrusion		0.85 to 1.06 {0.033 to 0.042}	—	Inspect the related parts
—	End play of connecting rod		0.15 to 0.45 {0.0059 to 0.018}	0.6 {0.024}	Replace
2, 4	Connecting rod bearing	Oil clearance	[65] 0.04 to 0.09 [2.56] 0.0016 to 0.0035	0.2 {0.0079}	Replace
		Expansion	—	69.5 {2.74} or less	Replace
5, 6	Clearance between piston and connecting rod assembly and cylinder sleeve		[118] 0.075 to 0.105 {[4.65] 0.003 to 0.0041}	—	Replace
6	Cylinder sleeve	Extent of flange protrusion	0.03 to 0.10 {0.0012 to 0.039}	—	Replace
		Inner diameter	ø118 to 118.03 {4.646 to 4.656}	ø118.25 {4.66}	Replace
		Cylindrical accuracy	0.03 {0.0012} or less	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

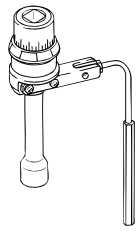
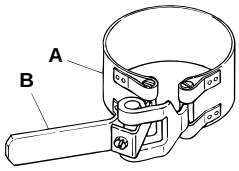
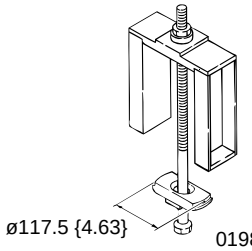
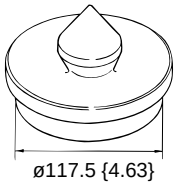
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt	29 {22, 3}+90°±5°	Wet

Lubricant

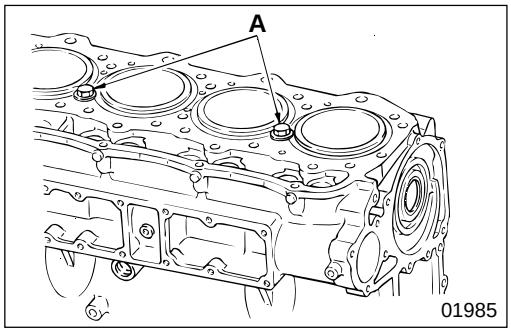
Location	Points of application	Kinds	Quantity
1	Thread area of bolt	Engine oil	As required
2, 4	Connecting rod bearing inner surface	Engine oil	As required
6	Outer periphery of cylinder sleeve	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Socket wrench  01984	MH061560 (Obtain Locally)	Installation of piston and connecting rod assembly
	Piston guide **A** : Piston guide clamp **B** : Piston guide lever  01981	(Obtain Locally) **A** : MH061760 **B** : MH061658	
6	Cylinder sleeve extractor  01982	MH061761	Extraction of cylinder sleeve
	Cylinder sleeve installer  01983	MH061771	Installation of cylinder sleeve

◆ Service procedure



● **Inspection before disassembly**

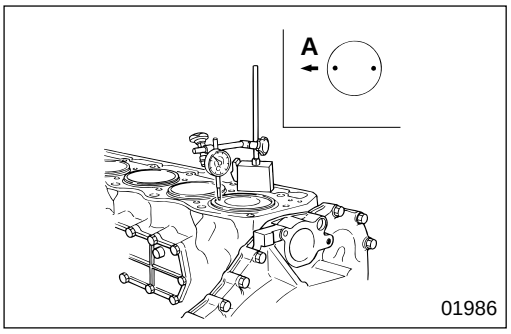
(1) Extent of piston protrusion from the upper surface of crankcase

NOTE

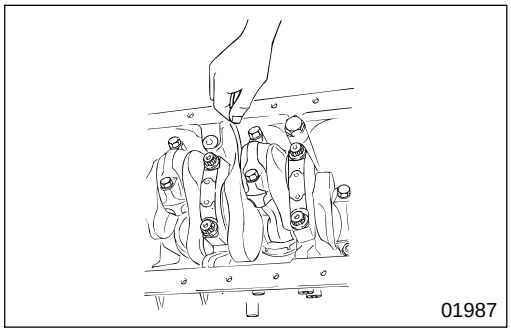
Always inspect the extent of piston protrusion because it affects the engine performance greatly.

WARNING⚠

Cylinder sleeves 6 might slip out beyond the top surface of the crankcase if the crankshaft is rotated. To avoid this, hold down the sleeves using bolts, tightened down with washers A at the cylinder sleeve flange.

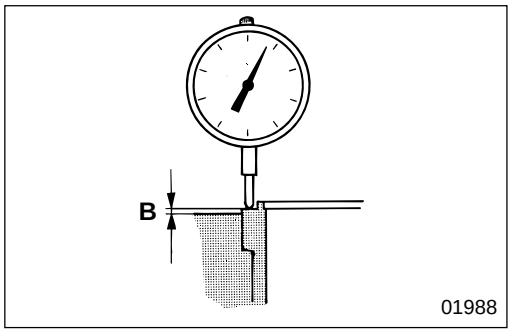


- Measure piston protrusion at two points on the top of the piston, and produce the average value.
  A : Front of the engine
- If the average value deviates from the limit, inspect clearance of the related parts.



(2) End play of connecting rod

- Measure the end play of each connecting rod.
- If the measured value is higher than the limit, replace the faulty parts.



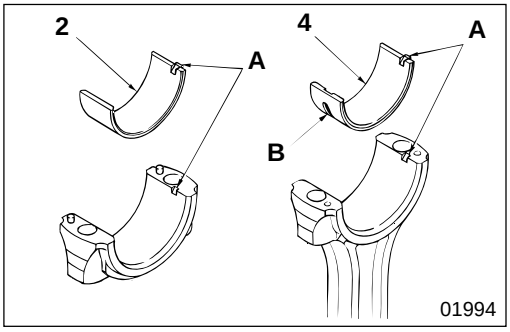
(3) Extent of cylinder sleeve flange area protrusion from the upper surface of crankcase

Replace cylinder sleeve **6** if the measured value deviates from the standard value.

B : Protrusion at cylinder sleeve flange area

CAUTION⚠

Unless the protrusion at the flange of cylinder sleeve 6 is adequate, contact pressure exerted upon the cylinder head gasket around the circumference of the cylinder sleeve will be low, and might cause leakage of combustion gases.



2 **4** **Connecting rod bearing**

[Installation]
Install connecting rod bearings **2**, **4** by matching lugs **A** to the connecting rods.

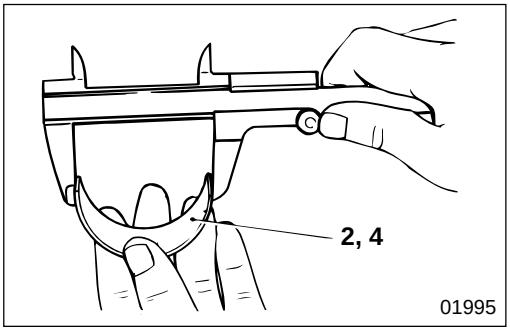
CAUTION

Be sure to distinguish between upper and lower connecting rod bearings 2, 4. The upper bearing has oil opening B while the lower bearing has no oil opening.

[Inspection]

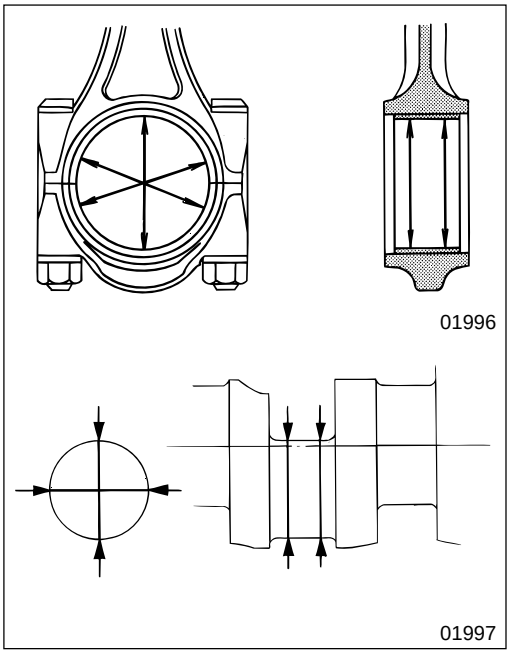
CAUTION

- **Do not forcibly open or expand connecting rod bearings 2, 4.**
- **When either upper or lower connecting rod bearings 2, 4 needs replacing, replace as a set.**



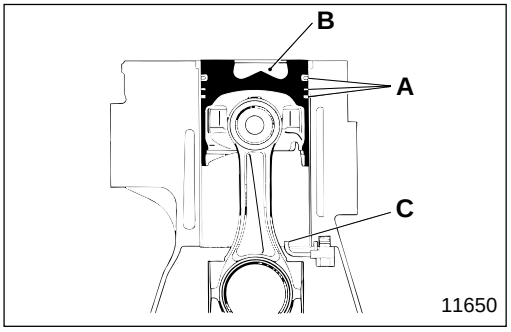
(1) Expansion at free state

If the measured value is lower than the limit, replace connecting rod bearings **2**, **4**.



(2) Clearance between connecting rod bearing and crankshaft

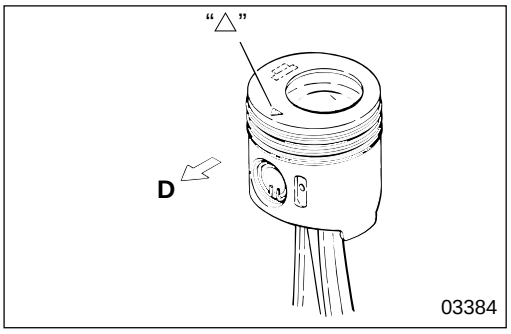
If the clearance between connecting rod bearing **2**, **4** and crankshaft is lower than the limit, replace the faulty parts.



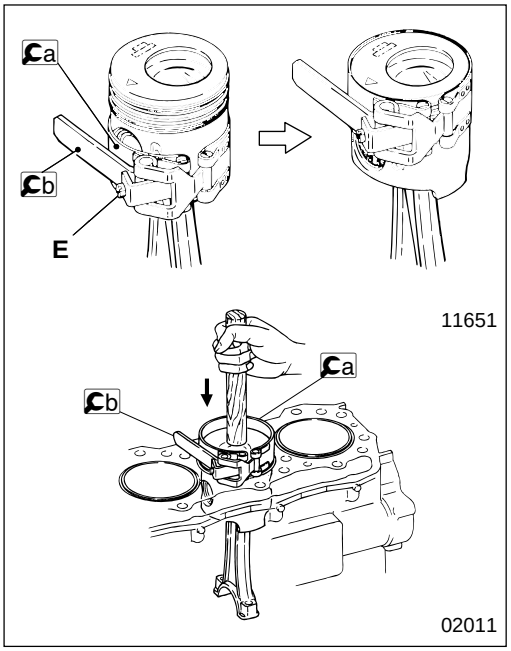
5 **Installation of piston and connecting rod assembly**

CAUTION

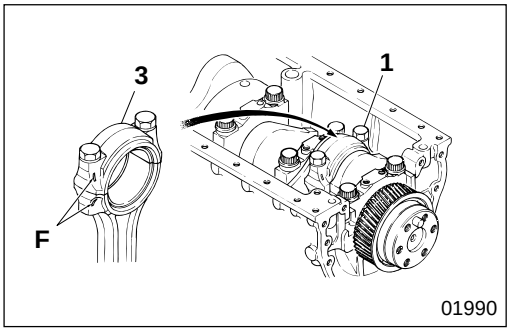
- **Be sure to fit piston ring A in the correct position.**
  P11-40
- **Be careful not to scratch or damage head B of the piston (a part of the combustion chamber).**
- **Make sure that the connecting rod does not hit oil jet C.**



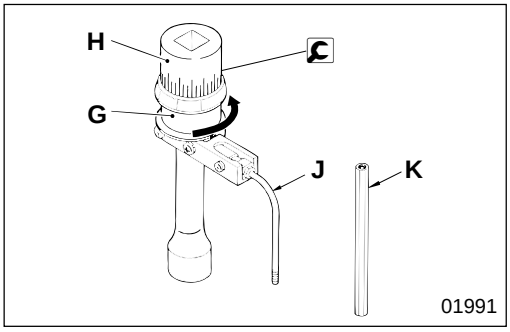
- Install piston front mark "△" directed towards the front of the engine using the following procedure.
  D : Front of the engine



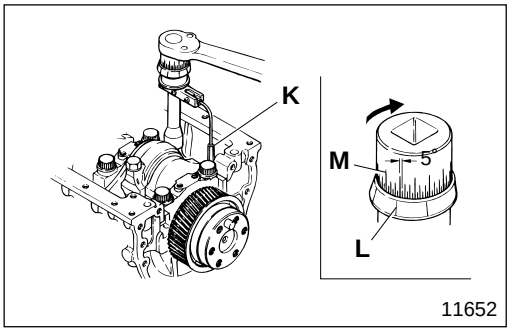
- Match the inner diameter of a piston guide clamp to the outer diameter of the piston skirt by turning adjusting bolt **E** of b piston guide lever.
- After adjusting, set a clamp and b lever at the top of the piston so that the clamp is flush with the top of the piston.



- After the piston is inserted, align alignment marks **F** on the connecting rod with the alignment marks on connecting rod cap **3** and tighten bolt **1** at specified torque. Then tighten the bolt further as follows:



- Turn socket wrench holder **G** counterclockwise and maintain spring tension in the wrench.
  H : Socket
  J : Rod
  K : Rod (for connection)

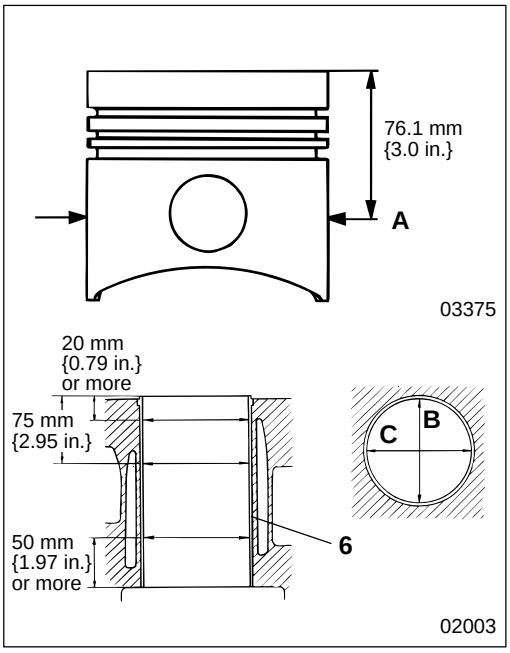


- Set the socket wrench holder **G** so that extension rod **K** maintains contact against the crankshaft.
- Select a scale that is convenient for reading graduation **L** on holder **G** side.
- Tighten further by turning socket **H** clockwise by 90°±5° (setting is in 5° increments) referring to graduation **M** using the selected scale.

NOTE

After installation of connecting rod cap 3, inspect the following points :

- **End play of the connecting rod : P11-30**
- **Piston protrusion : P11-30**



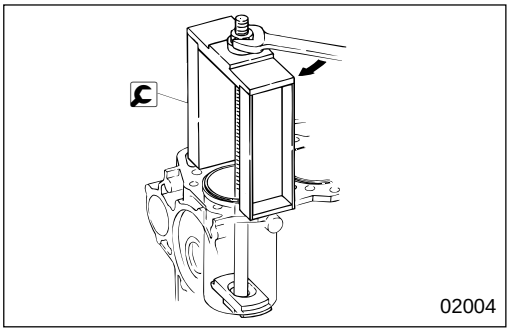
5 **6** **Piston and connecting rod assembly and cylinder sleeve**

[Inspection]
Replace the cylinder sleeve if the clearance deviates from the standard value. Mesure piston and sleeve as follows:

A : Position to measure the outer diameter of the piston
B : In the direction of the crankshaft axis (sleeve diameter - 3 places)
C : At right angles to the crankshaft axis (sleeve diameter - 3 places

NOTE

Cylinder sleeve 6 is a thin type so it is impossible to bore it out. Also, do not remove it except for replacement, because it is liable to become deformed when you remove it .



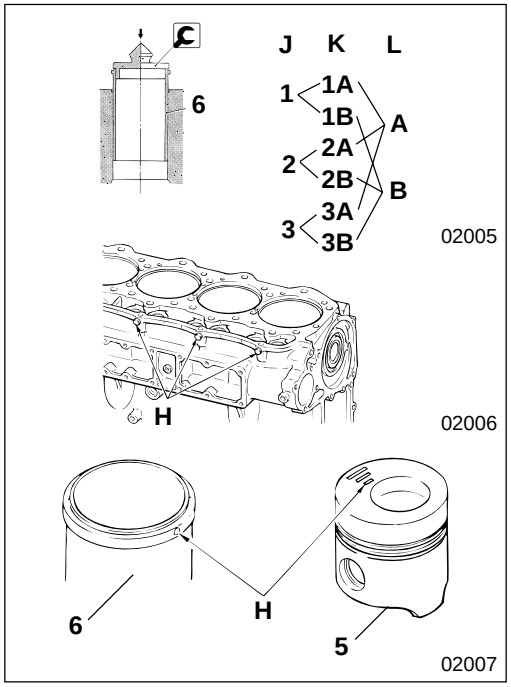
Cylinder sleeve

[Removal]

NOTE

If you are reusing cylinder sleeve 6, paint an alignment mark across the cylinder sleeve and the crankcase before removal so you can replace them in the same position.

PISTON, CONNECTING ROD AND CYLINDER SLEEVE



[Installation]
Apply engine oil to the outer surface of cylinder sleeve **6**, hold the entire upper part of [SST] cylinder sleeve installer in your hand evenly, and insert the cylinder sleeve slowly into the crankcase.

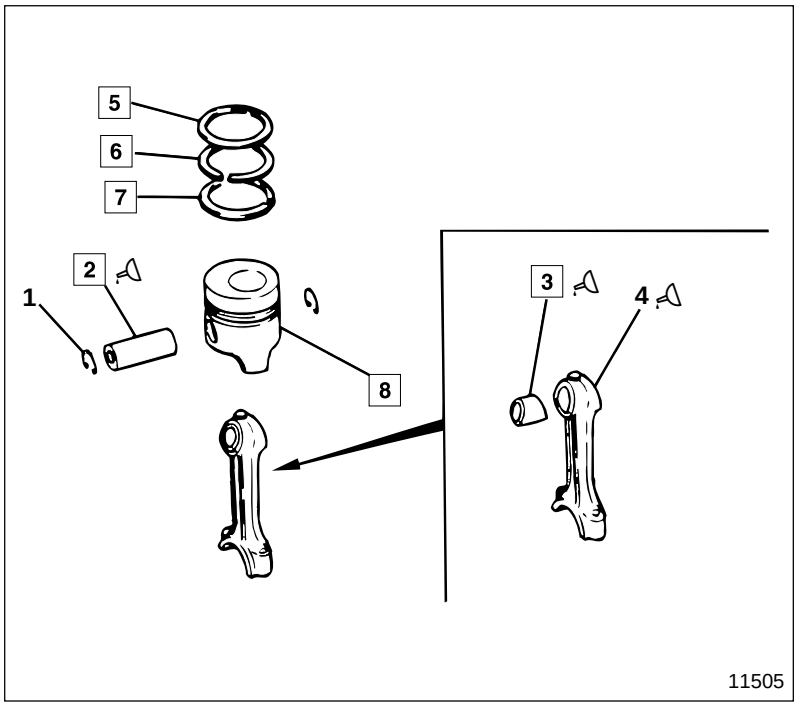
CAUTION

- **Use size marks H on cylinder sleeve 6, piston and connecting rod assembly 5, and the crankcase, as a reference when replacing the piston and sleeve.**
  - **J : Crankcase size mark**
  - **K : Cylinder sleeve size mark**
  - **L : Piston size mark**
- **Handle cylinder sleeve 6 with utmost care because it is thin; do not subject it to strong impact from a hammer, etc.**

M E M O

PISTON, CONNECTING ROD AND CYLINDER SLEEVE

Piston and Connecting Rod Assembly



● **Disassembly sequence**

1 Snap ring
2 Piston pin
3 Connecting rod bushing
4 Connecting rod
5 1st compression ring
6 2nd compression ring
7 Oil ring
8 Piston

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

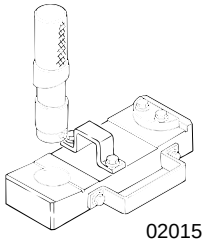
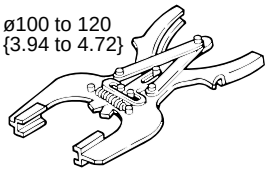
Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
2, 3	Clearance between piston pin and connecting rod bushing		[38] 0.02 to 0.05 {[1.50] 0.00079 to 0.002}	0.1 {0.0039}	Replace
2, 8	Clearance between piston and piston pin		[38] 0.004 to 0.02 {[0.15] 0.00016 to 0.00079}	0.05 {0.002}	Replace
4	Degree of bend and distortion of connecting rod		—	0.05 {0.002}	Repair or replace
5 to 7	Piston ring gap	1st compression ring	0.35 to 0.50 {0.014 to 0.018}	1.5 {0.059}	Replace
		2nd compression ring	0.45 to 0.60 {0.0177 to 0.024}		
		Oil ring	0.35 to 0.55 {0.014 to 0.022}		
5 to 8	Clearance between piston ring and piston ring groove	1st compression ring	0.02 to 0.10 {0.00079 to 0.0039}	0.2 {0.0079}	Replace
		2nd compression ring	0.07 to 0.10 {0.0028 to 0.0039}	0.15 {0.0059}	
		Oil ring	0.03 to 0.06 {0.0012 to 0.0024}		

Lubricant

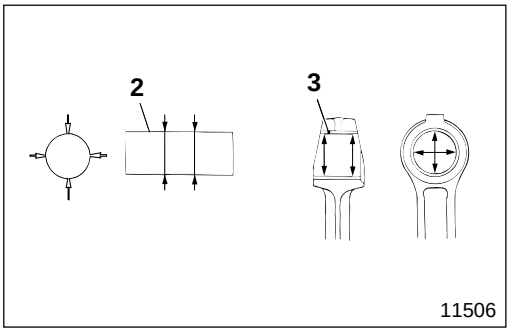
Location	Points of application	Kinds	Quantity
2	Exterior of piston pin	Engine oil	As required
3	Exterior of connecting rod bushing	Engine oil	As required
4	Bushing attachment area of connecting rod	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Connecting rod bushing puller kit  02015	MH062023 (Obtain Locally)	Removal and installation of connecting rod bushing
5 to 7	Piston ring tool  02013	30091-07100 (Obtain Locally)	Removal and installation of piston ring

◆ Service procedure



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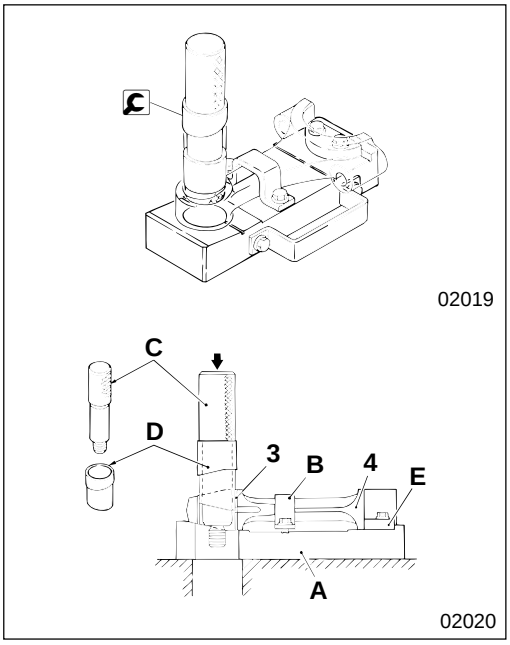
2 **3** **Piston pin and connecting rod bushing**

[Inspection]
If the clearances are higher than the limit, replace the faulty parts.



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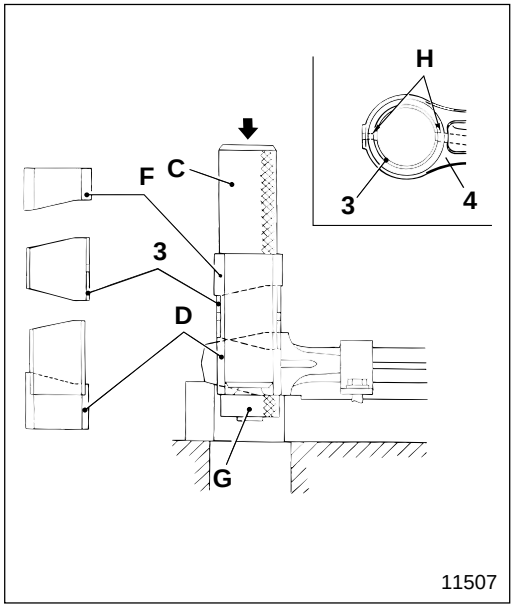
Connecting rod bushing

Use 🔧 connecting rod bushing puller kit to replace connecting rod bushing **3**.
(Components of 🔧 connecting rod bushing puller kit)
A : Base **B** : Bracket **C** : Puller **D** : Collar
E : Plate **F** : Collar **G** : Nut

[Pulling-out]

- Remove upper connecting rod bearing from the big end of connecting rod **4**.
- Place connecting rod **4** on base **A** and fix it to the base at two points, bracket **B** and plate **E**.
- Fit collar **D** in puller **C** in the direction as illustrated, and pull out connecting rod bushing **3** with a gradual load of approximately 49 kN {11020 lbf, 5000 kgf}.

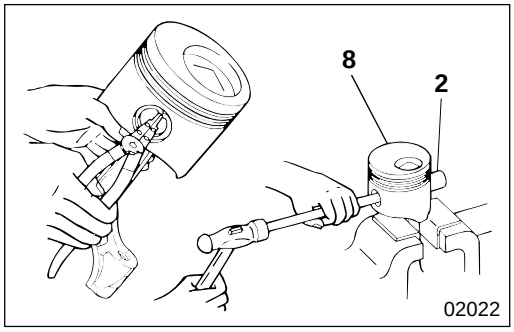


[Press-fitting]

- Apply engine oil to the exterior peripheral area of connecting rod bushing **3** and the inner area of the bushing fitting ring of connecting rod **4**.
- Fit collar **F**, connecting rod bushing **3** and collar **D** in puller **C** in the arrangement and direction as illustrated and mount them with nut **G**.
- Align oiling holes **H** of connecting rod bushing **3** and connecting rod **4**, and gradually press in the bushing with approximately 49 kN {11020 lbf, 5000 kgf} load.
- After press-fitting, ream connecting rod bushing **3** to make its clearance with piston pin **2** conform to the standard value.

NOTE

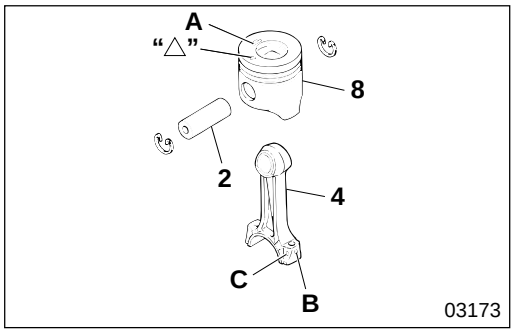
After press-fitting bushing 3, insert piston pin 2 and make sure that the rod moves smoothly without any excessive play.



2 4 8 Piston pin and connecting rod and piston

[Disassembly]

- Drive out piston pin **2** using a punch.
- When removal of piston pin **2** is difficult, warm piston **8** using a piston heater or hot water.

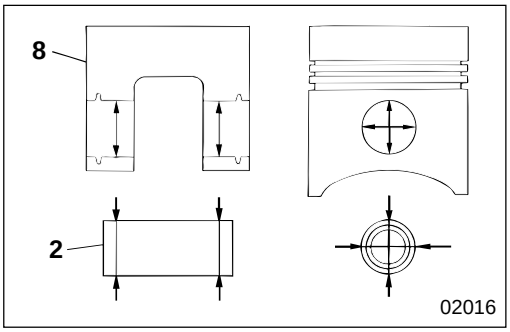


[Installation]

- Apply engine oil to piston pin **2** and assemble connecting rod **4** and piston **8** in the direction as illustrated.
  A : Piston mass (Mass of piston is marked)
  B : Connecting rod mass mark (Alphabetical : A, B, C, D, E, F, G, H, I, V, W, X, Y, or Z)
  C : Mounting base of connecting rod cap
  △ : Front mark
- When piston pin **2** insertion is difficult, warm piston **4** using a piston heater or hot water.

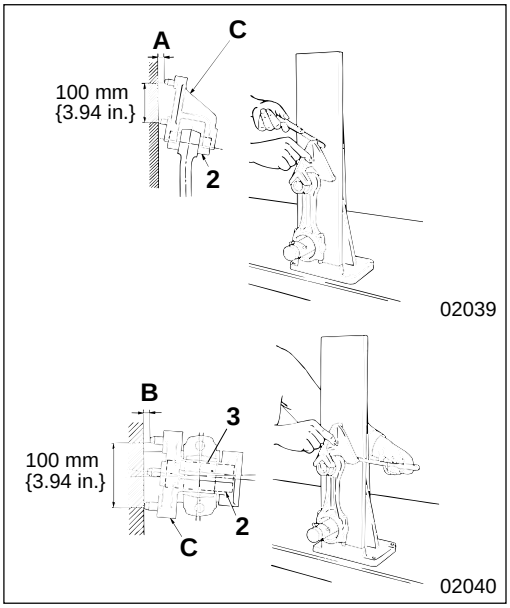
CAUTION⚠

- **Make sure that the total mass error of all pistons 8 in one engine is 10 g {0.35 oz} or less.**
- **Be sure to install connecting rods 4, to be used in one engine, that have identical mass mark B.**
- **Be sure that after inserting piston pin 2 the connecting rod operates smoothly without excessive play.**



2 **8** **Clearance between piston pin and piston**

If the clearance is higher than the limit, replace the faulty parts.



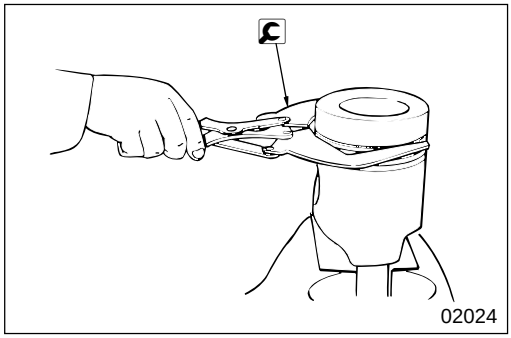
4 **Degree of bend or distortion of connecting rod**

- Mount connecting rod bushing **3** and piston pin **2** to connecting rod **4**.
- Measure degree of bend **A** and distortion **B** of connecting rod **4**. If the measured value is higher than the limit, repair or replace the connecting rod.
  C : Connecting rod aligner (Measuring instrument)

NOTE

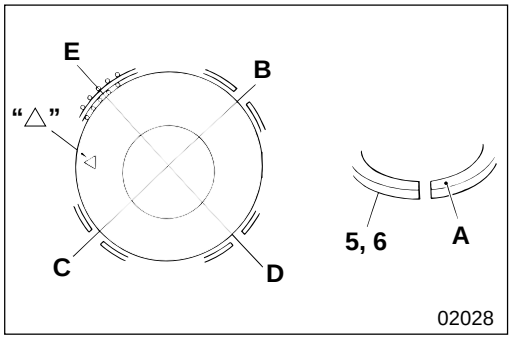
- **When making measurements by mounting connecting rod 4 to connecting rod aligner C, make sure that the upper connecting rod bearing and the lower connecting rod bearing are mounted on the rod.**
- **Mount the connecting rod cap by tightening the bolt at specified torque.** 🕮 **P11-28**

PISTON, CONNECTING ROD AND CYLINDER SLEEVE

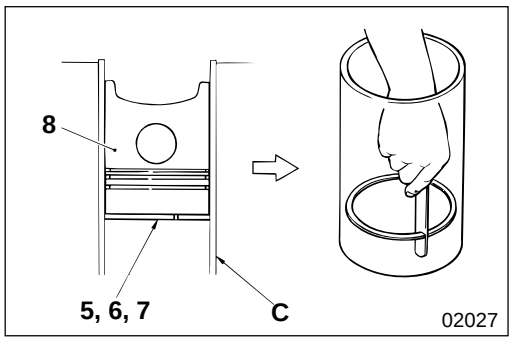


5 to 8 Piston ring and piston

Piston ring
[Removal]



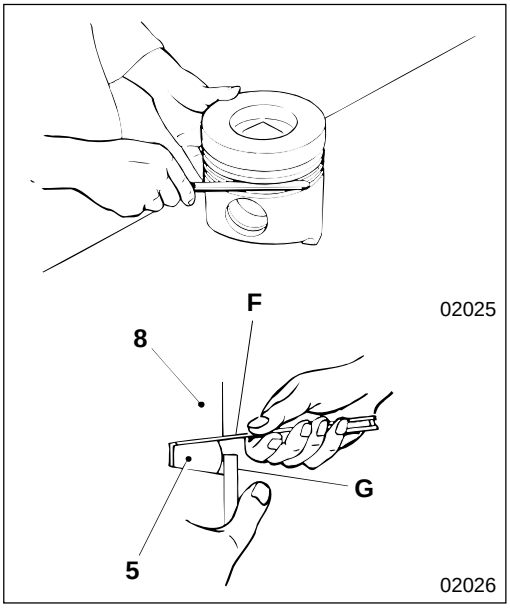
[Installation]
- Install oil ring **7** so that split **D** and the butting joint of expander spring **E** come to the points as illustrated.
- Compression rings **5** and **6** have a manufacturer's mark **A** at the split, and installation should be made with the mark upward.
  B : The split of the 1st compression ring
  C : The split of the 2nd compression ring
  D : Oil ring slit
  E : Oil ring expander spring butt joint
  △ : Front mark of piston



[Inspection]

(1) Piston ring gap
- Install piston rings **5** to **7** into the crankcase cylinder sleeve using the head of piston **8** to level the piston ring.
- Measure the clearance of the piston ring gap while keeping them level and stationary. If the measured value is higher than the limit, replace the piston ring.

NOTE
- **Use piston 8 to ensure that piston rings 5 to 7 are kept level when inserting them into the crankcase cylinder sleeve.**
- **Insert piston rings 5 to 7 into the lower part of the crankcase cylinder sleeve, where the area is less worn, when measuring clearance of piston ring gap 5 to 7.**
- **Exchange the whole set of piston rings 5 to 7 as a set if any of the rings is faulty.**



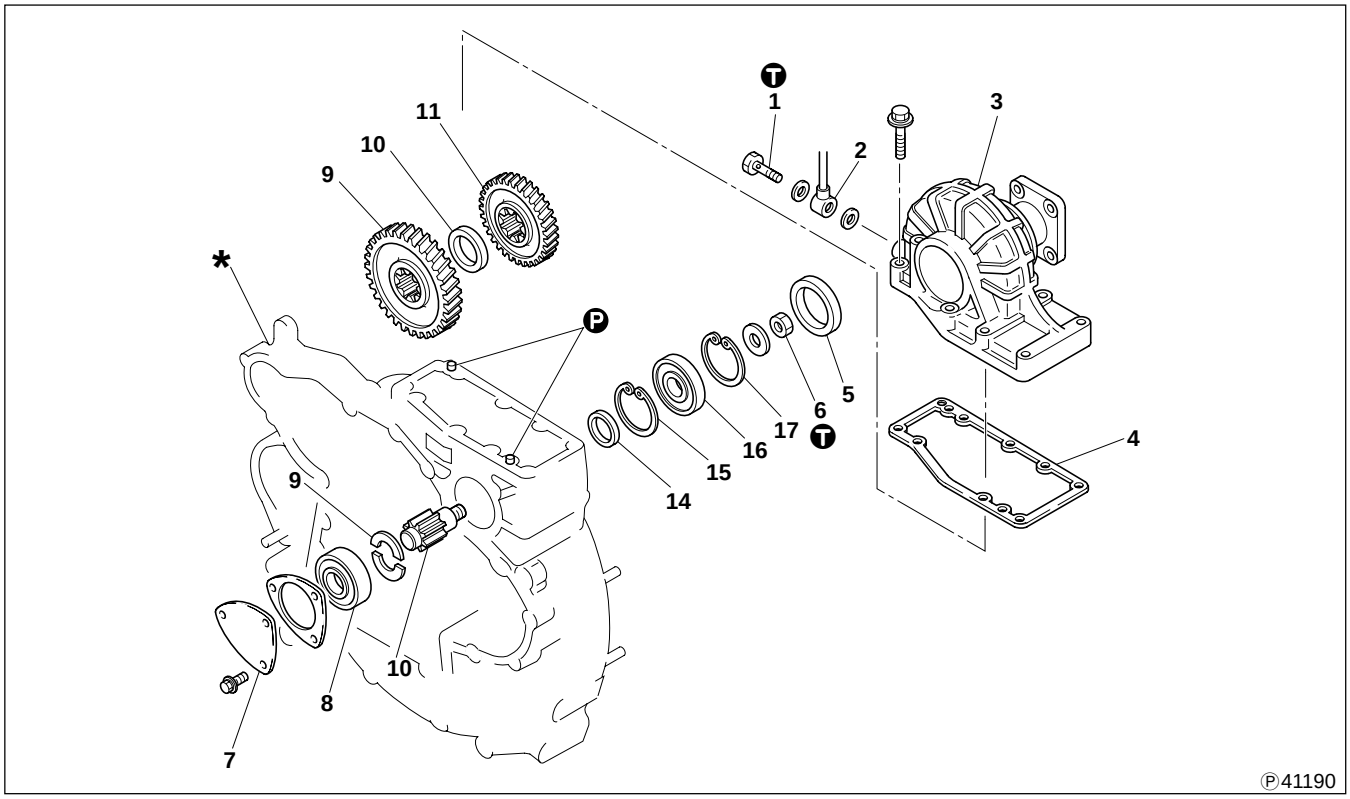
(2) Clearance between piston ring and ring groove

- If the measured value is higher than the limit, replace the faulty parts.
- Measure using feeler gauge **F**, by pressing 1st compression ring **5** against piston **8** with straight edge **G**.

NOTE

- **Measurement has to be conducted around the whole periphery of piston 8 after removing carbon deposits.**
- **Be sure to exchange the whole set of piston rings 5 to 7 as a set if any of the rings is faulty.**

FLYWHEEL POWER TAKE-OFF



● **Pre-disassembly inspection**

P11-43

● **Disassembly sequence**

1 Eye bolt
2 Oil pipe
3 Flywheel power take-off head assembly P11-44
4 Shim
5 Seal cap
6 Nut
7 Cover
8 Ball bearing
9 Cotter
10 Power take-off idler shaft
11 Power take-off idler gear A
12 Spacer
13 Power take-off idler gear B
14 Spacer
15 Snap ring
16 Ball bearing
17 Snap ring

* : Flywheel housing Gr 11
Ⓟ : Locating pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

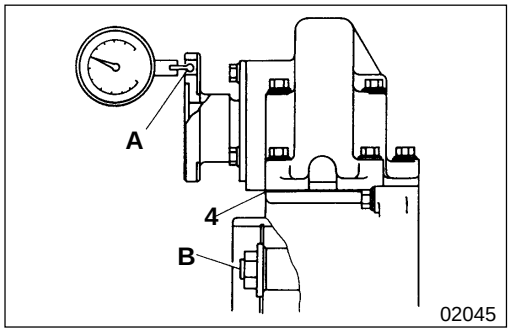
Unit: mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Gear backlash	Between power take-off idler gear A and No.1 idler gear	0.08 to 0.20 {0.0031 to 0.0079}	0.35 {0.014}	Reference value
		Between power take-off gear and power take-off idler gear B	0.08 to 0.20 {0.0031 to 0.0079}	0.35 {0.014}	Reference value
		Power take-off gear total backlash	0.12 to 0.32 {0.0047 to 0.0125}	—	Adjust or replace
3	Static friction torque		390 N·m {290 ft.lbs, 40 kgf·m} or more	—	Reference value

Ⓣ Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt	21 {15, 2.1}	—
6	Nut (power take-off idler shaft mounting)	295 {215, 30}	—



◆ Service procedure

● **Pre-disassembly inspection**

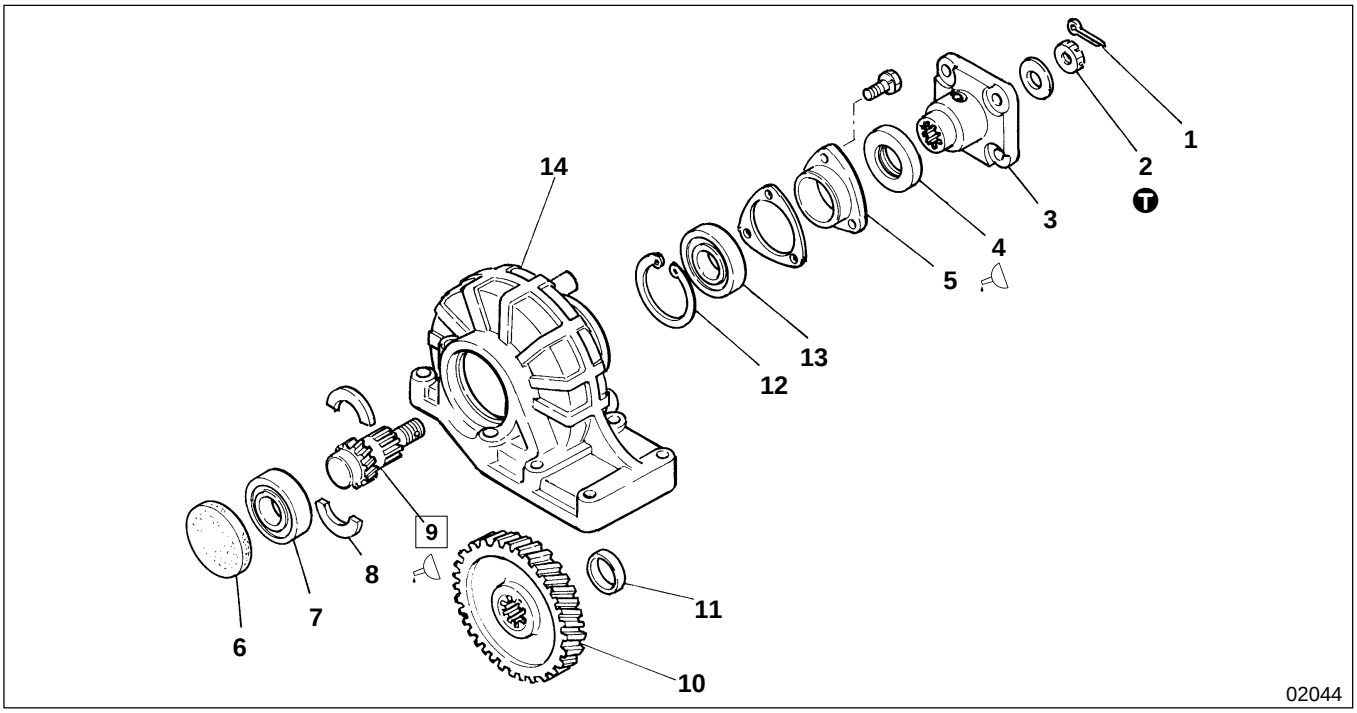
- **Backlash of gears**
  - Measure the total backlash of the power take-off idler gear A, No. 1 idler gear and power take-off gear on the 100 mm {3.94 in.} dia. pitch circle **A** at the power take-off flange section. If the measurement is out of the specification, correct with shim **4**.

    Thickness of available shims: 0.1, 0.2, 0.3 mm {0.0039, 0.0079, 0.012 in.}
  - Measure the backlash between the power take-off gear and power take-off idler gear **B** on the 100 mm{3.94 in.} dia. pitch circle at the power take-off flange section while holding the power take-off idler shaft **B**. If the measurement is out of the specification, correct with shim **4**.

    Thickness of available shims: 0.1, 0.2, 0.3 mm {0.0039, 0.0079, 0.012 in.}

FLYWHEEL POWER TAKE-OFF

Flywheel Power Take-Off Head Assembly



● **Disassembly sequence**

1 Split pin
2 Nut
3 Flange
4 Oil seal
5 Rear cover
6 Seal cap
7 Ball bearing
8 Cotter
9 Power take-off shaft
10 Power take-off gear
11 Spacer
12 Snap ring
13 Ball bearing
14 Cover

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Power take-off shaft end play	0 to 0.8 {0 to 0.031}	—	Replace

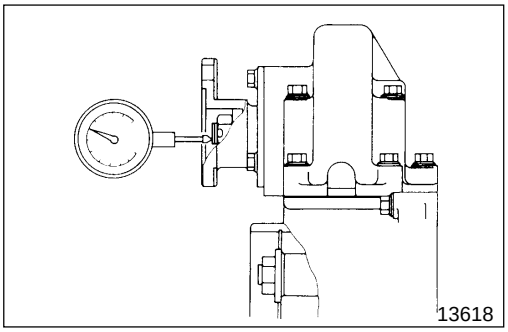
T Tightening torques

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (flange mounting)	125 {93, 12.8}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
4	Oil seal lip	Li-soap grease	As required
9	Power take-off spline	MITSUBISHI wheel bearing grease	As required

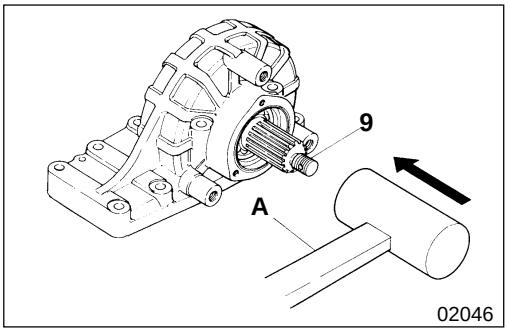


◆ Service procedure

● **Pre-disassembly inspection**

Power take-off shaft end play

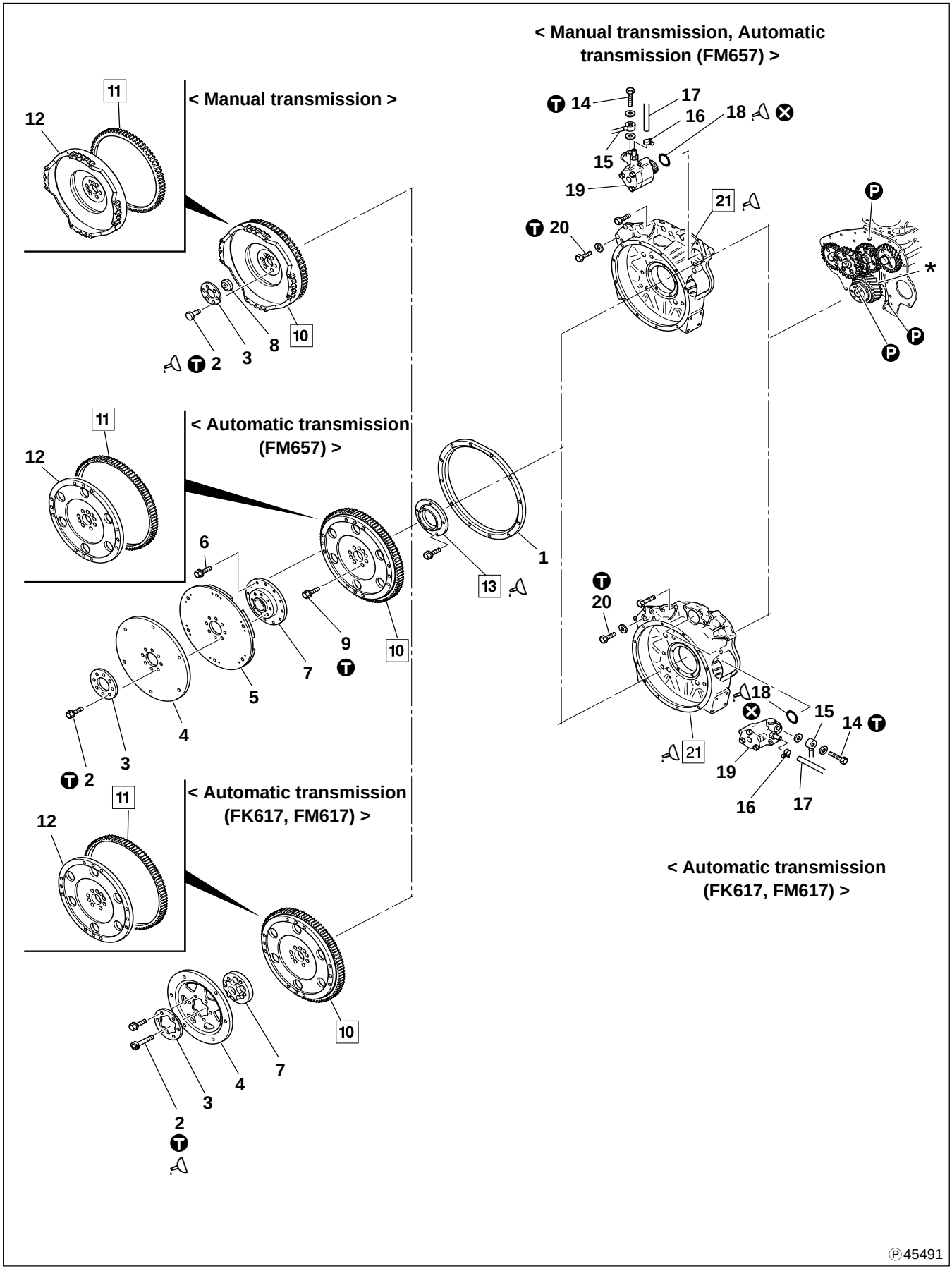
If the measurement exceeds the limit, replace the defective part(s).



9 **Removal of power take-off shaft**

A : Plastic hammer

FLYWHEEL


< Manual transmission, Automatic transmission (FM657) >
< Manual transmission >
< Automatic transmission (FM657) >
< Automatic transmission (FK617, FM617) >
< Automatic transmission (FK617, FM617) >
11
12
14
17
16
18
15
19
21
20
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13
Ⓟ 45491

● **Disassembly sequence**

1 Flywheel housing adaptor < Except for vehicles with M8 transmission >
2 Bolt
3 Washer plate
4 Flex plate < Automatic transmission >
5 Flex Plate assembly < Automatic transmission (FM657) >
6 Bolt < Automatic transmission (FM657) >
7 Flywheel adaptor < Automatic transmission >
8 Pilot bearing < Manual transmission >
9 Bolt < Automatic transmission (FM657) >
10 Flywheel assembly
11 Ring gear
12 Flywheel
13 Rear oil seal
14 Eye bolt
15 Power steering oil pipe
16 Clamp
17 Suction hose
18 O-ring
19 Power steering oil pump Gr 37
20 Plug
21 Flywheel housing

*: Crankshaft assembly P11-62
Ⓟ: Positioning pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
10	Flywheel assembly < Manual transmission >	Distortion of friction surface		0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Height from bolt mounting surface to friction surface	C6	20 {0.79}	19 {0.75}	Replace
			C7	26.5 {1.04}	25.5 {1.00}	Replace
		Runout of friction surface when installed		—	0.2 {0.0079}	Correct or replace
21	Eccentricity of when installed (flywheel housing out of round measurement)			—	0.2 {0.0079}	Inspect or replace

Ⓣ Tightening torque

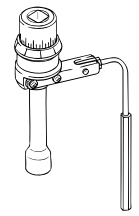
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened			Tightening torque	Remarks
2	Bolt	Manual transmission (Flywheel mounting)		98 {72, 10}+150°	Wet Reuse up to three times
		Automatic transmission	< FK617, FM617 (Flywheel mounting) >	250 {190, 26}	Wet
			< FM657 (Flex plate mounting) >	147 {110, 15}	—
6	Bolt (Flywheel adapter mounting)			74.5 {55, 7.6}	—
9	Bolt (Flywheel mounting)			98{72,103+150°}	Wet Reuse up to three times
14	Bolt (Power steering oil pipe mounting)			125 {94, 13}	—
20	Plug			88 {65, 9}	—

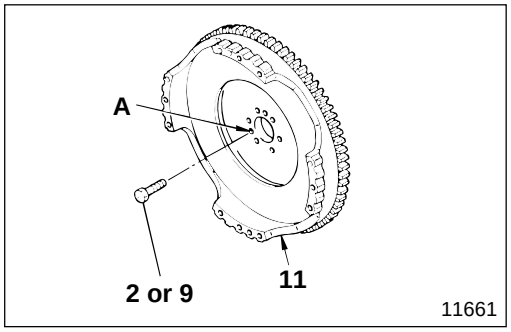
Lubricant and sealant

Location	Points of application	Kinds	Quantity
2	Thread area of bolt < Except Automatic transmission (FM657) >	Engine oil	As required
9	Thread area of bolt	Engine oil	As required
13	Lip area of rear oil seal	Engine oil	As required
	Flywheel housing mounting surface of rear oil seal	THREEBOND 1207C	As required
18	O-ring	Engine oil	As required
21	Engine mounting surface of flywheel housing	THREEBOND 1207C	As required

Special tools

Location	Tool name and shape	Part No.	Application
10	Socket wrench  01984	MH062354 (Obtain Locally)	Installation of flywheel assembly < Manual transmission, Automatic transmission (FM657) >
	Magnet base 00471	MH062356 (Obtain Locally)	

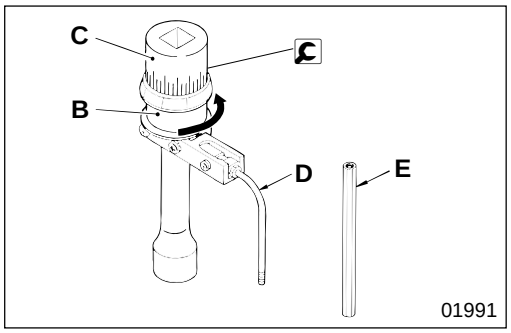
◆ Service procedure



11661

10 Flywheel assembly

[Removal]
Bolt **2** < Manual transmission, Automatic transmission (FK617, FM617) > or **9** into extraction hole **A** of flywheel assembly **10** to remove the flywheel assembly.



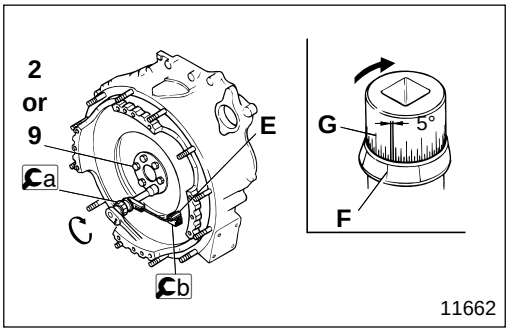
01991

[Installation]
< Manual transmission, Automatic transmission (FM657) >

- Center punch the head of bolt **2** < Manual transmission > or **9** before re-using.

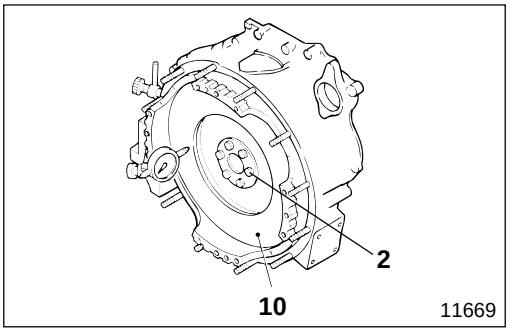
CAUTION
If there are three punches already, replace with a new bolt.

- After tightening bolt **2** < Manual transmission > or **9** at specified torque, tighten further as follows :
- Turn socket wrench holder **B** counterclockwise and maintain spring tension in the wrench.
  C : Socket
  D : Rod
  E : Rod (for connection)



11662

- Set [a] socket wrench holder **B** so that extension rod **E** maintains contact against [b] magnetic base.
- Select a scale that is convenient for reading graduation **F** on holder **B** side.
- Tighten further by turning the socket clockwise by 150° (setting is in 5° increments) referring to graduation **G** on the selected scale.

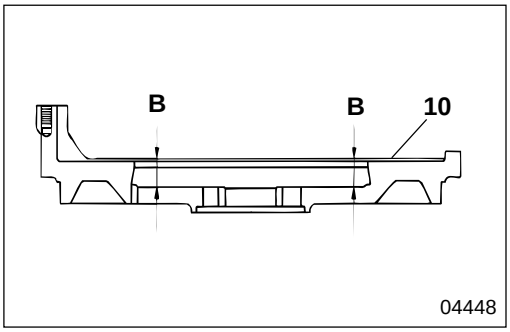


11669

[Inspection]
< Manual transmission >

(1) Runout

If the measured value is higher than the limit, check the fastening of bolt **2**, the attachment surface of crankshaft assembly, and depending on the condition found, either repair or replace flywheel assembly **10**.

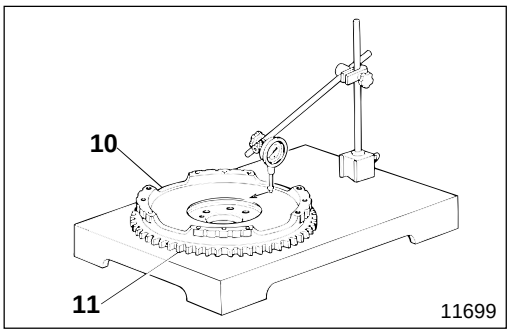


04448

(2) Thickness of friction surfaces

If the measured value is lower than the limit, repair or replace flywheel assembly **10**.

B : Thickness from bolt mounting surface to friction surface



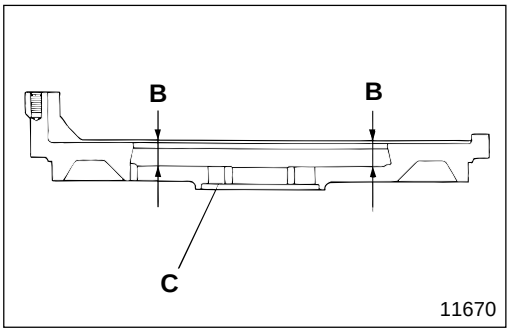
11699

(3) Distortion of friction surface

If the measured value is lower than the limit, repair or replace flywheel assembly **10**.

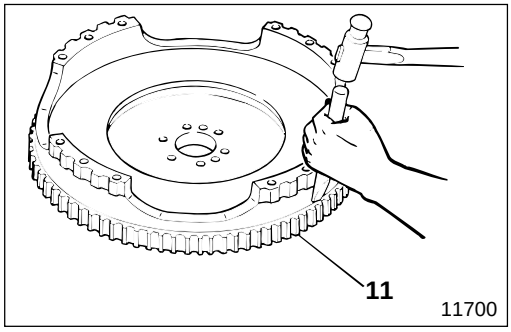
NOTE

If any fault is found in ring gear 11, replace it first, then begin the inspection.



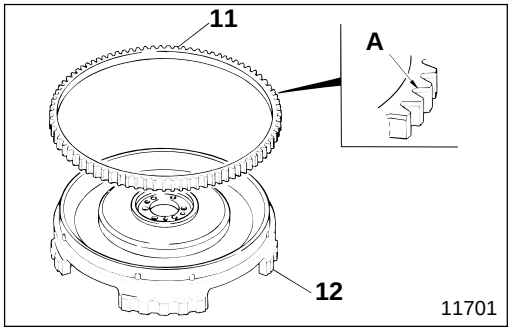
11670

[Correction]
Make sure when grinding the friction surfaces for correction, that height **B** is not lower than the limit while remaining parallel with surface **C** within 0.1 mm {0.0039 in.}.

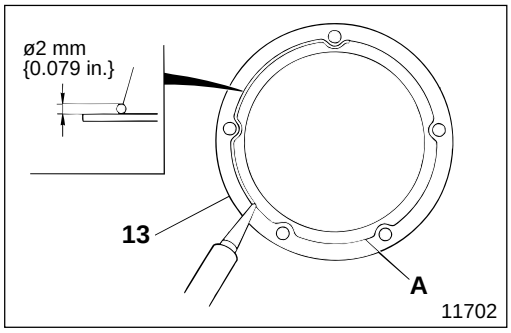


11 **Ring gear**

[Inspection]
Check and see if there is any damage, wear or other fault, and if any fault is found, replace ring gear **11**.
[Removal]
- Heat up ring gear **11** evenly using an acetylene torch.
- Hammer the outer edge of ring gear **11** evenly until it drops off.



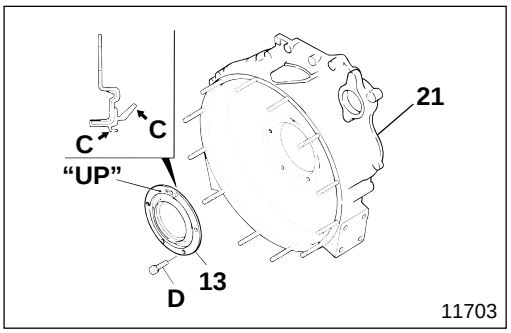
[Installation]
- Heat up ring gear **11** using a piston heater to approximately 100°C {212°F} for three minutes.
- With the side of the chamfered teeth of ring gear **11** facing you, mount it on flywheel **12**.
  A : Chamfered ring gear side



13 **Installation of rear oil seal**

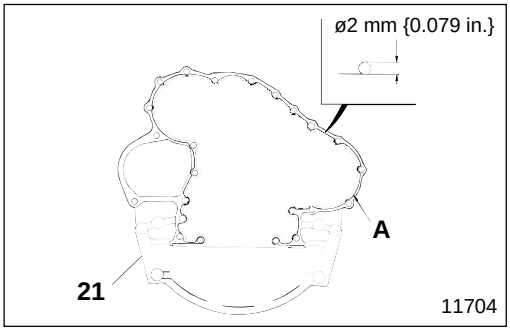
- Apply sealant **B** along line **A** of rear oil seal **13** evenly without break.

CAUTION
- **Be sure the surface of rear oil seal 13, where sealant is to be applied, is clean.**
- **Be sure not to disturb the sealant during installation.**
- **Do not start the engine for at least 30 minutes after installing rear oil seal 13.**
- **Be sure to reapply sealant B if the mounting bolts of rear seal 13 are loosened.**



- Apply engine oil to lip area **C** of rear oil seal **13**.
- Install rear oil seal **13** into flywheel housing **21** in the direction as illustrated.

CAUTION
Be sure to reapply sealant B if bolts D (for mounting rear oil seal 13) are loosened or removed by any cause whatsoever after mounting.



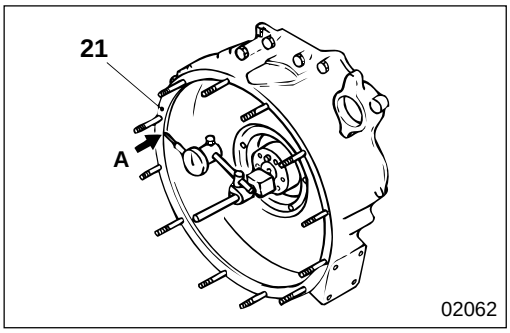
21 **Flywheel housing**

[Installation]

- Apply an even, unbroken bead of sealant **A** to the mounting surface of flywheel housing **21**, where the crankcase is to be installed.
- After applying sealant **A**, within three minutes, mount flywheel housing **21** to the crankcase.

CAUTION

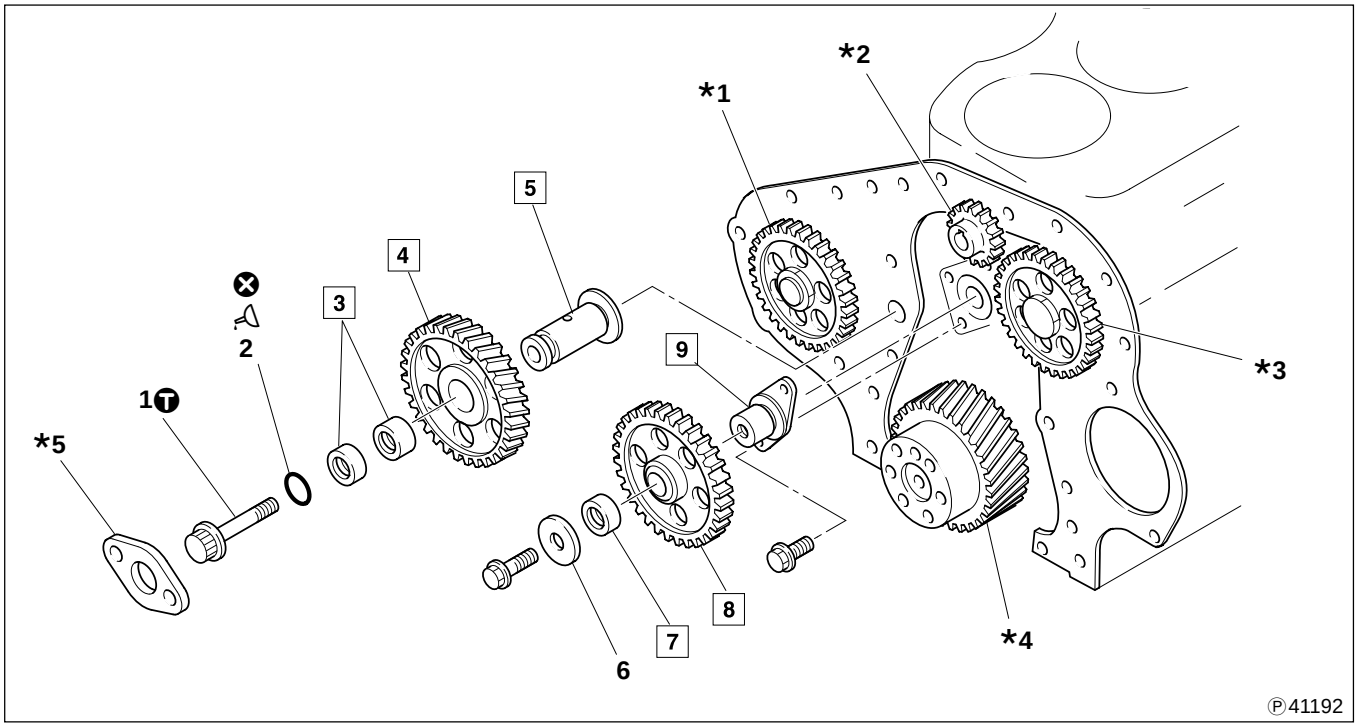
- **Be sure the surface of flywheel housing 21, where the sealant is to be applied, is clean.**
- **Be sure not to disturb the sealant during installation.**
- **Do not start the engine for at least 1 hour after installing flywheel housing 21.**
- **Be sure to reapply sealant A if the mounting bolts of rear seal 21 are loosened.**



[Inspection]

- Turn crankshaft * and measure the amount of eccentricity (out-of-roundness) at mating recession **A** of flywheel housing **21**.
- Reassemble if the amount of eccentricity exceeds the limit.
- If the amount of eccentricity exceeds the limit after reassembly, replace the faulty parts.

TIMING GEAR



● **Pre-disassembly inspection**

P11-53

● **Disassembly sequence**

1 Bolt
2 O-ring
3 No. 1 idler gear bushing
4 No. 1 idler gear
5 No. 1 idler shaft
6 Thrust washer
7 No. 2 idler gear bushing
8 No. 2 idler gear
9 No. 2 idler shaft

***1** Drive gear
***2** Power steering oil pump gear
***3** Camshaft gear P11-56
***4** Crankshaft gear P11-62
***5** Thrust plate P11-62

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
—	Gear backlash	Between No. 1 idler gear and crankshaft gear	0.07 to 0.20 {0.0028 to 0.0079}	0.35 {0.014}	Replace
		Between No. 1 idler gear and No.2 idler gear	0.10 to 0.20 {0.0039 to 0.0079}	0.35 {0.014}	Replace
		Between No. 1 idler gear and drive gear	0.10 to 0.20 {0.0039 to 0.0079}	0.35 {0.014}	Replace
		Between No. 2 idler gear and camshaft gear	0.12 to 0.26 {0.0047 to 0.010}	0.35 {0.014}	Replace
		Between No. 2 idler gear and power steering oil pump gear	0.06 to 0.17 {0.0024 to 0.0067}	0.35 {0.014}	Replace
		Between camshaft gear and power steering oil pump gear	0.06 to 0.17 {0.0024 to 0.0067}	0.35 {0.014}	Replace
3, 5	No. 1 idler gear bushing-to-idler shaft clearance		[40 {1.57}] 0.03 to 0.07 {0.0012 to 0.0028}	0.2 {0.0079}	Replace
4	No. 1 idler gear end play		0.1 to 0.6 {0.0039 to 0.024}	1.0 {0.03937}	Replace
7, 9	No. 2 idler gear bushing-to-idler shaft clearance		[32 {1.26}] 0.01 to 0.05 {0.00039 to 0.0020}	0.2 {0.0079}	Replace
8	No. 2 idler gear end play		0.05 to 0.20 {0.002 to 0.0079}	0.4 {0.016}	Replace

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

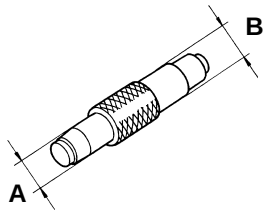
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (No. 1 idler shaft installation)	135 to 165 {100 to 120, 14 to 17}	—

Lubricant

Location	Points of application	Specified lubricant	Quantity
2	Entire periphery of O-ring	Engine oil	As required

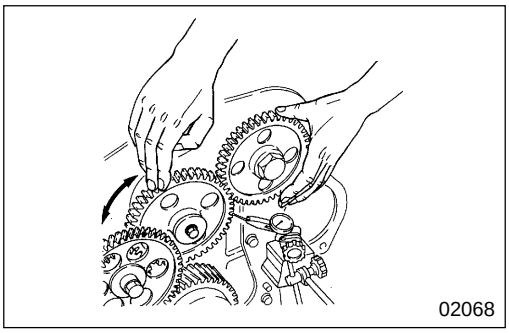
Special tools

Unit: mm

Location	Tool name and shape	Part No.	Application
3, 7	Idler Gear Bushing Remover/Installer  02066	< No. 1 > MH061228 < No. 2 > MH061779	Removing and fitting idler gear bushings

	A	B
No. 1 idler gear bushing	ϕ 40 {1.57}	ϕ 44 {1.73}
No. 2 idler gear bushing	ϕ 32 {1.26}	ϕ 35 {1.38}

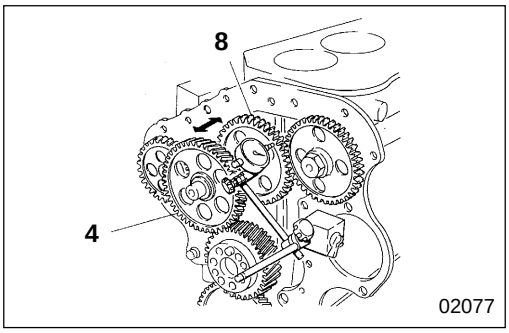
◆ Service procedure


02068

● Pre-disassembly inspection

(1) Gear backlash

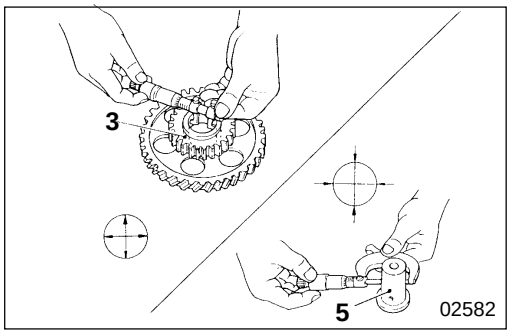
For each gear pair, measure backlash at three or more points. If any measurement exceeds the specified limit, replace the defective part(s).



02077

(2) No. 2 idler gear end play

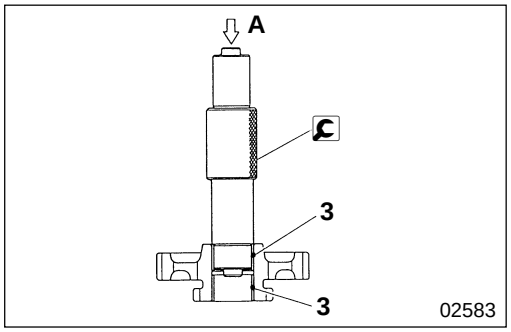
If the measurement exceeds the specified value, replace the defective part(s).



3 **5** **No. 1 idler shaft and No. 1 idler gear bushing**

[Inspection]

If the clearance exceeds the specified limit, replace the defective part(s).

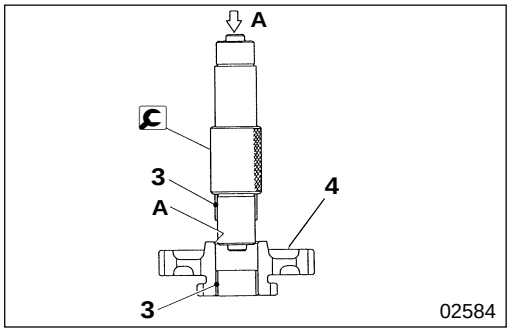


No. 1 idler gear bushing

[Removal]

The No. 1 idler gear bushing **3** consists of two pieces. Remove them at the same time.

A : Press

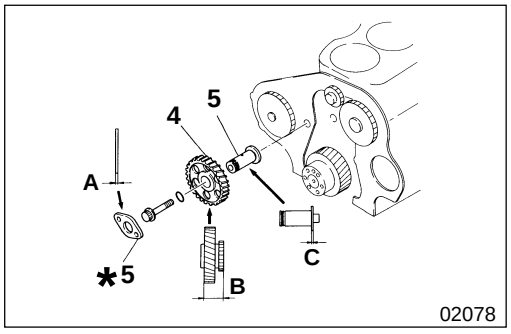


[Installation]

- Using the Idler Gear Bushing Installer, press-fit both pieces of No. 1 idler gear bushing **3** into the No. 1 idler gear **4** at the same time from the upper and lower sides.

  A: Press

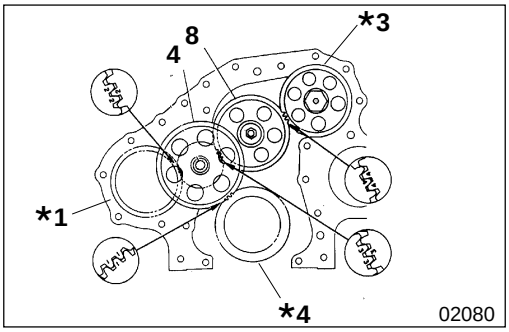
- After installation, measure the clearance again. If the measurement is below the nominal value range, ream the bushing **3**.



4 **No.1 idler gear end play**

Measure the illustrated dimensions of the parts, then calculate the end play **D**. If the end play exceeds the limit, replace the defective part(s).

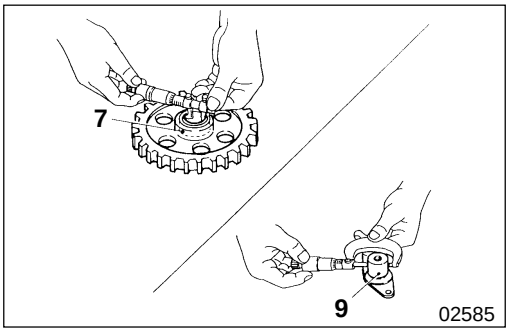
72.15 mm {2.84 in.} – (A + B + C) = D



4 **8** **Installation of No. 1 and No. 2 idler gears**

- Fit the idler gears **4**, **8** such that their alignment marks "**1**", "**2**", "**3**" and "**4**" are aligned with the corresponding alignment marks.

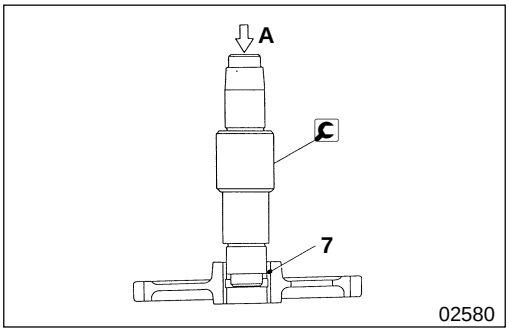
  ***1** : Drive gear
  ***3** : Camshaft gear
  ***4** : Crankshaft gear



7 **9** **No. 2 idler gear bushing and No. 2 idler shaft**

[Inspection]

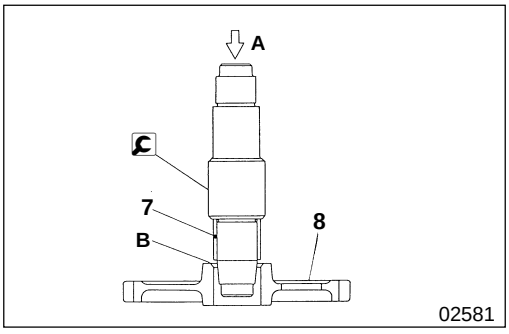
If the clearance exceeds the specified limit, replace the defective part(s).



No. 2 idler gear bushing

[Removal]

A : Press



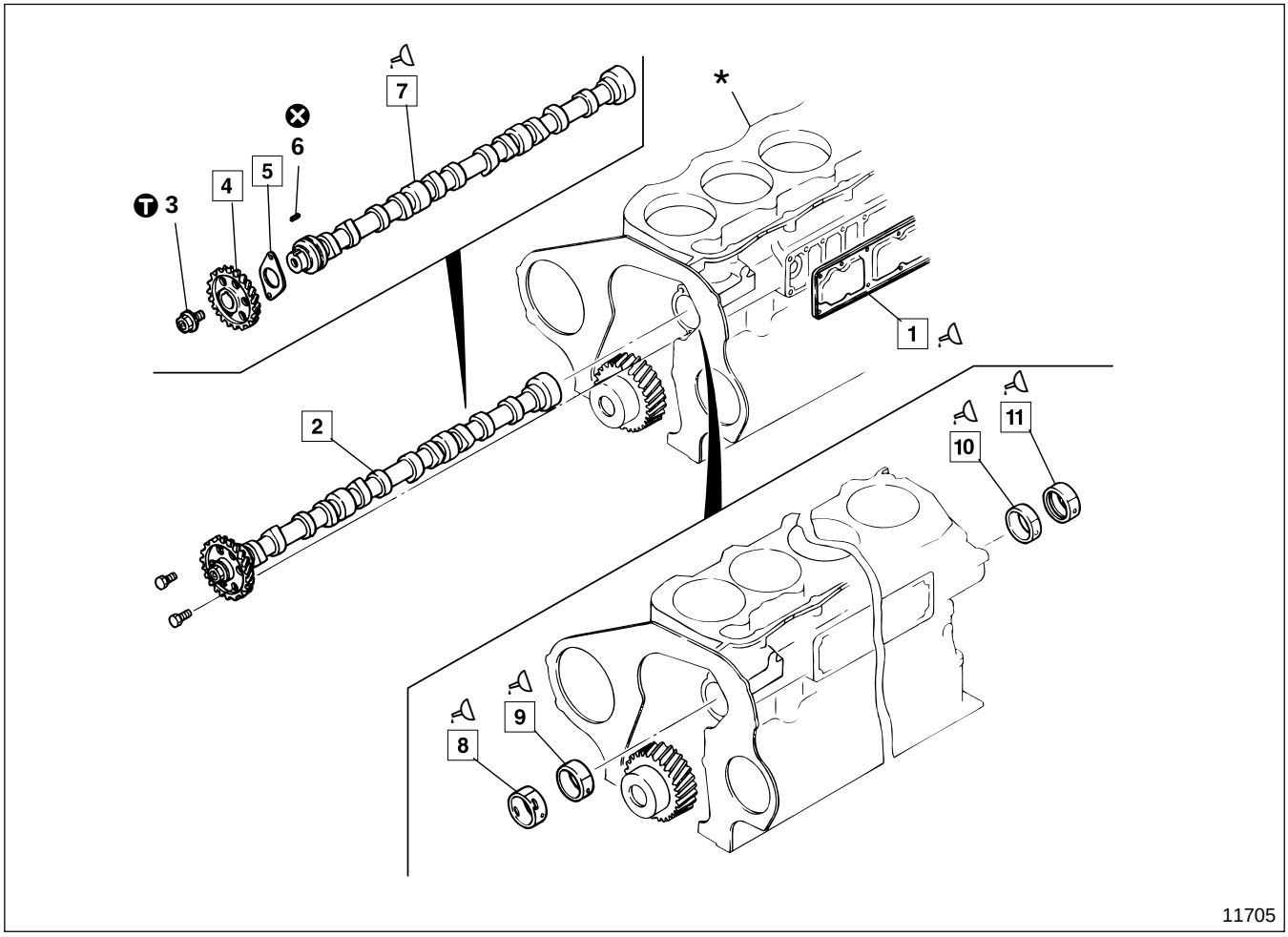
[Installation]

- Press-fit the No. 2 idler gear bushing **7** into the No. 2 idler gear **2** using the Idler Gear Bushing Installer. Install the bushing with the chamfered side **B** toward the gear.

  A : Press

- After installation, measure the clearance again. If the measurement is below the nominal value range, ream the No. 2 idler gear bushing **7**.

CAMSHAFT



● **Inspection before disassembly**

📖 P11-58

● **Disassembly sequence**

1 Side cover
2 Camshaft assembly
3 Bolt
4 Camshaft gear
5 Thrust plate
6 Key
7 Camshaft
8 No.4 camshaft bushing
9 No.3 camshaft bushing
10 No.2 camshaft bushing
11 No.1 camshaft bushing

***** : Crankcase 📖 P11-62

NOTE

Do not remove camshaft gear 4 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
—	End play of camshaft assembly			0.05 to 0.22 {0.0020 to 0.0087}	0.4 {0.016}	Check related items
7	Camshaft	Difference between long and short diameters	Inlet	6.901 {0.26}	6.40 {0.25}	Long diameter : 49.011 {1.93} Short diameter : 42.110 {1.66}
			Exhaust	7.680 {0.30}	7.18 {0.28}	Long diameter : 49.307 {1.94} Short diameter : 41.627 {1.64}
		Bend		0.02 {0.00079} or less	0.04 {0.0016}	Replace
7 to 11	Clearance between camshaft and camshaft bushing		At No.1 journal	[57.75] 0.05 to 0.10 {[2.27] 0.0020 to 0.0039}	0.25 {0.0098}	Replace
			At No.2 journal	[58.00] 0.05 to 0.10 {[2.28] 0.0020 to 0.0039}		
			At No.3 journal	[58.25] 0.13 to 0.18 {[2.29] 0.0051 to 0.0071}		
			At No.4 journal	[58.50] 0.05 to 0.10 {[2.30] 0.0020 to 0.0039}		

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

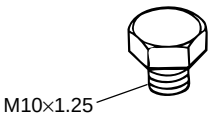
Location	Parts to be tightened	Tightening torque	Remarks
3	Bolt (Camshaft gear mounting)	175 {130, 18}	—

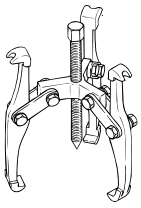
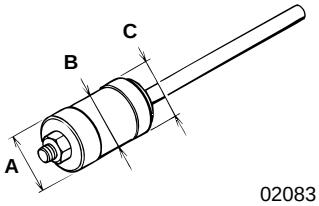
Lubricant and sealant

Location	Points of application	Kinds	Quantity
1	Contact surface of side cover to crankcase	THREEBOND 1207C	As required
7	Journal of camshaft	Engine oil	As required
8 to 11	Interior of camshaft bushing	Engine oil	As required

Special tools

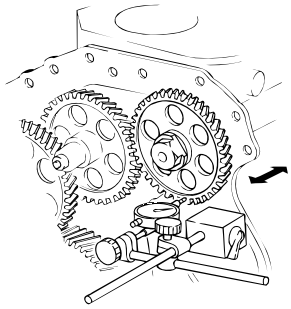
Unit : mm {in.}

<table>
<tr><th>Location</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td rowspan="2">4</td><td>Plug
 

02082</td><td>MF665007
(Obtain Locally)</td><td>Blind plug for removal of camshaft gear</td></tr>
<tr><td>Gear puller
 
02065</td><td>MH061326
(Obtain Locally)</td><td>Removal of camshaft gear</td></tr>
<tr><td>8 to 11</td><td>Camshaft bushing installer and extractor
<table>
<tr><th></th><th>Dimensions A,C</th><th>Dimension B</th></tr>
<tr><td>No. 1</td><td>ø62.00 {2.44}</td><td>ø57.75 {2.27}</td></tr>
<tr><td>No. 2</td><td>ø62.25 {2.45}</td><td>ø58.00 {2.28}</td></tr>
<tr><td>No. 3</td><td>ø62.50 {2.46}</td><td>ø58.25 {2.29}</td></tr>
<tr><td>No. 4</td><td>ø62.75 {2.47}</td><td>ø58.50 {2.30}</td></tr>
</table>


02083</td><td>MH062025
(Obtain Locally)</td><td>Removal and installation of camshaft bushing</td></tr>
</table>

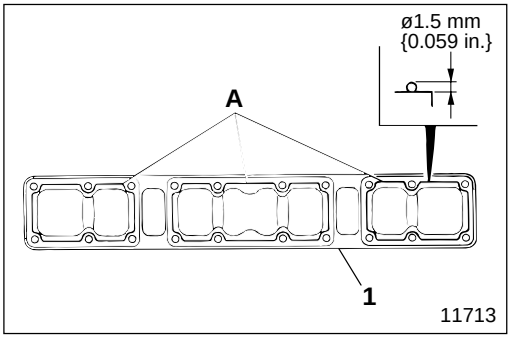
◆ Service procedure


02084

● Inspection before disassembly

Camshaft end play

If the measured value is higher than the limit, replace the thrust plate.

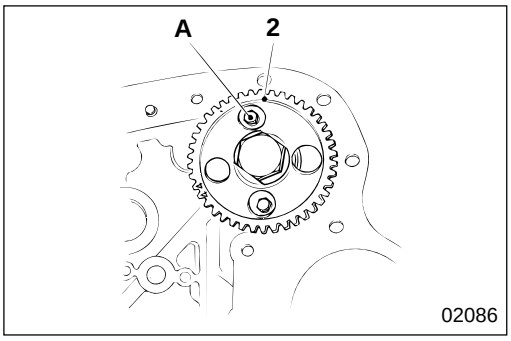


1 Installation of side cover

- Apply sealant **A** to the mounting surface of side cover **1**, evenly without break.
- After applying sealant **A**, within three minutes, mount side cover **1** to the crankcase.

CAUTION

- **Be sure the surface of side cover 1, where the sealant is to be applied, is clean.**
- **Be sure not to disturb the sealant during installation.**
- **Do not start the engine for at least 1 hour after installing side cover 1.**
- **Be sure to reapply sealant A if the mounting bolts of side cover 1 are loosened.**



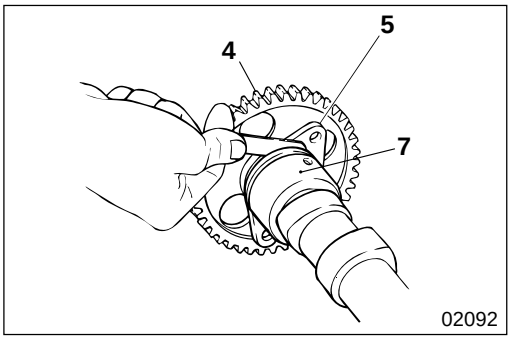
2 Camshaft assembly

[Removal]

- To remove camshaft assembly **2** first remove side cover **1**.
- Then, remove bolt **A** from the hole in camshaft gear **8**, then withdraw camshaft assembly **2** slowly, supporting it with your hand.

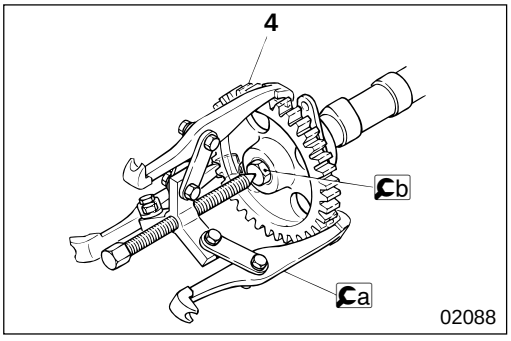
CAUTION

Be careful not to damage camshaft bushings 12 to15 when you remove camshaft assembly 2.



[Installation]

- Before installing camshaft assembly **2**, measure the end play between thrust plate **5** and camshaft **7**.
- If the measured value is higher than the limit, replace thrust plate **5**.
- Install the camshaft assembly by matching the alignment mark on camshaft gear **4** with the alignment mark on the No.2 idler gear. P11-55

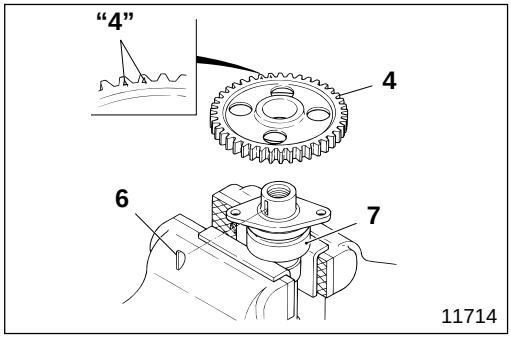


4 Camshaft gear

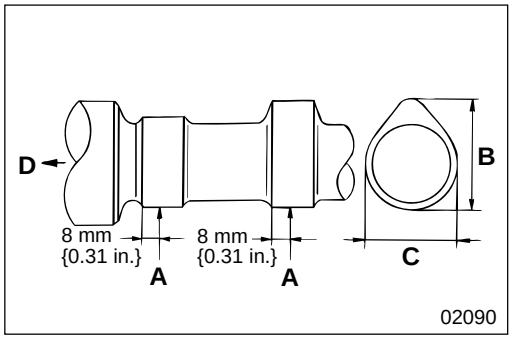
[Removal]

CAUTION

Never remove camshaft gear 4 by striking, hitting or hammering it.



[Installation]
- Install camshaft gear **4** onto camshaft **7** in the direction as illustrated.
- Be sure when finishing the installation to install key **6**.



7 Inspection of camshaft

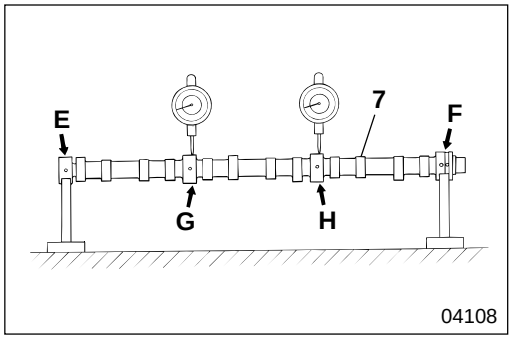
(1) Difference between short diameter and long diameter

If the measured value is lower than the limit, replace camshaft **7**.

NOTE

Measure at point A as illustrated, because the cam is tapered.

B : Long diameter
C : Short diameter
D : Front of the engine

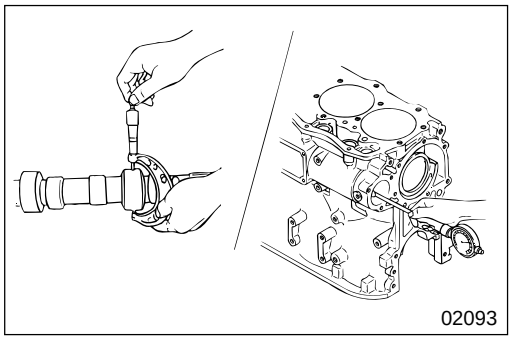


(2) Degree of bend

To measure bend, support camshaft **7** at area **E** of No.1 journal, and area **F** of No.4 journal. Then, measure the amount of bend at area **G** of No.2 journal and area **H** of No.3 journal. If any of the measured values are higher than the limit, replace the camshaft.

NOTE

The degree of bend of camshaft 7 is half of the indicated value of the gauge after rotating the shaft 360°.

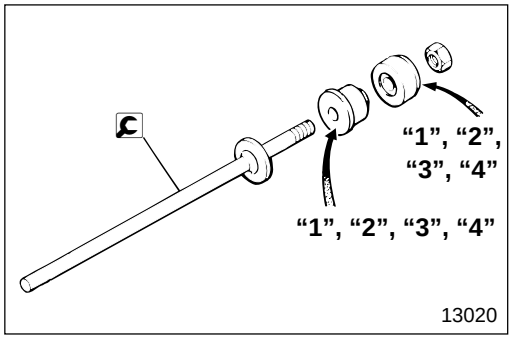


7 to 11 Camshaft and camshaft bushing

[Inspection]
If the measured value is higher than the limit, replace the faulty parts.

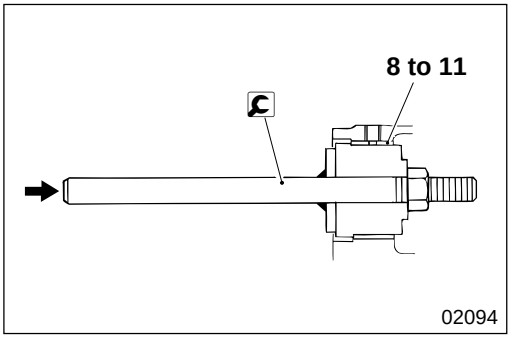
NOTE

Measure bushings 8 to 11 mounted in crankcase.



To remove or install the camshaft bushings, use 🔧 camshaft bushing installers and extractors, which have identification numbers "**1**", "**2**", "**3**" and "**4**" to identify the corresponding bushing.

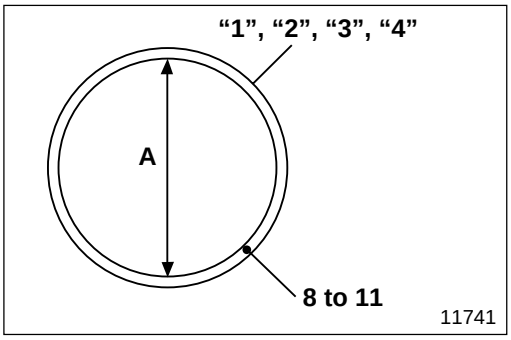
Bushing No. (From engine front)	Identification marks
1	**1**
2	**2**
3	**3**
4	**4**



Camshaft bushing

[Removal]

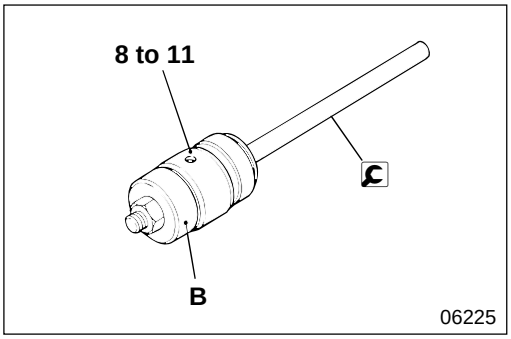
Remove No.4, 3 camshaft bushings **8**, **9** from the rear end of the engine, and No.2, 1 camshaft bushings **10**, **11** from the front end of the engine.



[Press-fitting]

- Identification numbers "**1**", "**2**", "**3**" or "**4**" on camshaft bushings **8** to **11** indicate the corresponding camshaft numbers. If the number is not clear, measure the bushing inner diameter and identify the corresponding camshaft number by referring to the table below :

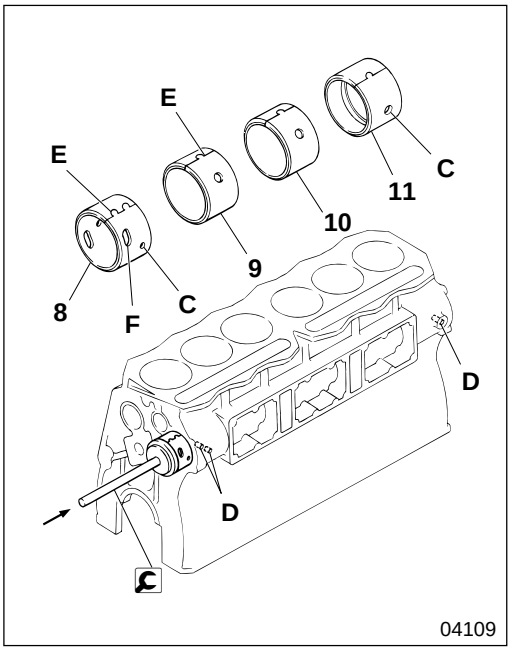
Bushing No. (From engine front)	Identification number	Inner diameter mm {in.}
No. 1	1	57.75 {2.27}
No. 2	2	58.00 {2.28}
No. 3	3	58.25 {2.29}
No. 4	4	58.50 {2.30}



- For press-fitting, mount guide **B** to camshaft bushing installer and extractor.
- Install camshaft bushings **8** to **11** in descending order from No.3 to 1.

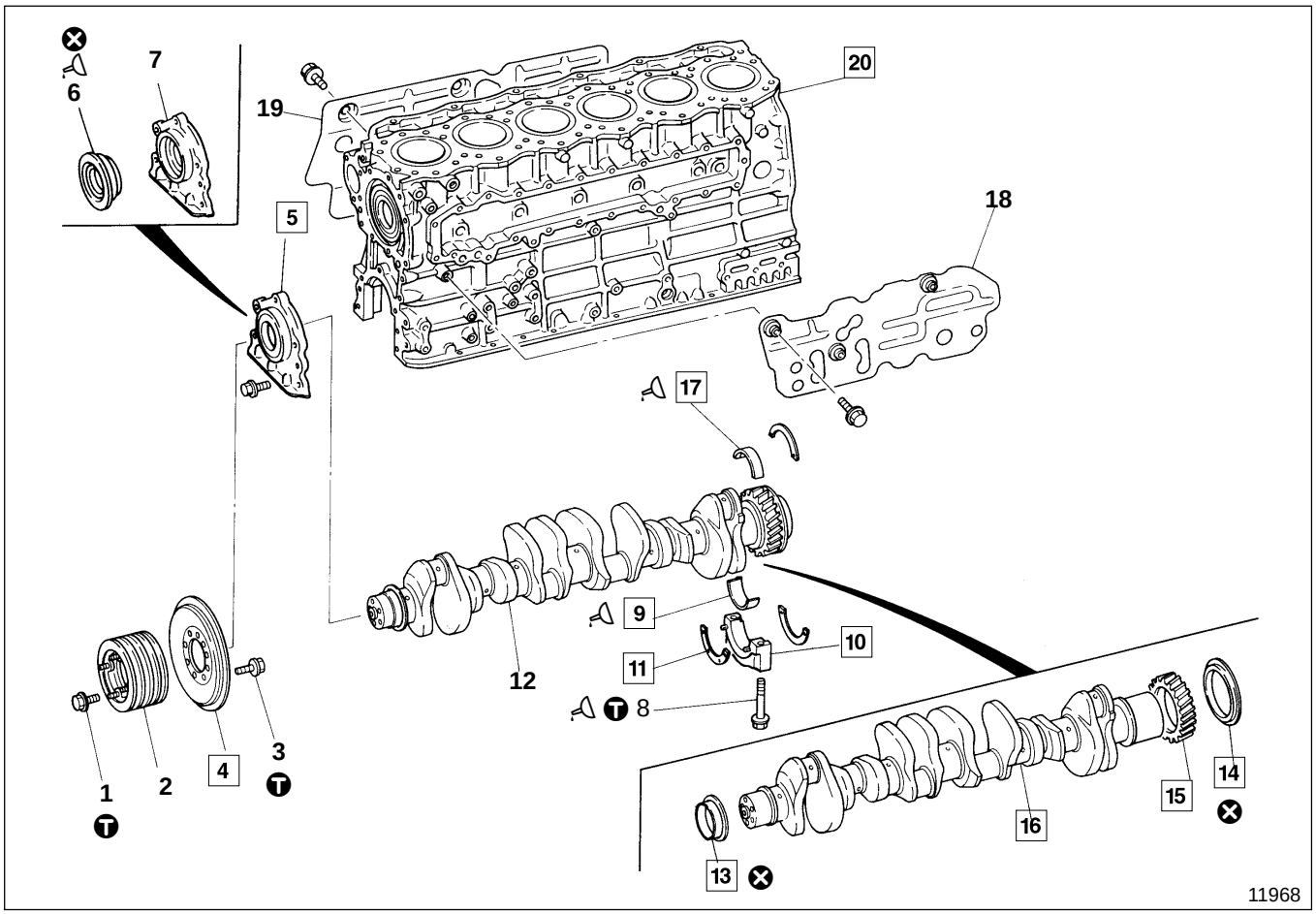
NOTE

Install No.3, 4 camshaft bushings 9, 8 from the rear end of the engine, and No.2, 1 camshaft bushings 10, 11 from the front end of the engine.



- Install the camshaft bushings by aligning bushing oil port **C** and crankcase oil port **D** at No.1 camshaft bushing **11**, and No.4 camshaft bushing **8**.
  Position bushing No.4 so that the oblong side of oil port **F** comes to the rear of the engine and press bushing No.4 in.
  E : Butting area of bushing

CRANKSHAFT AND CRANKCASE



● **Pre-disassembly inspection**

P11-65

● **Disassembly sequence**

1 Bolt
2 Crankshaft pulley
3 Bolt
4 Torsional damper
5 Front cover assembly
6 Front oil seal
7 Front cover
8 Bolt
9 Lower main bearing
10 Main bearing cap
11 Thrust plate
12 Crankshaft assembly
13 Front oil seal slinger
14 Rear oil seal slinger
15 Crankshaft gear
16 Crankshaft
17 Upper main bearing
18 Crankcase cover LH
19 Crankcase cover RH
20 Crankcase

⊗ : Non-reusable part

CAUTION ⚠

Do not remove the front oil seal slinger 13, rear oil seal slinger 14 and crankshaft gear 15.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
9, 17	Main bearing	Oil clearance		[80 {3.15}] 0.05 to 0.10 {0.0020 to 0.0039}	0.15 {0.0059}	Replace
		Span when free		—	Less than 85.5 {3.366}	Replace
16	Crankshaft	End play		0.10 to 0.25 {0.0039 to 0.0098}	0.4 {0.016}	Replace
		Bend		0.025 {0.00098} or less	0.1 {0.0039}	Correct or replace
		Pin and journal	Roundness	0.01 {0.00039} or less	0.03 {0.0012}	Correct or replace
			Taper	0.006 {0.00024} or less	—	Correct or replace
20	Crankcase top surface distortion			0.07 {0.0028} or less	0.2 {0.0079}	Replace

Tightening torques

Unit: N·m {ft.lbs, kgf·m}

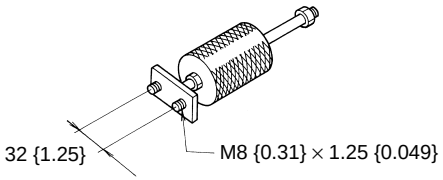
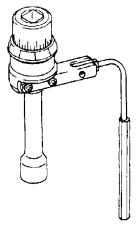
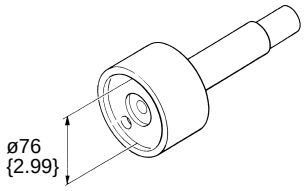
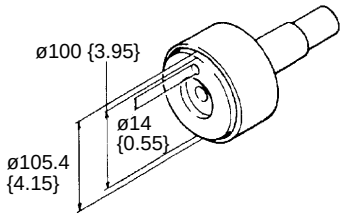
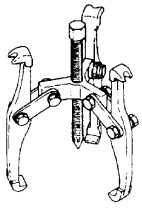
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (crankshaft pulley installation)	185 {135, 19}	—
3	Bolt (torsional damper installation)	78 {58, 8}	—
8	Bolt (main bearing cap installation)	78 {58, 8}+90°	• Wet • Reusable up to three times

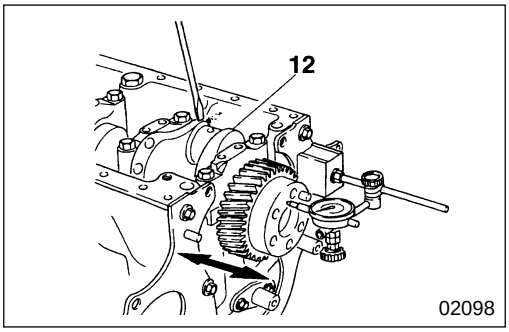
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
5	Front cover assembly surface in contact with crankcase	Threebond 1207C	As required
6	Front oil seal lip	Engine oil	As required
8	Bolt threads	Engine oil	As required
9, 17	Main bearing inside surfaces	Engine oil	As required

Special tools

Unit: mm {in.}

Location	Tool name and shape	Part No.	Application
10	Main Bearing Cap Extracter  02097	(Use locally purchased equivalent)	Removing main bearing caps
	Socket Wrench  01984	(Use locally purchased equivalent)	Fitting main bearing caps
13	Front Oil Seal Slinger Installer  13625	MH062710	Installing front oil seal slinger
14	Rear Oil Seal Slinger Installer  02051	MH061470	Installing rear oil seal slinger
15	Gear Puller  02065	(Use locally purchased equivalent)	Removing crankshaft gear

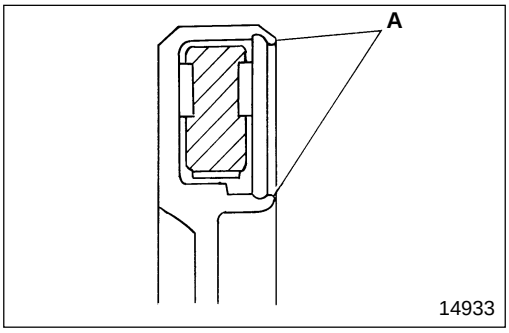


◆ Service procedure

● **Pre-disassembly inspection**

Crankshaft end play

If the measurement exceeds the specified limit, replace the defective part(s).

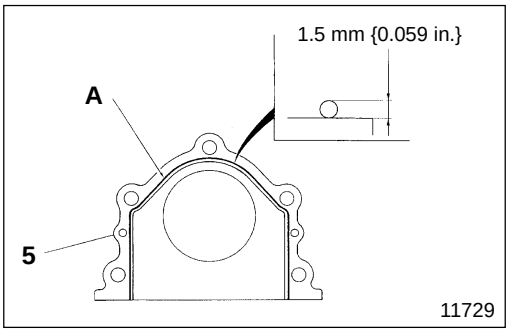


4 **Torsional damper**

CAUTION ⚠

The torsional damper is of a viscous type and filled with silicone oil. It can cause oil leaks at the staked portion A and thereby fail to function properly if handled roughly. To prevent this, pay attention to the following:

- **Ensure that the staked portion A is free from dents and other damages.**
- **Never give shocks such as by hammering or dropping it.**
- **Avoid trundling or stacking with heavy objects.**

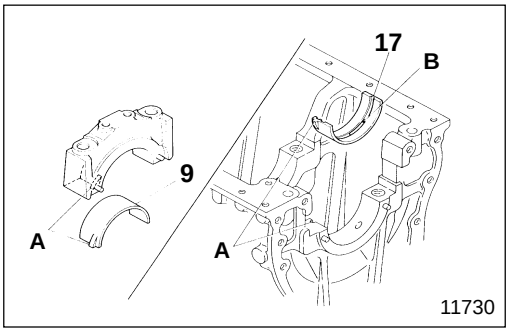


5 **Installation of front cover assembly**

- Apply an even, unbroken bead of sealant **A** to the surface of the front cover assembly **5** that contacts the crankcase **20** when installed.
- Fit the front cover assembly **5** onto the crankcase **20** within 3 minutes of applying the sealant **A**.

CAUTION ⚠

- **Ensure that the sealant application area on the front cover assembly 5 is clean before applying sealant.**
- **When fitting the front cover assembly 5, hold it firmly in position to prevent spreading the sealant.**
- **After fitting the front cover assembly 5, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant A whenever the mounting bolts of the front cover assembly 5 have been loosened.**



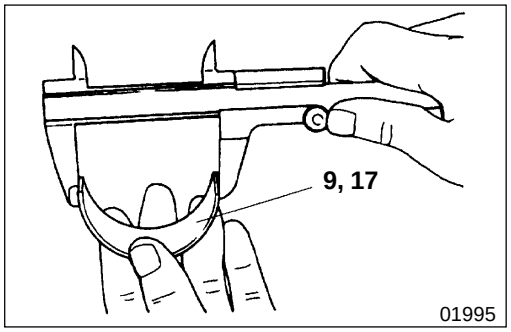
9 **17** **Main bearings**

[Installation]

Install the main bearings **9**, **17** such that their tangs **A** fit into the corresponding grooves.

CAUTION ⚠

The upper main bearing 17 has an oil hole B. The lower main bearing 9 has no oil hole. Take care not to confuse the upper and lower parts.



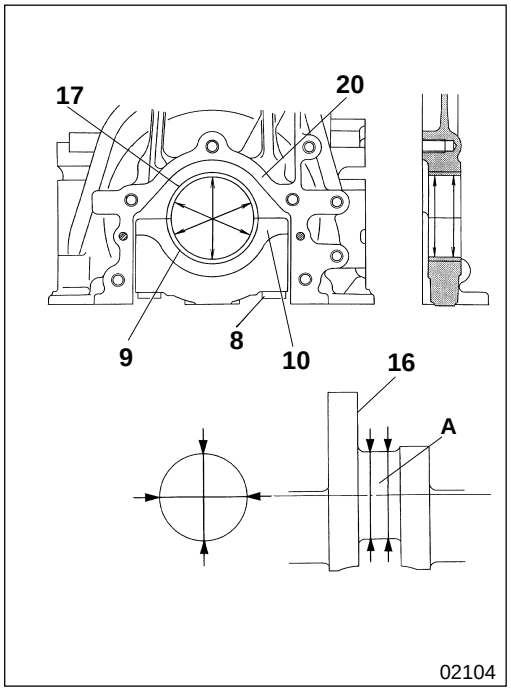
[Inspection]

CAUTION ⚠

- **Do not attempt to manually expand either bearing 9, 17 if its span is insufficient.**
- **Upper and lower bearings 9, 17 must be replaced as a set.**

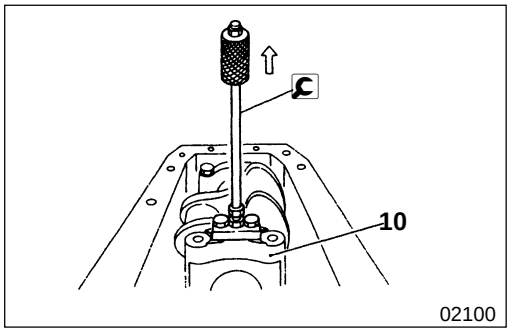
(1) Span when free

If either bearing's span when free exceeds the specified limit, the bearings **9**, **17** must be replaced.



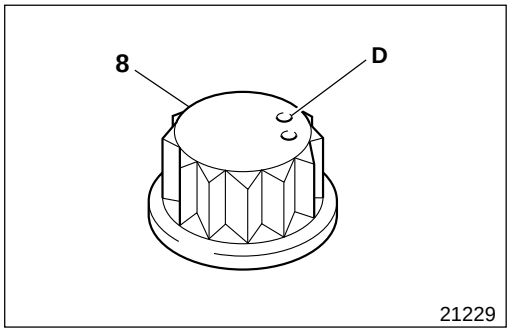
(2) Main bearing-to-crankshaft clearance

- Fit the upper main bearing **17** into the crankcase **20** and the lower main bearing **9** into the main bearing cap **10**. Then, tighten the bolts **8** to their specified torque.
- Measure the internal diameters of the main bearings **9**, **17** and the journal outside diameter **A** of the crankshaft **16**. If the clearance exceeds the specified limit, replace the defective part(s).



10 Main bearing caps

: Main Bearing Cap Extractor

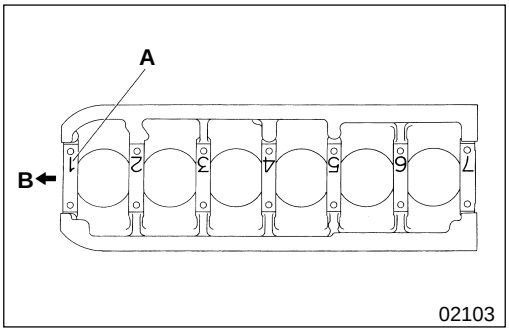


[Installation]

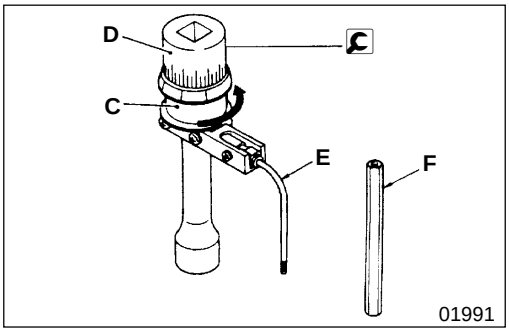
Centerpunch the head of the main bearing cap bolt.

CAUTION ⚠

- **Before fitting any bolt 8, check the punch marks D on its head. Do not use the bolt if there are more than three punch marks.**
- **The punch marks indicate the number of times each bolt has been tightened using the plastic area tightening method. Any bolt that already has three punch marks must be replaced.**

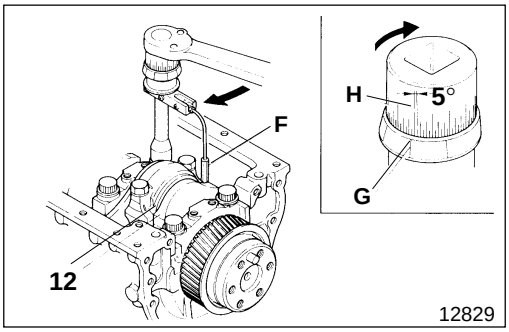


- Starting at the front of the engine **B**, fit the main bearing caps **10** in the order of the numbers **A** embossed on them and such that the numbers are in the positions illustrated.



- Tighten the bolts **8** to the specified torque. Then, turn the bolts further in accordance with the following procedure:
- Turn the holder **C** of the Socket Wrench counter-clockwise to maintain spring tension in the wrench.

  D : Socket
  E : Rod
  F : Rod (extension)

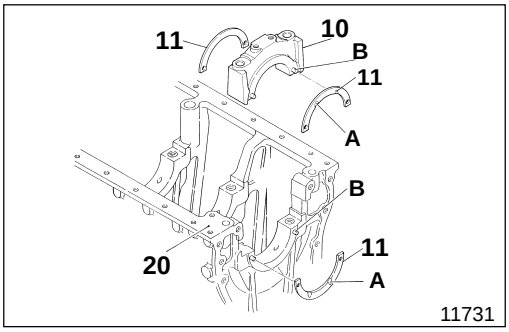


- Set the socket wrench such that the built-in spring forces the rod (extension) **F** against the crankshaft assembly **12**.
- Align any inscribed line **G** on the holder **C** with any inscribed line **H** on the socket. (Use this point as reference 0° position.)
- From the above reference position, turn the socket **D** by 90° clockwise. (One gradation on the scale represents 5°.)

CAUTION ⚠

By performing the above procedure, the bolt 8 is tightened to the plastic area. Do no attempt to tighten further after turning specified angle.

- After tightening, perform the following checks:
  - Turn the crankshaft by hand to check for smooth rotation.
  - Measure the crankshaft end play.



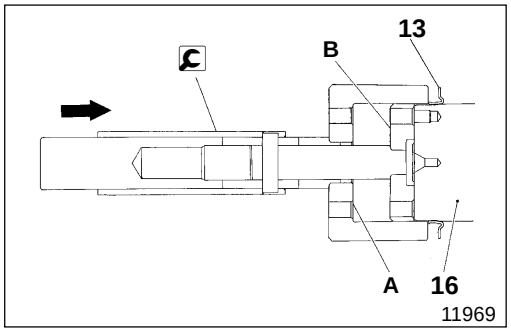
11 Installing thrust plates

Fit a thrust plate **11** on each side of the main bearing caps **10** and at the rear end of the crankcase **20** such that the oil grooves **A** are on the outside.

B : Locating pin

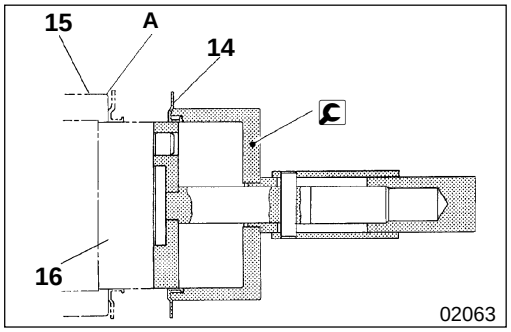
CAUTION ⚠

If any oversize thrust plates 11 are to be used, make sure that the upper and lower thrust plates installed at the rear end of the crankcase 20 are of the same size. However, the thrust plates installed on both sides of the main bearing cap 10 may be different in size.



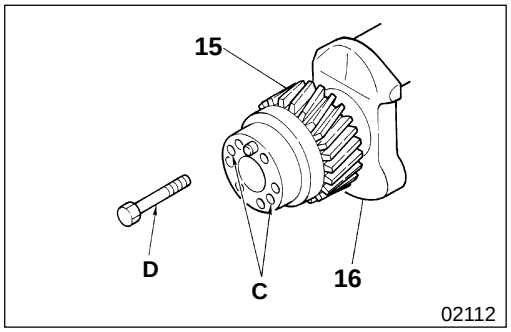
13 Installation of front oil seal slinger

Using the 🔧 Front Oil Seal Slinger Installer, drive the front oil seal slinger **13** onto the crankshaft **16** until the tool's end face **A** is pressed firmly against the guide **B**.



14 Installation of rear oil seal slinger

Using the 🔧 Rear Oil Seal Slinger Installer, drive the rear oil seal slinger **14** onto the crankshaft **16** until it touches the end surface **A** of the crankshaft gear **15**.



15 Crankshaft Gear

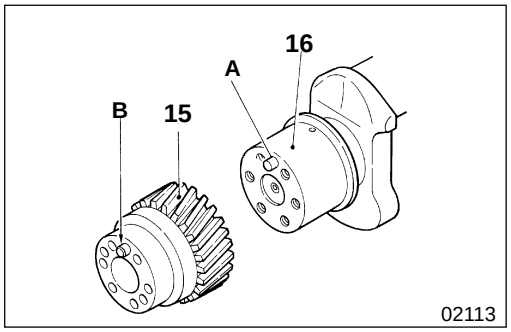
< With flywheel power take-off >

[Removal]

Screw the flywheel mounting bolts **D** evenly into the threaded holes **C** in the crankshaft **16** to remove the gear. The gear can also be removed by using the 🔧 Gear Puller.

CAUTION ⚠

Do not tap off the crankshaft gear 15 since this could damage it.



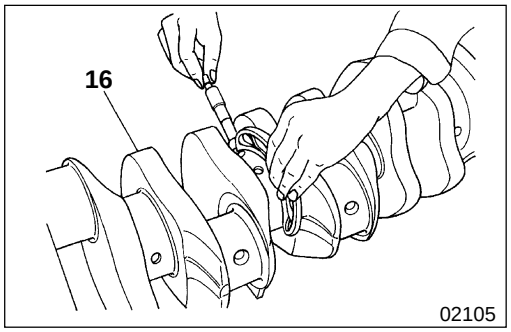
[Installation]

- Using a piston heater or the like, heat the crankshaft gear **15** to a temperature of approximately 100°C {212°F}.

WARNING ⚠

Be careful not to get burned.

- Align the locating pin **A** on the crankshaft **16** with the dowel pin **B** on the crankshaft gear **15**. Then, drive the gear into position by striking its end face with a plastic mallet.

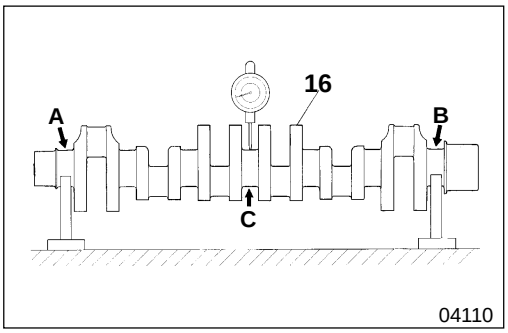


16 Crankshaft

[Inspection]

(1) Roundness and taper of crankshaft journal and pin

If either measurement exceeds the specified limit, grind it to undersize or replace the crankshaft **16**.

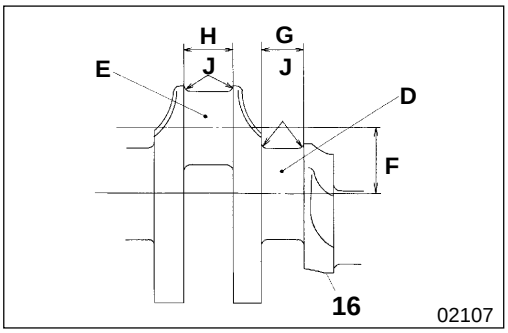


(2) Bend

- Support the crankshaft **16** at its No.1 journal **A** and No. 7 journal **B**. Measure the extent of bending in the crankshaft at the center of the No.4 journal **C**.
- If the measurement exceeds the specified limit, replace the crankshaft.

CAUTION ⚠

Turn the crankshaft 16 through one revolution. One-half of the dial indicator reading represents the extent of bending.



[Rectification]

CAUTION ⚠

If the crankshaft 16 is rectified by grinding, the main bearings 9, 17 must be replaced with undersized ones.

- Grind such that the center-to-center distance **F** between the journal **D** and pin **E** never be changed.

  F: $57.5\ ^{+0.025}_{-0.075}$ mm $\left\{2.26\ ^{+0.00098}_{-0.00295}\ \text{in.}\right\}$
- Grind such that the journal width **G** and pin width **H** do not change.

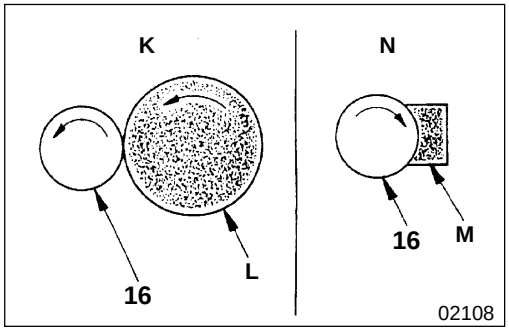
  G: 37 mm {1.45 in.}

  H: $42\ ^{+0.2}_{0}$ mm $\left\{1.65\ ^{+0.0078}_{0}\ \text{in.}\right\}$
- Finish the corner fillet smoothly and to the specified radius **J**.

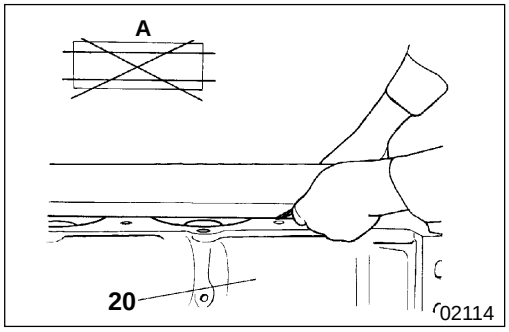
  J: R5 ± 2 mm {R0.02 ± 0.0079 in.}
- Carry out a magnetic inspection to check for cracks caused by grinding. Also, check that the Shore hardness of the surface has not dropped below Hs 75.

Crankshaft undersize dimensions — Unit: mm {in.}

	Degree of undersize			
	0.25 {0.0098}	0.50 {0.020}	0.75 {0.030}	1.00 {0.039}
Finished journal diameter	83.685 to 83.705 {3.294 to 3.295}	83.435 to 83.455 {3.284 to 3.285}	83.185 to 83.205 {3.274 to 3.275}	82.935 to 82.955 {3.265 to 3.266}
Finished pin diameter	64.67 to 64.69 {2.5460 to 2.5468}	64.42 to 64.44 {2.5362 to 2.5370}	64.17 to 64.19 {2.5263 to 2.5271}	63.92 to 63.94 {2.5165 to 2.5173}
Roundness	0.01 {0.00039} or less			
Cylindricity	0.006 {0.00024} or less			



- When grinding **K**, turn the crankshaft **16** counter-clockwise as viewed from its front end. The grinder **L** should rotate in the same direction.
- When finishing **N** the crankshaft **16** with whetstone or sandpaper **M**, rotate the crankshaft clockwise.



20 **Inspecting crankcase upper surface distortion**

If distortion exceeds the specified limit, correct it with a surface grinder.

A : Measurement positions

CAUTION ⚠

When grinding the crankcase 20, take care that the piston projections stay within specification.

MITSUBISHI
FUSO

Group 12

Lubrication

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-12

INDEX

SPECIFICATIONS 12- 2

STRUCTURE AND OPERATION 12- 3

TROUBLESHOOTING 12-10

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Replacement of Oil Filter 12-11
- Replacement of Engine Oil 12-12
- Measurement of Oil Pressure 12-13

OIL PAN AND OIL JET 12-14

OIL PUMP AND OIL STRAINER 12-16

OIL FILTER 12-18

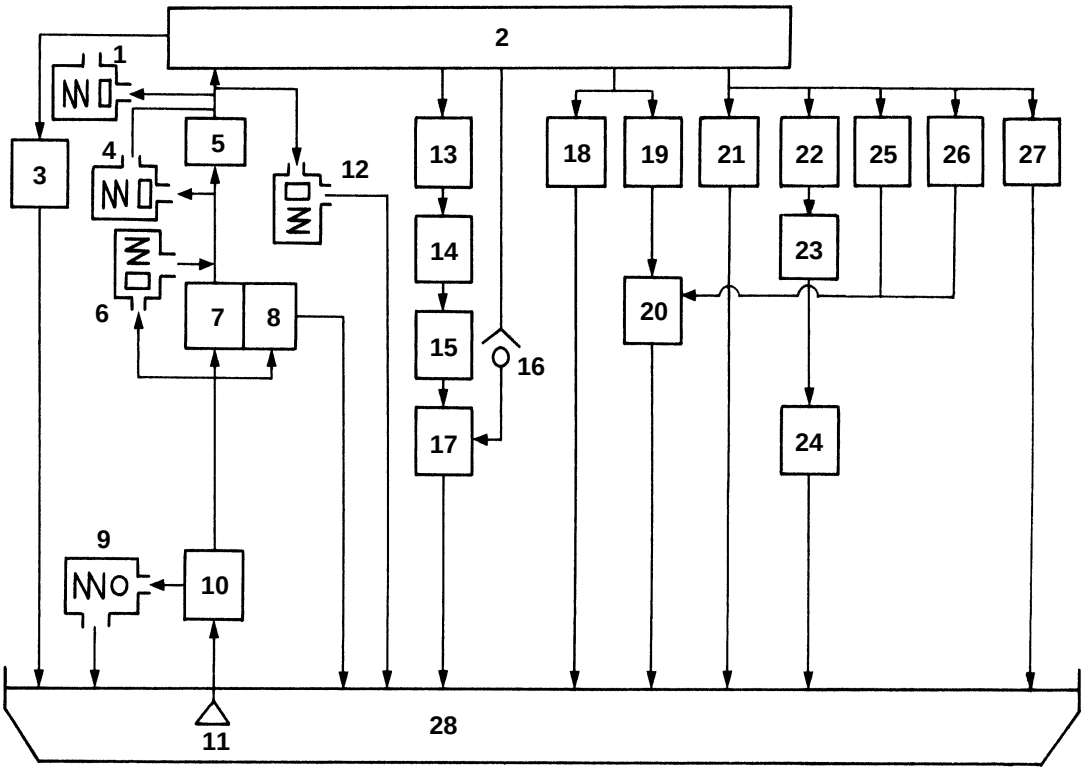
OIL COOLER 12-20

REGULATOR VALVE 12-22

SPECIFICATIONS

Item			Specifications
Mode of lubrication			Oil pump type
Oil filter type			Spin-on filter paper type
Oil cooler type			Shell and plate type (Multiple-plate type)
Engine oil	Grade		Grade CD or above as per API classification
	Quantity of oil L {qts}	Oil pan	Approximately 10 {11}
		Oil filter	Approximately 2.3 {2.4}

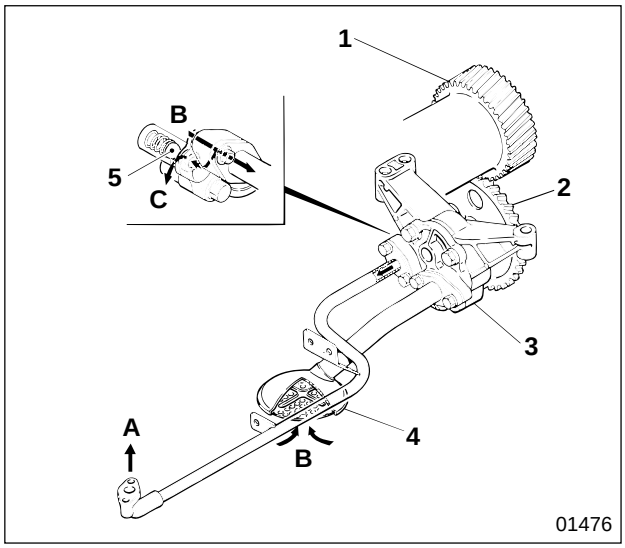
Lubrication System (Flow of Oil)



11099

1 Engine oil pressure switch
2 Main oil gallery
3 Water pump
4 Bypass valve
5 Oil cooler
6 Engine oil bypass alarm switch
7 Full-flow filter element
8 Bypass filter element
9 Relief valve (Built-in within oil pump)
10 Oil pump
11 Oil strainer
12 Regulator valve
13 Crankshaft main bearing
14 Connecting rod bearing
15 Connecting rod bushing
16 Check valve for oil jet
17 Piston
18 Injection pump
19 Air compressor
20 Timing gear
21 Camshaft bushing
22 Rocker bushing
23 Push rod
24 Tappet
25 Idler gear shaft No.1
26 Idler gear shaft No.2
27 Turbocharger
28 Oil pan

Oil Pump

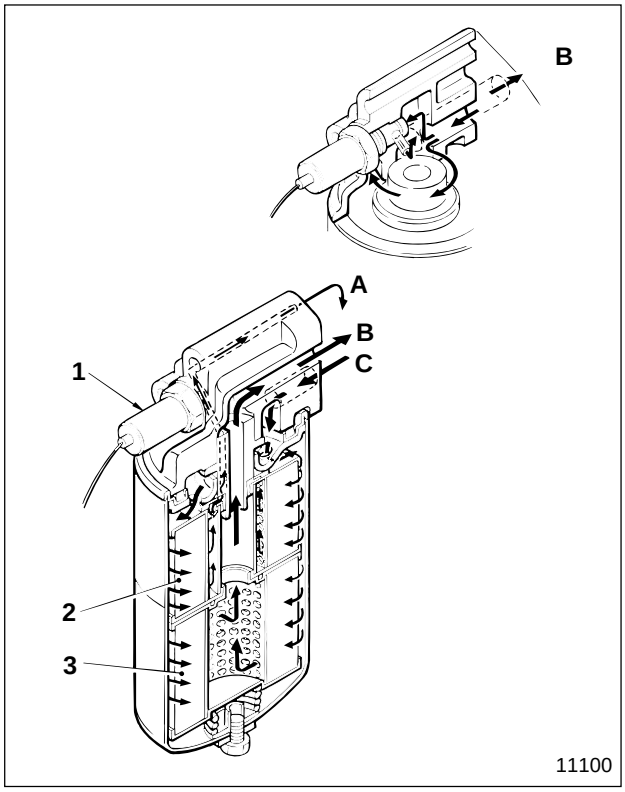


1 Crankshaft gear
2 Oil pump gear
3 Oil pump
4 Oil strainer
5 Relief valve

A : To oil filter
B : From oil pan
C : To oil pan

Oil pump **3** is a gear type, driven by rotation of the crankshaft transmitted by crankshaft gear **1** that engages oil pump gear **2**. Relief valve **5** is installed on the oil pump and when the oil pump discharge pressure becomes higher than standard, part of the engine oil is returned to the oil pan by relief action of the valve, protecting the lubricating system from breakdown caused by excessive oil pressure.

Oil Filter



1 Engine oil bypass alarm switch
2 Bypass filter element
3 Full-flow filter element

A : To oil pan
B : To oil cooler
C : From oil pump

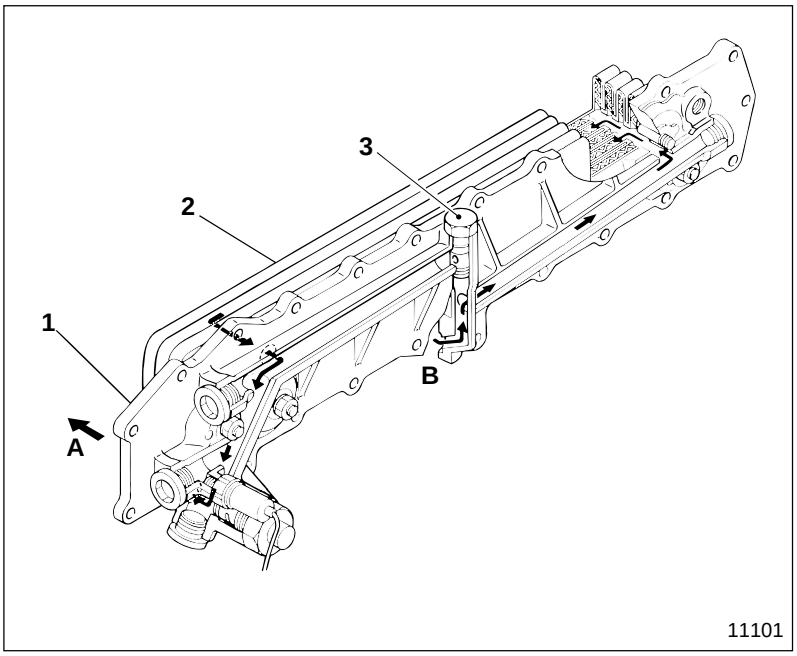
This oil filter uses a spin-on filter paper type element that integrates full-flow filter element **3** and bypass filter element **2**.

Operation of engine oil bypass alarm switch

- When the oil filter element is clogged, the engine oil pressure on flow becomes low and might cause seizure of engine parts, engine oil bypass alarm switch **1** is installed to prevent this.

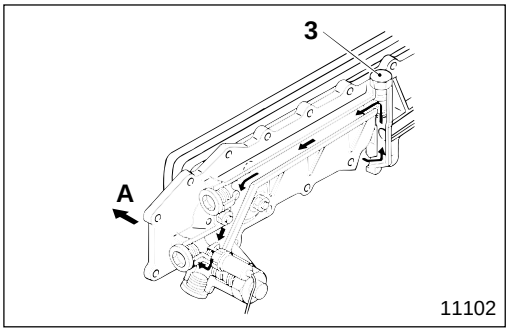
- When the oil filter element is clogged, engine oil bypass alarm switch **1** lets the engine oil flow directly to oil cooler **B**, bypassing full-flow filter element **3**. When the engine oil bypass alarm switch is activated it lights the warning lamp, warning the driver that the oil filter element is clogged.

Oil Cooler



1 Oil cooler cover
2 Oil cooler element
3 Bypass valve

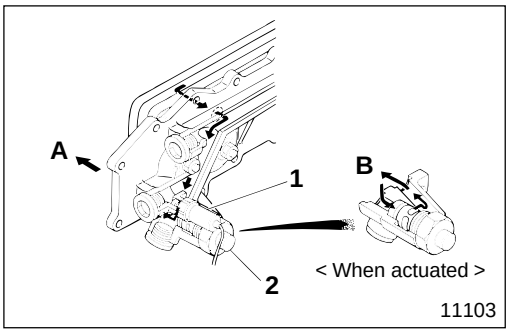
A : To main oil gallery
B : From oil filter



● **Bypass valve**

When the viscosity of the engine oil is high at low temperatures, or when oil cooler element **2** is clogged, flow resistance is high, and if this happens, bypass valve **3** opens to let the engine oil return directly to main oil gallery **A** without going through the oil cooler.

Engine Oil Pressure Switch, Regulator Valve



1 Engine oil pressure switch
2 Regulator valve

A : To main oil gallery
B : To oil pan

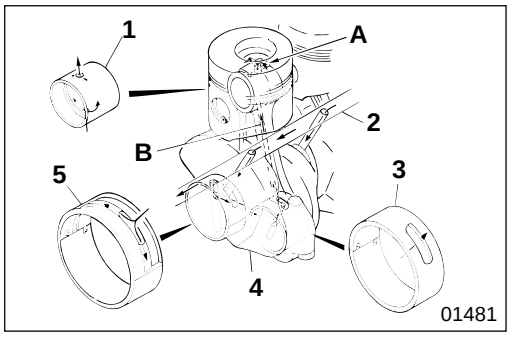
● **Engine oil pressure switch**

When pressure for delivering the engine oil to main oil gallery **A** becomes lower than standard, the built-in electric contact point of engine oil pressure switch **1** closes to light warning lamp in the meter cluster, warning the driver that the oil pressure is abnormal.

● **Regulator valve**

When the oil pressure in the main oil gallery becomes higher than standard, regulator valve **2** opens to let part of the engine oil return to oil pan **B**, thereby regulating the oil pressure.

Lubrication of Related Parts



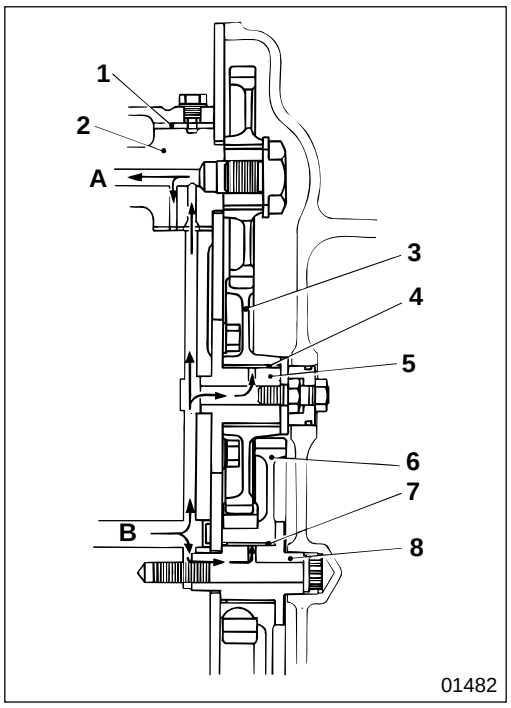
Engine oil delivered to the main oil gallery lubricates the following related parts.

● **Main bearing and connecting rod bearing**

1 Connecting rod bushing
2 Main oil gallery
3 Main bearing
4 Crankshaft
5 Connecting rod bearing

A : Oil jet
B : Connecting rod oil passage

Engine oil supplied through the oil passage drilled in crankshaft **4** flows through connecting rod oil passage **B** to lubricate the small end of the connecting rod, the engine oil then sprays out oil jet **A** at the top of the connecting rod to cool the piston.

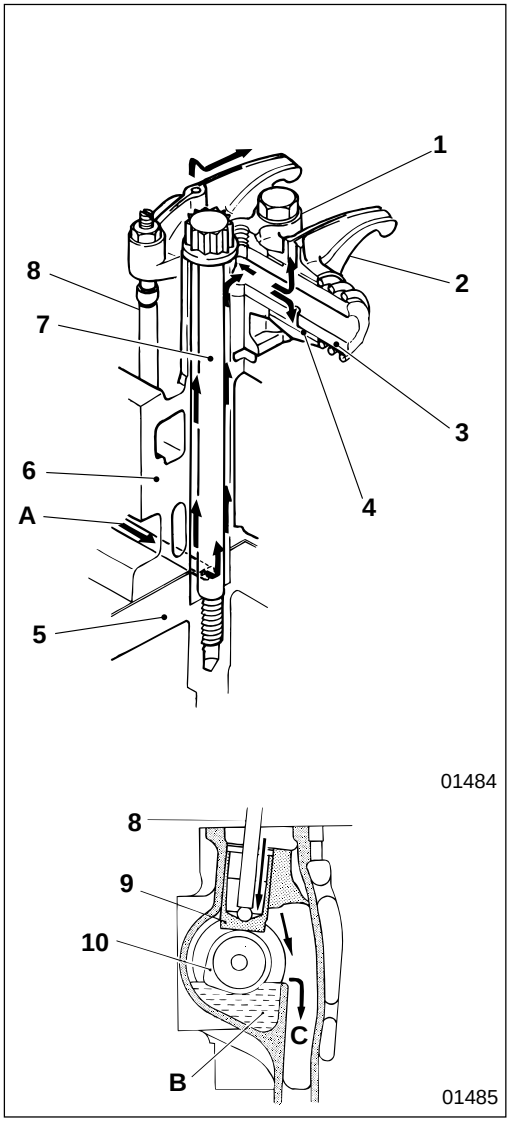


● **Timing gear and camshaft**

1 Camshaft bushing No.4
2 Camshaft
3 Idler gear No.2
4 Idler gear bushing
5 Idler gear shaft No.2
6 Idler gear No.1
7 Idler gear bushing
8 Idler gear shaft No.1

A : To rocker bushing
B : From main oil gallery

Engine oil flows through the inside of camshaft **2** and lubricates each camshaft bushing.

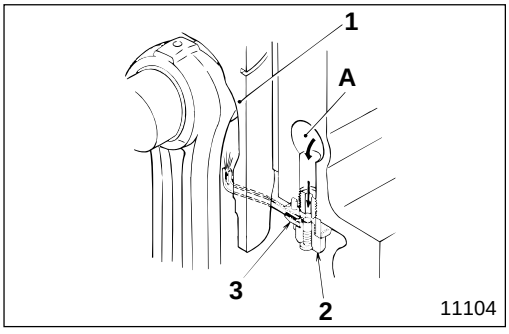


● **Valve mechanism**

1 Rocker shaft bracket
2 Rocker
3 Rocker shaft
4 Rocker bushing
5 Crankcase
6 Cylinder head
7 Cylinder head bolt
8 Push rod
9 Tappet
10 Camshaft

A : From No.4 camshaft bushing
B : Oil sump
C : To oil pan

Engine oil is lead to oil reservoir **B** to lubricate camshaft tops after lubricating rocker **2**, camshaft bushing, etc.

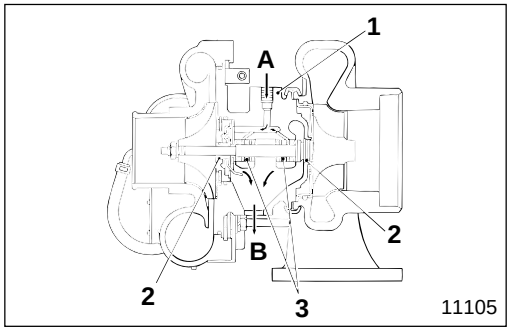


● **Oil jet**

1 Piston
2 Check valve
3 Oil jet

A : Main oil gallery

An oil jet **3** is installed, in the lower part of main oil gallery **A**, for each cylinder and cools pistons **1** by injecting engine oil toward the inside of the piston. The oil jet is fitted with check valve **2** which opens and closes at standard oil pressure levels. This prevents a decrease of oil volume at low oil pressure as well as a decrease of oil pressure itself.

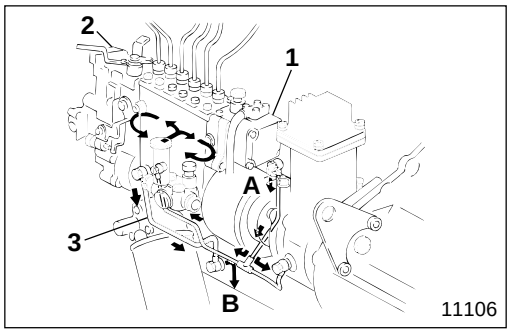


● **Turbocharger**

1 Bearing housing
2 Piston ring
3 Bearing

A : From main oil gallery
B : To oil pan

Engine oil is delivered from the main oil gallery to bearing housing **1** through the oil pipe to lubricate the inside of the bearing housing. Piston ring **2** installed at both ends of the turbine wheel shaft works as an oil seal.

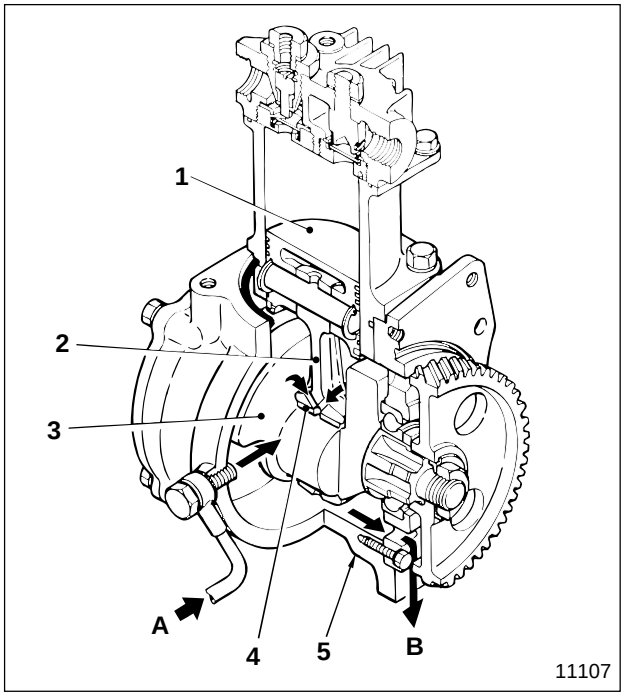


● **Injection pump**

1 Injection pump
2 Governor
3 Oil return pipe

A : From main oil gallery
B : To oil pan

Engine oil that has lubricated injection pump **1** and governor **2** returns to the oil pan through oil return pipe **3**.

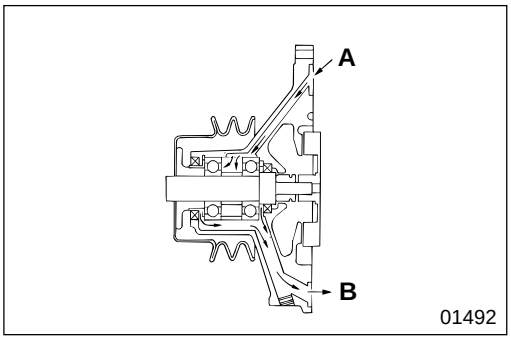


● **Air compressor**

1 Piston
2 Connecting rod
3 Crankshaft
4 Connecting rod bushing
5 Crankcase

A : From main oil gallery
B : To oil pan

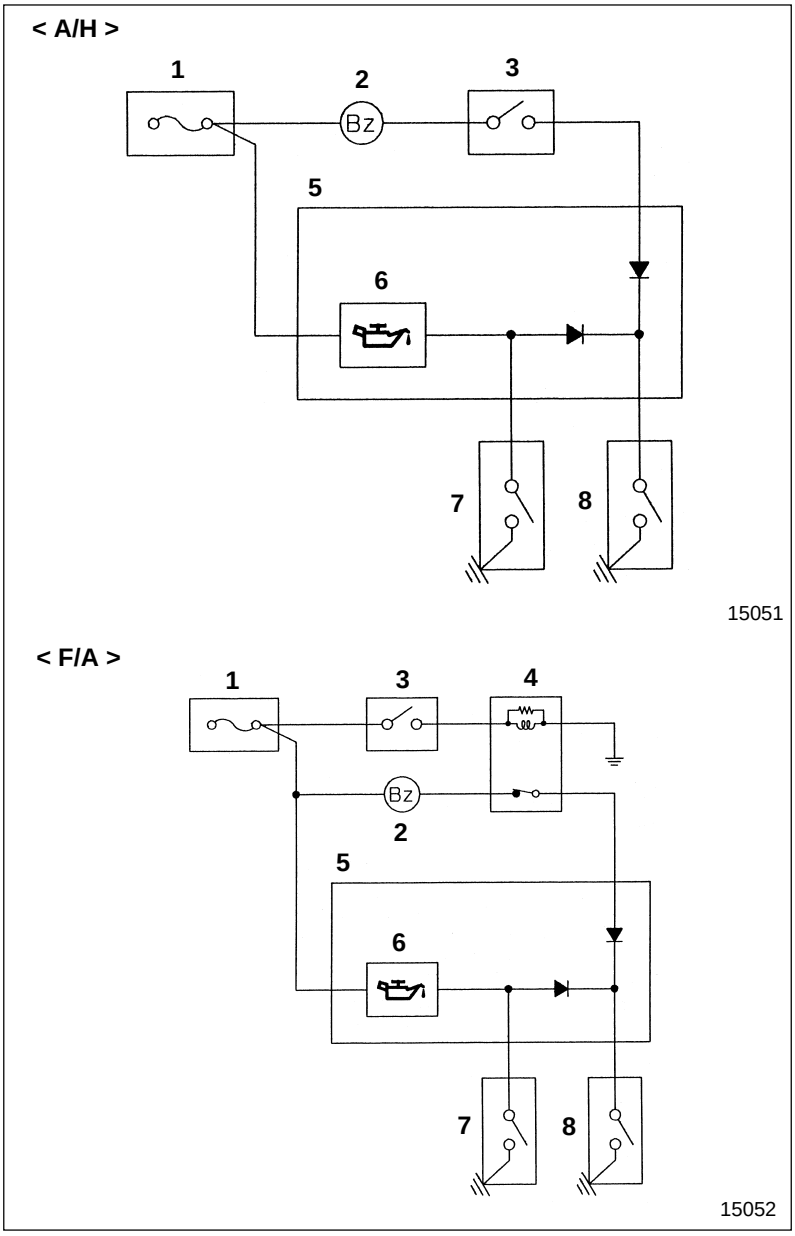
Engine oil from the main oil gallery splashes connecting rod **2** and lubricates connecting rod bushing **4**. Then the rotation of crankshaft **3** splashes engine oil onto piston **1** and the small end of the connecting rod to lubricate them.



● **Water pump**

A : From oil main gallery
B : To oil pan

Warning Circuit at Lubricating System



1 Relay and fuse box
2 Buzzer
(Buzzer does not work when the parking brake is engaged.)
3 Parking brake switch
4 Parking brake relay
5 Meter cluster
6 Warning lamp for oil pressure and oil filter
7 Oil bypass alarm switch
8 Oil pressure switch

A/H : Air over hydraulic brake
F/A : Full air brake

Possible causes / Symptoms		Engine hard to start	Overheating	Oil pressure low	Oil consumption excessive (Oil leakage)	Remarks
Oil cooler	Oil cooler element installation faulty		○	○	○	
	Gasket faulty		○	○	○	
	O-ring faulty		○	○	○	
	Oil cooler element clogged		○	○		
	Oil cooler element damaged		○	○	○	
	Bypass valve spring fatigued		○			
Oil pump	Malfunctioning	○		○		
	Oil pump gear interfering with oil pump case or cover		○	○		
	Installation faulty		○	○		
	Oil strainer clogged			○		
Oil filter	Installation faulty				○	
	Element clogged		○	○		
	O-ring faulty			○		
Front cover	Crankshaft front oil seal faulty				○	Gr 11
	Front cover installation faulty				○	Gr 11
Flywheel housing	Crankshaft rear oil seal faulty				○	Gr 11
	Flywheel housing installation faulty				○	Gr 11
Regulator valve spring fatigued				○		
Oil jet for piston cooling faulty			○			
Oil working its way up into combustion chamber					○	Gr 11
Oil working its way down into combustion chamber					○	Gr 11
Oil viscosity too high		○				
Oil quality unsuitable			○			
Oil deteriorated			○			
Fuel mixed with oil			○			

Replacement of Oil Filter

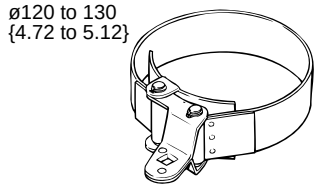
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Oil filter drain plug	7.8±2 {5.8±1.4, 0.8±0.2}	—

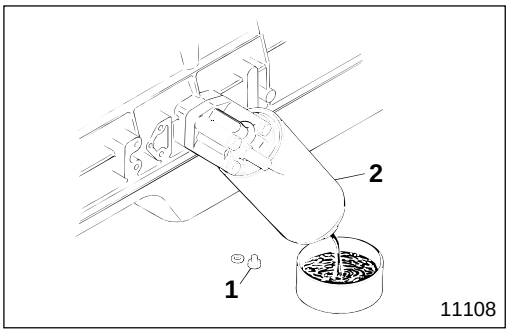
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Oil filter wrench  01503	MH061537 (Obtain Locally)	Removal of oil filter

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**
- **When replacing oil filter 2, take care not to spill oil on the V-belt.**



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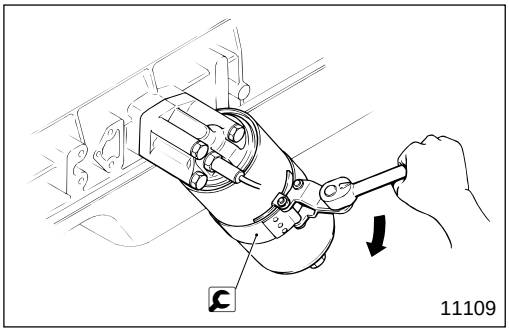
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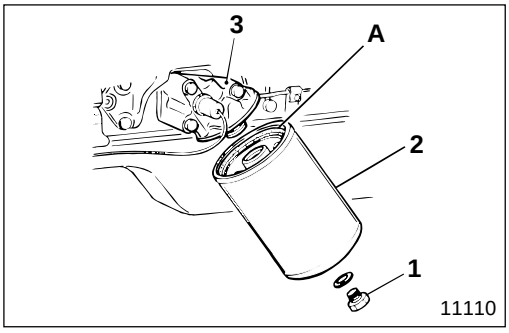


11110

[Removal]

1 Oil filter drain plug
2 Oil filter

[Installation]

- Clean the surface of oil filter head **3** that makes contact with oil filter **2**.
- Apply engine oil thinly and evenly to gasket area **A** of oil filter **2**.
- Screw in oil filter **2** to oil filter head **3** until gasket area **A** contacts the oil filter head.
- From this position, tighten further by rotating by one and one eighth to one and three eighths of a turn.
- Install oil filter drain plug **1**.
- After installation, run the engine and check that there is no oil leakage from gasket area **A**.
- Check the engine oil level and if it is low, fill to correct level.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Replacement of Engine Oil

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

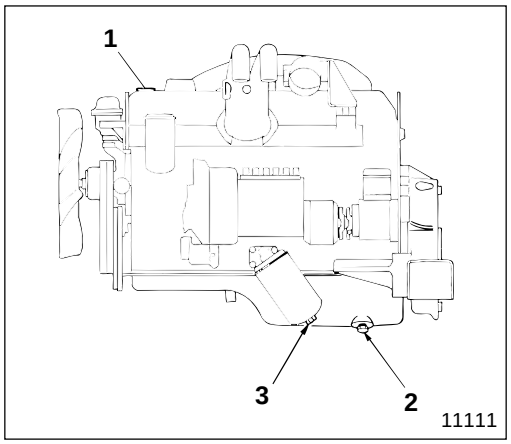
Location	Parts to be tightened	Tightening torque	Remarks
2	Oil pan drain plug	69 {51, 7}	—
3	Oil filter drain plug	7.8±2 {5.8±1.4, 0.8±0.2}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	Oil pan	Engine oil (Grade CD or above as per API Classification)	Approximately 11 L {12 qts}
—	Oil filter	Engine oil (Grade CD or above as per API Classification)	Approximately 2.3 L {2.4 qts}

WARNING

- **Wipe up any engine oil that has been spilled because it can cause a fire.**
- **Do not touch the engine while it is hot because it will burn you.**
- **When replacing engine oil, take care not to spill oil on the V-belt.**



[Draining]

- After warming-up the engine, remove oil filler cap **1**.
- Remove oil pan drain plug **2** and oil filter drain plug **3** and drain the engine oil.

[Refilling]

Tighten drain plug **2** of the oil pan and oil filter drain plug **3** at specified torque and fill with the specified quantity of engine oil.

Measurement of Oil Pressure

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Oil pressure (Oil temperature 70 to 90°C {158 to 194°F})	At no-load minimum revolution	145 to 295 kPa {21 to 43 psi, 1.5 to 3 kgf/cm²}	49 kPa {7.1 psi, 0.5 kgf/cm²}	Inspect
		At no-load maximum revolution	295 to 490 kPa {43 to 71 psi, 3 to 5 kgf/cm²}	195 kPa {28 psi, 2 kgf/cm²}	—

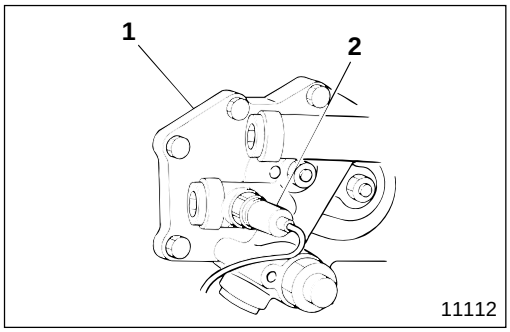
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

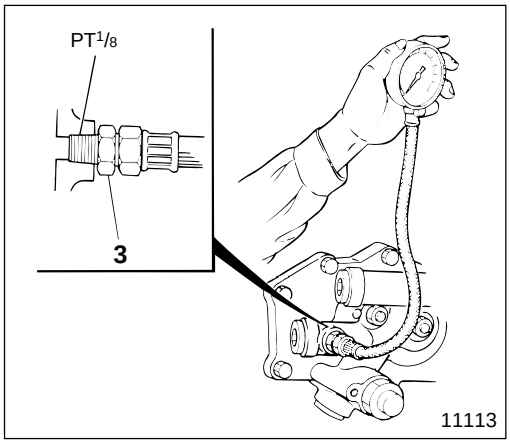
Location	Parts to be tightened	Tightening torque	Remarks
2	Engine oil pressure switch	15 to 22 {11 to 16, 1.5 to 2.2}	When engine is cold

Sealant

Location	Points of application	Kinds	Quantity
2	Thread area of engine oil pressure switch	Teflon tape	3 1/2 turns



- Remove oil pressure switch **2** from oil cooler **1**.
- Mount the oil pressure gauge after installing adaptor **3** onto oil cooler **1**.
- Warm up the engine until the oil temperature reaches 70 to 90°C {158 to 194°F}.
- Measure oil pressure at no-load minimum revolution and at no-load maximum revolution. If the measured values are lower than the limit, overhaul the lubricating system.



- After measurement, install engine oil pressure switch **2** and tighten at specified torque.

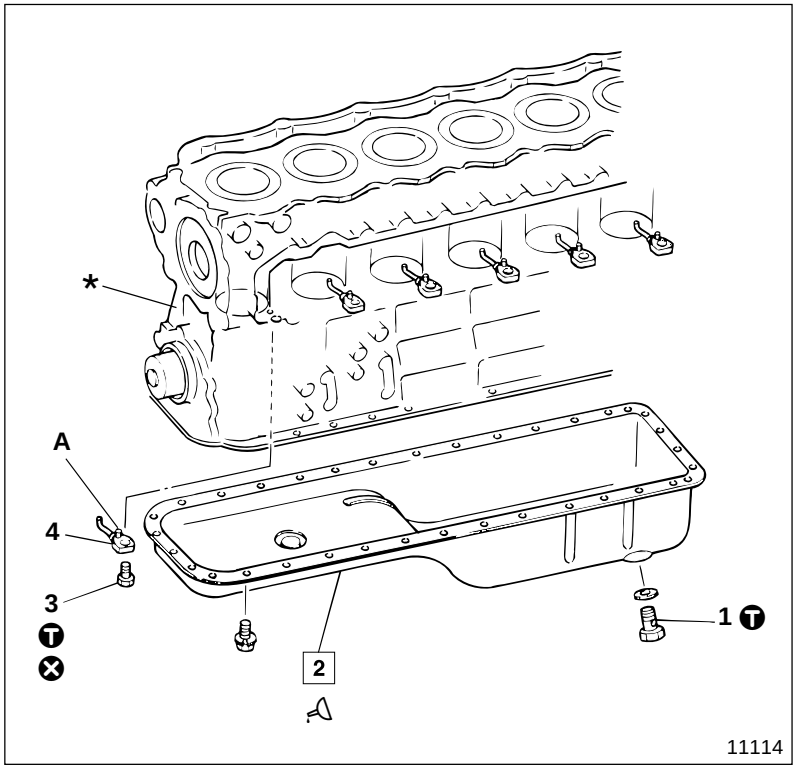
CAUTION

Be sure to install oil pressure switch 2 when the engine is cold.

Inspection of engine oil pressure switch

Gr 54

OIL PAN AND OIL JET



● **Disassembly sequence**

1 Drain plug
2 Oil pan
3 Check valve
4 Oil jet

***** : Crankcase Gr 11
A : Positioning pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION

Make sure that you do not tighten check valve 3 higher than specified torque, because excessive tightening causes faulty operation resulting in engine burning.

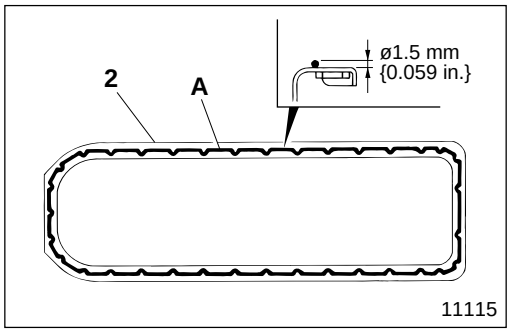
T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	69 {51, 7}	—
3	Check valve	34 {25, 3.5}	—

Sealant

Location	Points of application	Kinds	Quantity
2	Oil pan to crankcase connecting surface	THREEBOND 1207C	As required



◆ Service procedure

2 **Installation of oil pan**

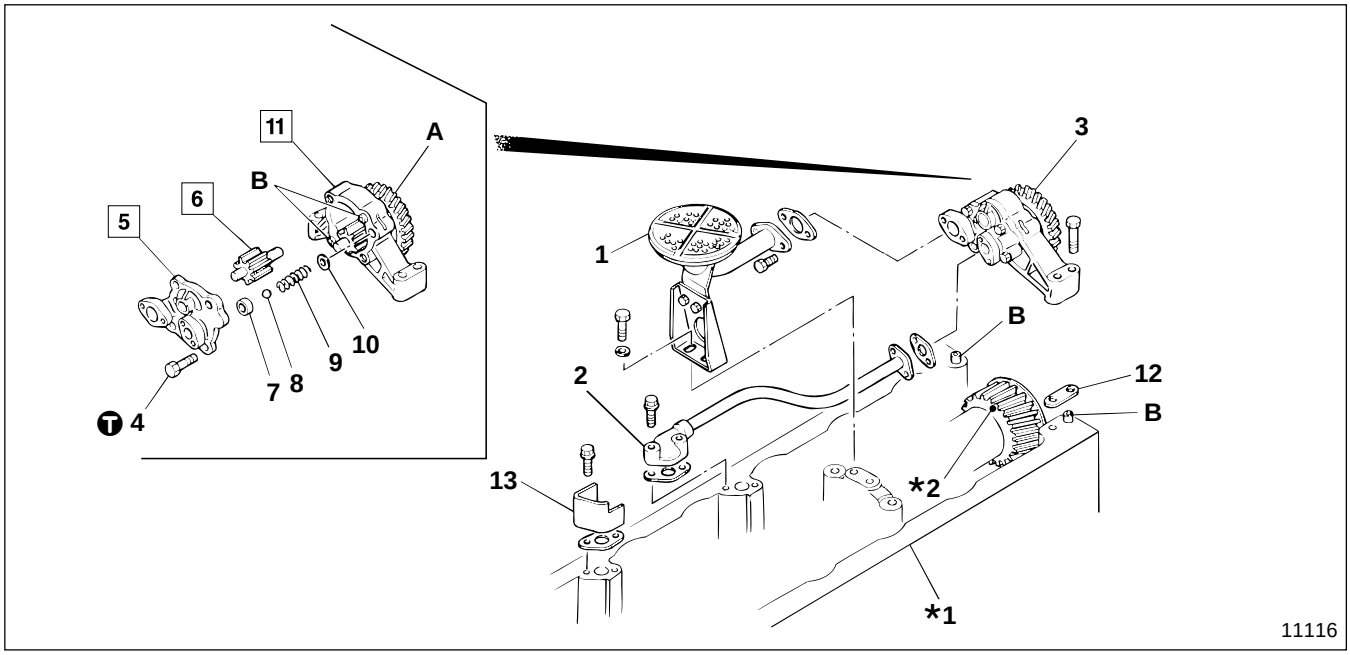
- Apply an even, unbroken bead of sealant **A** to lower connecting surface of oil pan **2** as illustrated.
- After applying sealant **A**, within three minutes, mount oil pan **2** to crankcase *****.

CAUTION

- **Be sure to clean and wipe off oily substances from the surface where sealant A is to be applied.**
- **Make sure that sealant A is not transferred to other areas while the mounting work is being done.**
- **Do not start the engine within an hour of mounting oil pan 2.**
- **Be sure to reapply sealant A if the bolts (for mounting oil pan 2) are loosened or removed by any cause whatsoever after mounting.**

M E M O

OIL PUMP AND OIL STRAINER



● **Inspection before disassembly**

P12-17

● **Disassembly sequence**

1 Oil strainer
2 Oil pipe
3 Oil pump assembly
4 Bolt
5 Cover
6 Driven gear assembly
7 Ring
8 Relief valve
9 Relief valve spring
10 Washer
11 Gear and case assembly
12 Shim
13 Oil deflector

***1** : Crankcase Gr 11
***2** : Crankshaft gear Gr 11
A : Oil pump gear
B : Positioning pin

NOTE

- **Do not remove oil pipe 2, oil strainer 1, and the oil pump as an assembly unless they are faulty.**
- **Gear and case assembly 11 is a unit construction, if there is a fault in it, replace it as a unit.**
- **Do not remove parts ring 7 through to washer 10 from gear and case assembly 11 unless they are faulty. If removed, replace ring 7.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

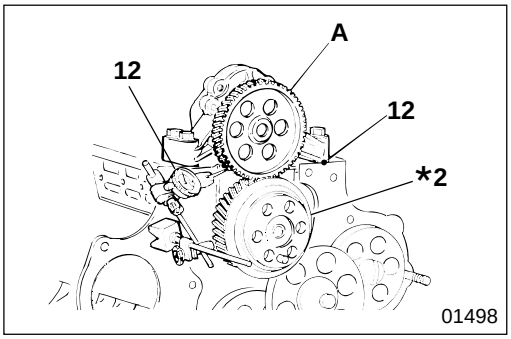
Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
5, 11	Clearance between drive gear shaft and inner diameter of cover	[20] 0.04 to 0.07 {[0.79] 0.0016 to 0.0028}	0.15 {0.0059}	Replace
5, 6, 11	Clearance between driven gear shaft and inner diameter of case and cover	[20] 0.04 to 0.07 {[0.79] 0.0016 to 0.0028}	0.15 {0.0059}	Replace
6, 11	Clearance between case and tooth tip of each gear	0.10 to 0.19 {0.0039 to 0.0075}	0.2 {0.0079}	Replace
	Difference between height of each gear and depth of case	0.06 to 0.11 {0.0024 to 0.0043}	0.15 {0.0059}	Replace
8	Relief valve opening pressure	1.1±0.1 MPa {11±1 kgf/cm^2}	—	Replace
9	Relief valve spring load (Installed length 30 {1.18})	84 N {19 lbf, 8.6 kgf}	—	Replace
***2, A**	Backlash between oil pump gear and crankshaft gear	0.08 to 0.18 {0.0031 to 0.0071}	0.35 {0.014}	Adjust with shims

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Bolt (Oil pump cover mounting)	25±4.9 {18±3.6, 2.5±0.5}	—



◆ Service procedure

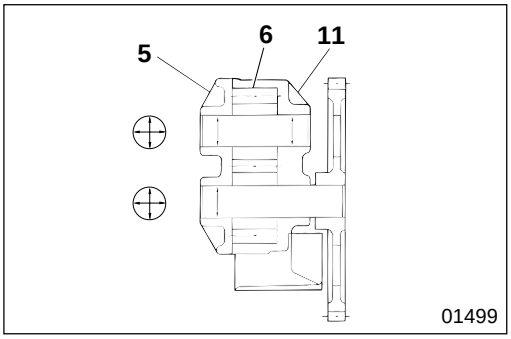
● Inspection before disassembly

Measure backlash between oil pump gear **A** and crankshaft gear **2**, if the measured value is higher than the limit, adjust with shims **12**.

Shim thickness	Backlash graduation
0.1 mm {0.0039 in.}	0.073 mm {0.0029 in.}
0.2 mm {0.0079 in.}	0.146 mm {0.0057 in.}

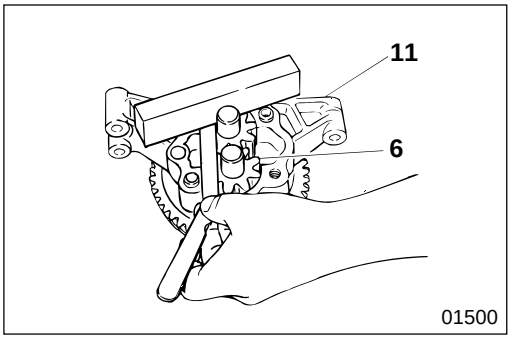
CAUTION ⚠

Make sure that you use the same thickness adjustment shims 12 for left and right sides.



5 6 11 Inspection of cover, driven gear assembly, gear and case assembly

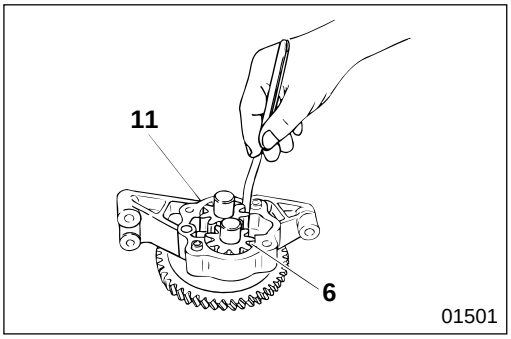
Measure the clearance between each gear shaft and cover **5**, and the clearance between the shaft and the shaft bore of gear and case assembly **11**. If the measured value is higher than the limit, replace the faulty parts.



6 11 Inspection of driven gear assembly, gear and case assembly

(1) Difference between height of each gear and depth of gear and case assembly

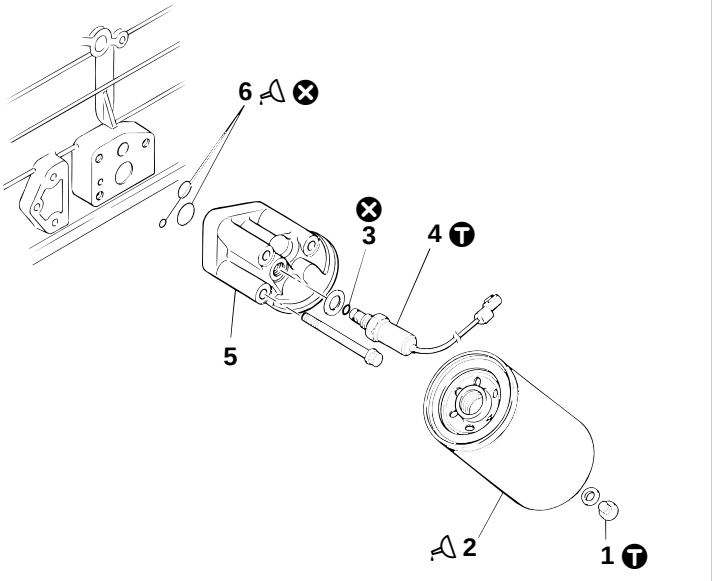
If the measured value is higher than the limit, replace the faulty parts.



(2) Clearance between tooth tip and case

If the measured value is higher than the limit, replace the faulty parts.

OIL FILTER



● **Disassembly sequence**

1 Oil filter drain plug
2 Oil filter P12-11
3 O-ring
4 Engine oil bypass alarm switch
Gr 54
5 Oil filter head
6 O-ring

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
4	Engine oil bypass alarm switch valve opening pressure	$0.2\ ^{+0.05}_{0}$ MPa {$27\ ^{+7.1}_{0}$ psi, $1.9\ ^{+0.5}_{0}$ kgf/cm^2}	—	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

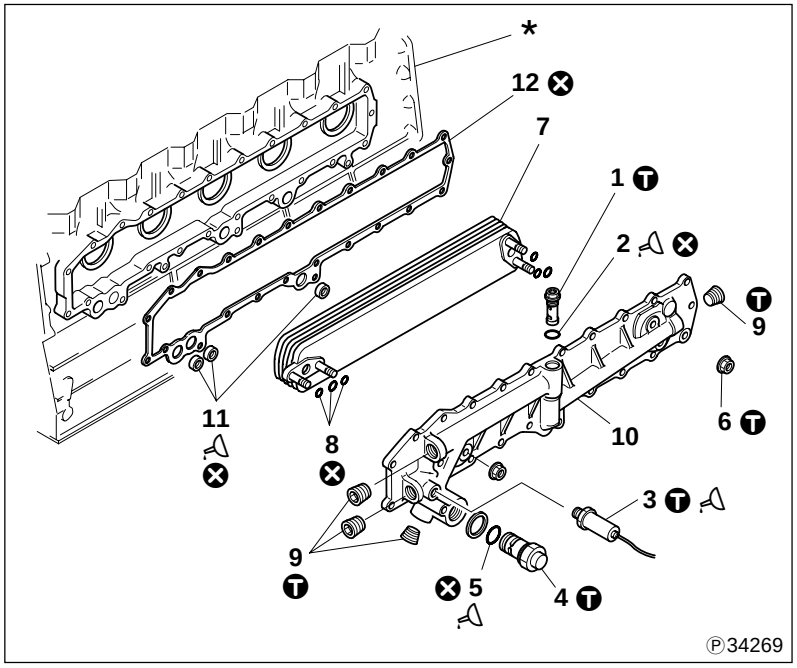
Location	Parts to be tightened	Tightening torque	Remarks
1	Oil filter drain plug	7.8±2 {5.8±1.4, 0.8±0.2}	—
4	Engine oil bypass alarm switch	49±4.9 {36±3.6, 5±0.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
2	Gasket area of oil filter with thin application P12-11	Engine oil	As required
6	Body of O-ring	Engine oil	As required

M E M O

OIL COOLER



● **Disassembly sequence**

1 Bypass valve
2 Engine oil pressure switch
3 O-ring
4 Regulator valve 📖 P12-22
5 O-ring
6 Nut
7 Oil cooler element
8 O-ring
9 Oil cooler plug
10 Oil cooler cover
11 O-ring
12 Gasket

*: Crankcase assembly Gr 11
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit: mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Bypass valve opening pressure	294±20 kPa {43±2.8 psi, 3.0±0.2 kgf/cm^2}	—	Replace
7	Oil cooler element air leak (Air pressure 1470 kPa {215 psi, 15 kgf/cm^2}, 15 sec)	0 cm^2 {0 cu. in.}	—	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bypass valve	14.7 to 19.6 {11 to 14, 1.5 to 2}	—
3	Engine oil pressure switch	15 to 22 {11 to 16, 1.5 to 2.2}	—
4	Regulator valve	98 to 118 {72 to 87, 10 to 12}	—
6	Nut (Oil cooler element mounting)	19.6±4.9 {14±3.6, 2.0±0.5}	—
9	Oil cooler plug	41.1±9.8 {33±7.2, 4.5±1}	—

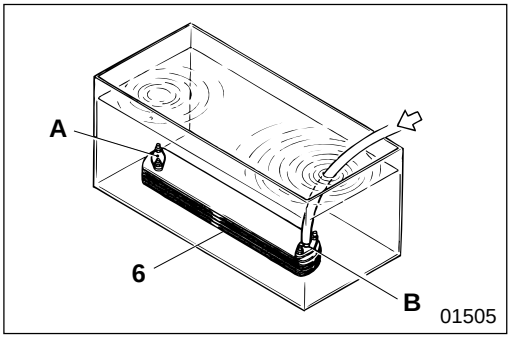
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
3	Wrap around threaded part of engine oil pressure switch	Thread tape	3 1/2 turns
2, 5, 11	Oil cooler O-ring	Engine oil	As required

◆ Service procedure

● Cleaning

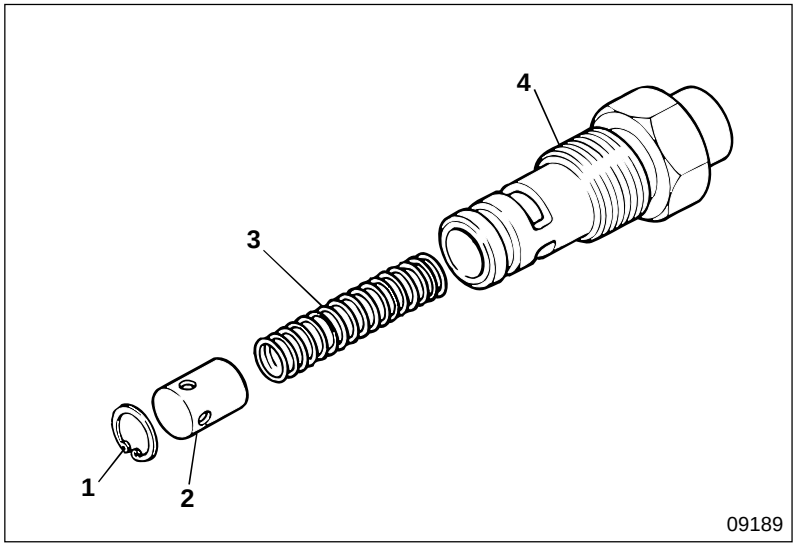
- Check and see if any carbon deposits or sludge have developed in the oil passage of oil cooler element **7** or its bypass. Clean any deposits off thoroughly with cleaning solvent.
- Also clean any water scale found in oil cooler element **7** or oil cooler cover **10**. Gr 14.



7 Inspection of oil cooler element

- Immerse oil cooler element **7** in a water tank after plugging exit port **A** and connecting the hose to engine oil entry port **B**.
- Apply air pressure of 1470 kPa {215 psi, 15 kgf/cm^2} via the hose and see if there is any air leakage from any part of oil cooler element **7**.
- If you see any leakage, replace oil cooler element **7**.

REGULATOR VALVE



● **Disassembly sequence**

1 Snap ring
2 Valve
3 Spring
4 Body

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
3	Regulator valve spring load (Installed length 48.3 {1.9})	76 to 80 N {17 to 18 lbf, 7.8 to 8.2 kgf}	—	Replace
—	Regulator valve opening pressure	390±29 kPa {57±4.3 psi, 4±0.3 kgf/cm^2}	—	Replace

MITSUBISHI
FUSO

Group 13

Fuel and Engine Control

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-13

INDEX

SPECIFICATIONS 13- 2

STRUCTURE AND OPERATION 13- 4

TROUBLESHOOTING 13-32

READING AND ERASING DIAGNOSIS CODES 13-34

SERVICE PROCEDURES USING MULTI-USE TESTER II 13-40

INSPECTION BASED ON DIAGNOSIS CODE 13-42

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Checking and Adjusting Injection Timing 13-46
- Bleeding Air from Fuel System 13-47
- Cleaning Gauze Filter 13-47
- Replacing Fuel Filter 13-48

ENGINE CONTROL 13-49

FUEL TANK 13-54

FUEL FILTER 13-55

WATER SEPARATOR 13-56

INJECTION PUMP 13-58

INJECTION NOZZLE 13-62

INSPECTION OF OTHER DEVICES 13-66

ELECTRIC CIRCUIT AND PART INSTALLATION LOCATIONS 13-78

SPECIFICATIONS

Injection Pump

Item	Specifications
Manufacturer	BOSCH AUTOMOTIVE SYSTEMS
Body model	MD-TICS (Pre-stroke control type)
Governor type	RED-III electronically controlled governor
Feed pump model	KD
Automatic timer model	SPG mechanical type

Injection Nozzle

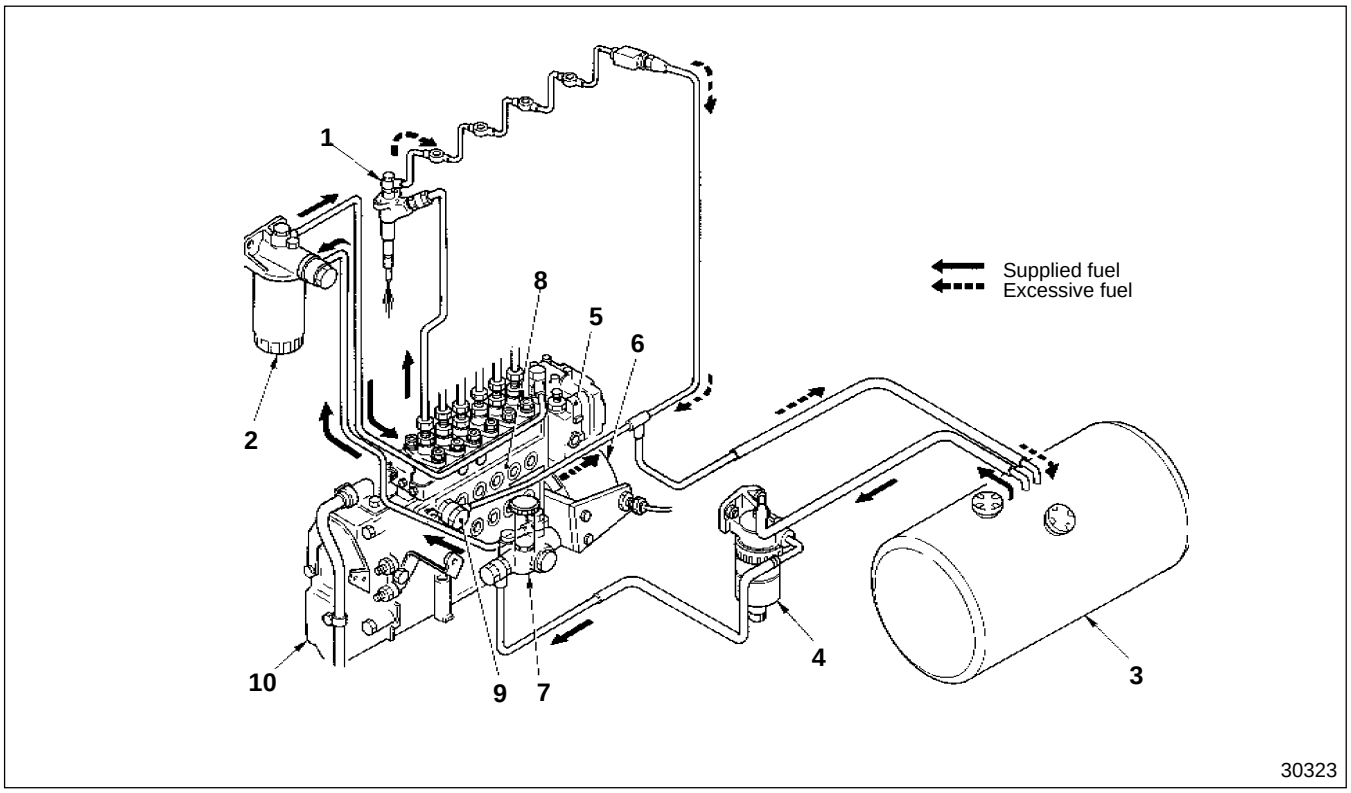
Item	Specifications
Manufacturer	BOSCH AUTOMOTIVE SYSTEMS
Model and type	DLLA hole type 1-spring nozzle
Nozzle orifice quantity	5
Orifice diameter mm {in.}	ϕ 0.23 {0.0091}

Fuel Filter Type

Item	Specifications
Filter type	Spin-on type

M E M O

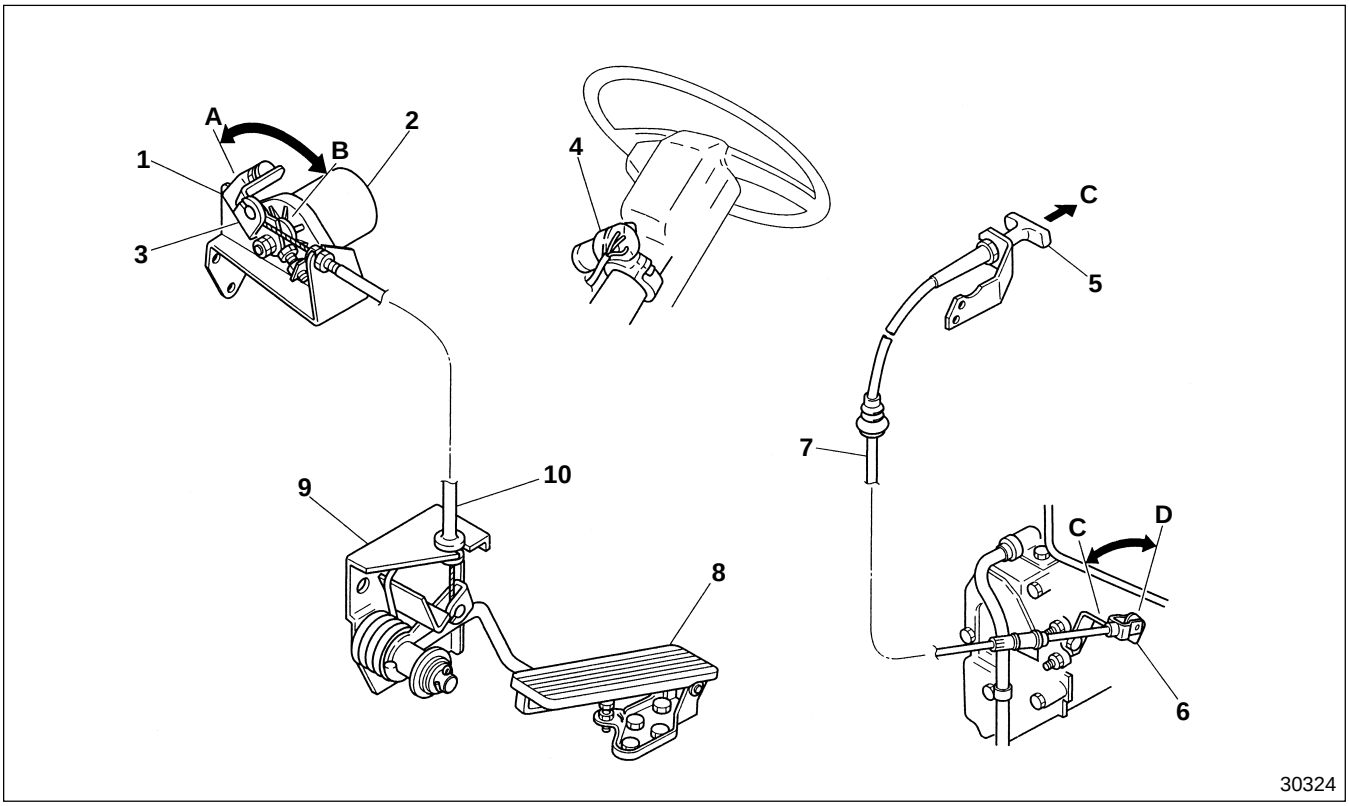
Fuel System (Flow of Fuel)



1 Injection nozzle
2 Fuel filter
3 Fuel tank
4 Water separator
5 Pre-stroke actuator
6 Automatic timer
7 Feed pump
8 Injection pump
9 Overflow valve
10 Electronic governor

Fuel in fuel tank **3** is sucked up by feed pump **7** which is driven by the cam action of injection pump **8** and is filtered through fuel filter **2** which removes dirt and other foreign particles.
Filtered fuel is sent to the injection pump where the fuel pressure is boosted and injected through injection nozzle **1** into the combustion chamber.
When fuel pressure is higher than the specified value, overflow valve **9** opens to let the fuel return to the fuel tank **3**.

Engine Control



1 Accelerator pedal switch
2 Accelerator pedal position sensor
3 Lever
4 Starter switch
5 Emergency engine stop button
6 Stop lever
7 Engine stop cable
8 Accelerator pedal assembly
9 Accelerator link assembly
10 Accelerator control cable

A : Idling position
B : Full-load position
C : Engine-stop position
D : Engine start-up position

● **Accelerator pedal switch**

Accelerator pedal switch **1** detects whether the accelerator pedal assembly **8** is depressed.

● **Accelerator pedal position sensor**

Accelerator pedal position sensor **2** detects the movement of the accelerator pedal assembly **8** and sends the information to the engine electronic control unit in the form of electrical signals. The accelerator position sensor lever **3** is pulled in the idling position direction **A** by the return spring.

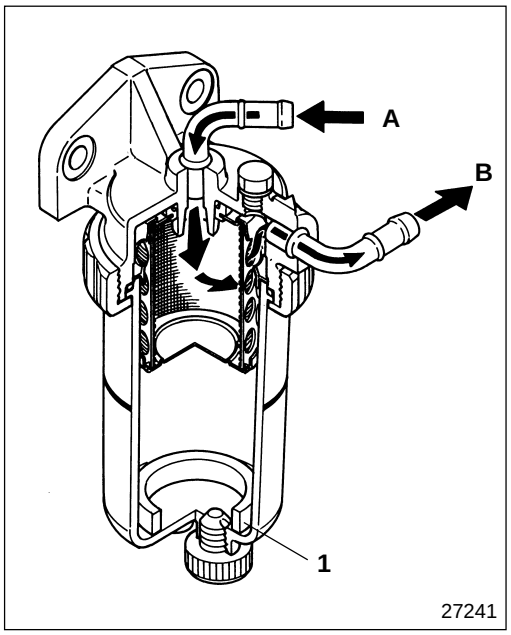
● **Emergency engine stop button**

The engine is generally stopped electrically by setting the starter switch **4** to the off position.
However, if the engine does not stop by setting the starter switch to the off position because of malfunctions in the electronic governor system, etc., pulling the emergency engine stop button **5** moves the electronic governor stop lever **6** to the stop position **C** and stops the engine.

CAUTION⚠

If the engine was stopped by pulling the engine stop button 5, the control unit computer must be reset by setting the starter switch 4 to the ACC or LOCK position.
If the engine is restarted without resetting the computer, the engine revolution control will be unstable.

Water Separator

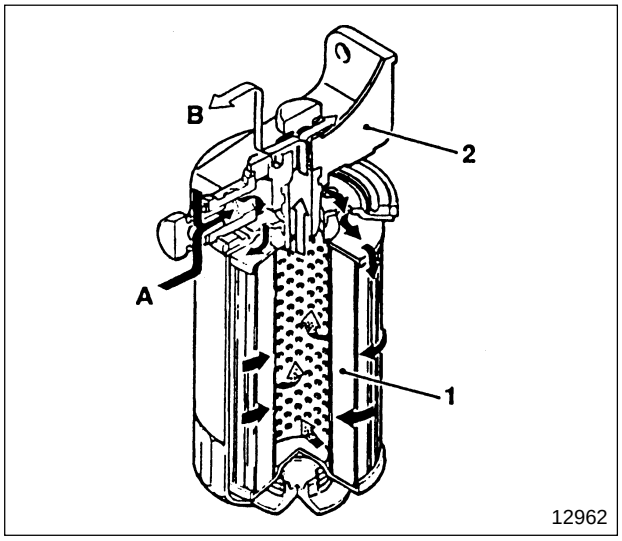


1 Water level ring

A : From fuel tank
B : To feed pump

The water separator is installed between the fuel tank and the feed pump. Any water present in the fuel is separated by the baffle plate and the screen assembly.

Fuel Filter

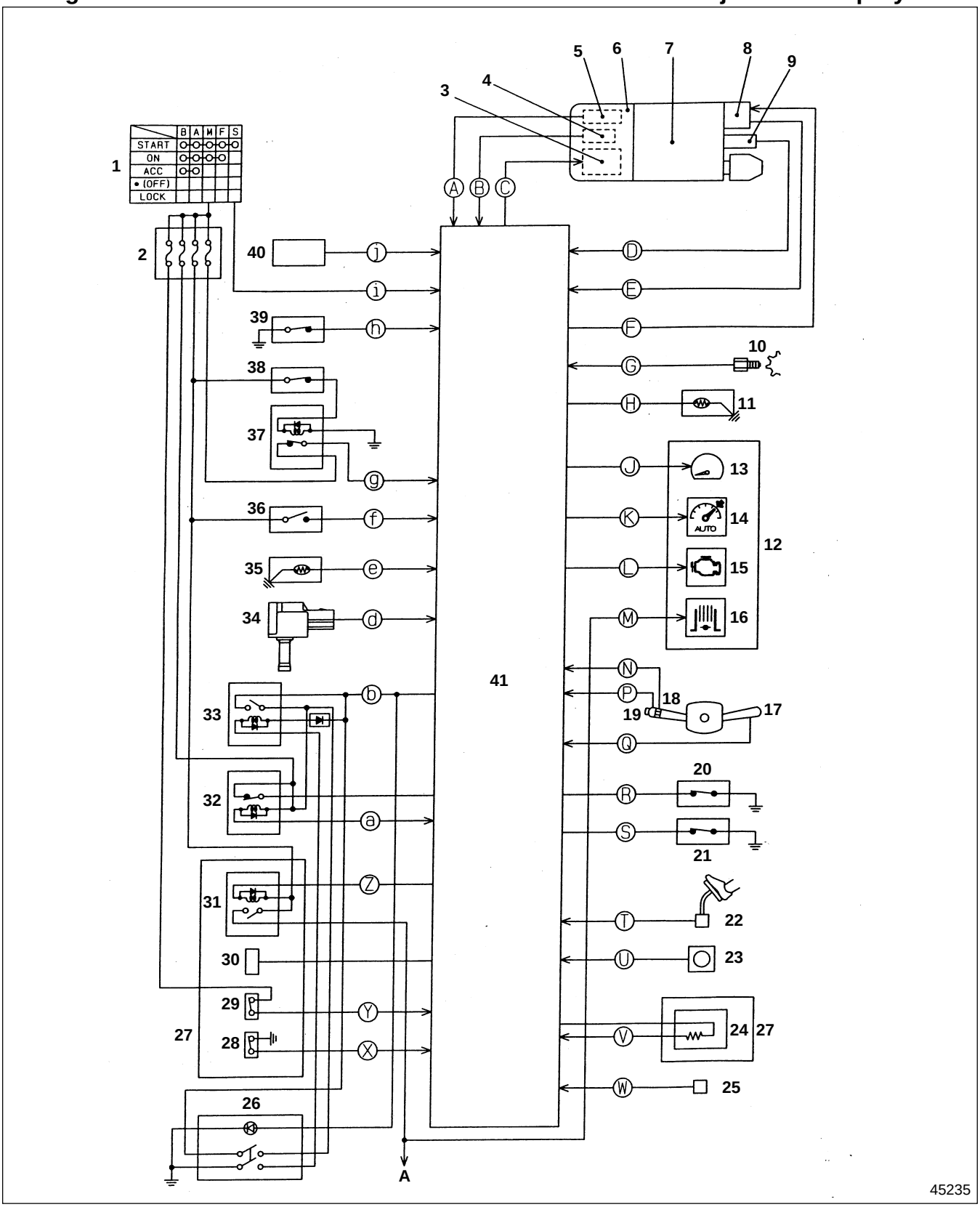


1 Fuel filter
2 Fuel filter head

A : From feed pump
B : To injection pump

Pressurized fuel is delivered from the feed pump of the injection pump to the fuel filter which separates water from the fuel and removes foreign particles from the fuel by fuel filter **1**.

Configuration of Electronic Governor and Pre-stroke Control Injection Pump System



A : To exhaust brake 3-way magnetic valve Gr 54

	Part	Main function/operation	Data signal
1	Starter switch	Sensing of start signal	ⓘ : Start signal
2	Fuse and relay box	—	—
3	Linear DC motor	Activation of rack	Ⓒ : Linear DC motor drive signal
4	Backup engine speed sensor	Sensing of engine speed	Ⓑ : Engine speed signal (backup)
5	Control rack position sensor	Sensing of control rack position	Ⓐ : Control rack position signal
6	Electronic governor	—	—
7	Pre-stroke control type injection pump	Alteration of pre-stroke (advancement of fuel injection timing)	—
8	Pre-stroke actuator • Pre-stroke position sensor • Drive unit	—	Ⓔ : Pre-stroke position signal Ⓕ : Actuator drive signal
9	Sub control rack position sensor	Sensing of control rack position	Ⓓ : Control rack position signal (backup)
10	Engine speed sensor	Sensing of engine speed	Ⓖ : Engine speed signal
11	Boost temperature sensor	Detection of engine intake air temperature	Ⓗ : Boost temperature signal
12	Meter cluster	—	—
13	Tachometer	—	Ⓙ : Tachometer drive signal
14	Indicator lamp	—	Ⓚ : Lamp illumination signal
15	Warning lamp	Indication of system faults and diagnosis codes	Ⓛ : Lamp illumination signal
16	Indicator lamp	—	Ⓜ : Lamp illumination signal
17	Auxiliary brake switch	ON/OFF switching of Exhaust brake	Ⓠ : Exhaust brake ON signal
18	Cruise control set resume switch	Cruise control vehicle speed set, change and reset	Ⓝ : Set resume signal
19	Cruise control cancel switch	Cruise control cancel	Ⓟ : Cruise control cancel signal
20	Stop lamp switch	Detection of brake signal	Ⓡ : Brake operation signal
21	Stop lamp switch (backup)	Detection of brake signal	Ⓢ : Brake operation signal
22	Accelerator pedal position sensor	Sensing of accelerator pedal depression amount	Ⓣ : Accelerator pedal position signal
23	Idling speed adjustment potentiometer	Shortening of warmup time	Ⓤ : Warmup time shortening signal
24	Fuel injection rate adjustment resistor	Correction of fuel injection rate	Ⓥ : Injection volume correction signal
25	Vehicle speed sensor	Detection of vehicle speed	Ⓦ : Vehicle speed pulse
26	Cruise control main switch	Cruise control system operation	—
27	Fuse and relay box	—	—
28	Diagnosis switch	Generation of diagnosis codes	Ⓧ : Diagnosis code signal
29	Memory clear switch	Eraser of diagnosis codes	Ⓨ : Diagnosis code eraser signal
30	Multi-Use Tester II connector (16-pin)	Connection of Multi-Use Tester II	—
31	Exhaust brake relay	Closes contacts upon exhaust brake operation	Ⓩ : Exhaust brake operation signal
32	Pre-stroke cut relay	Closes contacts upon plunger pre-stroke operation	ⓐ : Pre-stroke operation signal
33	Cruise control main relay	The contact point is closed when the cruise control system is in operation	ⓑ : Cruise control system operation signal
34	Boost pressure sensor	Sensing of boost pressure	ⓓ : Boost pressure signal

Part		Main function/operation	Data signal
35	Coolant temperature sensor	Sensing of engine coolant temperature	ⓔ : Coolant temperature signal
36	Clutch pedal switch	Turns OFF when clutch pedal is depressed	ⓕ : Clutch pedal depression signal
37	Transmission neutral relay	Contact opens when transmission is in neutral	ⓖ : Transmission neutral signal
38	Transmission neutral switch	Turns OFF when transmission neutral is selected	—
39	Accelerator pedal switch	Turns OFF when accelerator pedal is depressed	ⓗ : Accelerator pedal depression signal
40	Automatic transmission fluid temperature switch *	Detection of AFT temperature	ⓙ : High oil temperature signal
41	Engine electronic control unit	Control of overall system	—

* : Automatic transmission

- The electronic governor and pre-stroke control injection pump system combines an electronic governor **6** with an injection pump **7** that has an electronically controlled pre-stroke adjustment feature.
- The injection pump's plunger lift speed varies in accordance with the engine speed, causing concomitant variations in the injection pipe pressure.
- Variations in the injection pipe pressure make it difficult to achieve an optimum spray from the injection nozzles and the optimum air/fuel mixture.
- To compensate for changes in the injection pipe pressure, the injection pump plunger pre-stroke is increased at low and mid- range speeds, thus ensuring that fuel injection takes place late in the cam lift, when plunger movement is relatively fast.
- At high speeds, the plunger pre-stroke is decreased, thus ensuring that fuel injection takes place in early in the cam lift, when plunger movement is relatively slow. Excessive increases in injection pipe pressure are thus prevented.
- By adjusting the plunger pre-stroke in this manner, the pre-stroke control injection pump **7** ensures that the spray and air/ fuel mixture are always optimally suited to combustion.
- The overall benefits are higher engine torque and cleaner exhaust emissions than are possible with a conventional injection pump.
- Control operations are performed by the engine electronic control unit **41**, which receives data from sensors on the engine and other vehicle components, processes them, and issues appropriate drive signals to the pre-stroke actuator **8** (located at the rear of the injection pump) and to the linear DC motor **3** (located inside the electronic governor).

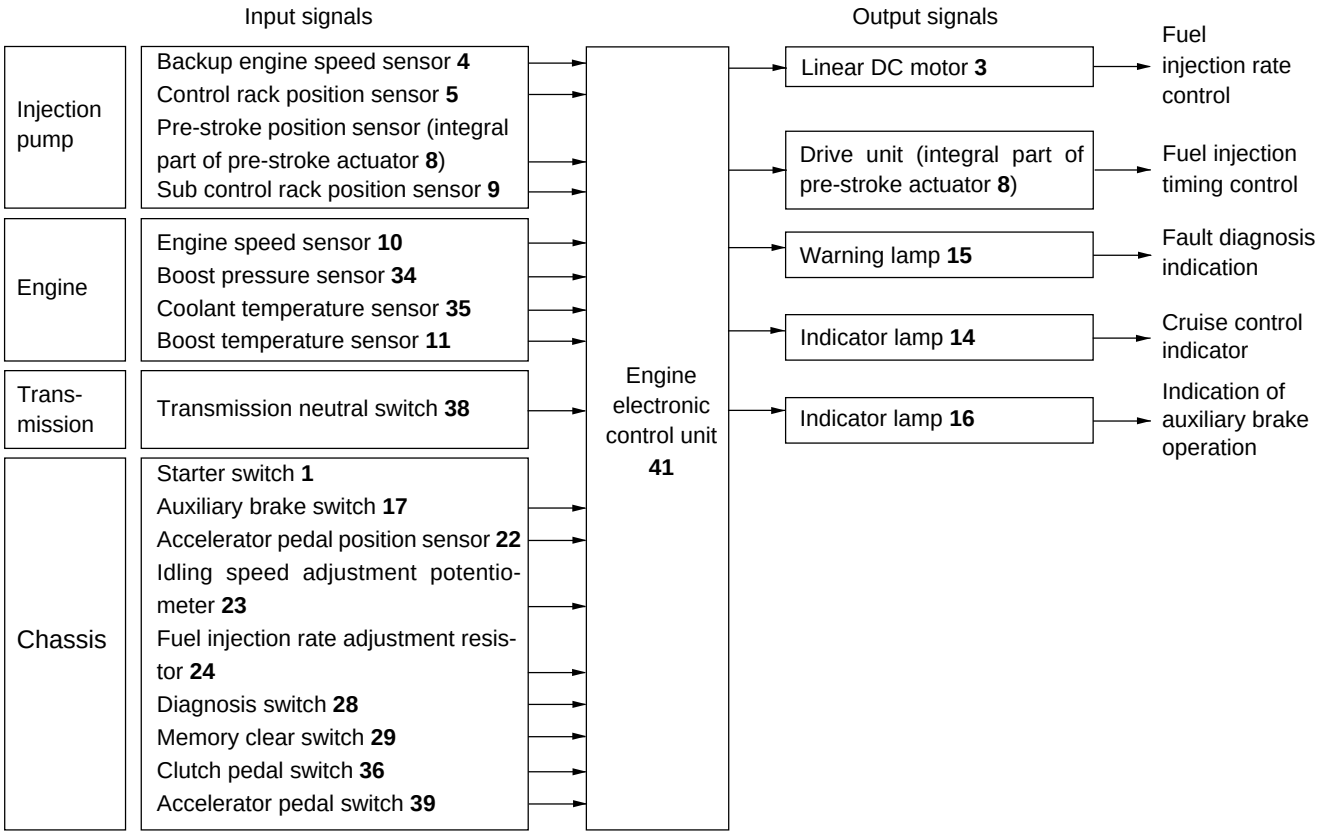
The system's control functions (including auxiliary functions) are shown in the following table.

Item	Operation	Data source	
		Sensor(s)	Data signal(s)
Fuel injection rate control	The fuel injection rate is optimized to match engine operating conditions. 🕮 P13-11	5, 10, 22, 24, 34, 39	Ⓐ, Ⓖ, Ⓣ, Ⓥ, ⓓ, ⓗ
Pre-stroke control	The timing sleeve position is altered, thereby changing the prestroke and advancing the fuel injection timing. 🕮 P13-12	8, 10, 22, 35	Ⓔ, Ⓕ, Ⓖ, Ⓣ, ⓔ
* Control rack preliminary operation	In cold weather and other conditions that are unfavorable for engine startup, the control rod is caused to move slightly in the fuel increase direction, thus enhancing startability. This operation takes place when the starter switch is turned ON.	1, 22, 25, 35	ⓘ, Ⓣ, ⓦ, ⓔ
* Warmup time shortening function	In cold weather, the engine's idling speed is increased to shorten the time required for warmup. 🕮 P13-13	22, 23, 35	Ⓣ, Ⓤ, ⓔ
* Overrun prevention function	In the event of an abnormal increase in engine speed, the control rack is pulled in the fuel decrease direction to prevent the engine from overrunning.	10	Ⓖ
* Emergency vehicle operation function (used in event of control rack position sensor fault)	In the event of a fault in the control rack position sensor **5**, the control rack position is sensed by the sub control rack position sensor **9**. If both rack position sensors develop faults, thus preventing detection of the rack position and optimization of the fuel injection rate, the fuel injection rate is controlled in accordance with engine speed signals only. 🕮 P13-15	5, 9, 10	Ⓐ, Ⓓ, Ⓖ

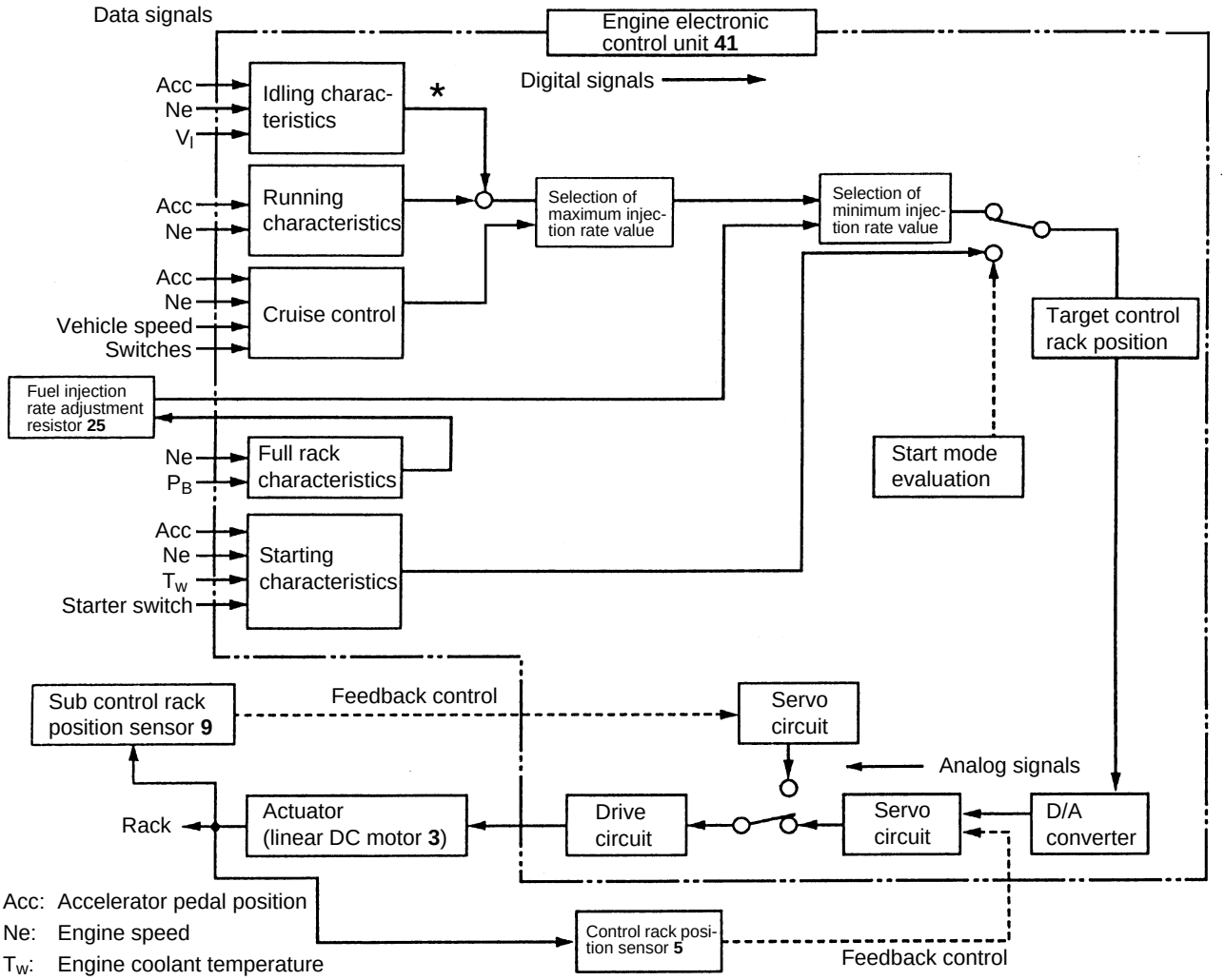
Item	Operation	Data source	
		Sensor(s)	Data signal(s)
* Cruise control function	It maintains the vehicle speed set by the driver while driving.	10, 14, 17 to 22, 25, 26, 33, 36 to 39	Ⓖ, Ⓚ, Ⓝ to Ⓣ, Ⓦ, ⓑ, ⓕ, to ⓗ
* Auxiliary brake control function	The auxiliary braking devices (Exhaust brake) are controlled by the engine electronic control unit **41**. (In a conventional system, the auxiliary braking devices are controlled by switches, relays, and dedicated controllers.) P13-19	10, 16, 22, 36 to 39	Ⓖ, Ⓜ, Ⓣ, ⓕ to ⓗ
* Fault diagnosis function	The status of each system sensor is monitored continuously during engine operation. In the event of a fault, a warning lamp is illuminated to alert the driver and data related to the fault are stored in memory. P13-32	ALL	ALL
* Fail-safe function	In the event of a fault, a backup mode is selected and remedial action is taken in accordance with the type of fault. P13-36	ALL	ALL
* Reverse engine operation prevention function	In the event of reverse engine operation, the control rack is pulled in the fuel decrease direction to stop the engine	10	Ⓖ
* Injection control function in high ATF temperature condition	In the event of high ATF temperature, the amount of fuel injection is adjusted to regulate the engine output power. P13-19	40	ⓙ

*: Auxiliary function

System Block Diagram



● Fuel injection rate control



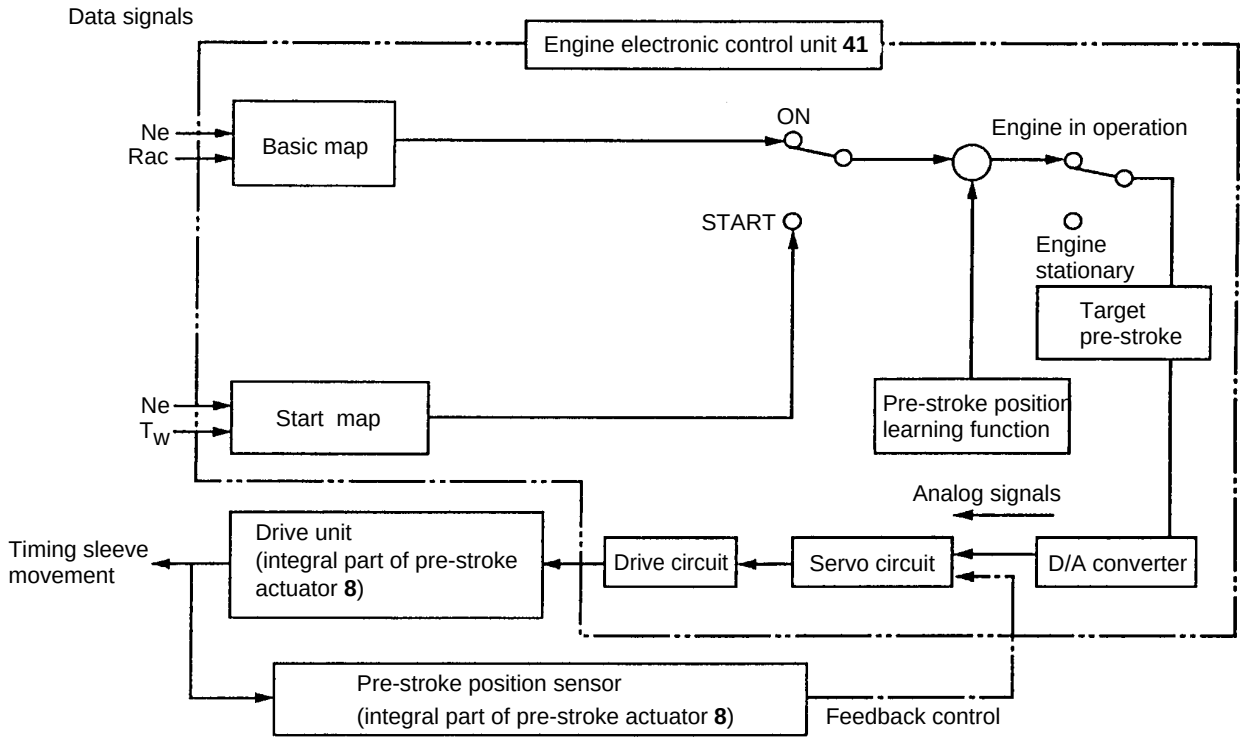
Operation of engine electronic control unit 41

- During engine operation control is effected in accordance with the cruise control, idling characteristics and running characteristics. The maximum fuel injection rate value is selected in accordance with the output signals.
- After this selection, the control unit calculates and determines the minimum injection rate to prevent the injection rate selected in accordance with the full rack characteristics from exceeding the maximum injection rate. The target control rack position is thus determined. (During engine startup, control is effected in accordance with the starting characteristics, with the target rack position determined directly in accordance with the data signals.)
- The determined control rack position signal is converted into a continuous analog signal. By way of the servo circuit and drive circuit, the signal is applied to the linear DC motor **3**, which moves the rack.

Operation of control rack position sensor 5

- The control rack position sensor **5** monitors the operation of the linear DC motor **3**. In accordance with the position of the control rack, the sensor determines whether the linear DC motor is operating in accordance with the target, and it transmits feedback signals to the engine electronic control unit **41**.
- In accordance with the feedback signals, the engine electronic control unit **41** calculates the actual control rack position. If the actual position differs from the target, the control unit issues a correction command.
- Through repetition of this process, the system ensures that the control rack position complies with the target at all times.

● Pre-stroke control



Rac: Control rack position
Ne: Engine speed
T_W: Engine coolant temperature
D/A converter: Digital-to-analog converter

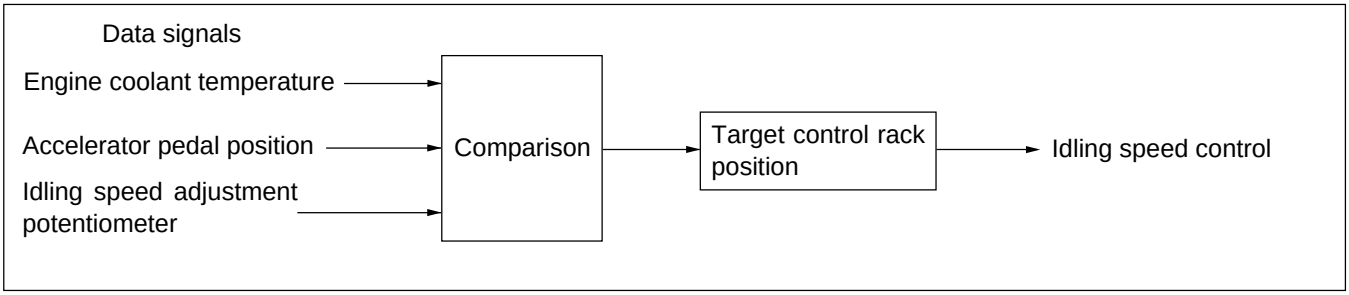
Operation of engine electronic control unit 41

- During engine operation, control is effected in accordance with the basic map.
- The pre-stroke position learning function compensates for pre-stroke position sensor adjustment errors and other injection pump errors using the pre-stroke position sensor output voltage, thereby enabling determination of the target pre-stroke.
- The determined target pre-stroke value is converted into a continuous analog signal. By way of the servo circuit and drive circuit, the signal is applied to the drive unit. The drive unit moves the timing sleeve to alter the pre-stroke.
- During engine startup, control is effected in accordance with the start map.

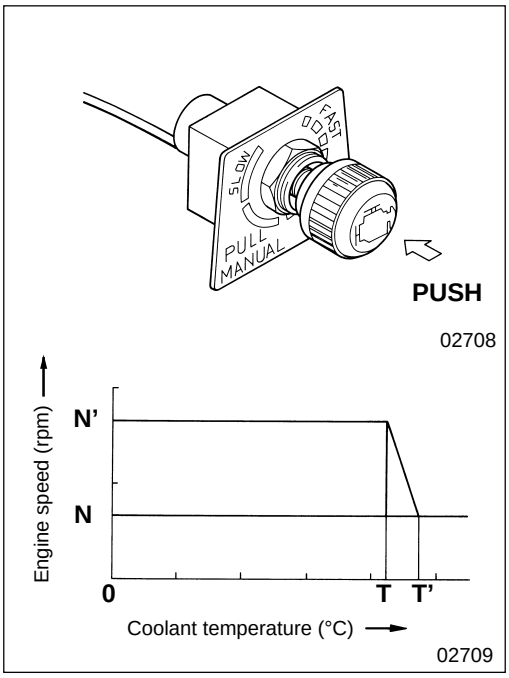
Operation of pre-stroke position sensor (integral part of pre-stroke actuator 8)

- The pre-stroke position sensor monitors the operation of the drive unit. In accordance with the position of the timing sleeve, the sensor determines whether pre-stroke control is being performed in accordance with the target, and it transmits feedback signals to the engine electronic control unit **41**.
- In accordance with the feedback signals, the engine electronic control unit **41** calculates the actual timing sleeve position. If the actual position differs from the target, the control unit issues a correction command.
- Through repetition of this process, the system ensures that the timing sleeve position complies with the target at all times. The appropriate pre-stroke is achieved as a result.

● Warmup time shortening function

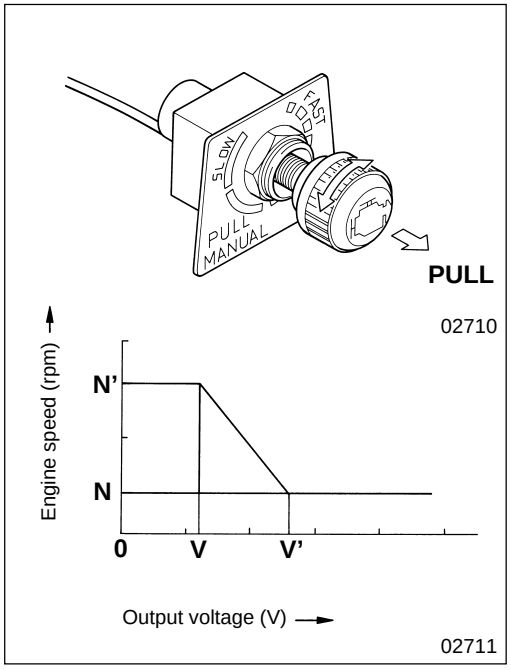


The warmup time shortening function increases the engine's idling speed in accordance with the coolant temperature, thereby shortening the time required for the engine to warm up. Control is effected automatically or manually in accordance with the position of the idling speed adjustment potentiometer **23**. Automatic control is selected by pushing the potentiometer, and manual control is selected by pulling it.



Automatic control (Potentiometer pushed)

- Automatic control is selected when the idling speed adjustment potentiometer **23** is pushed.
- When the coolant temperature is low, the engine's idling speed is automatically increased to shorten the time required for warmup.
- If the coolant temperature increases from **T** to **T'** (see the graph), the engine speed is decreased from **N'** to **N**. thus returning to its standard idling level.



Manual control (Potentiometer pulled)

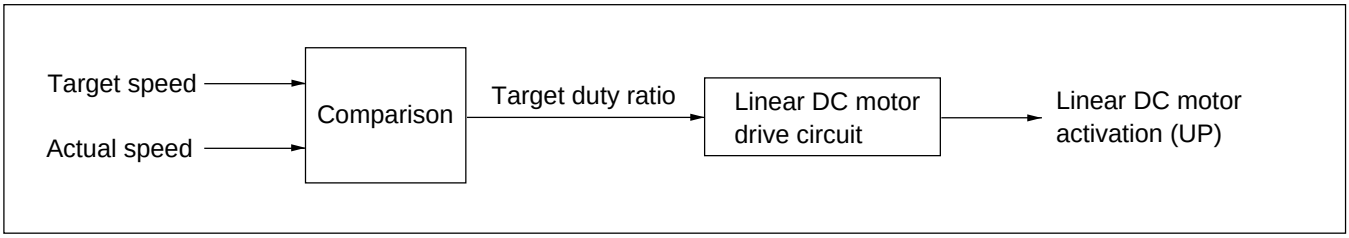
- When the idling speed adjustment potentiometer **23** is pulled, the automatic mechanism is cancelled. The driver can then adjust the idling speed as desired by rotating the potentiometer. (Rotation of the potentiometer causes the potentiometer's output voltage to change accordingly.)
- With the output voltage between **0** and **V**, the engine speed stays at the **N** to **N'** level.
- If the output voltage is increased from **V** to **V'** (see the graph), the engine speed decreases from **N'** until it reaches its standard idling level **N**.

● Emergency vehicle operation function (Used of event in control rack position sensor fault)

Fault in Control rack position sensor 5

In the event of a fault in the control rack position sensor **5**, detection of the control rack position is performed using the sub control rack position sensor **9**. This enables more-or-less normal vehicle operation.

Fault in control rack position sensor 5 and sub control rack position sensor 9



In the event of faults in both the control rack position sensor **5** and sub control rack position sensor **9**, the position of the rack, which is controlled by the linear DC motor **3**, cannot be sensed directly. The fuel injection rate cannot be controlled normally with the engine in this condition. As an emergency measure, therefore, control operations are performed in accordance with engine speed data signals only. For this function, target engine speeds for given degrees of accelerator pedal depression are pre-programmed into the engine electronic control unit **41**. Control is effected as follows:

- The target engine speed is compared with the actual engine speed (this is indicated by the engine speed sensor **10**).
- The target duty ratio is determined in accordance with the result of the comparison. In accordance with the target duty ratio, a drive signal is transmitted to the UP-side (speed increasing side) circuit to effect control over the engine speed. If the target engine speed exceeds the actual engine speed or vice versa, the UP-side circuit's ON time period is altered such that the target engine speed is maintained.

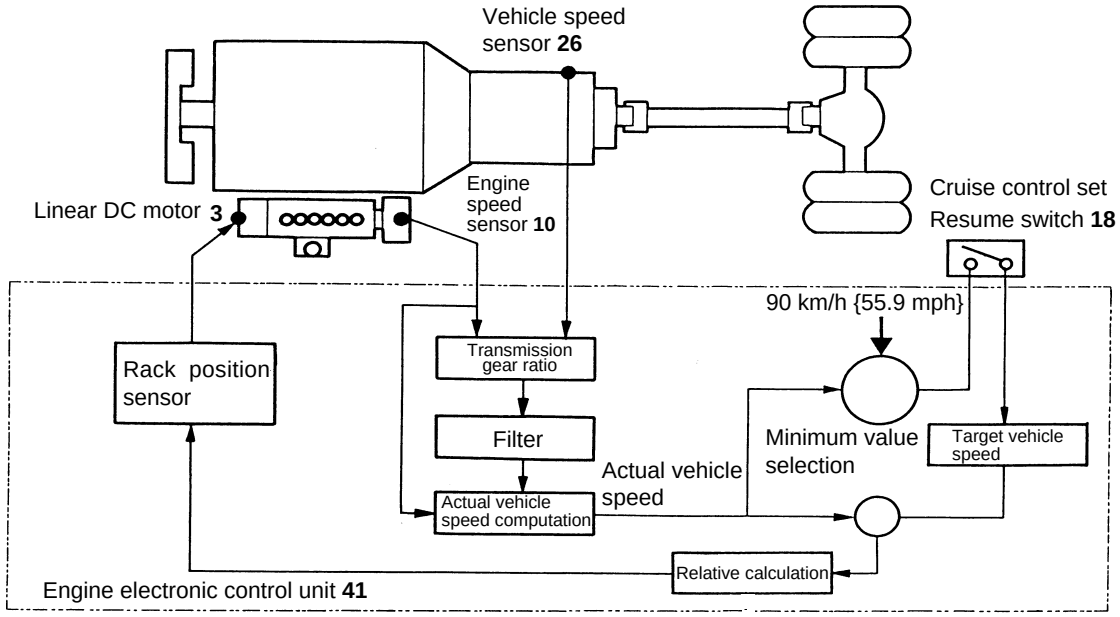
The target duty ratio is the ratio of the time periods during which the linear DC motor's UP-side and DOWN-side (speed decreasing side) circuits are energized. It is calculated as follows:

$$\text{Duty ratio} = \frac{\text{UP-side circuit ON time period}}{\text{UP-side circuit ON time period + DOWN-side circuit ON time period}} \times 100\%$$

CAUTION ⚠

When this function is activated, the warning lamp 15 flashes to indicate that the engine must be inspected immediately. 🕮 **P13-32**

● Cruise control function



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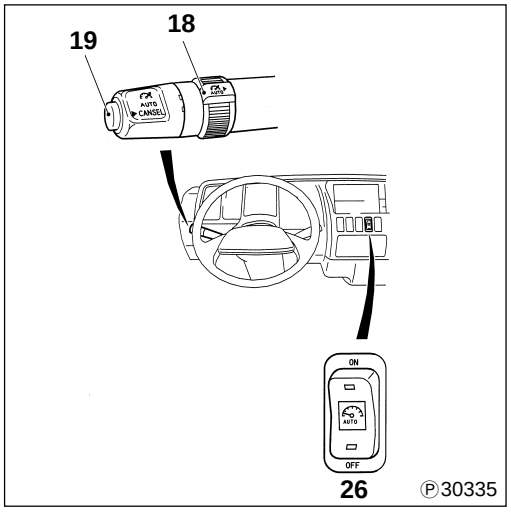
- The transmission gear ratio is calculated based on the information from the vehicle sensor **26** and the engine speed sensor **10**.
- The actual vehicle speed is calculated from the gear ratio and the engine revolution speed.
- The cruise control vehicle speed is set to the minimum of the maximum possible vehicle speed and the calculated actual vehicle speed.
- By setting the desired vehicle target speed, the difference between the set speed and the actual vehicle speed is calculated and the target rack position is determined.
- This command is sent to the linear DC motor **3** as an operational signal and thus an even vehicle speed can be maintained by controlling the rack position.



Ⓟ30335

The cruise control should be operated using the cruise control set switch **19** and the resume switch **18** as follows.

CAUTION ⚠

The following conditions must be satisfied for cruise control to operate.

- **The vehicle speed must be between 40 to 90 km/h {25 to 55.9 MPH} and the gear shift lever must be in the 4th position or higher.**
- **The cruise control main switch 28 must be ON.**
- **The exhaust brake must be OFF.**
- **The clutch and the brake pedal must be in released.**

Cruise control set resume switch 18

SET side

This switch is used to set and change the cruise vehicle speed.

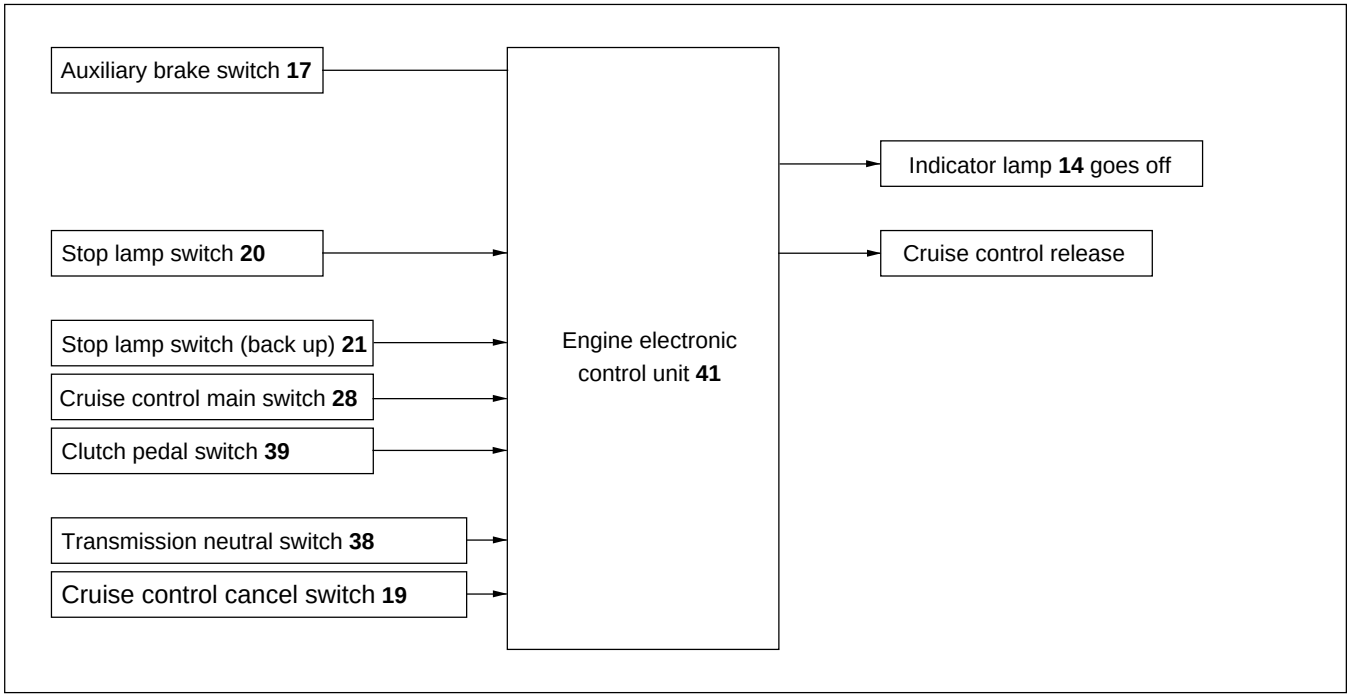
- Setting the cruise speed
  Set the vehicle speed at your discretion by operating the accelerator pedal.
  Turn cruise control set/resume switch **18** to SET, and the cruise speed will be set to the current vehicle speed when it is released. The indicator lamp will light up at the same time.
- Reducing the cruise speed
  With cruise control in activation, vehicle speed decreases while cruise control set/resume switch **18** is turned to SET. Release the switch when the vehicle reaches a desired speed to set cruise control at that speed.
- Increasing the cruise speed
  Press the accelerator pedal. When the vehicle reaches a desired speed, turn cruise control set/resume switch **18** to SET and release it immediately. The vehicle continues traveling at the set speed.

RESUME side

To restore or change vehicle speed setting.

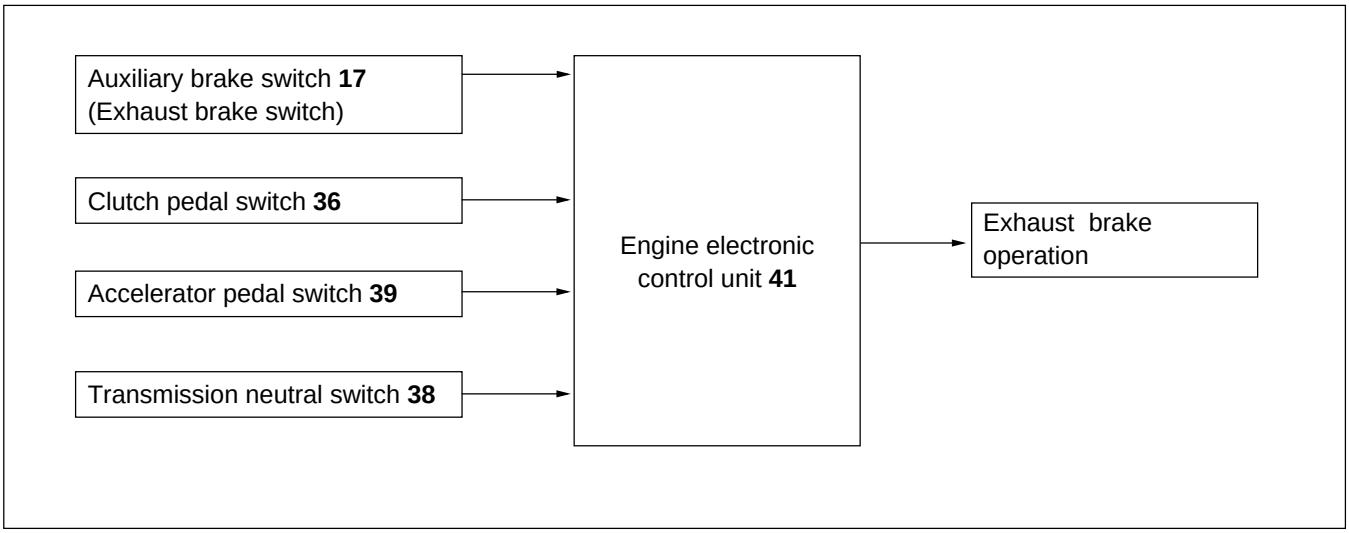
- Restoring previous vehicle speed setting when cruise control is deactivated by deceleration, turning and releasing cruise control set/resume switch **18** will restore the previous vehicle speed setting.
- Increasing the set vehicle speed setting with cruise control in activation, turning cruise control set/resume switch **18** to RESUME will increase vehicle speed. When the switch is released, vehicle speed at that time is set as cruise control speed.

Cruise control release



The cruise control is disengaged or temporarily disabled when the switches are in the following conditions.
< Disengaged >
Cruise control main switch **28** OFF
< Temporarily disabled >
- Auxiliary brake switch **17** ON
- Clutch pedal switch **39** ON (Depressing the clutch pedal)
- Transmission neutral switch **38** OFF (Transmission in neutral position)
- Stop lamp switch **21** ON (Depressing the brake pedal)
- Cruise control cancel switch **19** ON

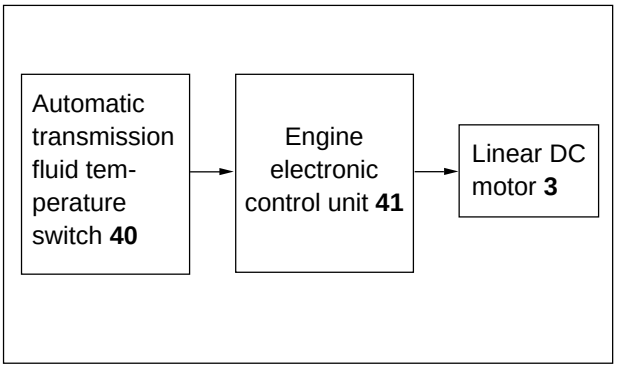
● Auxiliary brake control function



The auxiliary brake control function acts upon the auxiliary braking devices, i.e., the exhaust brake, when the following conditions are satisfied:

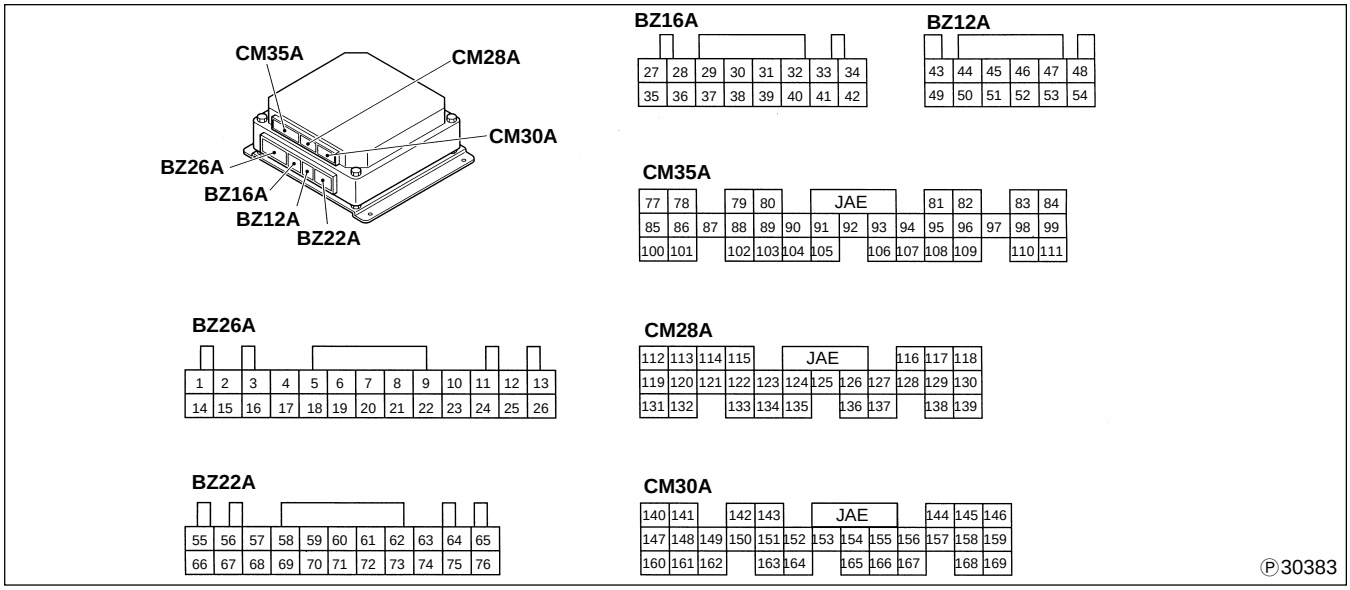
- Clutch pedal switch **36**: OFF (clutch pedal released)
- Accelerator pedal switch **39**: ON (accelerator pedal released)
- Transmission neutral switch **38**: ON (transmission not in neutral)

● Injection control function in high ATF temperature condition < Automatic transmission >



When the temperature of automatic transmission fluid exceeds the normal range, automatic transmission fluid temperature switch **40** turns ON. When engine electronic control unit **41** detects this rack limit switch operation, it controls linear DC motor **3** to reduce the engine output power.

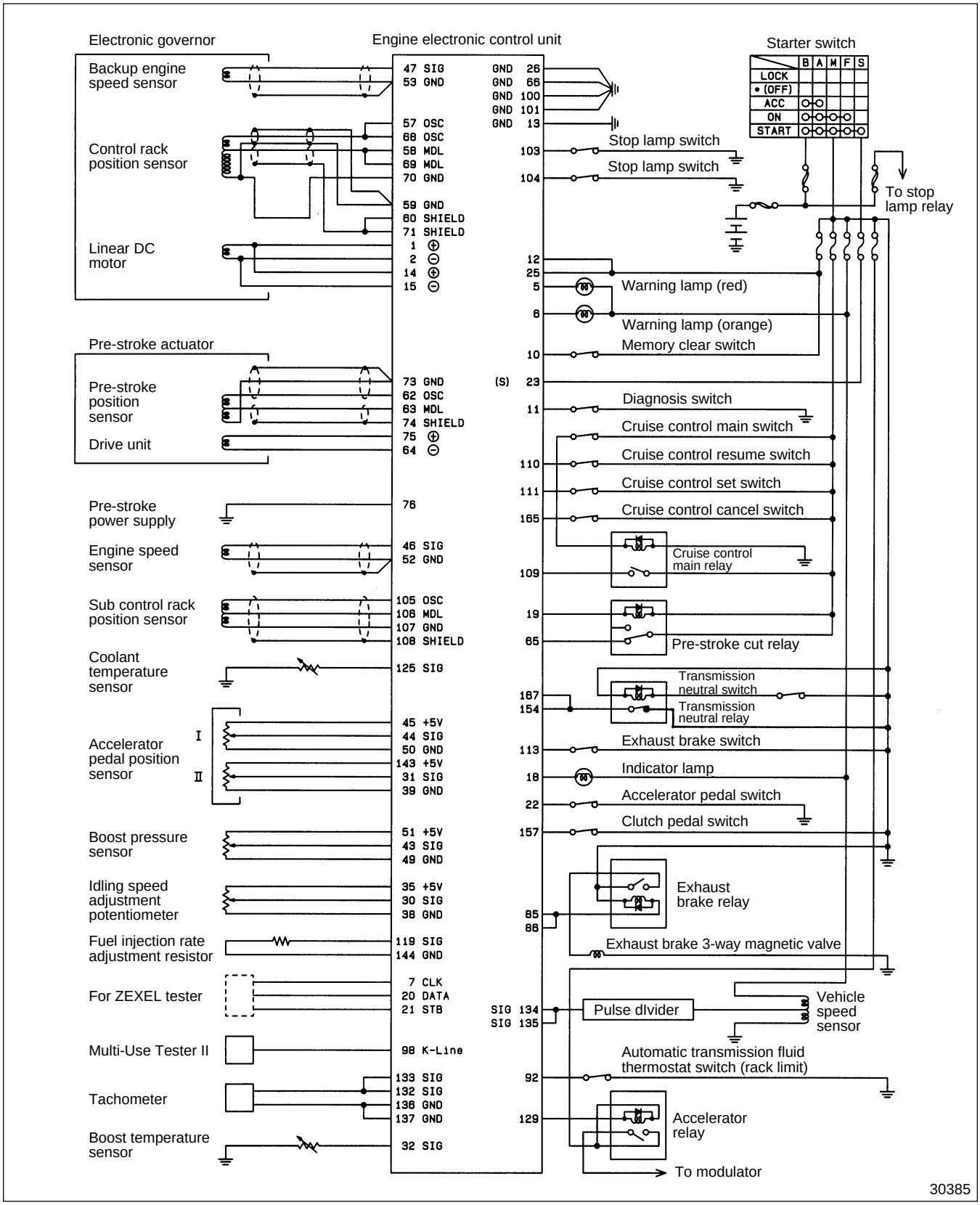
Engine Electronic Control Unit



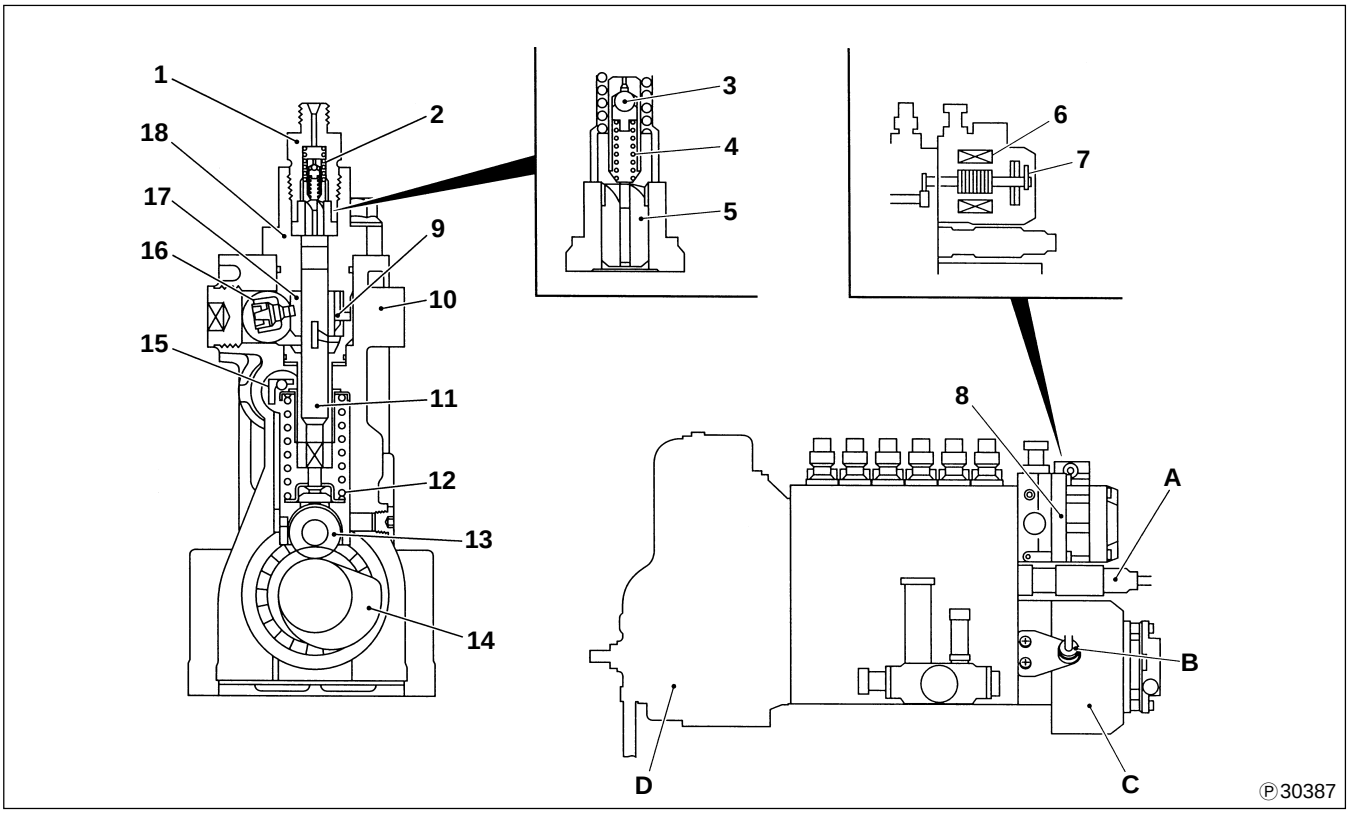
Connector	Terminal	Connected to		Connector	Terminal	Connected to		Connector	Terminal	Connected to	
BZ 26A	1	Linear DC motor	⊕	BZ 26A	19	Pre-stroke cut relay		BZ 16A	37	—	
	2		⊖		20	DDS-3	(DATA)		38	Idling speed adjustment potentiometer (GND)	
	3	—			21		(STB)		39	Accelerator pedal position sensor II (GND)	
	4				22	Accelerator pedal switch			40	—	
	5	Warning lamp	(Red)		23	Start signal			41		
	6		(Orange)		24	—			42		
	7	DDS-3 (CLK)			25	Electronic control unit power supply (starter switch terminal M)		BZ 12A	43	Boost pressure sensor (SIG)	
	8	—			26	Electronic control unit GND			44	Accelerator pedal position sensor I	(SIG)
	9			BZ 16A	27	—			45		(+5V)
	10	Memory clear switch			28	—			46	Engine speed sensor (SIG)	
	11	Diagnosis switch			29	—			47	Backup engine speed sensor (SIG)	
	12	Electronic control unit power supply (starter switch terminal M)			30	Idling speed adjustment potentiometer (SIG)			48	—	
	13	Control unit GND (analog GND)			31	Accelerator pedal position sensor II (SIG)			49	Boost pressure sensor (GND)	
	14	Linear DC motor	⊕		32	Boost temperature sensor (SIG)			50	Accelerator pedal position sensor I (GND)	
	15		⊖		33	—			51	Boost pressure sensor (+5V)	
	16	—			34	—			52	Engine speed sensor (GND)	
	17				35	Idling speed adjustment potentiometer (+5V)			53	Backup engine speed sensor (GND)	
	18	Indicator lamp			36	—			54	—	

Connector	Terminal	Connected to		Connector	Terminal	Connected to		Connector	Terminal	Connected to	
BZ 22A	55	—		CM 35A	94	—		CM 28A	132	Tachometer output	(SIG)
	56				95				133		(SIG)
	57	Control rack position sensor	(OSC)		96				134	Vehicle speed sensor (SIG)	
	58		(MDL)		97				135	Vehicle speed sensor (SIG)	
	59		(GND)		98	Multi-Use Tester II (K-line)			136	Tachometer output	(GND)
	60		(SHIELD)		99	—			137		(GND)
	61	—			100	Electronic control unit GND (power GND)			138	—	
	62	Pre-stroke position sensor	(OSC)		101				139		
	63		(MDL)		102	—		CM 30A	140		
	64	Pre-stroke actuator ⊖			103	Stop lamp switch			141		
	65	Pre-stroke cut relay (+24V)			104	Stop lamp switch			142		
	66	Electronic control unit GND			105	Sub control rack position sensor	(OSC)		143	Accelerator pedal position sensor II (+5V)	
	67	—			106		(MDL)		144	Fuel injection rate adjustment resistor (GND)	
	68	Control rack position sensor	(OSC)		107		(GND)		145	—	
	69		(MDL)		108		(SHIELD)		146		
	70		(GND)		109	Cruise control main relay			147		
	71		(SHIELD)		110	Cruise control resume switch			148		
	72	—			111	Cruise control set switch			149		
	73	Pre-stroke position sensor	(GND)	CM 28A	112	—			150		
	74		(SHIELD)		113	Exhaust brake switch			151		
	75	Pre-stroke actuator ⊕			114	—			152		
	76	Pre-stroke power supply (GND)			115				153		
CM 35A	77	—			116				154	Transmission neutral relay	
	78				117				155	—	
	79				118				156		
	80				119	Fuel injection rate adjustment resistor (SIG)			157	Clutch pedal switch	
	81				120	—			158	—	
	82				121				159		
	83				122				160		
	84				123				161		
	85	Exhaust brake relay			124				162		
	86				125	Coolant temperature sensor (SIG)			163		
	87	—			126	—			164		
	88				127				165	Cruise control cancel switch	
	89				128				166	—	
	90				129	Accelerator relay			167	Idle up prohibit switch	
	91				130	—			168	—	
	92	Rack limit switch			131				169		
	93	—									

Engine electronic control unit



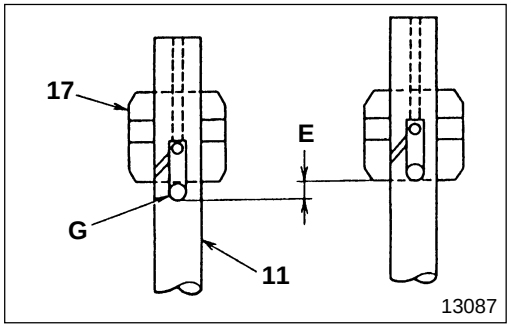
Pre-stroke control injection pump main unit



1 Delivery valve holder
2 Delivery valve spring
3 Ball
4 Spring
5 Delivery valve
6 Drive unit
7 Pre-stroke position sensor
8 Pre-stroke actuator
9 Pin
10 Pump housing
11 Plunger
12 Plunger spring
13 Tappet
14 Camshaft
15 Control rod
16 Timing rod
17 Timing sleeve
18 Plunger barrel

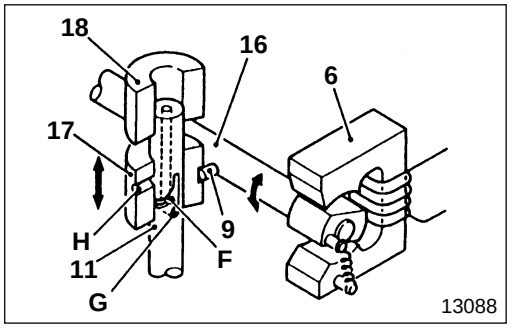
A : Sub-control rod position sensor
B : Engine speed sensor
C : Mechanical timer
D : Electronic governor

- The injection pump is provided with a mechanism that enables variation of the plunger pre-stroke.
- Variation of the plunger pre-stroke enables the creation of air/fuel mixture and spray conditions that are optimally suited to combustion. The overall benefits are higher engine torque and cleaner exhaust emissions than are possible with a conventional injection pump.



Pre-stroke

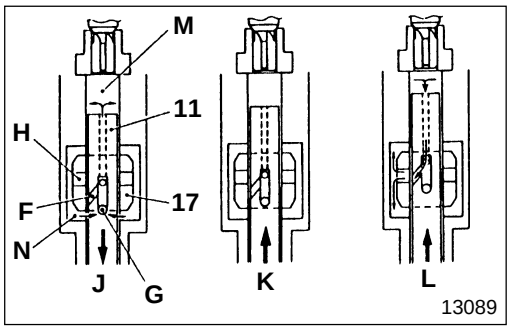
The term “pre-stroke” refers to the stroke dimension **E** of a plunger **11** from the plunger’s bottom dead center position to the point at which its fuel inlet hole **G** is closed by the timing sleeve **17** and fuel injection begins. This stroke dimension is constant in a conventional injection pump.



Variable pre-stroke mechanism

F : Lead
G : Inlet hole
H : Outlet hole

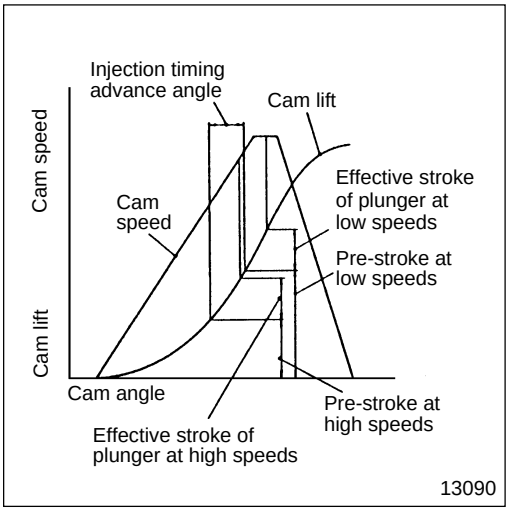
- In contrast to the fixed plunger barrel arrangement of a conventional injection pump, each plunger barrel **18** in the pre-stroke control type injection pump incorporates a vertically moveable timing sleeve **17**.
- Movement of the timing sleeve is effected by the timing rod **16**, pin **9**, and drive unit **6**.
- When the drive unit **6** rotates the timing rod **16**, the pin **9** moves the timing sleeve **17** up or down accordingly.
- Since the timing sleeve **17** incorporates a fuel outlet hole **H**, the pre-stroke changes in accordance with the movement of the timing sleeve.



Fuel feed action

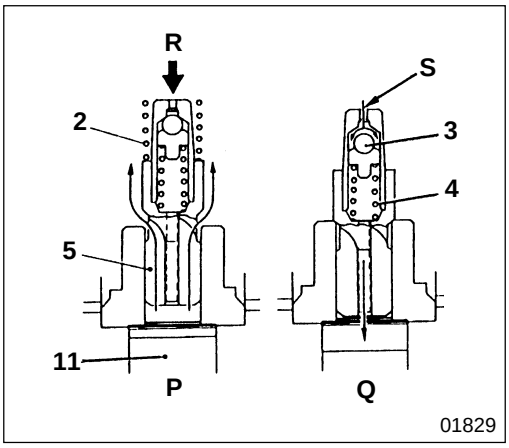
J : Fuel intake
K : Start of pressurization
L : End of pressure feed

- As the plunger **11**, moves downward from its top dead center position and its inlet hole **G** opens, fuel flows into the pressure chamber **M** owing to the vacuum pressure created by the plunger’s downward movement and the fuel pressure produced by the feed pump.
- When the plunger **11** moves upward but its lift dimension is still small, the fuel in the pressure chamber **M** escapes into the sump **N** through the inlet hole **G** in the plunger. Thus, the pressure in the pressure chamber does not increase.
- As the plunger **11** moves further upward and the inlet hole **G** is closed by the timing sleeve **17**, the fuel starts to be pressurized. The pressure increases as the plunger moves upward, and the injection pump starts to feed the pressurized fuel to each injector.
- When the lead **F** in the plunger **11** becomes aligned with the outlet hole **H** in the timing sleeve **17**, the fuel in the pressure chamber **M** returns to the sump **N**, thus completing the pressure feed cycle.
- Adjustment of the injected fuel volume is achieved by rotation of the plunger **11**, which alters the position of the outlet hole **H** in the timing sleeve **17** relative to the lead **F** in the plunger.



Fuel injection timing and fuel injection characteristics

- Changes in the position of the timing sleeve **17** cause concomitant changes in the pre-stroke, which in turn alter the fuel injection timing.
- A decrease in the pre-stroke causes the fuel inlet hole **G** in the plunger **11** to close earlier such that the fuel injection timing is advanced.
- This arrangement provides highly responsive control over the injection timing and thus enhances the engine's cold startability.

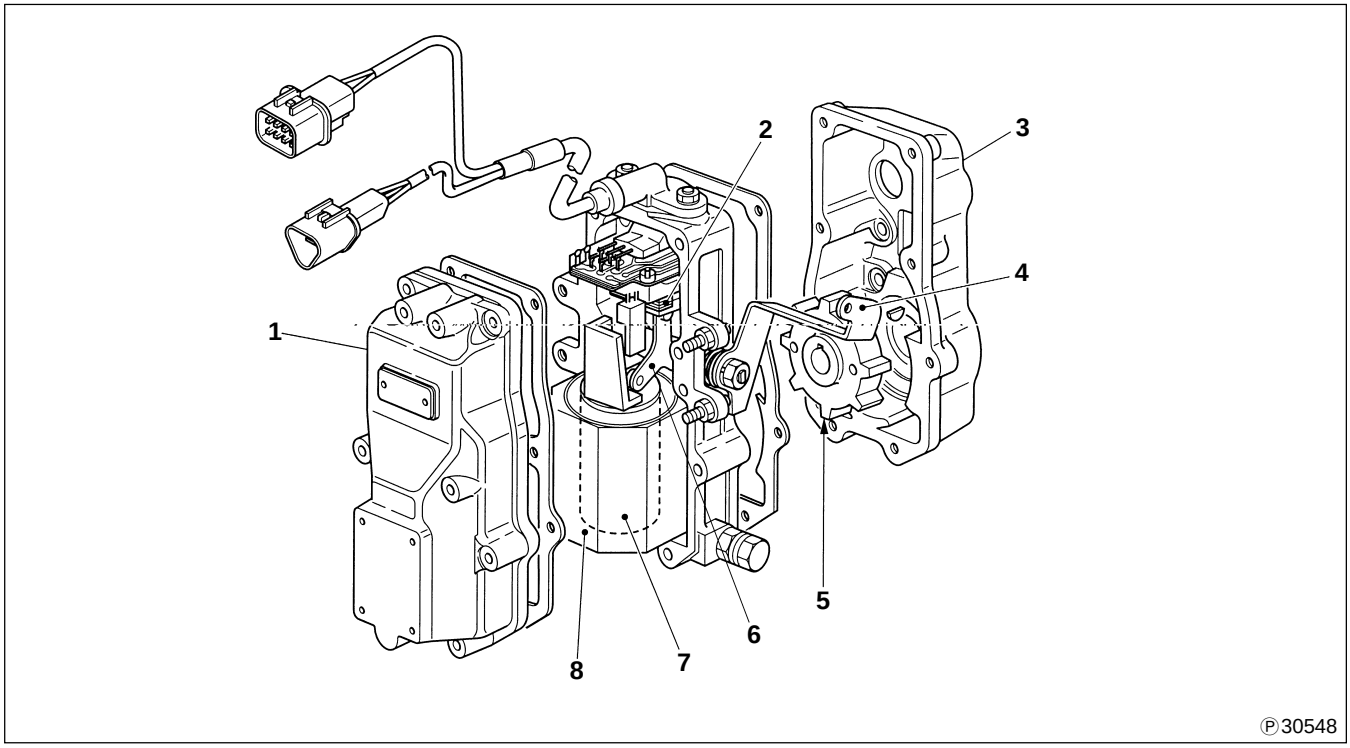


Delivery valve

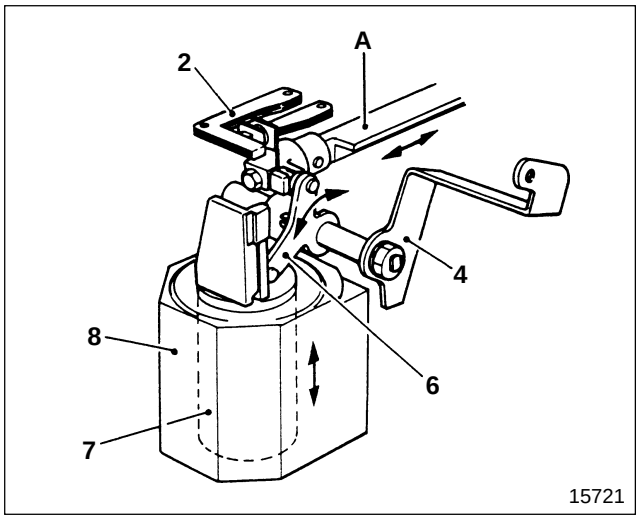
P : Start of pressure feed
Q : End of pressure feed

- The delivery valve **5** keeps constant the residual pressure **R** in the injection pipe at all engine speeds. This operation prevents the generation of bubbles in the fuel (this is known as "cavitation") and thus enables fuel injection at a high pressure.
- When the plunger **11** moves upward and the pressure of the fuel pushed by the plunger overcomes the residual pressure **R** in the injection pipe and the preset force of the delivery valve spring **2**, the delivery valve is pushed upward and delivery of the pressurized fuel begins.
- As soon as fuel delivery is complete, the fuel in the injection pipe rapidly returns to the plunger side and the delivery valve closes.
- Surplus fuel slowly returns through the orifice **S**, thus reducing the pressure in the injection pipe.
- When the preset force of the spring **4** in the delivery valve **5** is exactly offset by the pressure in the injection pipe, the ball **3** closes the orifice **S**, thus ensuring that the residual pressure **R** in the injection pipe remains constant.

Electronic Governor



1 Cover
2 Control rack position sensor
3 Housing
4 Emergency engine stop lever
5 Sensing gear
6 Link
7 Linear DC motor
8 Coil assembly



● Linear DC motor

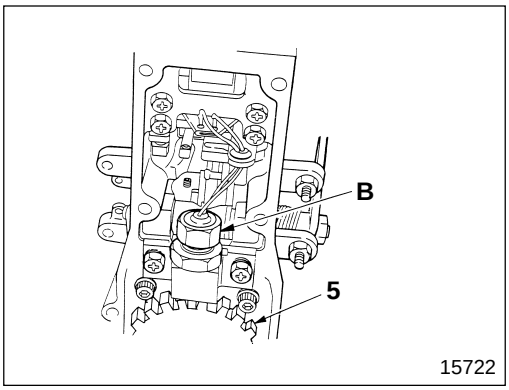
The linear DC motor **7** moves the coil assembly **8** vertically in accordance with signals from the engine electronic control unit. Via the link **6**, this movement is transmitted to the control rack **A**, which moves longitudinally to increase and decrease the fuel quantity.

● Control rack position sensor

The control rack position sensor **2** senses whether the control rack **A** is moved to the correct position by the linear DC motor **7**. In the event of a discrepancy between the actual control rack position and the target control rack position (this is determined by the engine control unit), the control unit instructs the linear DC motor to perform a corrective movement.

● **Emergency engine stop lever**

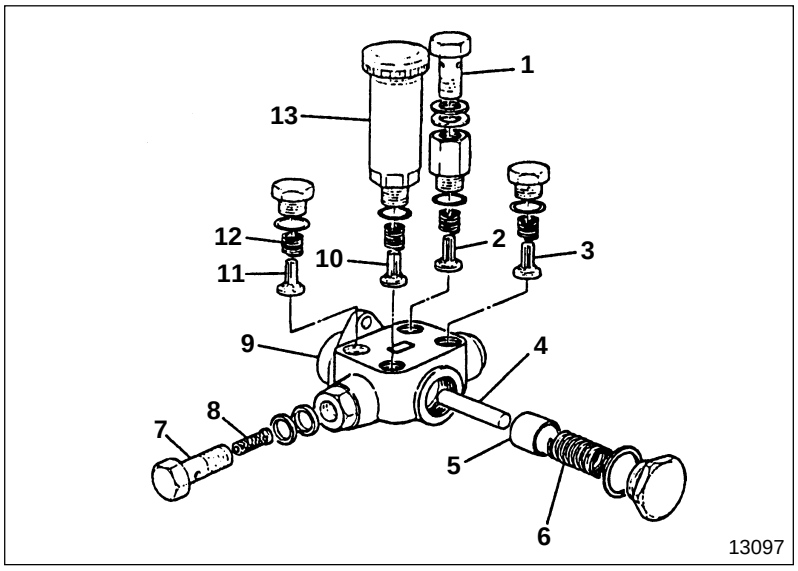
The emergency engine stop lever **4** is connected to the link **6**. Via a cable, it enables the link to be moved from the driver's seat. In the event of a system fault that prevents the engine from being stopped normally, operation of the emergency engine stop lever forces the control rack **A** to move to the position at which fuel injection is terminated. This operation takes place irrespective of the position of the linear DC motor **7**.



● **Backup engine speed sensor**

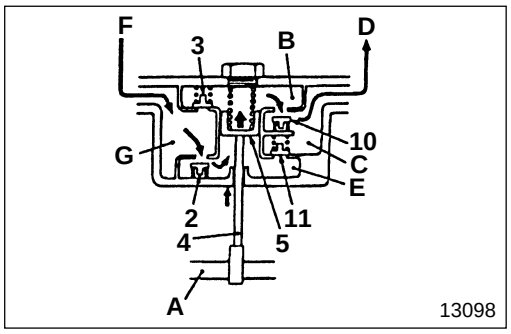
The backup engine speed sensor **B** is fitted inside the governor. It converts the rotation speed of the sensing gear **5** into electric signals and feeds the signals to the engine electronic control unit to provide an indication of the engine speed.

Feed Pump

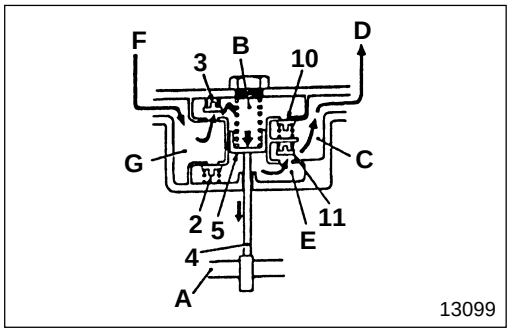


1 Eye bolt at fuel outlet
2 Check valve
3 Check valve
4 Push rod
5 Piston
6 Piston spring
7 Eye bolt at fuel inlet
8 Gauze filter
9 Feed pump housing
10 Check valve
11 Check valve
12 Check valve spring
13 Priming pump

- The feed pump is a double-action type pump which, with four check valves operating, sucks and discharges fuel during both strokes of pistons **5**.
- Push rod **4** makes contact with the injection pump camshaft directly, moving piston **5**.
- Priming pump **13** can be manually operated, when the injection pump is not operating, to suck up fuel and thus can be used for air bleeding.
- Mesh filter **8** eliminates large foreign particles from the fuel sucked up from the fuel tank to prevent clogging of the feed pump. This mesh filter must be cleaned with diesel fuel periodically.

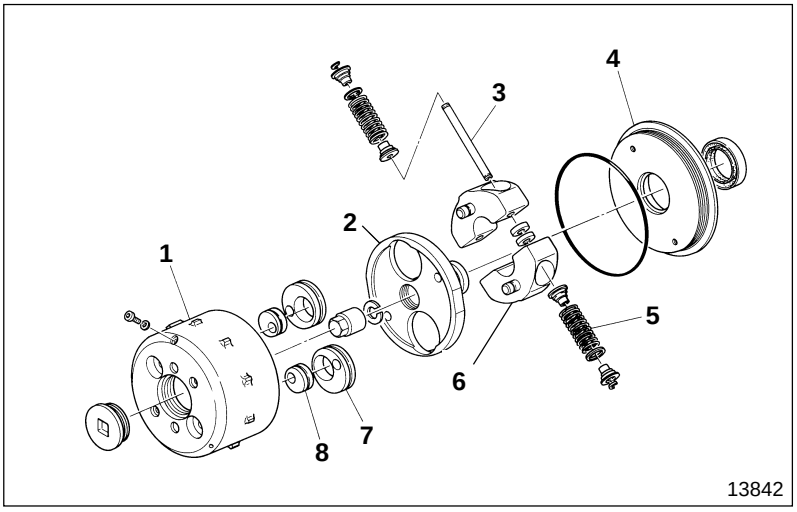


The rotation of injection pump camshaft **A**, pushes up push rod **4** and piston **5**, and the pressure in inner chamber **B** increases. This closes check valve **3**, and check valve **10** opens to let the fuel in inner chamber **B** flow through outer chamber **C** to fuel filter **D**.
When the pressure in inner chamber **E** decreases, check valve **11** closes, and check valve **2** opens to let fuel flow from fuel tank **F** through outer chamber **G** to inner chamber **E**.



When injection pump camshaft **A** rotates further, it pushes down push rod **4** and piston **5**, and the pressure in inner chamber **E** increases. This closes check valve **2**, and check valve **11** opens to let the fuel in inner chamber **E** flow through outer chamber **C** to fuel filter **D**.
When the pressure in inner chamber **B** decreases, check valve **10** closes, and check valve **3** opens to let fuel from fuel tank **F** flow through outer chamber **G** to inner chamber **B**.

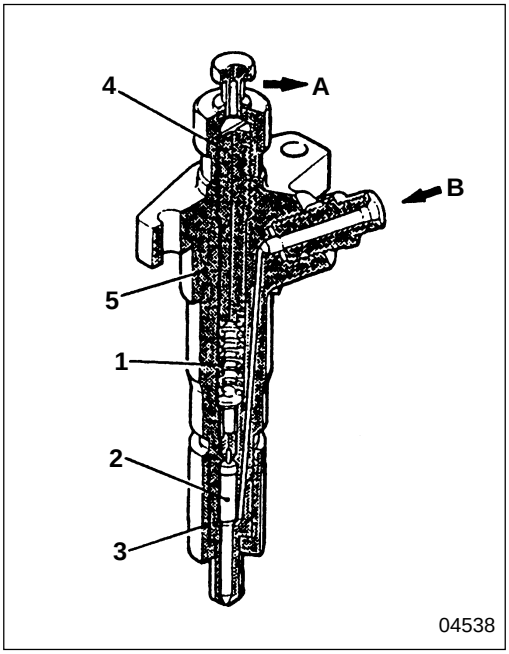
Automatic Timer



1 Timer housing
2 Timer holder
3 Pilot pin
4 Cover
5 Timer spring
6 Flyweight
7 Eccentric cam (Large)
8 Eccentric cam (Small)

- The mechanical type automatic timer changes fuel injection timing automatically when the engine revolution reaches the specified rate.
- The automatic timer controls the retard of fuel injection timing. The pre-stroke control unit controls the advance of fuel injection timing.

Injection Nozzle



1 Nozzle spring
2 Needle valve
3 Nozzle
4 Adjusting screw
5 Nozzle holder

A : Excess fuel
B : Supply of fuel

Fuel delivered from the injection pump enters the nozzle holder and, when the specified pressure is reached, the fuel pressure overcomes the repercussive force of the nozzle spring to push out the needle valve, allowing fuel to spray out the opening at the tip of the nozzle into the cylinder.
Part of the high-pressure fuel lubricates the needle valve and returns through the fuel return pipe to the fuel tank.

Possible causes \ Symptoms		Engine will not start	Engine difficult to start	Engine knocks	Unstable engine output	Insufficient engine output	Engine maximum speed too high	Unstable engine idling	Engine stops soon after starting	Engine does not reach maximum speed	Engine will not stop	Accelerator pedal too stiff	Defective fuel supply	Warning lamp illuminates	Remarks
Defective pre-stroke injection pump system														○	
Injection pump proper	Defective injection pump proper	○	○	○	○	○	○	○	○	○	○				*
	Defective mounting (poorly adjusted injection timing)		○		○	○		○							
	Defective overflow valve operation	○	○			○		○					○		
Defective pre-stroke actuator				○	○	○		○							
Fuel feed pump	Gauze filter clogged	○	○			○		○	○				○		
	Check valve not operating	○											○		
	Sticky piston	○											○		
	Sticky push rod	○											○		
	Defective check valve operation	○	○		○			○					○		
	Piston worn		○		○			○					○		
Defective governor				○	○	○	○	○	○	○	○				*
Injection nozzles	Sticky needle valve	○													
	Valve opening pressure too low	○								○					
	Blocked injection orifice	○		○		○		○		○					
	Poor airtightness in nozzle	○		○		○		○		○					
	Valve opening pressure too high			○											
	Broken spring				○	○									
	Defective sliding action in needle valve				○										
	Defective valve opening pressure				○										
	Weakness/deterioration in spring							○							
Fuel filter	Clogged filter	○			○			○	○						
Fuel tank empty		○													
Fuel pipes blocked and/or fuel leaking from connections		○													
Air or water in fuel system		○			○			○	○						
Low-quality fuel in use			○	○		○		○							

* : Must be serviced by BOSCH AUTOMOTIVE SYSTEMS service station.

Possible causes \ Symptoms		Engine will not start	Engine difficult to start	Engine knocks	Unstable engine output	Insufficient engine output	Engine maximum speed too high	Unstable engine idling	Engine stops soon after starting	Engine does not reach maximum speed	Engine will not stop	Accelerator pedal too stiff	Defective fuel supply	Warning lamp illuminates	Remarks
Engine control	Incorrect accelerator pedal stopper bolt adjustment					○				○					
	Rusted accelerator pedal arm											○			
	Poorly installed accelerator control cable											○			
	Defective sliding motion in accelerator control cable											○			
	Defective accelerator pedal position sensor													○	
Cracked fuel pipe													○		
Leaky fuel tank													○		
Incorrect oil viscosity			○												Gr 12
Incorrect valve clearance			○					○							Gr 11
Defective cylinder head gasket			○					○							Gr 11
Wear and/or carbon deposits on valve and valve seat			○					○							Gr 11
Weakness/deterioration in valve spring			○					○							Gr 11
Worn/damaged piston ring(s)			○					○							Gr 11
Worn/damaged piston ring groove(s)			○					○							Gr 11
Worn piston and cylinder liner			○												Gr 11
Cooling system malfunctioning			○					○							Gr 14
Defective starter switch			○												Gr 54

TROUBLESHOOTING

Fault Diagnosis Function

- While the starter switch is in the ON position, the fault diagnosis function continuously monitors relevant sensors for faults.
  In the event that a fault is detected, the function illuminates a warning lamp (red or orange) in the meter cluster to alert the driver, memorizes the location of the fault, and switches to a backup mode.
- The memorized fault location can be read as a diagnosis code using an Multi-use tester II or the diagnosis switch.

Warning lamp illumination

	(Orange)	(Red)
1. Safety-critical error (vehicle must not be driven)	OFF	ON
2. Non-safety-critical error (vehicle can be driven despite poor control feeling)	ON	OFF

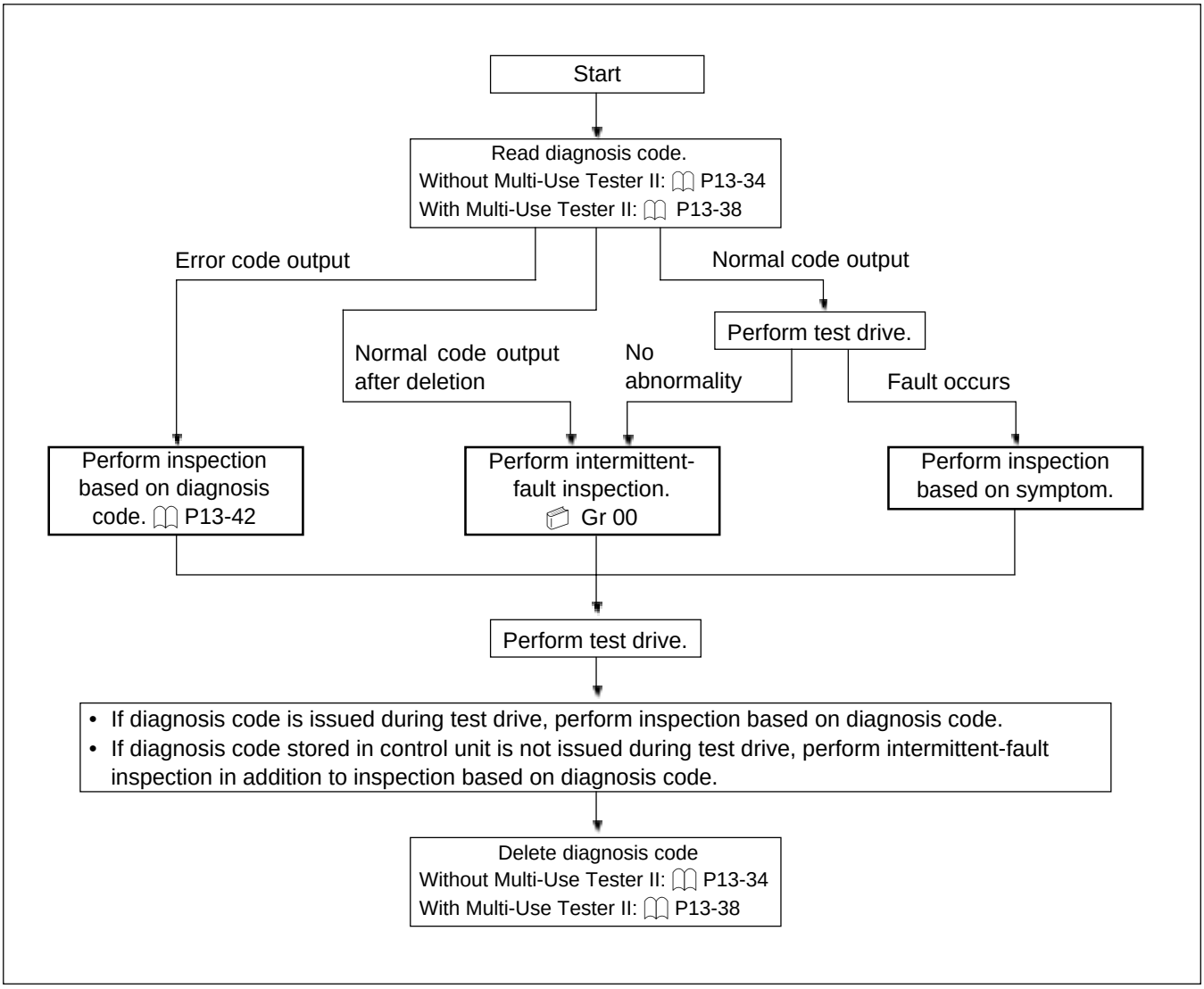
CAUTIONS ⚠

- **The fault diagnosis function requires a battery voltage of 12 V or higher.**
- **In the event of fault detection, check the harnesses and connectors for looseness. Before undoing any connector, turn the starter switch to the LOCK position and wait for 20 seconds.**
- **After rectifying a fault, delete the fault code using the Multi-use tester II or memory clear switch.**
- **As a general rule, inspections should be performed with the starter switch in the LOCK position. If any inspection requires that the starter switch be in the ON position, be careful to avoid short circuits between connector terminals and with the vehicle body.**
- **All component resistances shown in this manual assume a temperature range of 10 to 35°C {50 to 95°F}. In practice, component values may not comply with standard values owing to temperature effects and/or to inaccuracy in the test instrument.**
- **After the rectification of a fault, the system's ability to return to normal operation automatically depends upon the diagnosis code, i.e., the fault location. When the system returns to normal operation, the warning lamp goes out.**
- **When the system returns to normal operation after the rectification of a fault, the diagnosis code remains stored in engine control unit.**

Inspection Procedure

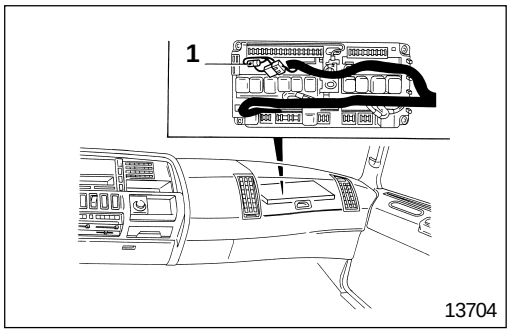
Inspection of the electronic governor and prestroke control injection pump system can be performed most effectively using an Multi-Use Tester II. Types of system inspection can, in accordance with fault systems and diagnosis codes, be broadly classified as follows:

- Inspections based on diagnosis codes stored in the control unit
- Inspections based on symptoms
- Inspections of intermittent faults



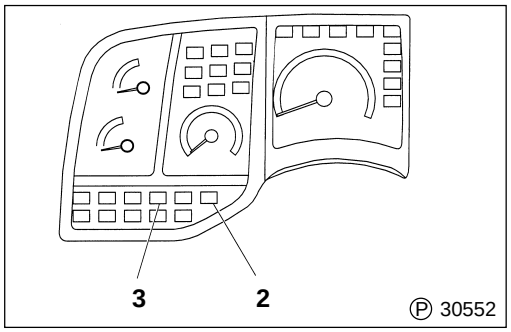
READING AND ERASING DIAGNOSIS CODES

Without Multi-Use Tester II

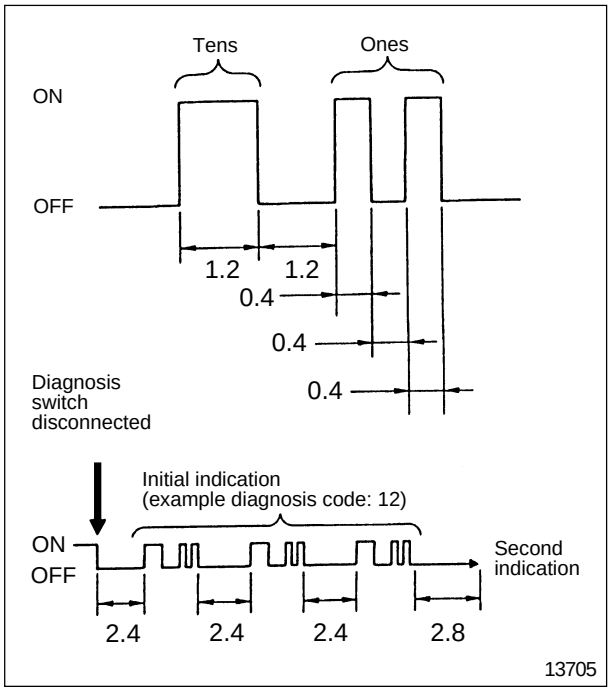


Current diagnosis code

- Turn ON the starter switch.
- Disconnect the diagnosis switch **1**.

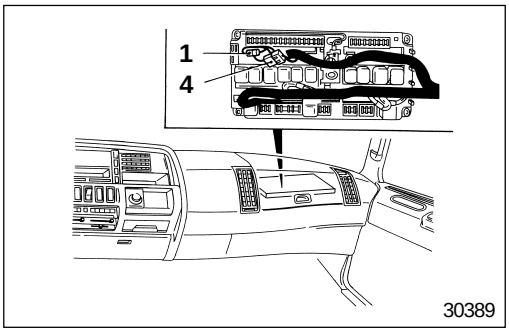


- The diagnosis code will be indicated by flashes of the warning lamp (orange) **2** or warning lamp (red) **3**.



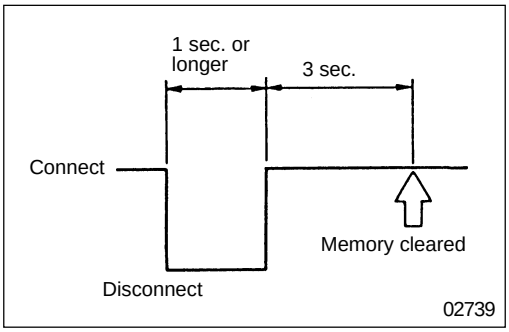
Diagnosis code indication

- Diagnosis codes are indicated by the numbers and durations of the warning lamp flashes.
  - Flashes for units of ten and units of one have different lengths, as follows:
    Units of ten: 1.2 seconds
    Units of one: 0.4 second
  - For each diagnosis code, units of ten are given first, followed by units of one. For a code that has no units of ten, only units of one are given.
- Each diagnosis code is indicated three times. If there are no new codes, the sequence is then repeated from the beginning with each code indicated three times.
- When the diagnosis switch **1** is connected, the control unit immediately stops the indication of codes.



Past diagnosis codes

With the diagnosis switch **1** disconnected, disconnect the memory clear switch **4** after reading the current diagnosis code(s). The warning lamp will begin to flash again, this time to indicate any past diagnosis code(s). Verify the fault location in accordance with the code(s).



Diagnosis code erasing

To erase all stored diagnosis codes from the control unit, disconnect and reconnect the memory clear switch **4**.

CAUTION

- **Stored codes are cleared only by disconnection and reconnection of the memory clear switch 4.**
- **To prevent the memory contents from being cleared after the indication of stored codes, turn OFF the starter switch with the memory clear switch 4 disconnected then connect the memory clear switch.**

READING AND ERASING DIAGNOSIS CODES

Diagnosis codes table

Diagnosis code	Fault location	Warning lamp	Electronic control unit countermeasure(s) in the case of failure (back-up mode)	Drive ability
01	Normal	—	—	○
03	Pre-stroke actuator learning function	Orange	Provides control with “0” as correction value.	○
06	Sub-control rack position sensor	Orange	Normal control using the main control rack position sensor	○
11	Governor servo	Red	*1 Engine stopped by the pull-down function.	×
12	Pre-stroke servo	Orange	Pre-stroke control stop engine revolution speed limit (approx-imately 1800 rpm)	△
13	Pre-stroke sensor	Orange	Pre-stroke control stop engine revolution speed limit (approx-imately 1800 rpm)	△
14	Back-up engine speed sensor	Orange	Control using the main engine speed sensor	○
15	Engine speed sensor	Orange	Calculate the engine revolution speed from the pulse count of the back-up engine speed sensor.	○
14+15	Both the back-up engine sensor and the main engine speed sensors are faulty upon start-up.	Red	Do not start the engine.	×
16	Accelerator pedal position sensor II	Orange	Control using the accelerator pedal sensor I	○
21	Water temperature sensor	Orange	Set the water temperature to 80 °C {176°F}.	○
22	Control rack position sensor	Orange	Switch to the sub-control rack position sensor control.	△
24	Accelerator pedal position sensor I	Orange	Control using the accelerator pedal position sensor II.	○
24+16	Both accelerator pedal position sensor I and accelerator pedal position sensor II are faulty	Red	Set the maximum accelerator depression angle to 30 degrees even if the accelerator pedal is depressed.	△
25	Vehicle speed sensor	Orange	Cruise control disabled.	○
31	Idling adjustment volume	Orange	Set to auto idling.	○
32	Boost pressure sensor	Orange	Set the boost pressure to 0 kpa {0 mmHg, 0 in. Hg}.	△*2
33	RAM (Electronic control unit internal memory circuit)	Red	Do not start the engine.	×
41	Boost air temperature sensor	Orange	Normal control assuming the boost temperature is 80°C {176 °F}	○
42	Cruise cotrol release switch	Orange	Cruise control disabled.	○
45	Reverse engine operation	Orange	*1 Engine stopped by the pull-down function.	×*2
65	Accelerator switch	Orange	Limited accelerator depressing angle (Approximately 30%)	○

*1 : The pull-down function indicates the rack pull-back action. In the event of an engine over-run or severe accident, the rack is pulled back immediately to the no-injection direction in order to protect the engine.

*2 : Driveable if the starter switch is turned OFF once and then restarted again.

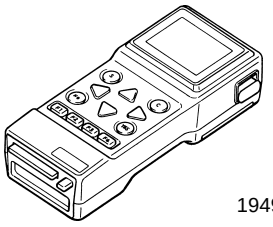
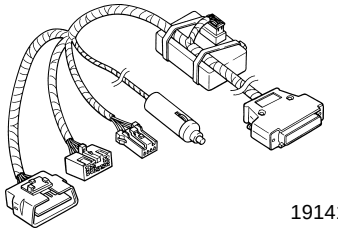
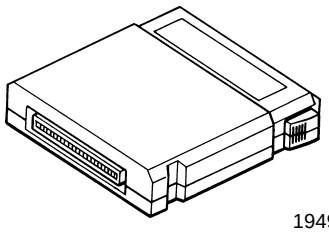
○ : Driveable
△ : Back-up mode driving possible
× : Undriveable

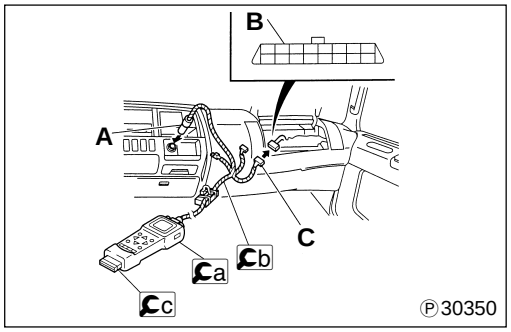
M E M O

READING AND ERASING DIAGNOSIS CODES

With Multi-Use Tester II

Special tools

Location	Tool name and shape	Part No.	Application
—	Multi-Use Tester II  19492	MB991496	Inspection of engine and pre-stroke control injection pump syste
—	MUT Communication Harness  19141	MK327601	
—	ROM Pack (MRT-E8.1)  19493	MH063580	



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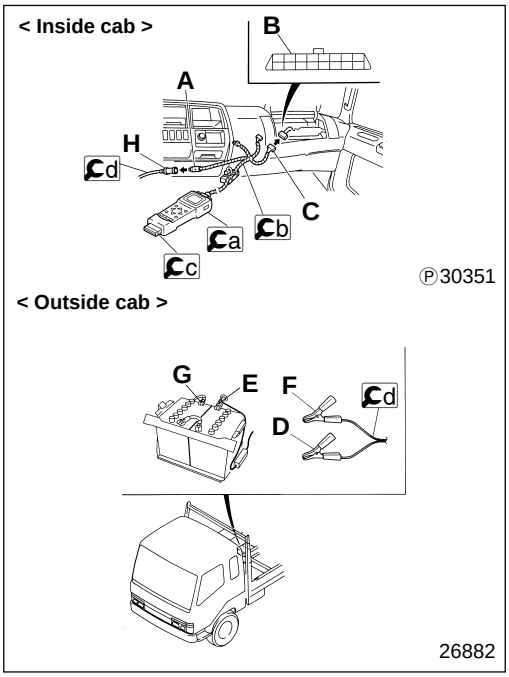
Connecting the Multi-Use Tester II

- Turn the starter switch to the LOCK position.
- Connect the b MUT Communication Harness to the a Multi-use tester II, and insert the c ROM Pack.
- Plug connector **A** into the cigarette lighter socket.
- Fit connector **C** onto MUT connector **B** (16-pin) in the relay box.

NOTE

Instructions for operation of the Multi-use tester II are given in the separate
Multi-Use Tester II Reference Manual.



- To verify the service data “START SIG”, connect the Multi-Use Tester II as follows:
- Turn the starter switch to the LOCK position.
- Connect the b MUT Communication Harness to the a Multi-Use Tester II, and insert the c ROM Pack.
- Attach the (+) clamp **D** (red) of the d Battery Clamp Harness to the battery’s (+) terminal **E**. Attach the (–) clamp **F** (black) of the d Battery Clamp Harness to the battery’s (–) terminal **G**.
- Fit the connector **A** into the socket **H** of the d Battery Clamp Harness.
- Fit connector **C** onto MUT connector **B** (16-pin) in the relay box.

CAUTION ⚠

Connect the (+) clamp D (red) of the b Battery Clamp Harness before connecting the (–) clamp F (black).

Current diagnosis codes
- Turn the starter switch to the ON position.
- Determine the fault location(s) in accordance with the Multi-Use Tester II diagnosis code(s).

Past diagnosis codes
- Turn the starter switch to the ON position.
- Determine the fault location(s) in accordance with the past Multi-Use Tester II diagnosis code(s).

Diagnosis code erasing
- Turn the starter switch to the ON position.
- Using the Multi-Use Tester II, erase all diagnosis codes stored in the control unit.

Diagnosis codes

Diagnosis codes are indicated as shown in the following table. For details of these codes, refer to the “Without Multi-Use Tester II” section. P13-36

Display item			
Diagnosis code	Fault	Diagnosis code	Fault
03	PS OFFSET	**24**	ACCEL. SNSR-1
06	SUB RACK SNSR	**25**	SPEED SNSR
11	GOV. SERVO	**31**	IDLE VOLUME
12	PS SERVO	**32**	BST PRES SNSR
13	PS SNSR	**33**	RAM
14	SUB NE SNSR	**41**	BST TEMP SNSR
15	NE SNSR	**42**	ASC REL SW
16	ACCEL. SNSR-2	**45**	ENG. REVERSE
21	WTR TEMP SNSR	**65**	ACCEL SW
22	RACK SNSR		

SERVICE PROCEDURES USING MULTI-USE TESTER II

Service operations can be performed most effectively using the following Multi-Use Tester II functions:

● **Reading of diagnosis codes**

Using the diagnosis code function, it is possible to read diagnosis codes stored in the control unit.

● **Eraser of diagnosis codes**

By selecting the diagnosis code eraser function from the special function menu, it is possible to erase diagnosis codes stored in the control unit.

● **Indication of service data**

When required for service operations, data in the control unit's random-access memory can be displayed as numeric values or graphs.

Service data

Multi-use tester II display			Inspection procedure	
No.	Data signal	Type of data	Inspection condition	Evaluation criterion
11	ENGINE SPEED	▮▮▮▮. rpm	Gradual acceleration (during engine operation)	Synchronization with tachometer
12	TARGET RACK	▮▮.▮▮ mm	Starter switch ON	3 mm
13	REAL RACK	▮▮.▮▮ mm	Starter switch ON	3 mm
14	ACCEL. VOLT	▮.▮▮▮ V	Accelerator pedal gradually depressed from throttle-fully-open to throttle-fully-closed position	1 to 3 V
15	WATER TEMP	▮▮▮.▮ °F	Engine cold Engine warming up Engine stopped after warmup	Same as ambient temperature Gradual increase Gradual decrease
16	BOOST PRESS	▮▮▮▮. mmHg	Engine running at high idling speed	270 mmHg or higher
17	PS ANG. DIFF.	▮▮.▮▮ deg	400 < Ne ≦ 2,000 Ne: Engine speed	–5.5° or greater 5.5° or smaller
18	SUPPLY VOLT	▮▮.▮▮ V	Starter switch ON	7 to 32 V
19	ACCEL. STROKE	▮▮▮.▮ %	Throttle completely closed Pedal gradually depressed Throttle completely open	0 % Gradual increase 100 %
20	BOOST TEMP	▮▮▮.▮ °F	Engine cold Engine warming up Engine stopped after warmup	Same as ambient temperature Gradual increase Gradual decrease
21	START SIG	ON/OFF	Engine cranked using starter switch	ON
27	ASC MAIN SW	ON/OFF	Main switch ON	ON
28	ASC SET SW	ON/OFF	Set switch ON	ON
29	ASC RSM SW	ON/OFF	Resume switch ON	ON
30	ASC CANCEL SW	ON/OFF	Cancel switch ON	ON
31	ASC BRK SW-1	ON/OFF	Brake pedal depressed	ON
32	ASC BRK SW-2	ON/OFF	Brake pedal depressed	ON
33	ACCEL. SW	ON/OFF	Accelerator pedal depressed	OFF
34	DIAGNOSIS SW	ON/OFF	Diagnosis switch turned ON/OFF	ON/OFF
35	DIAG. RESET SW	ON/OFF	Memory clear switch turned ON/OFF	ON/OFF
37	CLUTCH SW	ON/OFF	Clutch pedal depressed	ON
38	NEUTRAL SW	ON/OFF	Transmission in neutral	OFF
42	EXH. BRAKE SW	ON/OFF	Switch ON	ON
51	A/C SW	ON/OFF	Air conditioner switch turned ON or OFF	ON/OFF
61	EXH. BRAKE SIG	ON/OFF	Exhaust brake operating	ON
71	RACK LIM. SW	ON/OFF	Automatic transmission oil temperature increase	ON
72	AT ACC RELAY	ON/OFF	Accelerator fully depressed	ON
75	IDLE UP CNCL	ON/OFF	Automatic transmission selector lever in position other than N	ON
81	CAR SPEED	▮▮▮.▮ MPH	Vehicle in driving operation	Synchronized with speedometer

M E M O

INSPECTION BASED ON DIAGNOSIS CODE

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
03	Indicates that pre-stroke learning function has not been executed.	Faulty timing rod, timing sleeve or other parts in the injection pump assembly.	Repair or replace the injection pump assembly.*
		Faulty adjustment of pre-stroke position sensor	Repair or replace the injection pump assembly.*
		Faulty engine electronic control unit	Replace the engine electronic control unit
06	Displayed if the output voltage of the control rack position sensor is less than 0.06 V or more than 3.5 V.	Open or short in harness wire or poor connector contact between the sub-control rack position sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open, short, or poor connector contact in the sub-control rack position sensor	Inspect the sub-control rack position sensor 🕮 P13-73
		Faulty engine electronic control unit	Replace the engine electronic control unit
11	Displayed if the difference between the target control rackposition and the actual control rack position is ± 1mm {0.039 in.}.	Open or short in harness wire or poor connector contact between the linear DC motor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open or shorted wire in the linear DC motor connector	Inspect the linear DC motor 🕮 P13-74
		Poor adjustment of the emergency engine stop cable (The lever is pulled in the stop direction)	Inspect the emergency engine stop button 🕮 P13-76
		Faulty injection pump assembly rack movement or poor governor actuator link	Repair or replace the injection pump assembly.*
		Faulty engine electronic control unit	Replace the engine electronic control unit
12	Displayed if the difference between the target timing rod angle and the actual timing rod angle is ± 2°.	Open or short in harness wire or poor connector contact between the pre-stroke actuator, pre-stroke cut relay, and engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open or shorted wire in the pre-stroke cut relay	Inspect the pre-stroke cut relay 🕮 P13-75
		Faulty pre-stroke actuator	Repair or replace the injection pump assembly.*
		Faulty timing rod, timing sleeve, etc. in the injection pump assembly	Repair or replace the injection pump assembly.*
		Faulty engine electronic control unit	Replace the engine electronic control unit

*: Contact your MFTA representative for current injenction pump repair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
13	Displayed if the output voltage of the pre-stroke position sensor is less than 0.9 V or more than 3.4 V.	Open or short in harness wire or poor connector contact between the pre-stroke position sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open or shorted pre-stroke position sensor coil	Inspect the pre-stroke actuator 🕮 P13-73
		Faulty engine electronic control unit	Replace the engine electronic control unit
14	Displayed if the pulse count of the back-up engine speed sensor is less than that of the main engine speed sensor.	Open or short in harness wire or poor connector contact between the back-up engine speed sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Faulty back-up engine speed sensor	Repair or replace the injection pump assembly.*
		Faulty engine electronic control unit	Replace the engine electronic control unit
15	Displayed if the pulse count of the main engine speed sensor is less than that of the back-up engine speed sensor.	Open or short in harness wire or poor connector contact between the speed sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open or shorted wire or improperly assembled coil in the engine speed sensor main unit	Inspect the engine speed sensor main unit 🕮 P13-73
		Faulty engine electronic control unit	Replace the engine electronic control unit
16	Displayed if the output voltage of the accelerator pedal position sensor is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the accelerator pedal position sensor II and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Internal malfunction or faulty adjustment of the lever portion of the accelerator pedal position sensor II	• Inspect the accelerator pedal position sensor 🕮 P13-51 • Inspect the accelerator pedal position sensor using Multi-Use Tester II 🕮 P13-40
		Faulty adjustment of the accelerator control cable or faulty movement of the link or lever	Inspect the accelerator control cable 🕮 P13-50
		Faulty engine electronic control unit	Replace the engine electronic control unit
21	—	Open or short in harness wire or poor connector contact between the coolant temperature sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Faulty coolant temperature sensor	• Inspect the coolant temperature sensor 🕮 P13-72 • Inspect the coolant temperature sensor using Multi-Use Tester II 🕮 P13-40
		Faulty engine electronic control unit	Replace the engine electronic control unit

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

INSPECTION BASED ON DIAGNOSIS CODE

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
22	Displayed if the output voltage of the control rack position sensor I is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the control rack position sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open or shorted wire in the coil or poor control rack position sensor contact	• Inspect the control rack position sensor 🕮 P13-72 • Inspect the control rack position sensor using Multi-Use Tester II 🕮 P13-40
		Faulty movement of the injection pump assembly control hook or poor governor actuator link	Repair or replace the injection pump assembly.*
		Faulty engine electronic control unit	Replace the engine electronic control unit
24	Displayed if the output voltage of the accelerator pedal position sensor I is less than 0.5 V or more than 4.5 V.	Open or short in harness wire or poor connector contact between the accelerator pedal position sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Internal malfunction or poor adjustment of the accelerator pedal position sensor I lever	• Inspect the accelerator position sensor I 🕮 P13-51 • Inspect the accelerator pedal position sensor using Multi-Use Tester II 🕮 P13-40
		Faulty adjustment of the accelerator control cable or faulty movement of the link and lever	Inspect the accelerator control cable 🕮 P13-50
		Faulty engine electronic control unit	Replace the engine electronic control unit
25	—	Open or short in harness wire or poor connector between the vehicle speed sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Faulty vehicle speed sensor	• Inspect the vehicle speed sensor 🕮 P13-71 • Inspect the vehicle speed sensor using Multi-Use Tester II 🕮 P13-40
		Faulty engine electronic control unit	Replace the engine electronic control unit
31	Displayed if the output voltage of the idling adjustment volume is less than 0.6 V or more than 4.6 V.	Stuck idling speed adjustment potentiometer knob (between PUSH and PULL)	Reset the knob to PUSH or PULL
		Open or short in harness wire or poor connector contact between the idling speed adjustment potentiometer and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open wire in the switch portion of the idling speed adjustment potentiometer or faulty internal movement	Inspect the idling speed adjustment potentiometer 🕮 P13-75
		Faulty engine electronic control unit	Replace the engine electronic control unit
32	Displayed if the output voltage of the boost pressure sensor is less than 0.5 V or more than 4.8 V.	Open or short in harness wire or poor connector contact between the boost pressure sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Internal malfunction of boost pressure sensor	• Inspect the boost pressure sensor using Multi-Use Tester II 🕮 P13-40 • Inspect the boost pressure sensor 🕮 P13-70
		Clogged boost hose or faulty assembly	Inspect the boost hose
		Faulty engine electronic control unit	Replace the engine electronic control unit

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

Diagnosis code	Diagnosis code display condition (s)	Cause	Remedy
33	Displayed if the engine control unit is faulty	Faulty engine control main unit	In order to reset the engine control unit, temporarily turn the starter switch OFF and erase the diagnostic codes by pressing the memory clear switch 🕮 P13-35 Replace the engine electronic control unit if the diagnostic codes persist after performing the above procedure
41	Displayed if the output voltage of the boost temperature sensor is more than 4.9 V	Open or short in harness wire and poor connector contact between the boost temperature sensor and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open or shorted wire or poor assembly of the boost temperature sensor coil	• Inspect the boost temperature sensor 🕮 P13-72 • Inspect the boost temperature sensor using Multi-Use Tester II 🕮 P13-40
		Faulty engine electronic control unit	Replace the engine electronic control unit
42	—	Open or short in harness wire or poor connector contact between the cruise control release switch (stop lamp switch, transmission neutral switch, combination switch, clutch switch, accelerator switch) and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Faulty cruise control release switch	• Inspect the stop lamp switch 🕮 Gr 54 • Inspect the transmission neutral switch 🕮 Gr 54 • Inspect the combination switch 🕮 P13-69 • Inspect the clutch switch 🕮 Gr 54 • Inspect the accelerator switch 🕮 P13-51 • Inspect the cruise control release switch using Multi-Use Tester II 🕮 P13-40
		Faulty engine electronic control unit	• Inspect the engine electronic control unit
45	—	Faulty phase of engine speed sensor and backup engine speed sensor	• Inspect the engine speed sensor 🕮 P13-73 • Repair or replace the injection pump assembly.*
65	Faulty accelerator switch	Open or short in harness wire or poor connector contact between the accelerator switch and the engine electronic control unit	Inspect the harness and the connector 🕮 P13-78
		Open or shorted wire in the accelerator switch	Inspect the accelerator switch 🕮 P13-51
		Faulty engine electronic control unit	Replace the engine electronic control unit

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Checking and Adjusting Injection Timing

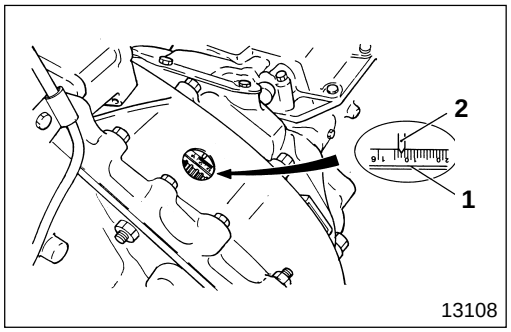
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
–	Fuel injection timing (BTDC)	2˚±0.5˚	–	Adjust

Tightening torque

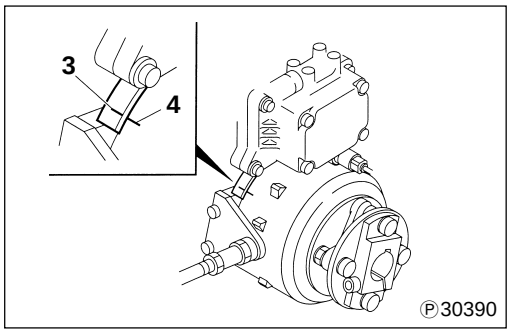
Unit: N·m {ft.lbs., kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Adjusting bolt	59 to 64 {43 to 47, 6 to 6.5}	–

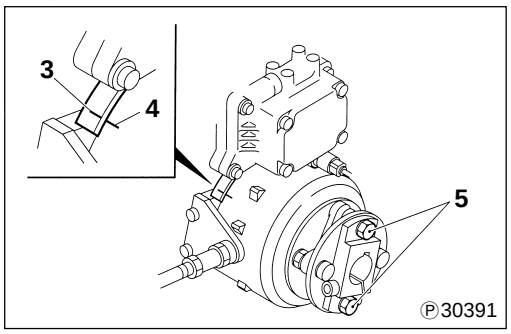


[Inspection]

- Turn the crankshaft more than 180° in the direction of engine rotation. Align the correct timing degree mark **1** on the flywheel with pointer **2** on the flywheel housing to show the standard fuel injection timing.



- When pointer **3** on the injection pump and mark **4** on the automatic timer align, the fuel injection timing is standard.
- If the fuel injection timing is not standard, adjust as follows.



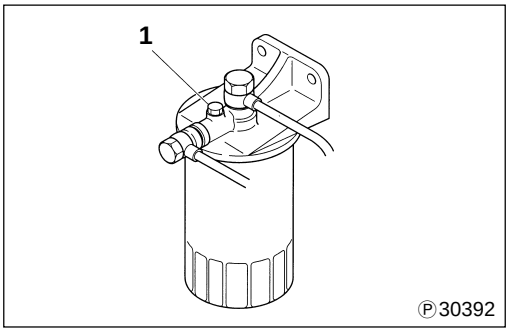
[Adjustment]

- Loosen adjusting bolts **5** and turn the automatic timer to align pointer **3** and mark **4**.
- Tighten adjusting bolts **5** at specified torque.
- Reinspect the fuel injection timing.

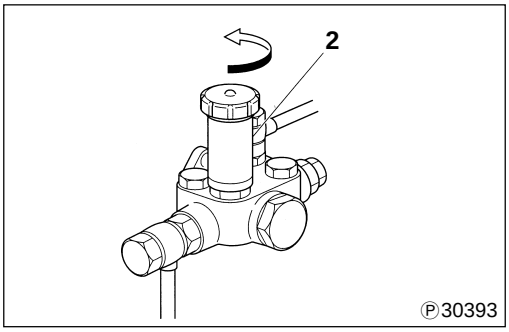
CAUTION ⚠

Do not loosen any bolts other than adjusting bolts 5.

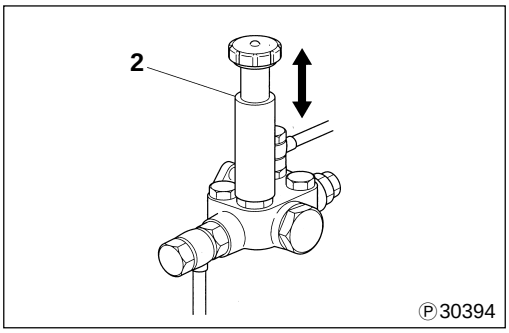
Bleeding Air from Fuel System



- Loosen the fuel filter air plug **1**.



- Turn the priming pump knob **2** counterclockwise until it pops up.
- Move the priming pump knob **2** up and down to feed fuel through the fuel filter.
- When fuel emerging from the fuel filter air plug **1** no longer contains air bubbles, tighten the air plug securely.

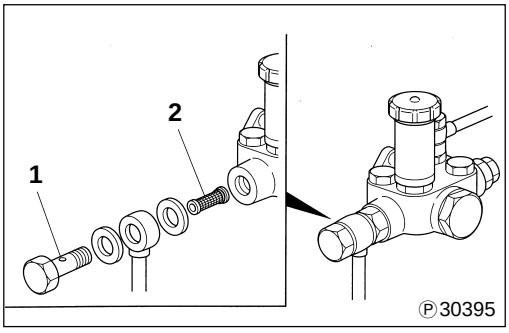


- Move the priming pump knob **2** up and down five or six more times. Then, press the knob down and screw it clockwise to lock it in position.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

WARNING⚠

- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**

Cleaning Mesh Filter



- Remove the eyebolt **1** from the suction port side **A** of the fuel feed pump.
- Remove the mesh filter **2** from the eyebolt **1**.
- Clean the mesh filter **2** in diesel fuel.
- Refit the mesh filter **2** and eyebolt **1** in the opposite order to that in which they were removed.
- Bleed all air out of the fuel system. 🕮 P13-47
- Start the engine and check that no fuel leakage occurs.

WARNING⚠

- **To minimize the risk of fire, wipe up any spilled fuel.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After refitting the mesh filter, check that no fuel leakage occurs.**

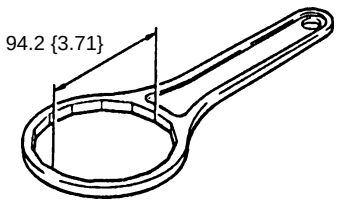
Replacing Fuel Filter

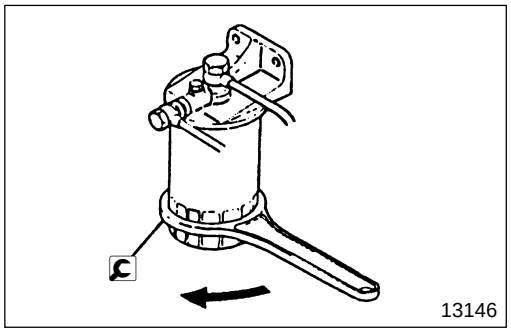
Lubricant

Location	Points of application	Specified lubricant	Quantity
1	Gasket between fuel filter and fuel filter head	Engine oil	As required

Special tool

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Filter wrench  01882	MH061572 (Obtain Locally)	Fuel filter removal


13146

[Removal]

: Filter Wrench

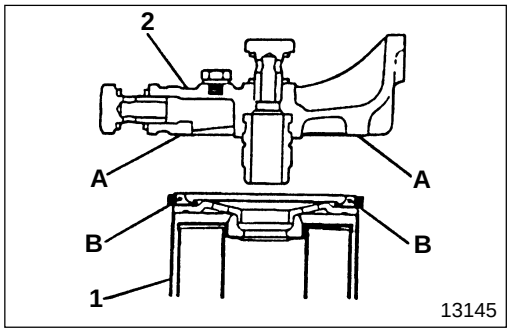
WARNING

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **To minimize the risk of fire, wipe up any spilled fuel.**

[Installation]

WARNING

Use of an unsuitable fuel filter 1 can lead to fuel leaks and fires. Be sure to use a genuine filter.

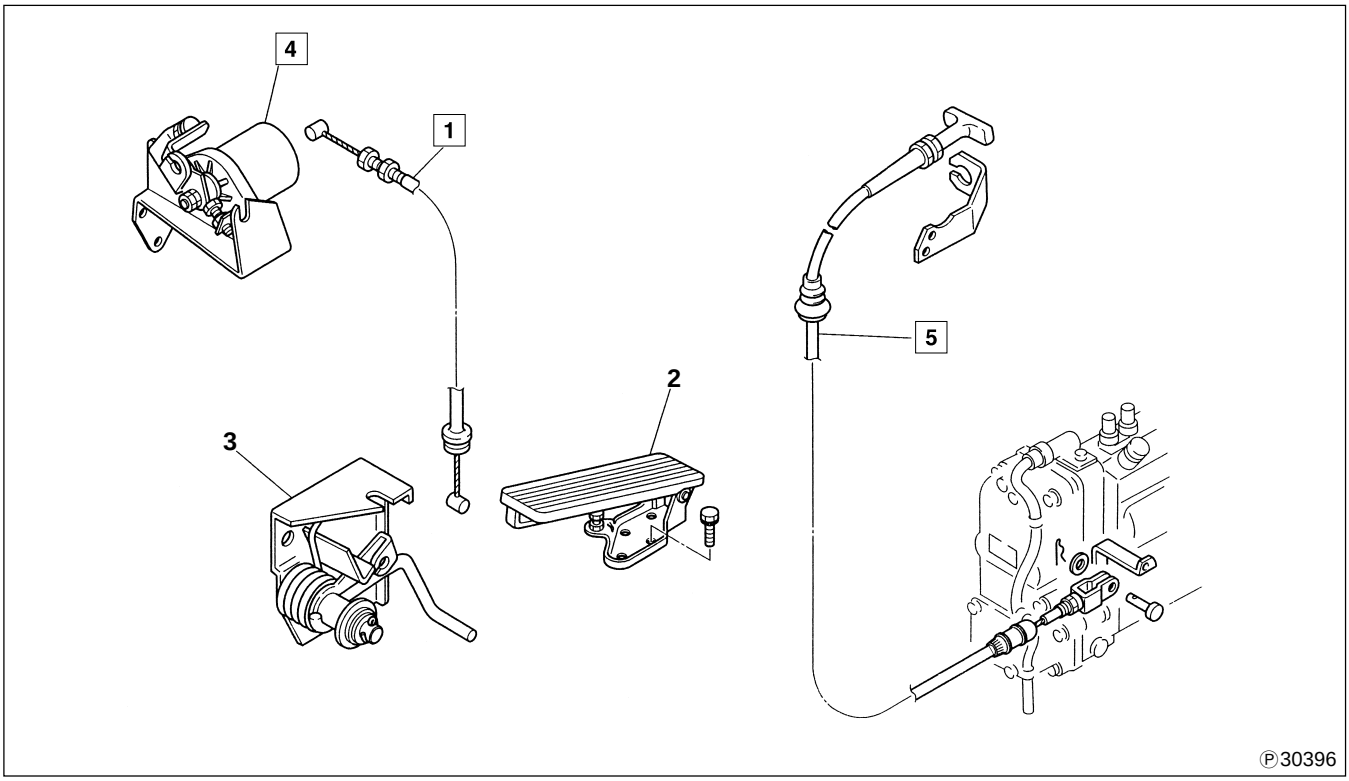


13145

- To fit the fuel filter **1**, turn it until the gasket **B** touches surface **A** of the fuel filter head **2**. Then, tighten the filter by 1 to $1\frac{1}{8}$ turn. Be sure to turn the filter by hand.
- Bleed all air out of the fuel system. P13-47

WARNING

After fitting the fuel filter 1, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.



● **Disassembly sequence**

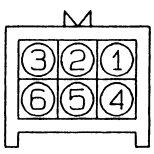
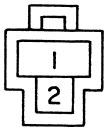
1 Accelerator control cable
2 Accelerator pedal assembly
3 Accelerator link assembly
4 Accelerator pedal position sensor
5 Emergency engine stop cable

***** : Injection pump assembly

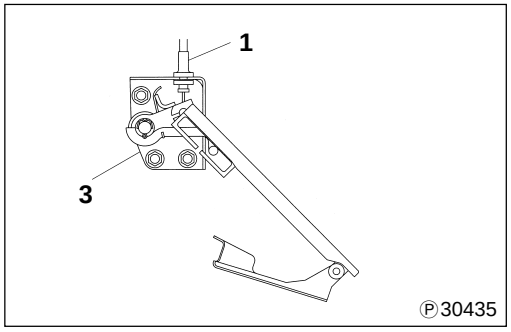
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

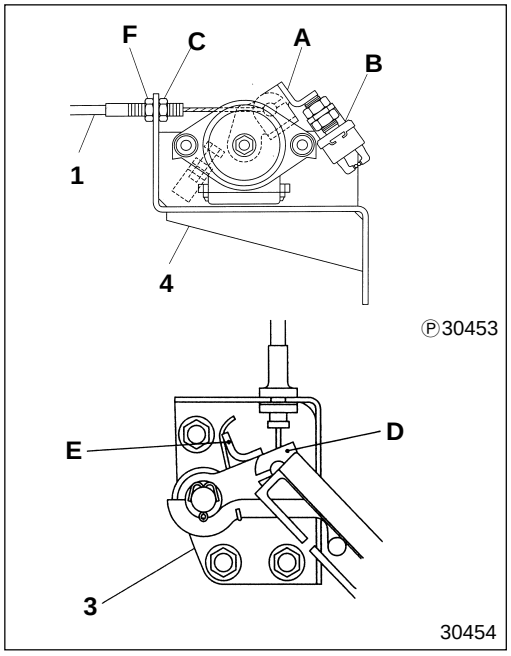
Location	Maintenance item			Standard value	Limit	Remedy
4	Accelerator pedal position sensor output voltage  13714	Sensor II: ② – ③	Idling position	0.85±0.1 V	—	Adjust or replace
			Full-load position	4.15±0.1 V	—	Adjust or replace
		Sensor I: ⑤ – ⑥	When there is conduction between the accelerator switch terminals ① and ②  31018	1.00±0.2 V	—	Adjust or replace

◆ Service procedure

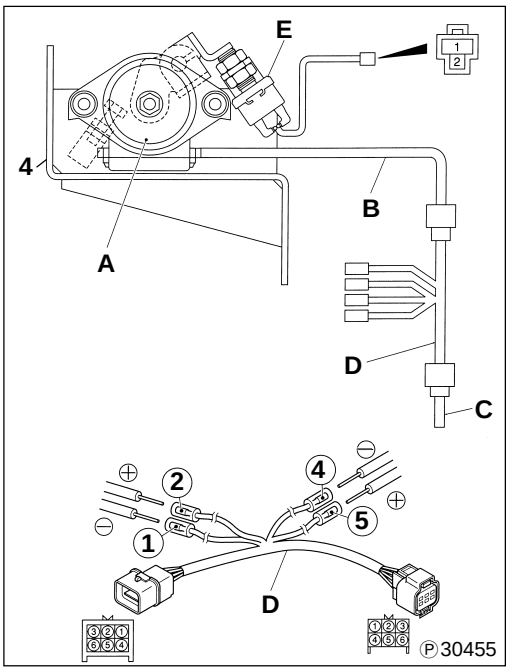


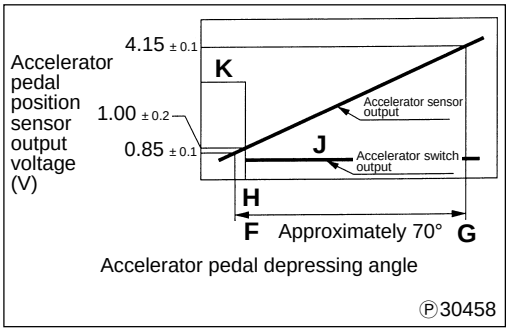
1 **Installation of the accelerator control cable**

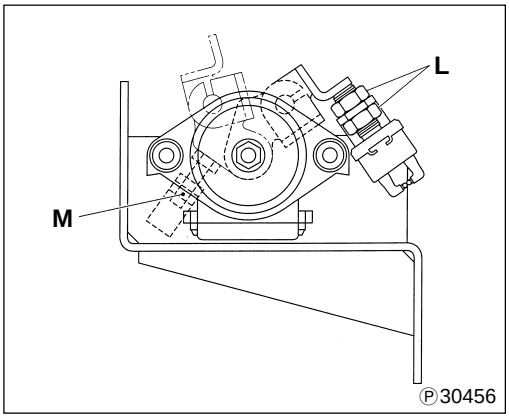
- Install accelerator control cable **1** to accelerator link assembly **3**.



- Install the other end of accelerator control cable **1** to lever **A** of the accelerator pedal position sensor **4**.
- Check that lever **A** of the accelerator pedal position sensor **4** is completely pushed down by accelerator switch **B**.
- Stretch the cable until lever **D** of the accelerator link assembly **3** meets stopper **E** using nut **C** of the accelerator control cable **1** and secure with nut **F**.







4 Inspect the accelerator pedal position sensor

- Disconnect connector **B** of accelerator pedal position sensor **A** from harness **C** on the cab side. Prepare inspection harness **D,** and connect it between the above two connectors.
- Disconnect the harness of accelerator switch **E**.
- Turn the starter switch ON.
- Inspect the output voltage of the accelerator pedal position sensor **A** and accelerator switch **E** as shown in the following chart and adjust as needed.

Item	Connector terminal					
	Inspection harness for accelerator pedal position sensor **A**				Accelerator switch **E**	
	Sensor II		Sensor I			
	③ :GND (–)	② :Output (+)	⑥ :GND (–)	⑤ :Output (+)	①	②
Output voltage ***a** (Idling position)	⊖	⊕	⊖	⊕	○	○
Output voltage ***b** (Full-load position)	⊖	⊕	⊖	⊕	○	○
Output voltage ***c** (Accelerator switch active position)	⊖	⊕	⊖	⊕	○	○

○—○ Conduction between the terminals

***a** : Measure the voltage with the accelerator pedal in the idling position.

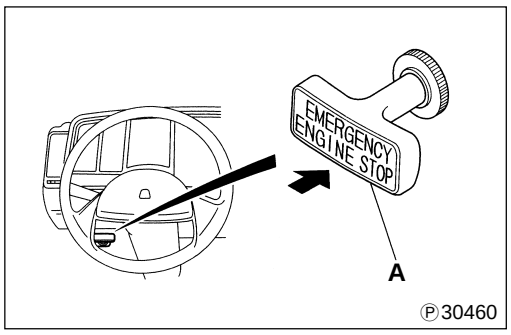
***b** : Measure the voltage with the accelerator pedal in the full-load position.

***c** : Gradually depress from the idling position and measure the voltage when the accelerator switch connector terminals ① and ② are no longer conducting.

F : Idling position
G : Full-load position
H : Accelerator switch change position
J : Accelerator switch - conduction
K : Accelerator switch - no conduction

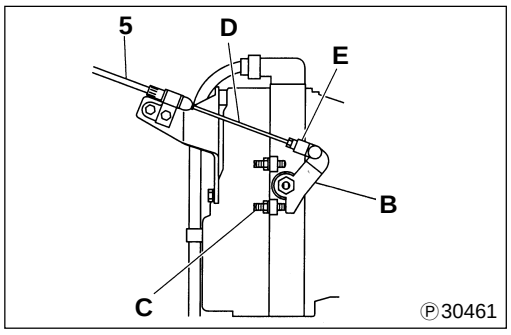
- If the measured value of the idling position output voltage is outside of the standard range, replace the accelerator pedal position sensor.
- If the measured values of ***b** and ***c** are outside of the standard range, adjust using the following adjustment bolts.

Adjustment item	Adjustment bolt
***b** Full-load position output voltage	Full-load stopper bolt **M**
***c** Accelerator switch active position output voltage	Adjustment bolt **L**



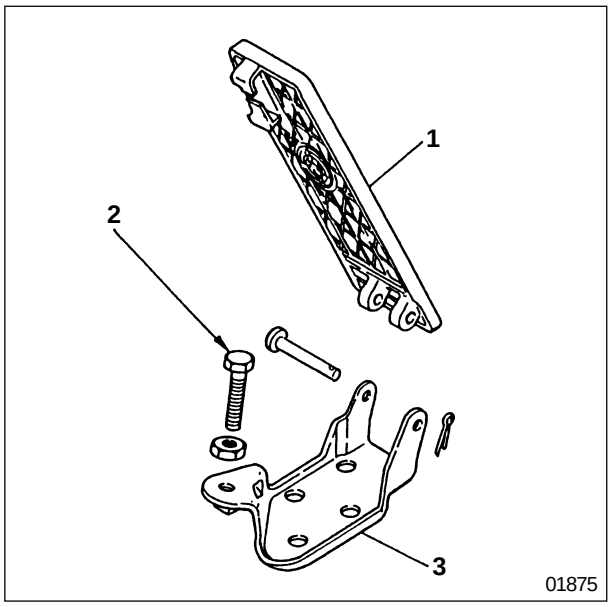
5 **Installation of the emergency engine stop cable**

- Install the push button **A** side of the emergency engine stop cable **5** and push the stop button in.



- With the stop lever **B** of the governor making contact with the stopper bolt **C**, install the cable and adjust clevis **E** such that the inner cable of the emergency engine stop cable is not loose.
- After the installation, start the engine. Check that pulling the stop button stops the engine.

Accelerator Pedal Assembly



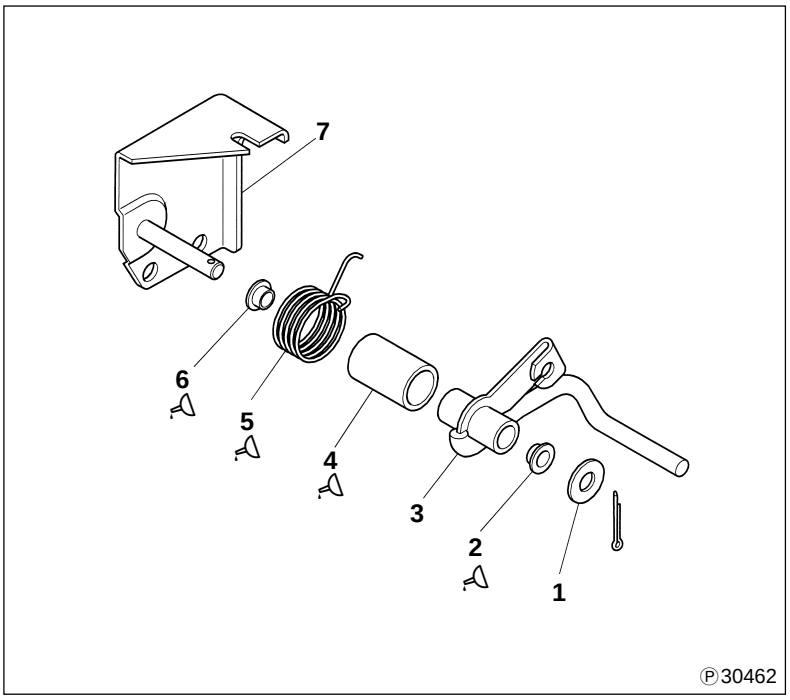
● **Disassembly sequence**

1 Accelerator pedal
2 Stopper bolt
3 Accelerator pedal bracket

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Accelerator link assembly



● **Disassembly sequence**

1 Washer
2 Bushing
3 Accelerator link
4 Collar
5 Return spring
6 Bushing
7 Accelerator link bracket

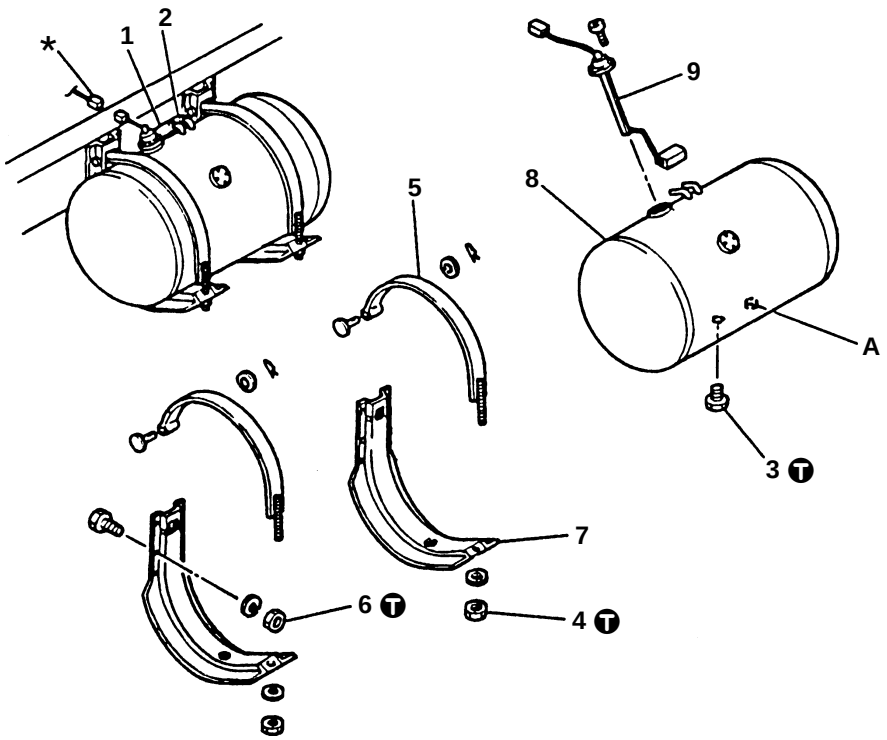
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Specified Lubricant	Quantity
2, 6	Moving surfaces of the bushing and the accelerator link bracket	Chassis grease [NLGI No.1 (Ca soap)]	As appropriate
4, 5	Moving surfaces of the collar and the return spring	Chassis grease [NLGI No.1 (Ca soap)]	As appropriate

FUEL TANK



● **Work before removal**

WARNING

- **Keep drop lights away because of the risk of explosion.**
- **Wipe up any spilled fuel because it can cause a fire.**

NOTE

Drain fuel before working on the job.

● **Removal sequence**

1 Suction hose
2 Return hose
3 Drain plug
4 Nut
5 Fuel tank strap
6 Nut
7 Fuel tank bracket
8 Fuel tank
9 Fuel gauge sending unit Gr 54

***** : Chassis harness Gr 54
A : Positioning pin

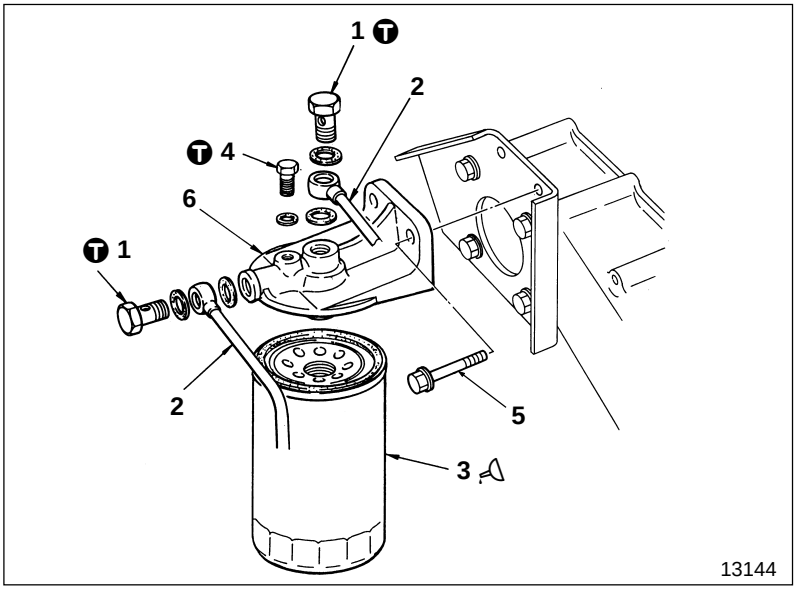
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Drain plug	59 to 98 {43 to 72, 6 to 10}	—
4	Nut (Fuel tank strap mounting)	12 to 15 {8.7 to 11, 1.2 to 1.5}	—
6	Nut (Fuel tank bracket mounting)	69 to 93 {51 to 69, 7 to 9.5}	—



● **Disassembly sequence**

1 Eye bolt
2 Fuel feed pipe
3 Fuel filter
4 Air vent plug
5 Bolt
6 Fuel filter head

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

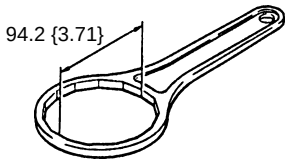
Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt	24 to 34 {18 to 25, 2.5 to 3.5}	—
4	Air vent plug	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—

Lubricant

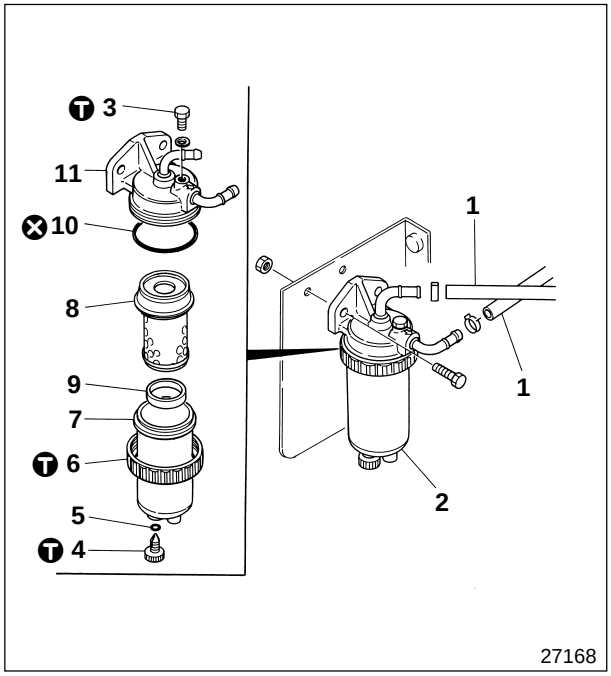
Location	Points of application	Specified lubricant	Quantity
3	Gasket contact surfaces of fuel filter and fuel filter head	Engine oil	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3	Filter wrench  01882	MH061572 (Obtain Locally)	Removal of fuel filter

WATER SEPARATOR



● **Disassembly sequence**

1 Fuel hose
2 Water separator assembly
3 Air vent plug
4 Drain plug
5 O-ring
6 Ring nut
7 Case
8 Screen assembly
9 Water level ring
10 O-ring
11 Head

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Operations after assembly**

Bleed all air out of the fuel system. P13-47

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After assembling the water separator, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.**

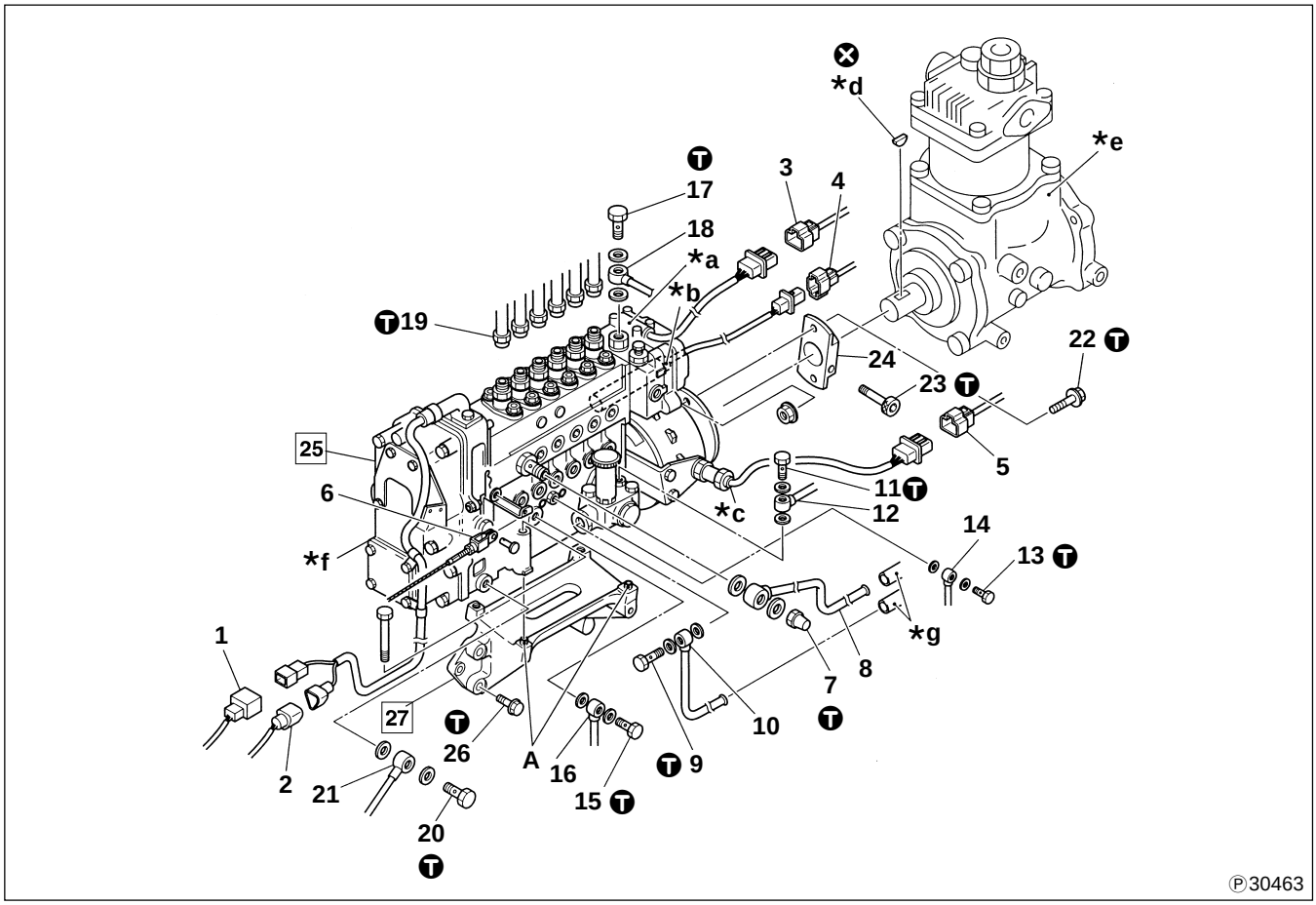
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Air vent plug	10±2 {7.7±1.4, 1.0±0.2}	—
4	Drain plug	3.5±0.5 {2.5±3.6, 0.35±0.05}	—
6	Ring nut	25±2 {18.0±1.4, 2.5±0.2}	—

M E M O

INJECTION PUMP



● **Disassembly sequence**

1 Harness (10 pins)
2 Harness (3 pins)
3 Harness (6 pins)
4 Harness (4 pins)
5 Harness (3 pins)
6 Emergency engine stop cable
7 Overflow valve
8 Fuel leak-off pipe
9 Eye bolt
10 Fuel suction pipe
11 Eye bolt
12 Fuel feed pipe
13 Eye bolt
14 Oil feed pipe
15 Eye bolt
16 Oil return pipe
17 Eye bolt
18 Fuel feed pipe
19 Injection pipe
20 Eye bolt
21 Oil pipe
22 Bolt
23 Cotter bolt
24 Driving coupling
25 Injection pump assembly
26 Bolt
27 Injection pump bracket

***a** : Pre-stroke actuator
***b** : Sub-control rod position sensor
***c** : Engine speed sensor
***d** : Key Gr 35A, B
***e** : Air compressor Gr 35A, B
***f** : Electronic governor
***g** : Fuel hose
A : Positioning pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**

CAUTION ⚠

- **For maintenance of the injection pump assembly 25, please contact MFTA.**
- **Dirt particles in the injection pump assembly 25 can seriously detract from engine performance. To prevent contamination, cover all pipes, hoses and other parts after removal.**
- **Do not suspend the injection pump assembly 25 from the prestroke actuator ∗a or the sub-control rod position sensor ∗b. If the injection pump assembly was suspended by either of these parts, it would be subjected to excessive force and could stop functioning normally.**
- **Do not remove the injection pump bracket 27 unless an abnormality is evident.**

Service standards

Unit : mm {in.}

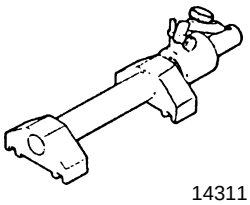
Location	Maintenance item	Standard value	Limit	Remedy
—	Fuel injection timing (BTDC)	2°±0.5°	—	Adjust
27	Injection pump bracket (eccentricity between Injection pump centering tool and pump drive case drive shaft)	0.2 {0.0079} or less	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

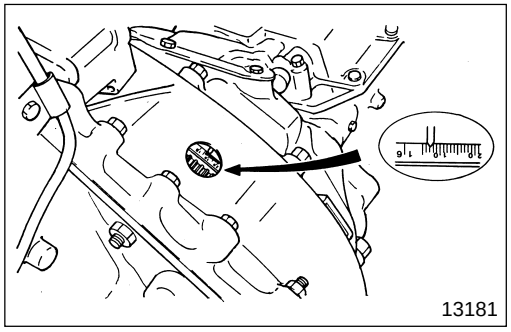
Location	Parts to be tightened	Tightening torque	Remarks
7	Overflow valve (fuel leak-off pipe mounting)	20 to 29 {14 to 22, 2 to 3}	—
9, **11**, **15**, **17, 20**	Eye bolt (fuel suction pipe, fuel feed pipe and oil return pipe mounting)	20 to 29 {14 to 22, 2 to 3}	—
13	Eye bolt (oil feed pipe)	12 to 15 {8.7 to 11, 1.2 to 1.5}	—
19	Injection pipe (Union nut mounting)	29 {22, 3}	—
22	Bolt (Driving coupling mounting)	59 to 64 {43 to 47, 6 to 6.5}	—
23	Cotter bolt	83 to 93 {61 to 69, 8.5 to 9.5}	—
26	Bolt (Injection pump bracket mounting)	33 to 55 {25 to 41, 3.4 to 5.6}	—

Special tools

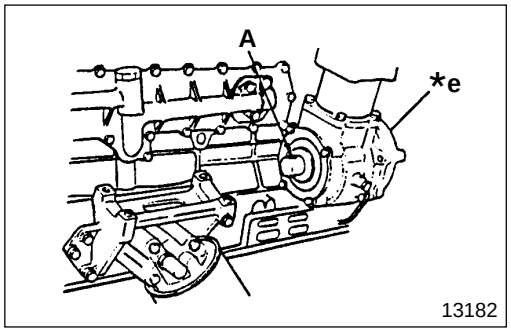
Location	Tool name and shape	Part No.	Application
27	Injection pump centering tool  14311	MH063336 Contact Field Service Manager	Positioning of injection pump bracket

◆ Service procedure

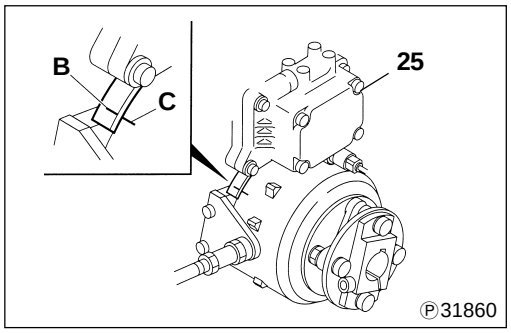
25 Installation of Injection pump assembly



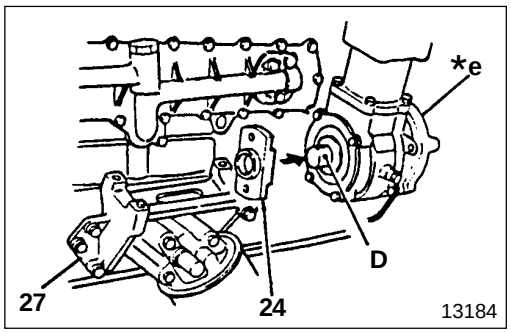
- Turn the engine and adjust No.1 cylinder piston to the specified fuel injection timing position.



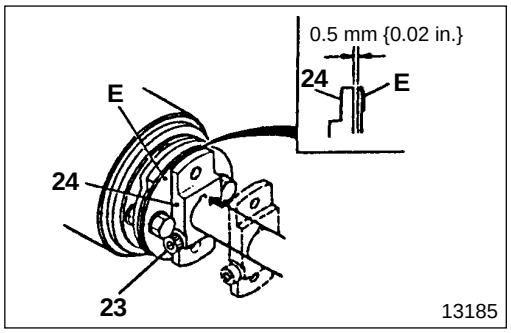
- In this state, make sure that keyway **A** in the crankshaft of air compressor ***e** faces upward.
- If keyway **A** is not facing upward, turn the engine crankshaft by one turn.



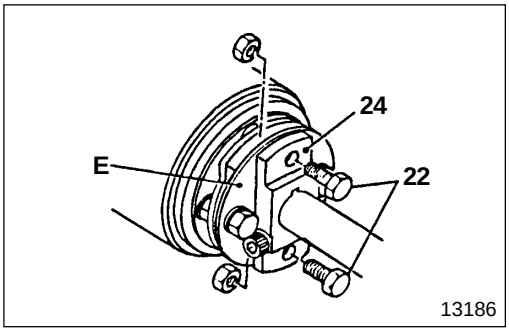
- Align pointer **B** on injection pump assembly **25** with mark **C** on the automatic timer.



- Install driving coupling **24** to crankshaft **D** of air compressor ***e** and place the driving coupling on the air compressor side.
- Install injection pump assembly **25** on injection pump bracket **27**.

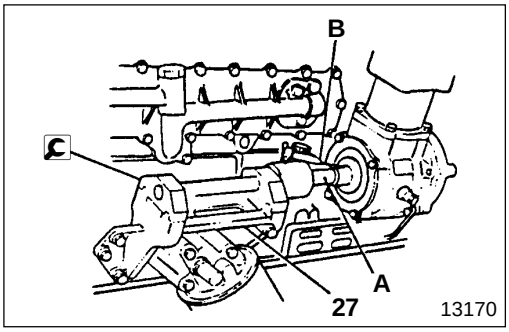


- Move driving coupling **24** to adjust the clearance between the driving coupling and coupling plate **E** as illustrated, then tighten cotter bolt **23** at specified torque.



- Attach driving coupling **24** and coupling plate **E** using bolts **22** and tighten the bolts temporarily.

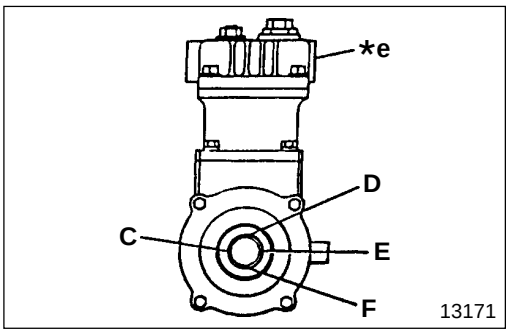
- In this state, adjust the fuel injection timing.
  Adjustment of fuel injection timing : P13-46
  After adjusting the fuel injection timing, tighten bolts **24** at specified torque.



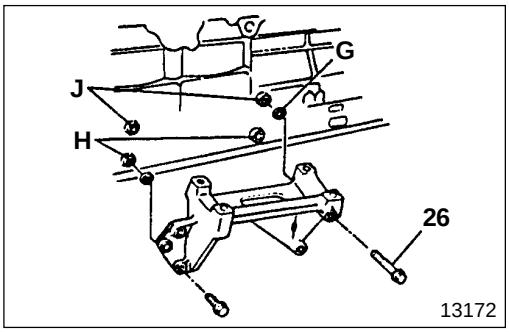
27 Injection pump bracket

[Inspection]

- Attach dial gauge **B** to arbor **A** of injection pump centering tool and adjust to gauge to zero setting.



- Slide dial gauge **B** toward air compressor ***e** and measure the eccentricity of crankshaft **C** against arbor **A** at points **D**, **E** and **F**.
- If the measured value is higher than the standard value, adjust as follows.



[Adjustment]

- When the measured value at point **E** is higher than the standard value: Insert shims **G** into four points equally.
- When the measured value at point **D** is higher than the standard value: Insert shims **G** into lower side **H**.
- When the measured value at point **F** is higher than the standard value: Insert shims **G** into upper side **J**.

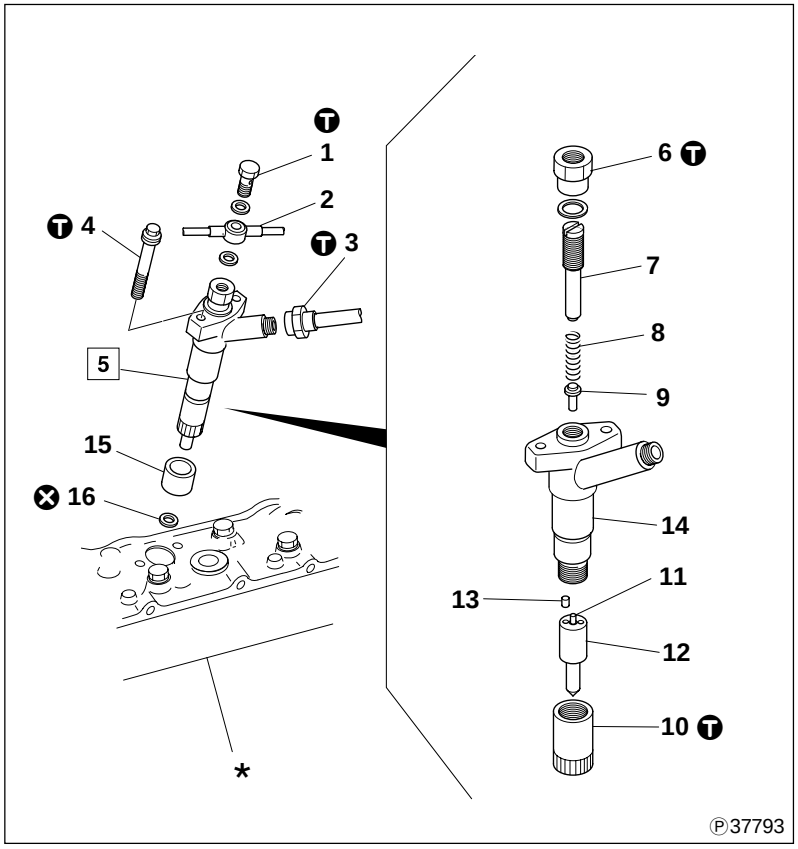
CAUTION

Insert shims G observing the following conditions:

- **Number of shims per point is three or less.**
- **The same number of shims should be used for the front and the rear.**
- **The difference in number of shims used for bottom and top is none or one.**

- Tighten bolt **26** at specified torque, then reinspect.

INJECTION NOZZLE



● **Inspection before disassembly**

P13-63

● **Disassembly sequence**

1 Eye bolt
2 Fuel return pipe
3 Injection pipe
4 Bolt
5 Injection nozzle assembly
6 Cap nut
7 Adjusting screw
8 Spring
9 Push rod
10 Retaining nut
11 Needle valve
12 Nozzle
13 Pin (ø3 mm {0.12 in.})
14 Nozzle holder
15 Dust seal
16 Gasket

* : Cylinder head Gr 11
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

Wipe up any spilled fuel because It can cause a fire

CAUTION ⚠

- **Be sure not to touch the slide-contact area of needle valve 11 because any scratches or corrosion might spoil the airtightness of nozzle 12. It must be handled with utmost care.**
- **Never change the combination of needle valve 11 and nozzle 12 for each cylinder.**
- **Be sure to protect all openings by covering them after removal of hoses and pipes because the engine performance is adversely affected if dirt and foreign particles enter injection nozzle assembly 5.**

NOTE

- **Remove carbon deposits and clean injectlon nozzle assembly 5 before working on it, then test the injection pressure and jet spray condition, and check for fuel leakage before disassembly. If no fault is found, do not disassemble.**
- **After installing injectlon nozzle assembly 5, tighten the two bolts 4 alternately.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
5	Value opening pressure	21.6 MPa {3130 psi, 220 kgf/cm²}	—	Adjust

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eye bolt (Fuel leak- off pipe mounting)	10 to 15 {7.2 to 11,1 to 1.5}	—
3	Union nut of injection pipe	29 {22, 3}	—
4	Bolt (Injection nozzle mounting)	15 {11, 1.5}	—
6	Cap nut	29 to 39 {22 to 29, 3 to 4}	—
10	Retaining nut	59 to 79 {43 to 58, 6 to 8}	—

Special tools

Location	Tool name and shape	Part No.	Application
—	Nozzle cleaning tool	★105789-0010	Cleaning of injection nozzle assembly

★ BOSCH AUTOMOTIVE SYSTEM code number

◆ Service procedure

● Inspection before disassembly

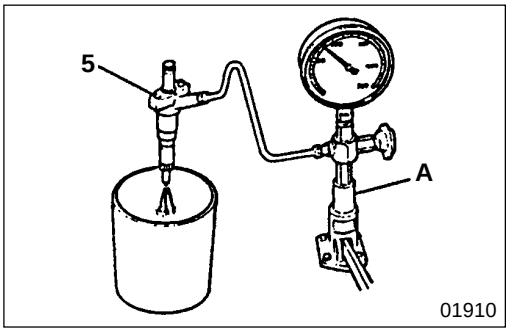
Attach injection nozzle assembly **5** to nozzle tester **A**, and conduct the following inspection.

WARNING ⚠

Never touch the spray from the nozzle or let your hands get too close to the spray point during the test.

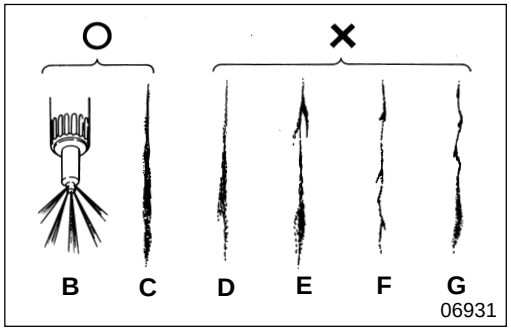
NOTE

Before inspection, bleed the air out in a couple of bursts by pressing nozzle tester A lever.



(1) Valve opening pressure

- Spray continuously with quick lever actions of nozzle tester **A**, one to two seconds per stroke, and measure the pressure that the gauge registers when the pressure is released which will be observed by the sudden movement of the gauge indicator.
- If the measured value deviates from the standard value, disassemble injection nozzle assembly **5** and clean it, then adjust using adjusting screw **7**.
- If the performance cannot reach the standard value even after adjustment, replace injection nozzle assembly **5**.



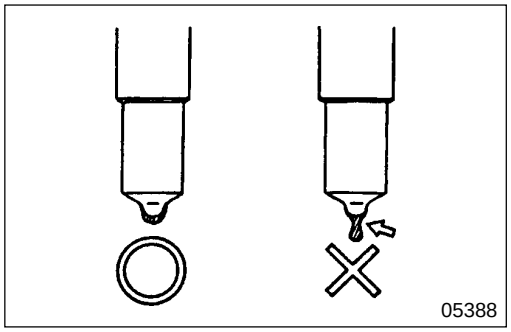
(2) Spray condition

- Spray continuously with quick lever actions of nozzle tester **A**, one to two seconds per stroke.
  - **B** : Even spray from all five orifices (Good)
  - **C** : Even and symmetrical spray (Good)
  - **D** : Asymmetrical spray (Faulty)
  - **E** : Spray direction deviates from the nozzle axis line (Faulty)
  - **F** : Thin and insufficient spray (Faulty)
  - **G** : Irregular spray (Faulty)

- If faulty spray cannot be corrected, disassemble injection nozzle assembly **5** and clean every part and repeat the test.
  If faulty spray still occurs after repeating test, replace the injection nozzle assembly.
- Make sure that there is no post-spray dripping after injection.

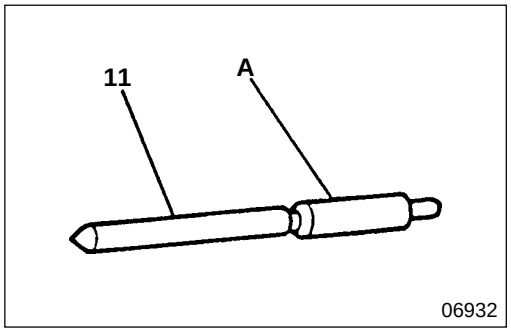
WARNING

Never touch the spray from the nozzle or let your hands get too close to the spray point during the test.



(3) Fuel air tightness and leakage at related contact points

- Raise the interior pressure of the nozzle gradually to the test pressure of 14.7 MPa {150 kgf/cm^2}. Maintaining the pressure, check and see if any fuel seeps out of the nozzle tip within 10 seconds.
- If any fault is found, disassemble injection nozzle assembly **5** and clean every part and repeat the test. If any fault is still found, replace the injection nozzle assembly.

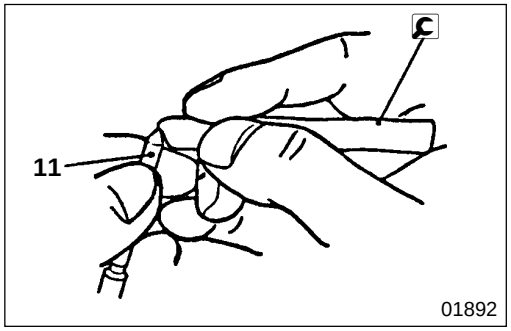


5 Injection nozzle assembly

[Disassembly]

CAUTION

- **Be sure not to touch sliding part A of needle valve 11 with your hands.**
- **Never change the combination of removed needle valve 11 and nozzle 12 for each cylinder.**



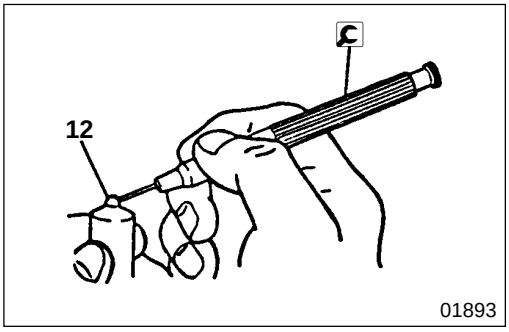
[Cleaning]

Clean needle valve **11** and nozzle **12** with diesel fuel (cleaning solvent).
Remove carbon deposits with cleaning tool in the following manner:

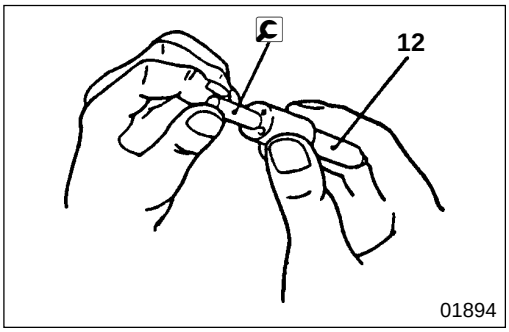
- Clean needle valve **11** by removing carbon deposits from its tip using the cleaning bar of cleaning tool.

CAUTION

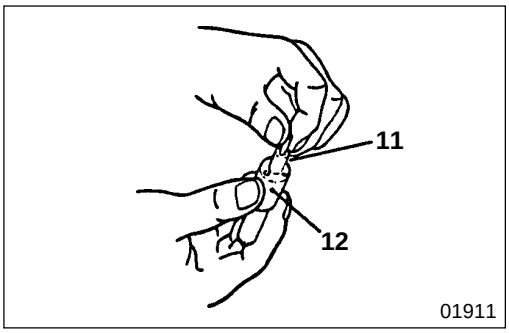
Never use a wire brush or hard steel for cleaning.



- To clean nozzle **12**, remove carbon deposits from the orifices of the nozzle using the needle cleaner of cleaning tool, by inserting it into the orifices and turning it.
  Needle cleaner diameter: ø 0.25 mm {0.0098 in.} or less



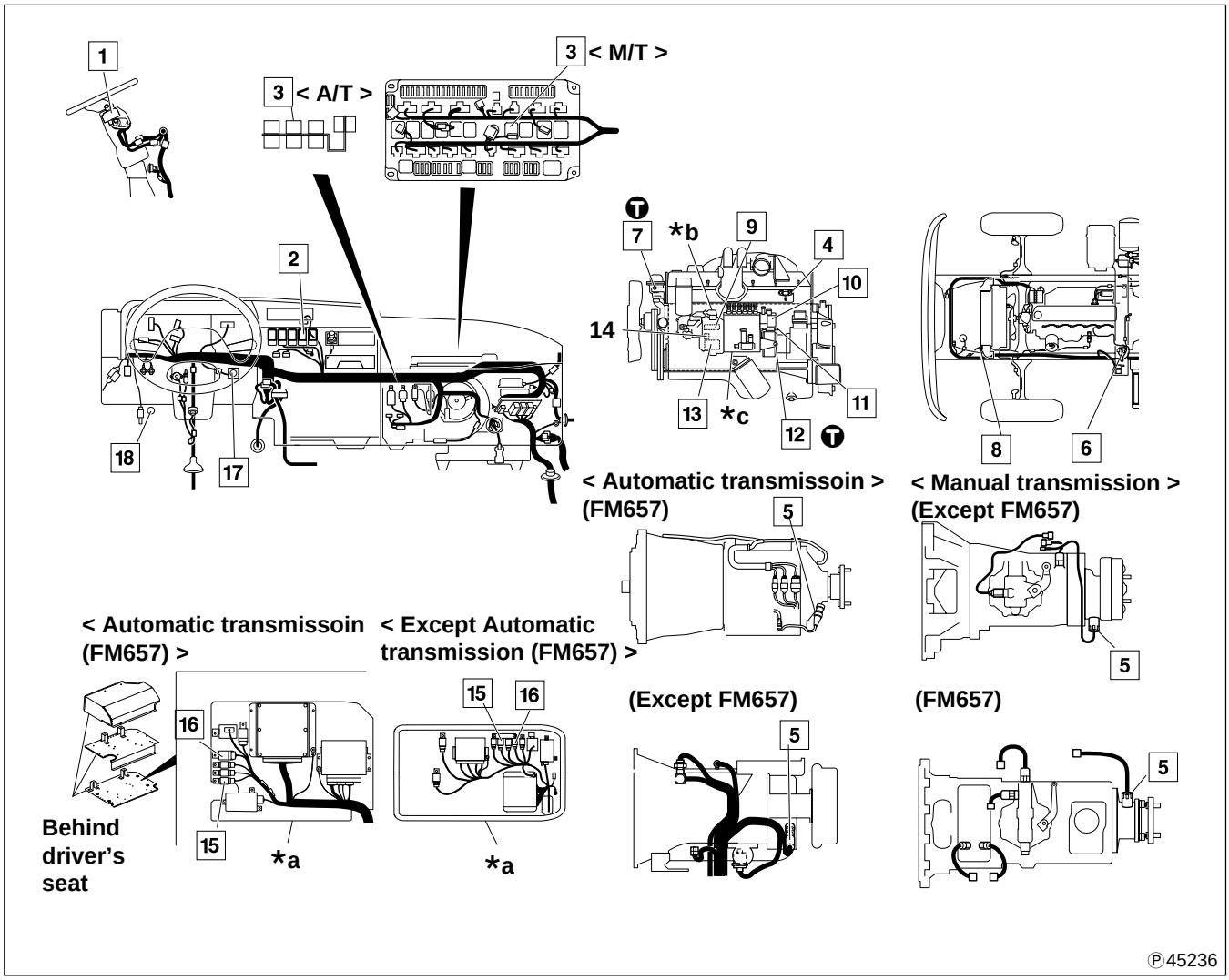
- Clean the seat of nozzle **12** using the cleaning scraper of cleaning tool.
- Use FUSO carbon remover to remove hard-to-remove, burnt-on carbon deposits.



[Inspection]

- Immerse needle valve **11** and nozzle **12** in diesel fuel (cleaning solvent) and clean them thoroughly.
- Check and see if needle valve **11** drops by its own weight into the nozzle from the position where a third of its length is pulled out.
  (Repeat this several times rotating the needle valve.)
- If needle valve **11** does not drop smoothly, repeat cleaning and repeat the test. If any fault is still found, replace both the needle valve and nozzle **12** together as a set.

INSPECTION OF OTHER DEVICES

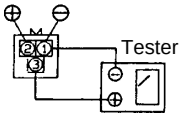
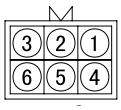
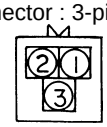
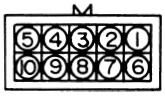
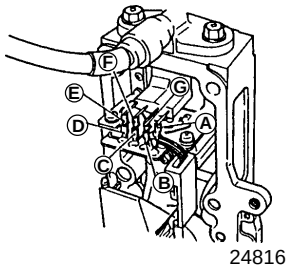
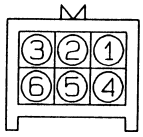


1 Combination switch
2 Cruise control main switch
3 Exhaust brake relay < M/T >
Accelator relay < A/T >
4 Boost pressure sensor
5 Vehicle speed sensor (25 - pulse)
6 Work load sensor
7 Engine coolane temperature sensor
8 Boost temperature sensor
9 Control rack position sensor
10 Prestroke actuator
11 Sub control rack position sensor
12 Engine speed sensor
13 Linear DC motor
14 Backup engine speed sensor
15 Pre-stroke cut relay
16 Cruise control main relay
17 Idling speed adjustment potentiometer
18 Emergency engine stop button

***a** : Bed under box (rear of passenger seat side)
***b** : Electronic governor
***c** : Injection pump assembly
M/T : Manual transmission
A/T : Automatic transmission

Service standards

Unit : mm {in.}

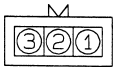
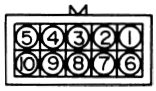
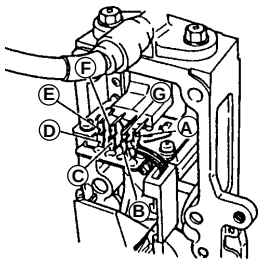
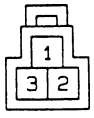
Location	Maintenance item		Standard value		Limit	Remedy
5	Vehicle speed sensor output voltage  15717	① – ③	Low pulse	0.6 V or less	—	Replace
			High pulse	8±1 V		
6	Output voltage of work load sensor  Ⓟ40148	④ – ⑤	Idling Position	0.85±0.1V	—	Replace
			Full load Position	3±0.1V	—	Adjust
7	Coolant temperature sensor	Between terminal and body	20°C {68°F}	(3.25 kΩ)	—	Replace
			40°C {104°F}	(1.5 kΩ)	—	Replace
			60°C {140°F}	(620±62 Ω)	—	Replace
8	Resistance value of boost temperature sensor		0°C {32°F}	5880±588 Ω	—	Replace
			20°C {68°F}	2450±245 Ω	—	Replace
			80°C {176°F}	322±48 Ω	—	Replace
9	Resistances of control rack position sensor	< Connector : 3-pin >  16165	③(3 pin) – ④(10 pin)	31.5 to 36.5 Ω	—	Repair or replace the injection pump assembly.*
			③(10 pin) – ④(10 pin)			
		< Connector : 10-pin >  16160	Ⓖ – Ⓒ			
			③(3 pin) – ⑨(10 pin)	18.0 to 21.0 Ω	—	
		< Governor actuator >  24816	③(10 pin) – ⑨(10 pin)			
			Ⓖ – Ⓕ			
			④(10 pin) – ⑨(10 pin)	13.5 to 15.5 Ω	—	
			Ⓒ – Ⓕ			
10	Resistances of pre-stroke actuator (measured at connector)  13714		② – ③	5.5 to 6.1 Ω	—	Repair or replace the injection pump assembly.*
			① – ③	11.0 to 12.2 Ω	—	
			① – ②	5.5 to 6.1Ω	—	
			④ – ⑤	0.9 to 1.3 Ω	—	

The values in ( ) are reference values.

*: Contact your MFTA representative for current injection pump repair and replacement procedures.

INSPECTION OF OTHER DEVICES

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
11	Resistances of sub control rack position sensor 13725	① – ④	92.5 to 101.5 Ω	—	Repair or replace the injection pump assembly.*
		① – ③	92.5 to 101.5 Ω	—	
		③ – ④	185 to 203 Ω	—	
12	Engine speed sensor resistor value (at 25°C {77°F})  14013	① – ②	2.1 to 2.5 kΩ	—	Replace
	Gap between the engine speed sensor and timer housing protrusion		0.8 to 1 {0.031 to 0.039}	—	Adjust
13	Resistances of linear DC motor	< Connector : 3-pin > 16165	②(3 pin) – ①(3 pin)	9.0 to 9.8 Ω	—	Repair or replace the injection pump assembly.*
		< Connector : 10-pin >  16160	②(3 pin) – ②(10 pin)		
		< Governor actuator >  24816	①(10 pin) – ②(10 pin)		
			①(10 pin) – ①(3 pin)		—
			Ⓐ – Ⓑ		
17	Output voltage of idling speed adjustment potentiometer  16184	② – ③	Knob pulled	1 to 3 V	—	Replace
			Knob pushed	3.6 to 4.3 V	—	Replace

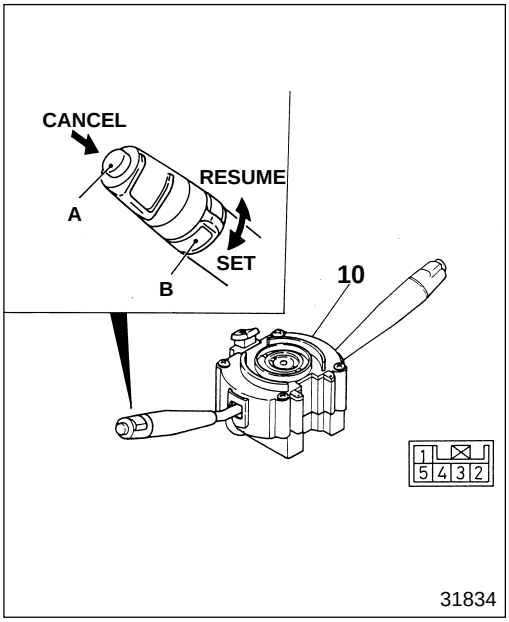
*: Contact your MFTA representative for current injection pump repair and replacement procedures.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Part to be tightened	Tightening torque	Remarks
7	Coolant temperature sensor	34±6.9 {25±5, 3.5±0.7}	—
12	Engine speed sensor lock nut	24 to 35 {17 to 26, 2.4 to 3.6}	—

◆ Service procedure



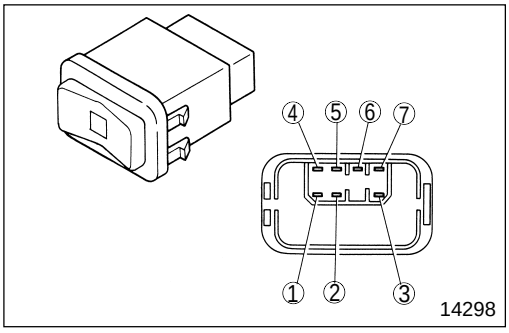
1 **Inspection of the combination switch**

- Check for conduction as indicated in the following chart.

		①	②	③	④	⑤
Set/resume switch and cancel switch	Set		○	○		
	Cancel			○		○
	Off					
	Resume			○	○	

A : Cruise control cancel switch
B : Cruise control set/resume switch
There should be conduction between the ○——○ terminals in the chart.

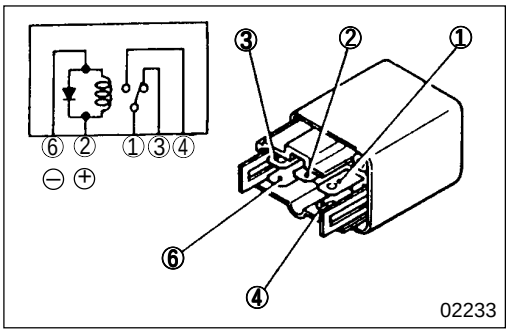
- If there is a malfunction, replace the combination switch **1**.



2 **Cruise control main switch**

- Check for conduction as indicated in the following chart. There should be conduction between the ○——○ terminals in the chart.
- If there is a malfunction, replace the main cruise control switch **2**.

	①	⑥	⑤	④	⑦	LED (Operation indicator)	③
ON	○	○	○	○	○	○	○
N (Neutral)		○		○			
OFF							



3 **16** **Inspection of the exhaust brake relay < M/T >, accelerator relay < A/T >, and cruise control main relay**

- Check for conduction as indicated in the following chart.

	①	②	③	④	⑥
Not Energized	○		○		
		○			○
Energized	○			○	
		○			○

There should be conduction between the ○——○ terminals in the chart.
Apply 12 V DC between ⊕——⊖ terminals.

- If there is a malfunction, replace the relay.

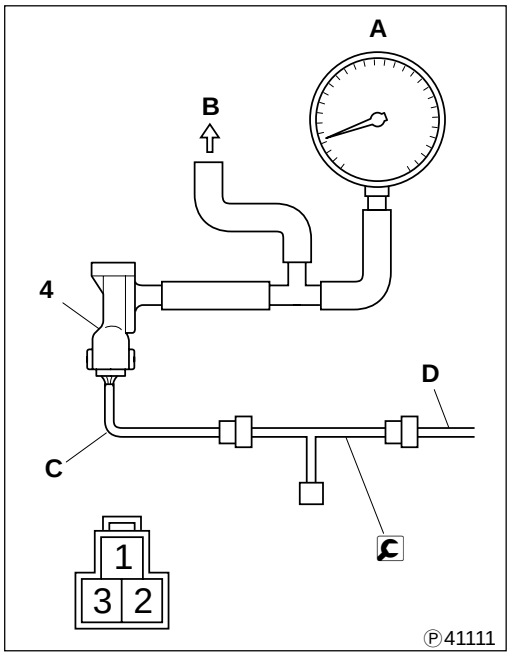
4 Checking Boost Pressure Sensor

< Checking by use of Multi-Use Tester II >

P13-40

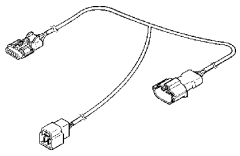
NOTE:

The boost pressure checking conditions differ between when the boost pressure is checked by use of the Multi-Use Tester II and when it is checked without use of the Multi- Use Tester II. So the standard values also differ.



< Checking without use of Multi-Use Tester II >

- Disconnect the harness **C** of the boost pressure sensor from the chassis side harness **D** and connect the inspection harness between them.

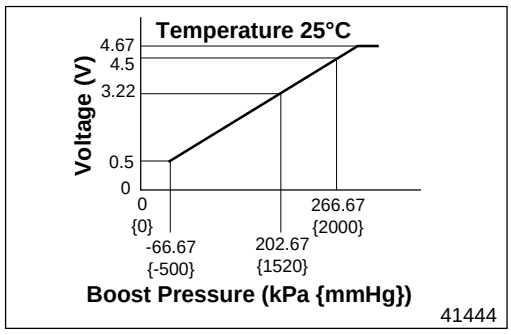
Tool Name and Shape	Part No.
Inspection Harness  02806	MC854336

- Mount pressure gauge **A** for measurement of the boost pressure.
  B: To inlet manifold
- Set the starter switch to ON.
- Measure the output voltage of the boost pressure sensor **4** according to the following table.

Item	Connector Pin		
	① Power (+)	② GND (-)	③ Output (+)
Power voltage	○	○	
* Output voltage (Refer to the output characteristics shown at left.)		○	○

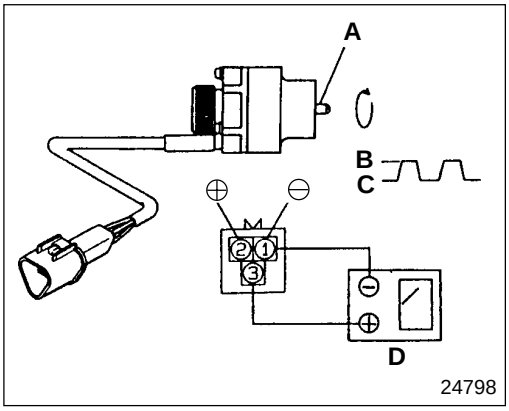
*: Start the engine before measurement.

Output Characteristics



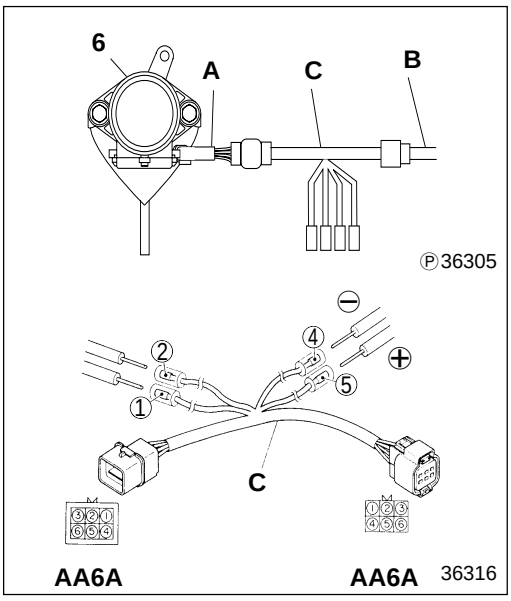
Standard Value	② - ③	5 V
	① - ②	0.5 V/–34.3 kPa {–10.0 in. Hg, –255 mmHg}
		1.86 V/33.7 kPa {9.84 in. Hg, 250 mmHg}
		3.22 V/98.7 kPa {29.1 in. Hg, 740 mmHg}
		4.5 V/163.7 kPa {48.4 in. Hg, 1230 mmHg}

- If the results of the above mentioned checks show any deviation from the standard values, replace the boost pressure sensor **4**.



5 Inspection of the vehicle speed sensor

- Apply 12 V DC between terminals ① and ②, and slowly turn portion **A** of the vehicle speed sensor **5**.
- Measure the maximum value (high pulse voltage **B**) and the minimum value (low pulse voltage **C**) generated between terminals ① and ③ under the above conditions.
  D : Tester
- If the measured value is outside of the standard range, replace vehicle speed sensor **5**.

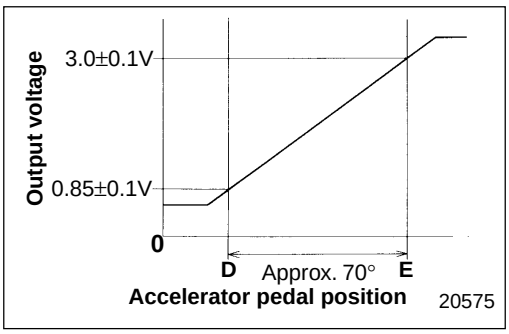


6 Inspection of work load sensor

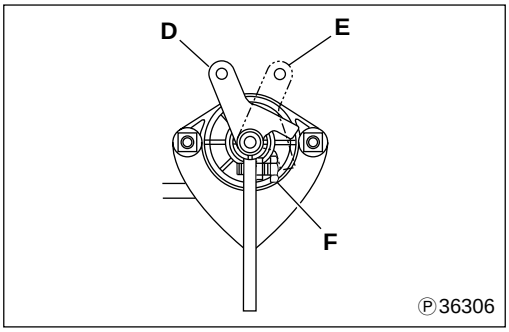
- Disconnect the harness **A** for work load sensor **6** from the cab side harness **B**, and connect a separately prepared inspection harness **C** between harnesses **A** and **B**.
- Check the output voltage of the work load sensor **6** according to the table below, and adjust it if necessary.

Lever position		AA6A Harneses for work load sensor inspection ④: GND (⊖)	AA6A Harneses for work load sensor inspection ⑤: Output (⊕)
Standard value	***a** Output voltage (idling position)	0.85±0.1V	
	***b** Output voltage (full-load position)	3±0.1V	

⊕ ⊖ show the polarities of tester probes to be connected when measuring output voltage.
***a** : Measure with the accelerator pedal in the idling position
***b** : Measure with the accelerator pedal in the full-load position
D : Idling position
E : Full-load position

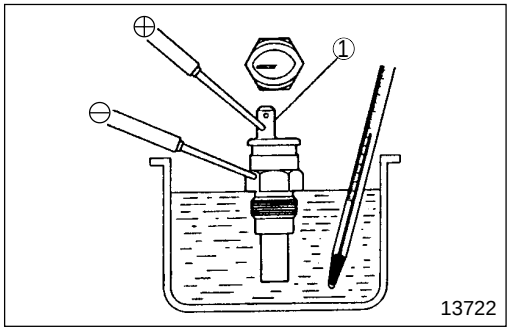


- If the output voltage measurement corresponding to the full-load position deviates from the standard value, adjust it using the full-load stopper bolt **F**.



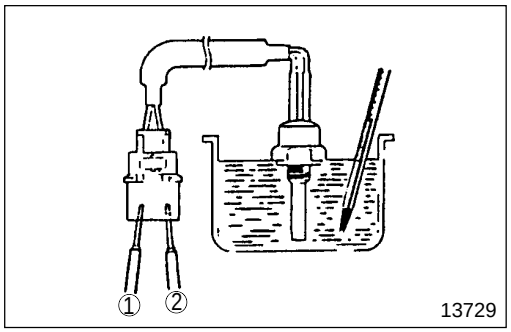
- If the output voltage measurement corresponding to the idling position deviates from the standard value, replace the work load sensor **6**.

INSPECTION OF OTHER DEVICES



7 Inspection of engine coolant temperature sensor

- Put the engine coolant temperature sensor **7** in a container of engine oil.
- Heat the oil to each of the specified temperatures. Stir the oil to ensure that it heats up evenly.
- At each of the specified temperatures, measure the resistance between the terminal ① and body of the engine coolant temperature sensor **7**.
- If the measurements are out of specification, replace the engine coolant temperature sensor **7**.

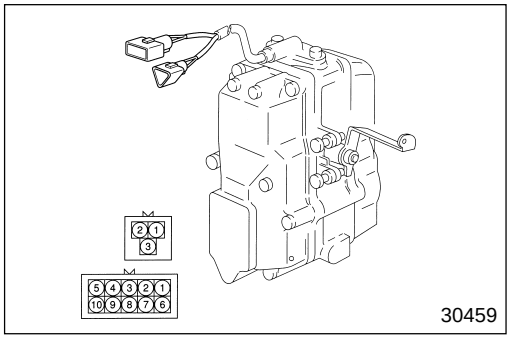


8 Inspection of boost temperature sensor

- Place boost temperature sensor **8** in glycerin in a container.
- Raise the glycerin temperature to the specified values and stir the glycerin.
- Measure the resistance between temminals ① and ②.
- If the measured value deviates from the standard value, replace boost temperature sensor **8**. Gr 15

9 Inspection of control rack position sensor

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA Dealer.



● Measurements on connectors

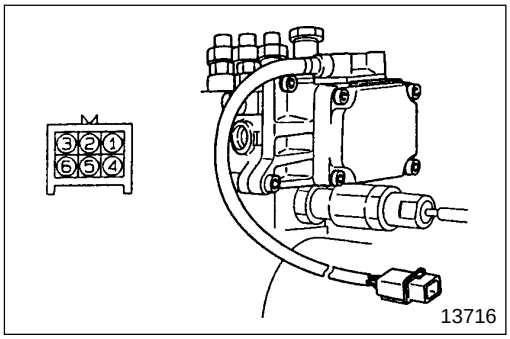
Measure the resistances between the following terminals: 3-pin connector's ③ and 10-pin connector's ④; 10-pin connector's ③ and ⑨; ④ and ⑨.

10 Inspection of pre-stroke actuator

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA Dealer.

CAUTION ⚠

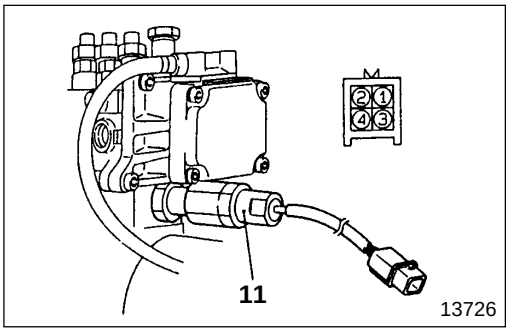
The pre-stroke actuator 10 must be inspected when the engine is cold.



13716

(1) Measurements on connectors

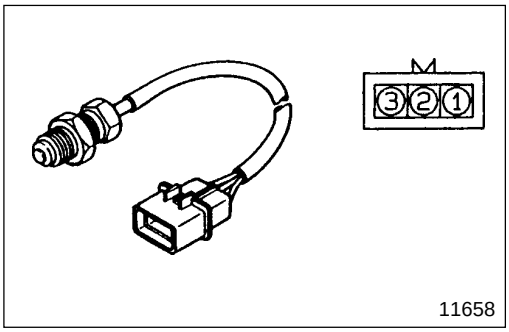
Measure the resistance between terminals ② and ③; ① and ③; ① and ②; ④ and ⑤.



13726

11 Inspection of sub control rack position sensor

- Measure the resistances between the following terminals: ① and ④; ① and ③; ③ and ④.
- If any resistance is out of specification, replace the sub control rack position sensor **11**.
- Have replacement performed by the nearest MFTA Dealer.



11658

12 Engine speed sensor

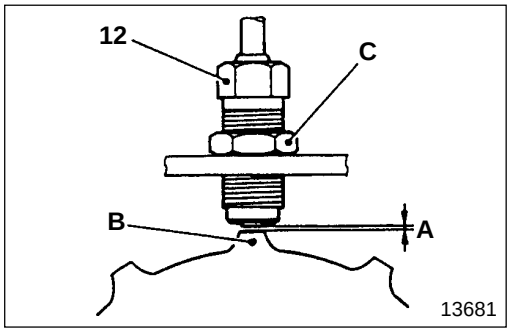
[Inspection]

(1) Main Unit

- Measure the resistance value between terminals ① and ②.
- If the measured value is outside of the standard range, replace the engine speed sensor **12**.

CAUTION ⚠

If the tightening torque of engine speed sensor 12 is insufficient, the signals may not be output correctly. Therefore, check the tightening torque.



(2) Gap of protrusion

If the gap **A** between the engine speed sensor **12** and the protrusion **B** of the timer housing is outside of the standard range, adjust with the following procedure.

[Adjustment]

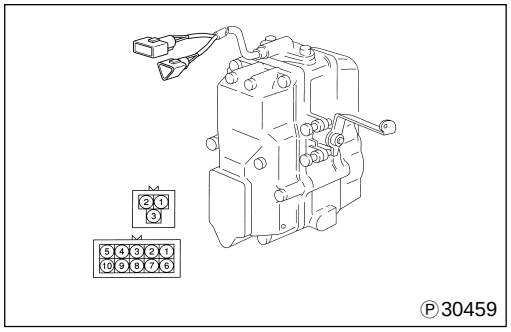
- Adjust by loosening lock nut **C** and turning engine speed sensor **12**.
- After adjustment is complete, tighten lock nut **C** with the specified torque.

CAUTION

If the gap C between the engine speed sensor 12 and the protrusion B of the timer housing is too large, no signals will be output, and if it is too small, the sensor might make contact with the protrusion.

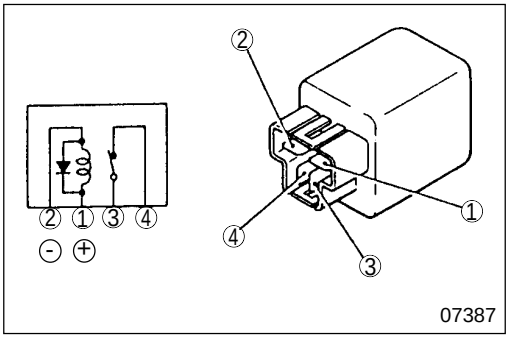
13 Inspection of linear DC motor

Perform the following inspections. If any abnormality is evident, have inspection and repair performed by the nearest MFTA Dealer.



(1) Measurements on connectors

Measure the resistance between terminals ① and ② on each connector.



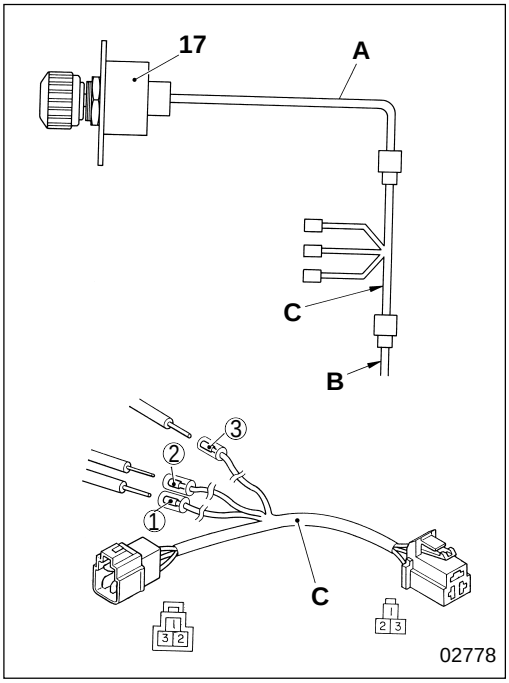
15 Inspection of pre-stroke cut relay (normally-closed type with 4-pin connector)

- Perform continuity checks in accordance with the following table.

	①	②	③	④
Not energized	○	○	○	○
Energized	⊕	⊖	◌	◌

○——○ : Continuity exists between terminals.
⊕——⊖ : Terminals across which 12 V DC is applied
◌- - -◌ : Continuity no longer exists between terminals

- Replace the relay if any abnormality is evident.



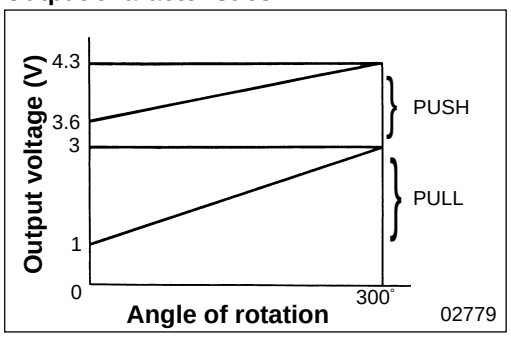
17 Inspection of idling speed adjustment potentiometer

- Disconnect the harness **A** of the idling speed adjustment potentiometer **17** from the cab-side harness **B**. Then, connect an inspection harness **C** between harnesses **A** and **B.** (The inspection harness must be made specially for this procedure.)
- Turn the starter switch to the ON position.
- Check the output voltages of the iding speed adjustment potentiometer **17** in accordance with the following table.

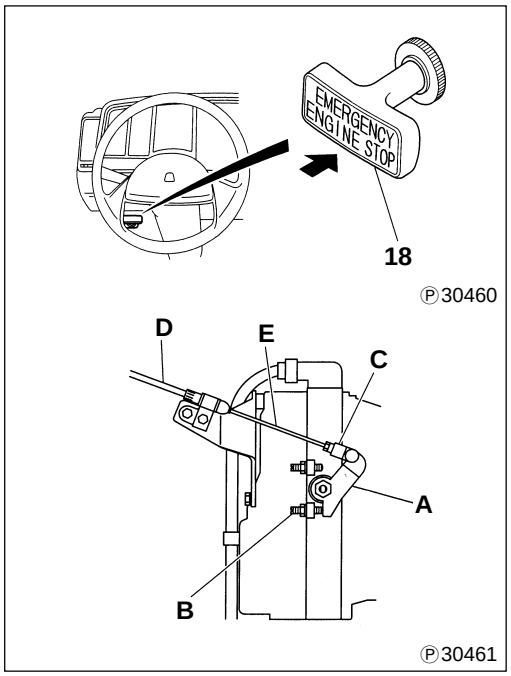
Item	Connector terminal		
	Accelerator pedal position sensor inspection harness		
	①: Power supply (+)	②: GND (–)	③: Output (+)
Output voltage with knob pulled		⊖	⊕
Output voltage with knob pushed			

INSPECTION OF OTHER DEVICES

Output characteristics



- If the output voltages are out of specification, replace the idling speed adjustment potentiometer **17**.

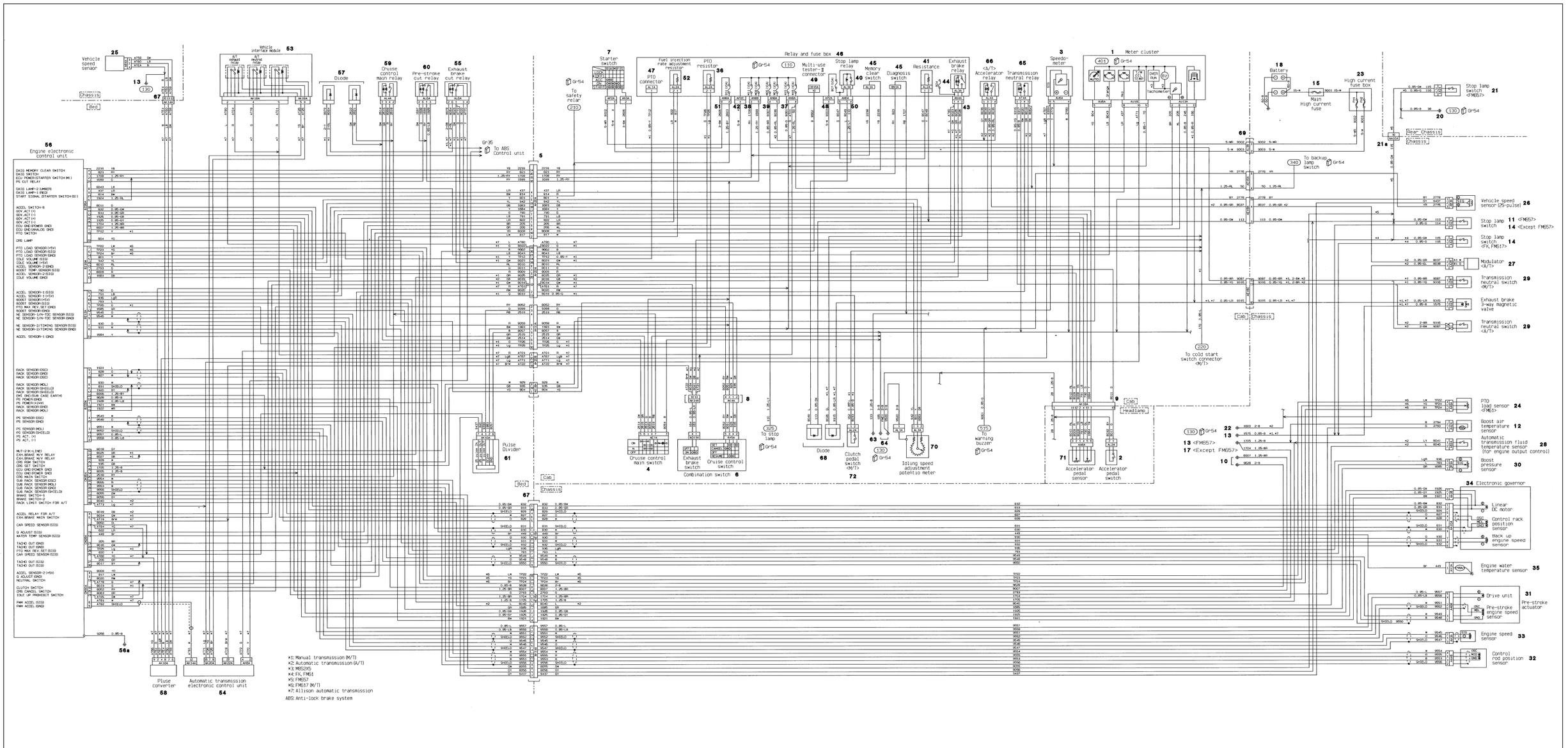


18 **Inspection of the emergency engine stop button**

- Fully press down the emergency engine stop button **18**.
- Check that the stop lever **A** of the governor is in contact with the stopper bolt **B** at this time.
- If it is not in contact, adjust it such that it makes contact by turning crevice **C**.
- Moreover, tighten inner wire **E** of stop cable **D** just enough to prevent it from being slack.

CAUTION ⚠

Be careful not to stretch the inner wire E too much. Doing so can cause the stop lever A not to make contact with the stopper bolt B.


Vehicle speed sensor* 25
Vehicle insurance module 53
A/T vehicle rear 53B
A/T vehicle front 53A
Diode 57
Cruise control main relay 59
Pre-stroke cut relay 60
Exhaust brake cut relay 55
Relay and fuse box 46
Starter switch 7
Fuel injection rate adjustment resistor 47
PTO resistor 36
PTO connector 52
Multi-use tester-II connector 49
Stop lamp relay 40
Memory clear switch 45
Diagnosis switch 45
Resistance 41
Exhaust brake relay 44
<A/T> Accelerator relay 66
Transmission neutral relay 65
Speedo-meter 3
Meter cluster 1
Battery 18
Main High current fuse 15
High current fuse box 23
Engine electronic control unit 56
To ABS Control unit
To safety relay
To backup lamp switch
To cold start switch connector <M/T>
To warning buzzer
To Stop lamp
Pulse Divider 61
Cruise control main switch 4
Exhaust brake switch
Cruise control switch
Combination switch 6
Diode 68
Clutch pedal switch <M/T> 72
Idling speed adjustment potentio meter 70
Accelerator pedal sensor* 71
Accelerator pedal switch 2
Headlamp
Vehicle speed sensor (25-pulse) 26
Stop lamp switch 11 <FM657> 14 <Except FM657>
Stop lamp switch 14 <FX, FM617>
Modulator <A/T> 27
Transmission neutral switch <M/T> 29
Exhaust brake 3-way magnetic valve
Transmission neutral switch <A/T> 29
PTO load sensor 24 <FM61>
Boost air temperature sensor 12
Automatic transmission fluid temperature sensor 28 (for engine output control)
Boost pressure sensor 30
Electronic governor 34
Linear DC motor
Control rack position sensor
Back up engine speed sensor
Engine water temperature sensor 35
Drive unit 31
Pre-stroke actuator
Pre-stroke engine speed sensor
Engine speed sensor 33
Control rod position sensor 32
Pulse converter 58
Automatic transmission electronic control unit 54
*1: Manual transmission (M/T)
*2: Automatic transmission (A/T)
*3: MB5295
*4: FX, FM61
*5: FM657
*6: FM617 (M/T)
*7: Allison automatic transmission
ABS: Anti-lock brake system

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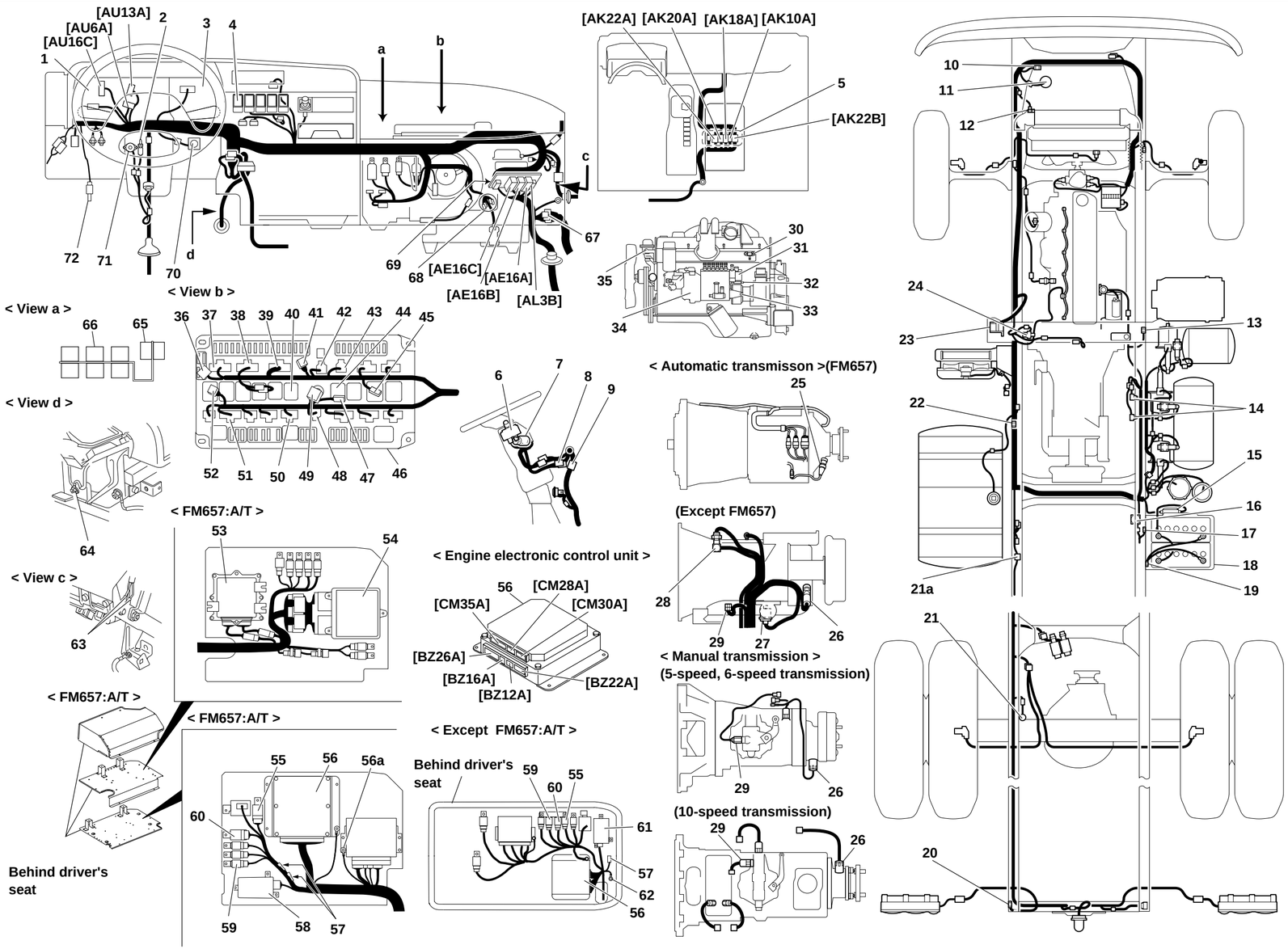


1 Meter cluster
2 Accelerator switch
3 Speedometer
4 Auto cruise main switch
5 Connection of cab harness and bed harness
6 Combination switch
7 Starter switch
8 Connection of cab harness and combination switch harness
9 Connection of cab harness and headlamp harness
10 Ground
11 Stop lamp switch < FM657 >
12 Boost air temperature sensor
13 Ground
14 Stop lamp switch
15 Main high current fuse
16 Exhaust brake 3-way magnetic valve
17 Ground
18 Battery
19 Ground
20 Ground
21 Stop lamp switch
21a Connection of chassis harness and rear chassis harness
22 Ground
23 High current fuse box
24 Power take-off load sensor
25 Vehicle speed sensor < A/T (FM657) >
26 Vehicle speed sensor
27 Modulator < A/T (Except FM657) >
28 Automatic transmisson fluid temperature sensor (for engine output speed sensor) < A/T (Except FM657) >
29 Transmission neutral switch
30 Boost pressure sensor
31 Pre-stroke actuator
32 Control rod position sensor
33 Engine speed sensor
34 Electronic governor
35 Water temperature sensor
36 Power take-off resistor < Manual transmission >
37 Connector
38 Connector
39 Connector
40 Stop lamp switch
41 Resistor unit
42 Connector
43 Connector
44 Exhaust brake relay
45 Diagnosis switch, memory clear switch
46 Relay & fuse box
47 Power take-off connector
48 Connector
49 Multi-use tester-II connecter
50 Connector
51 Connector
52 Fuel injection rate adjustment resistor
53 Vehicle interface module < A/T (FM657) >
54 Automatic transmission electronic control unit
55 Exhaust brake cut relay
56 Engine electronic control unit
57 Diode
58 Pulse converter < A/T (FM657) >
59 Cruise control main relay
60 Pre-stroke cut relay
61 Pulse divider < Except A/T (FM657) >
62 Ground
63 Ground
64 Ground
65 Transmission neutral start relay
66 Accelerator relay < A/T (Except FM657) >
67 Connection of bed harness and chassis harness
68 Diode
69 Connection of cab harness and chassis harness
70 Idling speed adjustment potentiometer
71 Accelerator pedal position sensor
72 Clutch switch

Ⓟ45847

MITSUBISHI
FUSO

Group 14

Cooling

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-14

INDEX

SPECIFICATIONS 14- 2

STRUCTURE AND OPERATION 14- 3

TROUBLESHOOTING 14- 7

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Replacing Coolant and Cleaning Cooling System 14- 8
- Air Bleeding of Cooling System 14-10
- Gas Leakage Test 14-10

RADIATOR AND FAN SHROUD 14-12

COOLING FAN AND V-BELT 14-16

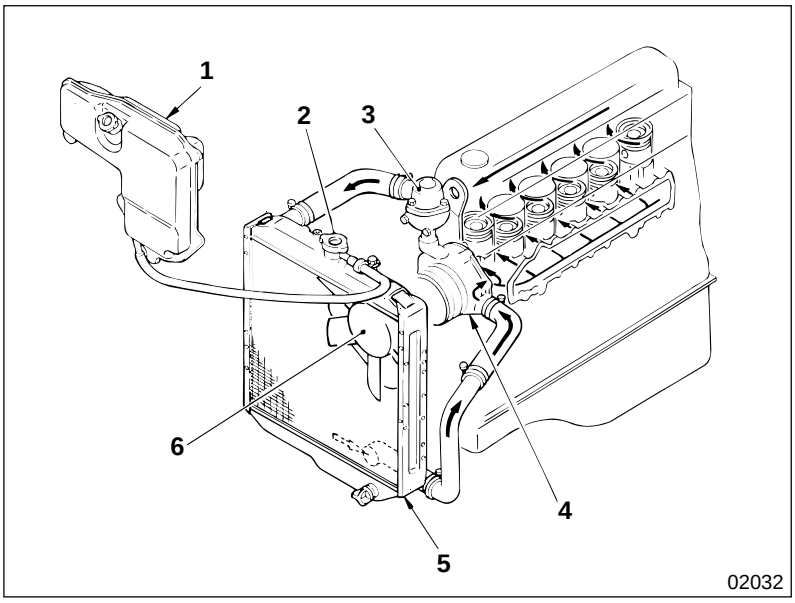
WATER PUMP 14-20

THERMOSTAT 14-22

SPECIFICATIONS

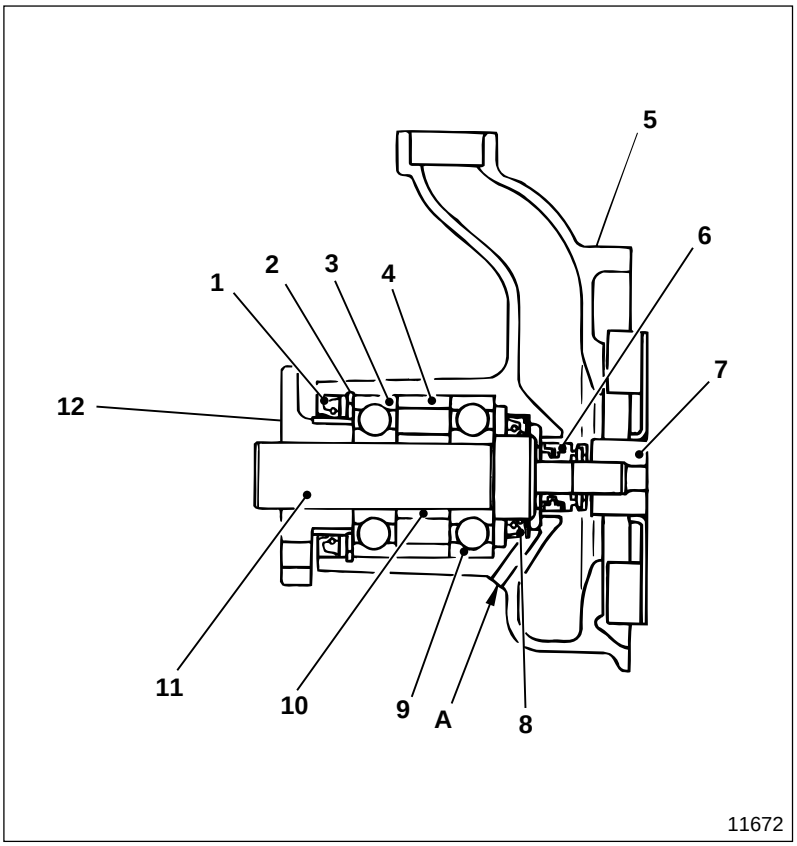
Item	Specifications
Kind of cooling system	Forced water circulation system
Water pump type	Belt-driven involute type
Thermostat type	Single valve, bottom bypass type
Radiator type	Tube and corrugated fin type
Coolant capacity L {qts}	21 {22}

Cooling System



1 Reservoir tank
2 Pressure cap
3 Thermostat
4 Water pump
5 Radiator
6 Cooling fan

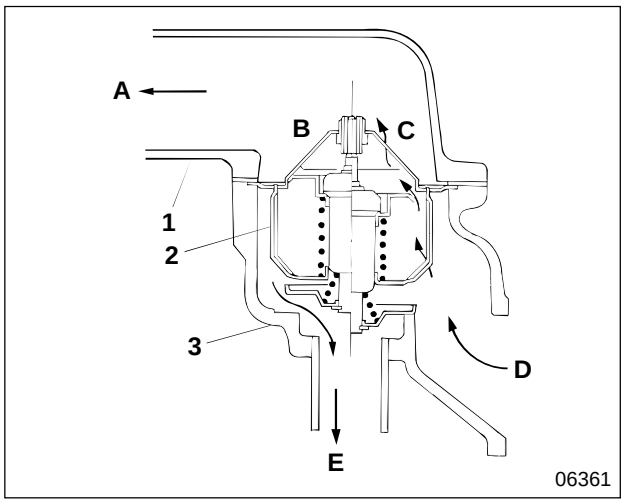
Water Pump



1 Front oil seal
2 Snap ring
3 Bearing
4 Outer spacer
5 Water pump case
6 Unit seal
7 Impeller
8 Rear oil seal
9 Bearing
10 Inner spacer
11 Water pump shaft
12 Flange

A : Drain hole

Thermostat



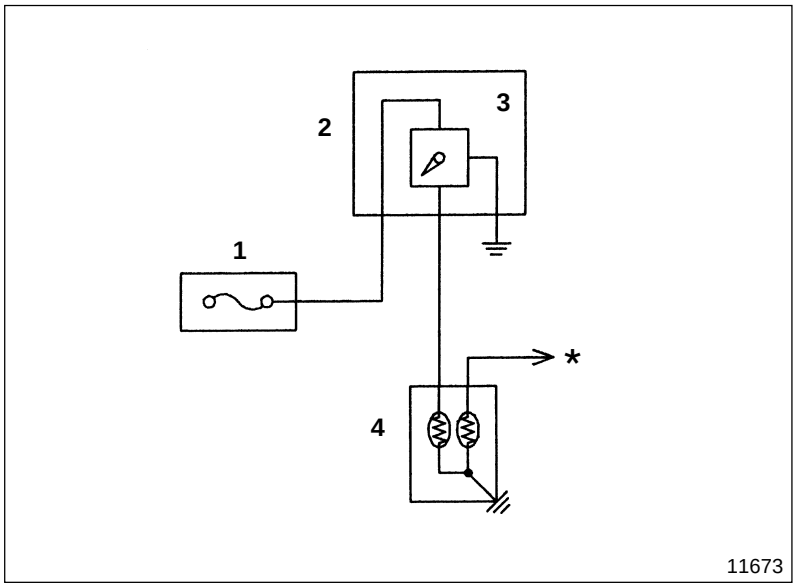
1 Thermostat cover
2 Thermostat
3 Thermostat case

A : To radiator
B : When low coolant temperature
C : When high coolant temperature
D : From cylinder head
E : To water pump

Thermostat **2** is a bottom bypass type that uses wax pellets as its regulating element. As the wax changes its form from solid to liquid according to changes in temperature, the volume of the wax changes. Therefore, the position of the valve, changed by the coolant temperature, regulates the flow of the coolant to the radiator and water pump (bypass side) and controls the coolant temperature.

Cooling System Electric Circuit

● Water temperature gauge circuit



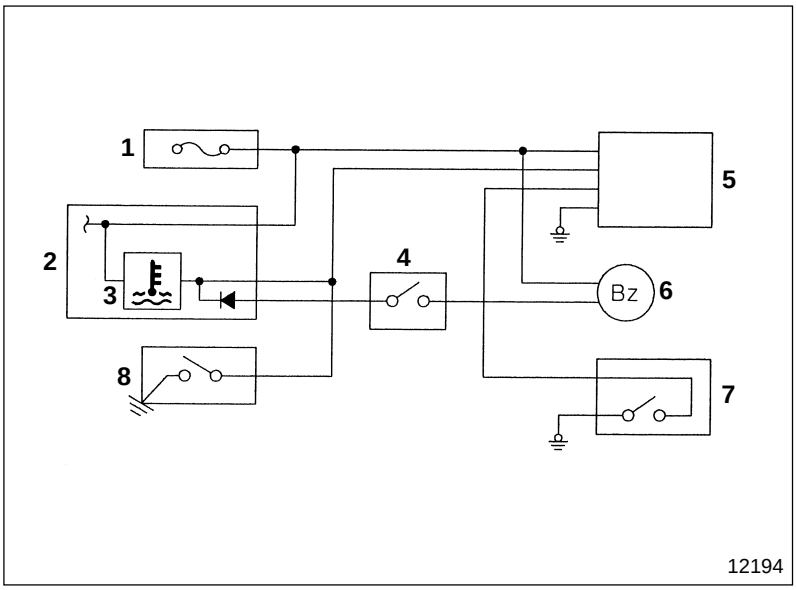
1 Fuse box
2 Meter cluster
3 Water temperature gauge
4 Water temperature sensor

***** : To cold start switch

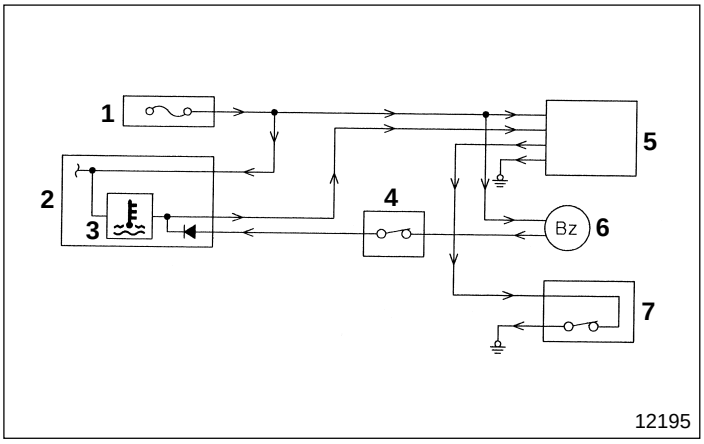
● Water level and overheating circuit

When this circuit detects insufficient coolant or extremely high coolant temperature, it lights water level warning lamp **3** and sounds buzzer **6** to warn the driver of the abnormal conditions.

< Air over hydraulic brake >

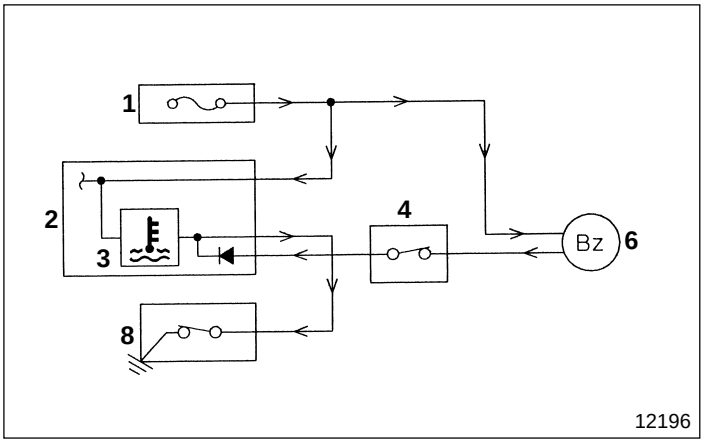


1 Fuse box
2 Meter cluster
3 Water level warning lamp
4 Parking brake switch
5 Multipurpose timing control unit
6 Buzzer (Buzzer does not work when the parking brake is engaged.)
7 Water level sensor
8 Overheating switch



When water level sensor is activated

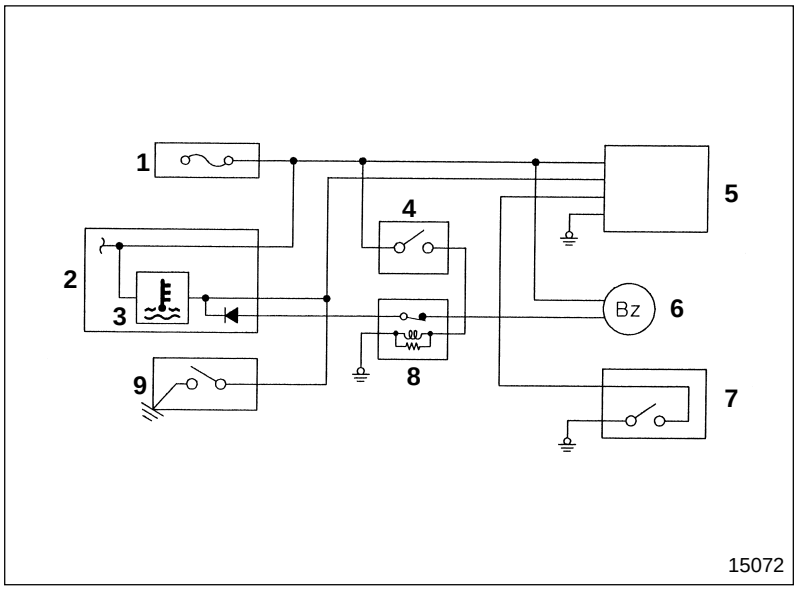
- **1**→**5**→**7**→Ground
- Water level control unit **5** detects insufficient coolant.
- **1** → **3** → **5** → Ground; **6** → **4** → **5**
- When the sensor is activated, water level warning lamp **3** lights up and buzzer **6** sounds.



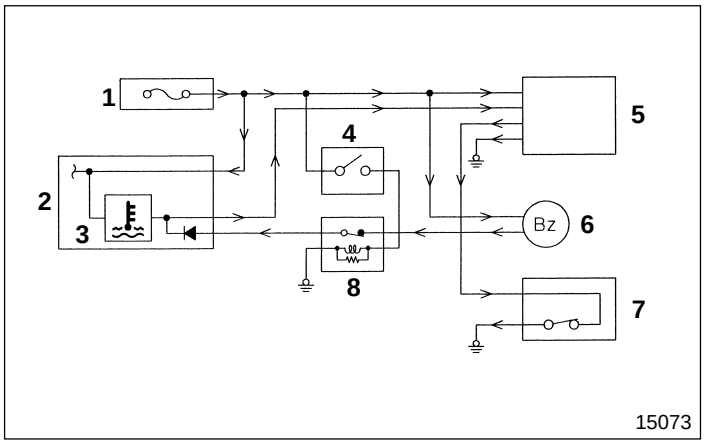
When overheating switch is activated

- **1** → **3** → **8** → Ground; **6** → **4** → **3**
- When the switch is activated, water level warning lamp **3** lights up and buzzer **6** sounds.

< Full air brake >

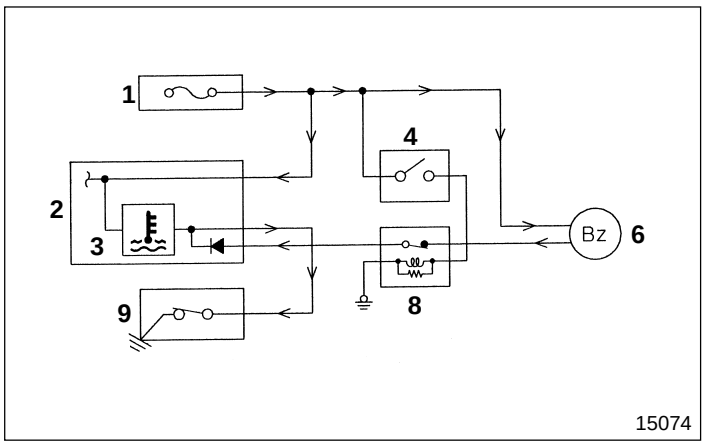


1 Fuse box
2 Meter cluster
3 Water level warning lamp
4 Parking brake switch
5 Multipurpose timing control unit
6 Buzzer (Buzzer does not work when the parking brake is engaged.)
7 Water level sensor
8 Parking brake relay
9 Overheating switch



When water level sensor is activated

- **1**→**5**→**7**→Ground
- Water level control unit **5** detects insufficient coolant.
- **1**→**3**→**5**→Ground, **1**→**6**→**4**→**5**→Ground
- When the sensor is activated, water level warning lamp **3** lights up and buzzer **6** sounds.

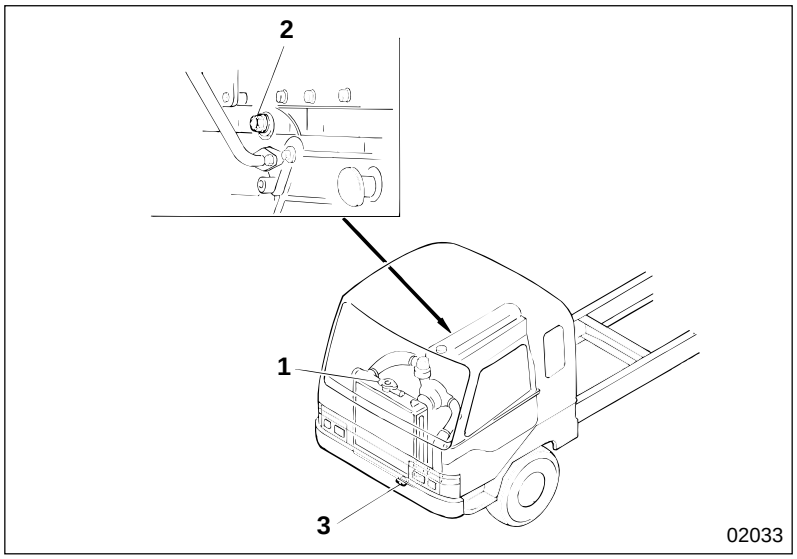


When overheating switch is activated

- **1**→**3**→**9**→Ground, **1**→**6**→**4**→**9**→Ground
- When the switch is activated, water level warning lamp **3** lights up and buzzer **6** sounds.

Possible causes \ Symptoms		Overheating (Low cooling effect)	Overcooling	Noise occurs	Coolant loss excessive	Remarks
V-belt	Loose or damaged	○		○		
	Tension excessive			○		
	Oily	○				
Water pump	Water pump installation faulty	○			○	
	Gasket faulty	○			○	
	Bearing faulty	○		○		
	Impeller faulty	○				
	Unit seal faulty	○			○	
	Shaft-to-flange and to-impeller fitting loose	○		○		
Thermostat	Case installation faulty	○			○	
	Gasket faulty	○			○	
	Valve opening temperature too high, valve remains closed	○				
	Valve opening temperature too low, valve remains open	○				
	Water level sensor leaking water	○			○	
Radiator	Space between core and fin clogged	○				
	Core cracked or soldered part separated	○			○	
	Pressure cap airtightness poor	○				
	Water level sensor leaking water	○			○	
Cooling fan	Fan shroud installation faulty	○		○		
Automatic cooling fan coupling	Bearing faulty	○		○		
	Bimetal damaged	○				
	Bimetal contaminated with foreign particles	○	○			
	Silicon oil leaking	○		○		
Oil cooler	Oil cooler installation faulty	○			○	Gr 12
	Gasket faulty	○			○	Gr 12
Cylinder head	Cylinder head installation faulty	○			○	Gr 11
	Gasket faulty	○			○	Gr 11
Coolant quantity insufficient		○				
Coolant passage furred and clogged		○				
Hose installation faulty		○			○	
Exterior temperature extremely cold			○			

Replacing Coolant and Cleaning Cooling System



1 Pressure cap
2 Crankcase drain plug
3 Radiator drain plug

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Crankcase drain plug	115 {87, 12}	—

Using the radiator for a long period of time without cleaning it will cause overheating because rust and scale deposits will accumulate inside the cooling system. Periodical cleaning is recommended.

● **Draining coolant**

First loosen pressure cap **1,** to lower the pressure in the cooling system, before draining coolant.

WARNING

- **You must make sure that the engine coolant is cold before draining it so as not to scald yourself.**
- **It is dangerous to open pressure cap 1, when the coolant temperature is high, without taking due care because the hot water would spray out. Be sure to cover the pressure cap with a cloth and loosen slowly to bleed the pressure before opening fully.**

● **Cleaning procedure**

- Keep the coolant temperature at approximately 90°C {194°F} so that the thermostat valve remains open and the coolant continues to circulate in the radiator.
- For the sake of convenience you can raise the coolant temperature quickly by covering the front of the radiator with corrugated cardboard or something similar.
- Set the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- In cases where a great amount of rust has accumulated it often happens that as a result of cleaning the radiator starts leaking. Conduct a thorough check for leakage after cleaning.
- Soft water to be used should have the following properties.

CAUTION

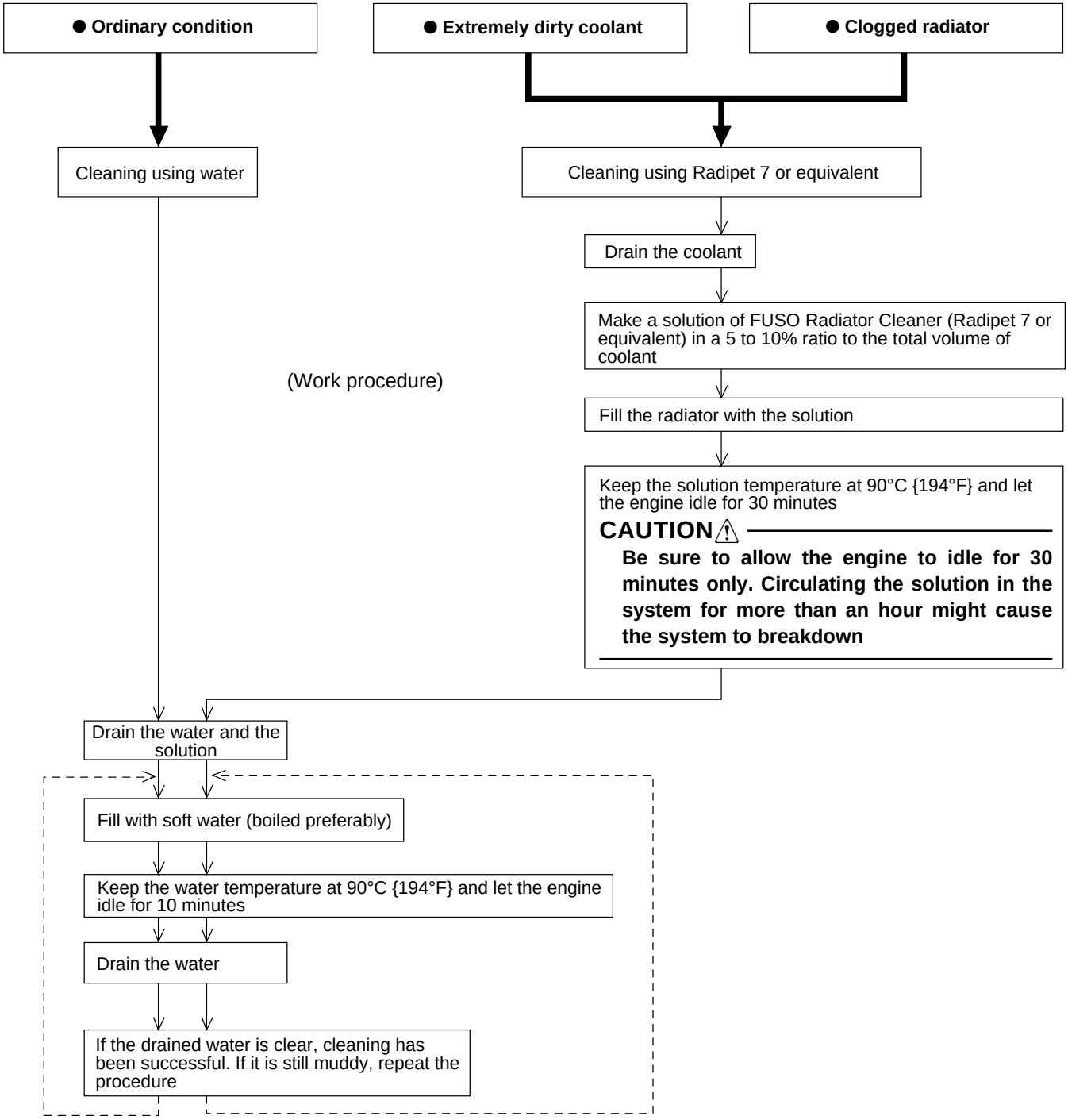
Do not use hard water as it causes scale and rust.

Required properties of soft water

Total hardness	300 ppm or less
Sulfate SO_4^-	100 ppm or less
Chloride Cl^-	100 ppm or less

Total dissolved solids	500 ppm or less
pH	6 to 8

Method of cleaning the cooling system depends on its condition.



DANGER

If FUSO DIESEL LONG LIFE COOLANT solution gets in your eyes accidentally, you must immediately rinse your eyes with copious amounts of water, and be sure to consult a doctor.

WARNING

FUSO DIESEL LONG LIFE COOLANT is inflammable. Do not put it near naked lights.

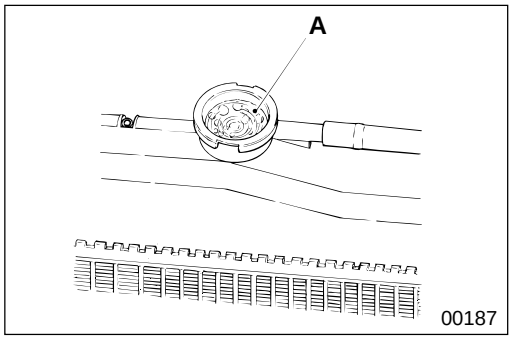
NOTE

- **After cleaning with solution, fill with coolant as quickly as possible.**
- **To prevent freezing of the coolant and corrosion of the cooling system, use specified coolant solution of FUSO DIESEL LONG LIFE COOLANT. (See the Owner's Handbook for use of these materials.)**

Air Bleeding of Cooling System

- Remove the pressure cap and keep the coolant temperature at 90°C {194°F} while letting the engine idle and bleed the air out completely. Keep the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- After completing adequate air bleeding of the cooling system, refill coolant sufficiently enough for the surge tank.

Gas Leakage Test



Air or exhaust gas in the coolant increases corrosion and rusting in the system. Therefore, carry out the following test:

- Remove the surge tank pressure cap and check if the coolant level comes up to the lip of the tank.
- Put the end of the overflow pipe into the water tank.

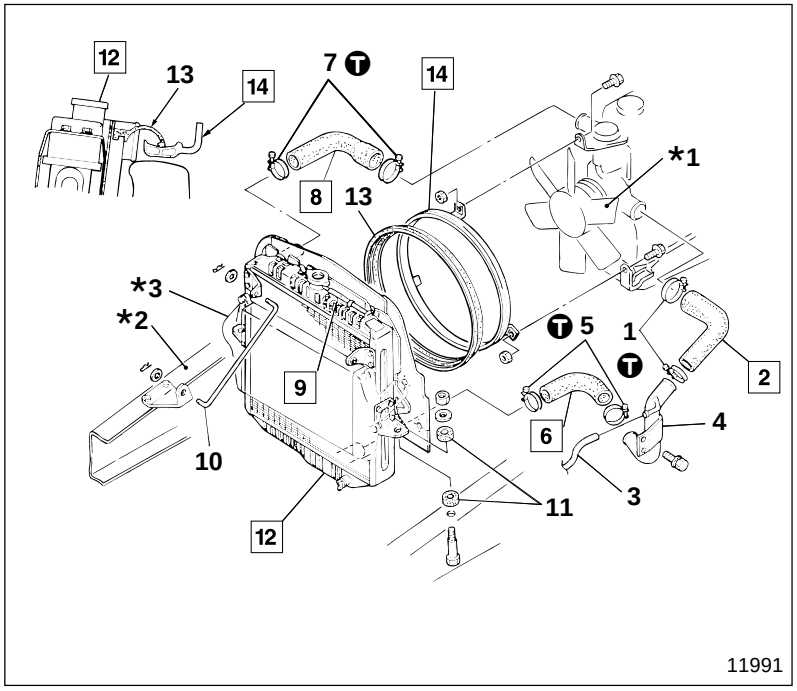
WARNING⚠

Be sure that the coolant temperature is low enough so that hot coolant does not spout out when you loosen the pressure cap.

- Run the engine to bring the coolant temperature to approximately 90°C {194°F}.
- If air bubbles **A** continuously rise in the water tank, it is an indication that air or exhaust gas has gotten into the coolant.
- If it is air, it is possible that the cylinder head bolts, the water pump mounting bolts or the hose connections are loose, or that the hose is damaged.
- If it is exhaust gas, it is possible that the cylinder head gaskets are damaged, or that the cylinder head is cracked.

M E M O

RADIATOR AND FAN SHROUD



● **Disassembly sequence**

1 Hose clamp
2 Inlet hose
3 Heater hose
4 Inlet pipe
5 Hose clamp
6 Outlet hose
7 Hose clamp
8 Supply hose
9 Reservoir hose
10 Support rod
11 Rubber seat
12 Radiator assembly P14-14
13 Shroud sealing
14 Fan shroud

***1** : Cooling fan
***2** : Frame
***3** : Intercooler

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
14, *1	Clearance between fan shroud and cooling fan tip	4.5 to 8.3 {0.18 to 0.33}	—	Adjust

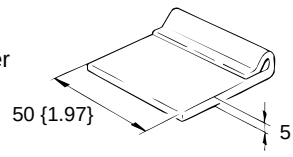
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

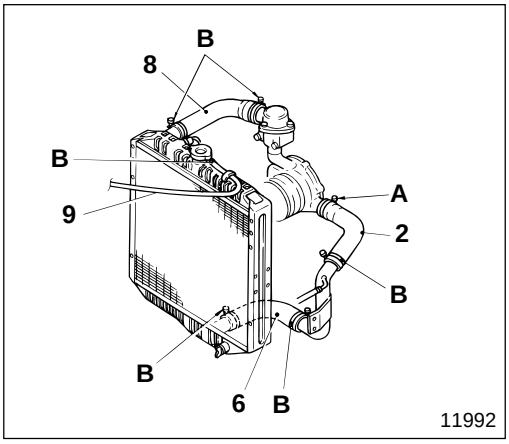
Location	Parts to be tightened	Tightening torque	Remarks
1, 5, 7	Hose clamp	3.9 {2.9, 0.4}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
14	Tip clearance spacer 	MC019470 (Obtain Locally)	Adjustment of clearance between fan shroud and cooling fan

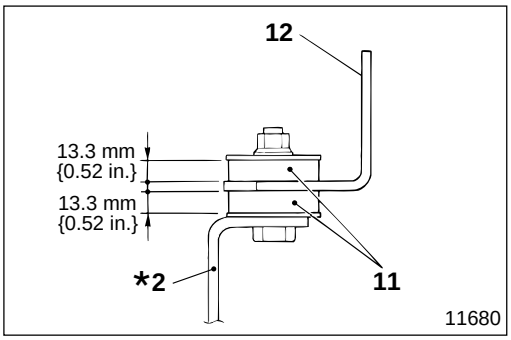
◆ Service procedure



2 **6** **8** **9** **Installation of hose**

The depth of hose installation is as follows.

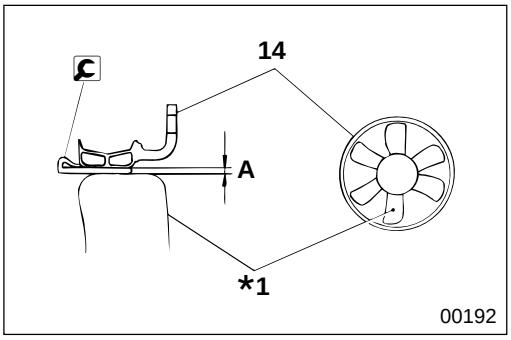
A : 30 mm {1.18 in.}
B : 35 mm {1.38 in.}



12 **Installation of radiator assembly**

Tighten nuts until thickness of rubber seat **11** conforms to the dimension as illustrated.

***2** : Frame



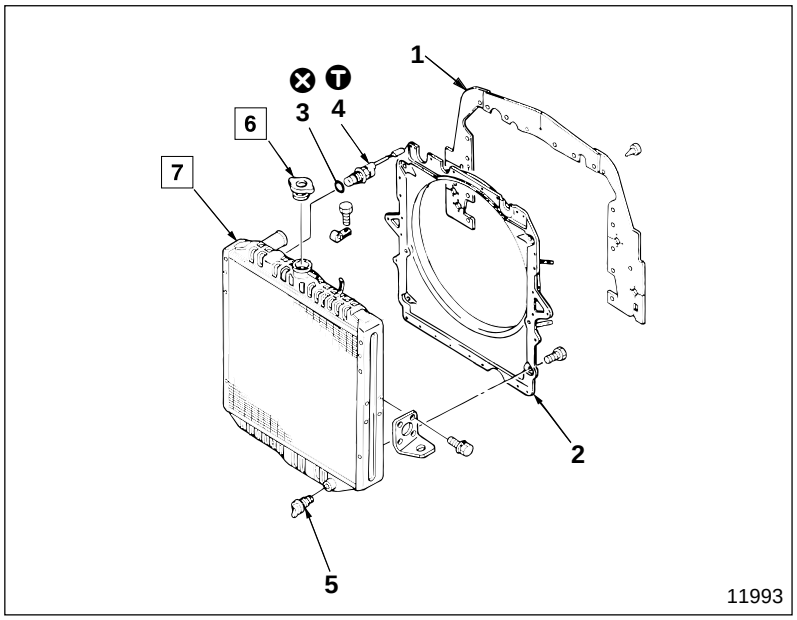
14 **Installation of fan shroud**

Adjust using tip clearance spacer so that clearance **A** conforms to the standard value all around the periphery.

***1** : Cooling fan

RADIATOR AND FAN SHROUD

Radiator Assembly



● **Disassembly sequence**

1 Baffle plate
2 Radiator shroud
3 O-ring
4 Water level sensor Gr 54
5 Drain cock
6 Pressure cap
7 Radiator

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

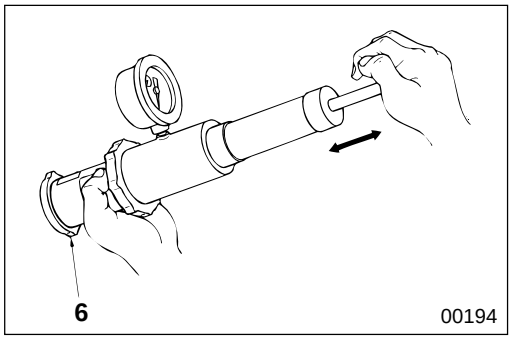
Location	Maintenance item	Standard value	Limit	Remedy
6	Pressure cap valve opening pressure	69±15 kPa {10±2.1 psi, 0.7±0.15 kgf/cm^2}	—	Replace
7	Radiator air leakage (Air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2})	0 cm^3 {0 cu. in.}	—	Correct or replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Water level sensor	2.9 to 3.9 {2.2 to 2.9, 0.3 to 0.4}	—

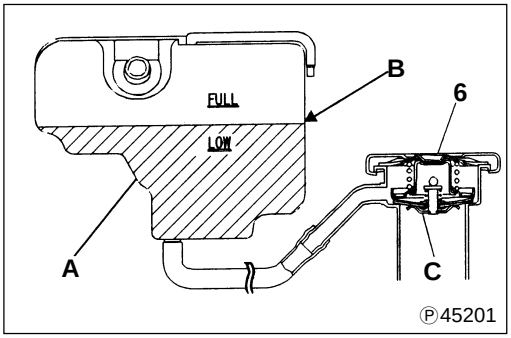
◆ Service procedure



6 **Inspection of pressure cap**

(1) Pressure valve opening pressure

If the measured value deviates from the standard value, replace pressure cap **6**.

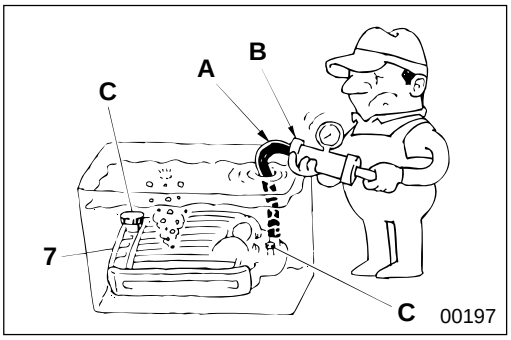


(2) Inspection of vent valve

- Take note of liquid level **B** of reservoir tank **A** before testing.
- Run the engine at a high revolution and stop engine before the overflow reaches the capacity of tank **A**.
- Leave things for a while. Check the time it takes for the coolant temperature to return to the ambient temperature, and check whether the coolant level in tank **A** is the same as before running the engine.
- If the coolant level has not returned to that before running engine, it means vent valve **C** is faulty, therefore replace pressure cap **6**.

NOTE

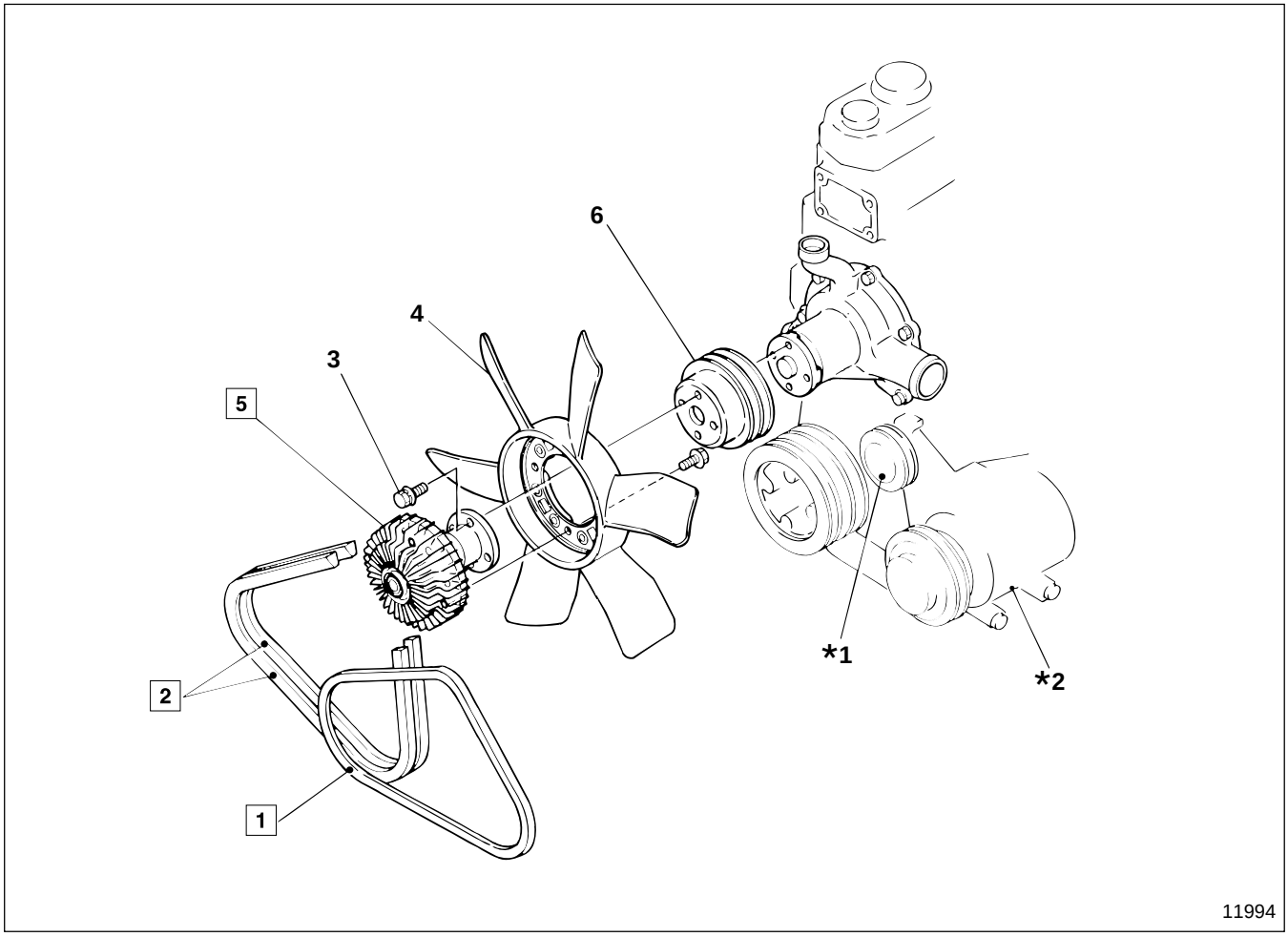
Do not remove pressure cap 6 before the coolant temperature decreases to the ambient temperature. If you do the coolant will not return to reservoir tank A because negative pressure in the radiator is lost.



7 Inspection of radiator

- Install radiator cap tester **B** by connecting hose **A** to the radiator inlet hole.
- Plug any other openings **C** with plugs, and immerse the radiator in a water tank.
- Apply specified air pressure of 150 kPa {21 psi, 1.5 kgf/cm^2} using cap tester **B**, and check if there is any air leakage.
- If you find air leakage, correct or replace radiator **7**.

COOLING FAN AND V-BELT



● **Disassembly sequence**

1 V-belt (Air-conditioner)
2 V-belt (Fan)
3 Bolt
4 Cooling fan
5 Automatic cooling fan coupling
6 Water pump pulley

***1** : Tension pulley
***2** : Cooler compressor

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

- **Be sure to replace automatic cooling fan coupling 5 as an assembly if it is faulty because it is a unit construction.**
- **Be sure to replace V-belts 2 as a set to maintain even tension between them.**

Service standards

Unit : mm {in.}

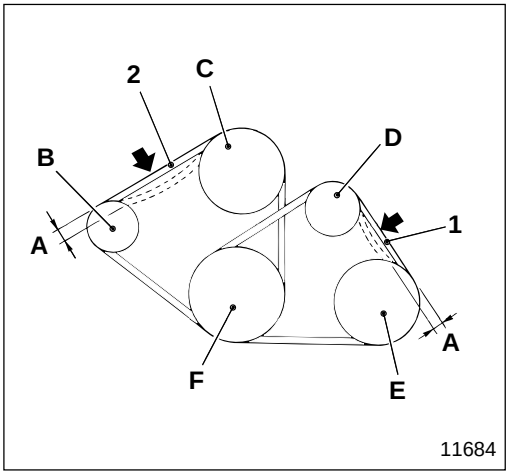
Location	Maintenance item	Standard value	Limit	Remedy
1	V-belt tension (Air-conditioner)	7 to 10 {0.28 to 0.39}	—	Adjust
2	V-belt tension (Fan)	10 to 15 {0.39 to 0.59}	—	Adjust

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1, 2	Belt tension gauge 03612	MH062345 (Obtain Locally)	Measurement of tension of V-belt

◆ Service procedure



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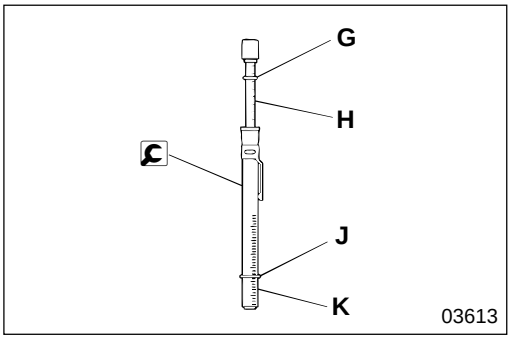
1 **2** **V-belt**

[Inspection]
Measure the extent of flex **A** when the center of V-belts **1**, **2** as illustrated is depressed with a force of approximately 98 N {72 lbf, 10 kgf}.

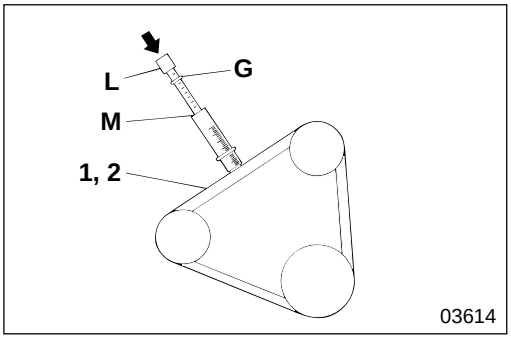
B : Alternator pulley
C : Water pump pulley
D : Tension pulley
E : Cooler compressor pulley
F : Crankshaft pulley



03613

● **Use of special tool belt tension gauge**

- Set upper O-ring **G** of 🔧 belt tension gauge to 98 N {72 lbf, 10 kgf} (push load) on graduation **H**.
- Set lower O-ring **J** of 🔧 belt tension gauge to graduation **K** (maximum flex of belt).



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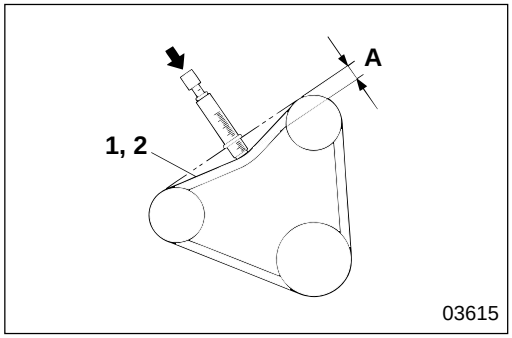
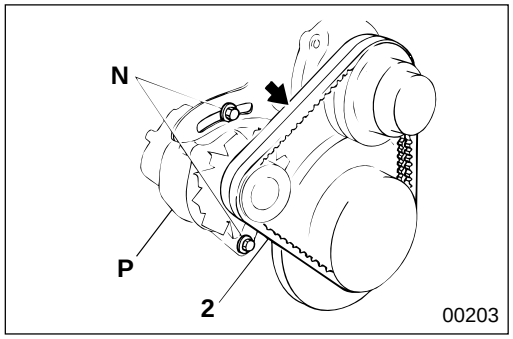
- Place 🔧 belt tension gauge at the center of V-belts **1**, **2** perpendicularly as illustrated and push top **L** all the way down until upper O-ring **G** hits upper edge **M**.



- Measure the extent of flex **A** of V-belts **1**, **2** at this point, and if the measured value deviates from the standard value, adjust as follows.



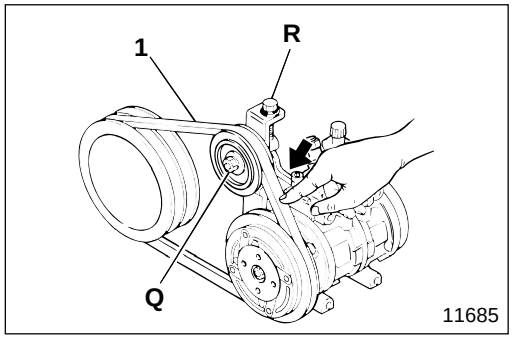
[Adjustment]

(1) Adjustment of V-belt tension for fan

- Loosen alternator mounting bolts **N** (two places), and adjust the tension of V-belts **2** by moving alternator **P** left or right.
- After adjustment, tighten the bolts and nuts securely.

CAUTION⚠

- **Bear in mind that excessive tension of V-belts 2 might damage the belts and bearings that engage with the V-belts.**
- **Be sure to replace V-belts 2 as a set to maintain even tension between them.**
- **Be careful not to let oil stick to V-belts 2, if oil gets onto the belts, it causes slipping, resulting in overheating and insufficient battery charging.**

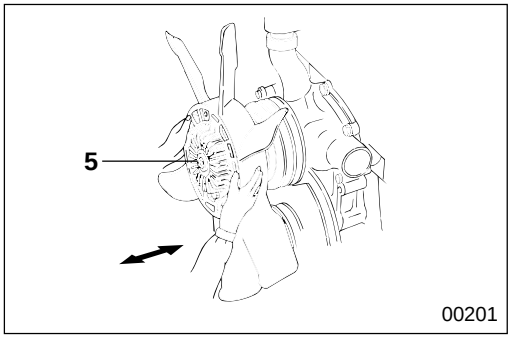


(2) Adjustment of V-belt tension for air-conditioner

- Loosen tension pulley mounting nut **Q**, and adjust the tension of V-belt **1** by adjusting bolt **R**.
- After adjustment, tighten the bolts and nuts securely.

CAUTION⚠

- **Bear in mind that excessive tension of V-belt 1 might damage the belt and bearings that engage with the V-belt.**
- **Be careful not to let oil stick to V-belt 1, if oil gets onto the belt, it causes slipping, resulting in poor performance of the air-conditioner.**

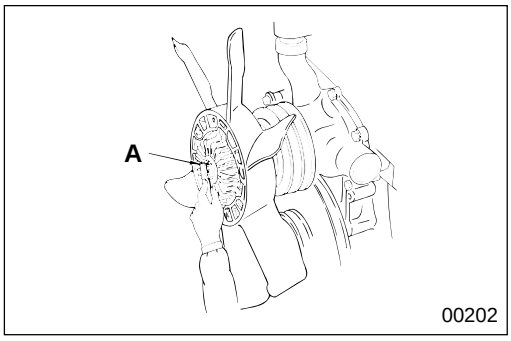


5 Automatic cooling fan coupling

[Inspection]

Carry out the following inspection of automatic cooling fan coupling **5** and if any fault is found, replace the unit.

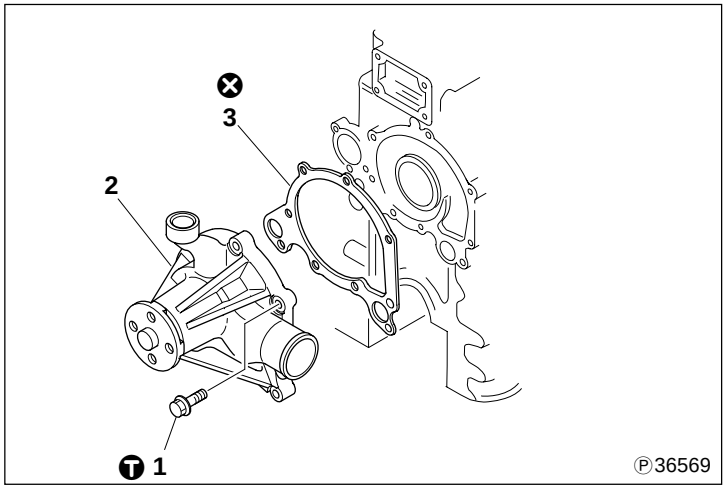
- Check for any leakage of lubricating oil sealed in the coupling body.
- Rotate automatic cooling fan coupling **5** by hand, and check for any irregularity in rotation related to the coupling bearing or any abnormal noise.
- Check for any excessive play of automatic cooling fan coupling **5** in the axial direction when the engine is cool.



[Cleaning]

- If there are any foreign particles sticking to bimetal **A**, remove them by brushing lightly.

WATER PUMP



● **Disassembly sequence**

1 Bolt
2 Water pump assembly
3 Gasket

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

Water pump assembly 2 is an integrated unit type that cannot be disassembled. If the pump is defective, replace the assembly.

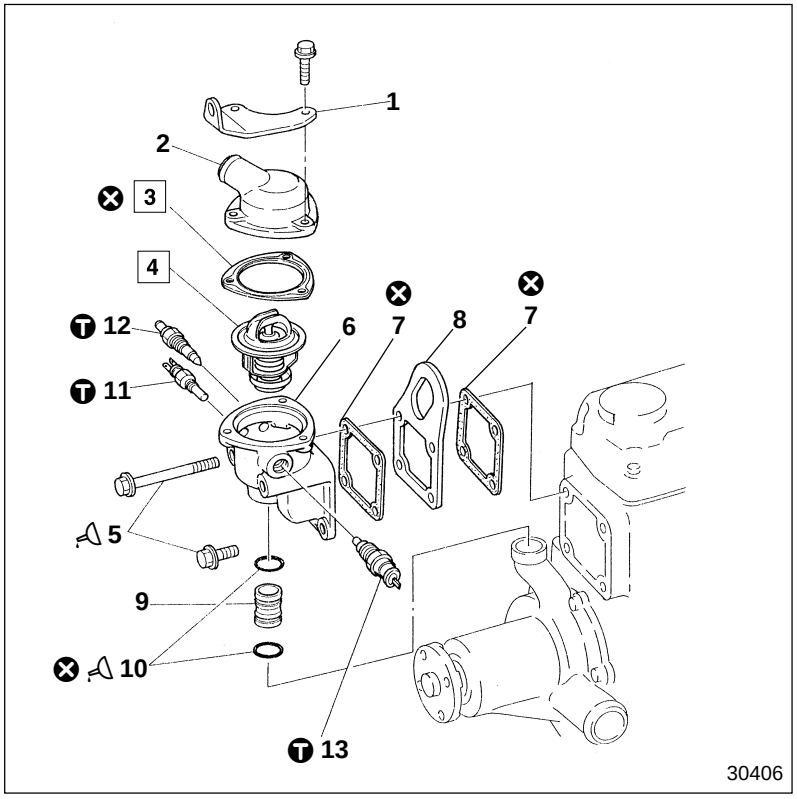
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Water pump assembly mounting)	9.8 {7.2, 1.0}	—

M E M O

THERMOSTAT



● **Disassembly sequence**

1 Fan shroud stay
2 Thermostat cover
3 Thermostat cover gasket
4 Thermostat
5 Bolt
6 Thermostat case
7 Hanger gasket
8 Front hanger
9 Joint
10 O-ring
11 Water temperature sensor (Water temperature gauge and multi-purpose timing control unit) Gr 54
12 Overheating switch Gr 54
13 Water temperature sensor (Pre-stroke control type injection pump) Gr 54

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Do not remove thermostat case 6 and front hanger 8 unless they are faulty, for example: leaking water.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
4	Thermostat	Valve opening temperature	82±2°C {180±3.6°F}	—	Replace
		Extent of valve lift (at 95°C {203°F})	10 {0.39} or more	—	Replace

Ⓣ Tightening torque

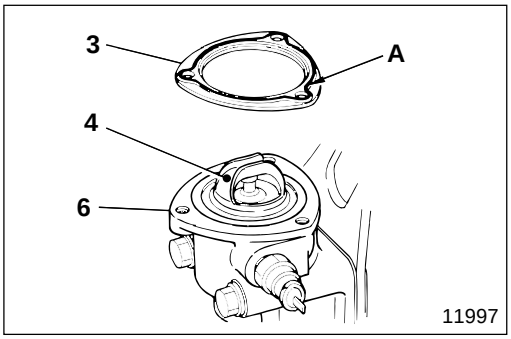
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
11	Water temperature sensor	34±6.9 {25±5.1, 3.5±0.7}	—
12	Overheating switch	27 to 41 {20 to 30, 2.8 to 4.2}	—
13	Water temperature sensor	34±6.9 {25±5.1, 3.5±0.7}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
5	Thread area of bolt (Thermostat mounting)	THREEBOND 2302	As required
10	Periphery of O-ring	Soapy water	As required

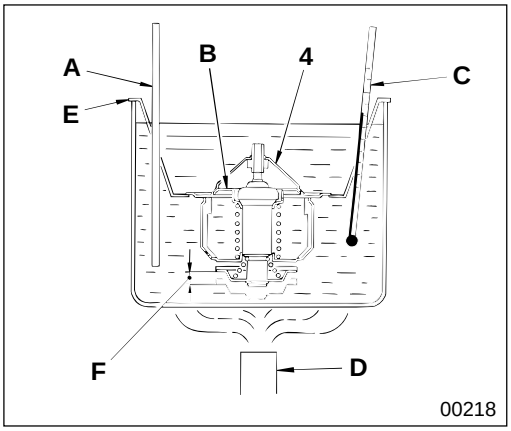
◆ Service procedure



3 Mounting of thermostat cover gasket

Mount thermostat cover gasket **3** on thermostat case **6** in the direction as illustrated.

A : Sealant application surface



4 Thermostat

[Inspection]

Stir the water using stick **A** to maintain an even water temperature in the container, then carry out the following tests. If the measured value deviates from the standard value, replace thermostat **4**.

(1) Valve opening temperature

- Hold thermostat **4** with wire **E** so as not to get the thermostat too close to heat **D**.
- Heat the water gradually to raise the temperature to the valve opening temperature.
- Maintain this temperature for five minutes and make sure that valve **B** has opened.
- Make sure that valve **B** has closed when the water temperature has dropped to 65°C {149°F}.

C : Water temperature gauge

(2) Extent of valve lift

Measure valve lift **F**, while maintaining the water temperature a little higher than the valve opening temperature, with valve **B** fully open for five minutes.

MITSUBISHI
FUSO

Group 15

Intake and Exhaust

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-15

INDEX

SPECIFICATIONS 15- 2

STRUCTURE AND OPERATION 15- 2

TROUBLESHOOTING 15- 6

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Measurement of Turbo Boost Pressure 15- 8

AIR DUCT AND AIR CLEANER 15-10

TURBOCHARGER 15-12

INTERCOOLER 15-24

INTAKE MANIFOLD 15-26

EXHAUST MANIFOLD 15-28

EXHAUST PIPE AND MUFFLER 15-30

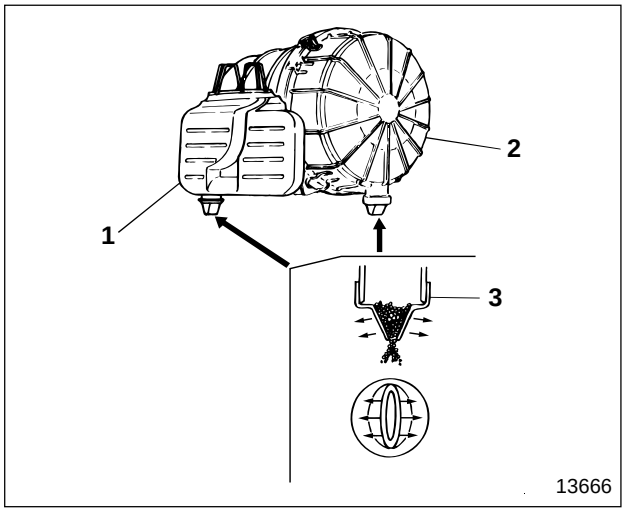
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Items		Specifications
Air cleaner element		Cyclone paper filter type
Turbocharger	Model	TD07
	Manufacturer	MITSUBISHI HEAVY INDUSTRIES
Intercooler type		Air-cooled, tube and corrugated fin type

STRUCTURE AND OPERATION

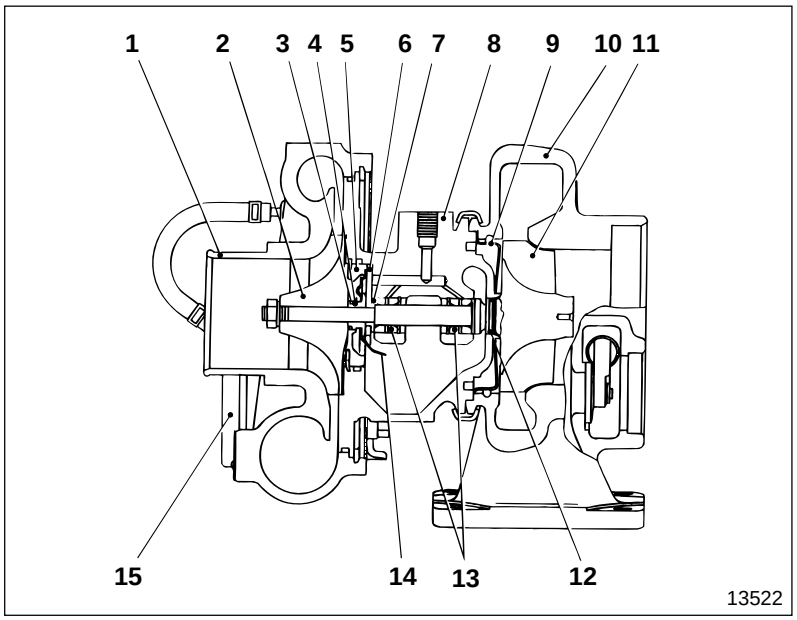
Air Cleaner



1 Air lower duct
2 Air cleaner assembly
3 Evacuator valve

- Air cleaner assembly **2** uses a single element.
- Evacuator valves **3** are fitted with air lower duct **1** and air cleaner assembly **2**.
- Evacuator valves **3** automatically vent dust and dirt by the repercussive force of the rubber of the valve that overcomes the inner negative pressure when the engine revolution falls below the specified revolution.

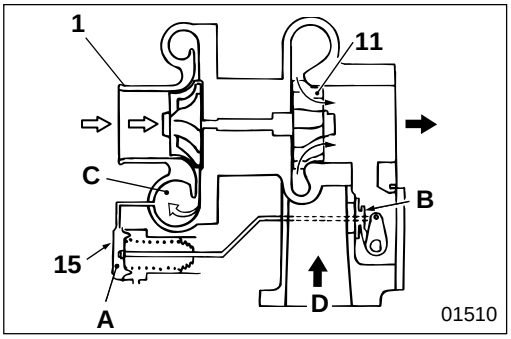
Turbocharger

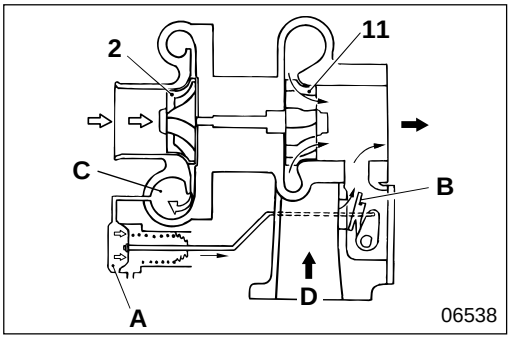


1 Compressor cover
2 Compressor wheel
3 Piston ring
4 Thrust sleeve
5 Insert
6 Thrust bearing
7 Thrust ring
8 Bearing housing
9 Turbine backplate
10 Turbine housing
11 Shaft and turbine wheel
12 Piston ring
13 Bearing
14 Oil deflector
15 Actuator

Waste gate mechanism

- The waste gate mechanism relieves the boost pressure of excess exhaust gas using actuator **15**. This controls the boost pressure appropriately and prevents the turbocharger from overrunning, and prevents excessive pressure in the intake manifold.
- The boost pressure is fed into chamber **A** of actuator **15** from compressor cover **1** via a rubber hose. When boost pressure **C**, acting on chamber **A**, is lower than the preset value, the actuator does not operate and waste gate valve **B** remains closed, therefore exhaust gas **D** is blown against shaft and turbine wheel **11**.

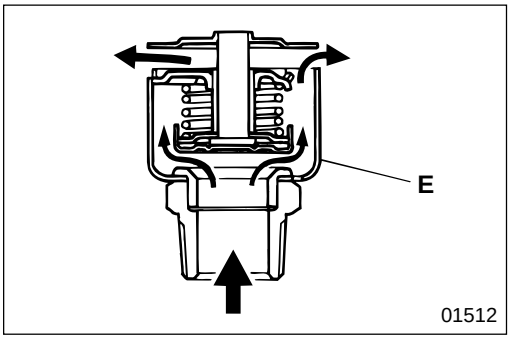




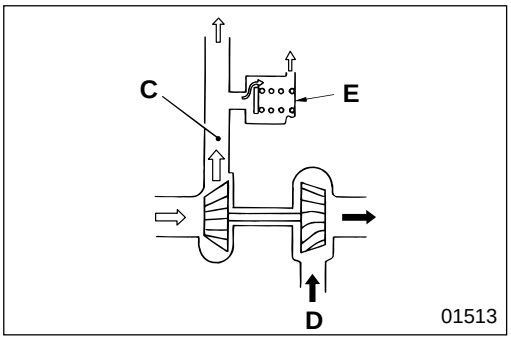
- As the boost pressure acting on chamber **A** increases to become higher than the preset value, waste gate valve **B** is opened and the exhaust gas blown against shaft and turbine wheel **11** decreases. Therefore the rotation of compressor wheel **2** decreases, causing the boost pressure to decrease.

