CANTER

For Gulf Countries

2014 Model

Shop Manual

4D3 diesel engine

GROUP INDEX

GENERAL..... 00

ENGINE 11

LUBRICATION..... 12

FUEL AND ENGINE CONTROL 13

COOLING 14

INTAKE AND EXHAUST 15

FOREWORD

This Shop Manual is published for the information and guidance of personnel responsible for maintenance of Mitsubishi Fuso CANTER series truck, and includes procedures for adjustment and maintenance services.
We earnestly look forward to seeing that this manual is made full use of in order to perform correct services with no wastage.

For more details, please consult your nearest authorized Mitsubishi Fuso dealer or distributors.
Kindly note that the specifications and maintenance service figures are subject to change without prior notice in line with improvement which will be effected from time to time in the future.

OCTOBER 2013

Applicable models (engine)
- 4D33
- 4D34T4

This Shop Manual contains the information classified into the following groups.
If any system or equipment has two or more variations with significantly different construction, the variations are handled as different groups. These groups are identified by different alphabets preceded by the same number.

1. ENGINE volume (Pub.No.00ELT0042)

Group No.	Group subject
00	GENERAL
11	ENGINE
12	LUBRICATION
13	FUEL AND ENGINE CONTROL
14	COOLING
15	INTAKE AND EXHAUST

2. CHASSIS Supplement volume (Pub.No.00ELT0043)

Group No.	Group subject
00	GENERAL
22	MANUAL TRANSMISSION
34	REAR SUSPENSION
35E	ANTI-LOCK BRAKE SYSTEM (ABS)
37B	STEERING <POWER STEERING (Except FB70)>
41	BUMPER, FRAME AND REAR BODY
42	CAB MOUNTING AND TILT
55	HEATER, AIR-CONDITIONER AND VENTILATION

3. ELECTRICAL volume (Pub.No.00ELT0044)

Group No.	Group subject
54	ELECTRICAL

GROUP 00 GENERAL

VEHICLE MODEL CODING SYSTEM 00-2

EQUIPMENT TYPE CODES LIST 00-3

POWER TRAIN TABLE 00-4

HOW TO READ THIS MANUAL 00-6

CHASSIS NUMBER, VEHICLE IDENTIFICATION NUMBER, ENGINE NUMBER AND NAME PLATE 00-14

PRECAUTIONS FOR MAINTENANCE OPERATION
1. General Precautions 00-16
2. Handling of Battery 00-19
3. Handling of Sensors, Relays and Electronic Control Units 00-19
4. Handling Precautions for Electric Circuits 00-20
5. Service Precautions for Alternators 00-23
6. Intermittent Faults 00-24
7. Precautions for Arc Welding 00-25
8. Precautions When Repainting 00-25

JACKING UP THE VEHICLE 00-26

DIAGNOSIS CODES
1. Diagnosis Codes 00-28
2. Reading and Erasing the Diagnosis Code 00-29

TABLE OF STANDARD TIGHTENING TORQUES
1. Tightening Torques 00-34
2. Table of Standard Tightening Torque 00-34

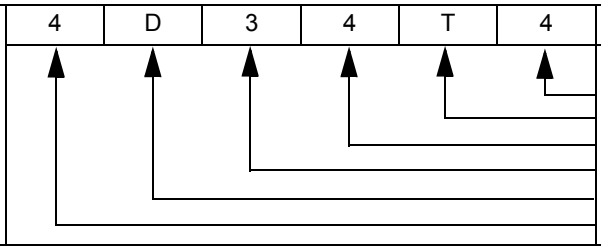
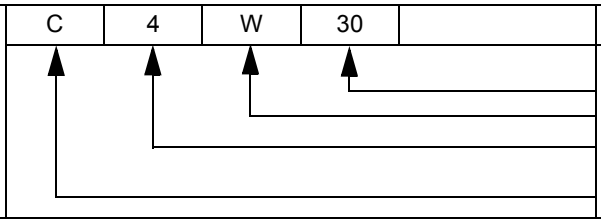
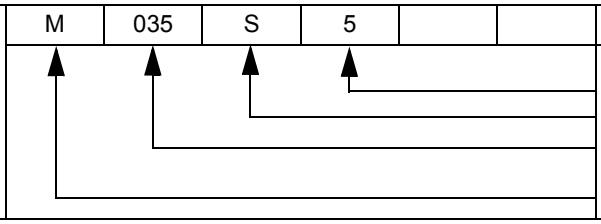
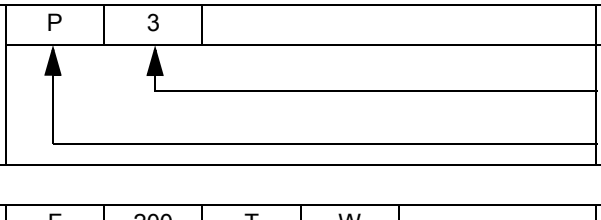
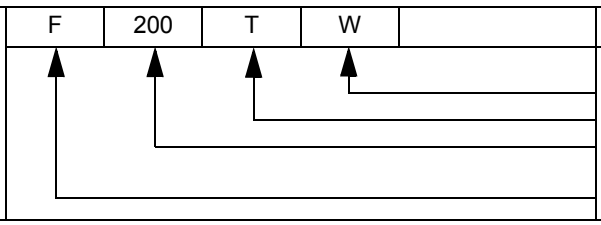
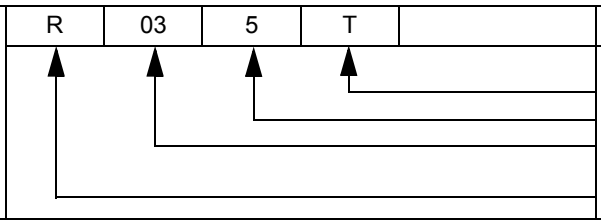
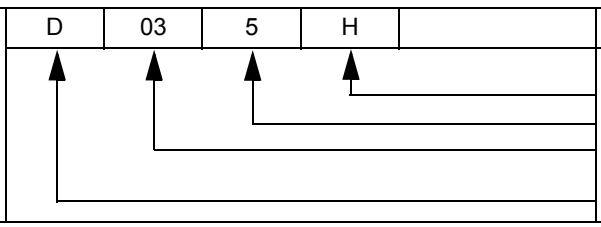
VEHICLE MODEL CODING SYSTEM