Operation of over-boost valve

- Over-boost valve **E** operates when the boost pressure increases abnormally because of faulty operation of the waste gate mechanism.

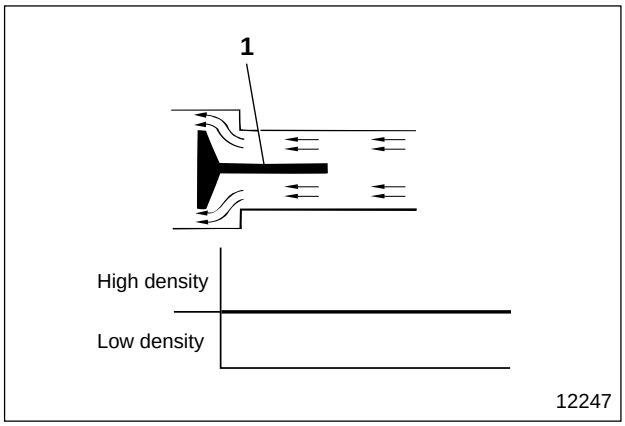


- If boost pressure **C** of over-boost valve **E** increases to become higher than the preset value, the excessive boost pressure is discharged into the atmosphere, protecting the engine from excessive boost pressure. When the valve is operating, a pipe-blowing sound is generated.

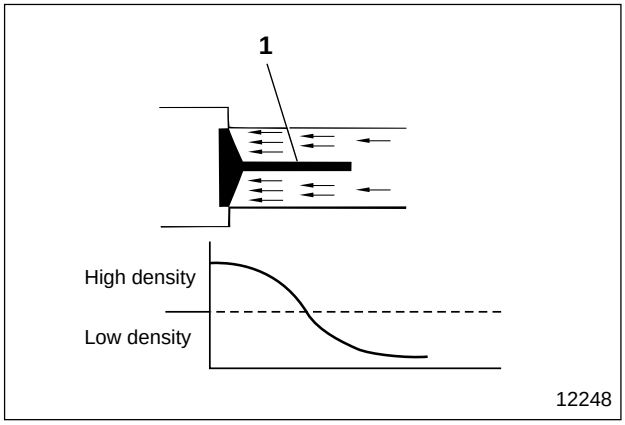


Inertia Supercharger

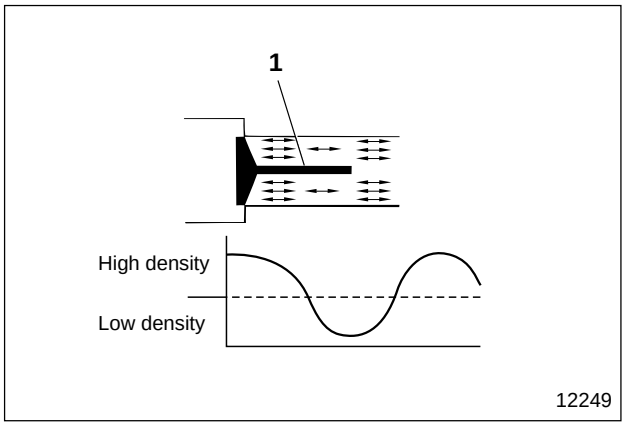
The inertia supercharger increases air intake by using the compressional wave of air generated by the air density in the intake manifold that is created by the inertia force of the air.
This supercharger improves engine performance in the low speed range where the air supply might be lower than necessary.



When inlet valve **1** is open, there is stable air flow in the intake manifold.

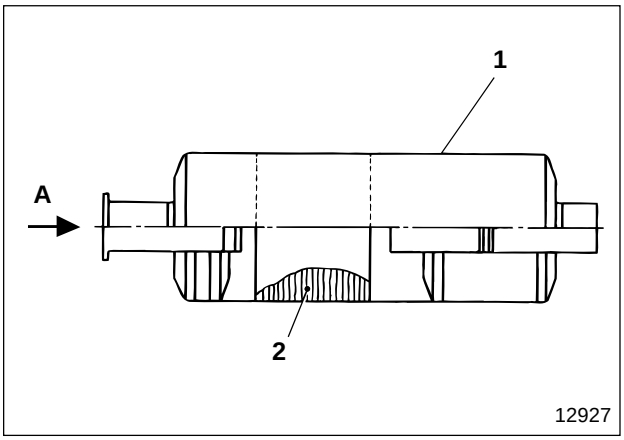


When inlet valve **1** closes and the air flow stops suddenly, the air around the inlet valve is compressed by the inertia force of the air, generating a compressional wave of air in the inlet manifold.



An intake coupler, which is split into two parts, resonates to amplify the compressional wave of air that is generated in each air conduit. When inlet valve **1** opens again, the air flows through an area where the air density is high, thus supplying a large mass of air to the combustion chamber.

Muffler



1 Muffler
2 Catalytic converter

A : Exhaust gas intake

Converter **2** is built into muffler **1** to decrease the amount of particulate matter (PM) in the exhaust gas.

TROUBLESHOOTING

Possible causes / Symptoms		Engine hard to start	Exhaust gas dark	Exhaust gas whitish	Engine output insufficient	Oil consumption excessive	Noise and vibration in intake/exhaust systems	Remarks
Air cleaner	Air cleaner element clogged	○	○		○			
Turbocharger	Bearing faulty		○		○		○	
	Carbon deposits on shaft and turbine wheel		○		○			
	Shaft and turbine wheel interfering with turbine backplate		○		○			
	Shaft and turbine wheel interfering with turbine housing		○		○			
	Shaft and turbine wheel bent		○		○		○	
	Shaft and turbine wheel broken		○		○		○	
	Compressor wheel interfering with compressor cover		○		○			
	Thrust sleeve and thrust bearing seized		○		○		○	
	Compressor wheel broken		○		○		○	
	Engine oil leaking because piston ring and inserter worn		○	○		○		
	Piston rings installation faulty					○		
	Parts not sliding smoothly because oil lubrication pipe and eye bolt clogged		○		○			
	Oil seals damaged because oil return pipe clogged			○		○		
	Compressor cover installation faulty		○		○	○	○	
	Turbine housing installation faulty				○		○	
Intercooler	Foreign particles on intercooler front core				○			
Front pipe, muffler and tail pipe deformed							○	
Front pipe, muffler and tail pipe installation faulty							○	
Valve clearance faulty			○					Gr 11
Head gasket faulty			○					Gr 11
Valve and valve seat worn and carbon deposits			○					Gr 11
Valve spring fatigued			○					Gr 11
Piston ring worn and damaged			○					Gr 11
Piston ring groove worn and damaged			○					Gr 11
Cooling system malfunctioning			○					Gr 14
Engine oil excessive			○					Gr 12
Main moving parts seized			○					Gr 11
Fuel injection quantity uneven or excessive			○					Gr 13

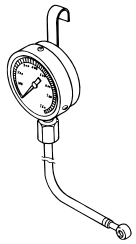
M E M O

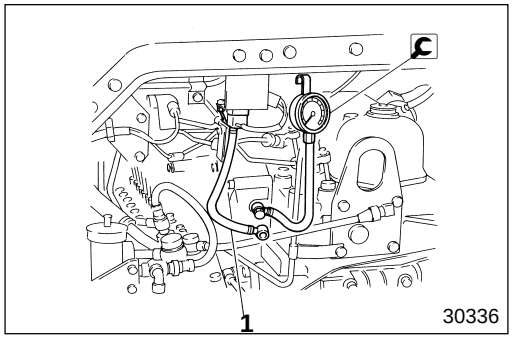
Measurement of Turbo Boost Pressure

Service standards

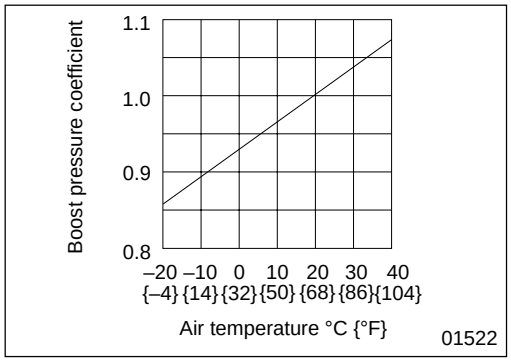
Location	Maintenance item		Standard value	Limit	Remedy
—	Boost pressure (Air temperature 20°C {68°F}, Atmospheric pressure 100 kPa {29.9 in. Hg, 760 mmHg})	6D16T2	—	38 kPa {11 in. Hg, 280 mmHg}/ 3200 rpm	Inspect and adjust
		6D16T3	—	40 kPa {11.8 in. Hg, 300 mm Hg} / 3275rpm	Inspect and adjust

Special tools

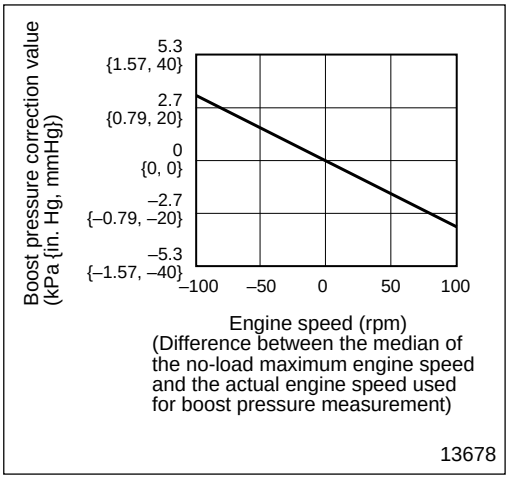
Location	Tool name and shape	Part No.	Application
—	Boost pressure gauge  01524	MH061366	Measurement of turbo boost pressure



- Before measuring the turbo boost pressure, clean or replace the air cleaner element.
- Remove boost compensator hose **1** and attach boost pressure gauge.
- After warming up the engine, measure the boost pressure at the no-load maximum engine speed. Also measure the engine speed and the air temperature.



- Correct the boost pressure at standard conditions. (Since the boost pressure varies depending on the air temperature and engine speed.)
  [Correction for air temperature]
  Identify boost pressure coefficient depending on the air temperature from the graph.



[Correction for engine speed]
Subtract the engine speed actually used for measuring the boost pressure from the median of the no-load maximum engine speed. Identify the boost pressure correction value (**Pa**) according to the graph.

Median value : 3200 rpm < 6D16T2 >
3275 rpm < 6D16T3 >

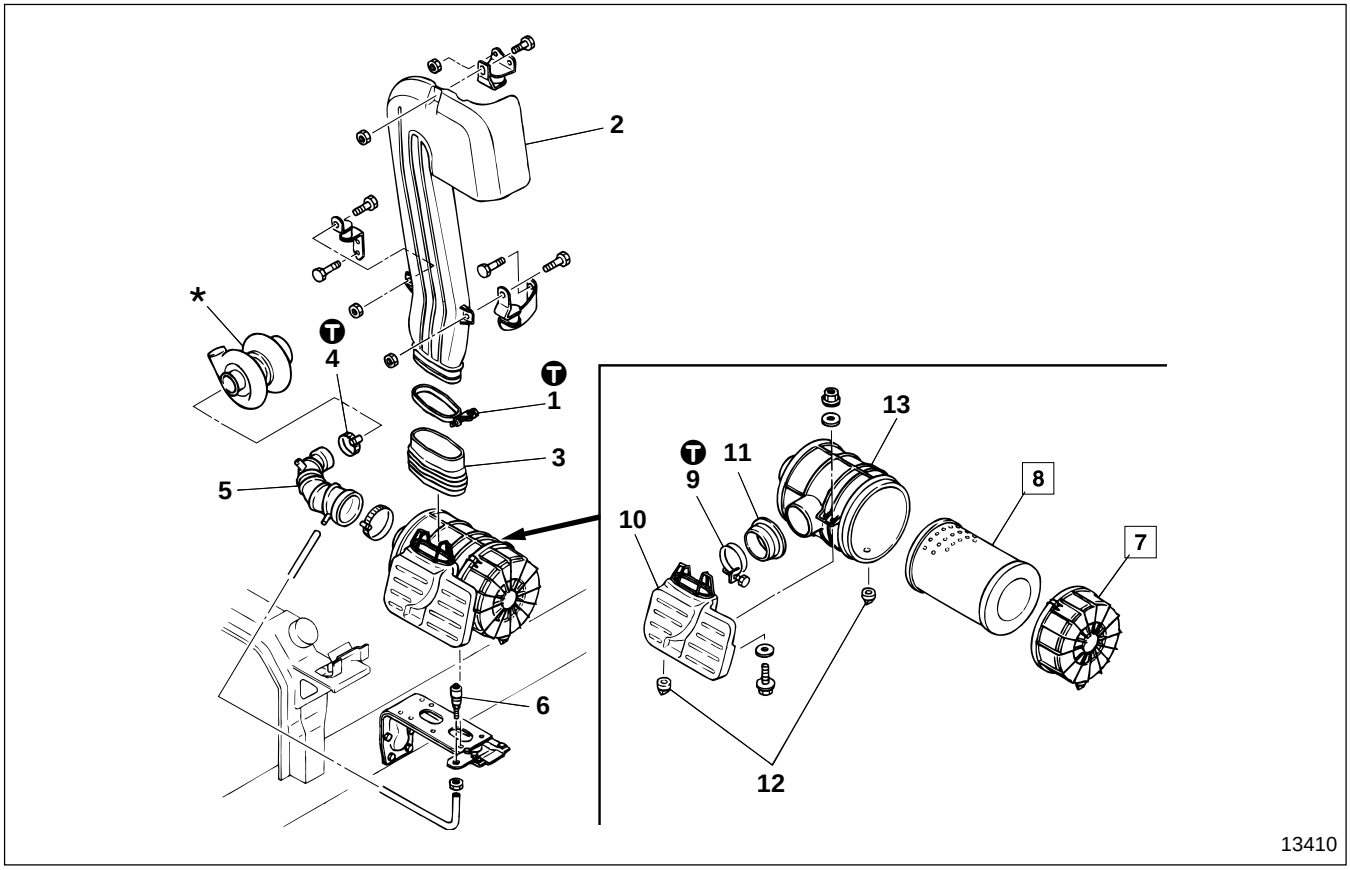
[Calculation of corrected boost pressure]
Given the measured boost pressure to be **P**, corrected boost pressure **Pb** can be calculated from the following equation:

Pb = ktP + Pa

- **Pb** : Corrected boost pressure
- **P** : Measured boost pressure
- **kt** : Boost pressure correcting coefficient depending on air temperature
- **Pa** : Boost pressure correction value

If **Pb** is lower than the limit, the turbocharger must be inspected and adjusted.

AIR DUCT AND AIR CLEANER



● **Disassembly sequence**

1 Clamp
2 Air upper duct
3 Rubber boot
4 Clamp
5 Air intake hose
6 Dust indicator
7 Cover
8 Element
9 Clamp
10 Air lower duct
11 Adaptor
12 Evacuator valve
13 Body

***** : Turbocharger 📖 P15-12

● **Assembly sequence**

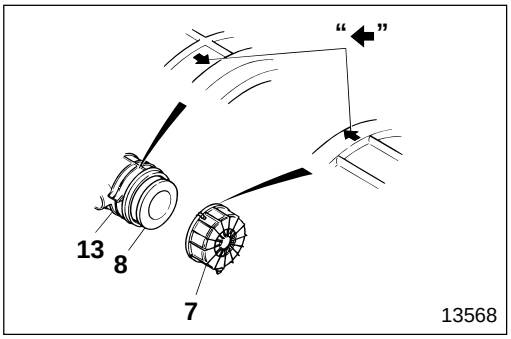
Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

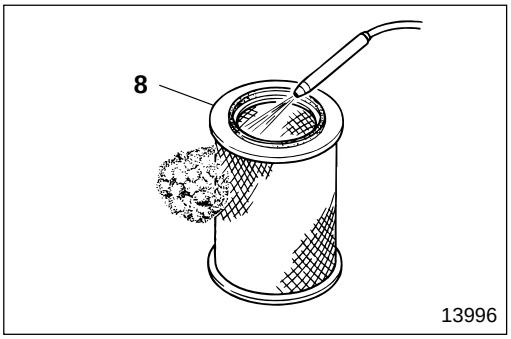
Location	Parts to be tightened	Tightening torque	Remarks
1, 4	Clamp	2.9 to 3.4 {2.17 to 2.53, 0.3 to 0.35}	—
9	Clamp	3.9 to 4.9 {2.9 to 3.6, 0.4 to 0.5}	—

◆ Service procedure



7 **Installation of cover**

➡ : Alignment mark



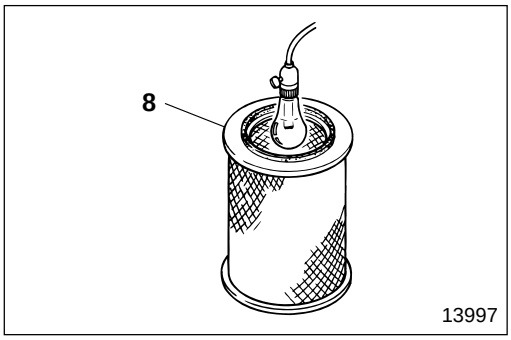
8 **Element**

[Cleaning]

- Blow compressed air of 685 kPa {100 psi, 7 kgf/cm^2} or less through element **8** from the inside.
- When using compressed air, move the blower's nozzle up and down along the pleats of element **8** evenly.

CAUTION ⚠

- **Do not tap or hit element 8 to remove dust.**
- **Do not blow compressed air through element 8 from the outside.**



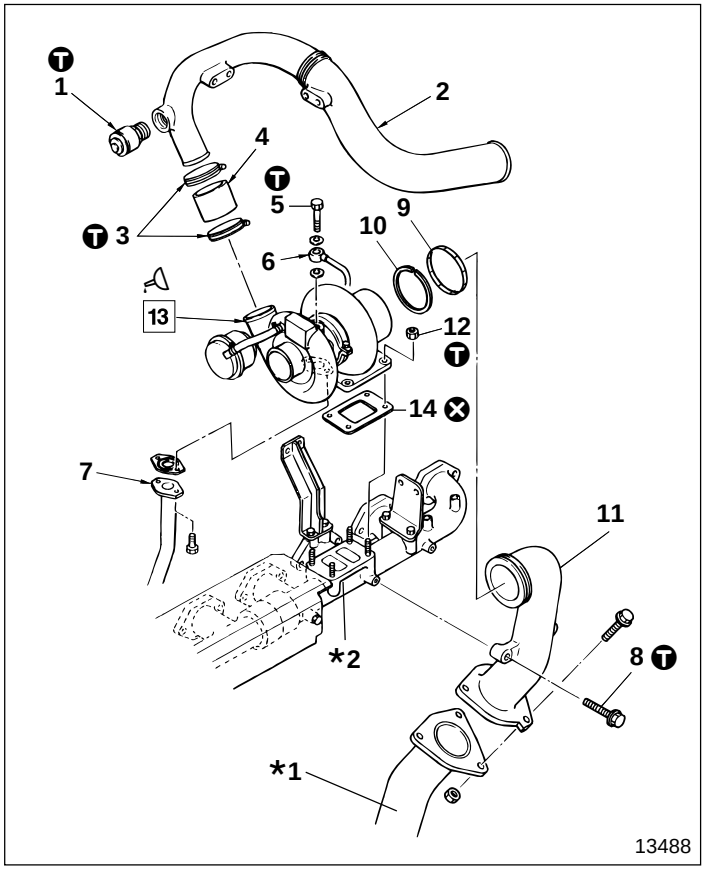
[Inspection]

- Illuminate the inside of element **8**.
- If parts of the filter paper are torn or thin, or if the packing of the upper surface of element **8** is damaged, replace the element.

NOTE

If the dust on element 8 is wet due to oil smoke or soot, replace the air cleaner regardless of the scheduled replacement interval.

TURBOCHARGER



● **Disassembly sequence**

1 Over-boost valve
2 Air inlet pipe
3 Clamp
4 Rubber hose
5 Eye bolt
6 Oil pipe
7 Oil return pipe
8 Bolt
9 Expansion ring
10 Seal ring
11 Exhaust pipe
12 Nut
13 Turbocharger assembly 📖 P15-14
14 Gasket

***1** : Front pipe 📖 P15-30
***2** : Exhaust manifold 📖 P15-28
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

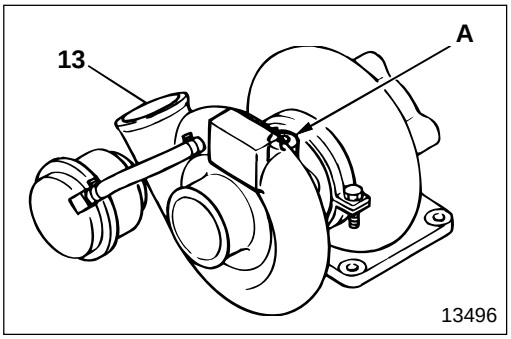
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Over-boost valve	49 {36, 5}	—
3	Clamp	4.9 {3.6, 0.5}	—
5	Eye bolt	21 {15, 2.1}	—
8	Bolt	53 {39, 5.4}	—
12	Nut	41 {30, 4.2}	—

Lubricant

Location	Points of application	Kinds	Quantity
13	Supply when installing turbocharger assembly	Engine oil	As required



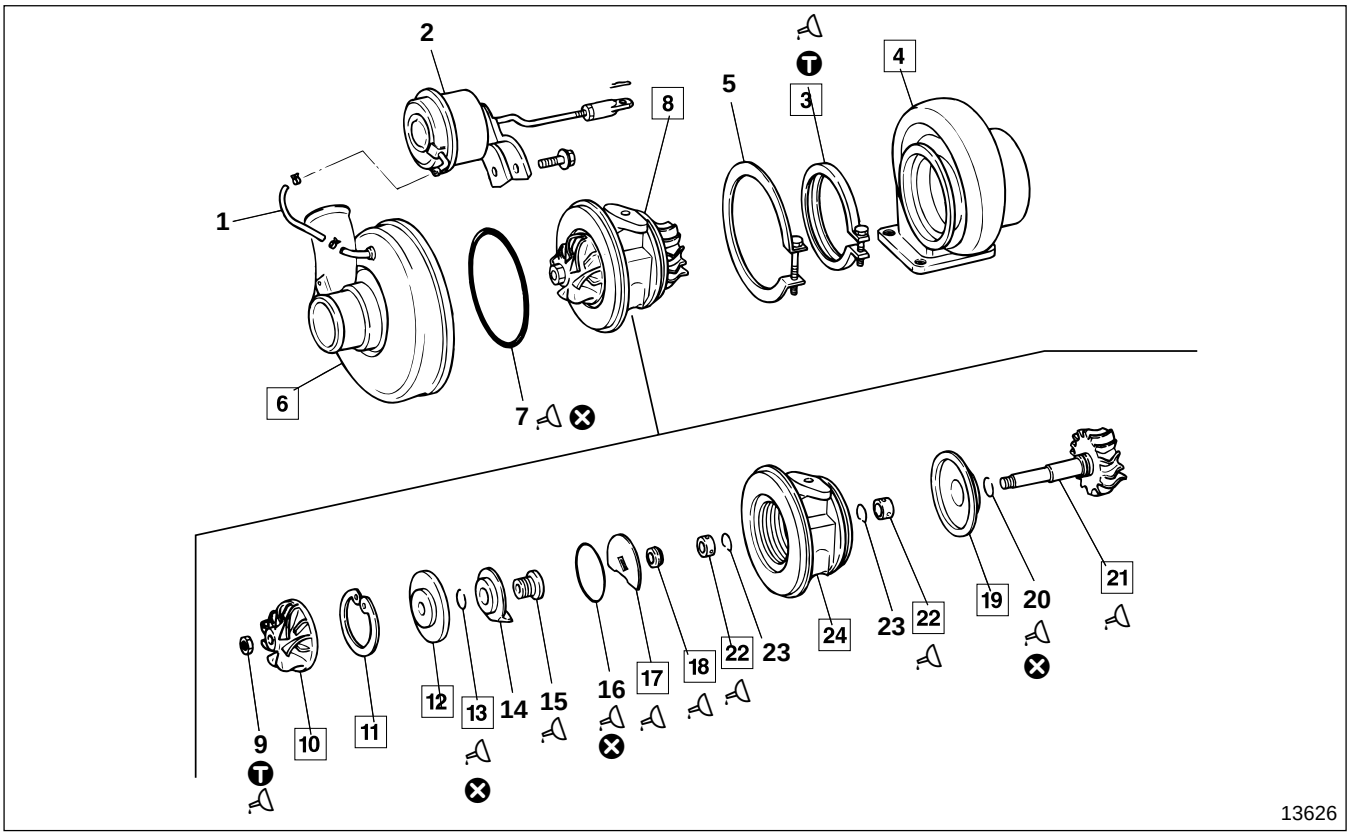
◆ Service procedure

13 **Installation of turbocharger assembly**

When installing turbocharger assembly **13**, prelubricate via oil port **A** as required to make parts move smoothly.

TURBOCHARGER

Turbocharger Assembly



● **Work before disassembly**

P15-16

● **Disassembly sequence**

1 Hose
2 Actuator
3 Coupling assembly
4 Turbine housing
5 Snap ring
6 Compressor cover
7 O-ring
8 Wheel and bearing housing assembly
9 Lock nut
10 Compressor wheel
11 Snap ring
12 Insert
13 Piston ring
14 Oil deflector
15 Thrust sleeve
16 O-ring
17 Thrust bearing
18 Thrust ring
19 Turbine backplate
20 Piston ring
21 Shaft and turbine wheel
22 Bearing
23 Snap ring
24 Bearing housing

⊗ : Non-reusable parts

● **Assembly sequence**

24→23→22
21→20→19
→16
18→17
→11→10→9→8→7→6→5→4→3→2→1
15→14→13→12

● **Inspection after assembly**

P15-17

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
4, 21	Clearance between turbine housing and shaft and turbine wheel		0.39 to 1.0 {0.015 to 0.039}	—	Disassemble
6, 8	Clearance between wheel and bearing housing assembly and compressor cover		0.08 to 0.28 {0.0031 to 0.011}	—	Disassemble
8	Wheel and bearing housing assembly	Play in shaft direction	0.075 to 0.155 {0.0030 to 0.0061}	—	Disassemble
		Clearance between turbine backplate and shaft and turbine wheel rear side	0.48 to 0.92 {0.019 to 0.036}	—	Disassemble
12, 13	Clearance of piston ring splits		0.05 to 0.25 {0.0020 to 0.0098}	—	Replace insert
21	Shaft and turbine wheel	Bend of shaft	0.015 {0.00059}	—	Replace
		Outer diameter of journal	—	11.996 {0.472}	Replace
22	Bearing	Outer diameter	—	20.382 {0.802}	Replace
		Inner diameter	—	12.042 {0.472}	Replace
		Length	—	11.94 {0.474}	Replace
24	Inner diameter of bearing installation area of bearing housing		—	20.506 {0.807}	Replace

Tightening torque

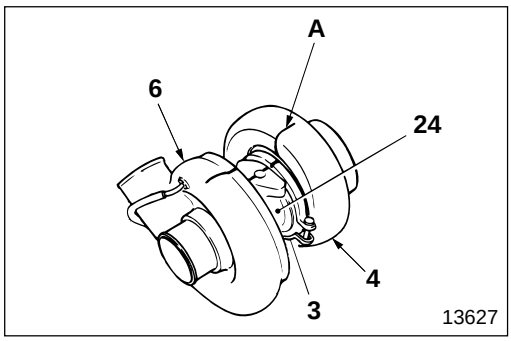
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Coupling assembly	4.9 to 6.9 {3.6 to 5.1, 0.5 to 0.7}	—
9	Lock nut	12 to 14 {8.7 to 10, 1.2 to 1.4}	—

Lubricant

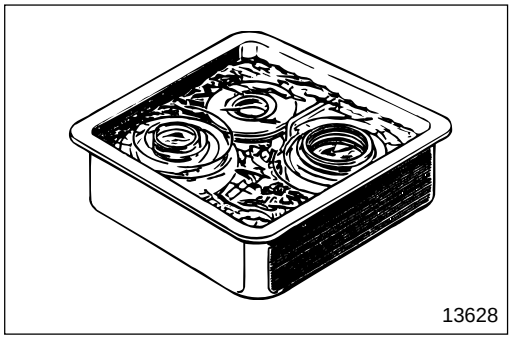
Location	Points of application	Kinds	Quantity
3	Thread area of bolt of coupling assembly	Molybdenum disulfide grease	As required
7, 13, 15, 16, 17, 18, 20, 21, 22	Respective parts	Engine oil	As required
9	Thread area of lock nut	Molybdenum disulfide grease	As required

◆ Service procedure



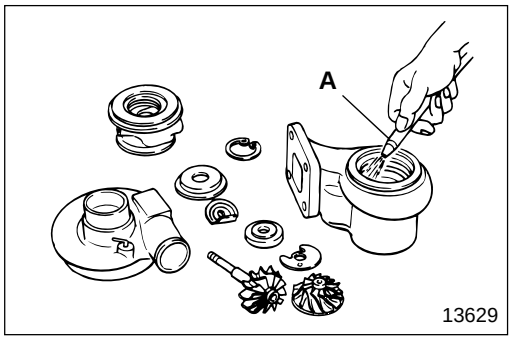
● Work before disassembly

Put alignment marks **A** on coupling assembly **3**, turbine housing **4**, compressor cover **6** and bearing housing **24**.

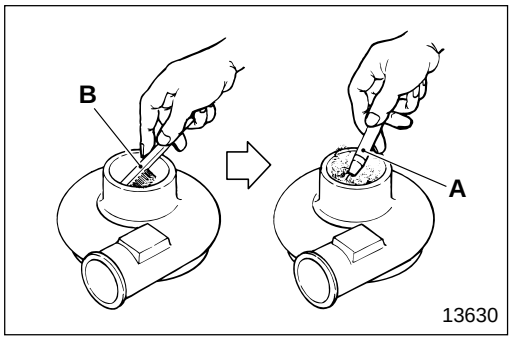


● Cleaning after disassembly

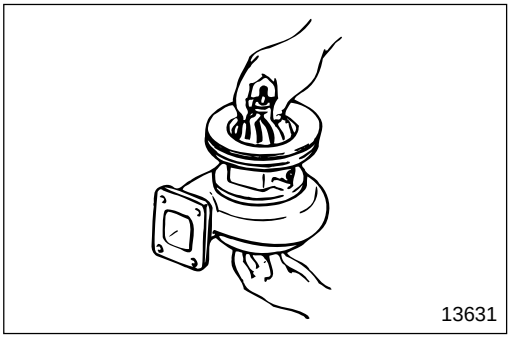
- Visually inspect related parts before cleaning to check if there are any burns or scratches as these would not be seen after cleaning. If any fault is found, replace the faulty parts.
- Immerse the disassembled parts in a nonflammable solvent (DAIDO KAGAKU KOGYO DAICLEANER T-30).



- Take the parts out and blow compressed air **A** on them.

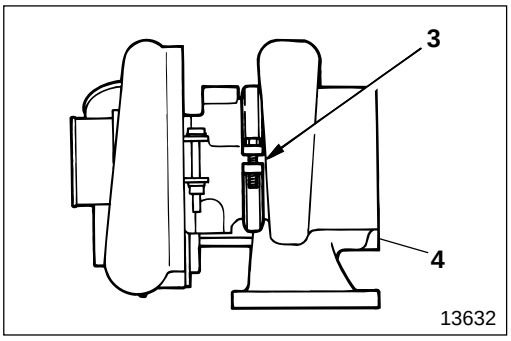


- Scrape foreign particles off.
  B : Plastic scraper or bristle-headed brush
- Immerse the parts again in the solvent.
- Blow compressed air **A** on them.


13631

● **Inspection after assembly**

Turn turbine wheel **21** and compressor wheel **10** to make sure that they turn smoothly.



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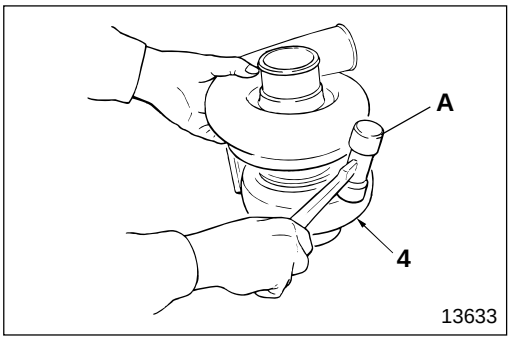
3 **Installation of coupling assembly**

Install coupling assembly **3** to turbine housing **4** in the direction as illustrated.



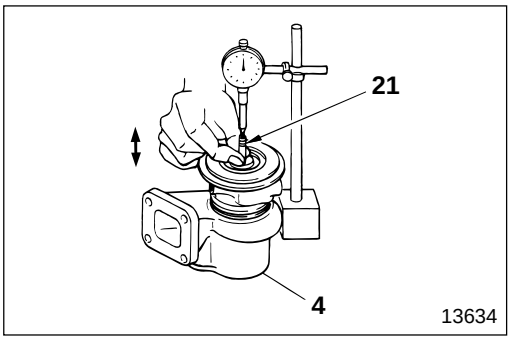
13633

4 **Removal of turbine housing**

A : Rubber-headed hammer

CAUTION

- **When removing turbine housing 4, tap all around the circumference lightly using rubber-headed hammer A so as not to damage the turbine housing.**
- **Do not hit the turbine wheel near turbine housing 4, since the blade of shaft and turbine wheel 21 can be easily bent.**



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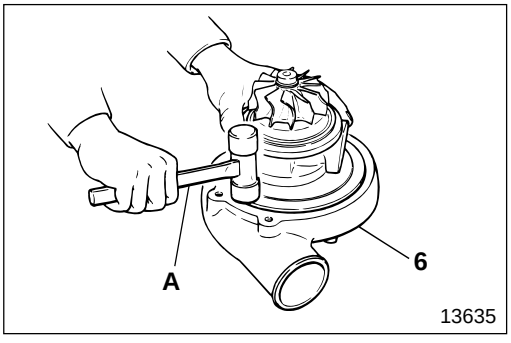
4 **21** **Inspection of clearance between turbine housing and shaft and turbine wheel**

If the measured value deviates from the standard value, disassemble and determine the cause.



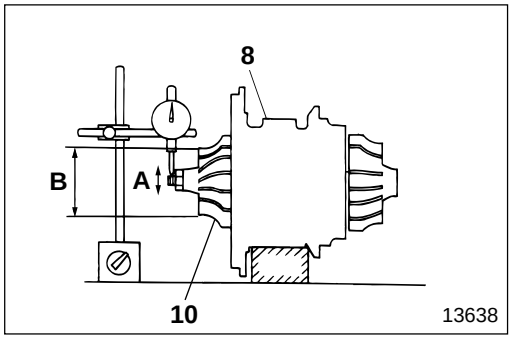
13635

6 **Removal of compressor cover**

A : Rubber-headed hammer

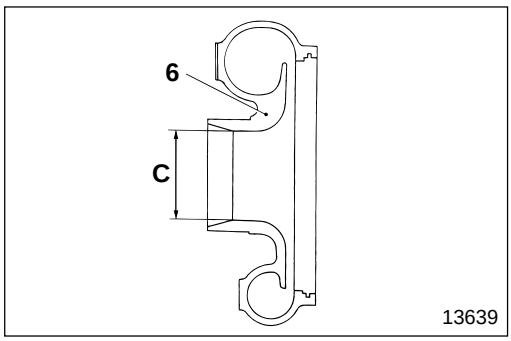
CAUTION

- **When removing compressor cover 6, tap all around the circumference lightly so as not to damage the compressor cover.**
- **Avoid hitting compressor wheel 10 near compressor cover 6, since the blade of the compressor wheel can be easily bent.**



6 **8** **Inspection of clearance between wheel and bearing housing assembly and compressor cover**

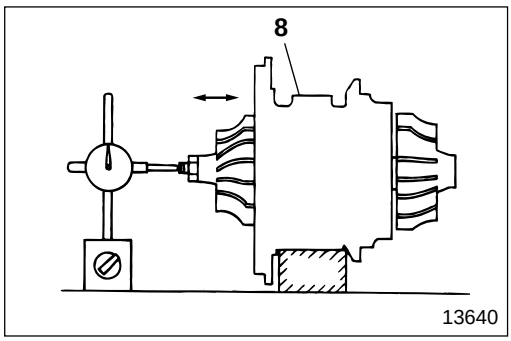
- Measure deflection **A**.
- Measure outer diameter **B** of compressor wheel **10**.



- Measure inner diameter **C** of compressor cover **6**.
- Calculate the clearance between wheel and bearing housing assembly **8** and compressor cover **6** using the following equation.

$$\text{Clearance} = \frac{\mathbf{C} - \mathbf{B} - \mathbf{A}}{2}$$

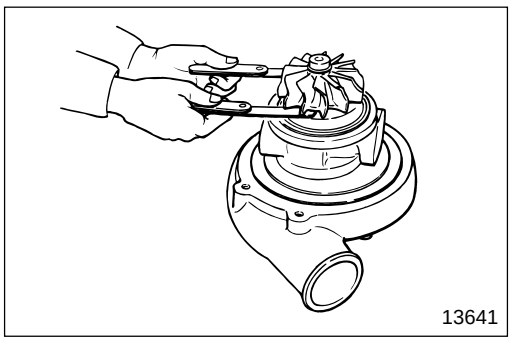
- If the calculated clearance deviates from the standard value, disassemble and determine the cause.



8 **Inspection of wheel and bearing housing assembly**

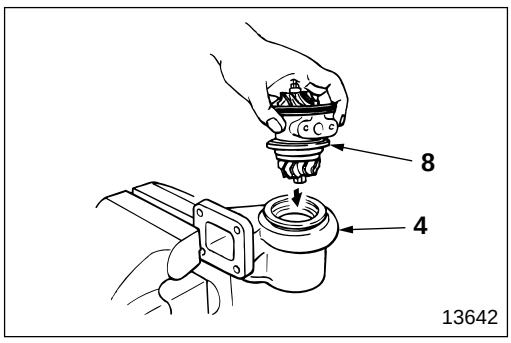
(1) Play in the shaft direction

If the measured value deviates from the standard value, disassemble and determine the cause.



(2) Clearance between turbine backplate and shaft and turbine wheel rear side.

- Measure using the tip of two feeler gauge blades.
- If the measured value deviates from the standard value, disassemble and determine the cause.



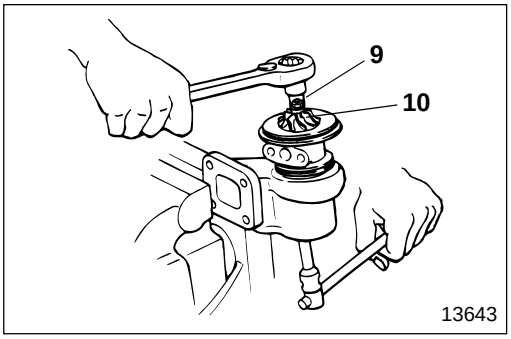
10 **Compressor wheel**

[Removal]

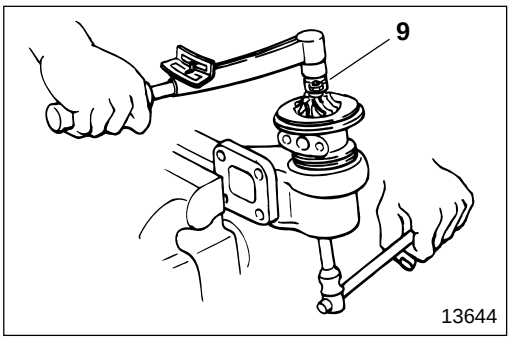
- Install wheel and bearing housing assembly **8** in turbine housing **4**.

CAUTION

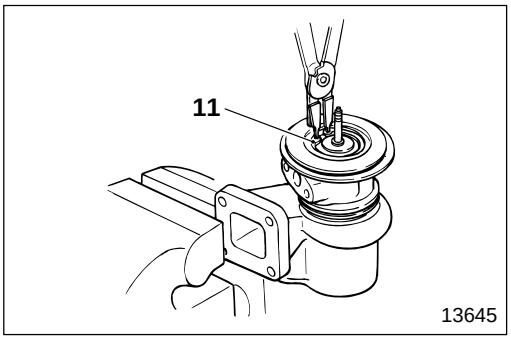
Avoid hitting shaft and turbine wheel 21 near turbine housing 4, since the blade of the shaft and turbine wheel can be easily bent.



- Remove lock nut **9** while holding the boss of shaft and turbine wheel **21**.



[Installation]
Tighten lock nut **9** at specified torque while holding the boss of shaft and turbine wheel **21**.

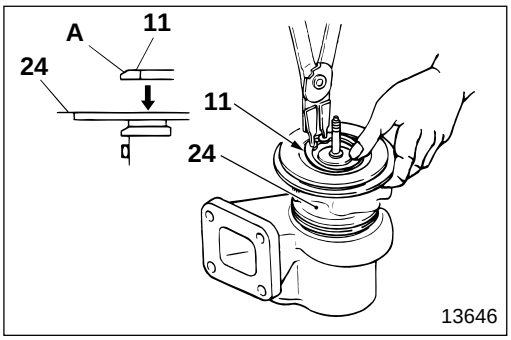


11 **Snap ring**

[Removal]

WARNING

When removing snap ring 11, hold it with your hand to prevent it from springing out.

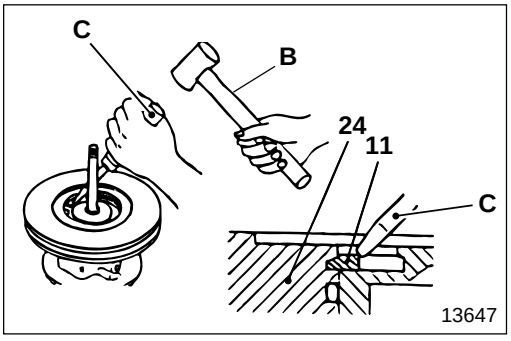


[Installation]

- Install snap ring **11** onto bearing housing **24** in the direction as illustrated.
  A : Tapered surface

WARNING

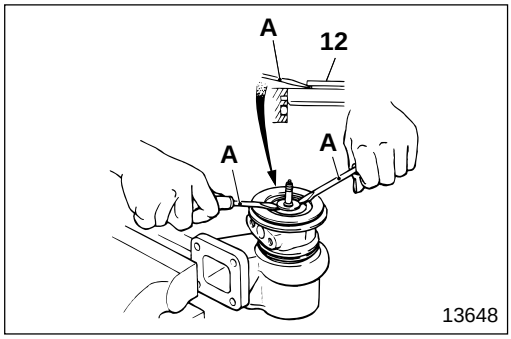
When installing snap ring 11, hold it with your hand to prevent it from springing out.



- Install so that snap ring **11** fits into the groove of bearing housing **24** fully.
  B : Mallet
  C : Screwdriver

CAUTION

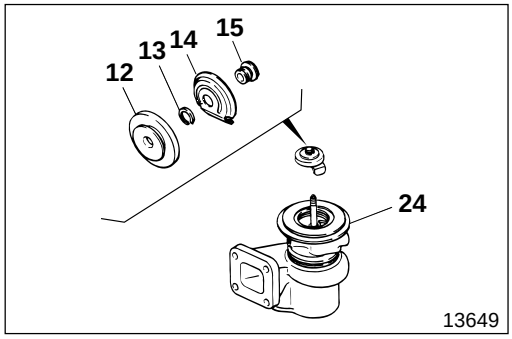
Make sure you do not hit bearing housing 24 with screwdriver C.



12 **Insert**

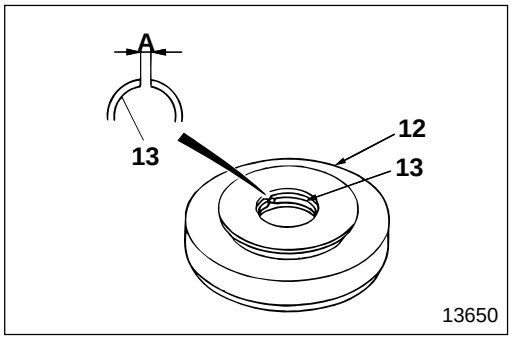
[Removal]

A : Screwdriver



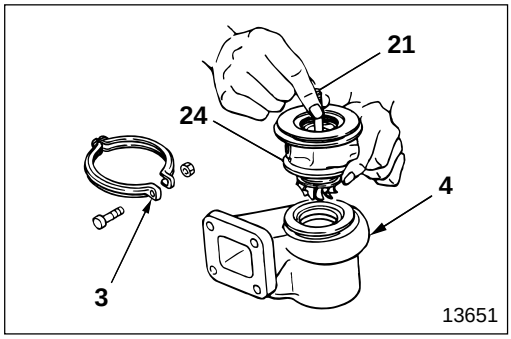
[Installation]

Install oil deflector **14** onto bearing housing **24** in the direction as illustrated.



13 **Inspection of clearance of piston ring split**

- Install new piston ring **13** in insert **12**.
- Measure clearance **A** of the split of piston ring **13**.
- If the measured value deviates from the standard value, replace inserter **12**.

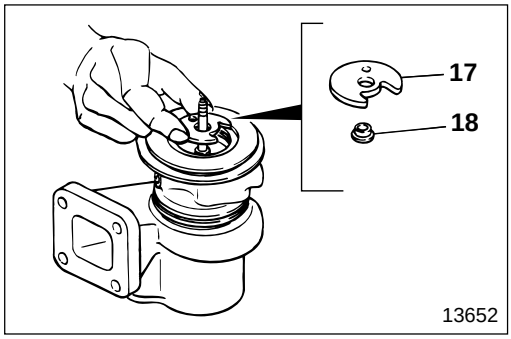


17 **18** **Installation of thrust bearing and thrust ring**

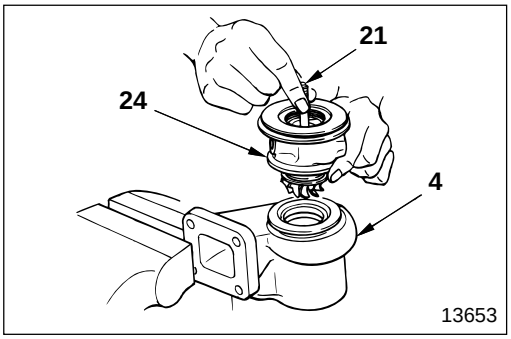
- Install parts **19** to **23** into bearing housing **24**.
- Hold shaft and turbine wheel **21** and bearing housing **24** with your hand and install them in turbine housing **4**.
- Fix temporarily using coupling assembly **3**.

CAUTION

- **Avoid hitting shaft and turbine wheel 21 near turbine housing 4, since the blade of the shaft and turbine wheel can be easily bent.**
- **Do not drop shaft and turbine housing 21.**



- Install thrust bearing **17** and thrust ring **18** so that the thrust bearing faces the direction as illustrated.

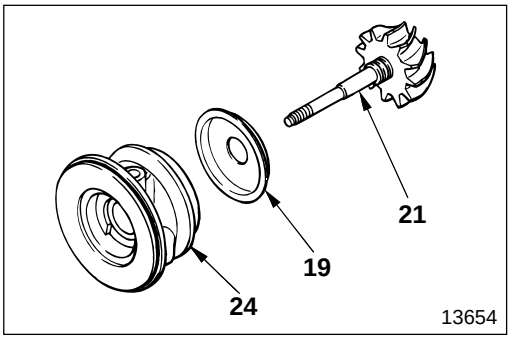


19 Removal of turbine backplate

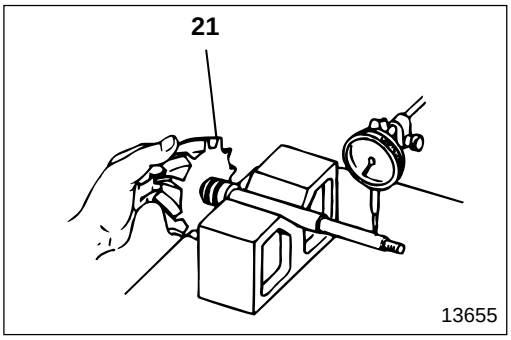
- Hold shaft and turbine wheel **21** and bearing housing **24** with your hand and remove them from turbine housing **4**.

CAUTION

- **Avoid hitting shaft and turbine wheel 21 near turbine housing 4, since the blade of the shaft and turbine wheel can be easily bent.**
- **Do not drop shaft and turbine housing 21.**



- Remove turbine backplate **19**.

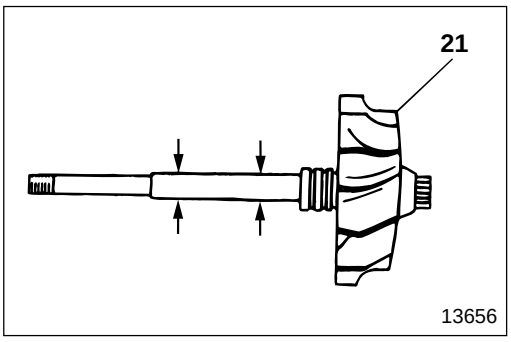


21 Shaft and turbine wheel

[Inspection]

(1) Bend of shaft

- Measure the bend at the position as illustrated.
- If the measured value is higher than the limit, replace shaft and turbine wheel **21**.



(2) Outer diameter of journal

If the measured value is lower than the limit, replace shaft and turbine wheel **21**.

(3) Smoothness of journal

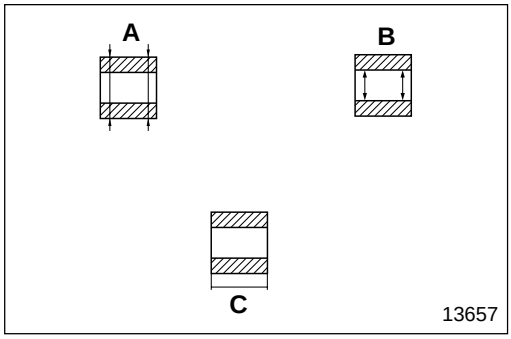
If the journal is rough, correct it.

[Correction]

- Mount shaft and turbine wheel **21** between two centers on a lathe.
- Polish the journal softly with emery paper (400 grit) and engine oil.

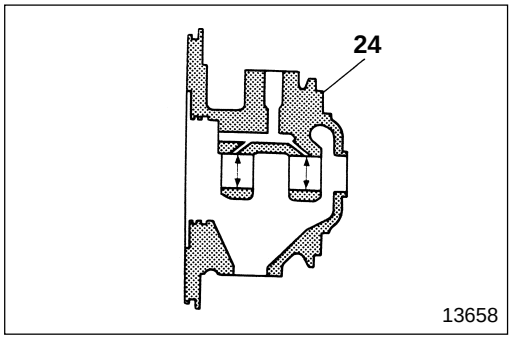
CAUTION

Be sure to measure the outer diameter of the journal after polishing it.



22 **Inspection of bearing**

- Measure at three points as illustrated.
  A : Outer diameter
  B : Inner diameter
  C : Length
- If the measured value of the inner diameter is higher than the limit, or if the outer diameter or the length is lower than the limit, replace bearing **22**.

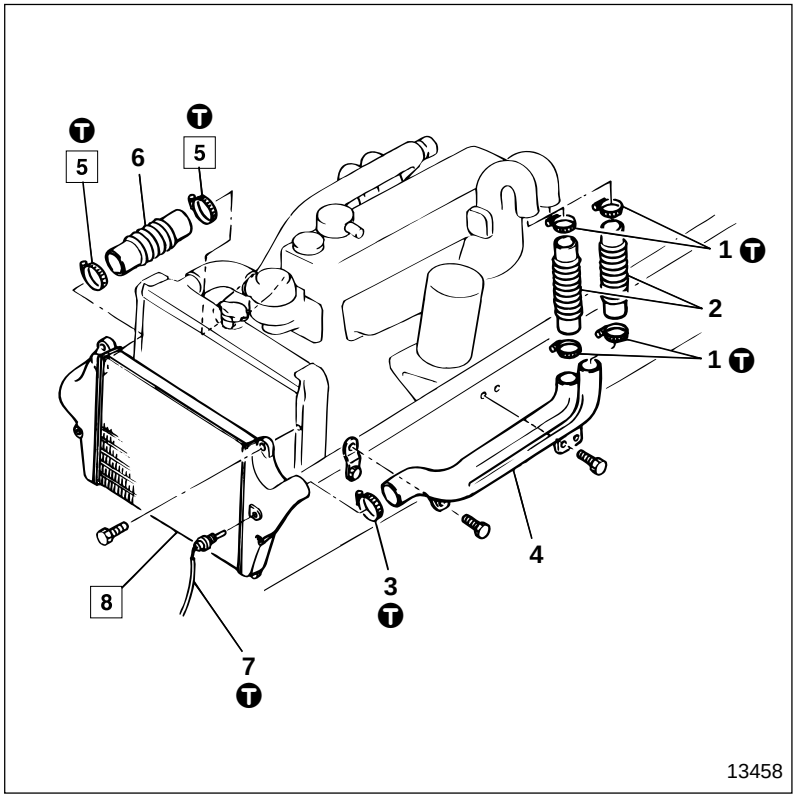


24 **Inspection of bearing housing**

- Measure the inner diameter of bearing **22** installation area.
- If the measured value is higher than the limit, replace bearing housing **24**.

M E M O

INTERCOOLER



● **Disassembly sequence**

1 Clamp
2 Air inlet hose
3 Clamp
4 Air inlet pipe
5 Clamp
6 Air inlet hose
7 Boost air temperature sensor Gr 13
8 Intercooler

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

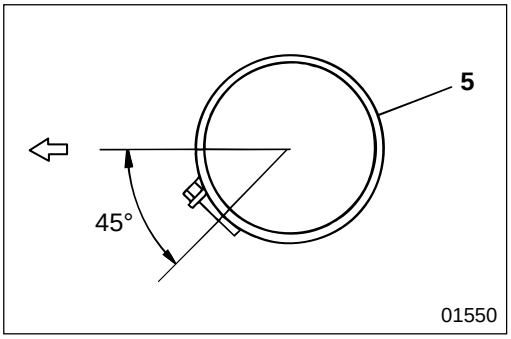
Location	Maintenance item	Standard value	Limit	Remedy
8	Air leakage from intercooler (Air pressure : 195 kPa {28 psi, 2.0 kgf/cm^2})	0 cm^3 {0 cu. in.}	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

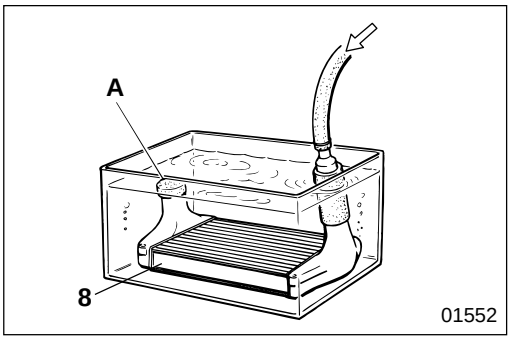
Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5	Clamp (Air inlet hose and inlet duct mounting)	4.9 to 9.8 {3.6 to 7.2, 0.5 to 1.0}	—
7	Boost air temperature sensor	14.7±2 {11±1.4, 1.5±0.2}	—

◆ Service procedure



5 **Installation of clamp**

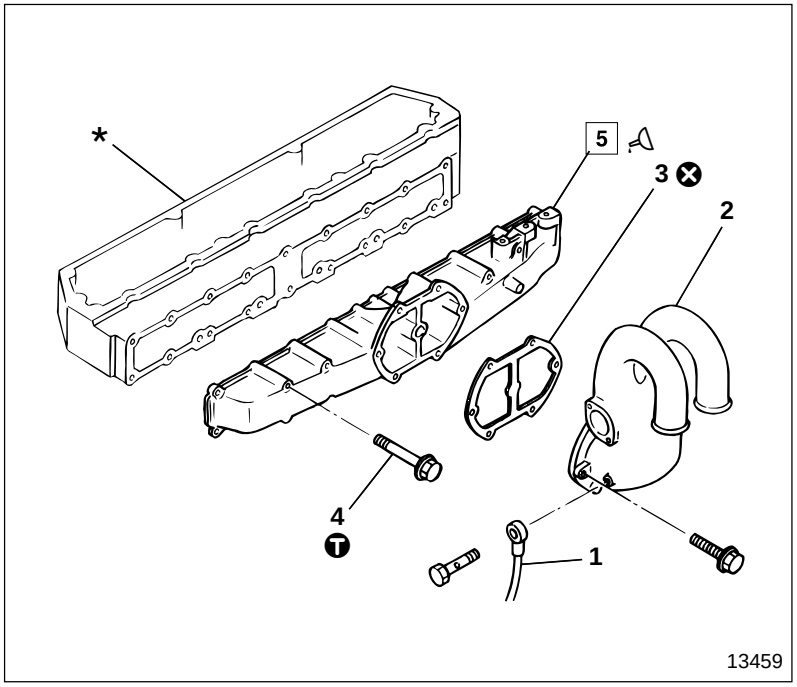
Install clamp **5** so that it faces the direction as illustrated when viewed from the front of the engine.



8 **Inspection of intercooler**

- Fit plug **A** on one of the air inlets of intercooler **8** and connect a hose to the other, then lower the intercooler into the water tank. Apply air at the specified pressure (195 kPa {28 psi, 2.0 kgf/cm^2}) from the hose side and check for air leaks.
- If air leaks, replace intercooler **8**.

INTAKE MANIFOLD



● **Disassembly sequence**

1 Boost compensator hose
2 Coupler assembly
3 Gasket
4 Bolt
5 Intake manifold

* : Cylinder head Gr 11
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

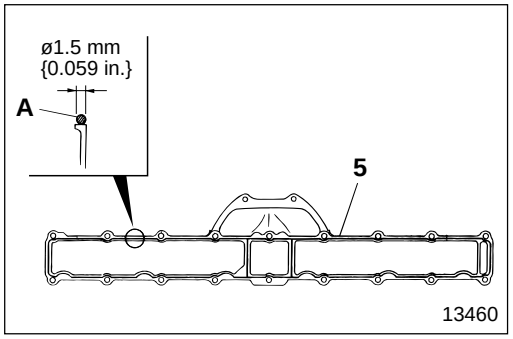
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Bolt (Intake manifold mounting)	23 {17, 2.37}	—

Sealant

Location	Points of application	Kinds	Quantity
5	Cylinder head installation area of intake manifold	THREEBOND 1207B	As required



◆ Service procedure

5 Installation of intake manifold

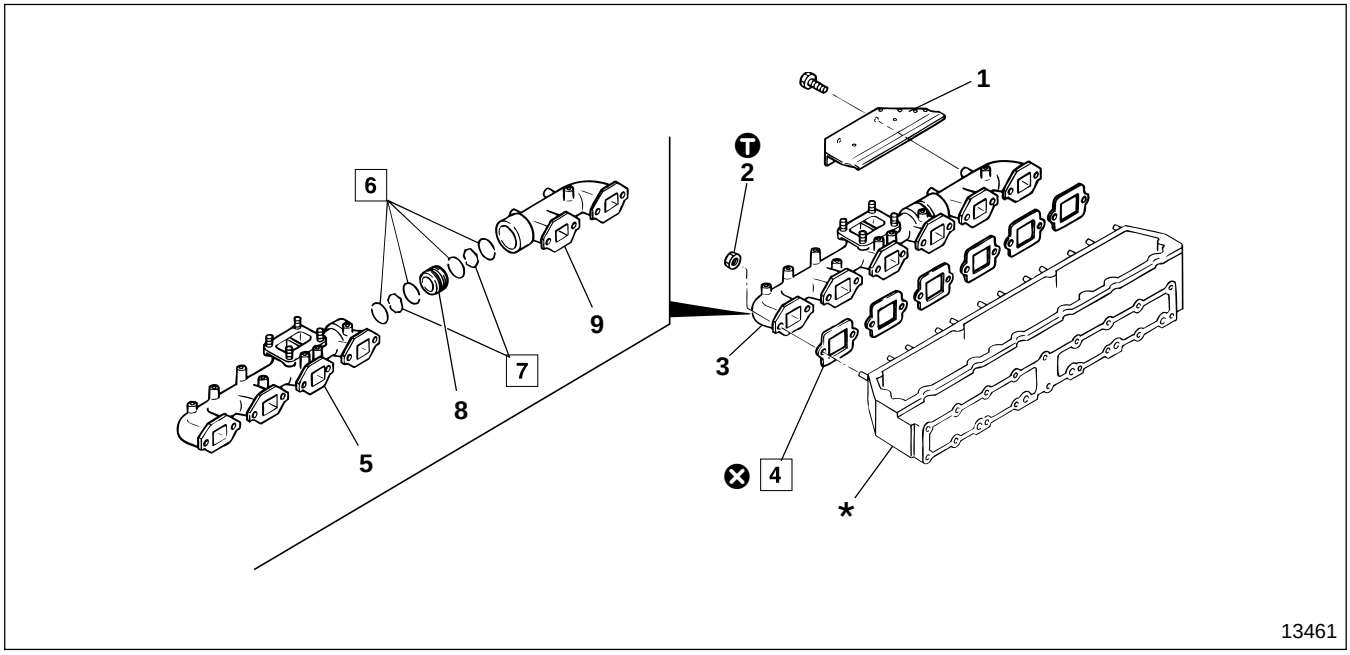
- Apply sealant **A** evenly and without break to the installation area of the intake manifold.
- After having applied sealant, within three minutes, install onto the cylinder head.

CAUTION ⚠

- **Make sure that sealant A is not transferred to other areas while the installation work is being done.**
- **Be sure to clean and wipe off oily substances from the surface where sealant A is to be applied.**
- **Be sure to reapply sealant A whenever bolts 4 are loosened.**
- **Do not start the engine within an hour of mounting.**

M E M O

EXHAUST MANIFOLD



● **Disassembly sequence**

1 Insulator
2 Nut
3 Exhaust manifold assembly
4 Gasket
5 Front exhaust manifold
6 Seal ring
7 Expansion ring
8 Joint
9 Rear exhaust manifold

***** : Cylinder head Gr 11
⊗ : Non-reusable parts

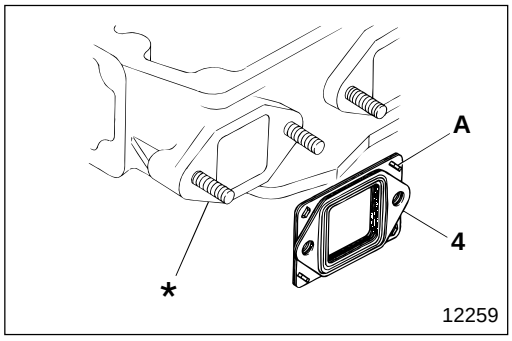
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

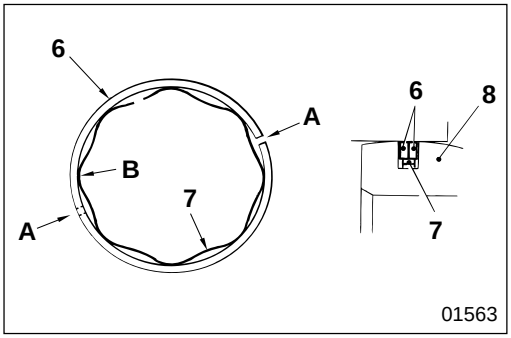
Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Exhaust manifold mounting)	41 {30, 4.2}	—



◆ Service procedure

4 **Installation of gasket**

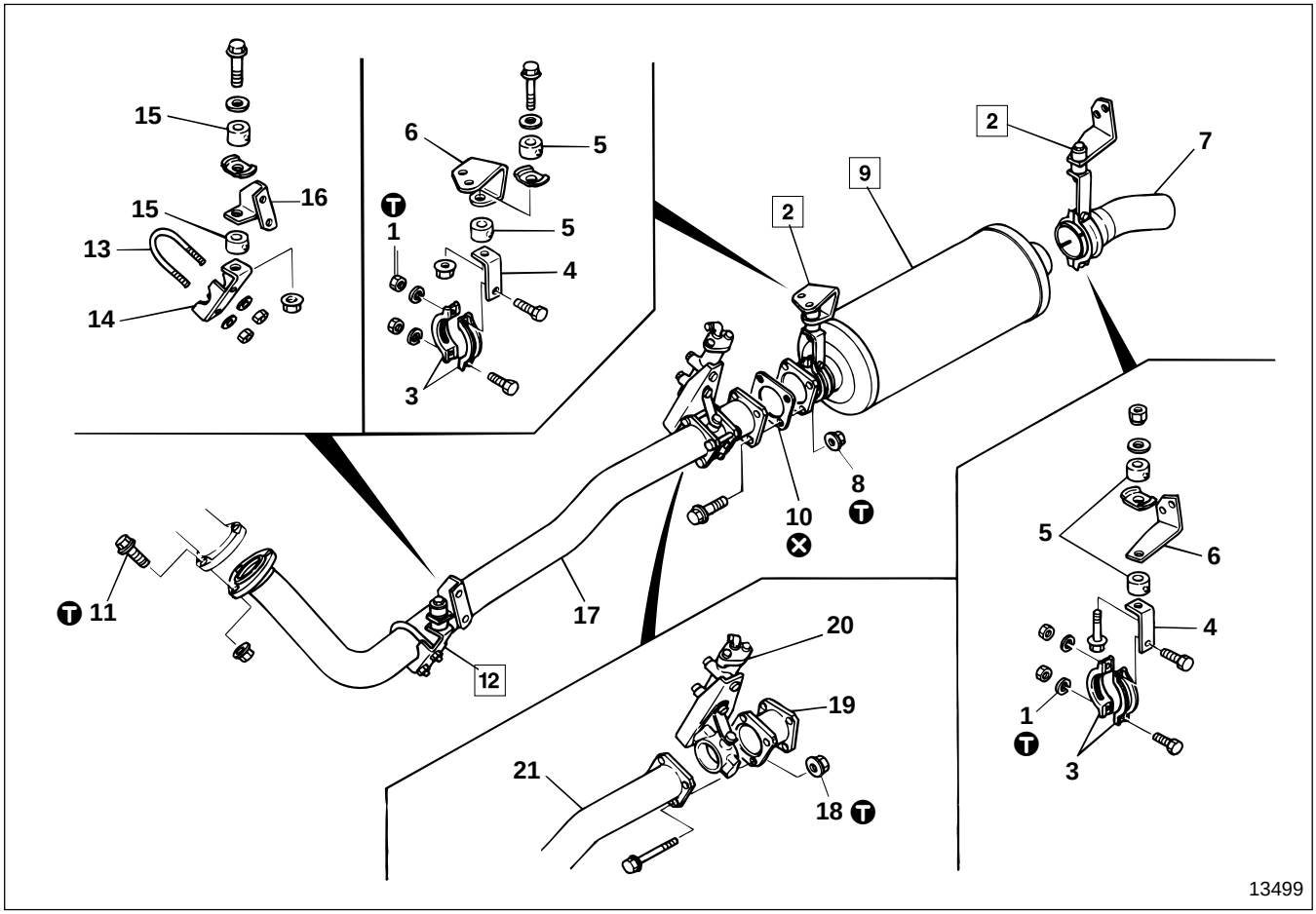
Install gasket **4** on cylinder head ***** in the direction as illustrated.
A : Protrusion



6 **7** **Installation of seal ring and expansion ring**

- Offset splits **A** of seal rings **6** at 180°.
- Align so that expansion ring **7** protrusions **B** and splits **A** of seal rings **6** do no meet.

EXHAUST PIPE AND MUFFLER



● **Disassembly sequence**

1 Nut
2 Clamp assembly
3 Clamp
4 Pipe clamp stay
5 Rubber cushion
6 Exhaust pipe hanger
7 Tail pipe
8 Nut
9 Muffler
10 Gasket
11 Bolt
12 Clamp assembly
13 U-bolt
14 Pipe clamp stay
15 Rubber cushion
16 Exhaust pipe hanger
17 Front pipe assembly
18 Nut
19 Center pipe
20 Exhaust brake unit Gr 35A, B
21 Front pipe

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

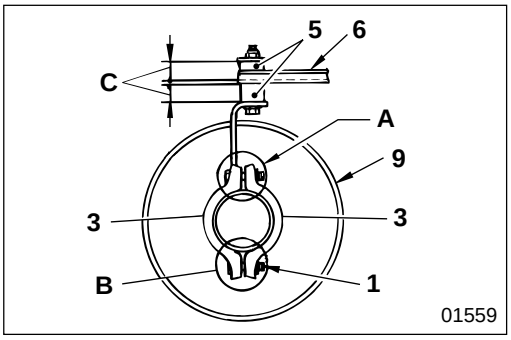
- **Never hit or kick muffler 9, or the catalyzer in the muffler will be damaged.**
- **A small amount of water sometimes collects inside muffler 9. Never touch this water, if you do by mistake, wash it off immediately with clean water.**

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

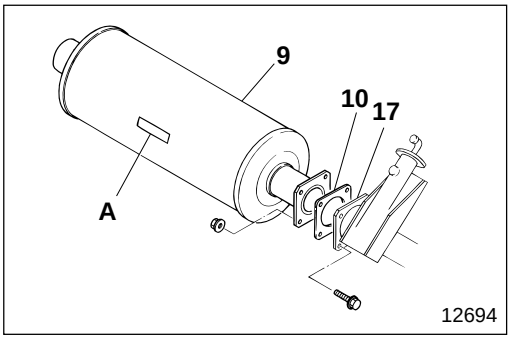
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Clamp mounting)	20 {14, 2}	—
8	Nut (Muffler mounting)	43 {32, 4.4}	—
11	Bolt (Front pipe assembly mounting)	91 {67.3, 9.3}	—
18	Nut (Exhaust brake unit mounting)	57.5 {42.7, 5.9}	—

◆ Service procedure



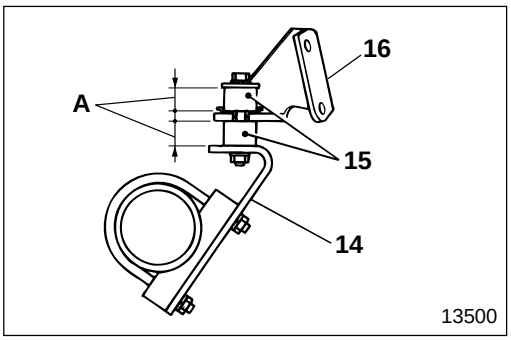
2 **Installation of clamp assembly**

- Tighten nut **1** temporally to let clamp **3** move slightly.
- Tighten nut **1** until it makes contact with area **A** of clamp **3**.
- After tightening area **A**, tighten area **B** using nut **1**.
- Tighten until dimension **C** of rubber cushion **5** is as follows:
  C : Before tightening 25 mm {0.98 in.}
  After tightening 23 mm {0.91 in.}



9 **Installation of muffler**

Install muffler **9** to front pipe assembly **17** in the direction as illustrated.
A : Part No. marked position



12 **Installation of clamp assembly**

Tighten until dimension **A** of rubber cushion **15** is as follows:
A : Before tightening 25 mm {0.98 in.}
After tightening 23 mm {0.91 in.}

MITSUBISHI
FUSO

Group 21

Clutch

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-21

INDEX

SPECIFICATIONS 21- 2

STRUCTURE AND OPERATION 21- 2

TROUBLESHOOTING 21- 7

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Power Cylinder > 21- 8
- Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Booster > 21-10
- Inspection of Function < Clutch Booster > 21-12
- Clutch Pedal Free Play < Clutch Power Cylinder > 21-13
- Clutch Pedal Free Play < Clutch Booster > 21-14

CLUTCH PEDAL < C6 (M060S6), C7 (M070S6) > 21-16

CLUTCH PEDAL < C7 (M8S2×5) > 21-20

CLUTCH MASTER CYLINDER 21-24

CLUTCH POWER CYLINDER < C6 (M060S6), C7 (M070S6) > 21-26

CLUTCH BOOSTER < C7 (M8S2×5) > 21-28

WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY 21-34

CLUTCH BODY < C6 > 21-36

CLUTCH BODY < C7 > 21-46

CLUTCH CONTROL 21-56

SPECIFICATIONS/STRUCTURE AND OPERATION

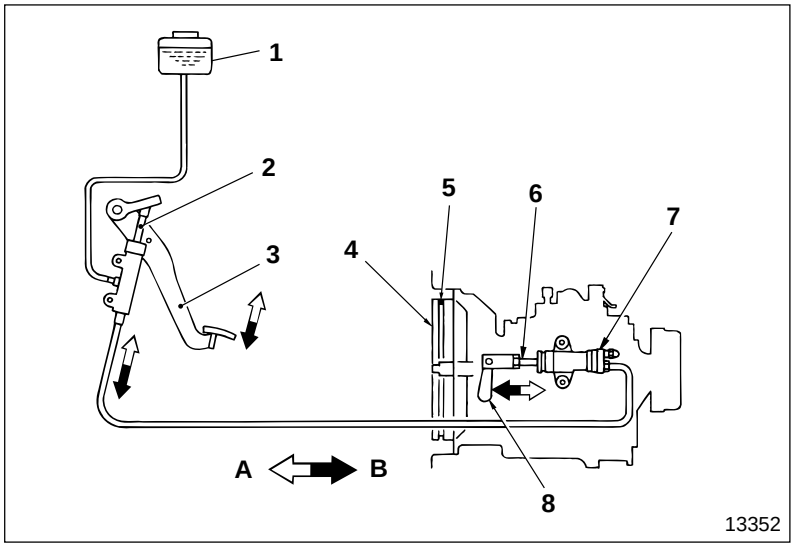
SPECIFICATIONS

Item		Specifications	
Clutch	Model	C6M35 < M060S6 >, C7M38 < M070S6 >	C7M38 < M8S2×5 >
Drive type		Strap drive	
Clutch disc	Type	Dry, single plate type	
Pressure plate	Type	Coil spring type	
Control system		Hydraulic pressure type	
Clutch master cylinder	Manufacturer	NABCO	
Clutch power cylinder	Manufacturer	NABCO	—
Clutch booster	Manufacturer	—	BOSCH BRAKING SYSTEMS

STRUCTURE AND OPERATION

Clutch Control

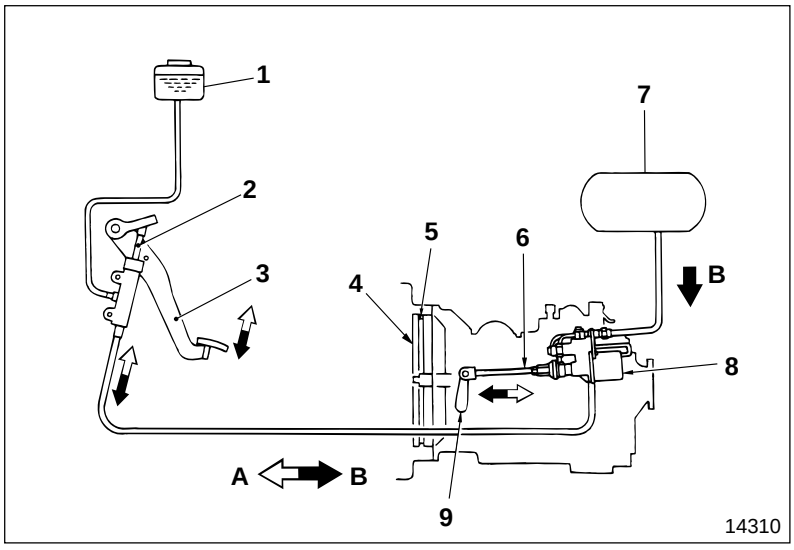
< C6M35 (M060S6), C7M38 (M070S6) >



1 Fluid tank
2 Clutch master cylinder
3 Clutch pedal
4 Flywheel
5 Clutch disc
6 Push rod
7 Clutch power cylinder
8 Release fork shaft

A : Power transmission
B : Cutting off power transmission

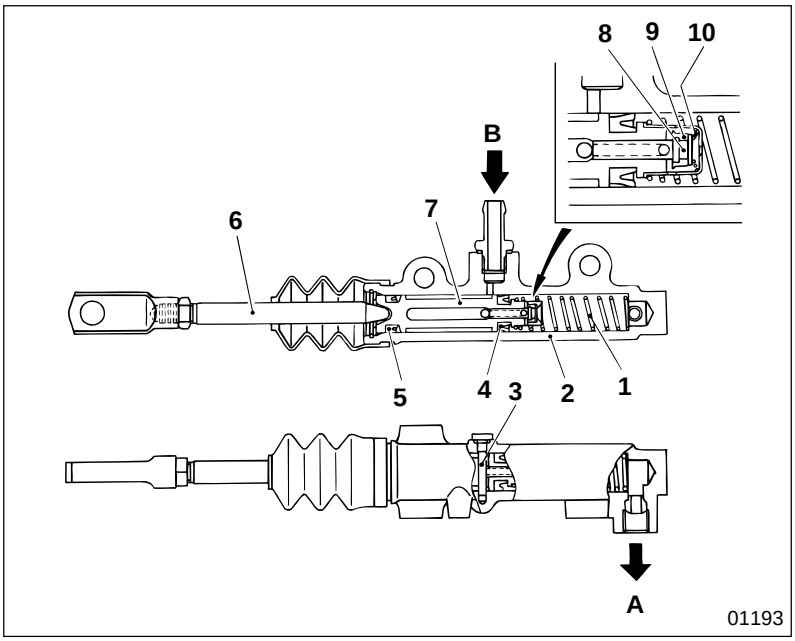
< C7M38 (M8S2×5) >



1 Fluid tank
2 Clutch master cylinder
3 Clutch pedal
4 Flywheel
5 Clutch disc
6 Push rod
7 Air tank
8 Clutch booster
9 Release fork shaft

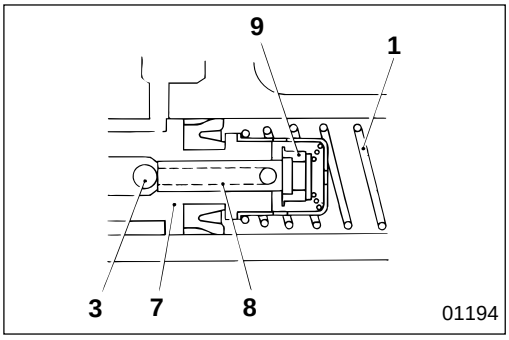
A : Power transmission
B : Cutting off power transmission

Clutch Master Cylinder



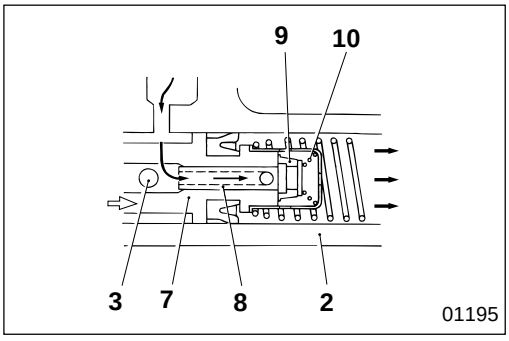
1 Return spring
2 Cylinder
3 Supply valve stopper
4 Primary cup
5 Secondary cup
6 Push rod
7 Piston
8 Supply valve rod
9 Supply valve
10 Supply valve spring

A : To clutch power cylinder
B : From fluid tank



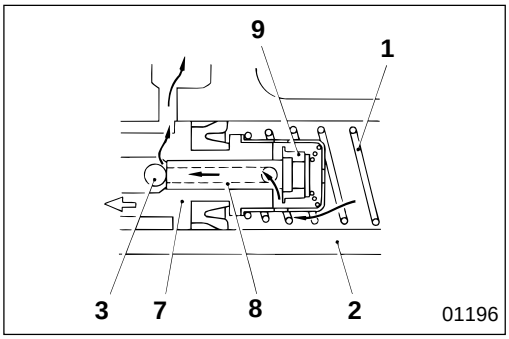
Before clutch pedal is depressed

- As piston **7** is pressed in the direction of push rod **6** by return spring **1**, supply valve rod **8** rests at supply valve stopper **3**, and supply valve **9** remains open.
- This opens the passage between the fluid tank and the clutch.



When clutch pedal is depressed

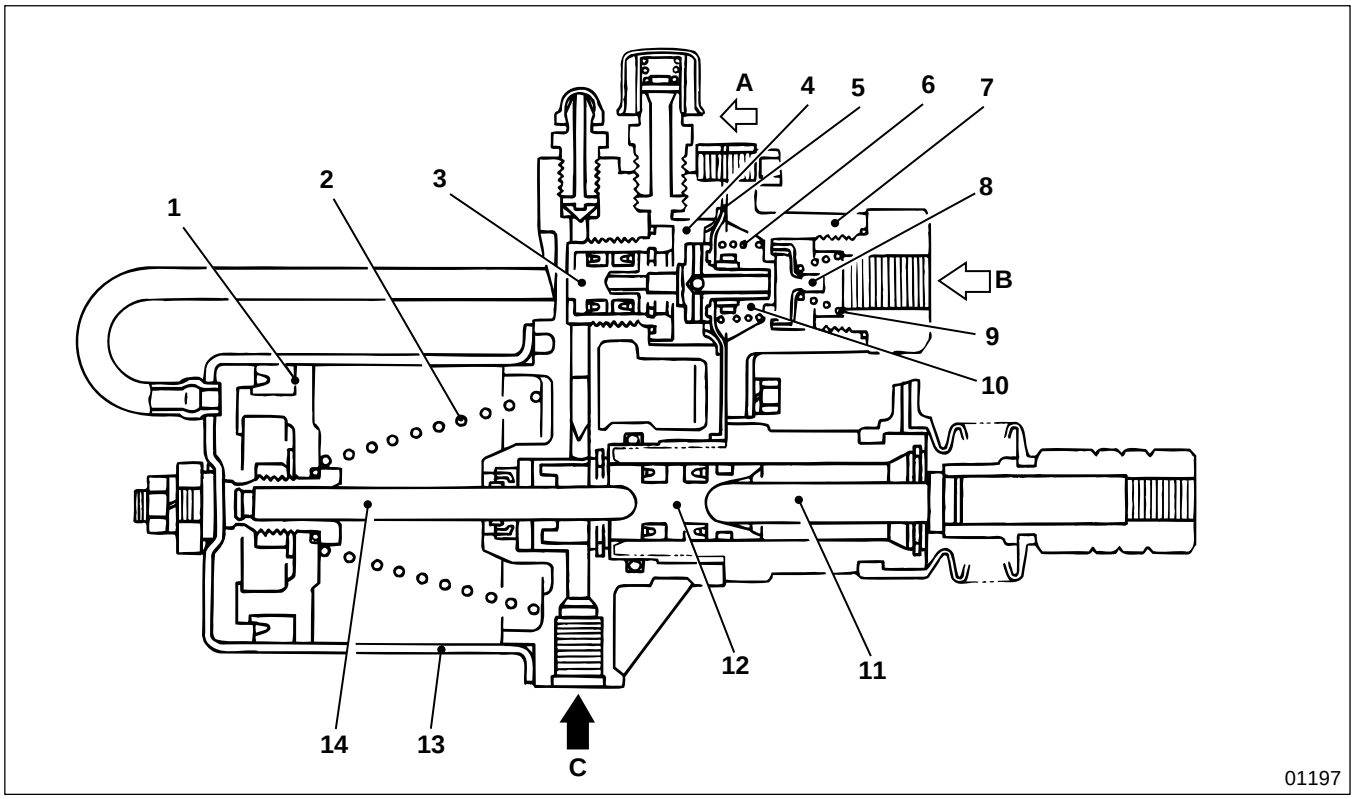
- As push rod **6** pushes piston **7**, supply valve rod **8** separates from supply valve stopper **3**. At the same time, supply valve spring **10** closes supply valve **9**.
- As piston **7** is pressed further, hydraulic pressure is generated inside cylinder **2** to actuate the clutch power cylinder.
- Fluid is supplied in proportion to the amount of movement of piston **7**.



When clutch pedal is released

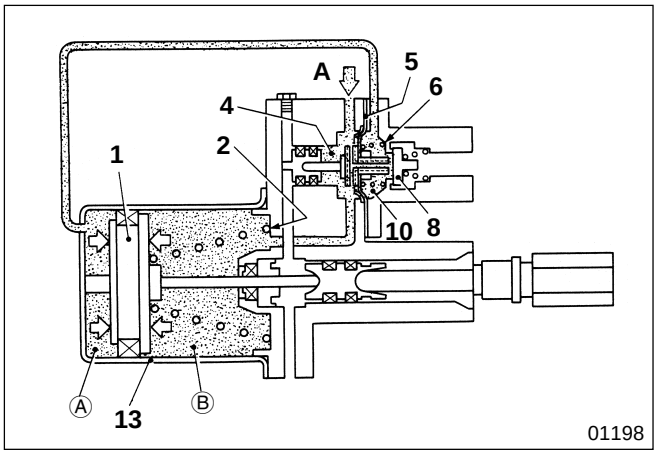
- The combined repercussive forces of the hydraulic pressure inside cylinder **2** and return spring **1** push piston **7** back, causing supply valve rod **8** to hit supply valve stopper **3**, opening supply valve **9**.
- Fluid from the clutch power cylinder returns to the fluid tank, and hydraulic pressure ceases to exist.

Clutch Booster < C7M38 (M8S2×5) >



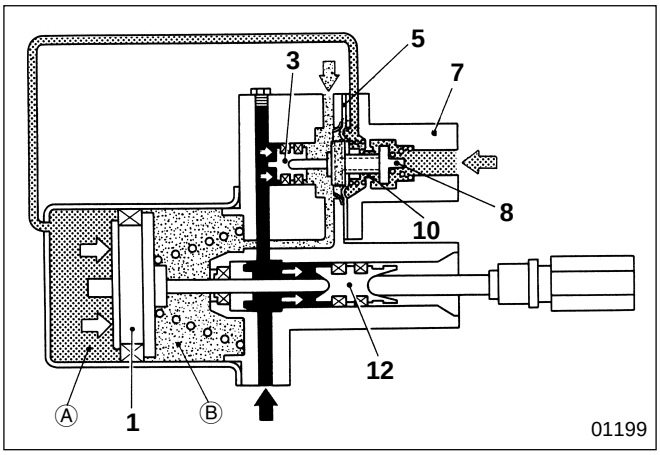
1 Power piston
2 Spring
3 Relay valve piston
4 Air chamber
5 Diaphragm
6 Spring
7 Valve body
8 Poppet valve
9 Spring
10 Control chamber
11 Rod
12 Hydraulic piston
13 Cylinder shell
14 Push rod

A : Atmospheric pressure
B : Air pressure from air tank
C : Hydraulic pressure from clutch master cylinder



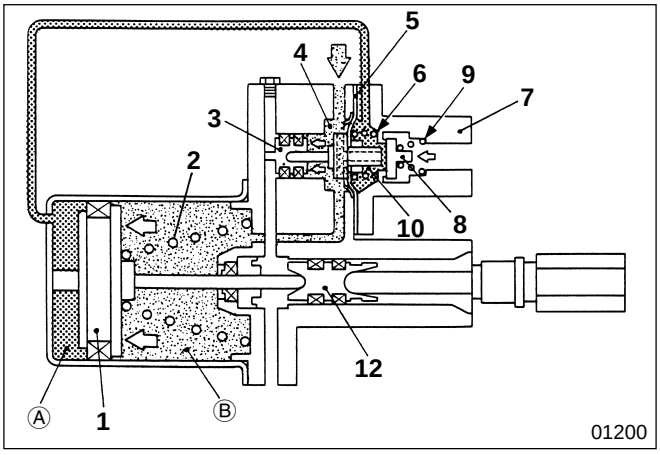
When clutch booster is not operated

- Both air chamber **4** and control chamber **10** are under atmospheric pressure **A**.
- Spring **6** pushes diaphragm **5** to the left, opening a clearance between the diaphragm and poppet valve **8**.
- This clearance connects control chamber **10** to chamber Ⓐ of cylinder shell **13**, so chamber Ⓐ is under atmospheric pressure.
- Since chamber Ⓑ of cylinder shell **13** is connected to air chamber **4**, chamber Ⓑ is under atmospheric pressure. Thus, there is no pressure difference between chambers Ⓐ and Ⓑ.
- Therefore, power piston **1** remains pushed to the left by spring **2**.



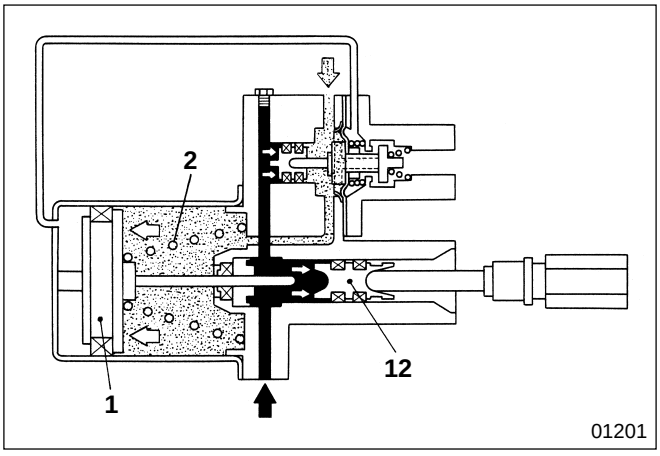
When clutch pedal is depressed

- Hydraulic pressure **C** acts on hydraulic piston **12** and relay valve piston **3**.
- Relay valve piston **3** pushes diaphragm **5** to the right and the diaphragm sticks to poppet valve **8**, closing the clearance.
- This blocks the atmospheric pressure passage between control chamber **10** and chamber Ⓐ.
- Diaphragm **5** pushes poppet valve **8** further, opening a clearance between the poppet valve and valve body **7**.
- Air pressure **B** flows into chamber Ⓐ through this clearance, creating a pressure difference between chambers Ⓐ and Ⓑ.
- This pressure difference acts on power piston **1** to push it to the right where it combines with the hydraulic pressure acting on hydraulic piston **12**, cutting off the clutch at low depression force.



When clutch pedal is released

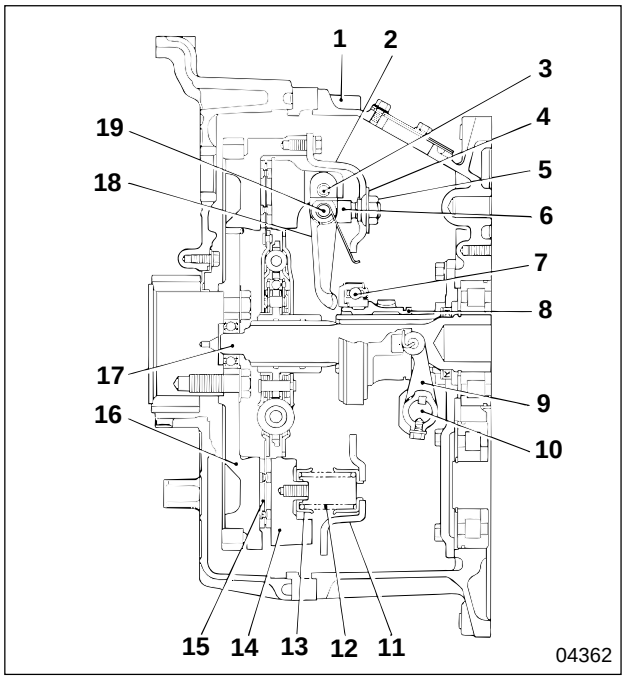
- The hydraulic pressure acting on hydraulic piston **12** and relay valve piston **3** ceases, freeing the pistons.
- Therefore, diaphragm **5** and poppet valve **8**, being pushed by relay valve piston **3**, are returned to the left by the repercussive force of springs **6**, **9**.
- Poppet valve **8** sticks to valve body **7** to block the air pressure passage to chamber Ⓐ, opening a clearance with diaphragm **5** instead.
- This clearance connects air chamber **4** to control chambers **10** and Ⓐ, and they are all under atmospheric pressure. Since the pressure difference between chambers Ⓐ and Ⓑ is lost, power piston **1** is returned to the left by the repercussive force of spring **2**.



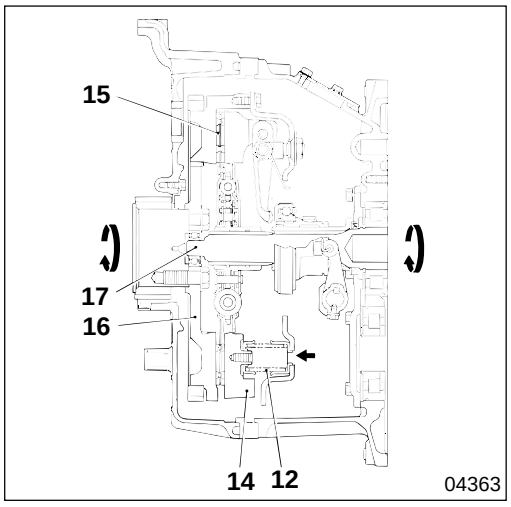
When air system is faulty

- If the air pressure fed by the air tank is lost, the air pressure in chamber Ⓐ is lost, too.
- As a result, power piston **1** is returned to the left by spring **2**.
- Therefore, the clutch is cut off solely by the hydraulic pressure applied to hydraulic piston **12**.

Clutch

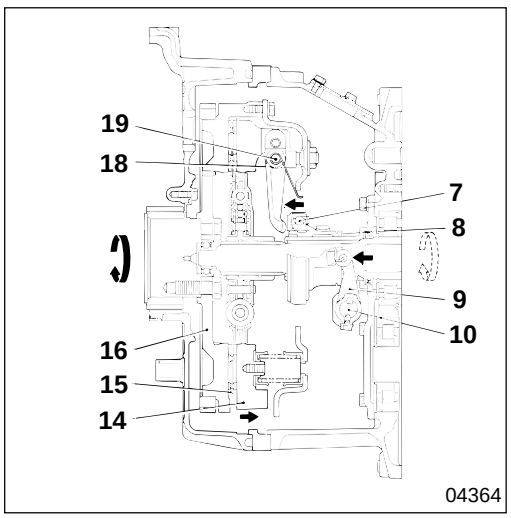


1 Clutch housing
2 Clutch cover
3 Release lever pin
4 Lock plate
5 Support nut
6 Support lever
7 Release bearing
8 Clutch shifter
9 Release fork
10 Release fork shaft
11 Pressure spring cap
12 Pressure spring
13 Pressure spring cap
14 Pressure plate
15 Clutch disc
16 Flywheel
17 Drive pinion
18 Release lever
19 Support lever pin



When clutch pedal is released

- Pressure plate **14**, activated by pressure spring **12**, forces clutch disc **15** against flywheel **16**.
- Clutch disc **15** forced against flywheel **16** runs together with the flywheel and transmits power from the engine to transmission drive pinion **17**.



When clutch pedal is depressed

- Hydraulic pressure generated within the clutch master cylinder activates the clutch power cylinder < C6 (M060S6), C7 (M070S6) >, or clutch booster < C7 (M8S2×5) >. Release fork shaft **10** actuates release fork **9** and pushes release bearing **7** forward together with clutch shifter **8**, pushing release lever **18**.
- Release lever **18**, with support lever pin **19** acting as the fulcrum, retracts pressure plate **14**, which opens a clearance between clutch disc **15** and flywheel **16**, cutting off power transmission from the engine.

Possible causes / Symptoms		Clutch disengaged but drags	Clutch slips	Clutch does not engage smoothly	Clutch makes noise on disengagement	Clutch makes noise on engagement	Judder when vehicle starting	Remarks
Pressure plate and lever assembly	Release bearing faulty	○			○			
	Release lever heights uneven	○	○	○			○	
	Pressure plate warped or faulty	○	○	○			○	
	Pressure spring fatigued		○	○		○		
	Loose strap bolts						○	
	Strap plate bent				○			
Clutch disc	Disc deformed	○		○			○	
	Disc rivets loose			○			○	
	Disc torsion spring fatigued or damaged		○	○	○	○	○	
	Spline worn	○			○	○	○	
	Spline area rusted	○		○				
	Facing worn		○					
	Facing surface hardened		○	○			○	
	Facing oily or greasy		○	○			○	
Clutch pedal	Pedal free play insufficient		○					
	Pedal free play excessive	○						
	Pedal stroke insufficient	○						
	Return spring fatigued		○					
	Pedal friction surfaces faulty			○			○	
Clutch master cylinder	Piston and piston cup sliding movement faulty	○	○	○				
	Spring fatigued	○	○	○				
	Brake fluid passage port clogged	○	○	○				
Clutch power cylinder	Return spring fatigued	○	○	○				
	Piston and piston cup sliding movement faulty	○	○	○				
	Brake fluid passage port clogged	○	○	○				
Clutch booster	Piston and piston cup sliding movement faulty	○	○					
	Spring fatigued	○	○					
	Brake fluid port clogged	○	○					
Clutch control	Release bearing faulty						○	
	Clutch shifter sliding movement faulty						○	
	Clutch shifter lubrication insufficient						○	
	Clutch release fork deformed						○	
Transmission drive pinion spline worn		○				○		Gr 22A, B
Engine idling speed too slow						○		Gr 13
Engine mounting fatigued							○	Gr 10
Flywheel warped, deformed or worn forming steps		○	○	○			○	Gr 11
Flywheel pilot bearing faulty		○			○			
Air mixed in clutch hydraulic system		○						
Clutch hydraulic system leaking		○						

Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Power Cylinder >

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

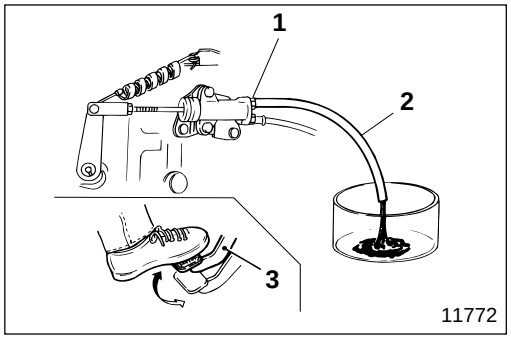
Location	Parts to be tightened	Tightening torque	Remarks
1	Air bleeder	25 to 34 {18 to 25, 2.5 to 3.5}	—

Fluid

Location	Points of application	Kinds	Quantity
4	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

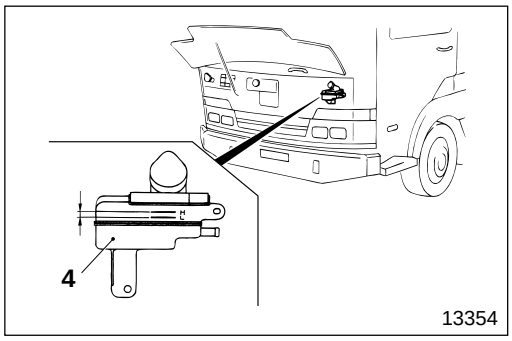
CAUTION

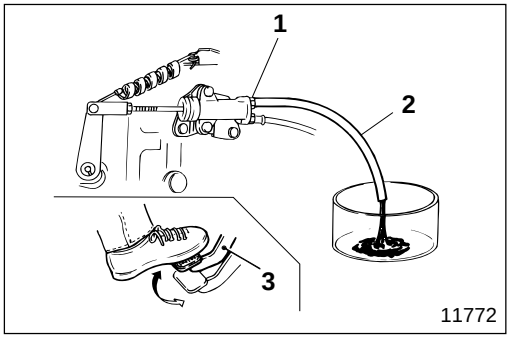
- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system to swell, resulting in faulty clutch operation.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will cause faulty clutch operation.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**

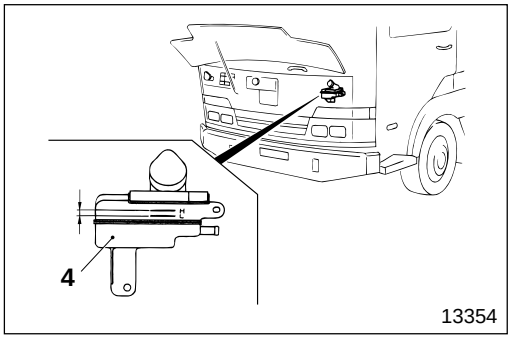


(1) Replacement of brake fluid

- Attach vinyl pipe **2** to air bleeder **1** of the clutch power cylinder.
- Loosen air bleeder **1** and depress clutch pedal **3** several times to drain brake fluid completely.
- Supply new brake fluid to the "**H**" level of fluid tank **4**. Depress clutch pedal **3** repeatedly until the old brake fluid discharged from vinyl pipe **2** is replaced by the new brake fluid.







(2) Air bleeding of clutch system

NOTE

Carry out this operation maintaining the brake fluid level in fluid tank 4 between "H" and "L".

- Attach vinyl pipe **2** to air bleeder **1** of the clutch power cylinder as in the replacement procedure.
- Fill fluid tank **4** with brake fluid, and loosen air bleeder **1** of the clutch power cylinder, then depress clutch pedal **3** continuously.
- Keep depressing clutch pedal **3**, and tighten air bleeder **1** when air is bled completely.
- Depress clutch pedal **3** several times again, then keep it depressed at its fullest extent.
- With clutch pedal **3** depressed, loosen air bleeder **1** to drain brake fluid containing air. Release the pedal after tightening the air bleeder.
- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten air bleeder **1** at specified torque.
- Check that brake fluid is at the "**H**" level of fluid tank **4**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **3** depressed.

Clutch Fluid (Brake Fluid) Replacement and Air Bleeding < Clutch Booster >

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

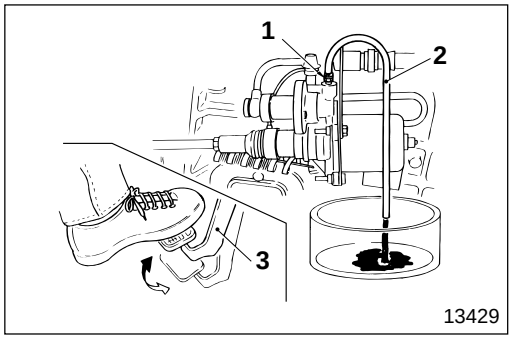
Location	Parts to be tightened	Tightening torque	Remarks
1	Air bleeder	6.9 to 13 {5.1 to 9.4, 0.7 to 1.3}	—

Fluid

Location	Points of application	Kinds	Quantity
4	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116 DOT3)	As required

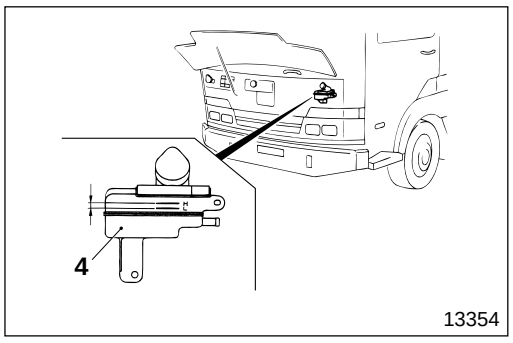
CAUTION

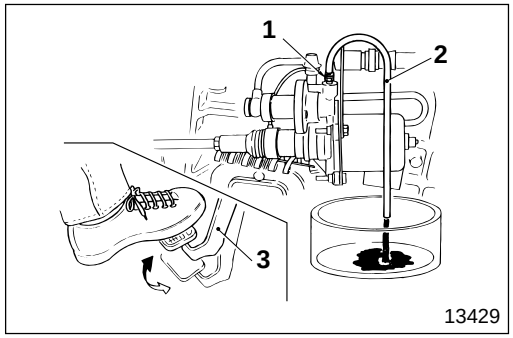
- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116 DOT3). Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the clutch system, because this will cause the rubber parts of the clutch system to swell, resulting in faulty clutch operation.**
- **Do not allow foreign particles or water to become mixed into the brake fluid when refilling, because this will cause faulty clutch operation.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oils.**

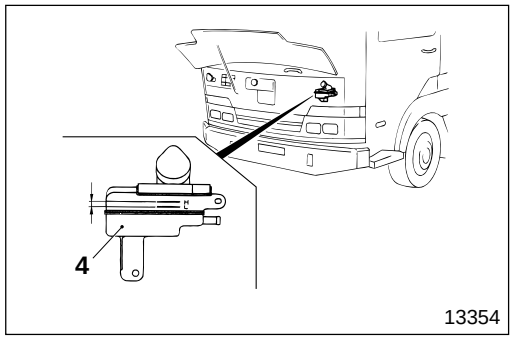


(1) Replacement of brake fluid

- Attach vinyl pipe **2** to air bleeder **1** of the clutch booster.
- Loosen air bleeder **1** and depress clutch pedal **3** several times to drain brake fluid completely.
- Supply new brake fluid to the "**H**" level of fluid tank **4**. Depress clutch pedal **3** repeatedly until the old brake fluid discharged from vinyl pipe **2** is replaced by the new brake fluid.







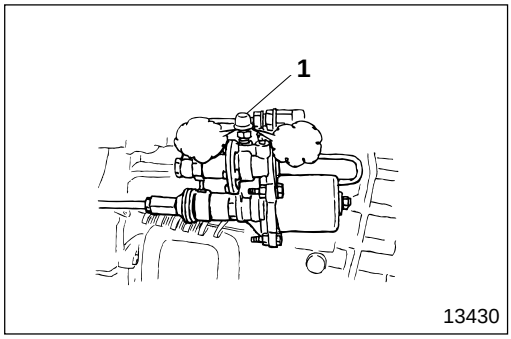
(2) Air bleeding of clutch system

NOTE

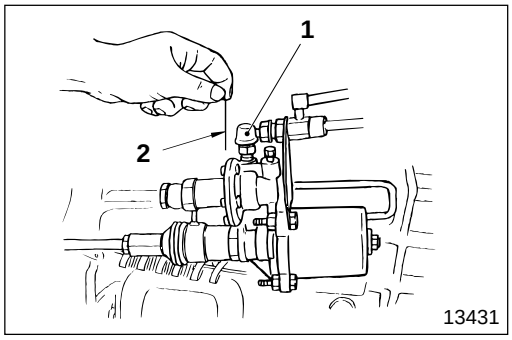
Carry out this operation maintaining the brake fluid level in fluid tank 4 between "H" and "L".

- Attach vinyl pipe **2** to air bleeder **1** of the clutch booster as in the replacement procedure.
- Fill fluid tank **4** with brake fluid, and loosen air bleeder **1** of the clutch booster, then depress clutch pedal **3** continuously.
- Keep depressing clutch pedal **3**, and tighten air bleeder **1** when air is bled completely.
- Depress clutch pedal **3** several times again, then keep it depressed at its fullest extent.
- With clutch pedal **3** depressed, loosen air bleeder **1** to drain brake fluid containing air. Release the pedal after tightening the air bleeder.
- Repeat this operation until air is no longer present in the fluid being drained.
- When this operation is completed, tighten air bleeder **1** at specified torque.
- Check that brake fluid is at the "**H**" level of fluid tank **4**, and supply new brake fluid if necessary.
- Check for brake fluid leakage from each of the parts with clutch pedal **3** depressed.

Inspection of Function < Clutch Booster >



- Make sure that the depression force required to depress the clutch pedal when the air pressure is 0 kPa {0 psi, 0 kgf/cm^2} is notably different from that when the air pressure is 590 to 785 kPa {85 to psi, 6 to 8 kgf/cm^2}.
- Make sure that air is instantly bled from exhaust cover **1** when you release the clutch pedal.



- Apply air pressure of 590 to 785 kPa {85 to 115 psi, 6 to 8 kgf/cm^2} and hang thread **2** in front of exhaust cover **1**. Make sure that the thread is not blown upward when depressing and releasing the clutch pedal.
  If the thread is blown upward, it indicates that air is leaking from the poppet valve.

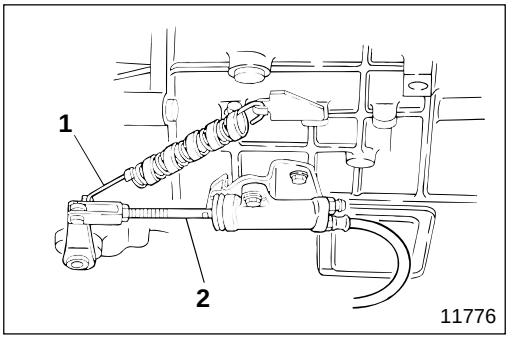
Clutch Pedal Free Play < Clutch Power Cylinder >

Service standards

Unit : mm {in.}

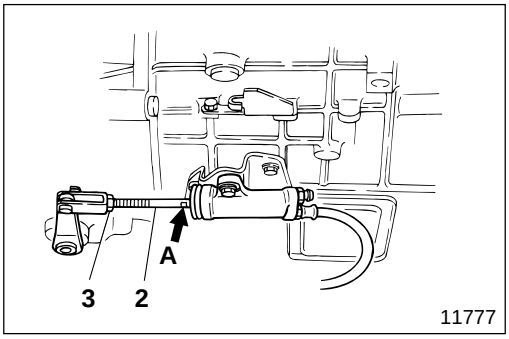
Location	Maintenance item	Standard value	Limit	Remedy
2	Push rod stroke	3.8 {0.15}	—	Adjust or replace
4	Clutch pedal free play	32 to 44 {1.25 to 1.73}	—	Adjust or replace

Inspect and adjust the free play of the clutch pedal, by noting the stroke of the clutch power cylinder push rod, after the clutch pedal has been correctly adjusted.



[Inspection]

- Bleed air from the clutch system. P21-9
- Adjust the clutch pedal. P21-18
- Remove return spring **1** and measure the free travel of push rod **2** by moving it with your hand. If the measured value deviates from the standard value, adjust as follows:

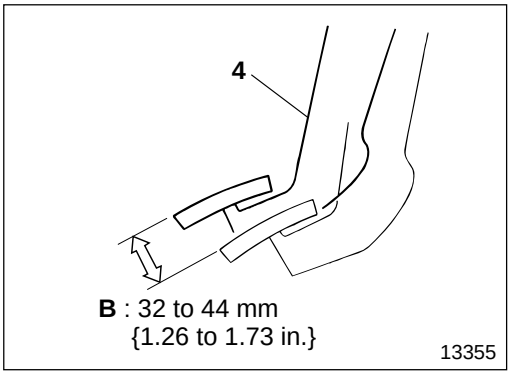


[Adjustment]

- Loosen nut **3** and turn head **A** of push rod **2** to extend the push rod until it stops.
- Then, slacken off head **A** of push rod **2** by the following value and retighten nut **3**.

  Amount of slackening off: Approximately three turns

- If push rod **2** does not return by the above amount, replace the clutch disc because it is worn beyond the limit.



[Confirmation]

Push clutch pedal **4** with your hand until you feel a resistance and measure free play **B**.

If the measured value deviates from the standard value, readjust or replace the clutch disc.

ON-VEHICLE INSPECTION AND ADJUSTMENT

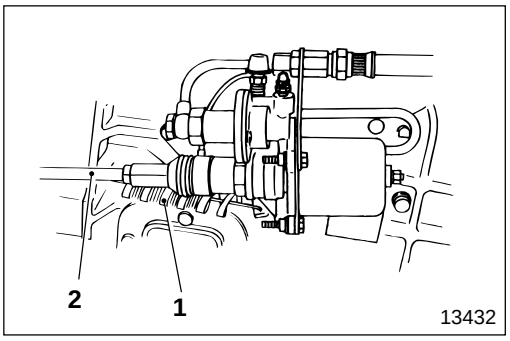
Clutch Pedal Free Play < Clutch Booster >

Service standards

Unit : mm {in.}

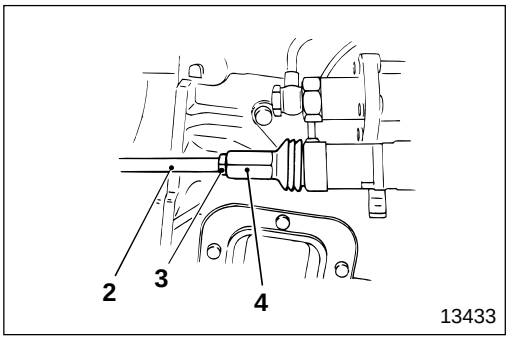
Location	Maintenance item	Standard value	Limit	Remedy
2	Push rod stroke	3.2 {0.13}	—	Adjust or replace
5	Clutch pedal free play	35 to 47 {1.38 to 1.85}	—	Adjust or replace

Inspect and adjust the free play of the clutch pedal, by noting the stroke of the clutch booster push rod, after the clutch pedal has been correctly adjusted.



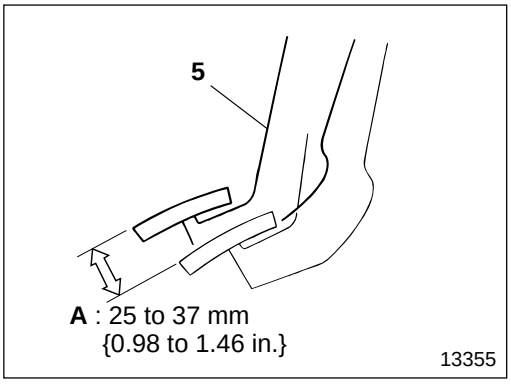
[Inspection]

- Bleed air from the clutch system. P21-11
- Adjust the clutch pedal. P21-22
- Remove return spring **1** and measure the free travel of push rod **2** by moving it with your hand. If the measured value deviates from the standard value, adjust as follows:



[Adjustment]

- Loosen nut **3** and turn head **4** of push rod **2** to extend the push rod until it stops.
- Then, slacken off head **4** of push rod **2** by the following value and retighten nut **3**.
  Amount of slackening off: Approximately two and three-fifth turns
- If push rod **2** does not return by the above amount, replace the clutch disc because it is worn beyond the limit.

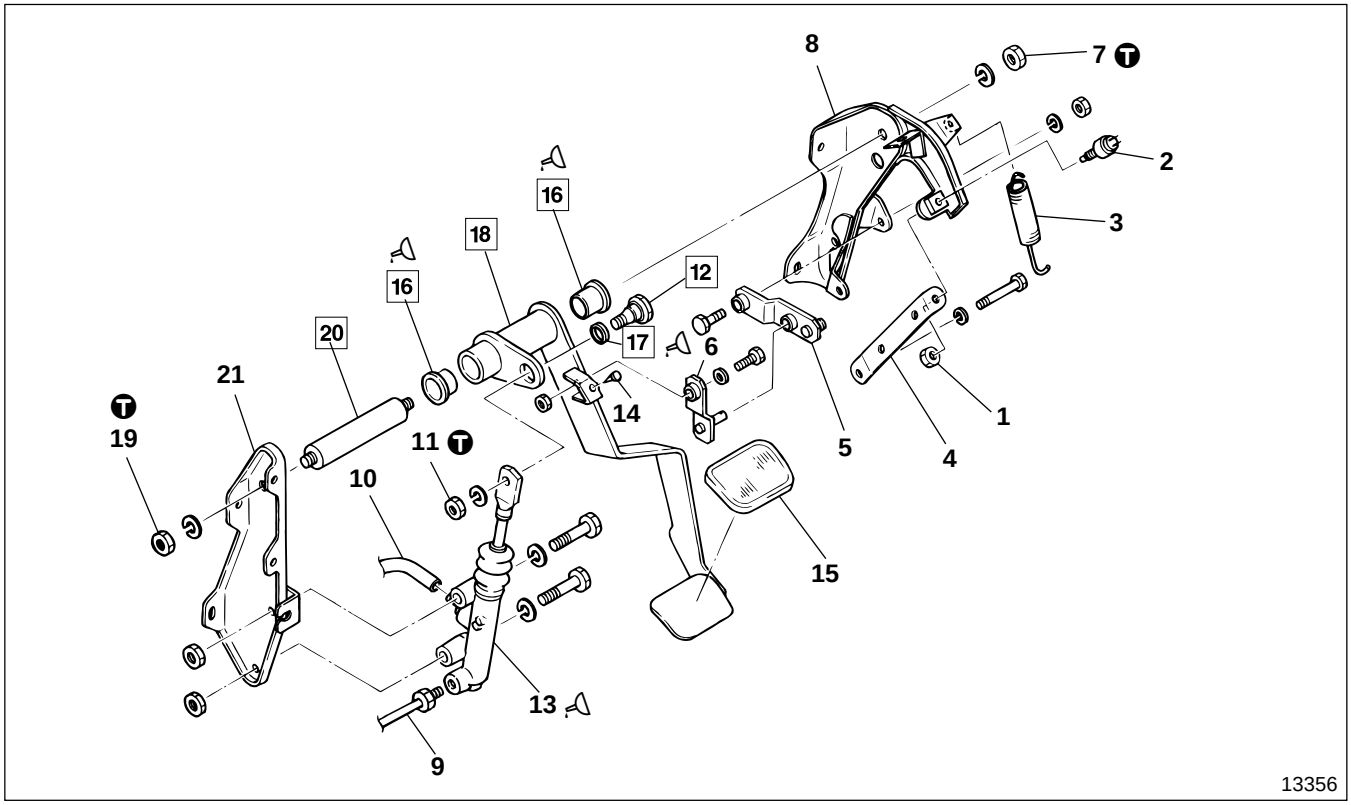


[Confirmation]

Push clutch pedal **5** with your hand until you feel a resistance and measure free play **A**.
If the measured value deviates from the standard value, readjust or replace the clutch disc.

M E M O

CLUTCH PEDAL < C6 (M060S6), C7 (M070S6) >



● **Disassembly sequence**

1 Nut
2 Clutch switch Gr 54
3 Return spring
4 Clutch switch stay
5 Lever assembly B
6 Lever assembly A
7 Nut
8 Clutch pedal bracket, RH
9 Clutch pipe
10 Clutch hose
11 Nut
12 Offset bolt
13 Clutch master cylinder P21-24
14 Clutch switch stopper
15 Pedal pad
16 Bushing
17 Bushing
18 Clutch pedal arm
19 Nut
20 Pedal arm shaft
21 Clutch pedal bracket, LH

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
3	Installed load of return spring	91 N {21 lbf, 9.3 kgf}	—	—
12, 17	Clearance between offset bolt and bushing	0.06 to 0.36 {0.0024 to 0.014}	—	Replace
16, 20	Clearance between bushing and pedal arm shaft	0.16 to 0.24 {0.0063 to 0.0094}	—	Replace

T Tightening torque

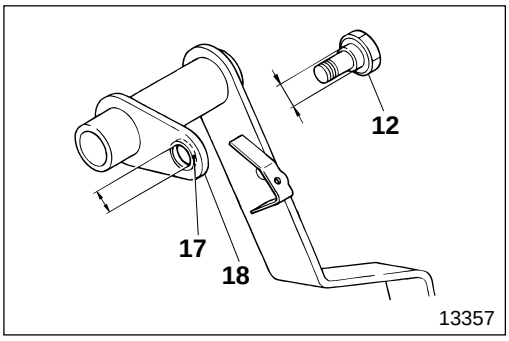
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
7, 19	Nut (Pedal arm shaft mounting)	48.1±9.8 {35±7.2, 4.9±1}	—
11	Nut (Offset bolt mounting)	48.1±9.8 {35±7.2, 4.9±1}	—

Lubricant

Location	Points of application	Kinds	Quantity
13	Offset bolt installation area	Chassis grease [NLGI No.1 (Ca soap)]	As required
16	Interior of bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required
17	Interior of bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure

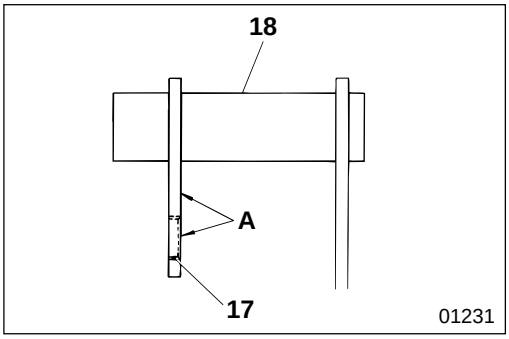


12 **17** **Offset bolt and bushing**

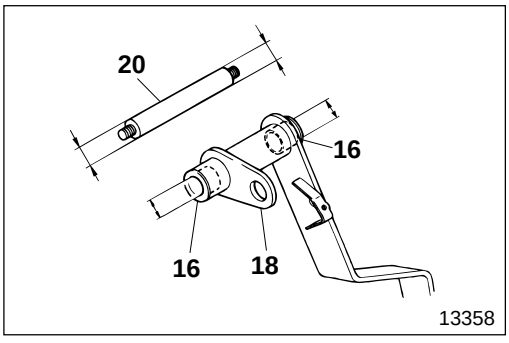
[Inspection]
Replace faulty parts if clearance is higher than the standard value.

NOTE

Inspect bushing 17 when it is press-fitted in clutch pedal arm 18.



[Press-fitting]
Make ends **A** of bushing **17** and clutch pedal arm **18** flush.

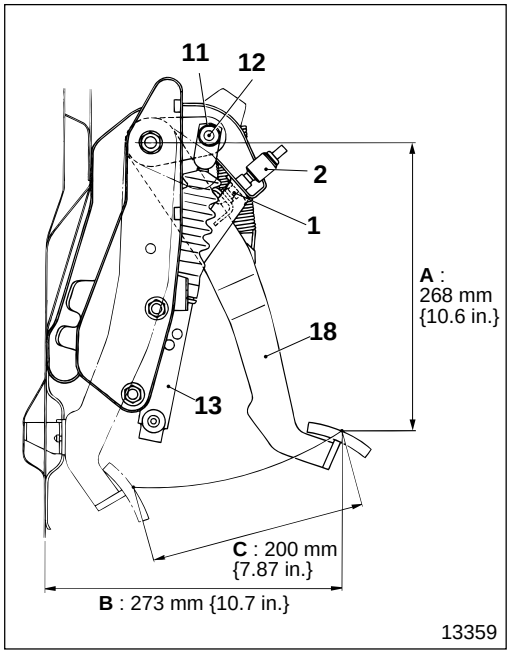


16 **20** **Clearance between bushing and pedal arm shaft**

If clearance is higher than the standard value, replace the faulty parts.

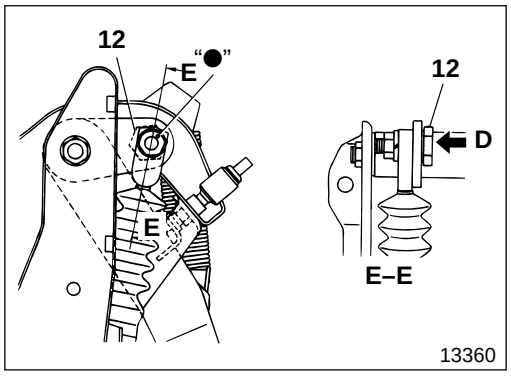
NOTE

Inspect bushing 16 when it is press-fitted in clutch pedal arm 18.

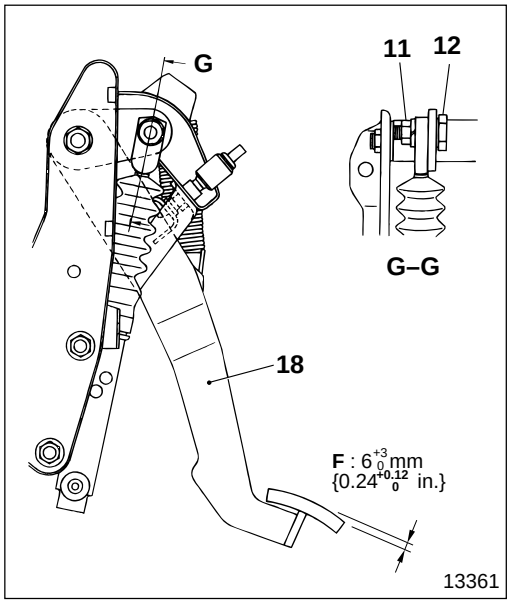


18 **Adjustment of clutch pedal**

- Loosen offset bolt **12** and nut **11** of clutch master cylinder **13**.
- Turn clutch switch **2** so that clutch pedal arm **18** is installed keeping dimensions **A**, **B**, **C** as illustrated, then tighten nut **1**.



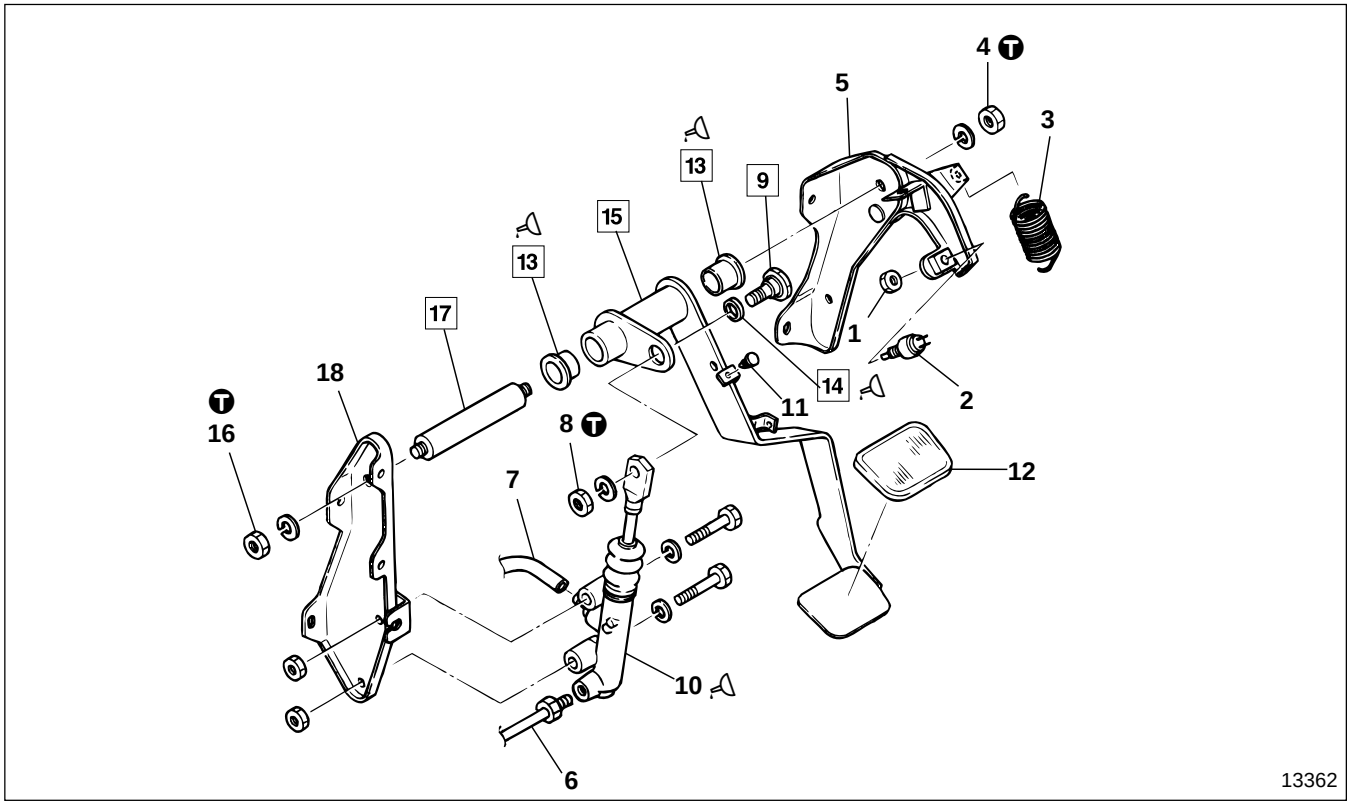
- At this time, temporarily tighten offset bolt **12** in the direction as illustrated.
  D : "●" mark side



- Then, turn offset bolt **12** to adjust free play **F** at the top of clutch pedal arm **18** to the dimensions as illustrated, then tighten nut **11**.

M E M O

CLUTCH PEDAL < C7 (M8S2×5) >



● **Disassembly sequence**

1 Nut
2 Clutch switch Gr 54
3 Return spring
4 Nut
5 Clutch pedal bracket, RH
6 Clutch pipe
7 Clutch hose
8 Nut
9 Offset bolt
10 Clutch master cylinder P21-24
11 Clutch switch stopper
12 Pedal pad
13 Bushing
14 Bushing
15 Clutch pedal arm
16 Nut
17 Pedal arm shaft
18 Clutch pedal bracket, LH

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
3	Installed load of return spring	91 N {21 lbf, 9.3 kgf}	—	—
9, 14	Clearance between offset bolt and bushing	0.06 to 0.36 {0.0024 to 0.014}	—	Replace
13, 17	Clearance between bushing and pedal arm shaft	0.16 to 0.24 {0.0063 to 0.0094}	—	Replace

Tightening torque

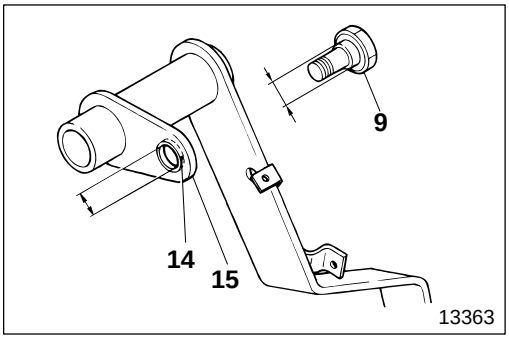
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4, 16	Nut (Pedal arm shaft mounting)	48.1±9.8 {35±7.2, 4.9±1}	—
8	Nut (Offset bolt mounting)	48.1±9.8 {35±7.2, 4.9±1}	—

Lubricant

Location	Points of application	Kinds	Quantity
10	Offset bolt installation area	Chassis grease [NLGI No.1 (Ca soap)]	As required
13	Interior of bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required
14	Interior of bushing	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure

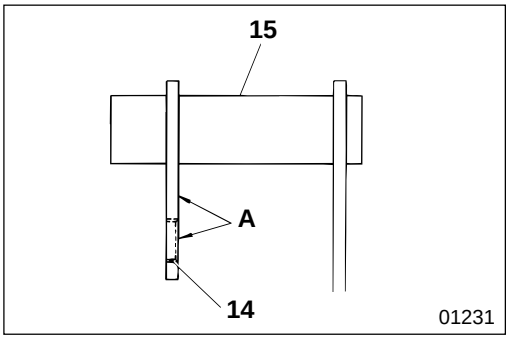


9 **14** **Offset bolt and bushing**

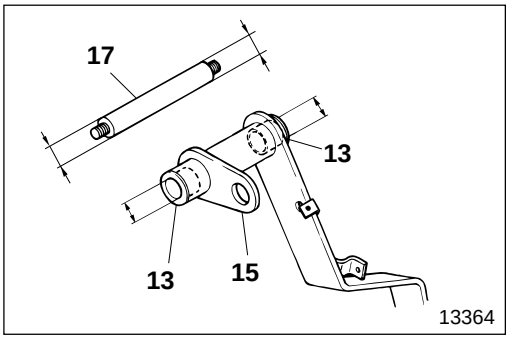
[Inspection]
Replace faulty parts if clearance is higher than the standard value.

NOTE

Inspect bushing 14 when it is press-fitted in clutch pedal arm 15.



[Press-fitting]
Make ends **A** of bushing **14** and clutch pedal arm **15** flush.



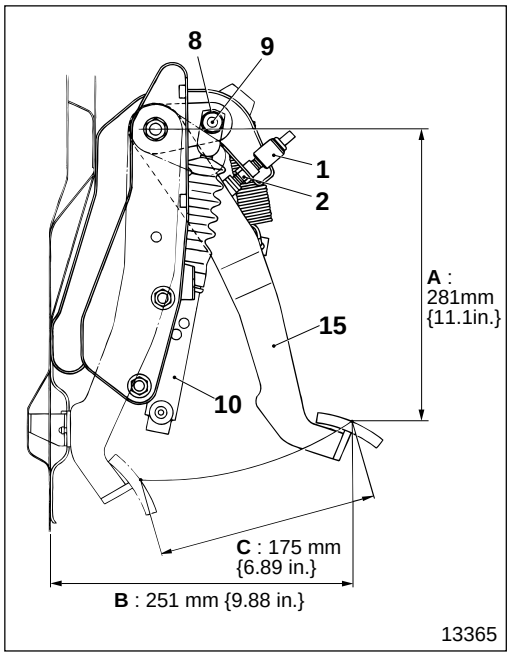
13 **17** **Clearance between bushing and pedal arm shaft**

If clearance is higher than the standard value, replace the faulty parts.

NOTE

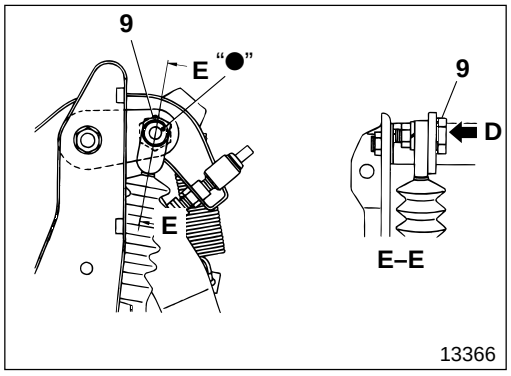
Inspect bushing 13 when it is press-fitted in clutch pedal arm 15.

CLUTCH PEDAL < C7 (M8S2×5) >

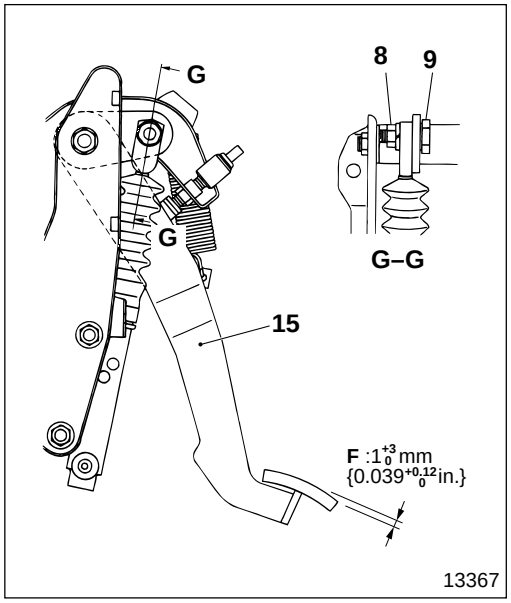


15 **Adjustment of clutch pedal**

- Loosen offset bolt **9** and nut **8** of clutch master cylinder **10**.
- Turn clutch switch **2** so that clutch pedal arm **15** is installed keeping dimensions **A**, **B**, **C** as illustrated, then tighten nut **1**.



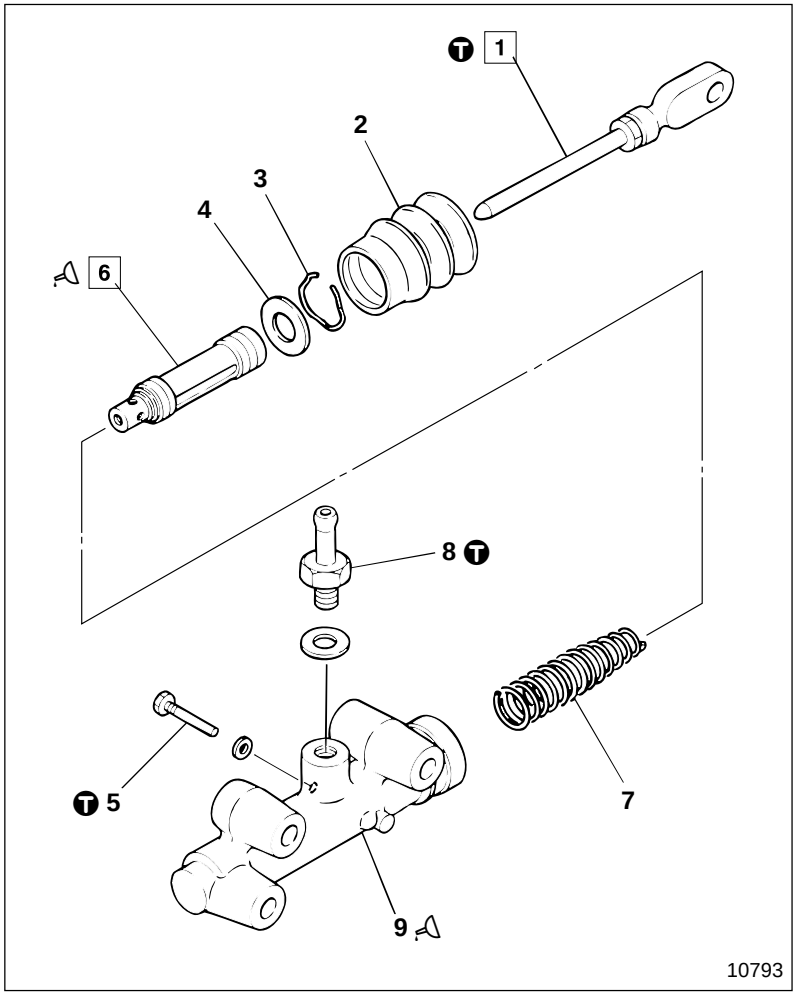
- At this time, temporarily tighten offset bolt **9** in the direction as illustrated.
  D : "●" mark side



- Then, turn offset bolt **9** to adjust free play **F** at the top of clutch pedal arm **15** to the dimensions as illustrated, then tighten nut **8**.

M E M O

CLUTCH MASTER CYLINDER



● **Disassembly sequence**

1 Push rod
2 Boot
3 Piston stop ring
4 Piston stop plate
5 Supply valve stopper
6 Piston assembly
7 Return spring
8 Nipple
9 Cylinder

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit: Piston and boot kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
6, 9	Clearance between piston assembly and cylinder	[19.05] 0.020 to 0.105 {[0.75] 0.00079 to 0.0041}	0.2 {0.0079}	Replace
7	Free length of return spring	97 {3.82}	92 {3.62}	Replace

Ⓣ Tightening torque

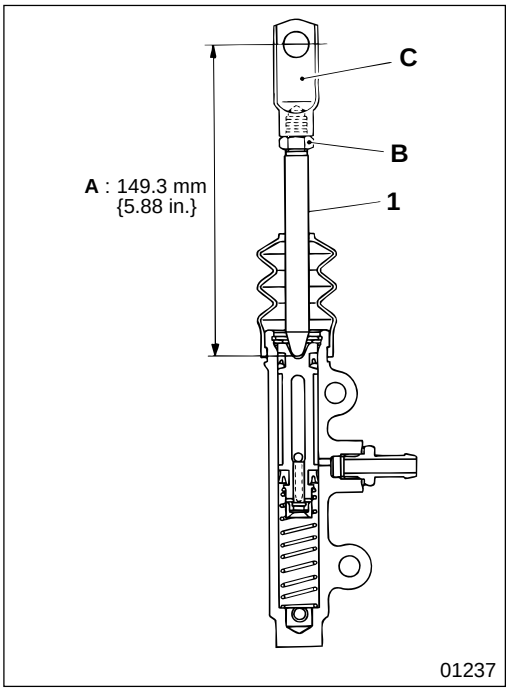
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Push rod (Lock nut mounting)	9.8 to 14.7 {7.2 to 11, 1.0 to 1.5}	—
5	Supply valve stopper	1.47 to 2.94 {1.1 to 2.2, 0.15 to 0.3}	—
8	Nipple	24.5 to 34.3 {18 to 25, 2.5 to 3.5}	—

Lubricant

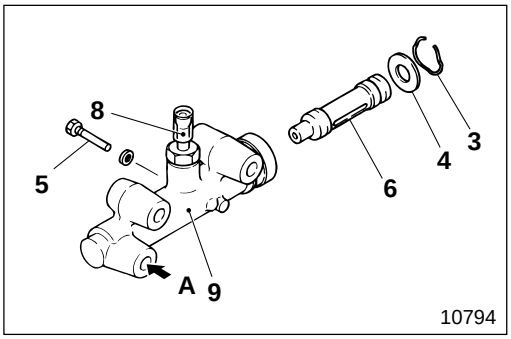
Location	Points of application	Kinds	Quantity
6, 9	Friction surfaces between piston assembly and cylinder	Rubber grease	As required

◆ Service procedure



1 Adjustment of push rod length

If illustrated dimension **A** does not conform to the standard value, loosen lock nut **B** of push rod **1** and turn head **C** to adjust.
After adjustment, tighten lock nut at specified torque.



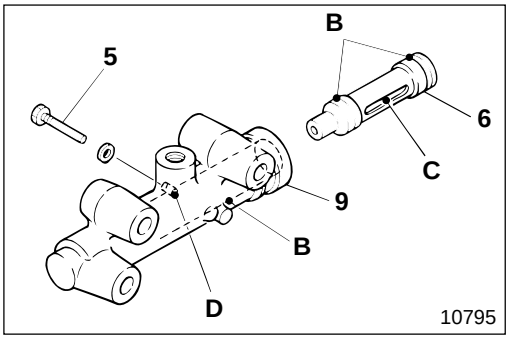
6 Piston assembly

[Removal]

- Remove piston stop ring **3**, piston stop plate **4** and supply valve stopper **5**.
- Block nipple **8** of cylinder **9**, and apply compressed air from **A** as illustrated to remove piston assembly **6**.

WARNING⚠

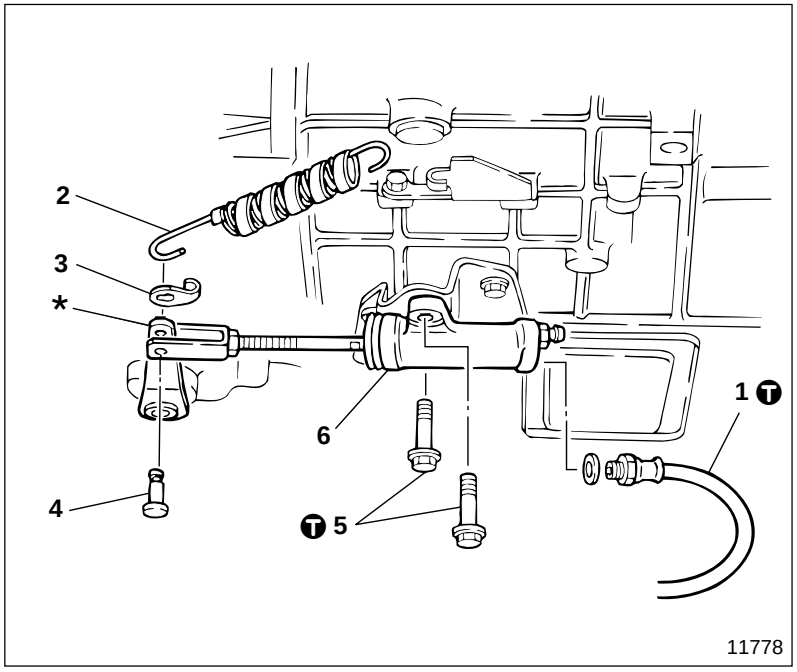
You must apply compressed air gradually when you remove piston assembly 6. If you applied compressed air strongly at one time, the piston assembly would be violently ejected.



[Installation]

- Apply grease to friction surfaces **B** of piston assembly **6** and cylinder **9**.
- Fit piston by aligning piston assembly **6** groove **C** to cylinder **9** hole **D**, then insert valve stopper **5** to hold the piston in place.

CLUTCH POWER CYLINDER < C6 (M060S6), C7 (M070S6) >



● **Removal sequence**

1 Fluid hose
2 Return spring
3 Return spring claw
4 Clevis pin
5 Bolt
6 Clutch power cylinder assembly
📖 P21-27

***** : Clutch release fork shaft

CAUTION⚠

After removing fluid hose 1, fit blanking plugs into its openings to prevent fluid from flowing out.

● **Installation sequence**

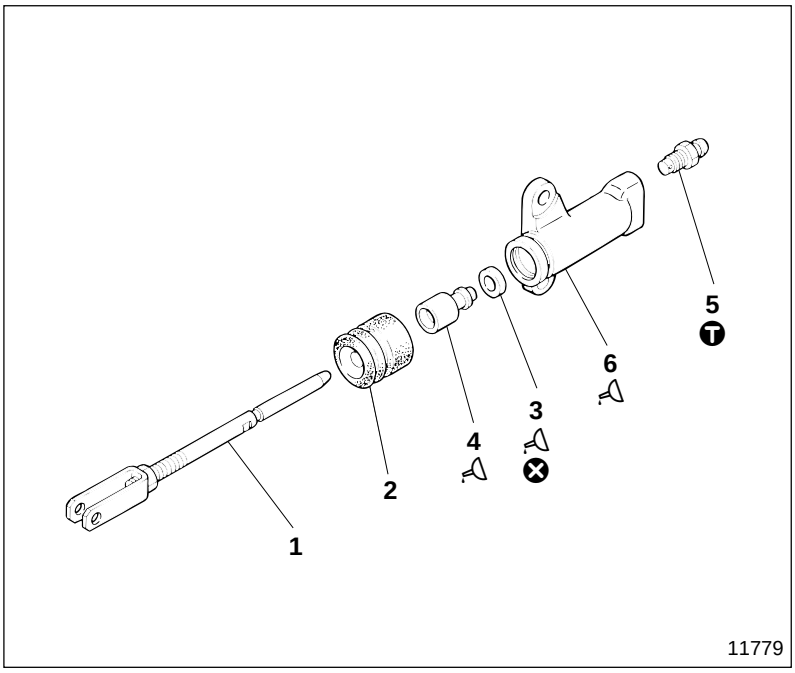
Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Fluid hose connection	21 to 31 {15 to 23, 2.1 to 3.2}	—
5	Bolt (Clutch power cylinder assembly mounting)	47 {35, 4.8}	—

Clutch Power Cylinder Assembly



● **Disassembly sequence**

1 Push rod
2 Boot
3 Piston cup
4 Piston
5 Air bleeder plug
6 Cylinder

⊗ : Non-reusable parts

● **Assembly sequence**

4→3→6→5→2→1

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
4, 6	Clearance between cylinder and piston	[20.64] 0.04 to 0.125 {[0.81] 0.0016 to 0.0049}	0.24 {0.0094}	Replace

Ⓣ Tightening torque

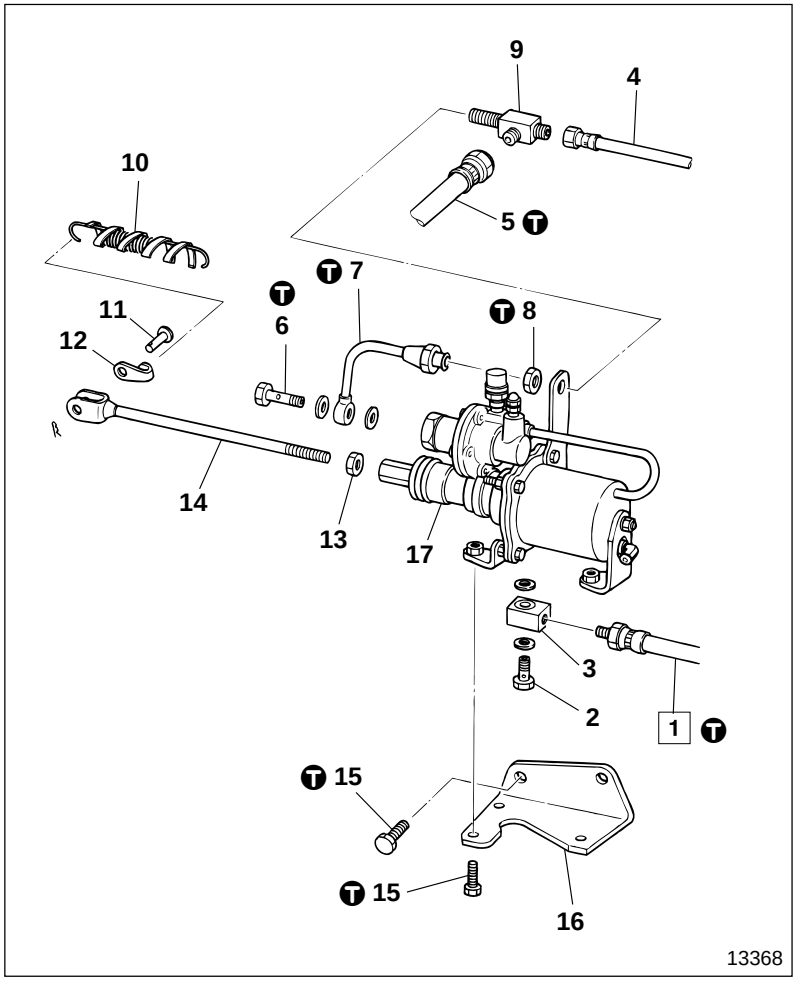
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Air bleeder	25 to 34 {18 to 25, 2.5 to 3.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
3	Piston cup circumference	Rubber grease	As required
4	Friction surface of piston	Rubber grease	As required
6	Cylinder bore	Rubber grease	As required

CLUTCH BOOSTER < C7 (M8S2×5) >



● **Removal sequence**

1 Fluid hose
2 Eye bolt
3 Connector
4 Air hose
5 Air hose
6 Eye bolt
7 Air pipe
8 Nut
9 Connector
10 Return spring
11 Clevis pin
12 Spring claw
13 Nut
14 Push rod
15 Bolt
16 Bracket
17 Clutch booster assembly 🕮 P21-29

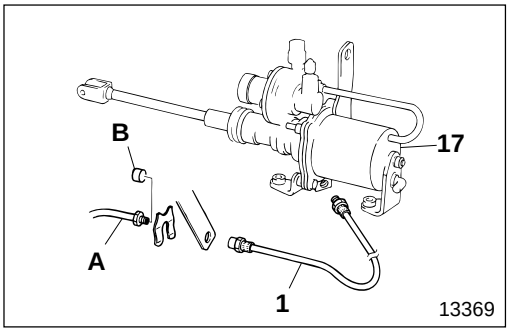
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Fluid hose	34±7.8 {25±5.8, 3.5±0.8}	—
5	Air hose	39 to 44 {29 to 33, 4.0 to 4.5}	—
6	Eye bolt (Air pipe mounting)	35 {26, 3.6}	—
7	Flare nut of air pipe	38 to 50 {28 to 37, 3.9 to 5.1}	—
8	Nut (Connector mounting)	93 to 125 {69 to 94, 9.5 to 13}	—
15	Bolt (Bracket mounting)	32 to 49 {24 to 36, 3.3 to 5.0}	—



◆ Service procedure

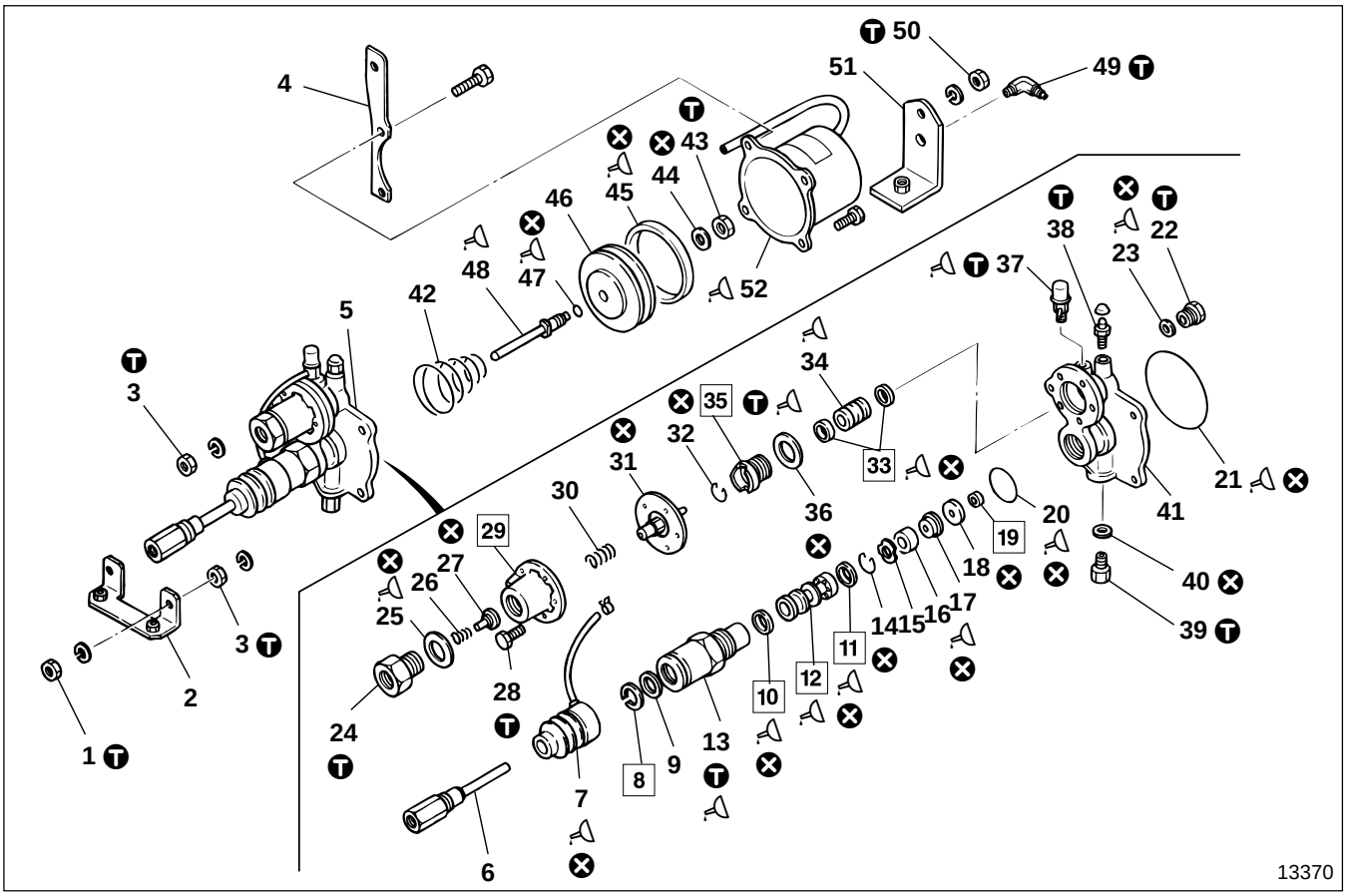
1 **Removal and installation of fluid hose**

- When removing fluid hose **1**, first disconnect from pipe **A** on the frame side, then disconnect from clutch booster assembly **17**.
- For installation, follow the removal sequence in reverse.
- After installing fluid hose **1**, bleed the system.

CAUTION⚠

After removing fluid hose 1, fit blanking plug B into pipe A to prevent fluid from flowing out.

Clutch Booster Assembly



● **Work before disassembly**

P21-31

● **Disassembly sequence**

1 Nut
2 Bracket
3 Nut
4 Bracket
5 End plate assembly
6 Rod
7 Guard
8 Retaining ring
9 Washer
10 Cup packing (Atmosphere side)
11 Cup packing (Hydraulic pressure side)
12 Hydraulic piston
13 Hydraulic cylinder
14 Retaining ring
15 Washer
16 Retainer
17 Cup packing
18 Washer
19 Oil seal
20 O-ring
21 O-ring
22 Bushing
23 Gasket
24 Connector
25 Gasket
26 Spring
27 Poppet valve
28 Bolt
29 Upper valve body
30 Spring
31 Diaphragm assembly
32 Retaining ring
33 Cup packing
34 Relay valve piston
35 Fitting
36 Gasket
37 Exhaust cover assembly
38 Air bleeder
39 Connector
40 Gasket
41 End plate
42 Spring
43 Nut
44 Spring
45 Cup packing
46 Power piston plate
47 O-ring
48 Push rod
49 Elbow connector
50 Nut
51 Bracket
52 Cylinder shell

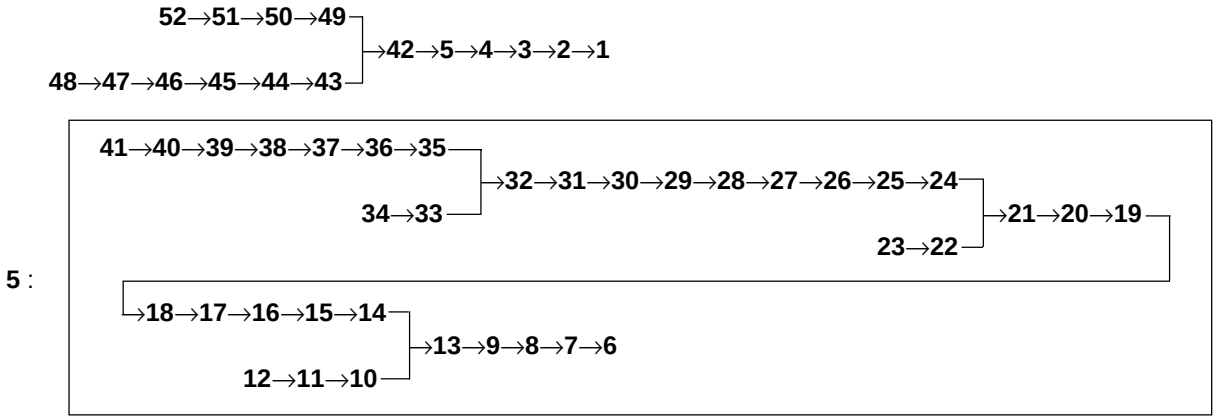
⊗ : Non-reusable parts

NOTE

Do not disassemble diaphragm assembly 31.

CLUTCH BOOSTER < C7 (M8S2×5) >

● **Assembly sequence**



Repair kit: Clutch booster kit

CAUTION ⚠

- **Be careful not to damage the periphery of hydraulic piston 12 and relay valve piston 34.**
- **If there is rust on fitting 35, the inside of hydraulic cylinder 13 or on hydraulic piston 12, rub off the rust gently using emery paper. Excessive rubbing or the use of coarse emery paper might cause air or fluid leakage.**

NOTE

- **Wash metal parts using metal cleaning agent.**
- **Wipe and clean rubber parts using alcohol.**

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
12, 13	Clearance between hydraulic piston and hydraulic cylinder	[19.05] 0.01 to 0.06 {[0.75] 0.00039 to 0.0024}	0.08 {0.0031}	Replace
26	Spring load (Installed length 13 {0.51})	2.6 N {0.60 lbf, 0.27 kgf}	2.3 N {0.51 lbf, 0.23 kgf}	Replace
30	Spring load (Installed length 10 {0.39})	12 N {2.76 lbf, 1.25 kgf}	10 N {2.34 lbf, 1.06 kgf}	Replace
34, 35	Clearance between relay valve piston and fitting	[14.3] 0.04 to 0.10 {[0.56] 0.0016 to 0.0039}	0.11 {0.0043}	Replace
42	Spring load (Installed length 55 {2.17})	69 N {15 lbf, 7 kgf}	58 N {13 lbf, 5.9 kgf}	Replace
46, 52	Clearance between power piston plate and cylinder shell	[70] 0.20 to 0.75 {[2.76] 0.0079 to 0.030}	—	Replace
48	Bend of push rod	—	0.1 {0.0039}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 50	Nut (Mounting of end plate, cylinder shell and bracket)	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	—
13	Hydraulic cylinder	29.4 to 39.2 {22 to 29, 3 to 4}	—
22	Bushing	7.8 to 9.8 {5.8 to 7.2, 0.8 to 1.0}	—
24	Connector	19.6 to 29.4 {14 to 22, 2 to 3}	—
28	Bolt (Upper valve body mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
35	Fitting	14.7 to 24.5. {11 to 18, 1.5 to 2.5}	—
37	Exhaust cover assembly	9.8 to 49.0 {7.2 to 36, 1 to 5}	—
38	Air bleeder	6.9 to 12.7 {5.1 to 9.4, 0.7 to 1.3}	—
39	Connector	44.1 to 58.8 {33 to 43, 4.5 to 6.0}	—
43	Nut (Push rod mounting)	19.6 to 29.4 {14 to 22, 2 to 3}	—
49	Elbow connector	9.8 {7.2, 1} or more	—

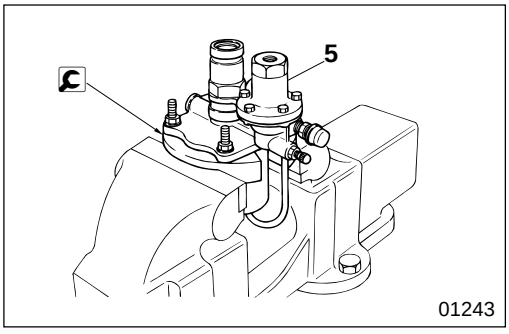
Lubricant

Location	Points of application	Kinds	Quantity
7	Friction surface of rod and guard	Rubber grease	As required
10, 11, 33	Surface of cup packing	Rubber grease	As required
12	Periphery of hydraulic piston and pack to grease groove	Rubber grease	As required
13	Inside of hydraulic cylinder	Rubber grease	As required
17	Periphery of cup packing	Rubber grease	As required
20	Periphery of O-ring	Rubber grease	As required
21, 47	Periphery of O-ring	Air master paste	As required
23, 25	Both sides of gasket	Silicon oil	As required
34	Periphery of relay valve piston	Rubber grease	As required
35	Inside of fitting	Rubber grease	As required
37	Thread area of exhaust cover assembly	THREEBOND 1105	As required
45	Surface of cup packing (especially friction surface with cylinder shell)	Air master paste	As required
48	Tip of push rod	Rubber grease	As required
52	Internal surface of cylinder shell	Air master paste	As required

Special tools

Location	Tool name and shape	Part No.	Application
—	Stand plate	*910-10691	Fixation of clutch booster
10	Cup insert guide	*910-23285	Installation of cup packing
11	Cup insert guide	*910-23284	Installation of cup packing
19	Push out tool	*910-23100	Removal of oil seal
19	Insert tool	*910-23090	Installation of oil seal
31	Push guide	*910-23270	Centering of diaphragm assembly
35	L-spanner	*910-23260	Removal and installation of fitting

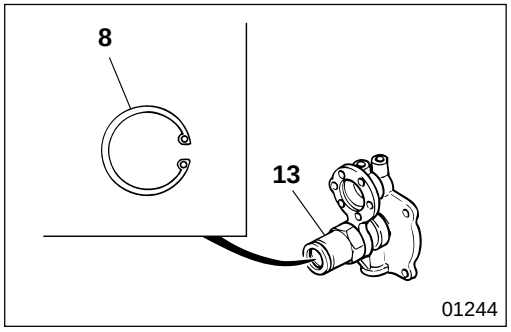
* : BOSCH BRAKING SYSTEMS part No.



◆ Service procedure

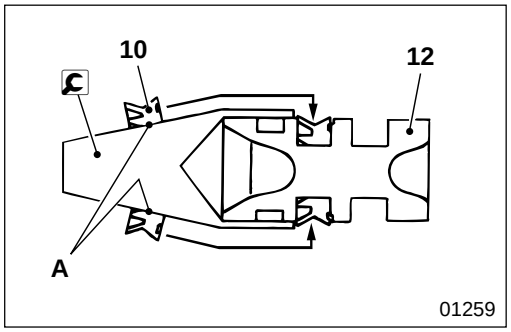
● Work before disassembly

- Put alignment marks on the connecting areas of all parts before disassembly.
- Mount the flange of end plate assembly **5** of the clutch booster on stand plate and place the clutch booster in a vise.



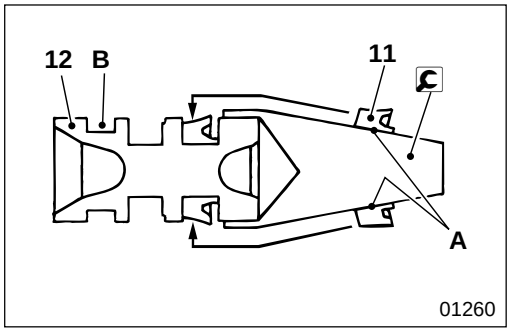
8 **Installation of retaining ring**

Install retaining ring **8** on hydraulic cylinder **13** in the direction as illustrated, so that opening area **A** of the retaining ring is horizontal.



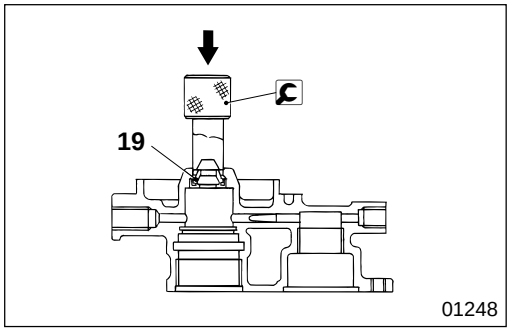
10 **Installation of cup packing**

Apply grease to inner periphery **A** of cup packing **10** and install the cup packing on hydraulic piston **12** in the direction as illustrated.



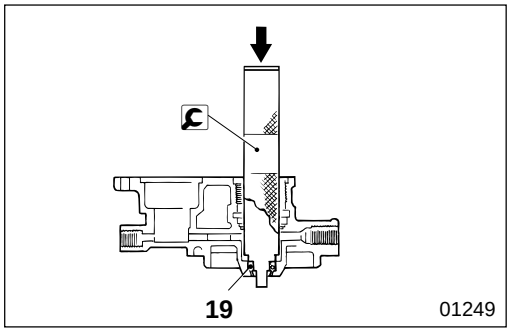
11 **12** **Installation of cup packing and grease packing of hydraulic piston**

- Apply grease to inner periphery **A** of cup packing **11** and install the cup packing on hydraulic piston **12** in the direction as illustrated.
- Pack grease into grease groove **B** of hydraulic piston **12**.

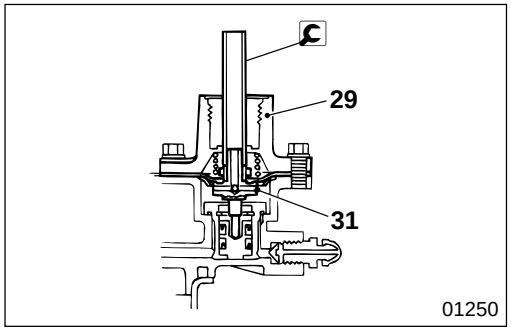


19 **Oil seal**

[Removal]

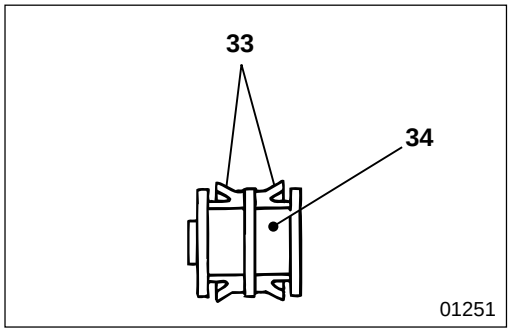


[Installation]



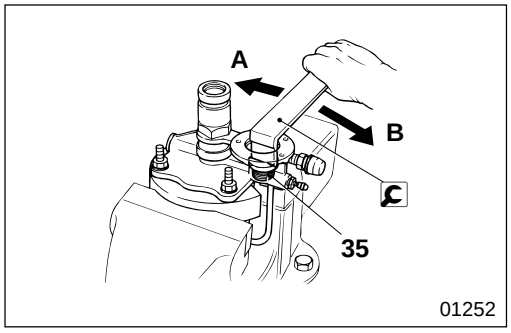
29 **Installation of upper valve body**

After centering diaphragm assembly **31** using push guide, install upper valve body **29**.



33 **Installation of cup packing**

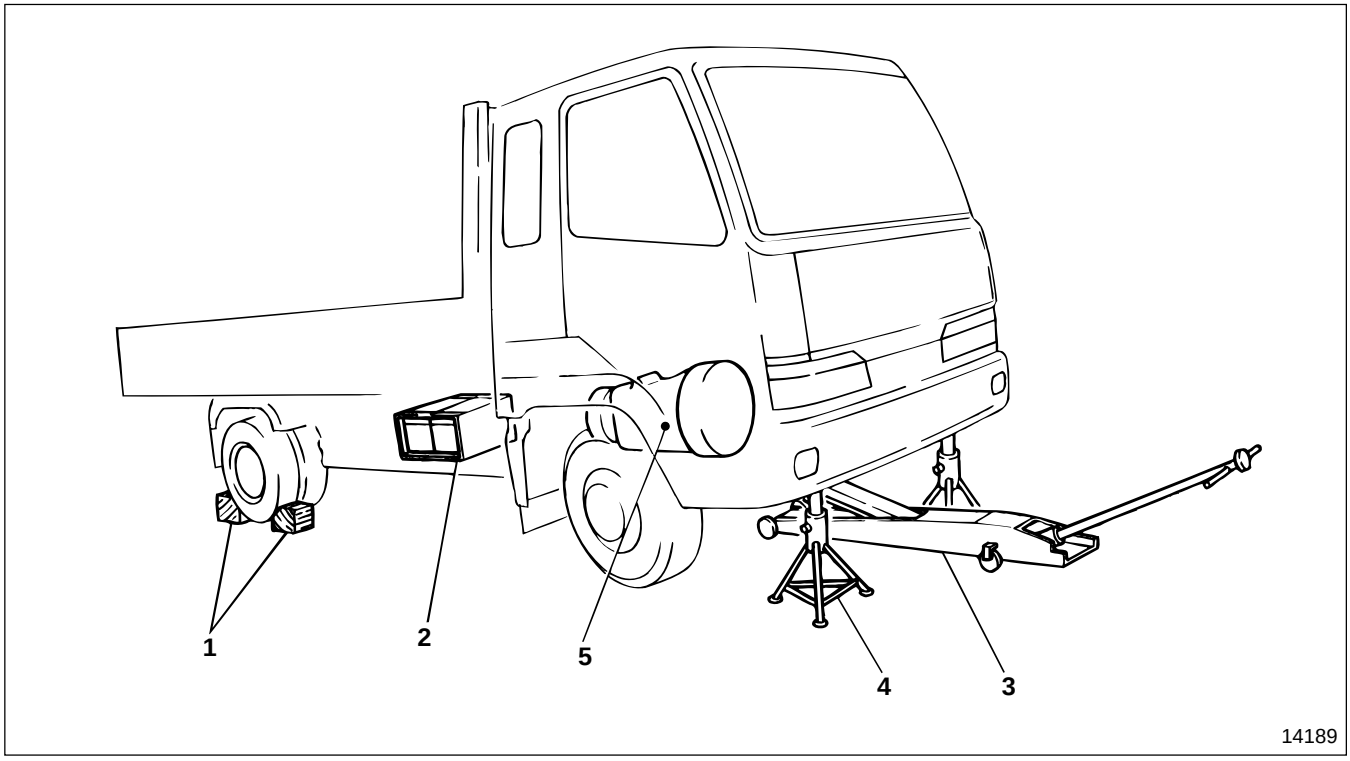
Install cup packing **33** on relay valve piston **34** in the direction as illustrated.



35 **Removal and installation of fitting**

A : Removal
B : Installation

WORK BEFORE REMOVAL AND INSTALLATION OF CLUTCH BODY



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable. Gr 54
3 Jack up the front axle using a garage jack.
4 Support the front frame on rigid racks.
5 Remove the transmission. Gr 22A, B

WARNING⚠

- **Since the parking brake (center parking) will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION⚠

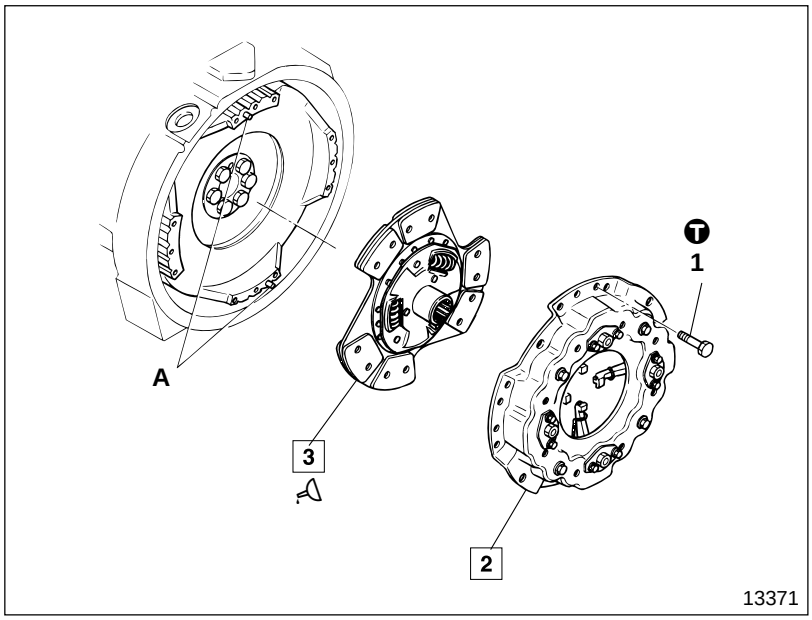
Keep the transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

Clutch Disc



● **Removal sequence**

1 Bolt
2 Pressure plate and lever assembly. P21-40
3 Clutch disc

A : Positioning pins (two points)

WARNING

Be careful when you handle pressure plate and lever assembly 2 because it is rather heavy.

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Be careful not to get oily substances on clutch disc 3 surfaces because this will cause the clutch to slip.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Clutch disc	Lateral runout	1.2 {0.047}or less	—	Replace
		Vertical runout	1.2 {0.047} or less	1.8 {0.071}	Replace
		Play to revolving direction at spline	0.07 to 0.23 {0.0028 to 0.0091}	0.5 {0.020}	Replace
		Depth from facing surface to cup	1.21 to 1.91 {0.048 to 0.075}	0.2 {0.0079}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

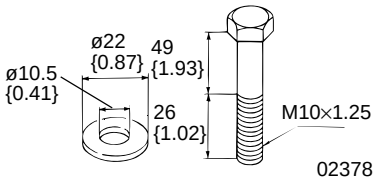
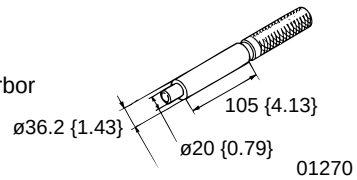
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Pressure plate and lever assembly mounting)	33 to 49 {24 to 36, 3.3 to 5.0}	—

Lubricant

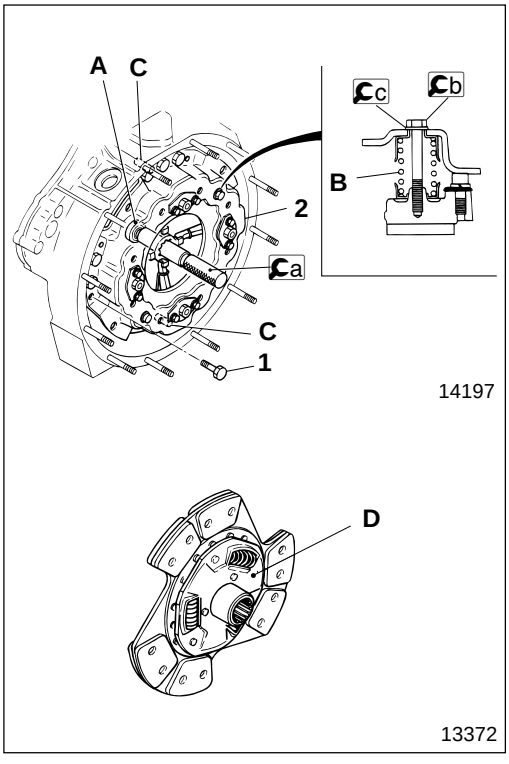
Location	Points of application	Kinds	Quantity
3	Spline of clutch disc	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	4.2 to 5.9 g {0.15 to 0.21 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Stopper bolt Washer 	43402-09200 < Stopper bolt > MH005024 < Washer >	Removal and installation of pressure plate and lever assembly
2, 3	Clutch alignment arbor 	MH061987	Holds clutch disc

◆ Service procedure

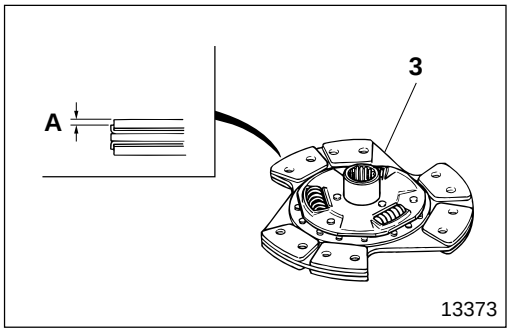


2 Removal and installation of pressure plate and lever assembly

- Insert a clutch alignment arbor in flywheel pilot bearing **A** to hold clutch disc **3**.
- Compress springs **B** using b stopper bolt and c washer, then remove bolt **1**.
- For installation, follow the removal sequence in reverse.
- Install clutch disc **3** so that part No. **D** is visible.
- Tighten bolts **1** gradually, in diagonal order, to specified torque.

CAUTION ⚠

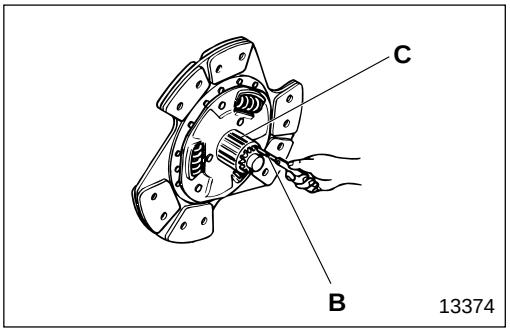
- **Beware, if you do not use b stopper bolts and c washers (four points) to remove bolt 1, the force of springs B might push out pressure plate and lever assembly 2, damaging the strap plate. It might even come apart from knock pin C and drop off.**
- **Remember to remove stopper bolts and washers after installation (four points). If the stopper bolts and washers are left on, the clutch will not engage.**



3 Clutch disc

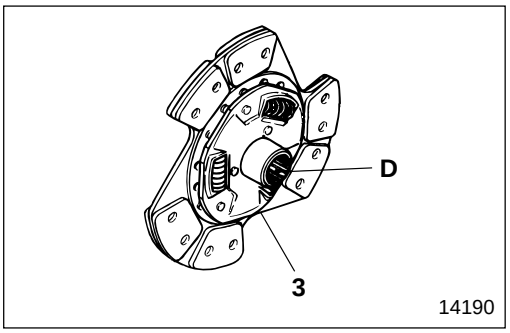
(1) Thickness of facing

Measure dimension **A** as illustrated.
If the measured value does not conform to the standard value, replace clutch disc **3**.



(2) Play in direction of revolution

- Reshape feeler gauge **B** for insertion into drive pinion spline **C**, and measure play.
- If the measured value is higher than the limit, replace clutch disc **3** or the drive pinion.
- Carry out the same measurement on new clutch disc **3**. If the measured value is higher than the limit, replace the drive pinion.



(3) Applying grease

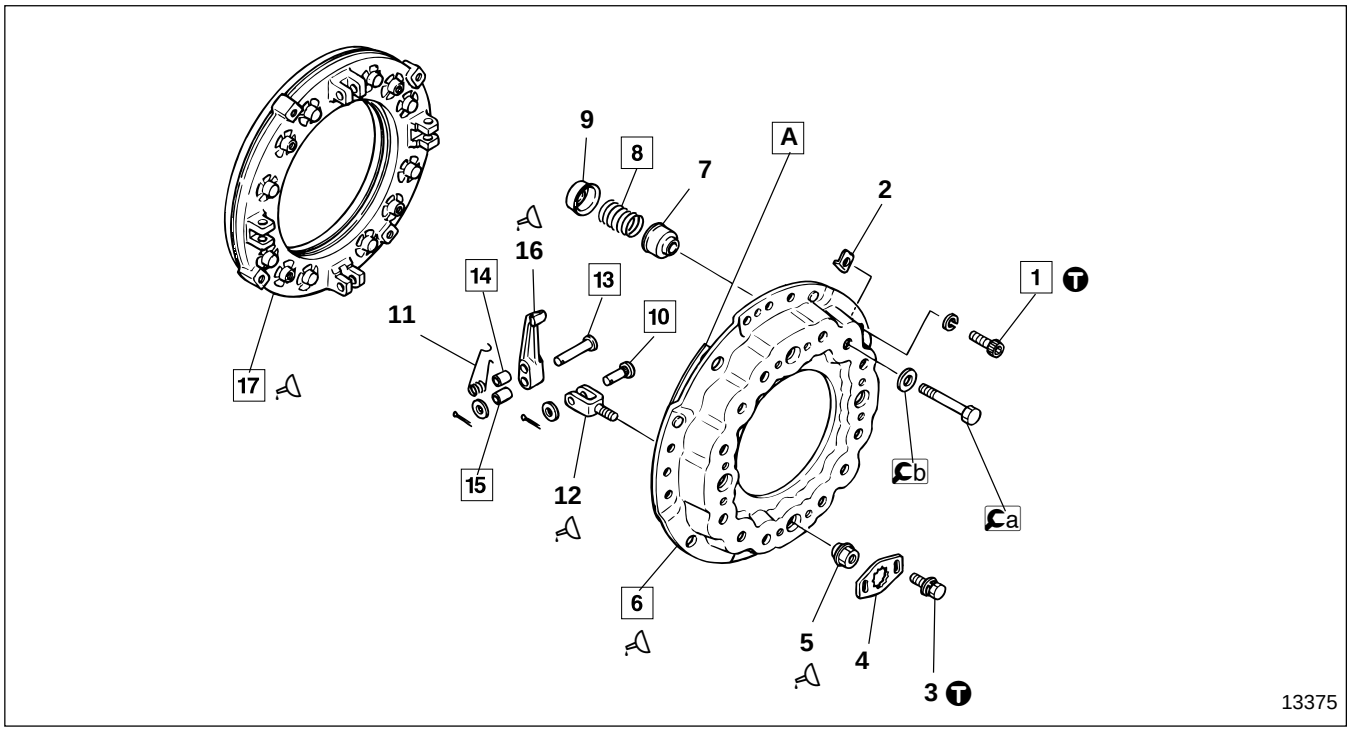
Apply grease evenly to spline **D** and the entire tooth surface of clutch disc **3**. Apply grease to the grease groove of the spline up to its large diameter.

CAUTION

Be careful not to apply too much grease because excessive grease causes grease leakage from spline D and makes the clutch slippery.

M E M O

Pressure Plate and Lever Assembly



● **Work before disassembly**

P21-42

● **Disassembly sequence**

1 Strap bolt
2 Washer
3 Lock bolt
4 Lock plate
5 Support nut
6 Clutch cover
7 Spring seat
8 Pressure spring
9 Spring seat
10 Support lever pin
11 Return spring
12 Support lever
13 Release lever pin
14 Bushing
15 Bushing
16 Release lever
17 Pressure plate

A : Strap plate
a : Stopper bolt
b : Washer

NOTE

Do not remove bushings 14, 15 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Clutch release lever kit

● **Inspection and adjustment after assembly**

P21-42

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
1, A	Clearance between strap plate and bolt		0 to 0.15 {0 to 0.0059}	0.3 {0.012}	Replace
8	Pressure spring	Load (Installed length 54.8 {2.16})	955 N {215 lbf, 97.5 kgf}	810 N {180 lbf, 82.9 kgf}	Replace
		Tilt	3.6 {0.14} or less	5.0 {0.20}	
10, 14	Clearance between support lever pin and bushing		[10] 0.017 to 0.126 {[0.39] 0.00067 to 0.0050}	0.4 {0.016}	Replace
14 to 16	Clearance between release lever and bushing		[10] 0.016 to 0.118 {[0.39] 0.00063 to 0.0046}	0.4 {0.016}	Replace
16	Height of release lever		61.8±0.5 {2.43±0.020}	Difference between any two: 0.5 {0.020} or less	Adjust
17	Pressure plate	Thickness	30.8±0.1 {1.21±0.0039}	28 {1.10}	Replace
		Flatness	0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Inner diameter of strap bolt fitting hole	10.2 to 10.25 {0.402 to 0.404}	10.5 {0.41}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

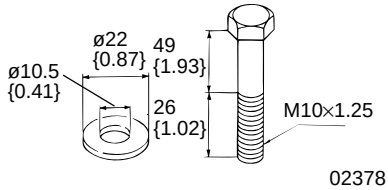
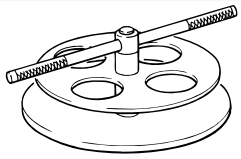
Location	Parts to be tightened	Tightening torque	Remarks
1	Strap bolt (Strap plate mounting)	39 to 49 {29 to 36, 4.0 to 5.0}	—
3	Lock bolt (Lock plate mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—

Lubricant

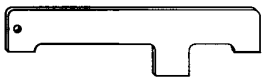
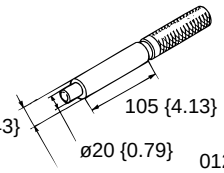
Location	Points of application	Kinds	Quantity
5	Threads of support nut and spherical surfaces	Anti-seizure compound	As required
5, 6	Contact areas of support nut and clutch cover	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
12, 16	Friction surfaces between release lever and support lever	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
16, 17	Release lever and pressure plate sliding section	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

Special tools

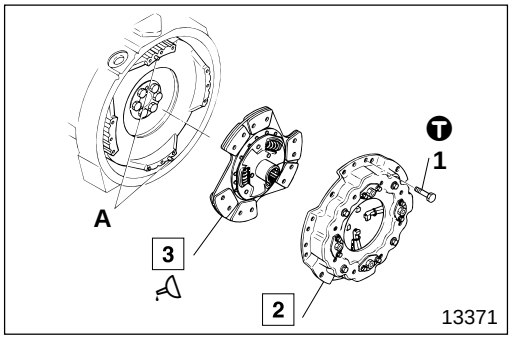
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Stopper bolt Washer 	43402-09200 < Stopper bolt > MH005024 < Washer >	Disassembly and assembly of pressure plate and lever assembly
6	Clutch installer 	MH061331 (Obtain Locally)	Removal and installation of clutch cover

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
16	Clutch release lever aligner 	43490-MH062292	Adjustment of release lever heights
	Clutch alignment arbor 	MH061987	

◆ Service procedure



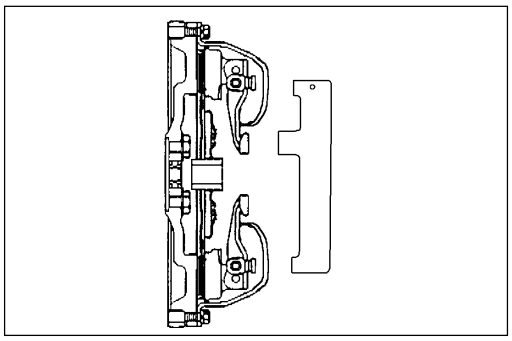
● Work before disassembly

Put alignment marks on all parts before disassembly.

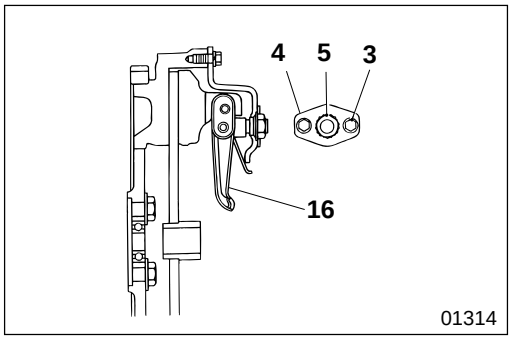
● Inspection and adjustment after assembly

(1) Measurement of release lever height

- Install the pressure plate and lever assembly using Ⓒa clutch master plate and Ⓒb clutch alignment arbor instead of clutch disc.
- Install Ⓒa clutch master plate so that identification mark "**6**" can be seen.

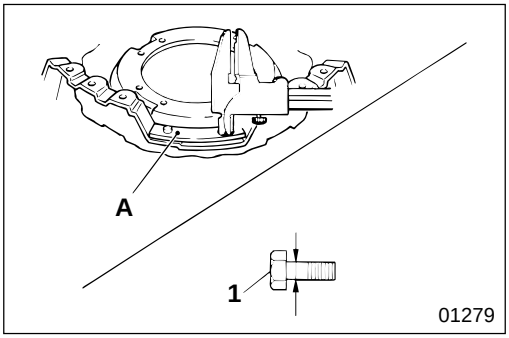


- Measure dimension **A** between Ⓒa clutch master plate and each upper surface of release levers **16** (four points).
- If the measured values deviate from the standard value, adjust as follows. Even if the measured values are within the standard value, if the relative difference among each measured value is 0.5 mm {0.020 in.} or more, adjust the heights, too.



(2) Adjustment of release lever height

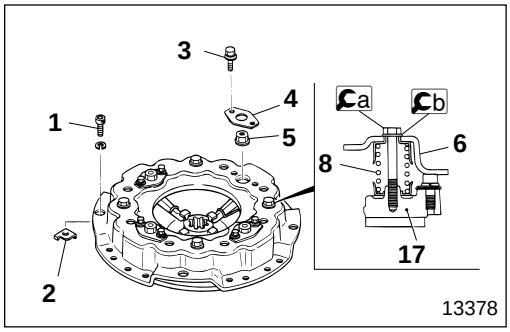
- Remove bolt **3** and lock plate **4**, and adjust the height by turning support nut **5**.
- After adjustment, install lock plate **4**, fasten support nut **5** and check the height of release lever **16**.



1 **A** **Clearance between strap bolt and strap plate**

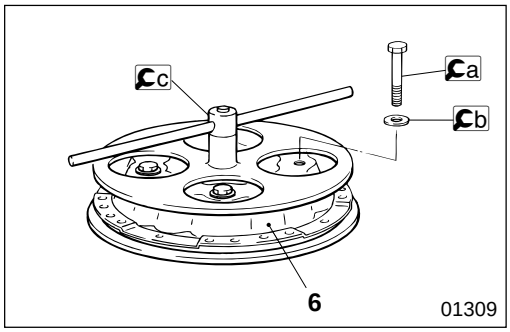
If the measured value is higher than the limit, replace the faulty parts.

A : Strap plate

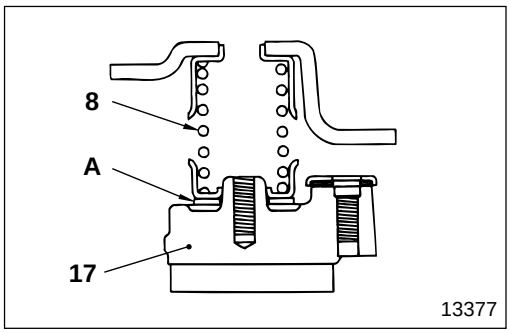


6 **Removal and installation of clutch cover**

- After fixing clutch cover **6** and pressure plate **17** using ca stopper bolt and cb washer, remove strap bolt **1**, washer **2**, lock bolt **3**, lock plate **4** and support nut **5**.



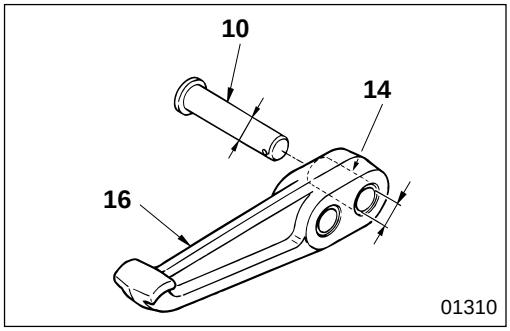
- Compress pressure spring **8** using cc clutch installer, and remove ca stopper bolt and cb washer.
- Gradually loosen cc clutch installer until pressure spring **8** is released, and remove clutch cover **6**.
- For installation, follow the removal sequence in reverse.



8 **Installation of pressure spring**

When grinding pressure plate **17** to correct it, insert adjusting washer **A**, equivalent to the amount of correction made by grinding, between the pressure plate and pressure spring **8**.

Amount of correction made by grinding	Thickness of adjusting washer
Less than 1mm {0.039 in.}	Not required
1 to 2mm {0.039 to 0.079 in.}	1.2 mm {0.047 in.}×1
2 to 3mm {0.079 to 0.12 in.}	1.2 mm {0.047 in.}×2 or, 2.3 mm {0.091 in.}×1

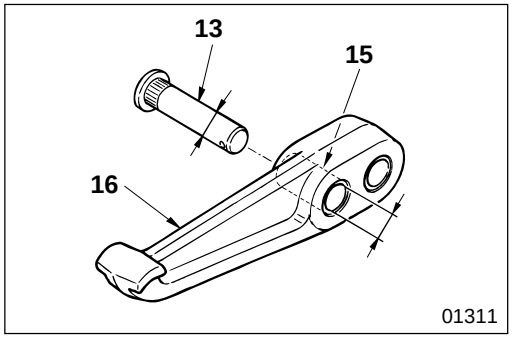


10 **14** **Clearance between support lever pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 14 press-fitted in release lever 16.

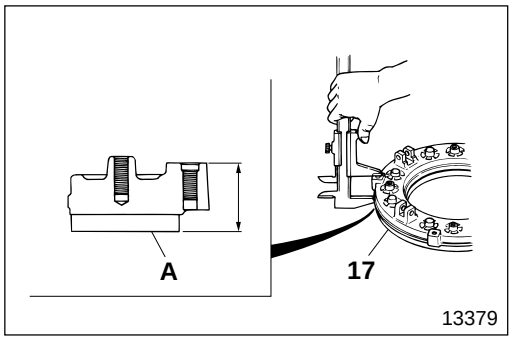


13 **15** **Clearance between release lever pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 15 press-fitted in release lever 16.

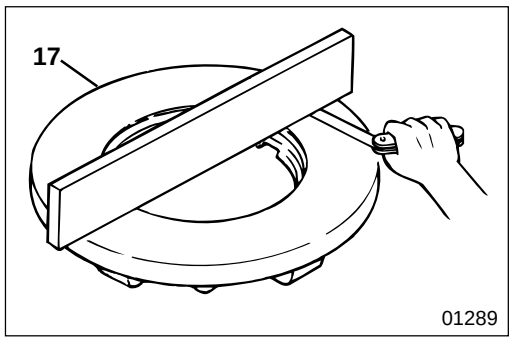


17 **Inspection of pressure plate**

(1) Thickness

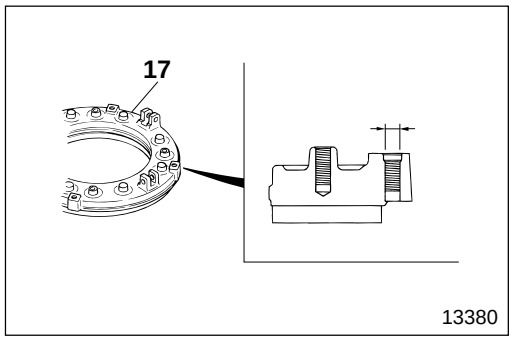
- Measure friction surface **A** of pressure plate **17** (measuring position must be within the maximum and minimum diameters), and if the measured value is lower than the limit, replace the pressure plate.

Maximum diameter	340 mm {13.4 in.}
Minimum diameter	250 mm {9.84 in.}



(2) Levelness

If the measured value is lower than the limit, replace pressure plate **17**.

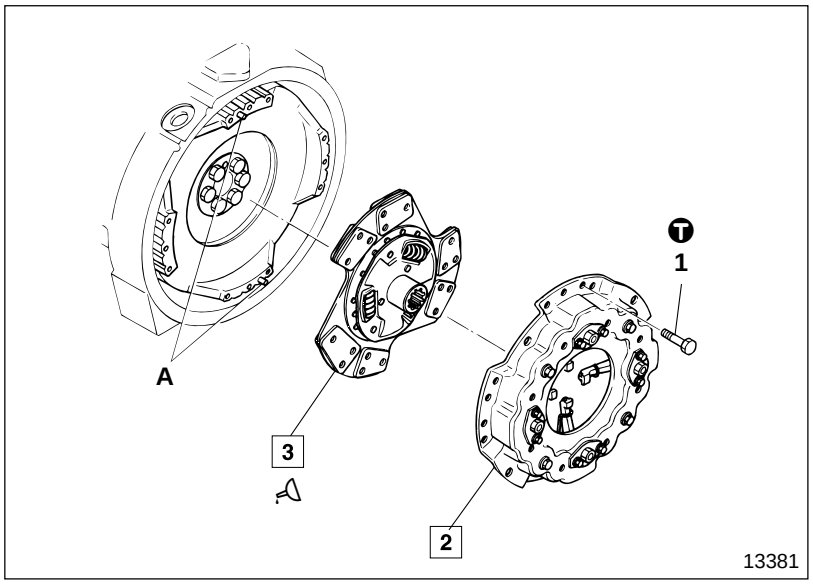


(3) Inner diameter of fitting hole of strap bolt

If the measured value is higher than the limit, replace pressure plate **17**.

M E M O

Clutch Disc



● **Removal sequence**

1 Bolt
2 Pressure plate and lever assembly
P21-50
3 Clutch disc

A : Positioning pins (two points)

WARNING

Be careful when you handle pressure plate and lever assembly 2 because it is rather heavy.

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Be careful not to get oily substances on clutch disc 3 surfaces because this will cause the clutch to slip.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Clutch disc	Lateral runout	1.2 {0.047} or less	—	Replace
		Vertical runout	1.2 {0.047} or less	1.5 {0.059}	Replace
		Play to revolving direction at spline	0.07 to 0.23 {0.0028 to 0.0091}	0.5 {0.020}	Replace
		Depth from facing surface to cup	1.88 to 2.62 {0.074 to 0.103}	0.2 {0.0079}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

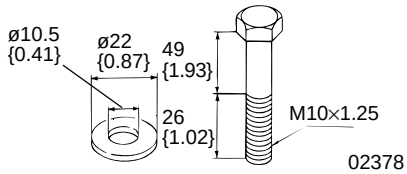
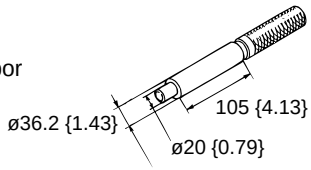
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Pressure plate and lever assembly mounting)	33 to 49 { 24 to 36, 3.3 to 5.0}	—

Lubricant

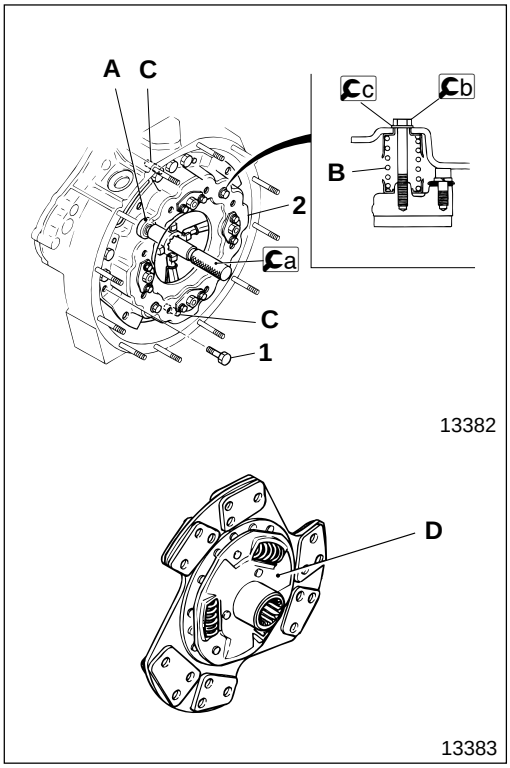
Location	Points of application	Kinds	Quantity
3	Spline of clutch disc	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	5.3 to 7.5 g {0.19 to 0.26 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Stopper bolt Washer 	43402-09200 < Stopper bolt > MH005024 < Washer >	Removal and installation of pressure plate and lever assembly
2, 3	Clutch alignment arbor 	MH061987	Holds clutch disc

◆ Service procedure

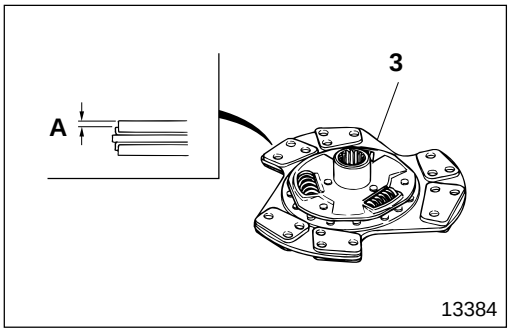


2 Removal and installation of pressure plate and lever assembly

- Insert [a] clutch alignment arbor in flywheel pilot bearing **A** to hold clutch disc **3**.
- Compress springs **B** using [b] stopper bolt and [c] washer, then remove bolt **1**.
- For installation, follow the removal sequence in reverse.
- Install clutch disc **3** so that part No. **D** is visible.
- Tighten bolts **1** gradually, in diagonal order, to specified torque.

CAUTION ⚠

- **Beware, if you do not use [b] stopper bolts and [c] washers (four points) to remove bolt 1, the force of springs B might push out pressure plate and lever assembly 2, damaging the strap plate. It might even come apart from knock pin C and drop off.**
- **Remember to remove stopper bolts and washers after installation (four points). If the stopper bolts and washers are left on, the clutch will not engage.**

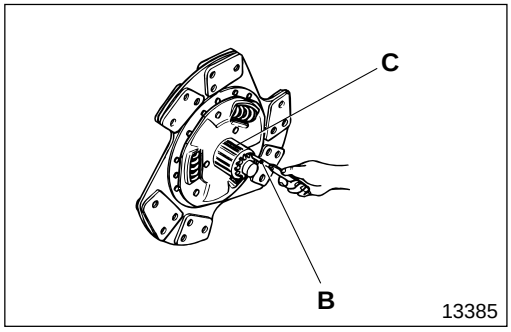


3 Clutch disc

(1) Thickness of facing

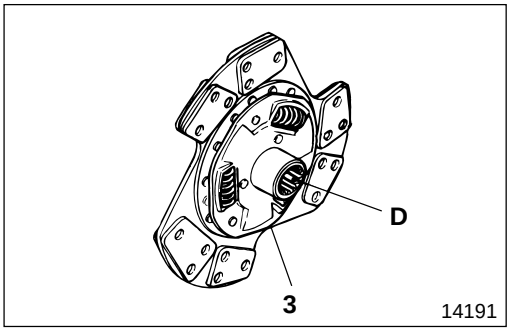
Measure dimension **A** as illustrated.

If the measured value does not conform to the standard value, replace clutch disc **3**.



(2) Play in direction of revolution

- Reshape feeler gauge **B** for insertion into drive pinion spline **C**, and measure play there.
- If the measured value is higher than the limit, replace clutch disc **3** or the drive pinion.
- Carry out the same measurement on new clutch disc **3**. If the measured value is higher than the limit, replace the drive pinion.



(3) Applying grease

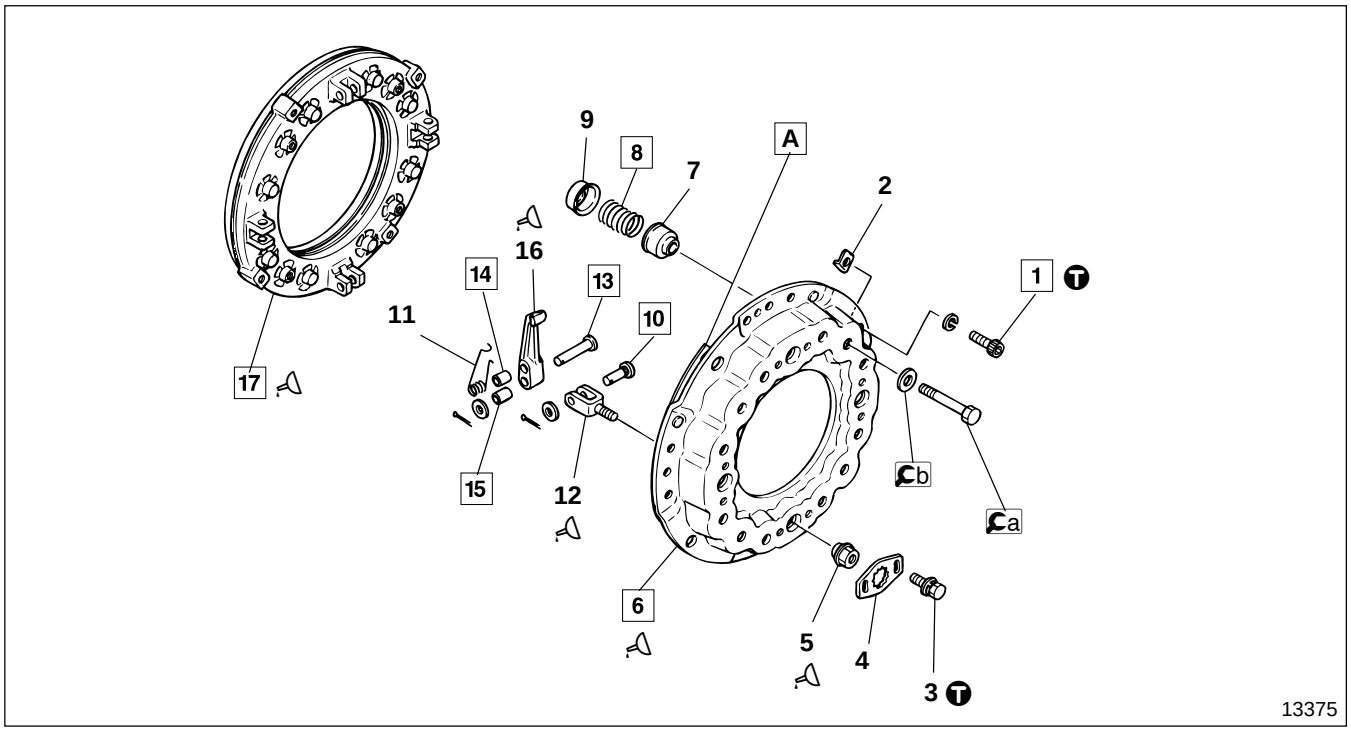
Apply grease evenly to spline **D** entire tooth surface of clutch disc **3**. Apply grease to the grease groove of the spline up to its large diameter.

CAUTION

Be careful not to apply too much grease because excessive grease causes grease leakage from spline D and makes the clutch slippery.

M E M O

Pressure Plate and Lever Assembly



● **Work before disassembly**

P21-52

● **Disassembly sequence**

1 Strap bolt
2 Washer
3 Lock bolt
4 Lock plate
5 Support nut
6 Clutch cover
7 Spring seat
8 Pressure spring
9 Spring seat
10 Support lever pin
11 Return spring
12 Support lever
13 Release lever pin
14 Bushing
15 Bushing
16 Release lever
17 Pressure plate

A : Strap plate
a : Stopper bolt
b : Washer

NOTE

Do not remove bushings 14, 15 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Clutch release lever kit

● **Inspection and adjustment after assembly**

P21-52

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
1, A	Clearance between strap plate and bolt			0.01 to 0.16 {0.00039 to 0.0063}	0.3 {0.012}	Replace
8	Pressure spring	Load (Installed length 56.05 {2.21})	M8	1159 N {260 lbf, 118.2 kgf}	988 N {220 lbf, 100.5 kgf}	Replace
			M070	1081 N {240 lbf, 110.2 kgf}	919 N {205 lbf, 93.7 kgf}	
		Tilt		3.6 {0.14} or less	5.0 {0.20}	
10, 14	Clearance between support lever pin and bushing			[10] 0.017 to 0.126 {[0.39] 0.00067 to 0.0050}	0.4 {0.016}	Replace
14 to 16	Clearance between release lever and bushing			[10] 0.016 to 0.118 {[0.39] 0.00063 to 0.0046}	0.4 {0.016}	Replace
16	Height of release lever			62.1±0.5 {2.44±0.020}	Difference between any two: 0.5 {0.020} or less	Adjust
17	Pressure plate	Thickness		30.8±0.1 {1.21±0.0039}	28 {1.10}	Replace
		Flatness		0.05 {0.0020} or less	0.2 {0.0079}	Correct or replace
		Inner diameter of strap bolt fitting hole		10.2 to 10.25 {0.402 to 0.404}	10.5 {0.41}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

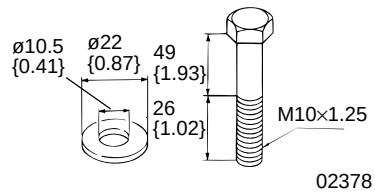
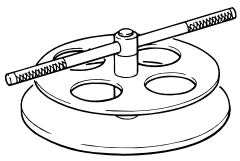
Location	Parts to be tightened	Tightening torque	Remarks
1	Strap bolt (Strap plate mounting)	32.9 to 49 {29 to 36, 4.0 to 5.0}	—
3	Lock bolt (Lock plate mounting)	9.8 to 14.7 {7.2 to 11, 1.0 to 1.5}	—

Lubricant

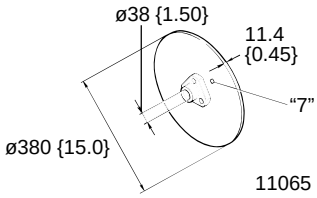
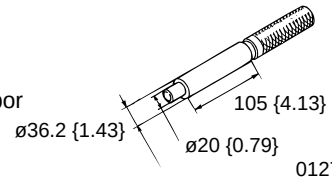
Location	Points of application	Kinds	Quantity
5	Threads of support nut and spherical surfaces	Anti-seizure compound	As required
5, 6	Contact areas of support nut and clutch cover	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
12, 16	Release lever to support lever friction surfaces	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
16, 17	Release lever and pressure plate sliding section	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

Special tools

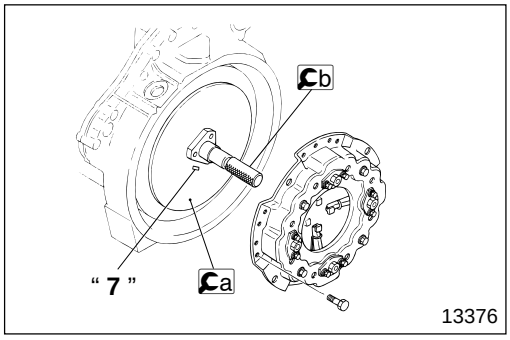
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
—	Stopper bolt Washer  02378	43402-09200 < Stopper bolt > MH005024 < Washer >	Disassembly and assembly of pressure plate and lever assembly
6	Clutch installer  01306	MH061331	Removal and installation of clutch cover

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
16	Clutch master plate 	MH062353	Adjusts release lever heights
	Clutch alignment arbor 	MH061987	

◆ Service procedure



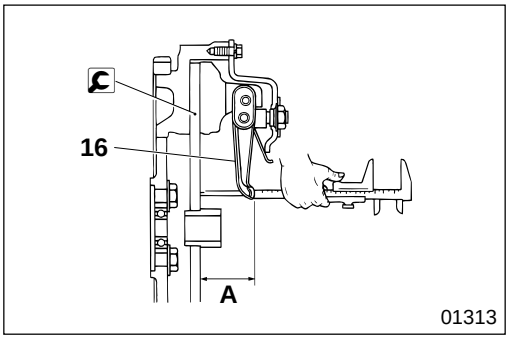
● Work before disassembly

Put alignment marks on all parts before disassembly.

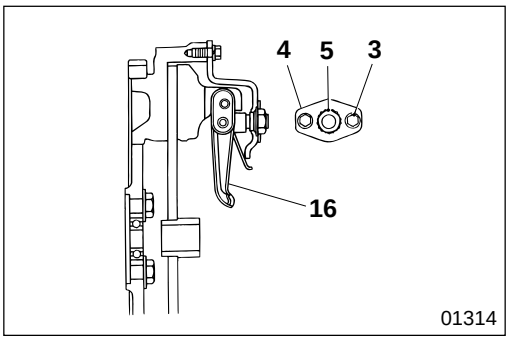
● Inspection and adjustment after assembly

(1) Measurement of release lever height

- Install the pressure plate and lever assembly using a clutch master plate and b clutch alignment arbor instead of clutch disc.
- Install a clutch master plate so that identification mark "**7**" can be seen.

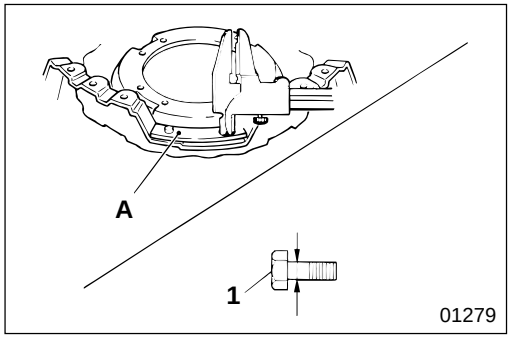


- Measure dimension **A** between clutch master plate and each upper surface of release levers **16** (four points).
- If the measured values deviate from the standard value, adjust as follows. Even if the measured values are within the standard value, if the relative difference among each measured value is 0.5 mm {0.020 in.} or more, adjust the heights, too.



(2) Adjustment of release lever height

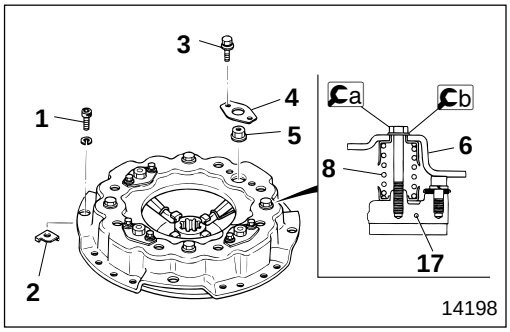
- Remove bolt **3** and lock plate **4**, and adjust the height by turning support nut **5**.
- After adjustment, install lock plate **4**, fasten support nut **5** and check the height of release lever **16**.



1 **A** **Clearance between strap bolt and strap plate**

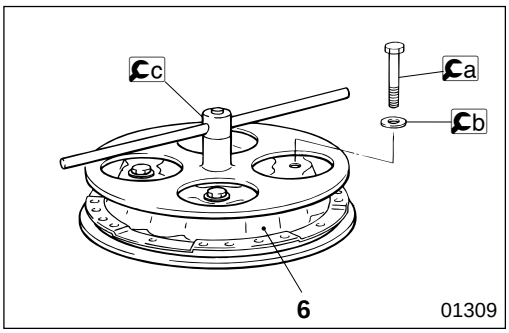
If the measured value is higher than the limit, replace the faulty parts.

A : Strap plate

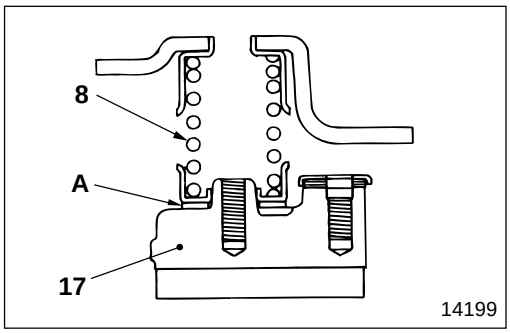


6 **Removal and installation of clutch cover**

- After fixing clutch cover **6** and pressure plate **17** using a stopper bolt and b washer, remove strap bolt **1**, washer **2**, lock bolt **3**, lock plate **4** and support nut **5**.



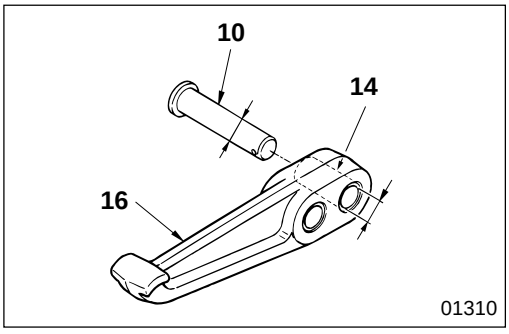
- Compress pressure spring **8** using c clutch installer, and remove a stopper bolt and b washer.
- Gradually loosen c clutch installer until pressure spring **8** is released, and remove clutch cover **6**.
- For installation, follow the removal sequence in reverse.



8 **Installation of pressure spring**

When grinding pressure plate **17** to correct it, insert adjusting washer **A**, equivalent to the amount of correction made by grinding, between the pressure plate and pressure spring **8**.

Amount of correction made by grinding	Thickness of adjusting washer
Less than 1 mm {0.039 in.}	Not required
1 to 2 mm {0.039 to 0.079 in.}	1.2 mm {0.047 in.}×1
2 to 3 mm {0.079 to 0.12 in.}	1.2 mm {0.047 in.}×2 or, 2.3 mm {0.091 in.}×1

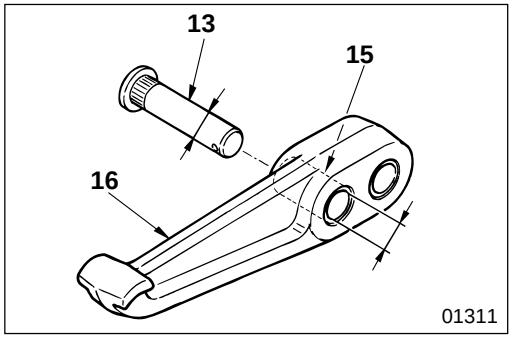


10 **14** **Clearance between support lever pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 14 press-fitted in release lever 16.

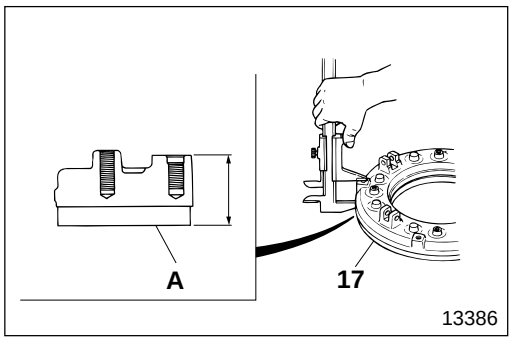


13 **15** **Clearance between release lever pin and bushing**

If the measured value is higher than the limit, replace the faulty parts.

NOTE

This inspection must be made with bushing 15 press-fitted in release lever 16.

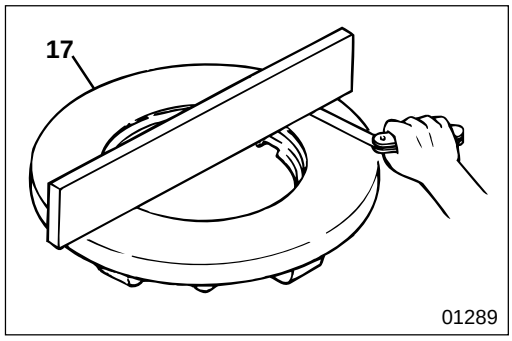


17 **Inspection of pressure plate**

(1) Thickness

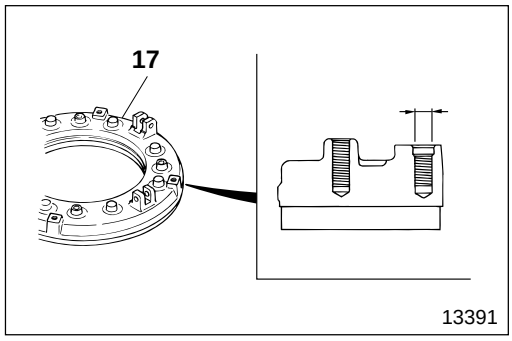
- Measure friction surface **A** of pressure plate **17** (measuring position must be within the maximum and minimum diameters), and if the measured value is lower than the limit, replace the pressure plate.

Maximum diameter	370 mm {14.6 in.}
Minimum diameter	240 mm {9.45 in.}



(2) Levelness

If the measured value is lower than the limit, replace pressure plate **17**.

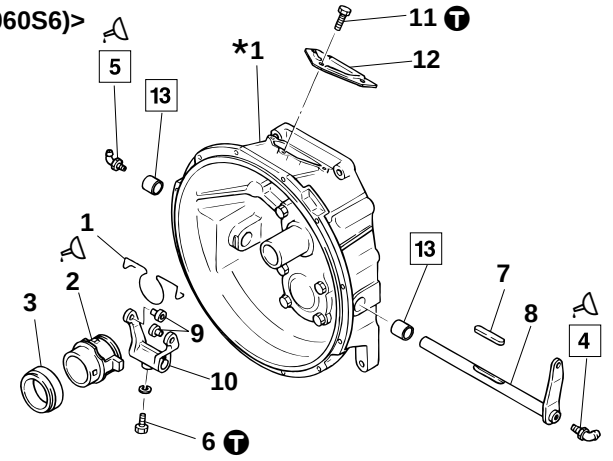


(3) Inner diameter of fitting hole of strap bolt

If the measured value is higher then the limit, replace pressure plate **17**.

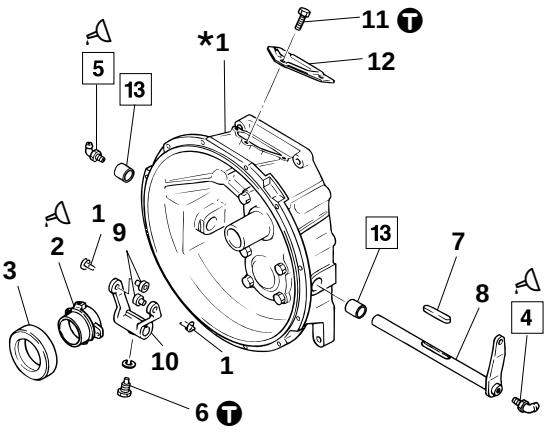
M E M O

< C6 (M060S6)>



13452

< C7 (M070S6) >



13453

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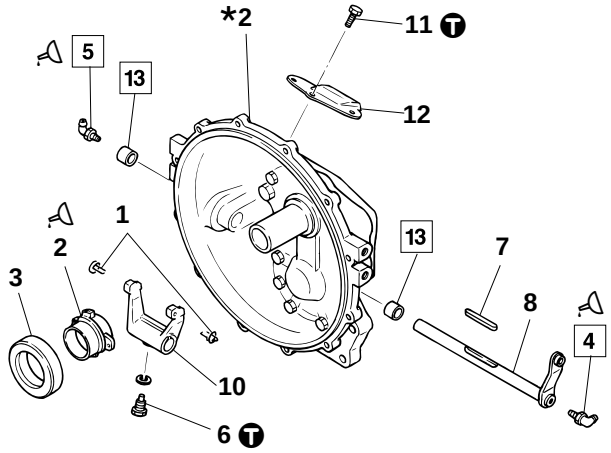


13454

● **Disassembly sequence**

1 Return spring
2 Clutch shifter
3 Release bearing
4 Grease nipple
5 Grease nipple
6 Set screw
7 Key
8 Release fork shaft
9 Cam follower < C6, C7 (M070S6) >
10 Release fork
11 Bolt
12 Cover
13 Needle roller bearing

***1** : Clutch housing Gr 22A
***2** : Clutch housing Gr 22B

NOTE

Do not remove release bearing 3 and needle roller bearing 13 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

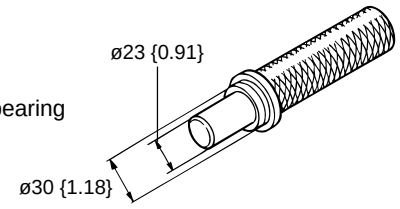
Location	Parts to be tightened	Tightening torque	Remarks
6	Set screw	21 {15, 2.1}	—
11	Bolt (Clutch housing cover mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—

Lubricant

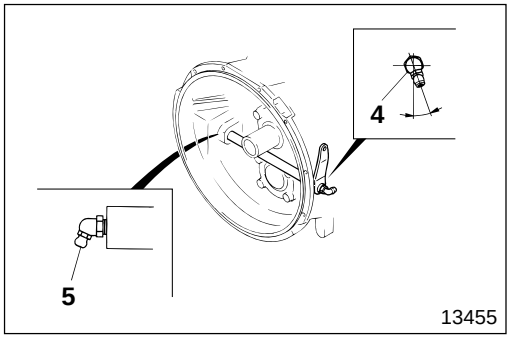
Location	Points of application	Kinds	Quantity
2	Pack into clutch shifter	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4, 5	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
13	Needle roller bearing installer 	03726-83000	Press-fitting of needle roller bearing

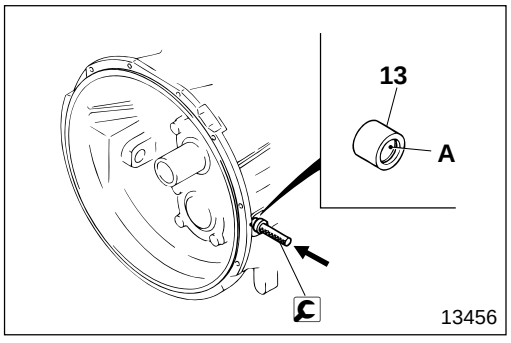
◆ Service procedure



4 **5** **Installation of grease nipple**

NOTE

Install grease nipple 4, 5 so that it faces the direction as illustrated.



13 **Installation of needle roller bearing**

CAUTION

Do not damage the bearing by hitting it directly with a hammer during installation.

NOTE

Install needle roller bearing 13 so that the side with yellow sticker A faces outside.

MITSUBISHI
FUSO

Group 22A

Manual Transmission
< M060S6, M070S6 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-22A

INDEX

SPECIFICATIONS 22A- 2

STRUCTURE AND OPERATION 22A- 2

TROUBLESHOOTING 22A-11

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22A-12

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22A-14

GEAR SHIFTER UPPER AND INTERLOCK PLATE 22A-18

POWER SHIFT ASSEMBLY 22A-24

EXTENSION HOUSING, REAR COVER AND PARKING BRAKE ASSEMBLY 22A-30

6TH GEAR < OVERDRIVE (O/D) > AND REVERSE IDLER GEAR < OVERDRIVE (O/D) > 22A-34

REVERSE GEAR AND REVERSE IDLER GEAR < DIRECT DRIVE (D/D) > 22A-42

TRANSMISSION BODY 22A-48

DRIVE PINION ASSEMBLY 22A-64

MAINSHAFT ASSEMBLY < OVERDRIVE (O/D) > 22A-66

MAINSHAFT ASSEMBLY < DIRECT DRIVE (D/D) > 22A-74

COUNTERSHAFT ASSEMBLY 22A-84

TRANSMISSION CONTROL 22A-88

PULLER AND INSTALLER KIT 22A-92

SPECIFICATIONS/STRUCTURE AND OPERATION

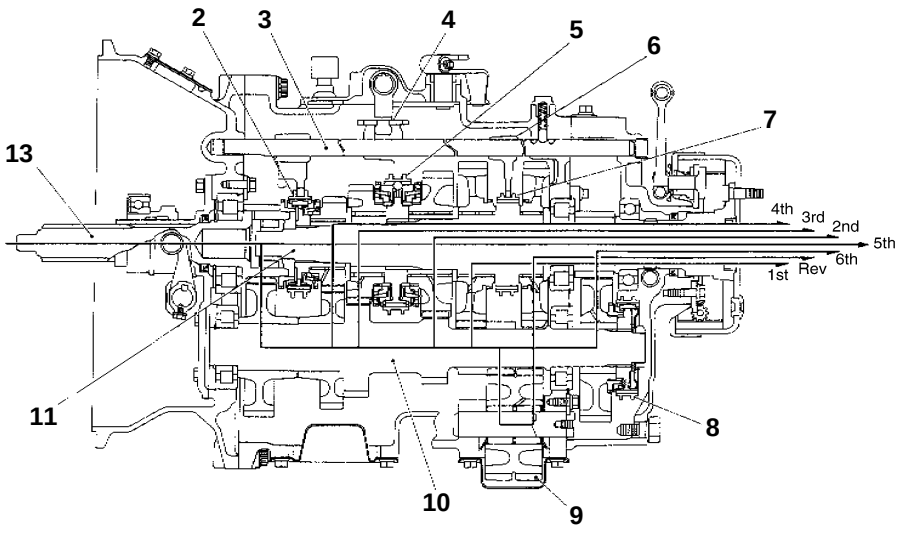
SPECIFICATIONS

Item		Specifications	
Mode of control		Floor shift remote control	
Transmission model		M060S6	M070S6
Gear ratio	1st	6.875	8.064
	2nd	4.189	5.443
	3rd	2.460	3.064
	4th	1.542	1.824
	5th	1.000	1.321
	6th	0.786	1.000
	Reverse	6.875	7.354
Oil capacity	Gear Oil	General : API GL-3 SAE 80 Warm region : API GL-3 SAE 90 Tropical region : API GL-4 SAE 90	
	Engine Oil	Long period of high-speed driving : API CC SAE 30 or SAE 40 : API CC/SF SAE 30 or SAE 40	
	Quantity L {qts}	6.7 {7.1}	8.1 {8.6}
Mass	kg {lbs}	151 {339}	176 {388}
Power shift manufacturer		BOSCH BRAKING SYSTEMS	

STRUCTURE AND OPERATION

Transmission

< O/D >



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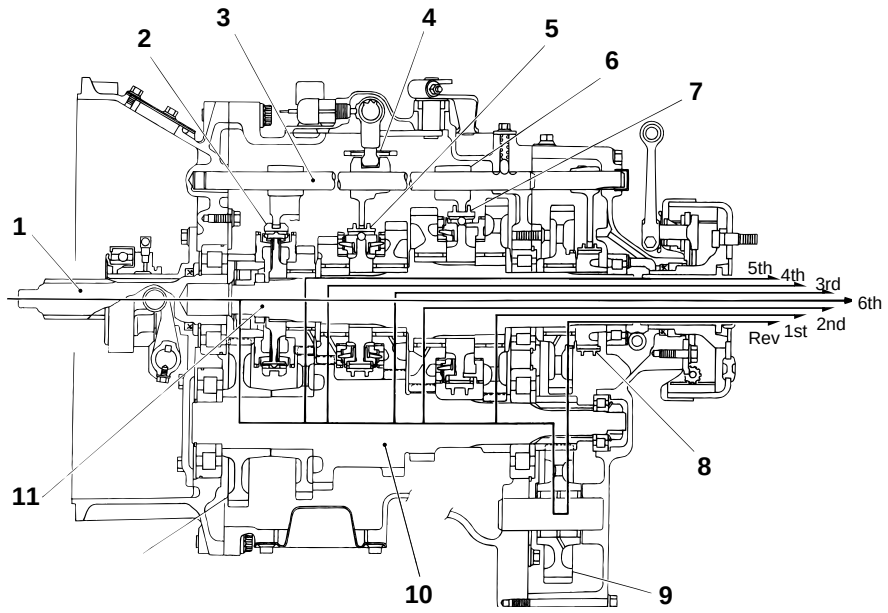
< D/D >



12065

1 Drive pinion
2 4th and 5th synchronizer assembly < O/D >
5th and 6th synchronizer assembly < D/D >
3 Shift rail
4 Interlock mechanism
5 2nd and 3rd synchronizer assembly < O/D >
3rd and 4th synchronizer assembly < D/D >
6 Shift fork
7 1st and reverse constant mesh assembly < O/D >
1st constant mesh and 2nd synchronizer assembly < D/D >
8 6th synchronizer assembly < O/D >
Reverse constant mesh < D/D >
9 Reverse idler gear
10 Countershaft
11 Mainshaft

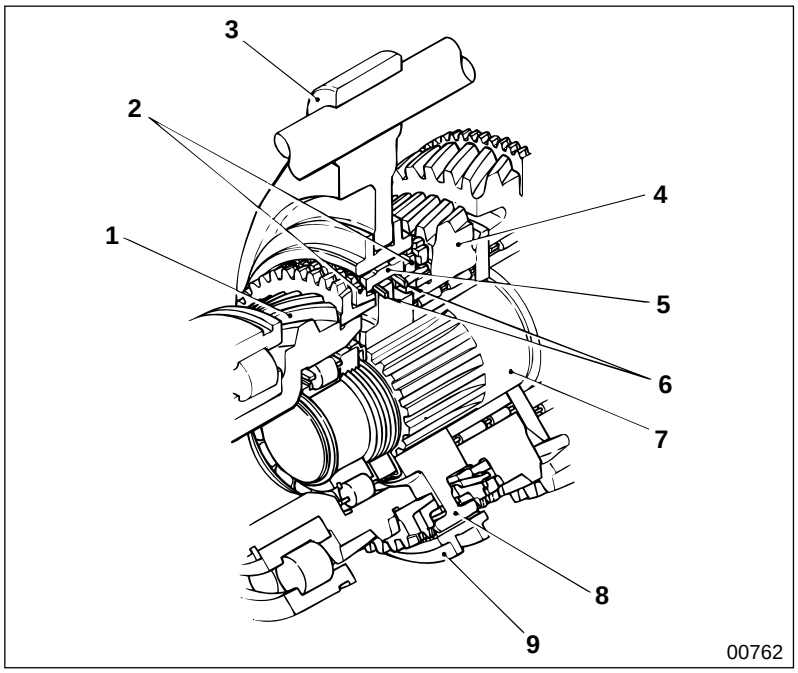
The transmission changes revolution and torque generated by the engine into those that match the vehicle's power requirement (driving force). Revolution and torque are increased or decreased by making a selection from several sets of engaged gears. The transmission uses an interlock mechanism to avoid double engagement.

Synchromesh Mechanism

This vehicle has two synchromesh mechanisms, a single cone type, and a double cone type, and uses the key system. The single or double cone type is used depending on the gear positions as shown below:

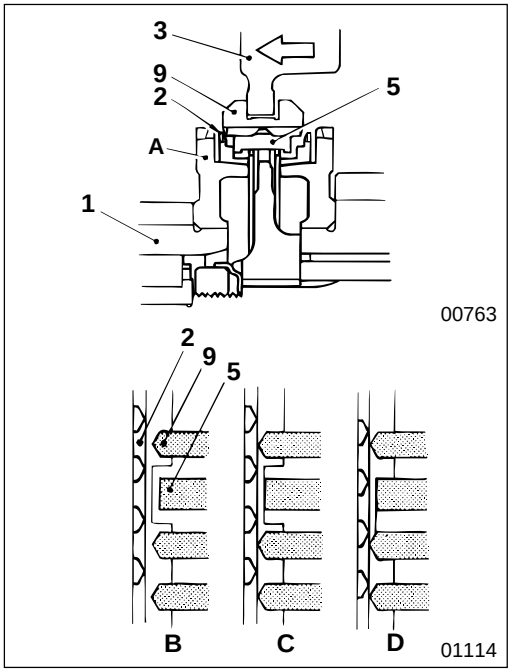
Transmission model / Synchromesh type	O/D	D/D
Single cone type	4th, 5th and 6th	5th, 6th
Double cone type	2nd and 3rd	2nd, 3rd and 4th

Single Cone Type

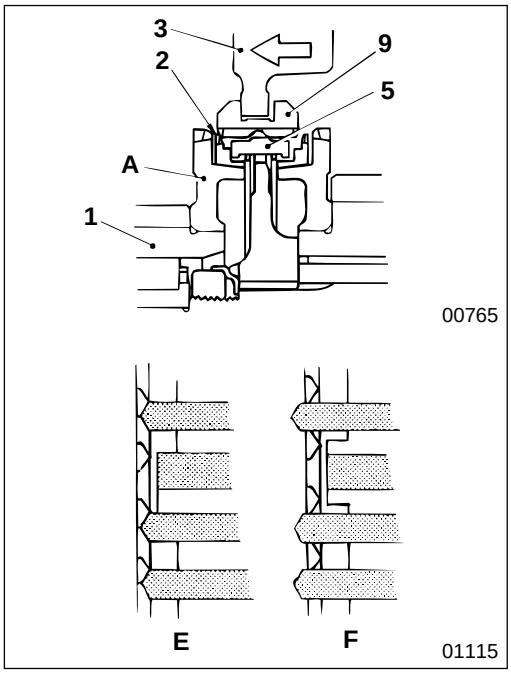


1 Drive pinion (Single cone type)
2 Synchronizer ring
3 4th and 5th shift fork
4 4th gear (Double cone type)
5 Shifting key
6 Shifting key spring
7 Mainshaft
8 Synchronizer hub
9 Synchronizer sleeve

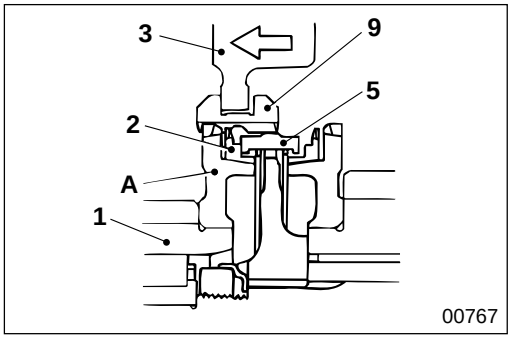
- The following descriptions are for 4th and 5th gear < O/D >
  The inside of synchronizer hub **8** engages the spline of mainshaft **7** and rotates with it. The outside of the synchronizer hub has a spline that engages synchronizer sleeve **9** and three keyways.
- Shifting keys **5** are inserted into these keyways. When the gear shift is in neutral, a protrusion in the center of each shifting key engages a groove inside the synchronizer sleeve and the shifting keys are pressed against the inside of the synchronizer sleeve by shifting key springs **6**.
- Synchronizer rings **2** are inserted into drive pinions **1** in the front and rear of synchronizer hub **8**, and the taper cone of 4th gear **4**.
- The internal tapers of synchronizer rings **2** have fine threads, and the outer splines engage synchronizer sleeve **9**. On the hub side of the synchronizer rings are three keyways in which the ends of shifting keys **5** are inserted. These keyways are wider than the width of the shifting keys.
- Synchronizer rings **2** rotate relative to synchronizer sleeve **9** by the amount of play of the keyways.



- When the gear shift is in neutral (Figure **B**), moving shift fork **3** in the direction of the arrow as illustrated, moves synchronizer sleeve **9** slightly to the left. At the same time, shifting key **5**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer rings **2** against taper cone **A** of drive pinion **1**. (Figure **C**)
- When the taper surfaces of synchronizer rings **2** make contact with the taper cone of the drive pinion, the taper surfaces of the synchronizer rings act as cone clutches. This frictional torque rotates the synchronizer rings in the rotating direction of the drive pinion by the amount of play between shifting key **5** and the synchronizer rings. The spline chamfers of the synchronizer rings and the spline chamfer of synchronizer sleeve **9** are offset from each other. (Figure **D**)
- The disengagement direction of synchronizer rings **2** is defined by the speed of rotation of the synchronizer—sleeve **9**, and the synchronized—drive pinion **1**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.

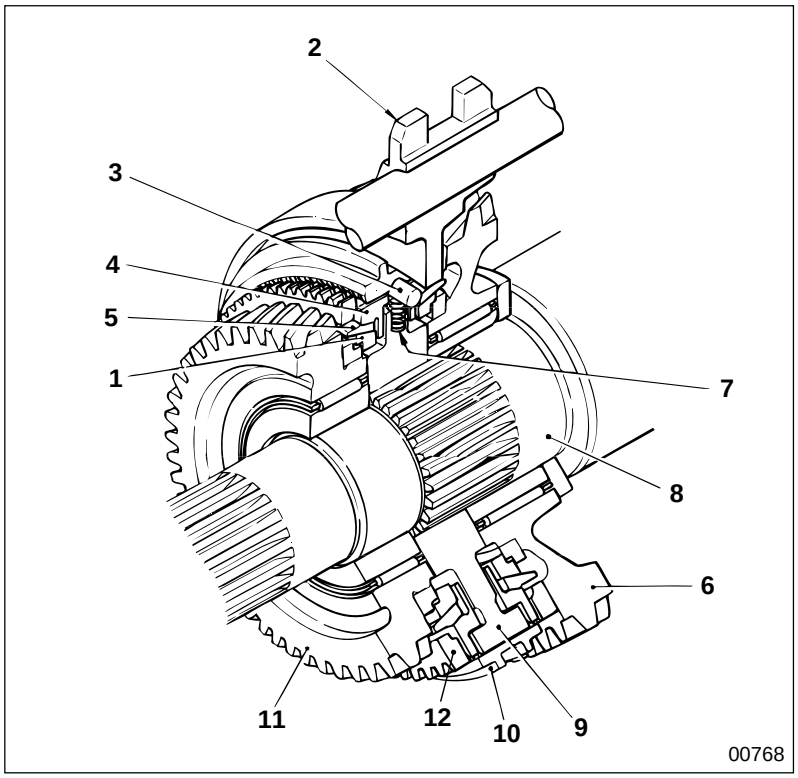


- When synchronizer sleeve **9** moves further to the left, synchronizer rings **2** prevent shifting key **5** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer rings **2** remain disengaged, the spline chamfer of synchronizer sleeve **9** presses the spline chamfers of the synchronizer rings, which in turn press the synchronizer rings against taper cone **A** of drive pinion **1**.
- As the frictional torque increases on the taper surfaces, the relative speed of the synchronizer and the synchronized gradually decreases.
  E : In synchronization
  F : After synchronization



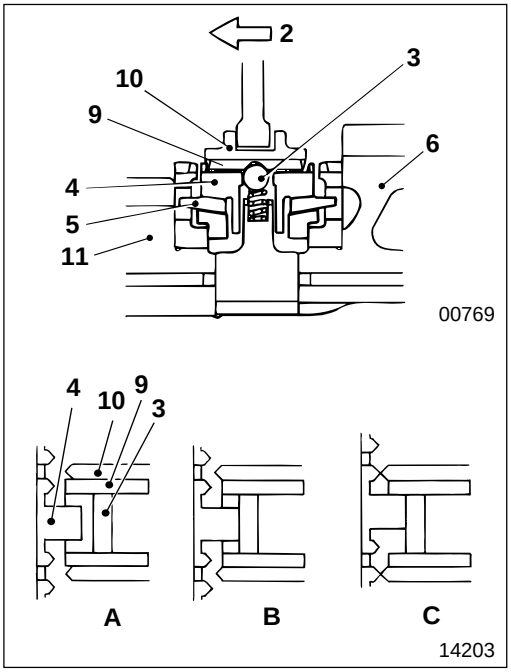
- When synchronizer sleeve **9** and drive pinion **1** rotate at the same speed, synchronizer rings **2** no longer prevent the synchronizer sleeve from moving, and the synchronizer sleeve moves further to the left and smoothly engages the spline of taper cone **A** of drive pinion **1**, transmitting the driving force.

Double Cone Type

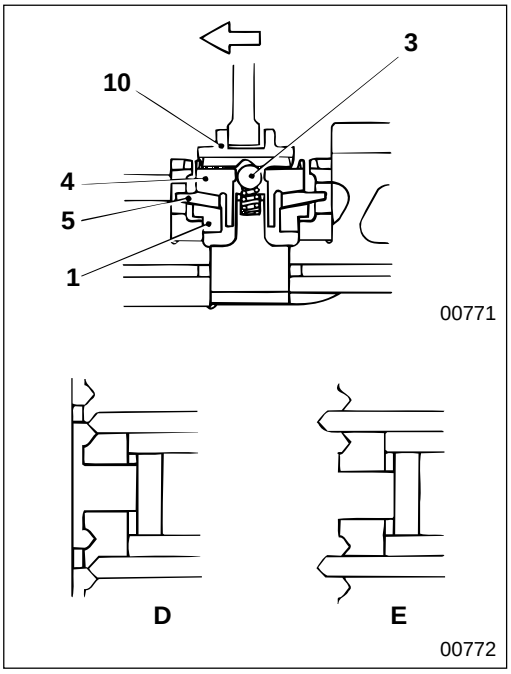


1 Synchronizer inner ring
2 2nd and 3rd shift fork
3 Shifting key
4 Synchronizer outer ring
5 Synchronizer center cone
6 2nd gear
7 Shifting key spring
8 Mainshaft
9 Synchronizer hub
10 Synchronizer sleeve
11 3rd gear
12 Dog clutch

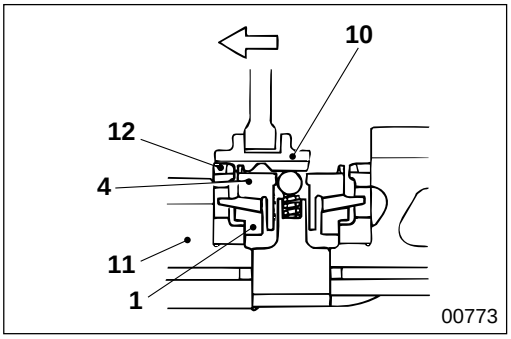
- The following descriptions are for 2nd and 3rd gear < O/D >
  The synchromesh structure and operation of the double cone type are basically the same as for the single cone type.
- Synchronizer center cone **5** is a taper cone independent of 2nd gear **6** and 3rd gear **11**, (both the inside and outside surfaces are tapered). The synchronizer center cone is between synchronizer inner ring **1** and synchronizer outer ring **4** to increase the synchronization capacity.
- Six protrusions on the outside of center cone **5** fit into corresponding gear holes, in the same manner as the taper cone of the single cone type. The center cone and the gear are installed as if integrated.
  Shifting key **3** is a cylinder installed so that the lengthwise direction of the cylinder is at right angles to the diameter direction of synchronizer hub **9**. Shifting key spring **7** is a coil spring inserted in a hole in the synchronizer hub, this spring presses the shifting key against the inside of synchronizer sleeve **10**.
- The 4th gear of the < O/D > model uses the double cone type; however, the structure of shifting key **3** and shifting key spring **7** is the same as for the single cone type.



- When the gear shift is in neutral (Figure **A**), moving shift fork **2** in the direction of the arrow as illustrated, moves synchronizer sleeve **10** slightly to the left. At the same time, shifting key **3**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer outer ring **4** against synchronizer center cone **5**. (Figure **B**)
- When the taper surface of synchronizer outer ring **4** makes contact with the taper cone of synchronizer center cone **5**, the taper surface of the synchronizer outer ring acts as a cone clutch. This frictional torque rotates the synchronizer outer ring in the rotating direction of 3rd gear **11** by the amount of play between the synchronizer outer ring and synchronizer hub **9**. The spline chamfer of the synchronizer outer ring and the spline chamfer of synchronizer sleeve **10** are offset from each other. (Figure **C**)
- The disengagement direction of synchronizer outer ring **4** is defined by the speed of rotation of the synchronizer—the sleeve, and the synchronized—3rd gear **11**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.

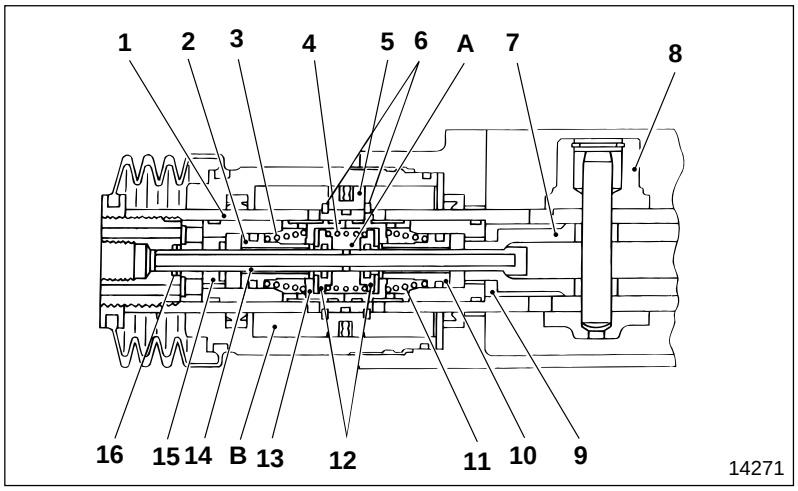


- When synchronizer sleeve **10** moves further to the left, synchronizer outer ring **4** prevents shifting key **3** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer outer ring **4** remains disengaged, the spline chamfer of synchronizer sleeve **10** presses the spline chamfer of the synchronizer outer ring, which in turn presses the synchronizer outer ring against the taper cone of synchronizer center cone **5**, and the frictional torque acts on the taper surface.
- As the frictional torque increases on the taper surface of synchronizer inner ring **1**, the relative speed of the synchronizer and the synchronized gradually decreases. The frictional torque acts on both sides of the synchronizer center cone. The double cone type has greater capacity for synchronization than the single cone type.
  D : In synchronization
  E : After synchronization



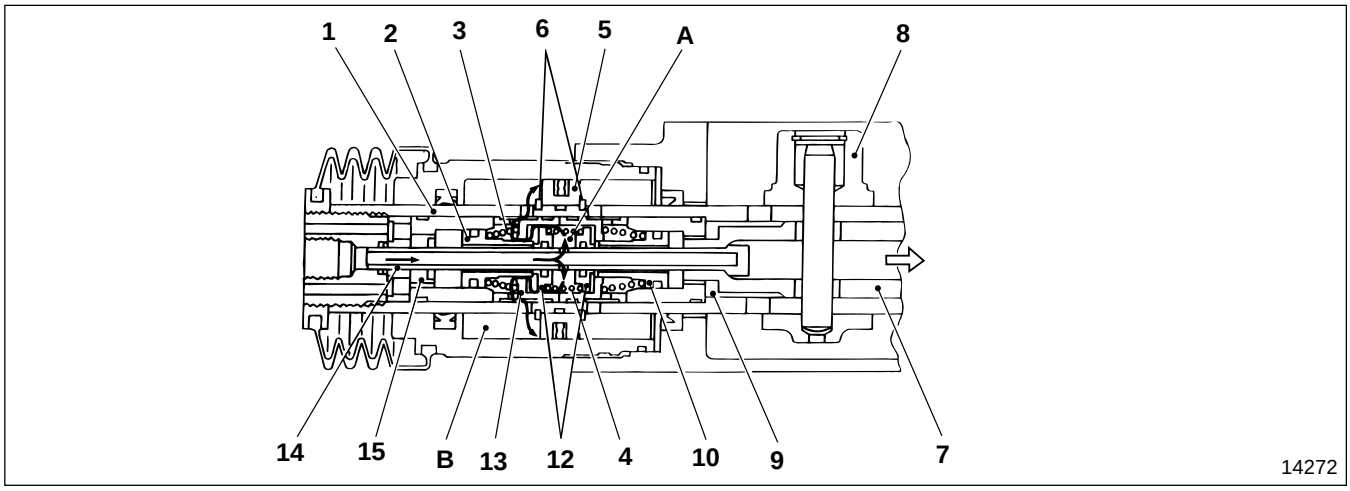
- When synchronizer sleeve **10** and 3rd gear **11** rotate at the same speed, synchronizer outer ring **4** no longer prevents the synchronizer sleeve from moving and the synchronizer sleeve moves further to the left and smoothly engages the spline of dog clutch **12** of the 3rd gear, transmitting the driving force.

Power Shift



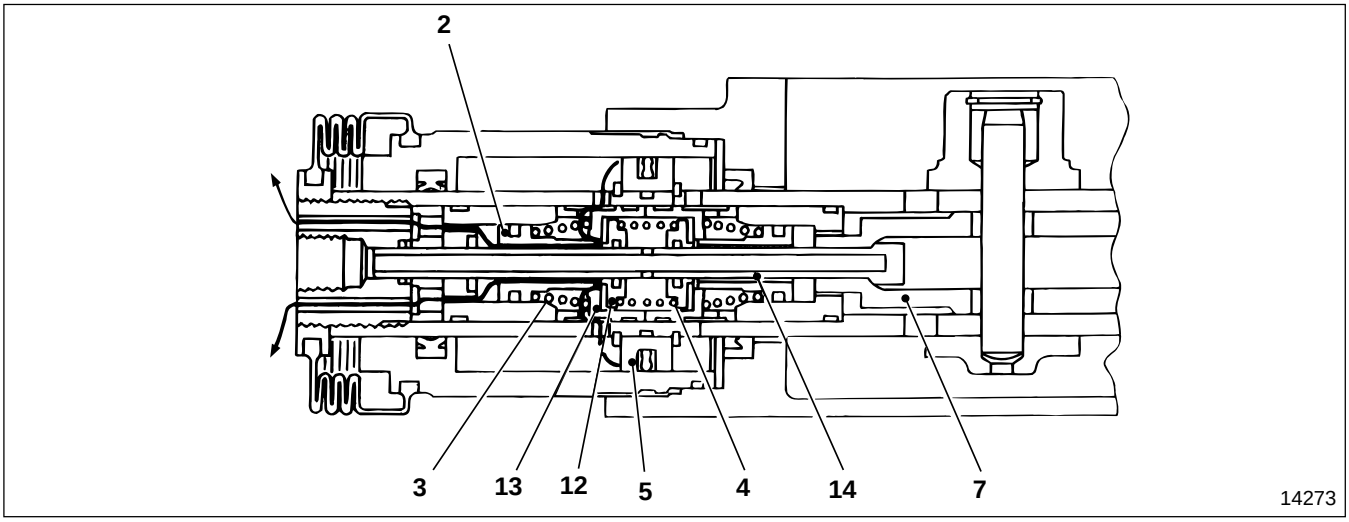
1 Shifter rod
2 Valve lifter
3 No.3 spring
4 No.2 spring
5 Piston
6 Retaining ring
7 Actuating rod
8 Striker
9 Cap
10 Valve lifter
11 No.1 spring
12 Valve seal
13 Valve seat
14 Pipe
15 Retainer
16 Retaining ring

A : Primary side chamber
B : Secondary side chamber



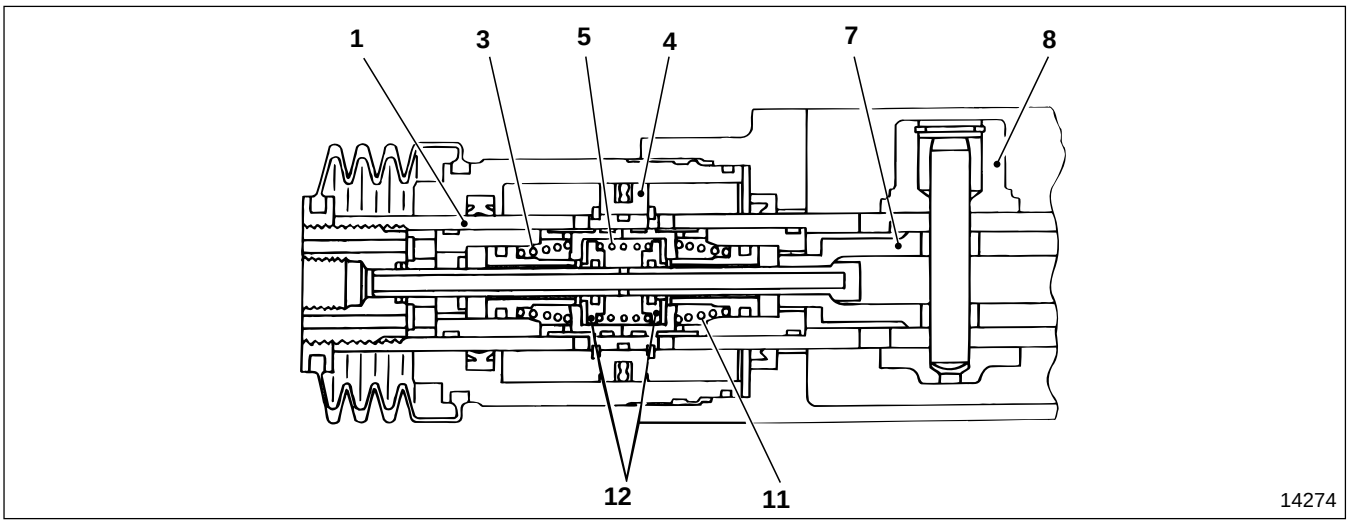
When activated

- When actuating rod **7** is moved in the direction of the arrow as illustrated, shifter rod **1** and the actuating rod move relative to this movement.
  Valve lifter **2** presses No.3 spring **3** against valve seal **12** to overcome the combined repercussive forces of the compressed air acting on the valve seal and No.2 spring **4**. The valve seal separates from valve seat **13**, and the compressed air supplied to primary side chamber **A** is let into secondary side chamber **B** via the opening between the valve seat and the valve seal. The compressed air flows into the cylinder through the hole and groove of the valve seal and the vent hole of shifter rod **1** to put pressure on piston **5**, generating output.
- The output given to piston **5** is transmitted to shifter rod **1** via retaining ring **6** to assist striker **8** which is fixed on the shifter rod. This operates the shift fork on the transmission side, shifting the gears. Thus, gear shifting is completed.
- When the power shift operates in the direction of the arrow as illustrated, the input from the gear shift lever is transmitted by actuating rod **7** via cap **9**, pipe **14**, and retainer **15** fixed on retaining ring **16**. For operation in the opposite direction, all operations are the same in principle as in the direction of the arrow as illustrated, except that the end of the cap, fixed on the end of the actuating rod, presses valve lifter **10** directly.



When releasing

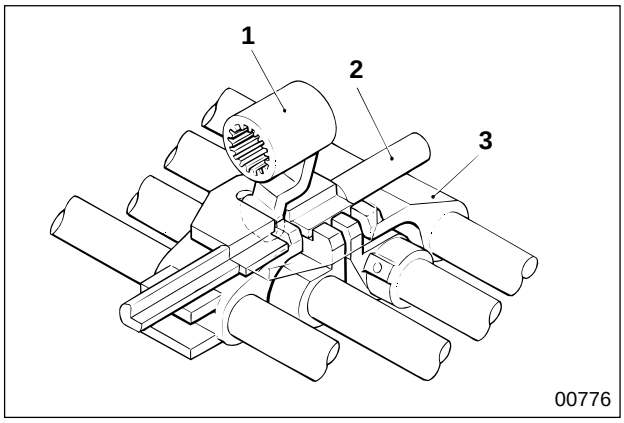
- When gear shifting is completed and the input is released, actuating rod **7** is returned to the valve center position (the condition before operation) by the combined repercussive forces of the compressed air of valve lifter **2**, the steel ball, and valve springs **3**, **4**.
  As the valve lifter returns, valve seal **12** seats against valve seat **13**, cutting off the flow of compressed air from primary side chamber **A** to secondary side chamber **B**. As the input rod returns, clearance is generated between the valve lifter and the valve seal.
- The compressed air in the cylinder of secondary side chamber **B** is discharged into the atmosphere through the clearance between valve lifter **2** and pipe **14**. This eliminates the pressure difference between the chambers on both sides of piston **5**, so output is lost.



When not operating (non-boosting)

- To operate the power shift, that is, to open the valve and let the compressed air into the output chamber, actuating rod **7** on the input side and shifter rod **1** on the output side must generate relative disengagement.
- When the operating force is transmitted from the gear shift lever to actuating rod **7**, and the resistance on the transmission side is less than the combined repercussive forces working on the relative disengagement of the input side and output side (repercussive forces of No.1 to 3 springs, **3**, **4**, **11**; pressure on valve seal **12**; and sliding resistance on various parts), the mechanism, from the actuating rod to striker **8**, is integrated and does not generate relative disengagement. Therefore, the valve does not open, and without boosting operation, piston **5** moves in the cylinder to shift gears.

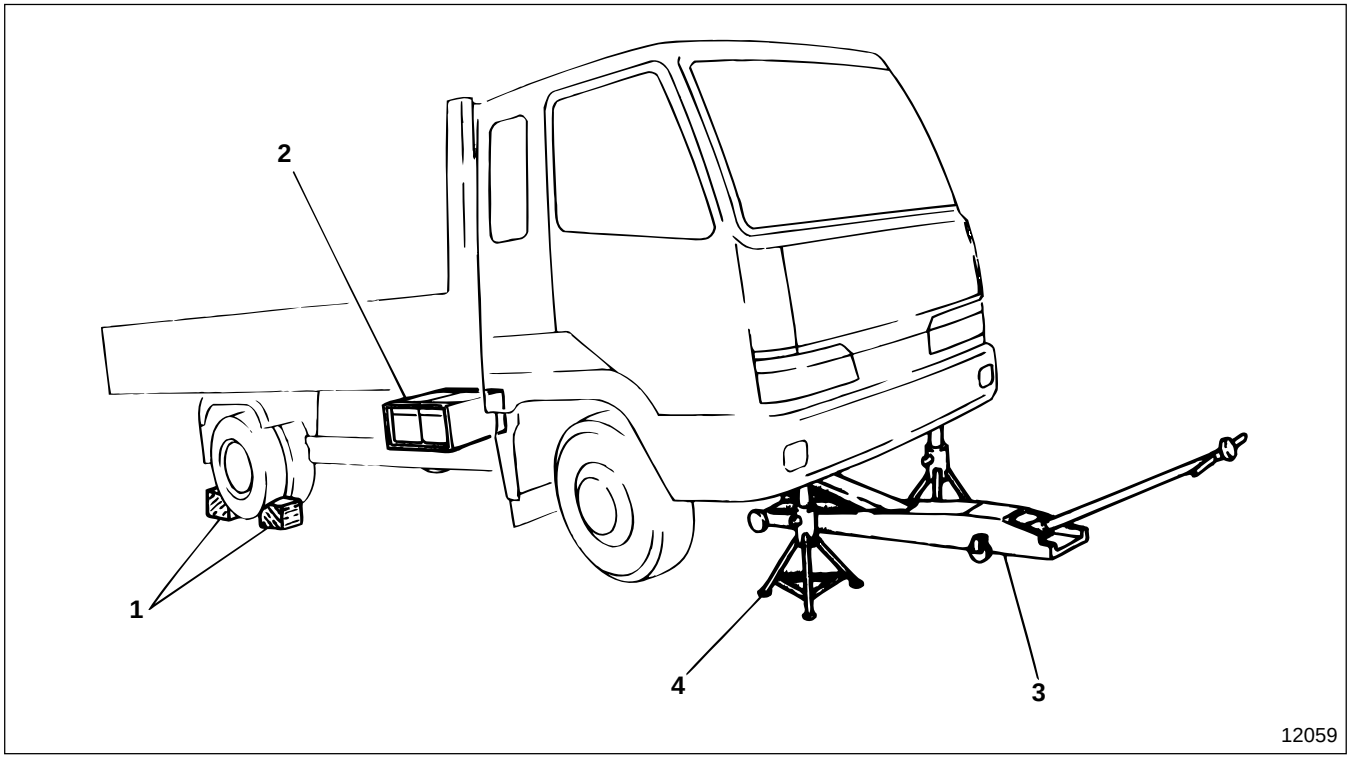
Interlock Mechanism



In the interlock mechanism, the rail beneath interlock plate **2** locks jaws **3**, (apart from the jaws shifted by gear shift slide lever **1**), preventing double engagement of gears.

Possible causes / Symptoms		Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise while cruising	Noise when changing gear
Transmission body faulty	Mainshaft rear lock nut loose	○	○			
	Mainshaft thrust washer worn	○	○			
	Mainshaft bearing worn or damaged	○	○			
	Synchronizer ring and synchronizer sleeve spline worn	○				
	Synchronizer ring and gears taper cone area worn		○			
	Mainshaft pilot bearing worn or damaged			○	○	
	Drive pinion bearing worn or damaged			○		
	Countershaft bearing worn or damaged			○		
	Needle bearings of gears worn or damaged			○	○	
	Mainshaft and countershaft bearings worn or damaged				○	
	Mainshaft and countershaft gears backlash excessive				○	
	Spline of gears worn					○
	Gears damaged				○	
	Gear oil insufficient				○	
Control mechanisms faulty	Control cable joint play	○	○			
	Set board assembly bushings worn	○				
	Shift rail steel ball and groove worn	○				
	Shift rail poppet spring fatigued or damaged	○				
	Shift rail sliding movement faulty		○			
	Shift fork jaws worn		○			
	Shift fork bent		○			
Power shift malfunctioning	Air compressor faulty (Gr 35A, B)		○			
	Air leakage (Gr 35A, B)		○			
	Power shift assembly faulty		○			
Clutch faulty	Clutch disengagement faulty (Gr 21)		○			○
	Clutch pedal play faulty (Gr 21)		○			
Synchronizer faulty	Contacting surfaces of synchronizer ring and gear taper cone worn					○
	Shifting key worn					○
	Shifting key spring deteriorated or damaged					○
	Synchronizer sleeve worn or damaged				○	○

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect negative battery cable. Gr 54
3 Jack up the front axle on a garage jack.
4 Support the front frame on rigid racks.

WARNING⚠

- **Since the parking brake will be removed, naturally it cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION⚠

Keep the transmission in neutral throughout the operation.

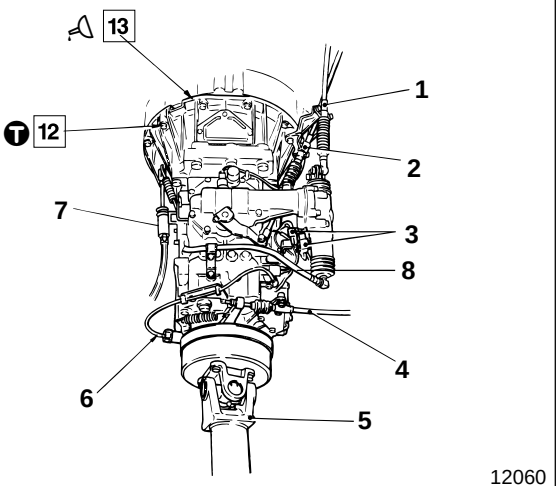
● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY

Removal and Installation



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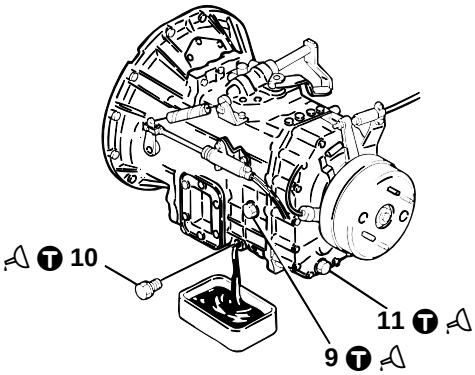

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● **Disassembly sequence**

1 Shift cable 🕮 P22A-88
2 Selector cable 🕮 P22A-88
3 Harness connector
4 Parking brake cable < FK, FM617 > Gr 36A
5 Propeller shaft Gr 25
6 Speed sensor Gr 54
7 Clutch power cylinder Gr 21
8 Power shift hose
9 Inspection plug
10 Drain plug (on transmission case)
11 Drain plug (on extension housing)
12 Nut or bolt
13 Transmission assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

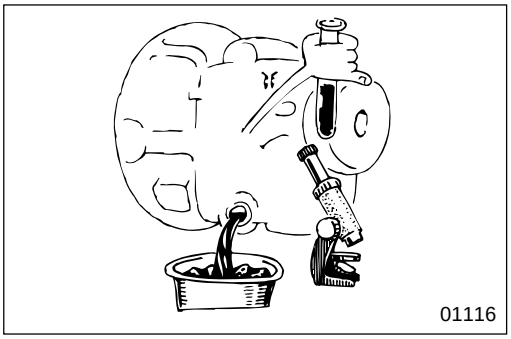
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Power shift hose connector	20 {14.8, 2}	—
9	Inspection plug	69±15 {51±11, 7±1.5}	—
10, 11	Drain plug	69±15 {51±11, 7±1.5}	—
12	Nut or bolt (Transmission mounting)	40 {30, 4.1}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
9	Thread area of inspection plug	THREEBOND 1105D	As required
10, 11	Thread area of drain plug	THREEBOND 1105D	As required
13	Spline of drive pinion	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

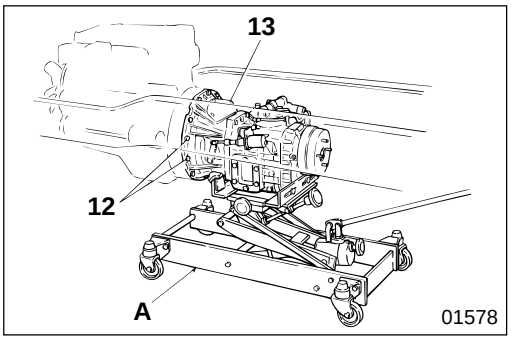
◆ Service procedure



● Oil change

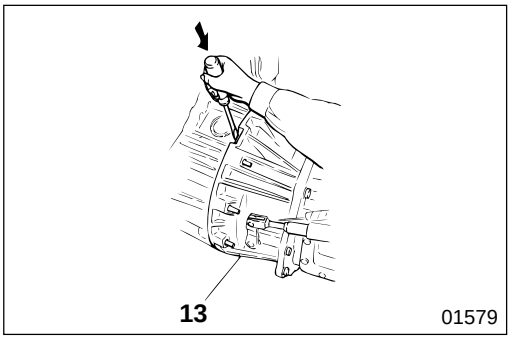
[Draining]
- When draining oil, check the quantity and quality of oil, especially for small pieces of metal and metal dust.
- Clean drain plug **9** before reinstalling it because it is magnetic.

[Filling]
- Check that drain plugs **10**, **11** are tightened at specified torque.
- Pour in gear oil until the oil overflows from the inspection hole. (For oil quantity, see specifications.)



12 Removal of transmission mounting nut or bolt

- Support transmission assembly **13** on transmission jack **A**.
- Tighten transmission mounting nuts or bolts **12**.

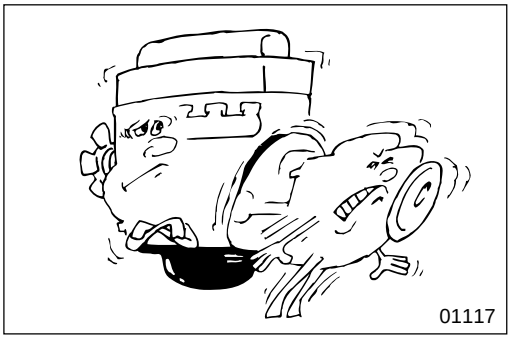


13 Transmission assembly

[Removal]
- Insert a screwdriver into the three removal grooves and pry transmission assembly **13** from the engine.

CAUTION⚠

Make sure that you remove hoses and cables before starting service operations.

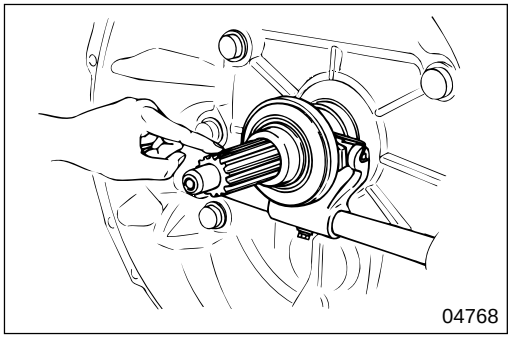


- Move transmission assembly **13** backward until the spline of the drive pinion is detached from the clutch.

CAUTION⚠

Make sure that you pull transmission assembly 13 out in a straight line. If you seesaw the transmission assembly violently, you will damage the spline that connects the drive pinion and the clutch.

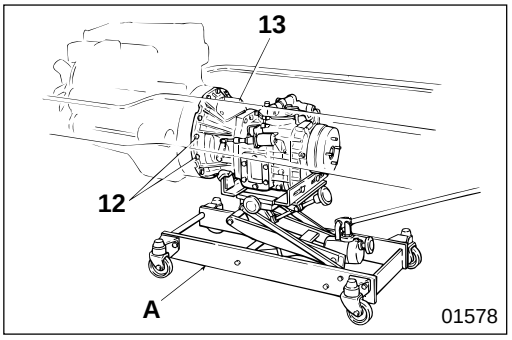
REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



[Installation]
- Check the spline of the drive pinion for rust.
- If rust is found, remove it using a wire brush.
- Rub grease onto the clutch disc sliding surfaces of the drive pinion using your hand.

CAUTION

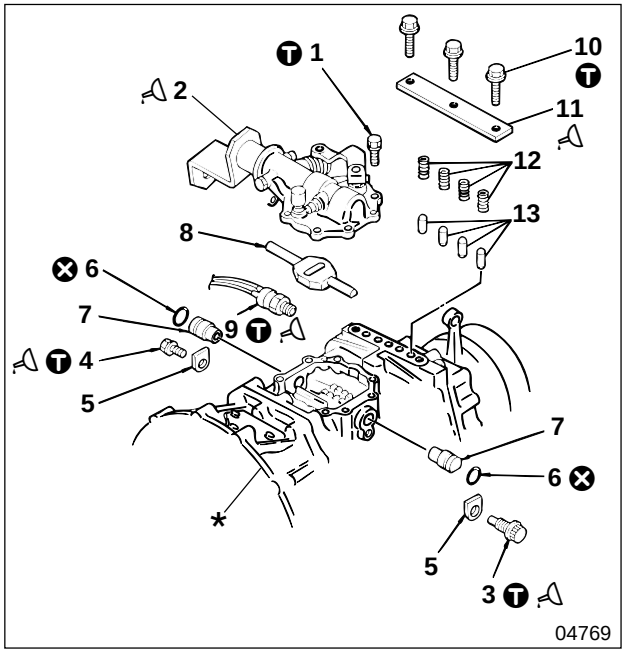
Make sure that you apply only the necessary amount of grease because too much grease would drip and cause clutch slip.



- Support transmission assembly **13** on transmission jack **A**, and insert the transmission assembly into the pilot bearing of the flywheel paying attention to the drive pinion spline.
- Tighten transmission mounting nuts or bolts **12** at specified torque.

M E M O

GEAR SHIFTER UPPER AND INTERLOCK PLATE



● **Disassembly sequence**

1 Bolt
2 Gear shifter upper assembly P22A-19
3 Jaw set bolt
4 Bolt
5 Lock plate
6 O-ring
7 Bushing
8 Interlock plate
9 Backup lamp switch Gr 54
10 Bolt
11 Poppet spring plate
12 Poppet spring
13 Interlock pin

* : Transmission body
⊗ : Non-reusable parts

● **Assembly sequence**

6→7
8
→5→4→3→9→2→1→13→12→11→10

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
7, 8	Clearance between interlock plate axis and bushing	[12 {0.47}] 0.14 to 0.19 {0.0055 to 0.0075}	0.4 {0.016}	Replace
12	Poppet spring load (Installed length 29 {1.14})	78 N {18 lbf, 8 kgf}	67 N {15 lbf, 68 kgf}	Replace

Ⓣ Tightening torque

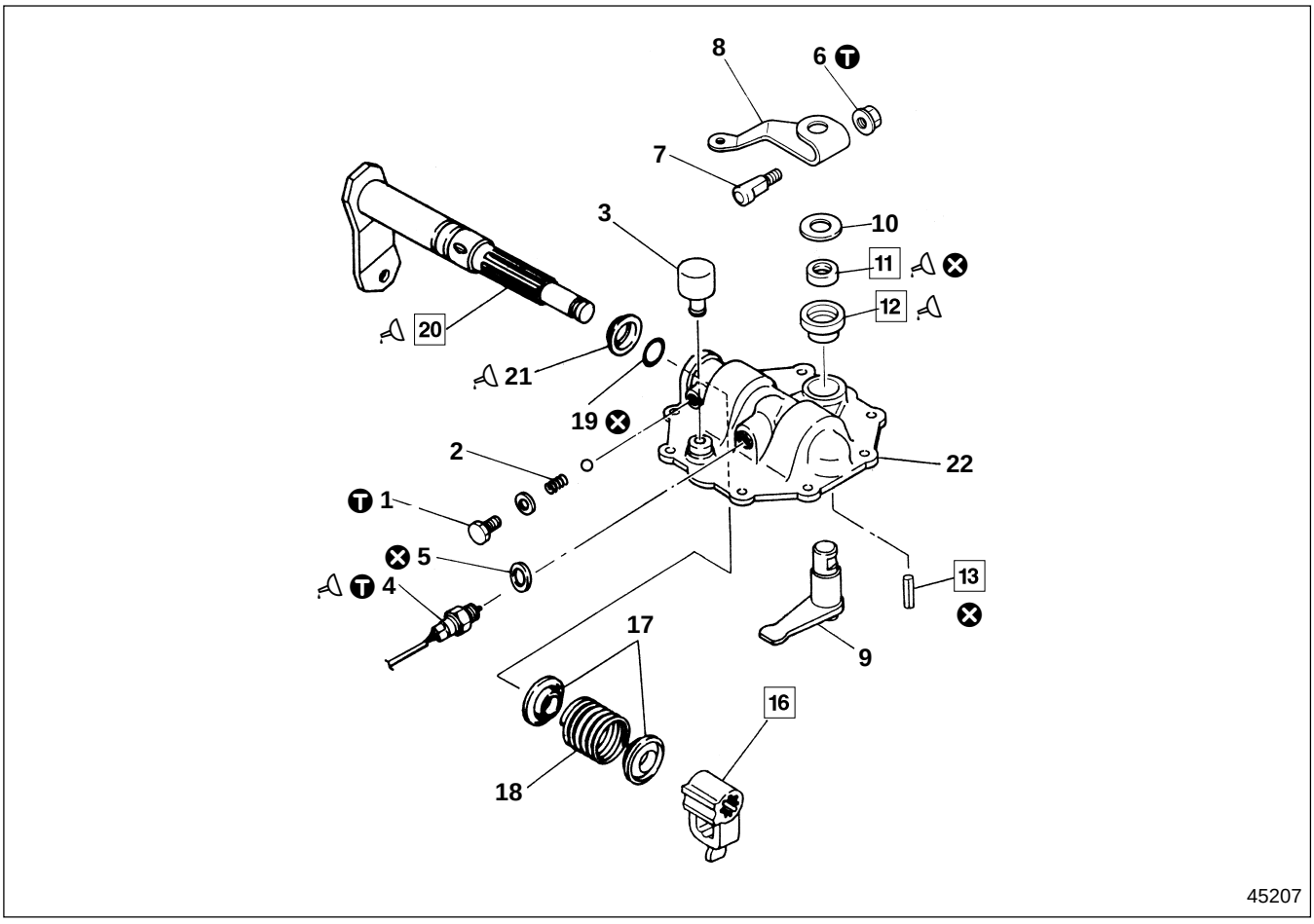
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Gear shifter upper mounting)	23 {17, 2.3}	—
3	Jaw set bolt	135 {98, 13.6}	—
4	Bolt (Lock plate mounting)	40 {30, 4.1}	—
9	Backup lamp switch	49 {36, 5.0}	—
10	Bolt (Poppet spring plate mounting)	49 {36, 5.0}	—

Sealant

Location	Points of application	Kinds	Quantity
2	Contact surface with transmission case	THREEBOND 1215	As required
3	Thread area of jaw set bolt	THREEBOND 1104J	As required
4	Thread area of bolt	THREEBOND 1104J	As required
9	Thread area of backup lamp switch	THREEBOND 1105D	As required
11	Contact surface with transmission case	THREEBOND 1215	As required

Gear Shifter Upper Assembly
< Without Power Shift >



● **Disassembly sequence**

1 Plug
2 Torsion shaft spring
3 Air breather
4 Neutral switch
5 Gasket
6 Nut
7 Lock pin
8 Gear selector lever B
9 Gear selector lever A
10 Washer
11 Oil seal
12 Bushing
13 Spring pin
14 Return spring B retainer
15 Return spring B
16 Gear shift slide lever
17 Return spring A retainer
18 Return spring A
19 O-ring
20 Gear shift lever
21 Dust seal
22 Selector lever case

⊗ : Non-reusable parts

NOTE
Do not remove bushing 12 except for replacement.

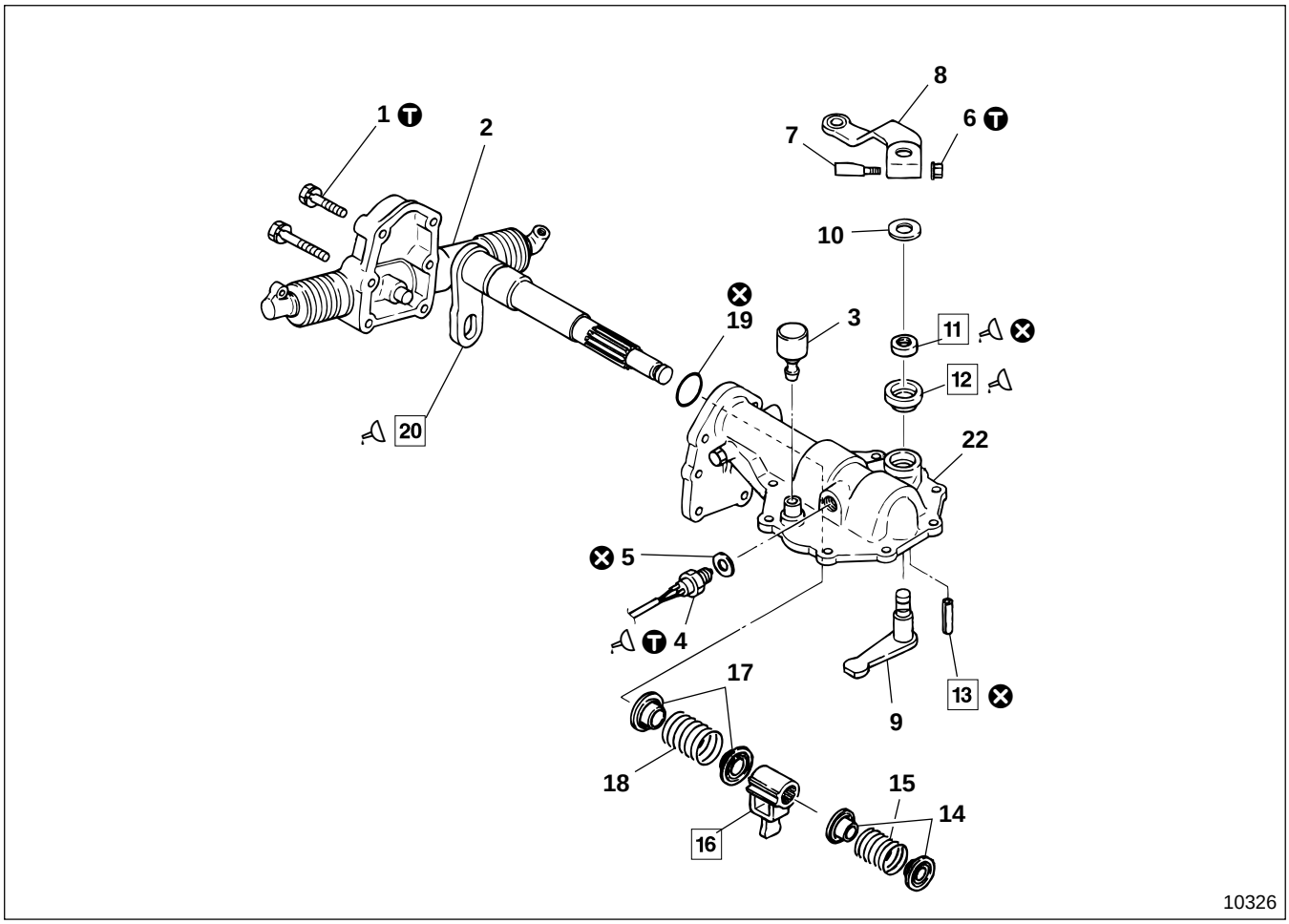
● **Assembly sequence**

22→12→11
20→21→19
→17→18→17→16→14→15→14→13→9→10→8→7→6
5→4
→3→2→1

CAUTION ⚠
Be sure when assembling gear selector lever A 9, that you turn the lever so you do not damage the lip area of oil seal 11.

GEAR SHIFTER UPPER AND INTERLOCK PLATE

< With Power Shift >



● **Disassembly sequence**

1 Bolt
2 Power shift assembly
P22A-24
3 Air breather
4 Neutral switch Gr 54
5 Gasket
6 Nut
7 Lock pin
8 Gear selector lever B
9 Gear selector lever A
10 Washer
11 Oil seal
12 Bushing
13 Spring pin
14 Return spring B retainer
15 Return spring B
16 Gear shift slide lever
17 Return spring A retainer
18 Return spring A
19 O-ring
20 Gear shift lever
22 Selector lever case

⊗ : Non-reusable parts

NOTE

Do not remove bushing 12 except for replacement.

● **Assembly sequence**

22→12→11
19→20
→17→18→17→16→14→15→14→13→9→10→8→7→6
5→4
→3→2→1

CAUTION ⚠

Be sure when assembling gear selector lever A 9, that you turn the lever so you do not damage the lip area of oil seal 11.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Torsion shaft spring load (Installed length 16.2 {0.64}) < Without power shift >	50 N {11 lbf, 5.1 kgf}	42 N {9.48 lbf, 4.3 kgf}	Replace
9	Play in axial direction of gear selector lever A	0.3 to 0.6 {0.012 to 0.024}	—	Replace
15	Return spring B load (Installed length 23.6 {0.93})	92 N {21 lbf, 9.4 kgf}	78 N {18 lbf, 8.0 kgf}	Replace
18	Return spring A load (Installed length 27.6 {1.09})	94 N {21 lbf, 9.6 kgf}	80 N {18 lbf, 8.2 kgf}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

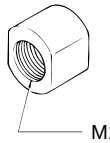
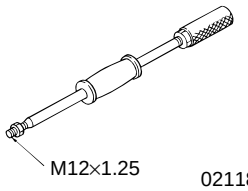
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Power shift assembly mounting) < With power shift >	40 {30, 4.1}	—
	Plug < Without power shift >	23 {17, 2.3}	—
4	Neutral switch	34 to 39 {25 to 29, 3.5 to 4.0}	—
6	Nut (Lock pin mounting)	17 {12, 1.7}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
4	Thread area of neutral switch	THREEBOND 1104J	As required
11	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
12	Inner surface of gear selector lever A axis bushing and its friction surface	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Contact surfaces between bushing outer surface and case	THREEBOND 1215	As required
20	Gear shift lever O-ring groove	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
21	Pack dust seal < Without power shift >	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

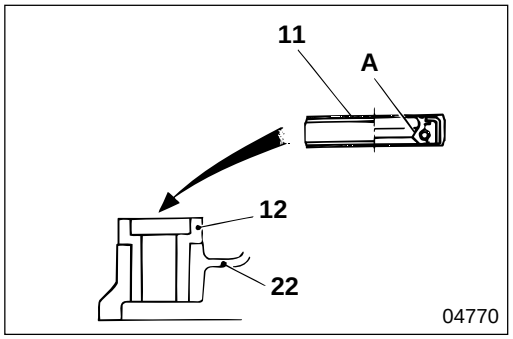
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
13	Spring pin puller  02399	MH062445	Removal of spring pin
	Reverse shaft puller  02118	03726-82000	

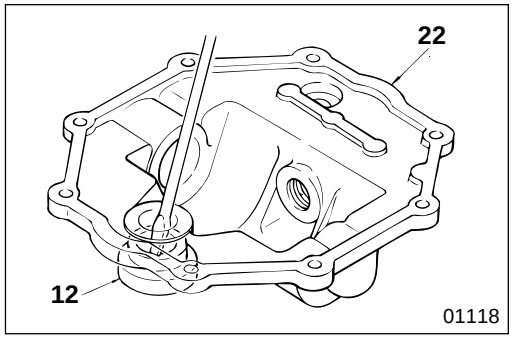
GEAR SHIFTER UPPER AND INTERLOCK PLATE

◆ Service procedure



11 Installation of oil seal

- Apply grease to lip area **A** of oil seal **11**.
- Press-fit oil seal **11** into bushing **12** in the direction as illustrated.



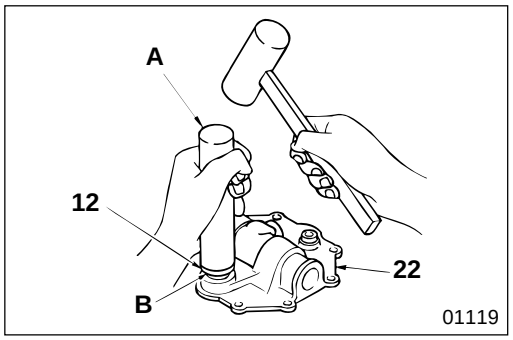
12 Bushing

[Removal]

Remove bushing **12** from selector lever case **22** using a screwdriver.

CAUTION

Be careful not to damage selector lever case 22.

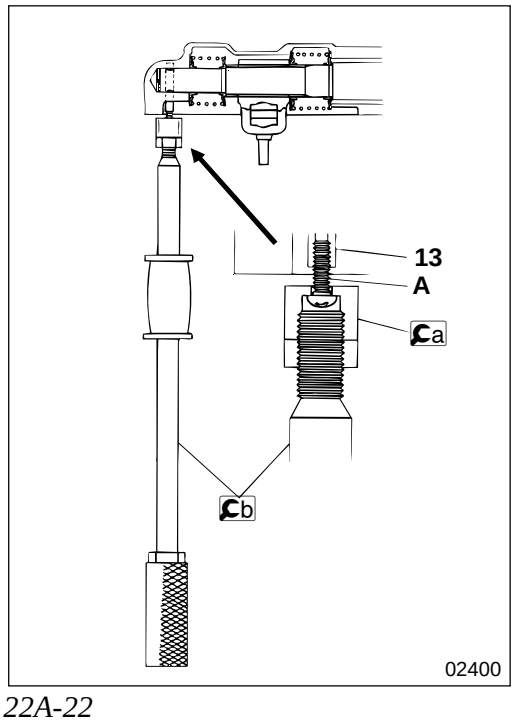


[Installation]

- Clean the inner surface of selector lever case **22**.
- Press-fit bushing **12** into selector lever case **22** using bar **A** (approximately ø40 mm {1.57 in.}).
- When press-fitting bushing **12**, take care not to damage selector lever case **22**.
- After press-fitting, apply sealant to press-fitted side **B** of bushing **12**.

CAUTION

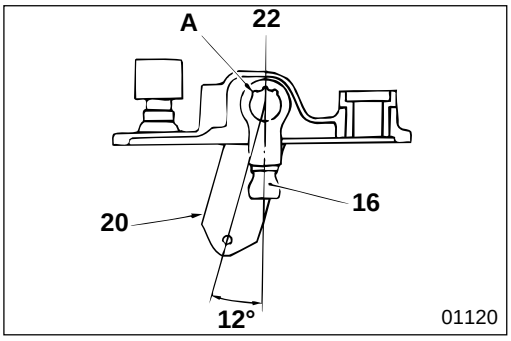
Prevent sealant from sticking to the inner surface of bushing 12.



13 Removal of spring pin

- Tap spring pin **13** using an M4 tap.
- Insert Ca spring pin puller with an M4 thread **A** of appropriate length into spring pin **13**.
- Position Cb reverse shaft puller on Ca spring pin puller.
- Remove spring pin **13** from selector lever case **22** using Ca spring pin puller and Cb reverse shaft puller.

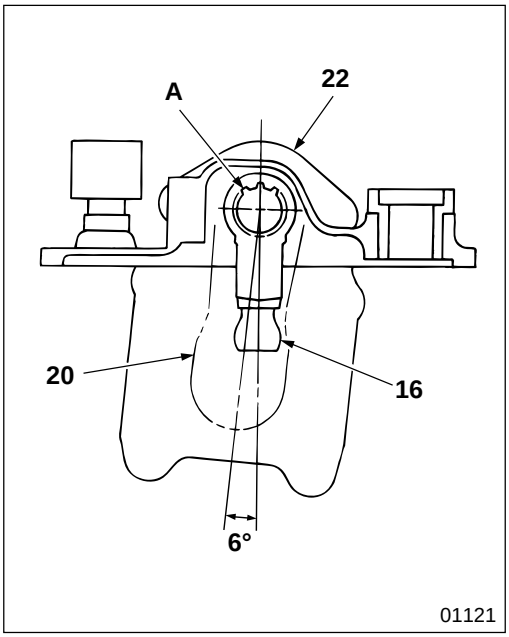
< Without Power Shift >



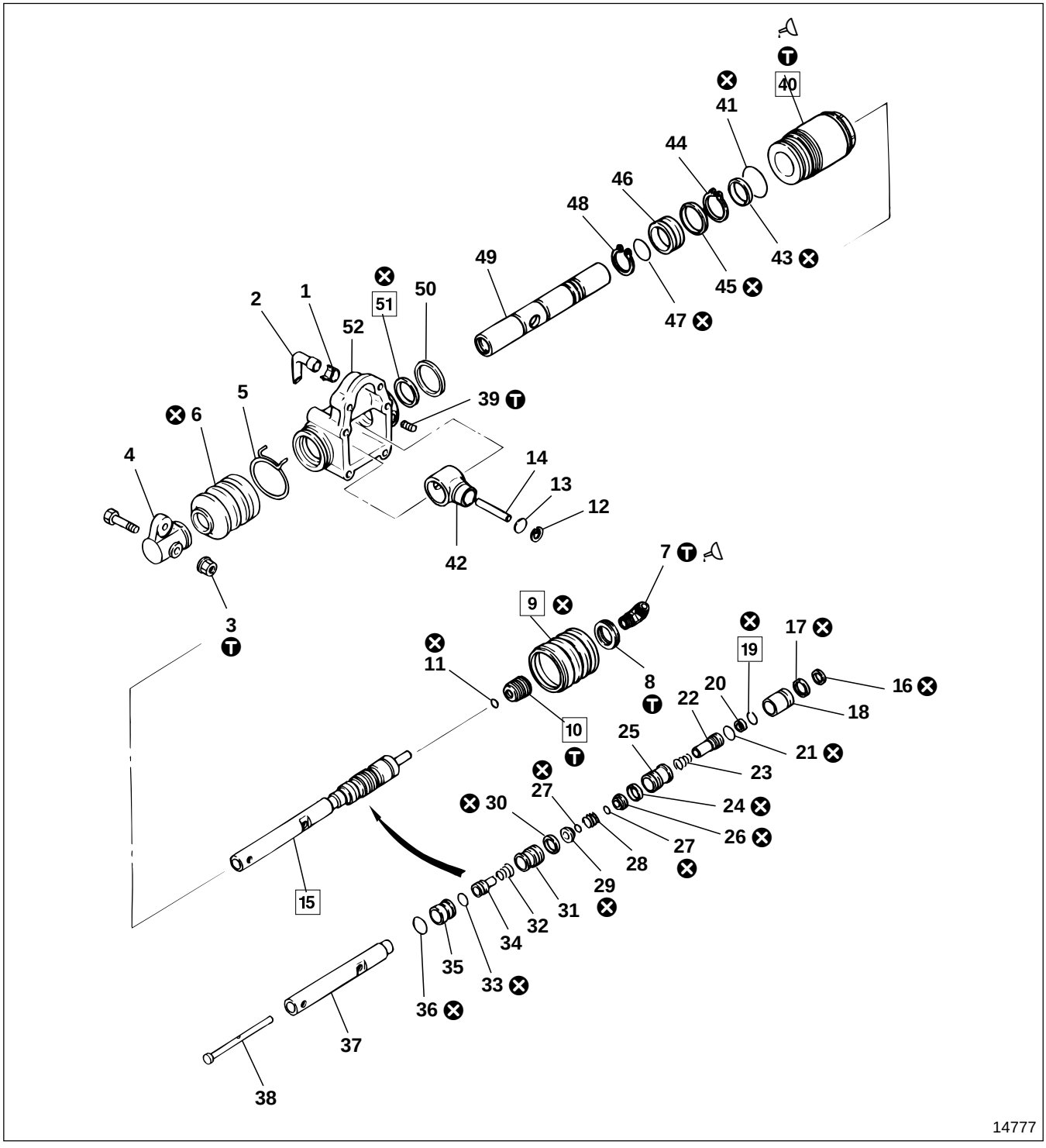
16 **20** **Installation of gear shift slide lever and gear shift lever**

When you install gear shift slide lever **16** in gear shift lever **20**, position spline **A** so that the angle between the slide lever and the shift lever is as illustrated.

< With Power Shift >



POWER SHIFT ASSEMBLY



● **Inspection before disassembly**

P22A-26

● **Disassembly sequence**

1 Clamp
2 Hose
3 Nut
4 Lever
5 Clamp
6 Boot
7 Connector
8 Nut
9 Boot
10 Connector
11 O-ring
12 Retaining ring
13 Plate
14 Straight pin
15 Valve assembly
16 Filter
17 Square ring
18 Tube
19 Retaining ring
20 Retainer
21 O-ring
22 Lifter
23 Spring
24 Square ring
25 Seat
26 Seal assembly
27 O-ring
28 Spring
29 Seal assembly
30 Square ring
31 Seat
32 Spring
33 O-ring
34 Lifter
35 Bushing
36 O-ring
37 Rod
38 Pipe
39 Set screw
40 Cylinder
41 O-ring
42 Striker
43 Packing
44 Retaining ring
45 Piston packing
46 Piston
47 O-ring
48 Retaining ring
49 Shifter rod
50 Plate
51 Cup packing
52 Housing

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
23	Spring load (Installed length 12.35 {0.49})	82 N {19 lbf, 8.4 kgf}	67 N {15 lbf, 6.8 kgf}	Replace
28	Spring load (Installed length 10 {0.39})	13 N {2.9 lbf, 1.3 kgf}	9.8 N {2.2 lbf, 1.0 kgf}	Replace
32	Spring load (Installed length 12.2 {0.48})	50 N {11 lbf, 5.06 kgf}	40 N {9.0 lbf, 4.1 kgf}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut	24 to 26 {17 to 20, 2.4 to 2.7}	—
7	Connecter (Air hose side)	14 to 49 {10 to 36, 1.4 to 5.0}	—
8	Nut (Cylinder side connecter)	59 to 69 {43 to 51, 6 to 7}	—
10	Connecter (Cylinder side)	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—
39	Set screw	2 to 3.4 {1.4 to 2.5, 0.2 to 0.35}	—
40	Cylinder	78 to 98 {58 to 72, 8 to 10}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
—	All friction surfaces	Multipurpose grease [NLGI No.2 (Li soap)]	As required
7	Thread area of connecter	THREEBOND 1110B	As required
40	Thread area of cylinder	LOCTITE 242 or THREEBOND 1401B	As required

Special tools

Location	Tool name and shape	Part No.	Application
10	Connector	*910-25790	Removal and installation of connector
15	Guide	*910-24800	Inserting valve assembly
19	Insert tool	*910-22011	Inserting retaining valve
		*910-26500	
40	Socket	*910-21982	Removal and installation of cylinder

* BOSCH BRAKING SYSTEMS part No.

◆ Service Procedure

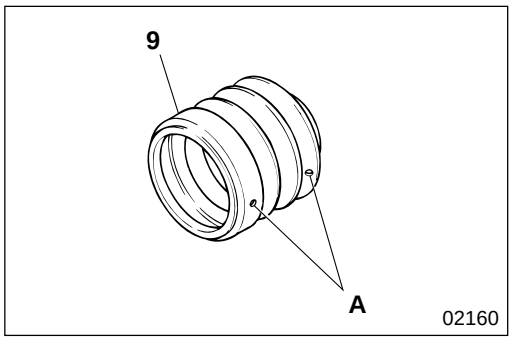
● Inspection before disassembly

(1) Apply 735 kPa {105 psi, 7.5 kgf/cm^2} of pressure to the power shift assembly from the connector, check the airtightness when not operating (valve in neutral), and when operating valve is pressed and pulled. If the measured value deviates from the standard value, replace the faulty parts.

Maintenance item	Standard value	
Airtightness when not operating	Decrease of pressure after 15 seconds	9.8 kPa {1.4 psi, 0.1 kgf/cm^2}
Airtightness when operating		49 kPa {7.1 psi, 0.5 kgf/cm^2}

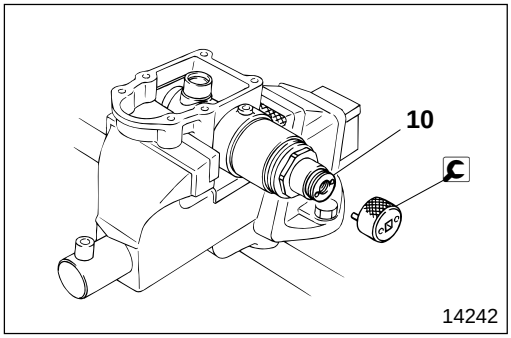
(2) Measure the sliding resistance in the disengagement direction. If the measured value deviates from the standard value, replace the faulty parts, or grease them.

Maintenance item	Standard value
Resistance in shifting direction	39 N {8.8 lbf, 4 kgf}

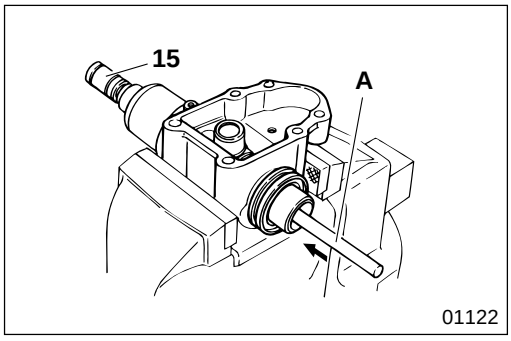


9 **Installation of boot**

When you install boot **9** on housing **52**, point drain holes **A** downward.



10 **Removal and installation of connector**

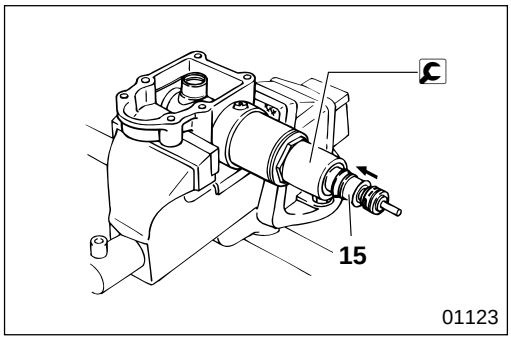


15 **Valve assembly**

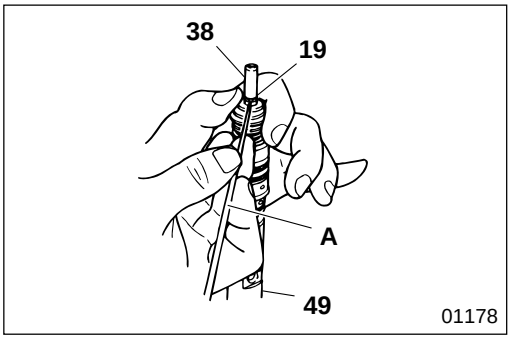
[Removal]
Gently drive valve assembly **15** out from the shifter rod from the lever side using bar **A**.

CAUTION

Do not drive valve assembly 15 too hard or you will damage the valve parts.



[Installation]
- Apply grease to valve assembly **15**.
- Install valve assembly **15** into the shifter rod using guide, taking care not to damage the seals.



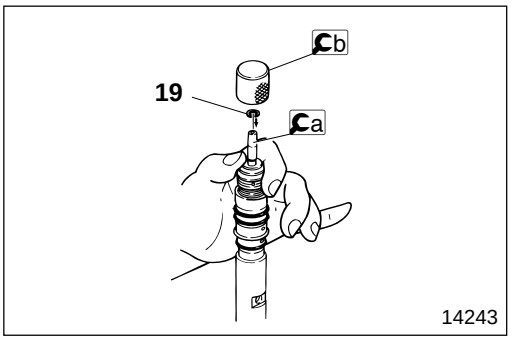
19 **Retaining ring**

[Removal]

- Hold shifter rod **49** in a vise, taking care not to damage the shifter rod.
- Remove retaining ring **19** from pipe **38** using bar **A** as illustrated.

CAUTION

- **After removing retaining ring 19, you can remove all the valve parts.**
- **Keep the valve parts in order to avoid mix ups when installing.**

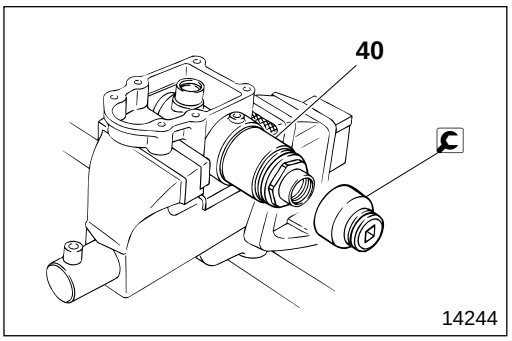


[Installation]

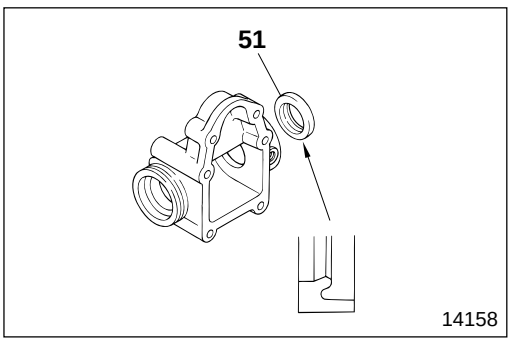
- Install the valve parts on pipe **38**.
- Install a insert tool on pipe **38** end.
- Insert retaining ring **19** into pipe **38** groove using b insert tool.

CAUTION

Be careful not to apply excessive force to retaining ring 19 when you insert it.



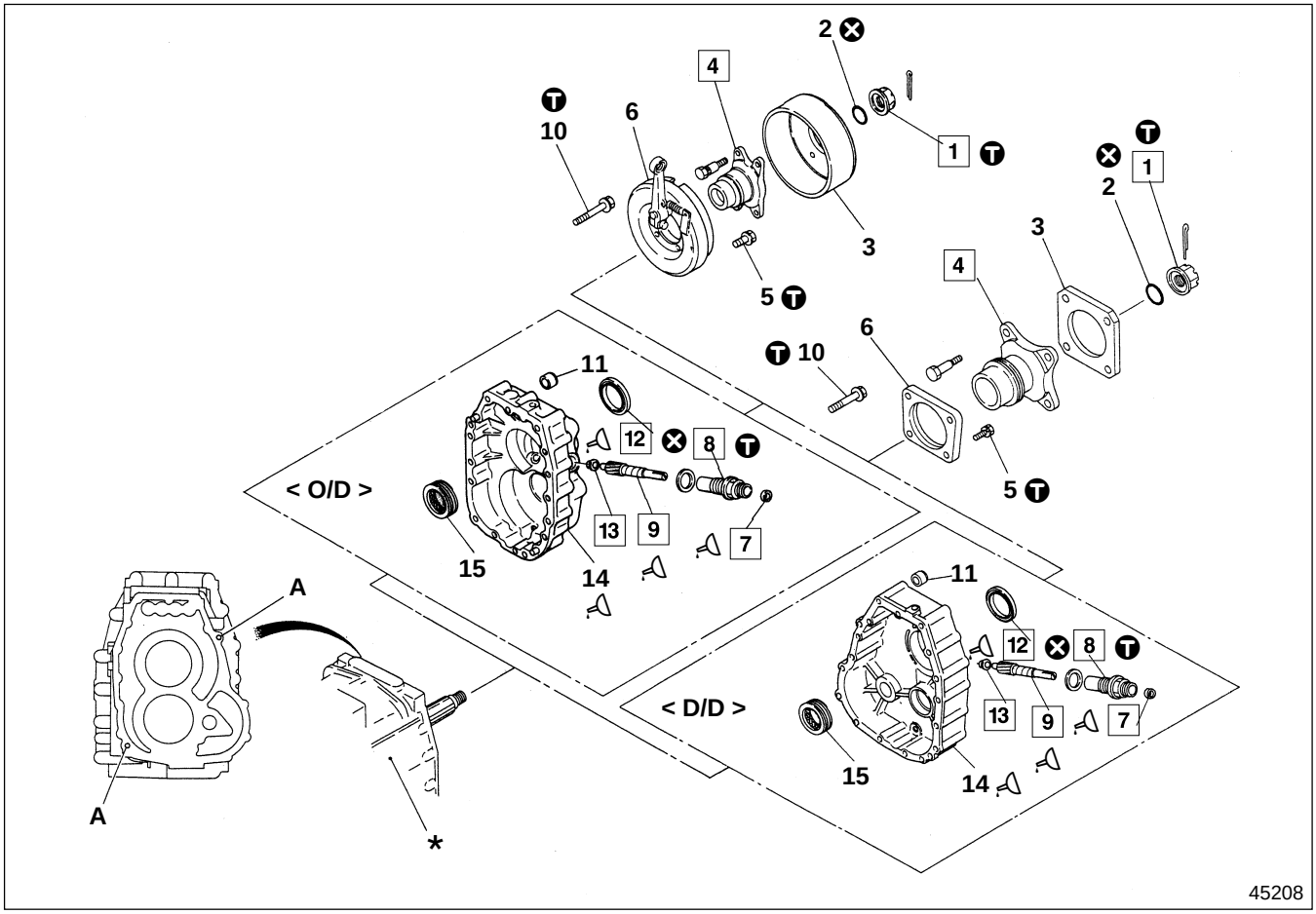
40 **Removal and installation of cylinder**



51 **Installation of cup packing and retainer**

M E M O

EXTENSION HOUSING, REAR COVER AND PARKING BRAKE ASSEMBLY

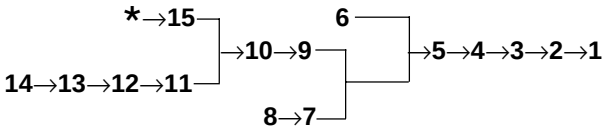


● **Disassembly sequence**

1 Lock nut
2 O-ring
3 Parking brake drum < FK, FM617 >
Flange spacer < FM657 >
4 Companion flange
5 Bolt
6 Dust cover
7 Oil seal
8 Speedometer gear bushing
9 Speedometer gear
10 Bolt
11 Dust plug
12 Oil seal
13 Speedometer gear bushing A
14 Extension housing
15 Speedometer worm

***** : Transmission body
A : Positioning pins (two points)
⊗ : Non-reusable parts

● **Assembly sequence**



NOTE

Inspect play of speedometer gear 9 before disassembly.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
8, 9	Clearance between speedometer gear bushing and speedometer gear	[12] 0.02 to 0.07 {[0.47] 0.00079 to 0.0028}	0.15 {0.0059}	Replace
9, 15	Play between speedometer gear and speedometer worm	0.13 to 0.29 {0.0051 to 0.011}	0.36 {0.014}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

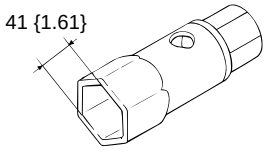
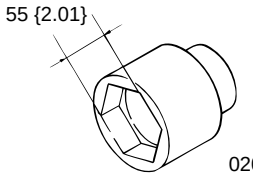
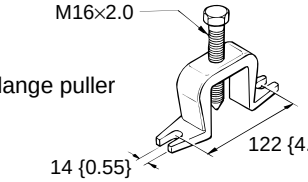
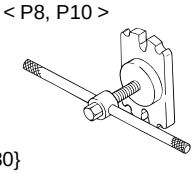
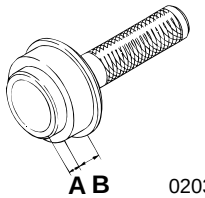
Location	Parts to be tightened		Tightening torque	Remarks
1	Lock nut	O/D	245 to 345 {180 to 255, 25 to 35}	—
		D/D	590 to 1080 {435 to 795, 60 to 110}	—
5	Bolt (Support plate and shoe assembly or dust cover mounting)		74 {54, 7.5}	—
8	Speedometer gear bushing		145 {110, 15}	—
10	Bolt (Extension housing or rear cover mounting)		40 {30, 4.1}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
7, 12	Interior and lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
9	Friction surface with speedometer gear bushing	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
14	Contact surfaces between rear cover or extension housing and transmission case	THREEBOND 1215	As required

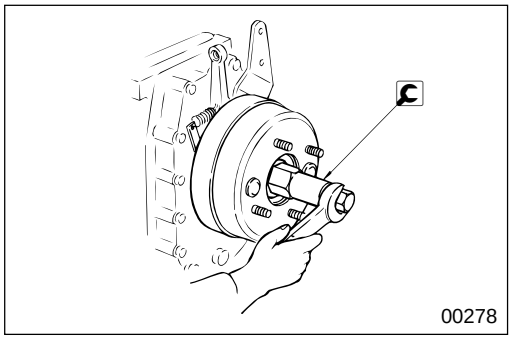
Special tools

Unit : mm {in.}

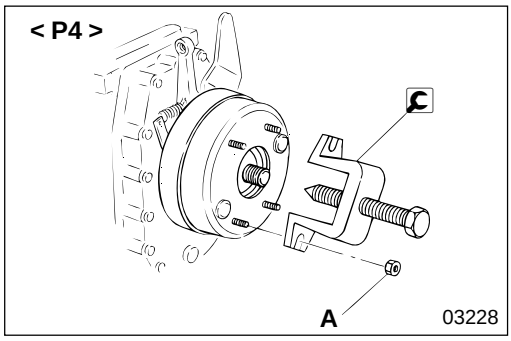
Location	Tool name and shape	Part No.	Application
1	Socket wrench  00069	< O/D > MH061532	Removal and installation of mainshaft rear lock nut
	Socket wrench  02030	< D/D > MH061519	
4	Flange puller < P4 >  < P8, P10 >  02153	< P4 > MC881524 < P8, P10 > MH061393	Removal of flange at rear of mainshaft
12	Oil seal installer  02031	< O/D > ME624242 < D/D > MH062640	Installation of oil seal in rear cover or extension housing

ME624242	**A** : 11 {0.43} **B** : 19.5 {0.77}
MH062640	**A** : 11 {0.43} **B** : 20.5 {0.81}

◆ Service procedure

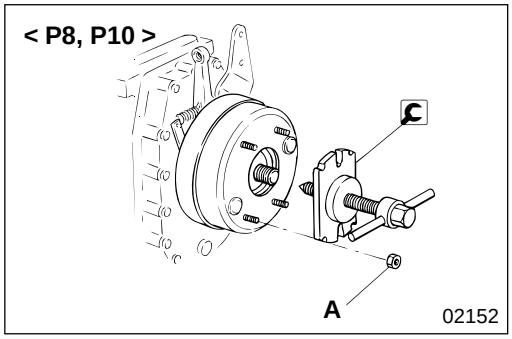


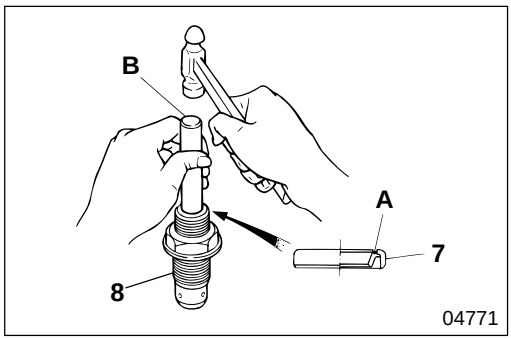
1 **Removal and installation of lock nut**



4 **Removal of companion flange**

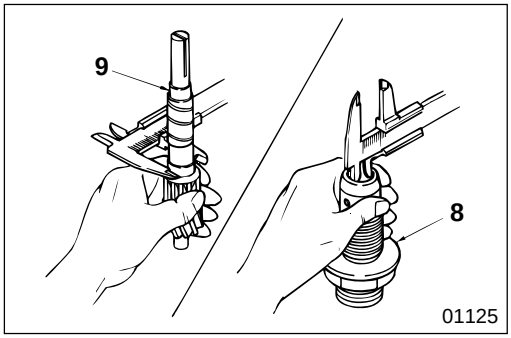
A : Propeller shaft mounting nut





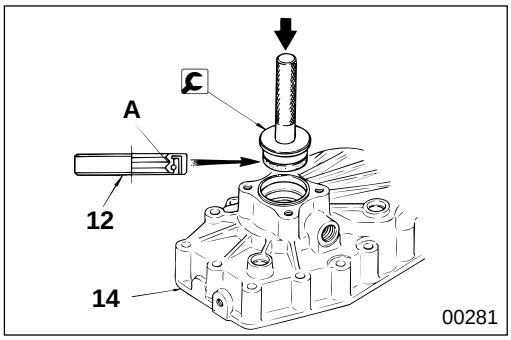
7 **Press-fitting of oil seal**

- Apply grease to inside of oil seal **7** packing **A**.
- Press-fit oil seal **7** into speedometer gear bushing **8** in the direction as illustrated using bar **B** (approximately ø15 mm {0.59 in.}).



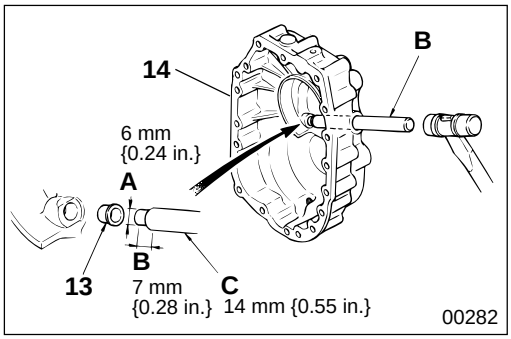
8 **9** **Clearance between speedometer gear bushing and speedometer gear**

If the clearance is higher than the limit, replace the faulty parts.



12 **Installation of oil seal**

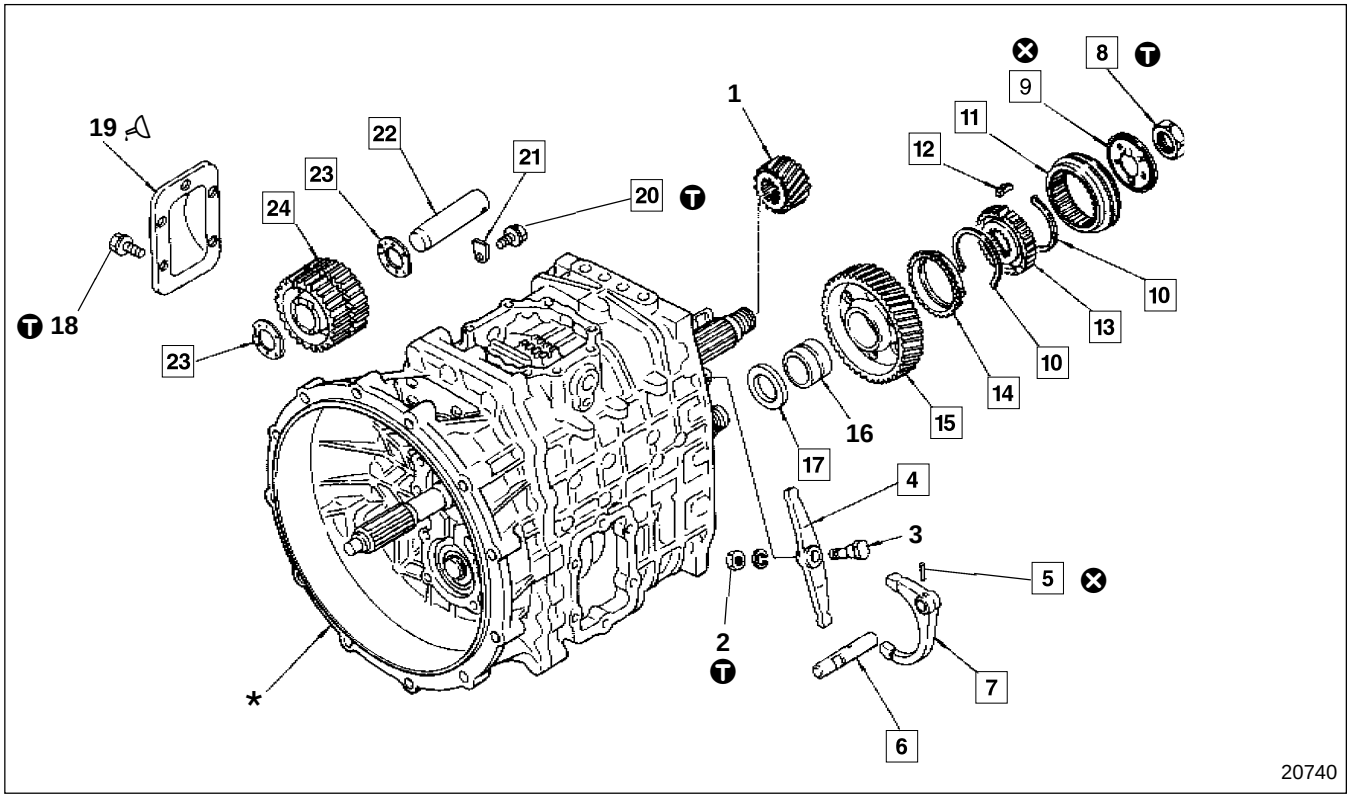
- Apply grease to lip area **A** of oil seal **12**.
- Press-fit oil seal **12** into extension housing or rear cover **14** in the direction as illustrated using oil seal installer.



13 **Installation of speedometer gear bushing A**

Press-fit speedometer gear bushing A **13** into extension housing or rear cover **14** using bar **B**, turned to the dimensions as illustrated.

6TH GEAR < OVER-DRIVE (O/D) > AND REVERSE IDLER GEAR < OVER-DRIVE (O/D) >



● **Inspection before disassembly**

P22A-36

● **Disassembly sequence**

1 Mainshaft O/D gear
2 Nut
3 O/D shift shaft
4 O/D shift lever
5 Spring pin
6 O/D shift rail C
7 O/D gear shift fork
8 Countershaft rear lock nut
9 Shifting Key retainer
10 Shifting key spring
11 Synchronizer sleeve
12 Shifting key
13 Synchronizer hub
14 Synchronizer ring
15 Countershaft O/D gear assembly
16 O/D gear sleeve
17 Thrust washer
18 Bolt
19 Reverse idler gear cover
20 Bolt
21 Reverse shaft lock piece
22 Reverse idler shaft
23 Reverse shaft gear side washer
24 Reverse idler gear

*: Transmission body
1 to 17 is applicable only to O/D.
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
3, 4	Clearance between O/D shift and O/D shift lever	[16 {0.63}] 0.02 to 0.07 {0.00079 to 0.0028}	0.15 {0.0059}	Replace
4	Bend of O/D shift lever	0.05 {0.0020} or less	0.1 {0.0039}	Replace
6	Bend of O/D shift rail C	0.02 {0.00079} or less	0.04 {0.0016}	Replace
7	Tilt of O/D gear shift fork claw	0.1 {0.0039} or less	0.2 {0.0079}	Replace
7, 11	Clearance between gear shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace
11, 13	Play to rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
12, 13	Clearance between shifting key and synchronizer hub	0.05 to 0.20 {0.0020 to 0.0079}	0.5 {0.020}	Replace
12, 14	Clearance between shifting key and synchronizer ring	4.75 to 4.95 {0.187 to 0.195}	5.8 {0.228}	Replace
13, *	Fitness to revolving direction of synchronizer hub and countershaft	–0.006 to 0.088 {–0.00024 to 0.0035}	0.2 {0.0079}	Replace
14, 15	Clearance between synchronizer ring and countershaft O/D gear assembly	1.45 to 1.85 {0.057 to 0.073}	0.2 {0.0079}	Replace
15	End play of countershaft O/D gear	0.25 to 0.40 {0.0098 to 0.016}	0.5 {0.020}	Replace
15, 16	Diameter direction after assembling countershaft O/D gear	0.105 to 0.150 {0.0041 to 0.0059}	0.3 {0.012}	Replace
22,24	Diameter direction after assembling reverse idler gear	—	0.12 {0.0047}	Replace
24	End play of reverse idler gear	0.2 to 0.9 {0.0079 to 0.0035}	1.2 {0.047}	Replace side washer

Tightening torque

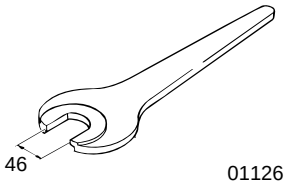
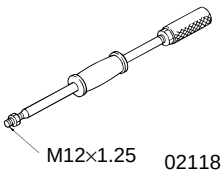
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (O/D shift shaft and O/D shift lever mounting)	42 {31, 4.3}	—
8	Countershaft rear lock nut	345±49 {253±36, 35±5}	—
18	Bolt (Reverse idler gear cover mounting)	40 {30, 4.1}	—
20	Bolt (Reverse shaft lock piece mounting)	40 {30, 4.1}	—

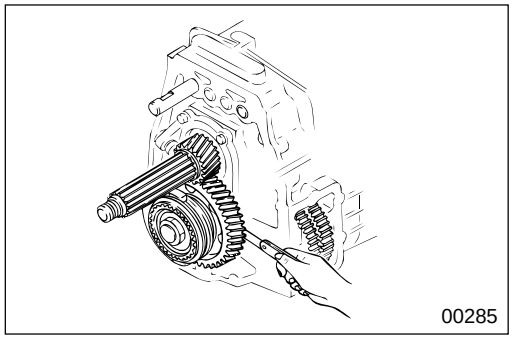
Sealant

Location	Points of application	Kinds	Quantity
19	Reverse idler gear cover installation surface	THREEBOND 1215	As required

Special tools

Location	Tool name and shape	Part No.	Application
8	Single spanner 	MH061555	Removal and istallation of countershaft rear lock nut
22	Drive pinion and reverse shaft puller 	03726-82000	Removal of reverse ilder shaft

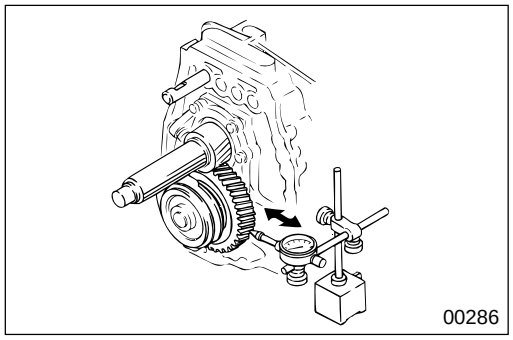
◆ Service procedure



● Inspection before disassembly

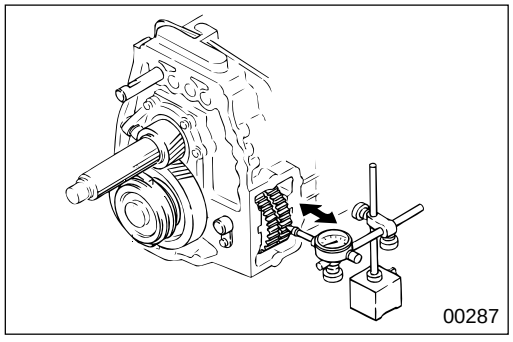
(1) End play of various gears

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



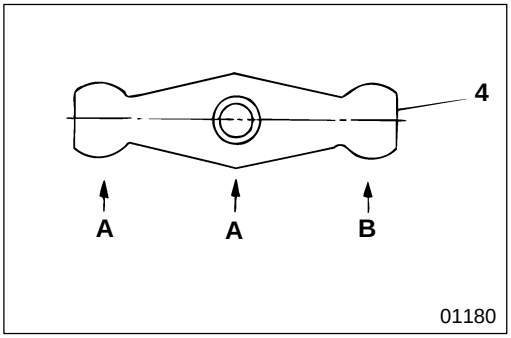
(2) Play of countershaft O/D gear in the diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



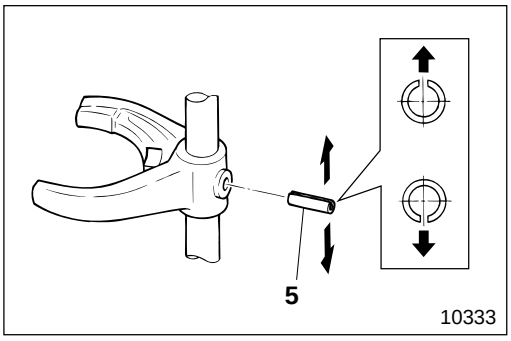
(3) Play of reverse ilder gear in the diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



4 Bend of O/D shift lever

If bend **B** exeeds the limit on the basis of illustrated **A - A**, replace O/D shift lever **4**.

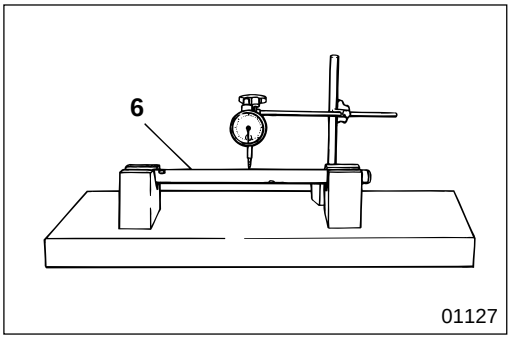


5 Installation of spring pin

Install spring pin **5** in O/D gear shift fork **7** in the direction as illustrated.

CAUTION

Make sure you do not drive in spring pin 5 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.

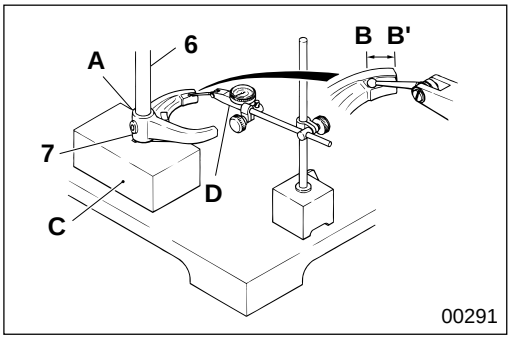


6 Bend of O/D shift rail C

If the measured value is higher than the limit, correct or replace O/D shift rail **C6**.

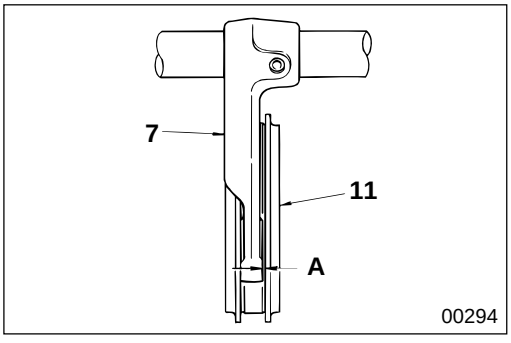
NOTE

Read the dial gauge after turning O/D shift rail C6 one full revolution. The bend is one half of the indicated value.



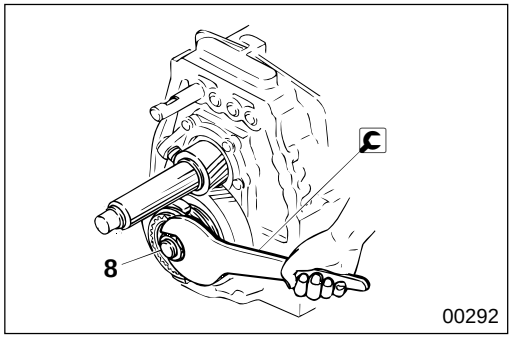
7 Tilt of O/D gear shift fork claw

- Measure the tilt (difference between **B** and **B'**) of claw **B-B'** against hole **A** of O/D shift rail C**6** of O/D gear shift fork **7** with the shift rail upright.
- If the measured value is higher than the limit, replace gear shift fork **7**.
  C : V-block
  D : Dial gauge



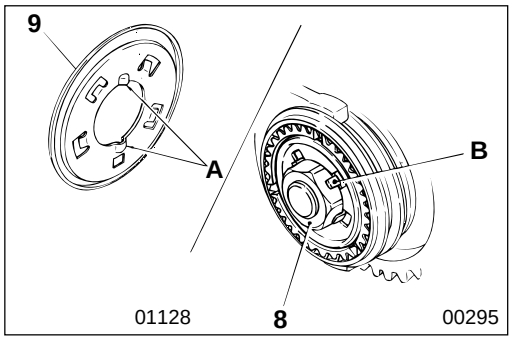
7 11 Clearance between O/D gear shift fork and synchronizer sleeve

- Measure clearance **A** between O/D gear shift fork **7** and synchronizer sleeve **11**.
- If the measured value is higher than the limit, replace the faulty parts.



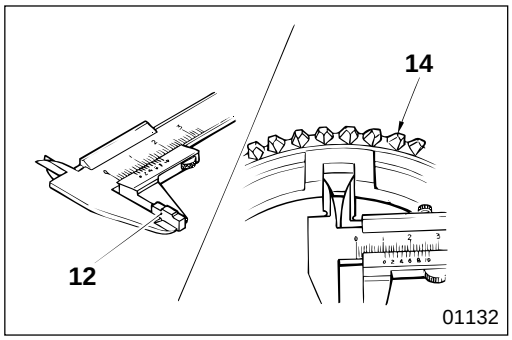
8 **Removal and installation of countershaft rear lock nut**

Have transmissions engaged in double to lock countershaft for this work.



9 **Installation of shifting key retainer**

- Install so that shifting key retainer **9** protrusions **A** (at 2 places) rest in recessions provided on synchronizer hub.
- After tightening of lock nut, caulk the areas with slits **B** at 4 places of shifting retainer, toward lock nut **8**.

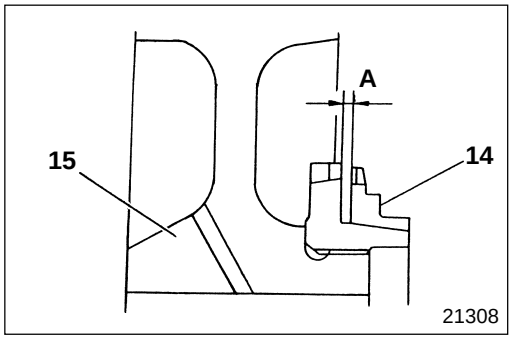


10 **to** **15** **Synchromesh mechanism and countershaft O/D gear assembly**

[Inspection]

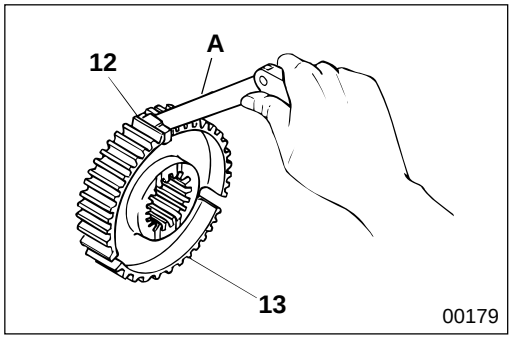
(1) Clearance between synchronizer ring 14 and shifting key 12.

If the measured value is higher than the limit, replace the faulty parts.



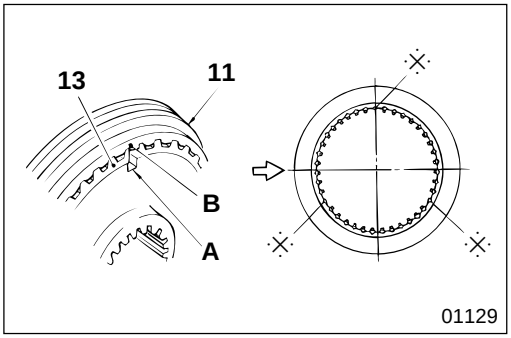
(2) Clearance between synchronizer ring 14 and countershaft O/D gear assembly 15

- Measure clearance **A** between synchronizer ring **14** and the gear cone of countershaft O/D gear assembly **15**.
- When measuring this value, press synchronizer ring **14** evenly, and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



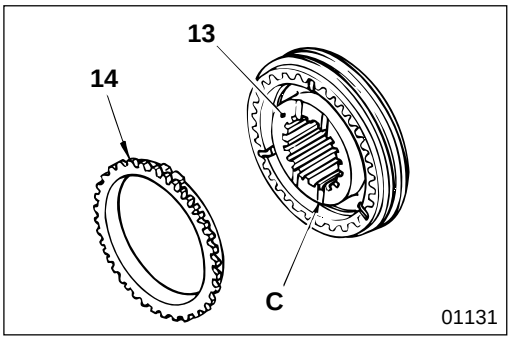
(3) Clearance between shifting key 12 and synchronizer hub 13

If the measured value is higher than the limit, replace the faulty parts.
A : Feeler gauge

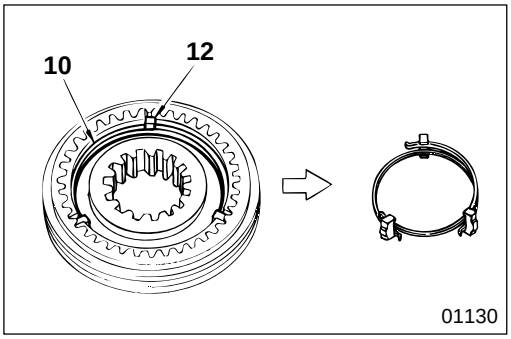


[Installation]

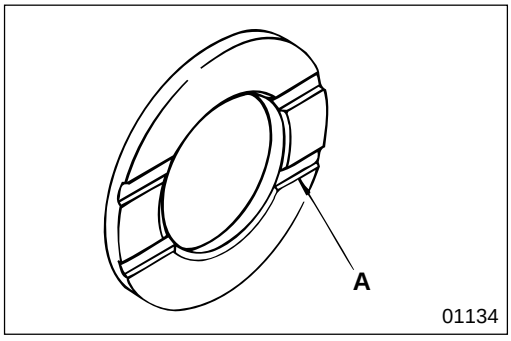
- Align the three keyways **A** of synchronizer hub **13** with the three stub teeth **B** (illustrated by ⋇ mark) of synchronizer sleeve **11** to install the synchronizer hub.
- To reassemble synchronizer hub **13** and synchronizer sleeve **11**, align the alignment marks made during disassembly.



- Assemble synchronizer ring **14** on synchronizer hub **13** with the keyway aligned to the side where oil groove **C** is located.

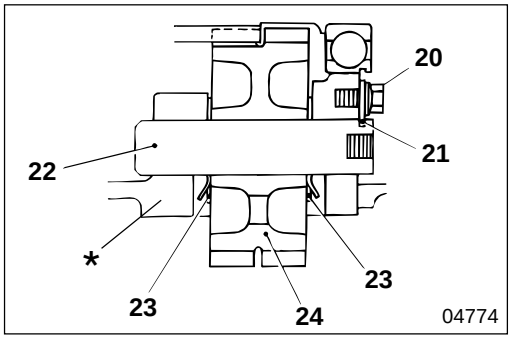


- Insert shifting **12** into the keyway.
- Install shifting key spring **10** so that its opening is offset from the one of the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.



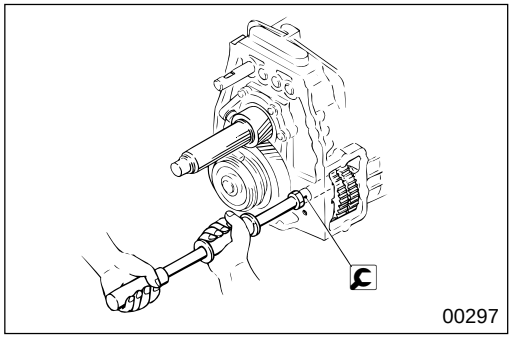
17 Installation of thrust washer

Install with the side having oil grooves **A** facing the side of gear.



20 to 24 Assembly of reverse idler gear

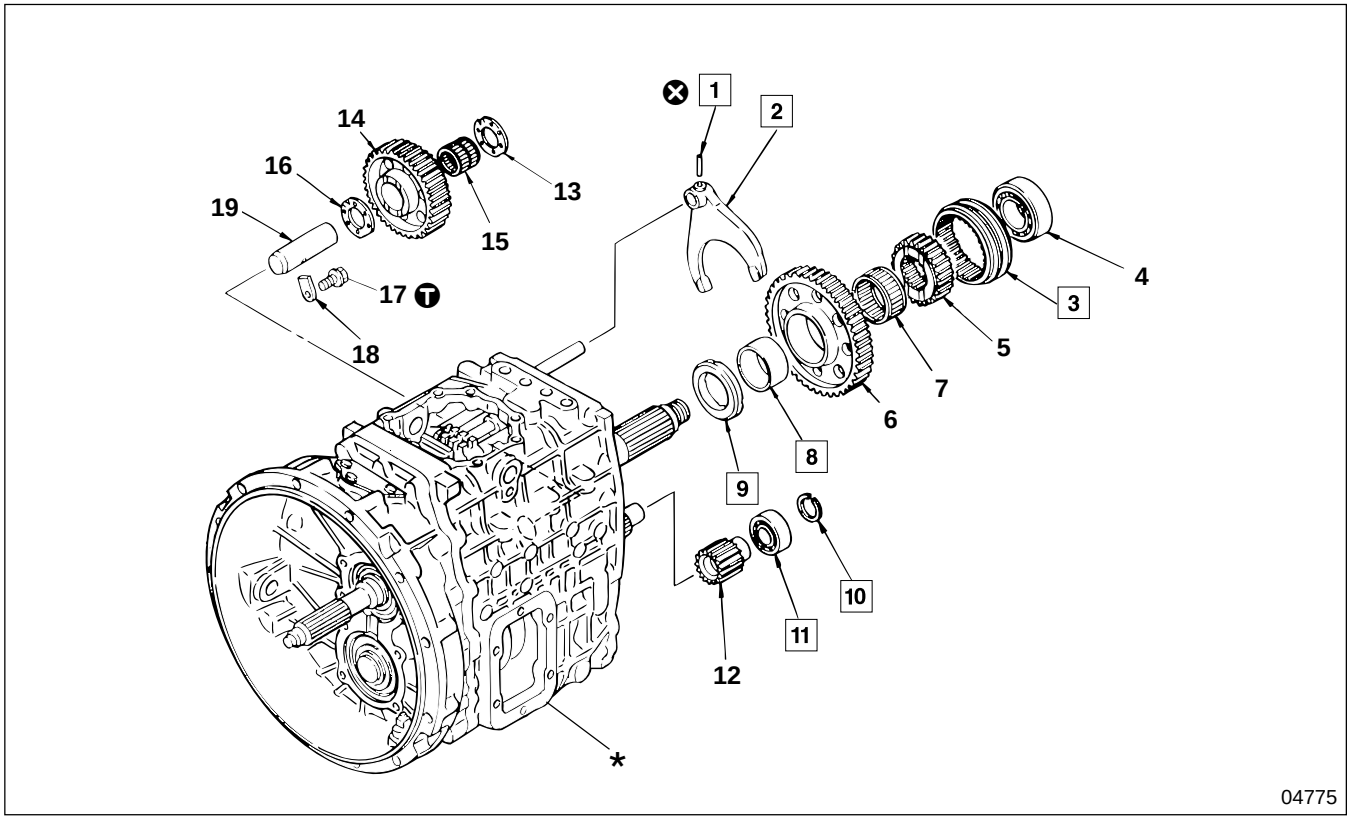
- Install reverse shaft gear side washer **23** and reverse idler gear **24** in trasmission body *****.
- Install reverse ilder shaft **22** in transmission body ***** using a plastic-headed mallet.
- Install reverse shaft lock piece **21** in transmission body ***** with mounting bolt **20**.



22 **Removal of reverse ilder shaft.**

M E M O

REVERSE GEAR AND REVERSE IDLER GEAR < DIRECT-DRIVE (D/D) >



● **Inspection before disassembly**

P22A-44

● **Disassembly sequence**

1 Spring pin
2 Reverse gear shift fork
3 Reverse gear shift sleeve
4 Mainshaft rear bearing
5 Hub
6 Mainshaft reverse gear
7 Needle bearing
8 Mainshaft reverse gear bearing sleeve
9 Thrust washer
10 Snap ring
11 Countershaft rear bearing
12 Countershaft reverse gear
13 Reverse idler gear side washer
14 Reverse idler gear
15 Needle bearing < M060 >
16 Reverse idler gear side washer
17 Bolt
18 Reverse idler shaft lock piece
19 Reverse idler shaft

***** : Transmission body
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

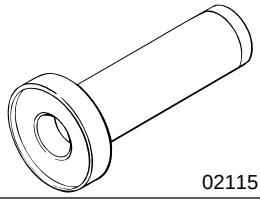
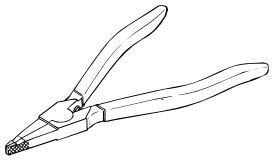
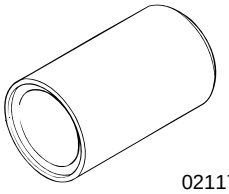
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
2	Tilt of reverse gear shift fork claw	0.1 {0.0039} or less	0.2 {0.079}	Replace
2, 3	Clearance between reverse gear shift fork and reverse gear shift sleeve	0.3 to 0.5 {0.012 to 0.020}	—	Replace
3, 5	Play in the rotating direction of reverse gear shift sleeve and hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
5, *	Engagement in the rotating direction of hub and mainshaft	–0.006 to 0.094 {–0.00024 to –0.0037}	0.2 {0.0079}	Replace
6	End play of mainshaft reverse gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace side washer
6, 7, 8, *	Play in the diameter direction after assembling mainshaft reverse gear	—	0.1 {0.0039}	Replace
8	Outer diameter of reverse gear bearing sleeve	$[71]^{-0.030}_{-0.040}$ {$[2.80]^{-0.0012}_{-0.0016}$}	– 0.1 {– 0.0039}	Replace
14	End play of reverse idler gear	0.2 to 0.9 {0.0079 to 0.035}	1.2 {0.047}	Correct
14, 15, 19	Play in the diameter direction after assembling reverse idler gear	—	0.15 {0.0059}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

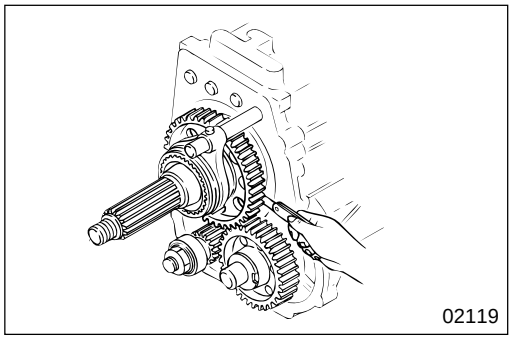
Location	Parts to be tightened	Tightening torque	Remarks
17	Bolt (Reverse idler shaft lock piece mounting)	40 {30, 4.1}	—

Special tools

Location	Tool name and shape	Part No.	Application
8	Mainshaft bearing installer  02115	*MH062634	Installation of mainshaft reverse gear bearing sleeve
10	Snap ring expander  01137	MH061268	Removal of countershaft rear bearing snap ring
11	Countershaft bearing installer  02117	*MH062642	Installation of countershaft rear bearing

* components of puller and installer kit P22A-92

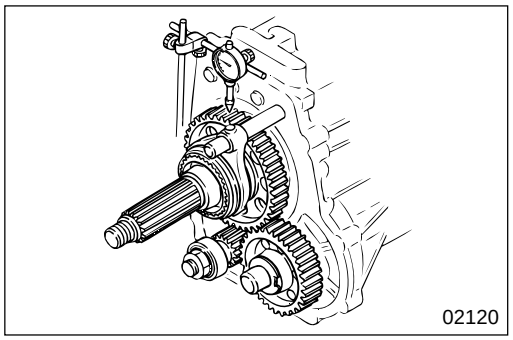
◆ Service procedure



● **Inspection before disassembly**

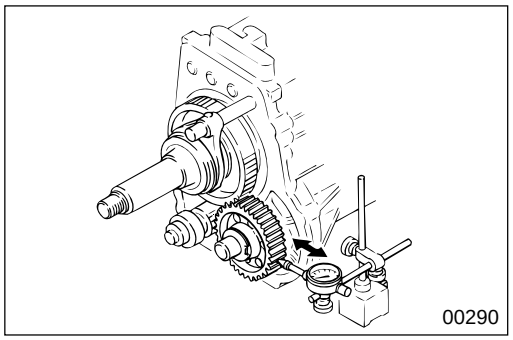
(1) End play of mainshaft reverse gear

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



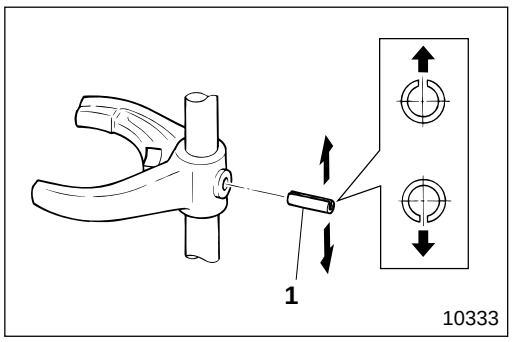
(2) Play of mainshaft reverse gear in diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.



(3) Play of reverse idler gear in diameter direction

- If the measured value is higher than the limit, replace the faulty parts.
- Reinspect play after assembly to check that the measured value is within the limit.

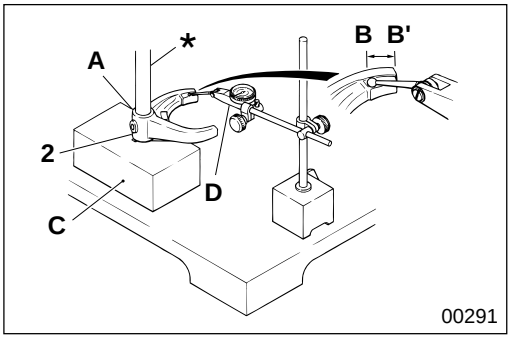


1 **Installation of spring pin**

Install spring pin **1** in reverse gear shift fork **2** in the direction as illustrated.

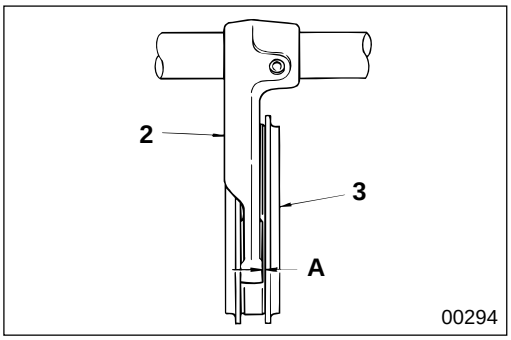
CAUTION⚠

Make sure you do not drive in spring pin 1 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.



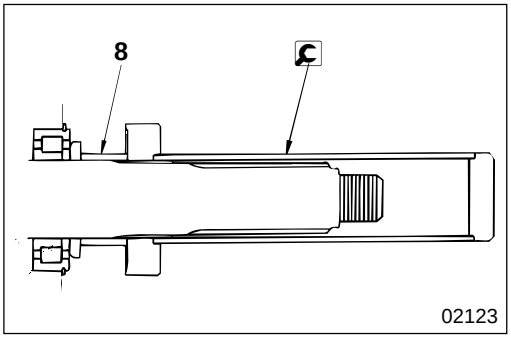
2 **Tilt of reverse gear shift fork claw**

- Measure the tilt (difference between **B** and **B'**) of claw **B**–**B'** against hole **A** of shift rail * of shift fork **2** with the shift rail upright.
- If the measured value is higher than the limit, replace reverse gear shift fork **2**.
  C : V-block
  D : Dial gauge

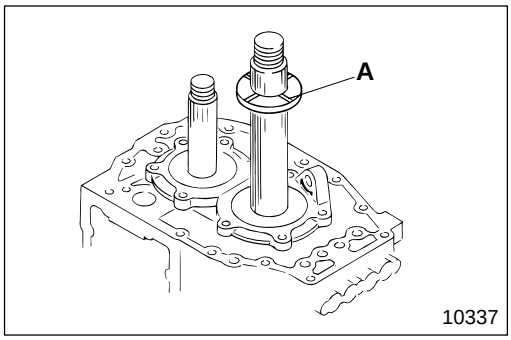


2 **3** **Clearance between reverse gear shift fork and reverse gear shift sleeve**

- Measure clearance **A** between reverse gear shift fork **2** and reverse gear shift sleeve **3**.
- If the measured value is higher than the limit, replace the faulty parts.

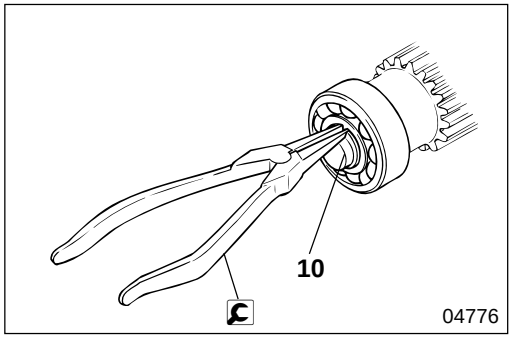


8 **Installation of mainshaft reverse gear bearing sleeve**

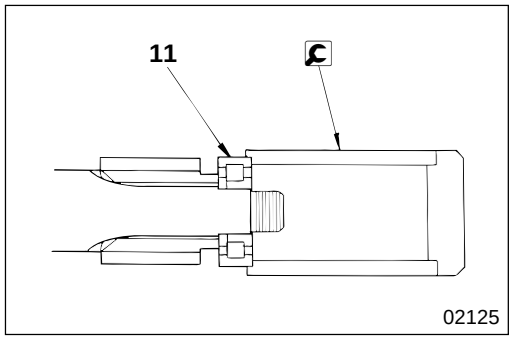


9 **Installation of thrust washer**

A : Oil groove



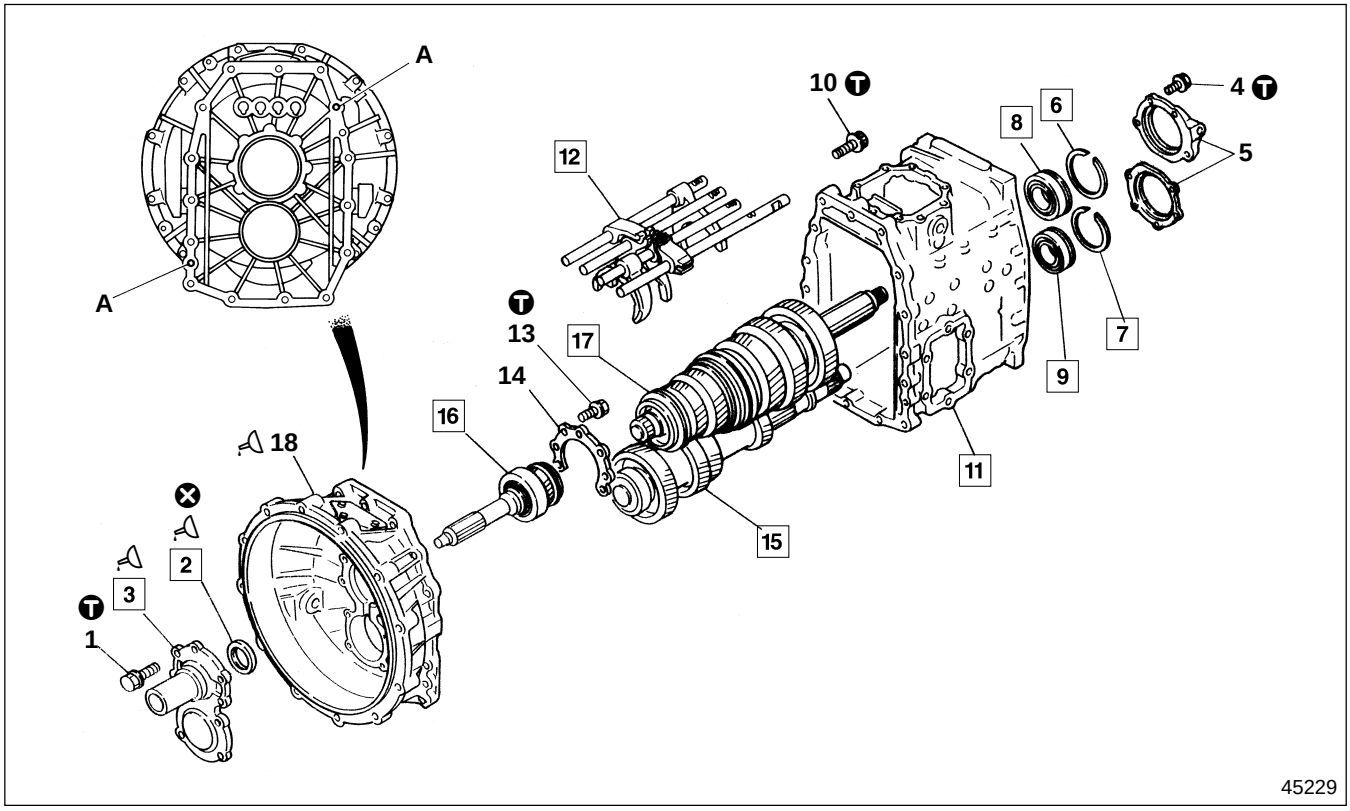
10 **Removal and installation of snap ring**



11 **Installation of countershaft rear bearing**

M E M O

TRANSMISSION BODY



● **Disassembly sequence**

1 Bolt
2 Oil seal
3 Front bearing retainer
4 Bolt
5 Rear bearing retainer
6 Snap ring
7 Snap ring
8 Mainshaft rear bearing
9 Countershaft rear bearing
10 Bolt
11 Transmission case
12 Shift rail and shift fork 🕮 P22A-58 or P22A-62
13 Bolt
14 Drive pinion bearing retainer
15 Countershaft assembly 🕮 P22A-84
16 Drive pinion assembly 🕮 P22A-64
17 Mainshaft assembly 🕮 P22A-66 or P22A-74
18 Clutch housing assembly

A : Positioning pin
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

- **After removing parts 1 to 3, disassemble the transmission assembly with the body laid vertically on its clutch housing side.**
- **Remove parts 12, and 15 to 17 as a group. However, shift rail and shift fork 12 can be disassembled on its own if you are not going to disassemble parts 15 to 17. 🕮 P22A-58 or P22A-62**

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

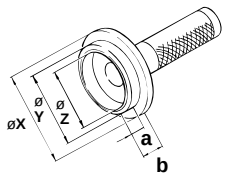
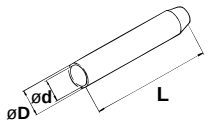
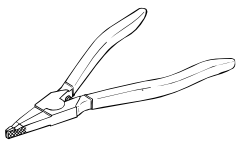
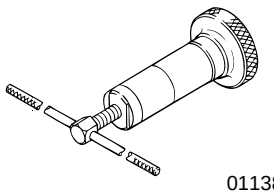
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Front bearing retainer mounting)	40 {30, 4.1}	—
4	Bolt (Rear bearing retainer mounting)	40 {30, 4.1}	—
10	Bolt (Transmission case mounting)	120 {90, 12.4}	—
13	Bolt (Drive pinion retainer mounting)	40 {30, 4.1}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
2	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
3	Contact surface between front bearing retainer and clutch housing assembly	THREEBOND 1215	As required
18	Contact surface between clutch housing assembly and transmission case	THREEBOND 1215	As required

Special tools

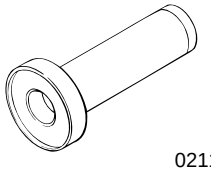
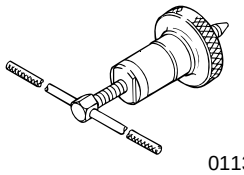
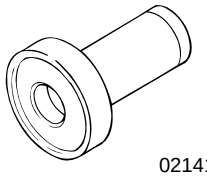
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Oil seal installer **X** 72 {2.83} **Y** 50 {1.97} **Z** 40 {1.57} **a** 10 {0.39} **b** 10 {0.39}  01135	< C6 > MH061992	Installation of front bearing retainer oil seal
3	Oil seal front guide **d** 44 {1.73}, **D** 46 {1.81}, **L** 217 {8.54}  01136	< C6 > MH061991	Installation of front bearing retainer
6, 7	Snap ring expander  01137	MH061268	Removal of snap rings from mainshaft rear bearing and countershaft front and rear bearings
8	Mainshaft bearing puller  01138	< O/D > *MH061732 < D/D > *MH062433	Removal of mainshaft rear bearing

* components of puller and installer kit P22A-92

TRANSMISSION BODY

Unit : mm {in.}

<table>
<tr><th>Location</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>8</td><td>Mainshaft bearing installer
 
02115</td><td>< O/D >
*MH624234
< D/D >
*MH062634</td><td>Installation of mainshaft rear bearing</td></tr>
<tr><td rowspan="2">9</td><td>Countershaft bearing puller
 
01139</td><td>< O/D >
*ME061731
< D/D >
*MH062432</td><td>Removal of countershaft rear bearing</td></tr>
<tr><td>Countershaft bearing installer
 
02141</td><td>< O/D >
*ME624233
< D/D >
*MH062630</td><td>Installation of countershaft bearing</td></tr>
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 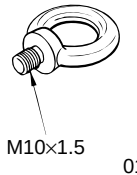
M10×1.5
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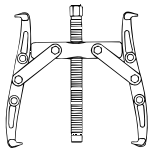
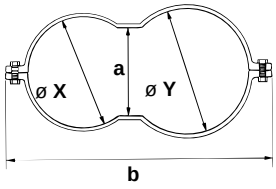
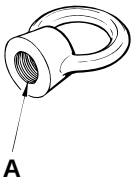
<tr><td>Gear puller
 
01148</td><td>MH062308 or
MH062250</td><td>Removal of transmission case</td></tr>
<tr><td rowspan="2">15 to 17</td><td>Steel lifting band
<table><tr><td>O/D</td><td>X=87 {3.43}
Y=175 {6.89}
a=80 {3.15}
b=336 {13.2}</td></tr><tr><td>D/D</td><td>X=116{4.57}
Y=173 {6.81}
a=100 {3.94}
b=360 {14.1}</td></tr></table> 
ø X a ø Y b
01141</td><td>< O/D >
MH062343
< D/D >
MH062344</td><td rowspan="2">Removal and installation of mainshaft assembly, countershaft assembly and drive pinion assembly</td></tr>
<tr><td>Eye nut
<table><tr><td></td><td>A</td></tr><tr><td>O/D</td><td>M27×1.5</td></tr><tr><td>D/D</td><td>M36×1.5</td></tr></table> 
A
01142</td><td>< O/D >
MH062341
< D/D >
MH062342</td></tr>
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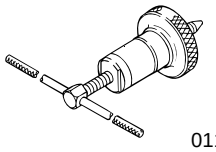
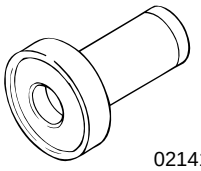
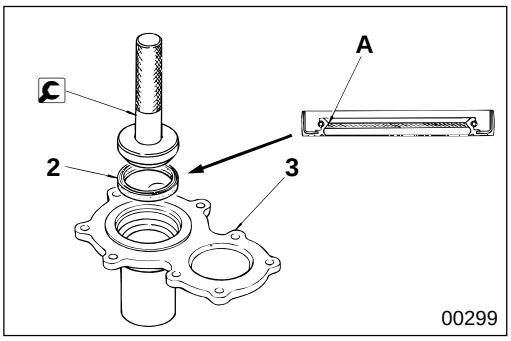
* components of puller and installer kit. P22A-92

Location	Tool name and shape	Part No.	Application
15	Countershaft bearing puller  01139	< O/D > *MH062426 < D/D > *MH062429	Removal of countershaft front bearing
	Countershaft bearing installer  02141	< O/D > *ME624233 < D/D > *MH062630	Installation of countershaft front bearing

* components of puller and installer kit. P22A-92

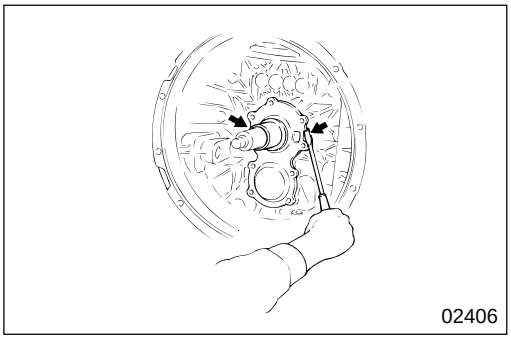
◆ Service procedure



00299

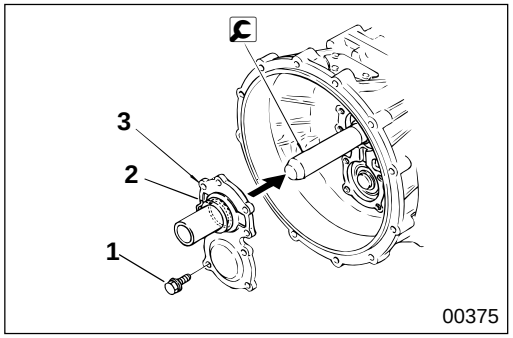
2 Installation of oil seal

- Apply grease to lip area **A** of oil seal **2**.
- Press-fit oil seal **2** into front bearing retainer **3** in the direction as illustrated using oil seal installer.


02406

3 Front bearing retainer

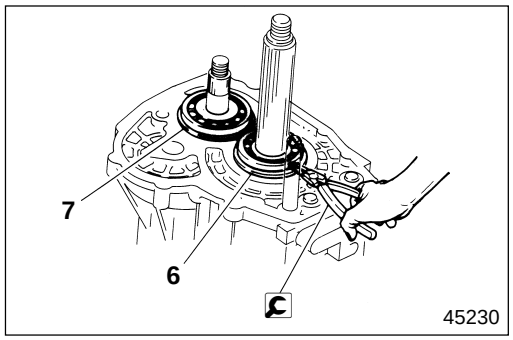
[Removal]



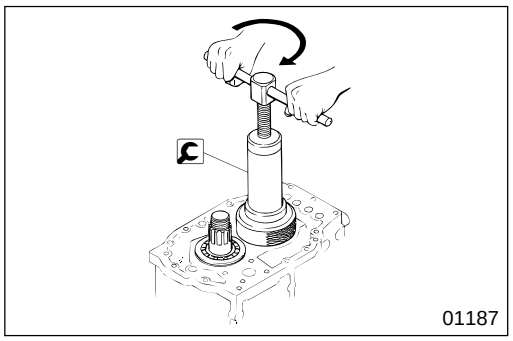
[Installation]
Press-fit front bearing retainer **3** into clutch housing assembly **18** using oil seal front guide.

CAUTION

Be careful when installing front bearing retainer 3, that you do not damage oil seal 2 installed on the front bearing retainer.

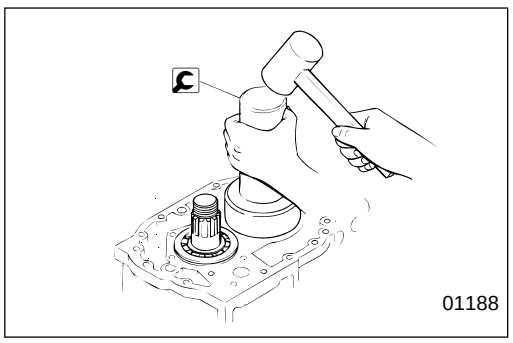


6 **7** **Removal and installation of snap ring**

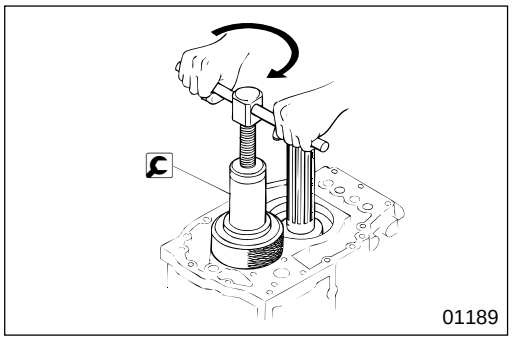


8 **Mainshaft rear bearing**

[Removal]

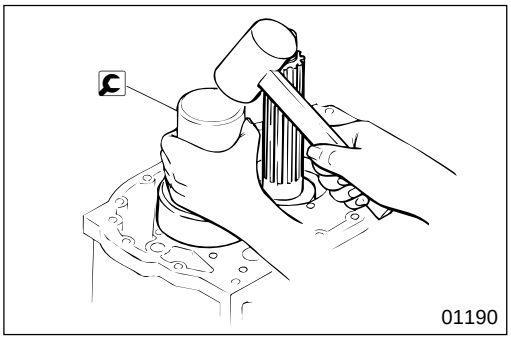


[Installation]

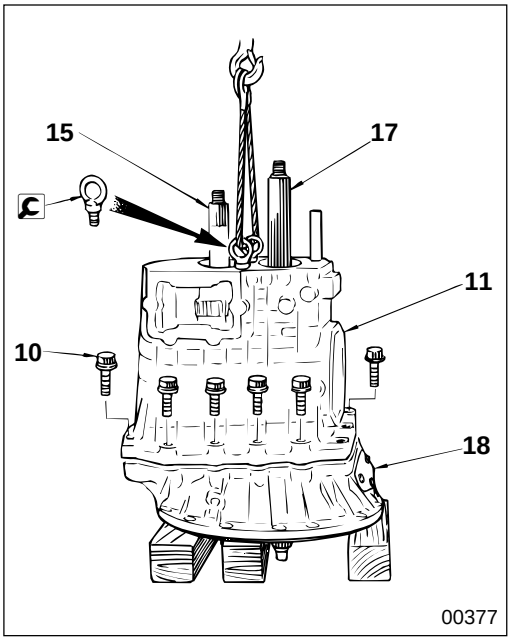


9 **Countershaft rear bearing**

[Removal]



[Installation]



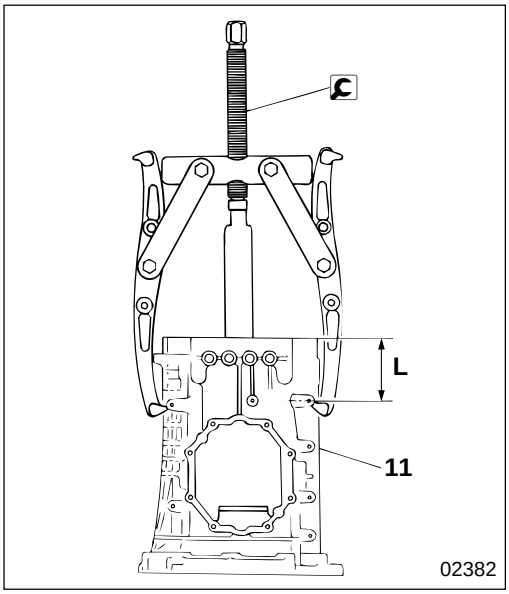
11 Removal and installation of transmission case

[Removal]

● **Remove transmission case 11.**

Method 1

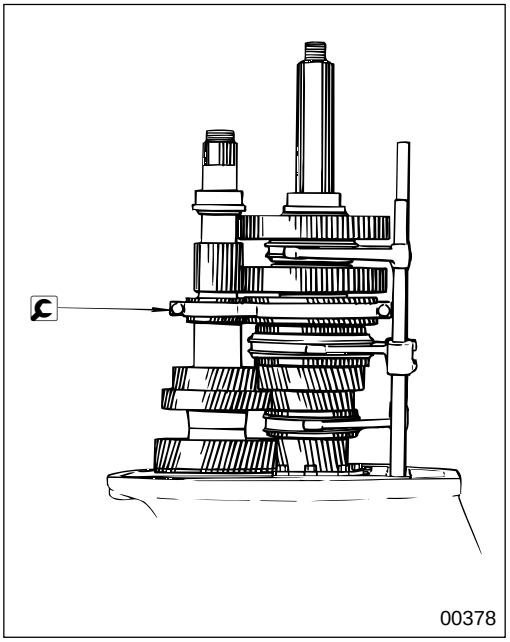
- When lifting up with a crane, install eye bolts on transmission case **11** and pass a steel sling through them.
- After removing bolts **10**, lift transmission case **11** up with a crane and keep hitting the rear ends of clutch housing assembly **18**, mainshaft assembly **17** and countershaft assembly **15**. Use a plastic-headed or copper-headed mallet to remove the transmission case.



Method 2

- A gear puller can be used instead of a crane.
  Puller installation position

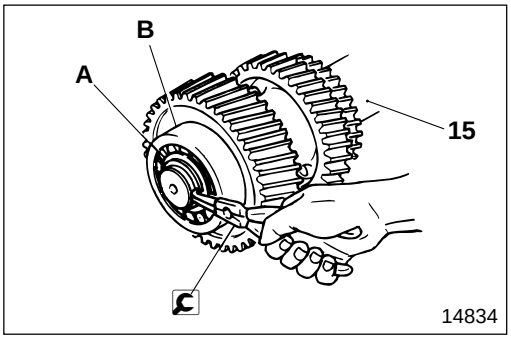
Model	Dimension of L mm {in.}
M060S6 O/D	146 {5.75}
M060S6 D/D	36 {1.42}
M070S6	93 {3.66}



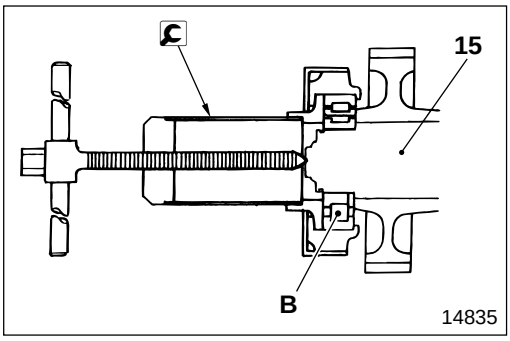
- After removing transmission case **11**, fit the 2nd gear unit < O/D > or 3rd gear unit < D/D > using steel lifting band to ensure safety.

CAUTION

Be sure to tighten steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.



- Remove snap ring **A** from countershaft assembly **15**.
  B : Countershaft front bearing

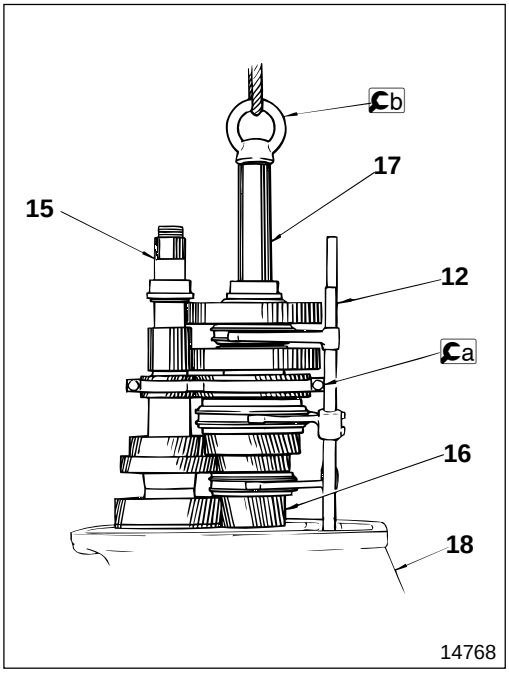


- Remove countershaft bearing **B** from countershaft assembly **15**.

[Installation]
Follow the removal sequence in reverse.

CAUTION

Be careful not to damage mainshaft assembly 17, or rear bearings 8, 9 of countershaft assembly 15 during installation.



12 **15** **to** **17** **Shift rail and shift fork, countershaft assembly, drive pinion assembly, and mainshaft assembly**

[Removal]
Remove or install shift rail and shift fork **12**, countershaft assembly **15**, drive pinion assembly **16**, and mainshaft assembly **17** as a group.

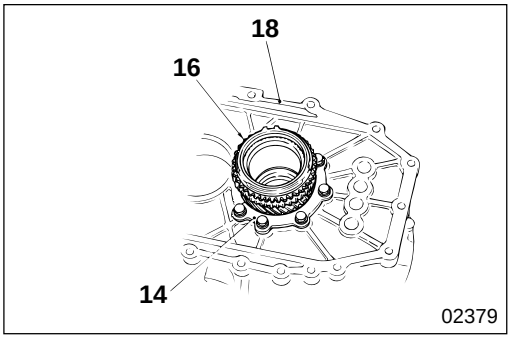
- Before lifting, after removing the case, install b eye nut at the end of mainshaft **17**, fitted with a steel lifting band.
- Fix shift rail and shift fork **12** to mainshaft assembly **17** with a rubber band.
- Fix a piece of wood to clutch housing assembly **18**, and use a crane to lift the clutch housing together with drive pinion assembly **16** up, at the same time hitting them with a plastic-headed mallet to remove them.

CAUTION

- **Be sure to tighten a steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.**
- **Make sure, when lifting mainshaft assembly 17 or other parts, that you support drive pinion assembly 16 with your hand in order to prevent it from falling when the mainshaft assembly and countershaft assembly 15 come apart.**

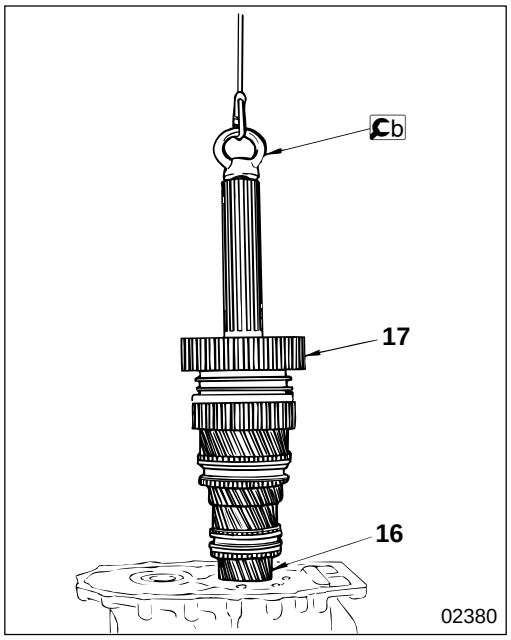
[Installation]
Method 1

- Follow the removal sequence in reverse.



Method 2

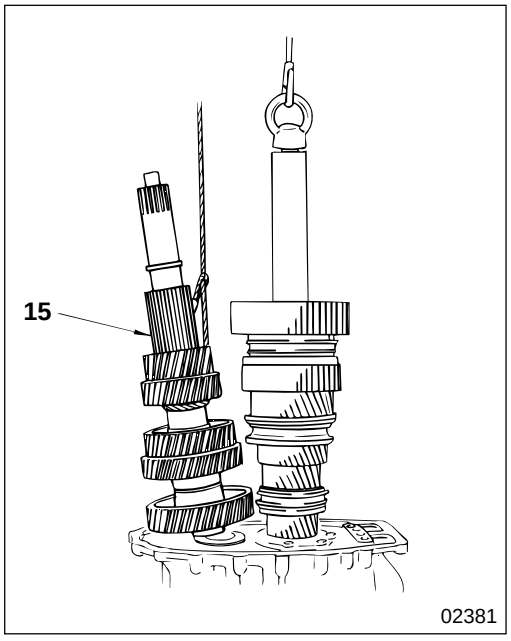
- After installing drive pinion assembly **16** in clutch housing assembly **18**, install drive pinion bearing retainer **14**.



- Install b eye nut at the end of mainshaft assembly **17**.
- Lift mainshaft assembly **17** up using a crane and install the mainshaft assembly on drive pinion assembly **16**.

CAUTION

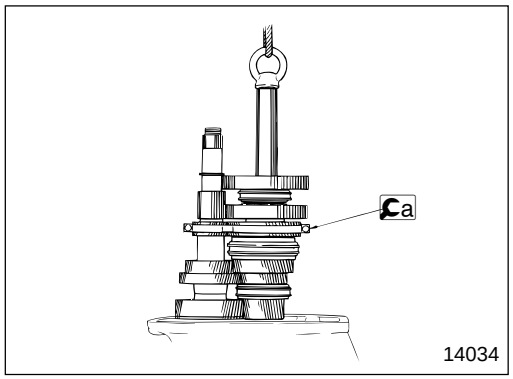
To prevent mainshaft assembly 17 from falling, support it using a crane.



- Install countershaft assembly **15** in clutch housing assembly **18**.

CAUTION

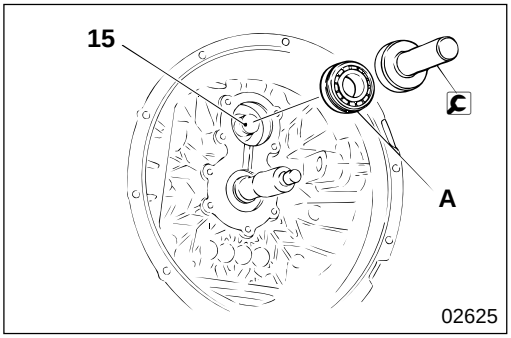
If you use this method of installation, first remove the countershaft front bearing. 🕮 P22A-84



- Fit the 2nd gear unit using a steel lifting band to ensure safety.

CAUTION

Be sure to tighten a steel lifting band adequately enough to prevent it from coming undone, but not excessively, because excessive tightening would damage the gears, etc.



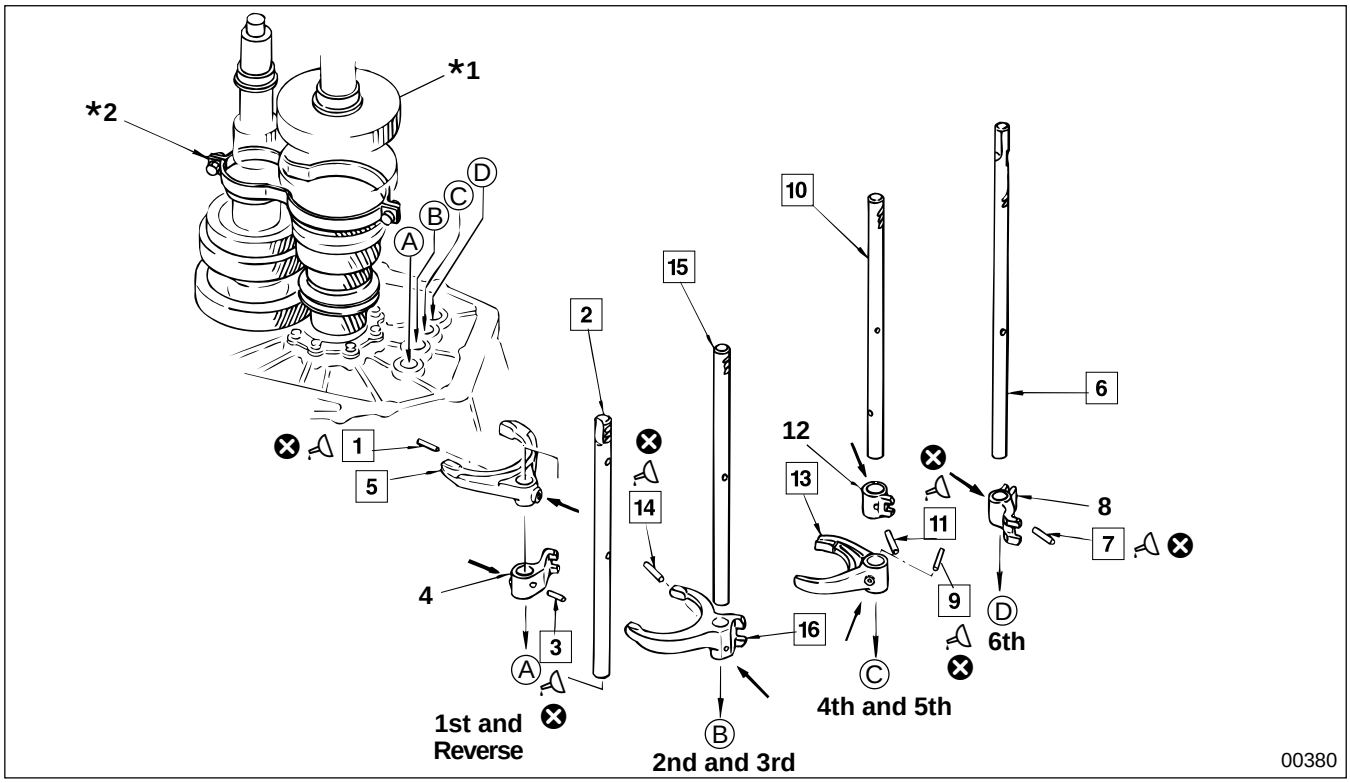
- Install shift rail and shift fork **12** and transmission case **11** in clutch housing assembly **18**.
- Place cluch housing assembly **18** horizontally so that countershaft assembly **15** is uppermost.
- Install the countershaft front bearing **A** into clutch housing assembly **18** using countershaft bearing installer.

CAUTION

Be sure to install the snap ring of the countershaft front bearing.

TRANSMISSION BODY

Shift Rail and Shift Fork < O/D >



Arrow mark : Removal and installation direction for spring pin

● **Disassembly sequence** (When the mainshaft assembly is not removed or installed and only the shift rail and shift fork is disassembled)

1 Spring pin
2 1st and reverse shift rail
3 Spring pin
4 1st and reverse shift rail jaw
5 1st and reverse shift fork
6 6th shift rail
7 Spring pin
8 6th shift rail jaw
9 Spring pin
10 4th and 5th shift rail
11 Spring pin
12 4th and 5th shift rail jaw
13 4th and 5th shift fork
14 Spring pin
15 2nd and 3rd shift rail
16 2nd and 3rd shift fork

***1** : Mainshaft assembly
***2** : steel lifting band
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse. Remove steel lifting band after installing the shift rail and shift fork.

Service standards

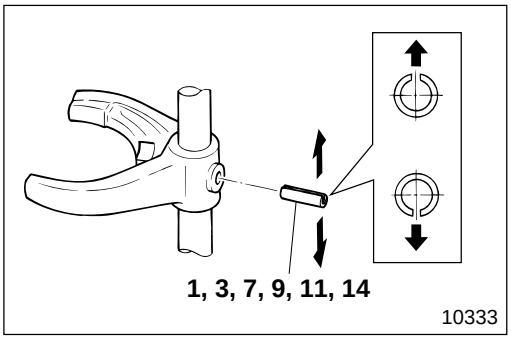
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2, 10, 15	Bend of shift rail	0.039 {0.0015} or less	0.08 {0.0031}	Correct or replace
5, 13, 16	Tilt of shift fork claw	0.1 {0.0039} or less	0.2 {0.0079}	Replace
5, *1	Clearance between 1st and reverse shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.020}	1.0 {0.039}	Replace
6	Bend of 6th shift rail	0.047 {0.0019} or less	0.09 {0.0035}	Correct or replace
13, *1	Clearance between 4th and 5th shift fork and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
16, *1	Clearance between 2nd and 3rd shift fork and synchronizer sleeve	0.2 to 0.4 {0.0079 to 0.016}	1.0 {0.039}	Replace

Sealant

Location	Points of application	Kinds	Quantity
1, 3, 7, 9, 11, 14	Spring pin	LOCTITE 601	As required

◆ Service procedure

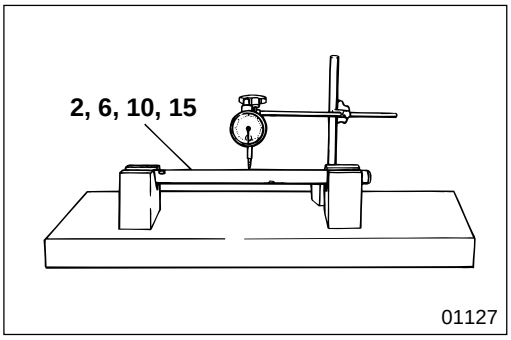


1 **3** **7** **9** **11** **14** **Installation of spring pin**

Install spring pins **1**, **3**, **7**, **9**, **11, 14** in the direction as illustrated.

CAUTION

- **Make sure you do not drive in spring pins 1, 3, 7, 9, 11, 14 fully, leave 0 to 0.5 mm {0 to 0.020 in.} outside to prevent them from slipping out.**
- **Do not remove spring pin 9 for 4th and 5th shift fork 13 (made of aluminum), except when replacing shift fork 13 or shift rail 10.**
- **Note that the length of spring pin 9 differs from that of spring pins 1, 3, 7, 11, 14.**
- **Be careful when driving in spring pins 1, 3, 7, 9, 11, 14 that you do not subject shift rails 2, 6, 10, 15 to excessive strain, because this would cause faults such as bent shift rails.**

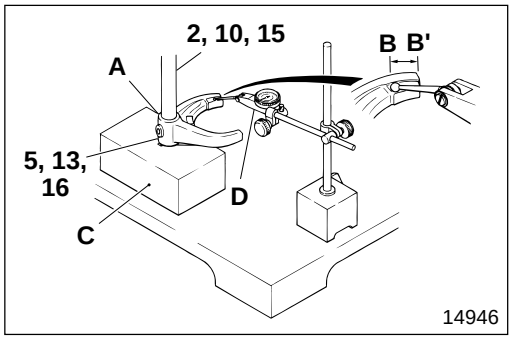


2 **6** **10** **15** **Bend of shift rail**

If the measured value is higher than the limit, correct or replace shift rail **2**, **6**, **10** or **15**.

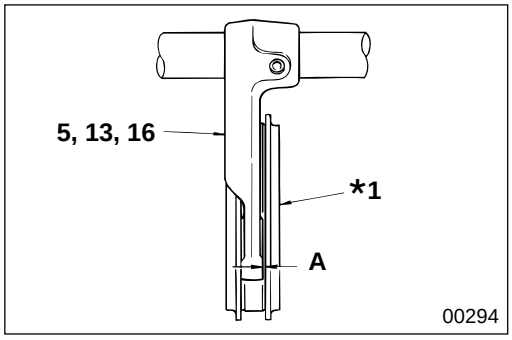
NOTE

Read the dial gauge after turning shift rails 2, 6, 10, 15 one full revolution. The bend is one half of the indicated value.



5 13 16 Tilt of shift fork claws

- Measure the tilt (difference between **B** and **B'**) of claw **B**–**B'** against hole **A** of shift rails **2, 10, 15** of shift forks **5, 13, 16** with the shift rails upright.
- If the measured value is higher than the limit, replace shift fork **5**, **13**, or **16**.
  C : V-block
  D : Dial gauge



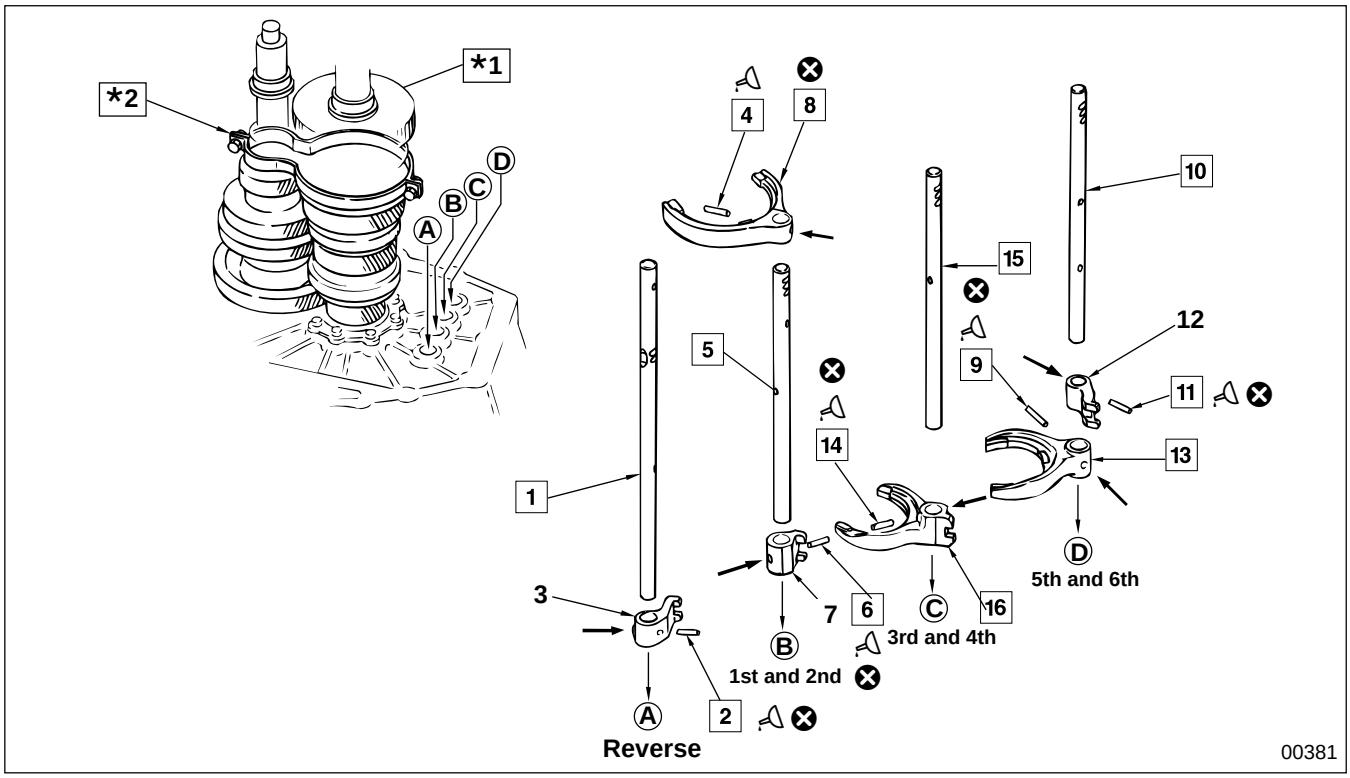
5 13 16 *1 Clearance between gear shift fork and synchronizer sleeve of mainshaft

If clearance **A** is higher than the limit, replace the faulty parts.
***1** : Synchronizer ring of mainshaft assembly

M E M O

TRANSMISSION BODY

Shift Rail and Shift Fork < D/D >



Arrow mark: Removal and installation direction for spring pin

● **Disassembly sequence** (Where the mainshaft assembly is not removed or installed and only the shift rail and shift fork is disassembled)

1 Reverse shift rail
2 Spring pin
3 Reverse shift rail jaw
4 Spring pin
5 1st and 2nd shift rail
6 Spring pin
7 1st and 2nd shift rail jaw
8 1st and 2nd shift fork
9 Spring pin
10 5th and 6th shift rail
11 Spring pin
12 5th and 6th shift rail jaw
13 5th and 6th shift fork
14 Spring pin
15 3rd and 4th shift rail
16 3rd and 4th shift fork

***1** : Mainshaft assembly
***2** : steel lifting band
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse. Remove steel lifting band after installing the shift rail and shift fork.

Service standards

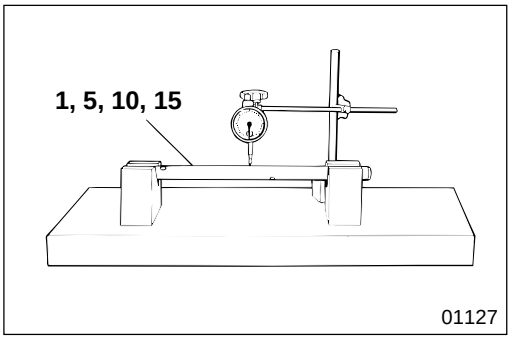
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Bend of reverse shift rail	0.047 {0.0019} or less	0.09 {0.0035}	Correct or replace
5, 10, 15	Bend of shift rails	0.037 {0.0015} or less	0.07 {0.0028}	Correct or replace
8, 13, 16	Tilt of shift fork claw	0.1 {0.0039} or less	0.2{0.0079}	Replace shift fork
8, *1	Clearance between 1st and 2nd shift fork and synchronizer sleeve	0.3 to 0.5 {0.012 to 0.002}	1.0 {0.039}	Replace
13, *1	Clearance between 5th and 6th shift fork and synchronizer sleeve	0.3 to 0.6 {0.012 to 0.024}	1.0 {0.039}	Replace
16, *1	Clearance between 3rd and 4th shift fork and synchronizer sleeve	0.2 to 0.4 {0.0079 to 0.016}	1.0 {0.039}	Replace

Sealant

Location	Points of application	Kinds	Quantity
2, 4, 6, 9, 11, 14	Spring pin	LOCTITE 601	As required

◆ Service procedure

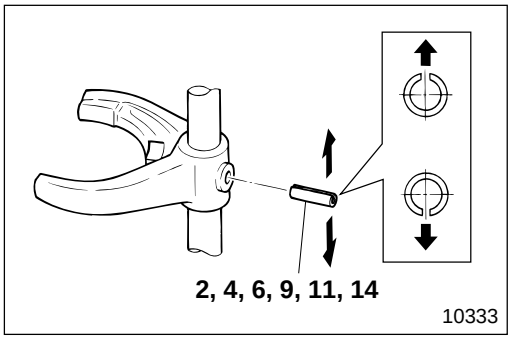


1 **5** **10** **15** **Bend of shift rail**

If the measured value is higher than the limit, correct or replace shift rail **1**, **5**, **10**, or **15**.

NOTE

Read the dial gauge after turning shift rails 1, 5, 10, 15 one full revolution. The bend is one half of the indicated value.

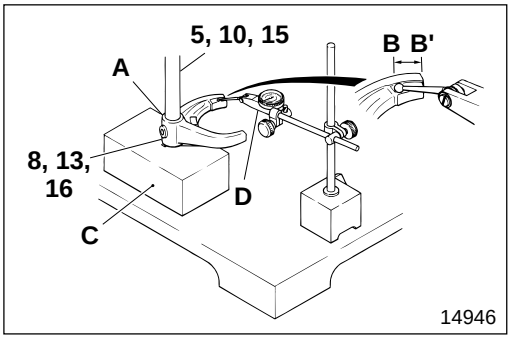


2 **4** **6** **9** **11** **14** **Installation of spring pin**

Install spring pins **2**, **4**, **6**, **9**, **11**, **14** in the direction as illustrated.

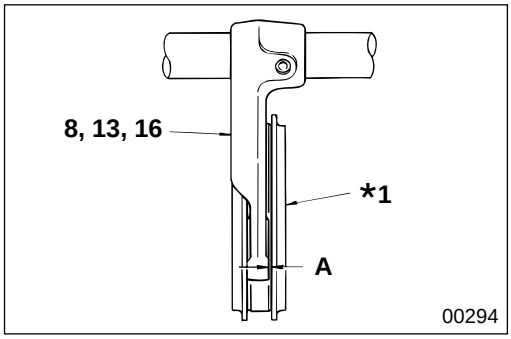
CAUTION

- **Make sure you do not drive in spring pins 2, 4, 6, 9, 11, 14 fully, leave 0 to 0.5 mm {0 to 0.02 in.} outside to prevent them from slipping out.**
- **Do not remove spring pin 6 for 4th and 5th shift fork 10 (made of aluminum), except when replacing shift forks 8, 13 or shift rails 5, 10.**
- **The lengths of spring pins 4, 9 differ from those of other spring pins 2, 6, 11, 14.**
- **Be careful when driving in spring pins 2, 4, 6, 9, 11, 14 that you do not subject shift rails 1, 5, 10, 15 to excessive strain, because this would cause faults such as bent shift rails.**



8 **13** **16** **Tilt of shift fork claw**

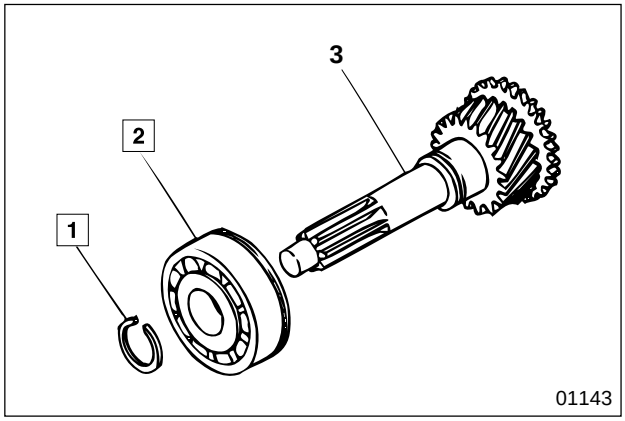
- Measure the tilt (difference between **B** and **B'**) of claw **B**–**B'** against hole **A** of shift rails **5**, **10**, **15** of shift forks **8**, **13**, **16** with the shift rails upright.
- If the measured value is higher than the limit, replace shift fork **8**, **13**, or **16**.
  C : V-block
  D : Dial gauge



8 **13** **16** ***1** **Clearance between shift fork and synchronizer sleeve of mainshaft**

If clearance **A** is higher than the limit, replace the faulty parts.
***1** : Synchronizer ring of mainshaft assembly

DRIVE PINION ASSEMBLY



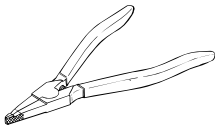
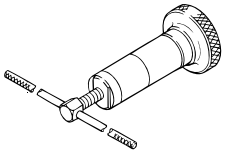
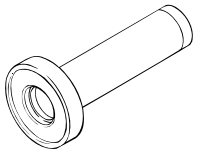
● **Disassembly sequence**

1 Snap ring
2 Drive pinion bearing
3 Drive pinion

● **Assembly sequence**

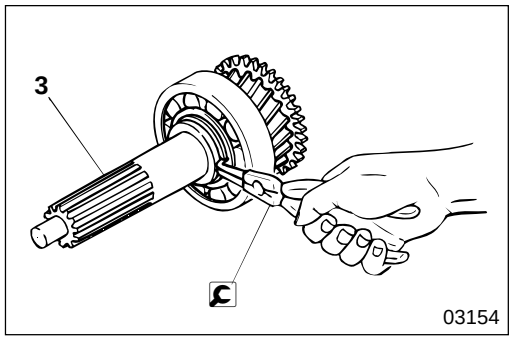
Follow the disassembly sequence in reverse.

Special tools

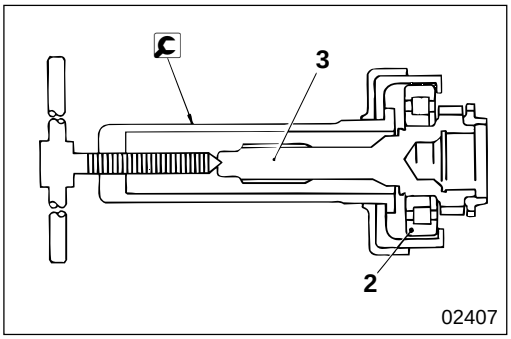
Location	Tool name and shape	Part No.	Application
1	Snap ring expander  01137	MH061268	Removal and installation of snap ring of drive pinion bearing
2	Drive pinion bearing puller  01138	*MH062440	Removal of drive pinion bearing
	Drive pinion bearing installer  02142	*ME624235	Installation of drive pinon bearing

* components of puller and installer kit P22A-92

◆ Service procedure

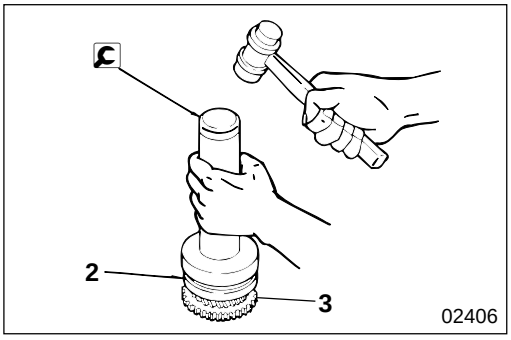


1 **Removal and installation of snap ring**



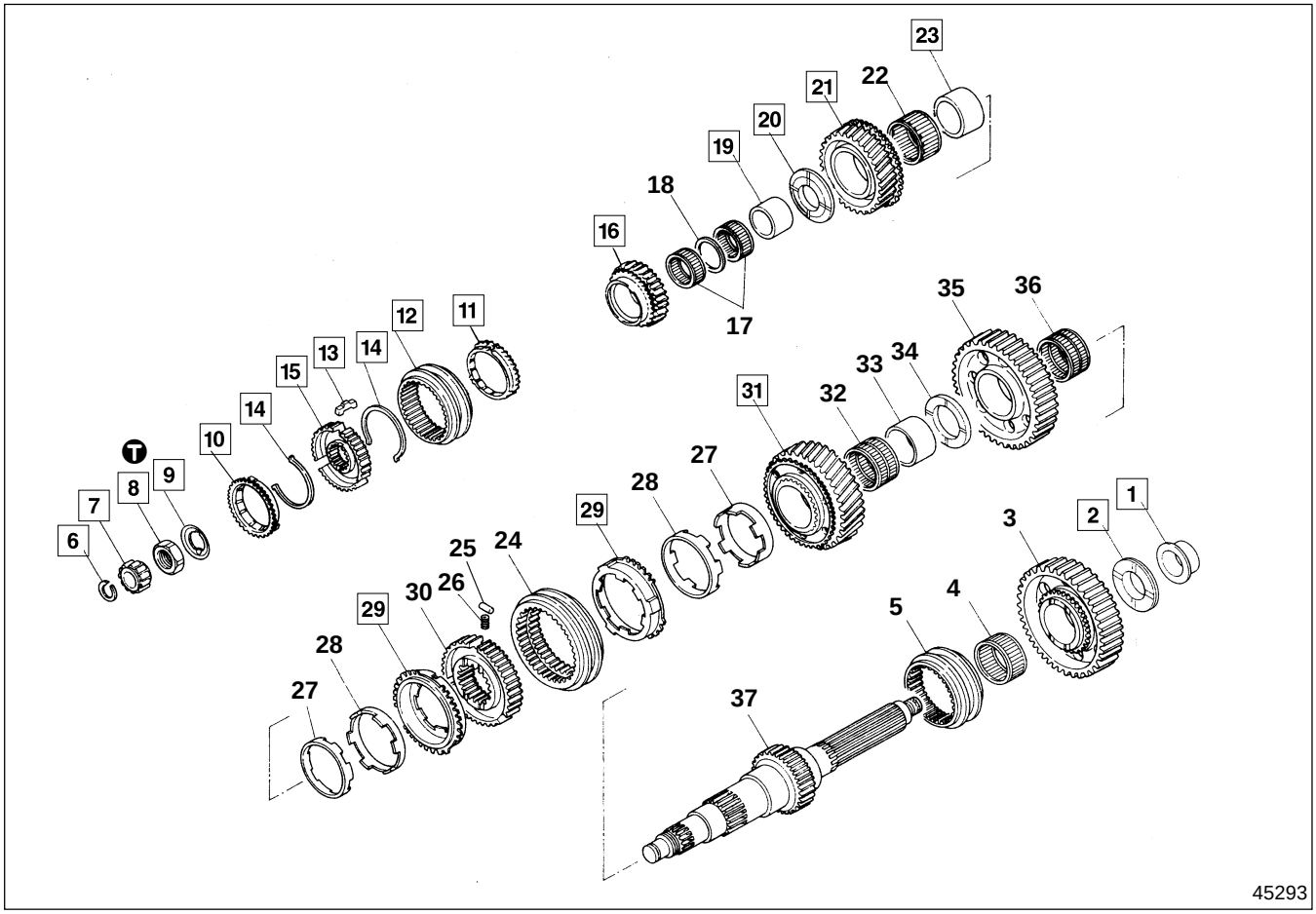
2 Drive pinion bearing

[Removal]



[Installation]

MAINSHAFT ASSEMBLY < OVER-DRIVE (O/D) >



● **Work before disassembly**

P22A-69

● **Disassembly sequence**

1 Mainshaft rear bearing inner race
2 Reverse gear thrust washer
3 Reverse gear
4 Needle bearing
5 Sleeve
6 Snap ring
7 Pilot bearing
8 Lock nut
9 Lock washer
10 Synchronizer ring
11 Synchronizer ring
12 Synchronizer sleeve
13 Shifting key
14 Shifting key spring
15 Synchronizer hub
16 4th gear assembly
17 Needle bearing
18 Bearing spacer
19 4th gear bearing sleeve
20 3rd and 4th gear thrust washer
21 3rd gear assembly
22 Needle bearing
23 3rd gear bearing sleeve
24 Synchronizer sleeve
25 Shifting key
26 Synchronizer spring
27 Synchronizer inner ring
28 Synchronizer center cone
29 Synchronizer outer ring
30 Synchronizer hub
31 2nd gear assembly
32 Needle bearing
33 2nd gear bearing sleeve
34 1st and 2nd gear thrust washer
35 1st gear
36 Needle bearing
37 Mainshaft

● **Assembly sequence**

37→36→35→34→33→36→31
30→29→28→27→24→26→25
→23→22→21→20→19→18→17→16
15→14→13→12→13→11→10
→9→8→7→6→5→4→3→2→1

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	End play of reverse gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
3, 4, 37	Play in the diameter direction after assembling reverse gear	—	0.12 {0.0047}	Replace
5, 37	Play in the rotating direction of sleeve and spline of mainshaft	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
7, 37	Play in the diameter direction after assembling pilot bearing	—	0.12 {0.0047}	Replace
10	Clearance between synchronizer ring and cone of drive pinion assembly	1.48 to 1.77 {0.058 to 0.070}	0.2 {0.0079}	Replace
10, 13	Clearance between synchronizer ring keyway and shifting key	4.75 to 4.95 {0.187 to 0.195}	5.8 {0.23}	Replace
11, 16	Clearance between synchronizer ring and cone area of 4th gear	1.48 to 1.77 {0.058 to 0.070}	0.2 {0.0079}	Replace
12, 15	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
13, 15	Clearance between shifting key and synchronizer hub keyway	0.05 to 0.2 {0.0020 to 0.0079}	0.5 {0.020}	Replace
17	End play of 4th gear	0.25 to 0.4 {0.0098 to 0.016}	0.5 {0.020}	Replace gear or thrust washer
16, 17, 19, 37	Play in the diameter direction after assembling 4th gear	—	0.12 {0.0047}	Replace
19	Outer diameter of 4th gear bearing sleeve	$[54]^{-0.030}_{-0.043}$ {$[2.12]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
21	End play of 3rd gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
21, 22, 23, 37	Play in the diameter direction after assembling 3rd gear	—	0.12 {0.0047}	Replace
21, 29	Clearance between cone area of 3rd gear and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
23	Outer diameter of 3rd gear bearing sleeve	$[68]^{-0.030}_{-0.043}$ {$[2.68]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
24, 30	Play in the rotating direction of sinchronizer sleeve and sinchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
29, 31	Clearance between synchronizer outer ring and cone area of 2nd gear	1.21 to 1.79 {0.048 to 0.070}	0.5 {0.020}	Replace
31	End play of 2nd gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
31, 32, 33, 37	Play in the diameter direction after assembling 2nd gear	—	0.12 {0.0047}	Replace
33	Outer diameter of 2nd gear bearing sleeve	$[71]^{-0.030}_{-0.043}$ {$[2.8]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
35	End play of 1st gear	0.15 to 0.35 {0.0059 to 0.014}	0.5 {0.020}	Replace gear or thrust washer
35, 36, 37	Play in the diameter direction after assembling 1st gear	—	0.12 {0.0047}	Replace

MAINSHAFT ASSEMBLY < OVER-DRIVE (O/D) >

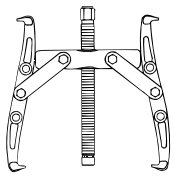
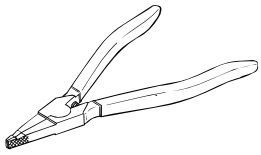
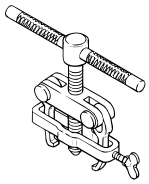
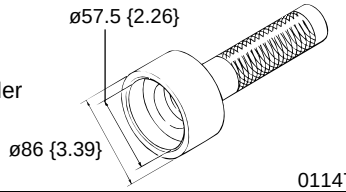
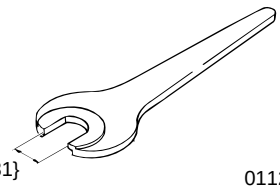
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Lock nut	245 {180, 25}	—

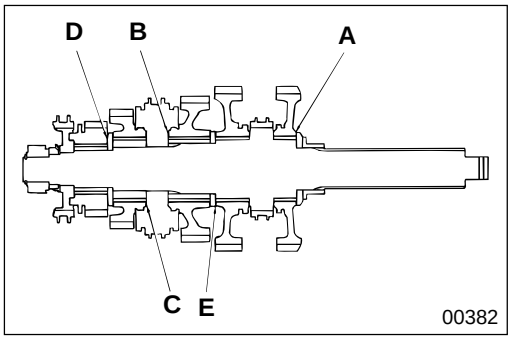
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1, 19, 23, 33	Gear puller  01148	MH062308	Removal of bearing sleeve
6	Snap ring expander  01137	MH061268	Removal and installation of snap ring
7	Pilot bearing puller  01146	MH061043	Removal of pilot bearing
	Pilot bearing installer  01147	*ME624236	Installation of pilot bearing
8	Single spanner  01126	MH061555	Removal and installation of lock nut

* Components of puller and installer kit P22A-92

◆ Service procedure



● **Work before disassembly**

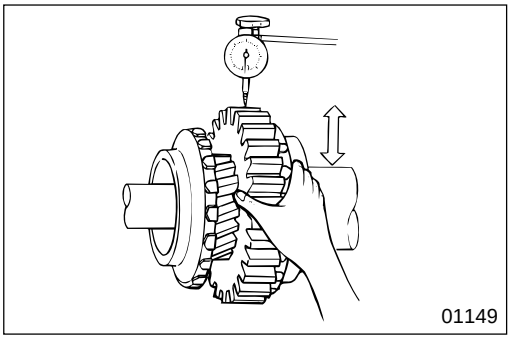
[Inspection]

(1) End play of gears

A : Reverse gear
B : 2nd gear
C : 3rd gear
D : 4th gear
E : 1st gear

If the measured value is higher than the limit, replace the faulty parts.

Also inspect this item after assembly and make sure that the measured value is within the limit.

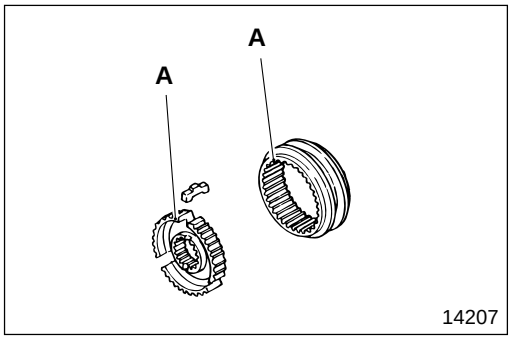


(2) Play of gears in diameter direction

If the measured value is higher than the limit, replace the faulty parts. Also inspect this item after assembly and make sure that the measured value is within the limit.

CAUTION⚠

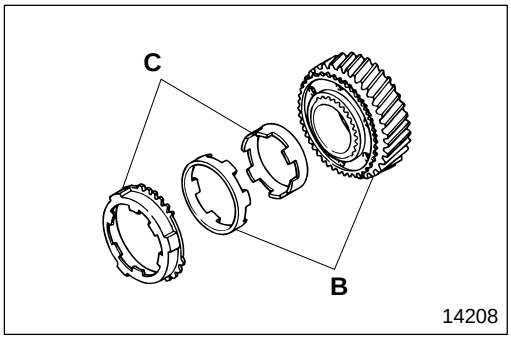
Be sure when you replace the two needle bearings of a gear, that both needle bearings are from the same color package.



[Alignment marks]

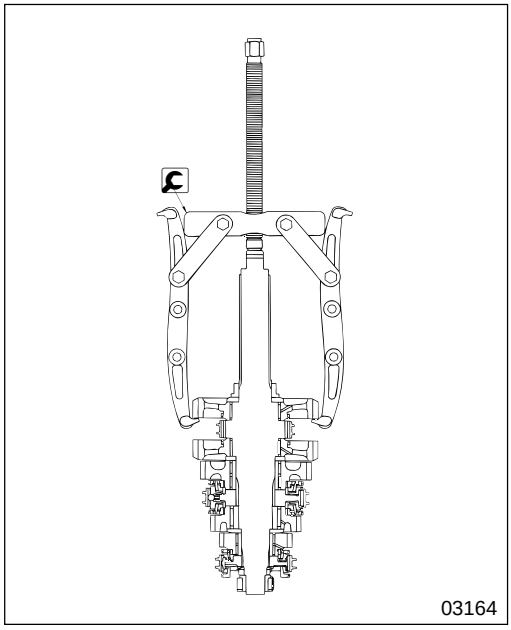
(1) Synchronizer sleeve and synchronizer hub

Before disassembling the synchronizer sleeve and the synchronizer hub, put alignment marks **A** on the places where the shifting keys are installed. When reusing parts, align the alignment marks to assemble.

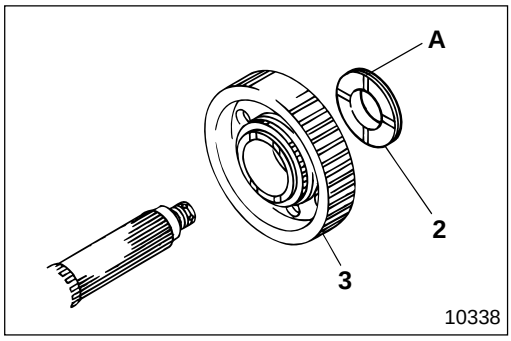


(2) Ring, cone and gear assembly of double cone synchronizer

Before disassembling synchronizer center cone and gear assembly (**B**), and synchronizer center ring and synchronizer outer ring (**C**), put alignment marks on them. When reusing parts, align the alignment marks to assemble.

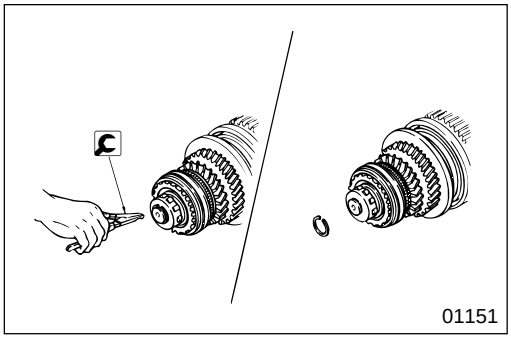


1 **Removal of mainshaft rear bearing inner race**

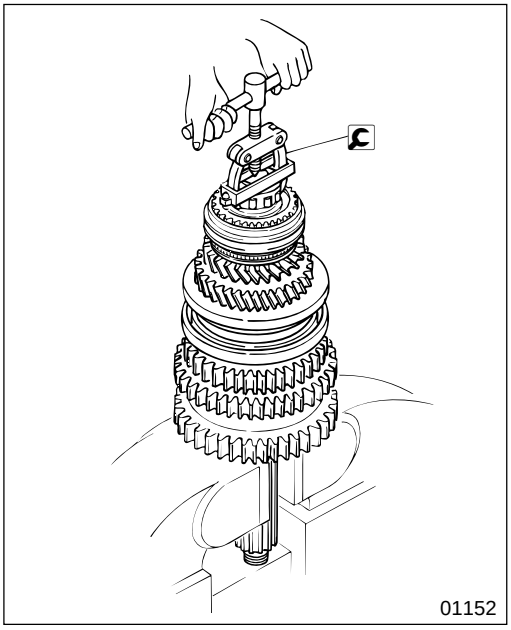


2 **Installation of reverse gear thrust washer**

A : Oil groove

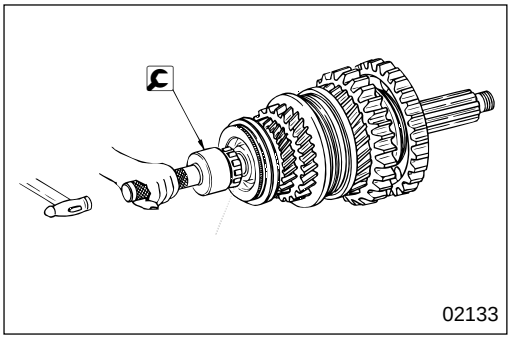


6 **Removal and installation of snap ring**

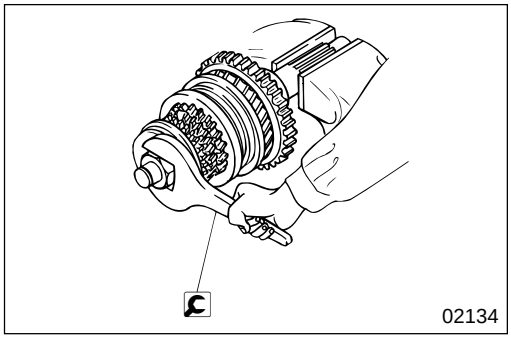


7 **Pilot bearing**

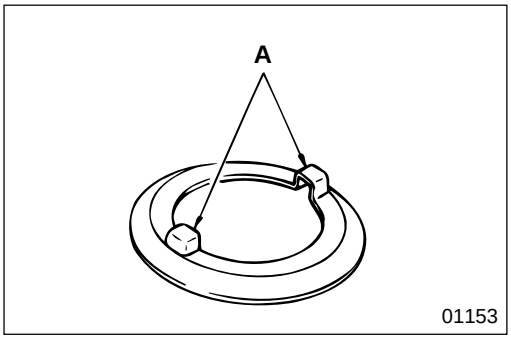
[Removal]



[Installation]

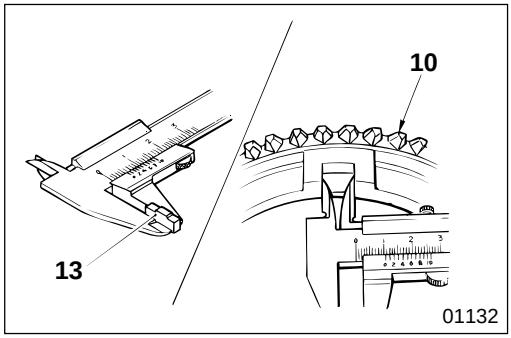


8 **Removal and installation of lock nut**



9 **Installation of lock washer**

Install so that protrusions **A** (two points as illustrated) fit into the grooves of synchronizer hub **15**.

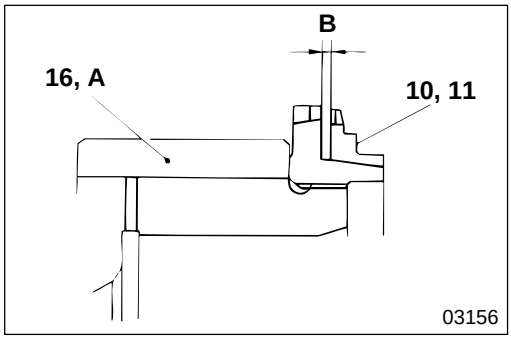


10 to 16 Synchromesh mechanism and 4th gear

[Inspection]

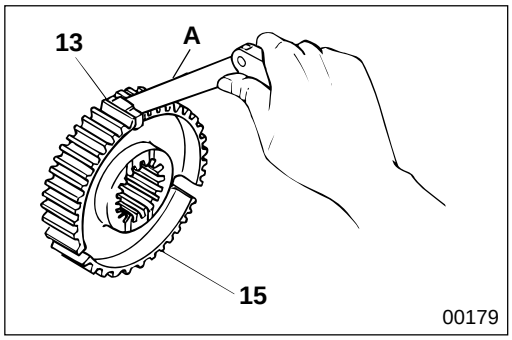
(1) Clearance between synchronizer ring 10 and shifting key 13

If the measured value is higher than the limit, replace the faulty parts.



(2) Clearance between synchronizer ring 10, 11 and drive pinion or 4th gear 16.

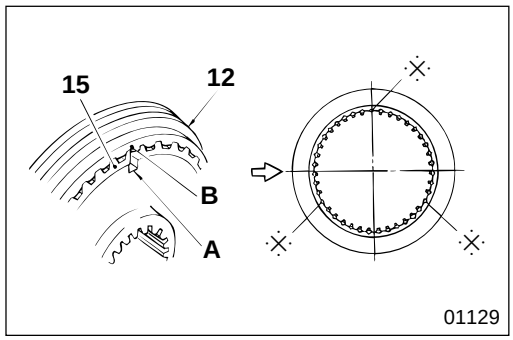
- Measure clearance **B** between synchronizer ring **10, 11** and the gear cone of drive pinon **A** or 4th gear **16**.
- When measuring this value, press synchronizer ring **10, 11** evenly, and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



(3) Clearance between shifting key 13 and synchronizer hub 15

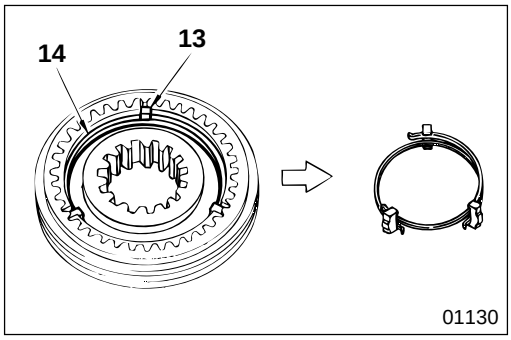
If the measured value is higher than the limit, replace the faulty parts.

A : Feeler gauge

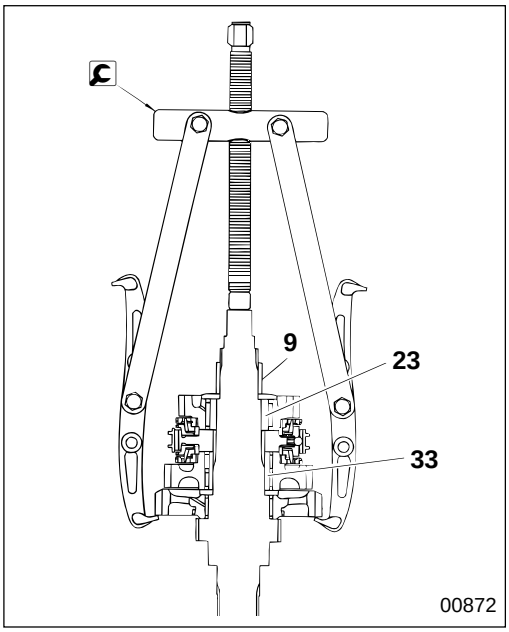


[Installation]

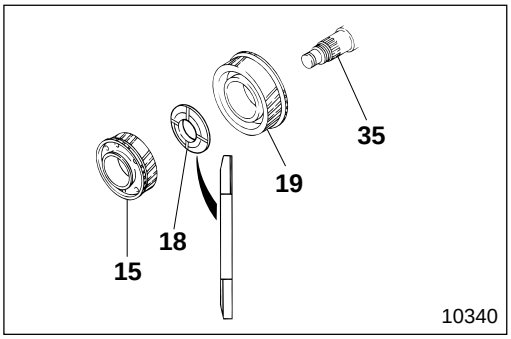
- Align the three keyways **A** of synchronizer hub **15** with the three stub teeth **B** (illustrated by ·⁜· mark) of synchronizer sleeve **12** to install the synchronizer hub.
- To reassemble synchronizer hub **15** and synchronizer sleeve **12**, align the alignment marks made during diassembly.



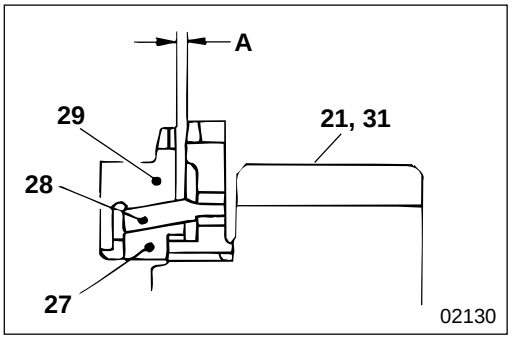
- Insert shifting key **13** into the keyway.
- Install shifting key spring **14** so that its opening is offset from the one of the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.



19 23 33 Removal of 4th, 3rd, 2nd gear bearing sleeves



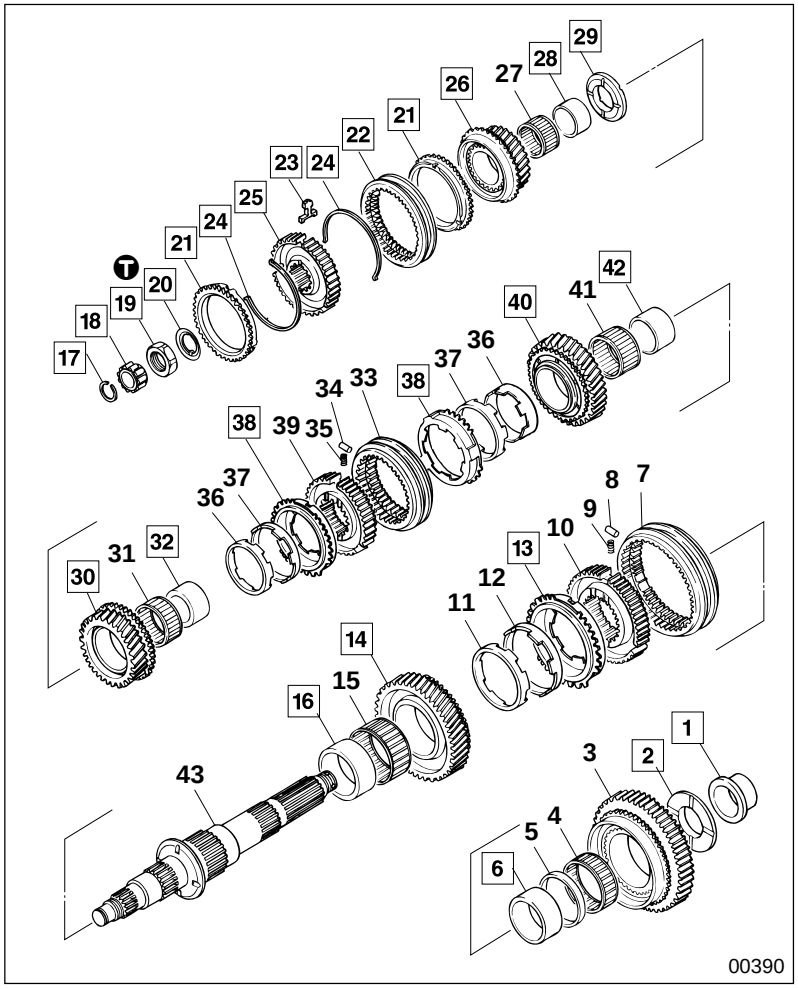
19 Installation of 3rd and 4th gear thrust washer



21 29 31 Clearance between synchronizer outer ring and 3rd gear assembly or 2nd gear assembly

- Measure clearance **A** between synchronizer outer ring **29** and the cone of 3rd gear assembly **21** or 2nd gear assembly **31**.
- When measuring this value, press synchronizer inner ring **27**, synchronizer outer ring **29** and synchronizer center ring **28** evenly and measure all around the circumference.
- If the measured value is higher than the limit, replace the faulty parts.

MAINSHAFT ASSEMBLY < DIRECT-DRIVE (D/D) >



● **Assembly sequence**

39→38→37→36→35→33→34
38→37→36
→32→31→30→29→28→27→26
43→42→41→40
25→22→23→24→21→24→21
→20→19→18→17→16→15→14
→6→5→4→3→2→1
10→13→12→11→9→7→8

● **Work before disassembly**

P22A-77

● **Disassembly sequence**

1 Mainshaft rear bearing inner race
2 1st gear thrust washer
3 1st gear
4 Needle bearing
5 Bearing spacer
6 1st gear bearing sleeve
7 Synchronizer sleeve
8 Shifting key
9 Shifting key spring
10 Synchronizer hub
11 Synchronizer inner ring
12 Synchronizer center cone
13 Synchronizer outer ring
14 2nd gear
15 Needle bearing
16 2nd gear bearing sleeve
17 Snap ring
18 Pilot bearing
19 Lock nut
20 Lock washer
21 Synchronizer ring
22 Synchronizer sleeve
23 Shifting key
24 Shifting key spring
25 Synchronizer hub
26 5th gear assembly
27 Needle bearing
28 5th gear bearing sleeve
29 4th and 5th gear thrust washer
30 4th gear assembly
31 Needle bearing
32 4th gear bearing sleeve
33 Synchronizer sleeve
34 Shifting key
35 Shifting key spring
36 Synchronizer inner ring
37 Synchronizer center cone
38 Synchronizer outer ring
39 Synchronizer hub
40 3rd gear assembly
41 Needle bearing
42 3rd gear bearing sleeve
43 Mainshaft

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	End play of 1st gear	0.35 to 0.55 {0.014 to 0.022}	0.75 {0.030}	Replace gear or thrust washer
3, 4, 5, 6, 43	Play in the diameter direction after assembling 1st gear	—	0.1 {0.0039}	Replace
6	Outer diameter of 1st gear bearing sleeve	$[96]^{-0.030}_{-0.043}$ {$[3.78]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
7, 10	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
10, 43	Engagement in the rotating direction of synchronizer hub and mainshaft	–0.005 to 0.114 {–0.0002 to 0.0045}	0.2 {0.0079}	Replace
13, 14	Clearance between cone area of 2nd gear and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
14	End play of 2nd gear	0.35 to 0.55 {0.014 to 0.022}	0.75 {0.030}	Replace gear or thrust washer
14, 15, 16, 43	Play in the diameter direction after assembling 2nd gear	—	0.1 {0.0039}	Replace
16	Outer diameter of 2nd gear bearing sleeve	$[95]^{-0.030}_{-0.043}$ {$[3.74]^{-0.012}_{-0.017}$}	– 0.1 {– 0.0039}	Replace
18, 43	Play in the diameter direction after assembling pilot bearing	—	0.12 {0.0047}	Replace
21	Clearance between synchronizer ring and cone area of drive pinion	1.49 to 1.86 {0.059 to 0.073}	0.2 {0.0079}	Replace
21, 25	Clearance between synchronizer ring and synchronizer hub groove	4.7 to 5.3 {0.19 to 0.21}	6.5 {0.26}	Replace
21, 26	Clearance between cone area of 5th gear and synchronizer ring	1.49 to 1.86 {0.059 to 0.073}	0.2 {0.0079}	Replace
22, 25	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.0020 to 0.0058}	0.3 {0.012}	Replace
23, 25	Engagement in the rotating direction of synchronizer hub and mainshaft	0.05 to 0.20 {0.0020 to 0.0079}	0.5 {0.020}	Replace
25, 43	Mating part in rotating direction on synchronizer hub and mainshaft	–0.006 to –0.094 {–0.00024 to –0.0037}	0.2 {0.0079}	Replace
26	End play of 5th gear	0.25 to 0.40 {0.0098 to 0.016}	0.6 {0.024}	Replace gear or thrust washer
26, 27, 28, 43	Play in the diameter direction after assembling 5th gear	—	0.1 {0.0039}	Replace
28	Outer diameter of 5th gear bearing sleeve	$[60]^{-0.030}_{-0.043}$ {$[2.36]^{-0.0012}_{-0.0017}$}	– 0.1 {– 0.0039}	Replace
30	End play of 4th gear	0.15 to 0.35 {0.0059 to 0.014}	0.55 {0.022}	Replace gear or thrust washer
30, 31, 32, 43	Play in the diameter direction after assembling 4th gear	—	0.1 {0.0039}	Replace

Unit : mm {in.}

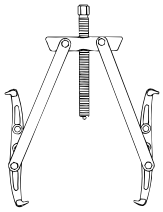
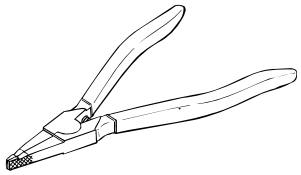
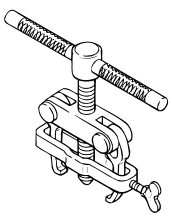
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
30, 38	Clearance between cone area of 4th gear and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
32	Outer diameter of 4th gear bearing sleeve	$[71]^{-0.030}_{-0.043}$ {$[2.80]^{-0.0012}_{-0.0017}$}	–0.1 {–0.0039}	Replace
33, 39	Play in the rotating direction of synchronizer sleeve and synchronizer hub	0.052 to 0.148 {0.002 to 0.0058}	0.3 {0.012}	Replace
38, 40	Clearance between cone area of 3rd gear and synchronizer outer ring	1.21 to 1.79 {0.048 to 0.070}	0.2 {0.0079}	Replace
39, 43	Engagement in the rotating direction of synchronizer hub and mainshaft	-0.005 to 0.114 {-0.0002 to 0.0045}	0.2 {0.0079}	Replace
40	End play of 3rd gear	0.15 to 0.35 {0.0059 to 0.014}	0.55 {0.22}	Replace gear or thrust washer
40, 41, 42, 43	Play in the diameter direction after assembling 3rd gear	—	0.1 {0.0039}	Replace

Tightening torque

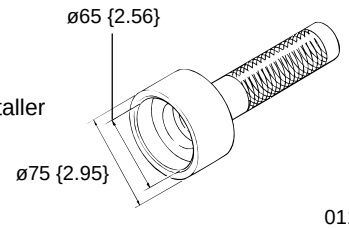
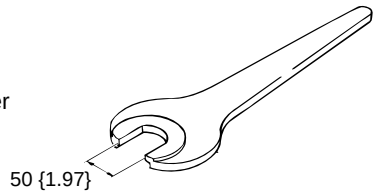
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
19	Lock nut	315 {230, 32}	—

Special tools

Location	Tool name and shape	Part No.	Application
1, 6, 28, 32	Gear puller  03160	MH062250	Removal of mainshaft rear bearing inner race and bearing sleeves
17	Snap ring expander  01137	MH061268	Removal and installation of snap ring
18	Pilot bearing puller  01146	MH061043	Removal of pilot bearing

Unit : mm {in.}

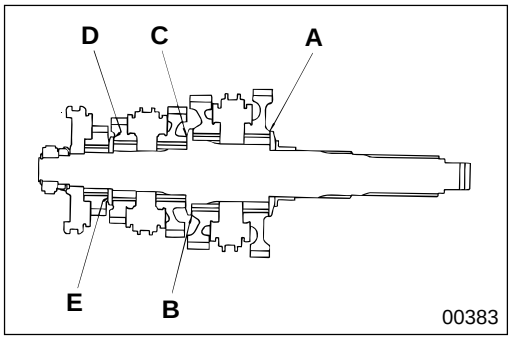
Location	Tool name and shape	Part No.	Application
18	Pilot bearing installer  01147	*MH062628	Installation of pilot bearing
19	Single spanner  01126	MH063101	Removal and installation of lock nut

* Components of puller and installer kit P22A-92

◆ Service procedure

● Work before disassembly

[Inspection]

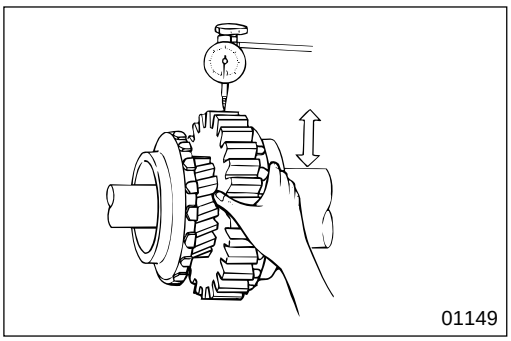


00383

(1) End play of gears

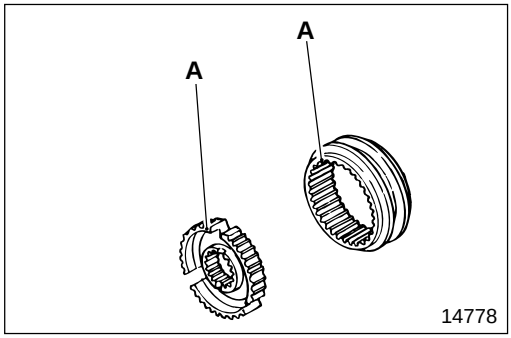
A : 1st gear
B : 2nd gear
C : 3rd gear
D : 4th gear
E : 5th gear

If the measured value is higher than the limit, replace the faulty parts.


01149

(2) Play of gears in diameter direction

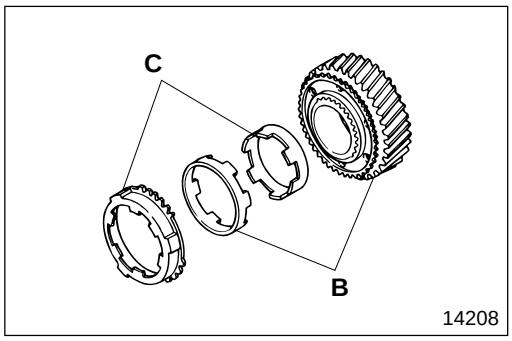
If the measured value is higher than the limit, replace the faulty parts.



[Alignment marks]

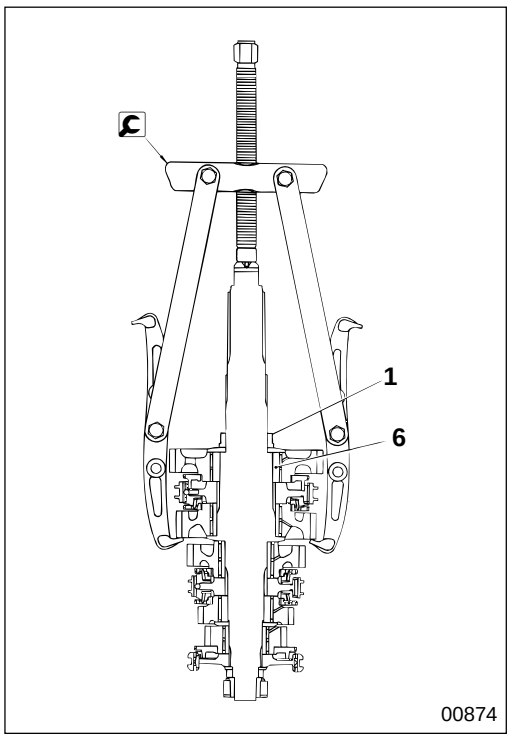
(1) Synchronizer sleeve and synchronizer hub

Before disassembling the synchronizer sleeve and the synchronizer hub, put alignment marks **A** on the places where the shifting keys are installed. When reusing parts, align the alignment marks to assemble.

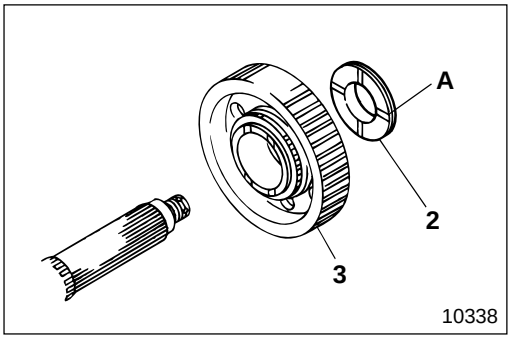


(2) Ring, cone and gear assembly of double cone synchronizer

Before disassembling synchronizer center cone and gear assembly (**B**), and synchronizer center ring and synchronizer outer ring (**C**), put alignment marks on them. When reusing parts, align the alignment marks to assemble.

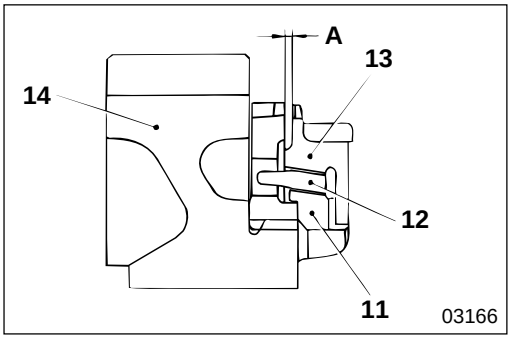


1 6 Removal of mainshaft rear bearing inner race and 1st gear bearing sleeve



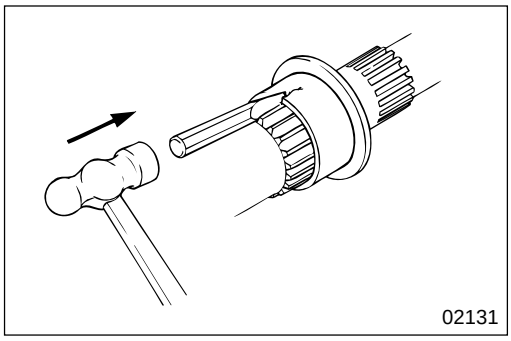
2 **Installation of 1st gear thrust washer**

A : Oil groove

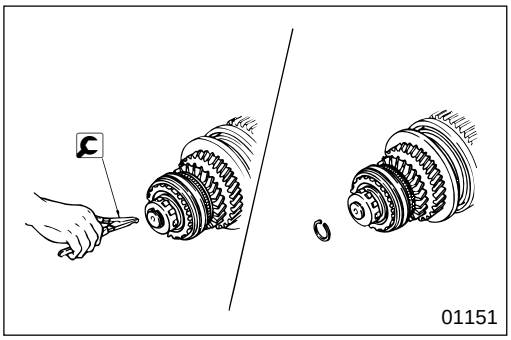


13 **14** **Clearance between synchronizer outer ring and 2nd gear assembly**

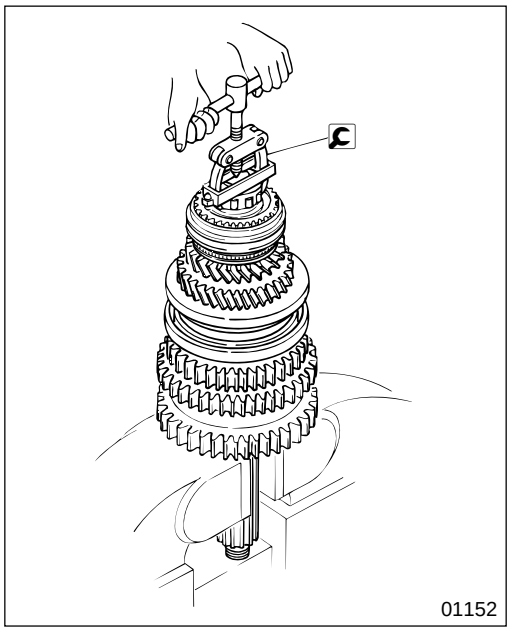
- Measure clearance **A** between synchronizer outer ring **13** and the cone of 2nd gear assembly **14**.
- When measuring this value, press synchronizer inner ring **11**, center cone **12** and outer ring **13** evenly and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



16 **Removal of 2nd gear bearing sleeve**

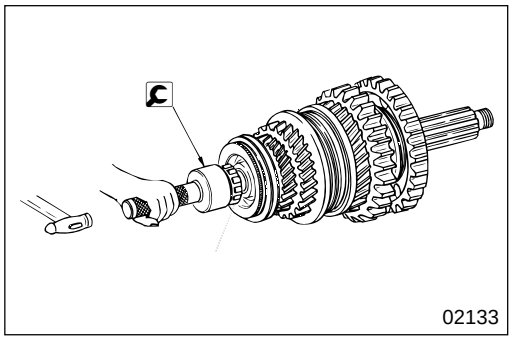


17 **Removal and installation of snap ring**

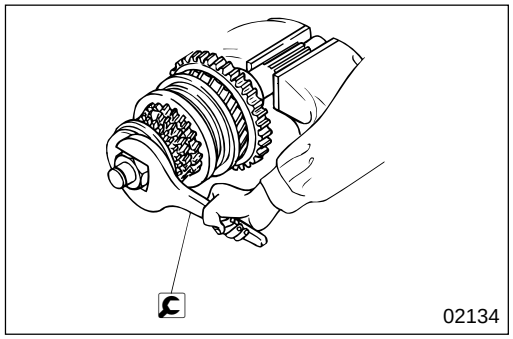


18 Pilot bearing

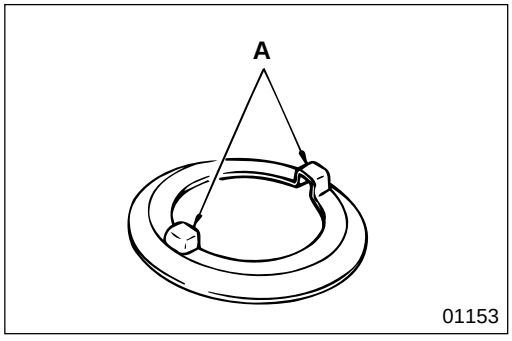
[Removal]



[Installation]

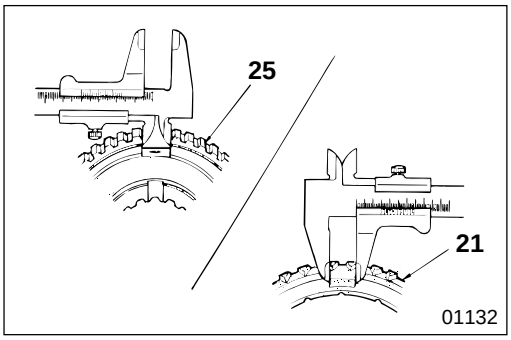


19 Removal and installation of lock nut



20 Installation of lock washer

Install so that protrusions **A** (two points as illustrated) fit into the grooves of synchronizer hub **25**.

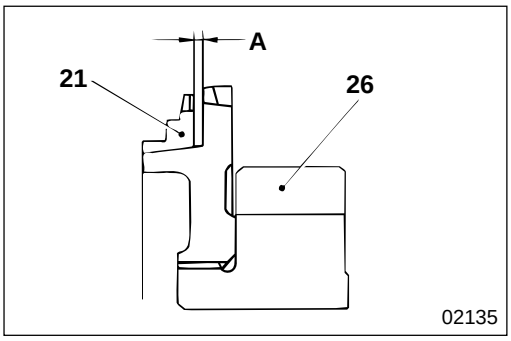


21 to 26 Synchromesh mechanism and 5th gear

[Inspection]

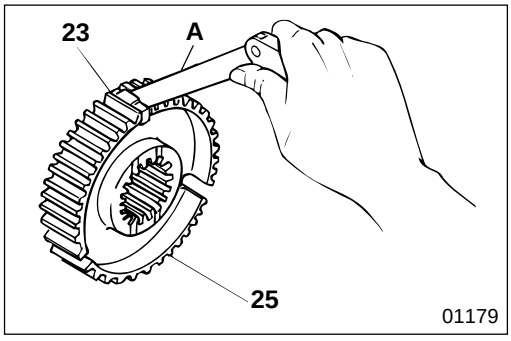
(1) Clearance between the protrusion of synchronizer ring 21 and the groove of synchronizer hub 25

If the measured value is higher than the limit, replace the faulty parts.



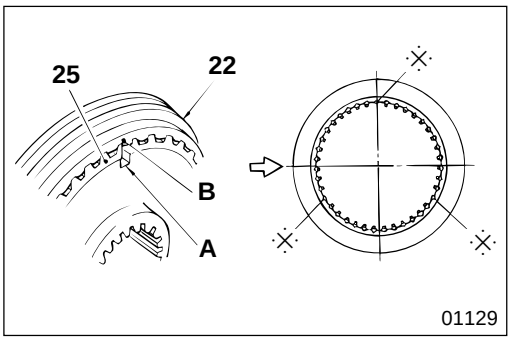
(2) Clearance between synchronizer ring 21 and 5th gear assembly 26 or drive pinion

- Measure the clearance between synchronizer ring **21** and the gear cone of 5th gear assembly **26** or drive pinion
- When measuring this value, press synchronizer ring **21** evenly **1** and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



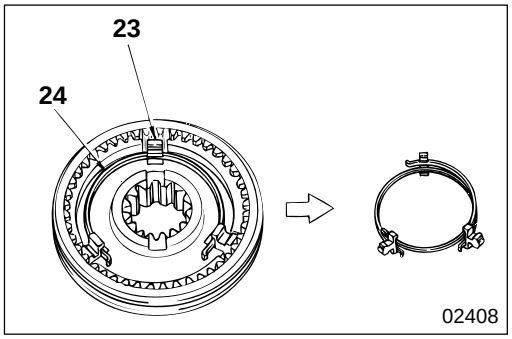
(3) Clearance between shifting key 23 and synchronizer hub 25.

if the measured value is higher than the limit, replace the faulty parts.
A : Feeler gauge

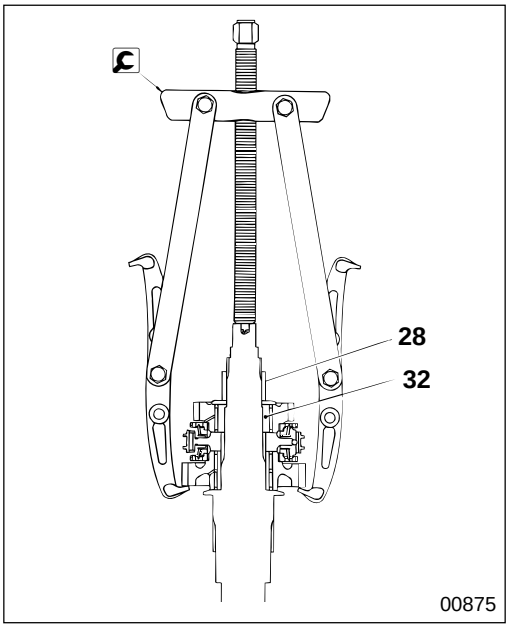


[Installation]

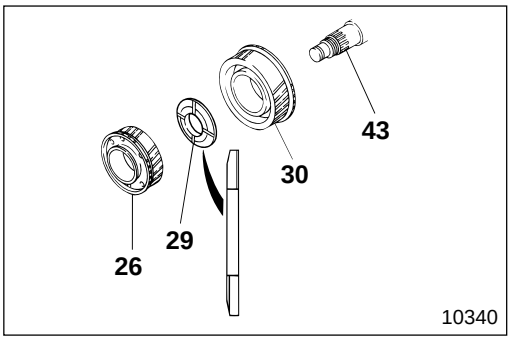
- Align the three keyways **A** of synchronizer hub **25** with the three stub teeth **B** (illustrated by ·⁜· mark) of synchronizer sleeve **22** to install the synchronizer hub.
- To reassemble synchronizer hub **25** and synchronizer sleeve **22**, align the alignment marks made during disassembly.



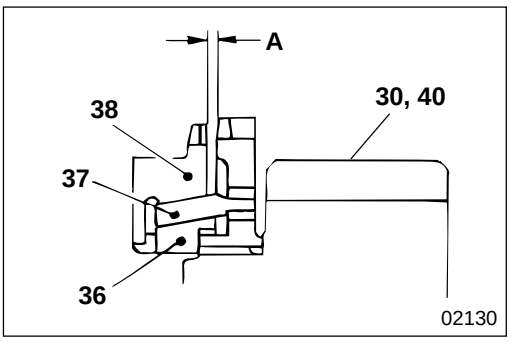
- Insert shifting key **23** into the keyway.
- Install shifting key spring **24** so that its opening is offset from the one on the shifting key.
- Make sure that the openings of shifting key springs do not align with each other.



28 **32** **Removal of 5th gear bearing 4 th sleeves**

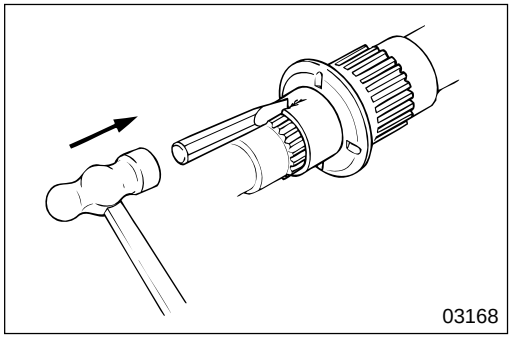


29 **Installation of 4th and 5th gear thrust washer**



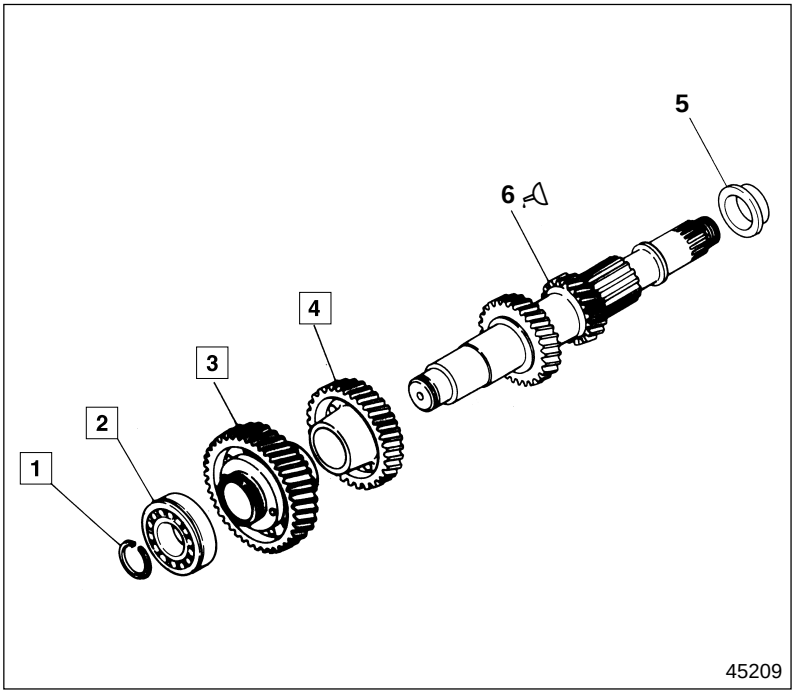
30 **38** **40** **Clearance between synchronizer outer ring and 3rd gear assembly or 4th gear assembly**

- Measure clearance **A** between synchronizer outer ring **38** and the cone of 3rd gear assembly **40** or 4th gear assembly **30**.
- When measuring this value, press synchronizer inner ring **36**, synchronizer center cone **37** and synchronizer outer ring **38** evenly and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



42 **Removal of 3rd gear bearing sleeve**

COUNTERSHAFT ASSEMBLY



● **Disassembly sequence**

1 Snap ring
2 Countershaft front bearing
3 Countershaft constant mesh gear
4 Countershaft 4th gear < O/D >
Countershaft 5th gear < D/D >
5 Countershaft rear bearing inner race
6 Countershaft

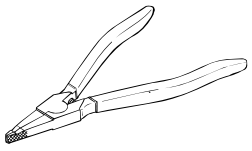
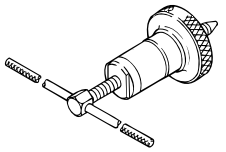
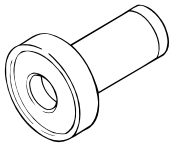
● **Assembly sequence**

Follow the disassembly sequence in reverse.

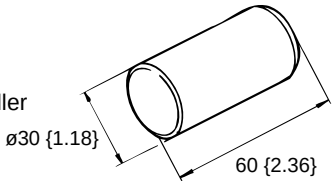
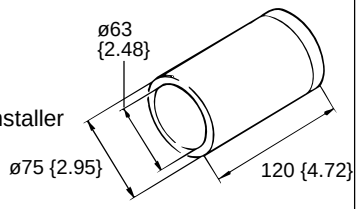
Sealant

Location	Points of application	Kinds	Quantity
6	Gear installation area of countershaft	THREEBOND 1375B	As required

Special tools

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  01137	MH061268	Removal and installation of snap rings of countershaft bearing
2	Countershaft bearing puller  01139	< O/D > *MH062426 < D/D > *MH062429	Removal of countershaft front bearing
	Countershaft bearing installer  02141	< O/D > *ME624233 < D/D > *MH062630	Installation of countershaft front bearing

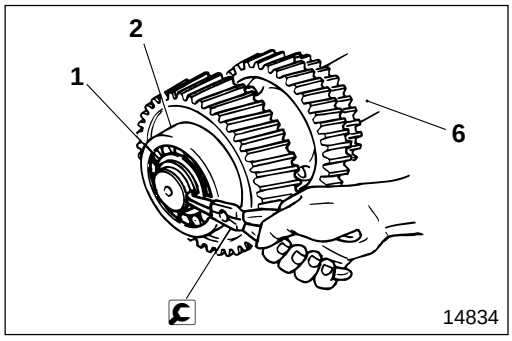
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
3, 4	Countershaft gear puller 	ME624243	Removal of countershaft gear
	Countershaft gear installer 	MH061740	Press-fitting of countershaft gear

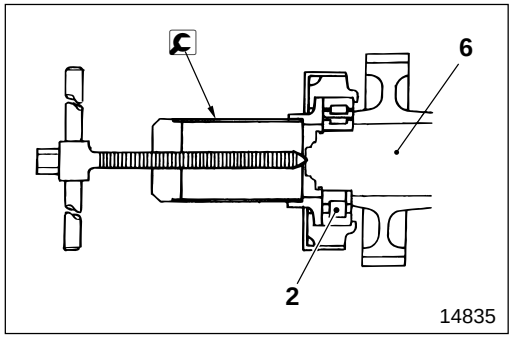
* Components of puller and installer kit P22A-92

◆ Service procedure

1 Removal and installation of snap ring

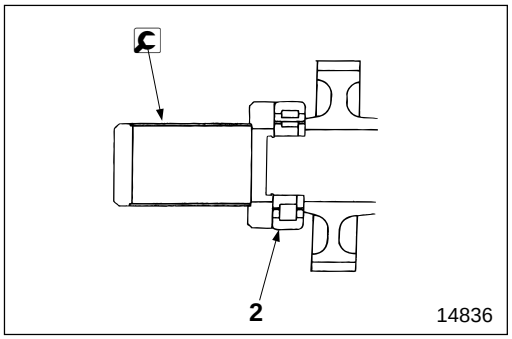


COUNTERSHAFT ASSEMBLY

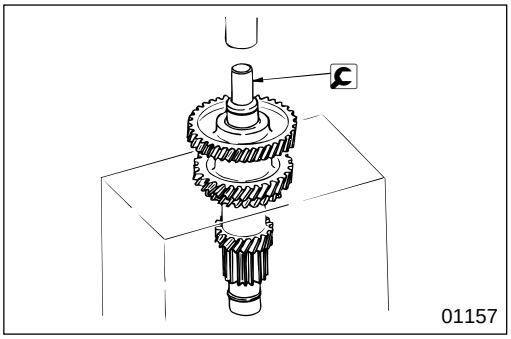


2 **Countershaft front bearing**

[Removal]

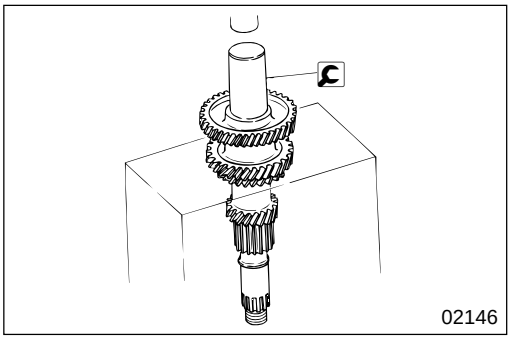


[Installation]



3 **4** **Countershaft constant mesh gear and countershaft 4th gear**

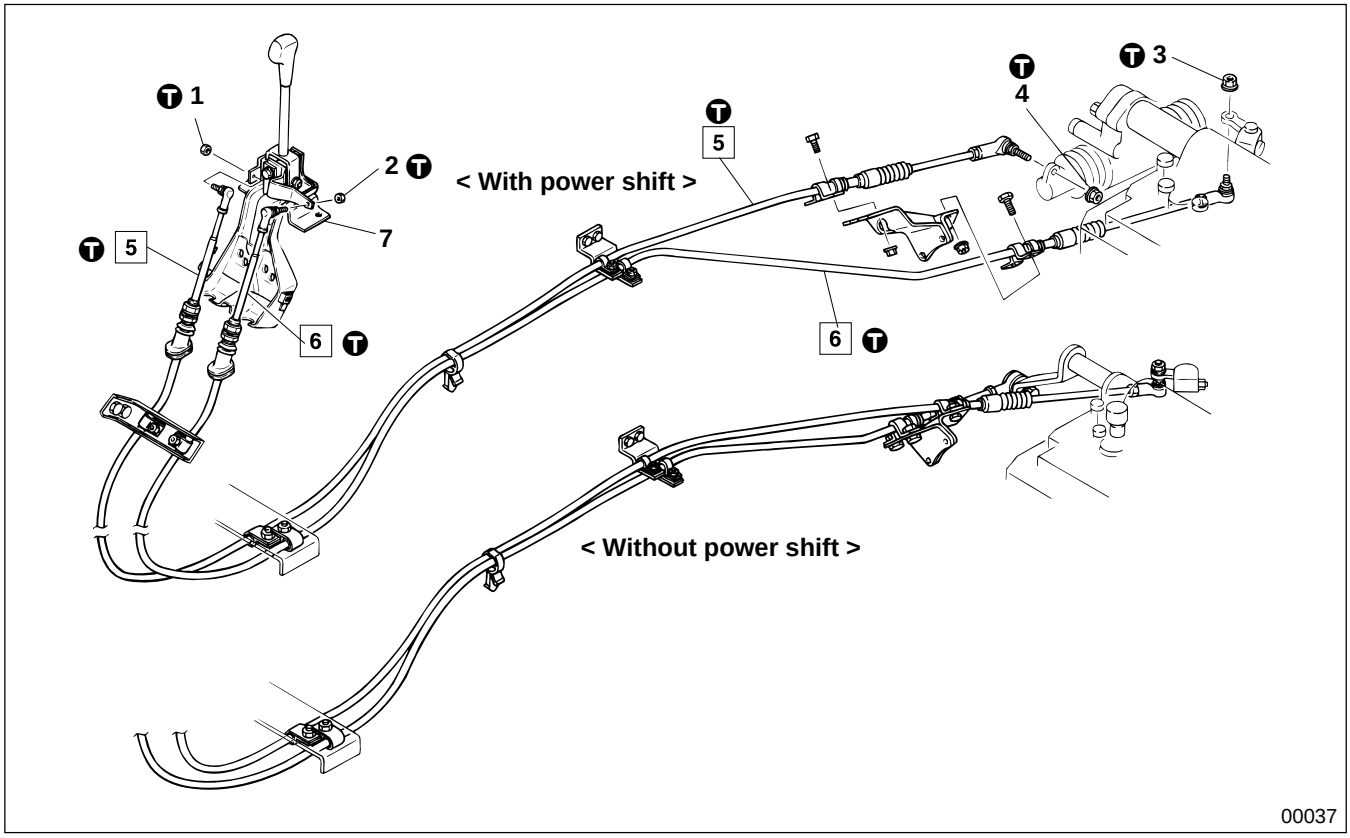
[Removal]
Use a press.



[Installation]
Use a press.

M E M O

TRANSMISSION CONTROL



For removal and installation of the shift lever console or floor console, refer to Gr 42.

CAUTION

When mounting shift cable 5 and selector cable 6 to the frame, do not mistake the vertical relationship between the shift cable and the selector cable. This relationship is opposite in vehicles with power shift and those without.

● **Disassembly sequence**

1 Nut
2 Nut
3 Nut
4 Nut
5 Shift cable
6 Selector cable
7 Transmission control lever assembly P22A-91

● **Assembly sequence**

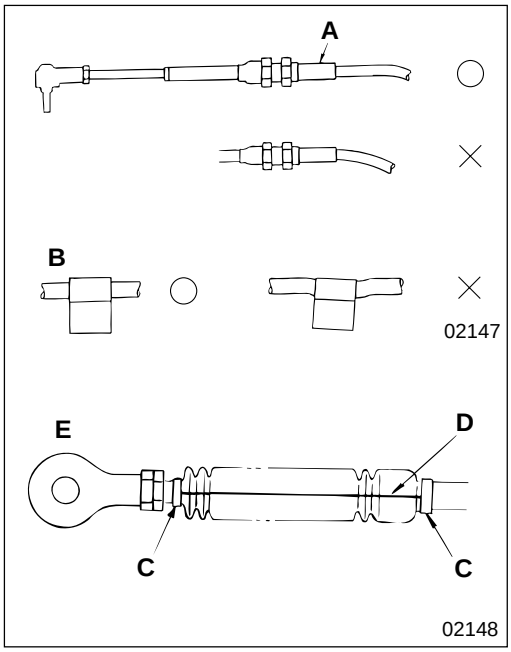
Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1 to 4	Nut (Ball joint or rubber damper mounting)	19 to 24 {14 to 17, 1.9 to 2.4}	—
5, 6	Cable lock nut tightening	59 to 83 {43 to 61, 6 to 8.5}	—

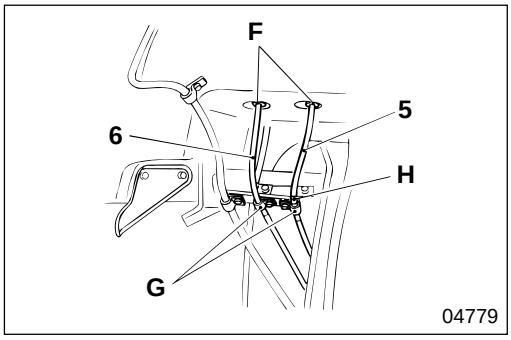
◆ Service procedure



5 **6** **Installation of shift cable and selector cable**

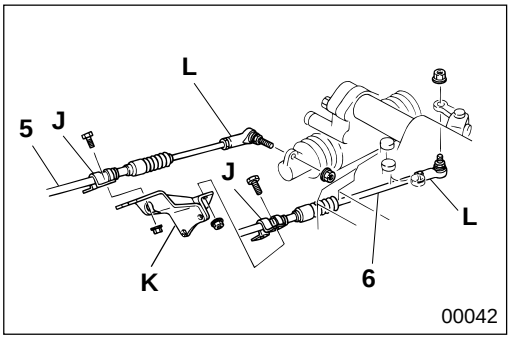
CAUTION⚠

- **Make sure the identification marks on the cable, ball joint L, and rubber damper M point in the right direction when you install the cables. Installing the cables with the identification marks in the wrong direction can remarkably reduce the durability of the cables.**
- **Install casing cap A lengthwise.**
- **Make sure the radius of the bend is 200 mm {7.87 in.} or more.**
- **Make sure the cable operates smoothly.**
- **Install the clamp vertically against the cable. (Figure B)**
- **Do not twist clamps C at both ends of the boot. Make sure that white line D on the boot is straight. (Figure E)**



- Insert shift cable **5** and selector cable **6** under the cab floor and clamp them in the correct place by identifying identification mark **H** on the shift cable. (The selector cable has no identification mark.)
  F : Grommet
  G : Clip

< With Power Shift >

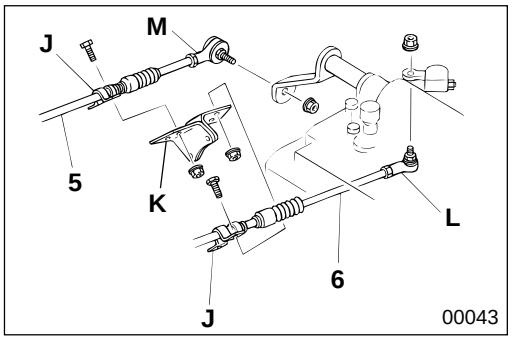


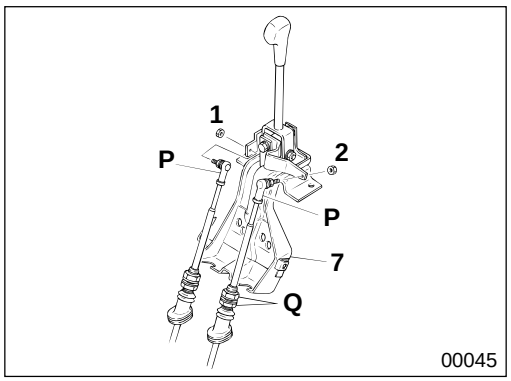
- Install cable clip **J** to bracket **K** temporarily and connect ball joint **L** or rubber damper **M** to the shift lever or selector lever.
- Arrange the cable so that it not twisted, then tighten clip **J** permanently.

CAUTION⚠

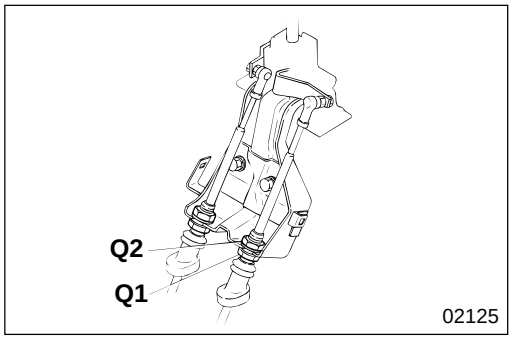
Make sure that ball joint L and rubber dumper M face the correct direction.

< Without Power Shift >





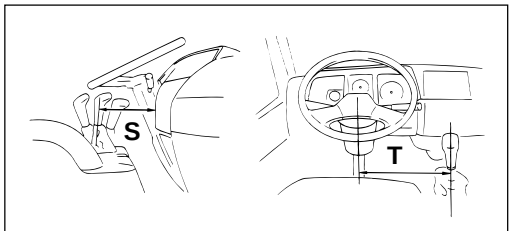
- Tilt the cab down.
- Install the cable on set board assembly **7** temporarily and connect ball joint **P** to shift lever **A** and selector lever **B**.
- Arrange the cable so that it is not twisted, then tighten lock nuts **Q** permanently.

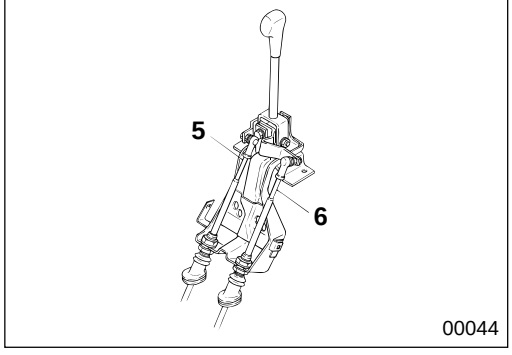


CAUTION⚠

- **Make sure that ball joint L faces the correct direction.**
- **When installing the lock nut, tighten lower nut Q1. Do not move nut Q2.**

- Make sure when you operate the gear shift lever that it shifts smoothly and selects each position.





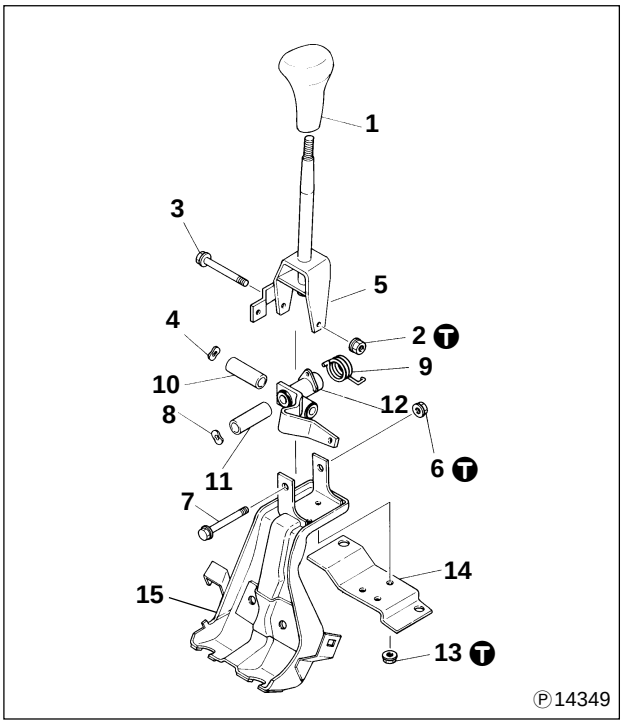
- If the gear shift lever leans to the front or rear, or to the left or right, excessively, adjust the length of the cable.
- When positioning the gear shift lever, use the distance from the center of the steering wheel or from the instrument panel as the reference distance.

Unit : mm {in.}

Front and rear direction S (Distance from the instrument panel)	Left and right direction T (Distance from the steering wheel center)
214 {8.43}	409 {16.1} (< O/D > 4th and 5th gear position) (< D/D > 3rd2 and 4th gear position)

	Shift cable **5**	Selector cable **6**
To front	Shorten	—
To rear	Lengthen	—
To left	—	Shorten
To right	—	Lengthen

Transmission Control Lever Assembly



● **Disassembly sequence**

1 Shift knob
2 Nut
3 Bolt
4 Washer
5 Shift lever
6 Nut
7 Bolt
8 Washer
9 Return spring
10 Collar
11 Collar
12 Select lever
13 Nut
14 Bracket
15 Set board

● **Assembly sequence**

15→14→13
12→11→10→9
→8→7→6→5→4→3→2→1

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Shift lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
6	Nut (Selector lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
13	Nut (Bracket mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	All sliding areas	Chassis grease [NLGI No.1 (Ca soap)]	As required

PULLER AND INSTALLER KIT

Component	Name / Part No.	Puller and installer kit		Bearing puller			
		< O/D >	< D/D >				
		MH062425	MH062444	MH062440	MH062429	MH062432	MH062433
MH062428	Protector	○	○	○	○		
MH062427	Claw	○					
ME624235	Installer	○	○				
ME624234	Installer	○					
ME624233	Installer	○					
ME624236	Installer	○					
MH061162	Handle	○	○	○	○	○	○
ME624232	Bolt	○	○	○	○	○	○
MH061735	Body	○	○	○			
MH061734	Body	○	○		○	○	
ME624229	Protector	○	○			○	
MH062430	Claw	○	○	○	○		
ME624227	Claw	○					
ME624226	Claw	○					
MH062436	Body		○				○
MH062435	Protector		○				○
MH062642	Installer		○				
MH062634	Installer		○				
MH062630	Installer		○				
MH062628	Installer		○				
MH062434	Claw		○				○
ME624228	Claw		○			○	

The puller and installer kit consists of principal bearing pullers and installers selected from the special tools used in this work group. For an installer use a component of this kit independently, and for a puller use the components of this kit in combination.

MITSUBISHI
FUSO

Group 22B

Manual Transmission

< M8S2×5 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-22B

INDEX

SPECIFICATIONS 22B- 2

STRUCTURE AND OPERATION 22B- 3

TROUBLESHOOTING 22B-12

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22B-14

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY 22B-16

GEAR SHIFTER UPPER 22B-20

POWER SHIFT ASSEMBLY 22B-24

GEAR SHIFTER LOWER 22B-30

REAR COVER 22B-34

SPLITTER 22B-38

SPLITTER UPPER ASSEMBLY 22B-44

POWER CYLINDER 22B-45

TRANSMISSION BODY 22B-46

MAINSHAFT ASSEMBLY 22B-54

COUNTERSHAFT ASSEMBLY 22B-62

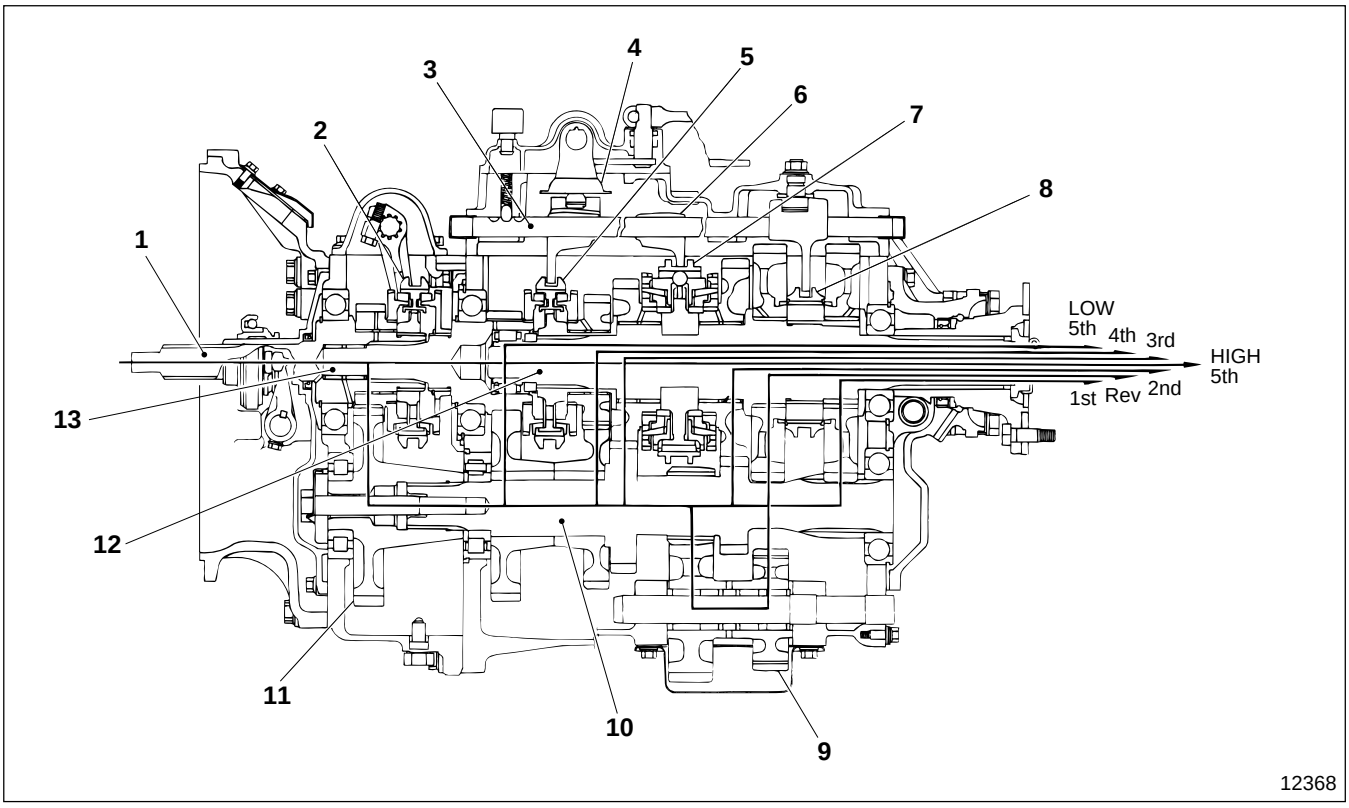
TRANSMISSION CONTROL 22B-64

SPLITTER CONTROL 22B-68

SPECIFICATIONS

Item		Specifications	
Mode of control		Floor shift remote control	
Transmission model		M8S2×5 splitter-changeover, direct-drive, 10-speed type	
Gear ratio	Splitter	LOW	HIGH
	1st	10.060	7.767
	2nd	5.894	4.551
	3rd	3.466	2.676
	4th	2.055	1.587
	5th	1.295	1.000
	Reverse	10.002	7.722
Oil	Gear Oil	General : API GL-3 SAE80 Warm region : API GL-3 SAE90 Tropical region : API GL-4 SAE90	
	Engine Oil	Long period of high-speed driving : API CC SAE 30 or SAE40 : API CC/SF SAE 30 or SAE40	
	Quantity L{qts}	17 {18.0}	
Mass kg {lb}		277 {610}	
Power shift Manufacturer		BOSCH BRAKING SYSTEMS Co., Ltd.	

Transmission



1 Input shaft
2 Splitter synchronizer assembly
3 Shift rail
4 Interlocking mechanism
5 4th and 5th synchronizer assembly
6 Shift fork
7 2nd and 3rd synchronizer assembly
8 1st and reverse constant mesh
9 Reverse idler gear
10 Countershaft
11 Splitter gear
12 Mainshaft
13 Drive pinion

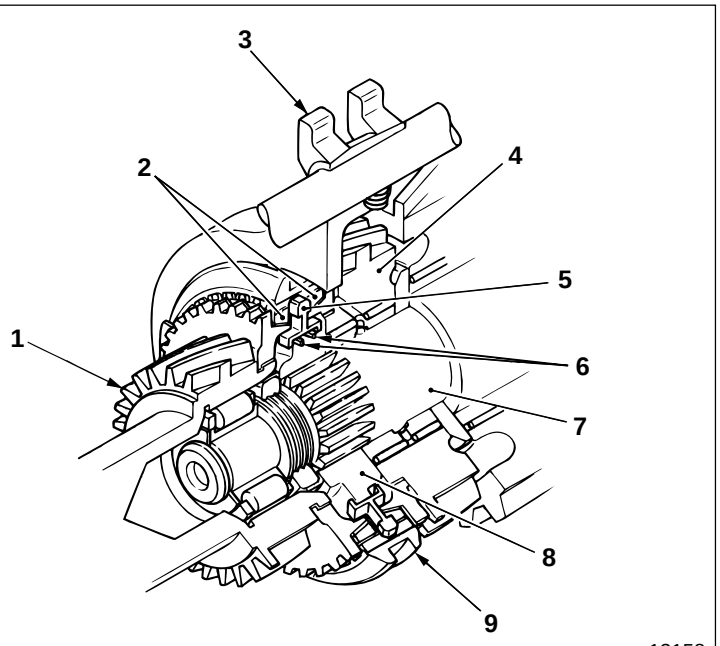
The transmission changes revolution and torque produced by the engine into those that match the vehicle's power requirement (driving force). Revolution and torque are increased or decreased by making a selection from several sets of engaged gears.
The transmission can also change the direction of rotation of the engine output. As the engine always turns in one direction, this allows the vehicle to be reversed. The rotation of the drive pinion is transmitted to the countershaft by the constant mesh gear, and a change in speed is made as the gears, or gear sections, on this countershaft engage those on the mainshaft. In 5th speed the drive pinion rotation is transmitted directly. This M8S2×5 transmission is a HIGH and LOW splitter type. The selector switch on the gearshift lever permits selection of ten forward speeds and two reverse gears by combining 2-speed splitter gears and 5-speed transmission gears.
The power shift lightens the shift operating force of the transmission.

Synchromesh Mechanism

This vehicle has two synchromesh mechanisms, a single cone type, and a double cone type, and uses the key system. The single or double cone type is used depending on the gear positions as shown below:

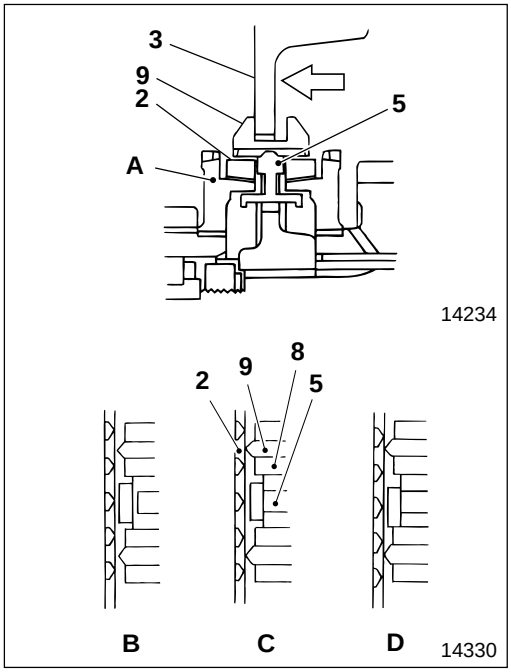
Synchronizer type	Parts used
Single cone type	4th and 5th
Double cone type	2nd and 3rd

Single Cone Type

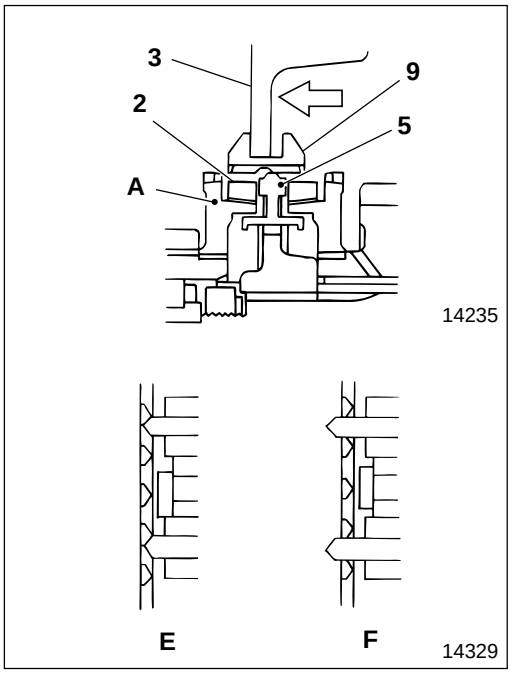


1 Drive pinion
2 Synchronizer ring
3 4th and 5th shift fork
4 4th gear
5 Shifting key
6 Shifting key spring
7 Mainshaft
8 Synchronizer hub
9 Synchronizer sleeve

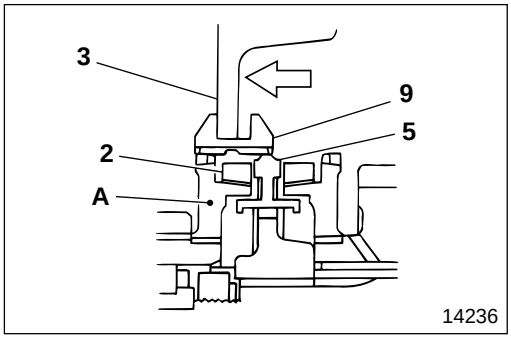
- The inside of synchronizer hub **8** engages the spline of mainshaft **7** and rotates with it. The outside of the synchronizer hub has a spline that engages synchronizer sleeve **9** and three keyways.
- Shifting keys **5** are inserted into these keyways. When the gear shift is in neutral, a protrusion in the center of each shifting key engages a groove inside the synchronizer sleeve and the shifting keys are pressed against the inside of the synchronizer sleeve by shifting key springs **6**.
- Synchronizer rings **2** are inserted into drive pinions **1** in the front and rear of synchronizer hub **8**, and the taper cone of 4th gear **4**.
- Synchronizer rings **2** rotate relative to synchronizer sleeve **9** by the amount of play of the keyways.



- When the gear shift is in neutral (Figure **B**), moving shift fork **3** in the direction of the arrow as illustrated, moves synchronizer sleeve **9** slightly to the left. At the same time, shifting key **5**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer rings **2** against taper cone **A** of drive pinion **1**. (Figure **C**)
- When the taper surfaces of synchronizer rings **2** make contact with the taper cone of the drive pinion, the taper surfaces of the synchronizer rings act as cone clutches. This frictional torque rotates the synchronizer rings in the rotating direction of the drive pinion by the amount of play between synchronizer hub **8** and the synchronizer rings. The spline chamfers of the synchronizer rings and the spline chamfer of synchronizer sleeve **9** are offset from each other. (Figure **D**)
- The disengagement direction of synchronizer rings **2** is defined by the speed of rotation of the synchronizer—sleeve **9**, and the synchronized—drive pinion **1**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.

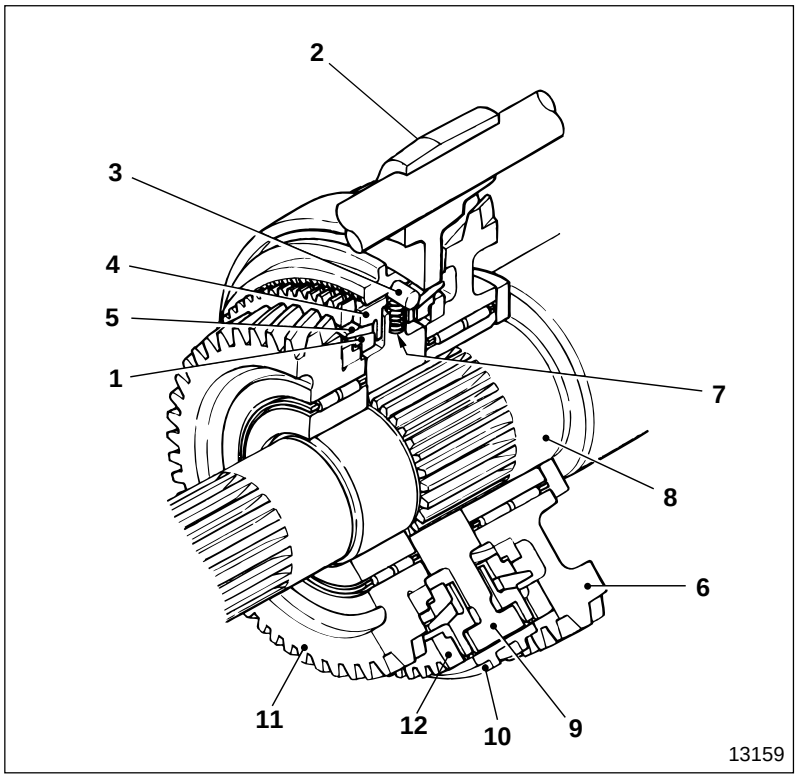


- When synchronizer sleeve **9** moves further to the left, synchronizer rings **2** prevent shifting key **5** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer rings **2** remain disengaged, the spline chamfer of synchronizer sleeve **9** presses the spline chamfers of the synchronizer rings, which in turn press the synchronizer rings against taper cone **A** of drive pinion **1**.
- As the frictional torque increases on the taper surfaces, the relative speed of the synchronizer and the synchronized gradually decreases.
  E : In synchronization
  F : After synchronization



- When synchronizer sleeve **9** and drive pinion **1** rotate at the same speed, synchronizer rings **2** no longer prevent the synchronizer sleeve from moving, and the synchronizer sleeve moves further to the left and smoothly engages the spline of taper cone **A** of drive pinion **1**, transmitting the driving force.

Double Cone Type

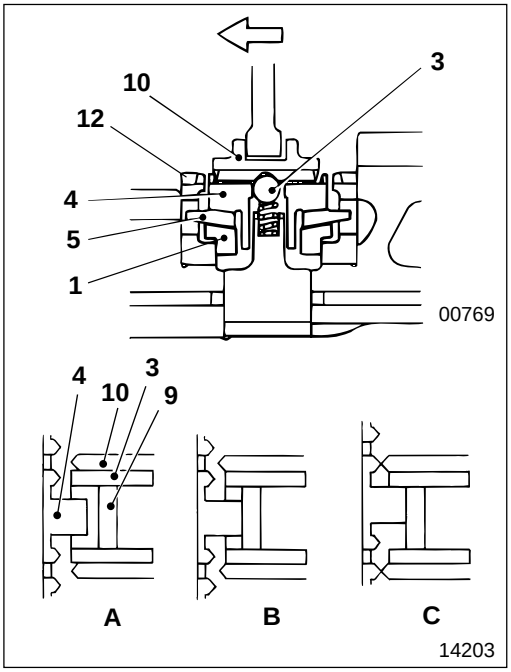


1 Synchronizer inner ring
2 2nd and 3rd shift fork
3 Shifting key
4 Synchronizer outer ring
5 Synchronizer center cone
6 2nd gear
7 Shifting key spring
8 Mainshaft
9 Synchronizer hub
10 Synchronizer sleeve
11 3rd gear
12 Dog clutch

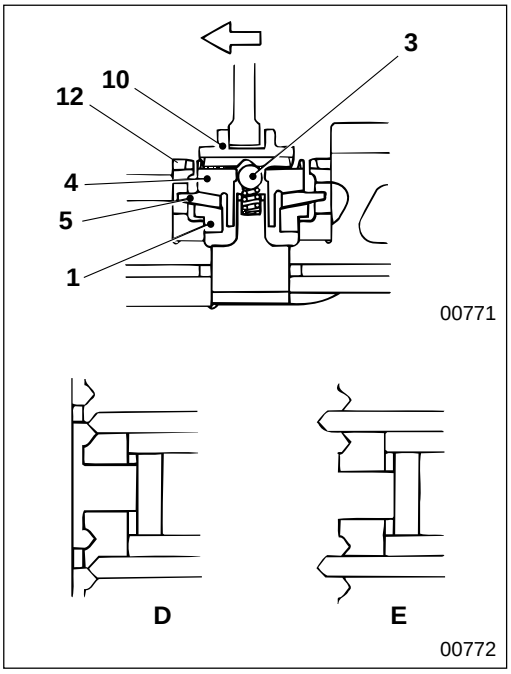
The synchromesh structure and operation of the double cone type are basically the same as for the single cone type.

- Synchronizer center cone **5** is a taper cone independent of 2nd gear **6** and 3rd gear **11**, (both the inside and outside surfaces are tapered). The synchronizer center cone is between synchronizer inner ring **1** and synchronizer outer ring **4** to increase the synchronization capacity.
- Six protrusions on the outside of center cone **5** fit into corresponding gear holes, in the same manner as the taper cone of the single cone type. The center cone and the gear are installed as if integrated.

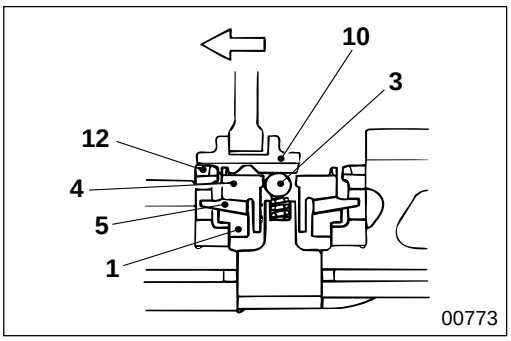
  Shifting key **3** is a cylinder installed so that the lengthwise direction of the cylinder is at right angles to the diameter direction of synchronizer hub **9**. Shifting key spring **7** is a coil spring inserted in a hole in the synchronizer hub, this spring presses the shifting key against the inside of synchronizer sleeve **10**.



- When the gear shift is in neutral (Figure **A**), moving shift fork **2** in the direction of the arrow as illustrated, moves synchronizer sleeve **10** slightly to the left. At the same time, shifting key **3**, the central protrusion of which engages the synchronizer sleeve, moves to the left and presses synchronizer outer ring **4** against synchronizer center cone **5**. (Figure **B**)
- When the taper surface of synchronizer outer ring **4** makes contact with the taper cone of synchronizer center cone **5**, the taper surface of the synchronizer outer ring acts as a cone clutch. This frictional torque rotates the synchronizer outer ring in the rotating direction of 3rd gear **11** by the amount of play between the synchronizer outer ring and synchronizer hub **9**. The spline chamfer of the synchronizer outer ring and the spline chamfer of synchronizer sleeve **10** are offset from each other. (Figure **C**)
- The disengagement direction of synchronizer outer ring **4** is defined by the speed of rotation of the synchronizer—the sleeve, and the synchronized—3rd gear **11**. When increasing the vehicle speed by shifting up, disengagement is made in the opposite direction to rotation, and when decreasing the vehicle speed by shifting down, disengagement is made in the rotating direction.

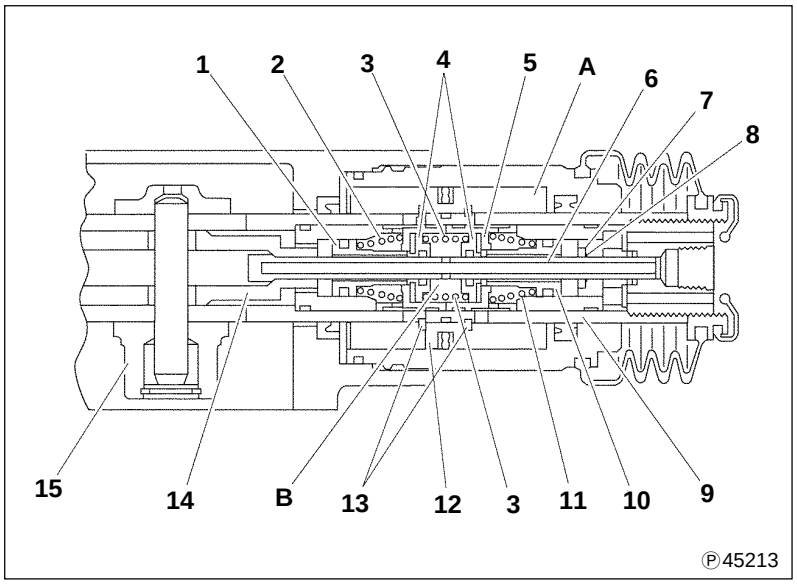


- When synchronizer sleeve **10** moves further to the left, synchronizer outer ring **4** prevents shifting key **3** from moving, and the synchronizer sleeve disengages from the protrusion of the shifting key.
- Since synchronizer outer ring **4** remains disengaged, the spline chamfer of synchronizer sleeve **10** presses the spline chamfer of the synchronizer outer ring, which in turn presses the synchronizer outer ring against the taper cone of synchronizer center cone **5**, and the frictional torque acts on the taper surface.
- As the frictional torque increases on the taper surface of synchronizer inner ring **1**, the relative speed of the synchronizer and the synchronized gradually decreases. The frictional torque acts on both sides of the synchronizer center cone. The double cone type has greater capacity for synchronization than the single cone type.
  D : In synchronization
  E : After synchronization



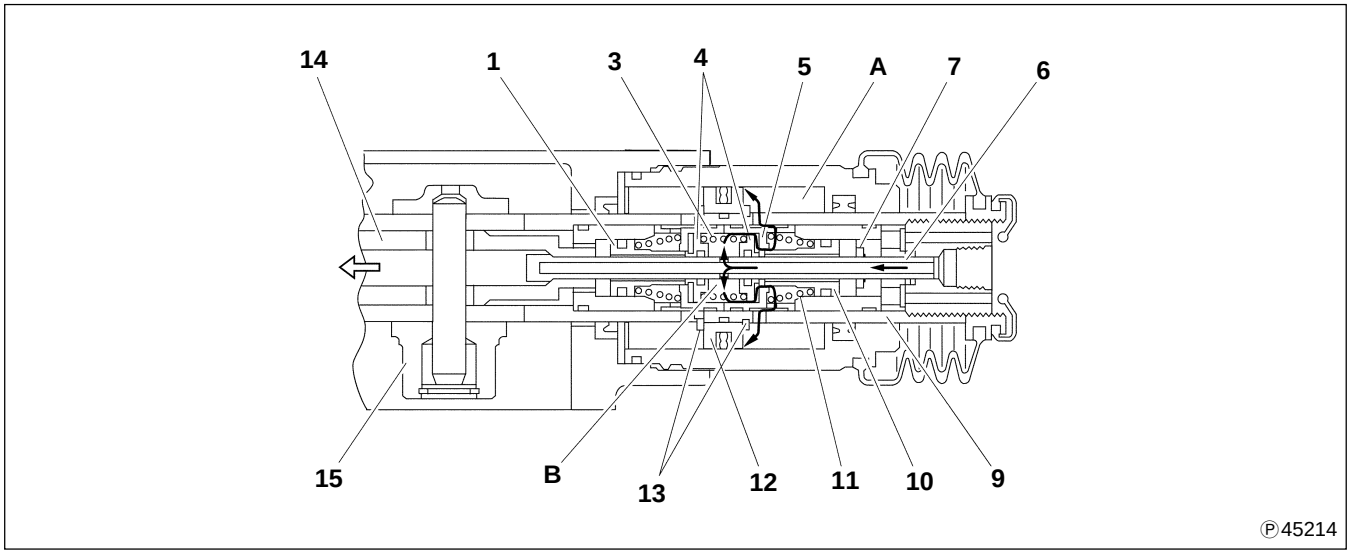
- When synchronizer sleeve **10** and 3rd gear **11** rotate at the same speed, synchronizer outer ring **4** no longer prevents the synchronizer sleeve from moving and the synchronizer sleeve moves further to the left and smoothly engages the spline of dog clutch **12** of the 3rd gear, transmitting the driving force.

Power shift



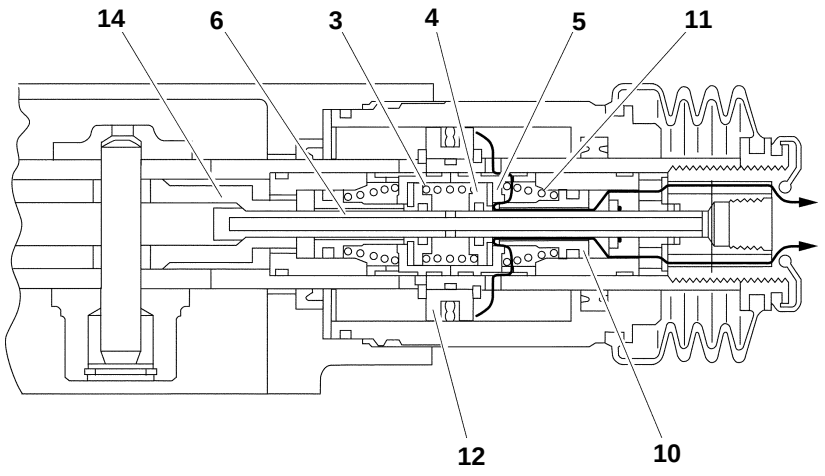
1 Valve lifter
2 No. 1 spring
3 No. 2 spring
4 Valve seal
5 Valve seat
6 Pipe
7 Plate
8 Retaining ring
9 Shifter rod
10 Valve lifter
11 No. 3 spring
12 Piston
13 Retaining ring
14 Actuating rod
15 Striker

A : Secondary chamber
B : Primary chamber



When activated

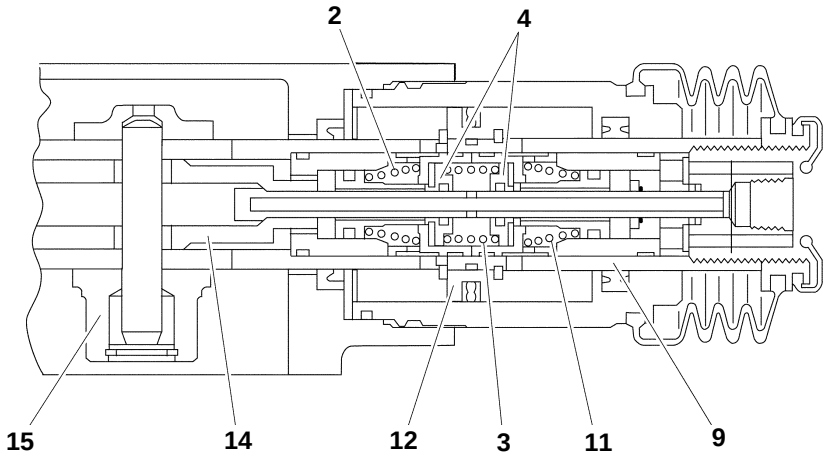
- When actuating rod **14** is moved in the direction of the arrow shown, a relative displacement occurs between shifter rod **9** and the actuating rod.
  This causes valve lifter **10** to compress no. 3 spring **11**, pushing valve seal **4**. The force of the valve lifter overcomes the forces of the compressed air and no. 2 spring **3**, separating the valve seal from the valve seat **5**. As a result, the compressed air being supplied to primary chamber **B** is allowed to go through the gap between the valve seat and the valve seal into seconday chamber **A**. The compressed air then passes through the hole in the valve seat and flows along the groove on its periphery and through the vent hole in the shifter rod into the cylinder, thus applying pressure to piston **12** to generate output power.
- The output power generated at piston **12** is transmitted via retaining ring **13** to shifter rod **9**, giving impetus to striker **15** secured to the shifter rod. This in turn actuates the shift fork on the transmission side, effecting gearshifting. This is the flow of operation from the start to end of gearshifting.
- When the actuating direction is as indicated by the arrow in fig., the input from gearshift lever is transmitted from actuating rod **14** to the valve lifter via plate **7** that is secured on pipe **6** by retaining ring **8**. When the actuating direction is opposite, the operation is exactly the same, except that the end face of the actuating rod directly pushes valve lifter **1**.



Ⓟ45215

When released

- When the input is released as gearshifting is completed, actuating rod **14** is returned to the original position, that is, the central positionof the valve, by the reaction forces of compressed air from valve lifter **10** and valve springs **3** and **11**. As the valve lifter is pushed back, valve seal **4** seats snugly on valve seat **5**, cutting off the supply of compressed air from the primary chamber to secondary chamber. When the input rod is further returned, there is a clearance produced between valve lifter **10** and valve seal.
- This releases the compressed air in the secondary chamber (inside the cylinder) to the atmosphere through the clearance between valve lifter **10** and pipe **6**. As a result, there is no pressure difference between the two chambers located before and behind piston **12**, zeroing the output.



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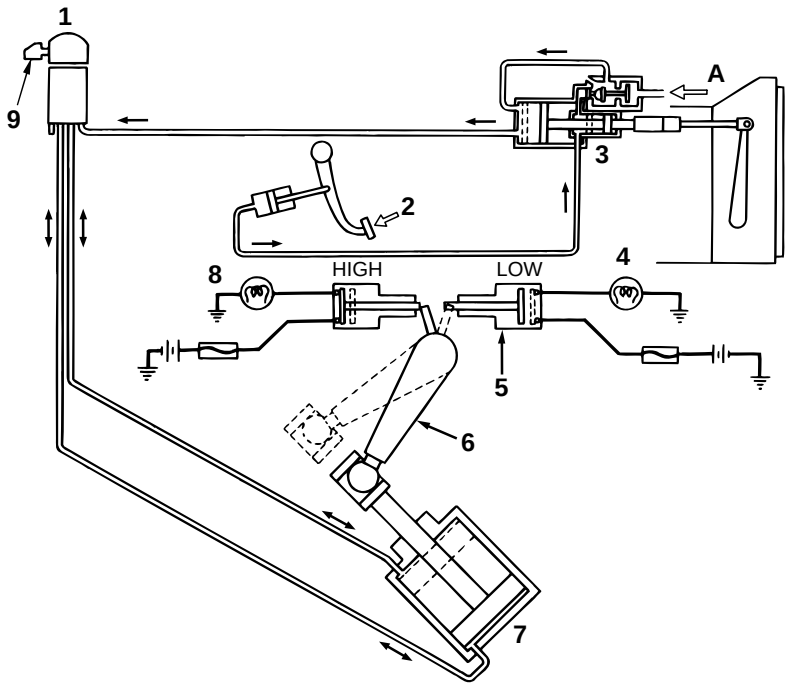
When not activated (when no boost is given)

- To actuate the power shift, that is, to open the valve and send compressed air to the output chamber, it is necessary to produce a relative displacement in actuating rod **14** on the input shaft end and shifter rod **9** on the output shaft end.
- When an operating force is applied from the gearshift lever to actuating rod **14** and if the resistance on the transmission end is smaller than the sum of the drag produced as a result of relative changes in the input and output sides (that is, the reaction forces of no. 1 through 3 springs **2**, **3**, **11**; pressure applied to valve seal **4**; and sliding resistance of each part), the mechanism from the actuation rod to striker **15** moves as an integral unit and no relative displacement is produced. The valve is therefore not opened and piston **12** moves in the cylinder to effect gearshifting with no power boost applied.

Splitter Control



1 Air control valve
2 Clutch pedal
3 Clutch booster
4 LOW indicator lamp
5 Interlock switch
6 Splitter shift lever
7 Power cylinder
8 HIGH indicator lamp
9 Knob

A : From air tank

- The splitter control allows change over between HIGH and LOW by the operation of power cylinder **7** installed on the splitter, using air pressure taken from the clutch booster.
- Depressing clutch pedal **2** operates clutch booster **3**, supplying air to air control valve **1** installed on the gear shift lever by the driver's seat.
- To change over the supplied air from HIGH to LOW, move the knob of air control valve **1** to H or L respectively.
- This supplied air operates power cylinder **7** changing over the splitter between HIGH and LOW.
- Due to the restriction of the above mechanism, change over of the splitter is possible only when depressing clutch pedal **2**.
- Interlock switch **5** of the splitter upper assembly detects whether splitter shift lever **6** is in HIGH or LOW, and accordingly lights up HIGH indicator lamp **8** or LOW indicator lamp **4** within the meter cluster, to notify the driver.

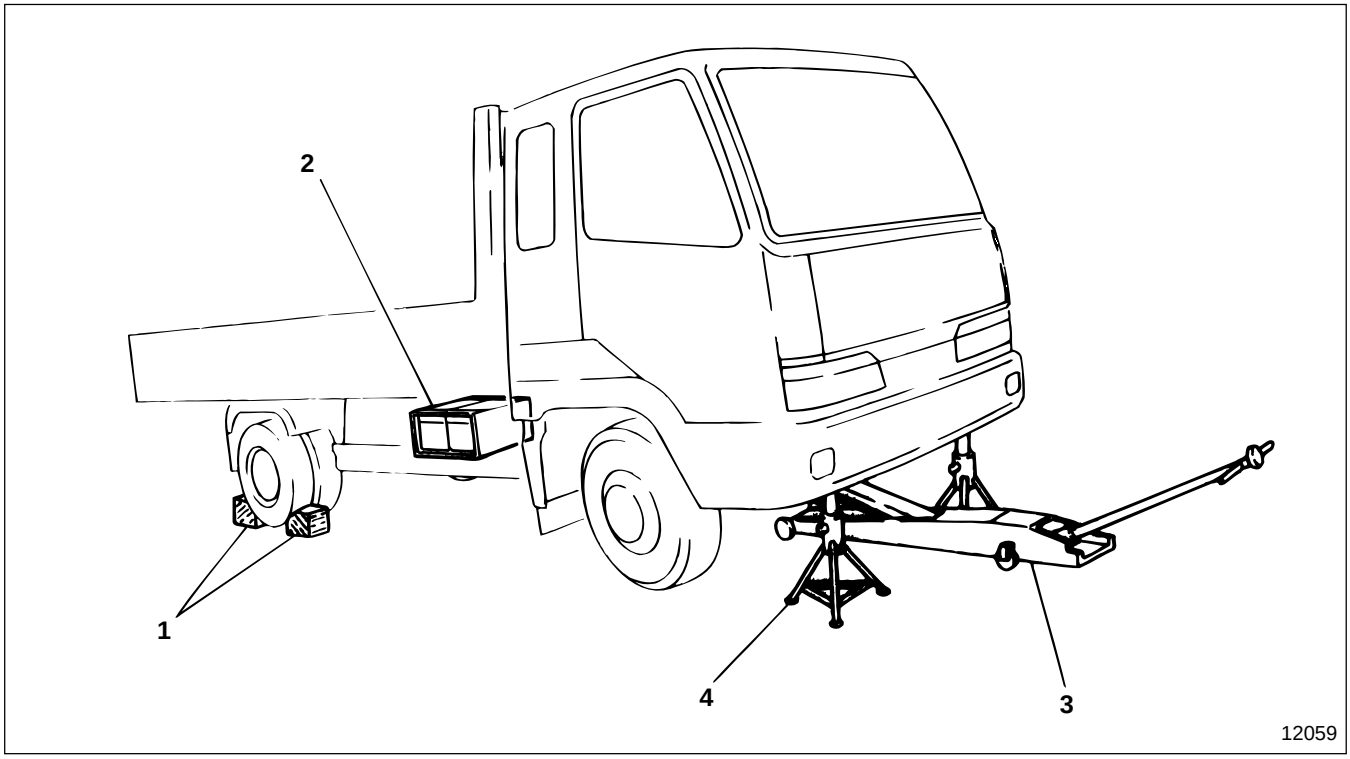
M E M O

TROUBLESHOOTING

Possible causes \ Symptoms		Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise while cruising	Noise when changing gear
Transmission body faulty	Mainshaft rear lock nut loose	○	○			
	Mainshaft thrust washer worn	○	○			
	Mainshaft bearing worn or damaged	○	○			
	Synchronizer ring and synchronizer sleeve spline worn	○				
	Synchronizer ring and gears taper cone area worn		○			
	Mainshaft pilot bearing worn or damaged			○	○	
	Drive pinion bearing worn or damaged			○		
	Drive pinion and countershaft constant mesh gear, or input shaft and splitter gears backlash excessive			○		
	Countershaft bearing worn or damaged			○		
	Needle bearings of gears worn or damaged			○	○	
	Mainshaft and countershaft bearings worn or damaged				○	
	Mainshaft and countershaft gears backlash excessive				○	
	Spline of gears worn					○
	Gears damaged				○	
	Gear oil insufficient				○	
Control mechanisms faulty	Control cable joint play	○	○			
	Set board assembly bushings worn	○				
	Shift rail steel ball and groove worn	○				
	Shift rail poppet spring fatigued or damaged	○				
	Shift rail sliding movement faulty		○			
	Shift fork jaws worn		○			
	Shift fork bent		○			

Possible causes \ Symptoms			Gears slip out of engagement	Gears hard to engage	Noise when engine is idling	Noise while cruising	Noise when changing gear
Power shift malfunctioning	Air compressor faulty	Gr 35A, B		○			
	Air leakage			○			
	Power shift assembly faulty			○			
Clutch faulty	Clutch disengagement faulty	Gr 21		○			○
	Clutch pedal play faulty			○			
Synchronizer faulty	Contacting surfaces of synchronizer ring and gear taper cone worn						○
	Shifting key worn						○
	Shifting key spring deteriorated or damaged						○
	Synchronizer sleeve worn or damaged					○	○
Splitter control faulty	Power cylinder faulty			○			
	Air leaking from tubes			○			

WORK BEFORE REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect negative battery cable. Gr 54
3 Jack up the front axle on a garage jack.
4 Support the front frame on rigid racks.

WARNING

- **You must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

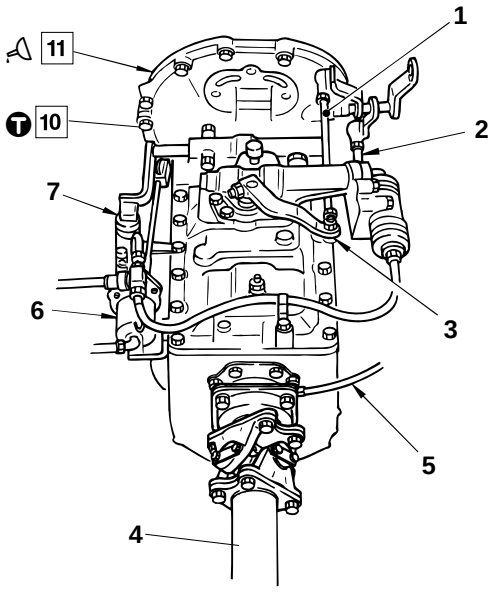
Keep the transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY



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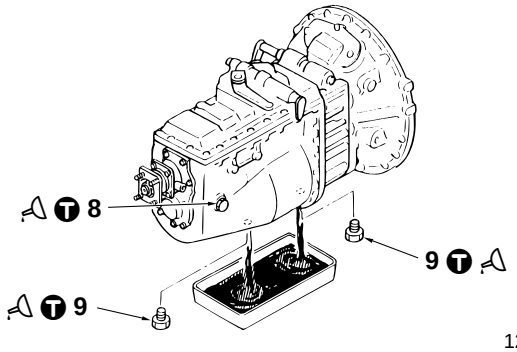

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● **Removal sequence**

1 Selector cable
2 Shift cable
3 Harness connector Gr 54
4 Propeller shaft Gr 25
5 Speed sensor Gr 54
6 Clutch booster Gr 21
7 Splitter control air piping
8 Inspection plug
9 Drain plug
10 Nut or bolt
11 Transmission assembly

NOTE

After removing propeller shaft 4, tie it to the frame temporarily at the height of installation assembly using a piece of rope.

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

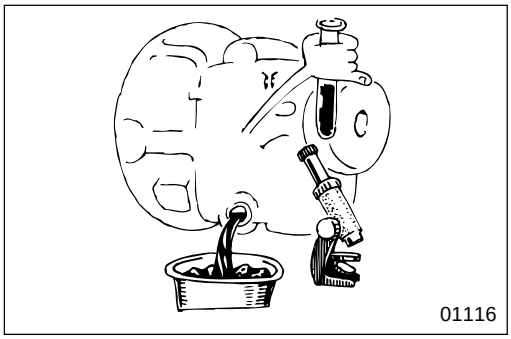
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Inspection plug	69±15 {51±11, 7±1.5}	—
9	Drain plug	69±15 {51±11, 7±1.5}	—
10	Nut or bolt (Transmission assembly mounting)	40 {30, 4.1}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
8	Thread area of inspection plug	THREEBOND 1105D	As required
9	Thread area of drain plug	THREEBOND 1105D	As required
11	Input shaft spline	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

◆ Service procedure



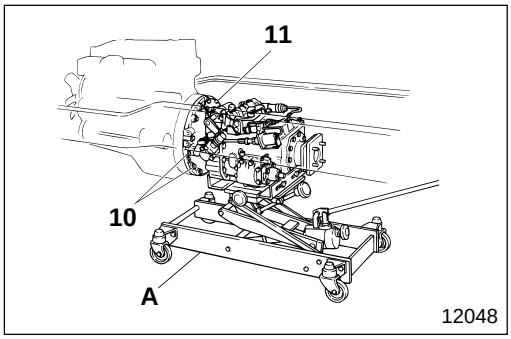
● Oil change

[Draining]

- When draining oil, check the quantity and quality of oil, especially for small pieces of metal and metal dust.
- Clean drain plug **9** before reinstalling it because it is magnetic.

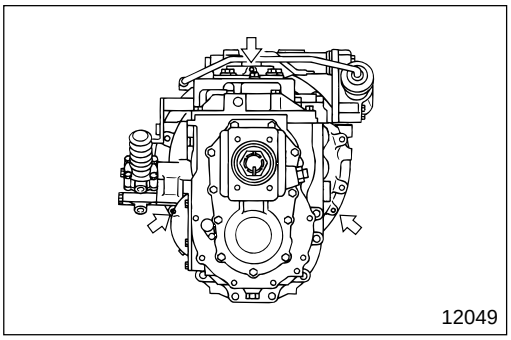
[Filling]

- Check that drain plug **9** is tightened at specified torque.
- Pour in gear oil until the oil overflows from the inspection hole.



10 Removal of transmission assembly mounting nut or bolt

- Support transmission assembly **11** on transmission jack **A**.
- Remove transmission assembly mounting nuts or bolts **10**.



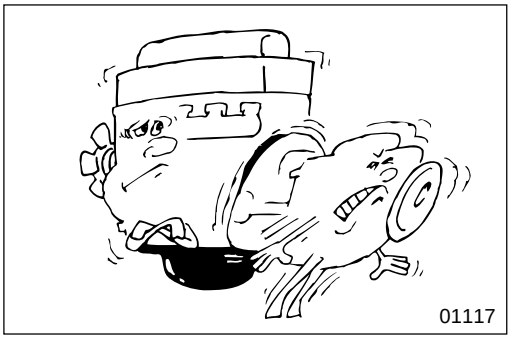
11 Transmission assembly

[Removal]

- Remove transmission assembly **11** from the engine using the screw holes (screw size : M10×1.5 mm) provided for disassembly.

CAUTION⚠

Make sure that you remove hoses and cables before starting service operations.

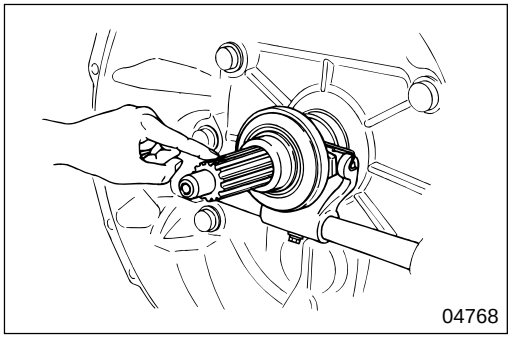


- Move transmission assembly **11** backward until the spline of the input shaft is detached from the clutch.

CAUTION⚠

Make sure that you pull transmission assembly 11 out in a straight line. If you seesaw the transmission assembly violently, you will damage the spline that connects the drive pinion and the clutch.

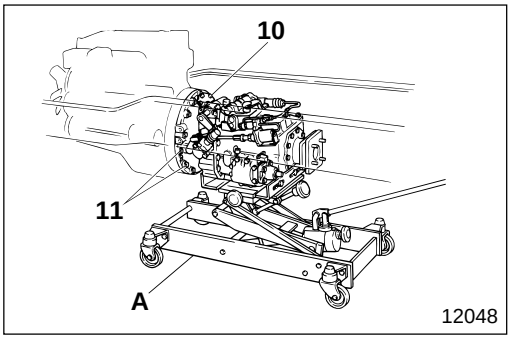
REMOVAL AND INSTALLATION OF TRANSMISSION ASSEMBLY


04768

[Installation]
- Check the spline of the input shaft for rust.
- If rust is found, remove it using a wire brush.
- Rub grease onto the clutch sliding surfaces of the input shaft using your hand.

CAUTION

Make sure that you apply only the necessary amount of grease because too much grease would drip and cause clutch slip.

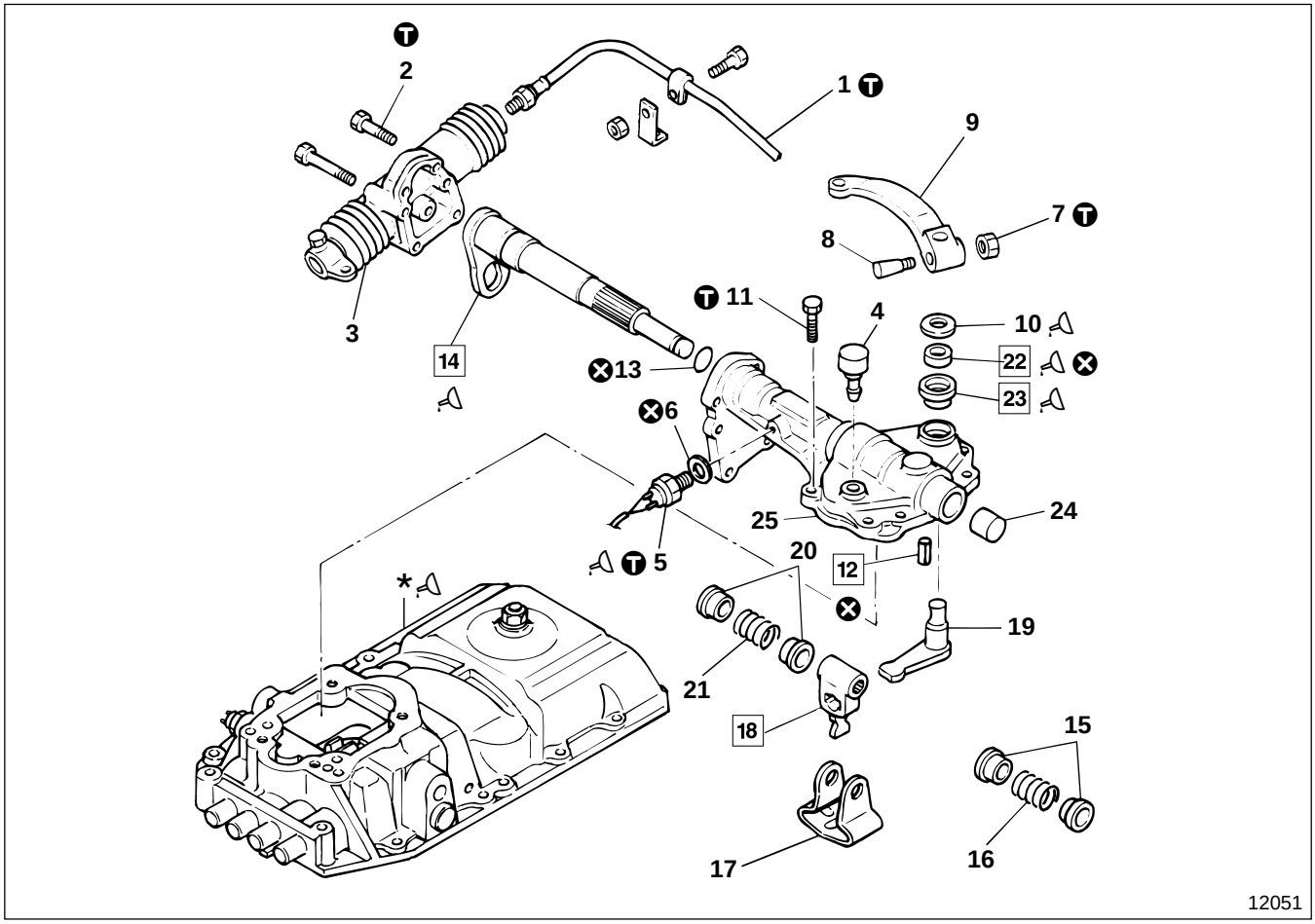


12048

- Support transmission assembly **11** on transmission jack **A**.
- Insert transmission assembly **11** into the pilot bearing of the flywheel paying attention to the input shaft spline.
- Tighten transmission mounting nuts or bolts **10** at specified torque.

M E M O

GEAR SHIFTER UPPER



● **Disassembly sequence**

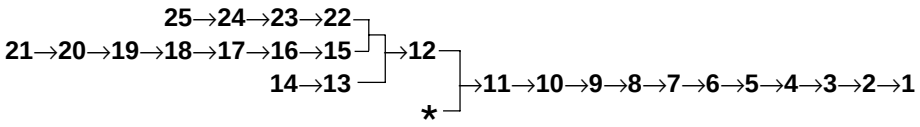
1 Air hose
2 Bolt
3 Power shift assembly
4 Air breather
5 Neutral switch Gr 54
6 Gasket
7 Nut
8 Lock pin
9 Gear selector lever B
10 Washer
11 Bolt
12 Spring pin
13 O-ring
14 Gear shift lever
15 4th and 5th return spring retainer
16 4th and 5th return spring
17 Interlock plate
18 Gear shift slide lever
19 Gear selector lever A
20 1st and reverse return spring retainer
21 1st and reverse return spring
22 Oil seal
23 Bushing
24 Dust plug
25 Selector lever case

*: Gear shifter lower
⊗: Non-reusable parts

NOTE

Do not remove bushing 23 except for replacement.

● **Assembly sequence**



CAUTION⚠

Be sure when assembling gear selector lever A 19, that you turn the lever so you do not damage the lip area of oil seal 22.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
16	4th and 5th return spring load (Installed length 37.6 {1.48})	39 N {8.8 lbf, 4.0 kgf}	31 N {7.1 lbf, 3.2 kgf}	Replace
21	1st and reverse return spring load (Installed length 27.6 {1.09})	130 N {29 lbf, 13.3 kgf}	104 N {23 lbf, 10.6 kgf}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Air hose connector	39 to 44 {29 to 33, 4.0 to 4.5}	—
2	Bolt (Power shift assembly mounting)	40 {30, 4.1}	—
5	Neutral switch	46 to 52 {34 to 38, 4.7 to 5.3}	—
7	Nut (Gear selector lever B mounting)	17 {12, 1.7}	—
11	Bolt (Selector lever case mounting)	40 {30, 4.1}	—

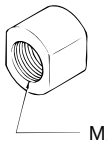
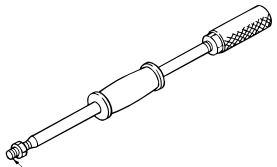
Lubricant and sealant

Location	Points of application	Kinds	Quantity
5	Plunger tip of neutral switch	Chassis grease [NLGI No.1 (Ca soap)]	As required
	Thread area of neutral switch	THREEBOND 1104J	As required
10	Friction surface of washer	Chassis grease [NLGI No.1 (Ca soap)]	As required
14	Friction surface of gear shift lever	Chassis grease [NLGI No.1 (Ca soap)]	As required
22	Lip area of oil seal	Chassis grease [NLGI No.1 (Ca soap)]	As required
23	Selector lever case mounting surface of bushing	THREEBOND 1215	As required
23	Friction surfaces of bushing and axle and gear selector lever A	Chassis grease [NLGI No.1 (Ca soap)]	As required
*****	Selector lever case mounting surface of gear shifter lower	THREEBOND 1104J	As required

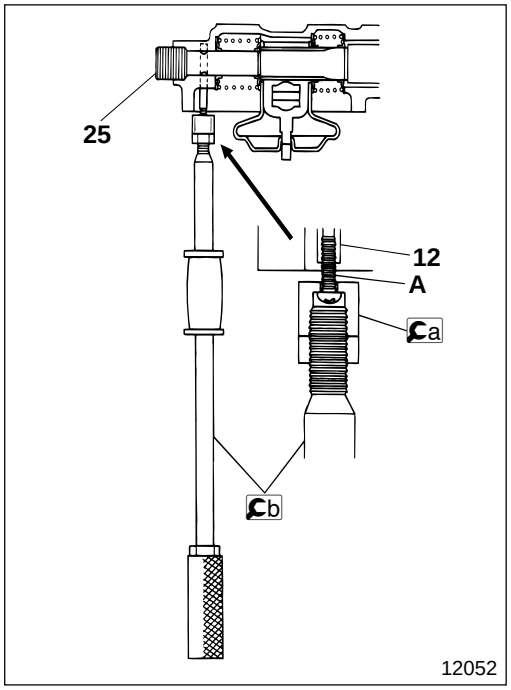
GEAR SHIFTER UPPER

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
14	Spring pin puller  02399	MH062445	Removal of spring pin
	Reverse shaft puller  02118	03726-82000	

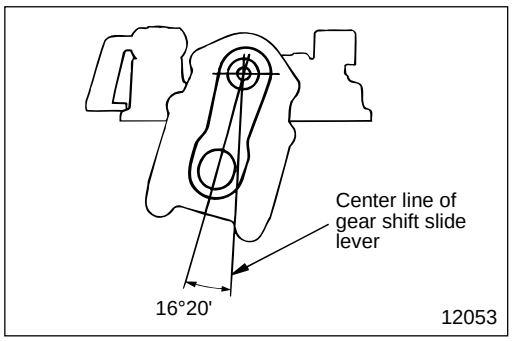
◆ Service procedure



12052

12 Removal of spring pin

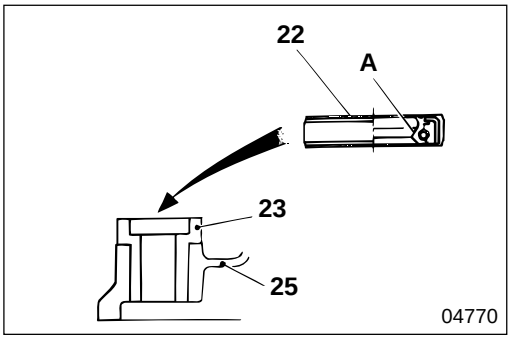
- Tap spring pin **12** using an M4 tap.
- Insert a spring pin puller with an M4 thread **A** of appropriate length into spring pin **12**.
- Position b reverse shaft puller on a spring pin puller.
- Remove spring pin **12** from selector lever case **25** using a spring pin puller and b reverse shaft puller.



12053

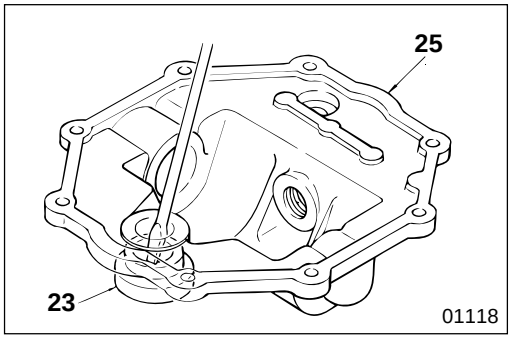
14 18 Installation of gear shift lever and gear shift slide lever

Install gear shift lever **14** and gear shift slide lever **18** as illustrated.



22 **Installation of oil seal**

Apply grease to lip area **A** of oil seal **22** and press-fit into bushing **23** in the direction as illustrated.



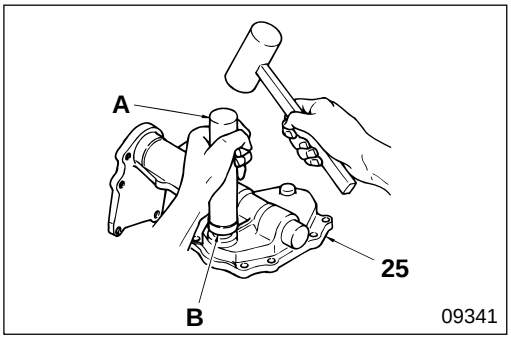
23 **Bushing**

[Removal]

Remove bushing **23** from selector lever case **25** using a screwdriver.

CAUTION⚠

Be careful not to damage selector lever case 25 .



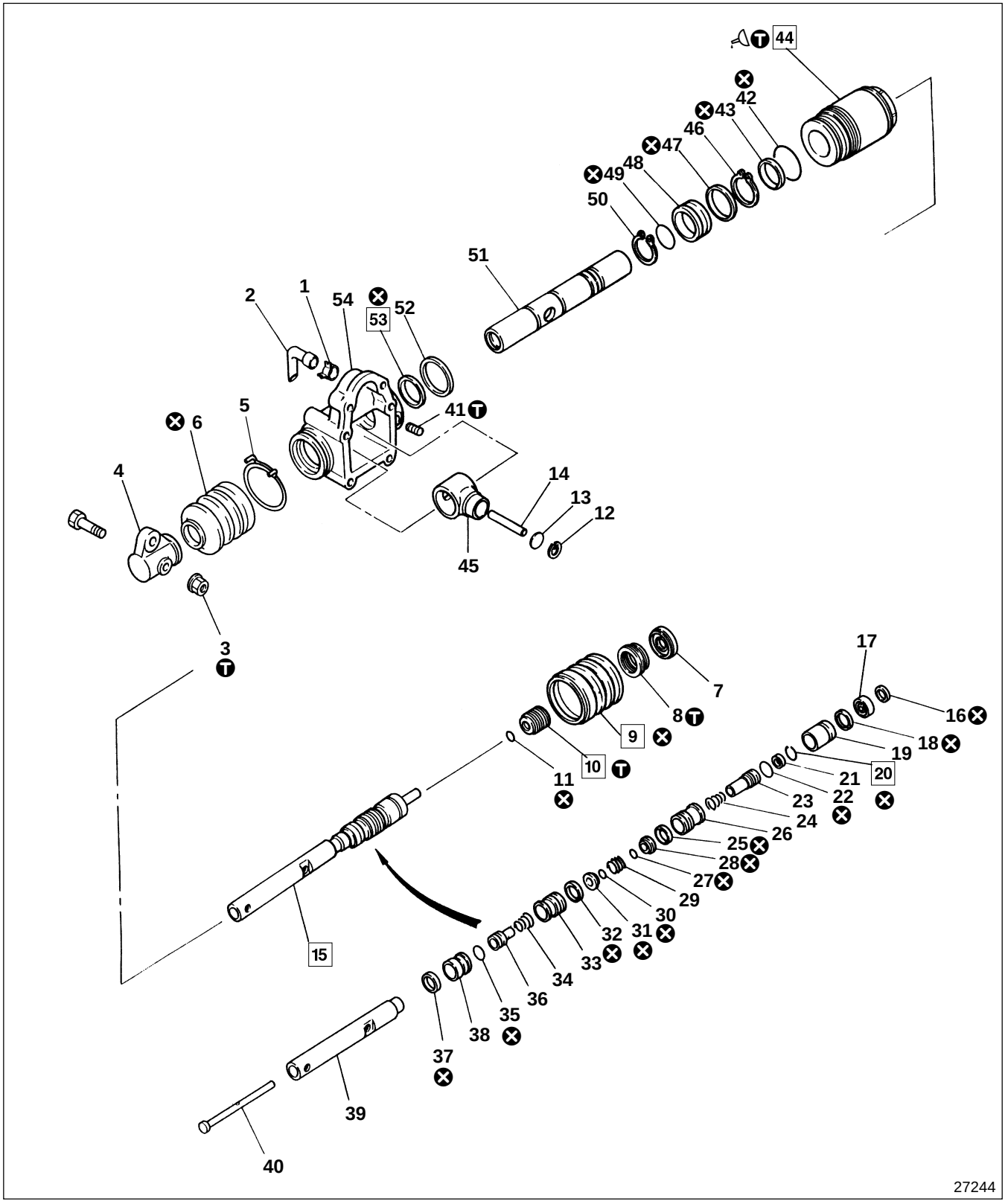
[Installation]

- Clean the inner surface of selector lever case **25** .
- Press-fit bushing **23** into selector lever case **25** using bar **A** (approximately ø40 mm {1.57 in.}).
- When press-fitting bushing **23** , take care not to damage selector lever case **25**.
- After press-fitting, apply sealant to press-fitted side **B** of bushing **23**.

CAUTION⚠

Prevent sealant from sticking to the inner surface of bushing 23.

POWER SHIFT ASSEMBLY



● **Inspection before diassembly**

P22B-26

● **Disassembly sequence**

1 Clamp
2 Hose
3 Nut
4 Lever
5 Clamp
6 Boot
7 Cover
8 Nut
9 Boot
10 Connector
11 O-ring
12 Retaining ring
13 Plate
14 Straight pin
15 Valve assembly
16 Filter
17 Collar
18 Square ring
19 Tube
20 Retaining ring
21 Plate
22 O-ring
23 Lifter
24 Spring
25 Square ring
26 Seat
27 O-ring
28 Seal assembly
29 Spring
30 O-ring
31 Seal assembly
32 Square-ring
33 Seat
34 Spring
35 O-ring
36 Lifter
37 Square-ring
38 Tube
39 Rod
40 Pipe
41 Set screw
42 O-ring
43 Packing
44 Cylinder
45 Striker
46 Retaining ring
47 Piston packing
48 Piston
49 O-ring
50 Retaining ring
51 Shift rod
52 Plate
53 Cup packing
54 Housing

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION⚠

Be sure to mount springs 24, 29 and 34 in the correct order.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
24	Spring load (Installed length 13 {0.51})	38 N {8.6 lbf, 3.9 kgf}	31 N {7.1 lbf, 3.2 kgf}	Replace
29	Spring load (Installed length 10 {0.39})	13 N {2.9 lbf, 1.3 kgf}	9.8 N {2.2 lbf, 1.0 kgf}	Replace
34	Spring load (Installed length 13 {0.51})	9.8 N {2.2 lbf, 1.0 kgf}	7.8 N {1.8 lbf, 0.8 kgf}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (Lever mounting)	24 to 27 {17 to 20, 2.4 to 2.7}	—
8	Nut	59 to 69 {43 to 51, 6 to 7}	—
10	Connector	7.8 to 12 {5.8 to 8.7, 0.8 to 1.2}	—
41	Set screw	2.0 to 3.4 {1.4 to 2.5, 0.2 to 0.35}	—
44	Cylinder	78 to 98 {58 to 72, 8 to 10}	—

POWER SHIFT ASSEMBLY

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
—	All friction surfaces	Multipurpose grease [NLGI No.2 (Li soap)]	As required
44	Thread area of cylinder	LOCTITE 242 or THREEBOND 1401B	As required

Special tools

Location	Tool name and shape	Part No.	Application
10	Connector	*910-25790	Installation and removal of connector
15	Sleeve	*910-24800	For valve assembly insertion
20	Insertion tool	*910-22011	For retaining ring insertion
	Insertion tool	*910-26500	
44	Socket	*910-21982	Installation and removal of cylinder

* BOSCH BRAKING SYSTEMS Co., Ltd. part No.

◆ Service procedure

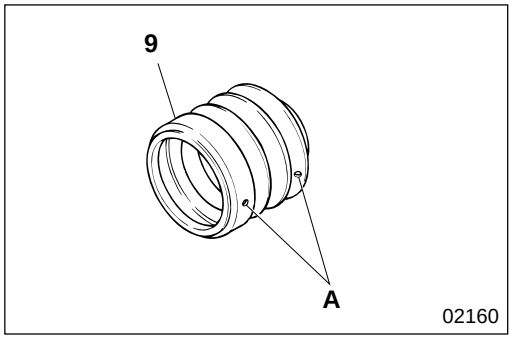
● Inspection before disassembly

(1) Apply 735 kPa {105 psi, 7.5 kgf/cm^2} of pressure to the power shift assembly from the connector, check the airtightness when not operating (valve in neutral), and when operating valve is pressed and pulled. If the measured value deviates from the standard value, replace the faulty parts.

Maintenance item	Standard value	
Airtightness when not operating	Decrease of pressure after 15 seconds	9.8 kPa {1.4 psi, 0.1 kgf/cm^2}
Airtightness when operating		49 kPa {7.1 psi, 0.5 kgf/cm^2}

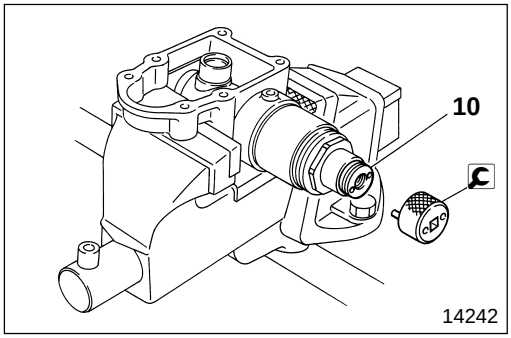
(2) Measure the sliding resistance in the disengagement direction. If the measured value deviates from the standard value, replace the faulty parts, or grease them.

Maintenance item	Standard value
Resistance in shifting direction	38 N {8.6 lbf, 3.9 kgf}



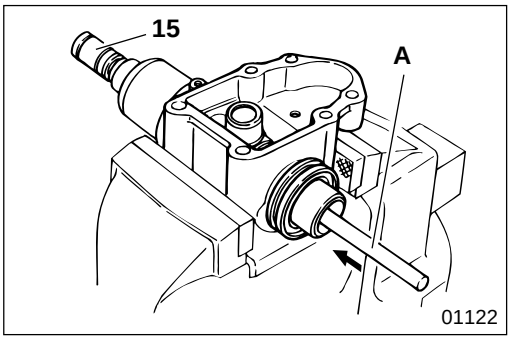
9 **Installation of boot**

When you install boot **9** on housing **54**, point drain holes **A** downward.



10 Installation and removal of connector

: Connector



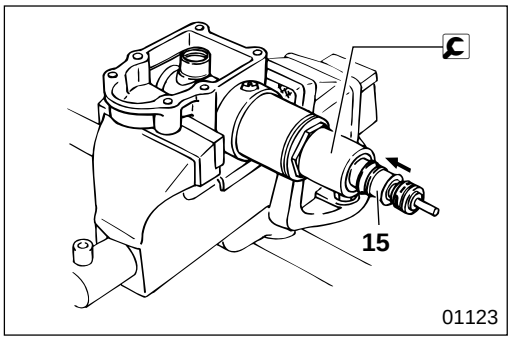
15 Valve assembly

[Removal]

Gently push valve assembly **15** off the shift rod from the lever side with rod A.

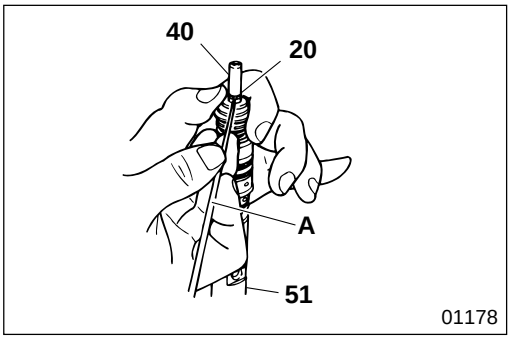
CAUTION

Use of excessive force to remove valve assembly 15 may result in damage.



[Installation]

- Apply grease to valve assembly **15**.
- Taking care not to damage the seals, install valve to shift rod with sleeve.



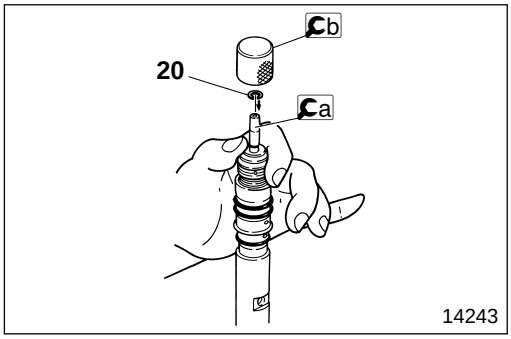
20 Retaining ring

[Removal]

- Secure shift rod **51** with a vise to prevent damage.
- Remove retaining ring **20** from pipe **40** with needle shaped object **A**.

CAUTION

- **When retaining ring 20 is removed, all valve parts are disconnected.**
- **To avoid wrong assembly, arrange all valve parts in correct order before assembly.**

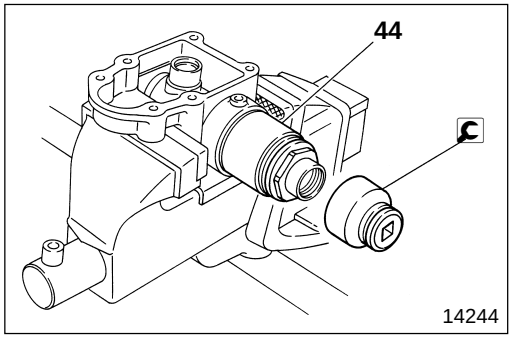


[Installation]

- Attach valve parts to pipe **40**.
- Connect a insertion tool to end of pipe **40**.
- Insert retaining ring **20** correctly in groove in pipe **40** with b insertion tool.

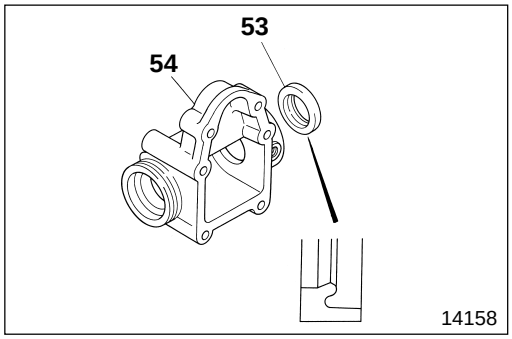
CAUTION

Do not use excessive force when inserting retaining ring 20.



44 **Installation and Removal of the Cylinder**

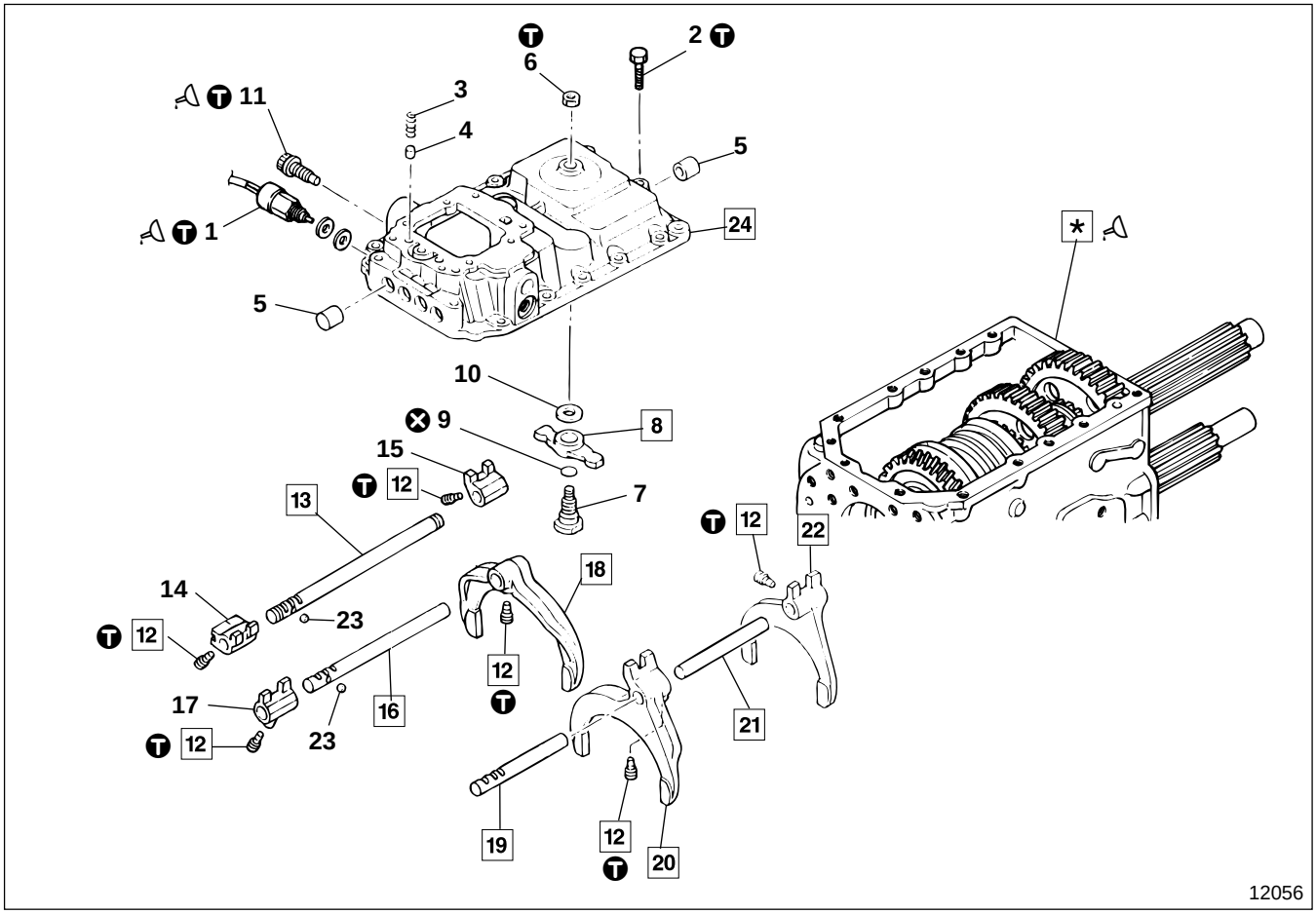
: Socket



53 **Installing cup packing**

M E M O

GEAR SHIFTER LOWER



● **Disassembly sequence**

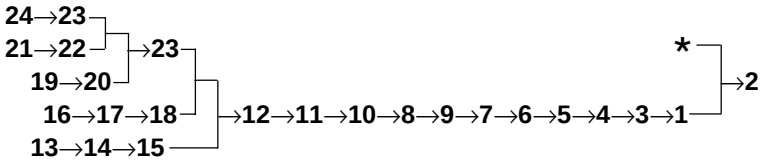
1 Backup lamp switch Gr 54
2 Bolt
3 Poppet spring
4 Interlock pin
5 Dust plug
6 Nut
7 1st and reverse shift lever shaft
8 1st and reverse shift lever
9 O-ring
10 Thrust washer
11 Jaw set bolt
12 Set bolt
13 1st and reverse shift rail A
14 1st and reverse shift rail jaw A
15 1st and reverse shift rail jaw B
16 2nd and 3rd shift rail
17 2nd and 3rd shift rail jaw
18 2nd and 3rd shift fork
19 4th and 5th shift rail
20 4th and 5th shift fork
21 1st and reverse shift rail B
22 1st and reverse shift fork
23 Steel ball
24 Gear shift lever lower case

* : Transmission assembly
⊗ : Non-reusable parts

CAUTION ⚠

- **Do not disassemble the lower gear shifter except to replace shift forks 18, 20, 22, shift rails 13, 16, 19, 21 and shift rail jaws 14, 15, 17.**
- **When you disassemble the lower gear shifter, put the lever in neutral.**
- **When you remove shift rails 13, 16, 19, 21, be careful not to lose interlock pin 4, steel balls 23 or poppet spring 3.**

● **Assembly sequence**



Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
3	Poppet spring load (Installed length 32.9 {1.30})	88 N {20 lbf, 9.0 kgf}	71 N {16 lbf, 7.2 kgf}	Replace
7, 8	Clearance between 1st and reverse shift lever shaft and 1st and reverse shift lever	[23] 0.02 to 0.09 {[0.91] 0.00079 to 0.0035}	0.15 {0.0059}	Replace
8	Bend of 1st and reverse shift lever	0.05 {0.0020} or less	0.1 {0.0039}	Replace
13	Bend of 1st and reverse shift rail A	0.03 {0.0012} or less	0.06 {0.0024}	Correct or replace
13, 16, 19, 21, 24	Clearance between shift rails and gear shift lever lower case	[20] 0.06 to 0.09 {[0.79] 0.0024 to 0.0043}	0.2 {0.0079}	Replace
16	Bend of 2nd and 3rd shift rail	0.03 {0.0012} or less	0.06 {0.0024}	Correct or replace
18, 20, 22	Tilt of claws of shift forks	0.1 {0.0039} or less	0.2 {0.0079}	Replace
18, 20, 22, *	Clearance between shift forks and synchronizer sleeves	0.25 to 0.45 {0.0098 to 0.018}	1 {0.039}	Replace
19	Bend of 4th and 5th shift rail	0.02 {0.00079} or less	0.04 {0.0016}	Correct or replace
21	Bend of 1st and reverse shift rail B	0.02 {0.00079} or less	0.04 {0.0016}	Correct or replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Backup lamp switch	46 to 52 {34 to 38, 4.7 to 5.3}	—
2	Bolt (Lower gear shifter assembly mounting to transmission assembly)	40 {30, 4.1}	—
6	Nut (1st and reverse shift lever shaft mounting)	135 {98, 13.6}	—
11	Jaw set bolt	135 {98, 13.6}	—
12	Set bolt (Shift fork and jaw mounting)	49 to 67 {36 to 49, 5.0 to 6.8}	—

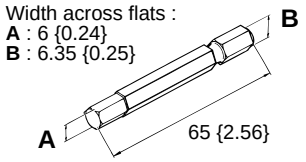
Sealant

Location	Points of application	Kinds	Quantity
1	Thread area of backup lamp switch	THREEBOND 1104J	As required
11	Thread area of jaw set bolt	THREEBOND 1104J	As required
*****	Gear shift lever lower case mounting surface of transmission assembly	THREEBOND 1215	As required

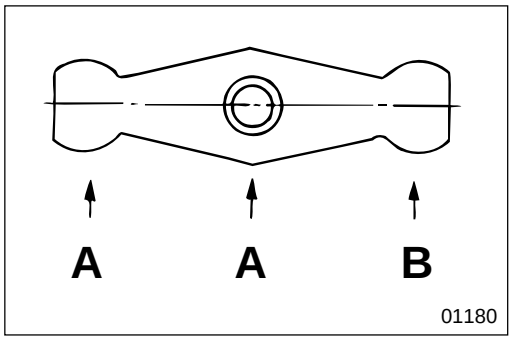
GEAR SHIFTER LOWER

Special tools

Unit : mm {in.}

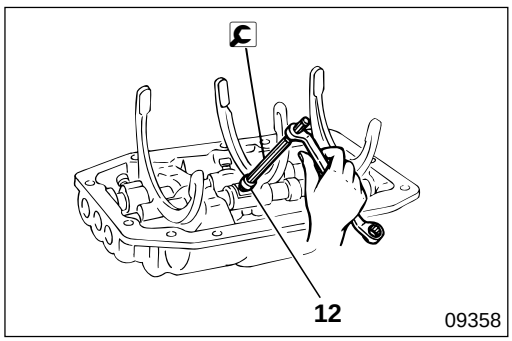
Location	Tool name and shape	Part No.	Application
12	Hexagon bit 	MH061533	Removal and installation of set bolt

◆ Service procedure



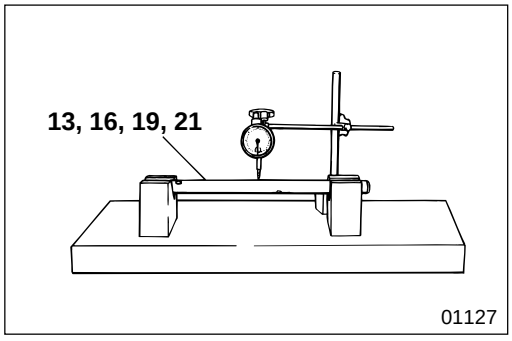
8 **Bend of 1st and reverse shift lever**

If bend **B** (in reference to **A-A** as illustrated) is higher than the limit, replace 1st and reverse shift lever **8**.



12 **Removal and installation of set bolt**

- Use hexagon bit to remove and install set bolt **12**.
- Caulk the thread area of set bolt **8** at three points or more after tightening.

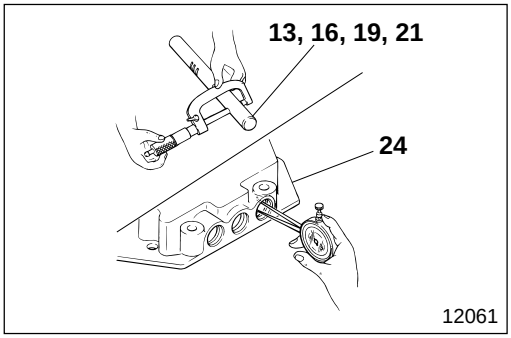


13 **16** **19** **21** **Bend of shift rail**

- If the measured value is higher than the limit, correct or replace the shift rail.

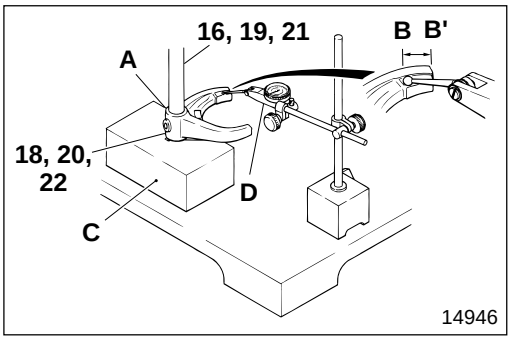
NOTE

Read the dial gauge after turning shift rails 13, 16, 19, 21 one full revolution. The bend is one half of the indicated value.



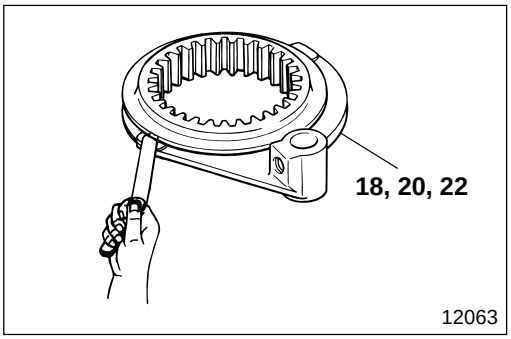
13 16 19 21 24 Clearance between shift rail and gear shift lever lower case

- Measure the outer diameter of the shift rail and the inner diameter of the gear shift lever lower case shift rail hole.
- If the clearance is higher than the limit, replace the faulty parts.



18 20 22 Tilt of shift fork claw

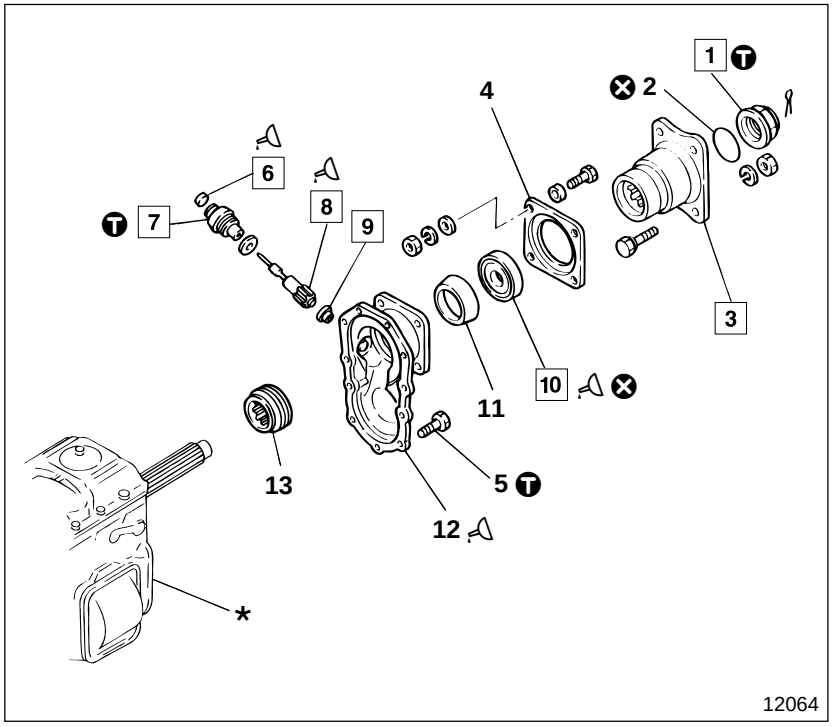
- Measure the tilt (difference between **B** and **B´**) of claw **B–B´**against hole **A** of shift rails **16**, **19**, **21** of shift forks **18**, **20**, **22** with the shift rails upright.
- If the tilt is higher than the limit, replace shift forks **18**, **20**, or **22**.
  C : V-block
  D : Dial gauge



18 20 22 ✱ Clearance between shift fork and synchronizer sleeve

If the clearance is higher than the limit, replace the faulty parts.

REAR COVER



● **Disassembly sequence**

1 Nut
2 O-ring
3 Companion flange
4 Dust cover
5 Bolt
6 Oil seal
7 Speedometer gear bushing
8 Speedometer gear
9 Speedometer gear bushing A
10 Oil seal
11 Oil separator plate
12 Rear cover
13 Speedometer worm

* : Transmission assembly
⊗ : Non-reusable parts

● **Assembly sequence**

***→13**
12→11→10→9→8→7→6→5→4→3→2→1

NOTE

Inspect the play of speedometer gear 8 before disassembly.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
7, 8	Clearance between speedometer gear bushing and speedometer gear	[12] 0.02 to 0.07 {[0.47] 0.00079 to 0.0028}	0.15 {0.0059}	Replace
8, 9	Clearance between speedometer gear and speedometer gear bushing A	[8] 0.35 {[0.31] 0.014} or less	0.4 {0.016}	Replace
8, 13	Backlash between speedometer gear and speedometer worm	0.13 to 0.29 {0.0051 to 0.011}	0.36 {0.014}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

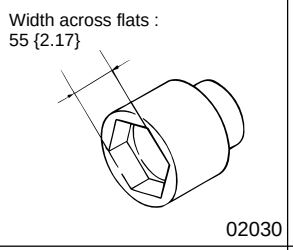
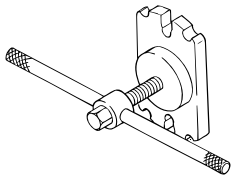
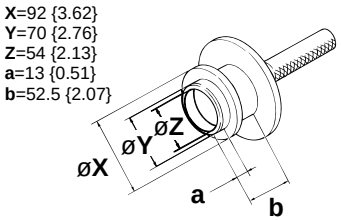
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut	590 to 1080 {435 to 795, 60 to 110}	—
5	Bolt (Rear cover mounting)	74 {54, 7.5}	—
7	Speedometer gear bushing	195 {145, 20}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
6	Lip area of oil seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required
8	Friction surfaces between speedometer gear and speedometer gear bushing	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
10	Lip area of oil seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required
12	Transmission assembly mounting surface of rear cover	THREEBOND 1215	As required

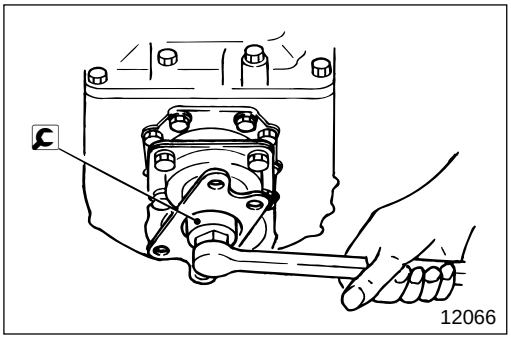
Special tools

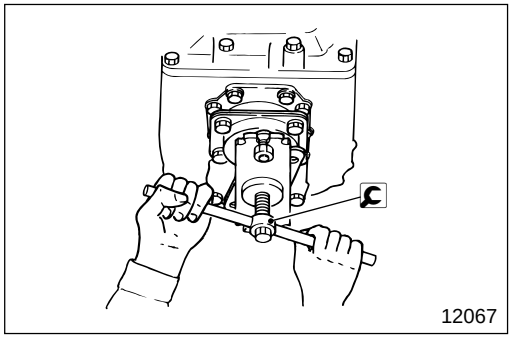
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Socket wrench  02030	MH061519	Removal and installation of nut
3	Flange puller  02153	MH061393 or MH062207	Removal of companion flange
10	Oil seal installer  09241	MH062065	Installation of oil seal of rear cover

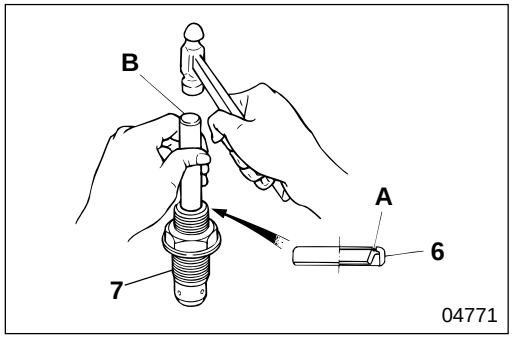
◆ Service procedure

1 **Removal and installation of lock nut**


12066

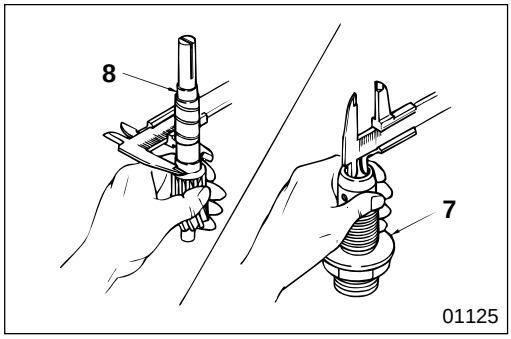


3 **Removal of companion flange**



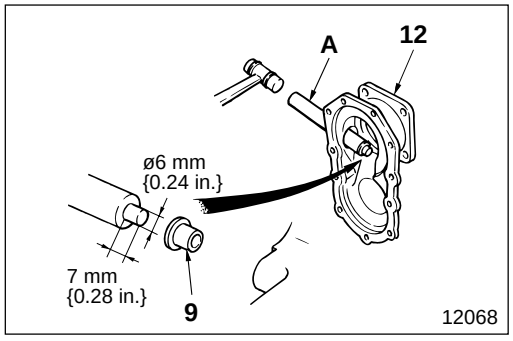
6 **Press-fitting of oil seal**

- Apply grease to inside of oil seal **6** packing **A**.
- Press-fit oil seal **6** into speedometer gear bushing **7** in the direction as illustrated using bar **B** (approximately ø15 mm {0.59 in.}).



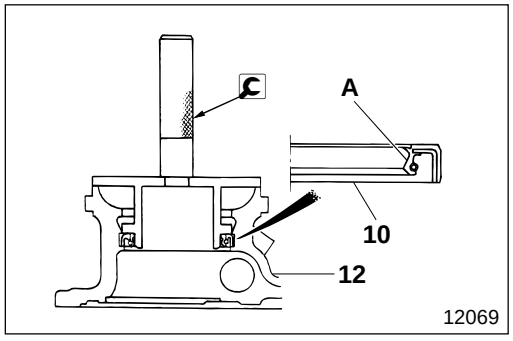
7 **8** **Clearance between speedometer gear bushing and speedometer gear**

If the clearance is higher than the limit, replace the bushings.



9 **Installation of speedometer gear bushing A**

Press-fit speedometer gear bushing **A** **9** into rear cover **12** using round bar **B** (ø14 mm {0.55 in.}), turned to the dimensions as illustrated.

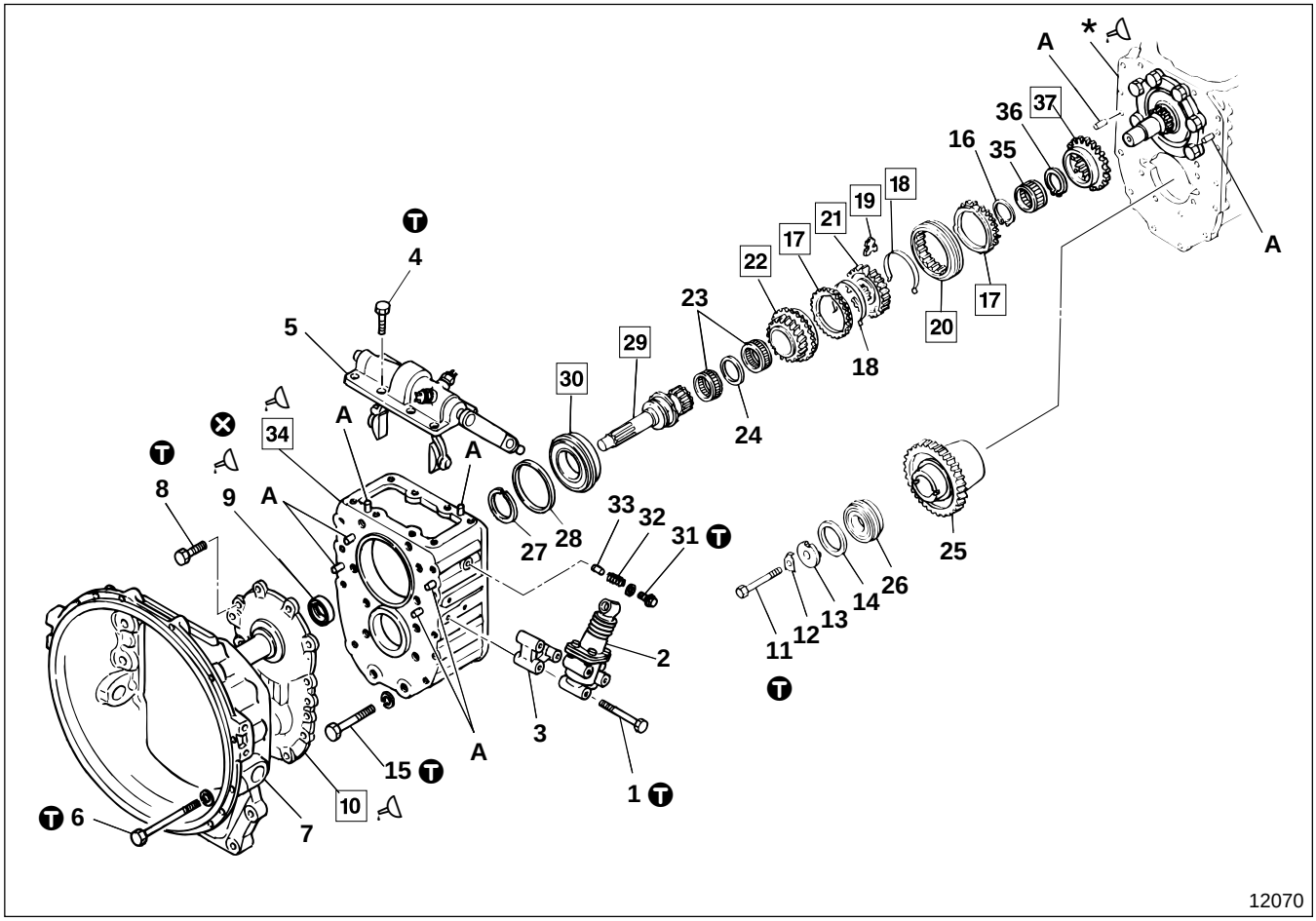


10 **Press-fitting of oil seal**

- Apply grease to lip area **A** of oil seal **10**.
- Press-fit oil seal **10** into rear cover **12** in the direction as illustrated using oil seal installer.

M E M O

SPLITTER



● **Work before disassembly**

P22B-40

● **Disassembly sequence**

1 Bolt
2 Power cylinder P22B-45
3 Spacer
4 Bolt
5 Splitter upper assembly P22B-44
6 Bolt
7 Clutch housing
8 Bolt
9 Oil seal
10 Bearing retainer
11 Bolt
12 Lock washer
13 Lock plate
14 Bearing shim
15 Bolt
16 Snap ring
17 Synchronizer ring
18 Shifting key spring
19 Shifting key
20 Synchronizer sleeve
21 Synchronizer hub
22 Splitter pinion assembly
23 Needle bearing
24 Spacer
25 Splitter high gear
26 Roller bearing
27 Snap ring
28 Bearing shim
29 Input shaft
30 Ball bearing
31 Plug
32 Poppet spring
33 Pin
34 Splitter case
35 Needle bearing
36 Snap ring
37 Splitter synchronizer cone

***** : Transmission assembly
A : Positioning pin (Eight points)
⊗ : Non-reusable parts

● **Assembly sequence**

29→30→28→27
34
→26→25→23→24→23→22
21→20→19→18→17
***→37→36→35**
→16
→15→14→13→12→11
10→9
7
→8
5
→6
→4→33→32→31
3→2
→1

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
17, 21	Clearance between synchronizer ring and synchronizer hub	4.8 to 5.4 {0.19 to 0.21}	6.5 {0.26}	Replace
17, 22, 37	Clearance between synchronizer ring, splitter pinion and splitter synchronizer cone	2.5 {0.0098}	0 {0}	Replace
19, 21	Clearance between shifting key and synchronizer hub	0.05 to 0.35 {0.0020 to 0.014}	0.5 {0.020}	Replace
20, 21	Clearance in diameter direction between synchronizer sleeve and synchronizer hub	0.06 to 0.14 {0.0024 to 0.0055}	0.3 {0.012}	Replace
22, 25	Backlash between splitter pinion assembly and splitter high gear	0.114 to 0.294 {0.0045 to 0.012}	0.5 {0.020}	Replace
22, 23, 29	Clearance in diameter direction after assembling splitter pinion assembly and needle bearing to input shaft	—	0.12 {0.0050}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

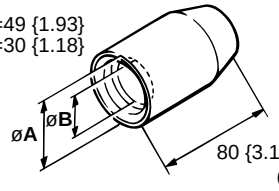
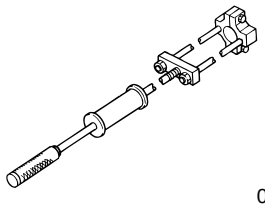
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Power cylinder mounting)	40 {30, 4.1}	—
4	Bolt (Splitter upper mounting)	40 {30, 4.1}	—
6	Bolt (Clutch housing mounting)	190 {140, 19.2}	—
8	Bolt (Bearing retainer mounting)	40 {30, 4.1}	—
11	Bolt (Splitter high gear mounting)	290 {215, 29.7}	—
15	Bolt (Splitter case mounting)	190 {140, 19.2}	—
31	Plug	34 {25, 3.5}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
9	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
10	Splitter case mounting surface of bearing retainer	THREEBOND 1215	As required
34	Splitter upper mounting surface of splitter case	THREEBOND 1215	As required
*****	Splitter case mounting surface of transmission assembly	THREEBOND 1215	As required

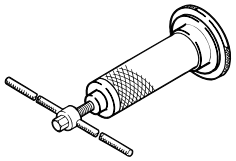
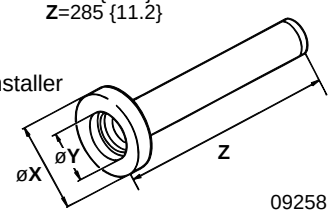
Special tools

Unit : mm {in.}

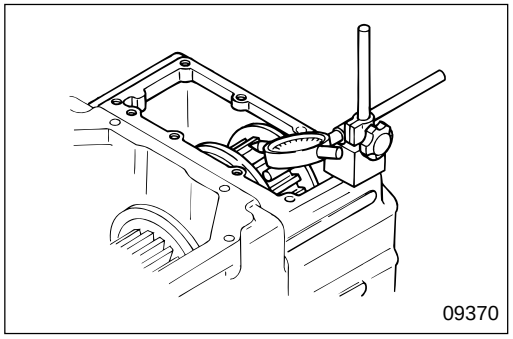
Location	Tool name and shape	Part No.	Application
10	Oil seal front guide 	MH061392	Installation of front bearing retainer
29	Drive pinion and reverse shaft puller 	MH061614	Removal of input shaft

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
29, 30	Drive pinion bearing puller  09253	MH061635	Removal of ball bearing of input shaft
	X=148 {5.83} **Y**=87 {3.43} **Z**=285 {11.2} Drive pinion bearing installer  09258	ME650584	Installation of ball bearing into input shaft, installation of input shaft into splitter case

◆ Service procedure

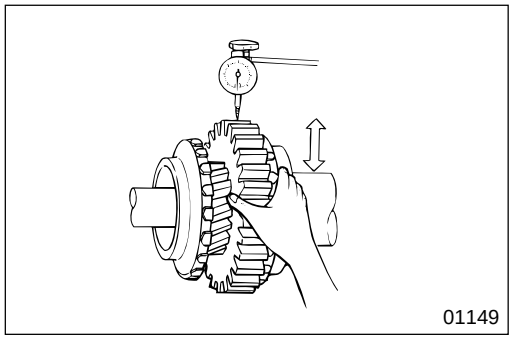

09370

● **Work before disassembly**

[Inspection]

(1) Backlash between splitter pinion assembly and splitter high gear

If the measured value is higher than the limit, replace the faulty parts. Also inspect this item after assembly and make sure that the measured value is within the limit.


01149

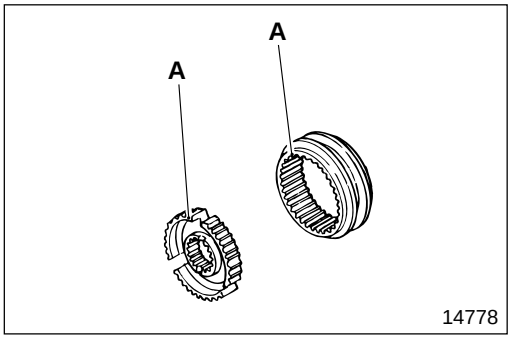
(2) Clearance in the diameter direction between input shaft, and splitter pinion assembly or needle bearing after assembling them on the shaft

If the measured values are higher than the limit, replace the faulty parts.

Also inspect this item after assembly and make sure that the measured value is within the limit.

CAUTION⚠

Be sure when you replace two needle bearings of a gear, that both needle bearings are from the same color package.

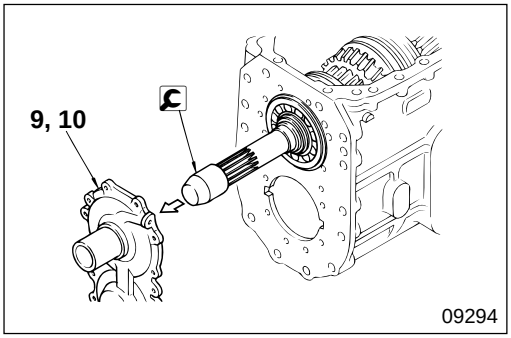


14778

[Alignment marks]

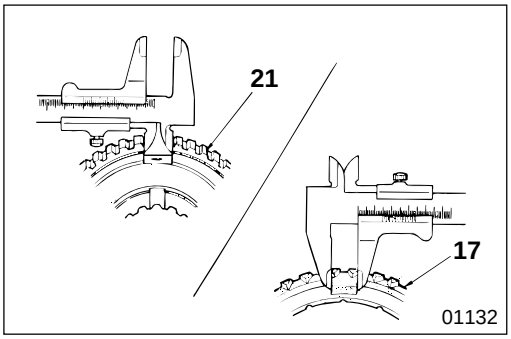
Synchronizer sleeve and synchronizer hub

Before disassembling the synchronizer sleeve and the synchronizer hub, put alignment marks **A** on the places where the shifting keys are installed. When reusing parts, align the alignment marks to assemble.



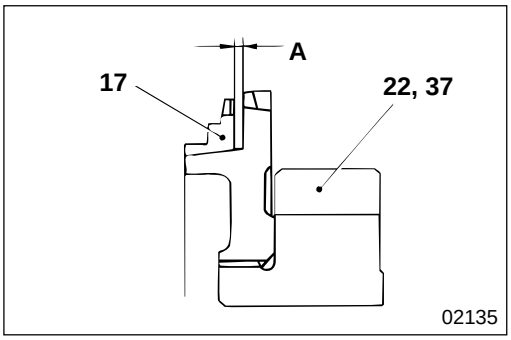
10 **Installation of bearing retainer**

When installing bearing retainer **10**, use oil seal front guide to avoid damage to oil seal **9**, which is installed on the bearing retainer.



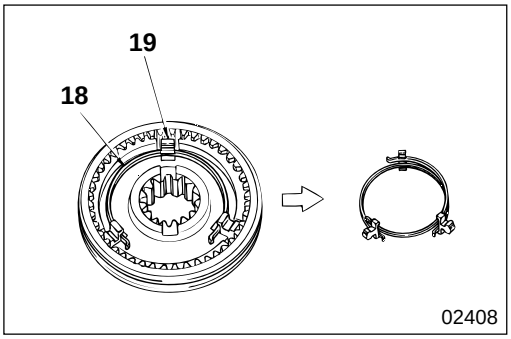
17 **21** **Clearance between synchronizer ring and synchronizer hub**

If the measured value is higher than the limit, replace the faulty parts.



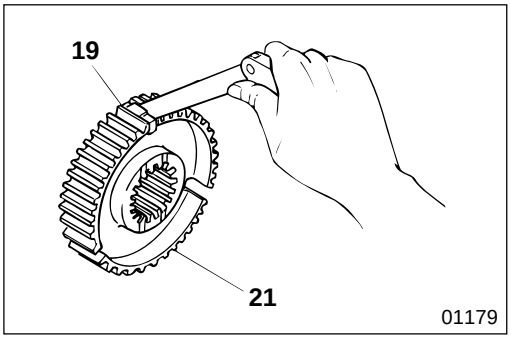
17 **22** **37** **Clearance between synchronizer ring, and splitter pinion or splitter synchronizer cone**

- Measure clearance **A** between synchronizer ring **17** and splitter pinion **22** or splitter synchronizer cone **37**.
- When measuring this value, press synchronizer ring **17** evenly and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



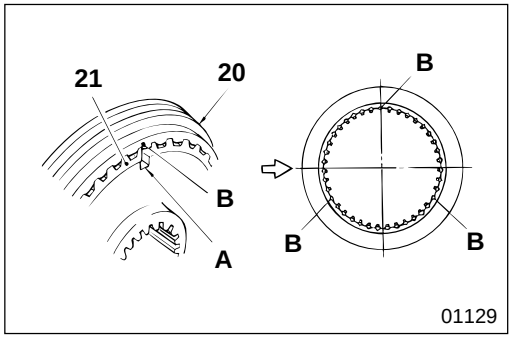
18 **Installation of shifting key spring**

- Insert shifting key **19** into the keyway.
- Install shifting key spring **18** so that its opening is offset from the one on the shifting key.
- Make sure that the opening of shifting key springs **18** do not align with each other.



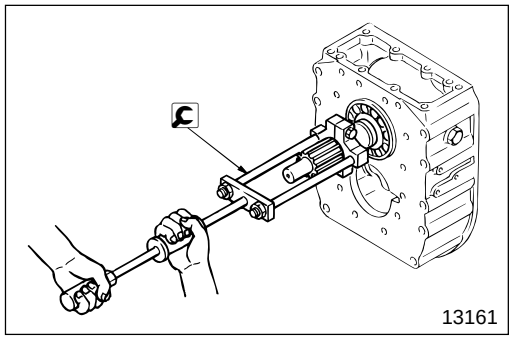
19 **21** **Clearance between shifting key and synchronizer hub**

If the measured value is higher than the limit, replace the faulty parts.



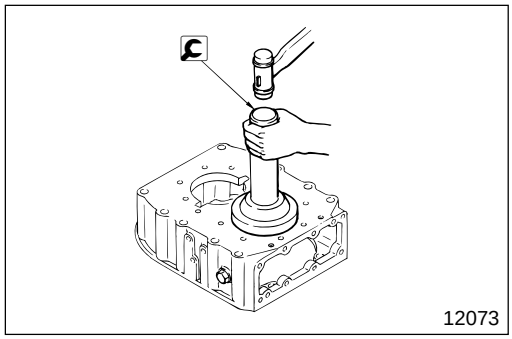
20 **Installation of synchronizer sleeve**

- Align the three keyways **A** of synchronizer hub **21** with the three stub teeth **B** of synchronizer sleeve **20** to install the synchronizer hub.
- To reassemble synchronizer hub **21** and synchronizer sleeve **20**, align the alignment marks made during disassembly.

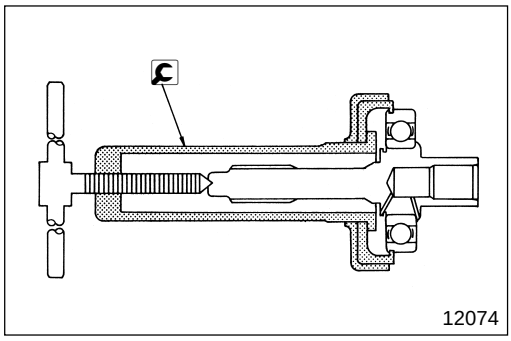


29 **Input shaft**

[Removal]

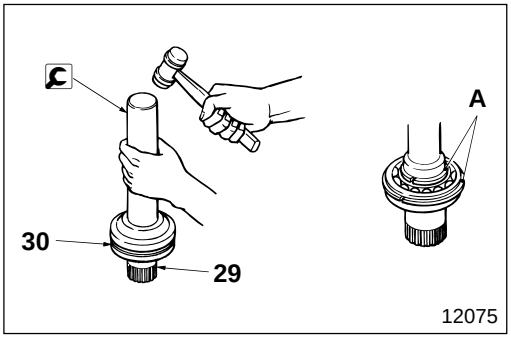


[Installation]

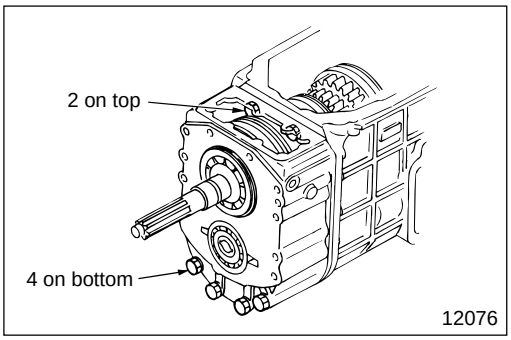


30 **Ball bearing**

[Removal]



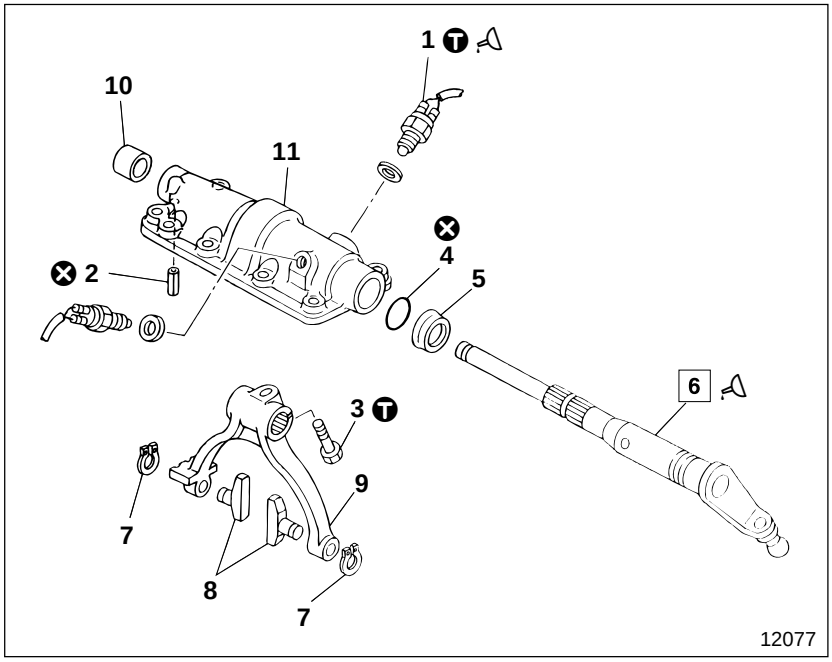
[Installation]
- Install ball bearings **30** on input shaft **29**.
- Install snap ring **A** on ball bearings **30**.



34 Removal and installation of splitter case

When you install splitter case **34**, note that there are two bolts on its top, and four bolts on its bottom.

SPLITTER UPPER ASSEMBLY



● **Disassembly sequence**

1 Interlock switch Gr 54
2 Spring pin
3 Bolt
4 O-ring
5 Dust seal
6 Splitter shift lever
7 Snap ring
8 Splitter shift fork piece
9 Splitter shift fork
10 Dust plug
11 Splitter upper case

⊗ : Non-reusable parts

● **Assembly sequence**

9→**8**→**7**
11 →**3**→**2**→**10**→**1**
6→**5**→**4**

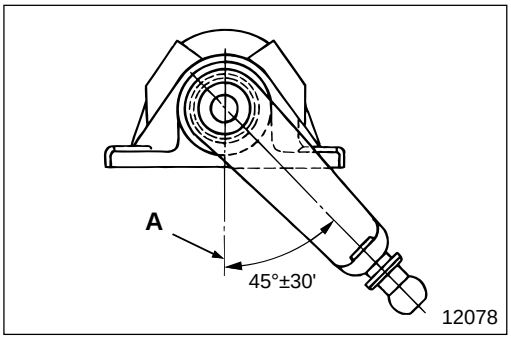
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Interlock switch	49 {36, 5}	—
3	Bolt (Splitter shift fork mounting)	33 {25, 3.4}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
1	Thread area of interlock switch	THREEBOND 1104J	As required
6	Pack O-ring groove of splitter shift lever	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

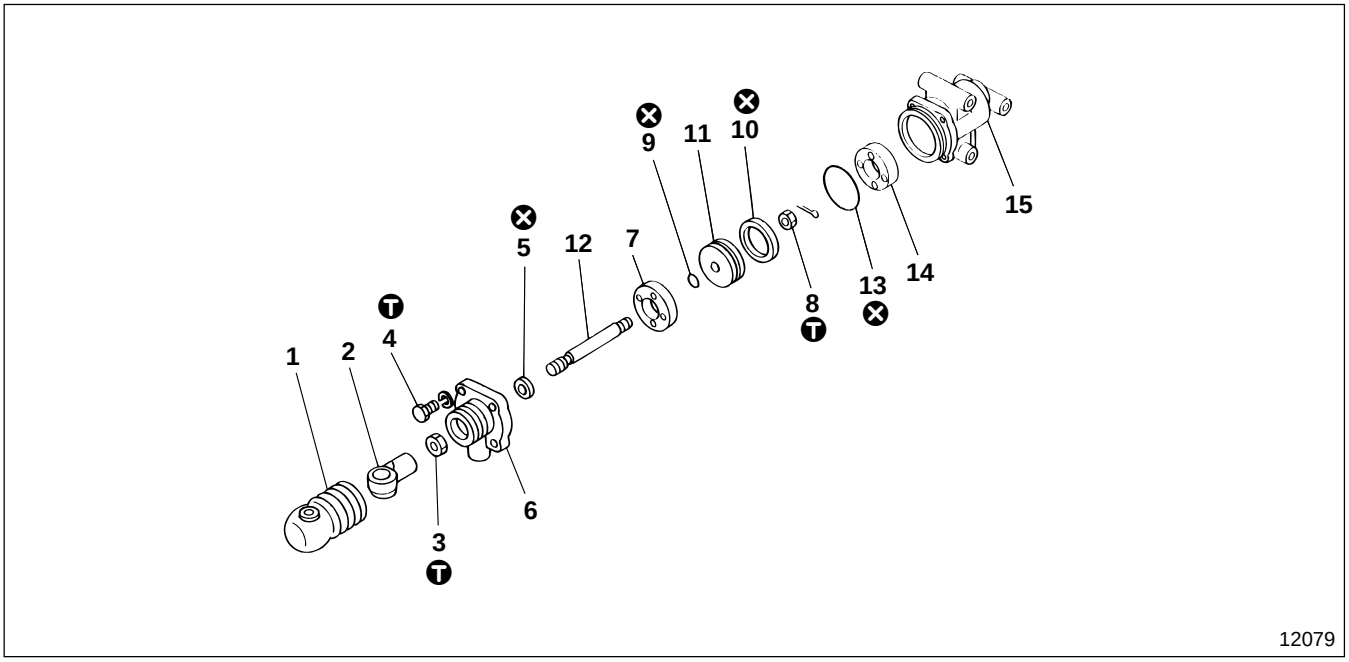


◆ Service procedure

6 **Installation of splitter shift lever**

Install splitter shift lever **6** to form the relation with splitter shift fork **9** as illustrated.

A : Splitter shift fork center

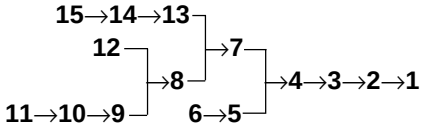


● **Disassembly sequence**

1 Boot
2 Shifter clevis
3 Nut
4 Bolt
5 X-ring
6 Body and seat assembly
7 Stopper
8 Nut
9 O-ring
10 X-ring
11 Piston plate
12 Piston rod
13 O-ring
14 Stopper
15 Cylinder assembly

⊗ : Non-reusable parts

● **Assembly sequence**



Ⓣ Tightening torque

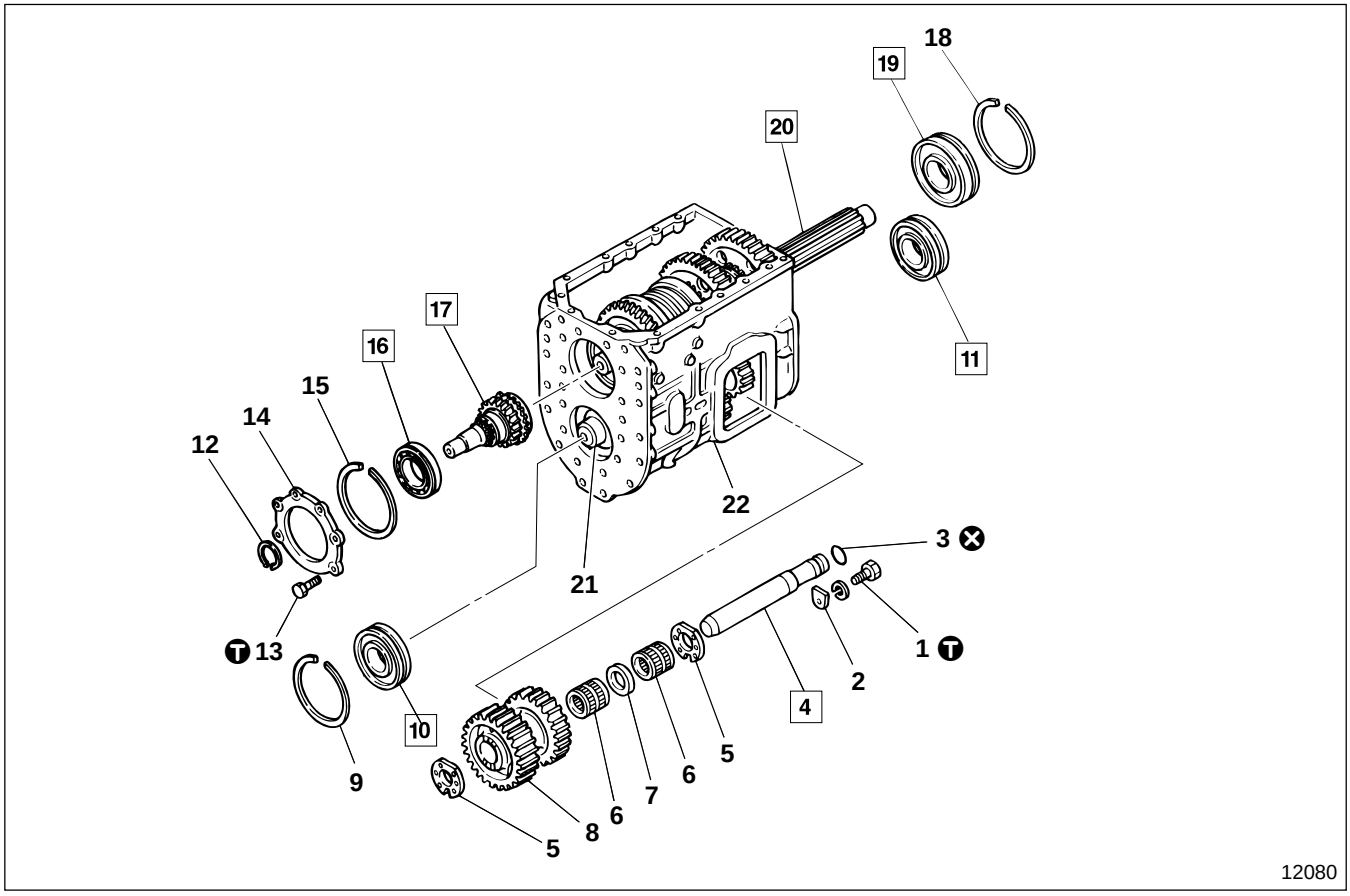
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Nut (Shifter clevis fixing)	78 to 98 {58 to 72, 8 to 10}	—
4	Bolt (Body and seat assembly mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
8	Nut (Piston plate and piston rod mounting)	9.8 to 15.0 {7.2 to 11.0, 1.0 to 1.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	Friction surfaces	Multipurpose grease [NLGI No.2 (Li soap)]	As required

TRANSMISSION BODY



● **Inspection before disassembly**

📖 P22B-49

● **Disassembly sequence**

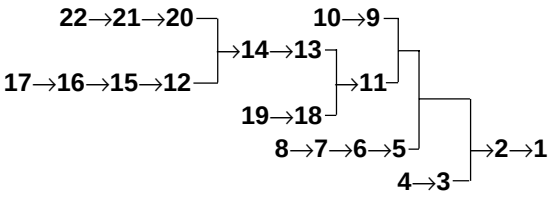
1 Bolt
2 Reverse shaft lock piece
3 O-ring
4 Reverse gear shaft
5 Reverse gear side washer
6 Needle bearing
7 Bearing spacer
8 Reverse gear
9 Snap ring
10 Countershaft front bearing
11 Countershaft rear bearing
12 Snap ring
13 Bolt
14 Bearing retainer
15 Snap ring
16 Drive pinion bearing
17 Drive pinion
18 Snap ring
19 Mainshaft rear bearing
20 Mainshaft assembly 📖 P22B-54
21 Countershaft assembly 📖 P22B-62
22 Transmission case

⊗ : Non-reusable parts

NOTE

Before removing mainshaft assembly 20, remove countershaft front and rear bearings 10, 11 so you can leave countershaft assembly 21 in transmission case 22.

● **Assembly sequence**



Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
4, 6, 7, 8	Clearance in diameter direction between reverse gear shaft, and needle bearing, bearing spacer and reverse gear after assembly			—	0.12 {0.0047}	Replace
8, 20, 21	Backlash	Drive pinion gear		0.08 to 0.26 {0.0031 to 0.01}	0.5 {0.020}	Replace gear P22B-54
		4th gear		0.09 to 0.27 {0.0035 to 0.011}	0.5 {0.020}	
		3rd gear		0.09 to 0.27 {0.0035 to 0.011}	0.5 {0.020}	
		2nd gear		0.08 to 0.25 {0.0031 to 0.0098}	0.5 {0.020}	
		1st gear		0.09 to 0.27 {0.0035 to 0.011}	0.5 {0.020}	
		Reverse gear	Mainshaft side	0.09 to 0.28 {0.0035 to 0.011}	0.5 {0.020}	
			Countershaft side	0.08 to 0.25 {0.0031 to 0.0098}	0.5 {0.020}	
20	End play	4th gear		0.25 to 0.40 {0.0098 to 0.016}	0.6 {0.024}	Replace gear or thrust washer P22B-54
		3rd gear		0.25 to 0.55 {0.0098 to 0.022}	0.75 {0.030}	
		2nd gear		0.15 to 0.60 {0.0059 to 0.024}	0.8 {0.031}	
		Reverse gear		0.15 to 0.65 {0.0059 to 0.026}	0.85 {0.033}	
		1st gear		0.15 to 0.55 {0.0059 to 0.022}	0.75 {0.030}	

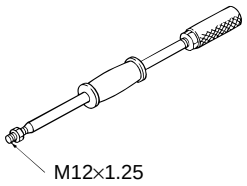
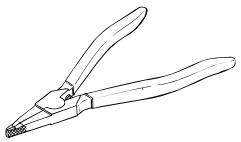
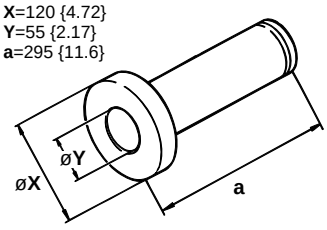
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

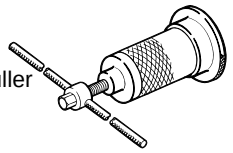
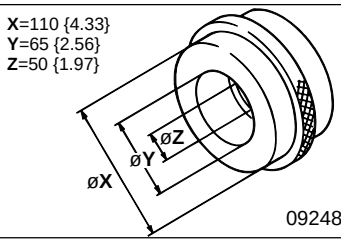
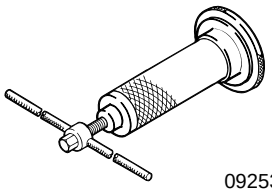
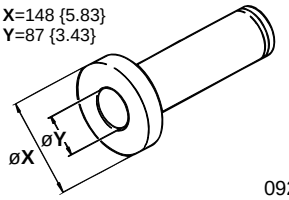
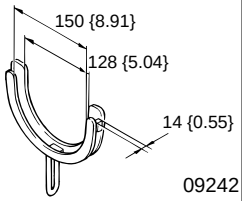
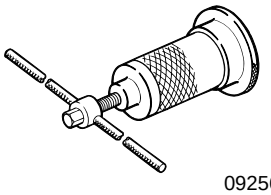
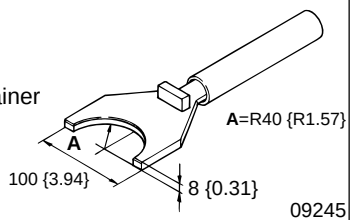
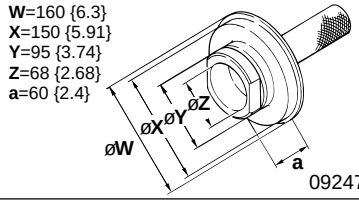
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Reverse shaft lock piece mounting)	40 {30, 4.1}	—
13	Bolt (Bearing retainer mounting)	40 {30, 4.1}	—

Special tools

Unit : mm {in.}

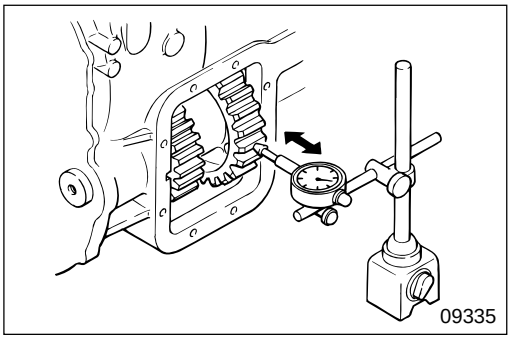
Location	Tool name and shape	Part No.	Application
4	Reverse gear shaft puller  02118	03726-82000	Removal of reverse gear shaft
9, 12, 15, 18	Snap ring expander  01137	MH061268	Removal and installation of snap ring
10, 11, 19	Mainshaft rear and countershaft bearing installer  09260	MH062076	Installation of mainshaft rear bearing and countershaft bearing

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
11	Countershaft rear bearing puller  09256	MH062098	Removal of countershaft rear bearing
	Dummy bearing  09248	MH061612	Installation of countershaft rear bearing
16	Drive pinion bearing puller  09253	MH061635	Removal of drive pinion bearing
16, 17	Drive pinion bearing installer  09260	ME650584	Installation of drive pinion bearing, installation of drive pinion in transmission case
	Synchronizer ring holder  09242	ME650566	Supporting of 4th and 5th synchronizer ring
19	Mainshaft bearing puller  09256	MH062099	Removal of mainshaft rear bearing
	Dummy bearing retainer  09245	MH061627	Blocking of movement of mainshaft when installing mainshaft rear bearing
	Dummy bearing  09247	MH061620	Installation of mainshaft rear bearing

◆ Service procedure

● Inspection before disassembly

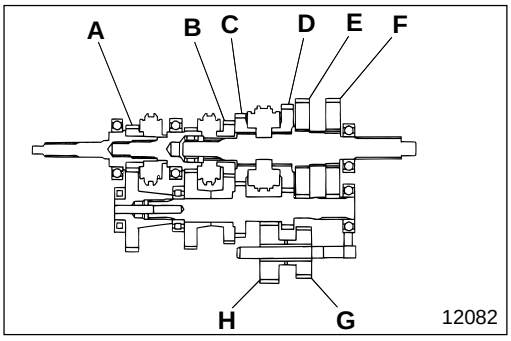


(1) Clearance in the diameter direction after assembling reverse gear

If the measured value is higher than the limit, replace the faulty parts. Also inspect this item after assembly and make sure that the measured value is within the limit.

CAUTION

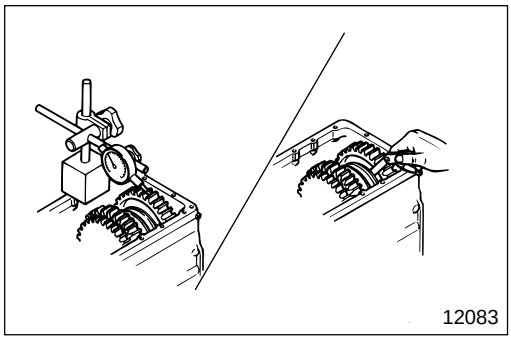
Be sure when you replace two needle bearings of a gear, that both needle bearings are from the same color package.

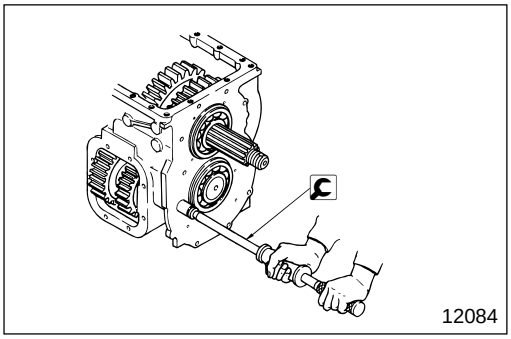


(2) Backlash and end play of gears

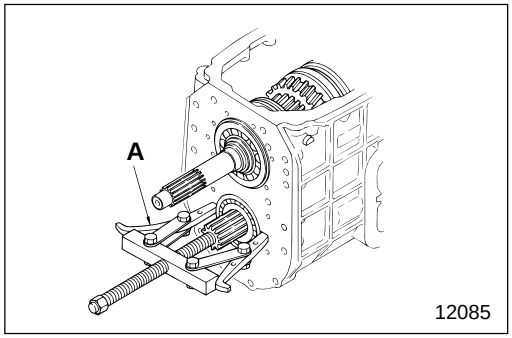
A : Drive pinion gear
B : 4th gear
C : 3rd gear
D : 2nd gear
E : Mainshaft reverse gear
F : 1st gear
G : Reverse gear (Mainshaft side)
H : Reverse gear (Countershaft side)

If the measured value is higher than the limit, replace the faulty parts. Also inspect this item after assembly and make sure that the measured value is within the limit.



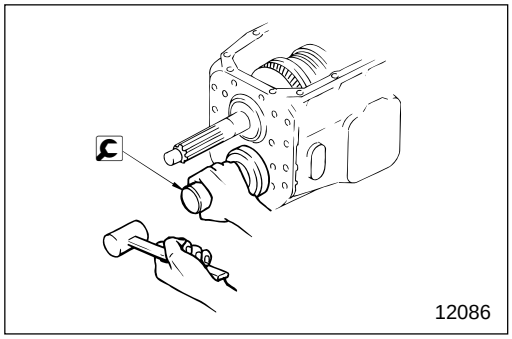


4 Removal of reverse gear shaft

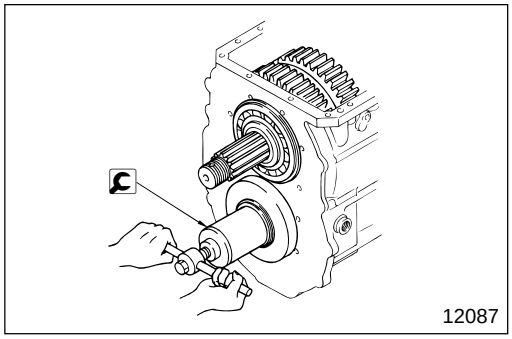


10 **Countershaft front bearing**

[Removal]
Remove countershaft front bearing **10** from transmission case **22** using a commercial gear puller of appropriate size.
A : Gear puller

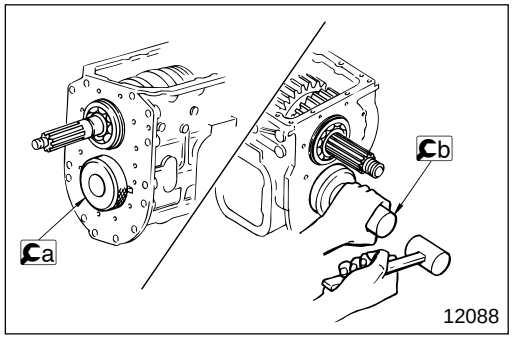


[Installation]

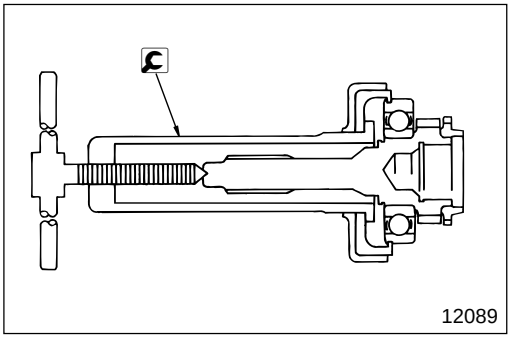


11 **Countershaft rear bearing**

[Removal]

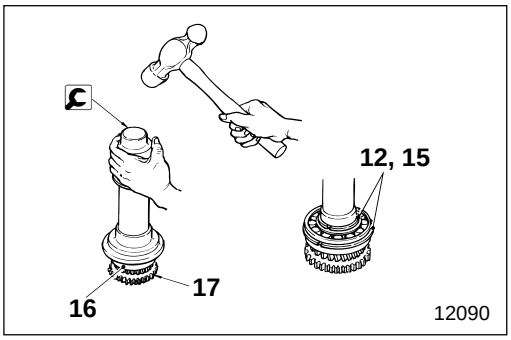


[Installation]
- Support the front end of countershaft **21** using a dummy bearing.
- Install countershaft rear bearing **11** in transmission case **22** using b mainshaft rear and countershaft bearing installer.



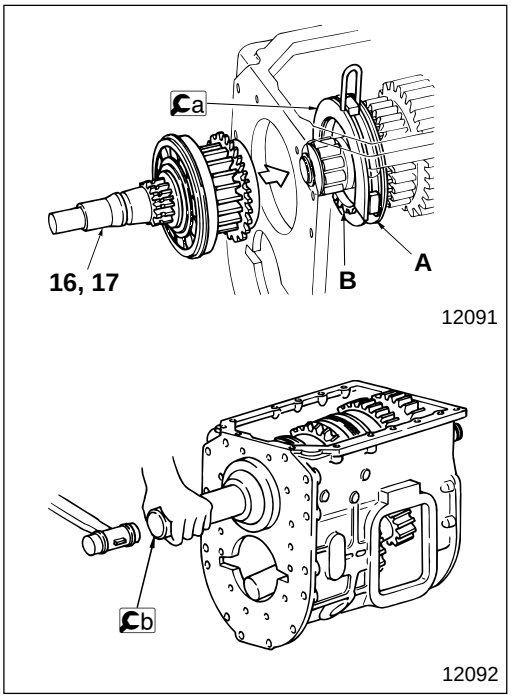
16 Drive pinion bearing

[Removal]



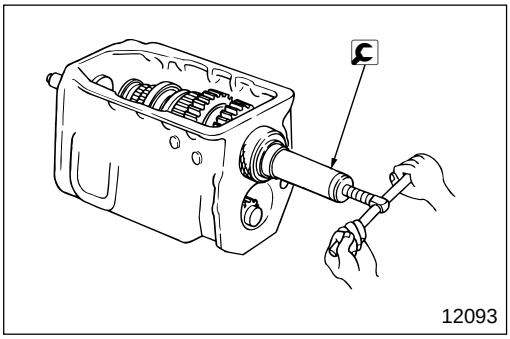
[Installation]

- Install drive pinon bearing **16** on drive pinion **17**.
- Install snap rings **12**, **15** on drive pinion bearing **16** and drive pinion **17** respectively.



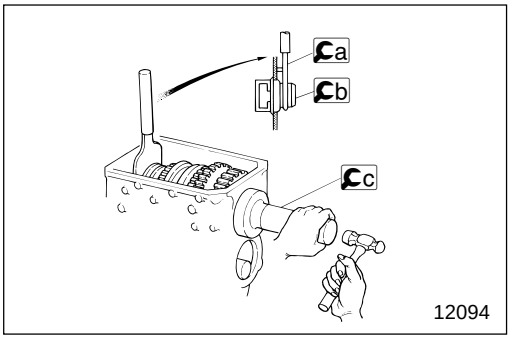
17 Installation of drive pinion

- When installing drive pinion **17** install a synchronizer ring holder to support synchronizer ring **A** and synchronizer sleeve **B**.
- Install drive pinon **17** in transmission case **22** using b drive pinion bearing installer.



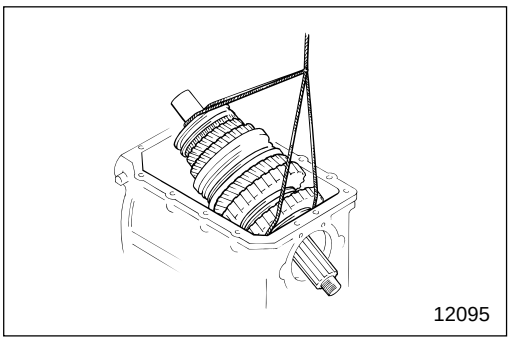
19 **Mainshaft rear bearing**

[Removal]



[Installation]

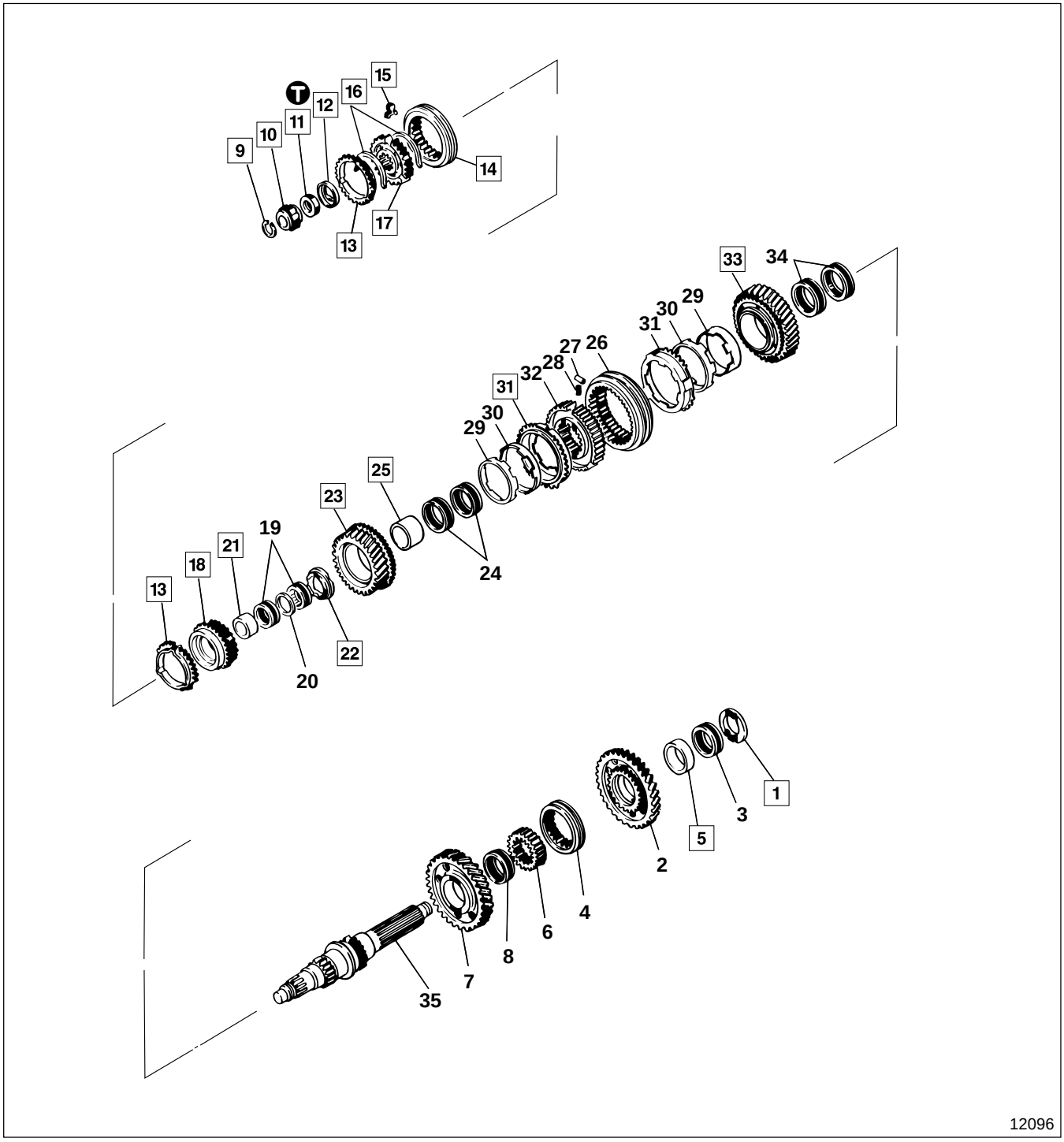
- Support the front end of mainshaft **20** using a dummy bearing retainer and b dummy bearing.
- Install mainshaft rear bearing **19**, on which snap ring **18** was installed, in transmission case **22** using c mainshaft rear and countershaft bearing installer.



20 **Removal and installation of mainshaft**

M E M O

MAINSHAFT ASSEMBLY



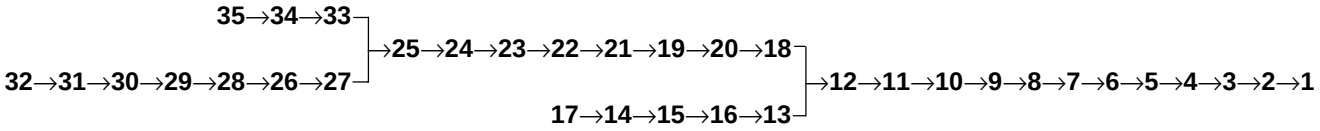
● **Work before disassembly**

📖 P22B-57

● **Disassembly sequence**

1 1st gear thrust washer
2 Mainshaft 1st gear
3 Needle bearing
4 1st and reverse constant mesh sleeve
5 1st gear bearing sleeve
6 1st and reverse constant mesh hub
7 Mainshaft reverse gear
8 Needle bearing
9 Snap ring
10 Pilot bearing
11 Lock nut
12 Lock washer
13 Synchronizer ring
14 Synchronizer sleeve
15 Shifting key
16 Shifting key spring
17 Synchronizer hub
18 4th gear assembly
19 Needle bearing
20 Bearing spacer
21 4th gear bearing sleeve
22 Thrust washer
23 3rd gear assembly
24 Needle bearing
25 3rd gear bearing sleeve
26 Synchronizer sleeve
27 Shifting key
28 Shifting key spring
29 Synchronizer inner ring
30 Synchronizer center cone
31 Synchronizer outer ring
32 Synchronizer hub
33 2nd gear assembly
34 Needle bearing
35 Mainshaft

● **Assembly sequence**



MAINSHAFT ASSEMBLY

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
2, 3, 5, 35	Play in the diameter direction after assembling 1st gear	—	0.12 {0.0047}	Replace
5	Outer diameter of 1st gear bearing sleeve	[85] –0.030 to –0.043 {[3.35] –0.0012 to –0.0017}	-0.10 {-0.0039}	Replace
8, 7, 35	Play in the diameter direction after assembling reverse gear	—	0.12 {0.0047}	Replace
10, 35	Play in the diameter direction after assembling pilot bearing	—	0.12 {0.0047}	Replace
13, 17	Clearance between synchronizer ring and synchronizer hub	4.8 to 5.4 {0.19 to 0.21}	6.5 {0.26}	Replace
13, 18	Clearance between synchronizer ring and 4th gear assembly cone	2.5 {0.0098}	0 {0}	Replace
14, 17	Play in the diameter direction between synchronizer sleeve and synchronizer hub	0.06 to 0.14 {0.0024 to 0.0055}	0.3 {0.012}	Replace
15, 17	Clearance between shifting key and synchronizer hub	0.05 to 0.35 {0.0020 to 0.14}	0.5 {0.020}	Replace
18, 19, 20, 35	Play in the diameter direction after assembling 4th gear assembly	—	0.12 {0.047}	Replace
21	Outer diameter of 4th gear bearing sleeve	[61] –0.030 to –0.043 {[2.4] –0.0012 to –0.0017}	-0.10 {-0.0039}	Replace
23, 31	Clearance between 3rd gear assembly cone and synchronizer outer ring	2 {0.079}	0 {0}	Replace
23, 24, 25, 35	Play in the diameter direction after assembling 3rd gear assembly	—	0.12 {0.047}	Replace
25	Outer diameter of 3rd gear bearing sleeve	[76] –0.030 to –0.043 {[2.99] –0.0012 to –0.0017}	-0.10 {0.0039}	Replace
26, 32	Play in the rotating direction between synchronizer sleeve and synchronizer hub	0.062 to 0.174 {0.0024 to 0.0069}	0.3 {0.012}	Replace
31, 32	Clearance between synchronizer outer ring and synchronizer hub	4.8 to 5.4 {0.19 to 0.21}	6.5 {0.26}	Replace
31, 33	Clearance between synchronizer outer ring and 2nd gear assembly cone	2 {0.079}	0 {0}	Replace
33, 34, 35	Play in the diameter direction after assembling 2nd gear assembly	—	0.12 {0.047}	Replace

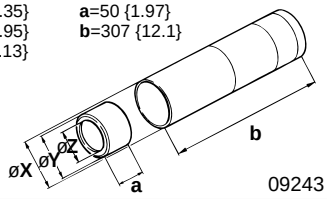
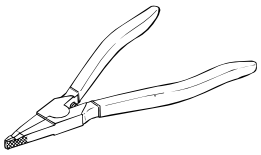
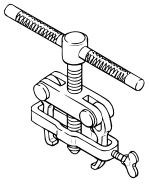
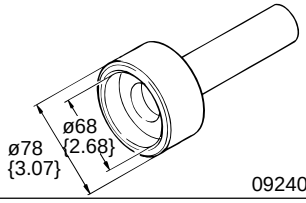
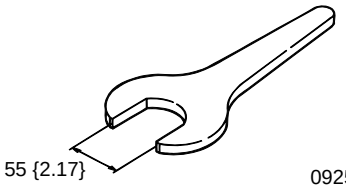
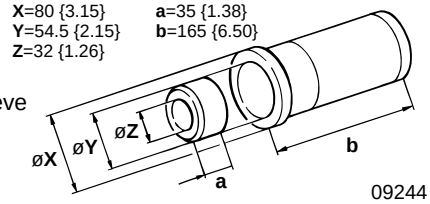
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

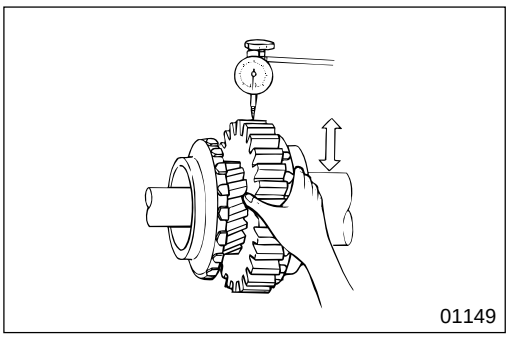
Location	Parts to be tightened	Tightening torque	Remarks
11	Lock nut	430 to 590 {97 to 130, 44 to 60}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Bearing sleeve installer 	ME650586	Installation of 1st gear bearing sleeve
9	Snap ring expander 	MH061268	Removal and installation of snap ring
10	Pilot bearing puller 	MH061043	Removal of pilot bearing
	Pilot bearing installer 	44490-51400	Installation of pilot bearing
11	Single spanner 	MH061551	Removal and installation of lock nut
21, 25	Bearing sleeve installer 	44490-53400	Installation of 4th gear and 3rd gear bearing

◆ Service procedure



● Work before disassembly

[Inspection]

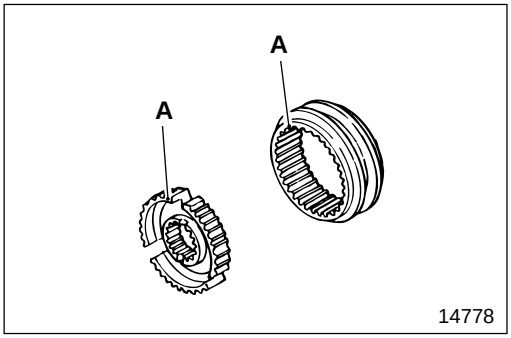
Play of gears in diameter direction

If the measured value is higher than the limit, replace the faulty parts. Also inspect this item after assembly and make sure that the measured value is within the limit.

CAUTION ⚠

Be sure when you replace two needle bearings of a gear, that both needle bearings are from the same color package.

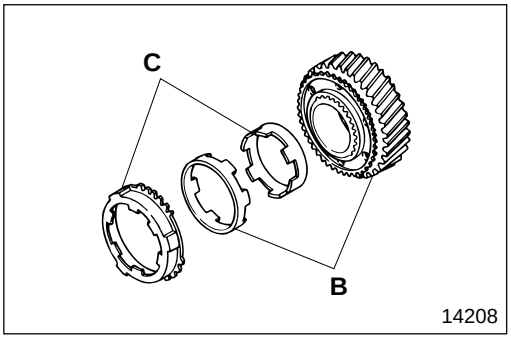
MAINSHAFT ASSEMBLY



[Alignment marks]

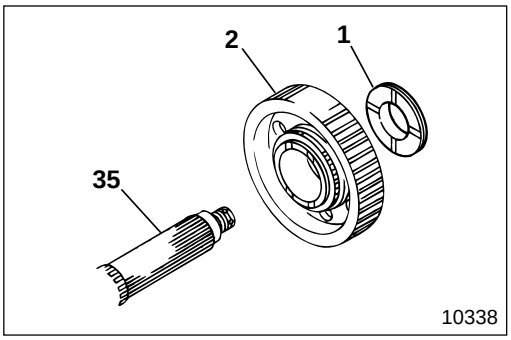
(1) Synchronizer sleeve and synchronizer hub

Before disassembling the synchronizer sleeve and the synchronizer hub, put alignment marks **A** on the places where the shifting keys are installed. When reusing parts, align the alignment marks to assemble.



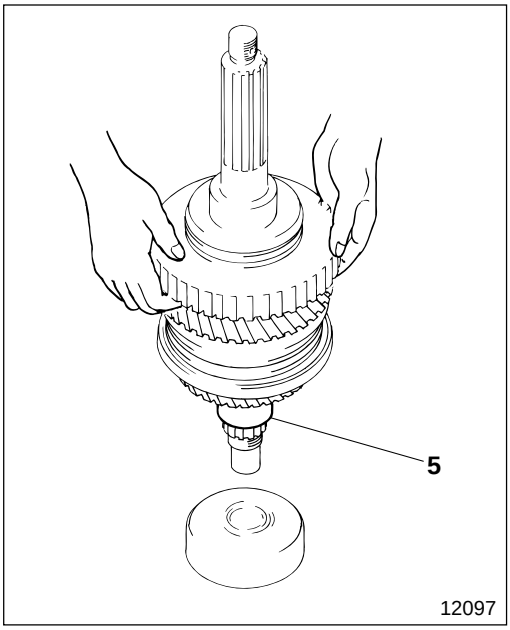
(2) Ring, cone and gear assembly of double cone synchronizer

Before disassembling synchronizer center cone and gear assembly (**B**), and synchronizer center ring and synchronizer outer ring (**C**), put alignment marks on them. When reusing parts, align the alignment marks to assemble.



1 Installation of 1st gear thrust washer

Install 1st gear thrust washer **1** onto mainshaft **35** in the direction as illustrated.



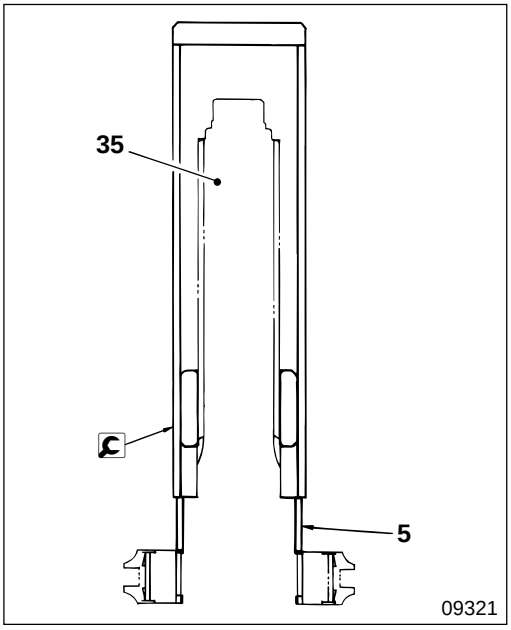
5 21 25 1st, 4th and 3rd gear bearing

[Removal]

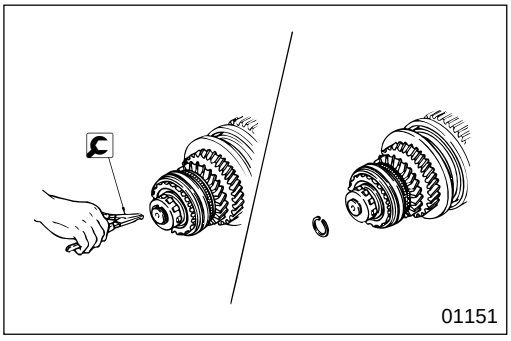
Drop mainshaft **35** on a lead block to remove bearing sleeves **5, 21, 25,** making use of the weight of the gears.

CAUTION

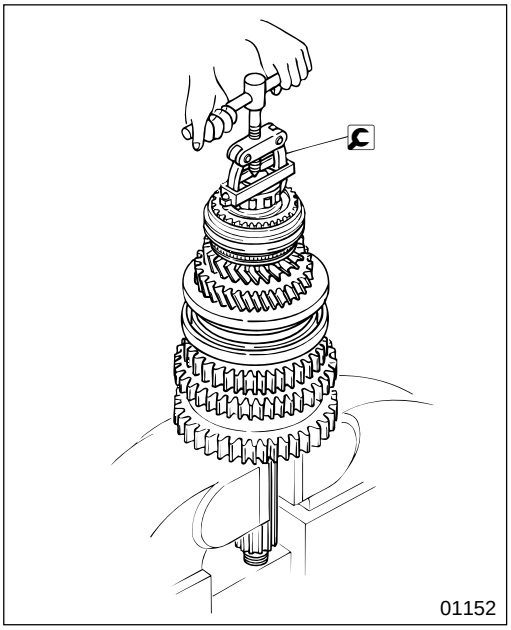
Make sure you use a lead block and be careful you do not damage the end of mainshaft 35.



[Installation]

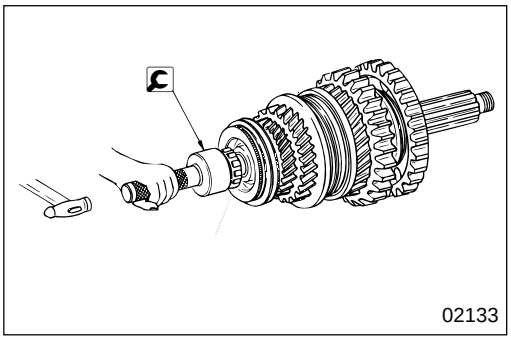


9 Removal and installation of snap ring

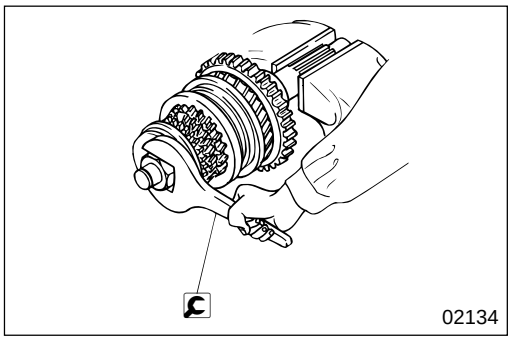


10 Pilot bearing

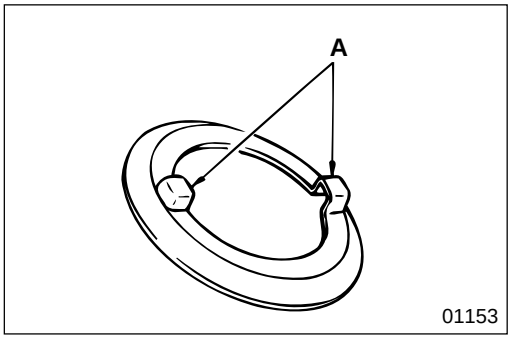
[Removal]



[Installation]

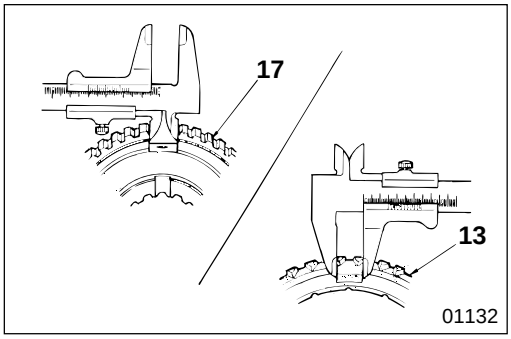


11 Removal and installation of lock nut



12 Installation of lock washer

Align protrusions **A** (two points as illustrated) with the grooves of synchronizer hub **17**.

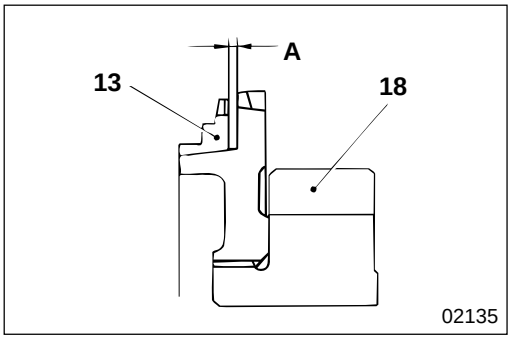


13 to 18 Synchromesh mechanism and 4th gear

[Inspection]

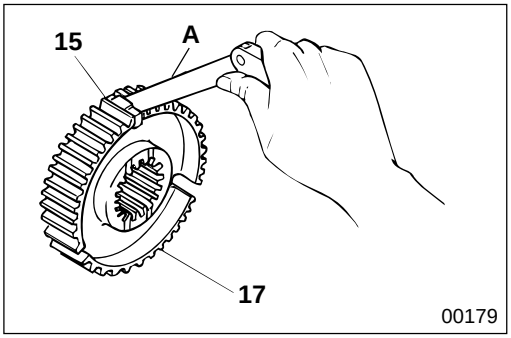
(1) Clearance between the protrusion of synchronizer ring 13 and the groove of synchronizer hub 17

If the measured value is higher than the limit, replace the faulty parts.



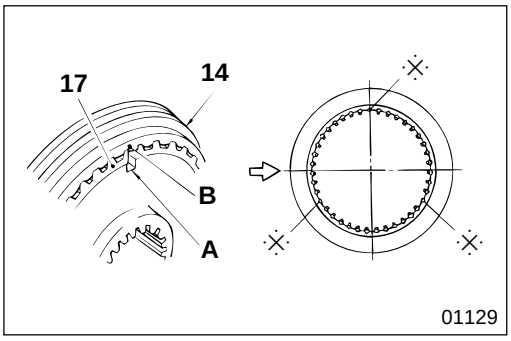
(2) Clearance between synchronizer ring 13 and 4th gear assembly 18 or drive pinion

- Measure clearance **A** between synchronizer ring **13** and the gear cone of 4th gear assembly **18** or drive pinion.
- When measuring this value, press synchronizer ring **13** evenly **1** and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.



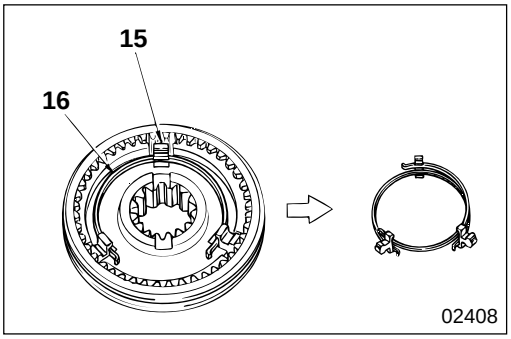
(3) Clearance between shifting key 15 and synchronizer hub 17

If the measured value is higher than the limit, replace the faulty parts.
A : Feeler gauge

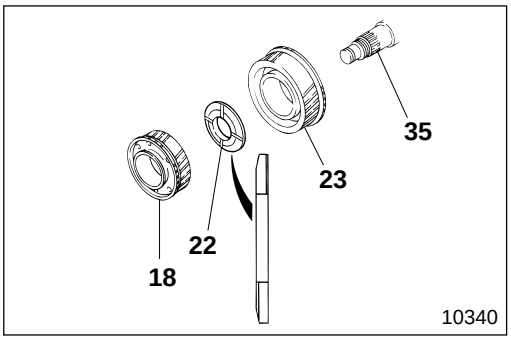


[Installation]

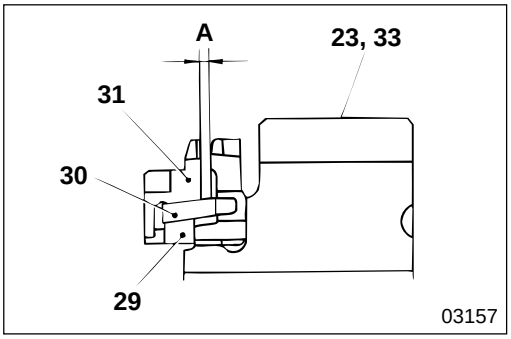
- Align the three keyways **A** of synchronizer hub **17** with the three stub teeth **B** (illustrated by ·⁜· mark) of synchronizer sleeve **14** to install the synchronizer hub.
- To reassemble synchronizer hub **17** and synchronizer sleeve **14**, align the alignment marks made during disassembly.



- Insert shifting key **15** into the keyway.
- Install shifting key spring **16** so that its opening is offset from the one on the shifting key.
- Make sure that the openings of shifting key springs **16** do not align with each other.



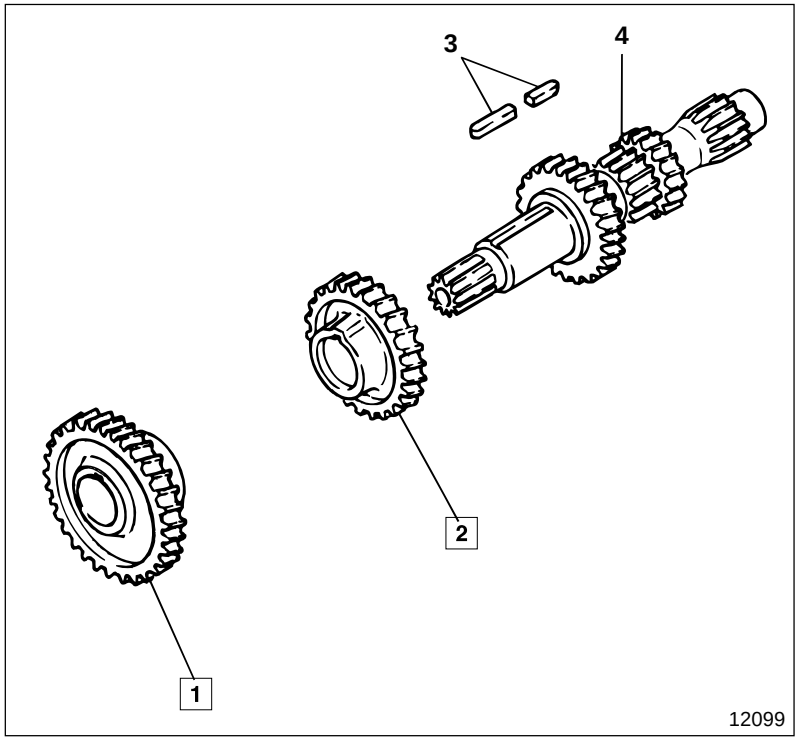
22 Installation of thrust washer



23 31 33 Clearance between synchronizer outer ring and 3rd gear assembly or 2nd gear assembly

- Measure clearance **A** between synchronizer outer ring **31** and 3rd gear assembly **23** or 2nd gear assembly cone **33**.
- When measuring this value, press synchronizer inner ring **29**, synchronizer center cone **30** and synchronizer outer ring **31** evenly and measure all around the circumference.
- If the measured value is lower than the limit, replace the faulty parts.

COUNTERSHAFT ASSEMBLY



● **Disassembly sequence**

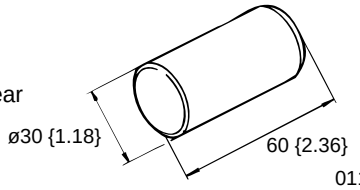
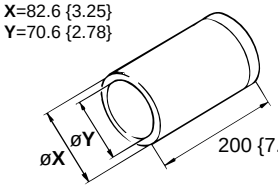
1 Countershaft constant mesh gear
2 Countershaft 4th gear
3 Sunk key
4 Countershaft

● **Assembly sequence**

Follow the disassembly sequence in reverse.

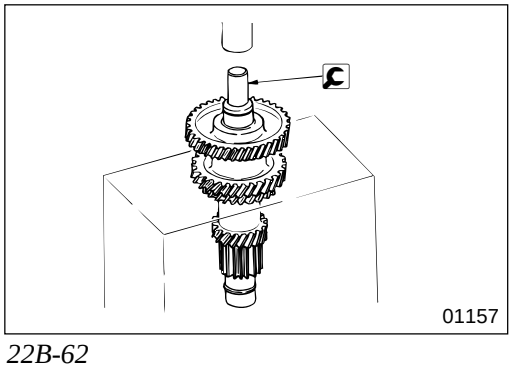
Special tools

Unit : mm {in.}

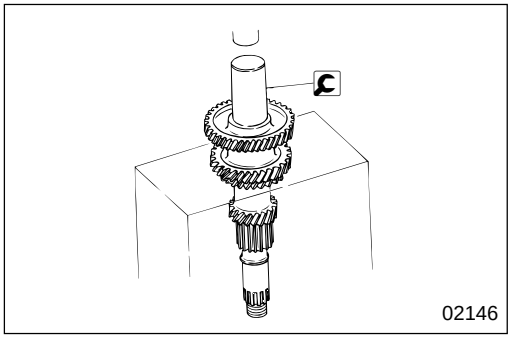
Location	Tool name and shape	Part No.	Application
1, 2	Countershaft gear puller 	ME624243	Removal of countershaft gear
	Countershaft gear installer 	44590-56100	Installation of countershaft gear

◆ Service procedure

1 **2** **Countershaft constant mesh gear and countershaft 4th gear**

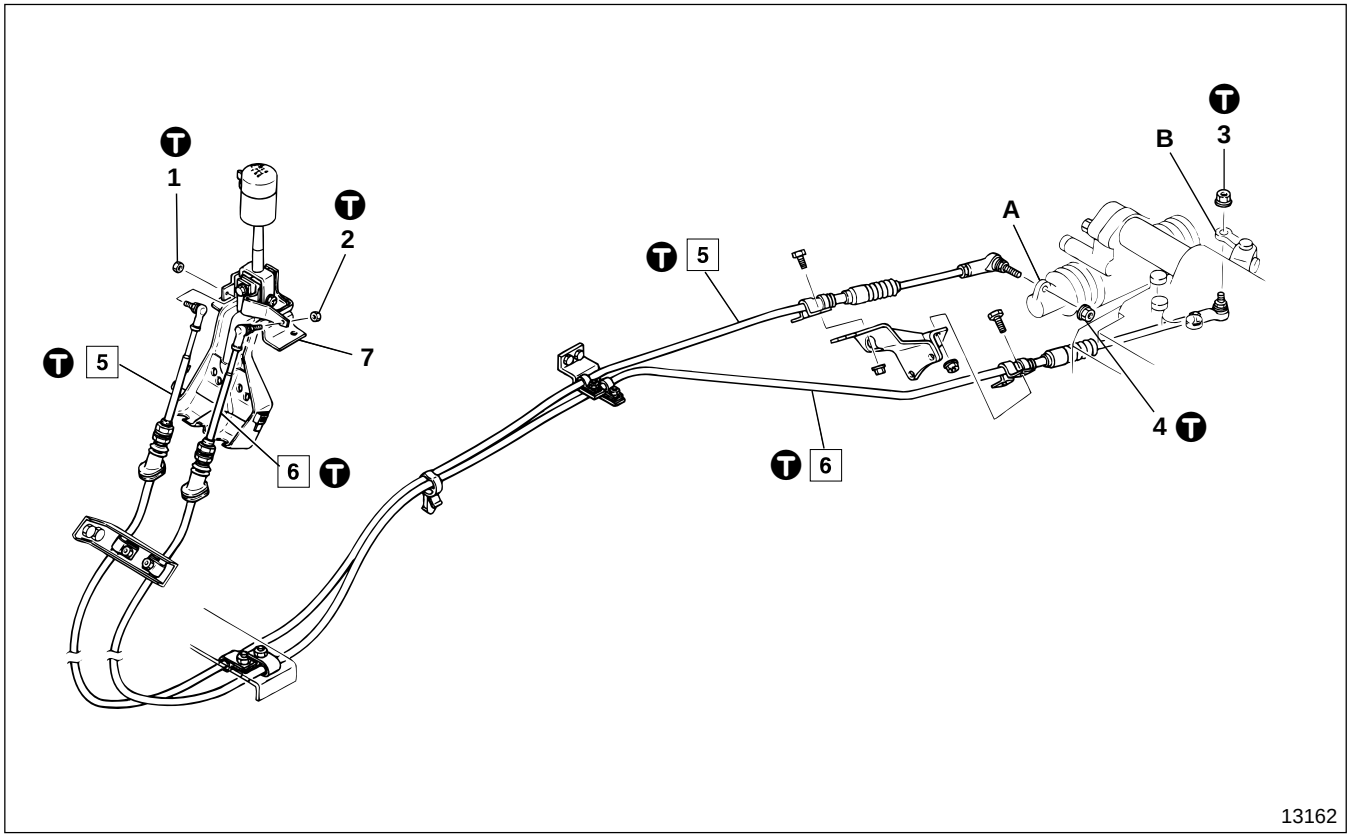


[Removal]
Use a press.



[Installation]
Use a press.

TRANSMISSION CONTROL



For removal and installation of the shift lever console and the floor console, refer to Gr 42

● **Disassembly sequence**

1 Nut
2 Nut
3 Nut
4 Nut
5 Shift cable
6 Select cable
7 Transmission control lever assembly P22B-67

A : Shift lever
B : Select lever

● **Assembly sequence**

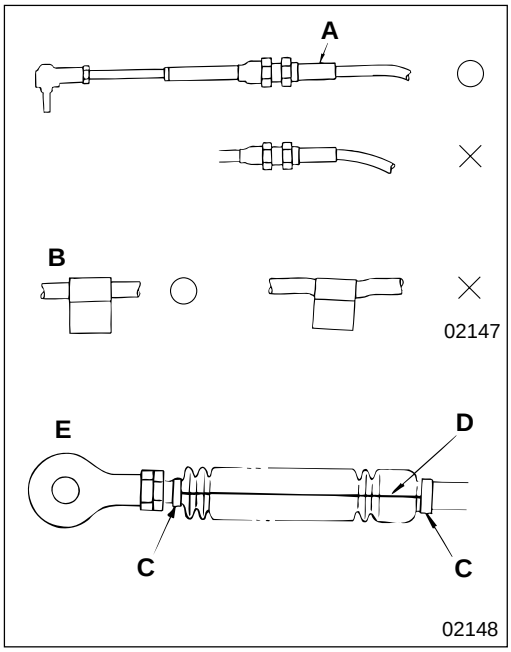
Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1 to 4	Nut (Ball joint or rubber damper mounting)	19 to 24 {14 to 17, 1.9 to 2.4}	—
5, 6	Tightening of cable lock nut	59 to 83 {43 to 61, 6 to 8.5}	—

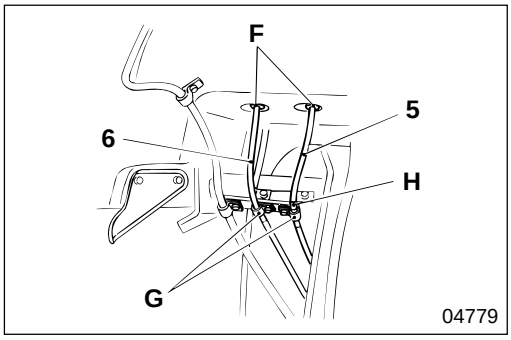
◆ Service procedure



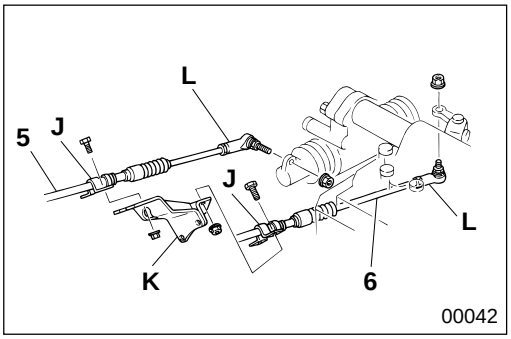
5 **6** **Installation of shift cable and selector cable**

CAUTION⚠

- **Install casing cap A lengthwise.**
- **Make sure the radius of the bend is 200 mm {7.87 in.} or more.**
- **Make sure the cable operates smoothly.**
- **Install the clamp vertically against the cable. (Figure B)**
- **Do not twist clamps C at both ends of the boot. Make sure that white line D on the boot is straight. (Figure E)**



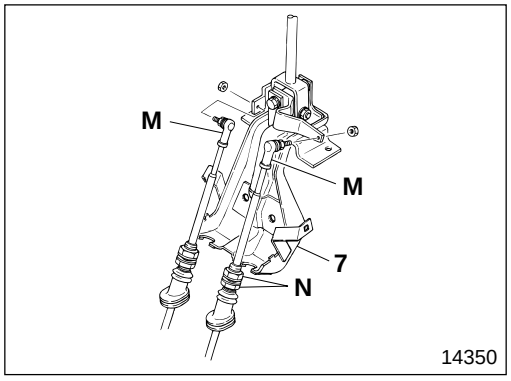
- Insert shift cable **5** and selector cable **6** under the cab floor and clamp them in the correct place by identifying identification mark **H** on the shift cable. (The selector cable has no identification mark.)
  F : Grommet
  G : Clip



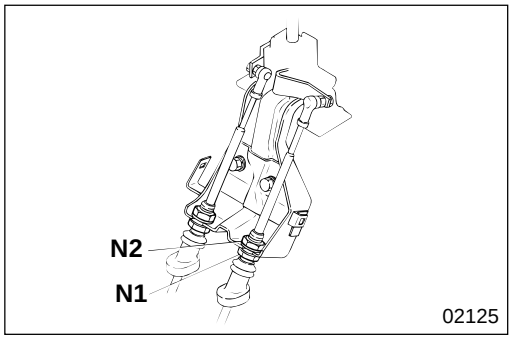
- Install cable clip **J** to bracket **K** temporarily and connect ball joint **L** to the shift lever or selector lever.
- Arrange the cable so that it not twisted, then tighten clip **J** permanently.

CAUTION⚠

Make sure the identification marks on the cable, ball joint L point in the right direction when you install the cables. Installing the cables with the identification marks in the wrong direction can remarkably reduce the durability of the cables.



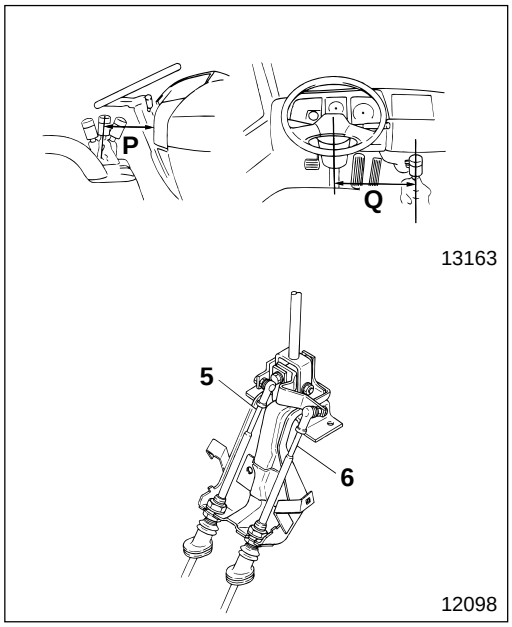
- Tilt the cab down.
- Install the cable on transmission control lever assembly **7** temporarily and connect ball joint **M** to shift lever and selector lever.
- Arrange the cable so that it is not twisted, then tighten lock nuts **N** permanently.



CAUTION⚠

- **Make sure that ball joint P faces the correct direction.**
- **When installing the lock nut, tighten lower nut N1. Do not move nut N2.**

- Make sure when you operate the gear shift lever that it shifts smoothly and selects each position.



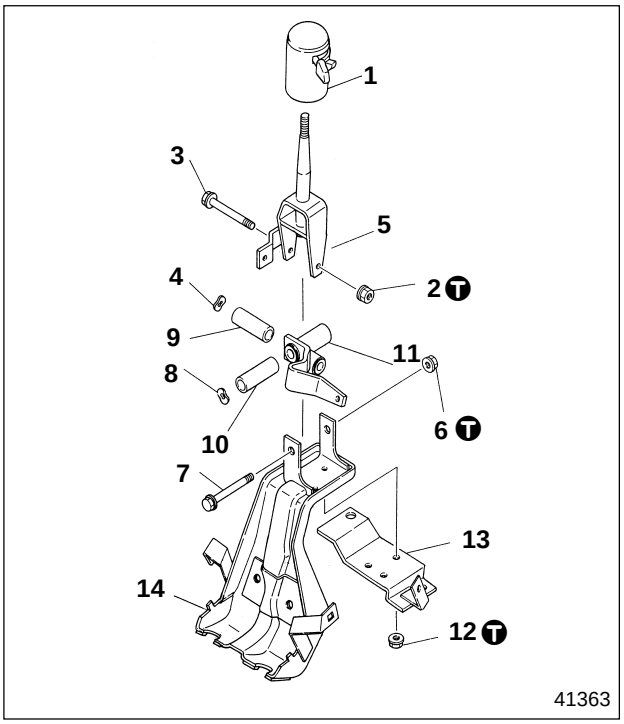
- If the gear shift lever leans to the front or rear, or to the left or right, excessively, adjust the length of the cable.
- When positioning the gear shift lever, use the distance from the center of the steering wheel or from the instrument panel as the reference distance.

Unit : mm {in.}

Front and rear direction **P** (Distance from the instrument panel)	Left and right direction **Q** (Distance from the steering wheel center)
214 {8.43}	409 {16.1} (4th and 5th gear position)

	Shift cable **5**	Selector cable **6**
To front	Shorten	—
To rear	Lengthen	—
To left	—	Shorten
To right	—	Lengthen

Transmission Control Lever Assembly



● **Disassembly sequence**

1 Air control valve 📖 P22B-69
2 Nut
3 Bolt
4 Washer
5 Shift lever
6 Nut
7 Bolt
8 Washer
9 Collar
10 Collar
11 Select lever
12 Nut
13 Bracket
14 Set board

● **Assembly sequence**

14→13→12
11→10→9 → **8→7→6→5→4→3→2→1**

T Tightening torque

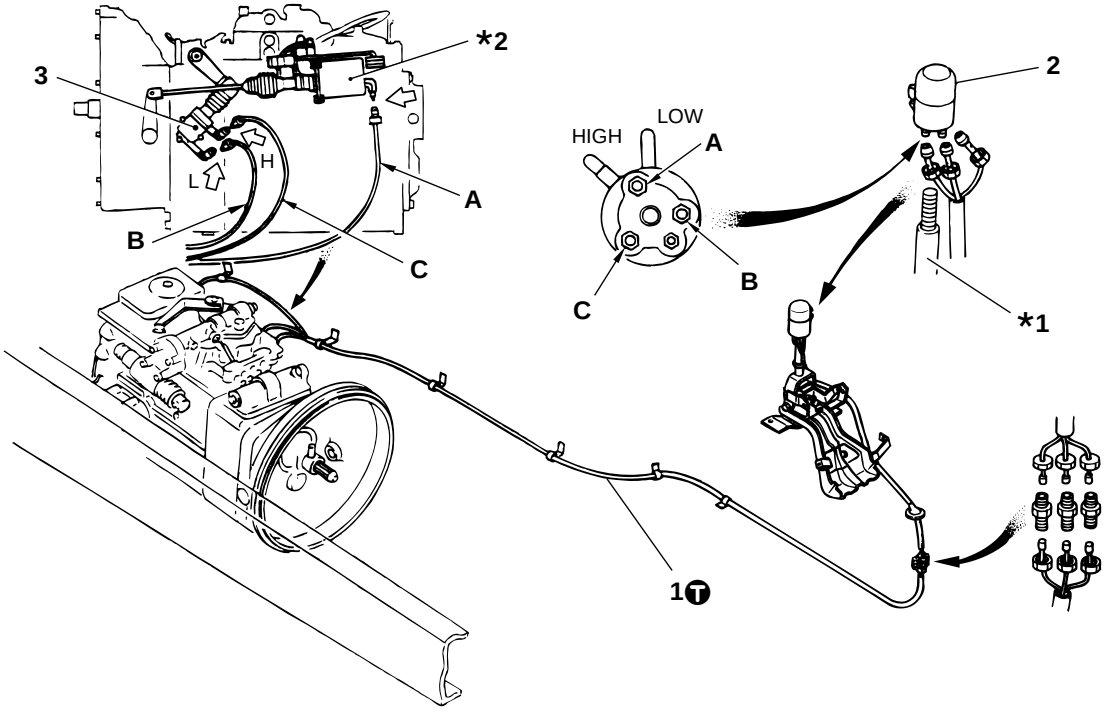
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (Shift lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
6	Nut (Selector lever mounting)	19 to 28 {14 to 21, 1.9 to 2.9}	—
12	Nut (Bracket mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	All sliding areas	Chassis grease [NLGI No.1 (Ca soap)]	As required

SPLITTER CONTROL



● **Removal sequence**

1 Air tube
2 Air control valve 📖 P22B-69
3 Power cylinder 📖 P22B-45

***1** : Gear shift lever
***2** : Clutch booster
A : Blue tube

B : Black tube
C : Yellow tube

CAUTION⚠

Protect tubes from dust by fitting blanking plugs after removal.

● **Installation sequence**

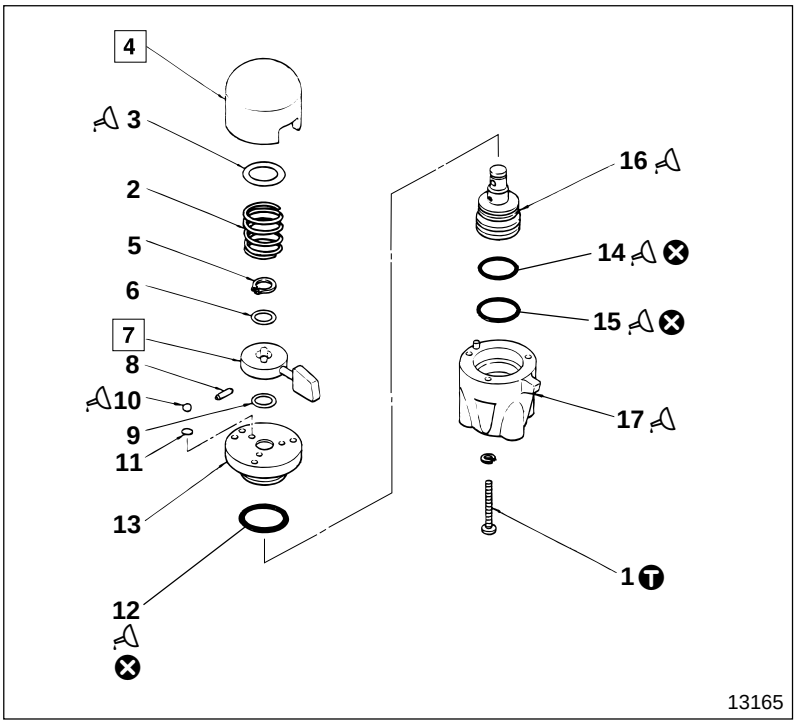
Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Air tube connector	4.9 to 6.9 {3.6 to 5.1, 0.5 to 0.7}	—

Air Control Valve



● **Disassembly sequence**

1 Screw
2 Detent spring
3 Spring seat
4 Cover
5 Snap ring
6 Shim
7 Lever
8 Pin
9 Shim
10 Steel ball
11 Detent seat
12 O-ring
13 Valve cover
14 O-ring
15 O-ring
16 Valve piston
17 Valve body

⊗ : Non-reusable parts

● **Assembly sequence**

17, 16→15→14, 13→12 → 9→8→11→10→7→6→5→4→3→2→1

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
4, 7	Clearance between cover and lever	$0.6\ ^{+0.3}_{0}$ {$0.024\ ^{+0.012}_{0}$}	—	Adjust with shim

Ⓣ Tightening torque

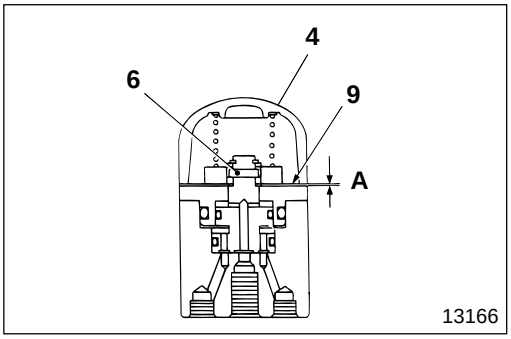
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Screw (Cover mounting)	1.0 to 1.5 {0.7 to 1.1, 0.1 to 0.15}	—

SPLITTER CONTROL

Lubricant

Location	Points of application	Kinds	Quantity
3	Spring seat	Multipurpose grease [NLGI No.3 (Li soap)]	As required
10	Steel ball	Multipurpose grease [NLGI No.3 (Li soap)]	As required
12, 14, 15	O-ring	Silicon grease	As required
16	Friction surfaces between valve piston and valve cover	Multipurpose grease [NLGI No.3 (Li soap)]	As required
17	Valve seat surface of valve body	Silicon grease	As required



◆ Service procedure

4 **7** **Adjustment of clearance between cover and lever**

After assembling air control valve assembly, measure clearance **A** between cover **4** and lever **7**.
If the measured value deviates from the standard value, adjust with shims **6, 9**.

MITSUBISHI
FUSO

Group 23A

Automatic Transmission

< FK617, FM617 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-23A

INDEX

SPECIFICATIONS 23A- 2

STRUCTURE AND OPERATION 23A- 3

TROUBLESHOOTING 23A- 6

ON-VEHICLE INSPECTION AND ADJUSTMENT 23A- 8

WORK BEFORE REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23A-11

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY 23A-12

OIL SEAL AND SPEEDOMETER WORM 23A-16

OIL PAN AND OIL FILTER 23A-19

AUTOMATIC TRANSMISSION CONTROL 23A-20

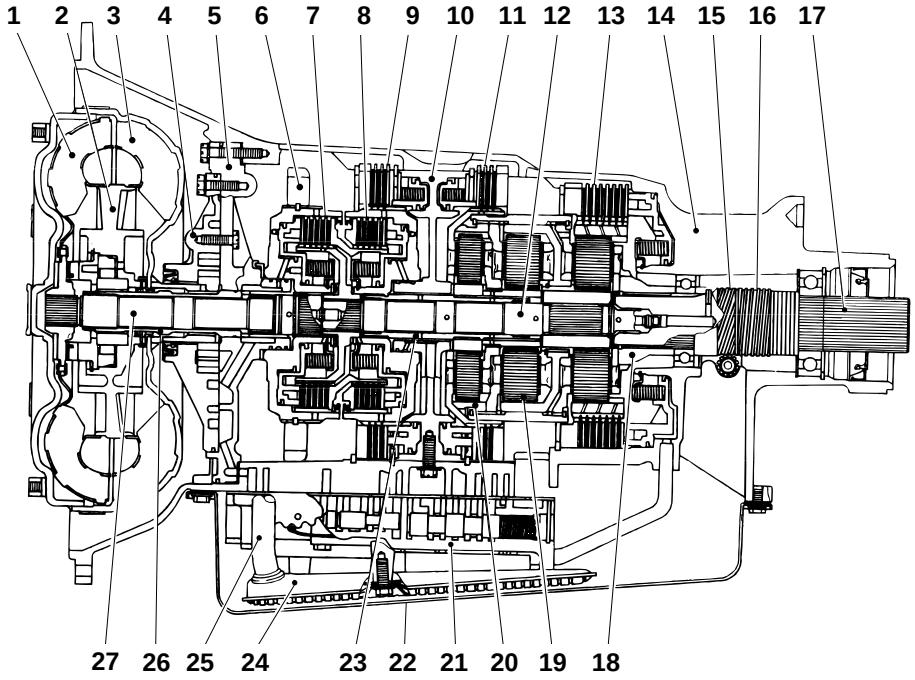
OIL COOLER 23A-26

OIL FILTER 23A-28

SPECIFICATIONS

Item			Specifications	
Vehicle model			FK617	FM617
Type			M4A4 (Allison AT542)	M4A4 (Allison AT545)
Torque converter	Type Stall torque ratio		3-element, 1-stage, 2-phase 1.72	←
Transmission	Type		Planetary gear type 4 forward speeds, 1 reverse speed	←
	Gear ratio	1st	3.454	←
		2nd	2.253	←
		3rd	1.407	←
		4th	1.000	←
		Reverse	5.024	←
Range selector pattern			R—Ⓝ—D—3—2—1 (Engine can be started in N position only)	←
Recommended fluid	Fluid quantity (except oil cooler piping) L {qts}		Automatic transmission fluid (DEXRON or DEXRON II type) 14 {15} When oil is replaced: 8.5 {9.0}	Automatic transmission fluid (DEXRON or DEXRON II type) 20.8 {22} When oil is replaced: 15 {16}
Mass < Wet > Kg {lb}			167 {368}	173 {381}
Transmission control			Floor shift remote control, cable type	←

Automatic Transmission Assembly



13919

1 Turbine
2 Stator
3 Impeller
4 Oil pump assembly
5 Front support
6 Power take-off drive gear
7 Forward clutch
8 4th clutch
9 3rd clutch
10 Center support
11 2nd clutch
12 Mainshaft
13 1st and reverse clutch
14 Transmission case
15 Governor drive gear
16 Speedometer sensor drive gear
17 Output shaft
18 Rear planetary gear set
19 Center planetary gear set
20 Front planetary gear set
21 Control valve assembly
22 Oil pan
23 Sun gear shaft
24 Oil filter
25 Intake pipe
26 Stator shaft
27 Turbine shaft

The automatic transmission consists of a torque converter and a fully automatic 4-speed gear system.

● **Torque converter**

The torque converter is driven by the engine crankshaft, and functions as the input device for the transmission. The torque converter also acts as the fluid coupling, absorbing shock during engine start up and gear shifting.

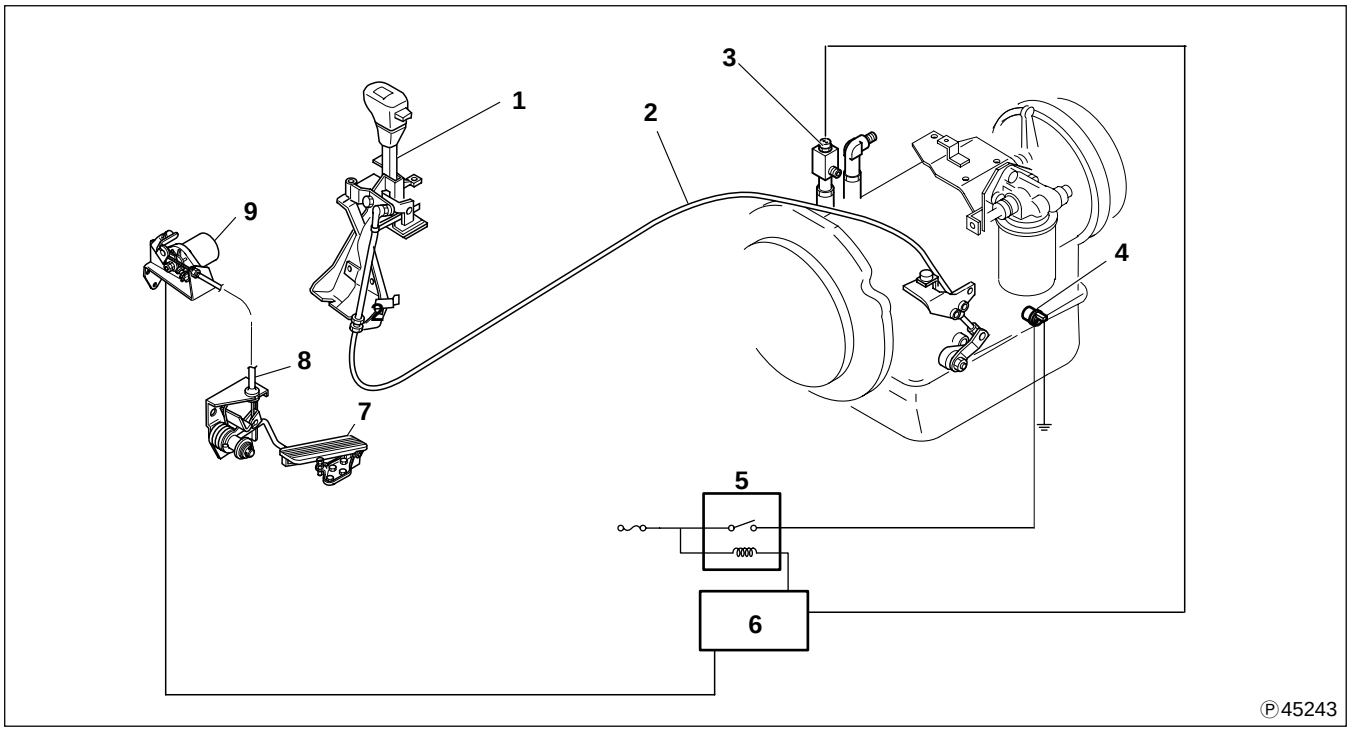
● **Transmission (4 forward speeds, 1 reverse speed)**

The transmission is accomplished by three sets of planetary gears **18**, **19**, **20** and five sets of oil pressure-operated, wet-type multiple disc clutches **7**, **8**, **9**, **11**, **13**. These oil-cooled clutch discs are self-adjusting to compensate for wear.

● **Oil pressure control area**

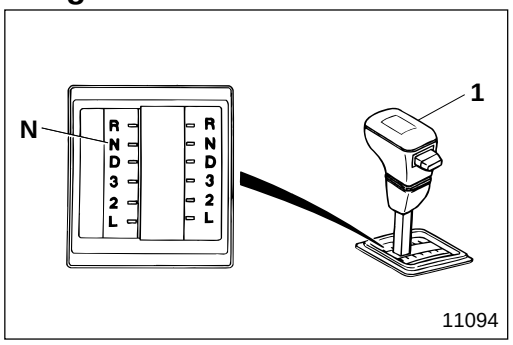
This oil pressure control area consists of oil pump **4**, control valve assembly **21** that controls the changeover between clutches **7**, **8**, **9**, **11**, and **13**, the modulator that monitors the amount the accelerator pedal is depressed, and the governor that monitors the vehicle speed. Gear shift is made automatically and depends on how much the accelerator pedal is depressed and how fast the vehicle is travelling.

Automatic Transmission Control



1 Range selector lever
2 Selector cable
3 Automatic transmission temperature sensor
4 Modulator
5 Relay
6 Engine electronic control unit
7 Accelerator pedal
8 Accelerator control cable

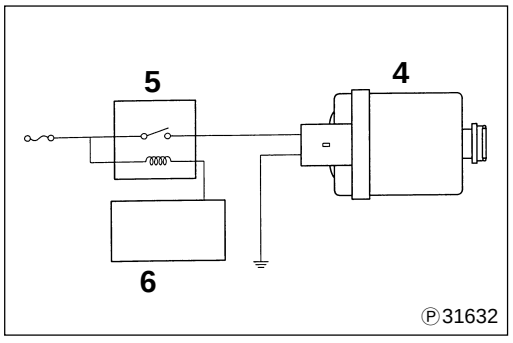
Range Selector Lever



Range selector lever **1** selects the most suitable range for the operating conditions, ensuring optimum service from the automatic transmission. Safety features are incorporated that make sure that the engine cannot be started when the range selector lever is in any position other than neutral (N).

N : Neutral

Modulator



Modulator **4** converts the amount the accelerator pedal is depressed into hydraulic pressure.

- **Outline of operating system**

  Engine electronic control unit **6** sends a signal via relay **5** to activate modulator 4 for switching between closed-throttle shift and full-throttle shift.

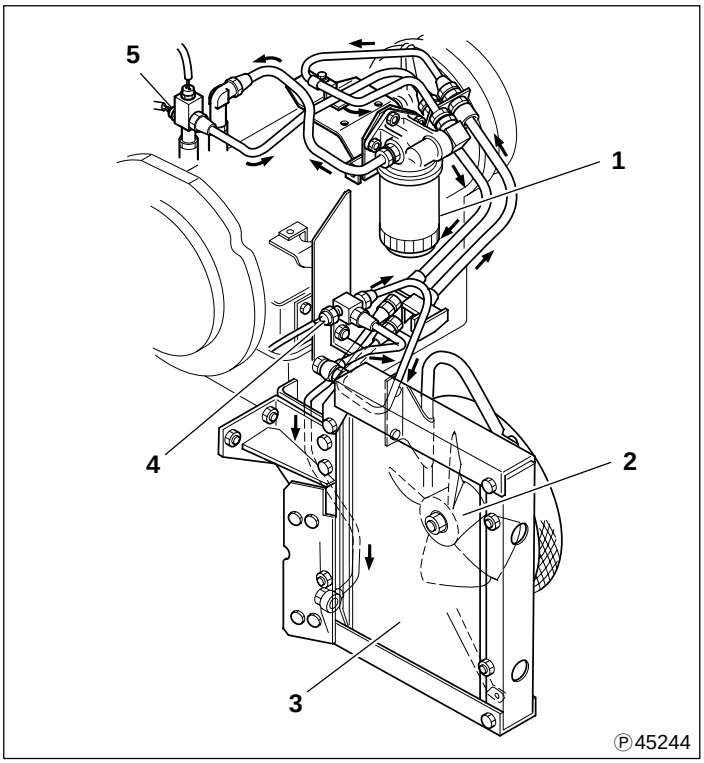
- **Operating conditions**

  Throttle opening of 85% or more: ON (Full-throttle shift)
  Throttle opening of 65% or less after ON: OFF (Closed-throttle shift)

- **Automatic transmission fluid temperature sensor**

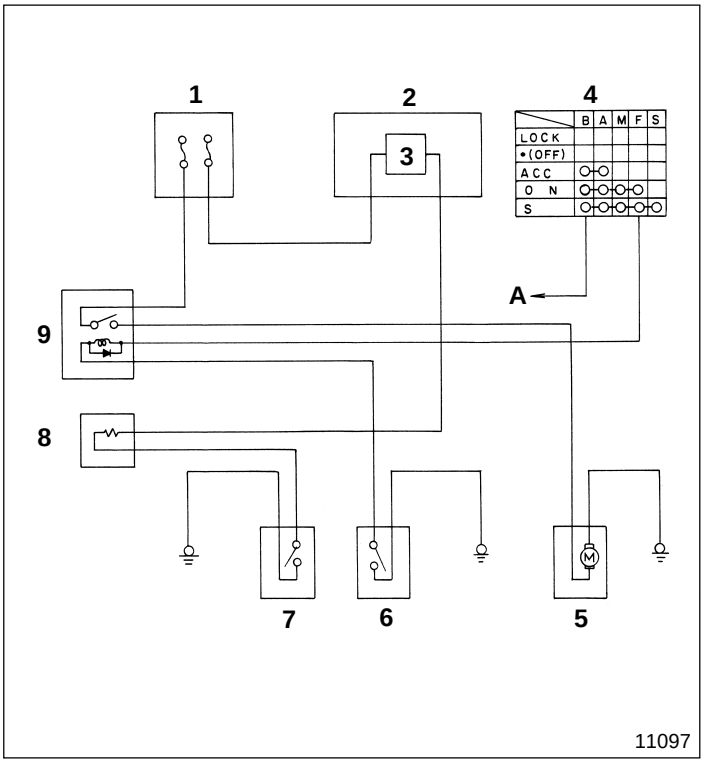
  Automatic transmission fluid temperature sensor **3** is added due to the use of engine output control mechanism which activates in high automatic transmission fluid temperature conditions.

Oil Cooler



1 Oil filter
2 Blower assembly
3 Oil cooler
4 Automatic transmission fluid thermostat switch (Oil cooler fan)
5 Automatic transmission fluid temperature switch (Warning lamp)

Oil Temperature Warning System



1 Relay and fuse box
2 Meter cluster
3 Indicator lamp
4 Starter switch
5 Automatic transmission fluid cooler fan motor
6 Automatic transmission fluid thermostat switch
7 Automatic transmission fluid temperature switch
8 Resistor
9 Automatic transmission fluid cooler fan motor relay

A : To high-current fuse box

TROUBLESHOOTING

Possible causes	Symptoms	Excessive shock when shifting from Ⓝ to Ⓓ	Engagement interval too long when shifting from Ⓝ to Ⓓ	Engine races when shifting up	Does not shift up	Kick down impossible or shifting down abnormal	Abnormal shifting	Slips out of gear while driving forward	Slips out of gear in Ⓡ position
Engine faulty	Engine idling speed too fast	○							
	Engine idling speed too slow		○						
Incorrect adjustment of cables	Selector cable adjusted incorrectly		○		○		○	○	○
	Modulator faulty	○				○			
Automatic transmission fluid unsuitable situation	Fluid level too low		○	○	○		○	○	○
	Oil filter clogged		○	○			○	○	○
	Air mixed in fluid		○	○			○	○	
	Fluid level too high								
	Oil cooler pipe damaged or deteriorated								
	Oil cooler fan malfunctioning								
Internal malfunction of automatic transmission assembly	Fluid pressure too low		○	○	○		○	○	○
	Valve body abnormality or leakage	○	○	○	○	○	○	○	○
	Oil pump malfunctioning		○				○	○	○
	Output shaft bearing or bushing damaged								
	Governor abnormal				○	○	○		
	Clutch damaged or malfunctioning		○	○	○		○	○	○
	Breather clogged								
	Fluid pressure too high	○							
	Clutch plate clearance insufficient								
	Clutch dragging								
	Planetary gear damaged or stuck								

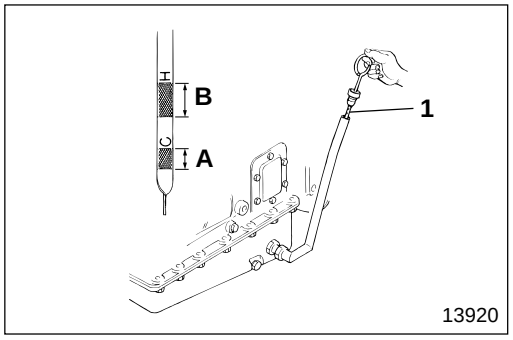
Possible causes \ Symptoms		Slips out of gear while in any position	Vehicle does not move irrespective of selector position	Vehicle does not move while selector in forward position	Vehicle does not move while selector in Ⓡ position	Vehicle moves while selector is in Ⓝ position	Scraping or squeaking noise	Humming noise	Trouble in fluid supply. Automatic transmission fluid spouting from filler tube	Excessive shock when shifting	Shift up too slow	Automatic transmission overheating
Engine faulty	Engine idling speed too fast											○
	Engine idling speed too slow											
Incorrect adjustment of cables	Selector cable adjusted incorrectly				○	○						○
	Modulator faulty									○	○	
Automatic transmission fluid unsuitable situation	Fluid level too low	○	○	○				○				○
	Oil filter clogged	○	○						○			
	Air mixed in fluid	○						○	○			
	Fluid level too high								○			
	Oil cooler pipe damaged or deteriorated											○
	Oil cooler fan malfunctioning											○
Internal malfunction of automatic transmission assembly	Fluid pressure too low	○	○	○	○					○		○
	Valve body abnormality or leakage	○	○	○	○	○		○		○	○	
	Oil pump malfunctioning	○	○									○
	Output shaft bearing or bushing damaged						○					
	Governor abnormal										○	
	Clutch damaged or malfunctioning			○	○						○	
	Breather clogged								○			
	Fluid pressure too high									○		
	Clutch plate clearance insufficient											○
	Clutch dragging					○						
	Planetary gear damaged or stuck		○	○	○		○					

ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspection of Automatic Transmission Fluid

(1) Inspection of characteristics

If the automatic transmission fluid smells burnt or if it contains metal particles or sludge as a result of internal friction and wear of metal or other material, the transmission assembly must be completely overhauled. Make sure you carefully examine the automatic transmission fluid on the dipstick. If you find the quality questionable, take a sample and examine it more closely.



(2) Inspection of automatic transmission fluid level

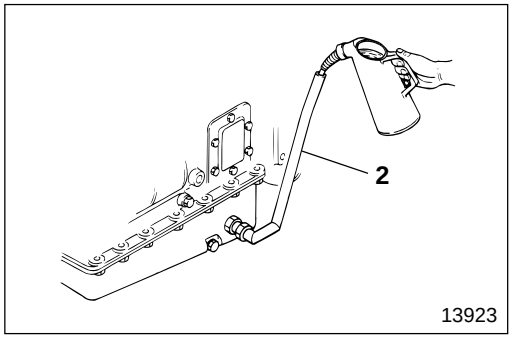
- Park the vehicle on level ground, make sure that the parking brake is fully activated and chock the wheels to keep them from rolling.
- Start the engine and let it idle. To fill the hydraulic circuit with automatic transmission fluid, shift the range selector lever from N → R → N → D → 2 → D → N. Repeat this process five times, finally shifting to N.
- While the engine is still idling, pull out dipstick **1** and wipe off the fluid sticking to it. Reinsert the dipstick, then pull it out again and check the fluid level.
- If the fluid level is inspected right after the engine is started and the fluid temperature is still low (approximately 15 to 49°C {60 to 120°F}), the level should be within area **A** marked COLD on dipstick **1**.
- If the fluid level is inspected after the vehicle has been driven and the fluid temperature is high (approximately 71 to 93°C {160 to 200°F}), the level should be within area **B** marked HOT on dipstick **1**.

WARNING⚠

Take care during the inspection because the engine will be running. Take sufficient care to avoid burns or injuries resulting from contact with moving parts.

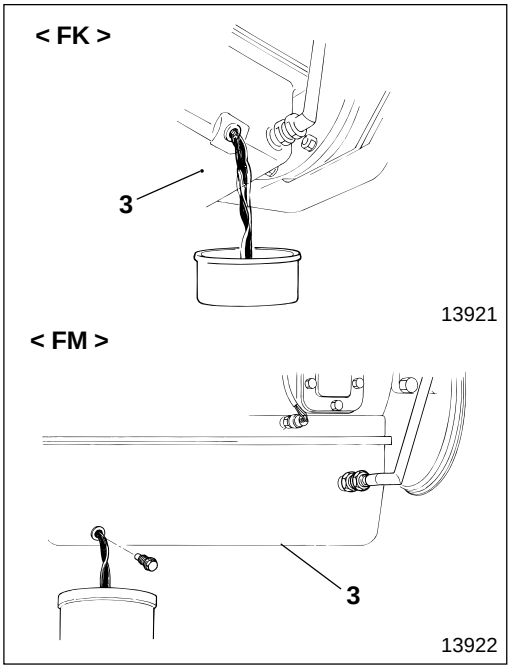
NOTE

- **Make sure the vehicle is parked on level ground when you are checking the fluid level.**
- **Make sure the selector lever is in the N position and the engine is idling when you are checking the fluid level. When the engine is stopped, the fluid level appears higher than it actually is.**
- **Be sure to wipe off the dust from the safety cap and the upper part of dipstick guide 2 before you pull out dipstick 1.**
- **To ensure the fluid is correct, reinspect the fluid level after an actual drive.**



- If the fluid level is low, add automatic transmission fluid (DEXRON or DEXRON II type) through dipstick guide **2** until the correct level on dipstick **1** is reached.

Replacement of Automatic Transmission Fluid



(1) Draining

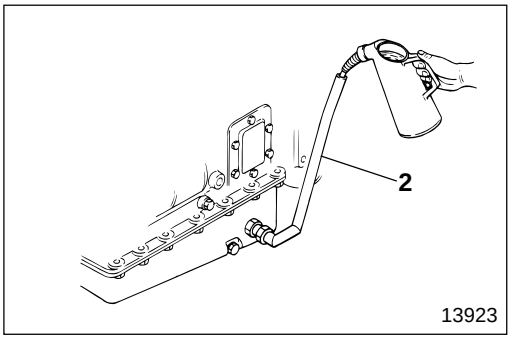
- Park the vehicle on level ground, chock the wheels and shift the selector lever to the **N** position.
- Place a container under oil pan **3**, remove the drain plug and drain the fluid.
- Clean oil pan **3** and the drain plug. Replace the oil filter. P23A-19
- Replace the outer oil filter. P23A-28

WARNING

Take care because the fluid temperature immediately after the engine has stopped is very high. To avoid scalds, wait until a safe temperature has been reached before draining the fluid.

NOTE

- **The fluid will drain faster if the engine is first run to raise the fluid temperature.**
- **The fluid cannot be drained from the hydraulic circuit, the torque converter or the oil cooler.**
- **Check the drained fluid for dirt, metal particles and metal fragments.**



(2) Refill

- Install the oil filter, oil pan **3** and the drain plug. P23A–19
- Add automatic transmission fluid (DEXRON or DEXRON II type) through dipstick guide **2**.
  FK : 8.5 L {9.0 qts}
  FM : 15 L {16 qts}

CAUTION

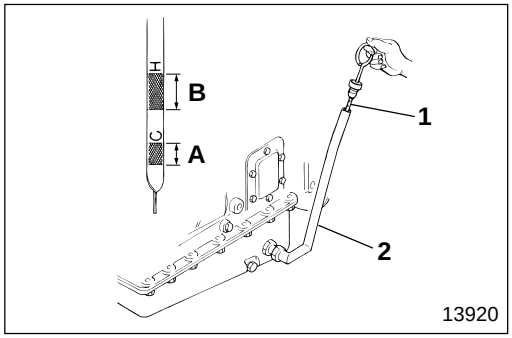
Make sure that dirt and foreign particles do not become mixed in with the fluid when it is added.

- Shift the range selector lever to the **N** position, start the engine and let it idle for about one minute.
- After shifting the lever through all positions once, shift it back to the **N** position.

CAUTION

To prevent burning out the interior of the automatic transmission assembly, make sure that the engine is not allowed to race when you do the above.

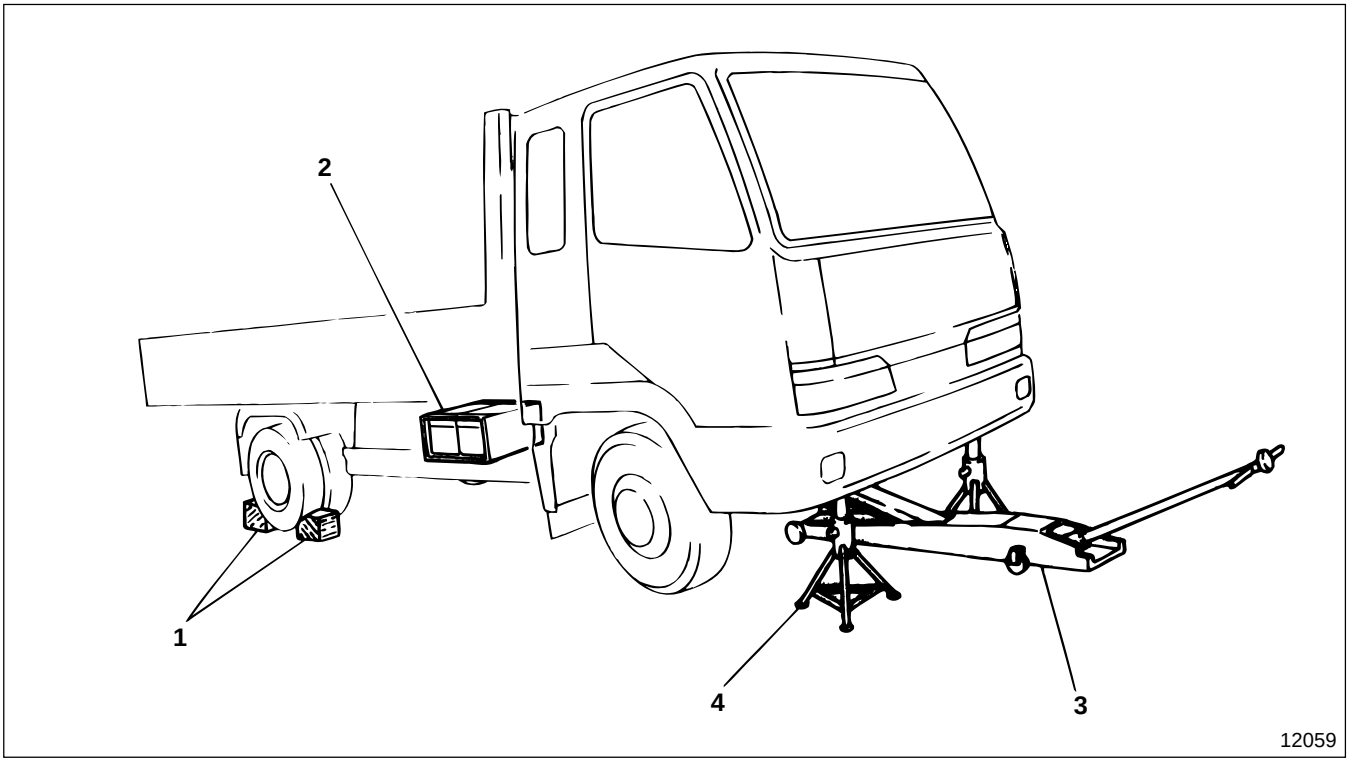
ON-VEHICLE INSPECTION AND ADJUSTMENT



- Check and adjust so that the fluid level is within the specified area on dipstick **1**.

NOTE

- **As the temperature of the fluid rises, so does the fluid level. If you add fluid while the temperature is still low (approximately 15 to 49°C {60 to 120°F}), make sure that the level stays within area A, marked COLD on dipstick 1.**
- **Let the engine idle and, while paying attention to the fluid level, pour in the fluid slowly.**
- **It is sometimes hard to check the fluid level, immediately after supplying fluid, because of the fluid adhering to the interior of dipstick guide 2. If this is the case, check the fluid level several times at intervals.**
- **Be careful not to supply too much fluid because you might mistake the fluid that overflows from the air breather for fluid leakage.**



● **Work sequence before removal**

1 Place wheel chocks.
2 Disconnect the negative battery cable Gr 54
3 Jack up the front axle with a garage jack.
4 Support the front frame on rigid racks.

WARNING⚠

- **The parking brake will be removed so naturally it cannot be used. Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

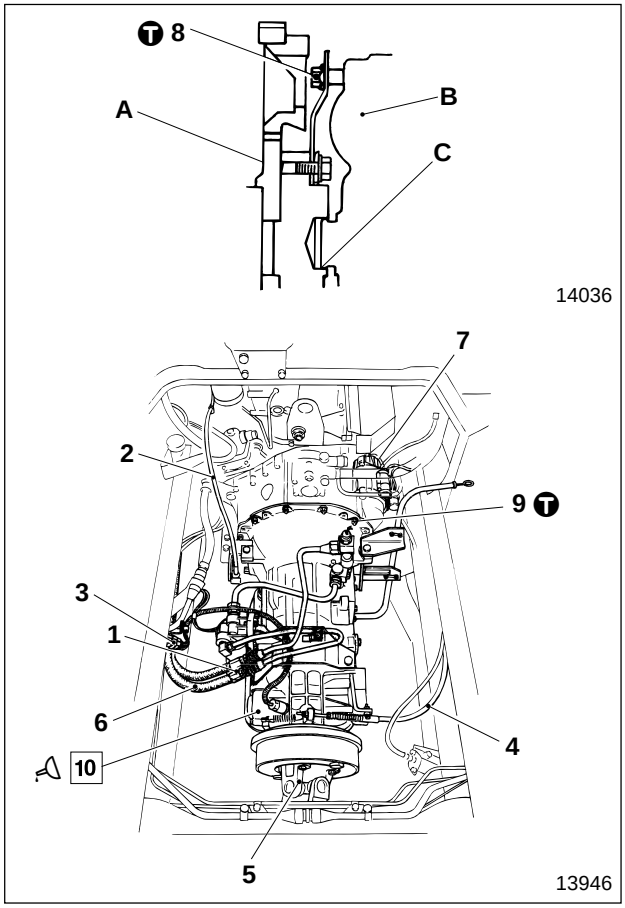
CAUTION⚠

Be sure to keep the automatic transmission in neutral throughout the operation.

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

REMOVAL AND INSTALLATION OF AUTOMATIC TRANSMISSION ASSEMBLY



● **Removal Sequence**

1 Chassis harness
2 Selector cable
3 Harness connector
4 Parking brake cable Gr 36A
5 Propeller shaft Gr 25
6 Oil cooler hose
7 Starter Gr 54
8 Bolt
9 Nut
10 Automatic transmission assembly

A : Flywheel
B : Torque converter
C : Torque converter pilot area

● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

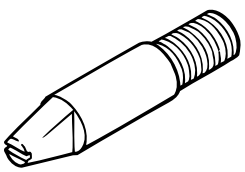
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Bolt (Torque converter and flywheel mounting)	51 to 61 {38 to 45, 5.20 to 6.22}	—
9	Nut (Automatic transmission assembly mounting)	39 to 58 {28 to 43, 3.9 to 6.0}	—

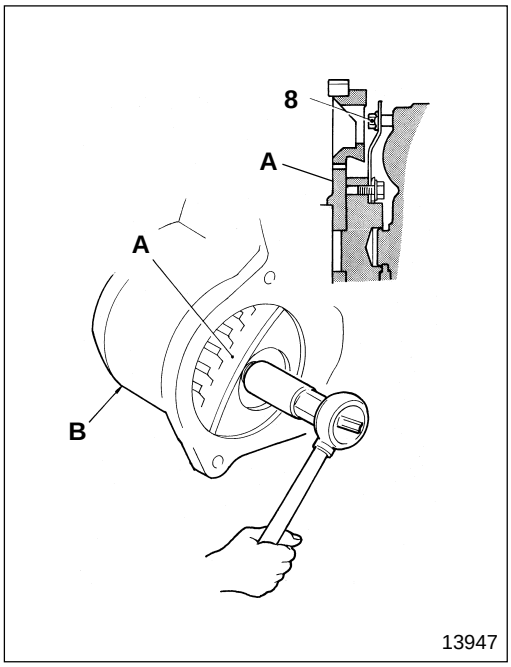
Lubricant

Location	Points of application	Kinds	Quantity
10	Torque converter pilot area (area C)	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
10	Converter installer  03726	ME633437	Automatic transmission assembly installation guide

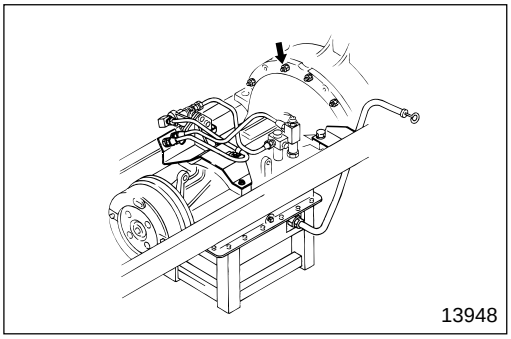
◆ Service procedure



10 **Automatic transmission assembly**

[Removal]

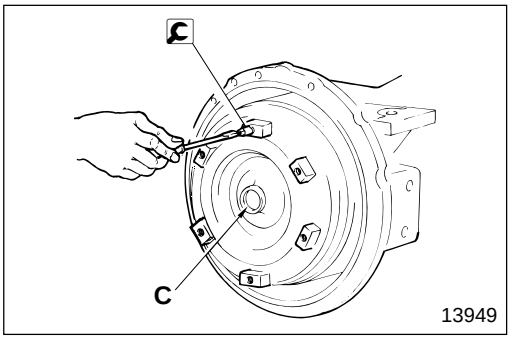
- Rotate flywheel **A** and remove bolts **8** in sequence.
  B : Starter housing



- Use a square bar or a similar object to support the oil pan of automatic transmission assembly **10**, then remove it by pulling it out backward.

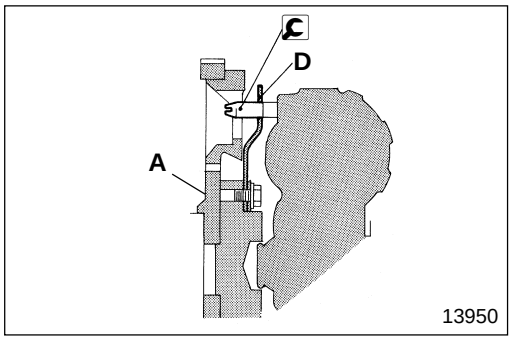
CAUTION

- **Be careful not to apply force unevenly to any of the oil pan parts.**
- **Be careful not to let the torque converter fall from the transmission body because as a single unit the torque converter can come loose easily.**

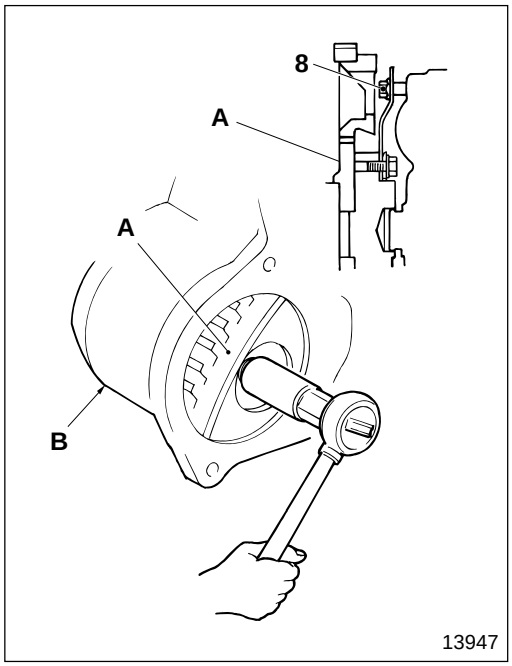


[Installation]

- Apply molybdenum disulfide grease to torque converter pilot area **C**.
- Mount torque converter installer in the tapped hole on the torque converter periphery.



- Install the automatic transmission assembly to the engine flywheel housing, by aligning torque converter installer with the hole in flexplate **D** of flywheel **A**.



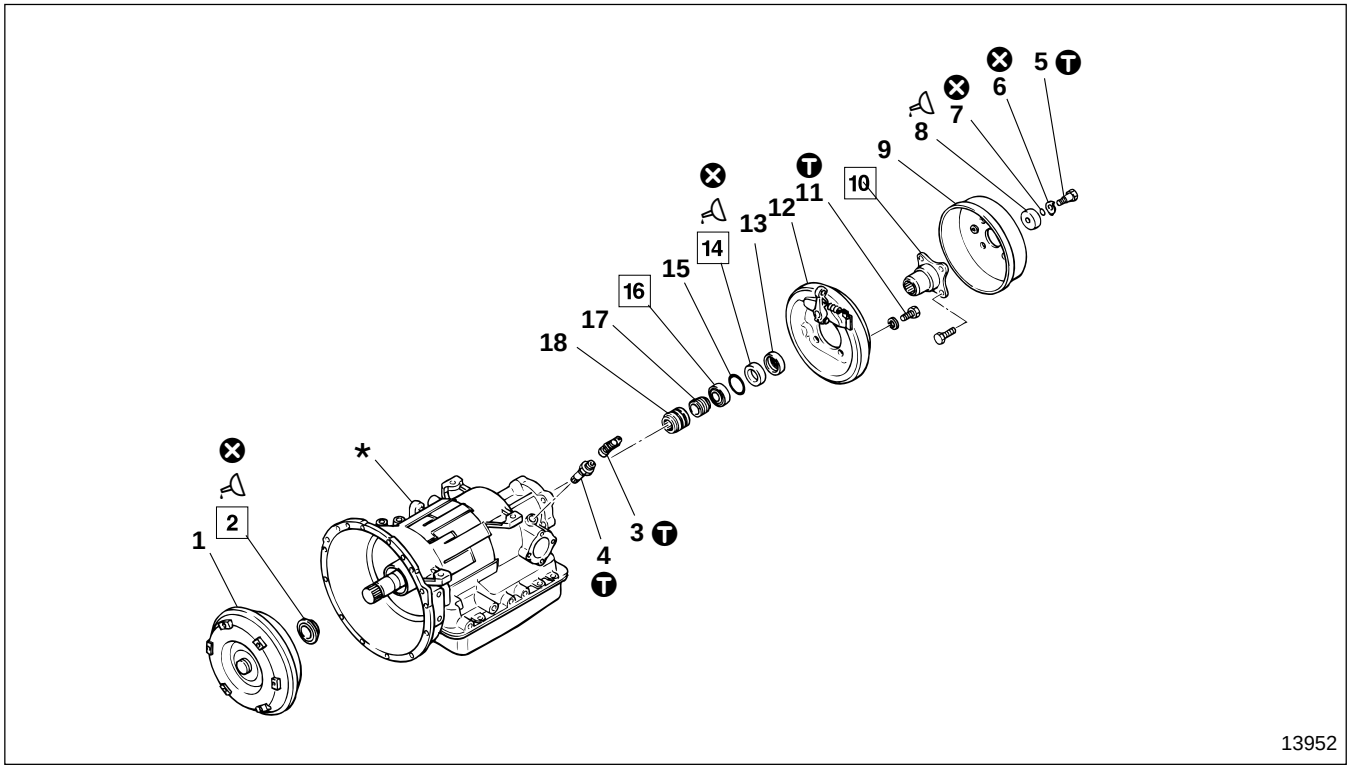
- Rotate flywheel **A** and tighten bolts **8**, in sequence, through the working hole of starter housing **B**. (6 points)
- Remove the converter installer and replace it with bolt **8**.
- First tighten all six bolts **8** temporarily, then tighten at specified torque.

NOTE

Be careful not to drop bolts 8 into the gap between flywheel A and the torque converter.

M E M O

OIL SEAL AND SPEEDOMETER WORM



● **Disassembly sequence**

1 Torque converter
2 Oil seal
3 Speedometer gear adapter
4 Speedometer gear
5 Flange set bolt
6 Lock washer
7 O-ring
8 Retainer washer
9 Parking brake drum
10 Companion flange
11 Bolt
12 Support plate and shoe assembly
13 Seal plate
14 Oil seal
15 Snap ring
16 Bearing
17 Spacer
18 Speedometer worm

***** : Automatic transmission assembly
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
4, 18	Backlash between speedometer gear and speedometer worm	0.13 to 0.29 {0.0051 to 0.011}	0.36 {0.014}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

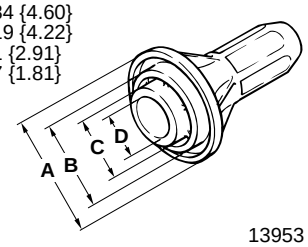
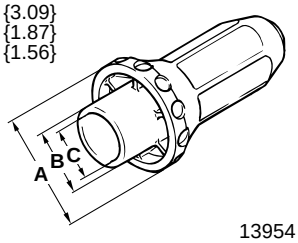
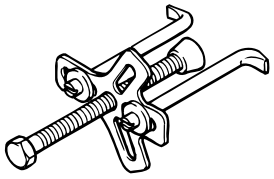
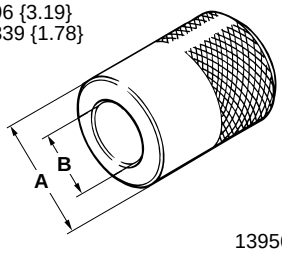
Location	Parts to be tightened	Tightening torque	Remarks
3	Speedometer gear adapter	55 to 82 {41 to 61, 5.6 to 8.4}	—
4	Speedometer gear	61 to 68 {45 to 50, 6.22 to 6.93}	—
5	Flange set bolt	140 to 160 {100 to 120, 14.1 to 16.72}	—
11	Bolt (Support plate and shoe assembly mounting)	110 to 130 {81 to 97, 11.22 to 13.46}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
2	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Oil seal periphery	THREEBOND 1215	As required
8	Retainer washer periphery	THREEBOND 1215	As required
14	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Oil seal periphery	THREEBOND 1215	As required

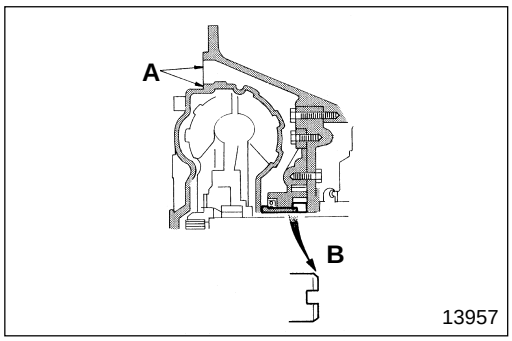
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	**A**=ø116.84 {4.60} **B**=ø107.19 {4.22} **C**=ø73.91 {2.91} **D**=ø45.97 {1.81} Pump seal installer  13953	ME633191	Installation of front side oil seal
14	**A**=ø78.6 {3.09} **B**=ø47.5 {1.87} **C**=ø39.6 {1.56} Rear oil seal installer  13954	ME633192	Installation of rear side oil seal
16	Bearing remover set  13955	ME633221	Removal of bearing
	A=ø80.96 {3.19} **B**=ø45.339 {1.78} Rear bearing installer  13956	ME633220	Installation of bearing

OIL SEAL AND SPEEDOMETER WORM

◆ Service procedure



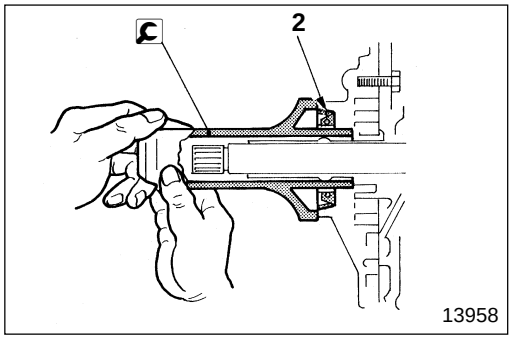
1 **Installation of torque converter**

Align the hub groove of torque converter **1** with the claw of the oil pump, then insert until the welded part on the converter periphery and the housing flange almost coincide.

CAUTION

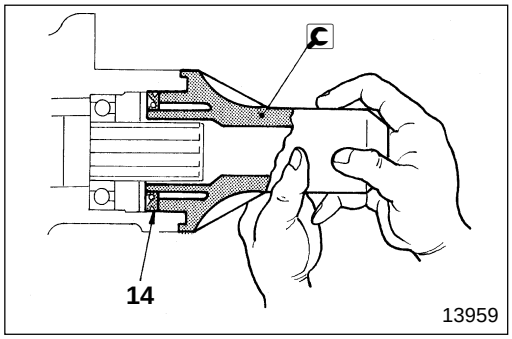
Be careful not to scratch the oil seal.

A : Guide to insertion position (Align faces)
B : Align claw position



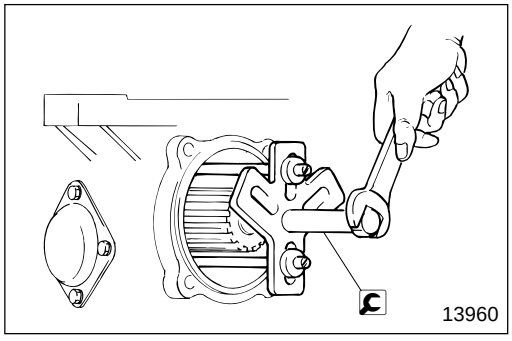
2 **Installation of oil seal**

- Apply grease to the lip area, and apply sealant to the periphery of oil seal **2**.
- Use 🔧 pump seal installer and install oil seal **2**.



14 **Installation of oil seal**

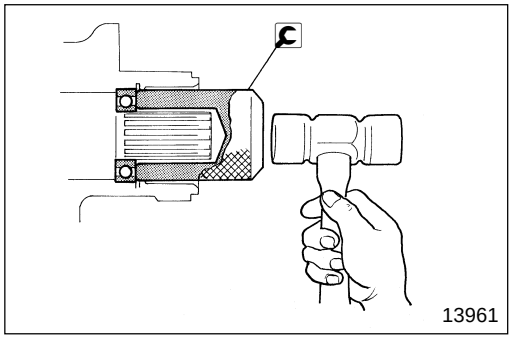
- Apply grease to the lip area, and apply sealant to the periphery of oil seal **14**.
- Use 🔧 rear oil seal installer and install oil seal **14**.



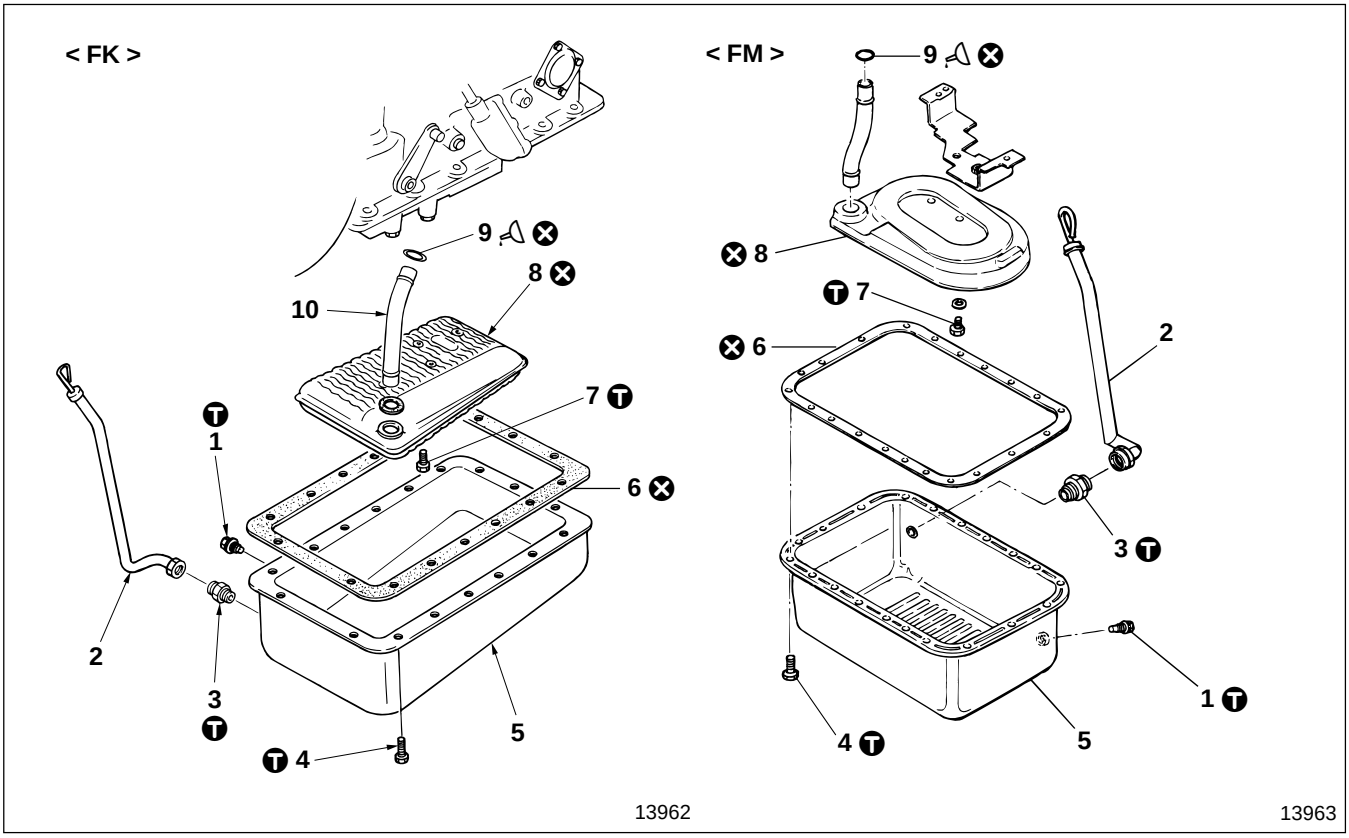
16 **Bearing**

[Removal]

- Insert the claw on the tip of 🔧 bearing remover set rod between the bearing race of bearing **16**.
- Insert the bolt of 🔧 bearing remover set into the automatic transmission output shaft, then remove bearing **16** by tightening the bearing remover.



[Installation]



● **Removal sequence**

1 Drain plug
2 Dipstick and dipstick guide
3 Dipstick guide connector
4 Bolt
5 Oil pan
6 Gasket
7 Bolt
8 Oil filter
9 Seal ring
10 Intake pipe

⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Repair kit : Oil filter and gasket kit

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

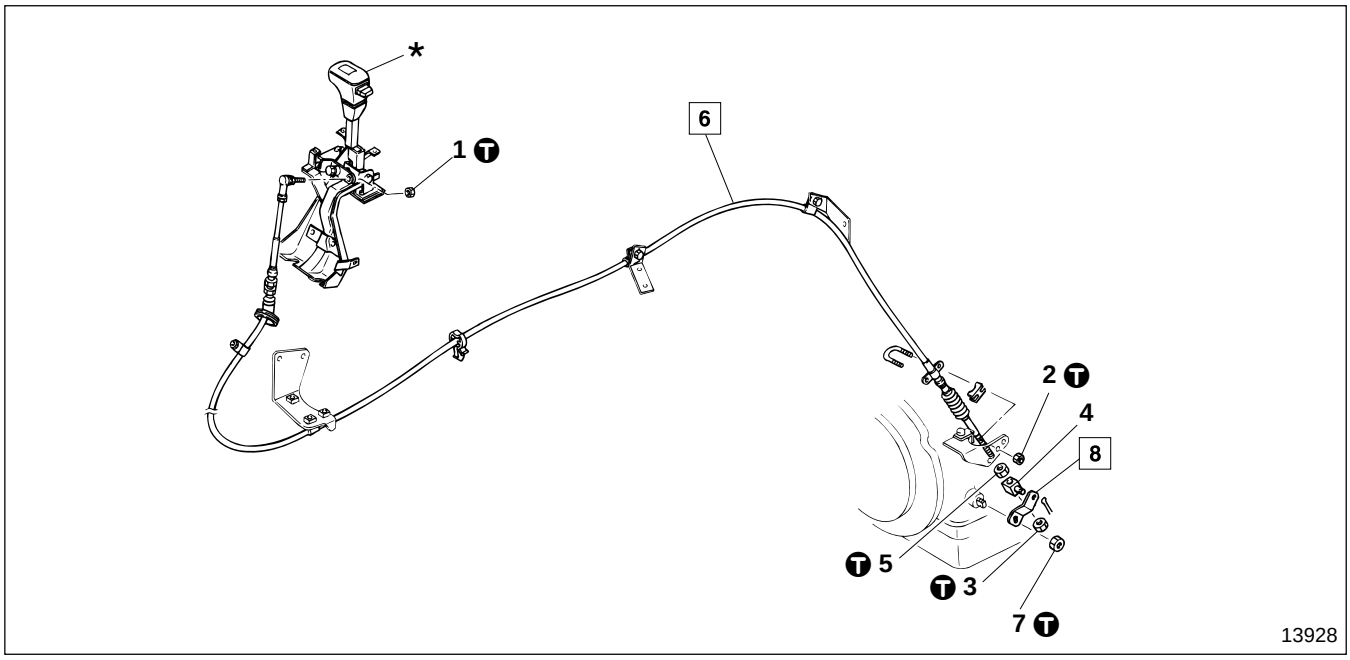
Location	Parts to be tightened	Tightening torque	Remarks
1	Drain plug	20 to 27 {15 to 20, 2.05 to 2.75}	—
3	Dipstick guide connector	125 to 135 {91 to 100, 12.55 to 13.76}	—
4	Bolt (Oil pan mounting)	14 to 18 {10 to 13, 1.4 to 1.8}	—
7	Bolt (Oil filter mounting)	14 to 18 {10 to 13, 1.4 to 1.8}	—

Fluid

Location	Points of application	Kinds	Quantity
9	Seal ring	Automatic transmission fluid (DEXRON or DEXRON II type)	As required

AUTOMATIC TRANSMISSION CONTROL

Selector Cable



● **Removal sequence**

1 Nut
2 Nut
3 Nut
4 Adjuster
5 Nut
6 Selector cable
7 Nut
8 Selector lever

***:** Range selector lever 🕮 P23A-22

● **Installation sequence**

***→6→1→5→4→3 →2**
8→7 →2

● **Inspection after installation**

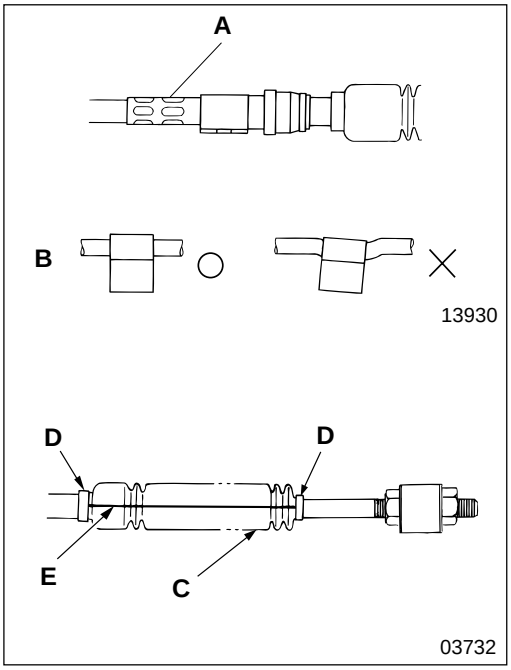
🕮 P23A-21

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Selector cable mounting)	18.6 to 23.5 {14 to 17, 1.9 to 2.4}	—
2	Nut (U-bolt mounting)	21 to 30 {16 to 22, 2.15 to 3.05}	—
3, 5	Nut (Selector cable mounting)	4 to 6 {3.0 to 4.4, 0.41 to 0.61}	—
7	Nut (Selector lever mounting)	23.5±3.4 {17±2.5, 2.4±0.35}	—

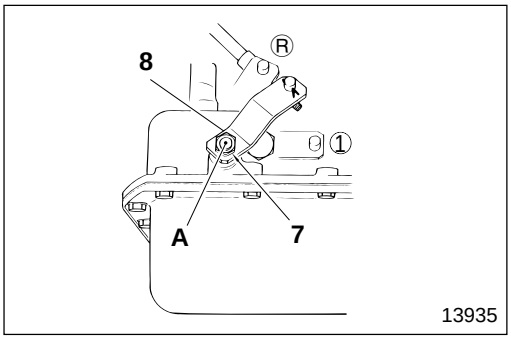
◆ Service procedure



6 **Installation of selector cable**

NOTE

- **Make sure casing cap A is installed in a straight line.**
- **Cable bend radius must be 20 cm {7.87 in.} or more.**
- **Make sure the cable is straight.**
- **Install the clamp at right angles to the cable. (Figure B)**
- **Do not twist clamps D at the ends of boot C. Install so that white line E on the boot is a straight line. (Figure E)**



8 **Installation of selector lever**

If selector lever **8** has been removed, rotate selector shaft **A** and move it to an intermediate position between, but other than, ① and Ⓡ, then tighten nut **7**.

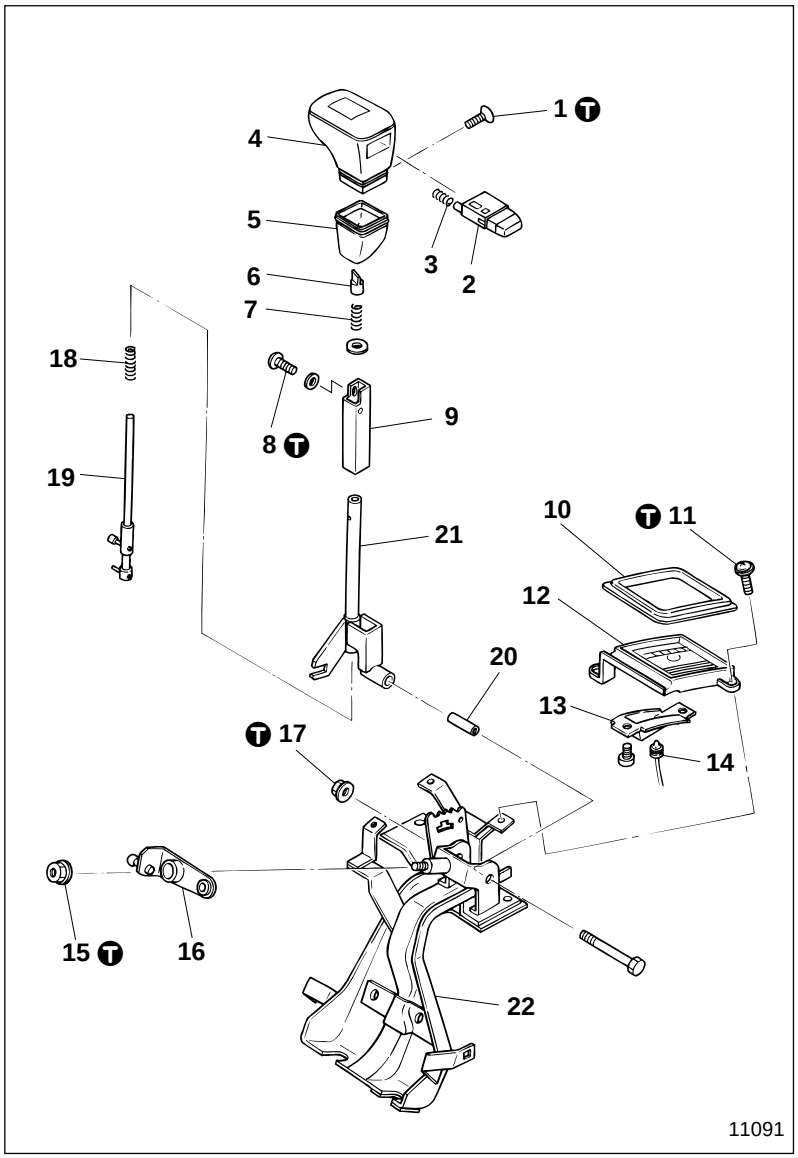
CAUTION⚠

Be careful not to overtighten nut 7, it might cause the internal lever to malfunction.

● **Inspection after installation**

- Make sure that when range selector lever * on the driver's side is operated, the detent positions of selector lever **8** on the automatic transmission side agree with the corresponding positions of the range selector lever on the driver's side. Also make sure that the range selector lever on the driver's side and the selector lever on the automatic transmission side are both operating smoothly.
- Make sure the modulator cable moves smoothly.
- Make sure the starter switch can be operated only in the neutral position, and is disabled for all other positions.
- Make sure the backup lamps light when the selector is in the reverse (R) position.
  (The lamps do not light when the engine is stopped.)

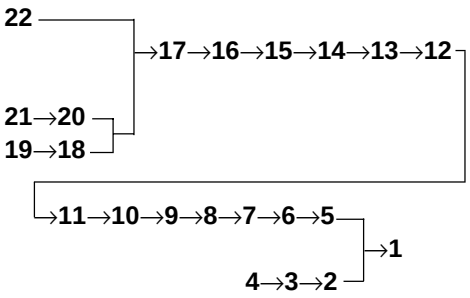
Range Selector Lever



● **Disassembly sequence**

1. Screw
2. Push button
3. Spring
4. Knob assembly
5. Cover
6. Sleeve
7. Spring
8. Screw
9. Pipe
10. Indicator rubber
11. Screw
12. Panel assembly
13. Holder
14. Indicator lamp
15. Nut
16. Range selector lever B
17. Nut
18. Spring
19. Rod assembly
20. Pipe
21. Range selector lever A
22. Set board assembly

● **Assembly Sequence**



T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

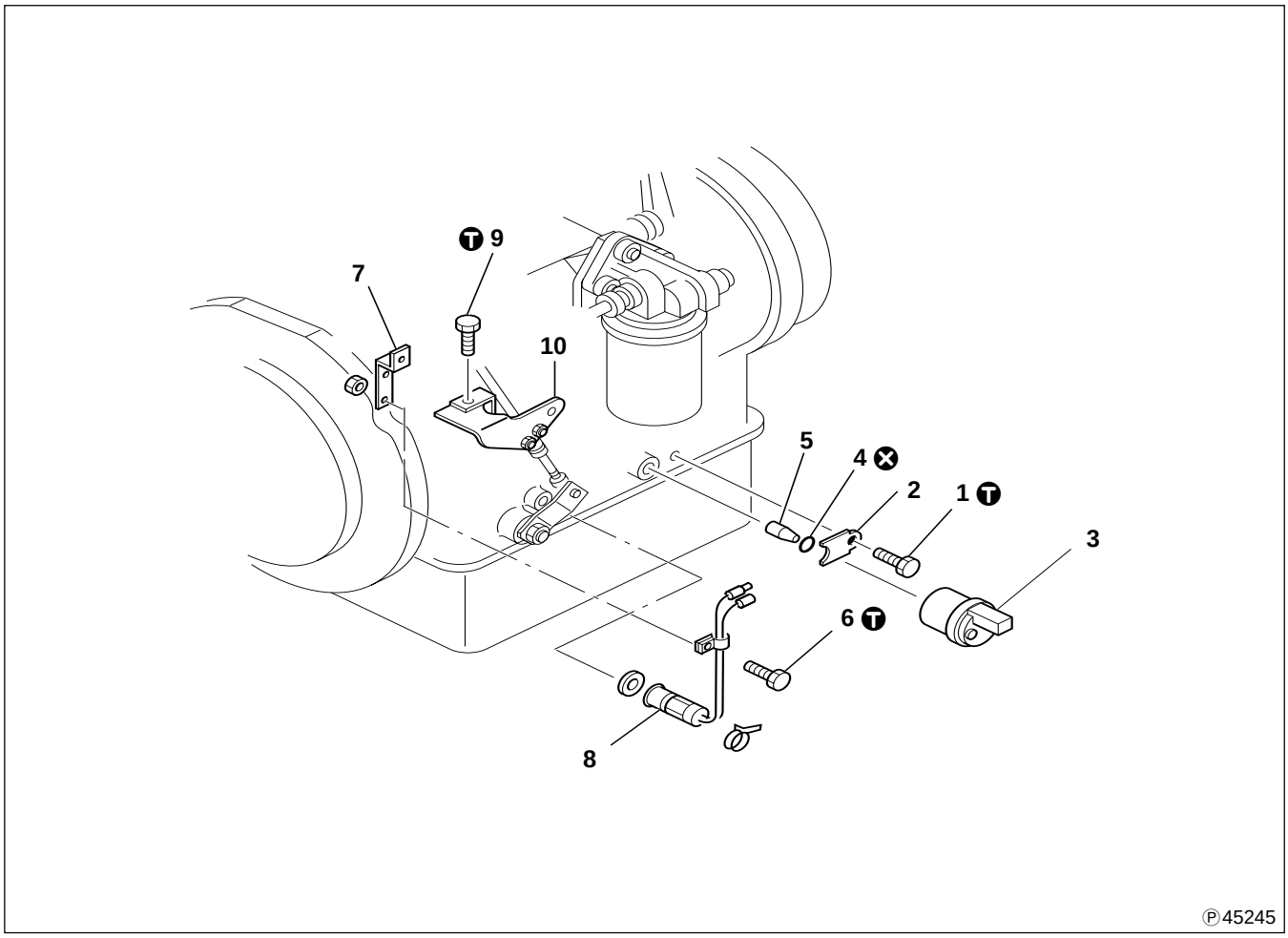
Location	Parts to be tightened	Tightening torque	Remarks
1	Screw (Knob assembly mounting)	2 {1.4, 0.2}	—
8	Screw (Pipe mounting)	2 {1.4, 0.2}	—
11	Screw (Panel assembly mounting)	2 {1.4, 0.2}	—
15	Nut (Range selector lever B mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—
17	Nut (Range selector lever A mounting)	9.8 to 15 {7.2 to 11, 1.0 to 1.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
—	All sliding areas	Chassis grease [NLGI No.1 (Ca soap)]	As required

M E M O

Modulator Assembly and Neutral Start Switch



● **Removal sequence**

1 Bolt
2 Retainer
3 Modulator assembly
4 O-ring
5 Valve rod
6 Bolt
7 Bracket
8 Neutral start switch Gr 54
9 Bolt
10 Bracket

⊗ : Non-reusable parts

● **Installation sequence**

10→**9**→**8**→**7**→**6**→**5**→**4**→**2**→**1**
3→**2**→**1**

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Retainer mounting)	17±2.5 {13±1.8, 1.75±0.25}	—
6	Bolt (Clamp mounting)	3.9 to 5.9 {2.9 to 4.3, 0.4 to 0.6}	—
9	Bolt (Bracket mounting)	59 to 83 {43 to 61, 6.0 to 8.5}	—

M E M O

OIL COOLER

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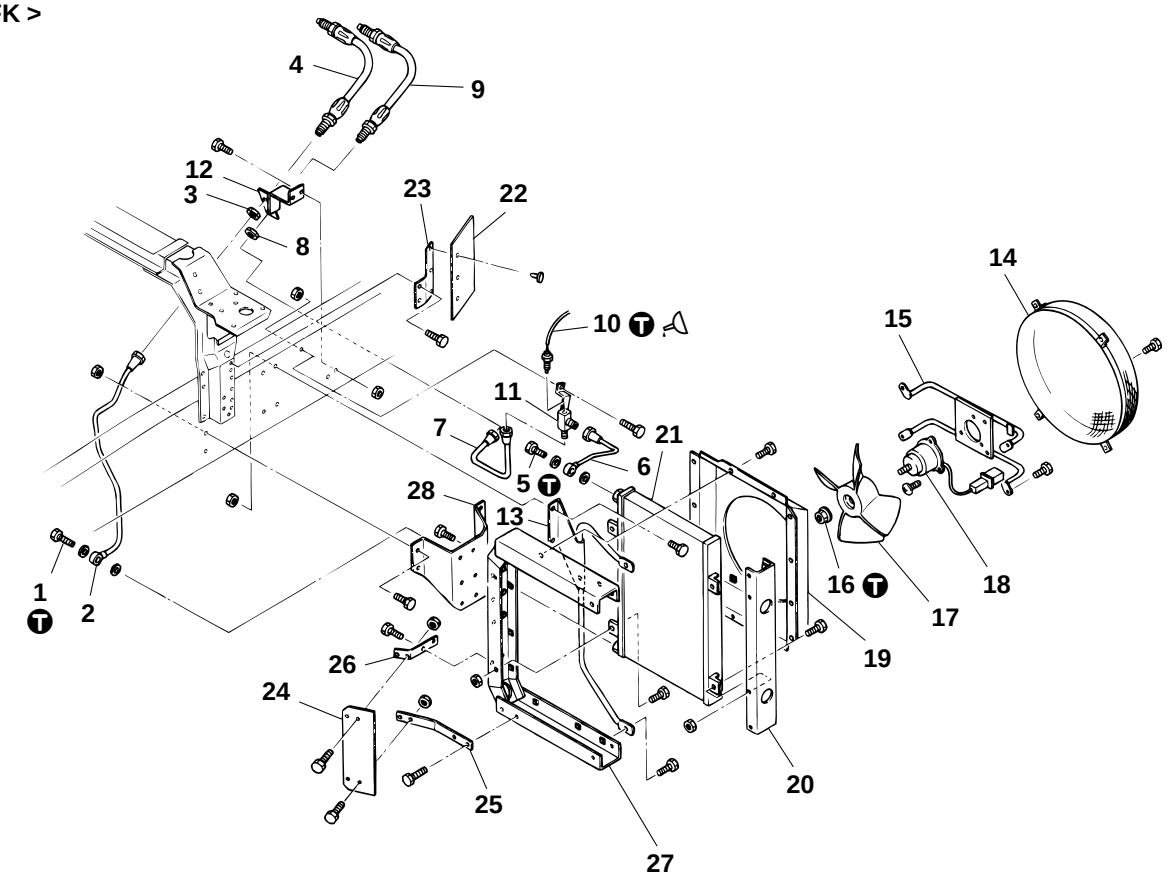

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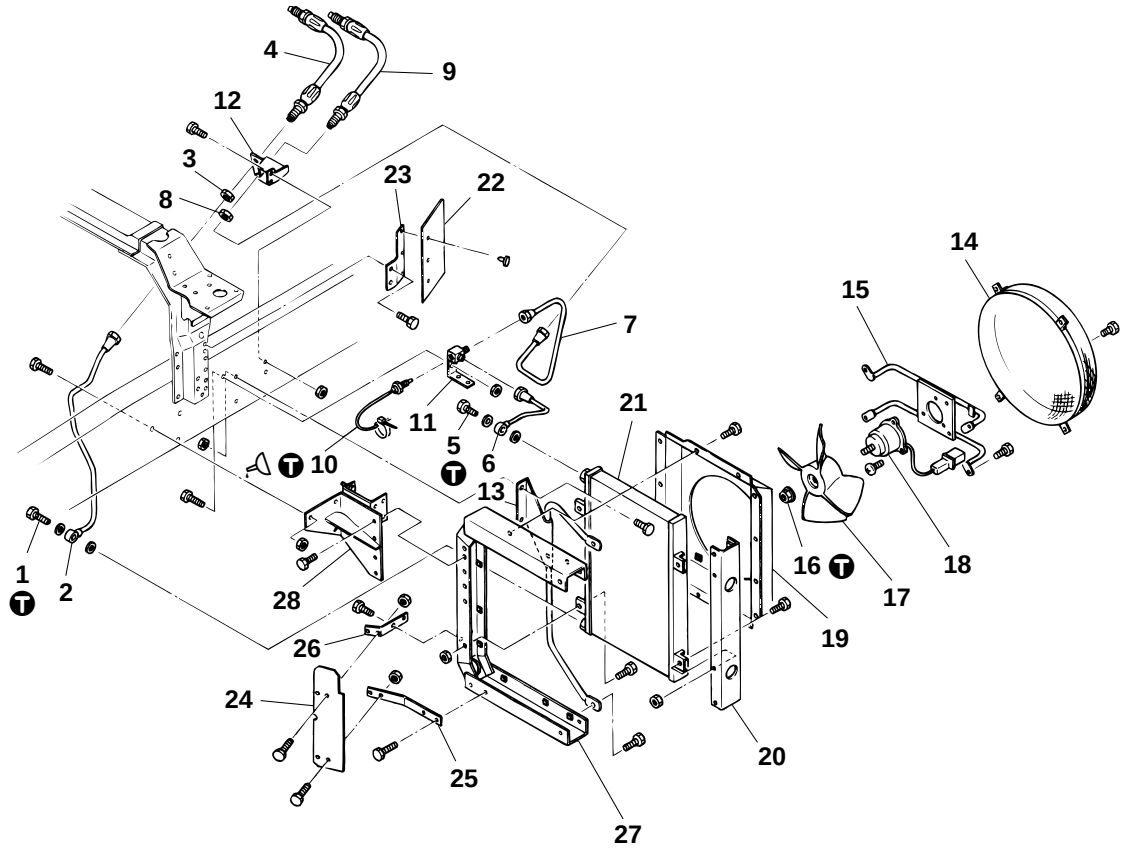

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● **Removal sequence**

1 Eye bolt
2 Cooler in pipe
3 Nut
4 Oil hose
5 Eye bolt
6 Cooler out pipe A
7 Cooler out pipe B
8 Nut
9 Oil hose
10 Automatic transmission fluid thermostat switch Gr 54
11 Connector
12 Hose bracket
13 Oil cooler stay
14 Fan cover
15 Fan motor bracket
16 Nut
17 Fan assembly
18 Motor assembly Gr 54
19 Fan shroud
20 Oil cooler bracket B
21 Oil cooler
22 Baffle plate
23 Baffle plate bracket
24 Air scoop
25 Air scoop bracket A
26 Air scoop bracket B
27 Oil cooler bracket A
28 Oil cooler bracket

● **Installation sequence**

28→**27**→**26**→**25**→**24**→**23**→**22**→**21**→**20**→**19**→**14**→**13**→**12**→**11**→**10**→**9**→**8**→**7**→**6**→**5**→**4**→**3**→**2**→**1**
18→**17**→**16**→**15**→**14**

Tightening torque

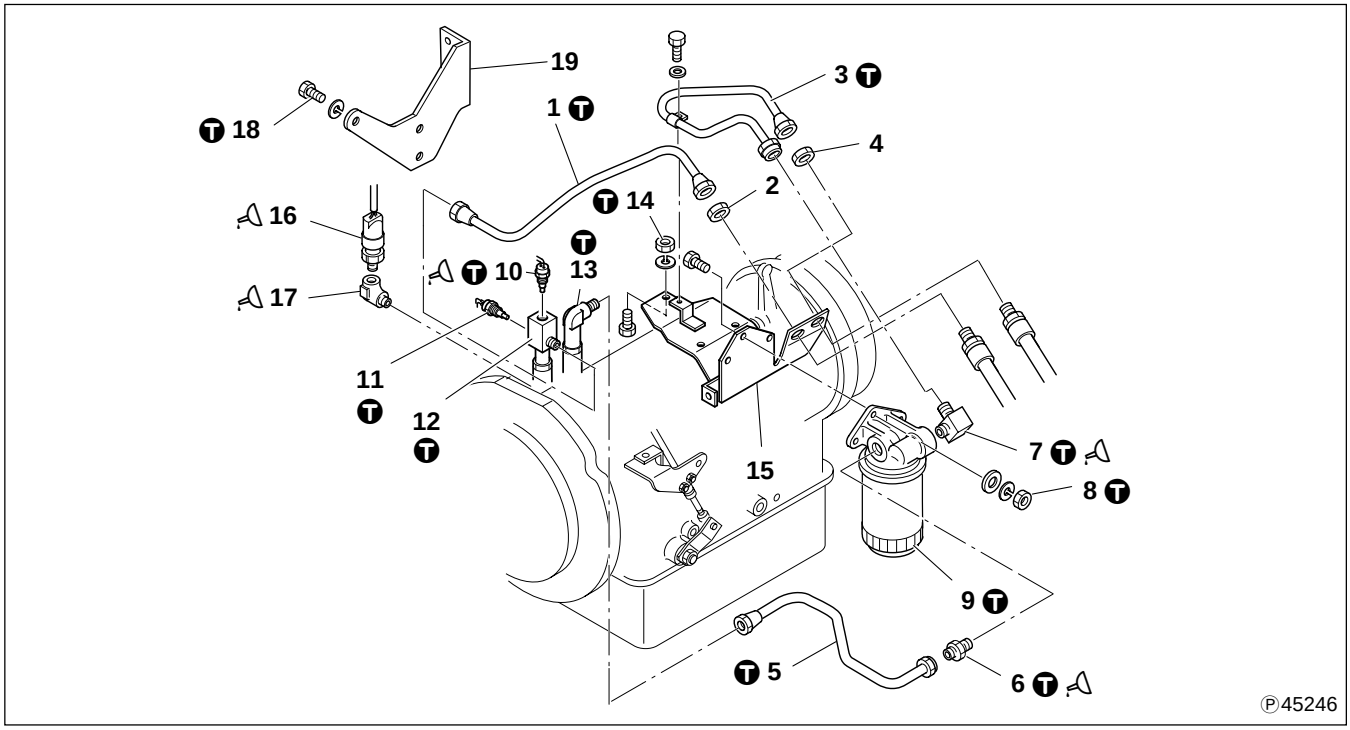
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 5	Eye bolt	59 to 88 {43 to 65, 6 to 9}	—
10	Automatic transmission fluid thermostat switch	29 to 39 {22 to 29, 3 to 4}	—
16	Nut (Fan assembly mounting)	4.2 to 5.2 {3.1 to 3.8, 0.43 to 0.53}	—

Sealant

Location	Points of application	Kinds	Quantity
10	Automatic transmission fluid thermostat switch	THREEBOND 1110B	As required

OIL FILTER



● **Removal sequence**

1 Oil pipe
2 Nut
3 Oil pipe
4 Nut
5 Oil pipe
6 Connector
7 Connector
8 Nut
9 Oil filter
10 Automatic transmission fluid temperature sensor Gr 54
11 Automatic transmission fluid temperature switch Gr 54
12 Connector
13 Connector
14 Nut
15 Oil filter bracket
16 Backup lamp switch Gr 54
17 Connector
18 Bolt
19 Hand brake cable bracket

● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3, 5	Oil pipe	69 to 93 {51 to 69, 7.0 to 9.5}	—
6, 7	Connector	59 to 98 {43 to 72, 6 to 10}	—
8	Nut (Oil filler mounting)	21 {15, 2.13}	—
9	Oil filter (Cartridge mounting)	9.8 to 20 {7.2 to 14, 1 to 2}	—
10	Automatic transmission fluid temperature sensor	29 to 39 {22 to 29, 3 to 4}	—
11	Automatic transmission temperature switch	23 to 39 {22 to 29, 3 to 4}	—
12, 13	Connector	39 to 49 {29 to 36, 4 to 5}	—
14	Nut (Oil filter bracket mounting)	115 to 155 {87 to 115, 12 to 16}	—
18	Bolt (Hand brake cable bracket)	58 to 68 {43 to 50, 5.9 to 6.9}	—

Sealant

Location	Points of application	Kinds	Quantity
6, 7, 16, 17	Connector and thread area of backup lamp switch	THREEBOND 1207B	As required
10	Thread area of automatic transmission fluid temperature sensor	THREEBOND 1110B	As required
11	Thread area of automatic transmission fluid temprerature switch	THREEBOND 1110B	As required

MITSUBISHI
FUSO

Group 23B

Automatic Transmission
< FM657 >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-23B

INDEX

SPECIFICATIONS 23B- 2

STRUCTURE AND OPERATION

1. Automatic Transmission Assembly 23B- 4
2. Automatic Transmission Control System 23B- 5
3. Oil Cooler System 23B- 6

TROUBLESHOOTING 23B- 7

ON-VEIHICLE INSPECTION AND ADJUSTMENT

1. Stall Test 23B-12
2. Line Pressure Test 23B-13
3. Inspection of Automatic Transmission Fluid 23B-15
4. Replacement of Automatic Transmission Fluid 23B-16
5. Level Check of Automatic Transmission Fluid 23B-18
6. Replacement of Oil Filter 23B-19

OIL COOLER 23B-20

ELECTRIC CIRCUIT AND PART INSTALLATION LOCATIONS .. 23B-24

SPECIFICATIONS

AUTOMATIC TRANSMISSION MAJOR SPECIFICATIONS

Item			M100A6
Torque cinverter	Type		3-element, 1-stage, 2-phase
	Stall torque ratio		2.35
Transmission	Type		Planetary gear type 6 forward speeds and 1 reverse speed
	Gear ratio	1st	3.487
		2nd	1.846
		3rd	1.409
		4th	1.000
		5th	0.750
		6th	0.652
		Rev	5.027
Range selector pattern			R – “N” – D – 5 – 4 – 3 – 2 – 1 Engine can be started in N position only.
Automatic transmission fluid	Specified fluid		DEXRON III
	Fluid quantity	Main unit dm^3 {L}	27 {27}
		Overall system dm^3 {L}	31 {31}
Mass of automatic transmission assembly kg			310

VEHICLE SPEED AT GEAR SHIFT (D RANGE)

Unit: km/h {mph} (rpm)

Operating of accelerator	Mode switch position / Gearshift	Normal	Power
8/8	1 → 2 2 → 3 3 → 4 4 → 5 5 → 6	15 {10} (540) 37 {23} (1270) 49 {30} (1700) 70 {43} (2430) 94 {58} (3270)	17 {11} (600) 41 {26} (1440) 55 {34} (1920) 78 {49} (2730) 105 {65} (3670)
4/8	1 → 2 2 → 3 3 → 4 4 → 5 5 → 6	15 {10} (540) 29 {18} (990) 37 {23} (1300) 50 {31} (1730) 71 {44} (2460)	17 {11} (600) 32 {20} (1120) 43 {26} (1480) 57 {35} (1970) 79 {49} (2760)
0/8	1 → 2 2 → 3 3 → 4 4 → 5 5 → 6	68 {42} (2380) 40 {25} (1400) 30 {19} (1050) 21 {13} (750) 9 {5} (300)	77 {48} (2680) 42 {26} (1450) 31{19} (1090) 22 {14} (770) 9 {5} (300)

LOCK-UP POINT

Unit: km/h {mph} (rpm)

Operating of accelerator	Mode switch position / Gearshift	Normal	Power
8/8	2C – L	26 {16} (900)	29 {18} (1010)
4/8	2C – L	22 {13} (750)	24 {15} (850)
0/8	L → 2C	15 {10} (540)	15 {10} (540)

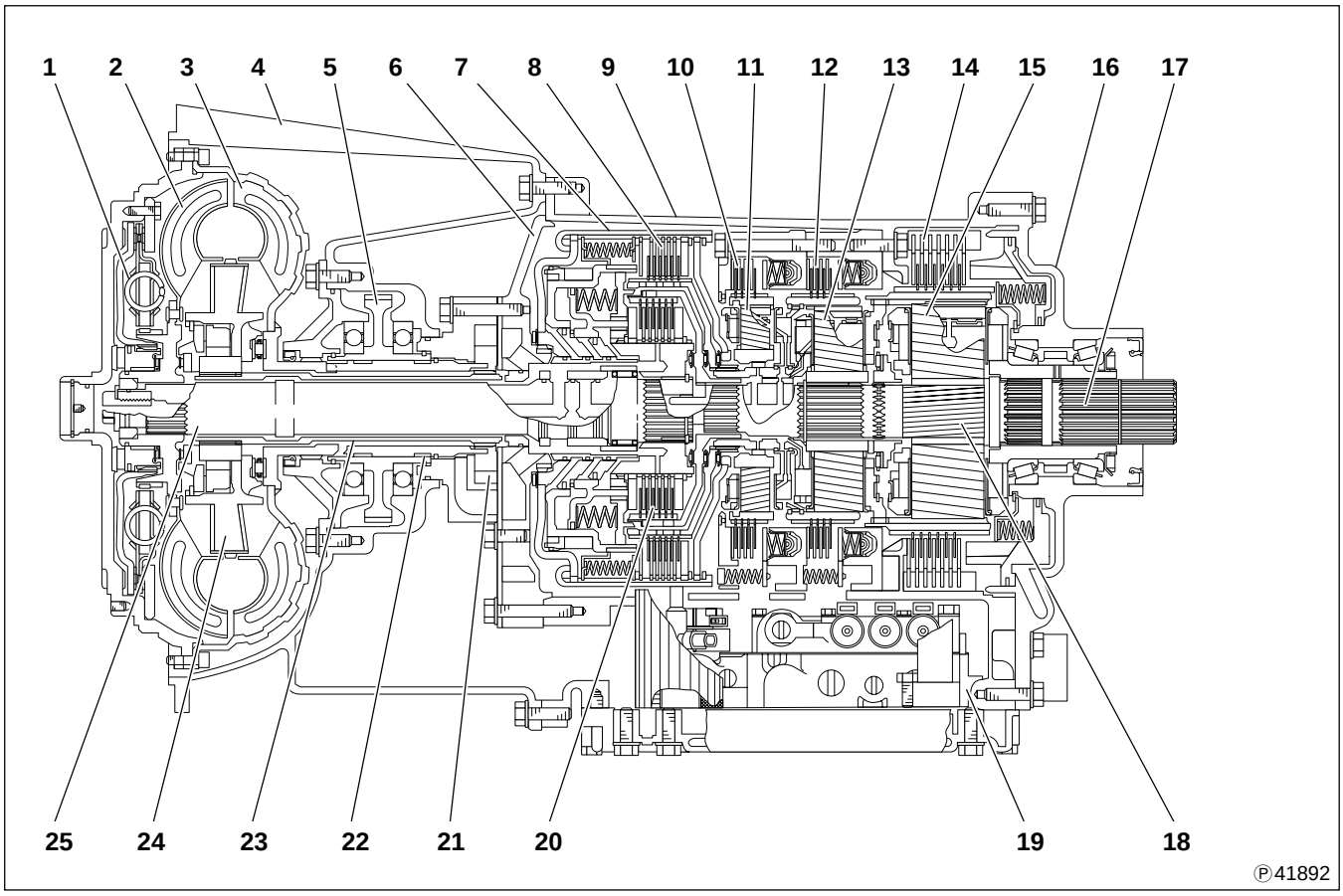
Note: Lock-up point is always set for the gear exceeding the 3rd.

- Revolutions shown in brackets indicates revolutions of transmission.
- The numerical value indicated in Table is calculated for vehicles set with the diff ratio of 6.666 and fitted with 11R22.5 tires. When the diff ratio or the tire size for vehicles is different, the speed of the vehicles varies based on such deviation. So, convert the numerical value in Table based on the applied specifications.

REPLACEMET INTERVALS OF AUTOMATIC TRANSMISSION FLUID AND OIL FILTER ELEMENT

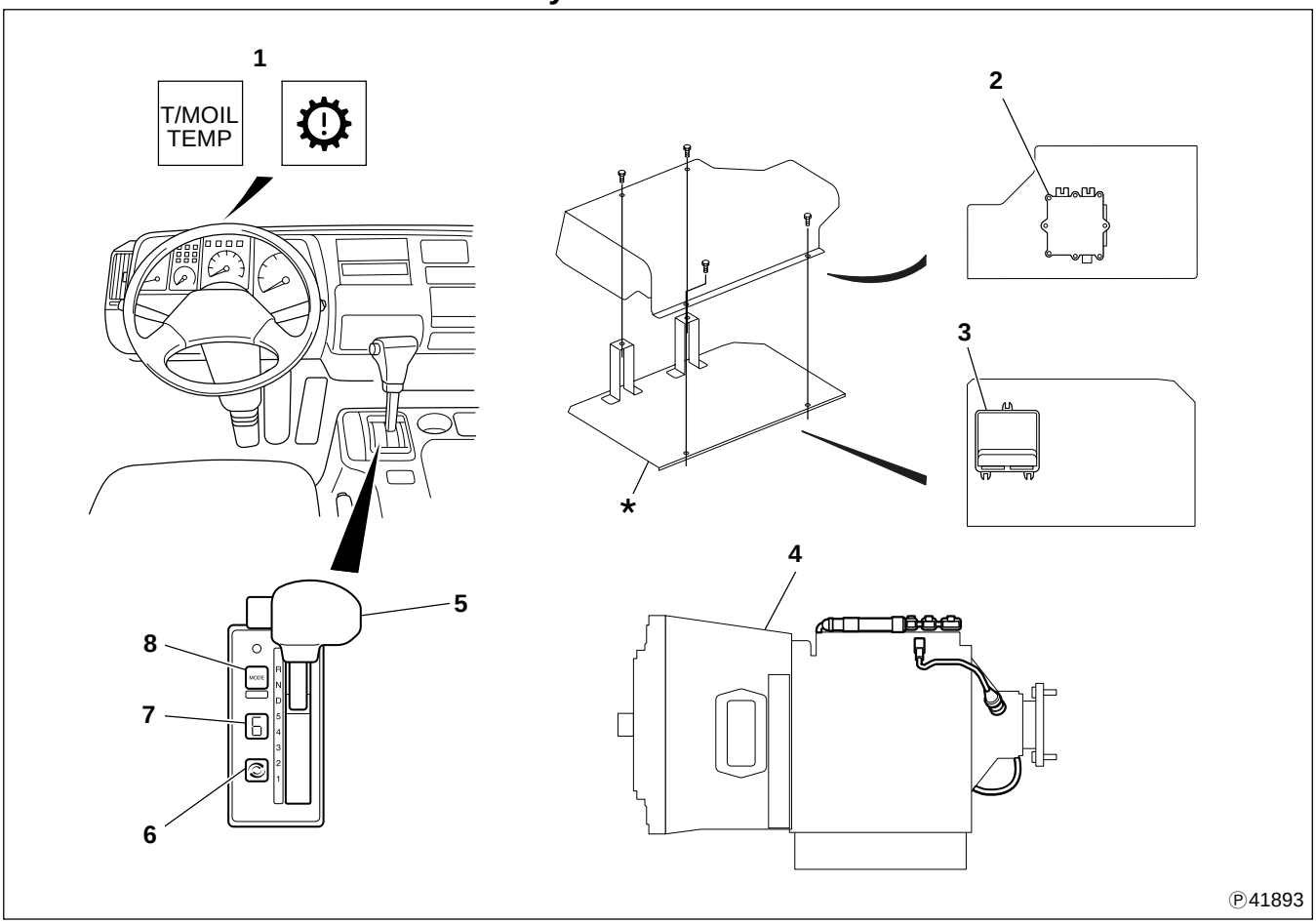
Location	Replacement intervals	Specified fluid
Automatic transmission fluid	8000km for new vehicle, 40000km or 1.5 years thereafter {25,000 miles}	DEXRON III
Oil filter element	8000km for new vehicle, 40000km or 1.5 years thereafter {25,000 miles}	—

1. Automatic transmission assembly



1 Lock-up clutch/dumper
2 Torque converter turbine
3 Torque converter pump
4 Torque converter housing
5 Power take-off (PTO) gear assembly
6 Front support
7 Rotation clutch module
8 C2 clutch
9 Main housing
10 C3 clutch
11 P1 planetary module
12 C4 clutch
13 P2 planetary module
14 C5 clutch
15 P3 planetary module
16 Rear cover module
17 Output shaft
18 Main shaft
19 Control valve module
20 C1 clutch
21 Hydraulic fluid charging pump
22 Charging pump drive hub
23 Ground sleeve
24 Torque converter stator
25 Turbine shaft

2. Automatic transmission control system

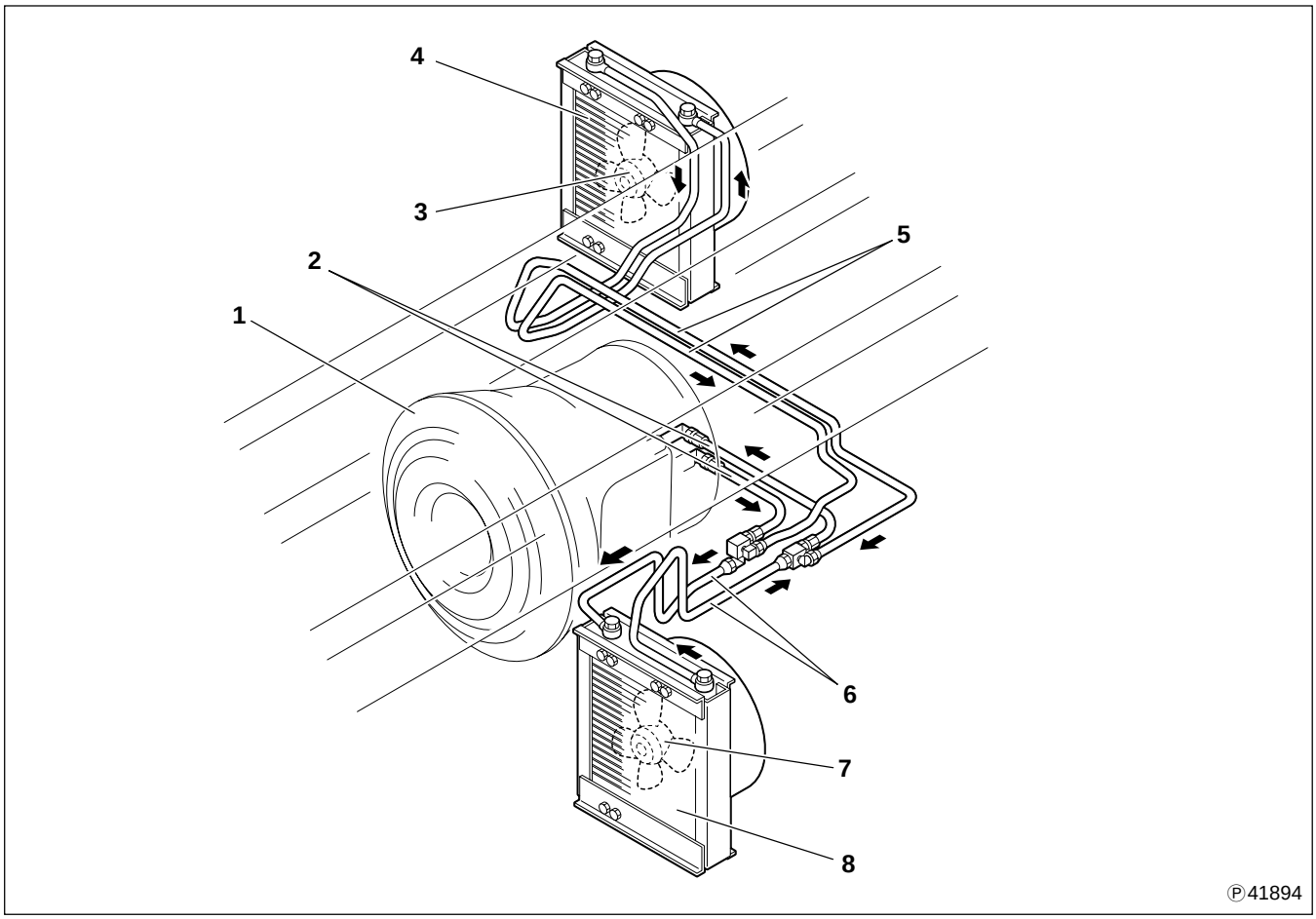


1 Warning lamp
2 Vehicle interface module
3 Automatic transmission electronic control unit
4 Automatic transmission assembly
5 Range selector
6 Display switch button
7 Select position display
8 Mode button

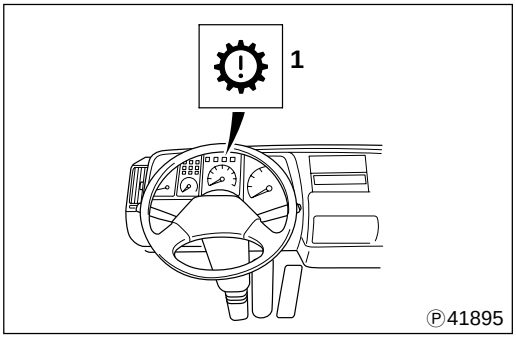
***** Back of driver's seat

Electronic control (ATEC: Allison Transmission Electronic Control) system is composed of vehicle interface module **2**, automatic transmission electronic control unit **3**, range selector **5**, throttle position sensor, electronic hydraulic valve body, and harnesses connecting these units. The automatic transmission electronic control unit receives electric signals, which are sent by each sensor and shift selector, processes them, transmits the signals to an appropriate solenoid, and thereby controls the transmission.

3. Oil cooler system



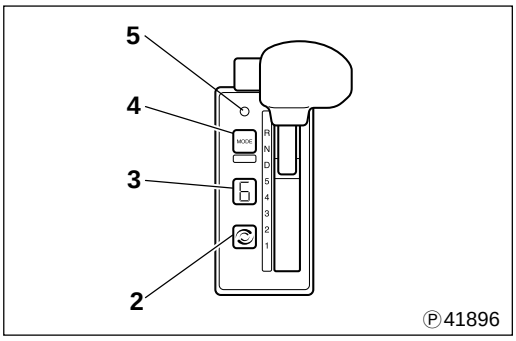
1 Automatic transmission assembly
2 Oil hose
3 Blower assembly (RH)
4 Oil cooler (RH)
5 Oil pipe
6 Oil pipe
7 Blower assembly (LH)
8 Oil cooler (LH)



This automatic transmission is equipped with trouble self-diagnosis function. When detecting abnormality, the function displays occurrence of troubles on warning lamp **1**, as well as memorizes the trouble code No. in the memory. A maximum number of five (5) trouble codes are memorized.

Start of trouble mode (reading trouble code No.)

- Push display switch button **2** of range selector twice.
- Trouble code No. is indicated in select position display **3**. If "OL" is indicated, push the display switch button **2** again.
- Record the trouble code No. that is indicated.
  For instance, if indicated in order of "d1", "25", and "11", it shows that main code No. 25 and sub code No. 11 are memorized in the 1st memory. When nothing is recorded, "--" "--" is repeatedly displayed in sequence.
- There are five (5) memories that memorize the code No. When pushing mode button **4**, the 2nd memory code is displayed following "d2".
- Whenever pushing mode button **4**, "d3", "d4", and "d5" are displayed in sequence, and finally "d1" is indicated back.



Clearing of diagnosis trouble code No.

After the repair is completed and mode button **4** is pushed for about 10 seconds, mode lamp **5** will flash for the first 5 seconds and the current malfunction code is cleared. After waiting another 5 seconds, the mode lamp will flash again and the past malfunction codes are cleared.

NOTE

The code No. is cleared only after if the trouble is repaired.

Release of diagnosis mode (returning to normal operation mode)

There are the following three (3) methods to return it to normal operation mode.

- Push the display switch button **2** of range selector.
- Switch it to either range of either range, "Reverse", "Neutral", or "Drive".
- Leave things as they are without doing anything (being automatically released in approximately ten (10) minutes).

Trouble self-diagnosis Table

CAUTION⚠

If finding out code No. that is not indicated in the trouble self-diagnosis Table; contact to GM Alison.

Code No.		Symptoms	Inspection and adjustment
Main	Sub		
13	12 13 23	Automatic transmission electronic control unit voltage: too low Automatic transmission electronic control unit voltage: low Automatic transmission electronic control unit voltage: high	1. Looseness or dirtiness of power supply and earth cable connections 2. Decrease of battery capacity 3. Abnormal charge system of vehicle 4. Blowout of vehicle interface module fuse 5. Connections of vehicle interface module connector 6. Abnormal vehicle-side wirings 7. Connections of automatic transmission electronic control unit connector 8. If corresponding items not available, contact to GM Alison Service.
14	12, 13	Oil level sensor	1. Operation of speed sensor (engine/output), temperature sensor, and level sensor 2. Disconnection or short-circuit of harnesses 3. If corresponding items not available, contact to GM Alison Service.
21	12, 13	Throttle position sensor	1. Connections of throttle position sensor connector 2. Method installing throttle position sensor cables 3. Idling return of control rod of electronic governor 4. Stroke of throttle position sensor cable 5. Disconnection or short-circuit of throttle position sensor harnesses 6. Replace throttle position sensor assembly 7. If corresponding items not available, contact to GM Alison Service.
22	14, 15, 16	Speed sensor	1. Connections of sensor connector 2. Installation looseness of sensor assembly 3. Disconnection or short-circuit of harnesses 4. If corresponding items not available, contact to GM Alison Service.
23	12, 13, 14, 15	Range selector	1. Connections of automatic transmission electronic control unit connector 2. Remedy of range selector connections or jump wires 3. Disconnection or short-circuit of range selector harnesses 4. Replacement of range selector assembly 5. If corresponding items not available, contact to GM Alison Service.
24	12	Temperature of automatic transmission fluid: too low	1. Outside air temperature: -32°C {-0.9°F} or less 1) Really low: if temperature rises, it is repaired. 2) Not low: connections of automatic transmission electronic connector 2. Connections of automatic transmission electronic control unit connector 3. If corresponding items not available, contact to GM Alison Service.

Code No.		Symptoms	Inspection and adjustment
Main	Sub		
13	23	Temperature of automatic transmission fluid: too high	1. Check oil level after operating the cooled unit 2. Result of automatic transmission fluid level check 1) Abnormal level; Adjust excess and deficiency 2) Normal level; Inspect the cooling system of engine 3. Inspect connections of automatic transmission electronic control unit and automatic transmission connector 4. If corresponding items not available, contact to GM Alison Service.
25	00, 11, 22, 33, 44, 55, 66, 77	Output speed sensor	1. Connections of sensor connector 2. Connections of automatic transmission electronic control unit connector 3. Check automatic transmission fluid level 4. Installation looseness of sensor 5. Disconnection or short-circuit of sensor harnesses 6. If corresponding items not available, contact to GM Alison Service.
32	00, 33, 55, 77	Disconnection of C3 pressure switch	1. Inspect automatic transmission level 2. Connections of automatic transmission connector 3. Connections of automatic transmission electronic control unit connector 4. Disconnection or short-circuit of automatic transmission harnesses 5. If corresponding items not available, contact to GM Alison Service.
33	12, 13	Faulty automatic transmission fluid temperature sensor	1. Connections of automatic transmission connector 2. Connections of automatic transmission electronic control unit connector 3. Disconnection or short-circuit of harnesses 4. If corresponding items not available, contact to GM Alison Service.
34	12, 13, 14, 15, 16	Faulty EEPROM (memory chip)	Contact to GM Alison Service.
35	00, 16	Temporary interruption of power supply EEPROM writing error	1. Connections of automatic transmission electronic control unit connector 2. Connections of vehicle interface module connector 3. Vehicle-side interface wirings 4. Do power supply and ground connect the battery directly? 5. Wiring and connection from ignition switch 6. If corresponding items not available, contact to GM Alison Service.
36	00	Unmatched hardware/ software	Contact to GM Alison Service.
41	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Disconnection or short-circuit of solenoid line	1. Connections of automatic transmission connector 2. Connections of automatic transmission electronic control unit connector 3. Damaged or broken harnesses 4. Disconnection or short-circuit of harnesses 5. Replace wiring harnesses 6. If corresponding items not available, contact to GM Alison Service.

Code No.		Symptoms	Inspection and adjustment
Main	Sub		
42	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Short-circuit of solenoid-circuit battery	1. Connections of automatic transmission connector 2. Connections of automatic transmission connector 3. Damaged or broken harnesses 4. Disconnection or short-circuit of harnesses 5. Wrong remodeling 6. Replace harnesses 7. If corresponding items not available, contact to GM Alison Service.
43	21, 25, 26	Solenoid Lo side circuit Disconnection or short-circuit	1. Connections of automatic transmission connector 2. Connections of electronic control unit connector 3. Disconnection or short-circuit of harnesses 4. Replace electronic control unit 5. If corresponding items not available, contact to GM Alison Service.
42	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Short-circuit of solenoid circuit ground	1. Connections of automatic transmission connector 2. Connections of electronic control unit connector 3. Disconnection or short-circuit of harnesses 4. If corresponding items not available, contact to GM Alison Service.
42	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26	Disconnection of solenoid circuit	1. Connections of automatic transmission connector 2. Connections of electronic control unit connector 3. Disconnection of harnesses 4. If corresponding items not available, contact to GM Alison Service.
51	01, 10, 12, 21, 23, 24, 35, 42, 43, 45, 46, 53, 64, 65	Off going ratio test	1. Connections of speed sensor (output/turbine) 2. Disconnection or short-circuit of sensor harnesses 3. Inspect automatic transmission fluid level 4. If corresponding items not available, contact to GM Alison Service.
52	01, 08, 32, 34, 54, 56, 71, 72, 78, 79, 99	C3 switch off test	1. Connections of speed sensor (output/turbine) 2. Disconnection or short-circuit of sensor harnesses 3. Disconnection or short-circuit of harnesses 4. Inspect automatic transmission fluid level 5. If corresponding items not available, contact to GM Alison Service.
53	08, 18, 28, 29, 38, 39, 48, 49, 58, 59, 68, 69, 78, 99	Off going speed test	1. Connections of speed sensor (turbine/engine) 2. Disconnection or short-circuit of sensor harnesses 3. Inspect automatic transmission fluid level 4. If corresponding items not available, contact to GM Alison Service.
54	01, 07, 10, 12, 17, 21, 23, 24, 27, 32, 34, 35, 42, 43, 45, 46, 53, 54, 56, 64, 65, 70, 71, 72, 80, 81, 82, 83, 85, 86, 92, 93, 95, 96, 97	On camming ratio test	1. Connections of speed sensor (turbine/output) 2. Disconnection or short-circuit of sensor harnesses 3. Inspect automatic transmission fluid level 4. Conform with specifications for EEPROM calibration. 5. If corresponding items not available, contact to GM Alison Service.

Code No.		Symptoms	Inspection and adjustment
Main	Sub		
55	17, 27, 87, 97	C3 switch on test	1. Inspect automatic transmission fluid level 2. Connections of speed sensor (turbine/output) 3. Disconnection or short-circuit of sensor harnesses 4. Connections of automatic transmission connector 5. Connections of automatic transmission electronic control unit connector 6. Disconnection or short-circuit of C3 switch circuit 7. If corresponding items not available, contact to GM Alison Service.
56	00, 11, 22, 33, 44, 55, 66, 77	Range check test	1. Connections of speed sensor (output/turbine) 2. Disconnection or short-circuit of sensor harnesses 3. Connections of automatic transmission connector 4. Connections of automatic transmission electronic control unit connector 5. Inspect automatic transmission fluid level 6. If corresponding items not available, contact to GM Alison Service.
57	11, 22, 44, 66, 88, 99	Range check test: C3 switch	1. Inspect automatic transmission fluid 2. Connections of speed sensor (turbine/output) 3. Disconnection or short-circuit of sensor harnesses 4. Connections of automatic transmission connector 5. Connections of automatic transmission electronic control unit connector 6. Disconnection or short-circuit of C3 switch circuit 7. If corresponding items not available, contact to GM Alison Service.
63	00, 26, 40	Faulty input function	1. Disconnection, short-circuit or faulty contact of wiring, switch, and connector 2. If corresponding items not available, contact to GM Alison Service.
65	00	Engine rating: too high	1. Exceeding the engine rating or maximum speed 2. If corresponding items not available, contact to GM Alison Service.
66	00	Faulty SCI interface	1. Connections of SCI connector 2. Disconnection or short-circuit of SCI wiring 3. Connections of automatic transmission electronic control unit connector 4. If corresponding items not available, contact to GM Alison Service.
69	12, 13, 14, 15, 16, 21, 22, 23, 24, 25, 26, 32, 33, 34, 35, 36, 41	Trouble of automatic transmission electronic control unit	1. Clear the code and restart the engine 2. If corresponding items not available, contact to GM Alison Service.

ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Stall test

● **Purpose**

"Stall test" checks the friction element in transmission, slide of one-way clutch in torque converter, operation of torque converter, or overall performance of the engine; thereby investigates the cause when the vehicle is malfunctioned due to insufficient power, performance, or others.

● **Measurement procedure**

Before starting the test, check the cooling water and oil of the engine, and automatic transmission fluid level of automatic transmission. Also, conduct sufficient warm-up operation of the engine and transmission.

- Fit the chocks securely at the front (rear) of the front (rear) wheels and engage the parking brake to prevent the vehicle from moving. In addition, when pushing the accelerator pedal down, depress the foot brake strongly.
- Start the engine and engage the range selector lever into D range.
- Push the accelerator pedal down slowly to the full acceleration; when the engine comes into a stable speed at a constant speed, read the revolutions (the stall revolutions) quickly, and then take off the foot from the accelerator pedal.

CAUTION⚠

- **Be sure to set a full stall acceleration time as less than 5 seconds, and complete the measurement during that time.**
- **Be careful for overheating of the engine and transmission.**

- Put the range selector lever in "N" range, and conduct the cooling for two (2) minutes or more per 1000 rpm.
  Stall revolutions
  1750±150 rpm

● **Result of diagnosis**

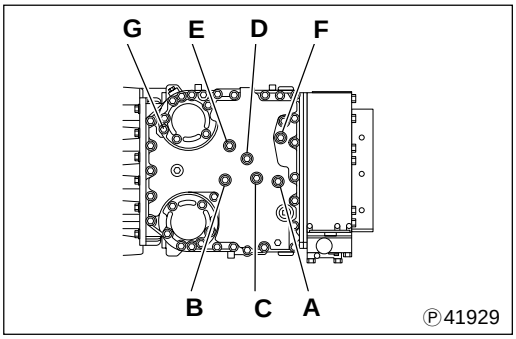
1. In case the stall revolution is too low; if the result of measurement is lower by 150 rpm or more than the standard value, the engine will be malfunctioned.
2. In case the stall revolution is abnormally low (approximately 1/3 of the specified value) even though the engine has no any trouble like emitting black smoke; there may be some abnormality inside the torque converter (one-way clutch failure).
3. In case the stall revolution is too high; if the result of measurement is higher by 150 rpm or more than the standard value, the cause may be due to the slide inside the transmission, cavitations, the bubbling of automatic transmission fluid, or damage of the torque converter.

2. Line pressure test

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
—	Plug	10 to 13 {7.2 to 9.4, 1.0 to 1.3}	—



● Purpose

"Line pressure test" checks the performance of oil pump, function of control valve, and the oil leaking of each component.

● Measurement procedure

Decide the pressure item to check according to the content of troubles, and measure the line pressure based on the following procedure.

- Remove the plug from the pressure detecting port of the gearbox casing, and install the pressure gauge.
  A : Main oil pressure
  B : C1 clutch oil pressure
  C : C2 clutch oil pressure
  D : C3 clutch oil pressure
  E : C4 clutch oil pressure
  F : C5 clutch oil pressure
  G : Lock-up oil pressure
- Conduct a sufficient warm-up operation, and raise oil temperature to 60 to 80°C {140 to176°F}.
- During the idling, measure the oil pressure in each condition when running, and make sure whether the result is within the standard value.
- When making sure the lock-up pressure, remove the propeller shaft, and conduct it in a dummy running condition.
- When having finished the measurement, tighten the plug with the specified torque.

CAUTION⚠

- **Be sure to prevent foreign particles from entering the pressure detecting port.**
- **Remove foreign particles in the pressure detection port before installing the plug.**

	Engine speed rpm	Range	Pressure clutch	Main oil pressure KPa {psi, kgf/cm^2}	Clutch oil pressure KPa {psi, kgf/cm^2}	Lock-up clutch oil pressure KPa {psi, kgf/cm^2}
Oil pressure when idling the engine	580-620	Neutral	C5	1400 to 2000 {203 to 290, 14.3 to 20.4}	—	—
		Reverse	C3, C5	1400 to 2000 {203 to 290, 14.3 to 20.4}	—	—
		1C	C1, C5	1300 to 1970 {189 to 286, 13.3 to 20.1}	—	—
		2C	C1, C4	1300 to 1970 {189 to 286, 13.3 to 20.1}	—	—
Oil pressure when operating	1980-2020	Neutral	C5	1900 to 2300 {275 to 334, 19.4 to 23.5}	1860 to 2300 {270 to 334, 19.0 to 23.5}	—
		Reverse	C3, C5	1790 to 2300 {261 to 334, 18.3 to 23.5}	1760 to 2300 {255 to 334, 18.0 to 23.5}	—
		1C	C1, C5	1550 to 1970 {225 to 286, 15.8 to 20.1}	1480 to 1970 {215 to 286, 15.1 to 20.1}	—
		2C	C1, C4	1550 to 1970 {225 to 286, 15.8 to 20.1}	1480 to 1970 {215 to 286, 15.1 to 20.1}	—
		2L	C1, C4	1050 to 1400 {152 to 203, 10.7 to 14.3}	980 to 1400 {142 to 203, 10.0 to 14.3}	1000 to 1400 {145 to 203, 10.2 to 14.3}
		3L	C1, C3	1050 to 1400 {152 to 203, 10.7 to 14.3}	980 to 1,400 {142 to 203, 10.0 to 14.3}	1000 to 1400 {145 to 203, 10.2 to 14.3}
		4L	C1, C2	1050 to 1400 {152 to 203, 10.7 to 14.3}	980 to 1400 {142 to 203, 10.0 to 14.3}	1000 to 1400 {145 to 203, 10.2 to 14.3}
		5L	C2, C3	1000 to 1350 {145 to 196, 10.2 to 13.8}	930 to 1350 {135 to 196, 9.5 to 13.8}	950 to 1350 {138 to 196, 9.7 to 13.8}
		6L	C2, C4	1000 to 1350 {145 to 196, 10.2 to 13.8}	930 to 1350 {135 to 196, 9.5 to 13.8}	950 to 1350 {138 to 196, 9.7 to 13.8}

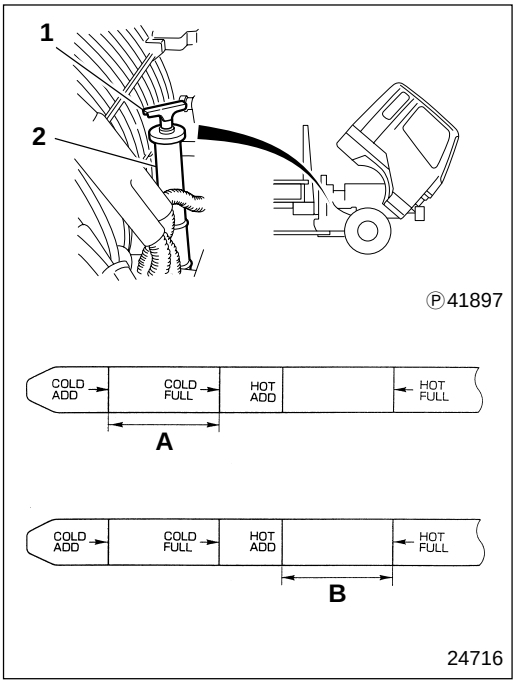
LU: Lock-up
C: In torque converter
L: In lock-up

Result of diagnosis

1. In case the main oil pressure is low in all ranges:
   - ATF level; too low
   - Filter Element; clogged
   - Suction filter; clogged
   - Main oil pressure regulator valve; adhered, and the spring; weakening or broken
   - Inside of control module; leaked
   - Oil pump; worn or broken
2. In case the oil pressure is low in the specific ranges (each clutch oil pressure):
   - If C1 clutch pressure is low; may cause slide or judder at 1st, 2nd, 3rd, or 4th gear.
   - If C2 clutch pressure is low; may cause slide or judder at 4th, 5th, or 6th gear.
   - If C3 clutch pressure is low; may cause slide or judder at 3rd, 5th, or Rev. gear.

- If C4 clutch pressure is low; may cause slide or judder at 2nd, or 6th gear.
- If C5 clutch pressure is low; may cause slide or judder at 1st or Rev. gear.
- If the lock-up clutch pressure is low; the speed extension of vehicle at 2nd or more gear (in lock-up) may be decreased. Or, the shift will not be performed as it is a shift map.

3. Inspection of automatic transmission fluid



(1) Inspection of characteristics

If the automatic transmission fluid smells burnt or if it contains metal particles or sludge as a result of internal friction and wear of metal or other material, the transmission assembly must be completely overhauled. Make sure you carefully examine the automatic transmission fluid on the dipstick. If you find the quality questionable, take a sample and examine it more closely.

(2) Inspection of automatic transmission fluid level

- Park the vehicle on level ground, make sure that the parking brake is fully activated and chock the wheels to keep them from rolling.
- Start the engine and let it idle. To fill the hydraulic circuit with automatic transmission fluid, shift the range selector lever from N → R → N → D → 2 → D → N. Repeat this process five times, finally shifting to N.
- While the engine is still idling, pull out dipstick **1** and wipe off the fluid sticking to it. Reinsert the dipstick, then pull it out again and check the fluid level.
- If the fluid level is inspected right after the engine is started and the fluid temperature is still low (approximately 15 to 49°C {60 to 120°F}), the level should be within area **A** marked COLD on dipstick **1**.
- If the fluid level is inspected after the vehicle has been driven and the fluid temperature is high (approximately 71 to 93°C {160 to 200°F}), the level should be within area **B** marked HOT on dipstick **1**.

WARNING

Since the inspection is conducted with running the engine, be careful of being caught in components, burn hazard, or the safety.

NOTE

- **Make sure to inspect the quantity of automatic transmission fluid at the horizontal level.**
- **Make sure to inspect the quantity of automatic transmission fluid with idling the engine at N range since the apparent quantity of automatic transmission fluid increases in a state of the engine stop.**
- **Remove any dirt of the protection cap and the upper part of filler tube 2 completely before pulling the level gauge 1 out.**
- **Do not raise the engine speed with keeping the engine in a state of idling until the adjustment of quantity of automatic transmission fluid is completed.**

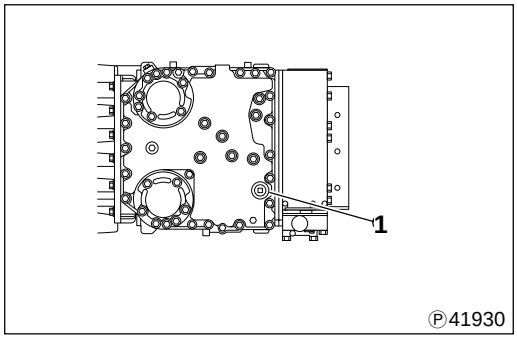
• Reconfirm the automatic transmission fluid level after the vehicle runs actually. In case the quantity of automatic transmission fluid is insufficient, replenish DEXRON III to the specified level of level gauge 1 using filler tube 2.

4. Replacement of automatic transmission fluid

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
—	Drain plug	25 to 32 {18 to 24, 2.6 to 3.3}	—



(1) Draining

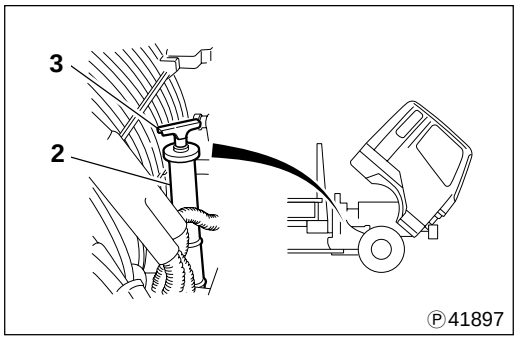
- Park the vehicle on level ground, chock the wheels and shift the selector lever to the **N** position.
- Place a container under oil pan **3**, remove the drain plug and drain the fluid.
- Clean oil pan **3** and the drain plug. Replace the oil filter. 🕮 P23A-19
- Replace the outer oil filter. 🕮 P23A-28

WARNING⚠

Take care because the fluid temperature immediately after the engine has stopped is very high. To avoid scalds, wait until a safe temperature has been reached before draining the fluid.

NOTE

- **The fluid will drain faster if the engine is first run to raise the fluid temperature.**
- **The fluid cannot be drained from the hydraulic circuit, the torque converter or the oil cooler.**
- **Check the drained fluid for dirt, metal particles and metal fragments.**

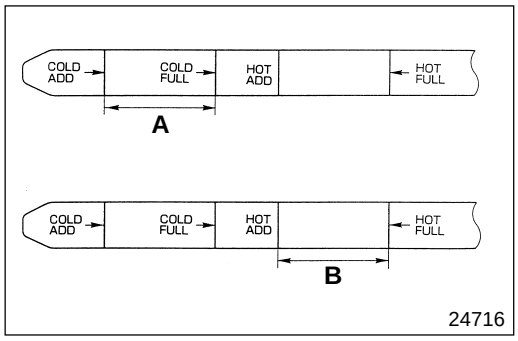


(2) Refill

- Install the oil filter, oil pan **3** and the drain plug. 🕮 P23A–19
- Add automatic transmission fluid (DEXRON or DEXRON II type) through dipstick guide **2**.
  FK : 8.5 L {9.0 qts}
  FM : 15 L {16 qts}

CAUTION⚠

Make sure that dirt and foreign particles do not become mixed in with the fluid when it is added.



- Shift the range selector lever to the **N** position, start the engine and let it idle for about one minute.
- After shifting the lever through all positions once, shift it back to the **N** position.

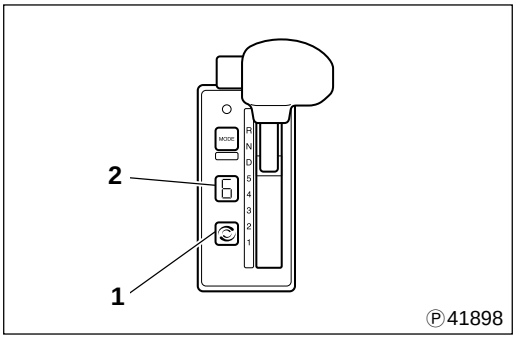
CAUTION⚠

To prevent burning out the interior of the automatic transmission assembly, make sure that the engine is not allowed to race when you do the above.

NOTE

- **After adding automatic transmission fluid, it may be difficult to see the level of automatic transmission fluid easily due to the automatic transmission fluid adhering to the inner wall of filler tube 2; therefore, reconfirm it after a short time.**
- **If overfilling automatic transmission fluid, the automatic transmission fluid begins to overflow from the air breather; as result, it might be misunderstood that the leakage of automatic transmission fluid be caused.**
- **Add automatic transmission fluid gradually, letting the engine idle, while paying careful attention to the level of automatic transmission fluid.**

5. Level check of automatic transmission fluid



This automatic transmission can check automatic transmission fluid level by operating the range selector.

Conditions required on check

- Stop the vehicle at the flat place, and put the range selector in “N” position.
  (Neutral must be selected.)
- Automatic transmission fluid must be warm.
  (oil temperature 60 to 104°C {140 to 219°F})
- Stabilize oil level at intervals of two (2) minutes or more after stopping the vehicle.
- Allow the engine to idle.

Check operation

- Push display switch button 1 of the range selector
- Various code No. are displayed in the position display 2 of the selector following “O” and “L” (indicating check mode of automatic transmission fluid level) after approximately two (2) minutes.

Judgment of check result

The code No. indicated means as follows:

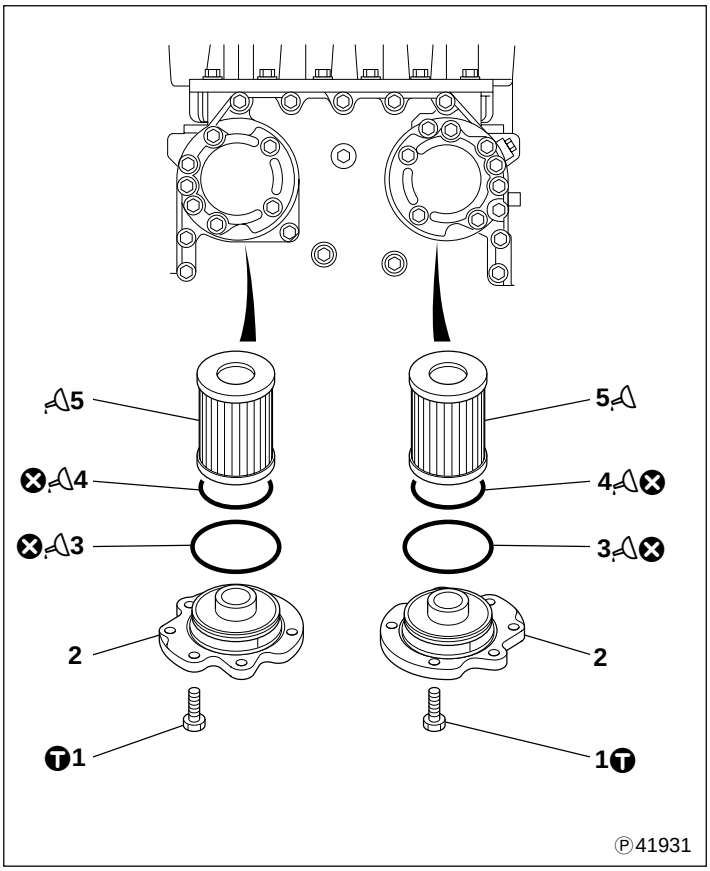
- “OL”, “OK”, and “--” ; automatic transmission fluid level is appropriate.
- “OL”, “LO”, and “XX”; automatic transmission fluid must be added by approximately XX liter.
- “OL”, “HI”, and “XX”; automatic transmission fluid must be extracted by approximately XX liter.
- “OL”, “--”, and “XX” ; check the level again based on the following table since the level could not be checked.

Display code No. XX	Contents
“50”	The engine speed is too low.
“59”	The engine speed is too high.
“65”	Range selection hot in neutral.
“70”	Oil temperature is too low.
“79”	Oil temperature is too high.
“89”	The output shaft rotates.
“95”	Trouble of oil temperature sensor

Operation after the check has ended.

After the check has ended, put the range selector in either of position, “Reverse”, “Neutral”, or “Drive”.

6. Replacement of oil filter



● **Disassembly sequence**

1 Bolt
2 Filter cover
3 Seal
4 O-ring
5 Filter

* : Automatic transmission assembly
⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

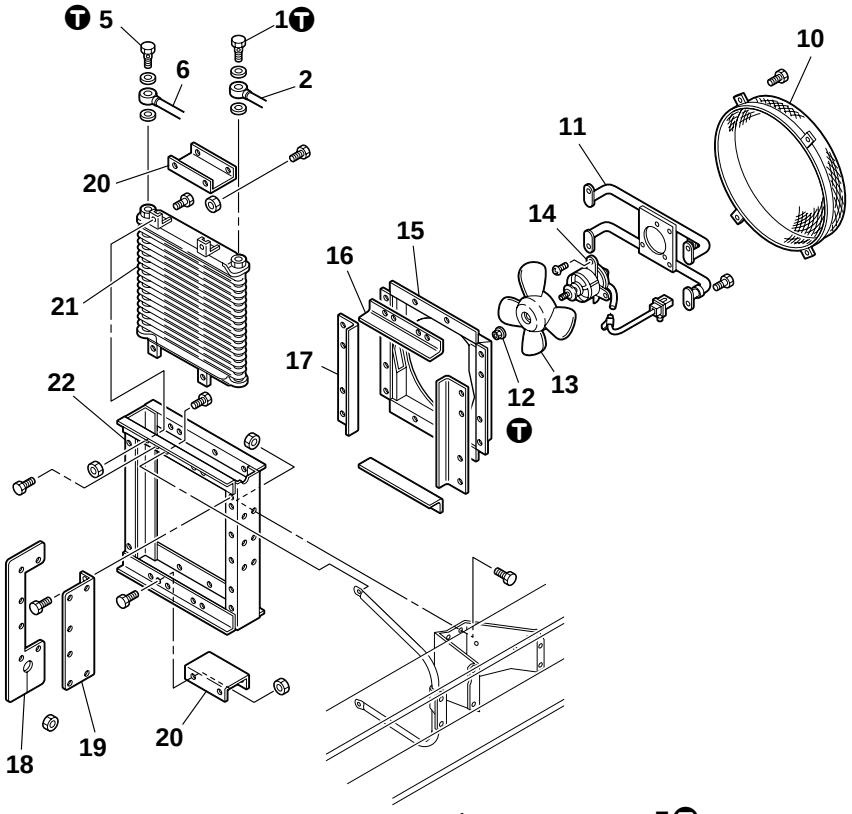
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (installing filter cover)	51 to 61 {38 to 45, 5.2 to 6.2}	—

Lubricant

Location	Points of application	Specified fluid	Quantity
2	Seal	DEXRON III	As required
4	O-ring	DEXRON III	As required
5	Engagement part of filter	DEXRON III	As required

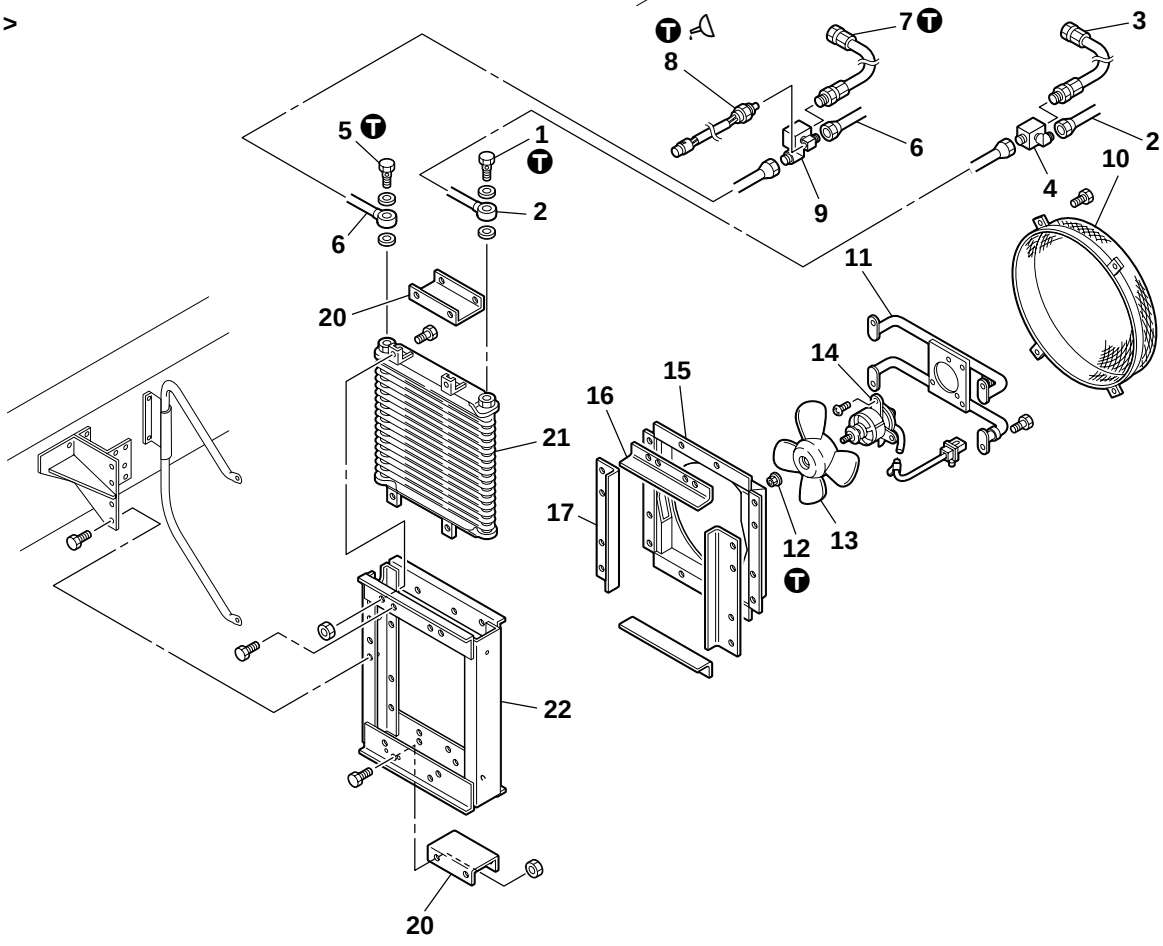
OIL COOLER

< RH >



Ⓟ41899

< LH >



Ⓟ41900

● **Disassembly sequence**

1 Eye bolt
2 Oil pipe
3 Oil hose
4 Connector
5 Eye bolt
6 Oil pipe
7 Oil hose
8 Oil temperature sensor
9 Connector
10 Fan cover
11 Fan Motor bracket
12 Nut
13 Fan assembly
14 Motor assembly Gr 54
15 Fan shroud
16 Fan shroud A
17 Fan shroud B
18 Baffle plate < RH >
19 Baffle plate bracket < RH >
20 Stay
21 Oil cooler
22 Oil cooler bracke

● **Assembly sequence**

Follow the disassembly sequence in reverse.

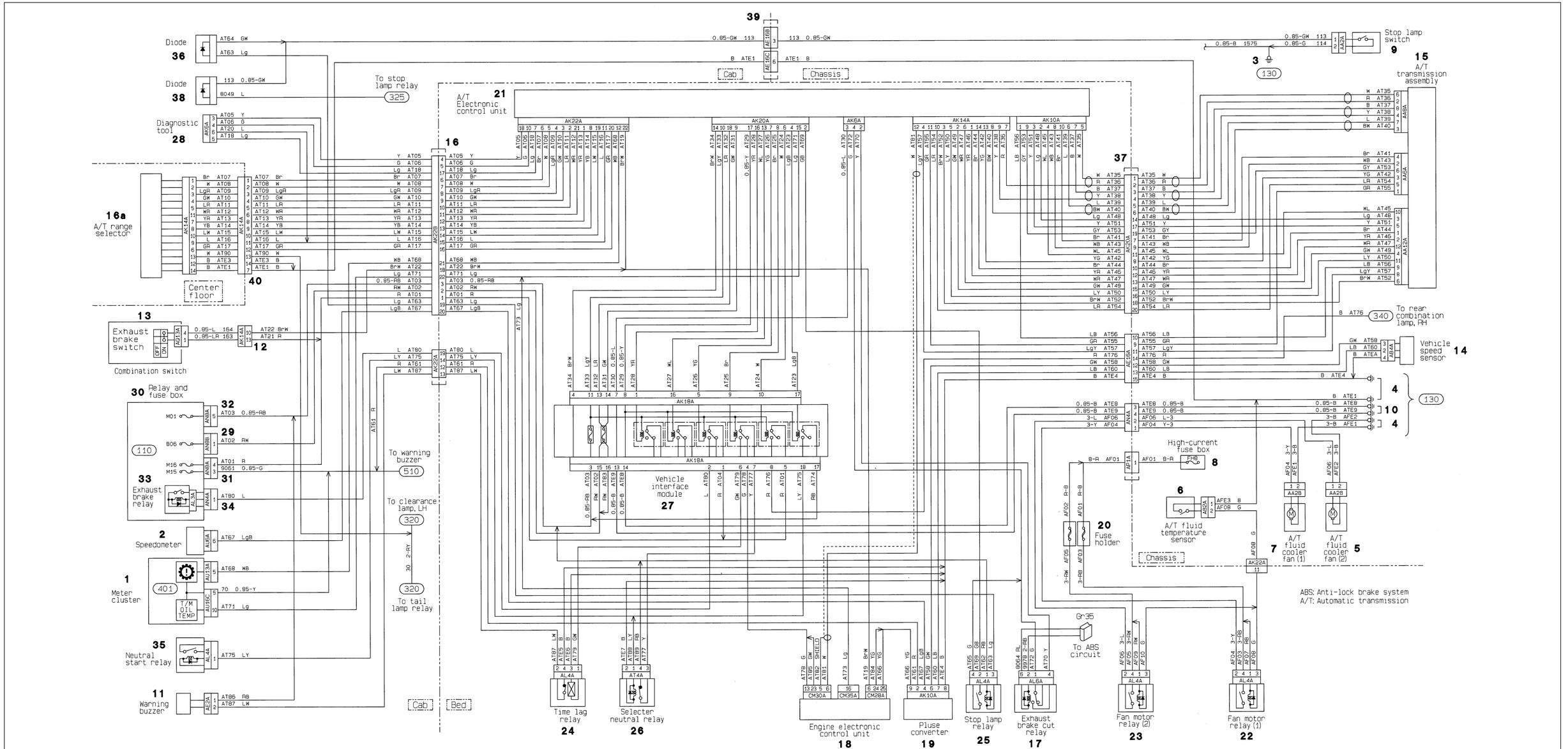
Tightening torque

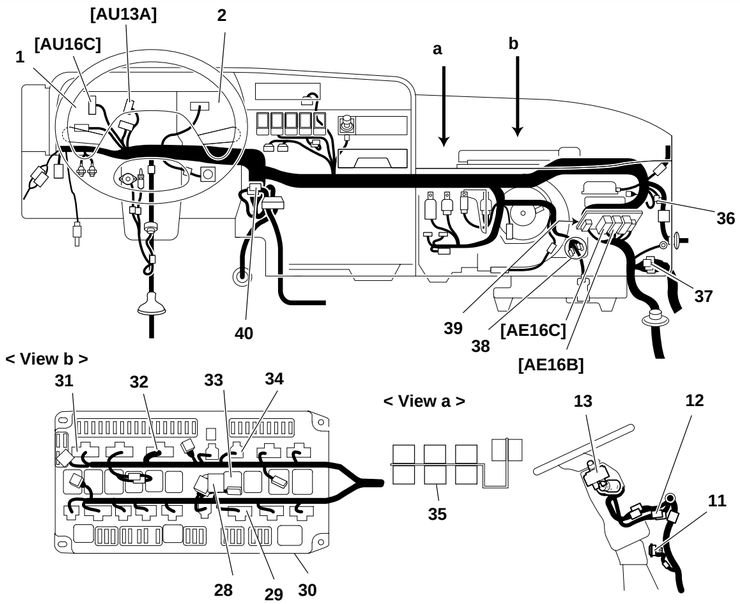
Unit : N·m {ft.lbs, kgf·m}

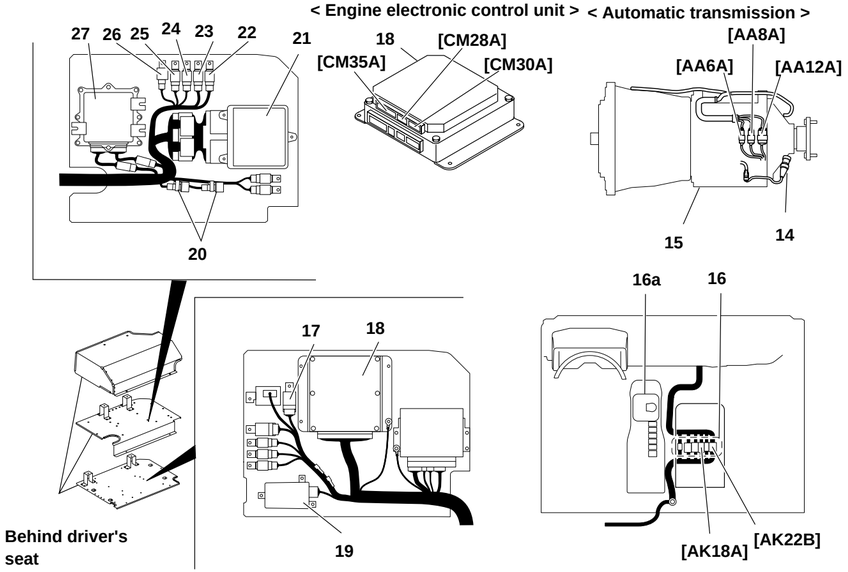
Location	Parts to be tightened	Tightening torque	Remarks
1, 5	Eye bolt	59 to 88 {43 to 65, 6 to 9}	—
8	Oil temperature sensor	29 to 39 {22 to 29, 3 to 4}	—
12	Nut (Fan assembly mounting)	4.9 to 7.5 {3.6 to 5.5, 0.50 to 0.76}	—

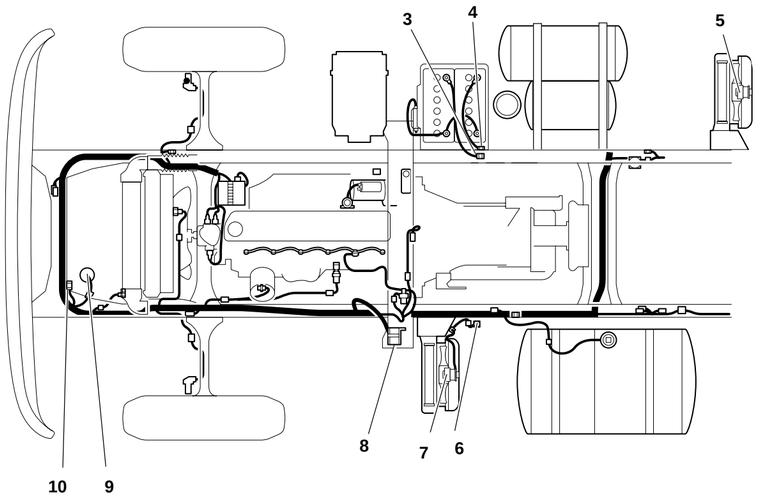
Sealant

Location	Points of application	Specified fluid	Quantity
8	Apply the sealant on the screw of oil temperature sensor.	THREEBOND 1110B	As required


Diode
36
Diode
38
Diagnostic tool
28
To stop lamp relay
325
A/T Electronic control unit
21
16
16a
A/T range selector
Center floor
40
13
Exhaust brake switch
Combination switch
12
30
Relay and fuse box
32
29
31
33
Exhaust brake relay
34
2
Speedometer
1
Meter cluster
35
Neutral start relay
11
Warning buzzer
To warning buzzer
510
To clearance lamp, LH
320
To tail lamp relay
320
Cab
Bed
Time lag relay
24
Selecter neutral relay
26
Vehicle interface module
27
39
Cab
Chassis
Stop lamp switch
9
3
130
15
A/T transmission assembly
37
To rear combination lamp, RH
340
Vehicle speed sensor
14
4
10
4
130
High-current fuse box
8
6
A/T fluid temperature sensor
20
Fuse holder
7
A/T fluid cooler fan (1)
5
A/T fluid cooler fan (2)
Chassis
ABS: Anti-lock brake system
A/T: Automatic transmission
To ABS circuit
Engine electronic control unit
18
Pluse converter
19
Stop lamp relay
25
Exhaust brake cut relay
17
Fan motor relay (2)
23
Fan motor relay (1)
22
44228







1 Meter cluster
2 Speedometer
3 Ground
4 Ground
5 Automatic transmission fluid cooler fan (2)
6 Automatic transmission fluid temperature sensor (for fan motor)
7 Automatic transmission fluid cooler fan (1)
8 High current fuse box
9 Stop lamp switch
10 Ground
11 Warning buzzer
12 Connection of cab harness and combination switch harness
13 Combination switch
14 Vehicle speed sensor
15 Automatic transmission assembly
16 Connection of cab harness and bed harness
16a Automatic transmission range selector
17 Exhaust brake cut relay
18 Engine electronic control unit
19 Pulse converter
20 Fuse holder
21 Automatic transmission electronic control unit
22 Fan motor relay 1
23 Fan motor relay 2
24 Time lag relay
25 Stop lamp relay
26 Selector neutral relay
27 Vehicle interface module
28 Diagnostic tool
29 Connector
30 Relay & fuse box
31 Connector
32 Connector
33 Exhaust brake relay
34 Connector
35 Neutral start relay
36 Diode
37 Connection of bed harness and chasiss harness
38 Diode
39 Connection of cab harness and chasiss harness
40 Connection of cab harness and center floor harness

MITSUBISHI
FUSO

Group 25

Propeller Shaft

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-25

INDEX

SPECIFICATIONS 25- 2

STRUCTURE AND OPERATION 25- 2

TROUBLESHOOTING 25- 4

REMOVAL AND INSTALLATION OF PROPELLER SHAFT 25- 6

REAR PROPELLER SHAFT

< P4 > 25- 8

< P8 > 25-12

< P10 > 25-16

FRONT PROPELLER SHAFT

< P4 > 25-20

< P8 > 25-24

< P10 > 25-30

BALANCING PROPELLER SHAFT 25-35

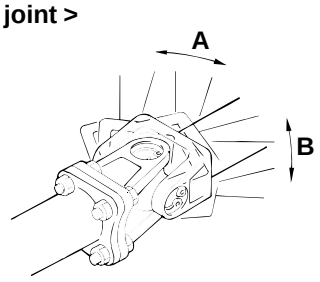
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

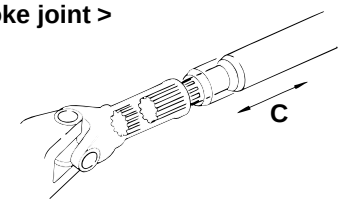
Item \ Vehicle model			FK617	FM617 FM657-A	FM657-B, C, D
Propeller shaft	Model		P4	P8	P10
Pipe	Outer diameter×Wall thickness	mm {in.}	90×2.6 {3.54×0.10}	90×3.2 {3.54×0.13}	101.6×3.2 {4.0×0.13}
Universal joint	Spider outer diameter	mm {in.}	26.7 {1.05}	28.56 {1.12}	30.494 {1.20}
Needle roller bearing	Outer diameter	mm {in.}	3.0 {0.12}	3.46 {0.14}	3.55 {0.14}
	Length of neddle roller	mm {in.}	21.8 {0.86}	20.8 {0.82}	22.8 {0.90}
	Quantity of neddle rollers		31	29	30
Slip yoke joint	Spline diameter	mm {in.}	48 {1.89}	54 {2.13}	54 {2.13}
Center bearing	Model No.		6209	6211	6211
	Inner diameter×Outer diameter	mm {in.}	45×85 {1.77×3.35}	55×100 {2.17×3.94}	55×100 {2.17×3.94}

STRUCTURE AND OPERATION
Swing of Propeller Shaft

< Universal joint >



< Slip yoke joint >

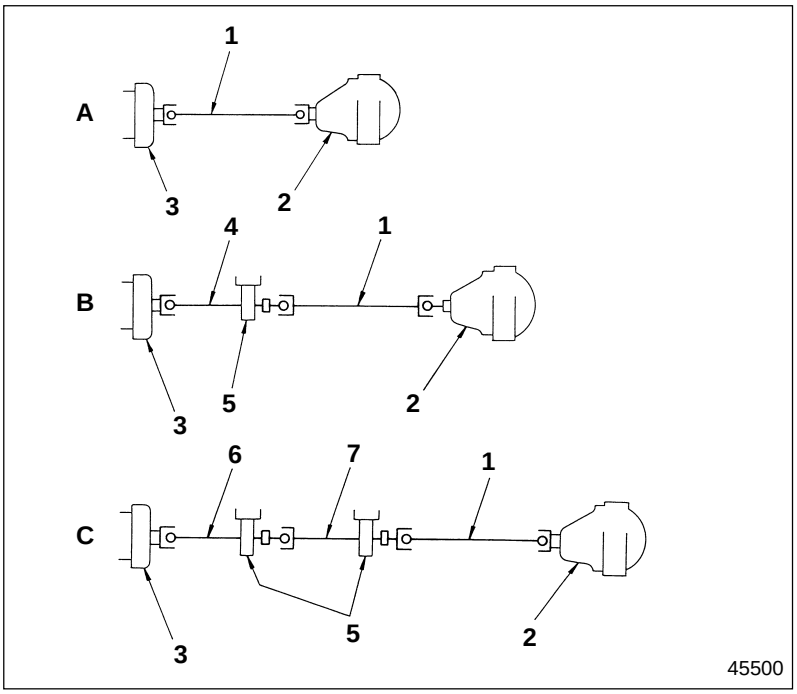


00815

A : Lateral swing
B : Longitudinal swing
C : Fore-and-aft movement

Relative positions of transmission, rear axle and front axle vary depending on the fluctuation of the road surface and load carried when operating the vehicle. The universal joint and the slip yoke joint are provided to absorb these influences.

Configuration of Propeller Shaft Connection



1 Rear propeller shaft
2 Rear axle
3 Parking brake drum < except FM657 >
Transmission < FM657 >
4 Front propeller shaft
5 Center bearing
6 Front propeller shaft No. 1
7 Front propeller shaft No. 2

A : Single-shaft connection
B : Twin-shaft connection
C : Triple-shaft connection

NOTE

In FM617F, front propeller shaft 4 is shifted 90˚ in phase.

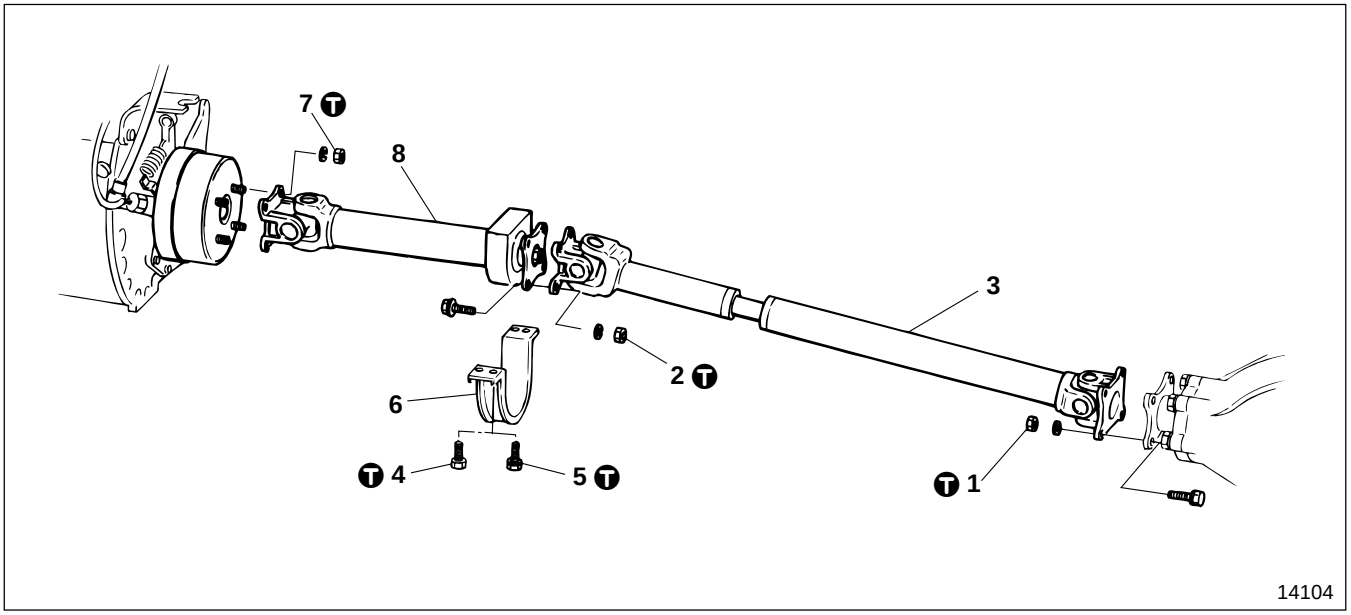
TROUBLESHOOTING

TROUBLESHOOTING

Possible causes \ Symptoms		Propeller shaft vibrating		Noise from propeller shaft		
		Vibration at high speed	Vibration at low speed	Noise when starting or while coasting	Noise while cruising	Clicking noise
Flange yoke assembly direction incorrect		○				
Companion flange tightening torque excessive						○
Slip yoke joint	Lubrication insufficient				○	
	Spline play excessive		○	○		
Universal joint	Clearance in spider axial direction excessive		○		○	
	Needle bearing lubricated insufficiently				○	
	Needle bearing worn	○		○	○	
Center bearing < Twin-shaft and triple-shaft connection >	Lubrication insufficient				○	
	Seized, worn, or rotation faulty	○			○	
	Cushion rubber deteriorated or deformed			○		
	Bracket mounting bolt loose			○		
Propeller shaft	Mounting bolt loose	○		○		
	Bent	○				
	Dynamic balance adjusted incorrectly	○				
Transmission gear selection too high			○			

M E M O

REMOVAL AND INSTALLATION OF PROPELLER SHAFT



● **Work before removal**

P25-7

● **Removal sequence**

1 Nut
2 Nut
3 Rear propeller shaft
P25-8
4 Bolt
5 Bolt
6 Center bearing bracket
7 Nut
8 Front propeller shaft
P25-20

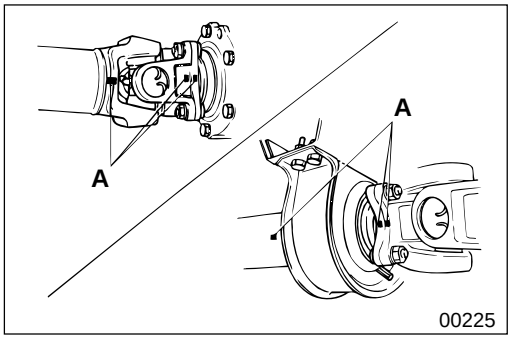
● **Installation sequence**

Follow the removal sequence in reverse.

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Propeller shaft mounting at rear axle side)	P4, P8	85 {61, 8.5}	—
		P10	120 to 180 {87 to 130, 12 to 18}	—
2	Nut (Propeller shaft mounting at center bearing side)	P4, P8	85 {61, 8.5}	—
		P10	120 to 180 {87 to 130, 12 to 18}	—
4	Bolt (Center bearing bracket mounting)	P4	39 to 59 {28 to 43, 3.9 to 6.0}	—
		P8 , P10	70 to 95 {51 to 69, 7.0 to 9.5}	—
5	Bolt (Center bearing bracket mounting)	P4	36 to 52 {25 to 40, 3.5 to 5.5}	With spring washer
7	Nut (Propeller shaft mounting at propeller shaft side)	P4, P8	85 {61, 8.5}	—
		P10	120 to 180 {87 to 130, 12 to 18}	—



◆ Service procedure

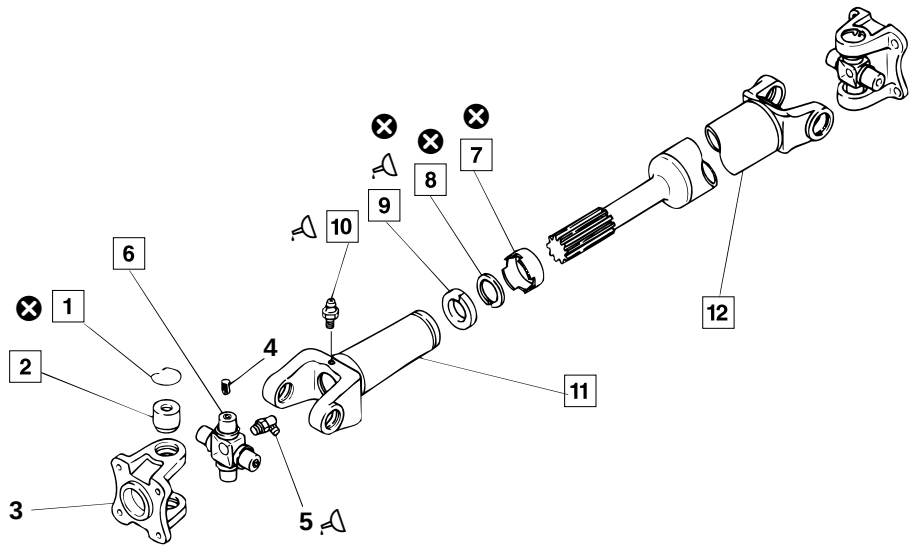
● **Work before removal**

WARNING⚠

- **Since the propeller shaft will be removed, the parking brake (center parking brake) cannot be used. Therefore, you must chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**

Remember to make alignment marks **A** before removal.

REAR PROPELLER SHAFT < P4 >



04404

● **Inspection before disassembly**

P25-9

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease keeper
5 Grease nipple
6 Spider
7 Dust cap
8 Retainer
9 Cork seal
10 Grease nipple
11 Slip yoke joint
12 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

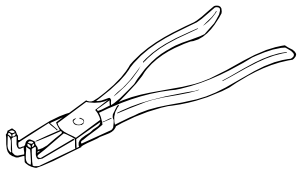
Unit : mm {in.}

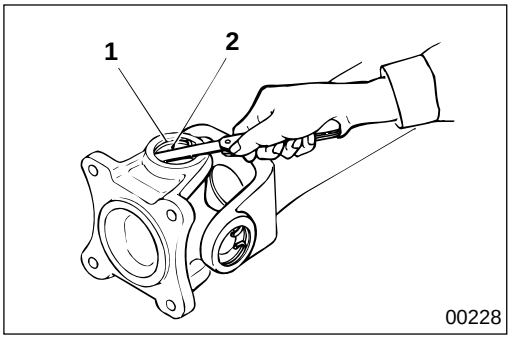
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 6	Clearance of spider in axial direction	0 to 0.25 {0 to 0.0098}	—	Adjust
2, 6	Clearance between needle bearing and spider	[26.7] 0.02 to 0.07 {[1.05] 0.00079 to 0.0028}	0.2 {0.0079}	Replace
11, 12	Play to revolving direction between slip yoke joint and rear propeller shaft	0.07 to 0.18 {0.0028 to 0.0071}	0.3 {0.012}	Replace
12	Bend of rear propller shaft (Center)	—	0.6 {0.024}	Correct or replace

Lubricant

Location	Points of application	Kinds	Quantity
5	Supply via grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	Pack until grease overflows from spider dust cover
9	Inner surface of cork seal	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
10	Supply via grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	Pack until grease overflows from dust plug hole

Special tools

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  00227	MH061001	Removal and installation of snap ring



00228

◆ Service procedure

● **Inspection before disassembly**

Clearance in axial direction for spider

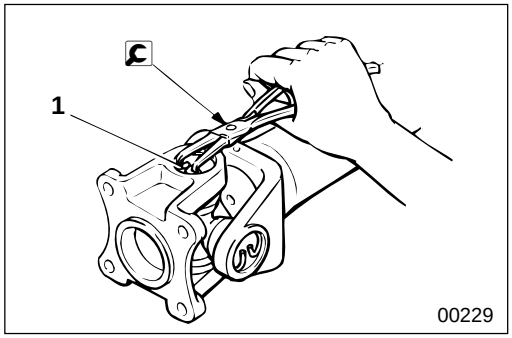
Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

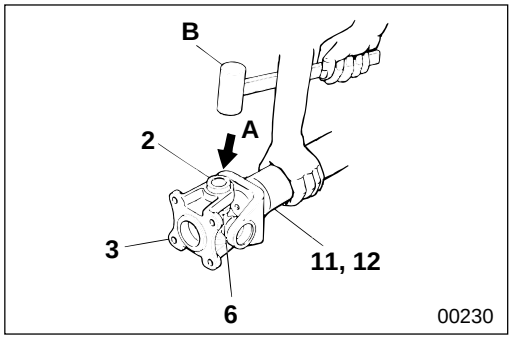
Part name	Thickness	Identification color
Snap ring A	2.5 mm {0.098 in.}	Green
Snap ring B	2.6 mm {0.10 in.}	Red

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.

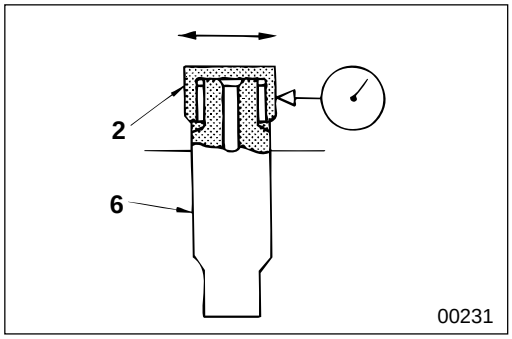


1 **Removal and installation of snap ring**



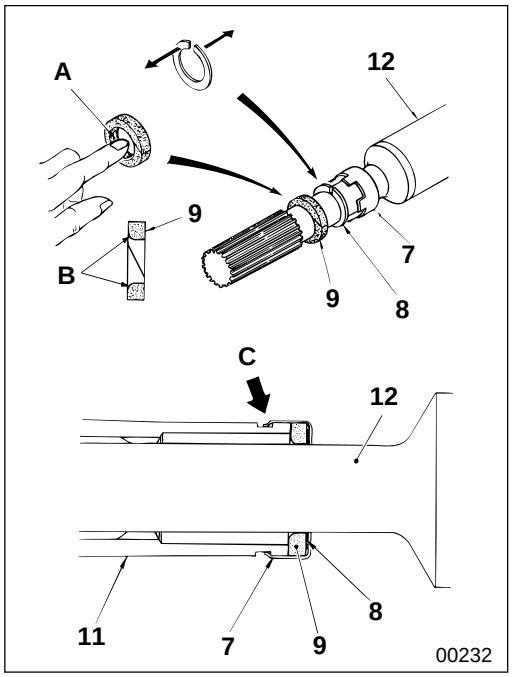
2 **Removal of needle bearing**

- Put alignment marks on needle bearing **2** and spider **6**.
- Put alignment marks across flange yoke **3**, slip yoke joint **11** and rear propeller shaft **12**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.
  B : Mallet



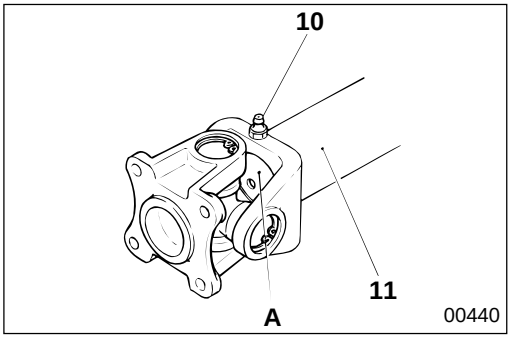
2 **6** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **2** and spider **6**. If the measured value is higher than the limit, replace with universal joint spider kit.



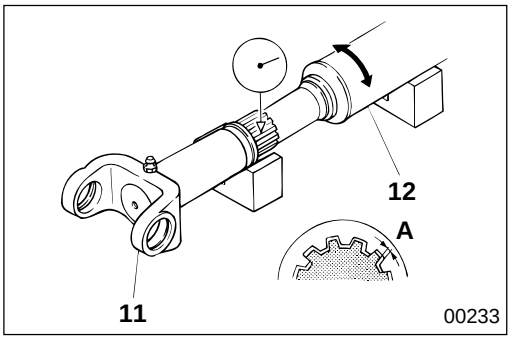
7 **to** **9** **Assembly of dust cap, retainer and cork seal**

- Insert dust cap **7** into rear propeller shaft **12** and expand retainer **8** carefully to mount it on the propeller shaft. Then, release the retainer and allow it to return to its original shape.
- Apply grease to inner surface **A** of cork seal **9**, face its chamfered side **B** towards the spline and mount in the same way as retainer **8**.
- Press cork seal **9**, compressing it by 1 to 2 mm {0.039 to 0.079 in.}, against slip yoke joint **11**, then caulk pawl area **C**.



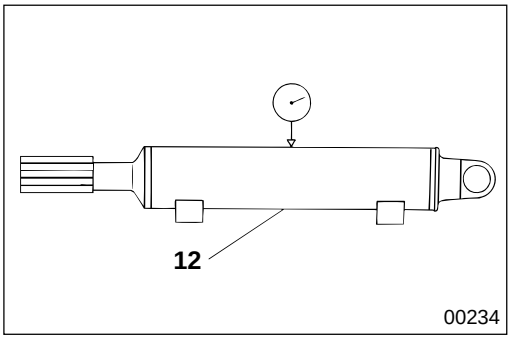
10 **Supply of grease via grease nipple**

Pack grease via grease nipple **10** until grease starts overflowing from the hole in dust plug **A** of slip yoke joint **11**.



11 **12** **Play between slip yoke joint and rear propeller shaft spline in rotating direction**

Measure play **A** in the rotation direction between slip yoke joint **11** and rear propeller shaft **12** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



12 **Bend of rear propeller shaft**

Measure bend of rear propeller shaft **12** at its center. If the measured value is higher than the limit, correct or replace it.

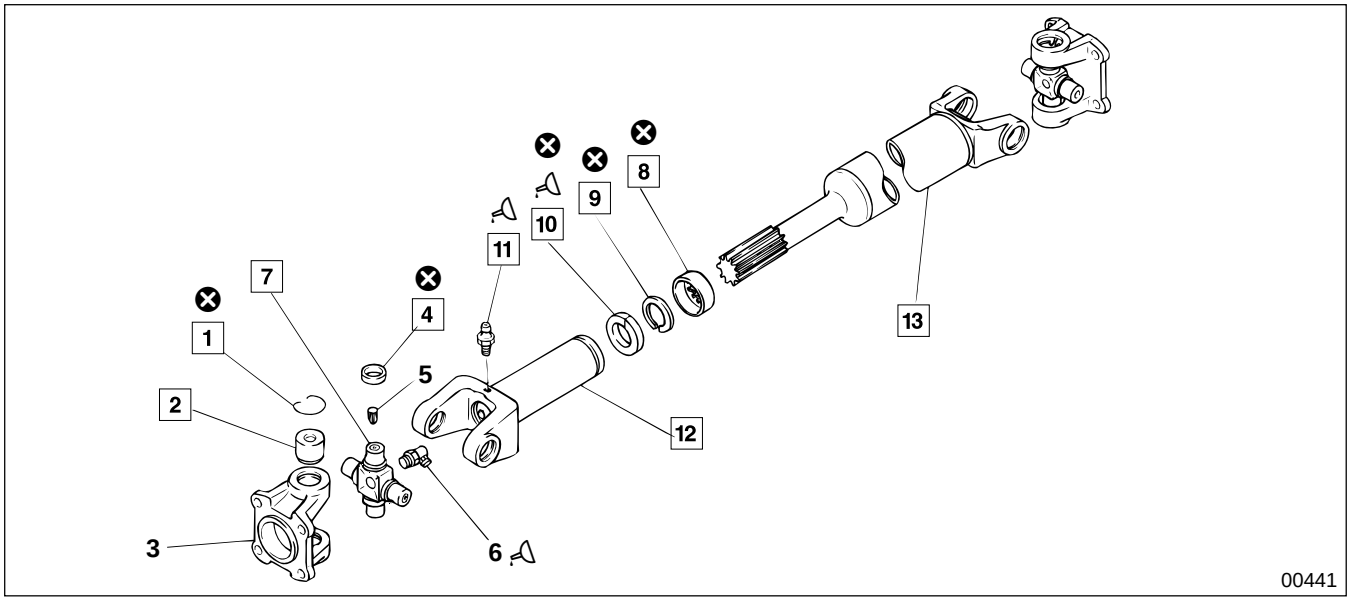
CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of rear propeller shaft 12, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

REAR PROPELLER SHAFT < P8 >



● **Inspection before disassembly**

P25-13

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Dust seal
5 Grease keeper
6 Grease nipple
7 Spider
8 Dust cap
9 Retainer
10 Cork seal
11 Grease nipple
12 Slip yoke joint
13 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

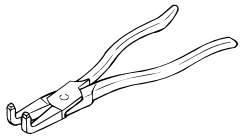
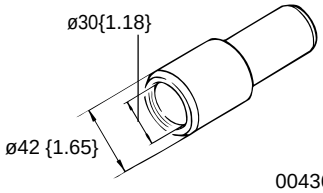
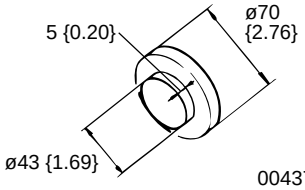
Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 7	Clearance of spider in axial direction	0 to 0.15 {0 to 0.0059}	—	Adjust
2, 7	Clearance between needle bearing and spider	[28.56] 0.02 to 0.07 {[1.12] 0.00079 to 0.0028}	0.2 {0.0079}	Replace
12, 13	Play to revolving direction between slip yoke joint and rear propeller shaft	0.07 to 0.18 {0.0028 to 0.0071}	0.3 {0.012}	Replace
13	Bend of rear propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Lubricant

Location	Points of application	Kinds	Quantity
6	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust seal
10	Inner surface of cork seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
11	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from dust plug hole

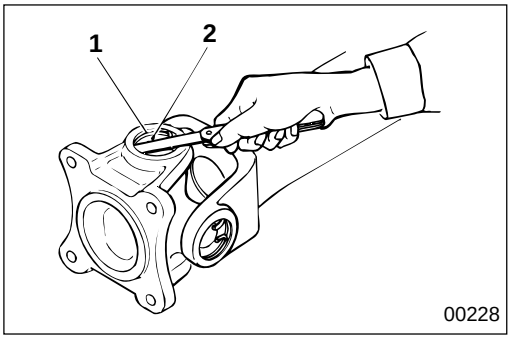
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  00227	MH061001	Removal and installation of snap ring
4	Dust seal installer  00436	03724-04000	Press-fitting of spider dust seal
4	Spider assembly rest A  00437	03724-13000	Press-fitting of spider dust seal

◆ Service procedure

● **Inspection before disassembly**



00228

Clearance in axial direction for spider

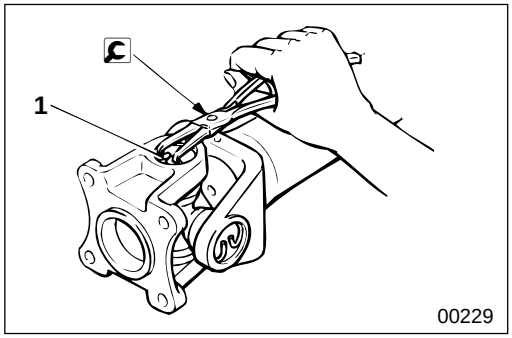
Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

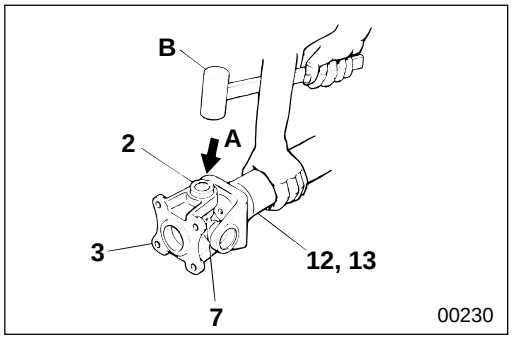
Part name	Thickness	Identification color
Snap ring A	3mm {0.118 in.}	Green
Snap ring B	3.05mm {0.120 in.}	White
Snap ring C	3.1mm {0.122 in.}	Red
Snap ring D	3.15mm {0.124 in.}	Blue
Snap ring E	3.2mm {0.126 in.}	Yellow

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.

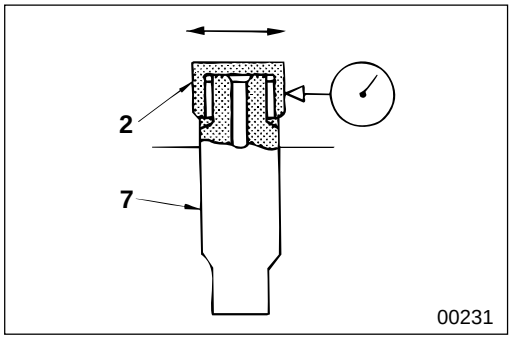


1 **Removal and installation of snap ring**



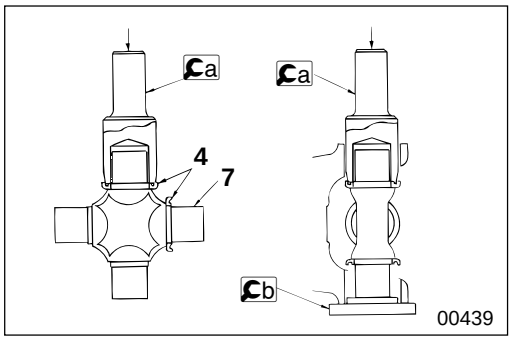
2 **Removal of needle bearing**

- Put alignment marks on needle bearing **2** and spider **7**.
- Put alignment marks across flange yoke **3**, slip yoke joint **12** and rear propeller shaft **13**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.
  B : Mallet

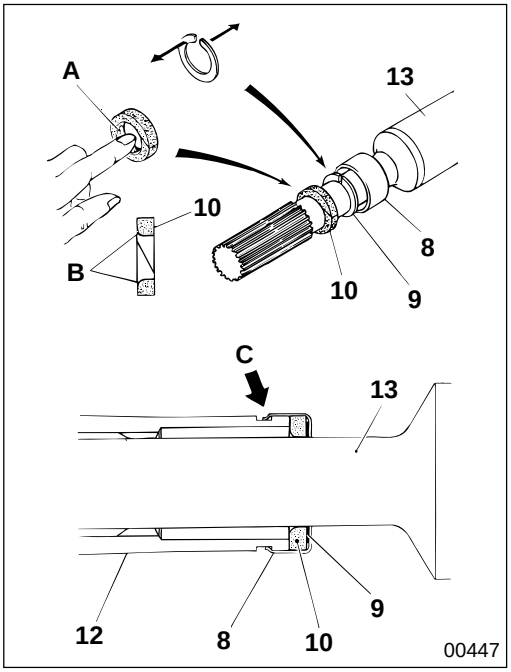


2 **7** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **2** and spider **7**. If the measured value is higher than the limit, replace with universal joint spider kit.

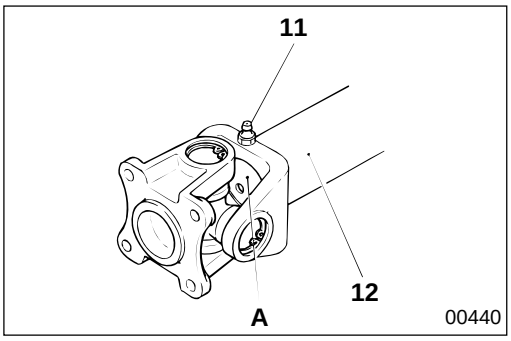


4 **Mounting of dust seal**



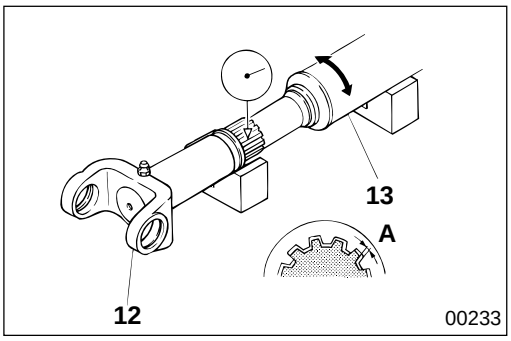
8 **to** **10** **Assembly of dust cap, retainer and cork seal**

- Insert dust cap **8** into rear propeller shaft **13** and expand retainer **9** carefully to mount it on the propeller shaft. Then, release the retainer and allow it to return to its original shape.
- Apply grease to inner surface **A** of cork seal **10**, face its chamfered side **B** towards the spline and mount in the same way as the retainer.
- Press cork seal **10**, compressing it by 1 to 2 mm {0.039 to 0.079 in.}, against slip yoke joint **12**, then caulk area **C**.



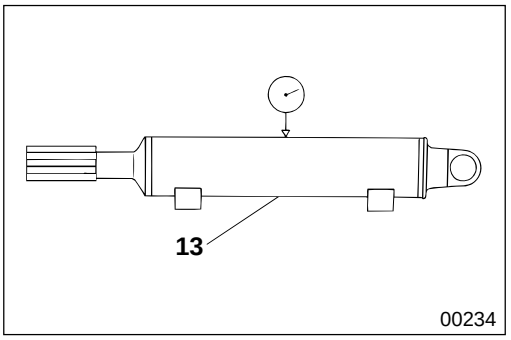
11 **Supply of grease via grease nipple**

Pack grease via grease nipple **11** until grease starts overflowing from the hole in dust plug **A** of slip yoke joint **12**.



12 **13** **Play between slip yoke joint and rear propeller shaft spline in rotating direction**

Measure play **A** in the rotation direction between slip yoke joint **12** and rear propeller shaft **13** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



13 **Bend of rear propeller shaft**

Measure bend of rear propeller shaft **13** at its center. If the measured value is higher than the limit, correct or replace it.

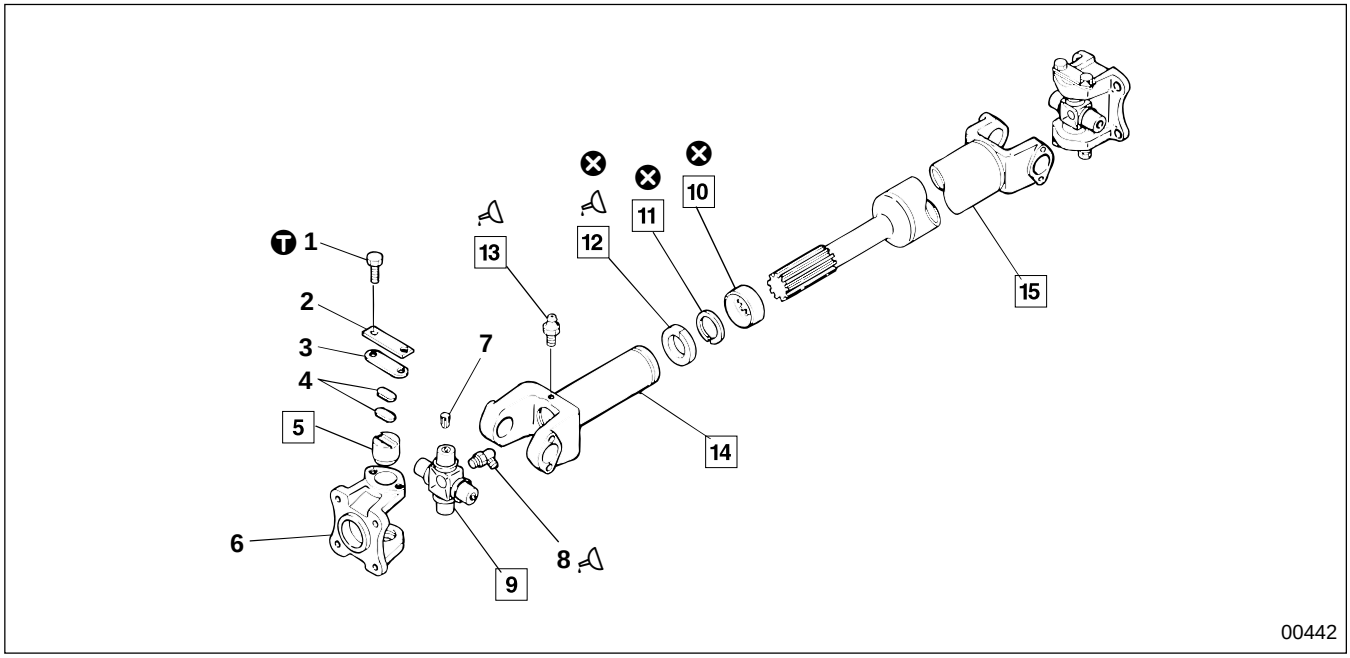
CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of rear propeller shaft 13, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

REAR PROPELLER SHAFT < P10 >



● **Inspection before disassembly**

P25-17

● **Disassembly sequence**

1 Bolt
2 Lock plate
3 Bearing case retainer
4 Shim
5 Needle bearing
6 Flange yoke
7 Grease keeper
8 Grease nipple
9 Spider
10 Dust cap
11 Retainer
12 Cork seal
13 Grease nipple
14 Slip yoke joint
15 Rear propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 9	Clearance of spider in axial direction	0 to 0.15 {0 to 0.0059}	—	Adjust
5, 9	Clearance between needle bearing and spider	[30.494] 0.02 to 0.08 {[1.20] 0.00079 to 0.0031}	0.2 {0.0079}	Replace
14, 15	Play to revolving direction between slip yoke joint and rear propeller shaft	0.07 to 0.18 {0.0028 to 0.0071}	0.3 {0.012}	Replace
15	Bend of rear propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

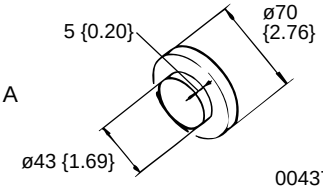
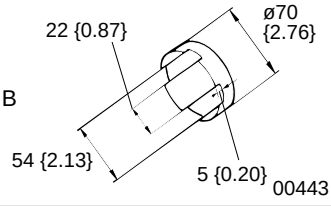
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Needle bearing mounting)	18 to 26 {13 to 20, 1.8 to 2.7}	—

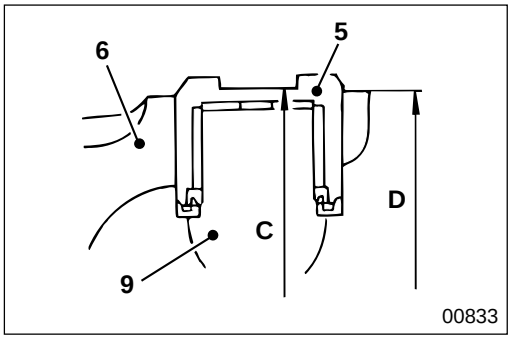
Lubricant

Location	Points of application	Kinds	Quantity
8	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust cover
12	Inner surface of cork seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from dust plug hole

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Spider assembly rest A 	03724-13000	Press-fitting of needle bearing
6	Spider assembly rest B 	03724-14000	Press-fitting of needle bearing



◆ Service procedure

● Inspection before disassembly

Clearance in axial direction for spider

Measure the clearance of needle bearing **5** (shim adjustment clearance = **D** – **C**). If the measured value is higher than the standard value, adjust it by changing the thickness of shim **4**.

- Available shim thicknesses

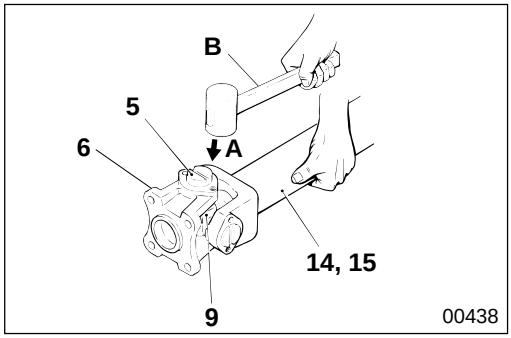
Part name	Thickness
Shim A	0.1 mm {0.0039 in.}
Shim B	0.2 mm {0.0079 in.}

CAUTION⚠

Make sure that shim 4 does not protrude above the surface of flange yoke 6 or needle bearing 5 will seize up.

NOTE

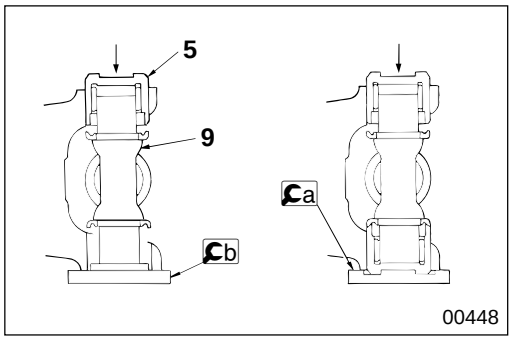
For shim 4, it is recommended that you use shims with the same thickness on both ends to ensure balanced revolution.



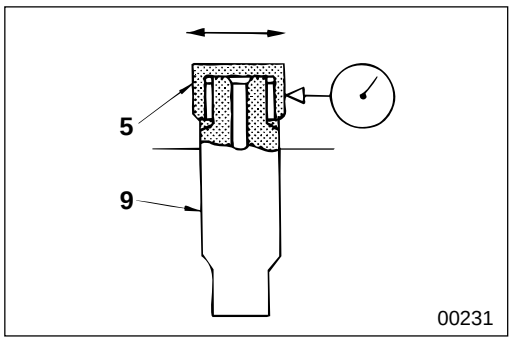
5 Needle bearing

[Removal]

- Put alignment marks on needle bearing **5** and spider **9**.
- Put alignment marks across flange yoke **6**, slip yoke joint **14** and rear propeller shaft **15**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **5** bounces out due to reaction.
  B : Mallet

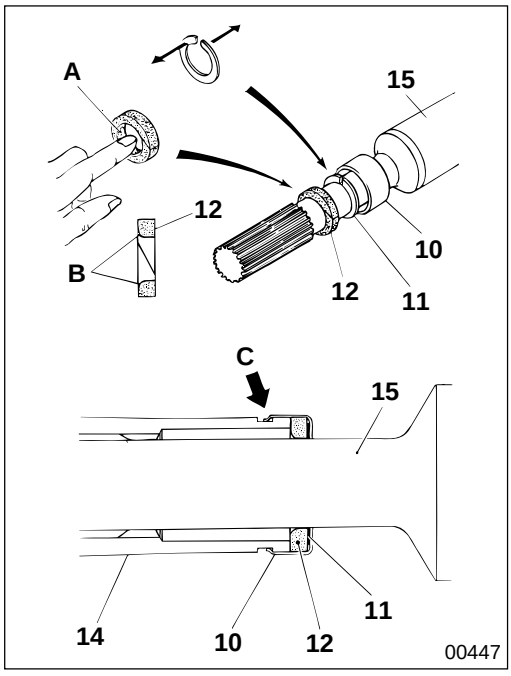


[Installation]



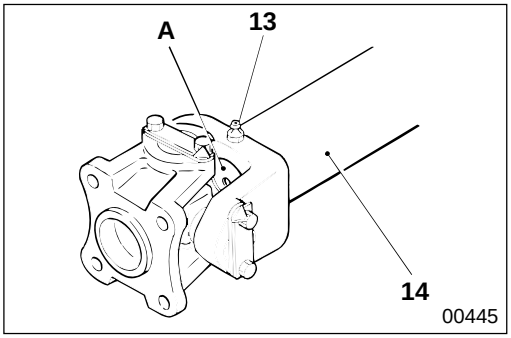
5 **9** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **5** and spider **9**. If the measured value is higher than the limit, replace with universal joint spider kit.



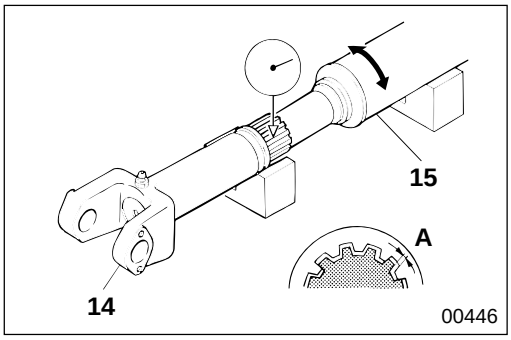
10 **to** **12** **Assembly of dust cap, retainer and cork seal**

- Insert dust cap **10** into rear propeller shaft **15** and expand retainer **11** carefully to mount it on the propeller shaft. Then, release the retainer and allow it to return to its original shape.
- Apply grease to inner surface **A** of cork seal **12**, face its chamfered side **B** towards the spline and mount in the same way as the retainer.
- Press cork seal **12**, compressing it by 1 to 2 mm {0.039 to 0.079 in.}, against slip yoke joint **14**, then caulk pawl area **C**.



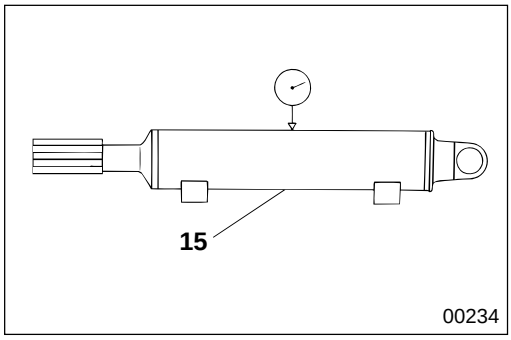
13 **Supply of grease via grease nipple**

Pack grease via grease nipple **13** until grease starts overflowing from the hole in dust plug **A** of slip yoke joint **14**.



14 **15** **Play between slip yoke joint and rear propeller shaft spline in rotating direction**

Measure play **A** in the rotation direction between slip yoke joint **14** and rear propeller shaft **15** at the spline area. If the measured value is higher than the limit, replace the faulty parts.



15 **Bend of rear propeller shaft**

Measure bend of rear propeller shaft **15** at its center. If the measured value is higher than the limit, correct or replace it.

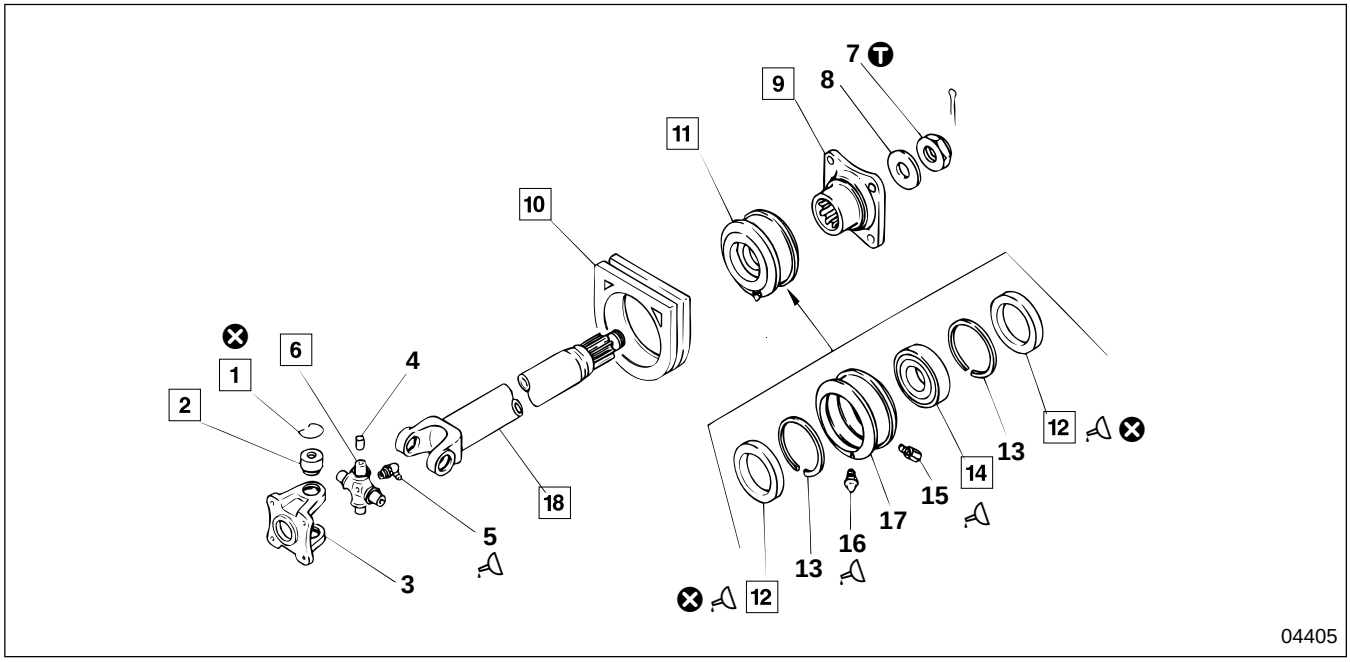
CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of rear propeller shaft 15, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

FRONT PROPELLER SHAFT < P4 >



● **Inspection before disassembly**

P25-21

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Grease keeper
5 Grease nipple
6 Spider
7 Nut
8 Washer
9 Companion flange
10 Cushion rubber
11 Center bearing
12 Oil seal
13 Snap ring
14 Center bearing
15 Relief valve
16 Grease nipple
17 Center bearing case
18 Front propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 6	Clearance of spider in axial direction	0 to 0.25 {0 to 0.0098}	—	Adjust
2, 6	Clearance between needle bearing and spider	[26.7] 0.02 to 0.07 {[1.05] 0.00079 to 0.0028}	0.2 {0.0079}	Replace
18	Bend of front propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

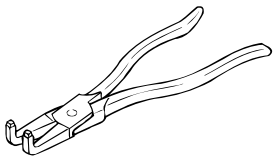
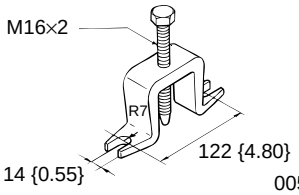
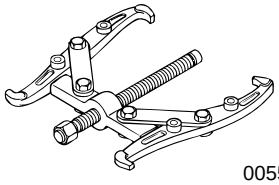
Location	Parts to be tightened	Tightening torque	Remarks
7	Nut (Companion flange mounting)	200 to 340 {145 to 255, 20 to 35}	—

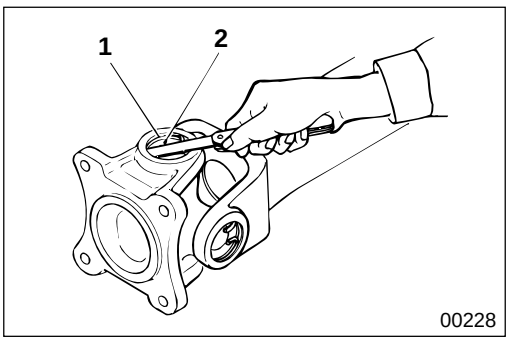
Lubricant

Location	Points of application	Kinds	Quantity
5	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust cover
12	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
14	Pack area of center bearing assembly that houses ball bearings	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
16	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from relief valve

Special tools

Unit : mm

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  00227	MH061001	Removal and installation of snap ring
9	Flange puller  00552	MC881524	Removal of companion flange
17	Gear puller  00553	MH061102	Removal of center bearing



00228

◆ Service procedure

● **Inspection before disassembly**

Clearance in axial direction for spider

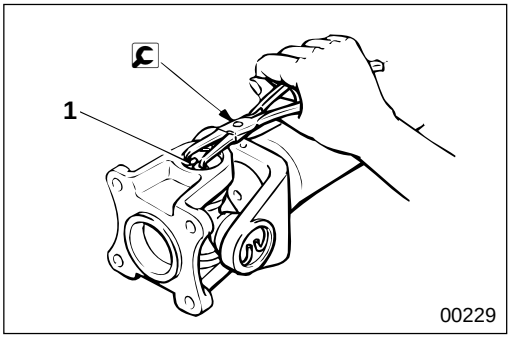
Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

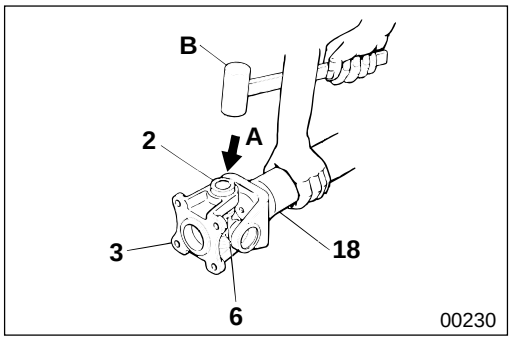
Part name	Thickness	Identification color
Snap ring A	2.5mm {0.098 in.}	Green
Snap ring B	2.6mm {0.10 in.}	Red

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.

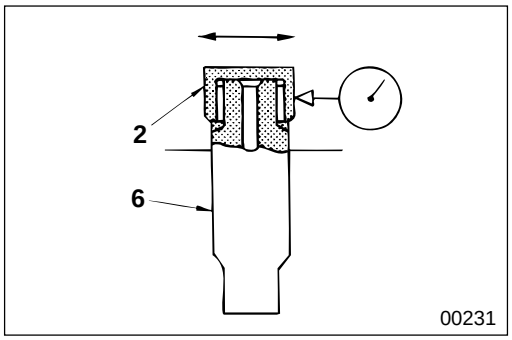


1 **Removal and installation of snap ring**



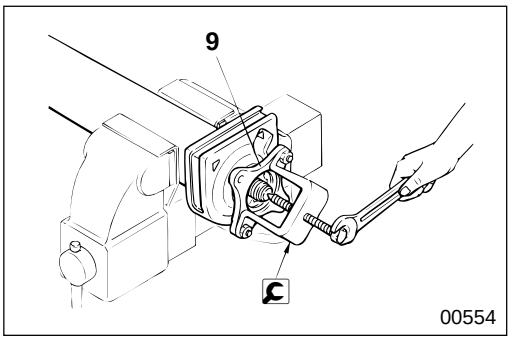
2 **Removal of needle bearing**

- Put alignment marks on needle bearing **2** and spider **6**.
- Put alignment marks across flange yoke **3** and front propeller shaft **18**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.
  B : Mallet

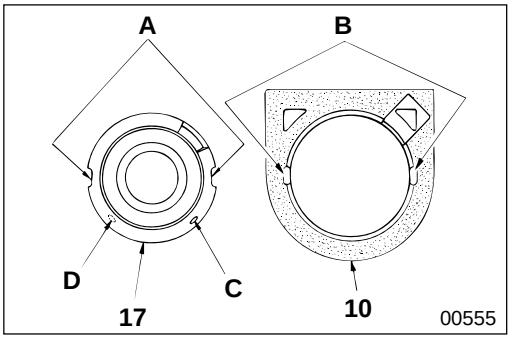


2 **6** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **2** and spider **6**. If the measured value is higher than the limit, replace with universal joint spider kit.



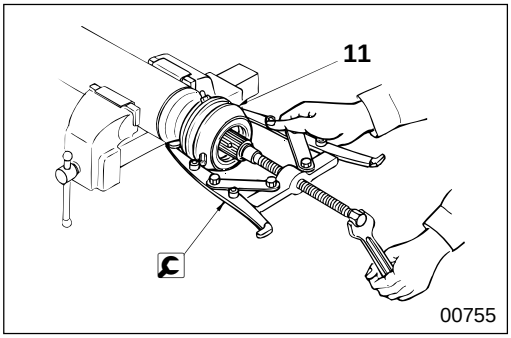
9 **Removal of companion flange**



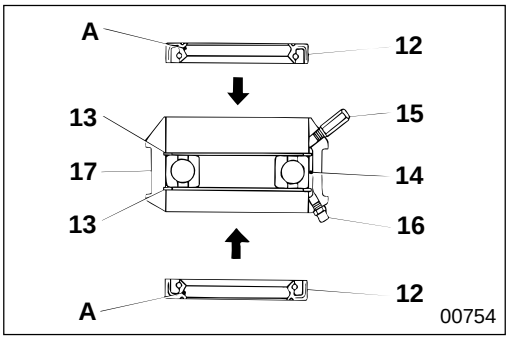
10 **Installation of cushion rubber**

- Align part **A** of center bearing case **17** with part **B** of cushion rubber **10**, and fit them together. If it is difficult to fit them together, use some soap water to make the job easier.
- Assemble center bearing case **17** so that grease nipple mounting hole **D** faces downward.

  C : Relief valve mounting hole
  D : Grease nipple mounting hole

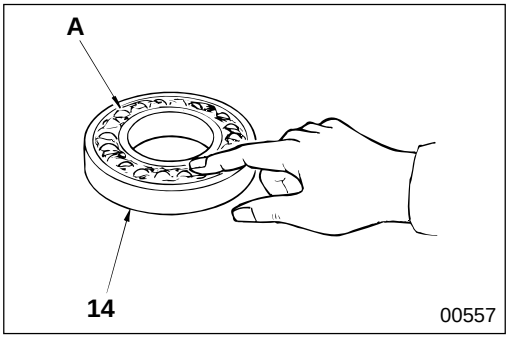


11 **Removal of center bearing housing**



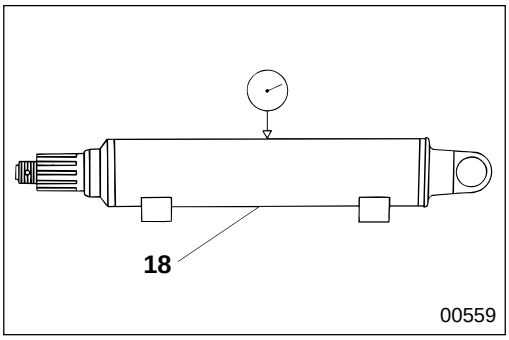
12 **Installation of oil seal**

- Apply grease to lip area **A** of oil seal **12** and install in the direction as illustrated.
- Install oil seal **12** flush with the end of center bearing case **17**.



14 **Packing grease in center bearing**

Pack grease into the area that houses ball bearings **A** of center bearing **14**.



18 **Bend of front propeller shaft**

Measure bend of front propeller shaft **18** at its center. If the measured value is higher than the limit, correct or replace it.

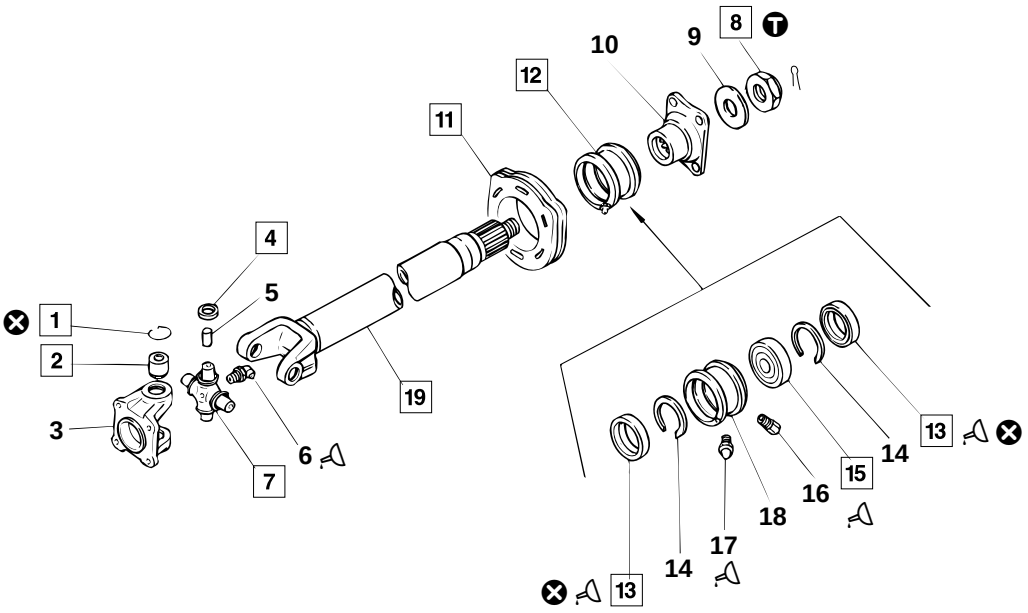
CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of front propeller shaft 18, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

FRONT PROPELLER SHAFT < P8 >



● **Inspection before disassembly**

P25-26

● **Disassembly sequence**

1 Snap ring
2 Needle bearing
3 Flange yoke
4 Dust seal
5 Grease keeper
6 Grease nipple
7 Spider
8 Nut
9 Washer
10 Companion flange
11 Cushion rubber
12 Center bearing assembly
13 Oil seal
14 Snap ring
15 Center bearing
16 Relief valve
17 Grease nipple
18 Center bearing case
19 Front propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 7	Clearance of spider in axial direction	0 to 0.15 {0 to 0.0059}	—	Adjust
2, 7	Clearance between needle bearing and spider	[28.56] 0.02 to 0.07 {[1.12] 0.00079 to 0.0028}	0.2 {0.0079}	Replace
19	Bend of front propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

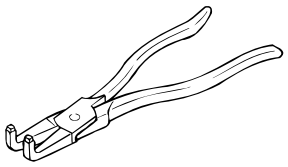
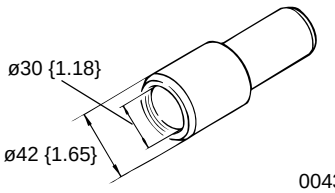
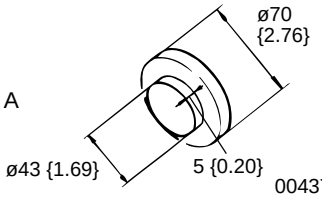
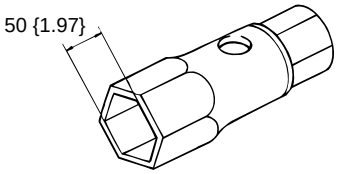
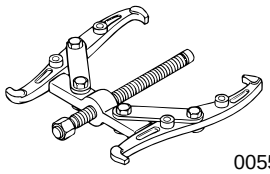
Location	Parts to be tightened	Tightening torque	Remarks
8	Nut (Companion flange mounting)	640 {470, 65}	—

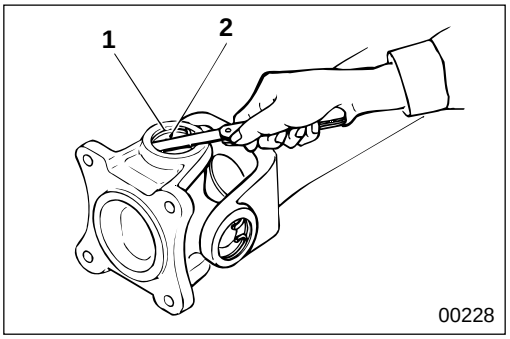
Lubricant

Location	Points of application	Kinds	Quantity
6	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust seal
13	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Pack area of center bearing assembly that houses ball bearings	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from relief valve

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Snap ring expander  00227	MH061001	Removal and installation of snap ring
4	Dust seal installer  00436	03724-04000	Press-fitting of spider dust seal
4	Spider assembly rest A  00437	03724-13000	Press-fitting of spider dust seal
8	Socket wrench  00561	44490-44101	Removal and installation of companion flange nut (Commercially available equivalent can be used)
12	Gear puller  00553	MH061102	Removal of center bearing assembly



◆ Service procedure

● **Inspection before disassembly**

Clearance in axial direction for spider

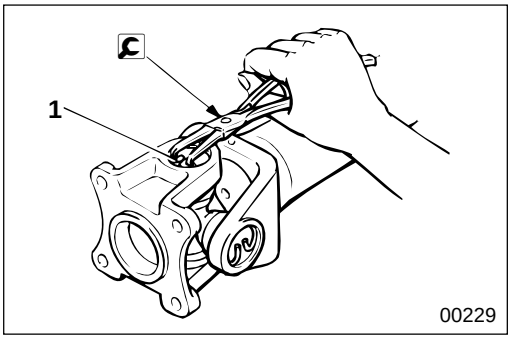
Press needle bearing **2** downward firmly, and measure the clearance between snap ring **1** and the needle bearing. If the measured value is higher than the standard value, adjust it by changing the thickness of the snap ring.

- Available snap ring thicknesses

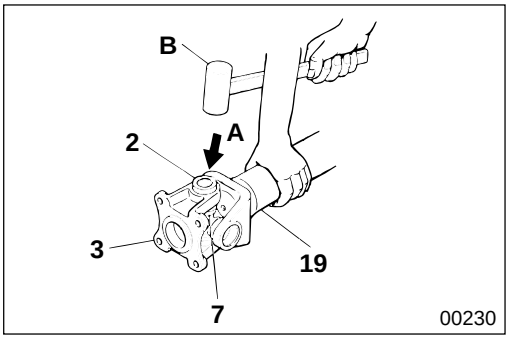
Part name	Thickness	Identification color
Snap ring A	3 mm {0.118 in.}	Green
Snap ring B	3.05 mm {0.120 in.}	White
Snap ring C	3.1 mm {0.122 in.}	Red
Snap ring D	3.15 mm {0.124 in.}	Blue
Snap ring E	3.2 mm {0.126 in.}	Yellow

NOTE

For snap ring 1, it is recommended that you use rings with the same thickness on both ends to ensure balanced revolution.



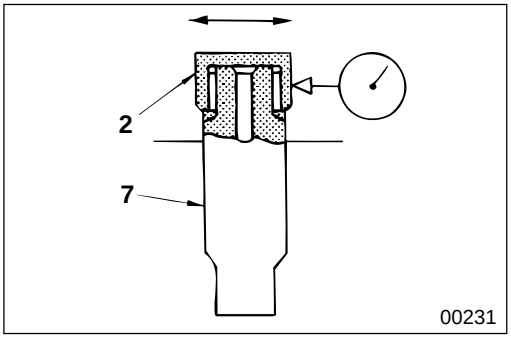
1 **Removal and installation of snap ring**



2 **Removal of needle bearing**

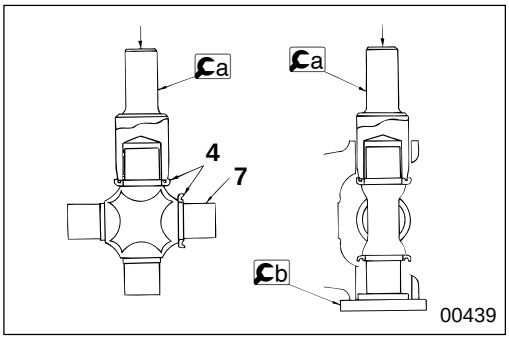
- Put alignment marks on needle bearing **2** and spider **7**.
- Put alignment marks across flange yoke **3** and front propeller shaft **19**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **2** bounces out due to reaction.

  B : Mallet

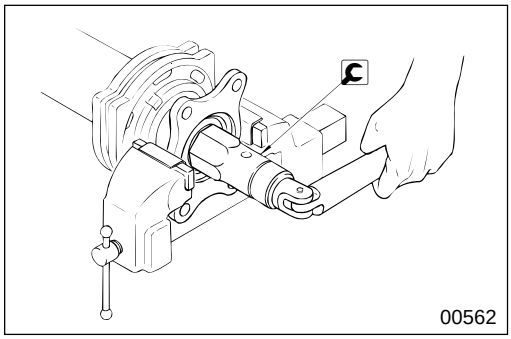


2 **7** **Clearance between needle bearing and spider**

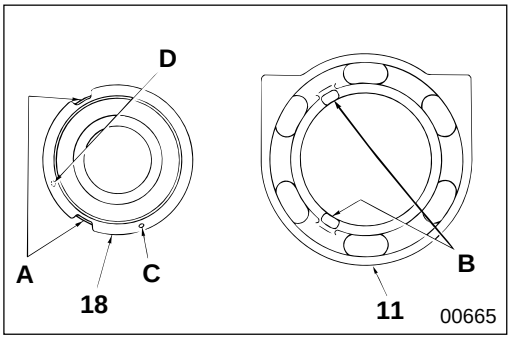
Measure the play towards the diameter direction between needle bearing **2** and spider **7**. If the measured value is higher than the limit, replace with universal joint spider kit.



4 **Mounting of dust seal**



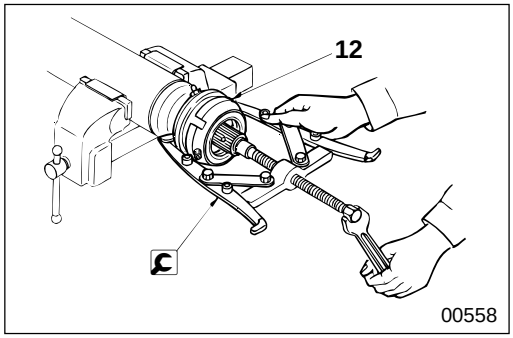
8 **Removal and installation of nut**



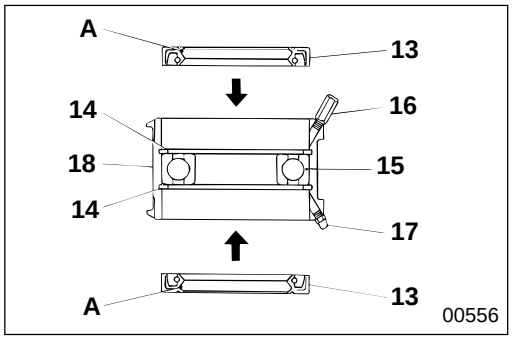
11 **Installation of cushion rubber**

- Align part **A** of center bearing case **18** with part **B** of cushion rubber **11**, and fit them together. If it is difficult to fit them together, use some soap water to make the job easier.
- Assemble center bearing case **18** so that grease nipple mounting hole **D** faces downward.

C : Relief valve mounting hole
D : Grease nipple mounting hole

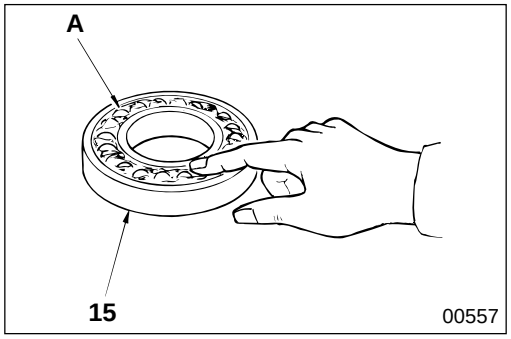


12 **Removal of center bearing housing**



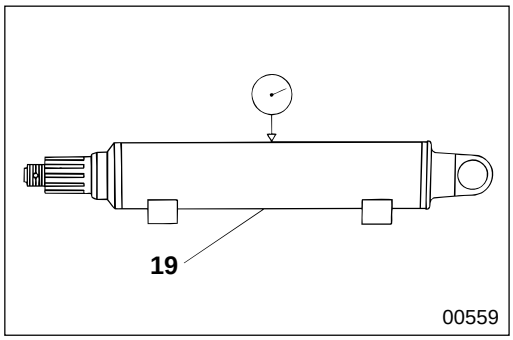
13 **Installation of oil seal**

- Apply grease to lip area **A** of oil seal **13** and install in the direction as illustrated.
- Install oil seal **13** flush with the end of center bearing case **18**.



15 **Packing grease in center bearing**

Pack grease into the area that houses ball bearings **A** of center bearing **15**.



19 **Bend of front propeller shaft**

Measure bend of front propeller shaft **19** at its center. If the measured value is higher than the limit, correct or replace it.

CAUTION

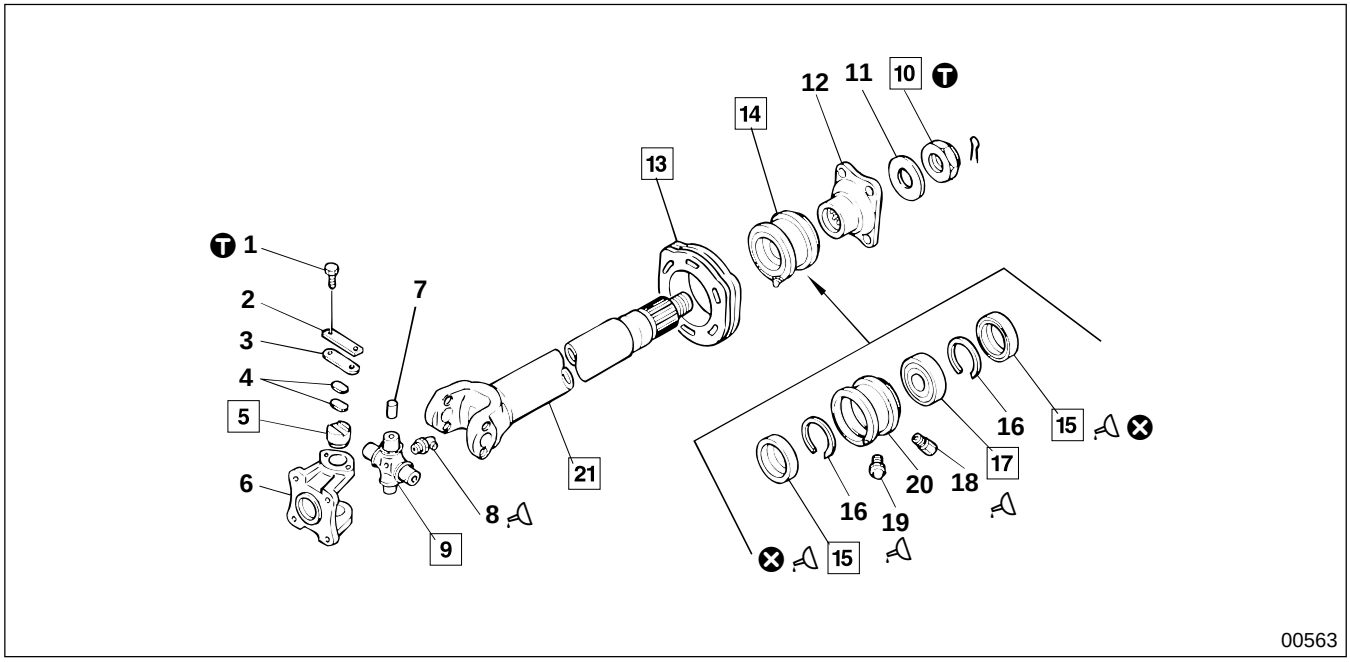
Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of front propeller shaft 19, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

M E M O

FRONT PROPELLER SHAFT < P10 >



● **Inspection before disassembly**

P25-32

● **Disassembly sequence**

1 Bolt
2 Lock plate
3 Bearing case retainer
4 Shim
5 Needle bearing
6 Flange yoke
7 Grease keeper
8 Grease nipple
9 Spider
10 Nut
11 Washer
12 Companion flange
13 Cushion rubber
14 Center bearing assembly
15 Oil seal
16 Snap ring
17 Center bearing
18 Relief valve
19 Grease nipple
20 Center bearing case
21 Front propeller shaft

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Universal joint spider kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
1 to 7	Clearance of spider in axial direction	0 to 0.15 {0 to 0.0059}	—	Adjust
5, 9	Clearance between needle bearing and spider	[30.494] 0.02 to 0.08 {[1.20] 0.00079 to 0.0031}	0.2 {0.0079}	Replace
21	Bend of front propeller shaft (Center)	—	0.6 {0.024}	Correct or replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

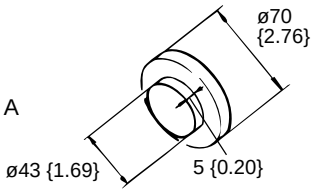
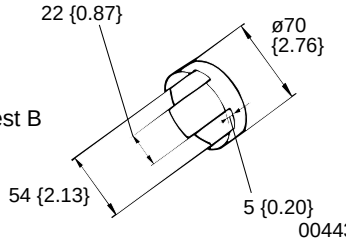
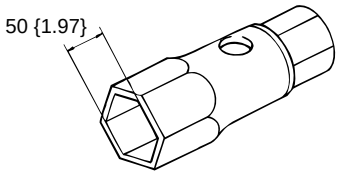
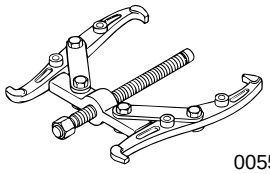
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Needle bearing mounting)	18 to 26 {13 to 20, 1.8 to 2.7}	—
10	Nut (Companion flange mounting)	640 {470, 65}	—

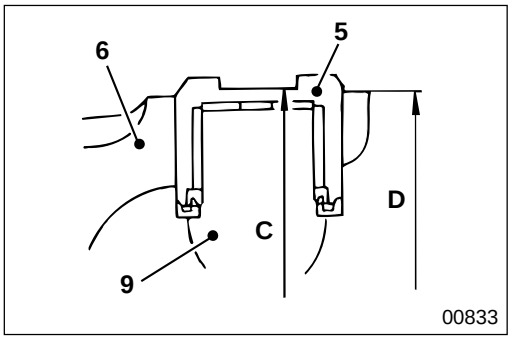
Lubricant

Location	Points of application	Kinds	Quantity
8	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from spider dust cover
15	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack area of center bearing assembly that houses ball bearings	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	Pack until grease overflows from relief valve

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
5	Spider assembly rest A 	03724-13000	Press-fitting of needle bearing
5	Spider assembly rest B 	03724-14000	Press-fitting of needle bearing
10	Socket wrench 	44490-44101	Removal and installation of companion flange nut (Commercially available equivalent can be used)
20	Gear puller 	MH061102	Removal of center bearing assembly



◆ Service procedure

● Inspection before disassembly

Clearance in axial direction for spider

Measure the clearance of needle bearing **5** (shim adjustment clearance = **D** – **C**). If the measured value is higher than the standard value, adjust it by changing the thickness of shim **4**.

- Available shim thicknesses

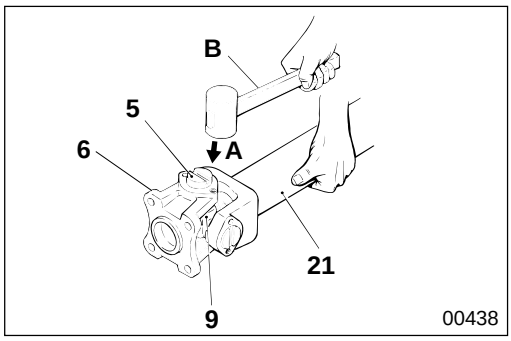
Part name	Thickness
Shim A	0.1 mm {0.0039 in.}
Shim B	0.2 mm {0.0079 in.}

CAUTION

Make sure that shim 4 does not protrude above the surface of flange yoke 6 or needle bearing 5 will seize up.

NOTE

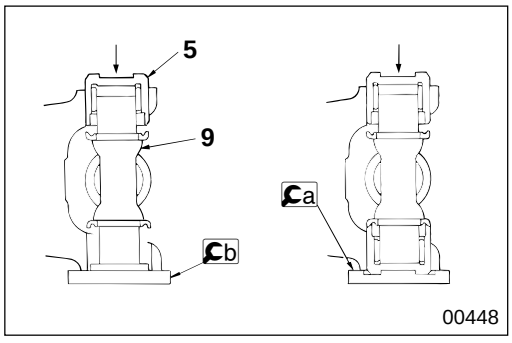
For shim 4, it is recommended that you use shims with the same thickness on both ends to ensure balanced revolution.



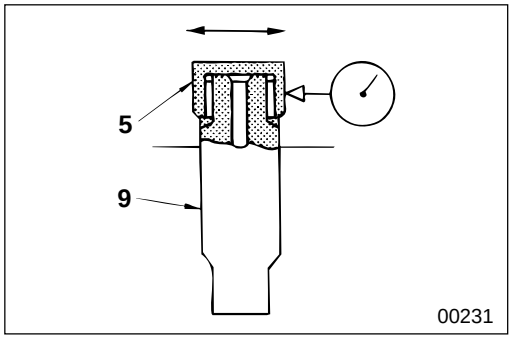
5 **Needle bearing**

[Removal]

- Put alignment marks on needle bearing **5** and spider **9**.
- Put alignment marks across flange yoke **6** and front propeller shaft **21**.
- Hit the yoke lightly at shoulder area **A** so that needle bearing **5** bounces out due to reaction.
  B : Mallet

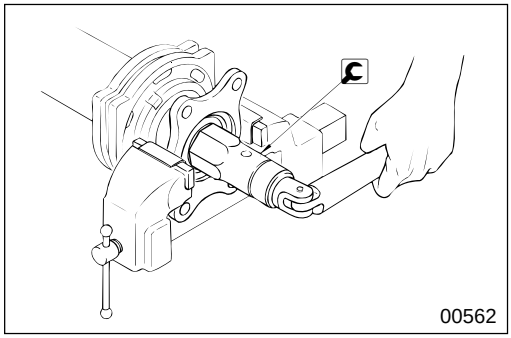


[Installation]

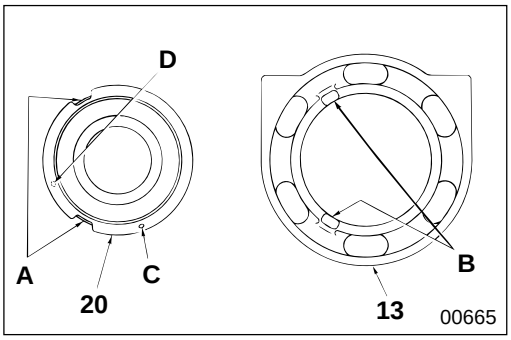


5 **9** **Clearance between needle bearing and spider**

Measure the play towards the diameter direction between needle bearing **5** and spider **9**. If the measured value is higher than the limit, replace with universal joint spider kit.



10 Removal and installation of nut

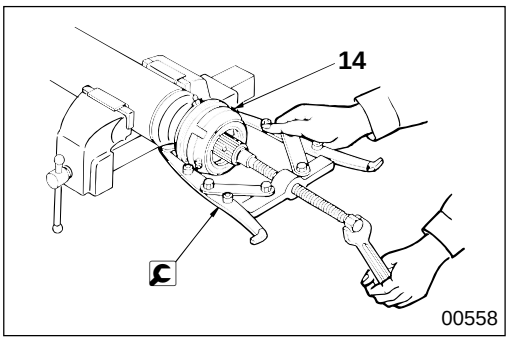


13 Installation of cushion rubber

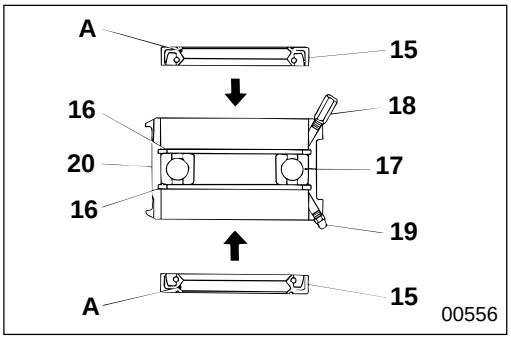
- Align part **A** of center bearing case **20** with part **B** of cushion rubber **13**, and fit them together. If it is difficult to fit them together, use some soap water to make the job easier.

  C : Relief valve mounting hole
  D : Grease nipple mounting hole

- Assemble center bearing case **20** so that grease nipple mounting hole **D** faces downward.

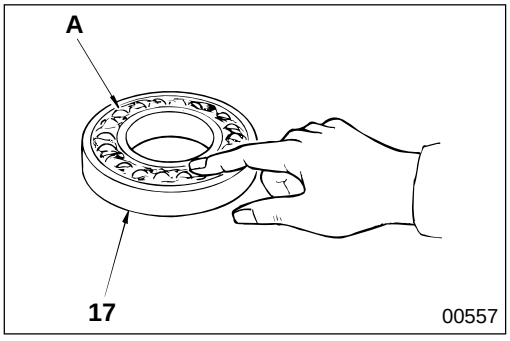


14 Removal of center bearing housing



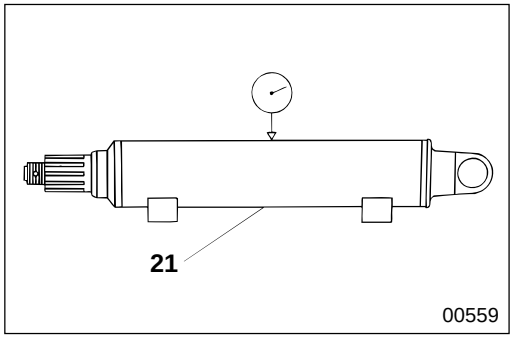
15 Installation of oil seal

- Apply grease to lip area **A** of oil seal **15** and install in the direction as illustrated.
- Install oil seal **15** flush with the end of center bearing case **20**.



17 Packing grease in center bearing

Pack grease into the area that houses ball bearings **A** of center bearing **17**.



21 **Bend of front propeller shaft**

Measure bend of front propeller shaft **21** at its center. If the measured value is higher than the limit, correct or replace it.

CAUTION

Be sure to check for cracks at the welded area after straightening has been done by means of a press.

NOTE

To measure the bend of front propeller shaft 21, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

Adjustment after Assembly

(1) After any correction has been made of propeller shaft deflection, or replacement of flange yoke and universal joint, adjust the amount of balance of completed propeller shaft assembly on a balancing machine, and make adjustment by installing a balance piece(s) so that the amount comes within the permissible limit.

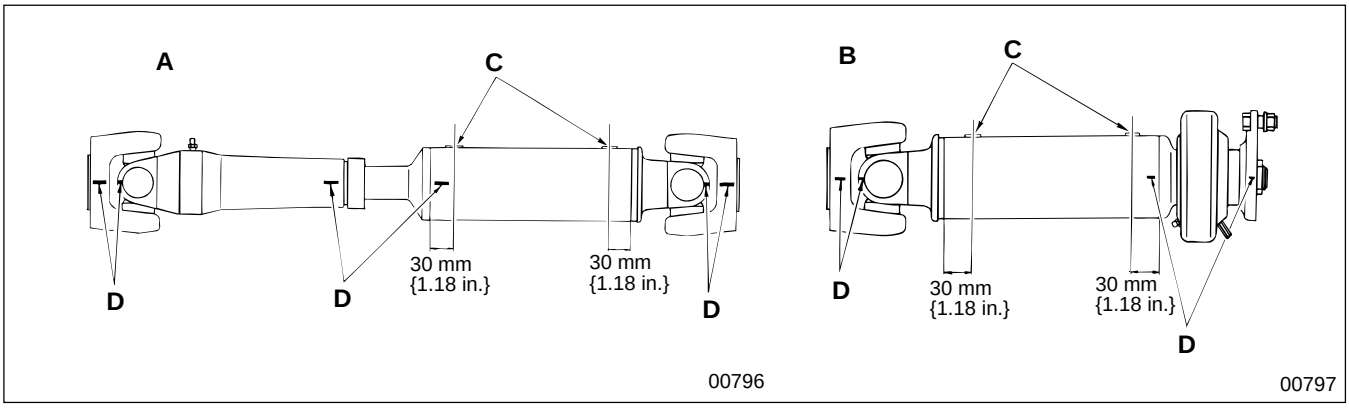
(2) There are two methods of correcting dynamic balance: the polar coordinate system method, and the 90-degree component force method.
Polar coordinate system method: P4, P8, P10
90-degree component force method: P10

(3) Permissible amount of unbalance
0.49 N·cm {0.0036 lbf.ft, 50 gf·cm}/1600 rpm (Pipe outer periphery)

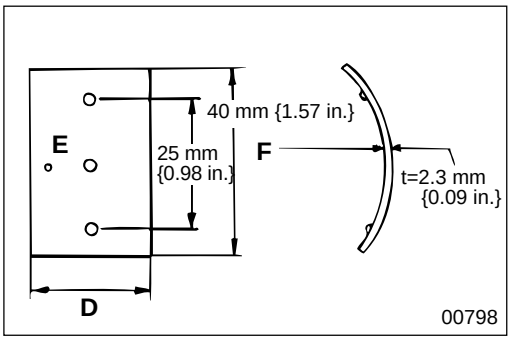
NOTE
When adjusting a propeller shaft with a large amount of deflection, the 90-degree component force < P10 > method is preferred since this method requires a smaller number of balance pieces.

(4) Method of correction by way of polar coordination method

- Balance piece attachment point



A : Rear propeller shaft
B : Front propeller shaft
C : Balance piece attachment point
D : Aligning mark



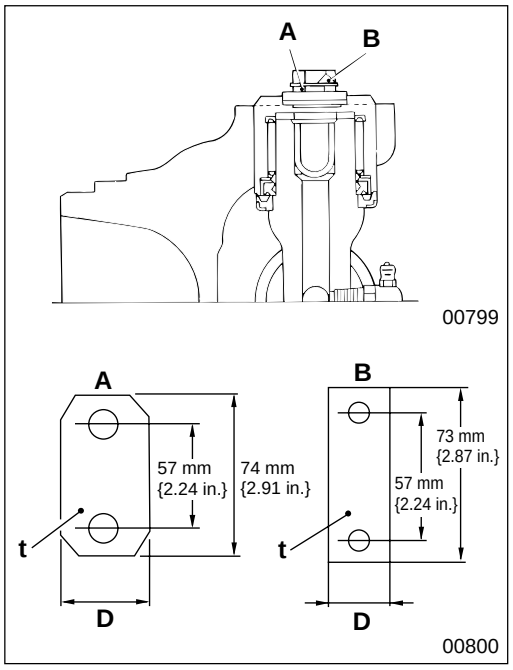
- Balance pieces available

Part name	P4	P8, P10	Mass g {oz}	Dimension D mm {in.}
Balance piece	G	G	10 {0.35}	14 {0.55}
Balance piece	A	A	20 {0.71}	28 {1.10}
Balance piece	B	B	40 {1.41}	55.7 {2.19}
Balance piece	C	C	60 {2.36}	83.5 {3.29}
Balance piece	H	—	30 {1.06}	42 {1.65}

E : Piece punch mark
F : R45 mm {1.77 in.} (R41.3 mm {1.63 in.} only for P8 and P10 balance piece G)

NOTE
- **Maximum balance piece allowed for one point is 120g {4.23 oz}.**
- **Use a combination that keeps balance pieces to the minimum.**

(5) Correction using 90-degree component force method



● **Installation of balance pieces**

Alignment marks are the same as for the polar coordinate system. P25-35

A : Balance piece
B : Lock plate

- Available lock plates and balance pieces

Model	Part name	Mass g {oz.}	Dimension D mm {in.}	Plate thickness t mm {in.}
P10	Lock plate	8 {0.28}	18 {0.71}	0.8 {0.031}
	Balance piece A	20 {0.71}	25 {0.98}	1.6 {0.063}
	Balance piece B	35 {1.23}	21.6 {0.85}	3.2 {0.13}
	Balance piece C	50 {1.76}	32.2 {1.27}	3.2 {0.13}

NOTE

- **Maximum balance piece allowance for one point is 120 g {4.23 oz}.**
- **Use a combination that keeps the number of balance pieces to the minimum.**

MITSUBISHI
FUSO

Group 26
Front Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No.TWME0103-26

INDEX

SPECIFICATIONS 26- 2

STRUCTURE AND OPERATION 26- 2

ON-VEHICLE INSPECTION AND ADJUSTMENT
- Adjustment of Wheel Alignment 26- 8
- Adjustment of Steering Angle 26-12
- Measurement of Side Slip 26-12

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT AXLE .. 26-13

WHEEL HUB AND BRAKE DRUM
< FK > 26-14
< FM (Air-Over Hydraulic Brake) > 26-26
< FM (Full-Air Brake) > 26-38

FRONT AXLE, KNUCKLE AND KINGPIN
< FK > 26-62
< FM (Air-Over Hydraulic Brake) > 26-68
< FM (Full-Air Brake) > 26-76

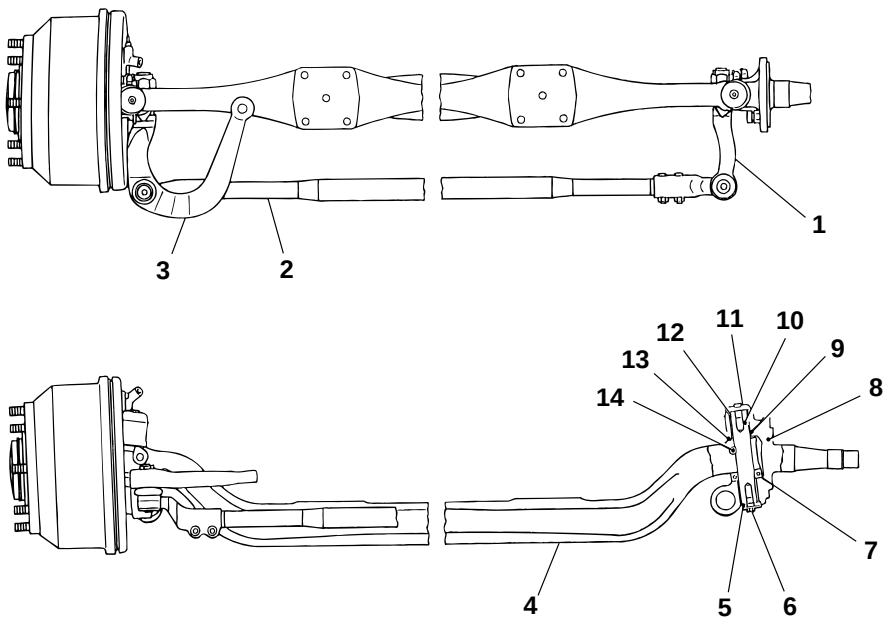
SPECIFICATIONS

Item \ Vehicle model		FK617	FM617	FM657
Front axle Model Type		F040T	F060T I-section, reverse elliot type	F070T
Kingpin Outer diameter × Length	mm {in.}	35×195 {1.38×7.68}	45×221 {1.77×8.70}	50×243 {1.97×9.57}
Tread	mm {in.}	1785 {70.3}	1900 {74.8} (10R22.5) 1880 {74.0} (11R22.5)	1920 {75.6}
Mass	kg {lb}	Approximately 245 {540}	Approximately 300 {660}	Approximately 360 {795}

STRUCTURE AND OPERATION

Front Axle, Knuckle and Kingpin

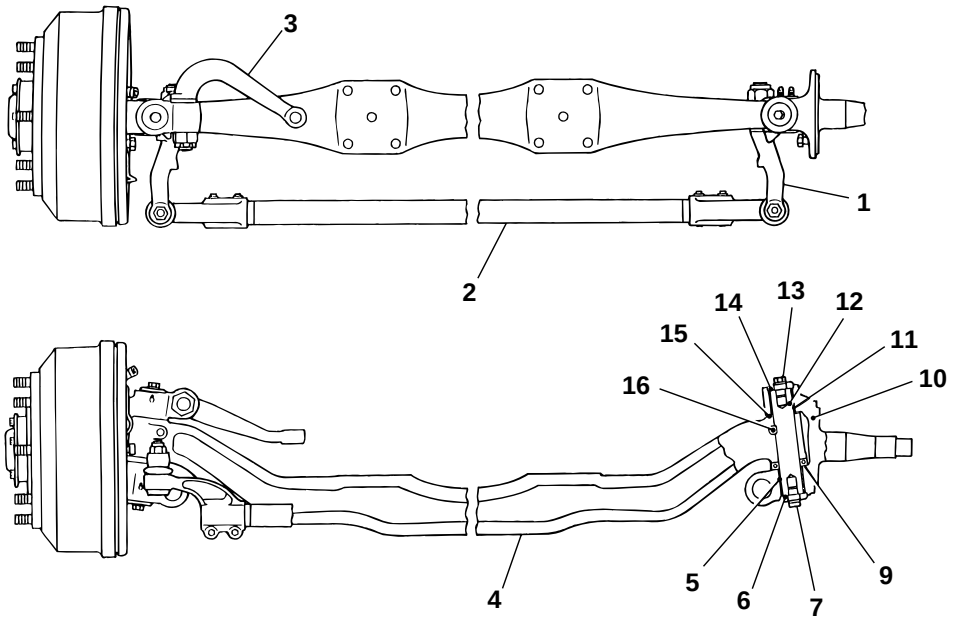
< FK617 >



12998

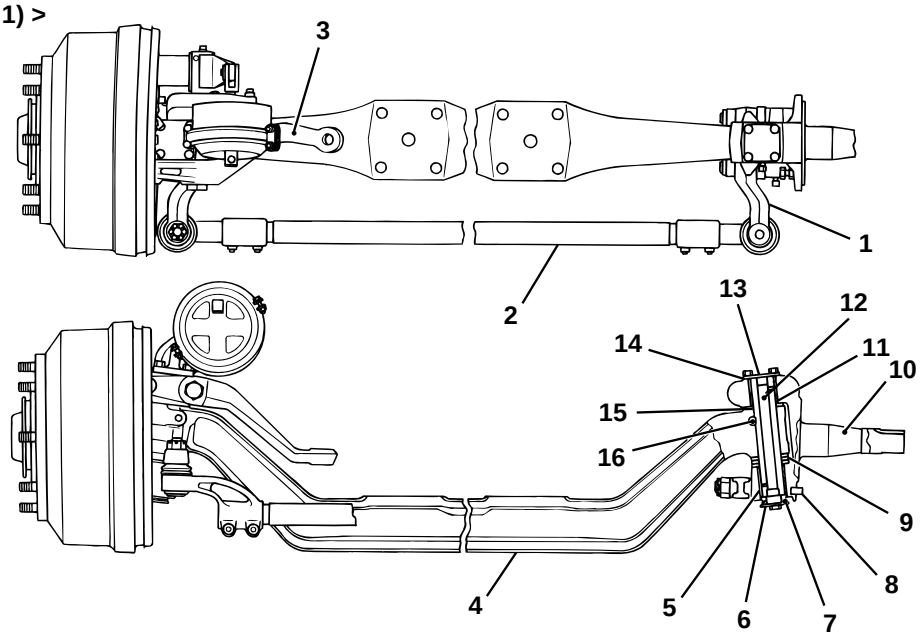
1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Front axle
5 Dust seal
6 Lower kingpin cover
7 Bearing
8 Knuckle
9 Oil seal
10 Kingpin
11 Kingpin cap
12 Bushing
13 Thrust washer
14 Set bolt

< FM617 >



04152

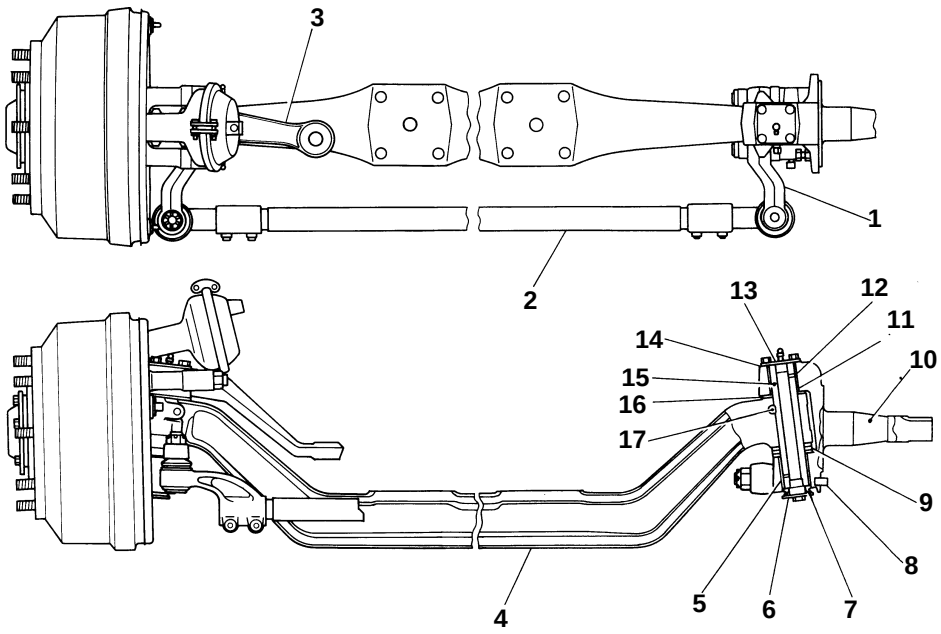
< FM657 (Type 1) >



13127

1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Front axle
5 Bushing
6 Dust seal
7 Lower kingpin cover
8 Knock pin < FM657 >
9 Bearing
10 Knuckle
11 Oil seal
12 Kingpin
13 Upper kingpin cover
14 Dust seal < FM617 >
Gasket < FM657 >
15 Thrust washer
16 Set bolt

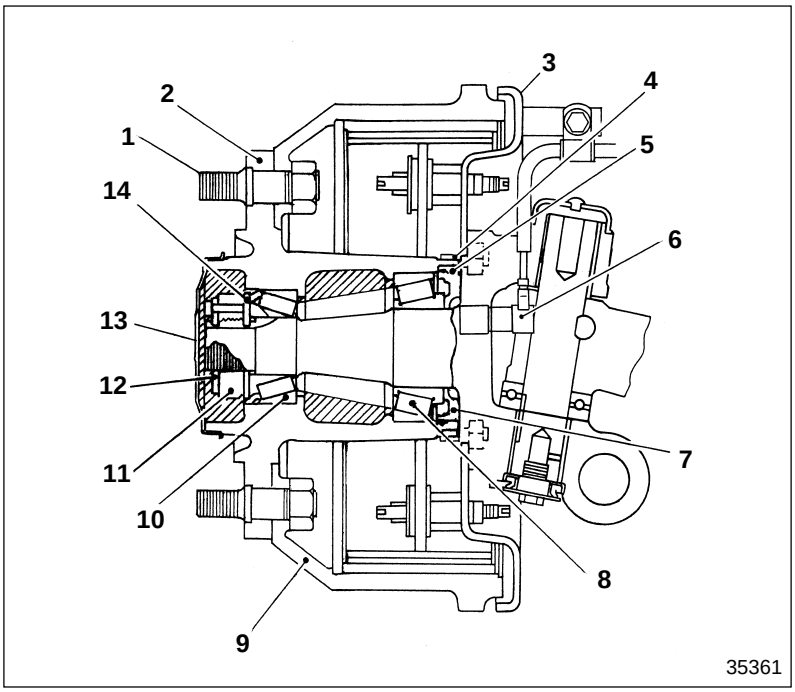
< FM657 (Type 2) >



1 Tie rod arm
2 Tie rod assembly
3 Knuckle arm
4 Front axle
5 Bushing
6 Lower kingpin cover
7 Dust seal
8 Knock pin
9 Bearing
10 Knuckle
11 Oil seal
12 Upper bushing
13 Upper kingpin cover
14 O-ring
15 Kingpin
16 Thrust washer
17 Set bolt

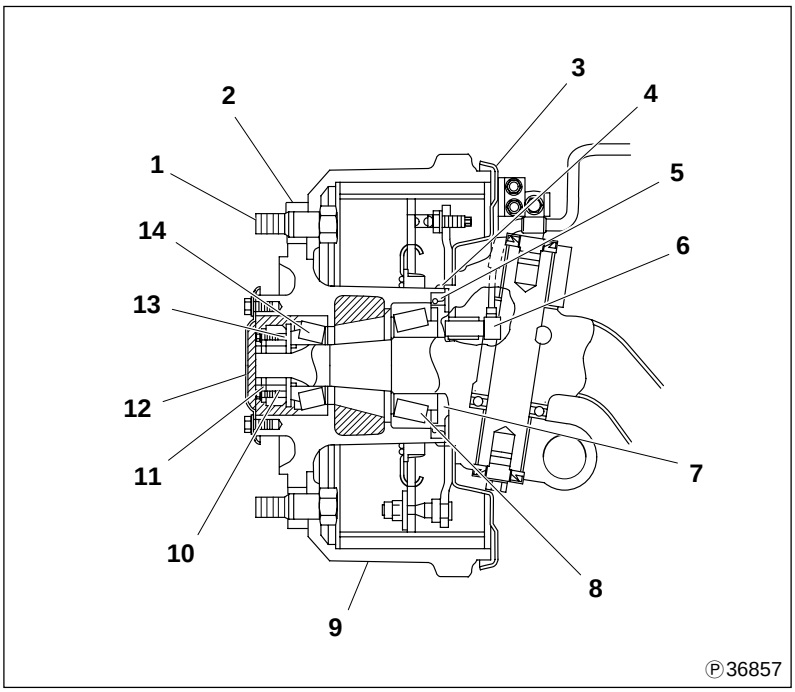
Wheel Hub and Brake Drum

< FK617 >



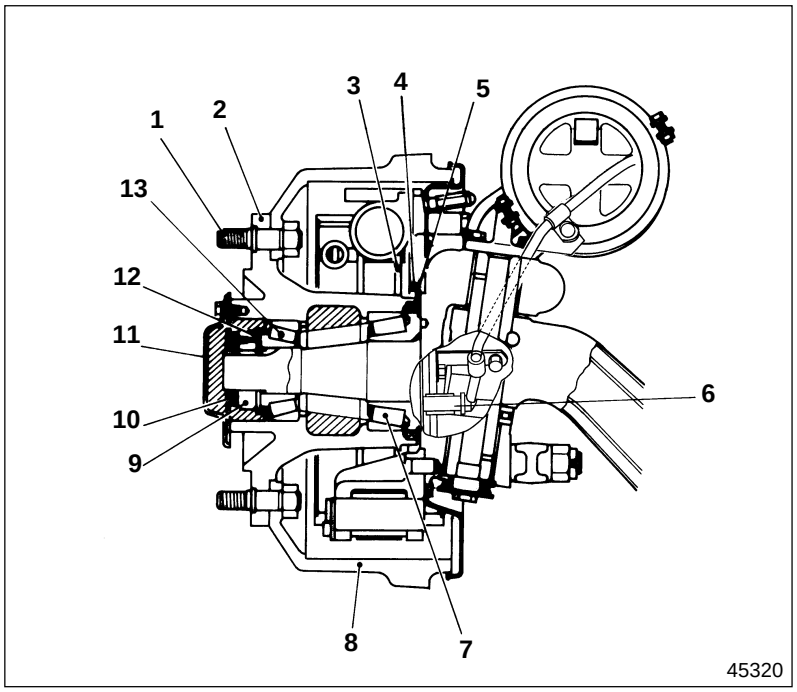
1 Hub bolt
2 Front wheel hub
3 Front brake assembly
4 Rotor
5 Oil seal
6 Wheel speed sensor
7 Oil seal retainer
8 Inner bearing
9 Front brake drum
10 Outer bearing
11 Lock nut
12 Lock plate
13 Wheel hub cap
14 Lock washer

< FM617 >



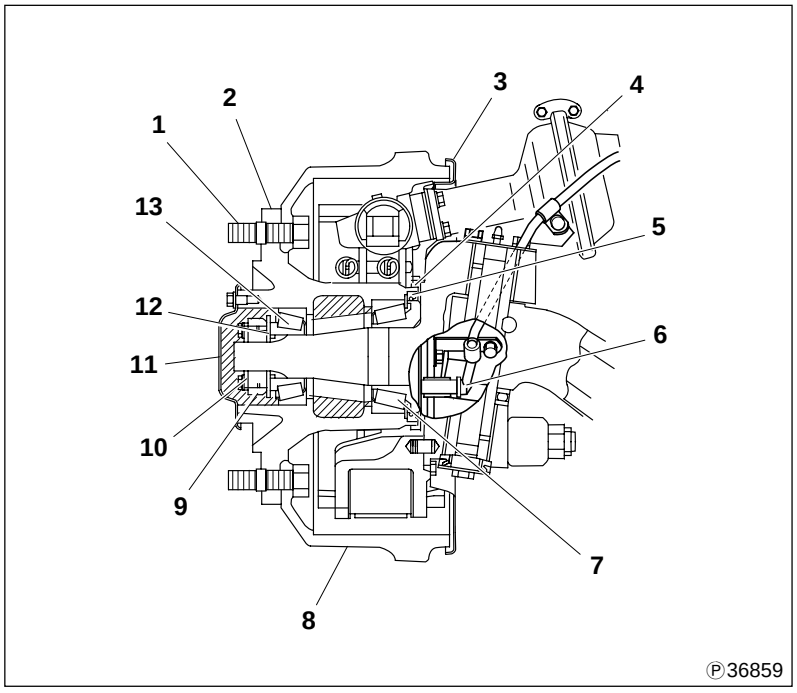
1 Hub bolt
2 Front wheel hub
3 Front brake assembly
4 Rotor
5 Oil seal
6 Wheel speed sensor
7 Oil seal retainer
8 Inner bearing
9 Front brake drum
10 Lock nut
11 Lock plate
12 Wheel hub cover
13 Lock washer
14 Outer bearing

< FM657 (Type 1) >



1 Hub bolt
2 Front wheel hub
3 Front brake assembly
4 Rotor
5 Oil seal
6 Wheel speed sensor
7 Inner bearing
8 Front brake drum
9 Lock nut
10 Lock plate
11 Wheel hub cover
12 Lock washer
13 Outer bearing

< FM657 (Type 2) >



M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

Adjustment of Wheel Alignment

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Wheel alignment	Toe-in (with tires on the ground)	0±1 {0±0.039}	—	Adjust
		Camber FK	1°30'±1°00'	—	Adjust
		Camber FM	1°00'±1°00'	—	Adjust
		Caster	2°30' $^{+1°30'}_{-1°00'}$	—	Adjust
		Kingpin inclination angle	7°00'	7°00'±30'	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

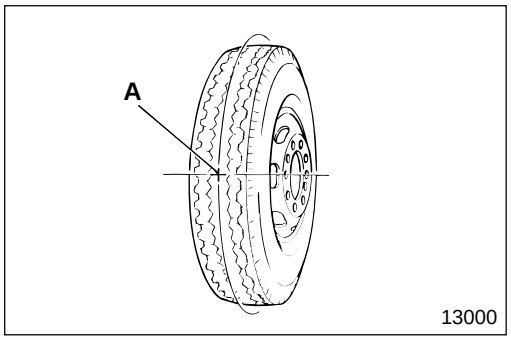
Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Tie rod end clamp fastening)	FK	78 {58, 8}	Wet
		FM	78 {58, 8}	—

NOTE

- **Measure the wheel alignment when the vehicle is empty and level.**
- **Be sure that each part of the front axle has been serviced perfectly before adjusting the wheel alignment.**

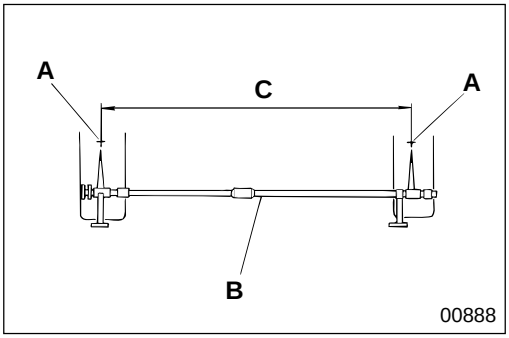
Before adjusting the wheel alignment, check for the following faults:

- Play in front wheel hub
- Play or looseness in kingpin
- Play or looseness in the joint between the tie rod and the knuckle arm
- Looseness of any fasteners
- Fatigued or damaged leaf springs
- Incorrect tire pressure
- Incorrect power steering booster backlash

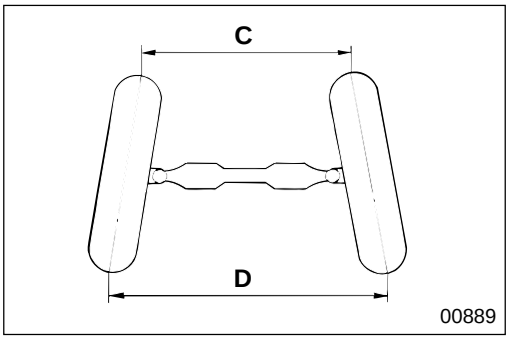


(1) Measurement and adjustment of toe-in

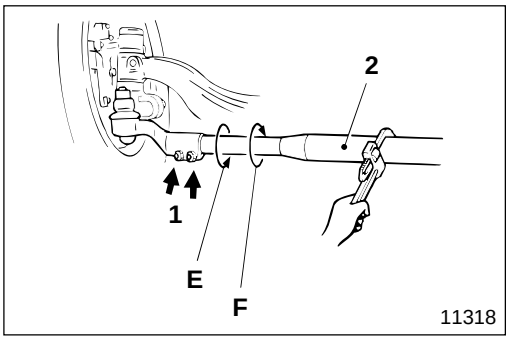
- Point the front wheels exactly forward.
- Put mark **A** on the left and right front tires at the height of front wheel axis and in the middle of the tire width.



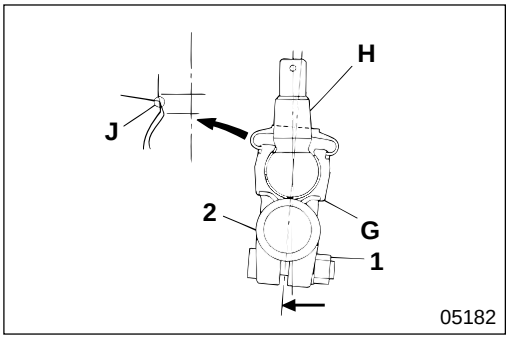
- Align the two points of toe-in gauge **B** to the respective marks **A** on the front tires. Measure the distance **C** between the marks at the front of the vehicle.



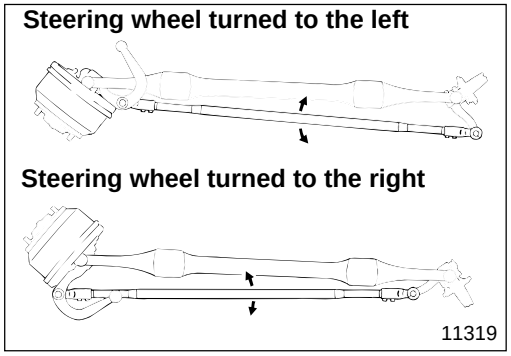
- Rotate the tires 180° and measure distance **D** between the marks at the rear of the vehicle with the tires on the ground.
- Check if the difference between distances **C** and **D** is within the standard value.



- If the measured value deviates from the standard value, with the tires pointed forward, loosen all four left and right tie rod nuts **1**.
- Adjust the toe-in to the standard value by turning tie rod **2** with a pipe wrench.
  E : Adjusting to the toe-out direction
  F : Adjusting to the toe-in direction
  (★ : If tie rod **2** does not swing after the adjustment on 📖 P26-10, redo from this item.)



- Hold down tie rod **2** toward the front or rear of the vehicle so that left and right tie rod ends **G** are in contact **J** with ball studs **H** at the same time. In this state tighten four nuts **1**.
- When tightening nuts **1**, do not let tie rod ends **G** move toward the front or rear of the vehicle.
- When you are working on your own: first tighten nut **1** on one tie rod end **G**, then tighten the nut on the other tie rod end. When you tighten the nuts, make sure you hold down tie rod **2** towards the same direction each time.

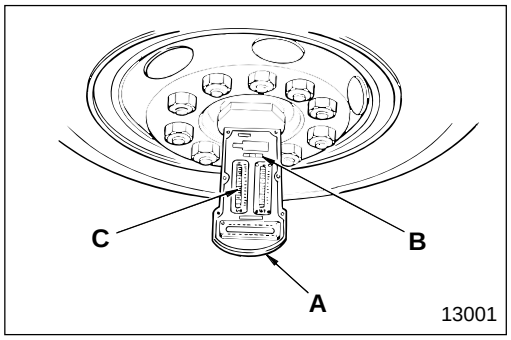


- After adjustment, turn the steering wheel fully to the left until the knuckle stopper bolt is hit. In this state, shake tie rod **2** to check that you can move it toward the front or rear of the vehicle.
  Carry out the same inspection on the right side.
  (Movability of the tie rod indicates that tie rod ends **G** are in contact with ball studs **H** at the same time.)

WARNING⚠

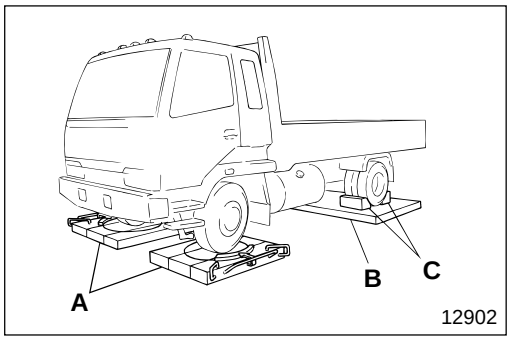
Be very careful that your hand, or anything else, is not caught due to the movement of the tie rod when the steering wheel is turned left and right.

- If tie rod **2** does not swing, redo the procedure from the item marked ★. 📖 P26-9



(2) Measurement of camber

- Point the front wheels exactly forward.
- Remove the wheel hub caps < FK > or the wheel hub covers < FM >.
- Wipe off grease from the knuckle end, and attach camber/caster /kingpin gauge **A** to the front wheel hub.
- While keeping the bubble in level **B** centered, measure the camber angle by reading the scale mark at the center of the bubble on camber scale **C**. Follow this procedure to measure the camber angles on the left and right sides.

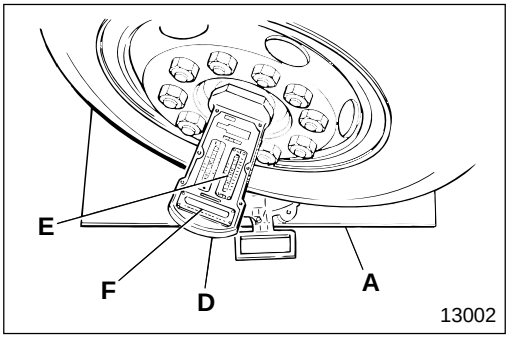


(3) Measurement of caster and kingpin inclination angle

- Align turning radius gauges **A**. Prepare a platform **B** having the same height as the turning radius gauges and place the platform under the rear wheels so that the vehicle is kept level.
- Keep turning radius gauges **A** locked.
- Jack up the vehicle and set the left and right front wheels so that the ground contact area of both front tires and the turntables of turning radius gauge **A** meet at their respective centers.

WARNING⚠

- **After jacking up the vehicle, chock the rear wheels securely with chocks C.**
- **Do not remove chocks C until the entire operation is completed.**



- Unlock turning radius gauge **A**, and set the scale to 0°.
- As in measuring camber explained previously, attach camber/caster kingpin gauge **D** tightly to the front wheel hub and keep the bubble centered.
- Apply the brake to the front wheels and turn the steering wheel slowly from the 0° point on the scale of turning radius gauge **A**, until direction changes 20° to the left for the left front wheel and 20° to the right for the right front wheel.

NOTE

It is not possible to obtain an exact reading of camber unless the brake is applied to the front wheels because the tires might rotate slightly.

- At the 20° point, align the bubbles in caster scale **E** and kingpin scale **F** to 0° by turning the adjuster.

NOTE

Kingpin scale F has scales for left and right; use the left scale when adjusting the left wheel, and the right scale when adjusting the right wheel.

- Turn the steering wheel slowly until the left front wheel changes its direction 20° to the right, or until the right front wheel changes its direction 20° to the left, past the 0° point of turning radius gauge **A** scale. At this point read the scale marks at the center of the bubbles on caster scale **E** and kingpin scale **F**. The scale marks indicate the caster and kingpin inclination angles.

ON-VEHICLE INSPECTION AND ADJUSTMENT

Adjustment of Steering Angle

Service standards

Location	Maintenance item			Standard value	Limit	Remedy
—	Steering angle	Inside (Outside : reference)	FK617	43° (33°57')	—	Adjust
			FM617	40° (34°38')	—	Adjust
			FM657	44° (35°44')	—	Adjust

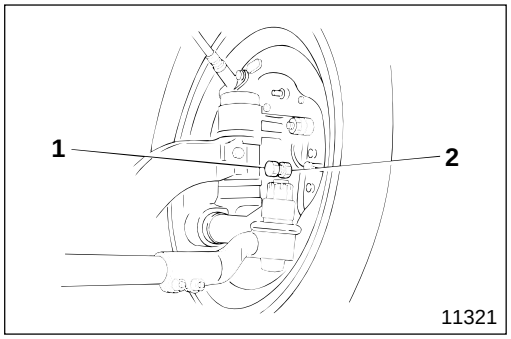
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Lock nut (Knuckle stopper bolt fastening)	71±12 {52±9, 7.25±1.25}	—

NOTE

Be sure that wheel alignment is adjusted perfectly before adjusting the steering angle.

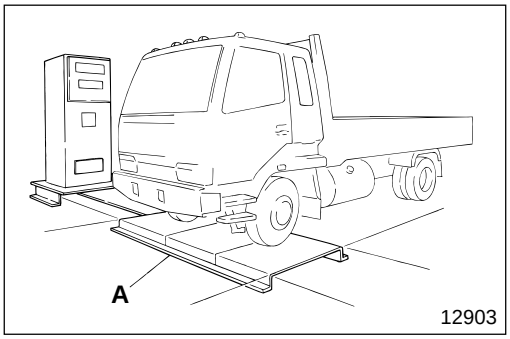


- To adjust the steering angle, set the turning radius gauges and platform in the same way as for caster and kingpin inclination angle measurement.
- Turn the steering wheel to the left or right completely, and from the position where the turning radius gauge is aligned to 0°, adjust knuckle stopper bolt **1**. Adjust so that the steering angle is within the standard inside steering angle value, to the left for the left front wheel, and to the right for the right front wheel. Then, tighten lock nut **2** at specified torque.

Measurement of Side Slip

NOTE

Be sure that wheel alignment is adjusted fully before measuring side slip.

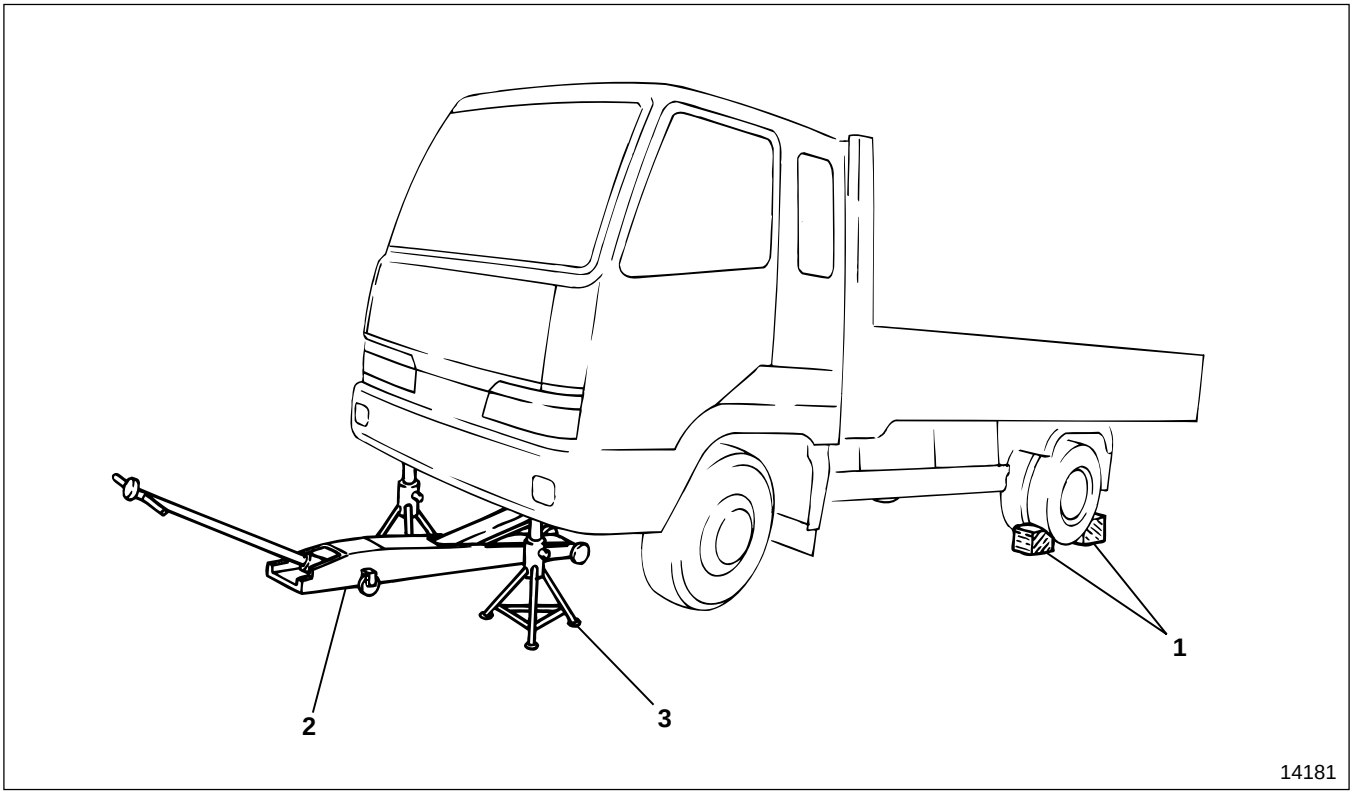


- Point the front wheels exactly forward.
- Maintain this position and slowly move vehicle forward, over side slip tester **A**, as slowly as possible.

NOTE

Make sure, when measuring side slip, that the wheels point exactly forward when the vehicle passes over side slip tester A. Do not allow the wheels to veer from side-to-side.

- The side slip is indicated by side slip tester **A** after the vehicle has passed through the tester. Readjust wheel alignment if slippage is 3 mm {0.12 in.} or more per meter {3.28 ft.}.



● **Work sequence before removal**

1 Place wheel chocks.
2 Jack up the front axle with a garage jack.
3 Support the front frame on rigid racks.

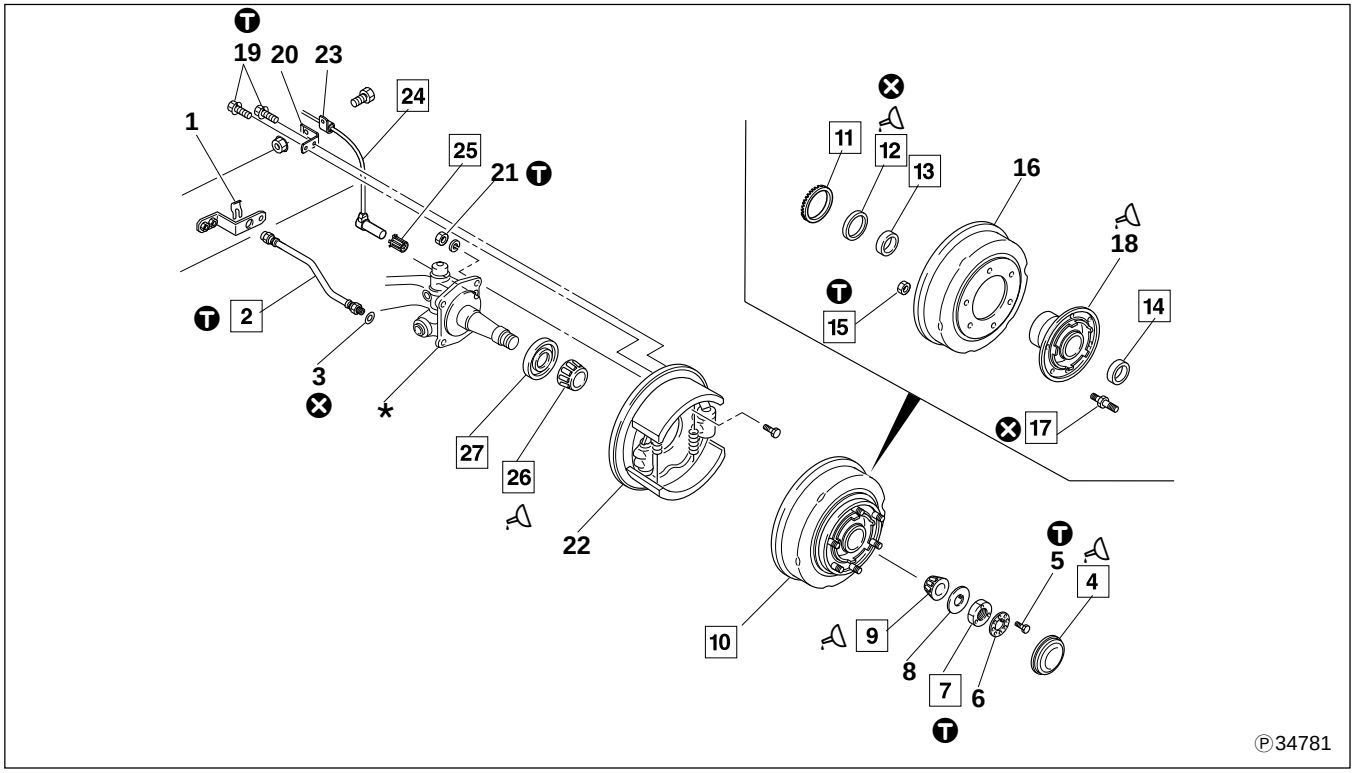
WARNING

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

WHEEL HUB AND BRAKE DRUM < FK >



● **Disassembly sequence**

1 Clip
2 Brake hose
3 Packing
4 Wheel hub cap
5 Bolt
6 Lock plate
7 Lock nut
8 Lock washer
9 Outer bearing inner race
10 Wheel hub and brake drum assembly
11 Rotor
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Brake drum Gr 35A
17 Hub bolt
18 Wheel hub
19 Bolt
20 Clip bracket
21 Nut
22 Brake assembly Gr 35A
23 Clip
24 Wheel speed sensor
25 Spring spacer
26 Inner bearing inner race
27 Oil seal retainer

*: Knuckle P26-62
⊗: Non-reusable parts

CAUTION

Be sure to protect brake hose 2 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 16 and wheel hub 18 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 16.**
- **Be careful not to damage oil seal 12 and rotor 11 when installing wheel hub and brake drum assembly 10 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
9, 13, 14, 26	Starting torque of wheel hub bearing		1 to 4 N·m {0.72 to 2.89 ft.lbs, 0.1 to 0.4 kgf·m}	—	Tangential force at wheel hub bearing 9 to 35 N {1.98 to 7.94 lbf, 0.9 to 3.6 kgf}
11	Wobbling of rotor		0.1 {0.0039}	—	Replace
25	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1MΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

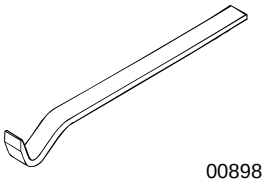
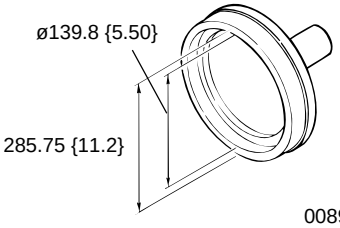
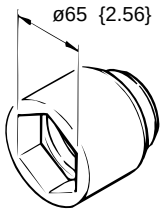
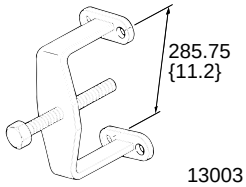
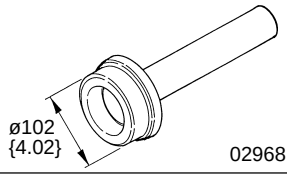
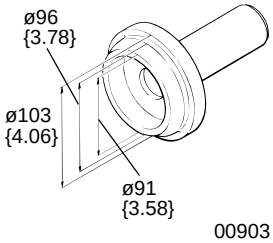
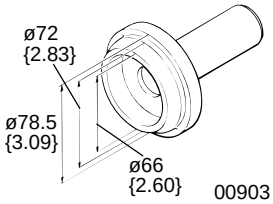
Location	Parts to be tightened	Tightening torque	Remarks
2	Brake hose (Brake side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
5	Bolt (Lock plate mounting)	7 to 11 {5.1 to 8, 0.7 to 1.1}	—
7	Lock nut	200 {145, 20}	Slackening off angle : 30° (one twelfth of a turn)
15	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
19	Bolt (Bracket mounting)	9.8 to 14.0 {7 to 10, 1.0 to 1.4}	—
21	Nut (Brake assembly mounting)	135 {100, 13.8}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
4	Pack wheel hub cap or wheel hub cover	Wheel bearing grease [NLGI No.2 (Li soap)]	120 g {4.23 oz}
	Mating area of wheel hub cap and wheel hub	THREEBOND 1104	As required
9, 26	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
12	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	250 g {8.82 oz}

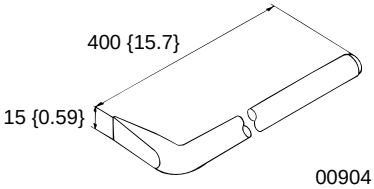
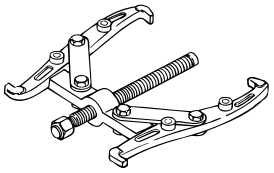
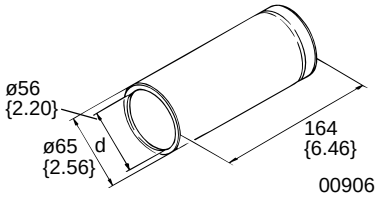
Special tools

Unit : mm {in.}

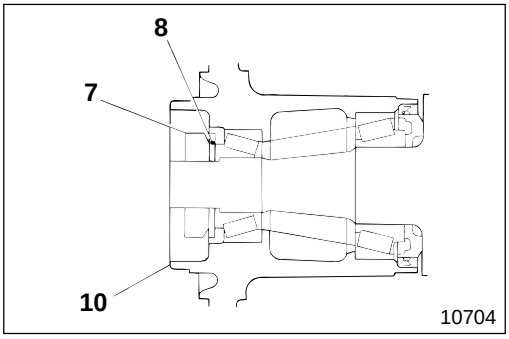
Location	Tool name and shape	Part No.	Application
4	Hub cap wrench  00898	MH061948	Removal of wheel hub cap
	Hub cap installer  00899	MH062204	Press-fitting of wheel hub cap
7	Socket wrench  00900	MH061531	Removal and installation of hub bearing lock nut
10	Wheel hub puller  13003	MH061993	Removal of hub and brake drum
12	Anti-lock brake system oil seal installer  02968	MH062305	Press-fitting of oil seal
13	Inner bearing installer  00903	MH061974	Press-fitting of inner bearing outer race
14	Outer bearing installer  00903	MC881484	Press-fitting of outer bearing outer race

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26, 27	Lever 	MH061683	Prying lever for knuckle to oil seal retainer
	Gear puller 	MH061102	Removal of oil seal retainer and inner bearing inner race
	Inner bearing installer 	MH061475	Press-fitting of inner bearing inner race and oil seal retainer

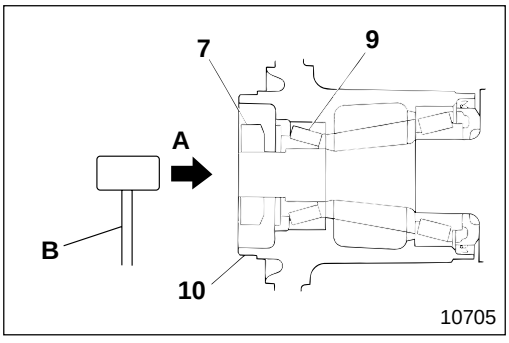
◆ Service procedure



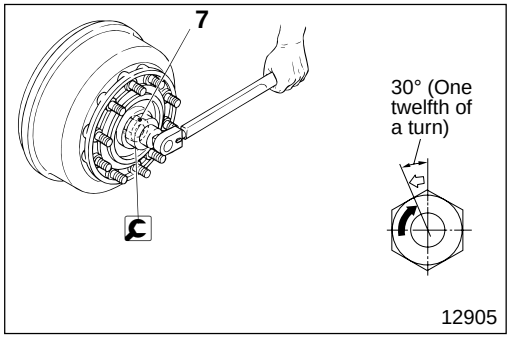
● Starting torque of wheel hub drum

[Adjustment]

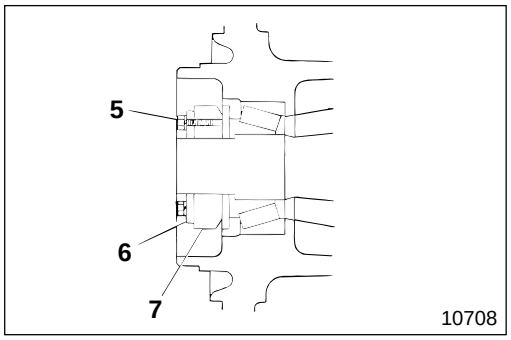
- Install lock washer **8** and lock nut **7**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **10** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **7** and lock washer **8**.