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬
F E 7 3 C B □ □ □ □ □ □ □

1	Basic vehicle type	F	Cab-over engine truck
2	Load capacity, drive system	E	2 ton class and over, 4 × 2
		G	2 ton class and over, 4 × 4
3	Cab type	7	Standard-width cab
		8	Wide cab
4	Vehicle variations, Suspension	3	Rigid axle Light duty vehicle (Payload 1500 to 3000 kg)
		4	Rigid axle Light duty vehicle (G.V.M 6000 to 6900 kg)
		5	Rigid axle Light duty vehicle (G.V.M. 7000 kg or more)
5	Engine	C	4D33
		P	4D34T4
6	Wheelbase	B	2500 mm
		C	2750 mm
		E	3350 mm
		G	3850 mm
		H	4710 mm
7	Chassis arrangement for use	None	Standard use
		D	Dump use
		Z	Wide frame
8	Rear tire arrangement, Payload	6	Rear double Payload 3000 kg to 4000 kg
9	Vehicle specification	S	With turbocharger
		W	Crew cab
		None	Standard
10	Steering position	L	Left-hand drive vehicle
11 to 13	Export specification		

- The information from ① to ⑥ is indicated on vehicles.

EQUIPMENT TYPE CODES LIST

Component	Name plate marking	Code description
Engine		
4D34T4		
Clutch		
C4W30		
Transmission		
M035S5		
Propeller shaft		
P3		
Front axle		
F200T		
Rear axle		
R035T		
Reduction and differential		
D035H		

POWER TRAIN TABLE

- FE

Vehicle model	Engine	Clutch	Transmission	Propeller shaft	Front axle	Rear axle	Reduction & Differential
FE73CB6LADG	4D33	C4W30	M035S5	P3	F200T	R033T	D033H
FE73CE6LADG	4D33	C4W30	M035S5	P3	F200T	R033T	D033H
FE84CCD6LGSG	4D33	C4W30	M035S5	P3	F200T	R033T	D033H
FE84CE6LADG	4D33	C4W30	M035S5	P3	F200T	R033T	D033H
FE84CE6WLGSG	4D33	C4W30	M035S5	P3	F200T	R033T	D033H
FE84CG6LADG	4D33	C4W30	M035S5	P3	F200T	R033T	D033H
FE85CC6LADG	4D33	C4W30	M035S5	P3	F200T	R035T	D035H
FE85CG6LADG	4D33	C4W30	M035S5	P3	F200T	R035T	D035H
FE85CHZLADG	4D33	C4W30	M035S5	P3	F200T	R040	D040H
FE85PHZSLADG	4D34T4	C4W30	M035S5	P3	F200T	R040	D040H

- FG

Vehicle model	Engine	Clutch	Transmission	Propeller shaft	Front axle	Rear axle	Reduction & Differential
FG83CE6LGSG	4D33	C4W30	M035S5	Front: P2 Rear: P3	F200TW	R035T	Front: D1H Rear: D033H
FG83CE6WLGSG	4D33	C4W30	M035S5	Front: P2 Rear: P3	F200TW	R035T	Front: D1H Rear: D033H

M E M O

HOW TO READ THIS MANUAL

This manual consists of the following parts:
- Specifications
- Structure and Operation
- Troubleshooting
- Circuits
- Electrical Equipment Installation Positions
- Inspection of Electrical Equipment
- On-vehicle Inspection and Adjustment
- Service procedures
- Connector configuration chart

On-vehicle Inspection and Adjustment
- Procedures for inspection and adjustment of individual parts and assemblies as mounted on the vehicle are described including specific items to check and adjust. Specified or otherwise, inspection should be performed for looseness, play, backlash, crack, damage, etc.

Service procedures
- Procedures for servicing components and parts off the vehicle are described centering on key points in their removal, installation, disassembly, reassembly, inspection, etc.

Inspection
- Check items subject to “acceptable/unacceptable” judgement on the basis of service standards are all given.
- Some routine visual checks and cleaning of some reused parts are not described but must always be included in actual service work.

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

DANGER ⚠	Precautions that should be taken in handling potentially dangerous substances such as battery fluid and coolant additives.
WARNING ⚠	Precautionary instructions, which, if not observed, could result in serious injury or death.
CAUTION ⚠	Precautionary instructions, which, if not observed, could result in damage to or destruction of equipment or parts.
NOTE	Suggestions or supplementary information for more efficient use of equipment or better understanding.

Terms and Units
- Front and rear
  The forward running direction of the vehicle is referred to as the front and the reverse running direction is referred to as the rear.

- Left and right
  Left hand side and right hand side, when facing the forward running direction of the vehicle, are respectively left and right.

Standard value
- Standard value dimensions in designs indicating: the design dimensions of individual parts, the standard clearance between two parts when assembled, and the standard value for an assembly part, as the case may be.

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

Tightening torque

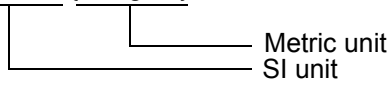
- Values are directly specified for out-of-standard tightening torques for bolts and nuts.
- Where there is no specified figure for tightening torque, follow the table covering standard tightening torques. (Values for standard tightening torques are based on thread size and material.)
- When the item is to be tightened in a wet state, “wet” is indicated. Where there is no indication, read it as dry.

Units

- Tightening torques and other parameters are given in SI* units with metric units added in brackets { }.

***SI: Le Système International d’Unités**

Example: 390 N·m {40 kgf·m}



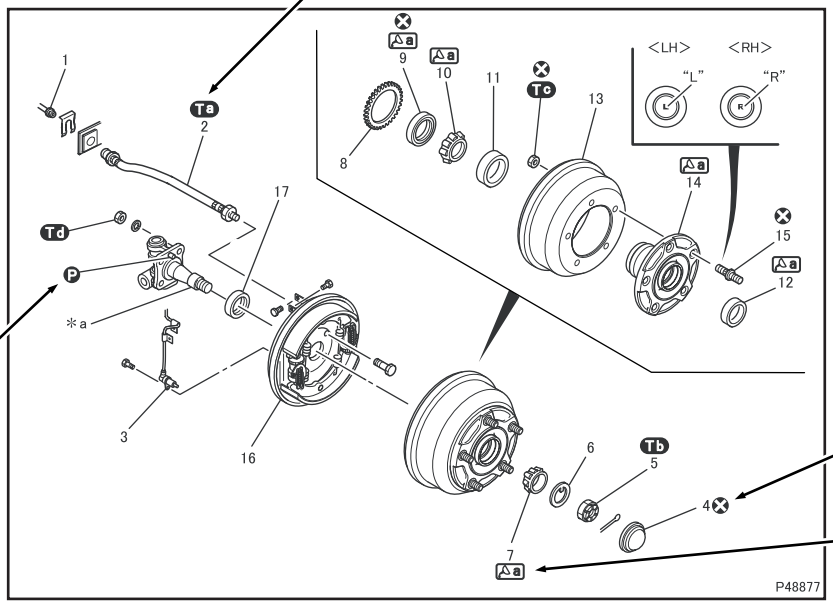
Unit		SI unit {metric unit}	Conversion factor
Force		N {kgf}	9.80665 N {1 kgf}
Moment of force		N·m {kgf·m}	9.80665 N·m {1 kgf·m}
Pressure	Positive pressure	kPa {kgf/cm^2}	98.0665 kPa {1 kgf/cm^2}
	Vacuum pressure	kPa {mmHg}	0.133322 kPa {1 mmHg}
		Pa {mmH_2O}	9.80665 Pa {1 mmH_2O}
Volume		dm^3 {L}	1 dm^3 {1 L}
Heat quantity		J {kcal}	4186.05 J {1 kcal}
Heat flow		W {kcal/h}	1.16279 W {1 kcal/h}
Power		kW {PS}	0.7355 kW {1 PS}

Illustrated Parts Breakdown and Service Procedures

Symbol	Denotation	Application	Remarks
Ta	Tightening torque	Parts not tightened to standard torques (standard torques specified where necessary for servicing)	Specified values shown in table See Table of Standard Tightening Torques for parts for which no tightening torques are specified.
P	Locating pin	Parts to be positioned for installation	
⊗	Non-reusable parts	Parts not to be reused	
a	Lubricant and/or sealant	Parts to be coated with lubricant or sealant for assembly or installation	Necessary lubricant and/or sealant, quantity required, etc. are specified in table.
a	Special tool	Parts for which special tools are required for service operation	Tool name/shape and part number are shown in table.
*a	Associated part	Parts associated with those removed/disassembled for servicing	

Denotes that tightening torque is specified.