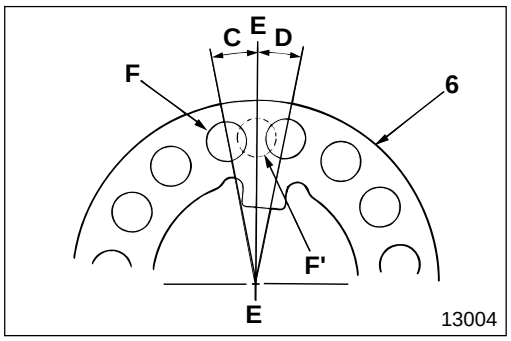
- Return outer bearing **9** toward lock nut **7** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **10** again.
  B : Copper-headed mallet



★ • After retightening lock nut **7** at specified torque, slacken it off by 30° (one twelfth of a turn).
(★ : If there is any deviation found when you measure the tangential force, carried out following the procedure on 🕮 P26-19, repeat the work.)

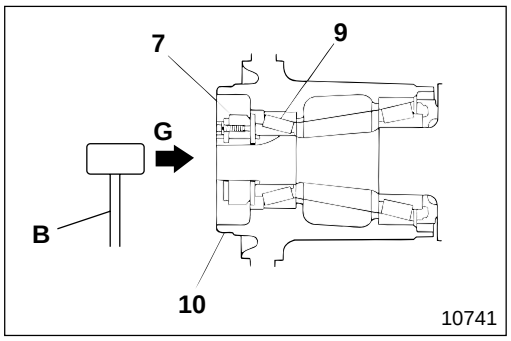


- Install lock plate **6**.
- Make sure that the bolt mounting holes of lock plate **6** and lock nut **7** align.
- Tighten mounting bolts **5** at specified torque.



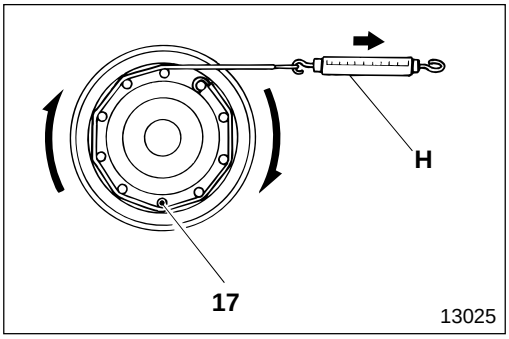
- If the mounting holes of lock plate **6** and lock nut **7** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



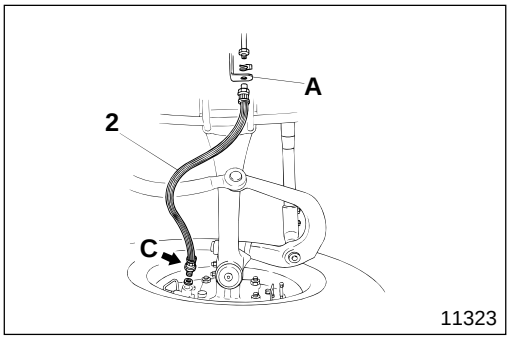
- To slide outer bearing **9** towards lock nut **7**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **10**.
B : Copper-headed mallet

- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.



[Measurement]
- Fasten spring balance **H** to hub bolt **17** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. 📖 P26-18
- If any fault is found after adjustment, replace outer bearings **9**, **14** and inner bearings **13**, **26**.

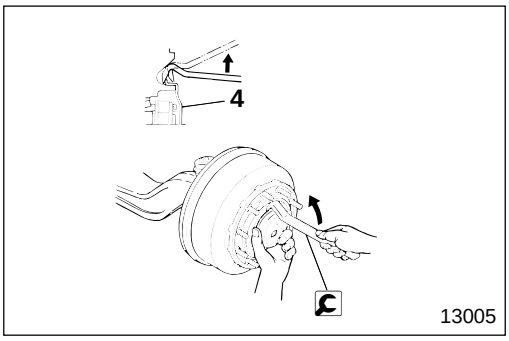
NOTE
- **Measure the starting torque when oil seal 12 has been installed.**
- **Make sure that the brake lining and brake drum 16 do not drag before measurement.**



2 Removal and installation of brake hose

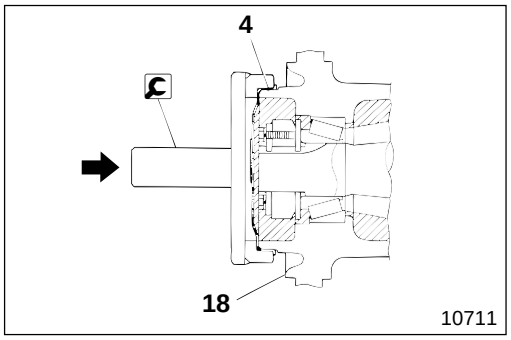
Remove the brake hose from frame side **A** first, then disconnect from wheel brake side **B**. For installation, connect the hose in a reverse order.

CAUTION ⚠
Make sure that brake hose 2 is not twisted when you install it.



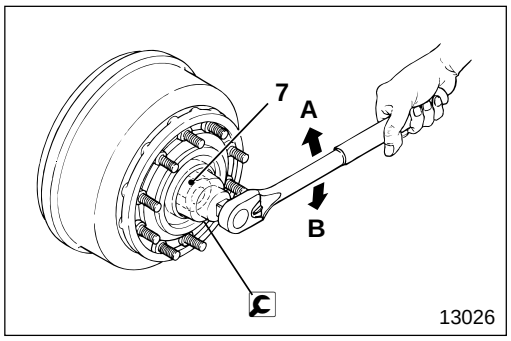
4 Wheel hub cap

[Removal]



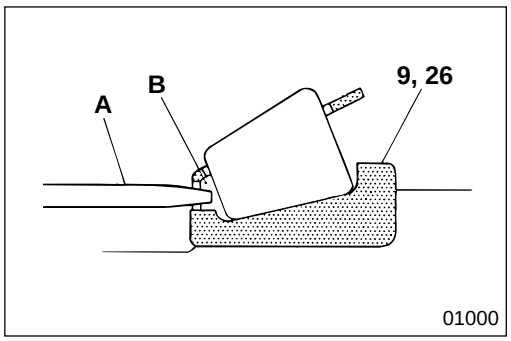
[nstallation]
Pack wheel hub cap **4** with grease, apply sealant to contact surfaces of wheel hub **18**, and press-fit it.

CAUTION
Do not use a hammer, etc. when you install wheel hub cap 4, or you might deform the mating surface, destroying watertightness.



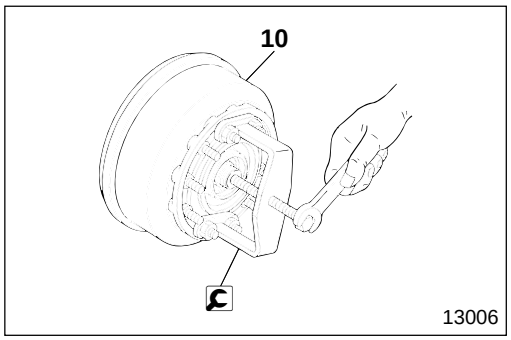
7 **Removal and installation of lock nut**

See adjustment of wheel hub bearing starting torque. P26-17
A : Removal
B : Installation



9 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

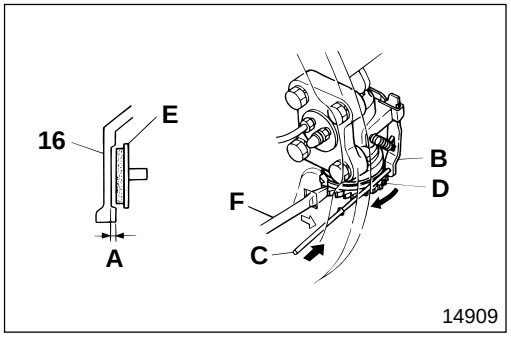
A : Grease pump nozzle
B : Between rollers



10 **Wheel hub and brake assembly**

[Removal]

CAUTION
Make sure you remove wheel hub and brake drum assembly 10 in a straight line to prevent damage to oil seal 12.



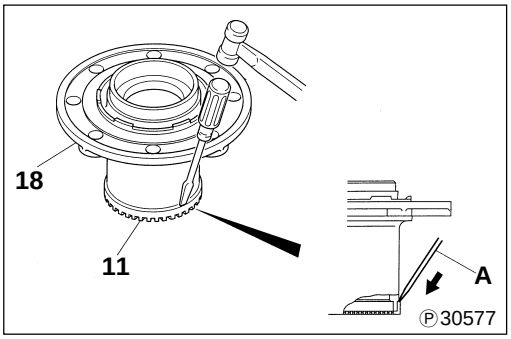
If wheel hub and brake drum assembly **10** cannot be removed because of stepped wear **A** in brake drum **16**, carry out the following:

- Remove the packing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **16** and brake shoe assembly **E**.
  F : Screwdriver
- Remove wheel hub and brake drum assembly **10**.

CAUTION

If brake drum 16 is faulty, correct it. Gr 35A

[Installation]
After installing wheel hub and brake drum assembly **10**, adjust the brake shoe clearance.
Gr 35A

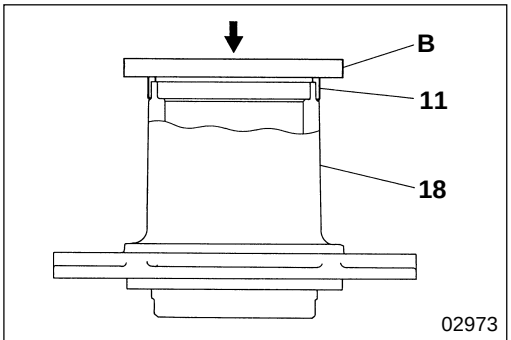


11 Rotor

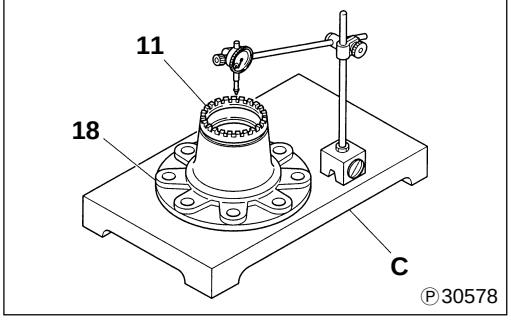
[Removal]
Strike the outer edge of rotor **11** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION

Be careful not to damage wheel hub 18.

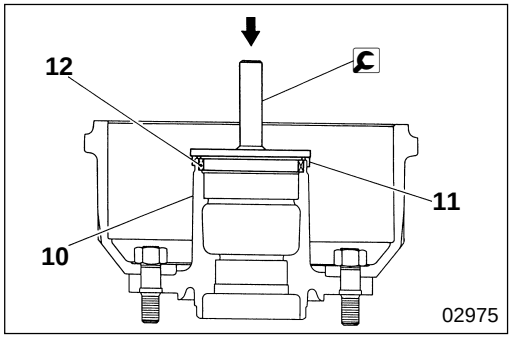


[Installation]
Heat rotor **11** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **18**. Make sure there is no space between the rotor and wheel hub.



[Inspection]

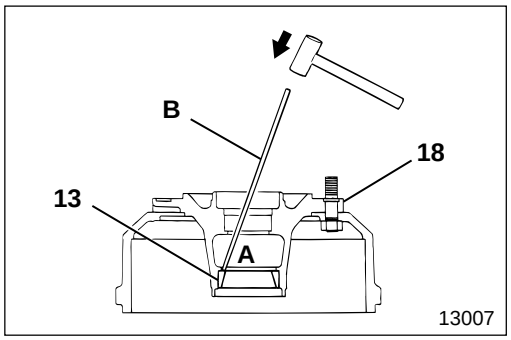
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



12 Installation of oil seal

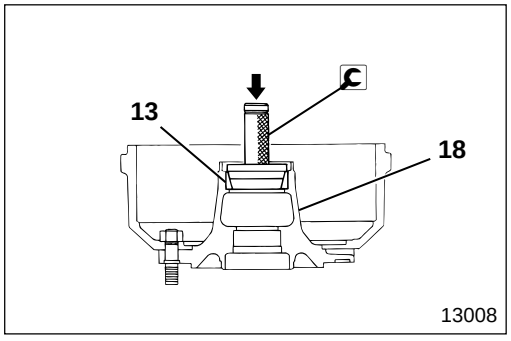
CAUTION

When hub and brake drum assembly 10 is removed for a service operation and if rotor 11 is still mounted on the wheel hub, use 0 ABS oil seal installer to press-fit oil seal 12.

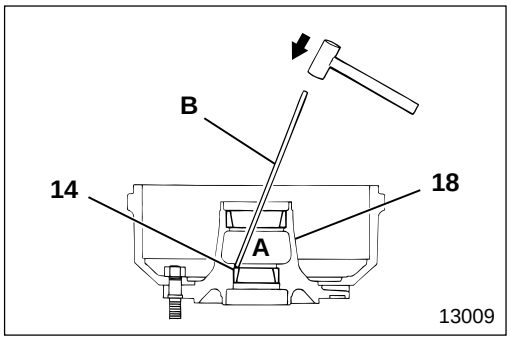


13 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **13** evenly from two indented parts **A** in wheel hub **18**.
B : Pin-punch

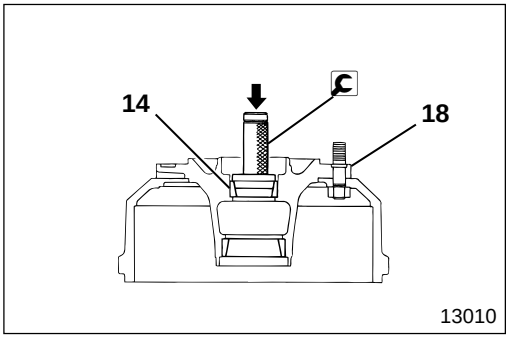


[Installation]

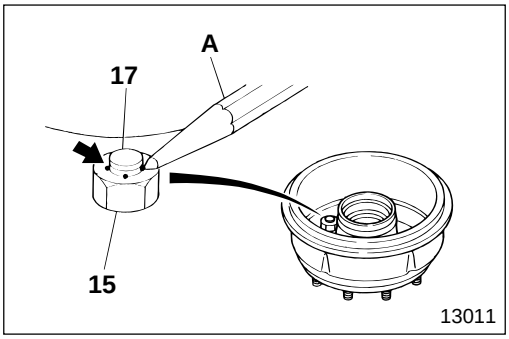


14 Outer bearing outer race

[Removal]
Drive out outer bearing outer race **14** evenly from two indented parts **A** in wheel hub **18**.
B : Pin-punch

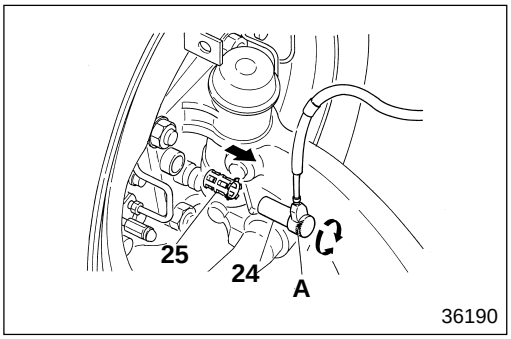


[Installation]



15 **17** **Installation of nut and hub bolts**

Tighten nut **15** at specified torque, then caulk hub bolt **17** evenly at four points.
A : Punch

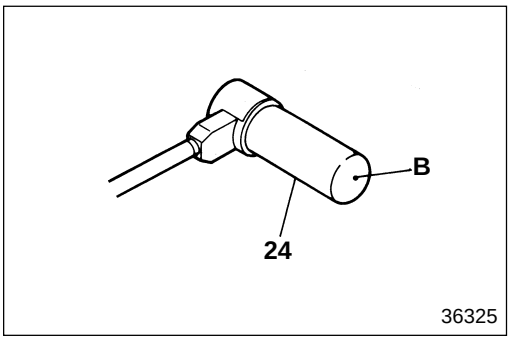


24 **Wheel speed sensor**

[Removal]
Hold shaded section **A** of wheel speed sensor **24** with pliers, and remove the sensor by twisting it slightly in left and right directions.

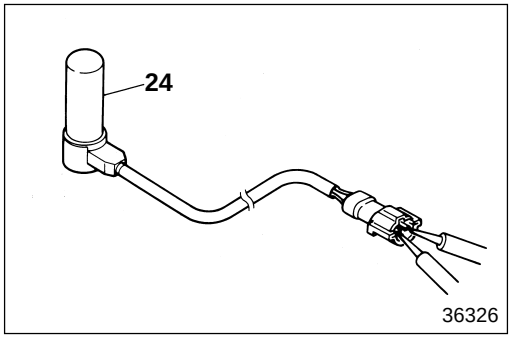
CAUTION

- **When holding wheel speed sensor 24 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 24 dismounts easily, replace spring spacer 25.**

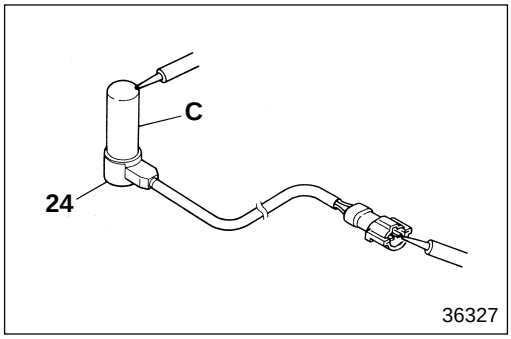


[Inspection]

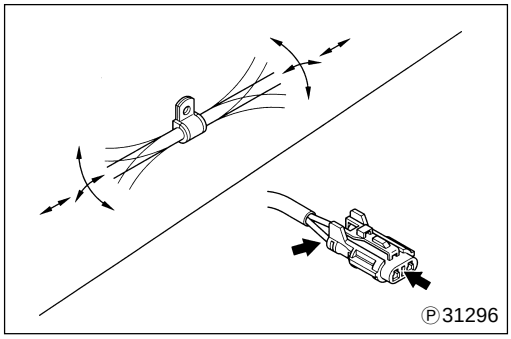
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **24**, it attracts metals. Do not allow the pole piece to collect metallic objects.



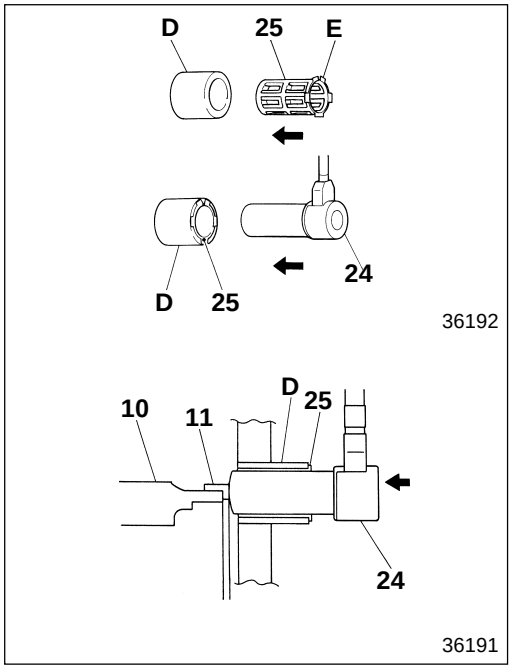
- Measure the resistance between the terminals of wheel speed sensor **24**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **24** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **24**.

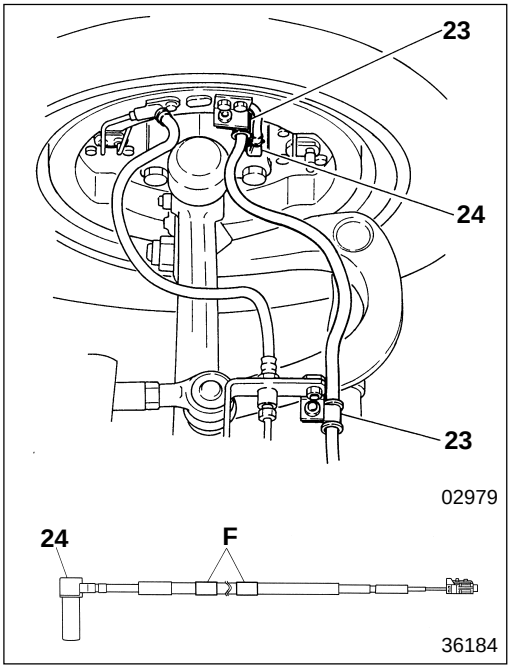


[Installation]

- Insert spring spacer **25** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **24**, and press until it contacts rotor **11**.
- Rotate hub and brake drum assembly **10** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION⚠

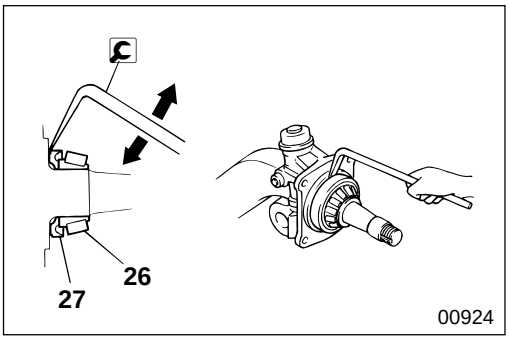
When installing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **24** in place using clip **23** on the wheel brake side and clip **23** on the frame side.

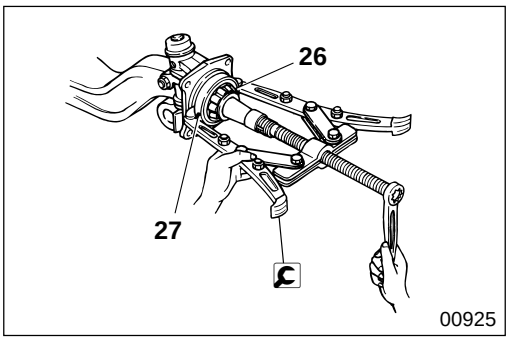
CAUTION⚠

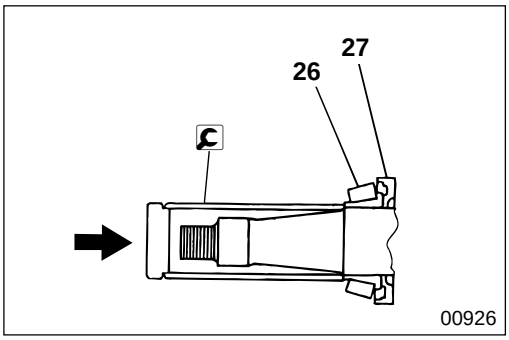
Be sure to clamp the harness of wheel speed sensor 24 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



26 **27** **Inner bearing inner race and oil seal retainer**

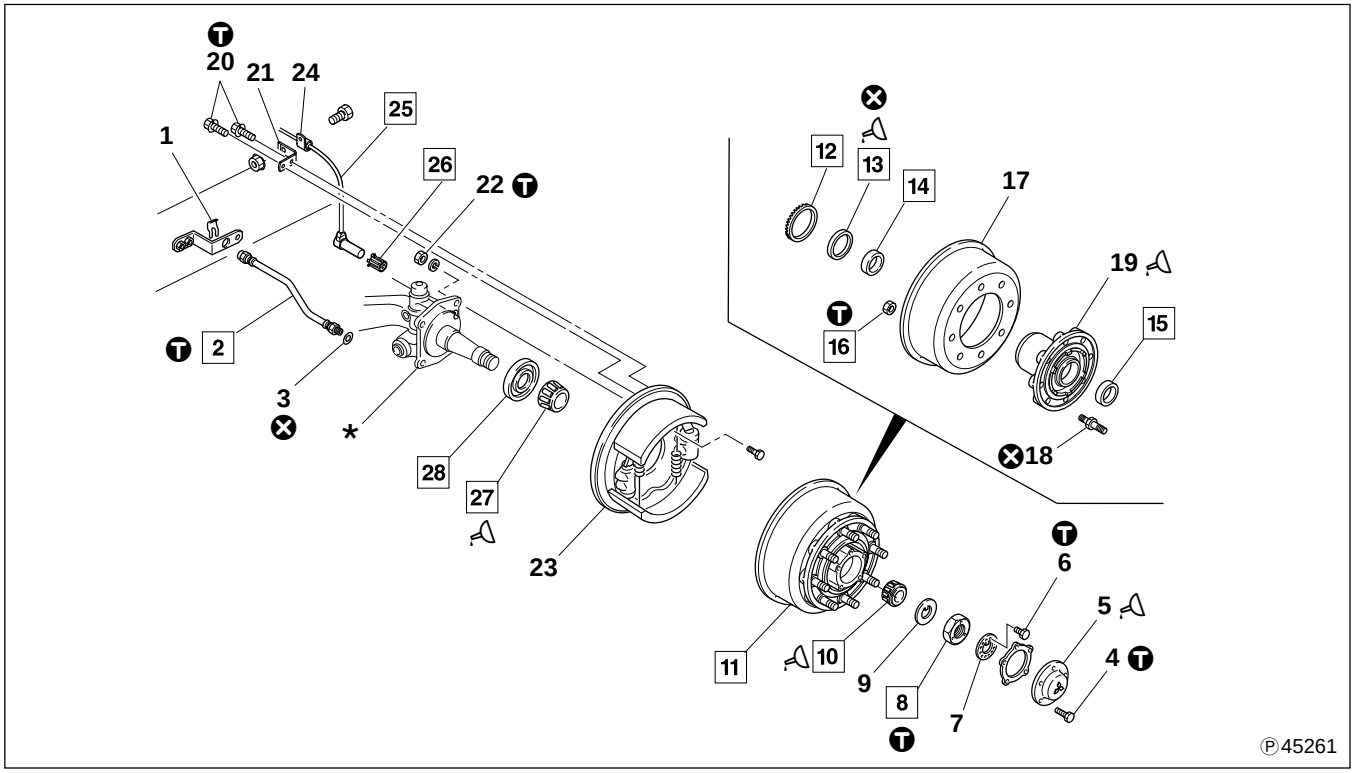
[Removal]





[Installation]

WHEEL HUB AND BRAKE DRUM < FM (AIR-OVER HYDRAULIC BRAKE) >



● **Disassembly sequence**

1 Clip
2 Brake hose
3 Packing
4 Bolt
5 Wheel hub cover
6 Bolt
7 Lock plate
8 Lock nut
9 Lock washer
10 Outer bearing inner race
11 Wheel hub and brake drum assembly
12 Rotor
13 Oil seal
14 Inner bearing outer race
15 Outer bearing outer race
16 Nut
17 Brake drum Gr 35A
18 Hub bolt
19 Wheel hub
20 Bolt
21 Clip bracket
22 Nut
23 Brake assembly Gr 35A
24 Clip
25 Wheel speed sensor
26 Spring spacer
27 Inner bearing inner race
28 Oil seal retainer

* : Knuckle P26-68
⊗ : Non-reusable parts

CAUTION

Be sure to protect brake hose 2 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 17 and wheel hub 19 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 17.**
- **Be careful not to damage oil seal 13 and rotor 12 when installing wheel hub and brake drum assembly 11 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
10, 14, 15, 27	Starting torque of wheel hub bearing		2.5 to 5.5 N·m {1.81 to 3.98 ft.lbs, 0.25 to 0.55 kgf·m}	—	Tangential force at wheel hub bearing 18 to 38 N {3.97 to 8.60 lbf, 1.8 to 3.9 kgf}
12	Wobbling of rotor		0.1 {0.0039}	—	Replace
26	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1MΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

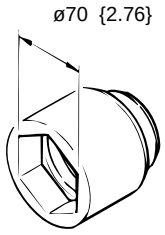
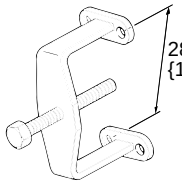
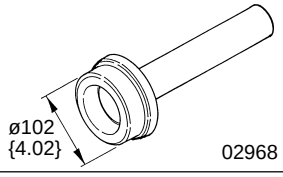
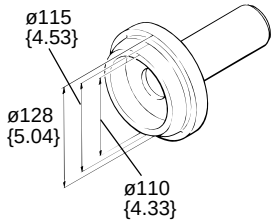
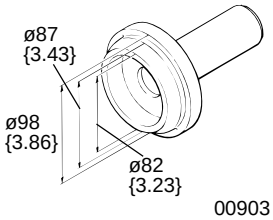
Location	Parts to be tightened	Tightening torque	Remarks
2	Brake hose (Brake side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
4	Bolt (Wheel hub cover mounting)	23±4 {17±3.3, 2.35±0.45}	—
6	Bolt (Lock plate mounting)	7 to 11 {5.1 to 8, 0.7 to 1.1}	—
8	Lock nut	200 {145, 20}	Slackening off angle : 30° (one twelfth of a turn)
16	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
20	Bolt (Bracket mounting)	9.8 to 14.0 {7 to 10, 1.0 to 1.4}	—
22	Nut (Brake assembly mounting)	135 {100, 13.8}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
5	Pack wheel hub cap or wheel hub cover	Wheel bearing grease [NLGI No.2 (Li soap)]	120 g {4.23 oz}
10, 27	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	500 g {17.6 oz}

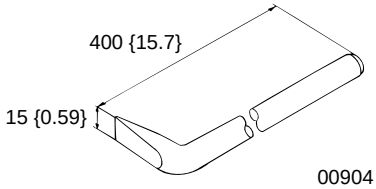
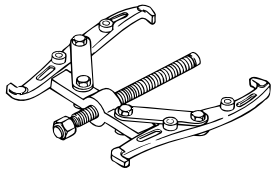
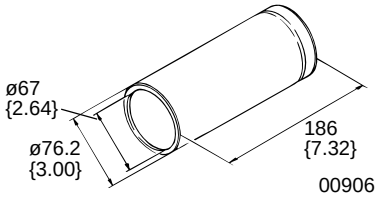
Special tools

Unit : mm {in.}

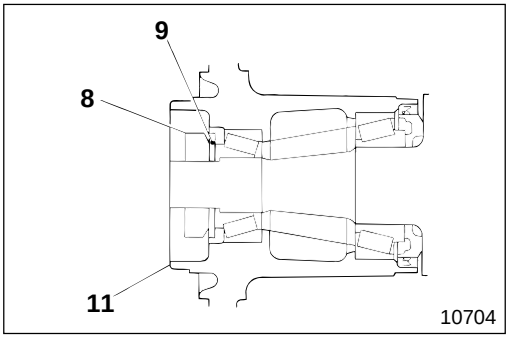
Location	Tool name and shape	Part No.	Application
8	Socket wrench 	MH061528	Removal and installation of hub bearing lock nut
11	Wheel hub puller 	MH061993	Removal of hub and brake drum
13	Anti-lock brake system oil seal installer 	MH062305	Press-fitting of oil seal
14	Inner bearing installer 	03724-62000	Press-fitting of inner bearing outer race
15	Outer bearing installer 	03724-63000	Press-fitting of outer bearing outer race

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
27, 28	Lever 	MH061683	Prying lever for knuckle to oil seal retainer
	Gear puller 	MH061102	Removal of oil seal retainer and inner bearing inner race
	Inner bearing installer 	MH061473	Press-fitting of inner bearing inner race and oil seal retainer

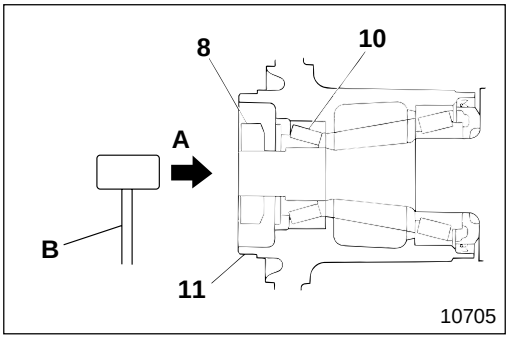
◆ Service procedure



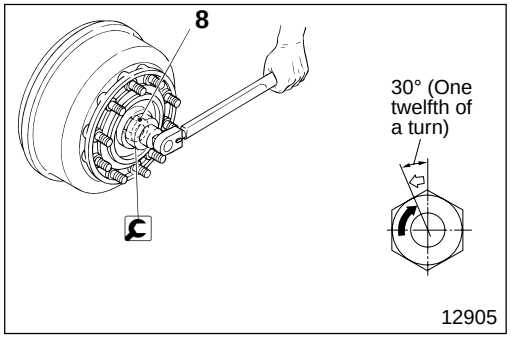
● Starting torque of wheel hub drum

[Adjustment]

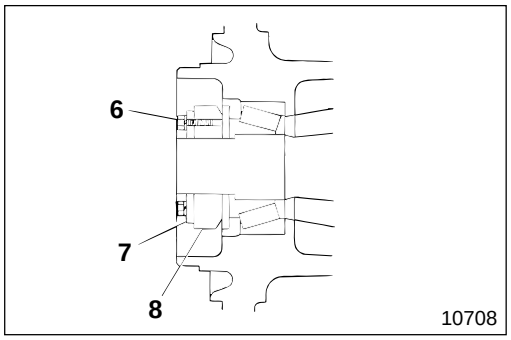
- Install lock washer **9** and lock nut **8**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **11** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **8** and lock washer **9**.



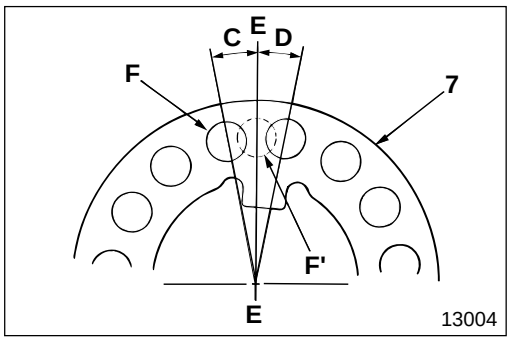
- Return outer bearing **10** toward lock nut **8** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **11** again.
  B : Copper-headed mallet



★ • After retightening lock nut **8** at specified torque, slacken it off by 30° (one twelfth of a turn).
(★ : If there is any deviation found when you measure the tangential force, carried out following the procedure on 🕮 P26-31, repeat the work.)

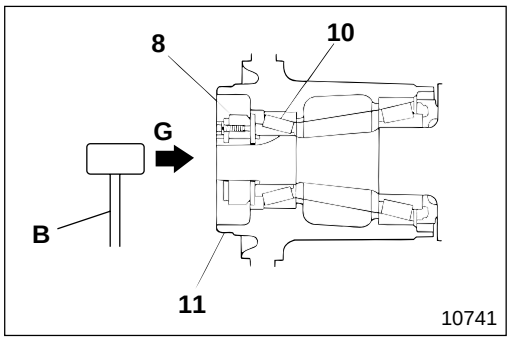


- Install lock plate **7**.
- Make sure that the bolt mounting holes of lock plate **7** and lock nut **8** align.
- Tighten mounting bolts **6** at specified torque.



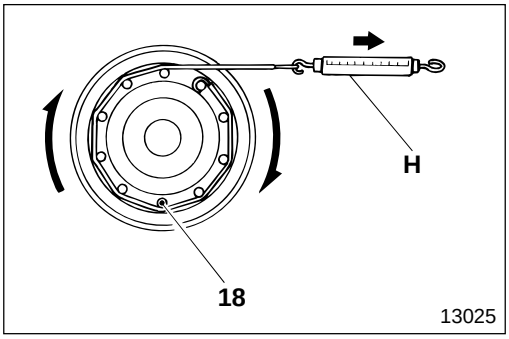
- If the mounting holes of lock plate **7** and lock nut **8** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



- To slide outer bearing **10** towards lock nut **8**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **11**.
B : Copper-headed mallet

- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.

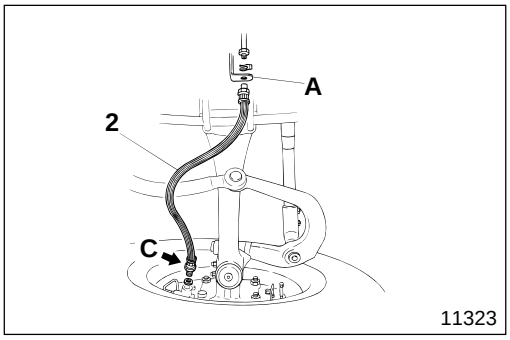


[Measurement]

- Fasten spring balance **H** to hub bolt **18** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. P26-30
- If any fault is found after adjustment, replace outer bearings **10**, **15** and inner bearings **14**, **27**.

NOTE

- **Measure the starting torque when oil seal 13 has been installed.**
- **Make sure that the brake lining and brake drum 17 do not drag before measurement.**

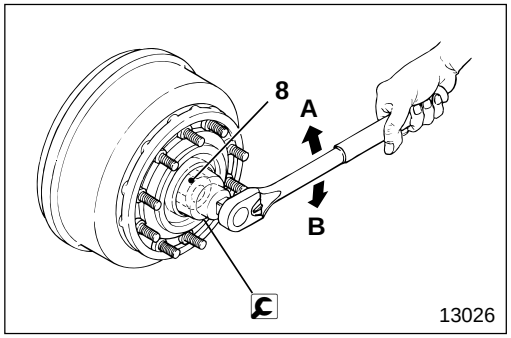


2 Removal and installation of brake hose

First remove brake hose **2** from bracket **A** or connector **B** (on the frame), then remove the brake hose from wheel brake **C** or front brake chamber **D**. For installation, follow this procedure in reverse.

CAUTION ⚠

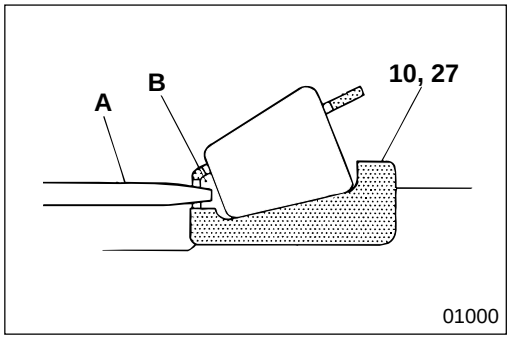
Make sure that brake hose 2 is not twisted when you install it.



8 **Removal and installation of lock nut**

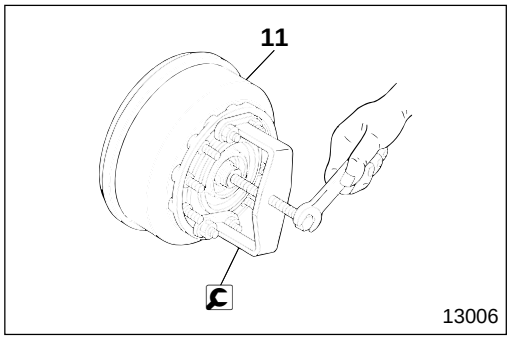
See adjustment of wheel hub bearing starting torque. 🕮 P26-29

A : Removal
B : Installation



10 **27** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Between rollers

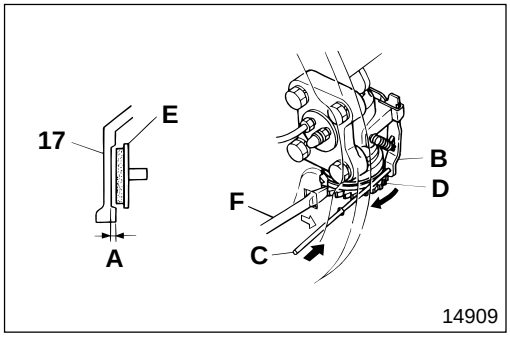


11 **Wheel hub and brake assembly**

[Removal]

CAUTION⚠

Make sure you remove wheel hub and brake drum assembly 11 in a straight line to prevent damage to oil seal 13.



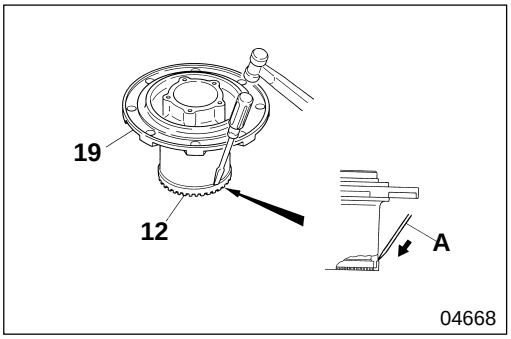
If wheel hub and brake drum assembly **11** cannot be removed because of stepped wear **A** in brake drum **17**, carry out the following:

- Remove the backing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **17** and brake shoe assembly **E**.
  F : Screwdriver
- Remove wheel hub and brake drum assembly **11**.

CAUTION

If brake drum 17 is faulty, correct it. Gr 35A

[Installation]
After installing wheel hub and brake drum assembly **11**, adjust the brake shoe clearance.
Gr 35A

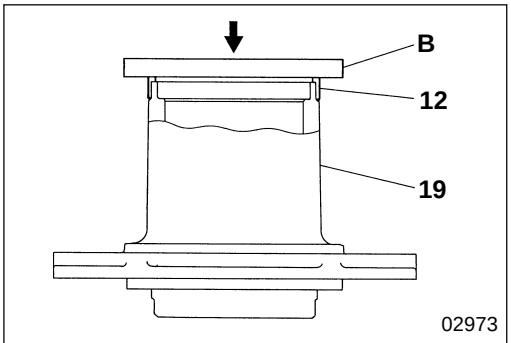


12 Rotor

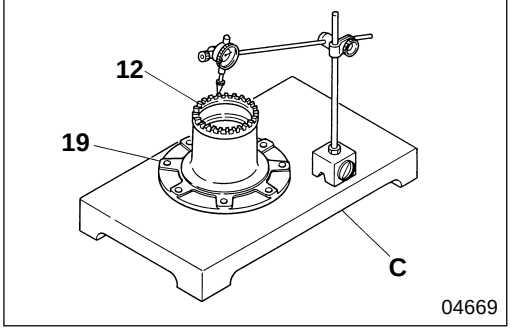
[Removal]
Strike the outer edge of rotor **12** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION

Be careful not to damage wheel hub 19.

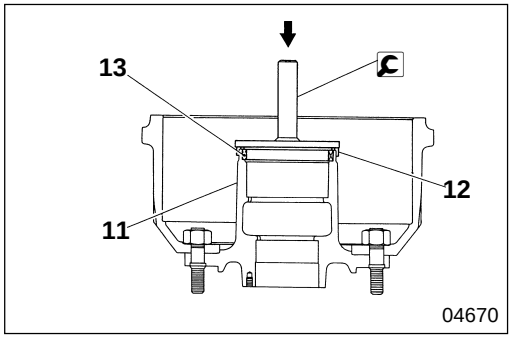


[Installation]
Heat rotor **12** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **19**. Make sure there is no space between the rotor and wheel hub.



[Inspection]

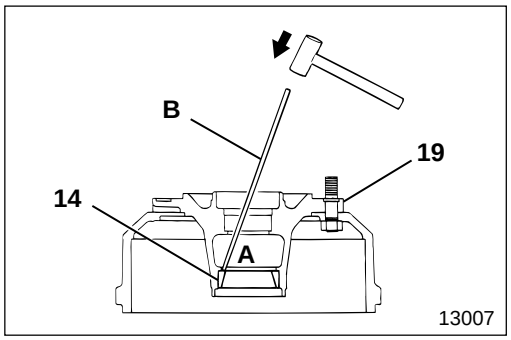
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



13 Installation of oil seal

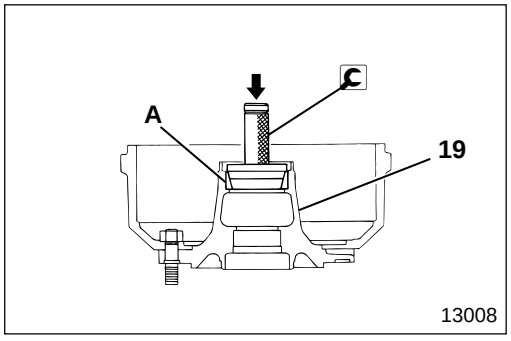
CAUTION

When hub and brake drum assembly 11 is removed for a service operation and if rotor 12 is still mounted on the wheel hub, use 0 ABS oil seal installer to press-fit oil seal 13.

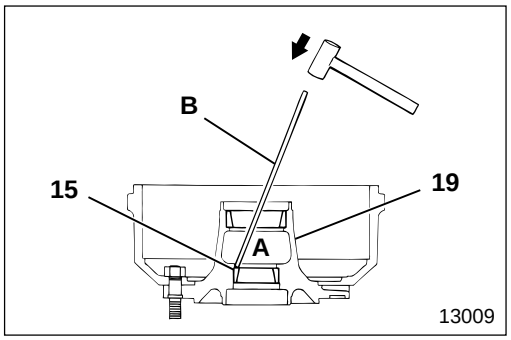


14 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **14** evenly from two indented parts **A** in wheel hub **19**.
B : Pin-punch

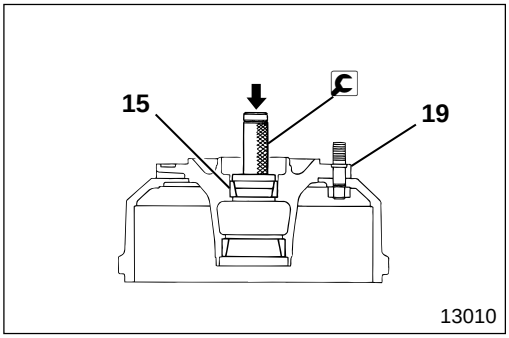


[Installation]

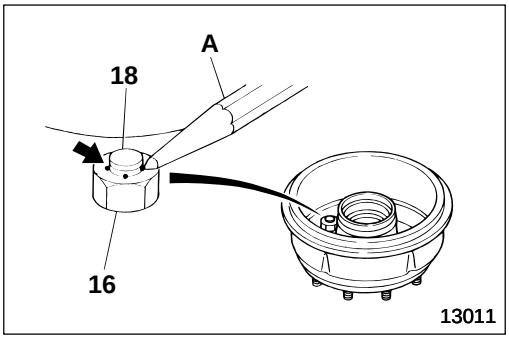


15 Outer bearing outer race

[Removal]
Drive out outer bearing outer race **15** evenly from two indented parts **A** in wheel hub **19**.
B : Pin-punch

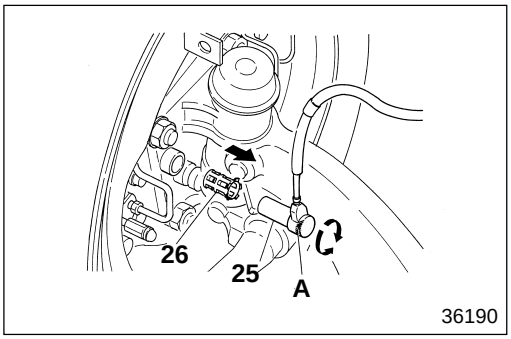


[Installation]



16 **18** **Installation of nut and hub bolts**

Tighten nut **16** at specified torque, then caulk hub bolt **18** evenly at four points.
A : Punch

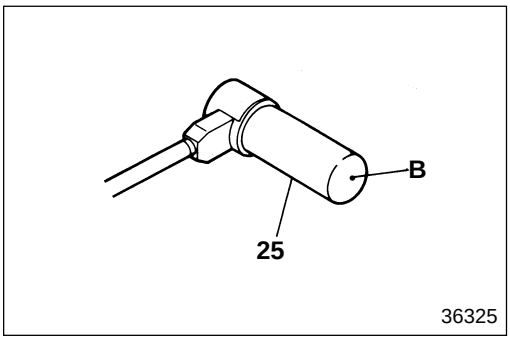


25 **Wheel speed sensor**

[Removal]
Hold shaded section **A** of wheel speed sensor **25** with pliers, and remove the sensor by twisting it slightly in left and right directions.

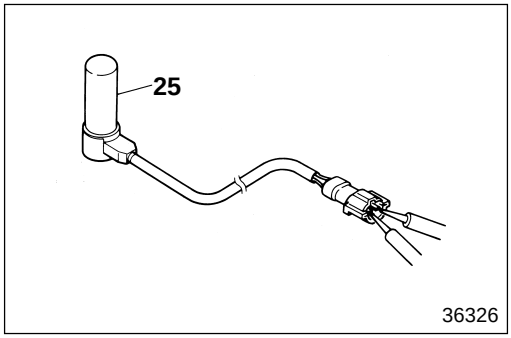
CAUTION

- **When holding wheel speed sensor 25 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 25, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 25 dismounts easily, replace spring spacer 26.**

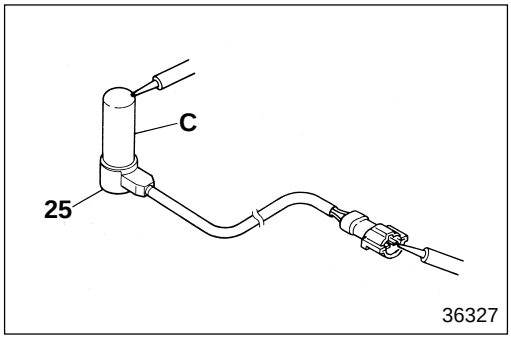


[Inspection]

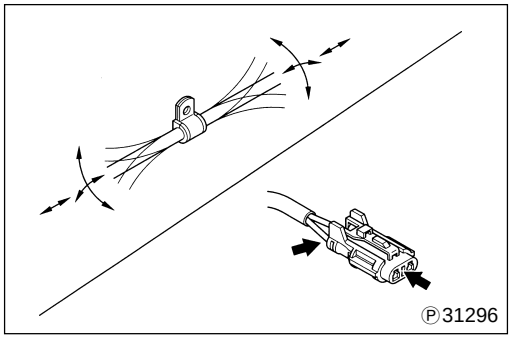
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **25**, it attracts metals. Do not allow the pole piece to collect metallic objects.



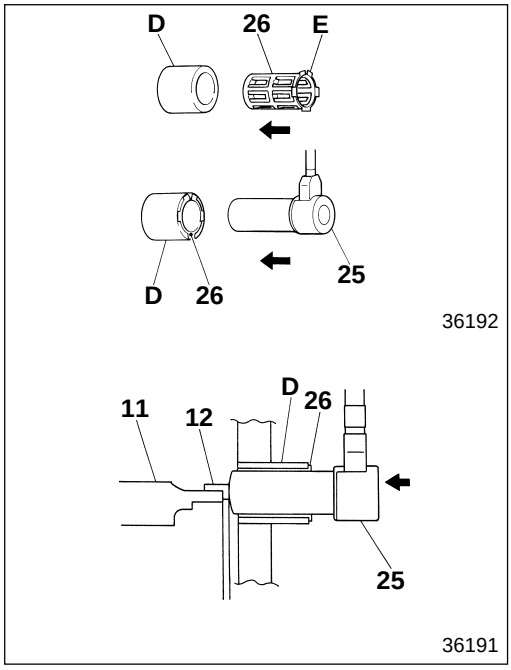
- Measure the resistance between the terminals of wheel speed sensor **25**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **25** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **25**.

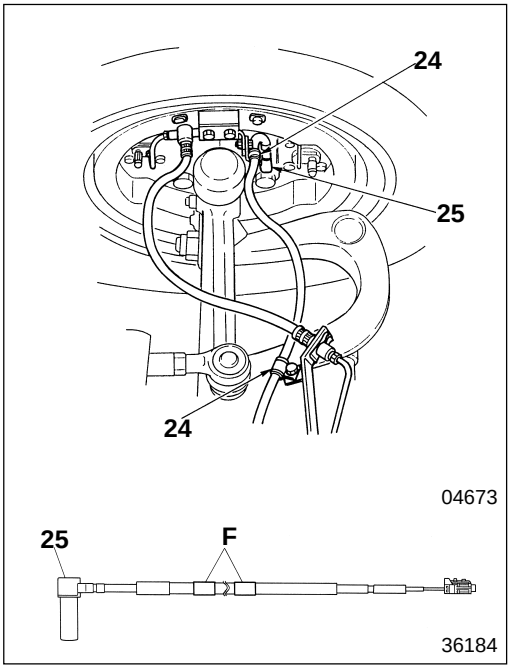


[Installation]

- Insert spring spacer **26** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **25**, and press until it contacts rotor **12**.
- Rotate hub and brake drum assembly **11** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION⚠

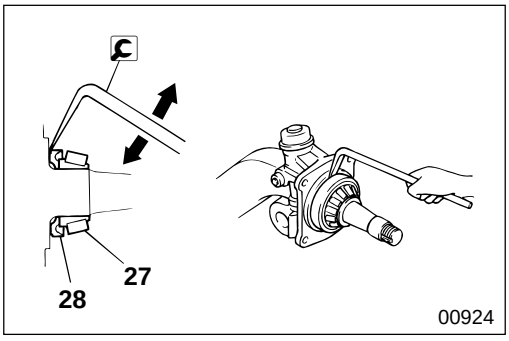
When installing wheel speed sensor 25, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **25** in place using clip **24** on the wheel brake side and clip **24** on the frame side.

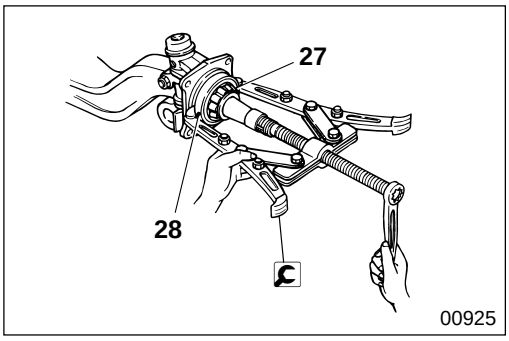
CAUTION⚠

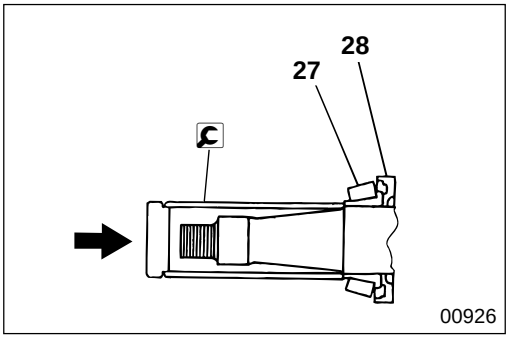
Be sure to clamp the harness of wheel speed sensor 25 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



27 **28** **Inner bearing inner race and oil seal retainer**

[Removal]

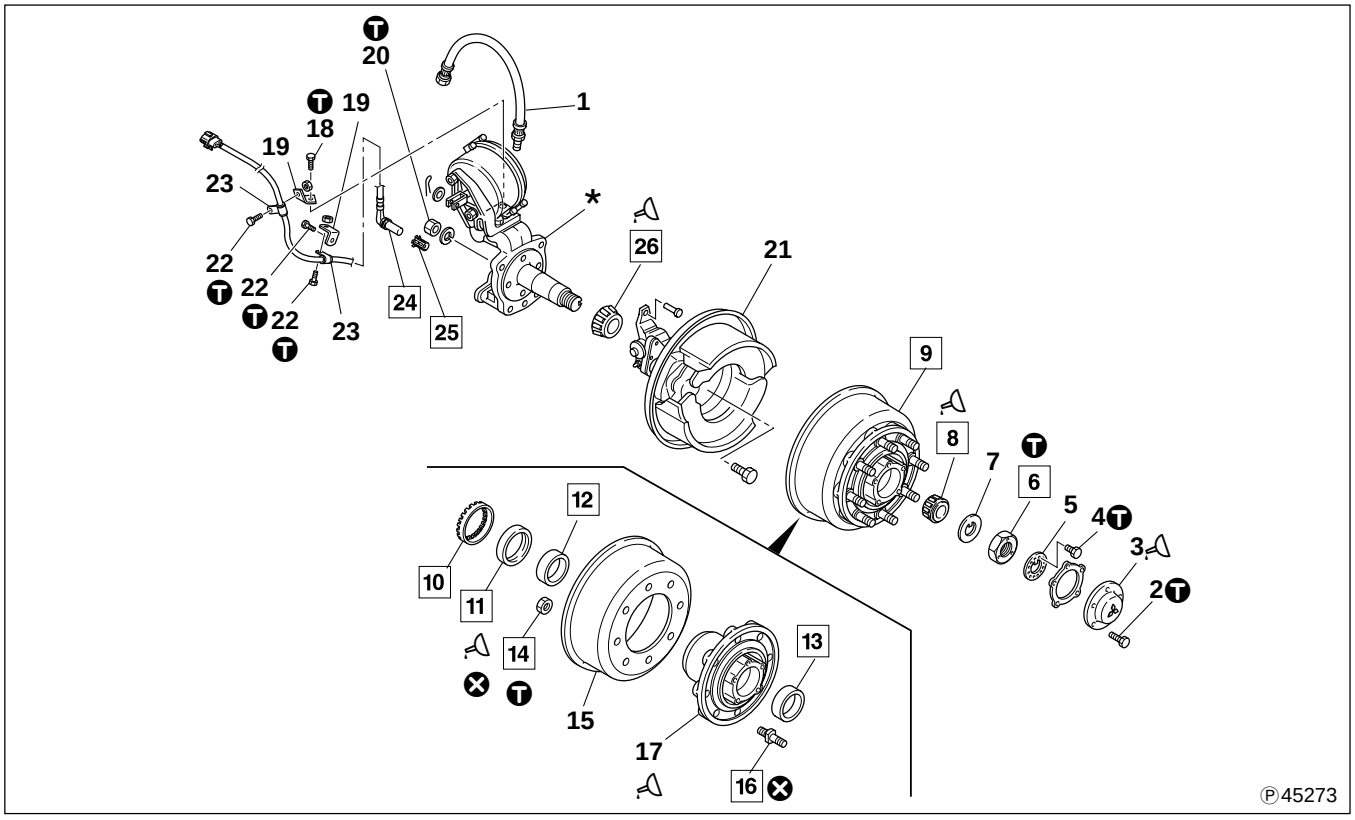




[Installation]

WHEEL HUB AND BRAKE DRUM < FM (FULL-AIR BRAKE) >

< Type 1 >



● **Disassembly sequence**

1 Brake hose
2 Bolt
3 Wheel hub cover
4 Bolt
5 Lock plate
6 Lock nut
7 Lock washer
8 Outer bearing inner race
9 Wheel hub and brake drum assembly
10 Rotor
11 Oil seal
12 Inner bearing outer race
13 Outer bearing outer race
14 Nut
15 Brake drum Gr 35B
16 Hub bolt
17 Wheel hub
18 Bolt
19 Clip bracket
20 Nut
21 Brake assembly Gr 35B
22 Bolt
23 Clip
24 Wheel speed sensor
25 Spring spacer
26 Inner bearing inner race

***** : Knuckle P26-76
⊗ : Non-reusable parts

CAUTION

Be sure to protect brake hose 1 from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 15 and wheel hub 17 except for replacement.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35B

CAUTION⚠

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 15.**
- **Be careful not to damage oil seal 11 and rotor 10 when installing wheel hub and brake drum assembly 9 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
8, 12, 13, 26	Starting torque of wheel hub bearing		2.5 to 5.5 N·m {1.81 to 3.98 ft.lbs, 0.25 to 0.55 kgf·m}	—	Tangential force at wheel hub bearing 18 to 38 N {3.97 to 8.60 lbf, 1.8 to 3.9 kgf}
10	Wobbling of rotor		0.1 {0.0039}	—	Replace
25	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1MΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

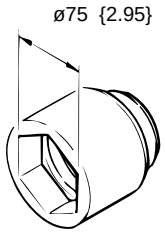
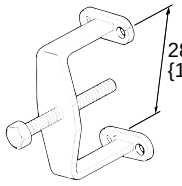
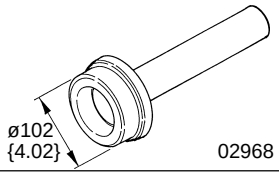
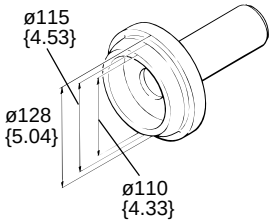
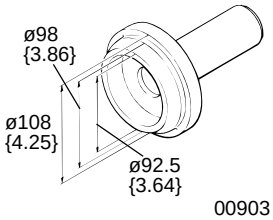
Location	Parts to be tightened	Tightening torque	Remarks
1	Brake hose (Brake side)	39 to 44 {29 to 33, 4.0 to 4.5}	—
2	Bolt (Wheel hub cover mounting)	23±4 {17±3.3, 2.35±0.45}	—
4	Bolt (Lock plate mounting)	7 to 11 {5.1 to 8, 0.7 to 1.1}	—
6	Lock nut	200 {145, 20}	Slackening off angle : 22.5° (one sixteenth of a turn)
14	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
18	Bolt (Bracket mounting)	41.2±7.8 {30±5.8, 4.2±0.8}	—
20	Nut (Brake assembly mounting)	215±32 {160±24, 22±3.3}	—
22	Bolt (Clip mounting)	44±9.8 {33±7.2, 4.5±1.0}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
3	Pack wheel hub cap or wheel hub cover	Wheel bearing grease [NLGI No.2 (Li soap)]	120 g {4.23 oz}
8, 26	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
11	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	570 g {20.1oz}

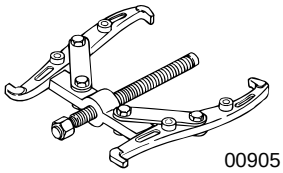
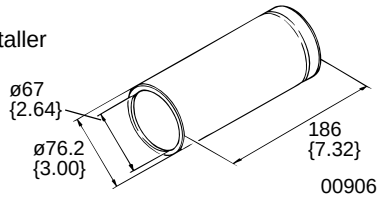
Special tools

Unit : mm {in.}

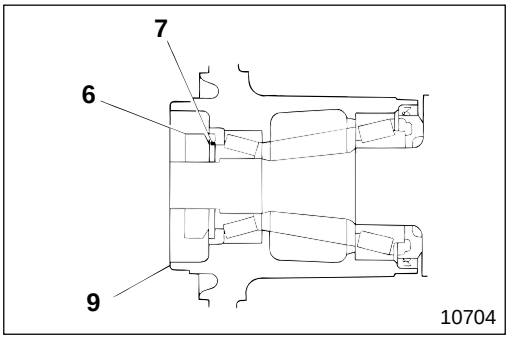
Location	Tool name and shape	Part No.	Application
6	Socket wrench 	MH061530	Removal and installation of hub bearing lock nut
9	Wheel hub puller 	MH061993	Removal of hub and brake drum
11	Anti-lock brake system oil seal installer 	MH062305	Press-fitting of oil seal
12	Inner bearing installer 	03724-62000	Press-fitting of inner bearing outer race
13	Outer bearing installer 	03723-23000	Press-fitting of outer bearing outer race

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26	Gear puller  00905	MH061102	Removal of inner bearing inner race
	Inner bearing installer  00906	MH061473	Press-fitting of inner bearing inner race

◆ Service procedure

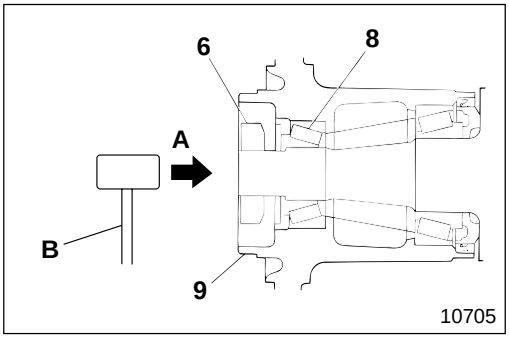


10704

● Starting torque of wheel hub drum

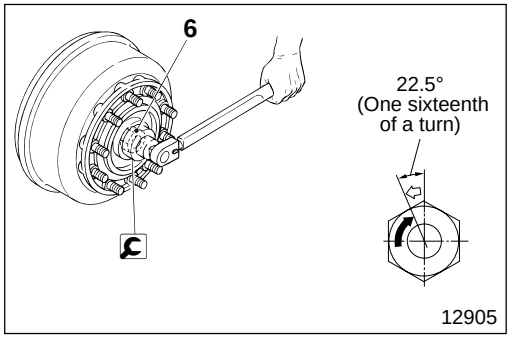
[Adjustment]

- Install lock washer **7** and lock nut **6**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **9** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **6** and lock washer **7**.

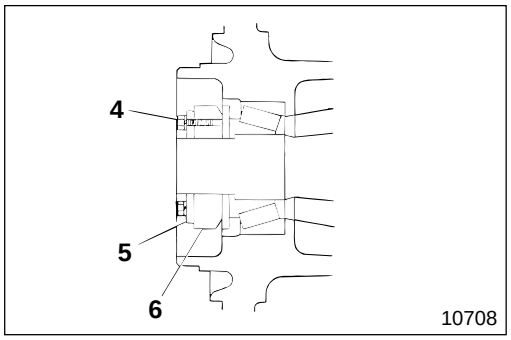


10705

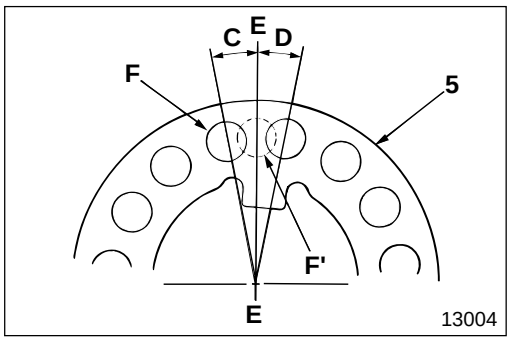
- Return outer bearing **8** toward lock nut **6** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **9** again.
  B : Copper-headed mallet



★ • After retightening lock nut **6** at specified torque, slacken it off by 22.5° (one sixteenth of a turn).
(★ : If there is any deviation found when you measure the tangential force, carried out following the procedure on 📖 P26-43, repeat the work.)

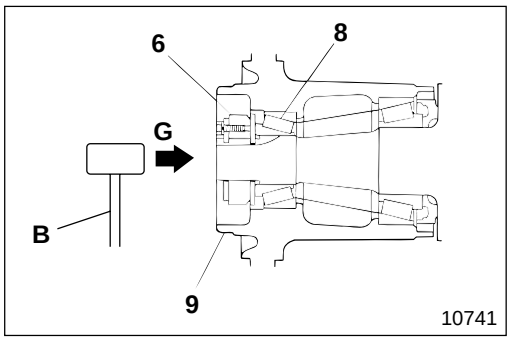


- Install lock plate **5**.
- Make sure that the bolt mounting holes of lock plate **5** and lock nut **6** align.
- Tighten mounting bolts **4** at specified torque.



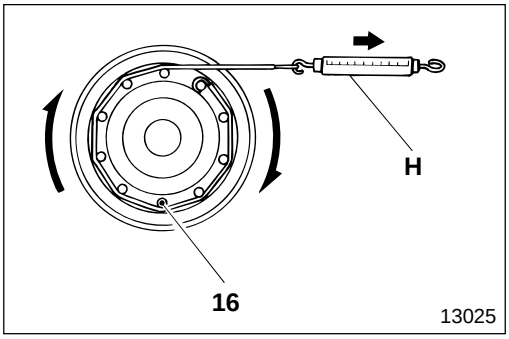
- If the mounting holes of lock plate **5** and lock nut **6** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



- To slide outer bearing **8** towards lock nut **6**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **9**.
B : Copper-headed mallet

- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.

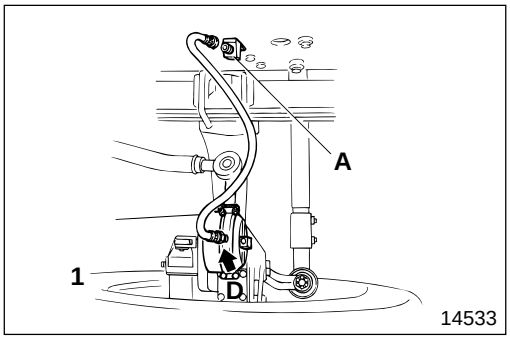


[Measurement]

- Fasten spring balance **H** to hub bolt **16** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. P26-42
- If any fault is found after adjustment, replace outer bearings **8**, **13** and inner bearings **12**, **26**.

NOTE

- **Measure the starting torque when oil seal 11 has been installed.**
- **Make sure that the brake lining and brake drum 15 do not drag before measurement.**

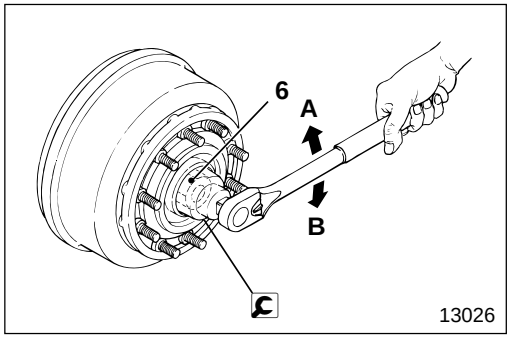


1 Removal and installation of brake hose

First remove brake hose **1** from bracket **A** or connector **B** (on the frame), then remove the brake hose from wheel brake **C** or front brake chamber **D**. For installation, follow this procedure in reverse.

CAUTION ⚠

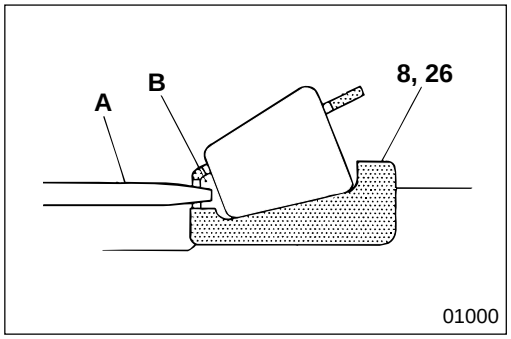
Make sure that brake hose 1 is not twisted when you install it.



6 **Removal and installation of lock nut**

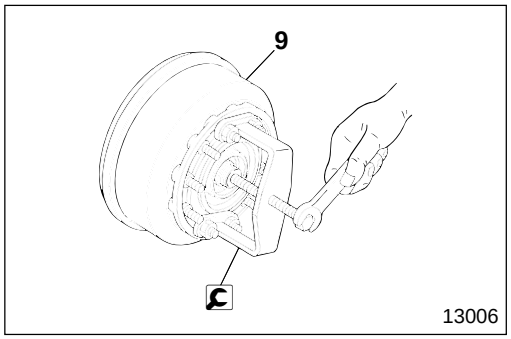
See adjustment of wheel hub bearing starting torque. 🕮 P26-41

A : Removal
B : Installation



8 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Between rollers

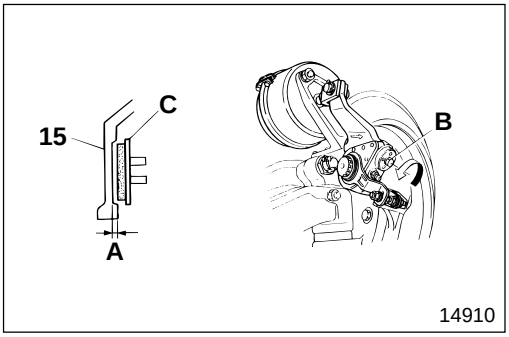


9 **Wheel hub and brake assembly**

[Removal]

CAUTION⚠

Make sure you remove wheel hub and brake drum assembly 9 in a straight line to prevent damage to oil seal 11.



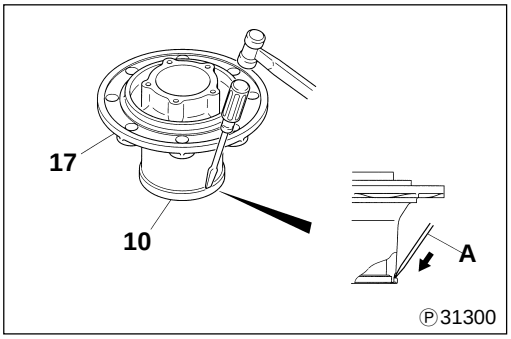
If wheel hub and brake drum assembly **9** cannot be removed because of stepped wear **A** in brake drum **15**, carry out the following:

- Turn worm shaft **B** of the automatic slack adjust counterclockwise, and expand the clearance between brake drum **15** and brake shoe assembly **C**.
- Remove wheel hub and brake drum assembly **9**.

CAUTION

If brake drum 15 is faulty, correct it. Gr 35B

[Installation]
After installing wheel hub and brake drum assembly **9**, adjust the brake shoe clearnace.
Gr 35B

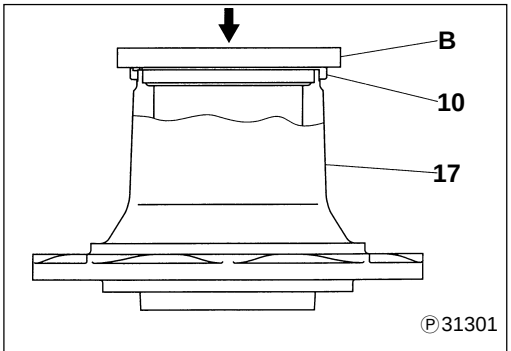


10 **Rotor**

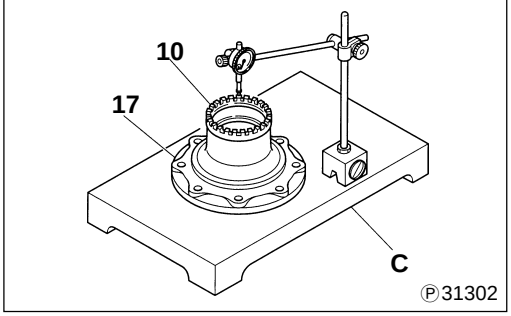
[Removal]
Strike the outer edge of rotor **10** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION

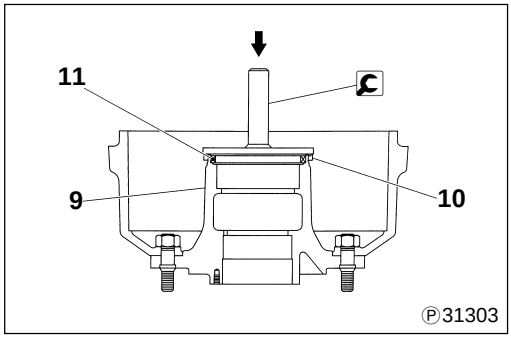
Be careful not to damage wheel hub 17.



[Installation]
Heat rotor **10** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **17**. Make sure there is no space between the rotor and wheel hub.



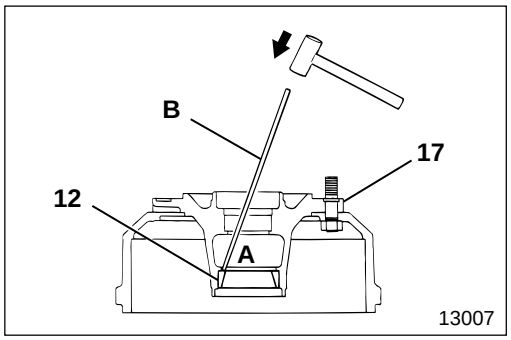
[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



11 **Installation of oil seal**

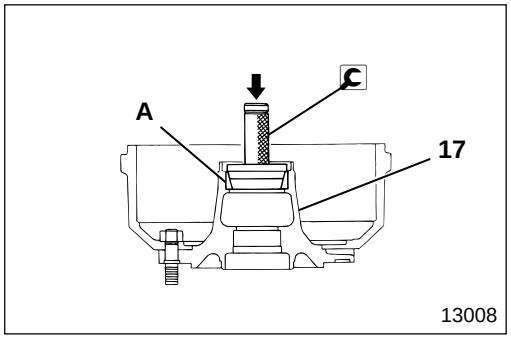
CAUTION

When hub and brake drum assembly 9 is removed for a service operation and if rotor 10 is still mounted on the wheel hub, use 0 ABS oil seal installer to press-fit oil seal 11.

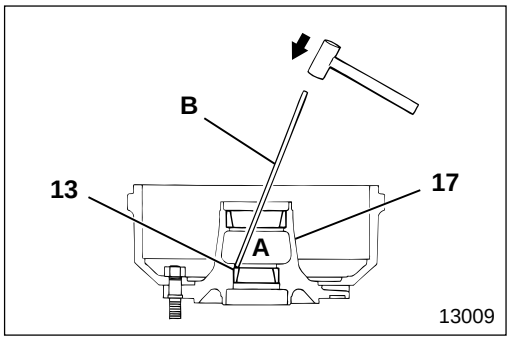


12 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **12** evenly from two indented parts **A** in wheel hub **17**.
B : Pin-punch

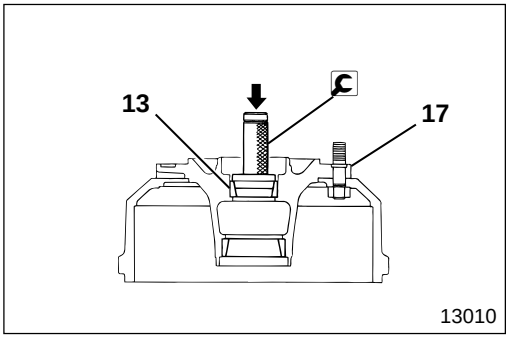


[Installation]

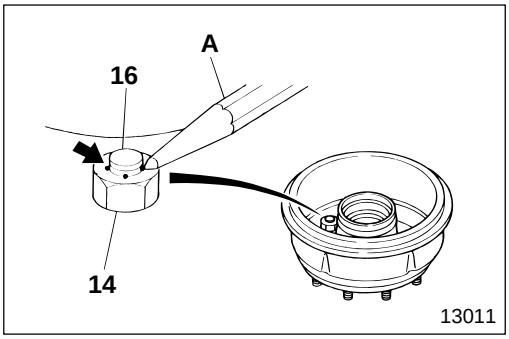


13 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **13** evenly from two indented parts **A** in wheel hub **17**.
B : Pin-punch

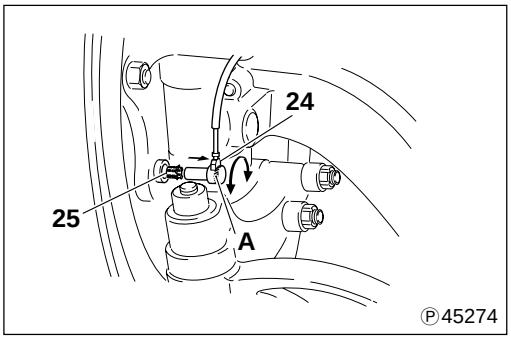


[Installation]



14 **16** **Installation of nut and hub bolts**

Tighten nut **14** at specified torque, then caulk hub bolt **16** evenly at four points.
A : Punch

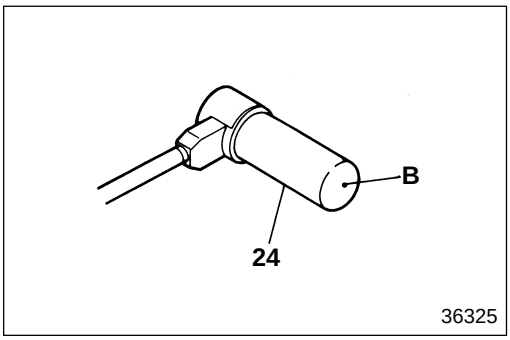


24 **Wheel speed sensor**

[Removal]
Hold shaded section **A** of wheel speed sensor **24** with pliers, and remove the sensor by twisting it slightly in left and right directions.

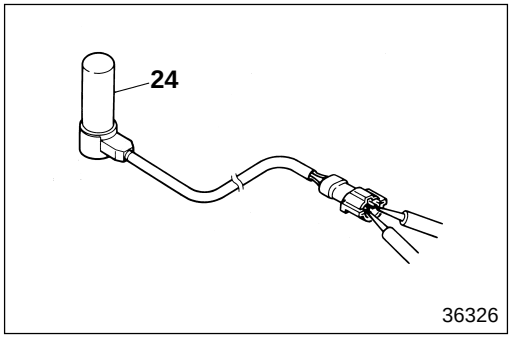
CAUTION

- **When holding wheel speed sensor 24 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 24 dismounts easily, replace spring spacer 25.**

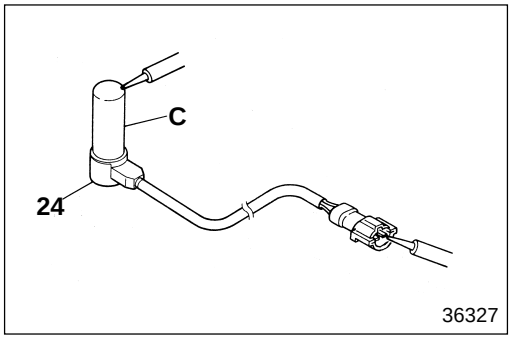


[Inspection]

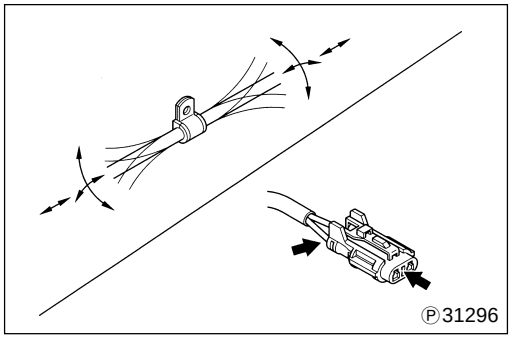
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **24**, it attracts metals. Do not allow the pole piece to collect metallic objects.



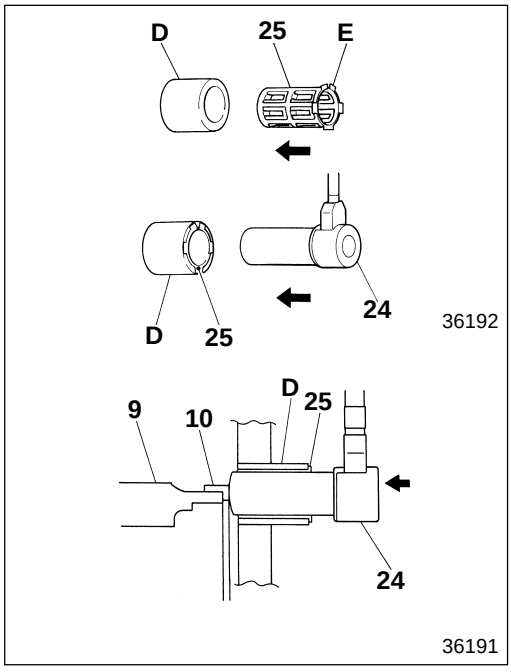
- Measure the resistance between the terminals of wheel speed sensor **24**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **24** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **24**.

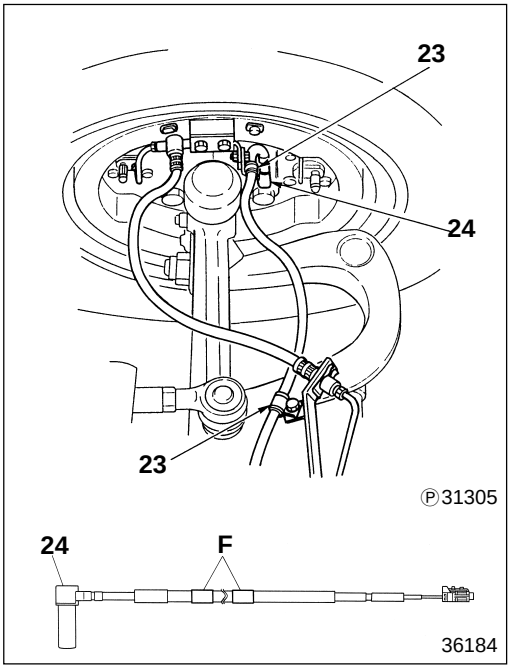


[Installation]

- Insert spring spacer **25** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **24**, and press until it contacts rotor **10**.
- Rotate hub and brake drum assembly **9** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION⚠

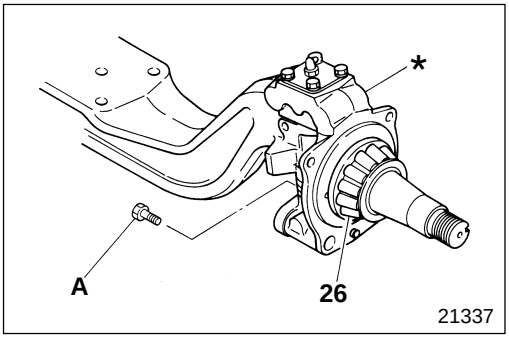
When installing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **24** in place using clip **23** on the wheel brake side and clip **23** on the frame side.

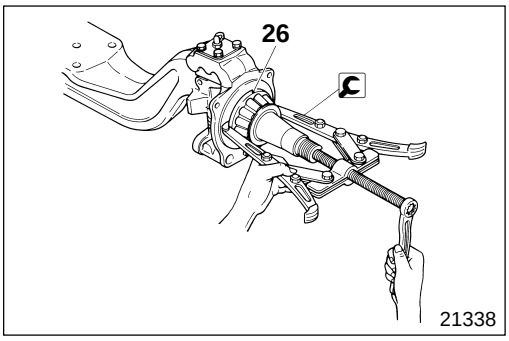
CAUTION⚠

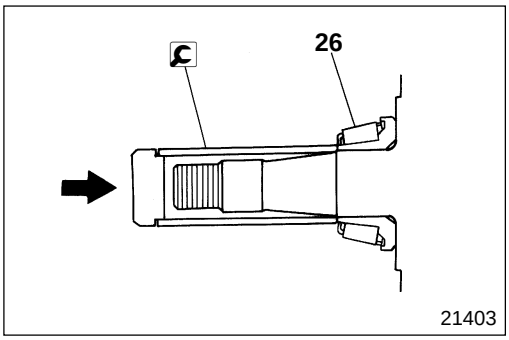
Be sure to clamp the harness of wheel speed sensor 24 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



26 **Inner bearing inner race**

[Removal]
Turn the knuckle stopper bolt on the knuckle , or screw two bolts **A** (M14 x 1.5 mm) evenly into the screw plug mounting holes to remove inner bearing inner race 26.

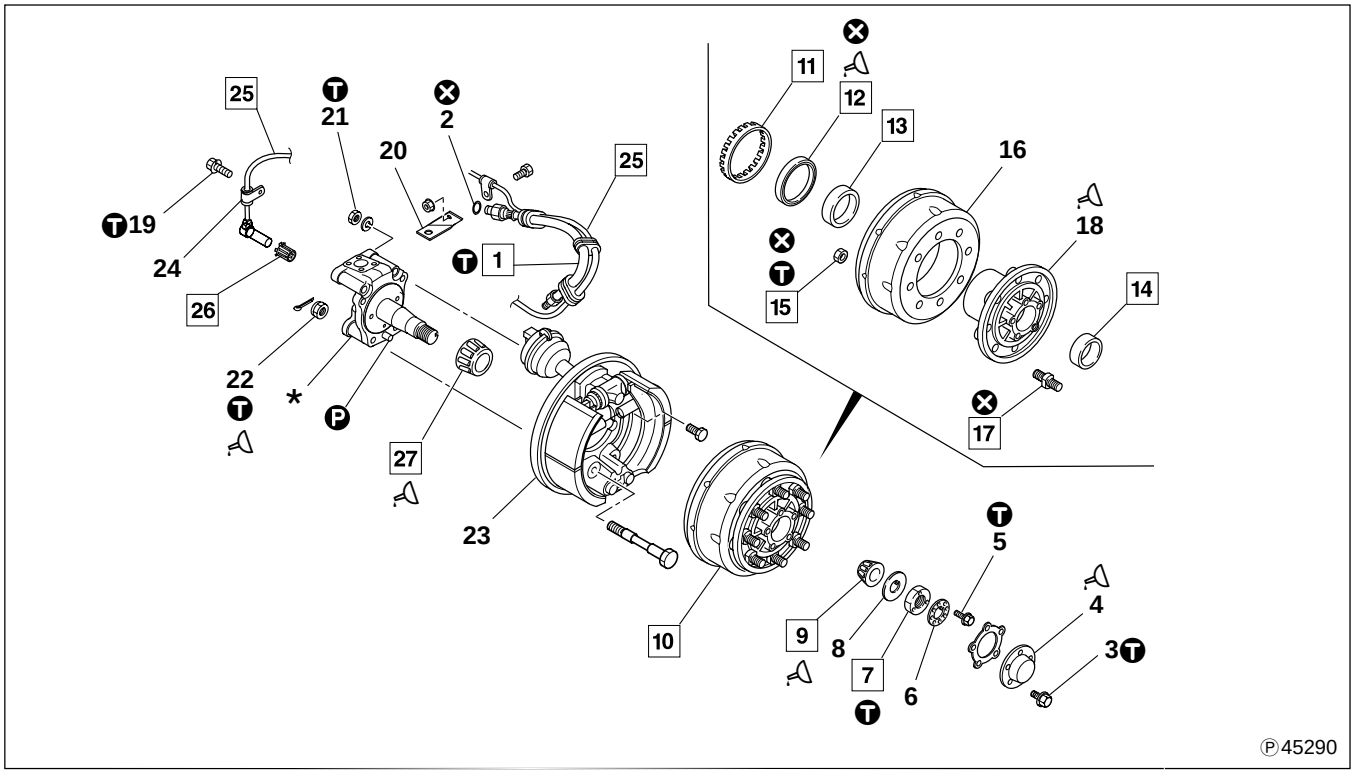




[Installation]

WHEEL HUB AND BRAKE DRUM < FM (FULL-AIR BRAKE) >

< Type 2 >



● **Disassembly sequence**

1 Brake hose
2 O-ring
3 Bolt
4 Wheel hub cover
5 Bolt
6 Lock plate
7 Lock nut
8 Lock washer
9 Outer bearing inner race
10 Wheel hub and brake drum assembly
11 Rotor
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Brake drum Gr 35B
17 Hub bolt
18 Wheel hub
19 Bolt
20 Clip bracket
21 Nut
22 Nut
23 Brake assembly Gr 35B
24 Clip
25 Wheel speed sensor
26 Spring spacer
27 Inner bearing inner race

*: Knuckle P26-76
⊗: Non-reusable parts
Ⓟ: Positioning pin

WARNING

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35B

CAUTION

- **Keep oil and grease off lining surface of front brake assembly * and the inner surface of brake drum 16.**
- **Be careful not to damage oil seal 12 and rotor 11 when installing wheel hub and brake drum assembly 10 onto knuckle *.**

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
9, 13, 14, 27	Starting torque of wheel hub bearing		2.5 to 5.5 N·m {1.81 to 3.98 ft.lbs, 0.25 to 0.55 kgf·m}	—	Tangential force at wheel hub bearing 18 to 38 N {3.97 to 8.60 lbf, 1.8 to 3.9 kgf}
11	Wobbling of rotor		0.1 {0.0039}	—	Replace
26	Wheel speed sensor	Resistance between terminals	950 to 1450Ω	—	Replace
		Insulation resistance	1MΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

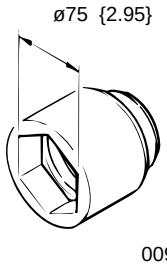
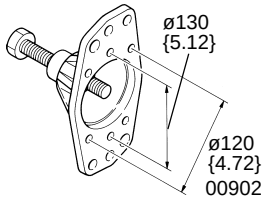
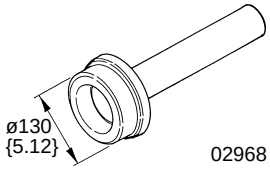
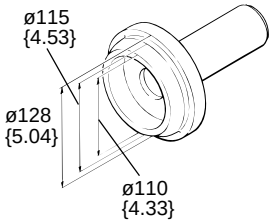
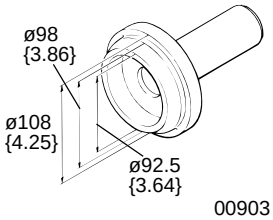
Location	Parts to be tightened	Tightening torque	Remarks
1	Brake hose (Brake side)	21 to 30 {15 to 22, 2.1 to 3.1}	—
3	Bolt (Wheel hub cover mounting)	44±9.8 {33±7.2, 4.5±1.0}	—
5	Bolt (Lock plate mounting)	9±2 {6.5±1.4, 0.9±0.2}	—
7	Lock nut	200 {145, 20}	Slackening off angle : 22.5° (one sixteenth of a turn)
15	Nut (Wheel hub and brake drum mounting)	322 {235, 32.8}	—
19	Bolt (Bracket mounting)	12±2 {8.7±1.4, 1.2±0.2}	—
21	Nut (Brake assembly mounting)	216±32 {160±24, 22±3.3}	—
22	Nut (Brake assembly mounting)	515±123 {380±90, 52.5±12.5}	Wet

Lubricant and sealant

Location	Points of application	Kinds	Quantity
4	Pack wheel hub cap or wheel hub cover	Wheel bearing grease [NLGI No.2 (Li soap)]	120 g {4.23 oz}
9, 27	Pack the space between rollers of wheel bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
12	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	570 g {20.1oz}

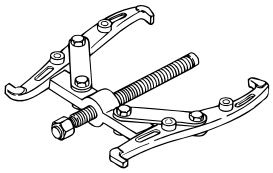
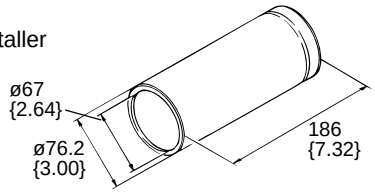
Special tools

Unit : mm {in.}

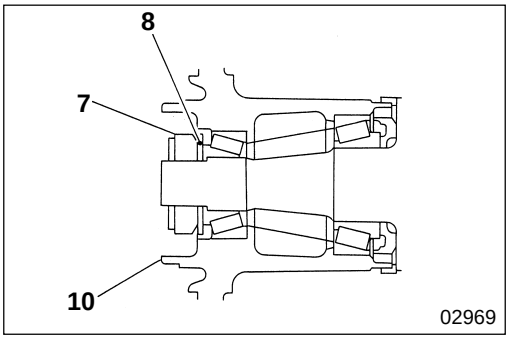
Location	Tool name and shape	Part No.	Application
7	Socket wrench 	MH061530	Removal and installation of hub bearing lock nut
10	Wheel hub puller 	MH061433 or MH061458	Removal of hub and brake drum
12	Anti-lock brake system oil seal installer 	MH062609	Press-fitting of oil seal
13	Inner bearing installer 	03724-62000	Press-fitting of inner bearing outer race
14	Outer bearing installer 	03723-23000	Press-fitting of outer bearing outer race

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
27	Gear puller  00905	MH061102	Removal of inner bearing inner race
	Inner bearing installer  00906	MH061473	Press-fitting of inner bearing inner race

◆ Service procedure

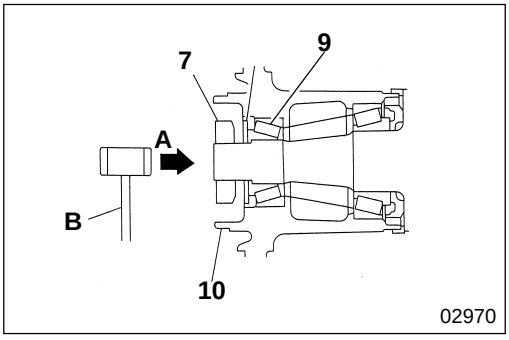


02969

● Starting torque of wheel hub drum

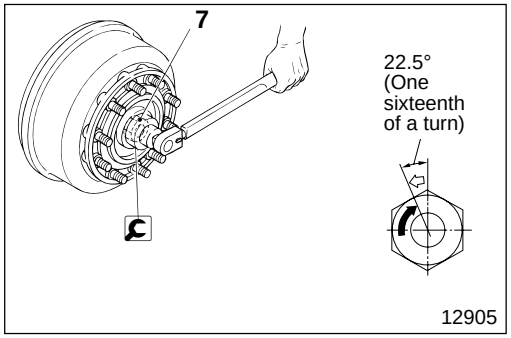
[Adjustment]

- Install lock washer **8** and lock nut **7**, then tighten the lock nut at specified torque while turning wheel hub and brake drum assembly **10** several times.
- Next, slacken off the lock nut fully until a clearance is obtained between lock nut **7** and lock washer **8**.

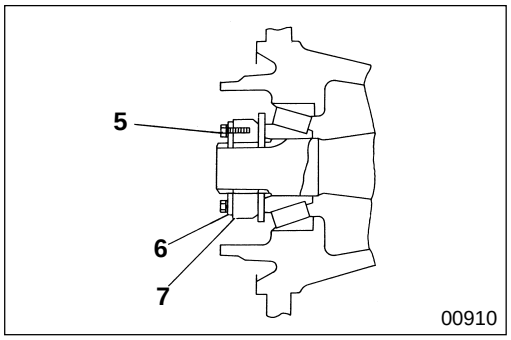


02970

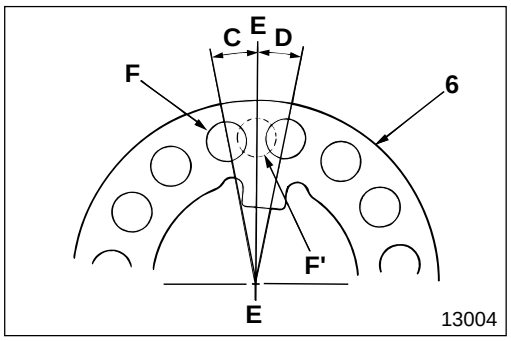
- Return outer bearing **9** toward lock nut **7** by hitting illustrated part **A**, while turning wheel hub and brake drum assembly **10** again.
  B : Copper-headed mallet



★ • After retightening lock nut **7** at specified torque, slacken it off by 22.5° (one sixteenth of a turn).
(★ : If there is any deviation found when you measure the tangential force, carried out following the procedure on 🕮 P26-55, repeat the work.)

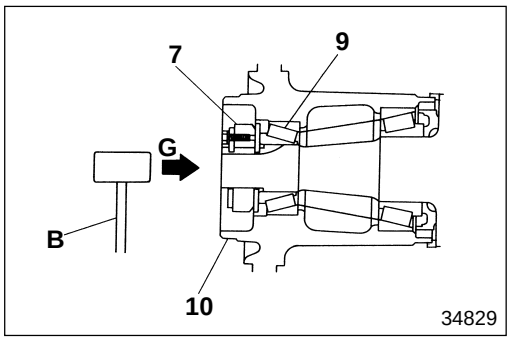


- Install lock plate **6**.
- Make sure that the bolt mounting holes of lock plate **6** and lock nut **7** align.
- Tighten mounting bolts **5** at specified torque.



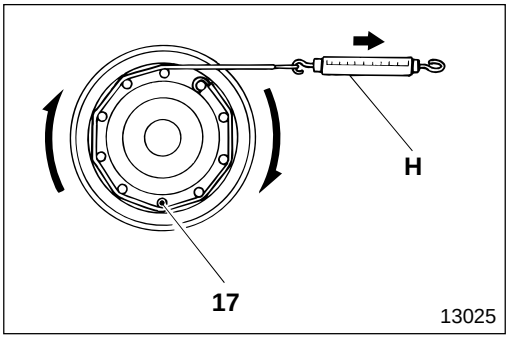
- If the mounting holes of lock plate **6** and lock nut **7** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **C**	Loosen lock nuts to align holes
Within range **D**	Turn over lock plate and loosen lock nut to align holes
On **E**–**E** line	Turn over the lock plate to align the holes (Lock nut hole position changes from **F'** to **F**)



- To slide outer bearing **9** towards lock nut **7**, hit end **G** two or three times with a copper-headed mallet, while turning wheel hub and brake drum assembly **10**.
B : Copper-headed mallet

- Once again, hit one end of the knuckle two or three times with a soft-faced mallet while turning the hub and drum assembly so that the outer bearing fits tightly to the lock nut.

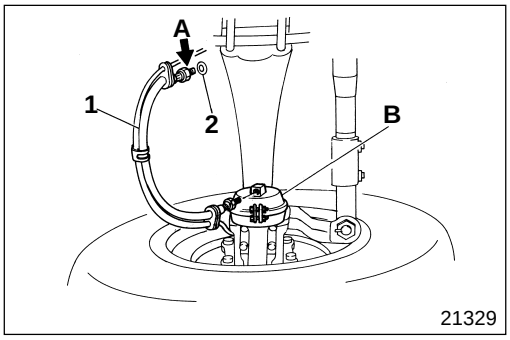


[Measurement]

- Fasten spring balance **H** to hub bolt **17** and measure the tangential force.
- If the measured tangential force is the standard value, the starting torque conforms to the standard value.
- Make sure that the starting torque is smaller than the tangential force.
- If the tangential force deviates from the specified value, adjust the starting torque again.
- If the measured value deviates from the specified value, redo the procedure from the item marked ★. 📖 P26-54
- If any fault is found after adjustment, replace outer bearings **9**, **14** and inner bearings **13**, **27**.

NOTE

- **Measure the starting torque when oil seal 12 has been installed.**
- **Make sure that the brake lining and brake drum 16 do not drag before measurement.**

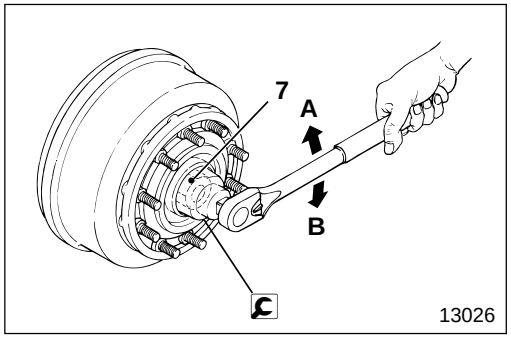


1 Removal and installation of brake hose

Remove the brake hose from frame side **A** first, then disconnect from brake chamber side **B**. For installation, connect the hose in a reverse order.

CAUTION ⚠

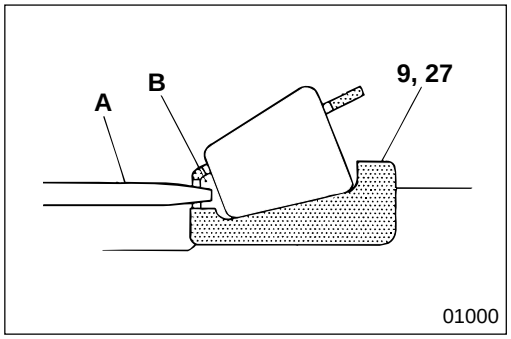
Make sure that brake hose 1 is not twisted when you install it.



7 **Removal and installation of lock nut**

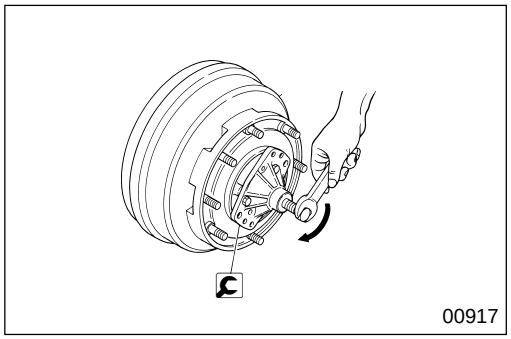
See adjustment of wheel hub bearing starting torque. 🕮 P26-53

A : Removal
B : Installation



9 **27** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Between rollers

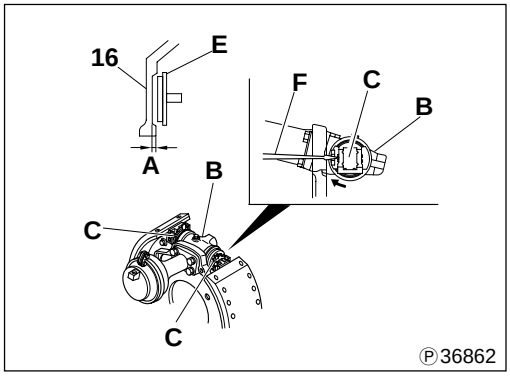


10 **Wheel hub and brake assembly**

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 10 in a straight line to prevent damage to oil seal 12.



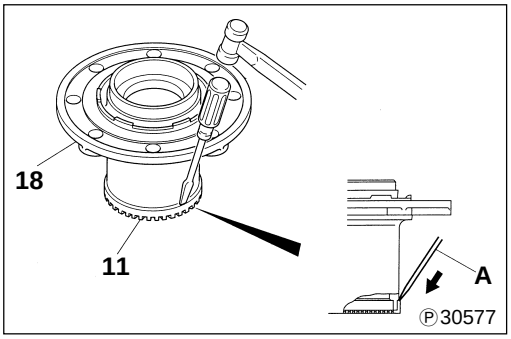
- Remove the dust cover.
- Turn adjuster **C** on expander assembly **B** in direction **D**, and widen gap **A** between brake drum **16** and brake shoe **E**.
- Reinstall the dust cover.

CAUTION

- **Be careful not to damage the boot of expander assembly B when inserting flat-tip screwdriver F.**
- **When an abnormality is found in brake drum 16, correct.** **Gr 35B**

- Use feeler gages only at the lower shoe when checking shoe clear ance. Also check only the lower lining when visually checking the remaining lining thickness.

[Installation]
After installing wheel hub and brake drum assembly **10**, adjust the brake shoe clearnace.
Gr 35B

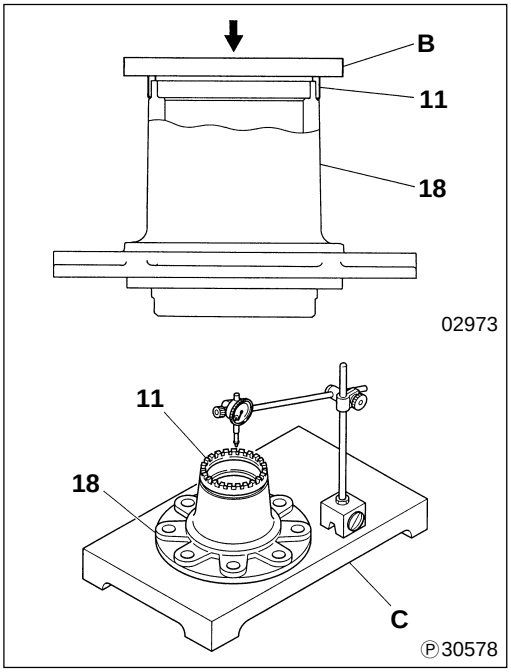


11 **Rotor**

[Removal]
Strike the outer edge of rotor **11** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

CAUTION

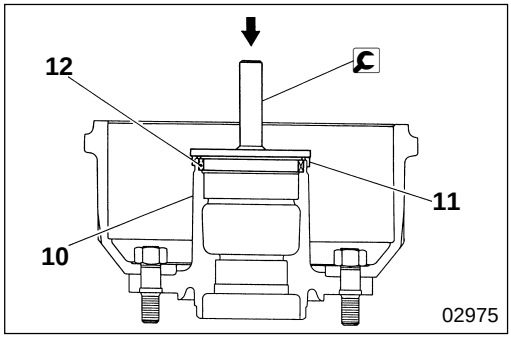
Be careful not to damage wheel hub 18.



[Installation]
Heat rotor **11** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **18**. Make sure there is no space between the rotor and wheel hub.

[Inspection]

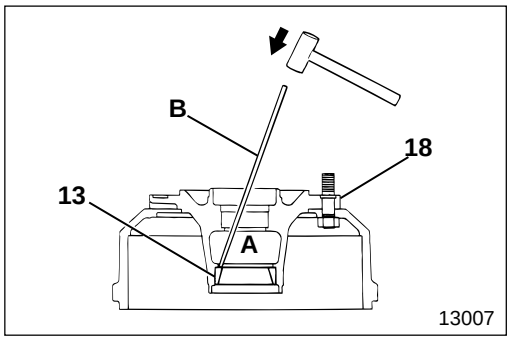
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



12 Installation of oil seal

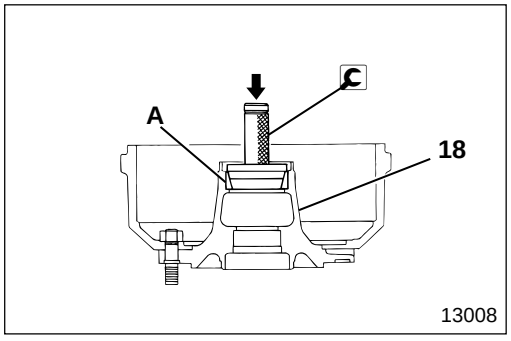
CAUTION

When hub and brake drum assembly 10 is removed for a service operation and if rotor 11 is still mounted on the wheel hub, use 0 ABS oil seal installer to press-fit oil seal 12.

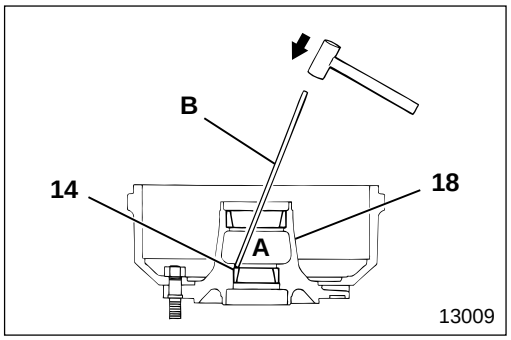


13 Inner bearing outer race

[Removal]
Drive out inner bearing outer race **13** evenly from two indented parts **A** in wheel hub **18**.
B : Pin-punch

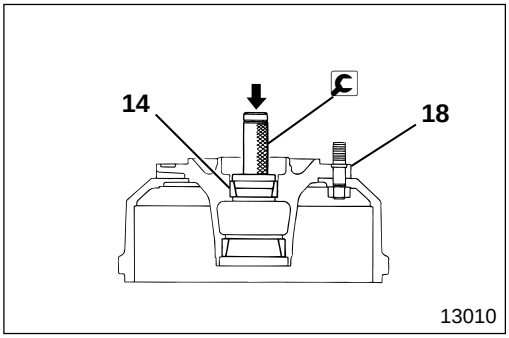


[Installation]

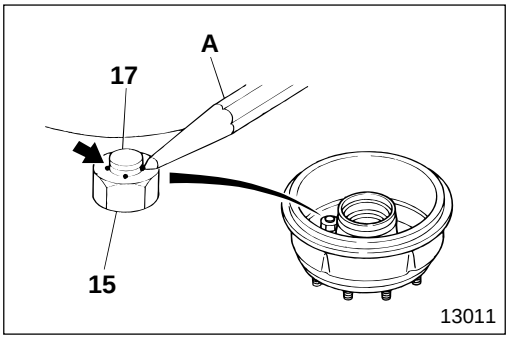


14 Outer bearing outer race

[Removal]
Drive out outer bearing outer race **14** evenly from two indented parts **A** in wheel hub **18**.
B : Pin-punch

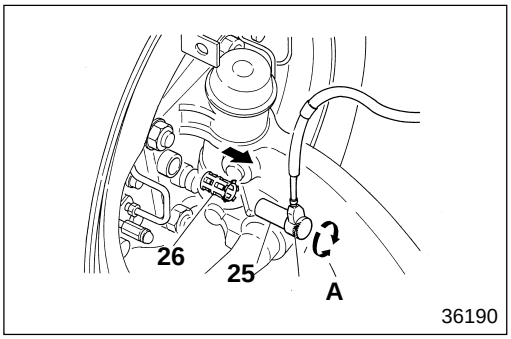


[Installation]



15 **17** **Installation of nut and hub bolts**

Tighten nut **15** at specified torque, then caulk hub bolt **17** evenly at four points.
A : Punch

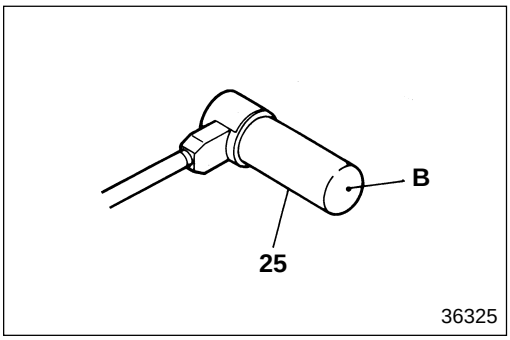


25 **Wheel speed sensor**

[Removal]
Hold shaded section **A** of wheel speed sensor **25** with pliers, and remove the sensor by twisting it slightly in left and right directions.

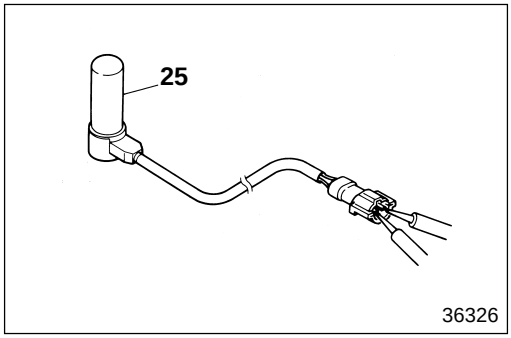
CAUTION

- **When holding wheel speed sensor 25 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 25, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 25 dismounts easily, replace spring spacer 26.**

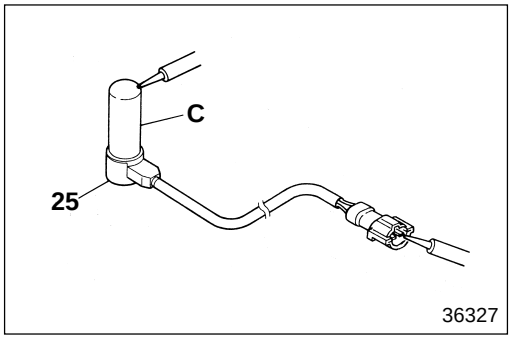


[Inspection]

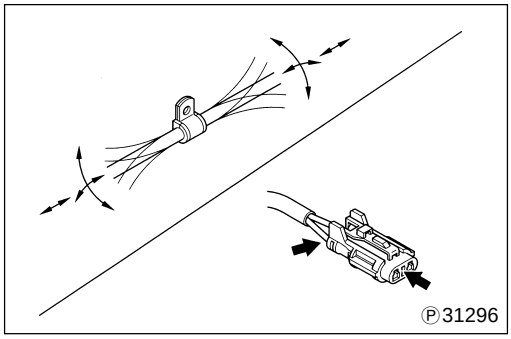
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **25**, it attracts metals. Do not allow the pole piece to collect metallic objects.



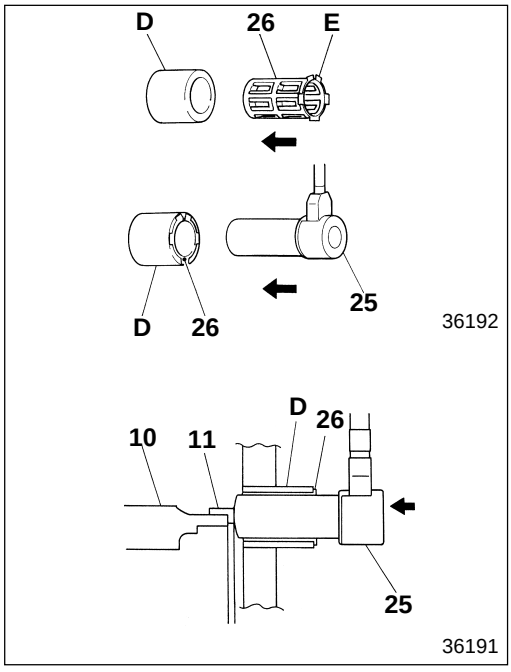
- Measure the resistance between the terminals of wheel speed sensor **25**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **25** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **25**.

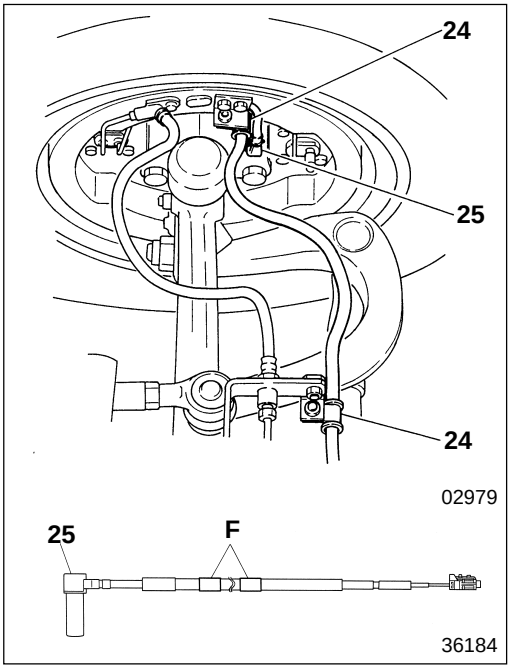


[Installation]

- Insert spring spacer **26** into holder section **D** of the knuckle, and press until stopper section **E** contacts the holder.
- Insert wheel speed sensor **25**, and press until it contacts rotor **11**.
- Rotate hub and brake drum assembly **10** slowly for two or three turns (2 seconds per turn) to make sure it rotates smoothly.

CAUTION⚠

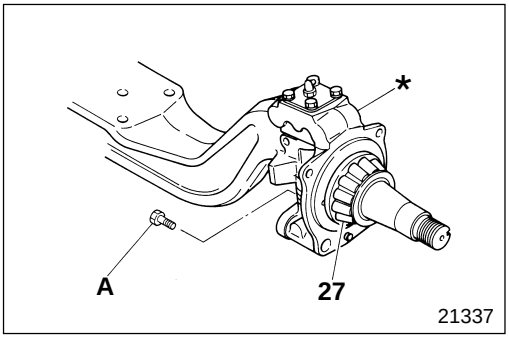
When installing wheel speed sensor 25, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.



- Secure white tape section **F** of the harness of wheel speed sensor **25** in place using clip **24** on the wheel brake side and clip **24** on the frame side.

CAUTION⚠

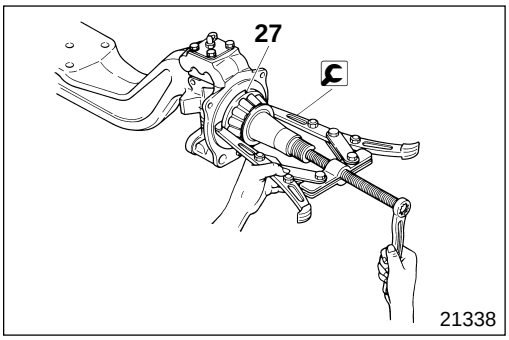
Be sure to clamp the harness of wheel speed sensor 25 at two white tape sections F. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.

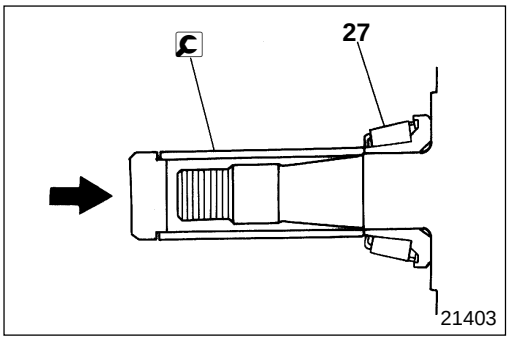


27 **Inner bearing inner race**

[Removal]

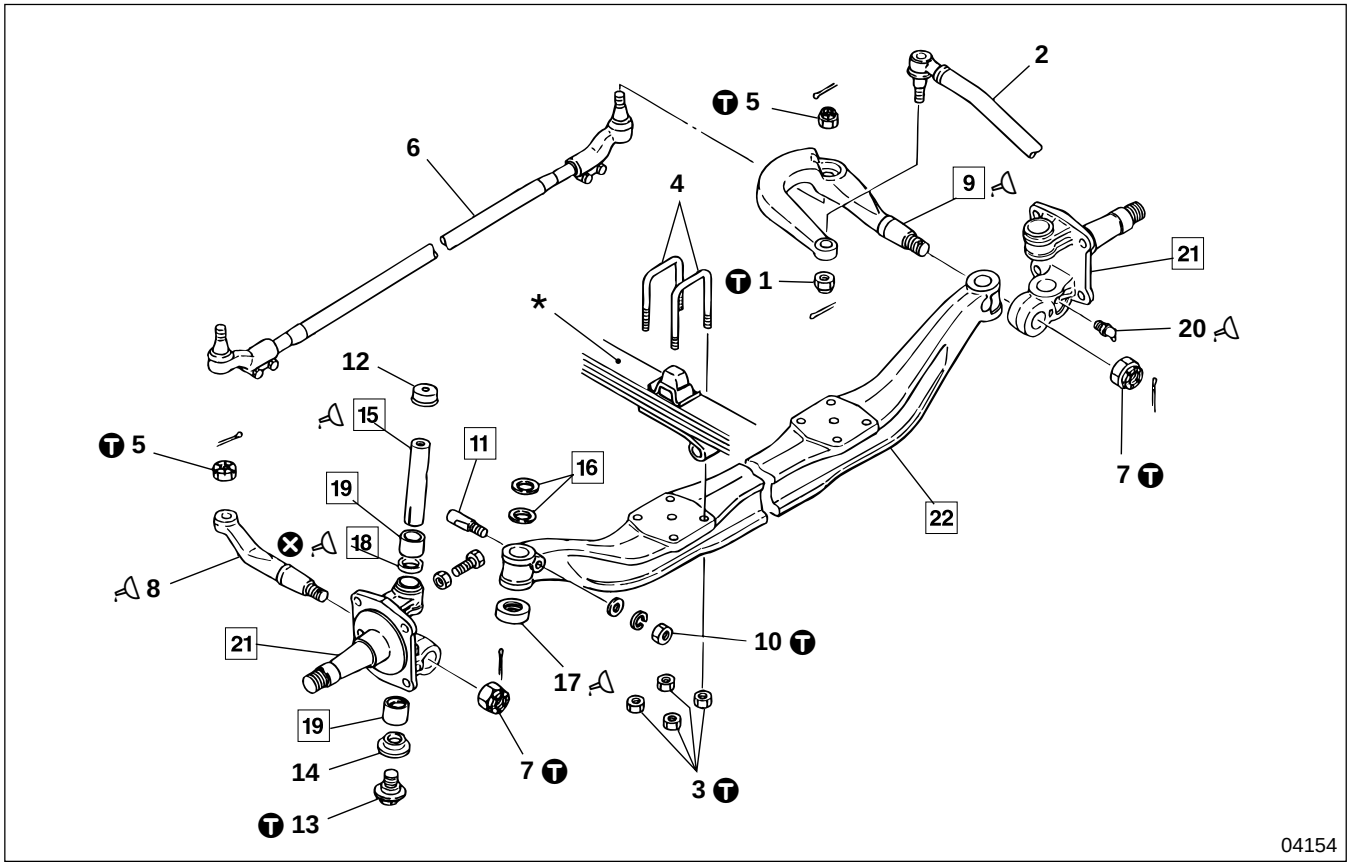
Turn the knuckle stopper bolt on the knuckle *, or screw two bolts **A** (M14 x 1.5 mm) evenly into the screw plug mounting holes to remove inner bearing inner race **27**.





[Installation]

FRONT AXLE, KNUCKLE AND KINGPIN < FK >



● **Disassembly sequence**

1 Nut
2 Drag link Gr 37
3 U-bolt nut Gr 33
4 U-bolt
5 Nut
6 Tie rod Gr 37
7 Nut
8 Tie rod arm
9 Knuckle arm
10 Nut
11 Set bolt
12 Kingpin cap
13 Lower kingpin cover
14 Dust seal
15 Kingpin
16 Thrust washer
17 Bearing
18 Oil seal
19 Bushing
20 Grease nipple
21 Knuckle
22 Front axle

*: Front leaf spring Gr 33
⊗: Non-reusable parts

● **Assembly sequence**

21 → **20** → **19** → **18**
22 → **17** → **16**
→ **15** → **11** → **10** → **14** → **13** → **12** → **9** → **8** → **7** → **6** → **5** → **4** → **3** → **2** → **1**

Repair kit : Kingpin kit

● **Work after assembly**

P26-64

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
15	Kingpin	Outer diameter	$[35]^{-0.002}_{-0.015}$ {$[1.38]^{-0.000079}_{-0.00059}$}	34.9 {1.37}	Replace
		Inclination angle	7°00'	7°00'±30'	
19	Kingpin bushing	Inner diameter (After press-fitting knuckle)	$[35]^{+0.045}_{+0.018}$ {$[1.38]^{+0.0018}_{+0.00071}$}	—	Replace
		Clearance between kingpin bushing and kingpin	0.02 to 0.06 {0.00079 to 0.0024}	0.15 {0.0059}	
21, 22	Vertical clearance between knuckle and front axle		0.1 {0.0039} or less	0.2 {0.0079}	Adjust with thrust washer
22	Font axle	Bend (Longitudinal)	2.5 {0.098} or less	7 {0.28}	Replace
		Bend (Vertical)	3 {0.12} or less	7 {0.28}	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

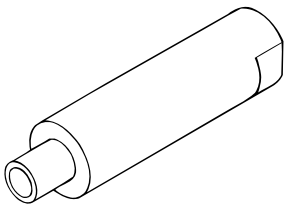
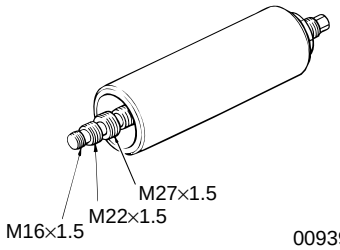
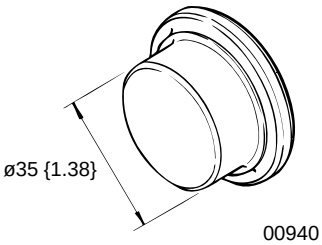
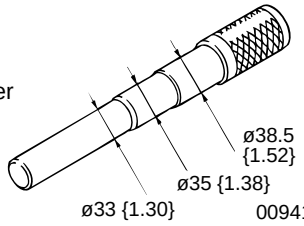
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drag link mounting)	190±48 {140±35, 19.4±4.85}	—
3	U-bolt nut (U-bolt mounting)	240±36 {175±27, 24.5±3.7}	Wet
5	Nut (Tie rod mounting)	190±48 {140±35, 19.4±4.85}	—
7	Nut (Tie rod arm and knuckle arm mounting)	686±98 {505±72, 70±10}	—
10	Nut (Set bolt tightening)	29 {22, 3}	—
13	Lower kingpin cover	39±10 {29±7, 4±1}	—

Lubricant

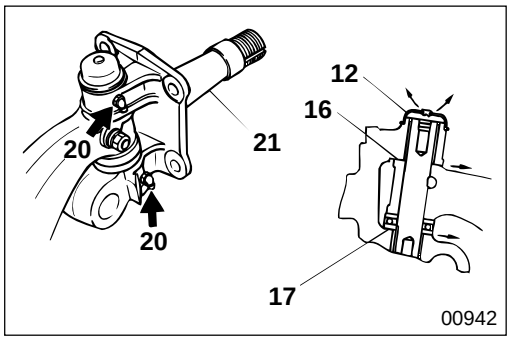
Location	Points of application	Kinds	Quantity
8, 9	Thread area of knuckle arm and tie rod arm	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Periphery of kingpin and hole	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack interior of bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
20	Supply via grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
11	Kingpin set bolt remover  00938	MH061688	Removal of kingpin set bolt
15	Kingpin puller  00939	MH061684	Removal of kingpin
18	Oil seal installer  00940	MH062201	Press-fitting of oil seal
19	Kingpin bushing remover  00941	MH061037	Removal and installation of kingpin bushing

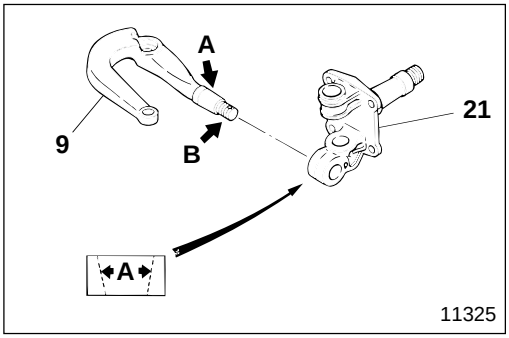
◆ Service procedure



00942

● Work after assembly

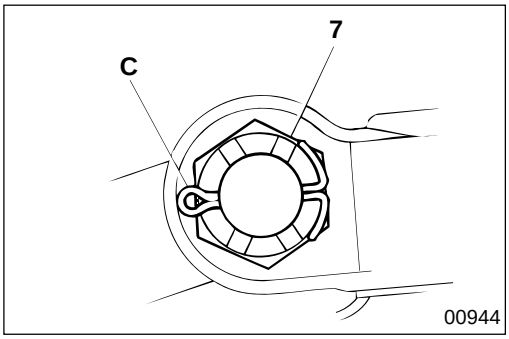
Supply grease via grease nipple **20** of knuckle **21**. Supply grease until it overflows from the dust plugs of upper cap **12**, thrust washer **16**, and the press side of ball bearing **17**.



9 **21** **Installation of knuckle arm and knuckle**

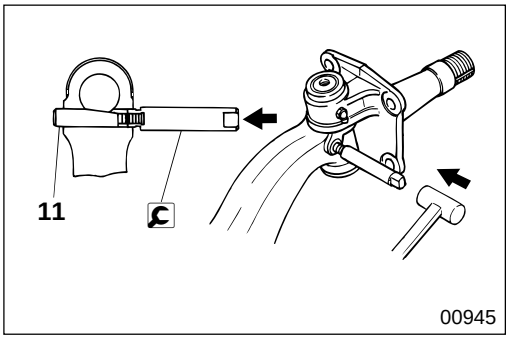
(1) Reassembly of existing knuckle arm 9 and/or knuckle 21

- Evenly polish taper surfaces **A** of knuckle arm **9** and knuckle **21** using emery paper (120 grit or finer), until abrasion traces left by the emery paper are only just visible. For new parts, polishing is not required.
- Clean taper surfaces **A** of knuckle arm **9** and knuckle **21** and thread area **B** of the knuckle arm. (Use a cleaning solvent for acetone color checking or other solvent.)
- Install knuckle arm **9** after applying grease to thread area **B**. (Do not grease the taper surfaces of the knuckle arm and the knuckle.)
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

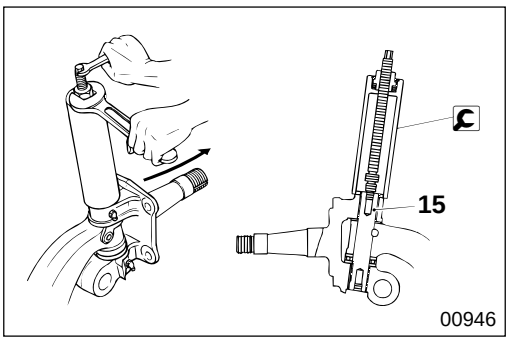


(2) Installation of new knuckle arm 9 and knuckle 21

- Clean taper surfaces **A**, or thread area **B**, of knuckle arm **9** and knuckle **21**, and install them without greasing.
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

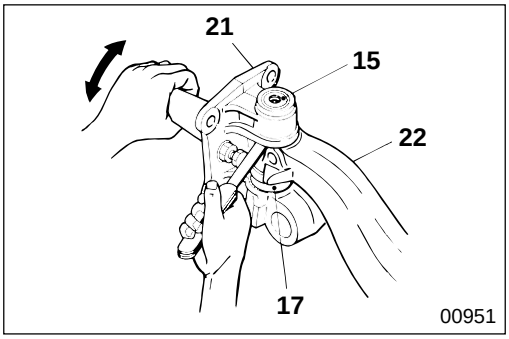


11 **Removal of set bolt**



15 **Removal of kingpin**

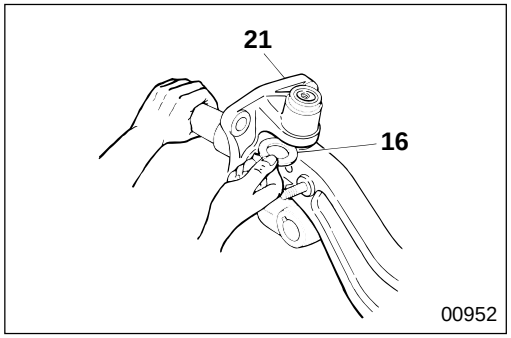
- Remove the kingpin cap. Screw the bolt of kingpin puller into the threads of kingpin **15**, and remove the kingpin.



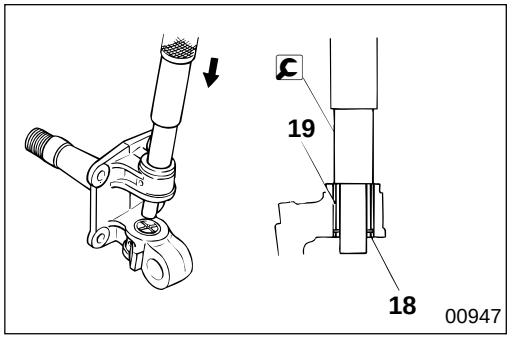
16 **21** **22** **Thrust washer, knuckle, and front axle**

[Inspection]

- Assemble kingpin **15** and bearing **17** temporarily, and turn knuckle **21** a couple of times to smooth its operation.
- Measure the clearance between the upper surface of front axle **22** and the lower part of knuckle **21**.
- If the measured value is higher than the limit, adjust with thrust washer **16**.

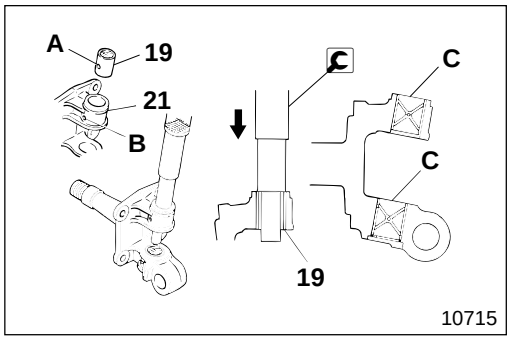


[Adjustment]
- Adjusting thrust washers **16** are available in the following sizes: 2.1 to 2.8 mm {0.083 to 0.11 in.} (eight thicknesses in 0.1 mm {0.0039 in.} increments)
- Be sure to minimize the clearance by selecting appropriate thrust washer **16**.
- Make sure that knuckle **21** moves smoothly after assembly.

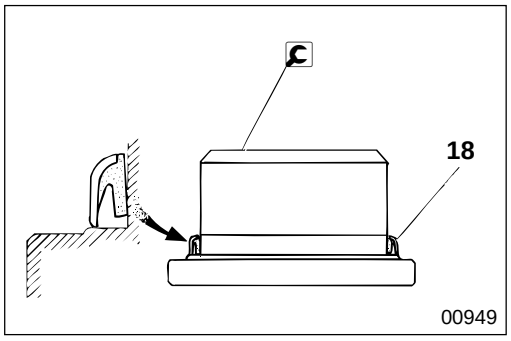


18 **19** **Oil seal and bushing**

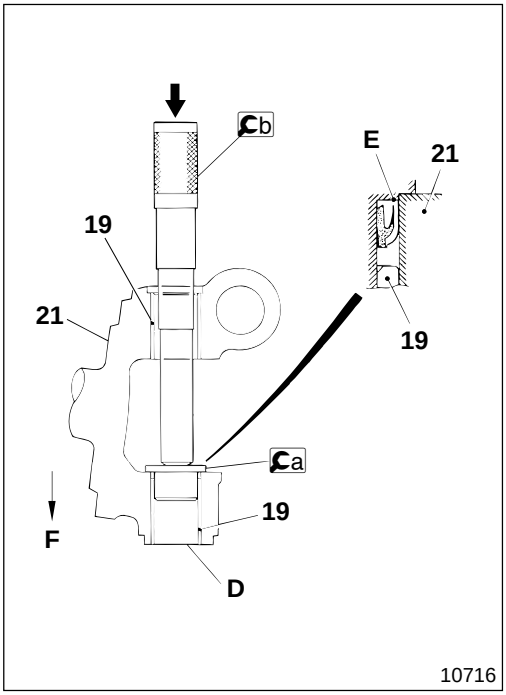
[Removal]



[Installation]
- Press bushing **19** in, with its oil hole **A** aligned to oil hole **B** of knuckle **21**, until end **C** is flush with the knuckle end.



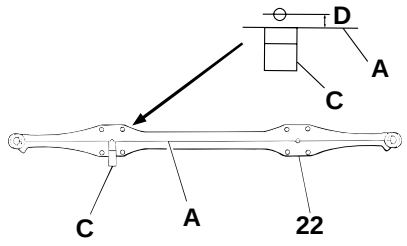
- Apply grease to the lip area of oil seal **18**, and position the oil seal on oil seal installer.



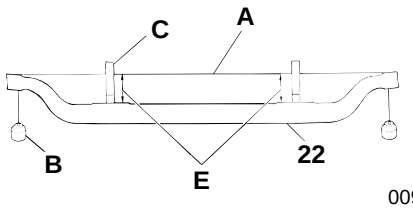
- Next, install a oil seal installer on knuckle **21** in the direction as illustrated.
- Pass b kingpin bushing remover through the kingpin hole and position it on a oil seal installer.
- Hit the head of b kingpin bushing remover until a oil seal installer makes contact with the knuckle.
- Make sure that end **D** of bushing **19** makes contact with knuckle **21** on the same level.
- Make sure that oil seal end **E** does not protrude from knuckle **21**.

F : Upper side of vehicle

< Longitudinal direction >



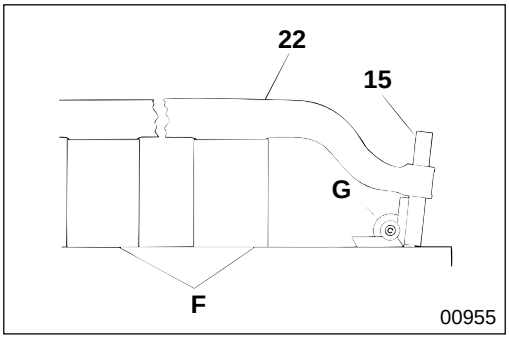
< Vertical direction >



22 Inspection of front axle

(1) Measurement of bend in front axle 22 in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **22** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **22**.

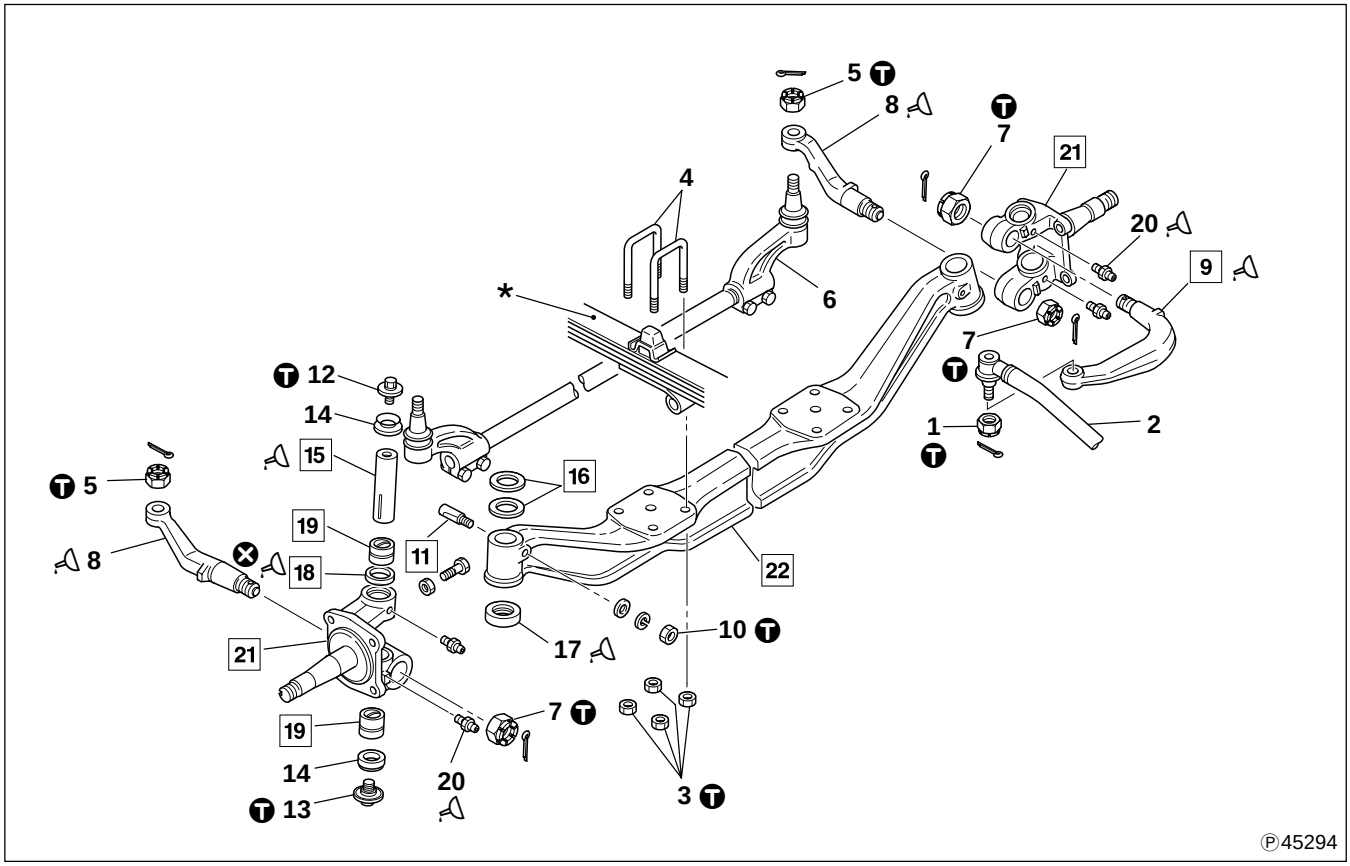


(2) Measurement of kingpin inclination angle

Mount kingpin **15** in front axle **22** as illustrated, and measure the kingpin inclination angle. If the measured value is higher than the limit, replace the front axle.

F : Block gauge
G : Bevel square

FRONT AXLE, KNUCKLE AND KINGPIN < FM (AIR-OVER HYDRAULIC BRAKE) >



● **Disassembly sequence**

1 Nut
2 Drag link Gr 37
3 U-bolt nut Gr 33
4 U-bolt
5 Nut
6 Tie rod
7 Nut
8 Tie rod arm
9 Knuckle arm
10 Nut
11 Set bolt
12 Upper kingpin cover
13 Lower kingpin cover
14 Dust seal
15 Kingpin
16 Thrust washer
17 Bearing
18 Oil seal
19 Bushing
20 Grease nipple
21 Knuckle
22 Front axle

* : Front leaf spring Gr 33
⊗ : Non-reusable parts

● **Assembly Sequence**

21 → **20** → **19** → **18** → **15** → **11** → **10** → **14** → **13** → **12** → **9** → **8** → **7** → **6** → **5** → **4** → **3** → **2** → **1**
22 → **17** → **16** → **15**

Repair kit : Kingpin kit

● **Work after assembly**

P26-70

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
15	Kingpin	Outer diameter	$[45]^{-0.002}_{-0.015}$ {$[1.77]^{-0.000079}_{-0.00059}$}	44.9 {1.77}	Replace
		Inclination angle	7°00'	7°00'±30'	
19	Kingpin bushing	Inner diameter (After press-fitting) knuckle	$[45]^{+0.045}_{+0.018}$ {$[1.77]^{+0.0018}_{+0.00071}$}	—	Replace
		Clearance between kingpin bushing and kingpin	0.02 to 0.06 {0.00079 to 0.0024}	0.15 {0.0059}	
21, 22	Vertical clearance between knuckle and front axle		0.1 {0.0039} or less	0.2 {0.0079}	Adjust with thrust washer
22	Font axle	Bend (Longitudinal)	2.5 {0.098} or less	7 {0.28}	Replace
		Bend (Vertical)	3 {0.12} or less	7 {0.28}	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

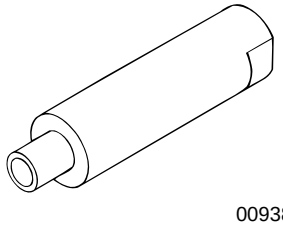
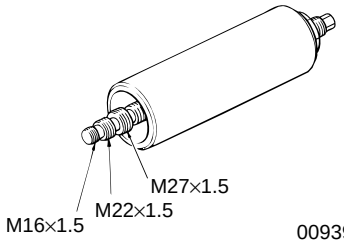
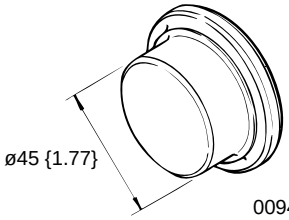
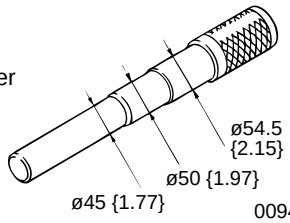
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drag link mounting)	190±48 {140±35, 19.4±4.85}	—
3	U-bolt nut (U-bolt mounting)	372±56 {275±41, 37.9±5.7}	Wet
5	Nut (Tie rod mounting)	190±48 {140±35, 19.4±4.85}	—
7	Nut (Tie rod arm and knuckle arm mounting)	677 {500, 69}	—
10	Nut (Set bolt tightening)	29 {22, 3}	—
12	Upper kingpin cover	74±15 {54±11, 7.5±1.5}	—
13	Lower kingpin cover	74±15 {54±11, 7.5±1.5}	—

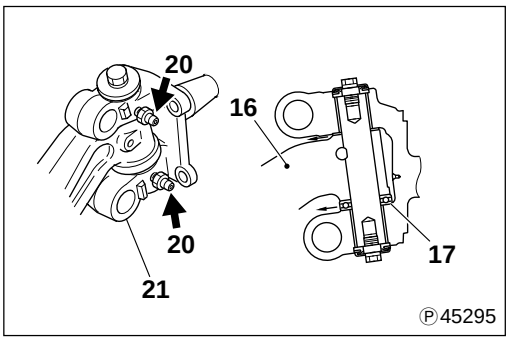
Lubricant

Location	Points of application	Kinds	Quantity
8, 9	Thread areas of tie rod arm and knuckle arm	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Periphery of kingpin and hole	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Pack interior of bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
18	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
20	Supply via knuckle grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

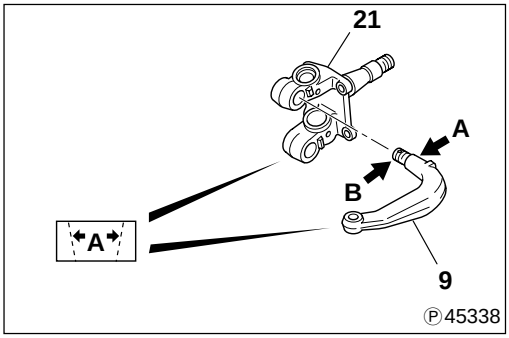
Location	Tool name and shape	Part No.	Application
11	Kingpin set bolt remover  00938	MH061688	Removal of kingpin set bolt
15	Kingpin puller  00939	MH061684	Removal of kingpin
18	Oil seal installer  00940	MH062202	Press-fitting of oil seal
19	Kingpin bushing remover  00941	MH061792 (MH061037)	Removal and installation of kingpin bushing. Tool No. in ( ) is used for press-fitting oil seal installer



◆ Service procedure

● Work after assembly

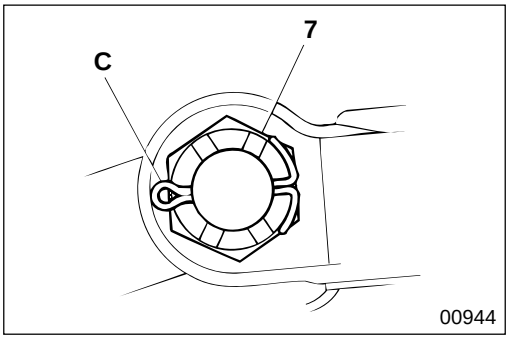
Supply grease via grease nipple **20** of knuckle **21**. Supply grease until it overflows from thrust washer **16** and the press side of ball bearing **17**.



9 **21** **Installation of knuckle arm and knuckle**

(1) Reassembly of existing knuckle arm 9 and/or knuckle 21

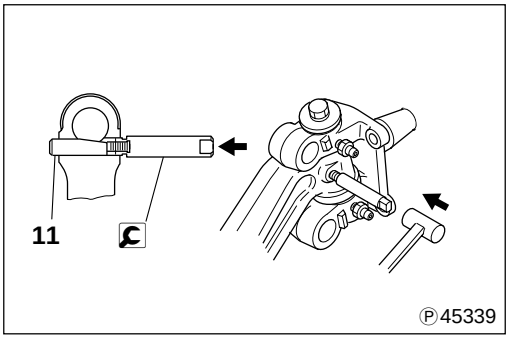
- Evenly polish taper surfaces **A** of knuckle arm **9** and knuckle **21** using emery paper (120 grit or finer), until abrasion traces left by the emery paper are only just visible. For new parts, polishing is not required.
- Clean taper surfaces **A** of knuckle arm **9** and knuckle **21** and thread area **B** of the knuckle arm. (Use a cleaning solvent for acetone color checking or other solvent.)
- Install knuckle arm **9** after applying grease to thread area **B**. (Do not grease the taper surfaces of the knuckle arm and the knuckle.)



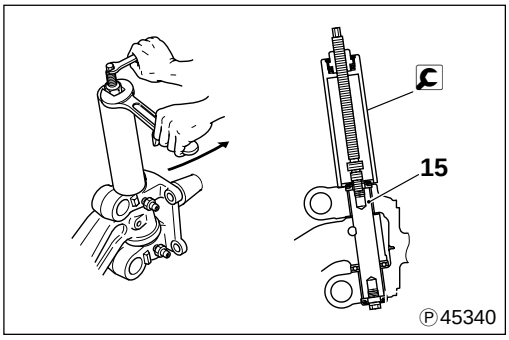
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

(2) Installation of new knuckle arm 9 and knuckle 21

- Clean taper surfaces **A**, or thread area **B**, of knuckle arm **9** and knuckle **21**, and install them without greasing.
- Tighten new nut **7** at specified torque. Without loosening the nut, insert split pin **C** into the pin hole to lock the nut.

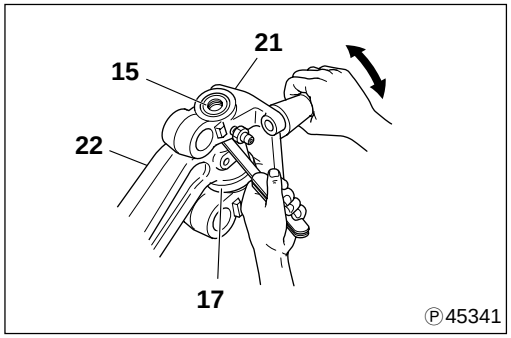


11 **Removal of set bolt**



15 **Removal of kingpin**

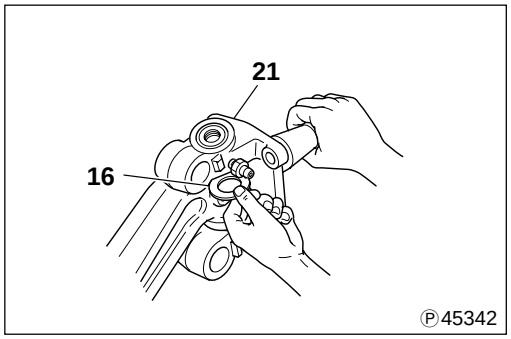
Remove the kingpin cover and dust seal. Screw the bolt of kingpin puller into the threads of kingpin **15**, and remove the kingpin.



16 **21** **22** **Thrust washer, knuckle, and front axle**

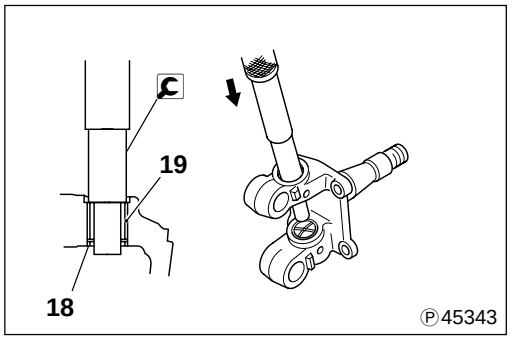
[Inspection]

- Assemble kingpin **15** and bearing **17** temporarily, and turn knuckle **21** a couple of times to smooth its operation.
- Measure the clearance between the upper surface of front axle **22** and the lower part of knuckle **21**.
- If the measured value is higher than the limit, adjust with thrust washer **16**.



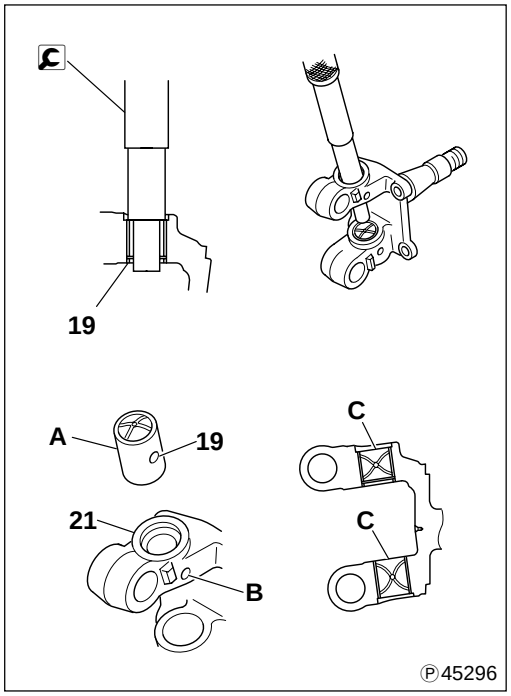
[Adjustment]

- Adjusting thrust washers **16** are available in the following sizes:2.9 to 3.6 mm {0.11 to 0.14 in.} (eight thicknesses in 0.1 mm {0.0039 in.} increments)
- Be sure to minimize the clearance by selecting appropriate thrust washer **16**.
- Make sure that knuckle **21** moves smoothly after assembly



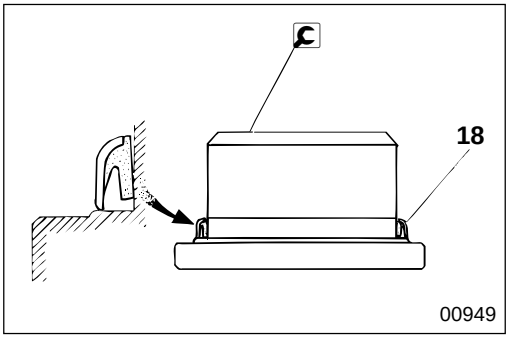
18 **19** **Oil seal and bushing**

[Removal]

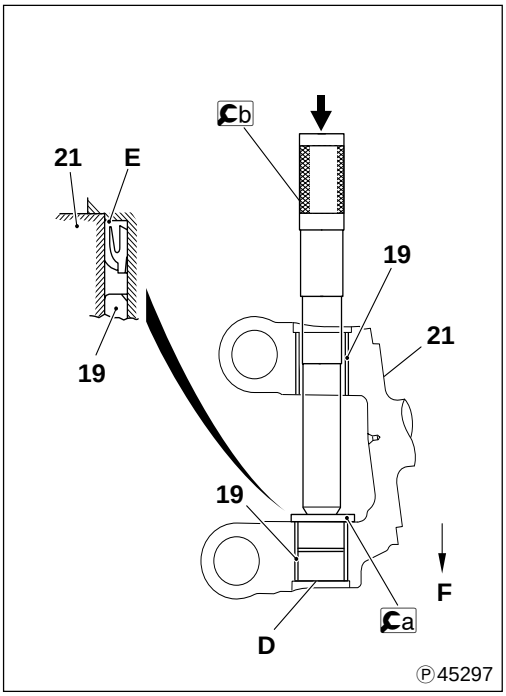


[Installation]

- Press bushing **19** in, with its oil hole **A** aligned to oil hole **B** of knuckle **21**, until end **C** is flush with the knuckle end.

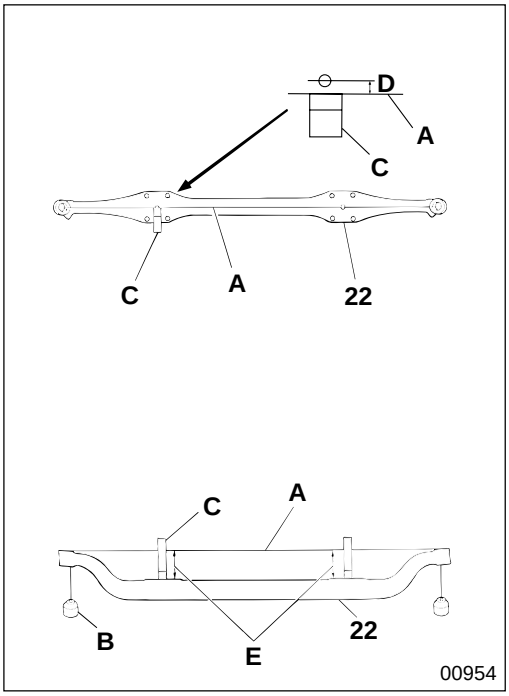


- Apply grease to lip area of oil seal **18**, and position the oil seal on oil seal installer.



- Next, install oil seal installer on knuckle **21** in the direction as illustrated.
- Pass kingpin bushing remover through the kingpin hole and position it on oil seal installer.
- Hit the head of kingpin bushing remover until oil seal installer makes contact with knuckle **21**.
- Make sure that end **D** of bushing **19** makes contact with knuckle **21** on the same level.
- Make sure that oil seal end **E** does not protrude from knuckle **21**.

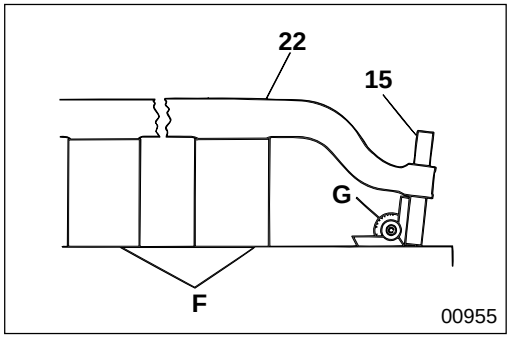
F : Upper side of vehicle



22 Inspection of front axle

(1) Measurement of bend in front axle 22 in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **22** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **22**.



(2) Measurement of kingpin inclination angle

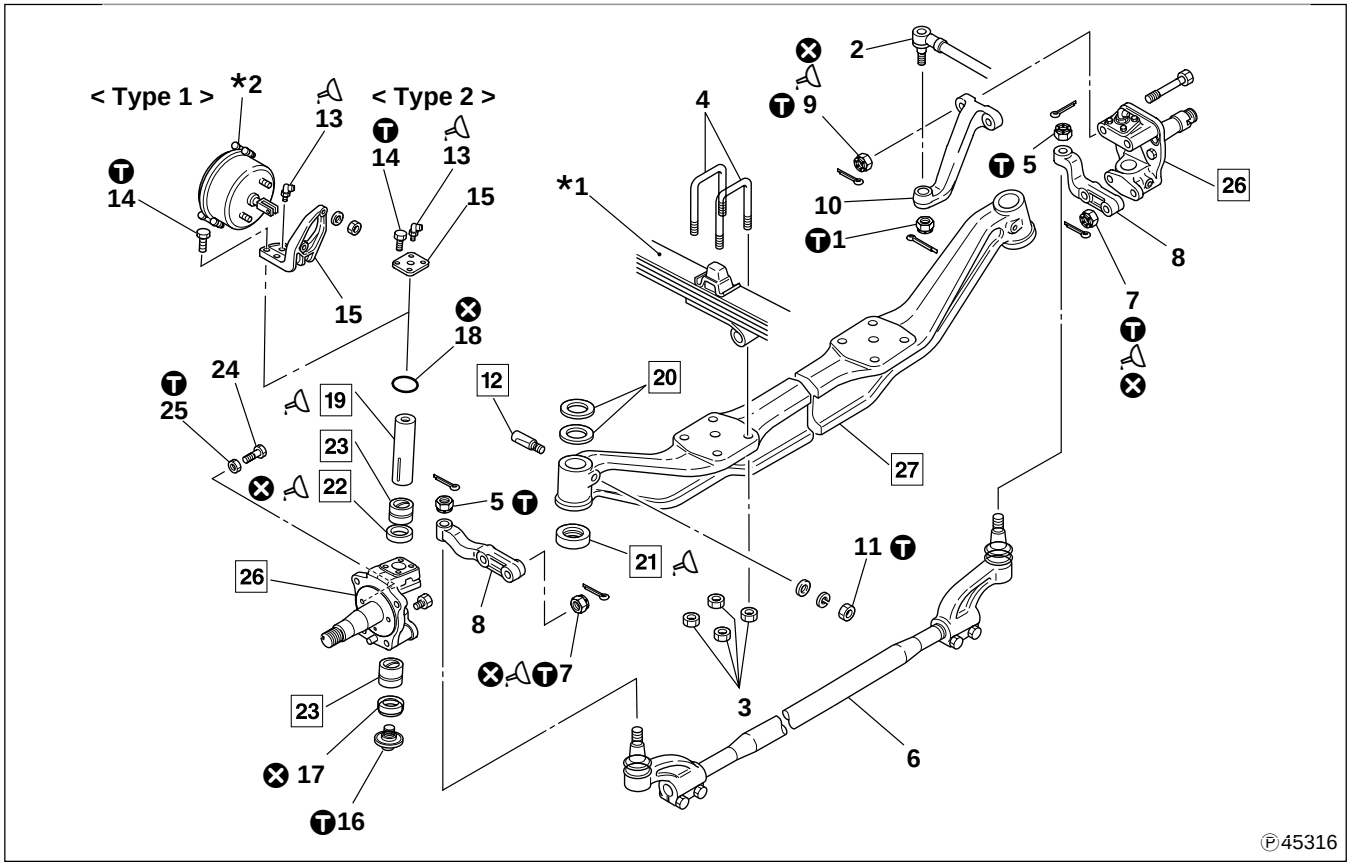
Mount kingpin **15** in front axle **22** as illustrated, and measure the kingpin inclination angle. If the measured value is higher than the limit, replace the front axle.

F : Block gauge

G : Bevel square

M E M O

FRONT AXLE, KNUCKLE AND KINGPIN < FM (FULL-AIR BRAKE) >



● **Disassembly sequence**

1 Nut
2 Drag link Gr 37
3 U-bolt nut Gr 33
4 U-bolt
5 Nut
6 Tie rod
7 Nut
8 Tie rod arm
9 Nut
10 Knuckle arm
11 Nut
12 Set bolt
13 Grease nipple
14 Bolt
15 Upper kingpin cover
16 Lower kingpin cover
17 Dust seal
18 O-ring
19 Kingpin
20 Thrust washer
21 Bearing
22 Oil seal
23 Bushing
24 Knuckle stopper bolt
25 Lock nut
26 Knuckle
27 Front axle

***1** : Front leaf spring Gr 33
***2** : Front brake chamber Gr 35B
⊗ : Non-reusable parts

● **Assembly Sequence**

Follow the disassembly sequence in reverse.

Repair kit : Kingpin kit

● **Work after assembly**

P26-78

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
19	Kingpin	Outer diameter	$[50]^{-0.002}_{-0.015}$ {$[1.97]^{-0.000079}_{-0.00059}$}	49.9 {1.96}	Replace
		Inclination angle	7°00'	7°00'±30'	
23	Kingpin bushing	Inner diameter (After press-fitting) knuckle	$[50]^{+0.045}_{+0.018}$ {$[1.97]^{+0.0018}_{+0.00071}$}	—	Replace
		Clearance between kingpin bushing and kingpin	0.02 to 0.06 {0.00079 to 0.0024}	0.15 {0.0059}	
26, 27	Vertical clearance between knuckle and front axle		0.1 {0.0039} or less	0.2 {0.0079}	Adjust with thrust washer
27	Font axle	Bend (Longitudinal)	2.5 {0.098} or less	7 {0.28}	Replace
		Bend (Vertical)	3 {0.12} or less	7 {0.28}	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

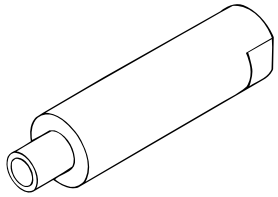
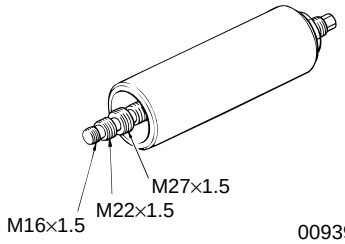
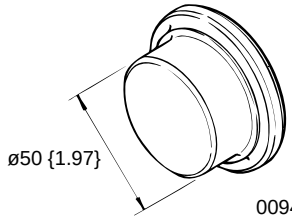
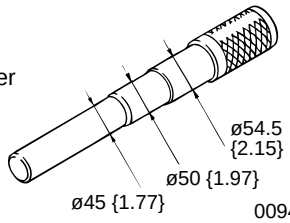
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drag link mounting)	353±88 {260±65, 36±9}	—
3	U-bolt nut (U-bolt mounting)	372±56 {275±41, 37.9±5.7}	Wet
5	Nut (Tie rod mounting)	270±68 {200±50, 27.6±6.9}	—
7	Nut (Tie rod arm and knuckle arm mounting)	515±123 {380±90, 52.5±12.5}	—
9	Nut (Knuckle arm mounting)	466±74 {345±54, 47.5±7.5}	Wet
11	Nut (Set bolt tightening)	29 {22, 3}	—
14	Bolt (Upper kingpin cover mounting)	41.2±7.8 {30±5.8, 4.2±0.8}	—
16	Lower kingpin cover	137±29.4 {100±22, 14±3}	—
25	Lock nut (installation of knuckle stopper bolt)	71±12 {53±9.4, 7.3±1.3}	—

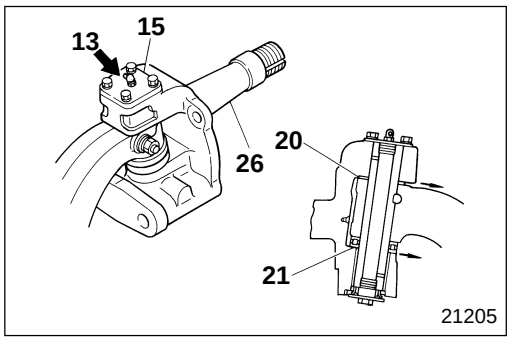
Lubricant

Location	Points of application	Kinds	Quantity
7, 9	Threaded section of nut	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
13	Supply via knuckle grease nipple	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Periphery of kingpin and hole	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
21	Pack interior of bearing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
22	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
12	Kingpin set bolt remover  00938	MH061688	Removal of kingpin set bolt
19	Kingpin puller  00939	MH061684	Removal of kingpin
22	Oil seal installer  00940	MH062203	Press-fitting of oil seal
23	Kingpin bushing remover  00941	MH061792 (MH061037)	Removal and installation of kingpin bushing. Tool No. in ( ) is used for press-fitting oil seal installer

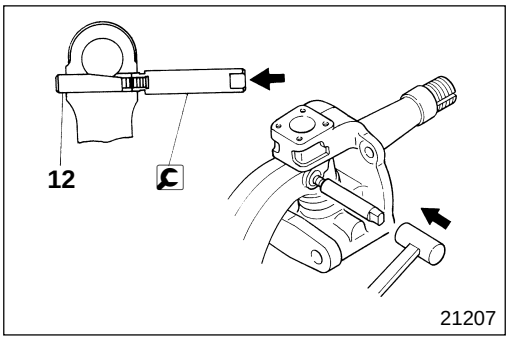


21205

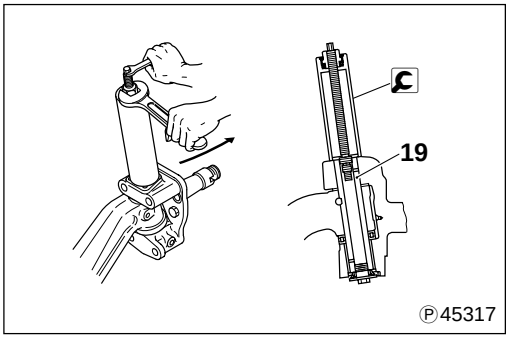
◆ Service procedure

● Work after assembly

Supply grease via grease nipple **13** of knuckle **26**. Supply grease until it overflows from thrust washer **20** and the press side of ball bearing **21**.

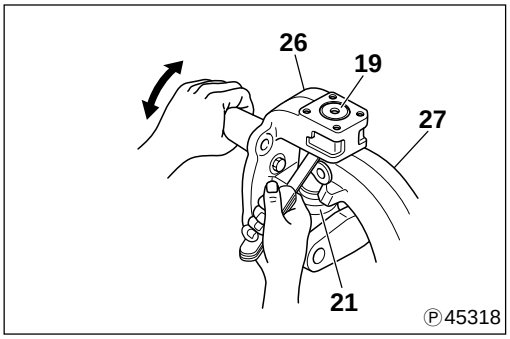


12 **Removal of set bolt**



19 **Removal of kingpin**

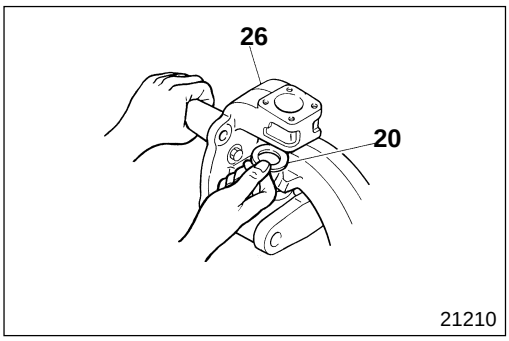
Screw the bolt of kingpin puller into the threads of kingpin **15**, and remove the kingpin.



20 **21** **26** **27** **Thrust washer, bearing, knuckle, and front axle**

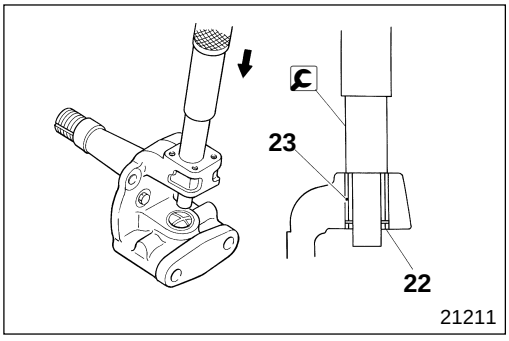
[Inspection]

- Assemble kingpin **19** and bearing **21** temporarily, and turn knuckle **26** a couple of times to smooth its operation.
- Measure the clearance between the upper surface of front axle **27** and the lower part of knuckle **26**.
- If the measured value is higher than the limit, adjust with thrust washer **20**.



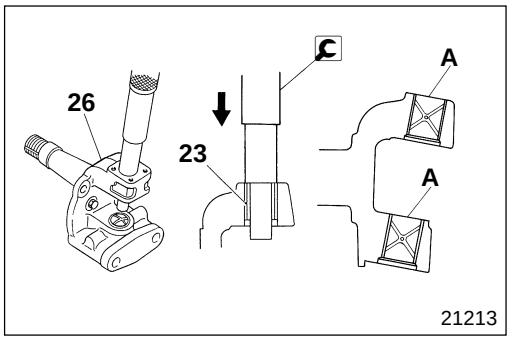
[Adjustment]

- Adjusting thrust washers **20** are available in the following sizes:2.9 to 3.6 mm {0.11 to 0.14 in.} (eight thicknesses in 0.1 mm {0.0039 in.} increments)
- Be sure to minimize the clearance by selecting appropriate thrust washer **20**.
- Make sure that knuckle **26** moves smoothly after assembly



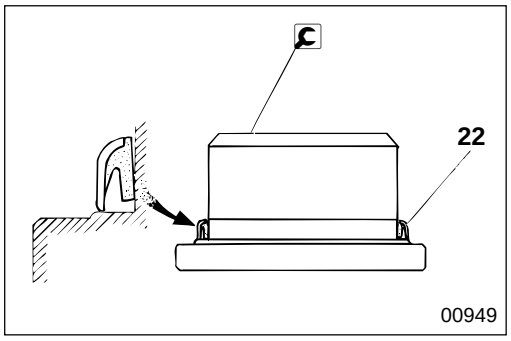
22 **23** **Oil seal and bushing**

[Removal]

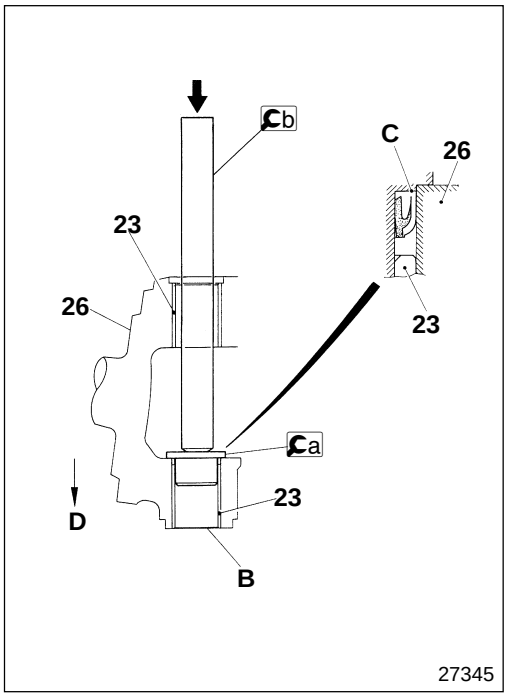


[Installation]

- Install bushing **23**, making sure that its surface is flush with the end face **A** on knuck **26**.



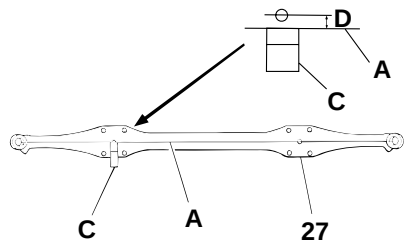
- Apply grease to lip area of oil seal **22**, and position the oil seal on oil seal installer.



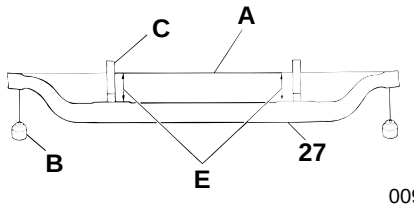
- Next, install a oil seal installer on knuckle **26** in the direction as illustrated.
- Pass b kingpin bushing remover through the kingpin hole and position it on a oil seal installer.
- Hit the head of b kingpin bushing remover until a oil seal installer makes contact with knuckle **26**.
- Make sure that end **B** of bushing **23** makes contact with knuckle **26** on the same level.
- Make sure that oil seal end **C** does not protrude from knuckle **26**.

D : Upper side of vehicle

< Longitudinal direction >



< Vertical direction >

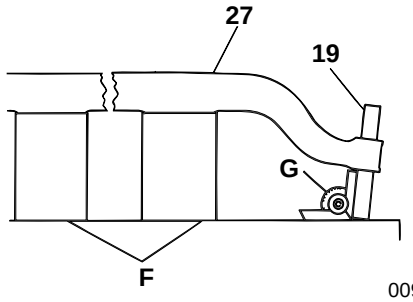


00954

27 Inspection of front axle

(1) Measurement of bend in front axle 27 in longitudinal and vertical directions

- Pass a piece of thread **A** through the kingpin hole of front axle **27** and hang weights **B** on both ends.
- Use square **C** to find the degree of bend in both the longitudinal direction **D** and the vertical direction **E**.
- If the measured value is higher than the limit, replace front axle **27**.



00955

(2) Measurement of kingpin inclination angle

Mount kingpin **19** in front axle **27** as illustrated, and measure the kingpin inclination angle. If the measured value is higher than the limit, replace the front axle.

F : Block gauge

G : Bevel square

MITSUBISHI
FUSO

Group 27

Rear Axle

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-27

INDEX

SPECIFICATIONS 27- 2

STRUCTURE AND OPERATION 27- 3

TROUBLESHOOTING 27- 6

WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE 27- 8

WHEEL HUB AND BRAKE DRUM

< FK > 27-10

< FM > 27-24

AXLE HOUSING 27-40

REDUCTION AND DIFFERENTIAL 27-44

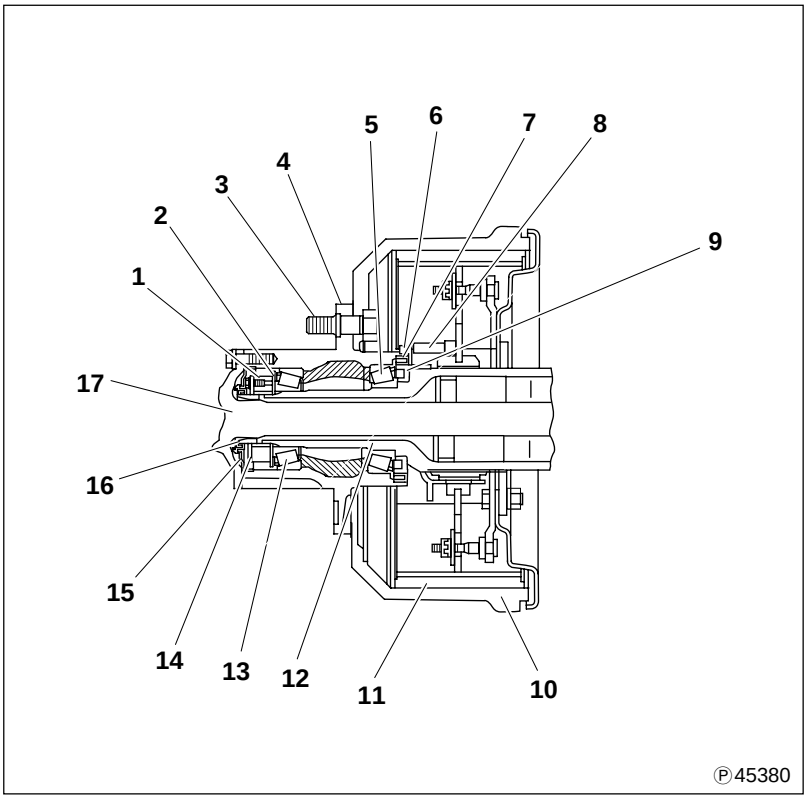
SPECIFICATIONS

Item \ Vehicle model		FK	FM617	FM657
Rear axle	Model	R050T (M)	R060T	
	Type	Banjo type, full floating		
Reduction	Model	D050H	D8H	
	Type	Single-reduction		
	Tooth shape	Hypoid gear		
	Speed reduction ratio	4.444 4.625	4.625 4.875 5.571	4.625 4.875
Differential	Tooth shape	Straight bevel gear		
Gear oil	Grade	* Normal : Maximum air temperature during operation below 40°C {104°F} API GL-5 SAE 90 Hot areas : Maximum air temperature during operation above 40°C {104°F} API GL-5 SAE 140		
	Quantity L {qts}	6.5 {6.9}		
Mass kg {lb}		Approximately 380 {835}	Approximately 615 {1360}	Approximately 615 {1360}

* When used under heavily-loaded, severe conditions such as continuous driving on uphill grades, it is recommended that you use gear oil with a SAE viscosity grade of 140. However, the air temperature must be above 10°C {50°F}.

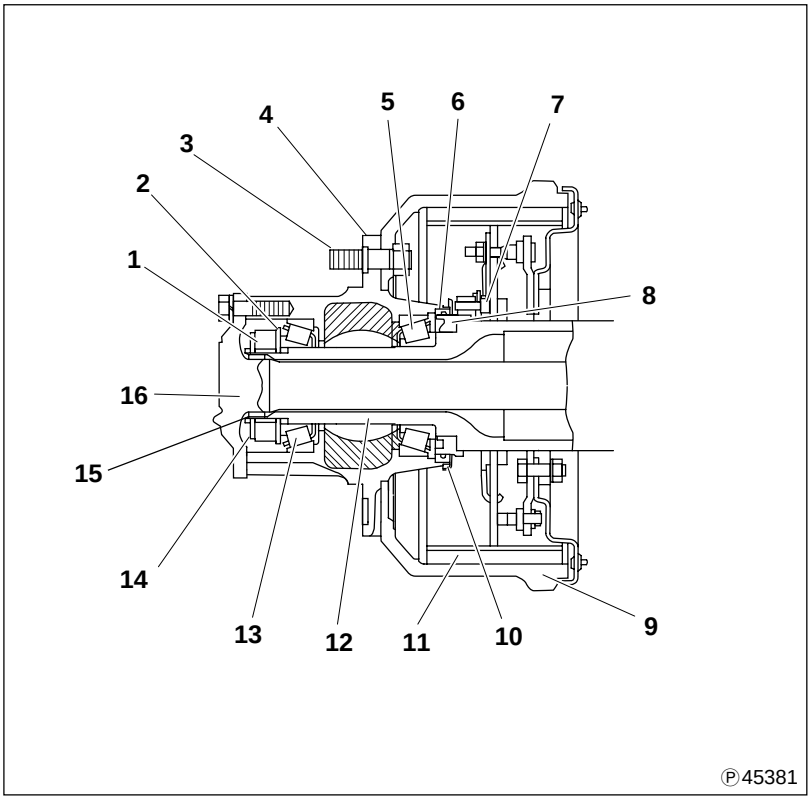
Wheel Hub and Brake Drum

< FK >



1 Lock nut
2 Lock washer
3 Hub bolt
4 Wheel hub
5 Inner bearing
6 Rotor
7 Oil seal
8 Wheel speed sensor
9 Oil seal retainer
10 Brake drum
11 Brake assembly
12 Axle tube
13 Outer bearing
14 Lock plate
15 Oil seal
16 Oil seal retainer
17 Rear axle shaft

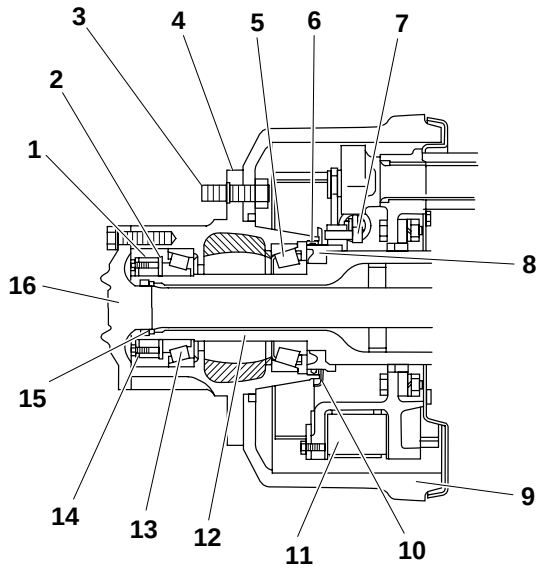
< FM617 >



1 Lock nut
2 Lock washer
3 Hub bolt
4 Wheel hub
5 Inner bearing
6 Oil seal
7 Wheel speed sensor
8 Oil seal retainer
9 Brake drum
10 Rotor
11 Brake assembly
12 Axle tube
13 Outer bearing
14 Lock plate
15 Oil seal
16 Axle shaft

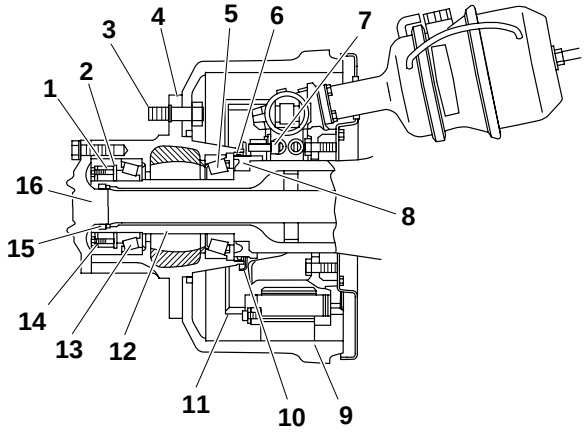
< FM657 >

< Type 1 >



Ⓟ45382

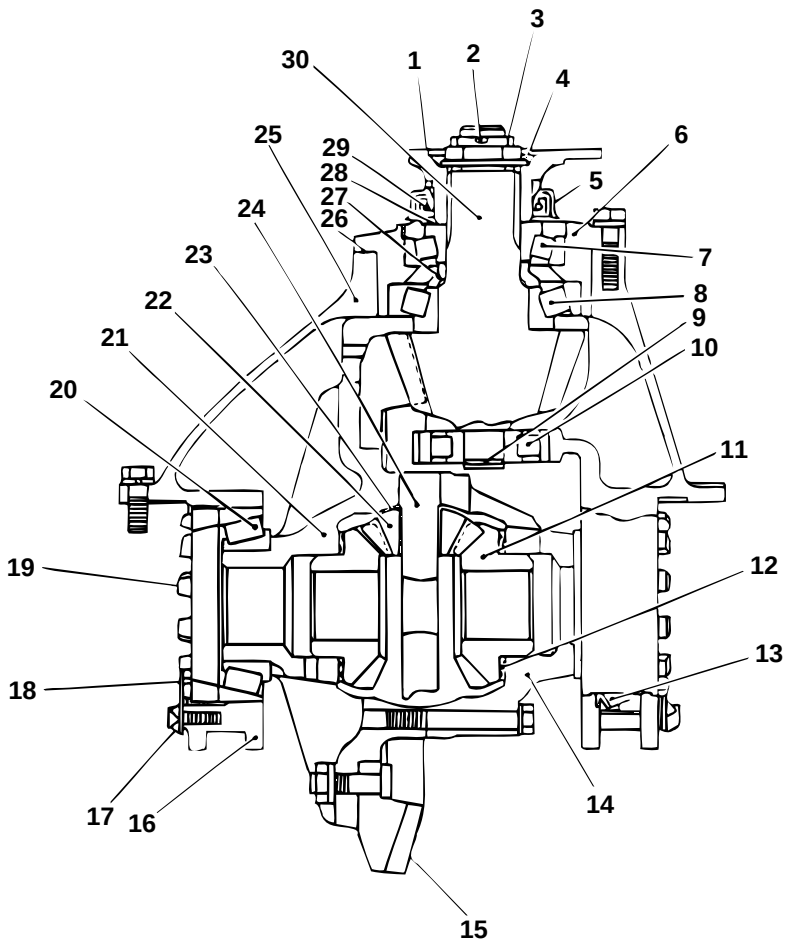
< Type 2 >



Ⓟ45383

1 Lock nut
2 Lock washer
3 Hub bolt
4 Wheel hub
5 Inner bearing
6 Oil seal
7 Wheel speed sensor
8 Oil seal retainer
9 Brake drum
10 Rotor
11 Brake assembly
12 Axle tube
13 Outer bearing
14 Lock plate
15 Oil seal
16 Axle shaft

Reduction and Differential



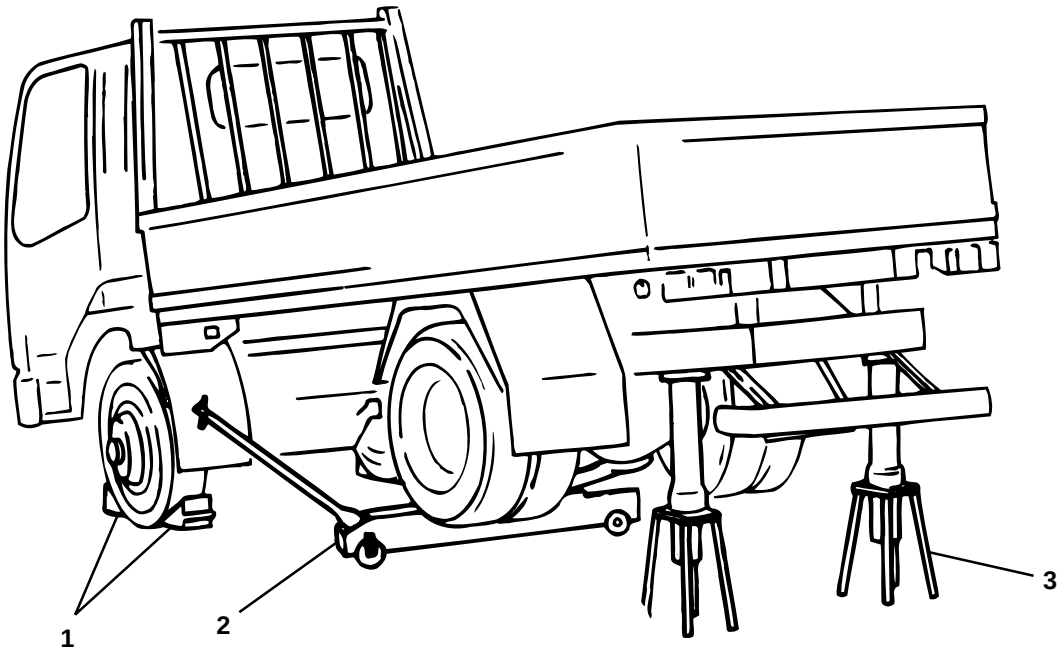
1 Companion flange
2 Split pin
3 Lock nut
4 Washer < D8H >
5 Dust cover
6 Bearing retainer
7 Outer bearing
8 Inner bearing
9 Lock ring
10 Pinion pilot bearing
11 Differential gear
12 Differential gear washer
13 Lock plate
14 Differential case, RH
15 Reduction gear
16 Bearing cap
17 Lock sheet
18 Lock pawl
19 Adjusting screw
20 Side bearing
21 Differential case, LH
22 Differential pinion
23 Differential pinion washer
24 Pinion spider
25 Differential carrier
26 Shim
27 Collar
28 Oil separator < D8H >
29 Oil seal
30 Reduction pinion

TROUBLESHOOTING

Possible causes	Symptoms	Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient							
					Propeller shaft turns but vehicle does not move	Noise when starting and changing speed	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Seizure	Damage
Wheel hub, axle housing	Axle shaft mounting bolt loose		○				○					
	Axle housing bent						○					
	Axle shaft bent						○					
	Axle shaft fractured				○							
	Axle shaft slips out of engagement			○								
	Oil seal faulty			○								
	Air breather clogged			○								
	Wheel hub bearing seized, worn or rotation faulty						○					
	Wheel hub bearing broken							○				
Reduction and differential	Gear oil excessive	○										
	Gear oil insufficient					○	○				○	
	Oil seal faulty	○										
	Sealant faulty		○									
	Side bearing seized, worn or rotation faulty						○		○			
	Side bearing broken							○				
	Side bearing preload adjusted incorrectly						○				○	
	Side bearing starting torque faulty					○	○		○			○
	Reduction and differential assembly mounting bolt and nut loose		○									
	Differential carrier cracked or damaged		○									
	Reduction gear and differential case tightening bolts loose					○		○				
	Reduction gear or reduction pinion broken				○	○	○	○	○			
	Reduction gear or reduction pinion worn						○		○			
	Reduction gear to reduction pinion backlash excessive					○						○
	Reduction gear to reduction pinion backlash insufficient						○				○	
	Reduction gear tooth contact adjusted incorrectly						○					

Possible causes / Symptoms		Oil leaking from companion flange assembly	Oil leaking from differential carrier and axle housing	Oil leaking from axle shaft	Power transmission insufficient							
					Propeller shaft turns but vehicle does not move	Noise when starting and changing speed	Continuous noise while cruising	Intermittent noise while cruising	Noise while cornering	Tires drag while cornering	Seizure	Damage
Reduction and differential	Reduction pinion assembly starting torque excessive					○	○				○	
	Reduction pinion assembly starting torque insufficient					○	○					
	Reduction pinion lock nut loose					○	○					
	Reduction pinion assembly inner bearing and outer bearing seized				○		○					
	Reduction pinion assembly inner bearing or outer bearing worn						○					
	Reduction pinion assembly inner bearing or outer bearing broken							○				
	Reduction pinion pilot bearing worn						○					
	Reduction pinion pilot bearing seized or damaged							○				
	Differential pinion spider broken				○							
	Differential gear or differential pinion broken				○			○	○	○		
	Differential gear or differential pinion seized				○					○		
	Differential gear or differential pinion worn								○	○		
	Differential gear washer worn or damaged							○	○	○		
	Differential gear backlash excessive					○						○
	Differential gear backlash insufficient								○		○	
	Play between differential gear and axle shaft spline excessive					○						○

WORK BEFORE REMOVAL AND INSTALLATION OF REAR AXLE



14176

● **Work sequence before removal**

1 Place wheel chocks.
2 Jack up the rear axle using a garage jack.
3 Support the rear frame on rigid racks.

WARNING⚠

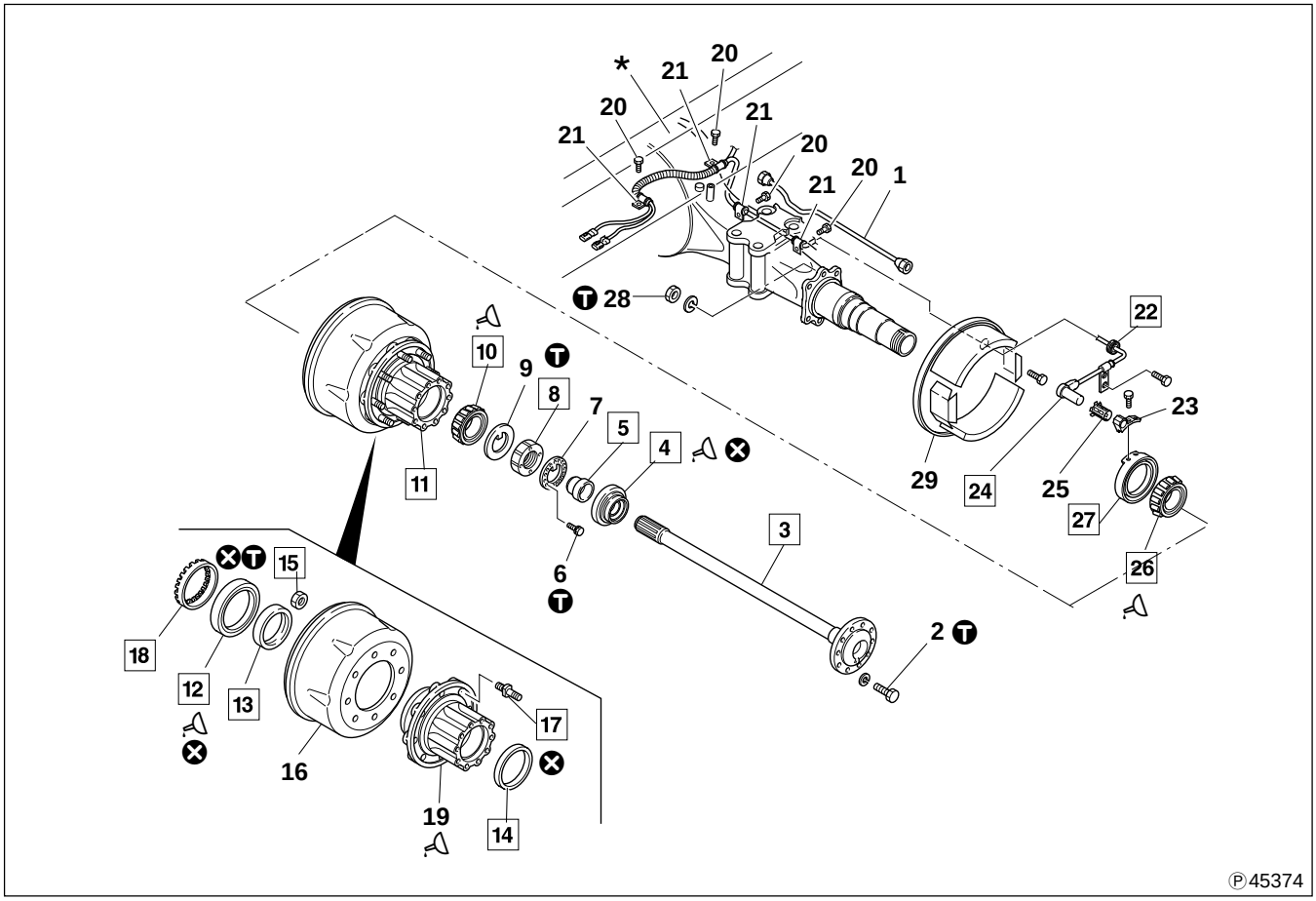
- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after installation**

Follow the work sequence before removal in reverse.

M E M O

WHEEL HUB AND BRAKE DRUM < FK >



● **Disassembly sequence**

1 Brake pipe
2 Bolt
3 Axle shaft
4 Oil seal
5 Oil seal retainer
6 Bolt
7 Lock plate
8 Lock nut
9 Lock washer
10 Outer bearing inner race
11 Wheel hub and brake drum assembly
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Brake drum
17 Hub bolt
18 Rotor
19 Wheel hub
20 Bolt
21 Clip
22 Grommet
23 Sensor holder
24 Wheel speed sensor
25 Spring spacer
26 Inner bearing inner race
27 Oil seal retainer
28 Nut
29 Brake assembly
Gr 35A

* : Axle housing P27-40
⊗ : Non-reusable parts

CAUTION

Be sure to protect brake pipe 1, from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 16 and wheel hub 19 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

- **When removing or installing wheel hub and brake drum assembly 11, handle rotor 18 with care to prevent damage. Also, do not damage oil seal 12 during assembly.**
- **Keep oil and grease off lining surface of brake assembly 29 and the inner surface of brake drum 17.**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
3	Axle shaft	Bend of shaft center	1.0 {0.039} or less	2.0 {0.079}	Replace
		Wobble of flange face	0.04 {0.0016}	0.5 {0.020}	Replace
10, 13, 14, 26	Starting torque of wheel hub bearing		2.5 to 5.4 N·m {1.8 to 4.0 ft.lbs, 0.25 to 0.55 kgf· m}	—	Tangential force at hub bolt position : 18 to 38 N {4.0 to 8.6 lbf, 1.8 to 3.9 kgf}
18	Wobbling of rotor		0.1 {0.0039}	—	Replace
24	Wheel speed sensor	Resistance between terminals	1570 to 1980 Ω	—	Replace
		Insulation resistance	30 kΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Axle shaft mounting)	105 {80, 11}	—
6	Bolt (Lock plate mounting)	6.9 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
8	Lock nut	195 {145, 20}	Slackening off angle : 22.5° (0ne sixteenth of a turn)
15	Nut (Wheel hub and brake drum mounting)	320 {235, 32.8}	—
28	Nut (Brake assembly mounting)	76 {56, 7.8}	—

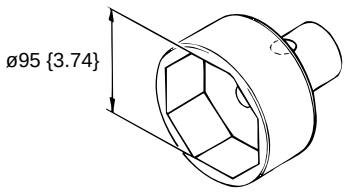
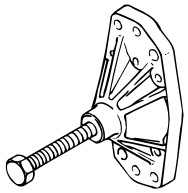
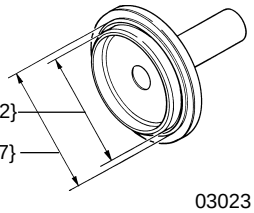
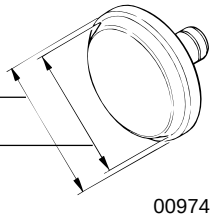
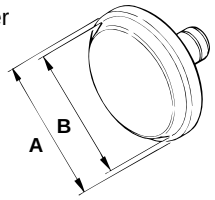
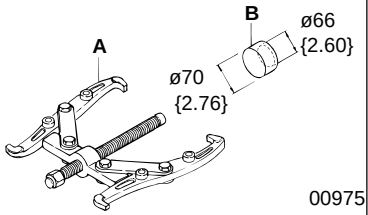
Lubricant

Location	Points of application	Kinds	Quantity
4, 13	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
10, 26	Pack the space between rollers of outer bearing inner race and inner bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	280 g {9.88 oz}

WHEEL HUB AND BRAKE DRUM < FK >

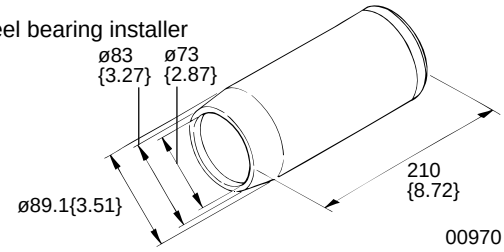
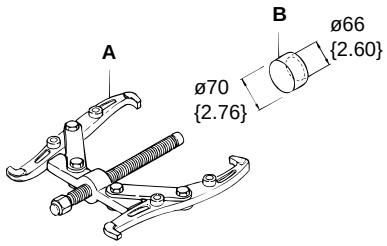
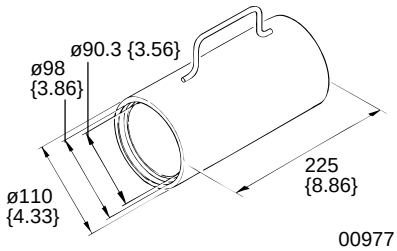
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Socket wrench  00969	MH061597	Removal and installation of lock nut
11	Wheel hub puller  00973	MH061458	Removal of wheel hub and brake drum assembly
12	Anti-lock brake system oil seal installer  03023	MH062664	Press-fitting of oil seal
13	Wheel hub inner bearing installer  00974	MH061010	Press-fitting of inner bearing outer race
14	Wheel hub outer bearing installer  00974	MH061012	Press-fitting of outer bearing outer race
26	**A** : Gear puller **B** : Adapter  00975	**A** : MH061102 **B** : MH061962	Removal of inner bearing inner race

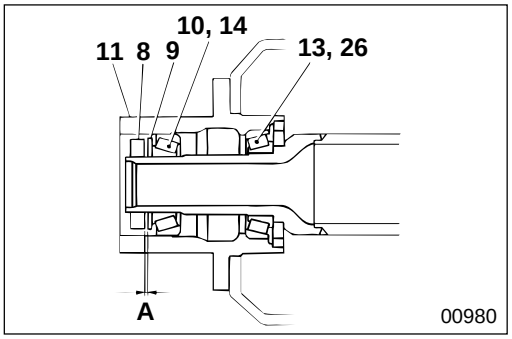
	A	B
FK	ø118 {4.65}	ø112 {4.41}
FM	ø149 {5.87}	ø138 {5.43}

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26	Wheel bearing installer 	MH061009	Press-fitting of inner bearing inner race
27	**A** : Gear puller **B** : Adapter 	**A** : MH061102 **B** : MH061962	Removal of oil seal retainer
	Oil seal retainer installer 	MH061008	Press-fitting of oil seal retainer

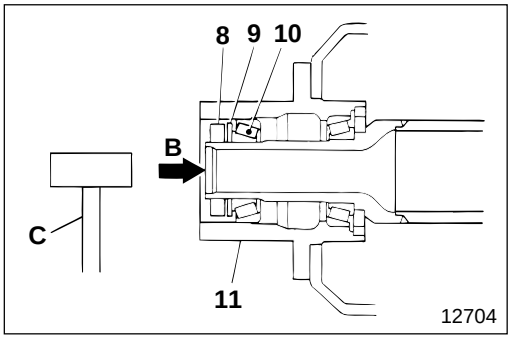
◆ Service procedure

● Starting torque of wheel hub bearing

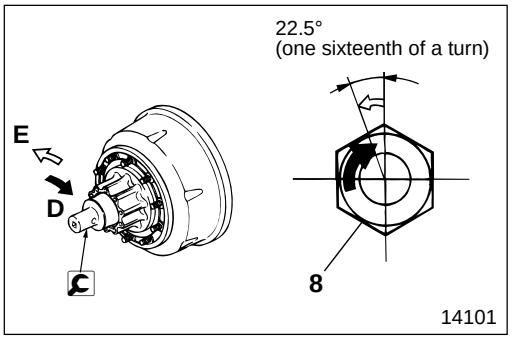


[Adjustment]

- Install lock washer **9** and lock nut **8**.
- Turn wheel hub and brake drum assembly **11** several times to smooth operation of outer bearings **10**, **14** and inner bearings **13**, **26**.
- Tighten lock nut **9** at specified torque.
- Slacken off lock nut **8** to obtain clearance **A** between the lock nut and lock washer **9**.



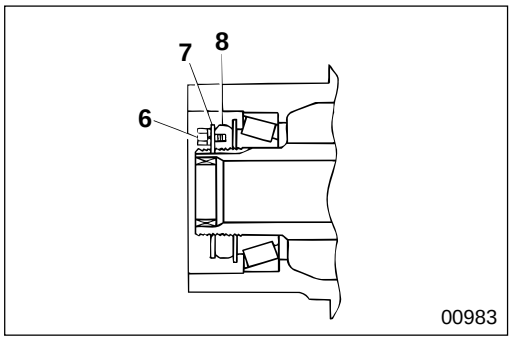
- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



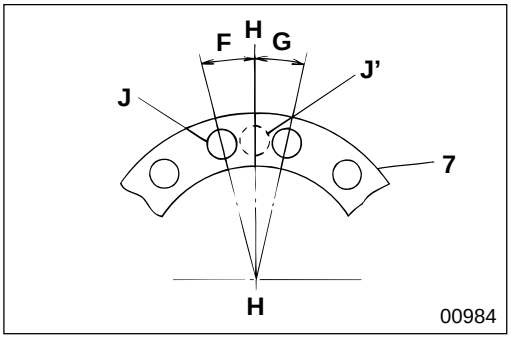
★ • Tighten lock nut **8** at specified torque.
  D : Tightening direction

- Slacken off lock nut **8** by 22.5° (one sixteenth of a turn).
  E : Slackening off direction

(★ : If any fault is found when measuring tangential force, redo from this item.)

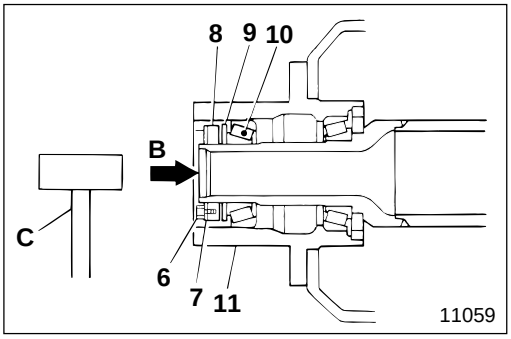


- Install lock plate **7**.
- Make sure that bolt **6** mounting holes of lock nut **8** and lock plate **7** align.
- Tighten bolt **6** at specified torque.

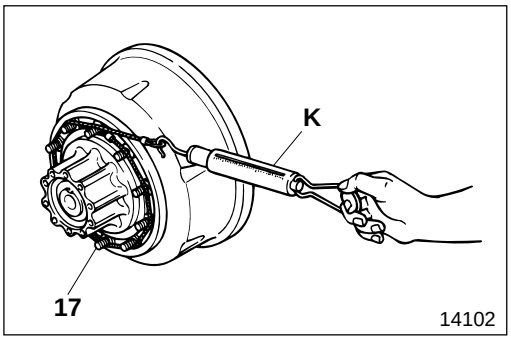


- If mounting holes of lock plate **7** and lock nut **8** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **F**	Loosen lock nut to align holes
Within range **G**	Turn over lock plate and loosen lock nut to align holes
On line **H-H**	Turn over lock plate to align holes (Hole position **J'** changes to **J**)



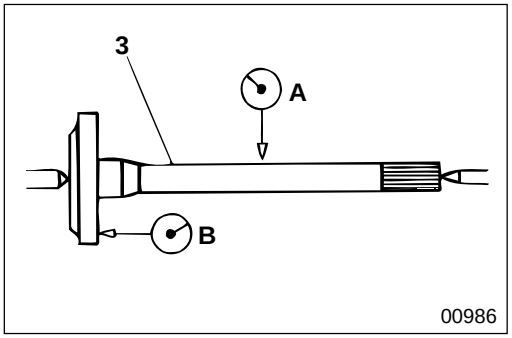
- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



[Measurement]
- Install spring balance **K** on hub bolt **17**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the tangential force to become higher than the upper limit of the specified value.
- If the measured value deviates from the specified value, repeat from step ★. 📖 P27-14
- If the result is still not satisfactory, replace outer bearings **10, 14** and inner bearings **13, 26**.

NOTE

- **Make sure that there is no drag in brake lining and brake drum 16 before you measure the tangential force.**
- **Measure the starting torque when oil seal 12 has been installed.**



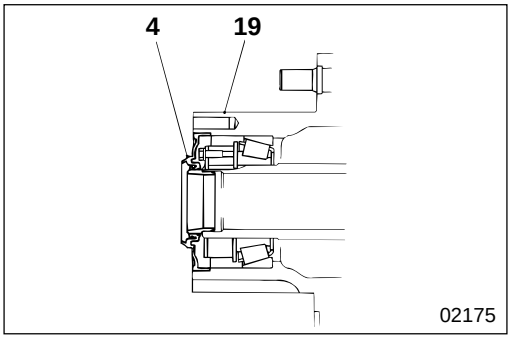
3 **Inspection of axle shaft**

A : Bend of shaft center

NOTE

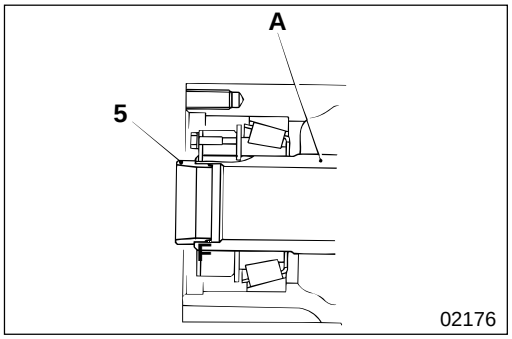
To measure the bend of axle shaft 3, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

B : Wobble of flange face



4 **Installation of oil seal**

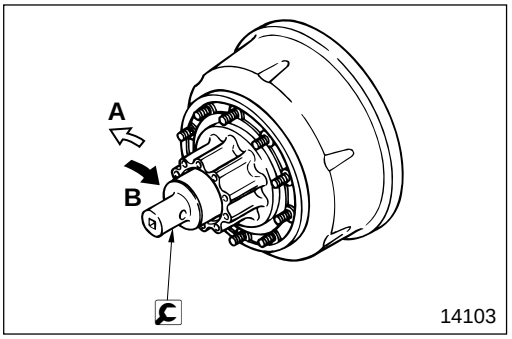
Press-fit oil seal **4** until it is flush with the end of wheel hub **19**.



5 **Oil seal retainer**

[Removal]
It is not necessary to remove oil seal retainer **5** other than for replacement of oil seal **4**.

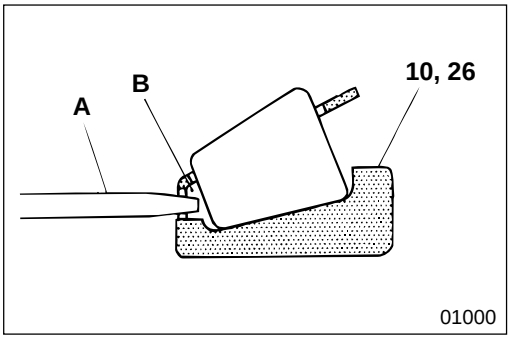
[Installation]
Press-fit oil seal retainer **5** until it is flush with the end of axle tube **A**.



8 **Removal and installation of lock nut**

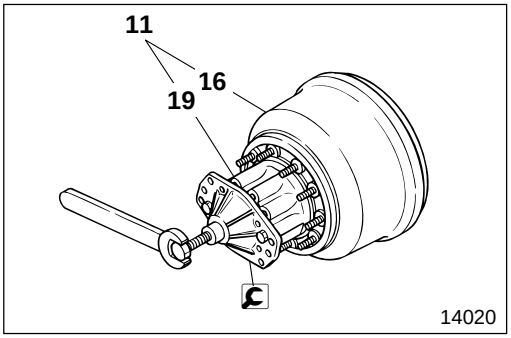
After installation, adjust the starting torque of the wheel hub bearing. See P27-14

A : Removal
B : Installation



10 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle
B : Space between rollers

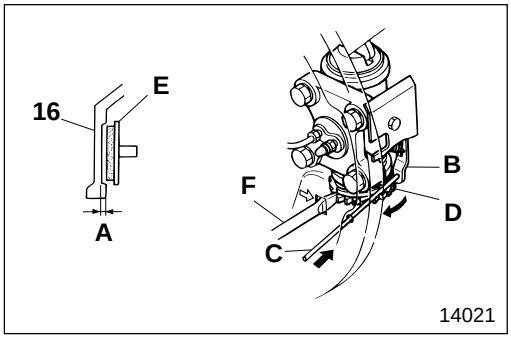


11 Wheel hub and brake drum assembly

[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 11 in a straight line to prevent damage to oil seal 12.



If wheel hub and brake drum assembly **11** cannot be removed because of stepped wear **A** in brake drum **16**, carry out the following:

- Remove the packing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **17** and brake shoe assembly **E**.
  F : Screwdriver
- Remover wheel hub and brake drum assembly **11**.

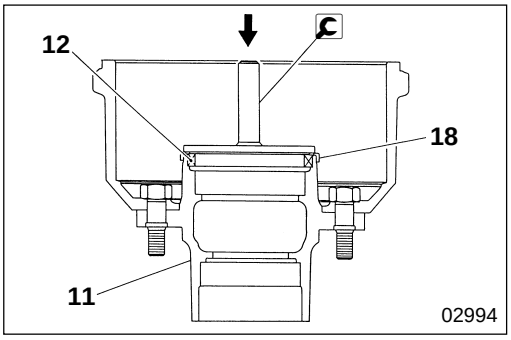
CAUTION

If brake drum 17 is faulty, correct it. Gr 35A, B

[Installation]

After installing wheel hub and brake drum assembly **11**, adjust the brake shoe clearance.

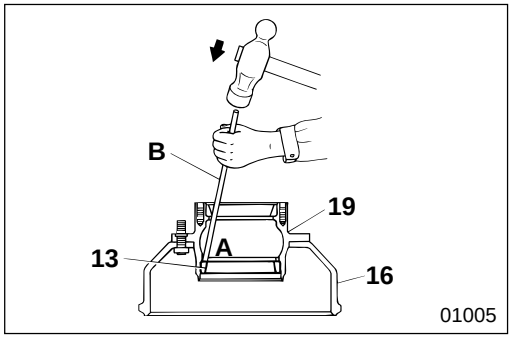
Gr 35A



12 Installation of oil seal

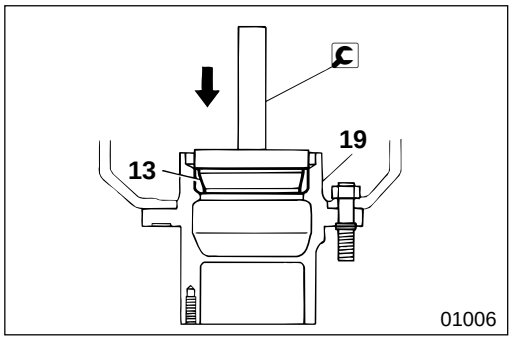
NOTE

When hub and brake drum assembly 11 is removed for a service operation and if rotor 18 is still mounted on the wheel hub, use Anti-lock brake system oil seal installer to press-fit oil seal 12.

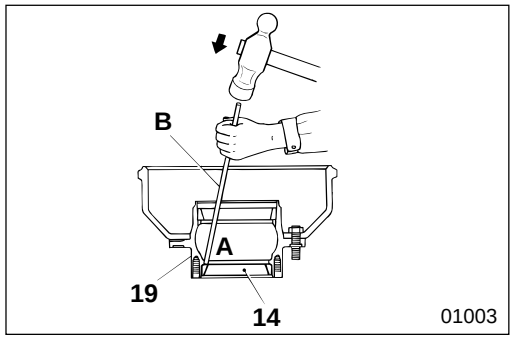


13 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **13** evenly from four indented parts **A** in wheel hub **19**.
B : Pin-punch

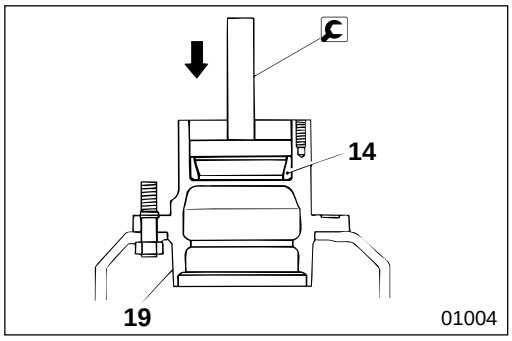


[Installation]

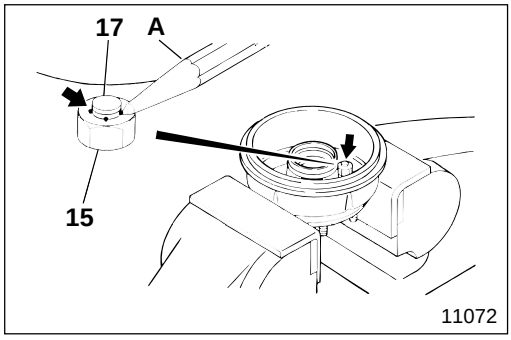


14 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **14** evenly from four indented parts **A** in wheel hub **19**.
B : Pin-punch

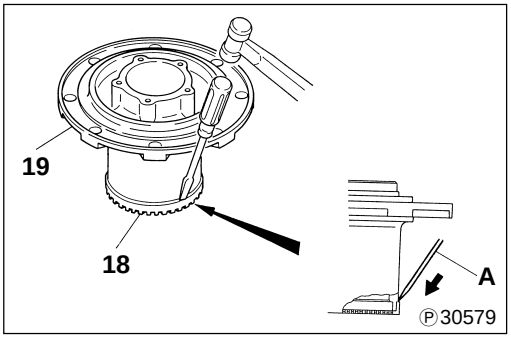


[Installation]



15 **17** **Installation of hub bolt and nut**

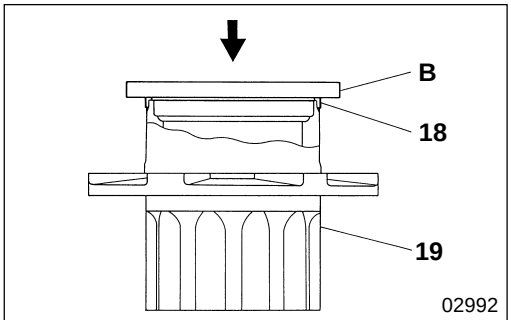
- Install hub bolt **17**.
- Tighten nut **15** at specified torque.
- Caulk nut **15** evenly at four points to keep it from turning.
  A : Pin-punch



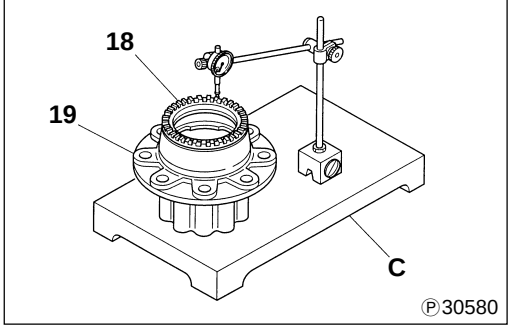
18 **Rotor**

[Removal]
Strike the outer edge of rotor **18** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub.

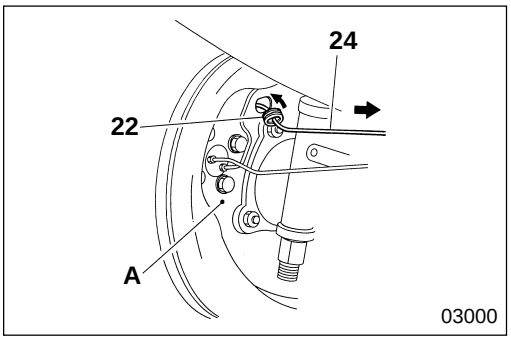
CAUTION ⚠
Be careful not to damage wheel hub 19.



[Installation]
Heat rotor **18** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **19**. Make sure there is no space between the rotor and wheel hub.

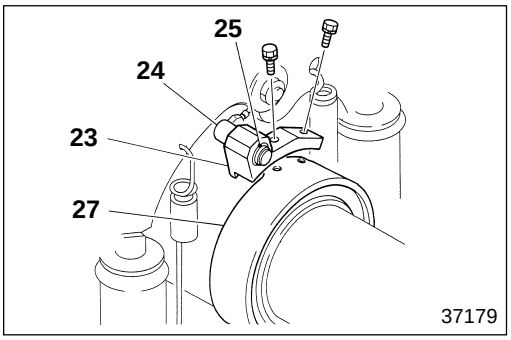


[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C : Base



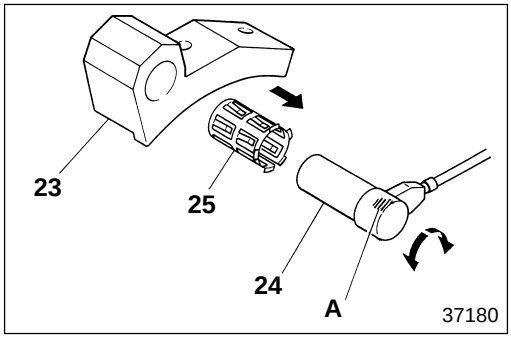
22 **Installation of grommet**

Mount grommet **22** on back plate **A**, and pull the harness of wheel speed sensor **24** to make sure there is no slack inside the wheel brake.



24 **Wheel speed sensor**

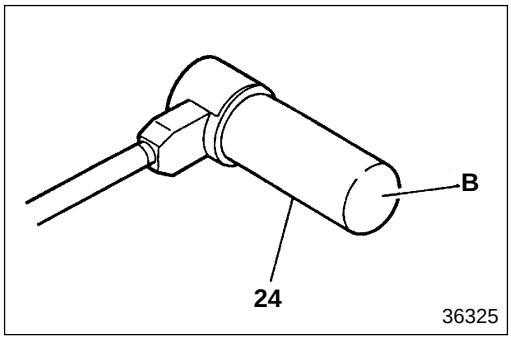
[Removal]
- With wheel speed sensor **24** and spring spacer **25** installed in sensor holder **23**, remove the sensor holder from oil seal retainer **27**.



- Hold shaded section **A** of wheel speed sensor **24** with pliers, and remove the sensor by twisting it slightly in left and right directions.

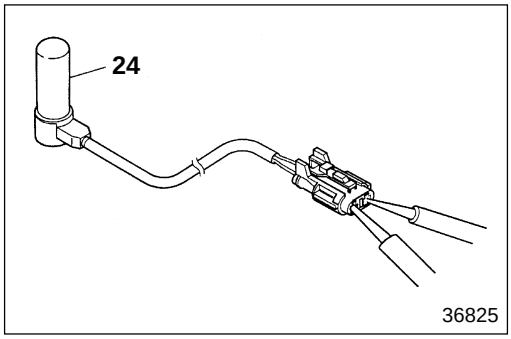
CAUTION

- **When holding wheel speed sensor 24 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 24 dismounts easily, replace spring spacer 25.**

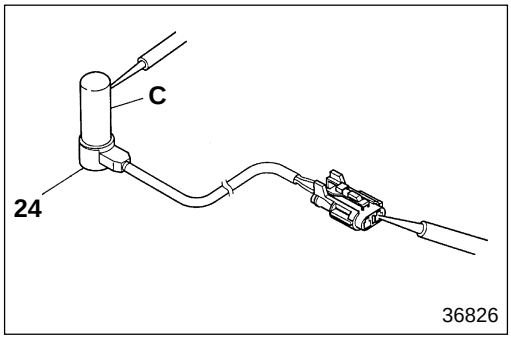


[Inspection]

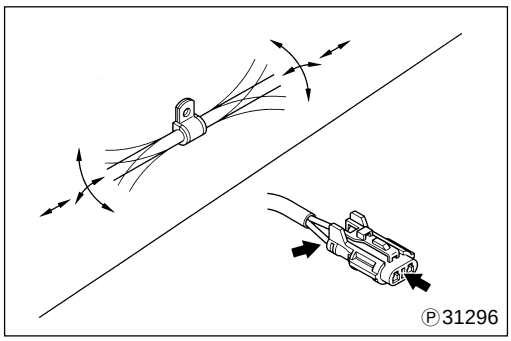
- Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **24**, it attracts metals. Do not allow the pole piece to collect metallic objects.



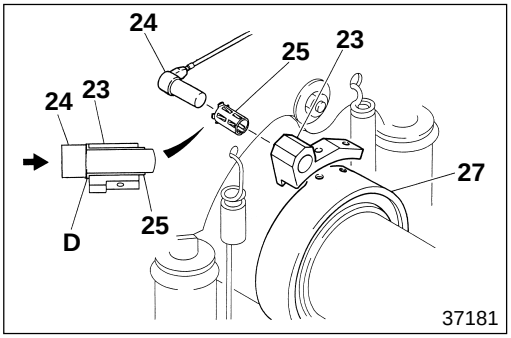
- Measure the resistance between the terminals of wheel speed sensor **24**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **24** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **24**.



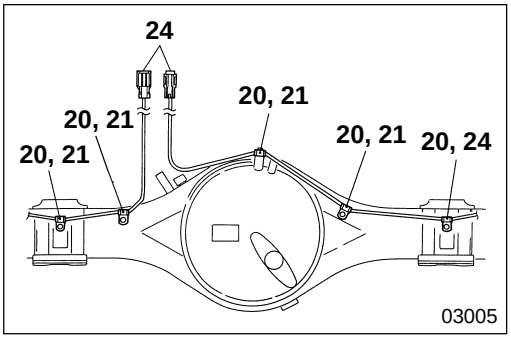
[Installation]

- Insert wheel speed sensor **24** from the back plate, and press until spring spacer **25** and stopper section **D** of the wheel speed sensor contacts sensor holder **23**.
- With wheel speed sensor **24** and spring spacer **25** installed in sensor holder **23**, mount the sensor holder on oil seal retainer **27**.

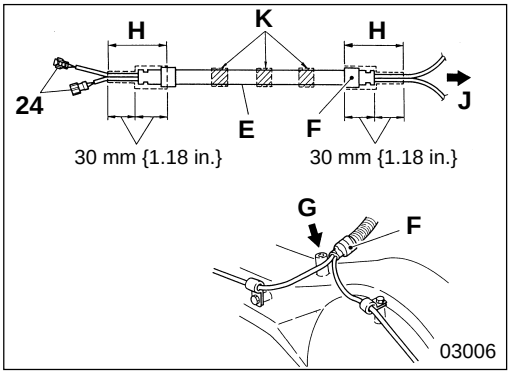
CAUTION

- **When installing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **Note that wheel speed sensor 24 is different for left and right wheels.**

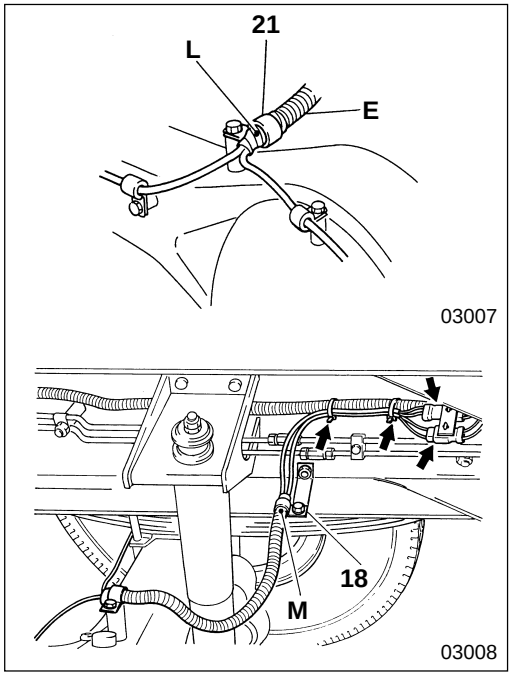
Location	Harness connector color	Harness connector shape
Left wheel	Gray	Male
Right wheel	Black	Female



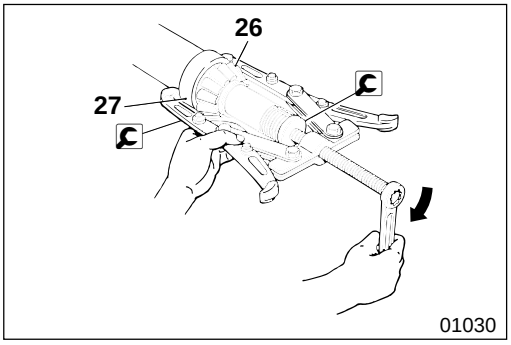
- Rear axle housing section
  Starting from the wheel brake side, secure the harness of wheel speed sensor **24** in place with clip **21** and bolt **20**. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



- Binding of harness
  - Gather the harnesses of left and right wheel speed sensors **24**, and bind with corrugated tube **E**.
  - Adjust the position of the corrugated tube **E** so that white tape section **F** is located at clip position **G** on the rear axle housing. Then, turn the corrugated tube so that the slit faces down. Wrap black tape (electric harness tape) on both ends **H** of the corrugated tube. The tape should be placed over the tube end and harness.
    J: Rear axle housing side
  - Wrap tape on the harnesses of wheel speed sensors **24** at sections **K** (three locations at equal intervals).

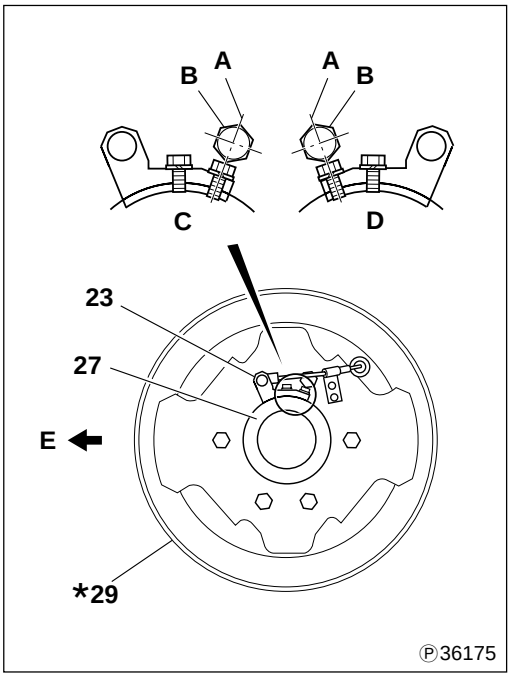


- Clamping of harness
  - Secure section **L** of corrugated tube **E** to the rear axle housing using clip **21**, and attach section **M** of the corrugated tube to the frame using clip **21**.
  - Connect the wheel speed sensor connector to the harness connector on the chassis side, and secure the connectors in place using the bracket.



26 **27** **Inner bearing inner race and oil seal retainer**

[Removal]



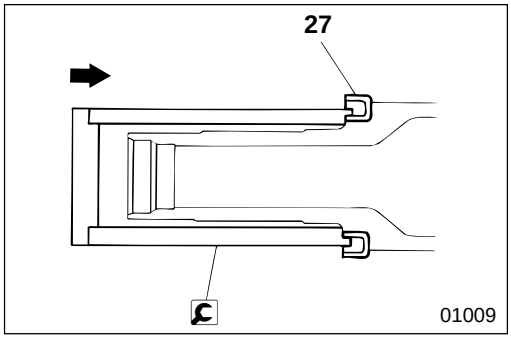
[Installation]

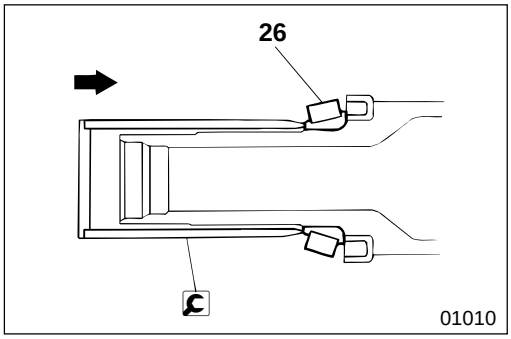
When installing oil seal retainer **27**, align mounting bolt center **A** of sensor holder **23** with the center line of mounting bolt **B** of brake assembly **29**.

C : For left wheel
D : For right wheel
E : Front of vehicle

NOTE

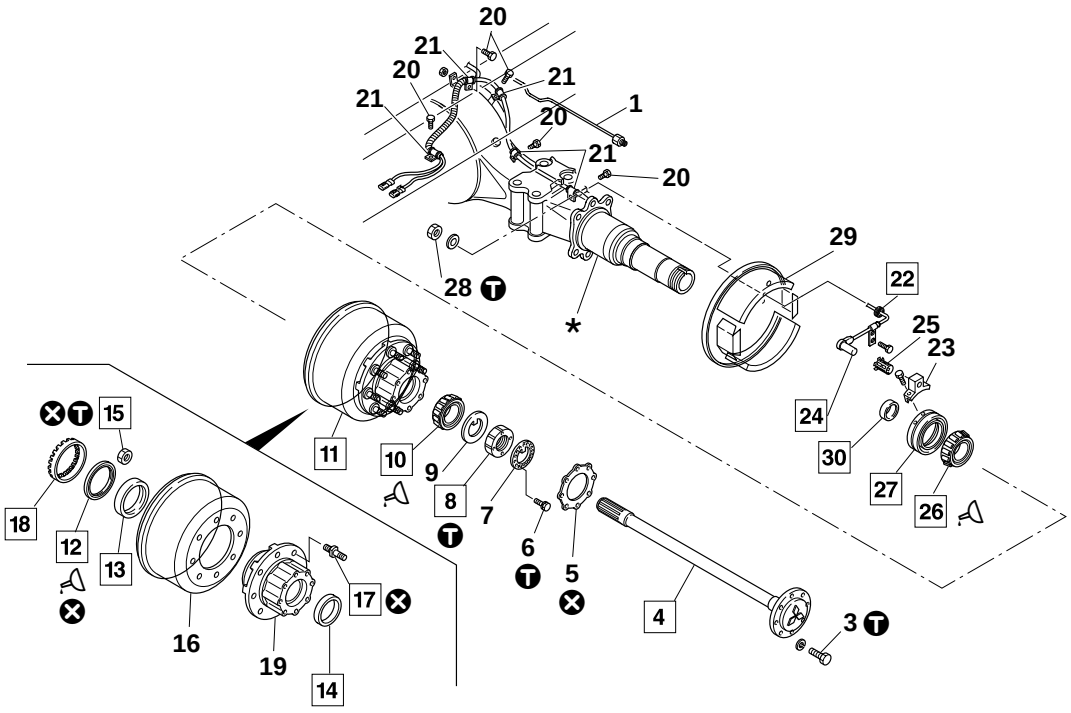
The brake assembly diagram shows a left wheel.





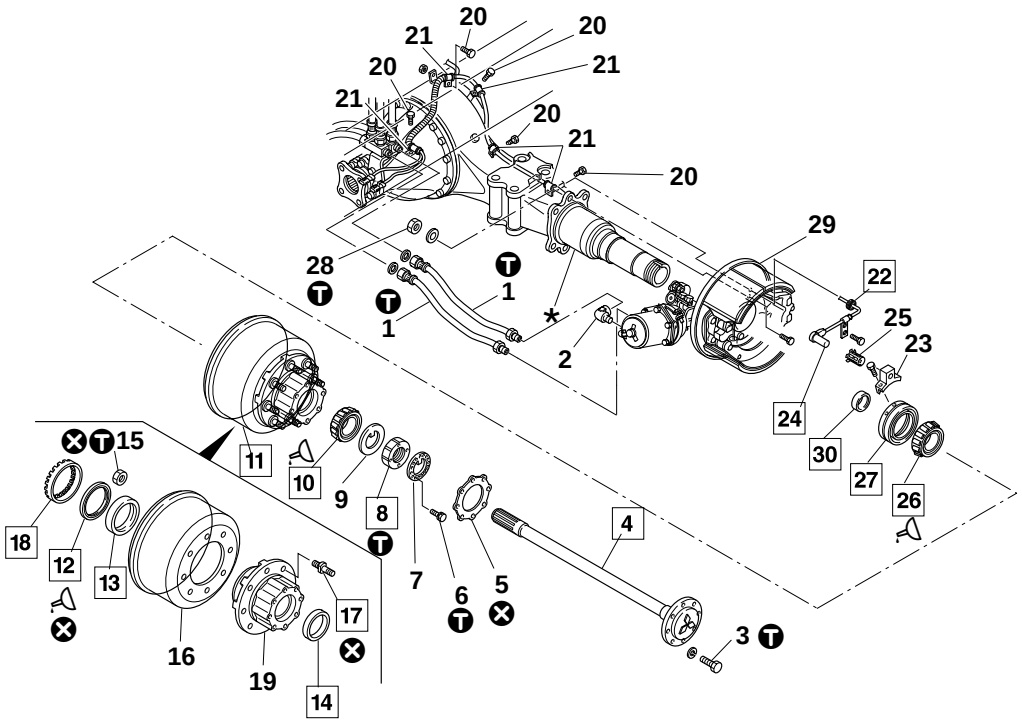
WHEEL HUB AND BRAKE DRUM < FM >

< FM617 >



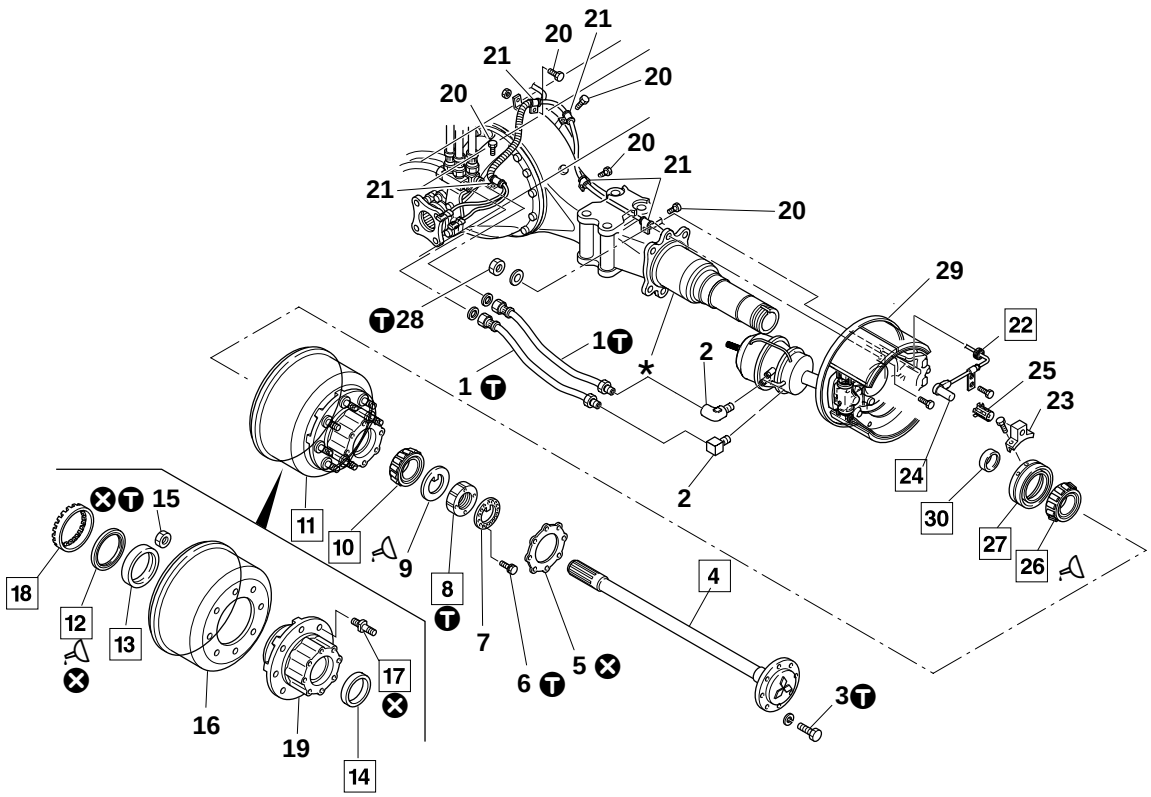
Ⓟ45375

< FM657 (Type 1) >



Ⓟ45376

< FM657 (Type 2) >



● **Disassembly sequence**

1 Brake pipe < FM617 >
Brake hose < FM657 >
2 Connector
3 Bolt
4 Axle shaft
5 Gasket
6 Bolt
7 Lock plate
8 Lock nut
9 Lock washer
10 Outer bearing inner race
11 Wheel hub and brake drum assembly
12 Oil seal
13 Inner bearing outer race
14 Outer bearing outer race
15 Nut
16 Brake drum
17 Hub bolt
18 Rotor
19 Wheel hub
20 Bolt
21 Clip
22 Grommet
23 Sensor holder
24 Wheel speed sensor
25 Spring spacer
26 Inner bearing inner race
27 Oil seal retainer
28 Nut
29 Brake assembly
Gr 35A < FM617 >
Gr 35B < FM657 >
30 Oil seal

* : Axle housing P27-40
⊗ : Non-reusable parts

CAUTION

Be sure to protect brake pipe 1 < FM617 >, or brake hose 1 < FM657 >, from dust by fitting blanking plugs after removal.

NOTE

Do not disassemble brake drum 16 and wheel hub 19 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING

You must bleed air from the brake system after assembly, failure to do so would cause the brake to malfunction. Gr 35A < FM617 >

WHEEL HUB AND BRAKE DRUM < FM >

CAUTION⚠

- **When removing or installing wheel hub and brake drum assembly 11, handle rotor 18 with care to prevent damage. Also, do not damage oil seal 12 during assembly.**
- **Keep oil and grease off lining surface of brake assembly 29 and the inner surface of brake drum 16.**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
4	Axle shaft	Bend of shaft center	1.0 {0.039} or less	2.0 {0.079}	Replace
		Wobble of flange face	0.05 {0.0020}	0.5 {0.020}	Replace
10, 13, 14, 26	Starting torque of wheel hub bearing		2.5 to 5.4 N·m {1.8 to 4.0 ft.lbs, 0.25 to 0.55 kgf· m}	—	Tangential force at hub bolt position : 18 to 38 N {4.0 to 8.6 lbf, 1.8 to 3.9 kgf}
18	Wobbling of rotor		0.1 {0.0039}	—	Replace
24	Wheel speed sensor	Resistance between terminals	1570 to 1980 Ω	—	Replace
		Insulation resistance	30 kΩ or higher	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

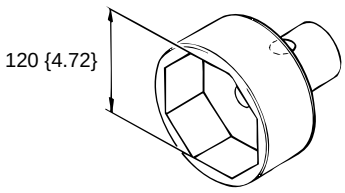
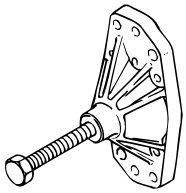
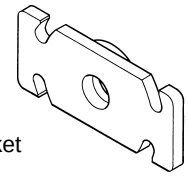
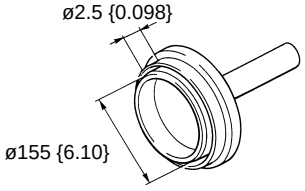
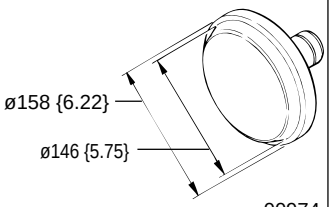
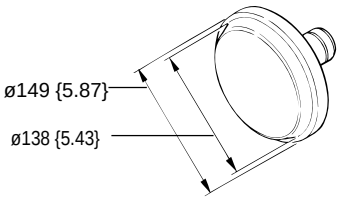
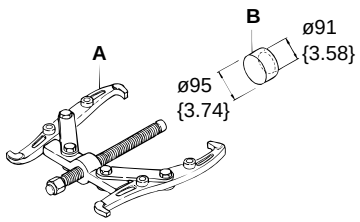
Location	Parts to be tightened		Tightening torque	Remarks
1	Brake hose (T-connector side)	FM657	39 to 44 {29 to 33, 4.0 to 4.5}	—
3	Bolt (Axle shaft mounting)		270 {200, 27.7}	—
6	Bolt (Lock plate mounting)		6.9 to 11 {5.1 to 8.0, 0.7 to 1.1}	—
8	Lock nut		295 {215, 30}	Slackening off angle : 22.5° (0ne sixteenth of a turn)
15	Nut (Wheel hub and brake drum mounting)		320 {235, 32.8}	—
28	Nut (Brake assembly mounting)		135 {100, 13.8}	—

Lubricant

Location	Points of application	Kinds	Quantity
12	Lip area of oil seal	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
10, 26	Pack the space between rollers of outer bearing inner race and inner bearing inner race	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
19	Pack interior of wheel hub	Wheel bearing grease [NLGI No.2 (Li soap)]	1100 g {38.8 oz}

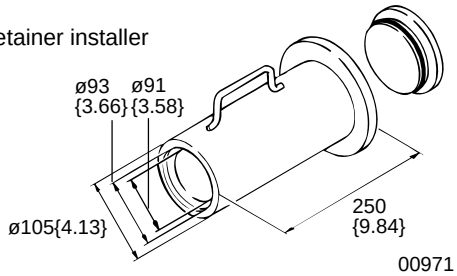
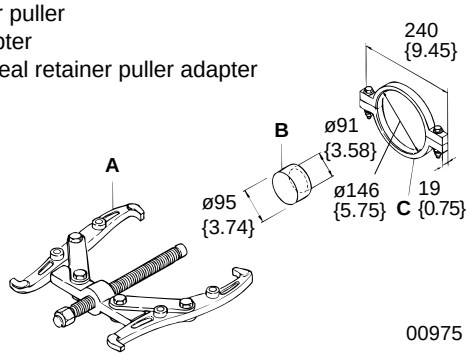
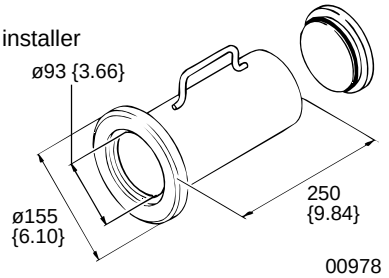
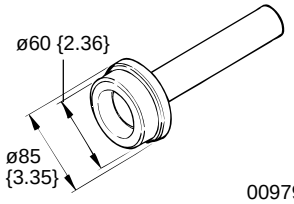
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Socket wrench  00969	MH061536	Removal and installation of lock nut
11	Wheel hub puller  00973	MH061458 (Obtain Locally)	Removal of wheel hub and brake drum assembly
	Anti-lock brake system hub stopper Note: Not being used in U.S. Market  04677	MH062058	Installation of wheel hub & brake drum assembly
12	Anti-lock brake system oil seal installer  04719	MH062057	Press-fitting of oil seal
13	Wheel hub inner bearing installer  00974	03723-21000	Press-fitting of inner bearing outer race
14	Wheel outer bearing installer  00974		Press-fitting of outer bearing outer race
26	**A** : Gear puller **B** : Adapter  00975	(Obtain Locally) **A** : MH061102 **B** : MH061103	Removal of inner bearing inner race

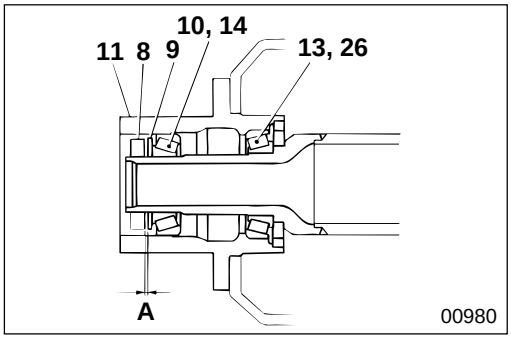
WHEEL HUB AND BRAKE DRUM < FM >

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
26	Oil seal retainer installer 	03723-31001	Press-fitting of inner bearing inner race
27	**A** : Gear puller **B** : Adapter **C** : Oil seal retainer puller adapter 	(Obtain Locally) **A** : MH061102 **B** : MH061103 **C** : 03724-16000	Removal of oil seal retainer
	Oil seal retainer installer 	03723-31001	Press-fitting of oil seal retainer
30	Oil seal installer 	MH062016	Press-fitting of oil seal at axle tube end

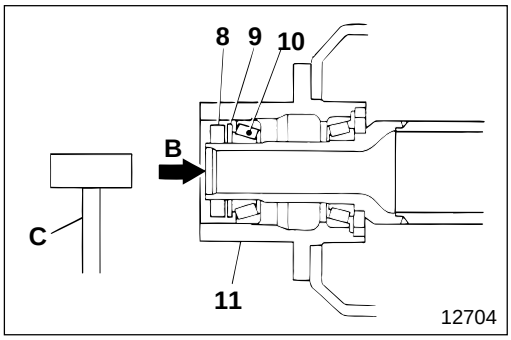
◆ Service procedure

● Starting torque of wheel hub bearing

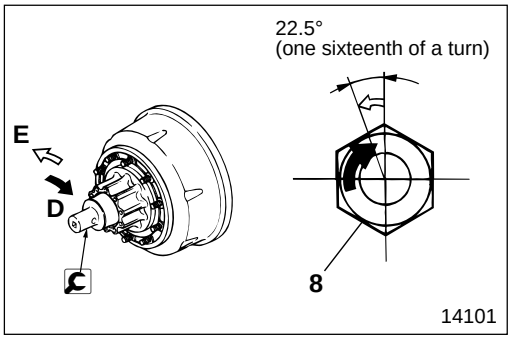


[Adjustment]

- Install lock washer **9** and lock nut **8**.
- Turn wheel hub and brake drum assembly **11** several times to smooth operation of outer bearings **10**, **14** and inner bearings **13**, **26**.
- Tighten lock nut **9** at specified torque.
- Slacken off lock nut **8** to obtain clearance **A** between the lock nut and lock washer **9**.



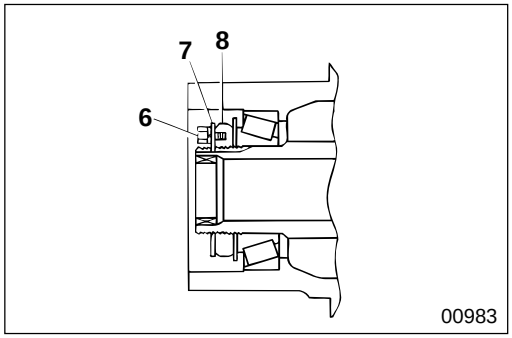
- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



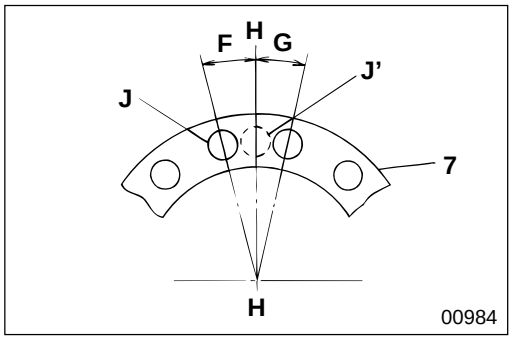
★ • Tighten lock nut **8** at specified torque.
  D : Tightening direction

- Slacken off lock nut **8** by 22.5° (one sixteenth of a turn).
  E : Slackening off direction

(★ : If any fault is found when measuring tangential force, redo from this item.)

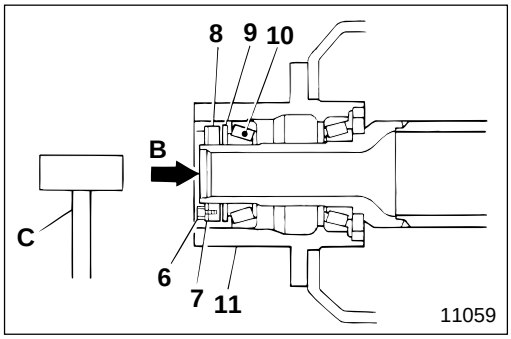


- Install lock plate **7**.
- Make sure that bolt **6** mounting holes of lock nut **8** and lock plate **7** align.
- Tighten bolt **6** at specified torque.

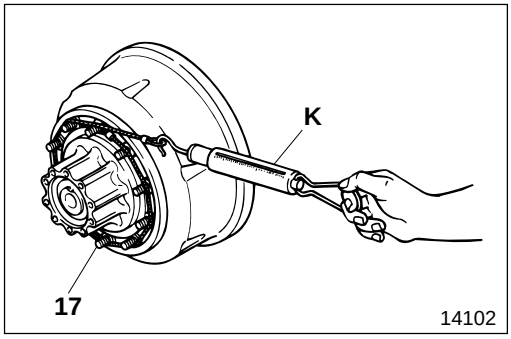


- If mounting holes of lock plate **7** and lock nut **9** do not align, align as follows:

Hole position of lock nut	How to align hole of lock plate
Within range **F**	Loosen lock nut to align holes
Within range **G**	Turn over lock plate and loosen lock nut to align holes
On line **H-H**	Turn over lock plate to align holes (Hole position **J'** changes to **J**)

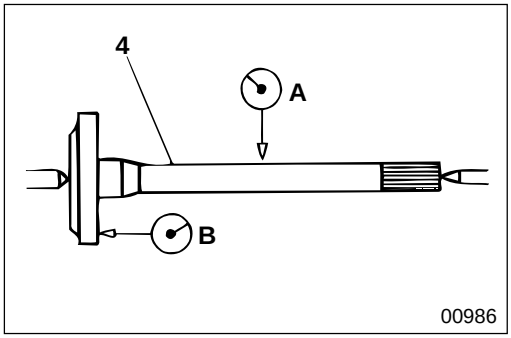


- To slide outer bearing inner race **10** towards lock nut **8**, hit end **B** of the axle tube two or three times with a mallet, while turning wheel hub and brake drum assembly **11**.
  C : Copper-headed mallet



[Measurement]
- Install spring balance **K** on hub bolt **17**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- Do not allow the tangential force to become higher than the upper limit of the specified value.
- If the measured value deviates from the specified value, repeat from step ★. 📖 P27-29
- If the result is still not satisfactory, replace outer bearings **10, 14** and inner bearings **13, 26**.

NOTE
- **Make sure that there is no drag in brake lining and brake drum 16 before you measure the tangential force.**
- **Measure the starting torque when oil seal 12 has been installed.**



4 **Axle shaft**

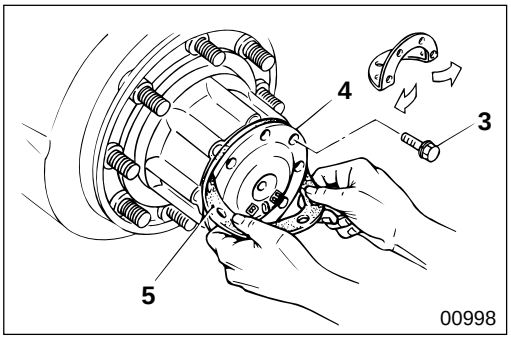
[Inspection]

A : Bend of shaft center

NOTE

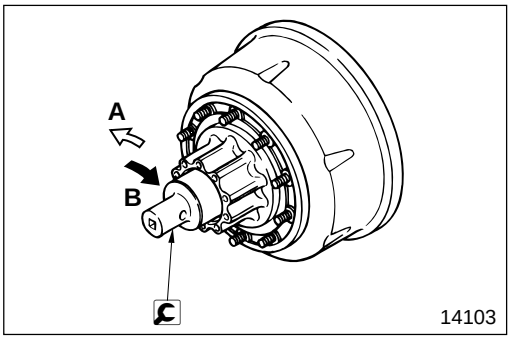
To measure the bend of axle shaft 4, turn it one full revolution and read the dial gauge indicator. The bend is one half of the indicated value.

B : Wobble of flange face



[Installation]

Install gasket **5** on axle shaft **4**, and tighten bolt **3** at specified torque.

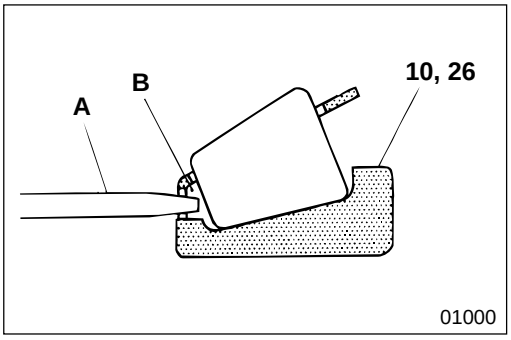


8 **Removal and installation of lock nut**

After installation, adjust the starting torque of the wheel hub bearing. See P27-29

A : Removal

B : Installation

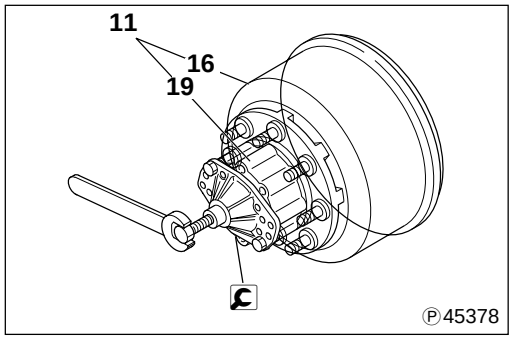


10 **26** **Packing grease in outer bearing inner race and inner bearing inner race**

A : Grease pump nozzle

B : Space between rollers

WHEEL HUB AND BRAKE DRUM < FM >



11 **Wheel hub and brake drum assembly**

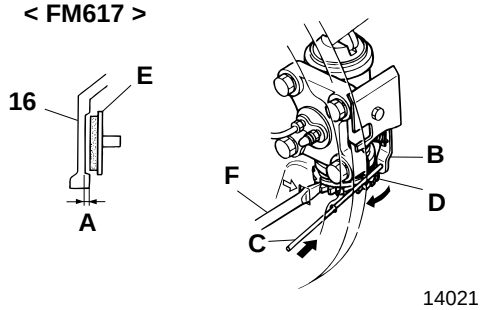
[Removal]

CAUTION

Make sure you remove wheel hub and brake drum assembly 11 in a straight line to prevent damage to oil seal 12.

If wheel hub and brake drum assembly **11** cannot be removed because of stepped wear **A** in brake drum **16**, carry out the following:

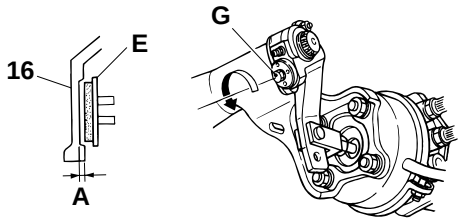
< FM617 >



< FM617 >

- Remove the packing plate cover.
- Lift lever **B**.
  C : Wire approximately ø5 mm {0.020 in.}
- Turn adjuster **D** in the opposite direction to the arrow on the packing plate, and expand the clearance between brake drum **16** and brake shoe assembly **E**.
  F : Screwdriver
- Remover wheel hub and brake drum assembly **11**.

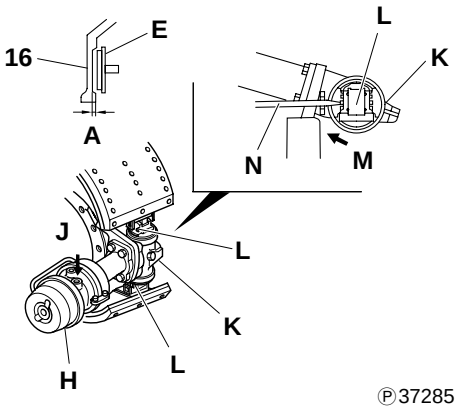
< FM657 (Type 1) >



< FM657 (Type 1) >

- Turn worm shaft **G** of the automatic slack adjuster counterclockwise, and expand the clearance between brake drum **16** and brake shoe assembly **E**.
- Remover wheel hub and brake drum assembly **11**.

< FM657 (Type 2) >



< FM657 (Type 2) >

- Remove the dust cover from the back side of the anchor bracket.
- Supply compressed air at pressure of 640 kpa {92 psi, 6.5 kgf/cm^2} to spring brake air inlet **J** of brake chamber assembly **H** to release the spring brake.
- Turn adjuster **L** on expander assembly **K** in direction **M**, and widen the gap between brake drum **16** and brake shoe **E**.
- Reinstall the dust cover on the back side of the anchor bracket.

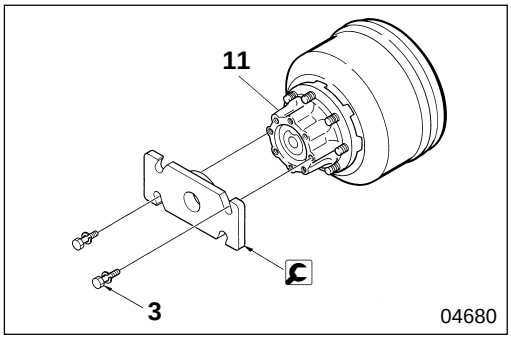
CAUTION

- **Be careful not to damage the boot of expander assembly K when inserting flat-tip screwdriver N.**
- **If brake drum 16 is faulty, correct it.** **Gr 35A, B**

[Installation]

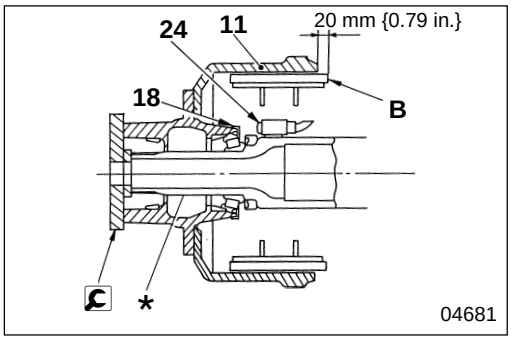
After installing wheel hub and brake drum assembly **11**, adjust the brake shoe clearance.

Gr 35A < FM617 >
Gr 35B < FM657 >



[Installation]

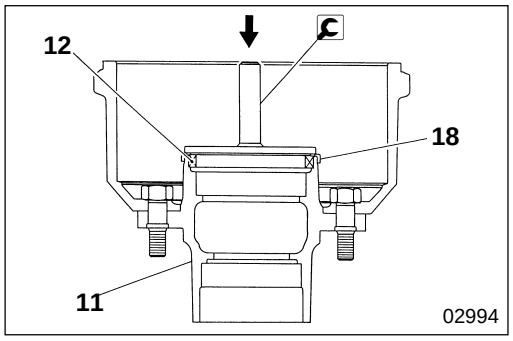
- Using two bolts **3**, mount Anti-lock brake system hub stopper on wheel hub and brake drum assembly **11**.



- Mount wheel hub and brake drum assembly **11** on axle housing * and press until Anti-lock brake system hub stopper contacts the end surface of the axle housing.
- Remove Anti-lock brake system hub stopper, and mount outer bearing inner lace **10**, lock washer **9** and lock nut **8**. Tighten the lock nut slowly.

CAUTION

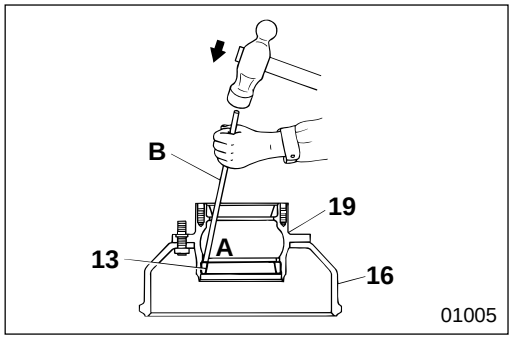
When installing wheel hub and brake drum assembly 11 without using Anti-lock brake system hub stopper, mount the assembly without jiggling until brake lining B extends approximately 20 mm {0.79 in.} from the edge of brake drum. Then, tighten lock nut 8 slowly.



12 Installation of oil seal

NOTE

When hub and brake drum assembly 11 is removed for a service operation and if rotor 18 is still mounted on the wheel hub, use Anti-lock brake system oil seal installer to press-fit oil seal 12.

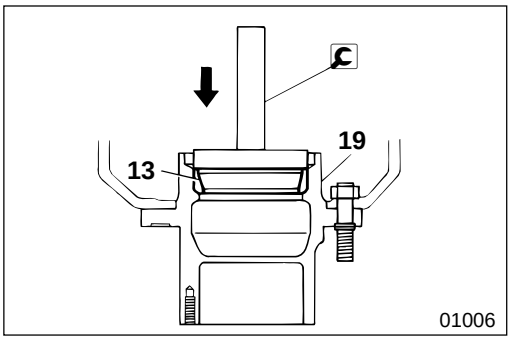


13 Inner bearing outer race

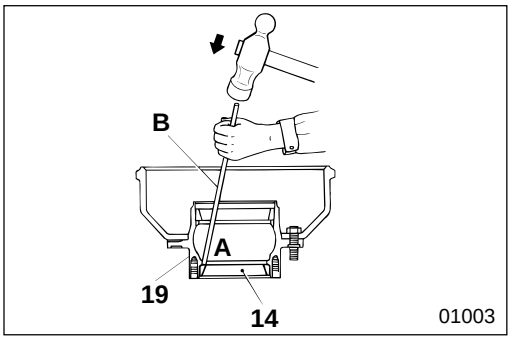
[Removal]

Drive out inner bearing outer race **13** evenly from four indented parts **A** in wheel hub **19**.

B : Pin-punch

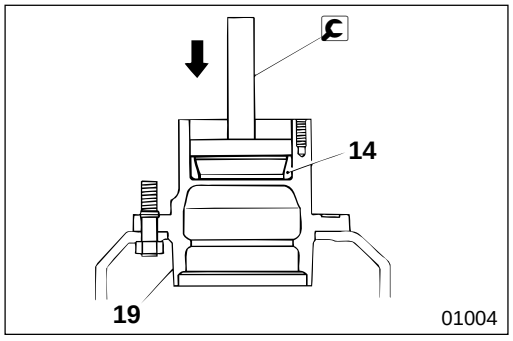


[Installation]

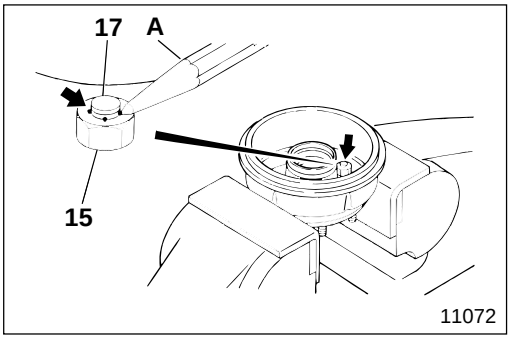


14 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **14** evenly from four indented parts **A** in wheel hub **19**.
B : Pin-punch

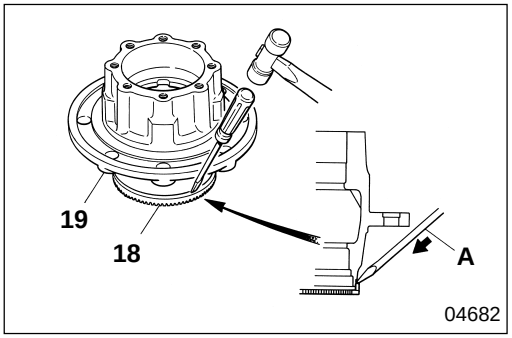


[Installation]



15 **17** **Installation of hub bolt and nut**

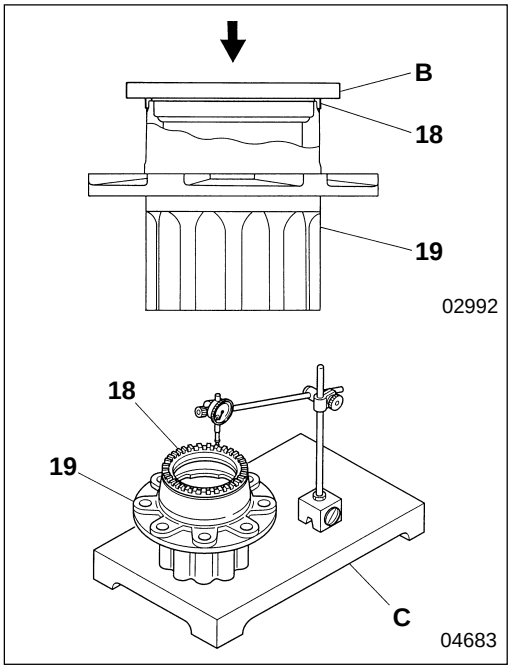
- Install hub bolt **17**.
- Tighten nut **15** at specified torque.
- Caulk nut **15** evenly at four points to keep it from turning.
  A : Pin-punch



18 **Rotor**

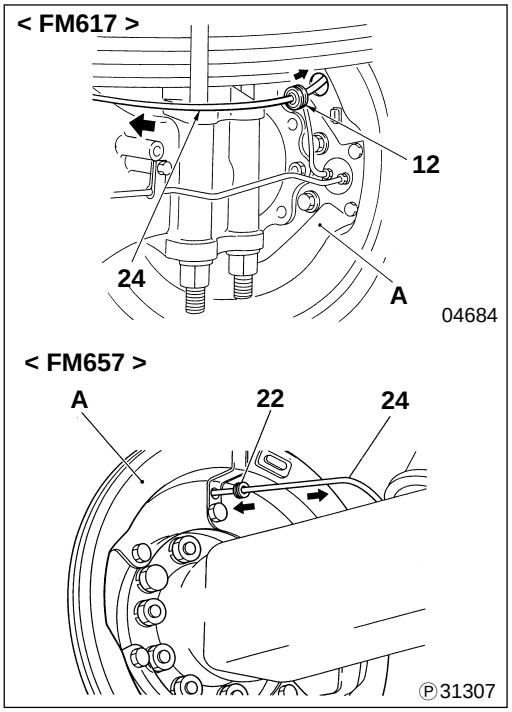
[Removal]
Strike the outer edge of rotor **18** evenly with flat-tip screwdriver **A** to remove the rotor from the wheel hub **19**.

CAUTION
Be careful not to damage wheel hub 19.



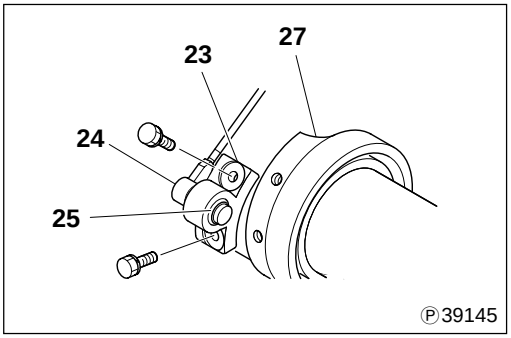
[Installation]
Heat rotor **18** to approximately 150°C {302°F}. Press the rotor evenly with iron plate **B** to press-fit the rotor to wheel hub **19**. Make sure there is no space between the rotor and wheel hub.

[Inspection]
- If the amount of wobbling exceeds the standard value, repeat the assembly procedure from the beginning.
- If the amount of wobbling exceeds the standard value after reassembly, replace defective parts.
  C: Base



22 **Installation of grommet**

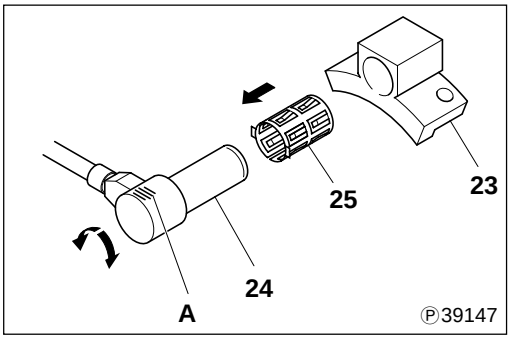
Mount grommet **22** on back plate **A**, < FM617 > or dust cover **A** < FM657 > and pull the harness of wheel speed sensor **24** to make sure there is no slack inside the wheel brake.



24 **Wheel speed sensor**

[Removal]

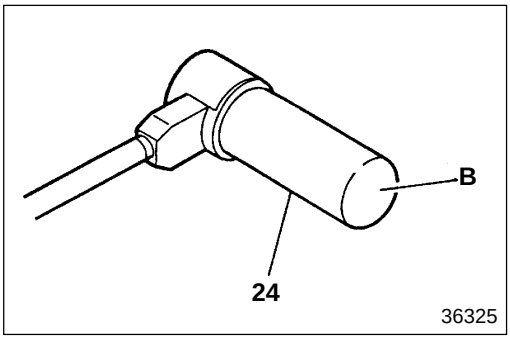
- With wheel speed sensor **24** and spring space **25** installed in sensor holder **23**, remove the sensor holder from oil seal retainer **27**.



- Hold shaded section **A** of wheel speed sensor **24** with pliers, and remove the sensor by twisting it slightly in left and right directions.

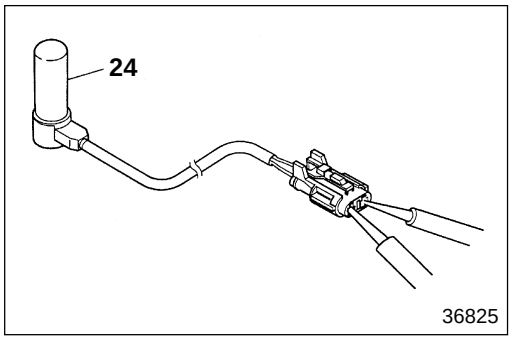
CAUTION

- **When holding wheel speed sensor 24 with pliers, do not grip any section other than shaded area A in the diagram.**
- **When removing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **If wheel speed sensor 24 dismounts easily, replace spring spacer 25.**

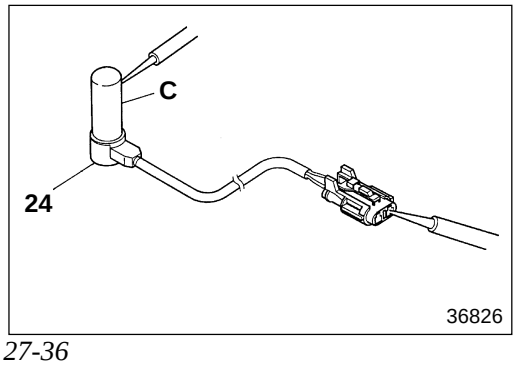


[Inspection]

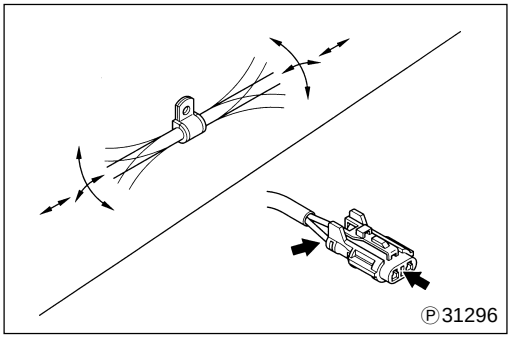
Since pole piece section **B** is magnetized by the magnet inside wheel speed sensor **24**, it attracts metals. Do not allow the pole piece to collect metallic objects.



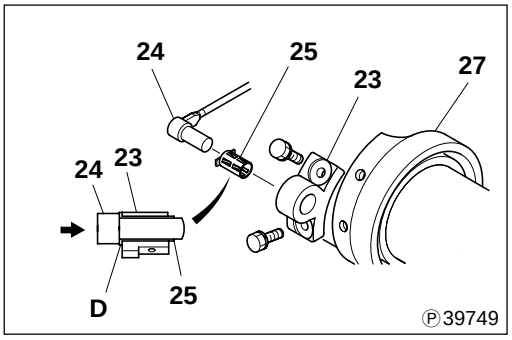
- Measure the resistance between the terminals of wheel speed sensor **24**.
  If the measured value deviates from the standard value, replace the wheel speed sensor.



- Measure the insulation resistance between body **C** of wheel speed sensor **24** and each terminal.
  If the measured values deviate from the standard value, replace the wheel speed sensor.



- To check for broken wires, remove the harness clamp section from the vehicle. Bend and extend the harness to check if there is any broken wire in the harness. Also, inspect the connector for proper contact.
  If a defect is found, replace wheel speed sensor **24**.



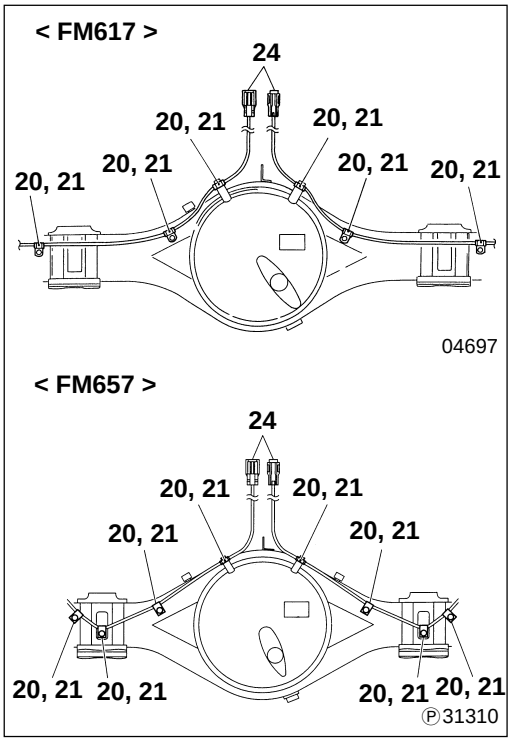
[Installation]

- Insert wheel speed sensor **24** from the back plate, and press until spring spacer **25** and stopper section **D** of the wheel speed sensor contacts sensor holder **23**.
- With wheel speed sensor **24** and spring spacer **25** installed in sensor holder **23**, mount the sensor holder on oil seal retainer **27**.

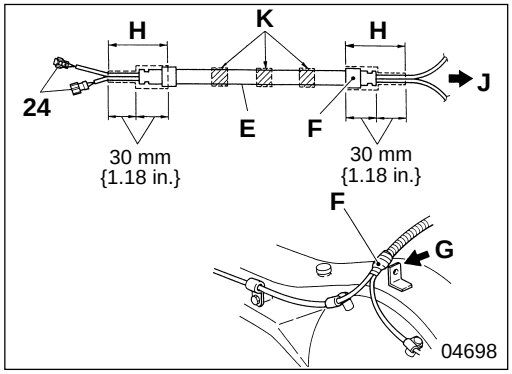
CAUTION

- **When installing wheel speed sensor 24, do not apply force on the sensor, such as by hitting with a hammer, prying with a screwdriver or pulling the harness, since these actions can result in wire breakage.**
- **Note that wheel speed sensor 24 is different for left and right wheels.**

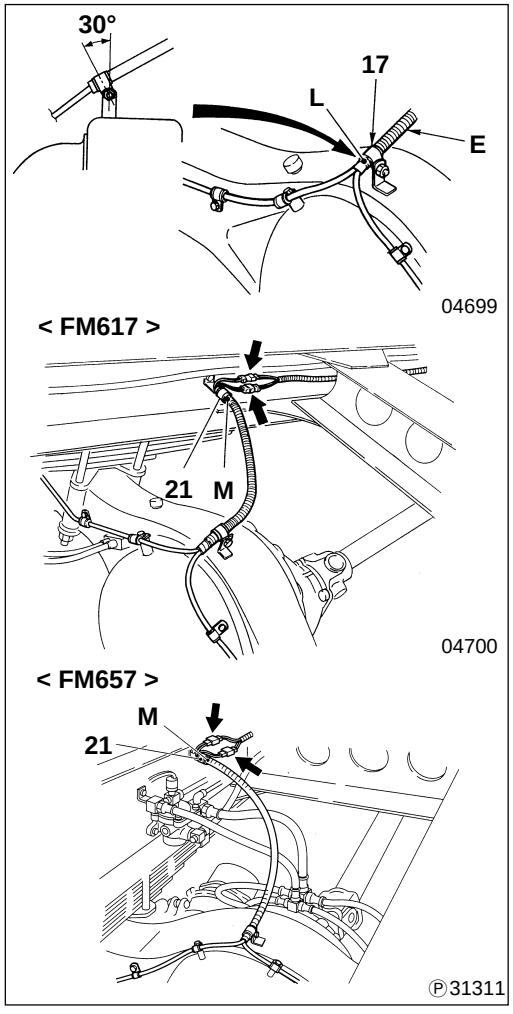
Location	Harness connector color	Harness connector shape
Left wheel	Gray	Male
Right wheel	Black	Female



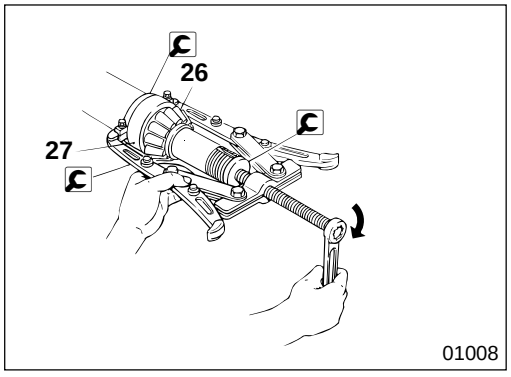
- Rear axle housing section
  Starting from the wheel brake side, secure the harness of wheel speed sensor **24** in place with clip **21** and bolt **20**. Make sure the harness does not interfere with other parts and there is no twist or slack in the harness.



- Binding of harness
  - Gather the harnesses of left and right wheel speed sensors **24**, and bind with corrugated tube **E**.
  - Adjust the position of the corrugated tube **E** so that white tape section **F** is located at clip position **G** on the rear axle housing. Then, turn the corrugated tube so that the slit faces down. Wrap black tape (electric harness tape) on both ends **H** of the corrugated tube. The tape should be placed over the tube end and harness.
    J : Rear axle housing side
  - Wrap tape on the harnesses of wheel speed sensors **24** at sections **K** (three locations at equal intervals).

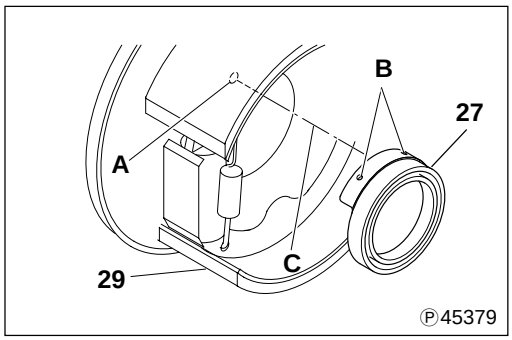


- Clamping of harness
  - Position section **L** of corrugated tube **E** so that it forms a 30° angle with clip **21**, then secure it to the rear axle housing.
  - Secure section **M** of the corrugated tube to the frame using the clip.
  - Connect the wheel speed sensor connector to the harness connector on the chassis side.



26 **27** **Inner bearing inner race and oil seal retainer**

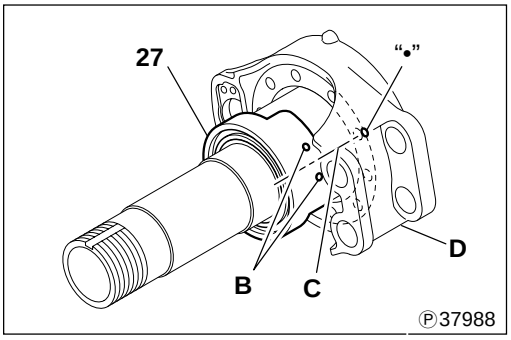
[Removal]



[Installation]

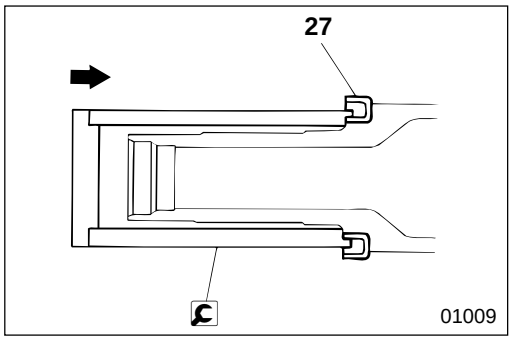
< FM617 >

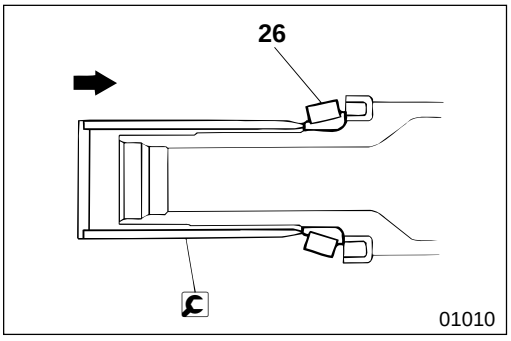
Install oil retainer **27** by aligning mounting hole **A** in brake assembly **29** with center line **C** between two center holder mounting holes **B** in oil seal retainer **27**.

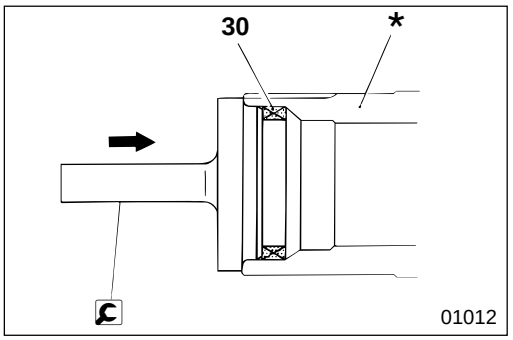


< FM657 >

- Make sure there is an alignment mark "•" on anchor bracket **D** at the location shown in the diagram.
- Install oil seal retainer **27** by aligning center line **C** between sensor holder mounting holes **B** in oil seal retainer **27** with the alignment mark "•" on anchor bracket D.

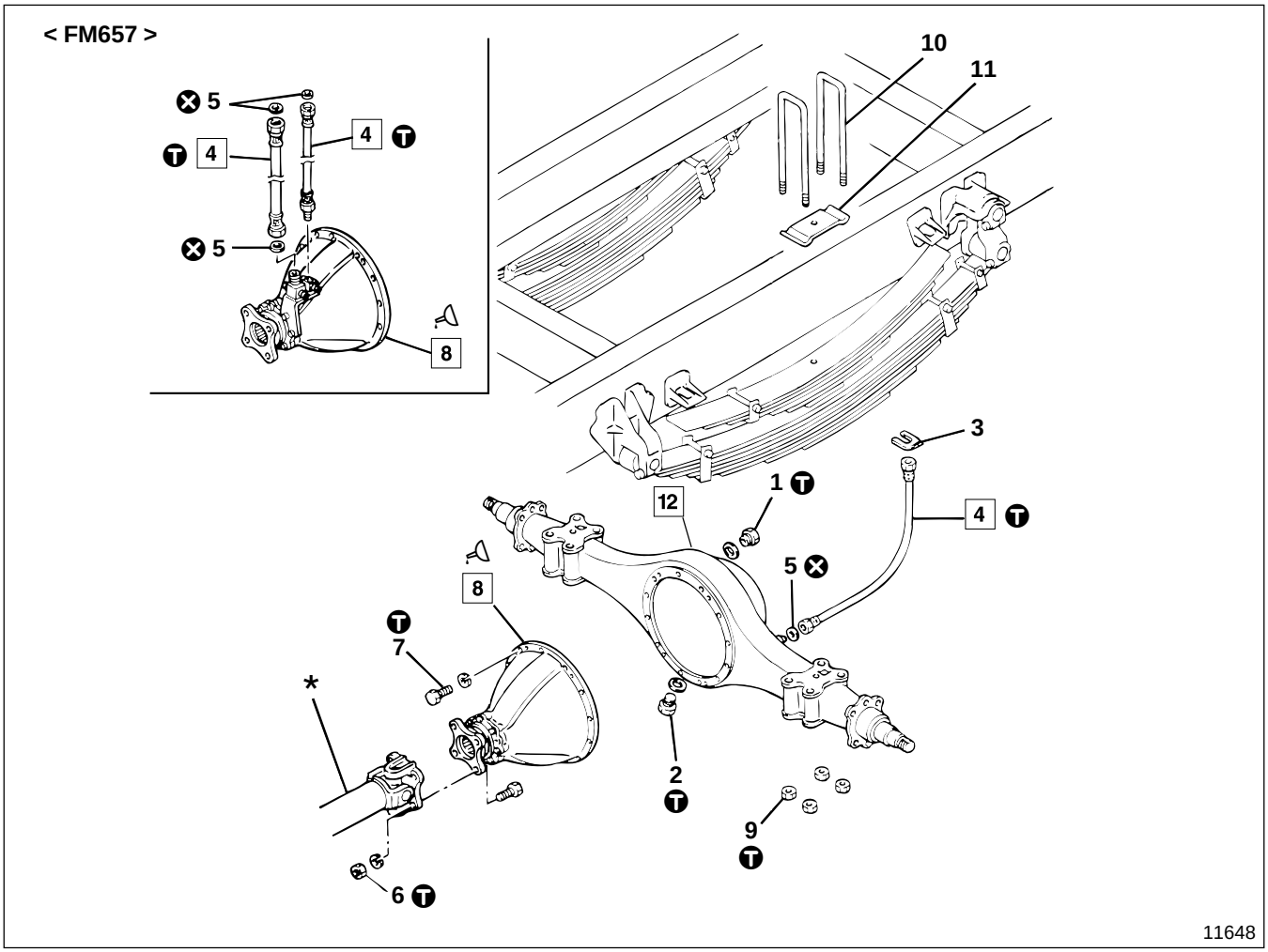






30 **Installation of oil seal**

AXLE HOUSING



● **Work before removal** P27-42

● **Removal sequence**

1 Inspection plug
2 Drain plug
3 Clip < FK, FM617 >
4 Brake hose
5 Packing
6 Nut
7 Bolt
8 Reduction and differential assembly P27-44
9 U-bolt nut
10 U-bolt
11 Spring upper pad
12 Axle housing

*: Propeller shaft Gr 25

CAUTION

Be sure to protect brake hose 4 from dust by fitting blanking plugs after removal.

NOTE

Do not remove axle housing 12 unless it is faulty.

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION

Make sure that brake hose 4 is not twisted when you install it.

NOTE

Do not let sealant ooze from the mounting surfaces of reduction and differential assembly 8 and axle housing 12.

● **Work after installation** P27-42

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
12	Bend of axle housing (C-B)	0.2 {0.0079} or less	0.5 {0.020} or more	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

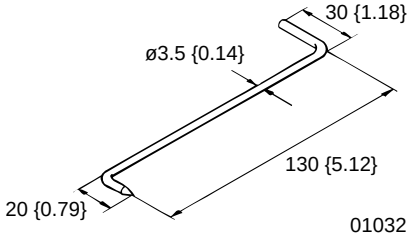
Location	Parts to be tightened				Tightening torque	Remarks
1	Inspection plug			FK	98 to 115 {72 to 87, 10 to 12}	—
				FM	175 to 195 {130 to 145, 18 to 20}	—
2	Drain plug			FK	98 to 115 {72 to 87, 10 to 12}	—
				FM	175 to 195 {130 to 145, 18 to 20}	—
4	Brake hose	FK, FM617	Axle housing side		21 to 30 {15 to 22, 2.1 to 3.1}	—
		FM657	For service brake		69 to 74 {51 to 54, 7.0 to 7.5}	—
			For spring brake (Frame side)		39 to 44 {29 to 33, 4.0 to 4.5}	—
6	Nut (Propeller shaft mounting)		Propeller shaft model	P4, P8	85 {61, 8.5}	—
				P10	120 to 180 {87 to 130, 12 to 18}	—
7	Bolt (Reduction and differential assembly mounting)				120 {90, 12.5}	—
9	U-bolt nut (U-bolt mounting)			FK	414±62 {305±46, 42.2±6.3}	Wet
				FM	546±82 {400±61, 55.7±8.4}	Wet

Sealant

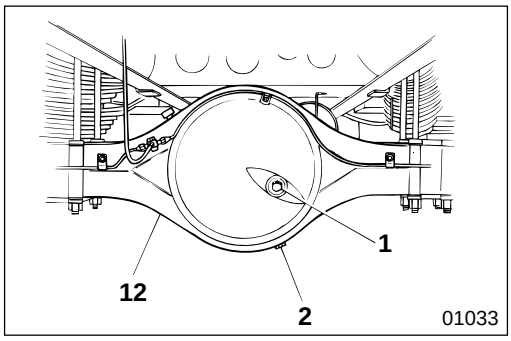
Location	Points of application	Kinds	Quantity
8	Connecting surfaces of reduction and differential assembly and axle housing	THREEBOND 1215	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
12	Measuring bar 	MH061003	Measures bend of axle housing : Two required

◆ Service procedure



● **Work before removal**

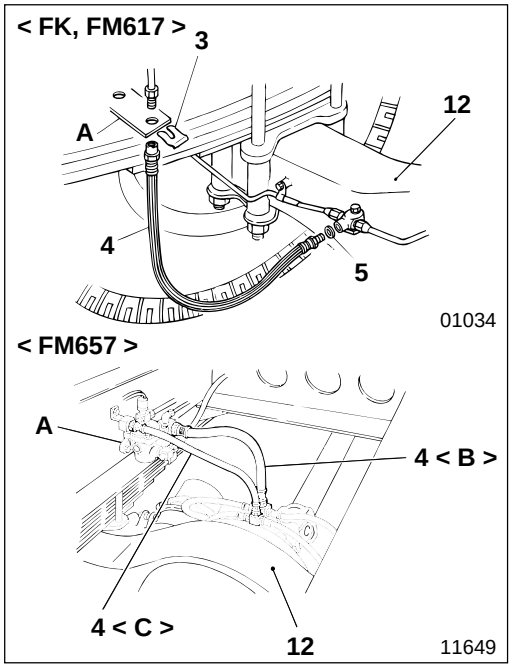
Remove drain plug **2** and drain the gear oil.

WARNING⚠

The oil temperature is high immediately after the vehicle has stopped, so take care not to scald yourself.

● **Work after installation**

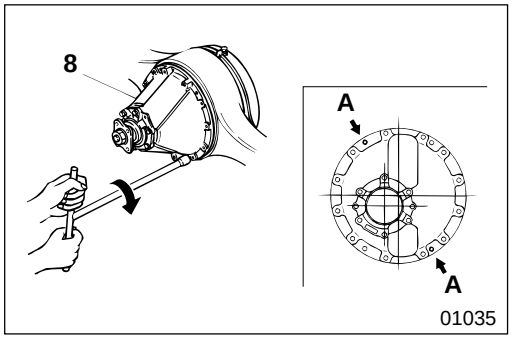
Fill with the specified amount of gear oil via inspection plug **1**.



4 **Removal and installation of brake hose**

- Remove brake hose **4** from frame **A** side first, then from axle housing **12** side.
- For installation, follow the removal sequence in reverse.

B : Service brake hose
C : Spring brake hose

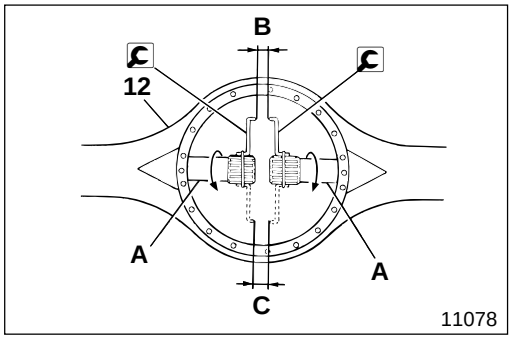


8 **Removal of reduction and differential assembly**

To remove reduction and differential assembly **8**, screw two M12×1.25 mm bolts evenly into two screw holes **A**.

NOTE

Completely remove adhered sealant from the mounting surfaces of reduction differential assembly 8 and axle housing 12.



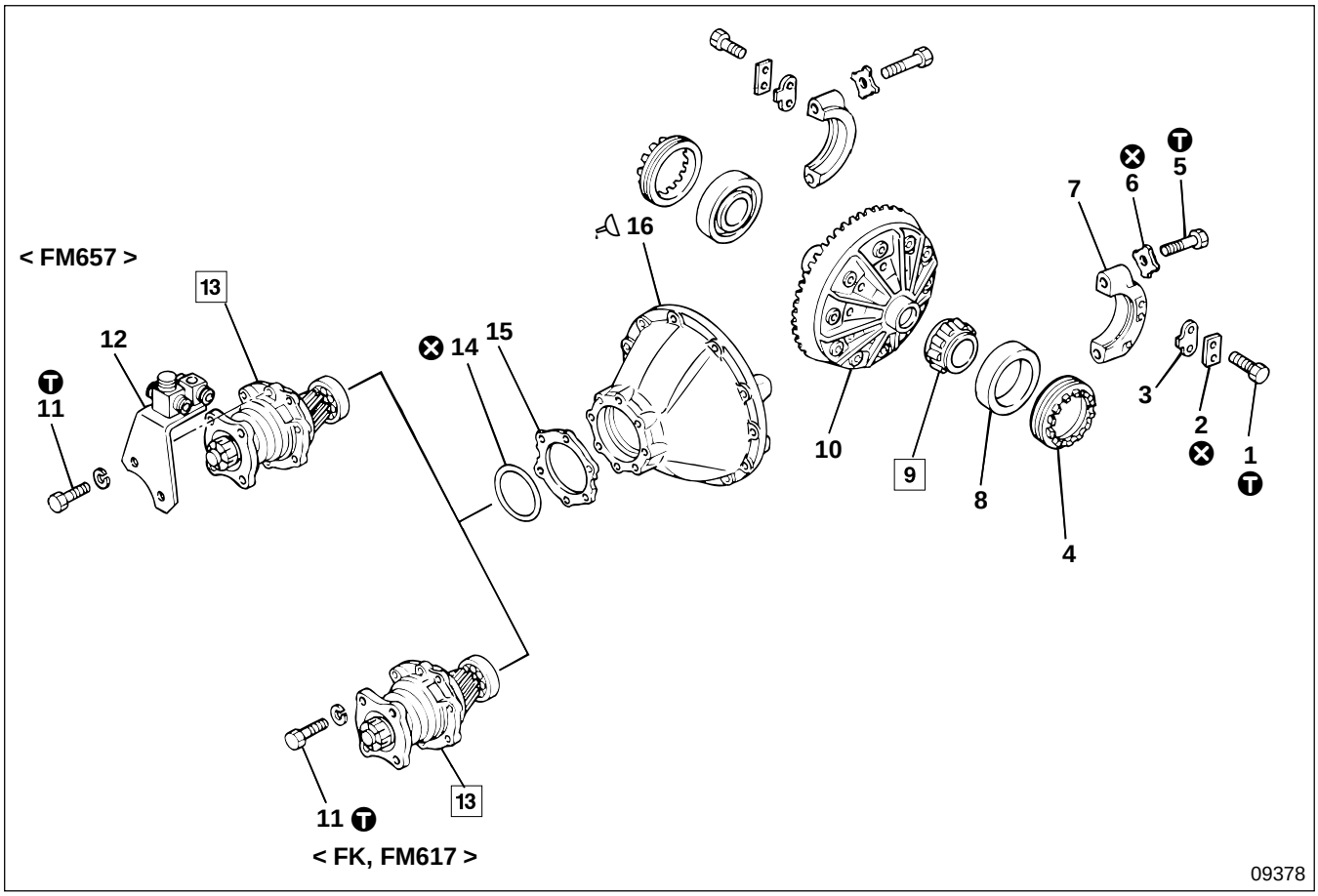
12 **Bend of axle housing**

- Leave axle shaft **A** installed in axle housing **12**.
- Install measuring bar on axle shaft **A**, and measure clearance **B**.
- Turn axle shaft **A** 180°, and measure clearance **C**.
- The difference between **B** and **C** is the amount of bend of axle housing **12**.
- If the bend of axle housing **12** is higher than the limit, replace the axle housing.

M E M O

REDUCTION AND DIFFERENTIAL

Reduction and Differential Assembly



● **Inspection before disassembly** 📖 **P27-47**

● **Work before disassembly** 📖 **P27-47**

● **Disassembly sequence**

1	Bolt	**7**	Bearing cap	**13**	Pinion assembly 📖 P27-58
2	Lock seat	**8**	Side bearing outer race	**14**	O-ring < D050H >
3	Lock pawl	**9**	Side bearing inner race	**15**	Shim
4	Adjusting screw	**10**	Differential assembly 📖 P27-54	**16**	Differential carrier
5	Bolt	**11**	Bolt		
6	Lock plate	**12**	T-connector < FM657 >	⊗	: Non-reusable pars

CAUTION ⚠

- **Make sure you replace bearing caps 7, differential carrier 16 and bolt 5 as a differential carrier set.**
- **Make sure you replace the reduction gear of differential assembly 10 and the reduction pinion of pinion assembly 13 as a reduction gear set.**
- **Make sure you keep left and right side bearings 8, 9 separate after removal, and be careful not to mix them up when installing them.**

NOTE

Write down the thickness of shim 15 before disassembly to use it as reference when assembling.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection and adjustment after assembly** 📖 **P27-48**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
8, 9	Starting torque of side bearing	D050H	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using adjusting screw • Tangential force at 170 {6.69} outer periphery point of differential case : 24 to 34 N {5.3 to 7.7 lbf, 2.4 to 3.5 kgf}
		D8H	2.5 to 3.4 N·m {1.8 to 2.5 ft.lbs, 0.25 to 0.35 kgf·m}	—	• Adjust using adjusting screw • Tangential force at 213 {8.39} outer periphery point of differential case : 23 to 32 N {5.1 to 7.3 lbf, 2.3 to 3.3 kgf}
10	Wobble of reduction gear back face	D050H	0.15 {0.0059} or less	0.2 {0.0079}	• Adjust or replace as a gear set • Measure at the 145 {5.71} radial point from reduction gear center
		D8H	0.15 {0.0059} or less	0.2 {0.0079}	• Adjust or replace as a gear set • Measure at the 185 {7.28} radial point from reduction gear center
10, 13	Backlash between reduction gear and reduction pinion		0.25 to 0.33 {0.0098 to 0.013}	0.6 {0.024}	Adjust or replace as a gear set

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

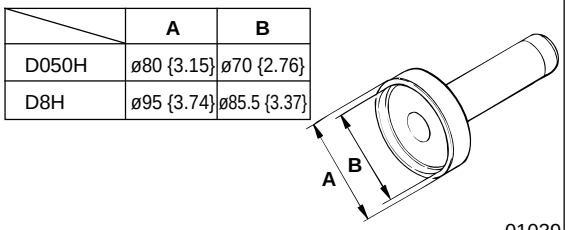
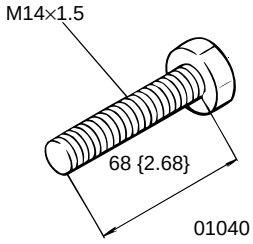
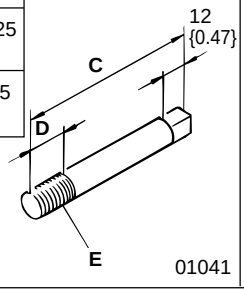
Location	Parts to be tightened		Tightening torque	Remarks
1	Bolt (Lock pawl mounting)		34 {25, 3.5}	—
5	Bolt (Bearing cap mounting)	D050H	235 {175, 24}	—
		D8H	445 {330, 45.5}	—
11	Bolt (Differential carrier and pinion assembly mounting)	D050H	78 {58, 8}	—
		D8H	115 {87, 12}	—

Sealant

Location	Points of application	Kinds	Quantity
16	Mounting surface of pinion pilot bearing	LOCTITE 601	As required

Special tools

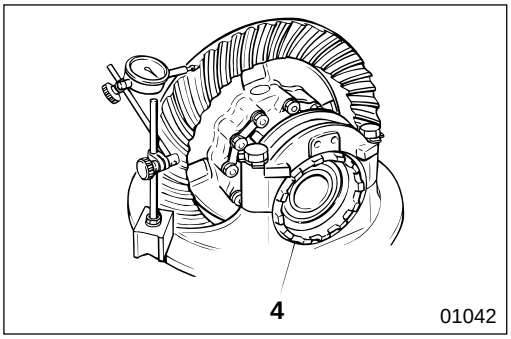
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
9	Side bearing installer  	< D050H > MH061748 < D8H > 03723-25000	Press-fitting of side bearing inner race
13	Bearing retainer remover  	< D8H > MH062172	Removal of pinion assembly : Two required
	Bearing retainer guide pin  	< D050H > MH061745 < D8H > MH061746	Installation of pinion assembly : Two required

	A	B
D050H	ø80 {3.15}	ø70 {2.76}
D8H	ø95 {3.74}	ø85.5 {3.37}

	C	D	E
D050H	85 {3.35}	18 {0.71}	M12×1.25
D8H	95 {3.74}	23 {0.91}	M14×1.5

◆ Service procedure

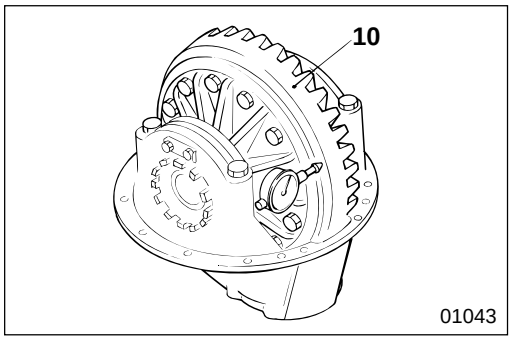


● Inspection before disassembly

Inspect for faulty parts before disassembly.

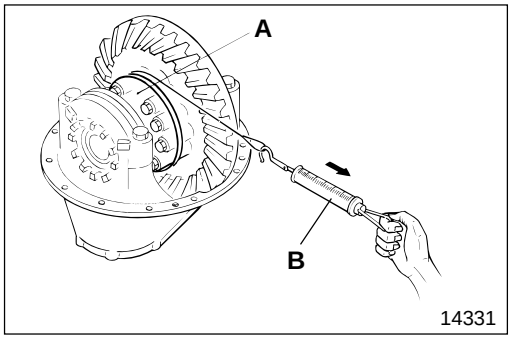
(1) Backlash of reduction gear and reduction pinion

If there is any fault, it is considered to be because of the amount adjusting screw **4** was tightened.



(2) Wobble of back face of reduction gear

Measure wobble at a point 145 mm {5.71 in.} (on the radius) for < D050H >, 185 mm {7.28 in.} for < D8H >, from the center of the reduction gear, turning differential assembly **10** one full revolution.

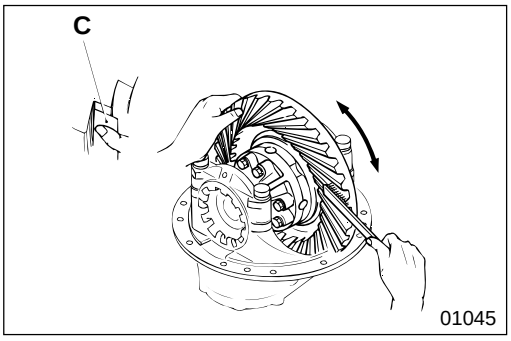


(3) Starting torque of side bearing

- Install spring balance **B** at 170 mm {6.69 in.} for < D050H >, 213 mm {8.39 in.} for < D8H >, outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.

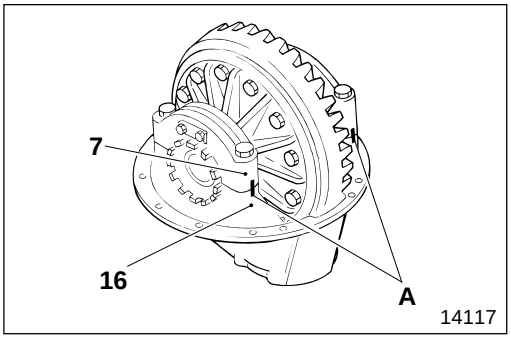
NOTE

Measure the starting torque within reduction gear and reduction pinion backlash range.



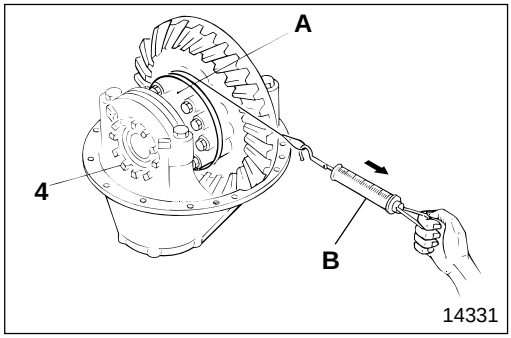
(4) Tooth contact of reduction gear

Apply red lead to three or four gear teeth, turn the gear a few times, and examine tooth contact with a piece of paper **C**.



● Work before disassembly

Put alignment marks **A** on bearing cap **7** and differential carrier **16** to identify left and right.



● **Inspection and adjustment after assembly**

(1) Starting torque of side bearing

[Inspection]

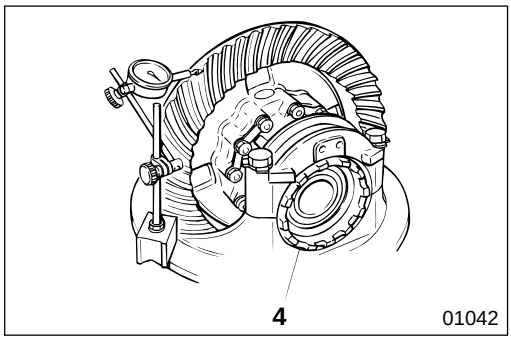
- Install spring balance **B** at 170 mm {6.69 in.} for < D050H >, 213 mm {8.39 in.} for < D8H >, outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

[Adjustment]

If the measured value does not meet the standard value, adjust using left and right adjusting screws **4**.

CAUTION

- **Tighten left and right adjusting screws 4 the same amount.**
- **Adjust the starting torque within the reduction gear and reduction pinion backlash range.**

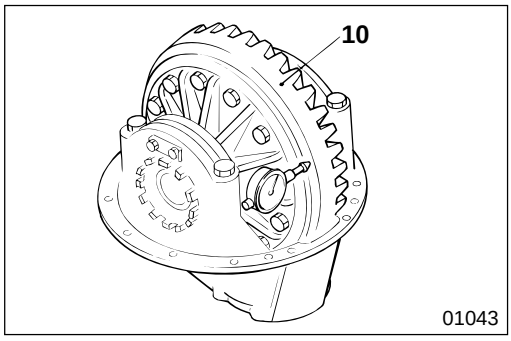


(2) Adjustment of backlash between reduction gear and reduction pinion

Adjust the starting torque of the side bearings using left and right adjusting screws **4**, taking care not to change the starting torque.

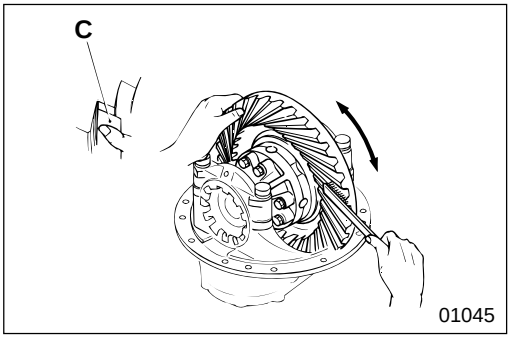
CAUTION

Make sure when you loosen one adjusting screw 4 that you tighten the other adjusting screw by the same amount, because the starting torque of the side bearing changes.



(3) Inspection of wobble of back face of reduction gear

Measure wobble at a point 145 mm {5.71 in.} (on the radius) for < D050H >, 185 mm {7.28 in.} for < D8H >, from the center of the reduction gear, turning differential assembly **10** one full revolution.



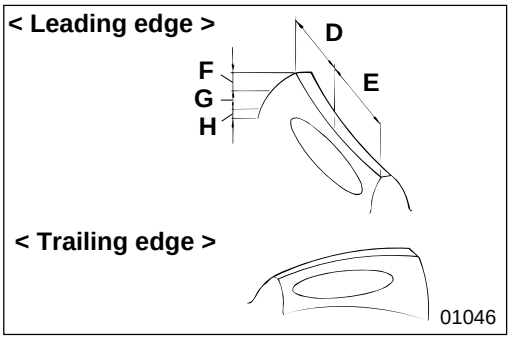
(4) Tooth contact of reduction gear

[Inspection]
Apply red lead to three or four gear teeth, turn the gear a few times, and examine tooth contact with a piece of paper **C**.

[Adjustment]
If contact area is remarkably offset, adjust with reduction pinion mounting adjusting shims to increase or decrease the backlash.

CAUTION

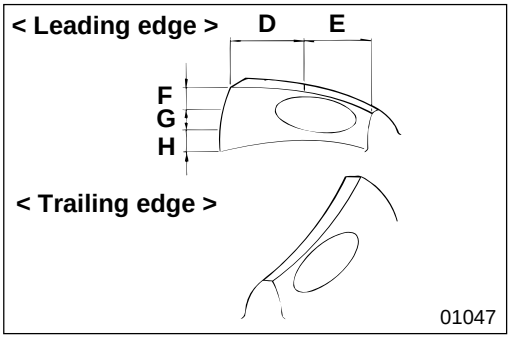
- **Make sure you replace as a reduction gear set (reduction gear and reduction pinion), when you replace the gear because of excessive teeth wear.**
- **When good tooth contact adjustment has been obtained, but backlash does not meet the standard value, tooth contact has priority. It is not necessary to adjust backlash to the standard value if it is less than 0.15 mm {0.0059 in.} out.**



● **Normal tooth contact at no load**

< Reduction gear >

D : Heel
E : Toe
F : Face
G : Flank
H : Clearance



< Reduction pinion >

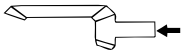
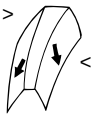
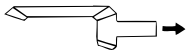
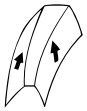
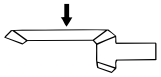
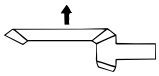
D : Heel
E : Toe
F : Face
G : Flank
H : Clearance

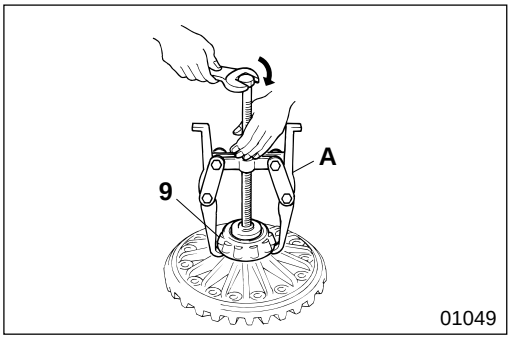
Maintenance item			Assembly standards
At no load	Tooth contact position	Lengthwise direction of tooth	From center toward toe
		Vertical direction	From center toward top of tooth for reduction gear and center of tooth for pinion
	Tooth contact shape	Length	About 50 to 70% of tooth width
		Width	About 50 to 70% of tooth depth
	Degree of tooth contact		Degree of tooth contact becomes weaker as it comes nearer to root or top

NOTE

When tooth contact area is nearer to toe at no load, it becomes middle area contact under load.

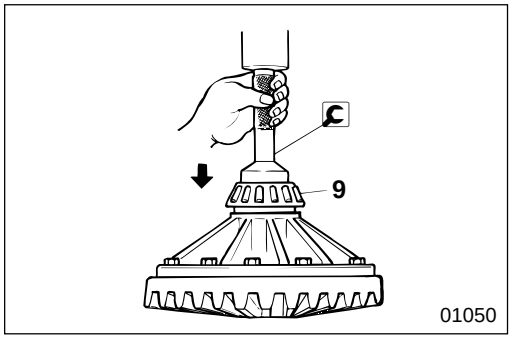
Adjustment of Tooth Contact

	Mode of adjustment	Moving direction
Adjustment by adding or reducing shims	Advances reduction pinion to reduction gear (Shims are reduced) 	< Leading edge >  < Trailing edge > Tooth contact moves toward root of tooth
	Retards reduction pinion from reduction gear (Shims are added) 	 Tooth contact moves toward top of tooth
Adjustment by controlling adjusting screw	Advance reduction gear to reduction pinion axis (Less backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to toe and slightly nearer to root of tooth Trailing edge: Nearer to heel and slightly nearer to top of tooth
	Retard reduction gear from reduction pinion axis (More backlash) 	Tooth contact moves in lengthwise direction of tooth Leading edge: Nearer to heel and slightly nearer to top of tooth Trailing edge: Nearer to toe and slightly nearer to root of tooth

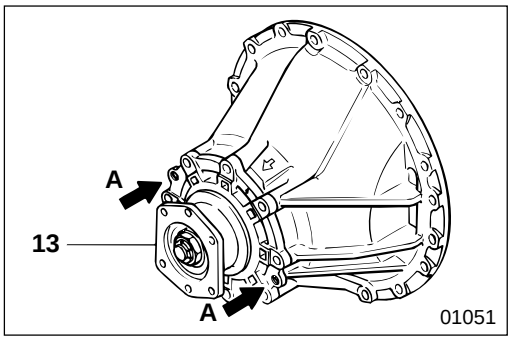


9 **Side bearing inner race**

[Removal]
A : Gear puller (General tool)

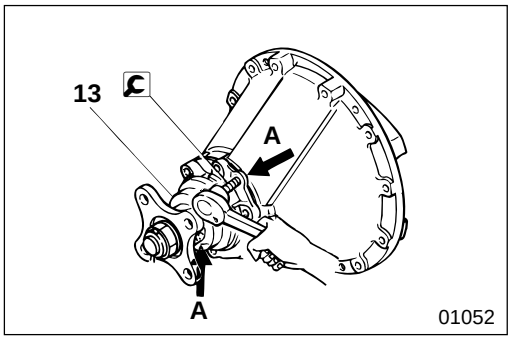


[Installation]

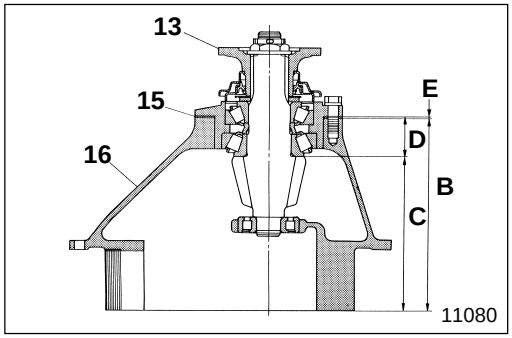


13 **Pinion assembly**

[Removal]
< D050H >
To remove pinion assembly **13**, screw two M12×1.25 mm bolts evenly into the two pinion assembly removal screw holes **A**.



< D8H >
To remove pinion assembly **13**, screw two bearing retainer removers into the two pinion assembly removal screw holes **A**.



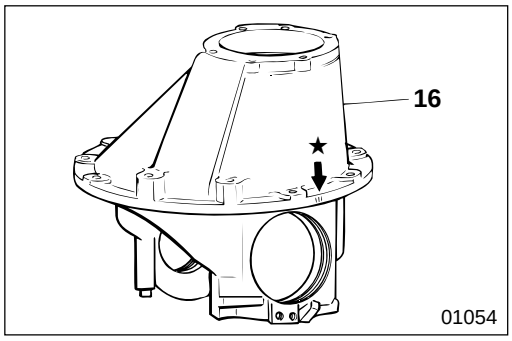
[Adjustment]

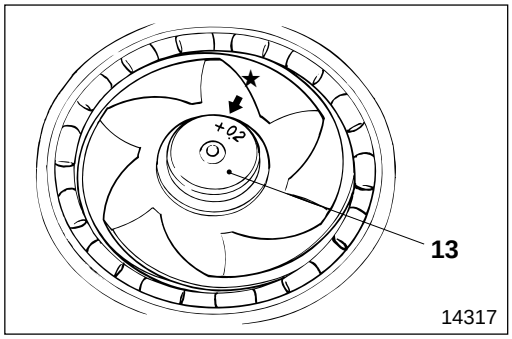
- Carry out the following procedure so that **B**, **C** and **D** conform to the standard dimension.
- Calculate shim thickness **E** according to the following formula based upon the machining error data stamped on pinion assembly **13** and differential carrier **16**.

Formula for calculation

E = 0.5 {0.020}–b+c+d

b : Deviation from basic dimension **B**
c : Deviation from basic dimension **C**
d : Deviation from basic dimension **D**





NOTE

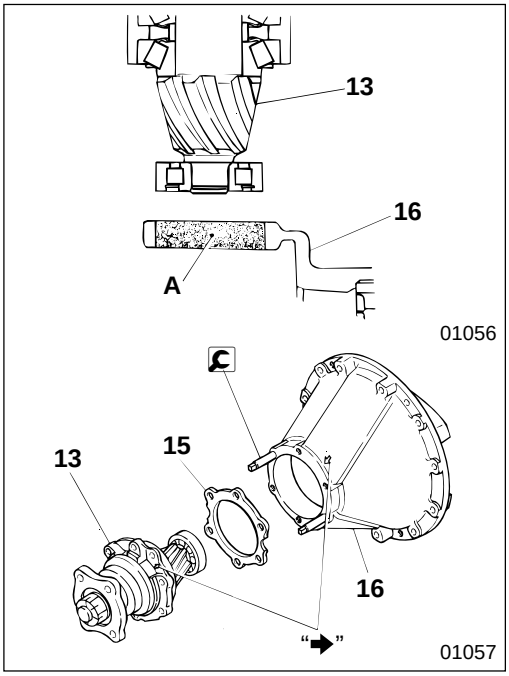
Thickness is stamped in millimeters.

Unit : mm {in.}

Location	Standard dimension		How to calculate deviation
	D050H	D8H	
Shim thickness	0.5 {0.020}		—
B	232 {9.13}	261 {10.3}	The basic dimension, multiplied by 100, is stamped on the periphery of differential carrier **16** flange
C	180 {7.09}	208 {8.19}	The basic dimension is stamped on the top of pinion assembly **13**
D	52 {2.05}	53.5 {2.11}	Measure the deviation from **D** using a dial gauge. However, If it is difficult to measure the actual deviation, assume a value from 0 to 0.2 {0 to 0.0079}

★ : Stamped number position

- Select shim **15** from shim thickness **E**.
  Available thicknesses of shim **15** : 0.1 mm {0.0039 in.} and 0.2 mm {0.0079 in.}



[Installation]

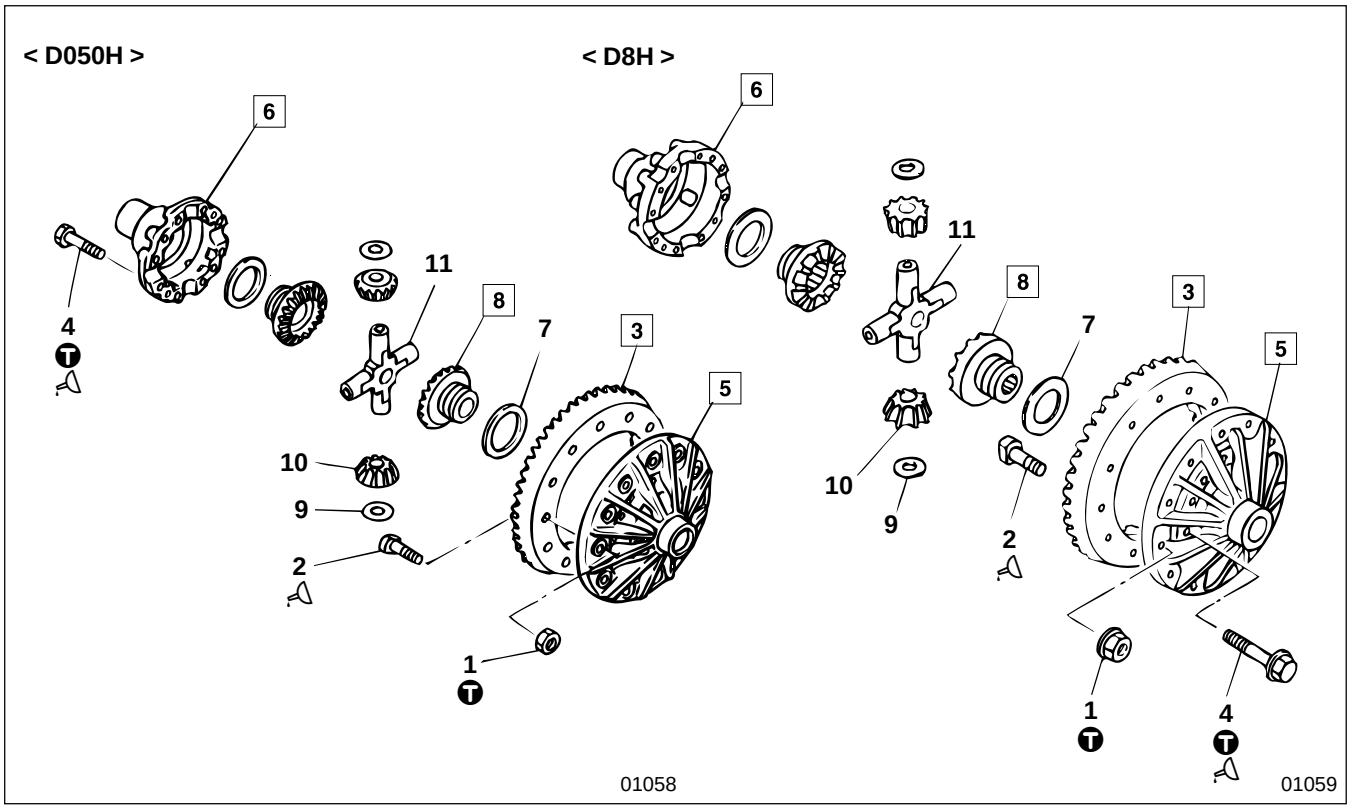
- Apply lock paint to pinion pilot bearing mounting surface **A** of differential carrier **16**.
- Install pinion assembly **13**.

CAUTION⚠

- **Be sure to let the lock paint harden undisturbed for 30 minutes to two hours after installation.**
- **Be sure to wait at least three hours before running the vehicle, and if possible wait 24 hours to let the lock paint harden.**

REDUCTION AND DIFFERENTIAL

Differential Assembly



● **Disassembly sequence**

1 Nut
2 Bolt
3 Reduction gear
4 Bolt
5 Differential case , LH
6 Differential case, RH
7 Differential gear washer
8 Differential gear
9 Differential pinion washer
10 Differential pinion
11 Pinion spider

CAUTION

Make sure you replace differential case LH 5 and differential case RH 6 as a differential case set.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Adjustment after assembly** **P27-55**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
8	Play between differential gear and axle shaft spline	D050H	0.10 to 0.18 {0.0039 to 0.0071}	0.5 {0.020}	Replace
		D8H	0.07 to 0.22 {0.0028 to 0.0082}	0.5 {0.020}	Replace
8, 10	Backlash between differential pinion and differential gear	D050H	0.19 to 0.25 {0.0075 to 0.0098}	0.5 {0.020}	Replace
		D8H	0.20 to 0.28 {0.0079 to 0.011}	0.8 {0.031}	Replace
10, 11	Clearance between differential pinion and pinion spider	D050H	[26] 0.17 to 0.27 {[1.02] 0.067 to 0.011}	0.5 {0.020}	Replace
		D8H	[35] 0.17 to 0.28 {[1.38] 0.0067 to 0.011}	0.5 {0.020}	Replace

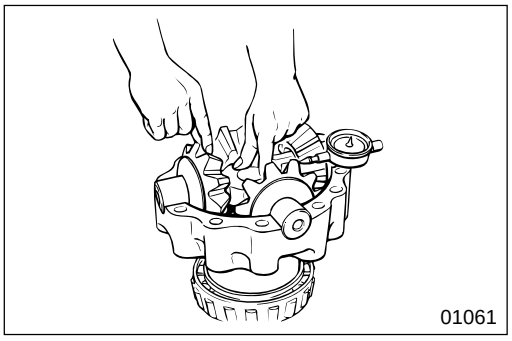
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Reduction gear and differential case LH mounting)	D050H	295 {215, 30}	—
		D8H	490 to 540 {360 to 395, 50 to 55}	—
4	Bolt (Differential case LH and differential case RH mounting)	D050H	180 {135, 18.5}	—
		D8H	165 to 225 {120 to 165, 17 to 23}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
2, 4	Entire bolt	Rust preventive	As required
	Thread area of bolt	LOCTITE 271	As required

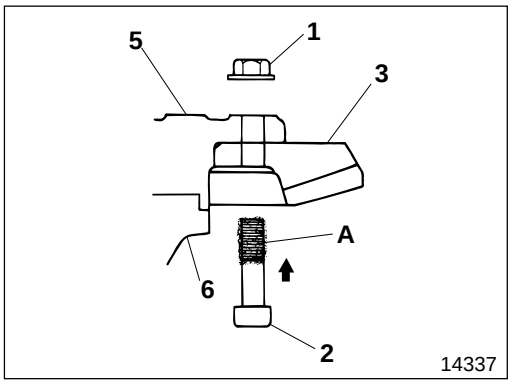


◆ Service procedure

● **Adjustment after assembly**

Backlash between differential gear and differential pinion

If the measured value deviates from the standard value, replace differential gear washer **7**.

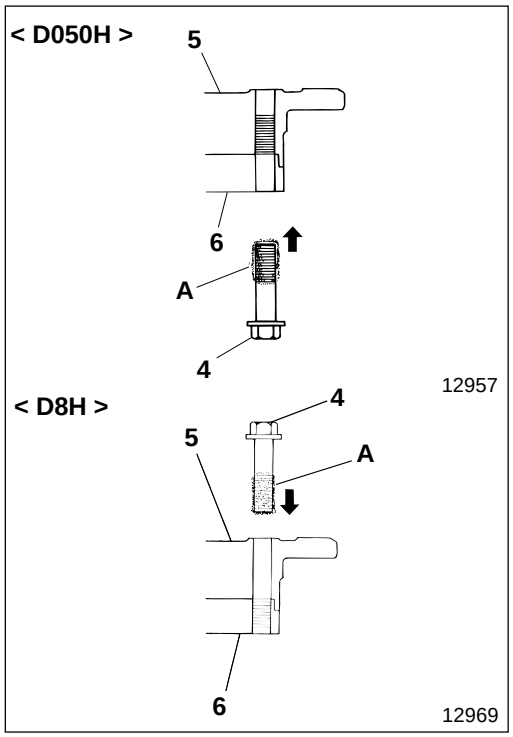


3 **5** **Installation of differential case LH and reduction gear**

- Apply rust preventive to entire surface of bolt **2**.
- Apply lock paint to thread area **A** of bolt **2**.
- Tighten nut **1** at specified torque.

CAUTION

- **Be sure to apply rust preventive to nut 1 because of the need to tighten it at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**

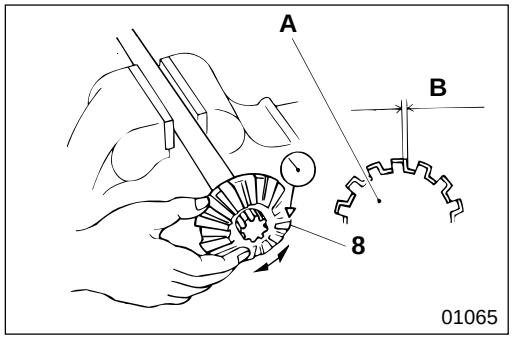


5 **6** **Installation of differential case LH and differential case RH**

- Apply rust preventive to entire surface of bolt **4**.
- Apply lock paint to thread area **A** of bolt **4**.
- Tighten bolt **4** at specified torque.

CAUTION

- **Be sure to apply rust preventive to bolt 4 because of the need to tighten it at specified torque.**
- **Be sure not to operate the vehicle for at least one hour after installation in order to let the lock paint harden.**
- **Be sure not to operate the vehicle at full torque for at least four hours after installation in order to let the lock paint harden.**



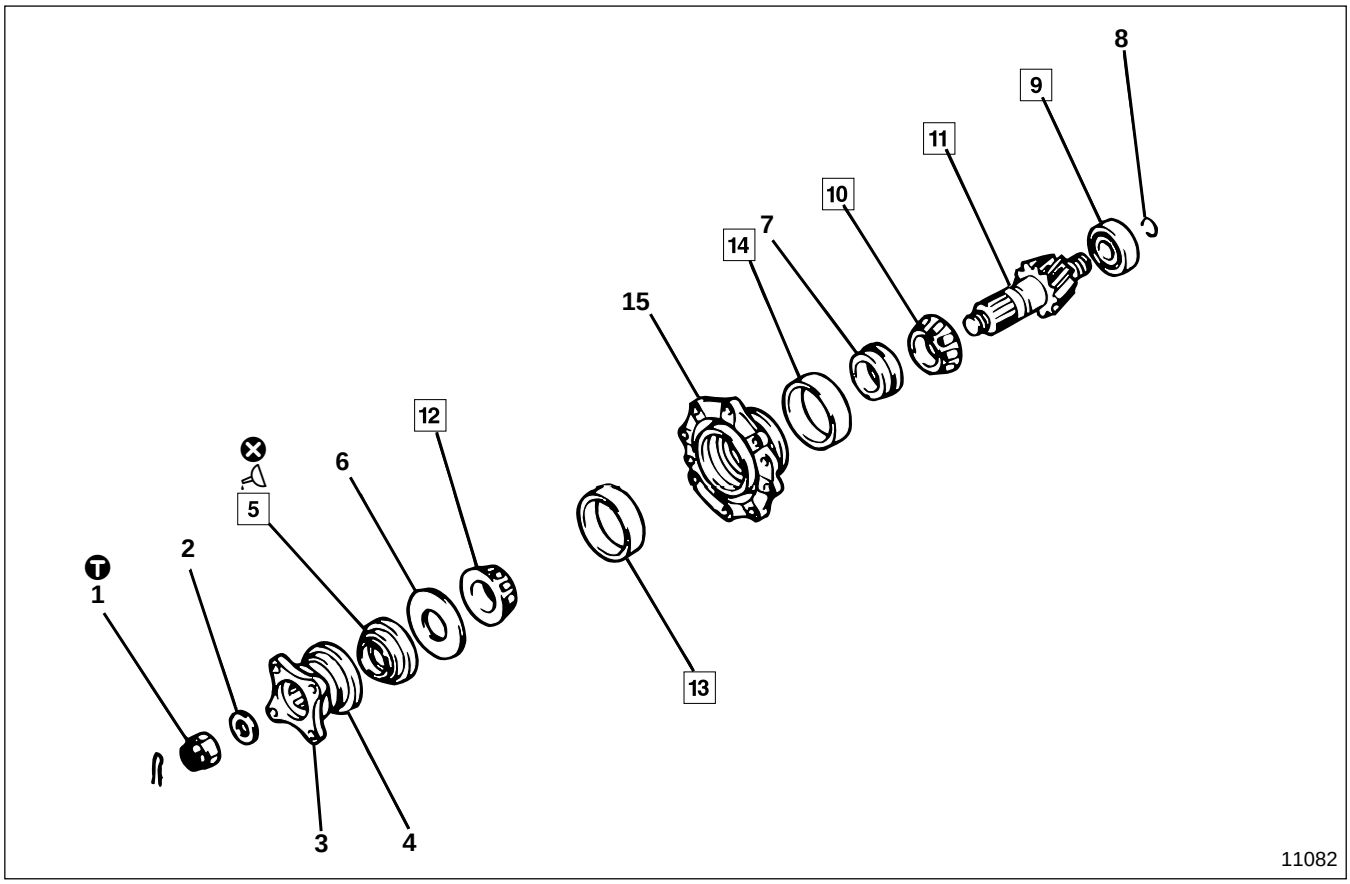
8 **Play between differential gear and rear axle shaft at the spline**

A : Axle shaft
B : Play

M E M O

REDUCTION AND DIFFERENTIAL

Pinion Assembly



● **Disassembly sequence**

1 Lock nut
2 Washer < D8H >
3 Companion flange
4 Dust cover
5 Oil seal
6 Oil separator < D8H >
7 Collar
8 Lock ring
9 Pinion pilot bearing
10 Inner bearing inner race
11 Reduction pinion
12 Outer bearing inner race
13 Outer bearing outer race
14 Inner bearing outer race
15 Bearing retainer

⊗ : Non-reusable parts

NOTE

Record the thicknesses and number of collars 7 before disassembling for reference when assembling.

● **Assembly sequence**

15→14→13
11→10→9→8→7 → **12→6→5** → **4→3** → **2→1**

● **Inspection and adjustment after assembly** **P27-61**

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
10, 12, 13, 14	Starting torque of pinion bearing	D050H	When new bearings are used	2.0 to 2.9 N·m {1.4 to 2.2 ft.lbs, 0.20 to 0.30 kgf·m}	—	• Adjust using collar • Tangential force at 170 {6.69} outer periphery point of bearing retainer : 24 to 34 N {5.3 to 7.7 lbf, 2.4 to 3.5 kgf}
			When bearings are reused	1.6 to 2.4 N·m {1.2 to 1.7 ft.lbs, 0.16 to 0.24 kgf·m}	—	• Adjust using collar • Tangential force at 170 {6.69} outer periphery point of bearing retainer : 19 to 28 N {4.2 to 6.4 lbf, 1.9 to 2.9 kgf}
		D8H	When new bearings are used	2.5 to 3.4 N·m {1.8 to 2.5 ft.lbs, 0.25 to 0.35 kgf·m}	—	• Adjust using collar • Tangential force at 160 {6.30} outer periphery point of bearing retainer : 30 to 43 N {6.8 to 9.7 lbf, 3.1 to 4.4 kgf}
			When bearings are reused	2.0 to 2.7 N·m {1.4 to 2.0 ft.lbs, 0.20 to 0.28 kgf·m}	—	• Adjust using collar • Tangential force at 160 {6.30} outer periphery point of bearing retainer : 25 to 34 N {5.5 to 7.7 lbf, 2.5 to 3.5 kgf}

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

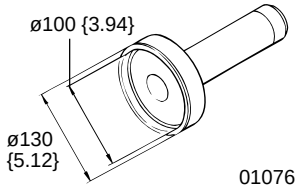
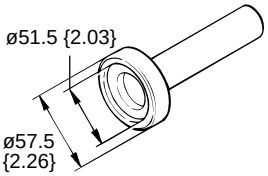
Location	Parts to be tightened		Tightening torque	Remarks
1	Lock nut (Companion flange and reduction pinion mounting)	D050H	195 to 345 {145 to 255, 20 to 35}	—
		D8H	540 to 735 {395 to 540, 55 to 75}	—

Lubricant

Location	Points of application	Kinds	Quantity
5	Lip area of oil seal	Chassis grease [NLGI No. 1 (Ca soap)]	As required

Special tools

Unit : mm {in.}

<table>
<tr><th>Location</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>5</td><td>Oil seal installer
 
</td><td>MH061752</td><td>Press-fitting of oil seal</td></tr>
<tr><td>9</td><td>Pinion pilot bearing installer
 
</td><td>03723-27001</td><td>Press-fitting of pinion pilot bearing</td></tr>
<tr><td>10</td><td>Pinion inner bearing installer
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th></tr>
<tr><td>D050H</td><td>ø70
{2.76}</td><td>ø58
{2.28}</td><td>170
{6.69}</td></tr>
<tr><td>D8H</td><td>ø85
{3.35}</td><td>ø65
{2.56}</td><td>180
{7.09}</td></tr>
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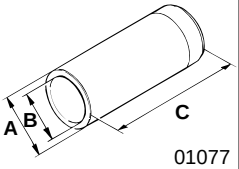
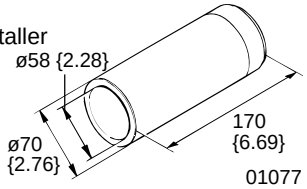
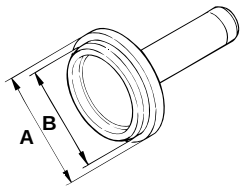
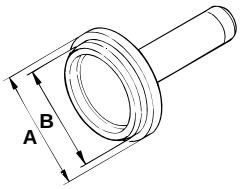
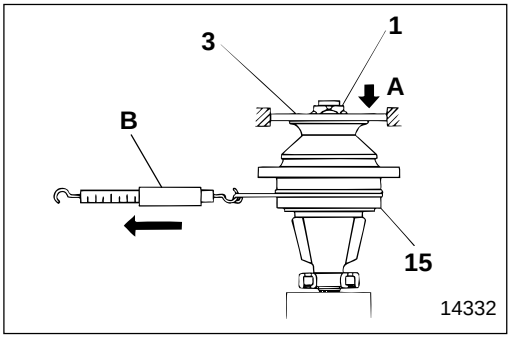

</td><td>< D050H >
MH061004

< D8H >
03724-51000</td><td>Press-fitting of inner bearing inner race</td></tr>
<tr><td>12</td><td>Pinion outer bearing installer
 
</td><td>MH061004</td><td>Press-fitting of outer bearing inner race</td></tr>
<tr><td>13</td><td>Pinion outer bearing installer
<table>
<tr><th></th><th>A</th><th>B</th></tr>
<tr><td>D050H</td><td>ø108 {4.25}</td><td>ø102.5 {4.04}</td></tr>
<tr><td>D8H</td><td>ø118 {4.65}</td><td>ø103 {4.06}</td></tr>
</table>

</td><td>< D050H >
MH061007

< D8H >
MH061006</td><td>Press-fitting of outer bearing outer race</td></tr>
<tr><td>14</td><td>Pinion inner bearing installer
<table>
<tr><th></th><th>A</th><th>B</th></tr>
<tr><td>D050H</td><td>ø118 {4.65}</td><td>ø103 {4.06}</td></tr>
<tr><td>D8H</td><td>ø129 {5.08}</td><td>ø123 {4.84}</td></tr>
</table>

</td><td>< D050H >
MH061006

< D8H >
03724-55000</td><td>Press-fitting of inner bearing outer race</td></tr>
</table>



◆ Service procedure

● Inspection and adjustment after assembly

Starting torque of pinion bearing

[Inspection]

- Apply load **A** to companion flange **3** or tighten lock nut **1** at specified torque.
  A : Approximately 39.2 kN {8.8 klbf, 4000 kgf} < D050H >
  Approximately 49 kN {11 klbf, 5000 kgf} < D8H >

- Install spring balance **B** at 170 mm {6.69 in.} for < D050H >, 160 mm {6.30 in.} for < D8H >, outer periphery point of differential case **A**.
- Measure the tangential force.
- If the measured tangential force is within the specified value, the starting torque conforms to the standard value.
- If the measured value deviates from the specified value, adjust.

NOTE

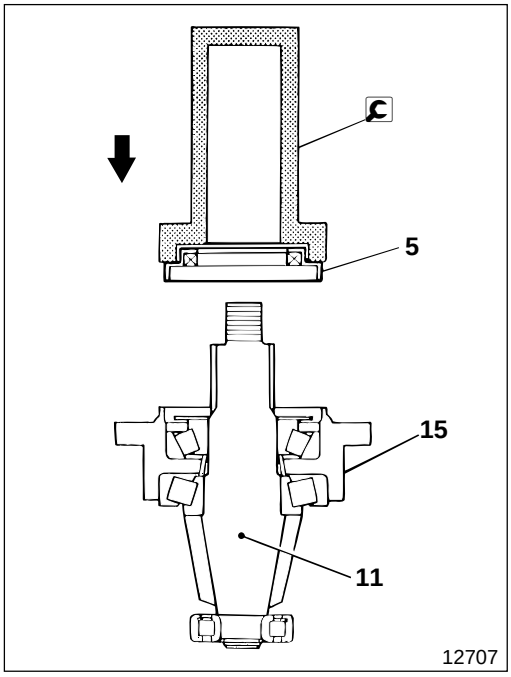
- **Tighten companion flange 3 before measuring.**
- **Oil separator 6 must be installed when you measure. < D8H >**
- **Measure with oil seal 5 removed.**

[Adjustment]

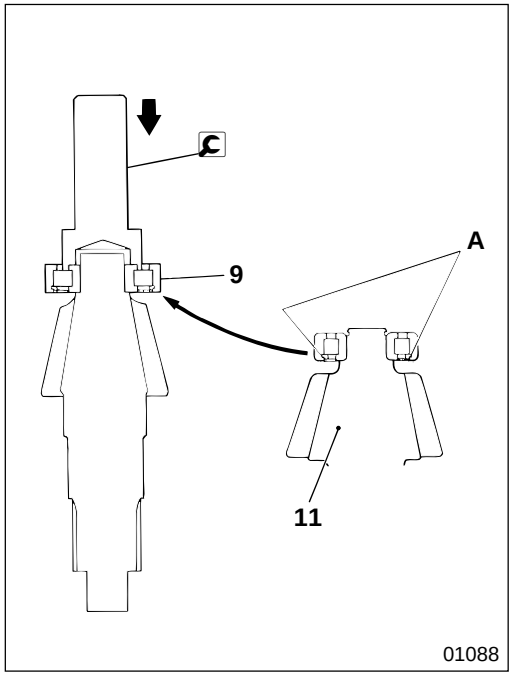
If the measured value does not conform to the specified value, adjust with collar **7** to obtain specified tangential force. Choose an appropriate collar by referring to the table below.

Unit : mm {in.}

Applicable model	Thickness of collar
D050H	13.875 to 14.475 {0.55 to 0.57} (25 thicknesses in 0.025 {0.00098} increments)
D8H	14.975 to 15.575 {0.59 to 0.61} (25 thicknesses in 0.025 {0.00098} increments)



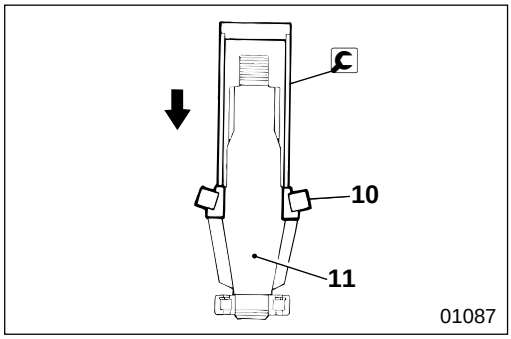
5 **Installation of oil seal**



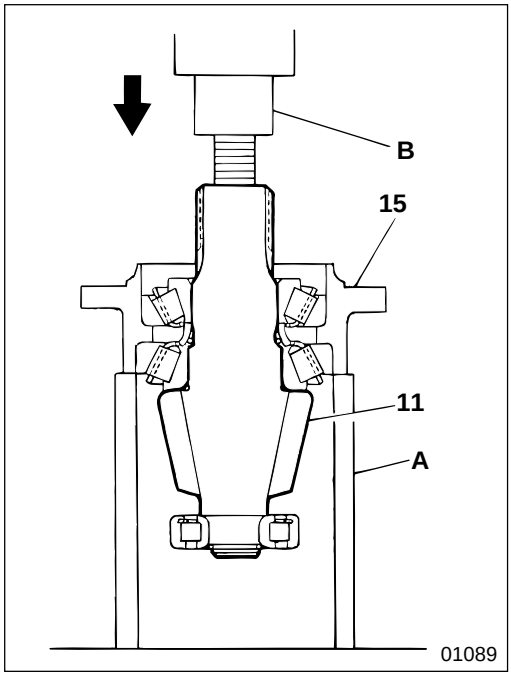
9 **Installation of pinion pilot bearing**

Press-fit pinion pilot bearing **9** in the direction as illustrated.

A : Lock ring



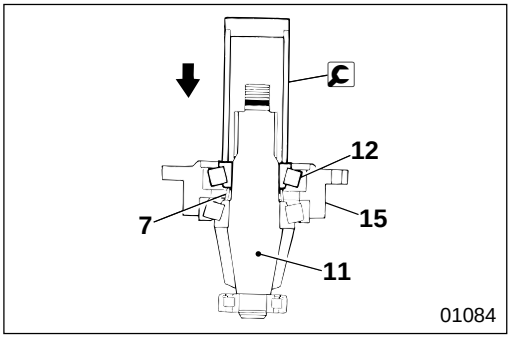
10 **Installation of inner bearing inner race**



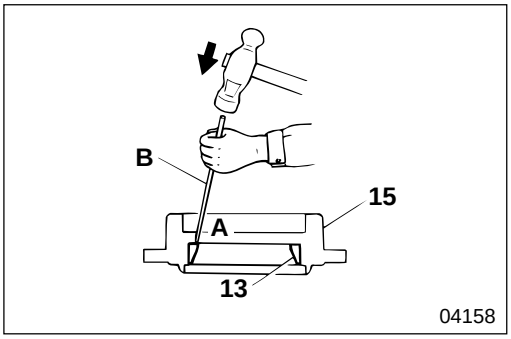
11 **Removal of reduction pinion**

A : Cylindrical guide

B : Press

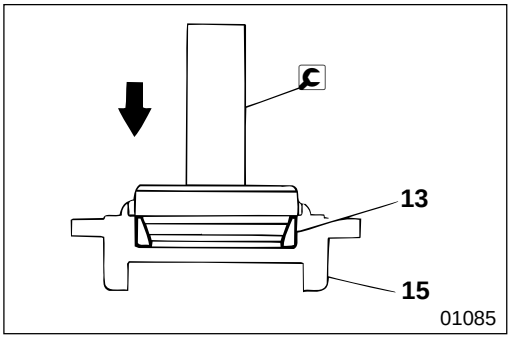


12 **Installation of outer bearing inner race**

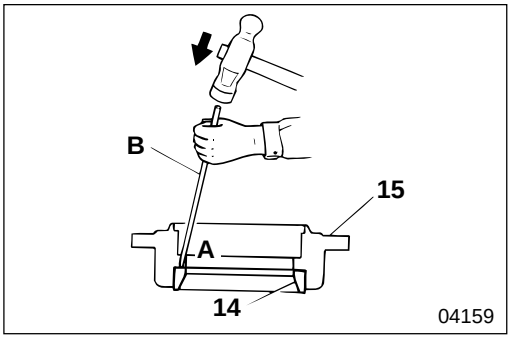


13 **Outer bearing outer race**

[Removal]
Drive out outer bearing outer race **13** evenly from three indented parts **A** in bearing retainer **15**.
B : Pin-punch

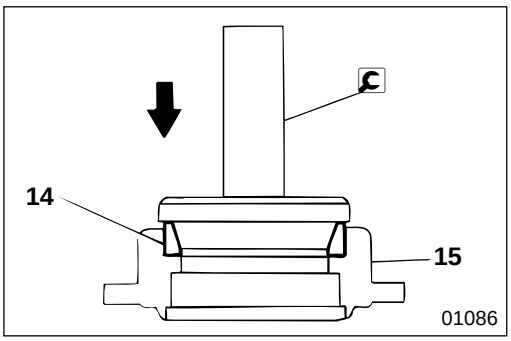


[Installation]



14 **Inner bearing outer race**

[Removal]
Drive out inner bearing outer race **14** evenly from three indented parts **A** in bearing retainer **15**.
B : Pin-punch



[Installation]

MITSUBISHI
FUSO

Group 31

Wheel and Tire

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-31

INDEX

SPECIFICATIONS 31-2

TROUBLESHOOTING 31-2

WHEEL AND TIRE 31-3

SPECIFICATIONS/TROUBLESHOOTING

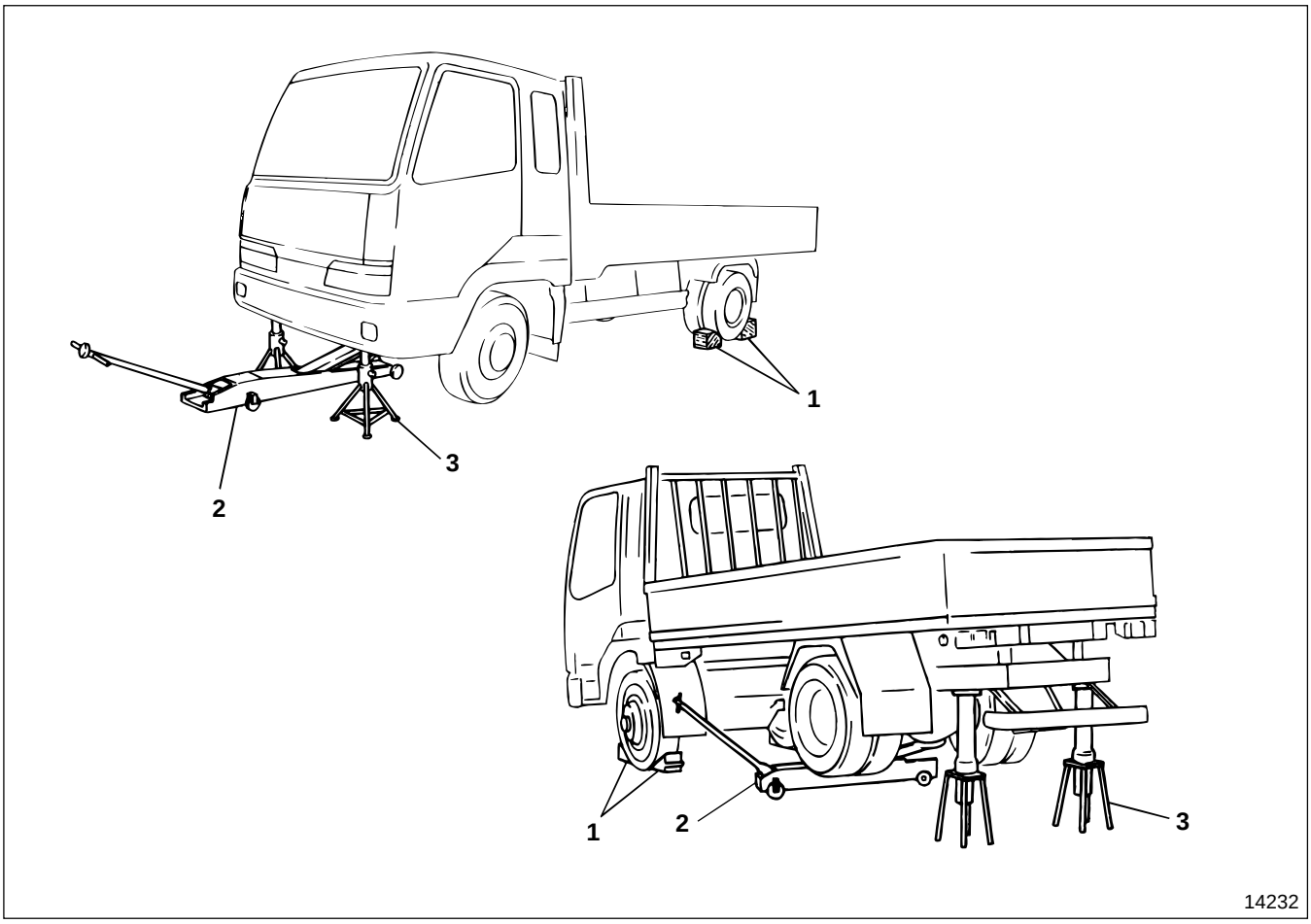
SPECIFICATIONS

Item / Vehicle model	Tire size	Air pressure kPa {psi, kgf/cm²}		Application wheel
		Front	Rear	
FK617	9R22.5-12PR	750 {105, 7.50}	675 {95, 6.75}	22.5×6.75-152-12
FM617	11R22.5-14PR	750 {105, 7.50}	675 {95, 6.75}	22.5×7.50-162-13
FM657	11R22.5-14PR	750 {105, 7.50}	675 {95, 6.75}	22.5×7.50-162-13

TROUBLESHOOTING

Possible causes / Symptoms			Tire tread worn										Remarks
			Both shoulders worn	Center worn	Outside worn	Inside worn	Feather-edged wear from outside to inside	Feather-edged wear from inside to outside	Wavy wear	Dished wear (one or more spots)	Pitted wear (dented) all around	Jagged wear	
Overloading			○										
Tire air pressure		Insufficient	○						○	○	○	○	
		Excessive		○									
Wheel alignment	Toe-in	Excessive			○		○						
Gr 26		Insufficient				○							
	Camber	Excessive			○								
		Insufficient				○							
	Toe-out excessive					○		○					
	Overall misalignment		○		○	○	○	○	○	○	○		
Knuckle arm bent					○	○	○	○					Gr 26
Left and right tie rod lengths different							○						Gr 26
Wheel balance incorrect									○	○	○	○	
Wheel bearing loose									○	○	○	○	Gr 26, 27
Ball joint loose										○			Gr 26
Tie rod end loose										○			Gr 37
Brake drum eccentric										○	○		Gr 35
Axle bent									○	○			Gr 26, 27
Sudden starting, sudden braking or sharp turn										○	○		
Left and right front wheel turning radius incorrect												○	Gr 26
Road surface influence					○	○							

Work for Removal and Installation of Wheel and Tire



● **Work sequence**

1 Place wheel chocks.
2 Jack up the front or rear axle using a garage jack placed under the center of the axle.
3 Support the frame on rigid racks.

WARNING⚠

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

● **Work sequence after removal and installation**

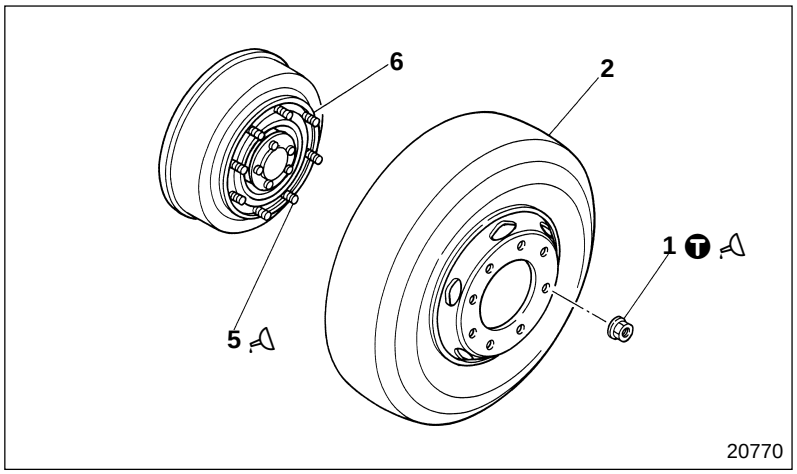
Follow the work sequence in reverse.

WHEEL AND TIRE

NOTE

Use right-hand threaded wheel nuts marked “R” for right side wheel and left-hand threaded wheel nuts marked “L” for left side wheel.

< Single tire >



● **Removal sequence**

1 Wheel nut
2 Tire assembly P31-6
5 Hub bolt
6 Hub

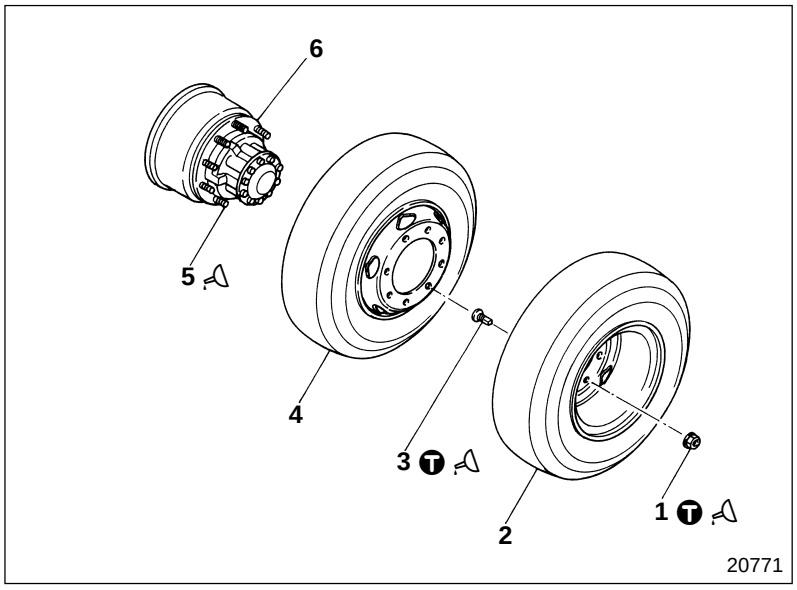
● **Cleaning and applying grease before installation**

P31-5

● **Installation sequence**

Follow the removal sequence in reverse.

< Double tire >



● **Removal sequence**

1 Wheel nut (outer)
2 Tire assembly P31-6
3 Wheel nut (inner)
4 Tire assembly P31-6
5 Hub bolt
6 Hub

● **Cleaning and applying grease before installation**

P31-5

● **Installation sequence**

Follow the removal sequence in reverse.

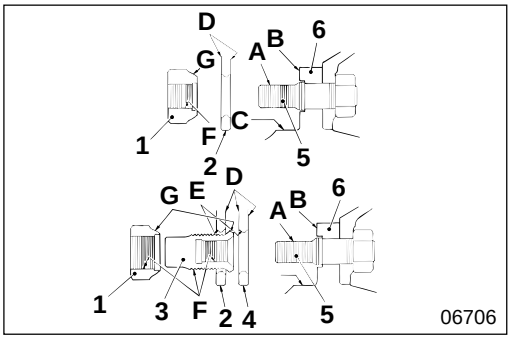
Tightening torque

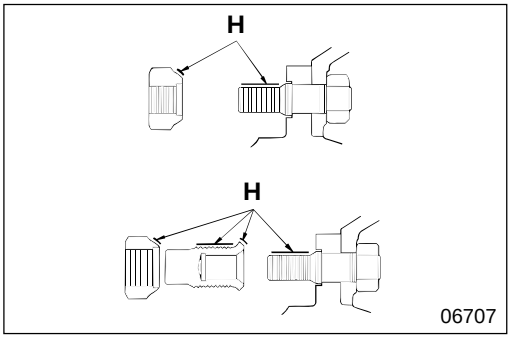
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3	Wheel nut	400 to 440 {295 to 325, 41 to 45}	Wet

Lubricant

Location	Points of application	Kinds	Quantity
1	Wheel nut spherical area	Chassis grease [NLGI No. 1 (Ca soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
3	Thread and spherical areas of wheel nut (inner)	Chassis grease [NLGI No. 1 (Ca soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
5	Thread area of hub bolt	Chassis grease [NLGI No. 1 (Ca soap)] or Wheel bearing grease [NLGI No. 2 (Li soap)]	As required





◆ Service procedure

● Cleaning and applying grease before installation

[Cleaning]

To prevent wheel nuts **1** and **3** and hub bolt **5** from becoming loose and to prevent mounting parts (tire assemblies **2** and **4** and hub **6**) from being damaged, remove rust, dust, additional coatings of paint, and foreign particles from the following areas:

A : Hub bolt thread area
B : Wheel mounting surface of hub
C : Wheel alignment area of hub
D : Disc wheel mating surface
E : Disc wheel nut mounting surface
F : Wheel nut thread area
G : Wheel nut spherical area

[Applying grease]

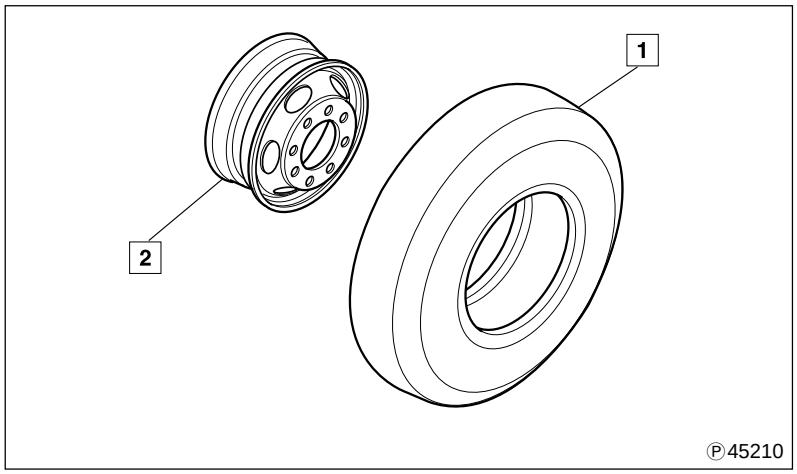
H : Grease application location

WARNING⚠

Never use grease containing molybdenum disulfide, since it can cause loosening of fitted screws.

WHEEL AND TIRE

Tire Assembly



● **Disassembly sequence**

1 Tire
2 Disc wheel

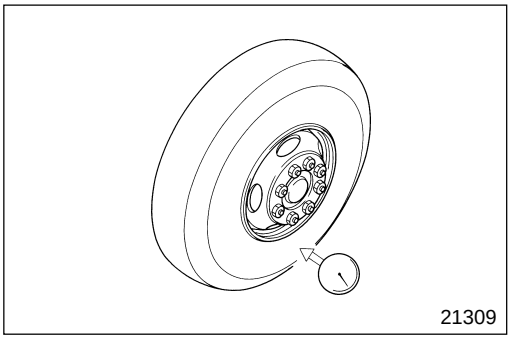
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

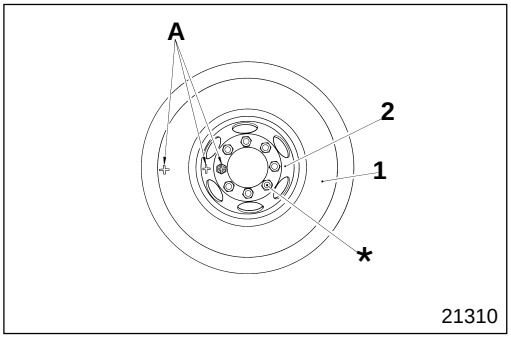
Location	Maintenance item		Standard value	Limit	Remedy
1	Horizontal deflection of tire (When assembled)		3.5 {0.14} or less	—	—
2	Disc wheel < 22.5×6.75-152-12 >	Flatness	0.2 {0.0079} or less	—	—
		Horizontal deflection	2.0 {0.079} or less	—	—
		Vertical deflection	1.8 {0.071} or less	—	—
	Disc wheel < 22.5×7.50-162-13 >	Flatness	0.2 {0.0079} or less	—	—
		Horizontal deflection	2.0 {0.079} or less	—	—
		Vertical deflection	1.8 {0.071} or less	—	—



◆ Service procedure

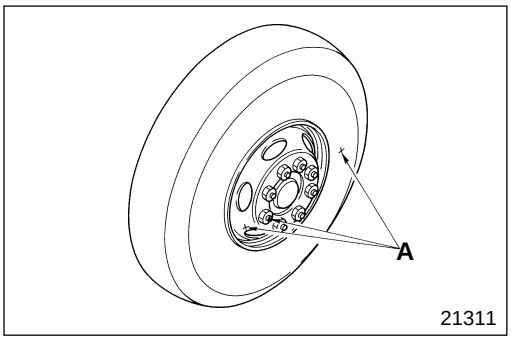
1 **Deflection of tire**

[Inspection]
If the measured value is higher than the limit, make corrections as follows.

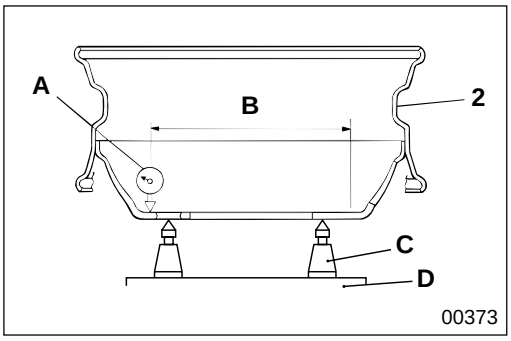


[Correction]

- Put chalk marks on tire **1**, disc wheel **2**, and hub bolt * (positions **A** as illustrated).
- Remove tire **1** from disc wheel **2**.



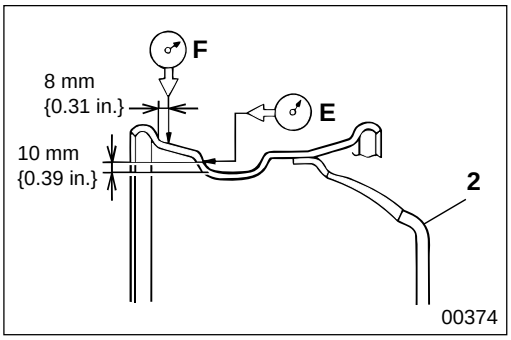
- Measure deflection of disc wheel **2**. If the most deflective position is near the chalk mark, reinstall tire **1** rotating it half a turn from the chalk mark and tighten nuts.
- Remeasure deflection of tire **1**.
- If the measured value is still higher than the limit, replace tire **1** and disc wheel **2** together as an assembly.



2 Inspection of disc wheel

(1) Flatness

- Measure flatness at specified position **B** from the center of disc wheel **2**.
  Measure flatness at ten equidistant points on the wheel.
  A : Dial gauge
  B : ø235 to 340 mm {9.25 to 13.4 in.}
  C : Portable screw jacks (x 4)
  D : Surface plate
- Replace disc wheel **2** if the measured value is higher than the limit.



(2) Deflection

Replace disc wheel **2** if the measured value is higher than the limit.
E : Horizontal deflection measuring point
F : Vertical deflection measuring point

MITSUBISHI
FUSO

Group 33
Front Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-33

INDEX

STRUCTURE AND OPERATION 33- 2

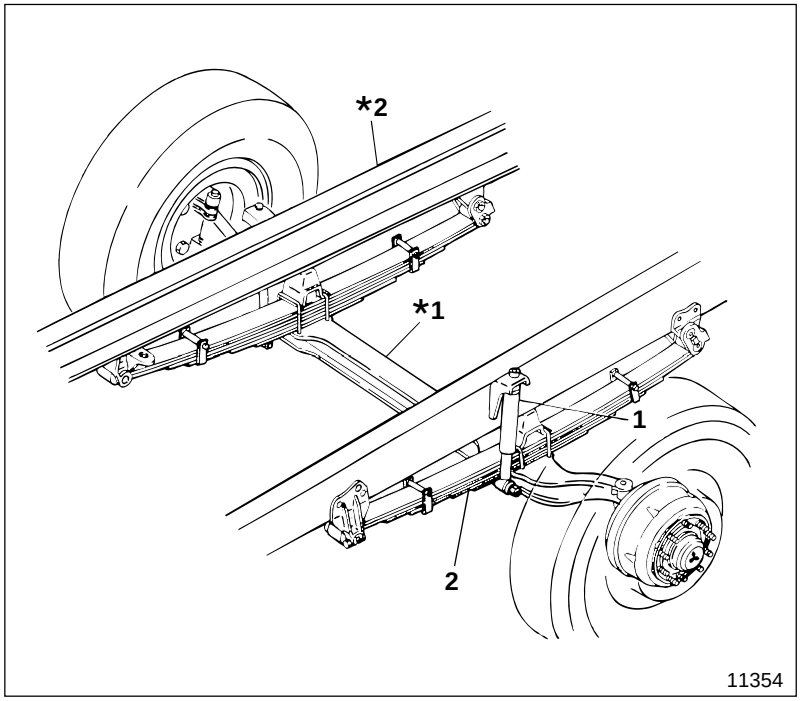
TROUBLESHOOTING 33- 3

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT SUSPENSION 33- 4

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY 33- 6

LEAF SPRING ASSEMBLY 33-10

SHOCK ABSORBER 33-12



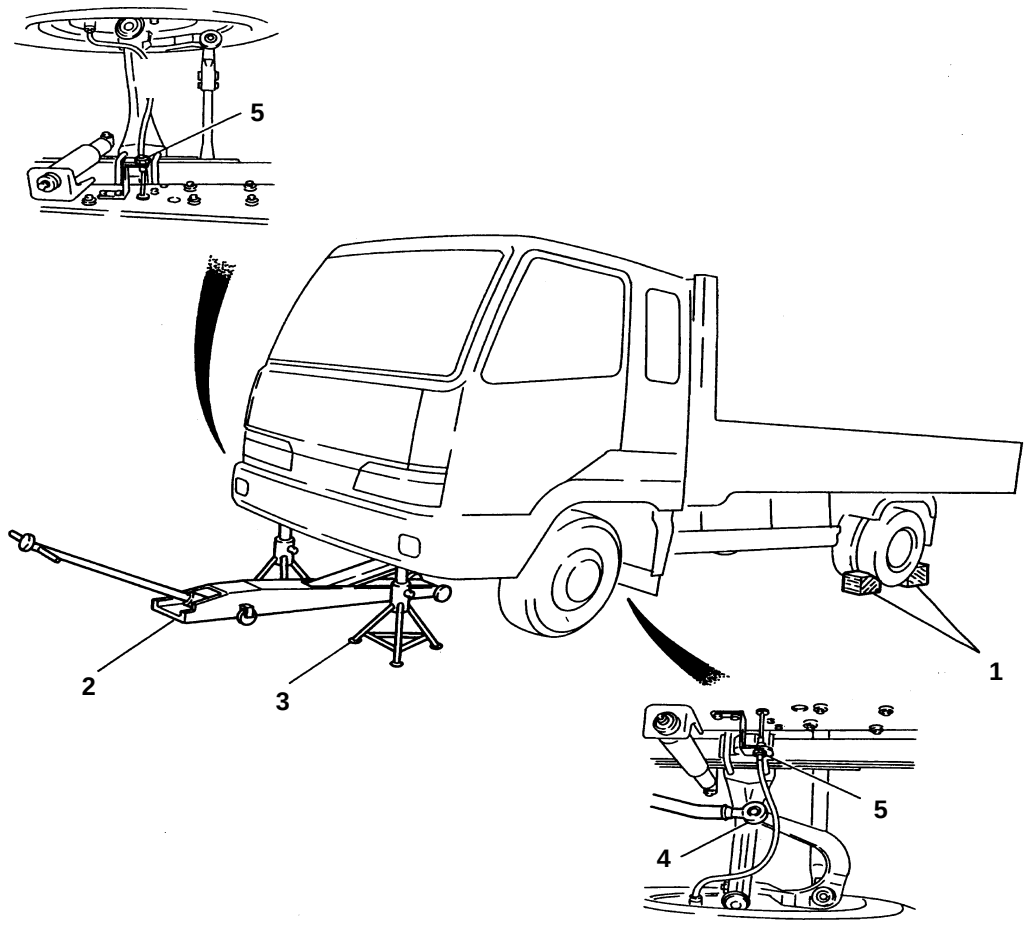
1 Shock absorber
2 Leaf spring assembly

***1** : Front axle
***2** : Frame

Leaf spring assembly **2** and shock absorber **1** are installed between frame ***2** and front axle ***1** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability.

Possible causes / Symptoms		Ride soft with gentle swaying	Noise generated when vehicle is unloaded	Impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Excessive rolling while cruising	Periodic jolts received from the road surface	Remarks
Leaf spring	Cracked or damaged			○				
	Fractured		○					
	Spring bracket broken				○			
	U-bolts loose				○			
	Spring bushing worn		○					
Shackle pins thrust play excessive			○					
Shackle pin tightening torque excessive					○			
Bump stopper damaged or broken					○			
Shock absorber	Oil leaking noticeably or damping force decreased	○						
	Rubber bushing worn		○					
	Bolt loose		○					
Tire	Tires worn unevenly						○	
	Tires and wheels unbalanced						○	Gr 31
	Air pressure excessive			○				

WORK BEFORE REMOVAL AND INSTALLATION OF FRONT SUSPENSION



● **Removal sequence**

1 Place wheel chocks.
2 Jack up the front axle with a garage jack.
3 Support the front frame on rigid racks.
4 Remove the nut (on the joint between the knuckle arm and the drag link). Gr 37
5 Remove the brake hose joint and wheel speed sensor (on the frame). Gr 26

WARNING

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame with rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Be sure to protect the brake hose from dust by fitting blanking plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

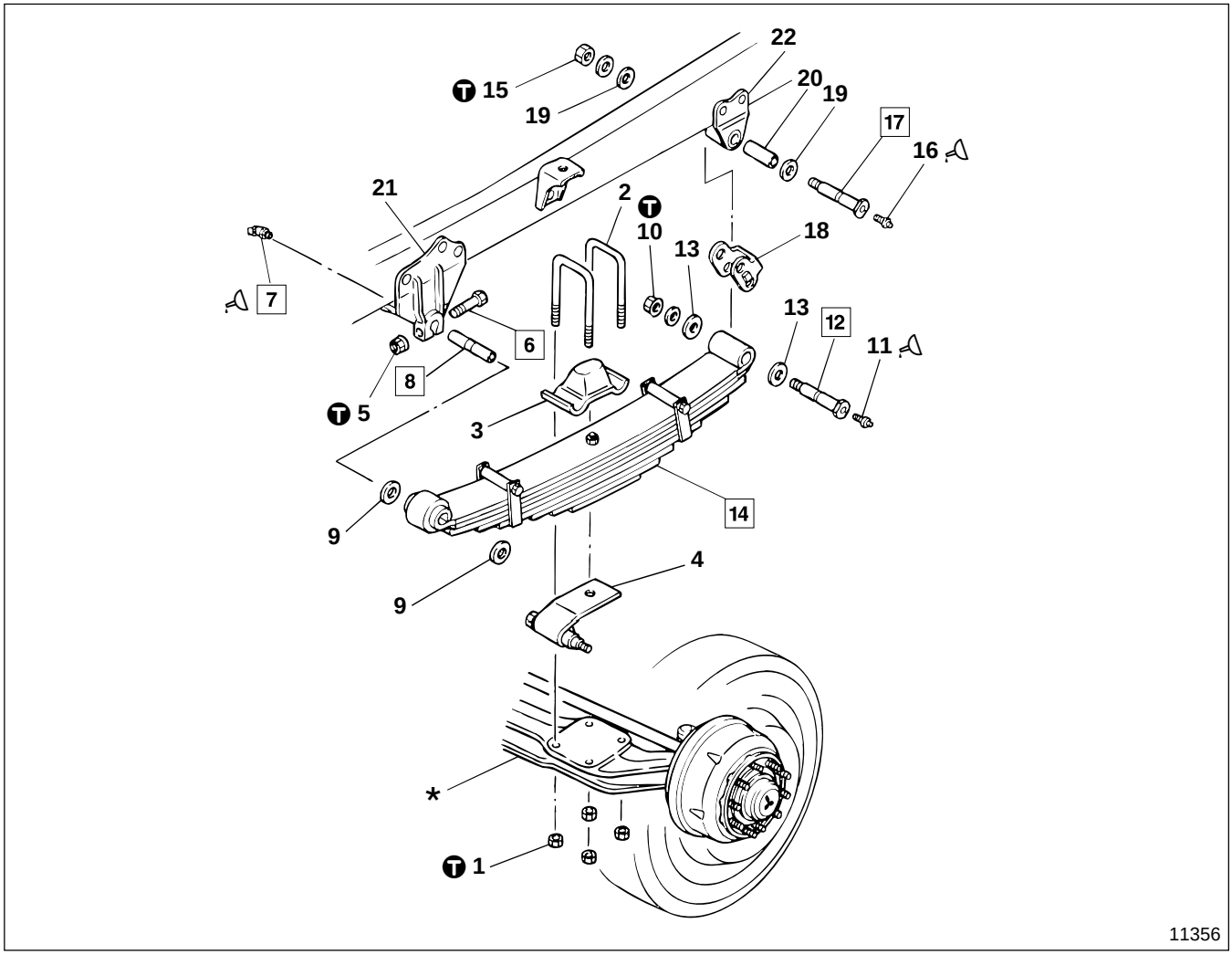
WARNING⚠

You must bleed air from the brake system after connecting the brake hose, failure to do so would cause the brakes to malfunction. Gr 35A

CAUTION⚠

Be sure that the brake hose is not twisted when you install it.

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Bump stopper
4 Lower bracket
5 Nut
6 Bolt
7 Grease nipple
8 Shackle pin
9 Side washer
10 Nut
11 Grease nipple
12 Shackle pin
13 Side washer
14 Leaf spring assembly P33-10
15 Nut
16 Grease nipple
17 Shackle pin
18 Shackle link
19 Side washer
20 Bushing
21 Front spring front bracket
22 Front spring rear bracket

***** Front axle Gr 26

NOTE

Do not remove front spring front bracket 21 or rear bracket 22 unless they are faulty. **Gr 41**

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
8, 12, 14	Clearance between shackle pin and spring bushing	FK	[28] 0 to 0.12 {[1.10] 0 to 0.0047}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.15 {[1.18] 0 to 0.0059}		
8, 21	Clearance between shackle pin and front spring front bracket	FK	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.05 {[1.18] 0 to 0.0020}		
12, 17, 18	Clearance between shackle pin and shackle link	FK	[28] 0.02 to 0.24 {[1.10] 0.00079 to 0.0094}	0.3 {0.012}	Replace
		FM	[30] 0.02 to 0.25 {[1.18] 0.00079 to 0.0098}		
14, 18	Clearance between leaf spring assembly and shackle link	FK	1.2 to 2.2 {0.047 to 0.087}	—	Replace side washer
		FM	0.8 to 1.7 {0.031 to 0.067}		
14, 21	Clearance between leaf spring assembly and front spring front bracket	FK	0.2 to 0.9 {0.0079 to 0.035}	—	Replace side washer
		FM	0 to 0.7 {0 to 0.028}		
17, 20	Clearance between shackle pin and bushing	FK	[28] 0.02 to 0.14 {[1.10] 0.00079 to 0.0055}	0.3 {0.012}	Replace
		FM	[30] 0.02 to 0.15 {[1.18] 0.00079 to 0.0059}		
18, 22	Clearance between shackle link and front spring rear bracket	FK	1.2 to 2.2 {0.047 to 0.087}	—	Replace side washer
		FM	0.8 to 1.7 {0.031 to 0.067}		

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

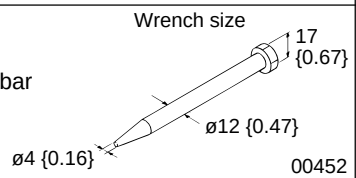
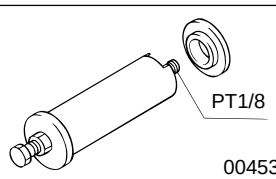
Location	Parts to be tightened		Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	FK	240±36 {175±27, 24.5±3.7}	Wet
		FM617	372±56 {275±41, 37.9±5.7}	
		FM657	472±71 {345±52, 48.1±7.2}	
5	Flange nut (Shackle pin mounting)		80 to 110 {58 to 80, 8.0 to 11}	—
10, 15	Shackle pin nut (Shackle pin mounting)	FK	190 to 260 {135 to 190, 19 to 26}	—
		FM	260 to 340 {190 to 255, 26 to 35}	

Lubricant

Location	Points of application	Kinds	Quantity
7, 11, 16	Supply via grease nipple	Chassis grease [NLGI No.1 (Ca soap)]	As required

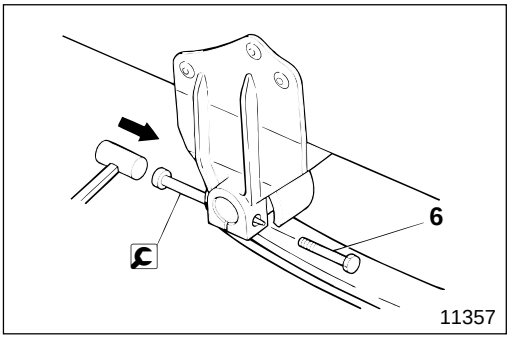
Special tools

Unit : mm {in.}

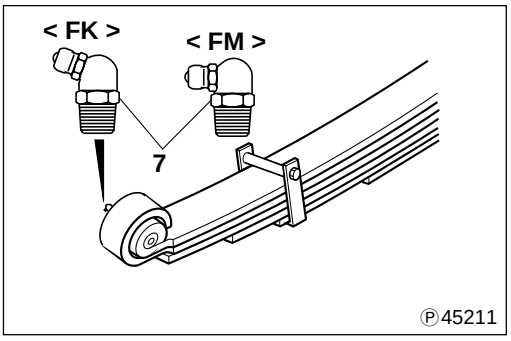
Location	Tool name and shape	Part No.	Application
6	Shackle pin setting bar 	MC023419	Removal of bolt (shackle pin installation), alignment of the shackle pin bolt groove
8, 12, 17	Shackle pin puller 	MH061452	Removal of shackle pin

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY

◆ Service procedure

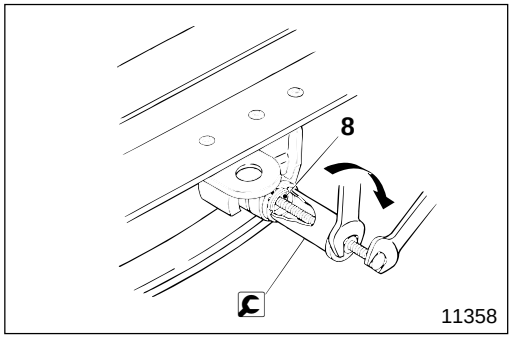


6 **Removal of bolt**



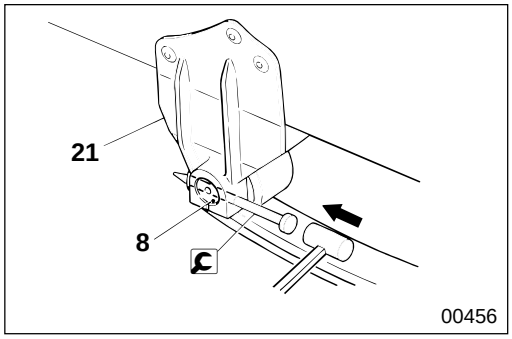
7 **Grease nipple < FK >**

- Install grease nipple **7**, on the driver's side, so that it can be easily accessed for grease supply. This is the only nipple that is installed on • the inner side of the vehicle. Grease nipples, **11**, **16** are straight types and are installed on the outer side of the vehicle.
- Grease nipple **7** at the forward side of the assistant driver's seat is a straight type, and it is installed on the outer side of the vehicle.

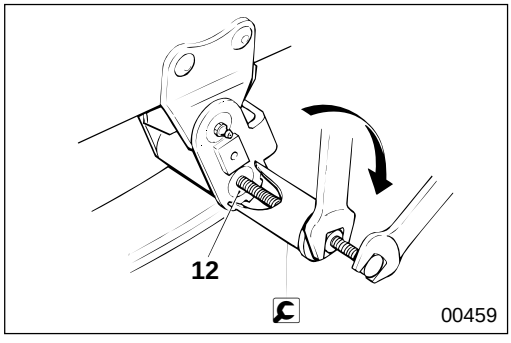


8 **Shackle pin**

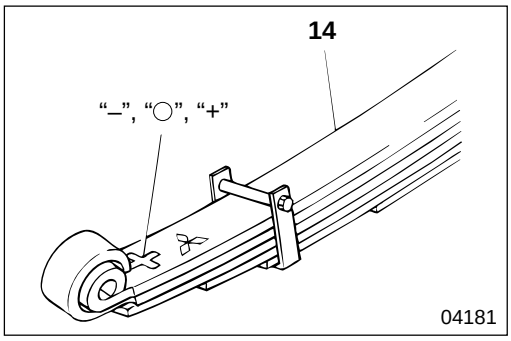
[Removal]



[Installation]
Align the bolt hole of front spring front bracket **21** with the bolt groove of shackle pin **8** using ⊏ shackle pin setting bar.



12 **Removal of shackle pin**



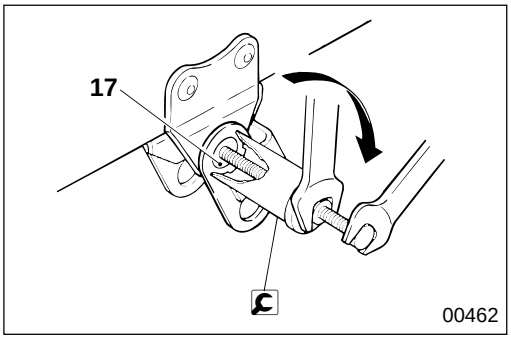
14 **Leaf spring assembly left/right height combinations**

When replacing leaf spring assembly **14**, select the members so that the left and right height marks "+", "○" and "–" are combined as shown below.

Item	Combination				
	1	2	3	4	5
Right leaf spring assembly, passenger's side	–	–	○	○	+
Left leaf spring assembly, driver's side	–	○	○	+	+

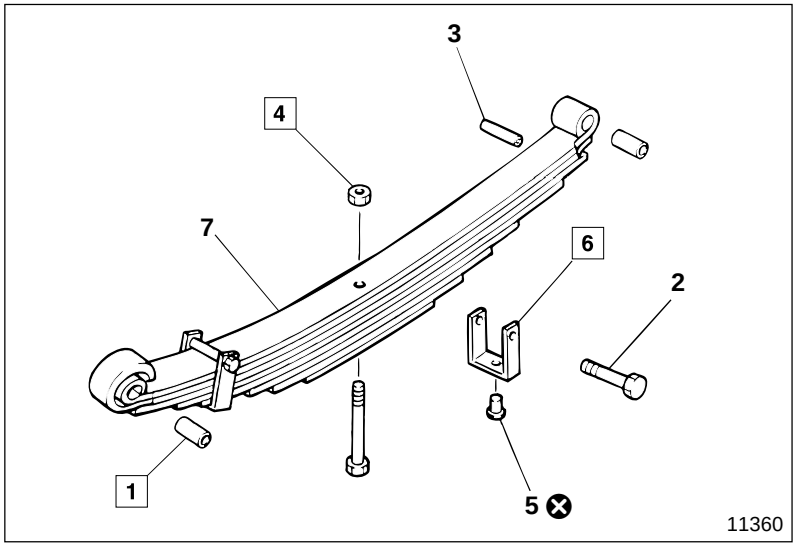
CAUTION⚠

Passenger's side leaf spring assembly 14 differs from the driver's side leaf spring assembly in camber (arch). Do not mix them up when mounting, or this would cause vehicle tilt.



17 **Removal of shackle pin**

LEAF SPRING ASSEMBLY



● **Disassembly sequence**

1 Spring bushing
2 Clip bolt
3 Pipe < FM >
4 Rivet
5 Clip
6 Leaf spring

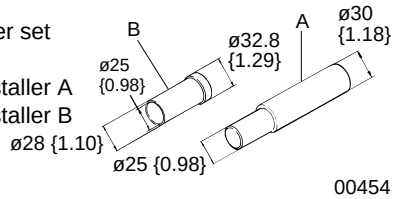
⊗ : Non-reusable parts

● **Assembly sequence**

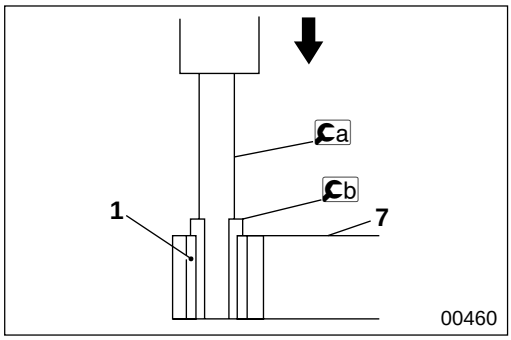
Follow the disassembly sequence in reverse.

Special tools

Unit : mm {in.}

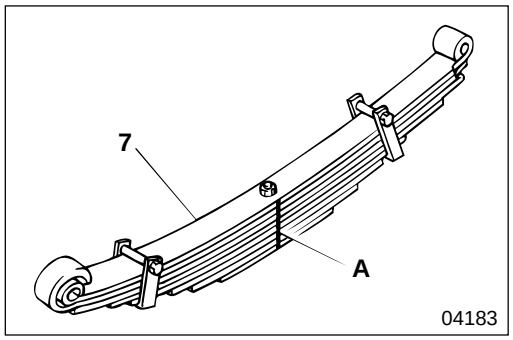
Location	Tool name and shape	Part No.	Application
1	Bushing installer set **A** : Bushing installer A **B** : Bushing installer B 	MB999066 **A** : MB999067 **B** : MB999068	Removal and press-fitting of spring bushing

◆ Service procedure



1 **Removal of spring bushing**

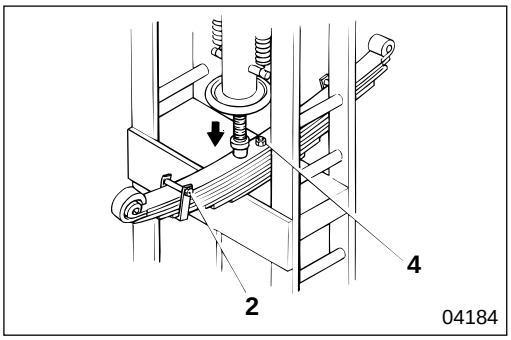
Remove the spring bushing from leaf spring **7** using a bushing installer **A** and b bushing installer **B**. For installation, follow the removal sequence in reverse.



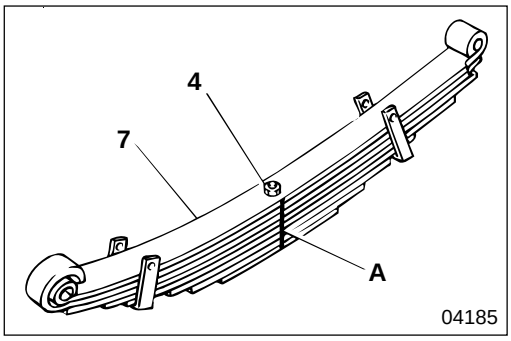
4 **Center nut**

[Removal]

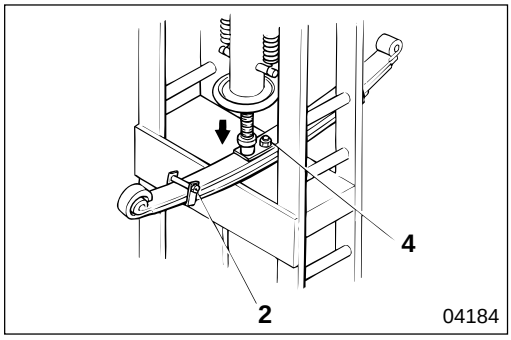
- Put aligning marks **A** across leaves of leaf spring **7**.



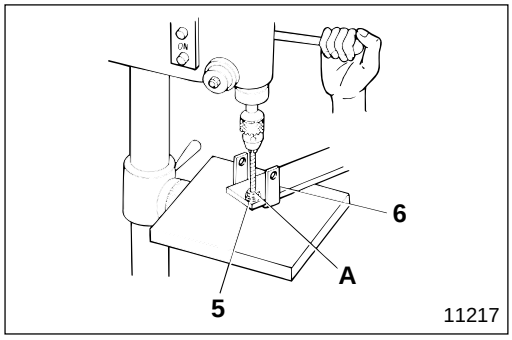
- Compress the leaf springs using a press to remove clip bolt **2** and center nut **4**.



[Installation]
- Align alignment marks **A** on leaf springs **7** and assemble.
- Tighten center nut **4** temporarily.

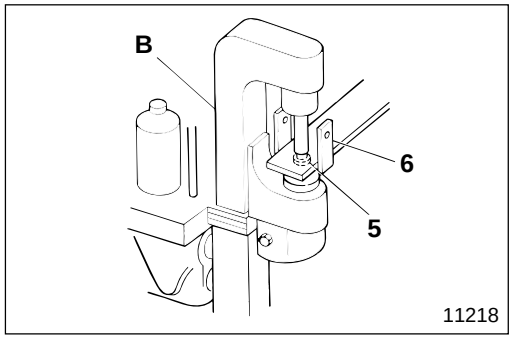


- Compress leaf spring **7** using a press, then install center nut **4**.
- Tighten clip bolt **2**.



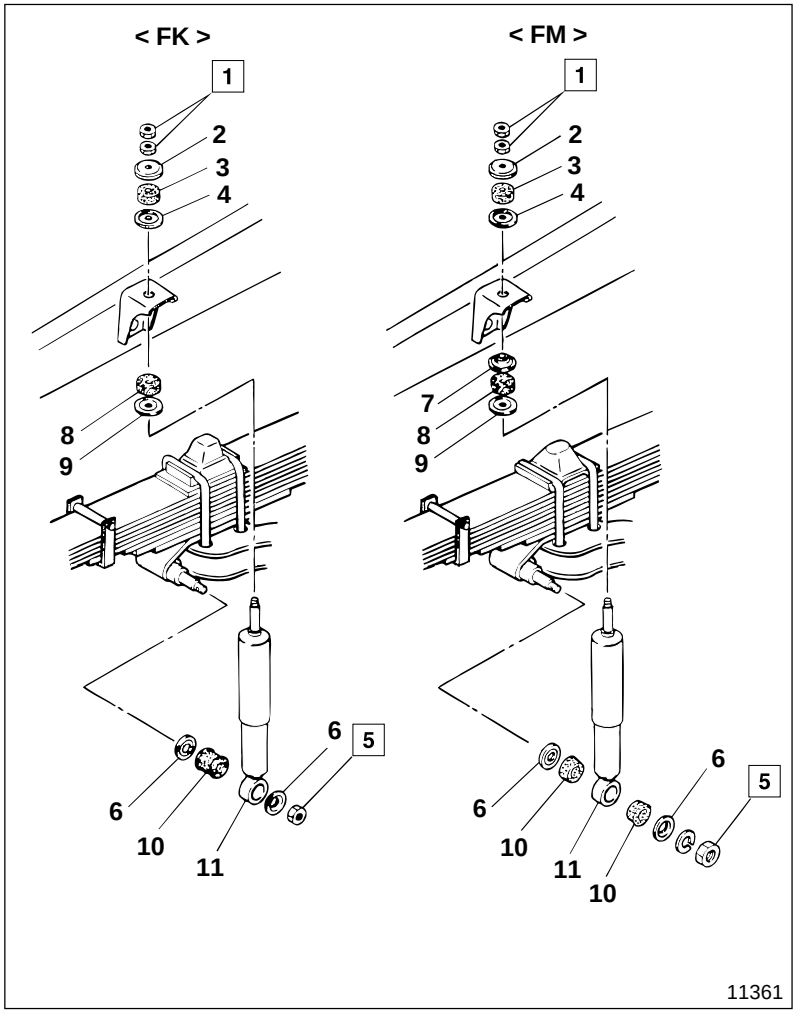
6 Clip

[Removal]
Drill out caulked ends **A** of rivet **5** on a drill press to remove clip **6**.



[Installation]
Using riveting machine **B**, install clip **6** by caulking rivet **5**.

SHOCK ABSORBER



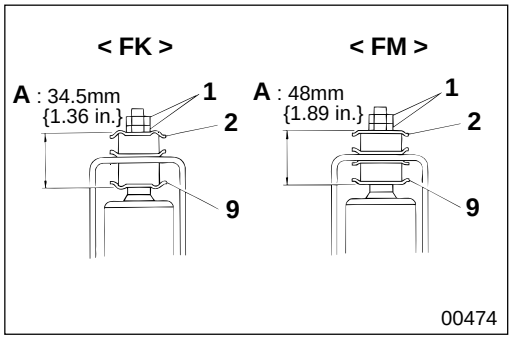
● **Removal sequence**

1 Nut
2 Washer
3 Rubber bushing
4 Centering washer
5 Nut
6 Washer
7 Centering washer < FM >
8 Rubber bushing
9 Washer
10 Rubber bushing
11 Shock absorber

● **Installation sequence**

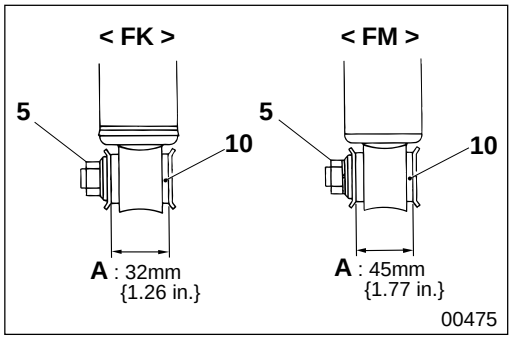
Follow the removal sequence in reverse.

◆ Service procedure



1 **Nut**

Install nut **1** so that the distance between washers **2**, **9** is **A**.



5 **Nut**

Install nut **5** so that dimension of rubber bushing **10** is **A**.

MITSUBISHI
FUSO

Group 34
Rear Suspension

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-34

INDEX

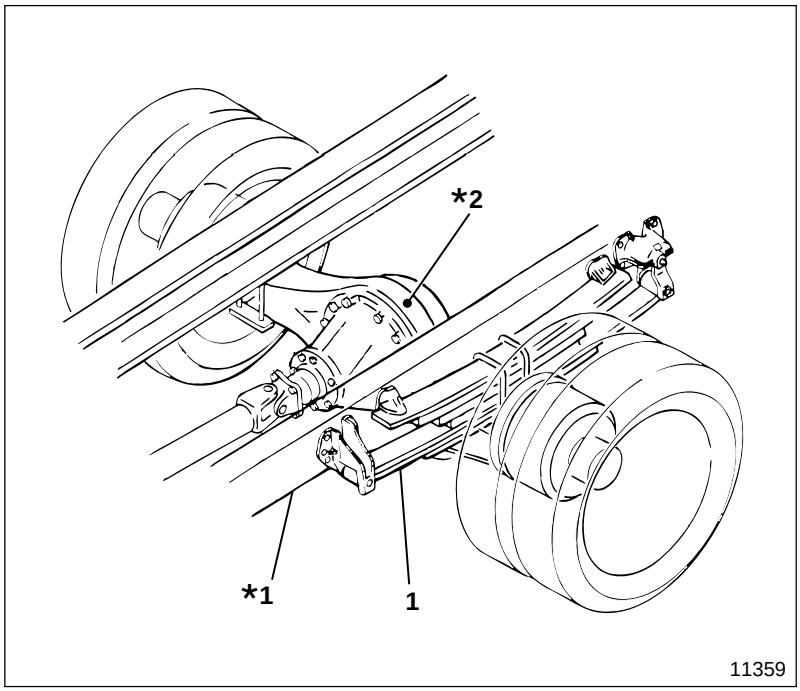
STRUCTURE AND OPERATION 34- 2

TROUBLESHOOTING 34- 3

WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION 34- 4

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY 34- 6

LEAF SPRING ASSEMBLY 34-12



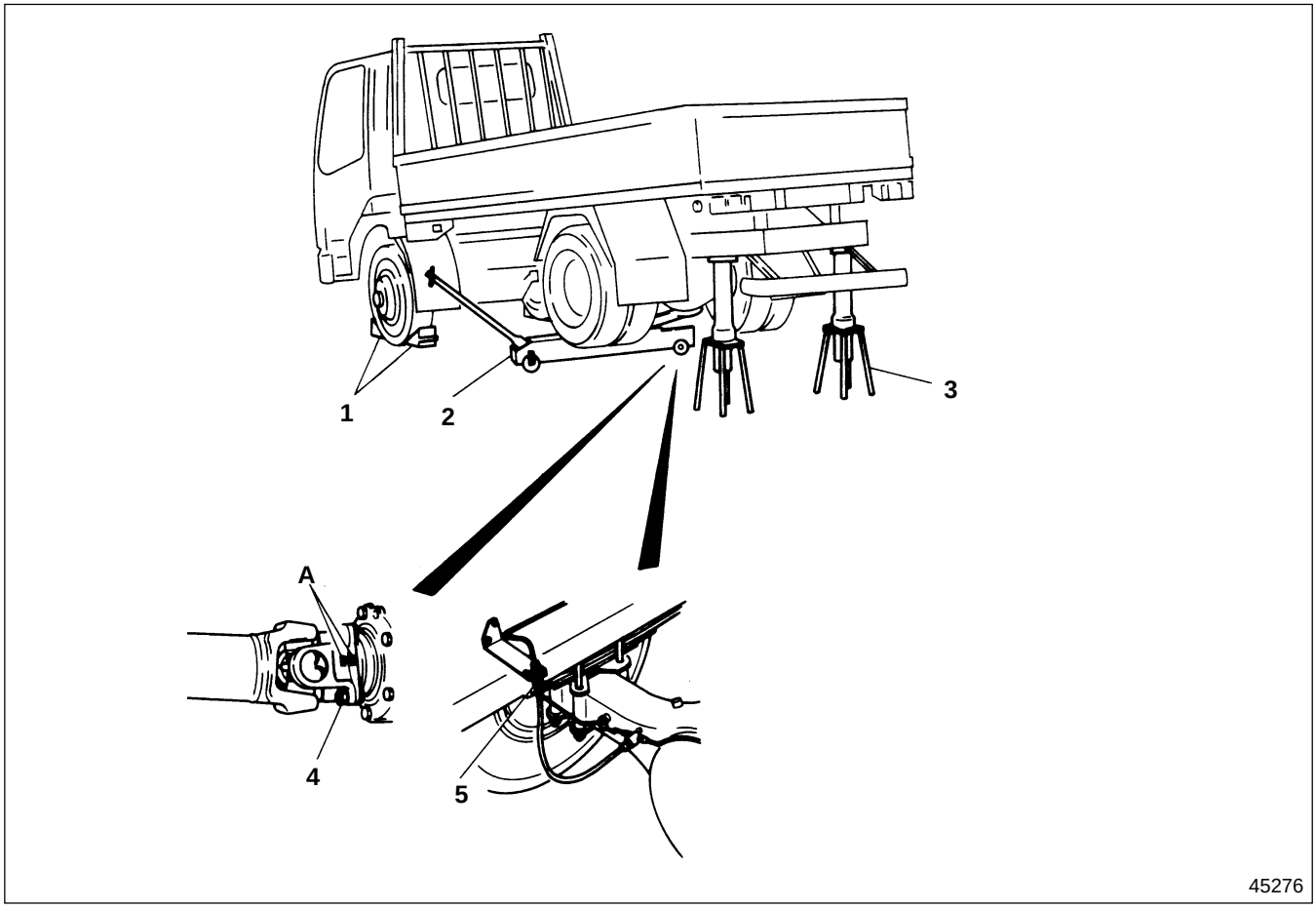
1 Leaf spring assembly

***1** : Frame
***2** : Rear axle

Leaf spring assembly **1** is installed between frame ***1** and rear axle ***2** to support the vehicle body mass and absorb vibration and shock from the road surface to prevent them from being directly transmitted to the vehicle body thereby protecting the crew, the vehicle body, and the cargo. In addition, irregular vibration from the wheels is restrained, ensuring driving stability.

Possible causes \ Symptoms		Ride spongy	Noise generated when vehicle is unloaded	Impact transmitted from uneven road surface	Noise generated when vehicle is loaded	Excessive rolling while cruising	Periodic jolts caused by the road surface	Remarks
Leaf spring	Cracked or damaged			○				
	Damaged		○					
	Spring bracket broken				○			
	U-bolts loose				○			
	Spring bushing worn		○					
Shackle pins thrust play excessive			○					
Sliding seat < FM > or helper stopper damaged or broken					○			
Tire	Tires worn unevenly						○	
	Tires and wheels unbalanced						○	Gr 31
	Air pressure excessive			○				

WORK BEFORE REMOVAL AND INSTALLATION OF REAR SUSPENSION



● **Removal sequence**

1 Place wheel chocks.
2 Jack up the rear axle with a garage jack.
3 Support the rear frame on rigid racks.
4 Put alignment marks **A** on the rear axle companion flange and the propeller shaft flange yoke, then remove the nuts (on the joint between the rear axle and the propeller shaft). Gr 25
5 Remove the brake hose joint and wheel speed sensor (on the frame). Gr 27

WARNING

- **Chock the wheels securely so the vehicle does not move.**
- **Do not remove the chocks until the entire operation is completed.**
- **Supporting a vehicle on a garage jack only is extremely dangerous, so always support the frame on rigid racks.**
- **Leave the garage jack and rigid racks in place until the entire operation is completed. Never remove them during the operation.**

CAUTION

Be sure to protect the brake hose from dust by fitting blanking plugs.

● **Installation sequence**

Follow the removal sequence in reverse.

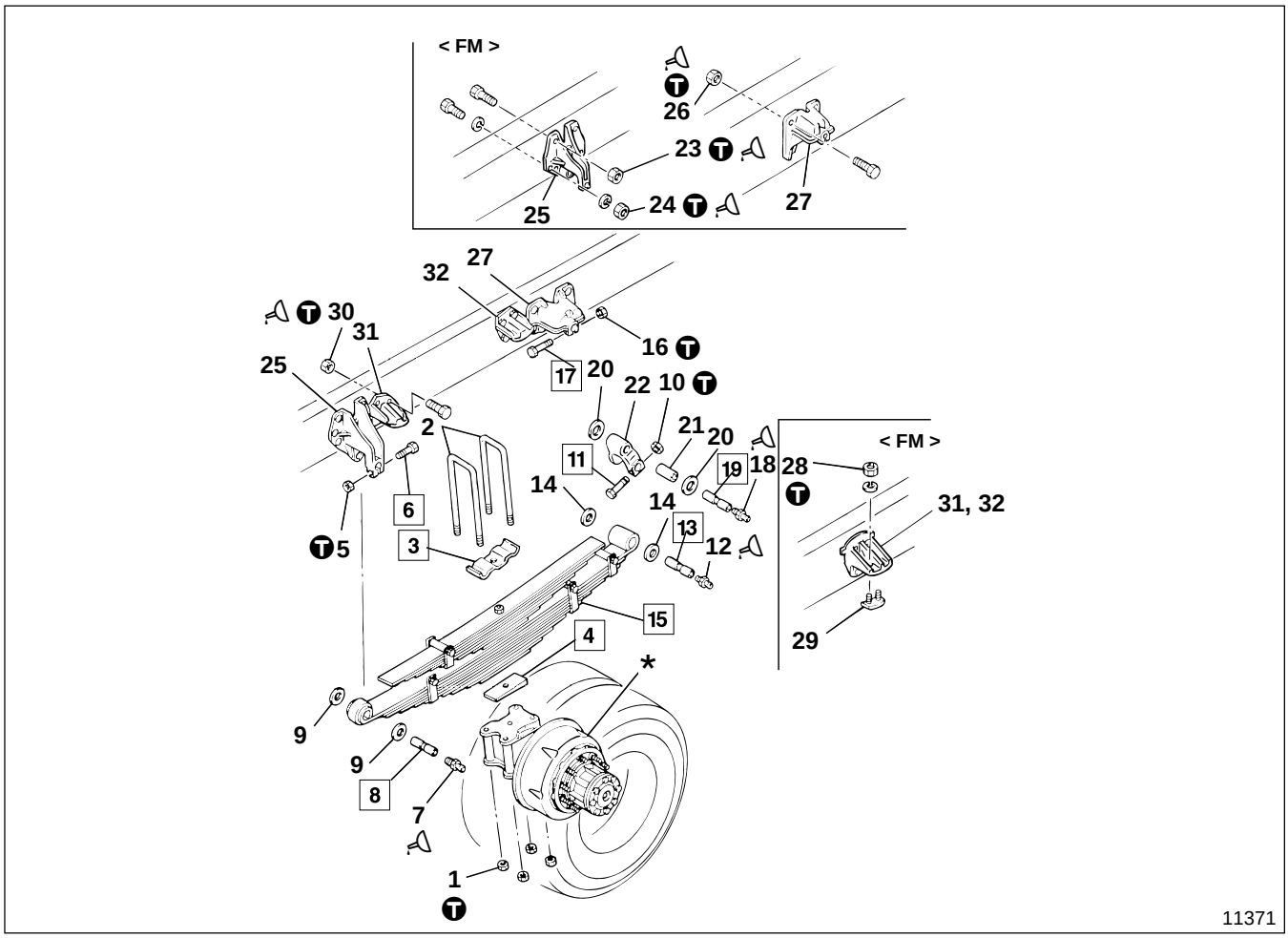
WARNING⚠

You must bleed air from the brake system after installing the brake hose, failure to do so would cause the brake to malfunction. Gr 35A

CAUTION⚠

Be sure that the brake hose is not twisted when you install it.

REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



● **Removal sequence**

1 U-bolt nut
2 U-bolt
3 Rear spring pad
4 Shim < FM617F >
5 Nut
6 Bolt
7 Grease nipple
8 Shackle pin
9 Side washer
10 Nut
11 Bolt
12 Grease nipple
13 Shackle pin
14 Side washer
15 Leaf spring assembly
📖 P34-12
16 Nut
17 Bolt
18 Grease nipple
19 Shackle pin
20 Side washer
21 Bushing
22 Shackle link
23 Nut < FM >
24 Nut < FM >
25 Rear spring front bracket
26 Nut < FM >
27 Rear spring rear bracket
28 Nut < FM >
29 Sliding seat < FM >
30 Nut
31 Front helper stopper
32 Rear helper stopper

***** Rear axle Gr 27

NOTE

Do not remove rear spring front bracket 25, or rear spring rear bracket 27, front helper stopper 31, or rear helper stopper 32 unless they are faulty. Gr 41

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
8, 13, 15	Clearance between shackle pin and spring bushing	FK	[28] 0 to 0.12 {[1.10] 0 to 0.0047}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.15 {[1.18] 0 to 0.0059}		
8, 13, 22, 25	Clearance between shackle pin and each of rear spring front bracket and shackle link	FK	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.05 {[1.18] 0 to 0.0020}		
15, 22	Clearance between leaf spring assembly and shackle link	FK	0.2 to 0.9 {0.0079 to 0.035}	—	Replace side washer
		FM	1.0 to 1.7 {0.039 to 0.067}	—	
15, 25	Clearance between leaf spring assembly and rear spring front bracket	FK	0.2 to 0.9 {0.0079 to 0.035}	—	Replace side washer
		FM	1.0 to 1.7 {0.039 to 0.067}	—	
19, 21	Clearance between shackle pin and bushing	FK	[28] 0.02 to 0.14 {[1.10] 0.00079 to 0.0055}	0.3 {0.012}	Replace
		FM	[30] 0.03 to 0.15 {[1.18] 0.0012 to 0.059}		
19, 27	Clearance between shackle pin and rear spring rear bracket	FK	[28] 0 to 0.04 {[1.10] 0 to 0.0016}	0.3 {0.012}	Replace
		FM	[30] 0 to 0.05 {[1.18] 0 to 0.0020}		
22, 27	Clearance between shackle link and rear spring rear bracket	FK	0.2 to 0.6 {0.0079 to 0.024}	—	Replace side washer
		FM	0 to 0.4 {0 to 0.016}	—	

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	U-bolt nut (U-bolt mounting)	FK	414±62 {305±46, 42.2±6.3}	Wet
		FM	546±82 {400±61, 55.7±8.4}	
5, 10, 16	Nut (Shackle pin mounting)		80 to 110 {58 to 80, 8 to 11}	—
23, 26	Nut (Rear spring front and rear bracket mounting)	FM	200 to 270 {145 to 200, 20.4 to 27.5}	Wet
24	Nut (Rear spring front bracket mounting)	FM	157 to 216 {115 to 160, 16 to 22}	Wet
28	Nut (Sliding seat mounting)	FM	59 to 84 {43 to 61, 6.0 to 8.5}	—
30	Nut (Helper stopper mounting)	FK	157 to 216 {115 to 160, 16 to 22}	Wet

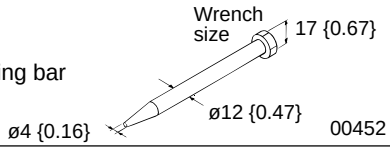
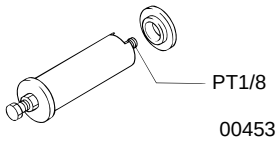
Lubricant and sealant

Location	Points of application		Kinds	Quantity
7, 12, 18	Supply via grease nipple		Chassis grease [NLGI No. 1 (Ca soap)]	As required
23, 24, 26	Thread area and contacting surface of nut	FM	LOCTITE 271 and Nippon grease Rusfighter J36	As required
30	Thread area and contacting surface of nut	FK	Engine oil	As required

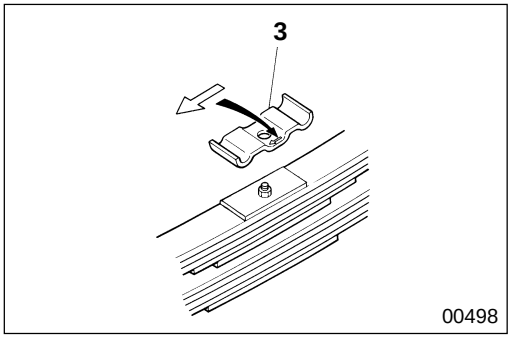
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY

Special tools

Unit : mm {in.}

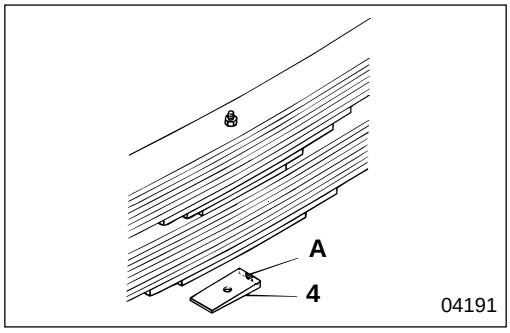
Location	Tool name and shape	Part No.	Application
6, 11, 17	Shackle pin setting bar 	MC023419	Removal of shackle pin mounting bolt and aligning of holes
8, 13, 19	Shackle pin puller 	MH061452	Removal of shackle pin

◆ Service procedure



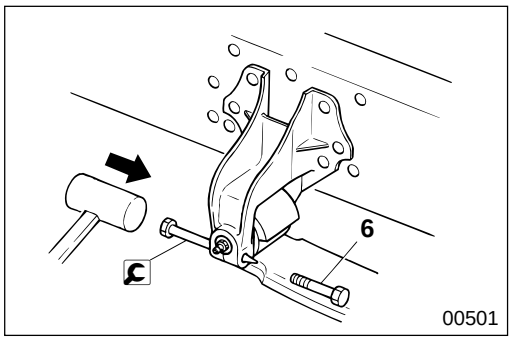
3 **Rear spring pad**

Align direction of arrow mark of the rear spring pad to front direction of vehicle.

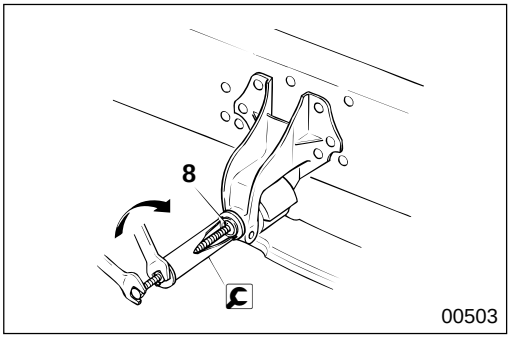


4 **Shim**

Yellow identification paint **A** must be positioned toward the front of the vehicle.

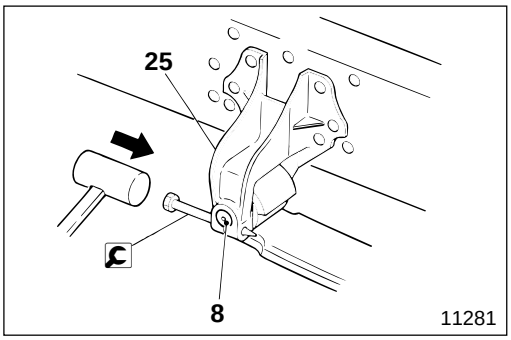


6 **Removal of bolt**

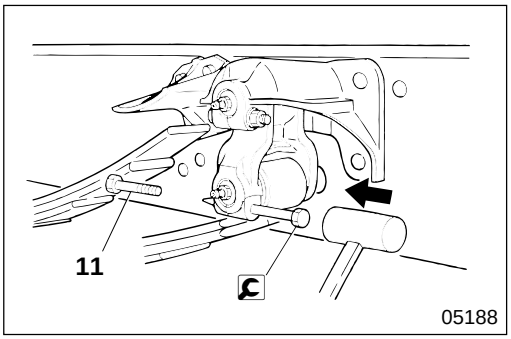


8 **Shackle pin**

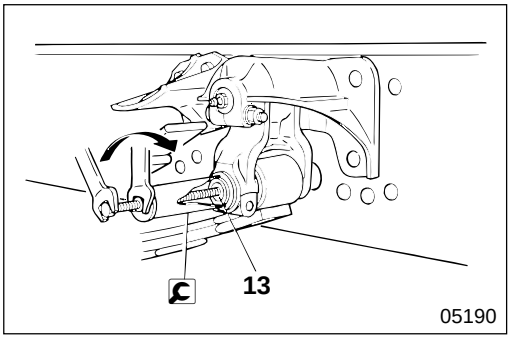
[Removal]



[Installation]
Align the bolt hole of rear spring front bracket **25** with the bolt groove of shackle pin **8** using shackle pin setting bar.

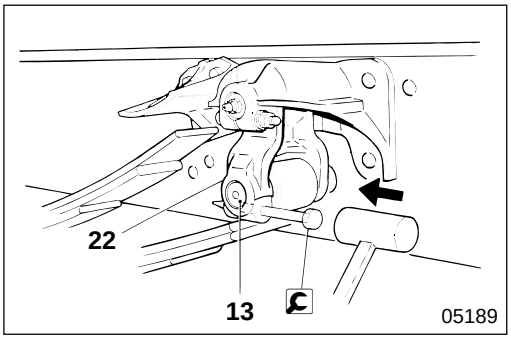


11 **Removal of bolt**



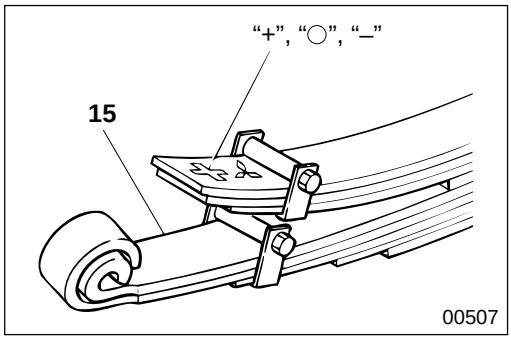
13 **Shackle pin**

[Removal]



[Installation]
Align the bolt hole of shackle link **22** with the bolt groove of shackle pin **13** using shackle pin setting bar.

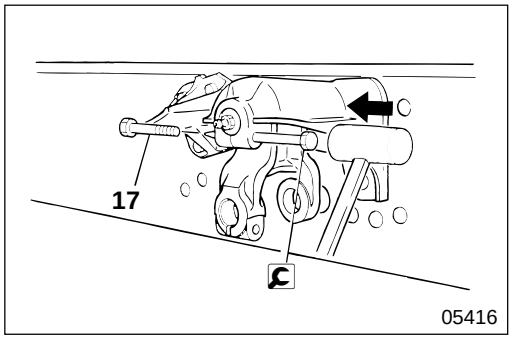
REMOVAL AND INSTALLATION OF LEAF SPRING ASSEMBLY



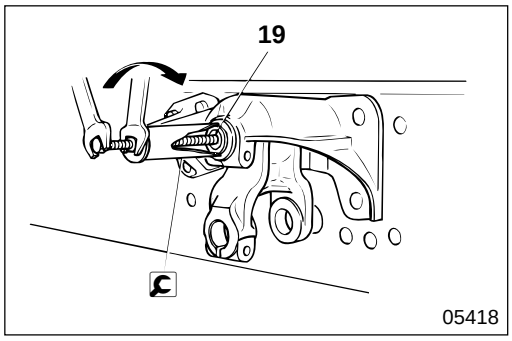
15 **Leaf spring assembly left/right height combinations**

When replacing leaf spring assembly **15**, select the members so that the left and right height marks "+", "○" and "–" are combined as shown below.

Item	Combination		
	1	2	3
Leaf spring assembly, left side	+	○	–
Leaf spring assembly, right side	+	○	–

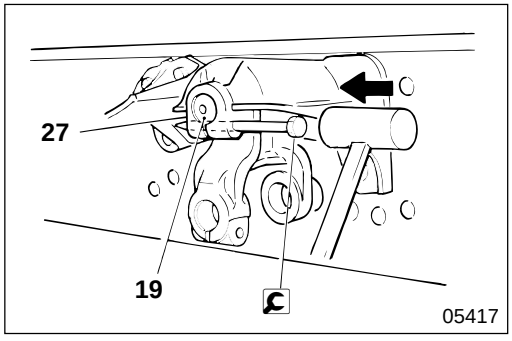


17 **Removal of bolt**



19 **Shackle pin**

[Removal]

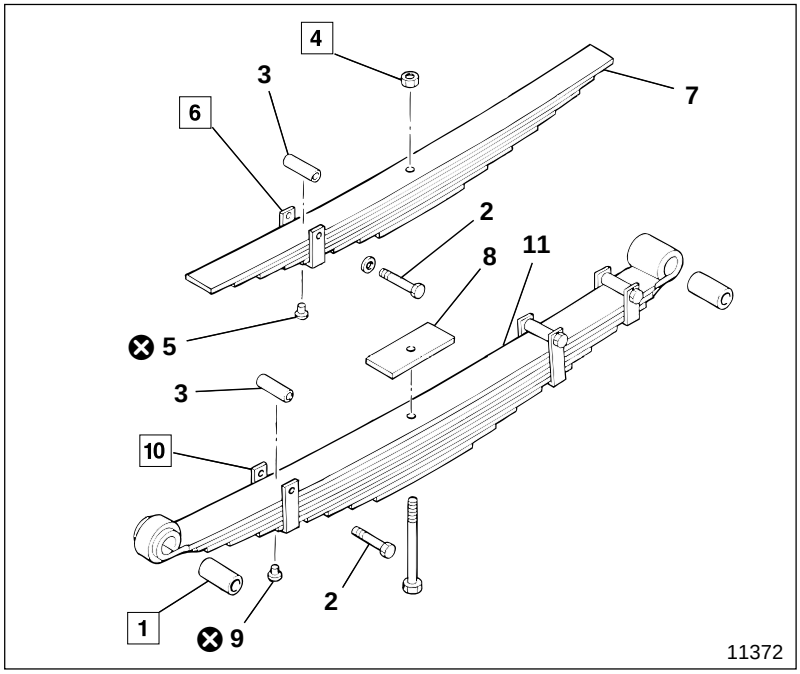


[Installation]

Align the bolt hole of rear spring rear bracket **27** and the bolt groove of shackle pin **19** using shackle pin setting bar.

M E M O

LEAF SPRING ASSEMBLY



● **Disassembly sequence**

1 Spring bushing
2 Clip bolt
3 Pipe < FM >
4 Center nut
5 Rivet
6 Clip
7 Helper spring
8 Seat
9 Rivet
10 Clip
11 Main spring

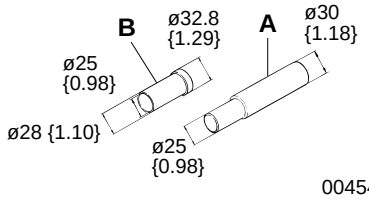
⊗ : Non-reusable parts

● **Assembly sequence**

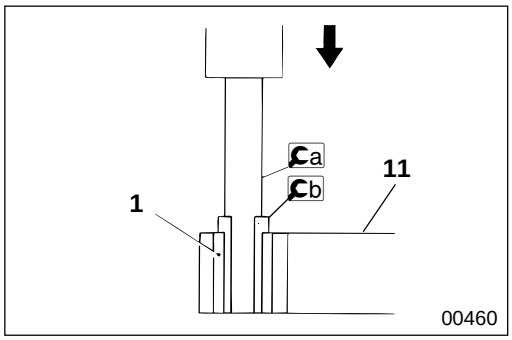
Follow the disassembly sequence in reverse.

Special tools

Unit : mm {in.}

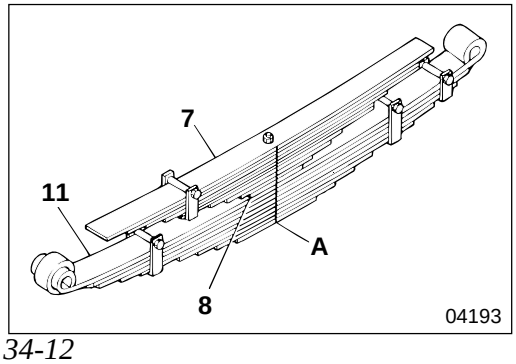
Location	Tool name and shape	Part No.	Application
1	Bushing installer set **A** : Bushing installer A **B** : Bushing installer B 	MB999066 **A** : MB999067 **B** : MB999068	Removal and installation of bushing

◆ Service procedure



1 **Removal and installation of spring bushing**

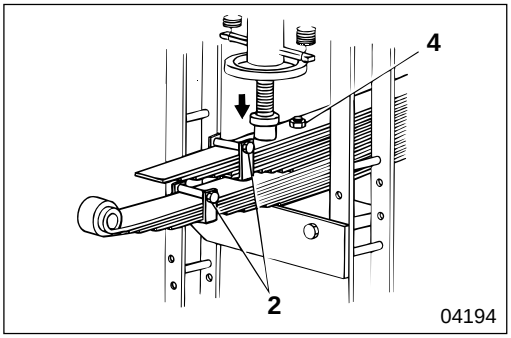
Remove spring bushing **1** from main springs **11** using a bushing installer **A** and b bushing installer **B**. For installation, follow the removal sequence in reverse.



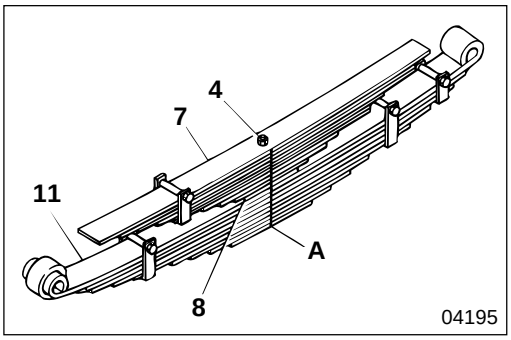
4 **Center nut**

[Removal]

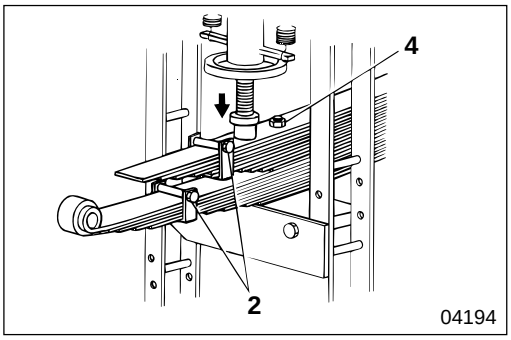
- Put alignment marks **A** on the sides of helper springs **7**, seat **8**, and main springs **11**.



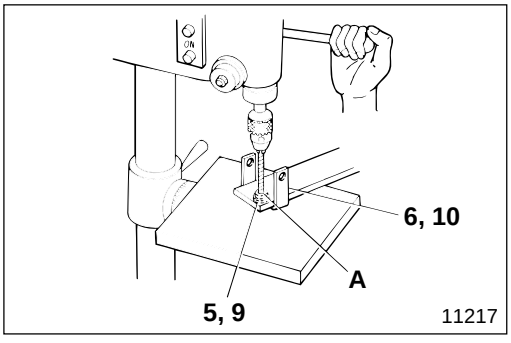
- Compress the leaf springs using a press to remove clip bolt **2** and center nut **4**.



[Installation]
- Align alignment marks **A** on helper springs **7**, seat **8**, and main springs **11** to assemble them.
- Tighten center nut **4** temporarily.

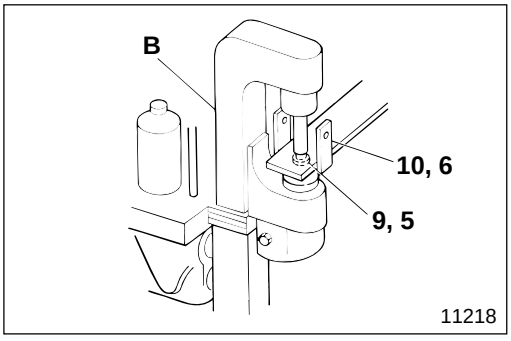


- Compress leaf springs using a press to install center nut **4**.
- Install clip bolt **2**.



6 **10** **Clip**

[Removal]
Drill out caulked ends **A** of rivets **5**, **9** on a drill press to remove clips **6**, **10**.



[Installation]
Caulk rivets **9**, **5** using riveting machine **B** to install clip **10**, **6**.

MITSUBISHI
FUSO

Group 35A
Brake
< Air Over Hydraulic Brake >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-35A

INDEX

SPECIFICATIONS 35A- 2

STRUCTURE AND OPERATION 35A- 4

TROUBLESHOOTING 35A-30

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Replacement of Brake Fluid 35A-34
- Air Bleeding of Brake System 35A-36
- Inspection and Adjustment of Brake Pedal Free Play 35A-38
- Thickness Inspection and Replacement of Brake Lining 35A-39
- Inspection of Brake Shoe Clearance 35A-39
- Inspection and Maintenance of Air Dryer 35A-40

HANDLING OF CONNECTOR AND NYLON TUBE PIPING 35A-42

BRAKE PEDAL 35A-44

DUAL BRAKE VALVE 35A-46

BRAKE BOOSTER (AIRMASTER) 35A-54

FRONT WHEEL BRAKE 35A-60

REAR WHEEL BRAKE 35A-70

AIR COMPRESSOR 35A-80

AIR DRYER 35A-88

AIR PRESSURE GOVERNOR 35A-92

FLUID TANK 35A-94

CHECK VALVE 35A-95

SAFETY VALVE 35A-95

SUPPLY VALVE 35A-96

EXHAUST BRAKE SYSTEM 35A-98

SPECIFICATIONS

< Equipment for Service Brake >

Item			Specifications
Brake booster (Airmaster)	Power cylinder Inner diameter×Stroke	mm {in.}	ø114.3×98 {4.50×3.86}
	Hydraulic cylinder Inner diameter×Stroke	mm {in.}	ø22.2×95 {0.87×3.74}
	Operating starting pressure	kPa {lbf/in², kgf/cm²}	18±9.8 {2.6±1.4, 0.18±0.1}
	Residual pressure	kPa {lbf/in², kgf/cm²}	78 to 125 {11 to 18, 0.8 to 1.3}
	Manufacturer		BOSCH BRAKING SYSTEMS
Air compressor	Type		Water-cooled one cylinder
	Cylinder diameter×Stroke	mm {in.}	ø80×40 {3.15×1.57}
	Cylinder capacity	cm³ {cu.in.}	201 {12.3}
	Manufacturer		SANWA SEIKI
Air dryer	Type		DR-31
	Heater capacity	V-W	12-50
	Thermostat operating temperature °C {°F}	ON	4±4 {39.2±7.2}
		OFF	20 {68} or lower
	Purge chamber capacity	L {qts}	1.4 {1.48}
	Required time for recycling desiccant	Sec	50
	Manufacturer		NABCO
Air tank	Capacity	L {qts}	8+15+22 {2.1+4.0+5.8}

< Wheel Brake >

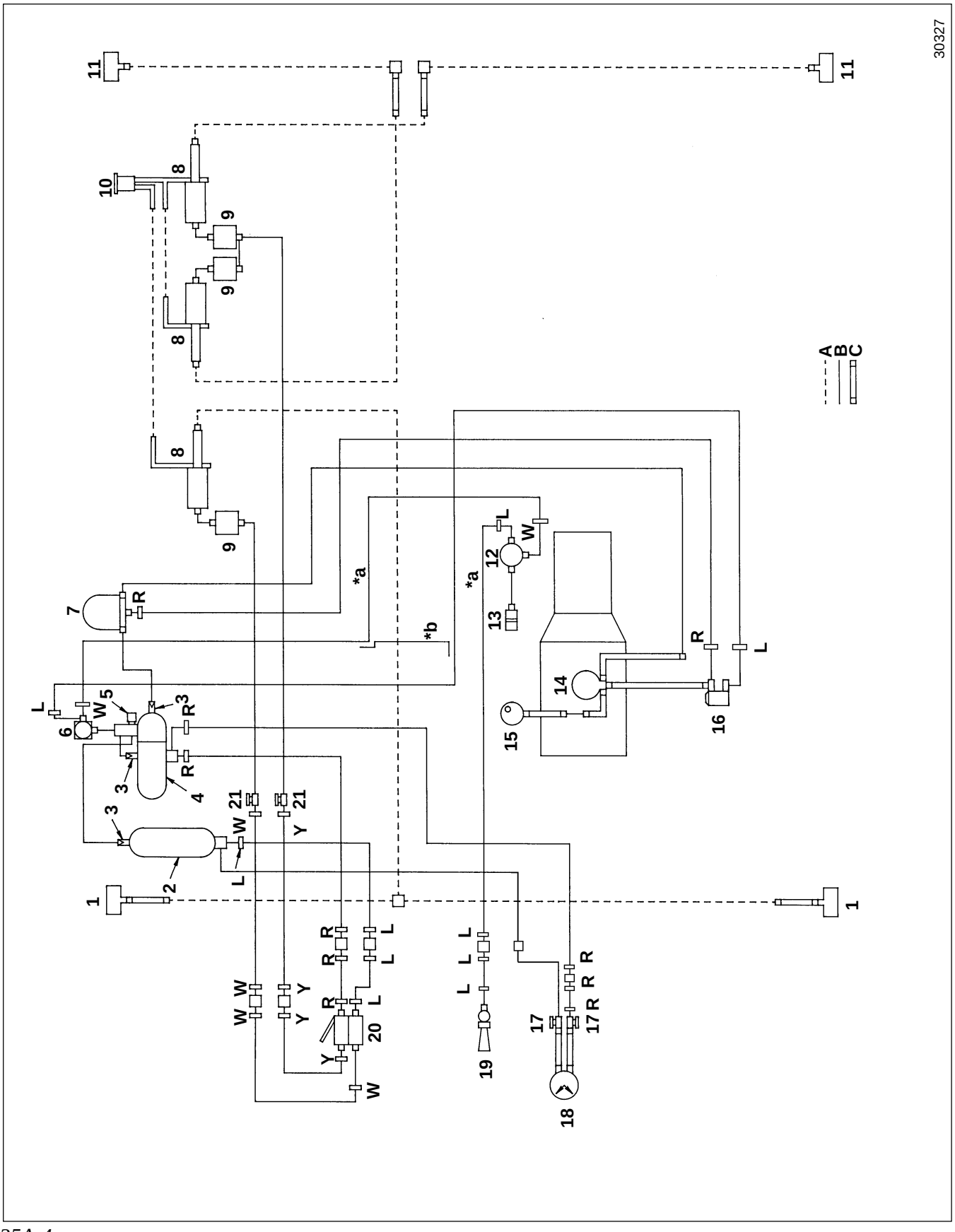
Item			Specifications
Brake type	Front		Drum brake (2-leading type)
	Rear		Drum brake (Dual 2-leading type)
Brake drum inner diameter		mm {in.}	ø400 {15.7}
Wheel cylinder inner diameter	Front	mm {in.}	ø34.93 {1.38}
	Rear	mm {in.}	ø38.10 {1.50}
Brake lining Width×Thickness	Front	mm {in.}	120×9.5 {4.72×0.37}
	Rear	mm {in.}	155×15.4 {6.10×0.61}

< Exhaust Brake >

Item	Specifications
Control type	Combined electric and air
Valve type	Butterfly valve

M E M O

Brake System

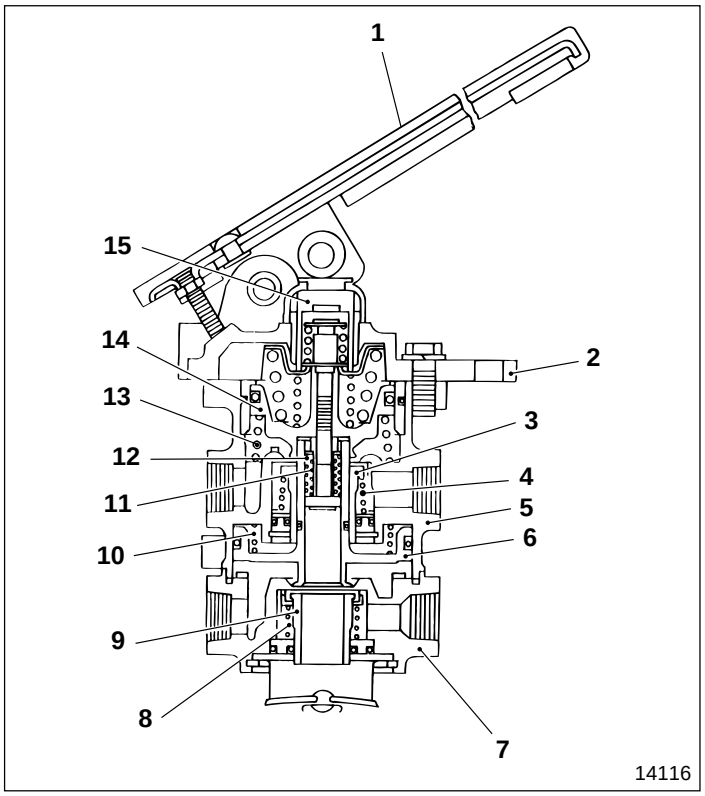


1 Front wheel cylinder
2 Air tank (front)
3 Check valve
4 Air tank (rear, wet)
5 Safety valve
6 Supply valve
7 Air dryer
8 Brake booster
9 Control valve
10 Brake fluid tank
11 Rear wheel cylinder
12 3-way magnetic valve
13 Exhaust brake unit
14 Air compressor
15 Air cleaner
16 Air pressure governor
17 Low air pressure switch
18 Air pressure gauge
19 Air horn
20 Dual brake valve
21 Stop lamp switch

A : Fluid line
B : Air line
C : Hose
L : Blue tape
R : Red tape
W : White tape
Y : Yellow tape
***a**: With exhaust brake
***b**: Without exhaust brake

- The brake system is an air over hydraulic, all wheel brake type consisting of separate front and rear systems.
- The servo system is fitted with brake boosters.
- An exhaust brake system of the exhaust pipe opening and closing valve type, is fitted as a sub-brake system.

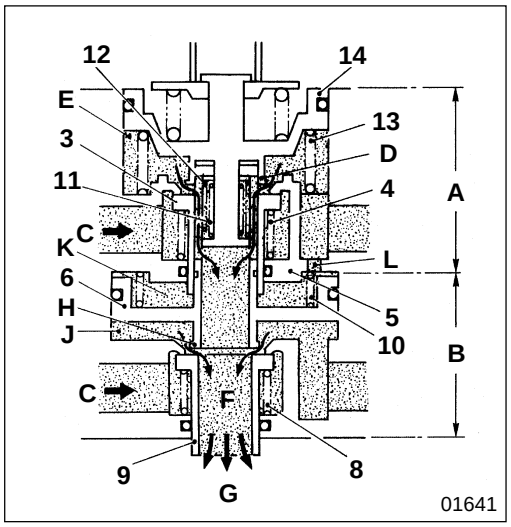
Dual Brake Valve



1 Brake pedal
2 Plate assembly
3 Primary inlet valve
4 Primary valve spring
5 Body
6 Relay piston
7 Cover
8 Secondary valve spring
9 Secondary inlet valve
10 Relay piston spring
11 Inner spring
12 Outer spring
13 Primary piston spring
14 Primary piston
15 Plunger

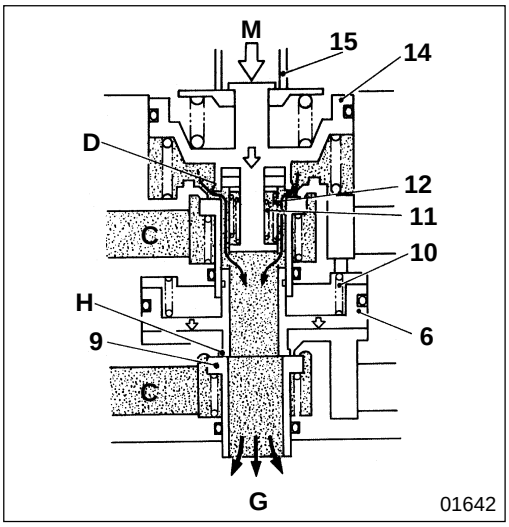
The dual brake valve controls the braking force of the vehicle by feeding pressurized air to the airmaster in accordance with the brake pedal depression angle of brake pedal **1**.

● When brake not operating



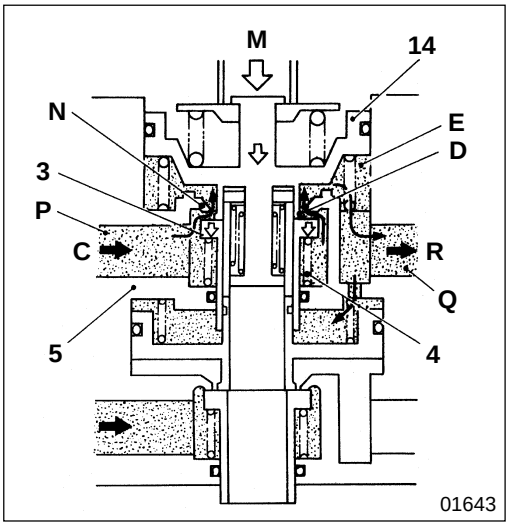
- The repercussive forces of primary valve springs **4**, secondary valve spring **8** seat primary inlet valve **3** at primary side **A**, and inlet valve **9** at secondary side **B**, on their respective seats. This shuts off air **C** from the air tank to maintain airtightness.
- The repercussive force of primary piston spring **13** raises primary piston **14** to its upper position. Exhaust valve seat **D** opens and chamber **E** is open to atmosphere **G** via chamber **F**.
- Since the repercussive forces of inner spring **11** and outer spring **12** is stronger than the repercussive force of relay piston spring **10**, relay piston **6** is raised to its upper position and exhaust valve seat **H** is opened. This opens chamber **J** to atmosphere **G** via chamber **F**.
  Chamber **E** at the primary side and chamber **K** at the upper part of relay piston **6** at the secondary side are connected via passage port **L** of body **5**.

● When depressing brake pedal (before braking pressure is generated)



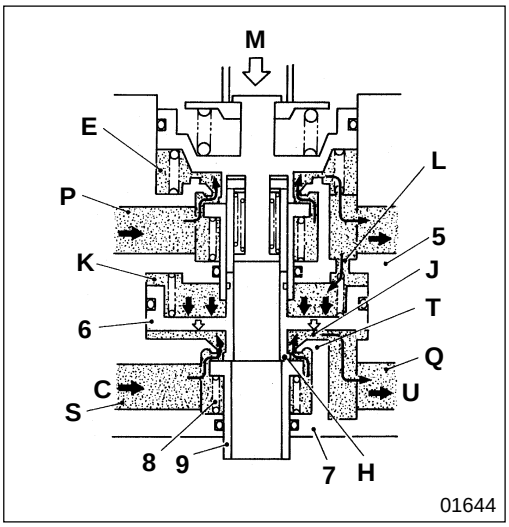
- Depressing the brake pedal (illustrated as pedal action **M**), forces down primary piston **14** via plunger **15**.
- Forcing down primary piston **14** changes the balance between the repercussive forces of inner spring **11** and outer spring **12**, and the repercussive force of relay piston spring **10**, forcing down relay piston **6**. This seats the relay piston on secondary inlet valve **9** and closes exhaust valve seat **H**.
- This closes the secondary side exhaust passage; however, primary side exhaust valve seat **D** remains open. No braking pressure is generated at either primary or secondary sides.

● When depressing brake pedal (braking pressure is generated)



Primary side

- As the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** is forced down until it is seated on primary inlet valve **3**, closing exhaust valve seat **D**.
- Primary inlet valve **3** is forced down, compressing primary valve spring **4**, and supply valve seat **N** of body **5** separates from the primary inlet valve. The air in chamber **P** flows into chamber **E** and is fed to rear brake system **R** via discharge port **Q** as braking pressure.

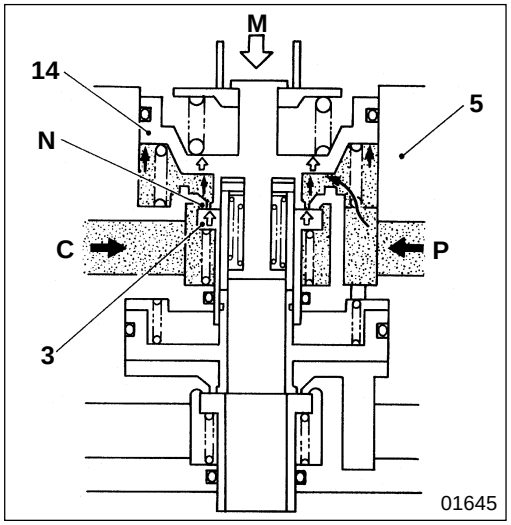


Secondary side

- The air at the primary side flows into chamber **K** via passage port **L** of body **5**.
- The air fed into chamber **K** acts on the upper part of relay piston **6** to force down the relay piston and compress secondary valve spring **8**, forcing down secondary inlet valve **9**.
- This separates supply valve seat **T** and secondary inlet valve **9** of cover **7**.
- The air in supply port chamber **S** flows into chamber **J** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

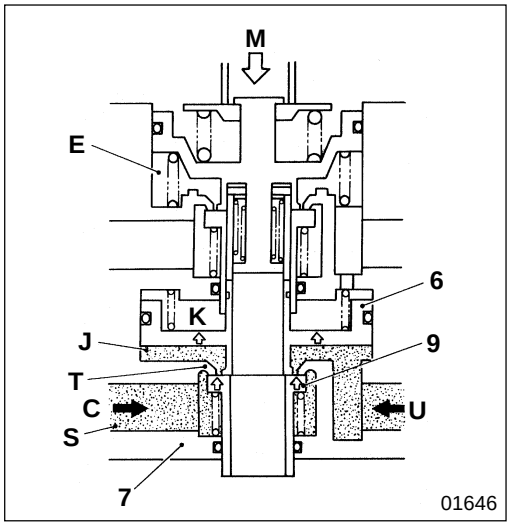
● Stabilization of braking pressure

When the brake pedal remains depressed at the specified depression angle, the braking air pressure stabilizes at the pressure corresponding to the brake pedal depression angle.



Primary side

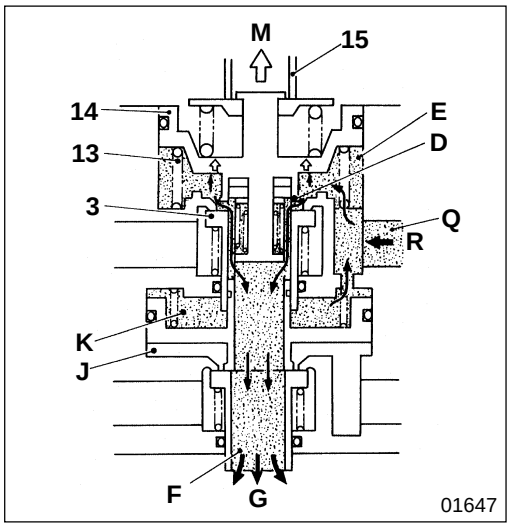
- The braking air pressure fed under the bottom of primary piston **14** raises the primary piston and primary inlet valve **3** together in tandem.
- Primary inlet valve **3** makes contact with supply valve seat **N** of body **5**, then the supply of air **C** from the air tank ceases and the increases in the braking air pressure stops. This stabilizes braking pressure **R** for the rear brake system.



Secondary side

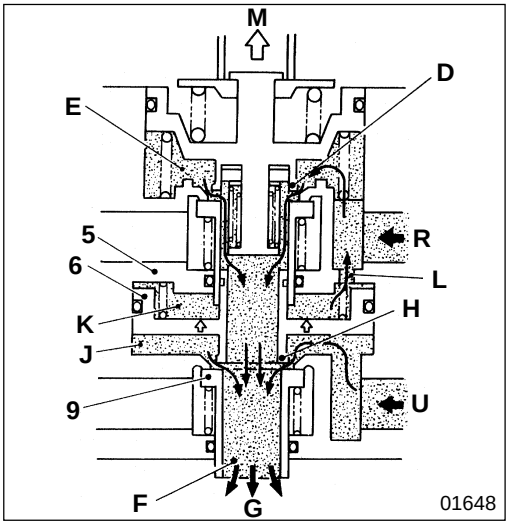
- As the braking pressure (pressure in chamber **J**) for the front brake system balances the pressures in chambers **E** and **K**, the force raising relay piston **6** disappears, and the relay piston rises in tandem with secondary inlet valve **9**.
- Secondary inlet valve **9** makes contact with supply valve seat **T** of cover **7**, then the supply of air from supply port chamber **S** to chamber **J** ceases. This stabilizes brake pressure **U** for the front system.

● Release of brake pressure



Primary side

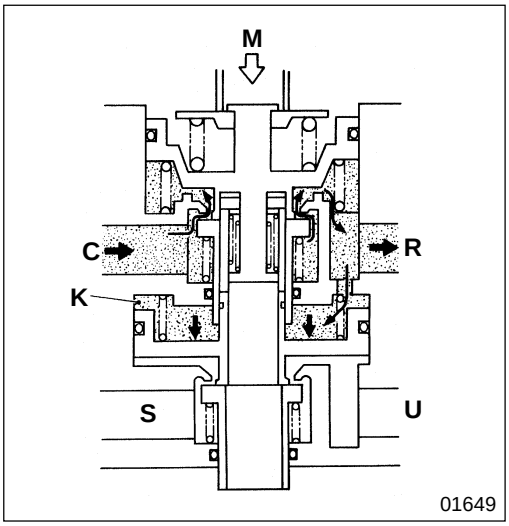
When the brake pedal is released (illustrated as brake pedal action **M**), primary piston spring **13** and air pressure **R** at discharge port **Q** (pressure in chamber **E**) raise plunger **15** and primary piston **14**. Then, exhaust valve seat **D** at the lower end of the primary piston separates from primary inlet valve **3**. The air pressure of the rear brake system flows through chamber **E** to be discharged from exhaust passage chamber **F** into atmosphere **G**.



Secondary side

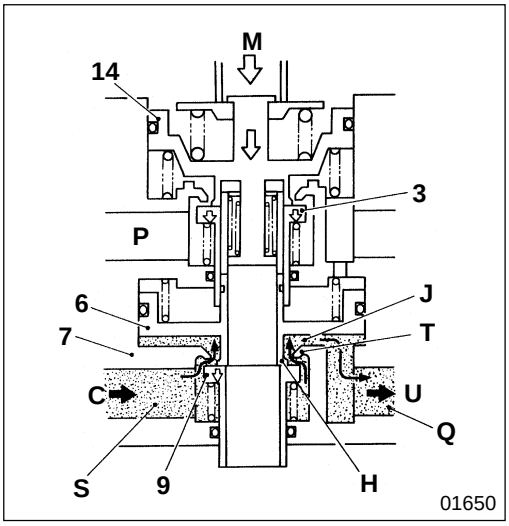
- As the air pressure in the rear brake system drops, the air pressure in chamber **K** is discharged via passage port **L** of body **5**, and chambers **E**, **F** into atmosphere **G**.
- This changes the air pressure balance between chambers **K** and **J**. The air pressure in chamber **J** raises relay piston **6**, and exhaust valve seat **H** at the lower end of the relay piston separates from secondary inlet valve **9**. Air pressure **U** in the front brake system is discharged from exhaust passage chamber **F** into atmosphere **G**.

● When abnormality occurs



Operation when the air pipe of the front brake system fails

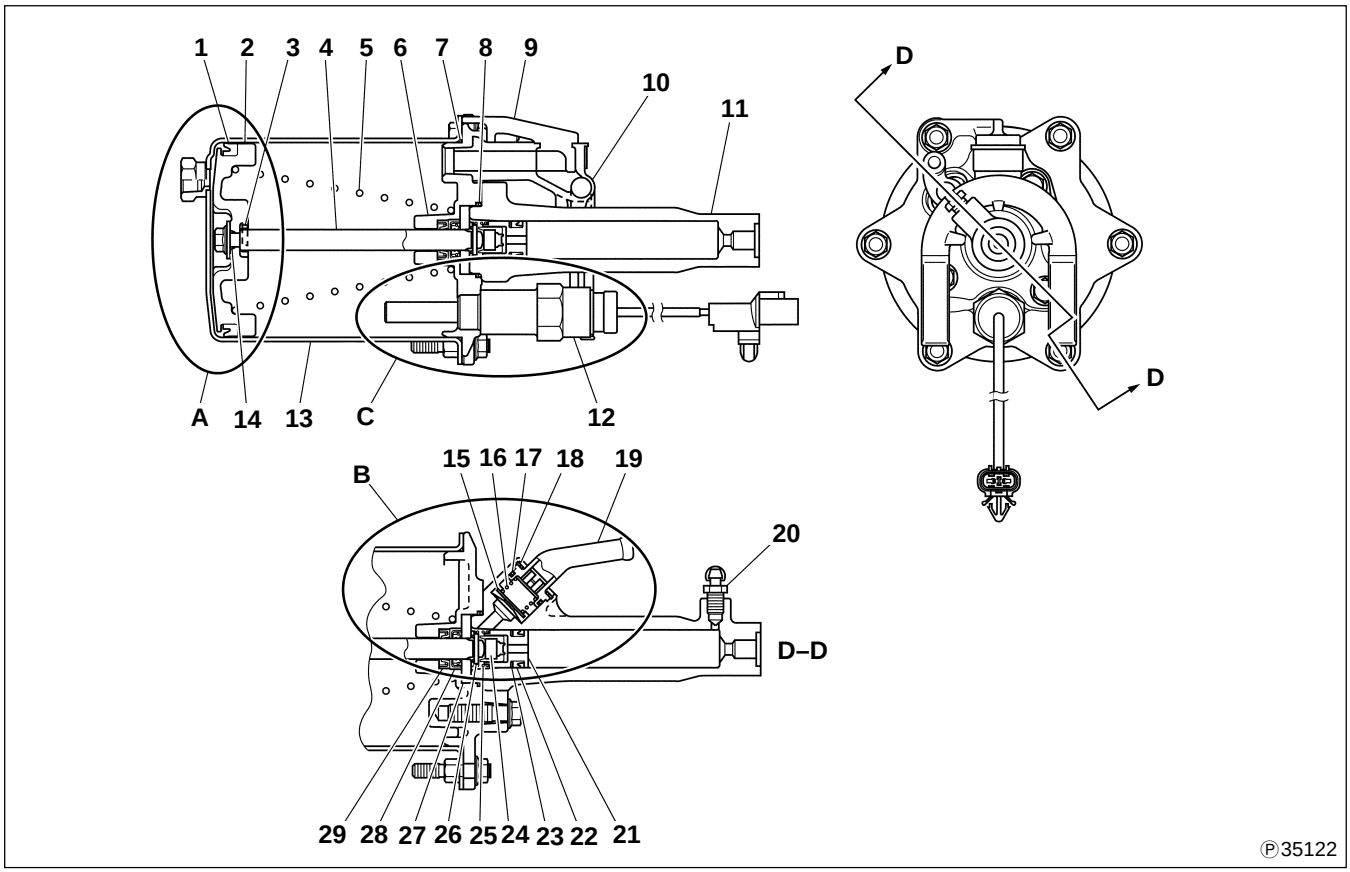
- The primary side operates the same as normal, generating braking pressure in rear brake system **R**.
- At the secondary side, even if the primary side generates air pressure in chamber **K**, braking pressure is not generated in front brake system **U**, since no air pressure is generated in supply port **S**.



Operation when the air pipe of the rear brake system fails

- In the rear brake system, air pressure is not generated up to supply port **P**. Therefore, even if the brake pedal is depressed (causing primary piston **14** to force down primary inlet valve **3**), braking pressure is not generated.
- If the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** makes contact with relay piston **6** and they force down secondary inlet valve **9**.
- This action separates supply valve seat **T** of cover **7** from secondary inlet valve **9**. The air pressure flows into chamber **J** from chamber **S** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

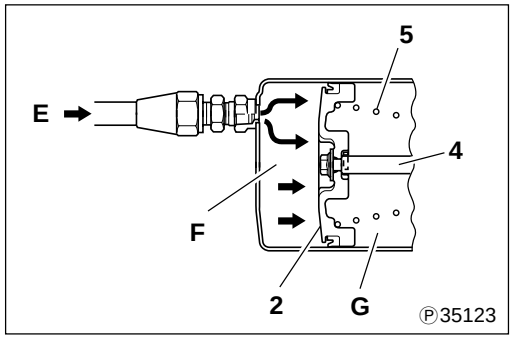
Brake Booster



1 Cup packing
2 Piston plate
3 Straight pin
4 Push rod
5 Return spring
6 End plate
7 O-ring
8 O-ring
9 Holder
10 Exhaust cover
11 Hydraulic cylinder
12 Brake booster stroke switch
13 Cylinder shell
14 O-ring
15 Valve assembly
16 Spring
17 O-ring
18 Retaining spring
19 Connector assembly
20 Plug
21 Hydraulic piston
22 Cup packing
23 Backup ring
24 Valve seal assembly
25 Spring
26 Straight pin
27 Washer
28 Oil seal
29 Oil seal

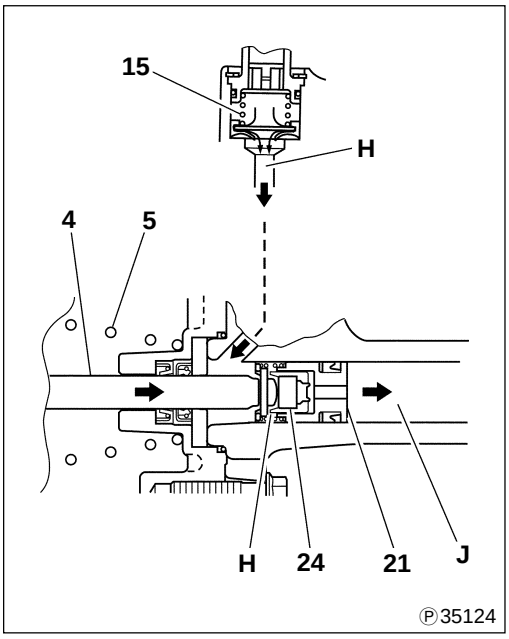
A : Power cylinder section
B : Hydraulic piston section
C : Brake booster stroke switch section

● Power cylinder section



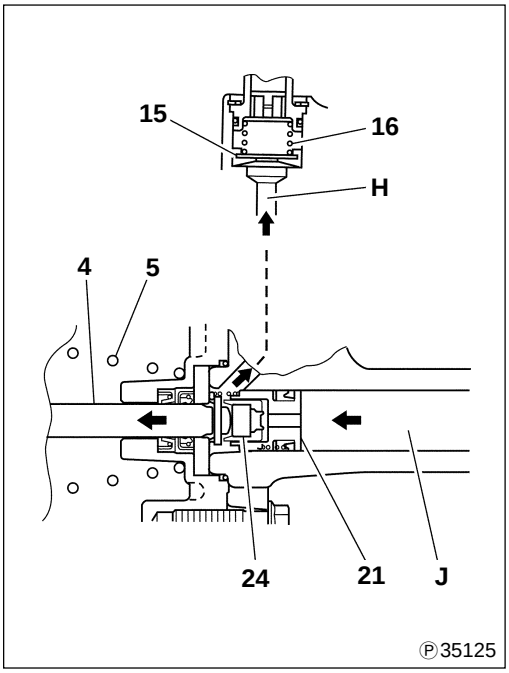
- The action of the dual-brake valve sends compressed air **E** into chamber **F**, which applies pressure to piston plate **2**. Since chamber **G** is open to the atmosphere, an internal pressure difference is created between chambers **F** and **G**. When the force of the pressure difference exceeds the force of return spring **5**, the piston plate moves toward the right.
- Piston plate **2** is attached to push rod **4**. The piston plate transmits the force applied by compressed air to the hydraulic piston section.

● **Hydraulic piston section**



When brake is applied

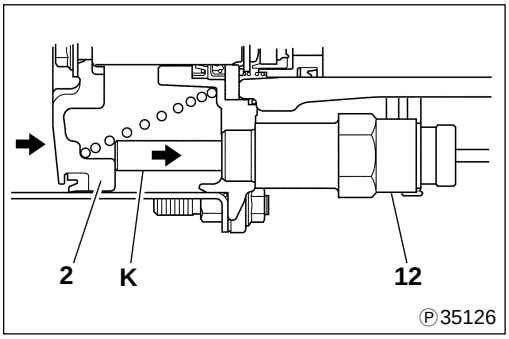
- The movement of piston plate **2** compresses return spring **5**, pushes push rod **4**, and moves hydraulic piston **21** to the right.
- Valve seal assembly **24** contacts the seat surface of hydraulic piston **21**. As a result, the passage between chamber **H** on the fluid tank side and chamber **J** on the wheel cylinder side closes, and applies pressure to the brake fluid inside chamber **J**. This pressure force is transmitted to the wheel cylinder.
- The movement of hydraulic piston **21** increases the volume of chamber **H** and causes negative pressure in the chamber. As a result, the valve in valve assembly **15** opens, and allows brake fluid to flow from the fluid tank into the valve assembly.