WHEEL HUB AND BRAKE DRUM



P48877

Indicates position of locating pin.

Identifies non-reusable parts.

Denotes that coating with lubricant or sealant is required.

● Disassembly sequence

1 Brake pipe
2 Brake hose
3 Wheel speed sensor
4 Hub cap
5 Lock nut
6 Lock washer
7 Outer bearing inner race
8 Anti-lock brake system rotor
9 Oil seal
10 Inner bearing inner race
11 Inner bearing outer race
12 Outer bearing outer race
13 Brake drum
14 Wheel hub
15 Hub bolt
16 Front drum brake (See Gr35A.)
17 Spacer

*a : Knuckle
P : Locating pin
⊗ : Non-reusable parts

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (unit : mm)

Location	Maintenance item		Standard value	Limit	Remedy
7, 10, 11, 12	Starting torque of wheel hub bearing (tangential force at hub bolt position with oil seal fitted in)		1 to 3.5 N·m {0.10 to 0.35 kgf·m} (tangential force:8.8 to 28.4 N {0.9 to 2.9 kgf})	–	Adjust or replace
14	Brake drum	Inside diameter	320	322	Repair or replace
		Cylindricality	0.05	0.20	

These location numbers correspond with disassembly sequence numbers.

P58289E

"Wet" is indicated when part is to be tightened with oil or grease applied to its threaded section.

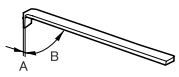
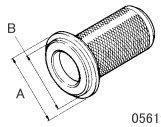
Tightening torque (unit: N·m{kgf·m})

Mark	Part to be tightened	Tightening torque	Remarks
Ta	Brake force tightening	13 to 17{1.3 to 1.7}	–
Tb	Lock nut	113 ± 15{11.5 ± 1.5}	Wet
Tc	Nut (brake drum and wheel hub mounting)	343 ± 39{35 ± 4}	–
Td	Nut (front drum brake mounting)	118 ± 20{12 ± 2}	–

Lubricant and/or sealant

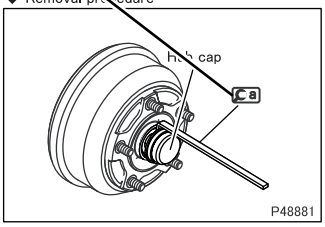
Mark	Point of application	Specified lubricant and/or sealant	Quantity
La	Between rolls of outer bearing inner race and inner bearing inner race	Mitsubishi wheel bearing grease	As required
	Inside wheel hub		395 ± 40 g

Special tools (unit: mm)

Mark	Tool name and shape	Part No.	Application
Ca	Hub Cap Wrench A: 0.5°, B: 78°  P49261	MB999108	Removal of hub cap
Cb	Oil Seal Installer A: φ84, B: φ70  05619	MB999097	Installation of oil seal

Identification marks for special tools are the same as used in the text.

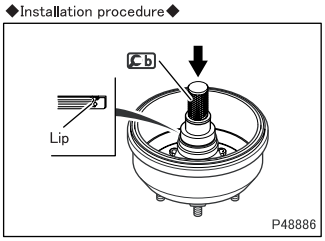
◆ Removal procedure



P48881

■Removal: Hub cap

◆Installation procedure◆

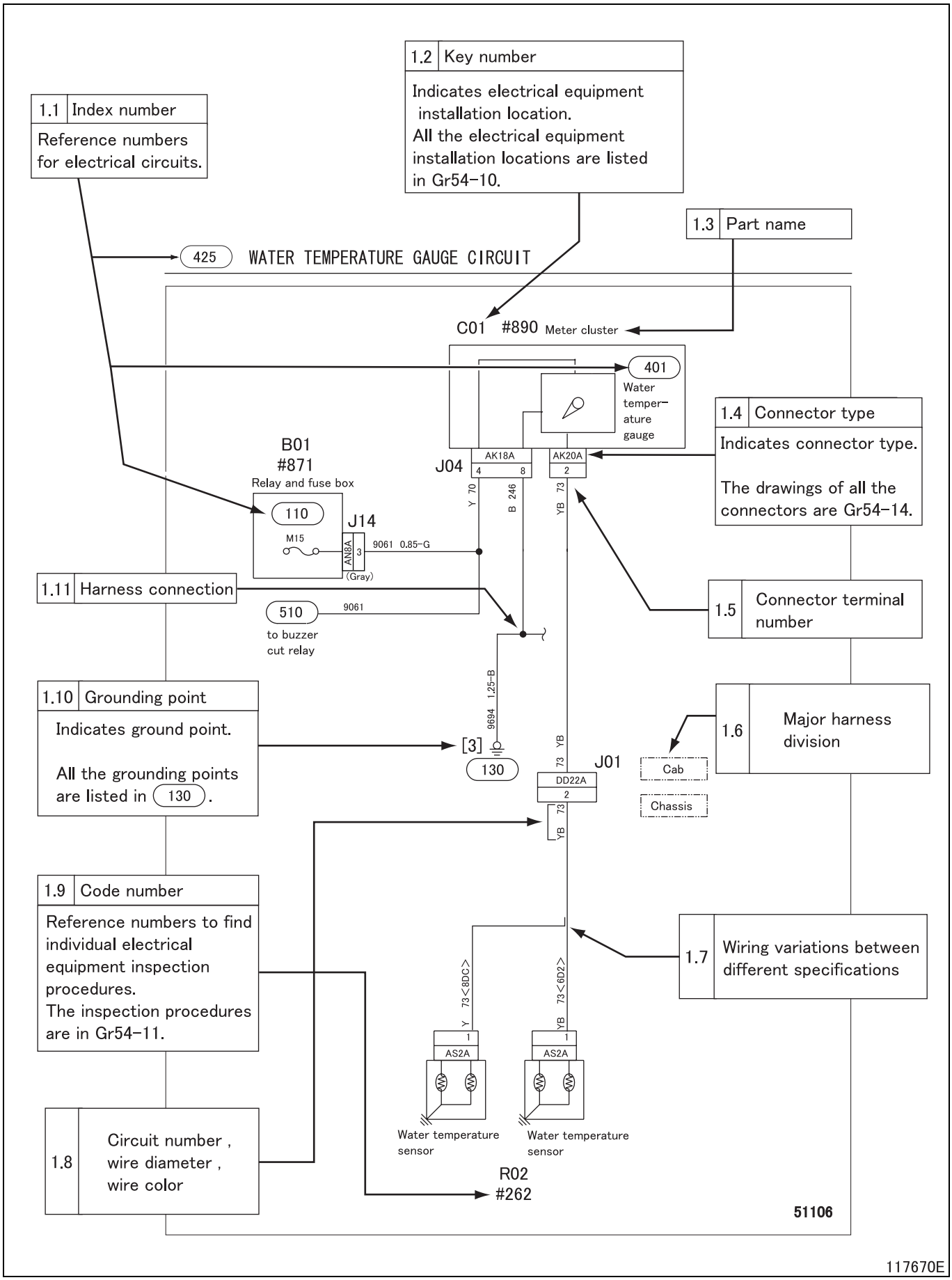


P48886

■Installation: Oil seal
Apply grease to the lip of the oil seal, then fit the oil seal onto the wheel hub in the illustrated direction.

P58290E

How to Read Circuits (Electrical)



1.1 Index number: (100) to (999)

- Index numbers are used as reference numbers for electrical circuits. Each electrical circuit has been assigned its own index number.

1.2 Key number: A01 to Z99

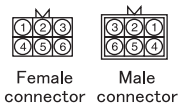
- Key numbers indicate electrical equipment installation locations. The installation location of an electrical equipment can be easily found using its key number shown in a circuit diagram.
  All of the electrical equipment installation locations are listed in Gr54-10.

1.3 Part name

1.4 Connector type (type indication)

- A list of the connectors used is included in Gr54-14.

1.5 Connector terminal number



Female connector Male connector

Connector terminal numbering starts with the upper left corner for female connectors and with the upper right corner for male connectors.