When brake is released

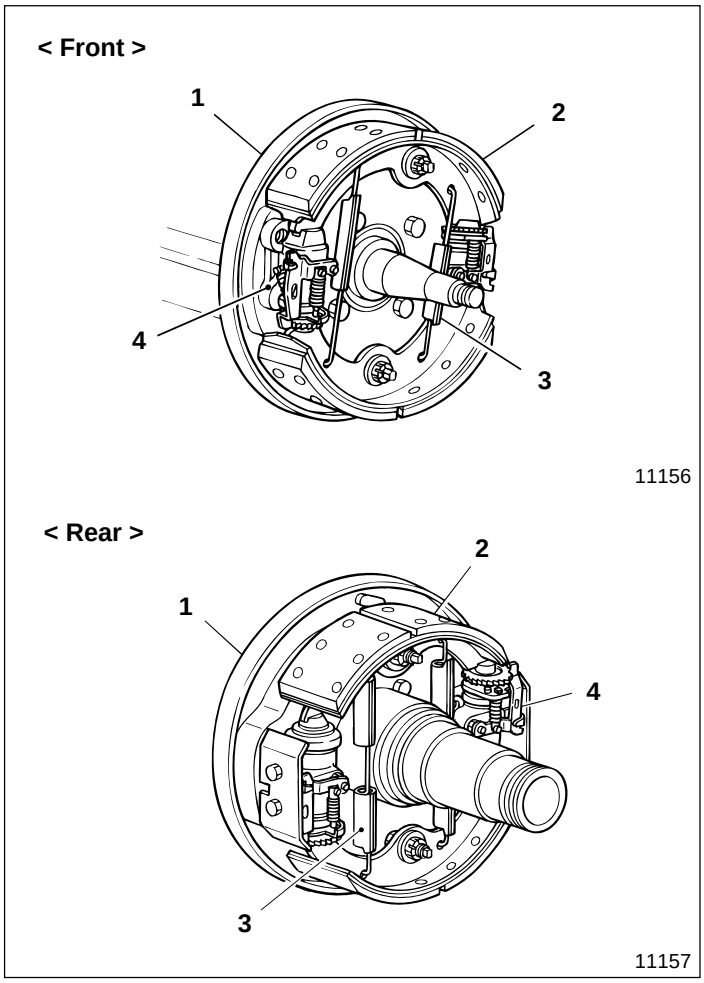
- When the brake pedal is released, compressed air behind piston plate **2** is released to the atmosphere. Hydraulic piston **21** is forced back to the original position by return spring **5** on push rod **4** and the pressure of the brake fluid in chamber **J**. When valve seal assembly **24** contacts push rod **4**, the passage between chambers **H** and **J** opens.
- Brake fluid passes through chamber **H**, compresses spring **16** in valve assembly **15** < not provided in disk brake system >, then flows around the valve assembly and return to the fluid tank.
- Valve assembly **15** remains at a position where the brake fluid pressure is in balance with the force of spring **16**.

● **Brake booster stroke switch section**



- If the brake lining is worn or brake fluid leaks due to damaged brake pipe, the stroke of piston plate **2** increases and causes the piston plate to contact the tip of rod **K**, thus moving the rod to the right.
- When the rod moves to the right, it activates brake booster stroke switch **12**, which in turn lights the warning lamp on the meter cluster to warn the driver.

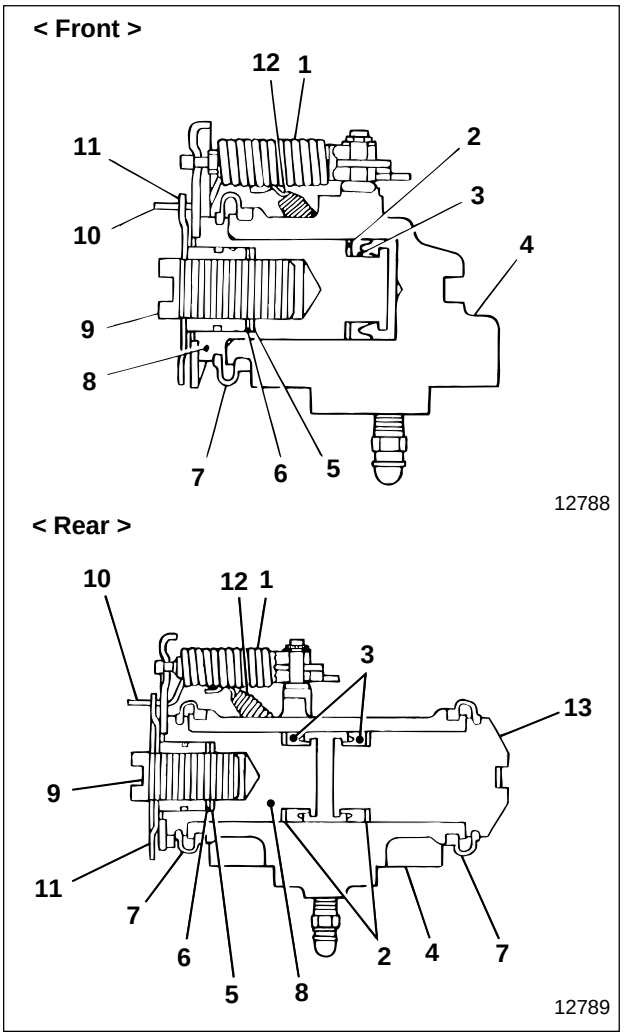
Wheel Brake



1 Backing plate
2 Brake shoe assembly
3 Return spring
4 Wheel cylinder assembly

- The front wheel brake is an internal expanding 2-leading brake type.
- The rear wheel brake is an internal expanding dual 2-leading brake type.
- Front and rear wheel cylinder assemblies **4** have shoe clearance automatic adjusting mechanisms to maintain the shoe clearance within a specific range.

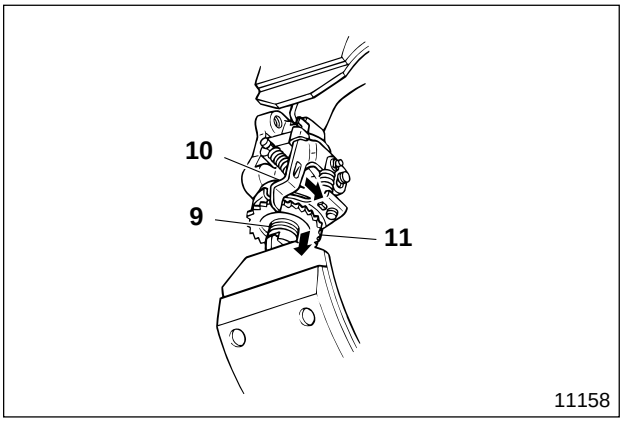
Wheel Cylinder Assembly



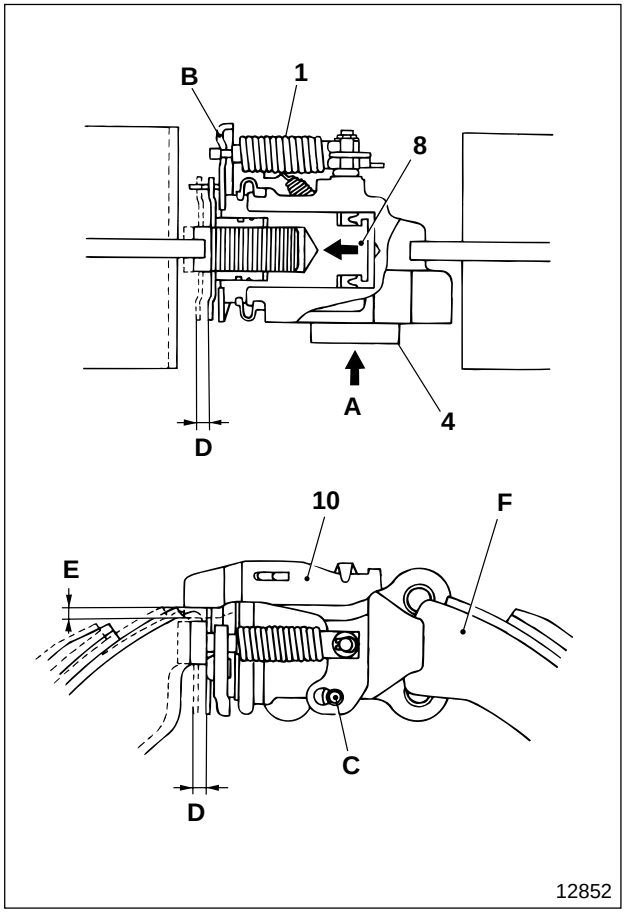
1 Spring
2 Backup ring
3 Piston cup
4 Cylinder body
5 Washer (Thick)
6 Washer (Thin)
7 Boot
8 Piston
9 Screw
10 Adjusting lever
11 Adjuster
12 Set spring
13 Piston < Rear wheel cylinder >

The automatic shoe clearance adjuster automatically adjusts the brake shoe clearance as the lining wears and the brake shoe clearance becomes higher than the specified value.

● **Operation of automatic shoe clearance adjusting mechanism**

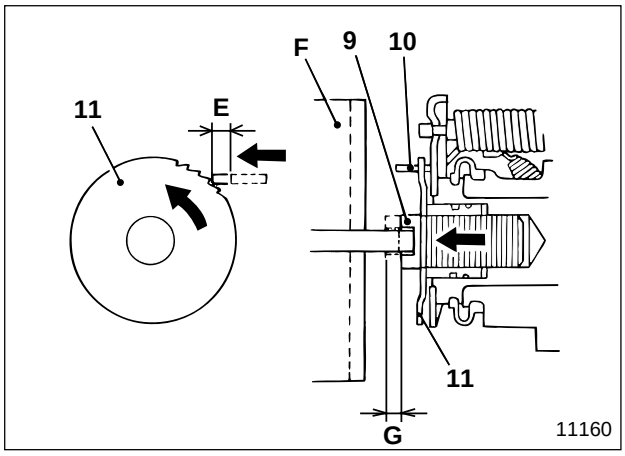


Adjusting lever **10** turns adjuster **11** to push out screw **9**, maintaining correct shoe clearance.



When depressing brake pedal

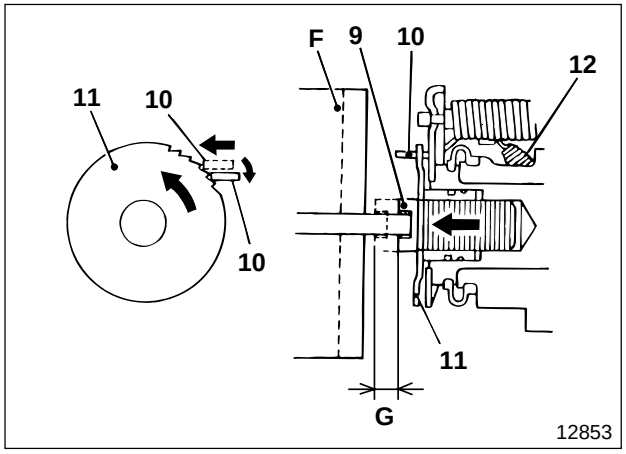
- Hydraulic pressure **A** acts on cylinder body **4** to push piston **8** forward.
- As spring hanger **B** of piston **8** is pushed forward, spring **1** which is connected to the spring hanger is pulled, and adjuster lever **10** turns around pin **C**.
  D : Travel of piston **8**
  E : Travel of adjusting lever **10**
  F : Brake shoe assembly



When the brake shoe clearance conforms to the specified value

- When the brake shoe clearance conforms to the specified value, the amount of travel of piston **8** is small. Therefore, the amount adjusting lever **10** turns is less than a one-tooth pitch of adjuster **11** and the adjuster does not turn, so no adjustment is made.
  E : Travel of adjusting lever **10**
  F : Brake shoe assembly
  G : Travel of screw **9**

- When the brake pedal is released, adjusting lever **10** does not climb one tooth of adjuster **11**, so the original engagement is maintained.



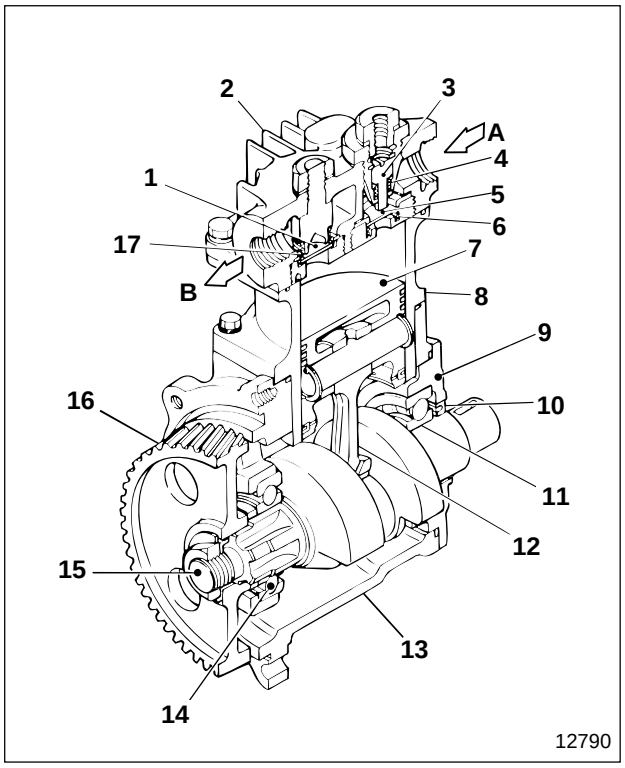
When the brake shoe clearance is higher than the specified value

- When the brake shoe clearance is higher than the specified value, the amount of travel of piston **8** is large. Therefore, adjusting lever **10** and adjuster **11** turn by a greater amount.
- The further adjuster **11** turns, the further screw **9** is pushed out. This regulates the brake shoe clearance to an amount within the specified value.
- When the brake pedal is released, adjuster **11** maintains the position after turning. Adjusting lever **10** climbs one tooth of the adjuster due to the action of set spring **12** to change the engagement, and is returned to the original position.

  F : Brake shoe assembly

  G : Travel of screw **9**

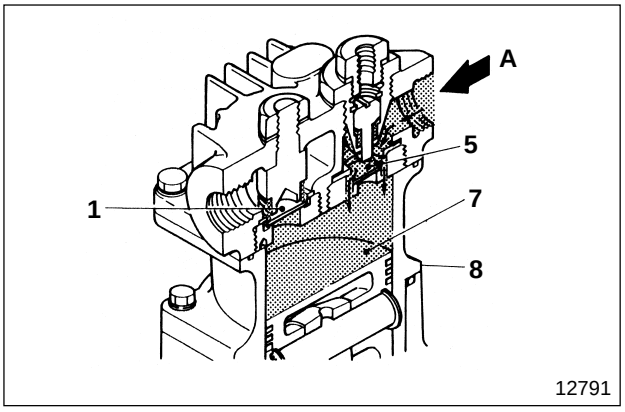
Air Compressor



1 Delivery valve
2 Cylinder head
3 Unloader valve
4 Unloader valve spring
5 Suction valve
6 Suction valve spring
7 Piston
8 Cylinder liner
9 Bearing holder
10 Oil seal
11 Bearing
12 Connecting rod
13 Crankcase
14 Bearing
15 Crankshaft
16 Drive gear
17 Delivery valve spring

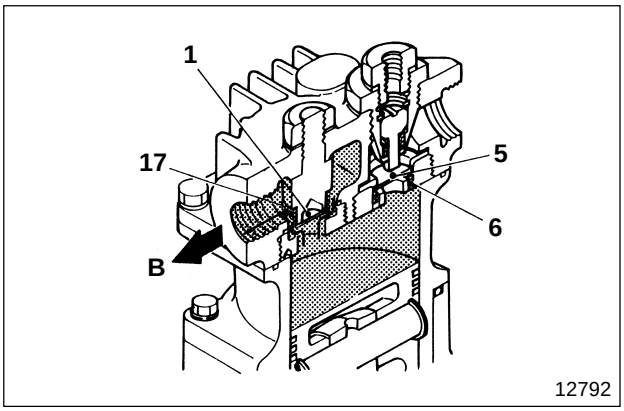
A : Air delivery port (From air cleaner)
B : Air discharge port (To air dryer)

● **During suction**



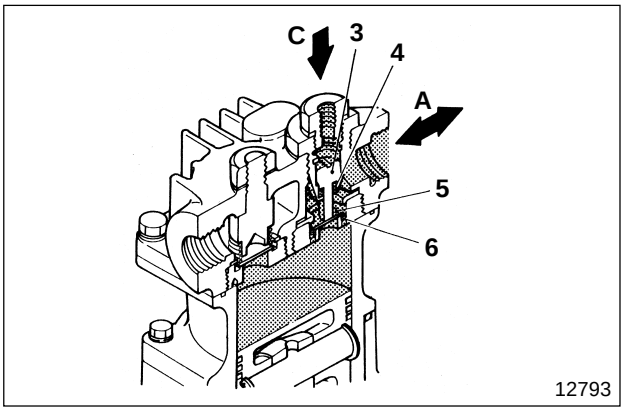
- When drive gear **16** is driven, crankshaft **15** engaged with the drive gear turns to force down piston **7**.
- The negative pressure generated at this time opens suction valve **5**, sucking air **A** into cylinder liner **8**.

● **During pressurized delivery**



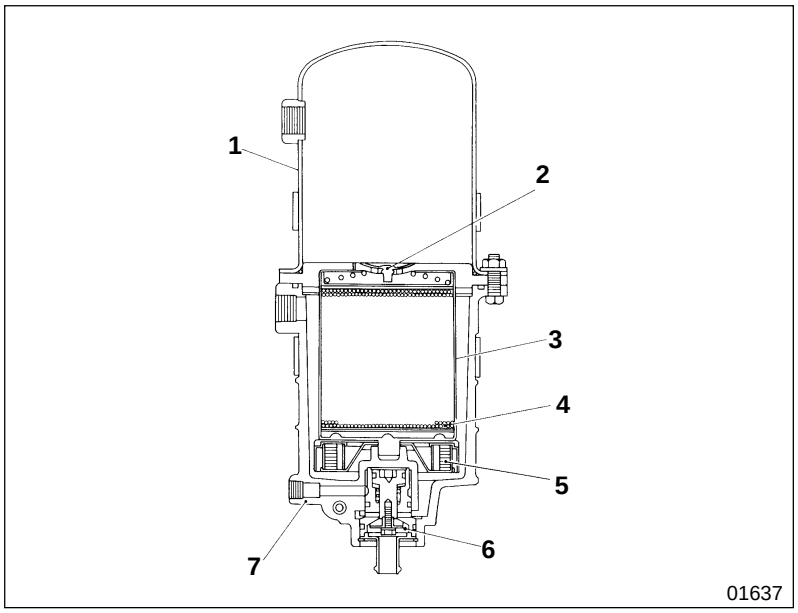
- As piston **7** rises and enters into the compression stroke, suction valve spring **6** closes suction valve **5**.
- The pressure of the compressed air overcomes the repercussive force of delivery valve spring **17** and opens delivery valve **1** to compress and deliver air **B** to the air dryer.

● **When unloader valve operates**



- When the air pressure in the air tank raises higher than the specified value, the air pressure governor operates to feed pressured air **C** to unloader valve **3**. This forces down the unloader valve and holds suction valve **5** open at the same time. Therefore, air **A** is not compressed and the air compressor idles.
- When the air pressure in the air tank drops lower than the specified value, the air pressure governor operates again to discharge pressured air from the upper side of unloader valve **3**. So, unloader spring **4** returns the unloader valve to its original position and the air compressor operates under a load.

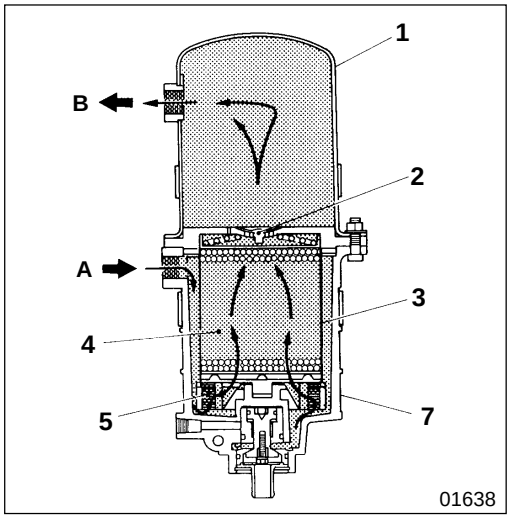
Air Dryer



1 Purge chamber
2 Check valve
3 Case
4 Desiccant
5 Oil filter
6 Valve
7 Body

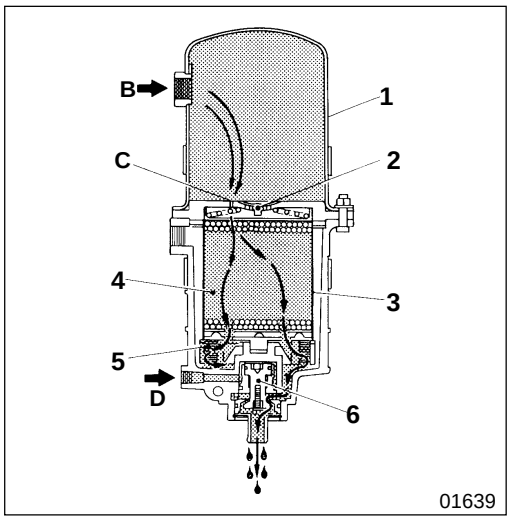
The air dryer removes moisture and oil from the air compressed by the air compressor, protecting the brake system.

● Dehumidification



- The pressurized air from the air compressor enters the air dryer through delivery port **A**. First, it flows in body **7** where moisture and oil are separated from the air and collected in the bottom. Then, the air passes through oil filter **5** where oil mist and dust are removed. Next, it is delivered into case **3** where moisture contained in the air is removed by desiccant **4**.
- As the air travels from the bottom to the top of case **3**, it comes into contact with more dried desiccant **4**. This removes residual moisture from the air, drying the air as it reaches the top of the case. The air passes through check valve **2** and purge chamber **1**, and is delivered to the air tank through exhaust port **B**.

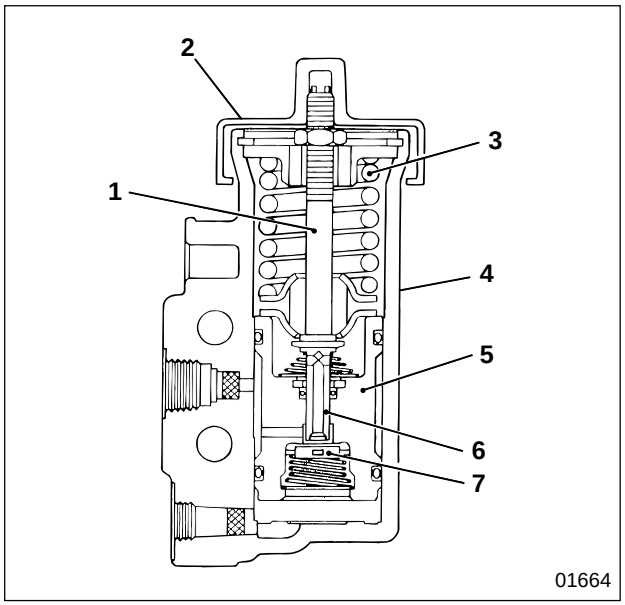
● Regeneration of desiccant



- When the supply of air from the air compressor stops, command pressure **D** from the air pressure governor opens valve **6** of the control port of the air dryer. This allows the pressure in case **3** to clean oil filter **5** and release the condensed water and oil into the atmosphere.
- Because of quick pressure reduction in the case, the dry air in purge chamber **1** flows through orifice **C** in the case **3** where the air expands under the reduced pressure, becoming super dry air. This air flows back through case **3** while removing the moisture from desiccant **4**, and is discharged together with moisture into the atmosphere, thereby recycling the desiccant.

M E M O

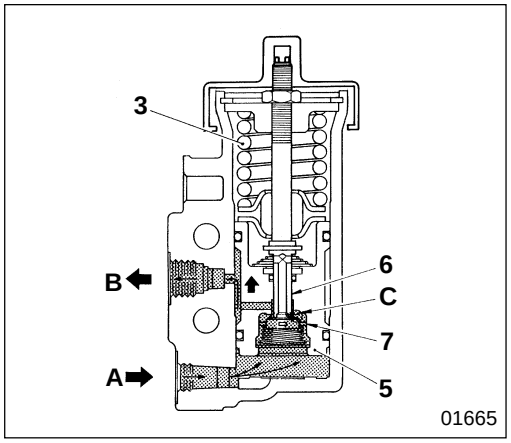
Air Pressure Governor



1 Adjusting screw
2 Cover
3 Spring
4 Body
5 Piston
6 Exhaust stem
7 Valve

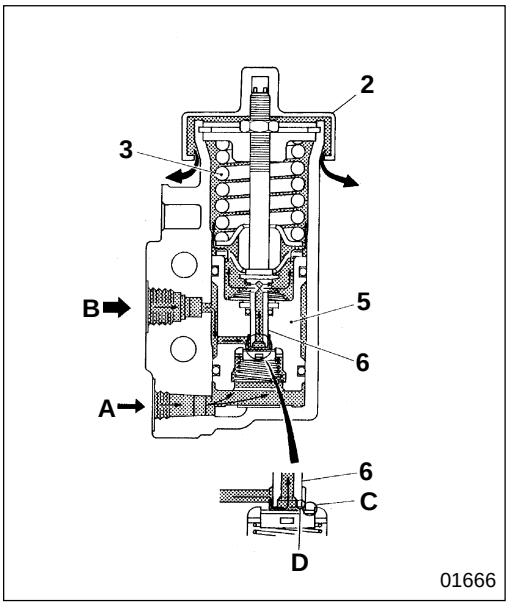
The air pressure governor keeps the air pressure in the air tank at the specified pressure, by operating the air compressor with or without load in accordance with the air pressure in the air tank.

● High specified-pressure



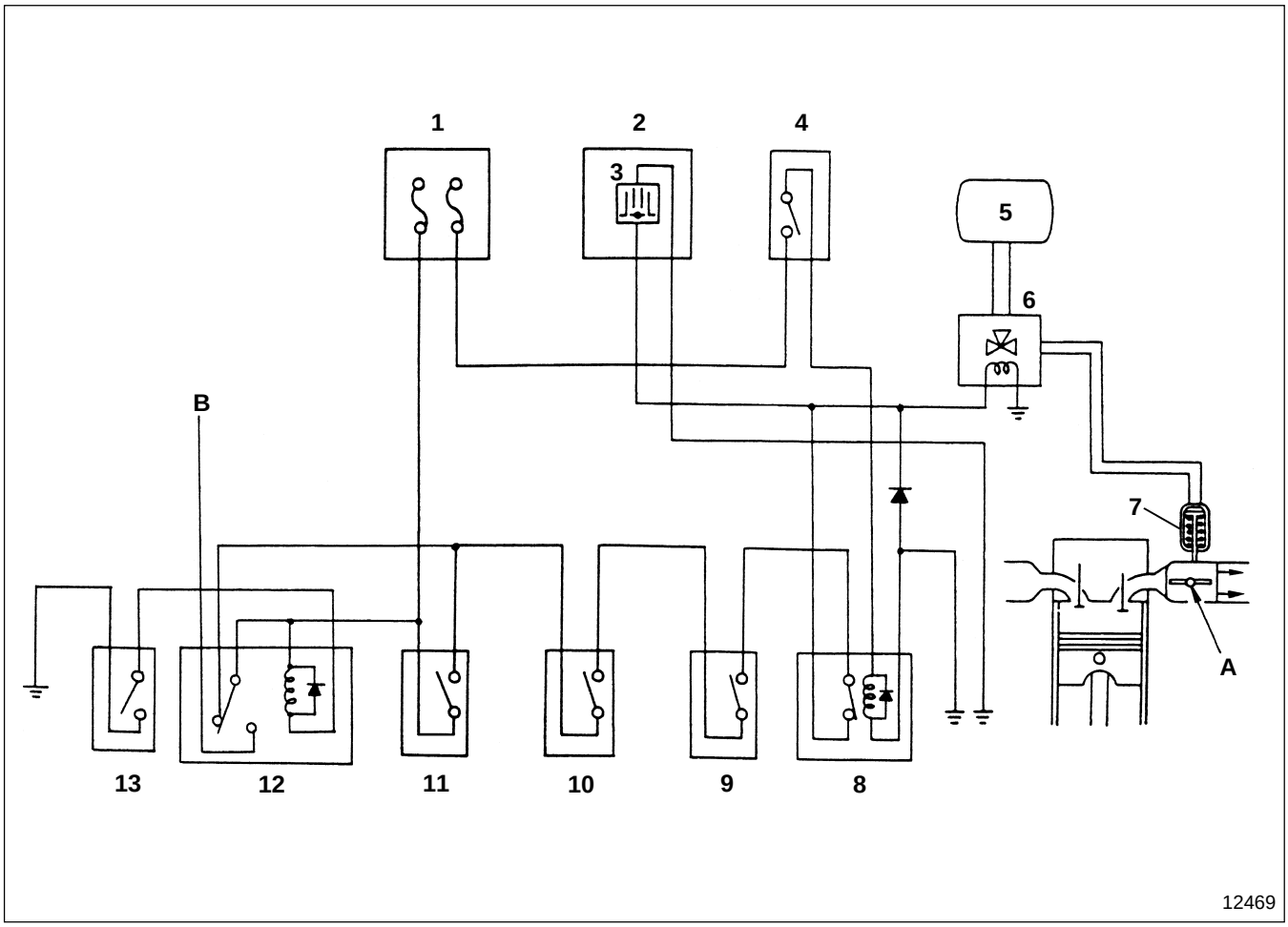
- Pressurized air **A** from the air tank acts constantly on piston **5**. As the pressure in the air tank rises to overcome the repercussive force of spring **3**, the piston rises and valve **7** closes.
- As air pressure **A** from the air tank rises further to become higher than the high specified-pressure, piston **5** rises further. Therefore, exhaust stem **6** opens inlet valve **C** and the air pressure in the air tank flows from unloader port **B** to the unloader valve of the air compressor via the inlet valve. Then the air compressor enters unloaded operation. Pressure also reaches the air dryer to recycle the desiccant

● Low specified-pressure



When pressurized air **A** from the air tank gradually drops below the specified-pressure, spring **3** forces down piston **5**. This closes inlet valve **C** and opens exhaust valve seat **D** so pressurized air **B**, up to the unloader valve of the air compressor, is discharged through the opening of cover **2** via exhaust stem **6**, operating the air compressor at load. The pressurized air up to the air dryer is also discharged into the atmosphere.

Exhaust Brake System

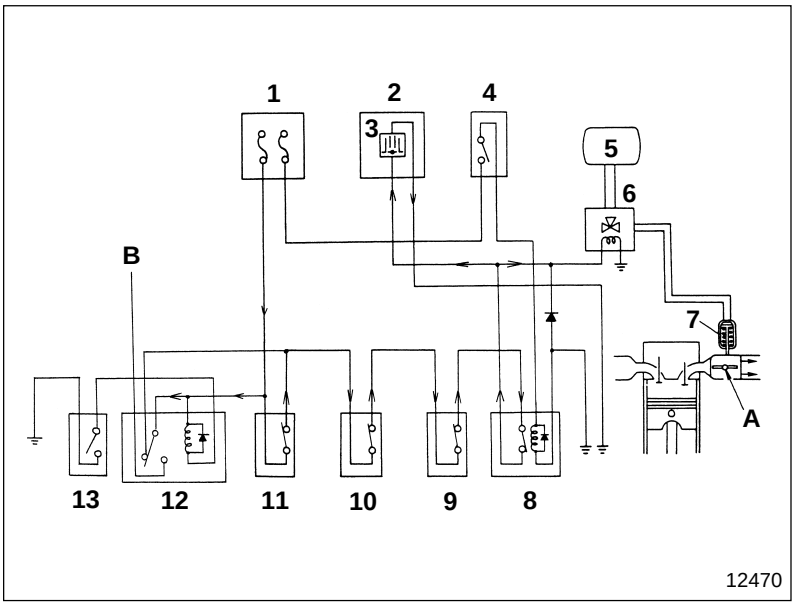


1 Relay and fuse box
2 Meter cluster
3 Exhaust brake indicator lamp
4 Transmission neutral switch
5 Air tank
6 3-way magnetic valve
7 Exhaust brake unit
8 Exhaust brake cut relay
9 Accelerator switch
10 Exhaust brake switch
11 Clutch switch < without power take-off >
12 Power take-off relay < with power take-off >
13 Clutch switch < with power take-off >

A : Butterfly valve
B : To power take-off switch

- Excitation of 3-way magnetic valve **6** causes the air pressure in air tank **5** to act on exhaust brake unit **7** to close butterfly valve **A**, activating the exhaust brake.
- If the exhaust brake is activated while the vehicle is stationary, the coolant temperature can rise excessively, overheating the engine. To avoid this, when the transmission is in neutral, transmission neutral switch **4** turns ON, cutting the exhaust brake system.

● When exhaust brake system is activated

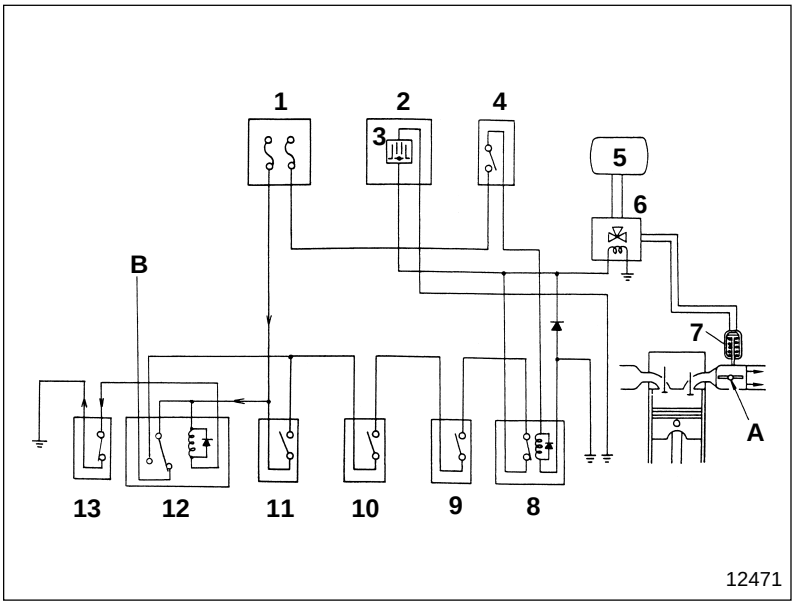


When exhaust brake switch **10** is turned on, the current flows as illustrated to activate the exhaust brake.

Fuse **1** → Power take-off relay **12** → Clutch switch **11** → Exhaust brake switch **10** → Accelerator switch **9** → Exhaust brake cut relay **8** → 3-way magnetic valve **6** → Ground

Fuse **1** → Exhaust brake indicator lamp **3** (ON) → Ground

● When the exhaust brake system is released



When the accelerator pedal or clutch pedal is depressed while the exhaust brake is working, all switches **9**, **11** turn off, shutting off the current, releasing the exhaust brake.

● When clutch pedal is depressed

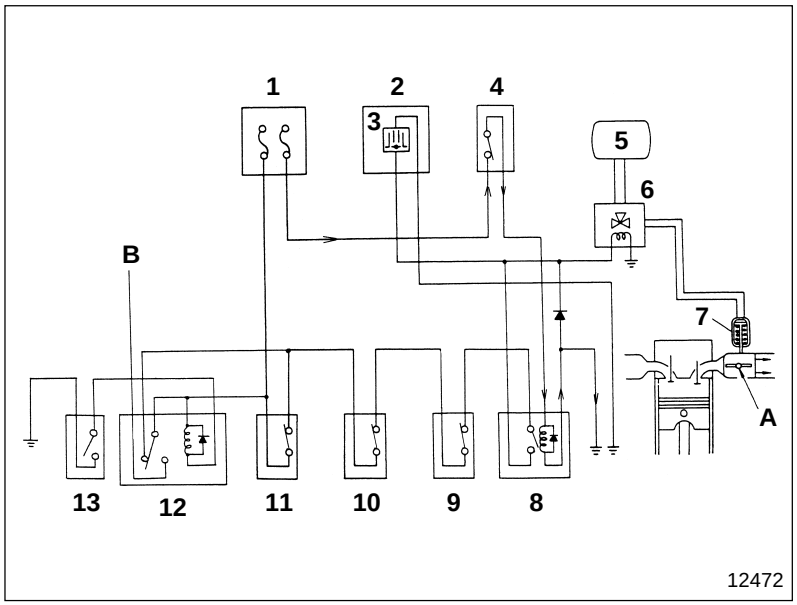
Fuse **1** → Clutch switch **11** (OFF) → Since no current flows, the circuit turns off and the exhaust brake is released.

Fuse **1** → Power take-off relay **12** excitation → Clutch switch **13** (ON) → Ground

● When accelerator pedal is depressed

Fuse **1** → Power take-off relay **12** → Clutch switch **11** → Exhaust brake switch **10** → Accelerator switch **9** (OFF) → Since there is no grounding, current does not flow, so the exhaust brake is released.

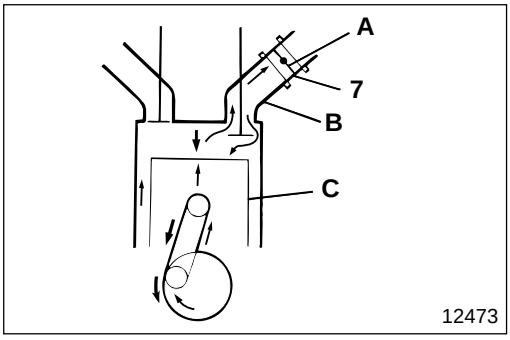
● Releasing exhaust brake system by placing transmission in neutral



When the transmission is placed in neutral, the current flows as illustrated and the exhaust brake is released.

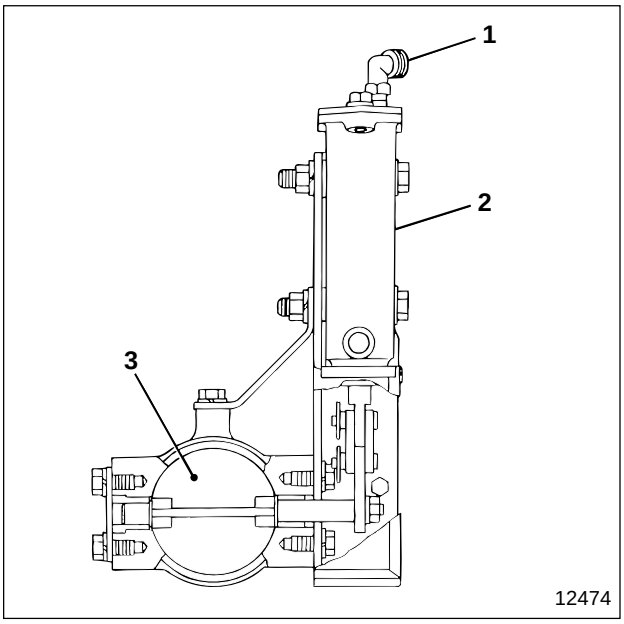
Fuse **1**⟶Transmission neutral switch **4**→Exhaust brake cut relay **8** excitation →Ground
Fuse **1**⟶Clutch switch **11**⟶ Exhaust brake switch **10**→Accelerator switch **9**→Exhaust brake cut relay **8** (OFF)
→Power take-off relay **12**
→Beyond this, current does not flow so the exhaust brake is released.

● Working principle of exhaust brake



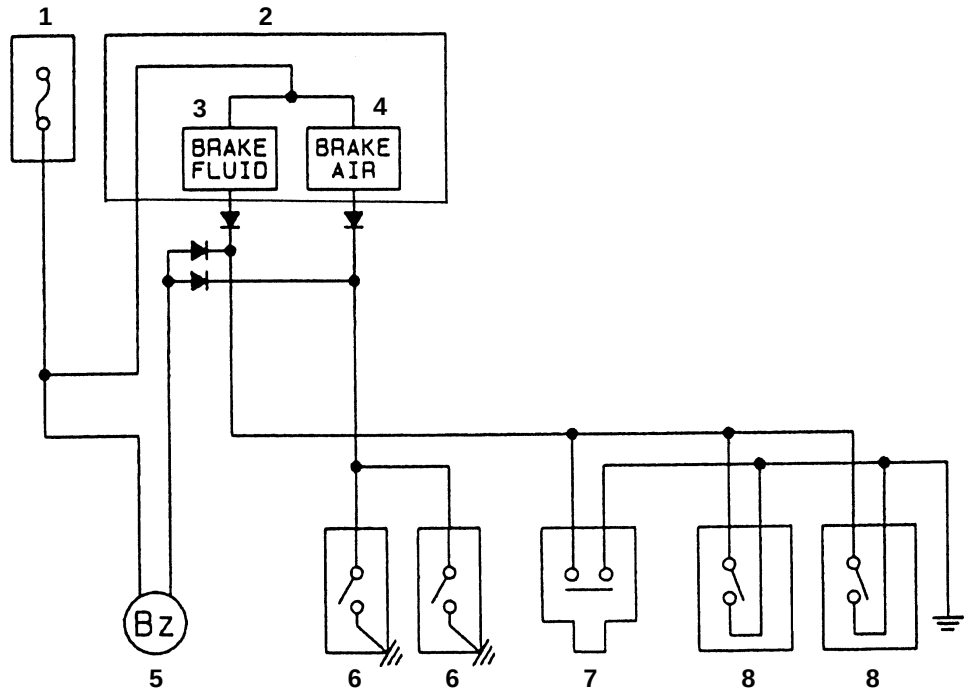
When butterfly valve **A** of exhaust brake unit **7**, in exhaust pipe **B**, is closed, the pressure in the exhaust pipe rises. The pressure rises further in the exhaust stroke, generating a force that pushes back piston **C**, the exhaust braking force.

● Exhaust brake unit



1 Connector
2 Control cylinder
3 Butterfly valve

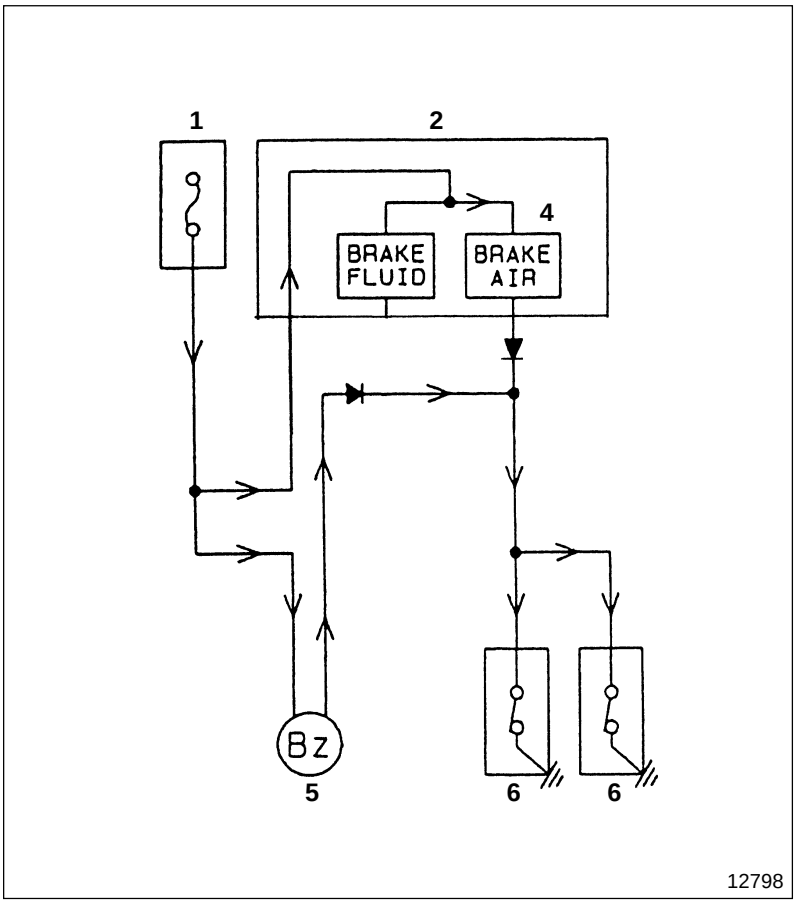
Brake Warning System



1 Fuse and relay box
2 Meter cluster
3 Brake fluid warning lamp
4 Air warning lamp
5 Warning buzzer
6 Low air pressure switch
7 Brake fluid level switch (installed on fluid tank)
8 Stroke switch (installed on airmaster)

The brake warning system consists of two circuits: the air pressure warning circuit and the brake fluid warning circuit. The first detects decrease of air pressure in the air tank, the second detects decrease in brake fluid in the fluid tank and brake fluid leakage in the brake fluid system. Both circuits light warning lamps and at the same time sound a buzzer to alert the driver.

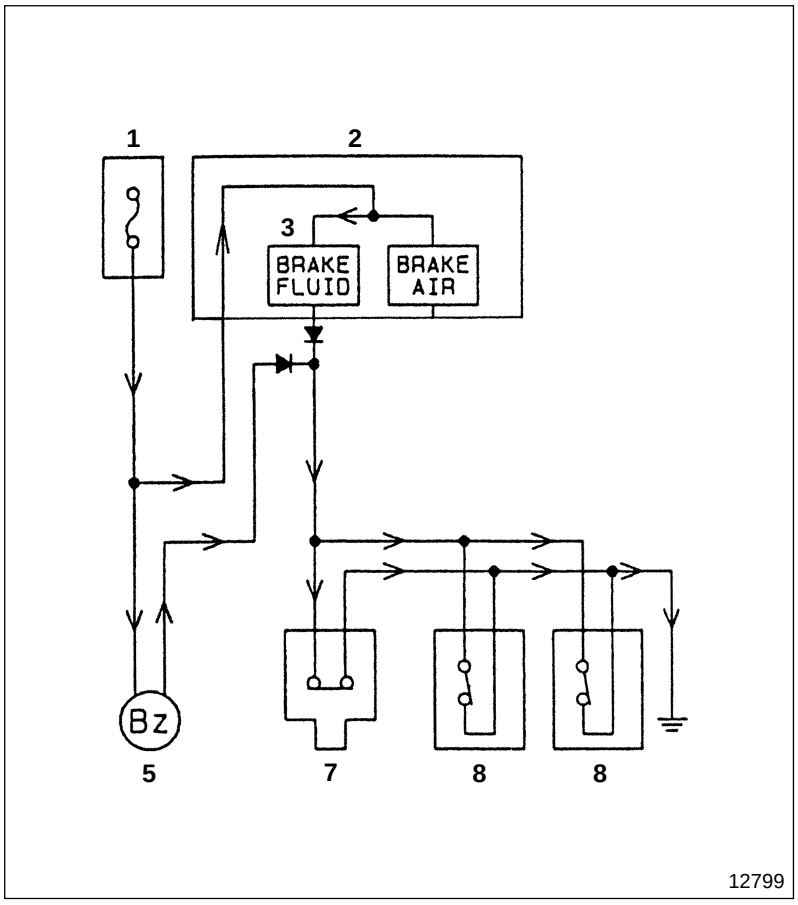
● Air pressure warning circuit



When the air pressure in the air tank drops below the specified value, low air pressure switch **6** turns on to light air warning lamp **4** and sound warning buzzer **5**. The current flows as follows:

Fuse **1**→Air warning lamp **4**→Low air pressure switch **6**→Ground
Fuse **1**→Warning buzzer **5**→Low air pressure switch **6**→Ground

● Brake fluid warning circuit



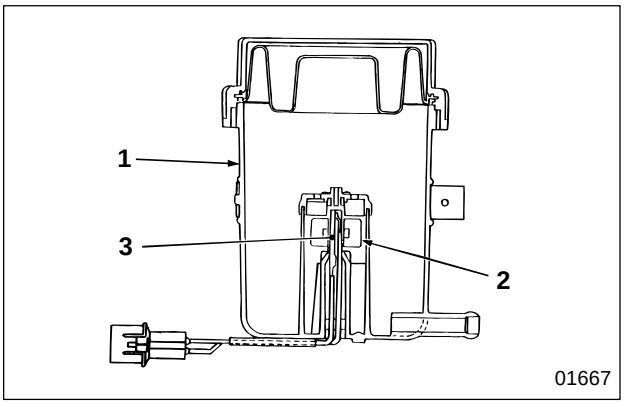
- When the brake fluid in the fluid tank drops below the specified level, brake fluid level switch **7** in the fluid tank turns on, brake fluid warning lamp **3** lights and warning buzzer **5** sounds. At this time, current flows as follows:

  Fuse **1** → Brake fluid warning lamp **3** → Brake fluid level switch **7** → Ground
  Fuse **1** → Warning buzzer **5** → Brake fluid level switch **7** → Ground

- If brake fluid leaks from the brake fluid system, stroke switch **8** of the airmaster turns on, brake fluid warning lamp **3** lights and warning buzzer **5** sounds. At this time, current flows as follows:

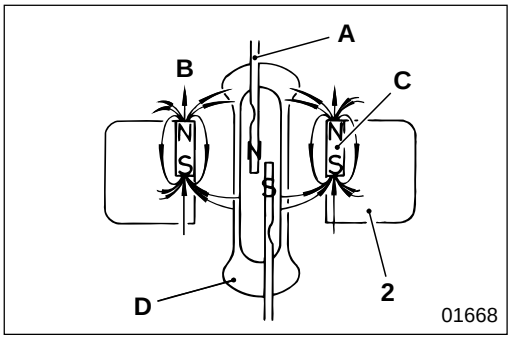
  Fuse **1** → Brake fluid warning lamp **3** → Stroke switch **8** → Ground
  Fuse **1** → Warning buzzer **5** → Stroke switch **8** → Ground

● Brake fluid level switch



1 Fluid tank
2 Float
3 Brake fluid level switch

- Brake fluid level switch **3**, installed on fluid tank **1**, detects the brake fluid level in the fluid tank. If the brake fluid level drops below the specified level, float **2** moves to turn on the brake fluid level switch and light up the brake fluid warning lamp to alert the driver.



- If the brake fluid level in fluid tank **1** drops and float **2** drops lower than level **L**, magnetic force **B** that passes through the contact points (ferromagnetic material **A**) increase, generating north and south poles at the ends of the contact points. Therefore, the contact points pull each other and overcome the repercussive force of the springs of the contact points, forming an electric circuit.
  C : Permanent magnet
  D : Glass

● Wheel Brake

Symptoms / Possible causes		Wheel brake does not work effectively: Air leakage when brake pedal depressed	Wheel brake does not work effectively: Air leakage when brake pedal released	Wheel brake does not work effectively: No air leakage but brake works ineffectively	Wheel brake does not work effectively: Air pressure low	Brake drum over-heating: Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal depressed	One-sided braking	Wheel brake works suddenly	Brake fluid warning lamp lights
Wheel brake	Wheel cylinder malfunctioning			○				○		○
	Brake lining surface contaminated with oil			○						
	Brake lining surface hardened			○			○			
	Brake fluid leaking because wheel cylinder cup worn			○						
	Brake lining worn									○
	Brake lining worn exposing rivet head						○			
	Brake drum interior worn unevenly						○			
	Brake shoe and brake lining close contact faulty						○			
	Brake drum installation loose						○	○		
	Brake lining materials unequal							○		
	Brake lining contact faulty							○		
	Brake drum runout							○		
	Backing plate warped							○		
	Brake shoe clearance insufficient					○		○	○	
	Brake shoe return spring deteriorated or fractured					○		○		
	Wheel cylinder piston return faulty					○		○		
	Brake fluid return faulty because brake pipe or joints clogged					○				

Possible causes	Symptoms	Wheel brake does not work effectively: Air leakage when brake pedal depressed	Wheel brake does not work effectively: Air leakage when brake pedal released	Wheel brake does not work effectively: No air leakage but brake works ineffectively	Wheel brake does not work effectively: Air pressure low	Brake drum over-heating: Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal depressed	One-sided braking	Wheel brake works suddenly	Brake fluid warning lamp lights
Dual brake valve	O-ring damaged	○								
	Primary and secondary valve airtightness faulty	○	○							
	Primary and secondary valve return faulty or exhaust port clogged with foreign particles					○				
Airmaster	Power cylinder lubrication faulty or rubber packing damaged			○						
	Hydraulic piston valve seal close contact faulty			○						
	Hydraulic piston cup packing damaged, wrong combination, or foreign particles adhering to it			○				○		
	Exhaust port clogged with foreign particles					○				
	Push rod bent					○				
	Power cylinder rubber packing lubricated incorrectly					○				
Brake air system	Connector loose	○	○							
	Air leakage				○					
	Air pressure governor adjusted incorrectly				○					
	Air compressor malfunctioning				○					
Brake fluid system	Brake fluid leaking or insufficient			○						○
	Air mixed in brake fluid system			○						○
Tire	Left and right air pressure different Gr 31							○		
Suspension	Leaf spring U-bolt loose Gr 33, 34							○		

Possible causes / Symptoms		Drainage from air tank drain cock	Drainage not drawn off from exhaust port	Air dryer interior frozen	Air leakage from exhaust port	Air pressure in air reservoir drops extraordinarily	Engine oil coming out exhaust port	Remarks
Air Dryer	Desiccant deteriorated	○						
	Heater not working and air dryer frozen		○					
	Valve malfunctioning because of foreign particles adhering to it		○					
	No warming because heater wiring broken			○				
	Heater malfunctioning because thermostat faulty			○				
	Temperature extremely low because of snow and ice sticking to air dryer body			○				
	Heater malfunctioning because wiring to thermostat disconnected			○				
	Valve seat close contact faulty because of clogging by foreign particles				○			
	Dry air returning from air tank because air tank check valve malfunctioning during air compressor unloading cycle					○		
	Air compressor oiling-up						○	

● Exhaust Brake

Possible causes \ Symptoms		Exhaust brake does not work	Exhaust brake cannot be released	Intake silencer does not work	Intake silencer cannot be released	Remarks
Exhaust brake unit	Valve assembly malfunctioning	○	○			
	Valve assembly shaft stuck	○	○			
	Control cylinder malfunctioning	○				
	Butterfly valve adjusted incorrectly	○				
Intake silencer	Malfunctioning			○	○	
3-way magnetic valve	Malfunctioning	○	○	○		Gr 54
Brake air system	Air pressure abnormal	○		○		
	Air pipes crushed	○		○		
Electric system	Malfunctioning	○	○	○	○	Gr 54

ON-VEHICLE INSPECTION AND ADJUSTMENT

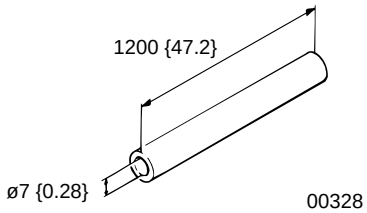
Replacement of Brake Fluid

Fluid

Location	Points of application	Kinds	Quantity
—	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116, DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Vinyl hose 	MH033102	Air bleeding

WARNING

- **You must use new brake fluid (SAE J1703f or FMVSS No. 116, DOT3).**
- **Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the brake system, because this will cause the rubber parts of the brake system to swell, resulting in brake dragging or ineffective braking.**
- **Do not allow foreign particles or water to get mixed in with the brake fluid when you add it.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oil.**

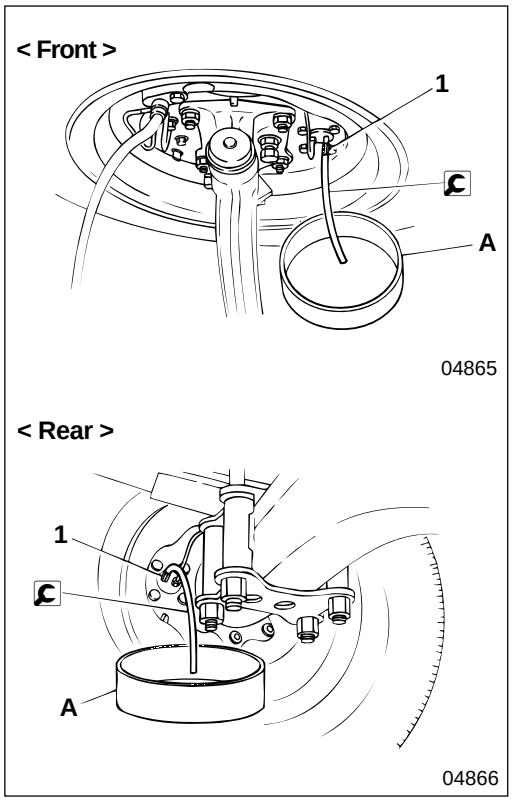
CAUTION

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

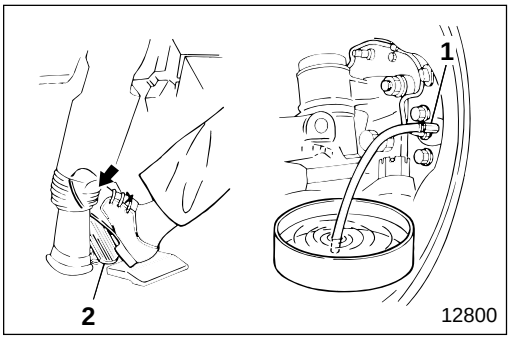
NOTE

Supply and maintain brake fluid to the “H” level of the fluid tank.

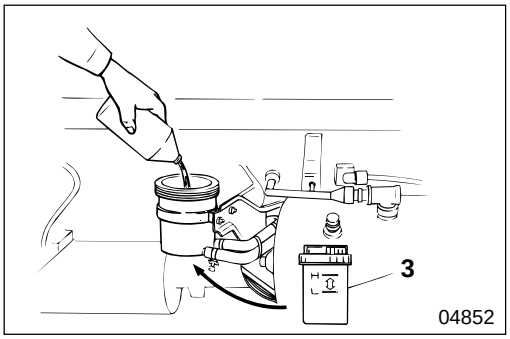
- Start engine and let it idle until brake fluid replacement is completed.



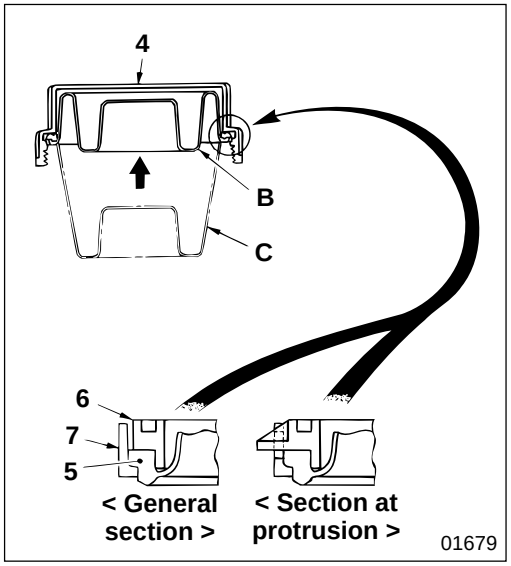
- Attach one end of vinyl hose to air bleeder **1** and place the other end in container **A**.



- Loosen air bleeder **1** and depress brake pedal **2** to drain brake fluid completely.



- Maintain a supply of new brake fluid up to the "**H**" level of fluid tank **3**, depress the brake pedal repeatedly until the old brake fluid of the brake system is replaced with new fluid.



- If diaphragm **5** is not in its normal posture when the brake fluid is supplied, correct it to its normal posture, and install cap **4**. If brake fluid leaks from the cap area after you have supplied brake fluid, check whether the diaphragm is assembled as illustrated.

  6 : Slide ring
  7 : Ring cover
  B : Correct condition of diaphragm when brake fluid is being supplied
  C : Condition when diaphragm is extended when brake fluid has decreased

- Air bleeding of brake system. P35A-36

Air Bleeding of Brake System

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

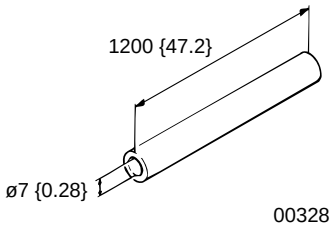
Location	Parts to be tightened	Tightening torque	Remarks
—	Air bleeder (Airmaster)	6.9 to 12.7 {5.1 to 9.4, 0.7 to 1.3}	—
—	Air bleeder (Wheel brake)	7.8 to 12 {5.8 to 8.5, 0.8 to 1.2}	—

Fluid

Location	Points of application	Kinds	Quantity
—	Fluid tank	Brake fluid (SAE J1703f or FMVSS No.116, DOT3)	As required

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Vinyl hose 	MH033102	Air bleeding

WARNING⚠

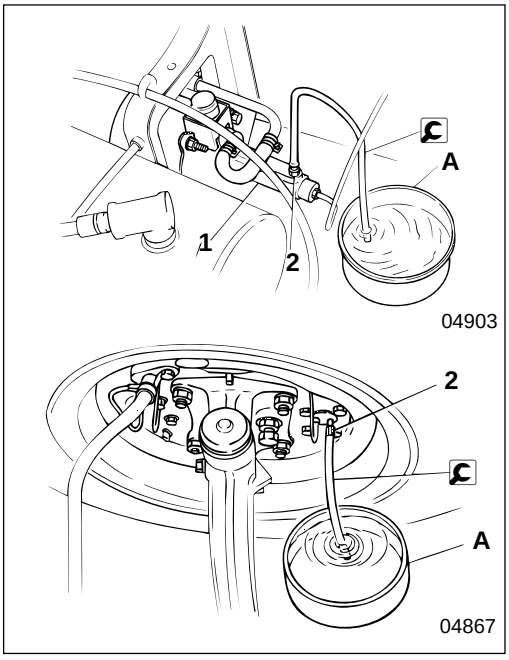
- **You must use new brake fluid (SAE J1703f or FMVSS No. 116, DOT3).**
- **Do not add different quality fluid or mineral oil (gas oil, engine oil, gear oil, automatic transmission fluid, etc.) to the brake system, because this will cause the rubber parts of the brake system to swell, resulting in brake dragging or ineffective braking.**
- **Do not allow foreign particles or water to get mixed in with the brake fluid when you add it.**
- **If you use a mug for adding brake fluid, keep it solely for that purpose to prevent contamination from different quality fluids or mineral oil.**

CAUTION⚠

- **Be careful not to splash brake fluid on related parts as this could damage the paintwork.**
- **Be sure to wipe off brake fluid immediately if you splash it on the paintwork.**

NOTE

- **Supply and maintain brake fluid to the "H" level of the fluid tank.**
- **Make sure you maintain brake fluid at the "H" level of the fluid tank since the brake fluid level drops during air bleeding.**



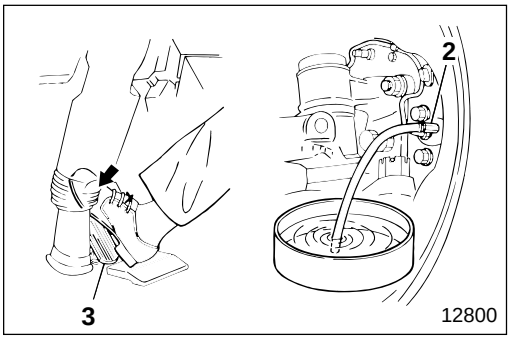
- Start engine and let it idle until brake fluid replacement is completed.
- Attach one end of vinyl hose to front or rear airmaster **1**. Then, attach one end of another vinyl hose to air bleeder **2** of the wheel brake. Finally, place both free ends in container **A** filled with brake fluid.
- Carry out air bleeding in the following sequence:

Front brake system

Airmaster for front
↓
Right-hand side wheel brake
↓
Left-hand side wheel brake

Rear brake system

< Right-hand side >	< Left-hand side >
Airmaster for rear (Right-hand side)	Airmaster for rear (left-hand side)
↓	↓
right-hand side wheel brake	Left-hand side wheel brake



- Depress brake pedal **3** slowly a few times, and with the brake pedal depressed, loosen air bleeder **2** to drain brake fluid containing air.

- Tighten air bleeder **2**, and release brake pedal **3**.
- Repeat this service procedure until air is no longer present in the fluid being drained.
- Tighten air bleeder **2** at specified torque as soon as brake fluid flowing out is free of air bubbles.

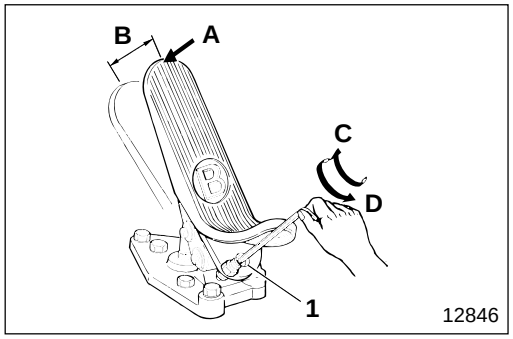
- Adjust brake shoe clearance when you have finished air bleeding. P35A-62
- Check that brake fluid comes up to level "**H**" of fluid tank. If it does not, refill with new brake fluid.
- Depress brake pedal **3** a few times and check for any leakage of brake fluid, then test the brakes.
- When you test the brakes, if the brake fluid warning lamp within the meter cluster lights, it means that air has not been bled completely. Redo air bleeding.

Inspection and Adjustment of Brake Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Free play of pedal	Pedal toe	$12^{+3.0}_{-1.5}\{0.47^{+0.12}_{-0.059}\}$	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	



Press pedal toe **A** with your hand and measure free play **B**. If the measured value deviates from the standard value, adjust it by turning set screw **1**.

C : Turning clockwise decreases the free play (For a small angle)

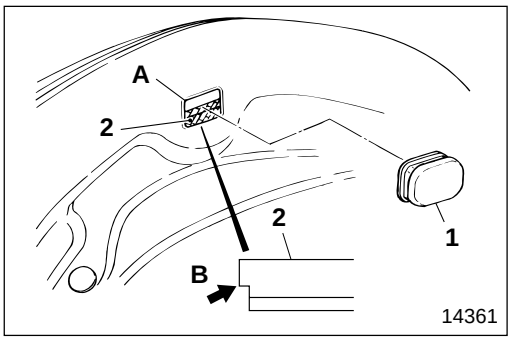
D : Turning counterclockwise increases the free play (For a large angle)

Thickness Inspection and Replacement of Brake Lining

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Thickness of brake lining	—	5.5 {0.22} (Side shoulder means wear limit)	Replace



[Inspection]

NOTE

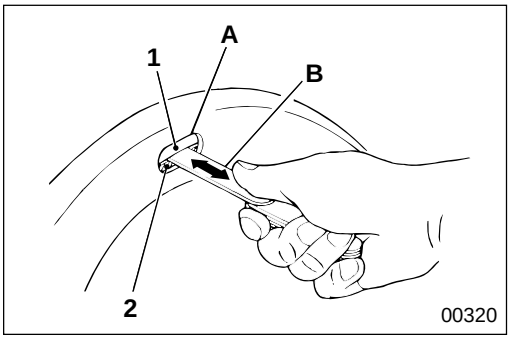
Be sure to inspect at two points for each wheel per side.

- Remove inspection hole plug **1** from the backing plate.
- Inspect through check hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall check hole plug **1**.

[Replacement]

P35A-60

Inspection of Brake Shoe Clearance



NOTE

When the vehicle is jacked up and the wheel is being turned, make sure that there is no dragging.

- Remove the inspection hole plug from the backing plate.
  A : Check hole
- Try to insert a 1 mm {0.039 in.} feeler gauge **B** between brake drum **1** and brake lining **2**. Check that the clearance is too small to allow feeler gauge to be inserted.
  If feeler gauge **A** can be inserted, disassemble the wheel cylinder and inspect.
  P35A-60

ON-VEHICLE INSPECTION AND ADJUSTMENT

Inspection and Maintenance of Air Dryer

Carry out inspection and maintenance according to the following interval or vehicle milage.

(1) Every 10000 km (6000 miles)

- To check that the air dryer operates correctly, open the drain cock of the tank and see if any drainage comes out.
- If a little drainage comes out, remove the indicator from the unit and check the indicator assembly for color change. If its color has changed to pink, replace with a new cartridge assembly and indicator assembly.
  P35A-88

NOTE

In an operational environment, where the decrease of the ambient temperature in the air tank is higher than 16°C {29°F}, a little moisture might collect.

- Carefully inspect the drainage from the exhaust port of the air dryer body.

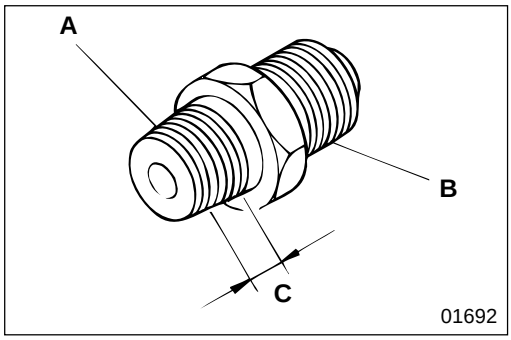
(2) Every year or every 60000 km {36000 miles}

Disassemble the air dryer body and replace the cartridge assembly, the indicator assembly and all rubber parts.
P35A-88

M E M O

HANDLING OF CONNECTOR AND NYLON TUBE PIPING

Connector

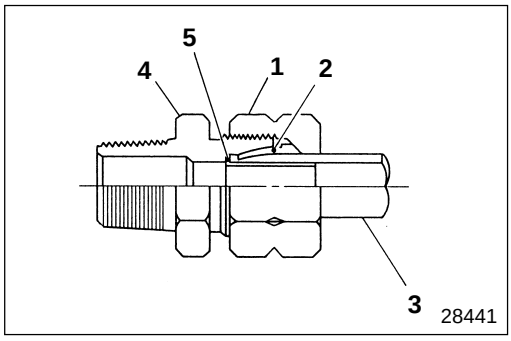


(1) Installation of connector

- When reusing a air system connector, remove remainder of sealer, oil, and water sufficiently, apply THREEBOND TB1110B to threads leaving 1 or 2 threads on top blank, and then screw in.
  Where alignment is required, stop at aligning point in additional tightening process.

A : Taper screw area
B : Parallel screw area (Do not apply sealer)
C : Area where sealer shall be applied

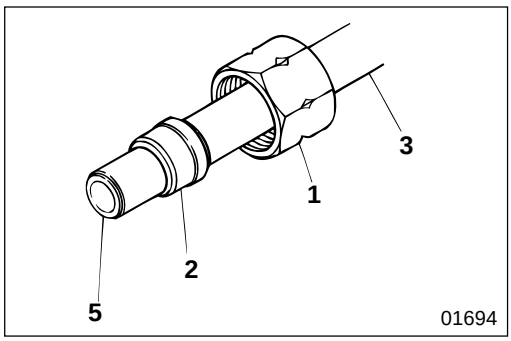
Nylon Tube



Follow the following process where nylon tube is employed.

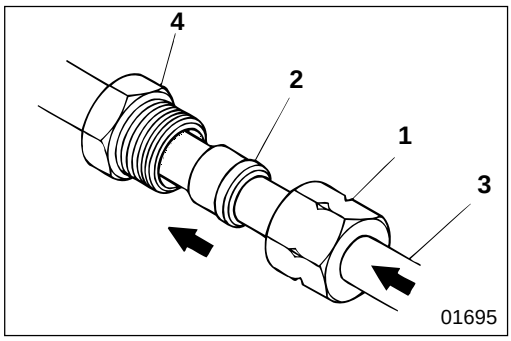
- Nylon tube is designed so that as nut **1** is tightened, sleeve **2** advances gripping to tube **3** while itself is being deformed in the process, thus keeping air tightness to prevent leakage. Accordingly, do not re-use: do not fail to replace with new one.

4 : Connector
5 : Insert



(2) Installation of nylon tube

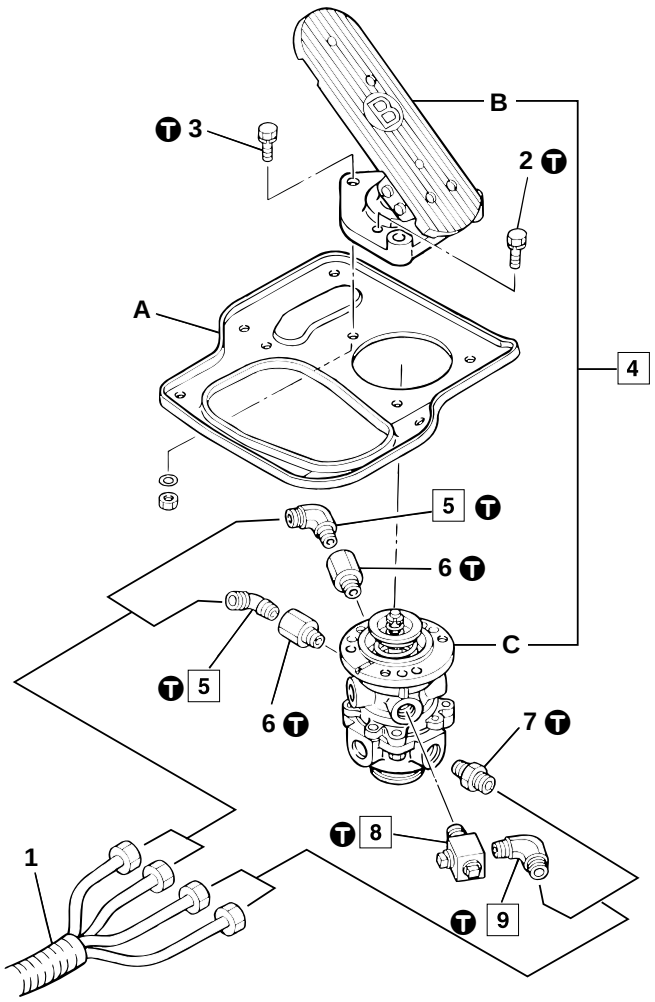
- Make sure that insert **5**, sleeve **2**, nut **1**, and tube **3** are assembled as illustrated.



- Insert tube **3** into connector **4**, push sleeve **2** into connector **4**, and provisionally tighten nut **1** by hand.
- After this, pull tube **3** to make sure that it does not have leakage, and it does not come apart.

M E M O

BRAKE PEDAL



Remove pedal assembly **B** upward from valve board **A**, and valve assembly **C** downward from the valve board to separate dual brake valve **4** (pedal assembly and valve assembly). Do this without removing the valve board from the vehicle.

● **Removal sequence**

1 Nylon tube
2 Bolt
3 Bolt
4 Dual brake valve P35A-46
5 Connector
6 Connector
7 Connector
8 Connector
9 Connector

● **Assembly sequence**

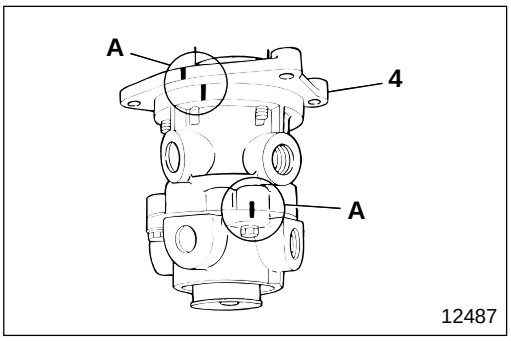
Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

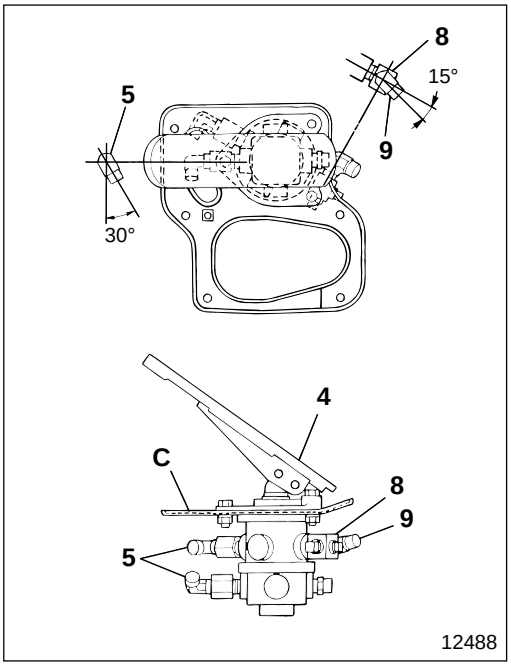
Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Pedal assembly and valve assembly mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
3	Bolt (Dual brake valve and valve board mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
5, 8, 9	Connector	29.4 to 117.7 {0.12 to 0.47, 3.0 to 12}	—
6, 7	Connector	29.4 to 39.2 {0.12 to 0.16, 3 to 4}	—

◆ Service procedure



4 **Dual brake valve**

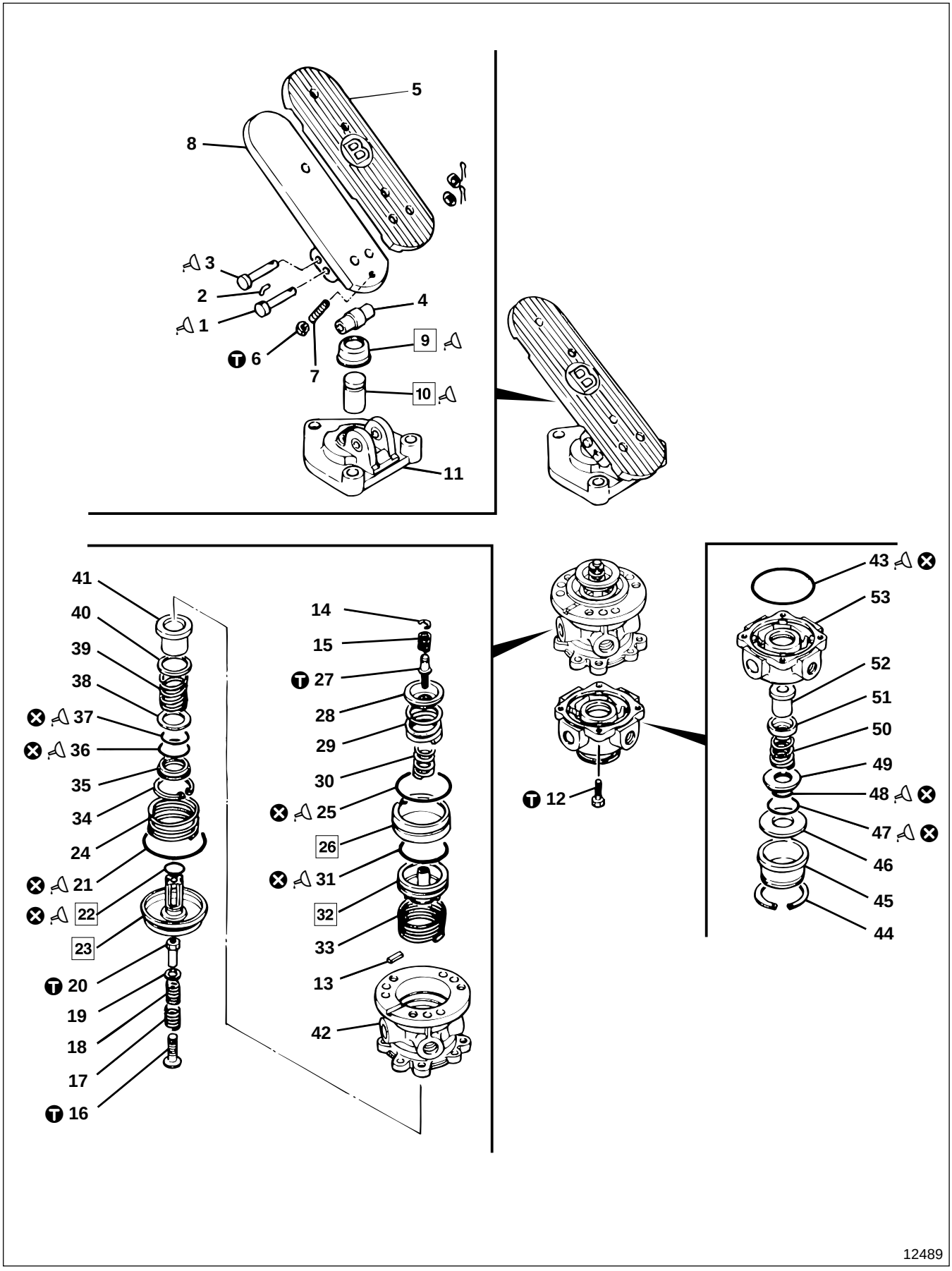
A : Alignment mark



5 **8** **9** **Connector positioning**

Position the connector within one turn after the lower limit tightening torque has been reached.

DUAL BRAKE VALVE



● **Disassembly sequence**

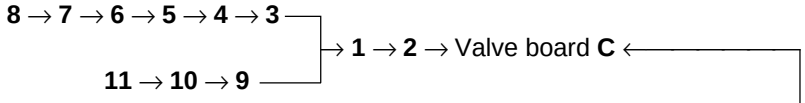
1 Straight pin
2 L-pin
3 Straight pin
4 Roller
5 Pedal cover
6 Lock nut
7 Set screw
8 Pedal
9 Boot
10 Plunger
11 Plate
12 Bolt
13 Plug
14 Retaining ring
15 Spring
16 Screw
17 Outer spring
18 Inner spring
19 Washer
20 Sleeve
21 O-ring
22 O-ring
23 Relay piston
24 Relay piston spring
25 O-ring
26 Bushing
27 Self-locking bolt
28 Spring seat
29 Outer spring
30 Inner spring
31 O-ring
32 Primary piston
33 Spring
34 Retaining ring
35 Valve retainer
36 O-ring
37 O-ring
38 Washer
39 Valve spring
40 Washer
41 Inlet valve
42 Body
43 O-ring
44 Retaining ring
45 Exhaust cover
46 Washer
47 O-ring
48 O-ring
49 Valve retainer
50 Valve spring
51 Valve retainer
52 Inlet valve
53 Cover

⊗ : Non-reusable parts

● **Assembly sequence**

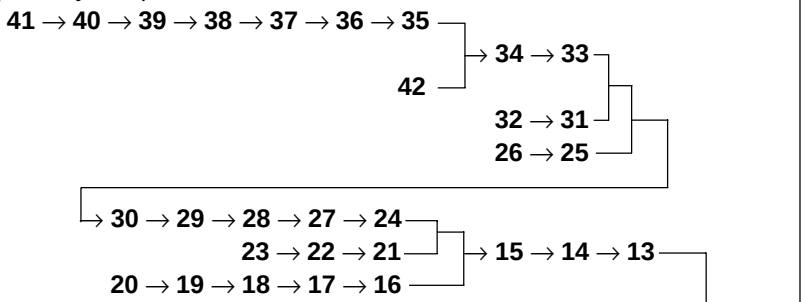
First assemble pedal assembly **A** and valve assembly **B**, then assemble by sandwiching valve board **C** between these two assemblies.

< Pedal assembly **A** >

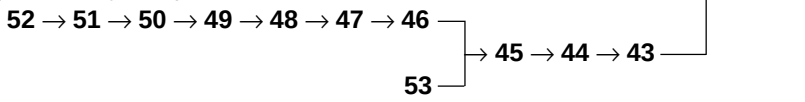


< Valve assembly **B** >

(Primary side)



(Secondary side)



Repair kit : Dual brake valve kit

● **Inspection of function after assembly**

🕮 P35A-49

DUAL BRAKE VALVE

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1, 3	Outer diameter of straight pin	Roller mounting	9.5 {0.374}	9.44 {0.371}	Replace
		Pedal mounting	9.5 {0.374}	9.45 {0.372}	
4	Roller	Inner diameter	9.5 {0.374}	9.67 {0.38}	Replace
		Outer diameter	18.3 {0.72}	18.15 {0.71}	
8	Pedal play	Pedal toe	$12^{+3.0}_{-1.5}$ {$0.47^{+0.12}_{-0.059}$}	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	
10	Outer diameter of plunger		19.9 {0.783}	19.8 {0.780}	Replace
11	Plate	Inner diameter of straight pin hole	9.5 {0.374}	9.68 {0.381}	Replace
		Inner diameter of bushing	20 {0.787}	20.08 {0.791}	
15	Spring load (Installed length 12.6 {0.50})		—	215 N {49 lbf, 22 kgf}	Replace
24	Relay piston spring load (Installed length 12.8 {0.50})		—	47 N {11 lbf, 4.8 kgf}	Replace
29	Outer spring load (Installed length 26.5 {1.04})		—	215 N {48 lbf, 21.8 kgf}	Replace
30	Inner spring load (Installed length 19.1 {0.75})		—	60 N {13 lbf, 6.1 kgf}	Replace
33	Spring load (Installed length 17 {0.67})		—	97 N {22 lbf, 9.9 kgf}	Replace
39	Valve spring load (Installed length 14.3 {0.56})		—	37 N {8.4 lbf, 3.8 kgf}	Replace
50	Valve spring load (Installed length 12.9 {0.51})		—	47 N {11 lbf, 4.8 kgf}	Replace
—	Pressure stroke	Input air pressure 685 kPa {100 psi, 7 kgf/cm²} — Pedal toe	25.5 {1.00}	Output air pressure — 105^{+25}_{-54} kPa {$16^{+3.6}_{-7.8}$ psi, $1.1^{+0.25}_{-0.55}$ kgf/cm²}	—	Replace springs
		Depression angle	7.5°		
		Pedal toe	45.5 {1.79}	355^{+39}_{-98} kPa {$52^{+5.7}_{-1.4}$ psi, $3.65^{+0.4}_{-1.0}$ kgf/cm²}	—	
		Depression angle	13.5°		
		Pedal toe	$52^{+8.5}_{-1.5}$ {$2.0^{+0.33}_{-0.059}$}	685 kPa {100 psi, 7 kgf/cm²}	—	
		Depression angle	$15.5°^{+2.5°}_{-0.5°}$		

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Lock nut	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—
12	Bolt (Valve assembly primary and secondary sides assembling)	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
16	Screw	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
20	Sleeve	1.0 to 2.9 {0.7 to 2.2, 0.1 to 0.3}	—
27	Self-locking bolt	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—

Lubricant

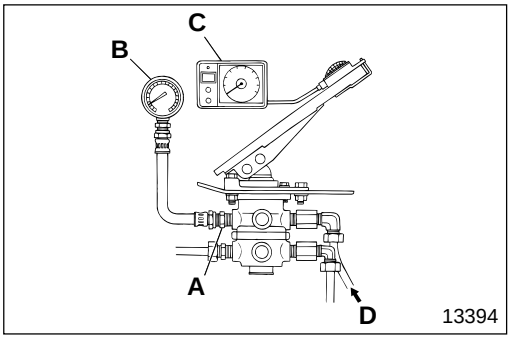
Location	Points of application	Kinds	Quantity
1, 3	Outer periphery of straight pin	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
9, 10	Pack between boot and plunger	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	1 cm^3 {0.061 cu. in.}
10	Friction surfaces of plunger and other parts	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
—	Friction surface and groove of O-ring, friction surfaces of metals	Multipurpose grease [NLGI No.2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
21	Insert tool	*910-24461	Installation of O-ring
32	Retainer	*910-24590	Holding of primary piston

* : BOSCH BRAKING SYSTEMS part No.

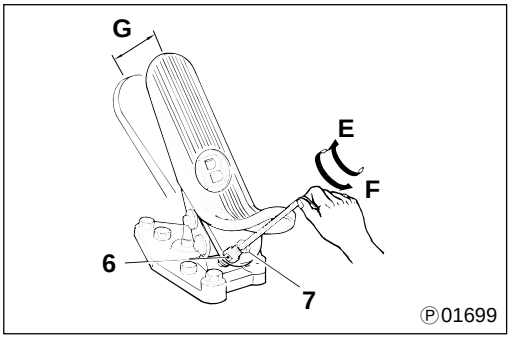
◆ Service procedure



● Inspection of function after assembly

Check that the output air pressure, corresponding to the pedal depression angle, conforms to the specified value.

- Mount pressure gauge **B**, capable of measuring 980 kPa {142 psi, 10 kgf/cm^2} or more, on primary output side port **A**.
- Mount depression gauge **C** on the brake pedal.
- Apply air pressure of 685 kPa {100 psi, 7 kgf/cm^2} to primary input side port **D** and inspect related parts for air leakage.
- If air leakage is found, do the following:
  - Tighten connectors.
  - Disassemble the dual brake valve and inspect the O-ring assemblies of all parts.

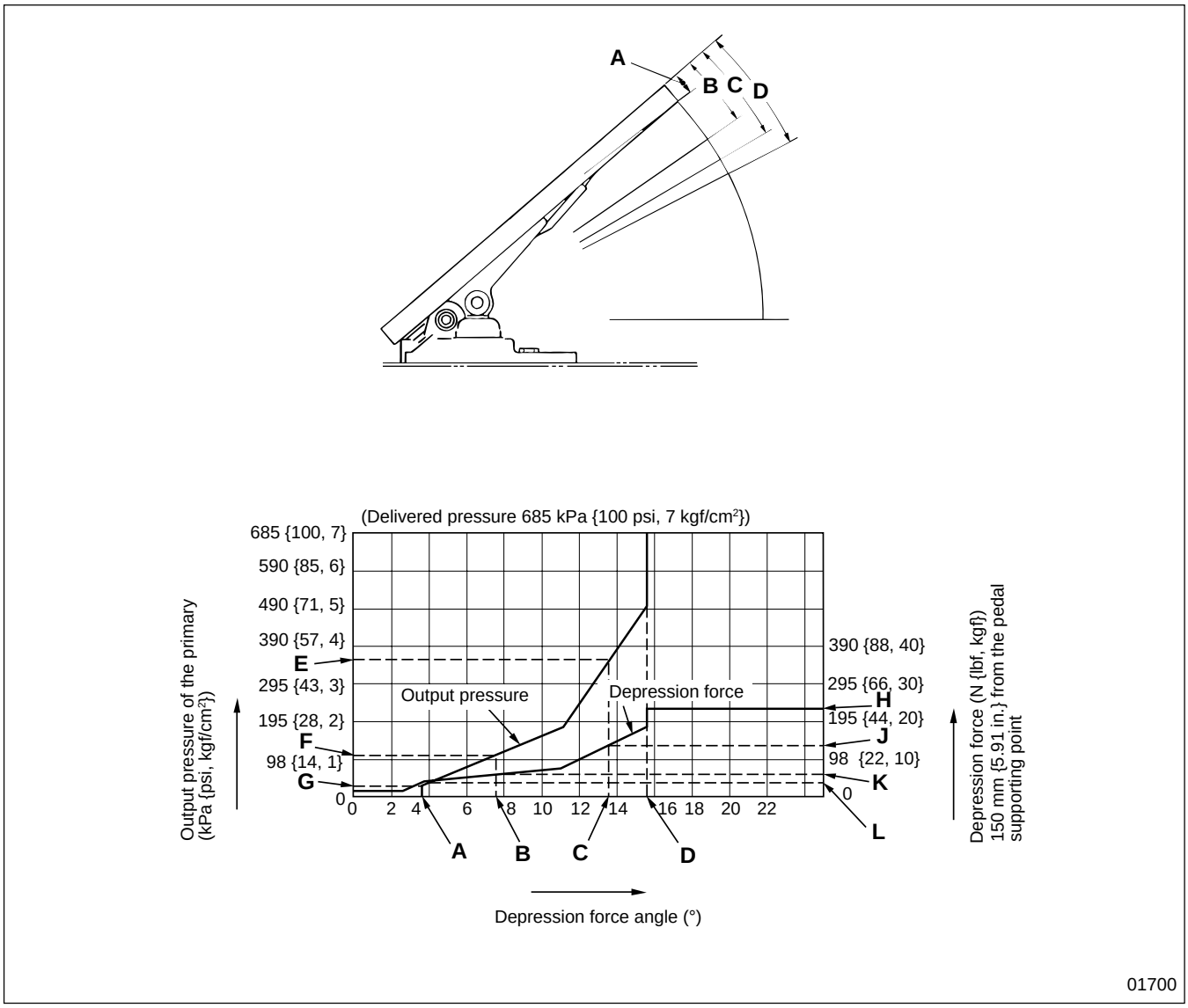


- Turn set screw **7** and adjust brake pedal play **G** to the standard value.
- Tighten lock nut **6** at specified torque to lock set screw **7**.
- Read pressure gauge **B** and make sure that the primary output pressure and brake pedal depression force angle, corresponding to the brake pedal depression angle, conform to the standard values shown in the input/output characteristic curve diagram overleaf.
- If the output air pressure is lower than the standard value, replace the following springs:
  - Spring **15**
  - Outer spring **29**
  - Inner spring **30**

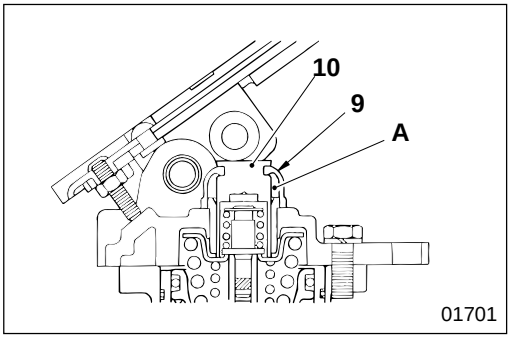
E : Turning clockwise decreases the play (To decrease brake pedal depression angle)

F : Turning counterclockwise increases the play (To increase brake pedal depression angle)

Input/Output Characteristic Curve Diagram

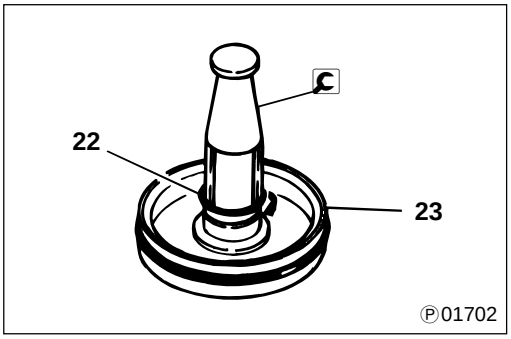


A : Play 3.5° $^{+1.0°}_{-0.5°}$(12 $^{+3.0}_{-1.5}$ mm {0.47 $^{+0.12}_{-0.059}$ in.})
B : Pressure stroke 7.5° (25.5 mm {1.0 in.})
C : Pressure stroke 13.5° (45.5 mm {1.8 in.})
D : Pressure stroke 15.5° $^{+2.5°}_{-0.5°}$(52 $^{+8.5}_{-0.5}$ mm {2.0 $^{+0.33}_{-0.020}$ in.})
E : 355$^{+39}_{-98}$ kPa {52$^{+5.7}_{-1.4}$ psi, 3.65$^{+0.4}_{-1.0}$ kgf/cm²}
F : 105$^{+25}_{-54}$ kPa {16$^{+3.6}_{-7.8}$ psi, 1.1$^{+0.25}_{-0.55}$ kgf/cm²}
G : 29 kPa {4.3 psi, 0.3 kgf/cm²} or less
H : 230.5±20 N {52±4.4 lbf, 23.5±2 kgf}
J : 132±25 N {30±5.5 lbf, 13.5±2.5 kgf}
K : 59±25 N {13±5.5 lbf, 6±2.5 kgf}
L : 39±10 N {8.8±2.2 lbf, 4±1 kgf}

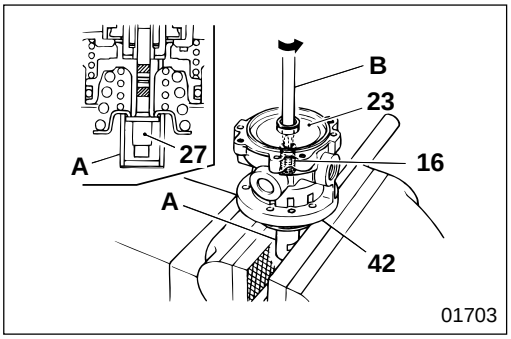


9 **10** **Packing grease between boot and plunger**

Pack area A with **1** cm^3 {0.061 cu in.} of grease.



22 **Installation of O-ring**



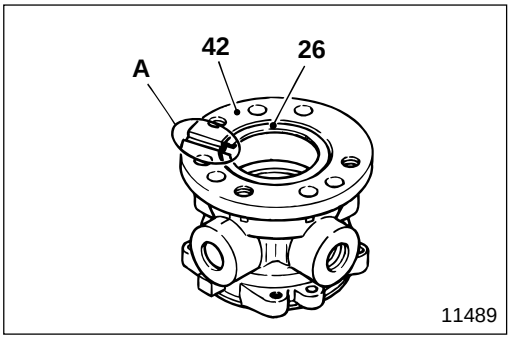
23 **Removal of relay piston**

- Grip (14 mm {0.55 in.}) socket wrench **A** in a vise.
- Insert the head of self-locking bolt **27** into socket wrench **A** to tighten body **42**.

WARNING ⚠

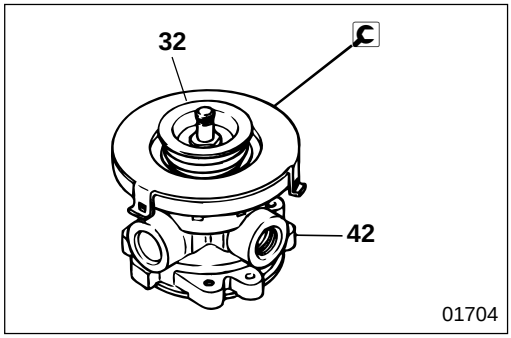
You must be careful when you loosen screw 16, because the spring in body 42 can forcibly eject relay piston 23. To avoid this hazard, press down on the relay piston with your hand when you carry out the above work.

- Loosen screw **16** gradually to remove relay piston **23**.
  B : Phillips screwdriver



26 **Installation of bushing**

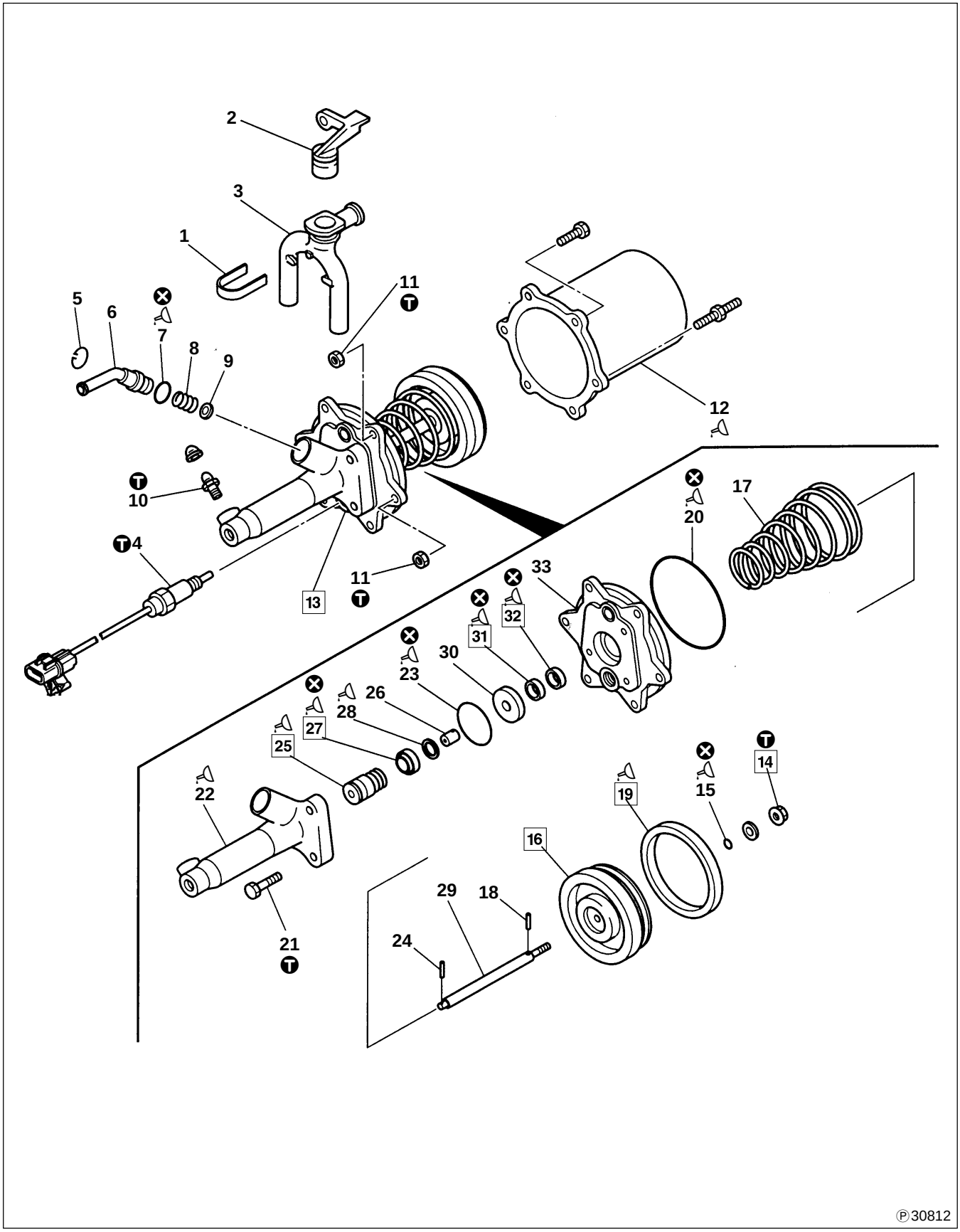
A : Indent



32 **Removal and installation of primary piston**

M E M O

BRAKE BOOSTER (AIRMASTER)



● **Disassembly sequence**

1 Clamp
2 Holder
3 Exhaust cover
4 Stroke switch
🕮 Gr 54
5 Retaining ring
6 Connector
7 O-ring
8 Spring
9 Valve assembly
10 Air bleeder
11 Nut
12 Cylinder shell
13 Body assembly
14 Nut
15 O-ring
16 Piston plate
17 Return spring
18 Straight pin
19 Cup packing
20 O-ring
21 Bolt
22 Hydraulic cylinder
23 O-ring
24 Straight pin
25 Hydraulic piston
26 Valve seal assembly
27 Cup packing
28 Backup ring
29 Push rod
30 Washer
31 Oil seal
32 Oil seal
33 End plate

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Brake booster kit

● **Inspection of function after assembly**

🕮 P35A-56

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
12, 16	Clearance between cylinder shell and piston plate	[114.3] 0.9 to 1.6 {[4.50] 0.035 to 0.063}	2.0 {0.079}	Replace piston plate
17	Return spring load (Installed length:132 {5.20})	137.3±20 N {31±4.4 lbf, 14±2 kgf}	107.3 N {26 lbf, 12 kgf}	Replace
22, 25	Clearance between hydraulic cylinder and hydraulic piston	[22.2] 0.04 to 0.11 {[0.87] 0.0016 to 0.0043}	0.2 {0.0079}	Replace hydraulic piston
29	Push rod deflection	0.05 {0.002}	0.15 {0.0059}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Stroke switch	8 to 12 {5.8 to 8.7, 0.8 to 1.2}	Overtightening prohibited
10	Air bleeder	7 to 12 {5.1 to 8.7, 0.7 to 1.3}	—
11	Nut (Mounting of body assembly and cylinder shell)	11 to 15 {8 to 12, 1.1 to 1.6}	—
14	Nut (Mounting of piston plate and push rod)	11 to 15 {8 to 12, 1.1 to 1.6}	Punch for installation
21	Bolt (Mounting of hydraulic cylinder)	20 to 29 {14 to 22, 2 to 3}	—

BRAKE BOOSTER (AIRMASTER)

Lubricant and/or fluid

Location	Points of application	Specified lubricant and/or fluid	Quantity
7, 23	Entire surface of O-ring	Brake fluid (SAE J1703f or FMVSS No. 116, DOT3)	As required
12	Cylinder shell bore	Multipurpose grease [NLGI No.2 (Li soap)]	10 g (0.35 oz)
15, 20	O-ring	Multipurpose grease [NLGI No.2 (Li soap)] or Silicon grease	As required
19	Entire surface of cup packing	Multipurpose grease [NLGI No.2 (Li soap)]	5 g (0.18oz)
22, 25 27	Entire surface of cup packing, and friction surfaces of hydraulic piston and hydraulic cylinder	Brake fluid (SAE J1703f or FMVSS No. 116, DOT3)	As required
31	Entire surface of oil seal	Silicon oil	As required
32	Groove on oil seal	Silicon grease	As required

Special tools

Location	Tool name and shape	Part No.	Application
13	Stand	*910-00450	Working bench
16	Holder	*910-24831	Removal and installation of piston plate
27	Cup Insert Guide	*910-23295	Mounting of cup packing
31, 32	Puller	*910-20350	Removal of oil seal
31, 32	Press-fit bar	*910-20195	Press-fitting of oil seal
–	Portable Tester	*916-00021	Function check after assembly

* BOSCH BRAKING SYSTEMS part No.

◆ Service procedure

● Inspection of function after assembly

(1) Install the brake booster on the vehicle, and conduct the performance test using Portable Tester.

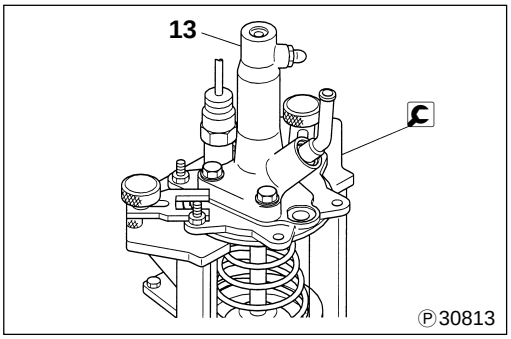
- Setting up of pressure gauge
  - Connect a pressure gauge (PG4) for measuring the command pressure to the air supply port of the power cylinder.
  - Remove air bleeder **10** from the hydraulic cylinder and connect an oil pressure gauge (PG2). Then bleed air from the inside of the tester.
- Raise the air pressure in the air tank to 590 kPa {85 psi, 6 kgf/cm^2), then inspect the functions given in the following table with the engine stopped.

Test item	Test condition	Standard value in assembled condition	Limit	Remedy
Air-tightness at full load	Air pressure decrease after keeping brake pedal fully depressed for 15 seconds	–	Air pressure gauge (PG4) reading less than 59 kPa {8.5 psi,0.6 kgf/cm^2}	Replace O-ring **15** and/or cup packing **19**
Operation at full load	Confirm that command air pressure (PG4) is 590 kPa {85 psi, 6 kgf/cm^2} with the brake pedal fully depressed	Oil pressure gauge (PG2) reading 14.0 to 15.4 MPa {2030 to 2230 psi, 143 to 157 kgf/cm^2}	Oil pressure gauge (PG2) reading 13.7 to 15.7 Mpa {1990 to 2280 psi, 140 to 160 kgf/cm^2}	Replace hydraulic piston **26** and/or cup packing **27**
Brake booster operation starting pressure	Depress brake pedal grad ually and read the com-mand pressure when oil pressure gauge (PG2) starts rising	Air pressure gauge (PG4) reading 14 to 33 kPa {2.0 to 4.8 psi, 0.14 to 0.34 kgf/cm^2}	Air pressure gauge (PG4) reading 43 kPa {6.3 psi, 0.44 kgf/cm^2}	Replace valve seal assembly **26**, cup packing **19** and/or cup packing **27**
Residual pressure	When brake pedal is released after depressed	Oil pressure gauge (PG2) reading 78 to 125 kPa {11 to 18 psi, 0.8 to 1.3 kgf/cm^2}	Oil pressure gauge (PG2) reading 59 to 155 kPa {8.5 to 23.0 psi, 0.6 to 1.6 kgf/cm^2}	Replace valve assembly **9** and/or spring **8**

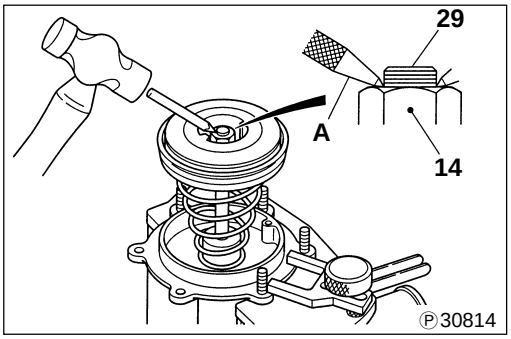
(2) After completion of the above tests, conduct the function test of stroke switch **4**. Loosen the air bleeder so as to allow fluid to leak out. Depress the brake pedal to let the power piston move full stroke so that stroke switch **4** may be operated. Then confirm that the brake warning lamp on the meter cluster comes on.

(3) Always bleed the brake system and pour brake fluid to the "**H**" line of the brake fluid tank after performing the brake booster function check.

◆ Service procedure



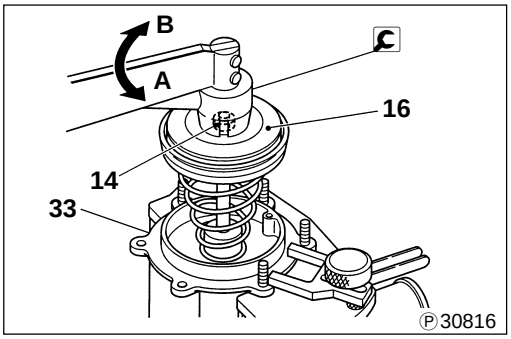
13 **Installation of body assembly**



14 **Installation of nut**

After tightening nut **14** at specified torque, stake the nut and push rod **29** thread area.

A : Center punch

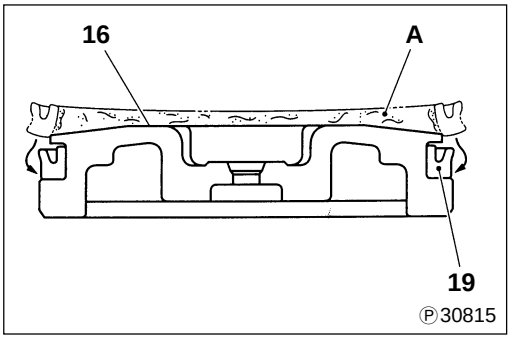


16 **Removal and installation of piston plate**

A : Removal
B : Installation

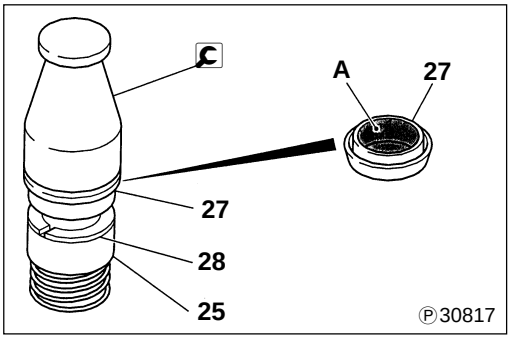
NOTE

To install, while pressing piston plate 16 to end plate 33 with sufficient force, tighten nut 14 to specified torque.



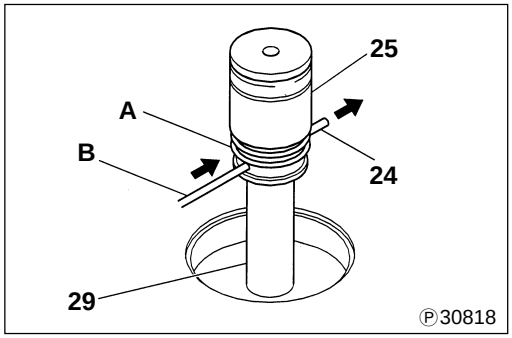
19 **Installation of cup packing**

A : Grease



27 **Installation of cup packing**

A : Brake fluid

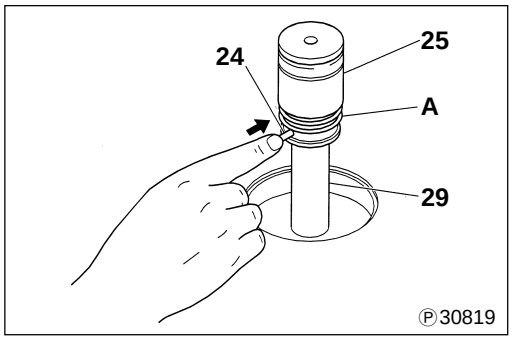


25 **Hydraulic piston**

[Removal]

A : Spring

B : Needle



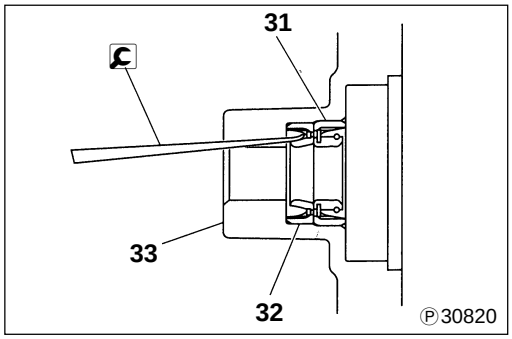
[Installation]

Align the holes of hydraulic piston **25**, valve seal assembly **26** and push rod **29**, and insert straight pin **24**.

A : Spring

NOTE

After inserting straight pin 24, make sure that the hydraulic piston spring is hanging over the straight pin and working as a stopper.

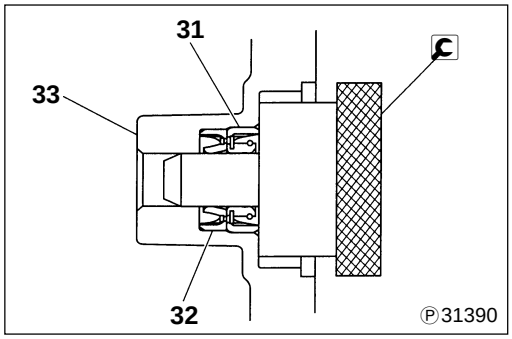


31 **32** **Oil seals**

[Removal]

CAUTION ⚠

Remove oil seals 31, 32 by tapping evenly. Be careful not to scratch inner surface of end plate 33.



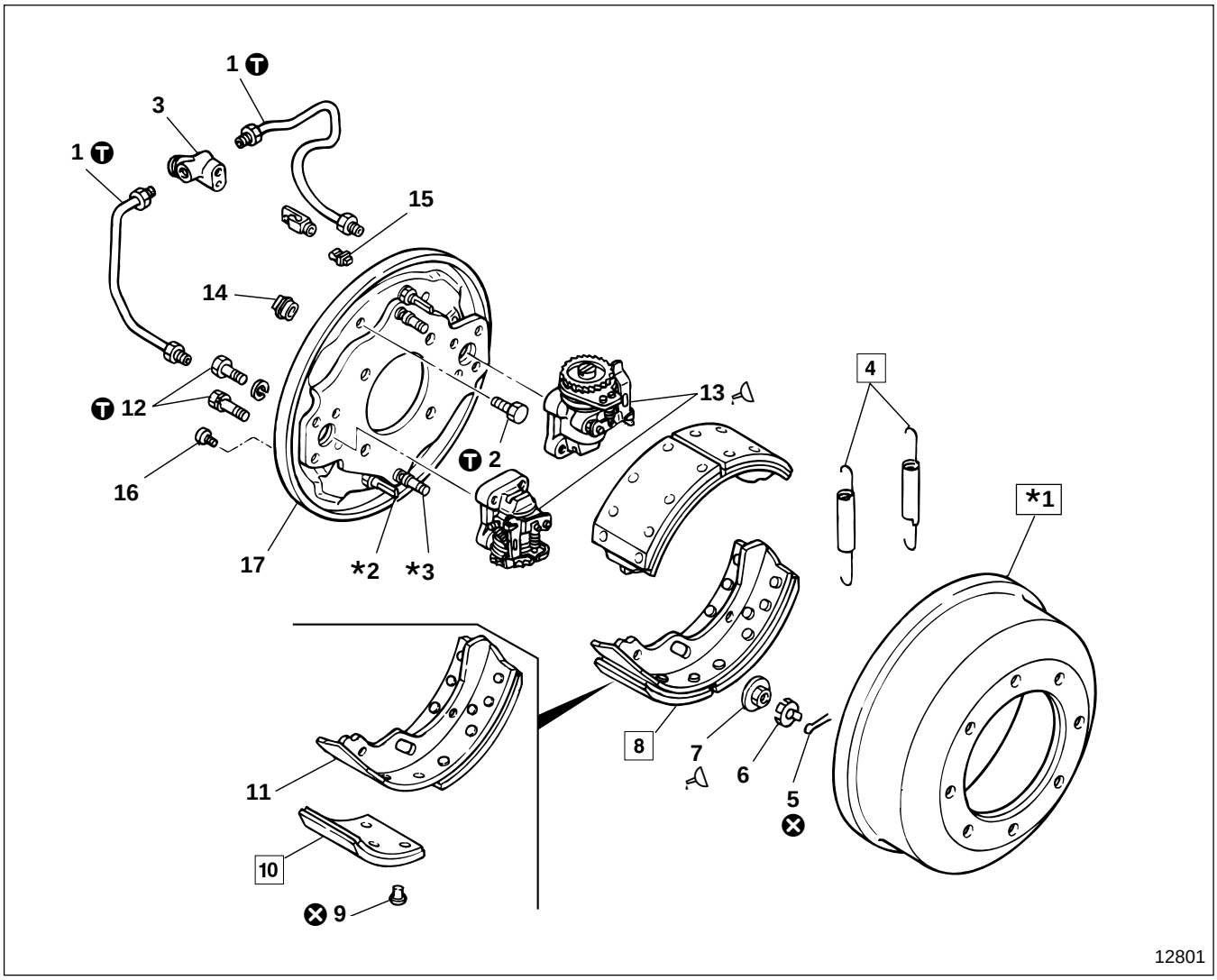
[Installation]

Install oil seals on end plate **33** in the direction shown in the diagram.

M E M O

FRONT WHEEL BRAKE

Front Wheel Brake Assembly



● **Disassembly sequence**

1 Brake pipe
2 Bolt
3 Joint
4 Return spring
5 Cotter pin
6 Lock plate
7 Nut
8 Brake shoe assembly
9 Rivet
10 Brake lining
11 Brake shoe
12 Bolt
13 Wheel cylinder assembly
P35A-66
14 Check hole plug
15 Adjusting hole plug
16 Cover
17 Backing plate

⊗ : Non-reusable parts
***1** : Brake drum Gr 26
***2** : Bolt
***3** : Stud pin

WARNING

Do not leave grease or oil on the surface of brake lining 10 or inner surface of brake drum *1 because this reduces braking performance.

CAUTION⚠

- **If you are replacing only brake lining 10, clean the adjuster and screw thread area of wheel cylinder assembly 13 and apply rubber grease to the thread area.**
- **Do not turn or remove bolt *2 that is fitted to keep brake shoe assembly 8 at 90°.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Initial adjustment of brake shoe clearance after installation**

🕮 P35A-62

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
4	Return spring load (Installed length 228.4 {8.99})		380 N {86 lbf. ft, 39 kgf}		Clearance between coils or coil and cover	Replace
8	Thickness of brake lining		15 {0.59}		5.5 {0.22} (Side shoulder means wear limit)	Replace brake lining
***1**	Brake drum	Inner diameter	400 {15.75}	*401 {15.79}	402 {15.83}	Repair or replace
		Cylindrical accuracy	0.025 {0.00098}		0.2 {0.0079}	Correct

* : Indicates correction limit.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Brake pipe flare nut	12.75 to 17.65 {9.4 to 13, 1.3 to 1.8}	—
2	Bolt (Joint mounting)	37.27 to 49.03 {27 to 36, 3.8 to 5.0}	—
12	Bolt (Wheel cylinder assembly mounting)	37.27 to 49.03 {27 to 36, 3.8 to 5.0}	M10
		122.58 to 166.7 {90 to 120, 12.5 to 17.0}	M12

Lubricant

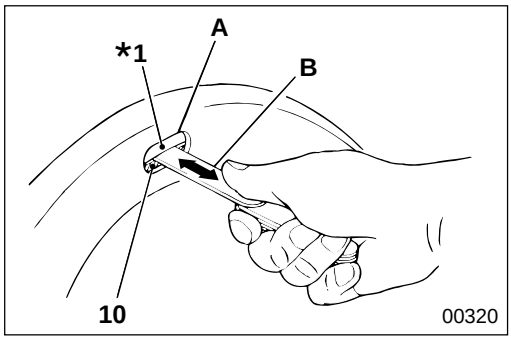
Location	Points of application	Kinds	Quantity
7	Brake shoe assembly contact surface of nut	Brake grease	As required
13	Wheel cylinder assembly anchor and screw groove contact area with brake shoe	Brake grease	As required

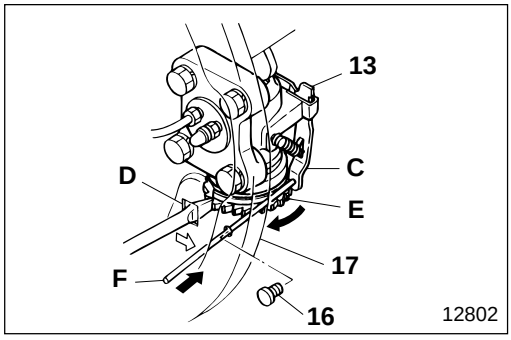
◆ Service procedure

● Initial adjustment of brake shoe clearance after installation

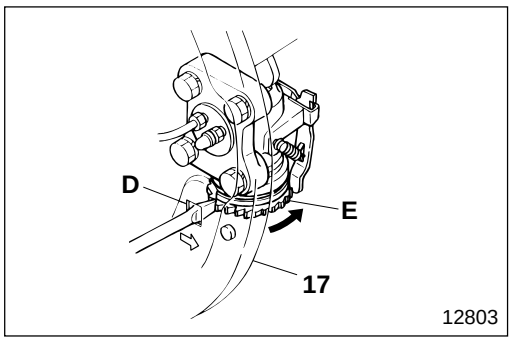
Turning the adjuster of wheel cylinder assembly **13** in arrow ⇨ direction expands brake shoe assembly **8**, narrowing the clearance between brake drum ***1** and brake lining **10**.

- Jack up the vehicle to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 26
- Remove adjusting hole plug **15** and check hole plug **14**.
- Adjust the brake shoe clearance as follows, so that 0.3 mm {0.012 in.} feeler gauge **B** can be inserted or extracted through check hole **A**, between brake drum ***1** and brake lining **10** with a little resistance.



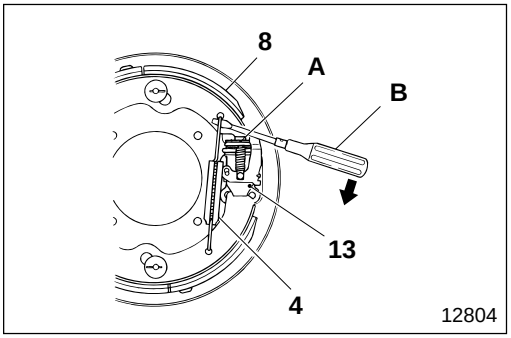


- To increase brake shoe clearance
  - Remove cover **16** on the rear of backing plate **17**.
  - Insert a wire (approximately ø5 mm {0.20 in.}) into the hole of cover **16** and lift adjusting lever **C** of wheel cylinder **13**.
  - Turn adjuster **E** of wheel cylinder **13**, through adjusting hole **D**, in the opposite direction to arrow ⇨ on backing plate **17**.



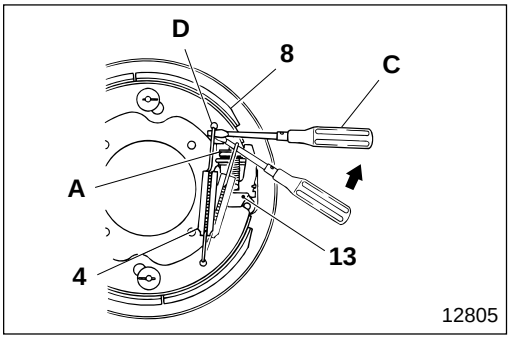
- To decrease brake shoe clearance
  Turn adjuster **E** in the arrow ⇨ direction marked on backing plate **17** through adjusting hole **D**.

- Extract the feeler gauge and depress the brake pedal two or three times fully, then the specified value brake shoe clearance can be obtained.
- Insert a 0.2 mm {0.0079 in.} feeler gauge through check hole **A** and make sure that it can be inserted or extracted with a little resistance.
  If there is any fault, disassemble and inspect wheel cylinder **13**.
  P35A-66

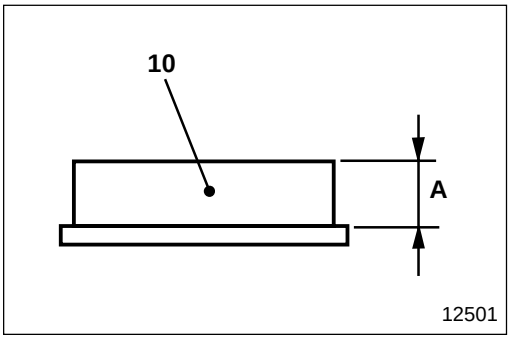


4 Return spring

[Removal]
To remove the return spring, place screwdriver **B** on the hook of the return spring, then pry and remove the return spring making use of wheel cylinder **13** adjusting screw **A** as a fulcrum.

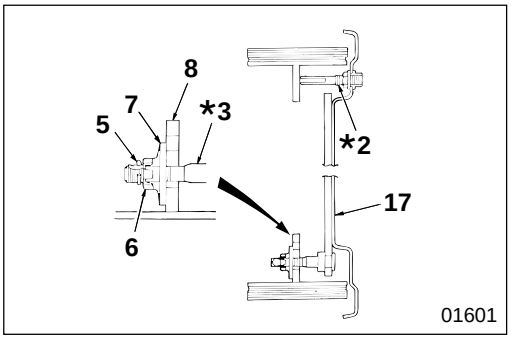


[Installation]
- Install the shorter hook of return spring **4** on brake shoe assembly **8**.
- Insert a small Phillips screwdriver **C** into the hook of return spring **4**, insert the tip of the screwdriver into return spring installation hole **D** of brake shoe assembly **8** to pry on the return spring.

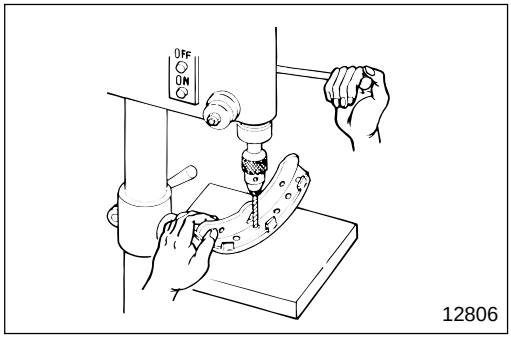


8 Brake shoe assembly

[Inspection]
If thickness **A** of brake lining **10** is lower than the limit replace the brake lining on the same axle as a unit.

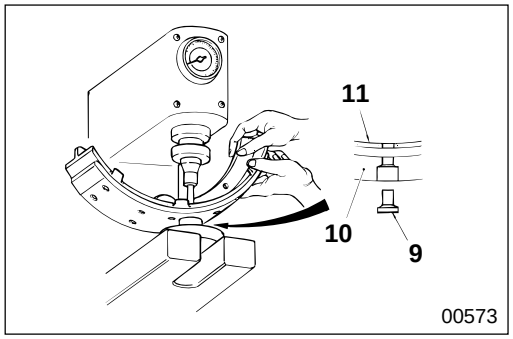


[Installation]
- Install brake shoe assembly **8**.
- Tighten nut **7**. When brake shoe assembly **8** makes contact with bolt ***2** of backing plate **17**, slacken off the nut by one third of a turn.
- Slacken off nut **7** until the holes of stud pin ***3** and lock plate **6** align with each other.
- Install cotter pin **5** and bend it.



10 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **10** and brake shoe **11** with cleaning fluid and dry them.
- Insert rivets **9** from brake lining **10** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **11** and the brake lining.

  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

- Make sure that you inspect contact with the inner surface of brake drum ***1** after you replace brake linings **10**. If contact is incorrect, correct with the brake assembled.

WARNING

Do not leave lubricant on the surface of brake lining 10 because this reduces braking performance.

CAUTION

Make sure that the type of brake linings 10 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.

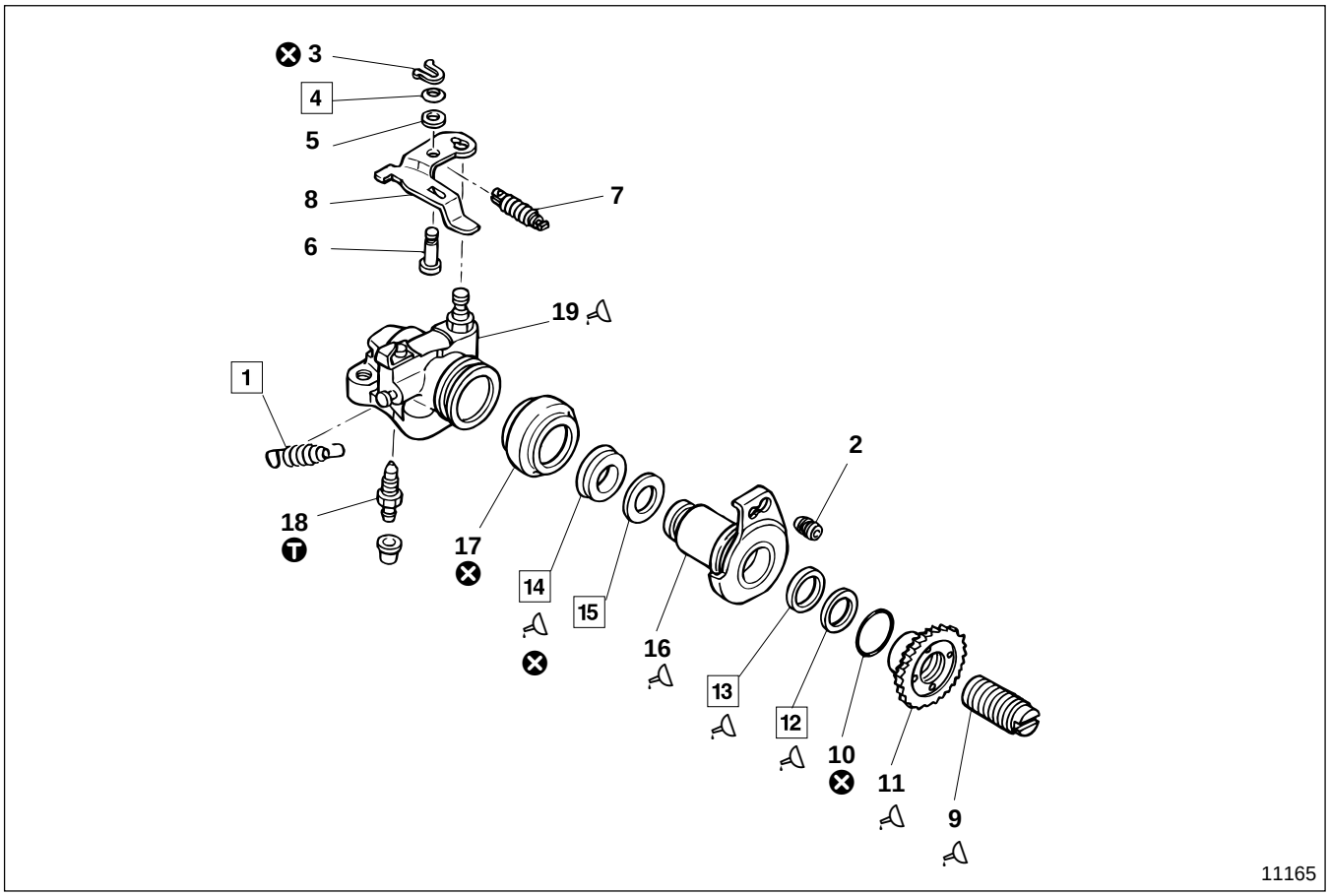
***1** **Correction of brake drum**

If the cylindrical accuracy of brake drum ***1** is higher than the limit, or there are seams, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

M E M O

FRONT WHEEL BRAKE

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Set spring
2 Cover
3 Retainer
4 Wave washer
5 Washer
6 Pin
7 Spring
8 Adjusting lever
9 Screw
10 O-ring
11 Adjuster
12 Washer (Thin)
13 Washer (Thick)
14 Piston cup
15 Backup ring
16 Piston
17 Boot
18 Air bleeder
19 Cylinder body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
16, 19	Clearance between piston and cylinder body	[34.93] 0.03 to 0.13 {[1.38] 0.0012 to 0.0051}	0.2 {0.0079}	Replace piston

Tightening torque

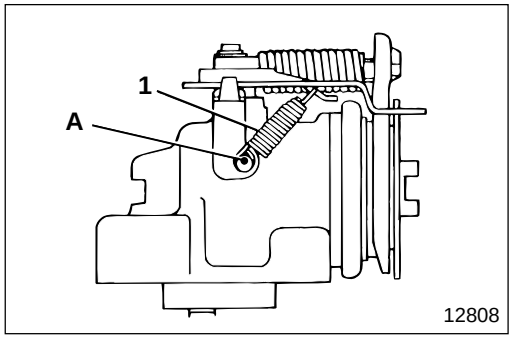
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
18	Air bleeder	6.86 to 11.77 {5.1 to 8.7, 0.7 to 1.2}	—

Lubricant

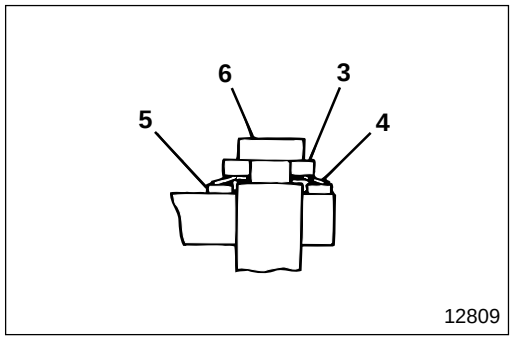
Location	Points of application	Kinds	Quantity
9	Thread area of screw	Rubber grease	As required
11	Screw mounting thread of adjuster and friction surface with piston	Rubber grease	As required
12, 13	Both sides of washer	Rubber grease	As required
14	Periphery of piston cup	Rubber grease	As required
16	Periphery and interior of piston	Rubber grease	As required
19	Boot mounting groove of cylinder body	Rubber grease	As required

◆ Service procedure



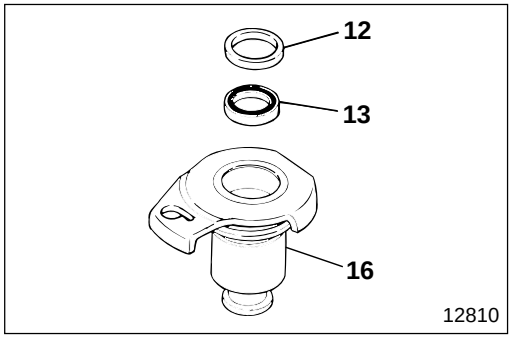
1 Installation direction of set spring

Fasten the closed end hook of set spring **1** on pin **A**.



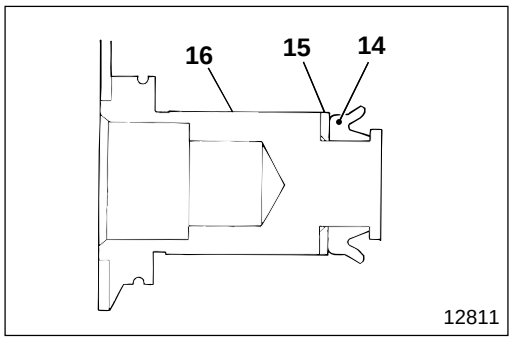
4 Installation direction of wave washer

Caulk retainer **3**.

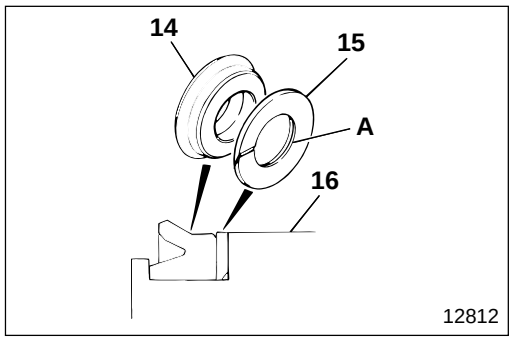


12 **13** **Installation sequence and direction of washer**

- Install thicker washer **13** first.
- Install washer **13** with its black face upward.



14 **Installation direction of piston cup**



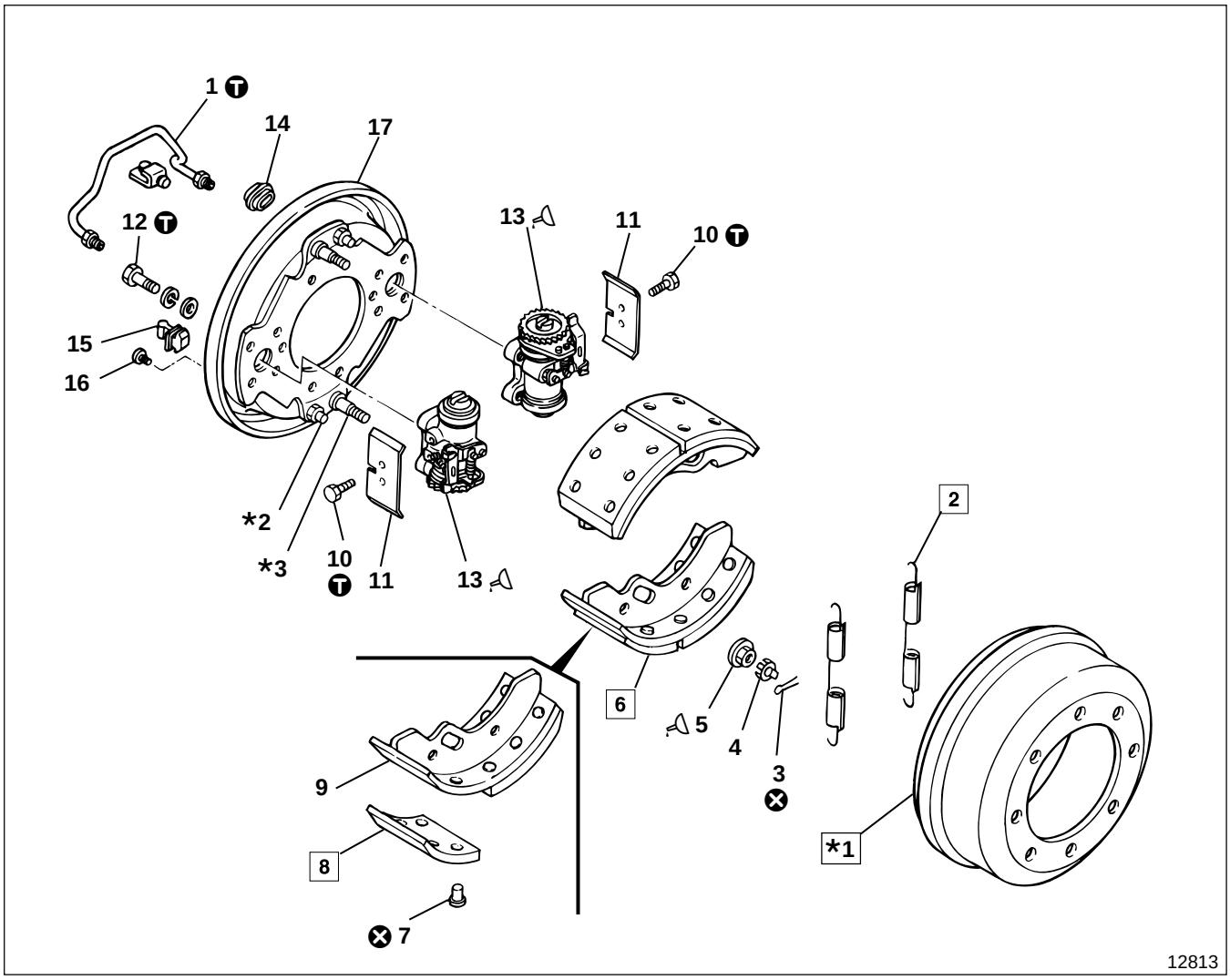
15 **Installation direction of backup ring**

Install backup ring **15** facing the side without chamfer **A** to piston cup **14**.

M E M O

REAR WHEEL BRAKE

Rear Wheel Brake Assembly



● **Disassembly sequence**

1 Brake pipe
2 Return spring
3 Cotter pin
4 Lock plate
5 Nut
6 Brake shoe assembly
7 Rivet
8 Brake lining
9 Brake shoe
10 Bolt
11 Wheel cylinder cover
12 Bolt
13 Wheel cylinder assembly
📖 35A-76
14 Inspection hole plug
15 Adjusting hole plug
16 Cover
17 Backing plate

⊗ : Non-reusable parts
***1** : Brake drum 📦 Gr 27
***2** : Bolt
***3** : Stud pin

WARNING ⚠

Do not leave grease or oil on the surface of brake lining 8 or inner surface of brake drum *1 because this reduces braking performance.

CAUTION⚠

- **If you are replacing only brake lining 8, clean the adjuster and screw thread area of wheel cylinder assembly 13 and apply rubber grease to the thread area.**
- **Do not turn or remove bolt *2 that is fitted to keep brake shoe assembly 6 at 90°.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Brake lining kit

● **Adjustment of initial brake shoe clearance after installation**

🕮 P35A-72

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
2	Return spring load (Installed length 266.5 {10.5})		420 N {95 lbf, 43 kgf}		Clearance between coils or coil and cover	Replace
6	Thickness of Brake lining		15 {0.59}		5.5 {0.22} (Side shoulder means wear limit)	Replace brake lining
***1**	Brake drum	Inner diameter	400 {15.75}	*401 {15.79}	402 {15.83}	Correct or replace
		Cylinder accuracy	0.025 {0.00098}		0.2 {0.0079}	Correct

* : Indicates correction limit

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Brake pipe flare nut	12.75 to 17.65 {9.4 to 13, 1.3 to 1.8}	—
10	Bolt (Wheel cylinder assembly cover mounting)	7.85 to 11.77 {5.8 to 8.7, 0.8 to 1.2}	—
12	Bolt (Wheel cylinder assembly mounting)	122.58 to 166.7 {90 to 120, 12.5 to 17.0}	—

Lubricant

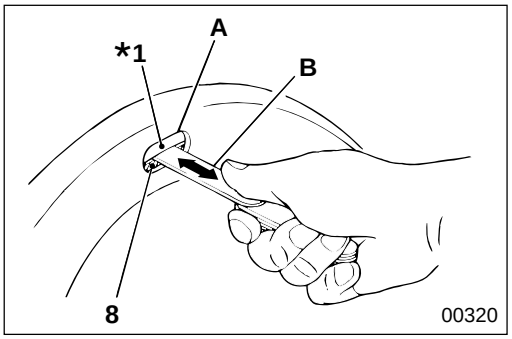
Location	Points of application	Kinds	Quantity
5	Brake shoe assembly contact surface of nut	Brake grease	As required
13	Wheel cylinder assembly anchor and screw groove contact areas with brake shoe	Brake grease	As required

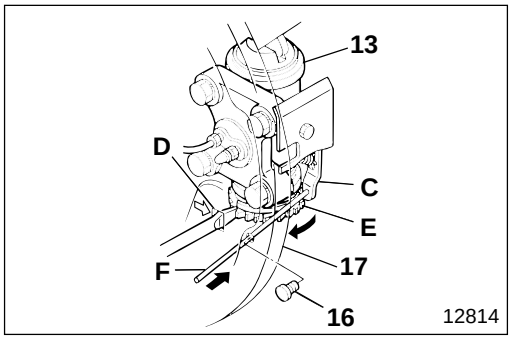
◆ Service procedure

● **Adjustment of initial brake shoe clearance after installation**

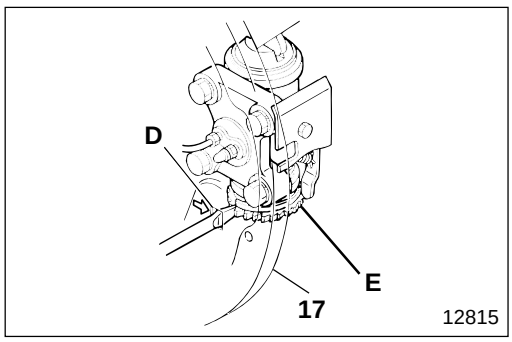
Turning the adjuster of wheel cylinder **13** in arrow ⇨ direction expands brake shoe assembly **6**, narrowing the clearance between brake drum ***1** and brake lining **8**.

- Jack up the vehicle to make sure that the wheel hub bearing has no play. If there is any play, correct it. Gr 27
- Remove adjusting hole plug **15** and check hole plug **14**.
- Adjust the brake shoe clearance as follows, so that 0.3 mm {0.012 in.} feeler gauge **B** can be inserted or extracted through inspection hole **A**, between brake drum ***1** and brake lining **8** with a little resistance.



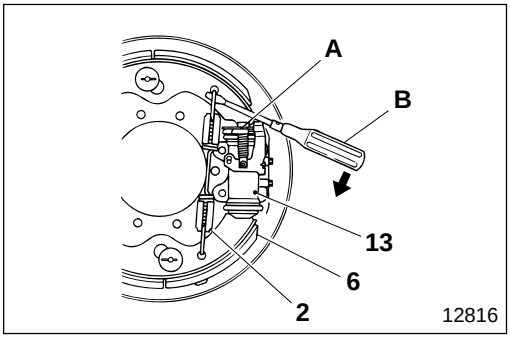


- To increase brake shoe clearance
  - Remove cover **16** on the rear of backing plate **17**.
  - Insert a wire (approximately ø5 mm {0.20 in.}) into the hole of cover **16** and lift adjusting lever **C** of wheel cylinder **13**.
  - Turn adjuster **E** of wheel cylinder **13**, through adjusting hole **D**, in the opposite direction to arrow ⇨ on backing plate **17**.



- To decrease brake shoe clearance
  Turn adjuster **E** in the arrow ⇨ direction marked on backing plate **17** through adjusting hole **D**.

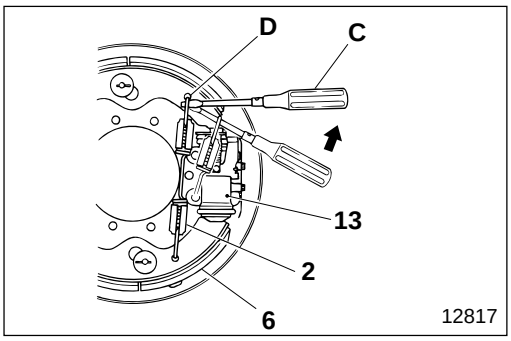
- Extract the feeler gauge and depress the brake pedal two or three times fully, then the specified value brake shoe clearance can be obtained.
- Insert a 0.2 mm {0.0079 in.} feeler gauge through check hole **A** and make sure that it can be inserted or extracted with a little resistance.
  If there is any fault, disassemble and inspect wheel cylinder **13**. P35A-76



2 **Return spring**

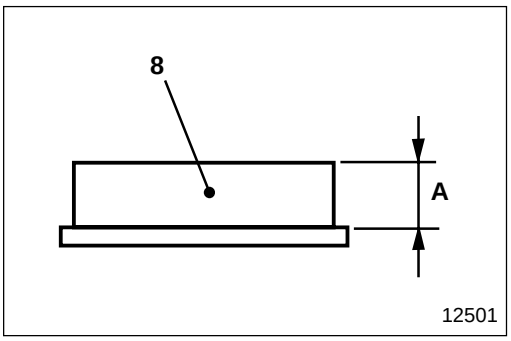
[Removal]

To remove the return spring, place screwdriver **B** on the hook of the return spring, then pry and remove the return spring making use of wheel cylinder assembly **13** adjusting screw **A** as a fulcrum.



[Installation]

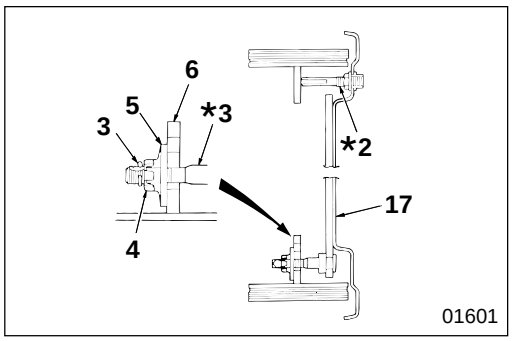
- Install the shorter hook of return spring **2** on brake shoe assembly **6**.
- Insert a small Phillips screwdriver **C** into the hook of return spring **2**, insert the tip of the screwdriver into return spring installation hole **D** of brake shoe assembly **6** to pry on the return spring.



6 **Brake shoe assembly**

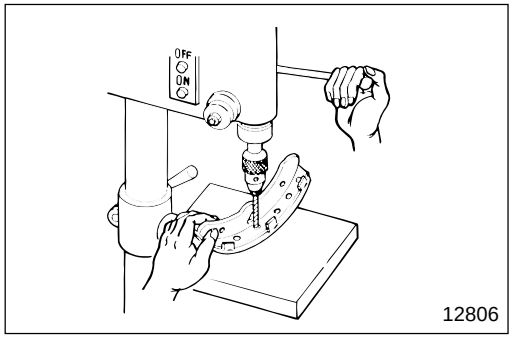
[Inspection]

If thickness **A** of brake lining **8** is lower than the limit replace the brake lining on the same axle as a unit.



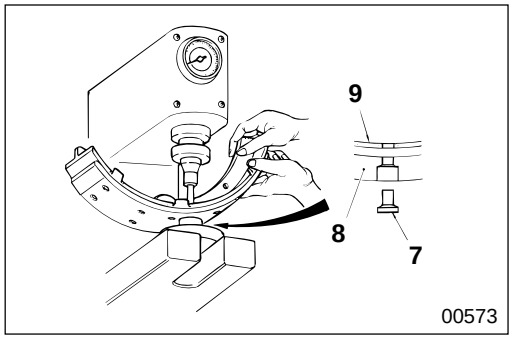
[Installation]

- Install brake shoe assembly **6**.
- Tighten nut **5**. When brake shoe assembly **6** makes contact with bolt ***2** of backing plate **17**, slacken off the nut by one third of a turn.
- Slacken off nut **5** until the holes of stud pin ***3** and lock plate **4** align with each other.
- Install cotter pin **3** and bend it.



8 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **8** and brake shoe **9** with cleaning fluid and dry them.
- Insert rivets **7** from brake lining **8** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **9** and the brake lining.

  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

- Make sure that you inspect contact with the inner surface of brake drum ***1** after you replace brake linings **8**. If contact is incorrect, correct with the brake assembled.

WARNING

Do not leave lubricant on the surface of brake lining 8 because this reduces braking performance.

CAUTION

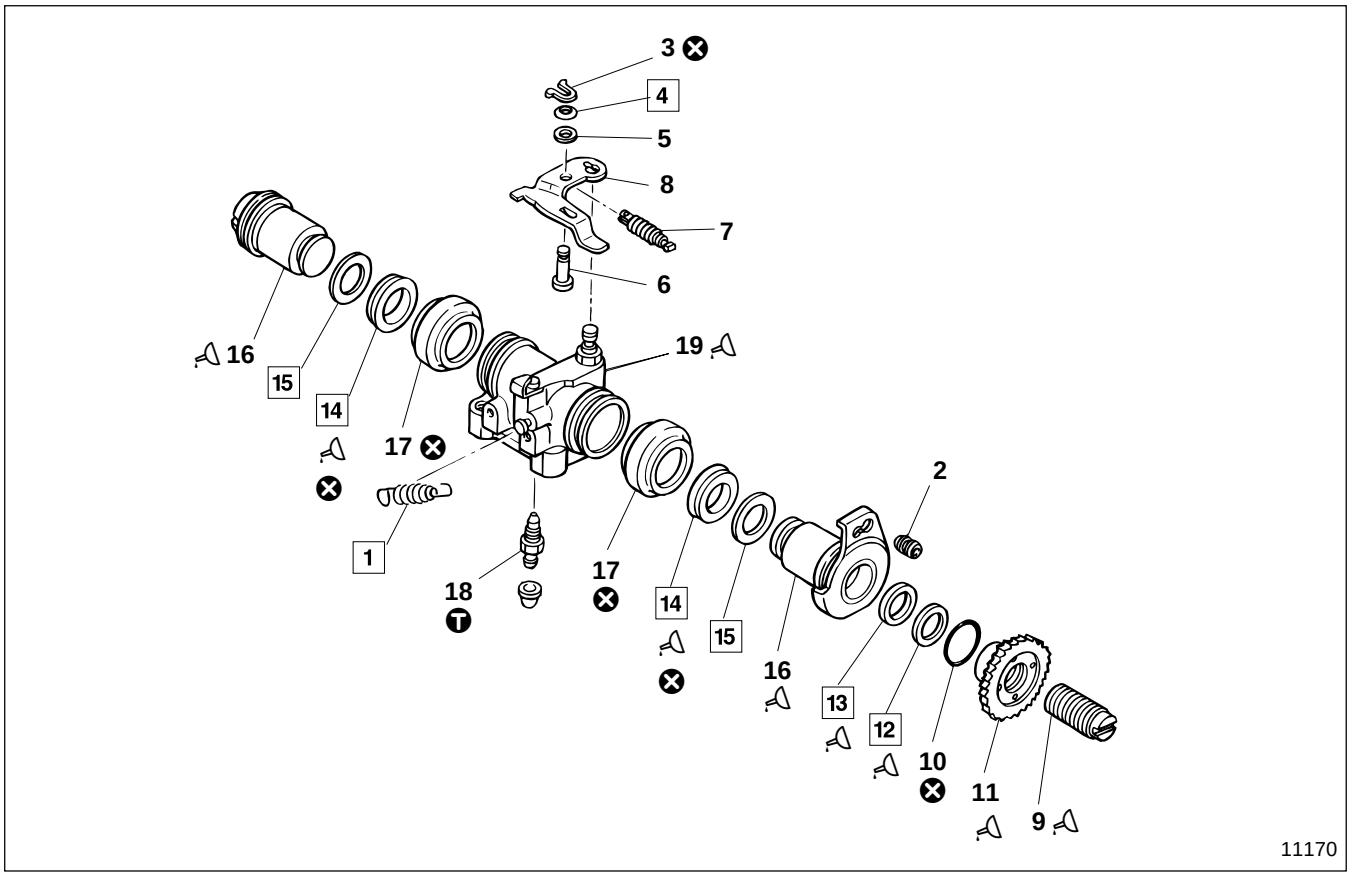
Make sure that the type of brake linings 8 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.

***1** **Correction of brake drum**

If the cylindrical accuracy of brake drum ***1** is higher than the limit, or there are seams, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

M E M O

Wheel Cylinder Assembly



● **Disassembly sequence**

1 Set spring
2 Cover
3 Retainer
4 Wave washer
5 Washer
6 Pin
7 Spring
8 Adjusting lever
9 Screw
10 O-ring
11 Adjuster
12 Washer (Thin)
13 Washer (Thick)
14 Piston cup
15 Backup ring
16 Piston
17 Boot
18 Air bleeder
19 Cylinder body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Wheel cylinder kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value (Basic diameter in [ ])	Limit	Remedy
16, 19	Clearance between piston and cylinder body	[38.10] 0.03 to 0.13 {[1.50] 0.0012 to 0.0051}	0.2 {0.0079}	Replace piston

Tightening torque

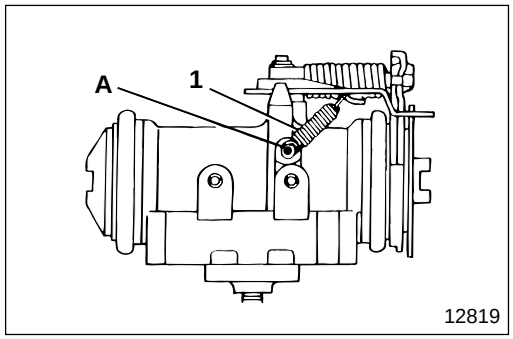
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
18	Air bleeder	6.86 to 11.77 {5.1 to 8.7, 0.7 to 1.2}	—

Lubricant

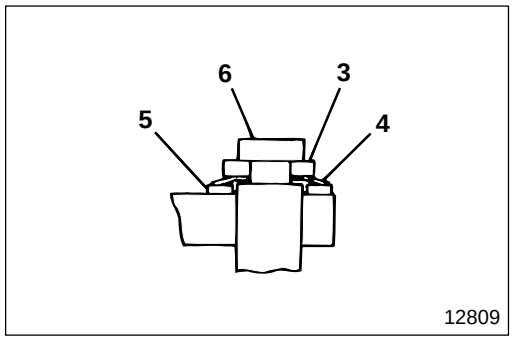
Location	Points of application	Kinds	Quantity
9	Thread area of screw	Rubber grease	As required
11	Screw mounting thread of adjuster and friction surface with piston	Rubber grease	As required
12, 13	Both sides of washer	Rubber grease	As required
14	Periphery of piston cup	Rubber grease	As required
16	Periphery and interior of piston	Rubber grease	As required
19	Boot mounting groove of cylinder body	Rubber grease	As required

◆ Service procedure



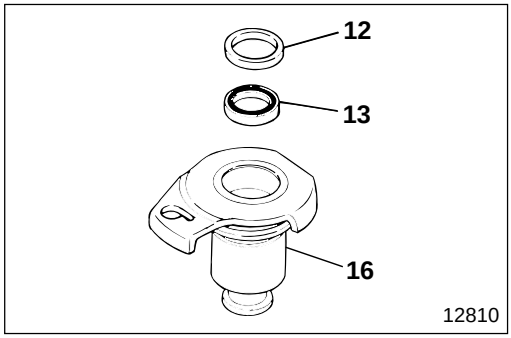
1 **Installation direction of set spring**

Fasten the closed end hook of set spring **1** on pin **A**.



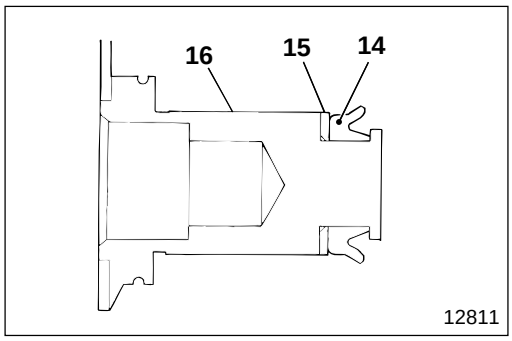
4 **Installation direction of wave washer**

Caulk retainer **3**.

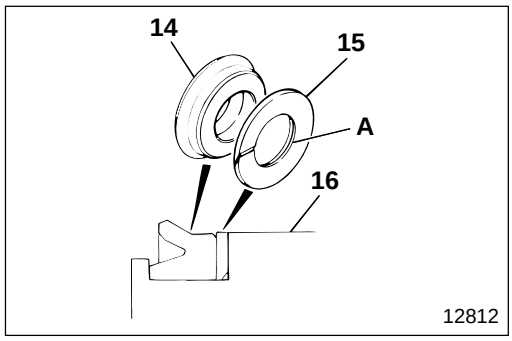


12 **13** **Installation sequence and direction of washer**

- Install thicker washer **13** first.
- Install washer **13** with its black face upward.



14 **Installation direction of piston cup**

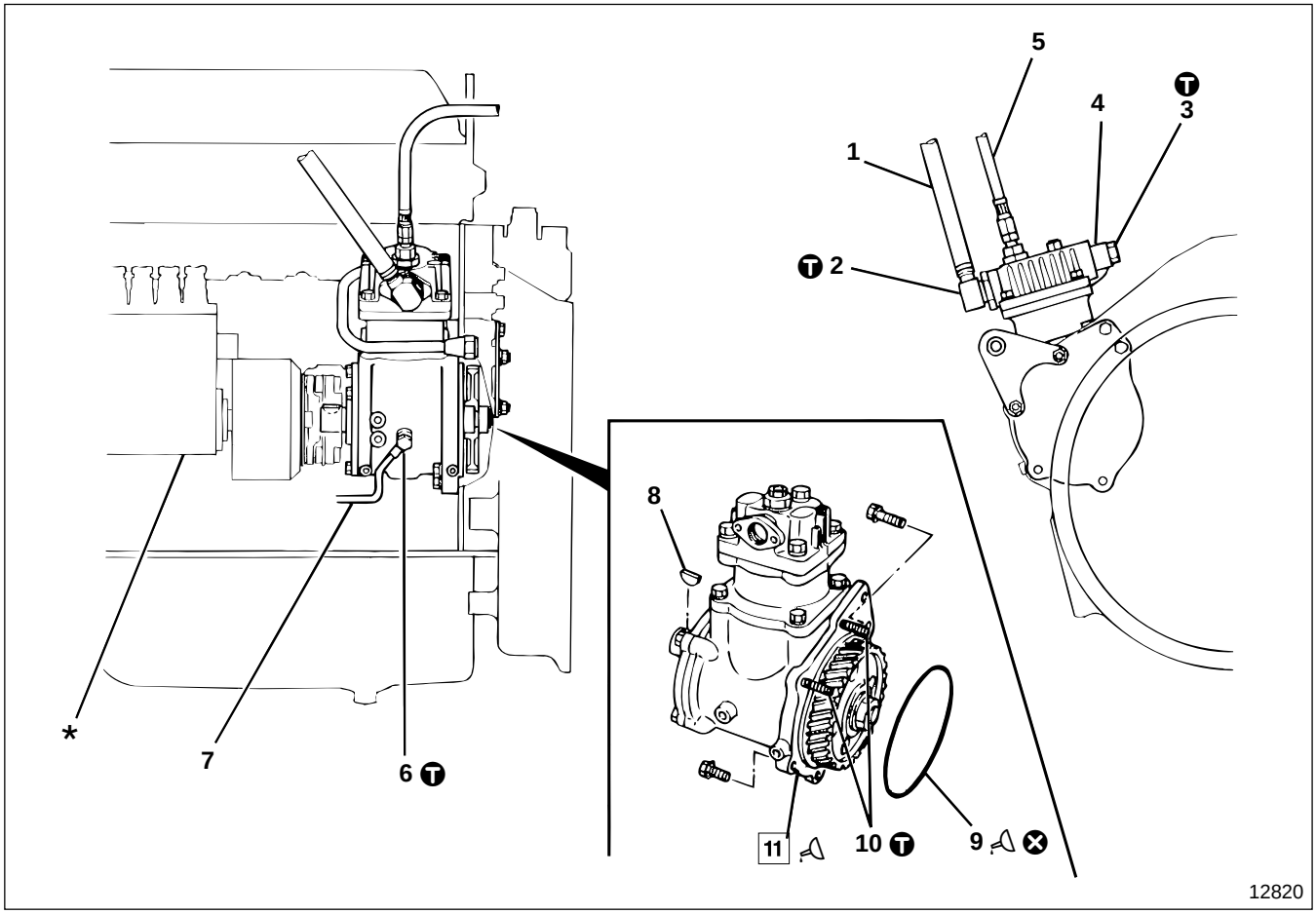


15 **Installation direction of backup ring**

Install backup ring **15** facing the side without chamfer **A** to piston cup **14**.

M E M O

AIR COMPRESSOR



● **Removal sequence**

1 Suction hose
2 Connector
3 Eye bolt
4 Air outlet pipe
5 Unloader hose
6 Eye bolt
7 Oil pipe
8 Key
9 O-ring
10 Stud bolt
11 Air compressor assembly
📖 P35A-82

*: Injection pump assembly Gr 13
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Connector	98 {72, 10.0}	—
3	Eye bolt	98 {72, 10.0}	—
6	Eye bolt	21 {15, 2.1}	—
10	Stud	5.9 to 12 {4.3 to 8.7, 0.6 to 1.2}	—

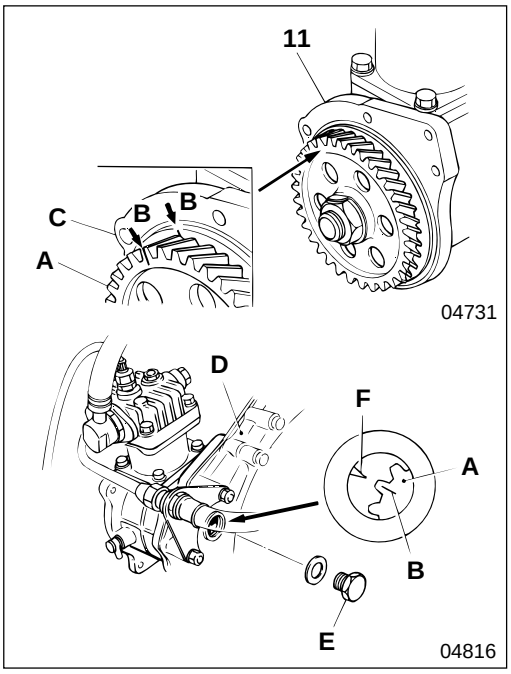
Lubricant and sealant

Location	Points of application	Kinds	Quantity
9	O-ring	Engine oil	As required
11	Air compressor assembly stud bolt mounting hole	LOCTITE 271	As required

◆ Service procedure

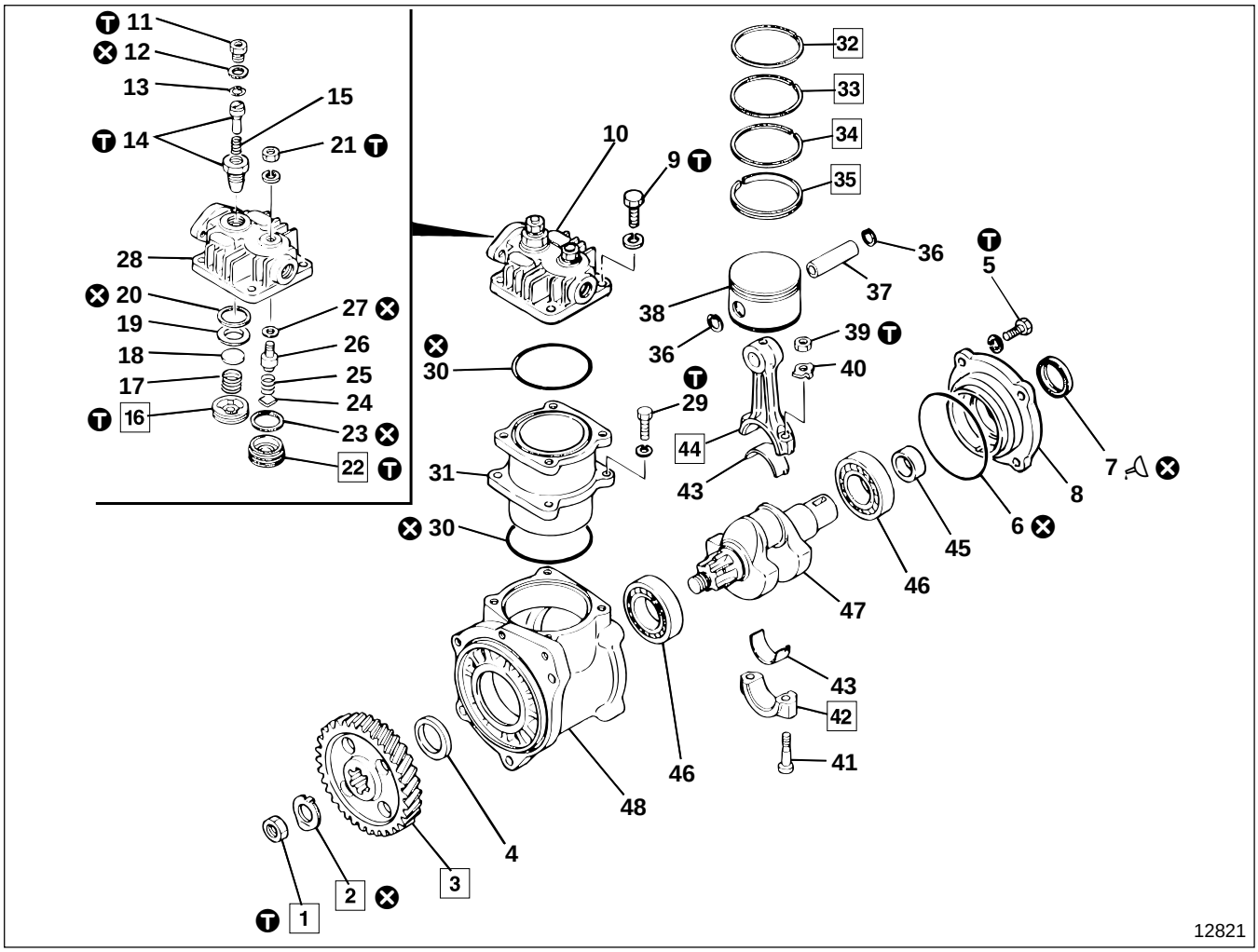
11 Installation of air compressor assembly

- Position No.1 cylinder at top dead center in the compression cycle. Gr 11
- Align punched marks **B** of drive gear **A** and crankcase **C** of air compressor assembly **11**. Then mount on flywheel housing **D**.
- Remove inspection plug **E** from flywheel housing **D** and check that punched mark **B** of drive gear **A** and pointer **F** align. If they do not, reinstall them.



AIR COMPRESSOR

Air Compressor Assembly



● **Disassembly sequence**

1 Nut
2 Lock washer
3 Drive gear
4 Collar
5 Bolt
6 O-ring
7 Oil seal
8 Bearing holder
9 Bolt
10 Cylinder head assembly
11 Connector
12 Gasket
13 Snap ring
14 Unloader valve assembly
15 Unloader spring
16 Suction valve holder
17 Suction valve spring
18 Suction valve
19 Suction valve seat
20 Suction gasket
21 Nut
22 Delivery valve holder
23 Suction gasket
24 Delivery valve
25 Delivery valve spring
26 Spring holder
27 Gasket
28 Cylinder head
29 Bolt
30 O-ring
31 Cylinder liner
32 1st compression ring
33 2nd compression ring
34 3rd compression ring
35 Oil ring
36 Snap ring
37 Piston pin
38 Piston
39 Nut
40 Lock washer
41 Bolt
42 Connecting rod cap
43 Connecting rod bearing
44 Connecting rod
45 Sleeve
46 Bearing
47 Crankshaft
48 Crankcase

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Piston ring kit

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
17	Suction valve spring load (Installed length 9 {0.35})		2.3 N {0.51 lbf, 0.23 kgf}	1.3 N {0.29 lbf, 0.13 kgf}	Replace
25	Delivery valve spring load (Installed length 10.5 {0.41})		3.2 N {0.73 lbf, 0.33 kgf}	2.4 N {0.53 lbf, 0.24 kgf }	Replace
31, 38	Clearance between piston and cylinder liner	Top	[80] 0.27 to 0.33 {[3.15] 0.011 to 0.013}	0.35 {0.014}	Replace cylinder liner
		Skirt	[80] 0.11 to 0.17 {[3.15] 0.0043 to 0.0067}	0.19 {0.0075}	
32 to 35	Clearance of piston ring gap (Measure at interior of cylinder liner)	Compression ring	—	1.0 {0.039}	Replace piston ring kit
		Oil ring	—	1.0 {0.039}	
32 to 35, 38	Clearance between piston ring and piston ring groove of piston	Compression ring	—	0.08 {0.0031}	Replace piston ring kit
		Oil ring	—	0.08 {0.0031}	
37, 38	Clearance between piston pin and piston		[16] {[0.63]}	0.08 {0.0031}	Replace piston pin
37, 44	Clearance between piston pin and connecting rod small end		[16] {[0.63]}	0.07 {0.0028}	Replace connecting rod
43, 47	Clearance between connecting rod bearing and crankshaft		[34] {[1.34]}	0.1 {0.0039}	Replace
42, 44, 47	End play of connecting rod		—	0.5 {0.020}	Replace
47, 48	End play of crankshaft		—	1.0 {0.039}	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

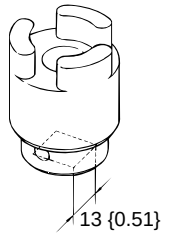
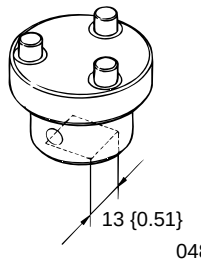
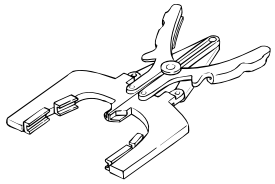
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Drive gear mounting)	116.7 to 210.8 {120 to 155, 17.0 to 21.5}	—
5	Bolt (Bearing holder mounting)	13.7 to 17.7 {10 to 13, 1.4 to 1.8}	—
9	Bolt (Cylinder head assembly mounting)	24.5 to 29.4 {18 to 22, 2.5 to 3.0}	—
11	Connector	29.4 to 34.3 {22 to 25, 3.0 to 3.5}	—
14	Unloader valve assembly	98.1 to 117.7 {72 to 87, 10 to 12}	—
16	Suction valve holder	98.1 to 117.7 {72 to 87, 10 to 12}	—
21	Nut (Spring holder mounting)	44.1 to 58.8 {33 to 43, 4.5 to 6.0}	—
22	Delivery valve seat	98.1 to 117.7 {72 to 87, 10 to 12}	—
29	Bolt (Cylinder liner mounting)	24.5 to 29.4 {18 to 22, 2.5 to 3.0}	—
39	Nut (Connecting rod mounting)	22.6 to 25.5 {17 to 19, 2.3 to 2.6}	—

Lubricant

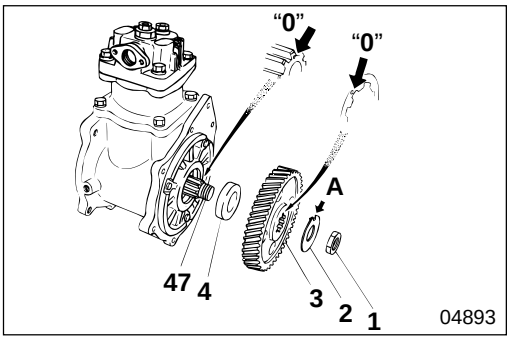
Location	Points of application	Kinds	Quantity
7	Oil seal lip	Engine oil	As required

Special tools

Unit : mm {in.}

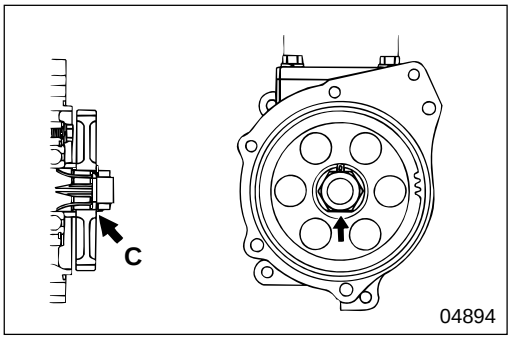
Location	Tool name and shape	Part No.	Application
16	Suction valve tool  01730	MH061263	Removal and installation of suction valve holder
22	Delivery valve tool  04813	MH062014	Removal and installation of delivery valve holder
32 to 35	Piston ring tool  01732	MH060014	Removal and installation of piston ring (Compression ring, oil ring)

◆ Service procedure

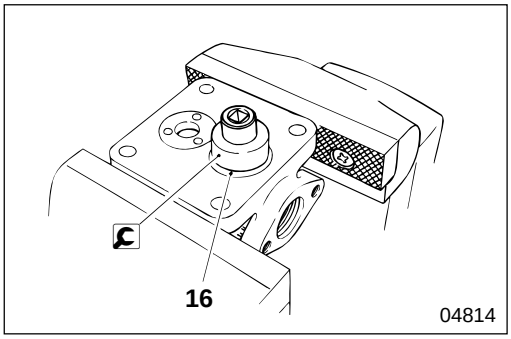


1 **to** **3** **Installation of drive gear**

- To install, align mark "**0**" of crankshaft **47** with alignment mark "**0**" of drive gear **3**.
  Assemble by aligning the alignment mark of the drive gear with indent **A** of lock washer **2**, then tighten nut **1** at specified torque.

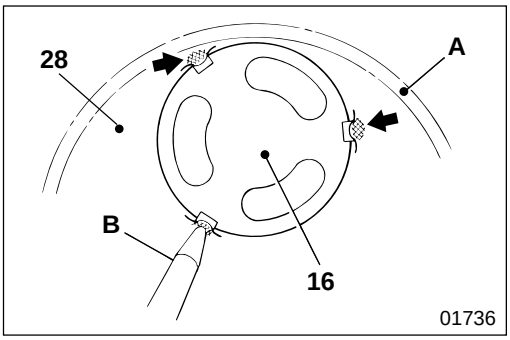


- Bend the lock washer toward nut **C** after assembly.

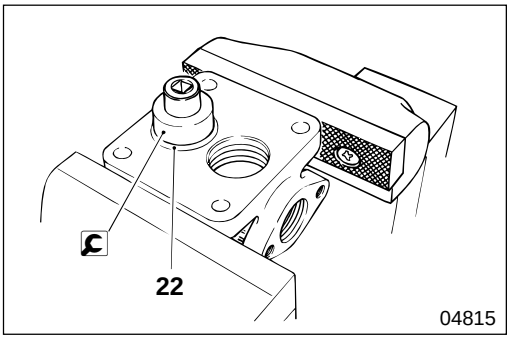


16 **Suction valve holder**

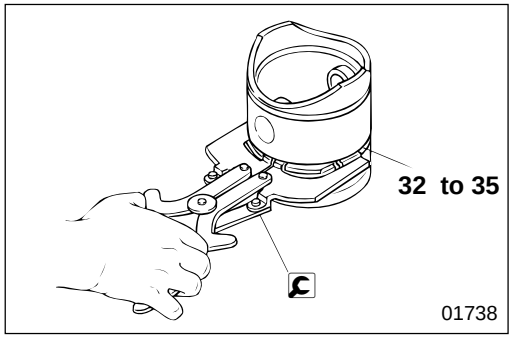
[Removal and installation]



[Caulking]
Caulk cylinder head **28** taking care not to damage seal surface **A** of the O-ring.
B : Center punch

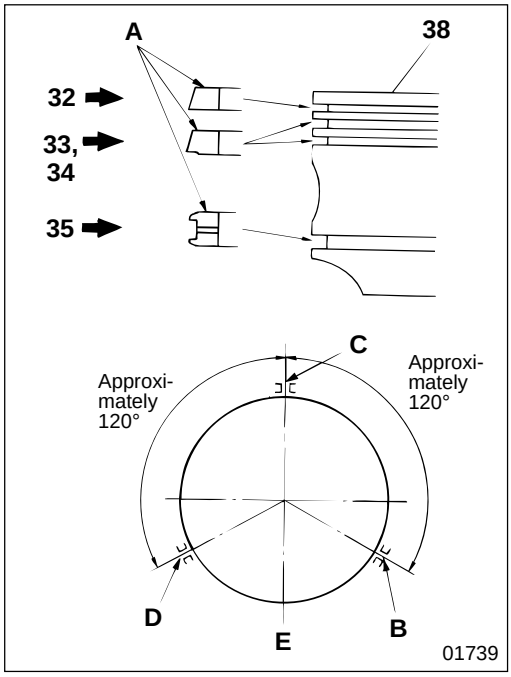


22 **Removal and installation of delivery valve holder**



32 to **35** **Piston ring (Compression ring and oil ring)**

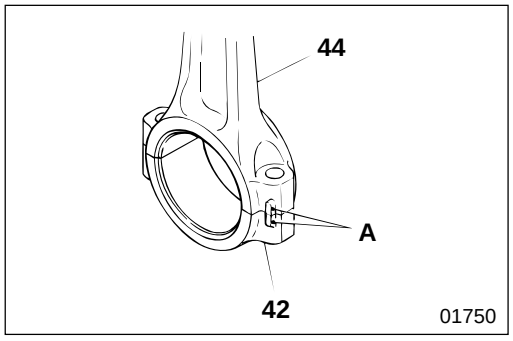
[Removal and installation]



[Mounting position]

- Pay attention to the mounting positions of compression rings **32** to **34** and oil ring **35**. Assemble the piston rings so that lettered side **A** faces toward the top of piston **38**.
- Arrange the piston rings so that each split, **B** to **D**, of the compression rings is offset by 120° from the preceding split.

  B : 1st compression ring split
  C : 2nd compression ring split
  D : 3rd compression ring split
- Position oil ring split **E** so that it comes midway between the splits of the two compression rings.

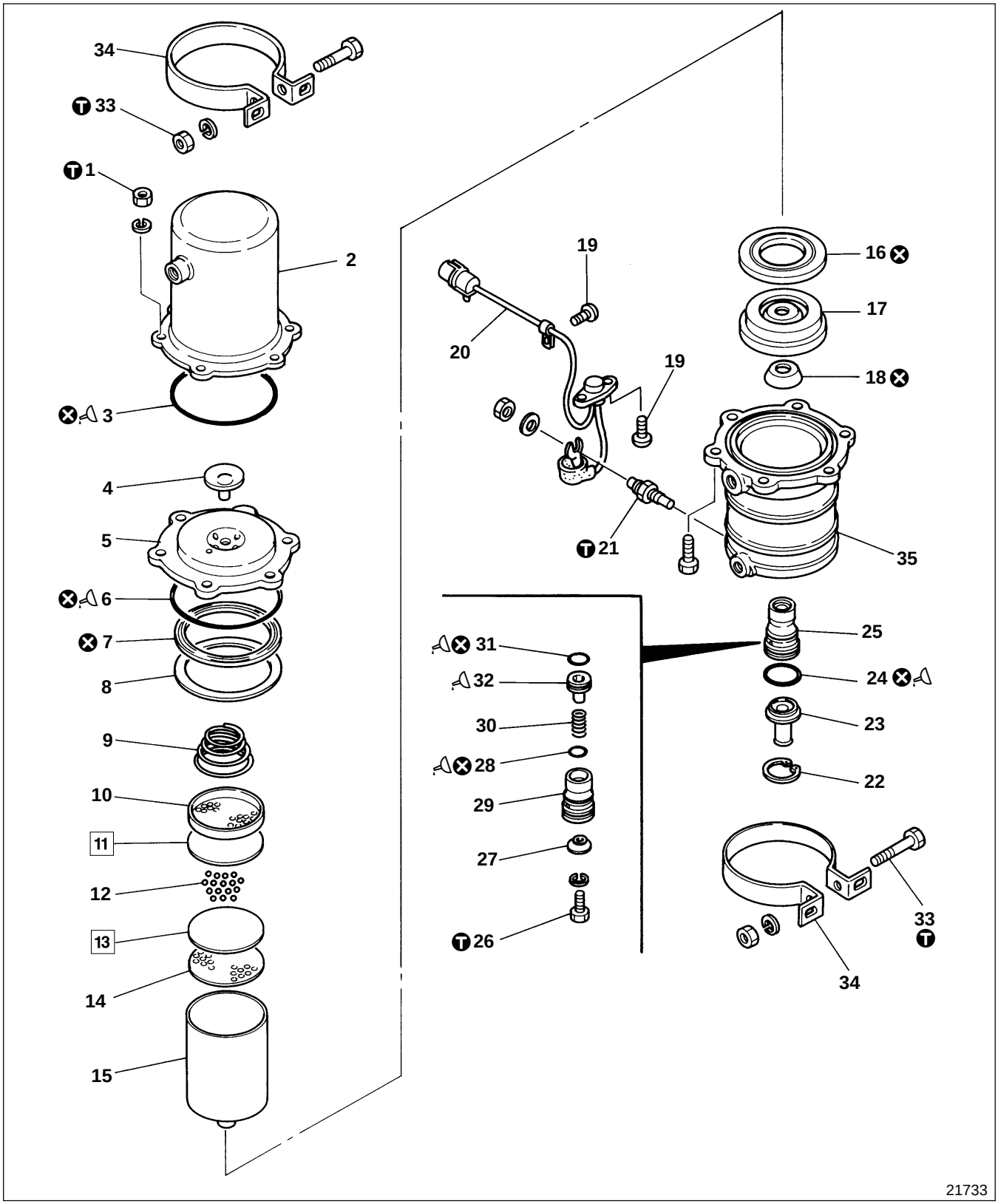


42 **44** **Installation of connecting rod and connecting rod cap**

Assemble connecting rod **44** and connecting rod cap **42** with alignment marks **A** aligned.

M E M O

AIR DRYER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● **Disassembly sequence**

1 Nut
2 Purge chamber
3 O-ring
4 Check valve
5 Cover assembly
6 O-ring
7 Sealing
8 Case guide
9 Set spring
10 Filter plate
11 Filter
12 Desiccant
13 Filter
14 Filter plate
15 Case
16 Filter gasket
17 Oil filter
18 Gasket ring
19 Screw
20 Thermostat assembly
21 Heater
22 Retaining ring
23 Exhaust cover
24 O-ring
25 Valve body assembly
26 Bolt
27 Valve assembly
28 O-ring
29 Valve body
30 Valve spring
31 O-ring
32 Piston
33 Bolt
34 Bracket
35 Body

⊗ : Non-reusable part

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: Air dryer kit

● **Inspection after assembly**

P35A-90

Tightening torque

Unit: N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Purge chamber and body mounting)	8.8 to 13.7 {6.5 to 10, 0.9 to 1.4}	—
26	Bolt (Valve assembly mounting)	3.9 to 6.9 {2.9 to 5.1, 0.4 to 0.7}	—
33	Bolt (Bracket mounting)	4.9 to 5.9 {3.6 to 4.3, 0.5 to 0.6}	—

Lubricant

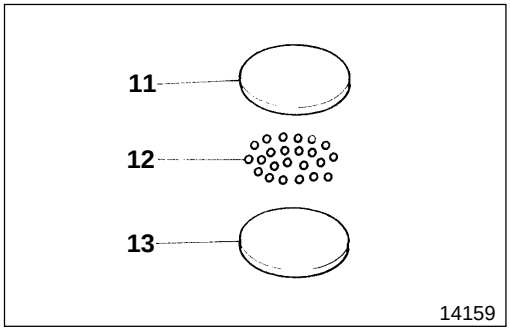
Location	Points of application	Specified lubricant	Quantity
—	O-ring and piston sliding surface	Multipurpose grease [NLGI No. 2 (Li soap)]	As required

◆ Service procedure

● Inspection after assembly

Inspection for air leakage

- Plug the air outlet port of the air dryer completely, and apply pressures of 49 kPa {7.1 psi, 0.5 kgf/cm^2} and 880 kPa {130 psi, 9 kgf/cm^2} from the air inlet port. Check to ensure that each section except valve assembly **30** is free from any air leaks. As for the valve assembly, a small amount of air leaks not exceeding 20 cm^3 {1.22 cu. in.}/min is permissible.
- Check to ensure that there are no air leaks in the air dryer body when an air pressure of 880 kPa {130 psi, 9 kgf/cm^2} is applied from the command pressure port of the air dryer.

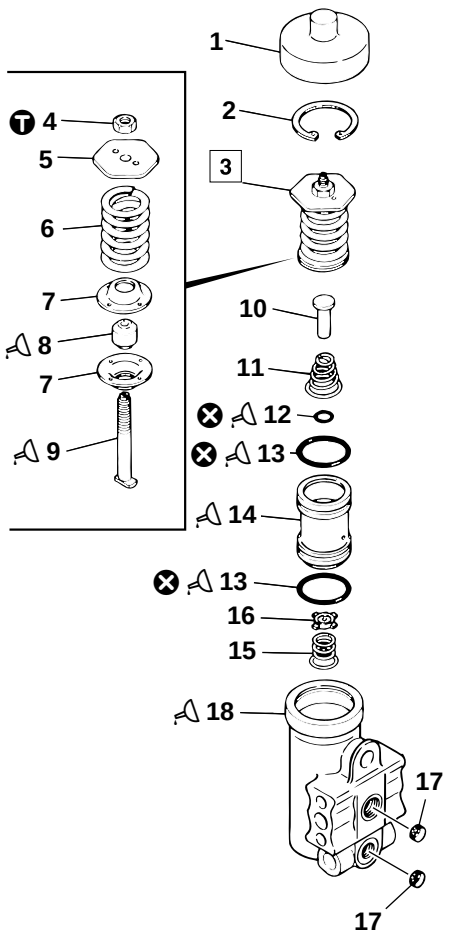


11 **13** **Installation of filter**

Install filters **11** and **13** with their softer layer facing desiccant **12**.

M E M O

AIR PRESSURE GOVERNOR



12536

● **Disassembly sequence**

1 Cover
2 C-ring
3 Adjusting screw assembly
4 Lock nut
5 Upper spring seat
6 Spring
7 Lower spring seat
8 Spring guide
9 Adjusting screw
10 Exhaust stem
11 Exhaust stem spring
12 O-ring
13 O-ring
14 Piston
15 Valve spring
16 Valve
17 Filter
18 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Air pressure governor kit

● **Inspection of function after assembly**

P35A-93

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Specified pressure	High specified pressure	805 $^{+29}_{-20}$ kPa {115 $^{+4.3}_{-2.8}$ psi, 8.2 $^{+0.3}_{-0.2}$ kgf/cm^2}	—	Adjust
		Low specified pressure	685±20 kPa {100±2.8 psi, 7.0±0.2 kgf/cm^2}		

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

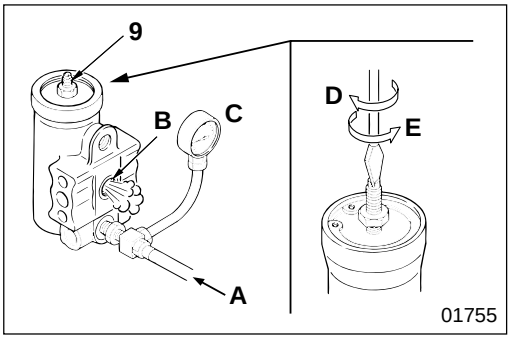
Location	Parts to be tightened	Tightening torque	Remarks
4	Lock nut	3.9 to 6.9 {2.9 to 5.1, 0.4 to 0.7}	—

Lubricant

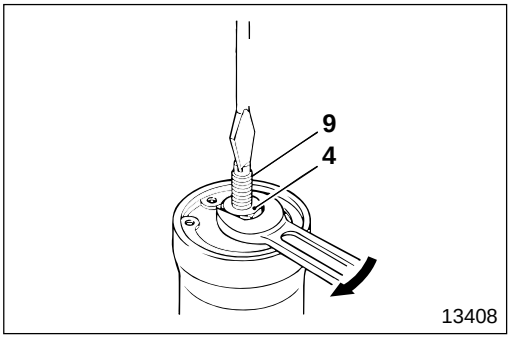
Location	Points of application	Kinds	Quantity
8	Surface of spring guide	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
9	Surface of adjusting screw, except for thread area	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
12, 13	O-ring	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
14	Outer periphery of piston and O-ring groove	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
18	Interior of body	Multipurpose grease [NLGI No. 2 (Li soap)]	As required

◆ Service procedure

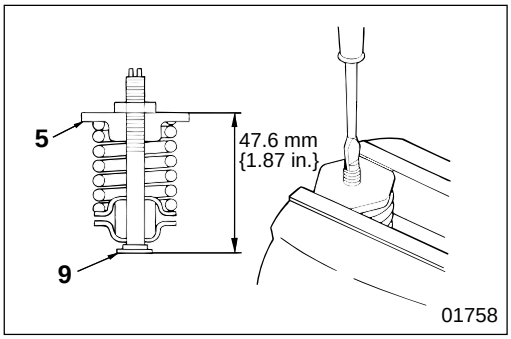
● Inspection of function after assembly



- Increase air pressure **A** gradually and read the value on air pressure gauge **C** when air is discharged from **B**. Adjust by turning adjusting screw **9** so that the reading conforms to the standard value (high specified-pressure).
  D : Turning clockwise decreases the pressure
  E : Turning counterclockwise increases the pressure
- Lower air pressure **A** to 685 kPa {100 psi, 7 kgf/cm²} or less, then raise the air pressure gradually. Read air pressure gauge **C** when it stops and check that the value conforms to the standard value (high specified-pressure). If the value deviates from the standard value, readjust.
- Lower air pressure **A** gradually. When the discharge of air from **B** ceases, read air pressure gauge **C** to check that the valve conforms to the standard value (high specified-pressure). If the value deviates from the standard value, replace the air pressure governor assembly.



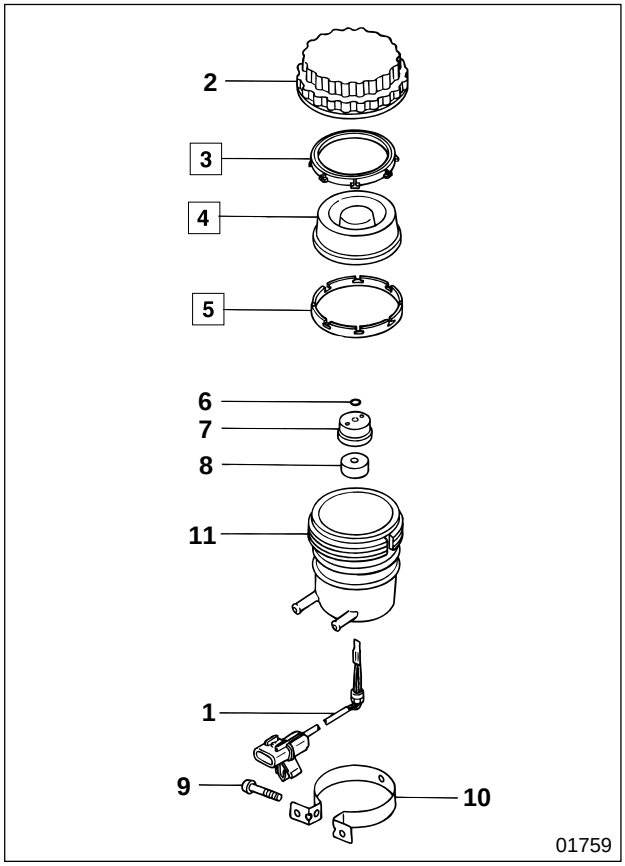
- After adjusting, tighten lock nut **4** to prevent adjusting screw **9** being turned accidentally.



3 **Preliminary adjustment of adjusting screw assembly**

It is recommended that you adjust the distance from the upper level of upper spring seat **5** to the lower level of adjusting screw **9** to 47.6 mm {1.87 in.} by turning the adjusting screw, because this makes adjustment to the specified value easier.

FLUID TANK

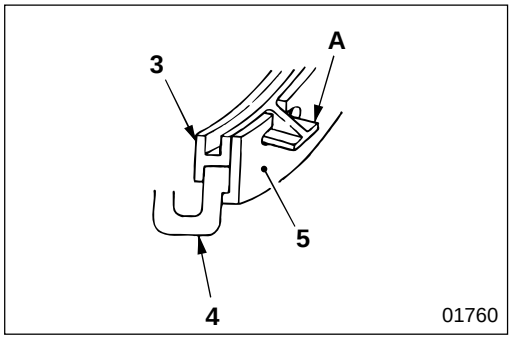


● **Disassembly sequence**

1. Brake fluid level switch Gr 54
2. Cap
3. Slide ring
4. Diaphragm
5. Ring cover
6. Stopper ring
7. Float stopper
8. Float
9. Screw
10. Fluid tank bracket
11. Tank

● **Assembly sequence**

Follow the disassembly sequence in reverse.

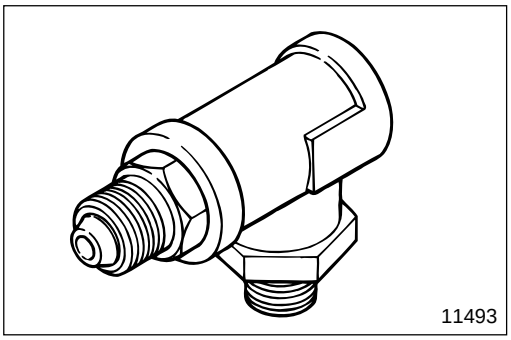


◆ Service procedure

3 to 5 Installation of slide ring, diaphragm and ring cover

Be sure to install claw **A** of slide ring **3** to ring cover **5** securely. Install diaphragm **4** in the direction as illustrated.

CHECK VALVE



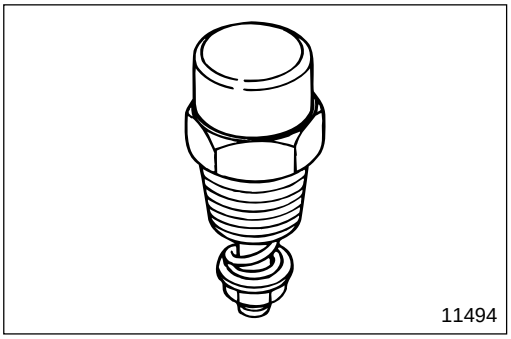
CAUTION⚠

Do not disassemble this check valve because it is a unit construction.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Pressure difference between inlet and outlet	29 kPa {4.3 psi, 0.3 kgf/cm^2} or less	—	Replace

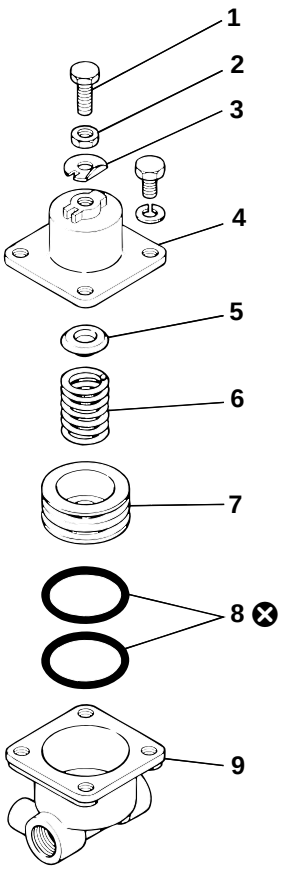
SAFETY VALVE



Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Release pressure of safety valve	950±20 kPa {135±2.8 psi, 9.7±0.2 kgf/cm^2}	—	Replace

SUPPLY VALVE



● **Disassembly sequence**

1 Adjusting bolt
2 Lock nut
3 Claw washer
4 Cap
5 Spring retainer
6 Spring
7 Piston
8 O-ring
9 Valve body

⊗ : Non-reusable parts

CAUTION⚠

Make sure that adjusting bolt 1 is not turned except for adjustment.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

🕮 P35A-96

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Specified pressure	Valve opening pressure	345±29 kPa {50±4.3 psi, 3.5±0.3 kgf/cm²}	—	Adjust or replace
		Valve closing pressure	315±20 kPa {46±2.8 psi, 3.2±0.2 kgf/cm²}	—	

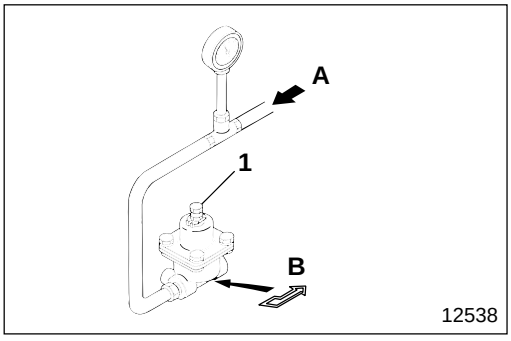
◆ Service procedure

● **Inspection after assembly**

Adjust by turning adjusting bolt **1** after loosening lock nut **2**. After adjusting, tighten the lock nut without turning the adjusting bolt, and bend claw washer **3** to secure the lock nut.

- Adjust adjusting bolt **1** so that air is discharged from the outlet port (arrow mark **B** in the illustration), when valve opening pressure is applied to the inlet port (arrow mark **A** in the illustration).
- After adjusting valve opening pressure, adjust adjusting bolt **1** so that air is not discharged from the outlet port (arrow mark **B** in the illustration) when valve closing pressure is applied to the inlet port (arrow mark **A** in the illustration).

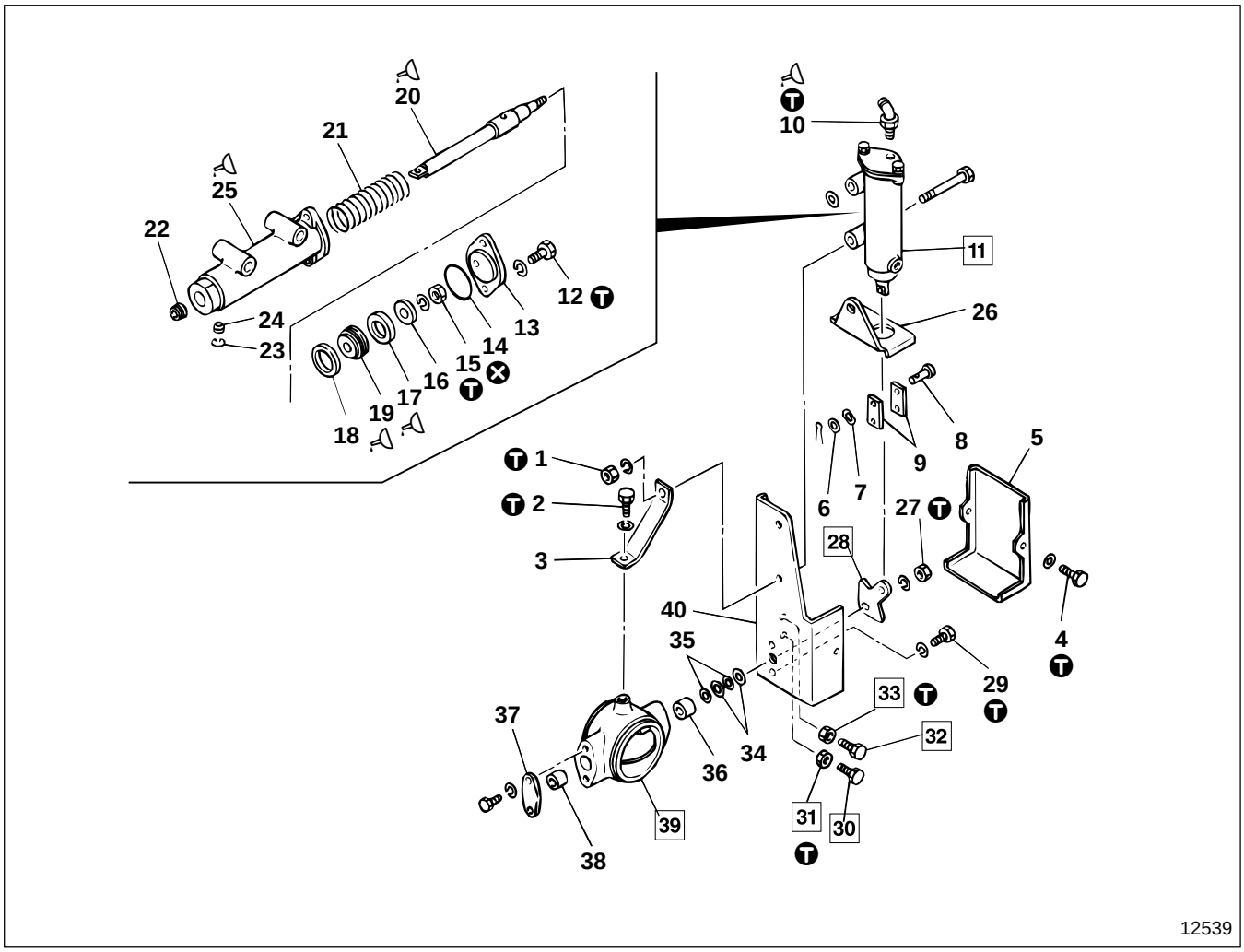
  B : Arrow showing the air flow direction



M E M O

EXHAUST BRAKE SYSTEM

Exhaust Brake Unit



● **Disassembly sequence**

1	Nut	**15**	Nut	**29**	Bolt
2	Bolt	**16**	Retainer	**30**	Adjusting bolt
3	Arm	**17**	Packing	**31**	Lock nut
4	Screw	**18**	Wear ring	**32**	Adjusting bolt
5	Cover	**19**	Plate	**33**	Lock nut
6	Plain washer	**20**	Shaft	**34**	Seal ring (Large)
7	Wave washer	**21**	Spring	**35**	Seal ring (Small)
8	Pin	**22**	Dust seal	**36**	Bushing
9	Link	**23**	Retaining ring	**37**	Cover
10	Connector	**24**	Filter	**38**	Bushing
11	Control cylinder	**25**	Cylinder	**39**	Valve assembly
12	Bolt	**26**	Cover	**40**	Plate
13	Cover	**27**	Nut		
14	O-ring	**28**	Lever	⊗ :	Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
11	Airtightness of control cylinder (Air leakage at air pressure 980 kPa {140 psi, 10 kgf/cm²})	No air leakage	—	Replace
21	Spring load (Installed length 109 {4.3})	72 N {16 lbf, 7.3 kgf}	61 N {13.7 lbf, 6.2 kgf}	Replace
39	Clearance between butterfly valve and body when valve assembly butterfly valve operating (Air pressure 685±49 kPa {100±7.1 psi, 7±0.5 kgf/cm²} supplied to control cylinder)	0.2 to 0.4 {0.0079 to 0.016}	—	Adjust

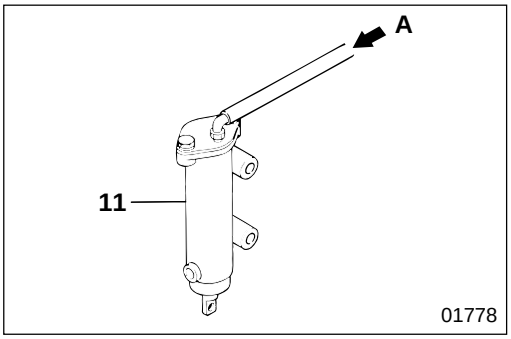
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Control cylinder mounting)	20.6 to 25.5 {15 to 19, 2.1 to 2.6}	—
2	Bolt (Arm mounting)	9.81 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
4	Screw (Cover mounting)	4.9 to 6.86 {3.6 to 5.1, 0.5 to 0.7}	—
10	Connector	4.9 {3.6, 0.5} or more	—
12	Bolt (Cover mounting)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
15	Nut (Plate mounting)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
27	Nut (Lever mounting)	9.81 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
29	Bolt (Valve assembly mounting)	9.81 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
31	Lock nut	4.9 to 6.86 {3.6 to 5.1, 0.5 to 0.7}	—
33	Lock nut	4.9 to 6.86 {3.6 to 5.1, 0.5 to 0.7}	—

Lubricant and sealant

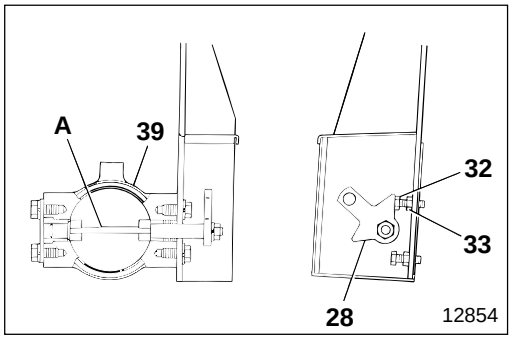
Location	Points of application	Kinds	Quantity
10	Thread area of connector	THREEBOND No.1211 or No.1213	As required
17	Surface of packing	Molybdenum disulfide bearing grease [NLGI No.2 (Li soap)]	As required
19, 20	Mounting areas of plate and shaft	Sealant [Hermetic GA (SANNOW KOGYO)]	As required
20	Shaft at ø12 {0.47}	Molybdenum disulfide bearing grease [NLGI No.2 (Li soap)]	As required
25	Interior of cylinder	Molybdenum disulfide bearing grease [NLGI No.2 (Li soap)]	2 cm³ {0.12 cu. in.}



◆ Service procedure

11 **Inspection on airtightness of control cylinder**

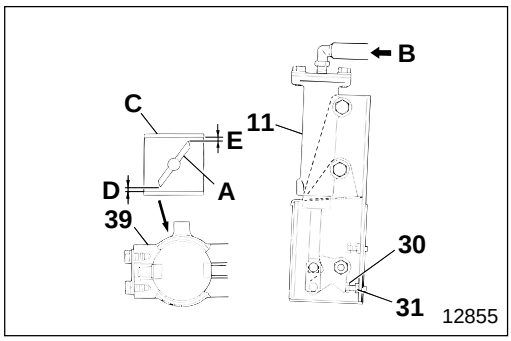
Make sure that there is no air leakage when air pressure of 980 kPa {140 psi, 10 kgf/cm²} is applied to control cylinder **11**. If any air leakage is found, replace the control cylinder assembly.



28 **30** **to** **33** **39** **Lever, adjusting bolt, lock nut, and valve assembly**

[Butterfly valve **A** fully-opened adjustment]

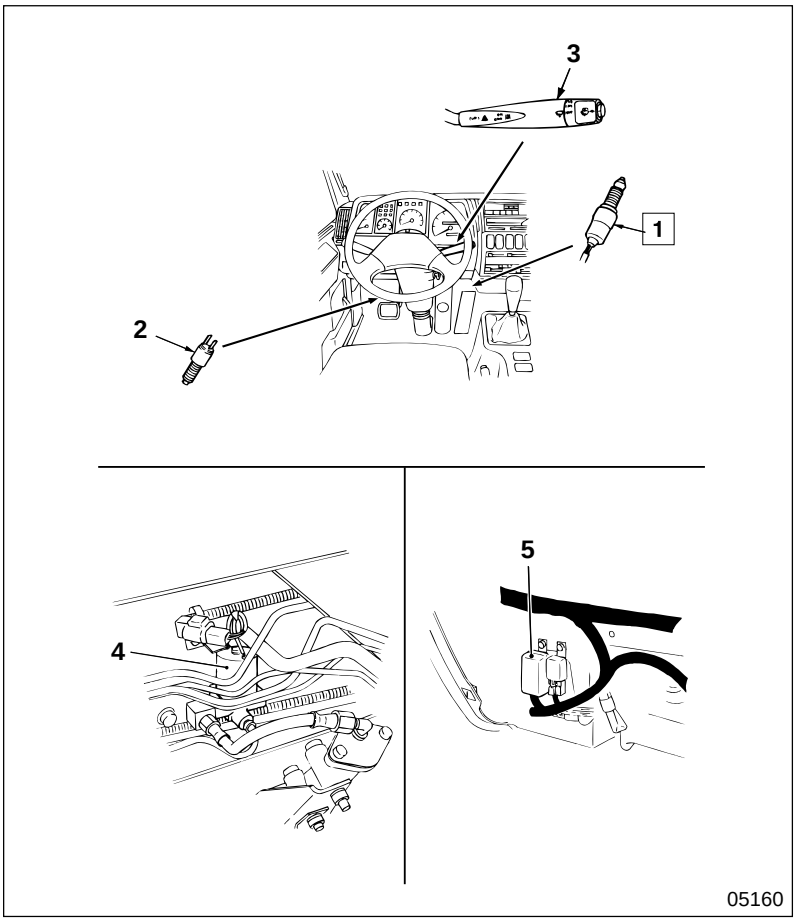
- Turn the adjusting bolt so that lever **28** and the head of adjusting bolt **32** make contact horizontally.
- Tighten lock nut **33** at specified torque.



[Butterfly valve **A** fully-closed adjustment]

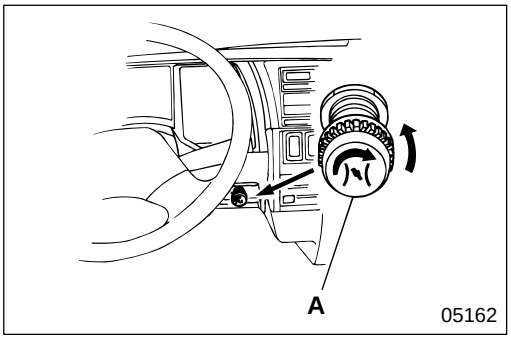
- Apply air pressure **B** of 685±49 kPa {100±7.1 psi, 7±0.5 kgf/cm^2} to control cylnder **11**.
- Turn adjusting bolt **30** so that the average value of clearances **D**, **E** between butterfly valve **A** and body **C** conforms to the standard value.
- Calculate the average of clearances **D**, **E** by (**D**+**E**)/2.
- Tighten lock nut **31** at specified torque.

Exhaust Brake Electric Equipment



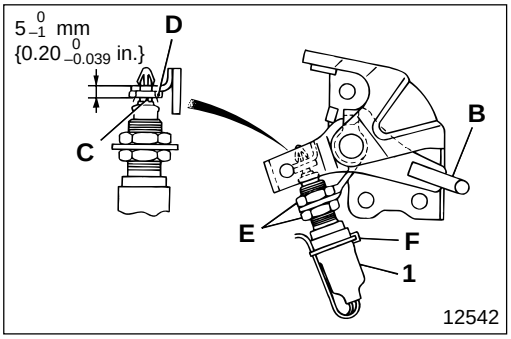
1 Accelerator switch
Gr 54
2 Clutch switch
Gr 21, 54
3 Exhaust brake switch
Gr 37, 54
4 3-way magnetic valve
Gr 54
5 Exhaust brake cut relay
Gr 54

◆ Service procedure



1 **Installation of accelerator switch**

- Turn idling control knob **A** in direction ⇨ (counterclockwise) to free the accelerator pedal.



- Screw in accelerator switch **1**, holding accelerator control lever **B** still, until push rod **C** makes contact with stopper **D**. Then screw in by a further 5 0 -1 mm {0.20 0 -0.039 in.} and tighten lock nut **E**.
- Secure accelerator switch **1** harness using band **F**.

MITSUBISHI
FUSO

Group 35B
Brake
< Full Air Brake >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-35B

INDEX

SPECIFICATIONS 35B- 2

STRUCTURE AND OPERATION 35B- 4

TROUBLESHOOTING 35B- 31

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Inspection and Adjustment of Brake Pedal Free Play 35B- 35
- Thickness Inspection and Replacement of Brake Lining 35B- 35
- Inspection of Automatic Slack Adjuster Function 35B- 36
- Inspection and Maintenance of Air Dryer 35B- 38

HANDLING OF CONNECTOR AND NYLON TUBE PIPING 35B- 39

BRAKE PEDAL 35B- 40

DUAL BRAKE VALVE 35B- 42

RELAY VALVE 35B- 50

QUICK RELEASE VALVE 35B- 52

FRONT WHEEL BRAKE

< MANUAL TRANSMISSION > 35B- 54

< AUTOMATIC TRANSMISSION > 35B- 64

REAR WHEEL BRAKE

< MANUAL TRANSMISSION > 35B- 74

< AUTOMATIC TRANSMISSION > 35B- 84

EXPANDER ASSEMBLY 35B- 98

AIR COMPRESSOR 35B-104

AIR DRYER 35B-112

AIR PRESSURE GOVERNOR 35B-116

CHECK VALVE 35B-118

SAFETY VALVE 35B-118

SUPPLY VALVE 35B-119

EXHAUST BRAKE SYSTEM 35B-120

SPECIFICATIONS

< Equipment for Service Brake >

Item			Specifications
Air compressor	Type		Water-cooled one cylinder
	Cylinder diameter×Stroke mm {in.}		ø85×60 {3.35×2.36}
	Cylinder capacity cm^2 {cu.in.}		340 {20.7}
	Manufacturer		SANWA SEIKI
Air dryer	Type		DR-5
	Heater capacity V-W		12 - 100 (50 W×2)
	Thermostat operating temperature °C {°F}	ON	4±4 {39±7.2}
		OFF	20 {68} or less
	Purge chamber capacity L {gal}		Approximately 2.7 {0.71}
	Required time for recycling desiccant Sec.		50
	Manufacturer		NABCO
Air tank	Capacity L {gal}		21+21+26 {5.5+5.5+6.9}

< Wheel Brake >

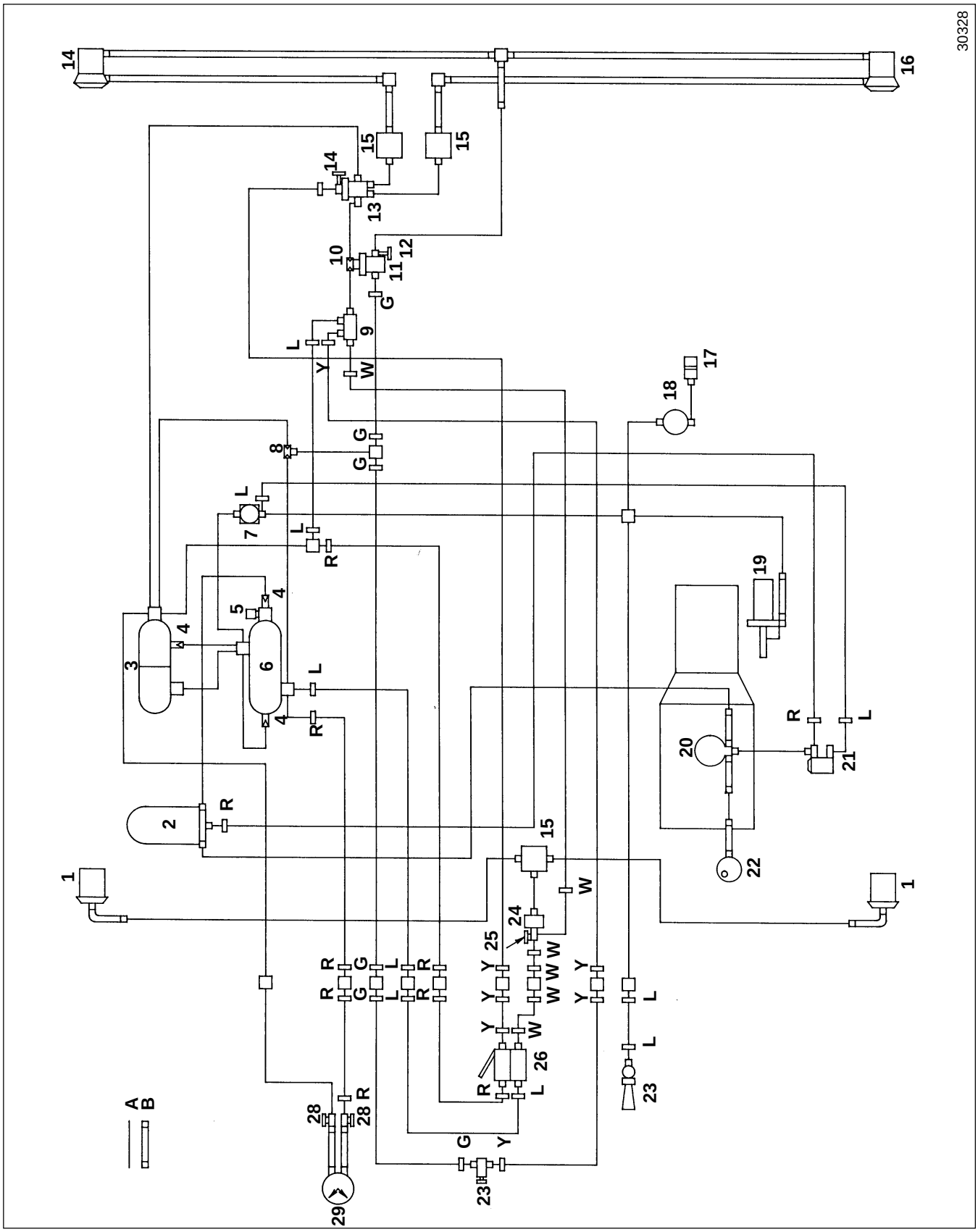
Item			Specifications
Brake type			Leading-trailing type
Brake drum	Inner diameter mm {in.}		ø410 {16.1}
Brake lining	Width×Thickness mm {in.}	Front	150×16 {5.9×0.63}
		Rear	200×16 {7.87×0.63}
Brake shoe clearance adjustment method			Auto adjustment type

< Exhaust Brake >

Item	Specifications
Control type	Combined electric and air
Valve type	Butterfly valve

M E M O

Brake System

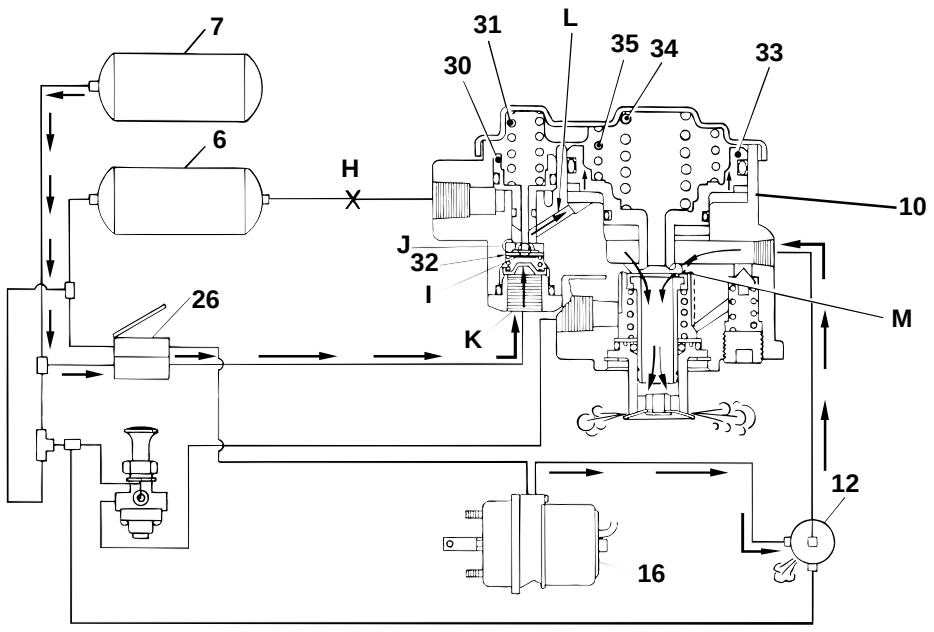


1 Front brake chamber
2 Air dryer
3 Air tank (Rear, Parking brake)
4 Check valve
5 Safety valve
6 Air tank (Front, Wet)
7 Supply valve
8 Double check valve
9 Spring brake valve
10 Double check valve
11 Relay valve
12 Paring brake switch
13 Relay valve
14 Stop lamp switch
15 Control valve
16 Rear brake chamber
17 Exhaust brake unit
18 3-way magnetic valve
19 Clutch booster < M8S2×5 >
20 Air compressor
21 Air pressure governor
22 Air cleaner
23 Air horn
24 Quick release valve
25 Stop lamp switch
26 Dual brake valve
27 Parking brake control valve
28 Low air pressure switch
29 Air pressure gauge

A : Air pipe
B : Hose
G : Green tape
L : Blue tape
R : Red tape
Y : Yellow tape
W : White tape

- The brake system is a full-air, all wheel brake type consisting of separate front and rear systems.
- Parking brake control valve **27** is fitted as a safety mechanism. It provides normal braking action on the spring brake of rear brake chamber **16** even if the rear brake system air line fails.
- An exhaust brake system, of the exhaust pipe opening and closing valve type, is fitted as a sub-brake system.

● Safety mechanism for rear brake system failure (Spring brake)

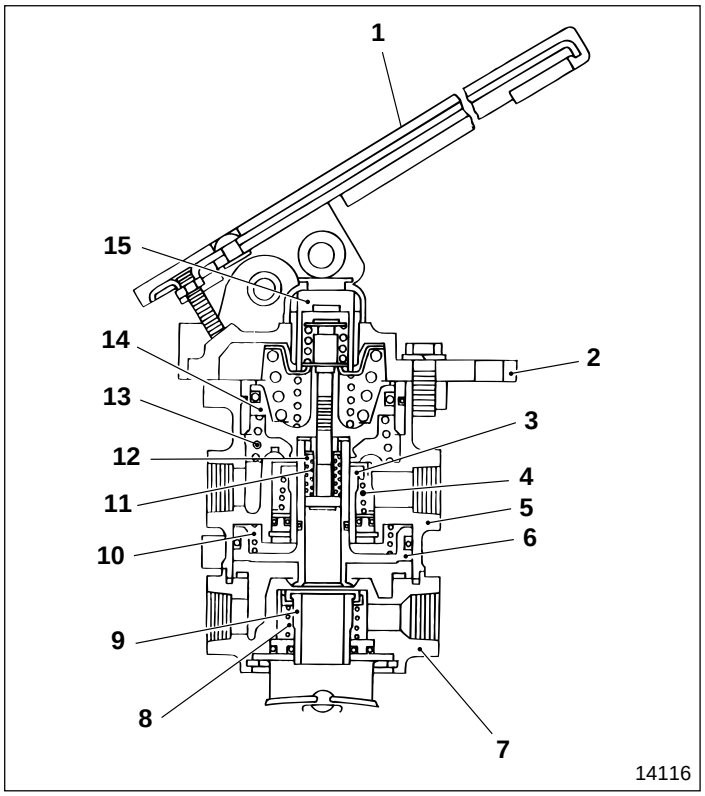


- If any part of the rear brake system fails and the air pressure in air tank **6** (for the rear brake system) drops below the specified pressure, the air pressure under piston **30** of spring brake valve **10** is overcome by the repercussive force of spring **31** and the piston is forced down.
- When forced down, piston **30** makes contact with valve **32** to close exhaust port **I** and open inlet port **J**.
- When brake pedal **26** is depressed, the air pressure in the air tank (for the front brake system) is fed to control port **K** of spring brake valve **10**, and is then fed under piston **33** via inlet port **J** and passage **L**.
- The air pressure under piston **33** overcomes the repercussive force of springs **34**, **35** to raise the piston and open exhaust valve **M**.
- When exhaust valve **M** opens, the pressurized air that flowed from spring brake valve **10** to relay valve **12** is discharged through the exhaust port in accordance with brake pedal **26** depression force.
- Since relay valve **12** opens the exhaust valve when air pressure is lost, and discharges the air in the spring brake of rear brake chamber **16**, the spring brake works to generate braking force.

H : Failure

M E M O

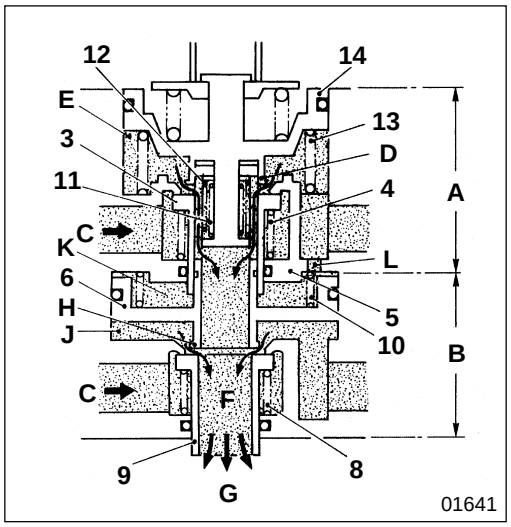
Dual Brake Valve



1 Brake pedal
2 Plate assembly
3 Primary inlet valve
4 Primary valve spring
5 Body
6 Relay piston
7 Cover
8 Secondary valve spring
9 Secondary inlet valve
10 Relay piston spring
11 Inner spring
12 Outer spring
13 Primary piston spring
14 Primary piston
15 Plunger

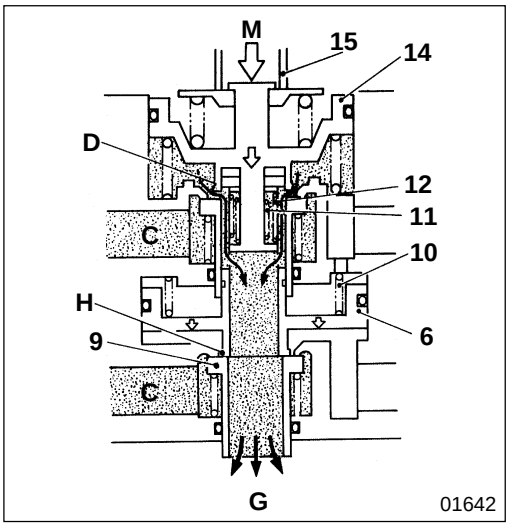
The dual brake valve controls the braking force of the vehicle by feeding pressurized air to the air master in accordance with the brake pedal depression angle of brake pedal **1**.

● When brake not operating



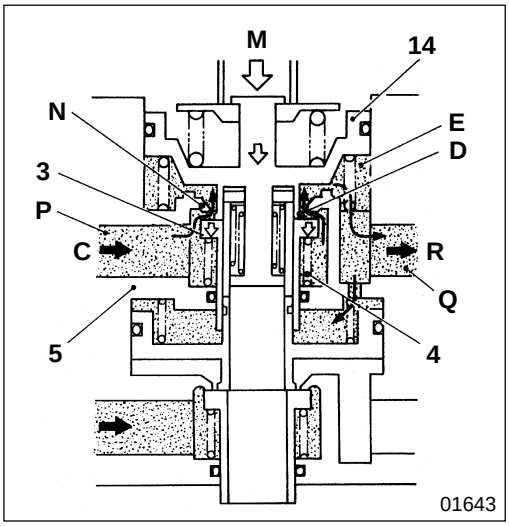
- The repercussive forces of primary valve springs **4**, secondary valve spring **8** seat primary inlet valve **3** at primary side **A**, and inlet valve **9** at secondary side **B**, on their respective seats. This shuts off air **C** from the air tank to maintain airtightness.
- The repercussive force of primary piston spring **13** raises primary piston **14** to its upper position. Exhaust valve seat **D** opens and chamber **E** is open to atmosphere **G** via chamber **F**.
- Since the repercussive forces of inner spring **11** and outer spring **12** is stronger than the repercussive force of relay piston spring **10**, relay piston **6** is raised to its upper position and exhaust valve seat **H** is opened. This opens chamber **J** to atmosphere **G** via chamber **F**.
  Chamber **E** at the primary side and chamber **K** at the upper part of relay piston **6** at the secondary side are connected via passage port **L** of body **5**.

● When depressing brake pedal (before braking pressure is generated)



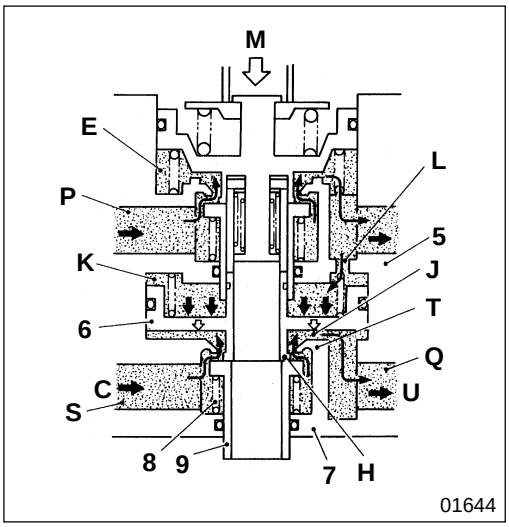
- Depressing the brake pedal (illustrated as pedal action **M**), forces down primary piston **14** via plunger **15**.
- Forcing down primary piston **14** changes the balance between the repercussive forces of inner spring **11** and outer spring **12**, and the repercussive force of relay piston spring **10**, forcing down relay piston **6**. This seats the relay piston on secondary inlet valve **9** and closes exhaust valve seat **H**.
- This closes the secondary side exhaust passage; however, primary side exhaust valve seat **D** remains open. No braking pressure is generated at either primary or secondary sides.

● When depressing brake pedal (braking pressure is generated)



Primary side

- As the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** is forced down until it is seated on primary inlet valve **3**, closing exhaust valve seat **D**.
- Primary inlet valve **3** is forced down, compressing primary valve spring **4**, and supply valve seat **N** of body **5** separates from the primary inlet valve. The air in chamber **P** flows into chamber **E** and is fed to rear brake system **R** via discharge port **Q** as braking pressure.

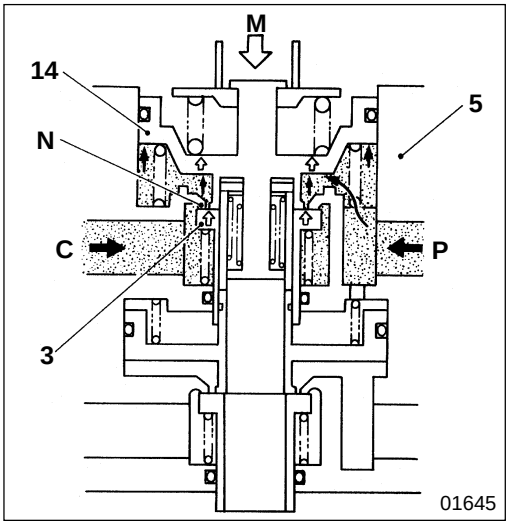


Secondary side

- The air at the primary side flows into chamber **K** via passage port **L** of body **5**.
- The air fed into chamber **K** acts on the upper part of relay piston **6** to force down the relay piston and compress secondary valve spring **8**, forcing down secondary inlet valve **9**.
- This separates supply valve seat **T** and secondary inlet valve **9** of cover **7**.
- The air in supply port chamber **S** flows into chamber **J** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

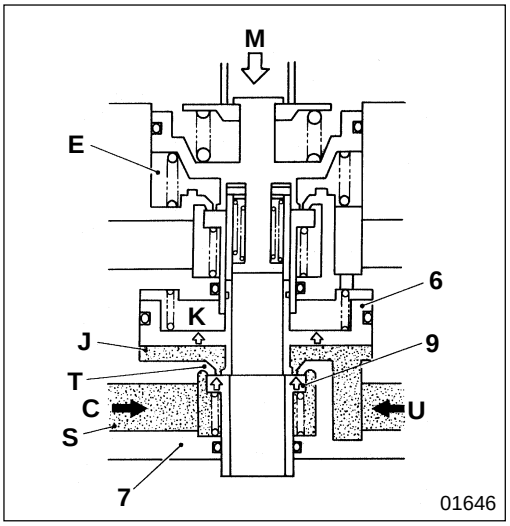
● Stabilization of braking pressure

When the brake pedal remains depressed at the specified depression angle, the braking air pressure stabilizes at the pressure corresponding to the brake pedal depression angle.



Primary side

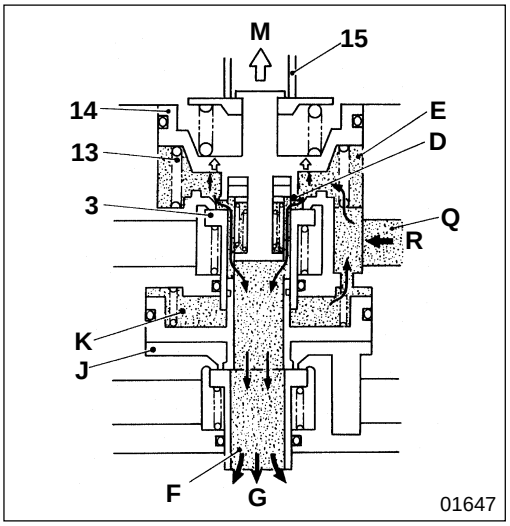
- The braking air pressure fed under the bottom of primary piston **14** raises the primary piston and primary inlet valve **3** together in tandem.
- Primary inlet valve **3** makes contact with supply valve seat **N** of body **5**, then the supply of air **C** from the air tank ceases and the increases in the braking air pressure stops. This stabilizes braking pressure **R** for the rear brake system.



Secondary side

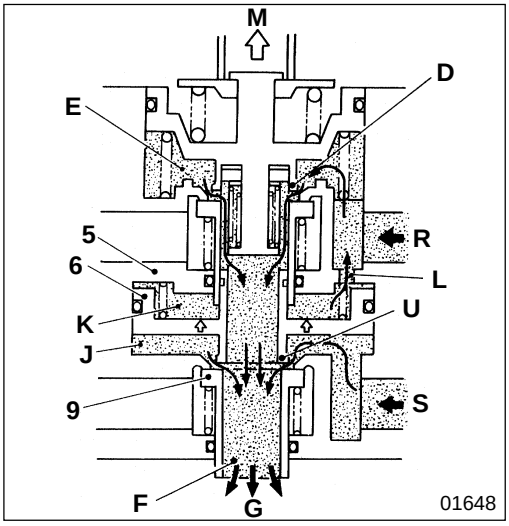
- As the braking pressure (pressure in chamber **J**) for the front brake system balances the pressures in chambers **E** and **K**, the force raising relay piston **6** disappears, and the relay piston rises in tandem with secondary inlet valve **9**.
- Secondary inlet valve 9 makes contact with supply valve seat **T** of cover **7**, then the supply of air from supply port chamber **S** to chamber **J** ceases. This stabilizes brake pressure **U** for the front system.

● Release of brake pressure



Primary side

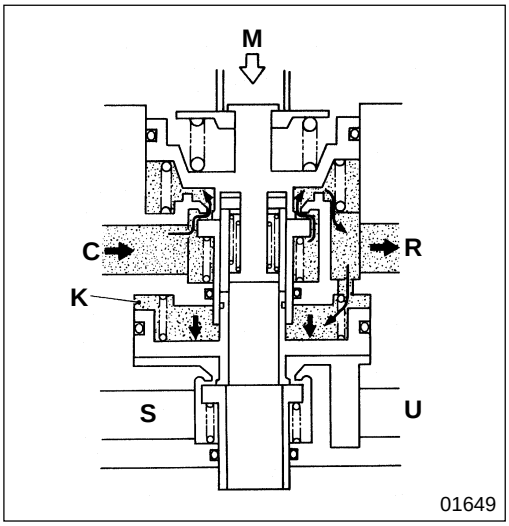
When the brake pedal is released (illustrated as brake pedal action **M**), primary piston spring **13** and air pressure **R** at discharge port **Q** (pressure in chamber **E**) raise plunger **15** and primary piston **14**. Then, exhaust valve seat **D** at the lower end of the primary piston separates from primary inlet valve **3**. The air pressure of the rear brake system flows through chamber **E** to be discharged from exhaust passage chamber **F** into atmosphere **G**.



Secondary side

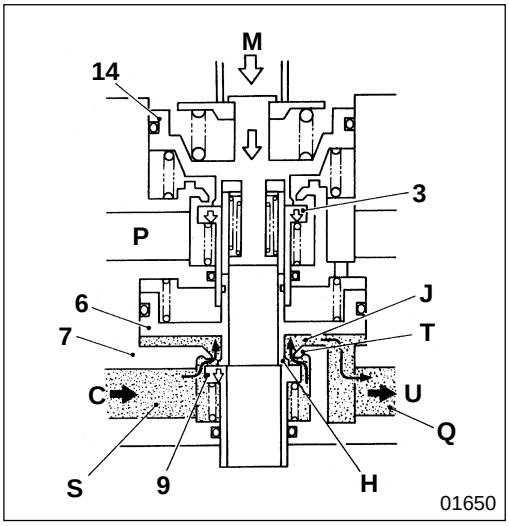
- As the air pressure in the rear brake system drops, the air pressure in chamber **K** is discharged via passage port **L** of body **5**, and chambers **E**, **F** into atmosphere **G**.
- This changes the air pressure balance between chambers **K** and **J**. The air pressure in chamber **J** raises relay piston **6**, and exhaust valve seat **H** at the lower end of the relay piston separates from secondary inlet valve **9**. Air pressure **U** in the front brake system is discharged from exhaust passage chamber **F** into atmosphere **G**.

● When abnormality occurs



Operation when the air pipe of the front brake system fails

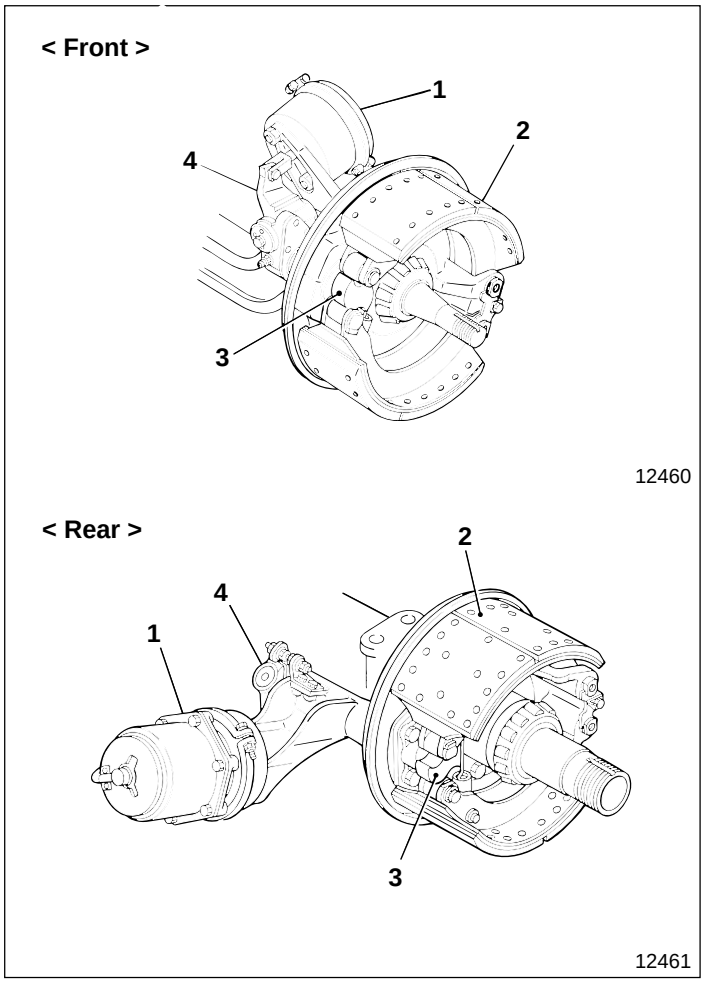
- The primary side operates the same as normal, generating braking pressure in rear brake system **R**.
- At the secondary side, even if the primary side generates air pressure in chamber **K**, braking pressure is not generated in front brake system **U**, since no air pressure is generated in supply port **S**.



Operation when the air pipe of the rear brake system fails

- In the rear brake system, air pressure is not generated up to supply port **P**. Therefore, even if the brake pedal is depressed (causing primary piston **14** to force down primary inlet valve **3**), braking pressure is not generated.
- If the brake pedal is depressed further (illustrated as brake pedal action **M**), primary piston **14** makes contact with relay piston **6** and they force down secondary inlet valve **9**.
- This action separates supply valve seat **T** of cover **7** from secondary inlet valve **9**. The air pressure flows into chamber **J** from chamber **S** and is fed to front brake system **U** via discharge port **Q** as braking pressure.

Wheel Brake < MANUAL TRANSMISSION >

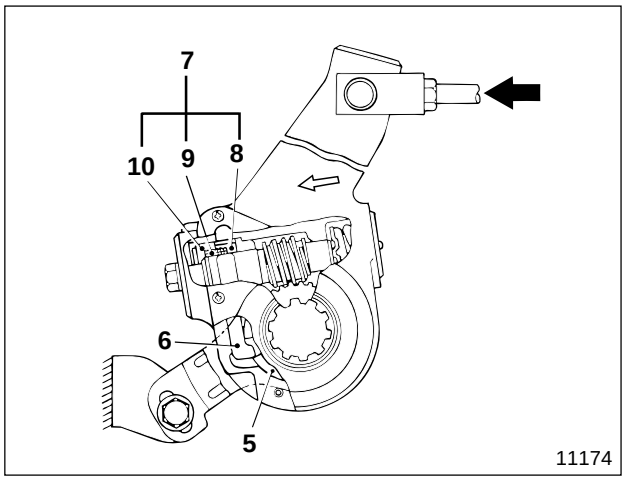


1 Brake chamber
2 Brake shoe assembly
3 Camshaft
4 Automatic slack adjuster

- The wheel brake is an internal expanding leading trailing brake type. Brake chamber **1** turns camshaft **3** to extend and press brake shoe assembly **2** against the brake drum, creating the braking force.
- Automatic slack adjuster **4** automatically adjusts the brake shoe clearance as the lining wears and the brake shoe clearance becomes higher than the specified value.

Automatic Slack Adjuster

● **When brake is operating**

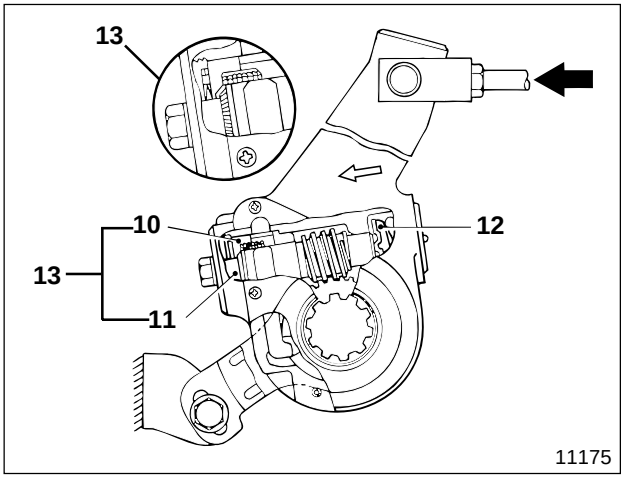


- Control disc **5** raises rack **6** in accordance with the lining wear.
- Rack **6** turns gear wheel **8** of one-way clutch **7**, but the gear wheel runs idle.

NOTE

One-way clutch 7 — **Gear wheel 8**, **Clutch spring 9**, **Clutch ring 10**

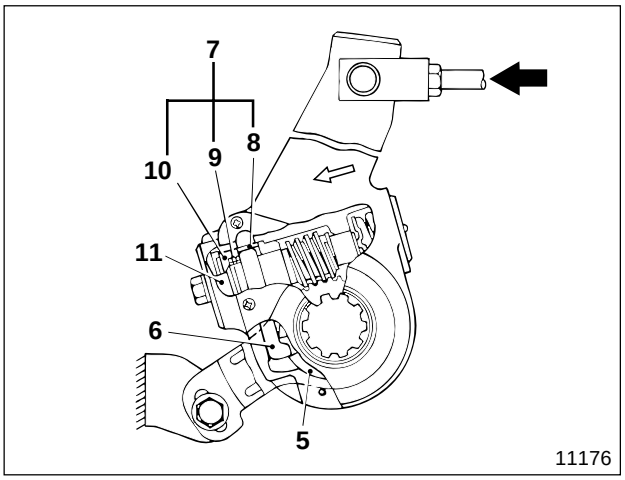
- As automatic slack adjuster **4** turns further and the force of the lining that pushes against the brake drum gradually increases, the torque of camshaft **3** of the wheel brake increases.



- As the torque of camshaft **3** of the wheel brake increases, worm screw **11** compresses spring **12** and moves in the axial direction to separate cone clutch **13**.

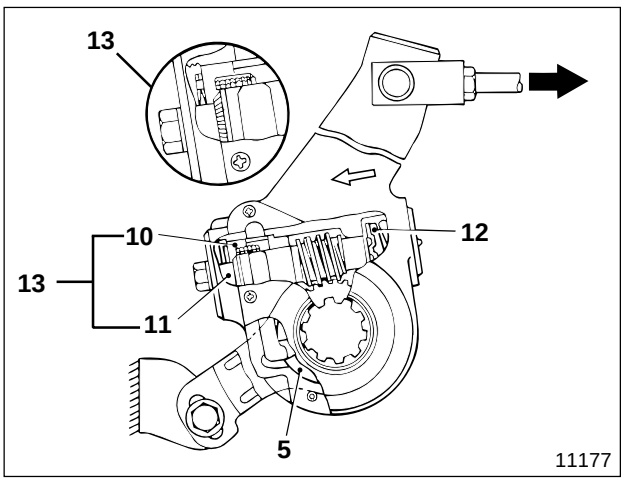
NOTE

Cone clutch 13 — **Clutch ring 10**, **Worm screw 11**

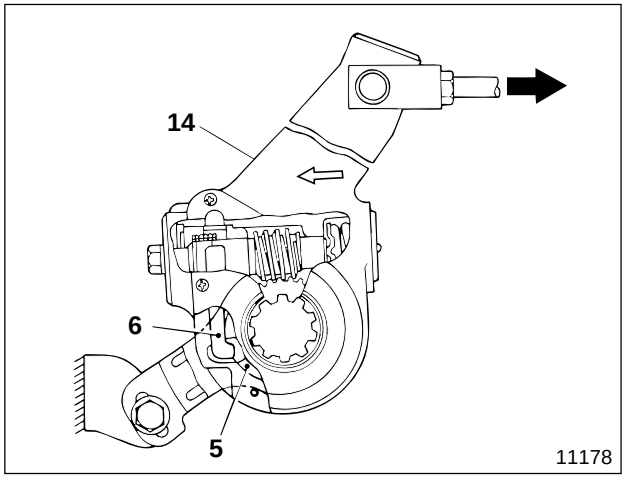


- Although control disc **5** pushes rack **6** further upward, the rack lets one-way clutch **7** idle, since cone clutch **13** is not engaged.

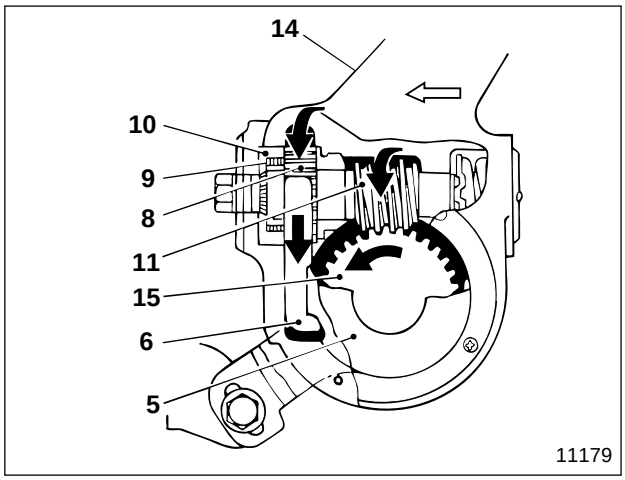
● **When releasing brake pedal**



- When the brake pedal is released, the torque from camshaft **3** of the wheel brake disappears, and the repercussive force of spring **12** pushes back worm screw **11**, engaging cone clutch **13**.

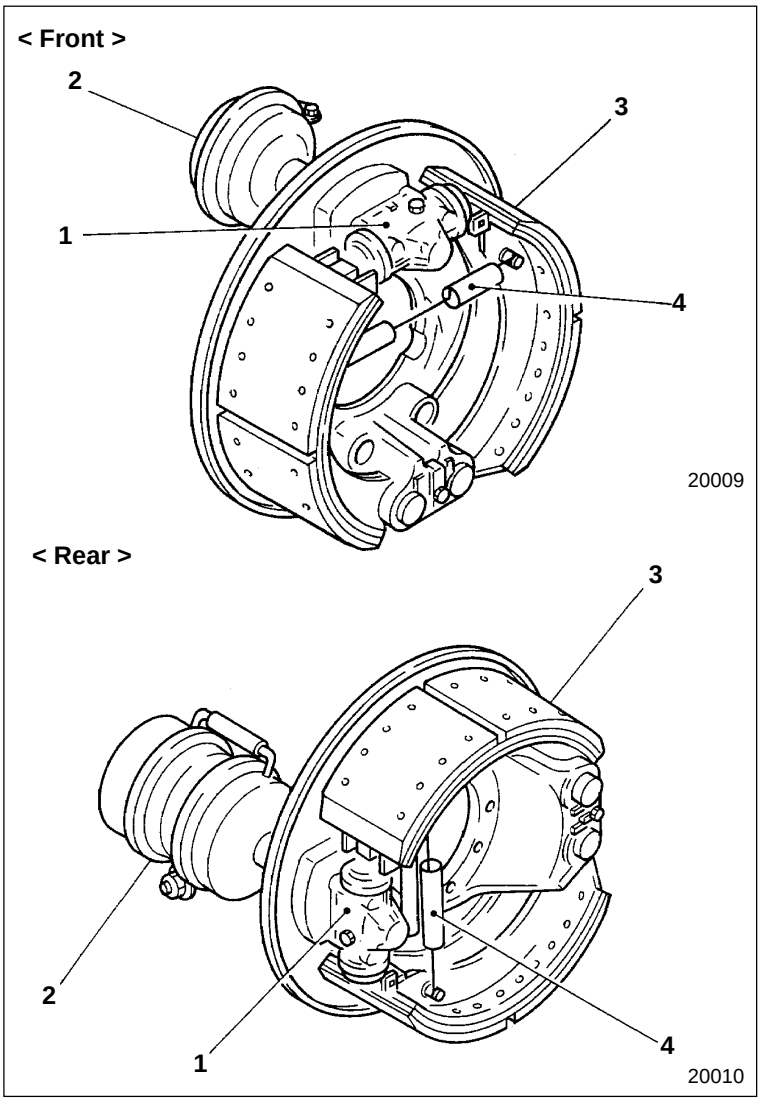


- Rack **6** is to be pushed down by the spring; however, gear wheel **8** engaged with the rack cannot turn because cone clutch **13** is engaged with the gear wheel.
- Therefore, rack **6** turns together with housing **14** until the rack makes contact with control disc **5**.



- When rack **6** makes contact with control disc **5**, the control disc is pushed down to the bottom of the rack under housing **14**.
- When rack **6** is pushed down, since cone clutch **13** is engaged with the rack, it turns worm wheel **15** and worm screw **11**.
- Therefore, since worm screw **11** turns camshaft **3** of the wheel brake in accordance with lining wear, constant brake shoe clearance is maintained.

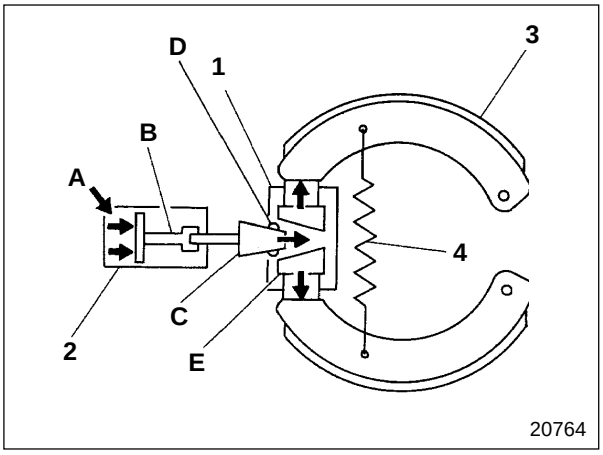
Wheel Brake < AUTOMATIC TRANSMISSION >



1 Expander
2 Brake chamber
3 Brake shoe
4 Return spring

- Drum brake expands brake shoe **3** by a wedge mechanism.
- Expander **1** incorporates an auto adjustment mechanism that automatically adjusts the brake shoe clearance.

● Wedge mechanism

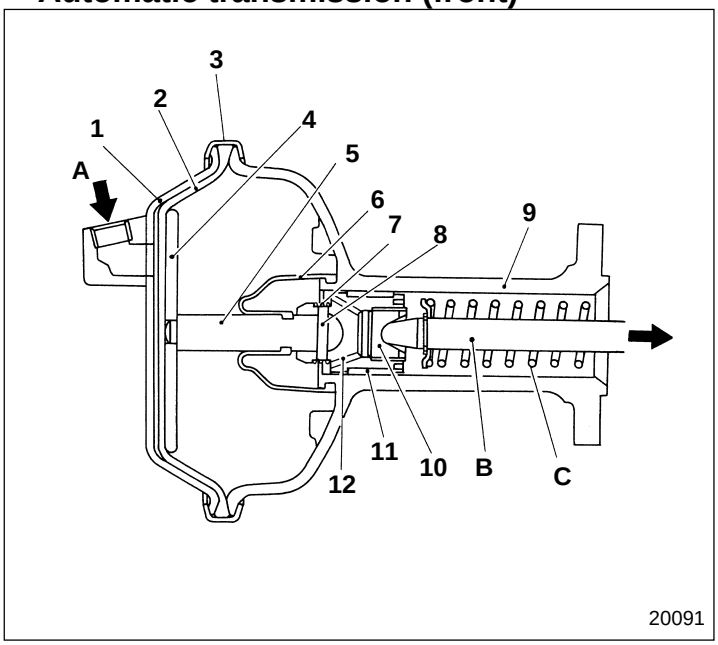


- When applying air pressure **A** on brake chamber **2**, the push rod **B** pushes wedge **C**.
- The wedge **C** pushes the sleeve **E** of expander **1** through roller **D** to expand brake shoe **3**.

STRUCTURE AND OPERATION

Brake Chamber

< Automatic transmission (front) >

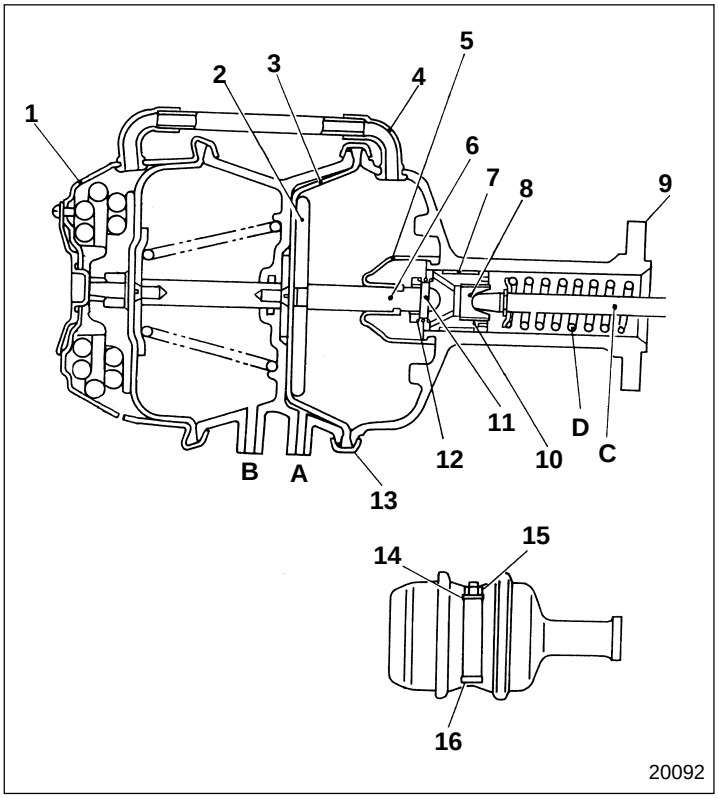


1 Pressure plate
2 Diaphragm
3 Clamp ring
4 Push plate
5 Push rod
6 Dust cover
7 Ring
8 Pin
9 Base
10 Guide head
11 Bush
12 Push rod guide

A : Air pressure
B : Wedge (expander)
C : Spring (expander)

- When applying air pressure **A** on the brake chamber < front >, the push rod **5** and wedge **B** are pushed through diaphragm **2**.
- When releasing air pressure **A**, wedge **B** and push rod **5** are returned by spring force of spring **C**.

< Automatic transmission (rear) >

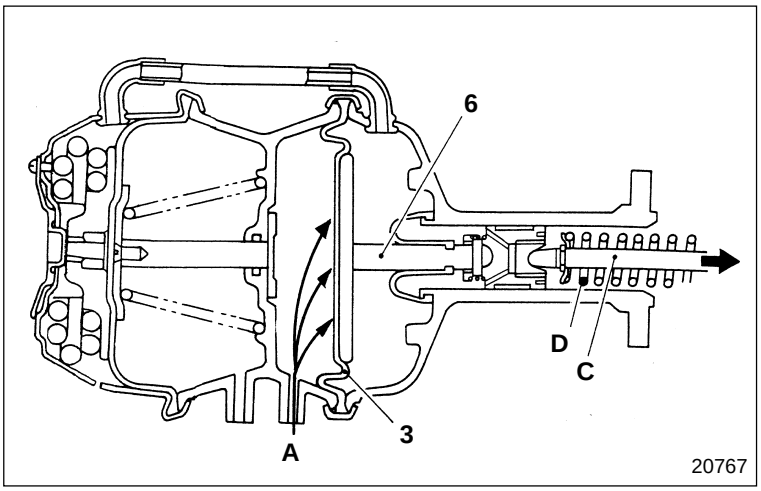


1 Piggyback
2 Push plate
3 Diaphragm
4 Elbow
5 Dust cover
6 Push rod
7 Bush
8 Guide head
9 Base
10 Push rod guide
11 Pin
12 Ring
13 Clamp ring
14 Washer
15 Release nut
16 Release bolt

A : Service brake port
B : Spring brake port
C : Wedge (expander)
D : Spring (expander)

- The brake chamber < rear > has a spring brake mechanism other than the service brake.
- The washer **14**, release nut **15**, and release bolt **16** are used when releasing the spring brake by a mechanical release.

● Service brake



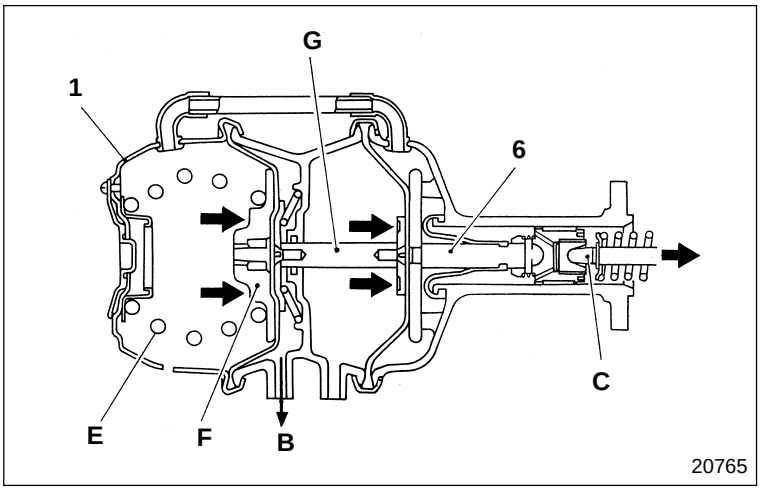
Operation

When applying air pressure on service brake port **A**, the push rod **6** and wedge **C** are pushed through diaphragm **3**.

Release

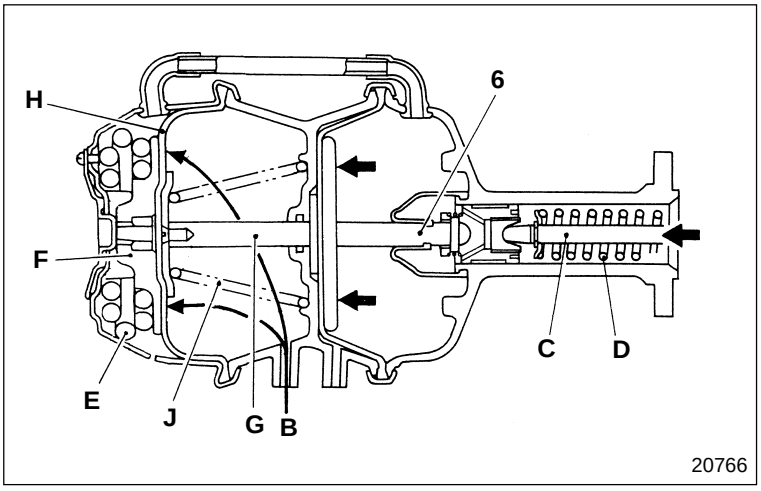
When releasing the air pressure of the service brake port **A**, wedge **C** and push rod **6** are returned by spring force of spring **D**.

● Spring brake



Operation

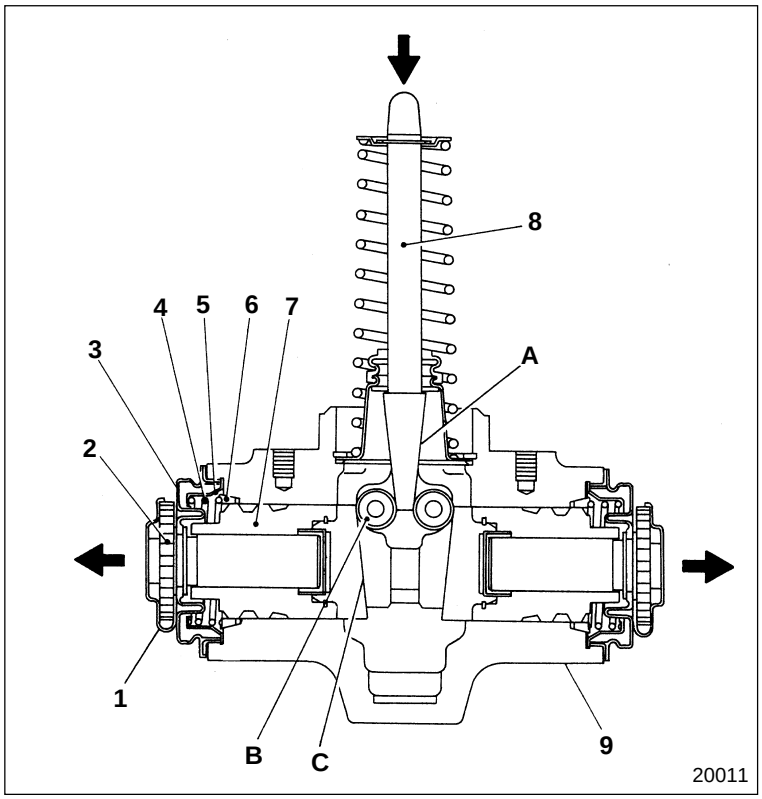
When releasing the air pressure of spring brake port **B**, piston **F**, push rod **G**, **6**, and wedge **C** are pushed by spring force of spring **E** of piggyback **1**.



Release

- When applying air pressure on spring brake port **B**, piston **F** is pushed back through diaphragm **H**, and thereby spring **E** is compressed.
- Push rod **G** is returned by spring force of spring **J**.
- Wedge **C** and push rod **6** are returned by spring force of spring **D**.

Expander

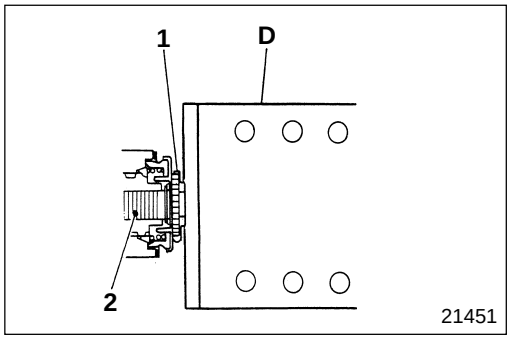


1 Clip
2 Adjusting screw
3 Boot
4 Spring
5 Cage
6 Drive ring
7 Sleeve assembly
8 Wedge
9 Body

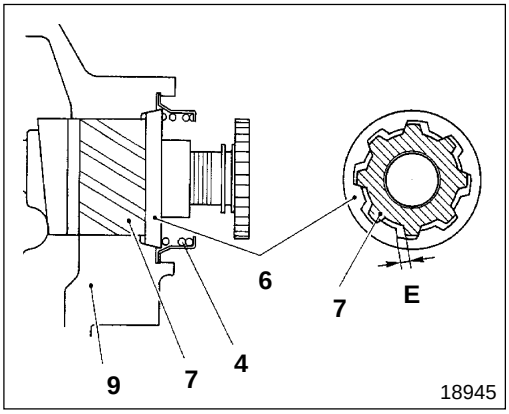
A : Inclination part (wedge)
B : Roller
C : Inclination part (sleeve assembly)

- When wedge **8** being pushed, roller **B** is spread out along inclination part **A** of the wedge.
- Roller **B** pushes out sleeve assembly **7** and adjusting screw **2** along inclination part **C** of sleeve assembly **7**.
- Body **9** of the expander incorporates an auto adjustment mechanism.

● Auto adjustment mechanism

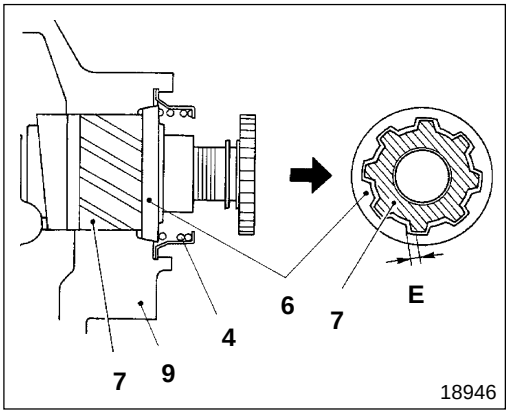


- The rotation direction of adjusting screw **2** is fixed by clip **1**.
- The rotation direction of clip **1** is fixed by brake shoe **D**.

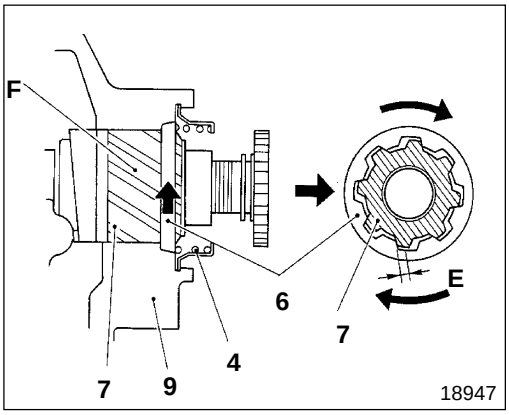


When brake shoe clearance is the standard value

- Before applying the brake, a low part of sleeve assembly **7** strikes body **9**.
- Drive ring **6** is pushed by spring **4**, strikes body **9**, and fixed.
  E : Backlash

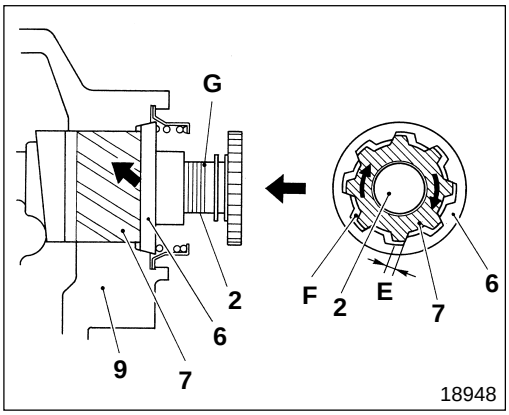


- If applying the brake, sleeve assembly **7** moves within a range of backlash **E**.



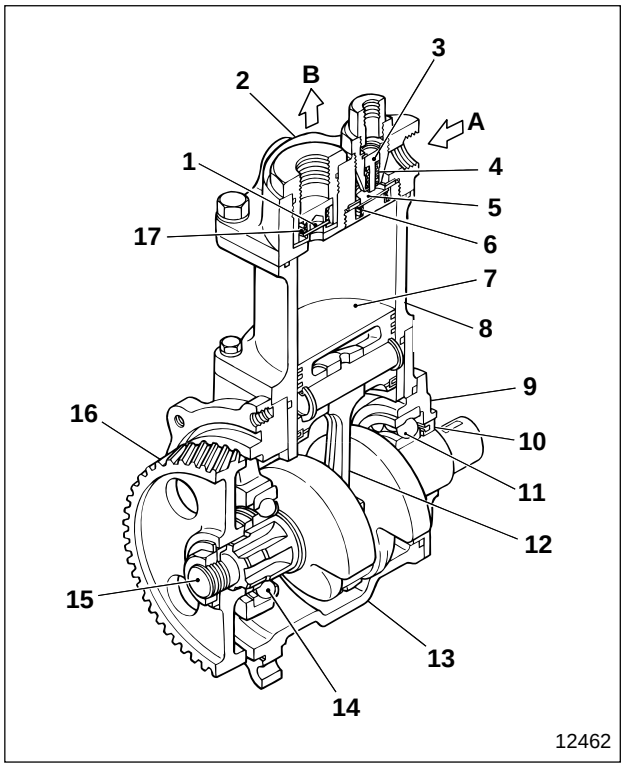
When brake shoe clearance exceeds the standard value

- If applying the brake, sleeve assembly **7** moves over backlash **E**, and rotates along screw lead face **F** of the sleeve assembly since drive ring **6** is pushed by spring **4**.
- Drive ring **6** remains to strike body **9** with being pushed to spring **4**.



- If releasing the brake, a low part of sleeve assembly **7** moves until it strikes body **9**.
  Thereby the sleeve assembly moves just to the extent of backlash **E** without any rotation; after that, it rotates along the screw lead face **F** of drive ring **6**; it pushes out the adjusting screw **2** by the action of screw **G**; and it adjusts the brake shoe clearance to the standard value.

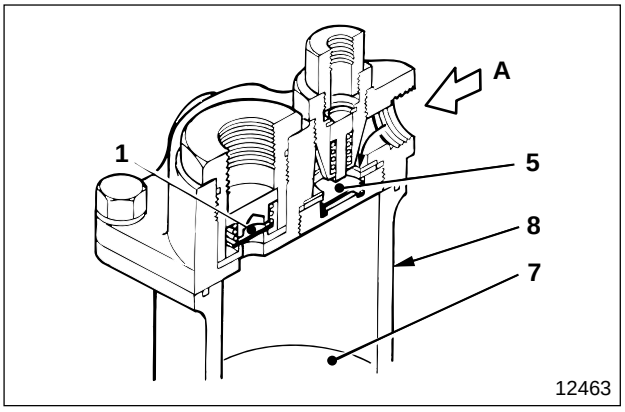
Air Compressor



1 Delivery valve
2 Cylinder head
3 Unloader valve
4 Unloader valve spring
5 Suction valve
6 Suction valve spring
7 Piston
8 Cylinder liner
9 Bearing holder
10 Oil seal
11 Bearing
12 Connecting rod
13 Crankcase
14 Bearing
15 Crankshaft
16 Drive gear
17 Delivery valve spring

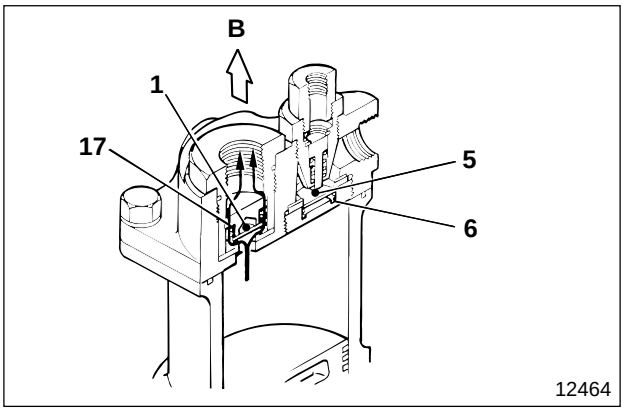
A : Air delivery port (From air cleaner)
B : Air discharge port (To air dryer)

● During suction



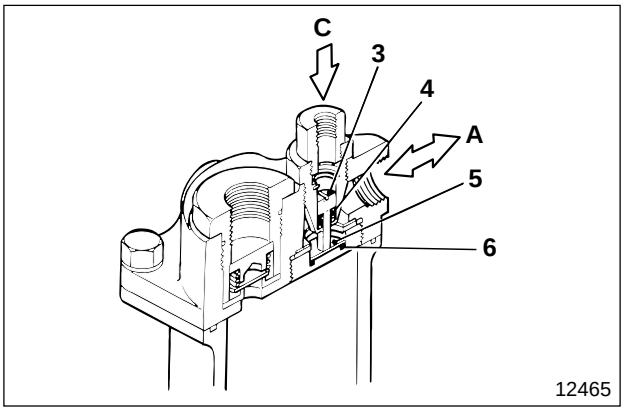
- When drive gear **16** is driven, crankshaft **15** engaged with the drive gear turns to force down piston **7**.
- The negative pressure generated at this time opens suction valve **5**, sucking air **A** into cylinder liner **8**.

● During pressurized delivery



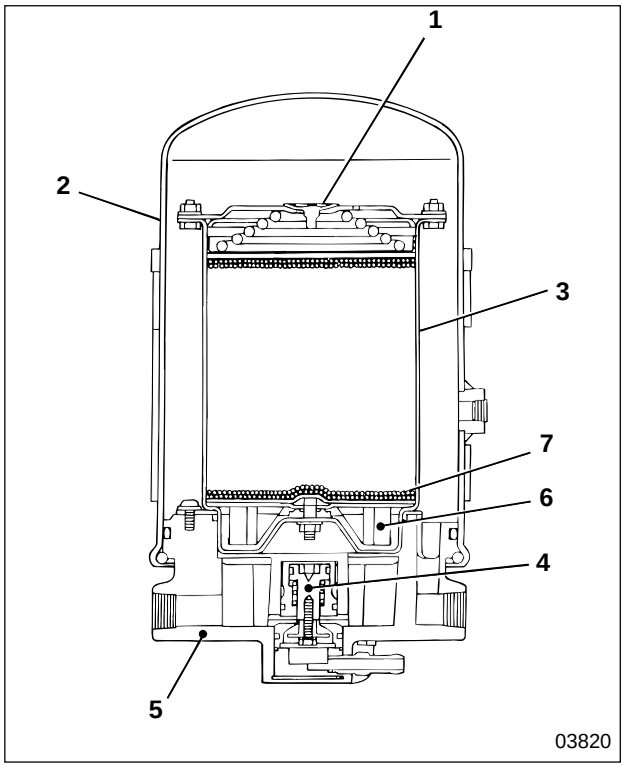
- As piston **7** rises and enters into the compression stroke, suction valve spring **6** closes suction valve **5**.
- The pressure of the compressed air overcomes the repercussive force of delivery valve spring **17** and opens delivery valve **1** to compress and deliver air **B** to the air dryer.

● When unloader valve operates



- When the air pressure in the air tank raises higher than the specified value, the air pressure governor operates to feed pressured air **C** to unloader valve **3**. This forces down the unloader valve and holds suction valve **5** open at the same time. Therefore, air **A** is not compressed and the air compressor idles.
- When the air pressure in the air tank drops lower than the specified value, the air pressure governor operates again to discharge pressured air from the upper side of unloader valve **3**. So, unloader spring **4** returns the unloader valve to its original position and the air compressor operates under a load.

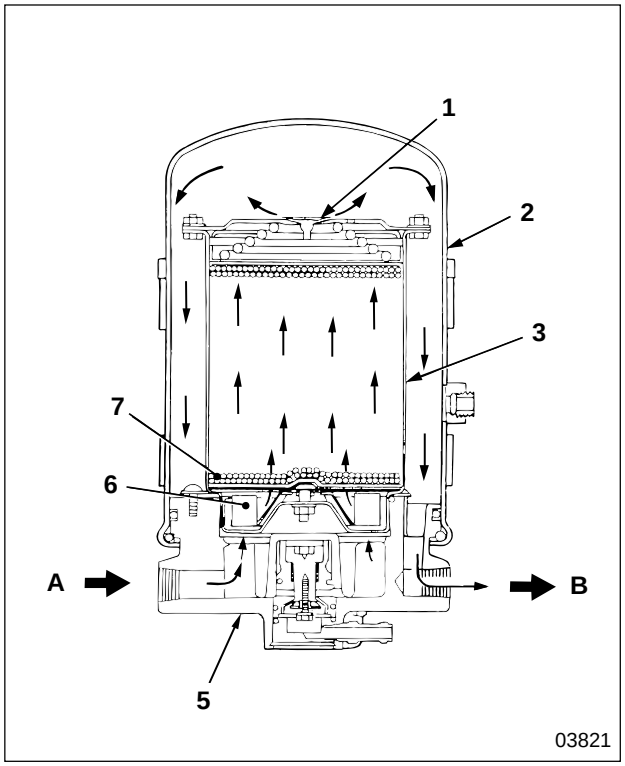
Air Dryer



1 Check valve
2 Case
3 Desiccant
4 Oil filter
5 Valve
6 Body
7 Purge chamber

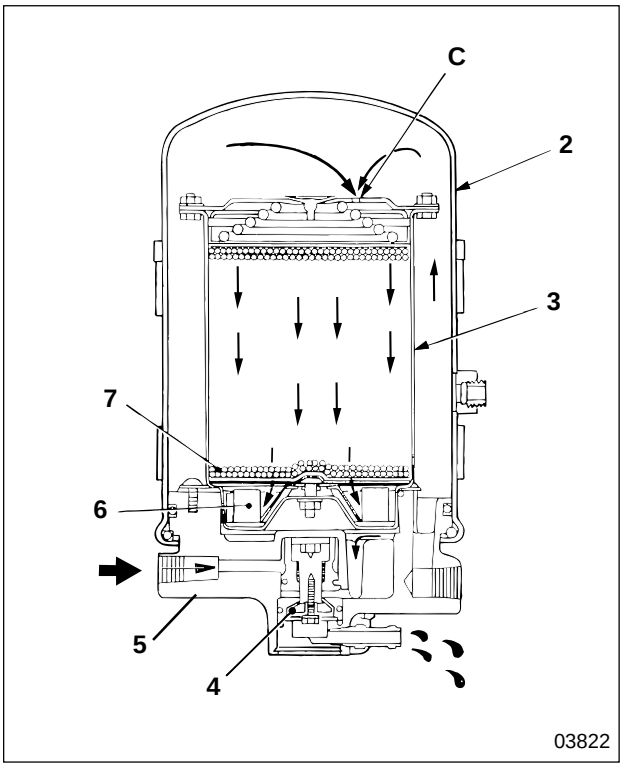
The air dryer removes moisture and oil in the air compressed by the air compressor and protects the brake assembly from rust or faulty operation.

● Dehumidification



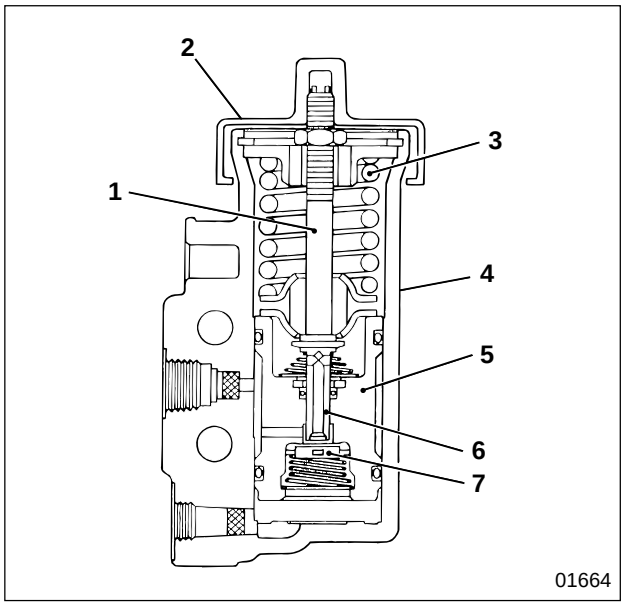
- The air from the air compressor enters delivery side **A** of the air dryer. Once in body **6**, moisture and oil are separated from the air and collected in the bottom. Then, the air passes through oil filter **4**, where small oil droplets and dust are removed. Next, the air is delivered into case **2**, where moisture is removed by desiccant **3**.
- As the air travels from the bottom to the top of case **2**, it comes into contact with more dried desiccant. This removes residual moisture from the air, drying the air as it reaches the top of the case. the air passes through check valve **1** and purge chamber **7**, and is delivered to the air tank through exhaust side **B**.

● Regeneration of desiccant



- When the supply of air from the air compressor stops, the pressure from the air pressure governor opens valve **5** of the control port of the air dryer. The pressure in case **2** cleans oil filter **4**, releasing the condensed water and oil into the atmosphere.
- After being quickly decompressed, the dry air in purge chamber **7** passes through hole **C**, where the air expands under the reduced pressure, becoming super dry air. This air flows back through case **2** and collects the moisture in desiccant **3**, releasing this moisture into the atmosphere, thereby recycling the desiccant.

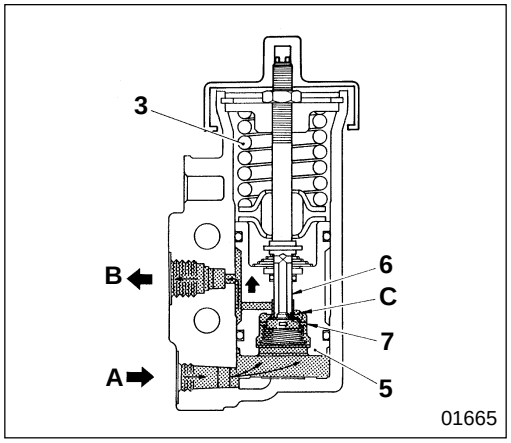
Air Pressure Governor



1 Adjusting screw
2 Cover
3 Spring
4 Body
5 Piston
6 Exhaust stem
7 Valve

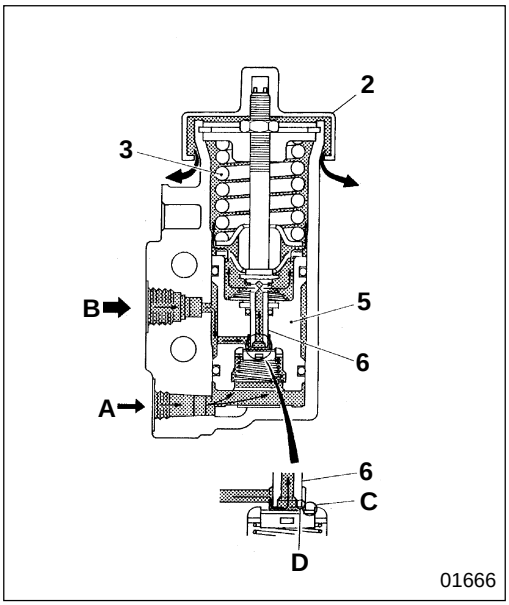
The air pressure governor keeps the air pressure in the air tank at the specified pressure, by operating the air compressor with or without load in accordance with the air pressure in the air tank.

● High specified-pressure



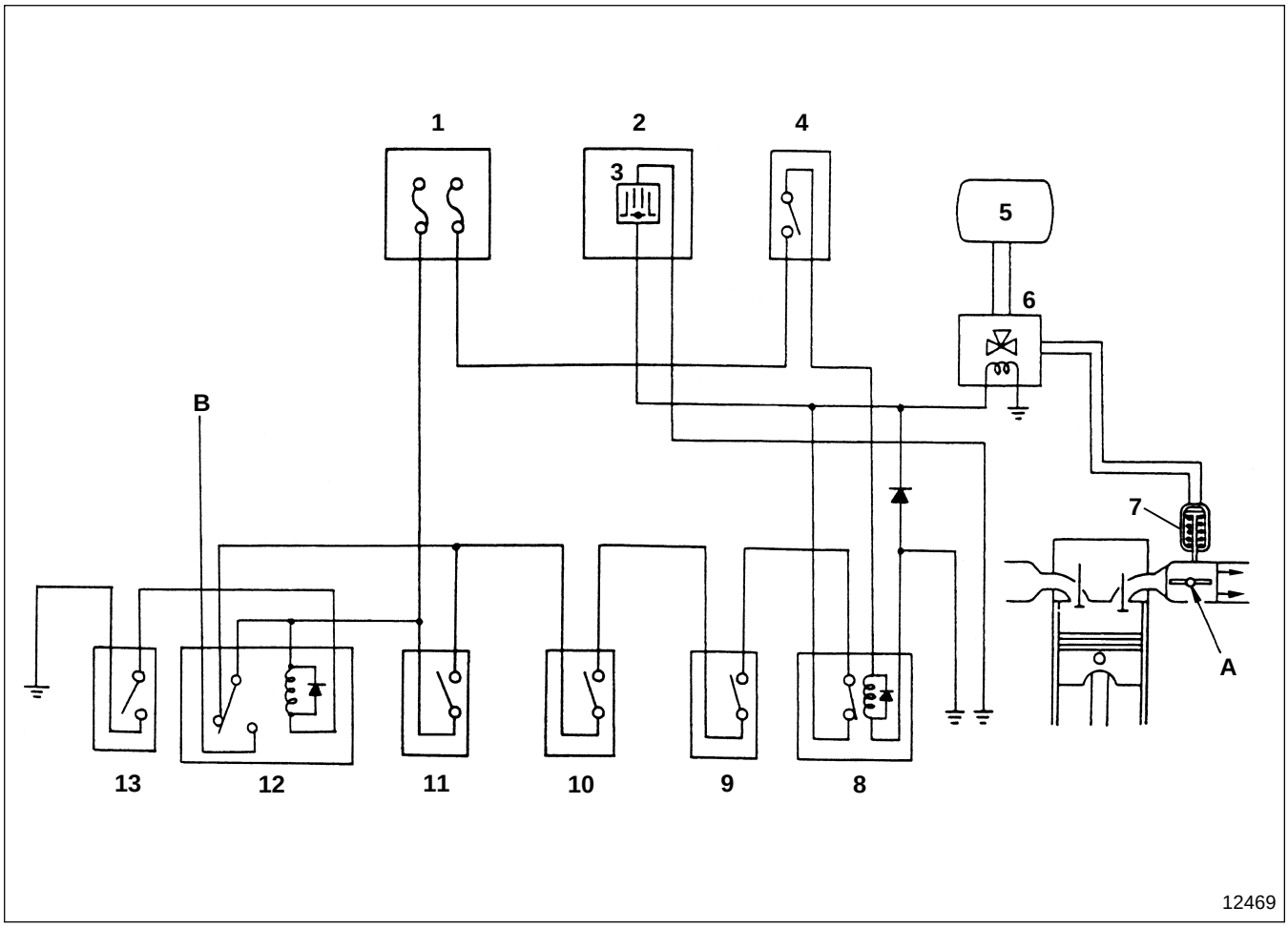
- Pressurized air **A** from the air tank acts constantly on piston **5**. As the pressure in the air tank rises to overcome the repercussive force of spring **3**, the piston rises and valve **7** closes.
- As air pressure **A** from the air tank rises further to become higher than the high specified-pressure, piston **5** rises further. Therefore, exhaust stem **6** opens inlet valve **C** and the air pressure in the air tank flows from unloader port **B** to the unloader valve of the air compressor via the inlet valve. Then the air compressor enters in unloaded operation. Pressure also reaches the air dryer to recycle the desiccant.

● Low specified-pressure



When pressurized air **A** from the air tank gradually drops below the specified-pressure, spring **3** forces down piston **5**. This closes inlet valve **C** and opens exhaust valve seat **D** so pressurized air **B**, up to the unloader valve of the air compressor, is discharged through the opening of cover **2** via exhaust stem **6**, operating the air compressor at load. The pressurized air up to the air dryer is also discharged into the atmosphere.

Exhaust Brake System

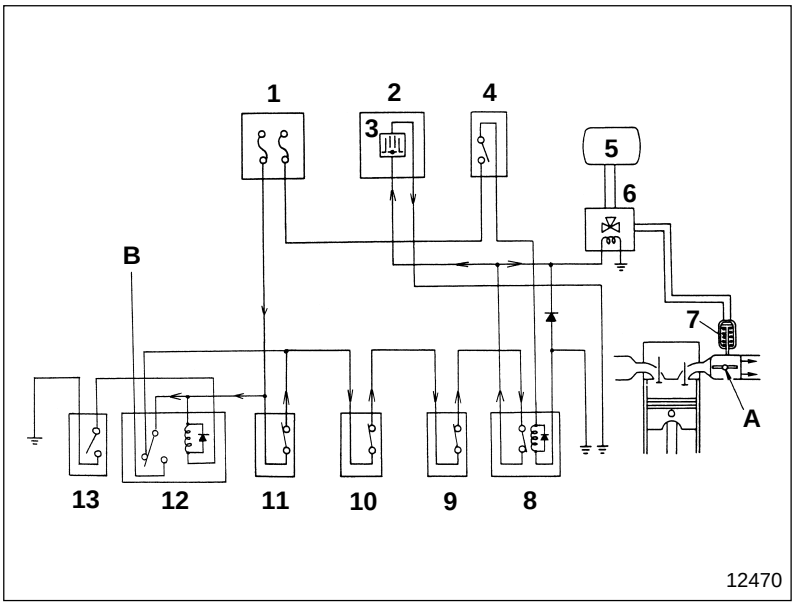


1 Relay and fuse box
2 Meter cluster
3 Exhaust brake indicator lamp
4 Transmission neutral switch
5 Air tank
6 3-way magnetic valve
7 Exhaust brake unit
8 Exhaust brake cut relay
9 Accelerator switch
10 Exhaust brake switch
11 Clutch switch < without power take-off >
12 Power take-off relay < with power take-off >
13 Clutch switch < with power take-off >

A : Butterfly valve
B : To power take-off switch

- Excitation of 3-way magnetic valve **6** causes the air pressure in air tank **5** to act on exhaust brake unit **7** to close butterfly valve **A**, activating the exhaust brake.
- If the exhaust brake is activated while the vehicle is stationary, the coolant temperature can rise excessively, overheating the engine. To avoid this, when the transmission is in neutral, transmission neutral switch **4** turns ON, cutting the exhaust brake system.

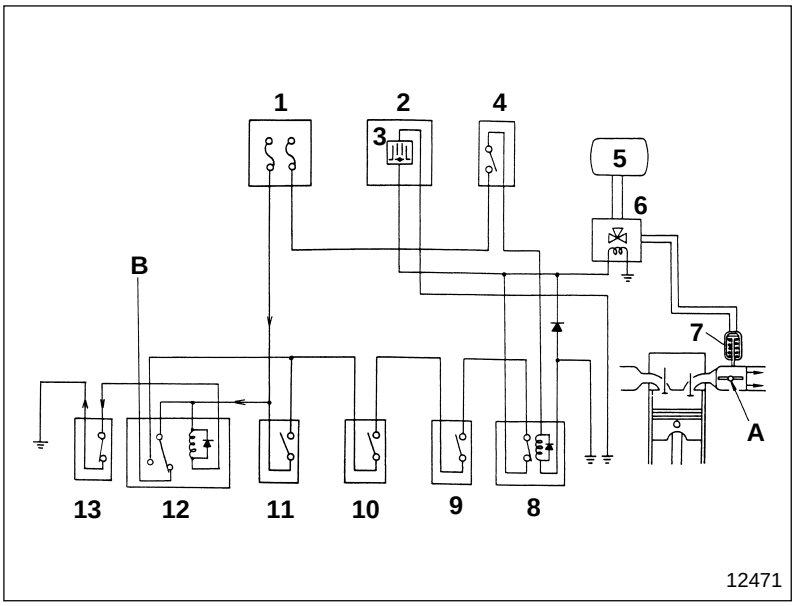
● When exhaust brake system is activated



When exhaust brake switch **10** is turned on, the current flows as illustrated to activate the exhaust brake.

Fuse **1**→Power take-off relay **12**→Clutch switch **11**→Exhaust brake switch **10**→Accelerator switch **9**→Exhaust brake cut relay **8**
→ 3-way magnetic valve **6**→Ground
→Exhaust brake indicator lamp **3** (ON)→Ground

● When the exhaust brake system is released



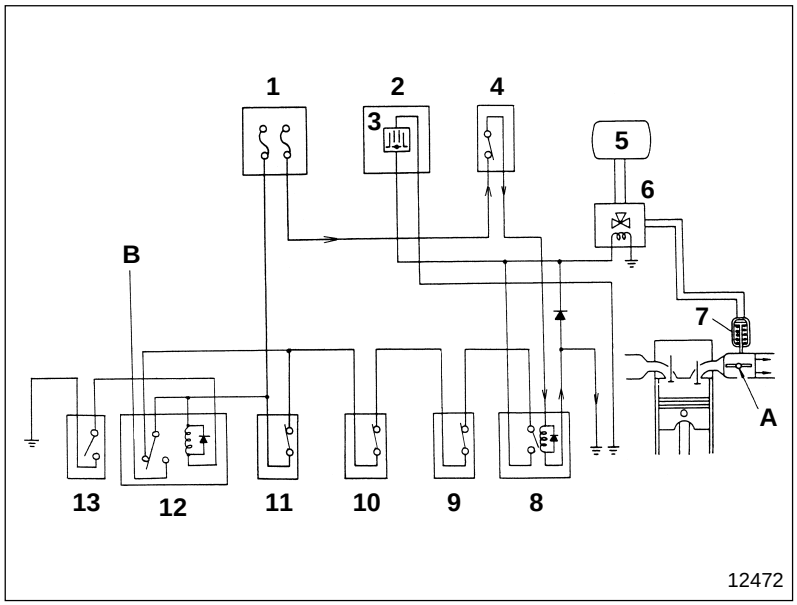
When the accelerator pedal or clutch pedal is depressed while the exhaust brake is working, all switches **9**, **11** turn off, shutting off the current, releasing the exhaust brake.

● When clutch pedal is depressed

Fuse **1**→Clutch switch **11** (OFF)→Since no current flows, the circuit turns off and the exhaust brake is released.
→Power take-off relay **12** excitation→Clutch switch **13** (ON)→Ground

Fuse **1**→Power take-off relay **12**→Clutch switch **11**→Exhaust brake switch **10**→Accelerator switch **9** (OFF)→Since there is no grounding, current does not flow, so the exhaust brake is released.

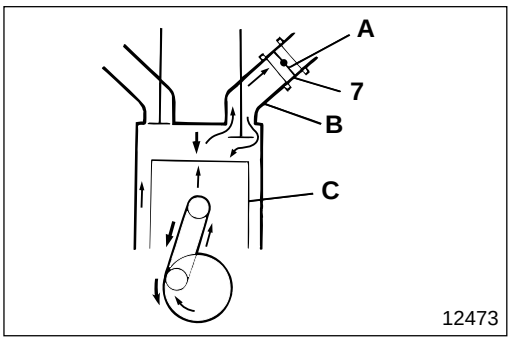
● Releasing exhaust brake system by placing transmission in neutral



Fuse **1**⟶Transmission neutral switch **4**→Exhaust brake cut relay **8** excitation →Ground
Fuse **1**⟶Clutch switch **11**⟶ Exhaust brake switch **10**→Accelerator switch **9**→Exhaust brake cut relay **8** (OFF)
└→Power take-off relay **12**

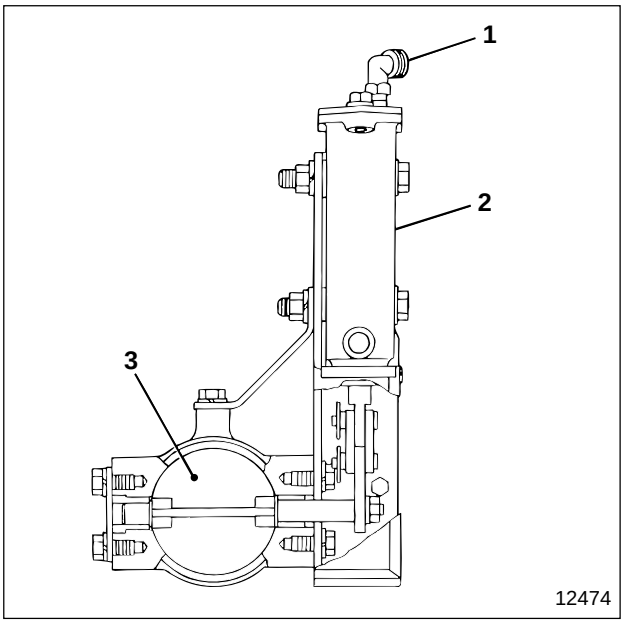
└→Beyond this, current does not flow so the exhaust brake is released.

● Working principle of exhaust brake



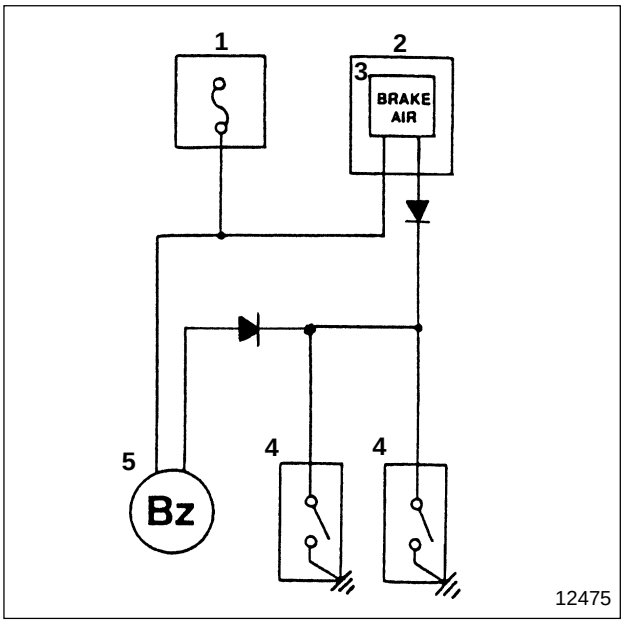
When butterfly valve **A** of exhaust brake unit **7**, in exhaust pipe **B**, is closed, the pressure in the exhaust pipe rises. The pressure rises further in the exhaust stroke, generating a force that pushes back piston **C**, the exhaust braking force.

● Exhaust brake unit

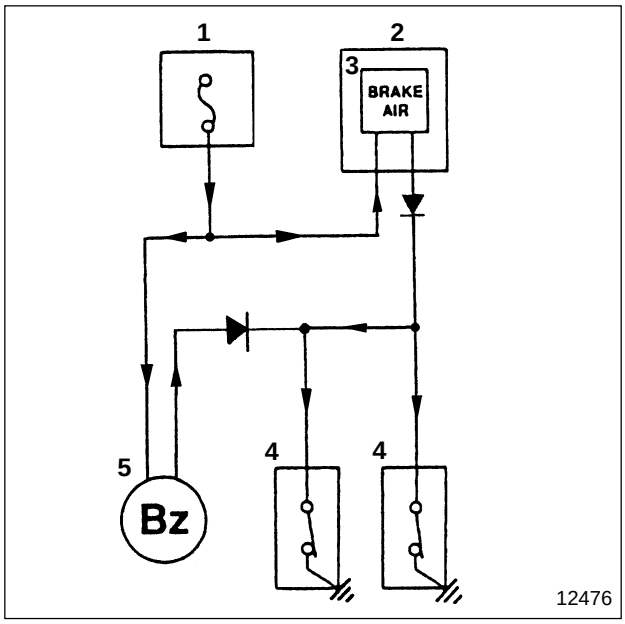


1 Connector
2 Control cylinder
3 Butterfly valve

Air pressure Warning Circuit



1 Relay and fuse box
2 Meter cluster
3 Air warning lamp
4 Low air pressure switch
5 Warning buzzer



When the air pressure in the air tank drops below the specified value, low air pressure switch **4** turns ON to light air warning lamp **3** and sound warning buzzer **5**. The warning buzzer continues sounding until the starter switch is turned OFF, or until the air pressure in the air tank becomes higher than the specified value and the low air pressure switch is turned OFF.

Fuse **1**→Air warning lamp **3**→Low air pressure switch **4**→Ground
Fuse **1**→Warning buzzer **5**→Low air pressure switch **4**→Ground

Wheel Brake

Possible causes \ Symptoms		Wheel brake does not work efficiently				Brake drum overheating				
		Air leakage when brake pedal depressed	Air leakage when brake pedal released	Air pressure low	No air leakage but brake works inefficiently	Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal depressed	One-sided braking	Wheel brake works suddenly	Brake air warning lamp is illuminated
Wheel brake	Excessive brake shoe clearance				○			○		○
	Brake lining surface contaminated with oil				○			○		
	Brake lining surface hardened				○		○			
	Brake lining worn exposing rivet head						○			
	Brake lining materials unequal							○		
	Worn brake linings									○
	Automatic slack adjuster malfunctioning 🕮 P35B-36				○	○		○	○	
	Brake shoe return faulty because anchor pin rusted					○				
	Anchor pin loose						○			
	Camshaft rusted					○				
	Brake shoe return spring fractured					○		○		
	Brake shoe return spring deteriorated					○				
	Faulty return of sleeve assembly of expander					○		○		
	Rusting of wedge or anchor pin					○		○		
	Brake drum interior worn unevenly						○			
	Improper contact of brake shoe and linings						○			
	Brake drum and brake linings close contact faulty						○			
	Brake drum runout							○		
	Brake drum installation loose						○	○		
	Brake drum and brake linings contact faulty							○		
	Improper contact of brake linings							○		
	Insufficient brake shoe clearance					○		○	○	
	Air pressure fed to brake chambers unequally							○		
	Air pressure in brake chamber not released					○				
	Wheel parking brake working 🗀 Gr 36B					○				

TROUBLESHOOTING

Possible causes	Symptoms	Wheel brake does not work efficiently				Brake drum overheating			
		Air leakage when brake pedal depressed	Air leakage when brake pedal released	Air pressure low	No air leakage but brake works inefficiently	Brake shoe self-return poor after releasing brake pedal (Wheel drags)	Noise when brake pedal is depressed	One-sided braking	Wheel brake works suddenly
Air compressor	Malfunctioning			○					
Dual brake valve	Primary and secondary valves airtightness faulty	○	○						
	Primary and secondary valves return faulty					○			
	O-ring damaged	○							
	Exhaust port clogged with foreign particles					○			
Air pressure governor	Specified pressure set incorrectly			○					
Air piping	Air leakage in air piping	○	○	○					
Tire	Left and right air pressure different Gr 31							○	
Suspension	U-bolt loose Gr 33, 34							○	

Air Dryer

Possible causes / Symptoms		Drainage from air reservoir drain cock	Drainage not drawn off from exhaust port	Air dryer interior frozen	Air leakage from exhaust port	Air pressure in air reservoir drops extraordinarily	Engine oil coming out exhaust port	Remarks
Air dryer	Desiccant deteriorated	○						
	Heater not working and air dryer interior frozen		○					
	No warming because heater wiring broken			○				
	Heater or thermostat wiring disconnected			○				
	Heater not working because thermostat faulty			○				
	Temperature extremely low because of snow or ice sticking to air dryer body			○				
	Valves clogged with foreign particles		○					
	Valve seat clogged with foreign particles				○			
Check valve	Air returning from air tank because air tank side check valve malfunctioning during air compressor unloading cycle					○		
Air compressor	Air compressor oiling-up						○	

Exhaust Brake

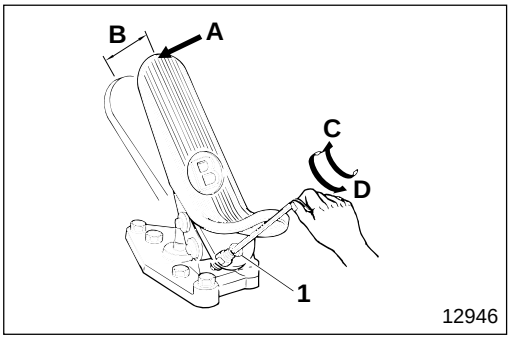
Symptoms / Possible causes	Exhaust brake does not work	Exhaust brake cannot be released	Remarks
Air pressure low	○		
Electrical system faulty	○	○	
Air pipe crushed	○		
3-way magnetic valve does not work	○	○	
Exhaust brake unit does not work	○	○	
Exhaust brake unit shaft stuck	○	○	
Control cylinder does not work	○		

Inspection and Adjustment of Brake Pedal Free Play

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Pedal play	Pedal toe	$12^{+3.0}_{-1.5}$ $\{0.47^{+0.12}_{-0.059}\}$	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	



Press pedal toe **A** with your hand and measure free play **B**. If the measured value deviates from the standard value, adjust it by turning set screw **1**.

C : Turning clockwise decreases the free play (For a small angle)

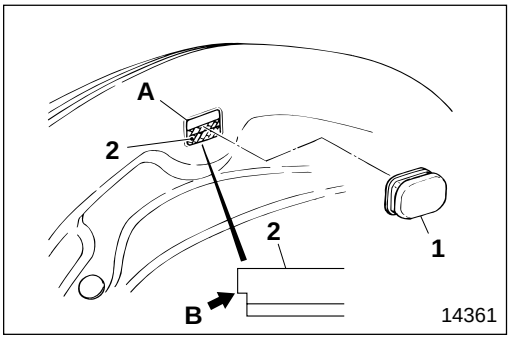
D : Turning counterclockwise increases the free play (For a large angle)

Thickness Inspection and Replacement of Brake Lining

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Thickness of brake lining	16 {0.63}	6{0.24}	Replace



[Inspection]

NOTE

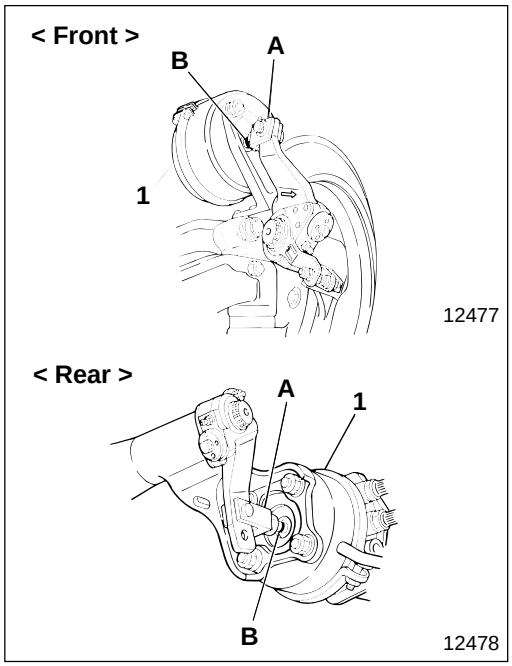
Be sure to inspect at two points for each wheel per side.

- Remove inspection hole plug **1** from the backing plate.
- Inspect through inspection hole **A** whether brake lining **2** is worn to the point of side shoulder **B** of the brake lining (the limit).
- If the measured value is lower than the limit, replace brake lining **2** on the same axle as a unit.
- After inspection, be sure to reinstall inspection hole plug **1**.

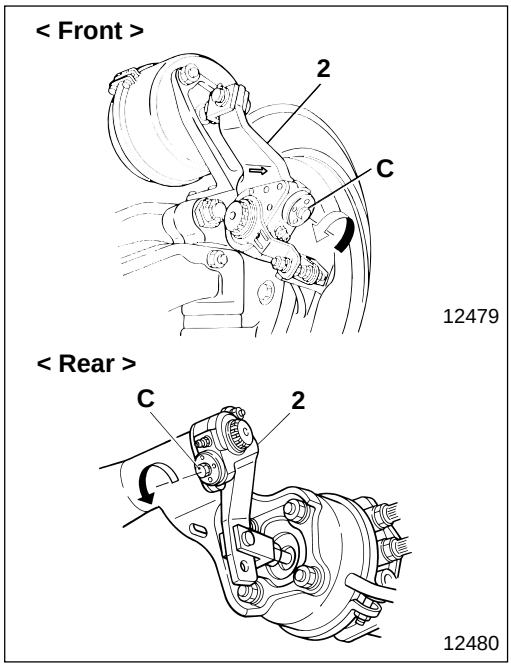
[Replacement]

P35B-54, 64, 74, 88

Inspection of Automatic Slack Adjuster Function



If red painted area **B** of push rod **A** of brake chamber **1** can be seen when the brake pedal is depressed fully, or if any abnormality is sensed in braking, inspect as follows:



- Increase the air pressure in the air tank to approximately 685 kPa {100 psi, 7 kgf/cm^2}.
- Turn worm shaft **C** of automatic slack adjuster **2** in direction ➡ (counterclockwise) to compress the brake shoe assembly and increase the brake shoe clearance to approximately 1.5 mm {0.059 in.}.

NOTE

A large force is required to turn worm shaft A.

- Put a spanner on worm shaft **C** of automatic slack adjuster **2** and inspect operation by watching how far the spanner moves.

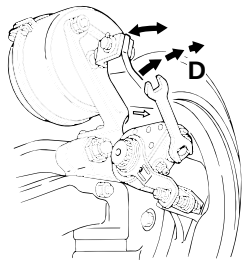
NOTE

Hold the spanner so that it does not fall off.

- Depress the brake pedal fully to work the brake, then release it.
- Check that worm shaft **C** of automatic slack adjuster **2** turns clockwise when the brake is released, and check if the turning stroke decreases every time the brake is depressed and released. If the automatic slack adjuster is faulty, replace it.

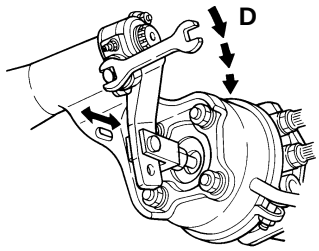
  D : Stroke

< Front >



11155

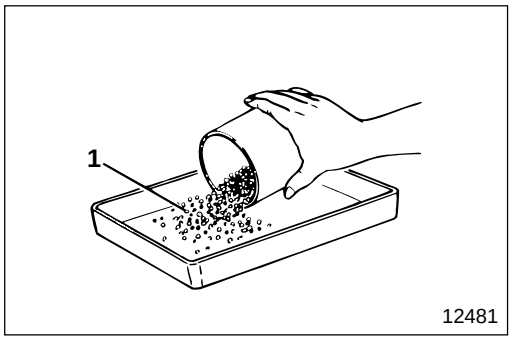
< Rear >



13014

Inspection and Maintenance of Air Dryer

Carry out inspection and maintenance according to the following interval or vehicle milage.

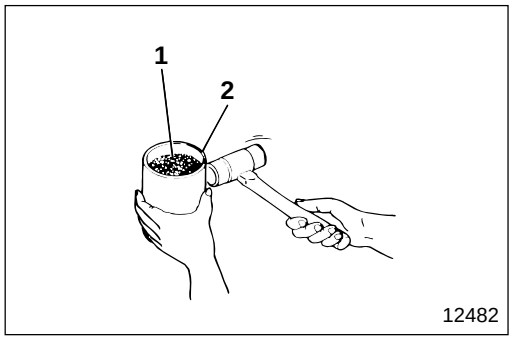


(1) Every 10000 km {6000 miles}

- To check that the air dryer operates correctly, open the drain cock of the air tank and see if any drainage comes out.
- If a little drainage comes out, check if the desiccant **1** is discolored. If more than one fifth of the desiccant has changed color from white to brown, renew desiccant.

NOTE

In an operational environment where the decrease of the ambient temperature in the air tank is higher than 16°C {29°F}, a little moisture might collect.



- Pour desiccant **1** into case **2**, tap around the container lightly to settle the desiccant.
- Carefully inspect the drainage from the exhaust port of the air dryer body. Inspect the air compressor and take appropriate action for abnormal oil consumption.
  P35B-112

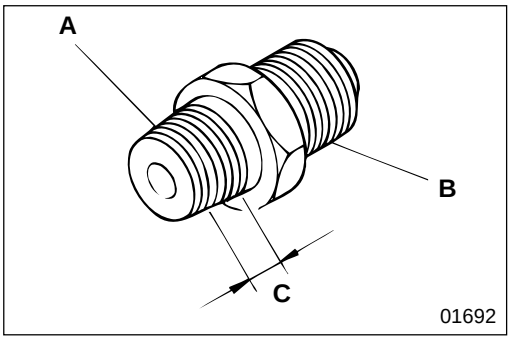
NOTE

Appropriate action means to inspect the clearance between the oil ring and the cylinder liner.

(2) Every year or every 60000 km {36000 miles}

Disassemble the air dryer body. Replace the oil filter, filter and all the rubber parts together with a repair kit.
P35B-112

Connector

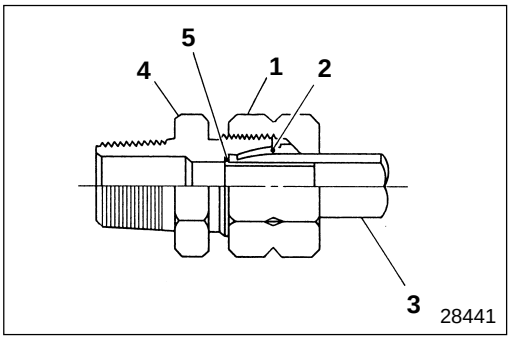


(1) Installation of connector

- When reusing air system connector, remove remainder of sealer, oil, and water sufficiently, apply THREEBOND TB1110B to threads leaving 1 or 2 threads on top blank, and then screw in.
  Where alignment is required, stop at aligning point in additional tightening process.

  A : Taper screw area
  B : Parallel screw area (Do not apply sealer)
  C : Area where sealer shall be applied

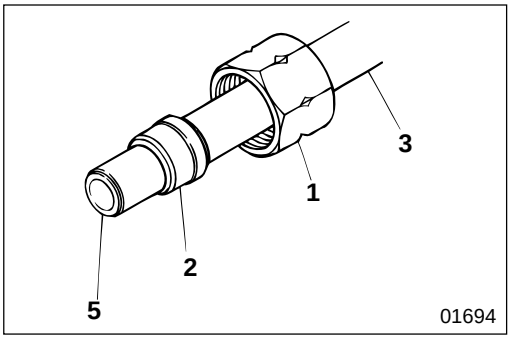
Nylon Tube



Follow the following process where nylon tube is employed.

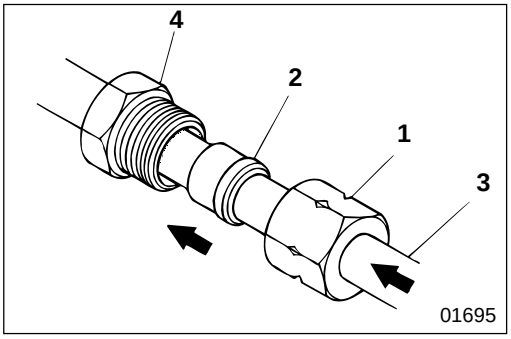
- Nylon tube is designed so that as nut **1** is tightened, sleeve **2** advances gripping to tube **3** while itself is being deformed in the process, thus keeping air tightness to prevent leakage. Accordingly, do not reuse: do not fail to replace with new one.

  4 : Connector
  5 : Insert



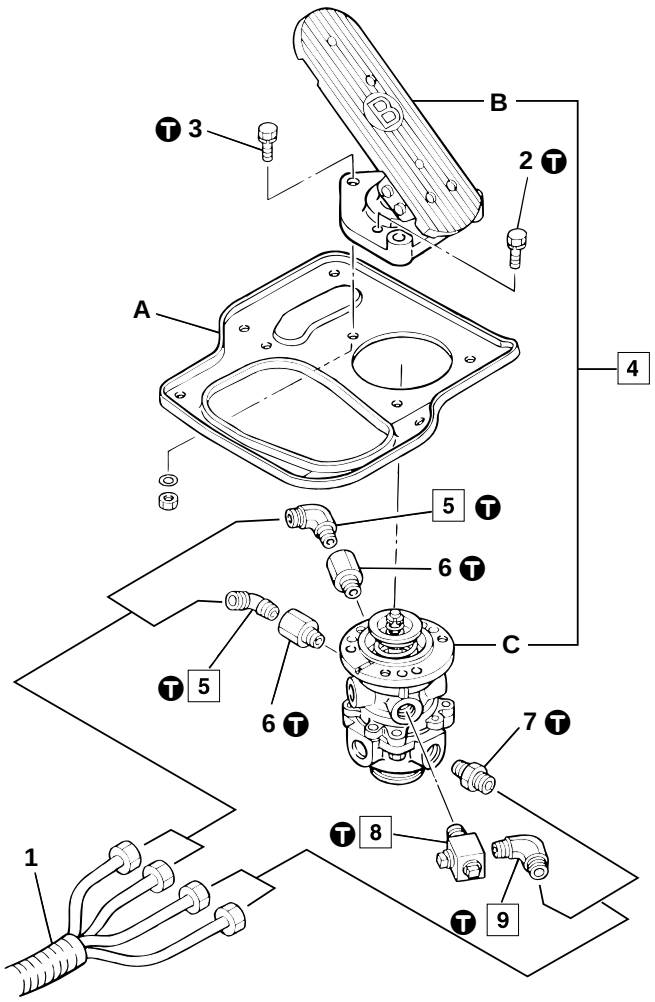
(2) Installation of nylon tube

- Make sure that insert **5**, sleeve **2**, nut **1**, and tube **3** are assembled as illustrated.



- Insert tube **3** into connector **4**, push sleeve **2** into connector **4**, and provisionally tighten nut **1** by hand.
- After this, pull tube **3** to make sure that it does not have leakage, and it does not come apart.

BRAKE PEDAL



Remove pedal assembly **B** upward from valve board **A**, and valve assembly **C** downward from the valve board to separate dual brake valve **4** (pedal assembly and valve assembly). Do this without removing the valve board from the vehicle.

● **Removal sequence**

1 Nylon tube
2 Bolt
3 Bolt
4 Dual brake valve
📖 P35B-42
5 Connector
6 Connector
7 Connector
8 Connector
9 Connector

● **Assembly sequence**

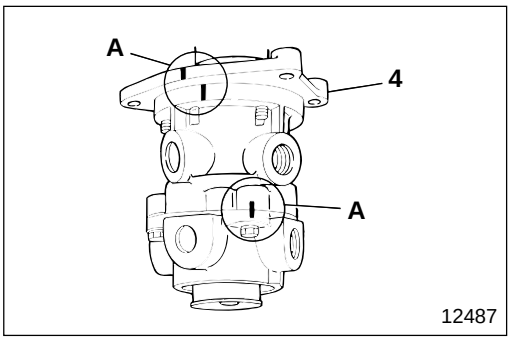
Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

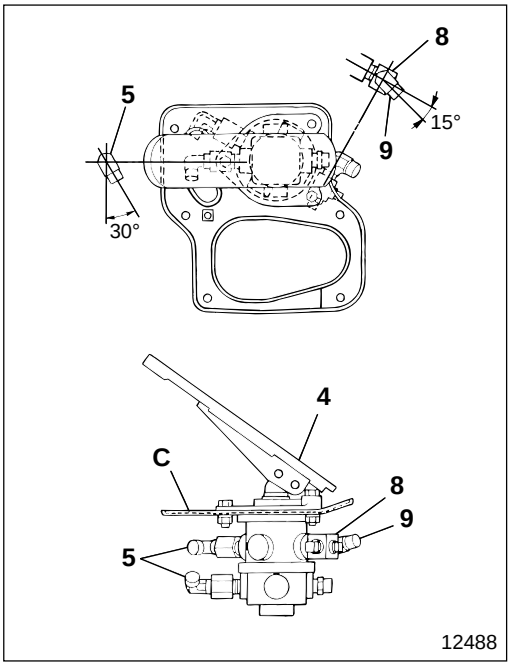
Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Pedal assembly and valve assembly mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
3	Bolt (Dual brake valve and valve board mounting)	12 to 19 {0.047 to 0.075, 1.2 to 1.9}	—
5, 8, 9	Connector	29.4 to 117.7 {0.12 to 0.47, 3.0 to 12}	—
6, 7	Connector	29.4 to 39.2 {0.12 to 0.16, 3.0 to 4.0}	—

◆ Service procedure



4 **Dual brake valve**

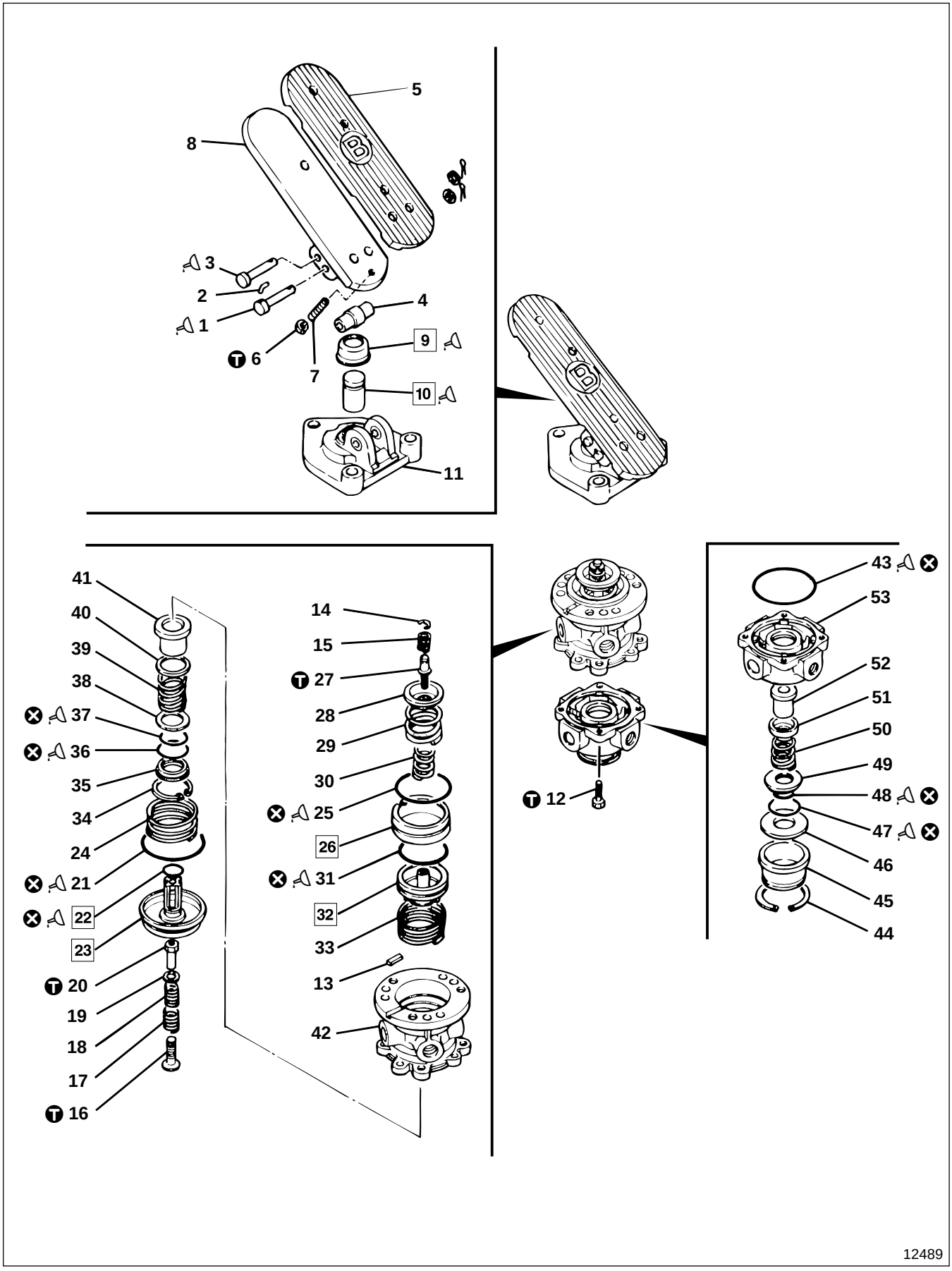
A : Alignment mark



5 **8** **9** **Connector positioning**

Position the connector within one turn after the lower limit tightening torque has been reached.

DUAL BRAKE VALVE



● **Disassembly sequence**

1 Straight pin
2 L-pin
3 Straight pin
4 Roller
5 Pedal cover
6 Lock nut
7 Set screw
8 Pedal
9 Boot
10 Plunger
11 Plate
12 Bolt
13 Plug
14 Retaining ring
15 Spring
16 Screw
17 Outer spring
18 Inner spring
19 Washer
20 Sleeve
21 O-ring
22 O-ring
23 Relay piston
24 Relay piston spring
25 O-ring
26 Bushing
27 Self-locking bolt
28 Spring seat
29 Outer spring
30 Inner spring
31 O-ring
32 Primary piston
33 Spring
34 Retaining ring
35 Valve retainer
36 O-ring
37 O-ring
38 Washer
39 Valve spring
40 Washer
41 Inlet valve
42 Body
43 O-ring
44 Retaining ring
45 Exhaust cover
46 Washer
47 O-ring
48 O-ring
49 Valve retainer
50 Valve spring
51 Valve retainer
52 Inlet valve
53 Cover

⊗ : Non-reusable parts

● **Assembly sequence**

First assemble pedal assembly **A** and valve assembly **B**, then assemble by sandwiching valve board **C** between these two assemblies.

< Pedal assembly **A** >

8 → **7** → **6** → **5** → **4** → **3** → **1** → **2** → Valve board **C**
11 → **10** → **9** → **1**

< Valve assembly **B** >

(Primary side)

41 → **40** → **39** → **38** → **37** → **36** → **35** → **34** → **33** → **32** → **31** → **26** → **25**
42 → **34**

30 → **29** → **28** → **27** → **24** → **15** → **14** → **13** → **12**
23 → **22** → **21** → **15**
20 → **19** → **18** → **17** → **16** → **15**

(Secondary side)

52 → **51** → **50** → **49** → **48** → **47** → **46** → **45** → **44** → **43** → **12**
53 → **45**

Repair kit : Dual brake valve kit

● **Inspection of function after assembly**

🕮 P35B-45

DUAL BRAKE VALVE

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
1, 3	Outer diameter of straight pin	Roller mounting	9.5 {0.374}	9.44 {0.371}	Replace
		Pedal mounting	9.5 {0.374}	9.45 {0.372}	
4	Roller	Inner diameter	9.5 {0.374}	9.67 {0.38}	Replace
		Outer diameter	18.3 {0.72}	18.15 {0.71}	
8	Pedal play	Pedal toe	$12^{+3.0}_{-1.5}$ {$0.47^{+0.12}_{-0.059}$}	—	Adjust using set screw
		Depression angle	$3.5°^{+1.0°}_{-0.5°}$	—	
10	Outer diameter of plunger		19.9 {0.783}	19.8 {0.780}	Replace
11	Plate	Inner diameter of straight pin hole	9.5 {0.374}	9.68 {0.381}	Replace
		Inner diameter of bushing	20 {0.787}	20.08 {0.791}	
15	Spring load (Installed length 12.6 {0.50})		—	215 N {49 lbf, 22 kgf}	Replace
24	Relay piston spring load (Installed length 12.8 {0.50})		—	47 N {11 lbf, 4.8 kgf}	Replace
29	Outer spring load (Installed length 26.5 {1.04})		—	215 N {48 lbf, 21.8 kgf}	Replace
30	Inner spring load (Installed length 19.1 {0.75})		—	60 N {13 lbf, 6.1 kgf}	Replace
33	Spring load (Installed length 17 {0.67})		—	97 N {22 lbf, 9.9 kgf}	Replace
39	Valve spring load (Installed length 14.3 {0.56})		—	37 N {8.4 lbf, 3.8 kgf}	Replace
50	Valve spring load (Installed length 12.9 {0.51})		—	47 N {11 lbf, 4.8 kgf}	Replace
—	Pressure stroke / Input air pressure 685 kPa {100 psi, 7 kgf/cm²}	Pedal toe	25.5 {1.00}	Output air pressure: 105^{+25}_{-54} kPa {$16^{+3.6}_{-7.8}$ psi, $1.1^{+0.25}_{-0.55}$ kgf/cm²}	—	Replace springs
		Depression angle	7.5°		
		Pedal toe	45.5 {1.79}	355^{+39}_{-98} kPa {$52^{+5.7}_{-1.4}$ psi, $3.65^{+0.4}_{-1.0}$ kgf/cm²}	—	
		Depression angle	13.5°		
		Pedal toe	$52^{+8.5}_{-1.5}$ {$2.0^{+0.33}_{-0.059}$}	685 kPa {100 psi, 7 kgf/cm²}	—	
		Depression angle	$15.5°^{+2.5°}_{-0.5°}$		

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Lock nut	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—
12	Bolt (Valve assembly primary and secondary sides assembling)	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
16	Screw	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8)	—
20	Sleeve	1.0 to 2.9 {0.7 to 2.2, 0.1 to 0.3}	—
27	Self-locking bolt	4.9 to 7.8 {3.6 to 5.8, 0.5 to 0.8}	—

Lubricant

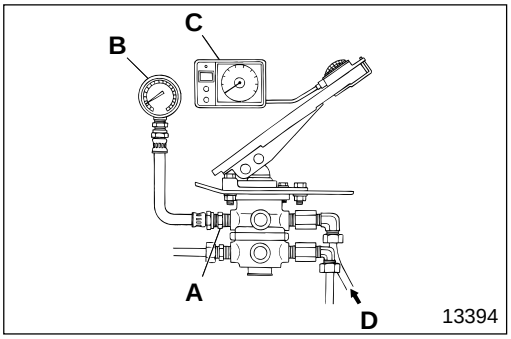
Location	Points of application	Kinds	Quantity
1, 3	Outer periphery of straight pin	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
9, 10	Pack between boot and plunger	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	1 cm^3 {0.061 cu. in.}
10	Friction surfaces of plunger and other parts	High pressure-resistant, high abrasion-resistant grease [NLGI No.2 (Li soap)]	As required
—	Friction surface and groove of O-ring, friction surfaces of metals	Multipurpose grease [NLGI No.2 (Li soap)]	As required

Special tools

Location	Tool name and shape	Part No.	Application
21	Insert tool	*910-24461	Installation of O-ring
32	Retainer	*910-24590	Holding of primary piston

* : BOSCH BRAKING SYSTEMS part No.

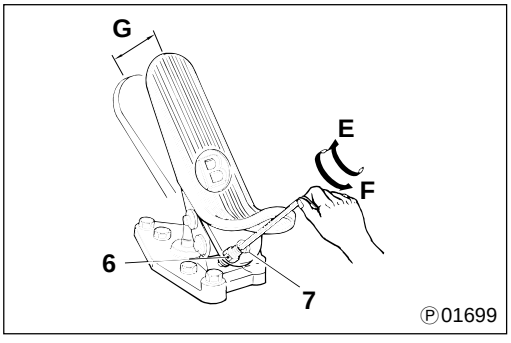
◆ Service procedure



● Inspection of function after assembly

Check that the output air pressure, corresponding to the pedal depression angle, conforms to the specified value.

- Mount pressure gauge **B**, capable of measuring 980 kPa {142 psi, 10 kgf/cm^2} or more, on primary output side port **A**.
- Mount depression gauge **C** on the brake pedal.
- Apply air pressure of 685 kPa {100 psi, 7 kgf/cm^2} to primary input side port **D** and inspect related parts for air leakage.
- If air leakage is found, do the following:
  - Tighten connectors.
  - Disassemble the dual brake valve and inspect the O-ring assemblies of all parts.

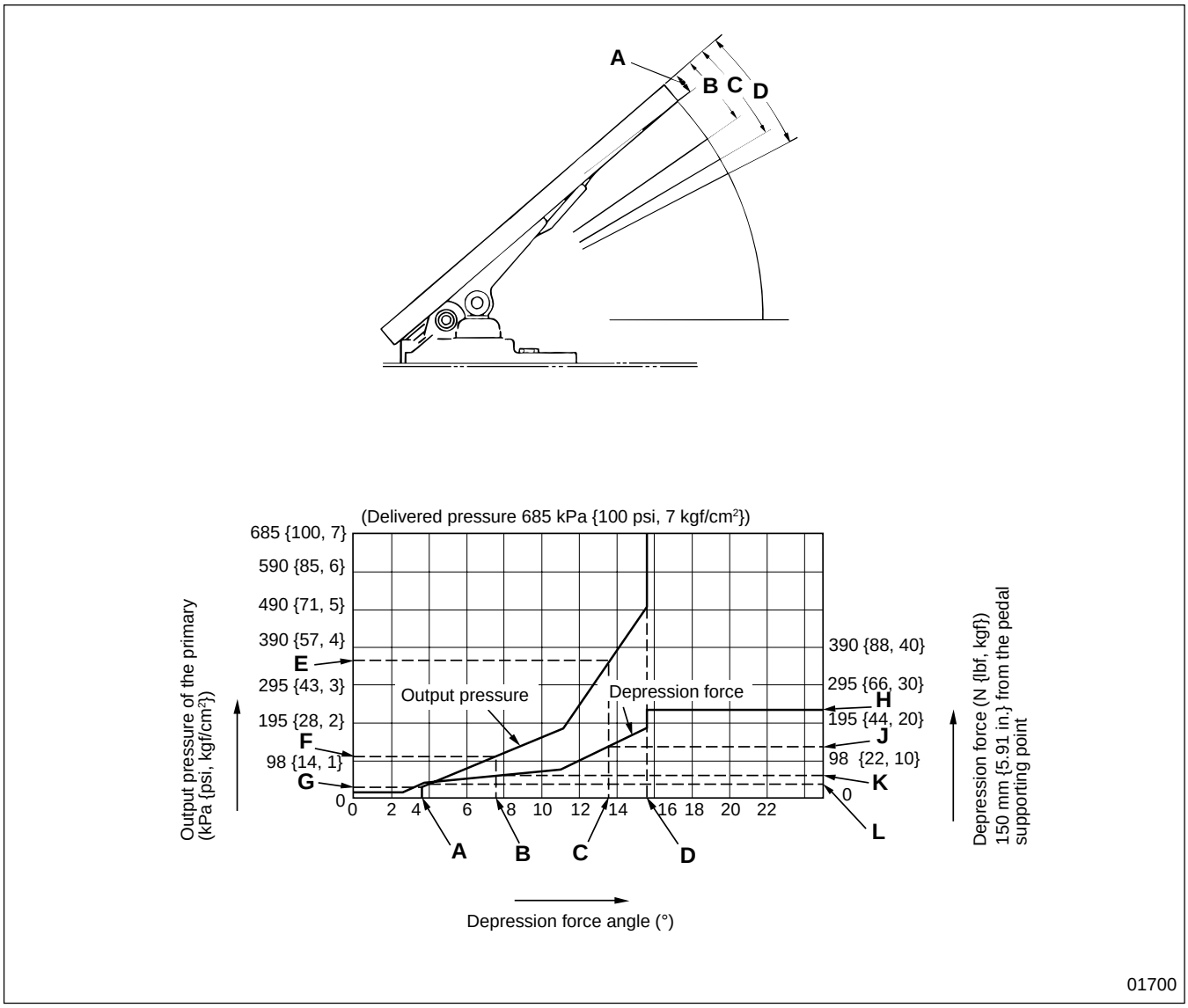


- Turn set screw **7** and adjust brake pedal play **G** to the standard value.
- Tighten lock nut **6** at specified torque to lock set screw **7**.
- Read pressure gauge **B** and make sure that the primary output pressure and brake pedal depression force angle, corresponding to the brake pedal depression angle, conform to the standard values shown in the Input/Output characteristic curve diagram overleaf.
- If the output air pressure is lower than the standard value, replace the following springs:
  - Spring **15**
  - Outer spring **29**
  - Inner spring **30**

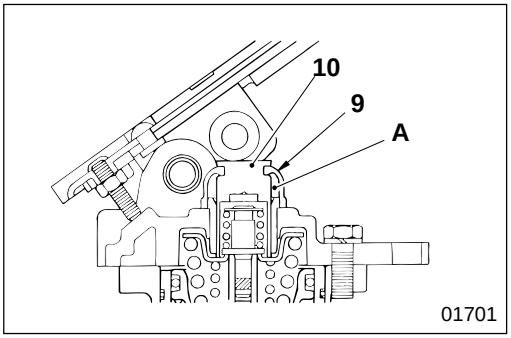
  E : Turning clockwise decreases the play (To decrease brake pedal depression angle)

  F : Turning counterclockwise increases the play (To increase brake pedal depression angle)

Input/Output Characteristic Curve Diagram

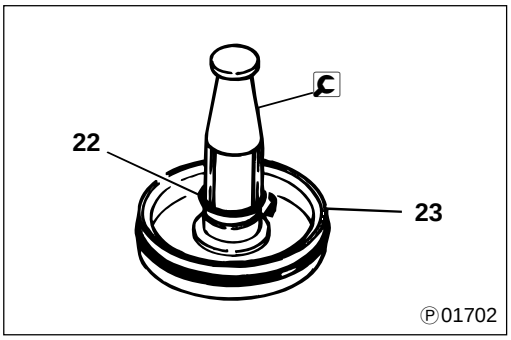


A : Play 3.5° $^{+1.0^\circ}_{-0.5^\circ}$(12 $^{+3.0}_{-1.5}$ mm {0.47 $^{+0.12}_{-0.059}$ in.})
B : Pressure stroke 7.5° (25.5 mm {1.0 in.})
C : Pressure stroke 13.5° (45.5 mm {1.8 in.})
D : Pressure stroke 15.5° $^{+2.5^\circ}_{-0.5^\circ}$ (52 $^{+8.5}_{-0.5}$ mm {2.0 $^{+0.33}_{-0.020}$ in.})
E : 355 $^{+39}_{-98}$ kPa {52 $^{+5.7}_{-1.4}$ psi, 3.65 $^{+0.4}_{-0.1}$ kgf/cm²}
F : 105 $^{+25}_{-54}$ kPa {16 $^{+3.6}_{-7.8}$ psi, 1.1 $^{+0.25}_{-0.55}$ kgf/cm²}
G : 29 kPa {4.3 psi, 0.3 kgf/cm²} or less
H : 230.5±20 N {52±4.4 lbf, 23.5±2 kgf}
J : 132±25 N {30±5.5 lbf, 13.5±2.5 kgf}
K : 59±25 N {13±5.5 lbf, 6±2.5 kgf}
L : 39±10 N {8.8±2.2 lbf, 4±1 kgf}

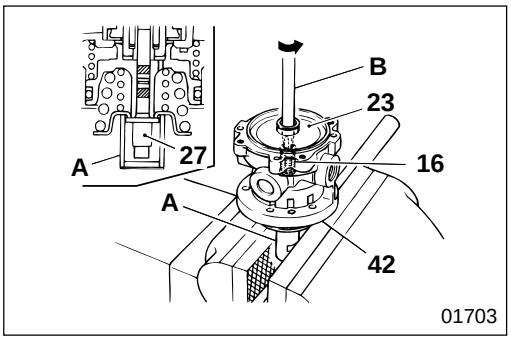


9 **10** **Packing grease between boot and plunger**

Pack area **A** with 1 cm^3 {0.061 cu. in.} of grease.



22 **Installation of O-ring**



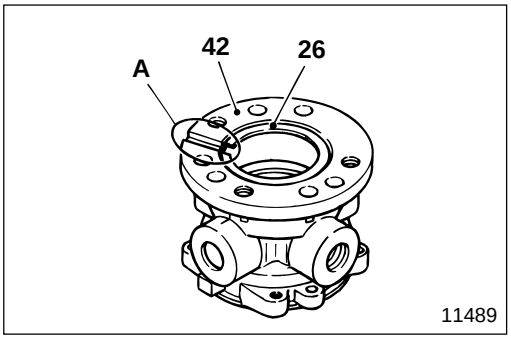
23 **Removal of relay piston**

- Grip (14 mm {0.55 in.}) socket wrench **A** in a vise.
- Insert the head of self-locking bolt **27** into socket wrench **A** to tighten body **42**.

WARNING ⚠

You must be careful when you loosen screw 16, because the spring in body 42 can forcibly eject relay piston 23. To avoid this hazard, press down on the relay piston with your hand when you carry out the above work.

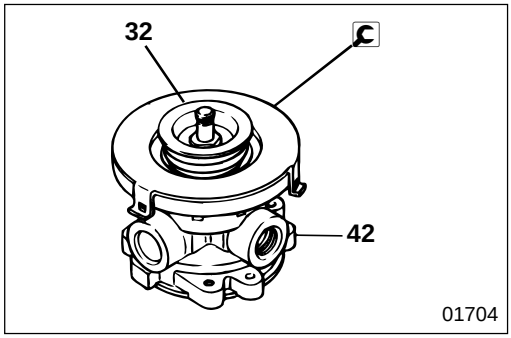
- Loosen screw **16** gradually to remove relay piston **23**.
  B : Phillips screwdriver



26 **Installation of bushing**

A : Indent

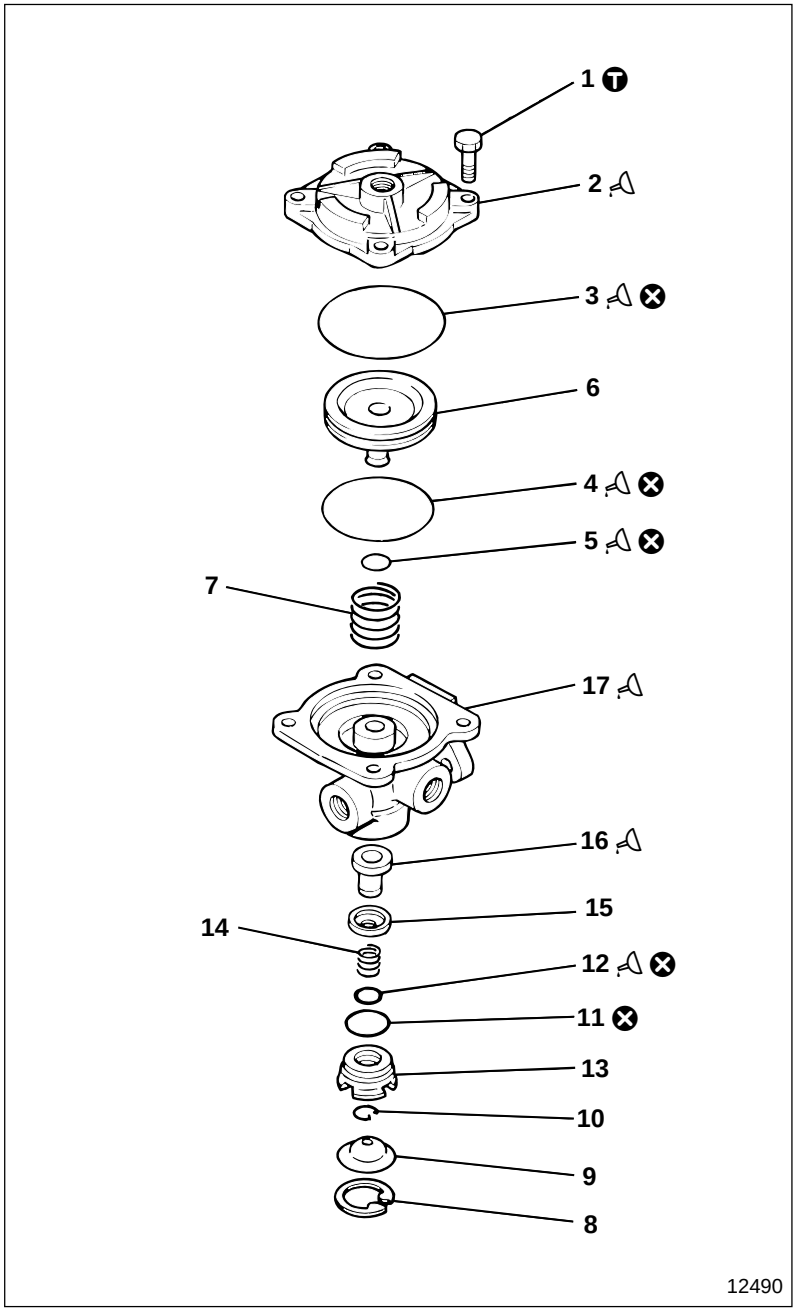
DUAL BRAKE VALVE



32 **Removal and installation of primary piston**

M E M O

RELAY VALVE



● **Disassembly sequence**

1 Bolt
2 Cover
3 O-ring
4 O-ring
5 O-ring
6 Piston
7 Spring
8 Retaining ring
9 Exhaust cover
10 Retaining ring
11 O-ring
12 O-ring
13 Valve guide
14 Spring
15 Valve retainer
16 Inlet valve
17 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Relay valve kit

● **Inspection after assembly** 🕮 P35B-51

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
7	Spring load (Installed length 10.3 {0.41})	16 N {3.6 lbf, 1.65 kgf}	13 N {3.0 lbf, 1.35 kgf}	Replace
14	Spring load (Installed length 15.7 {0.62})	29 N {6.6 lbf, 3.0 kgf}	24 N {5.3 lbf, 2.4 kgf}	Replace

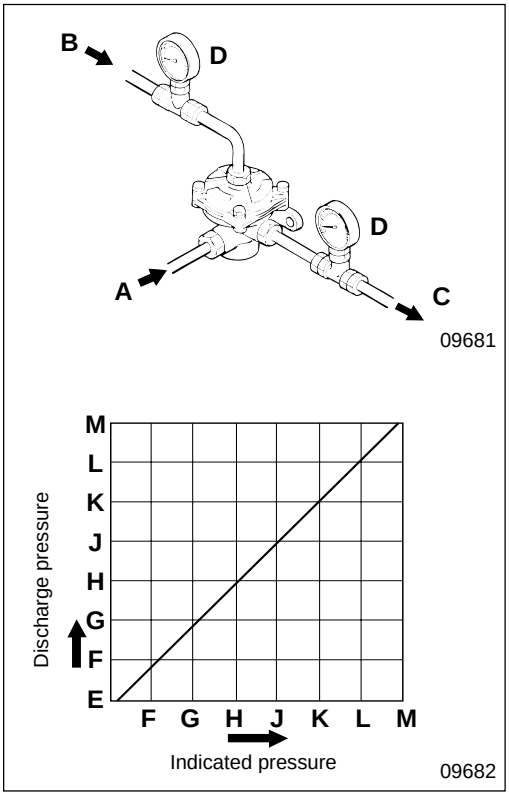
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Cover and body mounting)	12 to 19 {8.7 to 14, 1.2 to 1.9}	—

Lubricant

Location	Points of application	Kinds	Quantity
2	Friction surface of cover and piston	Multipurpose grease [NLGI No.2 (Li soap)]	As required
3, 4, 5,12	Periphery of O-ring	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Friction surface of inlet valve and valve guide	Multipurpose grease [NLGI No.2 (Li soap)]	As required
17	Friction surface of body and piston	Multipurpose grease [NLGI No.2 (Li soap)]	As required



◆ Service procedure

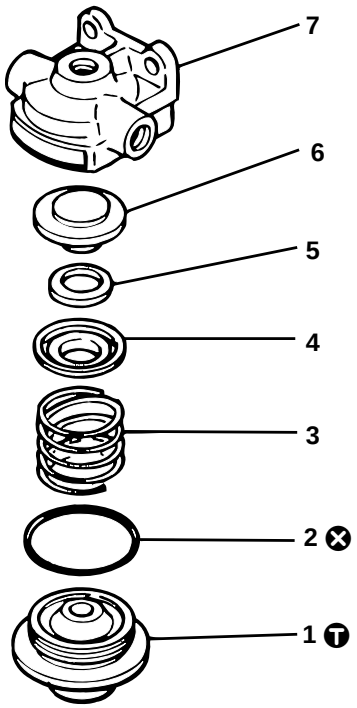
● Inspection after assembly

Mount the gauges on the pipes as illustrated. Apply pressurized air to air supply port **A** and indicated pressure port **B**, and measure the difference in operating pressure between the indicated pressure and the discharge pressure.

Operational pressure difference : 25 kPa {3.6 psi, 0.25 kgf/cm^2}
C : Discharge port
D : Pressure gauge
E : 0 kPa {0 psi, 0 kgf/cm^2}
F : 98 kPa {14 psi, 1 kgf/cm^2}
G : 195 kPa {28 psi, 2 kgf/cm^2}
H : 295 kPa {43 psi, 3 kgf/cm^2}
J : 390 kPa {57 psi, 4 kgf/cm^2}
K : 490 kPa {71 psi, 5 kgf/cm^2}
L : 590 kPa {85 psi, 6 kgf/cm^2}
M : 685 kPa {100 psi, 7 kgf/cm^2}

If any fault is found, replace springs **7, 14**.

QUICK RELEASE VALVE



● **Disassembly sequence**

1 Body
2 O-ring
3 Spring
4 Retainer
5 Ring
6 Diaphragm assembly
7 Housing

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Quick release valve kit

● **Inspection after assembly**

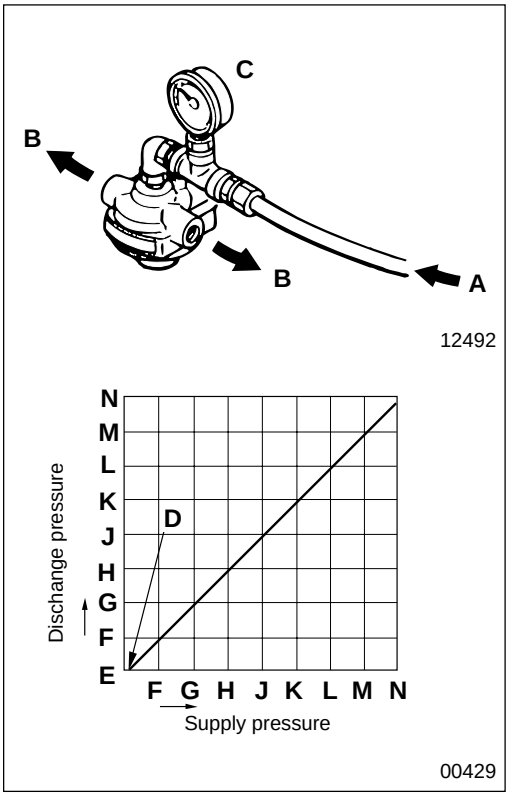
P35B-55

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Body	17 to 23 {12 to 17, 1.7 to 2.3}	—

◆ Service procedure



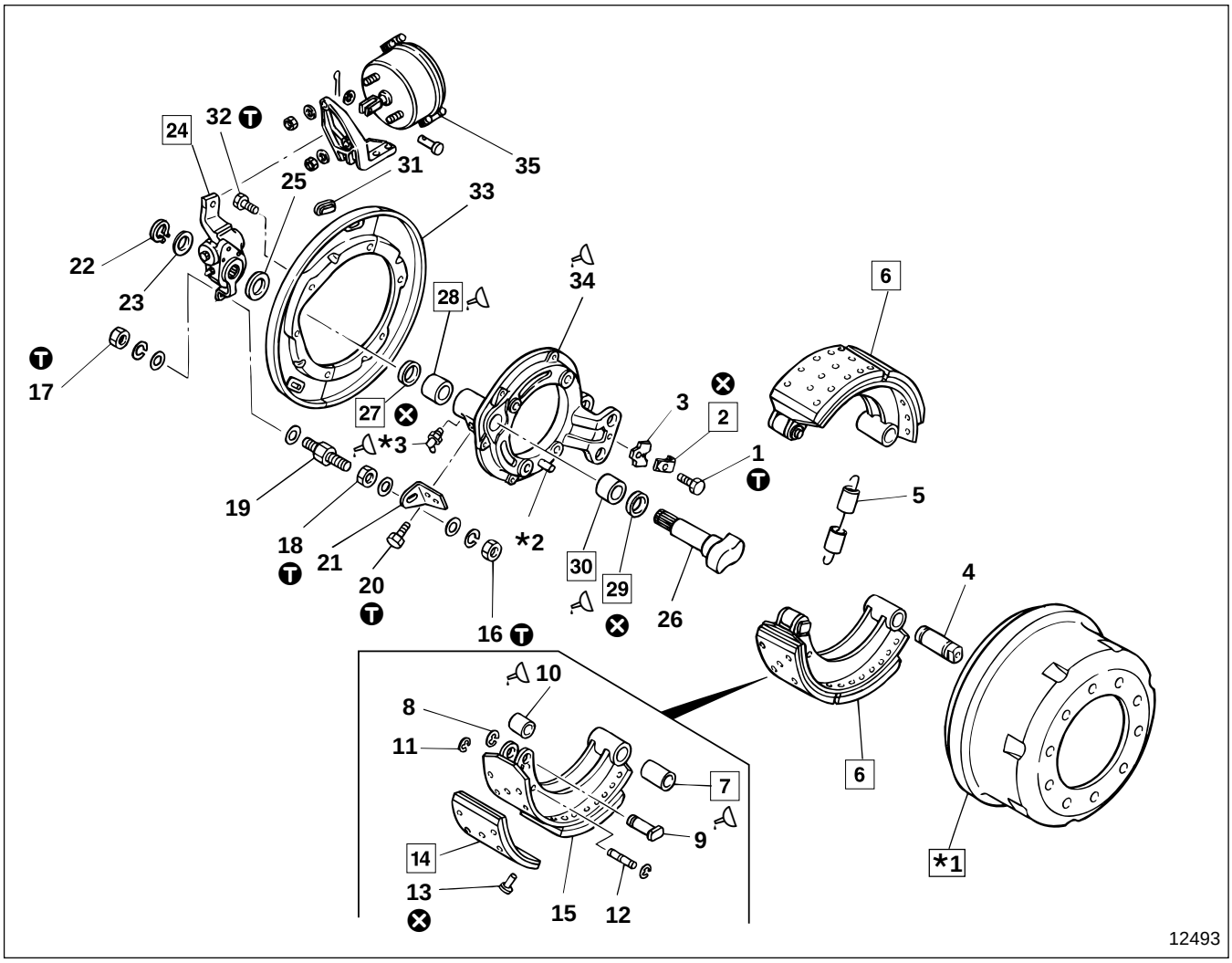
● **Inspection after assembly**

Mount the gauge on the pipe as illustrated. Apply pressurized air from air supply port **A** gradually. Make sure that air flows out discharge port **B** when the applied air pressure reaches the operating starting pressure.

Operational starting pressure : 9.8±4.9 kPa {1.4±0.7 psi, 0.1±0.05 kgf/cm^2}

C : Pressure gauge
D : Operating starting pressure point
E : 0 kPa {0 psi, 0 kgf/cm^2}
F : 98 kPa {14 psi, 1 kgf/cm^2}
G : 195 kPa {28 psi, 2 kgf/cm^2}
H : 295 kPa {43 psi, 3 kgf/cm^2}
J : 390 kPa {57 psi, 4 kgf/cm^2}
K : 490 kPa {71 psi, 5 kgf/cm^2}
L : 590 kPa {85 psi, 6 kgf/cm^2}
M : 685 kPa {100 psi, 7 kgf/cm^2}
N : 785 kPa {115 psi, 8 kgf/cm^2}

Front Drum Brake Assembly



● **Disassembly sequence**

1 Bolt
2 Lock washer
3 Lock plate
4 Anchor pin
5 Return spring
6 Brake shoe assembly
7 Bushing
8 Snap ring
9 Roller pin
10 Roller
11 Snap ring
12 Pin
13 Rivet
14 Brake lining
15 Brake shoe
16 Nut
17 Nut
18 Nut
19 Stopper pin
20 Bolt
21 Stopper pin bracket
22 Snap ring
23 Washer
24 Automatic slack adjuster
25 Spacer
26 Camshaft
27 Dust seal
28 Bushing
29 Oil seal
30 Bushing
31 Check hole plug
32 Bolt
33 Dust cover
34 Anchor bracket
35 Brake chamber assembly
Gr 26
P35B-63

⊗ : Non-reusable parts
***1** : Brake drum Gr 26
***2** : Positioning pin
***3** : Grease nipple

WARNING⚠

Do not leave lubricant on the surface of brake lining 14 because this reduces braking performance.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave lubricant on the surface of brake lining 14 because this reduces braking performance.

CAUTION⚠

Make sure you use a 1.2 mm {0.047 in.} thick washer for washer 23, not a 2 mm {0.079 in.} thick one.

Repair kit : Brake lining kit

● **Inspection of operation after installation**

🕮 P35B-56

● **Adjustment of initial brake shoe clearance after installation**

🕮 P35B-57

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])		Limit	Remedy
4, 7	Clearance between anchor pin and bushing		[35] 0.05 to 0.14 {[1.34] 0.0020 to 0.0055}		0.3 {0.012}	Replace bushing
5	Return spring load (Installed length 265 {10.4})		410 N {92 lbf, 41.8 kgf}		Clearance between coils and between coil and cover	Replace
6	Thickness of brake lining		16 {0.63}		6 {0.24} (Side shoulder means wear limit)	Replace brake lining
26, 28, 30	Clearance between bushing and camshaft		[40] 0.16 to 0.21 {[1.57] 0.0063 to 0.0083}		0.5 {0.020}	Replace bushing
***1**	Brake drum	Inner diameter	ø410 {16.1}	ø*412 {*16.2}	ø414 {16.3}	Replace
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct

* : Indicates correction limit.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

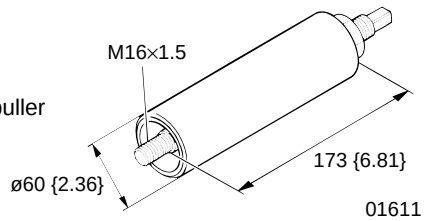
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	21 to 34 {15 to 25, 2.1 to 3.5}	—
16, 18	Nut (Stopper pin mounting)	27 to 40 {20 to 30, 2.7 to 4.1}	—
17	Nut (Stopper pin mounting)	14 to 20 {10 to 14, 1.4 to 2.0}	—
20	Bolt (Stopper pin bracket mounting)	27 to 40 {20 to 30, 2.7 to 4.1}	—
32	Bolt (Dust cover mounting)	16 to 24, {12 to 17, 1.6 to 2.4}	—

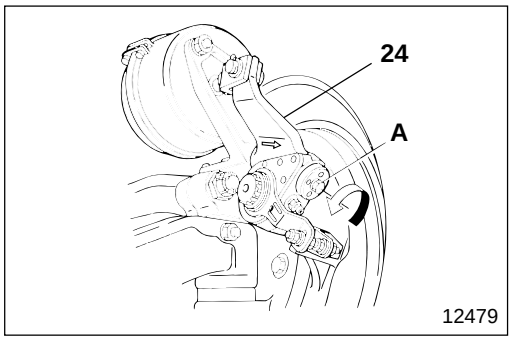
Lubricant

Location	Points of application	Kinds	Quantity
7	Interior of bushing	Wheel bearing grease [NLGI No.2 (Li soap)]	0.75 g {0.026 oz} or more
10	Interior of roller	Molybdenum disulfide grease	As required
28, 30	Interior of bushing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
34	Anchor bracket inserting hole for anchor pin	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
***3**	Pack via grease nipple after assembling wheel brake	Wheel bearing grease [NLGI No.2 (Li soap)]	10 g {0.35 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4	Anchor pin puller 	03727-60000	Removal of anchor pin



◆ Service procedure

● **Inspection of operation after assembly**

- Increase the air pressure in the air tank to approximately 685 kPa {100 psi, 7 kgf/cm^2}.
- Turn worm shaft **A** of automatic slack adjuster **24** in direction ➡ (counterclockwise) to compress brake shoe assembly **6** and increase the brake shoe clearance to approximately 1.5 mm {0.059 in}.

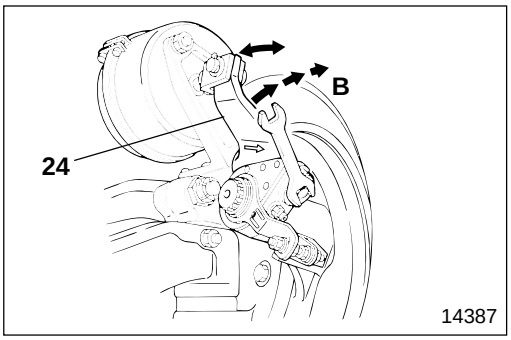
NOTE

A large force is required to turn worm shaft A.

- Put a spanner on worm shaft **A** of automatic slack adjuster **24** and inspect operation by watching how far the spanner moves.

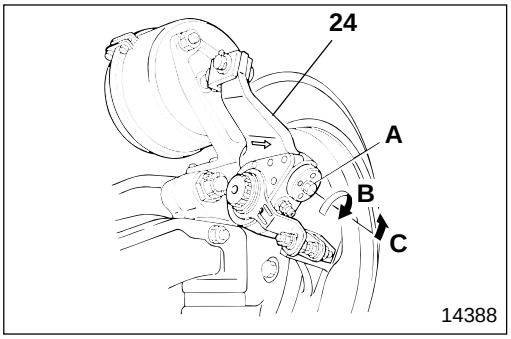
NOTE

Hold the spanner so that it does not fall off.



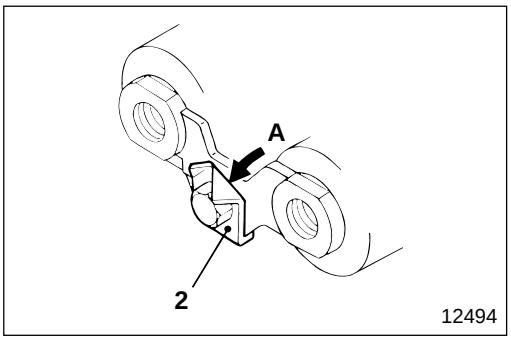
- Depress the brake pedal fully to work the brake, then release it.
- Check that worm shaft **A** of automatic slack adjuster **24** turns clockwise when the brake is released, and if the turning stroke decreases every time the brake is depressed and released. If the automatic slack adjuster is faulty, replace it.

  B : Stroke



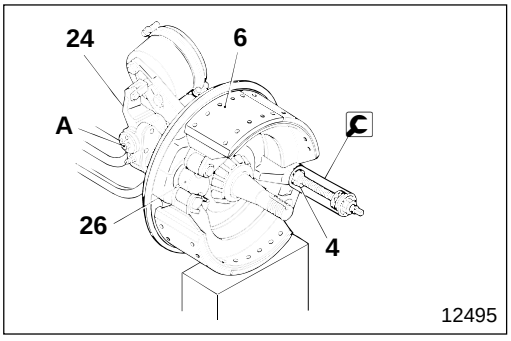
● **Adjustment of initial brake shoe clearance after installation**

- Turn worm shaft **A** of automatic slack adjuster **24** clockwise to open brake shoe assembly **6** until the brake shoe clearance is 0 mm {0 in.}.
- Slacken off worm shaft **A** counterclockwise by one quarter of a turn.
  B : Turn clockwise fully.
  C : Slacken off counterclockwise by one quarter of a turn.



2 **Bending up lock washer**

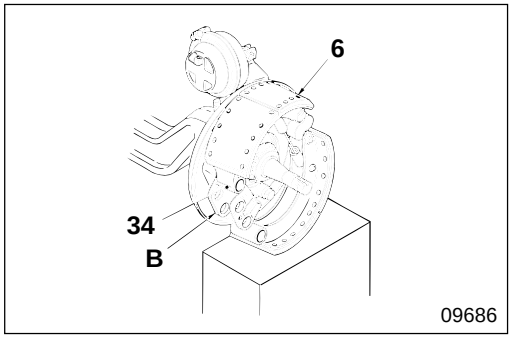
A : Bend



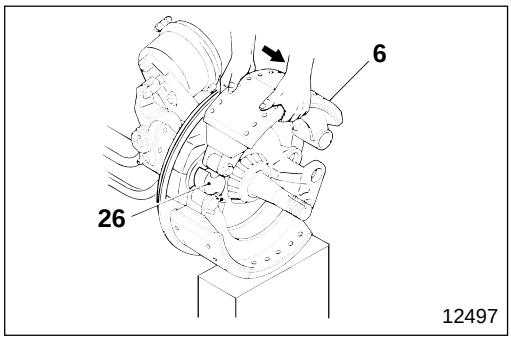
6 **Brake shoe assembly**

[Removal]

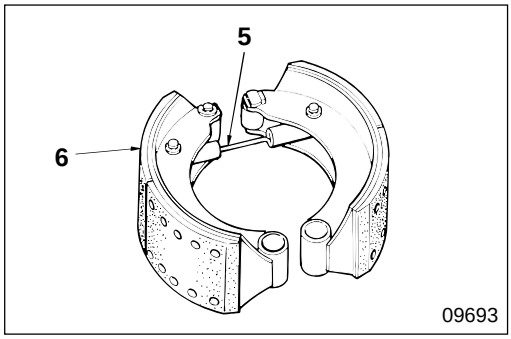
- Turn worm shaft **A** of automatic slack adjuster **24** so that camshaft **26** does not open brake shoe assembly **6**.
- Remove anchor pin **4** using [C] anchor pin puller.



- Remove heel part **B** of lower brake shoe assembly **6** from anchor bracket **34**.
- Remove heel part **B** of upper brake shoe assembly **6** from anchor bracket **34**.

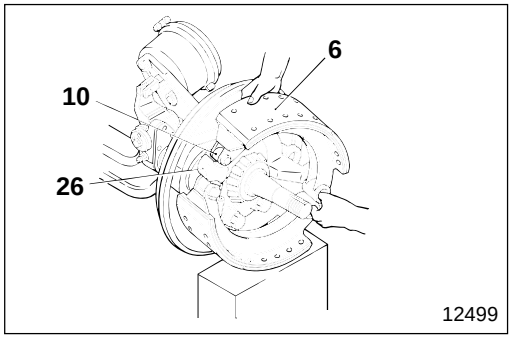


- Hold upper brake shoe assembly **6**, and remove it from camshaft **26** by sliding horizontally.

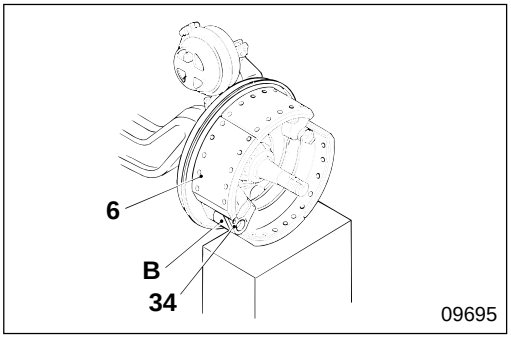


[Installation]

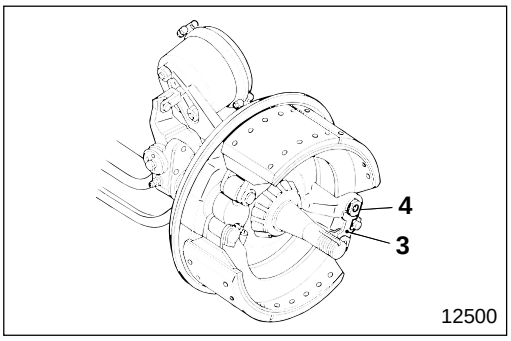
- Install return spring **5** in both brake shoe assemblies **6**.



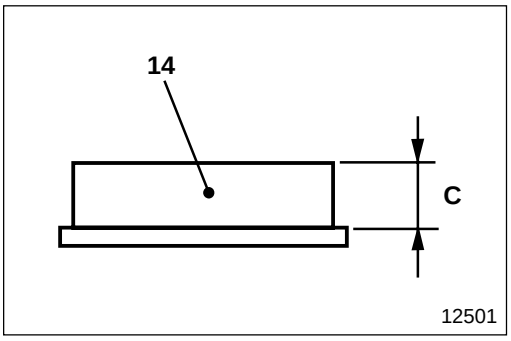
- Insert your thumb and forefinger into the anchor pin hole of both brake shoe assemblies **6**, and lift the upper brake shoe assembly with your other hand.
- Place and slide roller **10** of brake shoe assembly **6** onto camshaft **26**.



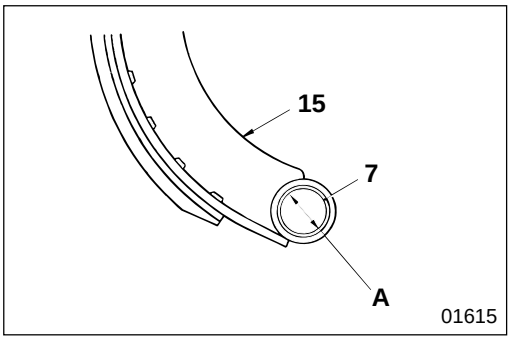
- Install heel part **B** of upper brake shoe assembly **6** in anchor bracket **34**.
- Install heel part **B** of lower brake shoe assembly **6** in anchor bracket **34**.



- Drive in anchor pin **4** and fix it with lock plate **3**.



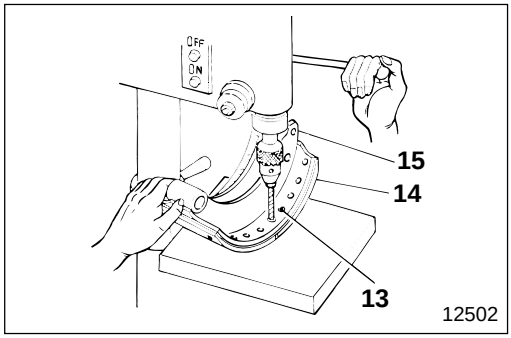
[Inspection]
If thickness **C** of brake lining **14** is lower than the limit replace the brake lining on both sides of the axle.



7 **Inner diameter of bushing**

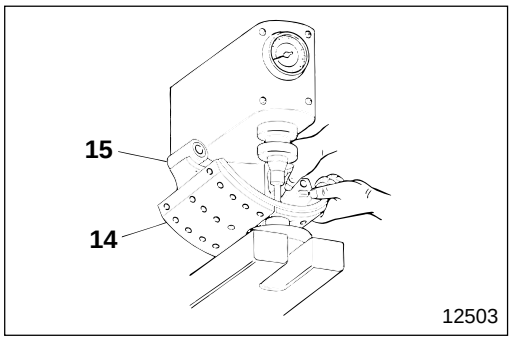
- After installing bushing **7** in brake shoe **15**, measure inner diameter **A** of the bushing.
- If the inner diameter deviates from dimension A ream the diameter to the standard value.

Dimension **A** : $35\ ^{+0.05}_{0}$ mm {$1.4\ ^{+0.0020}_{0}$ in.}



14 **Rivet, brake lining and brake shoe**

[Removal]



[Installation]

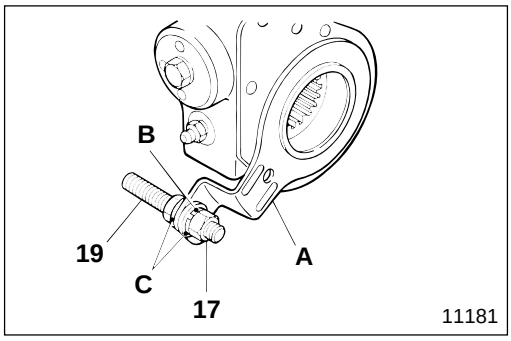
- Clean the mounting surfaces of brake lining **14** and brake shoe **15** with cleaning fluid and dry them.
- Insert rivets **13** from brake lining **14** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **15** and the brake lining.
  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

WARNING⚠

Do not leave lubricant on the surface of brake lining 14 because this reduces braking performance.

CAUTION⚠

- **Make sure that the type of brake linings 14 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.**
- **Make sure that you inspect contact with the inner surface of brake drum *1 after you replace brake linings 14. If contact is incorrect, correct with the brake assembled.**

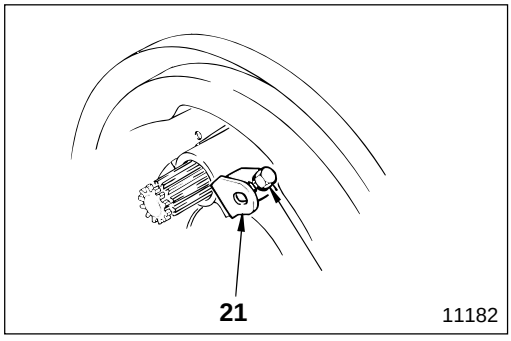


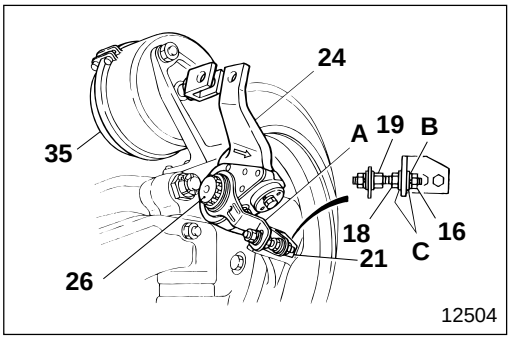
24 **Automatic slack adjuster**

[Installation]

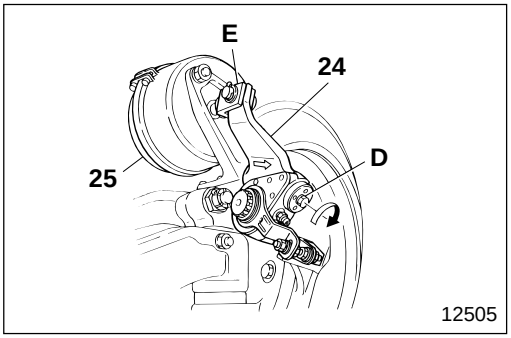
- Install stopper pin **19** in control arm **A** of automatic slack adjuster **24** temporarily.

  B : Spring washer
  C : Plain washer

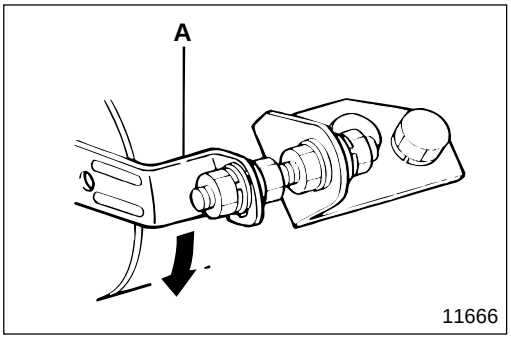




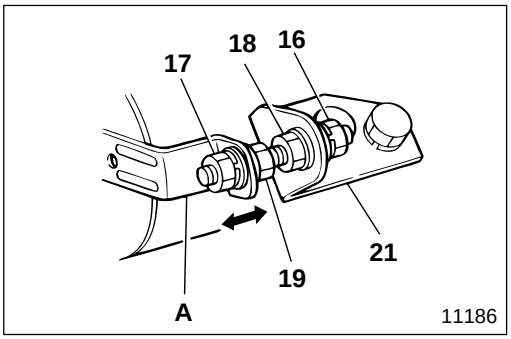
★ • Fit nuts **16**, **18**, spring washer **B** and plain washer **C** on stopper pin **19** that is installed in automatic slack adjuster **24**.
• Position control arm **A** so that stopper pin **19** can be fitted into the hole of stopper pin bracket **21**.
• Install automatic slack adjuster **24** on camshaft **26** of the wheel brake so that mark "⇨" on the arm of the automatic slack adjuster points away from brake chamber **35** as illustrated.



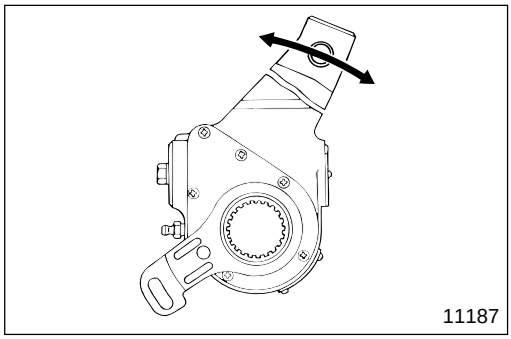
• Turn and align worm shaft **D** of automatic slack adjuster **24** clockwise in the direction of mark "➡" as illustrated, and install push rod **E** of brake chamber **35** in the arm.



• Push control arm **A** of automatic slack adjuster **24** in direction ➡ as illustrated, and confirm that the arm does not move due to contact with the inner stopper.
If the control arm does move, repeat the operation from step ★.

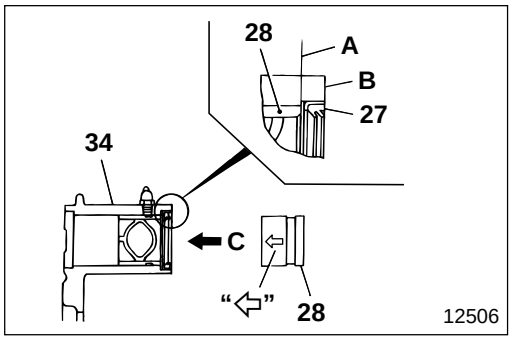


• First install stopper pin **19** in control arm **A**, then in stopper pin bracket **21**, tighten nuts **16**, **17**, **18** at specified torque. Check that the control arm does not move. When tightening the nuts at specified torque, do not apply force to the control arm in arrow mark direction ⟷ as illustrated.



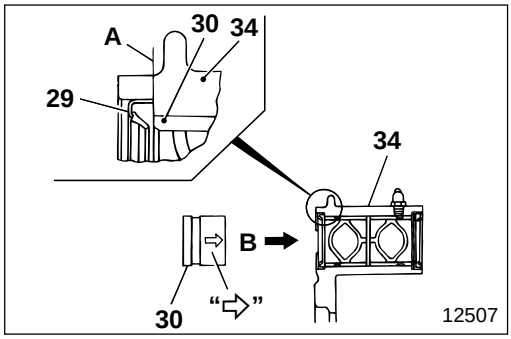
[Inspection of play]

- Inspect automatic slack adjuster **24** when it is disconnected from brake chamber **35**.
- To inspect play, move automatic slack adjuster **24** in direction ⟷ as illustrated. If play is higher than the limit, replace the automatic slack adjuster.
  Limit : 4 mm {0.16 in.} or less



27 **28** **Press-fitting of dust seal and bushing**

A : Press-fit bushing **28** to this level
B : Press-fit dust seal **27** to this level
C : Press-fitting direction for bushing **28**



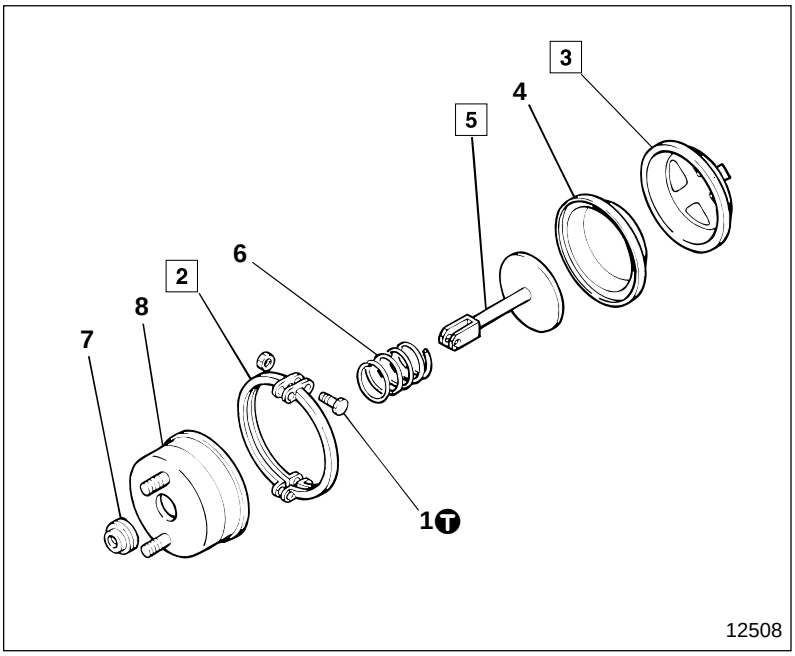
29 **30** **Press-fitting of oil seal and bushing**

A : Press-fit oil seal **29** and bushing **30** to this level
B : Press-fitting direction for bushing **30**

***1** **Correction of brake drum**

If the cylindrical accuracy of brake drum ***1** is higher than the limit, or there are seams, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub attached as an integral part.

Brake chamber assembly



12508

● **Disassembly sequence**

1 Bolt
2 Clamp
3 Pressure plate
4 Diaphragm
5 Push rod
6 Spring
7 Dust cover
8 Non-pressure plate

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Brake chamber kit

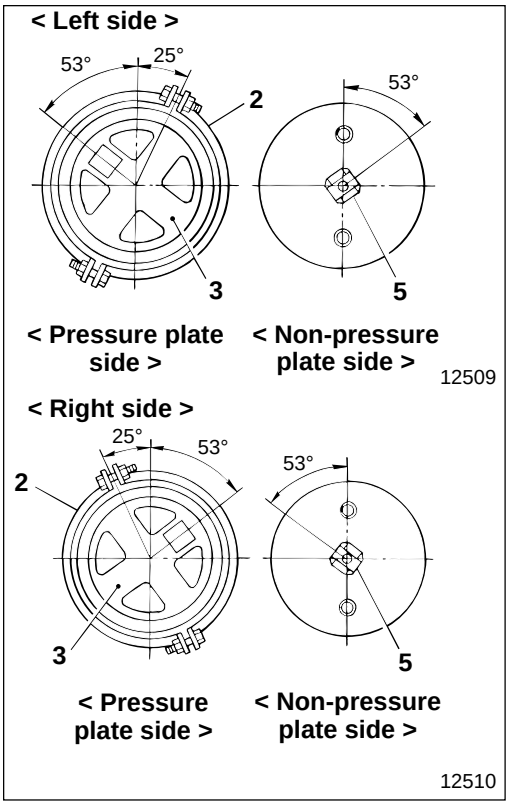
T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

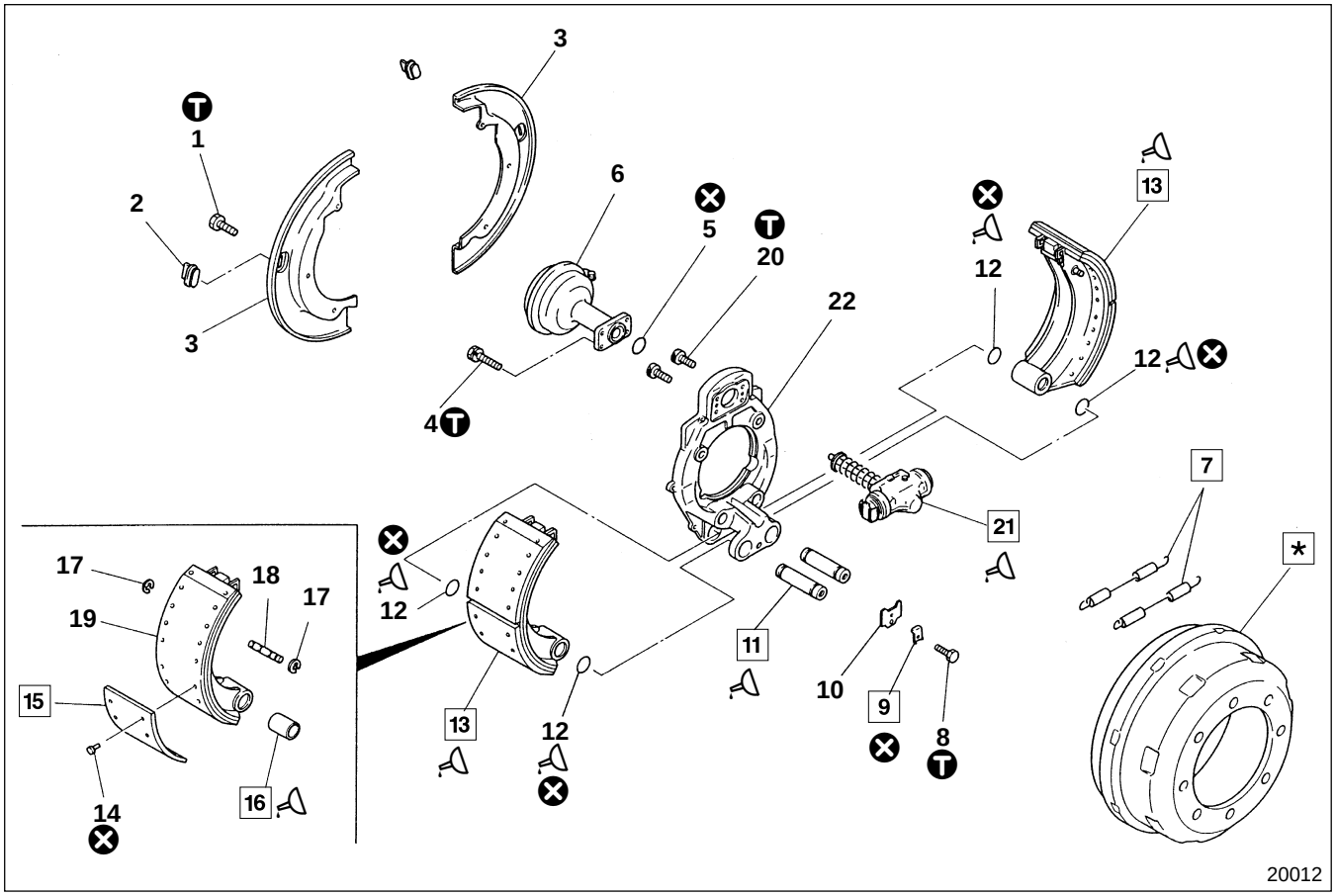
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Clamp tightening)	14.7 to 19.6 {11 to 14, 1.5 to 2.0}	—

◆ Service procedure

2 **3** **5** **Assembly direction for clamp, pressure plate and push rod**



Front Drum Brake Assembly



● **Disassembly sequence**

1 Bolt
2 Inspection hole plug
3 Dust cover
4 Bolt
5 O-ring
6 Brake chamber assembly
📖 P35B-72
7 Return spring
8 Bolt
9 Lock washer
10 Lock plate
11 Anchor Pin
12 O-ring
13 Brake shoe assembly
14 Rivet
15 Brake lining
16 Bushing
17 Snap ring
18 Pin
19 Brake shoe
20 Screw
21 Expander assembly
📖 P35B-98
22 Anchor bracket

***** : Brake drum
Gr 26
⊗ : Non-reusable parts

WARNING ⚠

Do not adhere oil and fat to the surface of brake lining 15 of brake shoe assembly 13 and the inside surface * of the brake drum, which may cause the malfunctioning of the brake.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: brake lining kit

● **Work after assembly**

📖 P35B-66

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])		Limit	Remedy
7	Load of return spring (installation length: 258{10})		292 N {66 lbf, 29.8 kgf}		Space must exist between coils, and between coils and cover.	Replace
11, **16**	Space between anchor pin and bush		[35] 0.05 to 0.14 {[1.38] 0.0020 to 0.0055}		0.3 {0.012)	Replace bush
15	Thickness of brake lining		16 {0.63}		6 {0.24} (side stagger is wear limit).	Replace brake lining
*	Brake drum	Inside diameter	410 {16.1}	(*1) 412 {16.2}	414 {16.3}	Replace
		Cylindrical degree	0.05 {0.0020}		0.2 {0.0079}	Correct

(*1) Indicating the repair limit value

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

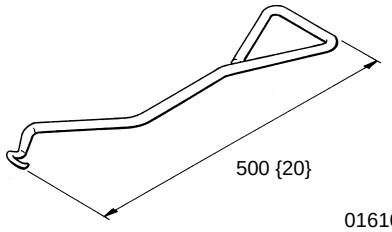
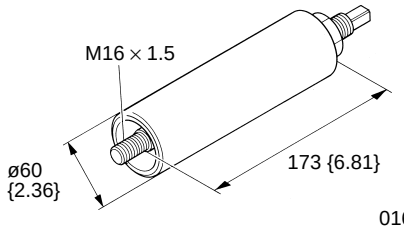
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (installation of dust cover)	19.6±3.9 {14±2.9, 2±0.4}	—
4	Bolt (installation of brake chamber assembly)	50±7.5 {37±5.1, 5.1±0.7}	—
6	Release bolt for brake chamber assembly, Release nut used when being stored	14.7 to 15.7 {10 to 12, 1.4 to 1.6}	—
8	Bolt (installation of lock plate)	19.6±3.9 {14±2.9, 2±0.4}	—
20	Screw (installation of expander assembly)	18.6±4.9 {14±3.6, 1.9±0.5}	—

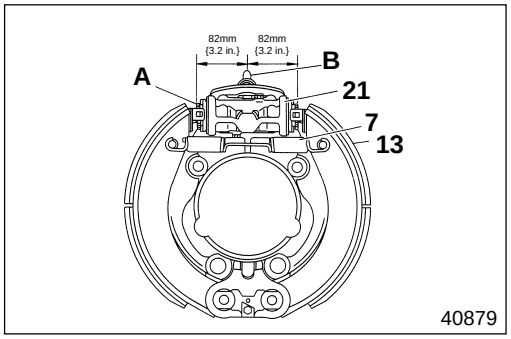
Lubricant

Location	Points of application	Specified fluid	Quantity
11	Grease groove of anchor pin	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
12	O-ring	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
13, 21	Contact surface of brake shoe assembly and expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
16	Inside surface of bush	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
21	Wedge tip of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
	Wedge insertion part of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	10 g {22 lb}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
7	Return spring setter 	MC809749	Remove return spring
11	Anchor pin puller 	03727-60000	Remove anchor



♦Service procedure

● **Work after assembly**

(1) Release of spring brake

Follow the work sequence before disassembly in reverse to release the mechanical release of spring brake. 🕮 P35B-90

NOTE

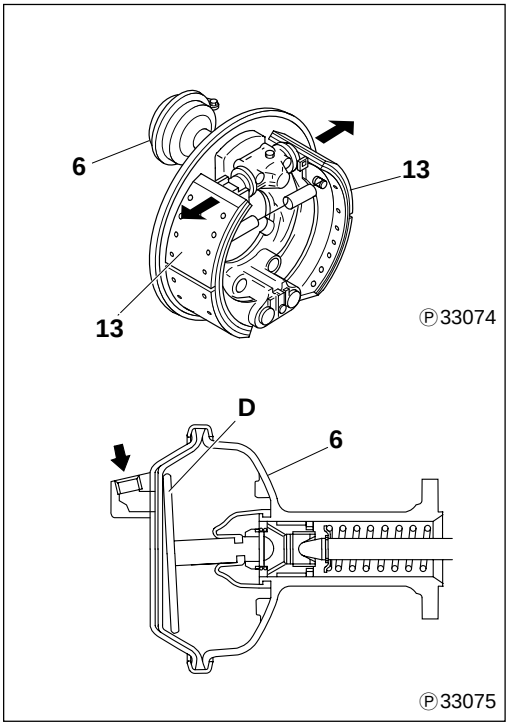
- **Confirm that end cap A is surely installed.**
- **Confirm that there is no damage in bleeder pipe B. Also, confirm that the bleeder pipe is surely installed.**

(2) Confirmation of operation

- Confirm that the installation dimension of expander assembly **24** is 82 mm {3.2 in.}.
  If it is incorrect, adjust it according to the following procedure.
- Set the part indicated in diagram to 82 mm {3.2 in.} by adjusting the adjusting screw **A**.
- Expand the brake shoe assembly **14** under a full stroke by pushing push rod **B**.
- Confirm that expander assembly **24** returns to 82 mm {3.2 in.} when returning the push rod **B**.
- If it operates incorrectly, inspect the spring force of return spring **8**, inactivation of brake shoe assembly **14**, and expander assembly **24** again.

WARNING⚠

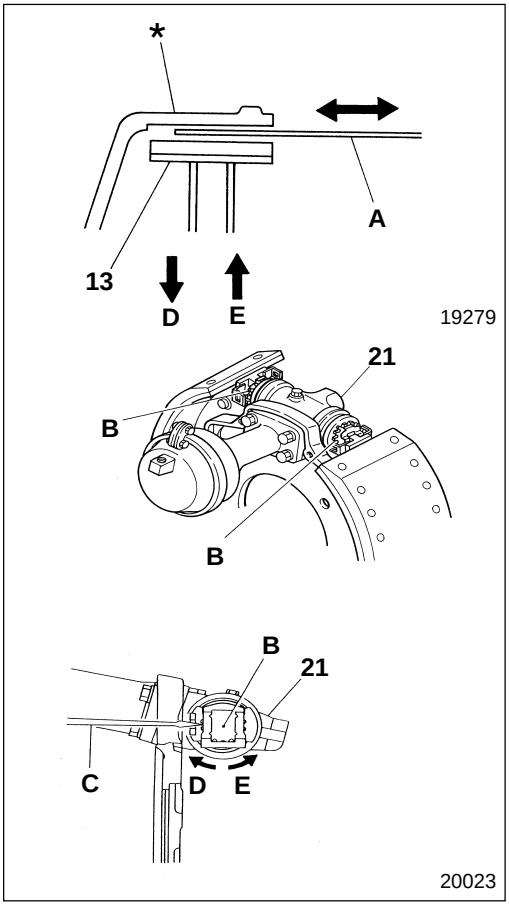
The auto adjustment mechanism might not operate normally if the assembly work is not surely executed.



- When disassembling brake chamber assembly **6**, inspect the following.

< When disassembling brake chamber assembly 6 >

- Confirm whether brake shoe assembly **13** does not move with the adjusting screw **C** of expander assembly **21** when pulling the brake shoe assembly **13** with a force of 20 to 30 N {4.4 to 6.6 lbf, 2 to 3 kgf}.
- If brake shoe assembly **13** moves, bush rod and pressure plate **D** of brake chamber assembly **6** are diagonally installed; therefore, correct the bush rod and the pressure plate to a regular position by depressing brake pedal 2 to 3 times with not installing brake drum.



(2) Initial adjustment of brake shoe clearance after assembly

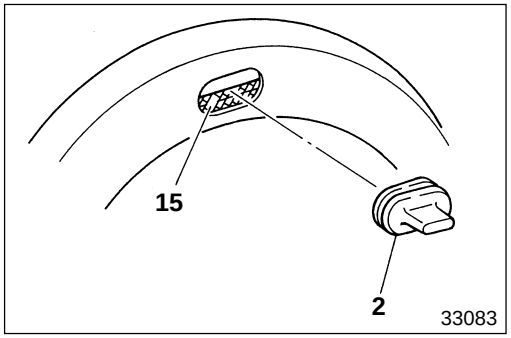
< When not replacing brake lining 15 with the new one >

- Remove dust cover **3**.
- Turn adjusting screw **B** of expander assembly **21** to the extent that the thickness gauge **A** of 0.3 to 0.5 mm {0.012 to 0.02 in.} can be easily pulled in and out at the inspection hole of the 2-points/per wheel.
  C : Flat screw driver
  D : Increasing brake shoe clearance
  E : Decreasing brake shoe clearance

- Install dust cover **3**

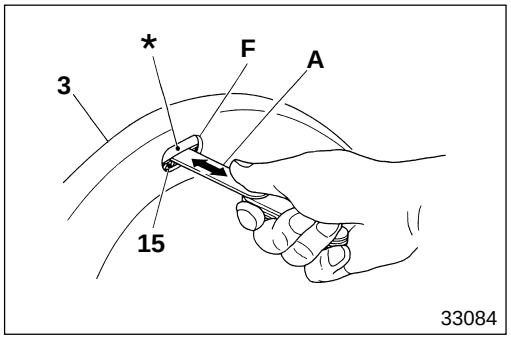
CAUTION⚠

Do not damage the boot of expander assembly 21 when inserting minus driver C.

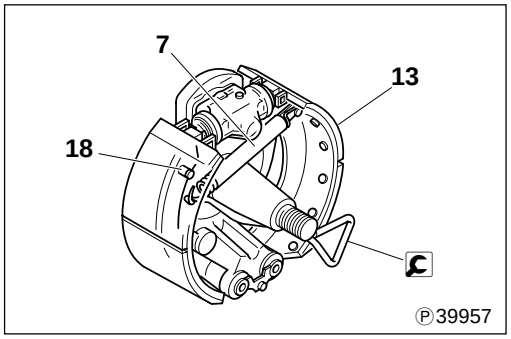


< When replacing brake lining 15 with the new one >

- Adjust expander assembly **21**.
  P35B-69
- Start the engine after having assembled brake drum *, and confirm whether brake air pressure is sufficient.
- Operate auto adjuster by fully depressing brake pedal ten times.
- Remove inspection hole plug **2**.



- Insert thickness gauge **A** into the inspection hole **F** of dust cover **3**, and confirm whether brake shoe clearance is 0.4 to 1.0 mm {0.016 to 0.039 in.}, as well as 0.3 mm {0.012 in.} or less in the right and left difference.
- If the clearance is not 0.4 to 1.0 mm {0.016 to 0.039 in.}, adjust it as required.



7 Return spring

[Removal]

Remove the return spring with hanging the return spring setter on the hook of return spring **7**.

WARNING

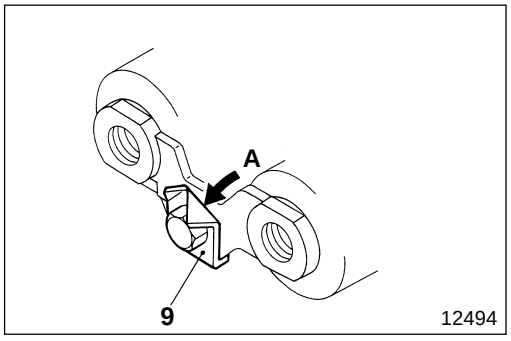
Do not hang return spring setter on the sliding area of oil seal.

[Installation]

- Hang one hook of return spring **7** on the pin **18** of brake shoe assembly **13**.
- Hang another hook on return spring setter, and install it while pressing against pin **18**.

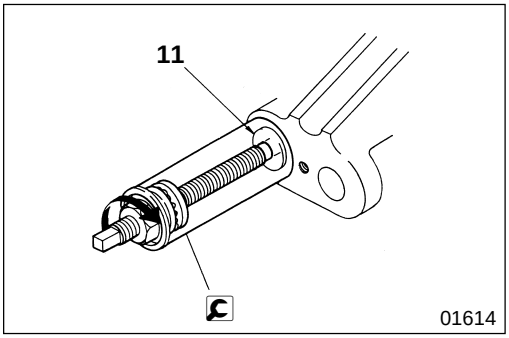
WARNING

Do not hang return spring setter on the sliding area of oil seal.



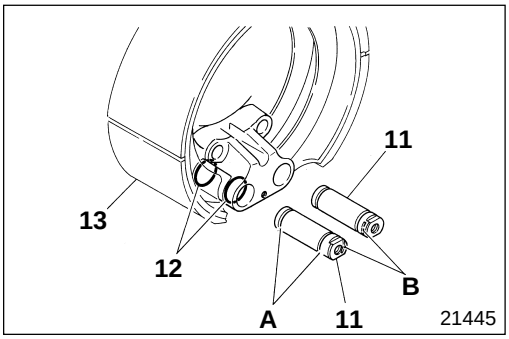
9 Installation of lock washer

A : Bend



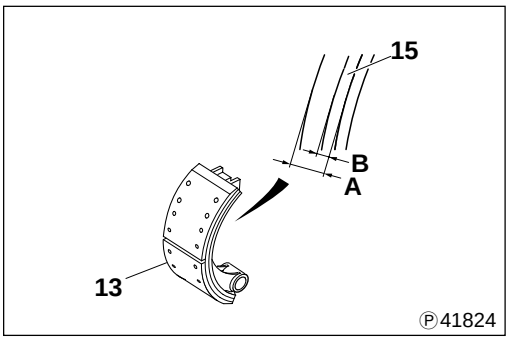
11 **Anchor pin**

[Removal]
: Anchor pin puller



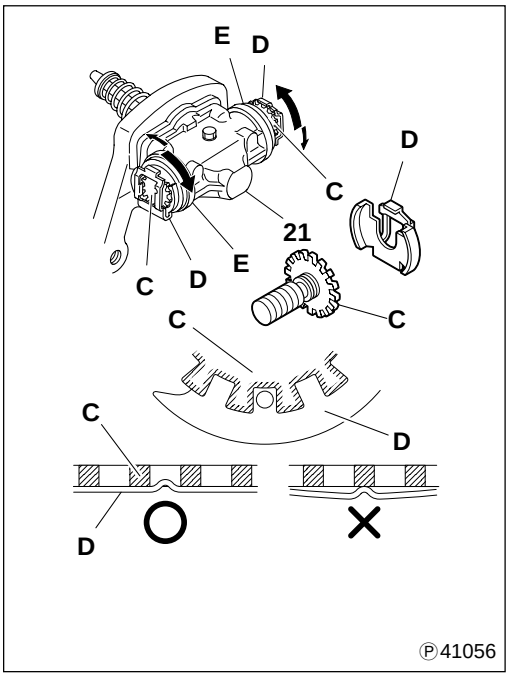
[Installation]
- Apply grease on the grease groove **A** of anchor pin **11**.
- Install anchor pin **11** in the direction shown in Figure.
  B : Groove installing lock plate

CAUTION
If anchor pin 11 is installed in the wrong direction of the anchor pin, O-ring 12 will be damaged; therefore, be sure to mount it as required.



13 **Brake shoe assembly**

[Inspection]
If the thickness **A** of brake lining **15** reaches below the limit **B**, replace the brake lining on both sides of the axle.

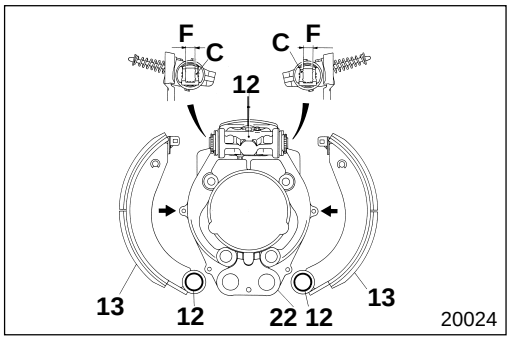


[Installation]
- Turn adjusting screw **C** of expander assembly **21** fully clockwise by hand.
  (Back off to align clip **D**)
- Confirm whether the open part of clip **D** is in the drum side; if it is not in the drum side, turn adjusting screw **C** further clockwise to match the position. (This is due to the rotation of sleeve assembly)

WARNING
- **Be sure to apply grease appropriately on the contact part of adjusting screw C in boot E; otherwise auto adjuster may be caused the malfunctioning due to breakage of boot.**

CAUTION
- **Turn it slowly so that boot E may not be jammed.**
- **Be sure to keep the convex part of clip D between teeth of adjusting screw C (2 points).**

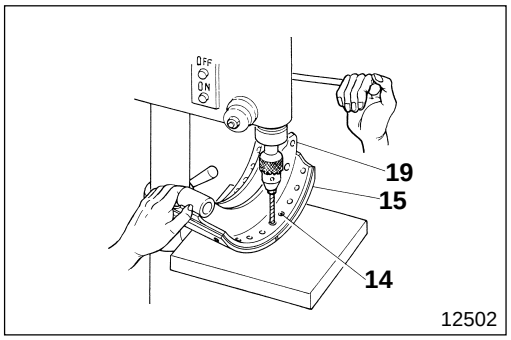
- Take care whether clip **D** is misaligned, and rotate adjusting screw **C** anticlockwise by two revolutions. (Only if the lining is replaced.)



- Install brake shoe assembly **13** so that it securely enters into the slot **F** of clip **C**.

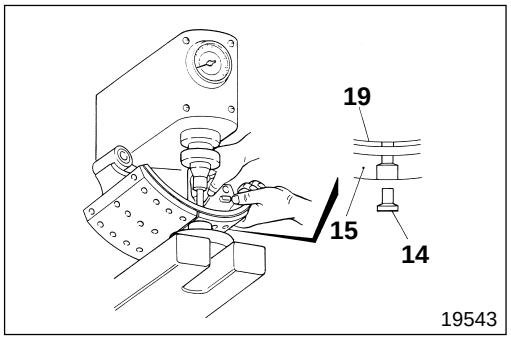
CAUTION

When installing brake shoe assembly 13, do not damage clip C and O-ring 12.



15 **Brake lining**

[Removal]



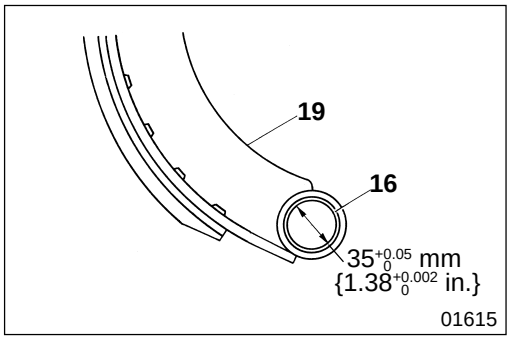
[Installation]

- Clean and dry brake lining **15** and brake shoe **19**.
- Insert rivet **14** from brake lining **15**, and stake the rivet in sequence from the center to both ends.
- Put a staking load of rivet **14** as 19.61±0.98 kN {4410±2200 lbf, 2000±1000 kgf}.
- Inspect how brake drum ***** and brake lining **15** touches: correct any faulty points if they are found. Such correction must be performed in a state that the brake has been assembled.

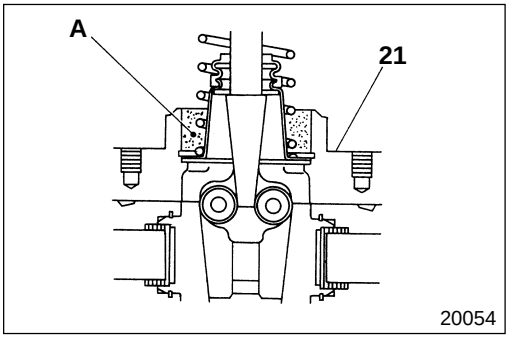
WARNING

- **Be sure to replace brake lining 15 on both sides of an axle since the lining may cause pulling under braking.**
- **Do not adhere oil and grease to the brake lining 15, which may cause the malfunctioning of braking.**

16 **Installation of bushing**

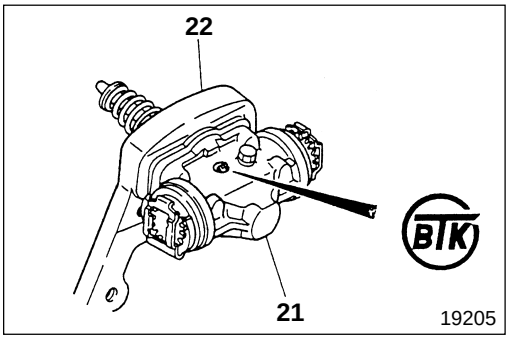


- Install bushing **16** on brake shoe **19**.
- Measure the inside diameter of bush 1**6**.
- If the inside diameter is not $35^{+0.05}_{0}$ mm {$1.38^{+0.002}_{0}$ in.}; align it with the same required dimensions, or $35^{+0.05}_{0}$ mm {$1.38^{+0.002}_{0}$ in.} by drilling it with reamer.



21 **Installation of expander assembly**

- Fill the grease of the specified amount in **A** part of expander assembly **21**.

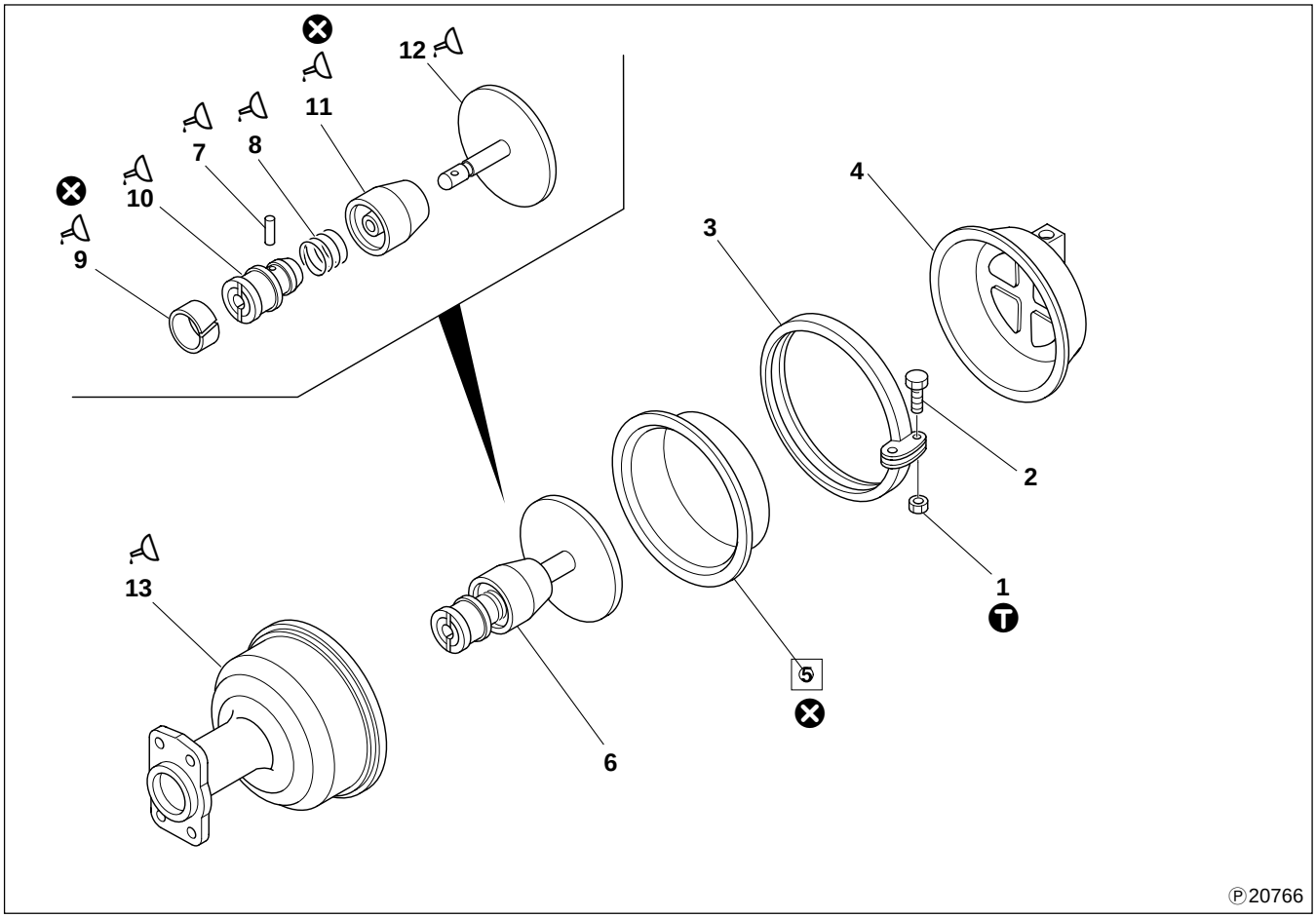


- Install expander assembly **21** on anchor bracket **22** in the direction shown in diagram.

***** **Correction of brake drum**

If the cylindrical degree of brake drum ***** exceeds the limit, or has heat checks; renew the wear surface with drum and hub assembled.

Brake Chamber Assembly



● **Work before disassembly**

P35B-73

● **Disassembly sequence**

1 Nut
2 Bolt
3 Clamp ring
4 Pressure plate
5 Diaphragm
6 Push rod assembly
7 Pin
8 Ring
9 Push
10 Push rod guide
11 Dust cover
12 Push rod complete
13 Base

⊗ : Non-reusable parts

CAUTION

Do not damage the seat surface of diaphragm 5 of pressure plate 4 and base 13 when removing clamp ring 3, which may cause air leakage.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: chamber kit

WARNING

Do not adhere oil and fat to diaphragm 5 so that the diaphragm may not come off.

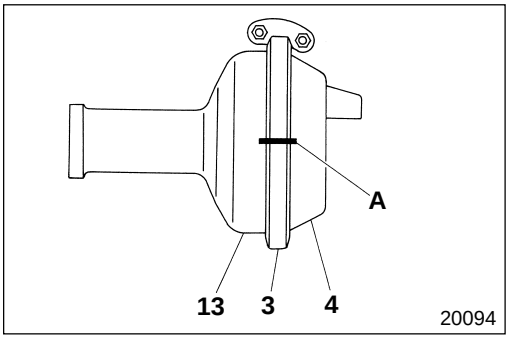
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut	14.7 to 20.0 {11 to 14, 1.5 to 2.0}	—

Lubricant

Location	Points of application	Specified fluid	Quantity
7 to 12	Each contact surface	Multipurpose grease [NLGI No.2 (Li soap)]	As required
13	Internal circumference of the base	Multipurpose grease [NLGI No.2 (Li soap)]	As required



♦ Service procedure

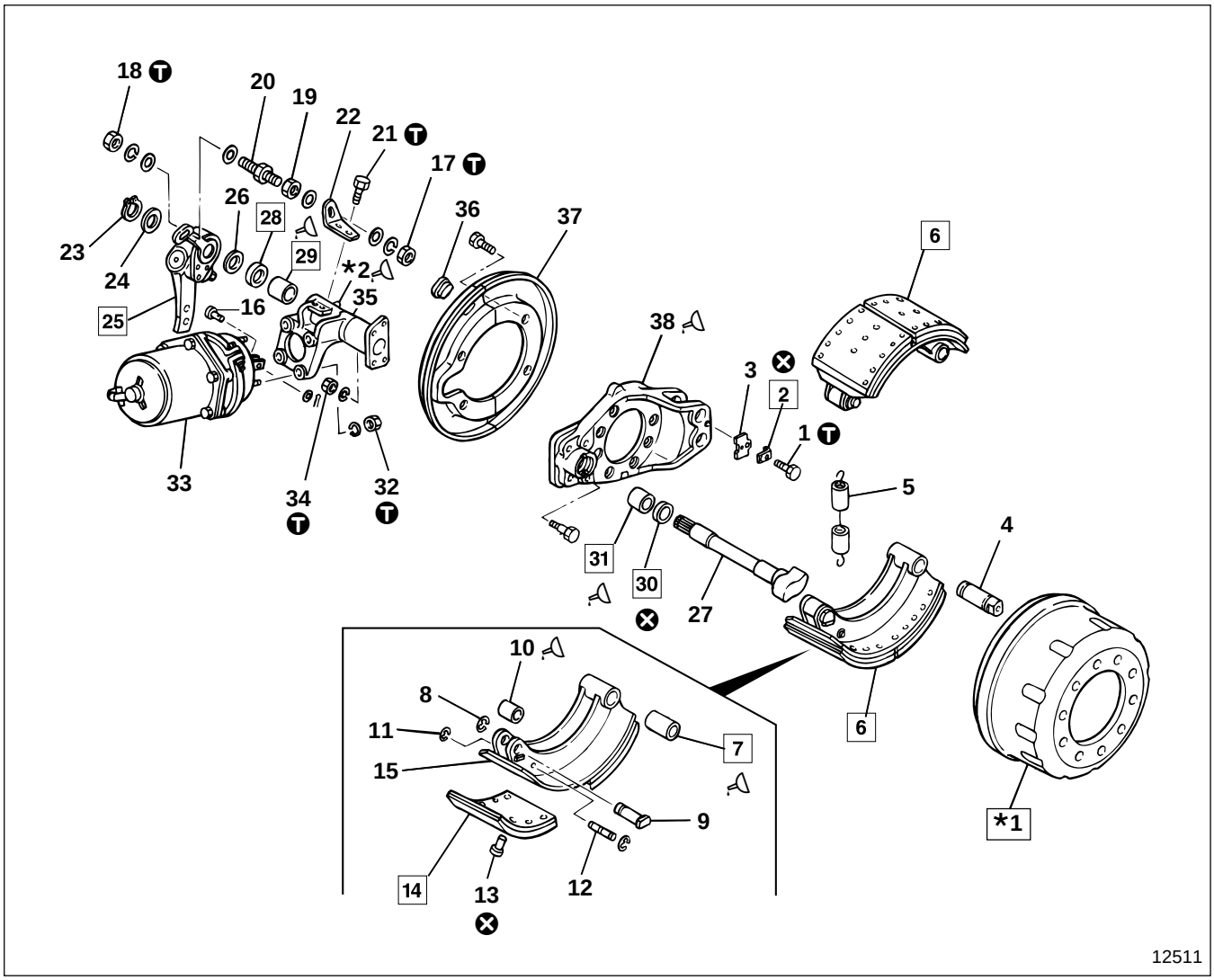
● **Work before assembly**

A : Counter mark

CAUTION

Be sure to match counter mark A when assembling, and install clamp ring 3, pressure plate 4, and base 13.

Rear Drum Brake Assembly



● **Disassembly sequence**

1 Bolt
2 Lock washer
3 Lock plate
4 Anchor pin
5 Return spring
6 Brake shoe assembly
7 Bushing
8 Snap ring
9 Roller pin
10 Roller
11 Snap ring
12 Pin
13 Rivet
14 Brake lining
15 Brake shoe
16 Clevis pin
17 Nut
18 Nut
19 Nut
20 Stopper pin
21 Bolt
22 Stopper pin bracket
23 Snap ring
24 Washer
25 Automatic slack adjuster
26 Spacer
27 Camshaft
28 Dust seal
29 Bushing
30 Oil seal
31 Bushing
32 Nut
33 Brake chamber assembly
📖 P35B-84
34 Nut
35 Chamber bracket
36 Inspection hole plug
37 Dust cover
38 Anchor bracket

⊗ : Non-reusable parts
***1** : Brake drum Gr 27
***2** : Grease nipple

WARNING ⚠
Do not leave lubricant on the surface of brake lining 14 because this reduces braking performance.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

Do not leave lubricant on the surface of brake lining 14 because this reduces braking performance.

CAUTION⚠

Make sure you use a 1.2 mm {0.047 in.} thick washer for washer 23, not a 2 mm {0.079 in.} thick one.

Repair kit : Brake lining kit

● **Inspection of operation after installation**

🕮 P35B-76

● **Adjustment of initial brake shoe clearance after installation**

🕮 P35B-77

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value		Limit	Remedy
4, 7	Clearance between anchor pin and bushing		[35] 0.05 to 0.14 {[1.34] 0.0020 to 0.0055}		0.3 {0.012}	Replace bushing
5	Return spring load (Installed length 268 {10.6})		520 N {115 lbf, 53 kgf}		Clearance between coils and between coil and cover	Replace
6	Thickness of brake lining		16 {0.63}		6 {0.24} (Side shoulder means wear limit)	Replace brake lining
27, 29, 31	Clearance between bushing and camshaft		[40] 0.16 to 0.21 {[1.57] 0.0063 to 0.0083}		0.5 {0.020}	Replace bushing
***1**	Brake drum	Inner diameter	ø410 {16.1}	ø*412 {*16.2}	ø414 {16.3}	Replace
		Cylindrical accuracy	0.05 {0.0020}		0.2 {0.0079}	Correct

* : Indicates correction limit.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

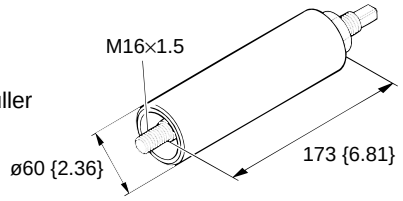
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Lock plate mounting)	16 to 24 {12 to 17, 1.6 to 2.4}	—
17, 19	Nut (Stopper pin mounting)	27 to 40 {20 to 30, 2.7 to 4.1}	—
18	Nut (Stopper pin mounting)	14 to 20 {10 to 14, 1.4 to 2.0}	—
21	Bolt (Stopper pin bracket mounting)	27 to 40 {20 to 30, 2.7 to 4.1}	—
32	Bolt (Brake chamber mounting)	135 to 195, {100 to 145, 14 to 20}	—
34	Nut (Chamber bracket mounting)	78 to 115 {58 to 87, 8 to 12}	—

Lubricant

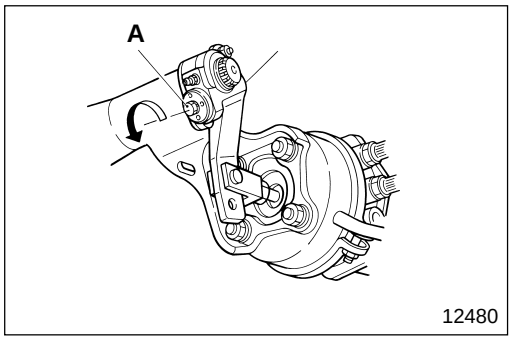
Location	Points of application	Kinds	Quantity
7	Interior of bushing	Wheel bearing grease [NLGI No.2 (Li soap)]	0.75 g {0.026 oz} or more
10	Interior of roller	Molybdenum disulfide grease	As required
29, 31	Interior of bushing	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
38	Anchor bracket inserting hole for anchor pin	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
***2**	Pack via grease nipple after assembling wheel brake	Wheel bearing grease [NLGI No.2 (Li soap)]	60 g {2.1 oz} or more

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
4	Anchor pin puller 	03727-60000	Removal of anchor pin

◆ Service procedure



● Inspection of operation after installation

- Increase the air pressure in the air tank to approximately 685 kPa {100 psi, 7 kgf/cm^2}.
- Turn worm shaft **A** of automatic slack adjuster **25** in direction ➡ (counterclockwise) to compress the brake assembly and increase the brake shoe clearance to approximately 1.5 mm {0.059 in}.

NOTE

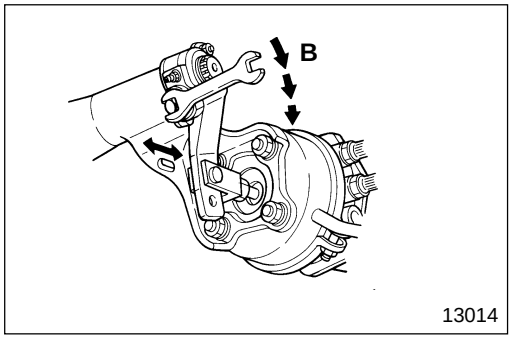
A large force is required to turn worm shaft A.

- Put a spanner on worm shaft **A** of automatic slack adjuster **25** and inspect its operation by watching how far the spanner moves.

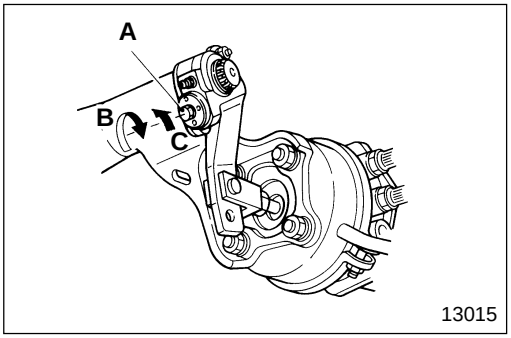
NOTE

Hold the spanner so that it does not fall off.

- Depress the brake pedal fully to work the brake, then release it.

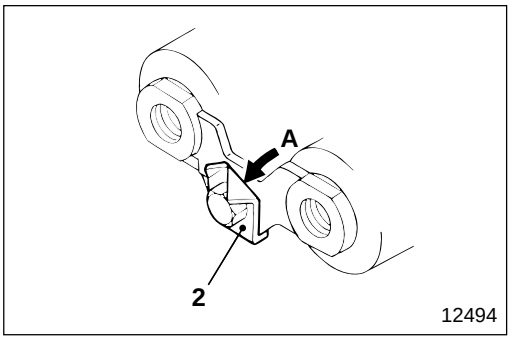


- Check that worm shaft **A** of automatic slack adjuster **25** turns clockwise when the brake is released, and if the turning stroke decreases every time the brake is depressed and released. If the automatic slack adjuster is faulty, replace it.
  B : Stroke



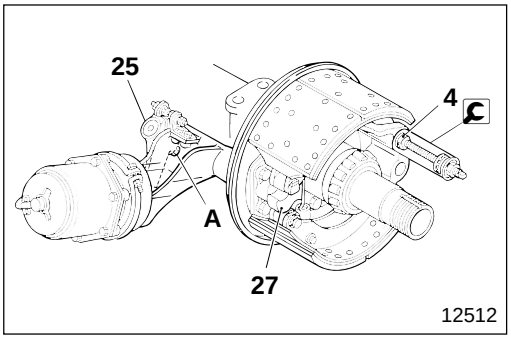
● **Adjustment of initial brake shoe clearance after installation**

- Turn worm shaft **A** of automatic slack adjuster **25** clockwise to open brake shoe assembly **6** until the brake shoe clearance is 0 mm {0 in.}.
- Slacken off worm shaft **A** counterclockwise by one quarter of a turn.
  B : Turn clockwise fully.
  C : Slacken off counterclockwise by one quarter of a turn.



2 **Bending up lock washer**

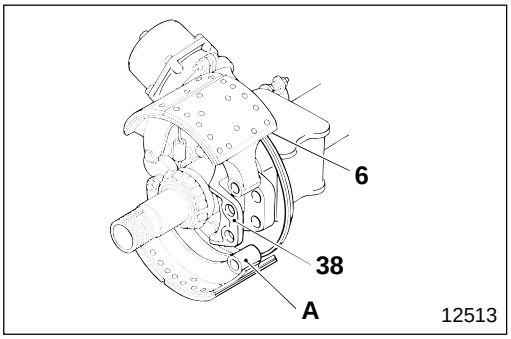
A : Bend



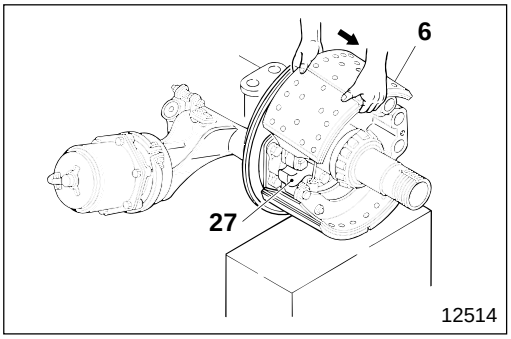
6 **Brake shoe assembly**

[Removal]

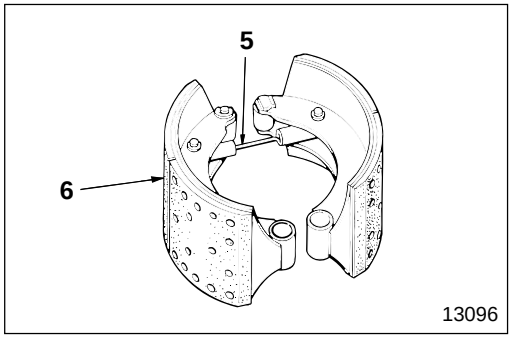
- Turn worm shaft **A** of automatic slack adjuster **25** so that camshaft **27** does not open brake shoe assembly **6**.
- Remove anchor pin **4** using 🔧 anchor pin puller.



- Remove heel part **A** of lower brake shoe assembly **6** from anchor bracket **38**.
- Remove heel part **A** of upper brake shoe assembly **6** from anchor bracket **38**.

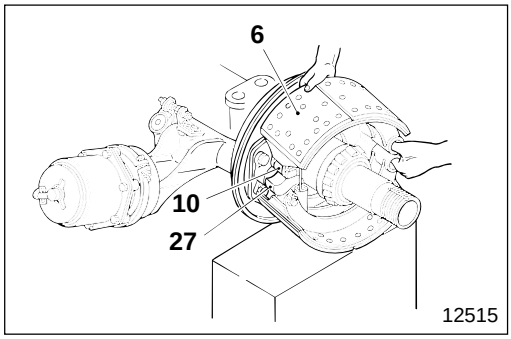


- Hold upper brake shoe assembly **6**, and remove it from camshaft **27** by sliding horizontally.

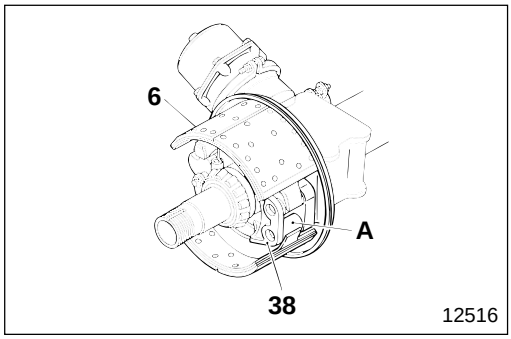


[Installation]

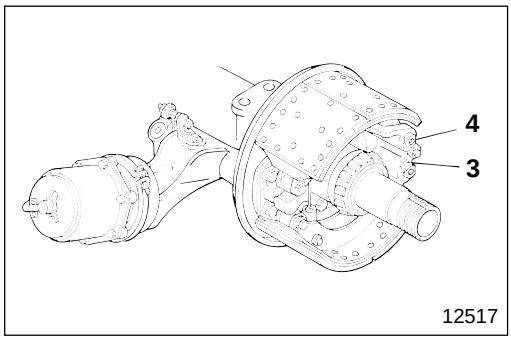
- Install return spring **5** in both brake shoe assemblies **6**.



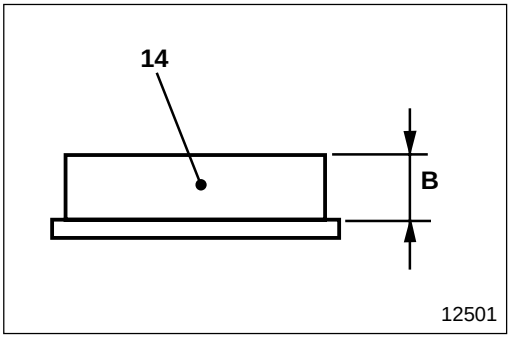
- Insert your thumb and forefinger into the anchor pin hole of both brake shoe assemblies **6**, and lift the upper brake shoe assembly with your other hand.
- Place and slide roller **10** of brake shoe assembly **6** onto camshaft **27**.



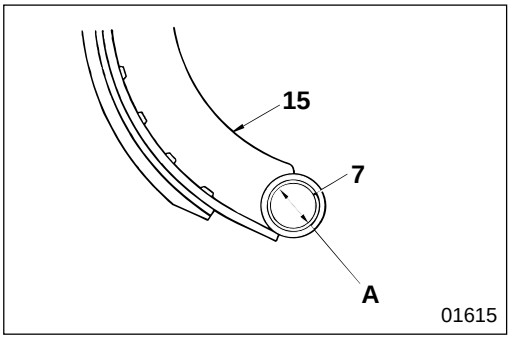
- Install heel part **A** of upper brake shoe assembly **6** in anchor bracket **38**.
- Install heel part **A** of lower brake shoe assembly **6** in anchor bracket **38**.



- Drive in anchor pin **4** and fix it with lock plate **3**.



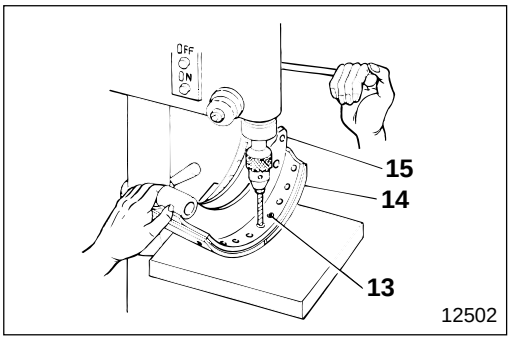
[Inspection]
If thickness **B** of brake lining **14** is lower than the limit replace the brake lining on both sides of the axle.



7 **Inner diameter of bushing**

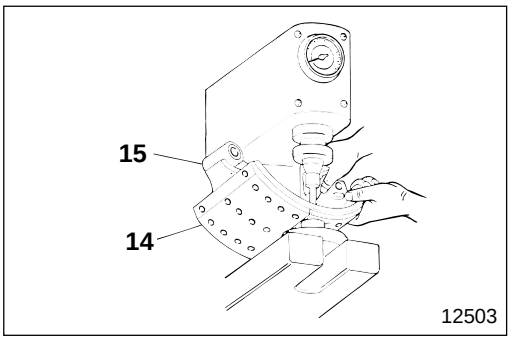
- After installing bushing **7** in brake shoe **15**, measure inner diameter **A** of the bushing.
- If the inner diameter deviates from dimension **A** ream the diameter to the standard value.

  Dimension **A** : $35\ ^{+0.05}_{0}$ mm {$1.4\ ^{+0.0020}_{0}$ in.}



14 **Brake lining**

[Removal]



[Installation]

- Clean the mounting surfaces of brake lining **14** and brake shoe **15** with cleaning fluid and dry them.
- Insert rivets **13** from brake lining **14** side, and caulk the rivets at the specified load so that there is no clearance between brake shoe **15** and the brake lining.

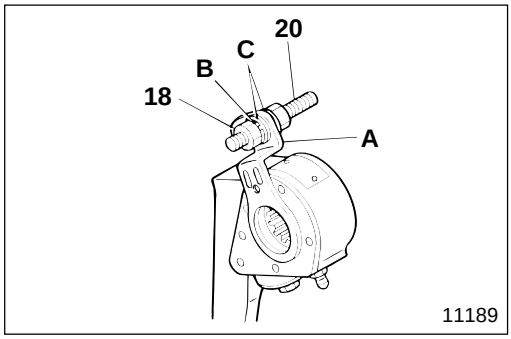
  Caulking load for rivets : 17 to 19 kN {3750 to 4190 lbf, 1700 to 1900 kgf}

WARNING

Do not leave lubricant on the surface of brake lining 14 because this reduces braking performance.

CAUTION

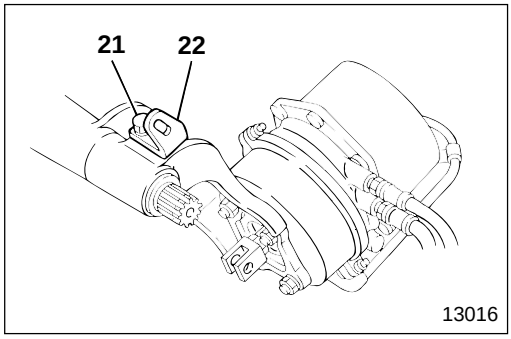
- **Make sure that the type of brake linings 14 you fit are suitable for the intended use of the vehicle. Make sure that you fit identical size and color coated linings on the left and right sides of one shaft.**
- **Make sure that you inspect contact with the inner surface of brake drum *1 after you replace brake linings 14. If contact is incorrect, correct with the brake assembled.**

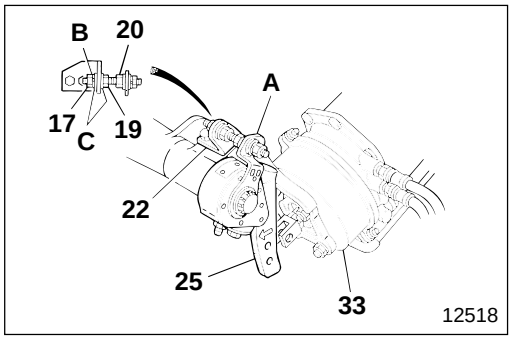


25 Automatic slack adjuster

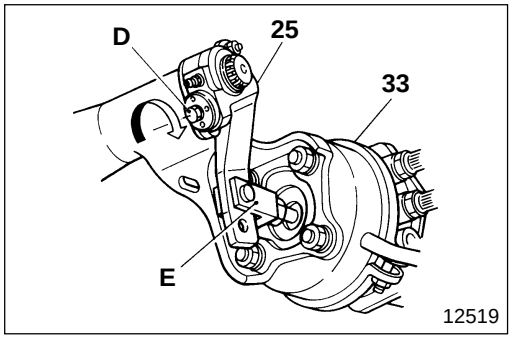
[Installation]

- Install stopper pin **20** in control arm **A** of automatic slack adjuster **25** temporarily.
  B : Spring washer
  C : Plain washer

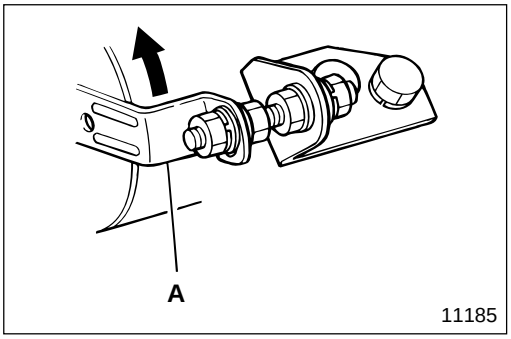




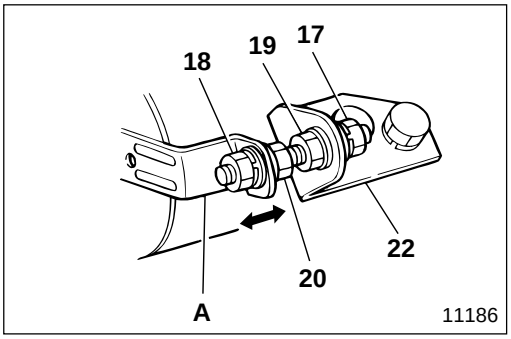
★ • Fit nuts **17**, **19**, spring washer **B** and plain washer **C** on stopper pin **20** that is installed in automatic slack adjuster **25**.
- Position control arm **A** so that stopper pin **20** can be fitted into the hole of stopper pin bracket **22**.
- Install automatic slack adjuster **25** on camshaft **27** of the wheel brake so that mark "⇨" on the arm of the automatic slack adjuster points away from brake chamber **33** as illustrated.



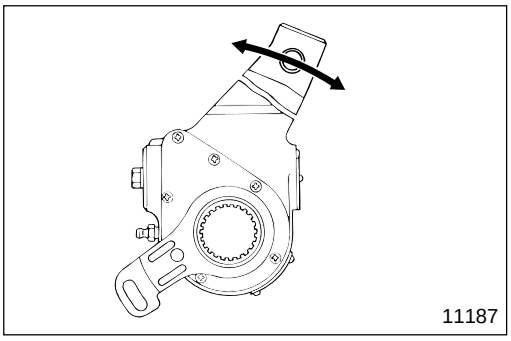
- Turn and align worm shaft **D** of automatic slack adjuster **25** clockwise in the direction of mark "➡" as illustrated, and install push rod **E** of brake chamber **33** in the arm.



- Push control arm **A** of automatic slack adjuster **25** in direction ➡ as illustrated, and confirm that the arm does not move due to contact with the inner stopper.
  If the control arm does moves, repeat the operation from step ★.

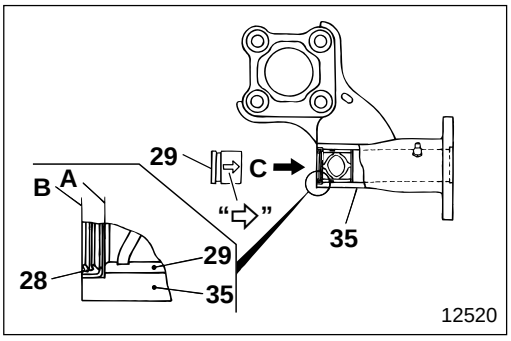


- First install stopper pin **20** in control arm **A**, then in stopper pin bracket **22**, tighten nuts **17**, **18**, **19** at specified torque. Check that the control arm does not move. When tightening the nuts at specified torque, do not apply force to the control arm in arrow mark direction ⟷ as illustrated.



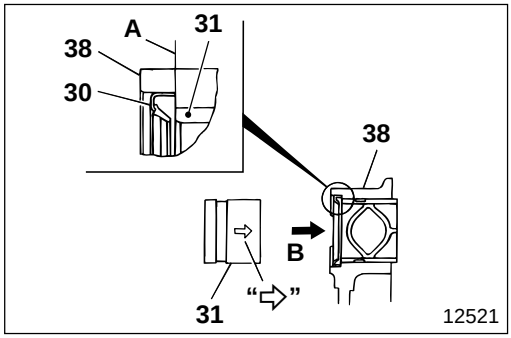
[Inspection of play]

- Inspect automatic slack adjuster **25** when it is disconnected from brake chamber **33**.
- To inspect play, move automatic slack adjuster **25** in direction ⟷ as illustrated. If play is higher than the limit, replace the automatic slack adjuster.
  Limit : 4 mm {0.16 in.} or less



28 **29** **Press-fitting of dust seal and bushing**

A : Press-fit bushing **29** to this level
B : Press and fit dust seal **28** to this level
C : Press-fitting direction for bushing **29**



30 **31** **Press-fitting of oil seal and bushing**

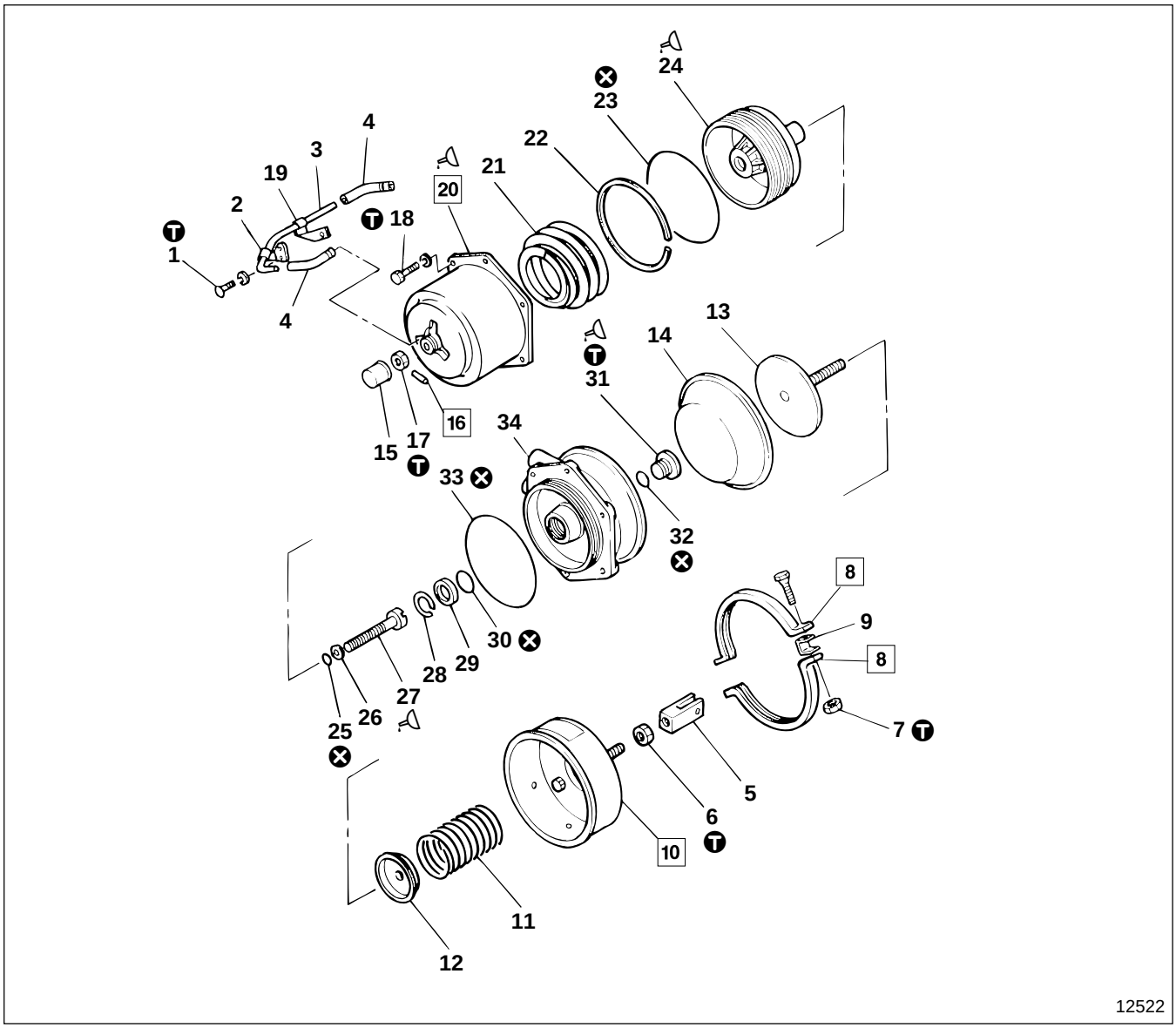
A : Press-fit oil seal **30** and bushing **31** to this level
B : Press-fitting direction for the bushing

***1** **Correction of brake drum**

If the cylindrical accuracy of brake drum ***1** is higher than the limit, or there are heat checks, correct by machining to the correction limit. Machining of the brake drum should be done with the wheel hub assembled.

M E M O

Brake Chamber Assembly



● **Disassembly sequence**

1 Screw
2 Holder
3 Pipe
4 Rubber bushing
5 Clevis
6 Nut
7 Nut
8 Clamp
9 Spacer
10 Chamber
11 Spring
12 Spring retainer
13 Push rod
14 Diaphragm
15 Cap
16 Spring pin
17 Lock nut
18 Bolt
19 Holder
20 Cylinder
21 Spring
22 Piston ring
23 O-ring
24 Piston
25 Rubber ring
26 Washer
27 Release bolt
28 C-ring
29 Bushing
30 Rod ring
31 Follower
32 O-ring
33 O-ring
34 Bulkhead

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

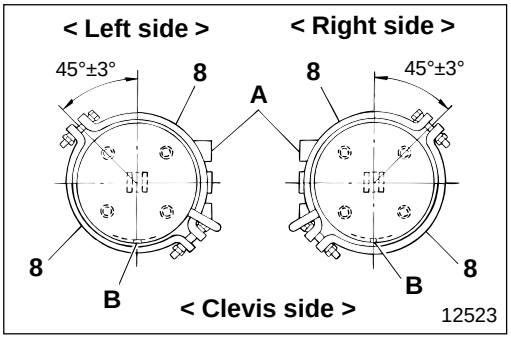
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Screw (Holder mounting)	1.2±0.2 {0.9±0.18, 0.125±0.025}	—
6	Nut (Clevis fixing)	44±5 {33±3.6, 4.5±0.5}	—
7	Nut (Clamp tightening)	29.4±2.9 {22±2.2, 3.0±0.3}	—
17	Lock nut (Release bolt fixing)	41.7±2.5 {31±1.8, 4.25±0.25}	—
18	Bolt (Cylinder and bulkhead mounting)	13.7±3.9 {10±2.9, 1.4±0.4}	—
31	Follower	44±5 {33±3.6, 4.5±0.5}	—

Lubricant and sealant

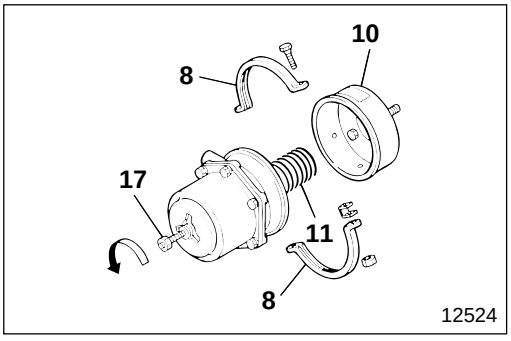
Location	Points of application	Kinds	Quantity
20	Interior of cylinder	Silicon grease	As required
24	Outer periphery of piston	Silicon grease	As required
27	Thread area of release bolt	Multipurpose grease [NLGI No.2 (Li soap)]	As required
31	Thread area of follower	LOCTITE 242	As required



◆ Service procedure

8 **Points of clamp installation**

A : Service port
B : Drain port

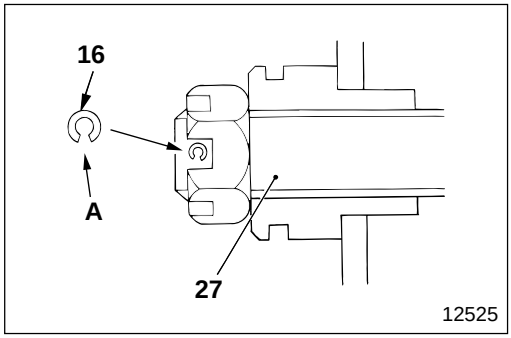


10 **Removal of chamber**

- Turn lock nut **17** in direction ➔ (counterclockwise) fully to compress spring **21**.
- Remove clamp **8** and chamber **10**.

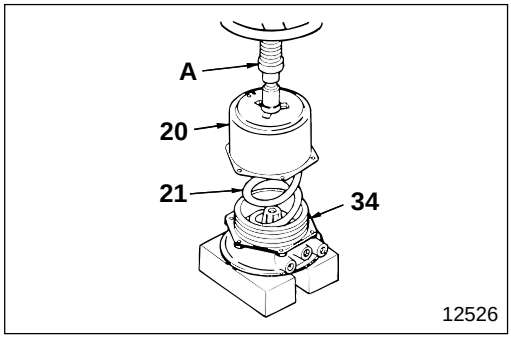
WARNING

You must be careful when you remove the clamp, because spring 11 in chamber 10 can be forcibly ejected. To avoid this hazard, press down the chamber with your hand when you carry out the above work.



16 **Installation of spring pin**

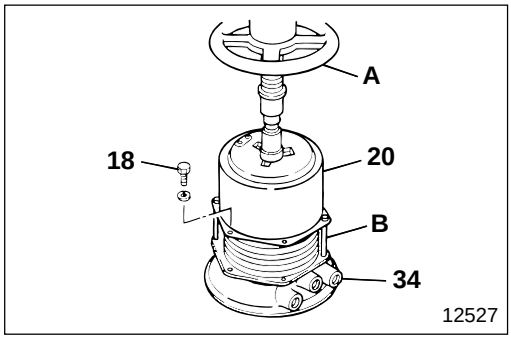
Drive in spring pin **16** so that slit **A** faces release bolt **27** at a right angle.



20 **Cylinder**

[Removal]

When you remove cylinder **20**, spring **21** might spring out. To prevent this, press down the cylinder using press **A** during removal.

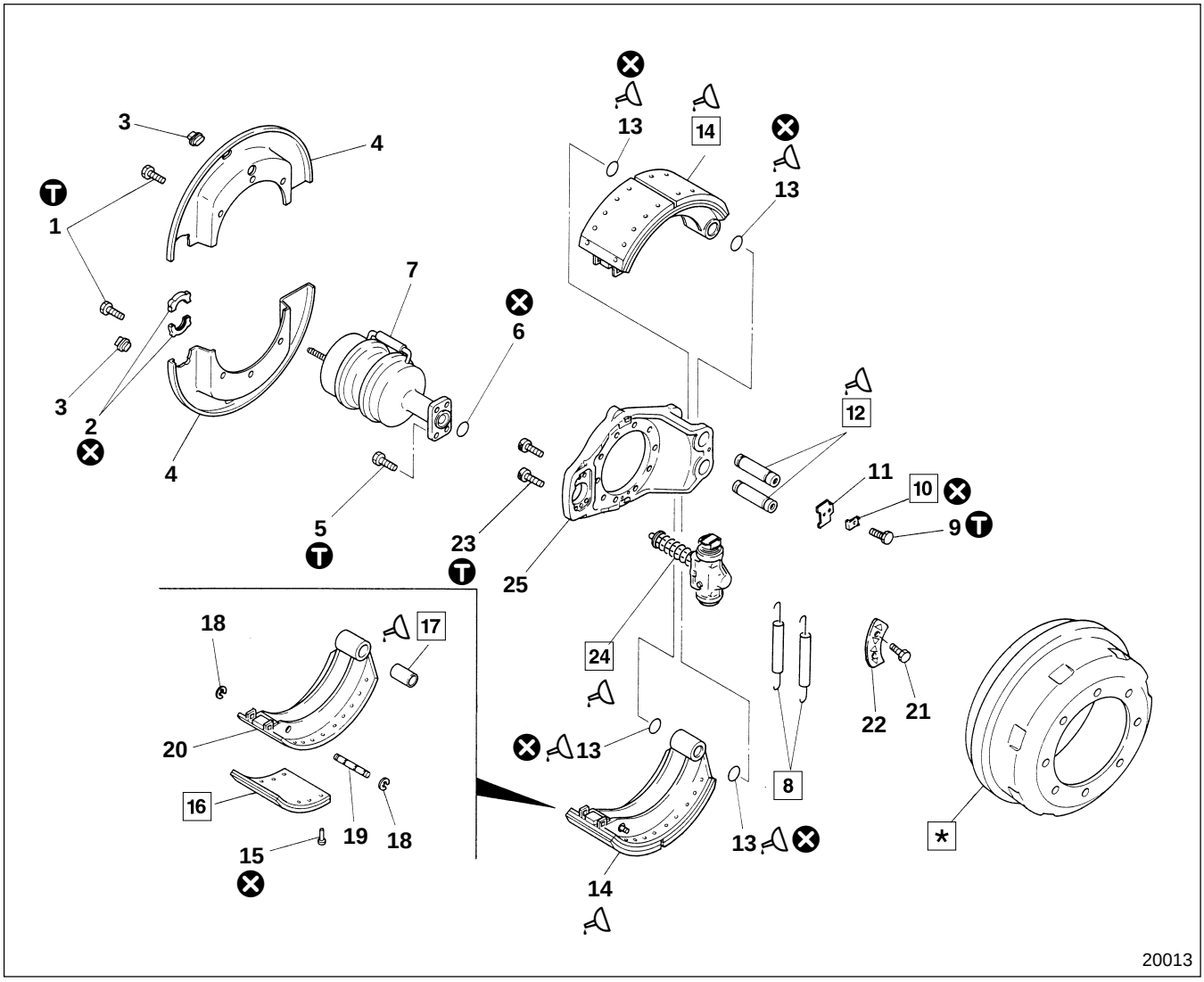


[Installation]

- Arrange bolt **B** (M8×1.25) as a guide.
- Install bolt **B** as a guide, pressing down cylinder **20** using press **A**.
- Align the bolt holes of cylinder **20** and bulk head **34**, and press down using press **A**. Tighten bolt **18** at specified torque.

M E M O

Rear Drum Brake Assembly



● **Work before disassembly**

P35B-92

● **Disassembly sequence**

1 Bolt
2 Seal
3 Inspection hole plug
4 Dust cover
5 Bolt
6 O-ring
7 Brake chamber assembly
P35B-96
8 Return spring
9 Bolt
10 Lock washer
11 Lock plate
12 Anchor pin
13 O-ring
14 Brake shoe assembly
15 Rivet
16 Brake lining
17 Bushing
18 Snap ring
19 Pin
20 Brake shoe
21 Bolt
22 Stopper Plate
23 Screw
24 Expander assembly
P35B-98
25 Anchor bracket

*: Brake drum
Gr27
⊗: Non-reusable parts

WARNING⚠

Do not apply oil or grease to the surface of brake lining 16 of brake shoe assembly 14 and the inside surface of brake drum *, which may cause a malfunction of the braking system.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: brake lining kit

● **Work after assembly**

P35B-91

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])		Limit	Remedy
8	Load of return spring (installation length: 258 {10})		292 N {66 lbf, 29.8 kgf}		Space must exist between coils, and between coils and cover.	Replace
12, **17**	Space between anchor pin and bushing		[35] 0.05 to 0.14 {[1.38] 0.0020 to 0.0055}		0.3 {0.012}	Replace bush
16	Thickness of brake lining		16 {0.63}		6 {0.24} (side stagger is wear limit).	Replace brake lining
*	Brake drum	Inside diameter	410 {16.1}	(*1) 412 {16.2}	414 {16.3}	Replace
		Cylindrical degree	0.05 {0.0020}		0.2 {0.0079}	Correct

(*1) Indicating the repair limit value

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

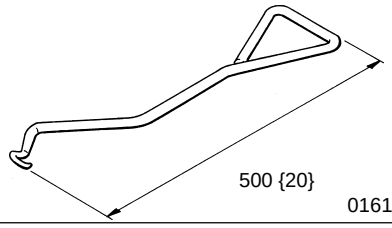
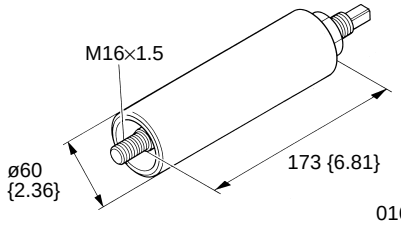
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Installation of dust cover)	19.6±3.9 {14±2.9, 2±0.4}	—
5	Bolt (Installation of brake chamber assembly)	44.1±7.8 {33±5.8, 4.5±0.8}	—
7	Release bolt for brake chamber assembly, Release nut used when being stored	14.7 to 15.7 {10 to 12, 1.4 to 1.6}	—
9	Bolt (Installation of lock plate)	19.6±3.9 {14±2.9, 2±0.4}	—
23	Screw (Installation of expander assembly)	18.6±4.9 {14±3.6, 1.9±0.5}	—

Lubricant

Location	Points of application	Specified fluid	Quantity
12	Grease groove of anchor pin	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
13	O-ring	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
14, 24	Contact surface of brake shoe assembly and expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
17	Inside surface of bushing	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
24	Wedge tip of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	As required
	Wedge insertion part of expander assembly	Shell Darina Grease 2 [NLGI No.2 (Non soap)]	10 g {22 lb}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
8	Return spring setter 	Obtain locally	Remove return spring
12	Anchor pin puller 	03727-60000	Remove anchor pin

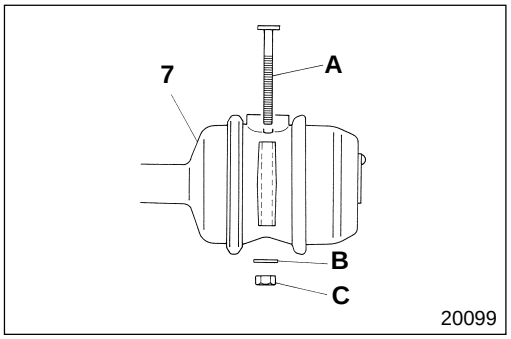
♦ Service procedure

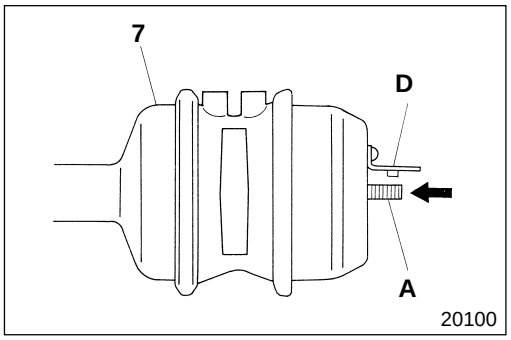
● **Work before disassembly**

Release of spring brake

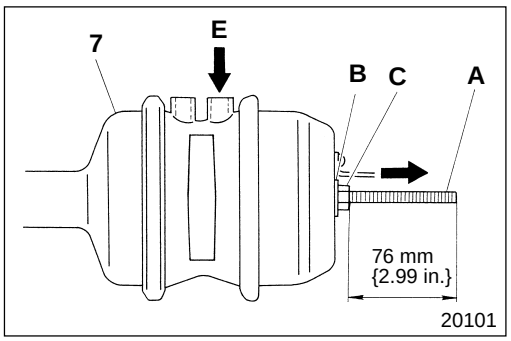
Release the spring brake by mechanical release.

- Remove the release bolt **A**, the washer **B**, and the release nut **C** from brake chamber assembly **7**.





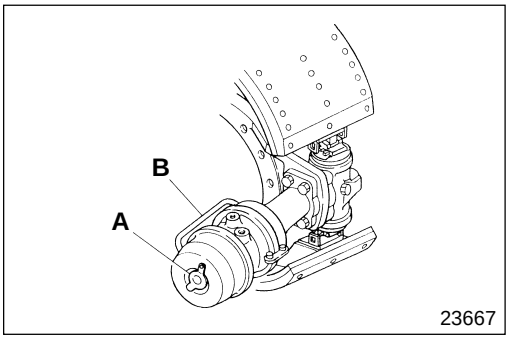
- Remove end cap **D**.
- Insert the release bolt **A** into the inner part, and turn it one quarter (1/4) turn.
- Pull up the release bolt **A**, and confirm that the release bolt does not come off.
- In case the release bolt **A** comes off, insert the release bolt again into the inner part, and turn it one quarter (1/4) turn.



- Install the washer **B** and the release Nut **C**.
- Turn the release nut **C**, and draw out the screw of release bolt **A** by 76 mm {2.99 in.}, while applying air pressure of 640 kPa {92 psi, 6.5 kgf/cm^2} to spring brake port **E**, while setting the hand control valve to the release position.

CAUTION

- **Do not turn the release nut C by a strong torque; (68.6 N·m {51 ft.lbs, 7 kgf·m} or more): because brake chamber assembly 6 may be damaged if turning it by such a strong torque.**
- **Use air pressure E so that the release nut C may be easily turned.**



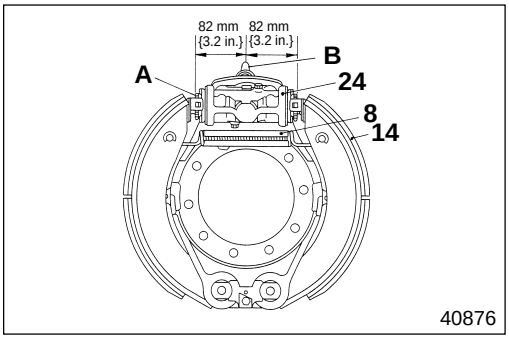
● **Work after assembly**

(1) Release of spring brake

Follow the work sequence before disassembly in reverse to release the mechanical release of spring brake. 🕮 P35B-90

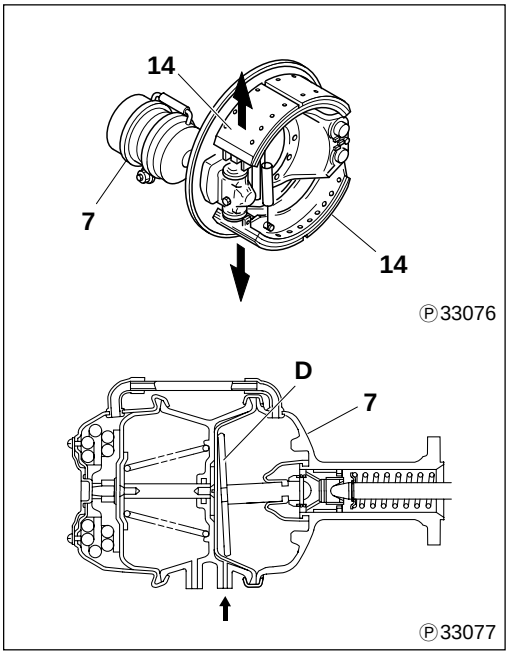
NOTE

- **Confirm that end cap A is surely installed.**
- **Confirm that there is no damage in bleeder pipe B. Also, confirm that the bleeder pipe is surely installed.**



(2) Confirmation of operation

- Confirm that the installation dimension of expander assembly **24** is 82 mm {3.2 in.}.
  If it is incorrect, adjust it according to the following procedure.
- Set the part indicated in diagram to 82 mm {3.2 in.} by adjusting the adjusting screw **A**.
- Expand the brake shoe assembly **14** under a full stroke by pushing push rod **B**.
- Confirm that expander assembly **24** returns to 82 mm {3.2 in.} when returning the push rod **B**.
- If it operates incorrectly, inspect the spring force of return spring **8**, inactivation of brake shoe assembly **14**, and expander assembly **24** again.



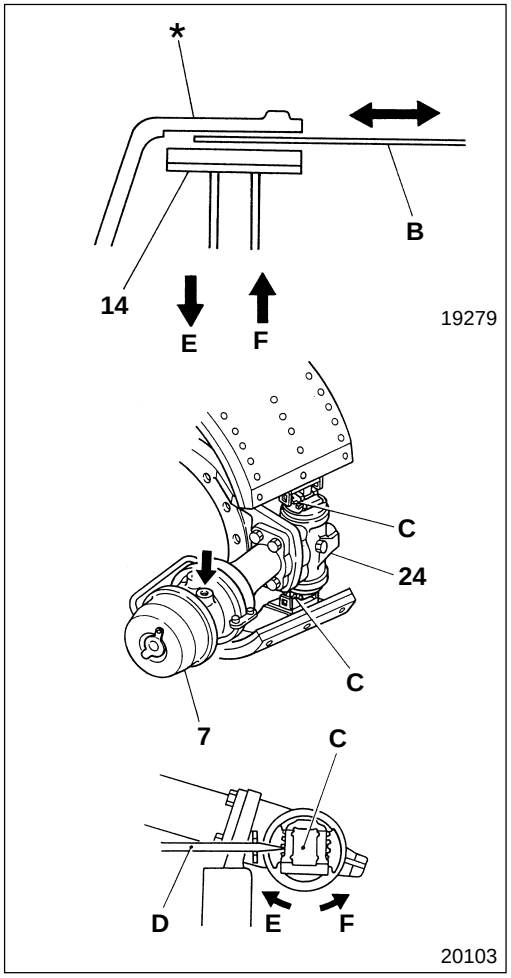
WARNING⚠

The auto adjustment mechanism might not operate normally if the assembly work is not surely executed.

- When disassembling brake chamber assembly **7**, inspect the following.

< When disassembling brake chamber assembly 7 >

- Confirm that brake shoe assembly **14** does not move with the adjusting screw **C** of expander assembly **24** when pulling the brake shoe assembly with a force of 20 to 30 N {4.4 to 6.6 lbf, 2 to 3 kgf}.
- If brake shoe assembly **14** moves, push rod and pressure plate **D** of brake chamber assembly **7** are diagonally installed; therefore, correct the push rod and the pressure plate to a regular position by depressing brake pedal 2 to 3 times with not installing brake drum ***.

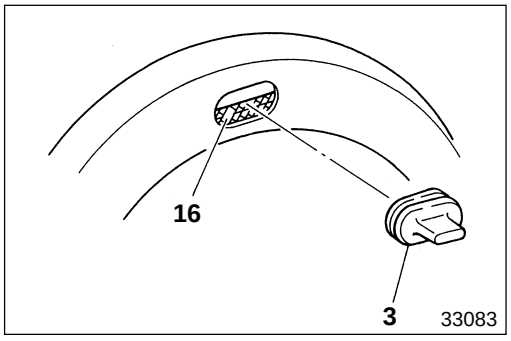


(2) Initial adjustment of brake shoe clearance
< When not replacing brake lining 16 with the new one >

- Remove dust cover **4**.
- Apply air pressure of 640 kPa {92 psi, 6.5kgf/cm^2}) on the spring brake air supply port **A** of brake chamber assembly **7** (thereby putting the hand control valve to the release position), and then release the spring brake.
- Turn adjusting screw **C** of expander assembly **24** until a feeler gauge **B** of 0.4 mm {0.016 in.} can be easily pulled in and out at the inspection hole of each shoe.
  D : Screw driver
  E : Increasing brake shoe clearance
  F : Decreasing brake shoe clearance

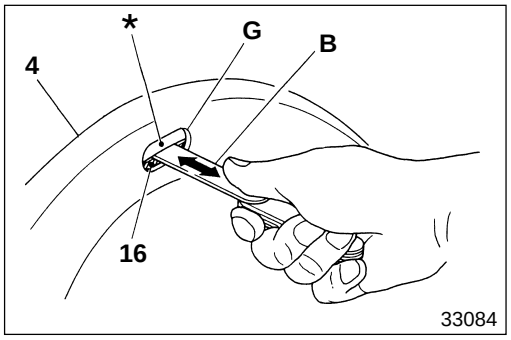
- Install dust cover **4**.

CAUTION
Do not damage the boot of expander assembly 24 when inserting screw driver D.