P50678E

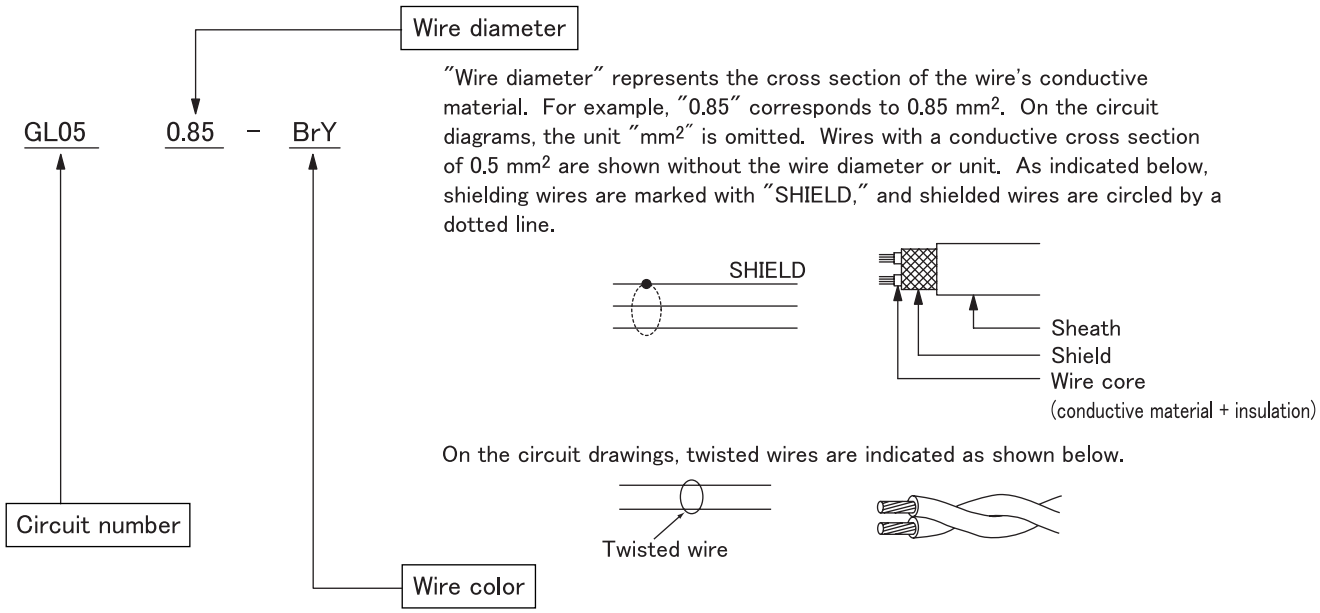
1.6 Major harness division

- Major harness divisions are shown.

1.7 Wiring variations between different specifications

- Variations in wiring/circuit between different vehicle specifications are clearly indicated as shown.

1.8 Circuit number, wire diameter, wire color



"Wire diameter" represents the cross section of the wire's conductive material. For example, "0.85" corresponds to 0.85 mm^2. On the circuit diagrams, the unit "mm^2" is omitted. Wires with a conductive cross section of 0.5 mm^2 are shown without the wire diameter or unit. As indicated below, shielding wires are marked with "SHIELD," and shielded wires are circled by a dotted line.

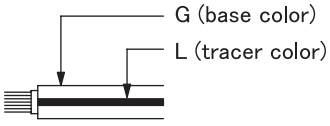
On the circuit drawings, twisted wires are indicated as shown below.

Wire colors are represented by the first letter of the color.
Colors that all start with the letter "B" are indicated as follows.

- BLACK → B
- BLUE → L
- BROWN → Br

Wires that have both base and tracer colors are indicated by two letters.

RY (Yellow tracer on Red base)
GL (Blue tracer on Green base)



P50680E

1.9 Code number: #001 to #999

- Code numbers are reference numbers to find individual electrical equipment inspection procedures. The inspection procedure for an electrical equipment can be found using its code number shown in a circuit diagram.

1.10 Grounding point: [1] to [99]

- Locations where wires are grounded to the vehicle. All of the grounding points are listed in (130).

1.11 Harness connection

- The arrow in the wiring diagram indicates where harnesses are connected, and NOT the flow of electricity.