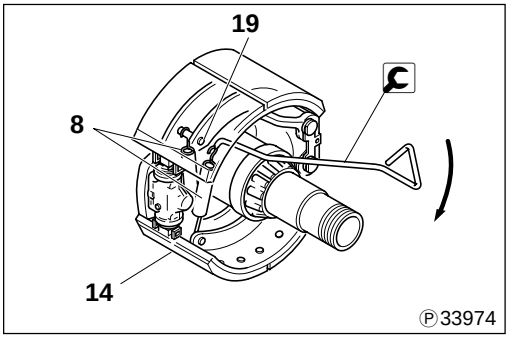


< When replacing brake lining 16 with the new one >

- Adjust expander assembly **24**. P35B-94
- Start the engine after having assembled brake drum *, and confirm whether brake air pressure is sufficient.
- Operate auto adjuster by fully depressing brake pedal ten times.
- Remove inspection hole plug **3**.



- Insert feeler gauge **B** into inspection hole **G** of dust cover **4**, and confirm whether brake shoe clearance is 0.4 to 1.0 mm {0.016 to 0.039 in.}, as well as 0.3 mm {0.012 in.} or less in the right and left difference.
- If the clearance is not 0.4 to 1.0 mm {0.016 to 0.039 in.}, adjust it again.



8 **Return spring**

[Removal]

Remove the return spring with the return spring setter as shown.

WARNING

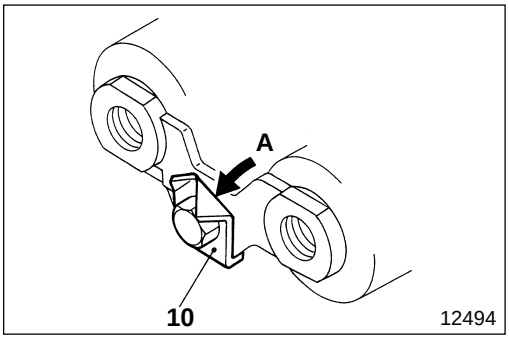
Do not allow the return spring setter to contact the mating surface of oil seal.

[Installation]

- Attach one hook of return spring **8** on the pin **19** of brake shoe assembly **14**.
- Attach the other hook on the return spring setter, and install it while pressing against pin **19**.

WARNING

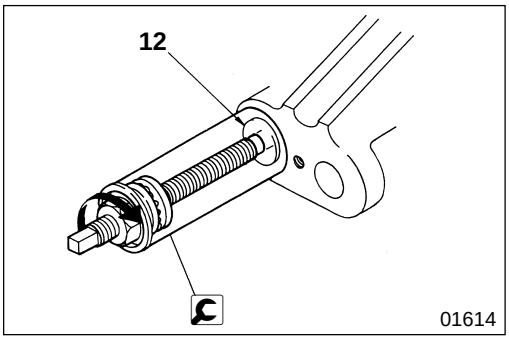
Do not hang the return spring setter on the sliding area of oil seal.



10 **Installation of lock washer**

A : Bend

- After installing the lock washer, bend the tab over the bolt head as shown in the figure on the left.

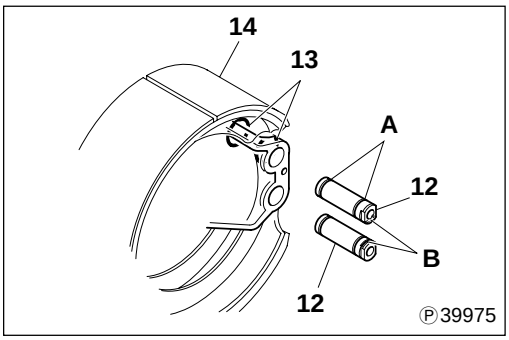


12 **Anchor pin**

[Removal]

: Anchor pin puller

- Remove the anchor pin using anchor pin puller as shown in the figure on the left.



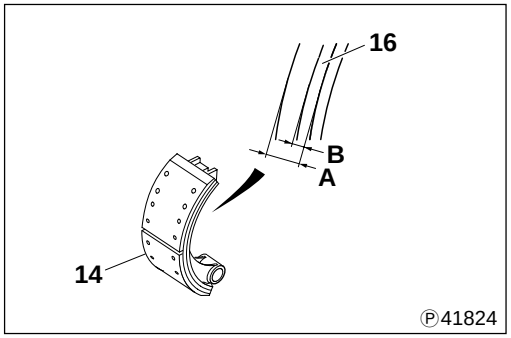
[Installation]

- Apply grease in the grease grooves **A** of anchor pin **12**.
- Install anchor pin **12** in the direction shown in Figure.

B : Groove installing lock plate

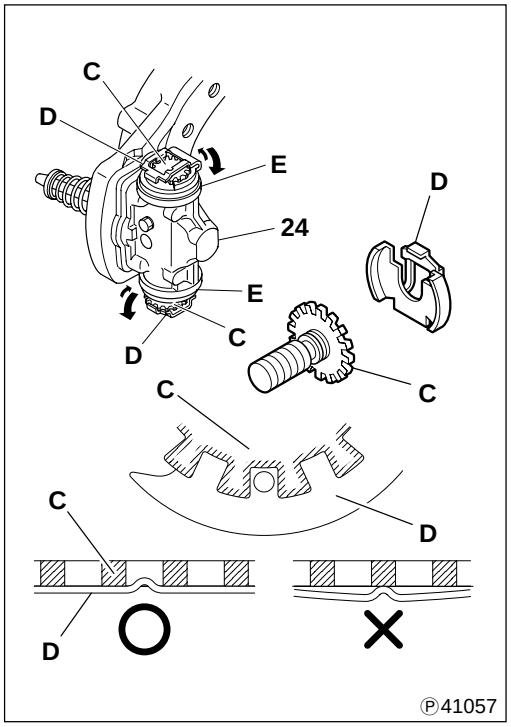
CAUTION

If anchor pin 12 is installed in the wrong direction of the anchor pin, O-ring 13 will be damaged; therefore, be sure to install it as required.



14 Brake shoe assembly

[Inspection]
If the thickness **A** of brake lining **16** reaches below the limit **B**, replace the brake lining by every one axis.

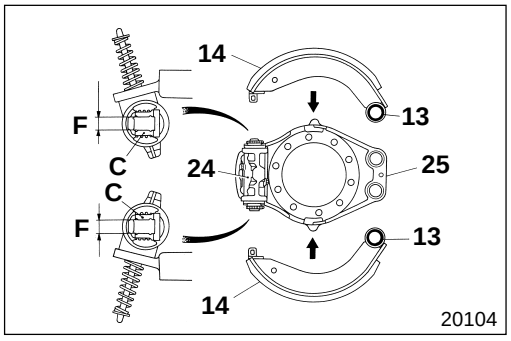


[Installation]
- Turn adjusting screw **C** of expander assembly **24** fully clockwise by hand.
- Install clip **D** with the open side facing the drum. Turn adjusting screw **C** further clockwise to match the position if alignment is incorrect.

WARNING
Be sure to apply grease as required on the contact part of adjusting screw C in boot E; otherwise the auto adjuster may malfunction due to breakage of boot.

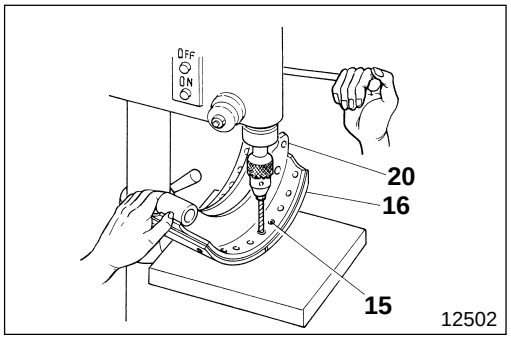
CAUTION
- **Turn it slowly so that boot E is not jammed.**
- **Be sure to keep the convex part of clip D between teeth of adjusting screw C (2 points).**

- If clip **D** is misaligned, rotate adjusting screw **C** counterclockwise by two revolutions to center of clip.



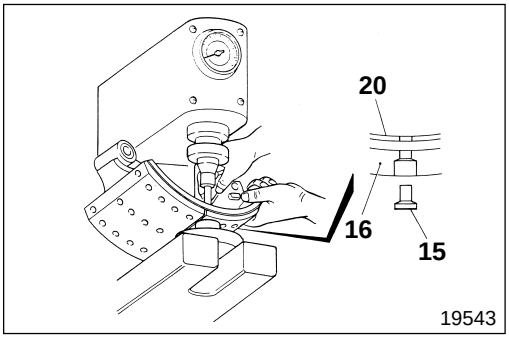
- Install brake shoe assembly **14** so that it securely enters into the slot **F** of clip **C**.

CAUTION
When installing brake shoe assembly 14, do not damage clip C and O-ring 13.



16 Brake lining

[Removal]
- Remove the rivets **15** by drilling, taking care not to damage the brake shoe **20**. Then, remove the brake lining **16**.

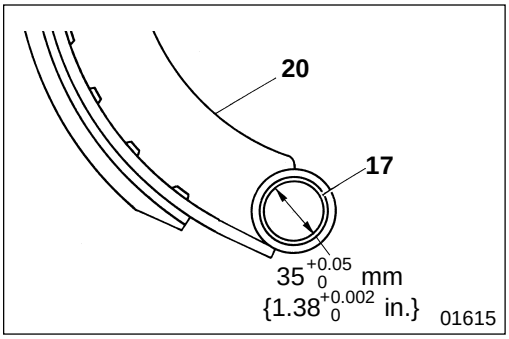


[Installation]

- Clean the surface of the brake lining **16** and brake shoe **20**.
- Insert rivet **15** through brake lining **16**, and stake the rivet in sequence from the center to both ends.
- Stake the rivet **15** with a load of 19.61±0.98 kN {4410±220 lbf, 2000±100 kgf}.
- Inspect brake drum * to brake lining **16** contact: correct any faulty points if they are found. Such correction must be performed in a state that the brake has been assembled.

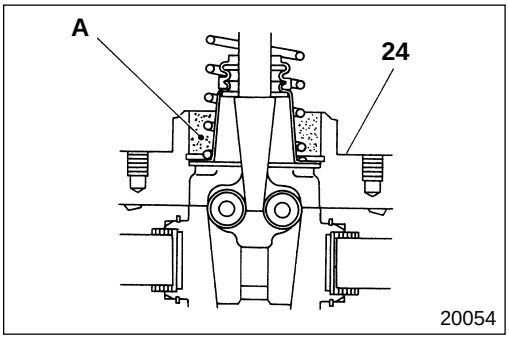
WARNING

- **Be sure to replace brake lining 16 to prevent uneven braking.**
- **Do not apply oil or grease to the brake lining 16, which may cause the malfunctioning of braking system.**



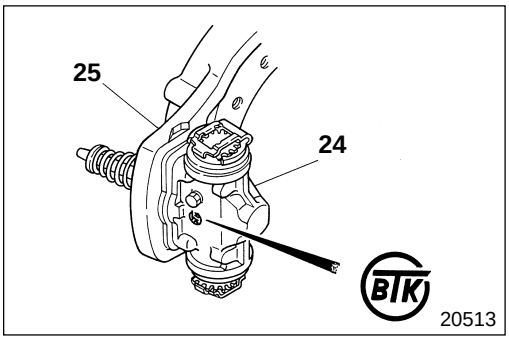
17 Installation of bushing

- Install bushing **17** on brake shoe **20**.
- Measure the inside diameter of bushing **17**.
- If the inside diameter is not $35^{+0.05}_{0}$ mm {$1.38^{+0.002}_{0}$ in.}; correct by reaming to specification.



24 Installation of expander assembly

- Fill the grease of the specified amount in **A** part of expander assembly **24**.

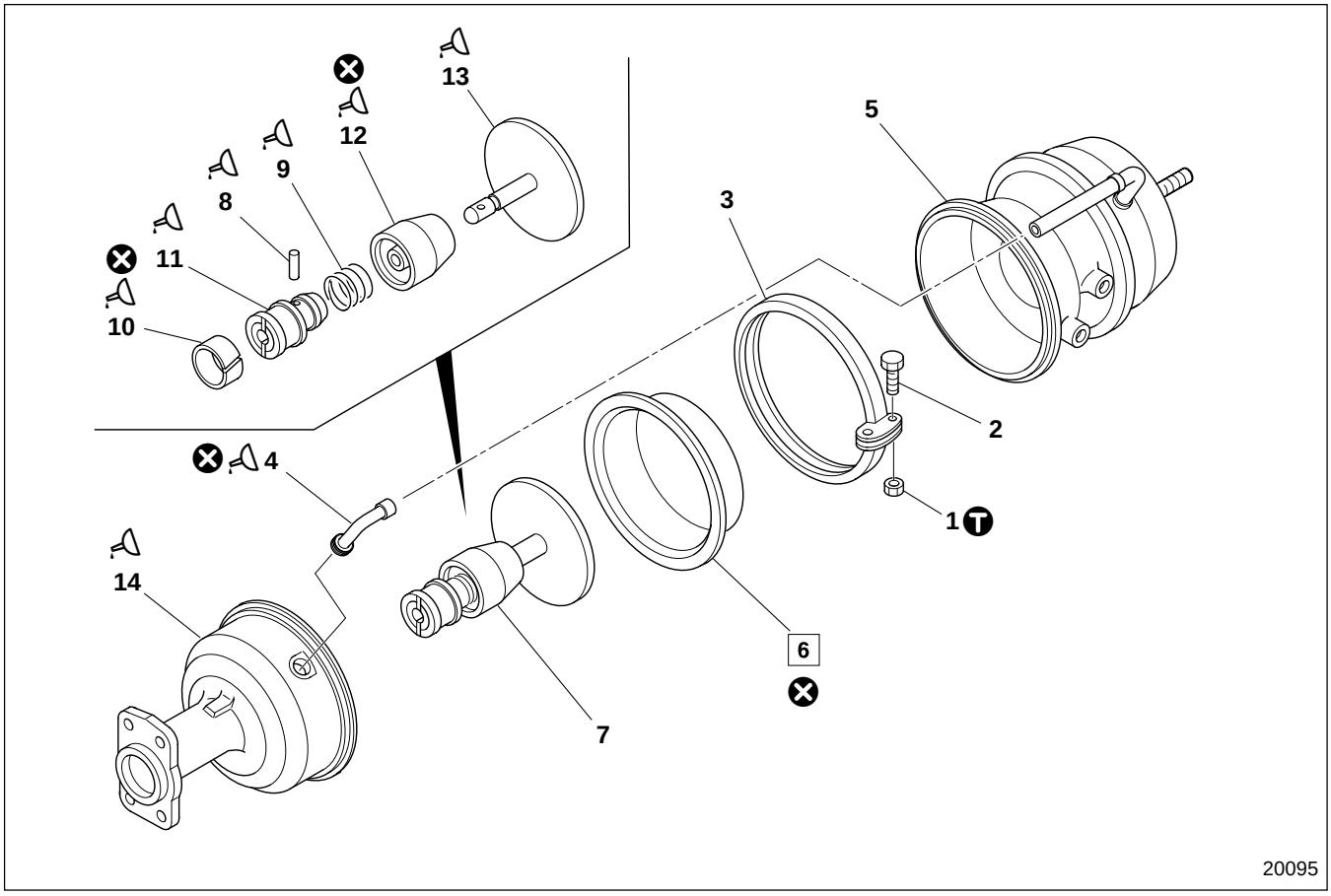


- Install expander assembly **24** on anchor bracket **25** in the direction shown in Figure.

*** Correction of brake drum**

If the taper of brake drum * exceeds the limit, or has deep grooves, cut them to the specified limit.

Brake Chamber Assembly



● **Work before disassembly**

P35B-97

● **Disassembly sequence**

1 Nut
2 Bolt
3 Clamp ring
4 Elbow
5 Emergency brake chamber
6 Diaphragm
7 Push rod assembly
8 Pin
9 Ring
10 Bushing
11 Push rod guide
12 Dust cover
13 Push rod complete
14 Base

⊗ : Non-reusable parts

WARNING

Make sure not to disassemble emergency brake chamber 5 since its built-in spring with a very strong spring force may cause a very dangerous result.

CAUTION

When removing clamp ring 3, do not damage emergency brake chamber 5 and the seat surface of diaphragm 6 of base 14, which may cause air leakage.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit: chamber kit

WARNING

Do not apply oil and grease to diaphragm 6 so that the diaphragm may not come off.

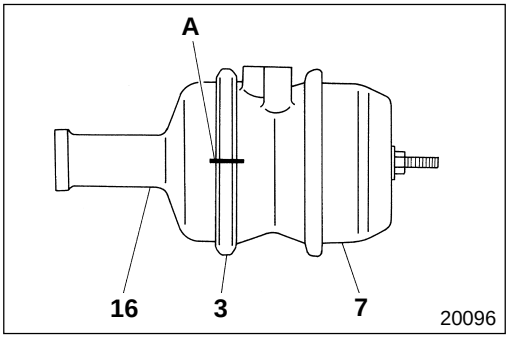
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut	14.7 to 20.0 {11 to 14, 1.5 to 2.0}	—

Lubricant

Location	Points of application	Specified fluid	Quantity
4	Installation surface of elbow tube	LOCKTITE 414	As required
8 to 13	Each contact surface	Multipurpose grease [NLGI No.2 (Li soap)]	As required
14	Internal circumference of the base	Multipurpose grease [NLGI No.2 (Li soap)]	As required



♦ Service procedure

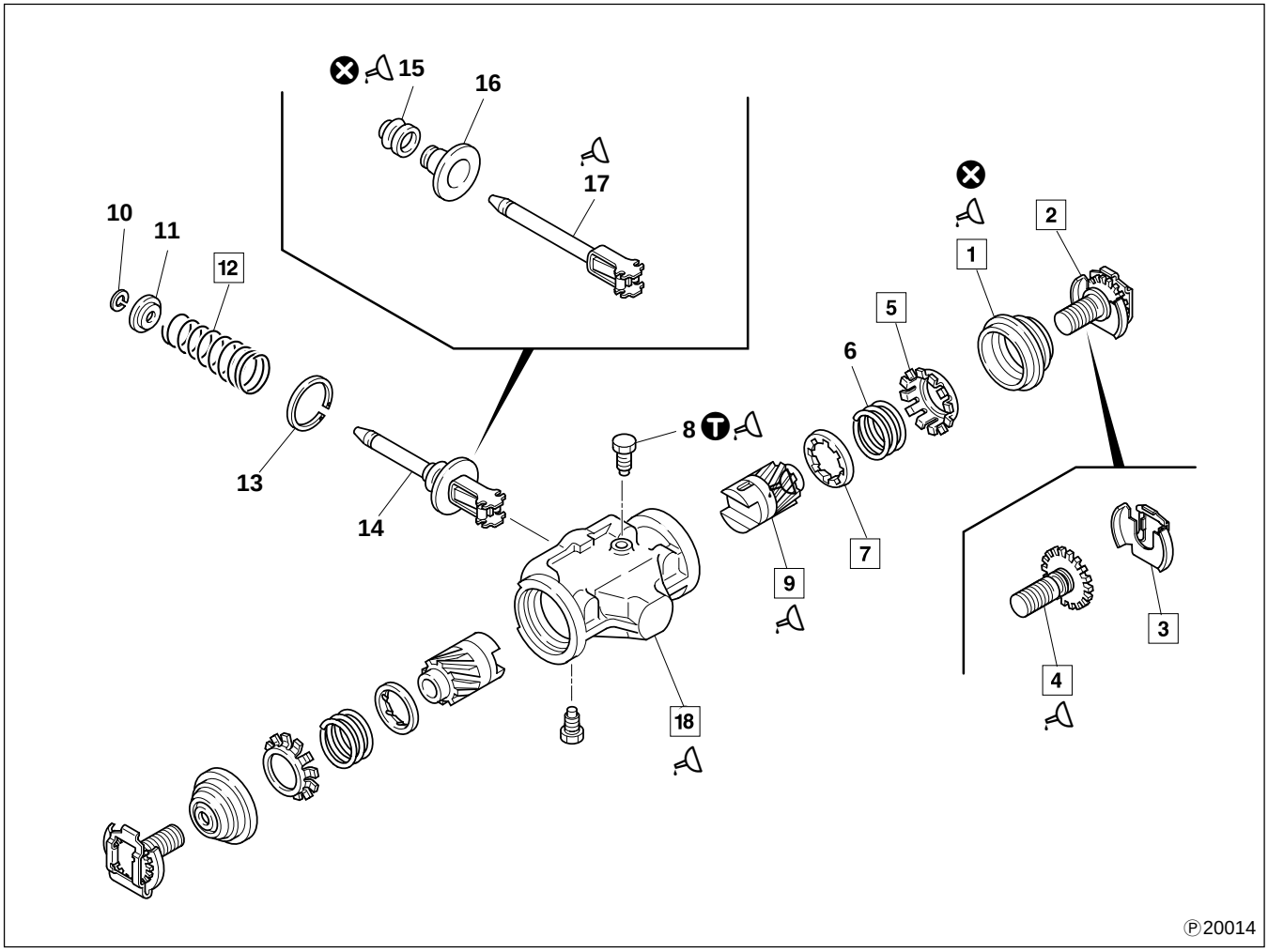
● **Work before assembly**

A : Counter mark

CAUTION⚠

Be sure to match counter mark A when assembling, and install clamp ring 3, emergency brake chamber 5 and base 14.

EXPANDER ASSEMBLY



● **Disassembly sequence**

1 Boot
2 Adjusting screw assembly
3 Clip
4 Adjusting screw
5 Spring cage
6 Spring
7 Drive ring
8 Screw
9 Sleeve assembly
10 Snap ring
11 Retainer
12 Spring
13 Snap ring
14 Wedge assembly
15 Boot
16 Cap assembly
17 Wedge and roller
18 Body

⊗ : Non-reusable parts

● **Assembly sequence**

(18→14→13→12→11→10→9→8→7→6→5)→(4→1)→3

2: The number is missing in the assembly sequence since the adjusting screw is not used for the assembly.

14 : **16→15→17**

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
2	Clip holding torque		1.5 to 5.0 N·m {1.1 to 3.6 ft.lbs, 0.15 to 0.5 kgf·m}	—	Replace
6	Load of spring (installation length 11.3 {0.44})		83.4 N {19 lbf, 8.5 kgf}	73.6 N {17 lbf,7.5 kgf} or less	Replace
12	Load of spring (installation length 105.8 {4.17})		147 N {33 lbf, 15 kgf}	132.3 N {30 lbf,13.5 kgf} or less	Replace
4, **9**	Rotation between adjusting screw and sleeve assembly		To be rotated smoothly	—	Replace
7, **9**	Backlash between drive ring and sleeve assembly		2.9 to 3.4 {0.11 to 0.13}	—	Replace
9	Rotating torque of sleeve assembly	Clockwise	0.6 N·m {0.4 ft.lbs, 0.06 kgf·m} or less	—	Replace
		Counterclockwise	2.0 N·m {1.4 ft.lbs, 0.20 kgf·m} or less	—	Replace
9, **17**	Dent on roller-rotation-moving surface of sleeve assembly and wedge & roller		—	0.010 {0.0004} or less	Replace
17	Roller appearance of wedge & roller		No damage allowed	—	Replace
18	Wear of inside bore of body		ø38.1 to 38.2 {1.5}	Wear to be 0.030 {0.0012} or less	Replace
—	Application force of auto adjustment mechanism of expander assembly (pushing-back force of sleeve assembly)		147 N {33 lbf, 15 kgf} or less	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
8	Screw	15±3 {11±2.2, 1.5±0.3}	—

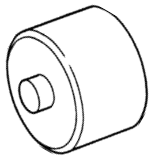
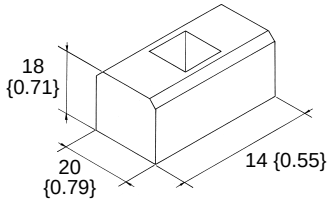
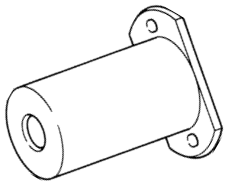
Lubricant

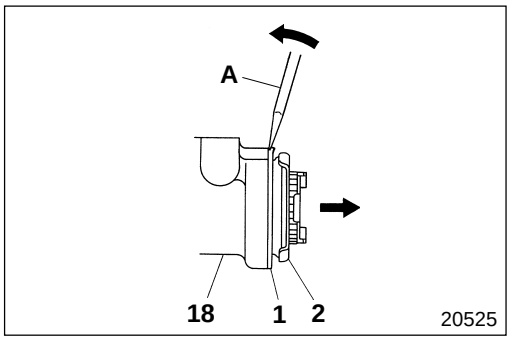
Location	Points of application	Specified fluid	Quantity
1	Contact part of the adjusting screw of boot	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
4	Screw of the adjusting screw	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
8	Screw of screw	LOCTITE 202 or THREEBOND 2415	As required
9	Outer of screw assembly, screw, and contact part of roller	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
15	Boot, and contact surface of wedge & roller	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
17	Inside surface of bushing	Wheel bearing grease [NLGI No.2 (Li soap)]	2 g {0.07 oz}
18	Inside surface of body	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
	Inside surface of body	Wheel bearing grease [NLGI No.2 (Li soap)]	8 g {0.282 lb}

EXPANDER ASSEMBLY

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Boot setterr  19000	Use a locally obtained equivalent	Install boot
2, 9	Clip adaptor  19111	Use a locally obtained equivalent	Measure holding torque of clip and rotating torque of sleeve assembly
12	Spring holder  18999	Use a locally obtained equivalent	Remove spring

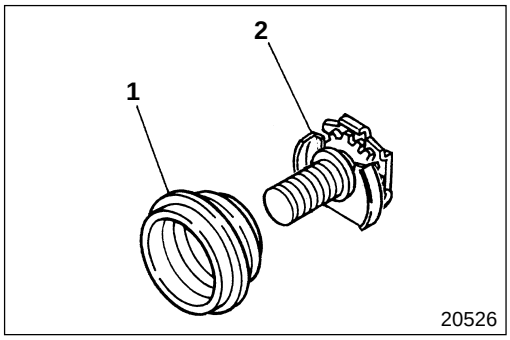


20525

◆ Service procedure

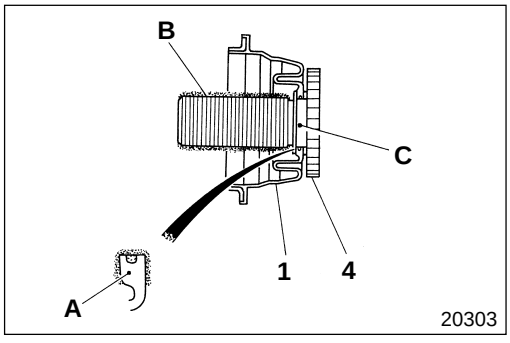
1 2 Removal of boot and adjusting screw assembly

- Remove the boot **1** from the body **18** with screw driver **A**.
- Remove adjusting screw assembly **2** and boot **1** by turning the adjusting screw assembly counterclockwise.



20526

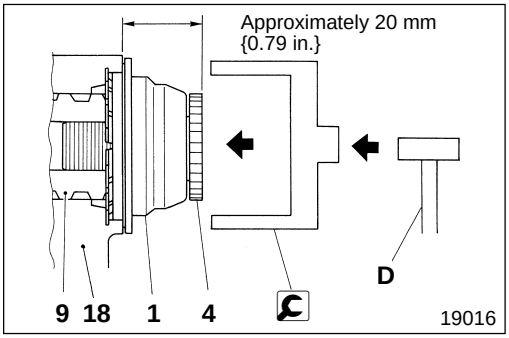
- Remove boot **1** from adjusting screw assembly **2**.



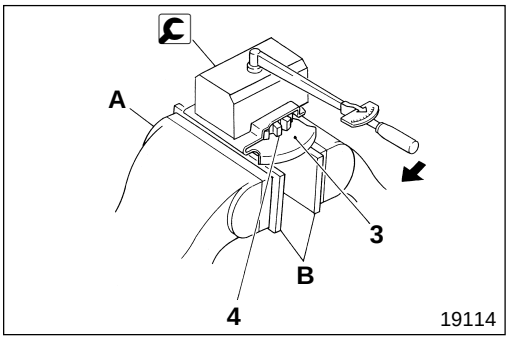
20303

1 4 Installation of boot and adjusting screw

- Apply grease on the contact part **A** of adjusting screw **4** of boot **1** and the threads **B** of the adjusting screw.
- Install boot **1** in groove **C** of adjusting screw **4**.



- Thread adjusting screw **4** into the sleeve assembly **9** until the adjusting screw reaches a distance of approximately 20 mm {0.79 in.} from the body **18**.
- Confirm that sleeve assembly **9** slides by pulling adjusting screw **4** lightly.
- Press boot **1** fit with 🔧 boot installer.
  D : Plastic hammer



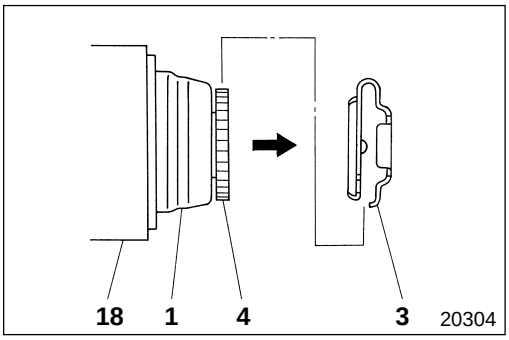
2 Inspection of clip-holding torque of adjusting screw assembly

- Fix adjusting screw **4** with vise **A**.
  B : Buffer (jaw protectors.)

CAUTION ⚠

Use buffer B such as jaw protectors so as not to give damage to adjusting screw 4.
Also, the auto adjustment mechanism will not operate when the threaded part of the adjusting screw is damaged.

- Install 🔧 clip adaptor
- The holding torque is a value indicated when clip **3** has began to turn.
- Replace clip **3** if the measurement value comes off from the standard value.

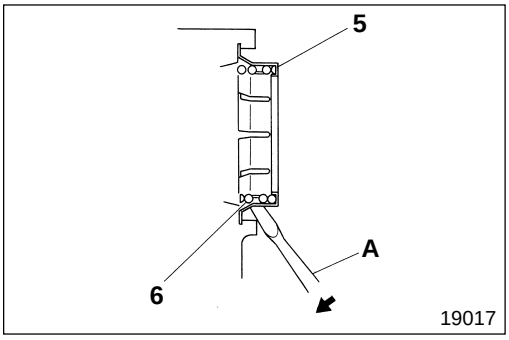


3 Installation of clip

- To install the clip **3** on adjusting screw **4**, extend the adjusting screw out to the extent that it does not come in contact with boot **1**.
- Install clip **3**.

CAUTION ⚠

Do not damage boot 1 when installing clip 3.

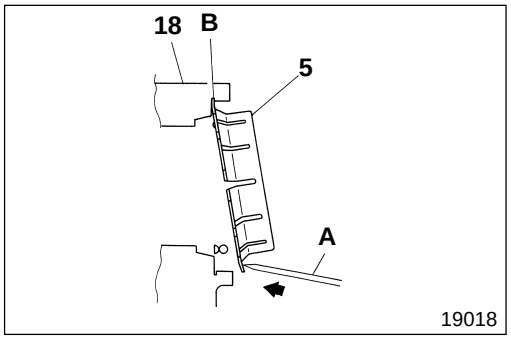


5 Spring cage

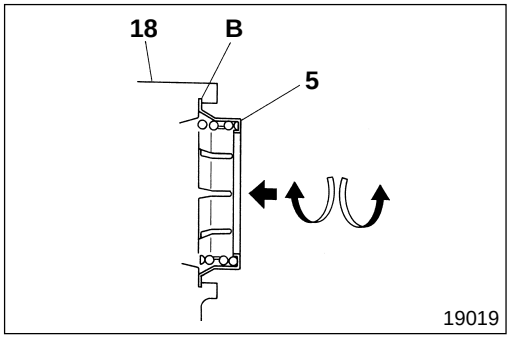
[Removal]
Remove spring cage **5** with holding it by hand so that spring **6** may not pop out.
A : Screw driver

WARNING ⚠

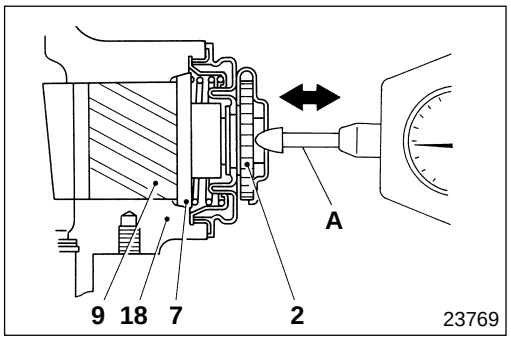
Take care that spring 6 may pop out.



[Installation]
- Fit the one side of spring cage **5** into groove **B** of body **18**.
- Push the other side of spring cage **5** with screw driver **A**.



- To check the spring cage **5** for proper installation into the groove of body **18**, push in on the spring cage while rotating the cage. It should rotate smoothly.

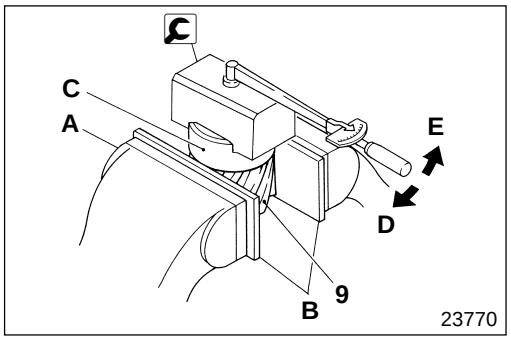


7 **9** **Inspection of backlash between drive ring and sleeve assembly**

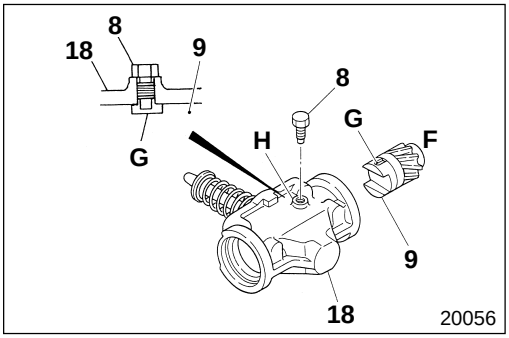
- Measure the backlash between drive ring **7** and sleeve assembly **9** with a dial indicator **A** while moving the adjusting screw assembly **2** in the direction of the arrow.
- If the measured value is out of specification, replace drive ring **7** and sleeve assembly **9**.

CAUTION

Measure the backlash with care so that drive ring 7 may not separate from body 18 with being pushed by sleeve assembly 9.



[Inspection]
- Fix sleeve assembly **9** with vise **A**.
  B : Buffer (jaw protectors)
- Install clip adaptor.
- Measure the torque at the time when tappet **C** begins to rotate.
  D : Clockwise
  E : Counterclockwise
- If the measured value is out of specification, replace sleeve assembly **9**.



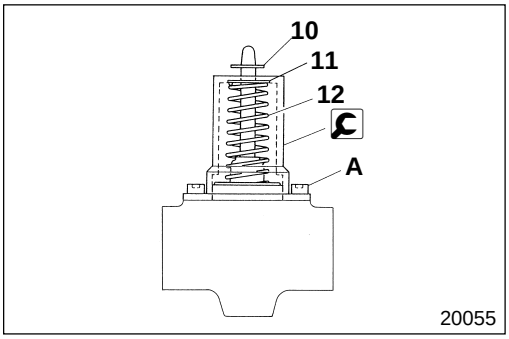
9 Sleeve assembly

[Installation]

- Install sleeve assembly **9** by aligning the identification groove **F** in the tip of the sleeve assembly with the threaded hole **H** of the body **18**.
- Apply grease on the outer, the screw part and the roller contact part of sleeve assembly **9**.
- Install screw **8** after groove **G** is aligned.
- Tighten the sleeve assembly with the specified torque after applying the sealing compound on the screw of screw **8**.
- Confirm whether sleeve assembly **9** does not come off.

NOTE

Recheck that the sleeve assembly 9 does not pull out of the housing.



12 Spring

[Removal]

- spring holder with bolt **A**, and compress spring **12**.
- Remove snap ring **10**.
- Remove bolt **A** and spring holder.

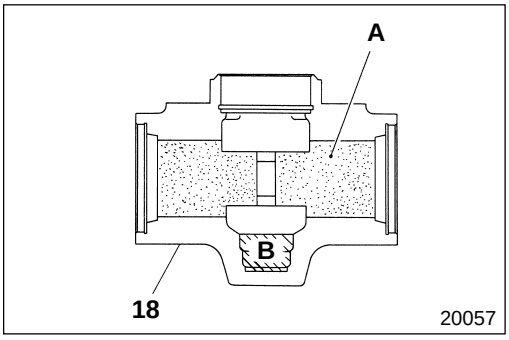
CAUTION

When removing bolt A, use caution as the spring 12 may pop out.

- Remove retainer **11** and spring **12**.

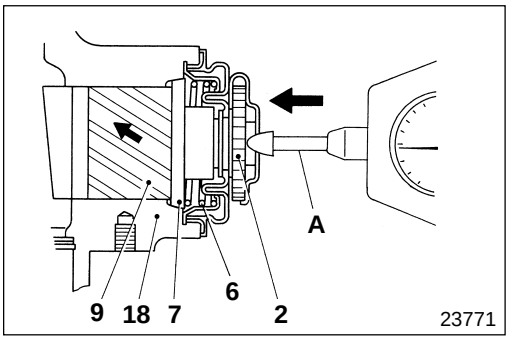
[Installation]

- Follow the removal sequence in reverse.



18 Applying and filling grease on body

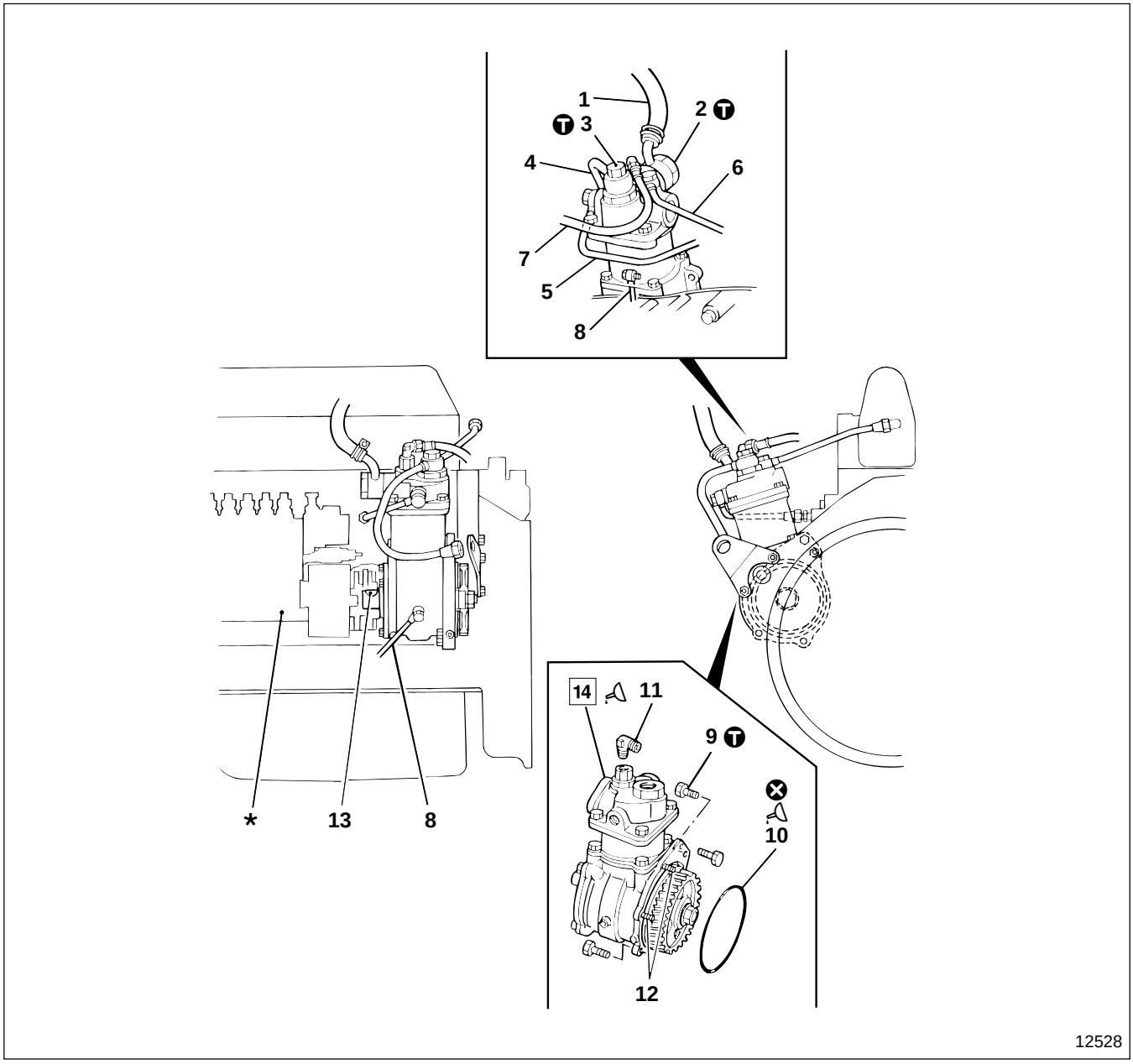
- Apply grease on the inside surface **A** of body **18**.
- Fill grease in the **B** part.



– Inspection of auto adjustment mechanism operation of expander assembly

- Pull the adjusting screw assembly **2** as far out as possible by hand.
- Push the adjusting screw assembly **2** back slightly until you feel the resistance change.
- Place the push-pull gauge **A** on the adjusting screw assembly **2**, then push the gauge **A** in the direction of the arrow as shown in the figure on the left, and measure the maximum moving resistance of the adjusting screw assembly **2**.
- If the measured value is out of specification, replace sleeve assembly **9**.

AIR COMPRESSOR



● **Removal sequence**

1 Suction hose
2 Eye bolt
3 Eye bolt
4 Air outlet pipe
5 Water inlet pipe
6 Water outlet pipe
7 Unloader hose
8 Oil pipe
9 Bolt
10 O-ring
11 Connector
12 Stud bolt
13 Key
14 Air compressor assembly
📖 P35B-106

* : Injection pump assembly Gr 13
⊗ : Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

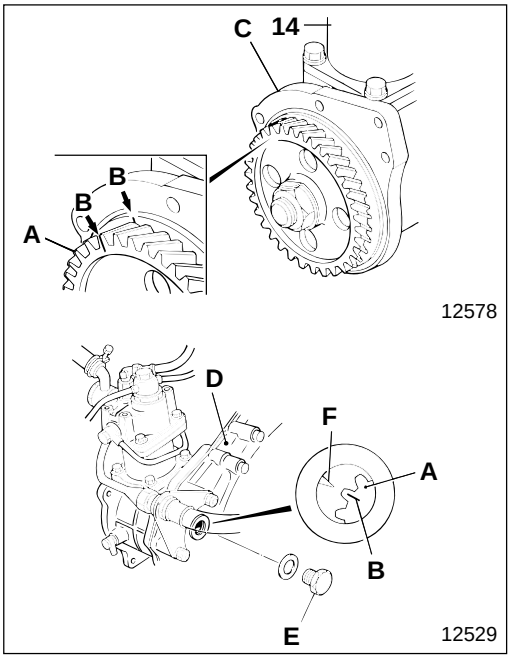
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Eye bolt	98 {72, 10}	—
3	Eye bolt	98 {72, 10}	—
9	Bolt (Air compressor assembly mounting)	37 {27, 3.8}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
10	Periphery of O-ring	Engine oil	As required
14	Air compressor assembly stud bolt mounting hole	LOCTITE 271	As required



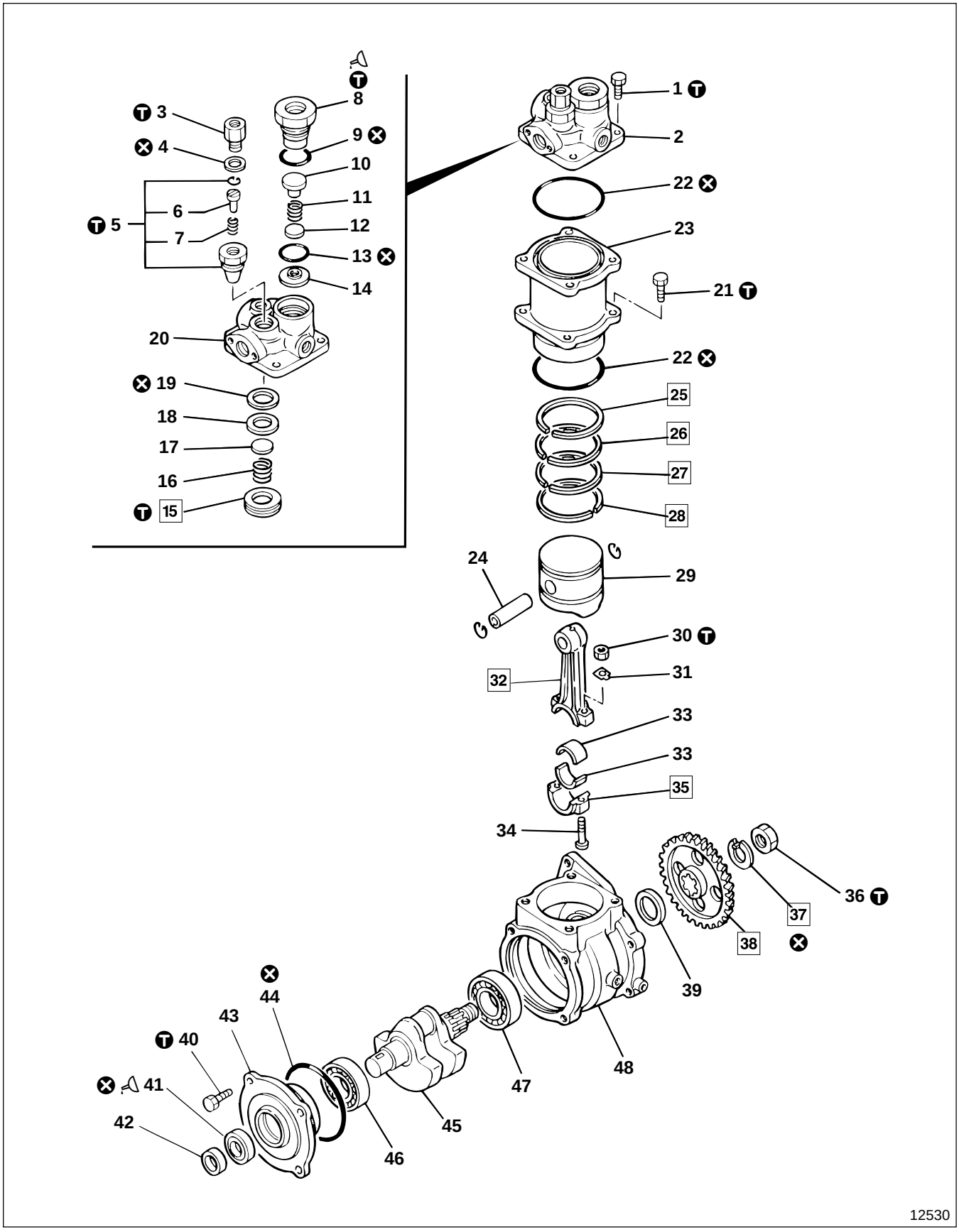
◆ Service procedure

14 **Installation of air compressor assembly**

- Position No.1 cylinder at top dead center in the compression cycle. Gr 11
- Align punched marks **B** of drive gear **A** and crankcase **C** of air compressor **14**. Then mount on flywheel housing **D**.
- Remove inspection plug **E** from flywheel housing **D** and check that punched mark **B** of drive gear **A** and pointer **F** align. If they do not, reinstall them.

AIR COMPRESSOR

Air Compressor Assembly



● **Disassembly sequence**

1 Bolt
2 Cylinder head assembly
3 Connector
4 Gasket
5 Unloader valve assembly
6 Unloader valve
7 Spring
8 Delivery valve holder
9 O-ring
10 Spring holder
11 Spring
12 Delivery valve
13 O-ring
14 Delivery seat
15 Suction valve holder
16 Spring
17 Suction valve
18 Suction seat
19 Gasket
20 Cylinder head
21 Bolt
22 O-ring
23 Cylinder liner
24 Piston pin
25 1st compression ring
26 2nd compression ring
27 3rd compression ring
28 Oil ring
29 Piston
30 Nut
31 Lock washer
32 Connecting rod
33 Connecting rod bearing
34 Bolt
35 Connecting rod cap
36 Nut
37 Lock washer
38 Drive gear
39 Spacer
40 Bolt
41 Oil seal
42 Sleeve
43 Bearing holder
44 O-ring
45 Crankshaft
46 Bearing
47 Bearing
48 Crankcase

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Piston ring kit

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value (Basic diameter in [ ])	Limit	Remedy
11	Spring load (Installed length 9.5 {0.37})		4.5 N {1.01 lbf, 0.46 kgf}	3.6 N {0.8 lbf, 0.37 kgf}	Replace
16	Spring load (Installed length 9 {0.35})		2.3 N {0.51 lbf, 0.23 kgf}	1.3 N {0.3 lbf, 0.13 kgf}	Replace
23, 29	Clearance between cylinder liner and piston	Top	[85 {3.35}]	0.27 {0.011}	Replace
		Skirt		0.18 {0.0071}	Replace
24, 29	Clearance between piston and piston pin		[18 {0.708}]	0.08 {0.0031}	Replace piston pin
24, 32	Clearance between piston pin and connecting rod small end		[18 {0.708}]	0.08 {0.0031}	Replace connecting rod
25 to 28	Clearance of piston ring gap (Measure at interior of cylinder liner)	Compression ring	—	1.0 {0.039}	Replace piston ring kit
		Oil ring	—	1.0 {0.039}	
25 to 27, 29	Clearance between compression ring and piston compression ring groove of piston		—	0.08 {0.0031}	Replace piston ring kit
32, 35, 45	End play of connecting rod		—	0.5 {0.020}	Replace
33, 45	Clearance between crankshaft and connecting rod bearing		[34 {1.34}]	0.1 {0.0039}	Replace
45, 48	Play of crankshaft		—	1.0 {0.039}	Replace

AIR COMPRESSOR

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

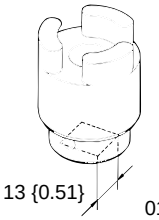
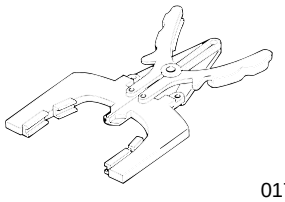
Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Cylinder head assembly mounting)	25 to 29 {18 to 22, 2.5 to 3.0}	—
3	Connector	29 to 34 {22 to 25, 3.0 to 3.5}	—
5	Unloader valve assembly	98 to 115 {72 to 87, 10 to 12}	—
8	Delivery valve holder	98 to 115 {72 to 87, 10 to 12}	—
15	Suction valve holder	98 to 115 {72 to 87, 10 to 12}	—
21	Bolt (Cylinder liner mounting)	25 to 29 {18 to 22, 2.5 to 3.0}	—
30	Nut (Connecting rod and connecting rod cap mounting)	23 to 25 {17 to 19, 2.3 to 2.6}	—
36	Nut (Drive gear mounting)	165 to 210 {120 to 155, 17 to 21.5}	—
40	Bolt (Bearing holder mounting)	14 to 18 {10 to 13, 1.4 to 1.8}	—

Lubricant and sealant

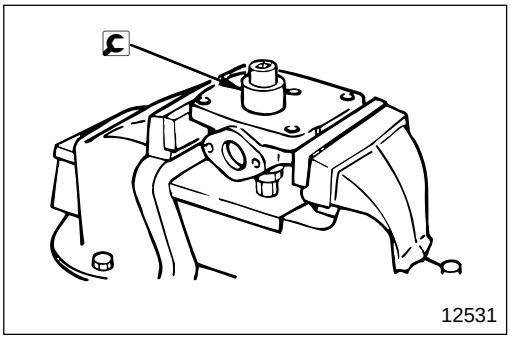
Location	Points of application	Kinds	Quantity
8	Thread area of delivery valve holder	THREEBOND 1323B	As required
41	Oil seal lip	Engine oil	As required

Special tools

Unit : mm {in.}

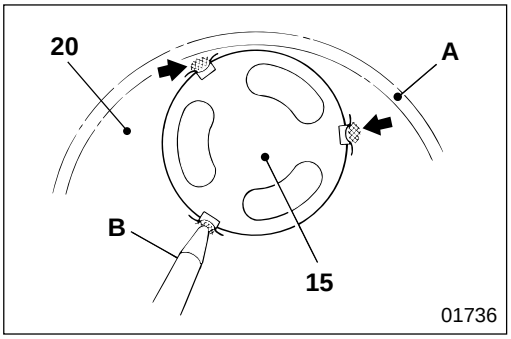
Location	Tool name and shape	Part No.	Application
15	Suction valve tool  01730	MH061263 (Obtain Locally)	Removal and installation of suction valve holder
25 to 28	Piston ring tool  01732	MH060014 (Obtain Locally)	Removal and installation of piston ring (compression ring and oil ring)

◆ Service procedure



15 **Suction valve holder**

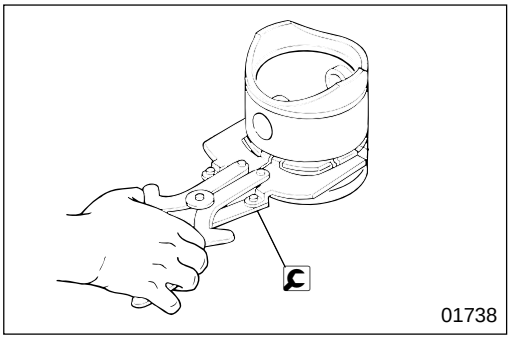
[Removal and installation]



[Caulking]

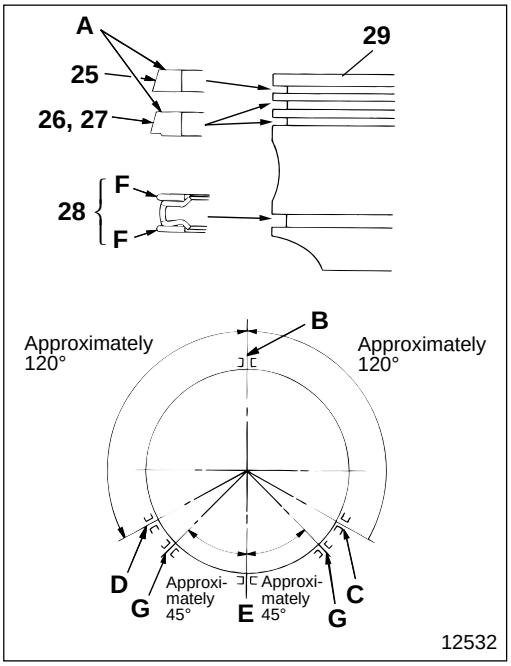
Caulk cylinder head **20** taking care not to damage seal surface **A** of the O-ring.

B : Center punch



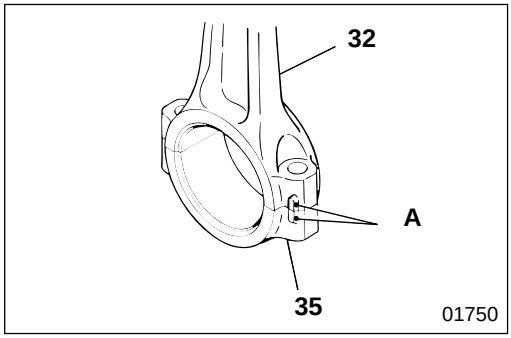
25 **to** **28** **Piston ring (compression ring and oil ring)**

[Removal and installation]



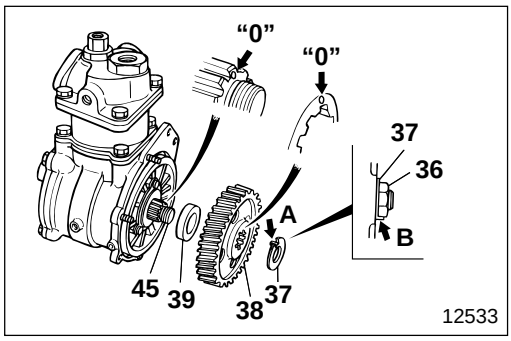
[Point of installation]

- Install compression rings **25** to **27** with punched marks **A** pointing toward the top of piston **29**.
- Stagger the splits of compression rings **25** to **27** at approximately 120°.
  B : No.1 compression ring split
  C : No.2 compression ring split
  D : No.3 compression ring split
- Arrange split **E** of oil ring **28** so that it is at the center of two compression ring splits, and install side rails **F** in position **G** staggered by approximately a further 45° to the right and left from the split of the oil ring.



32 **35** **Installation of connecting rod and connecting cap**

A : Alignment marks

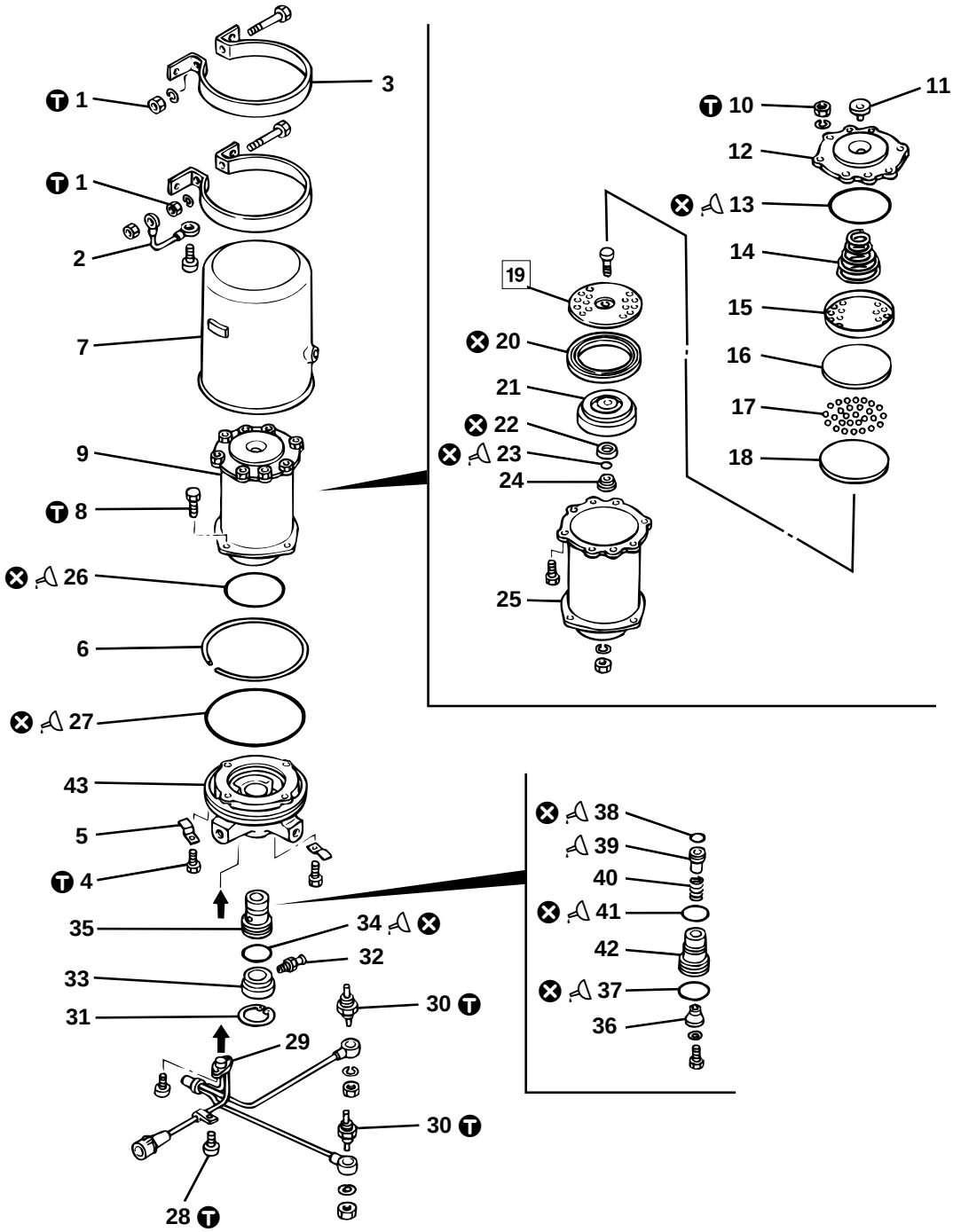


37 **38** **Installation of lock washer and drive gear**

- Align alignment marks "**0**" of crankshaft **45** and drive gear **38** and install.
- Align indent **A** of lock washer **37** and alignment mark "**0**" of drive gear **38** and install.
- Make bend **B** on lock washer **37**, against one side of nut **36**, to act as a stopper.

M E M O

AIR DRYER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● **Disassembly sequence**

1 Nut
2 Cord
3 Bracket
4 Bolt
5 Stopper
6 Stopper ring
7 Purge chamber
8 Bolt
9 Case assembly
10 Nut
11 Check valve
12 Case cover
13 O-ring
14 Spring
15 Filter plate
16 Filter
17 Desiccant
18 Filter
19 Filter plate
20 Gasket
21 Oil filter
22 Gasket
23 O-ring
24 Spacer
25 Case
26 O-ring
27 O-ring
28 Screw
29 Thermostat assembly Gr 54
30 Heater assembly Gr 54
31 Retaining ring
32 Nipple
33 Exhaust body
34 O-ring
35 Valve body assembly
36 Valve
37 O-ring
38 O-ring
39 Piston
40 Spring
41 O-ring
42 Valve body
43 Body

⊗ : Non-reusable parts

CAUTION⚠

Make sure you install filters 16, 18, with their soft layer sides toward the desiccant.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Air dryer kit

● **Inspection after installation**

P35B-114

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Bracket tightening)	4.9 to 5.9 {3.6 to 4.3, 0.5 to 0.6}	—
4	Bolt (Stopper mounting)	3.9 to 6.9 {2.9 to 5.1, 0.4 to 0.7}	—
8	Bolt (Case assembly mounting)	3.9 to 6.9 {2.9 to 5.1, 0.4 to 0.7}	—
10	Nut (Case cover mounting)	3.9 to 6.9 {2.9 to 5.1, 0.4 to 0.7}	—
28	Screw (Thermostat harness mounting)	1.5 to 2.5 {1.1 to 1.8, 0.15 to 0.25}	—
30	Heater	19.6 to 29.4 {14 to 22, 2 to 3}	—

Lubricant

Location	Points of application	Kinds	Quantity
39	Friction surface of piston	Multipurpose grease [NLGI No. 2 {Li soap)]	As required
—	Surface of O-ring	Multipurpose grease [NLGI No. 2 {Li soap)]	As required

● **Inspection after installation**

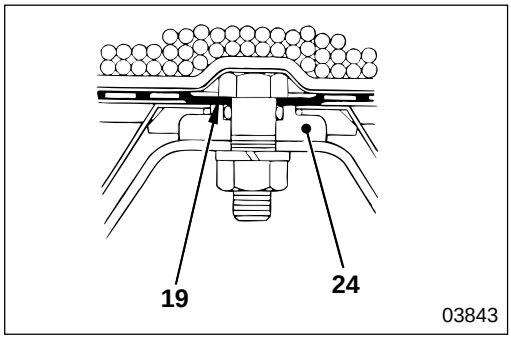
- Start the engine.
- Make sure that air is exhausted from the port of exhaust body **33** when the air pressure reaches the specified level and the air compressor is switched to idling.

NOTE

If high air pressure is exhausted first and approximately three seconds later, you cannot hear an exhausting sound, do not worry, it is normal.

- Make sure that there is no air leakage from any piping connection.

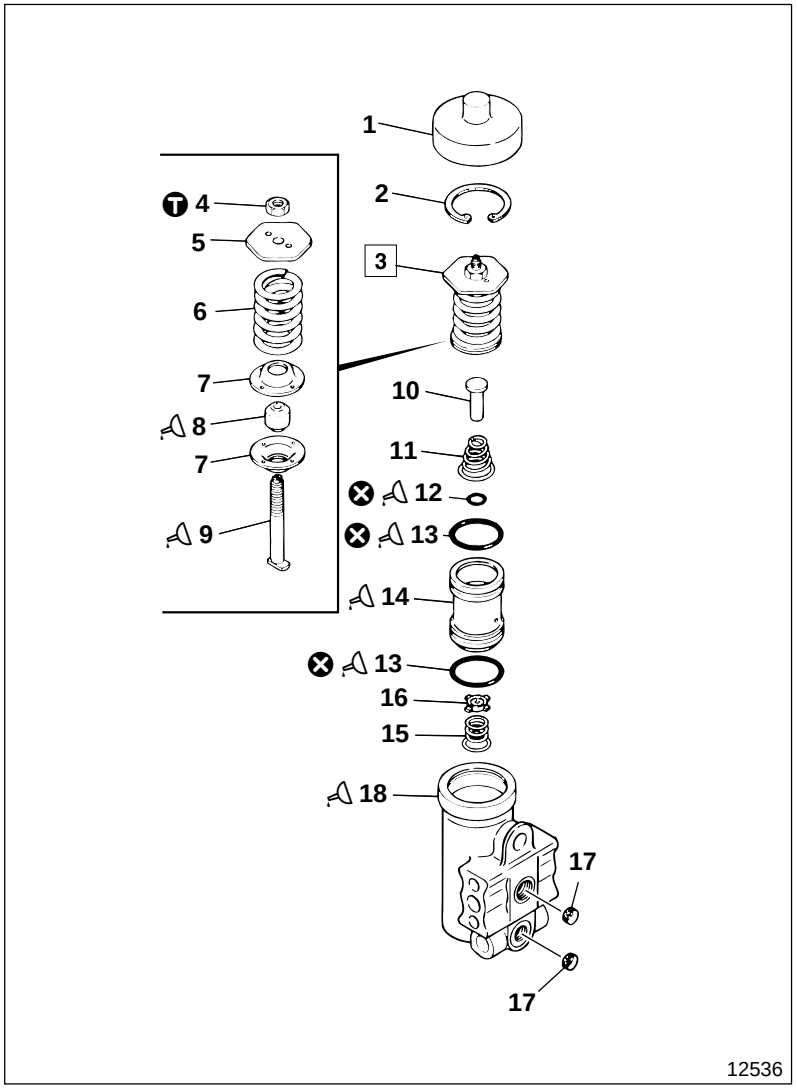
◆ Service procedure



19 **Installation direction of filter plate**

M E M O

AIR PRESSURE GOVERNOR



● **Disassembly sequence**

1 Cover
2 C-ring
3 Adjusting screw assembly
4 Lock nut
5 Upper spring seat
6 Spring
7 Lower spring seat
8 Spring guide
9 Adjusting screw
10 Exhaust stem
11 Exhaust stem spring
12 O-ring
13 O-ring
14 Piston
15 Valve spring
16 Valve
17 Filter
18 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Air pressure governor kit

● **Inspection of function after assembly**

📖 P35B-117

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
—	Specified pressure	High specified pressure	805^{+29}_{-20} kPa {$115^{+4.3}_{-2.8}$ psi, $8.2^{+0.3}_{-0.2}$ kgf/cm^2}	—	Adjust
		Low specified pressure	685±20 kPa {100±2.8 psi, 7.0±0.2 kgf/cm^2}		

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

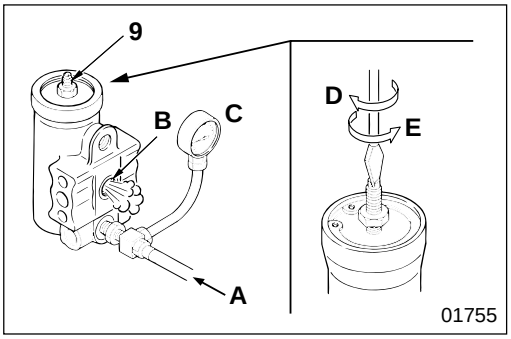
Location	Parts to be tightened	Tightening torque	Remarks
4	Lock nut	3.9 to 6.9 {2.9 to 5.1, 0.4 to 0.7}	—

Lubricant

Location	Points of application	Kinds	Quantity
8	Surface of spring guide	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
9	Surface of adjusting screw, except for thread area	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
12, 13	Entire O-ring	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
14	Outer periphery of piston and O-ring groove	Multipurpose grease [NLGI No. 2 (Li soap)]	As required
18	Interior of body	Multipurpose grease [NLGI No. 2 (Li soap)]	As required

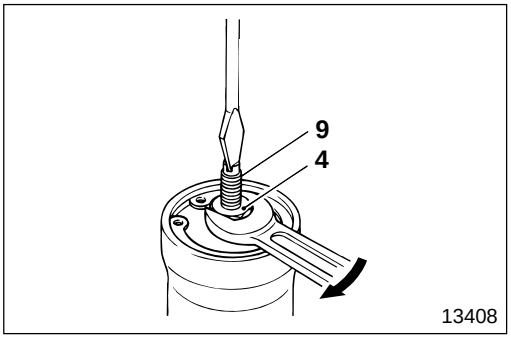
◆ Service procedure

● Inspection of function after assembly

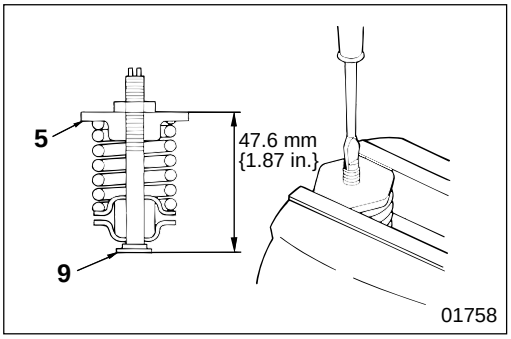


- Increase air pressure **A** gradually and read the value on air pressure gauge **C** when air is discharged from **B**. Adjust by turning adjusting screw **9** so that the reading conforms to the standard value (high specified-pressure).
  D : Turning clockwise decreases the pressure
  E : Turning counterclockwise increases the pressure
- Lower air pressure **A** to 685 kPa {100 psi, 7 kgf/cm²} or less, then raise the air pressure gradually. Read air pressure gauge **C** when it stops and check that the value conforms to the standard value (high specified-pressure). If the value deviates from the standard value, readjust.

- Lower air pressure **A** gradually. When the discharge of air from **B** ceases, read air pressure gauge **C** to check that the valve conforms to the standard value (high specified-pressure). If the value deviates from the standard value, replace the air pressure governor assembly.



- After adjusting, tighten lock nut **4** to prevent adjusting screw **9** being turned accidentally.

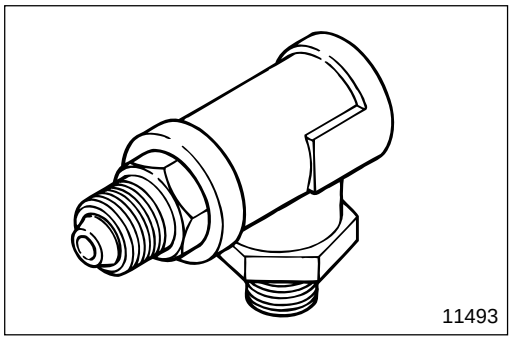


3 **Preliminary adjustment of adjusting screw assembly**

It is recommended that you adjust the distance from the upper level of upper spring seat **5** to the lower level of adjusting screw **9** to 47.6 mm {1.87 in.} by turning the adjusting screw, because this makes adjustment to the specified value easier.

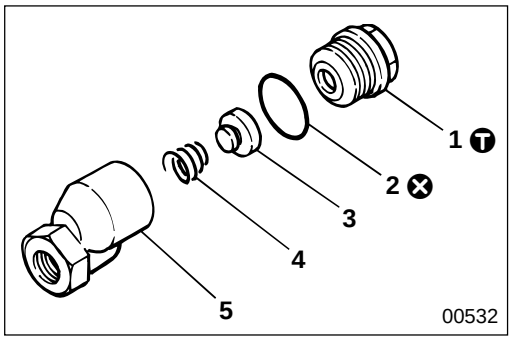
CHECK VALVE/SAFETY VALVE

CHECK VALVE



CAUTION⚠

Do not disassemble this check valve because it is a unit construction.



● **Disassembly sequence**

1 Cap
2 O-ring
3 Valve
4 Spring
5 Valve body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

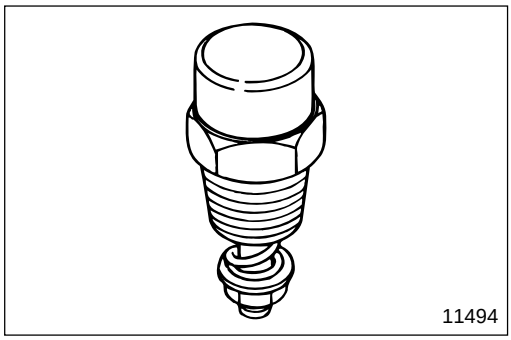
Location	Maintenance item	Standard value	Limit	Remedy
—	Pressure difference between check valve inlet and outlet ports	29 kPa {4.3 psi, 0.3 kgf/cm^2} or less	—	Replace

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

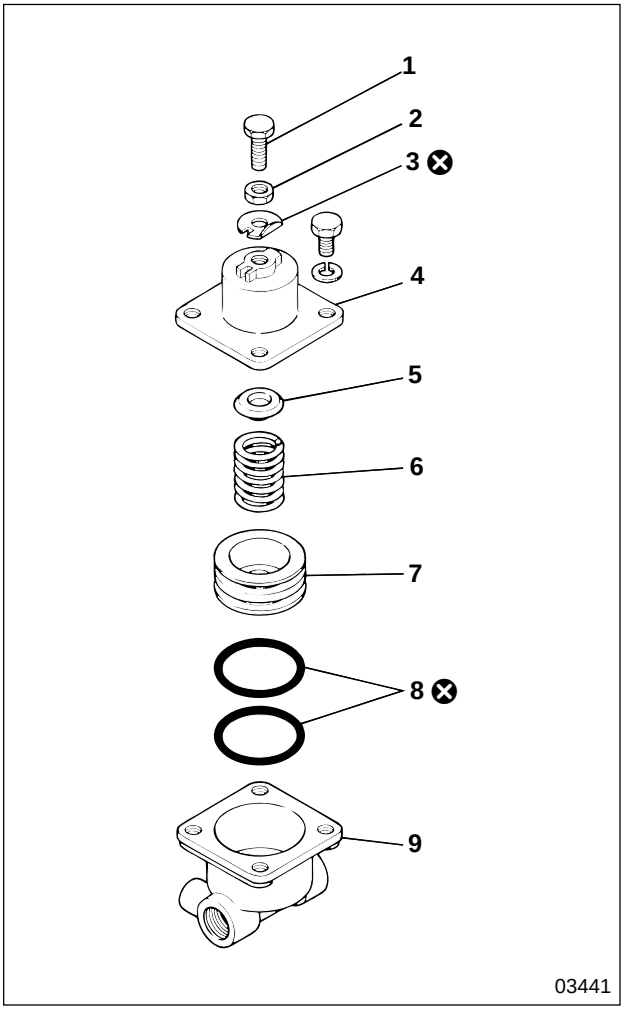
Location	Parts to be tightened	Tightening torque	Remarks
1	Cap	44 to 55 {33 to 40, 4.5 to 5.5}	—

SAFETY VALVE



Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Release pressure of safety valve	950±20 kPa {135±2.8 psi, 9.7±0.2 kgf/cm^2}	—	Replace



● **Disassembly sequence**

1 Adjusting bolt
2 Lock nut
3 Claw washer
4 Cap
5 Spring retainer
6 Spring
7 Piston
8 O-ring
9 Valve body

⊗ : Non-reusable parts

CAUTION

Make sure that adjusting bolt 1 is not turned except for adjustment.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection after assembly**

P35B-119

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
—	Specified pressure	Valve opening pressure	345±29 kPa {50±4.3 psi, 3.5±0.3 kgf/cm^2}	—	Adjust or replace
		Valve closing pressure	315±20 kPa {46±2.8 psi, 3.2±0.2 kgf/cm^2}	—	

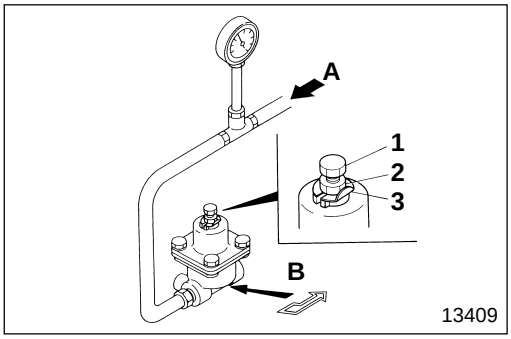
◆ Service procedure

● **Inspection after assembly**

Adjust by turning adjusting bolt **1** after loosening lock nut **2**. After adjusting, tighten the lock nut without turning the adjusting bolt, and bend claw washer **3** to secure the lock nut.

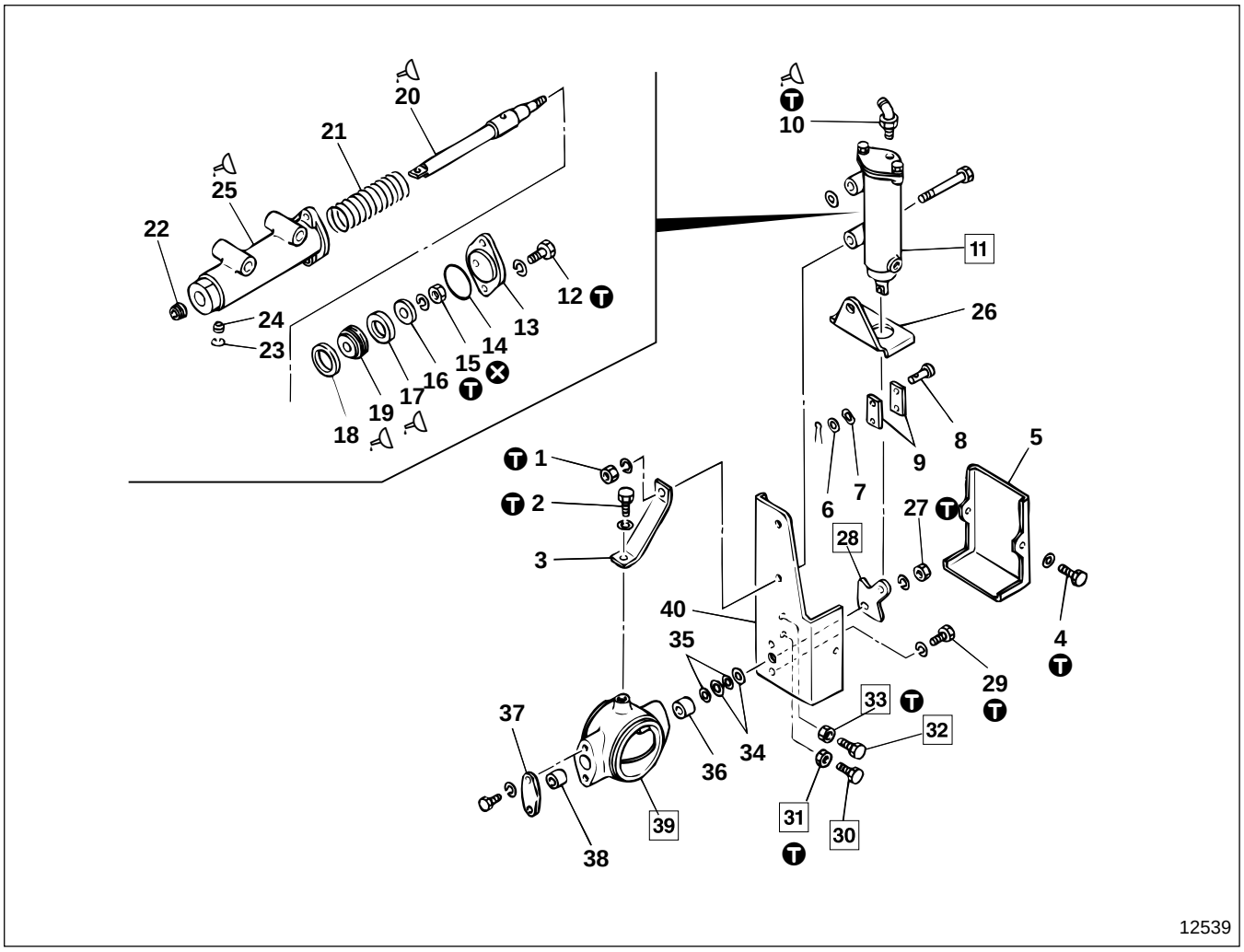
- Adjust adjusting bolt **1** so that air is discharged from the outlet port (arrow mark **B** in the illustration), when the air at valve opening pressure is applied to the inlet port (arrow mark **A** in the illustration).
- After adjusting valve opening pressure, adjust adjusting bolt **1** so that air is not discharged from the outlet port (arrow mark **B** in the illustration) when the air at valve closing pressure is applied to the inlet port (arrow mark **A** in the illustration).

  B : Arrow showing the air flow direction



EXHAUST BRAKE SYSTEM

Exhaust Brake Unit



● **Disassembly sequence**

1 Nut
2 Bolt
3 Arm
4 Screw
5 Cover
6 Plain washer
7 Wave washer
8 Pin
9 Link
10 Connector
11 Control cylinder
12 Bolt
13 Cover
14 O-ring
15 Nut
16 Retainer
17 Packing
18 Wear ring
19 Plate
20 Shaft
21 Spring
22 Dust seal
23 Retaining ring
24 Filter
25 Cylinder
26 Cover
27 Nut
28 Lever
29 Bolt
30 Adjusting bolt
31 Lock nut
32 Adjusting bolt
33 Lock nut
34 Seal ring (Large)
35 Seal ring (Small)
36 Bushing
37 Cover
38 Bushing
39 Valve assembly
40 Plate

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
11	Airtightness of control cylinder (Air leakage at air pressure 980 kPa {140 psi, 10 kgf/cm^2})	No air leakage	—	Replace
21	Spring load (Installed length 109 {4.29})	72 N {16 lbf, 7.3 kgf}	61 N {13.7 lbf, 6.2 kgf}	Replace
39	Clearance between butterfly valve and body when valve assembly butterfly valve operating (Air pressure 685±49 kPa {100±7.1 psi, 7±0.5 kgf/cm^2} supplied to control cylinder)	0.2 to 0.4 {0.0079 to 0.016}	—	Adjust

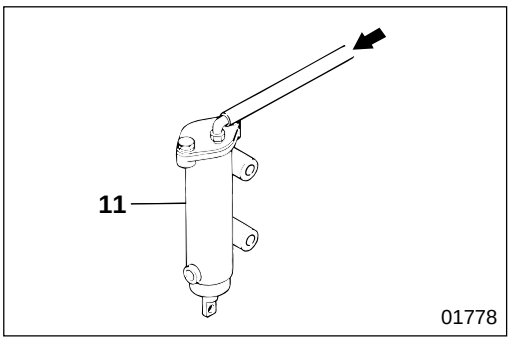
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Control cylinder mounting)	20.6 to 25.5 {15 to 19, 2.1 to 2.6}	—
2	Bolt (Arm mounting)	9.81 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
4	Screw (Cover mounting)	4.9 to 6.86 {3.6 to 5.1, 0.5 to 0.7}	—
10	Connector	4.9 {3.6, 0.5} or more	—
12	Bolt (Cover mounting)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
15	Nut (Plate mounting)	9.8 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
27	Nut (Lever mounting)	9.81 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
29	Bolt (Valve assembly mounting)	9.81 to 15.7 {7.2 to 12, 1.0 to 1.6}	—
31	Lock nut	4.9 to 6.86 {3.6 to 5.1, 0.5 to 0.7}	—
33	Lock nut	4.9 to 6.86 {3.6 to 5.1, 0.5 to 0.7}	—

Lubricant and sealant

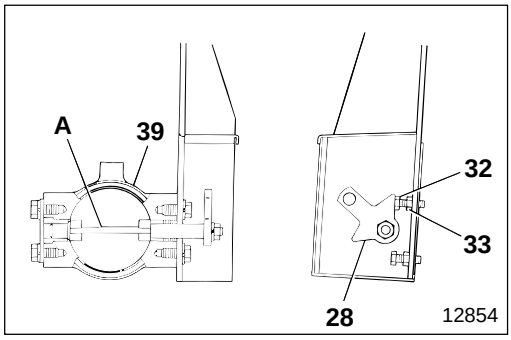
Location	Points of application	Kinds	Quantity
10	Thread area of connector	THREEBOND No.1211 or No.1213	As required
17	Surface of packing	Molybdenum disulfide bearing grease [NLGI No.2 (Li soap)]	As required
19, 20	Mounting areas of plate and shaft	Sealant [Hermetic GA (SANNOW KOGYO)]	As required
20	Shaft at ø12 {0.47}	Molybdenum disulfide bearing grease [NLGI No.2 (Li soap)]	As required
25	Interior of cylinder	Molybdenum disulfide bearing grease [NLGI No.2 (Li soap)]	2 cm^3 {0.12 cu. in.}



◆ Service procedure

11 **Inspection on airtightness of control cylinder**

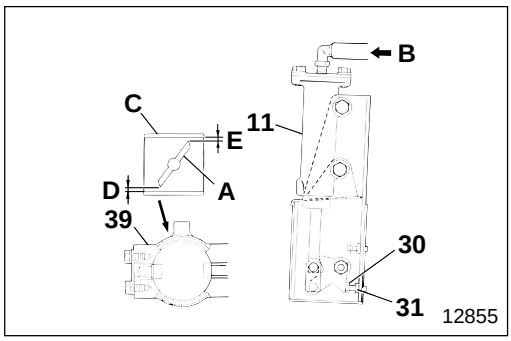
Make sure that there is no air leakage when air pressure of 980 kPa {140 psi, 10 kgf/cm^2} is applied to control cylinder **11**. If any air leakage is found, replace the control cylinder assembly.



28 **30** **to** **33** **39** **Lever, adjusting bolt, lock nut, and valve assembly**

[Butterfly valve **A** fully-opened adjustment]

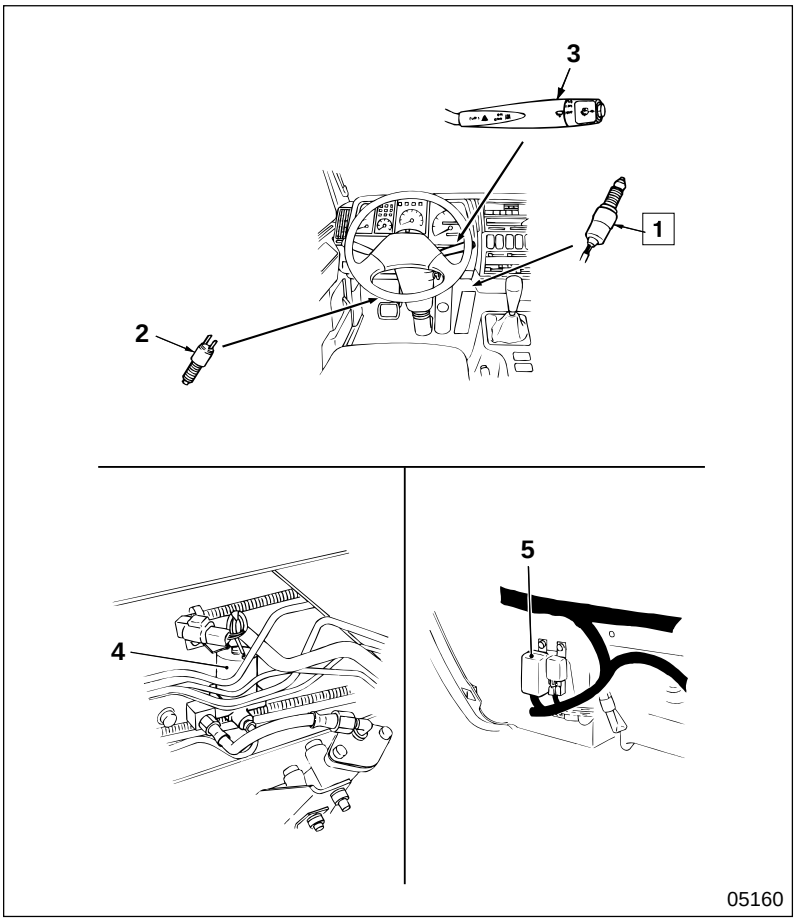
- Turn the adjusting bolt so that lever **28** and the head of adjusting bolt **32** make contact horizontally.
- Tighten lock nut **33** at specified torque.



[Butterfly valve **A** fully-closed adjustment]

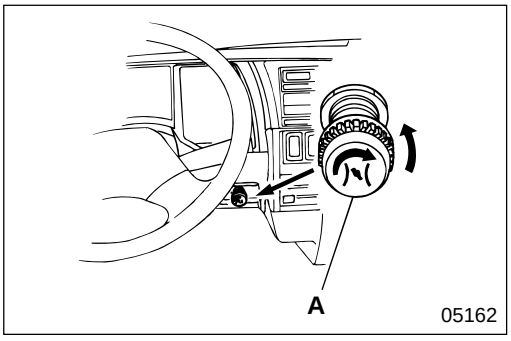
- Apply air pressure **B** of 685±49 kPa {100±7.1 psi, 7±0.5 kgf/cm^2} to control cylnder **11**.
- Turn adjusting bolt **30** so that the average value of clearances **D**, **E** between butterfly valve **A** and body **C** conforms to the standard value.
- Calculate the average of clearances **D**, **E** by (**D**+**E**)/2.
- Tighten lock nut **31** at specified torque.

Exhaust Brake Electric Equipment



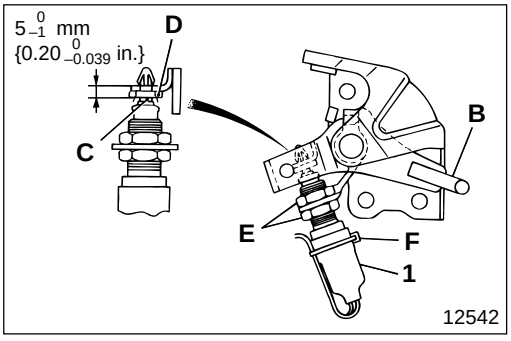
1 Accelerator switch
Gr 54
2 Clutch switch
Gr 21, 54
3 Exhaust brake switch
Gr 37, 54
4 3-way magnetic valve
Gr 54
5 Exhaust brake cut relay
Gr 54

◆ Service procedure



1 **Installation of accelerator switch**

- Turn idling control knob **A** in direction ➡ (counterclockwise) to free the accelerator pedal.



- Screw in accelerator switch **1**, holding accelerator control lever **B** still, until push rod **C** makes contact with stopper **D**. Then screw in by a further 5^{0}_{-1} mm {$0.20^{0}_{-0.039}$ in.} and tighten lock nut **E**.
- Secure accelerator switch **1** harness using band **F**.

MITSUBISHI
FUSO

Group 35E
Anti-Lock Brake System
(ABS)

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-35E

INDEX

SPECIFICATIONS 35E- 2

STRUCTURE AND OPERATION 35E- 2

ON-VEHICLE INSPECTION AND ADJUSTMENT

- **Periodic Inspection Procedures 35E-16**
- **Adjustment of Wheel Speed Sensor Clearance 35E-18**
- **Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope 35E-20**

TROUBLESHOOTING

- **Troubleshooting Procedures 35E-21**
- **Troubleshooting Flowchart 35E-22**
- **Tester 35E-24**
- **Procedure of Inspection Using Multi-Use Tester II 35E-26**
- **Procedure of Inspection Using Diagnosis Switch 35E-32**

ELECTRIC CIRCUIT AND PART INSTALLATION LOCATIONS 35E-38

SPECIFICATIONS/STRUCTURE AND OPERATION

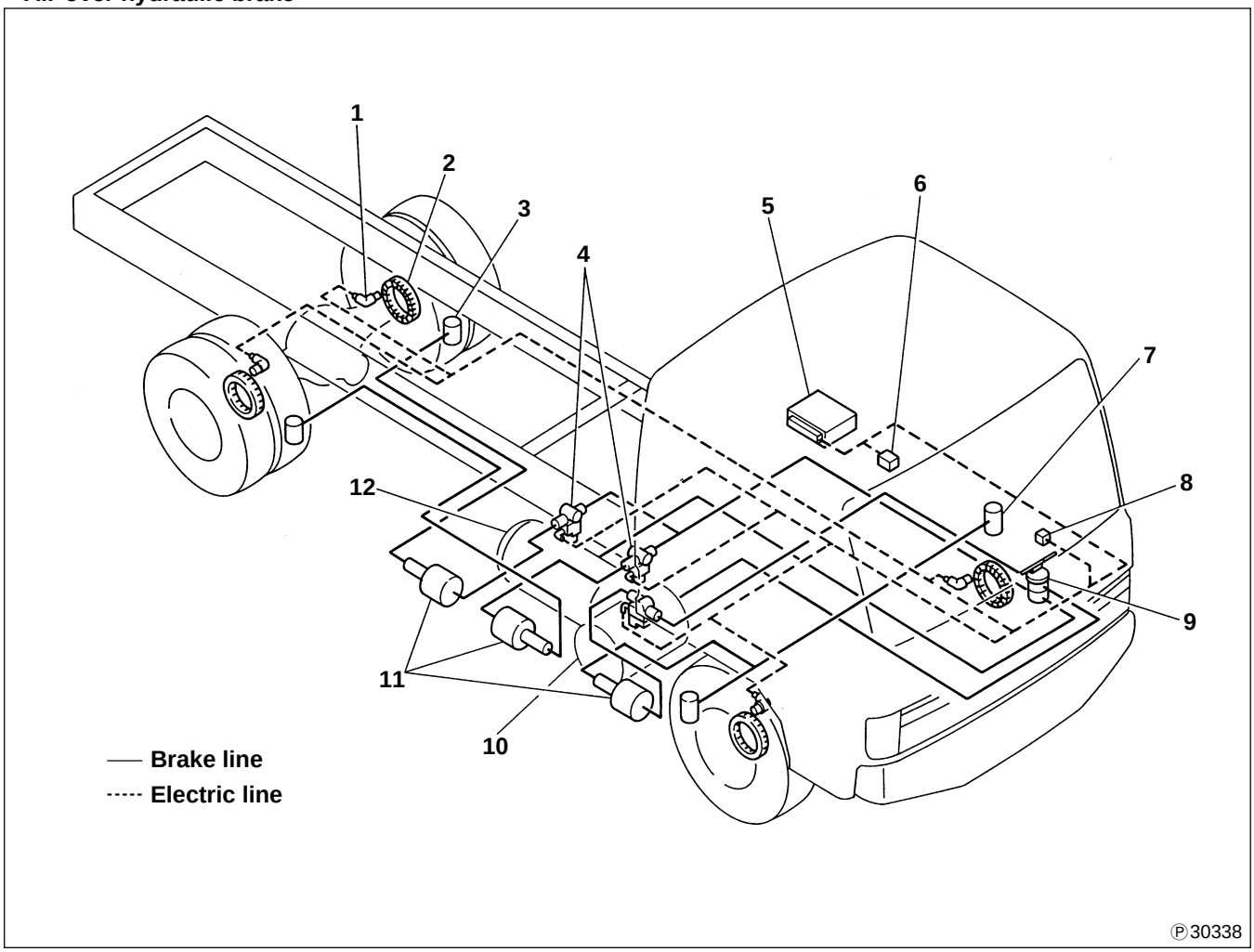
SPECIFICATIONS

Item \ Model	FK617	FM617	FM657
Brake system	Air-over hydraulic brake		Full-air brake
Anti-lock brake system (number of sensors/number of channels)	ABS (CN12: 4S/3K)		ABS (CN12: 4S/4K)
Manufacturer	NABCO		

STRUCTURE AND OPERATION
Anti-lock Brake System (ABS)

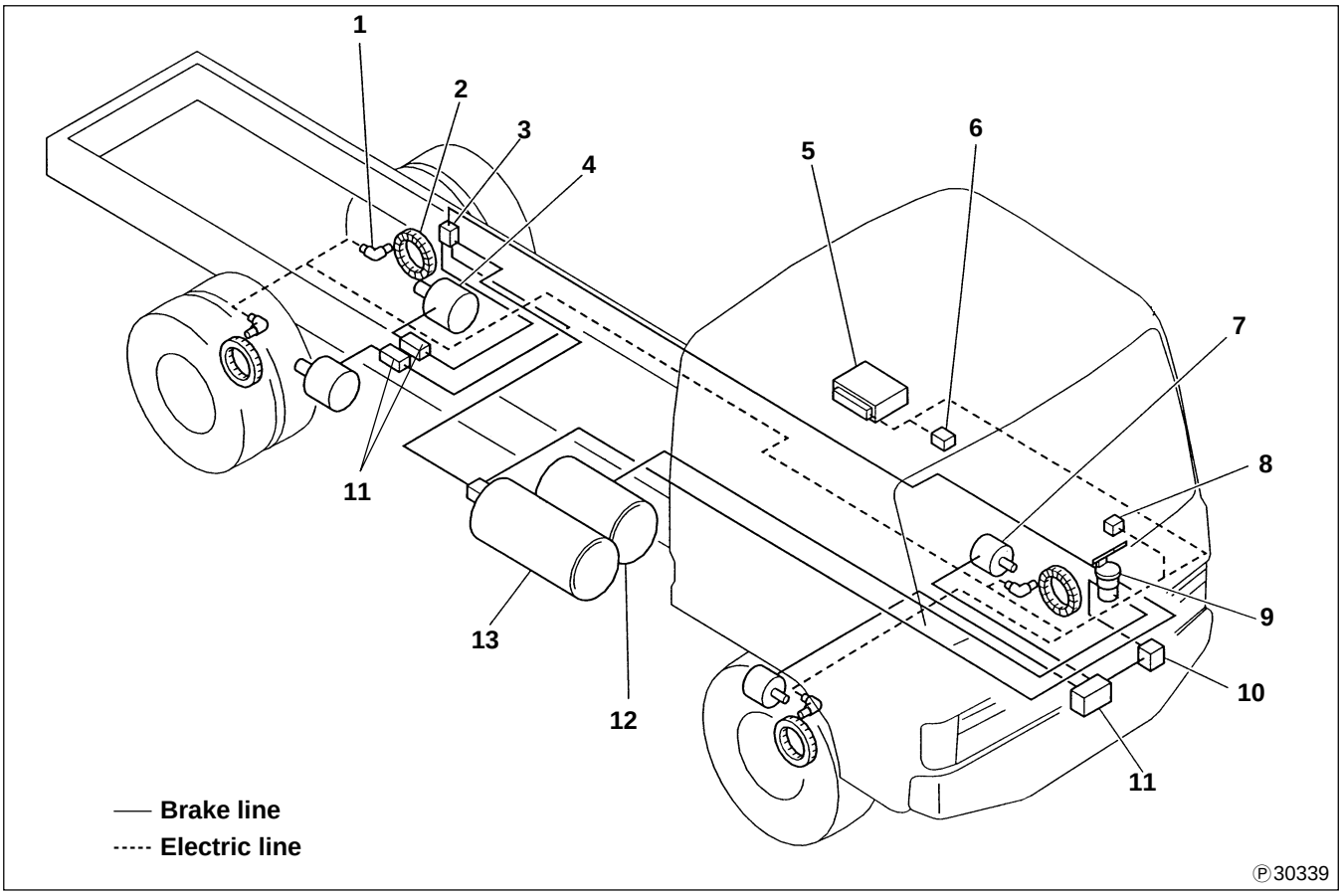
● System outline

< Air-over hydraulic brake >



1 Wheel speed sensor
2 Rotor
3 Rear wheel cylinder
4 Control valve
5 Electronic control unit
6 Exhaust brake cut relay
7 Front wheel cylinder
8 Anti-lock brake system warning lamp
9 Dual brake valve
10 Air tank (for front brake system)
11 Brake booster
12 Air tank (for rear brake system)

< Full-air brake >



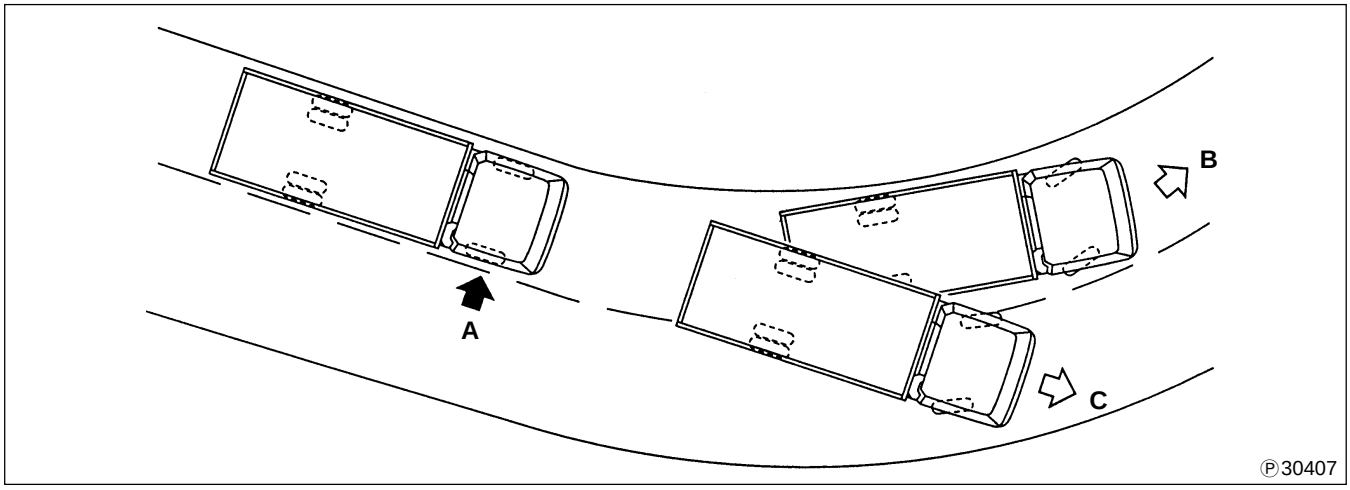
1 Wheel speed sensor
2 Rotor
3 Relay valve
4 Rear brake chamber
5 Electronic control unit
6 Exhaust brake cut relay
7 Front brake chamber
8 Anti-lock brake system warning lamp
9 Dual brake valve
10 Quick release valve
11 Control valve
12 Air tank (for front brake system)
13 Air tank (for rear brake system)

Anti-lock brake system prevents the slippage of tires resulting from wheel lockup that occurs during sudden braking on slippery pavement, thus helping maintain controllability and directional stability of the vehicle.
The following section explains how wheel lockup affects the vehicle's movement and directional stability.

Wheel lockup

Rotating tires of a moving vehicle have a tendency to travel in the direction of tire rotation. Therefore, a driver can control the vehicle's movement by turning the steering wheel to move the front tires to a desired direction. In a vehicle not equipped with Anti-lock brake system, when a driver presses the brake pedal all the way, wheel lockup occurs and tires stop rotating while the vehicle is still moving. Tires in this condition lose the tendency to maintain the direction of travel and slip in a direction of an externally applied force regardless of the tires' rotating direction. In other words, when wheels lock, the vehicle loses its directional stability, disallowing the driver to control the vehicle's movement. Anti-lock brake system eases the braking force on wheels before wheel lockup occurs, thus maintaining controllability and directional stability.

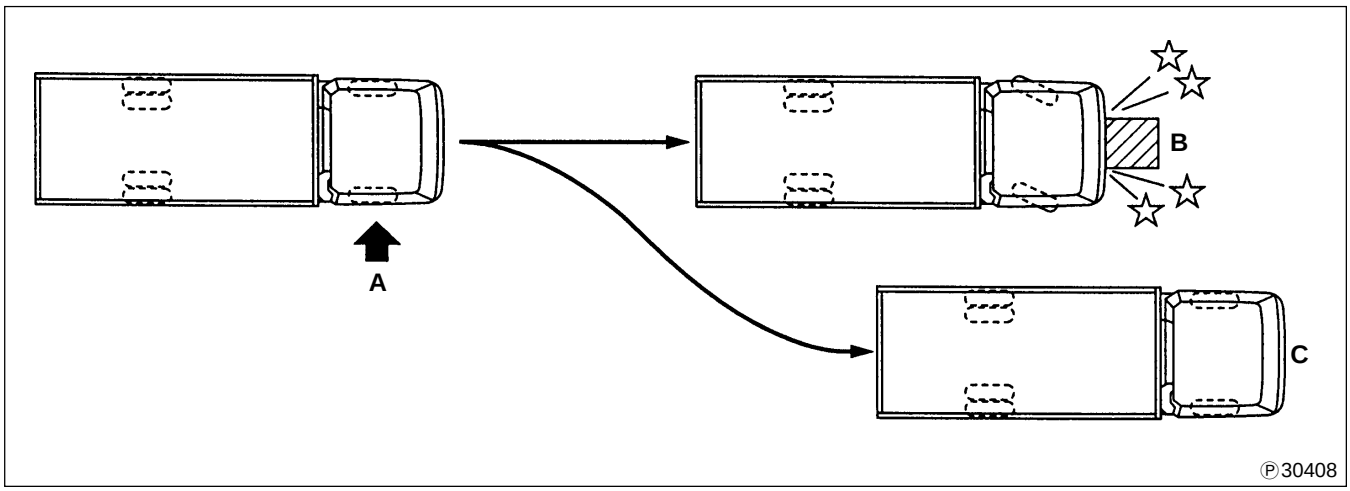
(1) Wheel lockup during cornering on slippery road



When wheel lockup occurs during braking at a curve on slippery pavement, the vehicle loses its directional stability and does not move in the steered direction.

A : Braking point (wheel lockup)
B : Steered direction
C : Vehicle continues to travel straight

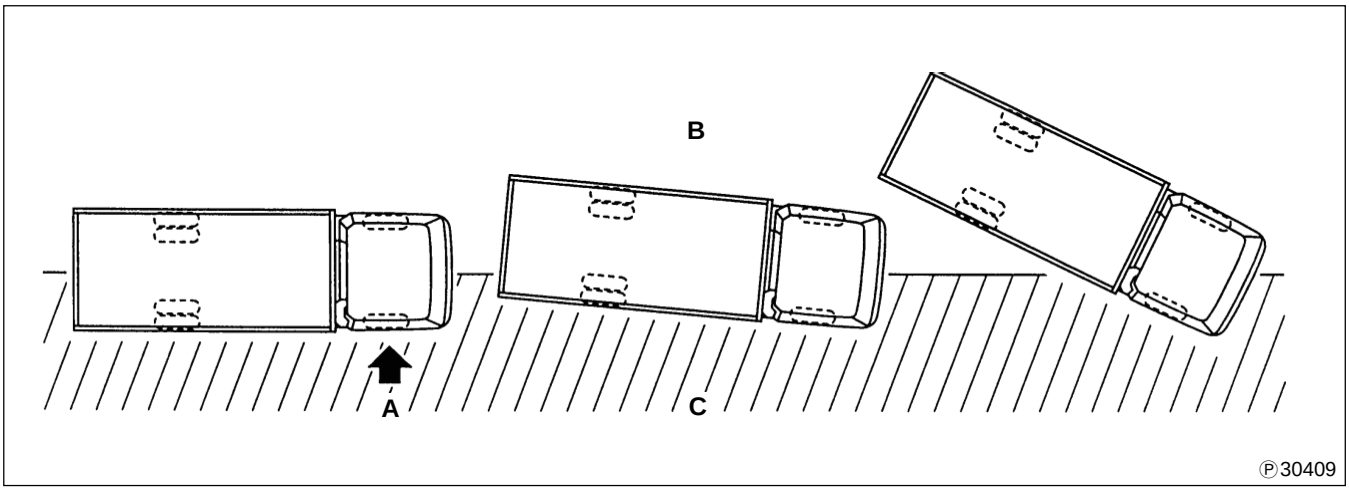
(2) Wheel lockup on straightway on slippery pavement



When wheel lockup occurs as a driver applies sudden braking on a straightway to avoid an obstacle ahead, the vehicle loses its directional stability and controllability. When this happens, the driver cannot control the vehicle's movement to avoid hitting the obstacle.

A : Braking point (wheel lockup)
B : Obstacle
C : Intended direction of vehicle movement

(3) Wheel lockup on surfaces with split μ factors (road surface with different friction coefficients for left and right wheels)



If the brake is applied hard when the friction coefficient of a road surface is different for the left and right tires, the tires which are on a surface with a lower friction coefficient lock up first and start sliding. Since the sliding of the tires on one side of the vehicle causes an imbalance in the stopping power between the left and right tires, one side of the vehicle slows down while the other side continues traveling at the same speed, resulting in the loss of directional stability. In this condition, the driver cannot maneuver the vehicle properly. When this happens during sudden braking, the vehicle spins.

A : Braking point (wheel lockup)
B : Slippery pavement
C : Non-slippery pavement

To prevent the above mentioned conditions, Anti-lock brake system controls the braking force to provide optimum stopping power to each wheel and prevents wheel lockup. Therefore, the vehicle maintains controllability and directional stability during hard braking without slipping or sliding.

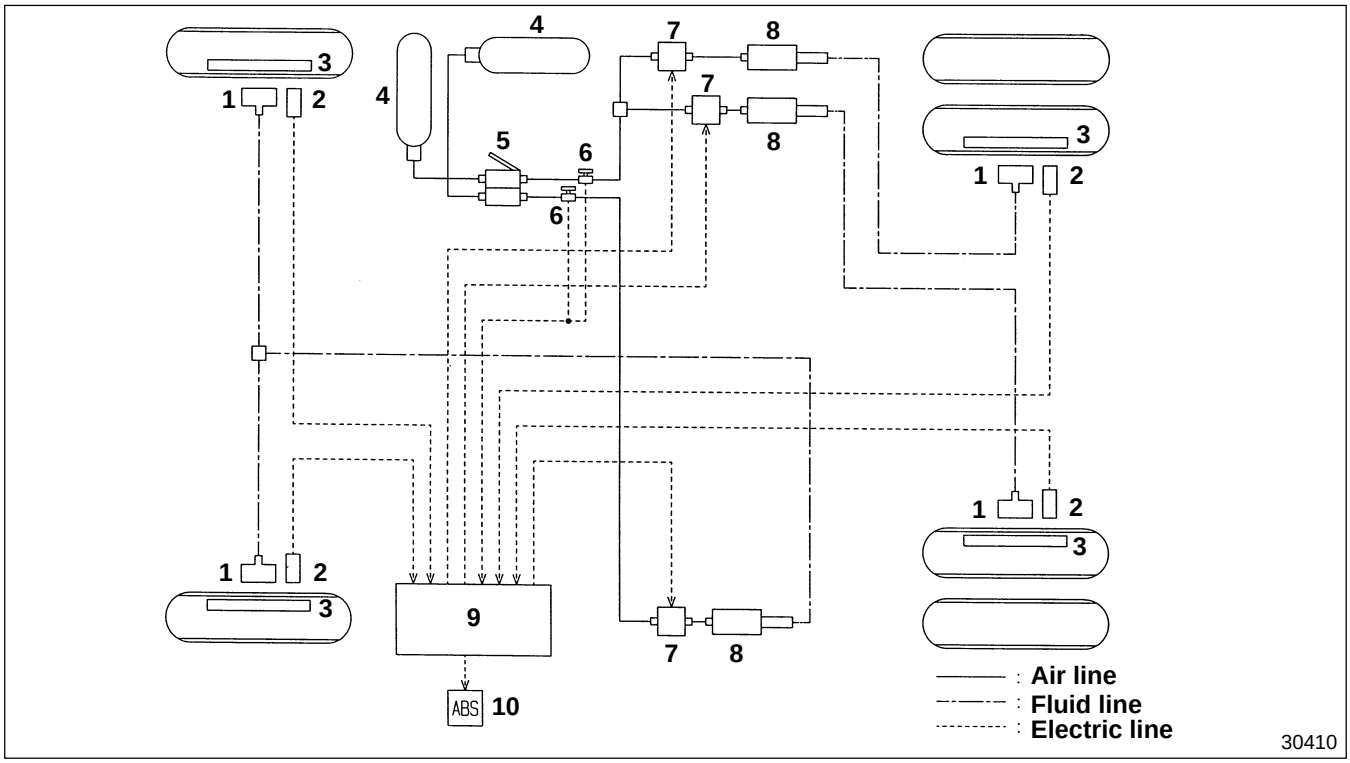
● Anti-lock brake system structure

Anti-lock brake system consists of wheel speed sensors **2** that detect wheel speed, control unit **9** that detects wheel lockup tendencies based on wheel speed data and outputs signals to control the braking force, control valves **7** that physically regulate the braking force, and Anti-lock brake system warning lamp **10** that indicates system abnormalities.

The following shows the Anti-lock brake system control process in a wheel lockup condition.

Schematic system diagram

< Air-over hydraulic brake >

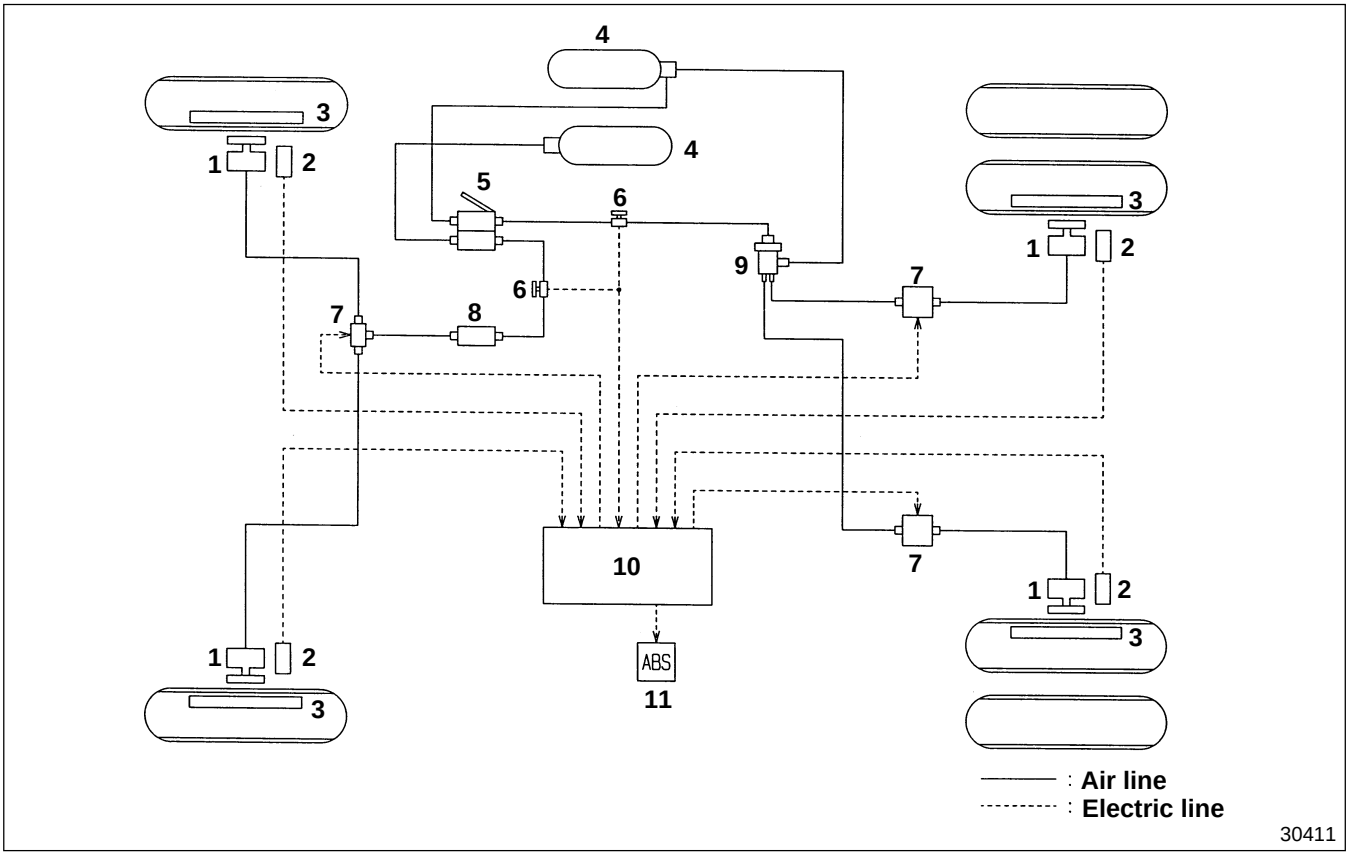


1 Wheel brake
2 Wheel speed sensor
3 Rotor
4 Air tank
5 Dual brake valve
6 Stop lamp switch
7 Control valve
8 Brake booster
9 Electronic control unit
10 Anti-lock brake system warning lamp

- Anti-lock brake system uses wheel speed sensors **2** and Electronic control unit **9** to monitor the rotating speed of wheels. When the wheel speed exceeds the preset deceleration speed or slip rate, the Electronic control unit detects it as the tendency leading to wheel lockup and activates control valves **7** to reduce air pressure inside brake boosters **8**. This decreases the braking force and prevents wheel lockup. Then, when the wheel speed increases, the wheel speed sensors send signals to the control valves by way of the Electronic control unit to increase air pressure in the brake boosters to augment the braking force.
- This control cycle is repeated to prevent wheel lockup on slippery pavements and ensure the vehicle's directional stability during braking. The 4-sensor 3-channel Anti-lock brake system uses four wheel speed sensors **2**, which are located at the front and rear wheels, to control each of the four wheels. For the front wheels, the control function is integrated for the left and right wheels.

Schematic system diagram

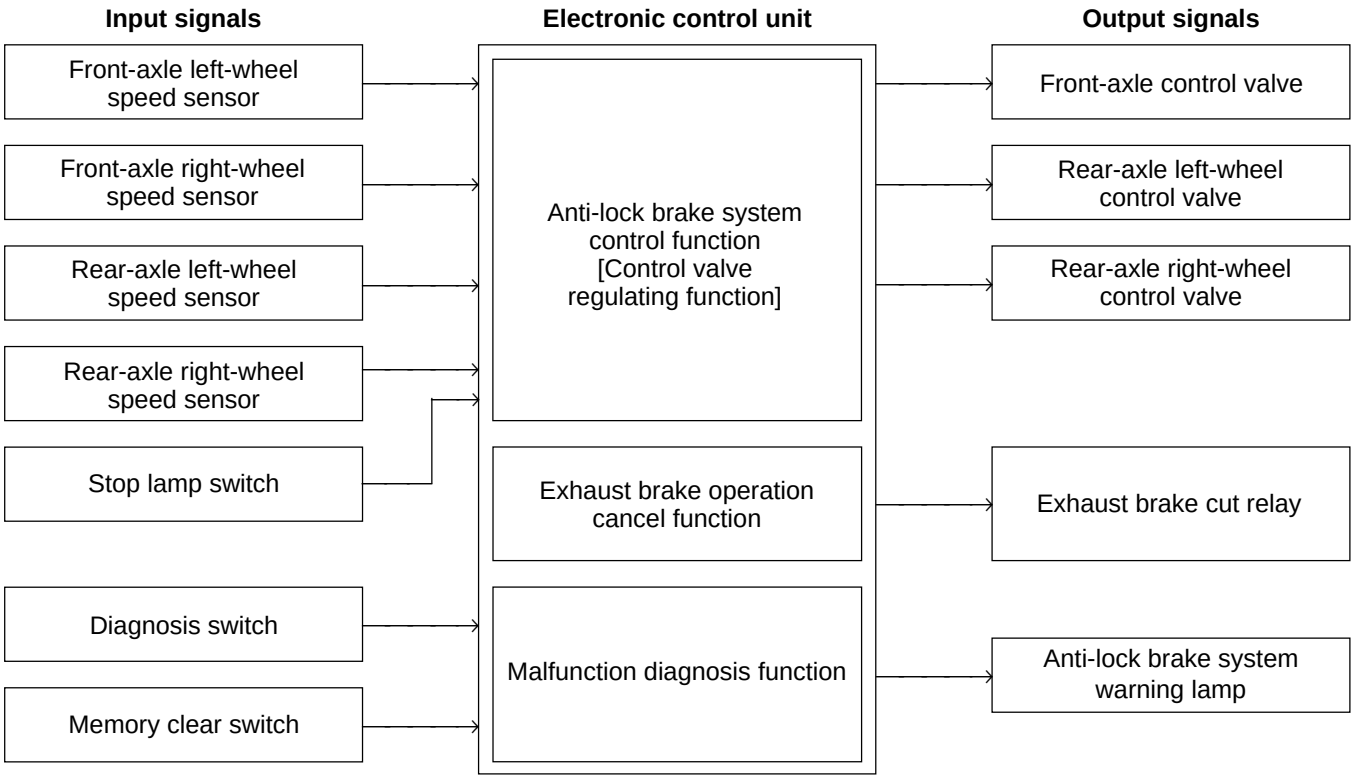
< Full-air brake >



1 Brake chamber
2 Wheel speed sensor
3 Rotor
4 Air tank
5 Dual brake valve
6 Stop lamp switch
7 Control valve
8 Quick release valve
9 Relay valve
10 Electronic control unit
11 Anti-lock brake system warning lamp

- Anti-lock brake system uses wheel speed sensors **2** and Electronic control unit **10** to monitor the rotating speed of wheels. When the wheel speed exceeds the preset deceleration speed or slip rate, the Electronic control unit detects it as a wheel lockup tendency and activates control valves **7** to reduce air pressure inside brake chambers **1**. This decreases the braking force and prevents wheel lockup. Then, when the wheel speed increases, the wheel speed sensors send signals to the control valves by way of the Electronic control unit to increase air pressure in the brake chambers to augment the braking force.
- This control cycle is repeated to prevent wheel lockup on slippery pavements and ensure the vehicle's directional stability during braking. The 4-sensor 3-channel Anti-lock brake system uses four wheel speed sensors **2**, which are located at the front and rear wheels, to control each of the four wheels. For the front wheels, the control function is integrated for the left and right wheels.

Anti-lock brake system function



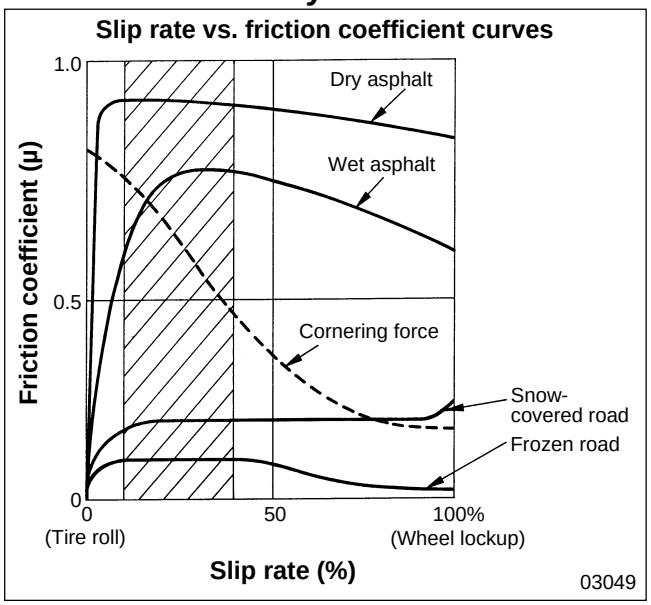
Anti-lock brake system malfunction diagnosis function

When the Electronic control unit detects malfunction of the following components, it turns on the Anti-lock brake system warning lamp to indicate the system abnormality.

- Broken wire, short-circuit or output abnormality in wheel speed sensors
- Broken wire or short-circuit in outlet and holding valves of control valves
- Broken wire, short-circuit or power supply voltage abnormality in power relays
- Abnormal detection of Electronic control unit

M E M O

● Anti-lock brake system control



To provide optimum stopping power, Anti-lock brake system controls the braking force based on the slip rate determined by the relationship between the wheel speed and vehicle speed. When the brake is applied, the resulting force creates resistance which slows down the wheel rotation, thus reducing the speed of the vehicle. However, inertia acts on the vehicle and maintains the vehicle's forward movement despite the stopping force applied by the tires. When there is a difference between the wheel speed and vehicle speed, slipping occurs. The degree of slippage is expressed by a slip rate.

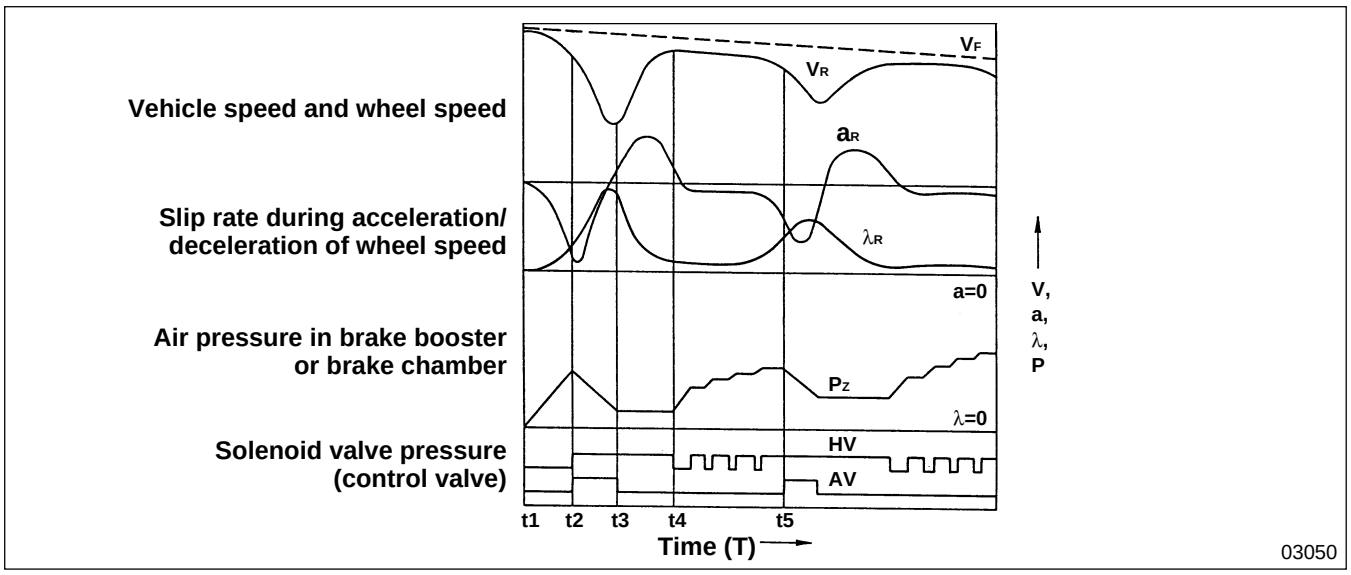
$$\text{Slip rate (\%)} = \frac{\text{Vehicle speed} - \text{Wheel speed}}{\text{Vehicle speed}} \times 100$$

When the slip rate is 0%, there is no slippage between the tires and pavement. The slip rate of 100% refers to a wheel lockup condition.

The graph shows the relationship between the slip rate and the friction coefficient of tire and pavement. In a vehicle equipped with Anti-lock brake system, the Electronic control unit and control valves adjust the braking force and maintains it within the shaded area on the graph where the friction coefficient is high, thus preventing tire slippage and maintaining stability during stopping.

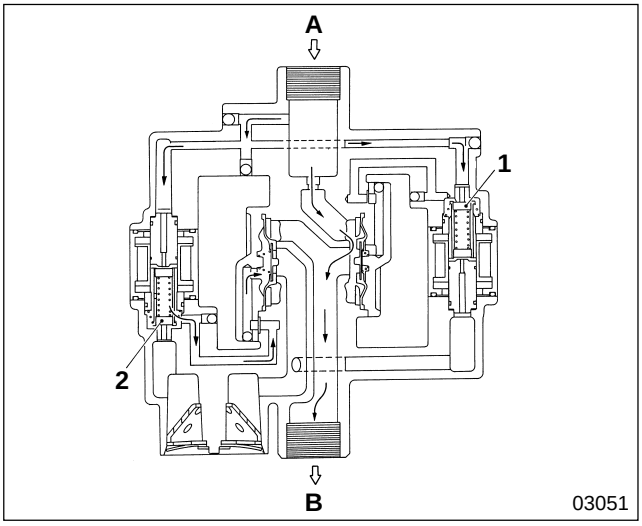
● Anti-lock brake system operation

Characteristic curve



The above Anti-lock brake system characteristic graph shows the time-based changes in vehicle speed, wheel speed of individual tires, and brake pressure levels during braking. The Electronic control unit calculates the wheel speed and estimates the vehicle speed based on signals sent from wheel speed sensors, and continuously monitors the slip rate and deceleration speed. When the Electronic control unit detects a tendency toward wheel lockup, it sends a signal to the solenoid valves of the control valves. The following shows the control system.

- **V_F** : Vehicle speed
- **V_R** : Wheel speed
- **a_R** : Acceleration/deceleration of wheel speed
- **λ_R** : Slip rate
- **P_Z** : Airpressure inside brake booster < air-over hydraulic brake > or brake chamber < full-air brake >
- **HV** : Solenoid valve (Pressure holding valve of control valve)
- **AV** : Solenoid valve (Outlet valve of control valve)

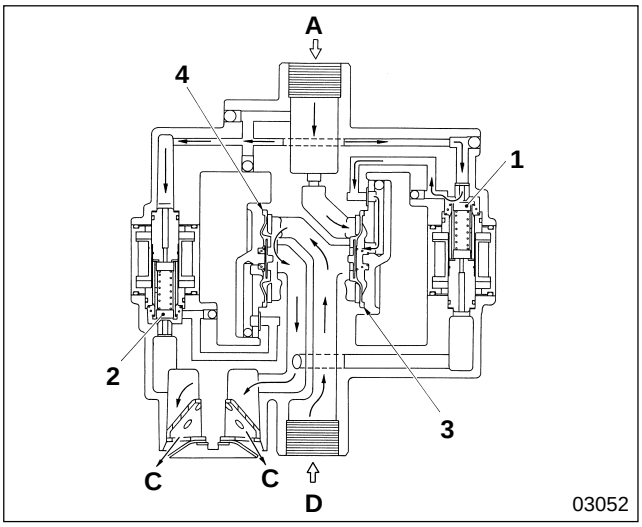


During normal braking

When there is no tendency toward wheel lockup under normal braking, solenoid valves **1**, **2** do not activate, thus air pressure is fed from the dual brake valve to the air master.

A : From dual brake valve < air-over hydraulic brake > From quick release valve (front) and relay valve (rear) < full-air brake >

B : To brake booster < air-over hydraulic brake > To brake chamber < full-air brake >



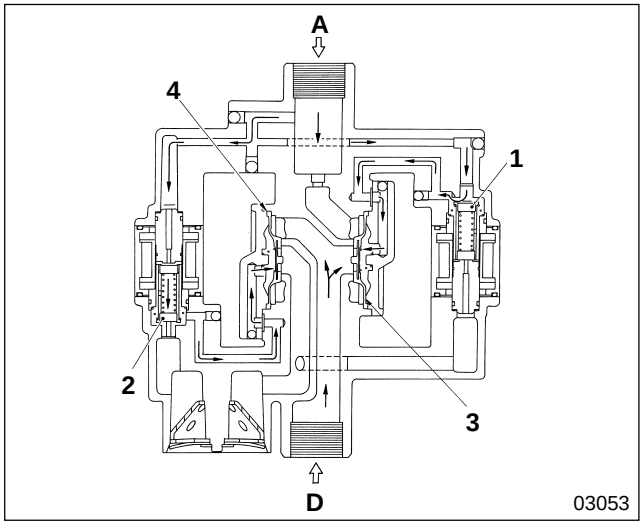
During depressurizing

- When the brake is applied at t_1 on the previous Anti-lock brake system characteristic graph, the air pressure inside the brake boosters or brake chambers increases, and the vehicle speed and wheel speed start decreasing. When the wheels show a tendency toward wheel lockup at t_2 on the graph, the Electronic control unit outputs a control signal to turn ON solenoid valve (holding valve) **1** and solenoid valve (outlet valve) **2**.
- Pressure holding valve **3** closes, and outlet valve **4** opens, discharging the air from the brake booster or brake chamber to minimize the wheel lockup tendency. ($t_2 \rightarrow t_3$)

A : From dual brake valve < air-over hydraulic brake > From quick release valve (front) and relay valve (rear) < full-air brake >

C : Pressure discharge

D : From brake booster < air-over hydraulic brake > From brake chamber < full-air brake >



During pressure holding

- At t_3 on the previous Anti-lock brake system characteristic graph, solenoid valve (outlet valve) **2** turns OFF and closes outlet valve **4**. Therefore, the air pressure inside the brake booster or brake chamber is retained. This makes the slip rate closer to ($\lambda = 0$) and the wheel speed increases.
- At t_4, solenoid valve (holding valve) **1** repeats ON and OFF operations until t_5. Momentary opening and closing of pressure holding valve **3** increase the pressure in steps. This operation reduces the wheel speed. The above control cycle ($t_2 \rightarrow t_5$) is repeated until the vehicle comes to a complete stop.

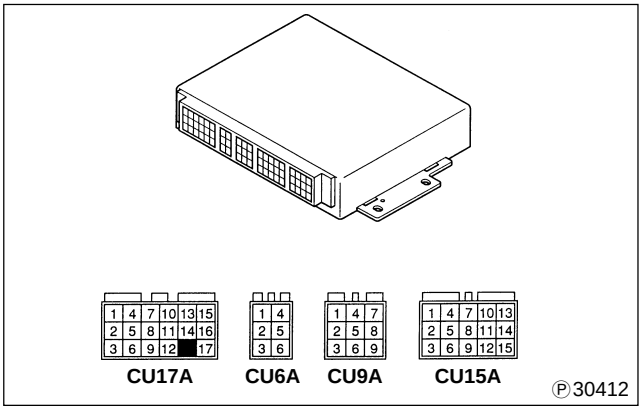
  A : From dual brake valve < air-over hydraulic brake > From quick release valve (front) and relay valve (rear) < full-air brake >

  D : From brake booster < air-over hydraulic brake > From brake chamber < full-air brake >

Anti-lock brake system and exhaust brake

On slippery pavement, the use of the exhaust brake can result in a condition similar to wheel lockup. Therefore, if the exhaust brake is activated while the Anti-lock brake system control is in operation, it hinders the Anti-lock brake system from providing proper brake control. To prevent this, when the Anti-lock brake system is in operation, the exhaust brake is deactivated even when the exhaust brake switch is turned ON.

When the Anti-lock brake system deactivates, the exhaust brake provides its normal function when the exhaust brake switch is ON.



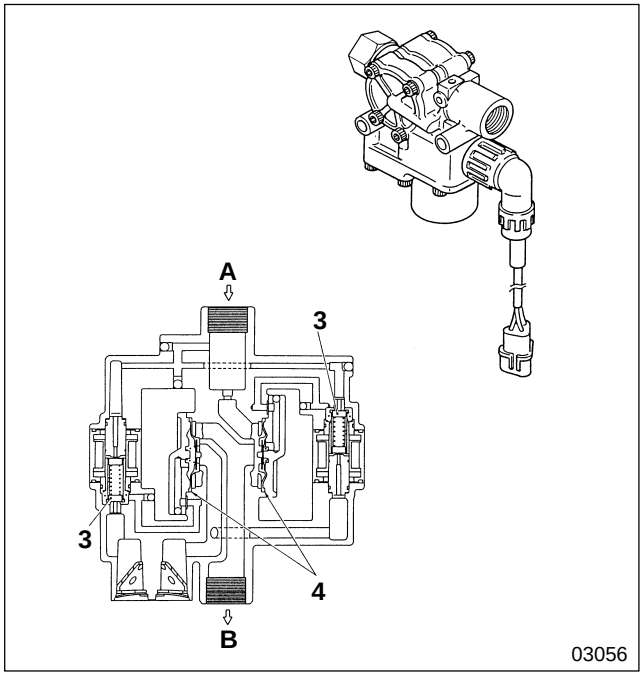
● Anti-lock brake system components

Electronic control unit

This component calculates the wheel speed and estimates the vehicle speed based on a signal sent from the wheel speed sensors. Based on the calculation results, it determines a tendency for wheel lockup, and sends a brake pressure control signal to the solenoid valves of the control valves to regulate air pressure accordingly.
The Electronic control unit is equipped with a self-diagnosis function. If an abnormality occurs, the Electronic control unit turns on the warning lamp to indicates the system malfunction and deactivates the Anti-lock brake system control to set the brake system in the normal condition (without Anti-lock brake system control).

Connector type	Terminal No.	Connection destination
CU17A	1	—
	2	—
	3	—
	4	Memory clear switch
	5	Diagnosis switch
	6	—
	7	Fuse (M12 Electronic control unit power supply)
	8	Fuse (B20 control valve power supply)
	9	Fuse (B20 control valve power supply)
	10	Grounding
	11	Grounding
	12	Grounding
	13	Multi-Use Tester II connector
	14	Multi-Use Tester II connector
	15	—
	16	Exhaust brake cut relay
	17	Anti-lock brake system warning lamp
CU6A	1	Control valve (front outlet)
	2	—
	3	Control valve (front grounding)
	4	Wheel speed sensor (front-axle left-wheel input)
	5	Wheel speed sensor (front-axle left-wheel grounding)
	6	Stop lamp relay

Connector type	Terminal No.	Connection destination
CU9A	1	—
	2	—
	3	—
	4	Wheel speed sensor (front-axle right-wheel input)
	5	Wheel speed sensor (front-axle right-wheel grounding)
	6	—
	7	—
	8	Control valve (front holding)
	9	—
CU15A	1	Control valve (rear LH outlet)
	2	Control valve (rear LH holding)
	3	Control valve (rear LH grounding)
	4	—
	5	Wheel speed sensor (rear-axle left-wheel input)
	6	Wheel speed sensor (rear-axle left-wheel grounding)
	7	—
	8	Wheel speed sensor (rear-axle right-wheel input)
	9	Wheel speed sensor (rear-axle right-wheel grounding)
	10	Control valve (rear RH outlet)
	11	Control valve (rear RH holding)
	12	Control valve (rear RH grounding)
	13	—
	14	—
	15	—



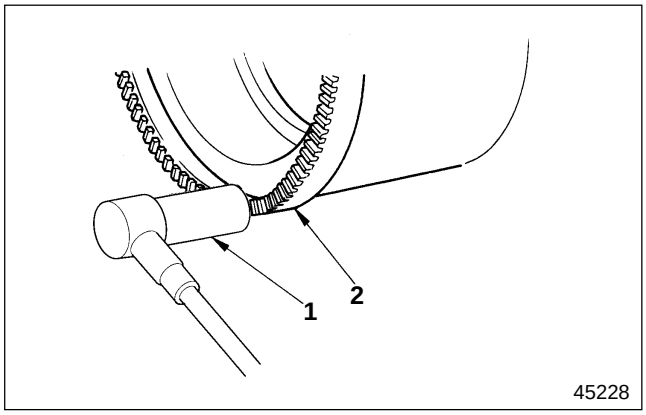
Control valve

The valve is comprised of solenoid valves **3** that receive a signal from the Electronic control unit and controls air pressure supplied from the dual brake valve, and diaphragm valves **4**.

The two solenoid valves operate in different combinations to increase, maintain and decrease air pressure.

A : Inlet port 1 (From dual brake valve < air-over hydraulic brake > or quick release valve (front), and relay valve (rear) < full-air brake >)

B : Outlet port 2 (To brake booster < air-over hydraulic brake > or brake chamber < full-air brake >)



Wheel speed sensor

Wheel speed sensor **1** detects the rotating speed of the wheel and sends a signal to the Electronic control unit. The sensor unit houses an electromagnetic pickup with a permanent magnet core placed inside the coil.

Rotor **2** is connected to the wheel hub. The rotor has a ring gear, and the evenly spaced tooth ridges are positioned perpendicular to the sensor. When the wheel rotates and the rotor teeth cross the magnetic flux of the sensor, the electric potential difference generated by the coil results in an alternate-current voltage that is directly proportional to the rotating speed. The resulting signal is then sent to the Electronic control unit.

M E M O

ON-VEHICLE INSPECTION AND ADJUSTMENT

Periodic Inspection Procedures

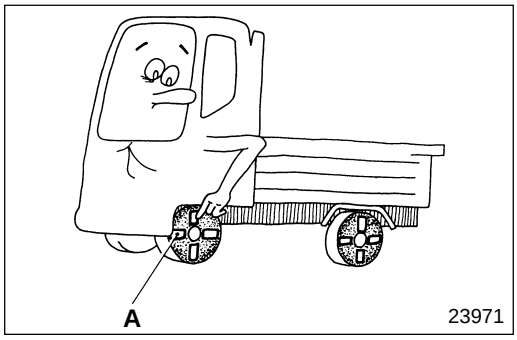
(1) Periodic inspection of Anti-lock brake system

- Inspect the vehicle's Anti-lock brake system following the procedure below.
- If an abnormality is found in this inspection, further inspect the Anti-lock brake system using Multi-Use Tester II or the diagnosis switch by referring to TROUBLESHOOTING section.
  P35E-21

- Inspection procedure

① With the vehicle stationary, press the brake pedal and inspect the control valves for air leaks.
If air leaks from the control valve unit, replace it. If air leaks from the air pipe or connector, tighten the joint.
Then, release the brake pedal and inspect the air discharge condition of the control valve. If there is no air discharging operation, replace the control valve.
Conduct the above inspection for each control valve.

② Inspection using brake tester
Check the braking force at each wheel with a brake tester by following the inspection procedure for ordinary vehicles.
If an abnormality is found, inspect the wheel brake units, service brake system and control valves.



③ Drive the vehicle and check the operation of the Anti-lock brake system.
- Conduct a test drive at an open area to ensure safety.
- Conduct a test drive without cargo.

Attach white tape **A** on the sides of tires, so that it is easy to observe the rotation of the front and rear wheels.
- Turn the starter switch from the OFF position to the ON position, and make sure that the ABS warning lamp lights.
  Then, check that the ABS warning lamp turns off approximately two seconds after the starter switch is turned on.
- Drive the vehicle at a speed of 20 to 30 km/h {12 to 19 mph}, and apply a sudden brake. Make sure that wheel lockup does not occur in any of the tires.

(2) Operating conditions resulting from Anti-lock brake system malfunction

Lamp condition	Possible causes		Fail-safe functions (operation in the case of malfunction)
ABS warning lamp ABS Warning lamp does not turn off two seconds after starter switch is turned on. ① ABS warning lamp lights when starter switch is turned to ON position, does not turn off two seconds after starter switch is turned on. ② ABS warning lamp lights during driving. ③ ABS warning lamp lights after 30 to 60 minutes regardless of whether vehicle is driven or stationary.	Power supply system (Lamp condition: ①, ②)	Faulty relay (for power supply) inside Electronic control unit	Anti-lock brake system control becomes inactive for all systems, and all wheels operate under normal brake system.
		Blown fuse	
		Broken wire in harness, short-circuit or disconnected connector, faulty contact or faulty grounding	
		Low battery voltage	
	Wheel speed sensor system	Excessive clearance between wheel speed sensor and rotor (Lamp condition: ②)	¥When malfunction occurs in one front wheel Properly operating front wheel speed sensor of the other front wheel is used for Anti-lock brake system control of the wheel with malfunctioning sensor. ¥When malfunction occurs in both front wheels Anti-lock brake system control is deactivated for front wheels. ¥When malfunction occurs in one rear wheel Anti-lock brake system control is provided only to the rear wheel with properly operating sensor.
		Defective wheel speed sensor (Lamp condition: ①, ②)	
		Broken wire, short-circuit or disconnected connector or faulty contact in wheel speed sensor harness (Lamp condition: ①, ②)	
	Control valve system (Lamp condition: ①, ②)	Short-circuit in coil or power-supply side of harness	Anti-lock brake system control becomes inactive for all systems, and all wheels operate under normal brake system.
		Defective relay (for power supply) inside Electronic control unit	
	Control valve	Broken wire or short-circuit in coil or harness	Only the properly operating control valves are used for Anti-lock brake system control.
	Electronic control unit (Lamp condition: ①, ③)	Electronic control unit internal malfunction or disconnected connector	Anti-lock brake system control becomes inactive for all systems, and all wheels operate under normal brake system.
	ABS warning lamp system (Lamp condition: ①, ②)	Short-circuit in harness	Anti-lock brake system control operates normally.

Adjustment of Wheel Speed Sensor Clearance

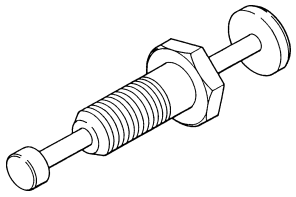
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

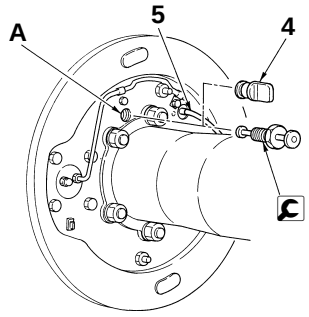
Location	Parts to be tightened	Tightening torque	Remarks
7	Bolt (Anchor bracket mounting)	135 {100, 13.8}	—

Special tools

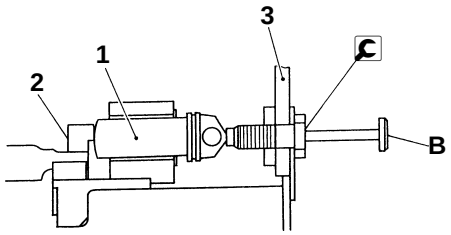
Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Adjuster  14912	MH062080	Adjustment of wheel speed sensor clearance

< Air-over hydraulic brake >



14913



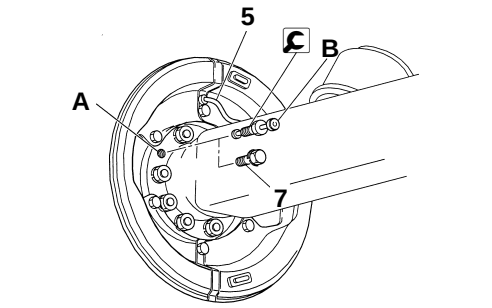
23974

Tighten adjuster to extend wheel speed sensor **1**, and adjust clearance between the sensor and rotor **2**.

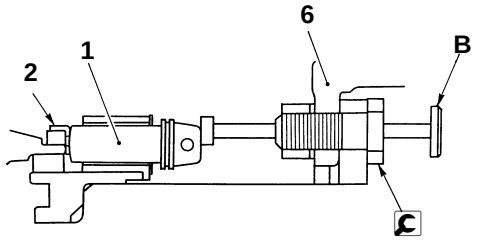
- Remove plug **4** located on the back side of back plate **3**.
- Mount adjuster in adjustment hole **A**, and tighten the adjuster.
- Wheel speed sensor **1** contacts the rotor before adjuster is completely tightened. Therefore, do not press shaft **B**, and tighten the adjuster until resistance is felt.
- Be sure to reinstall plug **4** after adjustment.

5 : Wheel speed sensor harness

< Full-air brake >



Ⓟ30555



23976

Tighten 🔧 adjuster to extend wheel speed sensor **1**, and adjust clearance between the sensor and rotor **2**.

- Remove bolt **7** located on the back side of anchor bracket **6**.
- Mount 🔧 adjuster in adjustment hole **A**, and tighten the adjuster.
- Wheel speed sensor **1** contacts the rotor before 🔧 adjuster is completely tightened. Therefore, do not press shaft **B**, and tighten the adjuster until resistance is felt.
- After adjustment, tighten bolt **7** to the specified torque.

5 : Wheel speed sensor harness

Inspection of Wheel Speed Sensor Signal Waveform Using Oscilloscope

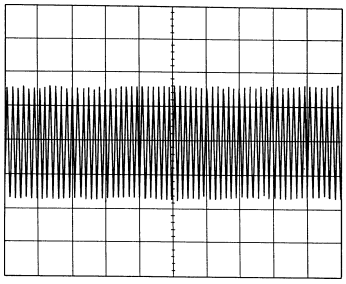
Inspect the rotor for dents using an oscilloscope, since the tester cannot be used for dent detection.

NOTE

Use an oscilloscope with a waveform recording function.

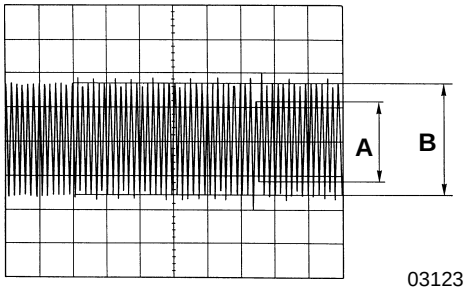
- Lift the wheel to be tested off the ground, and disconnect the connector at the wheel speed sensor.
- Connect the terminal of the oscilloscope to the terminal of the disconnected connector. Rotate the wheel at a constant speed. Check the waveform shown on the oscilloscope to check for dents on the rotor.

Normal waveform (no dent on rotor)



03122

Abnormal waveform (with dents on rotor)



03123

- Rotor dents are often made by the rotor press-fit on the hub end contacting the axle during installation of the hub and brake drum assembly on the axle. When installing the hub & brake drum assembly, pay close attention to prevent the rotor from contacting other parts.

A : Vmin (Minimum peak)

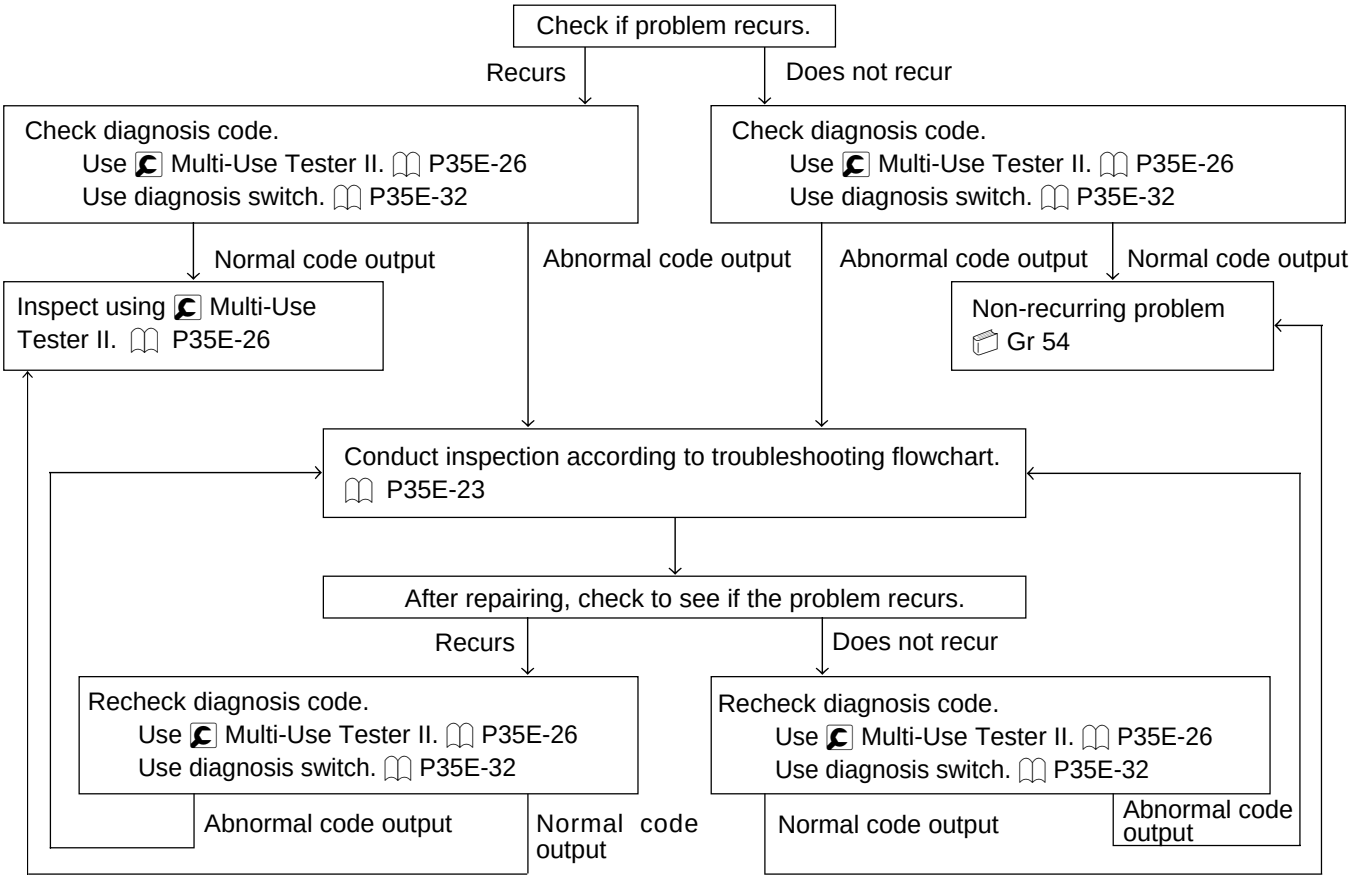
B : Vmean (Average of maximum peaks)

$$\frac{\text{Vmean} - \text{Vmin}}{\text{Vmean}} = 0.2(20\% \text{ or lower})$$

If more than 20%, replace the rotor.

Troubleshooting Procedures

Inspection the following components when the ABS warning lamp lights.
When the above warning lamp lights, conduct an inspection according to the following flowchart.



TROUBLESHOOTING

Troubleshooting Flowchart

- The Electronic control unit is equipped with a diagnosis function that monitors system operations. If the diagnosis function detects an abnormality, it turns on the ABS warning lamp on the meter cluster and stores the problem location data.
- The stored problem location data can be recalled by using Multi-Use Tester II or the diagnosis switch.
- Follow the instruction below to recall diagnosis codes.

(1) Multi-Use Tester II
Multi-Use Tester II displays diagnosis codes that indicate problem locations. The Multi-Use Tester II can also be used to check service data and actuator operations. P35E-26

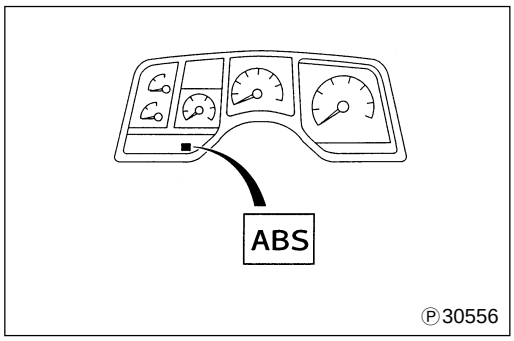
(2) Diagnosis switch
The diagnosis switch allows the indication of diagnosis codes and problem locations. When the diagnosis switch is operated, the ABS warning lamp on the meter cluster flashes. The number of lamp flashing operations indicates the code of problem location stored in the Electronic control unit. P35E-32

(3) Deletion of diagnosis code data
The method of erasing diagnosis code data from the Electronic control unit memory differs from model to model. Follow the procedure below.
- Multi-Use Tester II P35E-27
- Memory clear switch P35E-33

- Check the following items before conducting the troubleshooting described on the following page.

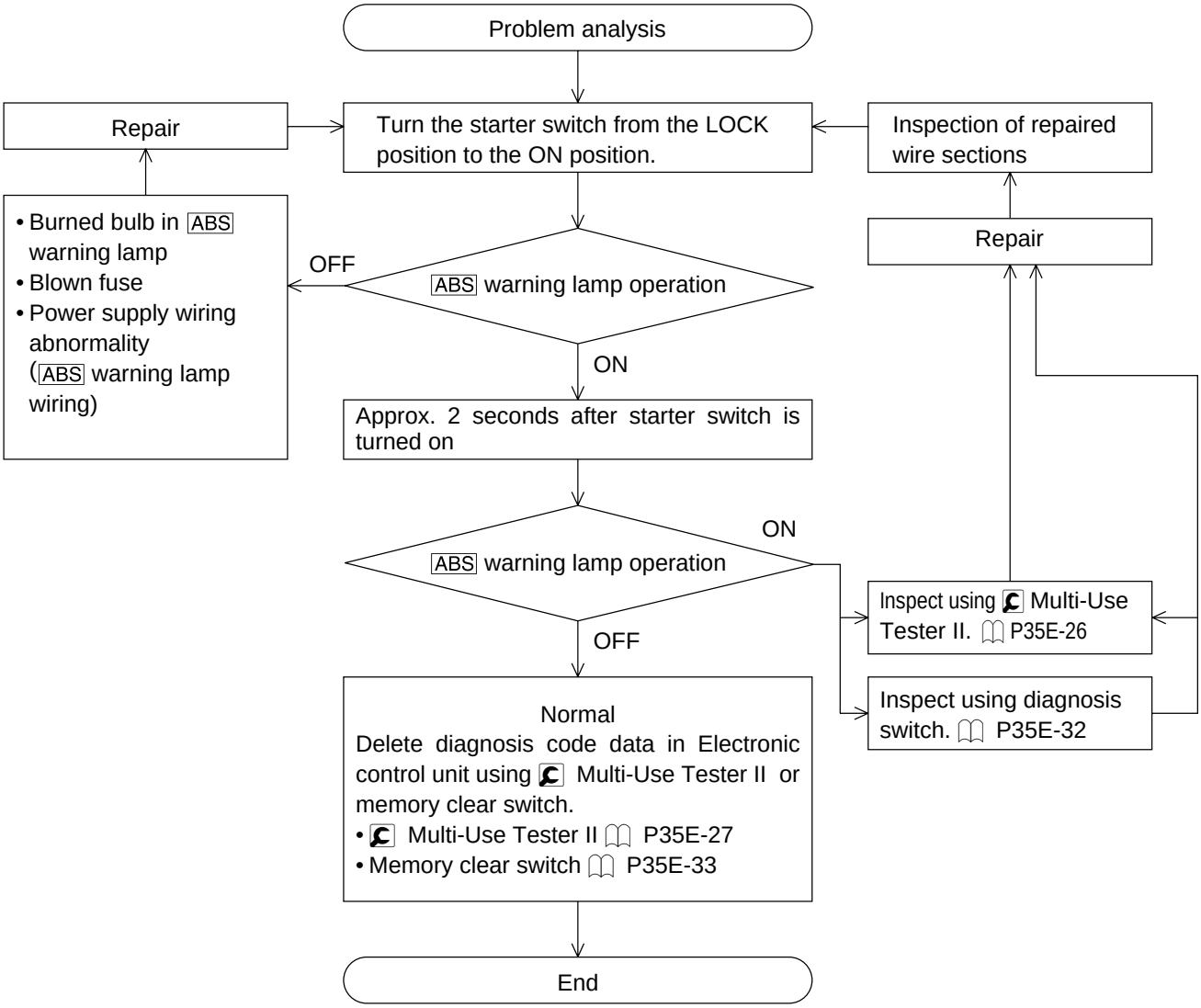
(1) Check to make sure that air pressure in the air tank is 685 kPa {100 psi, 7 kgf/cm^2} or higher.
(2) Check to make sure that the battery voltage is 12 V or higher.
(3) Check harness and connectors for secure connection. Before disconnecting connectors, turn starter switch to the LOCK position and wait for 20 seconds or longer.

- To inspect the ABS warning lamp, follow the procedure below.



- Check to see that the ABS warning lamp turns on and off in the following manner.
- Turn the starter switch to the ON position and check to see that the ABS warning lamp lights.
- The ABS warning lamp turns off approximately two seconds after the starter switch is turned on.
- If the warning lamp does not turn on and off in the above manner, check the diagnosis code. P35E-26, 32

< Troubleshooting Flowchart >



TROUBLESHOOTING

Tester

To inspect Anti-lock brake system, use Multi-Use Tester II.

(1) The Multi-Use Tester II displays inspection items on its LCD for easy data reading. It also enables detection of connection errors after rear wheel sensor connectors are repaired.

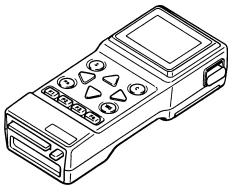
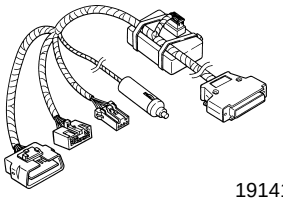
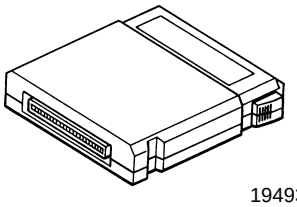
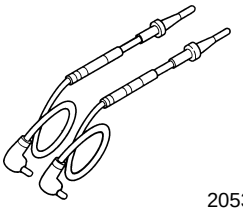
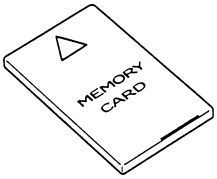
(2) The following items can be checked by the tester.

Inspection item
Diagnosis code
Service data
Actuator operation
Electronic control unit power supply voltage
Control valve power supply voltage
Stop lamp switch
Exhaust brake cut relay
ABS warning lamp
Control valve function
Wheel speed sensor function
Diagnosis switch

For details of tester inspection items, see the following pages. P35E-26

Special tools

Unit : mm {in.}

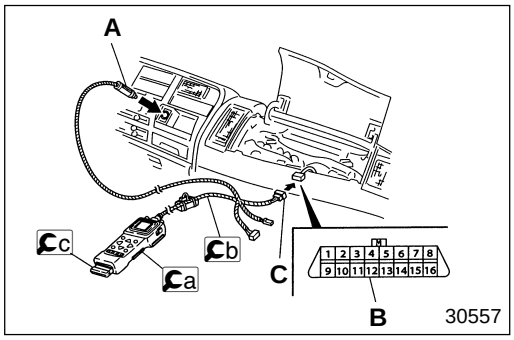
Tool name and shape	Part No.	Application
Multi-Use Tester II PLUS  19492	MB991496	Inspection of Anti-lock brake system
Multi-Use Tester II harness (for data communication)  19141	MK327601	
ROM pack (MRT-E8.1)  19493	MH063580	
Multi-Use Tester II harness (for circuit tester)  20536	MB991499	
Memory card (for Multi-Use Tester II)  20538	MB991500	

Procedure of Inspection Using Multi-Use Tester II

Use the Multi-Use Tester II to conduct necessary service operations listed below.

Test the operations of actuators related to the problem locations indicated by diagnosis codes, and inspect data list.

- Recall of diagnosis codes P35E-27
  Use the self-diagnosis function to recall the diagnosis codes stored in the Electronic control unit.
  Diagnosis codes of both current and previous malfunctions are indicated.
  The diagnosis code of the current malfunction is indicated when the starter switch remains in the ON position after abnormality generation.
  When the starter switch is turned from the ON position to the ACC or LOCK position after abnormality generation, diagnosis codes of previous malfunctions stored in the Electronic control unit are indicated. Diagnosis codes of non-recurring problem malfunctions that generated during vehicle operation but did not reproduce after the starter switch is turned from the ON position to the ACC or LOCK position are also stored as previous malfunctions.
- Deletion of diagnosis codes P35E-27
  Use the diagnosis code delete function in the special test mode to erase diagnosis codes stored in the Electronic control unit.
- Forced drive of devices P35E-31
  Use the actuator test function to forcibly turn devices on and off to check faulty device operations.
- Service data check and switch on/off check P35E-30
  Use the data list function to check the data of voltage and vehicle speed. When each switch is turned on and off in the data list mode using the tester, the Multi-Use Tester II displays the ON and OFF switch status, thus allowing inspection of switches for proper function after repair or replacement is performed.
- Use the above Multi-Use Tester II functions to locate causes of malfunctions.
- The following shows how to connect and use the Multi-Use Tester II. For other Multi-Use Tester II functions and further details, refer to the Multi-Use Tester II operation manual.



Connection of Multi-Use Tester II

- Turn the starter switch to the LOCK position.
- Connect ca Multi-Use Tester II and cb Multi-Use Tester II harness, and insert cc ROM pack.
- Insert connector **A** into the cigarette lighter socket.
  Connect connector **C** (16-pin) to Multi-Use Tester II connector **B** (16-pin) located inside the relay and fuse box.

NOTE

Regarding the operating procedure, refer to the Multi-Use Tester II operation manual.

Diagnosis code of current malfunction

- Turn the starter switch to the ON position.
- Check the diagnosis code using the self-diagnosis function of Ca Multi-Use Tester II to obtain data of the problem location.
  P35E-28

Diagnosis codes of previous malfunctions

- Turn the starter switch to the ON position.
- With the diagnosis switch disconnected, disengage the memory clear switch to set the Electronic control unit to the previous malfunction indication mode. P35E-33
- Check the diagnosis codes of previous malfunctions using the self-diagnosis function of Ca Multi-Use Tester II, and obtain data of problem locations. P35E-33
- After checking diagnosis codes, connect the diagnosis switch and memory clear switch in that order.

Deletion of diagnosis codes

- Turn the starter switch to the ON position.
- Delete all diagnosis codes stored in the Electronic control unit by using Ca Multi-Use Tester II.

CAUTION⚠

- **Before erasing diagnosis codes, test-drive the vehicle after the malfunction is repaired (when system is in normal condition), and make sure the ABS warning lamp is not lit.**
- **If diagnosis codes are deleted when some of the connectors are not connected or the system is still malfunctioning, the Electronic control unit becomes damaged.**

Diagnosis Code Chart

Multi-Use Tester II indication		Possible cause
Diagnosis code	Problem location	
21	FL-SNSR GAP	Front-axle left-wheel speed sensor: Improper clearance
22	FL-ROTA	Excessive wobbling of front-axle left rotor
23	FL-ROTA	Damaged front-axle left rotor
24	FL-SNSR SHORT	Front-axle left-wheel speed sensor: Prolonged period of unstable output
25	FL-SNSR OPEN	Front-axle left-wheel speed sensor: Abnormally fast speed drop
26	FL-SNSR WIRE	Front-axle left-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
27	FL-SNSR ECU	Front-axle left-wheel speed sensor: Electronic control unit internal damage
31	FR-SNSR GAP	Front-axle left-wheel speed sensor: Improper clearance
32	FR-ROTA	Excessive wobbling of front-axle right rotor
33	FR-ROTA	Damaged front-axle right rotor
34	FR-SNSR SHORT	Front-axle right-wheel speed sensor: Prolonged period of unstable output
35	FR-SNSR OPEN	Front-axle right-wheel speed sensor: Abnormally fast speed drop
36	FR-SNSR WIRE	Front-axle right-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
37	FR-SNSR ECU	Front-axle right-wheel speed sensor: Electronic control unit internal damage
41	RL-SNSR GAP	Rear-axle right-wheel speed sensor: Improper clearance
42	RL-ROTA	Excessive wobbling of rear-axle left rotor
43	RL-ROTA	Damaged rear-axle left rotor
44	RL-SNSR SHORT	Rear-axle left-wheel speed sensor: Prolonged period of unstable output
45	RL-SNSR OPEN	Rear-axle left-wheel speed sensor: Abnormally fast speed drop
46	RL-SNSR WIRE	Rear-axle left-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
47	RL-SNSR ECU	Rear-axle left-wheel speed sensor: Electronic control unit internal damage
51	RR-SNSR GAP	Rear-axle right-wheel speed sensor: Improper clearance
52	RR-ROTA	Excessive wobbling of rear-axle right rotor
53	RR-ROTA	Damaged rear-axle right rotor
54	RR-SNSR SHORT	Rear-axle right-wheel speed sensor: Prolonged period of unstable output
55	RR-SNSR OPEN	Rear-axle right-wheel speed sensor: Abnormally fast speed drop
56	RR-SNSR WIRE	Rear-axle right-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
57	RR-SNSR ECU	Rear-axle right-wheel speed sensor: Electronic control unit internal damage
61	F-DV 2BATT	Front-axle control valve: Short-circuit of outlet valve to positive (+) wire
62	F-DV 2GND	Front-axle control valve: Short-circuit of outlet valve to grounding wire
63	F-DV OPEN	Front-axle control valve: Broken wire in outlet valve
64	F-SOL OPEN	Front-axle control valve: Broken grounding wire
68	VALVE CONFIG	Front-axle control valve: Configuration error (*1)
75	F-HV 2BATT	Front-axle control valve: Short-circuit of holding valve to positive (+) wire
76	F-HV 2GND	Front-axle control valve: Short-circuit of holding valve to grounding wire
77	F-HV OPEN	Front-axle control valve: Broken wire in holding valve
78	VALVE CONFIG	Front-axle control valve: Configuration error (*1)
81	RL-DV 2BATT	Rear-axle left-wheel control valve: Short-circuit of outlet valve to positive (+) wire
82	RL-DV 2GND	Rear-axle left-wheel control valve: Short-circuit of outlet valve to grounding wire
83	RL-DV OPEN	Rear-axle left-wheel control valve: Broken wire in outlet valve
84	RL-SOL OPEN	Rear-axle left-wheel control valve: Broken grounding wire
85	RL-HV 2BATT	Rear-axle left-wheel control valve: Short-circuit of holding valve to positive (+) wire
86	RL-HV 2GND	Rear-axle left-wheel control valve: Short-circuit of holding valve to grounding wire
87	RL-HV OPEN	Rear-axle left-wheel control valve: Broken wire in holding valve
89	SOL 2BATT	Control valve grounding 2: Short-circuit to positive (+) wire
8A	SOL 2GND	Control valve grounding 2: Short-circuit to negative (-) wire

Multi-Use Tester II indication		Possible cause
Diagnosis code	Problem location	
91	RR-DV 2BATT	Rear-axle right-wheel control valve: Short-circuit of outlet valve to positive (+) wire
92	RR-DV 2GND	Rear-axle right-wheel control valve: Short-circuit of outlet valve to grounding wire
93	RR-DV OPEN	Rear-axle right-wheel control valve: Broken wire in outlet valve
94	RR-SOL OPEN	Rear-axle right-wheel control valve: Broken grounding wire
95	RR-HV 2BATT	Rear-axle right-wheel control valve: Short-circuit of holding valve to positive (+) wire
96	RR-HV 2GND	Rear-axle right-wheel control valve: Short-circuit of holding valve to grounding wire
97	RR-HV OPEN	Rear-axle right-wheel control valve: Broken wire in holding valve
99	SOL 2BATT	Control valve grounding 1: Short-circuit to positive (+) wire
9A	SOL 2GND	Control valve grounding 1: Short-circuit to negative (-) wire
D1	ECU ERR	Electronic control unit internal damage
D2	EEPROM ERR	Electronic control unit internal damage
D3	CAN RAM ERR	Electronic control unit internal damage
D4	ECU RLY ERR	Electronic control unit internal damage
D5	ECU RLY ERR	Electronic control unit internal damage
E1	SOL OVER VOLT	Control valve power supply voltage 1: Overvoltage
E2	SOL LOW VOLT	Control valve power supply voltage 1: Low voltage
E3	SOL OPEN	Control valve power supply voltage 1: Broken wire
E4	SOL OPEN	Control valve grounding 1: Broken wire
E5	SOL OVER VOLT	Control valve power supply voltage 2: Overvoltage
E6	SOL LOW VOLT	Control valve power supply voltage 2: Low voltage
E7	SOL OPEN	Control valve power supply voltage 2: Broken wire
E8	SOL OPEN	Control valve grounding 2: Broken wire
E9	ECU OVER VOLT	Electronic control unit power supply voltage: Overvoltage
EA	ECU LOW VOLT	Electronic control unit power supply voltage: Low voltage
EB	SOL VOLT ERR	Excessive voltage difference between control valve power supply voltages 1 and 2
F1	EXB RLY OPEN	Exhaust brake cut relay: Short-circuit to positive (+) wire, broken wire
F2	EXB RLY 2GND	Exhaust brake cut relay: Short-circuit to grounding wire
F5	ILLEGAL WHEEL	Wheel arrangement error: Excessive wheel speed difference between front and rear wheels
F6	ILLEGAL WHEEL	Wheel arrangement error: Wheel speed difference between front and rear wheels exceeding allowed range
FC	SNSR ERR	Wheel speed sensor abnormality generated previously. (*2)

*1 : Configuration error (mismatch between vehicle system and Electronic control unit system)

*2 : When a wheel speed sensor abnormality is generated in the previous driving operation, this diagnosis code is output. When this diagnosis code is generated, the ABS warning lamp does not turn off two seconds after the starter switch is turned on. However, if the wheel speed sensor is restored to its proper condition, the ABS warning lamp turns off and this diagnosis code is reset when the vehicle is operated at a speed of 10 km/h {6.2 mph} or faster.

Service Data Chart

Multi-Use Tester II indication			Data description	Inspection condition	Judgement criterion
Item No.	Item name	Service data			
21	SPEED FL	■■■.■MPH	Front-axle left-wheel speed	Drive at constant speed.	Should synchronize with speedometer
22	SPEED FR	■■■.■MPH	Front-axle right-wheel speed		
23	SPEED RL	■■■.■MPH	Rear-axle left-wheel speed		
24	SPEED RR	■■■.■MPH	Rear-axle right-wheel speed		
25	GAP SPEED FL	■■■.■MPH	Front-axle left-wheel speed sensor clearance	Drive prior to inspection.	Less than 8.7 MPH
26	GAP SPEED FR	■■■.■MPH	Front-axle right-wheel speed sensor clearance		
27	GAP SPEED RL	■■■.■MPH	Rear-axle left-wheel speed sensor clearance		
28	GAP SPEED RR	■■■.■MPH	Rear-axle right-wheel speed sensor clearance		
35	VALVE VOLTAGE	■■.■■V	Front-axle control valve power supply voltage	Starter switch OFF	Same as battery voltage
36	VALVE VOLTAGE	■■.■■V	Rear-axle control valve power supply voltage		
45	BATT VOLTAGE	■■.■■V	Electronic control unit power supply voltage	Starter switch ON	Same as battery voltage
51	DIAGNOSIS SW	ON/OFF	Diagnosis switch connector	Diagnosis switch connector in connection	ON
52	RR-DV	ON/OFF	Rear-axle right-wheel control valve	In all conditions	ON/OFF
54	RR-HV	ON/OFF		In all conditions	ON/OFF
55	RL-DV	ON/OFF	Rear-axle left-wheel control valve	In all conditions	ON/OFF
56	RL-HV	ON/OFF		In all conditions	ON/OFF
58	F-HV	ON/OFF	Front-axle control valve	In all conditions	ON/OFF
59	F-DV	ON/OFF		In all conditions	ON/OFF
61	STOP LAMP SW	ON/OFF	Stop lamp switch	Brake pedal depressed	ON
62	EXB CUT RLY	ON/OFF	Exhaust brake cut relay	Exhaust brake in operation	ON

Actuator Drive Chart

MULTI-USE TESTER II indication		Operation description
Item No.	Item name	
06	F-HV ON	Holding valve of front-axle control valve: ON
07	RL-HV ON	Holding valve of rear-axle left-wheel control valve: ON
08	RR-HV ON	Holding valve of rear-axle right-wheel control valve: ON
09	F-DV ON	Outlet valve of front-axle control valve: ON
11	RL-DV ON	Outlet valve of rear-axle left-wheel control valve: ON
12	RR-DV ON	Outlet valve of rear-axle right-wheel control valve: ON
15	EXB RLY ON	Exhaust brake cut relay: ON
16	EXB RLY OFF	Exhaust brake cut relay: OFF
19	ABS LAMP ON	ABS warning lamp: ON
20	ABS LANP OFF	ABS warning lamp: OFF

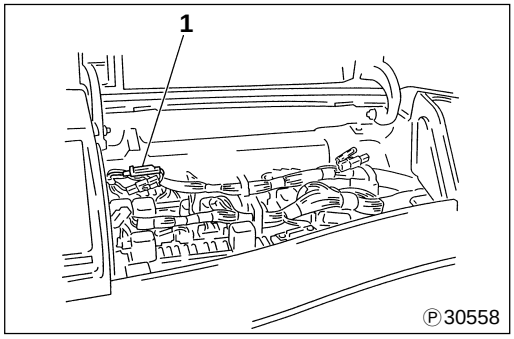
Item Nos. 15 and 16 are for vehicles equipped with an exhaust brake system.

Procedure of Inspection Using Diagnosis Switch

- When the ABS warning lamp lights, analyze the problem by following the procedure below.
- Diagnosis codes are used for the analysis of malfunctions. Diagnosis codes of both current and previous malfunctions are indicated.
- The diagnosis code of the current malfunction is indicated when the starter switch remains in the ON position after abnormality generation.
- When the starter switch is turned from the ON position to the ACC or LOCK position after abnormality generation, diagnosis codes of previous malfunctions stored in the Electronic control unit are indicated. Diagnosis codes of non-recurring malfunctions that generated during vehicle operation but did not reproduce after the starter switch is turned from the ON position to the ACC or LOCK position are also stored as previous malfunctions.

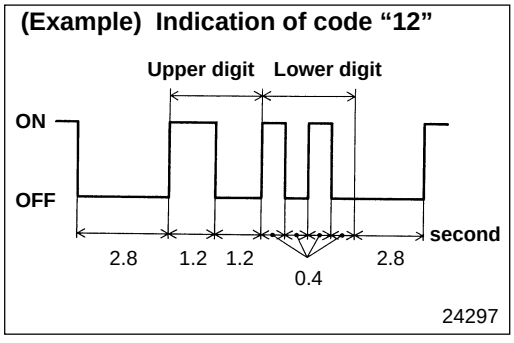
Diagnosis code indications and operations

Diagnosis switch	Memory clear switch		Current malfunction			
			Normal	Malfunction	Normal	Malfunction
			Previous malfunctions			
			Normal	Normal	Malfunction	Malfunction
Connect	Connect	ABS warning lamp	OFF	ON	OFF	ON
Disconnect	Connect		Lamp flashes to indicate diagnosis code for normal condition.	Lamp flashes to indicate diagnosis code of current malfunction.	Lamp flashes to indicate diagnosis code for normal condition.	Lamp flashes to indicate diagnosis code of current malfunction.
Disconnect	Disconnect		Lamp flashes to indicate diagnosis code for normal condition.	Lamp flashes to indicate diagnosis code of current malfunction.	Lamp flashes to indicate diagnosis codes of previous malfunctions.	Lamp flashes to indicate diagnosis codes of current and previous malfunctions.
Connect	Disconnect		OFF	ON	OFF	ON



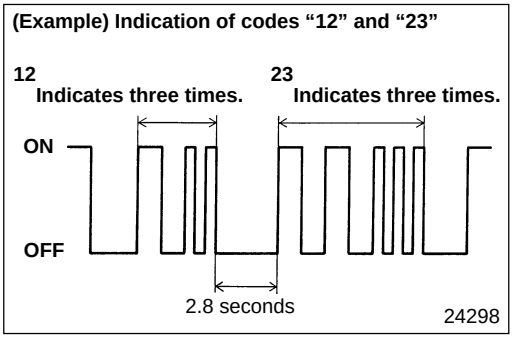
Diagnosis code indication

- Turn the starter switch to the ON position.
- Disconnect diagnosis switch **1** (white BN1A connector). The ABS warning lamp on the meter cluster begins flashing.
  The flashing pattern of the warning lamp indicates a diagnosis code. Check the code list to locate the problem location. P35E-34

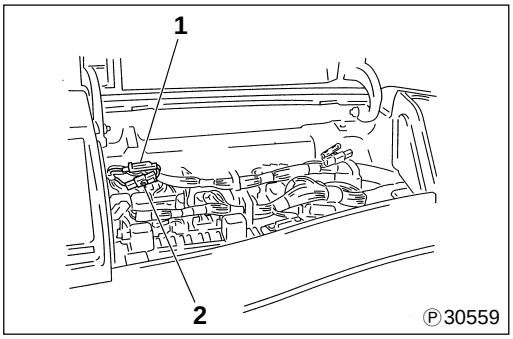


Reading diagnosis code of current malfunction

- After the Electronic control unit completes the self-diagnosis operation, the ABS warning lamp turns off in approximately 2.4 seconds, then starts indicating a diagnosis code.
  Each diagnosis code consists of two digits. The two digits are indicated in the following manner.
  - Tens digit indication
    The lamp remains ON for 1.2 seconds, then remains OFF for 1.2 seconds.
  - Ones digit indication
    The lamp remains ON for 0.4 second, then remains OFF for 0.4 second.
- Each malfunction code is indicated three consecutive times.



- If there are two or more malfunction codes in the memory, the lamp indicates the first malfunction code three times, turns off for 2.8 seconds, then indicates the next code three times.
  The lamp continues indicating all malfunction codes stored in the memory even if diagnosis switch **1** (white BN1A connector) is disconnected in the middle of code indication.



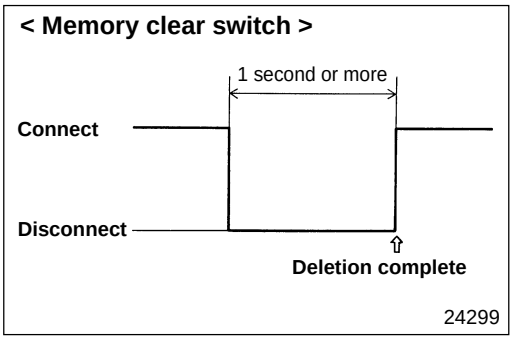
Reading diagnosis codes of previous malfunctions

- After reading the diagnosis code of the current malfunction, read the diagnosis codes of previous malfunctions.

CAUTION⚠

- **Note that connecting memory clear switch 2 (brown AL1A connector) erases diagnosis codes of current and previous malfunctions from the Electronic control unit memory.**
- **If diagnosis codes are deleted when some of the connectors are not connected or the system is still malfunctioning, the Electronic control unit becomes damaged.**

- To indicate diagnosis codes of previous malfunctions, with diagnosis switch **1** (white BN1A connector) disconnected, disengage memory clear switch **2** (brown AL1A connector). The ABS warning lamp starts flashing to indicate a diagnosis code.



Deleting diagnosis codes

CAUTION⚠

- **Before erasing diagnosis codes, test-drive the vehicle after the malfunction is repaired (when system is in normal condition), and make sure the ABS warning lamp is not lit.**
- **If diagnosis codes are deleted when some of the connectors are not connected or the system is still malfunctioning, the Electronic control unit becomes damaged.**

- Leave the starter switch in the ON position.
- After connecting diagnosis switch **1** (white BN1A connector), keep memory clear switch **2** (brown AL1A connector) disconnected for two seconds or more, then reconnect the memory clear switch.

Diagnosis Code Chart

Diagnosis code	Possible cause
11	Normal
21	Front-axle left-wheel speed sensor: Improper clearance
22	Excessive wobbling of front-axle left rotor
23	Damaged front-axle left rotor
24	Front-axle left-wheel speed sensor: Prolonged period of unstable output
25	Front-axle left-wheel speed sensor: Abnormally fast speed drop
26	Front-axle left-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
27	Front-axle left-wheel speed sensor: Electronic control unit internal damage
31	Front-axle left-wheel speed sensor: Improper clearance
32	Excessive wobbling of front-axle right rotor
33	Damaged front-axle right rotor
34	Front-axle right-wheel speed sensor: Prolonged period of unstable output
35	Front-axle right-wheel speed sensor: Abnormally fast speed drop
36	Front-axle right-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
37	Front-axle right-wheel speed sensor: Electronic control unit internal damage
41	Rear-axle right-wheel speed sensor: Improper clearance
42	Excessive wobbling of rear-axle left rotor
43	Damaged rear-axle left rotor
44	Rear-axle left-wheel speed sensor: Prolonged period of unstable output
45	Rear-axle left-wheel speed sensor: Abnormally fast speed drop
46	Rear-axle left-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
47	Rear-axle left-wheel speed sensor: Electronic control unit internal damage
51	Rear-axle right-wheel speed sensor: Improper clearance
52	Excessive wobbling of rear-axle right rotor
53	Damaged rear-axle right rotor
54	Rear-axle right-wheel speed sensor: Prolonged period of unstable output
55	Rear-axle right-wheel speed sensor: Abnormally fast speed drop
56	Rear-axle right-wheel speed sensor: Short-circuit to positive (+) wire, short-circuit to grounding wire, broken wire
57	Rear-axle right-wheel speed sensor: Electronic control unit internal damage
61	Front-axle control valve: Short-circuit of outlet valve to positive (+) wire
62	Front-axle control valve: Short-circuit of outlet valve to grounding wire
63	Front-axle control valve: Broken wire in outlet valve
64	Front-axle control valve: Broken grounding wire
68	Front-axle control valve: Configuration error (*1)
75	Front-axle control valve: Short-circuit of holding valve to positive (+) wire
76	Front-axle control valve: Short-circuit of holding valve to grounding wire
77	Front-axle control valve: Broken wire in holding valve
78	Front-axle control valve: Configuration error (*1)
81	Rear-axle left-wheel control valve: Short-circuit of outlet valve to positive (+) wire
82	Rear-axle left-wheel control valve: Short-circuit of outlet valve to grounding wire
83	Rear-axle left-wheel control valve: Broken wire in outlet valve
85	Rear-axle left-wheel control valve: Short-circuit of holding valve to positive (+) wire
86	Rear-axle left-wheel control valve: Short-circuit of holding valve to grounding wire
87	Rear-axle left-wheel control valve: Broken wire in holding valve
89	Control valve grounding 2: Short-circuit to positive (+) wire
8A	Control valve grounding 2: Short-circuit to negative (-) wire

Diagnosis code	Possible cause
91	Rear-axle right-wheel control valve: Short-circuit of outlet valve to positive (+) wire
92	Rear-axle right-wheel control valve: Short-circuit of outlet valve to grounding wire
93	Rear-axle right-wheel control valve: Broken wire in outlet valve
94	Rear-axle right-wheel control valve: Broken grounding wire
95	Rear-axle right-wheel control valve: Short-circuit of holding valve to positive (+) wire
96	Rear-axle right-wheel control valve: Short-circuit of holding valve to grounding wire
97	Rear-axle right-wheel control valve: Broken wire in holding valve
99	Control valve grounding 1: Short-circuit to positive (+) wire
9A	Control valve grounding 1: Short-circuit to negative (-) wire
D1	Electronic control unit internal damage
D2	Electronic control unit internal damage
D3	Electronic control unit internal damage
D4	Electronic control unit internal damage
D5	Electronic control unit internal damage
E1	Control valve power supply voltage 1: Overvoltage
E2	Control valve power supply voltage 1: Low voltage
E3	Control valve power supply voltage 1: Broken wire
E4	Control valve grounding 1: Broken wire
E5	Control valve power supply voltage 2: Overvoltage
E6	Control valve power supply voltage 2: Low voltage
E7	Control valve power supply voltage 2: Broken wire
E8	Rear-axle left-wheel control valve: Broken grounding wire
E9	Electronic control unit power supply voltage: Overvoltage
EA	Electronic control unit power supply voltage: Low voltage
EB	Excessive voltage difference between control valve power supply voltages 1 and 2
F1	Exhaust brake cut relay: Short-circuit to positive (+) wire, broken wire
F2	Exhaust brake cut relay: Short-circuit to grounding wire
F5	Wheel arrangement error: Excessive wheel speed difference between front and rear wheels
F6	Wheel arrangement error: Wheel speed difference between front and rear wheels exceeding allowed range
FC	Wheel speed sensor abnormality generated previously. (*2)

*1 : Configuration error (mismatch between vehicle system and Electronic control unit system)

*2 : When a wheel speed sensor abnormality is generated in the previous driving operation, this diagnosis code is output. When this diagnosis code is generated, the ABS warning lamp does not turn off two seconds after the starter switch is turned on. However, if the wheel speed sensor is restored to its proper condition, the ABS warning lamp turns off and this diagnosis code is reset when the vehicle is operated at a speed of 10 km/h {6.2 mph} or faster.

NOTE

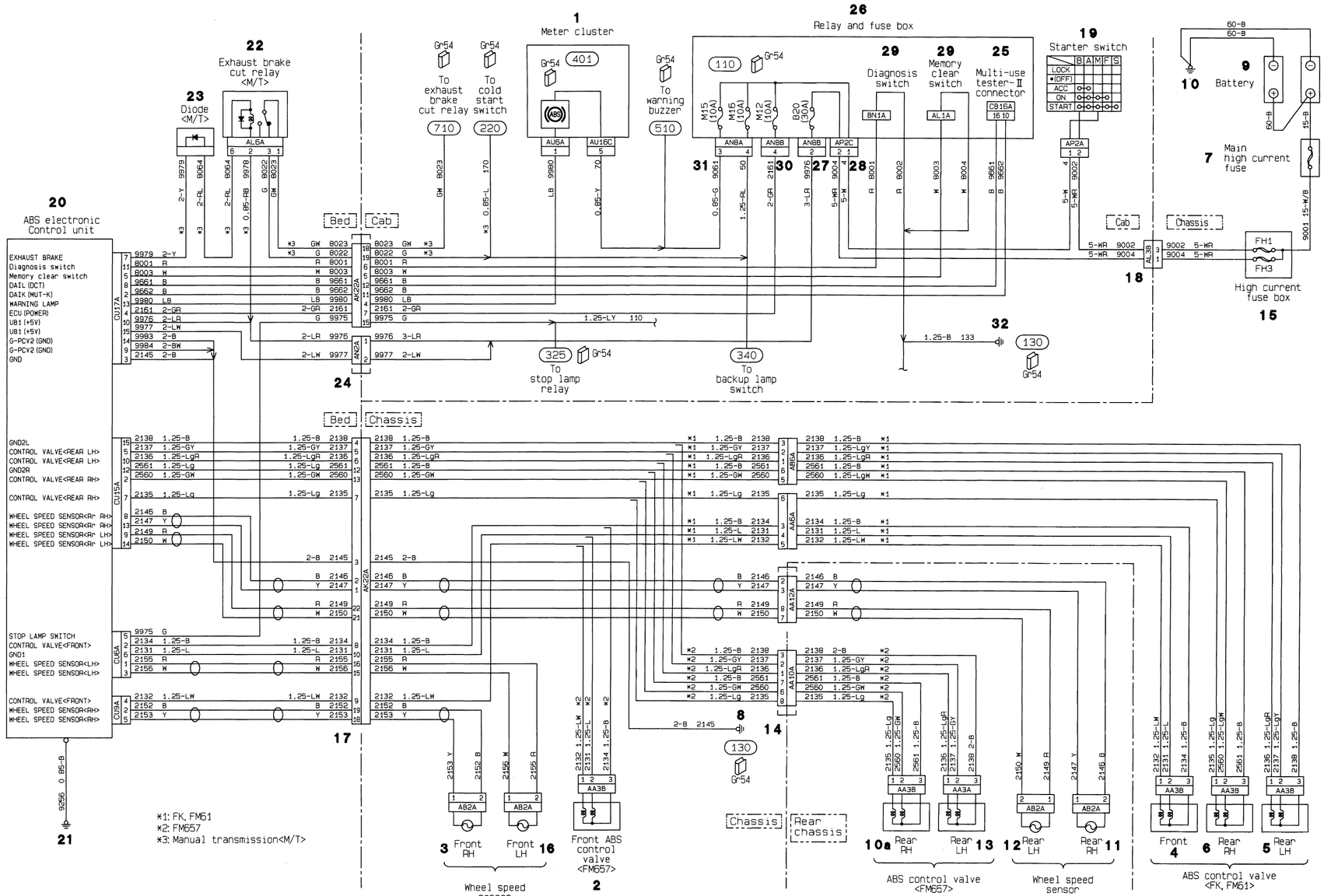
Alphabetic letters in the diagnosis codes indicate the following lighting cycles. A: 10, B:11, C: 12, D: 13, E: 14, F: 15

(Example) Diagnosis code: 8 A

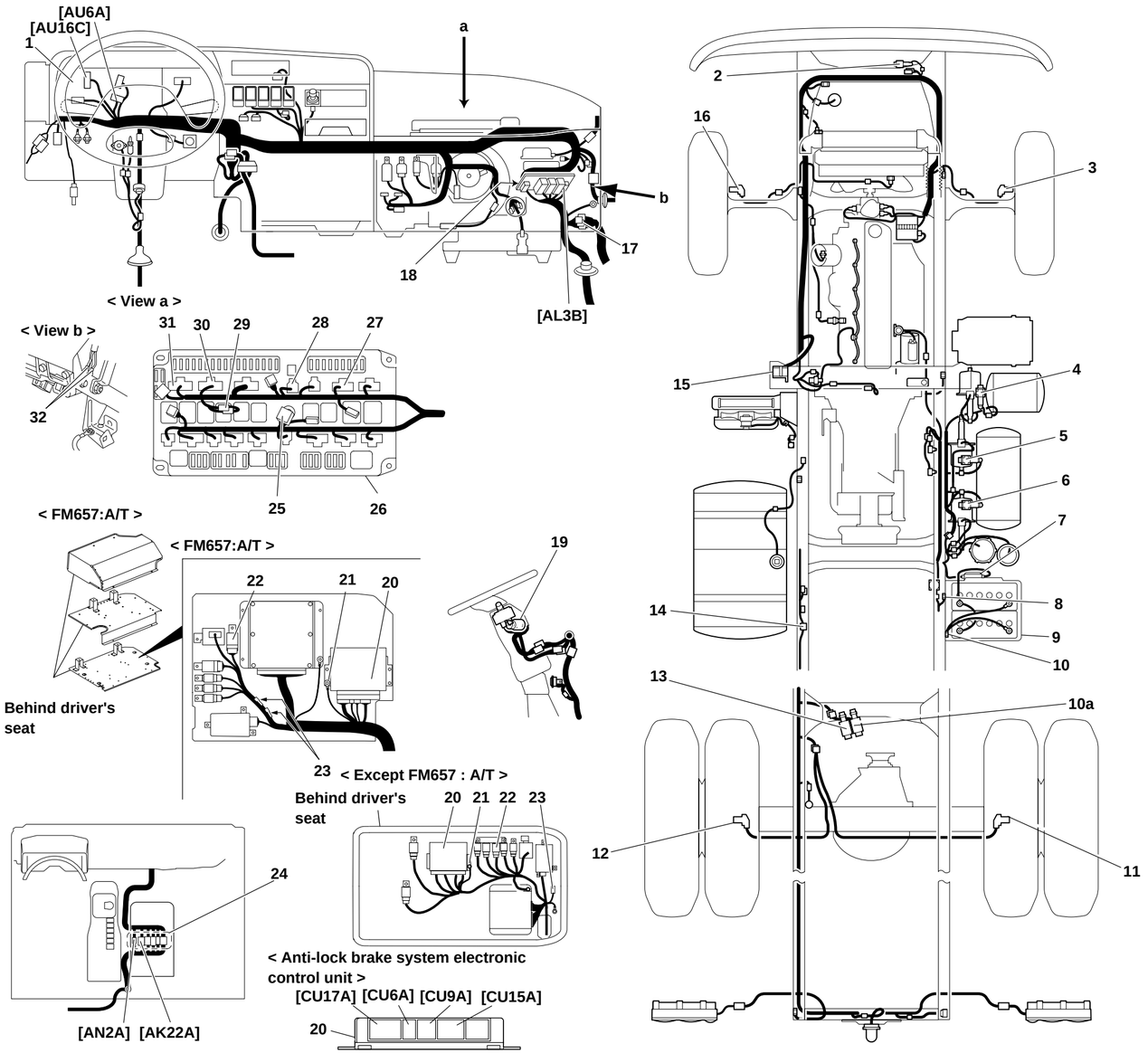
Number of ones

Number of tens

Diagnosis code 8A indicates that the indication lights eight times first, then 10 times.


1 Meter cluster
2 Front ABS control valve <FM657>
3 Front RH
4 Front
5 Rear LH
6 Rear RH
7 Main high current fuse
8
9 Battery
10 10a Rear RH
11 Rear RH
12 Rear LH
13 Rear LH
14
15 High current fuse box
16 Front LH
17
18
19 Starter switch
20 ABS electronic Control unit
21
22 Exhaust brake cut relay <M/T>
23 Diode <M/T>
24
25 Multi-use tester-II connector
26 Relay and fuse box
27 28 29 29 30 31 32
Diagnosis switch
Memory clear switch
To exhaust brake cut relay
To cold start switch
To warning buzzer
To stop lamp relay
To backup lamp switch
Bed
Cab
Chassis
Rear chassis
Wheel speed sensor
ABS control valve <FM657>
ABS control valve <FK, FM61>
*1: FK, FM61
*2: FM657
*3: Manual transmission<M/T>

44229



1 Meter cluster
2 Front ABS control valve < FM657 >
3 Front wheel speed sensor, RH
4 Front ABS control valve < FK, FM61 >
5 Rear ABS control valve, LH < FK, FM61 >
6 Rear ABS control valve, RH< FK, FM61 >
7 Main high current fuse
8 Ground
9 Battery
10 Ground
10a Rear ABS control valve, RH < FM657 >
11 Rear wheel speed sensor, RH
12 Rear wheel speed sensor, LH
13 Rear ABS control valve, LH < FM657 >
14 Connection of chassis harness and Rear chassis harness
15 High current
16 Front wheel speed sensor, LH
17 Connection of bed harness and chassis harness
18 Connection of cab harness and chassis harness
19 Starter switch
20 ABS electronic control unit
21 Ground
22 Exhaust brake cut relay
23 Diode
24 Connection of cab harness and bed harness
25 Multi-use tester II
26 Relay & fuse box
27 Connector
28 Connector
29 Diagnosis switch, memory switch
30 Connector
31 Connector
32 Ground
ABS : Anti-lock brake system

Ⓟ45874

MITSUBISHI
FUSO

Group 36A
Parking Brake
< Center Parking Brake >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-36A

INDEX

SPECIFICATIONS 36A- 2

STRUCTURE AND OPERATION 36A- 2

TROUBLESHOOTING 36A- 4

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Adjustment of Parking Brake Shoe Clearance and Lever Stroke 36A- 5

PARKING BRAKE CONTROL 36A- 6

PARKING BRAKE ASSEMBLY 36A- 8

SUPPORT PLATE AND SHOE ASSEMBLY 36A-12

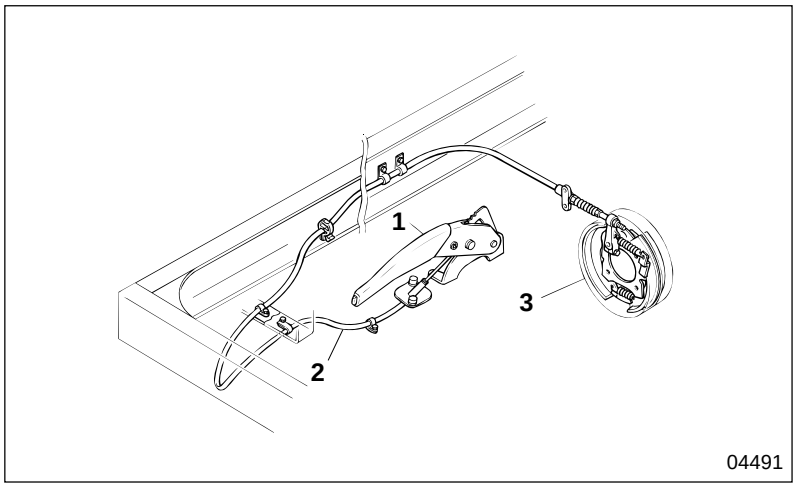
SPECIFICATIONS/STRUCTURE AND OPERATION

SPECIFICATIONS

Item \ Vehicle model		FK617, FM617
Brake	Type	Propeller shaft internal expanding type brake
	Operation type	Mechanical cable type
Parking brake assembly	Type	Duo-servo type
	Inner diameter of drum mm {in.}	ø254 {10}
	Lining width×Thickness mm {in.}	60×5.8 {2.36×0.23}

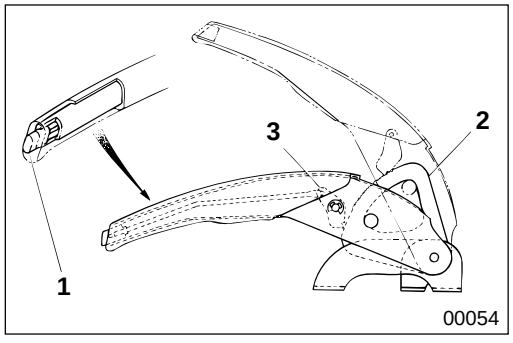
STRUCTURE AND OPERATION

Parking Brake Control



1 Parking brake lever
2 Parking brake cable
3 Parking brake assembly

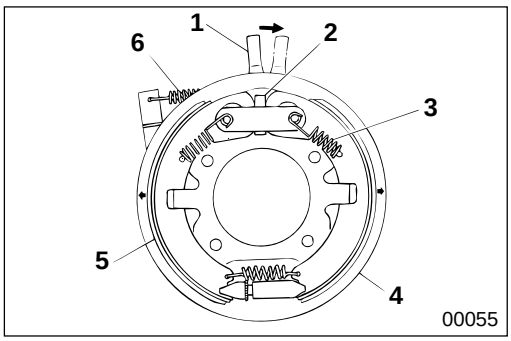
Parking Brake Lever



1 Release rod knob
2 Lever bracket
3 Locking latch

The parking brake has a built-in locking mechanism that prevents inadvertent release of the brake.
To release locking, push release rod knob **1** which will disengage from the serration of lever bracket **2** and the tooth of locking latch **3** freeing the parking brake lever and allowing it to return.

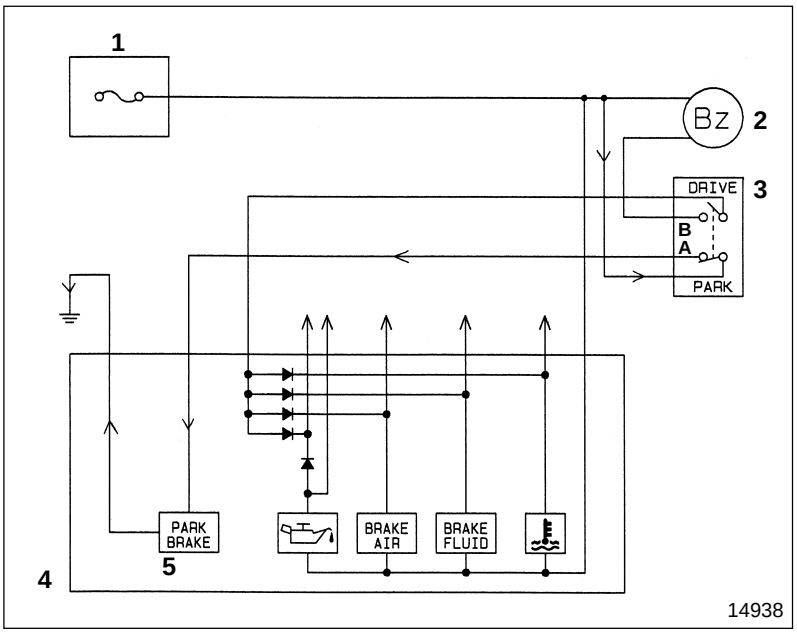
Parking Brake Assembly < Dual-servo Type >



1 Camshaft lever
2 Camshaft
3 Shoe return spring
4 Brake drum
5 Shoe and lining assembly
6 Camshaft lever return spring

Pulling the parking brake lever pulls the parking brake cable, which in turn pulls camshaft lever **1**. At the same time, camshaft **2** rotates in conjunction with the camshaft lever, and expands shoe and lining assembly **5** making it press against brake drum **4**. This frictional force locks the propeller shaft that is connected to the drum. When the brake lever is released, the repercussive force of shoe return spring **3** releases the brake.

Parking Brake System Electric Circuit



1 Relay and fuse box
2 Buzzer
3 Parking brake switch
4 Meter cluster
5 Parking brake indicator lamp

- The parking brake system electrical circuit is provided for indicating, its detecting and indicating function is activated by pulling the parking brake lever.
- When the parking brake lever is pulled, contact point **A** of parking brake switch **3** closes (ON), and parking brake indicator lamp **5** is lit, indicating that the parking brake is operating.
  The current flows as below:
  Fuse **1** → Parking brake switch **3** → Parking brake indicator lamp **5** → Ground
- Buzzer **2** sounds and gives a warning when any fault is detected in the engine oil pressure system, brake system or cooling system. Pulling the parking brake lever opens (OFF) contact point **B** of parking brake switch **3** to stop the buzzer from sounding.

TROUBLESHOOTING

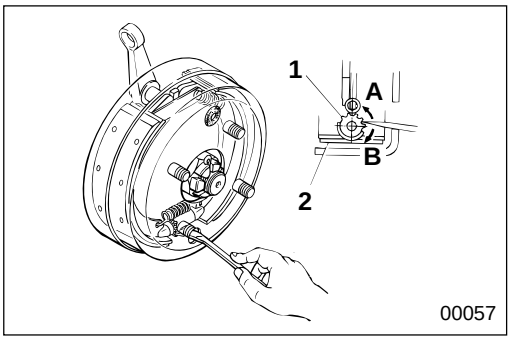
Possible causes / Symptoms		Parking brake does not work	Parking brake does not release smoothly (dragging)	Remarks
Parking brake cable	Inner cable stretched or damaged	○	○	
	Inner cable rusted		○	
Parking brake lever	Locking ratchet and lever bracket serration engagement faulty	○		
	Pulling stroke insufficient	○	○	
	Pulling stroke excessive	○		
Parking brake assembly	Shoe clearance insufficient		○	
	Shoe clearance excessive	○		
	Parking brake drum inner surface deformed or distorted	○		
	Parking brake drum inner surface greasy or oily	○		
	Linings worn unevenly	○		
	Lining surface greasy or oily	○		
	Camshaft lever return spring permanently set or fractured		○	
	Shoe return spring fatigued or fractured		○	

Adjustment of Parking Brake Shoe Clearance and Lever Stroke

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Brake shoe clearance	0.1 to 0.25 {0.0039 to 0.0098}	—	Adjust
3	Brake lever pulling stroke (at operation force of 490 N {110 lbf, 50 kgf})	7 to 10 notches	—	Adjust

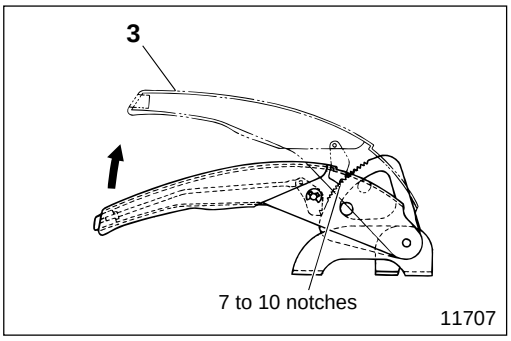


(1) Shoe clearance

When the camshaft lever is released, turn adjusting screw **1** in the expansion direction, using a screwdriver inserted through the shoe adjusting hole of the brake drum, and return 8 notches from the position where shoe **2** contacts the drum. Then, the shoe clearance will be the standard value.

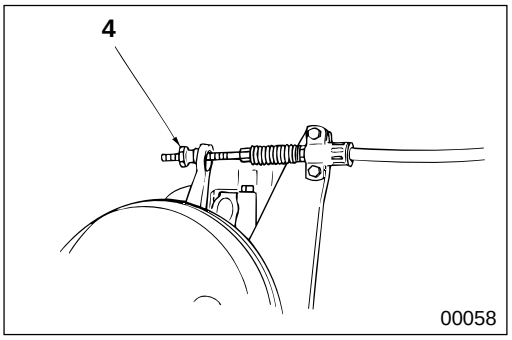
A : Expansion

B : Contraction

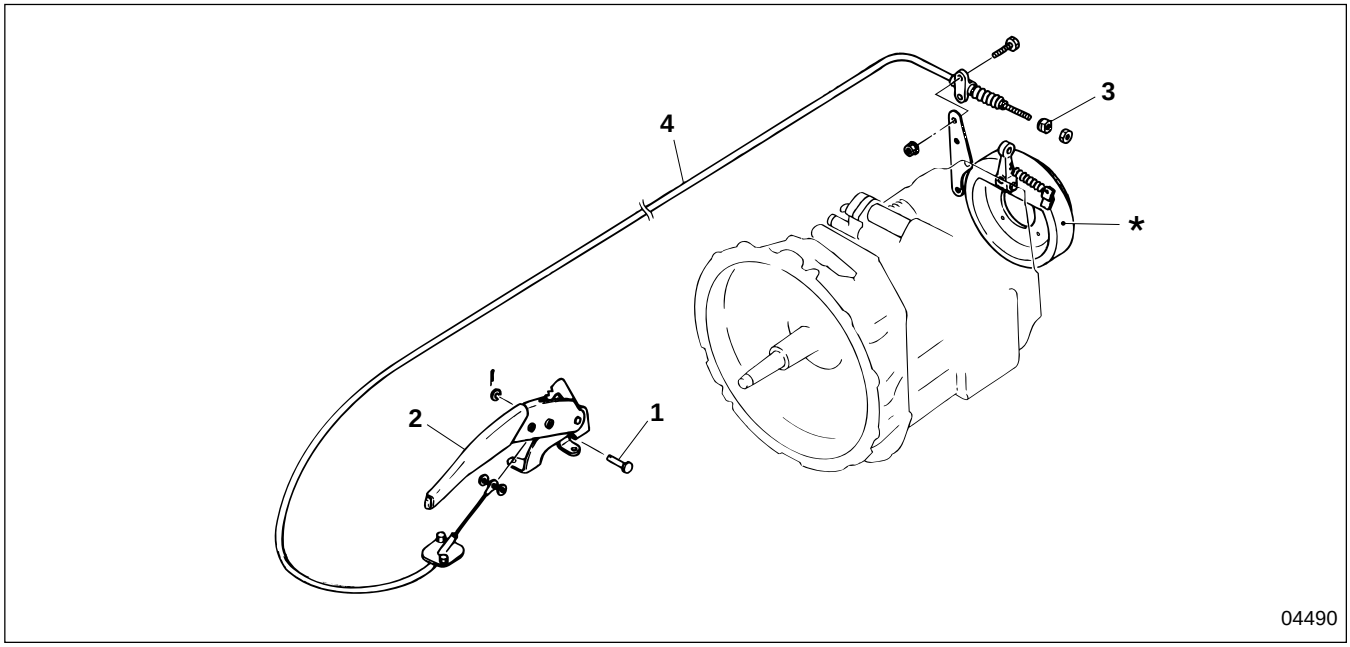


(2) Lever pulling stroke

Adjust camshaft lever lock nut **4** so that the number of notches (clicks heard) is the standard value when parking brake lever **3** is pulled from the released position by an operating force of 490 N {110 lbf, 50 kgf}. Operate the parking brake lever two or three times after adjusting to verify the pulling stroke, to make sure that the parking brake is operating properly and that the parking brake drum does not drag when the parking brake is released.



PARKING BRAKE CONTROL



● **Removal sequence**

1 Clevis pin
2 Parking brake lever assembly 🕮 P36A-7
3 Ball bushing
4 Parking brake cable

***** : Parking brake assembly 🕮 P36A-8

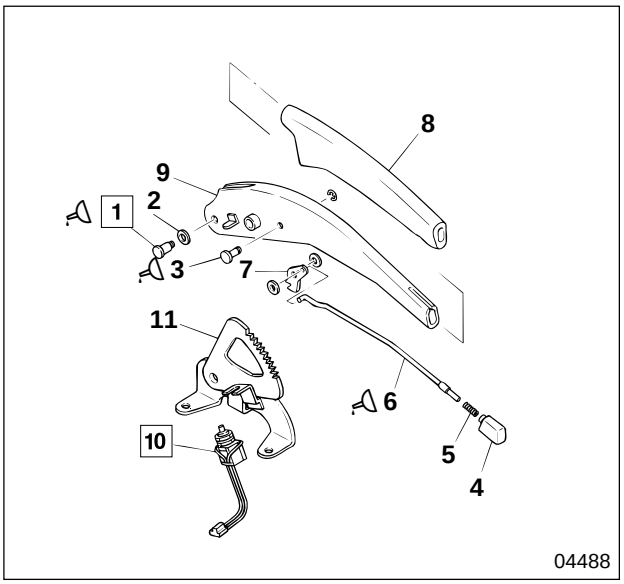
WARNING⚠

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Installation sequence**

Follow the removal sequence in reverse.

Parking Brake Lever Assembly



● **Disassembly sequence**

1 Pin
2 Spacer
3 Pin
4 Release rod knob
5 Return spring
6 Release rod
7 Locking latch
8 Grip
9 Parking brake lever
10 Parking brake switch Gr 54
11 Lever bracket

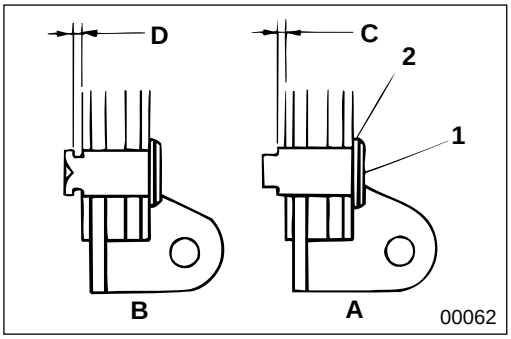
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and sealant

Location	Points of application	Kinds	Quantity
1, 3	Rotating area and friction surface of pins	Chassis grease [NLGI No.1 (Ca soap)]	As required
6	Thread area of release rod	Cemedine 1500	As required

◆ Service procedure

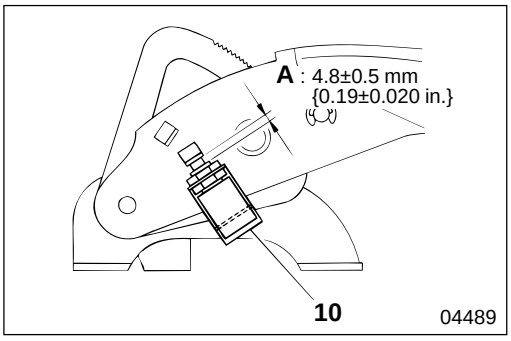


1 **Installation of pin**

A : Before caulking
B : After caulking

When clearance **C** before caulking is less than 0.6 mm {0.024 in.}, do not use spacer **2**.
Also, use spacer to adjust if it is 0.6 to 0.96 mm {0.024 to 0.038 in.}.

	Without spacer	With spacer
Dimension **D**	0.06 to 0.6 mm {0.0024 to 0.024 in.}	0 to 0.36 mm {0 to 0.014 in.}

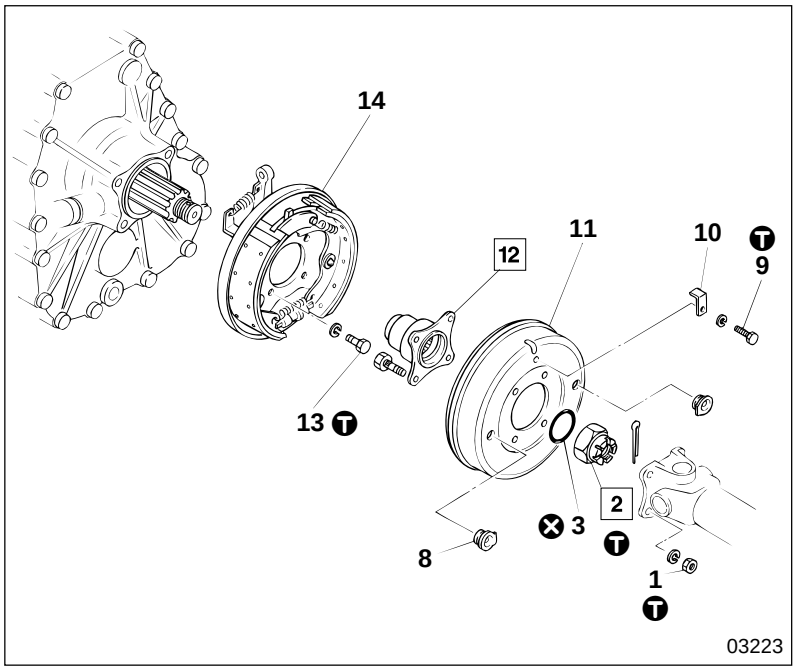


10 **Installation of parking brake switch**

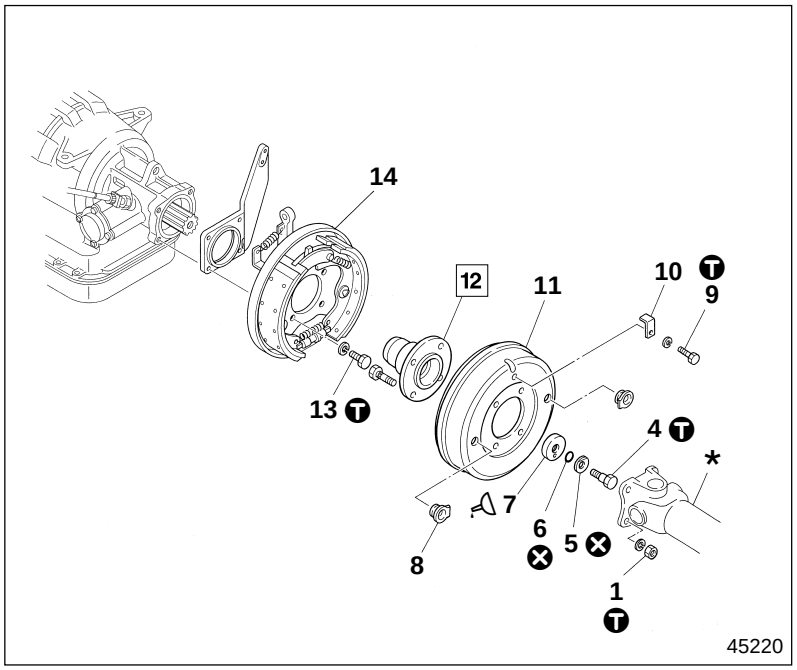
Install parking brake switch **10** so that the stroke equals **A**.

PARKING BRAKE ASSEMBLY

< Manual Transmission >



< Automatic Transmission >



● **Inspection before disassembly**

P36A-10

● **Disassembly sequence**

1 Nut
2 Lock nut
3 O-ring
4 Flange set bolt
5 Lock washer
6 O-ring
7 Retainer washer
8 Dust plug
9 Bolt
10 Drum plate
11 Parking brake drum
12 Companion flange
13 Bolt
14 Support plate and shoe assembly
P36A-12

* : Propeller shaft Gr 25
⊗ : Non-reusable parts

WARNING

- **You must place wheel chocks securely in place to prevent the vehicle from moving.**
- **Do not remove the chocks until the entire operation is completed.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item		Standard value	Limit	Remedy
11	Parking brake drum	Deflection at mating recession	0.15 {0.0059} or less	0.5 {0.020}	Replace
		Inner diameter	ø254.0$^{+0.5}_{0}${10$^{+0.020}_{0}$}	ø255.5 {10.1}	Replace
		Squareness	0.05 {0.0020} or less	—	Replace
		Coaxial trueness	ø0.1 {0.0039} or less	—	Replace
		Cylindrical trueness	0.05 {0.0020} or less	—	Replace
		Static revolution unbalance	0.88 N·cm {0.0065 ft.lbs, 90 gf·cm} or less	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

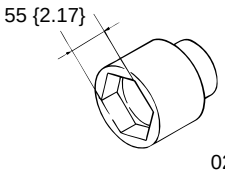
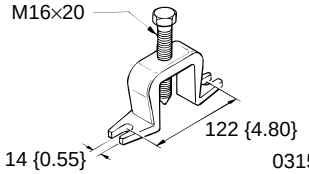
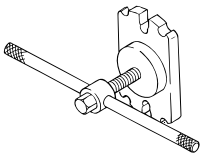
Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (Propeller shaft mounting)		85 {61, 8.5}	—
2	Lock nut (Companion flange mounting)		590 to 1080 {435 to 795, 60 to 110}	—
4	Flange set bolt (Companion flange mounting)		140 to 160 {100 to 120, 14.1 to 16.72}	—
9	Bolt (Drum plate mounting)		20 {14, 2}	—
13	Bolt (Support plate and shoe assembly mounting)	Manual transmission	74 {54, 7.5}	—
		Automatic transmission	110 to 130 {81 to 97, 11.22 to 13.46}	

Sealant

Location	Points of application	Kinds	Quantity
7	Outer periphery of retainer washer	THREEBOND 1215	As required

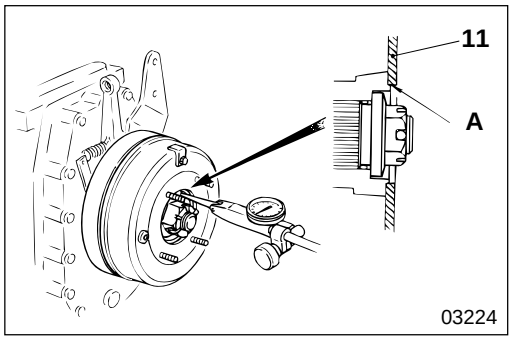
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Socket wrench  02030	MH061519 (Obtain Locally)	Removal and installation of main shaft rear lock nut < Manual transmission >
12	Flange puller  03159	< P4 > MC881524 (Obtain Locally)	Removal of main shaft rear companion flange
	Flange puller  02153	< P8 > MH061393 (Obtain Locally)	

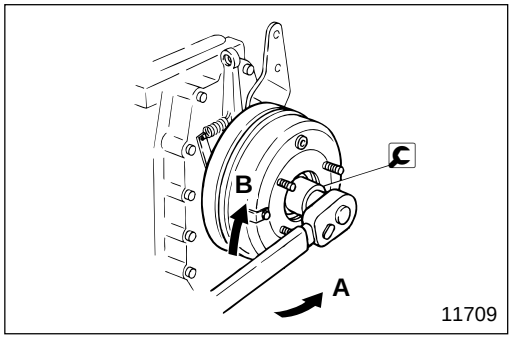
PARKING BRAKE ASSEMBLY

◆ Service procedure



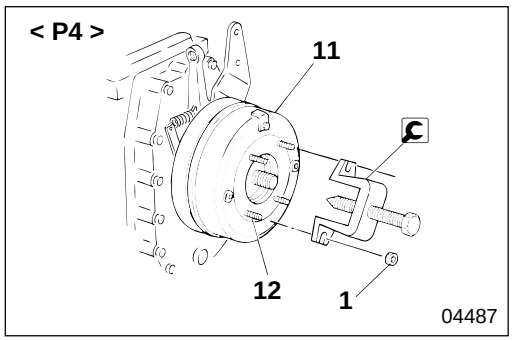
● **Inspection before disassembly**

Measure parking brake drum **11** at mating area **A**, and replace the brake drum if the measured value is higher than the limit.

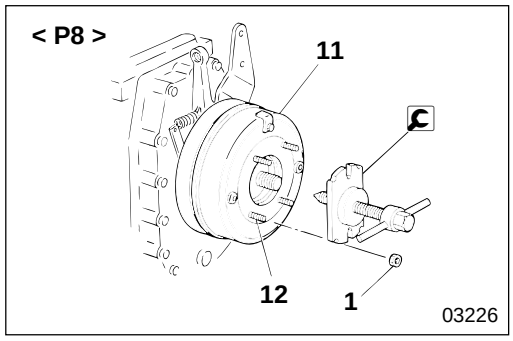


2 **Removal and installation of lock nut < Manual transmission >**

A : Removal
B : Installation

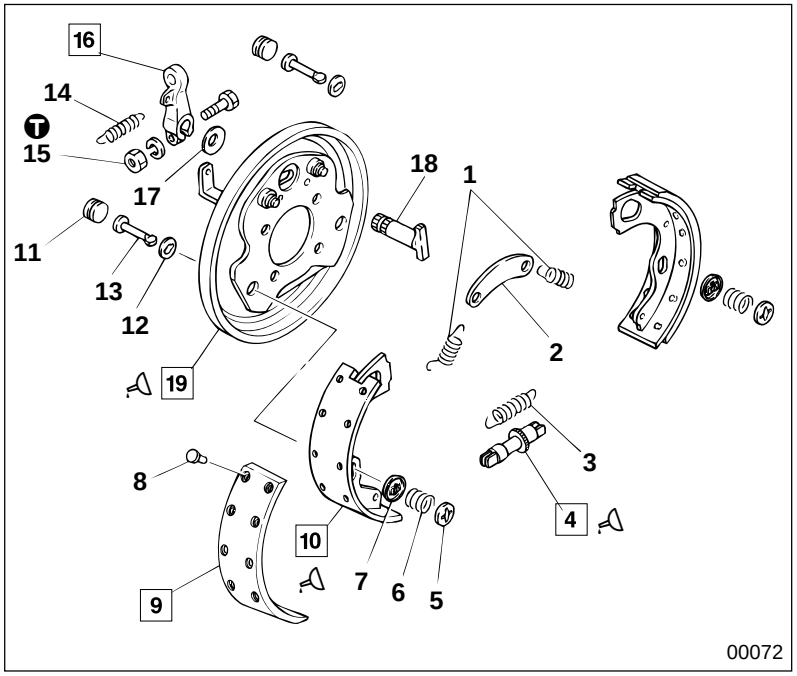


12 **Removal of companion flange**



M E M O

SUPPORT PLATE AND SHOE ASSEMBLY



● **Disassembly sequence**

1 Shoe return spring
2 Anchor pin brace
3 Adjusting wheel return spring
4 Adjusting screw
5 Shoe hold-down cup
6 Shoe hold-down spring
7 Shoe hold-down cup
8 Rivet
9 Lining
10 Brake shoe
11 Cover
12 Shoe hold-down washer
13 Shoe hold-down pin
14 Camshaft lever return spring
15 Nut
16 Camshaft lever
17 Spring spacer
18 Camshaft
19 Support plate and cover assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

Do not leave grease or oil on the surface of lining 9 because this reduces braking performance.

NOTE

If lining 9 has been replaced with a new part, check correctness of contact with the parking brake drum.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
1	Installed load of shoe return spring (Installed length 75 {2.95})	180±18 N {41±4.0 lbf, 18.5±1.8 kgf}	145 N {33 lbf, 15 kgf}	Replace
3	Installed load of wheel return spring (Installed length 85 {3.35})	105±11 N {24±2.4 lbf, 11±1.1 kgf}	86 N {19 lbf, 8.8 kgf}	Replace
6	Installed load of shoe hold-down spring (Installed length 14 {0.55})	145±15 N {33±3.3 lbf, 15±1.5 kgf}	115 N {26 lbf, 12 kgf}	Replace
9	Lining thickness	5.8 {0.23}	3.5 {0.14}	Replace
14	Installed load of camshaft lever return spring (Installed length 85 {3.35})	62±5.9 N {14±1.3 lbf, 6.3±0.6 kgf}	49 N {11 lbf, 5 kgf}	Replace

Ⓣ Tightening torque

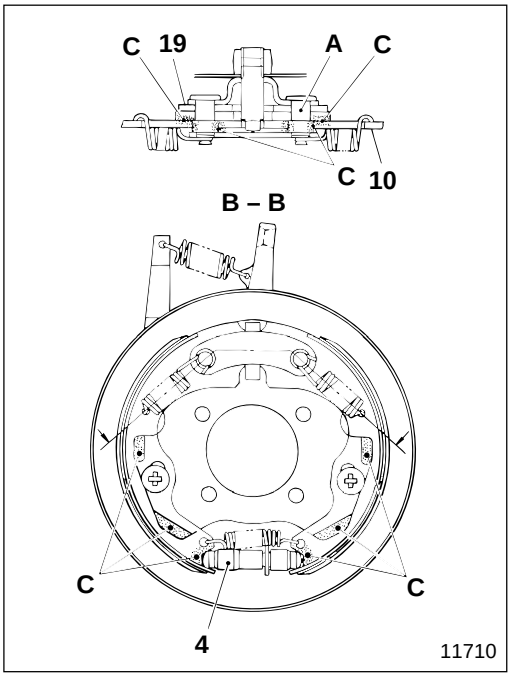
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
15	Nut (Camshaft lever mounting)	13.72 to 22.56 {10 to 17, 1.4 to 2.3}	—

Lubricant

Location	Points of application	Kinds	Quantity
4, 10	Apply to both ends of adjusting screw which makes contact with brake shoe	Brake grease (AKB 100)	As required
10, 19	Apply to support plate and cover assembly at the place which makes contact with brake shoe	Brake grease (AKB 100)	As required
	Apply to anchor pin area of support plate and cover assembly at the place which makes contact with brake shoe	Brake grease (AKB 100)	As required

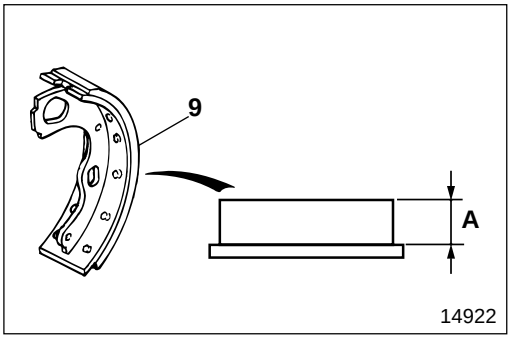
◆ Service procedure



4 **10** **19** **Applying grease to adjusting screw, brake shoe, and support plate and cover assembly**

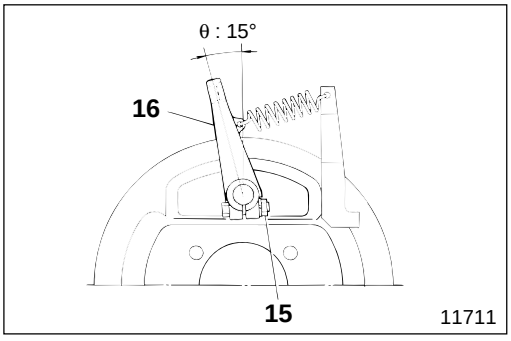
Apply grease to area **C**.

A : Anchor pin area



9 **Inspection of lining**

Measure thickness **A** of lining **9**. If the measured value is lower than the limit, replace the lining.



16 **Installation of camshaft lever**

Align camshaft lever **16** to lever mounting angle θ, and tighten nut **15** at specified torque.

MITSUBISHI
FUSO

Group 36B

Parking Brake
< Wheel Parking Brake >

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-36B

INDEX

STRUCTURE AND OPERATION 36B- 2

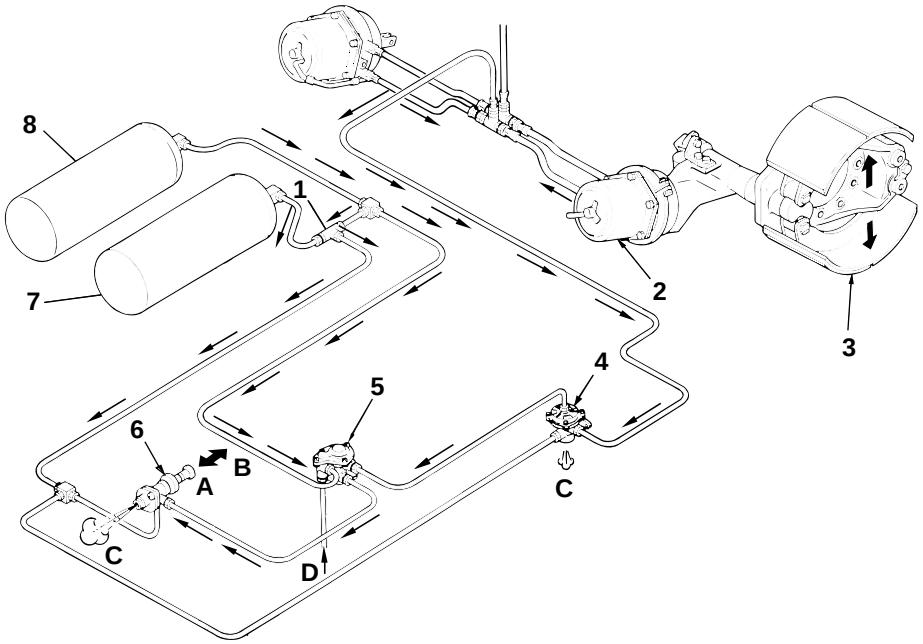
TROUBLESHOOTING 36B- 7

PARKING BRAKE CONTROL VALVE 36B- 8

SPRING BRAKE VALVE 36B-10

DOUBLE CHECK VALVE 36B-13

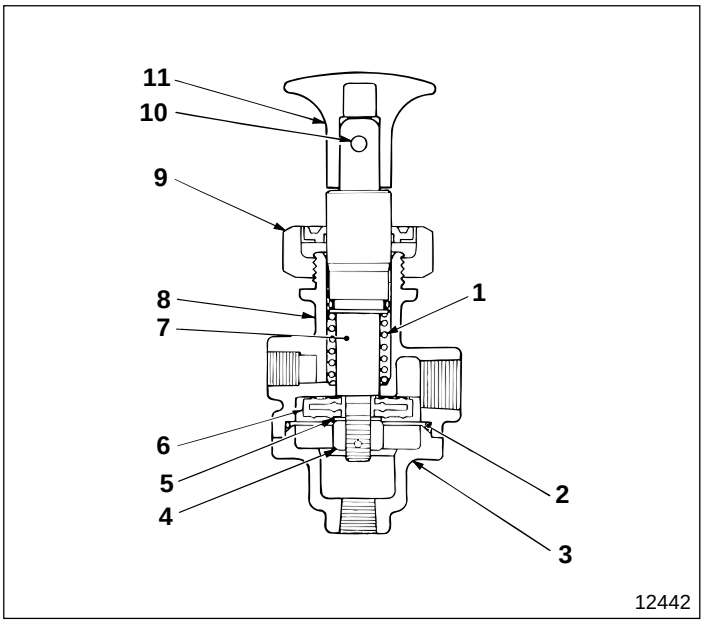
Parking Brake System



1	Double check valve	**5**	Spring brake valve	**A** :	RELEASE position
2	Rear brake chamber	**6**	Parking brake control valve	**B** :	PARK position
3	Rear wheel brake	**7**	Front brake air tank	**C** :	Pressurized air
4	Relay valve	**8**	Rear brake air tank	**D** :	From front brake system

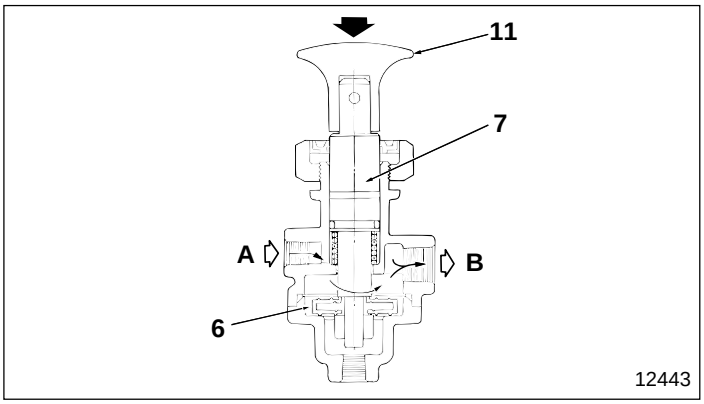
- In the wheel parking brake system, operating parking brake control valve **6** causes rear brake chamber **2**, which contains a spring brake, to apply rear wheel brake **3**, generating braking force.
- Pulling out the knob of parking brake control valve **6** to the PARK position, feeds pressurized air **C** from the parking brake control valve and spring brake valve **5** to relay valve **4**. This exhausts pressurized air **C** in the spring brake in rear brake chamber **2** through the exhaust port of the relay valve, causing the spring brake to generate braking force.
- Pushing in the knob of parking brake control valve **6** to the RELEASE position, feeds pressurized air from rear brake air tank **8** to relay valve **4** via the parking brake control valve.
  Consequently in the separate air system, pressurized air from the rear brake air tank is fed to the spring brake of rear brake chamber **2** via the relay valve, releasing the wheel parking brake.

Parking Brake Control Valve



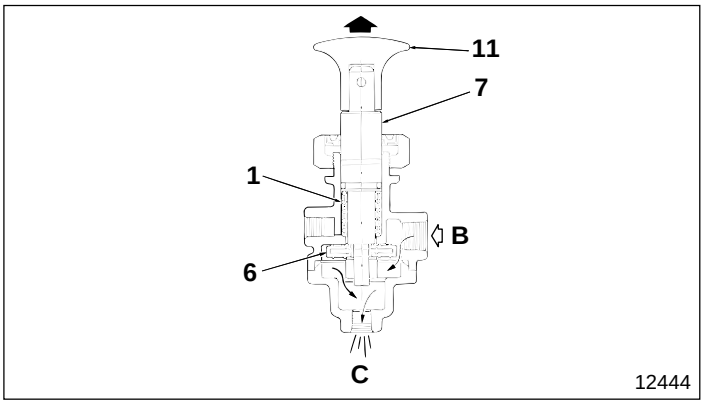
1 Plunger spring
2 Seal ring
3 Cover
4 Nut
5 Washer
6 Valve
7 Plunger
8 Body
9 Seal nut
10 Spring pin
11 Knob

● Feed action (RELEASE)



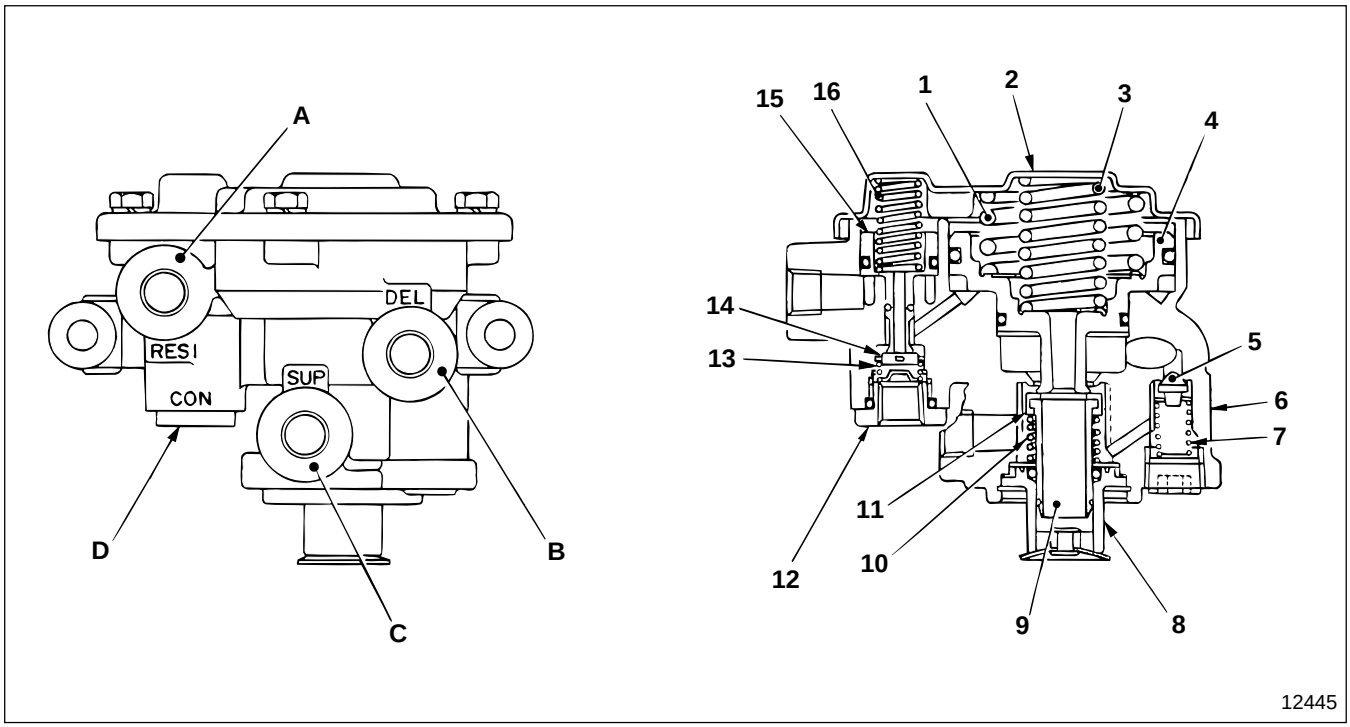
When the air pressure at feed port **A** reaches 420 kPa {61 psi, 4.3 kgf/cm^2} or higher, pushing in knob **11** causes valve **6** at the top of plunger **7** to close the exhaust port, feeding pressurized air to exit port **B**.

● Exhaust action (PARK)



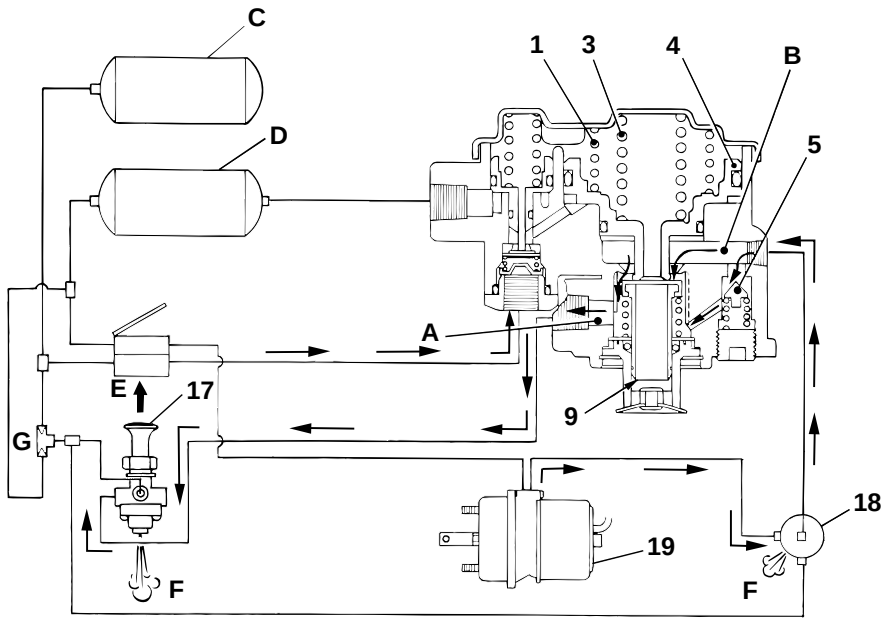
- Pulling out knob **11** causes valve **6** at the top of plunger **7** to open exhaust port **C**, and remains in that position, closing the supply port. This exhausts the air returned from exit port **B** through the air exhaust port.
- When the air pressure at the supply port drops to 275 kPa {40 psi, 2.8 kgf/cm^2} or lower, the repercussive force of plunger spring **1** overcomes the air pressure acting on valve **6** pushing out knob **11** automatically. This exhausts the air through exit port **B**.

Spring Brake Valve



1 Piston spring
2 Cover
3 Spring
4 Piston
5 Check valve
6 Body
7 Spring
8 Exhaust cover
9 Inlet and exhaust valve
10 Valve spring
11 Valve retainer
12 Cap nut
13 Valve spring
14 Valve
15 Piston
16 Piston spring
A : From rear brake air tank
B : To spring brake
C : From parking brake control valve
D : From front brake system

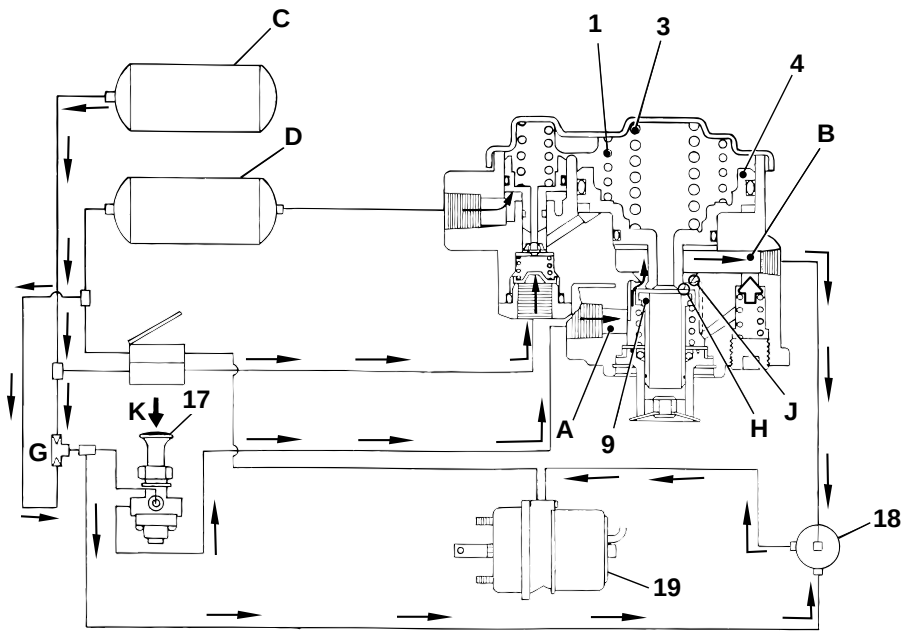
● When parking brake is operated



- Pulling out the knob of parking brake control valve **17** to PARK position **E**, exhausts the pressurized air in chamber **A** of the spring brake valve through the parking brake control valve. Then, the pressurized air in chamber **B** of the spring brake valve forces down check valve **5**, passes through chamber **A**, and is exhausted through the parking brake control valve.
- When the air pressure in chamber **B** of the spring brake valve drops sufficiently, springs **1**, **3** at the top of piston **4** force the piston down, opening inlet and exhaust valve **9**. This exhausts the pressurized air, which is fed to relay valve **18**, from the spring brake valve.
- Relay valve **18** exhausts the pressurized air from the spring brake in rear brake chamber **19** through the exhaust port.
- The spring brake of rear brake chamber **19** operates to generate braking force.

  C : Front brake air tank
  D : Rear brake air tank
  E : PARK position
  F : Pressurized air
  G : Double check valve

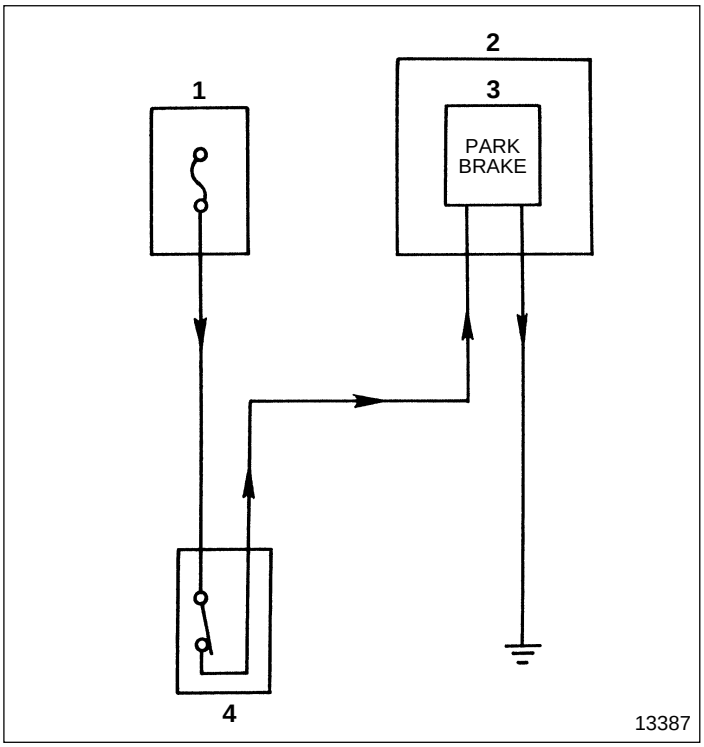
● When parking brake is released



- Pushing in the knob of parking brake control valve **17** to RELEASE position **K**, causes the pressurized air to flow through chamber **A** of the spring brake valve to chamber **B**, then the pressurized air is fed to relay valve **18** as air pressure.
- As the air pressure in chamber **B** rises further, the rising force of piston **4** overcomes the repercussive force of springs **1**, **3**. This closes exhaust valve **H** of inlet and exhaust valve **9**, and at the same time lifts the piston and the inlet and exhaust valve together.
- As piston **4** and inlet and exhaust valve **9** rise further, the inlet and exhaust valve closes inlet valve **J**, isolating chambers **A** and **B** from each other, stopping the air flow between them.
- When it receives pressurized air, relay valve **18** feeds pressurized air in the separate air system to the spring brake, releasing the wheel parking brake.

  C : Front brake air tank
  D : Rear brake air tank
  G : Double check valve
  K : RELEASE position

Parking Brake System Electric Circuit



1 Fuse
2 Meter cluster
3 Parking brake indicator lamp
4 Parking brake switch

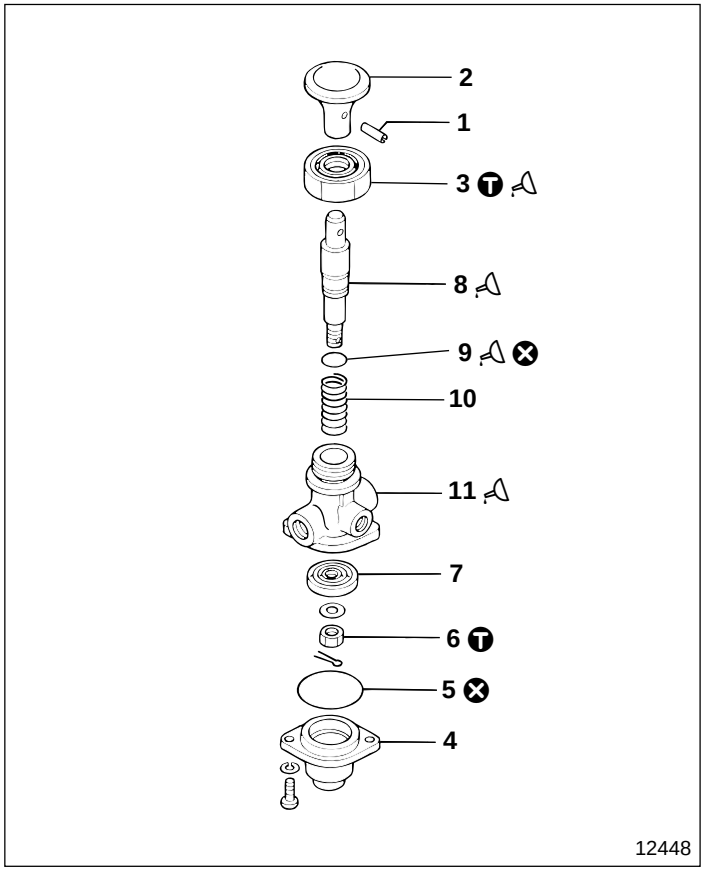
Operating the parking brake turns on parking brake switch **4** and lights parking brake indicator lamp **3**.
The current flows as below:

Fuse **1** → Parking brake switch **4** → Parking brake indicator lamp **3** → Ground

TROUBLESHOOTING

Possible causes / Symptoms		Parking brake does not work	Parking brake does not release	Remarks
Parking control valve	Malfunctioning	○	○	
Spring brake valve	Malfunctioning	○	○	
Brake chamber	Malfunctioning	○	○	Gr 35B
Wheel brake	Malfunctioning	○	○	Gr 35B
Air line	Air leaking		○	
	Air pressure low		○	

PARKING BRAKE CONTROL VALVE



● **Disassembly sequence**

1 Spring pin
2 Knob
3 Seal nut
4 Cover
5 Seal ring
6 Nut
7 Valve
8 Plunger
9 O-ring
10 Plunger spring
11 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Parking brake control valve kit

● **Inspection after assembly**

P36B-9

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Operating pressure (Air pressure when the knob is automatically pushed out from its pushed-in position)	235 to 315 kPa {34 to 45 psi, 2.4 to 3.2 kgf/cm^2}	—	Replace

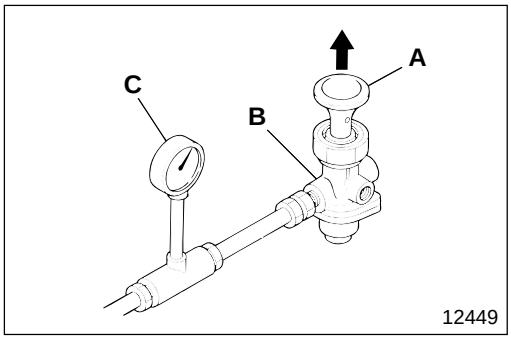
T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
3	Seal nut	25 to 34 {18 to 25, 2.5 to 3.5}	—
6	Nut (Valve mounting)	3.4 to 4.4 {2.5 to 3.3, 0.35 to 0.44}	—

Lubricant

Location	Points of application	Kinds	Quantity
3	Friction surfaces of seal nut and plunger	Multipurpose grease [NLGI No.2 (Li soap)]	As required
8	Friction surface and O-ring groove of plunger	Multipurpose grease [NLGI No.2 (Li soap)]	As required
9	Periphery of O-ring	Multipurpose grease [NLGI No.2 (Li soap)]	As required
11	Friction surfaces of body and plunger	Multipurpose grease [NLGI No.2 (Li soap)]	As required

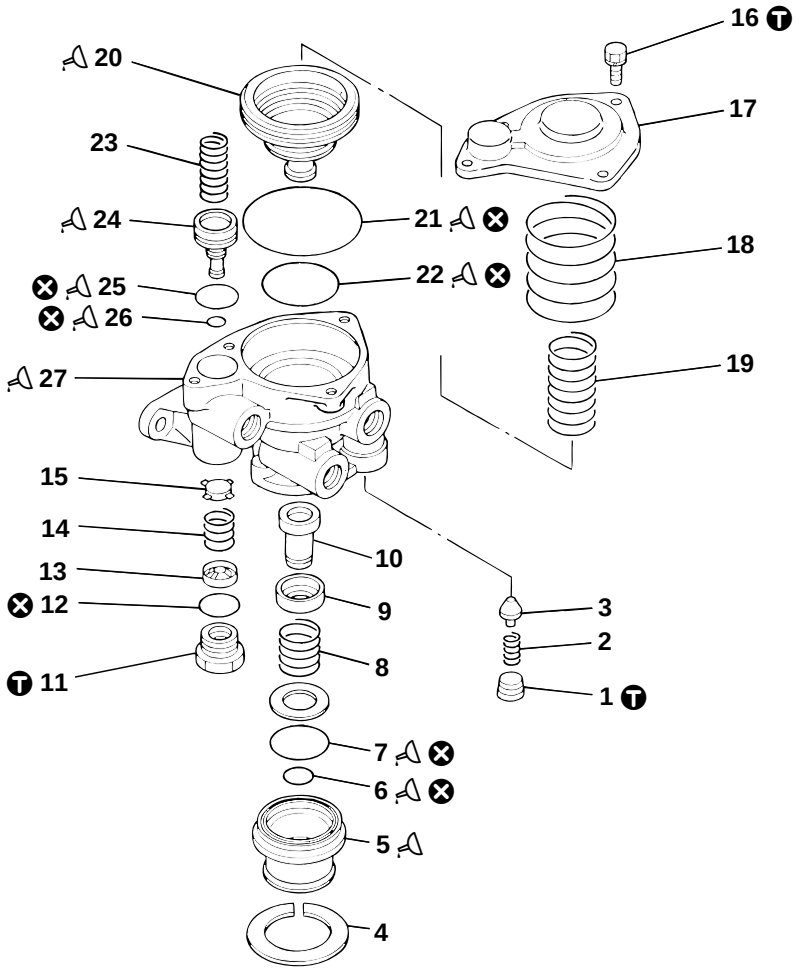


◆ Service procedure

● **Inspection after assembly**

- While pushing in knob **A**, feed air pressure of 685 kPa {100 psi, 7 kgf/cm^2} via air supply port **B**.
- Gradually decrease the air pressure and confirm that the air pressure required to push out the knob from its pushed-in position is the standard value.
  C : Air gauge

SPRING BRAKE VALVE



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● **Disassembly sequence**

1 Plug
2 Spring
3 Check valve
4 Retaining ring
5 Exhaust cover
6 O-ring
7 O-ring
8 Valve spring
9 Valve retainer
10 Inlet and exhaust valve
11 Cap nut
12 O-ring
13 Valve stop
14 Valve spring
15 Valve
16 Bolt
17 Cover
18 Piston spring
19 Piston
20 Piston
21 O-ring
22 O-ring
23 Piston spring
24 Piston
25 O-ring
26 O-ring
27 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Spring brake valve kit

● **Inspection of operation after assembly**

P36B-11

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Plug	15 to 20 {11 to 14, 1.5 to 2.0}	—
11	Cap nut	11 to 14 {8.0 to 10, 1.1 to 1.4}	—
16	Bolt (Cover mounting)	5.9 to 8.8 {4.3 to 6.5, 0.6 to 0.9}	—

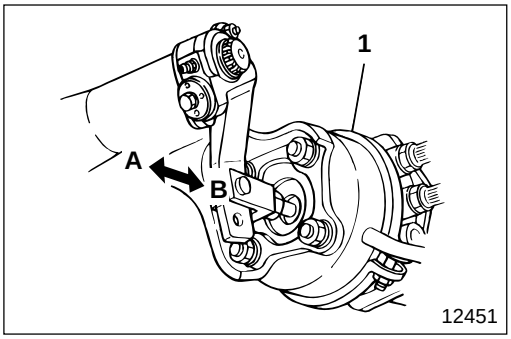
Lubricant

Location	Points of application	Kinds	Quantity
5	Friction surfaces of exhaust cover and inlet and exhaust valve	Silicon grease	As required
20, 24	O-ring groove and outer periphery of piston	Silicon grease	As required
27	Friction surfaces of body and piston	Silicon grease	As required
—	Periphery of O-ring	Silicon grease	As required

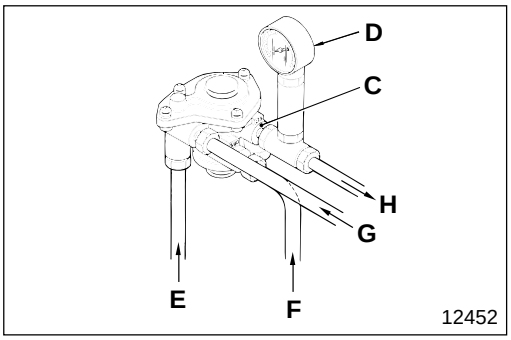
◆ Service procedure

● Inspection of operation after assembly

- Place wheel chocks at the rear wheels to prevent the vehicle from moving.
- Start the engine to raise the air pressure until the air pressure gauge reads 805^{+29}_{-20} kPa {$115^{+4.3}_{-2.8}$ psi, $8.2^{+0.3}_{-0.2}$ kgf/cm^2}.

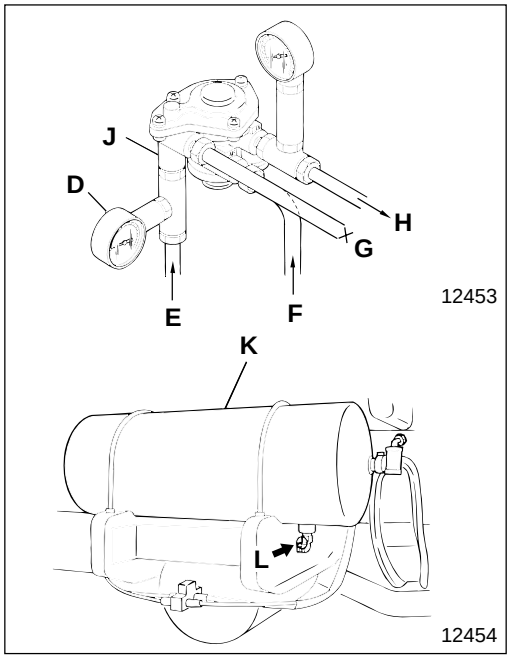


- Confirm that when the knob of the parking brake control valve is pulled out to the PARK position, rear brake chamber **1** operates immediately, applying the wheel parking brake .
- Confirm that when the knob of the parking brake control valve is pushed in to the RELEASE position, rear brake chamber **1** operates, releasing the wheel parking brake.
  A : Applied
  B : Released

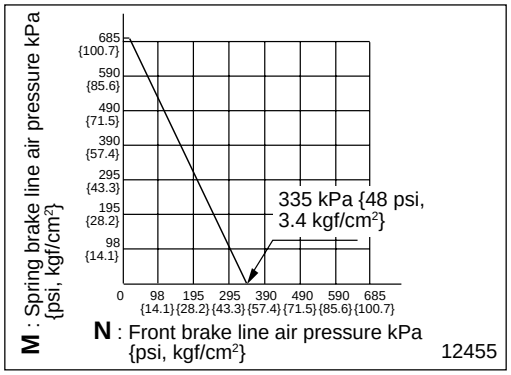


- Mount air pressure gauge **D** on delivery port **C** of the spring brake valve.
- Read air pressure gauge **D** when the knob of the parking brake control valve is pushed to the RELEASE position.
  Specified value: 650 kPa {95 psi, 6.62 kgf/cm^2}
  E : From front brake system
  F : From parking brake control valve
  G : From rear brake air tank
  H : To spring brake of rear brake chamber

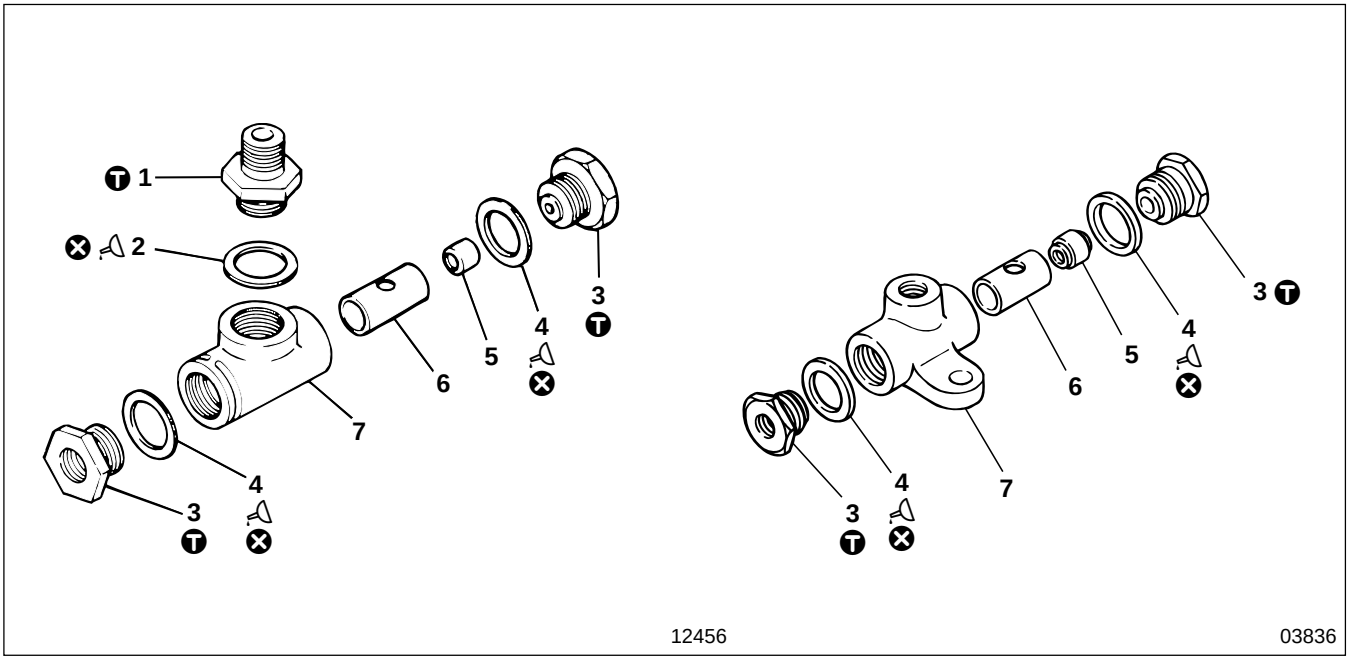
- Confirm that when the knob of the parking brake control valve is pulled out to the PARK position, the reading of air pressure gauge **B** drops immediately to 0 kPa {0 psi, 0 kgf/cm^2}. If the air pressure gauge indicator needle drops slowly, replace check valve **3**, since it is probably faulty.



- Mount air pressure gauge **D** on control port **J**.
- Push in the knob of the parking brake control valve to the RELEASE position and pull drain cock **L** to completely bleed tank **K** of the rear brake system.
  E : From front brake system
  F : From parking brake control valve
  G : No pressurized air from rear brake air tank
  H : To spring brake of rear brake chamber



- Have the brake pedal depressed several times and read the drop in the air pressure on both air pressure gauges **D** every time the brake is pressed to confirm that each value conforms to the specified value indicated on the performance curve diagram.
- Press the brake pedal several times to compress the air until rear brake chamber **1** operates on the wheel parking brake locking the rear wheels completely.



● **Disassembly sequence**

1 Joint
2 Packing
3 Joint
4 Packing
5 Check valve
6 Sleeve
7 Body

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Repair kit : Double check valve kit

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1, 3	Joint	34 to 44 {25 to 33, 3.5 to 4.5}	—

Sealant

Location	Points of application	Kinds	Quantity
2, 4	Surfaces of packing	THREEBOND 1101	As required

MITSUBISHI
FUSO

Group 37
Steering

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-37

INDEX

SPECIFICATIONS 37- 2

STRUCTURE AND OPERATION 37- 3

TROUBLESHOOTING 37-10

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Change of Power Steering Fluid 37-13
- Bleeding of Power Steering System 37-13
- Steering Wheel Play 37-14
- Performance Verification Test of Power Steering System 37-15

STEERING SYSTEM 37-16

LINKAGE AND BRACKET 37-20

POWER STEERING BOOSTER 37-22

POWER STEERING OIL PUMP 37-34

POWER STEERING OIL TANK 37-38

POWER STEERING FLUID LINE 37-39

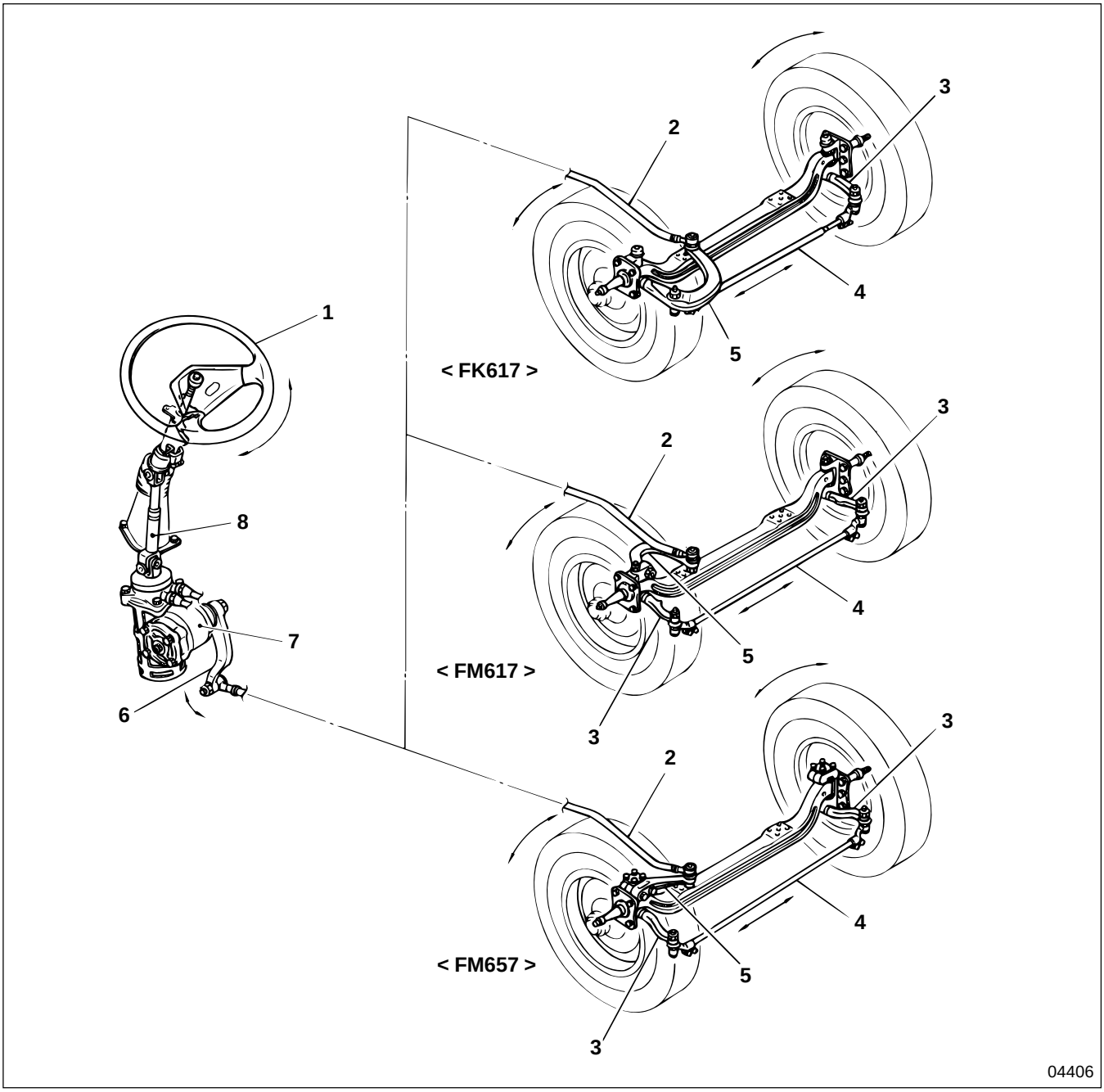
DRAG LINK 37-40

TIE ROD ASSEMBLY 37-42

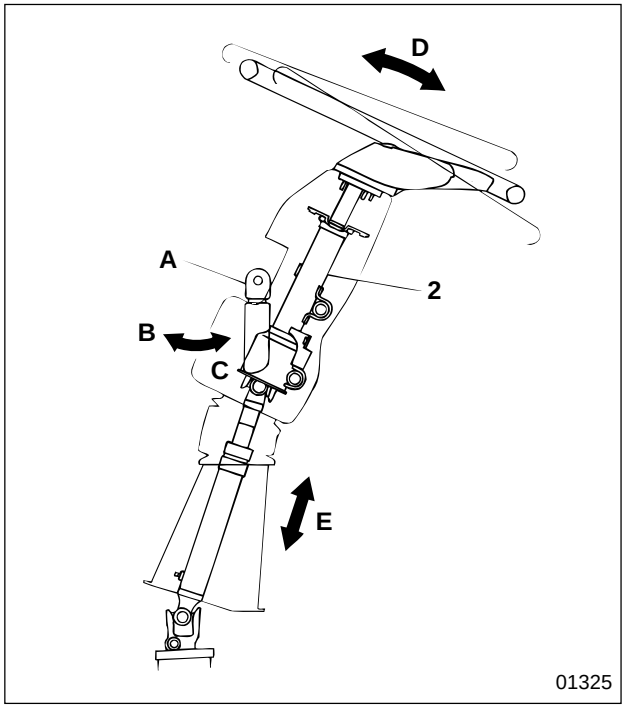
SPECIFICATIONS

Item \ Vehicle model		FK617-A	FK617-B	FM617-A FM617-C	FM617-B FM617-D	FM657
Steering wheel	Type	2-spoke type				
	Outer diameter mm {in.}	480 {18.9}				
Steering shaft	Type	Universal joint type (Tilt and telescopic type)				
Power steering booster	Manufacturer	BOSCH BRAKING SYSTEMS				
	Type	Ball nut type				
	Form	Integral type				
	Model No.	443-00013		446-00105		446-00545
	Gear ratio	17.1 to 20		19.05		22.4
	Cylinder diameter mm {in.}	85 {3.35}		90 {3.54}		100 {3.94}
	Mass (without pitman arm and fluid) kg {lb}	21 {46}		24 {53}		30 {66}
Power steering oil pump	Manufacturer	BOSCH BRAKING SYSTEMS				
	Type	Vane type				
	Model No.	475-03451	475-03454	475-03451	475-03454	475-03453
	Discharge amount cm^3 {cu.in.}/rotation	15 {0.92}				17.5 {1.07}
	Regulated flow amount L {qts}/min	12 {13}				18 {19}
	Regulated pressure (relief valve) MPa {psi, kgf/cm^2}	13.2 {1920, 135}				12.3 {1780, 125}
	Permissible revolutions rpm	600 to 4000				
	Mass (without drive gear, and fluid) kg {lb}	4.9 {11}				

Steering System

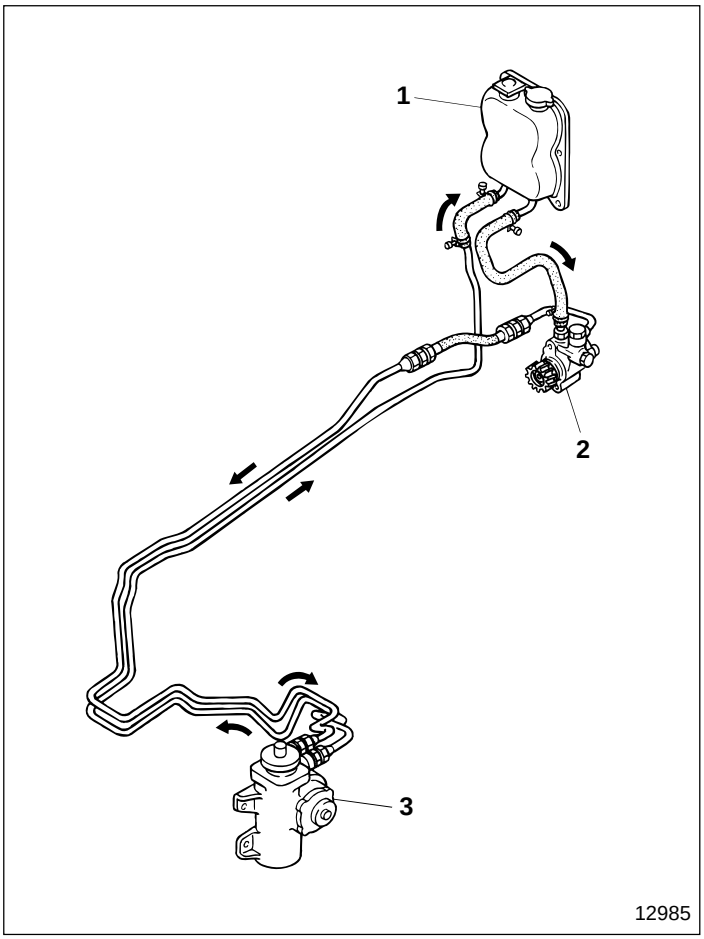


1 Steering wheel
2 Drag link
3 Tie rod arm
4 Tie rod
5 Knuckle arm
6 Pitman arm
7 Power steering booster
8 Steering shaft



Shifting lock lever **A** from lock position **B** to release position **C** allows you to adjust tilt **D** and telescopic movement **E** of steering shaft **2** to the optimum driving position.

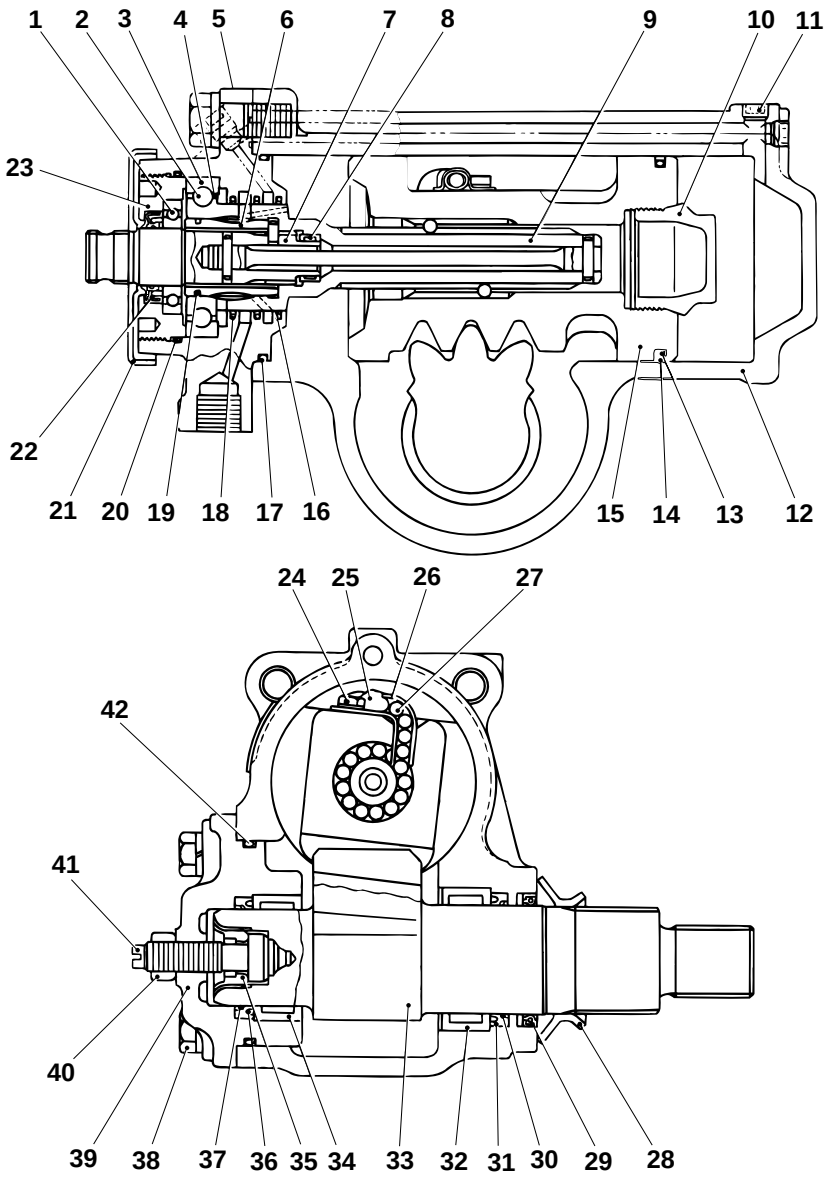
Power Steering System



1 Power steering oil tank
2 Power steering oil pump
3 Power steering booster

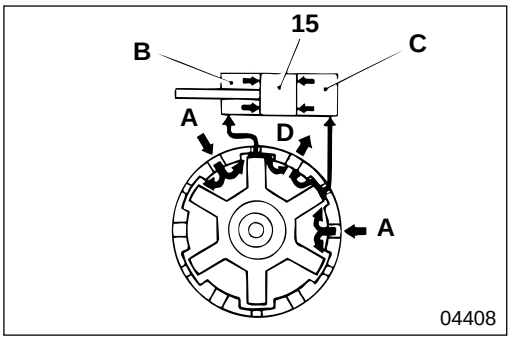
⬅ : Fluid flow

Power Steering Booster



1 Ball bearing
2 Steel ball
3 Side race
4 Bearing cage
5 Valve housing
6 Rotor
7 Stub shaft
8 Needle bearing
9 Worm shaft
10 Plug
11 Taper plug
12 Body
13 O-ring
14 Seal ring
15 Piston
16 Seal ring
17 O-ring
18 O-ring
19 Seal ring
20 O-ring
21 Dust cover
22 Oil seal
23 Adjusting plug
24 Screw
25 Ball tube clip
26 Ball tube
27 Steel ball
28 Dust cover
29 Oil seal
30 Backup ring
31 Y-packing
32 Needle bearing
33 Sector shaft
34 Needle bearing
35 Retainer
36 Y-packing
37 Backup ring
38 Bolt
39 Side cover
40 Nut
41 Adjusting screw
42 O-ring

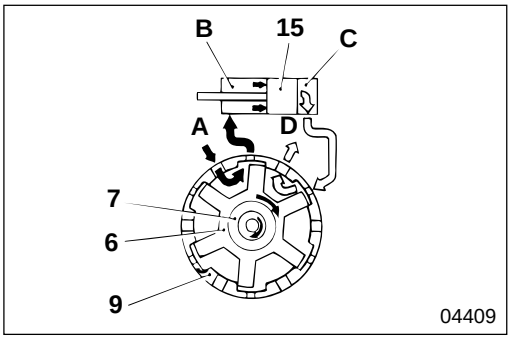
The rotary valve is the central part of the power steering booster. The torsion bar allows the steering reaction force and valve return to operate lightly and smoothly at low speed, and ensures stable steering feel even at high speed.



Straight-ahead operation

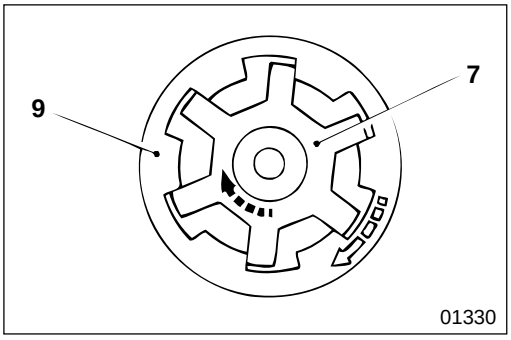
Piston **15** is in the neutral position as chambers **B** and **C** of the piston are under equal pressure.

A : From oil pump
D : To oil tank



Steering operation

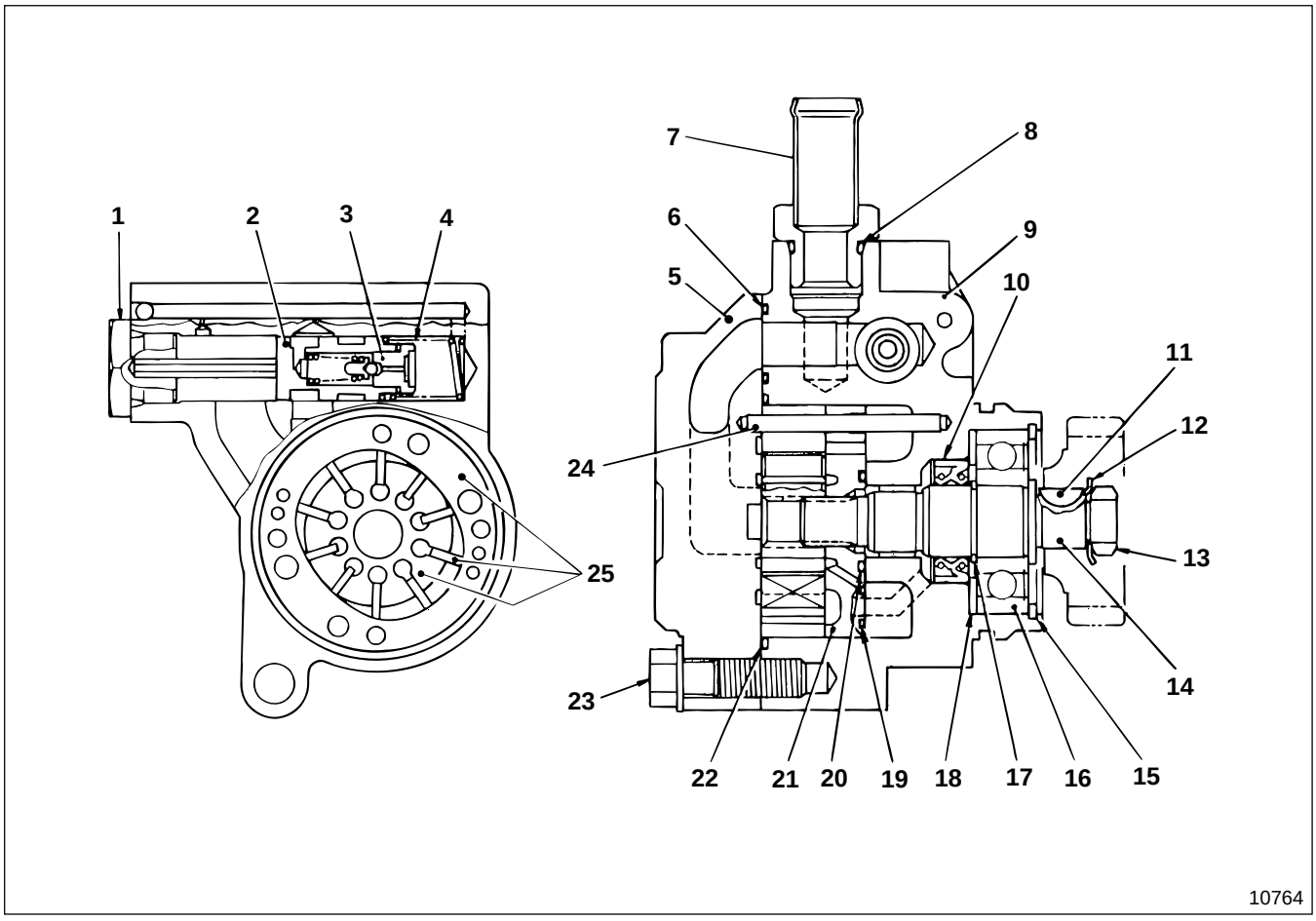
Turning the steering wheel rotates stub shaft **7**, causing rotor **6** to close the fluid feed passage to cylinder chamber **C**. This produces a pressure difference between cylinder chambers **B**, **C**, which causes piston **15** to move, and facilitates rotation of worm shaft **9**.



If the hydraulic circuit fails

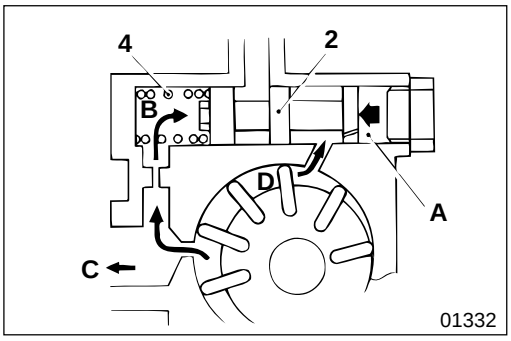
The safety mechanism allows the vehicle to be steered manually, when the rotating force of stub shaft **7** alone directly turns worm shaft **9**, transmitting the steering force.

Power Steering Oil Pump



1 Plug
2 Flow control valve assembly
3 Relief valve
4 Flow control spring
5 Rear body
6 O-ring
7 Hose connector
8 O-ring
9 Front body
10 Oil seal
11 Key
12 Lock washer
13 Nut
14 Drive shaft
15 Retaining ring
16 Ball bearing
17 Retaining ring
18 Retaining ring
19 O-ring
20 O-ring
21 Pressure plate
22 O-ring
23 Bolt
24 Straight pin
25 Cartridge assembly

Flow Control Valve Assembly

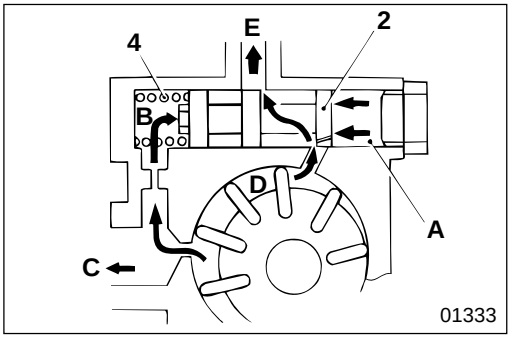


● **Operation of flow control valve**

(1) When not operating (When oil pump rotating at low speed)

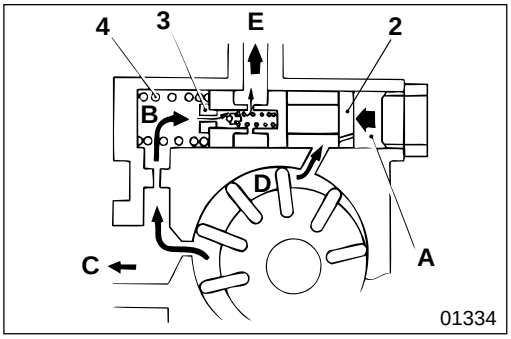
The fluid pressure from chamber **A** does not move flow control valve assembly **2** because the fluid pressure is lower than the combined force of the fluid pressure from chamber **B** and the repercussive force of flow control spring **4**.

C : To power steering booster
D : Pressure chamber



(2) When operating (When oil pump rotating at middle or high speed)

The fluid pressure from chamber **A** moves flow control valve assembly **2** because the fluid pressure is higher than the combined force of the fluid pressure from chamber **B** and the repercussive force of flow control spring **4**. Then, port **E** opens to release the fluid, maintaining the level of flow in chamber **A**.



● **Operation of relief valve**

The combined force of the fluid pressure from chamber **B** and the repercussive force of flow control spring **4** moves flow control valve assembly **2** because the fluid pressure is higher than the fluid pressure from chamber **A**. The fluid pressure in chamber **B** rises further to open relief valve **3** and port **E**, stabilizing the fluid pressure in chamber **B**.

Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Power steering mechanism faulty	Thrust bearing damaged or worn	○			○	○								
	Ball or groove of ball screw worn	○	○		○									
	Air bled insufficient	○												
	Fluid viscosity unsuitable	○												
	Power steering booster system faulty	○												
	Flow control valve malfunctioning	○												
	Ball screw unit rack and gear worn		○											
	Sector shaft bearing worn		○		○									
	Power steering booster mounting bolt loose		○											
	Ball screw unit and sector shaft play incorrect				○									
	Valve control edge damaged or control seal ring broken				○									
	Power steering system fluid unsuitable				○									
	Rack engagement starting torque adjusted incorrectly	○				○								
	Fluid circuit clogged	○				○								
	Sector shaft gear worn		○											
	Torsion shaft serration damaged or worn		○											
	Power steering booster body faulty			○	○									
	O-ring, oil seal faulty								○					
	Sealant applied incorrectly								○					
Steering column and linkage mechanism faulty	Universal joint worn abnormally, damaged, lubricated incorrectly	○	○											
	Linkage deformed	○												
	Drag link ball stud play		○		○									
	Tie rod end ball stud play		○		○									
	Tie rod bent						○							
	Pitman arm mounting position incorrect							○						
	Steering wheel turning center offset			○										

Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Front axle faulty	Kingpin lubricated incorrectly	○				○								
	Front wheel alignment (toe-in, camber, caster) incorrect	○		○	○	○								
	Thrust bearing damaged	○												
	Wheel hub bearing worn or damaged		○	○	○									Gr 26
	Kingpin or bushing worn or damaged		○	○	○									
	Front axle deformed			○										
	Knuckle arm, tie rod arm, or knuckle tightened incorrectly				○									
	Front spring U-bolt, nut loose				○									Gr 33
	Front axle parts overtightened					○								
	Turning angle adjusted incorrectly						○	○						Gr 26
	Mounting parts, connection point loose		○											
	Knuckle stopper bolt adjusted incorrectly							○						
Oil pump faulty	Oil pump body faulty								○					
	O-ring or oil seal faulty								○					
	Bolt tightened incorrectly								○					
	Maximum generated fluid pressure insufficient									○				
	Fluid line crushed or clogged									○				
	Air lock in oil pump										○			
	Oil pump interior seized									○	○	○		
	Mounting bolt or nut loose												○	
	Pump body faulty												○	
	Valve malfunctioning									○				
Oil tank faulty	Oil tank leaking due to overflowing								○					
	Oil tank leaking due to air lock								○					
	Fluid level insufficient	○												

TROUBLESHOOTING

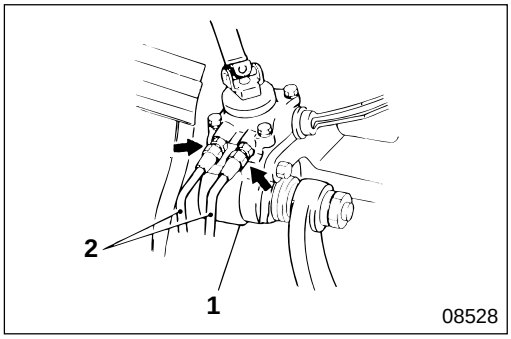
Possible causes \ Symptoms		Steering wheel operation heavy	Steering wheel play excessive and unstable	Steering wheel pulls to one side	Steering wheel vibration	Steering wheel self-return poor	Steering wheel does not turn	Steering angle insufficient or difference between right and left	Fluid leaking	Oil pump fluid pressure abnormal	Oil pump gurgles	Oil pump squeaks	Oil pump growls	Remarks
Other malfunctions	Load too far forward of load-carrying platform	○												
	Load too far rearward of load-carrying platform		○											
	Load too far to one side of load-carrying platform			○										
	Leaf spring fatigued or cracked			○										Gr 33
	Braking force unbalanced			○										Gr 35A, B
	Tire wear difference between left and right excessive			○										Gr 31
	Tire outer diameter difference between left and right			○										
	Front tire radial and lateral runout, static balance or dynamic balance faulty				○									
	Wheelbase difference between left and right excessive			○										
	Propeller shaft runout excessive				○									Gr 25
	Rear axle housing bent			○										Gr 27
	Reduction pinion and gear damaged or engaged incorrectly				○									

Change of Power Steering Fluid

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Oil pipe	66.69±12.75 {49±9.4, 6.8±1.3}	—



[Draining]
- Jack up the front wheels.
- Loosen oil pipe **2** connected to power steering booster **1**.
- Turn the steering wheel fully left and right repeatedly, and drain the fluid from power steering booster **1**.
- After draining the fluid, tighten oil pipe **2** at specified torque.

[Filling]
P37-13

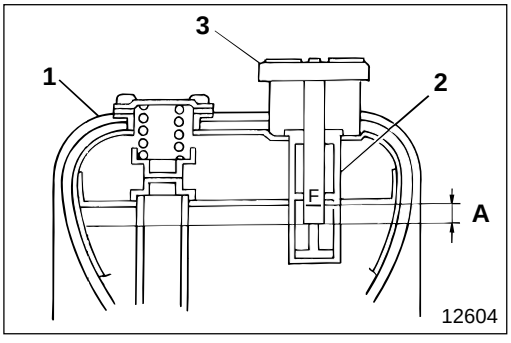
Bleeding of Power Steering System

Fluid

Location	Points of application	Kinds	Quantity
1	Power steering oil tank	Automatic transmission fluid (DEXRON or DEXRON II type)	Filler cap dipstick between end and F

CAUTION

Do not keep the steering wheel turned fully to the left or right for more than fifteen seconds when the engine is running, as this can cause the power steering oil pump to seize up.



- Pour fluid into power steering oil tank **1** up to the inner port of strainer **2**.
- With the engine stopped, jack up the front wheels and turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**.

NOTE

Check the fluid level without screwing on filler cap 3.

- Start the engine and letting it idle, turn the steering wheel fully left and right repeatedly. When the fluid level has dropped, add fluid to maintain the fluid level within range **A**. Repeat these steps until the fluid level does not drop.
- If there is an abnormal noise, air is still in the system. Turn the steering wheel several times to raise the fluid temperature to approximately 60 to 80°C {140 to 176°F}, then stop the engine and wait for approximately five minutes.
- Lower the front wheels and turn the steering wheel several times. If there is no noise, bleeding is completed.
- When bleeding is finished, check fluid level of power steering oil tank **1**, and pipe and hose connections for fluid leaks.

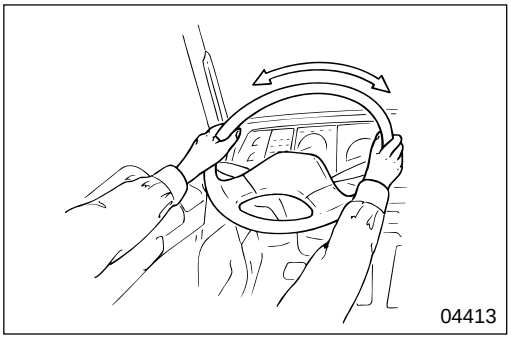
ON-VEHICLE INSPECTION AND ADJUSTMENT

Steering Wheel Play

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering wheel play (Measure at the outer circumference of steering wheel)	10 to 40 {0.39 to 1.57}	—	Adjust

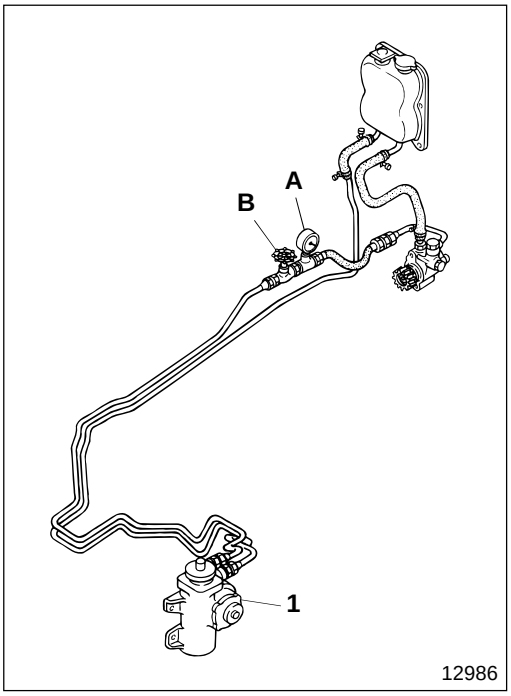


Point the wheels directly forward and gently turn the steering wheel left and right and measure the outer circumference play. If the play deviates from the standard value, adjust tightening points and power steering booster backlash. P37-27

Performance Verification Test of Power Steering System

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Steering system fluid pressure (With hands off steering wheel)	490 kPa {71 psi, 5 kgf/cm²}	—	Repair
—	Relief set pressure (Measure with engine speed at 1000 to 1500 rpm and stop valve closed)	< FK617, FM617 >: 13.2 MPa {1914 psi, 135 kgf/cm²}, < FM657 >: 12.3 MPa {1780 psi, 125 kgf/cm²},	Maximum +785 KPa {115 psi, 8 kgf/cm²} Minimum –1180 KPa {170 psi, 12 kgf/cm²}	Adjust or replace



Verify that the power steering booster and the power steering oil pump are operating properly by testing the following items.

CAUTION

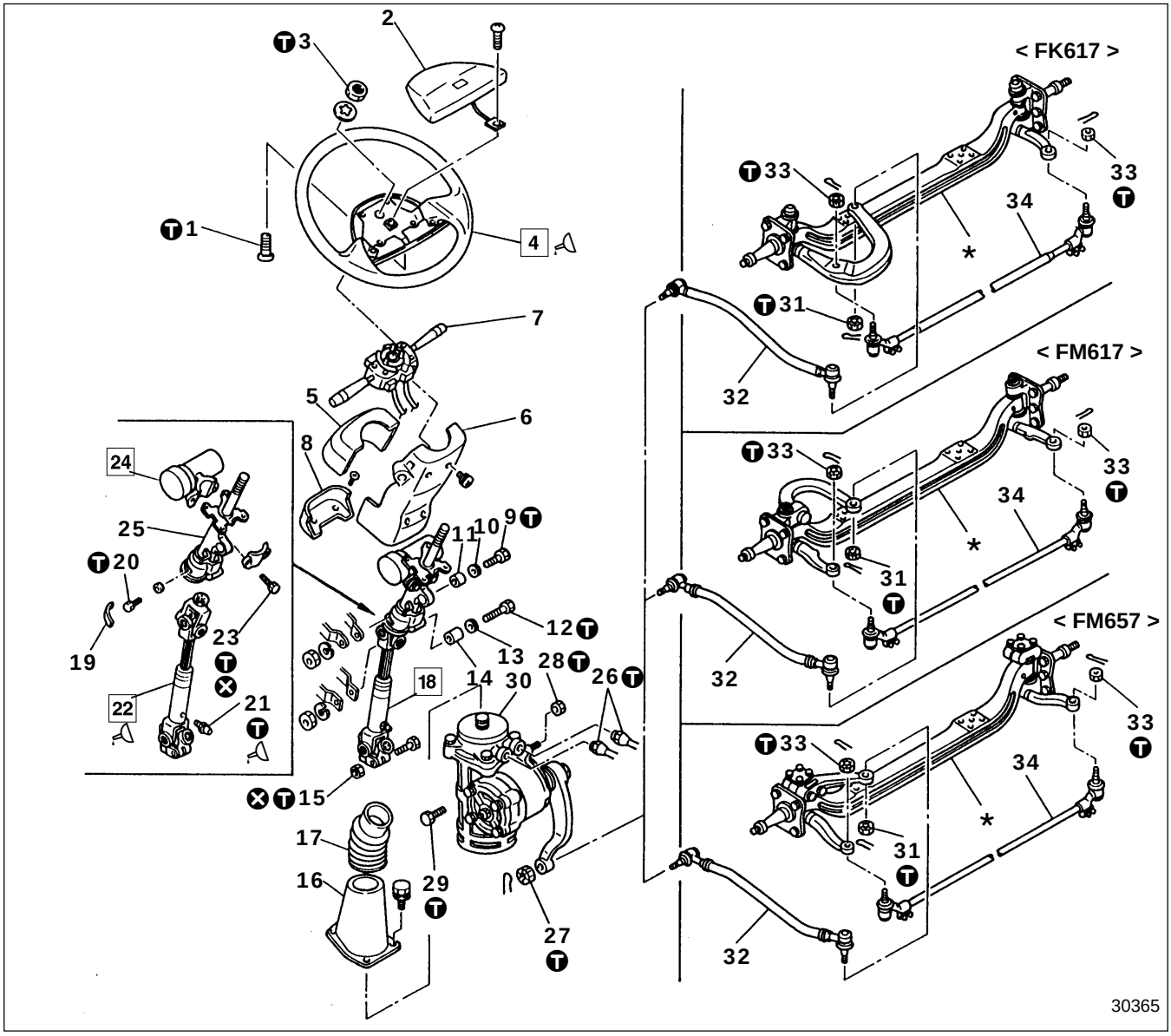
Do not keep stop valve B closed for more than fifteen seconds as this can cause the power steering oil pump to seize up.

NOTE

If the fluid pressure is higher than 490 kPa {71 psi, 5 kgf/cm²} with engine idling and the steering wheel free, inspect power steering booster 1 and fluid circuit for clogging.

Test item	Test procedure	Assembly standards
Verification of smooth operation	Jack up the front wheels and turn steering wheel fully left and right	Smooth operation throughout test
Measurement conditions	• Install oil pressure gauge **A** capable of measuring above 14.7 MPa {2130 psi, 150 kgf/cm²} and stop valve **B**, then bleed air • With engine idling, turn steering wheel left and right several times to raise fluid temperature to 50 to 60°C {122 to 140°F} • With the engine idling, open stop valve **B**	
Measurement of fluid pressure	Measure fluid pressure with hands off steering wheel	490 kPa {71 psi, 5 kgf/cm²}
Measurement of relief pressure	• Gradually increase engine speed and maintain it at 1000 to 1500 rpm, and close stop valve **B** to measure maximum fluid pressure • Do not keep stop valve **B** closed for more than fifteen seconds	Relief set pressure < FK617, FM617 >: 13.2 MPa {1920 psi, 135 kgf/cm²}, < FM657 >: 12.3 MPa {1780 psi, 125 kgf/cm²}

STEERING SYSTEM



● **Removal sequence**

1 Screw
2 Steering wheel pad
3 Nut
4 Steering wheel
5 Front column cover
6 Rear column cover
7 Combination switch Gr 54
8 Harness cover
9 Bolt
10 Wave washer
11 Collar
12 Bolt
13 Wave washer
14 Collar
15 Nut
16 Support
17 Dust cover
18 Steering shaft assembly
19 Seal
20 Bolt
21 Grease nipple
22 Steering lower shaft assembly
23 Head cutting bolt
24 Starter switch Gr 54
25 Steering upper shaft assembly
26 Oil pipe P37-39
27 Nut
28 Nut
29 Bolt
30 Power steering booster P37-22
31 Nut
32 Drag link P37-40
33 Nut
34 Tie rod assembly P37-42

* : Front axle assembly Gr 26
⊗ : Non-reusable parts

CAUTION

When disconnecting oil pipe 26, clean the port to keep it free from dust and other foreign particles.

● **Installation sequence**

Follow the removal sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
22, **25**	Play in rotating direction of joint	15' or less	—	Replace
	Play in axial direction of steering shaft	0.2 {0.0079} or less	—	Replace
22	Play in rotating direction of spline	30' or less	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

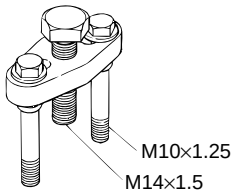
Location	Parts to be tightened		Tightening torque	Remarks
1	Screw (Steering wheel pad mounting)		3.9 {2.9, 0.4}	—
3	Nut (Steering wheel mounting)		68 to 78 {50 to 57, 6.9 to 7.9}	—
9	Bolt (Upper lever and steering shaft assembly mounting)		9.8 {7.2, 1}	—
12	Bolt (Lower lever and steering shaft assembly mounting)		36 {27, 3.7}	—
15	Nut (Steering shaft assembly and integral power steering assembly mounting)		51.42±2.45 {38±1.8, 5.25±0.25}	—
20	Bolt (Steering lower shaft assembly mounting)		48 to 63 {35 to 46, 4.9 to 6.4}	—
21	Grease nipple		2.9 to 4.9 {2.2 to 3.6, 0.3 to 0.5}	—
23	Head cutting bolt (Starter switch mounting)		13.7±1.0 {10±1.1, 1.4±0.1}	—
26	Oil pipe mounting		67±13 {49±9.4, 6.8±1.3}	—
27	Nut (Drag link assembly and integral power steering assembly mounting)	FK617, FM617	190±48 {140±35, 19.4±4.85}	—
		FM657	353±88 {260±65, 36±9}	—
28	Nut (Integral power steering booster assembly mounting)	FK617, FM617	175.4±26.5 {130±20, 17.9±2.7}	—
		FM657	341±51 {250±38, 34.8±5.2}	—
29	Bolt (Integral power steering booster assembly mounting)	FK617, FM617	175.4±26.5 {130±20, 17.9±2.7}	—
		FM657	341±51 {250±38, 34.8±5.2}	—
31	Nut (Drag link assembly and front axle assembly mounting)	FK617, FM617	190±48 {140±35, 19.4±4.85}	—
		FM657	353±88 {260±65, 36±9}	—
33	Nut (Tie rod assembly and front axle assembly mounting)	FK617, FM617	190±48 {140±35, 19.4±4.85}	—
		FM657	270±68 {200±50, 27.6±6.9}	—

Lubricant

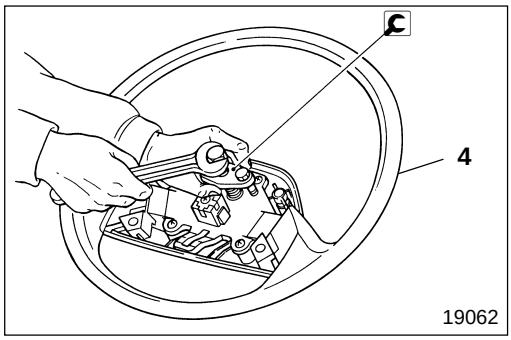
Location	Points of application	Specified lubricant	Quantity
4	Horn contact ring on combination switch side	Wheel bearing grease [NLGI No.2 (Li soap)]	As required
21	Supply via grease nipple after assembling spline	Chassis grease [NLGI No.1 (Ca soap)]	Supply until grease overflows from grease escape hole
22	Spline	Chassis grease [NLGI No.1 (Ca soap)]	As required

Special tools

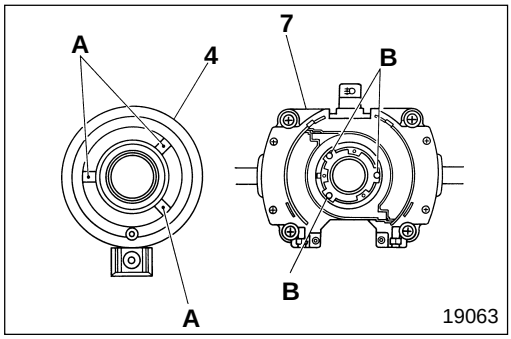
Unit : mm

Location	Tool name and shape	Part No.	Application
4	Steering wheel puller 	MH062421	Removal of steering wheel

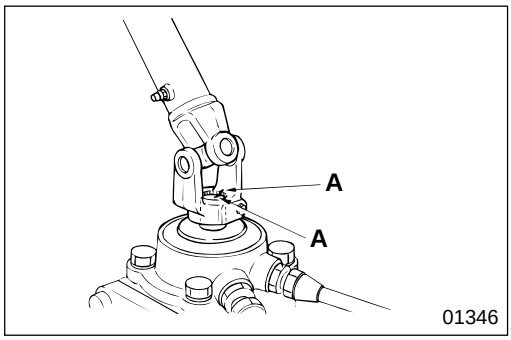
◆ Service procedure



4 **Removal of steering wheel**

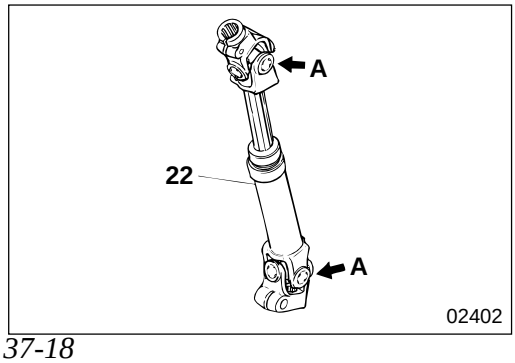


[Installation]
Align slots **A** in steering wheel **4** with cancel cam protrusions **B** of combination switch **7**.



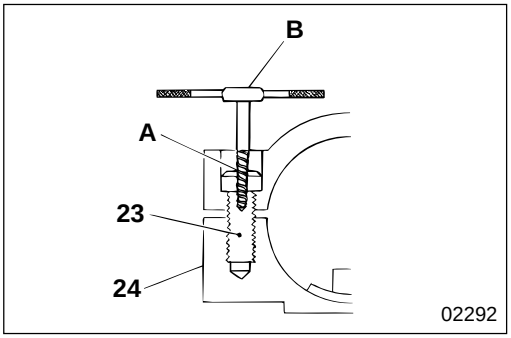
18 **Removal of steering shaft assembly**

A : Alignment mark



22 **Steering lower shaft assembly**

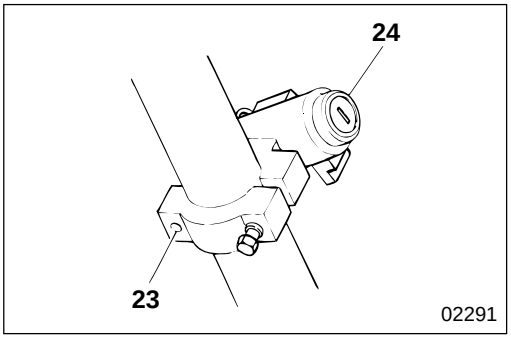
When the spline of steering lower shaft assembly **22** has been disconnected, align marks **A** on the yokes to face the same direction.



24 **Starter switch**

[Removal]

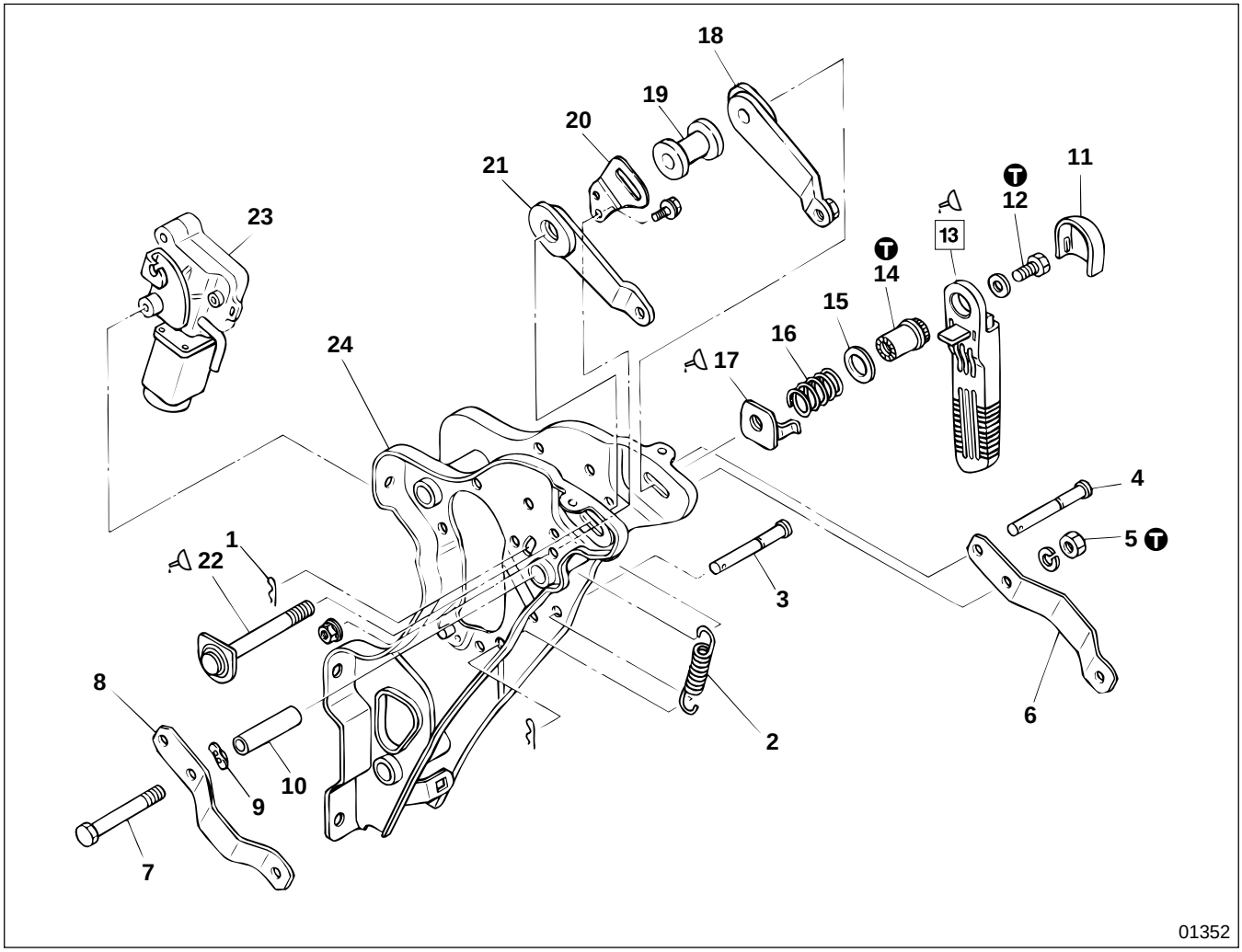
- Grip one end of the column in a vise, then drill a ø5.5 to 6 mm {0.22 to 0.24 in.} hole 10 to 15 mm {0.39 to 0.59 in.} deep in surface **A**, where the head was cut off, of head cutting bolt **23** for mounting starter switch **24**.
- Screw in screw extractor **B** counterclockwise, then remove head cutting bolt **23** from the steering column.



[Installation]

- Tighten new head cutting bolt **23** at specified torque to cut the head off the bolt.
- Check the steering lock mechanism after installation.

LINKAGE AND BRACKET



● **Disassembly sequence**

1 Snap ring
2 Coil spring
3 Clevis pin
4 Clevis pin
5 Nut
6 Lower lever, RH
7 Bolt
8 Lower lever, LH
9 Wave washer
10 Collar
11 Lock lever cap
12 Bolt
13 Lock lever
14 Nut
15 Washer
16 Coil spring
17 Washer and stopper set
18 Upper lever, RH
19 Collar
20 Steering column plate
21 Upper lever, LH
22 Adjusting bolt
23 Fuel-cut motor Gr 13 and Gr 54
24 Steering column bracket

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
2	Coil spring load (Installed length 106.5 {4.19})	115 N {26 lbf, 11.9 kg}	—	Replace
13	Play at lock lever tip	2.5 {0.098} or less	3.0 {0.12} or less	Replace
	Lock lever working angle	36 to 46°	—	Adjust

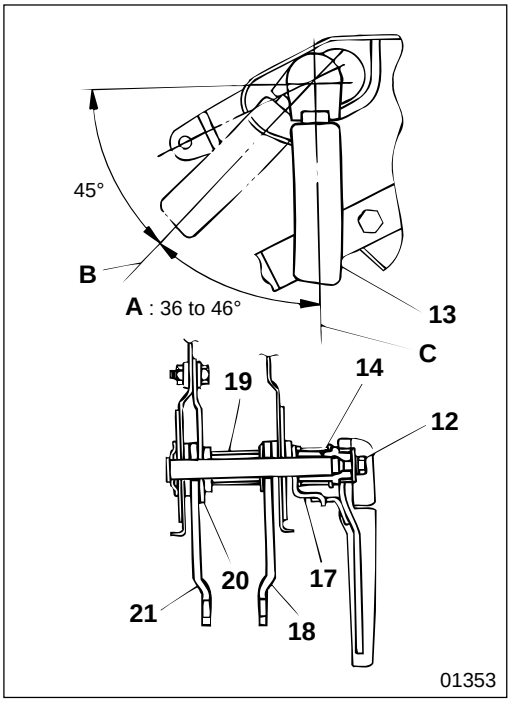
Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Nut (Lower lever mounting)	36.3 {27, 3.7}	—
12	Bolt (Lock lever mounting)	9.8 {7.2, 1}	—
14	Nut (Upper lever mounting)	41.2 to 44.1 {31 to 33, 4.3 to 4.5}	—

Lubricant

Location	Points of application	Kinds	Quantity
13	Serration area on lock lever	Chassis grease [NLGI No.1 (Ca soap)]	As required
17	Friction surfaces of stopper and steering column bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required
22	Friction surfaces of adjusting bolt and steering column bracket	Chassis grease [NLGI No.1 (Ca soap)]	As required
	Adjusting bolt thread area	Chassis grease [NLGI No.1 (Ca soap)]	As required

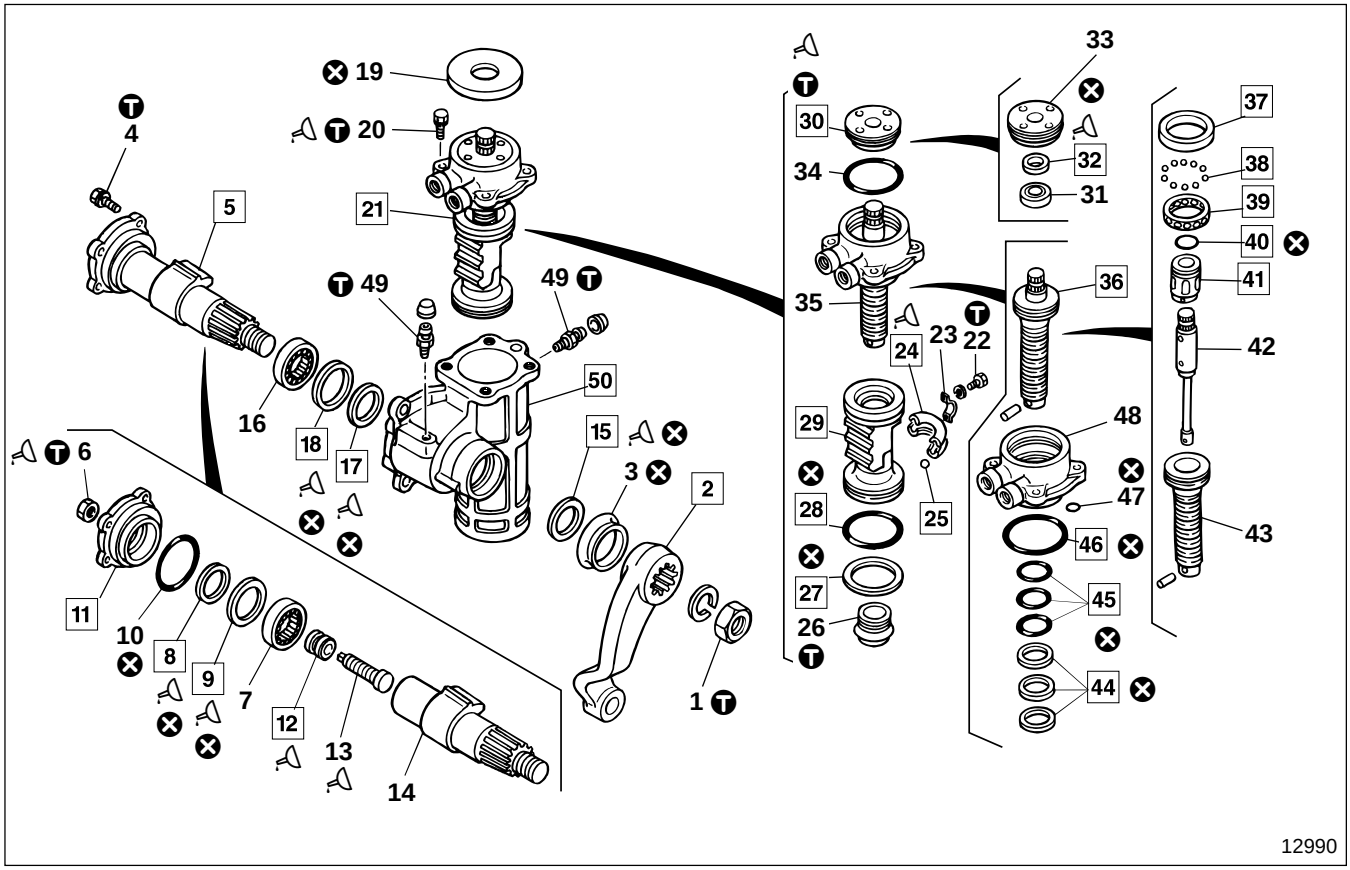


◆ Service procedure

13 **Installation of lock lever**

- Tighten nut **14** at specified torque.
- Install lock lever **13** at position **B** so it is within standard working angle **A** from where the lock lever hits stopper **17**.
- Pull up lock lever **13** to position **B**, and make sure that upper levers **18**, **21** moves vertically, as well as horizontally, smoothly.
- Pull down lock lever **13** to position **C**, and make sure that upper levers **18**, **21** are securely locked.

POWER STEERING BOOSTER



● **Work before disassembly**

P37-26

● **Disassembly sequence**

1 Lock nut
2 Pitman arm
3 Dust cover
4 Bolt
5 Sector shaft assembly and side cover assembly
6 Nut
7 Needle bearing
8 Backup ring
9 Y-packing
10 O-ring
11 Side cover
12 Retainer
13 Adjusting screw
14 Sector shaft
15 Oil seal
16 Needle bearing
17 Backup ring
18 Y-packing
19 Dust cover
20 Bolt
21 Ball screw assembly
22 Screw
23 Ball tube clip
24 Ball tube
25 Steel ball
26 Plug
27 Seal ring
28 O-ring
29 Piston
30 Adjusting plug assembly
31 Ball bearing
32 Oil seal
33 Adjusting plug
34 O-ring
35 Worm shaft assembly and valve housing assembly
36 Worm shaft assembly
37 Side race
38 Steel ball
39 Bearing cage
40 Seal ring
41 Rotor
42 Stub shaft
43 Worm shaft
44 Seal ring
45 O-ring
46 O-ring
47 O-ring
48 Valve housing
49 Plug < FM657 >
50 Body (Cylinder)

⊗ : Non-reusable parts

NOTE

- **Do not remove needle bearing 7 or 16 unless they are faulty.**
- **Do not remove retainer 12 or adjusting screw 13 unless they are faulty.**
- **Have a tray or box ready to catch steel balls 25, 38.**

● **Assembly sequence**

49 → **21** → **20** → **19** → **18** → **17** → **16** → **15** → **5** → **4** → **3** → **2** → **1**

36 : **43** → **42** → **41** → **40** → **39** → **38** → **37**

35 : **48** → **47** → **46** → **45** → **44** → **36**

40 : **33** → **32** → **31**

21 : **35** → **34** → **30** → **29** → **28** → **27** → **26** → **25** → **24** → **23** → **22**

5 : **14** → **13** → **12** → **6**; **11** → **10** → **9** → **8** → **7** → **6**

● **Adjustment after assembly**

P37-27

Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value (Basic diameter in [ ])	Limit	Remedy
5, 21	Backlash between sector shaft and ball screw (Measure at the end of pitman arm)		FK617	0.2 {0.0079}	0.5 {0.020}	*l*=250 {9.84}*1
			FM617	0.2 {0.0079}	0.5 {0.020}	*l*=300 {11.8}*1
			FM657	0.2 {0.0079}	0.5 {0.020}	*l*=305 {12.0}*2
12	Retainer			Tighten the retainer then slacken off by 180°, retighten at 39 N·m {29 ft.lbs, 4 kgf·m}, then slacken off by 20°. Make sure that the adjusting screw turns smoothly, then caulk it	—	—
13, 14	Axial play of adjusting screw and sector shaft			0.01 to 0.10 {0.00039 to 0.0039}	0.2 {0.0079}	Replace
14	Outer diameter of sector shaft	Adjusting screw side	FK617	ø39.975 {1.574}	ø39.875 {1.570}	Replace
			FM617	ø47.975 {1.889}	ø47.875 {1.885}	
			FM657	ø47.975 {1.889}	ø47.875 {1.885}	
		Pitman arm side	FK617	ø44.975 {1.771}	ø44.875 {1.767}	
			FM617	ø47.975 {1.889}	ø47.875 {1.885}	
			FM657	ø57.975 {2.282}	ø57.875 {2.279}	
29, 43	Side play (Play towards the diameter direction)			—	0.5 {0.02} or less	Replace
29, 49	Clearance between outer diameter of piston and inner diameter of body (Cylinder)		FK617	[85 {3.3}] 0.11 {0.0043}	0.16 {0.0063}	Replace
			FM617	[90 {3.5}] 0.11 {0.0043}	0.16 {0.0063}	
			FM657	[100 {3.9}] 0.11 {0.0043}	0.16 {0.0063}	
41, 43	Clearance between outer diameter of rotor and worm shaft			[35.5 {1.40}] 0.02 {0.00079}	0.03 {0.0012}	Replace

*1 : Adjust (Measure with applied load of ±15 N {3.3 lbf, 1.5 kgf})

*2 : Adjust (Measure with applied load of ±20 N {4.4 lbf, 2 kgf})

POWER STEERING BOOSTER

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

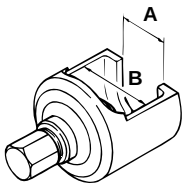
Location	Parts to be tightened		Tightening torque	Remarks
1	Lock nut (Pitman arm mounting)	FK617	269.5±24.5 {200±18, 27.5±2.5}	—
		FM617	338.1±24.5 {250±18, 34.5±2.5}	
		FM657	416.5±24.5 {305±18, 42.5±2.5}	
4	Bolt (Side cover mounting)	FK617, FM657	53.9 to 63.7 {40 to 47, 5.5 to 6.5}	—
		FM617	49.1 to 53.9 {36 to 40, 5 to 5.5}	
6	Nut (Adjusting screw tightening)	FK617	63.7 to 73.5 {47 to 54, 6.5 to 7.5}	—
		FM617, FM657	115 to 125 {87 to 94, 12 to 13}	
20	Bolt (Valve housing tightening)	FK617, FM617	98.1 to 107.9 {72 to 80, 10 to 11}	—
		FM657	115 to 125 {87 to 94, 12 to 13}	
22	Screw (Ball tube clip mounting)		4.41 to 5.39 {3.3 to 4.0, 0.45 to 0.55}	—
26	Plug	FK617, FM617	246 to 274 {180 to 200, 25 to 28}	—
		FM657	295 to 390 {215 to 290, 30 to 40}	
30	Adjusting plug assembly	FK617	177 to 195 {130 to 145, 18 to 20}	—
		FM617, FM657	226 to 244 {165 to 180, 23 to 25}	
49	Plug	FM657	6.9 to 13 {5.1 to 9.4, 0.7 to 1.3}	—

Lubricant and sealant

Location	Points of application	Kinds	Quantity
6	Contact surfaces of nut and side cover	Hermetic seal 101Y or THREEBOND 1102	As required
8, 17	Backup ring inner periphery	Multipurpose grease [NLGI No.2 (Li soap)]	As required
9, 18	Pack interior of Y-packing	Multipurpose grease [NLGI No.2 (Li soap)]	As required
12	Pack interior of retainer	Multipurpose grease [NLGI No.2 (Li soap)]	As required
13	Contact surfaces of adjusting screw and sector shaft	Multipurpose grease [NLGI No.2 (Li soap)]	As required
	Thread area of adjusting screw	Hermetic seal 101Y or THREEBOND 1102	As required
15, 32	Pack interior of oil seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required
24	Pack interior or role tube	Multipurpose grease [NLGI No.2 (Li soap)]	As required
30	Adjusting plug assembly outer periphery	Hermetic seal 101Y or THREEBOND 1102	As required

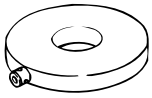
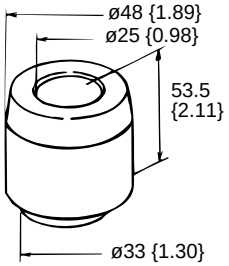
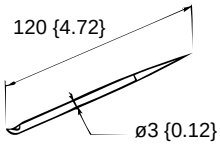
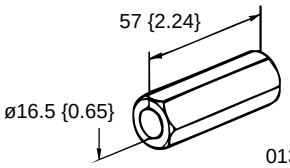
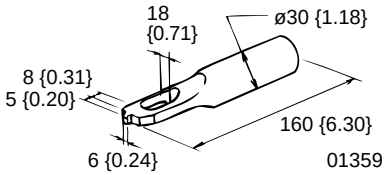
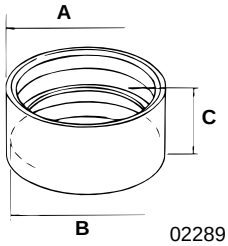
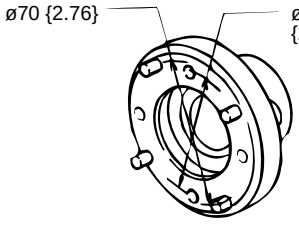
Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
2	Pitman arm puller Part No. / **A** / **B** MH061687 *910-00183 — 59 {2.32} — ø92 {3.62} *910-00184 — 59 {2.32} — ø100 {3.94}  01355	MH061687 *910-00183 *910-00184 (Obtain Locally)	Removal of pitman arm

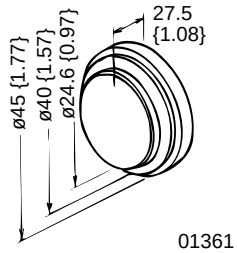
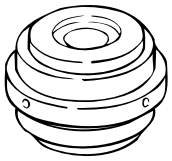
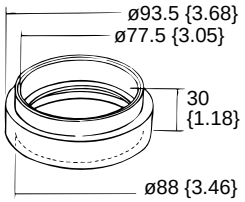
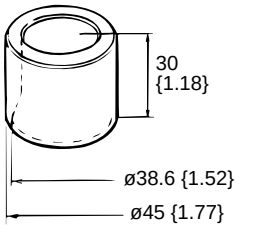
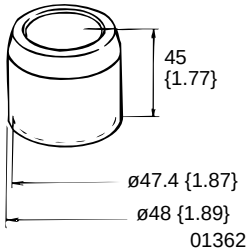
* BOSCH BRAKING SYSTEMS part No.

Unit : mm {in.}

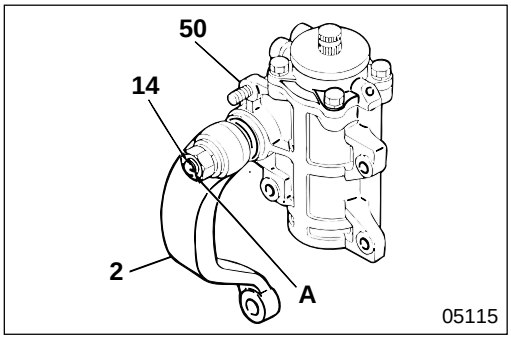
Location	Tool name and shape	Part No.	Application
8, 15, 17	Inserting tool assembly  01356	MC811971 *910-11001 (Obtain Locally)	Forming of backup ring and press-fitting of oil seal
8, 17	Inserting tool  01358	MC811974 *910-21715 (Obtain Locally)	Forming of backup ring
10, 27, 28, 34, 40, 44, 45, 46, 47	Needle  02288	MC811948 *910-21200 (Obtain Locally)	Removal of O-ring and seal ring
12	Bar  01360	MC811955 *910-22811 (Obtain Locally)	Turning of retainer
	Squeeze tool  01359	MC811950 *910-21801 (Obtain Locally)	Caulking of retainer
27	Inserting tool Part No. / A / B / C MC813516 *910-21718: ø98 {3.86} / ø90.05 {3.55} / 50 {1.97} MC811985 *910-21701: ø110 {4.33} / ø103 {4.06} / 37 {1.46}  02289	MC813516 *910-21718 < FK617, FM617 > MC811985 *910-21701 < FM656 > (Obtain Locally)	Forming of piston seal ring
30	Wrench assembly  01357	MC811970 *910-10743 (Obtain Locally)	Removal and installation of adjusting plug assembly
	Attachment (**A** : Adapter) (**B** : Bolt) 02290	(Obtain Locally) MC811969 *910-10671 (**A** : *910-23581) (**B** : *910-23194)	Holding down of valve housing

* BOSCH BRAKING SYSTEMS part No.

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
32	Press-fitting tool 	MC811972 *910-20404 (Obtain Locally)	Press-fitting of oil seal
37 to 39	Tool assembly 	MC811968 *910-10611 (Obtain Locally)	Assembly of thrust bearing
	Guide assembly 	MC090148 *910-23033 (Obtain Locally)	
40	Inserting tool 	*910-22777 (Obtain Locally)	Forming of rotor seal ring < FK617 >
40, 44	Inserting tool 	MC811975 *910-22722 (Obtain Locally)	Forming of rotor seal ring < FM617, FM657 > and forming of valve housing seal ring

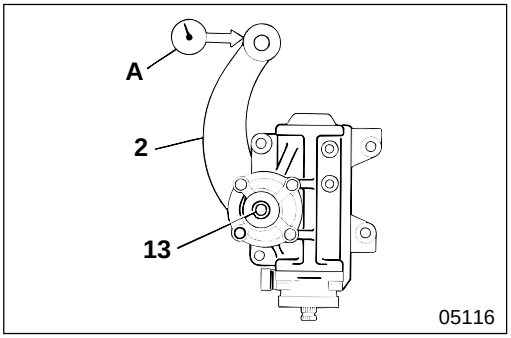
* BOSCH BRAKING SYSTEMS part No.



◆ Service procedure

● **Work before disassembly**

Move pitman arm **2**, and align slit **A** of the V-groove of sector shaft **14** to the center of body **50** so that the gears are in neutral position.

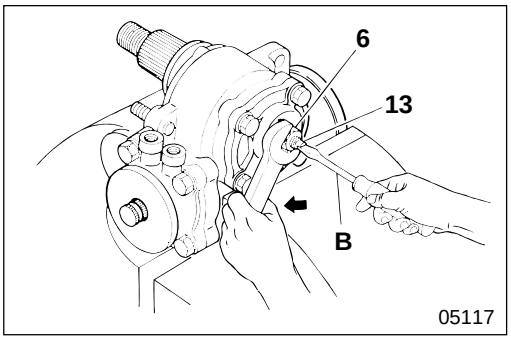


● **Adjustment after assembly**

Adjustment of backlash

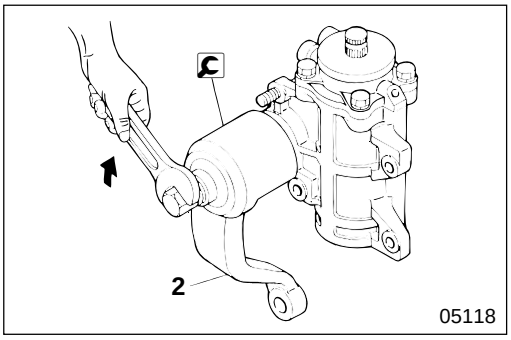
- (Carry out this work with the gears in neutral position.)
  Measure play at the end of pitman arm **2** with dial gauge **A**, and adjust adjusting screw **13** so that reading meets the standard value.

  Measuring load : < FK617, FM617 > ±15 N {3.3 lbf, 1.5 kgf}
  < FM657 > ±20 N {4.4 lbf, 2 kgf}



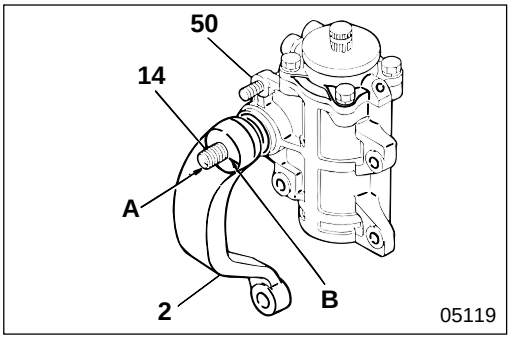
Tightening nut

- After adjusting backlash, apply sealer to thread area of adjusting screw **13**. Hold it in place with screwdriver **B** and tighten nut **6** at specified torque.



2 Pitman arm

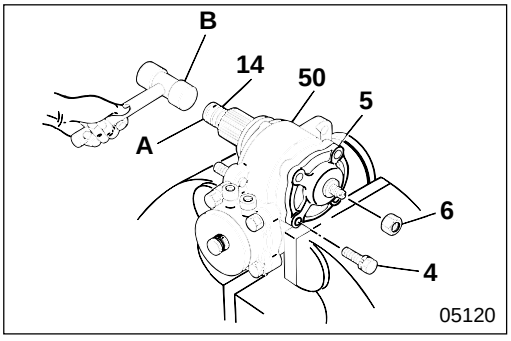
[Removal]



[Installation]
Align slit **A** of the V-groove of sector shaft **14** to the center of body **50**, and align slit **B** of the V-groove of pitman arm **2** on the same line.

NOTE

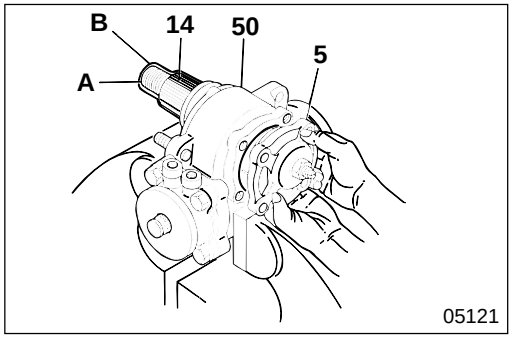
Have pitman arm 2 make a full stroke of the piston to make sure that the piston moves smoothly.



5 Sector shaft assembly and side cover assembly

[Removal]

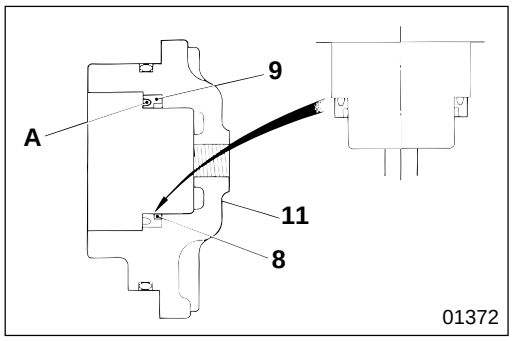
- Make sure that the piston is in the neutral position (slit **A** of the V-groove at one end of sector shaft **14** is aligned with the center of body **50**).
- Tap the end of sector shaft **14** and pull out sector shaft assembly and side cover assembly **5**.
  B : Plastic-headed mallet



[Installation]
Position sector shaft **14** of sector shaft assembly and side cover assembly **5** so that slit **A** of its V-groove is aligned with the center of body **50**, and the piston gear and sector shaft gear engage at their centers.

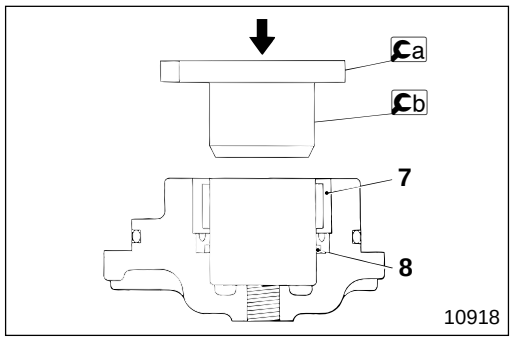
CAUTION⚠

Before installation, apply tape B to the Y-packing to prevent it being damaged by the threads of sector shaft 14.

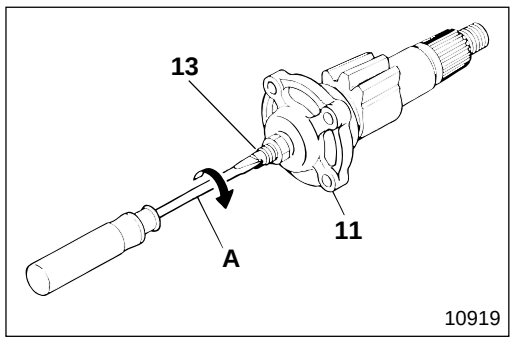


8 **9** **Backup ring, Y-packing**

[Installation]
- Install Y-packing **9** into side cover **11** in the direction as illustrated.
- After installing backup ring **8**, pack groove **A** of Y-packing **9** with grease.



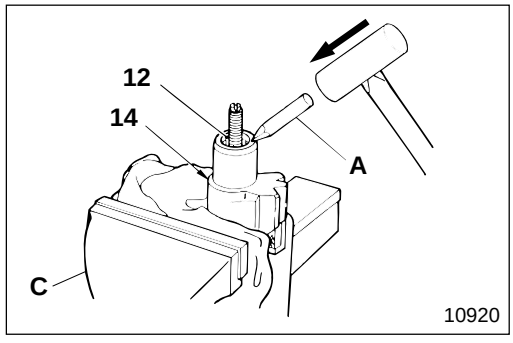
- After installing needle bearing **7** into backup ring **8**, form the bent up part of the backup ring using a insert tool assembly and b insert tool.



11 **Removal of side cover**

Screw in adjusting screw **13** and remove side cover **11.**

A : Screwdriver



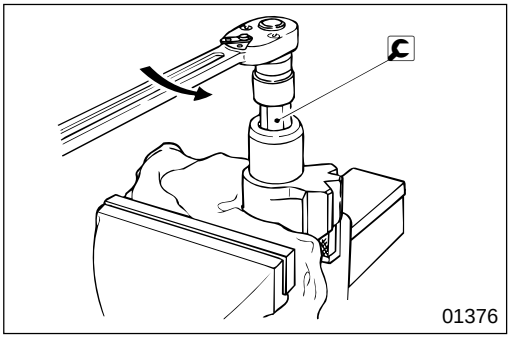
12 **Retainer**

Disassemble sector shaft **14**, as follows, only if it is faulty :
[Removal]
- Pry up (2 points) of retainer **12**.

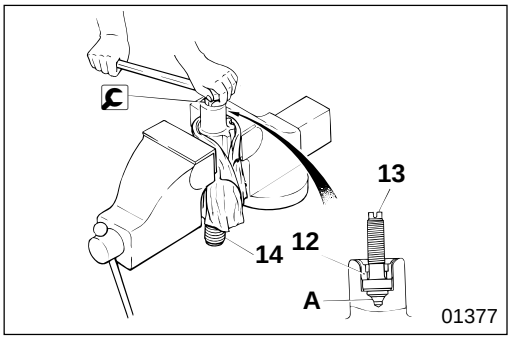
A : Chisel

CAUTION⚠

Make sure you use a cloth when you grip sector shaft 14 in vise C to prevent damage.

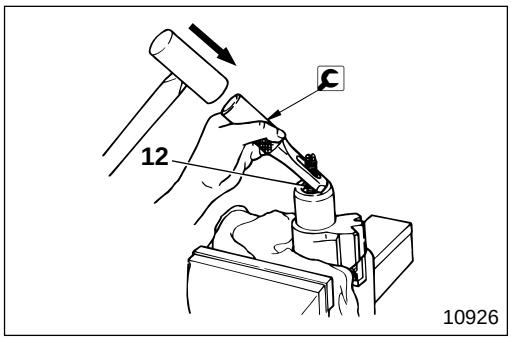


- Remove retainer **12** using [C] bar.

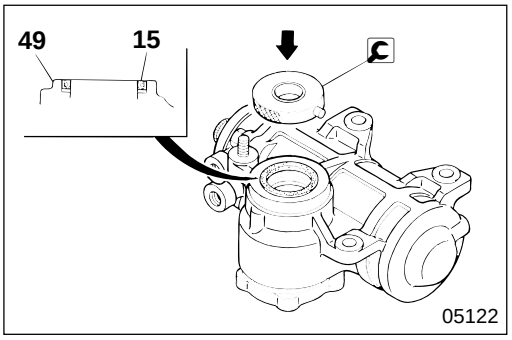


[Installation]

- Pack adjusting screw **13** mounting hole **A** of sector shaft **14** with grease.
- Install adjusting screw **13** into sector shaft **14**.
- Install retainer **12** into sector shaft **14** using [C] bar.
- After installation, slacken off by 180°, retighten at 39 N·m {29 ft.lbs, 4 kgf·m}, then slacken off by 20°.
- Make sure that adjusting screw **13** turns smoothly.

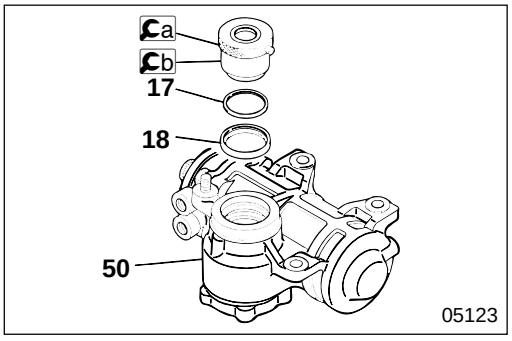


- After installing retainer **12**, caulk the retainer (2 points) using [C] squeeze tool.



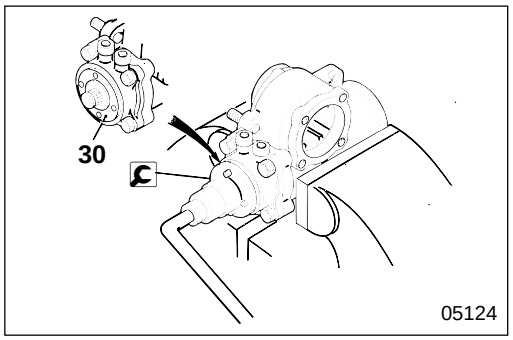
15 Installation of oil seal

Install oil seal **15** into body **50** in the direction as illustrated.



17 18 Installation of backup ring and Y-packing

- Install Y-packing **18** and backup ring **17** to body **50**.
- Pack the groove of Y-packing **18** with grease.
- Form the shape of backup ring **17** using [Ca] insert tool assembly and [Cb] insert tool.



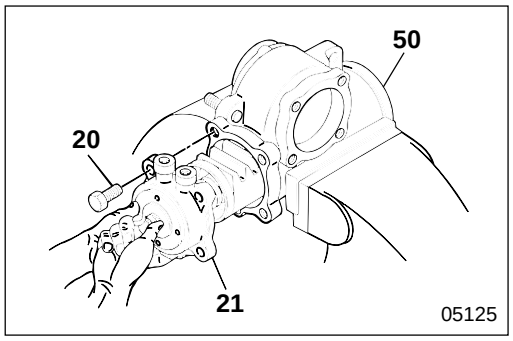
21 **Ball screw assembly**

[Removal]

- Loosen adjusting plug assembly **30** by approximately 180° using wrench assembly.

CAUTION

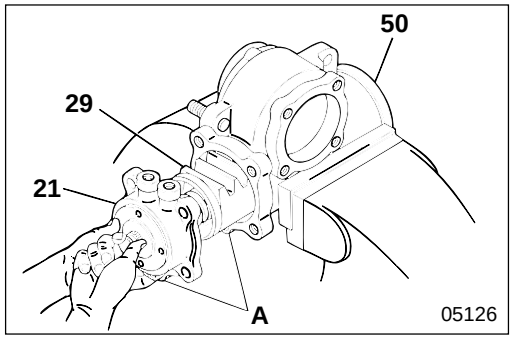
Make sure you only loosen adjusting plug assembly 30, do not undo it completely because the bearing inside the valve housing might spring out.



- Loosen bolt **20** and remove ball screw assembly **21** from body **50**.

CAUTION

- **Make sure that the balls of the ball screw do not spring out.**
- **Be careful not to damage the piston or the interior of body 50.**



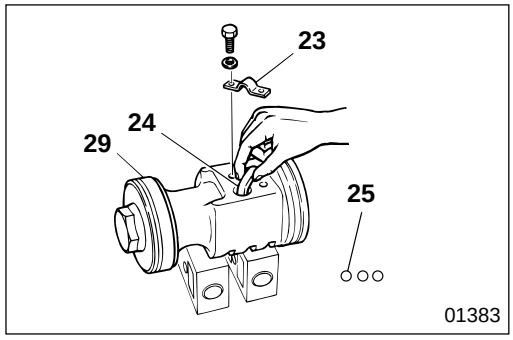
[Installation]

- Install ball screw assembly **21** into body **50**, holding piston **29** so it will not turn.

CAUTION

Be careful not to damage the piston seal ring or the interior of body 50.

- Align oil passage ports **A** of ball screw assembly **21** and body **50**, then tighten.

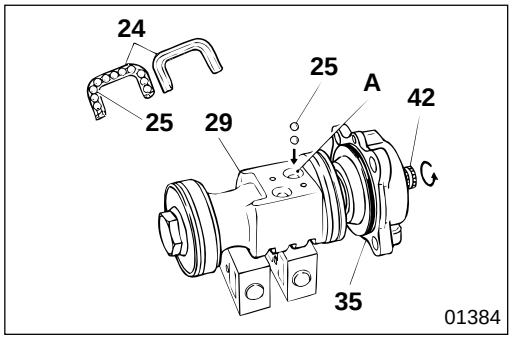


24 **25** **Ball tube and steel ball**

First remove steel balls **25** from piston **29** and place them in the receiving tray, remove ball clip **23**, grip ball tube **24** with your fingers and pull it out gently.

CAUTION

Be careful not to loose any steel balls 25.
< FK617, FM617 (×30) >
< FM657 (×32) >

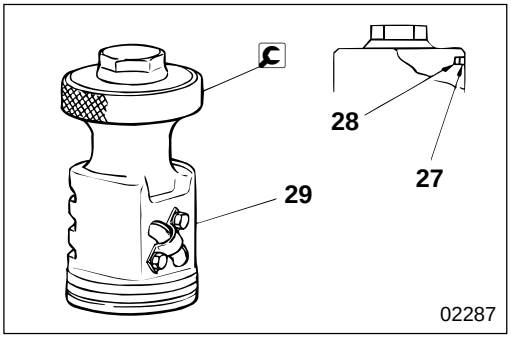


[Installation]

- Pack the interior of ball tube **24** with grease, lay 10 or 11 steel balls **25** in place, then mount the other side of the ball tube.
- Place piston **29** on a level surface, align assembled worm shaft assembly and valve housing assembly **35** and the piston ball race, then drop steel balls **25** through ball tube hole **A** while turning stub shaft **42**.

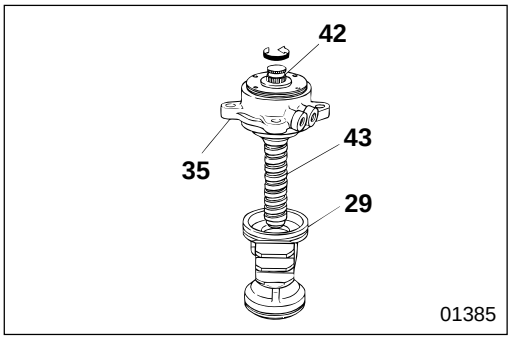
CAUTION

Make sure that you do not pull out worm shaft assembly and valve housing assembly 35 too far, or steel balls 25 will drop out of the ball race.



27 **28** **Installation of O-ring and seal-ring**

Install O-ring **28** and seal ring **27** in the outside grooves of piston **29**, then form the shape of the seal ring with 🔧 inserting tool.

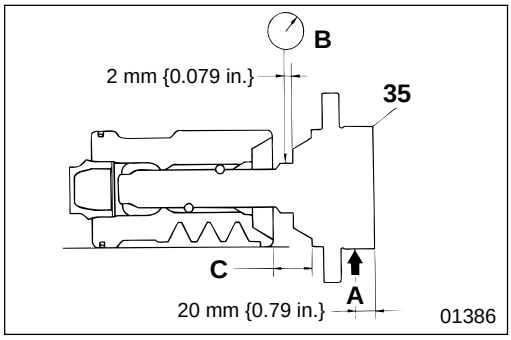


29 **Piston**

[Removal]
Holding worm shaft assembly and valve housing assembly **35** so that piston **29** is at the bottom, turn stub shaft **42** and remove the piston.

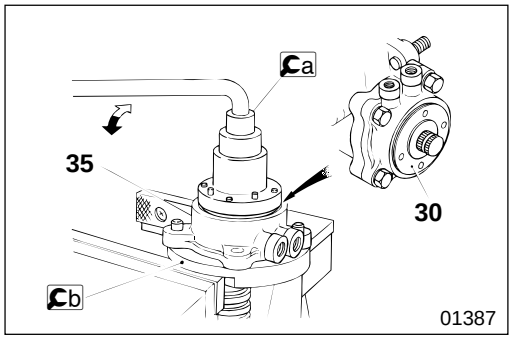
CAUTION ⚠

Be careful not to tilt piston 29 when you do this, otherwise steel balls 25 in the races of the piston and worm shaft 43, will drop into the piston.



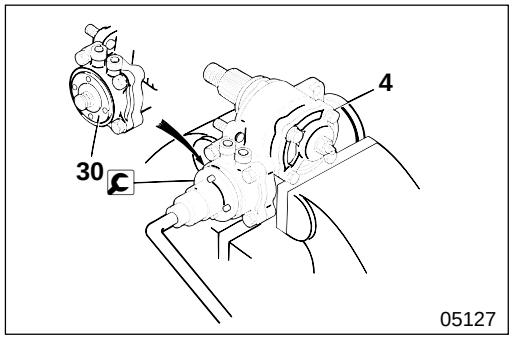
[Inspection]
Measure side play (play in axial direction) **B** of worm shaft assembly and valve housing assembly **35** when 49 N {11 lbf, 5 kgf} is applied to **A** as illustrated.

C :	< FK617 >	30.45 mm {1.20 in.}
	< FM617 >	30.24 mm {1.19 in.}
	< FM657 >	42.8 mm {1.69 in.}

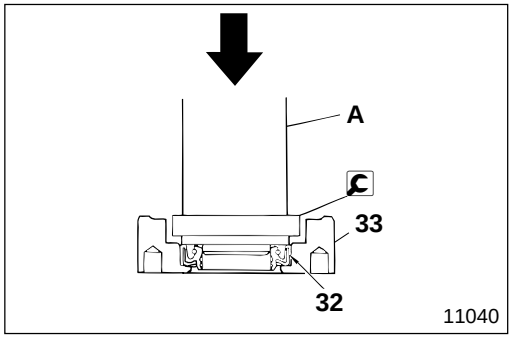


30 **Installation of adjusting plug assembly**

- After tightening adjusting plug assembly **30** of worm shaft assembly and valve housing assembly **35** at specified torque, slacken off by approximately 180°.

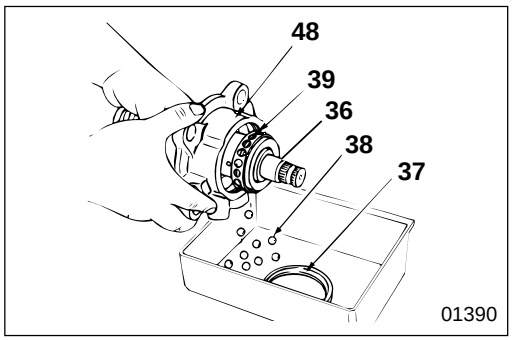


- Tighten bolt **4** at specified torque, then retighten adjusting plug assembly **30** at specified torque using 🔧 wrench assembly.



32 **Installation of oil seal**

Install oil seal **32** into adjusting plug **33** in the direction as illustrated.
A : Hand press



36 **Worm shaft assembly**

[Removal]
Push out worm shaft assembly **36** from valve housing **48** by pushing out the side of the worm shaft assembly where the piston is assembled.

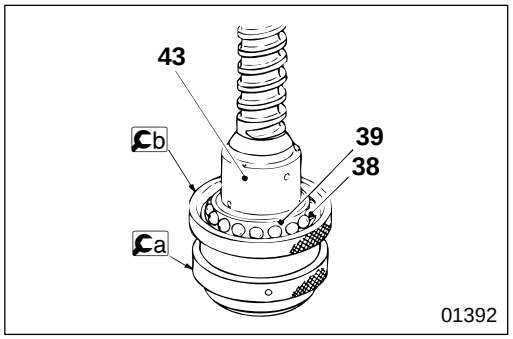
NOTE

Have a tray or box ready to catch side race 37, steel balls 38, and bearing cage 39 as these items separate on removal.

[Installation]

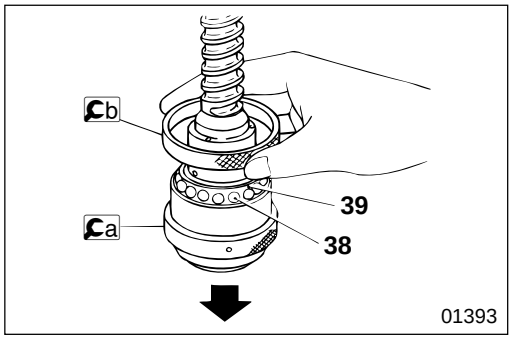
CAUTION

Be careful that worm shaft assembly 36 ball race does not damage seal ring 44.

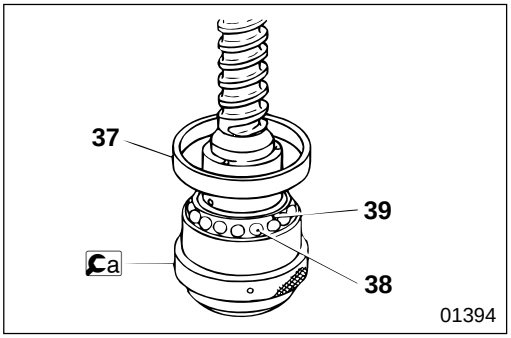


37 **to** **39** **Installation of side race, steel ball, and bearing cage**

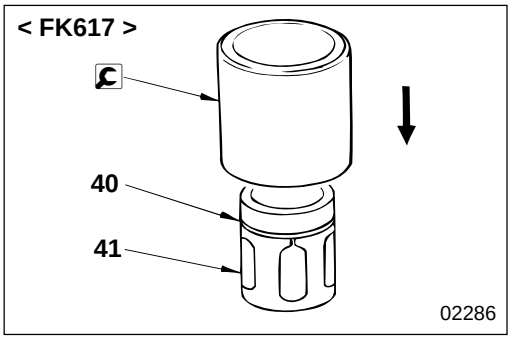
- Install b guide assembly on a tool assembly, and insert worm shaft **43** in the direction as illustrated.
- Assemble bearing cage **39** and steel balls **38** on worm shaft **43**.



- Hold down b with your hand and slide a downward, so that you can position steel balls **38** as specified.

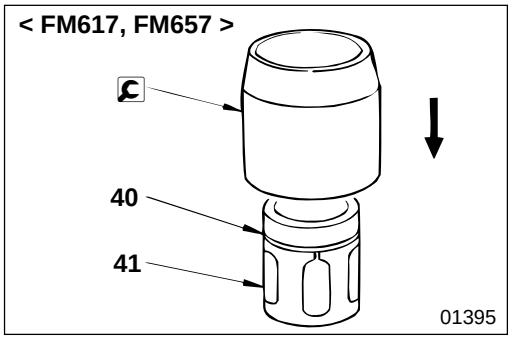


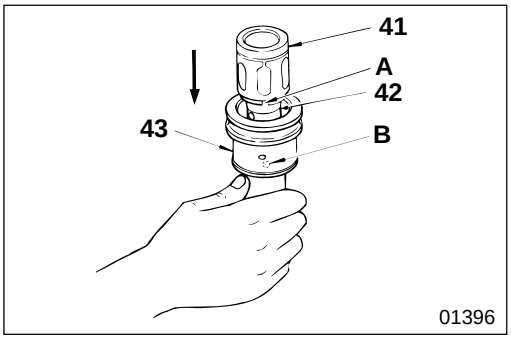
- Install side race **37** on top of steel balls **38** and bearing cage **39**.



40 **Installation of seal ring**

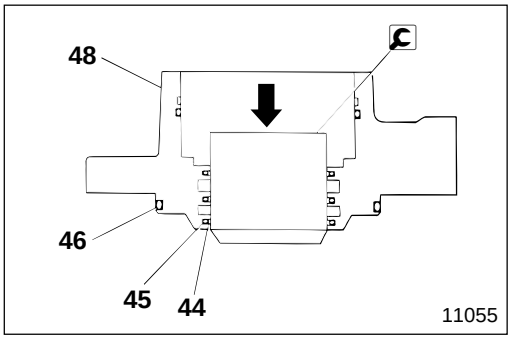
- Install seal ring **40** onto rotor **41**.
- Form seal ring **40** using insert tool.





41 **Installation of rotor**

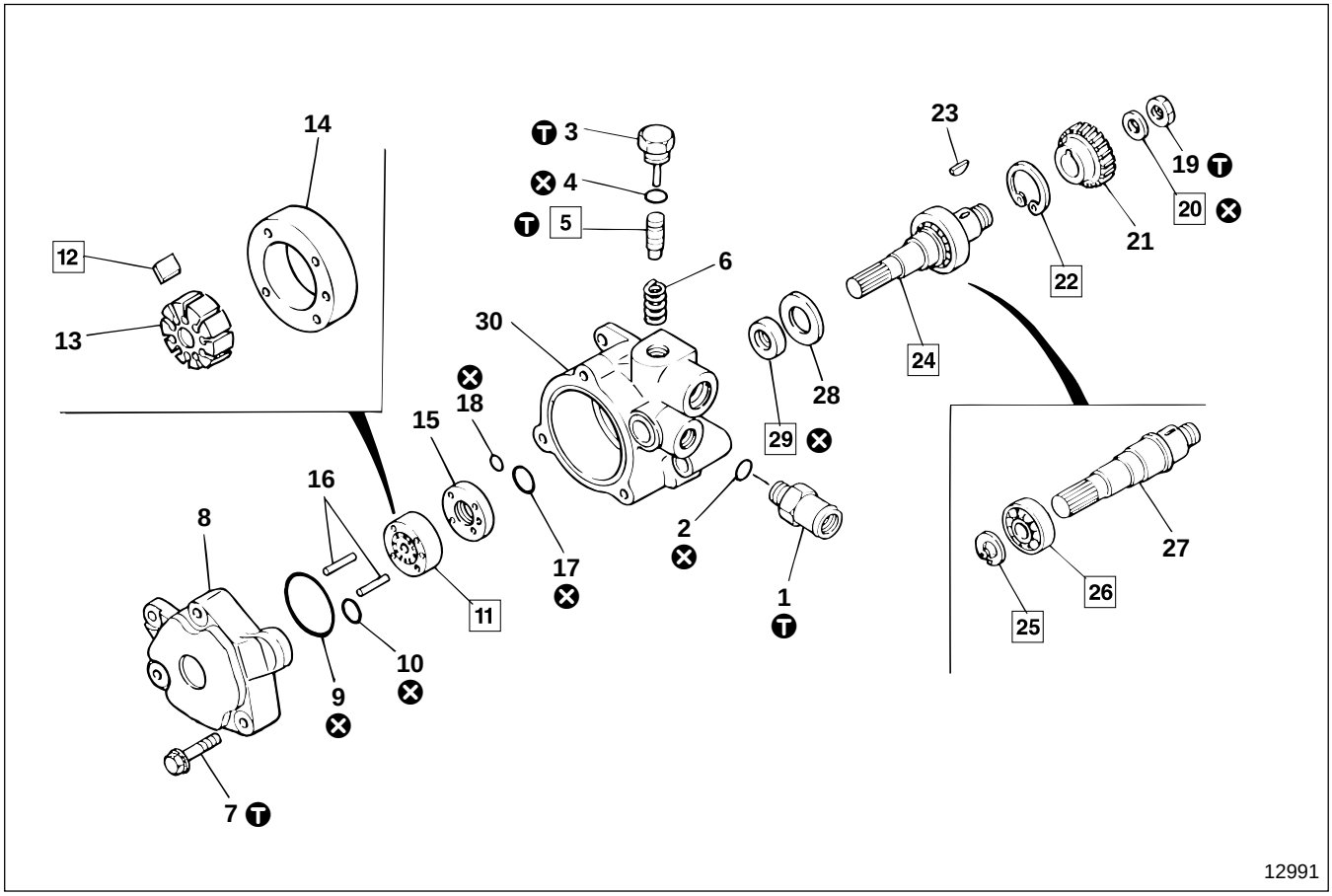
Install rotor **41** between stub shaft **42** and worm shaft **43** so that indent **A** of the rotor fits positioning pin **B** of the worm shaft.



44 **to** **46** **Installation of seal ring and O-ring**

- Install seal ring **44** and O-rings **45**, **46** into valve housing **48**.
- Form seal ring **44** using insert tool.

POWER STEERING OIL PUMP



● **Disassembly sequence**

1 Hose connector
2 O-ring
3 Plug
4 O-ring
5 Flow control valve assembly
6 Flow control spring
7 Bolt
8 Rear body
9 O-ring
10 O-ring
11 Cartridge assembly
12 Vane
13 Rotor
14 Cam
15 Pressure plate
16 Straight pin
17 O-ring
18 O-ring
19 Nut
20 Lock washer
21 Gear
22 Retaining ring
23 Key
24 Drive shaft assembly
25 Retaining ring
26 Ball bearing
27 Drive shaft
28 Retaining ring
29 Oil seal
30 Front body

⊗ : Non-reusable parts

NOTE

Do not disassemble flow control valve assembly 5 unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.
Repair kit : Seal kit, Cartridge assembly kit

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
5, 30	Clearance between flow control valve assembly and front body	—	0.03 {0.0012}	*1
8, 15	Stepped wear on rear body and pressure plate where it is subject to friction against rotor and vane	—	0.01 {0.00039}	*2

*1 No seizure, wear, or scoring sufficient to catch a finger nail. Replace flow control valve assembly or front body.
*2 No seizure, wear, or scoring sufficient to catch a finger nail. Replace rear body or pressure plate.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

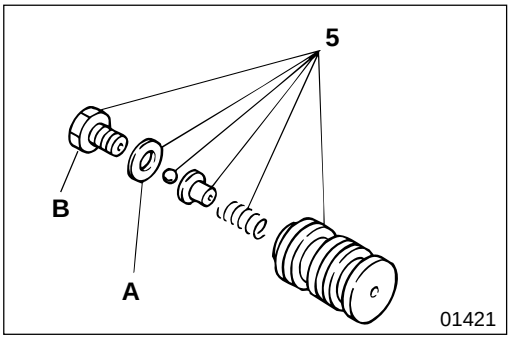
Location	Parts to be tightened	Tightening torque	Remarks
1	Hose connector	49 to 58.8 {36 to 43, 5 to 6}	—
3	Plug	49 to 58.8 {36 to 43, 5 to 6}	—
5	Flow control valve assembly	12±2 {8.7±1.4, 1.2±0.2}	—
7	Bolt (Rear body mounting)	49 to 58.8 {36 to 43, 5 to 6}	—
19	Nut (Gear mounting)	29 to 39 {22 to 29, 3 to 4}	—

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
22	Pliers	*910-22570	Removal and installation of retaining ring
25	Pliers	*910-22580	Removal and installation of retaining ring
26	Press-fitting tool	*910-22954	Removal of ball bearing
29	Stick	*910-21632	Driving out of oil seal
	Press-fitting tool	*910-21664	Press-fitting of oil seal

* BOSCH BRAKING SYSTEMS part No.



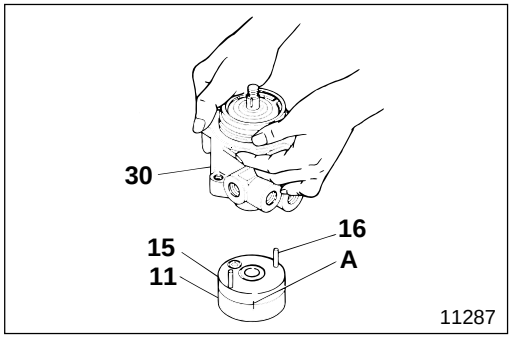
◆ Service procedure

5 Adjustment of flow control valve assembly

When you reassemble flow control valve assembly **5**, adjust the assembly so that the relief pressure conforms to the standard value. Do this with shim **A**. The thick shim lowers pressure, and the thin shim increases pressure.
After adjustment, tighten relief valve **B** at specified torque.

Shim thickness	Pressure variation
0.5mm {0.020 in.}	Approximately 1310 kPa {190 psi, 13.4 kgf/cm^2}
0.2mm {0.0079 in.}	Approximately 520 kPa {75 psi, 5.3 kgf/cm^2}

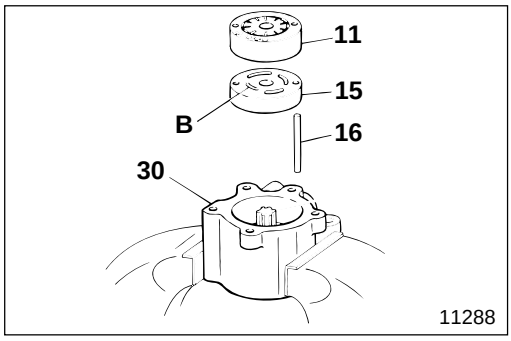
P37-15



11 Removal and installation of cartridge assembly

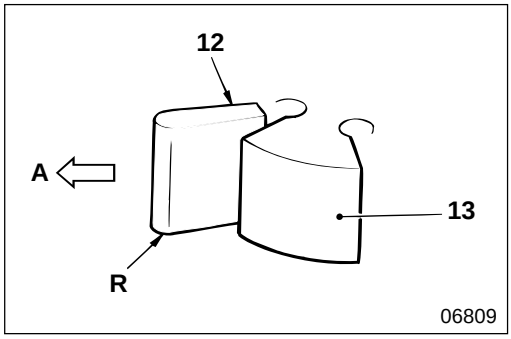
[Removal]

- Remove cartridge assembly **11**, pressure plate **15** and straight pin **16** together from front body **30**.
- Put alignment marks **A** around the outer circumferences of cartridge assembly **11** and pressure plate **15**.



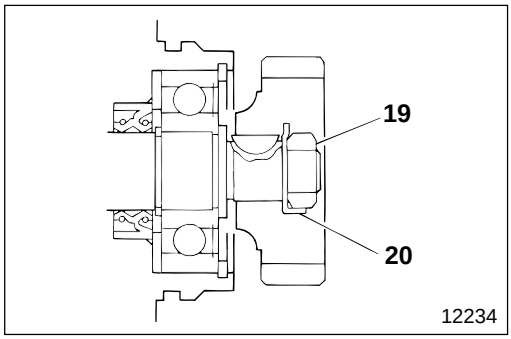
[Installation]

- Install straight pin **16** into front body **30**.
- Install pressure plate **15** onto front body **30**, so that groove **B** of the pressure plate faces the direction as illustrated.
- Align cartridge assembly **11** with straight pin **16**, then install the cartridge assembly.



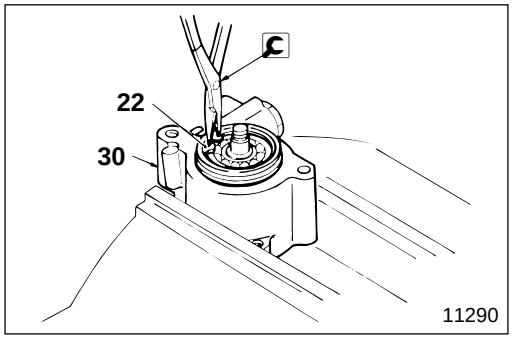
12 Installation of vane

With point **R** of vane **12** facing outside **A**, install it into rotor **13** and make sure that the vane moves smoothly. If it is faulty, replace the cartridge assembly.



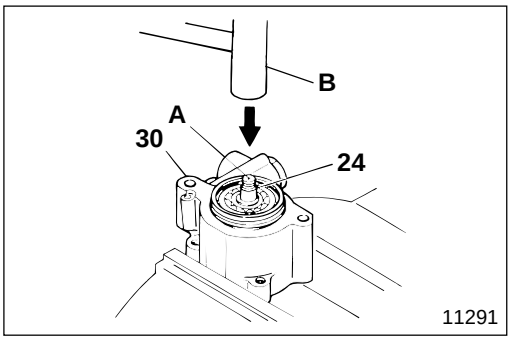
20 Installation of lock washer

After installing nut **19**, bend up one lug on the circumference of lock washer **20**.



22 Removal of retaining ring

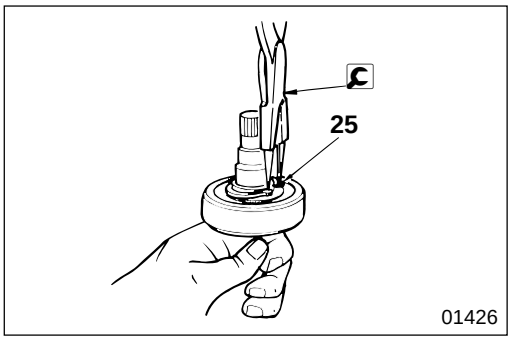
Remove retaining ring **22** using pliers.



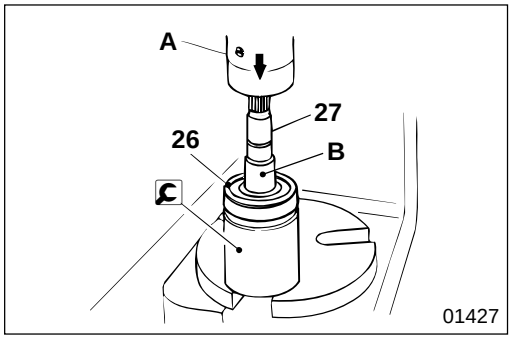
24 **Installation of drive shaft assembly**

If it is hard to install drive shaft assembly **24** in the correct position of front body **20** by hand, tap the shaft to install it.

B : Plastic-headed mallet



25 **Removal of retaining ring**



26 **Removal and installation of ball bearing**

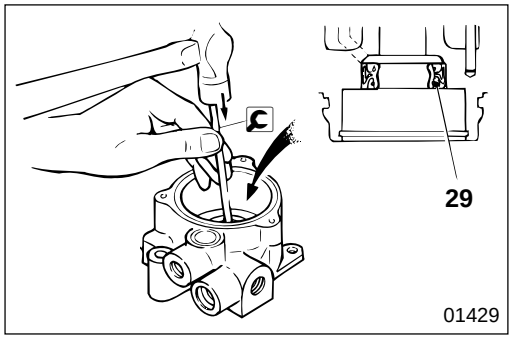
Remove ball bearing **26** from shaft **27** using 🔧 press-fitting tool.

A : Hand press

For installation, follow the removal sequence in reverse.

CAUTION ⚠

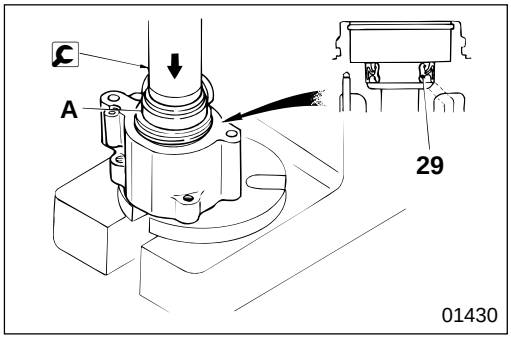
Be careful not to damage oil seal contact surface B.



29 **Oil seal**

[Removal]

Remove oil seal **29** using 🔧 stick.

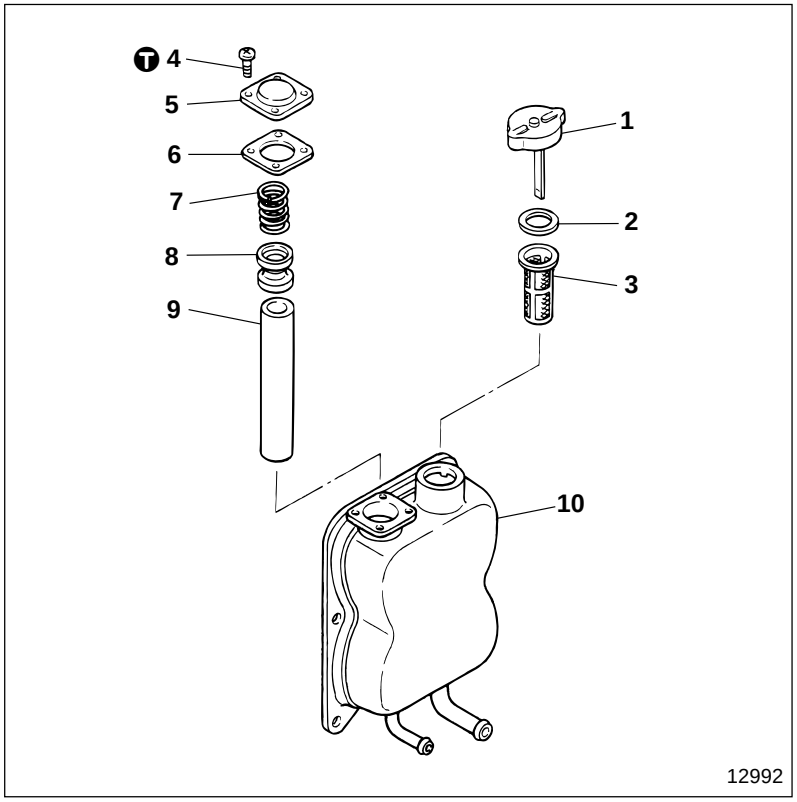


[Installation]

Install oil seal **29** in the direction as illustrated using 🔧 press-fitting tool.

A : Hand press

POWER STEERING OIL TANK



● **Disassembly sequence**

1 Filler cap
2 Packing
3 Strainer
4 Screw
5 Plate
6 Packing
7 Spring
8 Retainer
9 Return filter
10 Tank body assembly

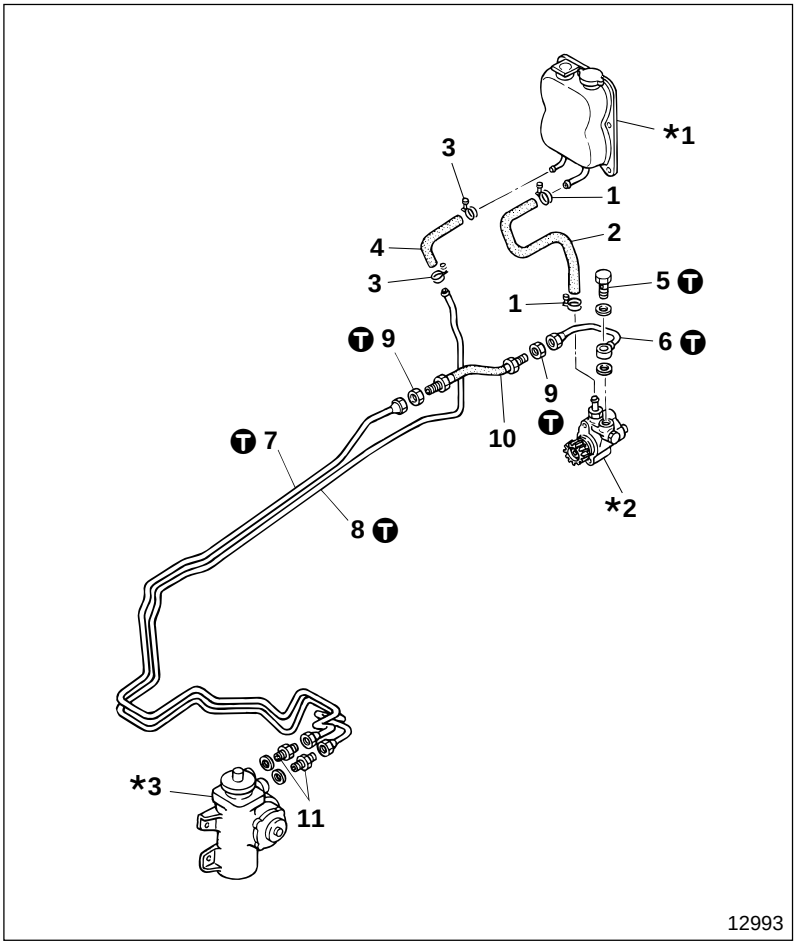
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Screw (Plate mounting)	0.49 to 0.98 {0.36 to 0.72, 0.05 to 0.1}	—



● **Removal sequence**

1 Clamp
2 Oil hose
3 Clamp
4 Oil hose
5 Bolt
6 Oil pipe
7 Oil pipe
8 Oil pipe
9 Nut
10 Oil hose
11 Connector

***1** : Power steering oil tank
***2** : Power steering oil pump
***3** : Power steering booster

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION⚠

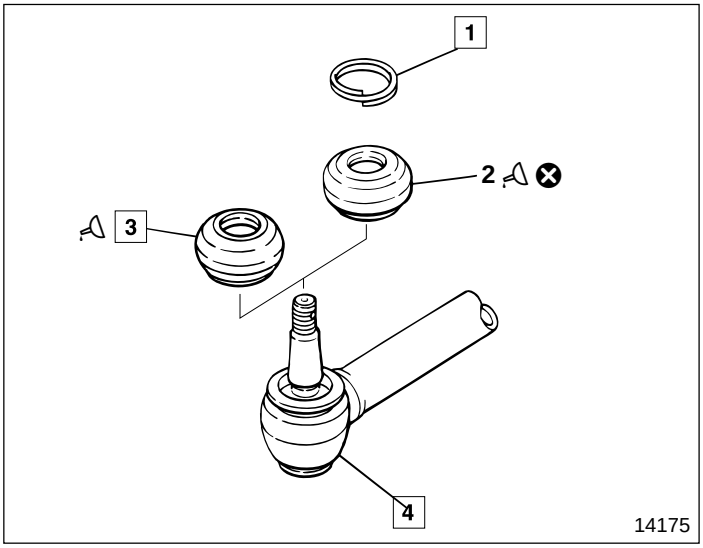
Be sure to bleed air after removing the fluid line, failure to do so would cause the power steering to malfunction.
P37-13

T Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
5	Bolt (Oil pipe mounting)	125 {94, 13}	—
6	Oil pipe (Oil hose connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
7	Oil pipe (Connector and oil hose connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
8	Oil pipe (Connector connecting)	66.69±12.75 {49±9.4, 6.8±1.3}	—
9	Nut	66.69±12.75 {49±9.4, 6.8±1.3}	—

DRAG LINK



● **Disassembly sequence**

1 Clip < FK617 >
2 Dust cover < FK617 >
3 Dust cover < FM617, FM657 >
4 Drag link

⊗ : Non-reusable parts

NOTE

- **Do not remove clip 1 and dust covers 2, 3 unless they are faulty.**
- **Do not disassemble drag link 4 because it is a unit construction.**

● **Assembly sequence**

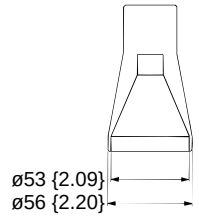
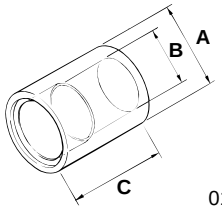
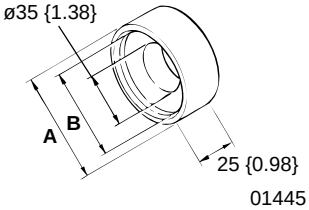
Follow the disassembly sequence in reverse.

Lubricant

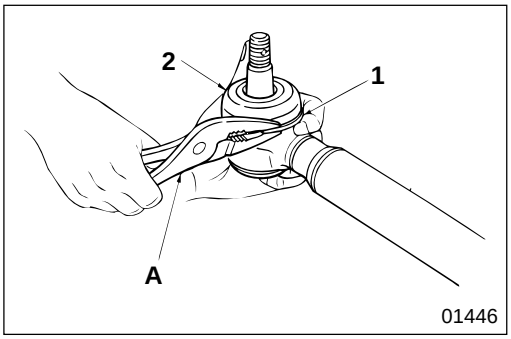
Location	Points of application		Kinds	Quantity
2, 3	Lip area of dust cover		Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
2	Pack interior of dust cover	FK617	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	11 g {0.39 oz}
3	Pack interior of dust cover	FM617	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	13 to 14 g {0.46 to 0.49 oz}
		FM657	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	19 to 20 g {0.67 to 0.71 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Clip guide 	< FK617 > MH061831	Installation of clip
3	Dust cover installer | | A | B | C | | MH061828 | ø60.3 {2.37} | ø45 {1.77} | 80 {3.15} | | MH061827 | ø65 {2.56} | ø51 {2.01} | ø100 {3.94} | 	< FM617 > MH061828 < FM657 > MH061827	Installation of dust cover
	End holder | | A | B | | MH061830 | ø60 {2.36} | ø50.5 {1.99} | | MH061829 | ø64 {2.56} | ø55.7 {2.19} | 	< FM617 > MH061830 < FM657 > MH061829	

◆ Service procedure



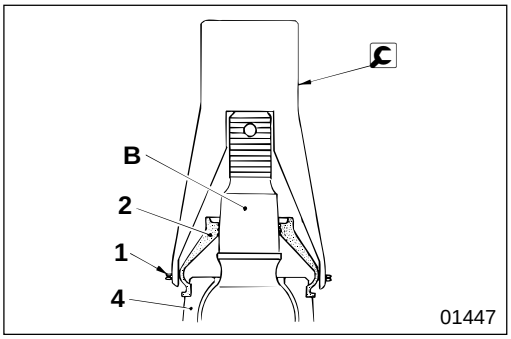
1 Clip < FK617 >

A : Long nose pliers

[Removal]

CAUTION

- **Be careful not to damage clip 1 or dust cover 2 when you remove the clip.**
- **If clip 1 is deformed, do not reuse it.**

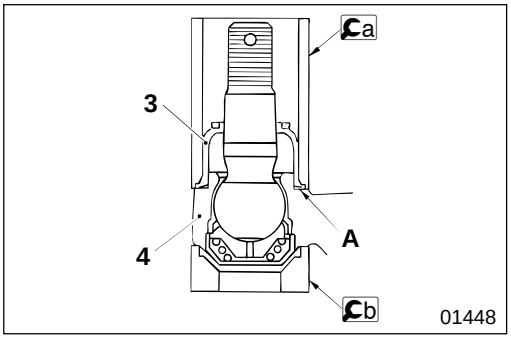


[Installation]

- Position the assembly so ball stud **B** is vertical.
- Place [C] clip guide on drag link **4**.
- Install clip **1** into the groove of dust cover **2**.

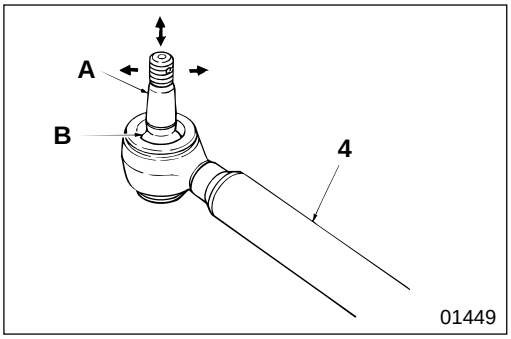
CAUTION

- **Be careful that [C] clip guide end does not dig into dust cover 2.**
- **Be especially careful that clip 1 end does not damage dust cover 2.**



3 Installation of dust cover < FM617, FM657 >

- Place dust cover **3** on drag link **4**.
- Hold drag link **4** between [Ca] dust cover installer and [Cb] end cover.
- Using a vise, press-fit dust cover **3** onto drag link **4** so as the dust cover is perpendicular to the drag link, and reinforcing ring **A** is in close contact with the drag link.

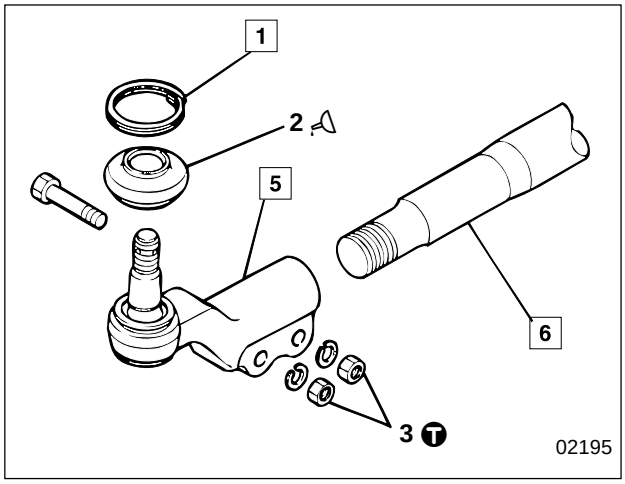


4 Inspection of drag link

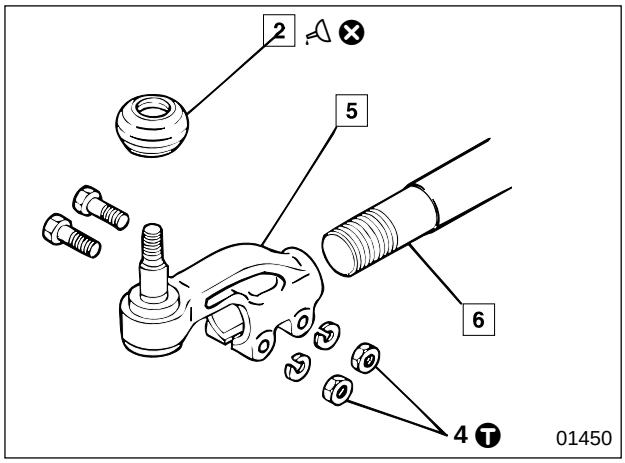
Move ball stud area **A** of drag link **4** vertically and horizontally to make sure that there is no play. Also, check that ball section **B** moves evenly. If any fault is found, replace the tie rod assembly.

TIE ROD ASSEMBLY

< FK617 >



< FM617, FM657 >



● **Disassembly sequence**

1 Clip < FK617 >
2 Dust cover
3 Nut < FK617 >
4 Nut < FM617, FM657 >
5 Tie rod end assembly
6 Tie rod

⊗ : Non-reusable parts

NOTE

- **Do not remover clip 1 or dust cover 2 unless they are faulty.**
- **Do not disassemble tie rod end assembly 5 because it is a unit construction.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
6	Bend of tie rod	1 {0.039} or less	1 {0.039}	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

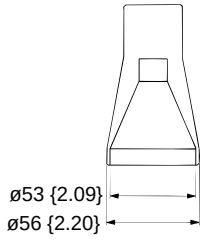
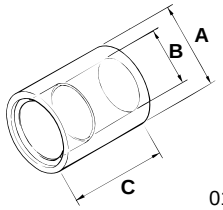
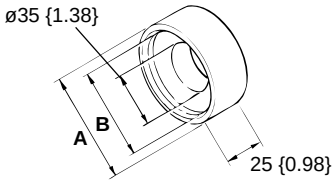
Location	Parts to be tightened	Tightening torque	Remarks
3	Nut < FK617 > (Tie rod end assembly fastening)	78 {58, 8}	Wet
4	Nut < FM617, FM657 > (Tie rod end assembly fastening)	78 {58, 8}	—

Lubricant

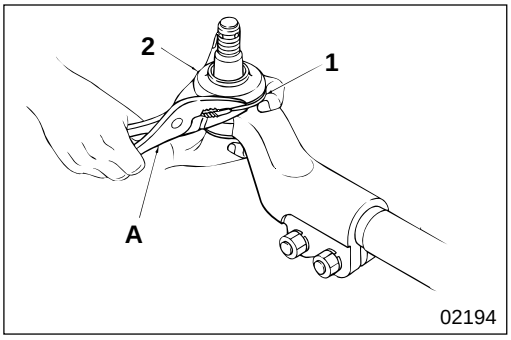
Location	Points of application		Kinds	Quantity
2	Lip area of dust cover		Molybdenum disulfide grease [NLGI No.2 (Li soap)]	As required
	Pack into dust cover	FK617	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	11 g {0.39 oz}
		FM617	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	8 to 10 g {0.28 to 0.35 oz}
		FM657	Molybdenum disulfide grease [NLGI No.2 (Li soap)]	20 to 21 g {0.71 to 0.74 oz}

Special tools

Unit : mm {in.}

Location	Tool name and shape	Part No.	Application
1	Clip guide  01443	< FK617 > MH061831 (Obtain Locally)	Installation of clip
2	Dust cover installer A: MH061828 ø60.3 {2.37}, MH061827 ø65 {2.56} B: MH061828 ø45 {1.77}, MH061827 ø51 {2.01} C: MH061828 80 {3.15}, MH061827 ø100 {3.94}  01444	< FM617 > MH061828 < FM657 > MH061827 (Obtain Locally)	Installation of dust cover
	End holder A: MH061830 ø60 {2.36}, MH061829 ø64 {2.56} B: MH061830 ø50.5 {1.99}, MH061829 ø55.7 {2.19}  01445	< FM617 > MH061830 < FM657 > MH061829 (Obtain Locally)	

◆ Service procedure



02194

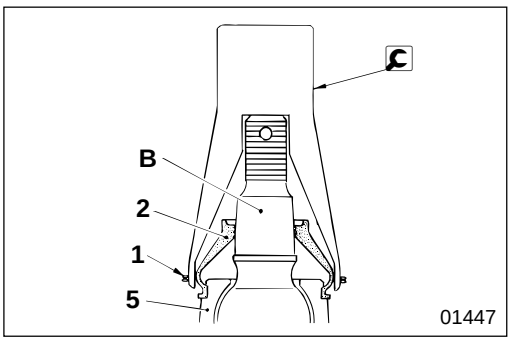
1 Clip < FK617 >

[Removal]

A : Long nose pliers

CAUTION

- **Be careful not to damage clip 1 or dust cover 2 when you remove the clip.**
- **If clip 1 is deformed, do not reuse it.**



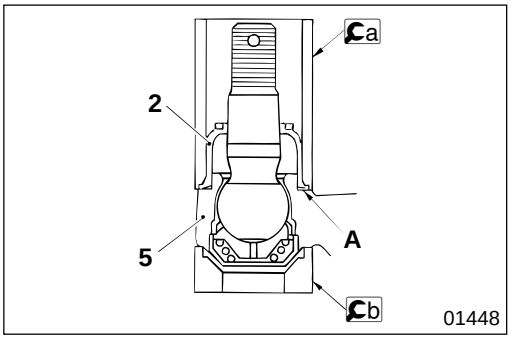
01447

[Installation]

- Position the assembly so ball stud **B** is vertical.
- Place clip guide on tie rod end assembly **5**.
- Install clip 1 into the groove of dust cover **2**.

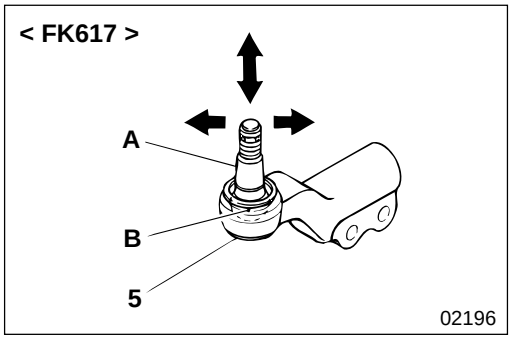
CAUTION

- **Be careful that clip guide end does not dig into dust cover 2.**
- **Be especially careful that clip 1 end does not damage dust cover 2.**



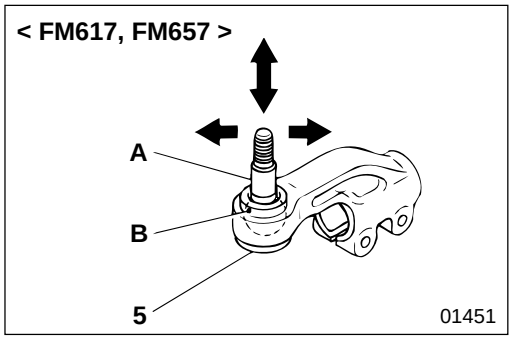
2 **Installation of dust cover < FM617, FM657 >**

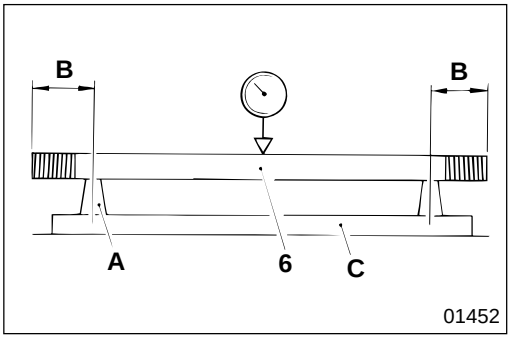
- Place dust cover **2** on tie rod end assembly **5**.
- Hold tie rod end assembly **5** between a dust cover installer and b end cover.
- Using a vise, press-fit dust cover **2** onto tie rod end assembly **5** so as the dust cover is perpendicular to the tie rod end assembly, and reinforcing ring **A** is in close contact with the tie rod end assembly.



5 **Inspection of tie rod end assembly**

Move ball stud area **A** of tie rod end assembly **5** vertically and horizontally to make sure that there is no play. Also, check that ball section **B** moves evenly. If any fault is found, replace the tie rod end assembly.





6 **Bend of tie rod**

Measure the bend of tie rod **6** at the center point. If the measured value exceeds the limit, correct or replace the tie rod.

NOTE

To measure the deflection of tie rod 6, turn it one full rotation and read the dial gauge indicator. The deflection is one half of the indicated value.

A : V-block
B : Approximately 300 mm {11.8 in.} < FK617 >
Approximately 250 mm {9.84 in.} < FM617, FM657 >
C : Surface plate

MITSUBISHI FUSO

Group 41

Frame

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-41

INDEX

SPECIFICATIONS 41-2

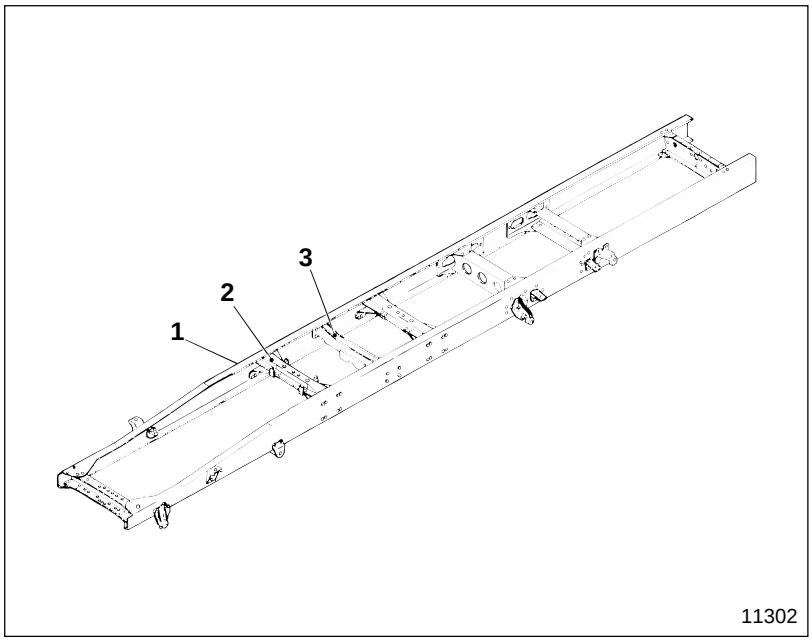
STRUCTURE AND OPERATION 41-2

INSPECTION AND REPAIR OF FRAMES 41-2

SPECIFICATIONS

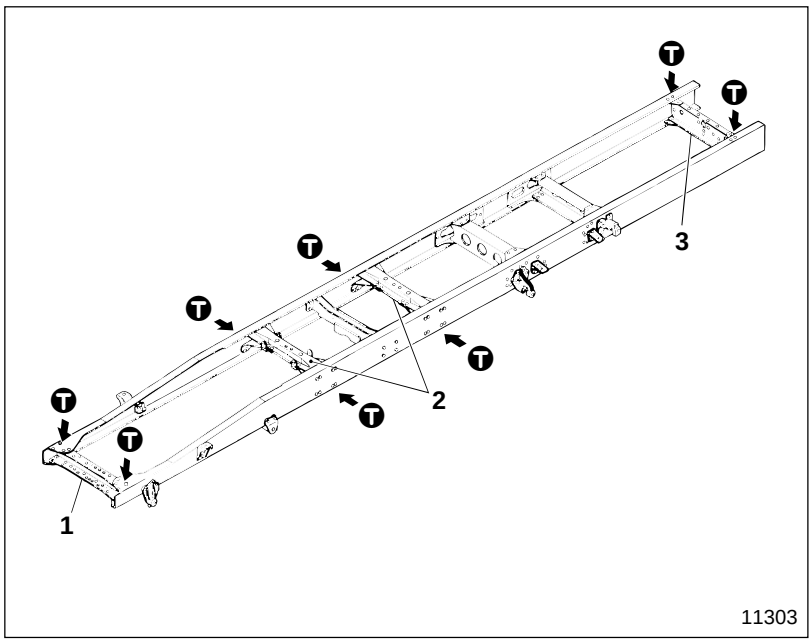
Item	Specifications
Frame type	Ladder type
Cross section configuration of side rail	⊐ shape channel section

STRUCTURE AND OPERATION



1 Side rail
2 Cross member
3 Center bearing bracket

INSPECTION AND REPAIR OF FRAMES



1 No.1 cross member
2 No.2 and No.3 cross member
3 Final cross member

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened		Tightening torque	Remarks
1	Nut (No.1 cross member to top of side rail mounting)	FM	118 to 159 {87 to 115, 12 to 16.3}	—
2	Nut (No.2 and No.3 cross members to side of side rail mounting)	FK	85 to 110 {61 to 80, 8.5 to 11}	—
		FM	200 to 269 {145 to 200, 20.4 to 27.5}	—
3	Nut (Final cross member to top of side rail mounting)		45 to 60 {33 to 43, 4.5 to 6}	—

◆ Service procedure

● Cleaning of frame

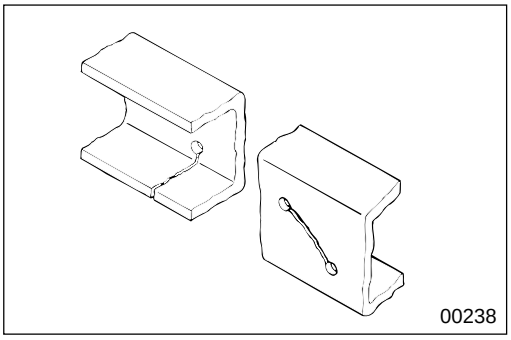
Carefully remove mud, grease, rust, etc. that is stuck to the outer and inner surfaces of the frame.

● Inspection for frame deformation

If any fault such as deformation is found, repair the frame.

● Inspection for cracks in frame

- Remove paint from any areas that are seemingly faulty and carefully inspect.
- If visual inspection is difficult, inspect using color contrast penetrant examination or other methods.
  If a crack is found, repair as follows.

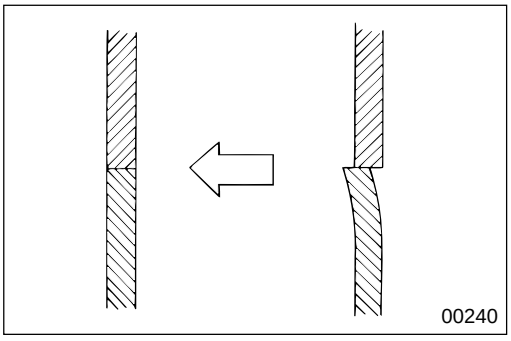


● Repair of crack in frame

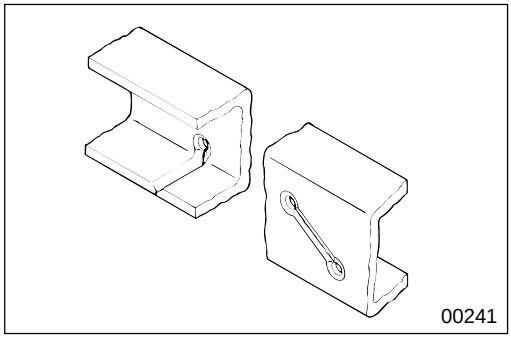
- With the vehicle unloaded, level the frame.
- Drill a hole, about twice the thickness of the frame, 10 mm {0.39 in.} from the end of the crack.

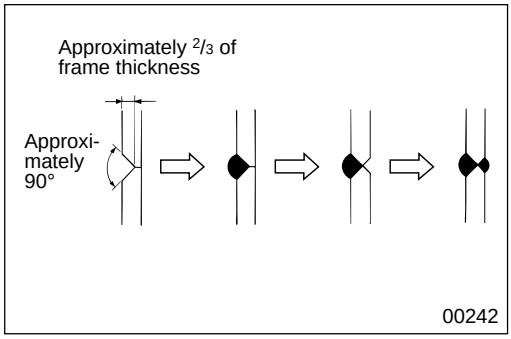
NOTE

If a crack is found inside the frame, drill holes at both ends of the crack.



- If the edges of the crack are not flush, make them flush with each other.





- Using a grinder, etc., grind a 90° V-section channel, two-thirds of the frame thickness, then weld.

WARNING

You must cover any inflammable materials, such as pipelines, wiring harnesses, rubber parts, and the fuel tank, that are near the welding site.

CAUTION

- **Do not use gas welding because the high temperature produced alters the material properties and weakens the welded area. Be sure, therefore, to use electric welding.**
- **Be sure to remove the negative terminal of the battery, then ground the welder near the area to be welded to prevent reversed flow of current from the welder which might burn out electrical components.**
- **Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.**

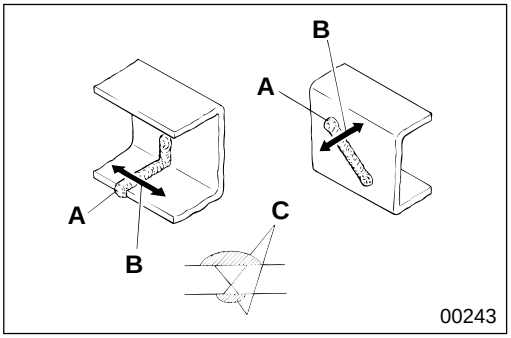
NOTE

- **Use low-hydrogen type coated CO_2 and arc welding electrodes for welding to prevent harmful defects such as undercutting, blow holes, etc.**
- **Preheat the area to be welded to approximately 50 to 350°C {122 to 662°F} before welding when the workshop temperature is below 0°C {32°F}.**

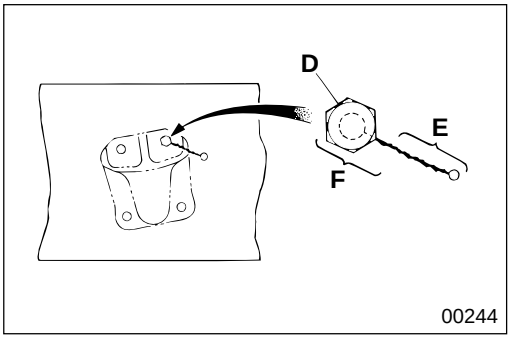
- Next, grind a V-section channel, as described above, on the opposite side of the weld and weld. At the same time, fill the holes at both ends of the crack by welding.

NOTE

In cold districts, heat the welded area to approximately 200°C {392°F} after welding.

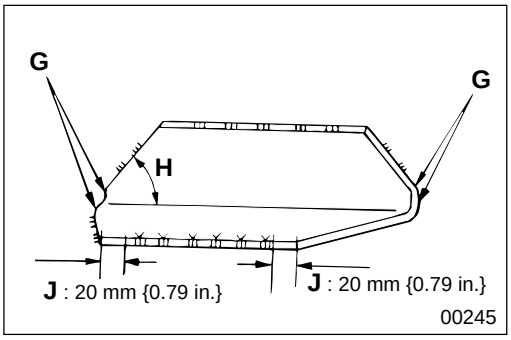


- After welding, grind bead **A** at right angles **B** to remove shaded area **C** as illustrated and grind the area flat.
- Finish the surface so that the frame thickness is identical to the original thickness.



[Repairing cracks caused by rivets or bolt holes]

- To make the edges of the holes flush at the cracked area, temporarily tighten bolt **D** in the hole.
- Weld cracked point **E** at least 20 mm {0.79 in.} from the center of the bolt.
  For welding method refer to the above-mentioned procedures for repairing cracks. P41-3.
- After removing the bolt and making the edges flush, weld remaining area **F** and fill the hole.
- After drilling a hole in the filled area, install a rivet or bolt.

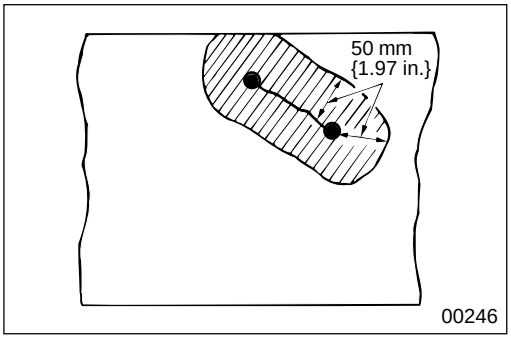


[Repairing using reinforcement plate]

- To prevent concentrated stress being produced at ends **G** of the reinforcement plate, weld the plate with angle **H** at both ends opened 30° or less.
  Do not weld area **J**.
- The reinforcement plate must have enough strength for the cracked area.

NOTE

- **Thickness of reinforcement plate : same as frame thickness**
- **Reinforcement plate material : HTP540 (high tensile strength steel) or equivalent strength.**

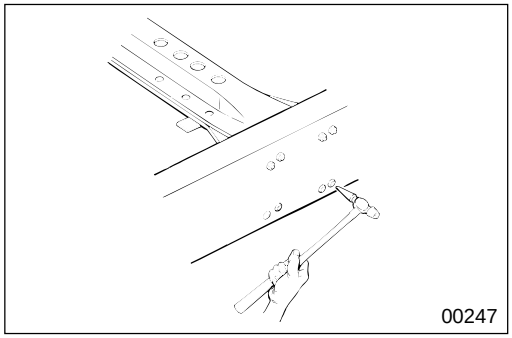


- After welding, heat the shaded area to 600 to 700°C {1112 to 1292°F}.

CAUTION

Be sure to protect mountings such as main sills that can be damaged by heat, by using heat insulators, etc.

INSPECTION AND REPAIR OF FRAMES

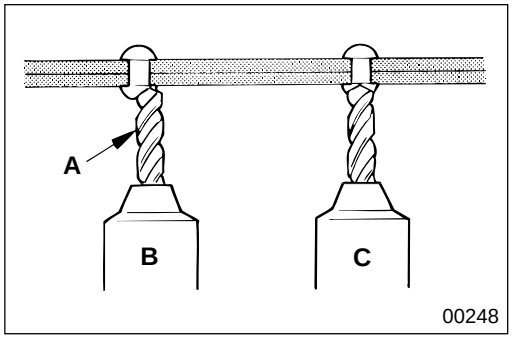


● **Inspection for loose rivets**

- Gently tap the rivet head using an inspection hammer and judge the condition by checking the vibration using the tip of your finger, or by listening to the sound.
- Rust between rivet and frame indicates that the rivet is loose.

CAUTION

Be sure to replace loose rivets because they can break or cause cracking of the frame in the area around the rivet hole, causing accidents.

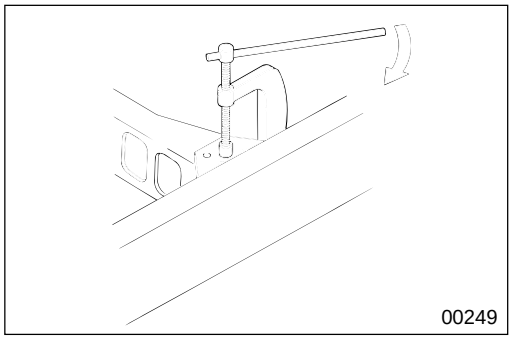


● **Repair of rivet**

- When removing rivets, use a center punch to make an indent in the center of the rivet head; then, drill out using drill **A** or grind.
  B : Incorrect
  C : Correct

CAUTION

Make sure that you do not damage the rivet hole.



- When rivetting, first clamp both plates tightly near the rivet hole using a clamp to eliminate gaps between plates.

- Using a rivetting machine, insert the rivet (cold rivet).
- If rivetting is impossible, ream the rivet hole, drive in a reamer bolt, fully tightening the nut, then weld it in place.
  A flange bolt and flange nut should be used for the reamer bolt and nut.

● **Inspection for loose bolts and nuts**

- Inspect the mounting bolts of the cross member, the helper stopper < FK > and the rear spring bracket < FM > for looseness. Loosened bolts should be tightened at specified torque. P41-2, Gr 34

NOTE

Tighten the nut side when working on the helper stopper < FK > and the rear spring bracket < FM > mounting bolts.

MITSUBISHI
FUSO

Group 42

Cab

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-42

INDEX

SPECIFICATIONS 42- 2

STRUCTURE AND OPERATION 42- 4

TROUBLESHOOTING 42-20

ON-VEHICLE INSPECTION AND ADJUSTMENT

- Adjustment of Cab Tilt 42-26
- Adjustment of Cab Tilt Lock Switch 42-27
- Adjustment of Door Fitting 42-28

REMOVAL AND INSTALLATION OF CAB 42-30

FRONT CAB MOUNTING 42-38

REAR CAB MOUNTING 42-41

CAB TILT LINK 42-42

DOOR 42-46

CAB EXTERIOR FITTING 42-52

MIRROR 42-58

WIPER AND WASHER 42-60

CAB INTERIOR FITTING 42-64

INSTRUMENT PANEL 42-70

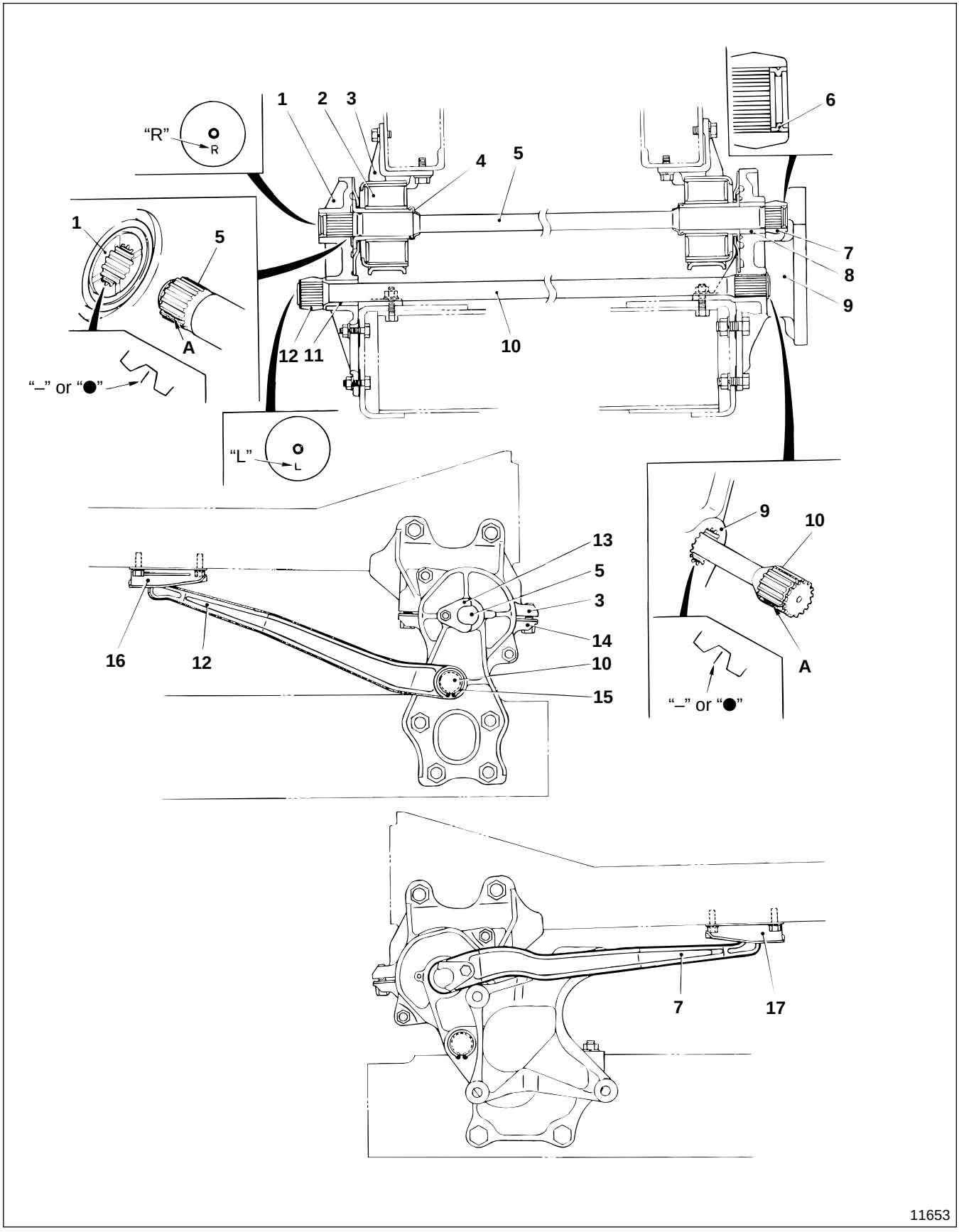
WINDOW GLASS 42-74

SPECIFICATIONS

Item		Specifications
Cab assembly	Type	Cab over type (Forward control type)
	Mass kg {lb}	Approximately 440 {970}
Cab tilt	Type	Torsion bar type
	Tilt angle	45°
Cab mounting Type		Fixed type
Windshield		Laminated glass
Glass other than windshield		Tempered glass
Door glass opening and closing mechanism		Manual control type (Cable driven)

M E M O

Front Cab Mounting



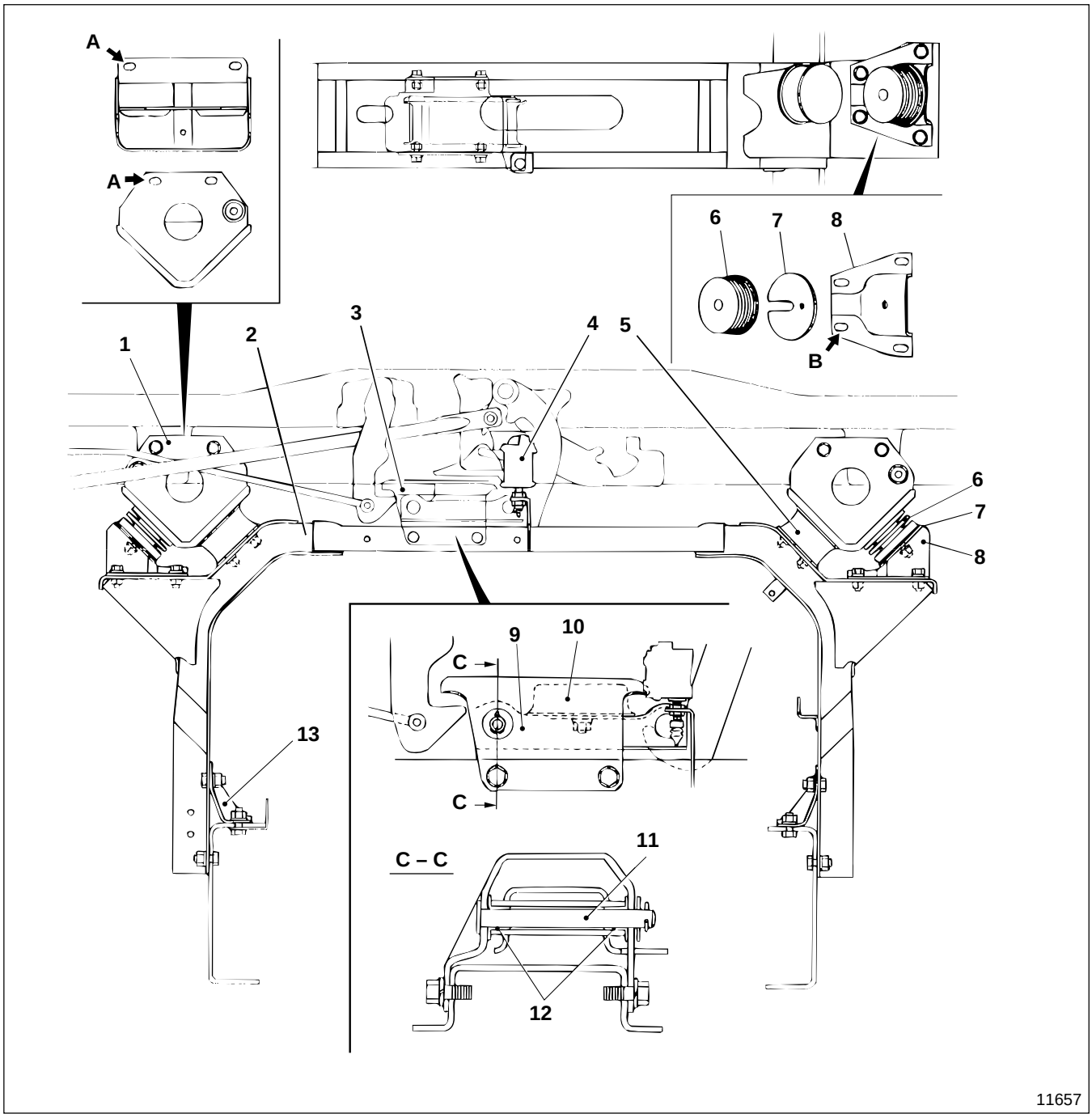
11653

1 Cab hinge bracket
2 Cab hinge cushion
3 Cab hinge upper bracket
4 Dust cover
5 Upper torsion bar
6 Dust cover
7 Torsion bar arm, LH
8 Bushing
9 Gear box bracket
10 Lower torsion bar
11 Bushing
12 Torsion bar arm, RH
13 Stopper plate
14 Cab hinge cap
15 Snap ring
16 Torsion bar support, RH
17 Torsion bar support, LH

A : White paint

- Since upper torsion bar **5** and lower torsion bar **10** have torsional directions, they are marked "**L**" and "**R**" on their right ends, preventing mistaken installation.
- Upper torsion bar **5** and cab hinge bracket **1** have alignment marks to aid alignment. The torsion bar is marked with white paint **A**, and the cab hinge bracket is marked with "–" or "●".
- Lower torsion bar **10** and gear box bracket **9** have alignment marks to aid alignment. The torsion bar is marked with white paint **A**, and the gear box bracket is marked with "–" or "●" .

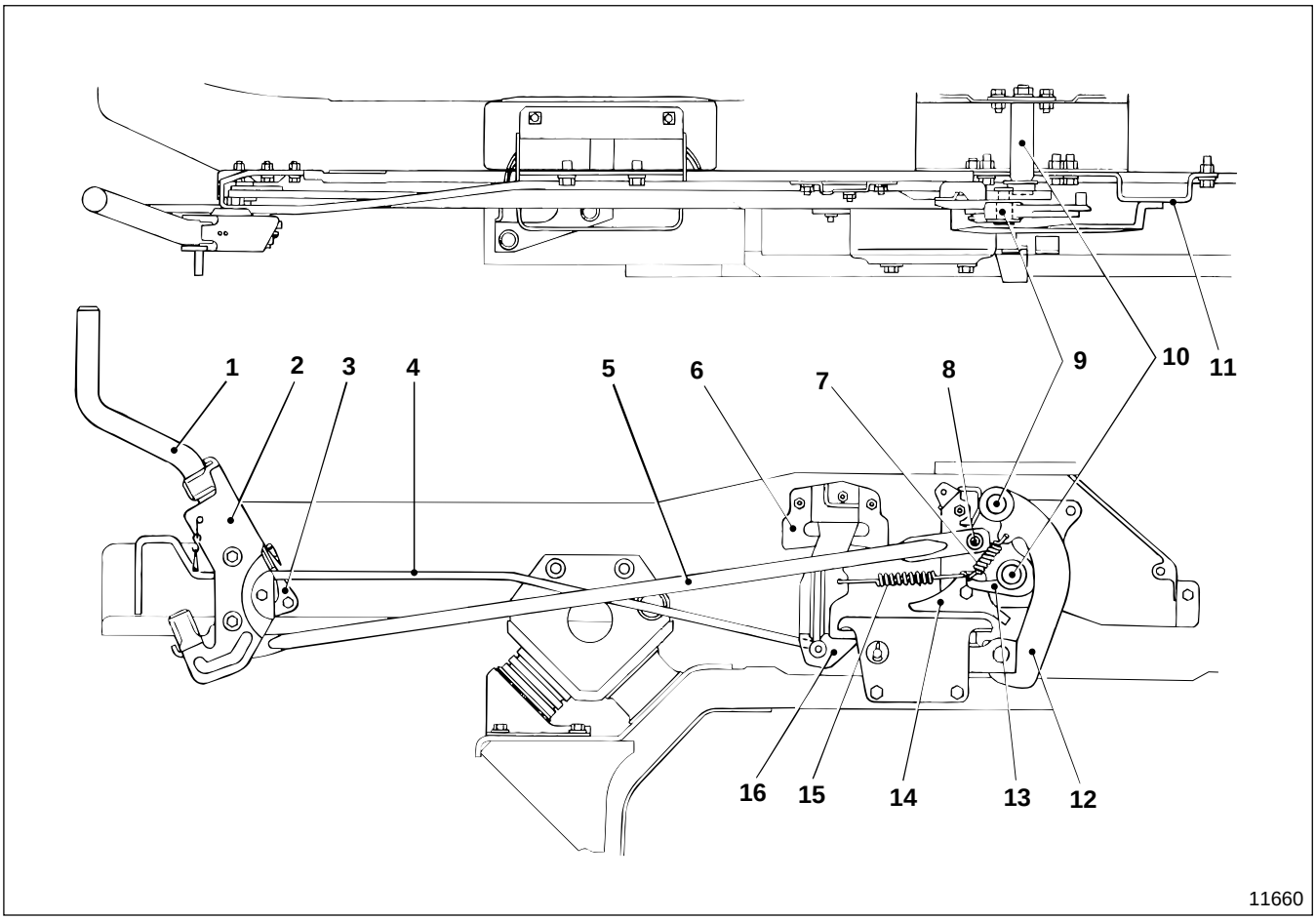
Rear Cab Mounting



1	Bottom bracket	**5**	Side cushion	**9**	Hook pin bracket	**13**	Cab bridge stiffener
2	Cab bridge	**6**	Compression cushion	**10**	Rebound cushion		
3	Hook hinge bracket	**7**	Shim	**11**	Clevis pin		
4	Cab tilt lock switch	**8**	Mounting bracket	**12**	Bushing		

- Mounting holes **A** of bottom bracket **1** are oval to allow adjustment of contact with side cushion **5**.
- Mounting bracket **8** and shim **7** allow you to adjust the position of bottom bracket **1** and compression cushion **6**.
  - Mounting holes **B** of mounting bracket **8** are oval to allow horizontal adjustment of compression cushion **6**.
  - Shim **7** allows vertical adjustment of compression cushion **6**.

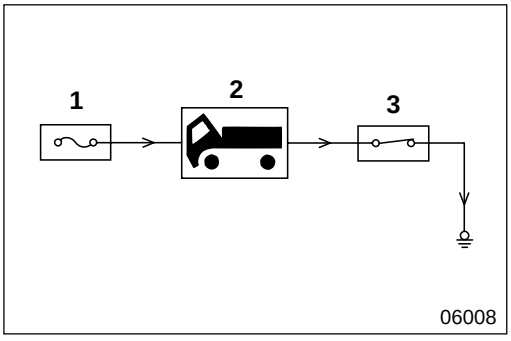
Cab Tilt Link



1 Control lever hook
2 Control lever hook bracket
3 Hinge bracket
4 L-lever rod
5 Control rod
6 L-lever bracket
7 Return spring
8 Lock pin
9 Main hook pin
10 Main hook shaft
11 Main hook bracket
12 Main hook
13 Main hook arm
14 Lock lever
15 Return spring
16 L-lever

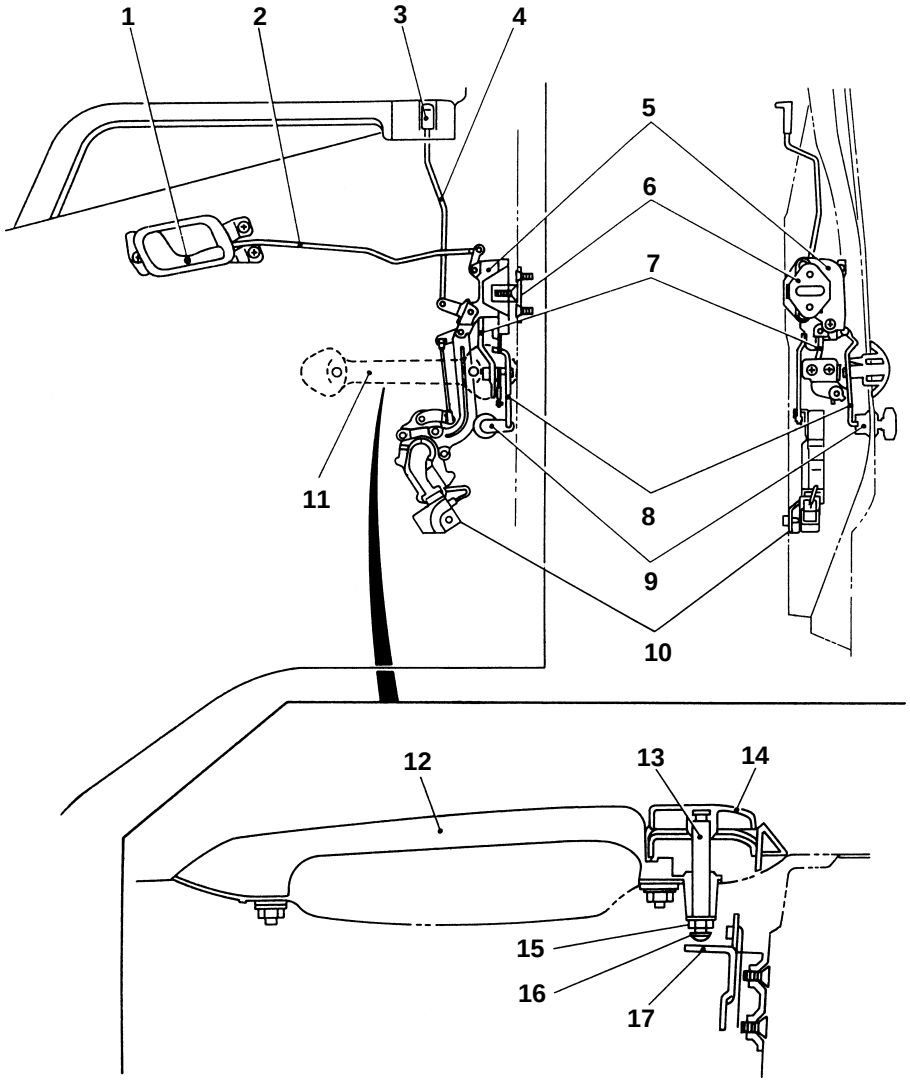
The heads of lock pin **8**, main-hook pin **9** and main-hook shaft **10** were caulked after installation. Therefore, set parts **5**, and **8** to **13** constitute the main hook assembly and they must be handled together. They must not be disassembled.

Cab Tilt Warning Electric Circuit



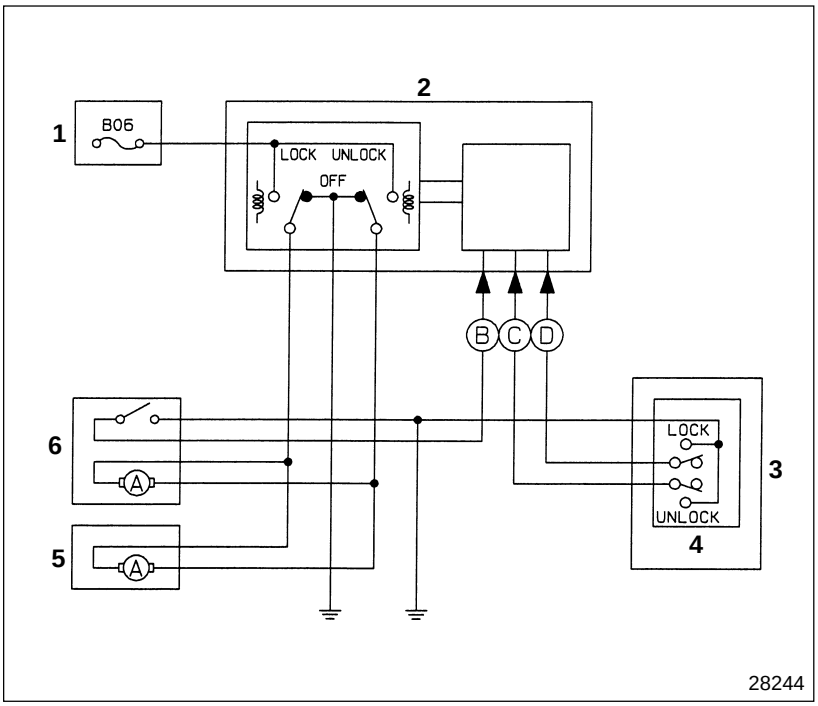
1 Relay and fuse box
2 Cab tilt warning lamp
3 Cab tilt lock switch

Door Locking System



1 Inside handle
2 Door opening rod
3 Door lock knob
4 Door lock rod
5 Door latch
6 Striker
7 Door opening rod
8 Door lock cylinder rod
9 Door lock cylinder
10 Door lock actuator
11 Outside handle
12 Handle
13 Shaft
14 Push button
15 Nut
16 Screw
17 Stay

- Push button **14** stroke of outside handle **11** can be adjusted to optimize opening and closing of the door .
- To adjust the stroke, turn screw **16** on shaft **13**.
- The head of screw **16** pushes stay **17**, and this moves door opening rod **7**, releasing door latch **5**.



● **Auto door lock system electric circuit**

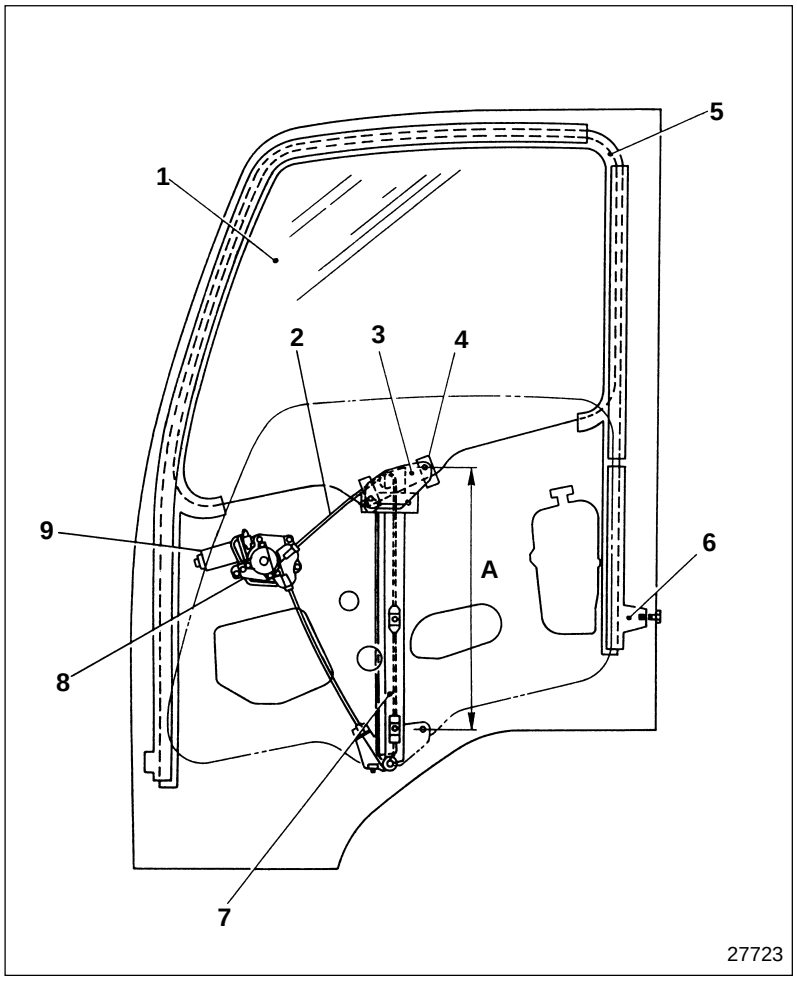
1 Fuse box
2 Power window electronic control unit
3 Power window switch and automatic door lock switch assembly
4 Automatic door lock switch
5 Assistant driver's seat side door lock actuator
6 Driver's seat side door lock actuator

A : Actuator

Ⓑ: Door lock and unlock signal by driver's seat side door lock actuator
Ⓒ: Door lock signal by automatic door lock switch
Ⓓ: Door unlock signal by automatic door lock switch

At the driver's seat side, the doors can be locked and unlocked by automatic door lock switch **4**. In addition, the doors can be locked and unlocked by procedures at door lock actuator **6**.

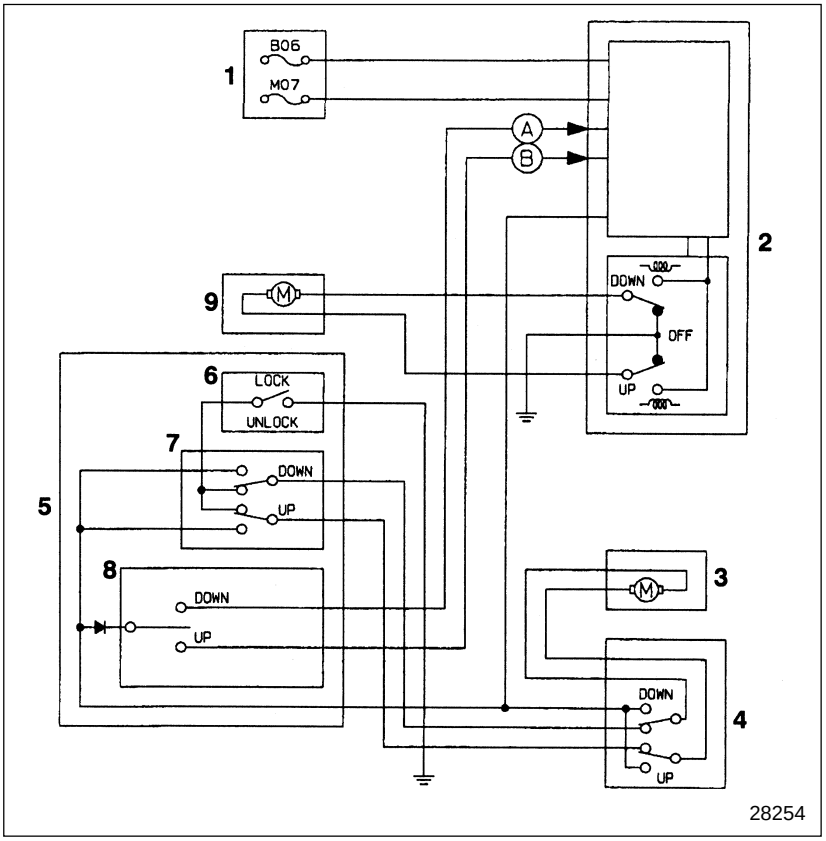
Door Glass Opening System



1 Door glass
2 Wire
3 Carrier plate
4 Glass holder
5 Run channel
6 Lower sash
7 Rail
8 Regulator
9 Power window motor

A : Carrier plate moving range

- Regulator **8** is so constructed that it is interlocked with power window motor **9** and carrier plate **3** through wire **2**.
- When power window motor **9** is rotated, carrier plate **3** is wound up or down by wire **2** to raise or lower door glass **1**.



● **Door glass opening system electric circuit**

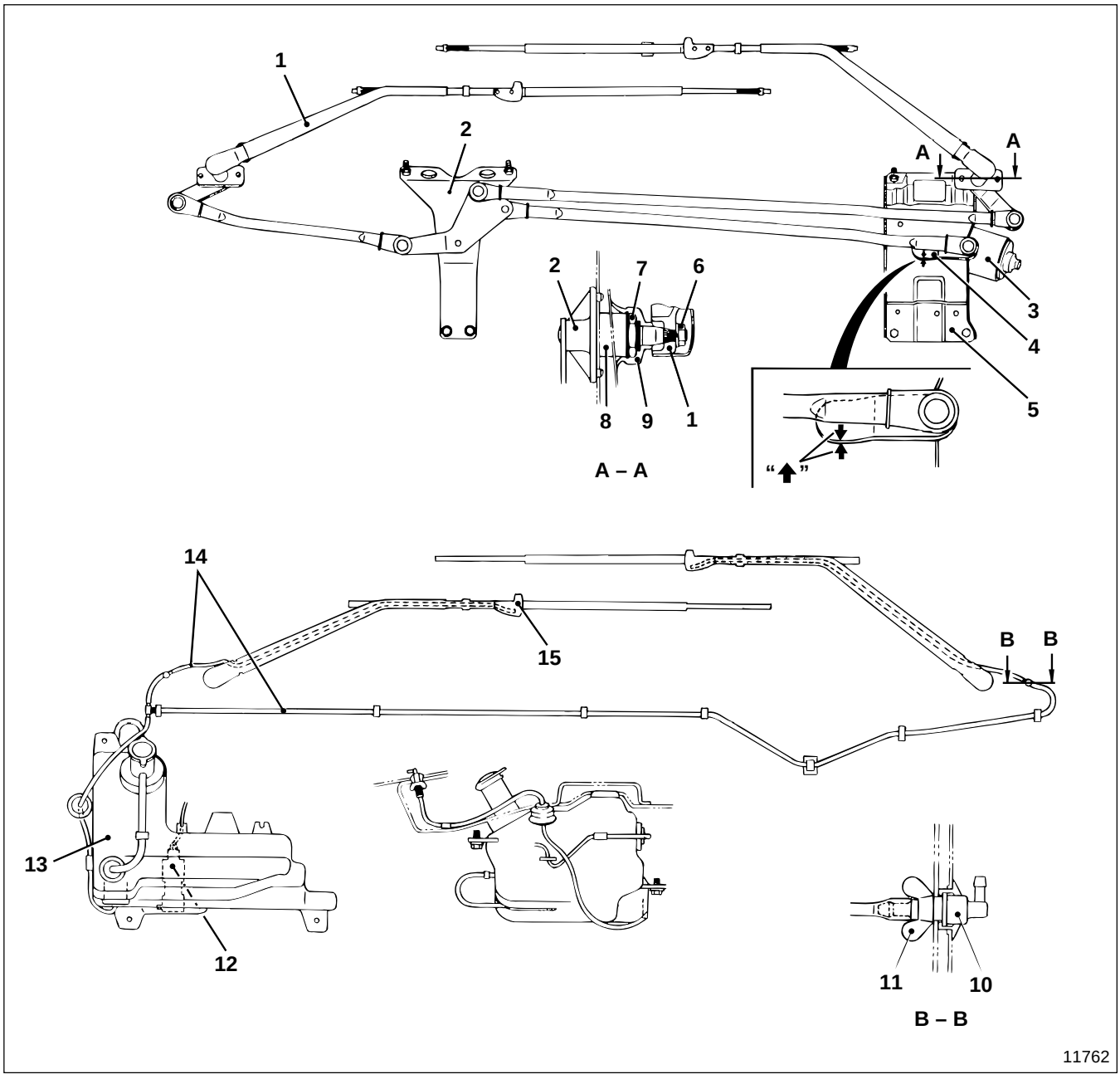
1 Fuse box
2 Door and mirror electric circuit unit
3 Assistant driver's seat side power window motor
4 Assistant driver's seat side power window switch
5 Power window switch assembly (driver's seat side)
6 Power window lock switch
7 Power window switch (to open and close assistant driver's side door glass from driver's seat)
8 Power window switch (driver's seat side)
9 Driver's seat side power window motor

M : Motor

Ⓐ: DOWN (MANUAL) signal from driver's seat side power window switch
Ⓑ: UP (MANUAL) signal from driver's seat side power window switch

- Driver's seat side power switch assembly **5** consists of power window lock switch **6**, power window switches **7** and **8**, and the automatic door lock switch put together as a unit.
- When power window lock switch **6** is placed at the LOCK position, the assistant driver's seat side door glass cannot be opened and closed even if the power window switches **4** and **7** are operated.

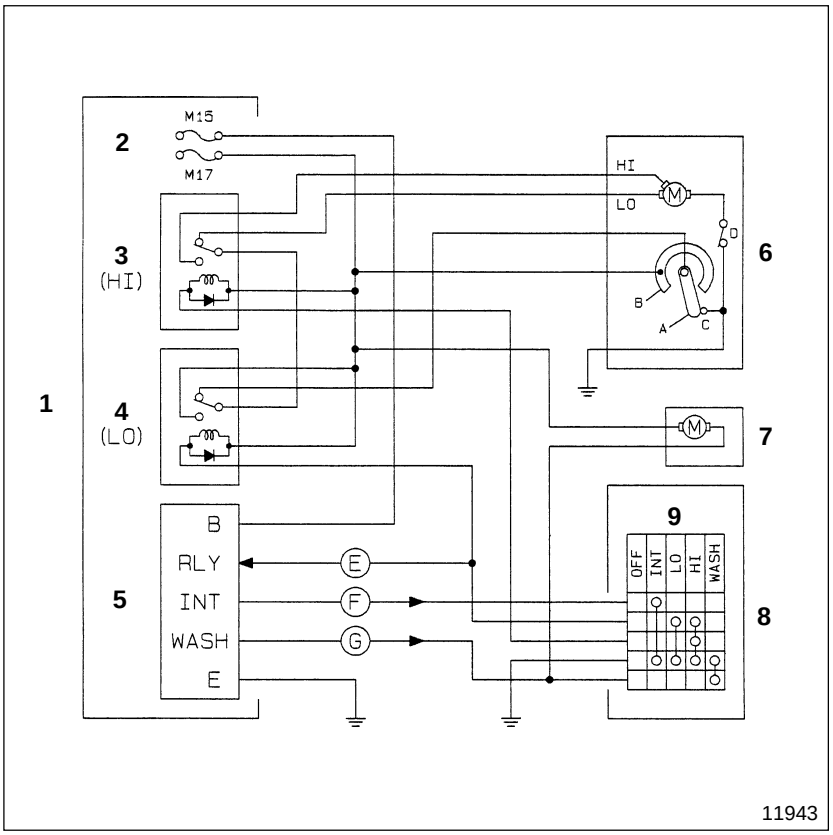
Wiper and Washer



1	Wiper and blade assembly	**6**	Nut	**11**	Nut
2	Link assembly	**7**	Nut	**12**	Washer motor
3	Wiper motor	**8**	Collar	**13**	Washer tank
4	Crank arm	**9**	Pivot cap	**14**	Washer hose
5	Wiper motor bracket	**10**	Hose joint	**15**	Washer nozzle

Crank arm **4** and wiper motor bracket **5** have alignment marks "⬆" that align when wiper and blade assembly **1** stop at the specified position.

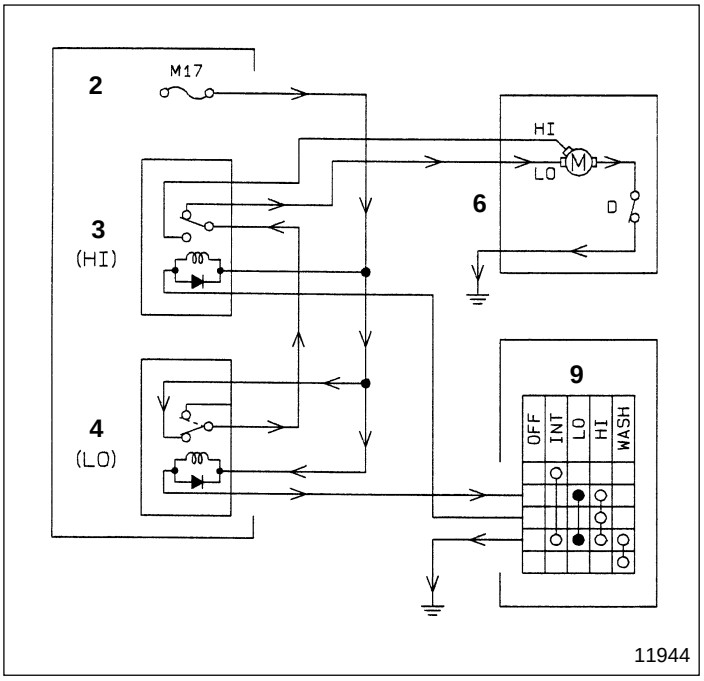
Wiper and Washer Electric Circuit



1 Fuse and realy box
2 Fuse
3 Wiper relay (HIGH)
4 Wiper relay (LOW)
5 Multipurpose timing control unit
6 Wiper motor
7 Washer motor
8 Combination switch
9 Wiper and washer switch

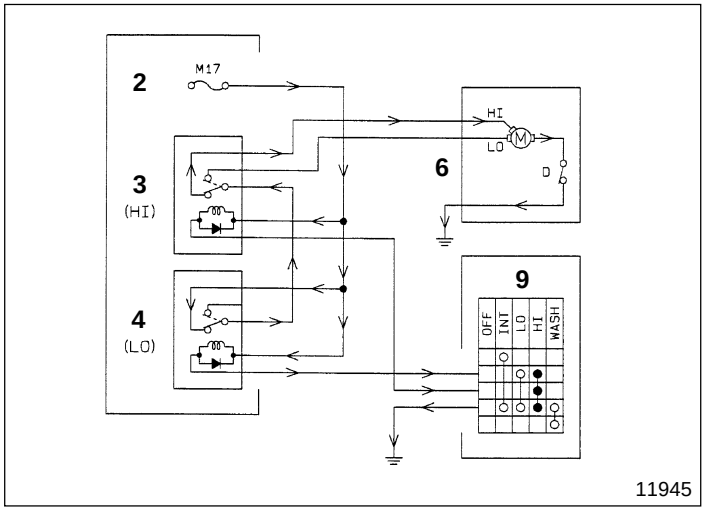
Wiper motor **6** section
A : Cam
B : Plate
C : Contact point
D : Circuit breaker

Ⓔ : Wiper motor driving signal (when wiper operating intermittently)
Ⓕ : Intermittent switch signal (when wiper operating intermittently)
Ⓖ : Washer switch signal



When wiper operating at LOW speed

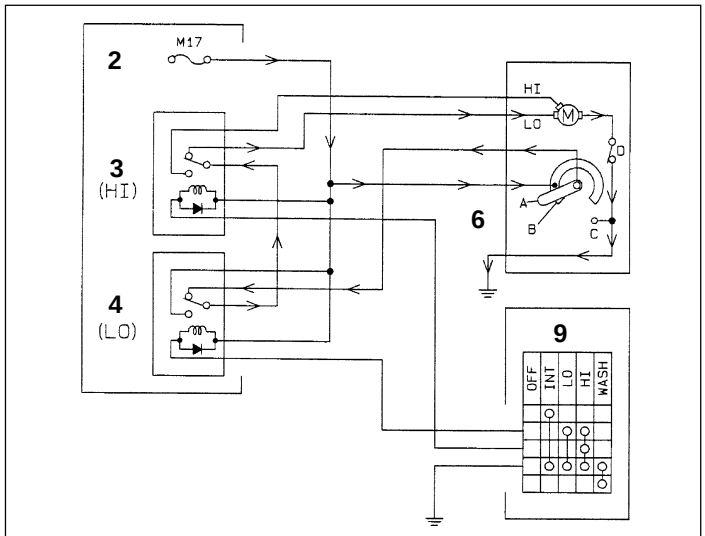
Position of wiper and washer switch **9** : LO
- **2** (M17) → **4** (coil) → **9** (LO) → Ground
- **2** (M17) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** rotates at low speed.



When wiper operating at HIGH speed

Position of wiper and washer switch **9** : HI

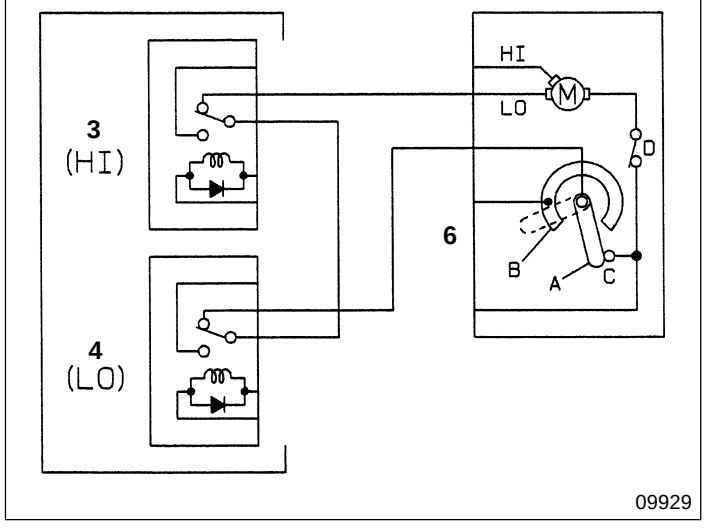
- **2** (M17) → **3** (coil) → **9** (HI) → Ground
  → **4** (coil) → **9** (HI) → Ground
- **2** (M17) → **4** (contact point) → **3** (contact point) → **6** (HI) → **6** (D) → Ground
  Wiper motor **6** rotates at high speed.



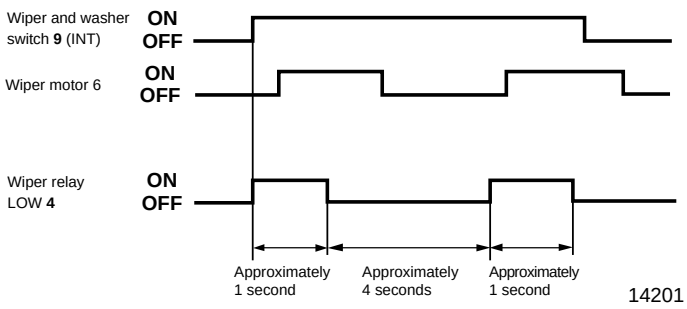
When wiper stops

Position of wiper and washer switch **9** : OFF

- **2** (M17) → **6** (B) → **6** (A) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** continues to rotate at low speed.



- When cam **A** is separated from plate **B** by rotation of wiper motor **6**, the current to the motor is cut off.
- Wiper motor **6** continues to rotate due to the inertia force of the motor and the wiper link.
- When cam **A** of wiper motor **6** makes contact with contact point **C**, the following ungrounded circuit is formed.
  → **6** (LO) → **6** (D) → **6** (C) → **3** (contact point) ← **4** (contact point) ← **6** (A) ←
- Wiper motor **6** stops by dynamic (electric) braking because of this circuit.



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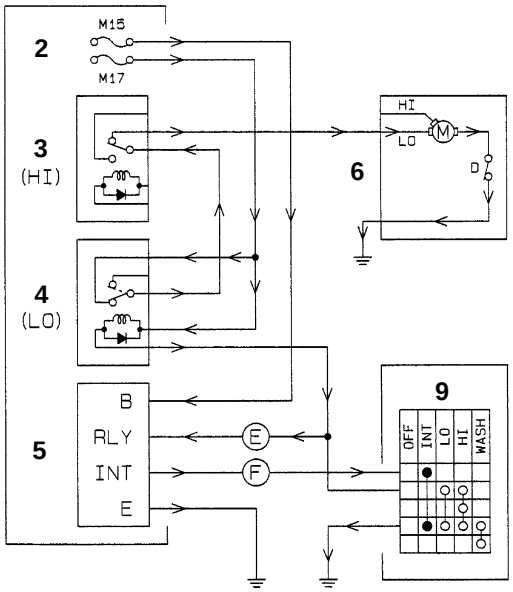

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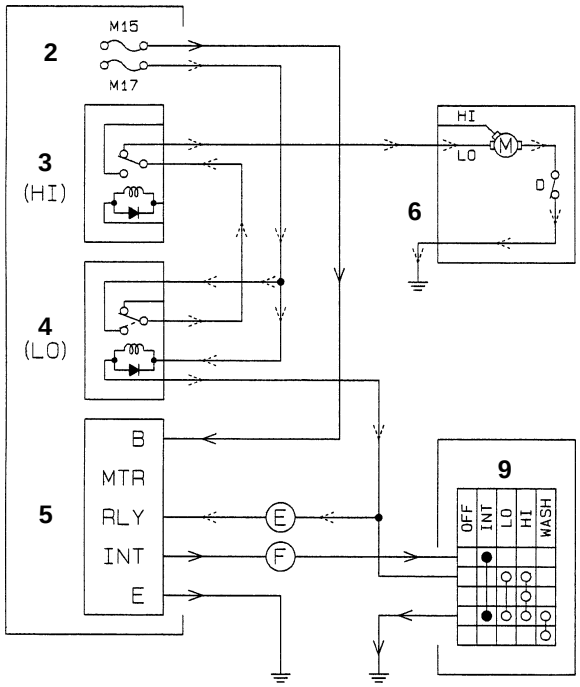


11948

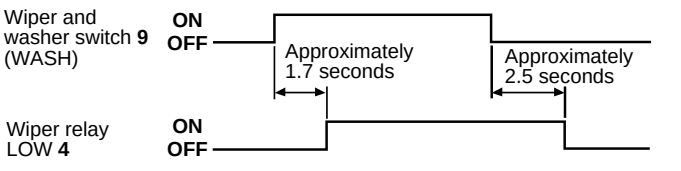
When wiper operating intermittently

Operation mode with multipurpose timing control unit **5**

Position of wiper and washer switch **9** : INT

- **2** (M15) → **5** (B) → Ground
- **5** (INT) —Ⓕ→ **9** (INT) → Ground
- Multipurpose timing control unit **5** sends wiper motor driving signal Ⓔ when it receives intermittent switch signal Ⓕ.
  2 (M17) → **4** (coil) —Ⓔ→ 5 (RLY)
- **2** (M17) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** rotates at low speed.

- Multipurpose timing control unit **5** turns wiper motor driving signal Ⓔ OFF for specified time.
  The illustrated part ⊣⊢ of the circuit turns OFF.
- Wiper motor **6** stops. 🕮 Gr 42-14
- After specified time has passed, multipurpose timing control unit **5** sends wiper motor driving signal Ⓔ again.
- Wiper motor **6** rotates at low speed.



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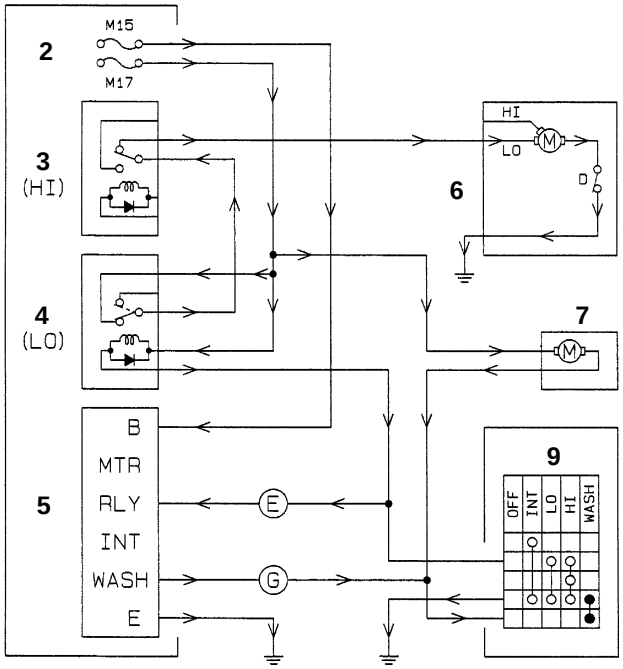


11949

When washer operating

Operation mode with multipurpose timing control unit **5**

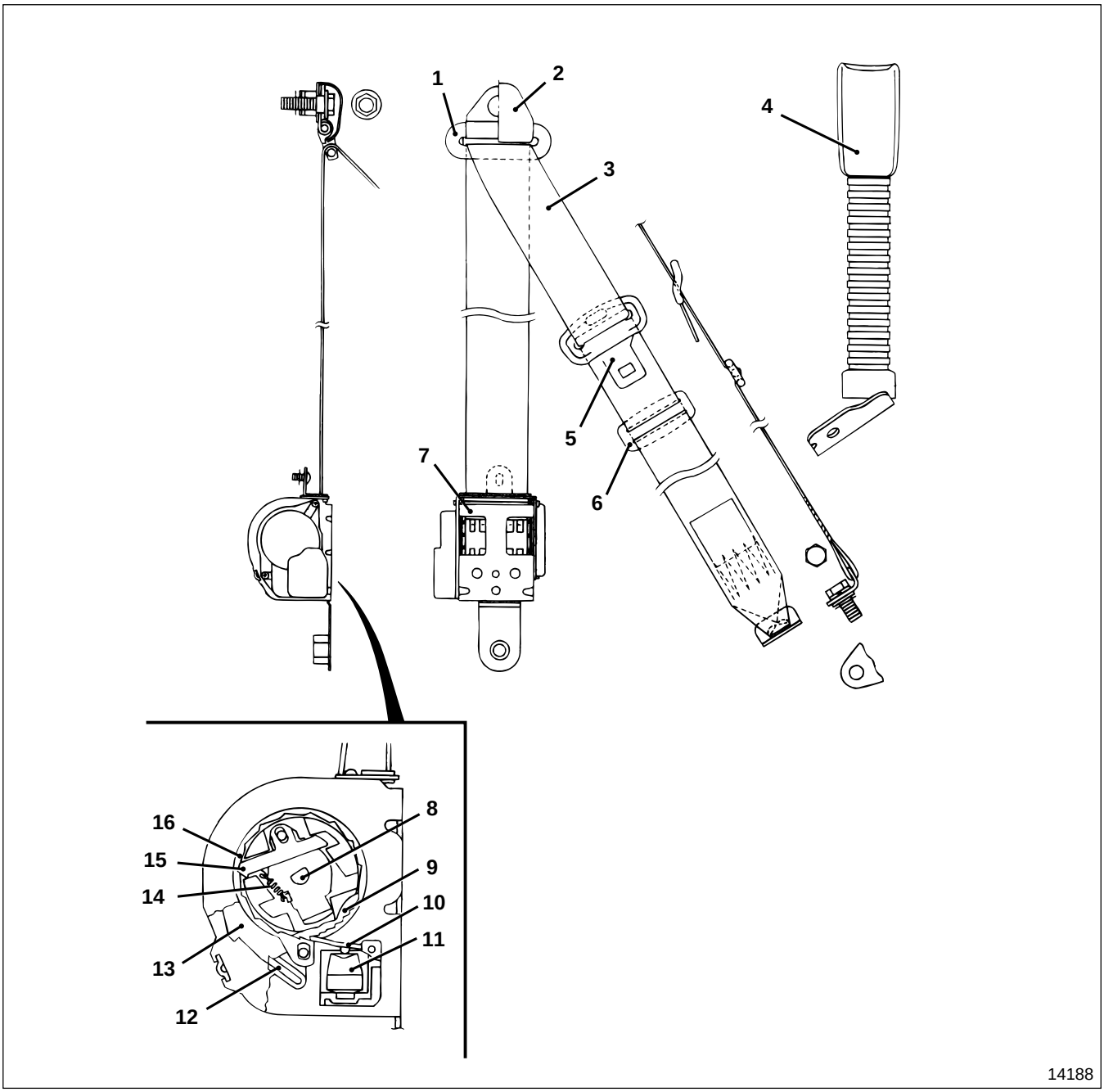
Position of wiper and washer switch **9** : WASH

- **2** (M15) → **5** (B) → Ground
- **2** (M17) → **7** → **9** → Ground
  5 (WASH)-Ⓖ

When washer motor **7** operates to spray washer fluid, multipurpose timing control unit **5** transmits washer switch signal Ⓖ.

- **2** (M17) → **4** (coil) —Ⓔ→ **5** (RLY)
  Washer switch signal Ⓖ makes multipurpose timing control unit **5** input wiper motor drive signal Ⓔ.
- **2** (M17) → **4** (contact point) → **3** (contact point) → **6** (LO) → **6** (D) → Ground
  Wiper motor **6** operates at LOW speed.
- When wiper and washer switch **9** is turned to OFF, washer motor **7** stops.
- Then, washer switch signal Ⓖ is turned off and multipurpose timing control unit **5** turns off wiper motor drive signal Ⓔ after specified time.
- Wiper motor **6** automatically stops.
  P42-14

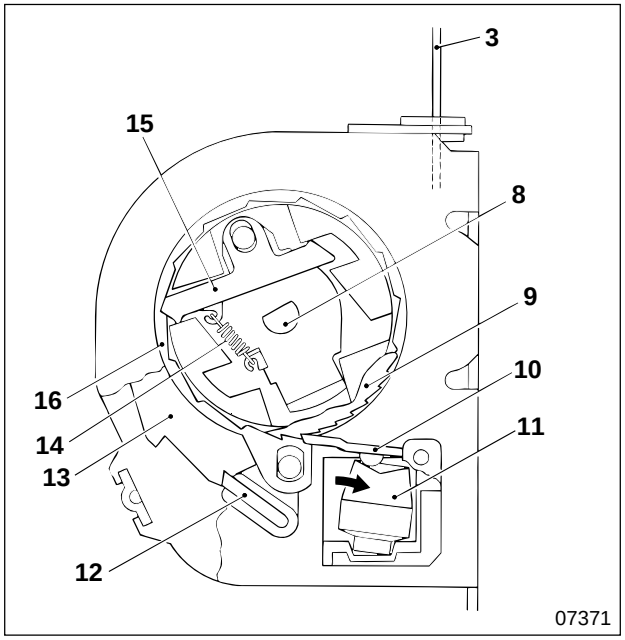
Emergency Locking Retractor (ELR) Type Seat Belt



1 Sash guide
2 Cover
3 Webbing
4 Buckle assembly
5 Tongue plate
6 Tongue stopper
7 Emergency locking retractor assembly
8 Spindle
9 Locking gear
10 Mechanism lever
11 Mechanism weight
12 Pawl
13 Ratchet gear
14 Sensor spring
15 Lock arm
16 Clutch

CAUTION⚠

Do not disassemble emergency locking retractor assembly 7, or malfunctions might occur.



Webbing detecting lock

- When the vehicle is subjected to a sudden impact, such as a crash, webbing **3** retracts according to the movement of passengers, and spindle **8** rotates.
- As the rotation of spindle **8** is higher than the specified value, the repercussive force of sensor spring **14** can no longer retain lock arm **15**. Then, the arm is pulled out from the specified position and is locked by clutch **16**.
- If spindle **8** further rotates, clutch **16** lifts pawl **12** to lock with ratchet gear **13**, making spindle rotation impossible.

Body detecting lock

- When the body is tilted excessively, mechanism weight **11** is tilted, engaging mechanism lever **10** with locking gear **9**, locking it.
- If spindle **8** further rotates, clutch **16** operates as described above, and the spindle cannot rotate.