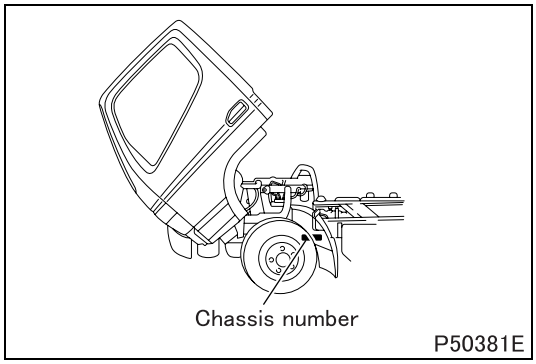
Wire color

Wire color	Base color + tracer						
B Black	BW Black/white	BY Black/yellow	BR Black/red	BG Black/green	BL Black/blue	BO Black/orange	
	BP Black/pink	BV Black/violet	B Br Black/brown				
Br Brown	BrW Brown/white	BrB Brown/black	BrY Brown/yellow	BrR Brown/red	BrG Brown/green	BrL Brown/blue	
	BrGr Brown/gray	BrV Brown/Violet					
G Green	GW Green/white	GR Green/red	GY Green/yellow	GB Green/black	GL Green/blue	GO Green/orange	
	GGr Green/gray	GBr Green/brown	GV Green/violet				
Gr, Gy Gray	GrL, GyL Gray/blue	GrR, GyR Gray/red	GrB, GyB Gray/black	GrG, GyG Gray/green	GrW, GyW Gray/white	GrY Gray/yellow	
	GrG Gray/green	GrBr Gray/brown					
L Blue	LW Blue/white	LR Blue/red	LY Blue/yellow	LB Blue/black	LO Blue/orange	LG Blue/green	
	LGr Blue/gray	LBr Blue/brown					
Lg Light green	LgR Light green/red	LgY Light green/yellow	LgB Light green/black	LgW Light green/white			
O Orange	OL Orange/blue	OB Orange/black	OG Orange/green				
P Pink	PB Pink/black	PG Pink/green	PL Pink/blue	PW Pink/white	PGr Pink/gray	PV Pink/violet	
Pu Purple							
R Red	RW Red/white	RB Red/black	RY Red/yellow	RG Red/green	RL Red/blue	RO Red/orange	
	RBr Red/brown	Rgr Red/Gray					
Sb Sky blue							
V Violet	VY Violet/yellow	VW Violet/white	VR Violet/red	VG Violet/green	VGr Violet/gray	VB Violet/black	
W White	WR White/red	WB White/black	WL White/blue	WG White/green	WO White/orange	WV White/violet	
	WBr White/brown	WY White/yellow					
Y Yellow	YR Yellow/red	YB Yellow/black	YG Yellow/green	YL Yellow/blue	YW Yellow/white	YO Yellow/orange	
	YP Yellow/pink	YV Yellow/violet	YGr Yellow/gray	YBr Yellow/brown			

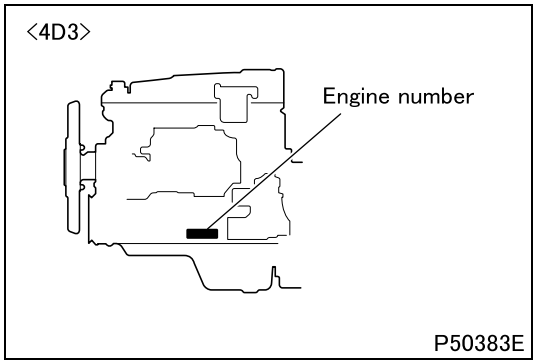
M E M O

CHASSIS NUMBER, VEHICLE IDENTIFICATION NUMBER, ENGINE NUMBER AND NAME PLATE

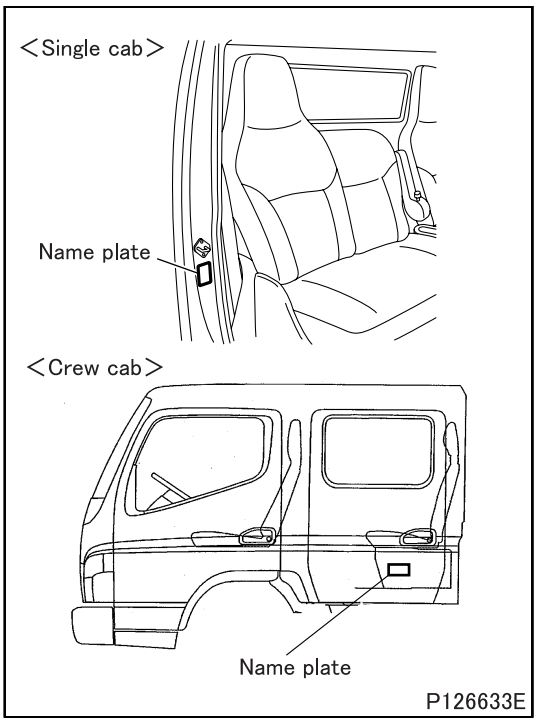
- Serial chassis and engine numbers are assigned to the vehicles and engines in manufacturing sequence. Every vehicle and engine has its own number. These numbers are required for registration and related inspection of the vehicle.



Chassis number

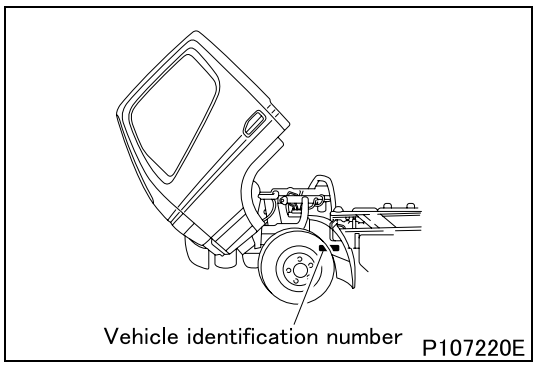


Engine number


<Single cab>
Name plate
<Crew cab>
Name plate
P126633E

Name plate

- Name plate contains the following information.
  - Month and year of manufacture
  - Gross vehicle mass
  - Front permissible load
  - Rear permissible load
  - Chassis number or vehicle identification number



Vehicle identification number (V.I.N.)