M E M O

Cab as a Whole

Possible causes / Symptoms		Cab shimmy (pitching and rolling vibration)	Cab or steering wheel high-frequency vibration (above 20 Hz) or noise	Cab cannot be tilted up	Cab cannot be locked to rear mounting post	Cab tilt warning lamp does not light	Cab tilt warning lamp does not go out	Remarks
Cab-related	Cab mounting loose or play	○						
	Front rubber, rear rubber deteriorated		○					
	Cab mounted incorrectly		○					
	Main hook from hook pin bracket does not release			○				
	L-lever release faulty			○				
	Torsion bar damaged or fatigued			○				
	Torsion bar arm installation position incorrect			○				
	Main hook not hooked to hook pin bracket				○			
	Bottom bracket contact with cushion incorrect				○			
	Cab tilt lock switch adjusted incorrectly					○	○	
	Cab tilt lock switch faulty					○	○	
	Cab tilt warning lamp bulb burnt-out					○		
	Fuse, high-current fuse blown					○		
	Wiring broken or connection faulty					○		
Engine-related	Crossed axes angle of propeller shaft excessive due to increased tilt caused by deteriorated engine mounting		○					
	Engine installation faulty		○					Gr 10
	Intake and exhaust system installation faulty		○					
Transmission-related	Transmission installation faulty		○					Gr 22A, Gr 22B, Gr 23
Propeller shaft-related	Propeller shaft run-out excessive		○					
	Universal joint worn excessively		○					
	Slip yoke joint spline play		○					
	Center bearing play excessive		○					Gr 25
	Crossed axes angle of mounting dimension excessive due to deteriorated center bearing cushion rubber, etc.			○				
	Crossed axes angle of propeller shaft excessive due to increased tilt of drive axis caused by overloading		○					

Possible causes / Symptoms		Cab shimmy (pitching and rolling vibration)	Cab or steering wheel high-frequency vibration (above 20 Hz) or noise	Cab cannot be tilted up	Cab cannot be locked to rear mounting post	Cab tilt warning lamp does not light	Cab tilt warning lamp does not go out	Remarks
Front axle-related	Axle seat resonance	○						Gr 26
Rear axle-related	Reduction gear engaged incorrectly		○					Gr 27
	Differential gear engaged incorrectly		○					
Wheel and tire-related	Wheel and tire run-out excessive	○						Gr 31
	Wheel and tire unbalanced	○						
	Size and kinds of tire unequal	○						
	Wheel mounting surface warped	○						
Front suspension-related	Leaf spring friction between leaves excessive	○						Gr 33
Brake-related	Brake drum unbalanced	○						Gr 35
	Brake drum eccentric	○						
	Rotor of disc brake eccentric	○						

TROUBLESHOOTING

Door Lock

Symptoms / Possible causes		Inside handle can not open door	Inside handle heavy to operate	Outer handle can not open door	Outer handle heavy to operate	Door does not open and close smoothly	Auto door lock system does not operate: Procedure by key	Auto door lock system does not operate: Procedure by door lock knob	Auto door lock system does not operate: Procedure by auto door lock switch	Remarks
Door setting ot of adjustment			○		○	○				
Each door rod	Rod deformed		○		○					
	Rod out of position	○		○			○	○	○	
	Rod interference		○		○					
Door lock cylinder deformed or damaged							○			
Power window and door lock switch assembly defective									○	Gr 54
Door lock actuator defective							○	○	○	
Door latch deformed or damaged			○		○	○				
Fuse of high current fuse blown							○	○	○	
Connector improperly connected, harness open-circuited, improperly grounded							○	○	○	Gr 54
Battery capacity insufficient							○	○	○	
Power window electronic control unit defective							○	○	○	
Striker deformed		○		○		○				
Outer handle out of adjustment					○					

Power Window

Symptoms / Possible causes	Door window glass falls of its own accord in cruising	Power window regulator generates strange sound in cruising	Power window does not operate	Power window does not stop	Power window generates strange sound when it operates	Remarks
Power window switch defective			○	○		
Power window control unit defective			○	○		
Power window regulator defective	○	○	○		○	Gr 54
Power window regulator improperly mounted					○	
Fuse or high current fuse blown			○			
Connector improperly connected, harness open-circuited, improperly grounded			○			

Wiper and Washer

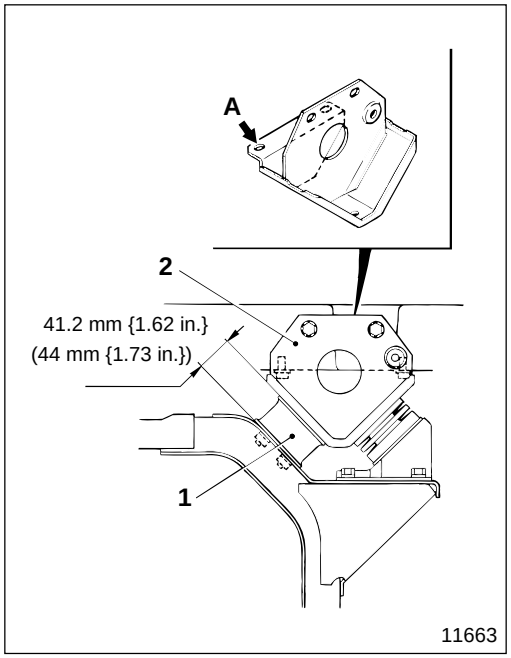
Symptoms / Possible causes	Wiper doe not work	Wiper does not stop	Wiper intermittent operation does not work	Wiper blade stop position incorrect	Wiper operation inadequate	Noise during wiper operation	Washer motor does not work	Washer fluid jetting insufficient	Washer fluid does not jet	Remarks
Wiper motor faulty	○	○		○		○				
Washer motor faulty							○	○	○	
Wiper and washer switch faulty	○	○	○				○			
Multipurpose timing control unit faulty			○							Gr 54
Wiper relay faulty	○						○			
Fuse, high-current fuse blown	○						○			
Wiring broken or connection faulty	○		○				○		○	
Wiper motor crank arm set position faulty				○						
Wiper link and wiper arm connection faulty						○				
Wiper blade faulty					○	○				
Wiper arm faulty					○					
Washer hose twisted								○		
Washer hose connected incorrectly									○	
Washer nozzle clogged								○	○	
Washer fluid insufficient									○	

M E M O

Adjustment of Cab Tilt

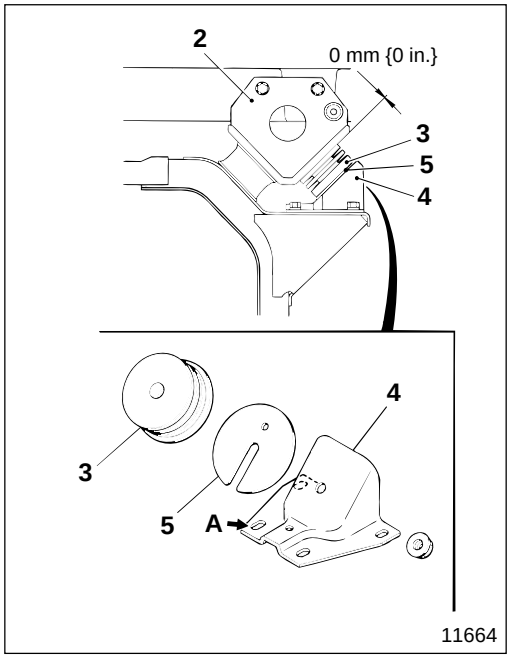
Lubricant

Location	Points of application	Kinds	Quantity
1	Contact surfaces between side cushion and bottom bracket	Molybdenum disulfide grease [NLGI No.2 (Li soap)] (Molykote BR 2 plus)	As required



(1) Contact adjustment between bottom bracket and side cushion

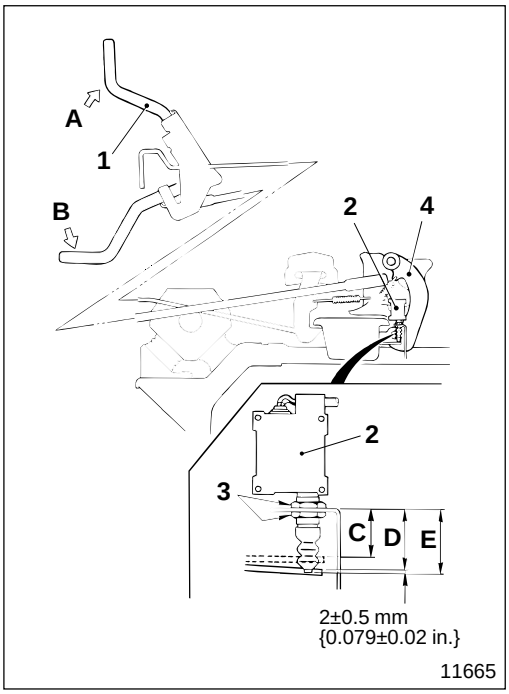
- Tilt the cab down and lock securely.
- To position side cushion **1** as high as illustrated, move it horizontally to install bottom bracket **2**.
  A : Oval hole for adjustment (4 points)
  ( ): Indicates free length.



(2) Contact adjustment between bottom bracket and compression cushion

- Tilt the cab down and lock.
- Adjust the clearance between compression cushion **3** and bottom bracket **2** to 0 mm {0 in.} as follows:
  - Adjust the installation position of mounting bracket **4** by moving it horizontally.
    A : Oval hole for adjustment (4 points)
  - Adjust by changing the thickness of shim **5**.
    Available shim thicknesses: 1.0 mm {0.039 in.}, 2.0 mm {0.079 in.}

Adjustment of Cab Tilt Lock Switch



- Turn the starter switch to ON.
- Use nut **3** to adjust the position of cab tilt lock switch **2** so that when you operate hook control lever **1**, warning lamp in the meter cluster turns on or off in accordance with the following conditions.

• Position of hook control lever **1** : **A** (Main hook **4** is locked.)

State of cab tilt		Adjustment dimension of cab tilt lock switch **2**
When tilted down	OFF	**C** : 31 mm {1.22 in.}

•Position of hook control lever **1** : **B** (Main hook **4** is released.)

State of cab tilt		Adjustment dimension of cab tilt lock switch **2**
When tilted down	ON	**D** : 37 mm {1.46 in.}
When tilted up	ON	**E** : 39 mm {1.54 in.}

ON-VEHICLE INSPECTION AND ADJUSTMENT

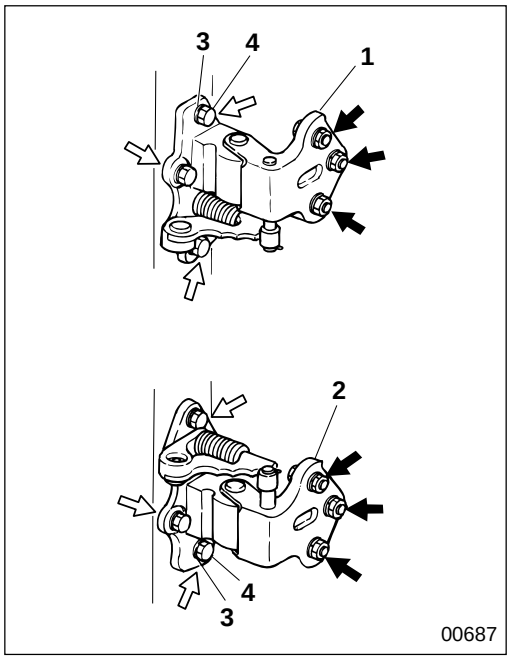
Adjustment of Door Fitting

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
4	Bolt (Upper and lower hinge mounting)	17 to 25 {12 to 19, 1.7 to 2.6}	—
6	Screw (Striker mounting)	8.8 to 14 {6.5 to 10, 0.9 to 1.4}	—

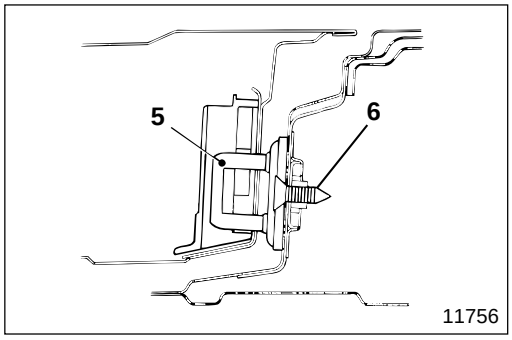
Adjust door fitting at hinge and striker.
(For door fitting dimensions : 🕮 P42-29)



(1) Adjustment of hinge

Adjust upper hinge **1** and lower hinge **2**. Adjustment depends on whether washer **3** is welded or unwelded.

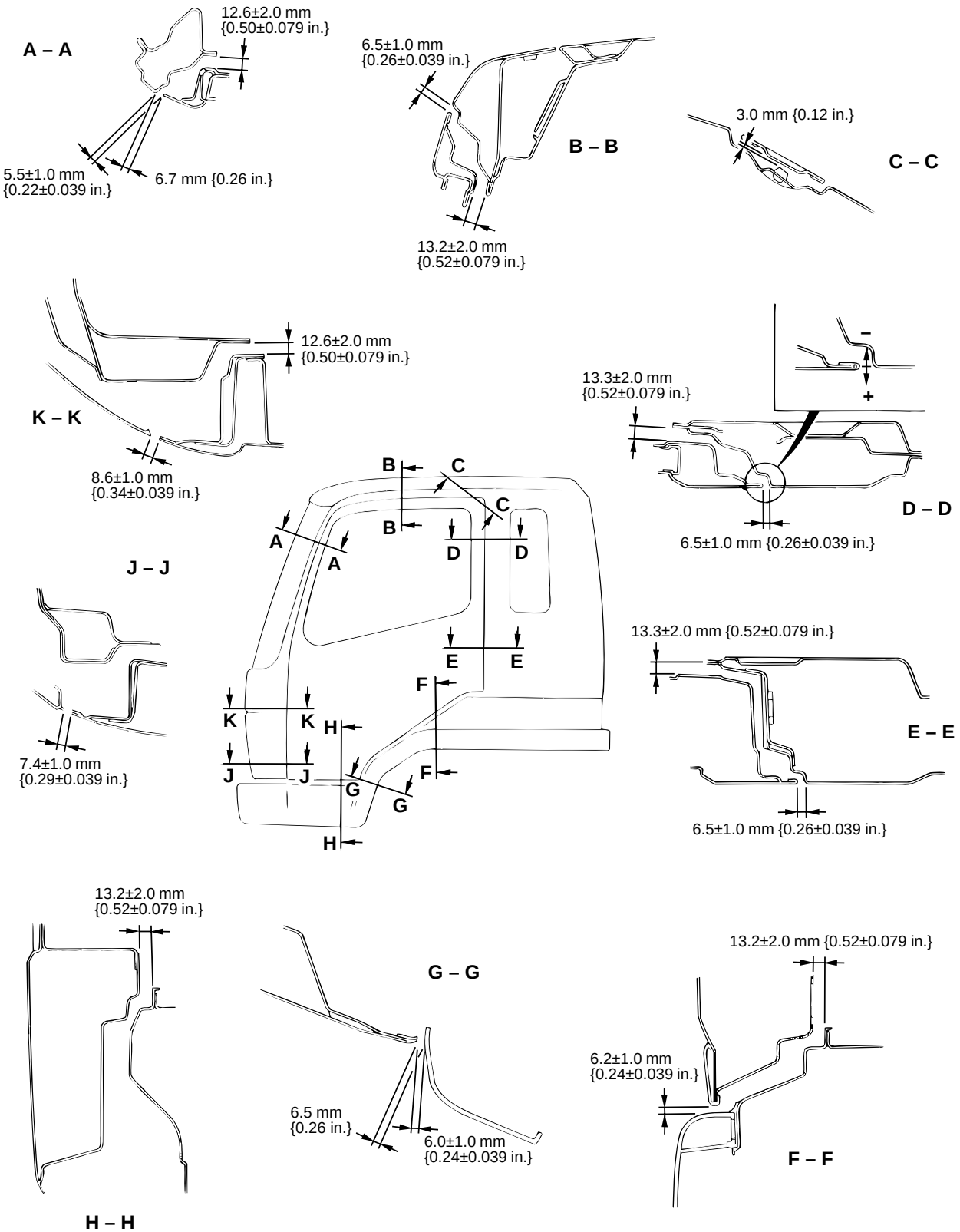
- For washer **3** that is welded:
  Adjust bolts **4** indicated by ➡.
- For washer **3** that is not welded:
  Adjust bolts **4** indicated by ⇨.



(2) Adjustment of striker

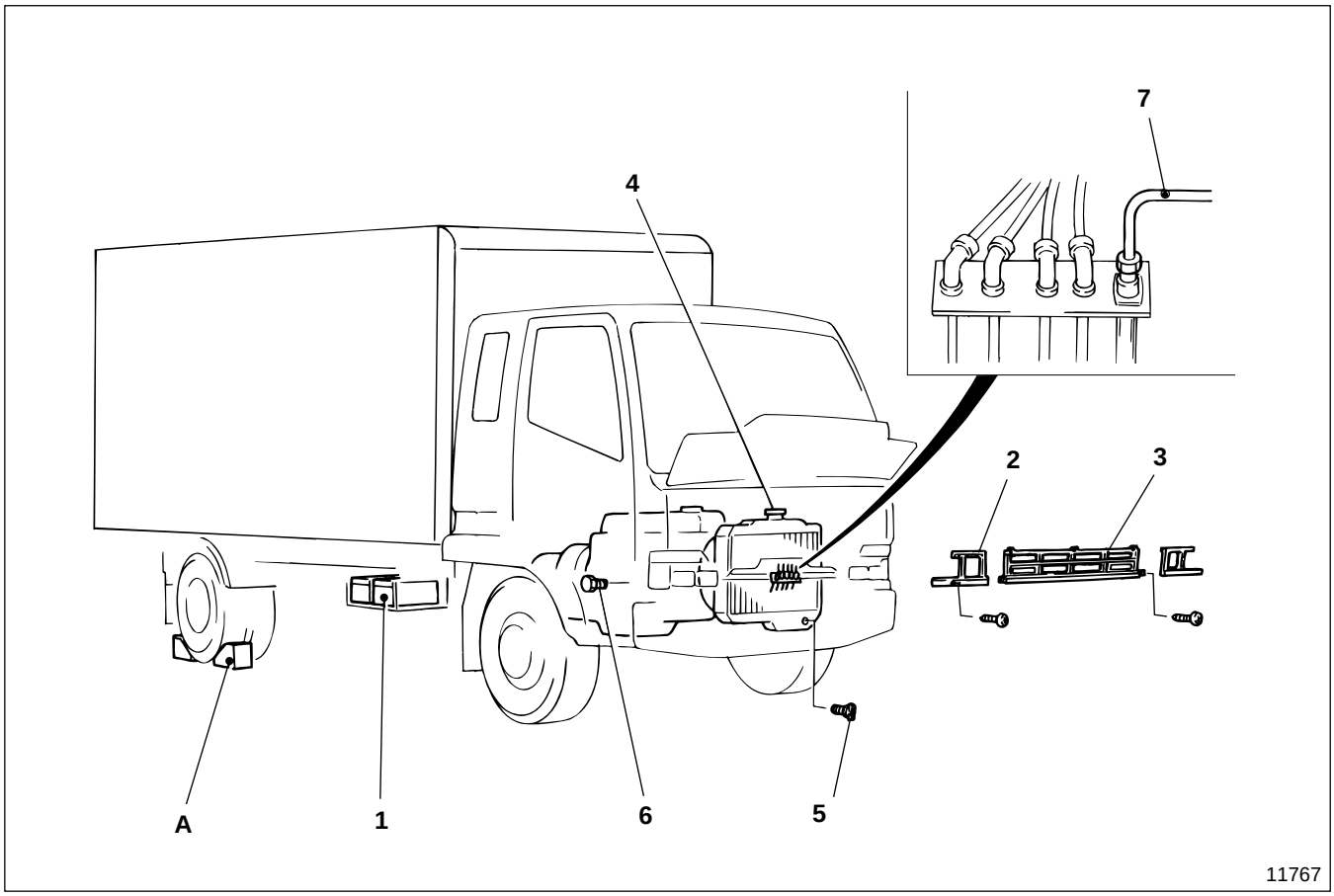
Adjust installation screw **6** of striker **5**.

Door Fitting Dimensions



REMOVAL AND INSTALLATION OF CAB

Preliminary Work



● **Disassembly sequence**

1 Battery (negative terminal) Gr 54
2 Headlamp bezel
3 Front grille Gr 42-52
4 Pressure cap Gr 14
5 Radiator drain plug Gr 14
6 Crankcase drain plug Gr 14
7 Clutch fluid pipe (Clutch)
< Manual transmission > Gr 21

A : Wheel chock

Work items

- Draining, filling, and air bleeding of clutch fluid and brake fluid Gr 21, Gr 35A
- Draining, filling, and air bleeding of coolant Gr 14

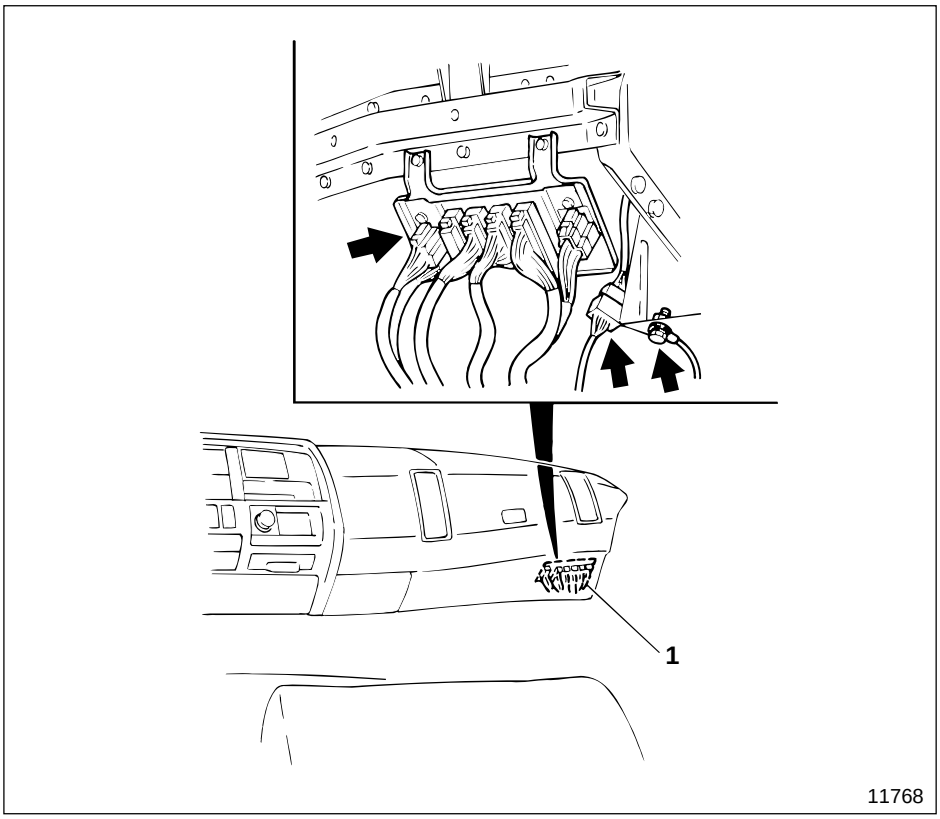
WARNING

- **Put chocks A securely in place because the vehicle cannot be maintained at a standstill just by using the parking brake, in the case of a vehicle fitted with a center brake, during removal and installation of the cab.**
- **Do not remove chocks A until the entire operation is completed.**

● **Assembly sequence**

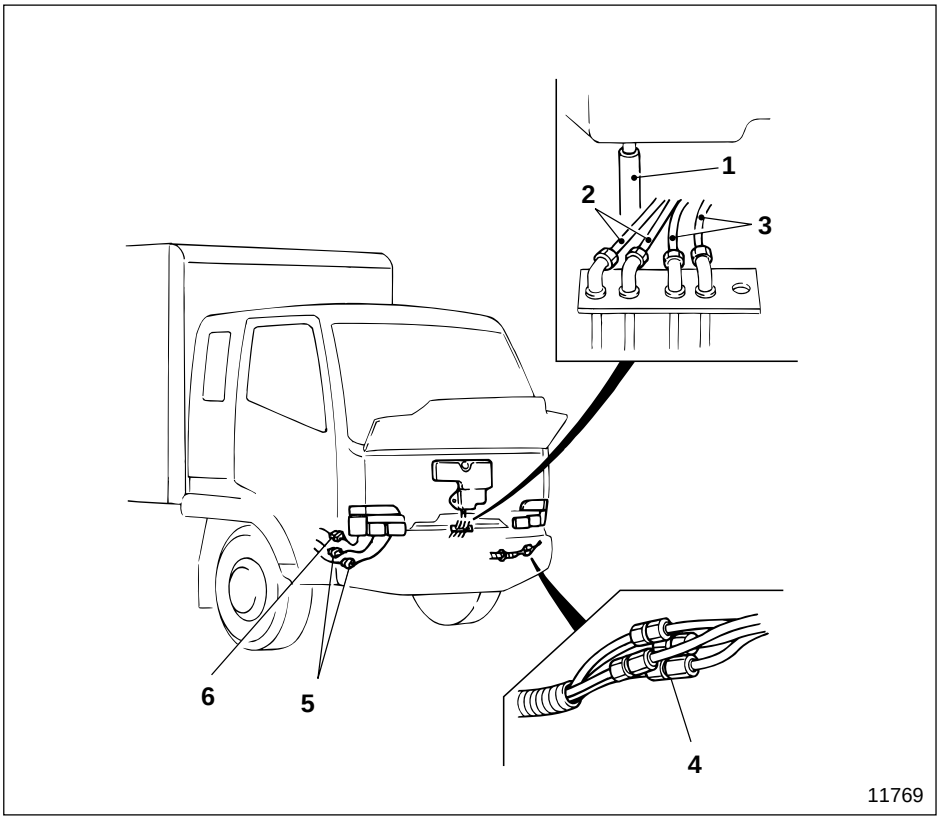
Follow the disassembly sequence in reverse.

Work Inside Cab



1 Connection between cab harness and chassis harness

Work from Front of Cab



● **Disassembly sequence**

1 Coolant reservoir hose
2 Nylon tube (Parking brake) < FM >
3 Nylon tube (Air gauge)
4 Nylon tubes (1 for air horn, 4 for brake)
5 Headlamp harness connector
6 Clearance lamp harness connector

● **Assembly sequence**

Follow the disassembly sequence in reverse.

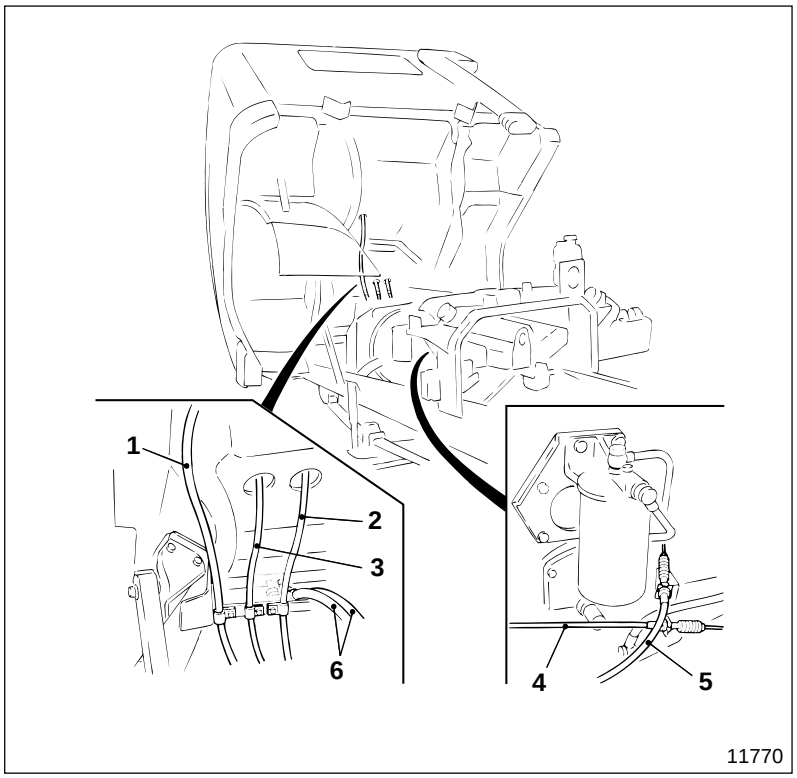
NOTE

Nylon tubes 2 to 4 are identified with colored tape. Be sure to match up the tape colors when installing.

Installation procedure: Gr 35A, B

REMOVAL AND INSTALLATION OF CAB

Work with Cab Tilted Up



● **Disassembly sequence**

1 Parking brake cable < Center brake > Gr 36A
2 Shift cable < Manual transmission > Gr 22A, Gr 22B
Range selector cable < Automatic transmission > Gr 23
3 Select cable < Manual transmission > Gr 22A, Gr 22B
4 Engine stop cable Gr 13
5 Accelerator control cable Gr 13
6 Heater hose Gr 55B

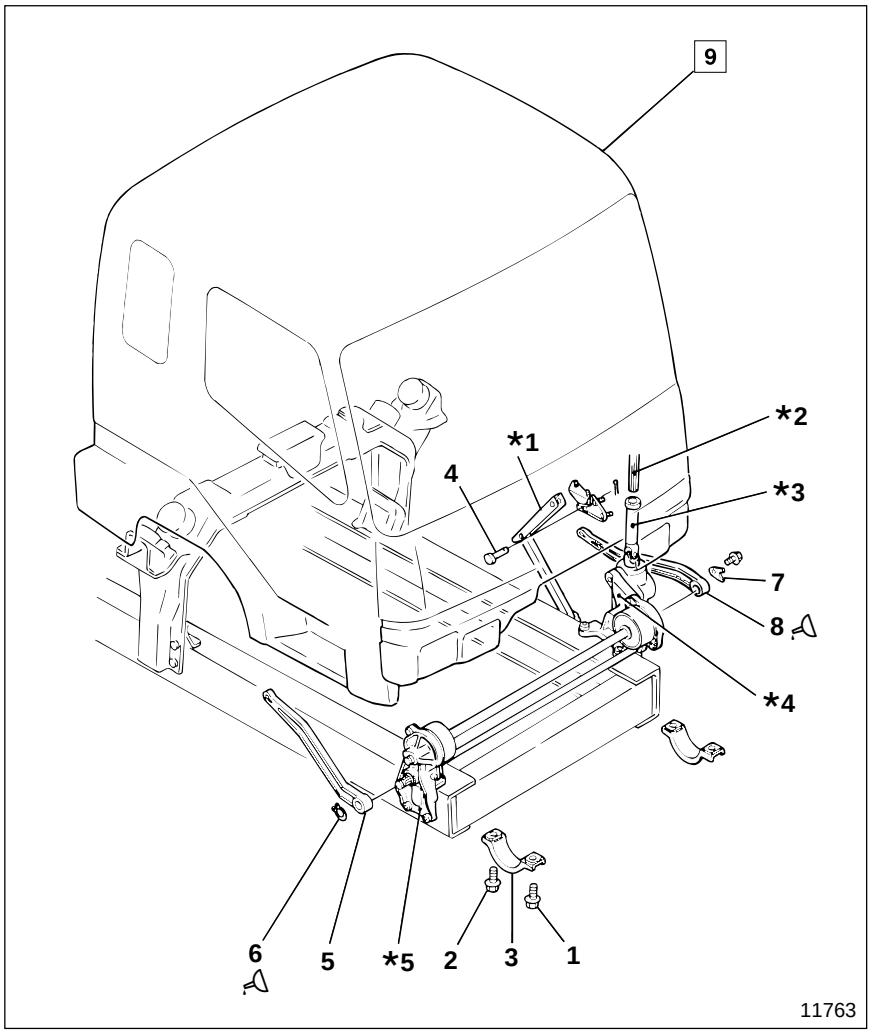
● **Assembly sequence**

Follow the disassembly sequence in reverse.

M E M O

REMOVAL AND INSTALLATION OF CAB

Removal and Installation of Tilt Cab Body



● **Disassembly sequence**

1 Bolt
2 Bolt
3 Cab hinge cap
4 Clevis pin
5 Snap ring
6 Torsion bar arm, RH
7 Stopper plate
8 Torsion bar arm, LH
9 Cab assembly

***1** : Cab stay
***2** : Steering yoke
***3** : Steering shaft
***4** : Gear box bracket
***5** : Cab hinge bracket

● **Assembly sequence**

Follow the disassembly sequence in reverse.

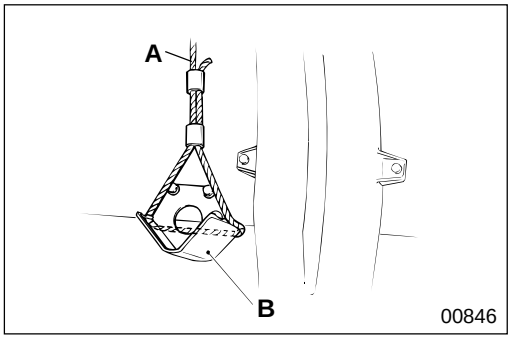
● **Inspection and adjustment after installation**

P42-26

Lubricant

Location	Points of application	Kinds	Quantity
6, 8	Contact area of torsion bar arm with torsion bar support	Chassis grease [NLGI No.1 (Ca soap)]	As required

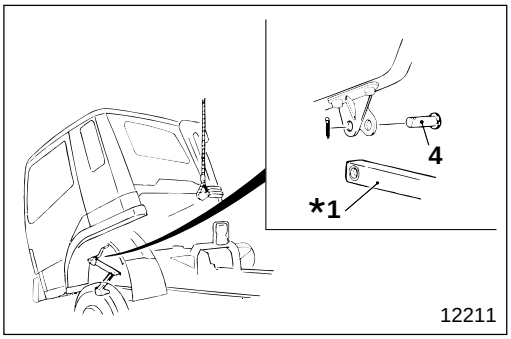
◆ Service procedure



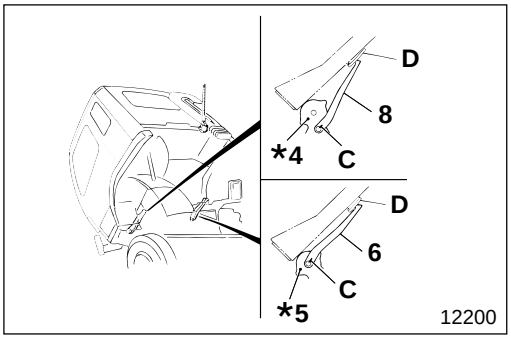
9 **Cab assembly**

[Removal]

- Tilt the cab, then fasten the hoist attachment of crane **A** around bottom bracket **B** of the cab.



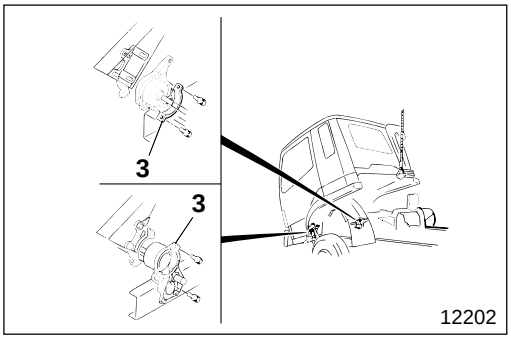
- Lower the cab until cab stay ***1** is no longer locked.
- Remove clevis pin **4** of cab stay ***1**, and separate the cab stay from the cab.



- Before removing torsion bar arm RH **6**, LH **8**, make alignment marks **C** across the torsion bar arm, cab hinge bracket ***5**, and gear box bracket ***4**.
  Remove the torsion bar arm by lifting up the cab with the crane until the torsion bar arm separates from torsion bar support **D**. If necessary, remove the torsion bar support first.

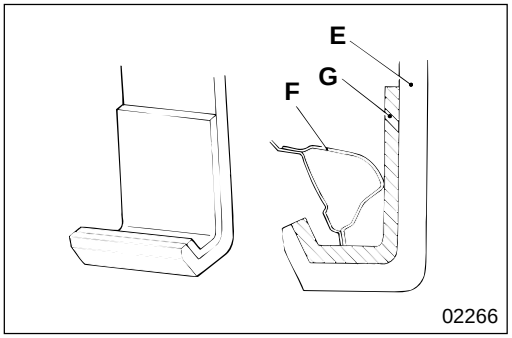
WARNING⚠

- **You must pay close attention to the tilt angle when tilting the cab. It is very dangerous to tilt the cab excessively because it will topple over.**
- **Lower the cab as soon as the torsion bar arm has been removed.**



- When you remove cab hinge cap **3**, tilt the cab only by the barest minimum needed to carry out the work.

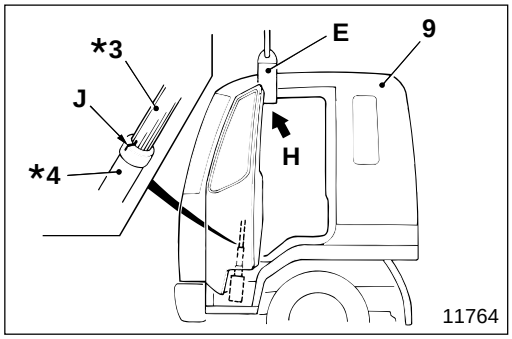
REMOVAL AND INSTALLATION OF CAB



- Set up hoist attachment **E** for the cab as illustrated.

CAUTION⚠

- **Make sure when you set up hoist attachment E that it is capable of lifting cab assembly 9 which weighs approximately 440 kg {970 lb}.**
- **Make sure you install rubber G on hoist attachment E to prevent cab roof F being deformed when the cab is lifted.**



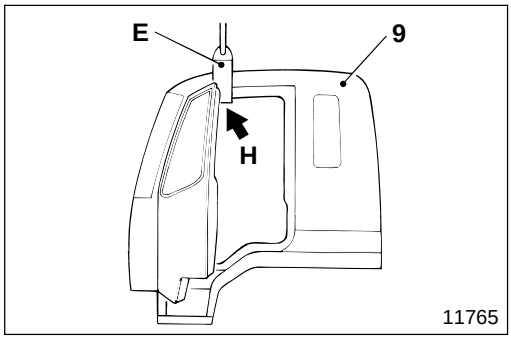
- Mount hoist attachment **E** at center-of-gravity point **H** of cab assembly **9**. Verify the position at which the cab can be lifted horizontally when the cab is lifted slightly.
- Slowly lift cab assembly **9** straight up, and finish lifting when steering yoke ***3** is pulled out from steering shaft ***4**. Make alignment mark **J** before the steering yoke is pulled out from the steering shaft.

WARNING⚠

Never get under cab assembly 9 when it is being lifted.

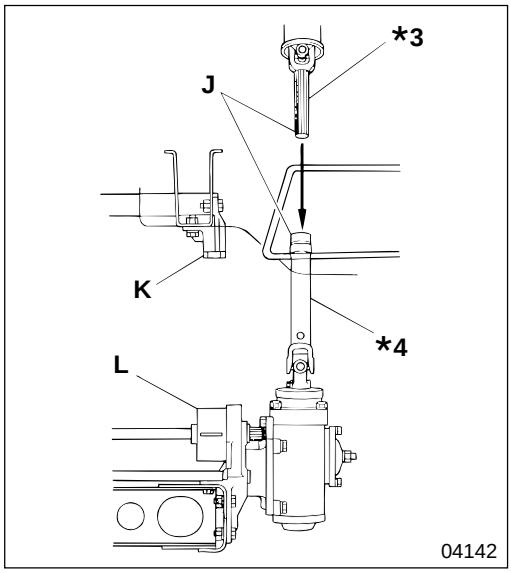
CAUTION⚠

Make sure, when lifting cab assembly 9, that the wiring harness, cable, hoses, etc. are completely disconnected when the cab is lifted slightly.

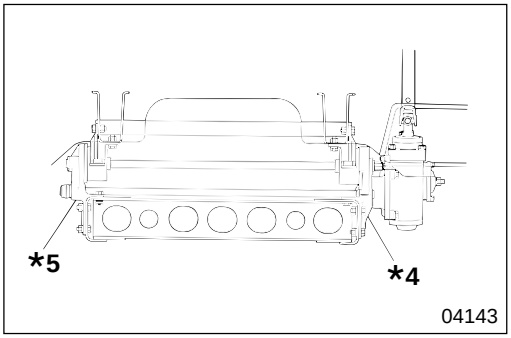


[Installation]

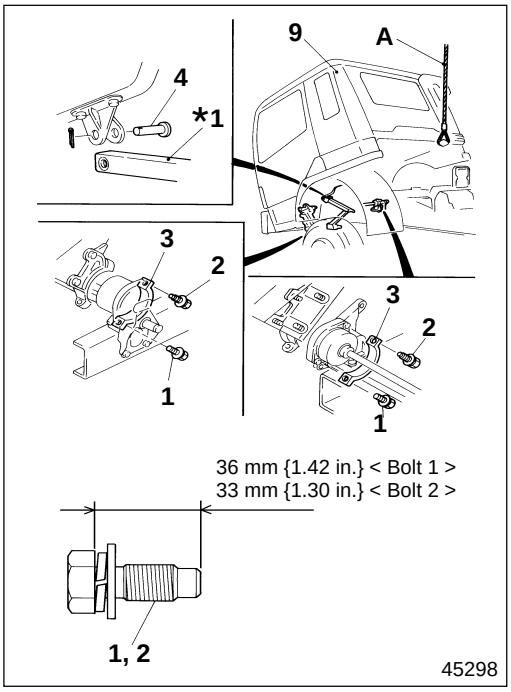
- Mount hoist attachment **E** at center-of-gravity point **H** of cab assembly **9**.



- Slowly lower cab assembly **9** horizontally to insert steering yoke ***3** into steering shaft ***4**, aligning alignment mark **J**.
- Install cab hinge upper bracket **K** aligning it to cab hinge cushion **L**.



- Check if the cab is installed one-sided in relation to cab hinge bracket ***5** or gear box bracket ***4**, and correct as necessary.



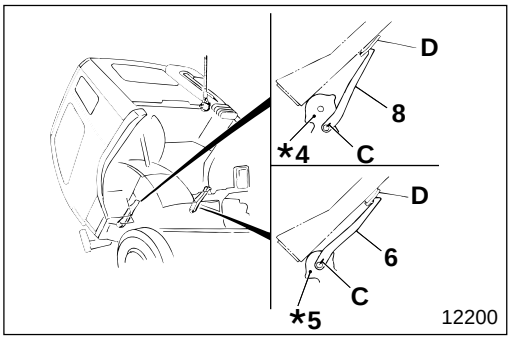
- Securely support the cab on crane **A** to tilt cab assembly **9**.
- Using crane **A** tilt cab assembly **9**, and install cab hinge cap **3** and clevis pin **4**.

WARNING

You must pay close attention to the tilt angle when tilting cab assembly 9 using crane A. It is very dangerous to tilt the cab excessively because it will topple over.

NOTE

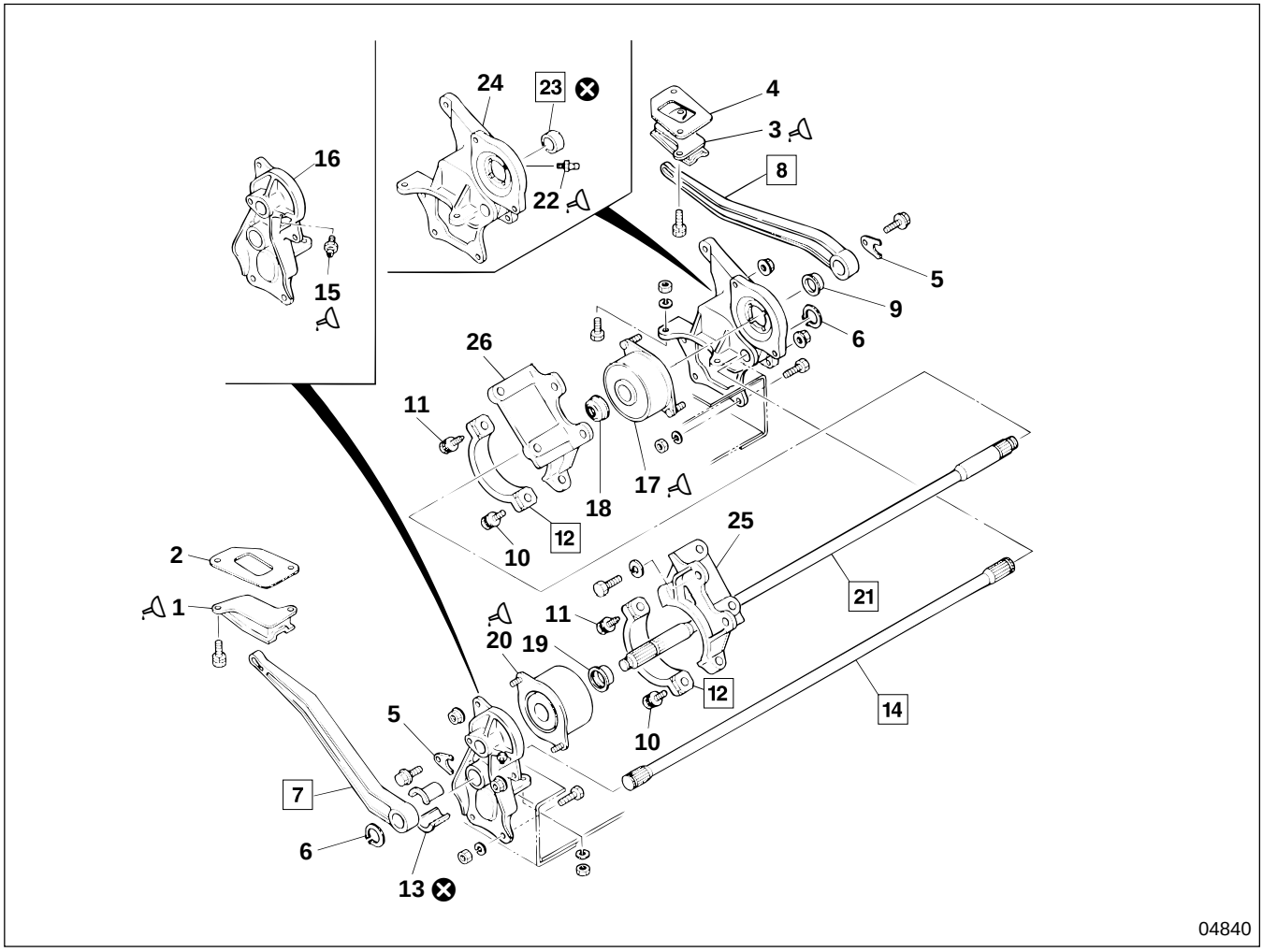
The cab hinge cap mounting bolts have different shapes, so pay close attention when you install them.



- Install torsion bar arm LH **6**, RH **8** aligning alignment marks **C** on the torsion bar arm, cab hinge bracket ***5**, and gear box bracket ***4**.
  If torsion bar support **D** has been removed, reinstall it after installing the torsion bar arm.

- After installation, tilt cab assembly **9** slowly until it is completely tilted, securely lock the cab stay, then detach the cab from crane **A**.

FRONT CAB MOUNTING



● **Disassembly sequence**

1 Torsion bar support, RH
2 Shim (for adjustment)
3 Torsion bar support, LH
4 Shim (for adjustment)
5 Stopper plate
6 Snap ring
7 Torsion bar arm, RH
8 Torsion bar arm, LH
9 Dust cover
10 Bolt
11 Bolt
12 Cab hinge cap
13 Bushing
14 Lower torsion bar
15 Grease nipple
16 Cab hinge bracket
17 Cab hinge cushion
18 Dust cover
19 Dust cover
20 Cab hinge cushion
21 Upper torsion bar
22 Grease nipple
23 Bushing
24 Gear box bracket
25 Cab hinge upper bracket, RH
26 Cab hinge upper bracket, LH

⊗ : Non-reusable parts

NOTE

Do not remove bushing 23 unless it is faulty.

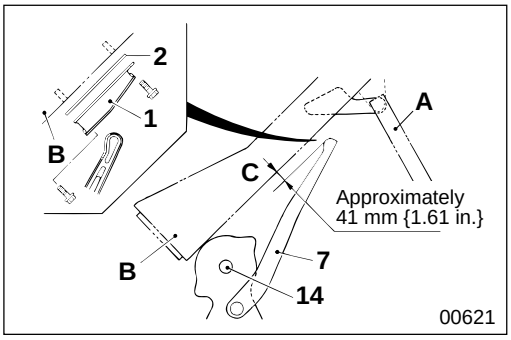
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

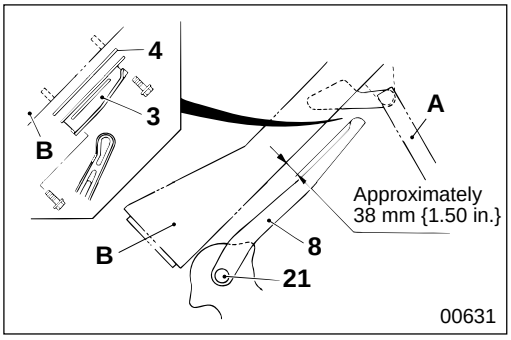
Location	Points of application	Kinds	Quantity
1	Torsion bar arm at the area which receives torsion bar support RH	Chassis grease [NLGI No. 1 (Ca soap)]	As required
3	Torsion bar arm at the area which receives torsion bar support LH	Chassis grease [NLGI No. 1 (Ca soap)]	As required
15, 22	Supply via grease nipple	Chassis grease [NLGI No. 1 (Ca soap)]	As required
17, 20	Interior of cab hinge cushion	Chassis grease [NLGI No. 1 (Ca soap)]	As required

◆ Service procedure



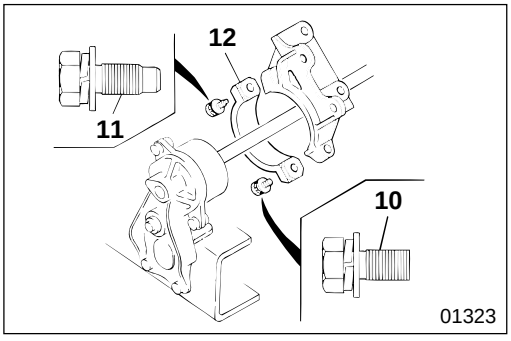
7 Installation of torsion bar arm RH

- Tilt up the cab and support using cab stay **A**.
- Install torsion bar arm RH **7** to lower torsion bar **14** so that clearance **C** between main sill **B** of the cab and the torsion bar arm conforms to the value as illustrated.
- If clearance **C** deviates from the value as illustrated, adjust using shim **2**. The shim must be installed between torsion bar support RH **1** and the cab when torsion bar support RH is installed.



8 Installation of torsion bar arm LH

- Tilt up the cab and support using cab stay **A**.
- Install torsion bar arm LH **8** to lower torsion bar **21** so that clearance **C** between main sill **B** of the cab and the torsion bar arm conforms to the value as illustrated.
- If clearance **C** deviates from the value as illustrated, adjust using shim **4**. The shim must be installed between torsion bar support LH **3** and the cab when torsion bar LH is installed.

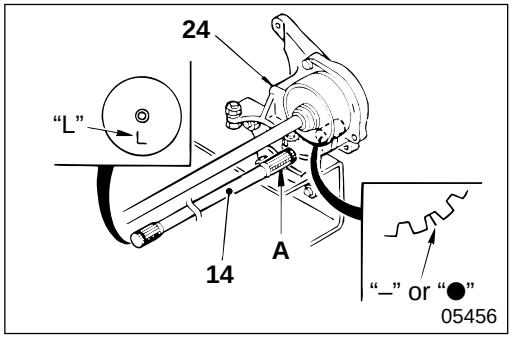


12 Installation of cab hinge cap

NOTE

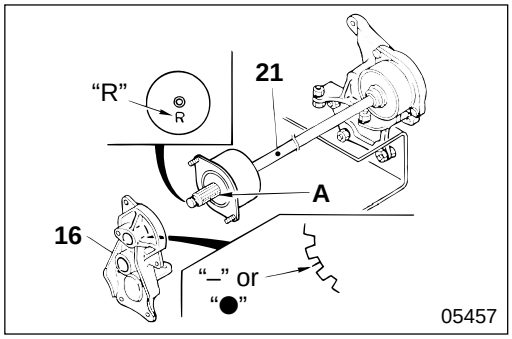
Bolts 10, 11 have different shapes, so pay close attention when you install them.

FRONT CAB MOUNTING



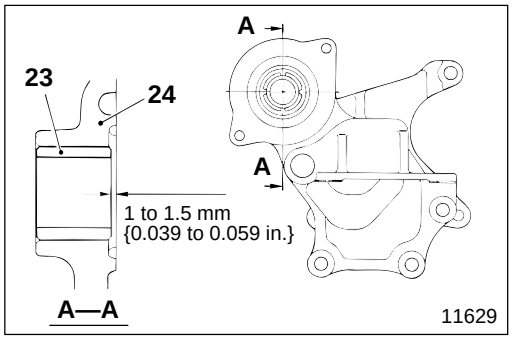
14 **Installation of lower torsion bar**

Install lower torsion bar **14** in gear box bracket **24** in the direction as illustrated. At this point, align white paint mark **A** on the torsion bar with alignment mark "–" or "●" on the gear box bracket.



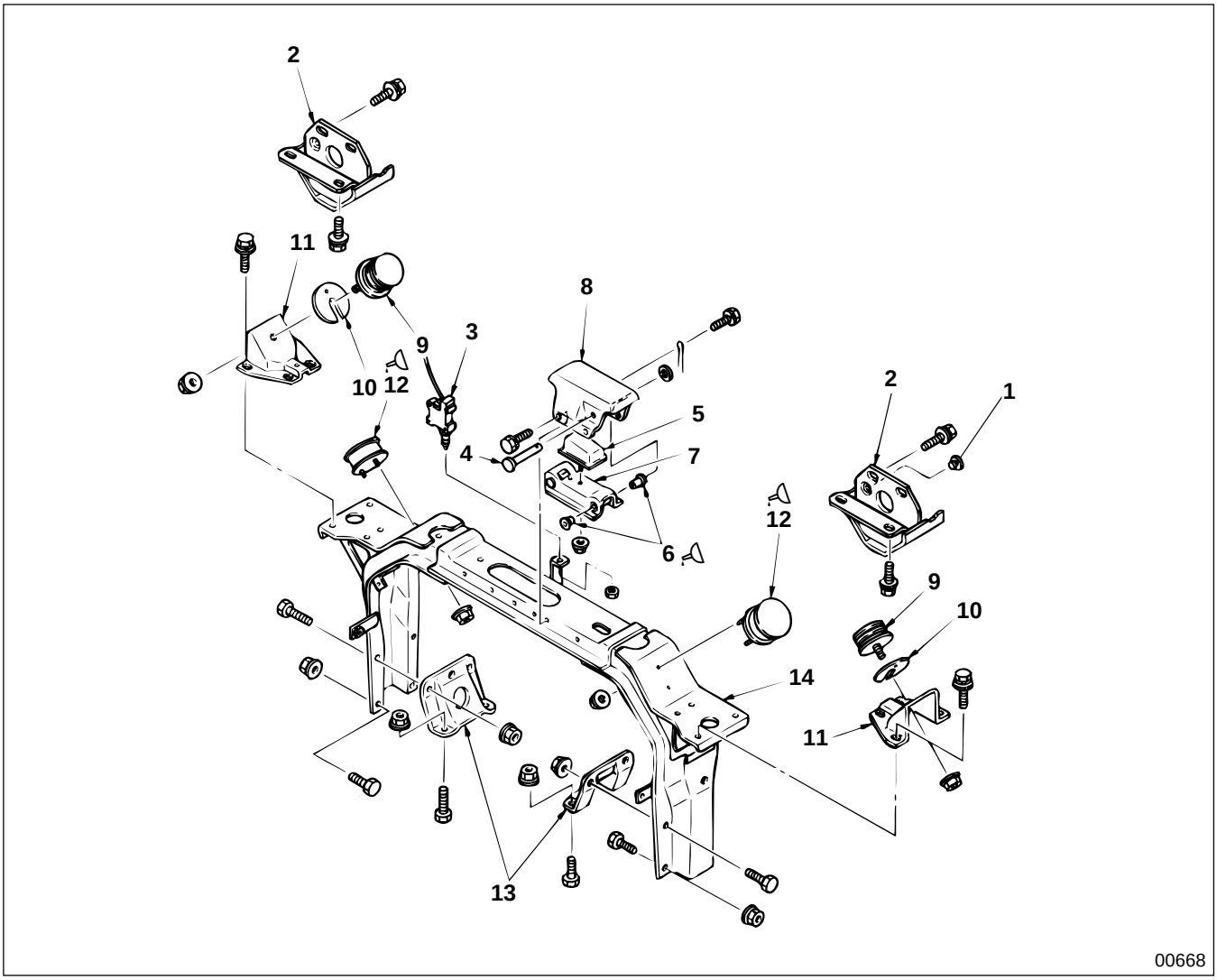
21 **Installation of upper torsion bar**

Install upper torsion bar **21** to cab hinge bracket **16** in the direction as illustrated. At this point, align white paint mark **A** on the torsion bar with alignment mark "–" or "●" on the cab hinge bracket.



23 **Installation of bushing**

Install bushing **23** in gear box bracket **24** so that the illustrated dimension is obtained.



● **Disassembly sequence**

1 Pad
2 Bottom bracket
3 Cab tilt lock switch Gr 54
4 Clevis pin
5 Rebound cushion
6 Bushing
7 Hook pin bracket
8 Hook hinge bracket
9 Compression cushion
10 Shim
11 Mounting bracket
12 Side cushion
13 Cab bridge stiffener
14 Cab bridge

● **Assembly sequence**

Follow the disassembly sequence in reverse.

● **Inspection and adjustment after installation**

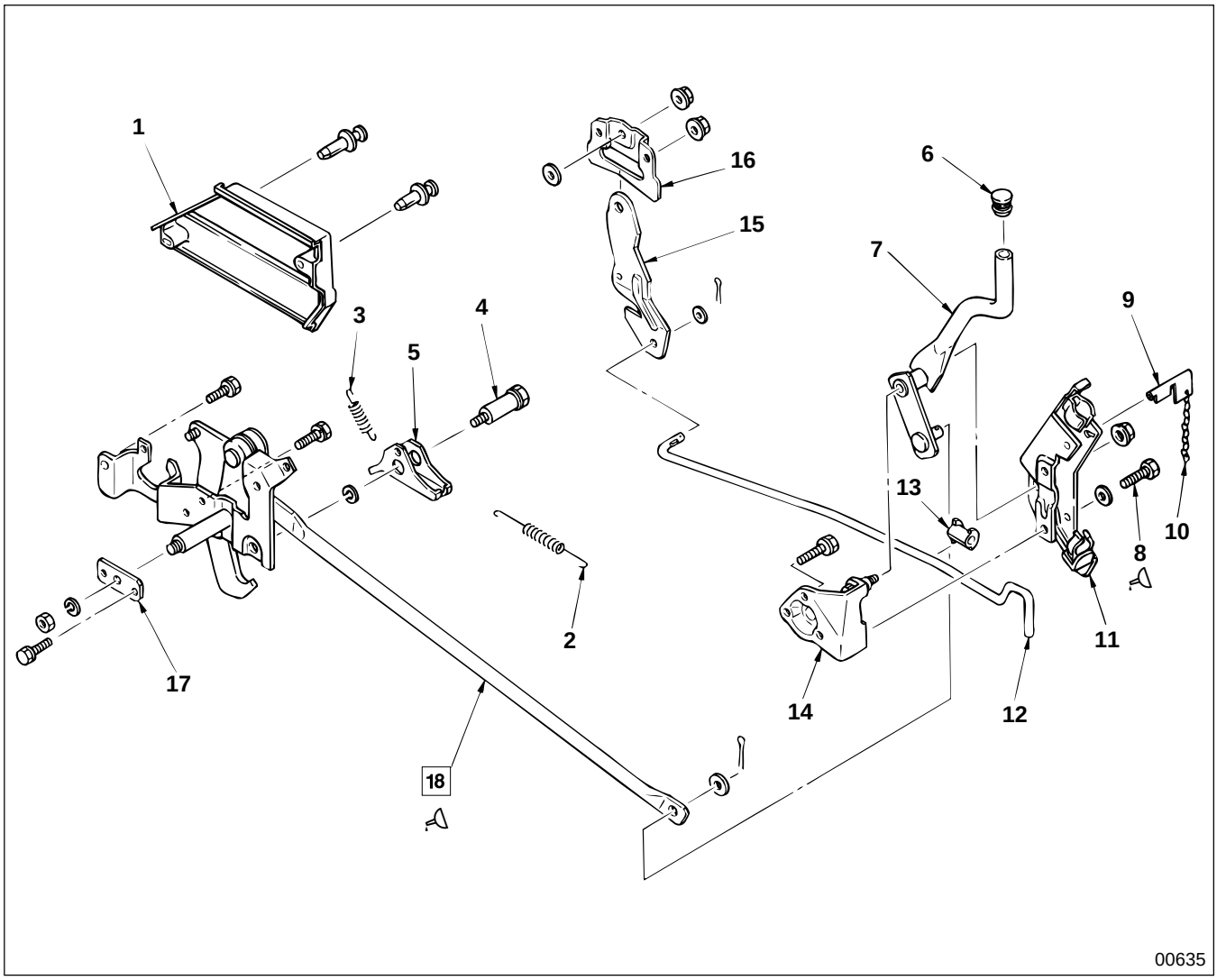
P42-26

Lubricant

Location	Points of application	Kinds	Quantity
6	Contact area of bushing and hook hinge bracket	Chassis grease [NLGI No. 1 (Ca soap)]	As required
12	Contact area of side cushion with bottom bracket	Molybdenum disulfide grease [NLGI No. 2 (Li soap)] (Molycoat BR2 Plus)	As required

CAB TILT LINK

Cab Tilt Link



● **Disassembly sequence**

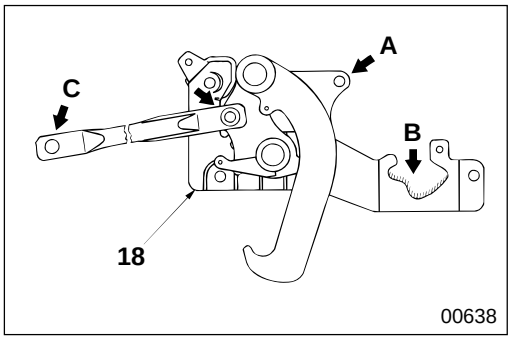
1 Main hook cover
2 Return spring
3 Return spring
4 Lock lever bolt
5 Lock lever
6 Plug
7 Hook control lever
8 Bolt
9 Key
10 Chain
11 Hook control lever bracket
12 L-lever rod
13 Sleeve
14 Hinge bracket
15 L-lever
16 L-lever bracket
17 Holder plate
18 Main hook assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant

Location	Points of application	Kinds	Quantity
8	Thread area of bolt (Hook control lever bracket mounting)	THREEBOND 1401 or LOCTITE 271	As required
18	Roller area of main hook assembly and friction area of roller	Chassis grease [NLGI No. 1 (Ca soap)]	As required
	Eye sections of main hook assembly control rod	Chassis grease [NLGI No. 1 (Ca soap)]	As required



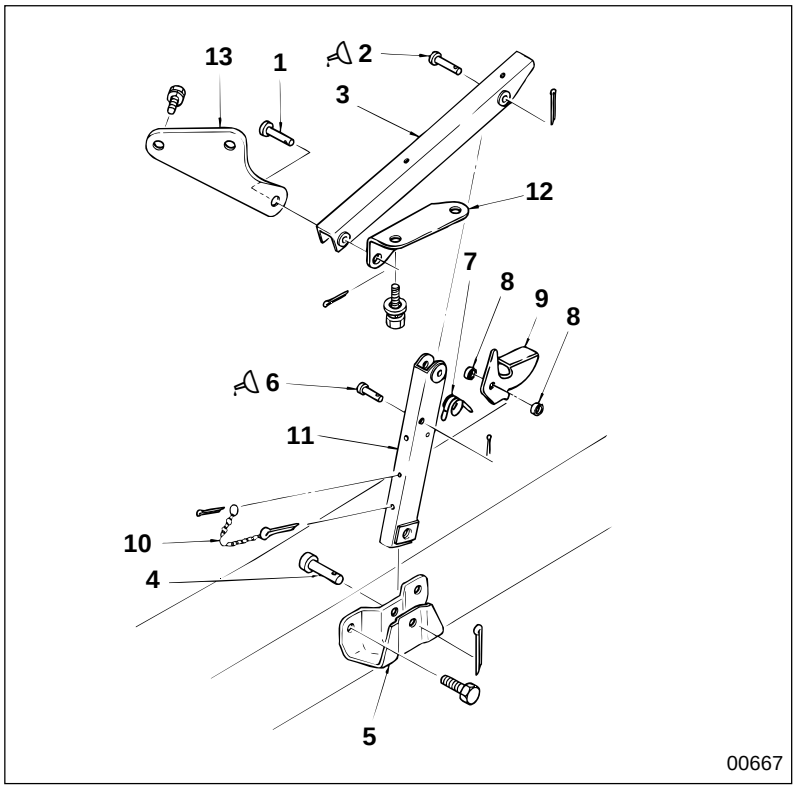
◆ Service procedure

18 **Points of greasing on main hook assembly**

A : Roller area
B : Roller frictional area
C : Eye sections at control rod ends

CAB TILT LINK

Cab Stay



● **Disassembly sequence**

1 Clevis pin
2 Clevis pin
3 Stay
4 Clevis pin
5 Lower bracket
6 Clevis pin
7 Return spring
8 Spacer
9 Locking latch
10 Chain
11 Stay
12 Upper bracket
13 Upper bracket

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING⚠

You must use a hoist to support the cab when you remove the cab stay assembly.

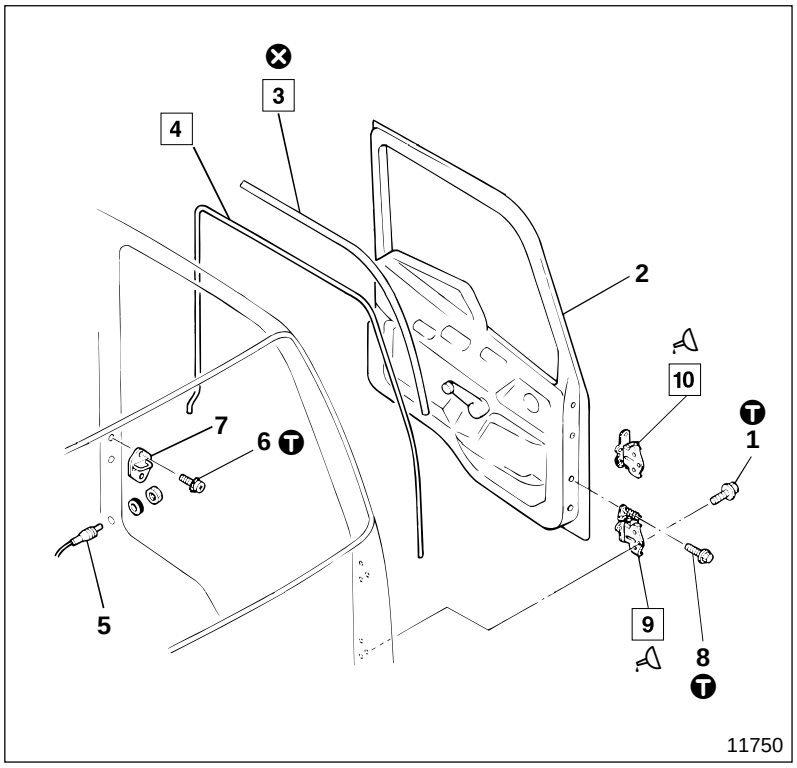
Lubricant

Location	Points of application	Kinds	Quantity
2, 6	Clevis pin	Chassis grease [NLGI No. 1 (Ca soap)]	As required

M E M O

DOOR

Door Hinge and Striker



● **Removal sequence**

1 Bolt
2 Door assembly P42-48
3 Roof side weatherstrip
4 Door inner weatherstrip
5 Door switch
6 Screw
7 Striker
8 Bolt
9 Lower hinge
10 Upper hinge

⊗ : Non-reusable parts

● **Inspection and adjustment after installation** **P42-28**

● **Installation sequence**

Follow the removal sequence in reverse.

Ⓣ Tightening torque

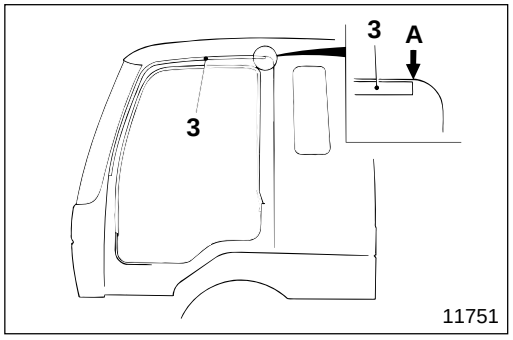
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (Door assembly mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—
6	Screw (Striker mounting)	9 to 14 {6.5 to 10.1, 0.9 to 1.4}	—
8	Bolt (Lower and upper hinge mounting)	17 to 26 {12 to 19, 1.7 to 2.6}	—

Lubricant

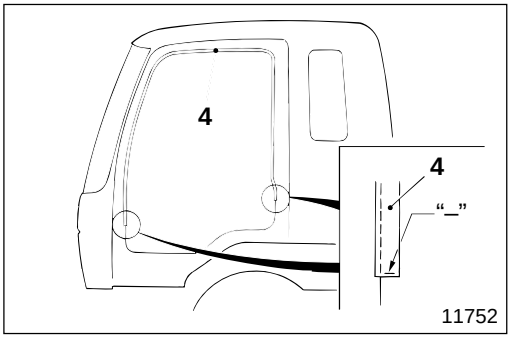
Location	Points of application	Kinds	Quantity
9, 10	Rotating and friction areas of lower hinge and upper hinge	Chassis grease [NLGI No.1 (Ca soap)]	As required

◆ Service procedure



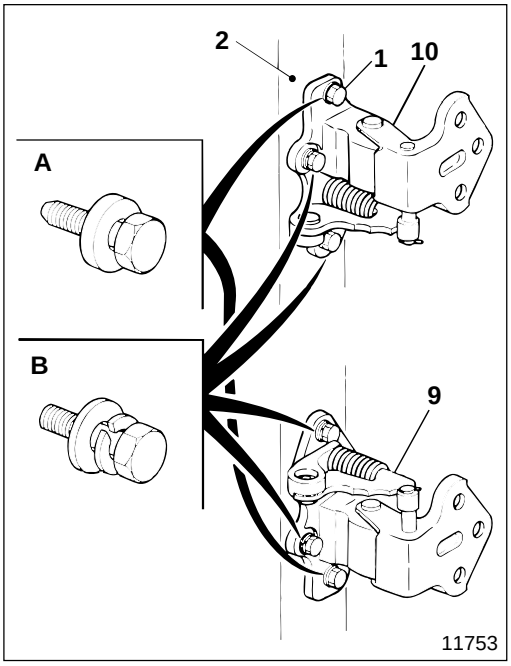
3 **Installation of roof side weatherstrip**

Install roof side weatherstrip **3** on the cab starting from point **A** as illustrated.



4 **Installation of door inner weatherstrip**

Install door weatherstrip **4** on the cab, aligning both ends of the weatherstrip with alignment marks "–" on the cab side.

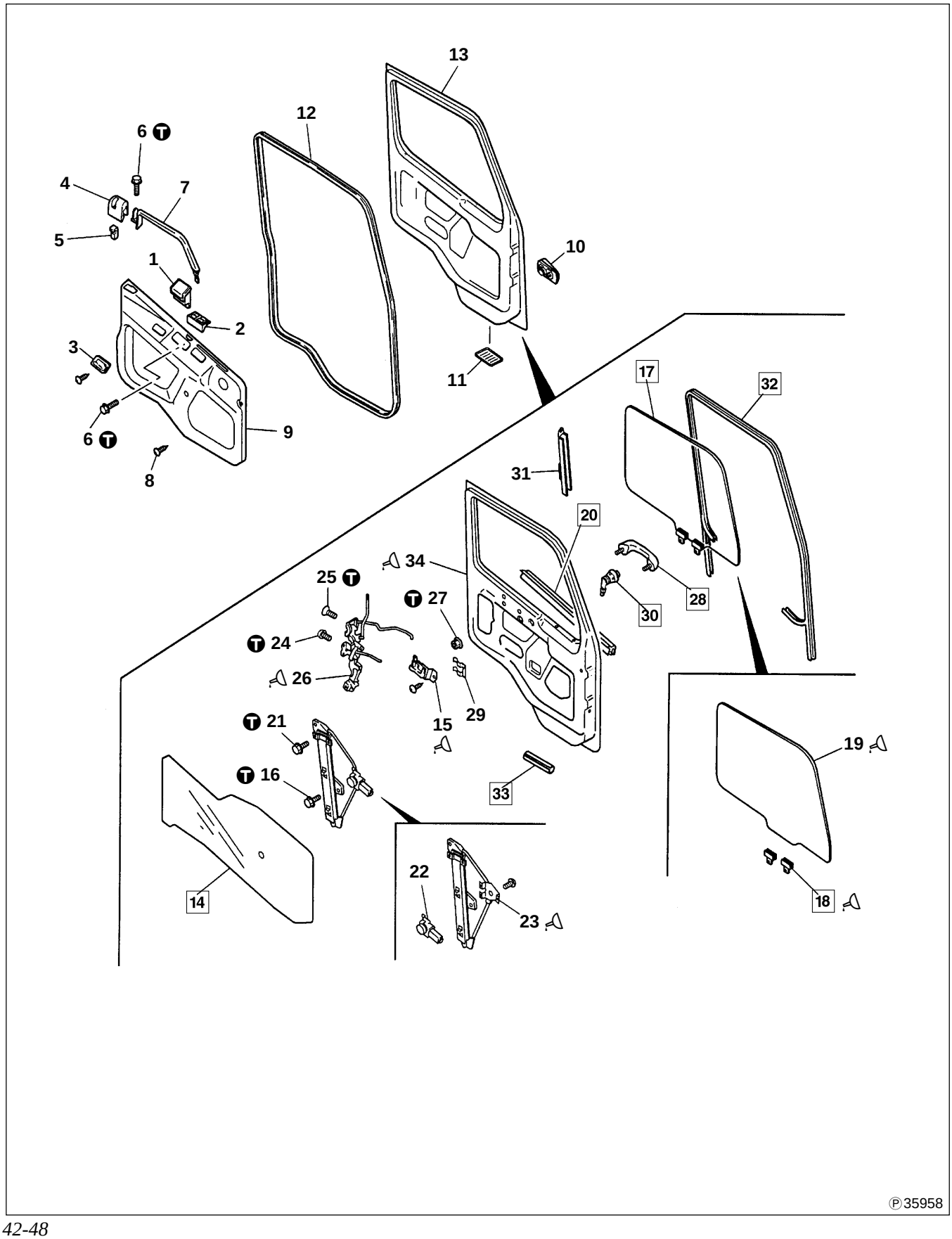


9 **10** **Installation of lower and upper hinges**

- Two types of bolt **1** are provided to install lower hinge **9** and upper hinge **10** to door assembly **2**:
  A : Bolt with built-in washer
  B : Bolt with built-in washer and spring washer
- Bolt **A** with built-in washer comes in two types; in one type the washer is welded to lower hinge **9** and upper hinge **10**, and in the other it is not welded to lower hinge **9** and upper hinge **10**.
- If the washers are not welded to the hinges, bolt **B** with built-in washer and spring washer can be used in place of bolt **A** with the built-in washer.

DOOR

Door Assembly



● **Disassembly sequence**

1 Ashtray
2 Power window switch Gr 54
3 Inside handle cover
4 Door lock knob cover
5 Door lock knob
6 Bolt
7 Door bar
8 Screw
9 Door trim assembly
10 Front side turn signal lamp Gr 54
11 Step lamp cover
12 Weather strip
13 Door panel assembly
14 Waterproof cover
15 Inside handle
16 Bolt
17 Door glass assembly
18 Glass holder
19 Door glass
20 Door belt line molding
21 Bolt
22 Power window motor Gr 54
23 Regulator & rail assembly
24 Screw
25 Screw
26 Door lock actuator Gr 54
27 Nut
28 Outside handle
29 Clip
30 Door lock cylinder
31 Lower sash
32 Run channel
33 Cushion rubber
34 Door panel

CAUTION ⚠

Do not remove weather strip 12, glass holder 18 and cushion rubber 33 unless abnormalities are found.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Ⓣ Tightening torque

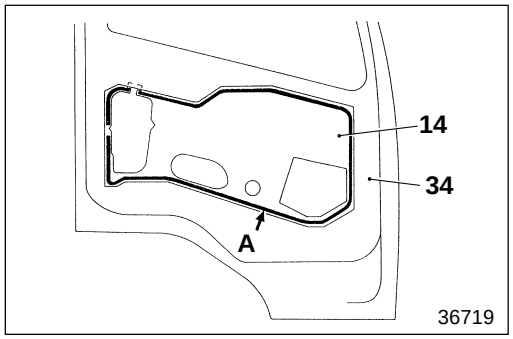
Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
6	Bolt (Door cover mounting)	9 to 14 {65 to 100, 0.9 to 1.4}	—
16	Bolt (Door glass assembly mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
21	Bolt (Regulator & rail assembly mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
24	Screw (Door lock actuator mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
25	Screw (Door lock actuator mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—
27	Nut (Outside handle mounting)	4 to 6 {29 to 43, 0.4 to 0.6}	—

Lubricant and/or sealant

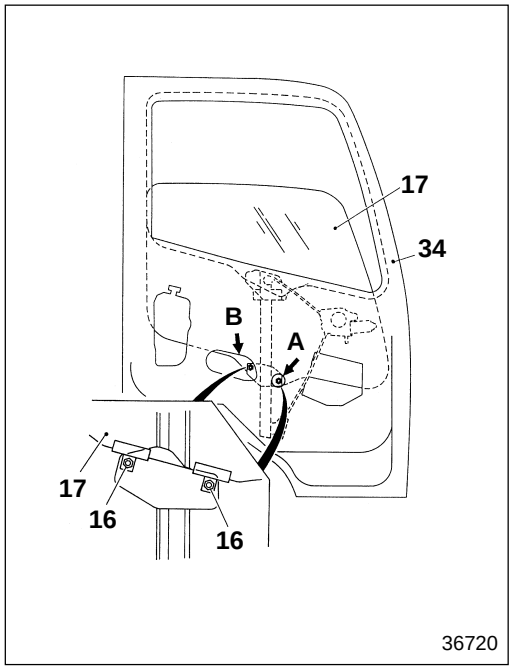
Location	Points of application	Specified lubricant and/or sealant	Quantity
15	Rotating surface of inside handle	Multipurpose grease [NGLI No.2 (Li soap)]	As required
18	Door glass mounting surface of glass holder	YH America Inc. M(RC-50KE) Primer	As required
19	Glass holder mounting surface of door glass	YH America Inc. G(MS-90) Primer	As required
	Glass holder mounting surface, 5 minutes after application of above primer	YH America Inc. WS-70FK Sealant (Urethame Base)	As required
23	Regulator sliding section of regulator & rail assembly	Dynamic GB	As required
26	Sliding surface of door lock actuator	Multipurpose grease [NGLI No.2 (Li soap)]	As required
34	Waterproof cover installation surface of door panel	Butyl tape	As required

◆ Service procedure



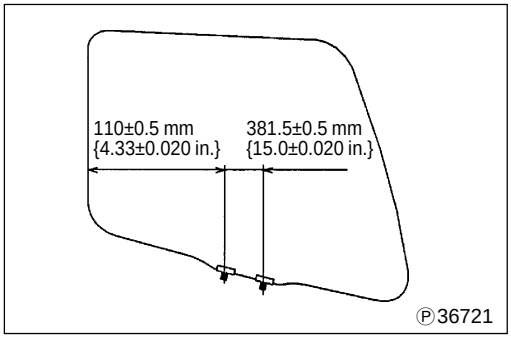
14 **Installation of waterproof cover**

- Apply butyl tape **A** to door panel **34**, as indicated in the illustration.
- Install waterproof cover **14** by pasting onto butyl tape **A**.



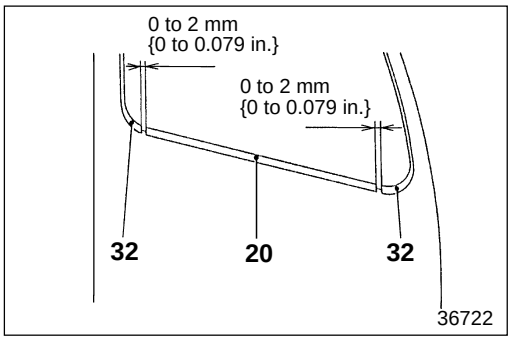
17 **Removal and installation of door glass assembly**

- Move door glass assembly **17** until bolts **16** of the door glass assembly become visible through holes **A** and **B** in the door panel **34**.
- While supporting door glass assembly **17** by hand, remove bolts **16**.
- Remove door glass assembly **17** through the open space in the door.
- To install, follow the removal procedure in reverse.



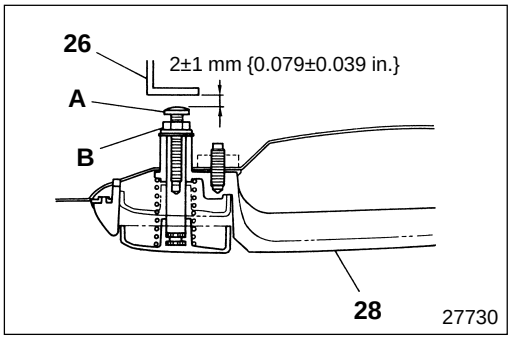
18 **Installation of glass holder**

Install glass holder **18** to door glass **19** at the location indicated in the illustration.



20 **Installation of door belt line molding**

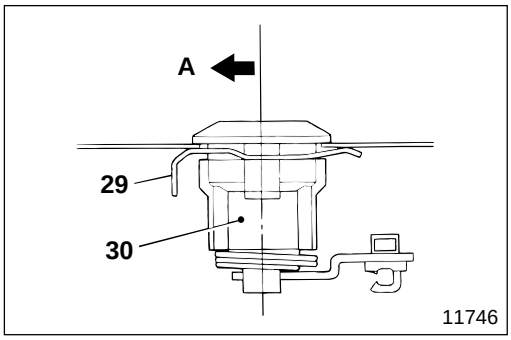
Install door belt line molding **20** so that gaps between the molding and run channel **32** are as indicated in the illustration.



28 **Installation of outside handle**

Turn push bolt **A** of outside handle **28** to adjust the gap between the push bolt and door actuator **26** as indicated in the illustration.

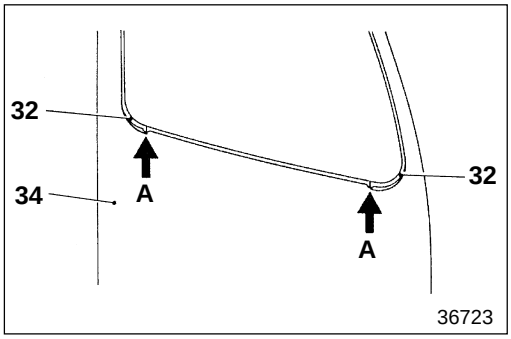
B : Lock nut



30 **Installation of door lock cylinder**

Install door lock cylinder **30** with clip **29** in the direction indicated in the illustration.

A : Vehicle front side

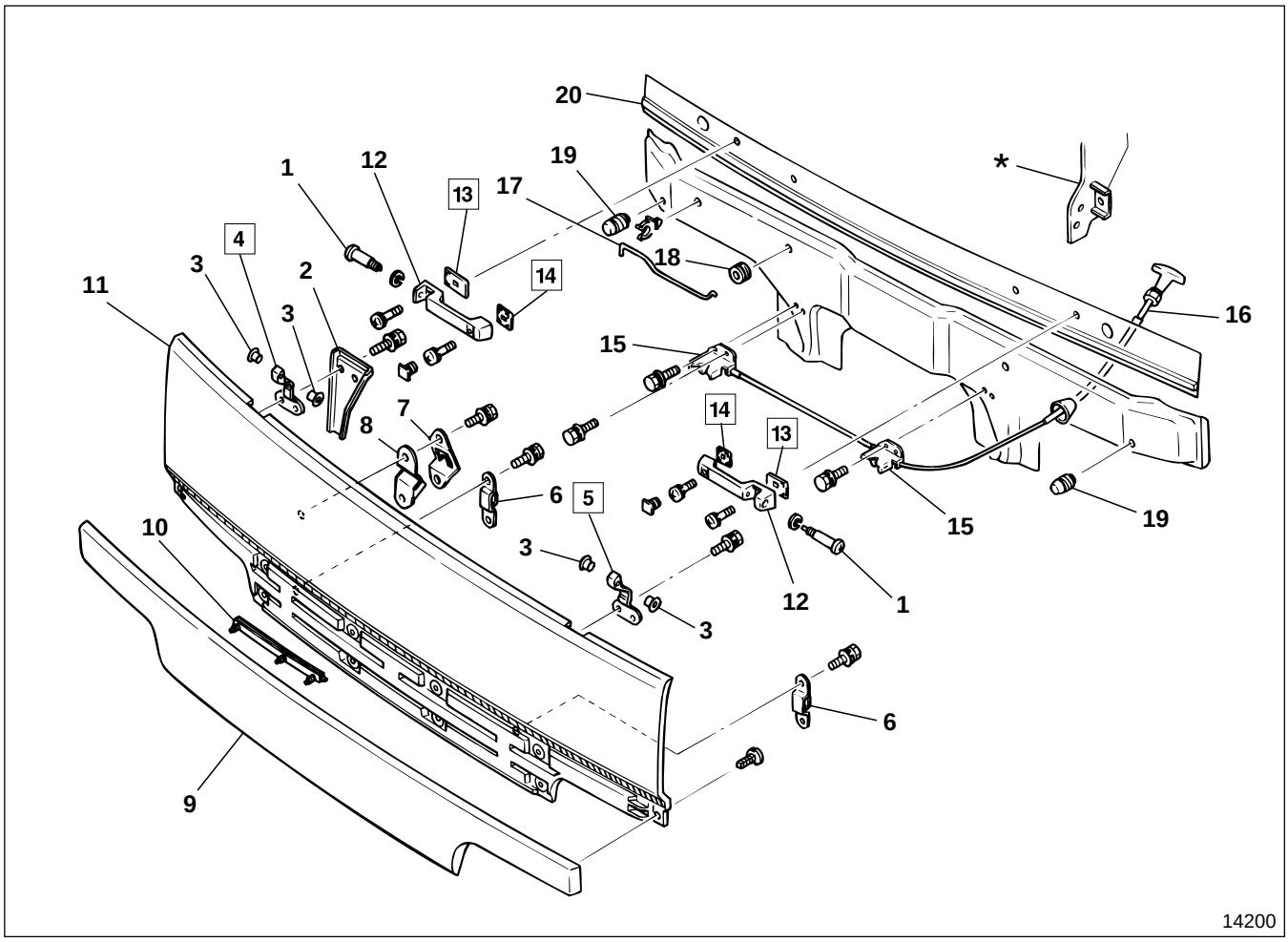


32 **Installation of run channel**

Install run channel **32** by aligning it with notches **A** on door panel **34**.

CAB EXTERIOR FITTING

Front Panel



● **Disassembly sequence**

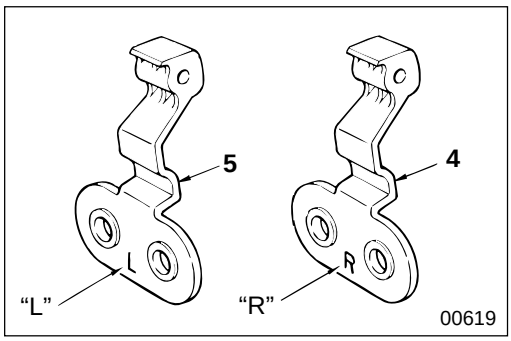
1 Front panel hinge pin
2 Splash shield plate
3 Bushing
4 Front panel hinge, RH
5 Front panel hinge, LH
6 Striker
7 Bracket A
8 Bracket B
9 Upper grille
10 Weather strip
11 Front panel
12 Front grip
13 Packing A
14 Packing B
15 Front panel latch
16 Front panel opener cable
17 Front panel support rod
18 Grommet
19 Bumper
20 Weatherstrip

***** : Brake pedal bracket

● **Assembly sequence**

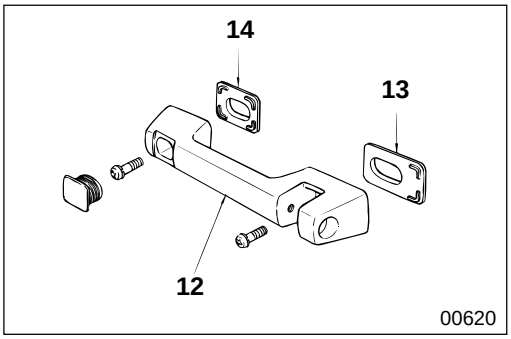
Follow the disassembly sequence in reverse.

◆ Service procedure



4 **5** **Installation of front panel hinge RH and LH**

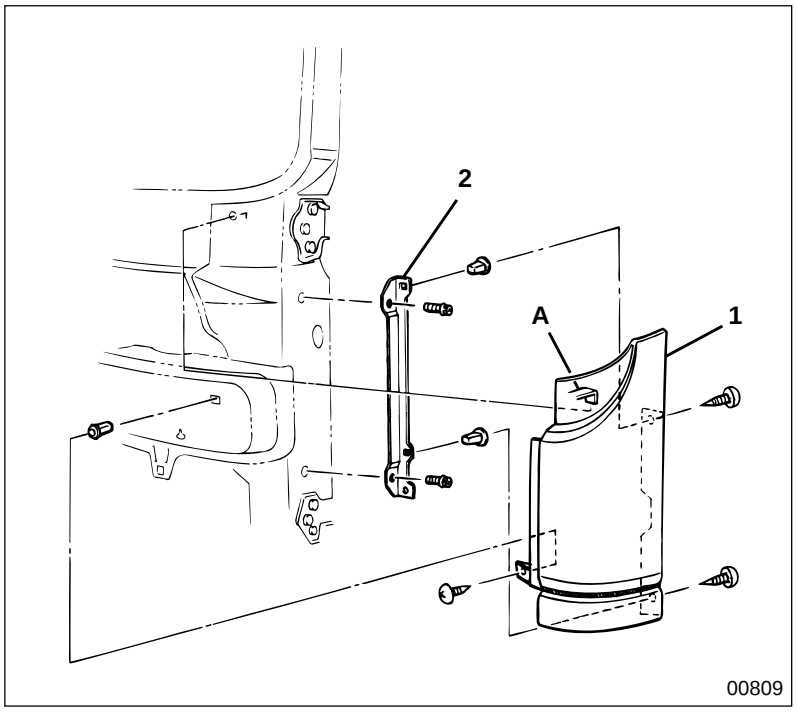
Front panel hinge RH **4**, LH **5** can be distinguished by "**L**" and "**R**" identification marks.



13 **14** **Installation of packing A and packing B**

Install packing **A 13** and packing **B 14** on front grip **12** in the direction as illustrated.

Front Corner Panel



● **Disassembly sequence**

1 Front corner panel
2 Corner panel bracket

A: Claw

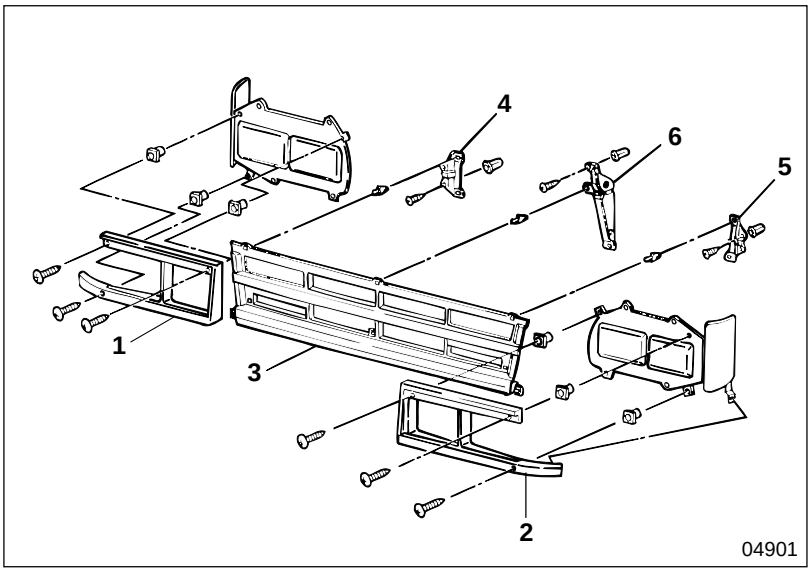
● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

The illustration shows the left side. The right side is symmetrical to the left side.

Front Grille



● **Disassembly sequence**

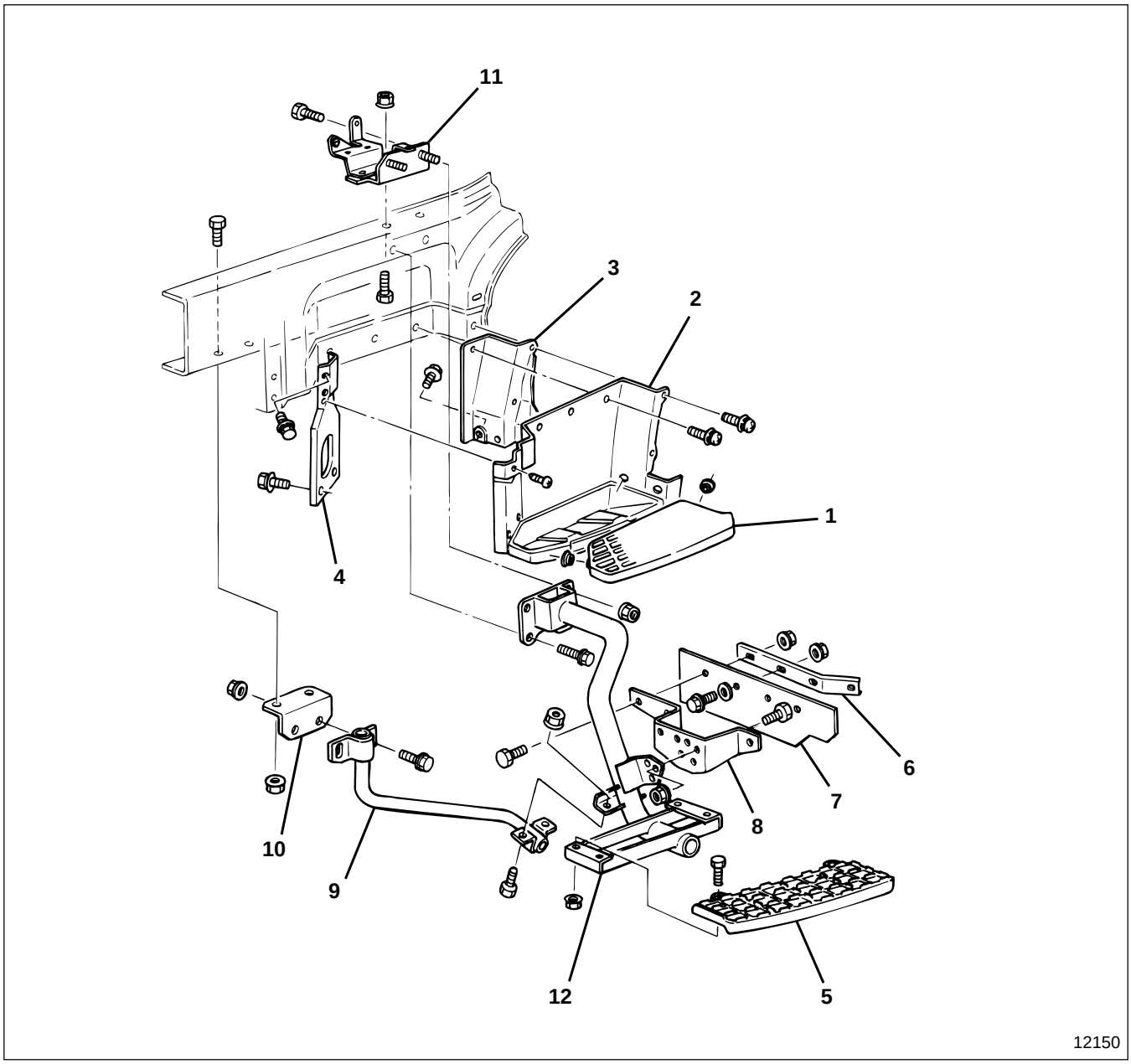
1 Headlamp bezel, RH
2 Headlamp bezel, LH
3 Front grille
4 Grille stay, RH
5 Grille stay, LH
6 Grille stay center

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAB EXTERIOR FITTING

Step



● **Removal sequence**

1 Upper step
2 Step wall
3 Step rear bracket
4 Step front bracket
5 Lower step
6 Apron support
7 Splash apron
8 Apron support
9 Step stay
10 Stay bracket
11 Step bracket
12 Step bracket assembly

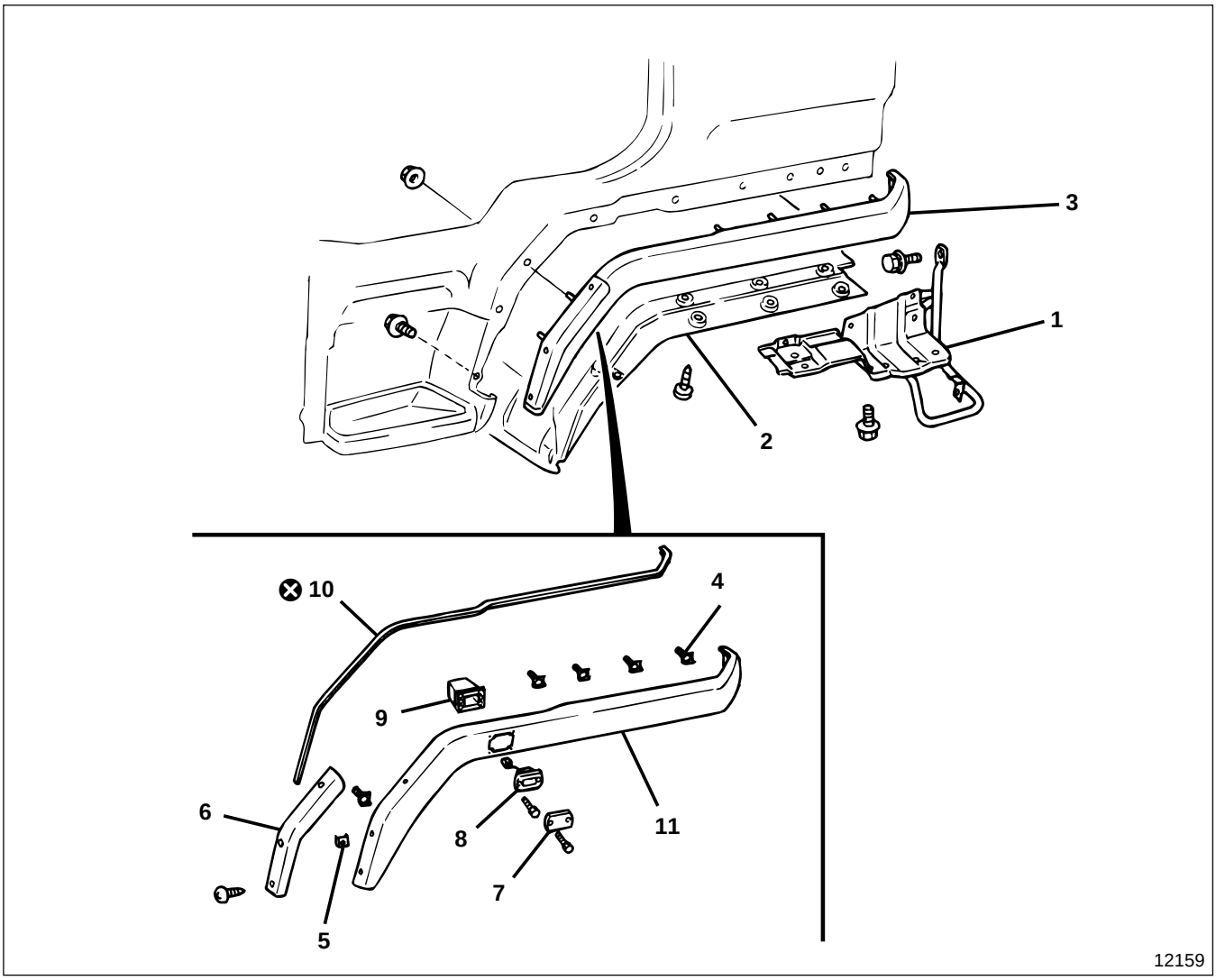
● **Installation sequence**

Follow the removal sequence in reverse.

NOTE

This illustration only shows the step for the left side; the same service procedure described above is used for the right side.

Fender



● **Disassembly sequence**

1 Cab tilt grip
2 Wheel arch cover
3 Fender assembly
4 Bolt plate
5 Nut plate
6 Fender protector
7 Lens
8 Side turn signal lamp Gr 54
9 Side turn signal lamp cover
10 Welt
11 Fender

⊗ : Non-reusable parts

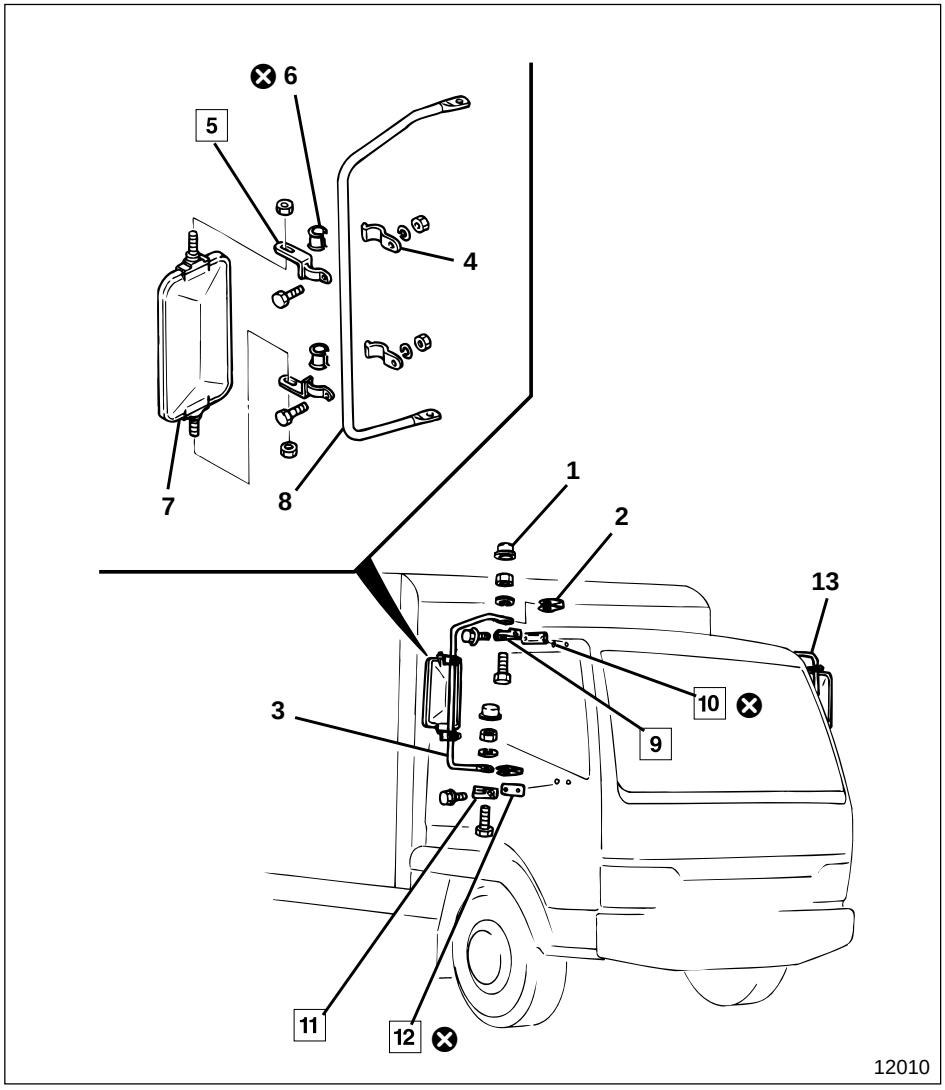
● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

The illustration shows the left side. The right side is symmetrical to the left side except that the right side does not have cab tilt grip 1.

MIRROR



● **Removal sequence**

1 Cap
2 U-washer
3 Outside mirror stay assembly, RH
4 Mirror holder B
5 Mirror holder
6 Packing
7 Outside mirror
8 Mirror stay
9 Mirror stay upper bracket
10 Packing
11 Mirror stay lower bracket
12 Packing
13 Outside mirror stay assembly, LH

⊗ : Non-reusable parts

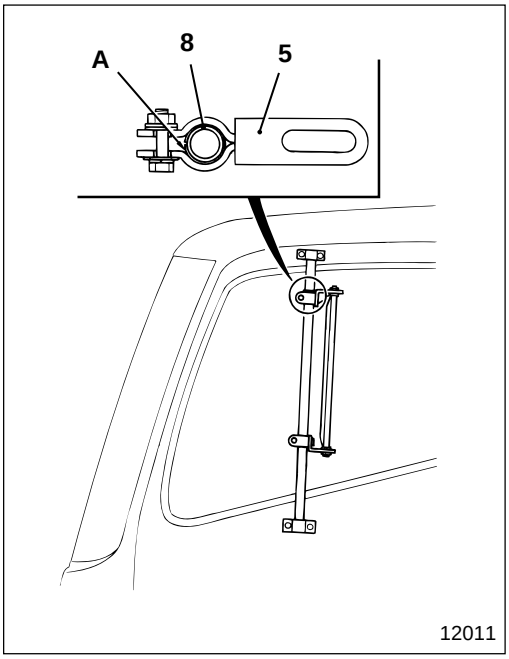
● **Installation sequence**

Follow the removal sequence in reverse.

NOTE

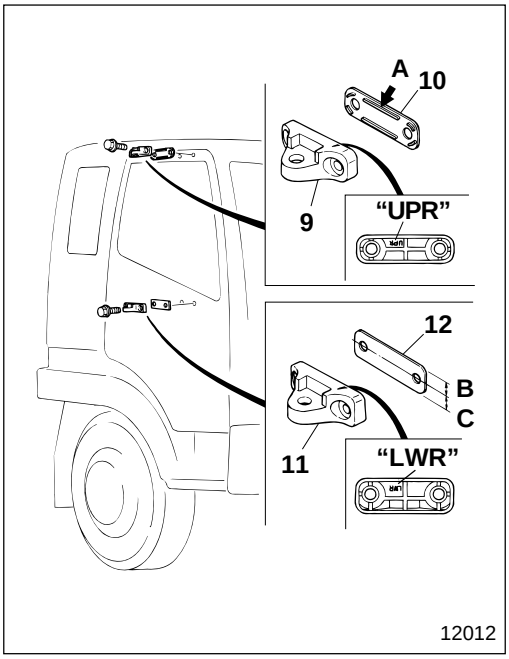
For outside mirror stay assembly LH 13, follow the same service procedure as for outside mirror stay assembly RH 3.

◆ Service procedure



5 **Installation of mirror holder**

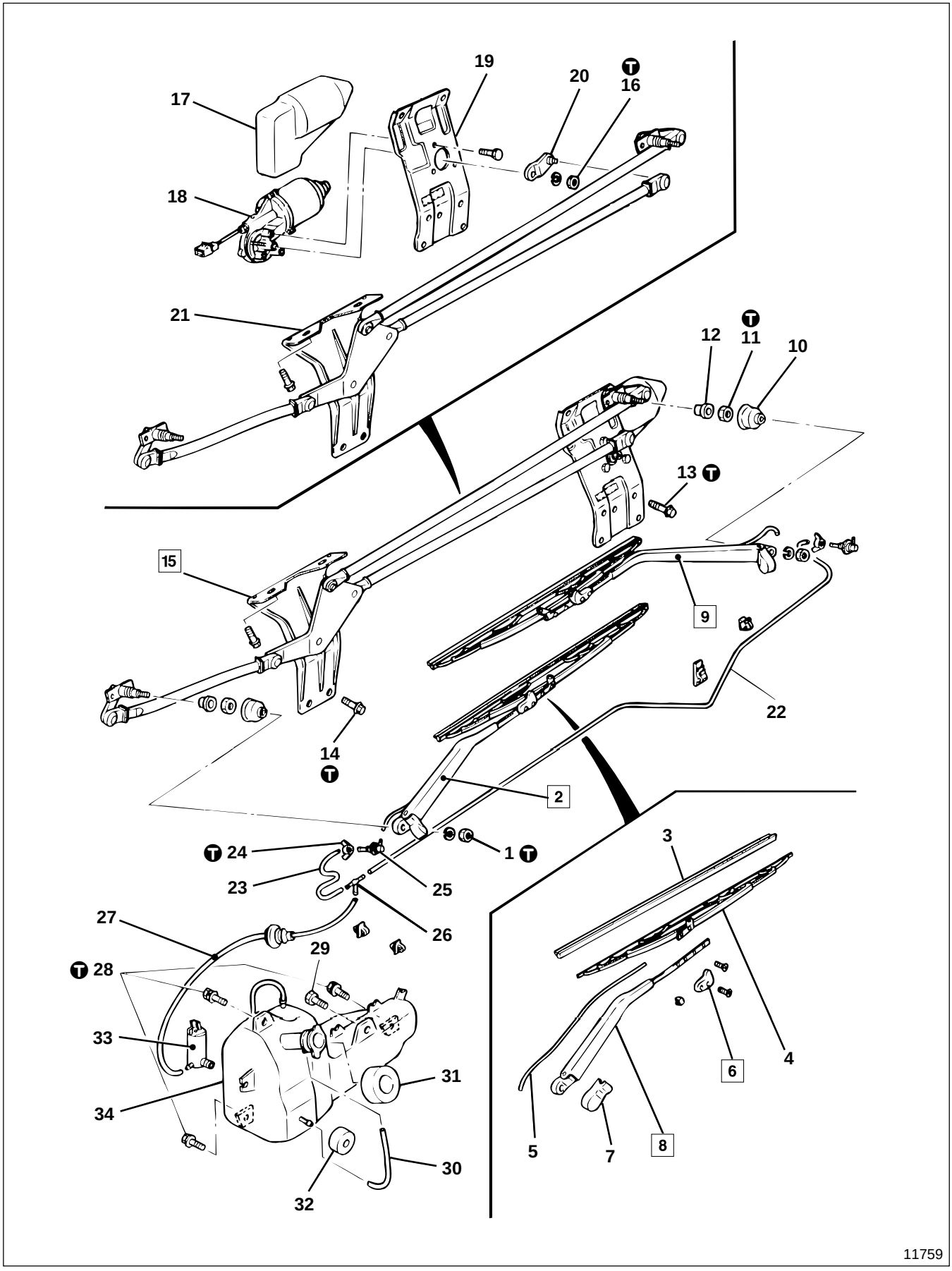
Install mirror holder **5** onto mirror stay **8** in the direction as illustrated.
A : Indent of mirror stay **8**



9 **to** **12** **Installation of mirror stay bracket and packing**

- "**UPR**" and "**LWR**" identification marks are marked on mirror stay upper bracket **9** and mirror stay lower bracket **11** respectively.
- Install indent **A** on packing **10**, facing mirror stay upper bracket **9**.
- Installation hole is offset on packing **12**.
  B : 13.8 mm {0.54 in.}
  C : 17.2 mm {0.68 in.}

WIPER AND WASHER



● **Disassembly sequence**

1 Nut
2 Wiper arm and blade assembly, RH
3 Blade rubber
4 Wiper blade
5 Washer hose
6 Washer nozzle
7 Head cover
8 Wiper arm
9 Wiper arm and blade assembly, LH
10 Pivot cap
11 Nut
12 Collar
13 Bolt
14 Bolt
15 Wiper link and motor assembly
16 Nut
17 Wiper motor cover
18 Wiper motor
19 Wiper motor bracket
20 Crank arm
21 Link assembly
21 Washer hose
23 Washer hose
24 Nut
25 Hose joint
26 Hose joint
27 Washer hose
28 Bolt
29 Bolt
30 Washer hose
31 Packing
32 Packing
33 Windshield washer motor
Gr 54
34 Washer tank

NOTE

Since crank arm 20 is installed corresponding to the wiper stop position of wiper motor 18, do not remove the crank arm unless it is faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

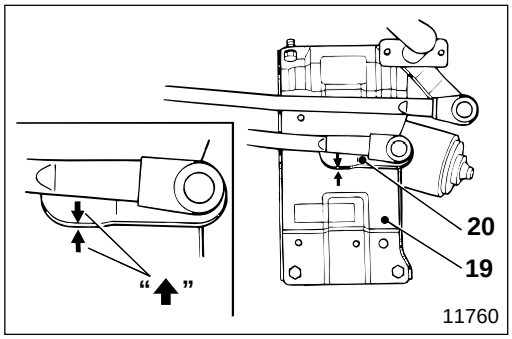
Location	Maintenance item	Standard value	Limit	Remedy
2, 9	Wiping force of wiper arm	7.65±0.49 N {1.72±0.11 lbf, 0.78±0.05 kgf}	—	Replace

Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

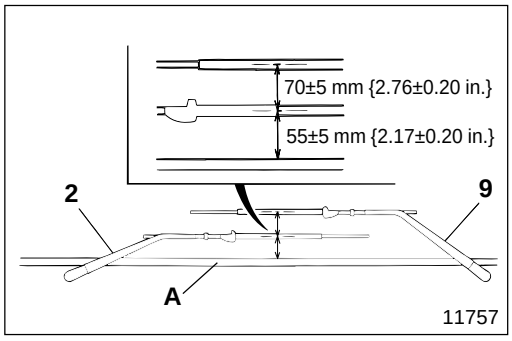
Location	Parts to be tightened	Tightening torque	Remarks
1	Nut (Wiper arm and blade assembly mounting)	17 to 23 {12.3 to 16.6, 1.7 to 2.3}	—
11	Nut (Wiper link and motor assembly mounting)	17 to 23 {12.3 to 16.6, 1.7 to 2.3}	—
13	Bolt (Wiper motor bracket mounting)	9 to 14 {6.5 to 10.1, 0.9 to 1.4}	—
14	Bolt (Link assembly mounting)	10 to 15 {7.2 to 10.8, 1.0 to 1.5}	—
16	Nut (Crank arm mounting)	16.7 to 23.5 {12.3 to 17.4, 1.7 to 2.4}	—
24	Nut (Hose joint connecting)	0.6 to 0.9 {0.43 to 0.65, 0.06 to 0.09}	—
28	Bolt (Washer tank mounting)	7.8 to 11.8 {5.8 to 8.7, 0.8 to 1.2}	—

◆ Service procedure

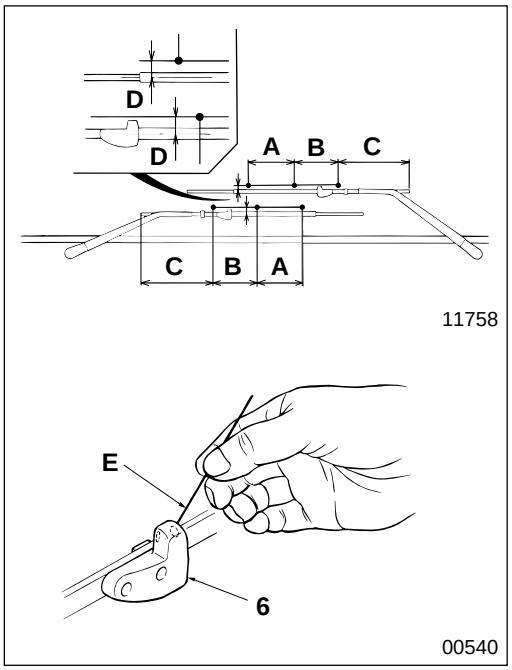


2 **9** **Installation of wiper arm and blade assembly**

- Align alignment marks "⬆" on wiper motor bracket **19** and crank arm **20**.



- Install wiper arm and blade assembly RH **2**, LH **9** so that dimensions from the edges of weatherstrip **A** are as illustrated.



6 **Inspection of washer nozzle**

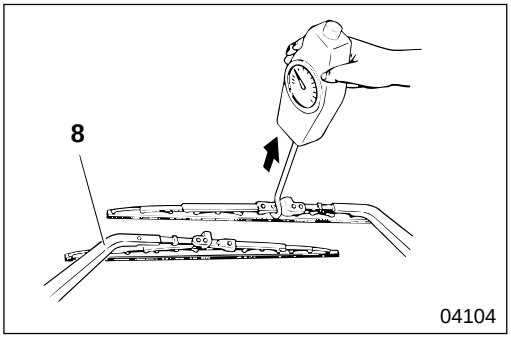
Make sure that washer fluid spreading target positions ("●" as illustrated) are within dimensions **A** to **D**.

A	130 mm {5.12 in.}
B	130 mm {5.12 in.}
C	210 mm {8.27 in.}
D	15 mm {0.59 in.}

If the washer fluid spreading target positions deviate from these dimensions, adjust the jet hole angle of washer nozzle **6** using wire **E**.

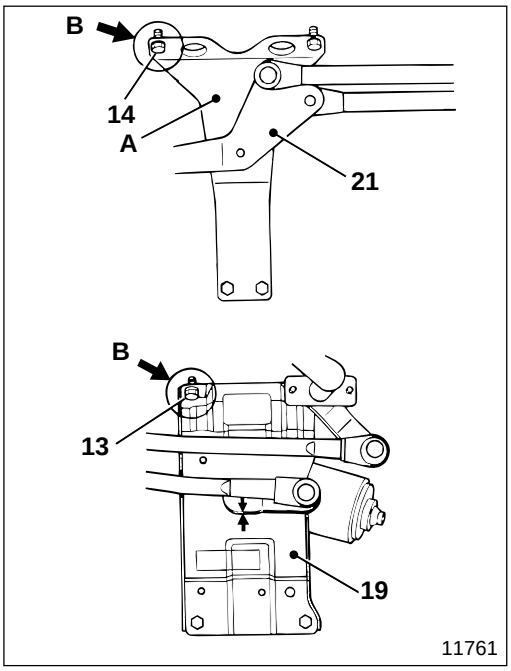
CAUTION⚠

Be careful not to damage the jet hole of washer nozzle 6 with wire E when adjusting the angle.



8 **Inspection of wiper arm**

If the measured value deviates from the standard value, replace wiper arm **8**.

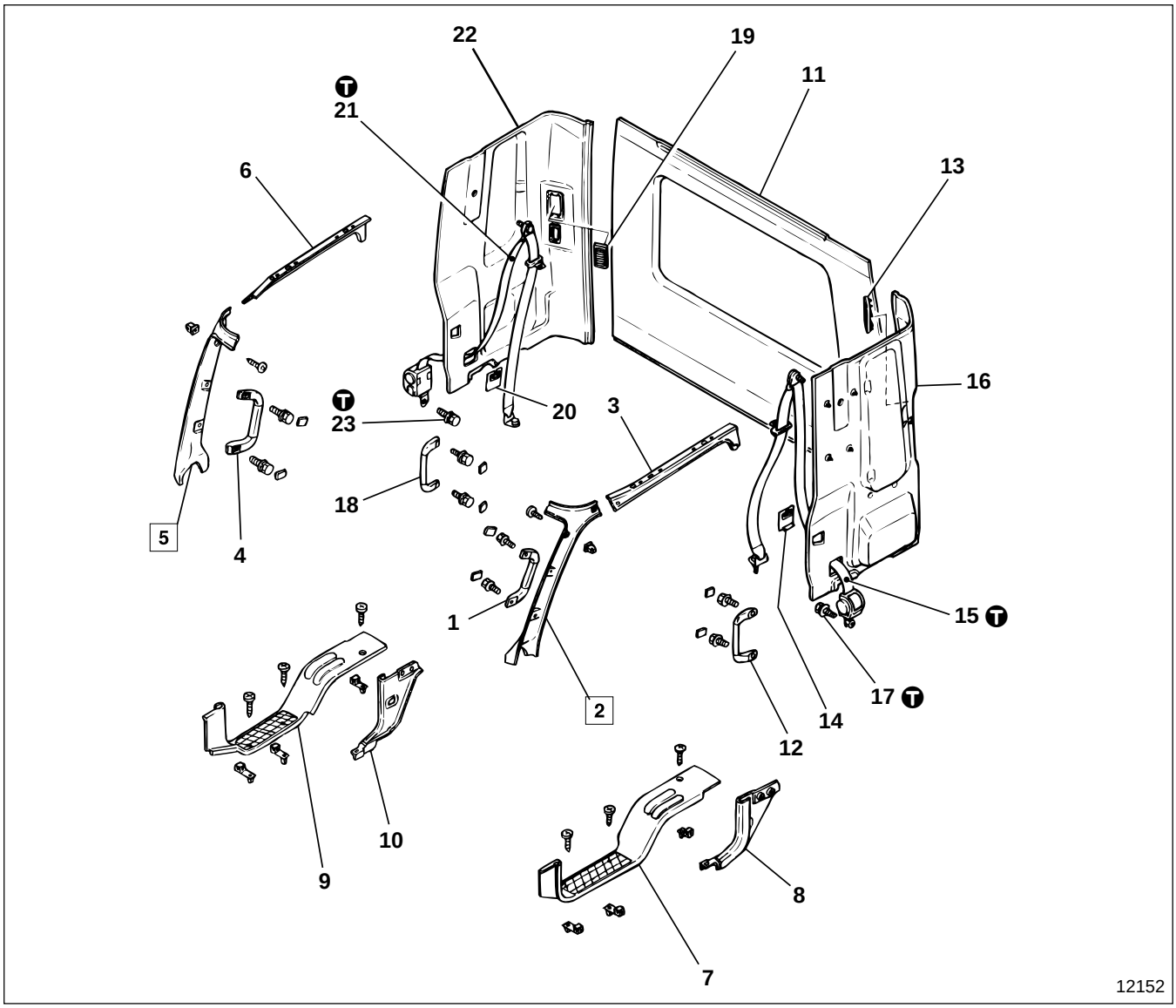


15 **Installation of wiper link and wiper motor assembly**

- Wiper motor bracket **19** and idler bracket **A** of link assembly **21** have reference holes **B** for installation.
- Tighten installation bolts **13**, **14** for wiper motor bracket **19** and idler bracket **A** starting from reference holes **B**.

CAB INTERIOR FITTING

Trim



● **Removal sequence**

1 Front pillar grip, LH
2 Front pillar trim, LH
3 Door header trim, LH
4 Front pillar grip, RH
5 Front pillar trim, RH
6 Door header trim, RH
7 Front scuff plate, LH
8 Rear scuff plate, RH
9 Front scuff plate, RH
10 Rear scuff plate, RH
11 Rear trim
12 Rear pillar grip, LH
13 Inside air outlet garnish
14 Seat belt guide, LH
15 Seat belt assembly
16 Side trim, LH
17 Bolt
18 Rear pillar grip, RH
19 Inside air outlet garnish
20 Seat belt guide, RH
21 Seat belt assembly
22 Side trim, RH
23 Bolt

CAUTION⚠

Do not disassemble seat belt assemblies 15, 21 because this might cause malfunction of the emergency locking retractor.

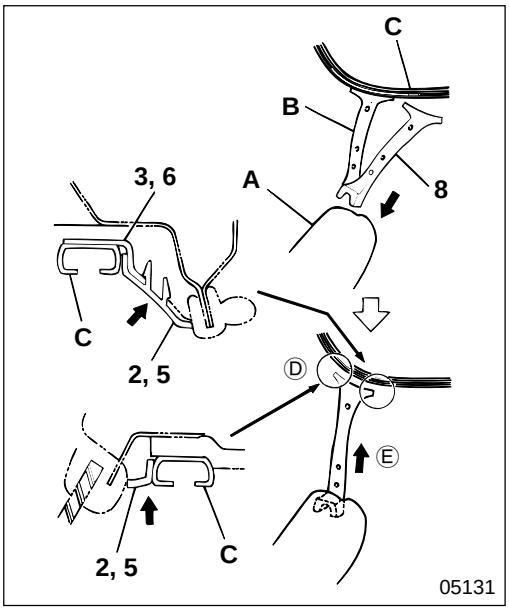
● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
15, 21	Bolts of seat belt assembly shoulder anchor and floor anchor	34 to 54 {25 to 40, 3.5 to 5.5}	—
17, 23	Bolt (Seat belt assembly mounting)	34 to 54 {25 to 40, 3.5 to 5.5}	—



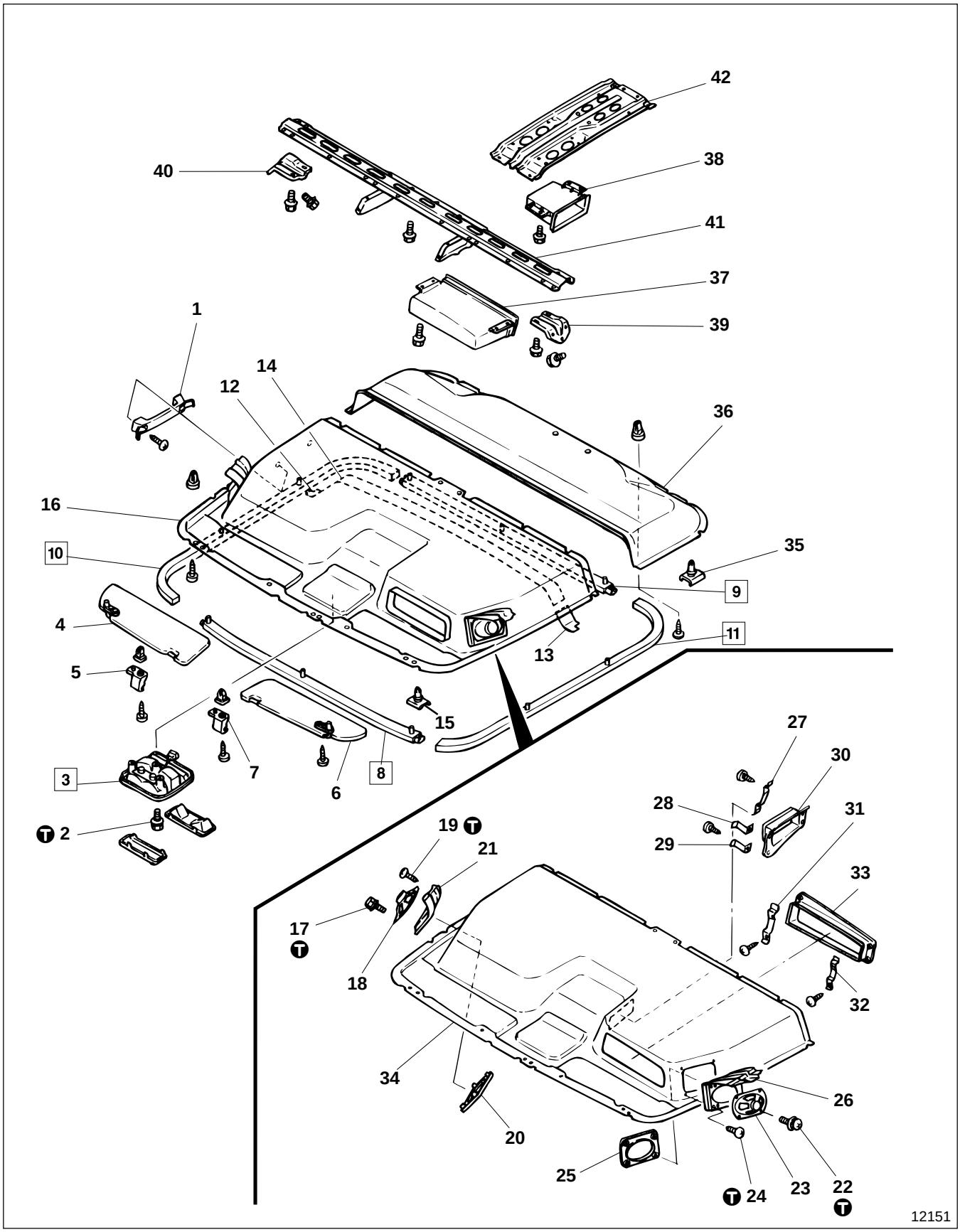
◆ Service procedure

2 **5** **Installation of front pillar trim**

- Insert lower end of front pillar trim LH **2**, RH **5** between instrument panel **A** and front pillar inner panel **B**.
- Insert upper end of trim between curtain rail **C** and front pillar inner panel **B**.
- Fit in part Ⓓ of trim as illustrated.
- Fit in part Ⓔ of trim as illustrated.

CAB INTERIOR FITTING

Headlining



● Removal sequence

1 Grip
2 Bolt
3 Cab and spot lamp Gr 54
4 Sun visor, RH
5 Sun visor catch
6 Sun visor, LH
7 Sun visor catch
8 Front curtain rail
9 Rear curtain rail
10 Side curtain rail, RH
11 Side curtain rail, LH
12 Center curtain rail end cover, RH
13 Center curtain rail end cover, LH
14 Center curtain rail
15 Headlining clip
16 Front headlining assembly
17 Screw
18 Speaker, RH Gr 54
19 Screw
20 Speaker cover
21 Speaker bracket, RH
22 Screw
23 Speaker, LH Gr 54
24 Screw
25 Speaker cover
26 Speaker bracket, LH
27 Bracket
28 Bracket
29 Bracket
30 Facing
31 Bracket
32 Bracket
33 Facing
34 Front headlining
35 Headlining clip
36 Rear headlining
37 Overhead console box A
38 Overhead console box C
39 Overhead side bracket, LH
40 Overhead side bracket, RH
41 Overhead cross frame
42 Overhead center frame

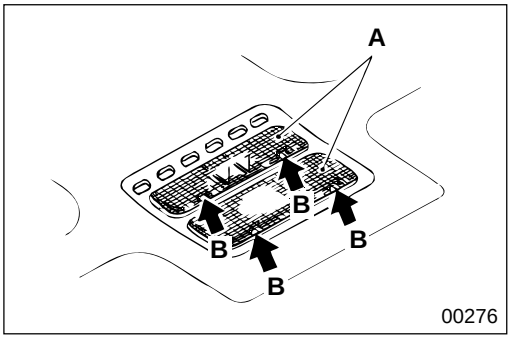
● **Installation sequence**

Follow the removal sequence in reverse.

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Cab and spot light lamp mounting)	2.9±0.5 {2.2±0.36, 0.3±0.05}	—
17, 22	Screw (Speaker mounting)	2.5 {1.8, 0.25}	—
19, 24	Screw (Speaker cover mounting)	1.8 {1.3, 0.18}	—



◆ Service procedure

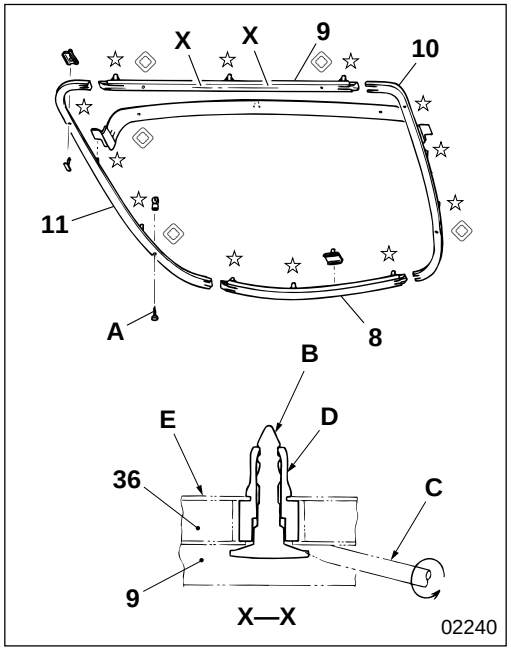
3 **Removal of cab and spot lamp**

Insert the tip of a screwdriver in groove area **B** of lens **A**, and use the screwdriver as a pry bar.

CAUTION

Make sure that you do not pry at any area other than B or you will damage the lens.

CAB INTERIOR FITTING



8 to 11 Removal of curtain rail

- Remove tapping screws **A**. (six points in ◇ mark)
- Insert screwdriver **C** into the taper of rail pins **B** and lever out curtain rails **8** to **11** from rail clips **D** by turning the screwdriver. (13 points in ☆ mark)

36 : Rear head lining
E : Cab metal

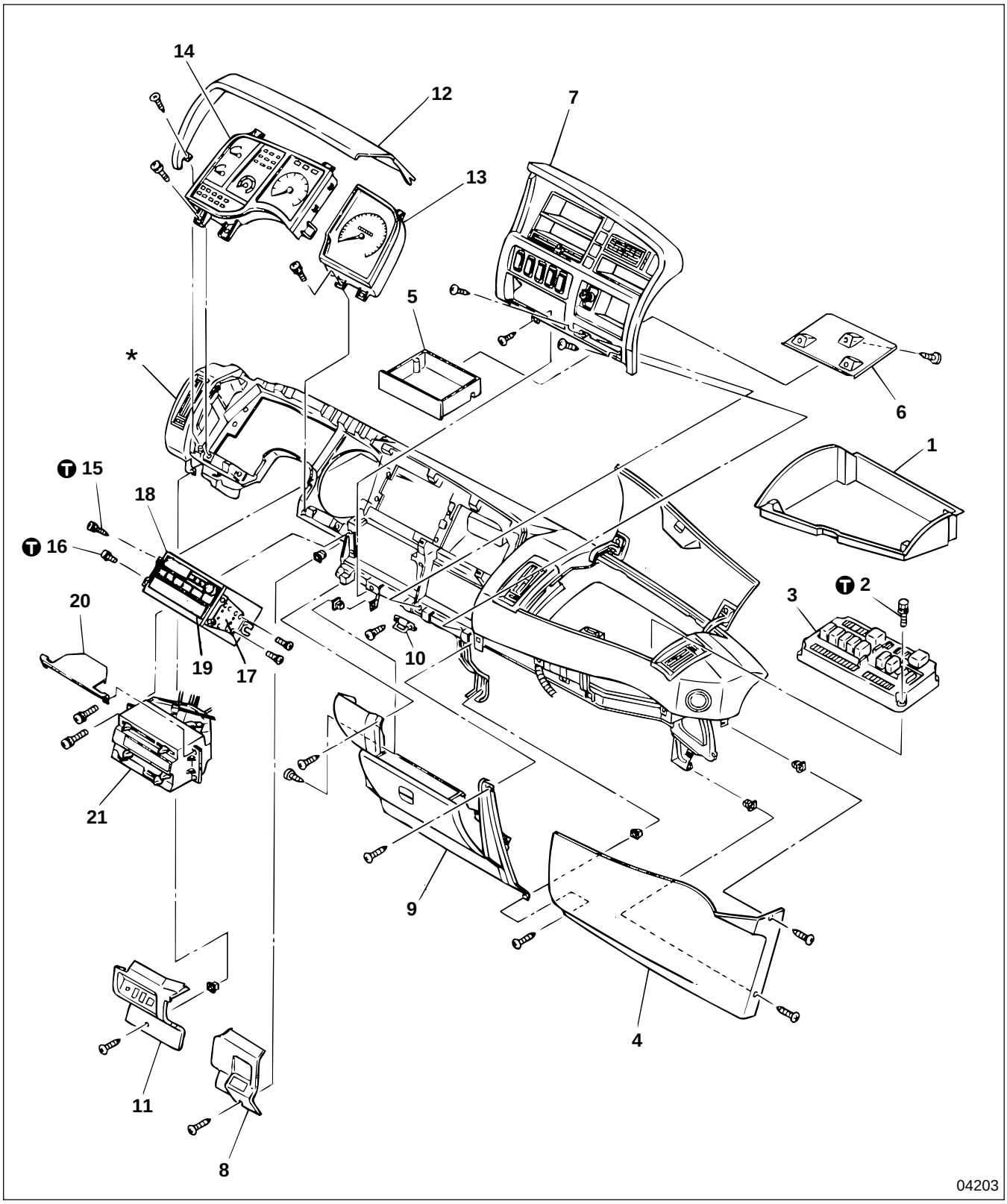
CAUTION ⚠

- **Be sure that you remove rail pins B first because the curtain rails would be deformed if you were to remove the rail pins after levering out curtain rails 8 to 11.**
- **Prepare extra fittings in advance because rail pins B and rail clips D might be damaged during removal.**

M E M O

INSTRUMENT PANEL

Lower Cover, Meter Cluster and Center Panel



● **Disassembly sequence**

1 Glove box
2 Bolt
3 Relay and fuse box
Gr 54
4 Lower cover
5 Ashtray
6 Ashtray outer case
7 Center panel
8 Driver side lower cover B
9 Parcel box and cover
10 Parcel box lock
11 Driver side lower cover A
12 Meter hood
13 Speedometer
Gr 54
14 Meter cluster
Gr 54
15 Screw
16 Screw
17 Radio bracket
18 Radio < Option >
19 Pocket
20 Harness protector
21 Heater control assembly
Gr 55B

***** : Instrument panel assembly P42-72

● **Assembly sequence**

Follow the disassembly sequence in reverse.

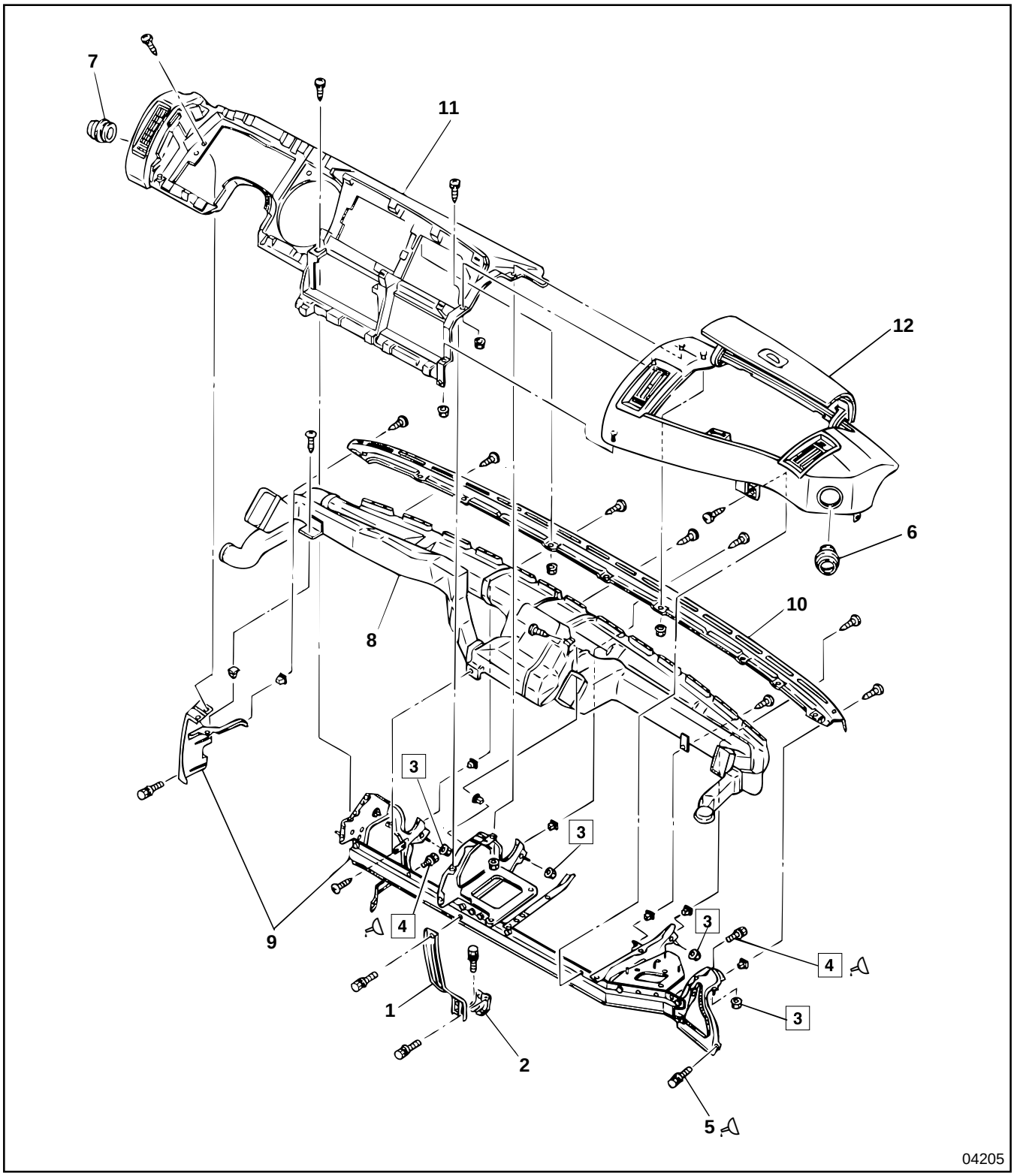
Ⓣ Tightening torque

Unit : N·m {ft.lbs, kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
2	Bolt (Relay and fuse box mounting)	7.8±1.5 {5.8±1.1, 0.8±0.15}	—
15	Screw (Radio bracket mounting on instrument panel assembly)	1.8 {1.3, 0.18}	—
16	Screw (Radio bracket mounting on radio)	1.8 {1.3, 0.18}	M5×0.8 mm
		1.2 {0.87, 0.12}	M4×0.7 mm

INSTRUMENT PANEL

Instrument Panel Assembly



● **Disassembly sequence**

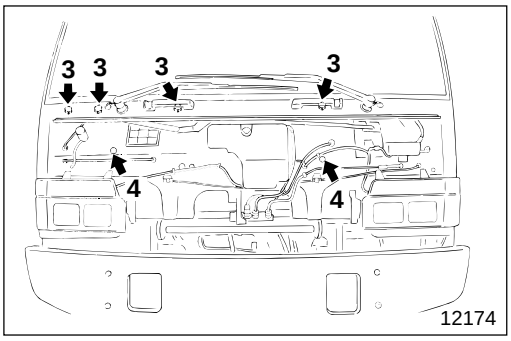
1 Vertical frame
2 Lower bracket
3 Nut
4 Bolt
5 Bolt
6 Side defroster joint
7 Side defroster joint
8 Defroster and duct assembly
Gr 55B
9 Instrument panel frame assembly
10 Duct cover
11 Instrument panel
12 Crash pad assembly

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Sealant

Location	Points of application	Kinds	Quantity
4, 5	Bolt (Instrument panel frame mounting)	SUMITOMO 3M scotch grip 2353	For re-use

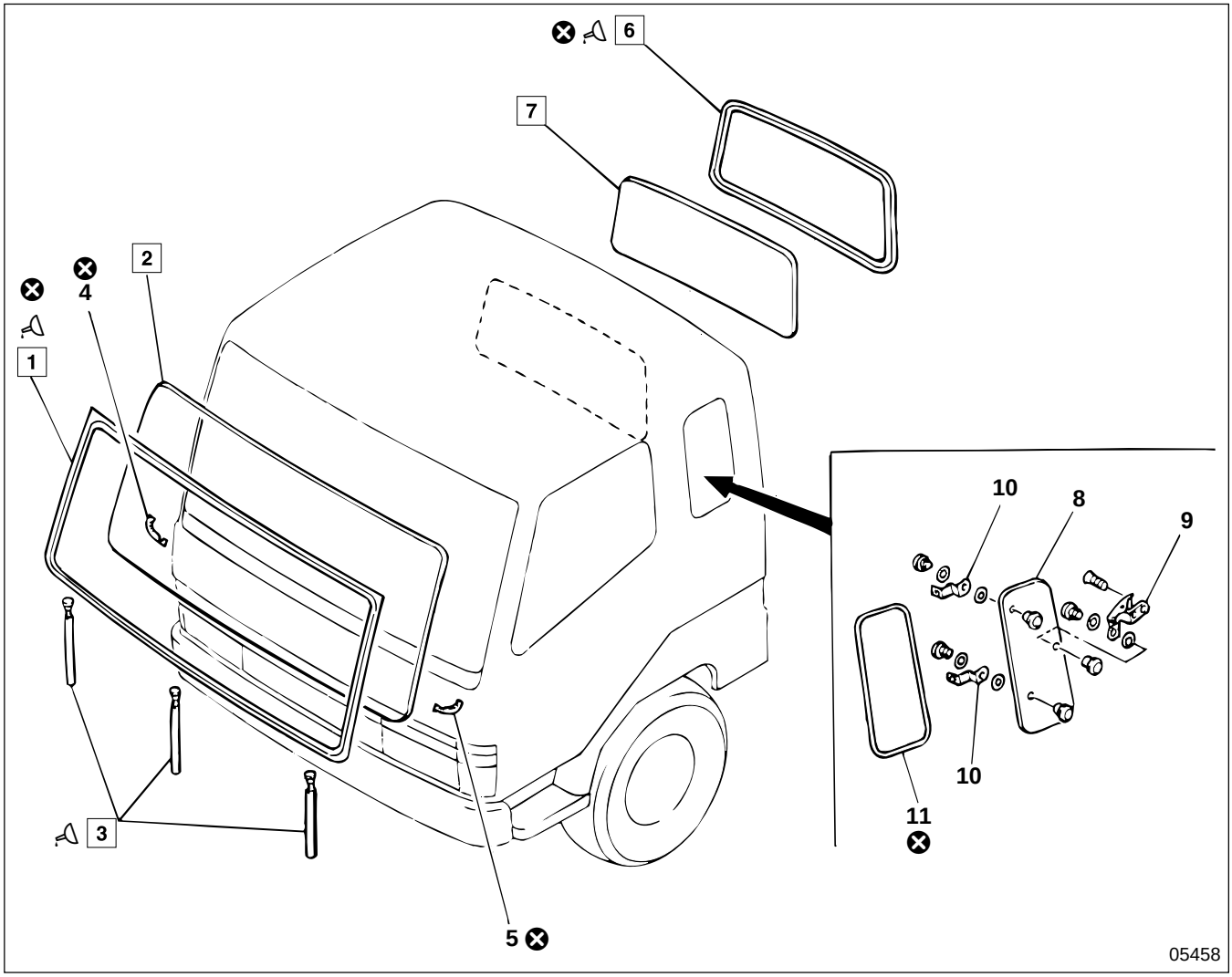


◆ Service procedure

3 **4** **Mounting position of nut and bolt**

- The four mounting positions for nut **3** are indicated by **3** ➡.
- The two mounting positions for bolt **4** are indicated by **4** ➡.

WINDOW GLASS



● **Disassembly sequence**

1 Windshield weatherstrip
2 Windshield
3 Drain hose
4 Seal tape, LH
5 Seal tape, RH
6 Rear window weatherstrip
7 Rear window glass
8 Side window glass
9 Side window link
10 Side window hinge
11 Side window weatherstrip

⊗ : Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

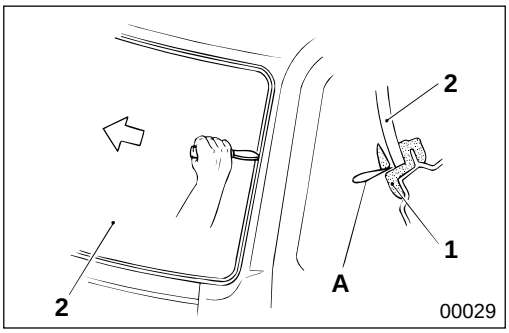
NOTE

The illustration shows the left side. The right side is symmetrical to the left side.

Lubricant and sealant

Location	Points of application	Kinds	Quantity
1, 6	Lip area of weatherstrip	Soapy water	As required
3	Fill the area around the drain hose mounting flange on cab	CEMEDINE 3061-D	As required

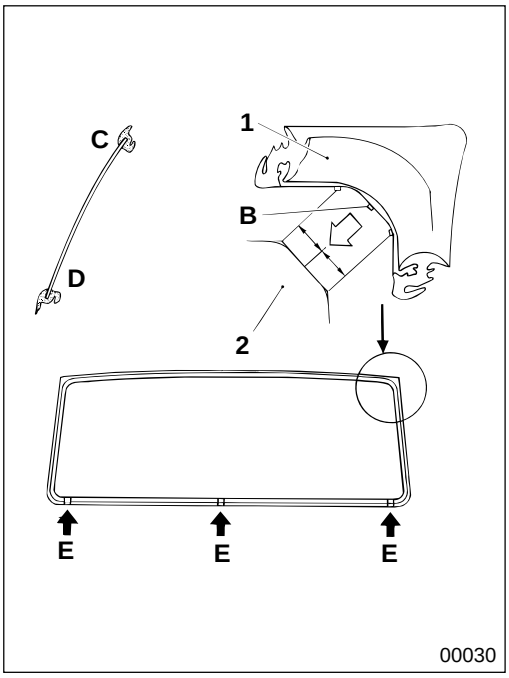
◆ Service procedure



1 **2** **Weatherstrip and windshield**

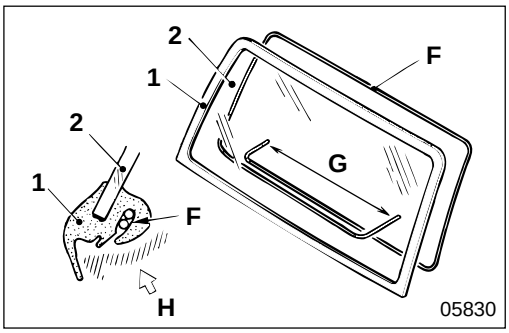
[Removal]

- Cut weatherstrip **1** with knife **A** at the area as illustrated.
- Support windshield **2**, and remove by pressing it from inside the cab.

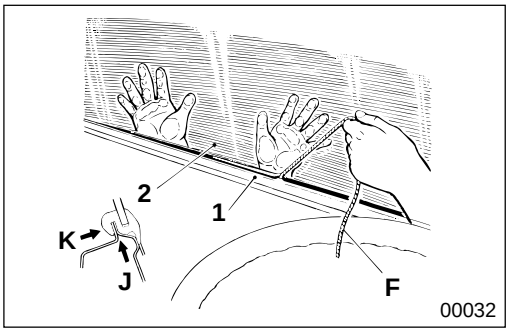


[Installation]

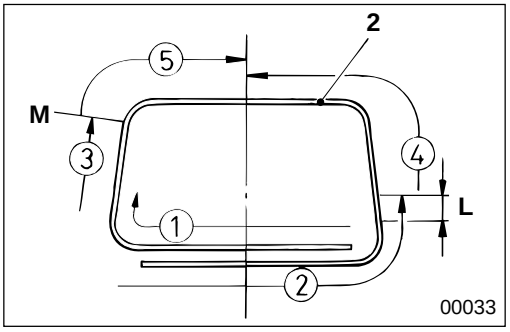
- Install weatherstrip **1** so that central basic point **B** meets the middle at the chamfered part of windshield **2**.
  C : Outside
  D : Inside
  E : Water drain hole



- Lay cord **F** in the cab mounting groove of weatherstrip **1** as illustrated, and overlap the cord at the lower side of the glass by the specified length, see **G**.
- Apply soapy water **H** to weatherstrip **1**.
- Align windshield **2** with the cab.



- Push windshield **2** inward from the outside of the cab firmly.
- Inside the cab, pull one end of cord **F** to install lip **K** of weatherstrip **1** into flange lip **J** of the cab.

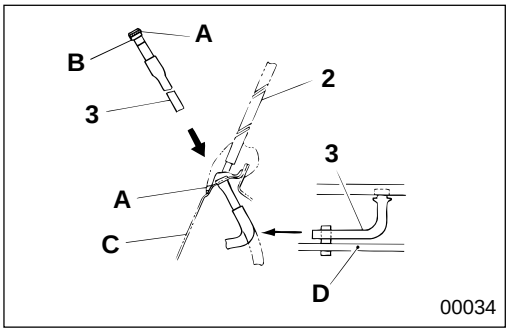


- Pull cord **F** in the numbered order as illustrated and at the same time have someone push windshield **2** into weatherstrip **1**, tapping the windshield with a rubber-headed mallet.

  L : approximately 100 mm {3.94 in.} from the starting point of the straight section
  M : up to the end of the straight section

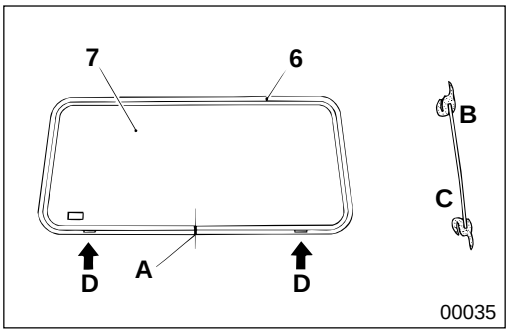
CAUTION

Make sure that windshield 2 is installed correctly into the cab before hitting the windshield with the rubber-headed mallet, otherwise the windshield might be broken.



3 **Installation of drain hose**

- Fill the area around the flange of drain hose **3** with sealant **A**, and press the drain hose in until its flared area **B** fits into cab **C**. Carefully smooth down excess sealant that is squeezed out so that the hose opening is not clogged.
- Secure drain hose **3** at the middle of the vehicle together with windshield washer hose **D**.



6 **7** **Weatherstrip and rear window glass**

- Install so that joint **A** of weatherstrip **6** is at the bottom center of rear window glass **7**.

  B : Outside
  C : Inside
  D : Drain hole

- Except for the point mentioned above, follow the same service procedure as for installation of the windshield.
  P42-75

M E M O

MITSUBISHI
FUSO

Group 54

Electrical

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-54

INDEX

HOW TO READ THIS GROUP

HOW THIS GROUP IS STRUCTURED 2

0 GENERAL

SPECIFICATIONS 54-0-2

STRUCTURE AND OPERATION

1. Starter 54-0-6
2. Alternator 54-0-8
3. Lamp 54-0-11
4. MUTIC (Multipurpose Timing Control Unit) 54-0-14

TROUBLESHOOTING

Power and charging 54-0-22

Enging starting, preheating and stopping 54-0-23

Lighting 54-0-24

Meter 54-0-27

Cigarette lighter and Audio 54-0-28

Accessory noise generation source 54-0-28

Horn 54-0-29

1 POWER, CHARGE AND GROUND CIRCUIT

(110) POWER CIRCUIT 54-1-2

(115) RESERVE POWER CIRCUIT 54-1-11

(125) BATTERY CHARGING CIRCUIT 54-1-12

(130) GROUND 54-1-13

2 STARTING AND PREHEATING CIRCUIT

(210) ENGINE STARTING CIRCUIT 54-2-2

(215) ENGINE STOPPING CIRCUIT ..... Gr 13

(220) ENGINE PREHEATING CIRCUIT 54-2-3

3 LIGHTING CIRCUIT

HEADLAMP CIRCUIT 54-3-2

(313) DAYTIME RUNNING LIGHT CIRCUIT 54-3-4

(320) TAIL, CLEARANCE AND LICENSE PLATE LAMP CIRCUIT 54-3-6

(325) STOP LAMP CIRCUIT 54-3-7

(330) TURN SIGNAL AND HAZARD LAMP CIRCUIT 54-3-8

(340) BACKUP LAMP CIRCUIT 54-3-9

(345) CAB LAMP CIRCUIT 54-3-10

(348) ILLUMINATION LAMP CIRCUIT 54-3-11

(349) MARKER AND IDENTIFICATION LAMP CIRCUIT 54-3-12

(352) VAN BODY DOME LIGHT CIRCUIT 54-3-13

4 METER CIRCUIT

(401) METER CLUSTER INTERNAL CIRCUIT 54-4-2

(410) TACHOMETER CIRCUIT 54-4-4

(412) SPEEDOMETER CIRCUIT 54-4-5

(420) FUEL GAUGE CIRCUIT 54-4-7

(425) WATER TEMPERATURE GAUGE CIRCUIT 54-4-8

5 INDICATOR AND WARNING LAMP CIRCUIT

(510) PARKING BRAKE INDICATOR CIRCUIT 54-5-2

(515) BRAKE WARNING CIRCUIT 54-5-4

(530) WATER LEVEL WARNING CIRCUIT 54-5-6

(536) ENGINE OIL PRESSURE WARNING CIRCUIT 54-5-7

(537) OVERHEATING WARNING CIRCUIT 54-5-8

(547) ATF TEMPERATURE WARNING CIRCUIT 54-5-9
FM657 < A/T > ..... Gr 23B

(548) TRANSMISSION HIGH/LOW INDICATOR CIRCUIT 54-5-10

(550) CAB TILT WARNING CIRCUIT 54-5-11

6 CAB SIDE ELECTRICAL CIRCUIT

(610) CIGARETTE LIGHTER CIRCUIT 54-6-2

(612) AUDIO CIRCUIT 54-6-3

(614) WIPER AND WASHER CIRCUIT 54-6-4

(616) HORN CIRCUIT 54-6-5

(618) HEATER CIRCUIT 54-6-6

(622) POWER WINDOW AND AUTO DOOR LOCK CIRCUIT 54-6-7

(629) MIRROR HEATER CIRCUIT 54-6-8

7 CHASSIS SIDE ELECTRICAL CIRCUIT

(710) EXHAUST BRAKE CIRCUIT 54-7-2

(718) AIR DRYER CURCUIT 54-7-4

8 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

(850) TRANSMISSION POWER TAKE-OFF CIRCUIT 54-8-2

9 OTHERS CIRCUIT

(910) MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT 54-9-2

ELECTRONICALLY CONTROLLED FUEL SYSTEM CIRCUIT ..... Gr 13

AUTOMATIC TRANSMISSION CIRCUIT < FM657 > ..... Gr 23B

ANTI-LOCK BRAKE SYSTEM CIRCUIT ..... Gr 35E

10 PARTS INSTALLATION POSITION

Cab side

A SWITCH 54-10-2

B RELAY AND ELECTRONIC CONTROL UNIT 54-10-4

C FUSE, METER, SENSOR AND MOTOR 54-10-6

D HEATER 54-10-8

E DOOR AND MIRROR 54-10-9

F ROOF 54-10-10

G CAB 54-10-12

J JOINT OF MAIN HARNESS CONNECTORS 54-10-14

Engine and transmission side

R ENGINE 54-10-16

S TRANSMISSION 54-10-18

Chassis side

T SWITCH AND SENSOR 54-10-20

U BATTERY, FUSE AND CONNECTOR 54-10-22

V MAGNETIC VALVE, MOTOR AND ACTUATOR 54-10-23

W BUZZER 54-10-23

11 INSPECTION OF PARTS

001 to 179 SWITCH 54-11-2

180 to 249 RELAY 54-11-10

250 to 349 SENSOR 54-11-13

350 to 409 CONTROL UNIT 54-11-16

410 to 509 MOTOR 54-11-17

510 to 559 ACTUATOR 54-11-19

560 to 609 MAGNETIC VALVE 54-11-20

610 to 649 BUZZER AND HORN 54-11-21

650 to 699 LAMP 54-11-22

750 to 859 OTHER 54-11-23

860 BATTERY 54-11-25

870 to 889 FUSE 54-11-28

890 METER CLUSTER 54-11-32

12 STARTER AND ALTERNATOR

930 STARTER 54-12-2

940 ALTERNATOR 54-12-16

950 INSPECTION OF ALTERNATOR 54-12-23

951 INSPECTION OF REGULATOR 54-12-24

13 ON-VEHICLE INSPECTION AND ADJUSTMENT

955 INSPECTION OF PREHEATING SYSTEM 54-13-2

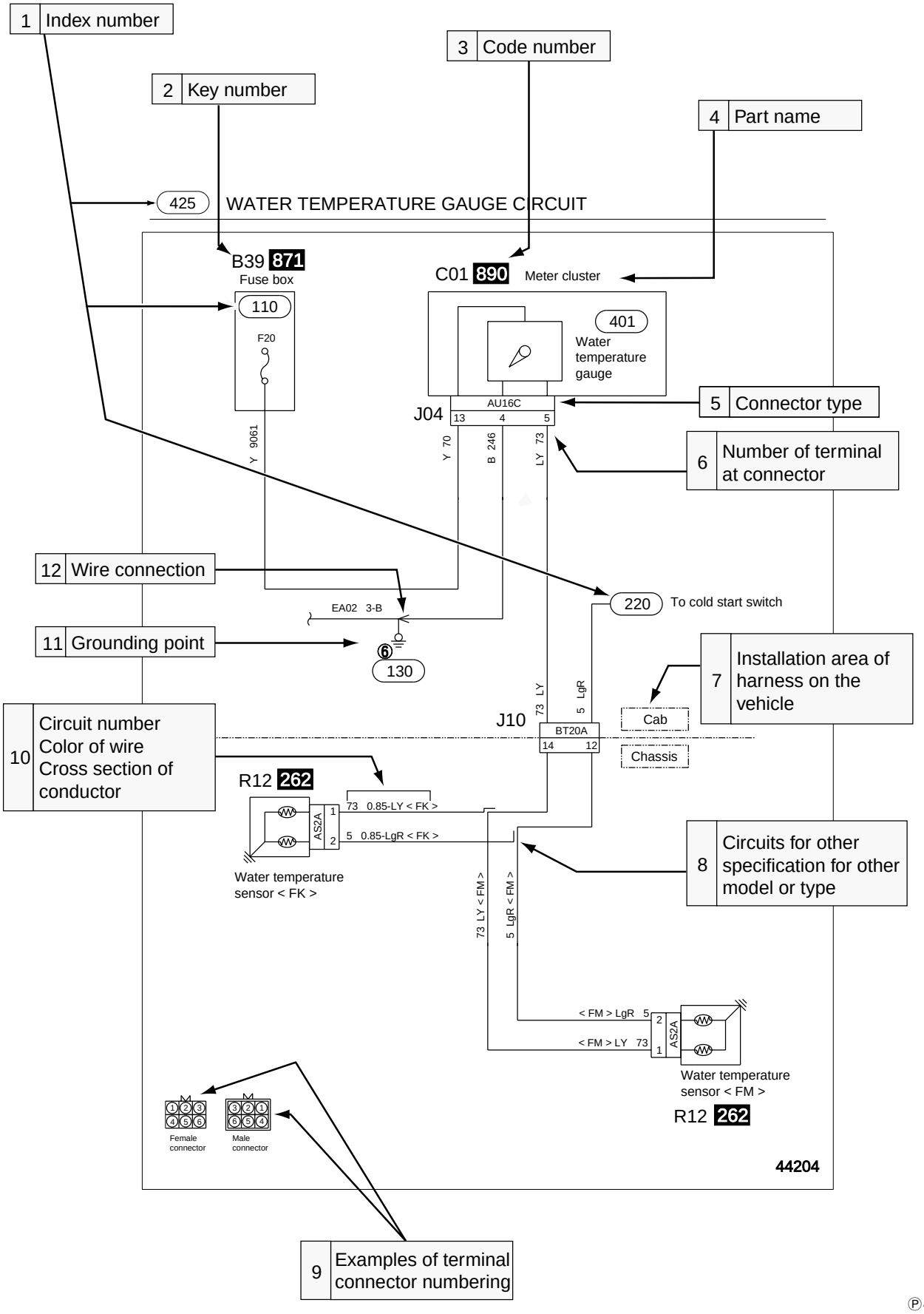
960 HEADLAMP AIMING 54-13-4

965 INSPECTION OF BRAKE FLUID LEVEL SWITCH 54-13-6

HOW TO READ THIS GROUP

HOW THIS GROUP IS STRUCTURED 2

HOW TO READ CIRCUITS(GROUP 54)



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1 Index number: **110**

Each circuit has its own Index number identified with three digits (**110**).
How to read index number

- By referring to the index number, it is possible to easily locate the circuit drawing in the manual as they are classified by function. (including “POWER CIRCUIT” **110** and “GROUND” **130** .)
- How to check the location of circuit drawing in each part
  The circuit drawing which can not be diagramed in one page due to its complicated structure (such as meter cluster and electronic control unit etc.), has its remarked index number to be connected to other circuit drawing. (**401** , **910** , etc.)

2 Key number: A01~

Key number identifies the installation position of the parts, and is shown by A01 ~ Z.
The details of the installation position are described in GROUP 10 .

3 Code number: **001** ~

Code number indicates an inspection procedure or detail exists and has three digits (**001**).
The details of the parts to be checked are described in GROUP 11 .

4 Part name

5 Connector type

Connectors are shown by □ without reference to Male or Female. In the box is a description of connector, number of terminals and its classification, etc.
Table of connectors is described in GROUP 00.

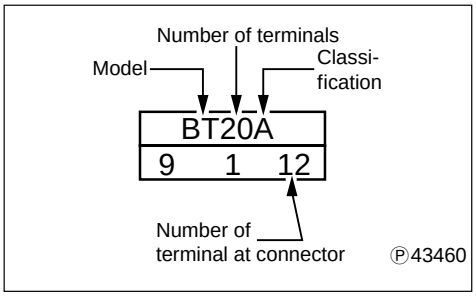
6 Number of terminal at connector

Terminal numbers of connector are shown by figures in the box.

7 Installation area of harness on the vehicle

The location and boundary of the harnesses in the vehicle are shown in the each circuit drawing and it may help to check mounting position of connectors.

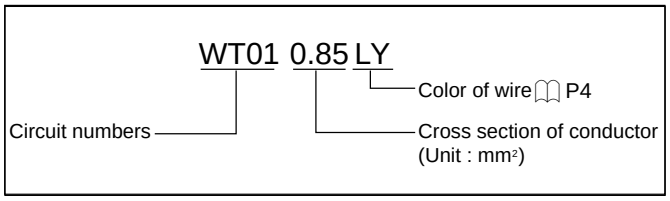
8 Circuits for other specification for other model or type



9 Examples of terminal connector numbering

As it is shown, for female connectors, with placing the lock upward then starting to put numbers from the upper left. And when it is male connector, put numbers from the upper right, also with placing the lock upward.

10 Circuit number, color of wire, and cross section of conductor are shown in circuit drawings.



Except for 0.5 mm², Wire thickness is described in the circuit drawing. The reason why only wire thickness, 0.5 mm² is not described in the drawings is 0.5 mm² is so common and so that the circuit drawing can be seen more easily.
(Examples) 0.5 mm²: Y
0.85 mm²: 0.85 — LY
3 mm²: 3 — B

11 Grounding point

The actual locations of grounding points on the vehicle are shown. Refer to **130** for detailed information.

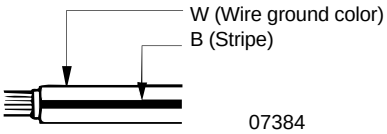
12 Wire connection

When the wires are connected into one point of the harnesses, the circuit drawing shows “Arrow mark”.

CAUTION !
Be careful as the direction of the arrow does not show the direction of the electric current flow.

● Wire Colors

Example: WB means a wire whose ground color is white and whose stripe is black.



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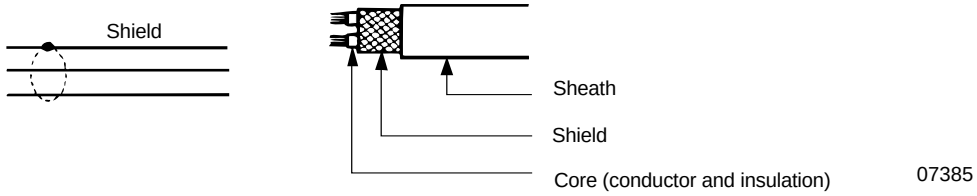
Wire ground color		Wire ground color + Stripe							
W	White	WR	White red	WB	White black	WL	White blue	WG	White green
B	Black	BW	Black white	BY	Black yellow	BR	Black red		
R	Red	RW	Red white	RB	Red black	RY	Red yellow	RG	Red green
Y	Yellow	YR	Yellow red	YB	Yellow black	YG	Yellow green	YL	Yellow blue
G	Green	GW	Green white	GR	Green red	GY	Green yellow	GB	Green black
Br	Brown	BrW	Brown white						
L	Blue	LW	Blue white	LR	Blue red	LY	Blue yellow	LB	Blue black
Lg	Yellow green	LgR	Yellow green red	LgY	Yellow green yellow	LgB	Yellow green black	LgW	Yellow green white
O	Orange								
P	Pink	PB	Pink black						

● Shield Wire

A shield wire is clearly identified as follows:

Example



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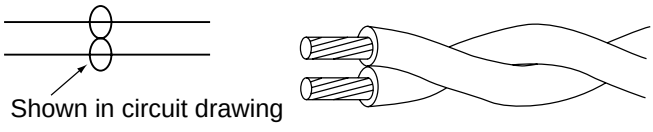
● Twist wire

Twist wires are made by twisting the core of wires by the constant pitch.
Example:



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0 GENERAL

SPECIFICATIONS

Battery

Item	Specifications
Model	115E41R
Voltage × Quantity	12 × 2 (Parallel connection)
Capacity (5-hour rating)	80

Alternator

Item	Specifications
Manufacturer	DENSO CORPORATION
Type	Alternator with built-in regulator
	Brushless type
	External fan
Model	101211-8260
Output V-A	12-100

Engine starter, Glow

Item			Specifications
Starter	Manufacturer		MITSUBISHI ELECTRIC
	Reduction gear system		Planetary gear
	Model		M9T50071
	Output	V-kW	12-5
	Magnetic switch operating voltage	V	8 or less
Starter relay	Model		U1X15076
	Excitation current	V-A	12-4
	Closing voltage	V	8 or less
	Operating voltage	V	3.5 or less
	Allowable cutoff current	A	200
Glow plug	Model		Sheathed type
	Rated voltage current	V-A	11-5.3
Glow relay	Model		U1T11373
	Excitation current	V-A	12-4
	Closing voltage	V	8 or less
	Operating voltage	V	3.5 or less
	Allowable cutoff current	A	200
	Temperature fuse capacity	A	127

SPECIFICATIONS

Lighting

Item			Specifications
Headlamp	Model		Sealed beam
	Main beam	W	50
	Dipped beam	W	40/60 (Main/Dipped)
Front turn signal lamp (serving also as hazard warning lamp)		W	21
Clearance lamp		W	7.5
Side turn signal lamp (serving also as hazard warning lamp)		W	10
Clearance and side marker lamp		W	7.5
Rear combination lamp	Stop / Tail lamp	W	27/8
	Backup lamp	W	27
	Turn signal lamp (serving also as hazard warning lamp)	W	27
Cab and spot lamp		W	12/8 (Cab/Spot)
Identification lamp		W	7.5
License plate lamp		W	7.5
Back buzzer	Rated voltage	V	12
	Rated current	A	50 or less
	Sound pressure	dB	85±10 (at 1 m {3.3 ft.})
	Intermittent frequency	frequency per minute	85±15

All bulbs of the lamps shown above voltage rating of 12 V.

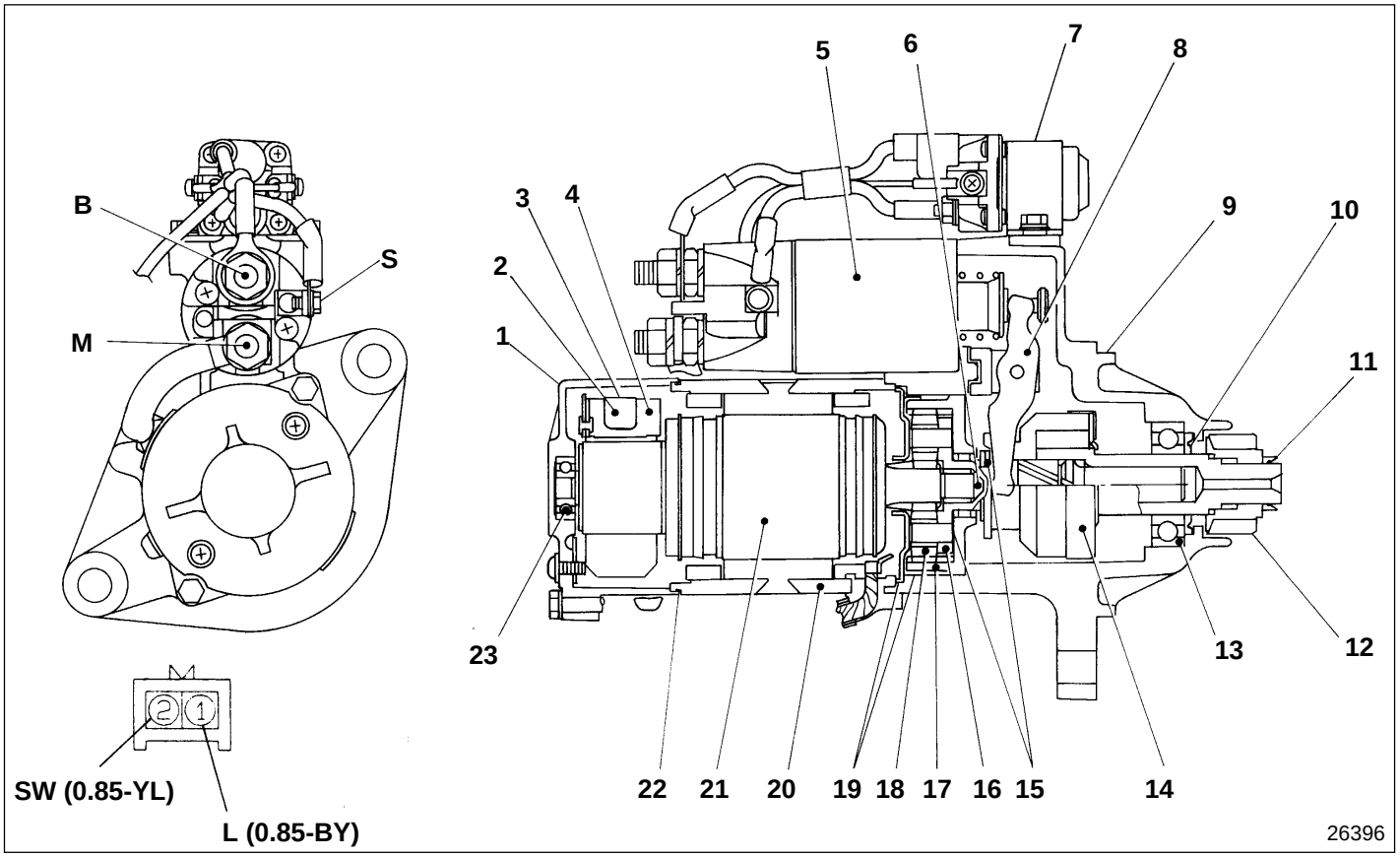
Meter

Item			Specifications
Meter cluster	Manufacturer		DENSO CORPORATION
	Rated voltage	V	12
	Lighting bulb	W	3
	Indicator lamp bulb	W	1.4
	Warning lamp bulb	W	1.4
	Meter warning buzzer (Overrunning buzzer) < 10-speed transmission >	Rated current mA	50 or less (Mean value)
		Sound pressure dB	60 $^{+6}_{0}$ (at 1 m {3.3 ft.})
Speedometer	Manufacturer		DENSO CORPORATION
	Lighting buld	W	2

Relay, Motor, Horn, Buzzer

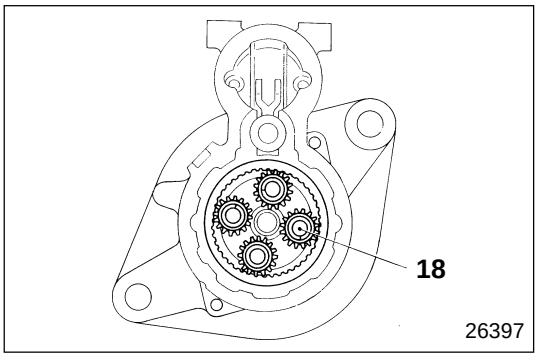
Item			Specifications
Relay	Rated voltage	V	12
	Minimum operating voltage	V	8 or less
Speaker	Rated input	W	12
	Maximum input	W	25
	Impedance	Ω	4±0.6
Power window motor	Rated voltage	V	13.5
	Rated current	A	9 or less < Up >, 7 or less < Down >
Door lock actuator	Rated voltage	V	12
	Bound current	A	6 or less
Air horn	Rated voltage	V	12
	Current consumption	mA	3.2 or less
	Sound pressure	dB	115 $^{0}_{-5}$ (at 2 m {6.6 ft.})
Wiper motor	Rated voltage	V	12
	Non-load current	A	3 or less
	Bound current	A	15 or less
Windshield washer motor	Rated voltage	V	12
	Rated current	A	3.8 or less

1. Starter



1 Rear braket
2 Brush
3 Brush spring
4 Brush holder
5 Magnetic switch
6 Ball
7 Starter relay
8 Lever
9 Front bracket
10 Spring
11 Pinion stopper
12 Pinion
13 Front bearing
14 Overrunning clutch
15 Washer
16 Gear shaft
17 Internal gear
18 Planetary gear
19 Rubber packing
20 Yoke assembly
21 Armature
22 Rubber packing
23 Rear bearing

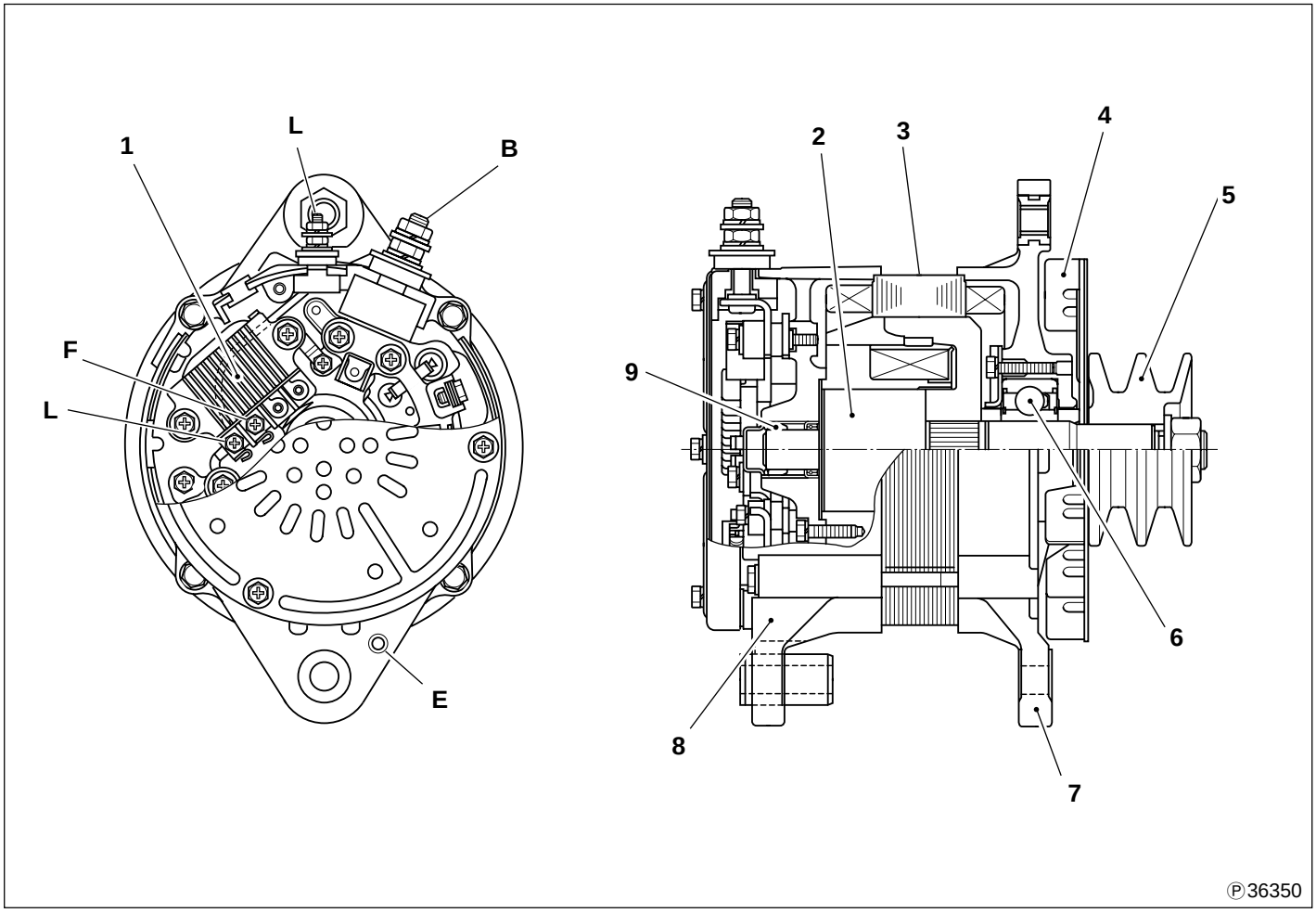
B : Terminal B
L : Terminal L
M : Terminal M
S : Terminal S
SW : Terminal SW



This starter uses planetary gear **18** in a decelaration gear mechanism.

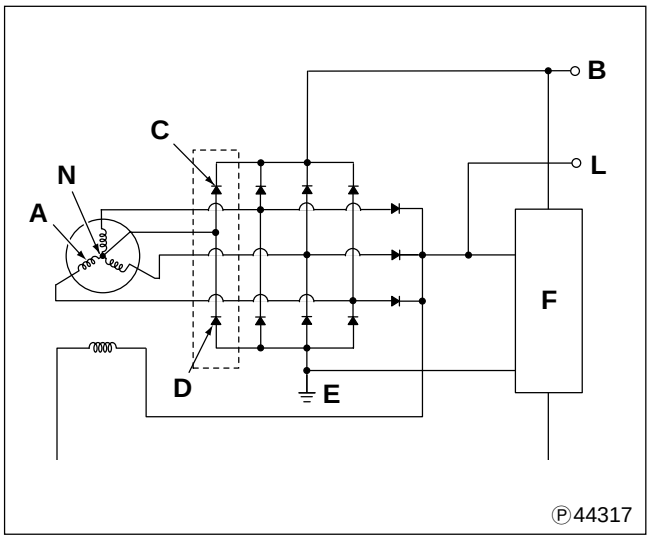
M E M O

2. Alternator



1 Regulator
2 Coil
3 Stator
4 Fan
5 Pulley
6 Front bearing
7 Drive frame
8 Rear frame
9 Rear bearing

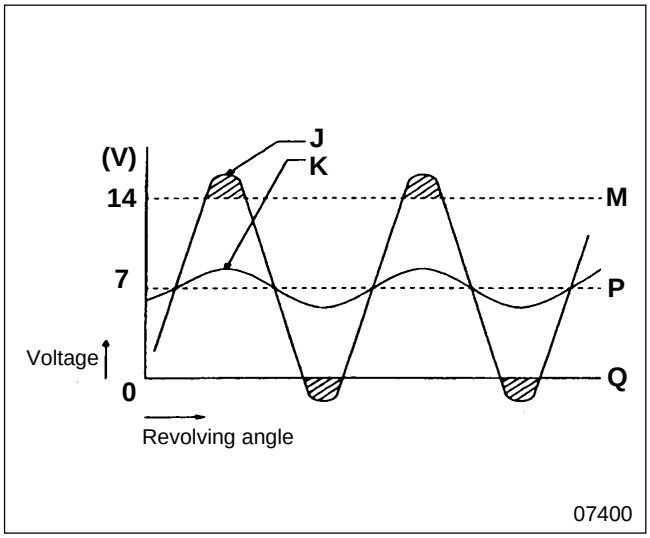
B : Terminal B
E : Terminal E
F : Terminal F
L : Terminal L



Features of alternator with neutral diodes

- The alternator is the same as the current alternator except neutral diodes **C** and **D** added.
- These neutral diodes **C** and **D** enable this alternator to provide higher DC output during operation at high speeds than the alternator without neutral diodes.

A: Stator coil
B: Alternator terminal B
E: Alternator terminal E
F: IC regulator
L: Alternator terminal L
N: Neutral point



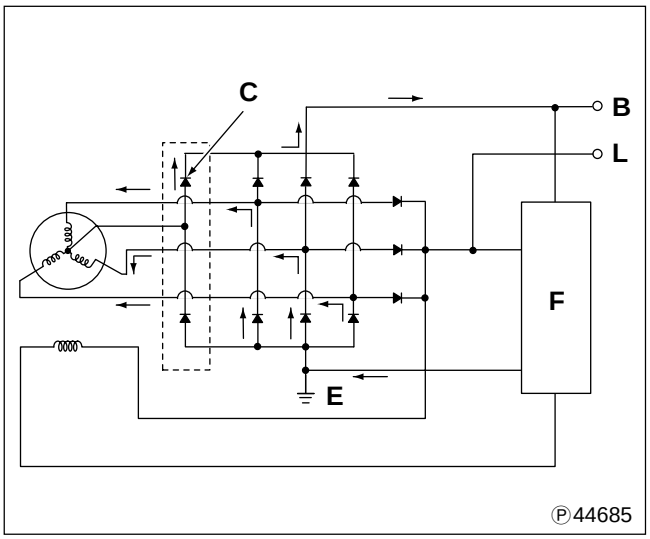
Variations of voltage at neutral point and operation of neutral diodes

- The potential at the neutral point **N** varies up and down with the neutral point DC voltage **P** as a center as shown.
- When alternator is operated at high speeds, the voltage at the neutral point **N** can increase to exceed the output voltage **M** (16 volts) and decrease to become lower than the ground voltage **Q** (0 volt). To adjust these over-voltage and under-voltage (shaded portions of diagram) the current from the excess voltages is taken by neutral diodes **C** and **D** and added to the DC output.

J: Voltage waveform at neutral point during high speed operation
K: Voltage waveform at neutral point during low speed operation
M: Output voltage
P: Average voltage at neutral point (1/2 of output voltage)
Q: Ground potential

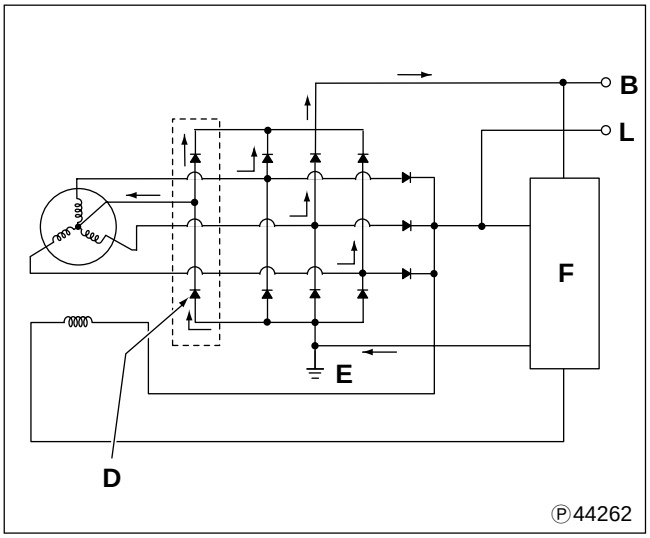
The operation of neutral diodes **C** and **D** for each voltage and potential is as follows.

- When the voltage at neutral point is in the range from 0 to 16 volts, the other 6 diodes are operated. Neutral diodes are not operated.



● **When the voltage at neutral point exceeds 14 volts**

The positive diode **C** adds extra output to the DC output for supply to each electric equipment.

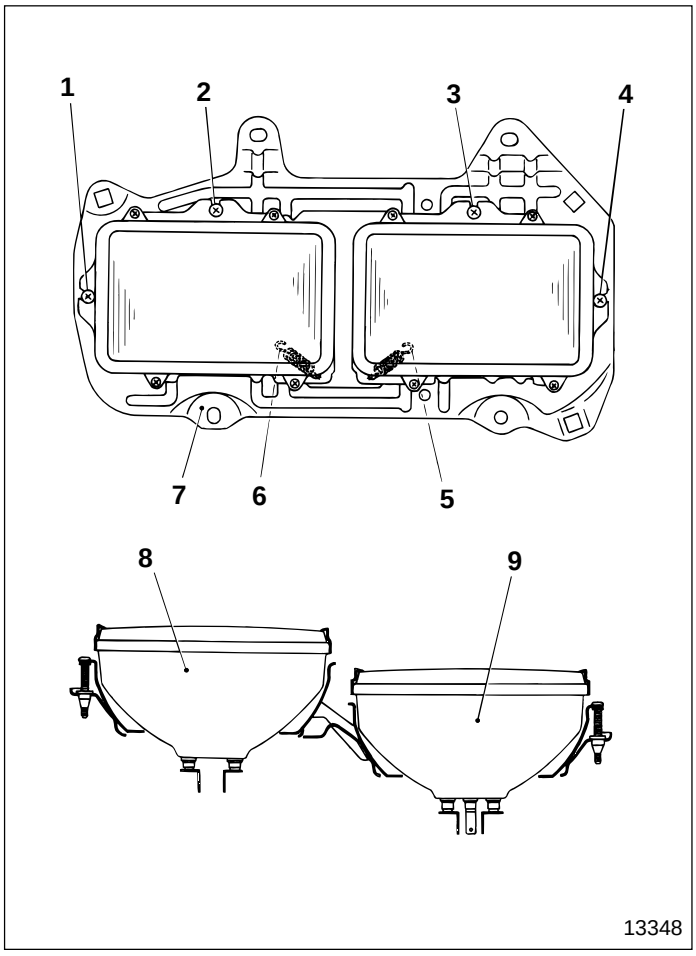


● **When the voltage at neutral point drops below 0 volt**

The negative diode **D** supplies the output from neutral point through other 3 diodes.

3. Lamp

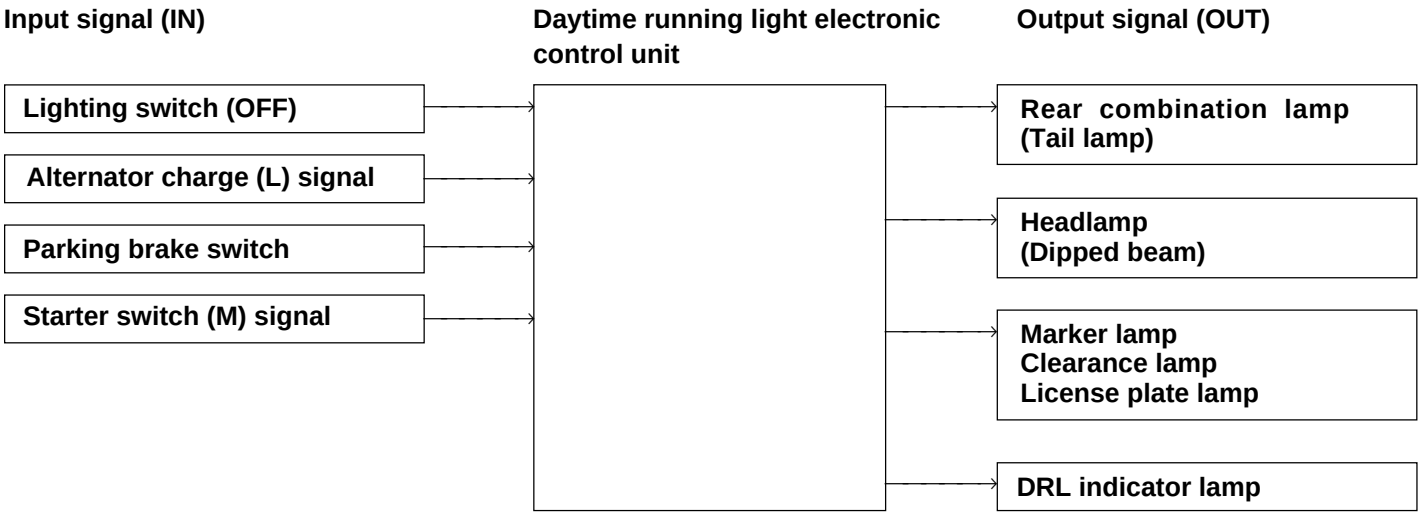
Headlamp



1 Screw (Main beam, horizontal adjustment)
2 Screw (Main beam, vertical adjustment)
3 Screw (Dipped beam, vertical adjustment)
4 Screw (Dipped beam, horizontal adjustment)
5 Extension spring
6 Extension spring
7 Housing
8 Sealed beam unit (Main beam)
9 Sealed beam unit (Dipped beam)

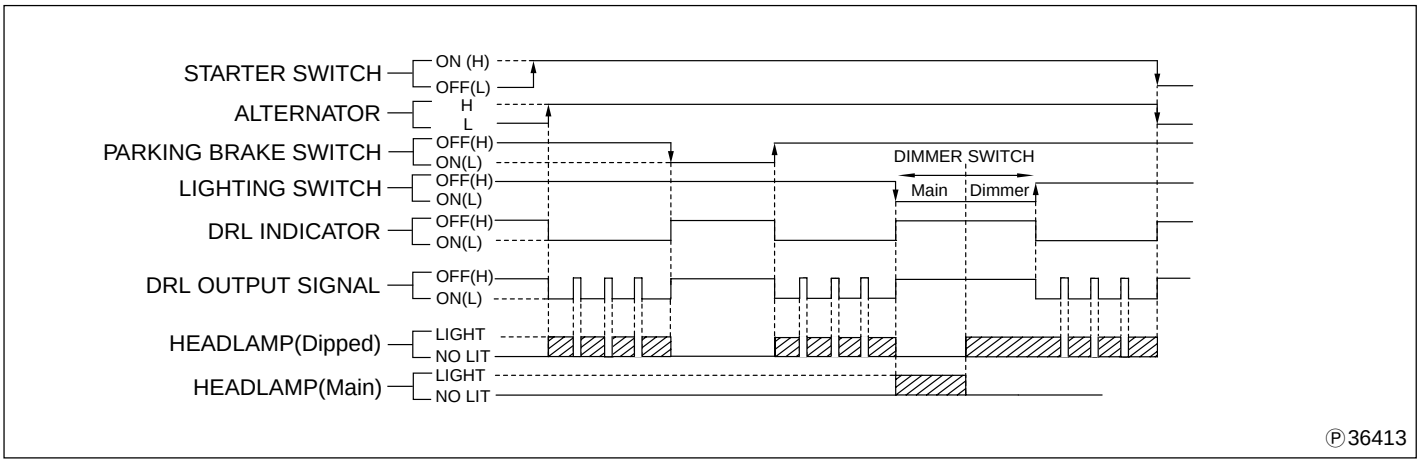
- The headlamp unit consists of sealed beam units **8, 9** separately installed in housing **7**. Sealed beam unit **8** is for Main beam, and sealed beam unit **9** is for Dipped beam.
- The headlamp aiming can be adjusted by changing the installation angle of sealed beam units **8, 9**.
- To adjust the installation angle of sealed beam unit **8**, turn screws **1, 2**. Extension spring **6** sets the angle of the sealed beam unit.
- To adjust the installation angle of sealed beam unit **9**, turn screws **3, 4**. Extension spring **5** sets the angle in the same way as for sealed beam unit **8**.

Daytime running light system



- In a daytime running light system, regardless the position of lighting switch while engine is running, the dipped beam of the headlamp and the tail lamp of the rear combinations, position lamp, license plate lamp will light on.
- Except for that the lighting switch is OFF or when the passing switch is ON, the same lamps as usual switch operation will light.

• Timing chart

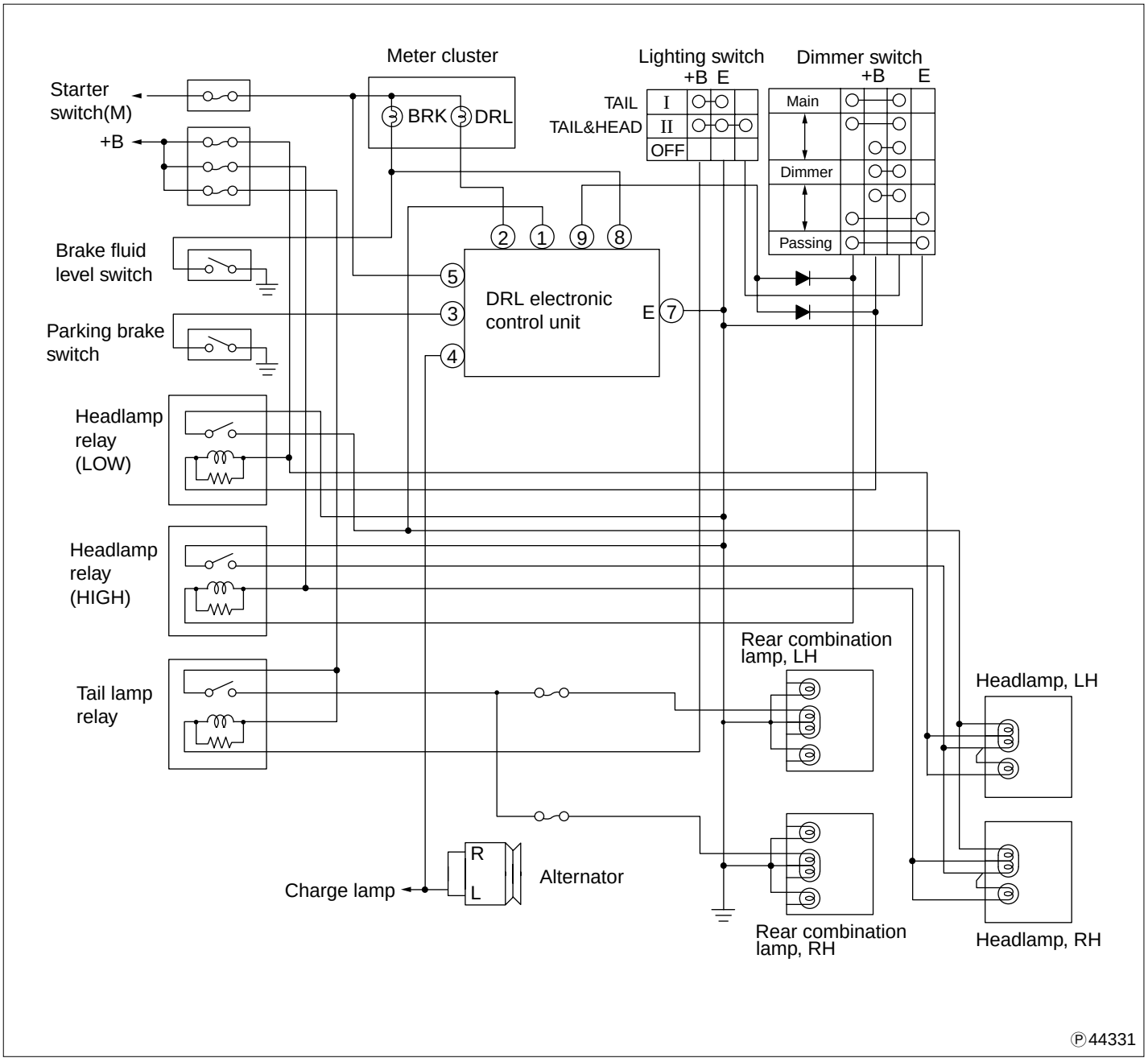


Headlamps repeat ON/OFF operations at 120 Hz according to the above timing chart. Because of the cyclic ON/OFF operations, the headlamps are dimmer than when the headlamp switch is ON.

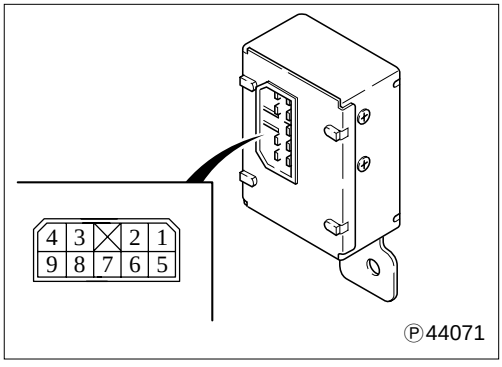
Explanation of timing chart

- After the engine starts, when alternator begins generating electricity with starter switch in the ON position, headlamps light.
- When parking brake switch is ON, the DRL turns off to switch off the headlamps.

• Daytime running light electronic control unit circuit diagram



• DRL electronic control unit



Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Head lamp (Dipped)	6	–
2	DRL indicator lamp	7	Ground
3	Parking brake switch	8	Parking brake indicator lamp
4	Alternator L terminal	9	Lighting switch
5	Starter switch M terminal	–	–

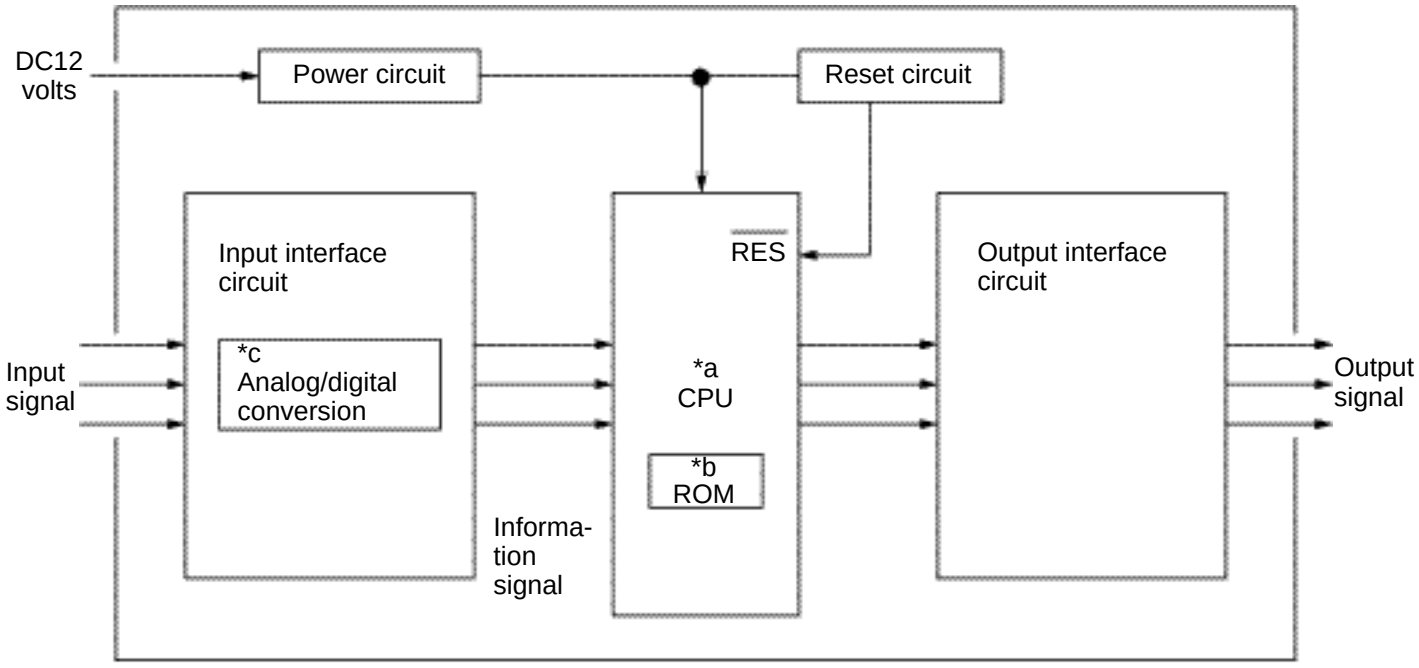
4. MUTIC (Multipurpose Timing Control Unit)

- This control unit is an integrated control unit for controlling the following functions.

Preheating function	P54-0-18
Intermittent wiper activation function	Gr 42
Wiper activation function (Even if the wiper switch is OFF, this function automatically activates the wiper when the window washer works)	Gr 42
Water level warning function	Gr 14
Starter continuous-ON prevention function	P54-0-20

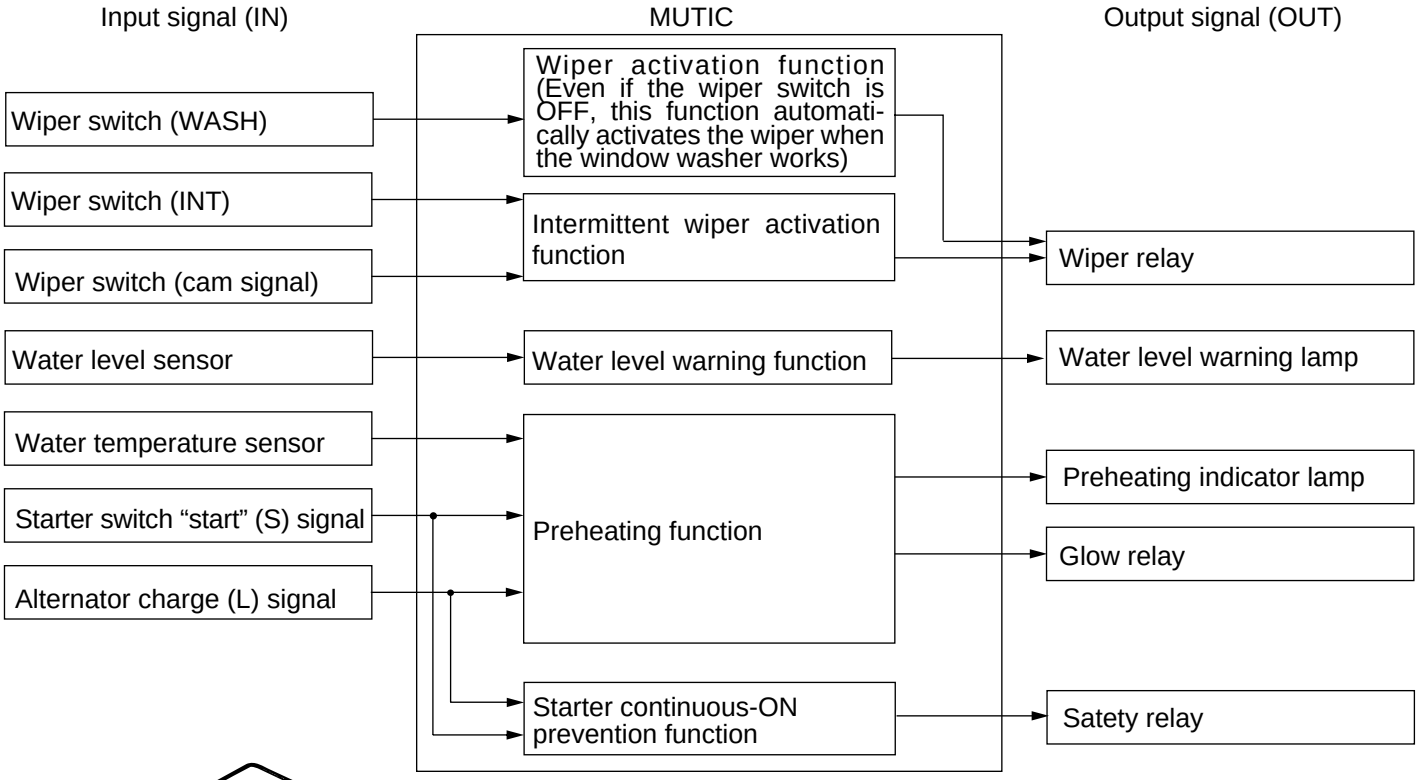
- For controlling each function, sensors and switches are needed as sources of information, and they are provided for respective systems.
- Based on the information provided by the sensors and switches, the MUTIC controls above functions by means of the circuits inside itself.

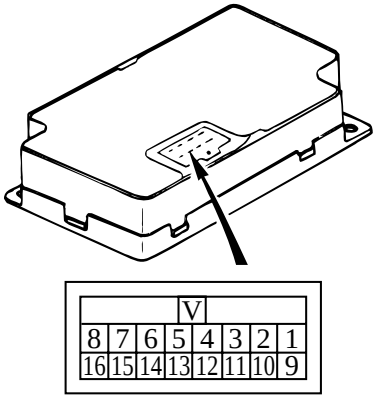
● **Internal structure of MUTIC**



- The MUTIC is internally made up roughly of the input interface circuit, CPU*a, ROM*b, and output interface circuit.
  *a: An abbreviation for Central Processing Unit. It compares the input information and the information stored in the ROM and makes a decision and sends commands to the outputs.
  *b: An abbreviation for Read-Only Memory. It is an element used exclusively to have its contents read. It stores fixed data and program, and such retained information is not deleted even after power is cut off.
- Information sources such as sensor, switch send input signal to the input interface circuit.
- The input interface circuit performs A/D conversion*c of the input signals, and the converted signals are transmitted to the CPU as information signals.
  *c: An abbreviation for Analog/Digital conversion. It is a conversion from analog to digital signals. This conversion enables calculation to be made in the CPU.
- The CPU compares the received signals with the data in the ROM, makes a decision, and sends the results to the output interface circuit.
- The output interface circuit transmits these results to each system as output signals to instruct operations.
- Performing these series of operations continuously enables optimum control of each function.

System function schematic





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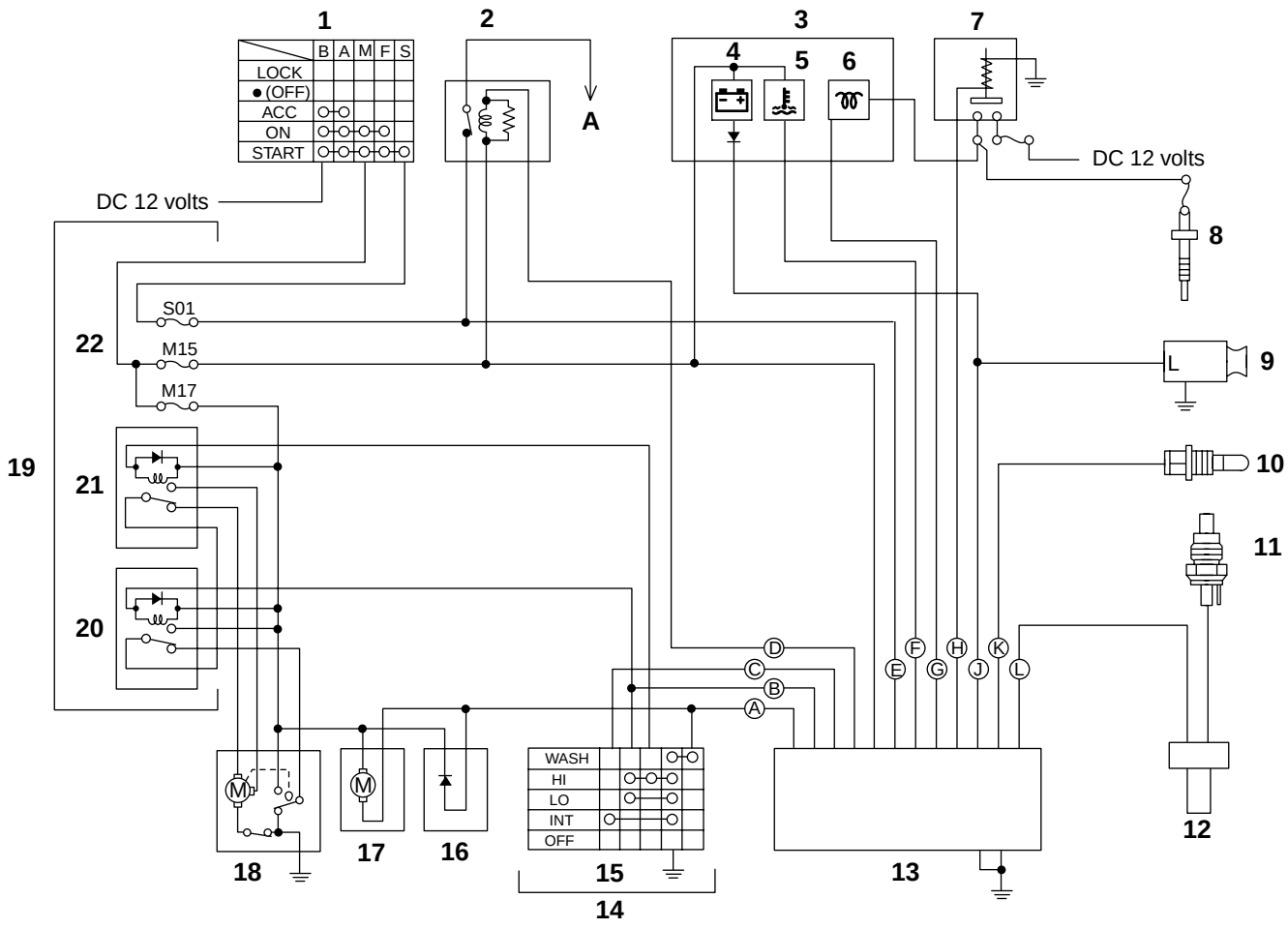
Terminal No.	Connecting destinations	Terminal No.	Connecting destinations
1	Glow relay	9	Wiper relay (LOW)
2	Starter switch (ON power supply)	10	Engine preheating indicator lamp
3	Water temperature sensor	11	Safety relay
4	—	12	Water level warning lamp
5	Ground	13	Ground
6	Water level sensor	14	Alternator terminal L
7	Wiper switch (Intermittent)	15	Starter switch (Start signal)
8	Washer switch	16	—

MUTIC (Multipurpose Timing Control Unit) Functional Circuit Diagram



A : To starter relay

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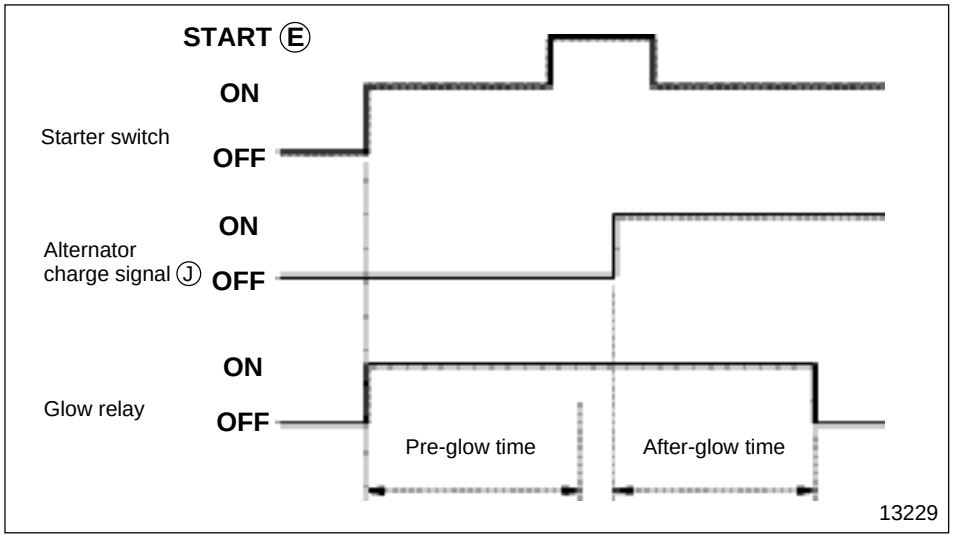
No.	Part name	Principal function sensors	Information signal
1	Starter switch	Start position detection	Ⓔ : Start signal
2	Safety relay	—	Ⓓ : Starter continuous-ON cancellation signal
3	Meter cluster	—	—
4	Battery charge indicactor lamp	—	—
5	Water level warning lamp	—	Ⓕ : Lamp ON signal
6	Engine preheating indicator lamp	—	Ⓖ : Lamp ON signal
7	Glow relay	—	Ⓗ : Glow relay activation signal
8	Glow plug	—	—
9	Alternator	Output of alternator charge signal	Ⓙ : Alternator charge signal
10	Water level sensor	Detection of engine coolant level	Ⓚ : Engine coolant level signal
11	Water temperature sensor	Detection of engine coolant temperature	Ⓛ : Engine coolant temperatur signal
12	Cold start switch connector	—	—
13	MUTIC	—	—
14	Combination switch	—	—
15	Wiper and washer switch	—	Ⓒ : Intermittent wiper switch signal
16	Diode unit	—	—
17	Washer motor	—	Ⓐ : Washer switch signal
18	Wiper motor	—	—
19	Relay and fuse box	—	—
20	Wiper relay (LOW)	Intermittent wiper operation	Ⓑ : Wiper relay activation signal
21	Wiper relay (HIGH)	—	—
22	Fuse	—	—

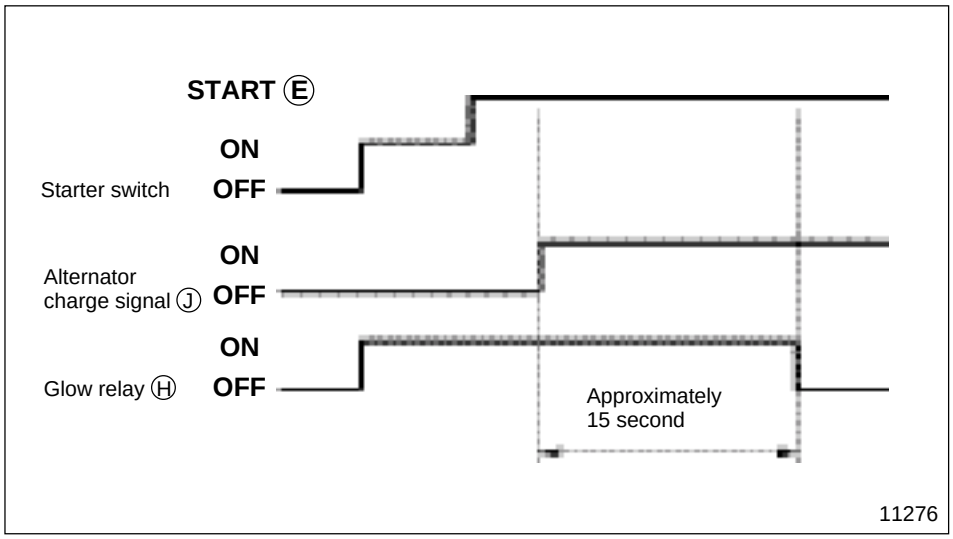
Preheating Function

This preheating function aims to enhance the engine start up when the engine coolant is low in cold weather or temperature.
MUTIC (Multipurpose Timing Control Unit) controls the entire function as follows:



Pre-glow and After-glow

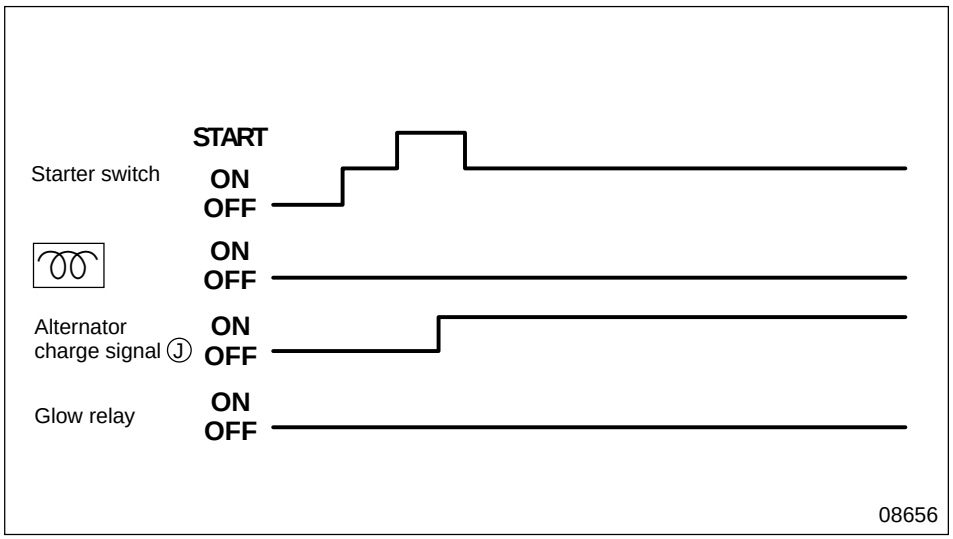
The preheating is operated with a pre-glow before the engine starting and an after-glow after the engine starting, which are controlled by the starter switch (S terminal) signal Ⓔ and the alternator (L terminal) signal Ⓙ.



Fail Safe

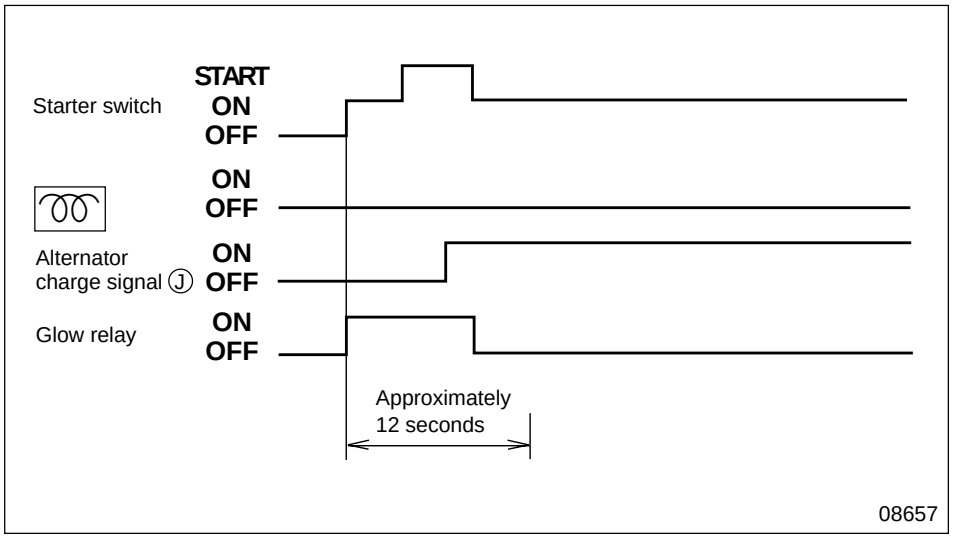
- In case the contact point operating the glow relay in MUTIC has melted, the preheating indicator lamp flashes to warn this abnormality.
- Operation mode turns glow relay activation signal Ⓗ to OFF only after all the following conditions are met.
  - Where the engine coolant temperature is 60°C or less.
  - Alternator (L terminal) signal Ⓙ is ON for 15 seconds continuously.
  - Starter switch (S terminal) signal Ⓔ is ON.

ON
OFF

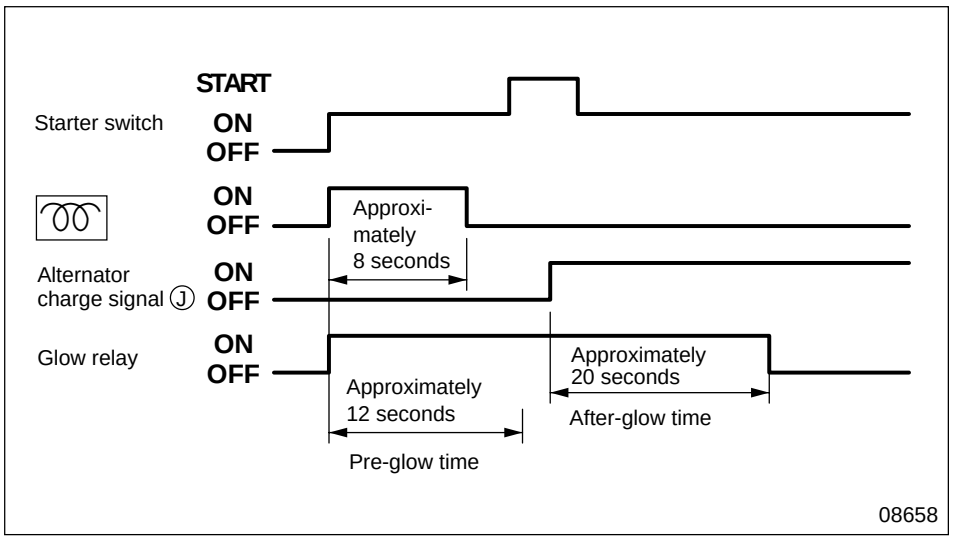


Operation mode

- Where the engine coolant temperature is 60°C {140°F} or more.



- Where the engine coolant temperature is 0 to 60°C {32 to 140°F}.



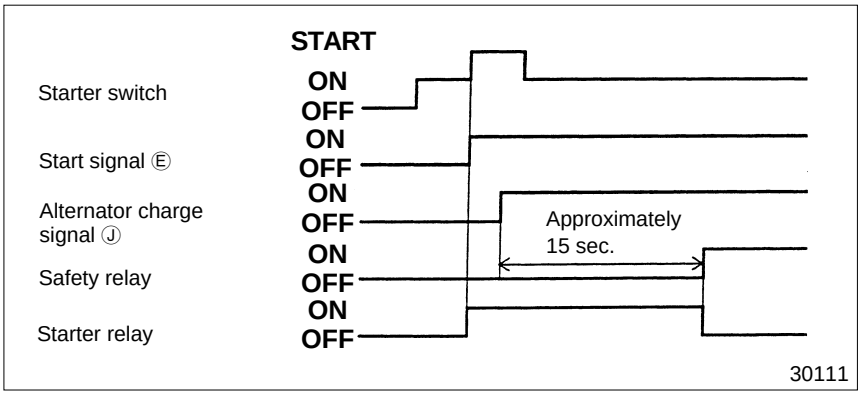
- Where the engine coolant temperature is 0°C {32°F} or less.

Starter Continuous-ON Prevention Function

- This function prevents a starter overrun.
- If the start continues to operate for more than a preset time after the engine starts, the MUTIC detects a starter continuous-ON condition, and stops the current to the starter and starter relay to prevent the starter from seizing.

When a preset time elapses after the engine starts, the safey relay is activated (opening of contact) by signal Ⓙ from the alternator (terminal L).

Operation mode



M E M O

TROUBLESHOOTING

Power and charging

Possible causes \ Symptoms		Battery electrolyte decreases too early	Battery overheating	Battery is normal but overdischarged	Charge warning lamp [-+] does not light when starter switch is turned ON, with engine stopped	Alternator is normal but battery overdischarged	Remarks
Defective connector connection, harness open/short circuit, defective grounding				○		○	
Fuse blown				○	○	○	
V-belts loose				○		○	Gr 14
V-belts damaged				○		○	Gr 14
Battery faulty		○				○	
Alternator	Stator coil broken			○			
	Stator coil short-circuited with core			○			
	Field coil faulty			○			
	Rectifier faulty			○			
	Regulator faulty		○	○	○		
	Wiring faulty			○			
Meter cluster faulty					○		

Engine starting, preheating and stopping

Symptoms / Possible causes		Starter does not operate	Starter operates but engine does not start: Pinion does not engage with ring gear	Starter operates but engine does not start: Pinion engages with ring gear but does not rotate	Starter operates but engine does not start: Flywheel rotates but engine does not start	Engine does not stop	Engine cannot be preheated	Engine is hard to start	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○			○	○	○		
High-current fuse blown		○							
Fuse blown		○				○	○		
Battery insufficiently charged		○		○					
Starter	Magnetic switch contacts stuck or fused together	○							
	Open circuit in magnetic switch coil	○							
	Overrunning clutch malfunctioning			○					
	Pinion worn or damaged		○						
Starter relay defective		○							
Starter switch defective		○				○			
Flywheel ring gear worn or damaged			○						^ Gr 11
Glow plugs defective							○	○	
Glow relay defective							○	○	
Water temperature sensor defective							○	○	
MUTIC (control unit) defective		○					○	○	
Faulty connection of connecting plate							○	○	^ Gr 11
Transmission neutral switch faulty < M/T >		○							
Transmission neutral relay faulty < M/T >		○							
Neutral start relay faulty		○							
Vechicle interface module faulty < A/T : FM657 >		○							^ Gr 23
Safety relay faulty		○							

A/T: Automatic transmission
M/T: Manual transmission

Lighting

Symptoms / Possible causes		Headlamp: Does not light.	Headlamp: Dim.	Headlamp: Does not switch to main beam.	Headlamp: Does not switch to dipped beam.	Tail lamp does not light.	Stop lamp does not light.	Clearance lamp does not light.	Position lamp does not light.	License plate lamp does not light.	Backup lamp does not light.	Back buzzer does not sound.	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○				○	○	○	○	○	○	○	
Fuse blown		○				○	○	○	○	○	○	○	
Battery capacity insufficient			○										
Alternator output insufficient			○										
Bulb burnt-out		○				○	○	○	○	○	○	○	
Power (wattage) of bulb is lower than specified value													
Power (wattage) of bulb is higher than specified value													
Combination switch	Lighting switch faulty	○				○		○	○	○			
	Turn signal lamp switch faulty												
	Dimmer switch faulty			○	○								
	Hazard warning lamp switch faulty												
Relay box	Headlamp relay (HIGH, LOW) faulty	○		○	○								
	Tail lamp relay faulty					○		○	○	○			
	Flasher unit faulty												
Stop lamp switch faulty							○						
Backup lamp switch faulty											○	○	
Back buzzer faulty												○	
Cab lamp switch faulty													
Cab lamp faulty													
Door switch faulty													
Rheostat switch faulty													
Tail lamp bulb burnt-out												○	

Symptoms / Possible causes		Turn signal lamp (also used as hazard)					Cab lamp does not light.	Interior illumination lamps for meters, heater control panel, etc. cannot be adjusted	Marker lamp does not light.	Remarks
		Does not blink.	Stays ON.	Blinks too slowly.	Blinks too quickly.	Blinks irregularly.				
Defective connector connection,harness open/short circuit, defective grounding		○					○	○	○	
Fuse blown		○					○		○	
Battery capacity insufficient			○							
Alternator output insufficient			○							
Bulb burnt-out		○			○			○	○	
Power (wattage) of bulb is lower than specified value					○					
Power (wattage) of bulb is higher than specified value				○						
Combination switch	Lighting switch faulty								○	
	Turn signal lamp switch faulty									
	Dimmer switch faulty									
	Hazard warning lamp switch faulty	○	○							
Relay box	Headlamp relay (HIGH, LOW) faulty									
	Tail lamp relay faulty							○	○	
	Flasher unit faulty	○	○	○	○	○				
Stop lamp switch faulty										
Backup lamp switch faulty										
Back buzzer faulty										
Cab lamp switch faulty							○			
Cab lamp faulty						○				
Door switch faulty							○			
Rheostat switch faulty								○		

Lighting

Symptoms / Possible causes		Van body dome light does not light	Daytime running light system does not operate after engine starts, and headlamps do not light	Identification lamp does not light	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○	○	
Fuse blown		○		○	
Battery capacity insufficient					
Alternator output insufficient			○		
Bulb burnt-out		○	○	○	
Power (wattage) of bulb is lower than specified value					
Power (wattage) of bulb is higher than specified value					
Combination switch	Lighting switch faulty	○			
	Turn signal lamp switch faulty				
	Dimmer switch faulty				
	Hazard warning lamp switch faulty				
Relay box	Headlamp relay (HIGH, LOW) faulty	○	○		
	Tail lamp relay faulty			○	
Van body dome light relay faulty		○			
Van body dome light switch faulty		○			
Daytime running light electronic control unit faulty			○		

Meter

Possible causes \ Symptoms		Pointer does not move	Pointer movement unstable	Indication error large	Abnormal noise from meter	Remarks
Defective connector connection, harness open/short circuit, defective grounding		○	○			
Fuse blown		○				
Internal circuits of meter cluster faulty		○	○	○		
Printed wiring board of meter cluster faulty		○				
Tachometer	Engine speed sensor coil open-circuited	○				
	Engine speed sensor improperly mounted	○	○			Gr 11, 13
	Tachometer faulty	○	○	○	○	
	Engine electronic control unit faulty	○	○	○		Gr 13
Speedometer	Speedometer cable broken	○				
	Speedometer cable connection faulty		○		○	
	Speedometer cable lubricant exhausted		○		○	
	Specified tires not used			○		Gr 31
	Tires worn or inflation pressure incorrect			○		Gr 31
	Specified L-joint of transmission not used (Different in gear ratio)			○		Gr 22
	Specified speedometer gear of transmission not used (Different in gear ratio)			○		Gr 22
	Installation angle of speedometer gear bushing on transmission incorrect (Not set at correct gear ratio position)			○		Gr 22
	Speedometer faulty	○	○	○	○	
Water temperature gauge	Water temperature sensor faulty	○		○		
	Water temperature gauge faulty	○		○		
	Thermostat does not close	○				Gr 14
Fuel gauge	Fuel level sensor faulty	○		○		
	Fuel gauge faulty	○		○		

Cigarette lighter and Audio

Symptoms / Possible causes	Cigarette lighter			Audio					Remarks
	Does not glow	Does not return	Night lamp does not light up	Specific frequency band does not work	Spurious noise generated	Sound quality poor	Sound from one side only	Left and right volume different	
Defective connector connection, harness open/short circuit, defective grounding	○		○		○		○		
Fuse blown	○		○						
Cigarette lighter faulty	○	○							
Tail lamp relay faulty			○						
Antenna and antenna cable connection faulty					○				
Speaker faulty				○	○	○	○	○	
Left and right speaker impedance different								○	

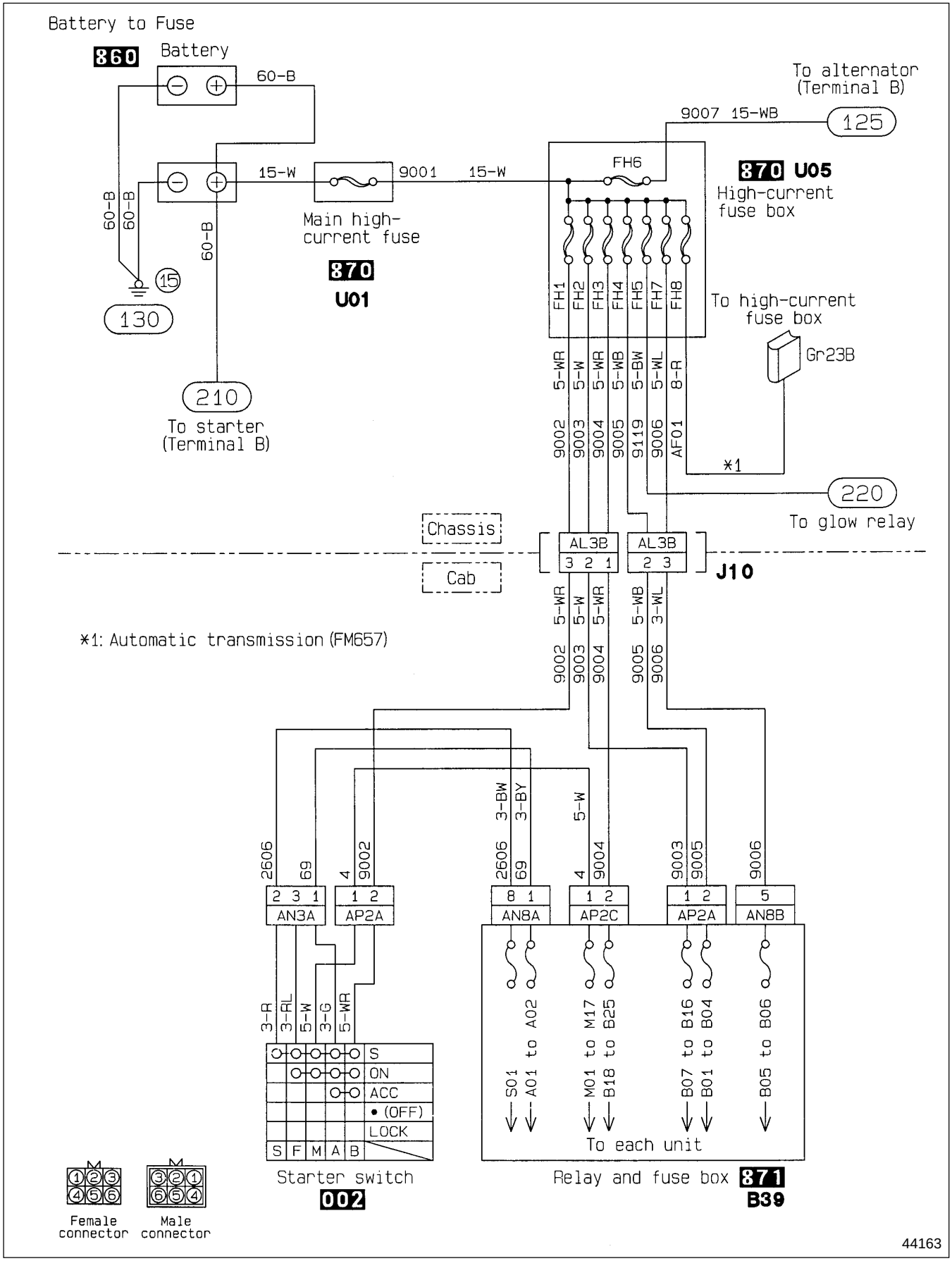
Accessory noise generation source

Accessory	Noise	Symptoms
Alternator	Whistling	High pitch sound when accelerator pedal suddenly depressed (Stops soon after engine stopped)
Water temperature gauge	Scratching	Occurs when engine running (Continues for a while after engine stops)
Engine oil pressure switch	Rattling	Depends on engine speed (Does not occur during idling)
Fuel level sensor	Scratching	Occurs when engine suddenly revved, while running on rough roads, or starter switch turned ON
Flasher unit	Banging	When turn signal blinks
Horn	Hissing	Occurs when horn button pressed or released
Wiper motor	Whining	Depends on wiper speed
Windshield washer motor	Whining	When windshield washer operates

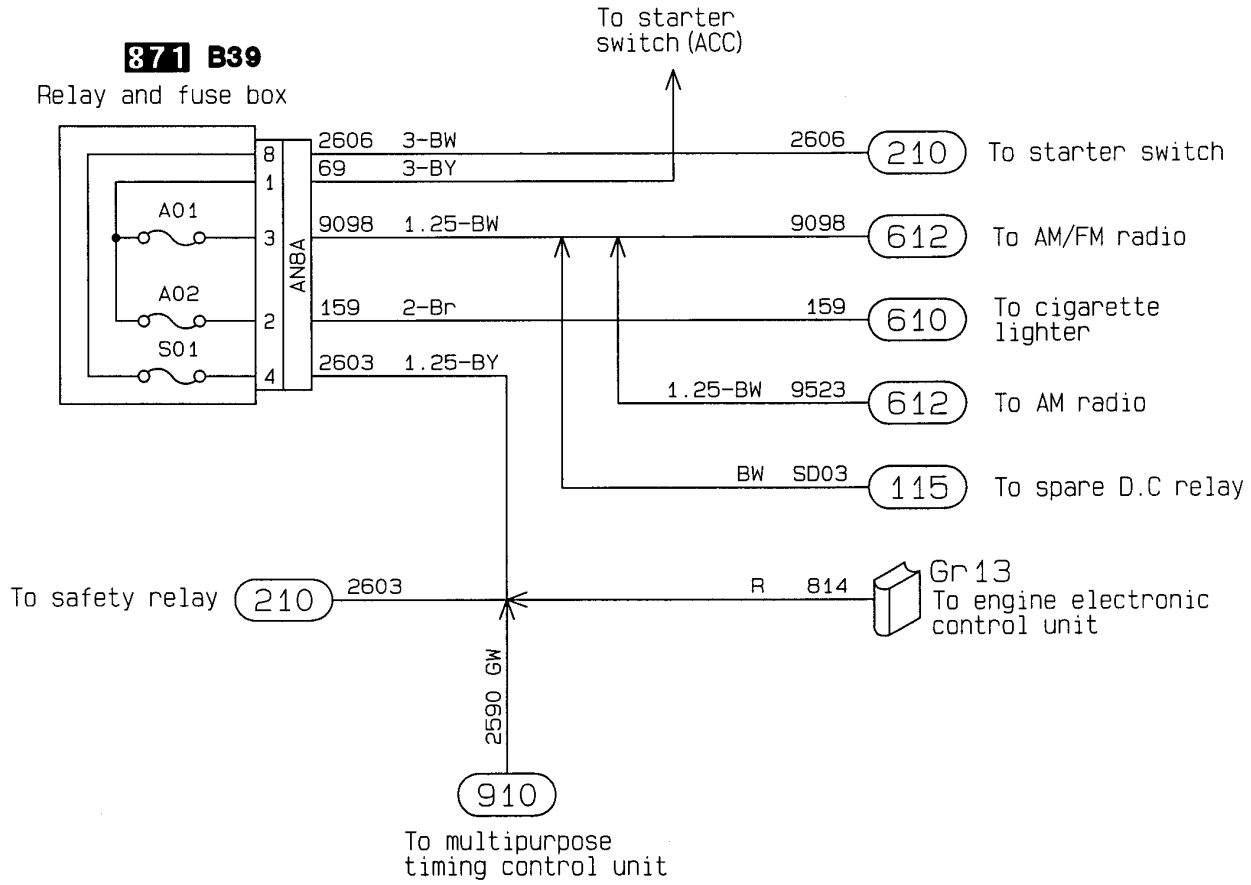
Horn

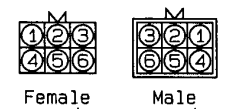
Symptoms / Possible causes	Horn				Remarks
	No Sound	Continuous sound	Small sound	Sound quality poor	
Defective connector connection, harness open/short circuit, defective grounding	○				
Fuse blown	○				
Horn switch faulty	○	○			
Horn faulty	○		○	○	
Horn stay warped			○	○	
Battery voltage insufficient	○		○		
Air leaking from air system	○		○	○	

1 POWER, CHARGE AND GROUND CIRCUIT


Battery to Fuse
860 Battery
60-B
To alternator (Terminal B)
9007 15-WB
125
15-W
9001
15-W
FH6
870 U05
High-current fuse box
60-B
60-B
60-B
Main high-current fuse
870
U01
15
130
210
To starter (Terminal B)
FH1 FH2 FH3 FH4 FH5 FH7 FH8
To high-current fuse box
Gr23B
5-WR 5-W 5-WR 5-WB 5-BW 5-WL 8-R
9002 9003 9004 9005 9119 9006 AF01
*1
220
To glow relay
Chassis
Cab
AL3B 3 2 1
AL3B 2 3
J10
*1: Automatic transmission (FM657)
5-WR 5-W 5-WR 5-WB 3-WL
9002 9003 9004 9005 9006
2606 69 4 9002
3-BW 3-BY 5-W
2606 69 4 9004
9003 9005 9006
2 3 1 AN3A
1 2 AP2A
8 1 AN8A
1 2 AP2C
1 2 AP2A
5 AN8B
3-R 3-RL 5-W 3-G 5-WR
C S ON ACC • (OFF) LOCK
S F M A B
Starter switch
002
S01 A01 to A02
M01 to M17 B18 to B25
B07 to B16 B01 to B04
B05 to B06
To each unit
Relay and fuse box 871
B39
Female connector
Male connector
44163

Fuse A01, A02, S01

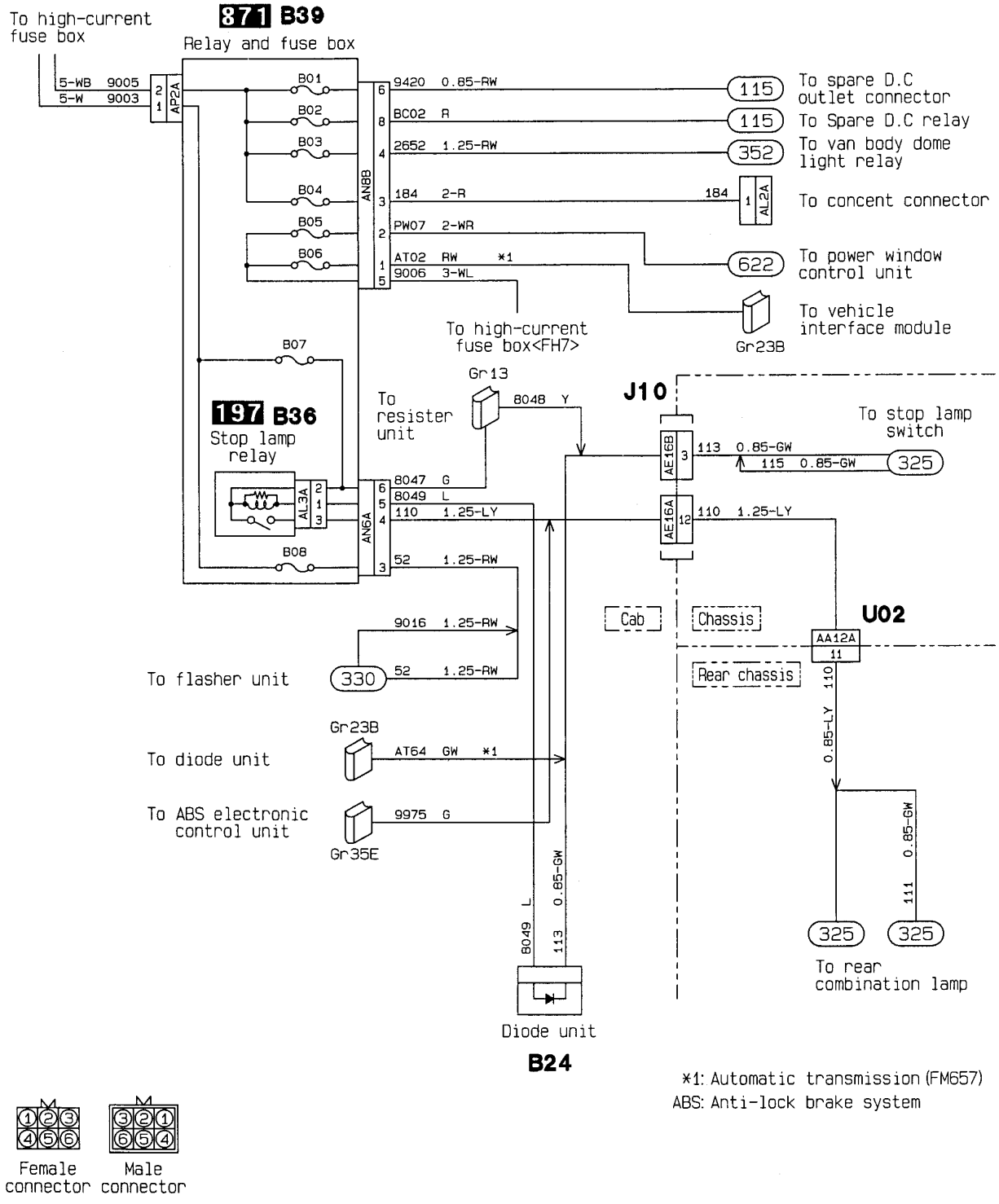




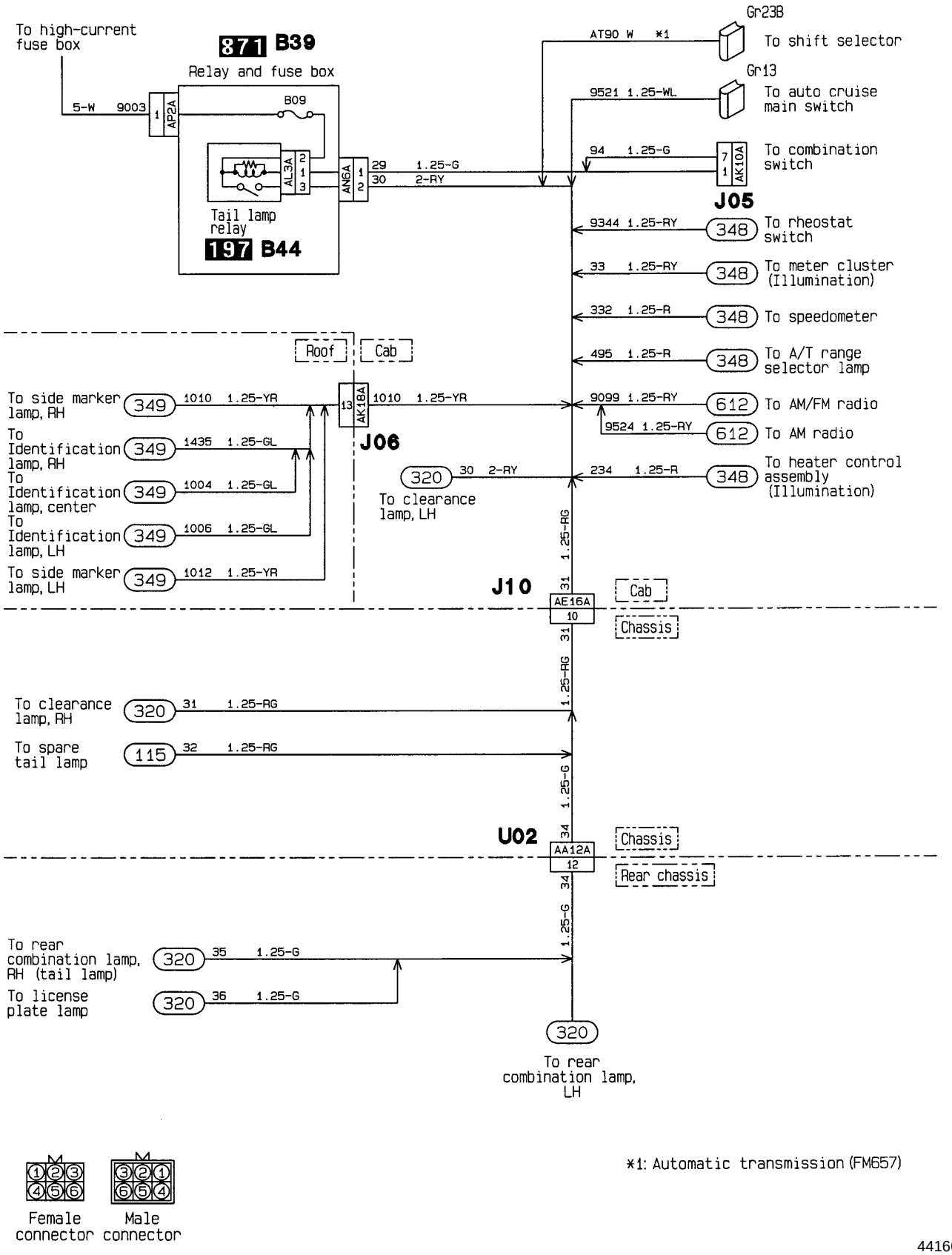
Female connector Male connector

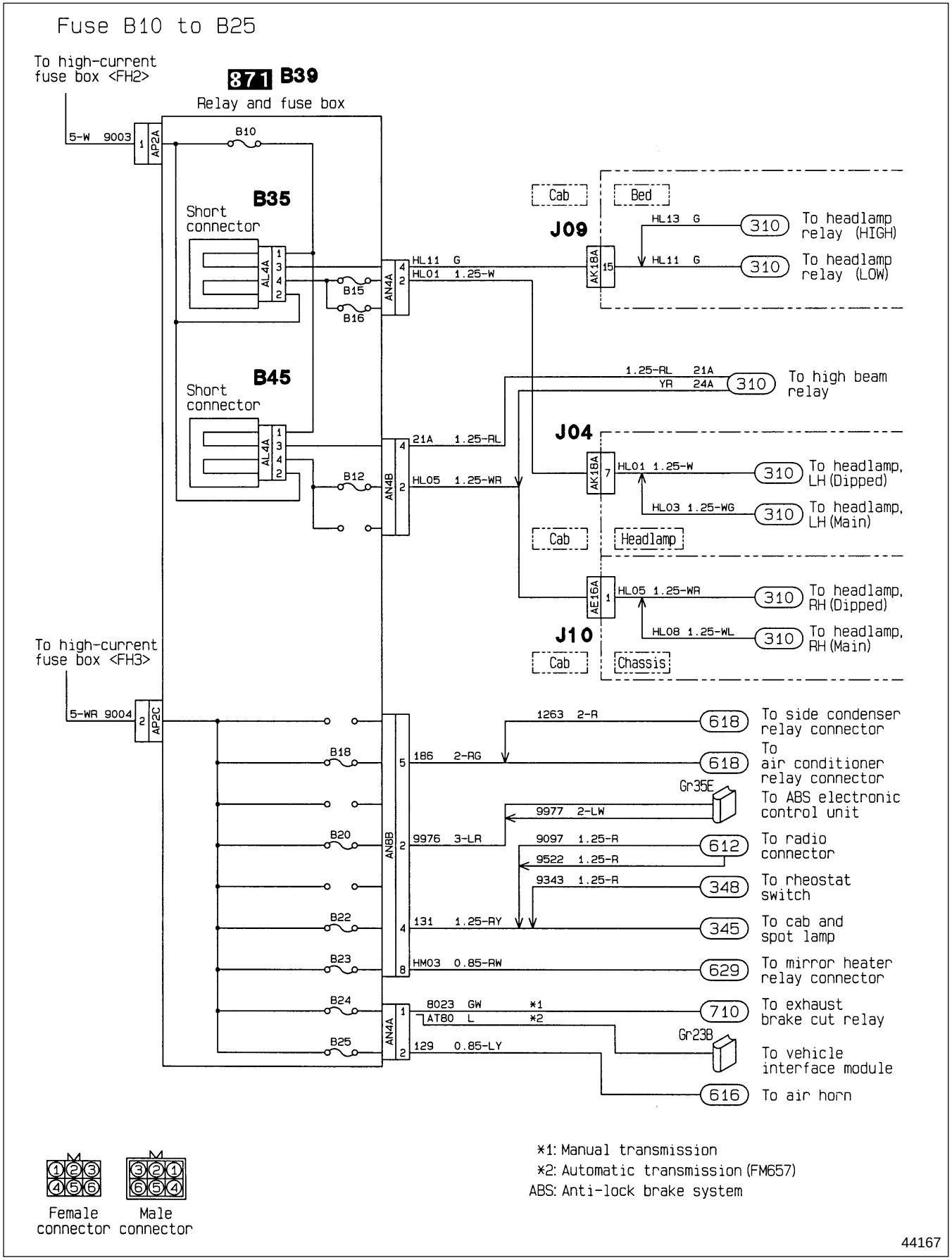
44164

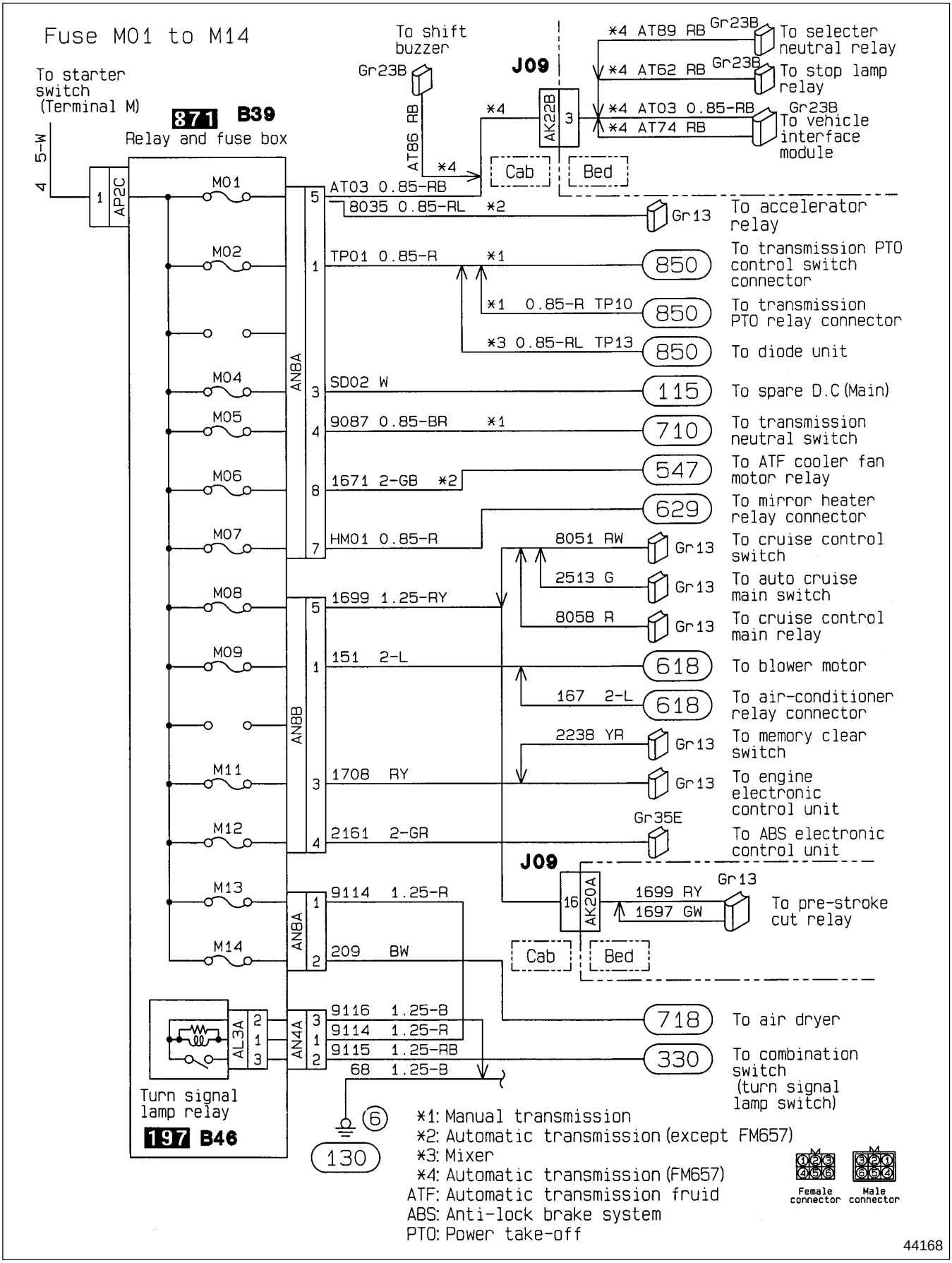
Fuse B01 to B08

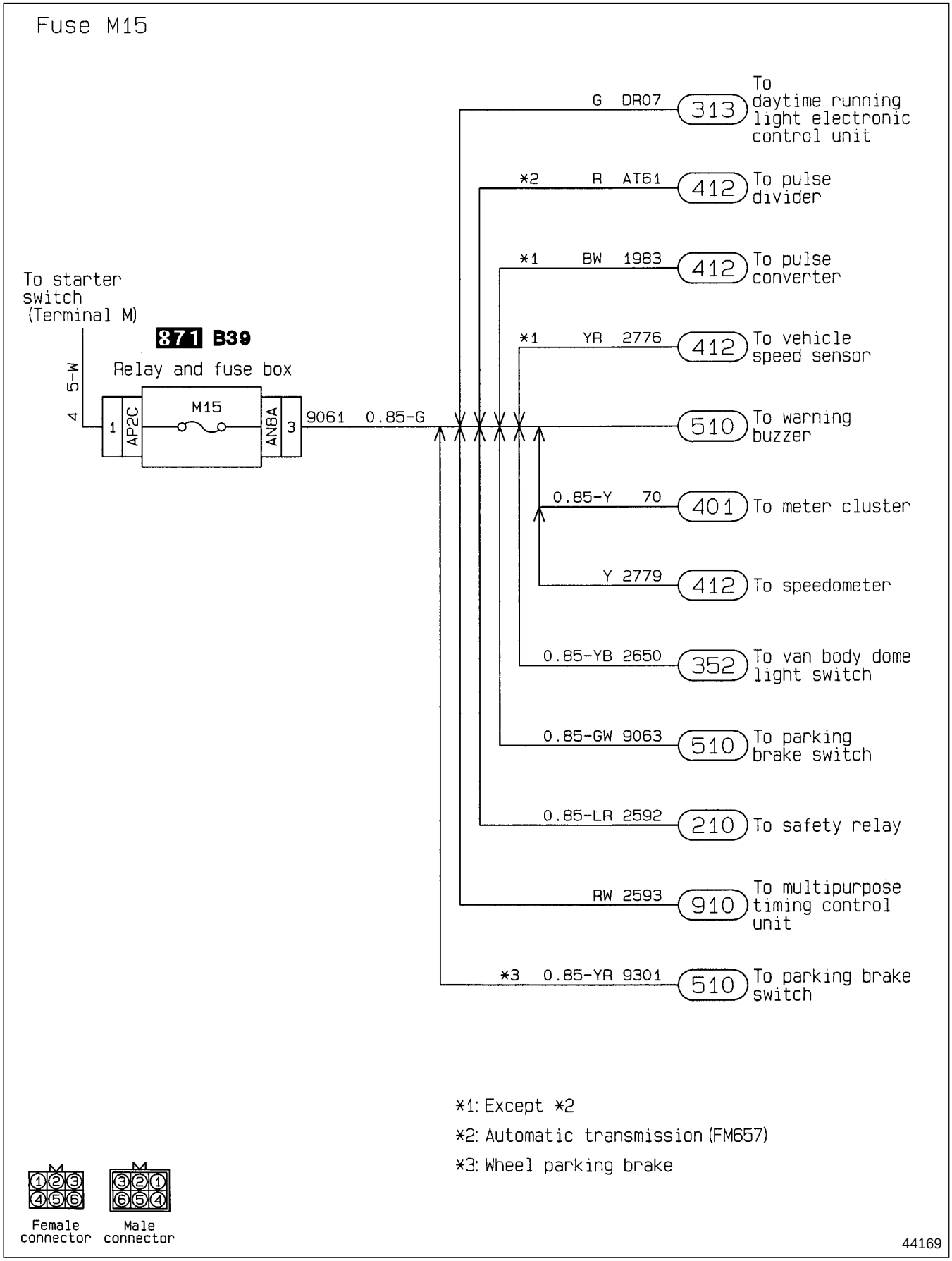


Fuse B09

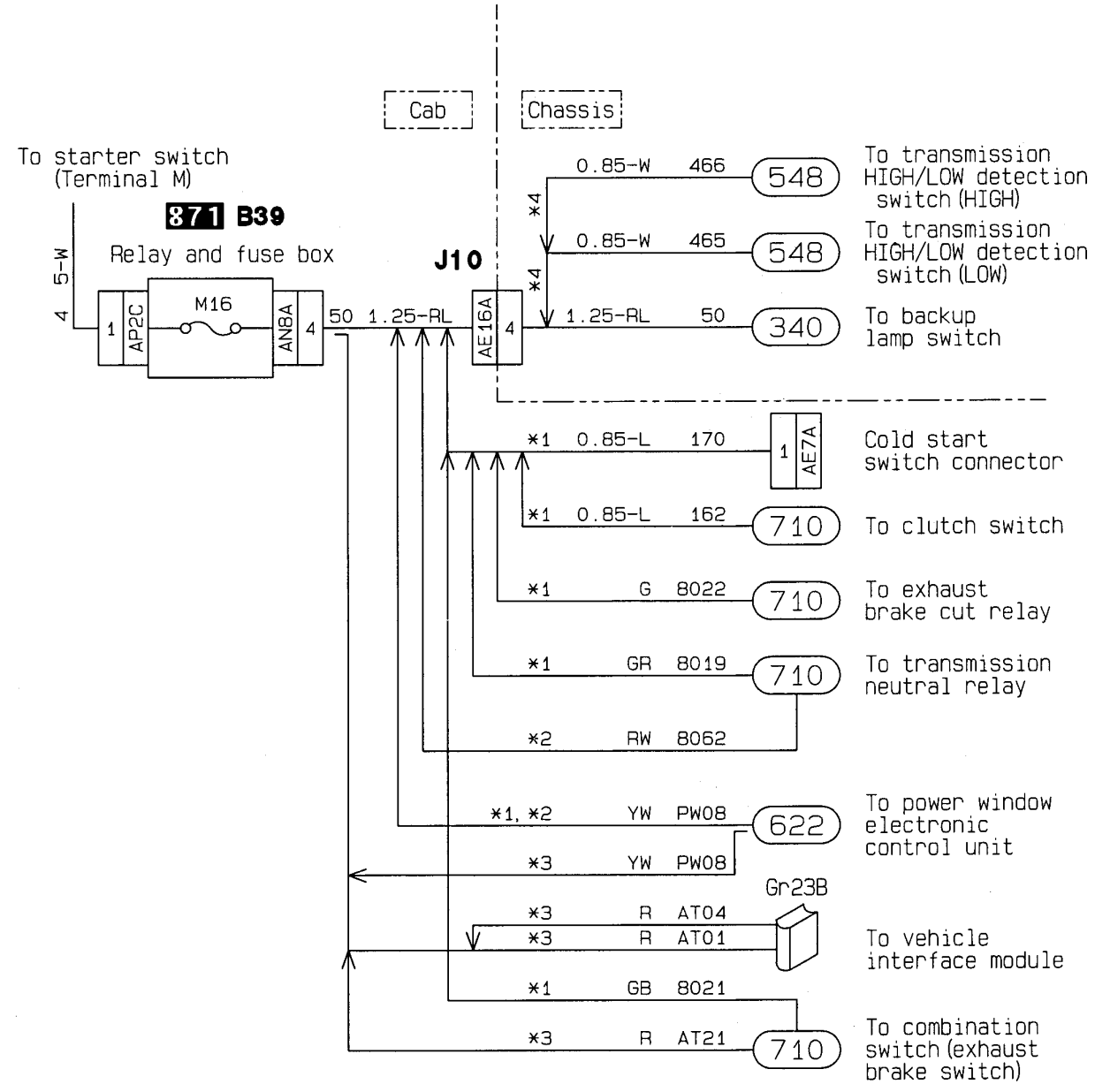

To high-current fuse box
871 B39
Relay and fuse box
5-W 9003
1 AP2A
B09
AL3A
AN6A
29 1.25-G
30 2-RY
Tail lamp relay
197 B44
Gr23B
AT90 W *1
To shift selector
Gr13
9521 1.25-WL
To auto cruise main switch
94 1.25-G
7 1 AK10A
To combination switch
J05
9344 1.25-RY 348 To rheostat switch
33 1.25-RY 348 To meter cluster (Illumination)
332 1.25-R 348 To speedometer
495 1.25-R 348 To A/T range selector lamp
9099 1.25-RY 612 To AM/FM radio
9524 1.25-RY 612 To AM radio
234 1.25-R 348 To heater control assembly (Illumination)
Roof
Cab
To side marker lamp, RH 349 1010 1.25-YR
To Identification lamp, RH 349 1435 1.25-GL
To Identification lamp, center 349 1004 1.25-GL
To Identification lamp, LH 349 1006 1.25-GL
To side marker lamp, LH 349 1012 1.25-YR
13 AK18A
1010 1.25-YR
J06
320 30 2-RY
To clearance lamp, LH
1.25-RG
J10
AE16A 10
31
Cab
Chassis
To clearance lamp, RH 320 31 1.25-RG
To spare tail lamp 115 32 1.25-RG
1.25-G
U02
AA12A 12
34
Chassis
Rear chassis
To rear combination lamp, RH (tail lamp) 320 35 1.25-G
To license plate lamp 320 36 1.25-G
320
To rear combination lamp, LH
Female connector
Male connector
*1: Automatic transmission (FM657)
44166


Fuse B10 to B25
To high-current fuse box <FH2>
871 B39
Relay and fuse box
5-W 9003
AP2A
B10
B35
Short connector
AL4A
B15
B16
AN4A
HL11 G
HL01 1.25-W
Cab
Bed
J09
AK18A
HL13 G
HL11 G
310
To headlamp relay (HIGH)
To headlamp relay (LOW)
B45
Short connector
1.25-RL 21A
YR 24A
To high beam relay
21A 1.25-RL
B12
AN4B
HL05 1.25-WR
J04
HL01 1.25-W
To headlamp, LH (Dipped)
HL03 1.25-WG
To headlamp, LH (Main)
Cab
Headlamp
AE16A
HL05 1.25-WR
To headlamp, RH (Dipped)
J10
HL08 1.25-WL
To headlamp, RH (Main)
Cab
Chassis
To high-current fuse box <FH3>
5-WR 9004
AP2C
1263 2-R
618
To side condenser relay connector
B18
186 2-RG
618
To air conditioner relay connector
Gr35E
9977 2-LW
To ABS electronic control unit
B20
AN8B
9976 3-LR
9097 1.25-R
9522 1.25-R
612
To radio connector
9343 1.25-R
348
To rheostat switch
B22
131 1.25-RY
345
To cab and spot lamp
B23
HM03 0.85-RW
629
To mirror heater relay connector
B24
8023 GW *1
AT80 L *2
710
To exhaust brake cut relay
Gr23B
B25
AN4A
129 0.85-LY
To vehicle interface module
616
To air horn
Female connector
Male connector
*1: Manual transmission
*2: Automatic transmission (FM657)
ABS: Anti-lock brake system
44167


Fuse M01 to M14
To starter switch (Terminal M)
4 5-W
871 B39
Relay and fuse box
1 AP2C
M01
M02
M04
M05
M06
M07
M08
M09
M11
M12
M13
M14
AN8A
AN8B
AN4A
AL3A
To shift buzzer
Gr23B
AT86 RB
*4
J09
AK22B 3
*4 AT89 RB Gr23B To selecter neutral relay
*4 AT62 RB Gr23B To stop lamp relay
*4 AT03 0.85-RB
*4 AT74 RB
Gr23B To vehicle interface module
Cab
Bed
AT03 0.85-RB
8035 0.85-RL *2
Gr13 To accelerator relay
TP01 0.85-R *1
850 To transmission PTO control switch connector
*1 0.85-R TP10 850 To transmission PTO relay connector
*3 0.85-RL TP13 850 To diode unit
SD02 W
115 To spare D.C (Main)
9087 0.85-BR *1
710 To transmission neutral switch
1671 2-GB *2
547 To ATF cooler fan motor relay
629 To mirror heater relay connector
HM01 0.85-R
8051 RW Gr13 To cruise control switch
2513 G Gr13 To auto cruise main switch
8058 R Gr13 To cruise control main relay
1699 1.25-RY
151 2-L
618 To blower motor
167 2-L 618 To air-conditioner relay connector
2238 YR Gr13 To memory clear switch
1708 RY
Gr13 To engine electronic control unit
Gr35E
2161 2-GR To ABS electronic control unit
J09
16 AK20A
1699 RY
1697 GW
Gr13 To pre-stroke cut relay
9114 1.25-R
209 BW
9116 1.25-B
9114 1.25-R
9115 1.25-RB
68 1.25-B
718 To air dryer
330 To combination switch (turn signal lamp switch)
Turn signal lamp relay
197 B46
6
130
*1: Manual transmission
*2: Automatic transmission (except FM657)
*3: Mixer
*4: Automatic transmission (FM657)
ATF: Automatic transmission fruid
ABS: Anti-lock brake system
PTO: Power take-off
Female connector
Male connector
44168


Fuse M15
To starter switch (Terminal M)
871 B39
Relay and fuse box
5-W
4
1
AP2C
M15
ANBA
3
9061 0.85-G
G DR07
313
To daytime running light electronic control unit
*2 R AT61
412
To pulse divider
*1 BW 1983
412
To pulse converter
*1 YR 2776
412
To vehicle speed sensor
510
To warning buzzer
0.85-Y 70
401
To meter cluster
Y 2779
412
To speedometer
0.85-YB 2650
352
To van body dome light switch
0.85-GW 9063
510
To parking brake switch
0.85-LR 2592
210
To safety relay
RW 2593
910
To multipurpose timing control unit
*3 0.85-YR 9301
510
To parking brake switch
*1: Except *2
*2: Automatic transmission (FM657)
*3: Wheel parking brake
Female connector
Male connector
44169

Fuse M16

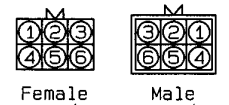


*1: Manual transmission

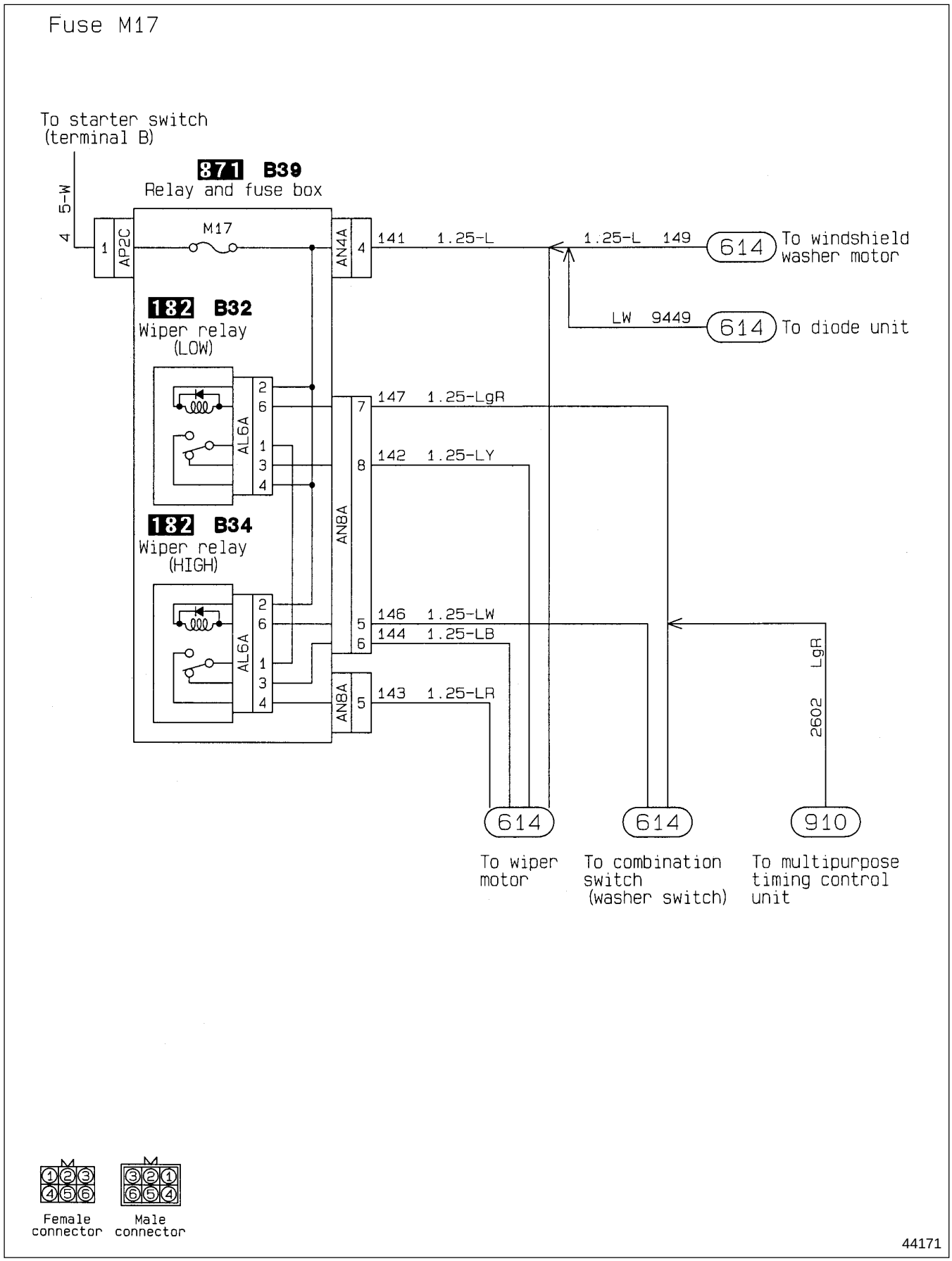
*2: Automatic transmission (except FM657)

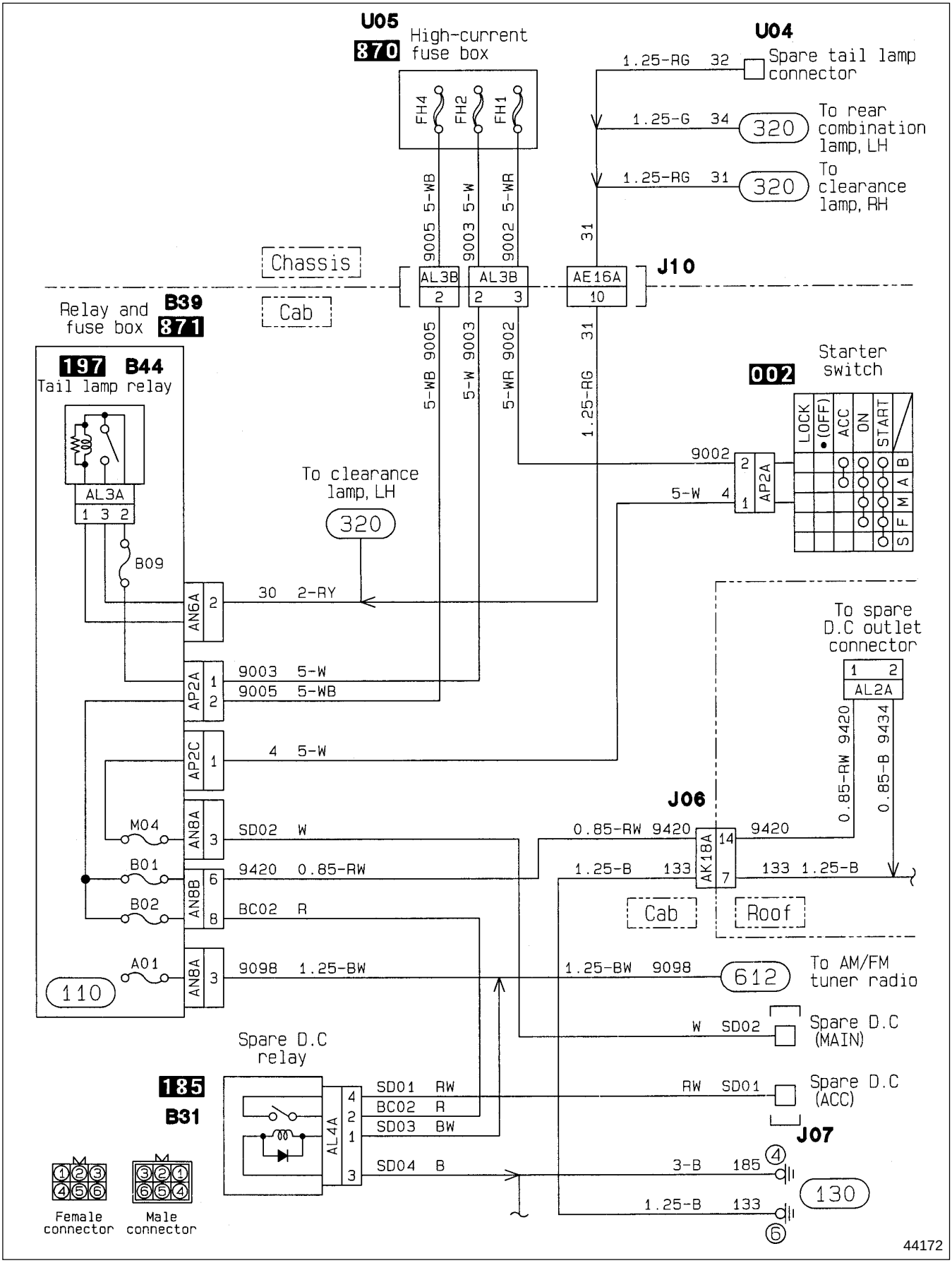
*3: Automatic transmission (FM657)

*4: FM657<10 speed>

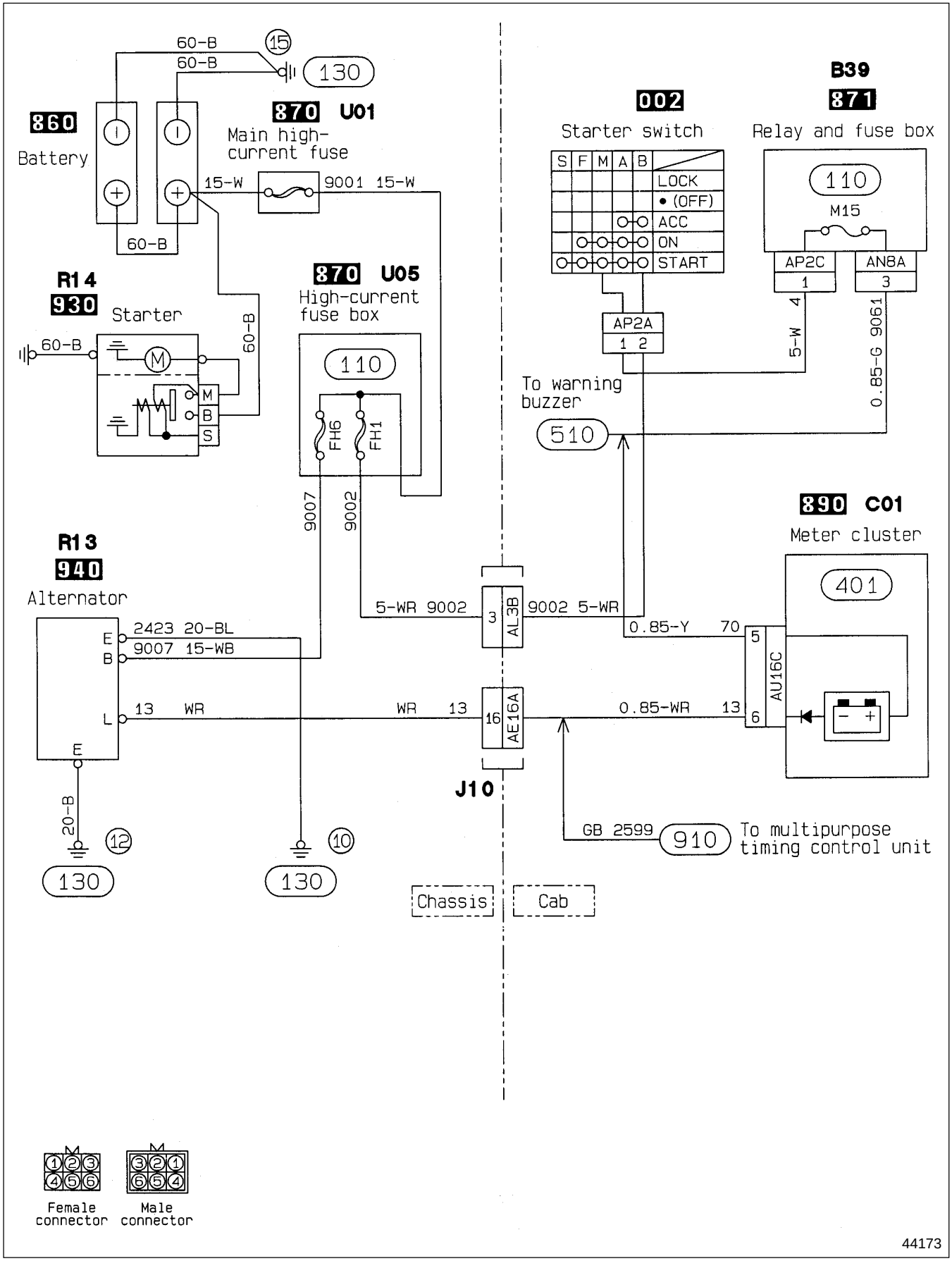


44170


Fuse M17
To starter switch
(terminal B)
4 5-W
871 B39
Relay and fuse box
1 AP2C
M17
AN4A 4
141 1.25-L
1.25-L 149
614
To windshield washer motor
LW 9449
614
To diode unit
182 B32
Wiper relay
(LOW)
AL6A
2
6
1
3
4
AN8A
7
147 1.25-LgR
8
142 1.25-LY
182 B34
Wiper relay
(HIGH)
AL6A
2
6
1
3
4
AN8A
5
146 1.25-LW
6
144 1.25-LB
AN8A 5
143 1.25-LR
2602 LgR
614
614
910
To wiper motor
To combination switch (washer switch)
To multipurpose timing control unit
Female connector
Male connector
44171

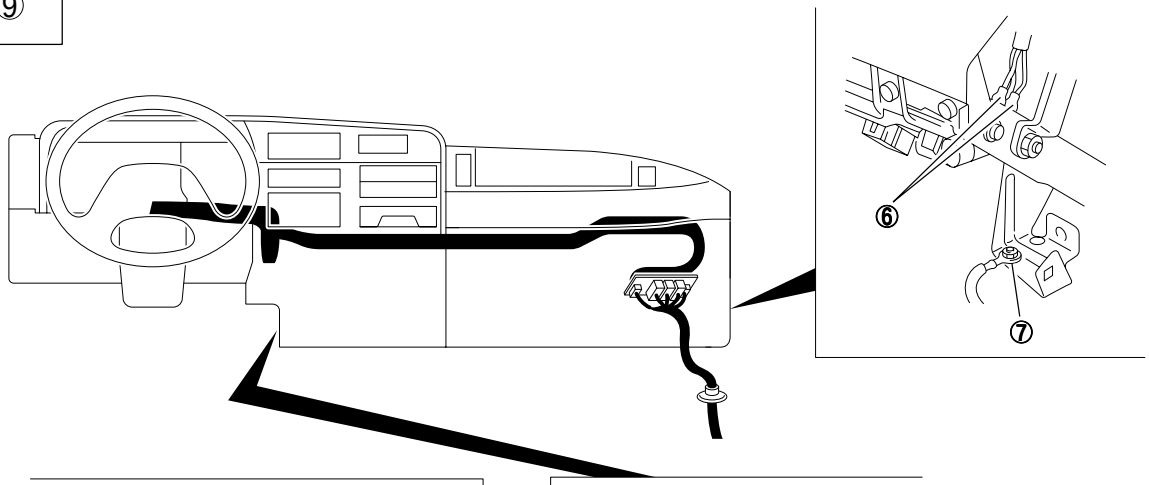

U05
870 High-current fuse box
FH4
FH2
FH1
U04
1.25-RG 32 Spare tail lamp connector
1.25-G 34 320 To rear combination lamp, LH
1.25-RG 31 320 To clearance lamp, RH
9005 5-WB
9003 5-W
9002 5-WR
31
Chassis
Cab
AL3B
AL3B
AE16A
J10
Relay and fuse box B39 871
197 B44
Tail lamp relay
AL3A
1 3 2
B09
5-WB 9005
5-W 9003
5-WR 9002
1.25-RG 31
002 Starter switch
LOCK
• (OFF)
ACC
ON
START
B
A
M
S
F
9002
5-W 4
AP2A
To clearance lamp, LH
320
AN6A 2 30 2-RY
AP2A 1 9003 5-W
2 9005 5-WB
AP2C 1 4 5-W
To spare D.C outlet connector
AL2A
0.85-RW 9420
0.85-B 9434
J06
M04
B01
B02
A01
AN8A 3 SD02 W
AN8B 6 9420 0.85-RW
8 BC02 R
AN8A 3 9098 1.25-BW
0.85-RW 9420
AK18A 14 9420
1.25-B 133
7 133 1.25-B
Cab
Roof
110
1.25-BW 9098 612 To AM/FM tuner radio
W SD02 Spare D.C (MAIN)
Spare D.C relay
185
B31
AL4A
4 SD01 RW
2 BC02 R
1 SD03 BW
3 SD04 B
RW SD01 Spare D.C (ACC)
J07
3-B 185 ④
130
1.25-B 133 ⑥
Female connector
Male connector
44172

125 BATTERY CHARGING CIRCUIT

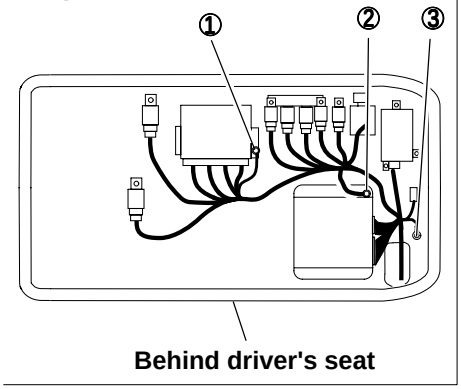


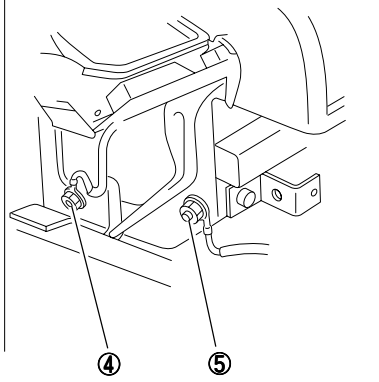
Ground Point < Cab side >

① to ⑨

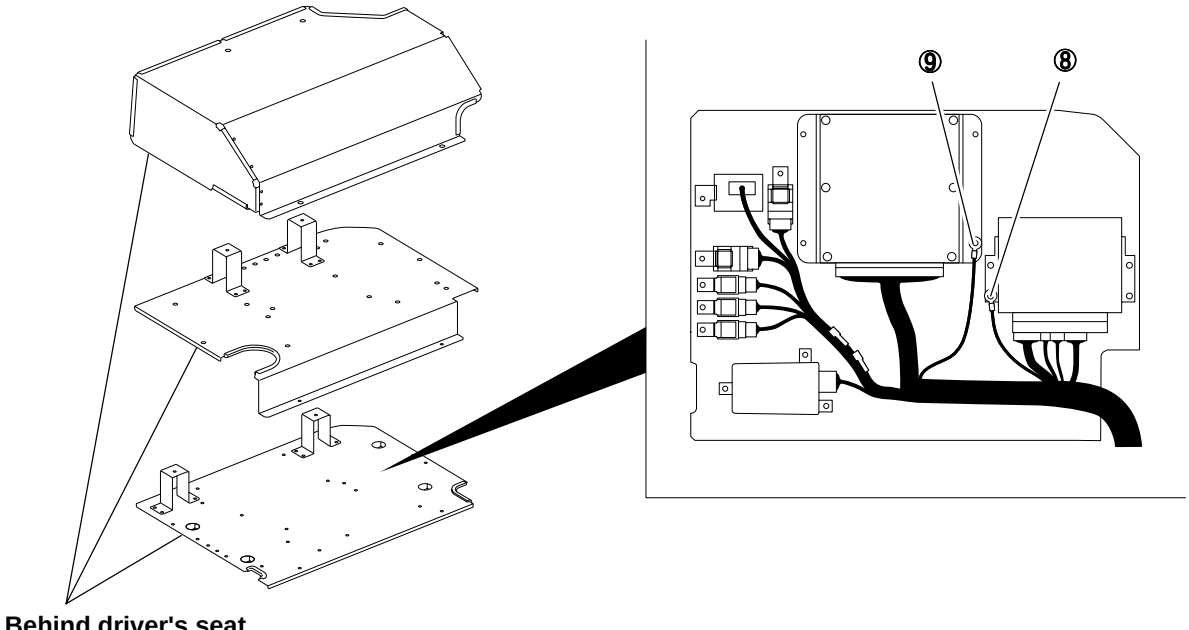


<Except FM657>



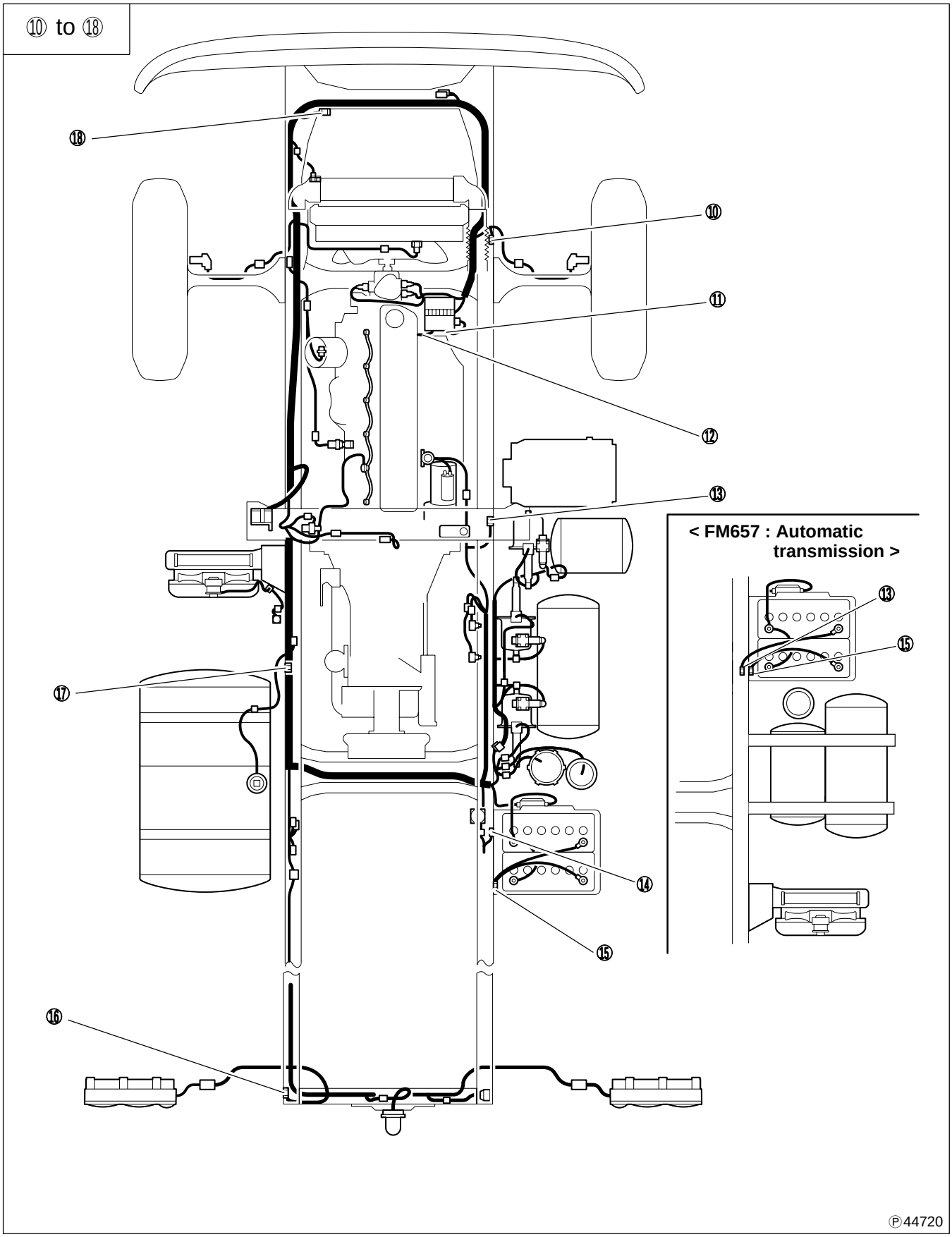


<FM657>

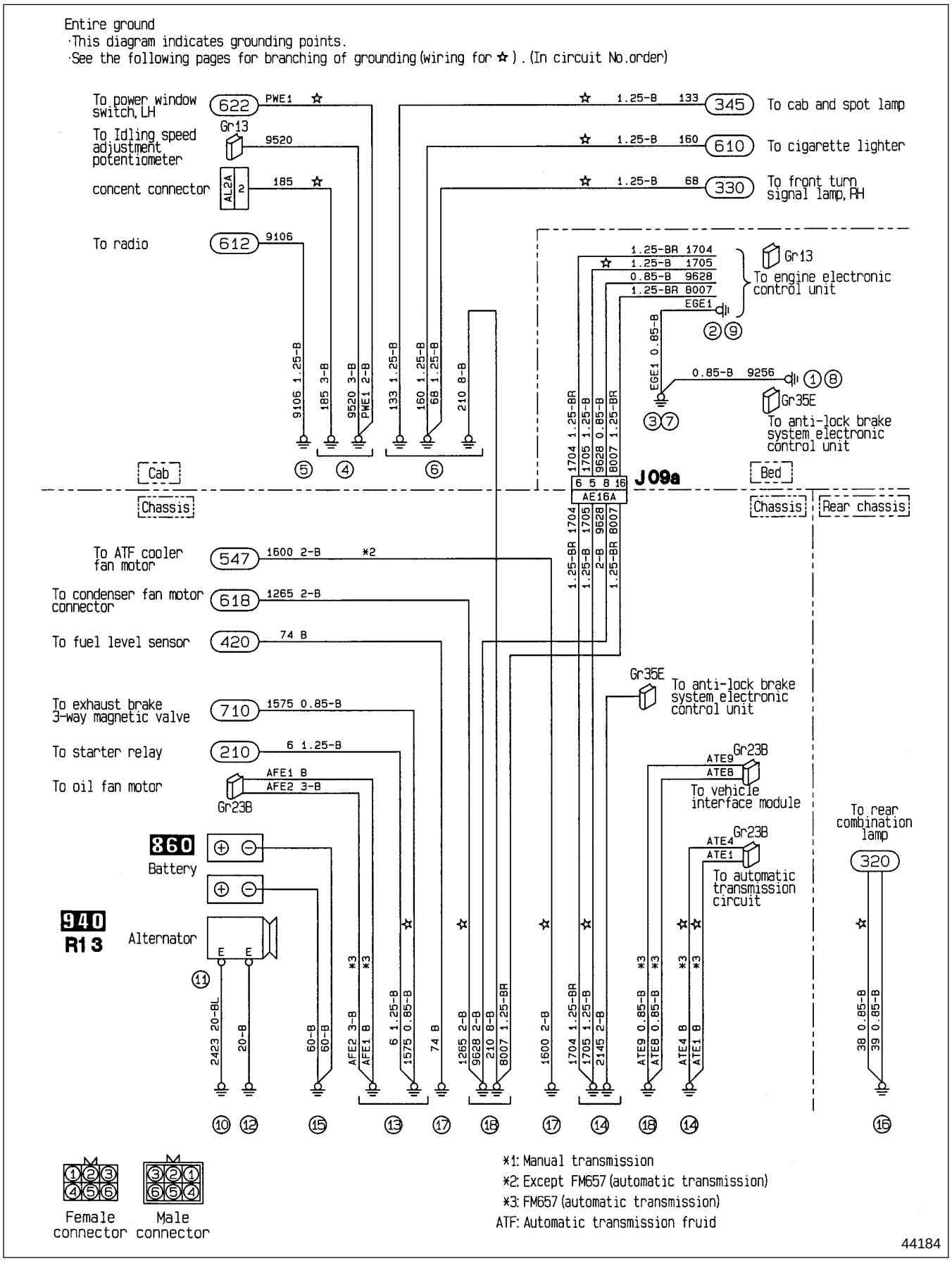


Ⓟ44737

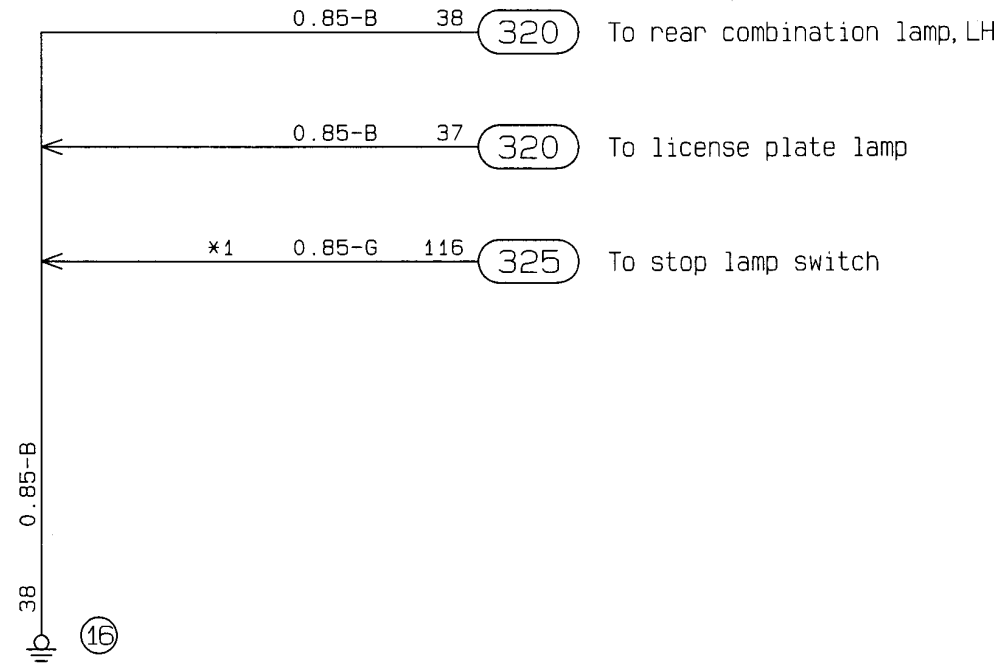
Ground Point < Chassis side >



Location	Circuit No.	Wire diameter—wire color	Remarks
①	9256	0.85-B	Except FM657 : Automatic transmission
②	EGE1	0.85-B	Except FM657 : Automatic transmission
③	9256	0.85-B	Except FM657 : Automatic transmission
	EGE1	0.85-B	Except FM657 : Automatic transmission
④	185	3-B	
	9520	3-B	
	PWE1	2-B	
⑤	9106	1.25-B	
⑥	68	1.25-B	
	133	1.25-B	
	160	1.25-B	
	210	8-B	
⑦	9256	0.85-B	FM657 : Automatic transmission
	EGE1	0.85-B	FM657 : Automatic transmission
⑧	9256	0.85-B	FM657 : Automatic transmission
⑨	EGE1	0.85-B	FM657 : Automatic transmission
⑩	2423	20-BL	
⑪	2423	20-BL	
⑫	–	20-B	Alternator ground
⑬	6	1.25-B	
	1575	0.85-B	
	1704	1.25-BR	FM657
	1705	1.25-B	FM657
	2145	2-B	FM657
	AFE1	3-B	FM657 : Automatic transmission
	AFE2	3-B	FM657 : Automatic transmission
	ATE1	B	FM657 : Automatic transmission
	ATE4	B	FM657 : Automatic transmission
⑭	1704	1.25-BR	Except FM657
	1705	1.25-B	Except FM657
	2145	2-B	Except FM657
⑮	–	60-B	Battery ground
⑯	38	0.85-B	
	39	0.85-B	
⑰	74	B	
	1600	2-B	
⑱	210	8-B	
	1265	2-B	
	8007	1.25-BR	
	9628	2-B	
	ATE8	0.85-B	FM657 : Automatic transmission
	ATE9	0.85-B	FM657 : Automatic transmission


Entire ground
·This diagram indicates grounding points.
·See the following pages for branching of grounding (wiring for ☆). (In circuit No. order)
To power window switch, LH
622
PWE1
To Idling speed adjustment potentiometer
Gr13
9520
concent connector
AL2A
2
185
To radio
612
9106
☆ 1.25-B 133
345
To cab and spot lamp
☆ 1.25-B 160
610
To cigarette lighter
☆ 1.25-B 68
330
To front turn signal lamp, RH
1.25-BR 1704
1.25-B 1705
0.85-B 9628
1.25-BR 8007
Gr13
To engine electronic control unit
EGE1
2 9
0.85-B 9256
1 8
Gr35E
To anti-lock brake system electronic control unit
3 7
9106 1.25-B
185 3-B
9520 3-B
PWE1 2-B
133 1.25-B
160 1.25-B
68 1.25-B
210 8-B
5
4
6
Cab
Chassis
J09a
6 5 8 16
AE16A
Bed
Chassis
Rear chassis
To ATF cooler fan motor
547
1600 2-B
*2
To condenser fan motor connector
618
1265 2-B
To fuel level sensor
420
74 B
To exhaust brake 3-way magnetic valve
710
1575 0.85-B
To starter relay
210
6 1.25-B
To oil fan motor
AFE1 B
AFE2 3-B
Gr23B
860
Battery
940
R13
Alternator
E E
11
2423 20-BL
20-B
60-B
60-B
AFE2 3-B
AFE1 B
6 1.25-B
1575 0.85-B
74 B
1265 2-B
9628 2-B
210 8-B
8007 1.25-BR
1600 2-B
1704 1.25-BR
1705 1.25-B
2145 2-B
ATE9 0.85-B
ATE8 0.85-B
ATE4 B
ATE1 B
*3
10 12 15 13 17 18 17 14 18 14
Gr35E
To anti-lock brake system electronic control unit
Gr23B
ATE9
ATE8
To vehicle interface module
Gr23B
ATE4
ATE1
To automatic transmission circuit
To rear combination lamp
320
38 0.85-B
39 0.85-B
16
Female connector
Male connector
*1: Manual transmission
*2: Except FM657 (automatic transmission)
*3: FM657 (automatic transmission)
ATF: Automatic transmission fruid
44184

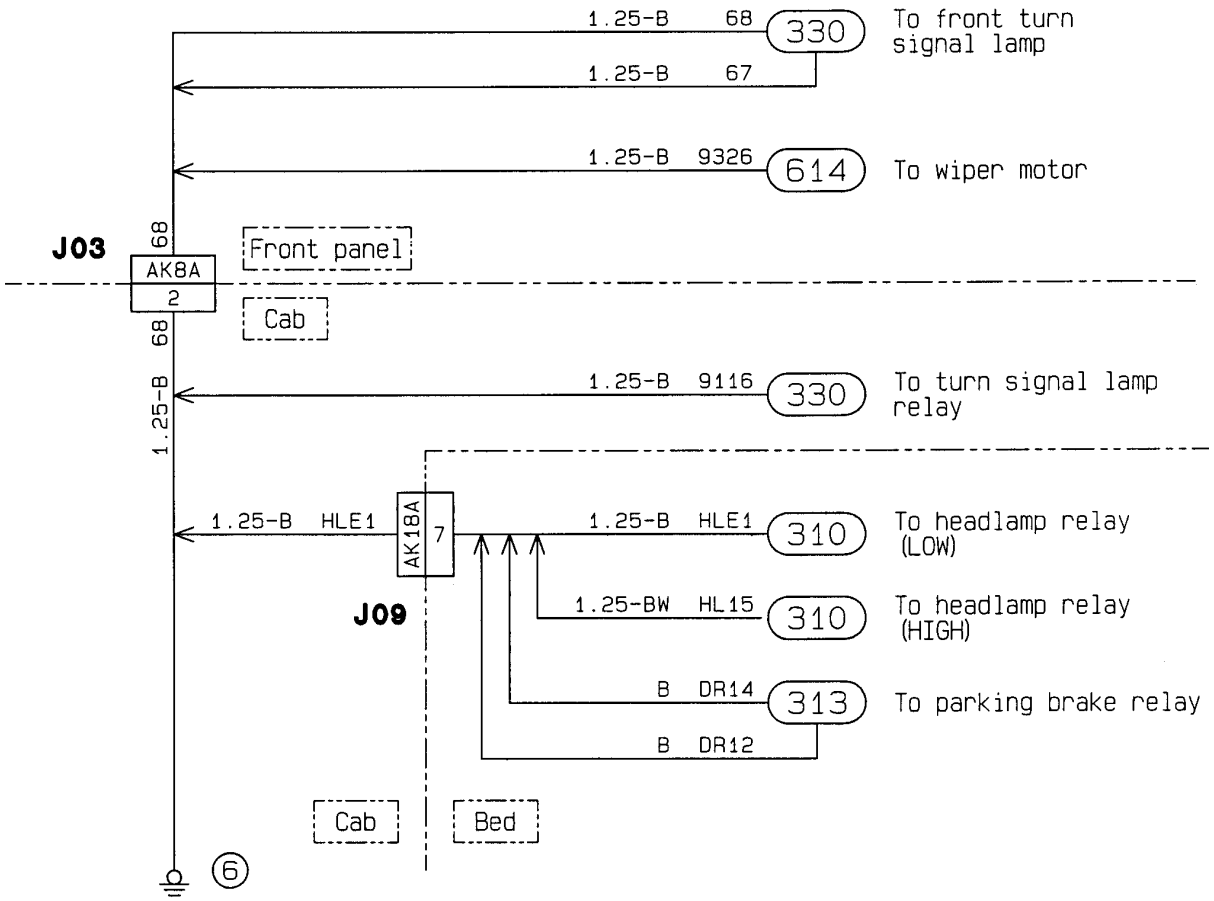
Circuit No.38 Rear Chassis Ground

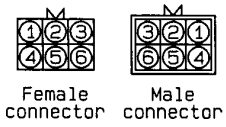


*1: Wheel parking brake

44174

Circuit No.68 Cab Ground

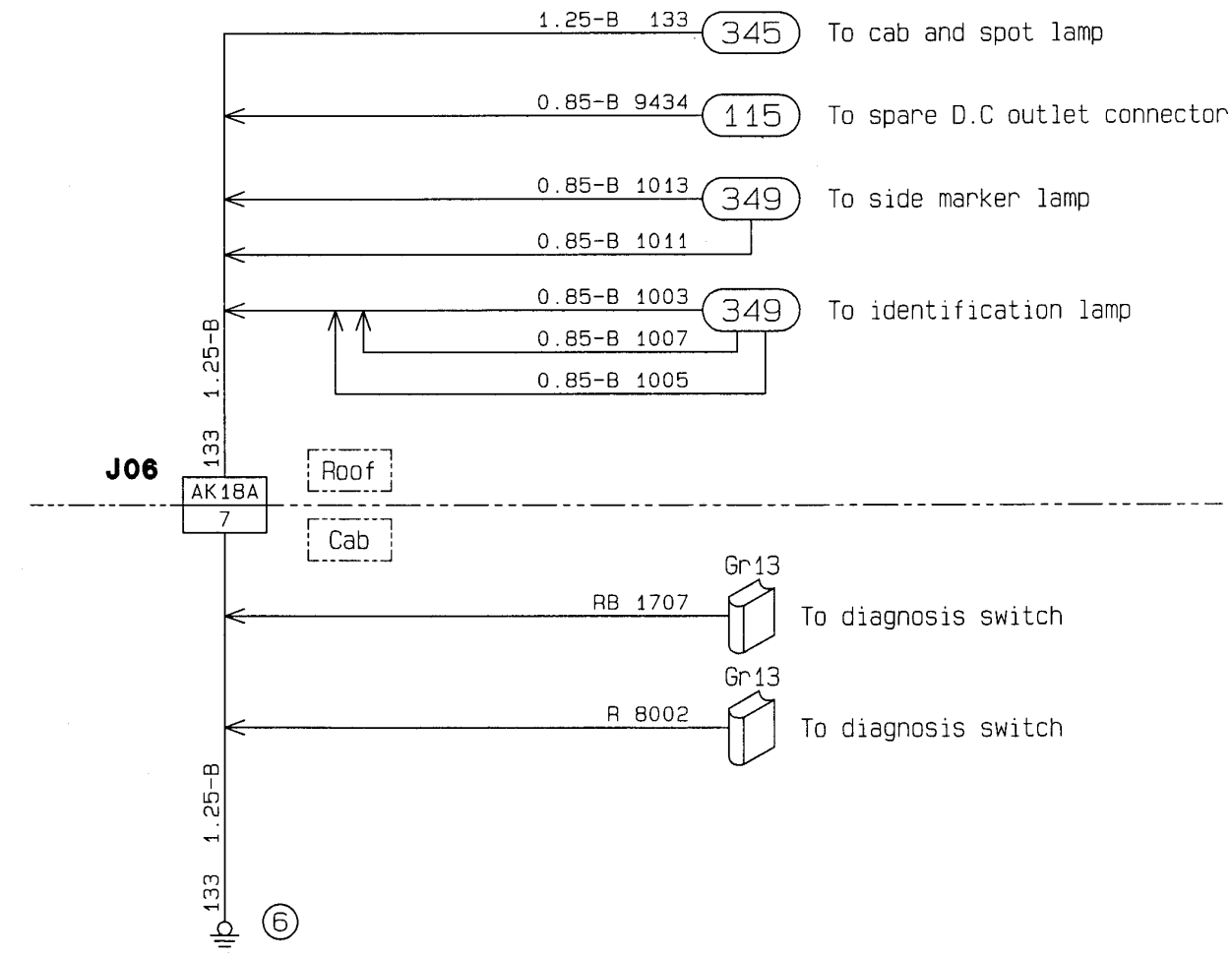


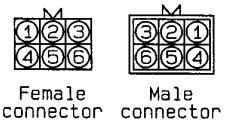


Female connector Male connector

44175

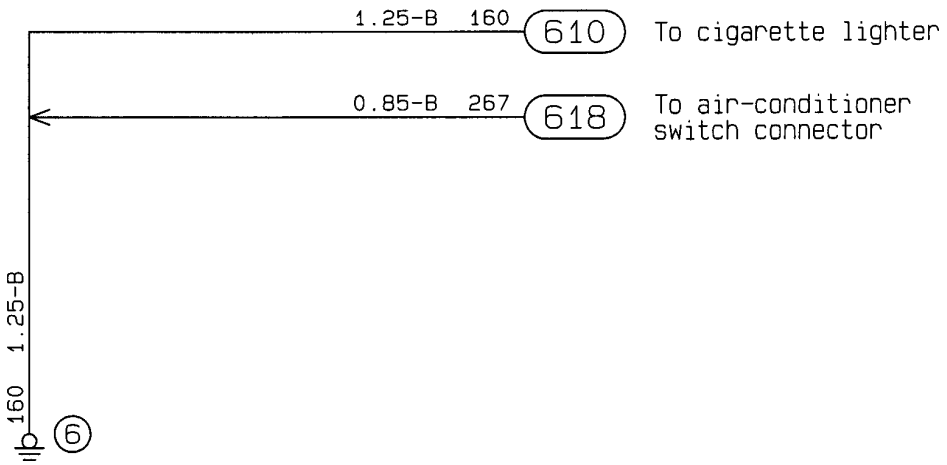
Circuit No.133 Cab Ground





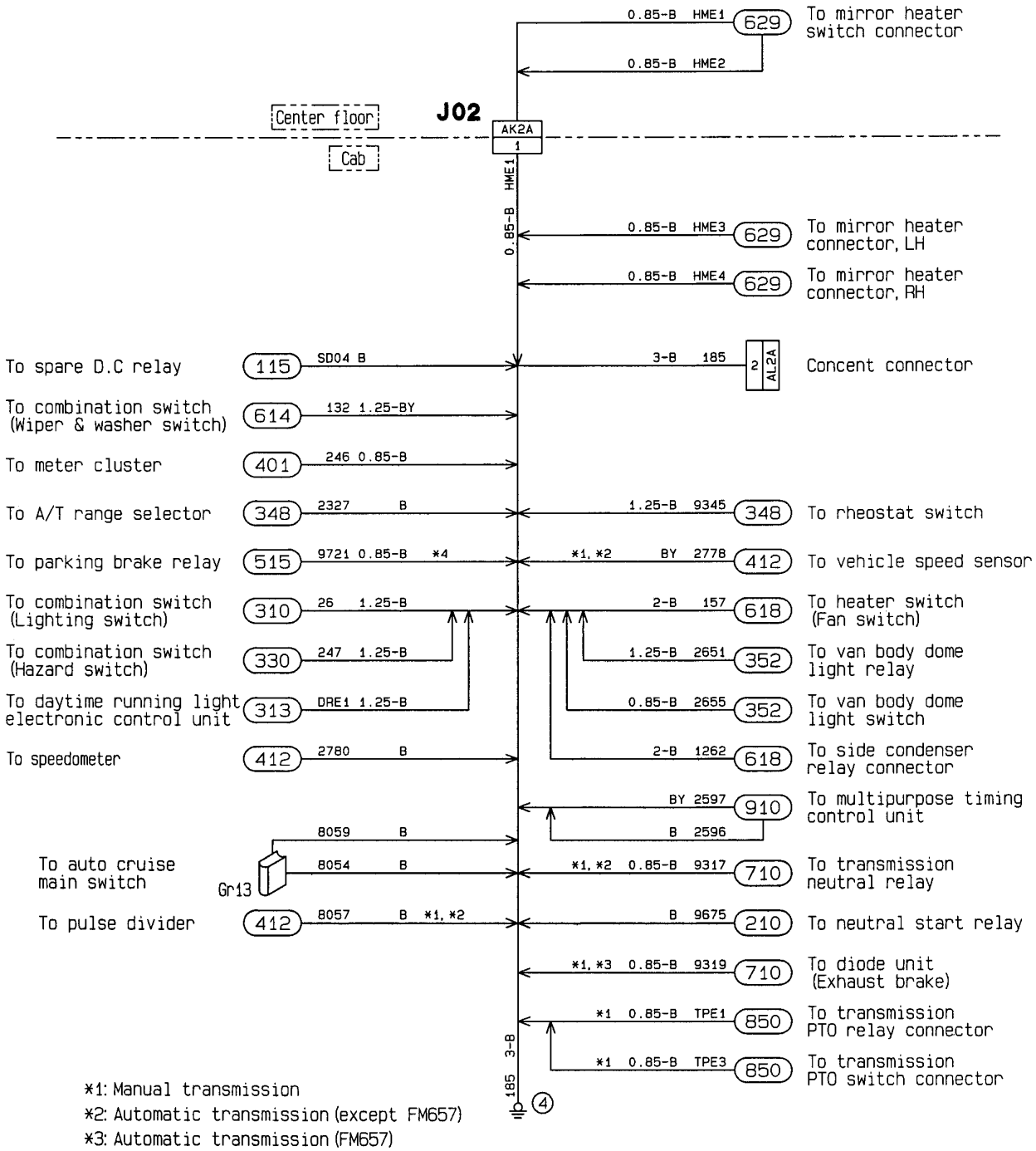
44176

Circuit No.160 Cab Ground

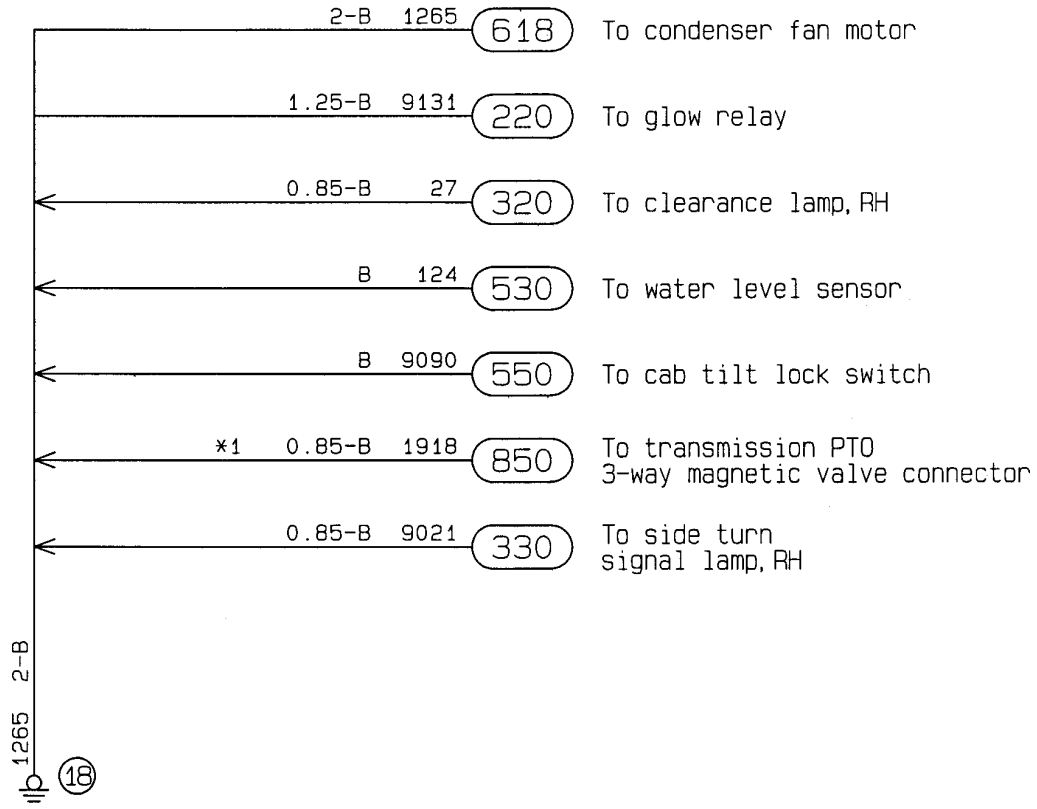


44177

Circuit No.185 Cab Ground



Circuit No.1265 Cassis Ground

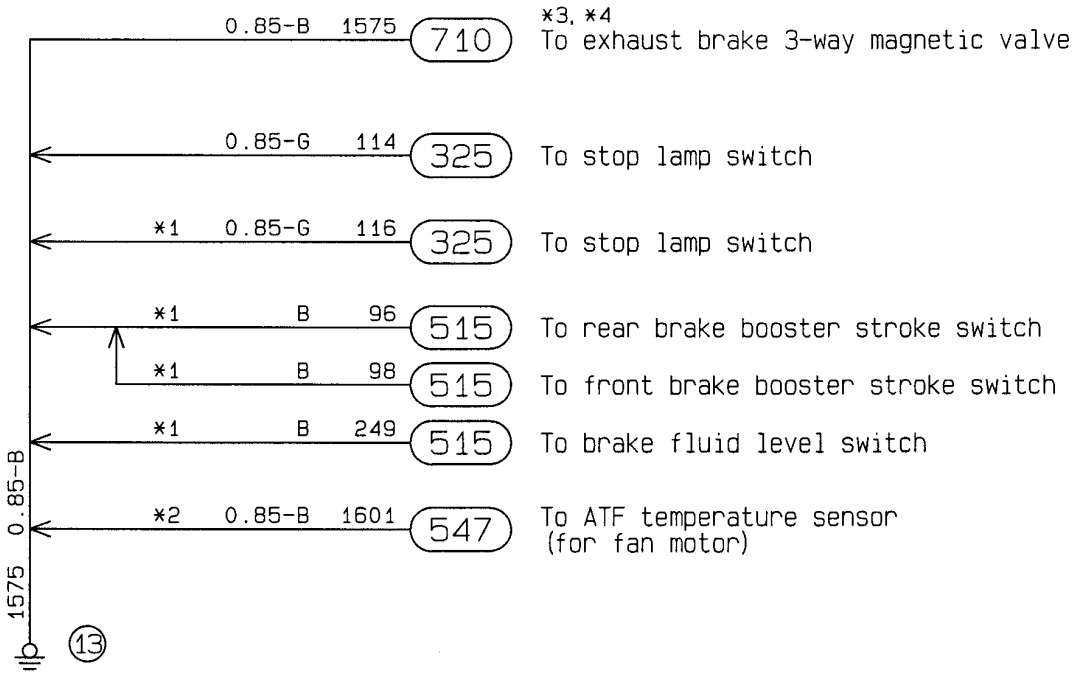


*1: Manual transmission

PTO: Power take-off

44179

Circuit No.1575 Chassis Ground



*1: Center parking brake

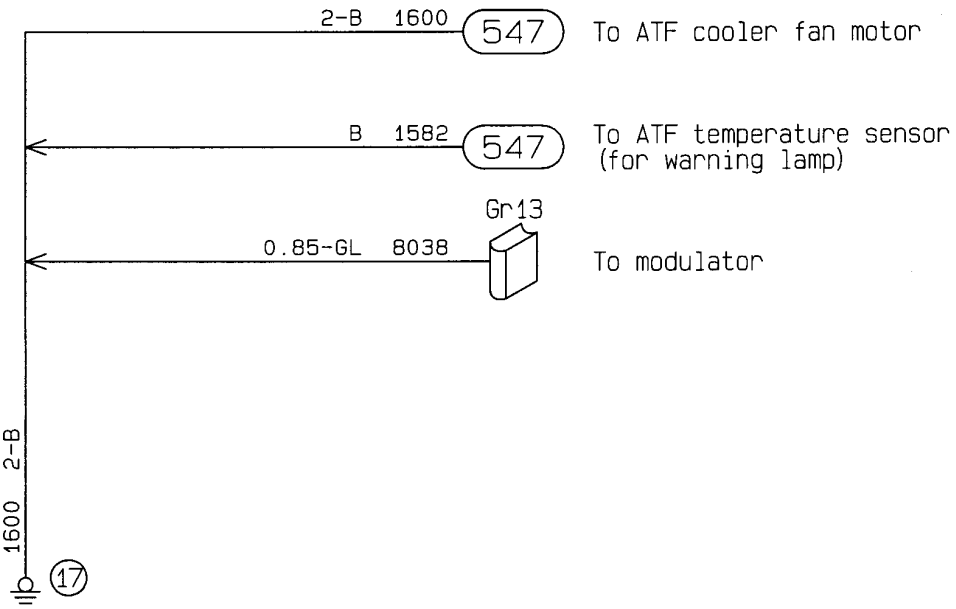
*2: Automatic transmission (except FM657)

*3: Manual transmission

*4: Automatic transmission (FM657)

44180

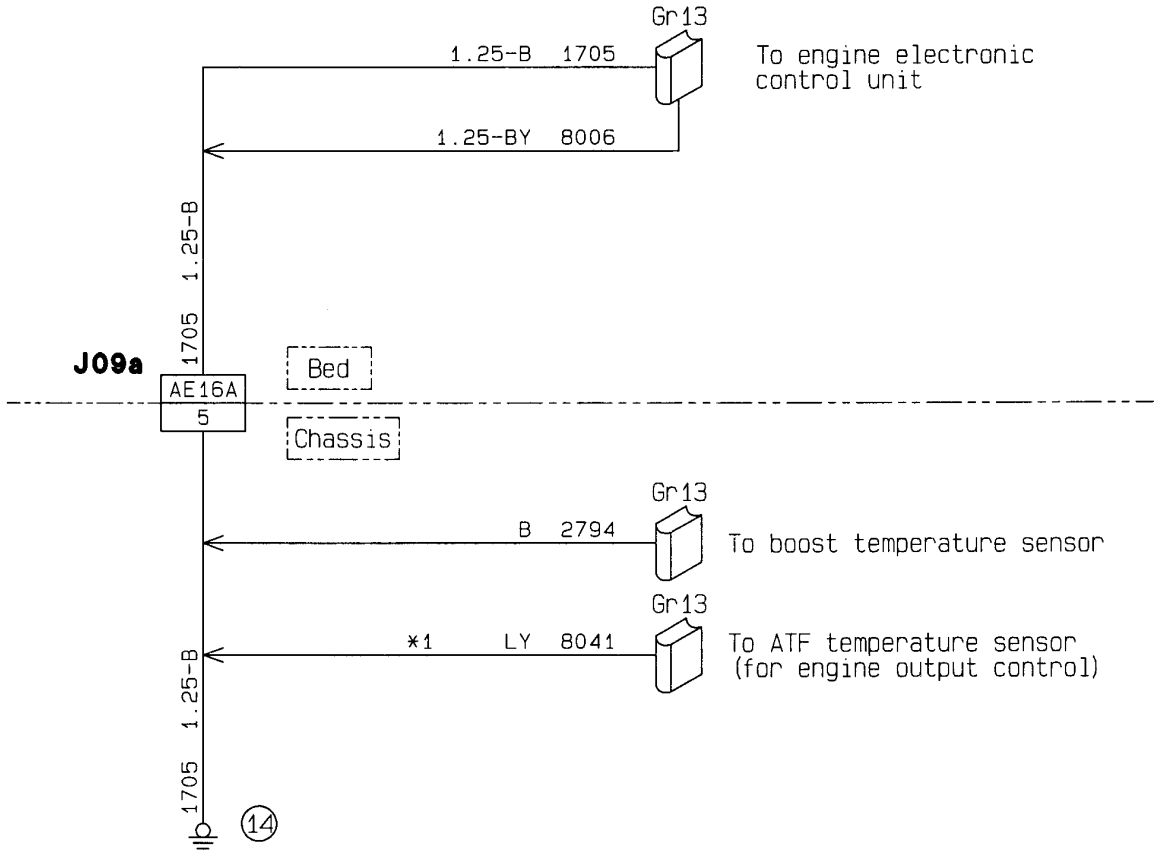
Circuit No.1600 Chassis Ground
<Automatic transmission(except FM657)>



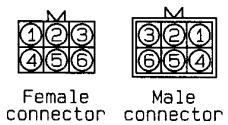
ATF: Automatic transmission fluid

44181

Circuit No.1705 Chassis Ground

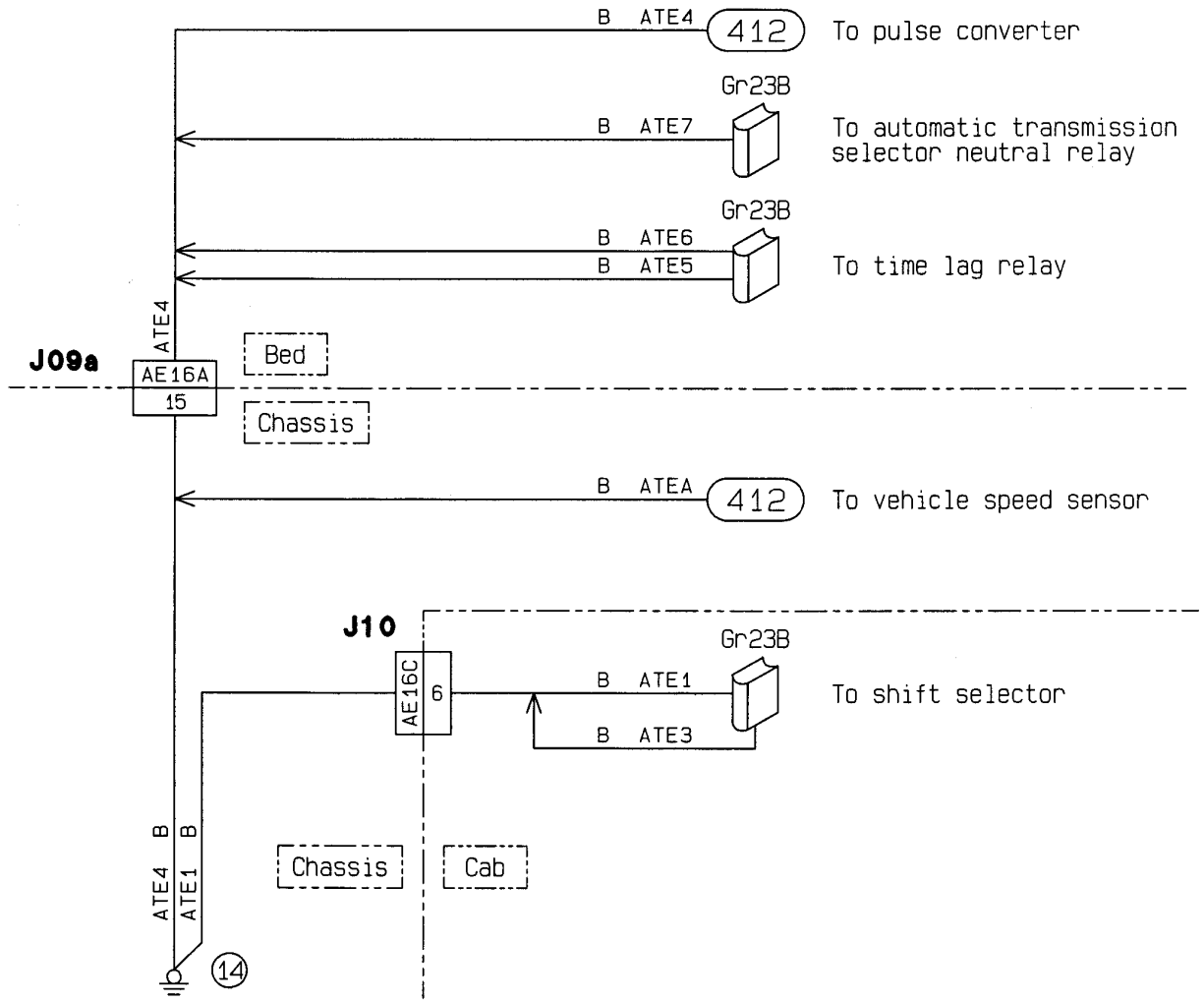


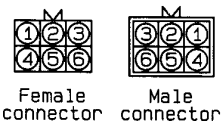
ATF: Automatic transmission fluid



44182

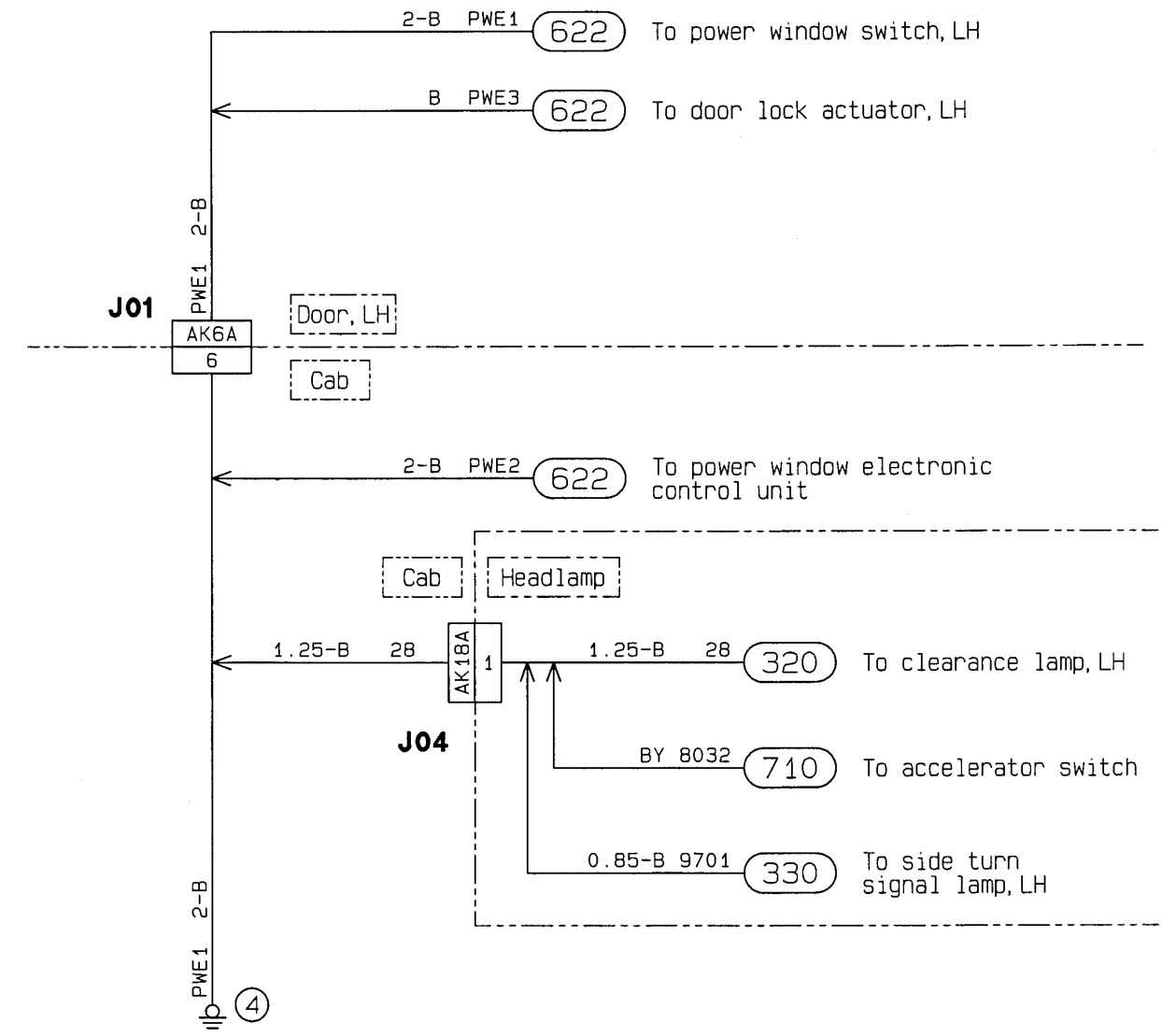
Circuit No.ATE1, ATE4 Chassis Ground
<Automatic transmission (FM657)>

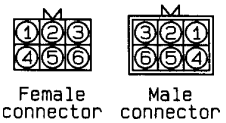




44230

Circuit No.PWE1 Cab Ground



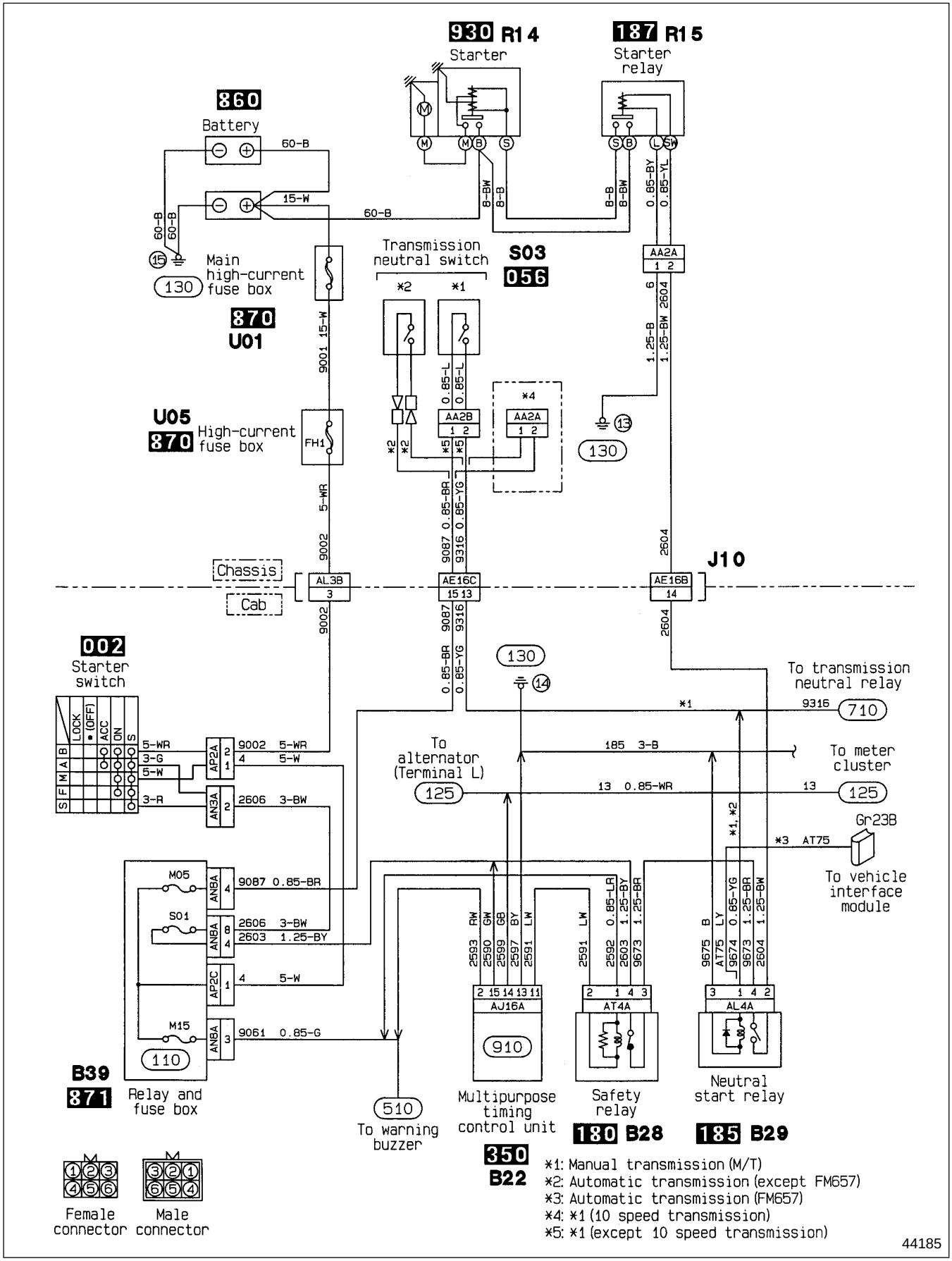


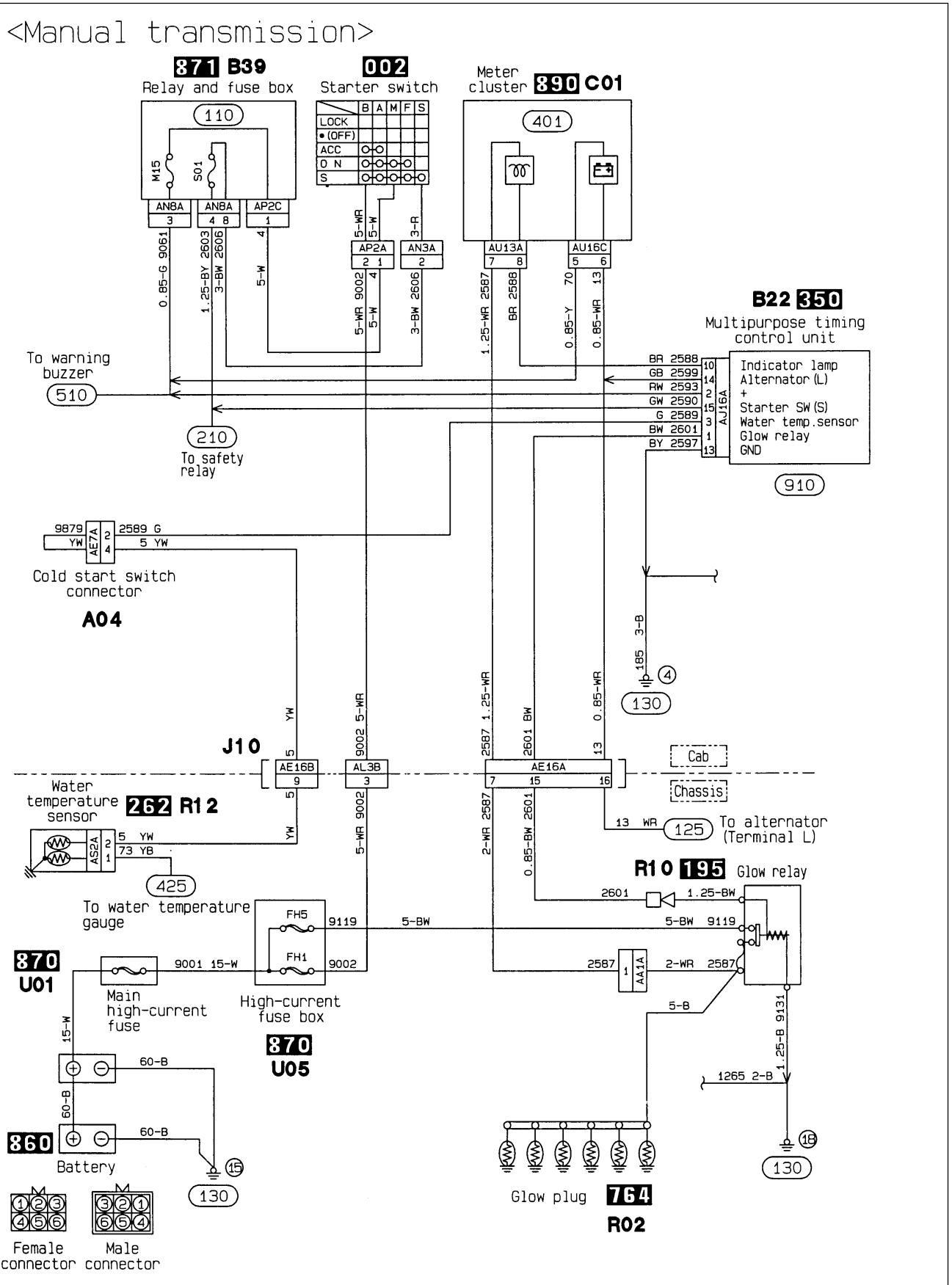
Female connector Male connector

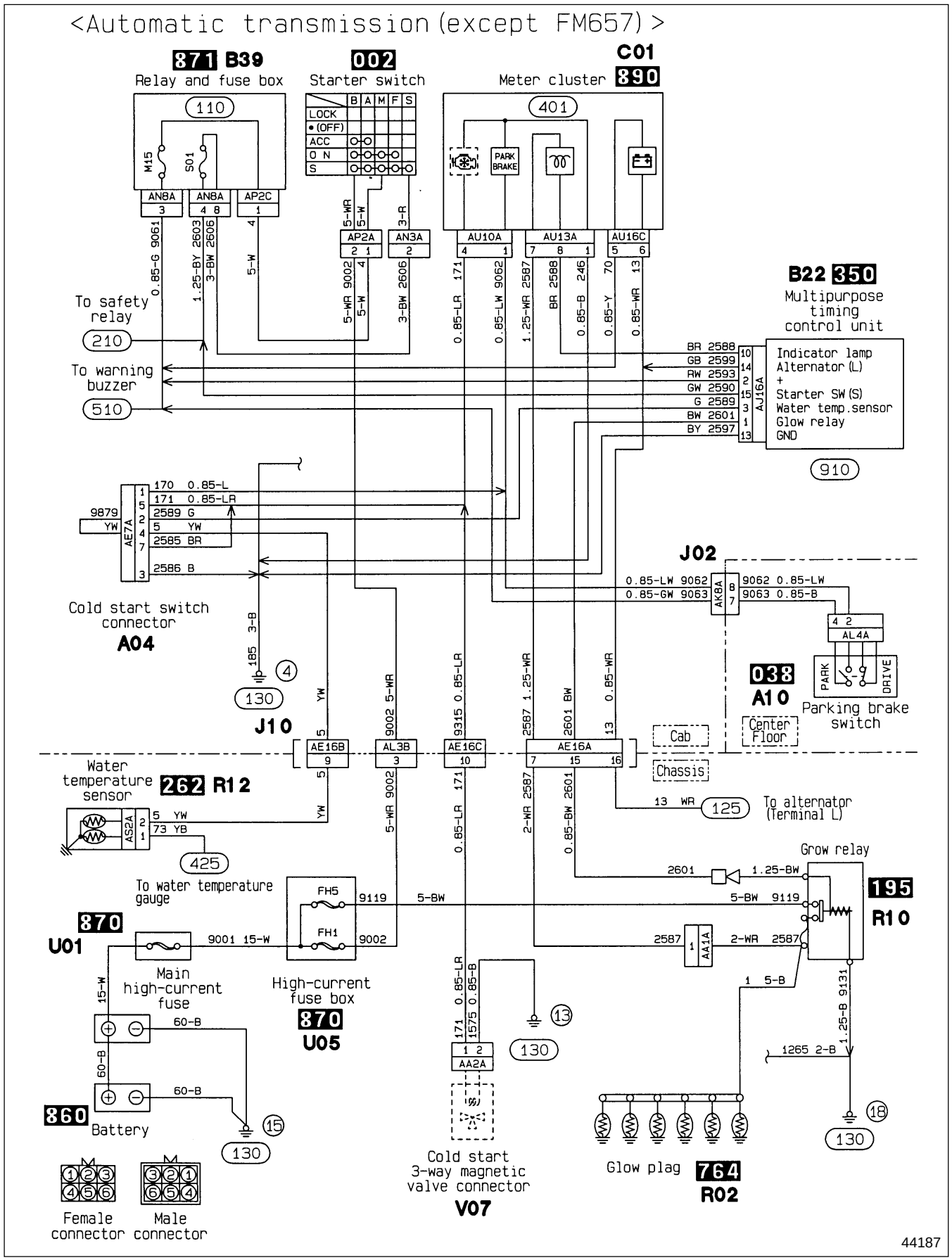
44183

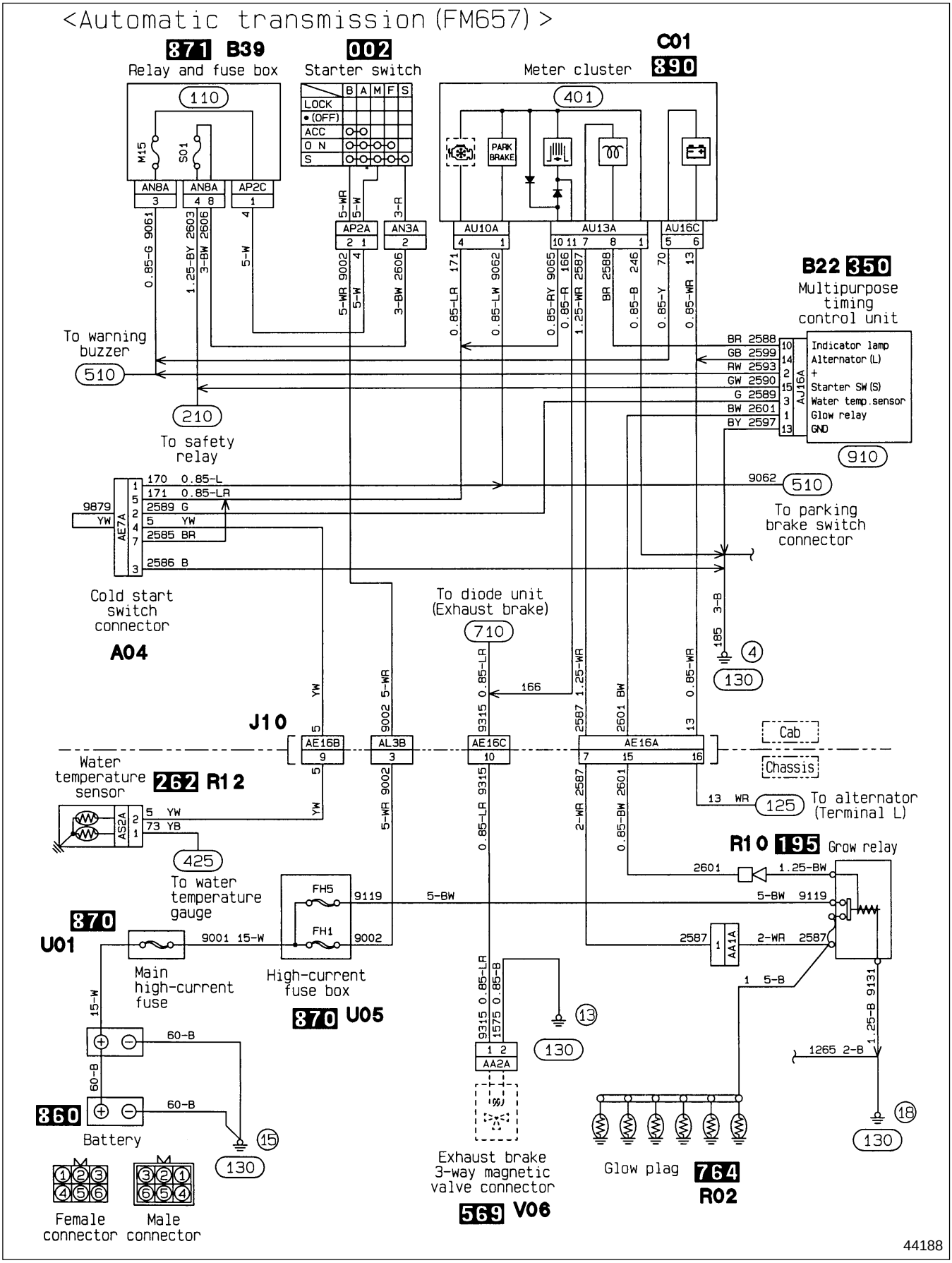
2 STARTING AND PREHEATING CIRCUIT

210 ENGINE STARTING CIRCUIT

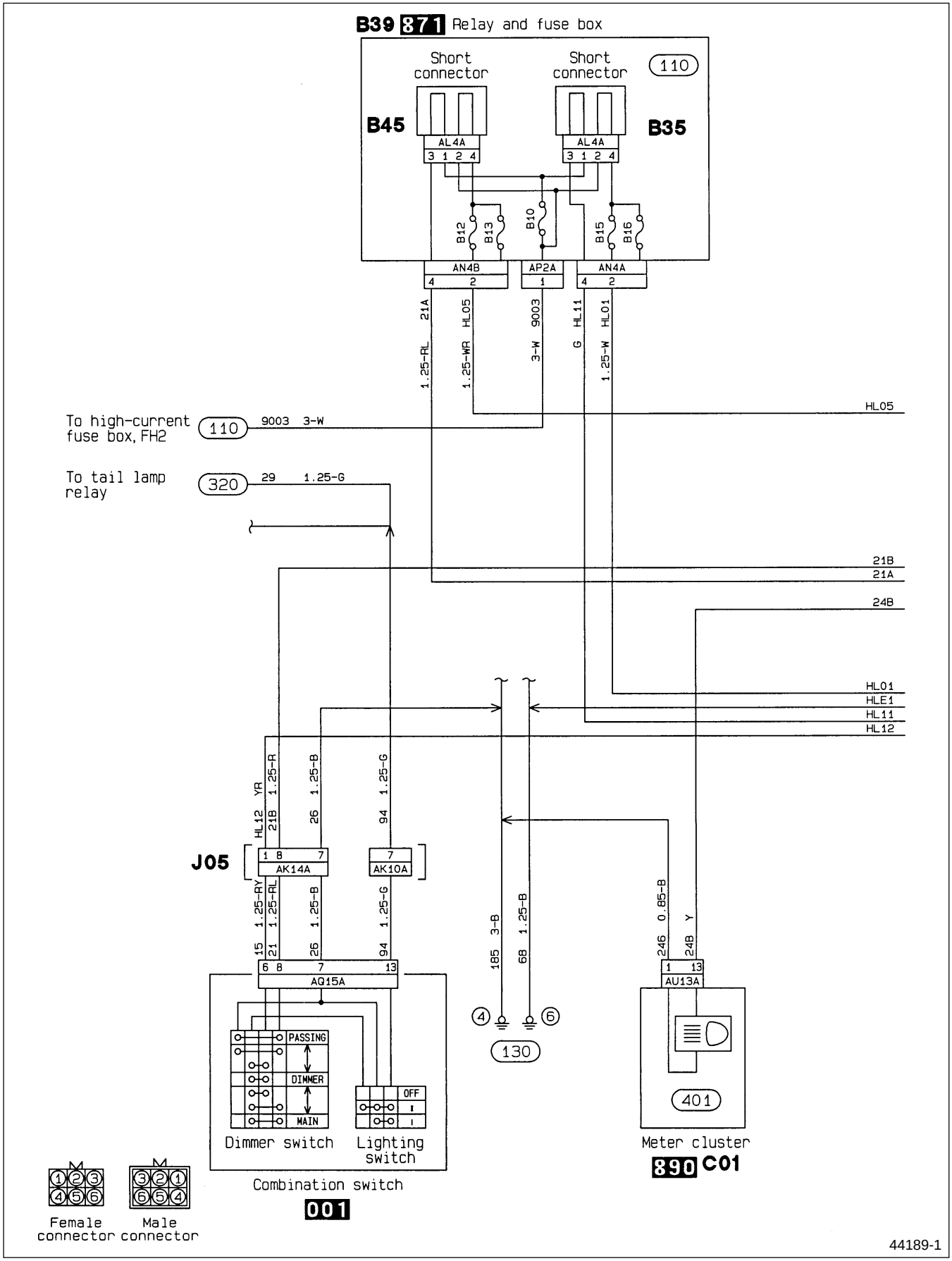


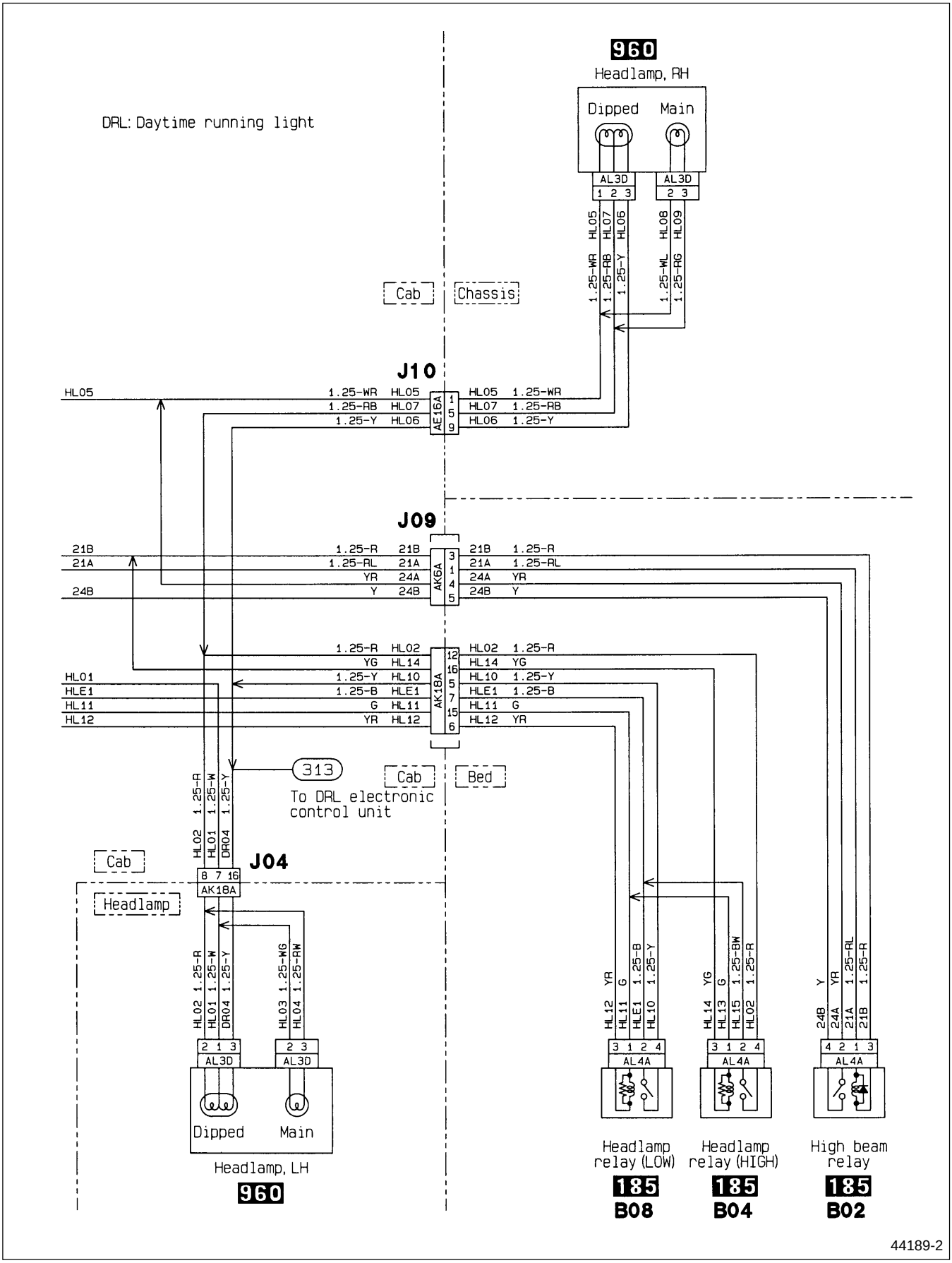

<Manual transmission>
871 B39
Relay and fuse box
110
M15
S01
AN8A
AN8A
AP2C
002
Starter switch
LOCK
(OFF)
ACC
ON
S
AP2A
AN3A
Meter cluster 890 C01
401
AU13A
AU16C
B22 350
Multipurpose timing control unit
Indicator lamp
Alternator (L)
+
Starter SW (S)
Water temp.sensor
Glow relay
GND
AJ16A
910
To warning buzzer
510
210
To safety relay
Cold start switch connector
A04
AE7A
J10
AE16B
AL3B
AE16A
Cab
Chassis
Water temperature sensor 262 R12
AS2A
425
To water temperature gauge
To alternator (Terminal L)
125
R10 195 Glow relay
FH5
FH1
9119
9002
9001 15-W
870 U01
Main high-current fuse
High-current fuse box
870 U05
AA1A
860
Battery
130
Female connector
Male connector
Glow plug 764 R02
44186


<Automatic transmission (except FM657)>
871 B39
Relay and fuse box
002
Starter switch
C01
890
Meter cluster
B22 350
Multipurpose timing control unit
To safety relay
210
To warning buzzer
510
910
Indicator lamp
Alternator (L)
+
Starter SW (S)
Water temp.sensor
Glow relay
GND
Cold start switch connector
A04
J02
J10
130
038
A10
Parking brake switch
Center
Floor
Cab
Chassis
Water temperature sensor
262 R12
To water temperature gauge
425
To alternator (Terminal L)
125
Grow relay
195
R10
870
U01
Main high-current fuse
High-current fuse box
870
U05
860
Battery
Cold start 3-way magnetic valve connector
V07
Glow plug
764
R02
Female connector
Male connector
44187

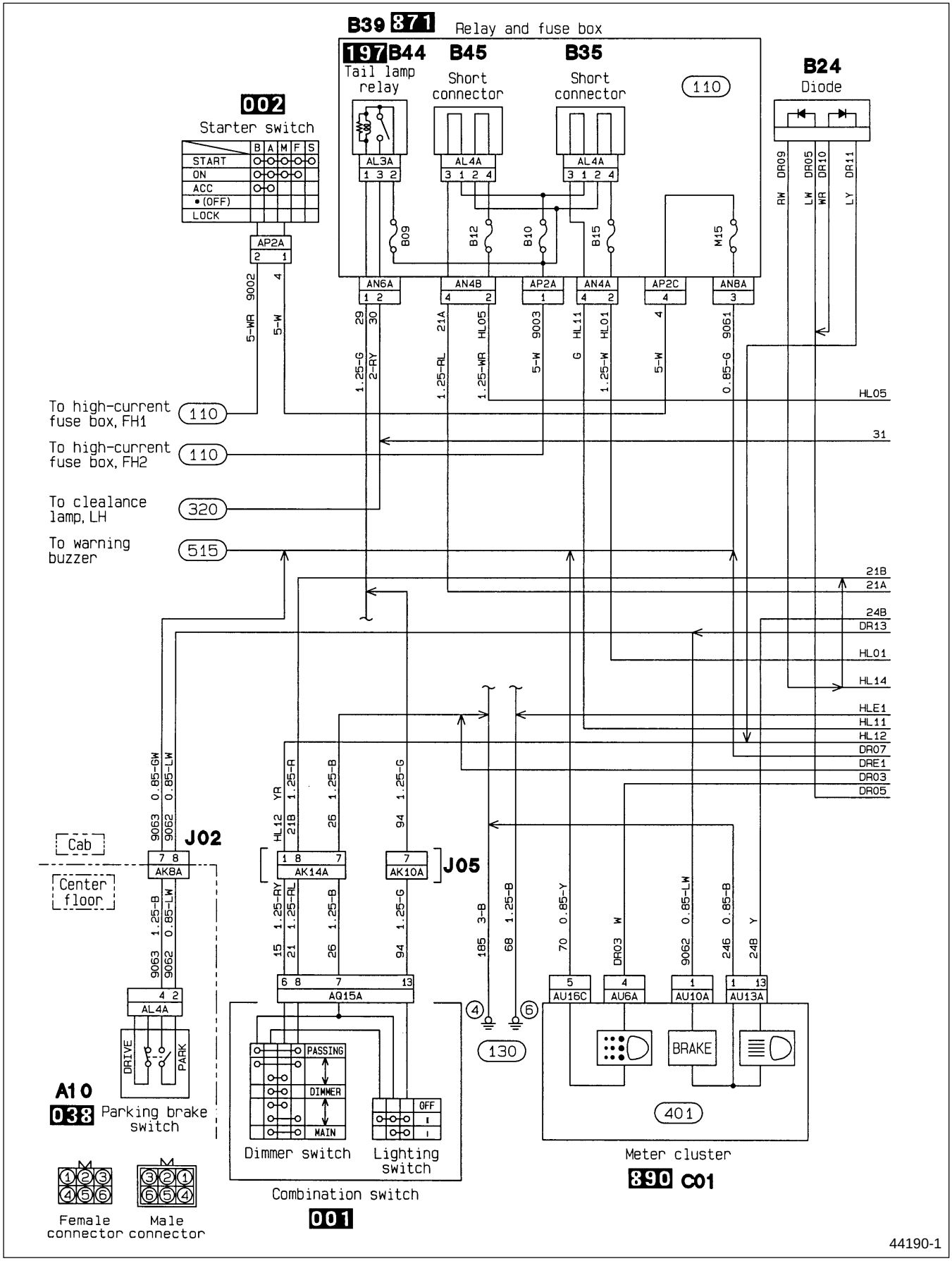

<Automatic transmission (FM657)>
871 B39
Relay and fuse box
002
Starter switch
C01
890
Meter cluster
B22 350
Multipurpose timing control unit
To warning buzzer
510
210
To safety relay
Cold start switch connector
A04
To diode unit (Exhaust brake)
710
To parking brake switch connector
910
J10
Water temperature sensor
262 R12
425
To water temperature gauge
Cab
Chassis
To alternator (Terminal L)
125
R10 195 Grow relay
870
U01
Main high-current fuse
High-current fuse box
870 U05
860
Battery
130
Female connector
Male connector
Exhaust brake 3-way magnetic valve connector
569 V06
Glow plag
764
R02
44188

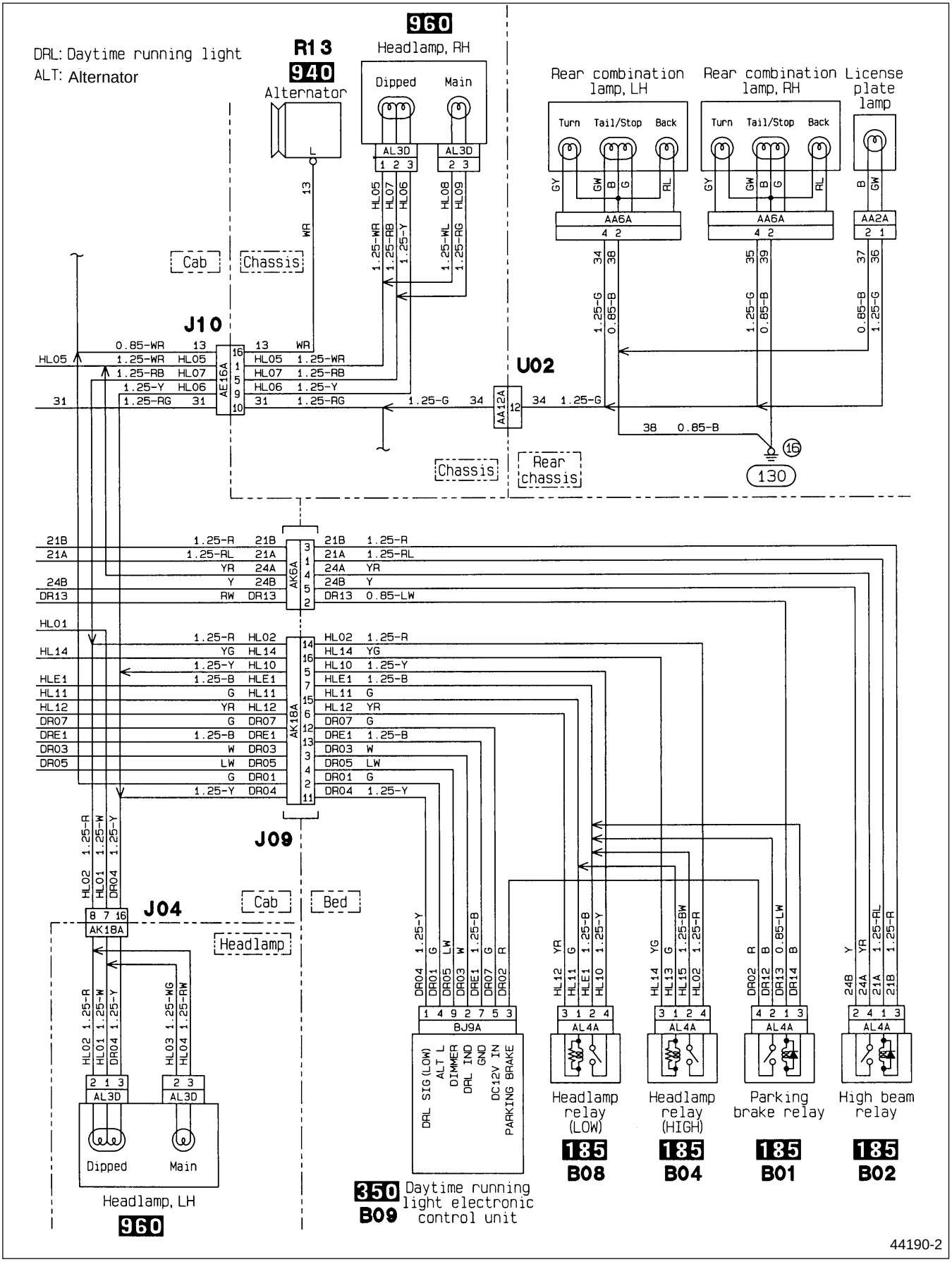
3 LIGHTING CIRCUIT


B39 871 Relay and fuse box
Short connector
Short connector
110
B45
B35
AL4A
3 1 2 4
B12
B13
B10
B15
B16
AN4B
AP2A
AN4A
4 2
1
21A
1.25-RL
HL05
1.25-WR
9003
3-W
G
HL11
HL01
1.25-W
HL05
To high-current fuse box, FH2
110
9003 3-W
To tail lamp relay
320
29 1.25-G
21B
21A
24B
HL01
HLE1
HL11
HL12
HL12 YR
218 1.25-R
26 1.25-B
94 1.25-G
J05
1 8 7
AK14A
7
AK10A
15 1.25-RY
21 1.25-RL
26 1.25-B
94 1.25-G
6 8 7 13
AQ15A
185 3-B
68 1.25-B
246 0.85-B
24B Y
1 13
AU13A
4
6
130
PASSING
DIMMER
MAIN
OFF
Dimmer switch
Lighting switch
Combination switch
001
401
Meter cluster
890 C01
Female connector
Male connector
44189-1

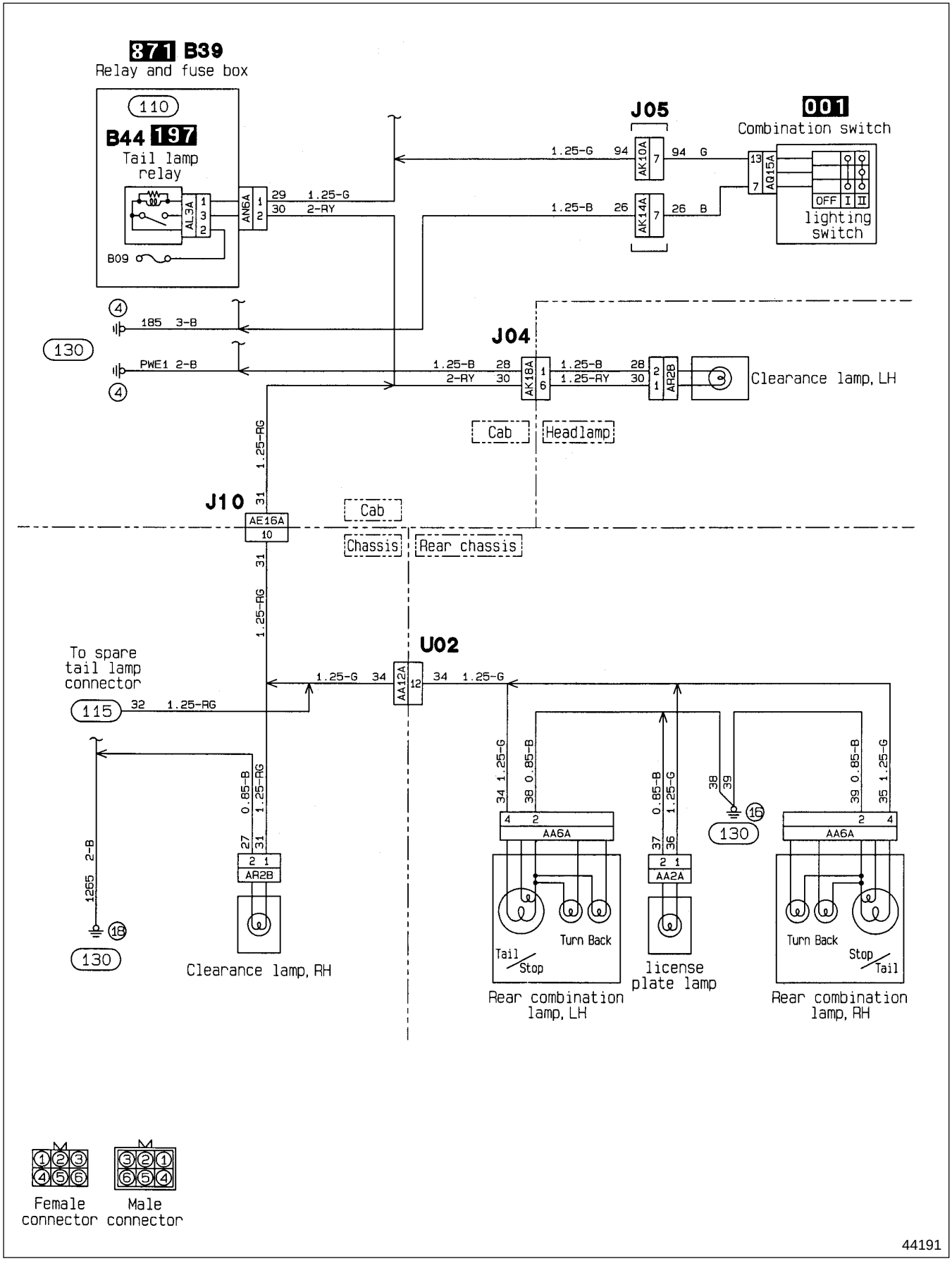

960
Headlamp, RH
Dipped
Main
DRL: Daytime running light
AL3D
1 2 3
2 3
HL05
HL07
HL06
HL08
HL09
1.25-WR
1.25-RB
1.25-Y
1.25-WL
1.25-RG
Cab
Chassis
J10
HL05
1.25-WR HL05
1.25-RB HL07
1.25-Y HL06
AE16A
1
5
9
HL05 1.25-WR
HL07 1.25-RB
HL06 1.25-Y
J09
21B
21A
24B
1.25-R 21B
1.25-RL 21A
YR 24A
Y 24B
AK6A
3
1
4
5
21B 1.25-R
21A 1.25-RL
24A YR
24B Y
HL01
HLE1
HL11
HL12
1.25-R HL02
YG HL14
1.25-Y HL10
1.25-B HLE1
G HL11
YR HL12
AK18A
12
16
5
7
15
6
HL02 1.25-R
HL14 YG
HL10 1.25-Y
HLE1 1.25-B
HL11 G
HL12 YR
313
To DRL electronic
control unit
Cab
Bed
HL02 1.25-R
HL01 1.25-W
DR04 1.25-Y
Cab
J04
8 7 16
AK18A
Headlamp
HL03 1.25-WG
HL04 1.25-RW
2 1 3
AL3D
2 3
AL3D
Dipped
Main
Headlamp, LH
960
HL12 YR
HL11 G
HLE1 1.25-B
HL10 1.25-Y
HL14 YG
HL13 G
HL15 1.25-BW
HL02 1.25-R
24B Y
24A YR
21A 1.25-RL
21B 1.25-R
3 1 2 4
AL4A
4 2 1 3
AL4A
Headlamp
relay (LOW)
185
B08
Headlamp
relay (HIGH)
185
B04
High beam
relay
185
B02
44189-2

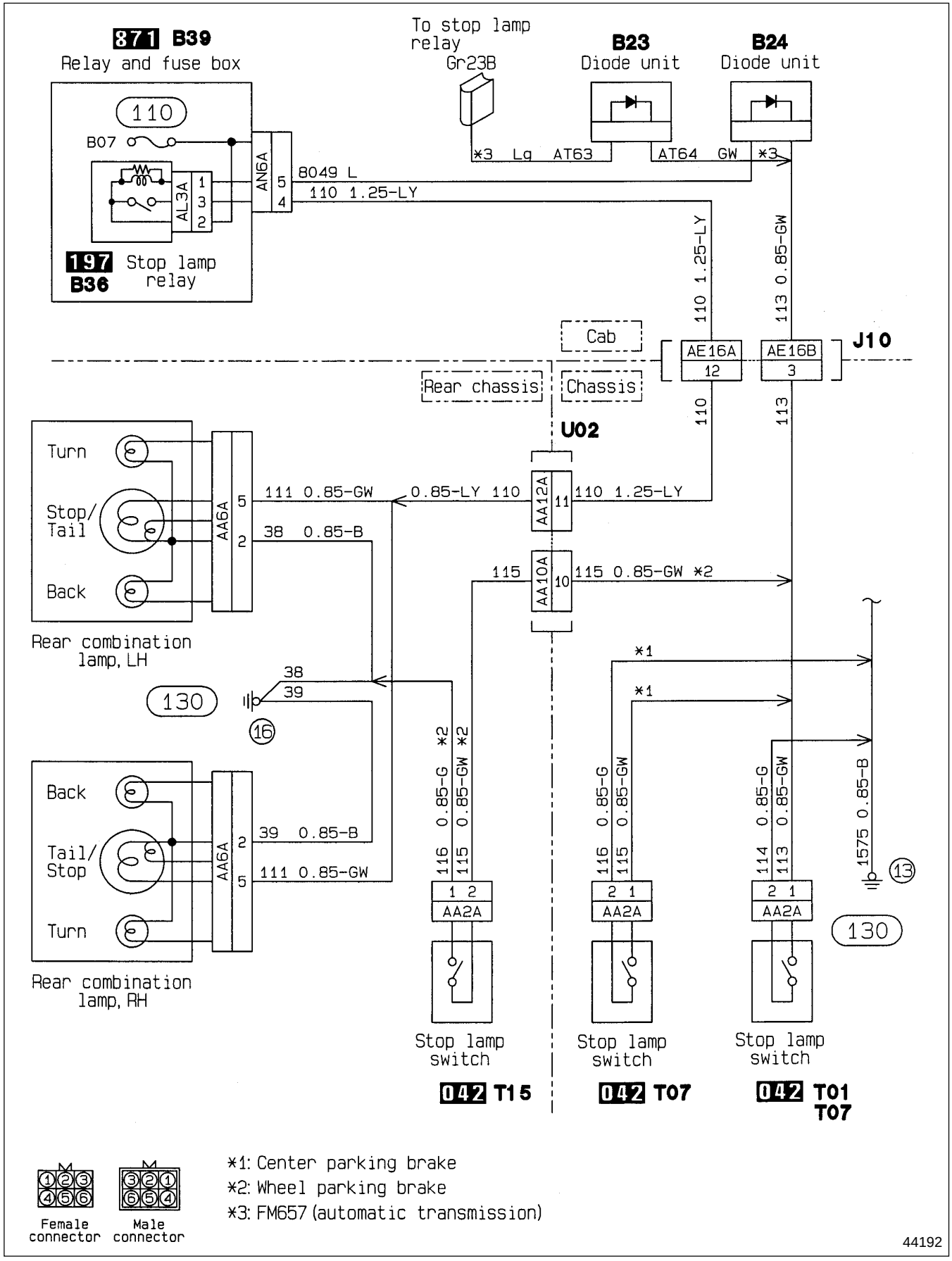
313 DAYTIME RUNNING LIGHT CIRCUIT



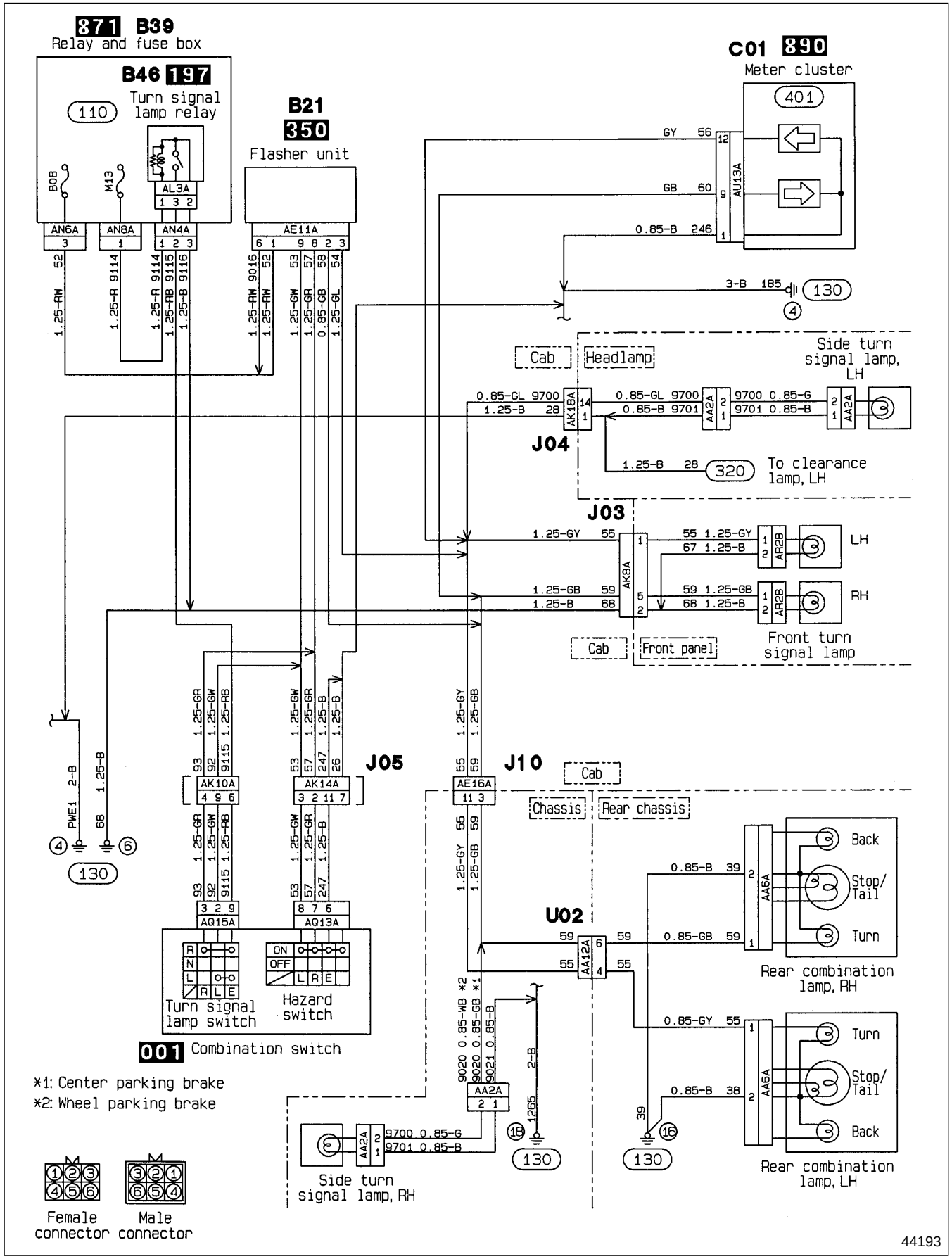

DRL: Daytime running light
ALT: Alternator
R13
940
Alternator
960
Headlamp, RH
Dipped
Main
Rear combination lamp, LH
Rear combination lamp, RH
License plate lamp
Turn
Tail/Stop
Back
AL3D
AA6A
AA2A
Cab
Chassis
J10
AE16A
U02
AA12A
Rear chassis
130
AK6A
AK18A
J09
J04
Bed
Headlamp
BJ9A
DRL SIG (LOW)
ALT L
DIMMER
DRL IND
GND
DC12V IN
PARKING BRAKE
AL4A
Headlamp relay (LOW)
Headlamp relay (HIGH)
Parking brake relay
High beam relay
185
B08
185
B04
185
B01
185
B02
350
B09
Daytime running light electronic control unit
Headlamp, LH
960
44190-2

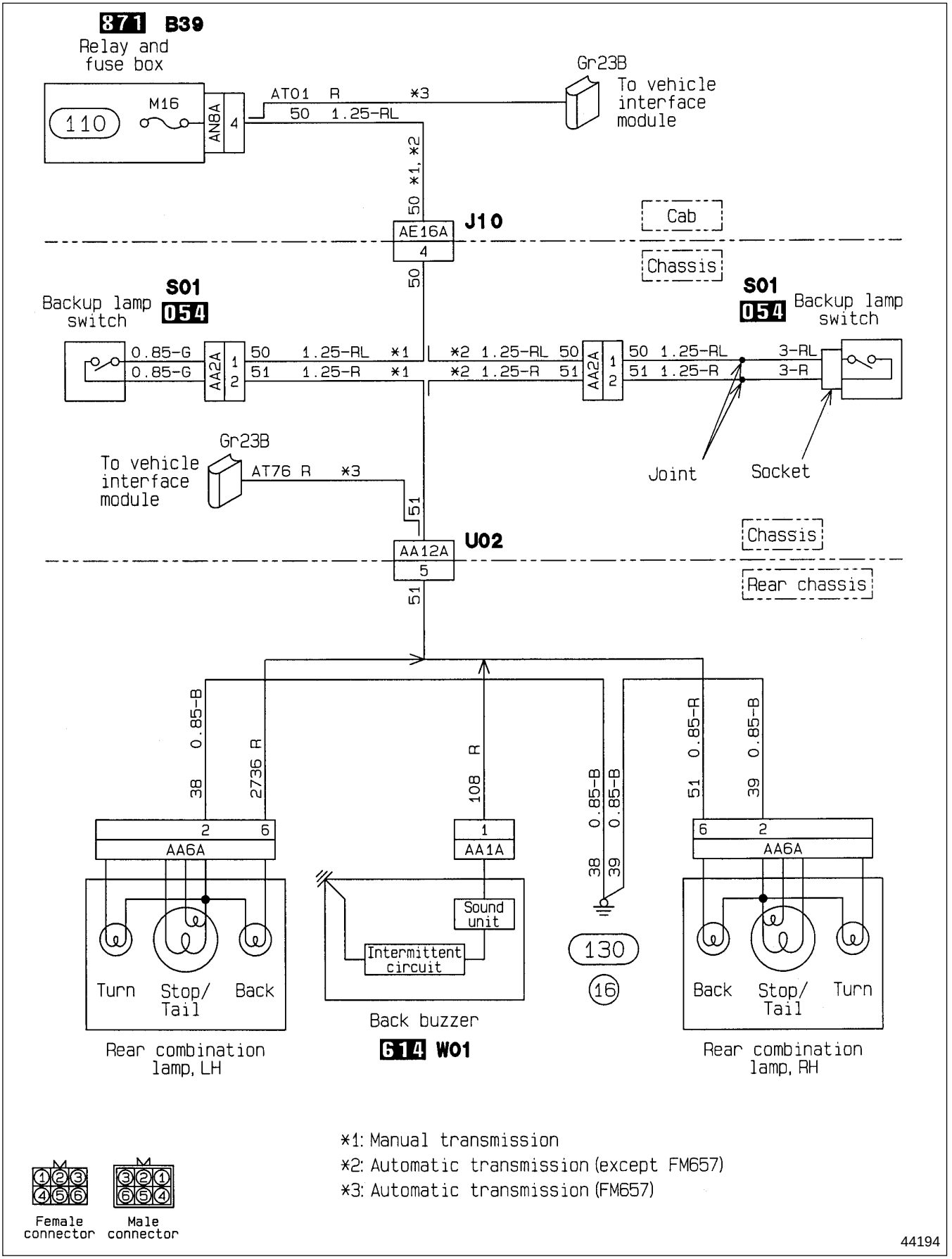
320 TAIL, CLEARANCE AND LICENSE PLATE LAMP CIRCUIT



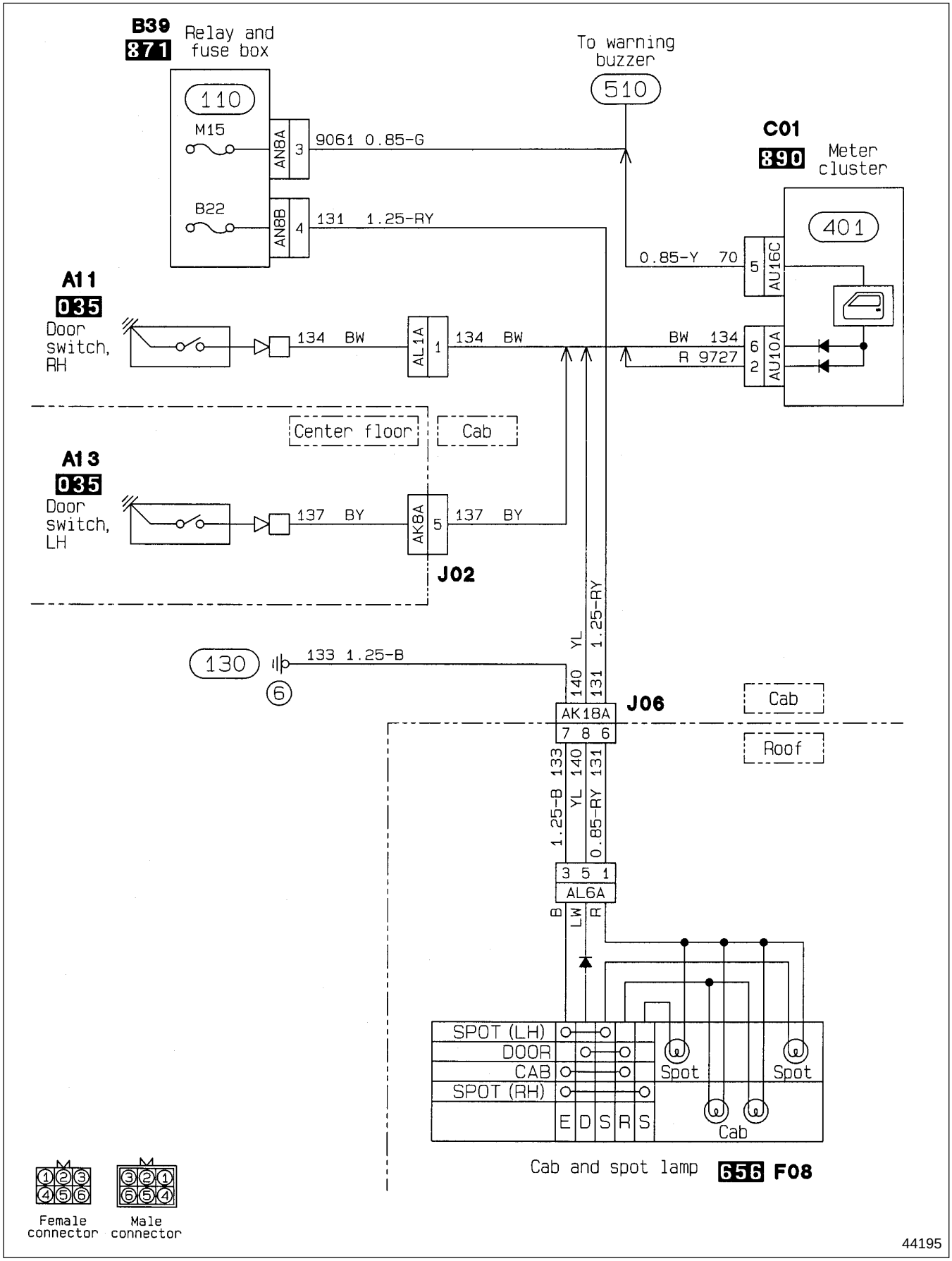

871 B39
Relay and fuse box
110
B07
AL3A
AN6A
197 Stop lamp relay
B36
To stop lamp relay
Gr23B
B23
Diode unit
B24
Diode unit
*3 Lg AT63
AT64 GW *3
8049 L
110 1.25-LY
110 1.25-LY
113 0.85-GW
Cab
Rear chassis
Chassis
AE16A
12
AE16B
3
J10
U02
110
113
Turn
Stop/ Tail
Back
AA6A
111 0.85-GW
38 0.85-B
0.85-LY 110
AA12A
11
110 1.25-LY
115
AA10A
10
115 0.85-GW *2
Rear combination lamp, LH
38
39
130
16
*1
*1
Back
Tail/ Stop
Turn
39 0.85-B
111 0.85-GW
Rear combination lamp, RH
116 0.85-G *2
115 0.85-GW *2
116 0.85-G
115 0.85-GW
114 0.85-G
113 0.85-GW
1575 0.85-B
13
1 2
2 1
AA2A
130
Stop lamp switch
042 T15
Stop lamp switch
042 T07
Stop lamp switch
042 T01
T07
Female connector
Male connector
*1: Center parking brake
*2: Wheel parking brake
*3: FM657 (automatic transmission)
44192

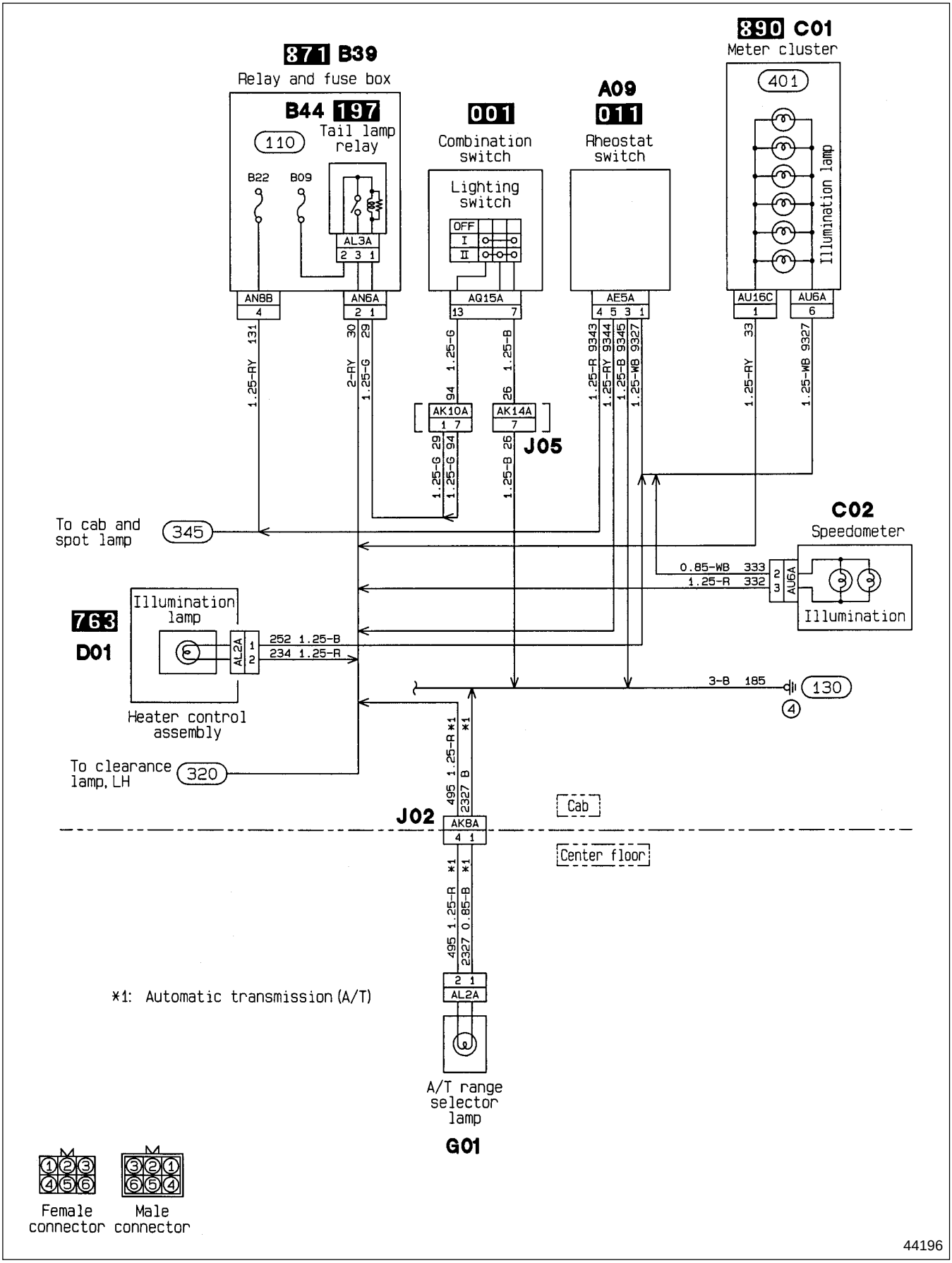
330 TURN SIGNAL AND HAZARD LAMP CIRCUIT



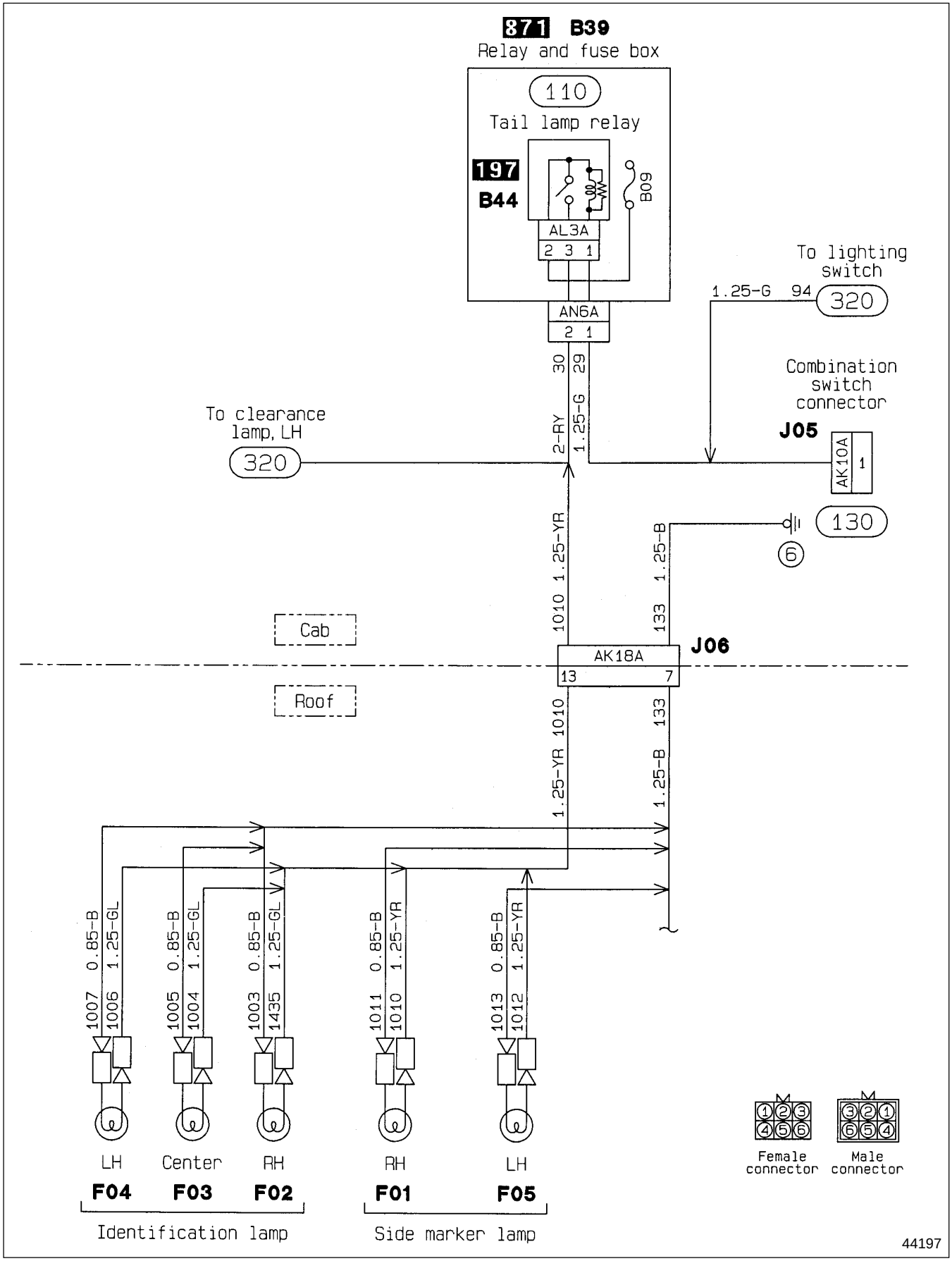

871 B39
Relay and fuse box
110
M16
AN8A
4
AT01 R *3
50 1.25-RL
Gr23B
To vehicle interface module
50 *1, *2
AE16A
4
J10
Cab
Chassis
50
S01
054
Backup lamp switch
0.85-G
0.85-G
AA2A
1
2
50 1.25-RL *1
51 1.25-R *1
*2 1.25-RL 50
*2 1.25-R 51
50 1.25-RL
51 1.25-R
3-RL
3-R
Joint
Socket
Gr23B
To vehicle interface module
AT76 R *3
51
AA12A
5
U02
Chassis
Rear chassis
51
38 0.85-B
2736 R
108 R
38 0.85-B
39 0.85-B
51 0.85-R
39 0.85-B
2
6
AA6A
1
AA1A
6
2
AA6A
Sound unit
Intermittent circuit
130
16
Turn
Stop/ Tail
Back
Back buzzer
614 W01
Back
Stop/ Tail
Turn
Rear combination lamp, LH
Rear combination lamp, RH
*1: Manual transmission
*2: Automatic transmission (except FM657)
*3: Automatic transmission (FM657)
Female connector
Male connector
44194

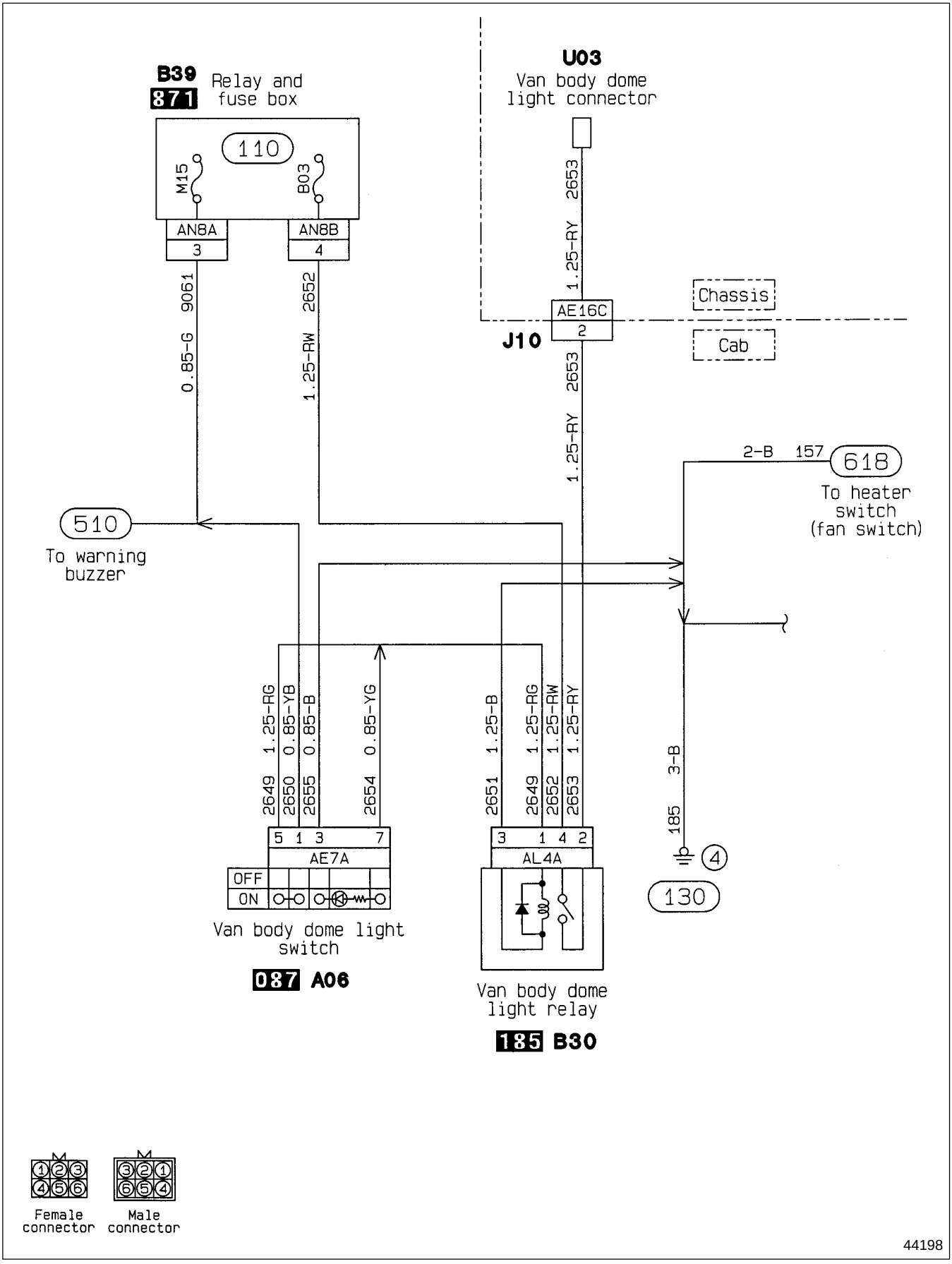
345 CAB LAMP CIRCUIT




890 C01
Meter cluster
401
Illumination lamp
871 B39
Relay and fuse box
B44 197
Tail lamp relay
110
B22
B09
AL3A
2 3 1
AN8B
4
AN6A
2 1
001
Combination switch
Lighting switch
OFF
I
II
AQ15A
13 7
A09
011
Rheostat switch
AE5A
4 5 3 1
AU16C
1
AU6A
6
131 1.25-RY
30 2-RY
29 1.25-G
94 1.25-G
26 1.25-B
1.25-R 9343
1.25-RY 9344
1.25-B 9345
1.25-WB 9327
33 1.25-RY
1.25-WB 9327
AK10A
1 7
AK14A
7
J05
1.25-G 29
1.25-G 94
1.25-B 26
To cab and spot lamp
345
C02
Speedometer
0.85-WB 333
1.25-R 332
AU6A
2
3
Illumination
763
D01
Illumination lamp
AL2A
1
2
252 1.25-B
234 1.25-R
Heater control assembly
3-B 185
130
4
To clearance lamp, LH
320
495 1.25-R *1
2327 B
*1
J02
AK8A
4 1
Cab
Center floor
495 1.25-R *1
2327 0.85-B *1
2 1
AL2A
*1: Automatic transmission (A/T)
A/T range selector lamp
G01
Female connector
Male connector
44196

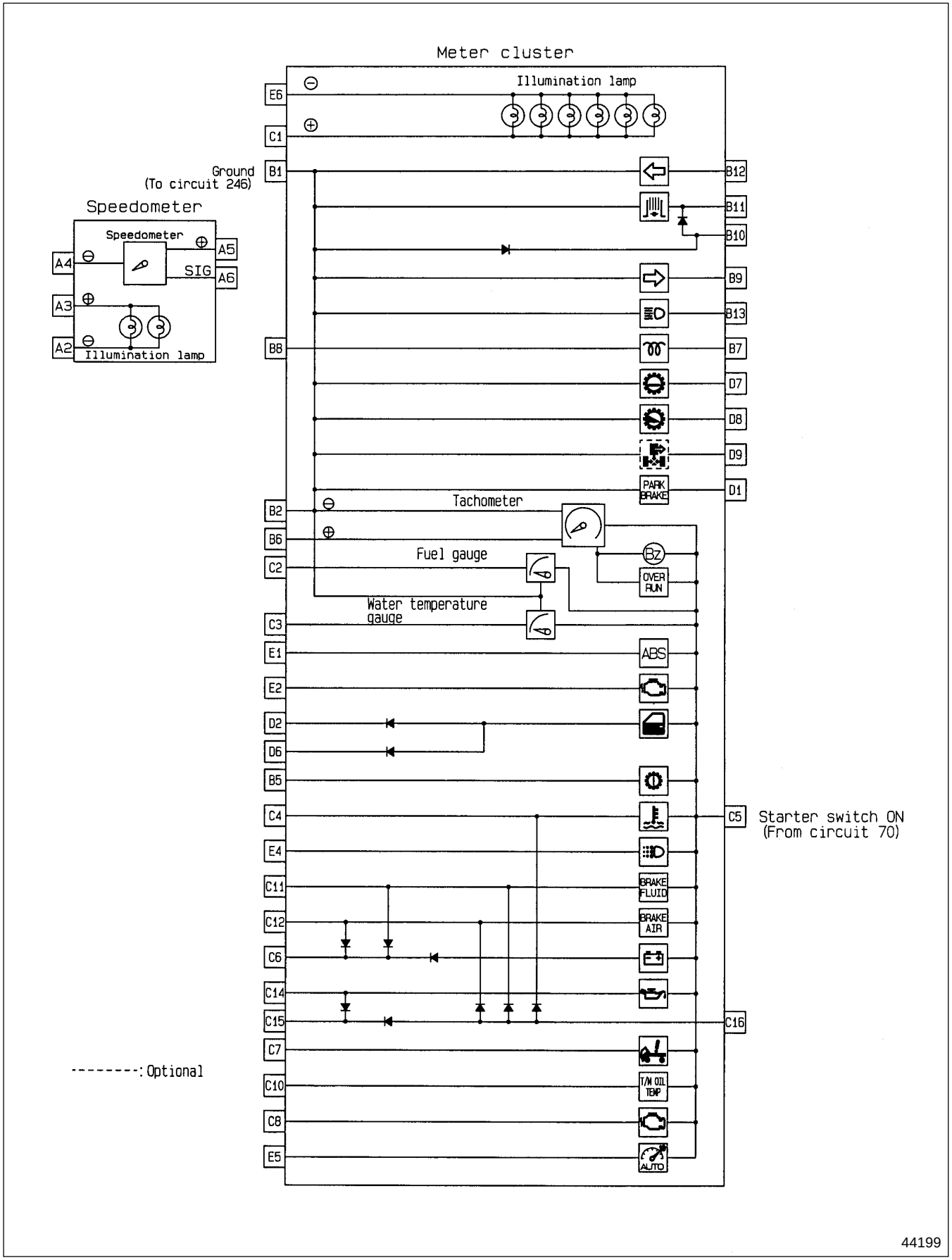
349 MARKER AND IDENTIFICATON LAMP CIRCUIT

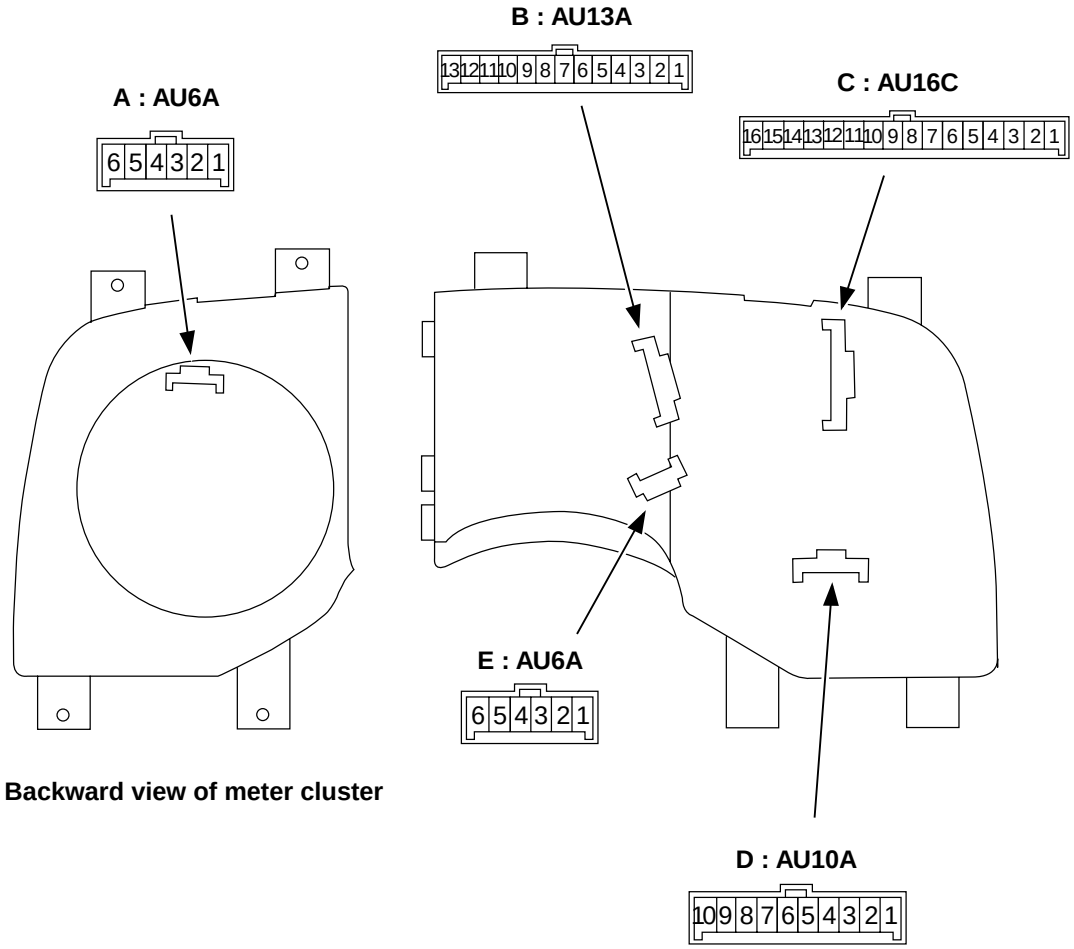



B39
871
Relay and fuse box
110
M15
B03
AN8A
3
AN8B
4
0.85-G 9061
1.25-RW 2652
U03
Van body dome light connector
1.25-RY 2653
AE16C
2
J10
Chassis
Cab
1.25-RY 2653
2-B 157
618
To heater switch (fan switch)
510
To warning buzzer
2649 1.25-RG
2650 0.85-YB
2655 0.85-B
2654 0.85-YG
5 1 3 7
AE7A
OFF
ON
Van body dome light switch
087 A06
2651 1.25-B
2649 1.25-RG
2652 1.25-RW
2653 1.25-RY
3 1 4 2
AL4A
Van body dome light relay
185 B30
185 3-B
4
130
Female connector
Male connector
44198

4 METER CIRCUIT

401 METER CLUSTER INTERNAL CIRCUIT

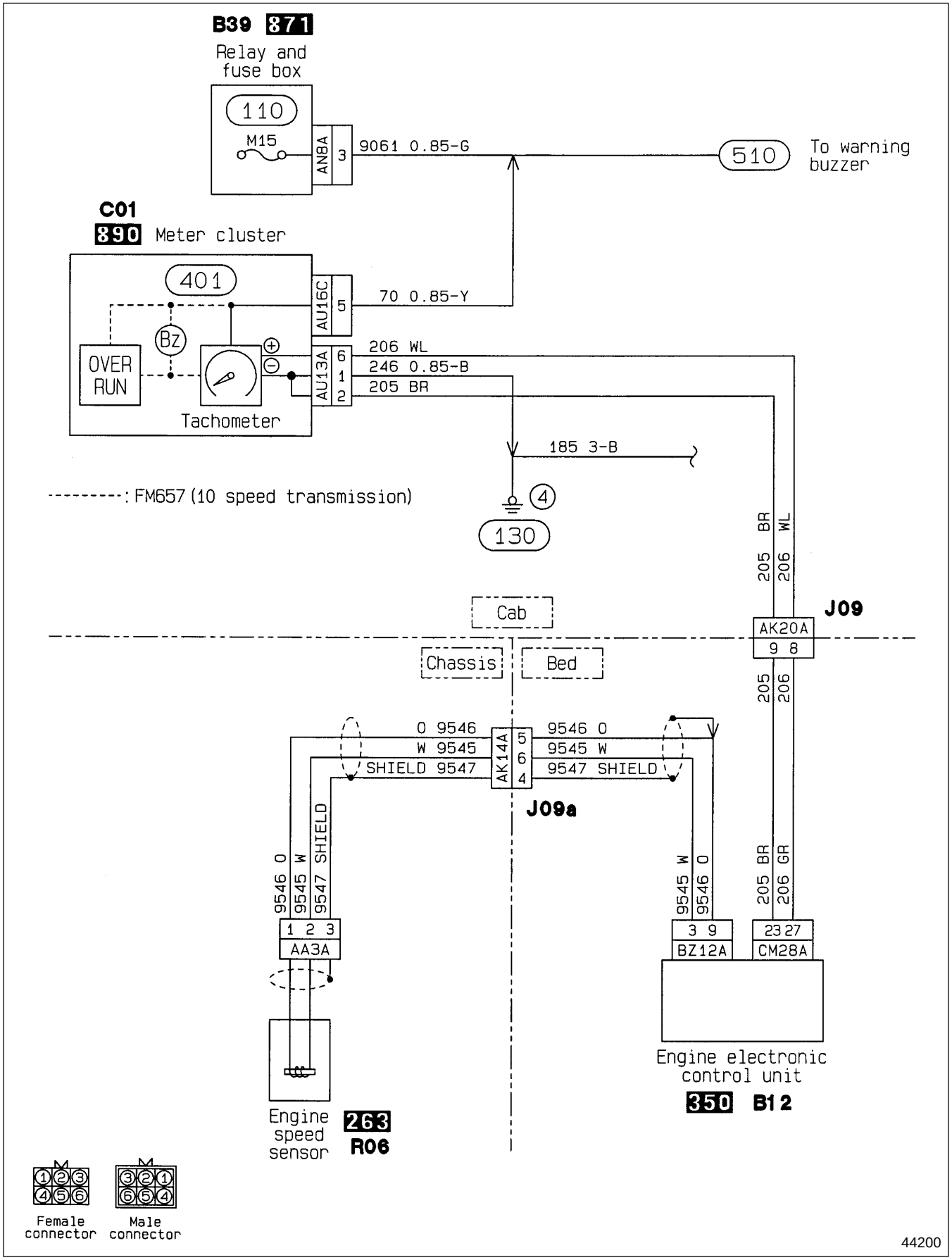


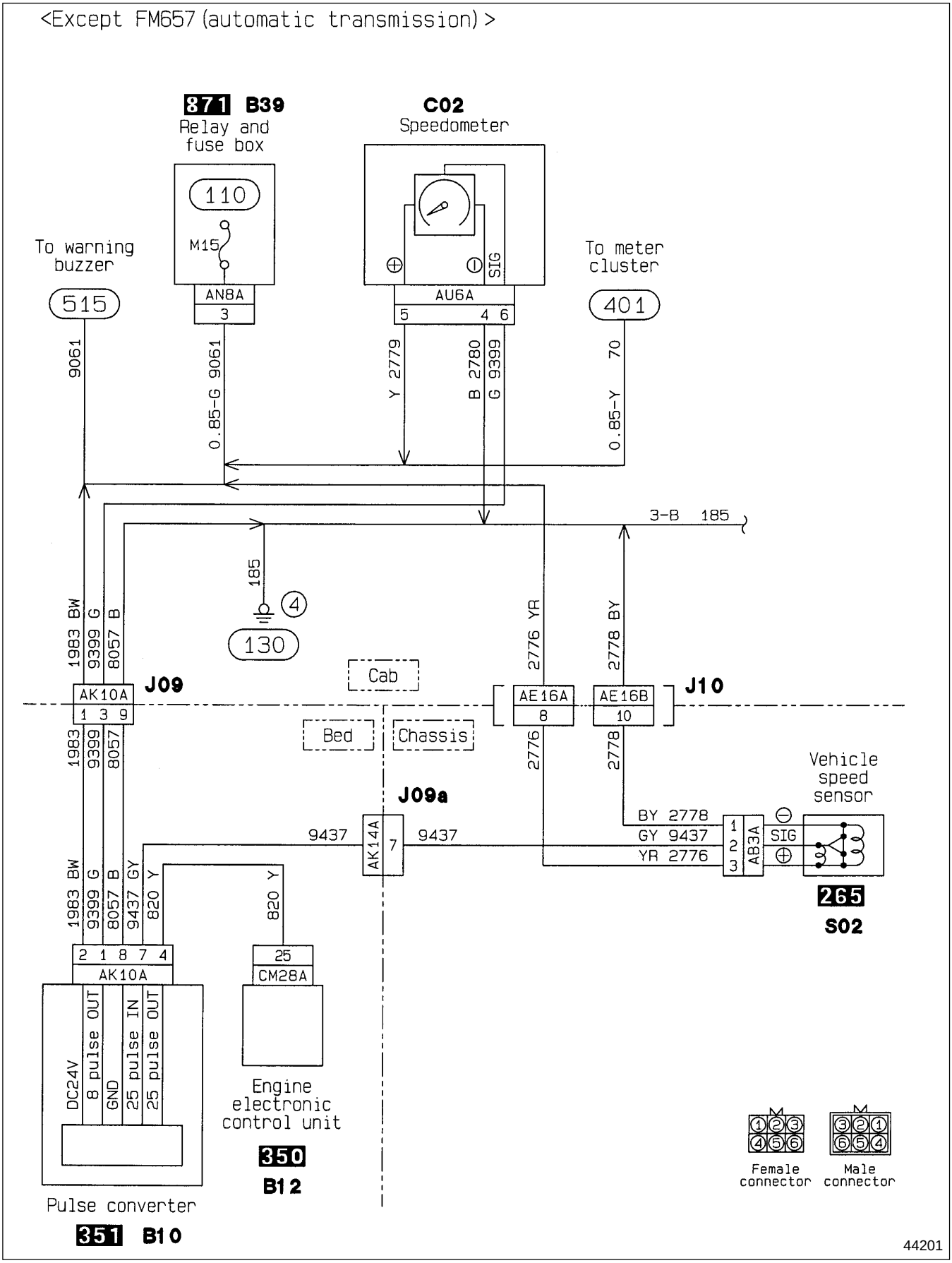


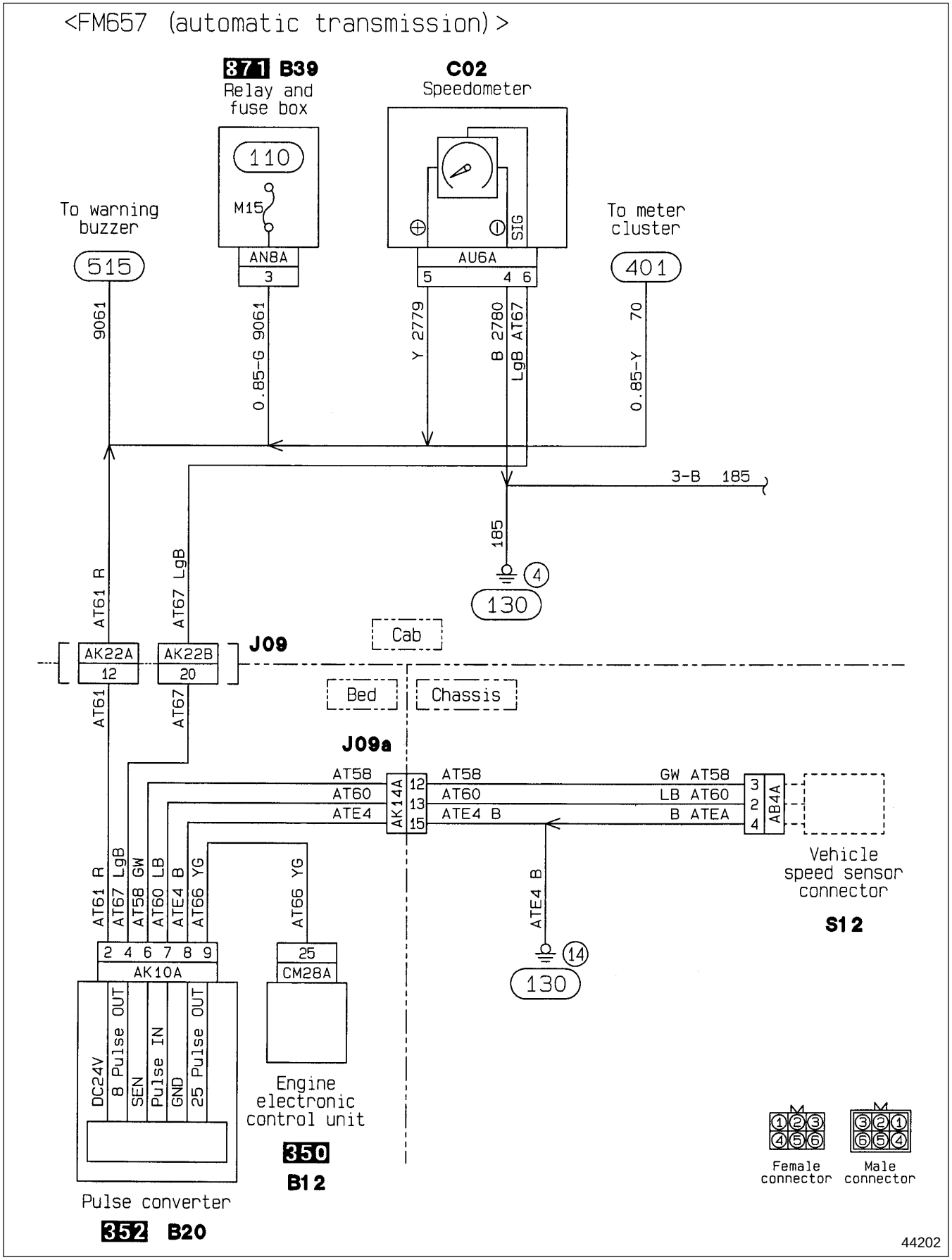
Backward view of meter cluster

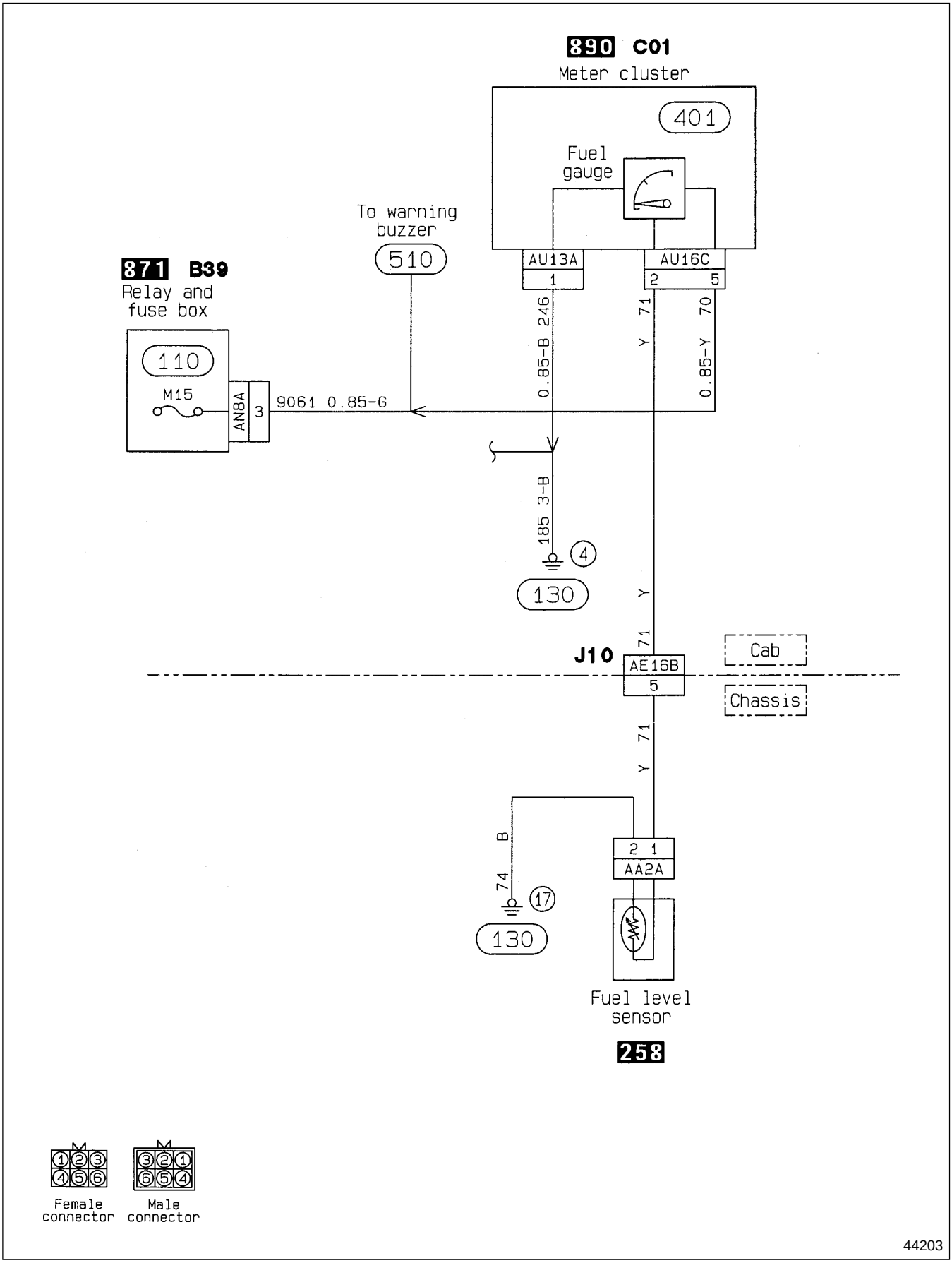
Ⓟ45321

410 TACHOMETER CIRCUIT

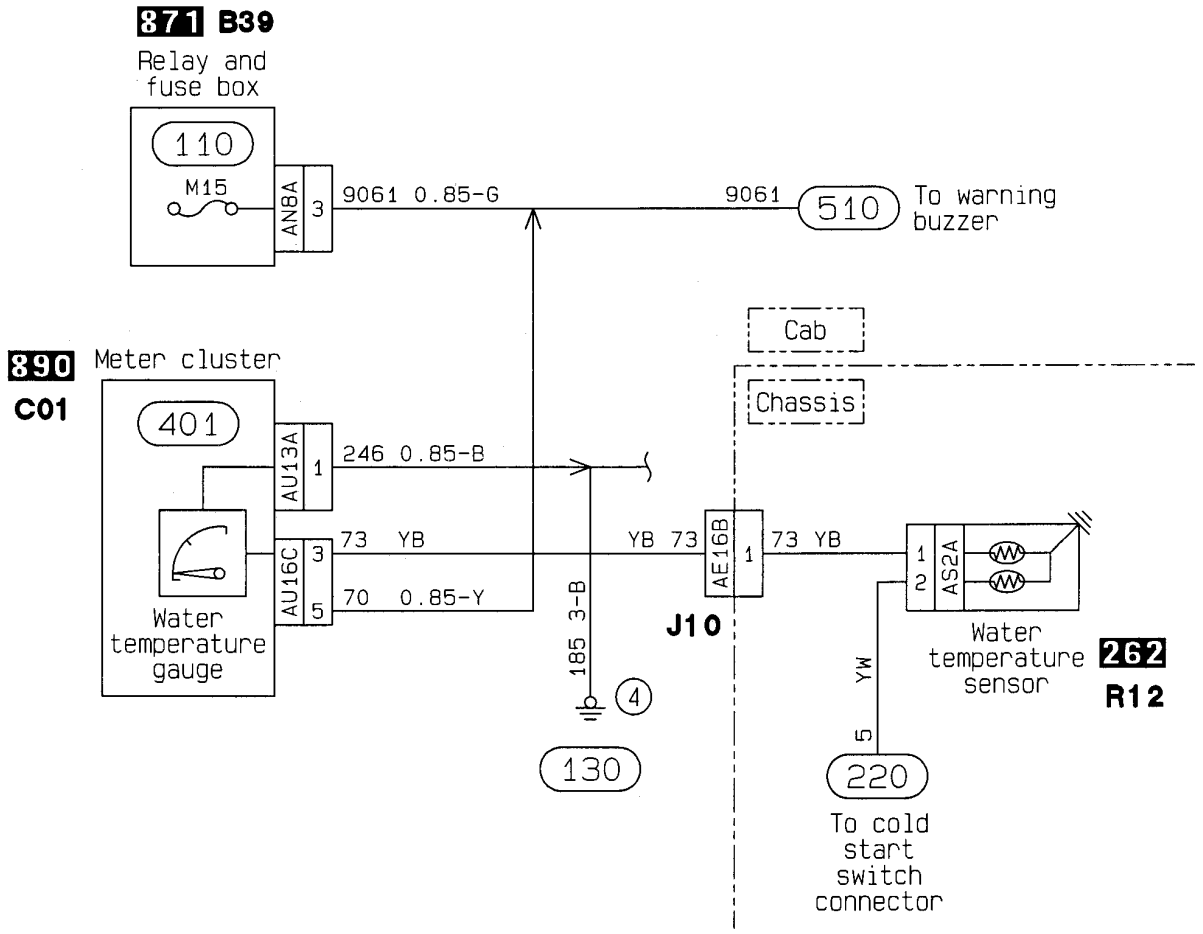


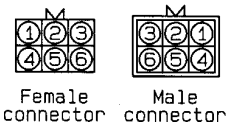

<Except FM657 (automatic transmission)>
871 B39
Relay and fuse box
C02
Speedometer
110
M15
AN8A
3
AU6A
5 4 6
SIG
To warning buzzer
515
To meter cluster
401
9061
0.85-G 9061
Y 2779
B 2780
G 9399
0.85-Y 70
3-B 185
185
4
130
1983 BW
9399 G
8057 B
2776 YR
2778 BY
J09
AK10A
1 3 9
Cab
AE16A
8
AE16B
10
J10
Bed
Chassis
2776
2778
J09a
Vehicle speed sensor
9437
AK14A
7
BY 2778
GY 9437
YR 2776
AB3A
SIG
265
S02
9437 GY
820 Y
2 1 8 7 4
AK10A
25
CM28A
DC24V
8 pulse OUT
GND
25 pulse IN
25 pulse OUT
Engine electronic control unit
350
B12
Pulse converter
351 B10
Female connector
Male connector
44201


<FM657 (automatic transmission)>
871 B39
Relay and fuse box
110
M15
AN8A
3
C02
Speedometer
AU6A
5 4 6
SIG
To warning buzzer
515
To meter cluster
401
9061
0.85-G 9061
Y 2779
B 2780
LgB AT67
0.85-Y 70
3-B 185
185
4
130
AT61 R
AT67 LgB
AK22A
12
AK22B
20
J09
Cab
Bed
Chassis
J09a
AT61
AT67
AT58
AT60
ATE4
AK14A
12
13
15
AT58
AT60
ATE4 B
GW AT58
LB AT60
B ATEA
3
2
4
AB4A
Vehicle speed sensor connector
S12
AT61 R
AT67 LgB
AT58 GW
AT60 LB
ATE4 B
AT66 YG
AT66 YG
ATE4 B
14
130
2 4 6 7 8 9
AK10A
25
CM28A
DC24V
8 Pulse OUT
SEN
Pulse IN
GND
25 Pulse OUT
Engine electronic control unit
350
B12
Pulse converter
352 B20
Female connector
Male connector
44202


890 C01
Meter cluster
401
Fuel gauge
To warning buzzer
510
871 B39
Relay and fuse box
110
M15
ANBA
3
9061 0.85-G
AU13A
1
AU16C
2
5
0.85-B 246
Y 71
0.85-Y 70
185 3-B
4
130
J10
AE16B
5
Cab
Chassis
Y 71
B 74
17
130
2 1
AA2A
Fuel level sensor
258
Female connector
Male connector
44203

425 WATER TEMPERATURE GAUGE CIRCUIT

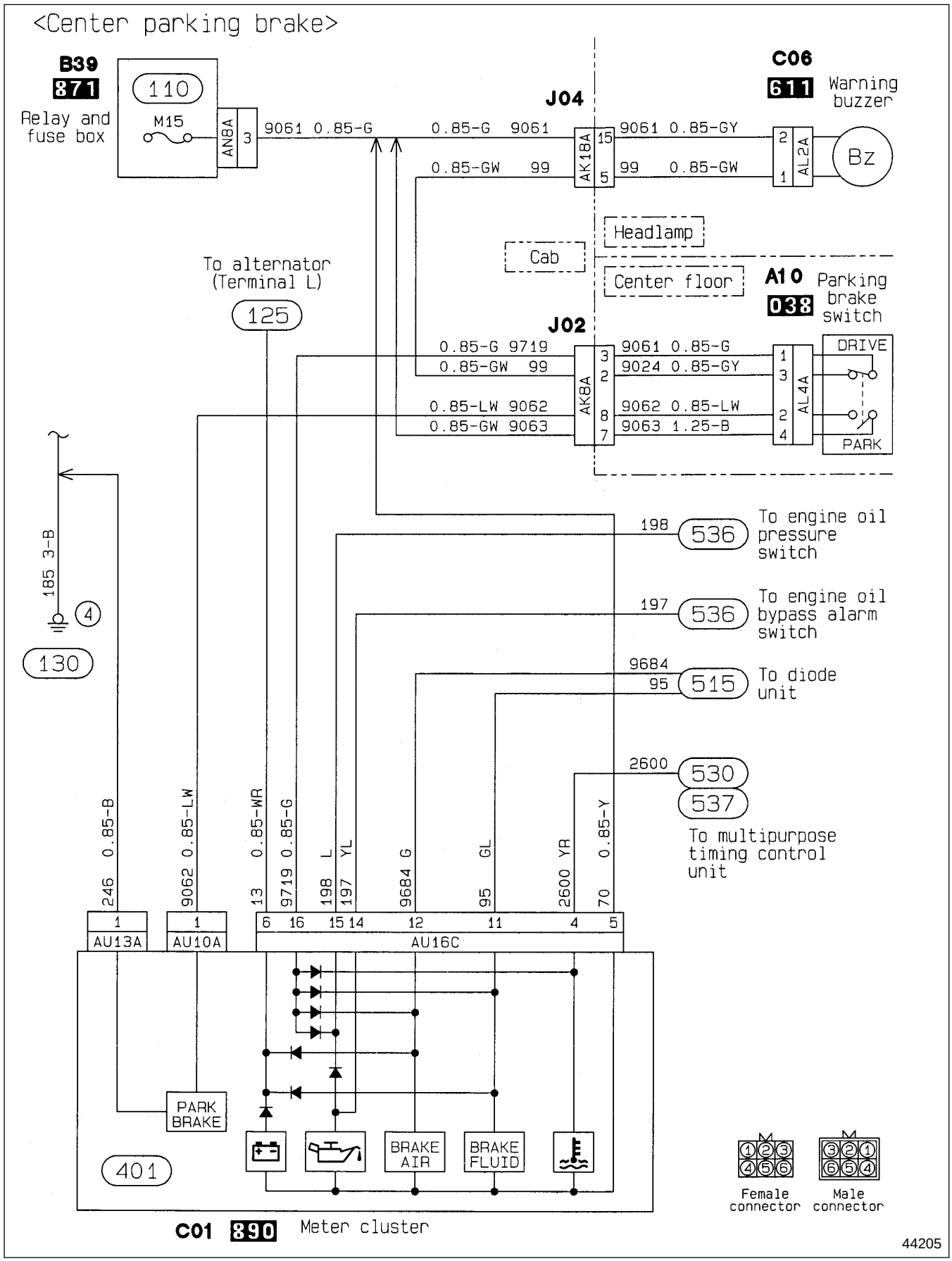


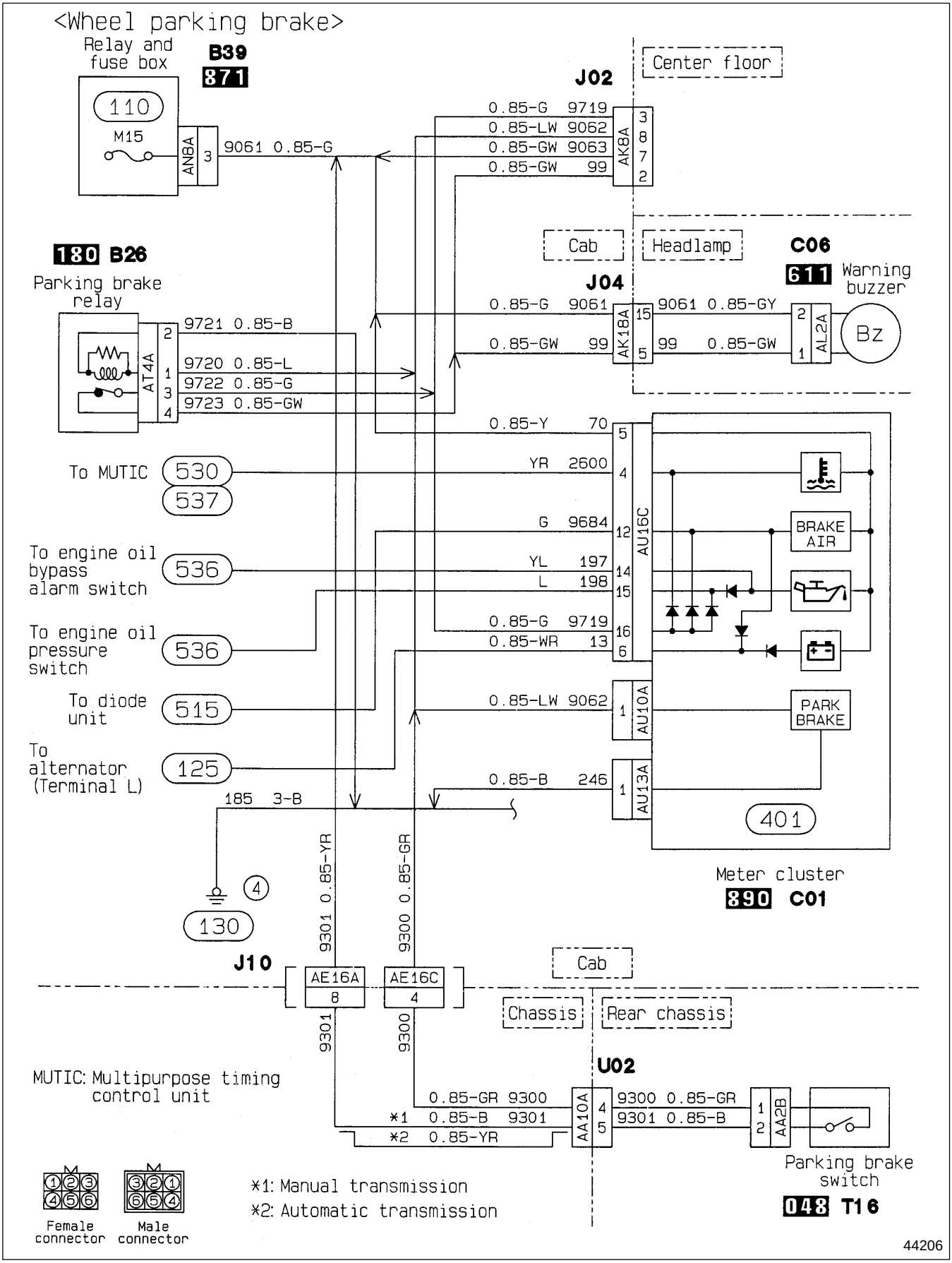


44204

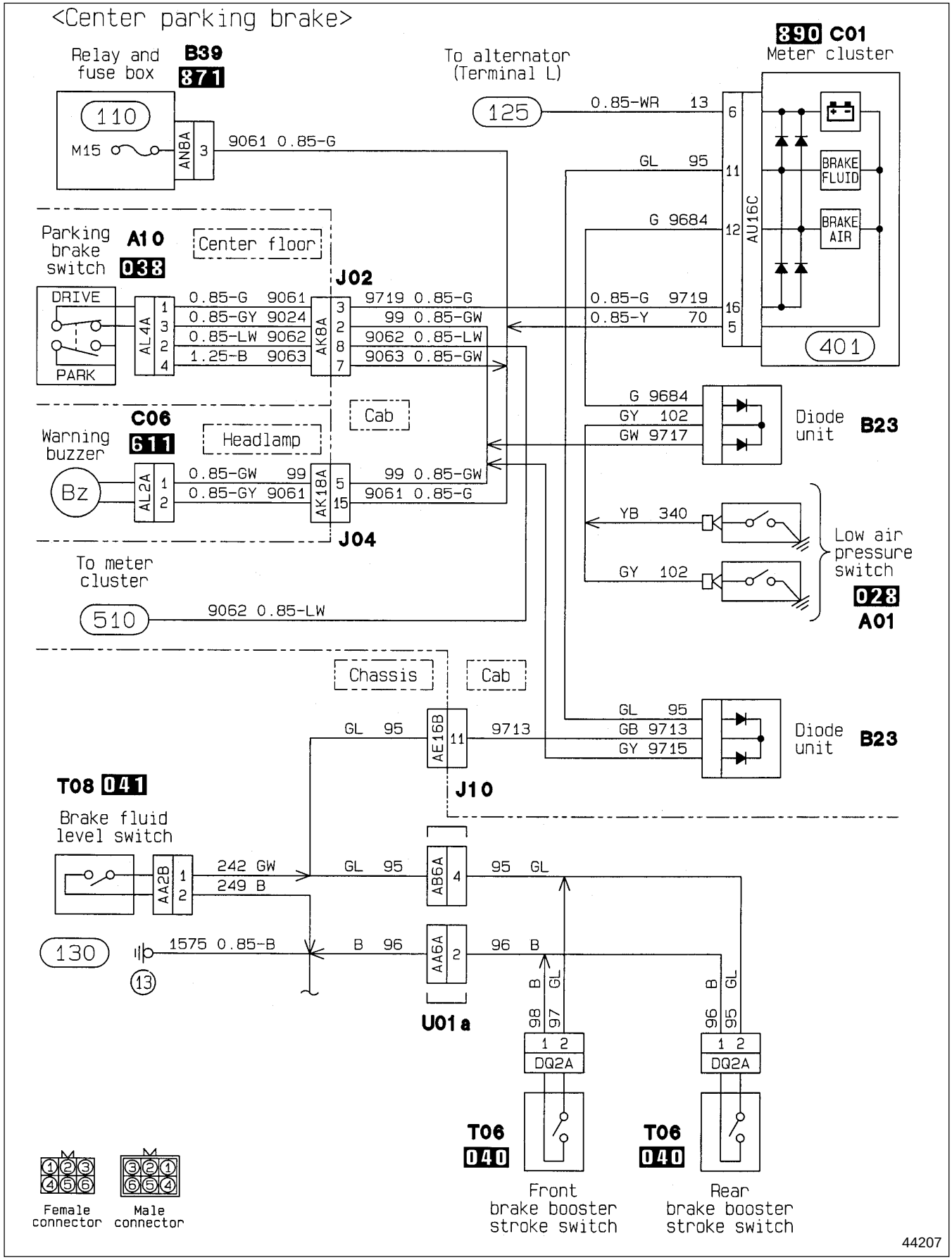
5 INDICATOR AND WARNING LAMP CIRCUIT

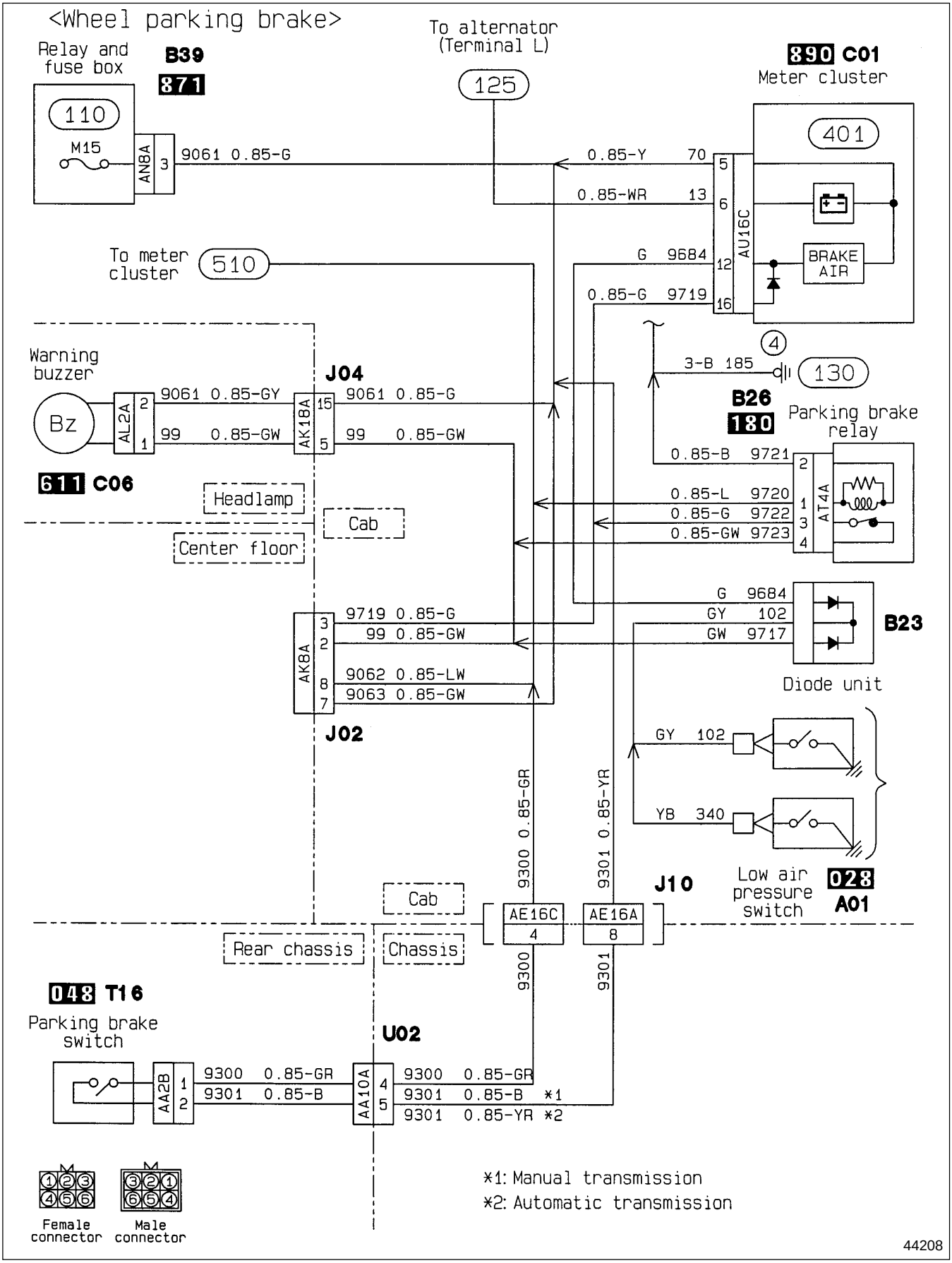
510 PARKING BRAKE INDICATOR CIRCUIT



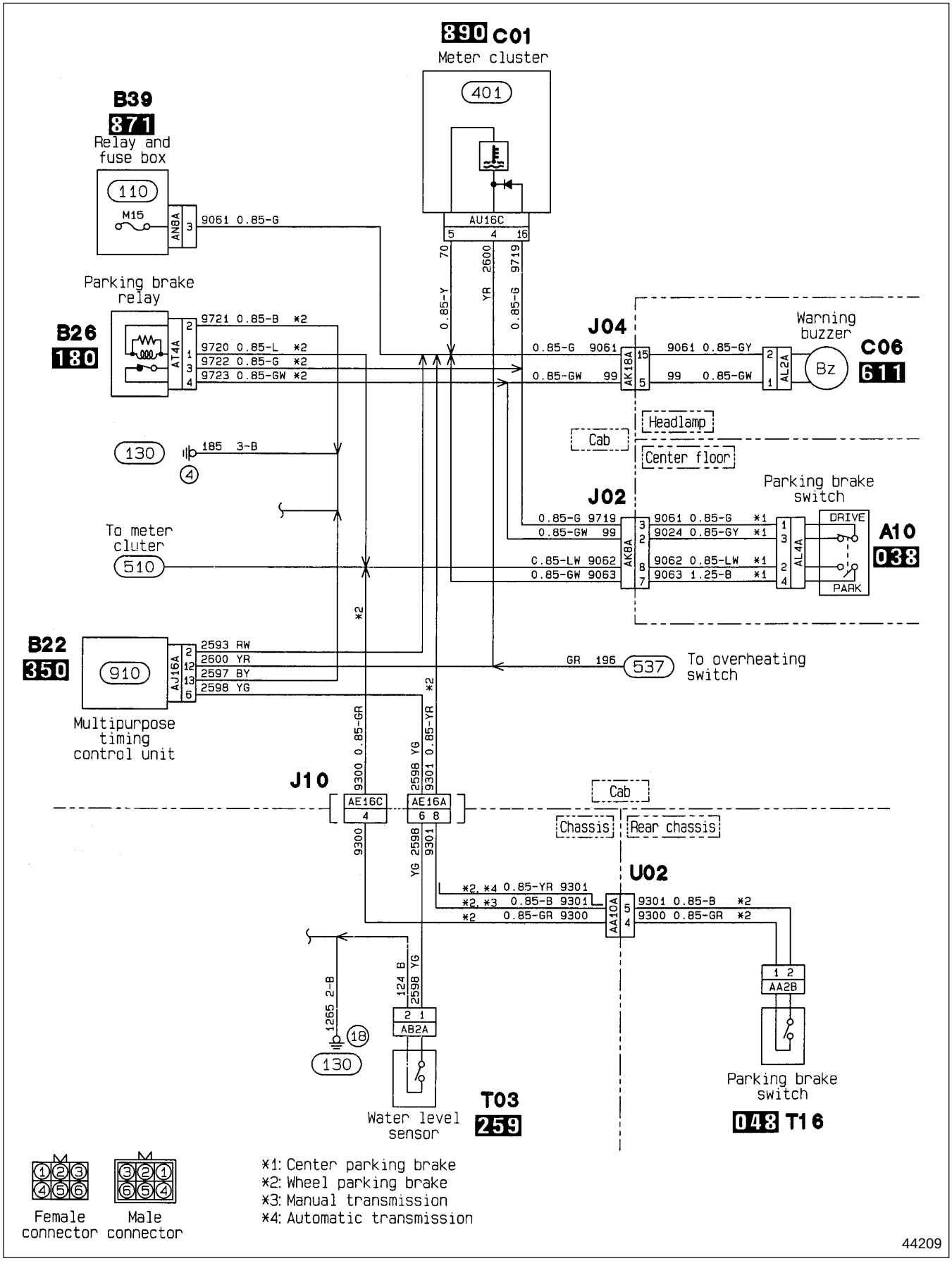

<Wheel parking brake>
Relay and fuse box
B39
871
110
M15
AN8A
3
9061 0.85-G
J02
Center floor
0.85-G 9719
0.85-LW 9062
0.85-GW 9063
0.85-GW 99
AK8A
3
8
7
2
180 B26
Parking brake relay
AT4A
2
1
3
4
9721 0.85-B
9720 0.85-L
9722 0.85-G
9723 0.85-GW
Cab
Headlamp
C06
611
Warning buzzer
J04
0.85-G 9061
0.85-GW 99
AK18A
15
5
9061 0.85-GY
99 0.85-GW
2
1
AL2A
Bz
0.85-Y 70
YR 2600
G 9684
YL 197
L 198
0.85-G 9719
0.85-WR 13
AU16C
5
4
12
14
15
16
6
To MUTIC
530
537
To engine oil bypass alarm switch
536
To engine oil pressure switch
536
To diode unit
515
To alternator (Terminal L)
125
0.85-LW 9062
AU10A
1
0.85-B 246
AU13A
1
185 3-B
BRAKE AIR
PARK BRAKE
401
Meter cluster
890 C01
4
130
9301 0.85-YR
9300 0.85-GR
J10
AE16A
8
AE16C
4
Cab
Chassis
Rear chassis
9301
9300
U02
MUTIC: Multipurpose timing control unit
0.85-GR 9300
*1 0.85-B 9301
*2 0.85-YR
AA10A
4
5
9300 0.85-GR
9301 0.85-B
1
2
AA2B
Parking brake switch
048 T16
Female connector
Male connector
*1: Manual transmission
*2: Automatic transmission
44206

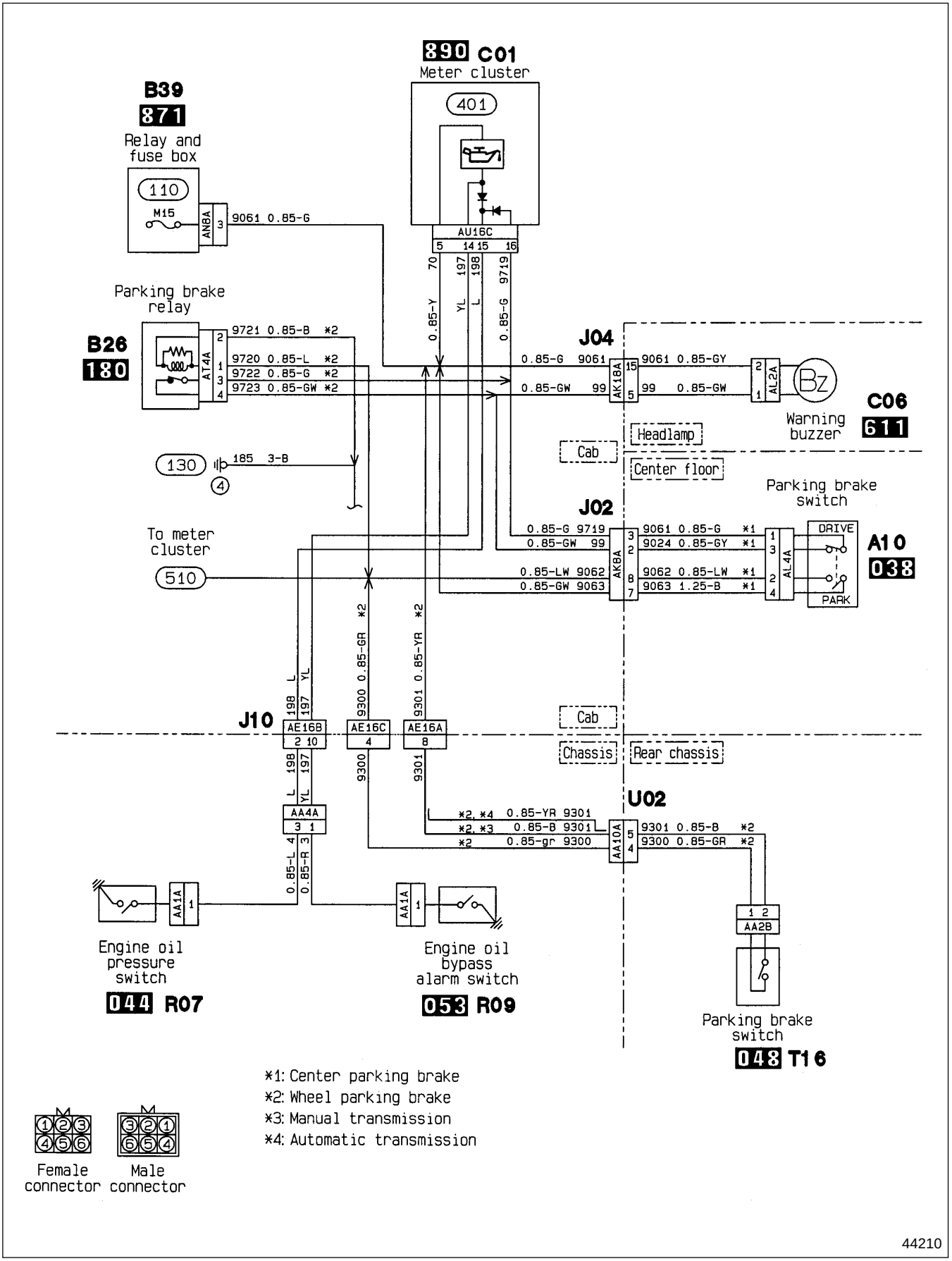
515 BRAKE WARNING CIRCUIT



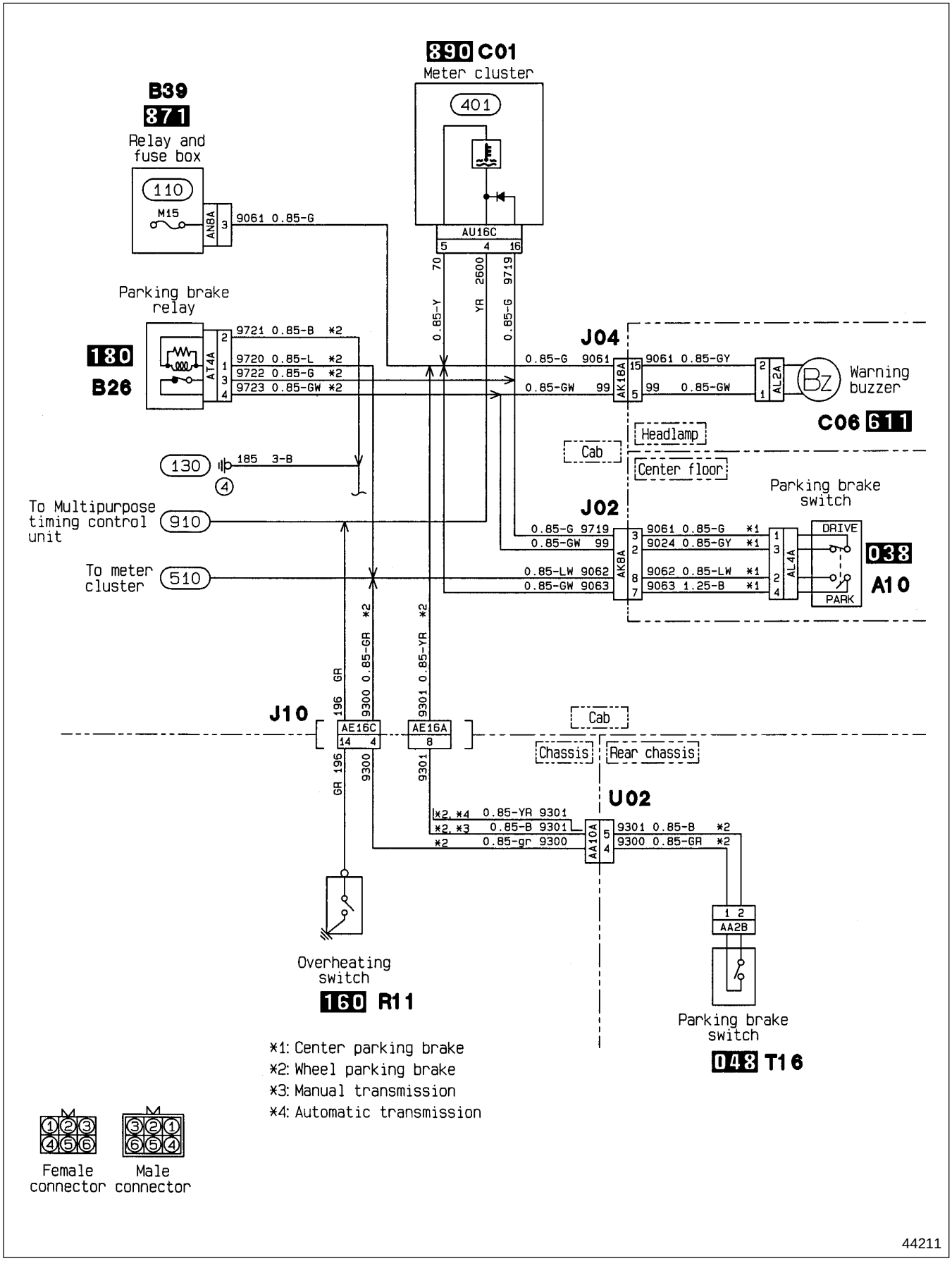

<Wheel parking brake>
Relay and fuse box
B39
871
110
M15
ANBA
3
9061 0.85-G
To alternator (Terminal L)
125
890 C01
Meter cluster
401
0.85-Y 70
0.85-WR 13
5
6
AU16C
12
16
BRAKE AIR
To meter cluster
510
G 9684
0.85-G 9719
4
3-B 185
130
B26
180
Parking brake relay
Warning buzzer
Bz
AL2A
2
1
9061 0.85-GY
99 0.85-GW
J04
AK18A
15
5
9061 0.85-G
99 0.85-GW
0.85-B 9721
0.85-L 9720
0.85-G 9722
0.85-GW 9723
AT4A
611 C06
Headlamp
Cab
Center floor
AK8A
3
2
8
7
9719 0.85-G
99 0.85-GW
9062 0.85-LW
9063 0.85-GW
J02
G 9684
GY 102
GW 9717
B23
Diode unit
GY 102
YB 340
9300 0.85-GR
9301 0.85-YR
J10
Low air pressure switch
028
A01
Cab
AE16C
4
AE16A
8
Rear chassis
Chassis
9300
9301
048 T16
Parking brake switch
U02
AA2B
1
2
AA10A
4
5
9300 0.85-GR
9301 0.85-B
9301 0.85-YR
*1
*2
*1: Manual transmission
*2: Automatic transmission
Female connector
Male connector
44208

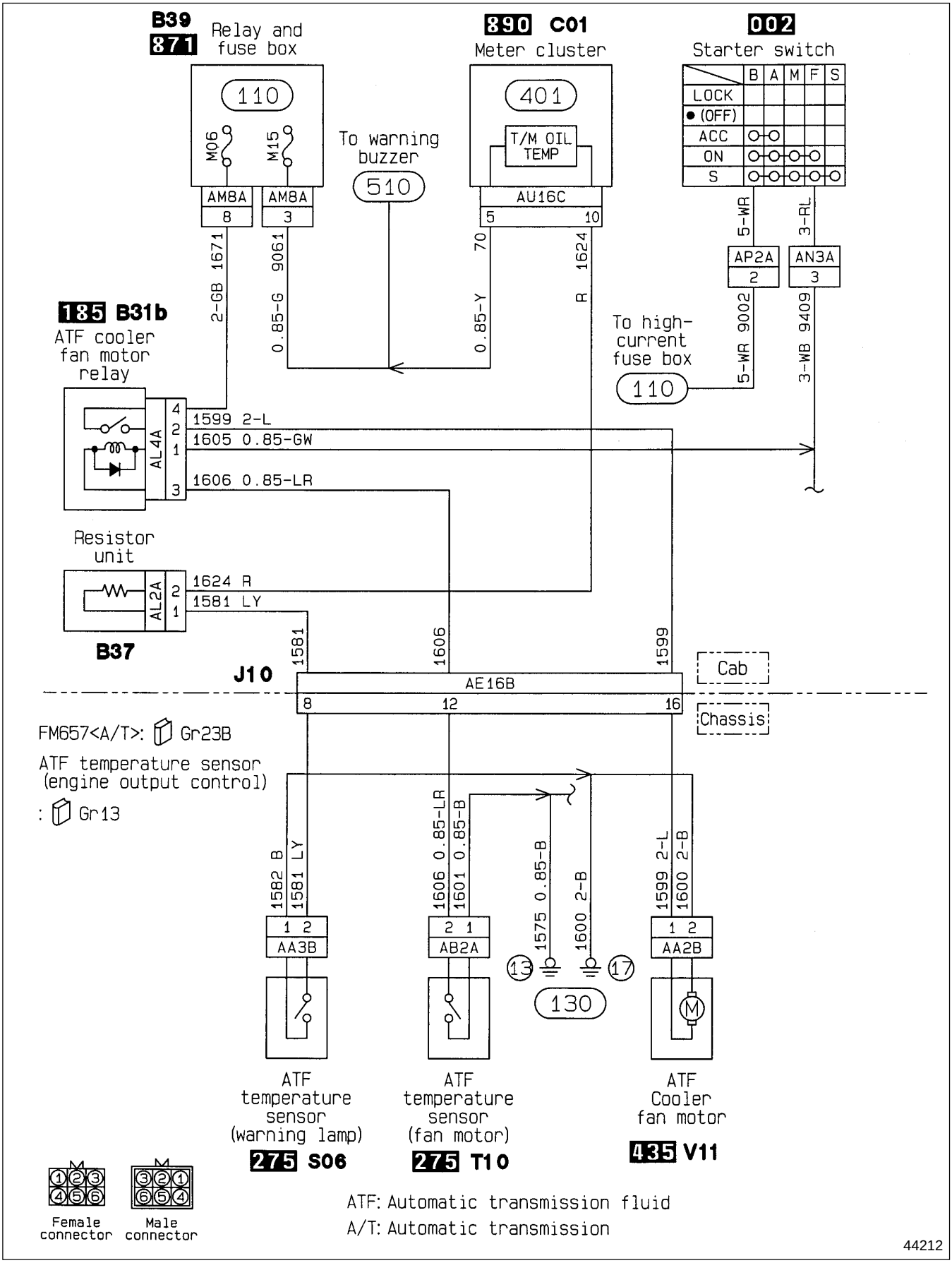
530 WATER LEVEL WARNING CIRCUIT




890 C01
Meter cluster
401
AU16C
5 14 15 16
B39
871
Relay and fuse box
110
M15
AN8A
3
9061 0.85-G
70 0.85-Y
197 YL
198 L
9719 0.85-G
Parking brake relay
B26
180
AT4A
2
1
3
4
9721 0.85-B *2
9720 0.85-L *2
9722 0.85-G *2
9723 0.85-GW *2
J04
0.85-G 9061
0.85-GW 99
AK18A
15
5
9061 0.85-GY
99 0.85-GW
AL2A
2
1
Bz
Warning buzzer
C06
611
Headlamp
Cab
Center floor
130
185 3-B
4
Parking brake switch
J02
0.85-G 9719
0.85-GW 99
AK8A
3
2
8
7
9061 0.85-G *1
9024 0.85-GY *1
0.85-LW 9062
0.85-GW 9063
9062 0.85-LW *1
9063 1.25-B *1
AL4A
1
3
2
4
DRIVE
PARK
A10
038
To meter cluster
510
198 L
197 YL
9300 0.85-GR *2
9301 0.85-YR *2
J10
AE16B
2 10
AE16C
4
AE16A
8
Cab
Chassis
Rear chassis
198 L
197 YL
9300
9301
U02
AA4A
3 1
0.85-L 4
0.85-R 3
*2, *4 0.85-YR 9301
*2, *3 0.85-B 9301
*2 0.85-gr 9300
AA10A
5
4
9301 0.85-B *2
9300 0.85-GR *2
AA1A
1
AA1A
1
1 2
AA2B
Engine oil pressure switch
044 R07
Engine oil bypass alarm switch
053 R09
Parking brake switch
048 T16
*1: Center parking brake
*2: Wheel parking brake
*3: Manual transmission
*4: Automatic transmission
Female connector
Male connector
44210

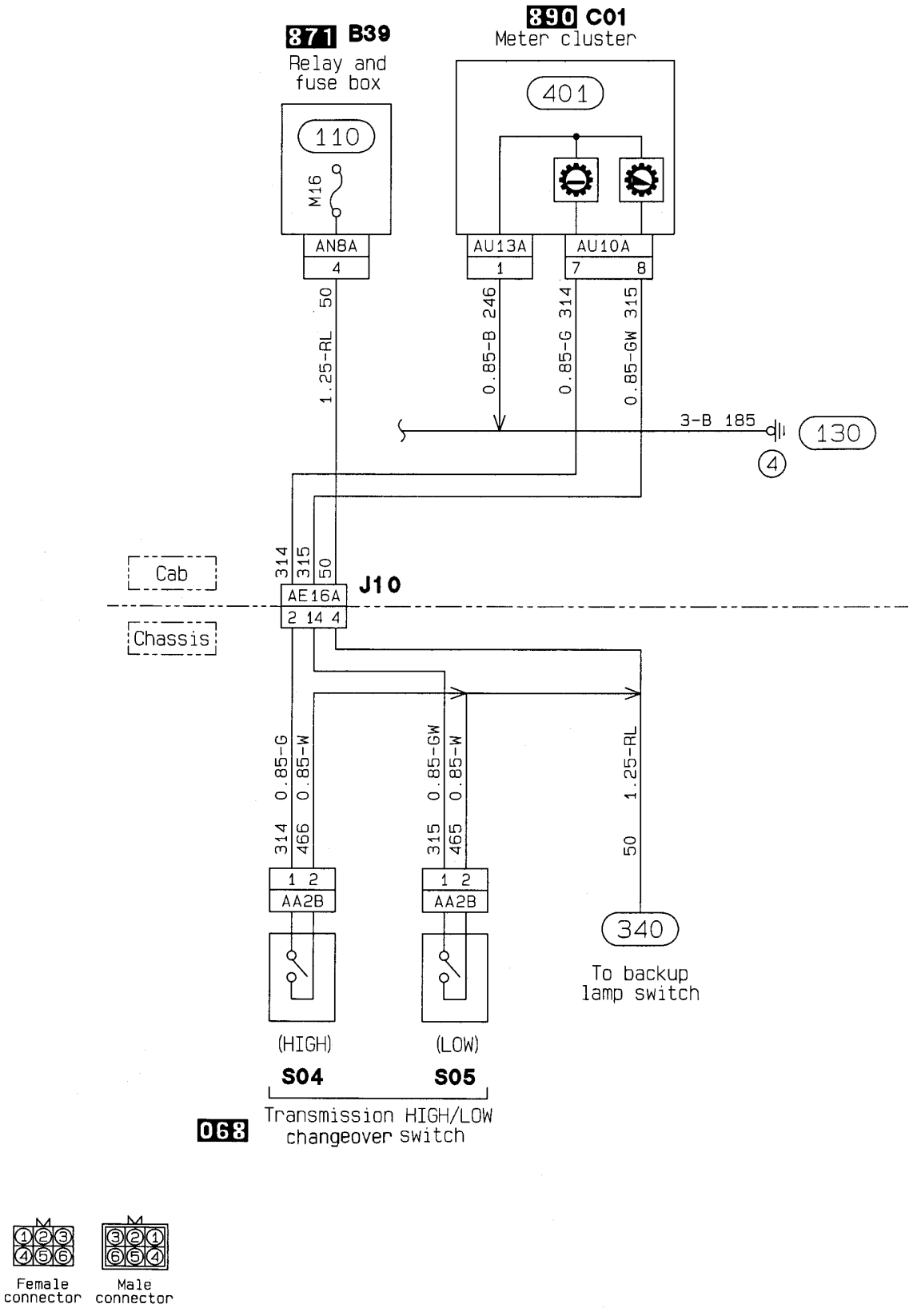
537 OVERHEATING WARNING CIRCUIT

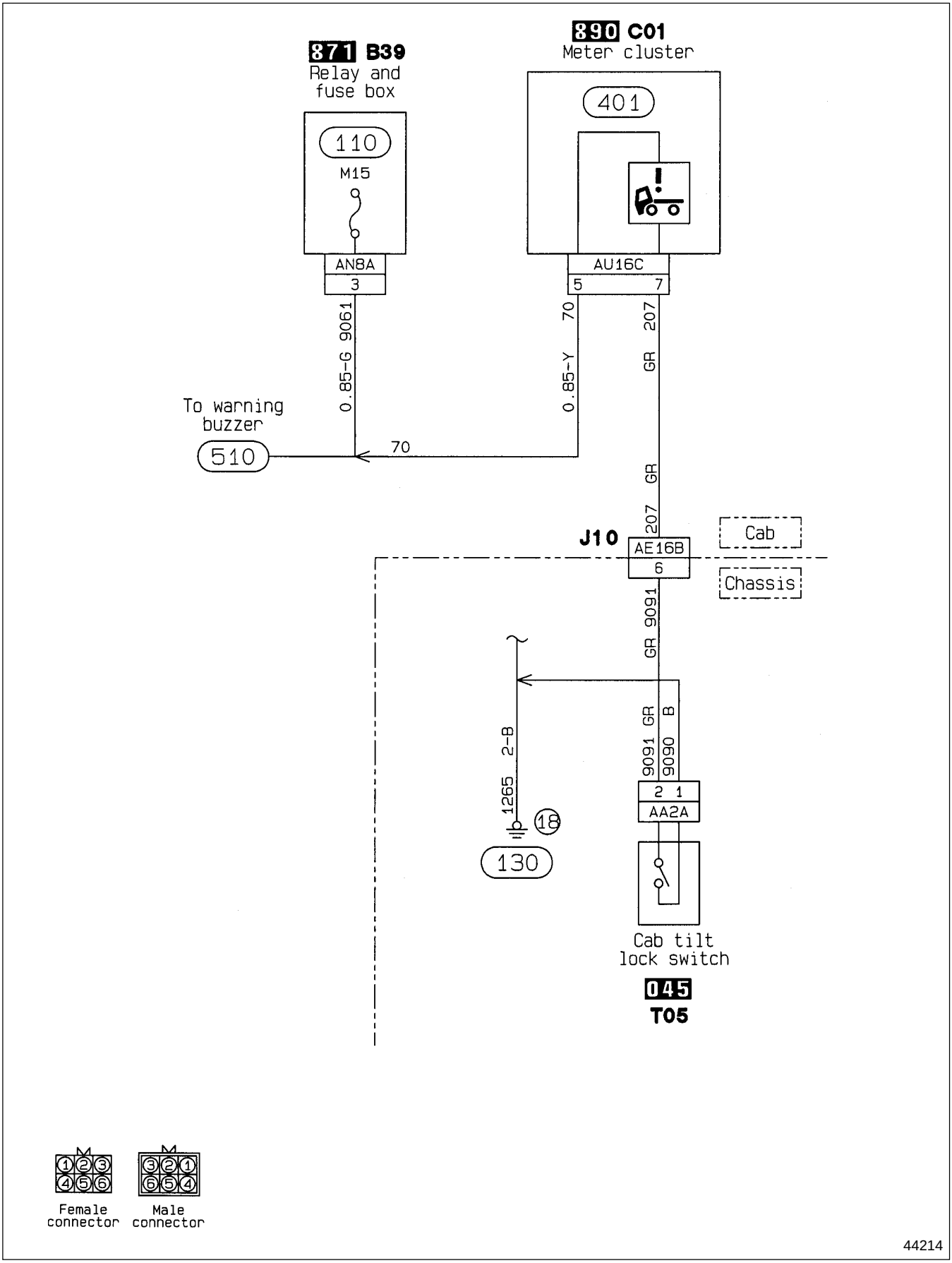



B39
871
Relay and fuse box
110
M06
M15
AM8A
8
AM8A
3
2-GB 1671
0.85-G 9061
To warning buzzer
510
890 C01
Meter cluster
401
T/M OIL TEMP
AU16C
5
10
70
0.85-Y
1624
R
002
Starter switch
B A M F S
LOCK
(OFF)
ACC
ON
S
5-WR
3-RL
AP2A
2
AN3A
3
5-WR 9002
3-WB 9409
To high-current fuse box
110
185 B31b
ATF cooler fan motor relay
AL4A
4
2
1
3
1599 2-L
1605 0.85-GW
1606 0.85-LR
Resistor unit
AL2A
2
1
1624 R
1581 LY
B37
1581
1606
1599
J10
AE16B
8
12
16
Cab
Chassis
FM657<A/T>: Gr23B
ATF temperature sensor (engine output control)
: Gr13
1582 B
1581 LY
1606 0.85-LR
1601 0.85-B
1575 0.85-B
1600 2-B
1599 2-L
1600 2-B
1 2
AA3B
2 1
AB2A
1 2
AA2B
13
17
130
M
ATF temperature sensor (warning lamp)
275 S06
ATF temperature sensor (fan motor)
275 T10
ATF Cooler fan motor
435 V11
Female connector
Male connector
ATF: Automatic transmission fluid
A/T: Automatic transmission
44212

548 TRANSMISSION HIGH/LOW INDICATOR CIRCUIT

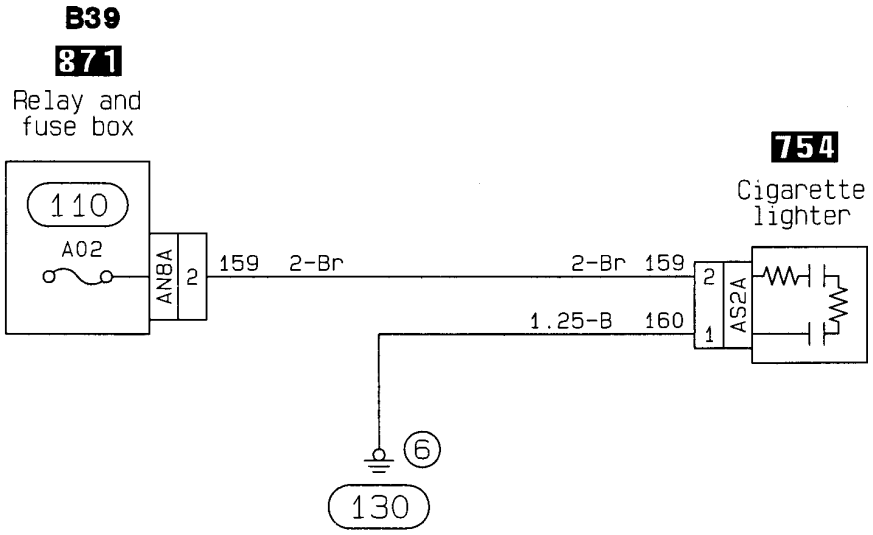
<FM657: (10 Speed transmission)>

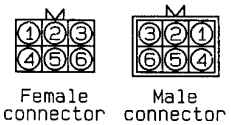



871 B39
Relay and fuse box
110
M15
AN8A
3
890 C01
Meter cluster
401
AU16C
5
7
0.85-G 9061
70
0.85-Y
207
GR
To warning buzzer
510
70
GR
207
J10
AE16B
6
Cab
Chassis
GR 9091
2-B
1265
18
130
9091 GR
9090 B
2 1
AA2A
Cab tilt lock switch
045
T05
Female connector
Male connector
44214

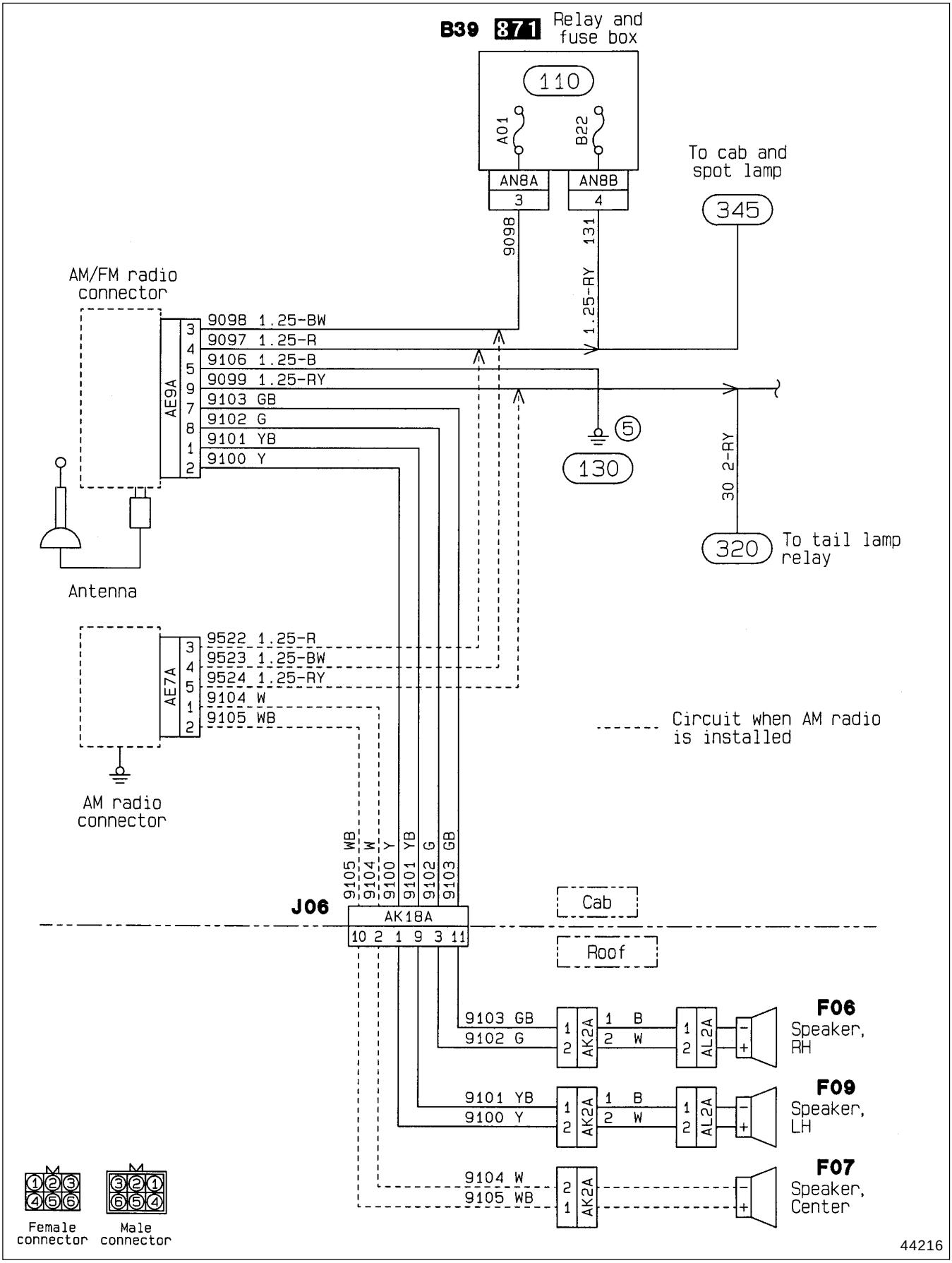
⑥ CAB SIDE ELECTRICAL CIRCUIT

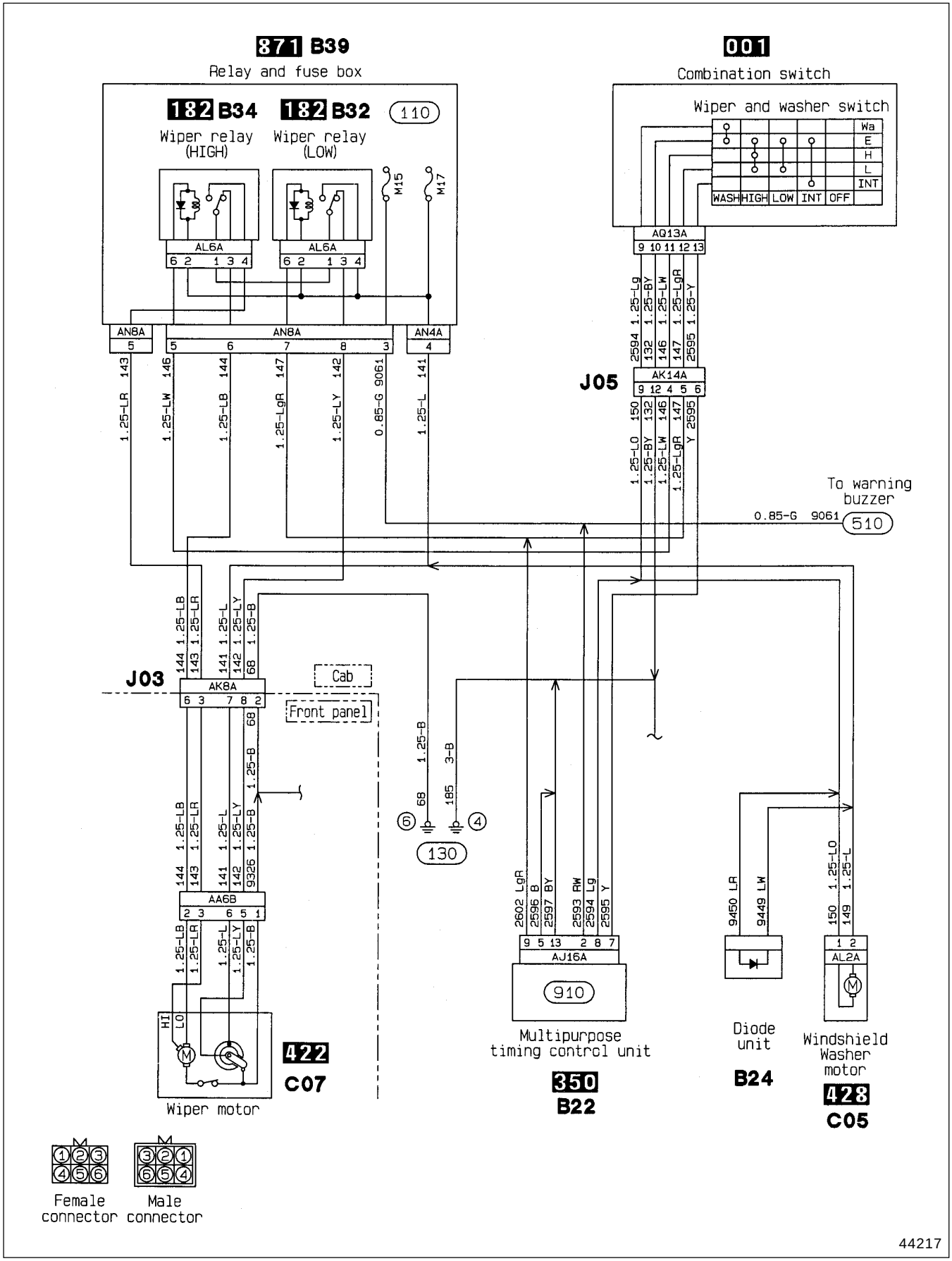
610 CIGARETTE LIGHTER CIRCUIT

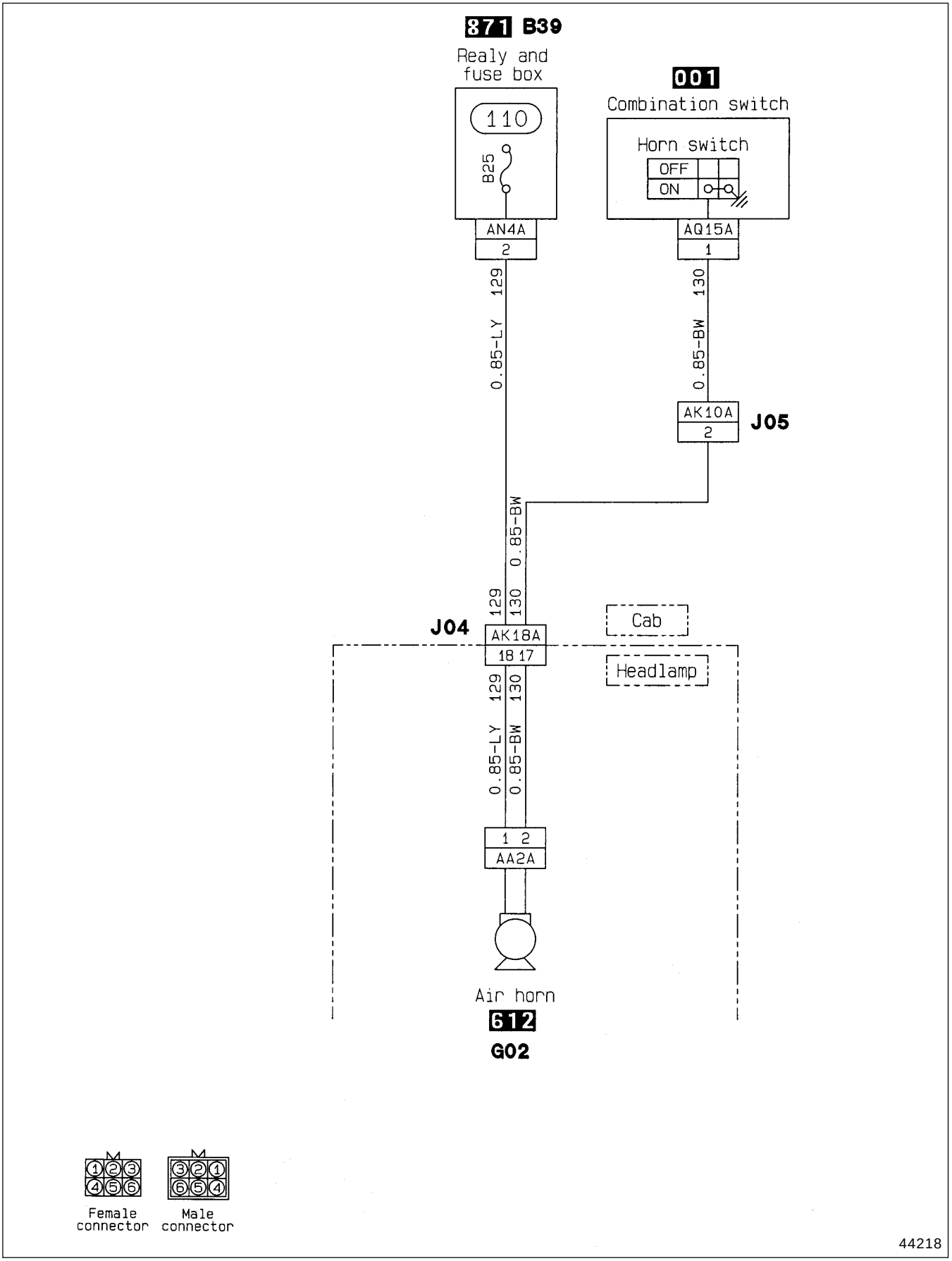


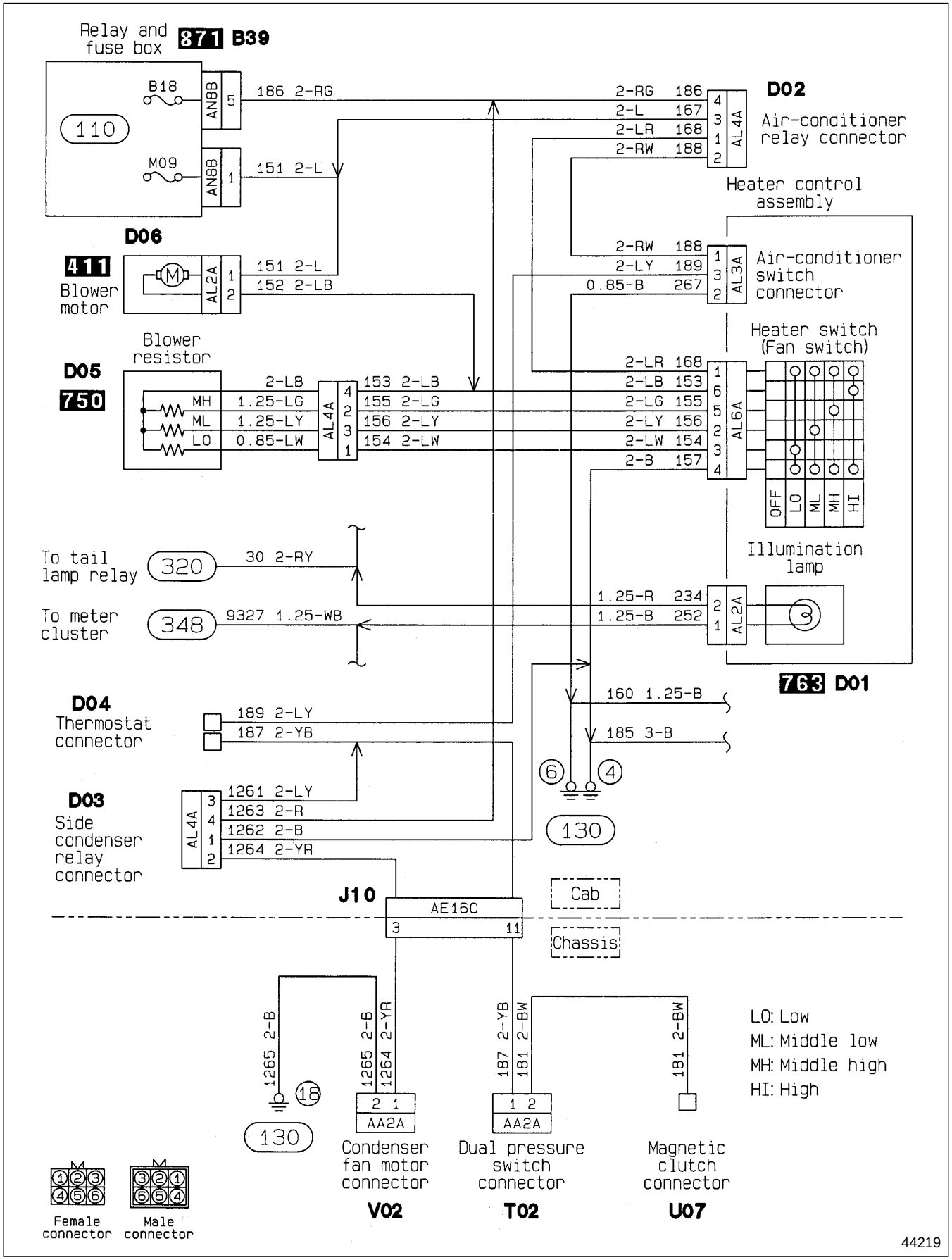


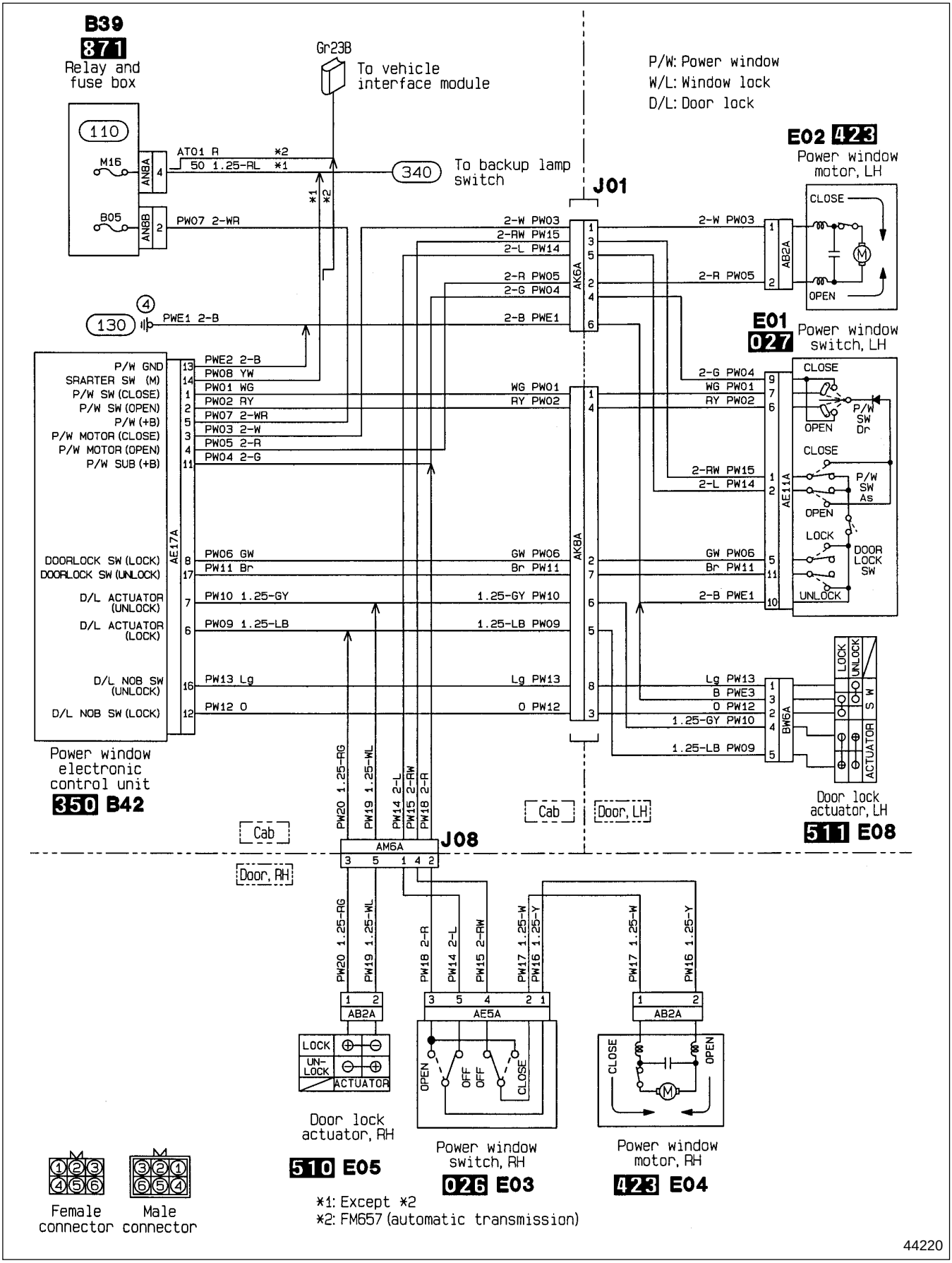
44215

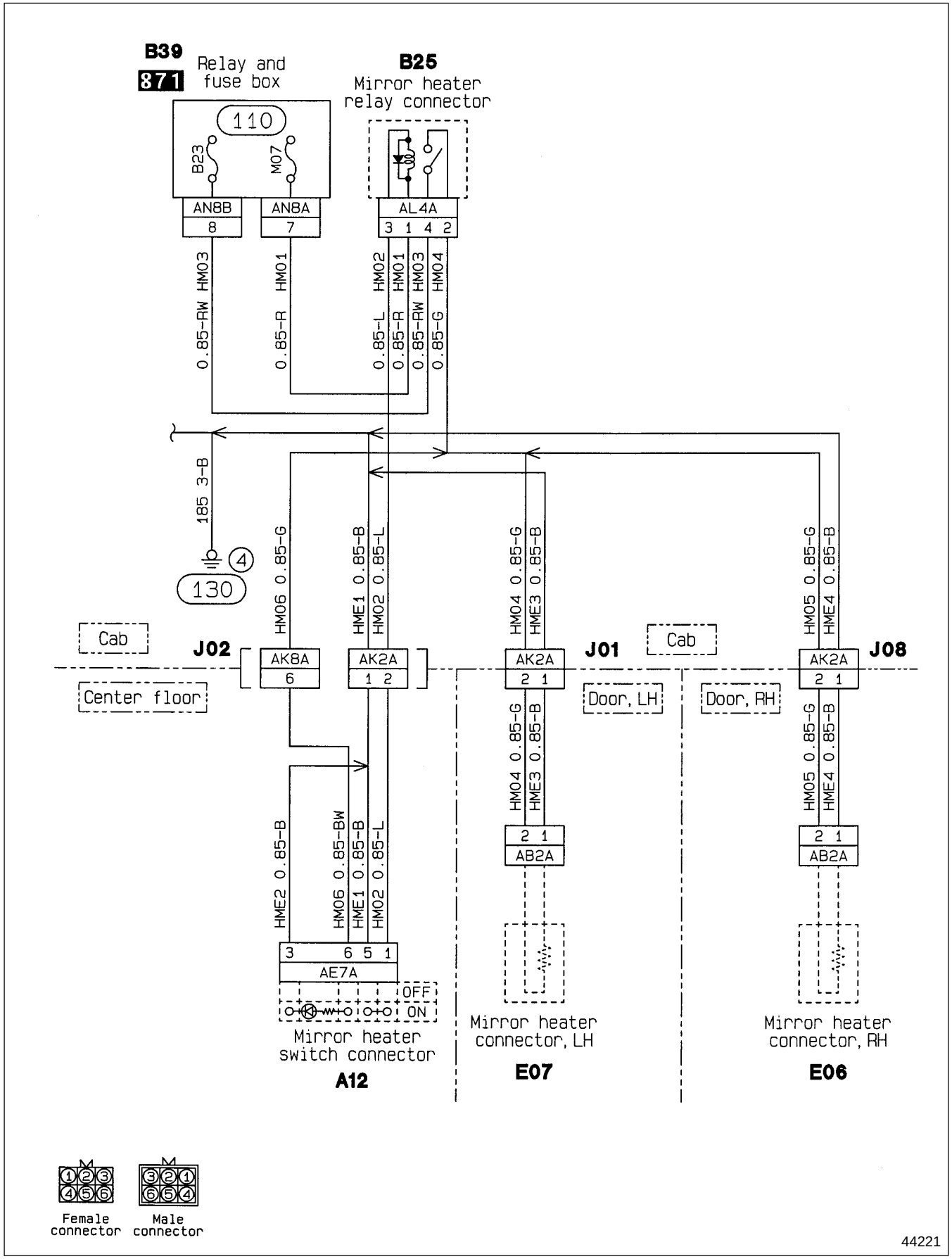

B39 871 Relay and fuse box
110
A01
B22
AN8A
3
AN8B
4
9098
131
1.25-RY
To cab and spot lamp
345
AM/FM radio connector
AE9A
3 9098 1.25-BW
4 9097 1.25-R
5 9106 1.25-B
9 9099 1.25-RY
7 9103 GB
8 9102 G
1 9101 YB
2 9100 Y
5
130
30 2-RY
320
To tail lamp relay
Antenna
AE7A
3 9522 1.25-R
4 9523 1.25-BW
5 9524 1.25-RY
1 9104 W
2 9105 WB
AM radio connector
Circuit when AM radio is installed
9105 WB
9104 W
9100 Y
9101 YB
9102 G
9103 GB
J06
AK18A
10 2 1 9 3 11
Cab
Roof
9103 GB
9102 G
AK2A
1 B
2 W
AL2A
F06 Speaker, RH
9101 YB
9100 Y
F09 Speaker, LH
9104 W
9105 WB
F07 Speaker, Center
Female connector
Male connector
44216


871 B39
Relay and fuse box
182 B34
Wiper relay (HIGH)
182 B32
Wiper relay (LOW)
110
M15
M17
AL6A
AN8A
AN4A
001
Combination switch
Wiper and washer switch
WASH HIGH LOW INT OFF
Wa
E
H
L
INT
AQ13A
J05
AK14A
To warning buzzer
0.85-G 9061
510
J03
AK8A
Cab
Front panel
130
AA6B
HI
LO
422
C07
Wiper motor
AJ16A
910
Multipurpose timing control unit
350
B22
Diode unit
B24
AL2A
Windshield Washer motor
428
C05
Female connector
Male connector
44217

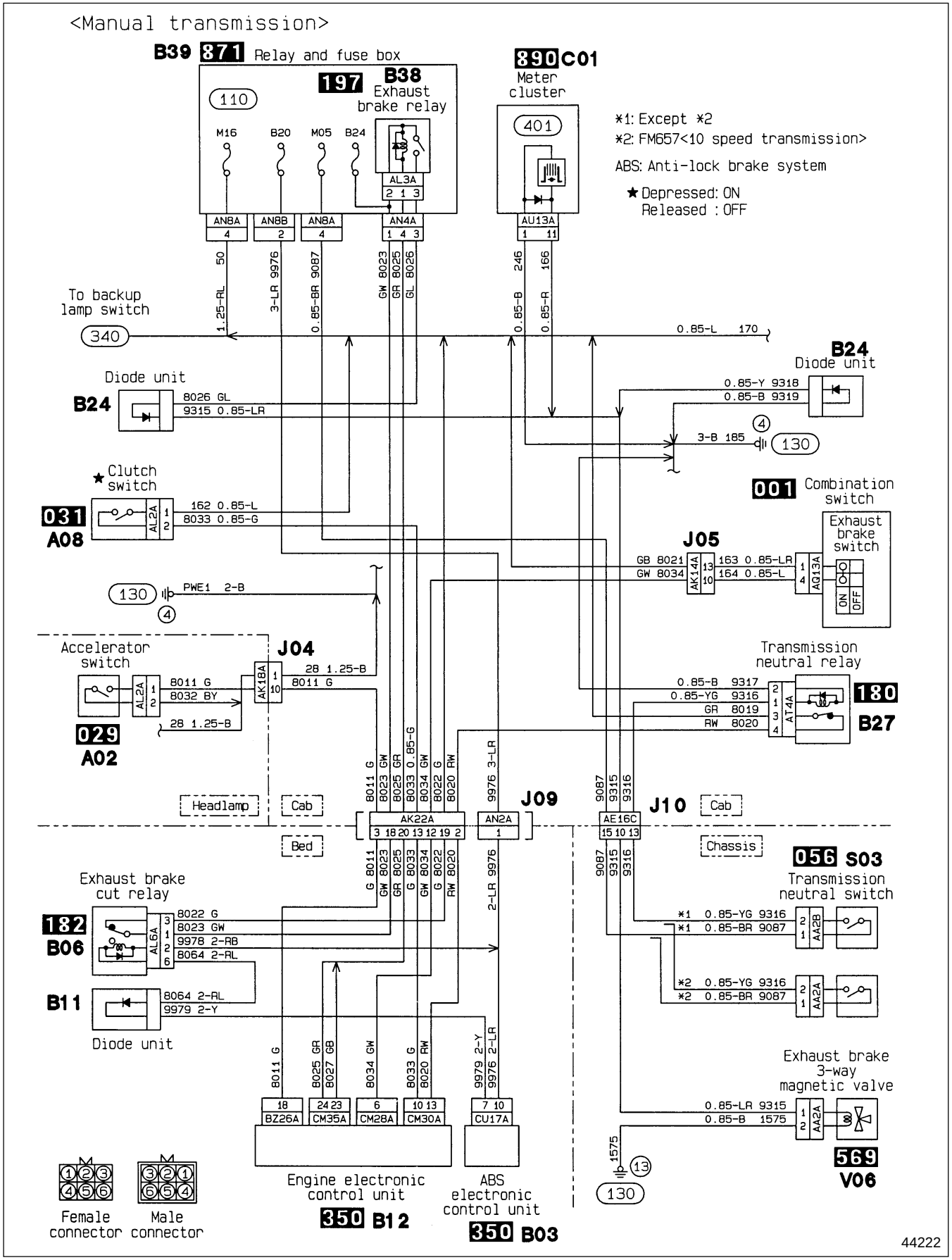

871 B39
Realy and fuse box
110
B25
001
Combination switch
Horn switch
OFF
ON
AN4A
2
AQ15A
1
129
0.85-LY
130
0.85-BW
AK10A
2
J05
0.85-BW
129
130
J04
AK18A
18 17
Cab
Headlamp
129
0.85-LY
130
0.85-BW
1 2
AA2A
Air horn
612
G02
Female connector
Male connector
44218

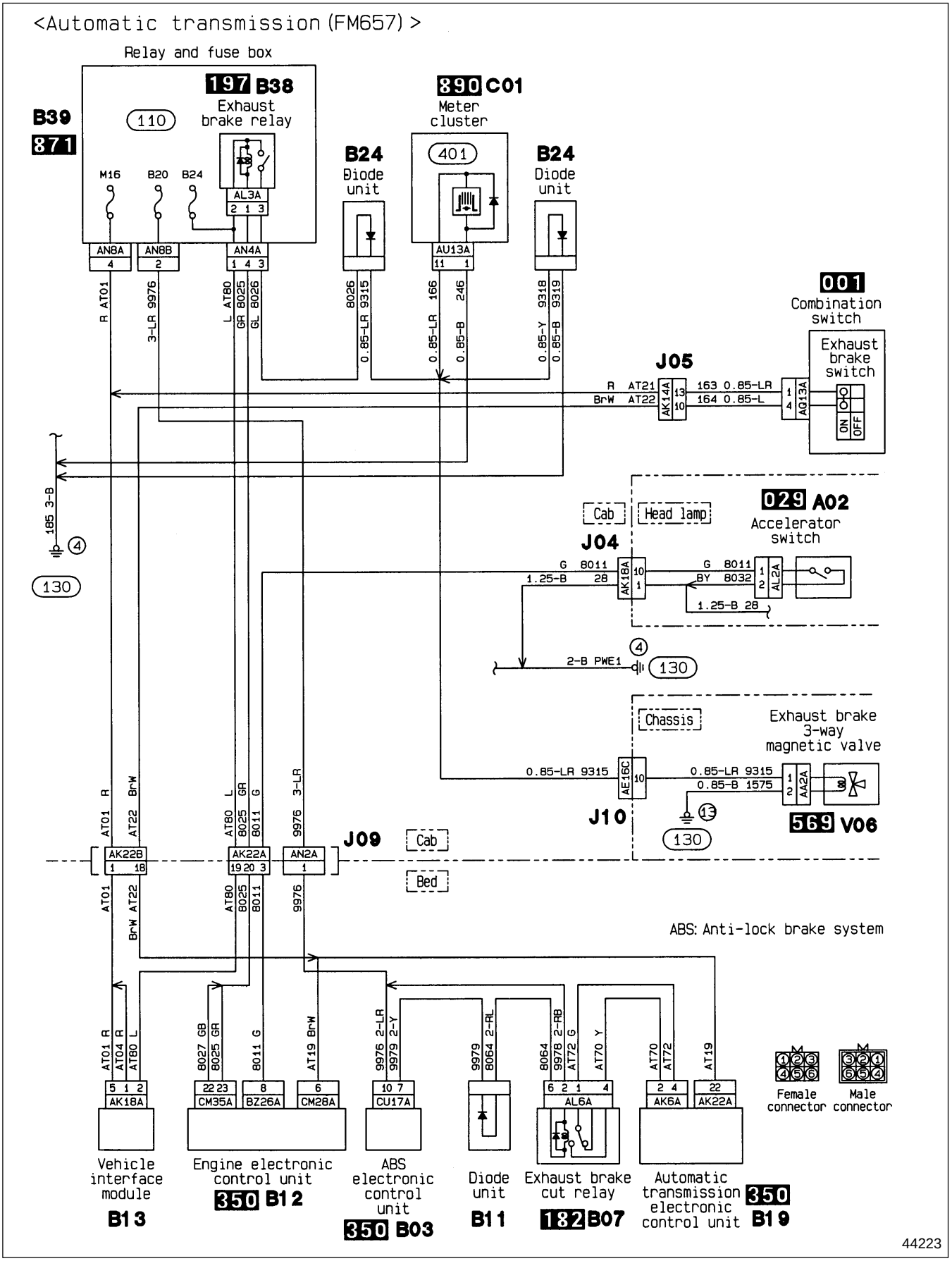

Relay and fuse box 871 B39
B18
M09
AN8B
110
186 2-RG
151 2-L
D02
Air-conditioner relay connector
AL4A
2-RG 186
2-L 167
2-LR 168
2-RW 188
Heater control assembly
D06
411
Blower motor
AL2A
151 2-L
152 2-LB
2-RW 188
2-LY 189
0.85-B 267
AL3A
Air-conditioner switch connector
Blower resistor
D05
750
MH
ML
LO
1.25-LG
1.25-LY
0.85-LW
2-LB
153 2-LB
155 2-LG
156 2-LY
154 2-LW
AL4A
Heater switch (Fan switch)
2-LR 168
2-LB 153
2-LG 155
2-LY 156
2-LW 154
2-B 157
AL6A
OFF
LO
ML
MH
HI
To tail lamp relay
320
30 2-RY
To meter cluster
348
9327 1.25-WB
Illumination lamp
1.25-R 234
1.25-B 252
AL2A
763 D01
D04
Thermostat connector
189 2-LY
187 2-YB
160 1.25-B
185 3-B
D03
Side condenser relay connector
AL4A
1261 2-LY
1263 2-R
1262 2-B
1264 2-YR
130
J10
AE16C
3
11
Cab
Chassis
1265 2-B
1265 2-B
1264 2-YR
187 2-YB
181 2-BW
181 2-BW
18
130
2 1
AA2A
1 2
AA2A
Condenser fan motor connector
V02
Dual pressure switch connector
T02
Magnetic clutch connector
U07
LO: Low
ML: Middle low
MH: Middle high
HI: High
Female connector
Male connector
44219

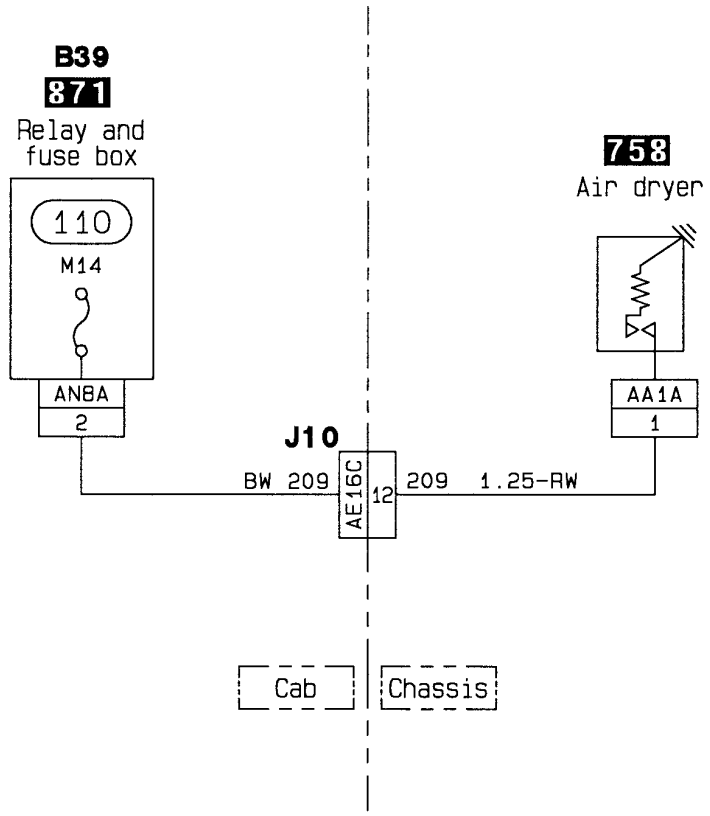

B39
871
Relay and fuse box
Gr23B
To vehicle interface module
P/W: Power window
W/L: Window lock
D/L: Door lock
E02 423
Power window motor, LH
To backup lamp switch
J01
E01
027
Power window switch, LH
Power window electronic control unit
350 B42
Door lock actuator, LH
511 E08
Cab
Door, LH
Door, RH
J08
Door lock actuator, RH
510 E05
Power window switch, RH
026 E03
Power window motor, RH
423 E04
Female connector
Male connector
*1: Except *2
*2: FM657 (automatic transmission)
44220

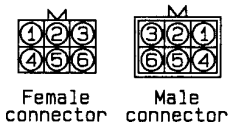

B39
871
Relay and fuse box
110
B23
M07
AN8B
8
AN8A
7
B25
Mirror heater relay connector
AL4A
3 1 4 2
0.85-RW HM03
0.85-R HM01
0.85-L HM02
0.85-R HM01
0.85-RW HM03
0.85-G HM04
185 3-B
4
130
HM06 0.85-G
HME1 0.85-B
HM02 0.85-L
HM04 0.85-G
HME3 0.85-B
HM05 0.85-G
HME4 0.85-B
Cab
J02
AK8A
6
AK2A
1 2
J01
AK2A
2 1
Cab
J08
AK2A
2 1
Center floor
Door, LH
Door, RH
HME2 0.85-B
HM06 0.85-BW
HME1 0.85-B
HM02 0.85-L
HM04 0.85-G
HME3 0.85-B
HM05 0.85-G
HME4 0.85-B
2 1
AB2A
2 1
AB2A
3 6 5 1
AE7A
OFF
ON
Mirror heater switch connector
A12
Mirror heater connector, LH
E07
Mirror heater connector, RH
E06
Female connector
Male connector
44221

7 CHASSIS SIDE ELECTRICAL CIRCUIT


<Manual transmission>
B39 871 Relay and fuse box
197 B38 Exhaust brake relay
890 C01 Meter cluster
*1: Except *2
*2: FM657<10 speed transmission>
ABS: Anti-lock brake system
★ Depressed: ON
Released : OFF
To backup lamp switch
340
Diode unit
B24
★ Clutch switch
031 A08
001 Combination switch
Exhaust brake switch
J05
Accelerator switch
J04
029 A02
Transmission neutral relay
180 B27
Headlamp
Cab
Bed
J09
J10
Chassis
Exhaust brake cut relay
182 B06
B11
Diode unit
056 S03 Transmission neutral switch
Exhaust brake 3-way magnetic valve
569 V06
Engine electronic control unit
350 B12
ABS electronic control unit
350 B03
Female connector
Male connector
44222


<Automatic transmission (FM657)>
Relay and fuse box
197 B38
Exhaust brake relay
B39
871
110
M16
B20
B24
AL3A
2 1 3
AN8A
AN8B
AN4A
B24
Diode unit
890 C01
Meter cluster
401
AU13A
B24
Diode unit
001
Combination switch
Exhaust brake switch
J05
AK14A
AG13A
ON
OFF
R AT21
BrW AT22
163 0.85-LR
164 0.85-L
R AT01
3-LR 9976
L AT80
GR 8025
GL 8026
8026
0.85-LR 9315
0.85-LR 166
0.85-B 246
0.85-Y 9318
0.85-B 9319
185 3-B
130
Cab
Head lamp
029 A02
Accelerator switch
J04
AK18A
AL2A
G 8011
1.25-B 28
BY 8032
2-B PWE1
Chassis
Exhaust brake 3-way magnetic valve
0.85-LR 9315
0.85-B 1575
AE16C
AA2A
J10
569 V06
J09
AK22B
AK22A
AN2A
Cab
Bed
ABS: Anti-lock brake system
AT01 R
AT04 R
AT80 L
8027 GB
8025 GR
8011 G
AT19 BrW
9976 2-LR
9979 2-Y
9979
8064 2-RL
8064
9978 2-RB
AT72 G
AT70 Y
AT70
AT72
AT19
AK18A
CM35A
BZ26A
CM28A
CU17A
AL6A
AK6A
AK22A
Female connector
Male connector
Vehicle interface module
B13
Engine electronic control unit
350 B12
ABS electronic control unit
350 B03
Diode unit
B11
Exhaust brake cut relay
182 B07
Automatic transmission electronic control unit
350 B19
44223

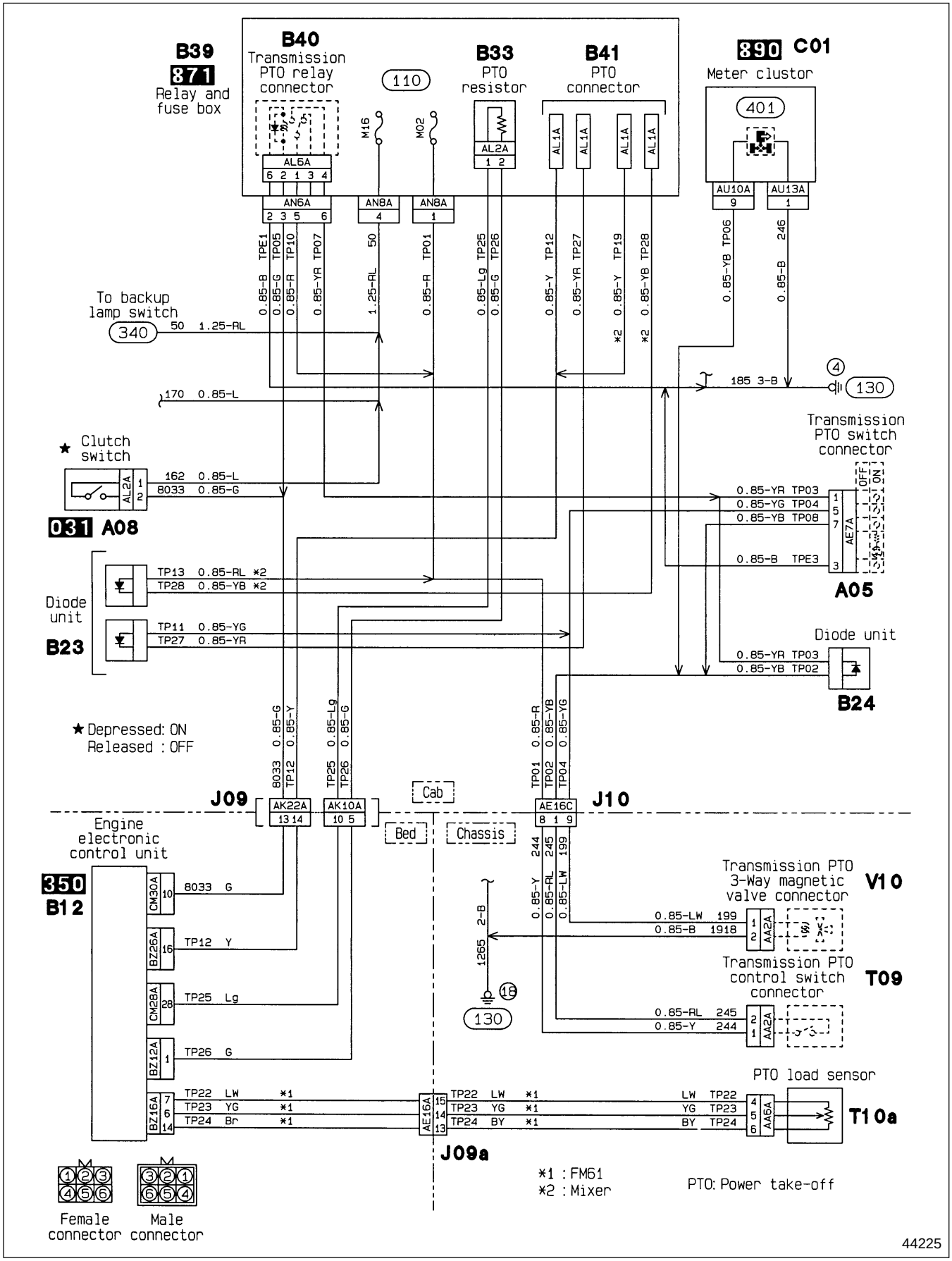

B39
871
Relay and
fuse box
110
M14
AN8A
2
758
Air dryer
AA1A
1
J10
BW 209
AE16C
12
209 1.25-RW
Cab
Chassis


Female
connector
Male
connector

44224

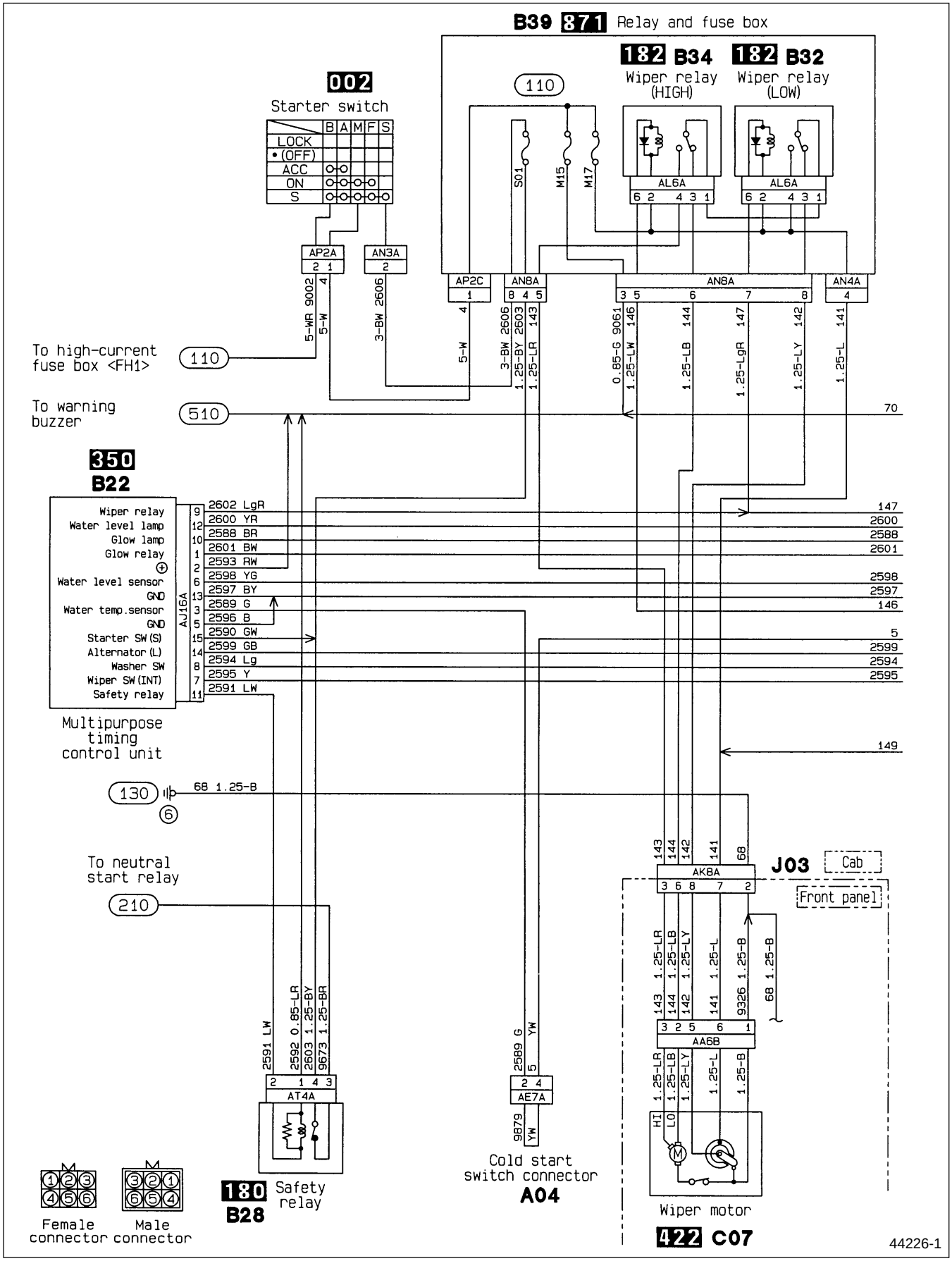
8 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

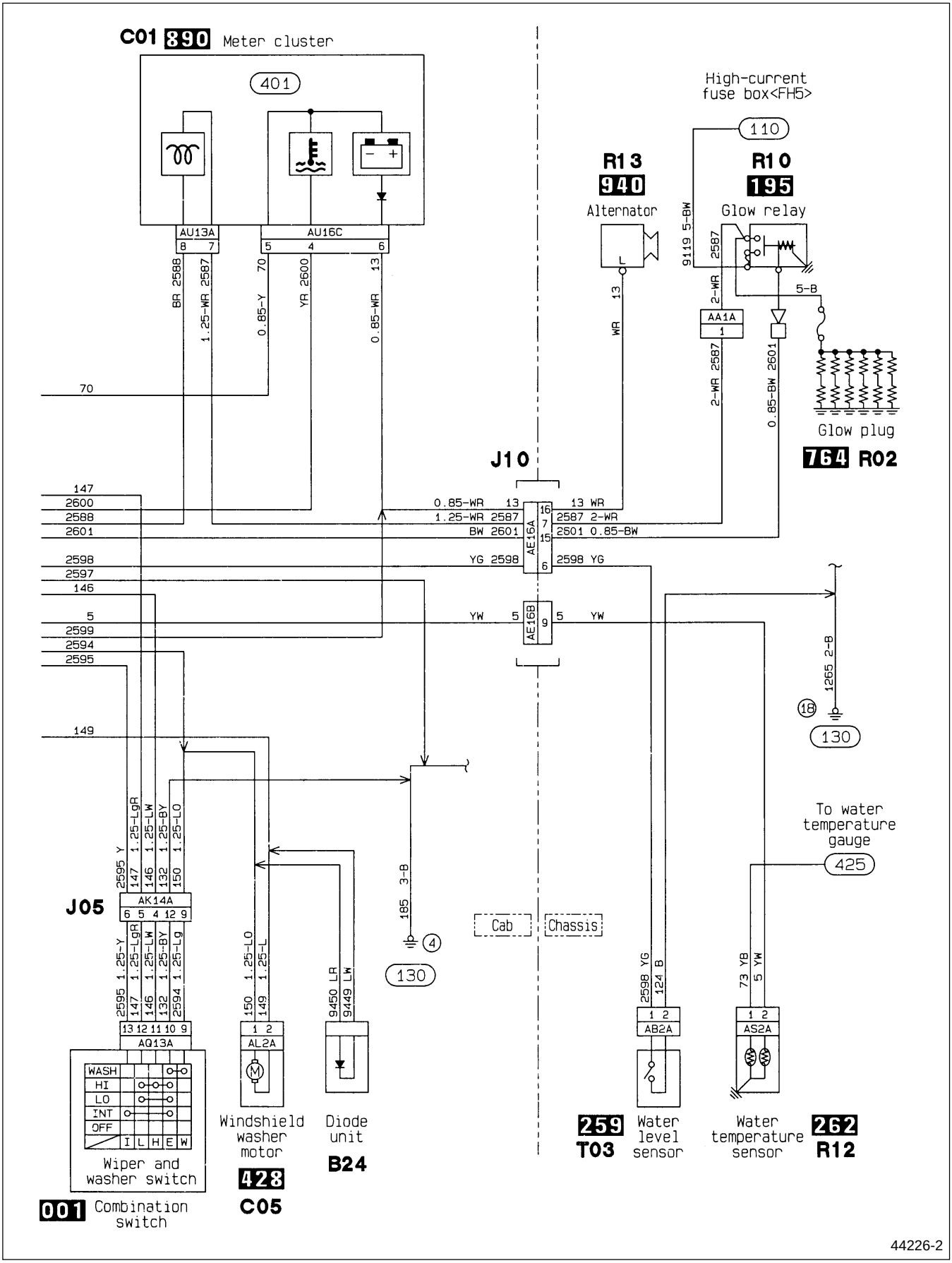
850 TRANSMISSION POWER TAKE-OFF CIRCUIT



⑨ OTHERS CIRCUIT

910 MULTIPURPOSE TIMING CONTROL UNIT CIRCUIT



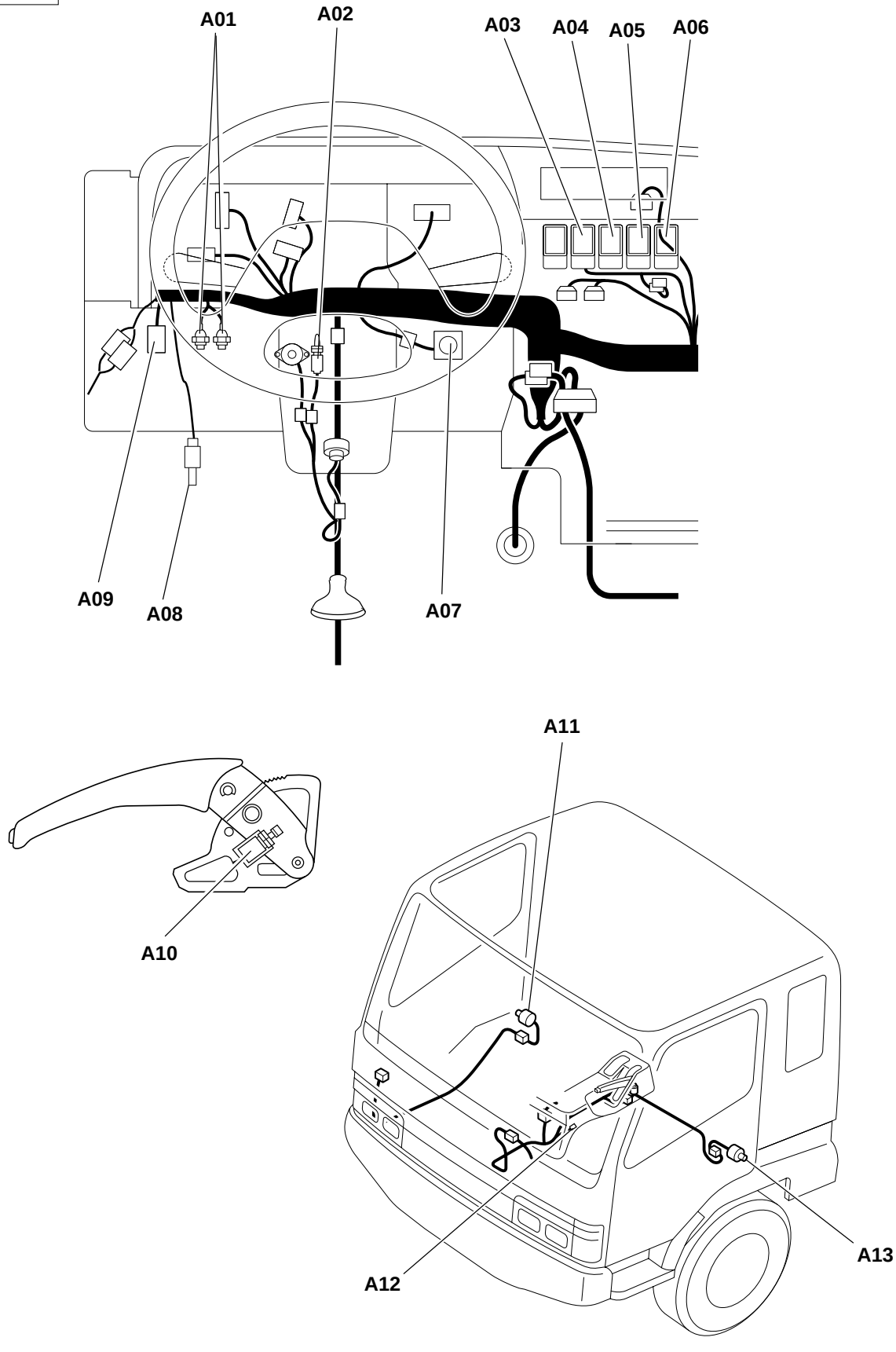

C01 890 Meter cluster
401
AU13A
AU16C
BR 2588
1.25-WR 2587
0.85-Y
YR 2600
0.85-WR
70
147
2600
2588
2601
2598
2597
146
5
2599
2594
2595
149
J10
AE16A
AE16B
0.85-WR 13
1.25-WR 2587
BW 2601
YG 2598
YW 5
13 WR
2587 2-WR
2601 0.85-BW
2598 YG
5 YW
High-current fuse box<FH5>
110
R13 940 Alternator
R10 195 Glow relay
9119 5-BW
2587
2-WR
5-B
AA1A
1
WR 13
2-WR 2587
0.85-BW 2601
Glow plug
764 R02
1265 2-B
18
130
To water temperature gauge
425
J05
AK14A
2595 Y
147 1.25-LgR
146 1.25-LW
132 1.25-BY
150 1.25-LO
2595 1.25-Y
147 1.25-LgR
146 1.25-LW
132 1.25-BY
2594 1.25-Lg
AQ13A
WASH
HI
LO
INT
OFF
I L H E W
Wiper and washer switch
001 Combination switch
150 1.25-LO
149 1.25-L
AL2A
Windshield washer motor
428 C05
9450 LR
9449 LW
Diode unit
B24
185 3-B
4
130
Cab
Chassis
2598 YG
124 B
AB2A
259 T03 Water level sensor
73 YB
5 YW
AS2A
Water temperature sensor
262 R12

44226-2

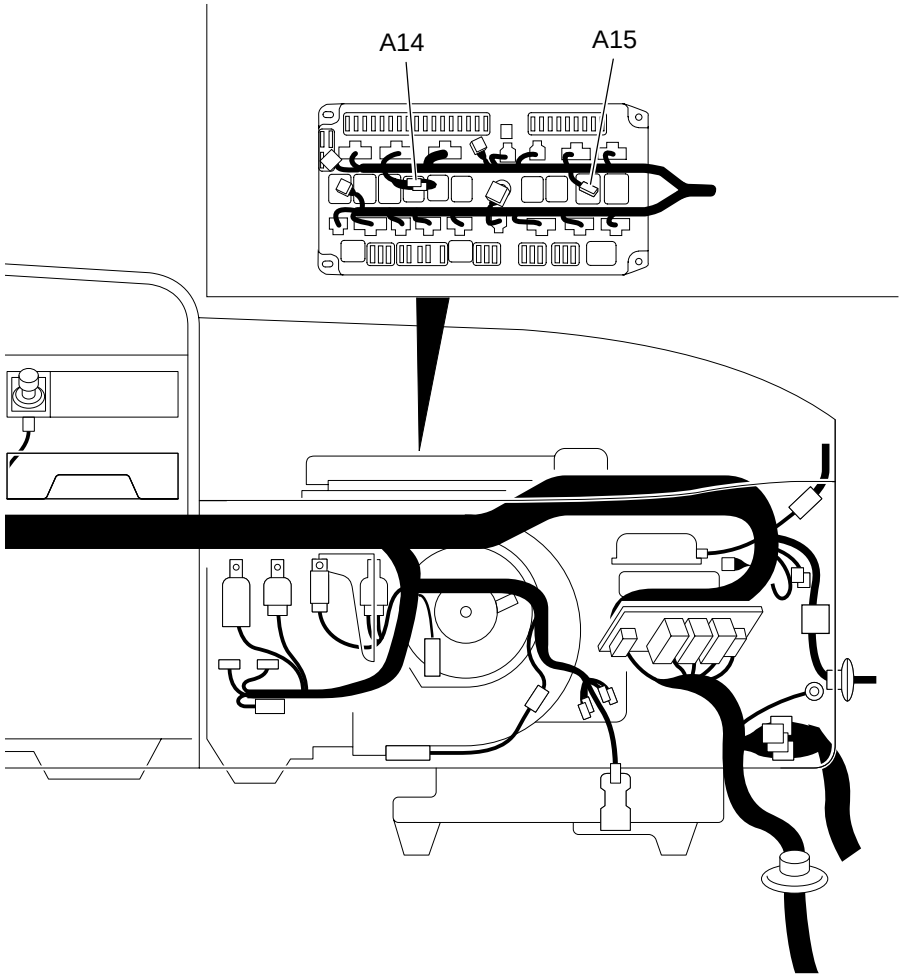
10 PARTS INSTALLATION POSITION

A SWITCH

A 01 to 15



Ⓟ44617



A01 Low air pressure switch
A02 Accelerator switch
A03 Auto cruise main switch
A04 Cold start switch connector
A05 Transmission power take-off switch
A06 Van body dome light switch
A07 Idling speed adjustment potentiometer
A08 Clutch switch
A09 Rheostat switch
A10 Parking brake switch < center parking brake >
A11 Door switch , RH
A12 Mirror heater switch connector
A13 Door switch , LH
A14 Diagnosis switch and memory clear switch (ABS ECU)
A15 Diagnosis switch and memory clear switch (engine ECU)

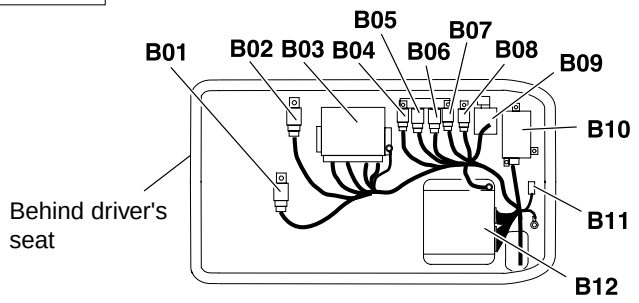
ABS : Anti-lock brake system
ECU : Electronic control unit

Ⓟ44622

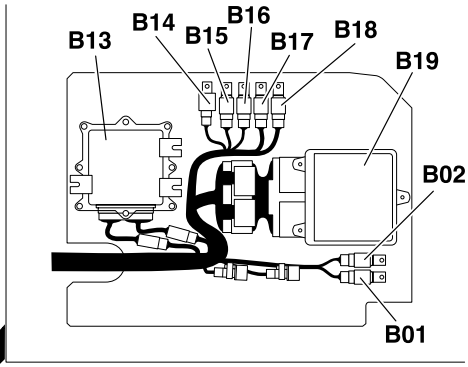
B RELAY AND ELECTRONIC CONTROL UNIT

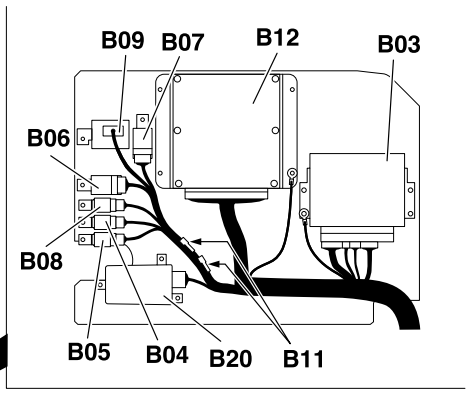
B 01 to 20

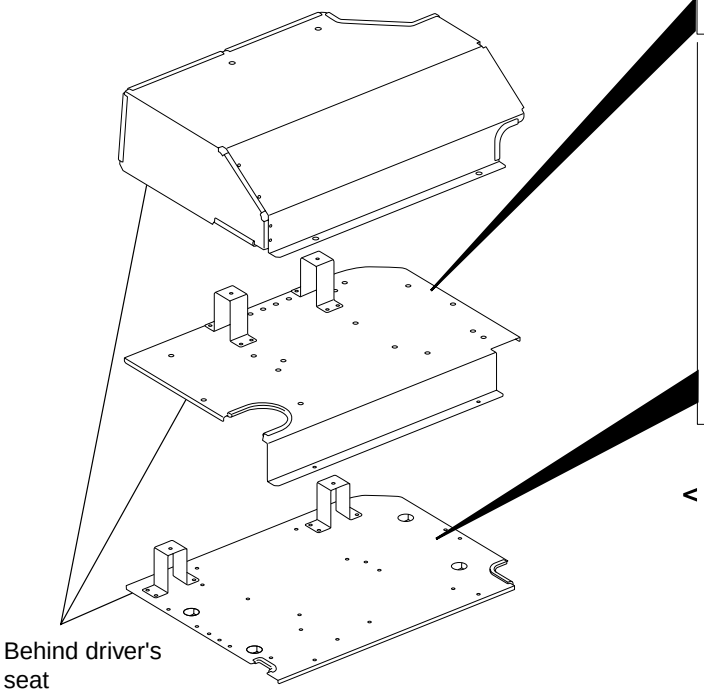
< Except FM657 : A/T >



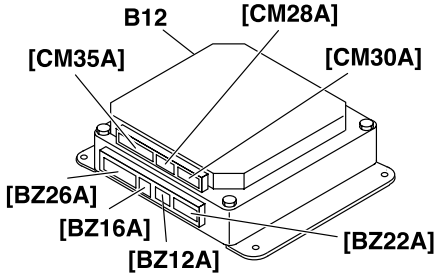
< FM657 : A/T >



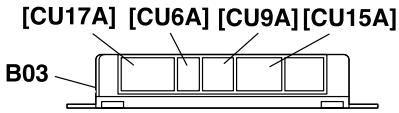




< Engine electronic control unit >



< Anti-lock brake system electronic control unit >

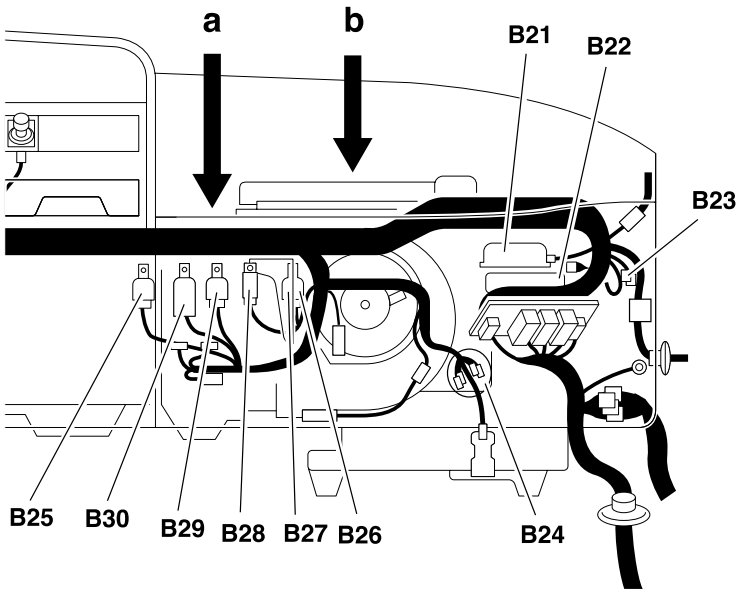


B01 Parking brake relay
B02 High beam relay
B03 Anti-lock brake system electronic control unit
B04 Headlamp relay (LOW)
B05 Pre-stroke cut relay
B06 Exhaust brake cut relay
B07 Cruise control main relay
B08 Headlamp relay (HIGH)
B09 Daytime running light electronic control unit
B10 Pulse divider < except FM657 : A/T >
B11 Diode unit
B12 Engine electronic control unit
B13 Vehicle interface module < FM657 : A/T >
B14 Selector neutral relay < FM657 : A/T >
B15 Stop lamp relay < FM657 : A/T >
B16 Time lag relay < FM657 : A/T >
B17 Fan motor relay 2 < FM657 : A/T >
B18 Fan motor relay 1 < FM657 : A/T >
B19 Automatic transmission electronic control unit < FM657 : A/T >
B20 Pulse converter < FM657 : A/T >

A/T : Automatic transmission

Ⓟ44643

B 21 to 47



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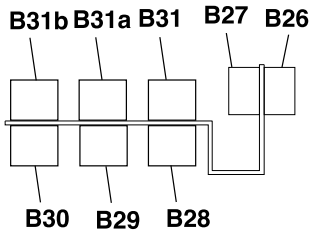

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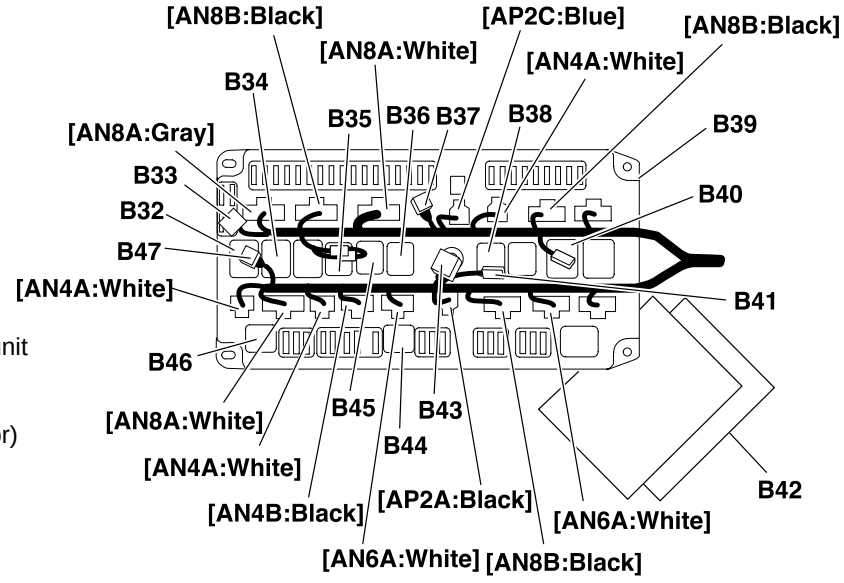


B21 Flasher unit
B22 Multipurpose timing control unit
B23 Diode unit
B24 Diode unit
B25 Mirror heater relay (connector)
B26 Parking brake relay
B27 Transmission neutral relay
< A/T (except FM657) >
B28 Safety relay
B29 Neutral start relay
B30 Van body dome light relay
B31 Spare D.C relay
B31a Accelertor relay < A/T (except FM657) >
B31b Automatic transmission fluid cooler fan motor relay
< A/T (except FM657) >
B32 Wiper relay (LOW)
B33 Power take-off resistor < M/T >
B34 Wiper relay (HIGH)
B35 Short connector
B36 Stop lamp relay
B37 Resistor unit
B38 Exhaust brake relay
B39 Relay and fuse box
B40 Transmission power take-off relay (connector)

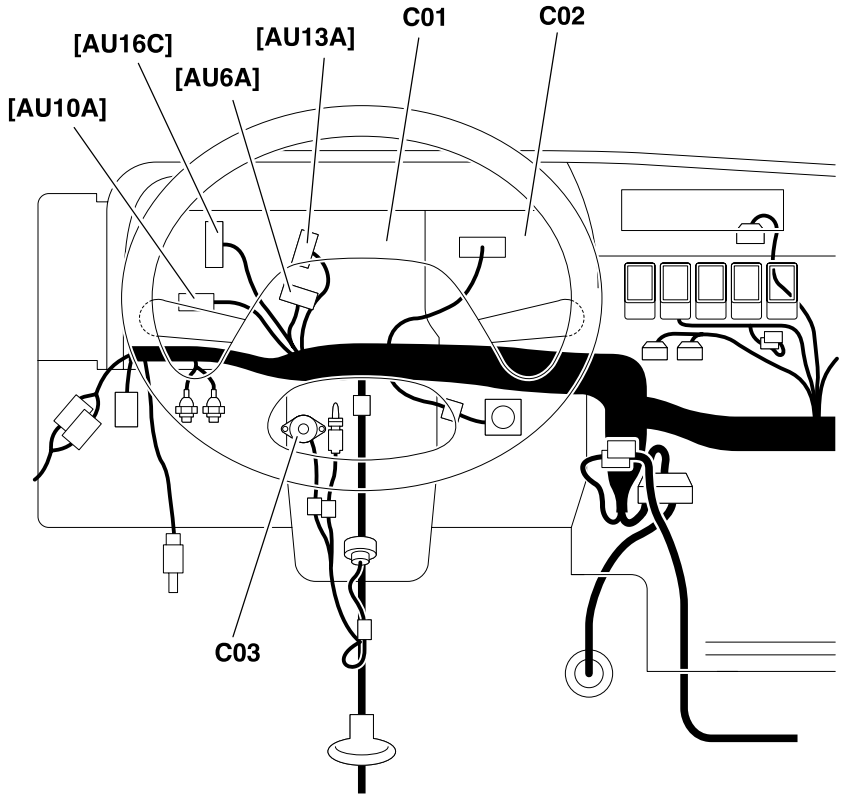
B41 Power take-off connector
B42 Power window electronic control unit
B43 Multi-use tester-II connector
B44 Tail lamp relay
B45 Short connector
B46 Turn signal lamp relay
B47 Fuel injection rate adjusutment resistor

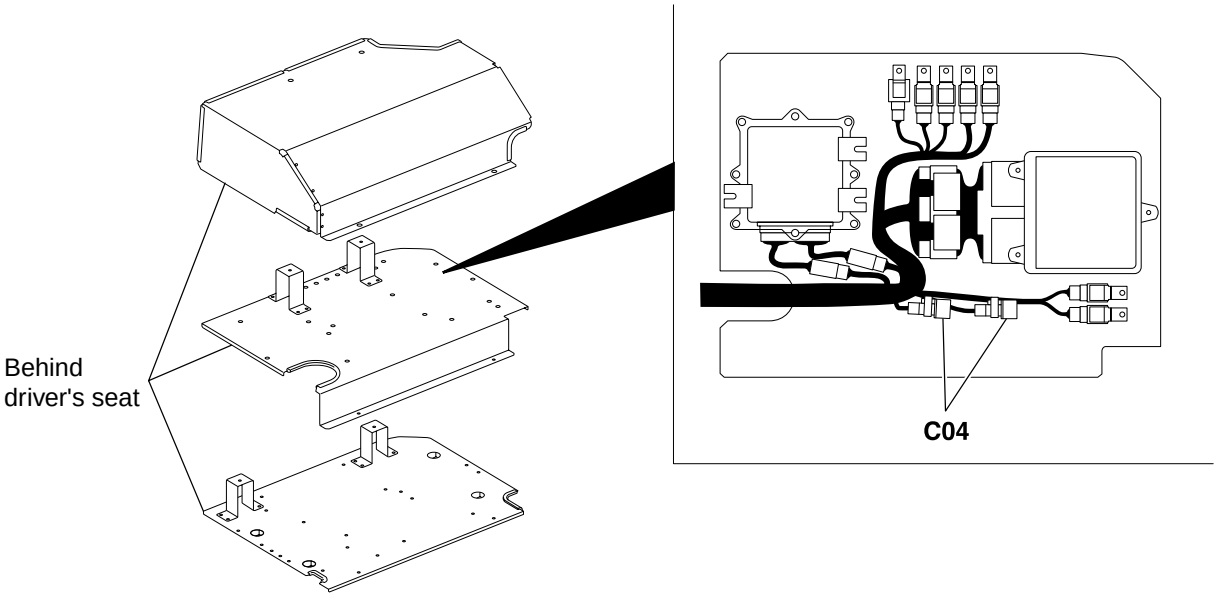
A/T : Automatic transmission
M/T : Manual transmission
Indicate by connector type and color [ ].
[connector type : connector color]

Ⓟ44644

C FUSE, METER, SENSOR, BUZZER AND MOTOR

C 01 to 04



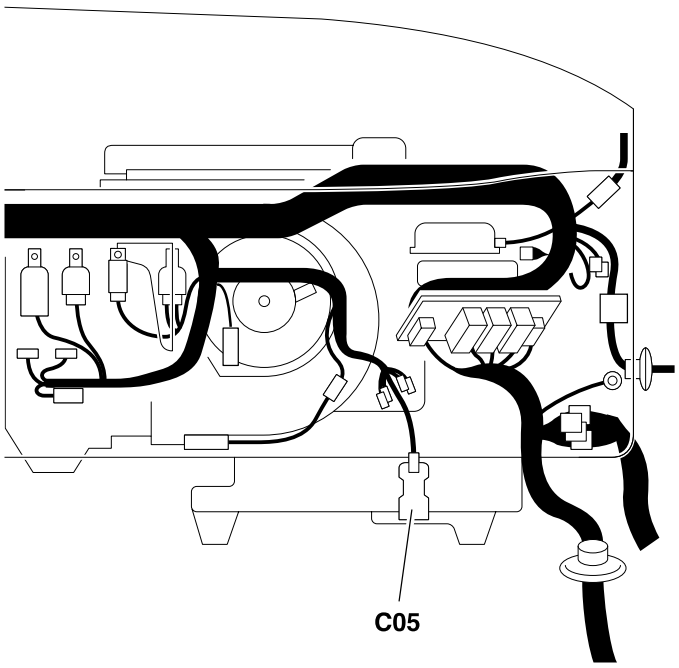


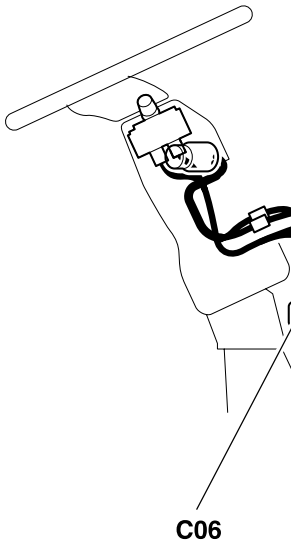
C01 Meter cluster
C02 Speedometer
C03 Accelerator pedal position sensor
C04 Fuse holder < FM657 : A/T >

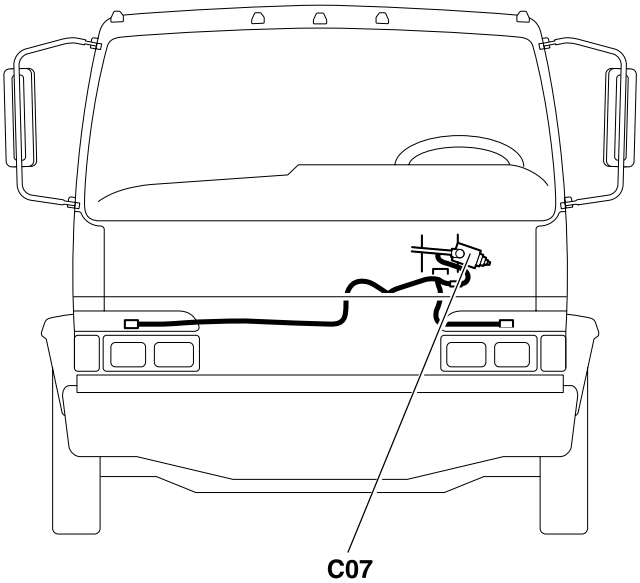
A/T : Automatic transmission
Indicate by connector type [ ].

Ⓟ44645

C 05 to 07



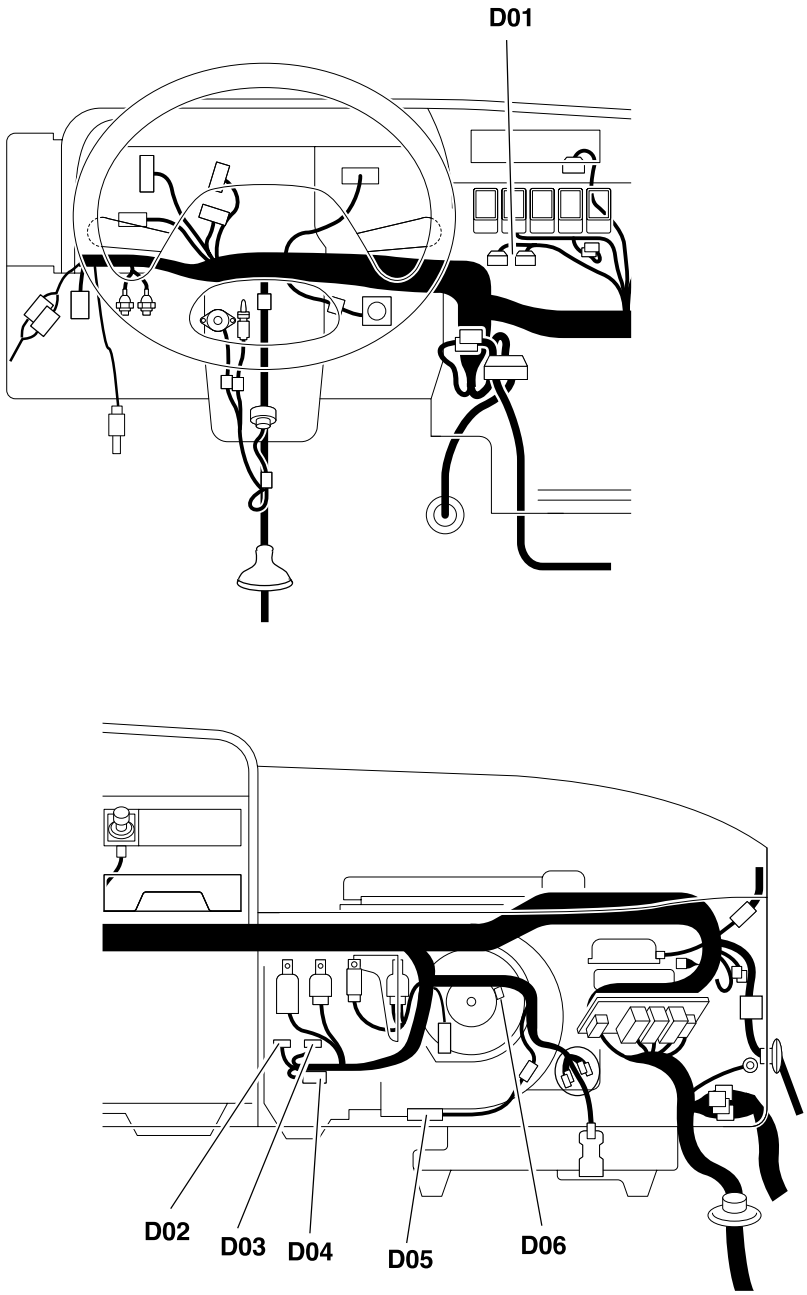




C05 Windshield washer
C06 Warning buzzer
C07 Wiper motor

Ⓟ44646

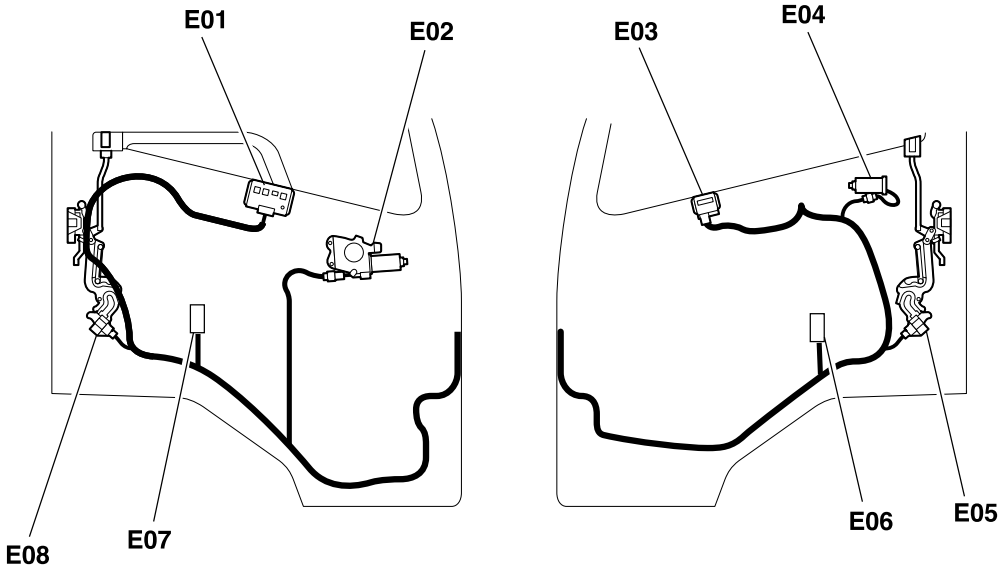
D 01 to 06



D01 Heater control assembly
D02 Air-conditioner relay connector
D03 Side condenser relay connector
D04 Thermostat connector
D05 Blower resistor
D06 Blower motor

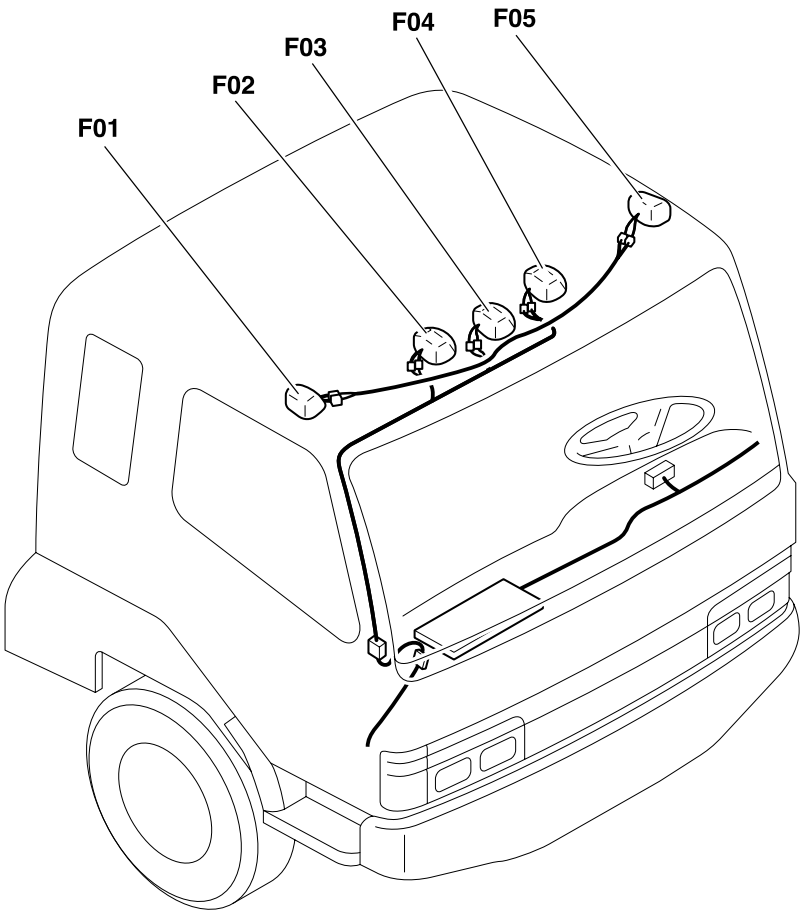
Ⓟ44648

E 01 to 08



E01 Power window switch, LH
E02 Power window motor, LH
E03 Power window switch, RH
E04 Power window motor, RH
E05 Door lock actuator, RH
E06 Mirror heater connector, RH
E07 Mirror heater connector, LH
E08 Door lock actuator, LH

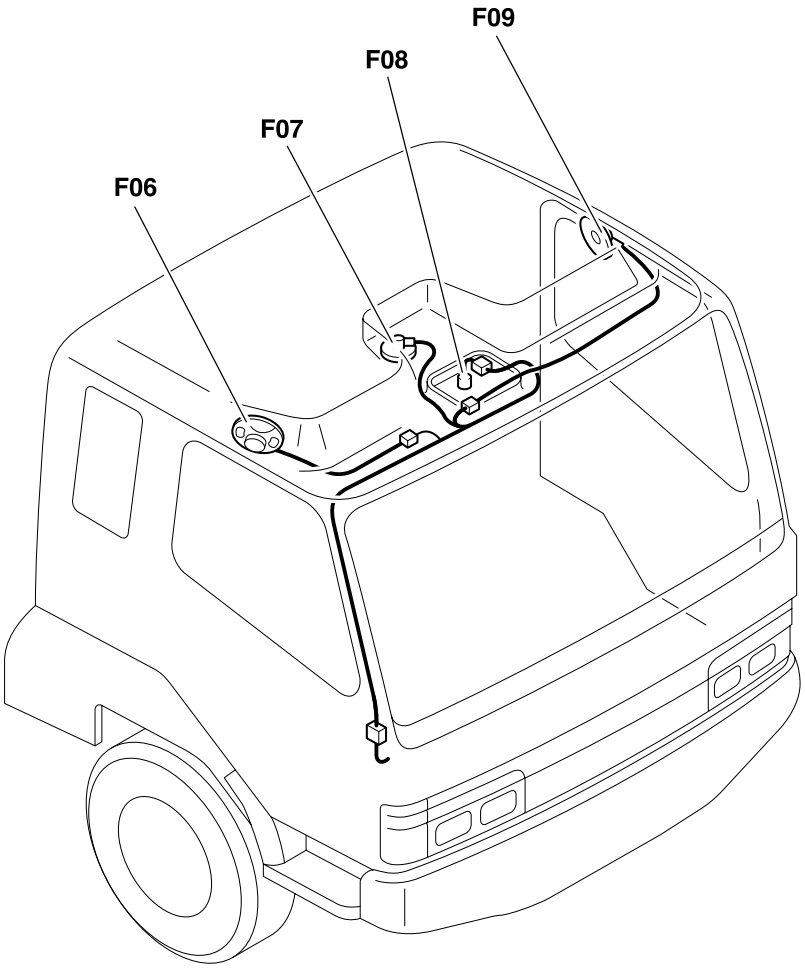
F 01 to 05



F01 Side marker lamp, RH
F02 Identification lamp, RH
F03 Identification lamp, CENTER
F04 Identification lamp, LH
F05 Side marker lamp, LH

Ⓟ44257

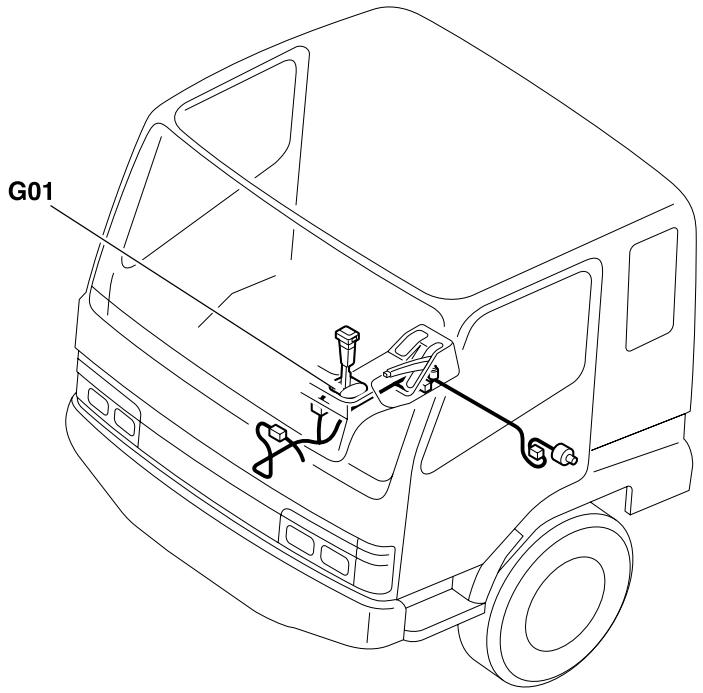
F 06 to 09

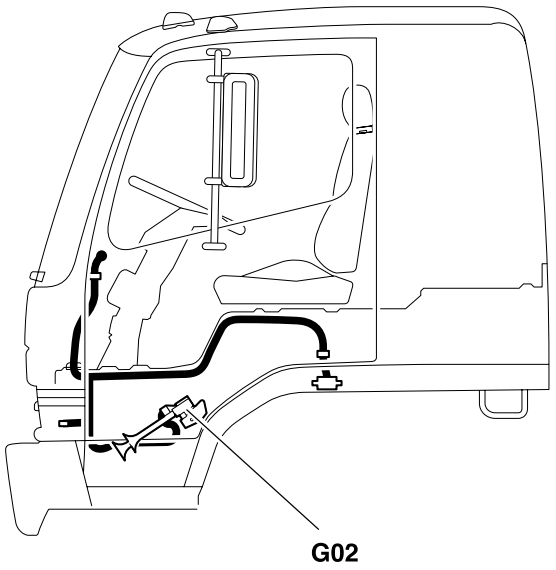


F06 Speaker, RH
F07 Speaker, CENTER
F08 Cab and spot lamp
F09 Speaker, LH

Ⓟ44259

G 01 to 02





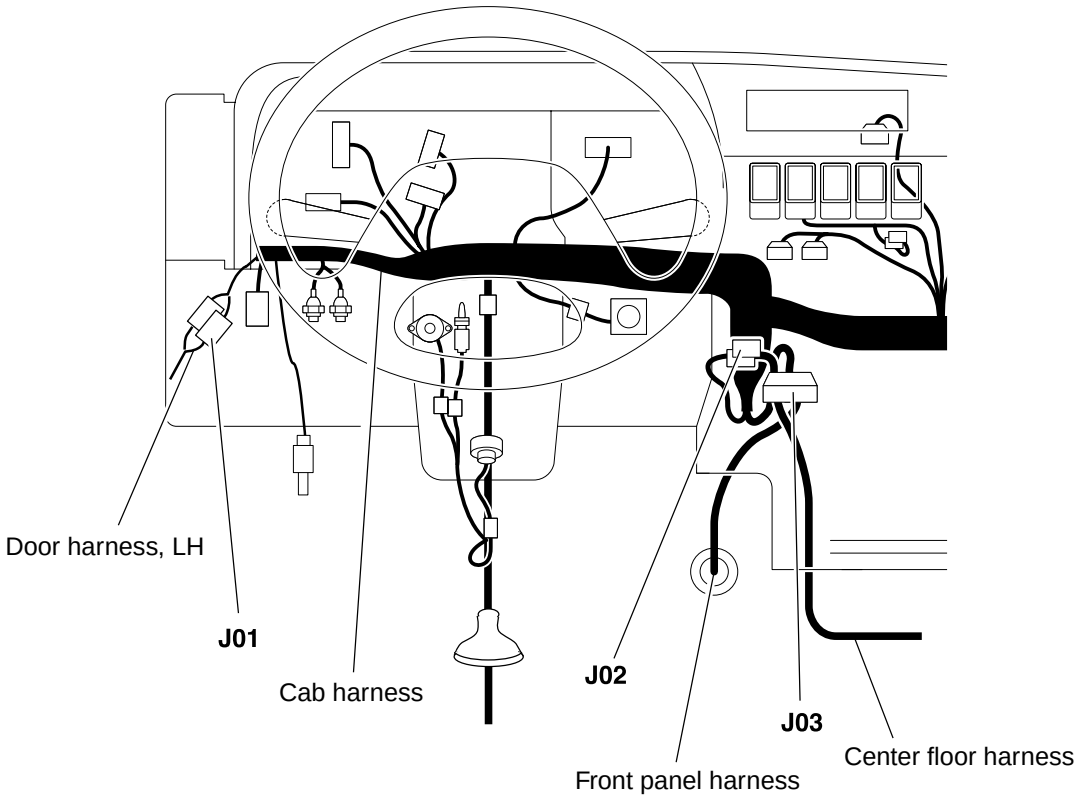
G01 Automatic transmission range selector lamp
G02 Air horn

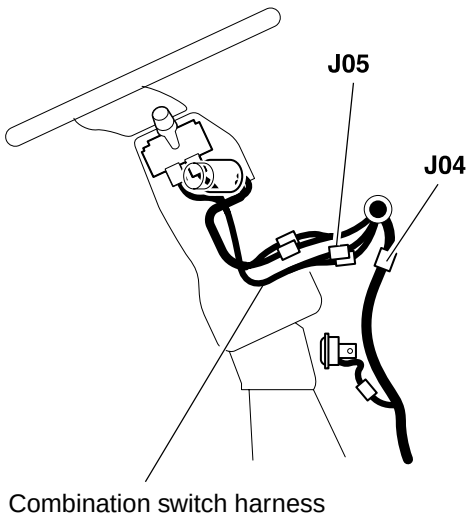
Ⓟ44650

M E M O

J JOINT OF MAIN HARNESS CONNECTORS

J 01 to 05

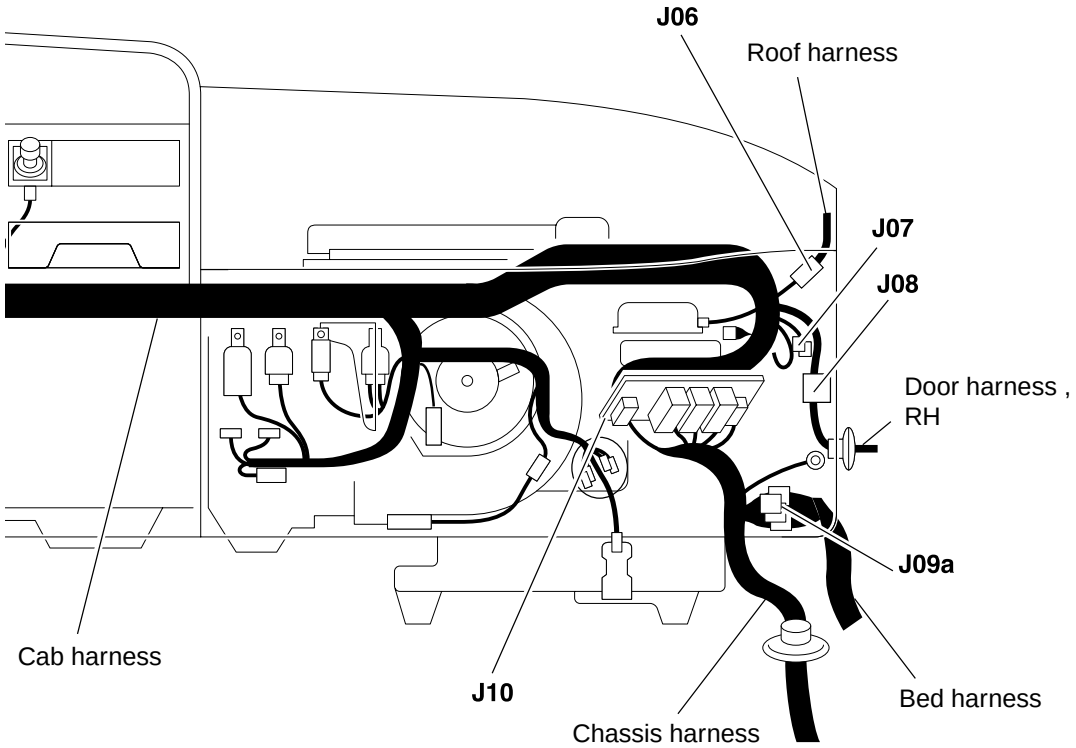


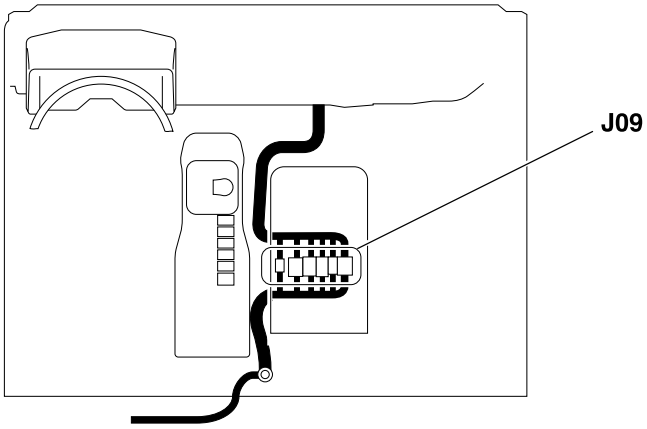


J01 Connection of cab harness and door harness, LH
J02 Connection of cab harness and center floor harness
J03 Connection of cab harness and front panel harness
J04 Connection of cab harness and headlamp harness
J05 Connection of cab harness and combination switch harness

Ⓟ44651

J 06 to 10



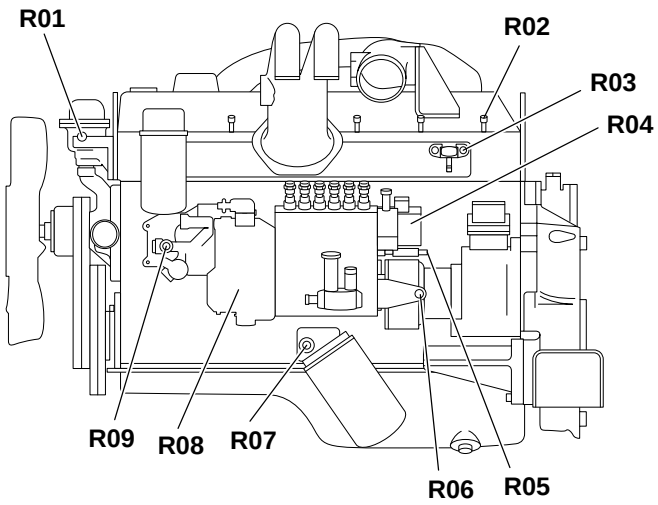


J06 Connection of cab harness and roof harness
J07 Spare D.C connector
J08 Connection of cab harness and door harness , RH
J09 Connection of cab harness and bed harness
J09a Connection of bed harness and chassis harness
J10 Connection of cab harness and chassis harness

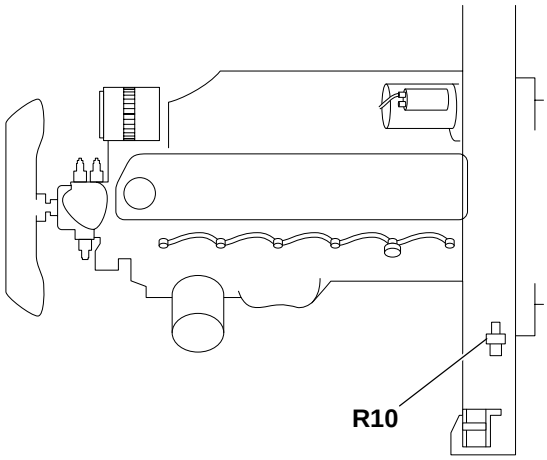
Ⓟ44652

R 01 to 15

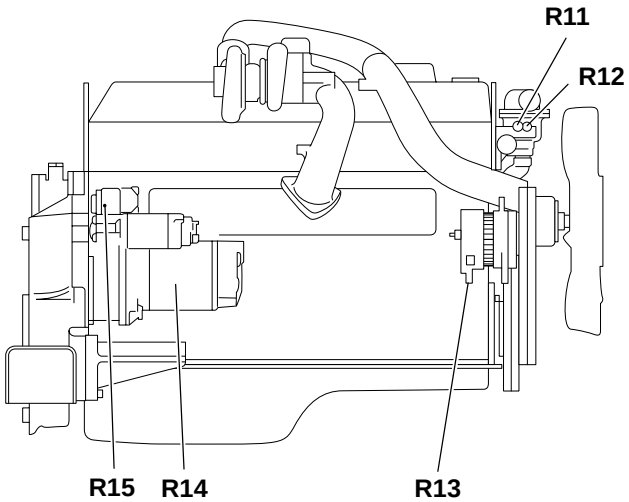
Left side view



Upper view



Right side view



Ⓟ44692

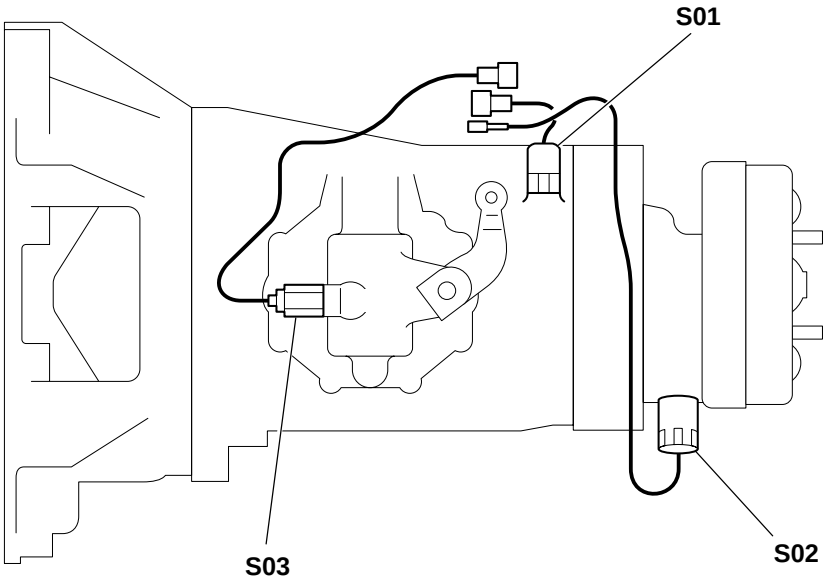
R01 Water temperature sensor
(Connects to engine electronic control unit)
R02 Glow plug
R03 Boost pressure sensor
R04 Pre-stroke actuator
R05 Control rod position sensor
R06 Engine speed sensor
R07 Engine oil bypass alarm switch
R08 Electronic governor
R09 Engine oil pressure switch
R10 Glow relay
R11 Overheating switch
R12 Water temperature sensor
(Connects to water temperature gauge and multipurpose timing control unit)
R13 Alternator
R14 Starter
R15 Starter relay

M E M O

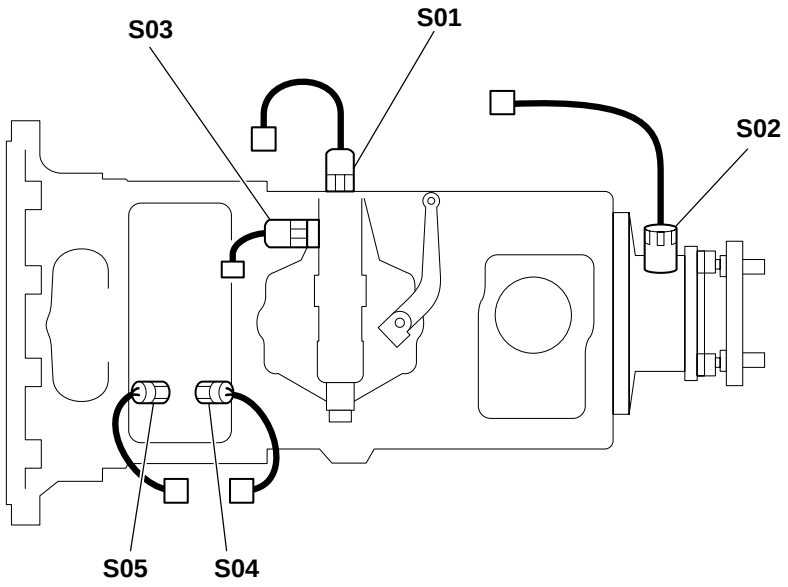
S 01 to 12

< Manual transmission >

(5-speed, 6-speed transmission)



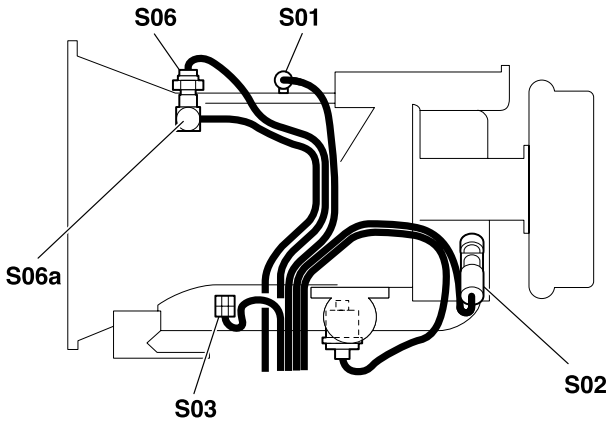
(10-speed transmission)



Ⓟ44250

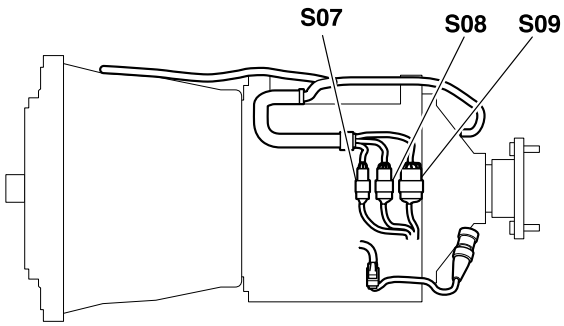
< Automatic transmission >

(Except FM657)

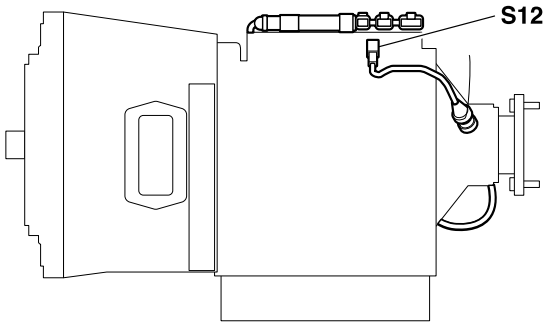


(FM657)

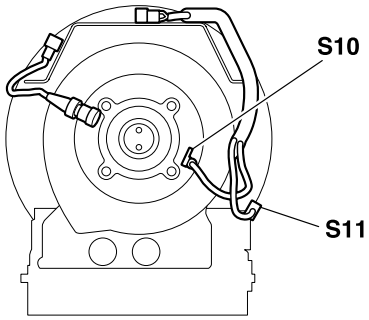
Upper view



Left side view



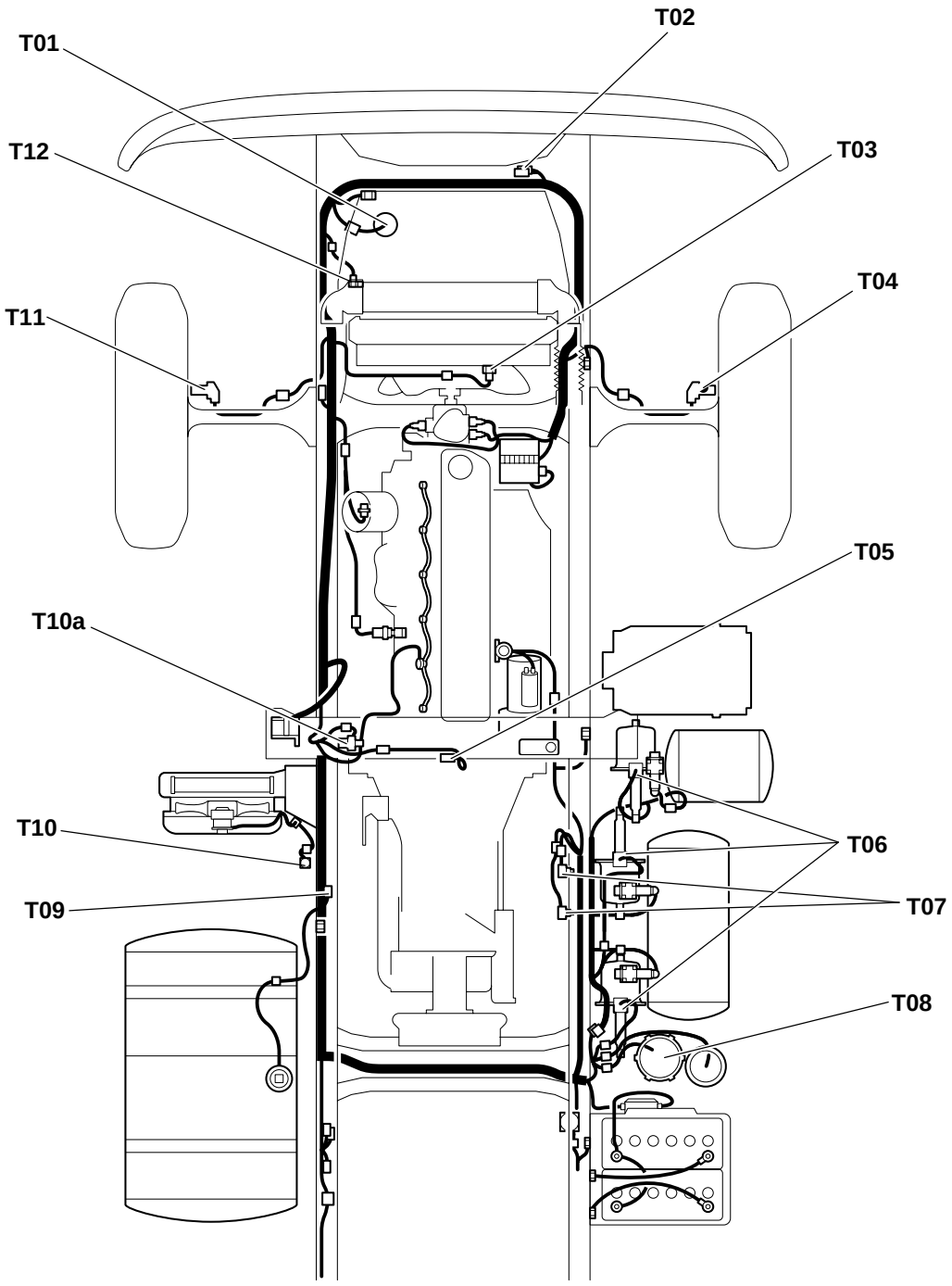
Rear view



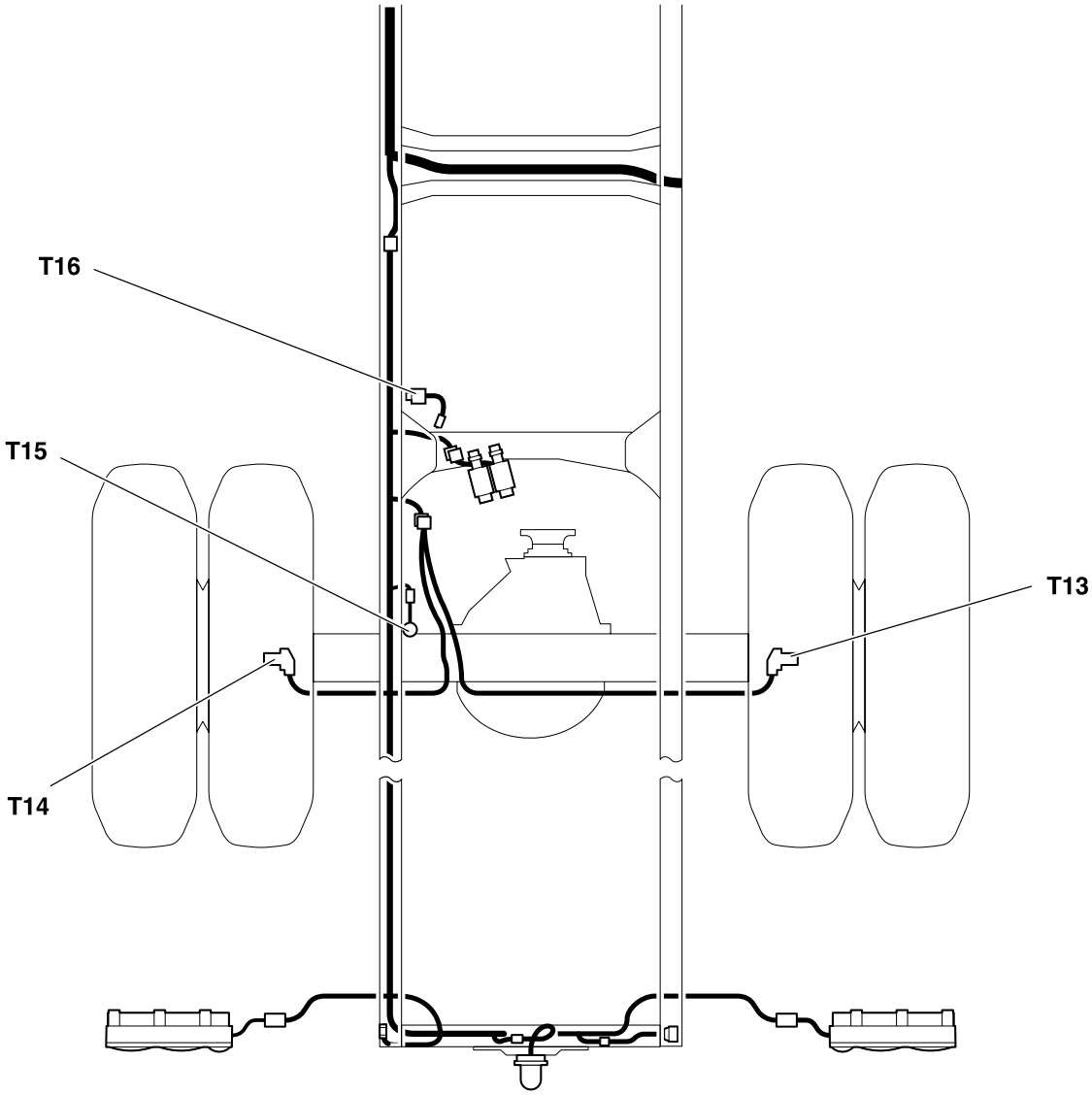
S01 Backup lamp switch
S02 Vehicle speed sensor
S03 Transmission neutral switch
S04 Transmission HIGH/LOW changeover switch (HIGH)
S05 Transmission HIGH/LOW changeover switch (LOW)
S06 Automatic transmission fluid temperature sensor (for warning lamp)
S06a Automatic transmission fluid temperature sensor (for engine output control)
S07 Connector (for fluid temperature sensor and fluid level sensor)
S08 Connector (for engine speed sensor and vehicle speed sensor)
S09 Connector (for transmission solenoid)
S10 Connector (for transmission output speed sensor)
S11 Connector (for input speed sensor : engine speed)
S12 Connector (for speedometer)

Ⓟ44693

T 01 to 16



Ⓟ44694

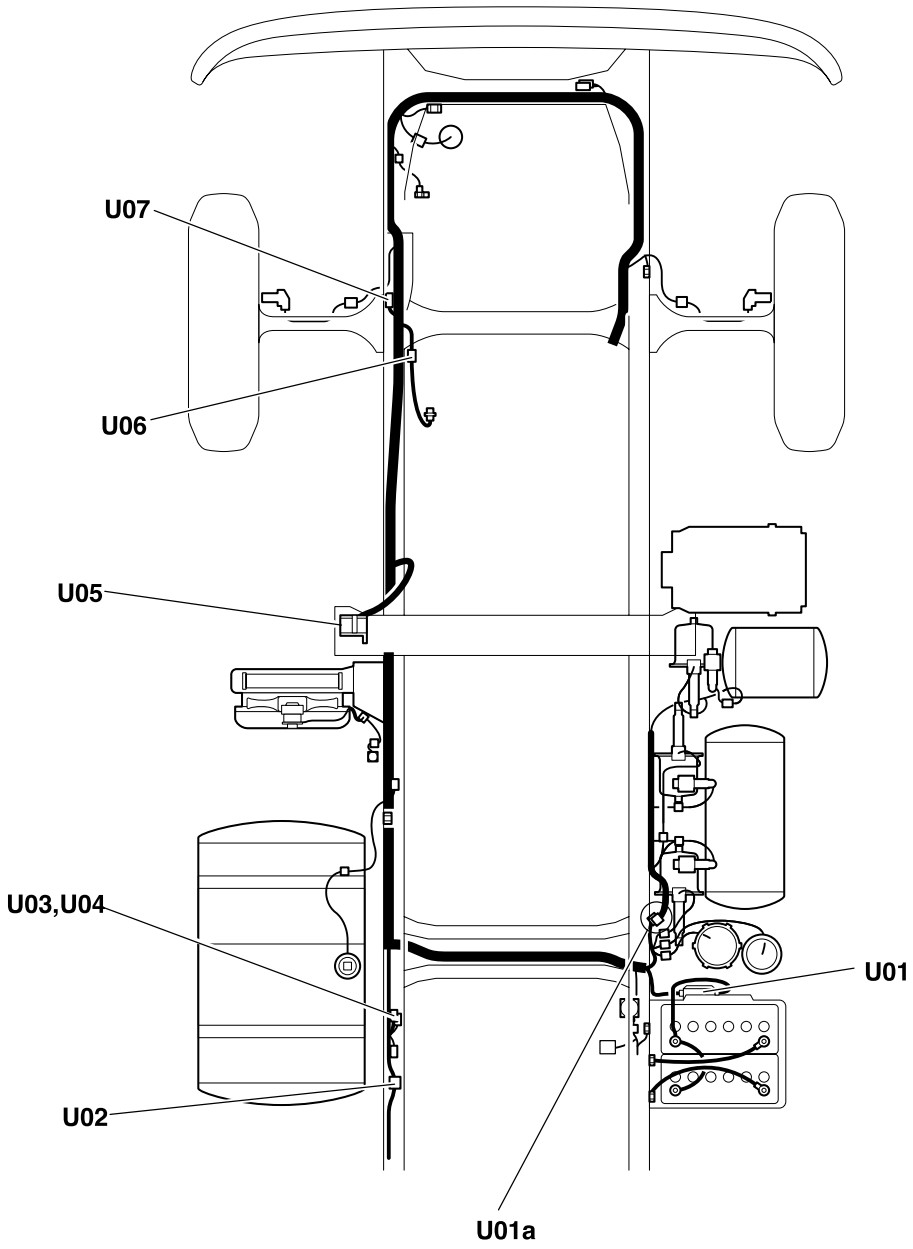


T01 Stop lamp switch < FM657 >
T02 Dual pressure switch connector
T03 Water level sensor
T04 Front wheel speed sensor, RH
T05 Cab tilt lock switch
T06 Brake booster stroke switch
T07 Stop lamp switch < FK61, FM61 >
T08 Brake fluid level switch
T09 Transimission power take-off control switch connector
T10 Automatic transmission fluid temperature sensor (for fan motor)
T10a Power take-off load sensor
T11 Front wheel speed sensor, LH
T12 Boost air temperature sensor
T13 Rear wheel speed sensor, RH
T14 Rear wheel speed sensor, LH
T15 Stop lamp switch < FM657 >
T16 Parking brake switch < wheel parking brake >

Ⓟ44695

U BATTERY, FUSE AND CONNECTOR

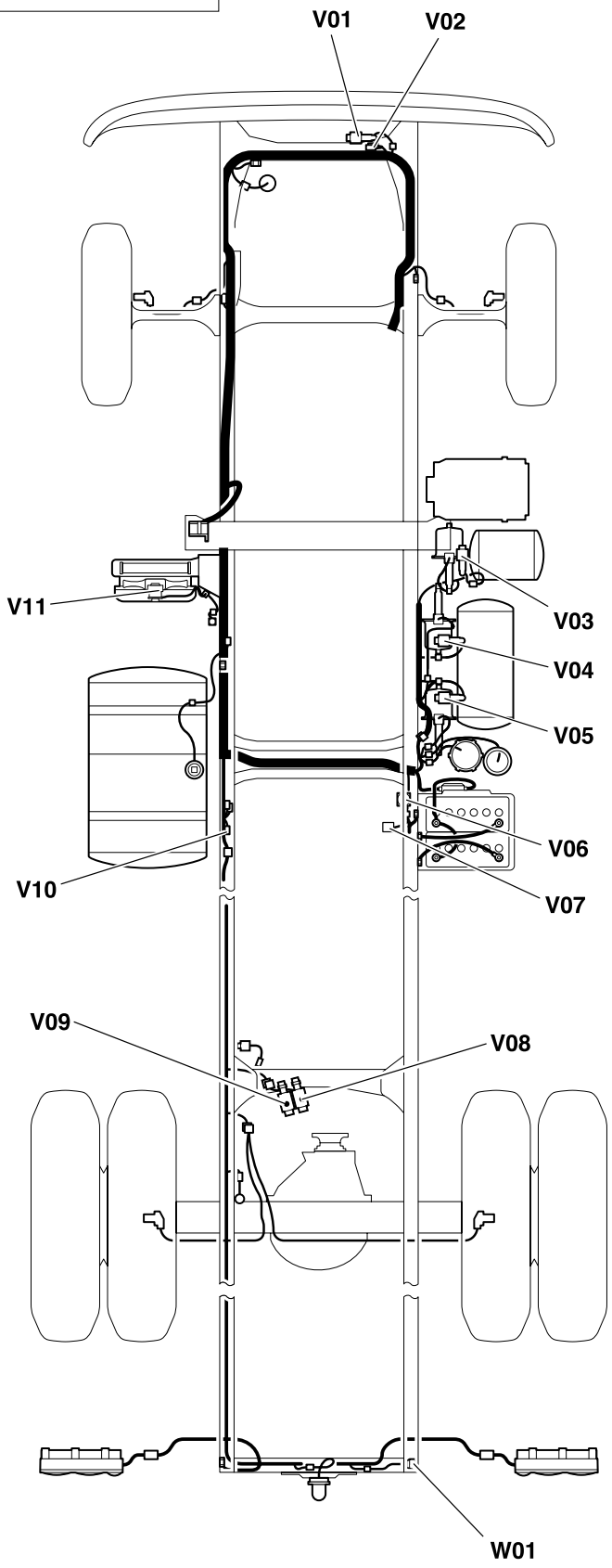
U 01 to 07



U01 Main high-current fuse
U01a Connection of chassis harness and anti-lock brake system harness
U02 Connection of chassis harness and rear chassis harness
U03 Van body dome light connector
U04 Spare tail lamp connector
U05 High-current fuse box
U06 Connection of chassis harness and engine harness
U07 Magnetic clutch connector

Ⓟ44697

V 01 to 11, W 01



V

V01 Front ABS control valve < FM657
V02 Condenser fan motor connector
V03 Front ABS control valve < FK617, FM617 >
V04 Rear ABS control valve, LH < FK617, FM617 >
V05 Rear ABS control valve, RH < FK617, FM617 >
V06 Exhaust brake 3-way magnetic valve
V07 Cold start 3-way magnetic valve connector
V08 Rear ABS control valve, RH < FM657 >
V09 Rear ABS control valve, LH < FM657 >
V10 Transmission power take-off 3-way magnetic valve connector
V11 Automatic transmission fluid cooler fan

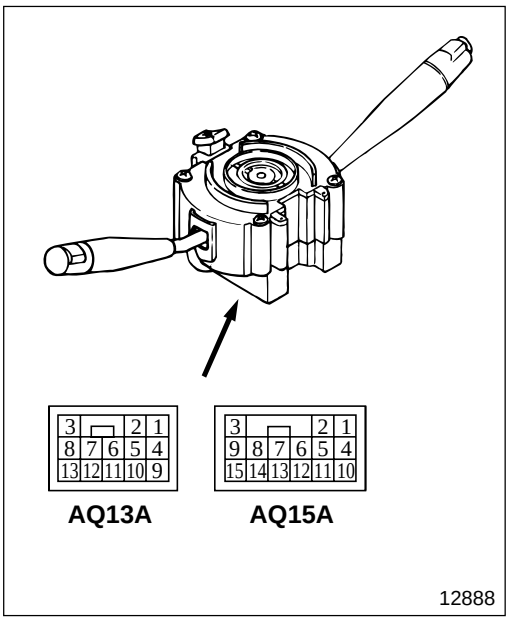
W

W01 Back buzzer

ABS : Anti-lock brake system

Ⓟ44711

11 INSPECTION OF PARTS



001 Inspection of combination switch

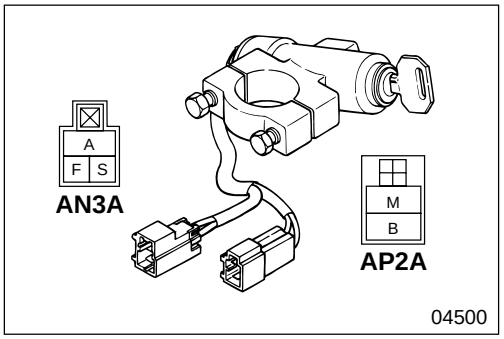
- Follow the table below to check for continuity.
  ○—○ : There is continuity between terminals.
- If any fault is found, replace the switch.

AQ15A Connector connection table

		①	②	③	⑤	⑥	⑦	⑧	⑨	⑬	Body ground
Lighting switch	OFF										
	I						○			○	
	II				○		○			○	
Dimmer switch	Main				○			○			
	↕				○ ○			○			
	Dimmer				○	○					
	↕				○	○	○	○			
	Passing						○	○			
Turn signal switch	LH		○						○		
	N (neutral)										
	RH			○					○		
Horn switch	OFF										
	ON	○									○

AQ13A Connector Connection Table

		①	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
Wiper switch	OFF											
	INT (intermittent)								○			○
	LO (LOW)								○		○	
	HI (HIGH)								○	○	○	
	WASH (washer)							○	○			
Exhaust brake switch < Manual transmission >	OFF											
	ON	○	○									
Hazard switch	OFF											
	ON			○	○	○	○					



002 Inspection of starter switch

- Follow the table below to check for continuity.

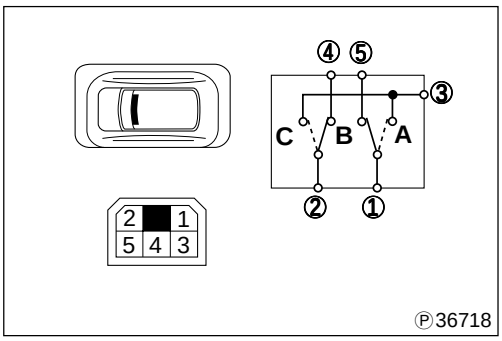
	AP2A		AN6A		
	②	①	①	③	②
LOCK					
ACC	○	———	○		
ON	○	———	○	———	○
START	○	———	○	———	○
	B	M	A	F	S

○——○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 37

011 Inspection of rheostat switch

- Rheostat switch contains a control circuit, because of this it is difficult to inspect rheostat switch independently, therefore you should inspect the rheostat switch indirectly, by inspecting the system harness and the related parts.
- If no fault is found in the related parts but the system is faulty, replace the switch.



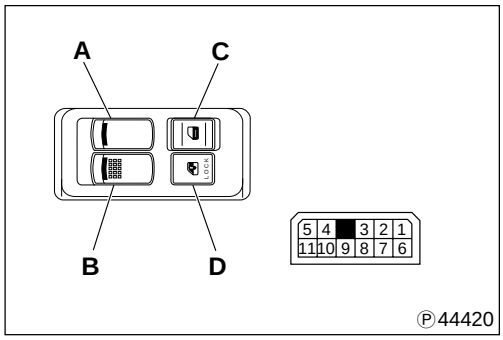
026 Inspection of power window switch (assistant driver's seat side)

- Follow the table below to check for continuity.

	①	②	③	④	⑤
A : OPEN	○	———	○		
		○	———	○	
B : OFF		○	———	○	
	○	———		———	○
C : CLOSE	○				○
		○	———	○	

○——○ : There is continuity between terminals.

- If any fault is found, replace the switch.



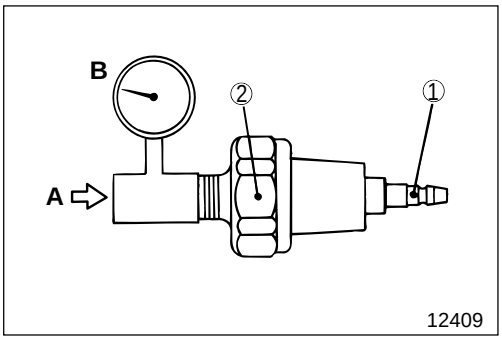
027 Inspection of power window switch (driver's seat side)

- Follow the table below to check for continuity.

			①	②	⑤	⑥	⑦	⑧	⑨	⑩	⑪
A : Assistant driver's seat side window switch	UP		○						○		
	NEUTRAL										
	DOWN			○					○		
B : Driver's seat side window switch	UP	Manual					○		○		
		Auto					○	○	○		
	NEUTRAL										
	DOWN	Manual				○			○		
		Auto				○		○	○		
C : Door lock switch	UNLOCK									○	○
	LOCK				○					○	
D : Assistant driver's seat side window lock switch	UNLOCK		○							○	
				○						○	
	LOCK										

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



028 Inspection of low air pressure switch

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying air pressure

Make sure that there is continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

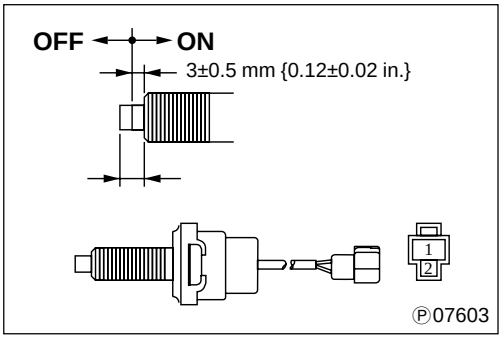
- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm^2}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (When applying pressure ON → OFF)	470 to 510 kPa {68 to 74 psi, 4.8 to 5.2 kgf/cm^2}

- Apply air pressure **A** up to 785 kPa {115 psi, 8 kgf/cm^2} then gradually decrease the air pressure.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

Standard value (When releasing pressure OFF → ON)	470 to 559 kPa {68 to 81 psi, 4.8 to 5.7 kgf/cm^2}



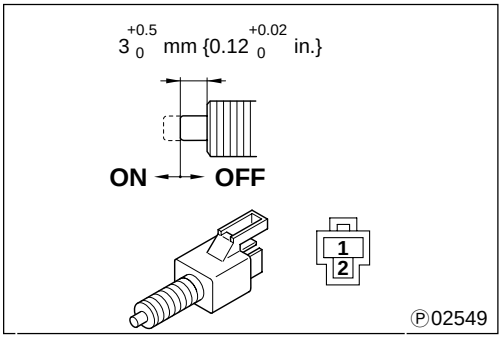
029 Inspection of accelerator switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch.



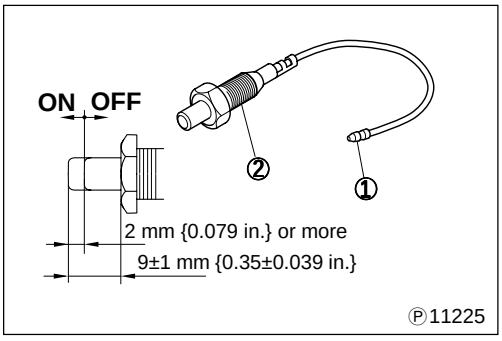
031 Inspection of clutch switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 21



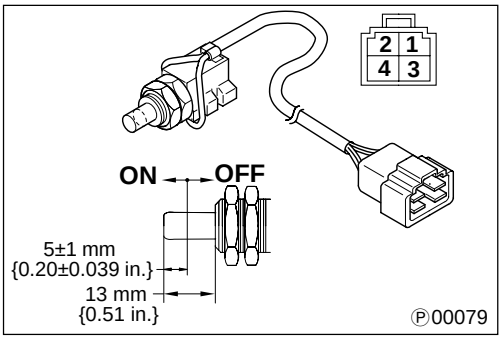
035 Inspection of door switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 42



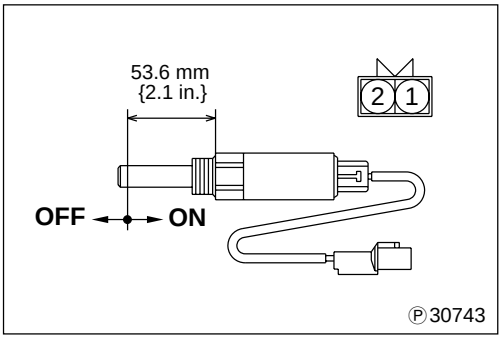
038 Inspection of parking brake switch

- Follow the table below to check for continuity.

	①	②	③	④
ON (PARK)		○		○
OFF (DRIVE)	○		○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 36A



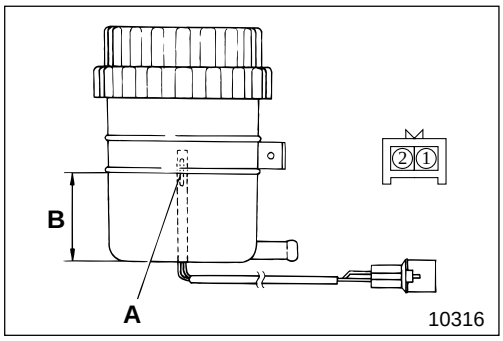
040 Inspection of brake booster stroke switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 35A



041 Inspection of brake fluid level switch

- Remove brake fluid slowly from fluid tank assembly.

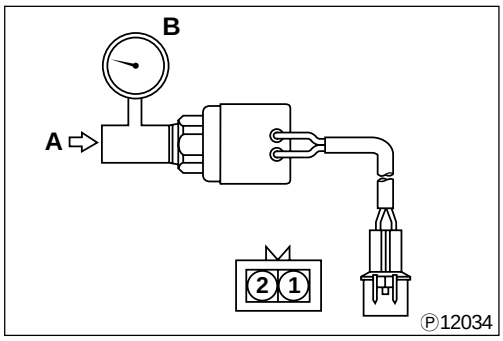
CAUTION

If brake fluid is gets on a painted surface it will dissolve the paint, so wipe it off immediately.

- Measure the height **B** of switch **A** when the continuity is detected between terminals ① and ②.

Standard value	$57^{+3.5}_{-0.5}$ mm {$2.24^{+0.14}_{-0.02}$ in.} (equivalent to 345 cm³ {21.1 cu.in., 0.345 L})

- If the measured value deviates from the standard value, replace the brake fluid tank assembly. Gr 42



042 Inspection of stop lamp switch

Perform the following checks, and if any fault is found, replace the switch. Gr 35

(1) Inspection by without applying air pressure

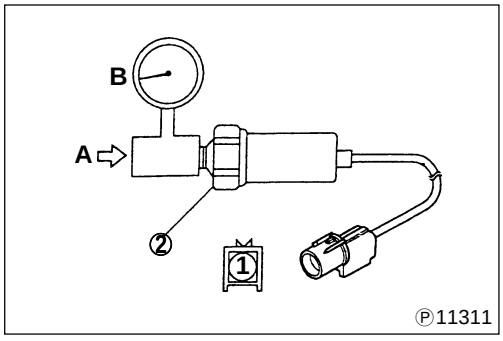
Make sure that there is no continuity between terminals ① and ②.

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	29±9.8 kPa {4.3±1.4 psi, 0.3±0.1 kgf/cm²}



044 Inspection of engine oil pressure switch

Perform the following checks, and if any fault is found, replace the switch.

(1) Inspection by without applying air pressure

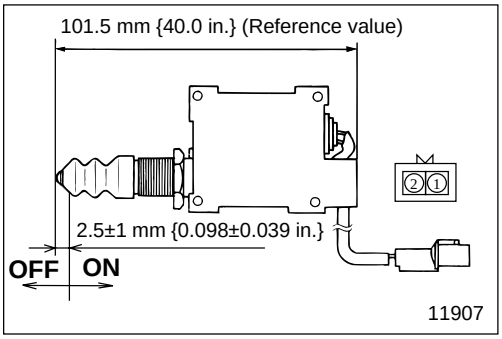
Make sure that there is continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	49±9.8 kPa {7.1±1.4 psi, 0.5 ± 0.1 kgf/cm²}



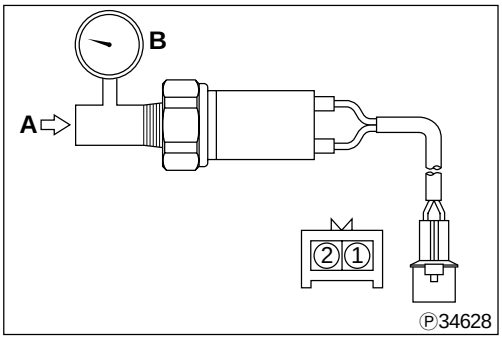
045 Inspection of cab tilt lock switch

- Follow the table below to check for continuity.

	①	②
ON	○	○
OFF		

○——○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 42



048 Inspection of parking brake switch

Perform the following checks, and if any fault is found, replace the switch. Gr 36B

(1) Inspection by without applying air pressure

Make sure that there is no continuity between terminals ① and ②.

(2) Inspection by applying air pressure

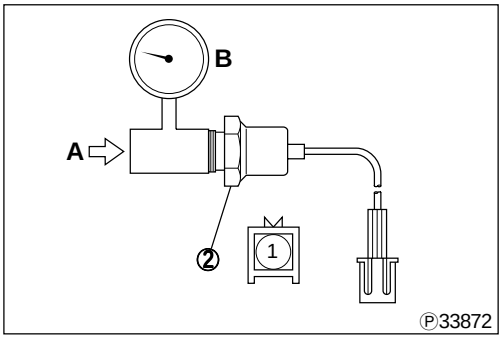
- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is not detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (When applying pressure ON → OFF)	441 to 539 kPa {64 to 72 psi, 4.5 to 5.5 kgf/cm²}

- Apply air pressure **A** up to 785 kPa {115 psi, 8 kgf/cm²} then gradually decrease the air pressure.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

Standard value (When releasing pressure OFF → ON)	461 to 559 kPa {67 to 81 psi, 4.7 to 5.7 kgf/cm²}



053 Inspection of engine oil bypass alarm switch

Perform the following checks, and if any fault is found, replace the switch. Gr 12

(1) Inspection by without applying air pressure

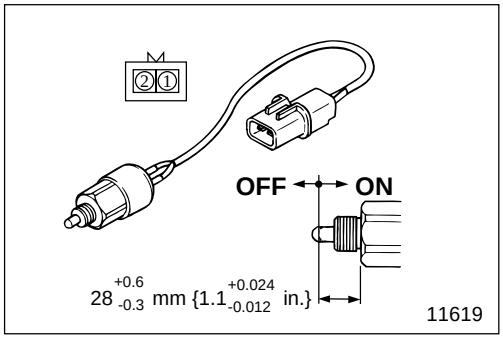
Make sure that there is no continuity between terminals ① and ② (body).

(2) Inspection by applying air pressure

- Gradually apply air pressure **A** to the switch starting from 0 kPa {0 psi, 0 kgf/cm²}.
- Measure the degree of air pressure at the moment when continuity is detected between terminals ① and ② (body), and make sure to confirm if the value meets the standard.

B : Air pressure gauge

Standard value (operating pressure)	185^{+49}_{0} kPa {$27^{+7.1}_{0}$ psi, $1.9^{+0.5}_{0}$ kgf/cm²}



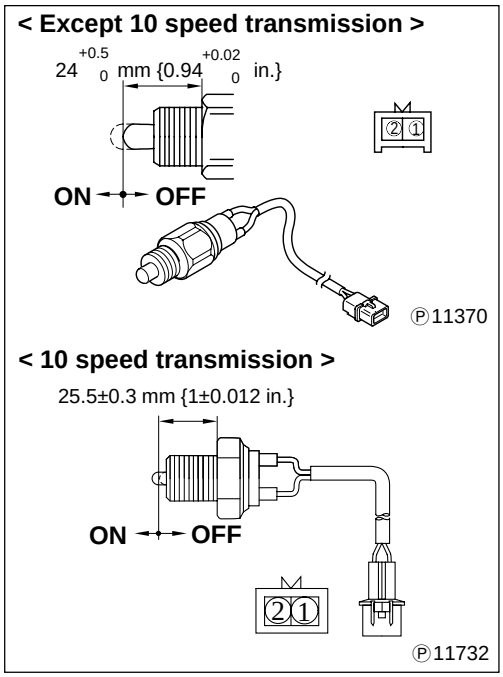
054 Inspection of backup lamp switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 22



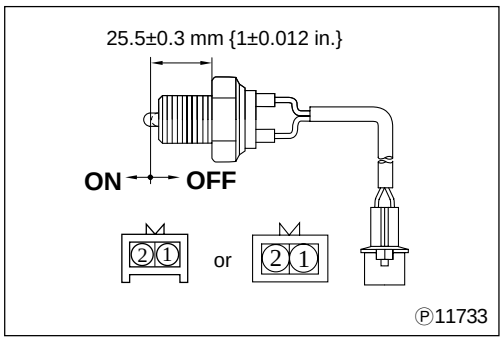
056 Inspection of transmission neutral switch

- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 22



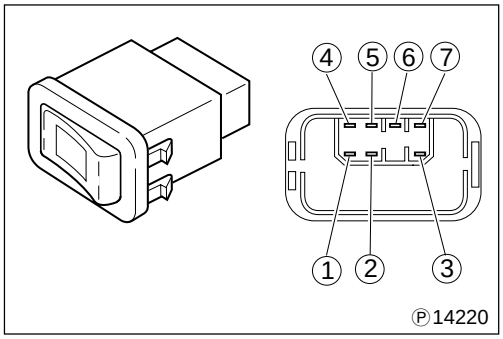
068 Inspection of transmission HIGH/LOW changeover switch

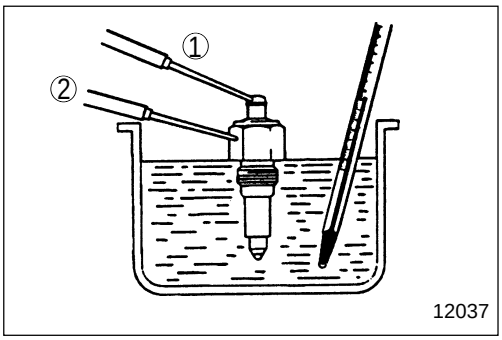
- Follow the table below to check for continuity.

	①	②
OFF		
ON	○—○	

○—○ : There is continuity between terminals.

- If any fault is found, replace the switch. Gr 22





087 Inspection of van body dome light switch

- Follow the table below to check for continuity.

	①	⑤	⑦	LED (Operation indication light	③
ON	○—○		○	⟋⟍⟋ ⊳|	○
OFF					

○—○ : There is continuity between terminals.

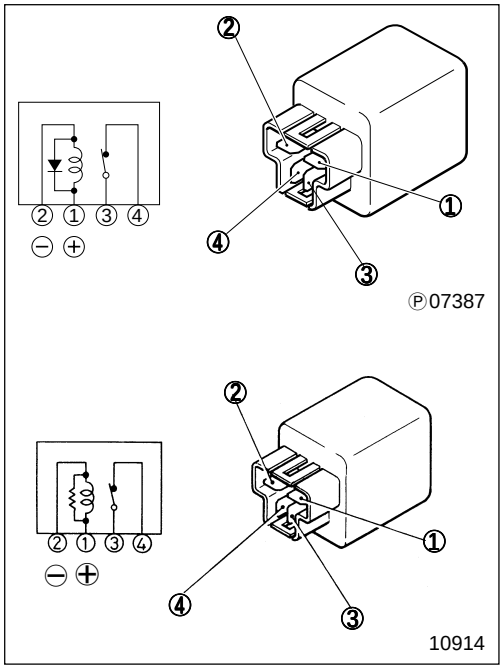
- If any fault is found, replace the switch.

160 Inspection of overheating switch

- Place the switch in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the operating temperature between terminals ① and ② (body) respectively.

Standard Value	When temperature increase (ON→OFF)	110±2°C {230±36°F}
	When temperature decrease (OFF→ON)	99.5 to 112.5 °C {211 to 235 °F}

- If the measured value deviates from the standard value, replace the switch. Gr 14



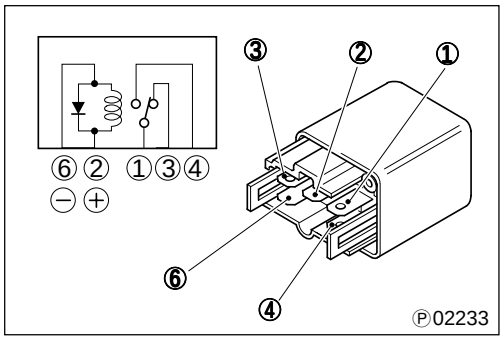
180 Inspection of relay (Close type 4-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④
No current	○	○	○	○
Current	⊕	⊖	◌	◌

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.
◌—◌ : Indicates the terminals across which there is no continuity.

- If any fault is found, replace the relay.



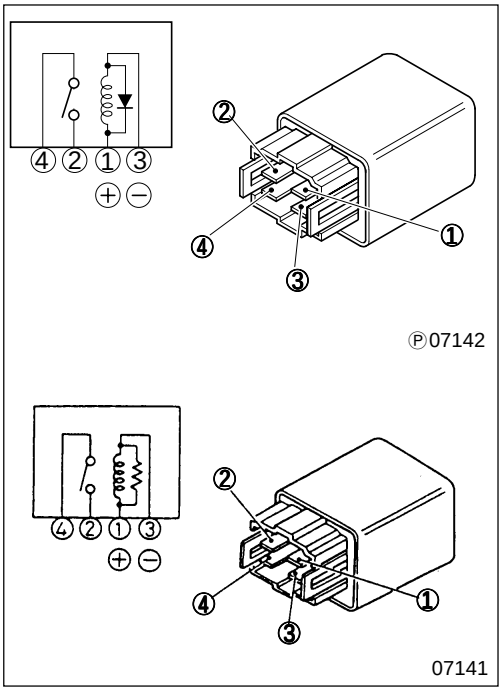
182 Inspection of relay (Open type 6-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④	⑥
No current	○	○	○		○
Current	○	⊕		○	⊖

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



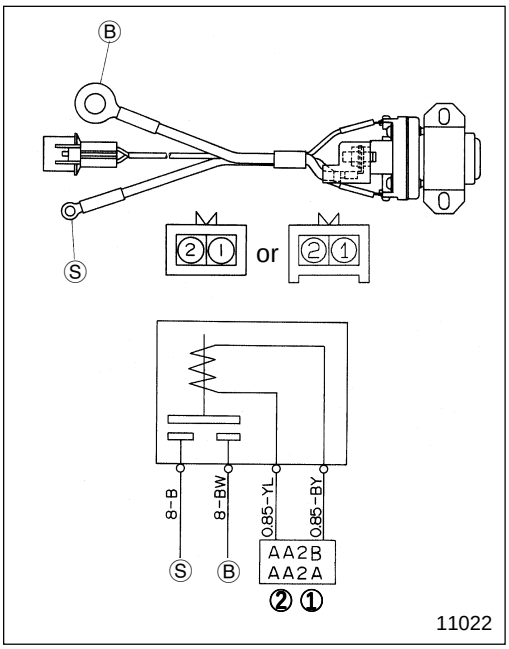
185 Inspection of relay (Open type 4-pin)

- Follow the table below to check for continuity and operation.

	①	②	③	④
No current	○		○	
Current	⊕		⊖	○

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



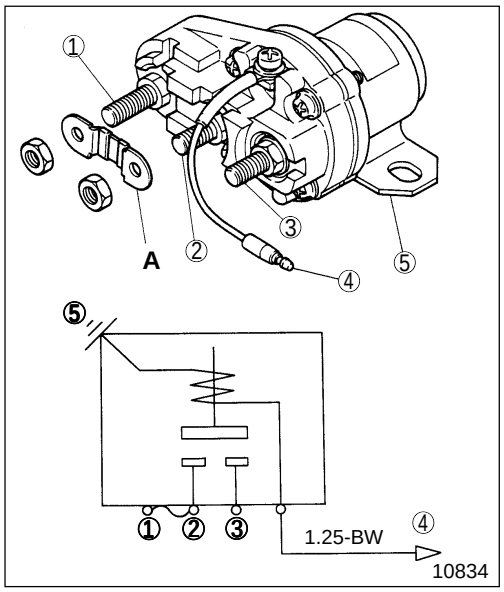
187 Inspection of starter relay

- Follow the table below to check for continuity and operation.

	B	S	①	②
No current			○	○
Current	○	○	⊖	⊕

○—○ : There is continuity between terminals.
⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



195 Inspection of glow relay

(1) Inspection of fuse

If any fault is found, replace the fuse **A** (127 ampere).

(2) Inspection of main body

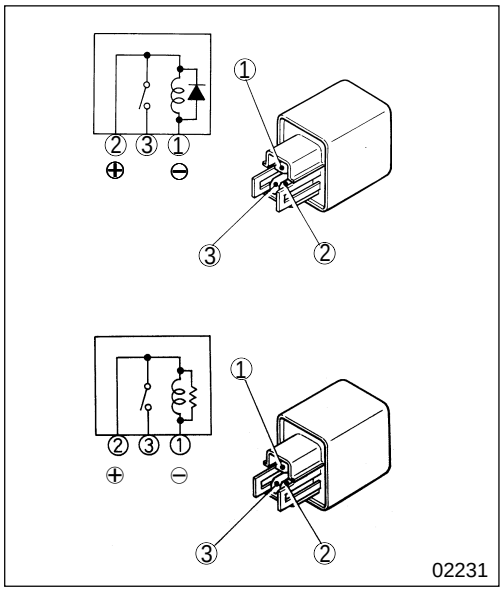
- Follow the table below to check for continuity and operation.

	①	②	③	④	⑤ (Body)
OFF	○	○		○	○
ON	○	○	○	⊕	⊖

○—○ : There is continuity between terminals.

⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.



197 Inspection of relay (Open type 3-pin)

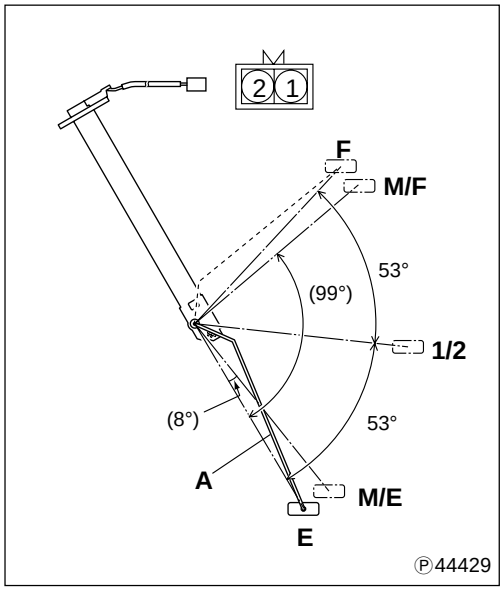
- Follow the table below to check for continuity and operation.

	①	②	③
No current	○	○	
Current	⊕	○ ⊖	○

○—○ : There is continuity between terminals.

⊕—⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the relay.

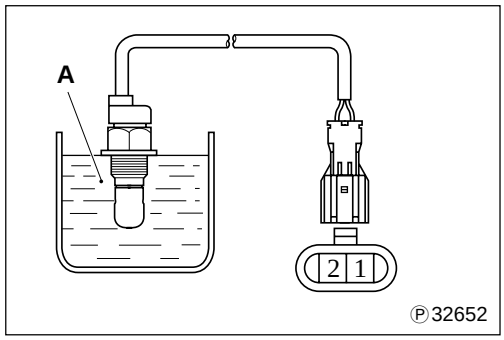


258 Inspection of fuel level sensor

- Measure the resistance between terminals ① and ② when float arm **A** contacts to both stoppers (positions **E** and **F**) and also M/E, 1/2 and M/F position.

Standard value	F (FULL)	0 Ω
	M/F (MIDDLE FULL)	4 Ω
	1/2	50±3 Ω
	M/E (MIDDLE EMPTY)	135 Ω
	E (EMPTY)	150±10 Ω

- If the measured value deviates from the standard value, replace the sensor. Gr 13



259 Inspection of water level sensor

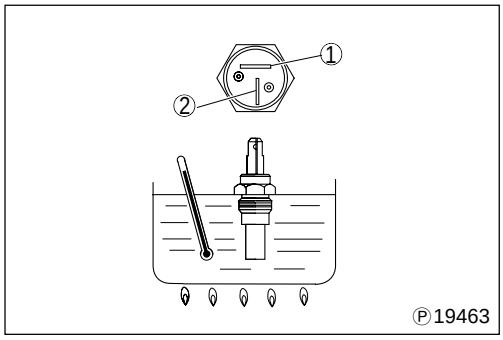
- Follow the table below to check for continuity.

	①	②
When water level sensor is out of the water		
When water level sensor is in the water	○	○

○——○ : There is continuity between terminals.

- If any fault is found, replace the sensor. Gr 14

A : Engine coolant



262 Inspection of water temperature sensor

< For multipurpose timing control unit >

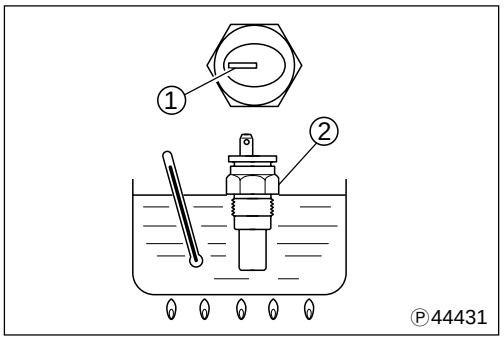
- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ②, and the body respectively.

  Terminal ① : Water temperature gauge connection

  Terminal ② : Multipurpose timing control unit connection

Standard Value	①—Body (connection side of water temperature sensor)	50°C {122°F}	153.9 Ω (Reference value)
		80°C {176°F}	$51.9^{+4.9}_{-4.4}$ Ω
		100°C {212°F}	$27.4^{+1.9}_{-1.2}$ Ω
	②—Body (connection side of multipurpose timing control unit)	20°C {68°F}	3.25 ± 0.33 kΩ
		60°C {140°F}	620 Ω (Reference value)
		80°C {176°F}	300 Ω (Reference value)

- If the measured value deviates from the standard value, replace the sensor. Gr 14

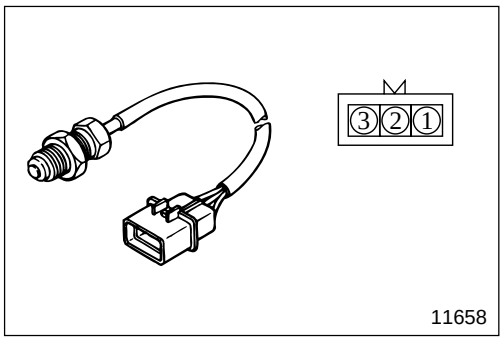


< For engine control >

- Place the sensor in engine oil in a container.
- Raise the oil temperature to the specified values and stir the oil.
- Measure the resistance between terminals ① and ② (body).

Standard value	20°C {68°F}	3.25 kΩ (Reference value)
	60°C {140°F}	620±62 Ω
	80°C {176°F}	300 Ω (Reference value)

- If the measured value deviates from the standard value, replace the sensor. Gr 14

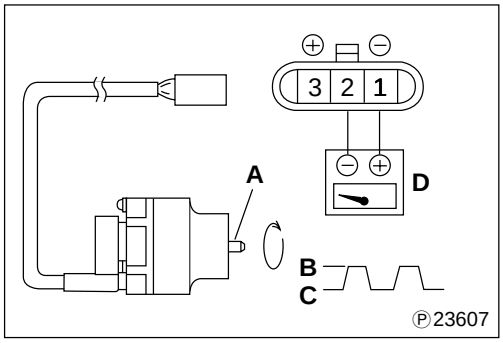


263 Inspection of engine speed sensor

- Measure the resistance between terminals ① and ②.

Standard value (at 25°C {77°F})	2.3±0.2 kΩ

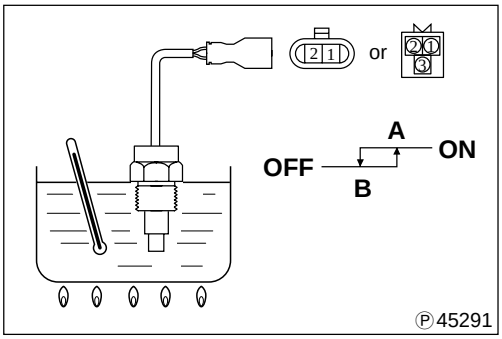
- If the measured value deviates from the standard value, replace the sensor.



265 Inspection of vehicle speed sensor

- Perform the following checks, and if any fault is found, replace the sensor. Gr 22, 23A
  - Turn slowly the portion **A** of the sensor with battery voltage applied between terminals ① and ③.
  - Measure the maximum value (high level **B**) and minimum value (low level **C**) of the voltages generated between terminals ① and ②.
    D : Tester

Standard value	Low level of pulse	0.5 V or less
	High level of pulse	8±1 V



275 Inspection of automatic transmission fluid temperature sensor

Perform the following checks, and if any fault is found, replace the sensor. Gr 23

- Make sure that there is no continuity between terminals ① and ② at room temperature (20±5°C {68±41°F}).
- Place the sensor in a container filled with engine oil and raise the oil temperature while stirring the oil. Measure the temperature when there is continuity between terminals ① and ②, and make sure that the measured value conforms to the standard value.
- Lower the oil temperature and measure the temperature when continuity is lost between terminals ① and ②, and make sure that the measured value conforms to the standard value.

A : When temperature is increase (OFF → ON)
B : When temperature is decrease (ON → OFF)

- Sensor for engine output control

Standard value	A	140±3°C {284±37°F}
	B	133°C {271°F} MIN

- Sensor for fan motor

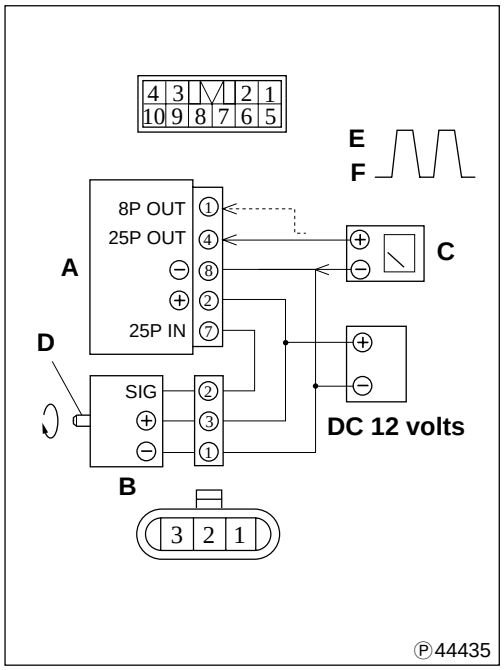
Standard value	A	97±3°C {207±37°F}
	B	90°C {194°F} MIN

- Sensor for warning lamp

Standard value	A	145±3°C {293±37°F}
	B	138°C {280°F} MIN

350 Inspection of control units and other units

- Since the units alone cannot be readily checked in the off-vehicle state, check the harness, switch and other related parts in each system.
- If any fault is not found in the related parts, and the problem still remains in the system, replace the control units or other units.

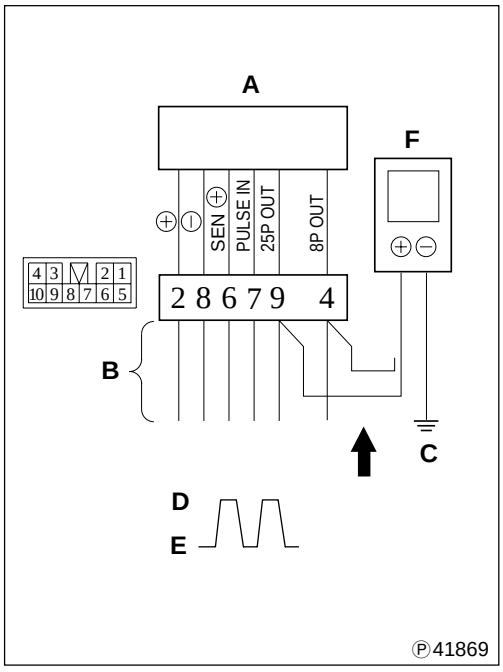


351 Inspection of pulse divider

- Connect the pulse divider **A** as shown.
  B : Vehicle speed sensor (25-pulse)
  C : Tester
- Slowly rotate the shaft **D** of the vehicle speed sensor **B** by hand and measure the maximum voltage (high pulse voltage **E**) and the minimum voltage (low pulse voltage **F**) of the voltage generated across each of the output terminals ①, ④ and terminal ⑧ of the pulse divider **A**.

Standard value (Output voltage)	8-pulse	Low pulse voltage **F**	1.5 V or less
		High pulse voltage **E**	8 ± 1 V
	25-pulse	Low pulse voltage **F**	0.6 V or less
		High pulse voltage **E**	8 ± 1 V

- If the measured value deviates from the standard value, replace the pulse divider **A**.

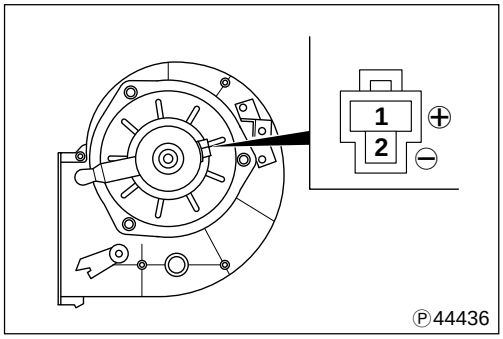


352 Inspection of pulse converter

- Inspect with the engine speed sensor installed in the engine.
- Install the inspection harness **C** on the connector between pulse converter **A** and body harness **B**.
- Start the engine and measure the maximum (high pulse voltage **D**) and minimum (low pulse voltage **E**) value generated at inspection harness **C**.
  F : Tester

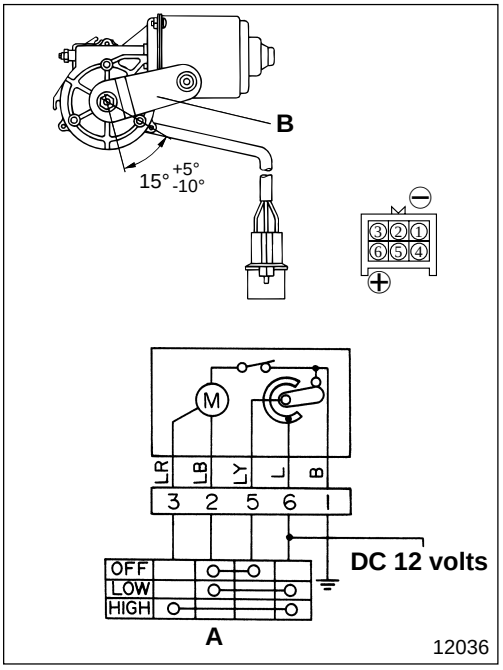
Standard value (Output voltage)	8-pulse	Low pulse voltage **E**	1.0 V or less
		High pulse voltage **D**	8–0.5 V or more
	25-pulse	Low pulse voltage **E**	0.5 V or less
		High pulse voltage **D**	8±1 V

- If the measured value deviates from the standard value, replace the pulse coverter A.



411 Inspection of blower motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 55



422 Inspection of wiper motor

- Connect a switch to the motor as shown.

  A : Switch

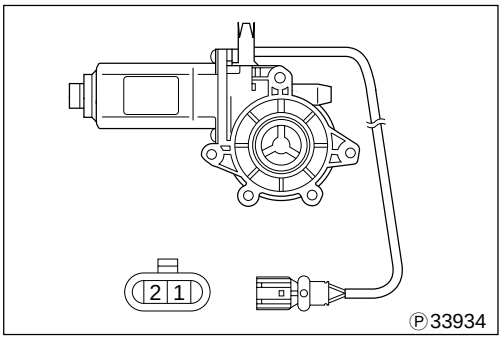
- Check the motor for correct operation as follows. If any fault is found, replace the motor. Gr 42

(1) Inspection of motor operation

- Set switch **A** in HIGH position to check that the motor rotates at high speed.
- Set switch **A** in LOW position to check that the motor rotates at low speed.

(2) Inspection of automatic stop position

- Set switch **A** in LOW position to let the motor rotates at low speed.
- When crank arm **B** is at a position other than the automatic stop position (outside the angles shown), set switch **A** in OFF position.
- Check to see the crank arm **B** stops at the automatic stop position (within the angles range shown).



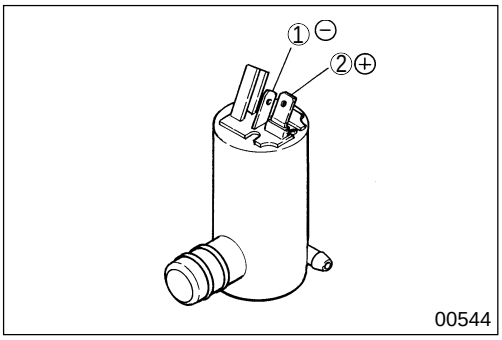
423 Inspection of power window motor

- Follow the table below to check for operation.

	①	②
UP	⊖	⊕
DOWN	⊕	⊖

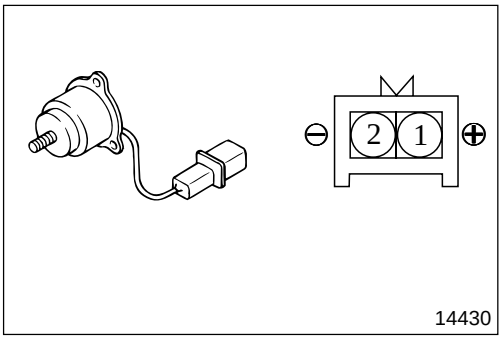
⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the motor. Gr 42



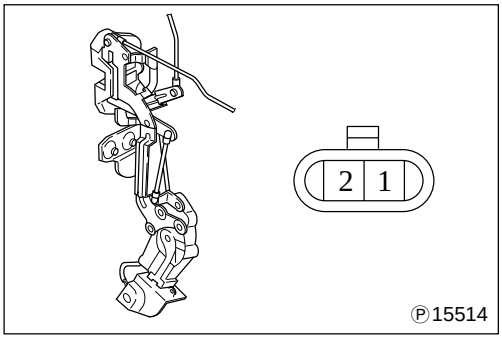
428 Inspection of windshield washer motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 42



435 Inspection of automatic transmission fluid cooler fan motor

- Make sure that the motor operates when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the motor. Gr 23



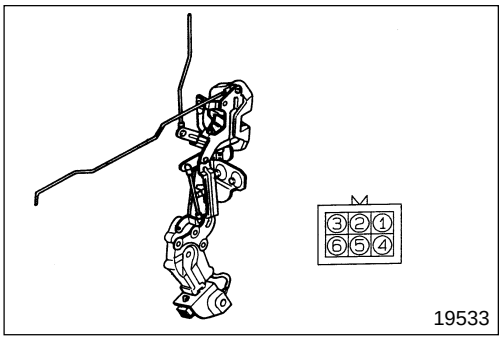
510 Inspection of door lock actuator (Assistant driver's seat side)

- Follow the table below to check for operation.

	①	②
LOCK	⊕	⊖
UNLOCK	⊖	⊕

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42



511 Inspection of door lock actuator (Driver's seat side)

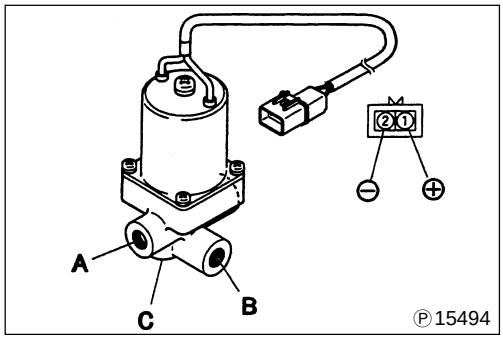
- Follow the table below to check for continuity and operation.

	①	③	②	④	⑤
LOCK		○——○		⊖	⊕
UNLOCK	○——○			⊕	⊖

○——○ : There is continuity between terminals. (OFF in LOCK position)

⊕——⊖ : Indicates the terminals where battery voltage is to be applied.

- If any fault is found, replace the actuator. Gr 42



569 Inspection of exhaust brake 3-way magnetic valve

Perform the following checks, and if any fault is found, replace the 3-way magnetic valve.

(1) Operation test

- Gradually apply battery voltage to between terminals ① and ② from 0 volt.
- Measure the voltage (minimum operating voltage) at the moment when the 3-way magnetic valves starts operating. (The OFF to ON operating can be noticed from a sound the magnetic valve generates.)

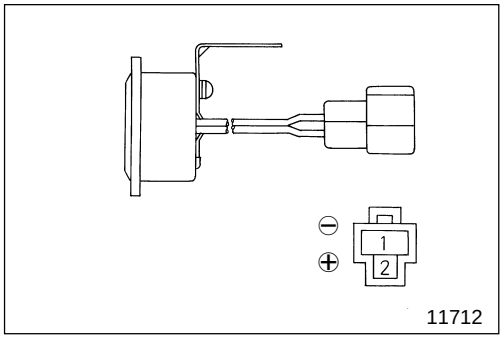
Standard value (Minimum operating voltage)	10 V or less

(2) Continuity and airtightness test

Follow the table below to check for continuity.

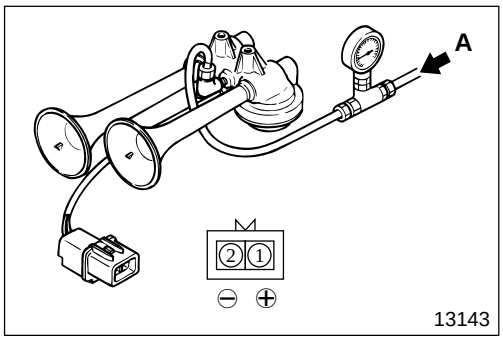
	Input port A	Output port B	Exhaust port C
ON	○———	———○	
OFF		○———	———○

Air circuit table (○——○ : Air passage is open between ports.)
Air pressure at the time of check : 981 kPa {140 psi, 10 kgf/cm^2}



611 Inspection of warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.



612 Inspection of air horn

Perform the following checks, and if any fault is found, replace the horn.

(1) Minimum operating voltage of air horn valve

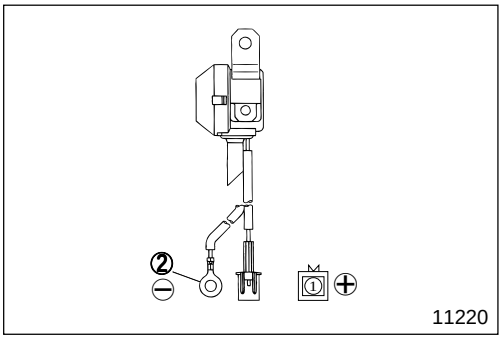
- Apply air pressure **A** of 785 kPa {115 psi, 8 kgf/cm²} to the horn.
- Apply voltage between terminals ① and ② starting from 0 volt gradually.
- Measure the voltage when the horn sounds.

Standard value	10 V or less

(2) Operating pressure of horn

- Apply battery voltage between terminals ① and ②.
- Apply air pressure **A** to the horn starting from 0 kPa {0 psi, 0 kgf/cm²} gradually.
- Measure air pressure **A** when the horn sounds.

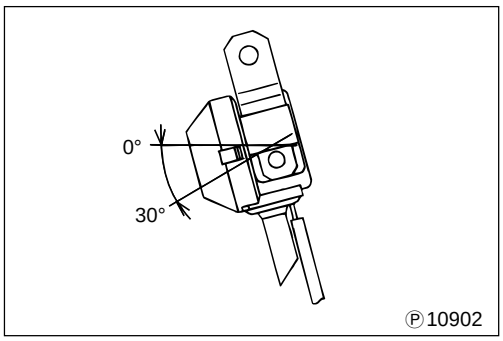
Standard value	195 to 980 kPa {28 to 142 psi, 2 to 10 kgf/cm²}



614 Back buzzer

[Inspection]

- Make sure that the buzzer sounds intermittently when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.

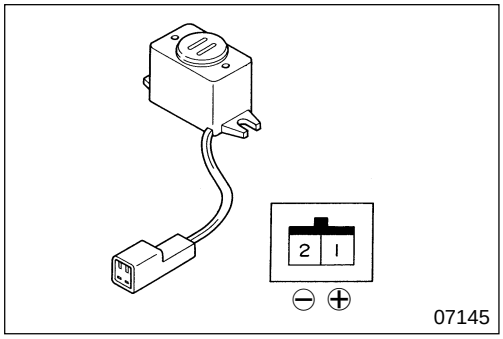


[Installation]

Attach the buzzer to the frame at an angle within the range shown.

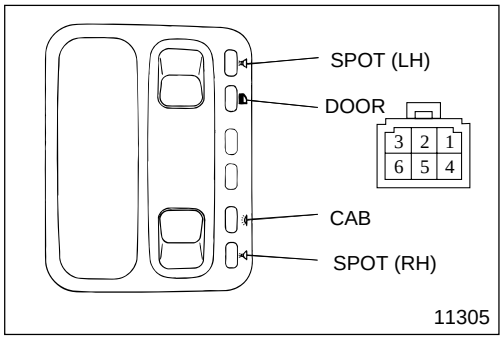
CAUTION ⚠

Be careful to install the buzzer within the illustrated angle range or the buzzer will not be drained normally.



616 Inspection of reverse warning buzzer

- Make sure that the buzzer sounds when battery voltage is applied between terminals ① and ②.
- If any fault is found, replace the buzzer.



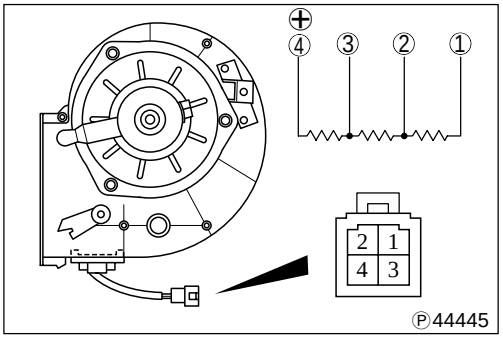
656 Inspection of cab lamp

- Follow the table below to check for continuity.

	①	③	⑤
OFF			
SPOT (LH)	○—○		
SPOT (RH)	○—○		
DOOR	○		○
CAB	○—○		

○—○ : There is continuity between the terminals. (when bulb is installed)

- If any fault is found, replace the lamp.

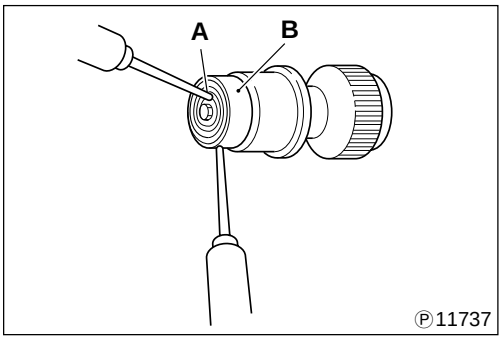


750 Inspection of blower resistor

- Follow the table below to check for resistance of between terminals

Standard value	LOW	①—④	1.78 Ω
	MIDDLE LOW	③—④	0.88 Ω
	MIDDLE HIGH	②—④	0.27 Ω

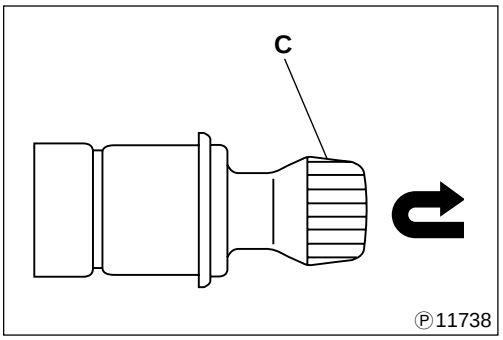
- If the measured value deviates from the standard value, replace the blower resistor.



754 Inspection of cigarette lighter

Perform the following checks, and if any fault is found, replace the cigarette lighter.

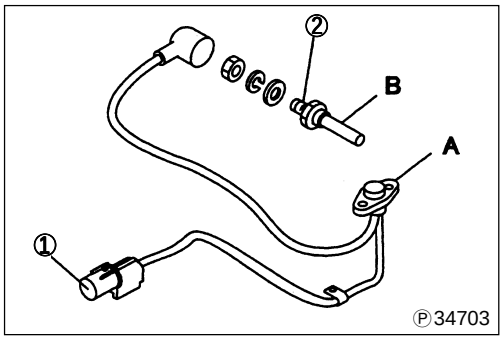
- Make sure that there is continuity between heater element **A** and body **B**.



- Make sure that when plug **C** is pushed in by hand, it immediately returns to its original position.
- Turn the starter switch at ACC or ON position.
- Push plug **C** into the socket in the cab.
- Measure the time required for plug **C** automatically returns.

Standard value	15±5 seconds

- Check to see that heater element **A** is red-hot.



758 Inspection of air dryer

Perform the following checks, and if any fault is found, replace the air dryer. Gr 35

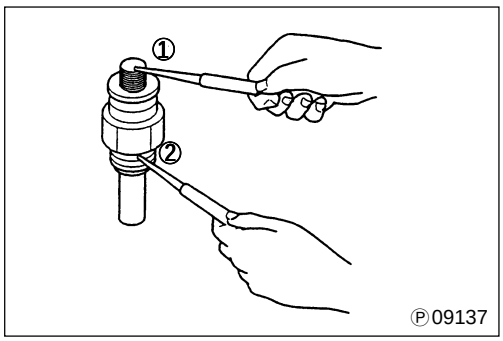
(1) Inspection of thermostat assembly

- Lower the temperature at thermostat **A** to 0°C {32°F} or lower, then gradually raise the temperature.
- Measure the degree of temperature at the moment when continuity is detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

Standard value (During temperature increase: OFF → ON)	7±4.0°C {45±39.2°F}

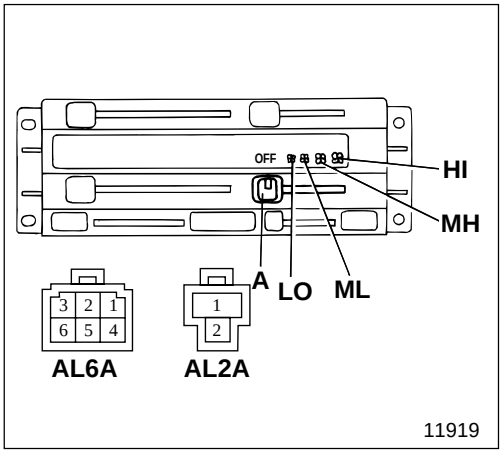
- Raise the temperature at thermostat **A** to 20°C {68°F} or higher, then gradually lower the temperature.
- Measure the degree of temperature at the moment when continuity is not detected between terminals ① and ②, and make sure to confirm if the value meets the standard.

Standard value (During temperature decrease: ON → OFF)	20°C {68°F} or less



(2) Inspection of heater

- Make sure that there is continuity between terminals ① and ②.
- If any fault is found, replace the heater.



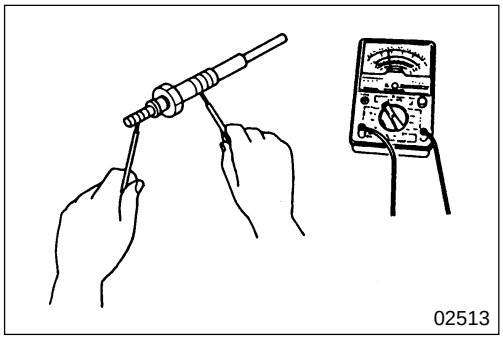
763 Inspection of heater control assembly

- Follow the table below to check for continuity.

	AL6A						AL2A	
	①	③	②	⑤	⑥	④	①	②
OFF								
LOW	○	○				○		
MIDDLE LOW	○		○			○		
MIDDLE HIGH	○			○		○		
HIGH	○				○	○		
	C	L	ML	MH	H	E	ILL	

○—○ :There is continuity between terminals.

- If any fault is found, replace the switch **A** or heater control assembly.
- If the illumination lamp has blown out, replace the bulb.



764 Inspection of glow plug

- Measure the resistance of glow plug as shown.

Standard Value (Cold resistance of glow plug)	1.0 Ω (Reference value)

- If the measured value deviates from the standard value, replace the glow plug. Gr 11

DANGER⚠

- **Because flammable hydrogen gas is generated from battery, be sure to obey the following:**
  - **Never attempt to short-circuit the positive and negative terminals of battery, and generate sparks, or smoke a cigarette near it.**
  - **Do not wear metal objects on your arms or do not lean over battery.**
- **Sulfuric acid of the electrolyte is very corrosive. Whenever handling battery, wear safety goggles and rubber gloves to protect your eyes and hands.**
- **Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.**

WARNING⚠

- **When you disconnect battery cables, disconnect the negative battery cable ⊖ first.**

CAUTION⚠

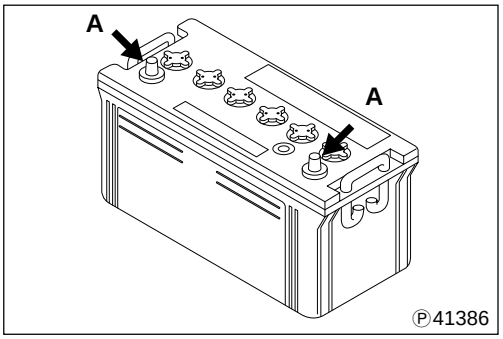
- **Make sure that all electrical switches of the vehicle are off before connecting battery cables.**
- **Be sure to connect the positive battery cable ⊕ first before you connect the negative battery cable ⊖.**
- **To prevent a short-circuit, take care that disconnected battery cables may not accidentally touch the battery terminals.**

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
—	Specific gravity of battery electrolyte (20°C {68°F})	1.220 to 1.290	—	Charge or replace

◆ Service procedure

Inspection of battery

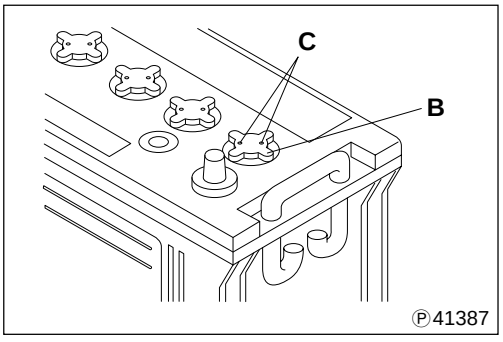


(1) Visual inspection

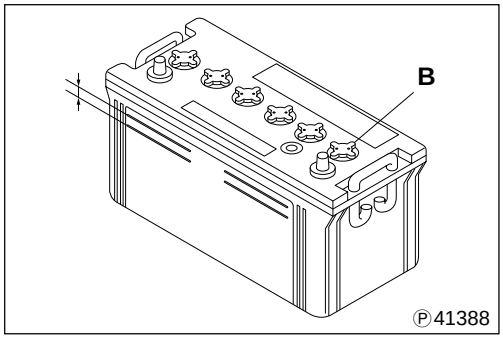
- If terminal **A** is corroded, scrub off the corrosion from it using a wire brush.
- If cracks or defects are found on battery, replace it since the cracks or defects can cause liquid spills.

CAUTION⚠

Make sure you grease the ⊕ side of terminal A because it is easily corroded.

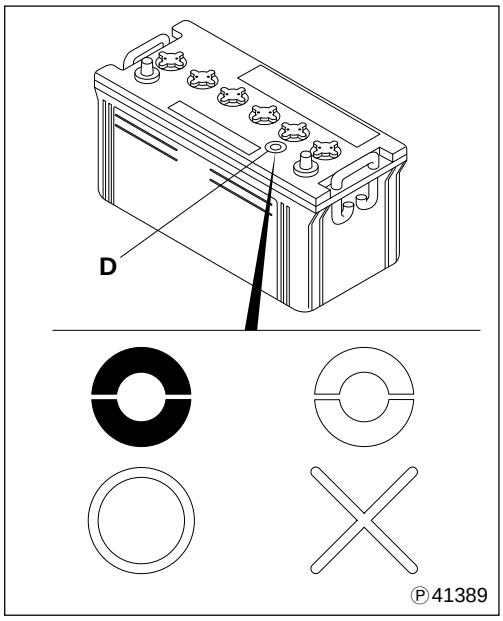


- If bleed hole **C** of vent plug **B** is clogged, clean the hole.



(2) Inspection of fluid level

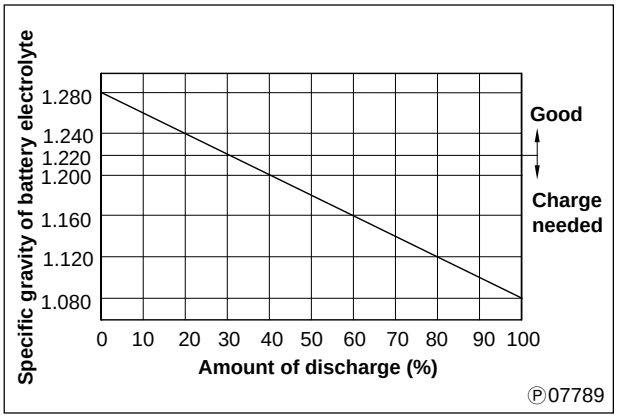
- Make sure that the battery electrolyte level is between UPPER and LOWER.
- If the level is below LOWER, remove vent plug **B** and fill the battery with distilled water or battery replenisher to UPPER.



(3) Measurement of specific gravity

You can tell the specific gravity of the battery electrolyte by the color shown in indicator **D**.

Blue : Good
White : Charge or replace



(4) Charging

- Although, as a rule, battery charging should be done with the battery removed from the vehicle, if you have to charge the battery while it is on the vehicle, make sure that you stop the engine and disconnect battery cable ⊖.
- Remove vent plug before charging the battery.
- For the recommended charge time and current, see the following table to avoid overcharging.

	Charge current (A)	Charge time (H)	Upper limit of fluid temperature (°C {°F})
Normal charge	$\frac{\text{Value of 5-hour rating capacity}}{10}$	$\frac{\text{*Amount of discharge (Ah)}}{\text{Charge current (A)}} \times 1.2$ (to 1.5)	45 {113}
Quick charge	$\frac{\text{Value of 5-hour rating capacity}}{1.5}$	0.5	55 {131}

* Amount of discharge (Ah)=5-hour rating capacity (Ah)$\times \frac{\text{Amount of discharge (\%)}}{100}$

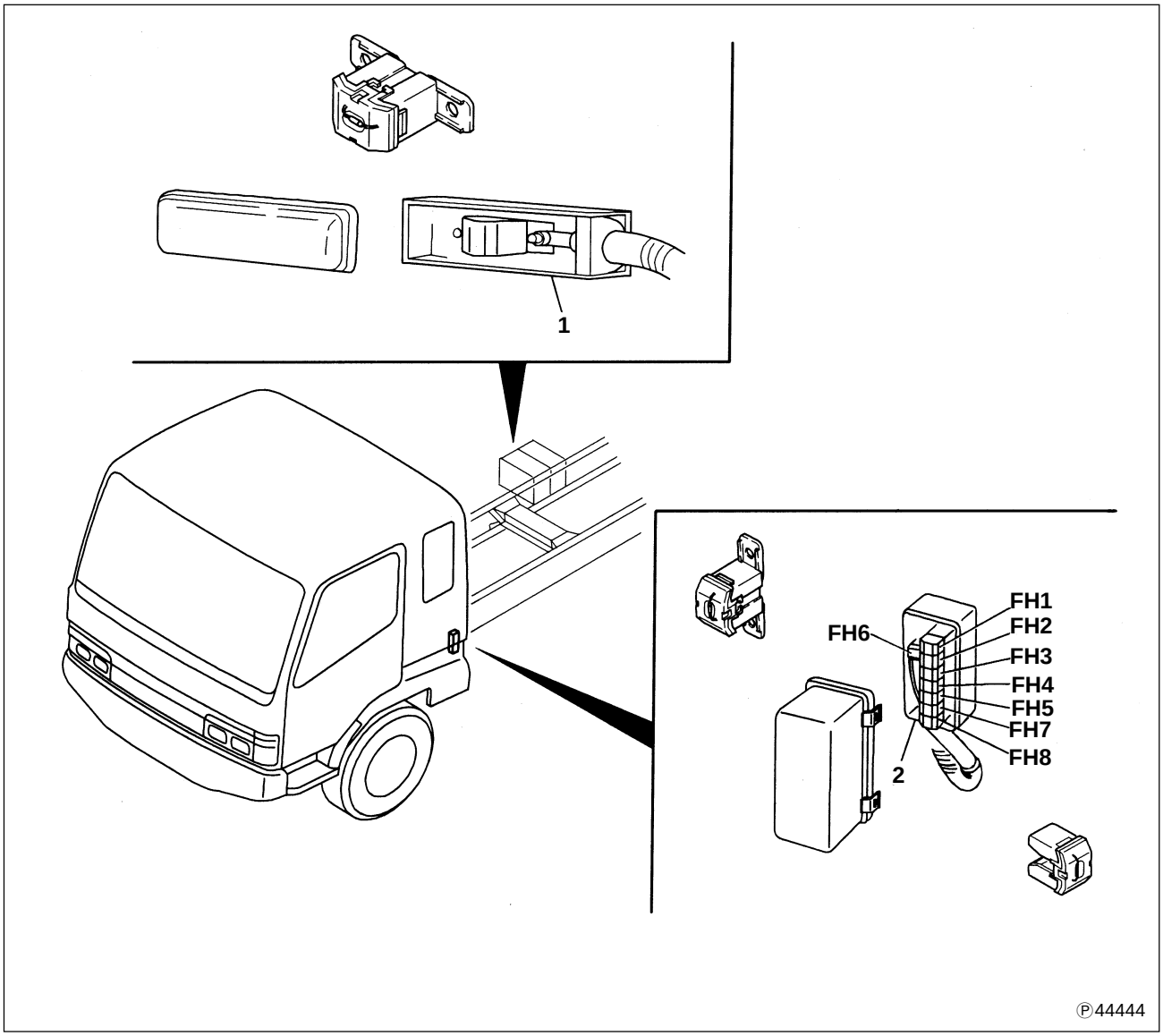
- Use the graph shown on the left to calculate the amount of discharge (%).
- Use diluted sulfuric acid, made up of sulfuric acid and refined or distilled water, as the battery electrolyte.
- The specific gravity of fully-charged battery electrolyte is 1.280 with the temperature at 20°C {68°F}.

DANGER⚠

- **Do not let the battery electrolyte level rise and overflow while charging the battery.**
- **Keep open flame away from the battery while charging it or it might explode.**
- **Be careful not to generate sparks while charging the battery because it is dangerous.**
- **After charging the battery, tighten the vent plugs, wash away sulfuric acid from the battery using water, and dry the surface.**
- **Be sure to check the electrolyte level before charging the battery. Charging with the electrolyte level below the lower limit (LOWER LEVEL) can cause premature deterioration, heat generation and explosion of the battery.**

870 to 889 FUSE

870 High-current fuse box



1 Main high-current fuse
2 High-current fuse box

WARNING⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing high-current fuses (FH1 to FH8). 🕮 860

With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:
Always (directly connected to the battery): FH1 to FH8

CAUTION⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use the fuse of the specified ampere.**

Main high-current fuse

Fuse No.	Main load	Capacity
—	High-current fuse box	140A

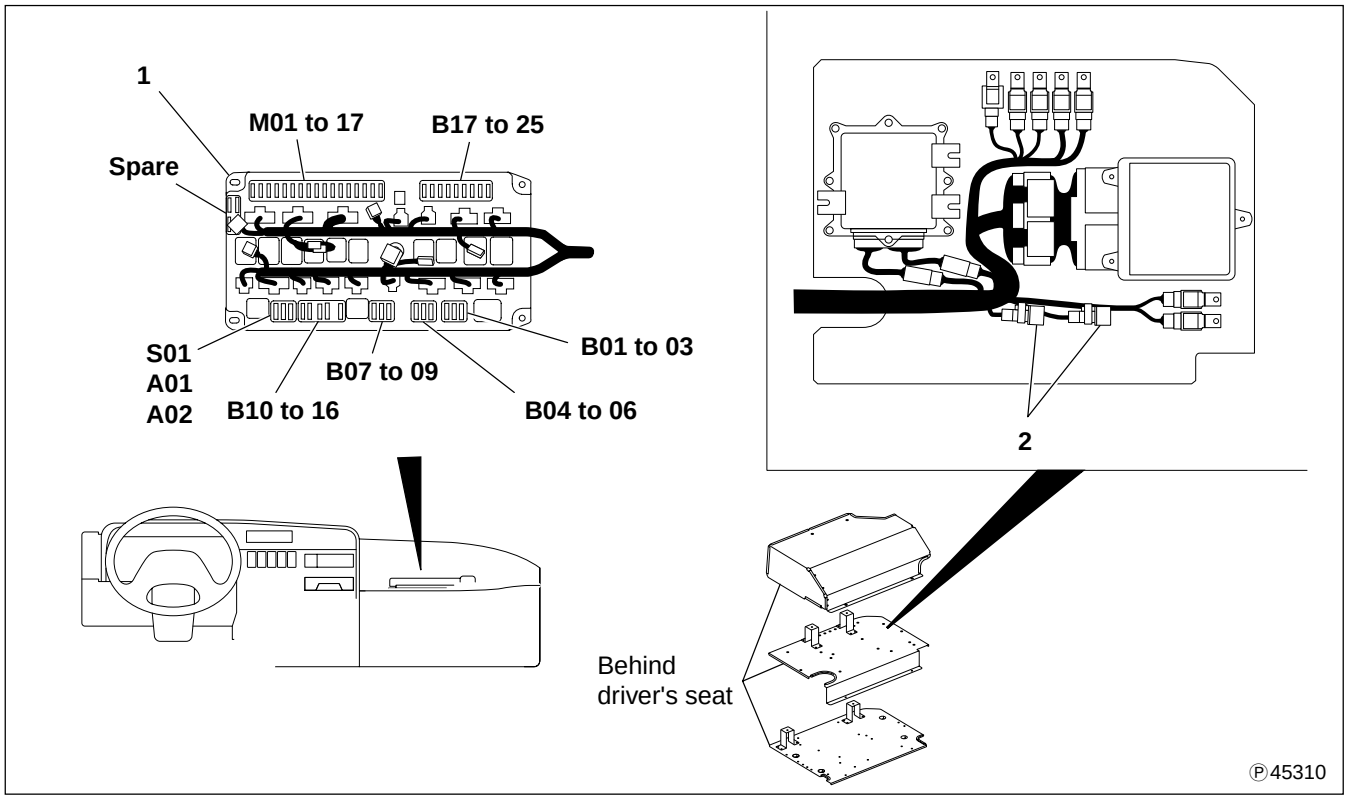
High-current fuse box

Fuse No.	Main load	Capacity
FH1	Starter switch (terminal B)	50A
FH2	Fuse (B07 to B16)	40A
FH3	Fuse (B18 to B24)	40A
FH4	Fuse (B01 to B04)	40A
FH5	Glow relay (terminal B)	50A
FH6	Alternator (terminal B)	140A
FH7	Fuse (B06)	40A
FH8	A/T<FM657>	60A

A/T : Automatic transmission

870 to 889 FUSE

871 Relay and fuse box



1 Relay and fuse box
2 Fuse holder

WARNING⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing fuses. 🕮 860

With the negative terminal ⊖ of the battery connected, battery voltage is always applied to each fuse.
The battery voltage is applied to the fuses under the following conditions:
Always (directly connected to the battery) : B01 to B25
When starter switch is in ON position : M01 to M17
When starter switch is in ACC position : A01 to A02
When starter switch is in START position : S01

CAUTION⚠

- **If a fuse blows out, identify and remedy the cause, then replace the fuse.**
- **Be sure to use a fuse of the specified ampere.**

Relay and fuse box

Fuse No.	Main load	Capacity
A01	Audio	10A
A02	Cigarette lighter	15A
B01	Reserve power (BATT)	10A
B02	Reserve power (ACC)	10A
B03	Van body dome light	15A
B04	Socket connector	20A
B05	Power window	25A
B06	Automatic transmission	10A
B07	Stop lamp	10A
B08	Turn/hazard	15A
B09	Tail lamp	20A
B10	Headlamp, relay	10A
B11	—	—
B12	Headlamp, RH	15A
B13	—	—
B14	—	—
B15	Headlamp, LH	15A
B16	—	—
B17	Spare	—
B18	Air-conditioner	20A
B19	—	—
B20	ABS	30A
B21	—	—

Fuse No.	Main load	Capacity
B22	Cab lamp	10A
B23	Mirror heater	10A
B24	—	—
B25	Horn	15A
M01	Automatic transmission	10A
M02	Transmission power take-off	10A
M03	—	—
M04	Reserve power (MAIN)	10A
M05	Neutral switch	10A
M06	Automatic transmission	20A
M07	Mirror heater	10A
M08	Engine control (ACT)	10A
M09	Blower motor	20A
M10	—	—
M11	Engine control (ECU)	10A
M12	ABS electronic control unit	10A
M13	Turn/hazard	10A
M14	Air dryer	15A
M15	Meter, speed indicator, DRL	10A
M16	Backup lamp	10A
M17	Wiper	15A
S01	Safety relay	10A

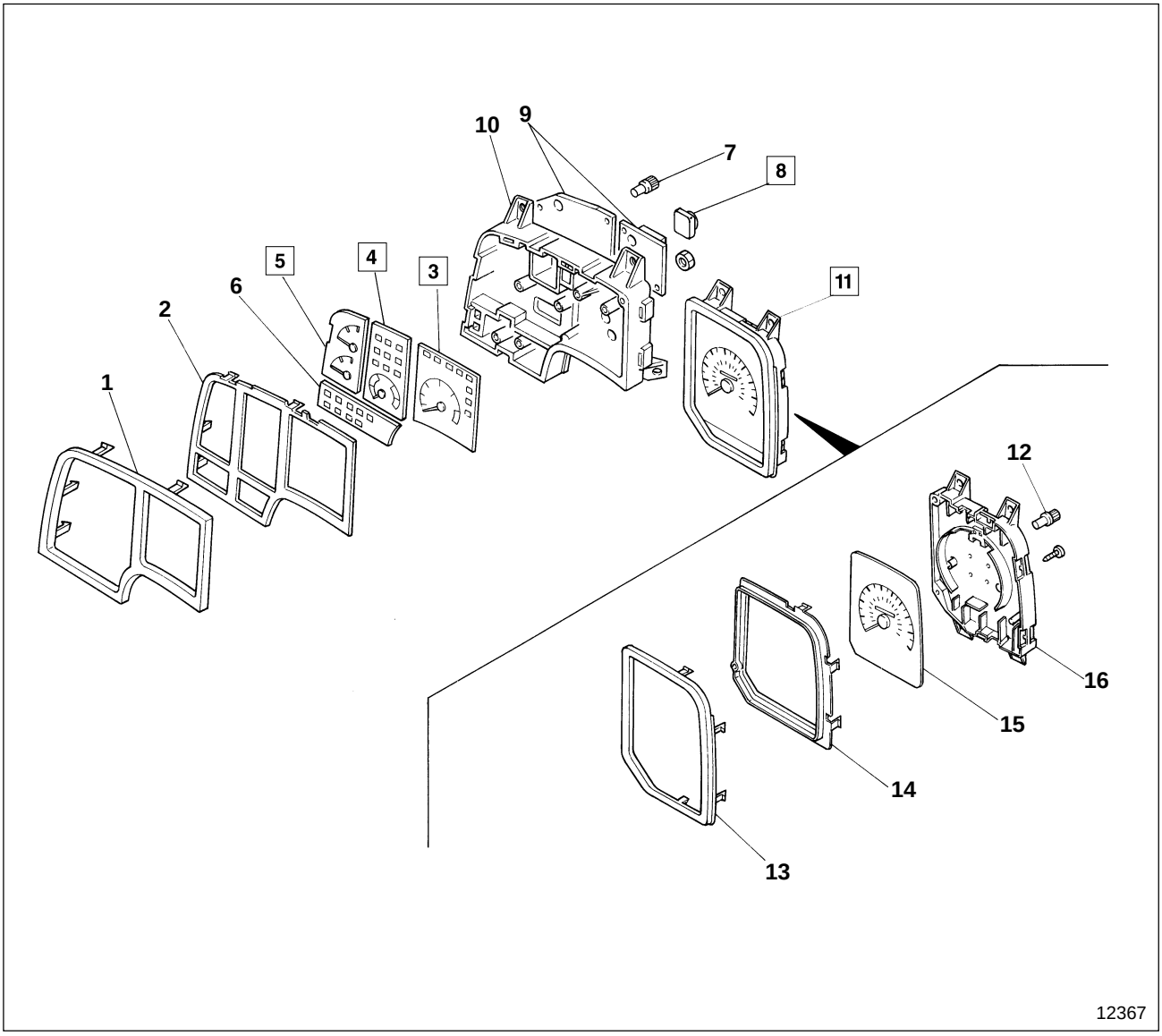
ABS : Anti-lock brake system
ACT : Actuator
DRL : Daytime running light
ECU : Electronic control unit

Fuse holder

Fuse No.	Main load	Capacity
—	A/T <FM657>	30A

A/T : Automatic transmission

890 METER CLUSTER



● **Disassembly sequence**

1 Front plate
2 Retainer
3 Tachometer
4 Air pressure gauge and indicator lens
5 Fuel gauge and water temperature gauge
6 Indicator lens
7 Bulb
8 Meter warning buzzer (Overrunning buzzer) < 10-speed transmission >
9 Print panel
10 Case
11 Speedometer assembly
12 Bulb
13 Plate
14 Window plate
15 Speedometer
16 Case

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Removal and installation of meter cluster speedometer. Gr 42

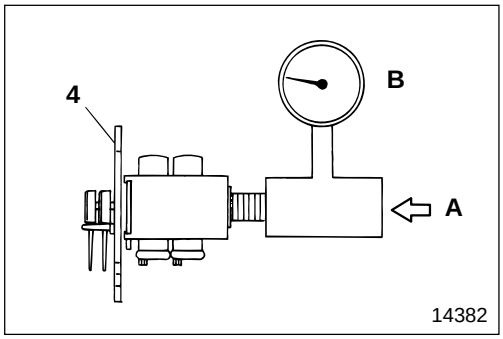
Service standards

Location	Maintenance item			Standard value	Limit	Remedy
3	Indication range of tachometer 20±2°C {68±36°F} 13.5±0.1 V		At 550 rpm	550±35 rpm	—	Replace
			At 1000 rpm	1000±50 rpm		
			At 1500 rpm	1500±60 rpm		
			At 2000 rpm	2000±65 rpm		
			At 2500 rpm	2500±70 rpm		
			At 3000 rpm	3000±75 rpm		
4	Indication range of air pressure gauge		At 40 psi	275±50 kPa {40±7 psi, 2.8±0.5 kgf/cm^2}	—	Replace
			At 75.4 psi	520±50 kPa {75.4±7 psi, 5.3±0.5 kgf/cm^2}		
			At 120 psi	825±50 kPa {120±7 psi, 8.4±0.5 kgf/cm^2}		
	Tolerance of reading by two needless under the same pressure		At 75.4 psi	±50 kPa or less {±7 psi, ±0.5 kgf/cm^2}	—	Replace
			At 120 psi	±50 kPa or less {±7 psi, ±0.5 kgf/cm^2}		
5	Resistance of fuel gauge	Needle position	FULL	4 Ω	—	Replace
			1/2	50 Ω		
			EMPTY	135 Ω		
	Resistance of water temperature gauge	Needle position	65°C {149°F}	81.8 Ω	—	Replace
			100°C {212°F}	26.6 Ω		
11	Inspection range of speedometer 14 V 20±2°C {68±36°F}	Inspection using mph	At 10 mph	10^{+2}_{0} mph	—	Replace
			At 20 mph	20^{+2}_{0} mph		
			At 40 mph	$40^{+2.5}_{0}$ mph		
			At 50 mph	50^{+3}_{0} mph		
			At 60 mph	60^{+3}_{0} mph		
		Inspection using km/h	At 20 km/h	20^{+3}_{0} km/h	—	Replace
			At 35 km/h	35^{+3}_{0} km/h		
			At 40 km/h	40^{+3}_{0} km/h		
			At 60 km/h	$60^{+3.5}_{0}$ km/h		
			At 80 km/h	$80^{+4.5}_{0}$ km/h		
			At 100 km/h	100^{+5}_{0} km/h		

◆ Service procedure

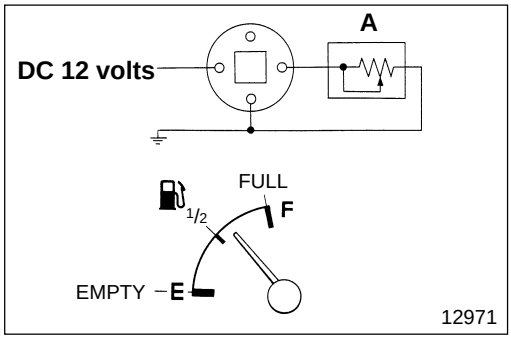
3 Inspection of tachometer

- Use the engine revolution counter to check that the indication area of tachometer **3** is in the standard value at each revolution.
- If the measured value deviates from the standard value, replace tachometer **3**.



4 Inspection of air pressure gauge

- Apply air pressure **A** to air pressure gauge **4**.
  B : Air pressure gauge
- Measure the indication range of air pressure gauge **4** at standard pressure.
- If the measured value deviates from the standard value, replace air pressure gauge.



5 Inspection of fuel gauge and water temperature gauge

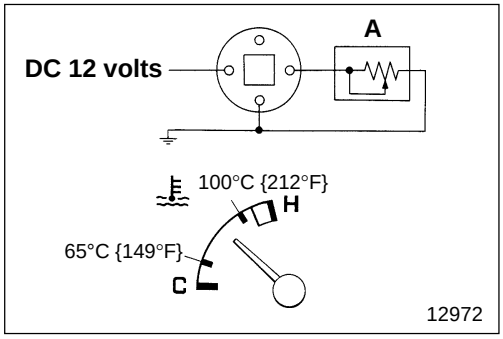
(1) Inspection of fuel gauge

- Connect a variable resistor to fuel gauge **5** as shown.
  A : Variable resistor
- Measurement order
  FULL → 1/2 → EMPTY

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of fuel gauge **5** indicates FULL, 1/2, and EMPTY.
- If the measured value deviates from the standard value, replace fuel gauge **5**.



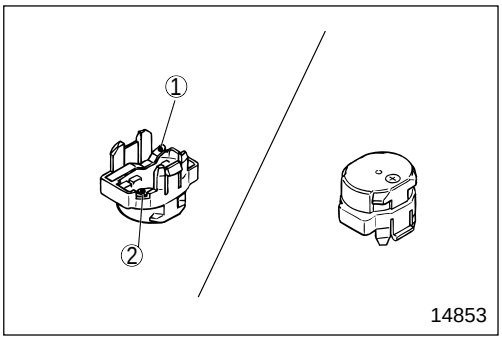
(2) Inspection of water temperature gauge

- Connect a variable resistor to water temperature gauge **5** as shown.
  A : Variable resistor
- Measurement order
  65°C {149°F}→ 100°C {212°F}

NOTE

The movement of the gauge needle is subject to hysteresis (oscillation). Be sure to measure following the measurement order.

- Increase the value of variable resistor **A** gradually from 0 Ω.
- Measure the resistance respectively when the needle of water temperature gauge **5** indicates 65°C {149°F} and 100°C {212°F}.
- If the measured value deviates from the standard value, replace water temperature gauge **5**.



8 **Inspection of meter warning buzzer**

- Make sure that the buzzer operates when battery voltage is applied between terminals ① and ②.

CAUTION ⚠

- **Be careful not to mix up ⊕ and ⊖ when you apply voltage to the buzzer 8, because this would damage the meter warning buzzer.**
- **Make sure you check ⊕ and ⊖ on the top of the buzzer 8.**

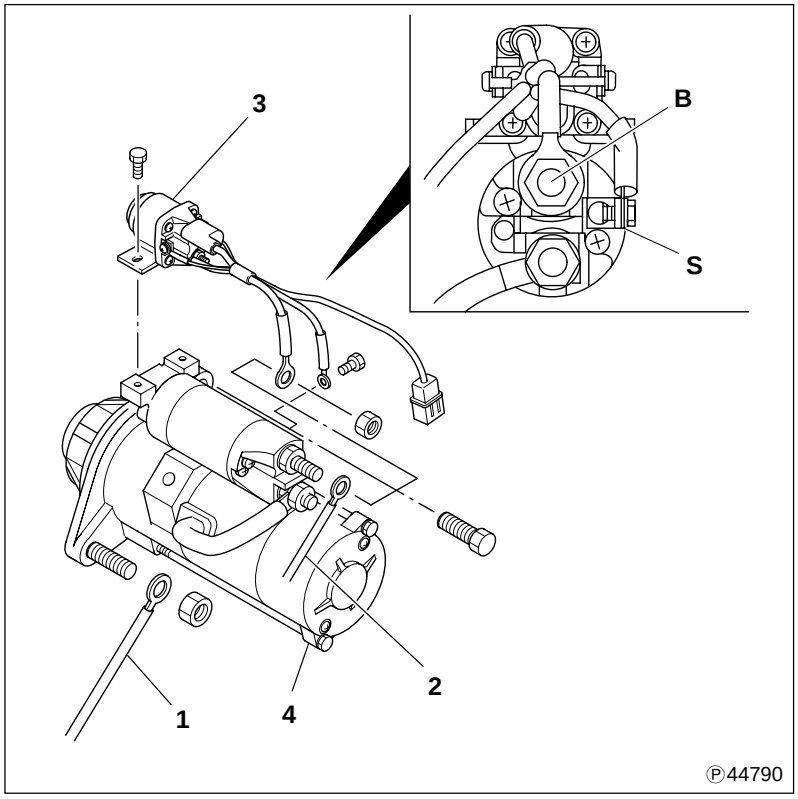
- If any fault is found, replace the buzzer.

11 **Inspection of speedometer**

Use the speedometer tester to check that the indication area of speedometer **11** does not deviate from the standard value at each speed. If the measured value deviates from the standard value, replace the speedometer.

12 STARTER AND ALTERNATOR

930 STARTER



● **Removal sequence**

1 Ground strap
2 Starter cable
3 Starter relay 🕮 187
4 Starter 🕮 P54-12-4

B : Connect to terminal B
S : Connect to terminal S

WARNING⚠

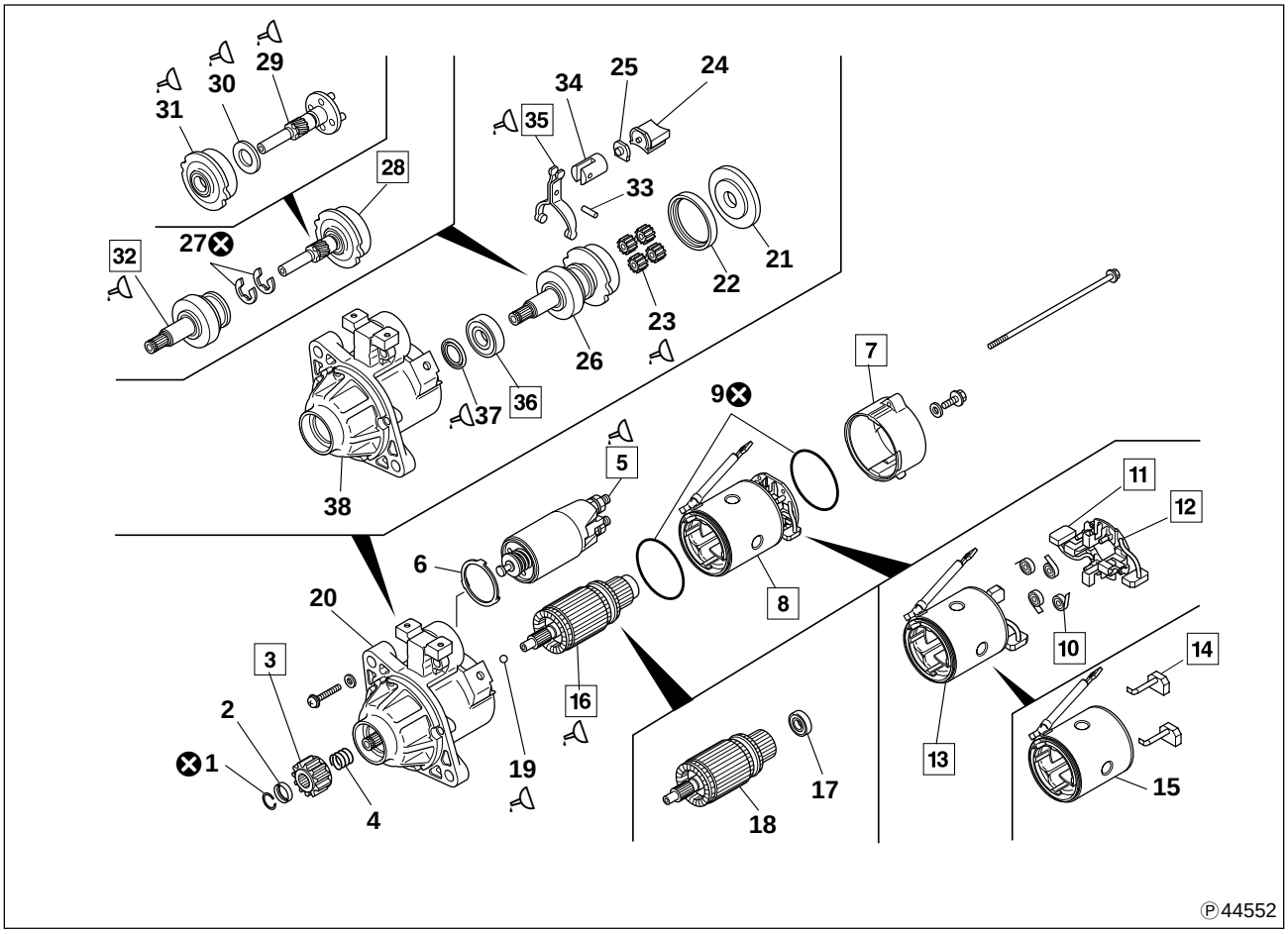
Never touch the starter 5 with tools when you remove the harness from terminal B. This is because voltage is always supplied to it from starter cable 2, and you will short-circuit the starter. Before removing the harness from terminal B, remove the ⊖ battery terminal and tape it up to insulate it.

● **Installation sequence**

Follow the removal sequence in reverse.

M E M O

Starter



● **Disassembly sequence**

1 Stopper ring
2 Pinion stopper
3 Pinion
4 Spring
5 Magnetic switch assembly
6 Shim
7 Rear bracket
8 Yoke and brush holder assembly
9 Rubber packing
10 Brush spring
11 Brush ⊖
12 Brush holder assembly
13 Yoke assembly
14 Brush ⊕
15 Yoke
16 Armature assembly
17 Rear bearing
18 Armature
19 Ball
20 Front bracket assembly
21 Cover
22 Rubber packing
23 Planetary gear
24 Rubber packing
25 Plate
26 Gear shaft and overrunning clutch assembly
27 E-ring
28 Gear shaft and internal gear assembly
29 Gear shaft assembly
30 Washer
31 Internal gear
32 Overrunning clutch
33 Pin
34 Holder
35 Lever
36 Front bearing
37 Oil seal
38 Front bracket

⊗ : Non-reusable parts

CAUTION⚠

- **Do not remove bearings 17, 36 unless they are faulty.**
- **Be careful not to lose ball 19, since it might come out together with armature assembly 16 when you remove it.**

NOTE

- **You do not have to remove pinion 3 when you disassemble or inspect only the motor assembly, for example: when inspection of the brush assembly is required.**
- **Except for the above, make sure you remove pinon 3 before disassembling any parts.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

NOTE

Whenever magnetic switch assembly 5 has been replaced, be sure to adjust the pinion gap.

● **Inspection after assembly**

🕮 P54-12-6

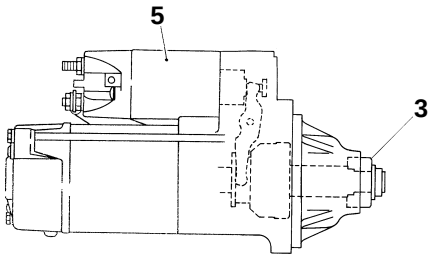
Service standards

Unit : mm {in.}

Location	Maintenance item			Standard value	Limit	Remedy
—	Pinion gap			0.5 to 2.0	—	Adjust
—	No-load characteristic	With current of 11 V	Current	230 A or less	—	Inspect
			Revolutions per minute	3400 rpm or more	—	
10	Pressure of brush spring			33.3 to 45.0 N {7.5 to 10.1 lbs, 3.4 to 4.58}	17.7 N {4.0 lbs, 1.8 kgf}	Replace
11, 14	Length of brush			18 {0.71}	11 {0.43}	Replace
16	Outer diameter of commutator			38.7 {1.52}	38.1 {1.50}	Replace
	Deflection of commutator periphery			—	0.1 {0.0039} or more	Replace
	Mica depth between segments			—	0.2 {0.0079} or less	Correct or replace

Lubricant

Location	Points of application	Specified lubricant	Quantity
5	Lever contact surface of magnetic switch assembly	Multipurpose grease [NLGI No.2 (Li soap)]	As required
16	Teeth of armature assembly gear and shaft	MOLYKOTE ® AG650	As required
16, 29	Sliding surface of armature assembly and gear shaft assembly	MOLYKOTE ® AG650	As required
19	Ball	MOLYKOTE ® AG650	As required
23, 31	Teeth of internal gear and planetary gear	MOLYKOTE ® AG650	As required
29, 32	Friction surfaces of gear shaft assembly and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
30	Washer	MOLYKOTE ® AG650	As required
32	Spline of overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
35	Friction surfaces of lever and overrunning clutch	Multipurpose grease [NLGI No.2 (Li soap)]	As required
37	Oil Seal	Multipurpose grease [NLGI No.2 (Li soap)]	As required



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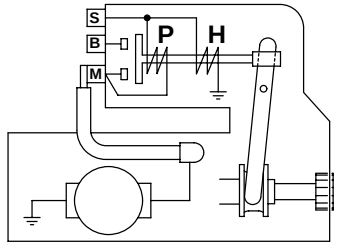


Ⓟ14257

◆ Service procedure

● Inspection after assembly

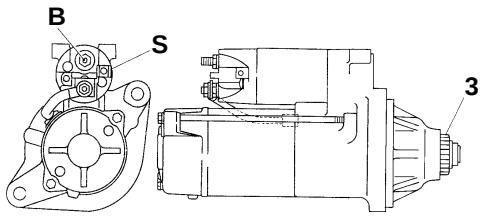
Inspection after assembling the starter should be carried out with current fed to the starter.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot during inspection.**

CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits the coil might burn due to overheating.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



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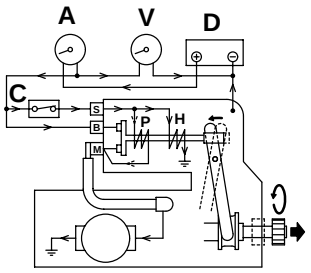


Ⓟ14258

(1) Performance test

- Connect the starter as shown.

A : Ammeter	**D** : 12 volts DC
B : Terminal B of starter	**S** : Terminal S of starter
C : Switch	**V** : Voltmeter

- Set the voltage to 11 volts DC.

CAUTION⚠

Up to 12 volts can be loaded.

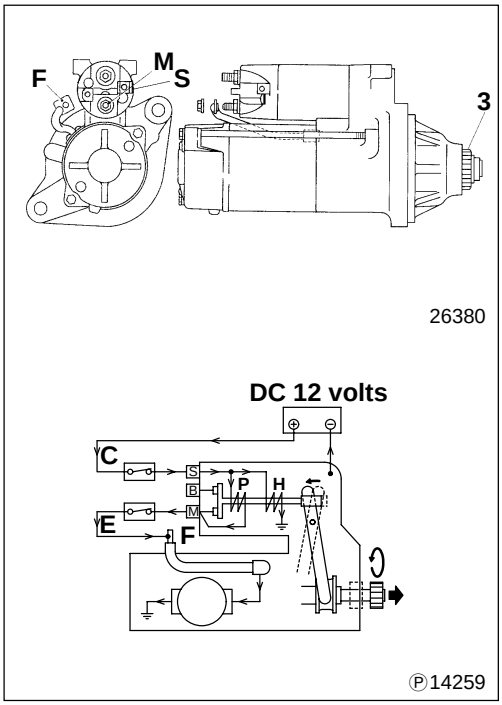
- The following work should be done with current fed to the starter. You must complete measurement of the current and the number of revolutions within 30 seconds.
  - Turn switch **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.

CAUTION⚠

When switch C is turned ON, current is fed both to pull-in coil P and holding coil H. When a large amount of current is fed into terminal M from DC power supply D, via terminal B of the starter, the current stops flowing into the pull-in coil but continues to flow into the holding coil.

To avoid burning the holding coil, be sure to carry out the performance test within 30 seconds.

  - Measure the current and the number of revolutions of the starter. Train a strobe light on pinion **3** to measure the number of revolutions.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, disassemble the starter again and inspect it.

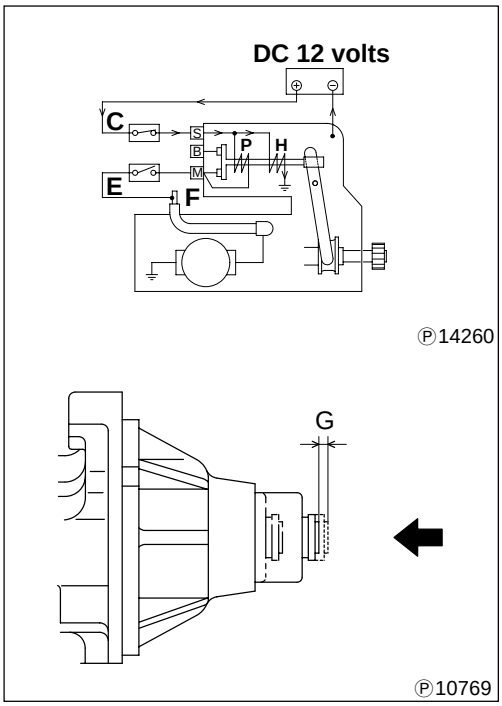


(2) Pinion gap

[Inspection]

- Connect the starter as shown.
  C : Switch
  E : Switch
  F : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete measurement of the pinion gap within 30 seconds.
  - Turn switches **C** and **E** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



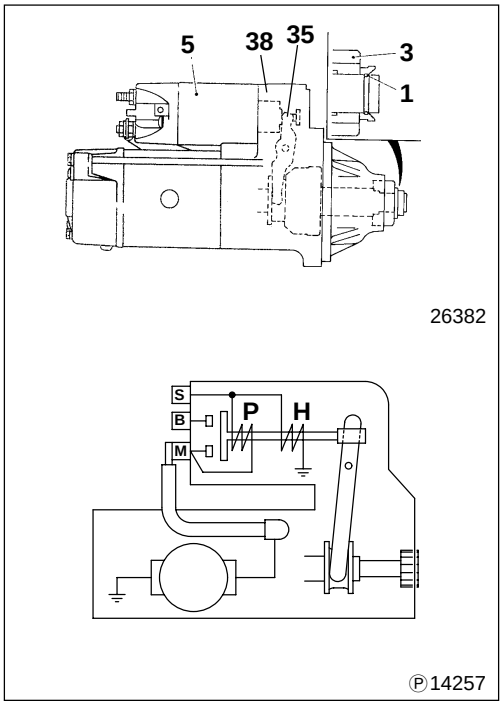
  - Within 5 seconds of pinion **3** rotating, turn switch **E** OFF to stop rotation of the pinion.

CAUTION ⚠

When switches C and E are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.

To avoid burning the pull-in coil, be sure to turn switch E OFF within 5 seconds of the pinion rotating.

  - Hold the end of overrunning clutch **32** with fingers, and pull it. Measure the distance **G** (pinion gap) in the shaft direction that the overrunning clutch moves when it is lightly pushed back by hand.
  - Turn switch **C** OFF to stop current to the starter.
- If the measured value deviates from the standard value, replace lever **35**.



3 **Pinion**

[Removal]

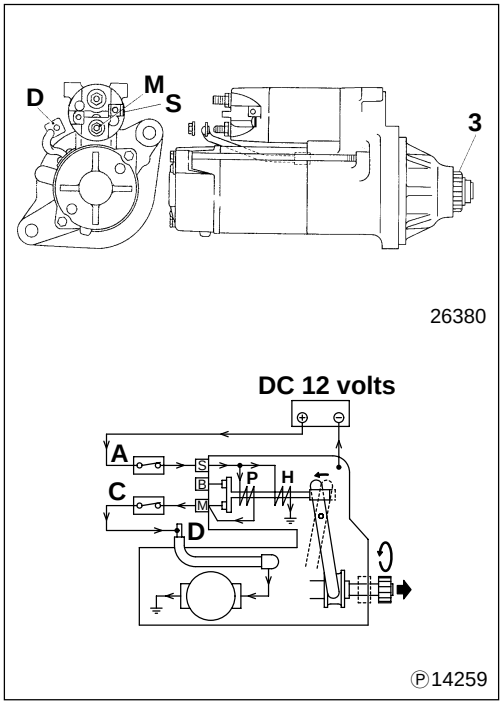
Feed current to the starter and protrude pinion **3** to remove the pinion.

WARNING⚠

- **Do not touch pinion 3 because it jumps out and turns when current is fed to the starter.**
- **Take care not to burn your hand, magnetic switch assembly 5 might be hot after inspection.**

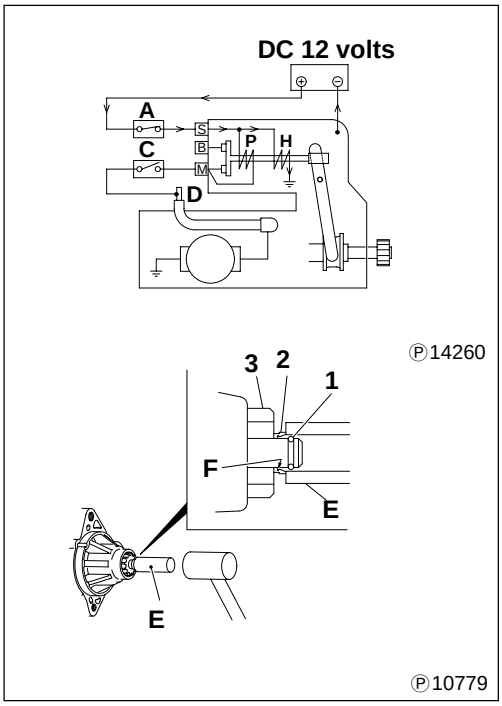
CAUTION⚠

- **The current feeding time to the starter should be within 10 seconds at pull-in coil P side and within 30 seconds at holding coil H side. If the current feeding time exceeds these limits, the coil might burn due to overheating.**
- **Before making pinion 3 jump out, be sure to feed current to the starter to obtain the correct state. If current is not fed to the starter and lever 35 is pulled to protrude the pinion, front bracket 38 or the lever might be damaged due to the shock produced on removal of stopper ring 1.**
- **The current, when fed to the starter, is over 100 amperes. When inspecting, use thick cable, such as a booster cable, and make secure connections.**



- Connect the starter as shown.
  A : Switch
  C : Switch
  D : Cable
  M : Terminal M of starter
  S : Terminal S of starter

- The following work should be done with current fed to the starter. You must complete removal of pinion **3** within 30 seconds.
  - Turn switches **A** and **C** ON and feed current to the starter. In this state, pinion **3** jumps out and rotates.



- Within 5 seconds of pinion **3** rotating, turn switch **C** OFF to stop rotation of the pinion**.**

CAUTION⚠

When switches A and C are turned ON, current is fed both to pull-in coil P and holding coil H. The circuit is wired in such a way that the voltage is not applied to terminal B of the starter, so the current continues to flow into the pull-in coil while pinion 3 rotates.

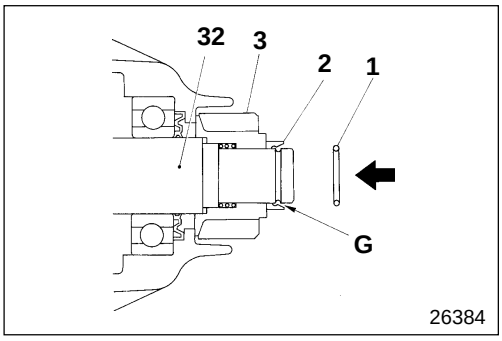
To avoid burning pull-in coil P, be sure to turn switch C OFF within 5 seconds after the pinion rotates.

- Apply pipe-shaped tool **E** onto pinion stopper **2**.
- Hit tool **E** lightly using a mallet to remove stopper ring **1** from ring groove **F** of pinion stopper **2**.
- Remove stopper ring **1** and pinion **3**.
- Turn switch **A** OFF to stop current to the starter.

NOTE

When the current to the starter is stopped, stopper ring 1 might fall back into ring groove F of pinion stopper 2 because pinion 3 is pushed inside.

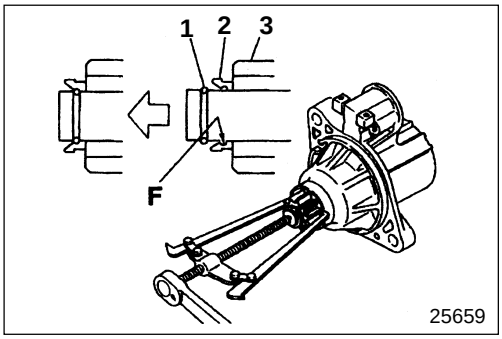
If this occurs, feed current to the starter again and carry out the work.



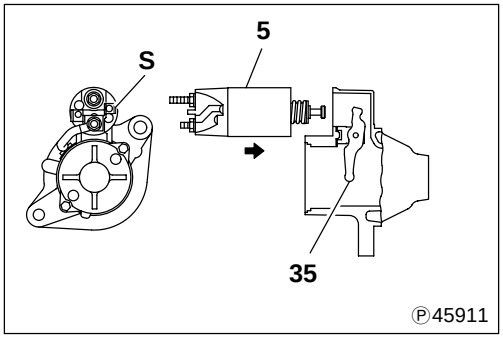
[Installation]

When installing pinion **3**, it is not necessary to feed current to the starter.

- Install pinion stopper **2** and pinion **3** onto overrunning clutch **32** in the direction as shown.
- Fit stopper ring **1** into ring groove **G** of overrunning clutch **32**.

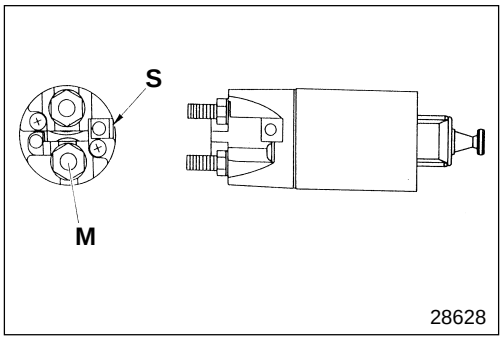


- Pull pinion **3** firmly and set stopper ring **1** on groove **F** of pinion stopper **2** securely.



5 Magnetic switch assembly

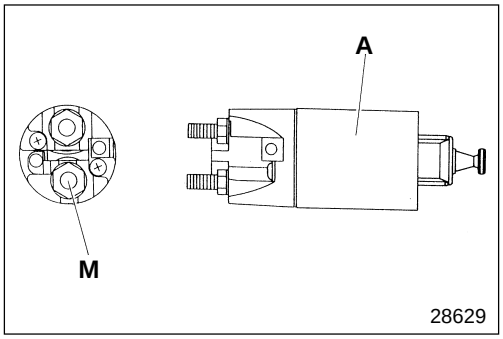
[Installation]
Install magnetic switch assembly **5** to lever **35**, with terminal **S** facing the direction as shown.



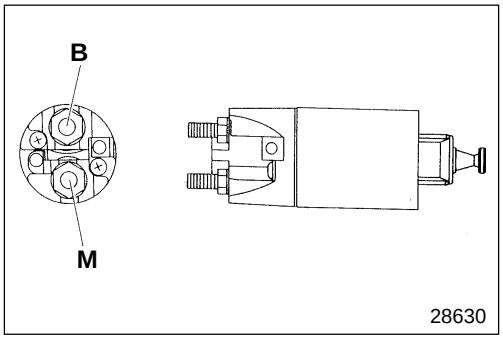
[Inspection]

(1) Testing for coil breakage

- Make sure that there is continuity between terminals **S** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.

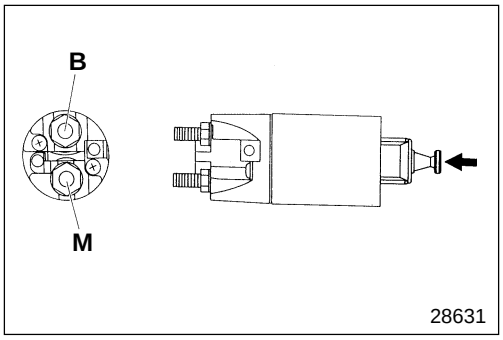


- Make sure that there is continuity between terminal **M** and body **A**.
- If there is no continuity, replace magnetic switch assembly **5**.



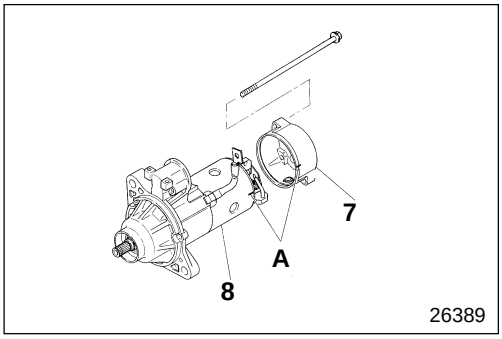
(2) Inspection of welded connections

- Make sure that there is no continuity between terminals **B** and **M**.
- If there is continuity, replace magnetic switch assembly **5**.



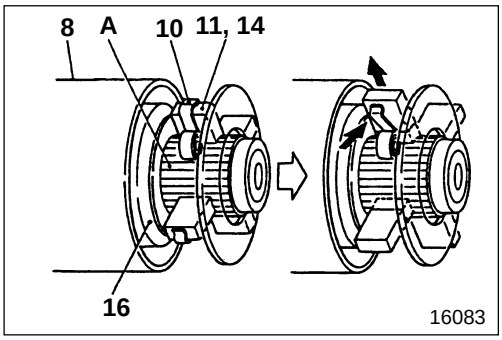
(3) Inspection of connections

- Push the tip of magnetic switch assembly **5** to close the internal connection.
  Make sure that there is continuity between terminals **B** and **M**.
- If there is no continuity, replace magnetic switch assembly **5**.



7 **Installation of rear bracket**

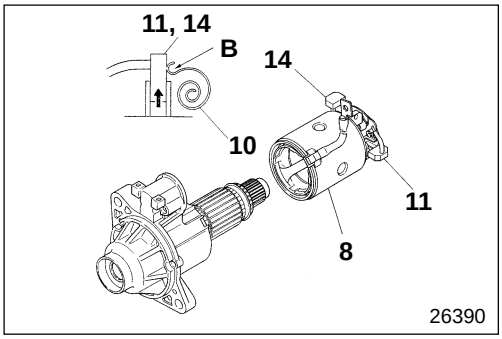
A : Alignment mark



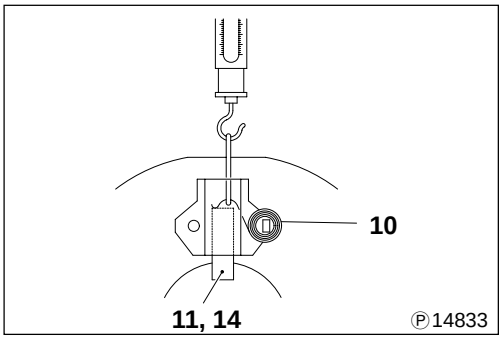
8 **Removal and installation of yoke and brush holder assembly**

Use the following method to remove the yoke and brush holder assembly **8** in order to prevent the commutator **A** of the armature assembly **16** from being damaged by the brushes **11** and **14**.

- Lift the brushes **11** and **14** away from the commutator **A** and hold them lifted by applying the brush springs **10** against the sides of the brush springs.

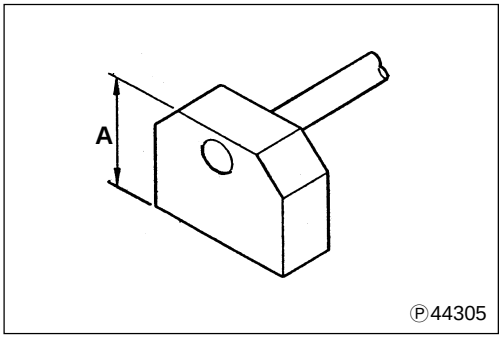


- Pull part **B** of each brush spring **10** and pull up the brushes **11** and **14**.
- Hold the brushes **11** and **14** in position with brush spring **10** as shown.
- Remove yoke and brush holder assembly **8**.
- To reinstall the yoke and brush holder assembly **8**, follow the removal instructions in, reverse.



10 **Inspection of brush spring**

- Use new brushes **11, 14** and measure the load when brush spring **10** is detached from the brushes.
- If the measured value is lower than the limit, replace brush spring **10**.



11 **14** **Inspection of brush**

(1) Length of brush

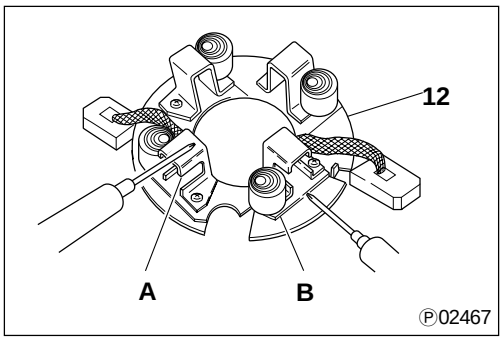
If the measured value **A** is lower than the limit, replace brushes **11, 14**.

NOTE

To replace brush ⊖ 11, replace entire brush holder assembly 12.

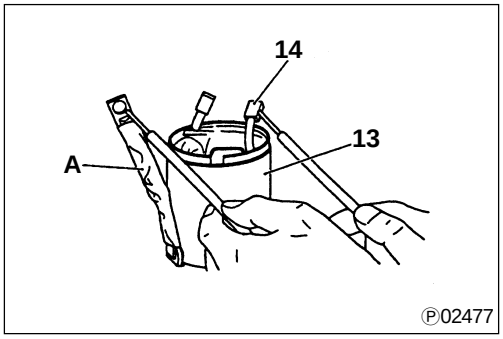
(2) Contact surface with commutator

If the surface where the brushes contact the commutator is rough or is worn unevenly, polish the surface with emery paper (300 to 500 grit)



12 Inspection of brush holder assembly

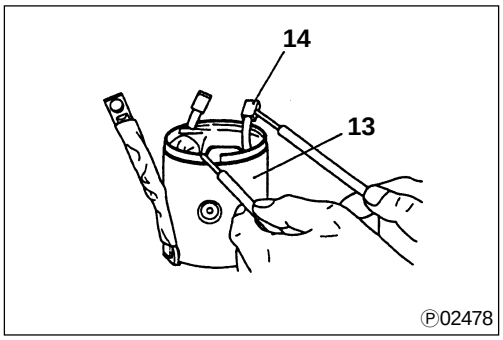
- Cleaning the brush holder **A** and holder plate **B**.
- Make sure that there is no continuity between the ⊕ side of the brush holder **A** and the ⊖ side of the holder plate **B**.
- If there is continuity between them, they are short-circuited. Replace brush holder assembly **12**.



13 Inspection of yoke assembly

(1) Testing for coil breakage

- Make sure that there is continuity between cable **A** and brush ⊕ **14**.
- If there is no continuity, they are broken. Replace brush ⊕ **14** or yoke assembly **13**.

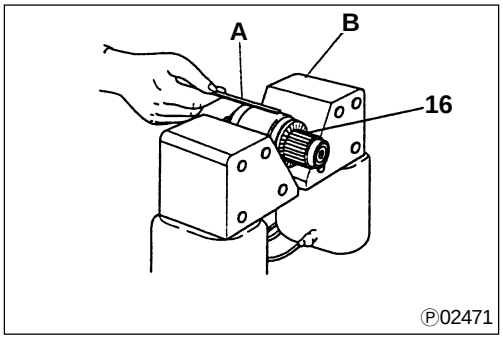


(2) Testing for coil grounding

- Make sure that there is no continuity between yoke assembly **13** and brush ⊕ **14**.
- If there is continuity, they are short-circuited. Inspect the insulated point. If it is hard to repair, replace brush ⊕ **14** or yoke assembly **13**.

NOTE

The coil may be short-circuited to the yoke assembly 13 due to the accumulation of worn-off metal particles from the brushes and/or armature.



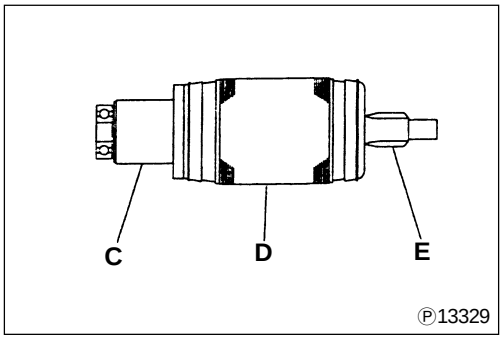
16 Inspection of armature assembly

(1) Testing for coil short-circuit

- Hold an iron rod **A** parallel with the armature assembly **16**.

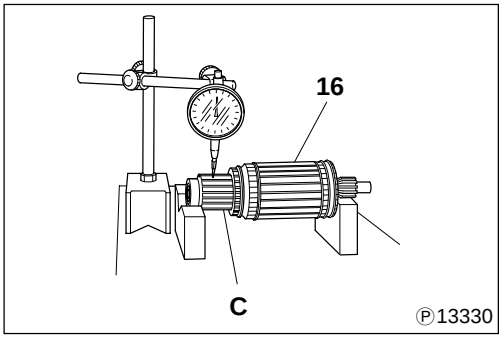
B : Armature tester

- Slowly rotate the armature assembly **16** by hand.
- If the iron rod **A** vibrates or is pulled toward the armature assembly **16**, the coil is short-circuited and the armature assembly must be replaced.



(2) Testing for coil grounding

- Make sure that there is no continuity between commutator **C** and core **D** (or shaft **E**).
- If there is continuity between them, they are short-circuited. Replace armature assembly **16**.

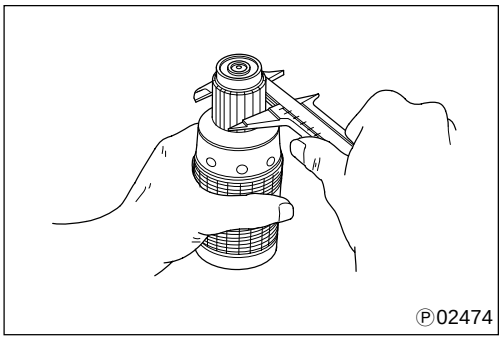


(3) Deflection of commutator

If the measured value is higher than the limit, correct the outer diameter of commutator **C** within the limit.

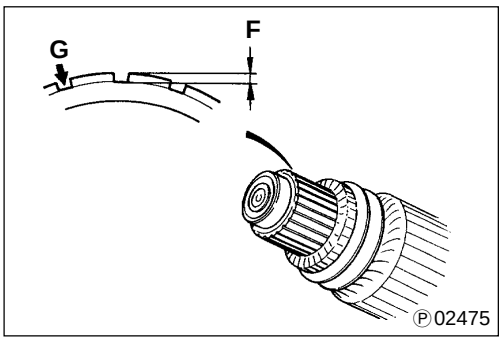
(4) Condition of the surface of cummutator

- If the surface is rough or has stepped wear, polish the surface with emery paper (300 to 500 grit).
- After polishing, check deflection of commutator **C**.



(5) Outer diameter of commutator

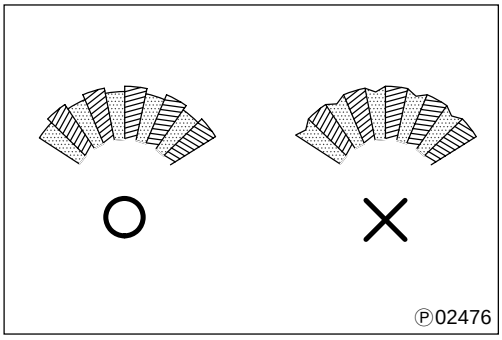
If the measured value is higher than the limit, replace armature assembly **16**.



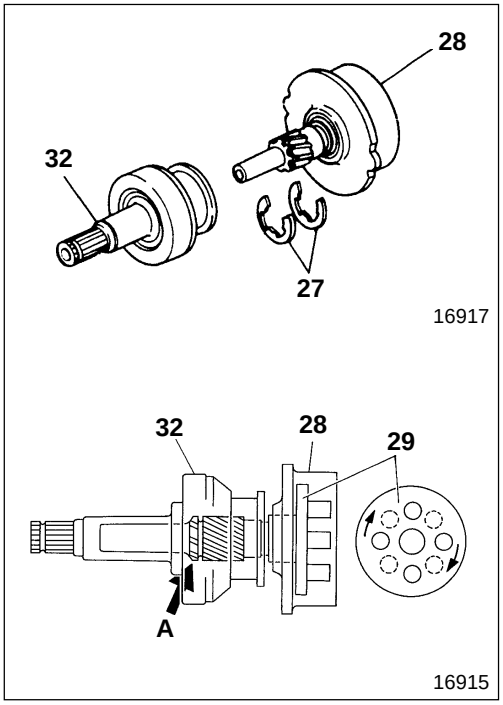
(6) Mold depth between segments

- If the measured value is lower than the limit, replace armature assembly **16**.
  F : Mold depth

- To rectify the armature assembly **16**, grind the shown portions **G**.



- If the mold is worn as shown, correct or replace armature assembly **16**.
  ○ : Good
  × : Faulty

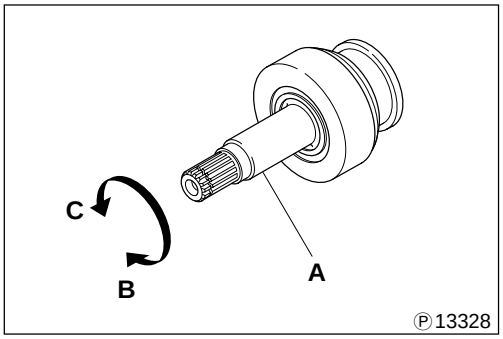


28 Removal of gear shaft and internal gear assembly

Remove the E-rings **27** and then the gear shaft and internal gear assembly **28** from the overrunning clutch **32**.

Proceed as follows if the gear shaft and internal gear assembly **28** cannot be removed due to interference of the splined section **A** of gear shaft assembly **29** with internal parts of the overrunning clutch **32**.

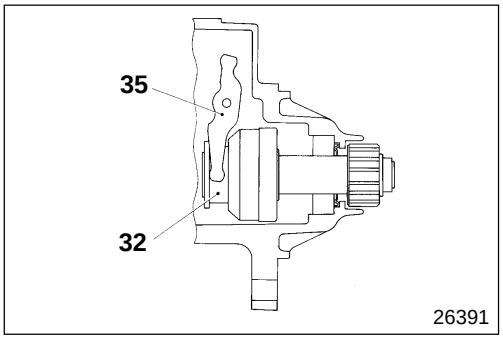
- Press the gear shaft assembly **29** against the overrunning clutch **32**.
- Turn the gear shaft assembly **29** approx. 1/8 of a turn to change the position of splined section **A**.



32 Inspection of overrunning clutch

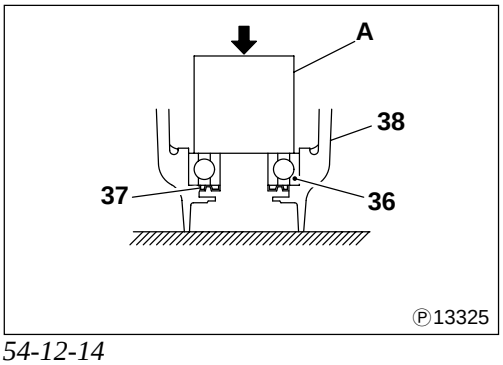
Perform the following checks, and if any fault is found, replace the overrunning clutch **32**.

- Make sure that shaft **A** turns smoothly when turned in direction **B**.
- Make sure that shaft **A** locks when turned in direction **C**.



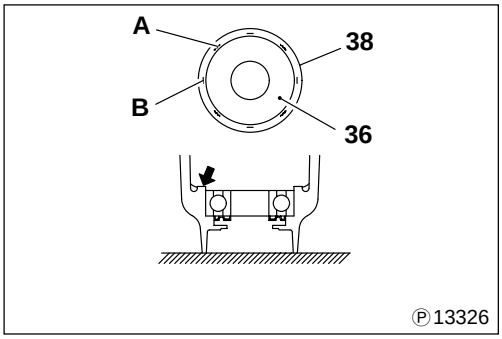
35 Installation of lever

Install lever **35** onto overrunning clutch **32** in the direction as shown.



36 Installation of front bearing

- Install oil seal **37** before press-fitting front bearing **36**.
- Press-fit front bearing **36** into front bracket **38** using pipe-shaped tool **A**.



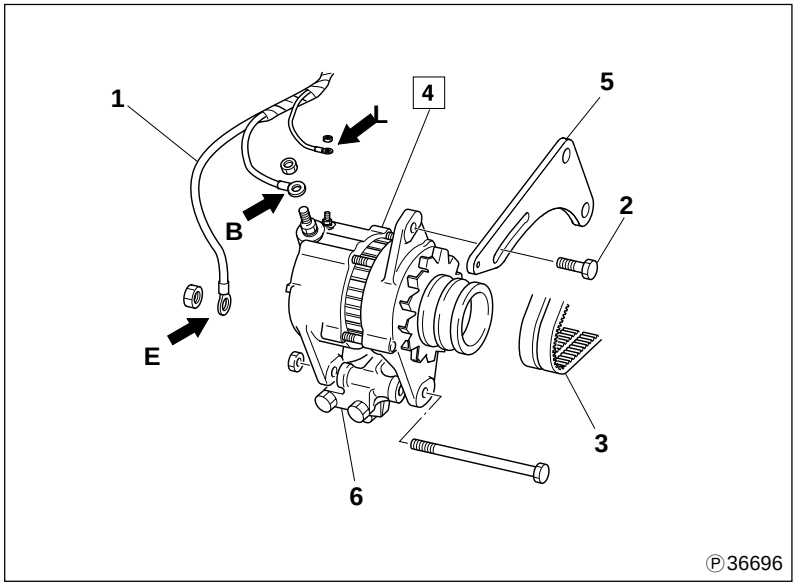
- Re-caulk the side of front bracket **38**.

NOTE

Do not re-caulk previously caulked points B.

A : Caulking points (4 points)

940 ALTERNATOR



● **Removal sequence**

1 Chassis harness
2 Adjusting bolt
3 V-belts
4 Alternator 🕮 P54-12-18
5 Adjusting plate
6 Alternator bracket

B : To terminal B
E : To terminal E
L : To terminal L

WARNING⚠

To prevent possible injury, be sure to disconnect the negative terminal ⊖ of the battery and insulate it with tape before removing alternator 4.
With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.

● **Installation sequence**

Follow the removal sequence in reverse.

● **Adjustment after installation**

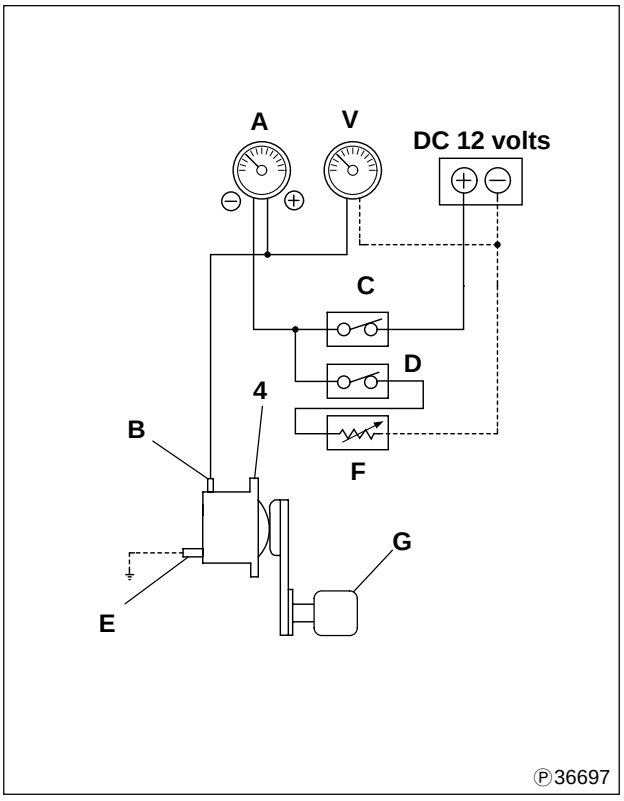
For adjustment of V-belt 3 tension 🗀 Gr 14

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
4	Alternator output current (*When alternator is hot and producing 13.5 V) at 25°C	At 1000 rpm	Approximately 20 A	—	Inspect
		At 2000 rpm	Approximately 80 A	—	
		At 3500 rpm	Approximately 100 A	—	
	Adjustment voltage of regulator (At 5000 rpm, 10 A is loaded) at 25°C		14.2±0.2 V	—	Replace

* The hot condition is the one after the alternator has been run at normal ambient temperature with 5000 rpm and maximum output for 30 minutes.

◆ Service procedure



4 Inspection of alternator

(1) Alternator performance check (bench test)

- Connect the alternator **4** as shown.

CAUTION⚠

Sufficiently thick wires should be used for wiring and each connection should be securely fastened.

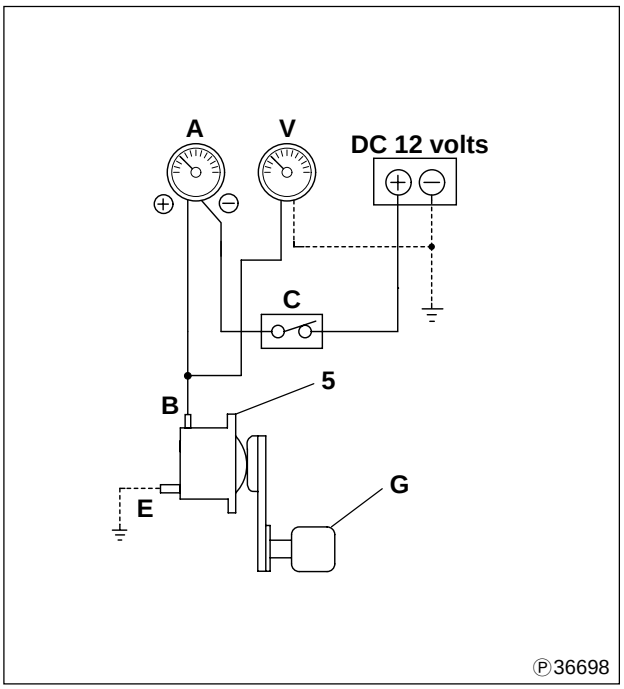
A : Ammeter
B : Alternator terminal B
C : Switch
D : Switch
E : Alternator terminal E
F : Load resistance (variable resistance)
G : Alternator drive motor
V : Voltmeter

- Increase load resistance **F** to the maximum (condition which the load current hardly flow).
- Turn switches **C** and **D** ON.
- Run alternator at 5000 rpm for 30 minutes by adjusting load resistance **F** so that electric current can conform to the specified standard.

Alternator nominal current

12V-100A

- Measure the current at each specified revolution of alternator **4**.
- If the measured value deviates from the standard value, disassemble and check alternator **4**. 📖 P54-12-18



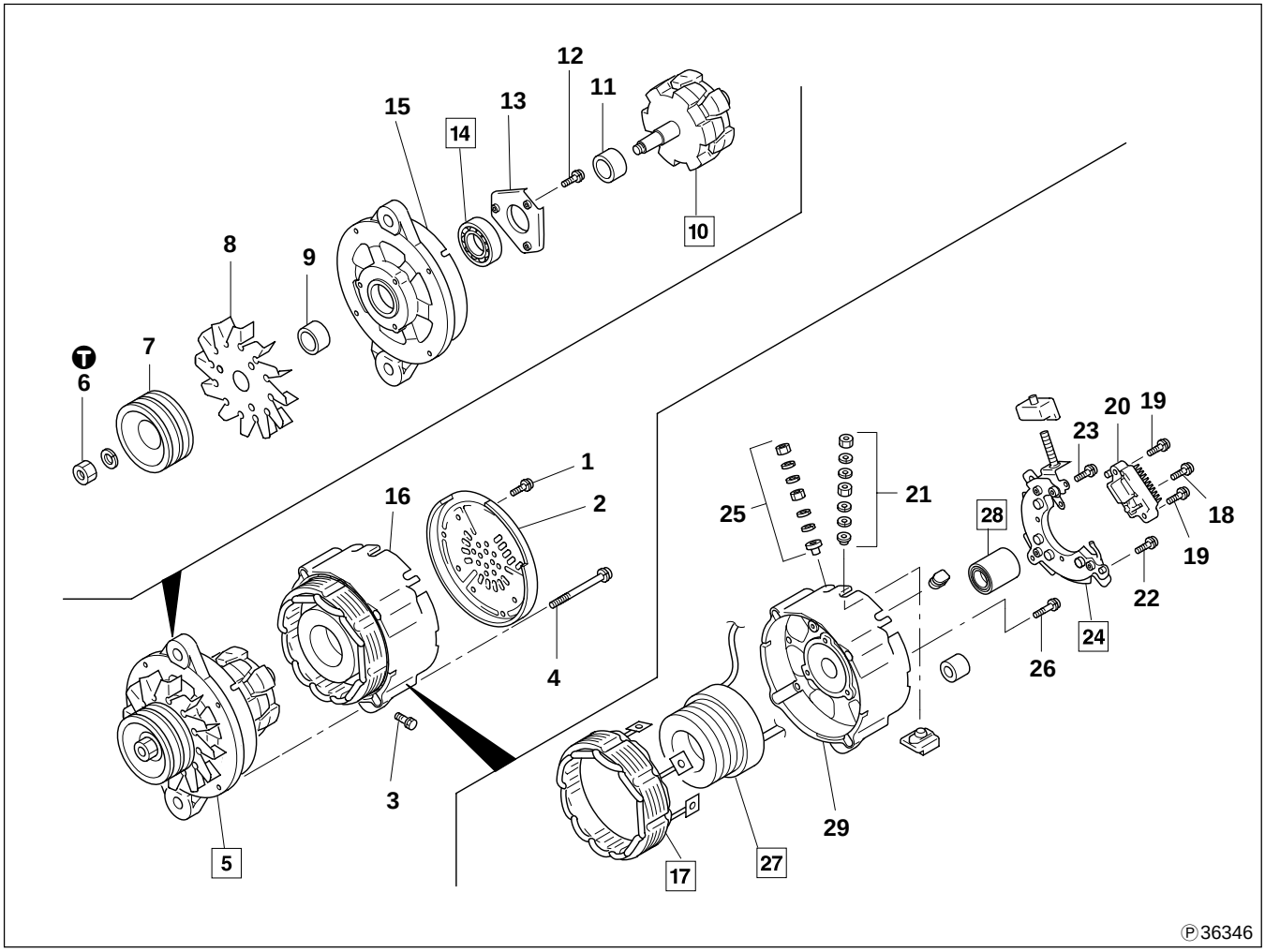
(2) Regulator performance check (bench test)

- Connect the alternator **4** as shown.

A : Ammeter
B : Alternator terminal B
C : Switch
E : Alternator terminal E
G : Alternator drive motor
V : Voltmeter

- Turn switches **C** ON.
- Run alternator **4** at low speeds.
- Increase the speed of alternator **4** to 5000 rpm and measure the voltage (adjustment voltage) at this speed. At the same time, make sure that the current is 10 amperes or less at 5000 rpm.
- If the measured value deviates from the standard value, do as follows:
  - If higher than the standard value: Replace the regulator.
  - If follow than the standard value: Inspect the alternator related parts before replacing the regulator.

940 ALTERNATOR



● **Disassembly sequence**

1 Screw
2 Rear cover
3 Screw
4 Bolt
5 Drive frame assembly
6 Nut
7 Pulley
8 Fan
9 Collar
10 Rotor
11 Collar
12 Screw
13 Bearing cover
14 Front bearing
15 Drive frame
16 Rear frame assembly
17 Stator
18 Screw
19 Screw
20 Regulator
21 Terminal **L**
22 Screw
23 Screw
24 Rectifier
25 Terminal **B**
26 Screw
27 Exciting coil
28 Rear bearing
29 Rear frame

NOTE

Do not remove parts 14, 28 unless they are faulty.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards

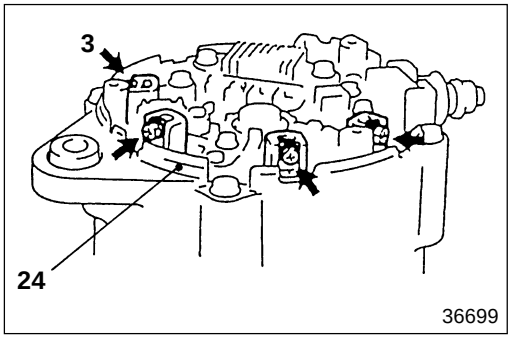
Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
10	Outer diameter of the portion that presses into the front bearing	25.00 to 25.01 {0.9842 to 0.9846}	24.99 {0.9838}	Replace
	Outer diameter of the portion that presses into the rear bearing	16.99 to 17.00 {0.6689 to 0.6693}	16.98 {0.6685}	
	Outer diameter of the portion that joins with the pulley	22.189 to 22.202 {0.8735 to 0.8741}	22.18 {0.8732}	
17	Resistance between the coil oultet terminals	0.01 to 0.10 Ω	—	Replace
	Resistance between the coil outlet terminal and core	1MΩ min.	—	
27	Resistance between the coil outlet terminal	2 to 3 Ω	—	Replace

Tightening torque

Unit : N·m {ft.lbs, kgf·m}

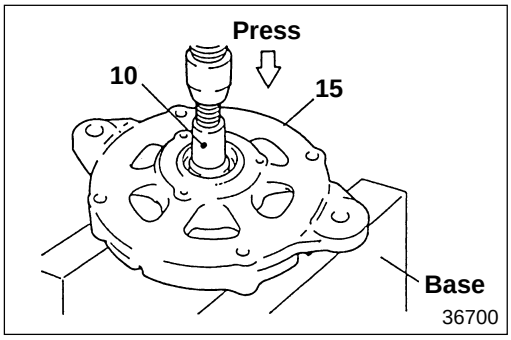
Location	Parts to be tightened	Tightening torque	Remarks
6	Nut (Pulley mounting)	117.6 to 137.2 {26 to 31, 12 to 14}	—



◆ Service procedure

5 **Drive frame assembly**

Remove screw **3** and separate the stator **17** outlet terminal and the rectifier **24**.



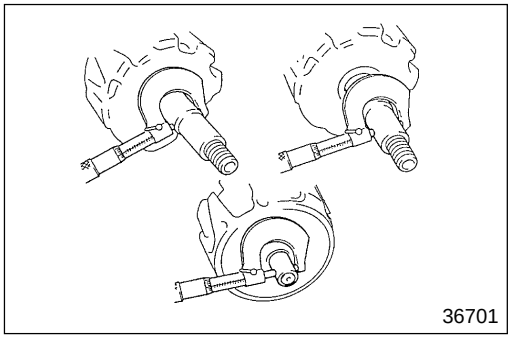
10 **Rotor**

[Removal]

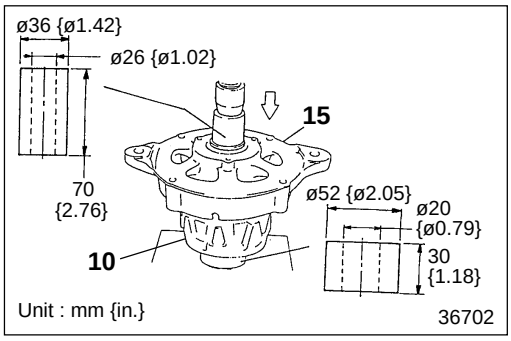
Using a press, remove the rotor **10** from the drive frame **15**.

CAUTION⚠

Do not drop the rotor 10.



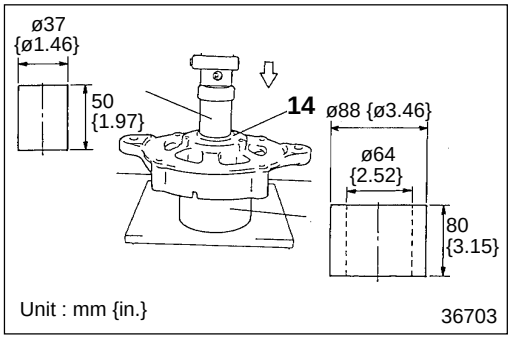
[Inspection]
- Measure the outer diameter of the portion as shown.
- If the measured value deviates from the standard value, replace the rotor **10**.



[Installation]
Using a press, press the rotor **10** into the bearing in the drive frame **15**.

CAUTION

Press the rotor 10 while making sure that the rotor's shaft is perpendicular to the bearing. During pressing, make sure not to damage the portion of the rotor 10 that presses into the rear bearing 28.

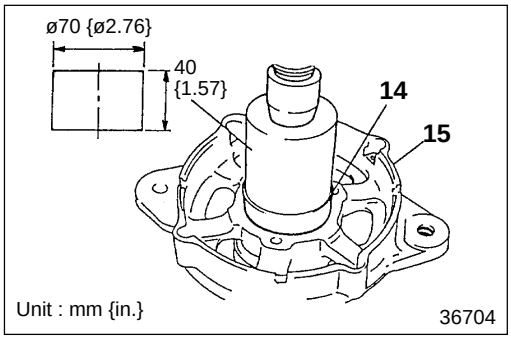


14 **Front bearing**

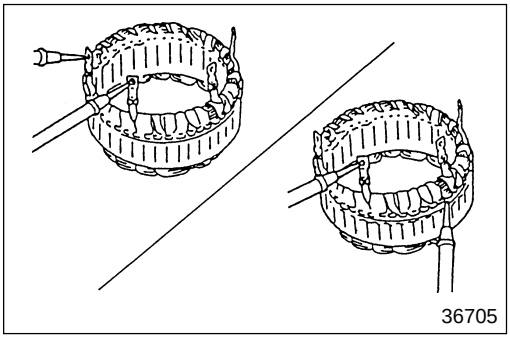
[Removal]
Using a press, remove the front bearing **14** from the drive frame **15**.

CAUTION

Do not drop the front bearing 14.

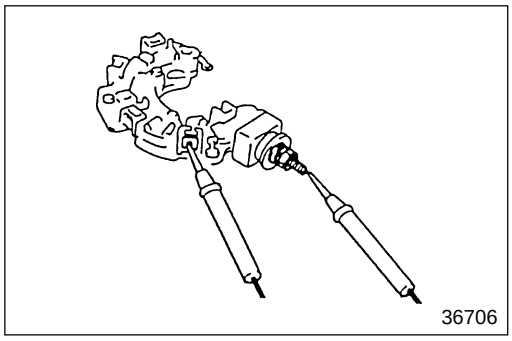


[Installation]
Using a press, press the front bearing **14** into the drive frame **15**.



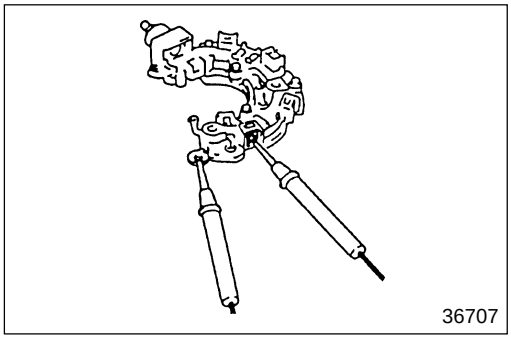
17 **Inspection of stator**

- Measure the resistance between the coil outlet terminals. (using a circuit tester)
- Measure the resistance between the coil outlet terminal and core. (using a megger tester)
- If the measured value deviates from the standard value, replace the stator **17**.

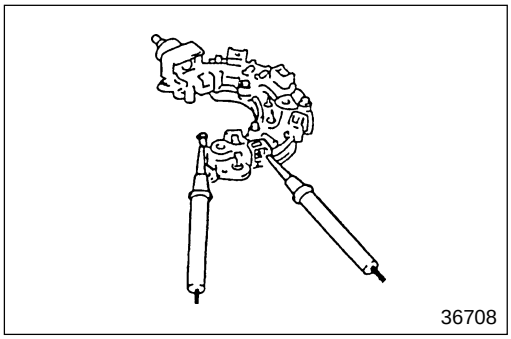


24 **Inspection of rectifier**

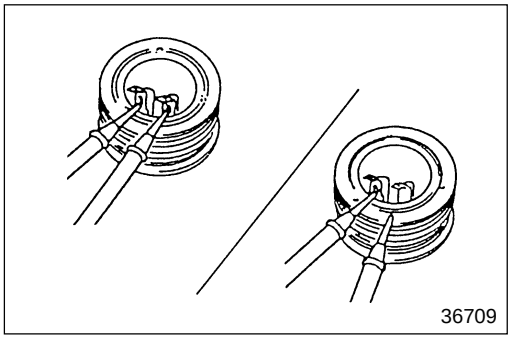
- Check for continuity between the terminal **B** and the heat sink.
- When polarity is changed, there is continuity in one direction but not in the opposite direction.



- Check for continuity between the terminal ⊖ and the heat sink.
- When polarity is changed, there is continuity in one direction but not in the opposite direction.

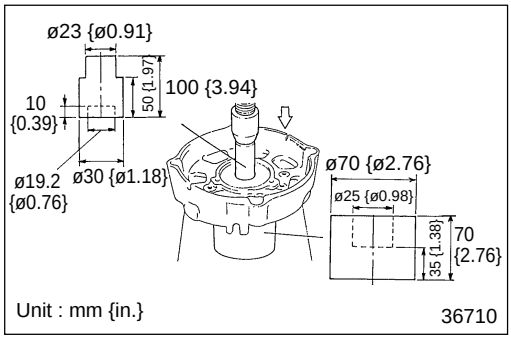


- Check for continuity between the auxiliary diode terminal and the heat sink.
- When polarity is changed, there is continuity in one direction but not in the opposite direction.



27 **Inspection of exciting coil**

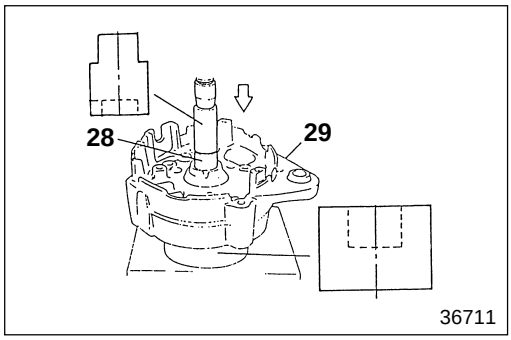
- Measure the resistance between the coil outlet terminal. (using a circuit tester)
- Measure the resistance between the coil outlet terminal and core.
- If the measured value deviates from the standard value, replace the exciting coil **27**.



28 **Rear bearing**

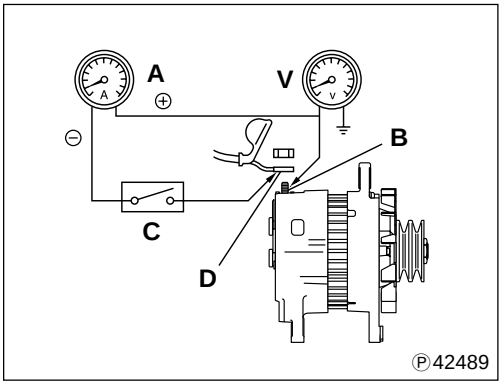
[Removal]
Using a press, remove the rear bearing **28** from the rear frame **29**.

CAUTION
Do not drop the rear bearing 28.



[Installation]
Using a press, press a new rear bearing **28** into the rear frame **29**.

CAUTION
Once a bearing is removed, do not reuse it.



Performance test

- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING⚠

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn on switch **C** and make sure that voltmeter **V** indicates battery voltage.
- Start the engine.
- Immediately turn on the switches for all lamps on the vehicle.
- Immediately accelerate the engine to the speed indicated below and measure the alternator's output current.

Engine speed	Approx. 2400 rpm

- The alternator is considered to be good if the measured value is 70% or more of the nominal output current.
  Alternator nominal output

Voltage	Output current
12V	100A

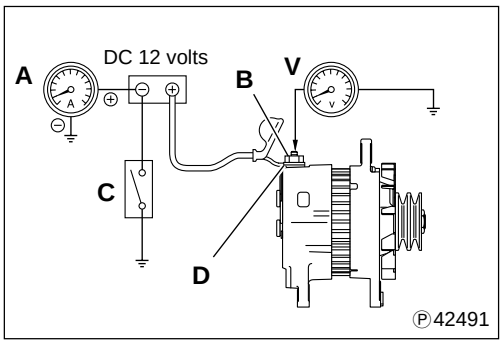
NOTE

The on-vehicle inspection is only a simplified check. Use a test bench for accurate checking. 🕮 940

951 INSPECTION OF REGULATOR

Service standards

Location	Check item	Standard value	Limit	Remedy
—	Regulator adjusting voltage	14.2±0.2V	—	Replace



- Connect the meters to the alternator as shown.

  A : Ammeter (100 amperes class)
  B : Alternator terminal B
  C : Switch
  D : Terminal
  V : Voltmeter

WARNING⚠

- **To prevent possible injury, be sure to disconnect the negative terminal of the battery and insulate it with tape before working on the wiring. With the negative terminal ⊖ of the battery connected, battery voltage is always applied to the terminal B.**
- **To connect to switch C, use a lead wire with the same or larger diameter than that of the chassis harness connected to terminal B.**

- Turn off the switches for lamps, heater, etc. so that electric loads may not be applied during the inspection.
- Turn on switch **C** and then start the engine.
- If the output current is 10 amperes or less when the engine speed is raised to the appropriate speed indicated below, then measure the voltage at terminal **B**.

Speed (rpm)
Approx. 2400

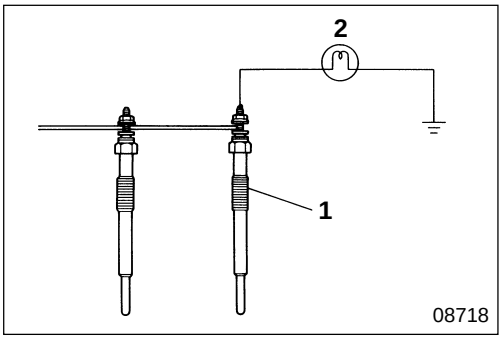
- If the output current is 10 amperes or more, do one of the following:
  - Run the engine for a while to charge the battery.
  - Replace the battery with a fully-charged one.
- If the measured value deviates from the standard value, conduct checking again on the test bench.

13 ON-VEHICLE INSPECTION AND ADJUSTMENT

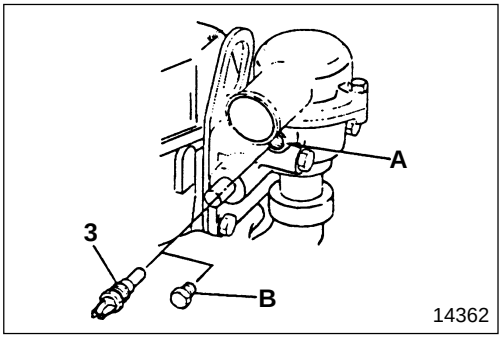
955 INSPECTION OF PREHEATING SYSTEM

Service standards

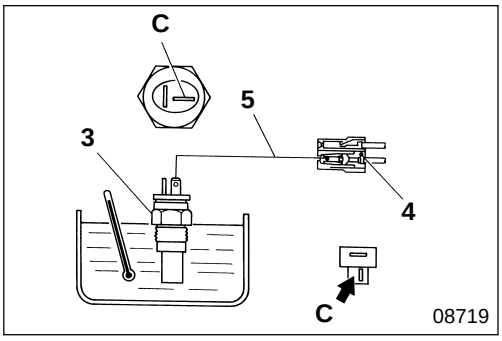
Location	Maintenance item			Standard value	Limit	Remedy
—	Pre-glow time	Coolant temperature	60°C {140°F} or more	Does not pre-glow	—	Inspect
			0 to 60°C {32 to 140°F}	About 12 seconds	—	
			0°C {32°F} or less	About 12 seconds	—	
	After-glow time	Coolant temperature	60°C {140°F} or more	Does not after-glow	—	
			0 to 60°C {32 to 140°F}	Does not after-glow	—	
			0°C {32°F} or less	About 20 seconds	—	
	Indicator lamp ON time	Coolant temperature	60°C {140°F} or more	Does not illuminate	—	
			0 to 60°C {32 to 140°F}	Does not illuminate	—	
			0°C {32°F} or less	About 8 seconds	—	



- Turn the starter switch to OFF.
- Connect a check lamp **2** to the glow plug **1** as shown.



- Remove the water temperature sensor **3** from the engine, and close the sensor mounting hole **A** with the plug **B** (M16 × 1.5 mm).
  Removal and installation of the water temperature sensor **3** Gr 14



- Connect the extension harness **5** between the water temperature sensor **3** and connector **4**.

NOTE

Connect the extension harness 5 to the terminal C on the MUTIC (multipurpose timing control unit).

- Put water temperature sensor **3** into a container filled with water.
- Carry out the following inspection while changing the water temperature in the container. If any fault is found, inspect each unit.

(1) Inspection of pre-glow time and indicator lamp lighting time

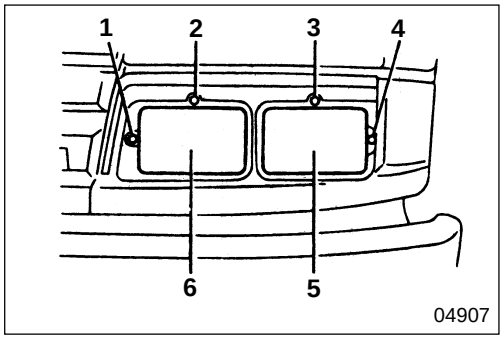
Turn the starter switch ON but do not start the engine. Make sure that the pre-glow time and the indicator lamp lighting time at each water temperature conform to the standard value.

- For pre-glow time inspection, measure the lighting time of inspection lamp **2**.
- For indicator lamp lighting time inspection, measure the lighting time of lamp within the meter cluster directly.

(2) Inspection of after-glow time

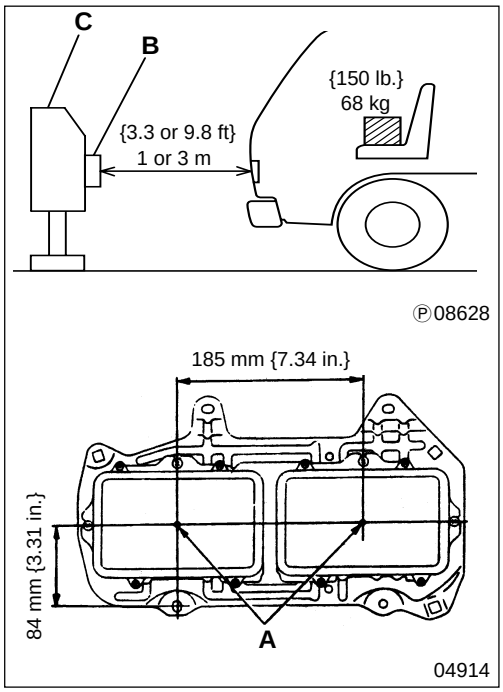
Start the engine and measure the lighting time of inspection lamp **2** from the point lamp within the meter cluster goes off, and make sure that the after-glow time conforms to the standard value.

960 HEADLAMP AIMING



1 Screw (Main beam, horizontal adjustment)
2 Screw (Main beam, vertical adjustment)
3 Screw (Dipped beam, horizontal adjustment)
4 Screw (Dipped beam, vertical adjustment)
5 Dipped beam
6 Main beam

To adjust the headlamp move the optical axis of Main beam **6** by turning screws **1, 2** and move the optical axis of Dipped beam **5** by turning screws **3, 4**. You need to adjust the aiming of both the Main and the Dipped beams on both the left and right headlamps.



(1) Preparation before adjustment

- Park the vehicle on a level place.

WARNING

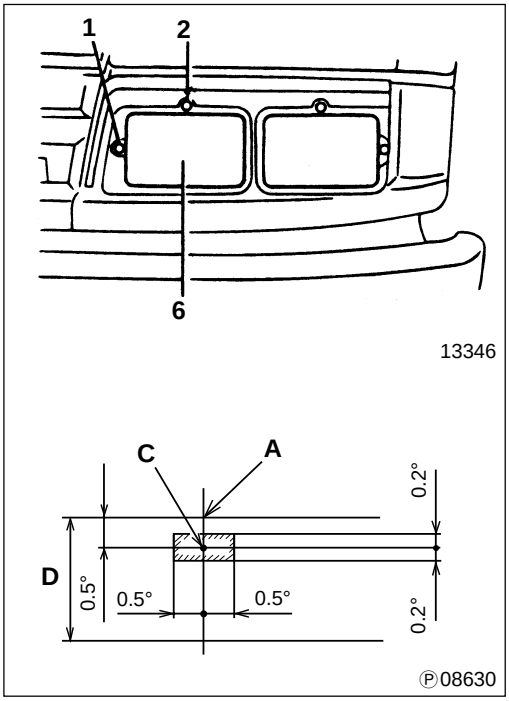
Be sure to put tire chocks securely in place.

- Unload the vehicle and make sure no one is in it.
- Inflate the tires to the specified pressure. Gr 31
- Seat one person of an equivalent mass (68 kg {150 lb.}) in the vehicle
- Start the engine and check that the battery is being charged.
- Place convergent headlamp tester **C** in line with Main beam **6** or Dipped beam **5** of either the left or right headlamp at a distance of 1 m {3.3 ft.} or 3 m {9.8 ft.}.
- Align the center of convergent lens **B** of convergent headlamp tester **C** with lamp center **A** of Main beam **6** or Dipped beam **5**. (The illustration shows a left headlamp.)
- When adjusting one headlamp, mask the other to avoid light leakage.

(2) Adjustment

WARNING

Do not mask a lit headlamp for more than 10 minutes or the heat generated might cause a fire.



● **Adjustment of Main beam unit**

- Turn on Main beam **6**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Main beam **6** is located as shown:
  - Vertical adjustment: Turn screw **2** to adjust.
  - Horizontal adjustment: Turn screw **1** to adjust.

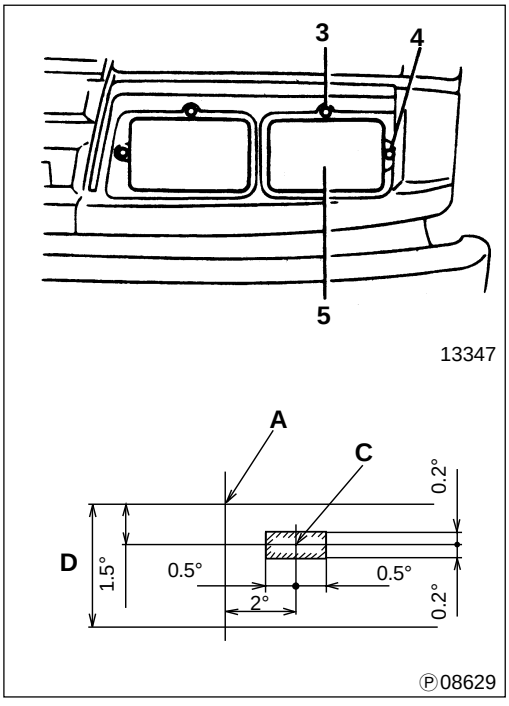
  The aiming of both left and right Main beams **6** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of headlamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 1	—	—	(Counter-clockwise)	(Clockwise)
Screw 2	(Clockwise)	(Counter-clockwise)	—	—

Turning direction of the screws in the table is as viewed from the front.



● **Adjustment of Dipped beam unit**

- Turn on the LOW beam of Dipped beam **5**.
- Adjust as follows so that the optical axis (max luminous illumination point) **C** of Dipped beam is located as shown:
  - Vertical adjustment: Turn screw **3** to adjust.
  - Horizontal adjustment: Turn screw **4** to adjust.

  The aiming of both left and right Dipped beams **5** should be adjusted to the position as shown.

▨ : Tolerance of adjustment

A : Center of lamp
D : Height from the ground to headlamp center

	Adjusting direction for optical axis			
	Upward	Downward	Leftward	Rightward
Screw 3	(Clockwise)	(Counter-clockwise)	—	—
Screw 4	—	—	(Clockwise)	(Counter-clockwise)

Turning direction of the screws in the table is as viewed from the front.

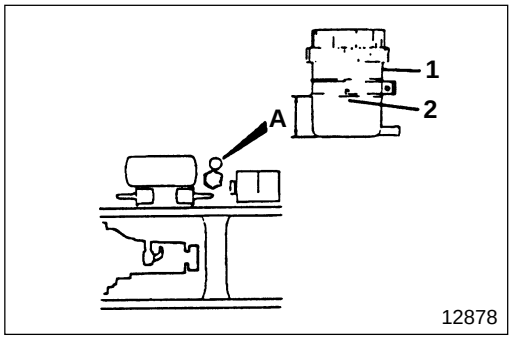
965 INSPECTION OF BRAKE FLUID LEVEL SWITCH

< Center parking >

Service standards

Unit : mm {in.}

Location	Maintenance item	Standard value	Limit	Remedy
—	Warning lamp lighting position for brake fluid level switch	$57^{+3.5}_{-0.5}$ {$2.24^{+0.14}_{-0.02}$}	—	Replace



- Start engine.
- Drain the brake fluid gradually from fluid tank assembly **1**.

CAUTION

If brake fluid is spilt on any part of the vehicle, wipe it off immediately, since the solvent in the fluid can damage the paintwork.

- Measure height **A** of brake fluid level switch **2** when BRAKE FLUID warning lamp within the meter cluster lights.
- If the measured value deviates from the standard value, remove and check fluid tank assembly **1**.

Removal and installation : Gr 35A
Inspection : 041

MITSUBISHI
FUSO

Group 55A
Air-conditioner

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-55A

FOREWORD

This service manual describes the maintenance data consisting of construction & outline, inspection, and repair service of MITSUBISHI FUSO GENUINE TRUCK CAB AIR CONDITIONER

Table of contents

1. SPECIFICATIONS ---- 1
2. OUTLINES OF REFRIGERATION SYSTEM ---- 2
3. CONSTRUCTION ---- 4
4. TROUBLE SHOOTING ---- 11
5. REMOVAL AND INSTALLATION ---- 18
6. TREATMENT AFTER INSTALLATION ---- 21
7. MAINTENANCE ---- 27
8. COOLING UNIT ASSEMBLY ---- 28
9. COMPRESSOR & CLUTCH ASSEMBLY ---- 30

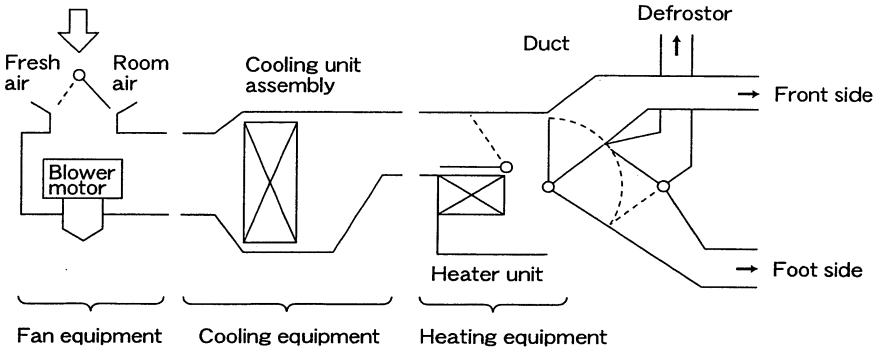
1. SPECIFICATIONS

Item			Specification
Vehicle model			FK/FM
* Cooling capacity (on JIS conditions)			4,650W
Compressor	Model		MSC90T
	Displacement		90㎤
	Maximum revolution		MAX 9000min^{-1}
	Compressor oil		SUN PAG 56, 120㎤
Magnetic clutch	Type		Dry single disc magnet
	Voltage & input		DC12V, 45W
Cooling unit assembly	Type		Laminated fin type
Controls	Air flow control		Slide switch, Four step type
	Temperature control		Electric thermostat
Condenser	Type		Corrugate fin type
Receiver assembly			Cylinder type, approx 300㎤
Protective equipment	Frost prevention (Thermostat)		OFF : 1.6℃ ON : 4.6℃
	Releif valve		Open : 3.50~4.10MPa Close : 2.94MPa
	Dual pressure switch	Low pressure switch	OFF : 0.20MPa ON : 0.225MPa
		High pressure switch	OFF : 2.94MPa ON : 2.35MPa
	Fuse (Fan equipmemt) Fuse (Magnetic clutch)		10A 10A
Refrigerant and quantity			HFC-134a, 740g

- The * marked cooling capacity is based on JIS conditions.
- Compressor speed : 1,800min^{-1}
- Condensing temperature : 55℃
- Cooling unit inlet air dry bulb temperature : 27℃DB
- Cooling unit inlet air wet bulb temperature : 19.5℃WB
- Terminal voltage :DC24V

2 . OUTLINES OF REFRIGERATION SYSTEM

2.1 Air system



Cooling operation

Fresh air is induced to the cooling unit assembly by a blower fan, where it is cooled down and dehydrated, charged at the front side outlet through a duct.

Heating operation

Fresh air is induced to the heater unit by a blower fan through the cooling unit assembly, where it is heated, then discharged at the foot side outlet through a duct.

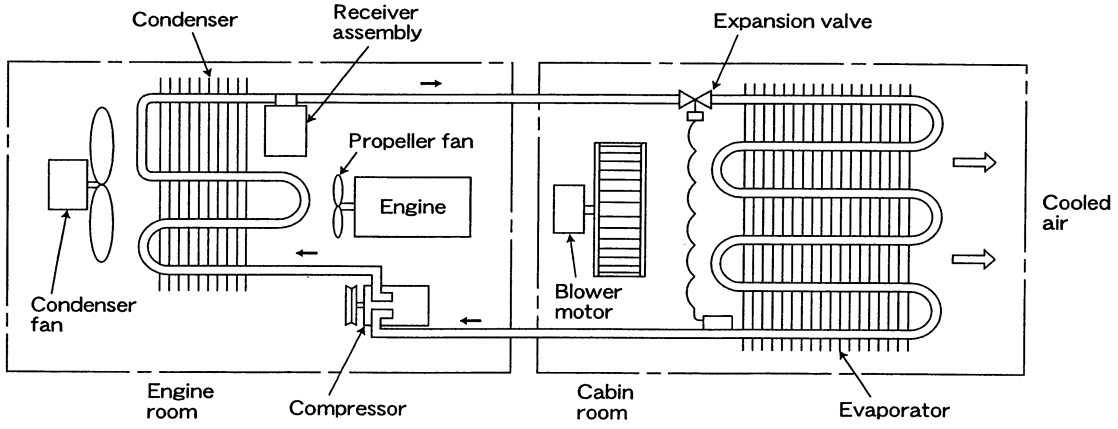
Dehumidifying operation

Fresh air is induced to the cooling by a blower fan, where it is cooled down and dehydrated, and succeedingly to the heater unit for warming, then discharged at the front side outlet through a duct.

Temperature control

Cooled air and warmed air are mixed for temperature control of the room inside.

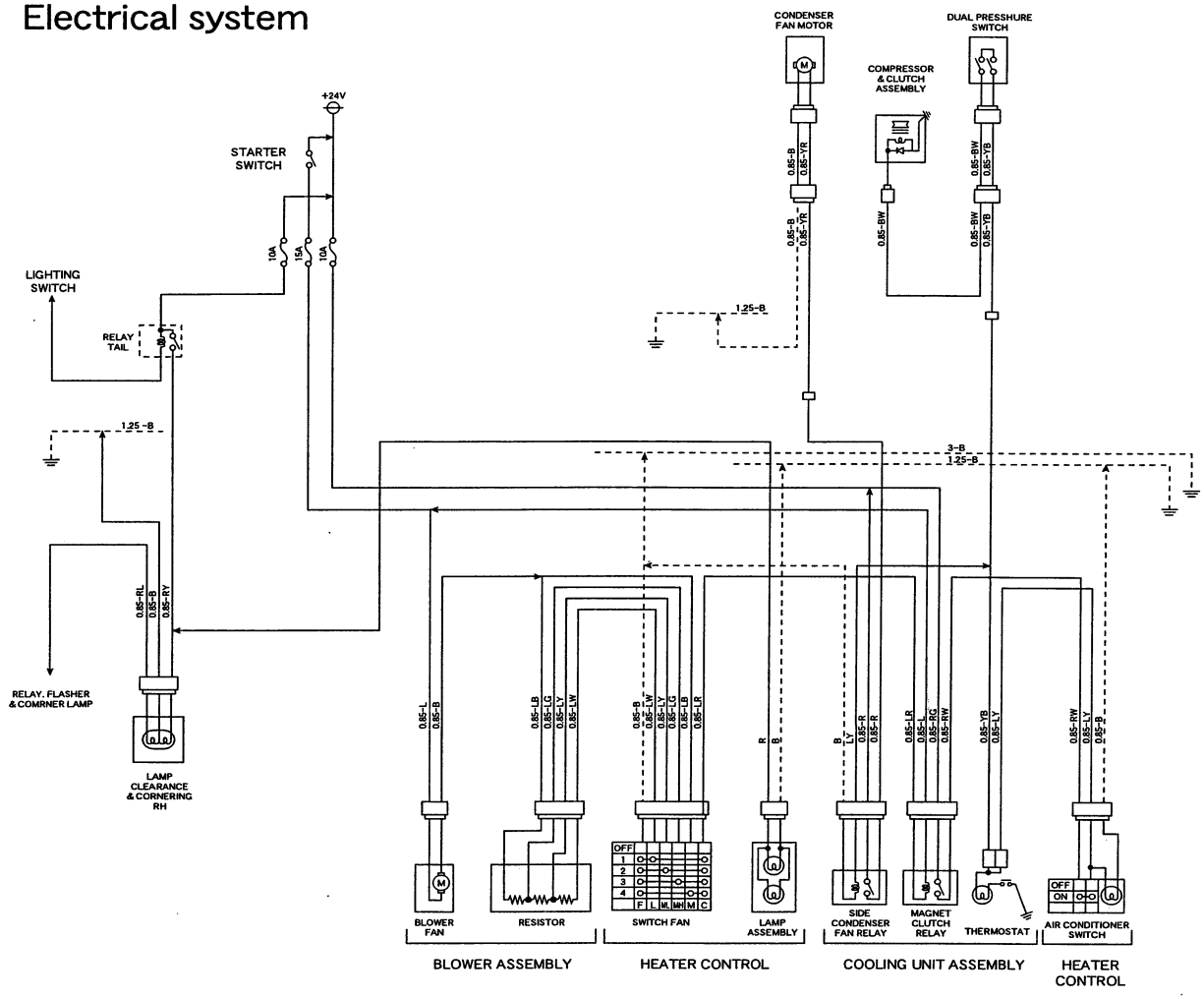
2.2 Refrigerating circuit



While the refrigerant, HFC-134a is cooling the air drawn into the evaporator, it evaporates and becomes a gas. This gas is compressed to high pressure and temperature in the compressor, and sent into the condenser, where it is cooled and becomes liquid.
This cooling in the condenser is carried out by the open air passing through the condenser sucked by radiator fan and vehicle motion of the vehicle.
The liquid refrigerant flows through the receiver assembly where water and dirt are removed, and then it enters the expansion valve. Here the liquid refrigerant is throttled and changed to a mixture of liquid and gas in low temperature and low pressure, and is sent to the evaporator.

In the evaporator, the refrigerant absorbs heat from the surroundings and becomes a gas. That is, because the evaporator it self is cooled at this time, the return air to the cooling unit assembly is cooled,
and the interior of the vehicle becomes cool. In this way the refrigerant flow makes a complete circuit.

2.3 Electrical system

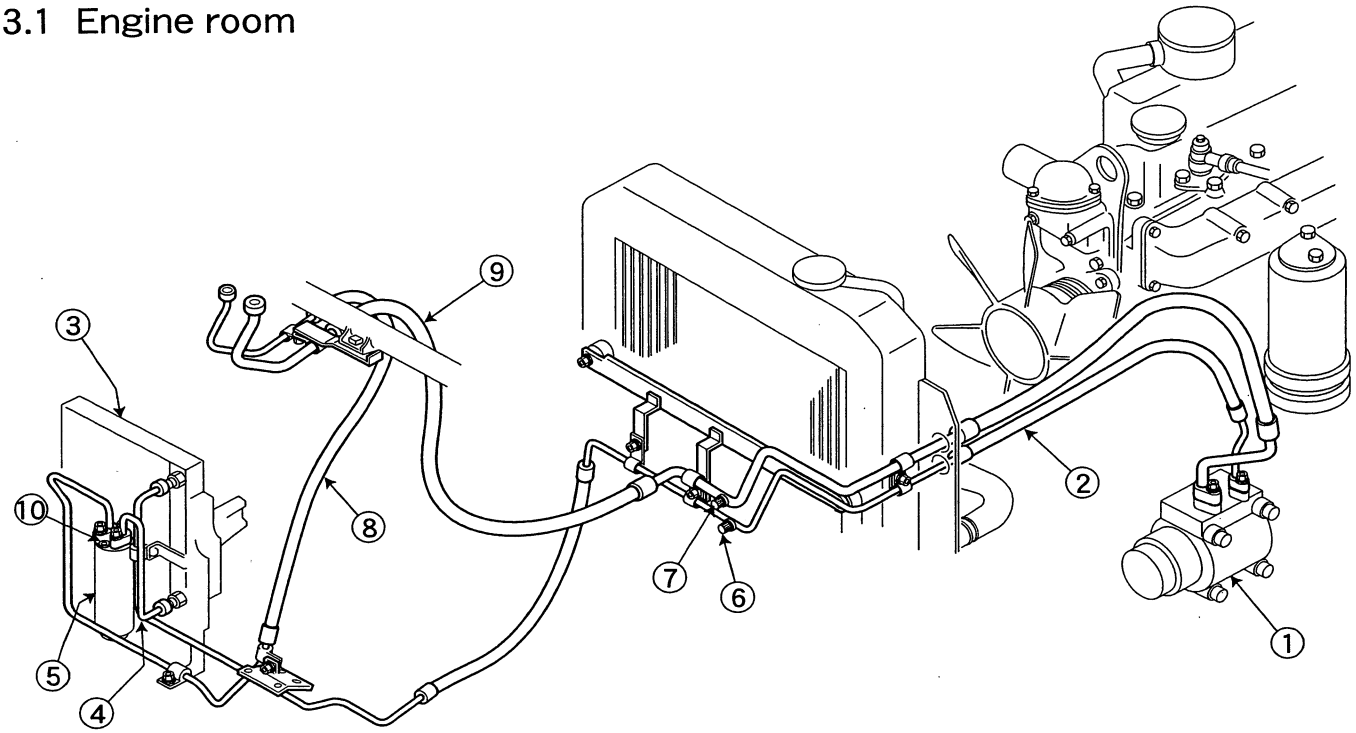


The power source is supplied from the TRUCK battery. When the blower switch is put ON, the power relay becomes ON, and electricity is connected to the magnetic clutch of the compressor. The magnetic clutch switches ON or OFF by air conditioner switch, fin thermo, and low pressure switch as the controls for operation service, or safety protection.

The cabin room air temperature is set to a preset point by adjusting the temperature control lever, and the opening degree of the air mix damper.

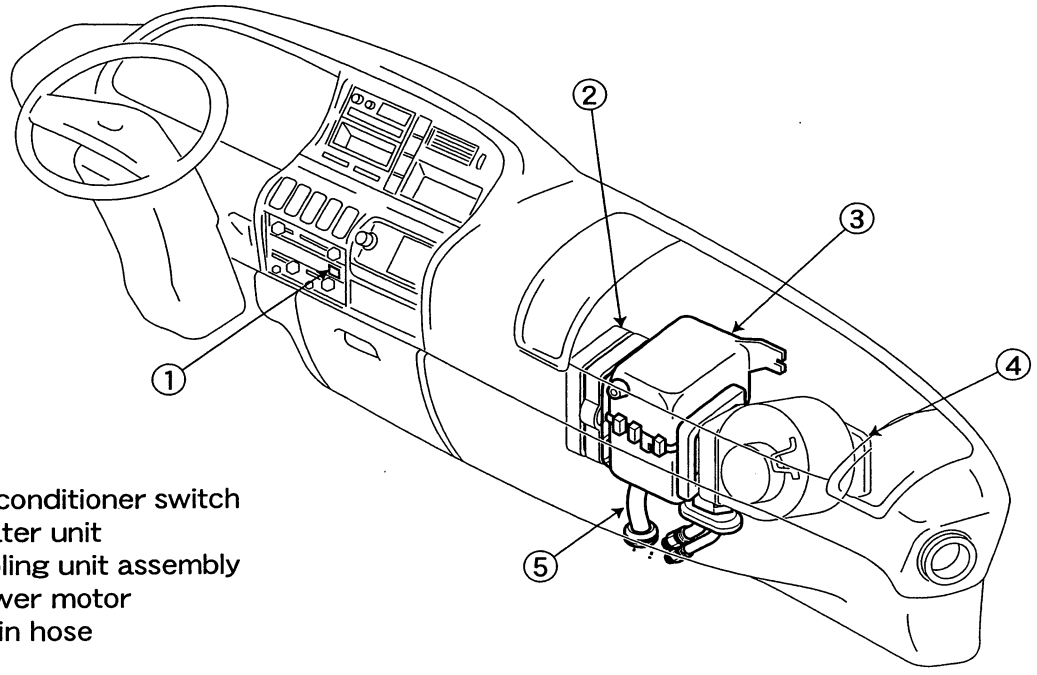
3 . CONSTRUCTION

3.1 Engine room



① Compressor & clutch assembly
② Discharge hose
③ Side condenser assembly
④ Pipe (LQ)
⑤ Receiver assembly
⑥ Check valve (HP)
⑦ Check valve (LP)
⑧ Liquid hose
⑨ Suction hose
⑩ Sight glass

3.2 Cabin room



① Air conditioner switch
② Heater unit
③ Cooling unit assembly
④ Blower motor
⑤ Drain hose

3.3 Control system

(1) Control in panel

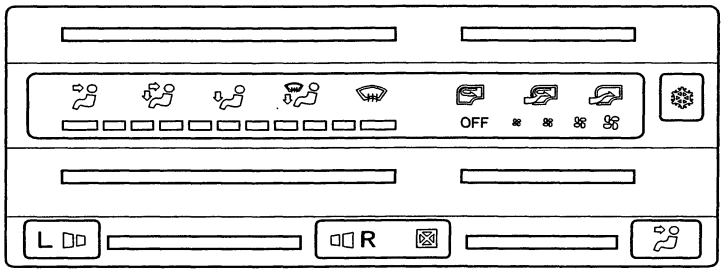
☐ Air outlet mode select switch
The air outlet is selected by positioning in cooling and heating operation.

- ----- The conditioned air is discharged at the center and both side outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the center and both side and foot outlets directed by the louvers as reguired.
- ----- The conditioned air is discharged at the foot outlets directed by the louvers as reguired.
- ----- The conditioned air for dehumidifying is discharged at the foot outlets and to the front glass.
- ----- The conditioned air for dehumidifying is discharged to the front glass.

☐ Air circulation shift lever
The recirculation air is selectable out of the below circulation models.

- ----- ROOM AIR CIRCULATION
- ----- ROOM AIR CIRCULATION AND FRESH AIR INTAKE
- ----- FRESH AIR INTAKE

☐ Air conditioner switch
By pushing the air conditioner switch initially in cooling or drying operation, the compressor starts running.
By pushing it secondarily, the compressor stops.



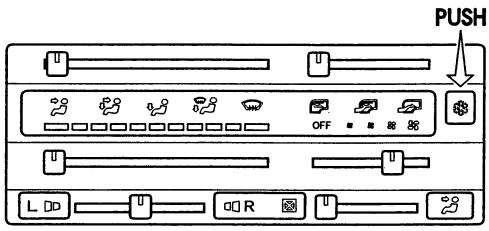
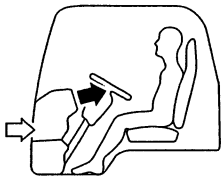
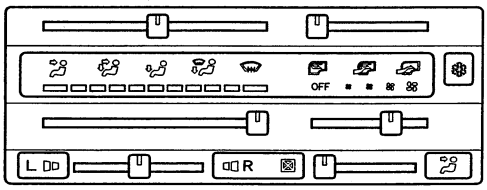
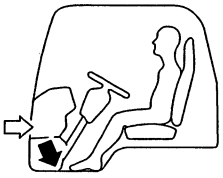
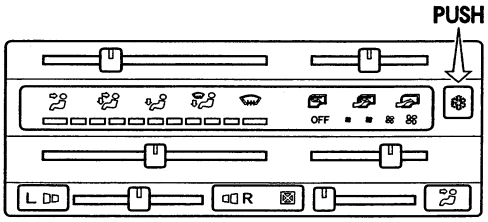
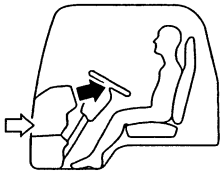
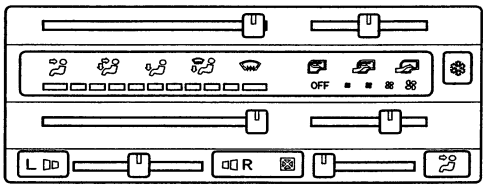
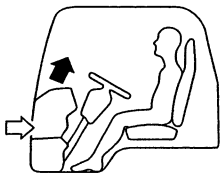
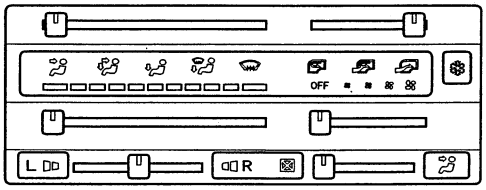
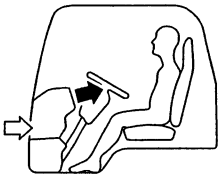
☐ A lager volume of air is discharged to the driver's feet.
R ----- Evenly to the left and right.
L ----- A lager flow to driver's feet.

☐ Temperature control switch
The discharged air temperature is controllable by selecting the position of the control lever in cooling, heating or drying operation.
BLUE ZONE ------ For cool air blow
WHITE ZONE ----- For dry air blow
RED ZONE ------- For warm air blow
By moving the lever toward the BLUE and RED ZONE sides, the supply air temperature becomes more cooler and warmer respectively.

☐ Fan switch
The air flow is selectable, out of the below four volume.
OFF ------- No air flow
------- Gentle
------- Low
------- Medium
------- High

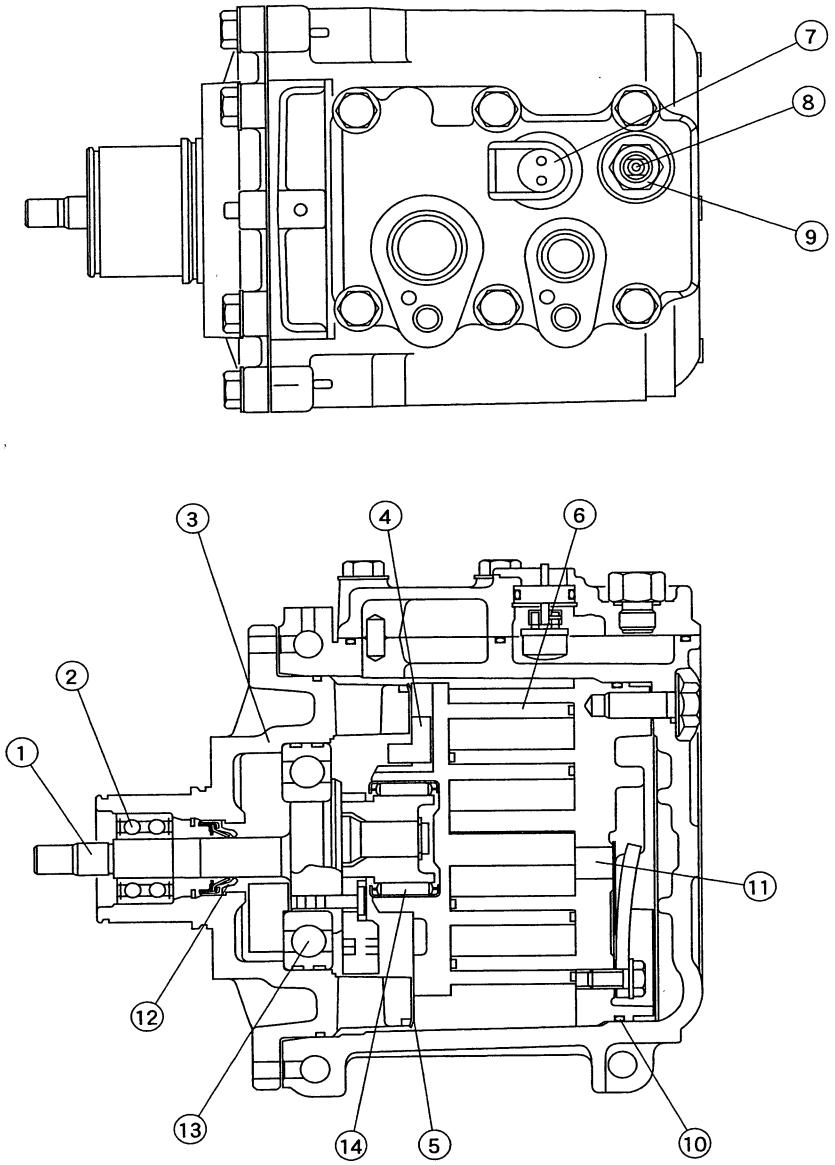
☐ Cool air lever
While heating the vehicle with the air outlet shift lever is set to the , or position, cool air can be flowed out from the ventilator to get rid of a glow in the upper half of the body.
Cool air does not flow out when the lever is in the position.

(2) Operation control

Operation mode	Setting control lever	Air delivery	Remarks
COOL			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation
HEAT			Earlier cooling service, or conditioning at dusty, polluted air prevailing places : Shift lever : Air circulation Air outlet mode select switch
DEHUMIDIFY			Wetty conditioning in head cooled, and foot warmed : Shift lever : Air outlet Air outlet mode select switch
DEFROST			
VENTILATION			

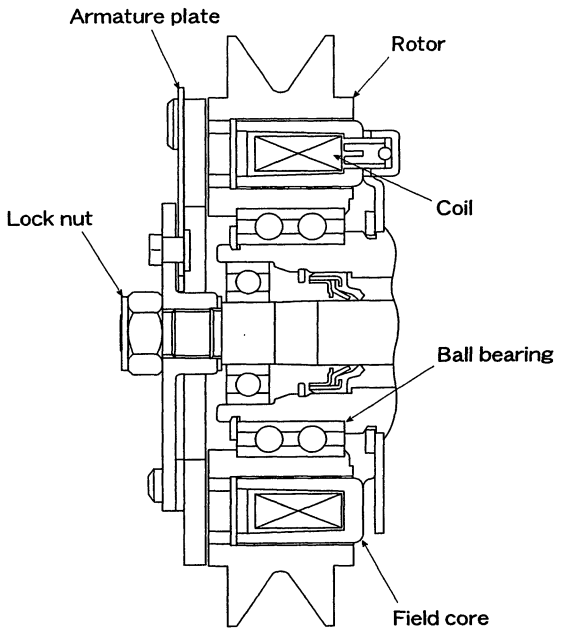
3.4 Compressor and clutch assembly

3.4.1 Compressor



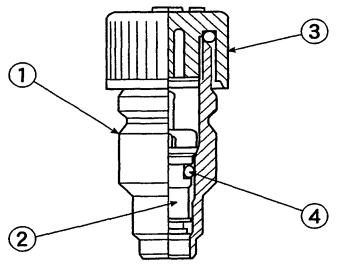
① Crankshaft
② Bearing
③ Front case assembly
④ Housing assembly
⑤ Thrust plate
⑥ Orbit scroll assembly
⑦ Thermostat
⑧ Dust seal
⑨ H/P relief valve
⑩ O-ring
⑪ Port hole
⑫ Shaft seal
⑬ Bearing
⑭ Needle bearing

3.4.2 Magnetic clutch



The magnetic clutch is mounted on the compressor crankshaft to start and stop the compressor.
This means that the magnetic clutch is actuated to control the compressor operation electrically by the thermostat.

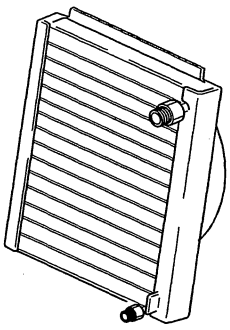
3.5 Check valve



① Valve body ③ Cap
② Valve core ④ Packing

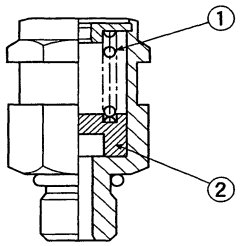
The suction hose and discharge hose are provided with check valve, and designed for gas evacuation and charging service. (shown above)
In the valves, a valve rubber tube, as in automobile tire tubes, is provided as shown in the figure.
Stackening the flare nut on the gauge manifold causes the passage to close automatically by the spring force, and tightening the flare nut causes the passage to open while pressing the compressed spring.

3.6 Side condenser assembly



The condenser is a means to liquefy the refrigerant gas. As the condenser is cooled by the air pulled in by the condenser fan, the refrigerant in the condenser is cooled into liquid. Therefore, when any obstacle prevents the air from flowing evenly to the condenser or the air flow is short circuited, the cooling effect is reduced, with a decrease in the performance of the condenser. When the vehicle is driven at a high speed, the air flow increases resulting in an increase of the cooling effect, and performance of the condenser.

3.7 Relief valve



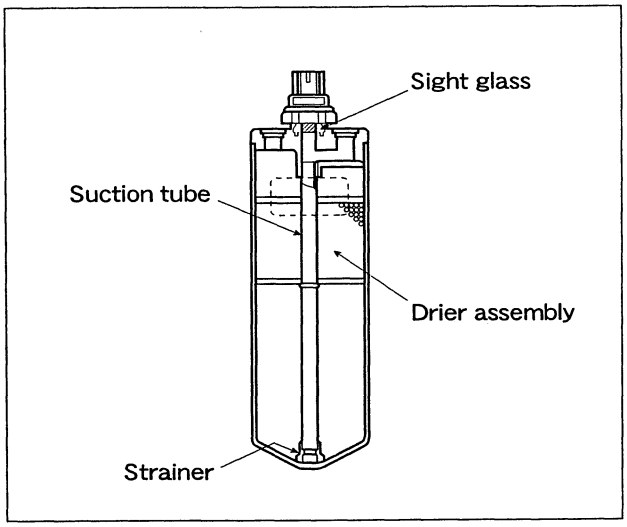
① Spring ② Valve

The relief valve is mounted to the compressor & clutch assembly. The relief valve is usually closed by spring.
If pressure of refrigerant in air conditioner system is higher than spring pressure, refrigerant is discharged from relief valve. The pressure drop due to discharge refrigerant, and relief valve is closed again.

Unit : MPa

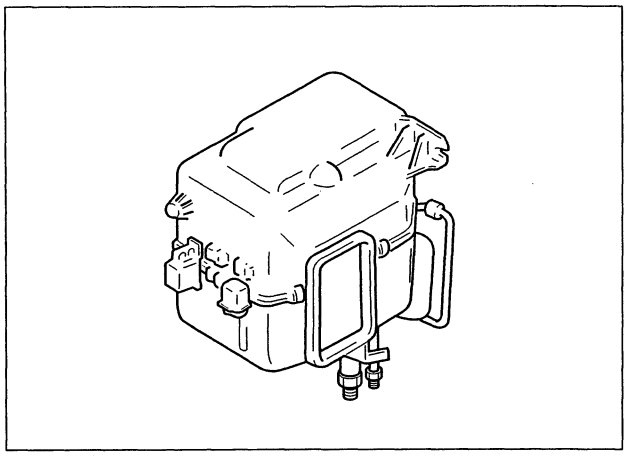
Open	3.50~4.10
Close	2.94

3.8 Receiver assembly



The receiver assembly is served as a refrigerant reservoir located between the condenser and expansion valve. The receiver assembly consists of a filter and a sight glass. The filter is used to remove dust , the drier is used to remove moisture from the refrigerant in the circuit, and the sight glass is used to check the refrigerant charge. Any moisture in the refrigerant may not only corrode metal surfaces in the refrigerant circuit, but also cause the throttle of the expansion valve to be frosted, resulting in the interruption of refrigerant circulation.
Therefore, the receiver assembly must be handled very carefully. When storing or installing it, care should be taken to protect it from the deterioration of drying performance due to exposure to the air.
The retardation of heat exchange, or any fire around the refrigerant circuit will cause excessive pressurization or heating of the refrigerant. Should such an accident occur, the refrigerant in the circuit must be expelled to the outside to prevent the above hazards.
The sight glass is a sort of peep window used to check the refrigerant flow in the refrigerant circuit.
The sight glass appears clear when the refrigerant flow is enough, and shows bubbles flowing when the refrigerant flow is short.

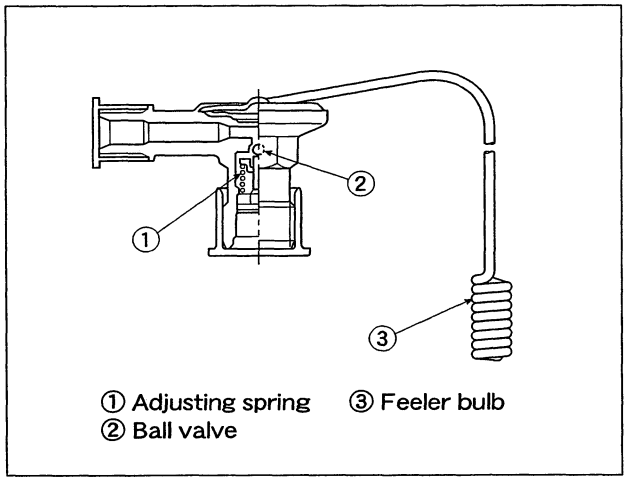
3.9 Cooling unit assembly



The evaporator core is a type of corrugated fin and tube. The tube is arranged in zigzag to achieve high effciency, and to make the core system compact.
A thicker reinforced plastic plate is used as the enclosure to inclease heat and shock resistance, and to protect the core from humidity. This case is a split type, and in a simple design to facilitate installation on the floor panel and the instrument panel frame of the vehicle.

3.10 Expansion valve

The expansion valve is mounted at the inlet of the cooling unit. The liquid refrigerant from the receiver is led to it through a narrow passage (for throttle action), where-in, the liquid refrigerant is condensed with pressure dropping and at the same time the flow rate is adjusted before the refrigerant is sent to the cooling unit.
The refrigeration load in the cooling unit is not constant, but usually fluctuates over a certain range. So the refrigerant flow should under go the control in design.
An automatic expansion valve performs this function automatically. The air condenser uses a thermal type automatic expansion valve.

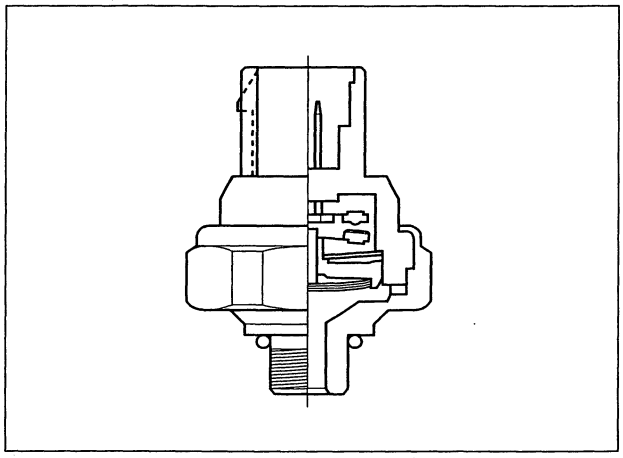


3.11 Dual pressure switch

The dual pressure switch, fixed to the receiver functions as a protector for stopping the compressor (OFF) at a preset value of pressure in the refrigerant circuit.

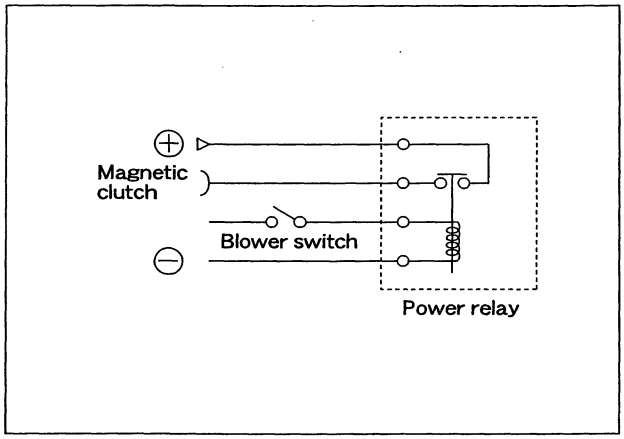
Unit : MPa

	LP side	HP side
OFF	0.20	2.94
ON	0.225	2.35



3.12 Power relay

The power relay is excited at a closed position of the micro switch and enables the magnetic clutch to be ready for engaging electically.

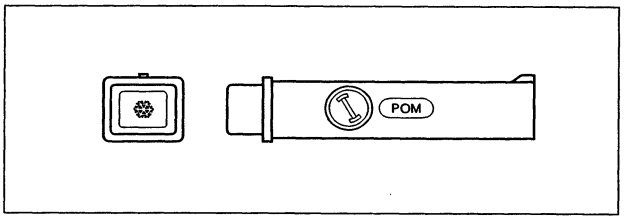


3.13 Air conditioner switch

The air conditioner switch functions as an operation controller for starting or stopping the compressor in cooling and dehumidifying.

By initially depressing it, the magnetic clutch becomes engaged and the compressor starts with the indication lamp signing.

By secondarily depressing it, the magnetic clutch becomes disengaged and the compressor stops with the indication lamp signing.

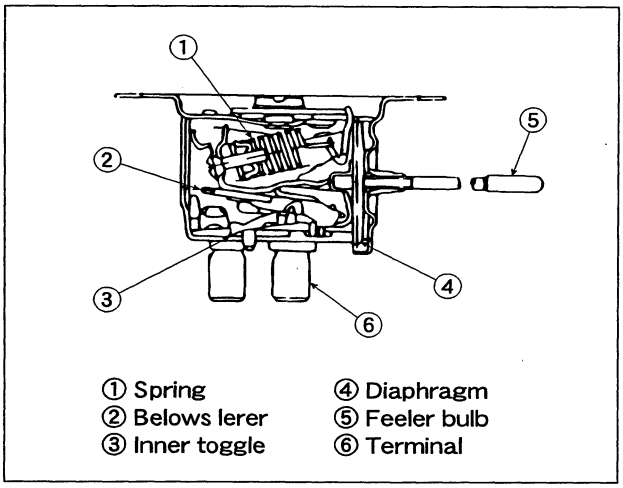


3.14 Thermostat

The thermostat is mounted on the evaporator case. It senses the temperature of evaporator fins, and controls the compressor operation for ON or OFF as specified below.

Unit : ℃

OFF	1.6
ON	4.6



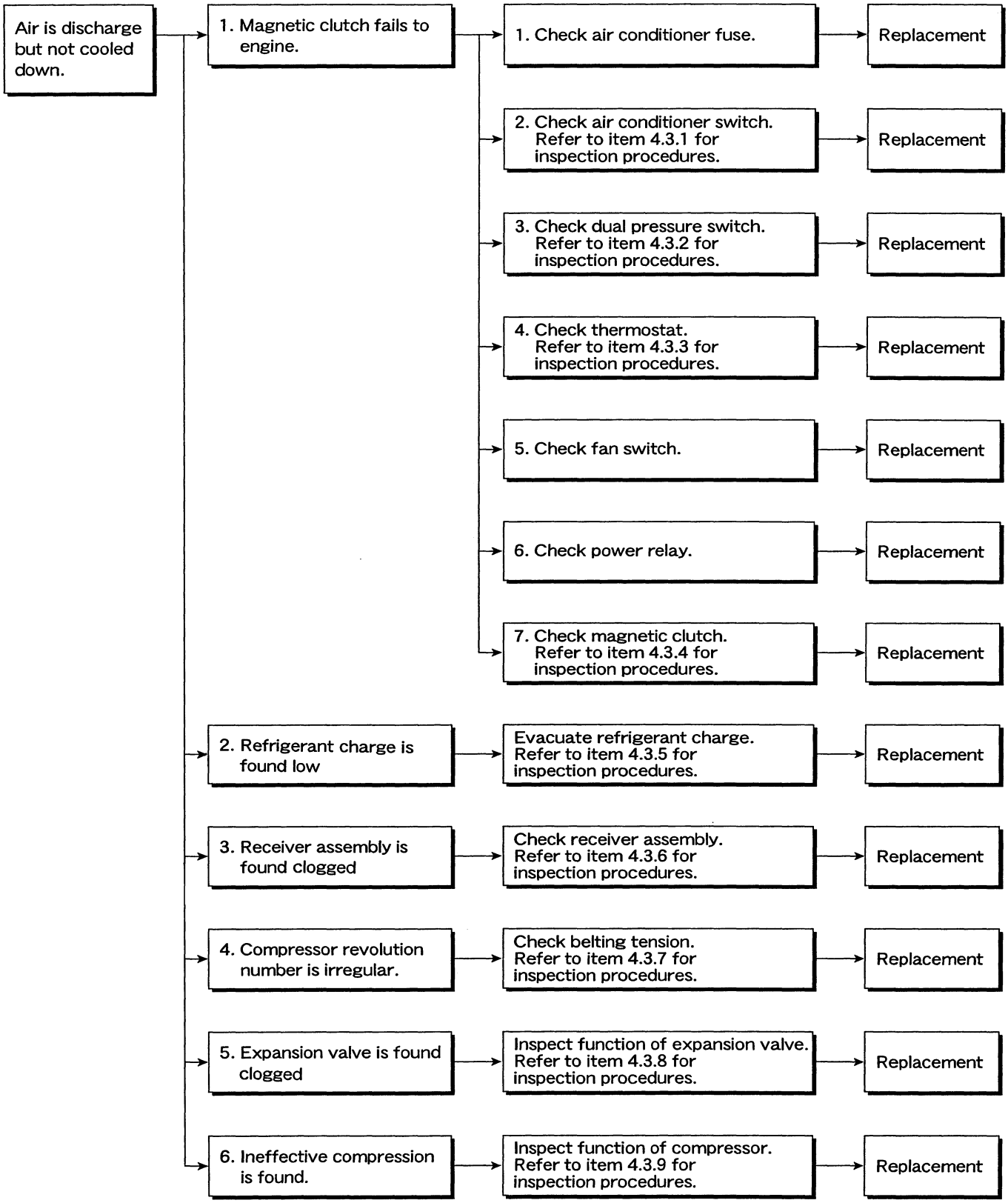
4 . TROUBLE SHOOTING

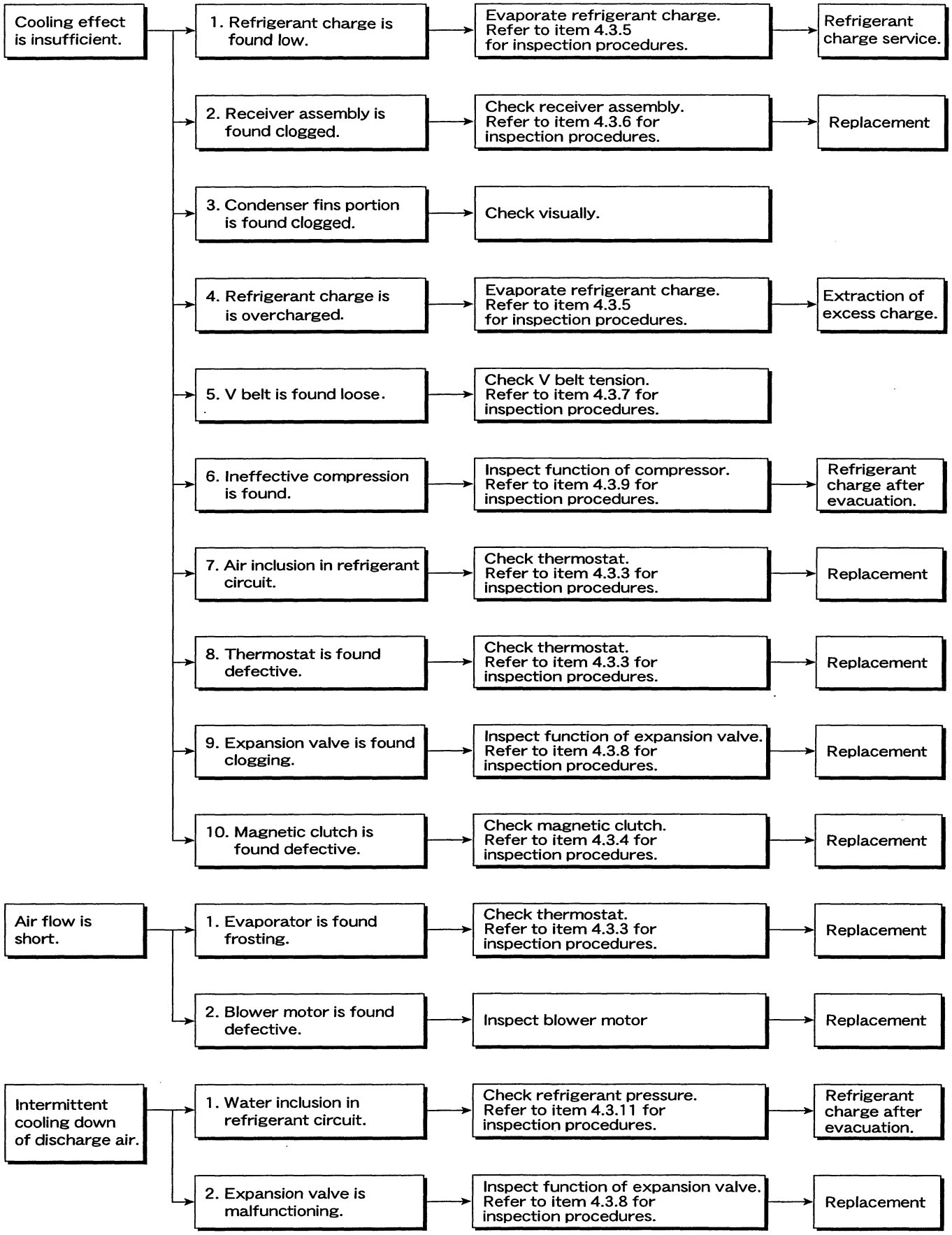
4.1 General precaution

(1) When handling refrigerant (HFC-134a), the following precautions must be observed.
   a. Allways wear eye protection and a pair of gloves which handling refrigerant.
   b. Be careful the liquid refrigerant dose not contact the skin.
   c. Keep the refrigerant container blow 40 degrees C.
   d. Do not handle the refrigerant in an enclosed area having an open flame. The refrigerant may produce a poisonous gas.
   e. When dumping the refrigerant from the system, release it slowly so as not to expell all the compressor oil.

(2) If liquid refrigerant strikes eye or skin.
   a. Do not rub eye or skin.
   b. Splash large quantities of cool water on the eye or skin.
   c. Rush to a physician or hospital for immediate professional treatment.

4.2 Trouble cause and remedy




Cooling effect is insufficient.
1. Refrigerant charge is found low.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Refrigerant charge service.
2. Receiver assembly is found clogged.
Check receiver assembly. Refer to item 4.3.6 for inspection procedures.
Replacement
3. Condenser fins portion is found clogged.
Check visually.
4. Refrigerant charge is is overcharged.
Evaporate refrigerant charge. Refer to item 4.3.5 for inspection procedures.
Extraction of excess charge.
5. V belt is found loose.
Check V belt tension. Refer to item 4.3.7 for inspection procedures.
6. Ineffective compression is found.
Inspect function of compressor. Refer to item 4.3.9 for inspection procedures.
Refrigerant charge after evacuation.
7. Air inclusion in refrigerant circuit.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
8. Thermostat is found defective.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
9. Expansion valve is found clogging.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement
10. Magnetic clutch is found defective.
Check magnetic clutch. Refer to item 4.3.4 for inspection procedures.
Replacement
Air flow is short.
1. Evaporator is found frosting.
Check thermostat. Refer to item 4.3.3 for inspection procedures.
Replacement
2. Blower motor is found defective.
Inspect blower motor
Replacement
Intermittent cooling down of discharge air.
1. Water inclusion in refrigerant circuit.
Check refrigerant pressure. Refer to item 4.3.11 for inspection procedures.
Refrigerant charge after evacuation.
2. Expansion valve is malfunctioning.
Inspect function of expansion valve. Refer to item 4.3.8 for inspection procedures.
Replacement

4.3 Inspection procedure

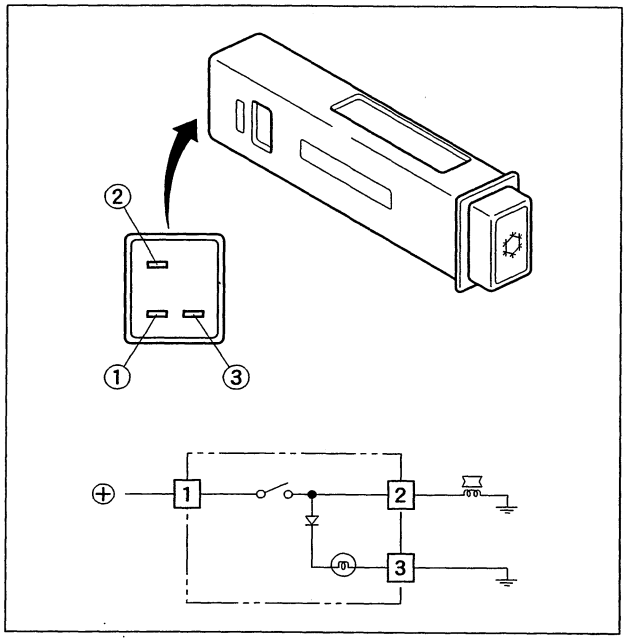
4.3.1 Air conditioner switch

(1) Unplug the air conditioner switch.
(2) Check the continuity between terminals of the air conditioner switch with a tester.

Continuity

Switch position	Terminal's number	Result, in normal
OFF	①-②	No
	②-③	Yes
ON	①-②-③	Yes

Switch position \ Terminal's number	1	2	2	Lighting
OFF				OFF
ON				ON

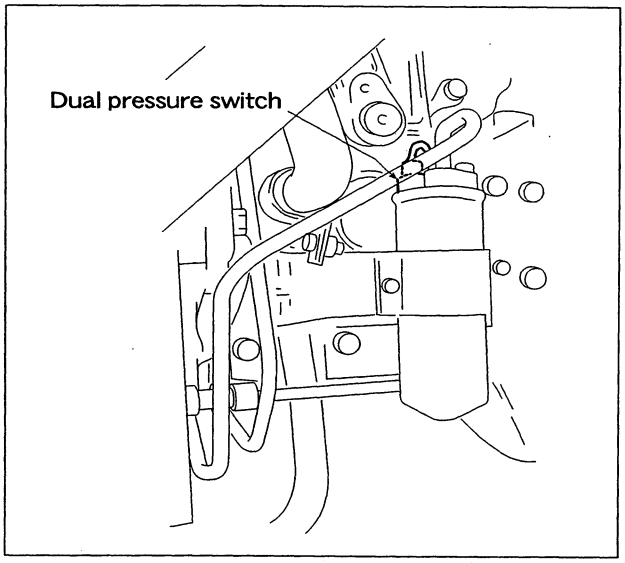


4.3.2 Dual pressure switch

The dual pressure switch is attached to the receiver assembly for controlling the operation of the air conditioner by checking the inside pressure of the receiver assembly.

Unit : MPa

	LP side	HP side
OFF	0.20	2.94
ON	0.225	2.35



(1) Unplug the connector at the receiver assembly.
(2) Check the continuity between terminals of the connector with a tester.
(3) When electric continuity is found, connect the connector to the high pressure switch.
(4) Attach the high pressure gauge and low pressure gauge.
(5) Operate the air conditioner.
(6) Cover the surface of the condenser by using a piece of paper.
(7) When the high pressure exceeds 2.94 MPa, if the magnetic clutch is turned off, the switch is normal.
(8) If the magnetic clutch is not turned off, replace pressure switch with new one.
(9) Check the accuracy of the preset as below.
  (a) Stop the air conditioner.
  (b) Purge the air conditioner of refrigerant slowly starting at over 0.225 MPa.
  (c) At reading the pressure 0.20 MPa, the switch opens.
  (d) Here, stop the purging, then turn it to charging.
  (e) At reading the pressure 0.225 MPa, the switch closes.

If the dual pressure switch does not meet specifications, replace the switch.

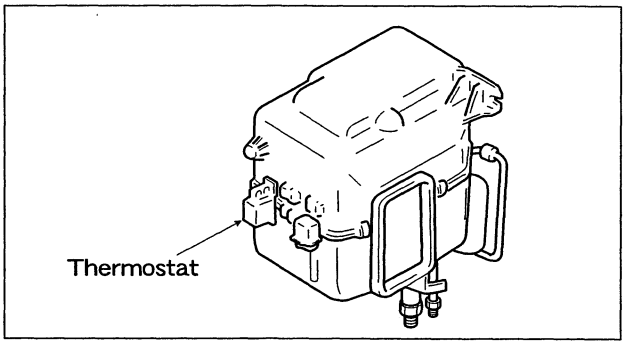
4.3.3 Thermostat

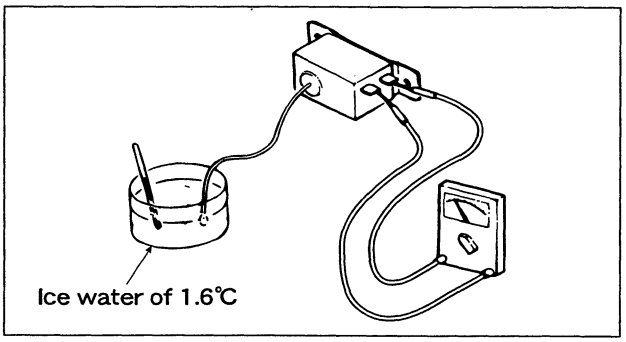
The thermostat is mounted on the evaporator case. It controls the operation of the air conditioner by sensing the temperature of the evaporator fins.

Unit : ℃

OFF	1.6
ON	4.6

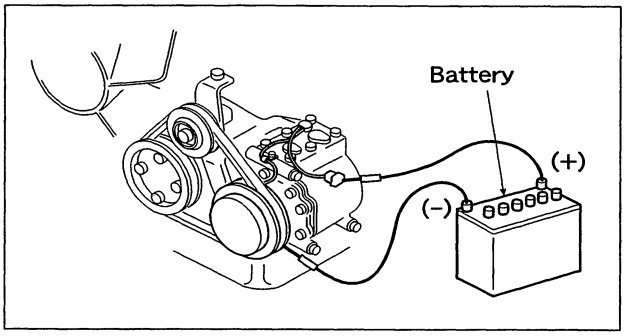
(1) Check the accuracy of the preset as below.
  (a) Soak the sensor of the thermostat in ice-water of below 1.6℃.
  (b) Check the continuity between the switch terminals.
  (c) Pull the senser out of the ice-water, and check the continuity at over 4.6℃ of the senser.





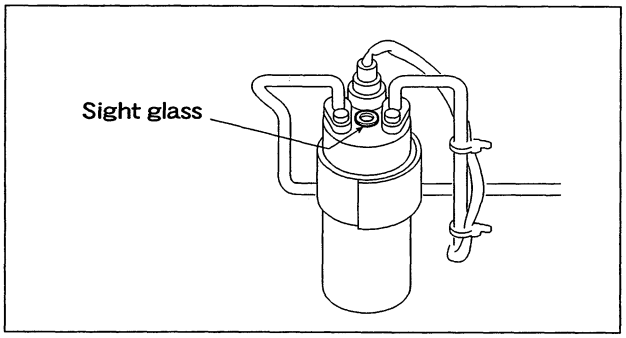
4.3.4 Magnetic clutch

(1) Disconnect the wiring to the magnetic clutch.
(2) Apply a positive side power voltage to the magnetic clutch through the wiring.
(3) In the case of regular functioning, the pulley and magnetic clutch are engaged with a clicking sound. The falling means any malfunction of the magnetic clutch.



4.3.5 Refrigerant charge

(1) Set the temperature control lever at the cool position.
(2) Open doors of the room.
(3) Set the blower switch at the ON position.
(4) Adjust the engine revolution at 1500min^{-1}.
(5) Operation the air conditioner switch for comp. ON.
(6) Watch the sight glass of the liquid hose at the inside of the engine room.
  (a) If judged insufficient refrigerant charging, repair the leaks, then charge it additionally.
  (b) If judged as over charging of refrigerant, extract an excess refrigerant.
(7) Diagnosis by pressure reading.
  (a) Short of refrigerant:
    Lower pressure for both LP and HP reading.
  (b) Express of refrigerant:
    Higher pressure for LP and HP reading.

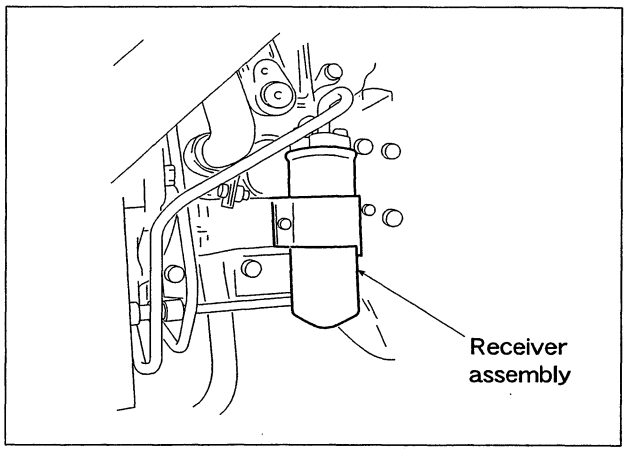


Sight glass		Remarks
Proper refrigerant level	Bubble	1. Bubble occasionally appears. 2. Bubble disappear if speed is a little increased.

Sight glass		Remarks
Insufficient refrigerant	Bubble	Considerable bubbles appear. If the system is extremely short of refrigerant, the sight glass appear white.
Excessive refrigerant		1. No bubbles appear. 2. Slight bubbles appear if speed is decreased.

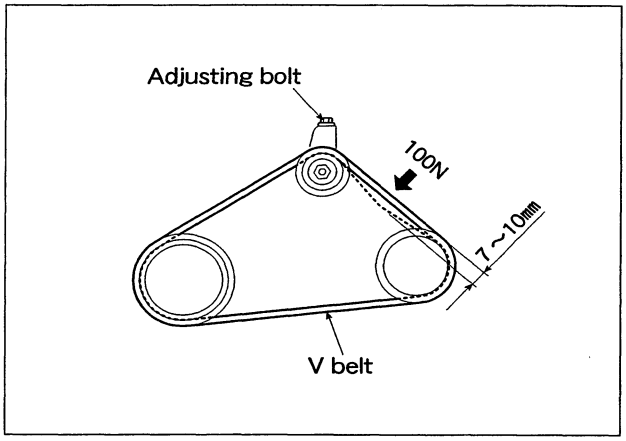
4.3.6 Receiver assembly

(1) While operating the air conditioner, touch the refrigerant piping with a hand at the inlet and outlet portions.
  (a) Sensed temperature difference:
    It is possible that clogging is happening at the inside, liquid receiver assembly is to be replaced with a new one.



4.3.7 Belt tension

(1) Depress the V belt with a thumb at the ⬅ marked position, and adjust the stretching as below.
  Stretching degree : 7~10 ㎜
  (deflection)
(2) Adjustment
  (a) Loosen the nut of the tension pulley.
  (b) Control the belting tension by the adjusting bolt.
  (c) After finishing, retighten the nut as before.

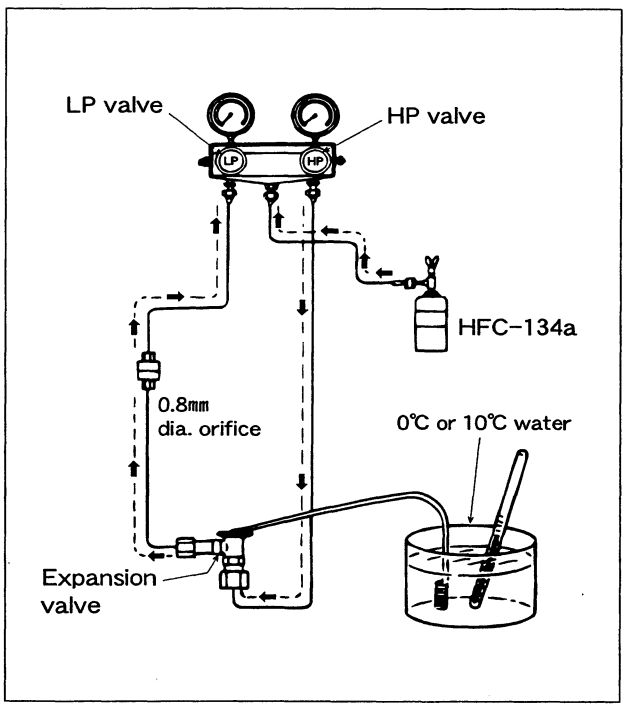


4.3.8 Expansion valve

⚠ CAUTION

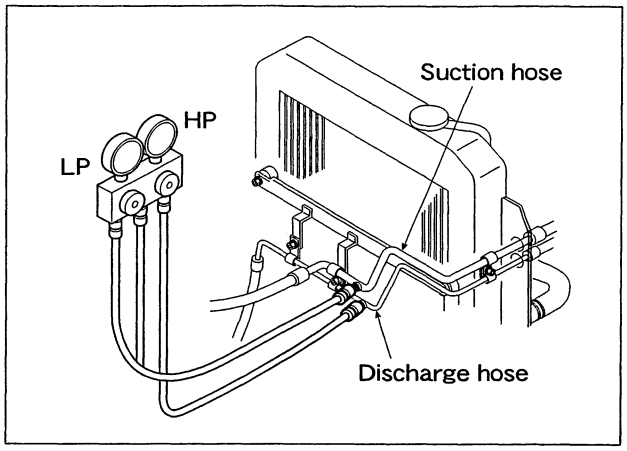
The test should be applied to only the case of the other components being free from troubles, and the expansion malfunctioning singly.

(1) Build up the test circuit with a gauge manifold.
(2) Soak the sensor bulb in ice water of 0℃, and of 10℃ respectively.
(3) Pressurize the HP side with dry nitrogen gas of 1.03MPa.
(4) Check the reading of the LP side pressure gauge for the standard range.
  At 0℃ ····0.127MPa
  At 10℃ ····0.23MPa



4.3.9 Pressure check

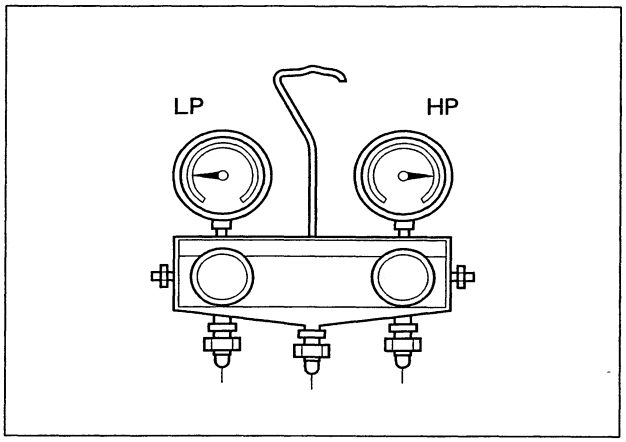
(1) Mount a low pressure gauge hose and a high pressure gauge hose on the check valve.
(2) Drive the air conditioner.
(3) Showing of higher LP side pressure and lower HP side pressure evidences ineffective compression.
Standard pressure
LP side pressure About 0.26MPa
HP side pressure About 1.42MPa



4.3.10 Air inclusion in ref.circuit

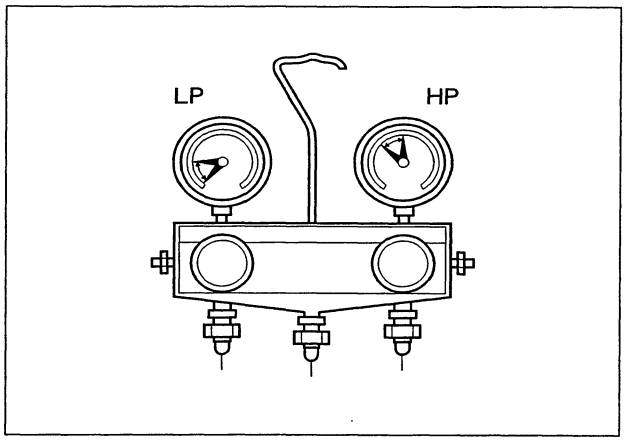
The abnormal reading of refrigerant circuit evidences afraid air inclusion.

A little higher LP side pressure. Noticeably higher HP side pressure.



4.3.11 Moisture inclusion in ref.circuit

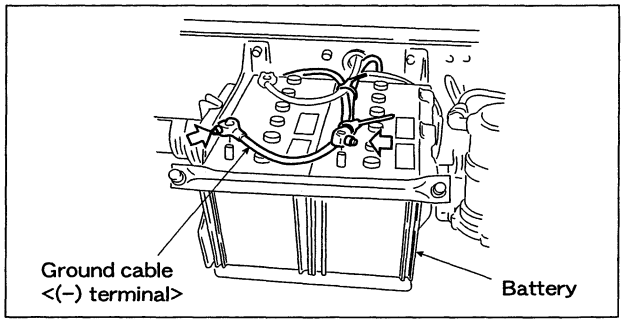
(1) During the operation, cooled air supply is interrupted periodically with a time interval.
This phenomenon evidences water inclusion.
(2) Check the refrigerant pressure at a stop of the cooled air supply to make sure of the water inclusion.
LP side pressure ····Almost vacuum
HP side pressure ····Noticeably low



5 . REMOVAL AND INSTALLATION

5.1 Precaution for removal and installation

(1) Disconnect the (-) ground cable from the battery, and place a cover on the battery.

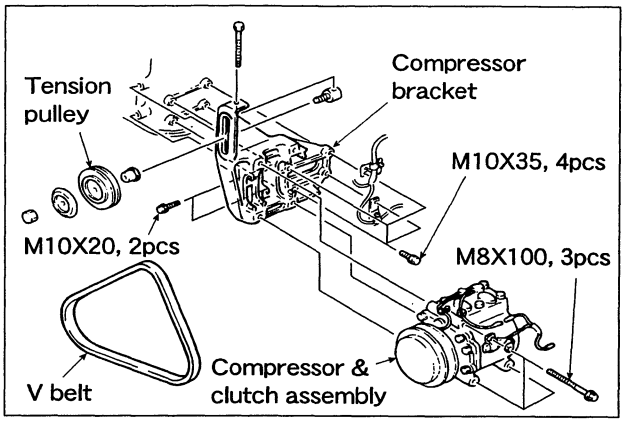


(2) Make certain all the openings are covered with caps in order to prevent entry of foreign substances such as dust and dirt.
(3) Never tamper with the brake and fuel systems, including the brake tubes and hoses.
(4) Avoid doing the work in a dusty place or outdoors in rainy weather. If tubes or functional parts are removed, put a cap in position immediately in order to prevent entry of dust and moisture.
(5) Connect the charging hose of the gauge manifold to the check valves (suction and discharge) of the suction hose and discharge hose, and recover the refrigerant by refrigerant recovery unit until its pressure is reduced to 0 kPa.
(Make sure that there is no internal pressure in the equipment.)
About discharging might result in the discharge of the refrigerant oil from the compressor.
(6) Be sure to use two spanners when removing pipes. Loosen the flare nut on the pipe with one spanner while holding the opposite part in position with the other spanner.
(7) When coupling the flared tube, coat the flared portion with the compressor oil at the inner side.
(8) Make sure to use the wheel chocks.

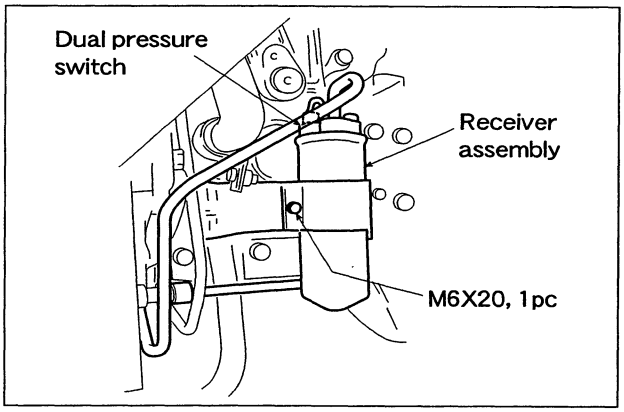
5.2 Removal

5.2.1 Inside engine room

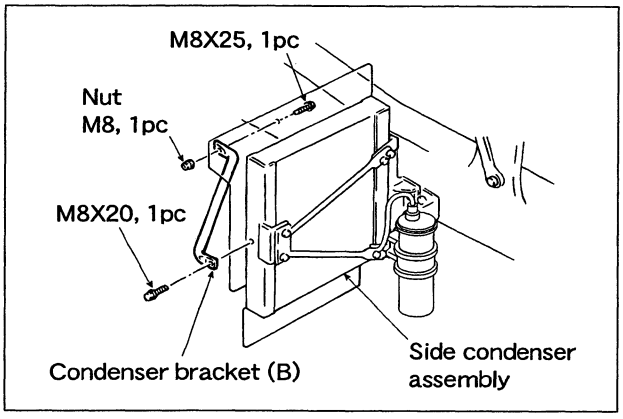
(1) Compressor & clutch assembly
(a) Remove the duct for air cleaner.
(b) Withdraw the wiring of the magnetic clutch at the connector.
(c) Remove the V belt by loosening fixature of the tension pulley.
(d) Take of the anchor bolts : M8X100, 3pcs.
(e) Dismount the compressor & clutch assembly.



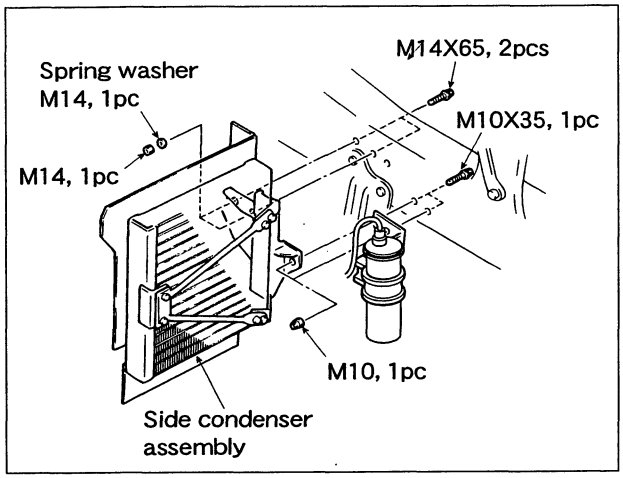
(2) Reciever assembly
(a) Unplug the dual pressure switch at the connector.
(b) Separete the interconnecting refrigerant pipe of the receiver assembly.
(c) Take off the fixing bolt : M6X20, 1pc.
(d) Dismount the receiver assembly.



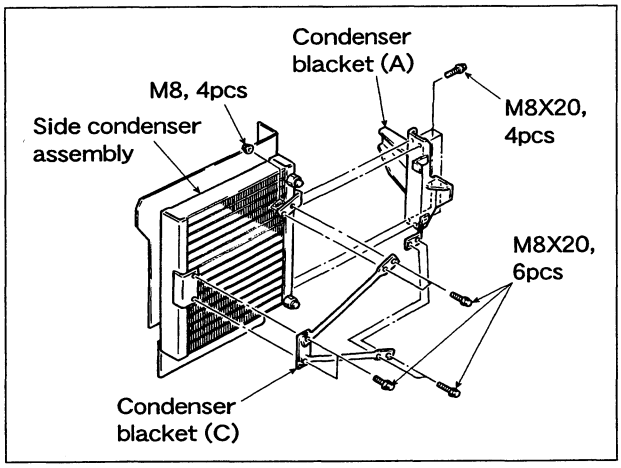
(3) Side condenser assembly
(a) Take off the fixing bolt : M8X20. 1pc, M8X25, 1pc, fixing nut : M8, 1pc.
(b) Dismount the condenser bracket (B).



(c) Take off the fixing bolt : M14X65. 2pcs, spring washer : M14, 2pcs, and nut : M14, 2pcs, and bolt : M10X35, 1pc, and nut : M10, 1pc.
(b) Dismount the condenser bracket (A).

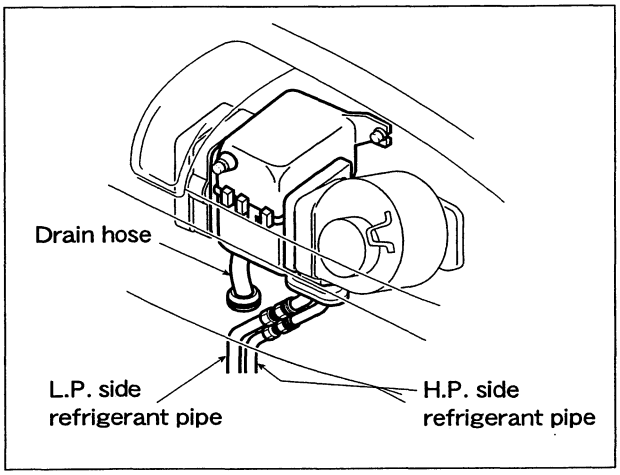


(e) Take off the fixing bolt : M8X20, 4pcs and M8X20, 6pcs, and nut : M8, 4pcs.
(f) Dismount the side condenser assembly.

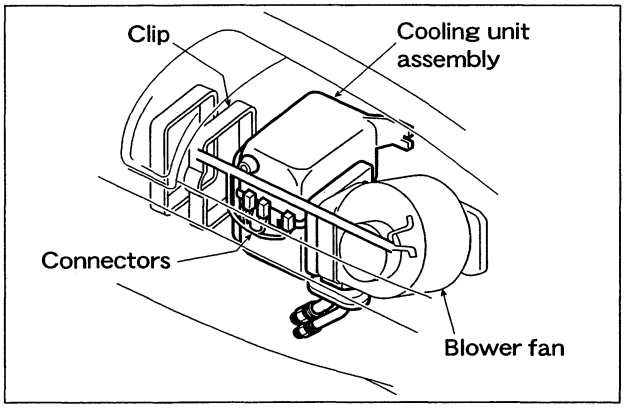


5.2.2 Cabin room

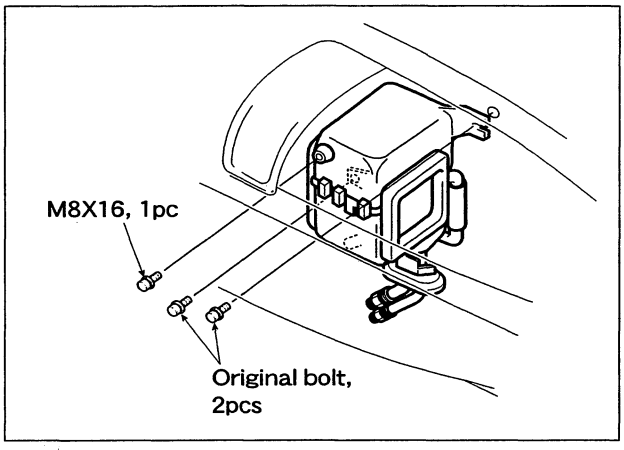
(1) Cooling unit assembly
(a) Separate the interconnecting refrigerant pipes of the cooling unit assembly.
(b) Remove the drain hose.



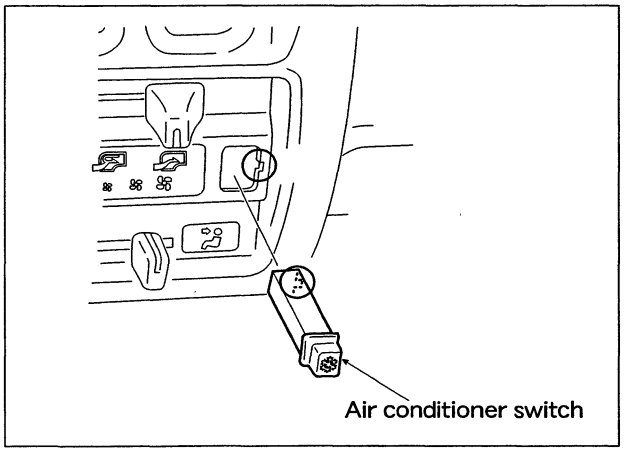
(c) Dismount the clip to the cooling unit assembly.
(d) Dismount the blower fan.
(e) Withdraw the wiring of the cooling unit assembly at the connectors.



(f) Tale off the fixing bolt : M8X16, 1pc and original bolts, 2pcs.
(g) Dismount the cooling unit assembly.



(2) Air conditioner switch
Pull out the air conditioner switch.



5.3 Installation

Installation is performed in the opposite sequence of removal.

○ Torque for tightening coupler of refrigerant tubing.

Unit : N・m

Compressor suction hose	29~34
Compressor discharge hose	20~25
Condenser inlet hose	20~25
Condenser outlet hose	12~14
Liquid receiver assembly inlet and outlet hoses	12~14
Cooling unit inlet hose	12~14
Cooling unit outlet hose	29~34

○ Torque for tightening general bolt and nut

Unit : N・m

Nominal size	Pitch	Tightening torque		
		Head mark 4	Head mark 7	Head mark 8
M5	0.8	3~4	5~6	5~7
M6	1.0	5~6	9~11	8~12
M8	1.25	12~14	19~24	19~29
M10	1.25	24~29	38~48	43~58
M10	1.5	17~26	32~48	41~58
M12	1.25	34~43	58~77	82~106
M14	1.5	72~82	115~134	125~173

NOTE

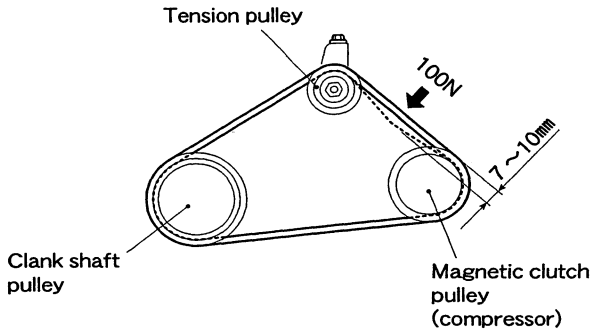
For the cases of spring washer seated, and thread or seating surface coated with oil, the value shall be reduced down to 85 percent of the data listed.

6. TREATMENT AFTER INSTALLATION

6.1 Check and adjustment

After installation, check the following points and confirm that everything is normal, then charge the gas, and do the performance and operation tests.

(1) Check if any abnormal vehicle performance, happens or not by installing the air conditioner.
(2) Check the operation of the magnetic clutch. (with the compressor disengaged)
(3) Check if any parts left unmounted or any tool left in the vehicle.
(4) Check to ensure that the temperature control lever operates properly.
(5) Check the tension of the belt.



6.2 Leak test

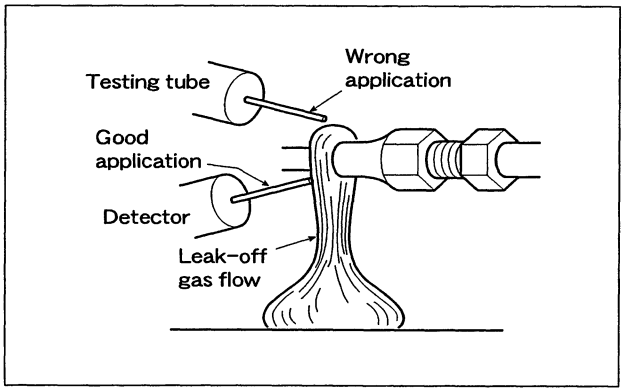
After all the piping works are completed, conduct an leak test by the following procedure to check any leaks at the flare coupling, etc. and then evacuate the system. If this leak test is omited and evacuation is immediately started, there is no way of detecting possible leak. If there are leaks, the specified vacuum cannot be attained. In order to save the service time be sure to conduct the leak test before evacuation.

6.2.1 Test points

(1) All pipe joint.
(2) Shaft seal and check valve on the compressor.

6.2.2 Test procedure

(1) For the gas leak test, the use of an electric gas leak detector is recommended. (HFC-134a SAE Approved)
(2) Perform the test at a place as in free from air flowing.
(3) The refrigerant is heavier than air. Leaks will concentrate at the bottom. Make certain that the testing tube is applied below the check point.



(4) The test should be performed patiently. Make certain that testing tube is moved slowly [approx. 10mm/sec].
(5) The high pressure side refrigerant circuit should be tested for gas leaks during operation. Those areas which are dangerous or hard to test during operation (including areas around the compressor and condenser) should be tested direct after shutdown.

(6) The low pressure side refrigerant circuit should be tested during shutdown after the gas pressure has balanced.
(7) The test should be performed on the basis of the following standards:

Gas leak test standards

test point / Instrument	Compressor shaft seal	Other parts
Electric gas leak detector	Pointer shall not swing more than 0.1mA at the low sensitivity.	Pointer shall not swing more than 0.1mA at the low sensitivity.
handle torch gas leak detector	Flame colour (moss green) shall not change.	

⚠ WARNING

- Smoking should be forbidden if a gas leak is detected.
- If a flame is applied to the refrigerant, toxic phosgene gas will be produced. Do not keep the detector in contact with a leaky point for a long time.

- Leak test procedure

1. Attach refrigerant supply and gauge set as shown with all valves closed. Open refrigerant supply valve on can.
2. Loosen the center charging hose fitting at the gauge manifold end to blow any air from the hose until it hisses for a few seconds, then refrigerant.
3. Open both gauge valves to partially charge the system and then close both valves.
4. The system can then be checked for leaks using an electronic leak detector.
5. If leaks are found that require the system to be opened (to repair or replace hoses, fittings, etc.), release any charge in the system.
6. After checking and repairing leaks, system must be evacuated.

6.3 System charging

GENERAL PRECAUTIONS

⚠ WARNING

When handling refrigerant (HFC-134a), the following precautions must be observed.

- Always wear eye protection and gloves while handling refrigerant.
- Be careful that liquid refrigerant does not contact the skin.
  If liquid refrigerant strikes eye or skin:
  - Do not rub on skin.
  - Splash large quantities of cool water on the eye or skin.
  - Flush eyes or skin with cool water for 5 minutes.
  - Rush to a physician or hospital for immediate professional treatment.
  - Do not attempt to treat it yourself.
- Keep the refrigerant (HFC-134a) container below 40℃.
- Do not handle the refrigerant in an enclosed area having an open flame; the refrigerant may produce a poisonous gas.
- Use approved recovery equipment to recover HFC-134a refrigerant before attempting service of this or any other HFC-134a system.
- Do not attempt to leak test an HFC-134a system with high pressure air or nitrogen. Mixing HFC-134a with a concentrated quantity of air may be combustible in the presence of ignition.

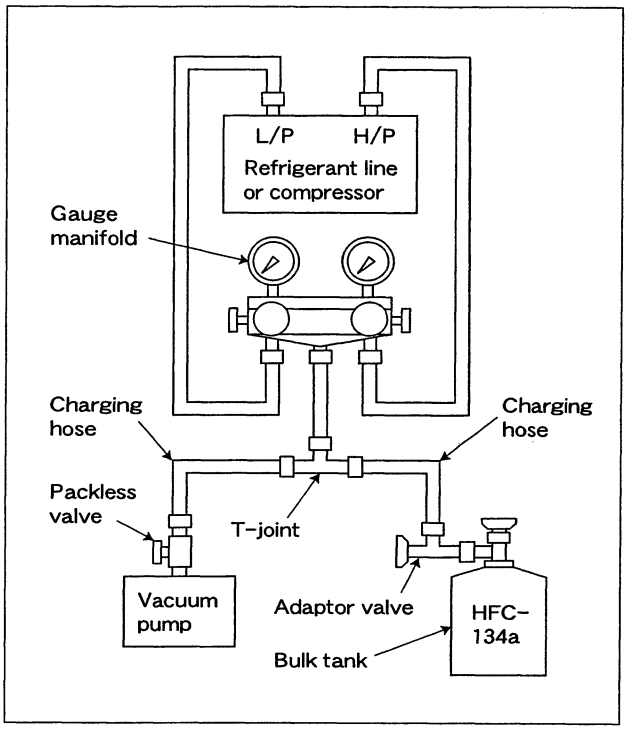
6.3.1 Evacuation

INSTALLATION OF CHARGE EQUIPMENT

(1) Connect the gauge manifold to the service valves.
(2) Connect the packless valve to the vacuum pump.
(3) With the charge valve handle turned back all the way, install the bulk tank.
(4) Connect each charge equipment as illustrated.

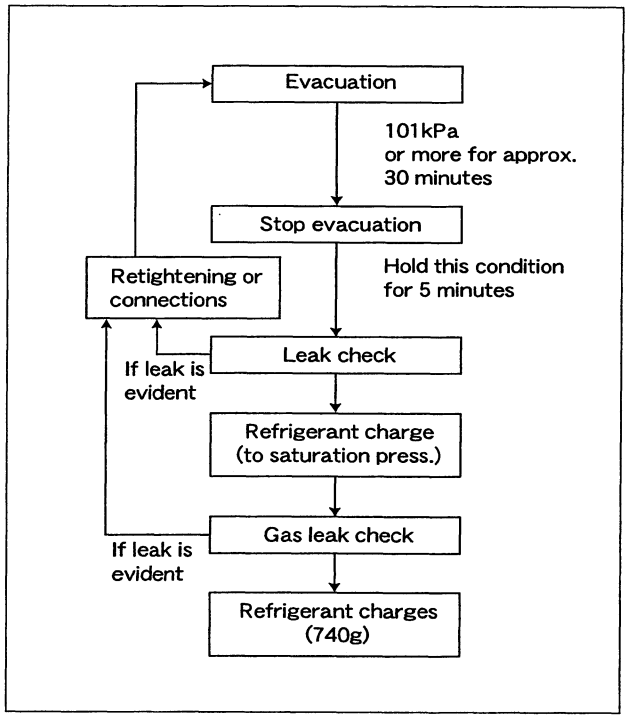
⚠ CAUTION

1. Do not connect the high and low pressure sides adversely. (Connect high pressure side to the condenser and low pressure side to the cooling unit.)
2. The indications "DIS" and "SUC" on the compressor indicate high and low pressure sides respectively.



6.3.2 Evacuate the system

The refrigerant system must have been evacuated using the previous procedure before charging. Charge using only HFC-134a refrigerant. HFC-134a is available in bulk tank. Follow the safety precautions for handling HFC-134a as listed in this section.
Follow the evacuation procedure below and at right.
This procedure assumes no HFC-134a refrigerant has been introduced into the system. If evacuating a charged system, it is necessary to recover the existing HFC-134a refrigerant before continuing with these instructions.
Refer to the recover equipment manufacture's instructions for proper refrigerant recovery.



CHARGING WITH BULK TANK

When using disposable cans of this type, follow carefully the tank manufactures instructions.

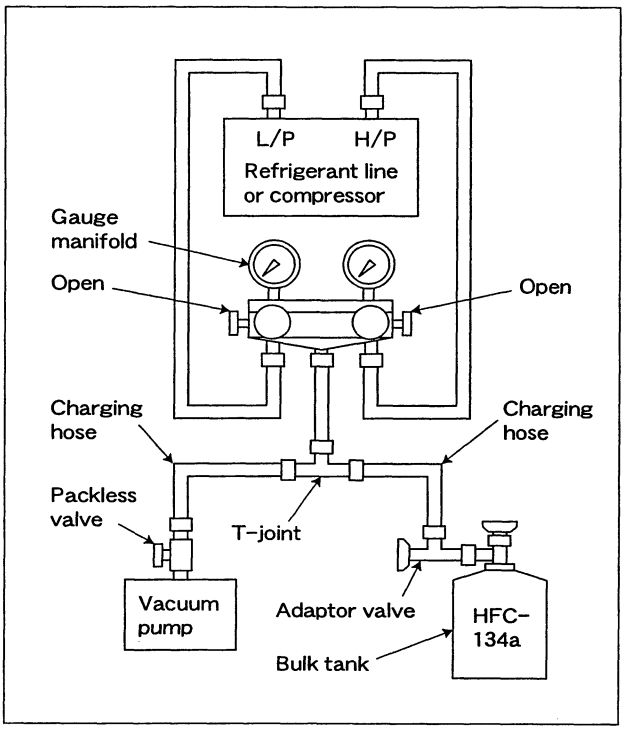
(1) Start up the vacuum pump.

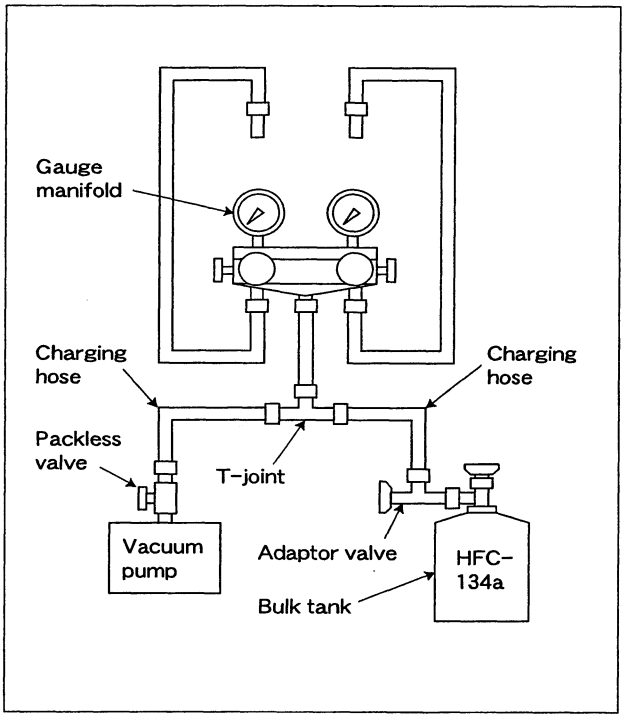
> ⚠ CAUTION
>
> 1. Do not use the compressor for evacuation.
> 2. Do not operate the compressor in the vacuum condition; damage may occur.

(2) Open the gauge manifold handles and the packless valve.
(3) Evacuate to a vacuum reading of 101kPa higher (approx.30 minutes).
(4) Turn back the packless valve all the way and close the bulk tank.
(5) Stop the vacuum pump and allow to stand for 5 minutes.
(6) Check for leak. (Good if the vacuum is held.)
(7) Tighten the charge valve handle to puncture the bulk tank.
(8) Open the charge valve to charge the system with refrigerant.
(9) When the refrigerant is no longer drawn in, turn back the high pressure side gauge manifold handles.
(10) Check for gas leaks using a leak detector.
(11) Start the engine.
(12) Operate the air conditioner and set at the lowest temperature (MAX. COOL).
(13) Fix the engine speed at 1500min^{-1}.
(14) Continue charging system until proper refrigerant quantity is introduced into the system.

> ⚠ CAUTION
>
> If the bulk tank is inverted, liquid refrigerant may be drawn into the compressor damaging it by liquid compression. Keep the bulk tank upright to ensure that refrigerant is charged in gas state.

(15) Upon completion of charging, turn back the low pressure side gauge manifold handles.





6.3.3 Removal of charge equipment

(1) Close the charge valve.
(2) Remove the gauge manifold from each service valves.

> ⚠ CAUTION
>
> Do not remove the bulk tank, T-joints and adaptor valves but keep them connected for next charge operation.

OPERATING LOW REFRIGERANT LEVEL

Locate the souce of the low refrigerant level, recover system, repair system, evacuate system, charge ststem, check for leaks.

> ⚠ CAUTION
>
> If the bulk tank is not emptied completely, keep the charge valve connected to the tank for next charging.

6.3.4 Discharging system

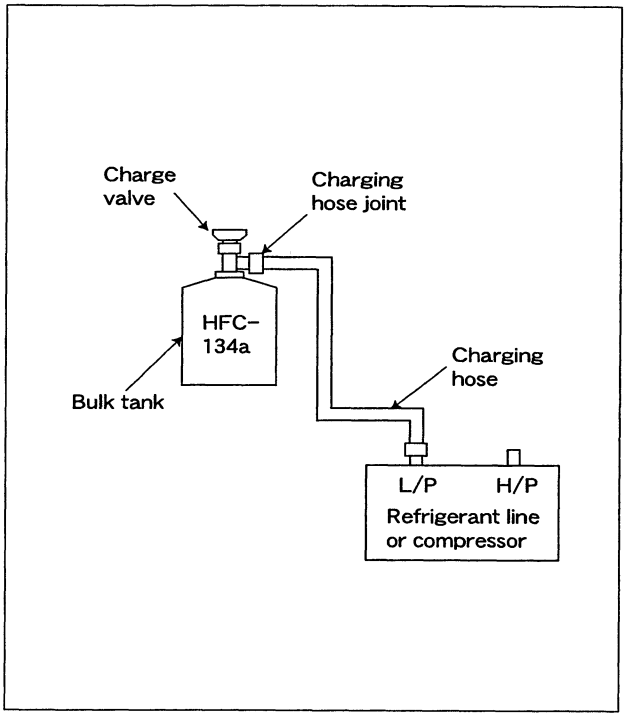
Use the refrigerant recovery unit which can be purchased in local market to discharge refrigerant gas from the system.

> ⚠ CAUTION
>
> Refer to that Refrigerant Recovery Unit Instruction Manual for operation which is attached on the unit.

LIQUID CHARGE, through high side using charging station:

> ⚠ CAUTION
>
> Do not run engine when performing liquid charge; compressor will be damage.

(1) After the system is evacuated, close gauge valves, connect center hose to refrigerant supply. Loosen center fitting at gauge to blow any air out of the hose and then retighten.
(2) Following charging station manufacture's instructions charge the system until 740g of refrigerant is pumped into the system.
(3) When system is fully charged, close high gauge valve and refrigerant supply valve, then quickly disconnect gauge hoses from service
(4) After charging the system, refer to pre-delivery inspection.



6.4 Performance test

6.4.1 Preparation

Reinstall all vehicle parts that were removed for installation of the air conditioner at their original positions, adjust the mounting, and test the following items.

(1) Installation of grommets.

Install the specified grommets.

6.4.2 Stationary performance test

(1) Operating conditions

(a) Place the vehicle in the shade with doors open.

(b) Keep the return air temperature between 25 to 30℃, (Adjust by changing the opening degree of the doors).

(c) Set the fan switch to the max position.

(d) Turn the thermostat control lever to the cool position.

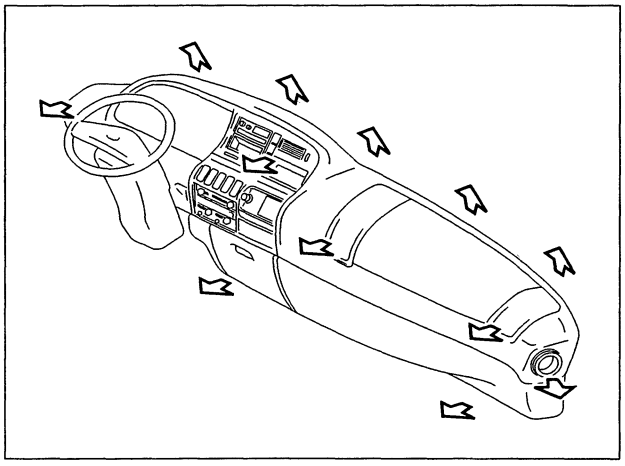
(e) Set the engine speed to approx. 1500min^{-1}.

(f) Set the high pressure at 1.17 to 1.37 MPa.

(If the high side pressure does not rise up, place paper or the like in front of the condenser.)

(2) Test procedure

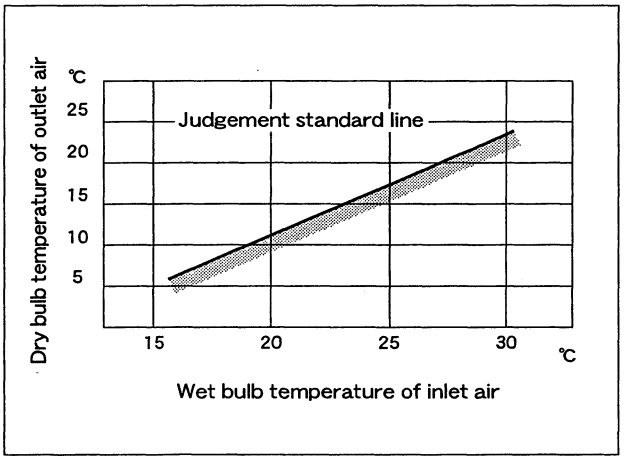
Operate the air conditioner for more than 10 minutes under the above operating conditions in order to stabilize the high and low pressures. Then perform the test by the following procedure:



(a) Measure the outlet air temperature at the inside space of the outlet grille.

(b) Measure the air conditioner intake air temperature, humidity, etc, and the items shown in the Table of Measuring Items at a position free from the effects of cool outlet air.

(c) The intersecting point of the plotted line perpendicular to the point which corresponds to the air conditioner intake and outlet air temperature difference and the plotted line perpendicular to the relative humidity of intake air should be between the oblique lines in figure.



7. MAINTENANCE

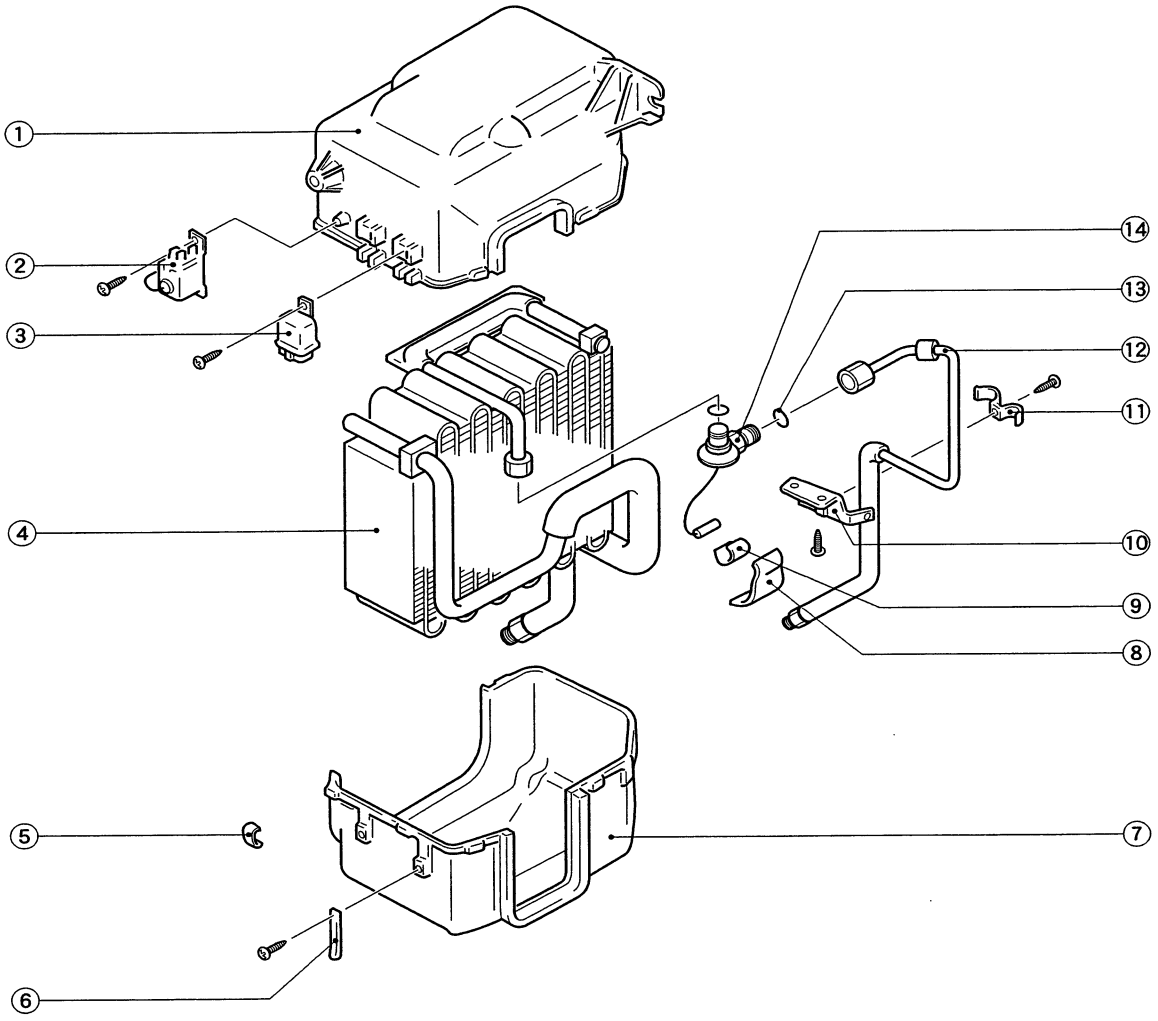
No.	Check point	Service and inspection intervals				
		When used only in summer (approx. for three months)		When used in all seasons		
		At the beginning or season	At the end of season	Every 5,000km (3,000miles)	Every 10,000km (6,000miles)	Every 20,000km (12,000miles)
1	Check condenser and radiator fin for clogging.	○	○	○		
2	Retighten all bolts.	○			○	
3	Check for refrigerant leaks.	○			○	
4	Check refrigerant level.	○		○		
5	Check V-belt tension.	○		○		
6	Check operation of magnetic clutch.	○			○	
7	Check operation of thermostat.	○				○
8	Cooling unit assembly performance test.	○		○		
9	Compressor overhaul.			Every four years		Every 40,000km (24,000miles)

⚠ WARNING

Even after the hot season is over, the air conditioner should be kept ready for operation all year round. Do not remove the V-belt or other parts.
This is because the air conditioner must be operated once a week for several minutes regardless of the season in order to prevent gas leaks caused by drying of the compressor shaft seal, and also to maintain the compressor itself in the best condition.

8. COOLING UNIT ASSEMBLY

8.1 Components



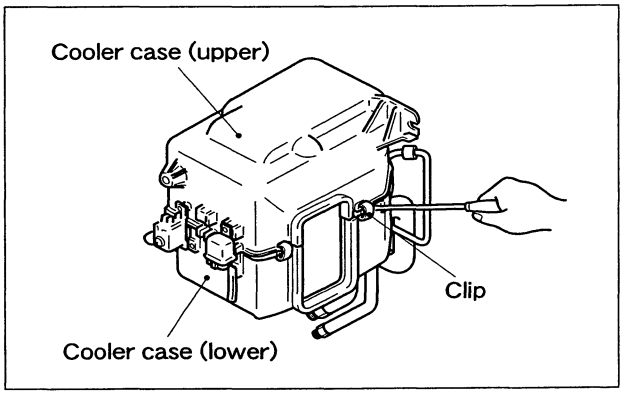
① Cooler case (upper)
② Thermostat
③ Power relay
④ Evaporator
⑤ Clip
⑥ Clamp
⑦ Cooler case (lower)
⑧ Insulation rubber
⑨ Clip
⑩ Bracket
⑪ Clamp
⑫ Pipe
⑬ O-ring
⑭ Expansion valve

8.2 Cautions in disassembling

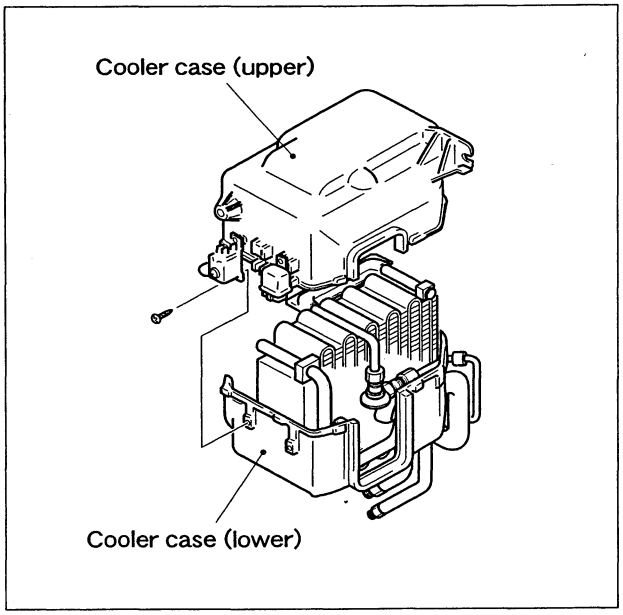
(1) Direct after disconnecting the refrigerant piping plug the opening to prevent dust and moisture etc. from entering in it.
(2) When disconnecting the expansion valve, surely apply two spanners to prevent unstable twisting from applyng with the one for supporting and the other for torquing at the connection.
(3) Pipings in the cooling unit assembly should be handled gently. Particularly, during the installation and removal.
(4) If the cooling unit assembly is stored, or transported on disassembled condition, be careful not to deform the fins.
(5) When disconnecting the wiring, avoid pulling it with the insulation cover catched, but apply force by pinching the terminals or by catching the connectors.

8.3 Disassembling

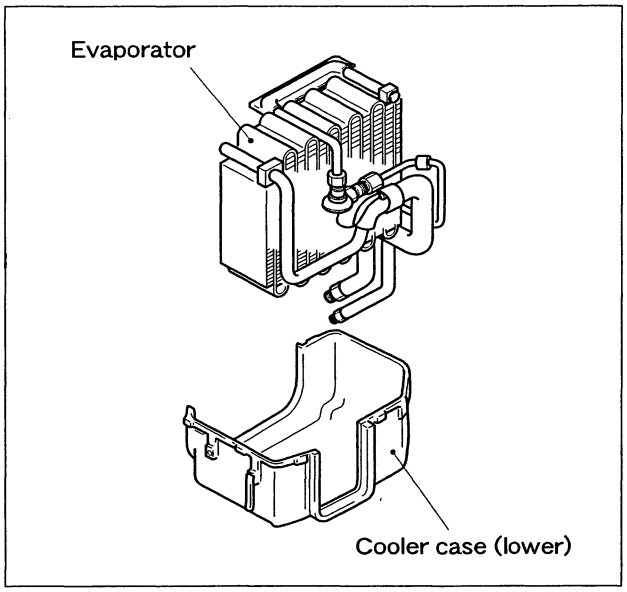
(1) Remove the clips for jointings the upper & lower side cooler case with a flat type screwdriver.



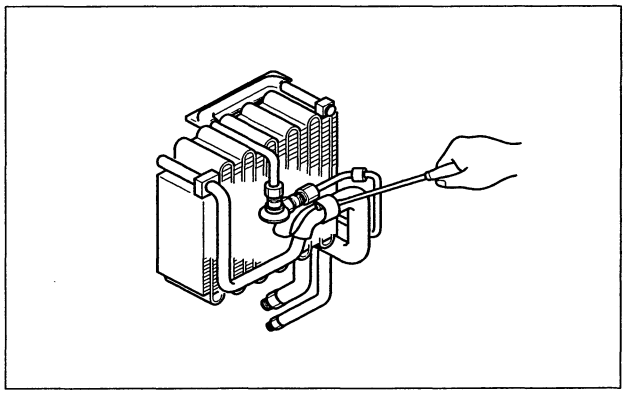
(2) Dismount the cooler case (upper).



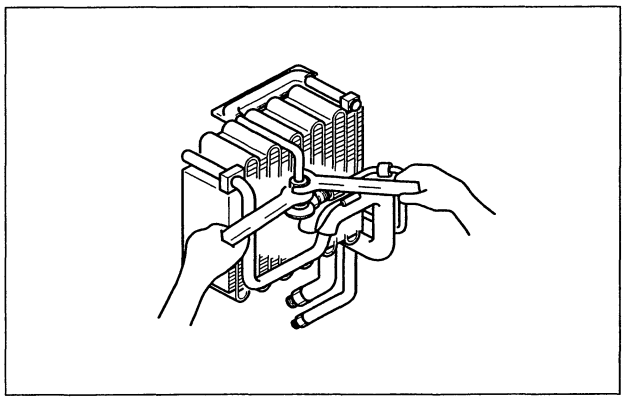
(3) Dismount the evaporator.



(4) Separate the expansion valve.
Dismount the feeler bulb at the suction side.

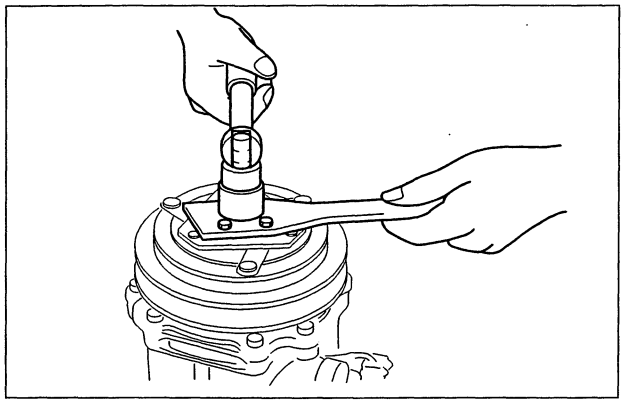


(5) Dismount the expansion valve from the circuit.

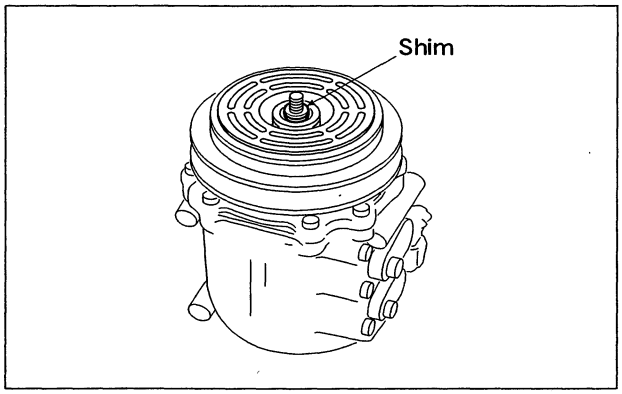


9. COMPRESSOR & CLUTCH ASSEMBLY

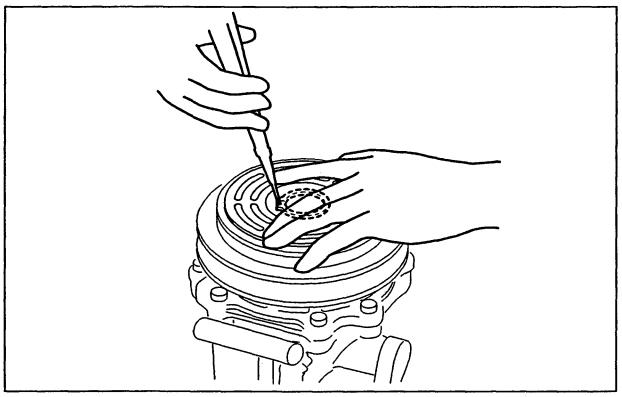
9.1 Disassembling the clutch



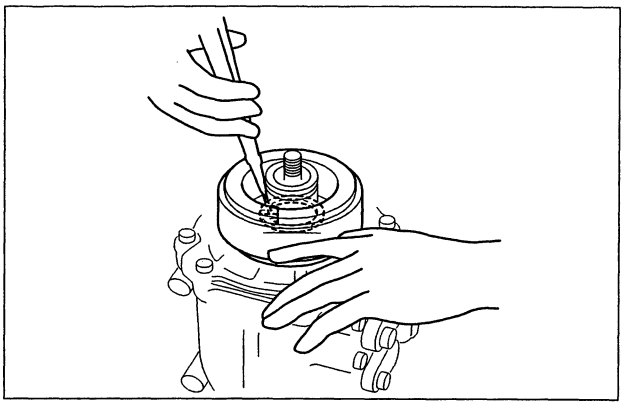
(1) Removal of armature plate.
  (a) Lock up the armature plate with a armature plate fixture and remove the lock nut.
  (b) Remove the armature plate.



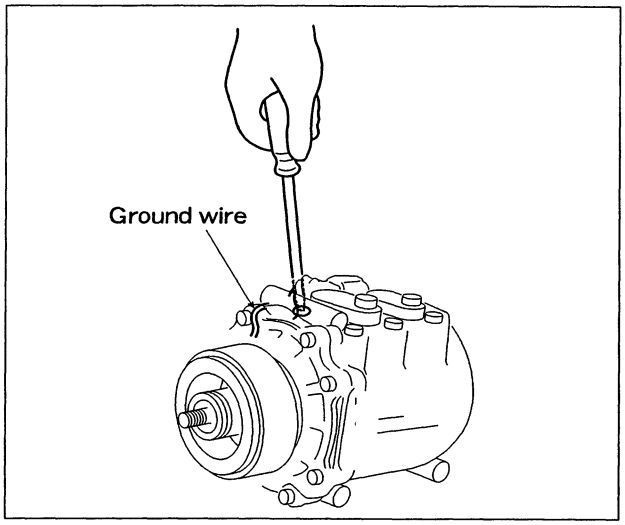
(2) Remove the shim.



(3) Withdrawing rotor.
  (a) Remove the snap ring at the front case side with snap ring pliers.
  (b) Withdraw the rotor toward you and remove it from the front case.

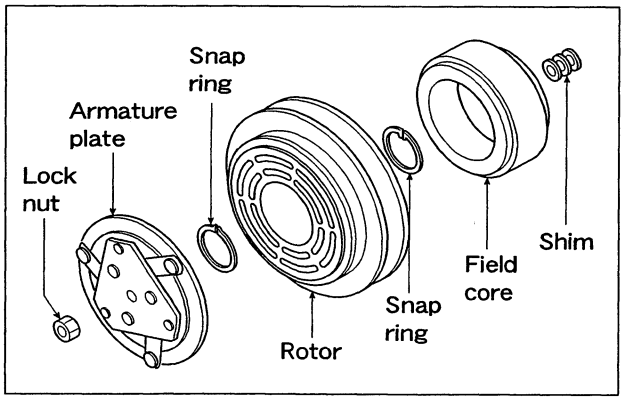


(4) Removal of field core.
  (a) Remove the snap ring for fixing the field core with snap ring pliers.



  (b) Remove the ground wire with a cross point screwdriver and withdraw the field core toward you to remove it from the crank case.

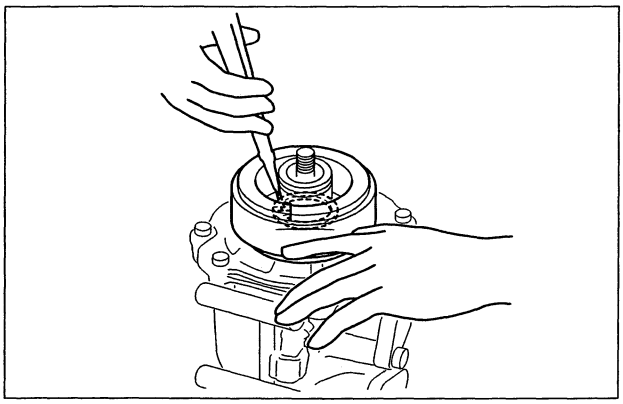
(5) Removal of key.
  Remove the key from the shaft using the top of a flat type screwdriver.



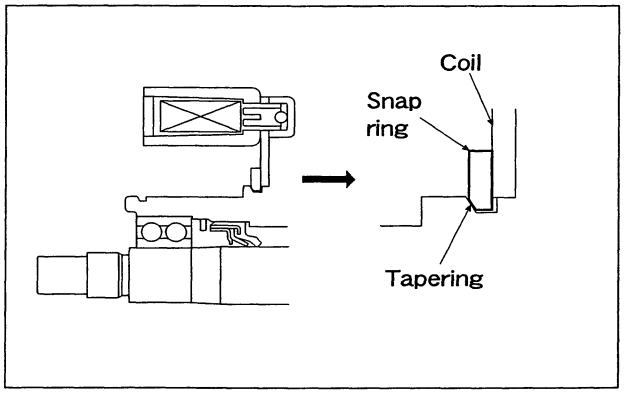
(6) Components of magnetic clutch.

9.2 Reassembly the clutch

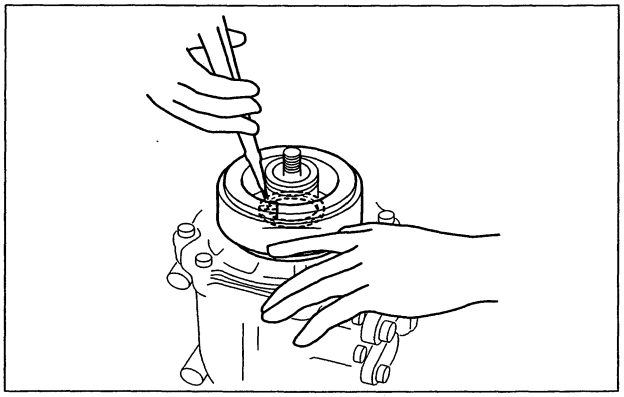
(1) Insert the key into the clankshaft.
(2) Insert the field core.



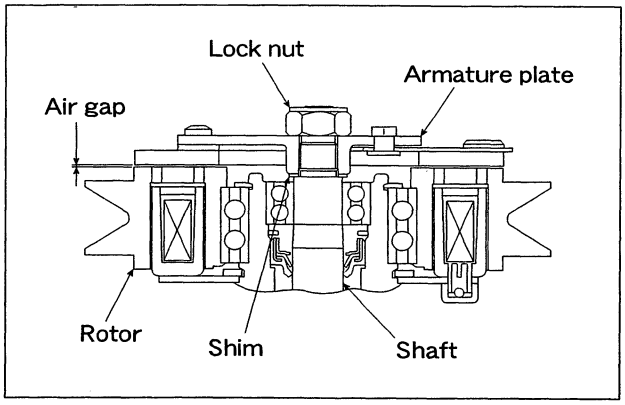
(a) Insert the field core into the front case and position it with a knock pin.
(b) Insert the snap ring for fixing field core into the groove and fix it with snap ring pliers as shown the below.



(c) Connect the ground wire.
(3) Insert the rotor into the front case.



(4) Insert the snap ring for the front case side into the groove with snap ring pliers.



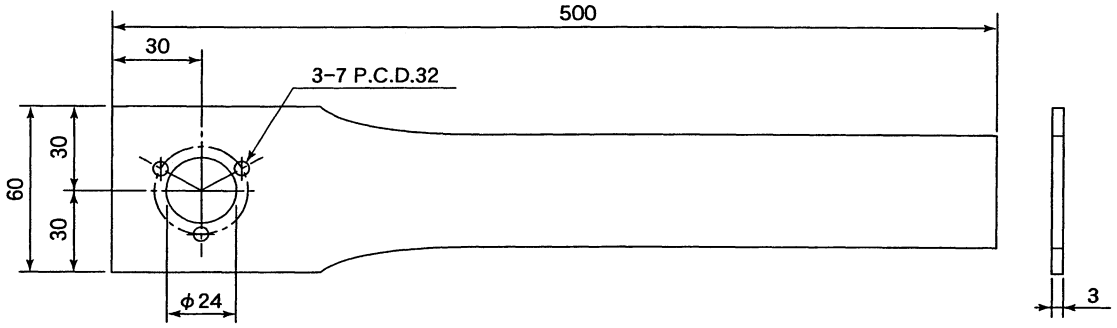
(5) Insert the armature plate.
(a) Place a shim on the end of the shaft and insert the armature plate, adjusting to the key.
(b) Tighten the center bolt to the specified torque, 15.7N.m, with in between plain washer.
(c) Measure the air gap.
The air gap should be within 0.4 to 0.65 ㎜.
Adjust it by shim if it is not within the specifications.
Adjusting shim : 0.1, 0.3, 0.5, or 0.8 ㎜.

9.3 Special tool figure

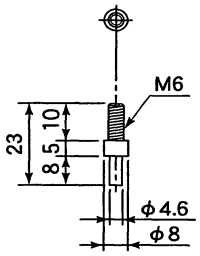
The dimensions are in millimeter

(1) Armature plate fixture

① Material S45C



② Material S45C(3pcs)



MITSUBISHI
FUSO

Group 55B

Heater

Table of Contents

BACK

HOME

MITSUBISHI FUSO TRUCK OF AMERICA, Inc.

Pub No. TWME0103-55B

INDEX

SPECIFICATIONS 55B- 2

STRUCTURE AND OPERATION 55B- 2

TROUBLESHOOTING 55B- 8

HEATER HOSE 55B-10

HEATER CONTROL 55B-12

AIR DUCT 55B-15

HEATER UNIT AND BLOWER 55B-16

AIR OUTLET VENTILATION 55B-17

SPECIFICATIONS/STRUCTURE AND OPERATION

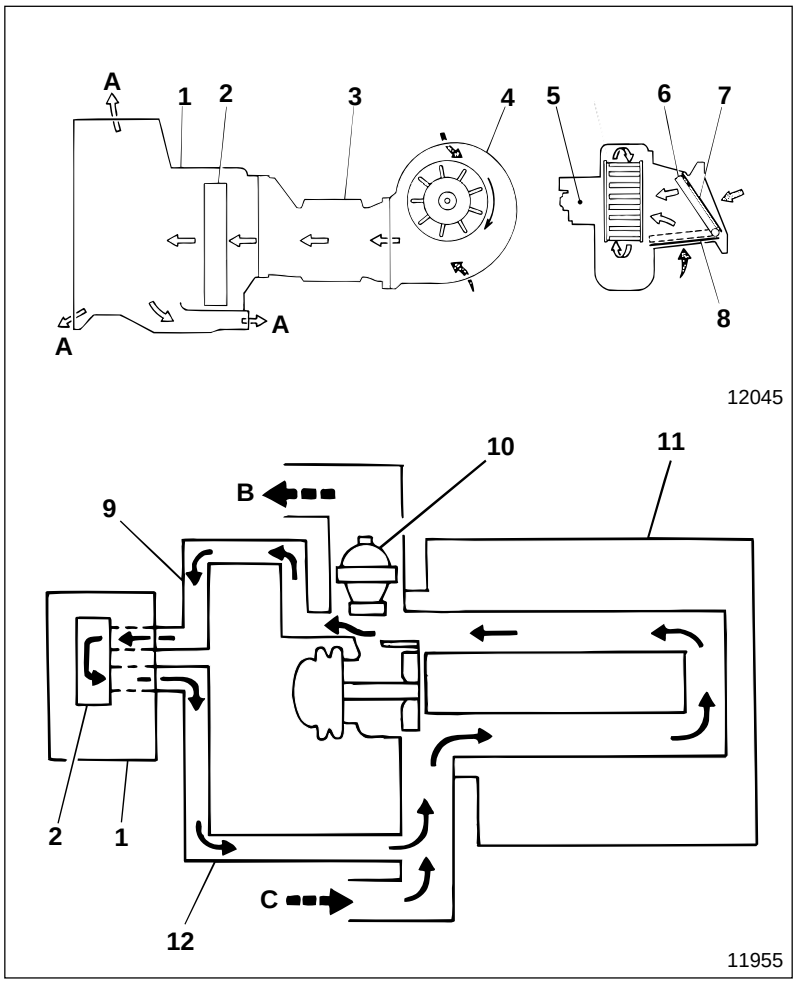
SPECIFICATIONS

Items			Specifications
System	Type		Inside/outside air combining, hot-water type heating system
	Standard voltage	V	12
	Damper changeover system		Manual cable type
Blower assembly	Manufacturer		DENSO
	Power consumption	W	170
	Maximum rotation	rpm	3550
Heater unit assembly	Manufacturer		DENSO
	Temperature control system		Air mixing type
	*Heating performance kW {BTU/h, kcal/h}		*4.31{14720, 3710}

* : Heating performance is shown under the following conditions.
Temperature difference : 65°C {119°F}
Water flow : 6 L/min {0.0035 ft^3/s}
Voltage : 12 V DC

STRUCTURE AND OPERATION

Heater



1 Heater unit
2 Heater core
3 Joint duct
4 Blower assembly
5 Blower motor
6 Damper
7 Air filter (Outside air)
8 Air filter (Inside air)
9 Heater hose (Heater in)
10 Thermostat
11 Engine
12 Heater hose (Heater out)

A : To duct
B : To radiator
C : From radiator

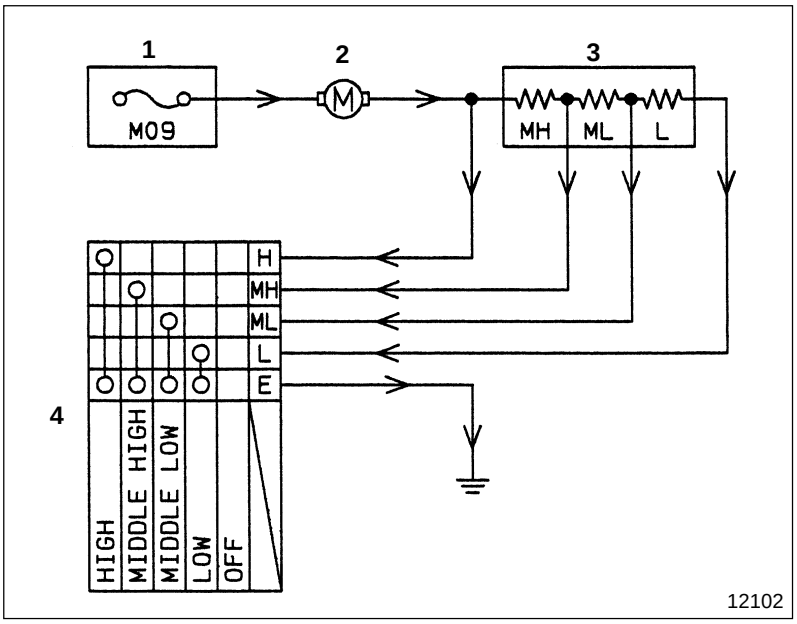
Outside air (Intake)

Inside air (Circulation)

Filtered air

- Warm engine coolant that has absorbed heat from engine **11** does not flow through thermostat **10** but circulates as follows:
  9→2→12→11
  ↑ ↓
- Air sent to heater unit **1** from blower assembly **4** is warmed by heater core **2** (heat exchanger). Then the ducts deliver the warmed air to the cab.

Heater Electric Circuit



1 Relay and fuse box
2 Blower motor
3 Blower resistor
4 Fan switch (Heater switch)

- The resistance of blower resistor **3** controls blower motor **2**, which in turn controls the air flow, except when the air flow is set to H (high speed). When the air flow is set to H, the current does not flow through the blower resistor.

Fan switch 4 set to L position

- **1**→**2**→**3** (L)→**4** (L)→Ground

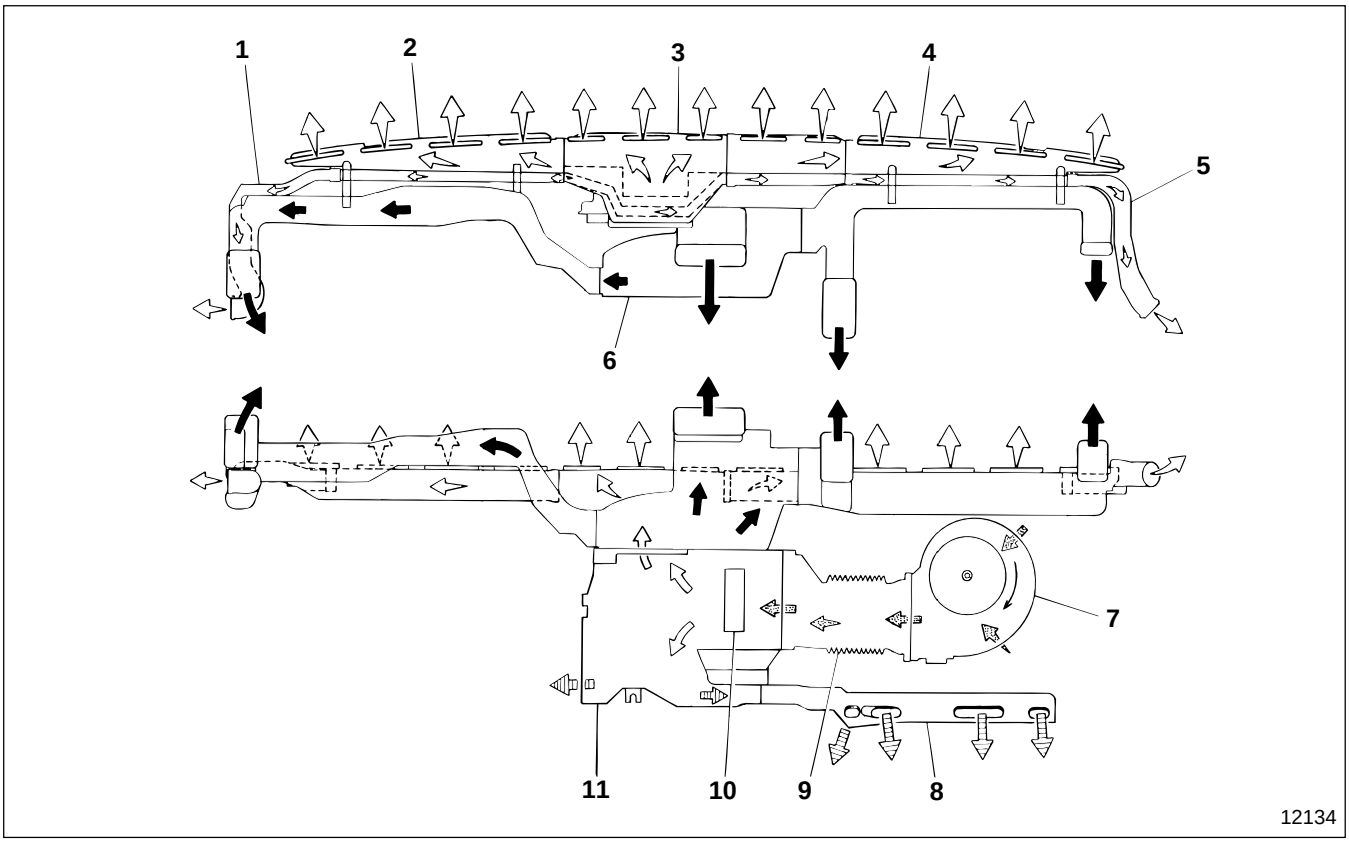
Fan switch 4 set to H position

- **1**→**2**→**4** (H)→Ground

Fan switch 4 set to either ML or MH position

The current flows through blower resistor **3** in the same way as when set to L position, routing ML or MH respectively instead of L.

Air Duct

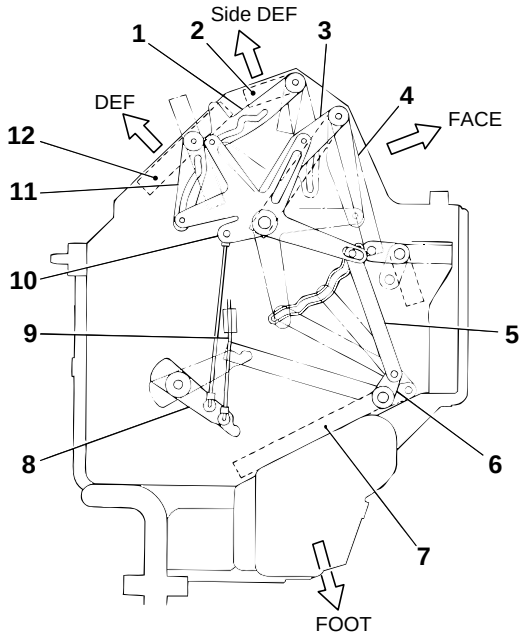


1 Defroster side duct, LH
2 Front duct, LH
3 Center duct
4 Front duct, RH
5 Defroster side duct, RH
6 Face center duct
7 Blower assembly
8 Foot duct
9 Joint duct
10 Heater core
11 Heater unit

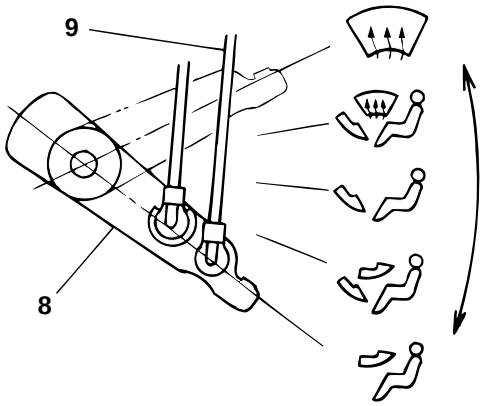
Outside air (Intake) Inside air (Circulation) Filtered air (in heater and cooling unit)

Air (FACE) ( )Air (DEF) Air (FOOT)

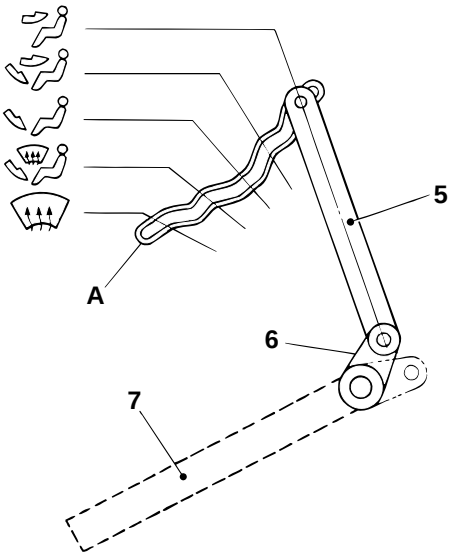
Since the opening and closing of the dampers of heater unit **11** is controlled by the switching operation of the heater unit assembly, the outside air and the inside air from blower assembly **7** flow as illustrated.



12203



12204



12205

● **Mode changeover system**

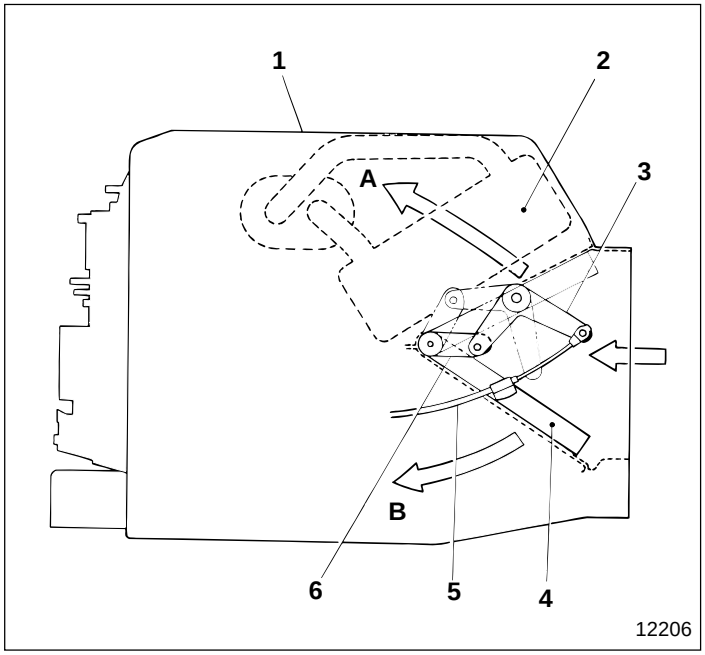
1 Plate
2 Damper (Side DEF)
3 Plate
4 Damper (FACE)
5 Plate
6 Plate
7 Damper (FOOT)
8 Lever (MODE-SUB)
9 Mode changeover control cable
10 Lever (MODE-MAIN)
11 Plate
12 Damper (DEF)

A : Rail

- The opening and closing of dampers **2**, **4**, **7, 12** is mechanically controlled by the movement of mode changeover control cable **9**, transmitted as follows:
  9→**8**→**10**→**11**→**12** (DEF)
  →**1**→**2** (Side DEF)
  →**3**→**4** (FACE)
  →**5**→**6**→**7** (FOOT)

  Plates **1, 3, 5, 6, 11** move together with lever **10**. Dampers **2, 4 , 7, 12** move together with plates 1, **3, 5, 6, 11,** but the degree of opening of the dampers is determined by the shape of the plate grooves.

- Plate **5** is connected to rail **A**. Since the plate moves along the groove of the rail, damper **7** (FOOT) can be opened and closed in combination with other modes to activate bi-level mode.

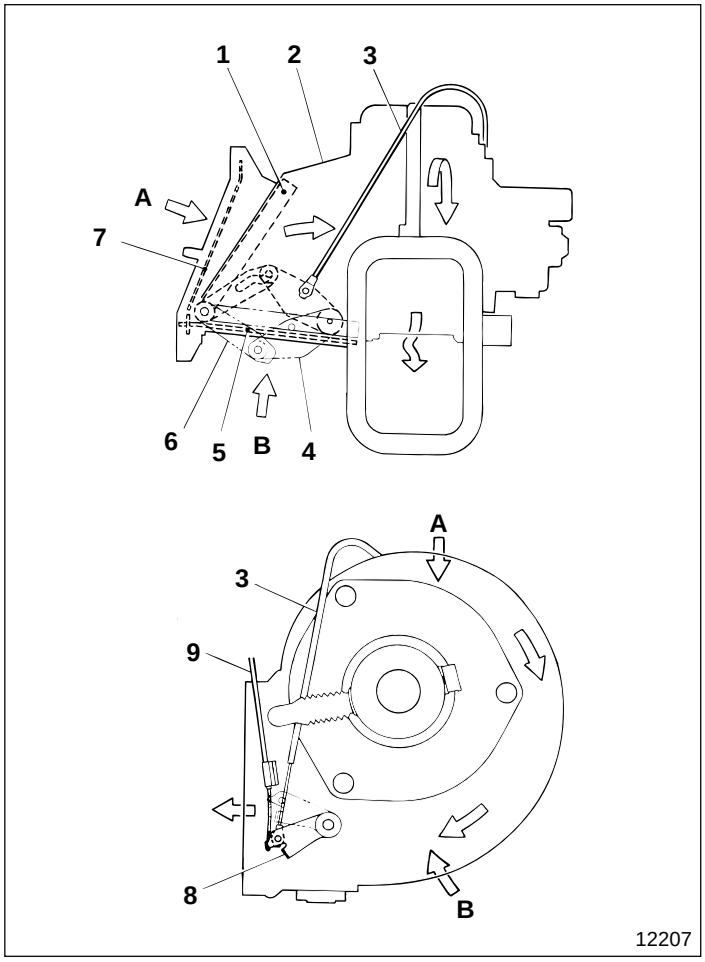


● **Air mixing control**

1 Heater unit
2 Heater core
3 Lever
4 Damper
5 Air mixing control cable
6 Plate

A : Warm air
B : Unwarmed air

- The degree of opening of damper **4** controls the flow of both air **A** that has passed through and been warmed by heater core **2**, and air **B** that has not been warmed.
- Damper **4** is mechanically operated by the movement of air mixing control cable **5**, transmitted as follows:
  5→3→6→4
  Plate **6** moves together with damper **4**.

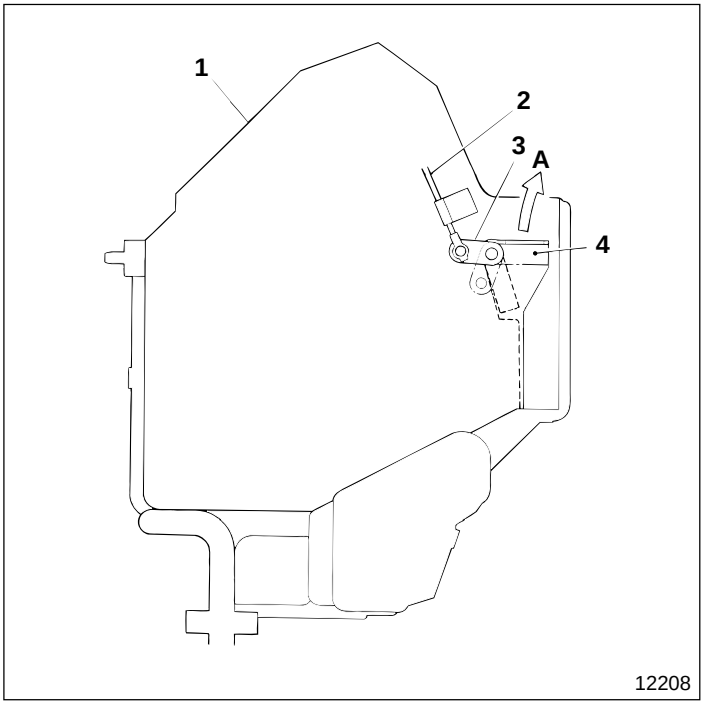


● **Air intake control**

1 Damper
2 Blower assembly
3 Control cable
4 Lever
5 Air filter (Inside air)
6 Shaft
7 Air filter (Outside air)
8 Lever
9 Air intake control cable

A : Outside air
B : Inside air

- Changeover of air intake from inside to outside is controlled by the opening and closing of damper **1**.
- Damper **1** is mechanically operated by the movement of air intake control cable **9**.
  9→8→3→4→6→1
  Shaft **6** moves together with damper **1**.



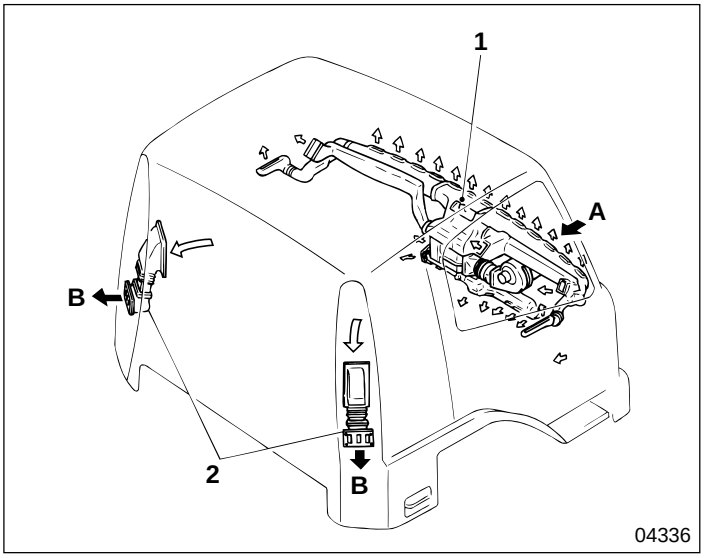
● **Air flow bypass changeover**

1 Heater unit
2 Air bypass changeover control cable
3 Plate
4 Damper

A : Air not warmed by heater unit

- Damper **4** is opened and closed to change the air flow from warm air to air that has not passed through and been warmed by the heater core.
- Damper **4** is mechanically operated by the movement of air flow bypass changeover control cable **2**, transmitted as follows:
  2→3→4
  Plate 3 moves together with damper **4**.

Ventilation System



1 Heater and duct assembly
2 Air outlet ventilation

A : Incoming outside air
B : Outgoing inside air

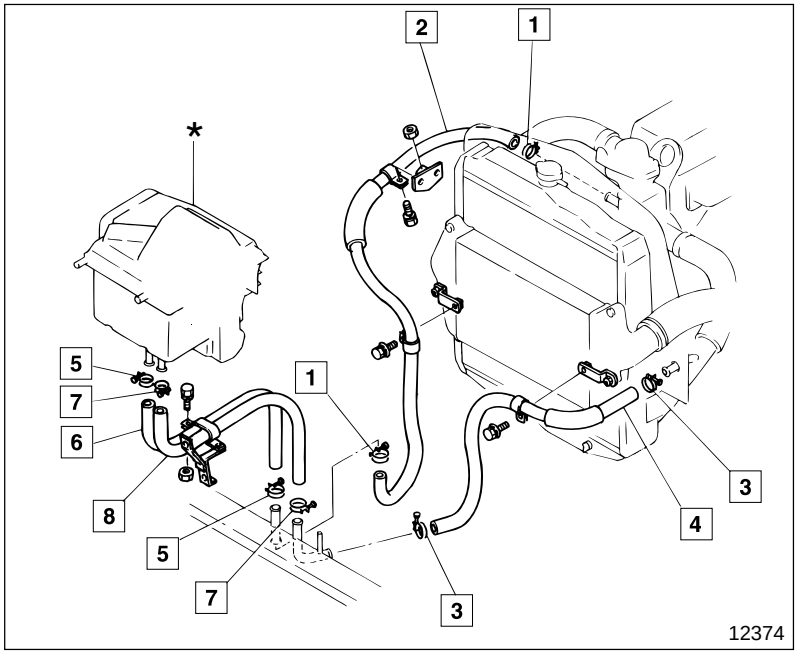
The ventilation system replaces the air in the cabin using frontal air pressure, generated when the vehicle is in motion.

TROUBLESHOOTING

Symptoms / Possible causes	Air does not flow from vents	Heater does not work well	Airflow control setting cannot be changed	Drafts from vents	Temperature control setting cannot be adjusted	Outside/inside air control cannot be changed	Air volume from vents unstable	Control switches operation heavy	Air flow bypass cannot be changed	Remarks
Blower motor coil broken or short-circuited	○									
Blower resistor operation malfunctioning							○			
Mode damper opening and closing faulty			○	○				○		
Air mixing damper opening and closing faulty				○	○			○		
Inside/outside air changeover damper opening and closing faulty				○		○		○		
Heater control assembly faulty	○	○	○	○	○	○			○	
Thermostat does not close		○								Gr 14
Engine coolant insufficient		○								Gr 14
Connector connection faulty, harness broken or grounding faulty	○		○	○	○	○				
Fuse blown	○									
Heater pipes clogged, loose or connection faulty		○								
Duct connection faulty				○						
Heater unit clogged		○								
Control cable sliding movement faulty, installation faulty			○	○		○		○	○	
Control cable connecting lever of units bent			○	○		○		○		
Control cable connecting lever sliding parts of units worn or lubricated insufficiently			○	○		○		○		
Air flow bypass changeover damper opening and closing faulty									○	

M E M O

HEATER HOSE



● **Disassembly sequence**

1 Hose clamp
2 Heater hose (Engine out)
3 Hose clamp
4 Heater hose (Engine in)
5 Hose clamp
6 Heater hose (Heater in)
7 Hose clamp
8 Heater hose (Heater out)

***** : Heater unit

NOTE

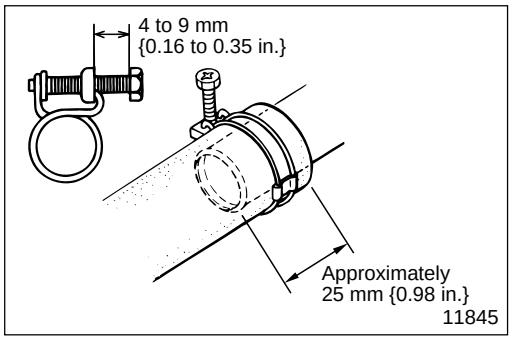
Drain engine coolant from radiator before removing the hoses. **Gr 14**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Be sure that hoses are inserted securely to prevent coolant leaking.**
- **Make sure not to mix up heater hoses 2, 4, 6, 8 when connecting them because mistaken connection would damage the heater unit.**



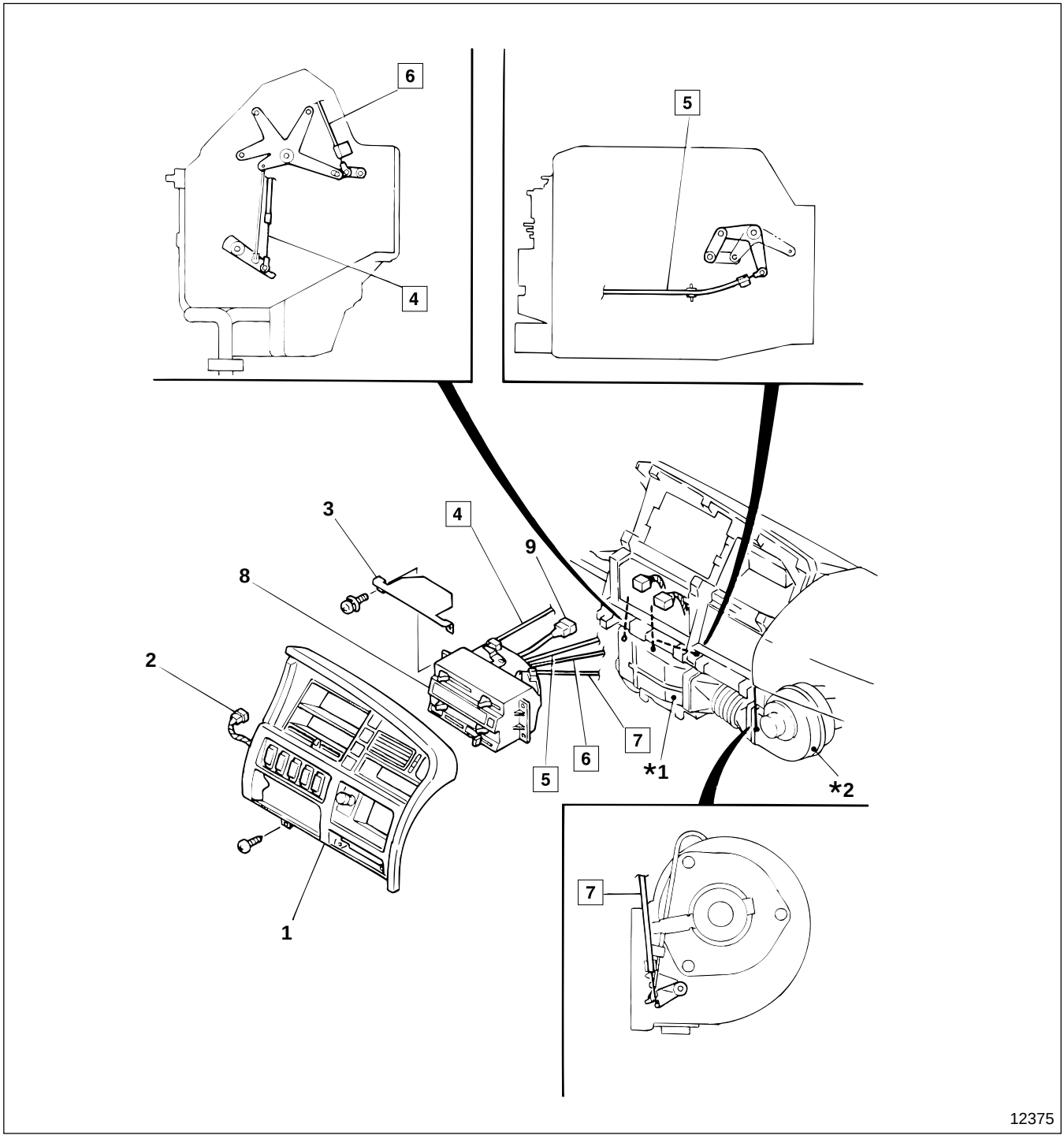
◆ Service procedure

1 **to** **8** **Installation of heater hose and hose clamp**

- Install heater hoses **2, 4, 6, 8** to conform to the dimension as illustrated.
- Tighten hose clamps **1, 3, 5, 7** to conform to the dimension as illustrated.

M E M O

HEATER CONTROL



● **Disassembly sequence**

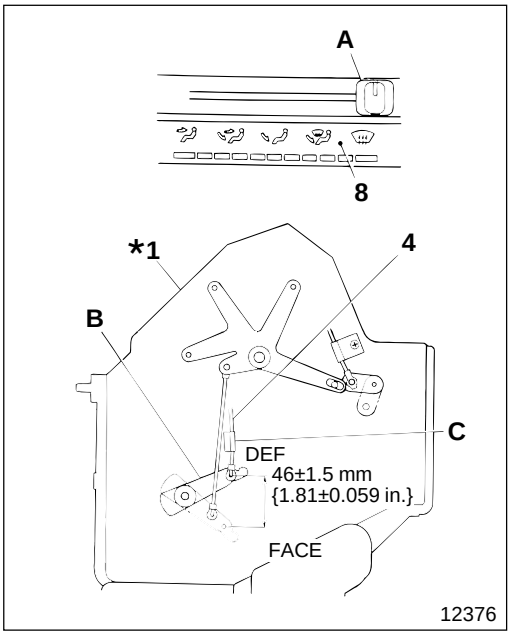
1 Center panel
2 Harness
3 Harness protector
4 Mode changeover control cable
5 Air mixing control cable
6 Air bypass changeover control cable
7 Inside/outside air changeover control cable
8 Heater control assembly 🕮 Gr 54
9 Harness

***1** : Heater unit 🕮 P55B-16
***2** : Blower assembly 🕮 P55B-16

● **Assembly sequence**

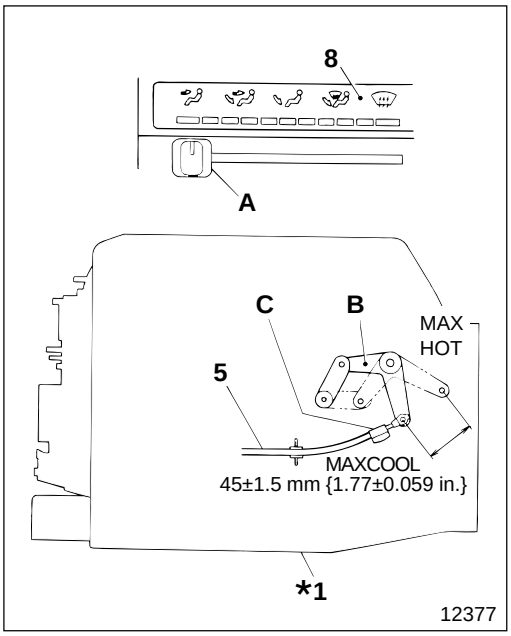
Follow the disassembly sequence in reverse.

◆ Service procedure



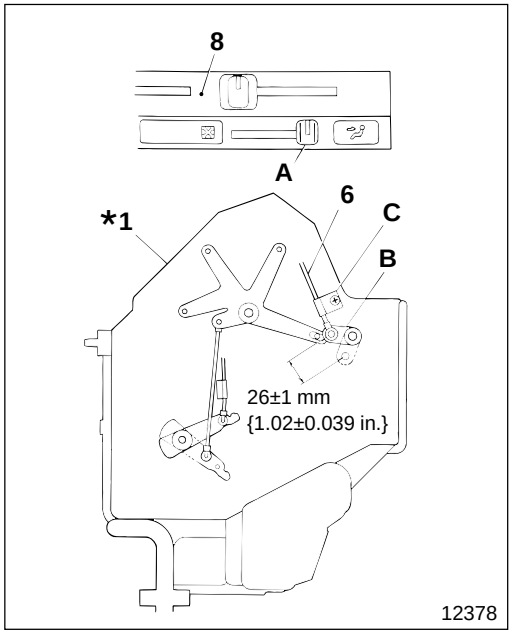
4 Installation of mode changeover control cable

- Set mode changeover lever **A** of heater control assembly **8** to (DEF).
- Set lever **B** of heater unit assembly ***1** to DEF.
- Under these conditions, install mode changeover control cable **4** onto lever **B**.
- Gently pull outer shield of mode changeover control cable **4** to DEF side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.



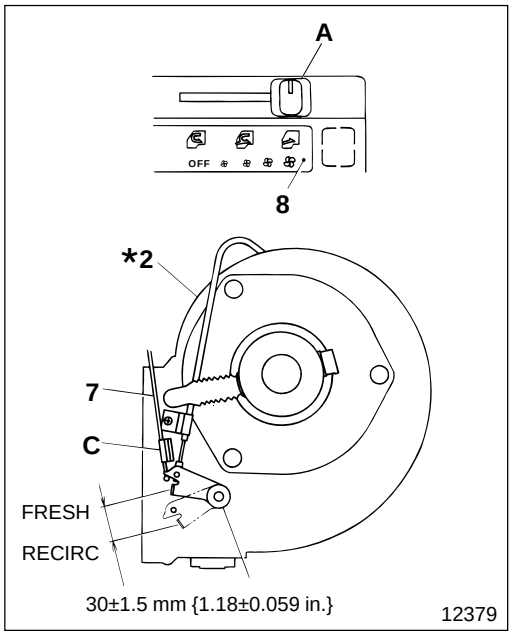
5 Installation of air mixing control cable

- Set temperature control lever **A** of heater control assembly **8** to MAX COOL.
- Set lever **B** of heater unit assembly ***1** to MAX COOL.
- Under these conditions, install air mixing control cable **5** onto lever **B**.
- Gently pull outer shield of air mixing control cable **5** to MAX COOL side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.



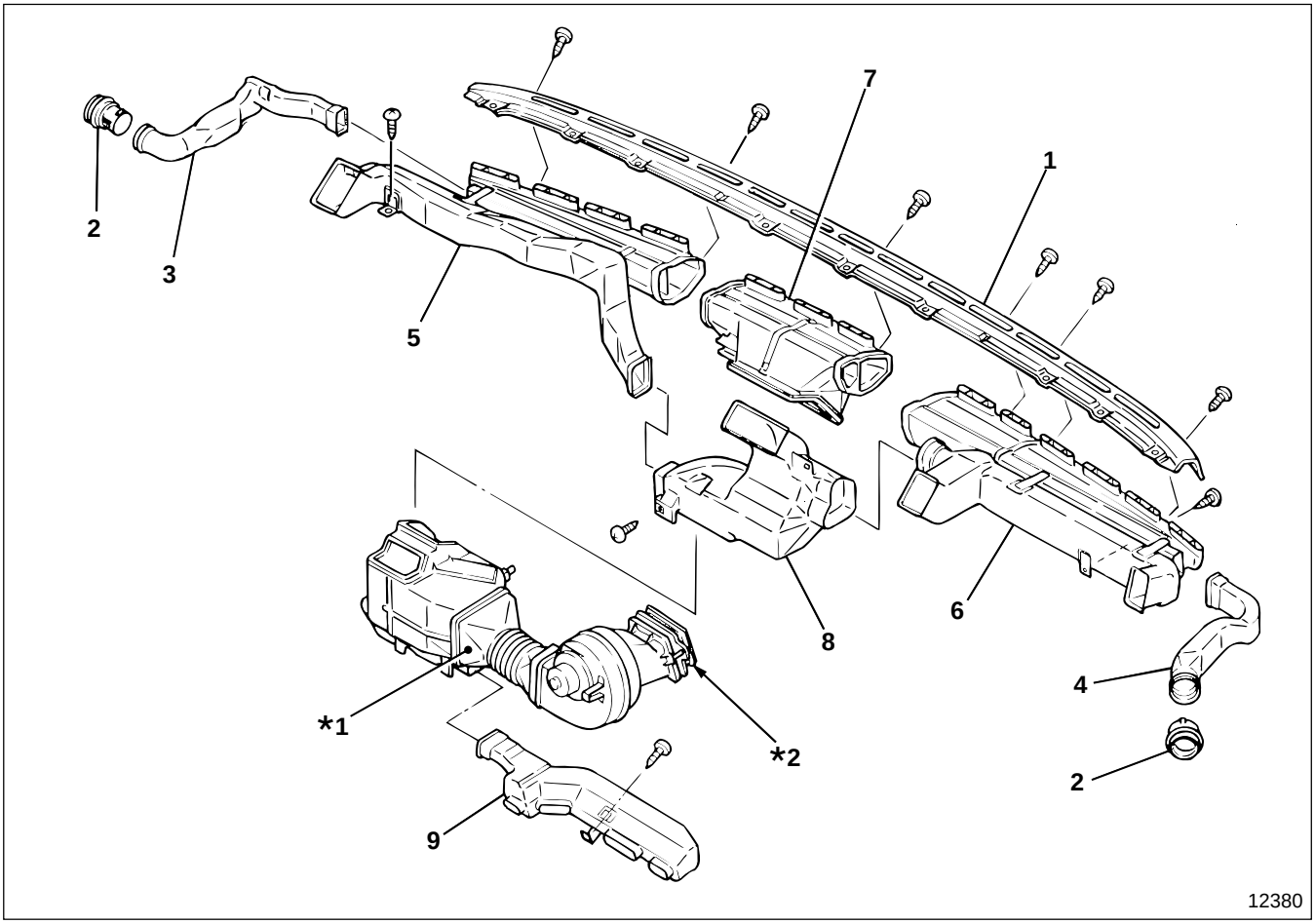
6 **Installation of air bypass changeover control cable**

- Set air bypass changeover control lever **A** of heater control assembly **8** to (OPEN).
- Set plate **B** of heater unit assembly ***1** to OPEN.
- Under these conditions, install air bypass changeover control cable **6** onto plate **B**.
- Gently pull outer shield of air bypass changeover control cable **6** to OPEN side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.



7 **Installation of inside/outside air changeover control cable**

- Set inside/outside air changeover lever **A** of heater control assembly **8** to (FRESH).
- Set lever **B** of blower assembly ***2** to FRESH.
- Under these conditions, install inside/outside air changeover control cable **7** onto lever **B**.
- Gently pull outer shield of inside/outside air changeover control cable **7** to FRESH side (load of 4.9 N {1.1 lbf, 0.5 kgf} and fasten by locking clamp **C**.



● **Disassembly sequence**

1 Duct cover 🕮 Gr 42
2 Side defroster joint
3 Side defroster duct, LH
4 Side defroster duct, RH
5 Front duct, LH
6 Front duct, RH
7 Center duct
8 Face duct
9 Foot duct

*1 : Joint duct 🕮 P55B-16
*2 : Air intake duct 🕮 P55B-16

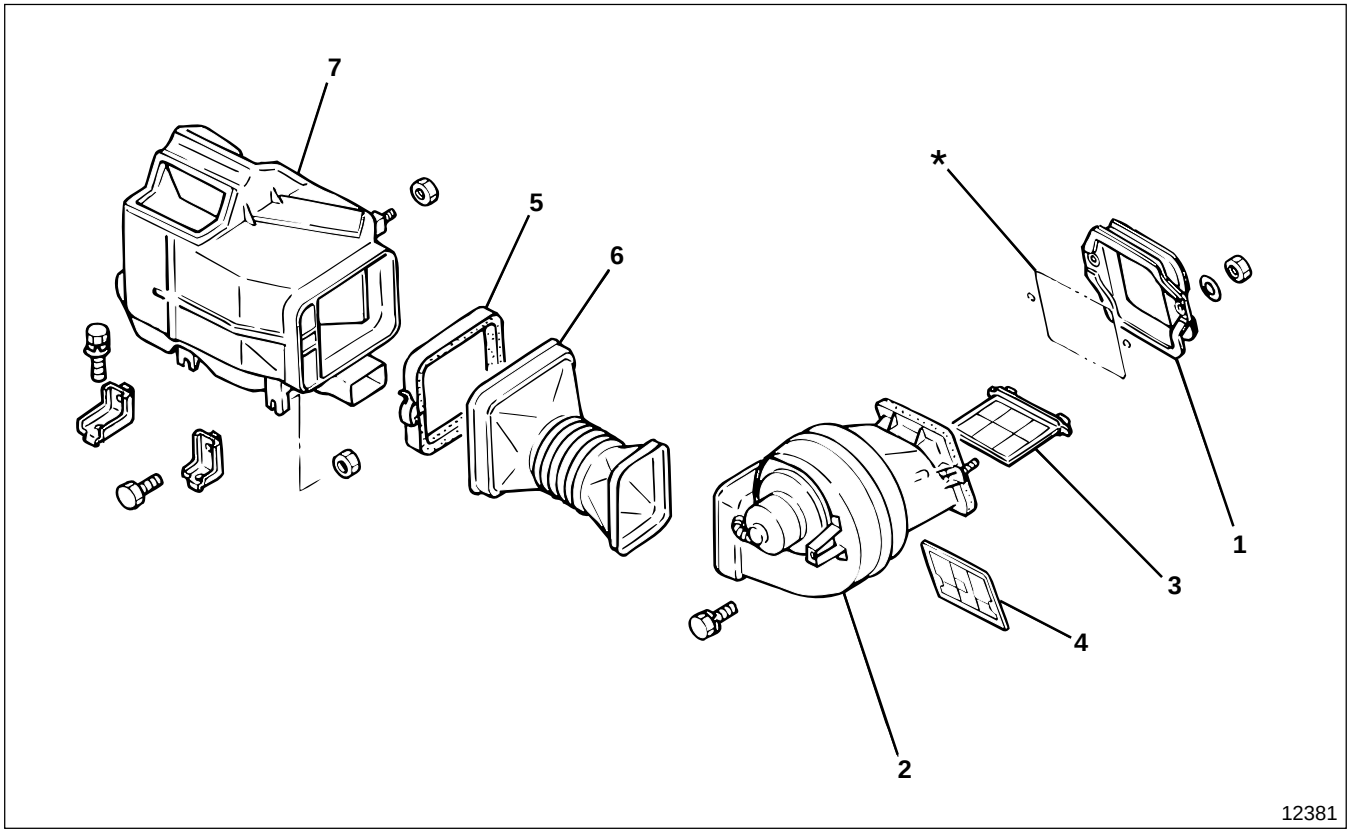
NOTE

Remove the instrument panels, crash pads and lower panels as a unit before removing ducts. 🕮 Gr 42

● **Assembly sequence**

Follow the disassembly sequence in reverse.

HEATER UNIT AND BLOWER



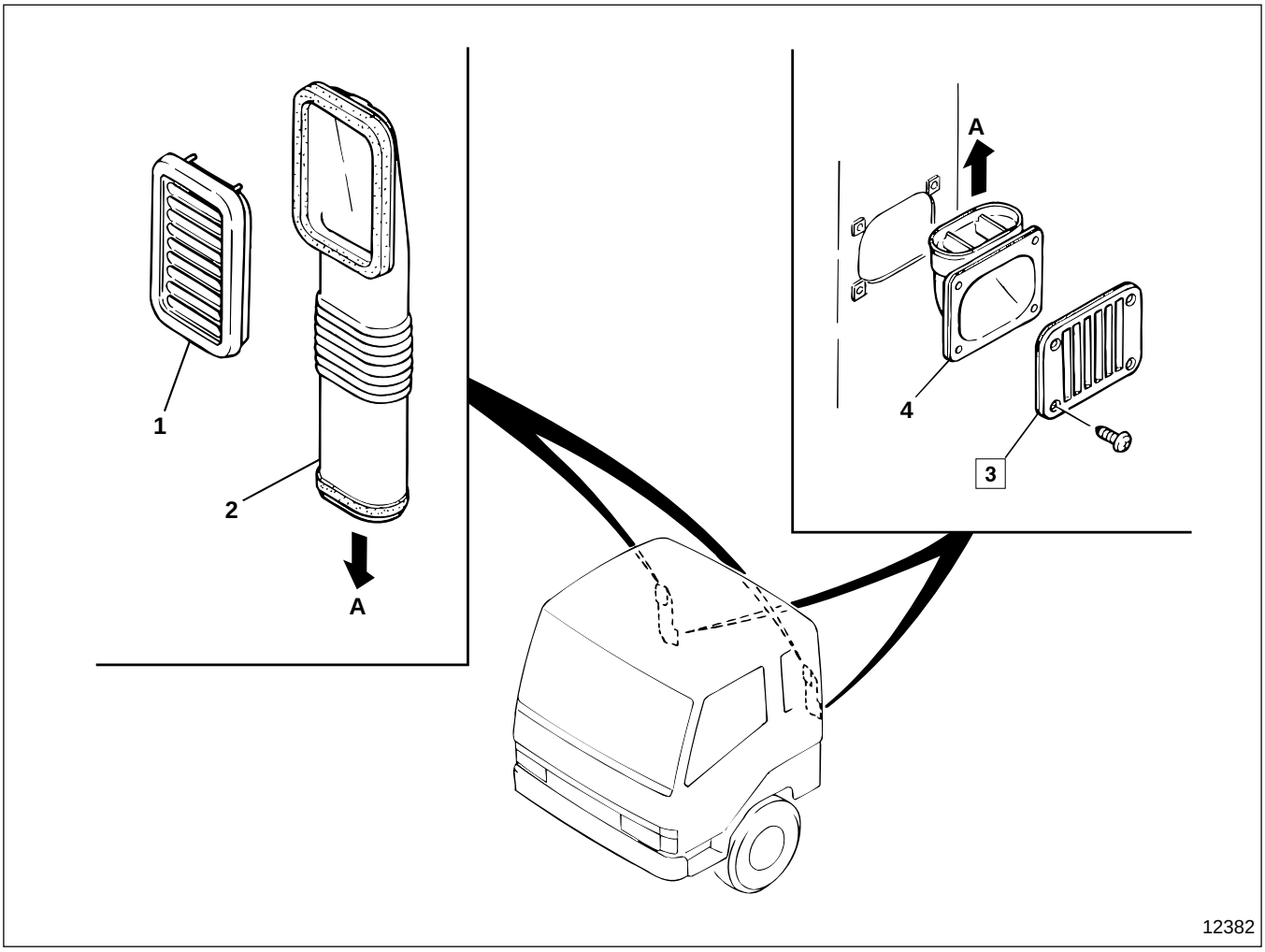
● **Disassembly sequence**

1 Air intake duct
2 Blower assembly 📖 P55B-12, Gr 54
3 Air filter (Inside air)
4 Air filter (Outside air)
5 Band
6 Joint duct
7 Heater unit 📖 P55B-12, Gr 54

***** : Dashboard

● **Assembly sequence**

Follow the disassembly sequence in reverse.



● **Disassembly sequence**

1 Inside air outlet garnishment
2 Air outlet duct (Upper)
3 Outside air outlet garnishment
4 Air outlet duct (Lower)

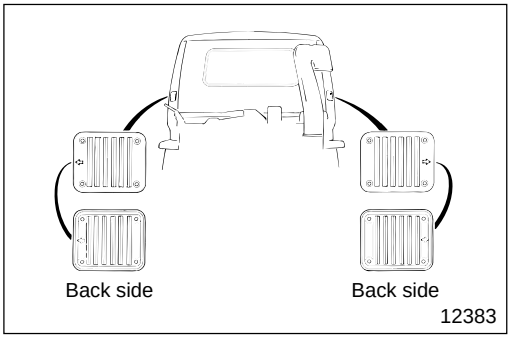
NOTE

Remove inside air outlet garnishment 1 and air outlet duct 2 after removing the side trim. 🕮 **Gr 42**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

◆ Service procedure

3 **Installation of outside air outlet garnishment**

Install air outlet garnishment **3** in the direction as illustrated.