Example: J L 6 B 5 E 1 K □ E K □□□□□□

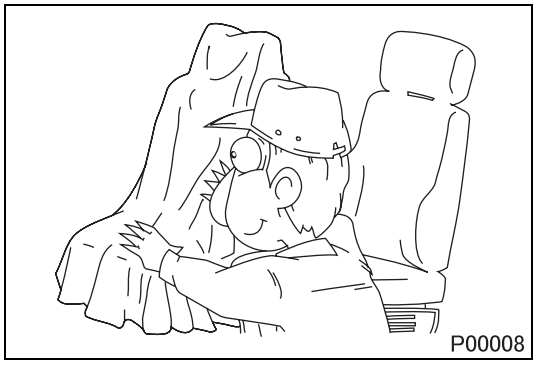
(1)(2)(3)(4)(5)(6)(7)(8)(9)(10)(11) (12)

(1)	Country	J : Japan
(2)	Make	L : Mitsubishi Fuso Truck & Bus
(3)	Vehicle type	6 : Incomplete vehicle
		7 : Truck
(4)	G.V.W./Brake system	B : 3500 kg < G.V.W. ≤ 1200 kg/ Hydraulic
(5)	Model	5 : FE73C
		6 : FE84C
		7 : FE85C
		8 : FG83C
		9 : FE85P-Z
(6)	Series (wheelbase)	1 : 2.3 to 2.59 m
		C : 2.6 to 2.89 m
		D : 2.9 to 3.19 m
		E : 3.2 to 3.49 m
		G : 3.8 to 4.09 m
		H : 4.1 to 4.39 m
(7)	Chassis cab type	1 : Cargo
		2 : Dump
		5 : Others
(8)	Engine	J : 3.097 L Diesel engine (4D34T4)
		P : 4.214 L Diesel engine (4D33)
(9)	Check digit	
(10)	Model year	E : 2014
		F : 2015
		G : 2016
		H : 2017
(11)	Plant	K : Kawasaki
(12)	Serial No.	

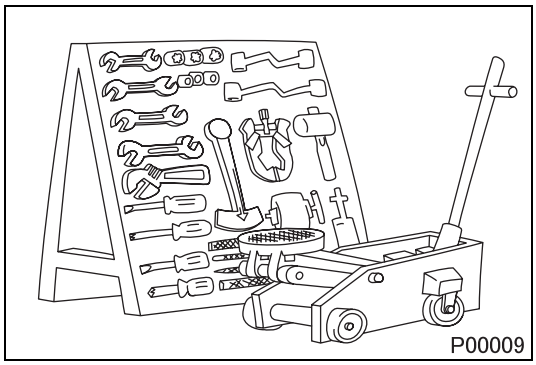
PRECAUTIONS FOR MAINTENANCE OPERATION

1. General Precautions

- Before performing service operations, inquire into the customer's complaints and ascertain the condition by checking the total distance traveled, the conditions under which the vehicle is operated, and other relevant factors on the vehicle. And note the necessary information. This information will help you to service the vehicle efficiently.
  - Check the location of the fault, and identify its cause. Based on your findings, determine whether parts must be removed or disassembled. Then, follow the service procedure given in this manual.


P00008

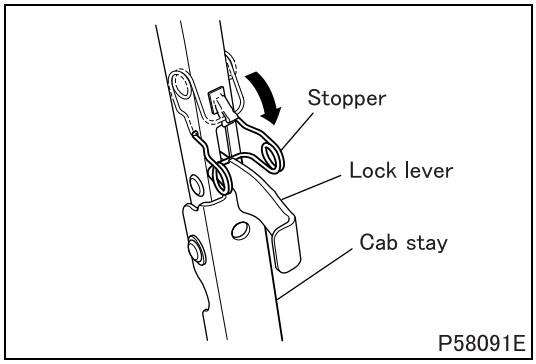
- Perform service operations on a level surface. Before starting, take the following preparatory steps:
  - To prevent soiling and damage, place covers over the seats, trim and floor in the cab and over the paintwork of the body.


P00009

- Prepare all the general and special tools necessary for the job.

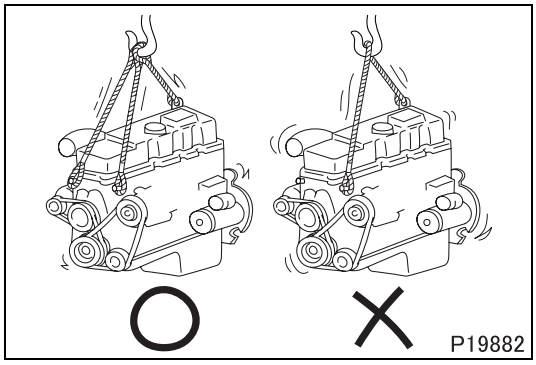
WARNING ⚠

- **Special tools must be used wherever specified in this manual. Do not attempt to use other tools since they could cause injuries and/or vehicle damage.**

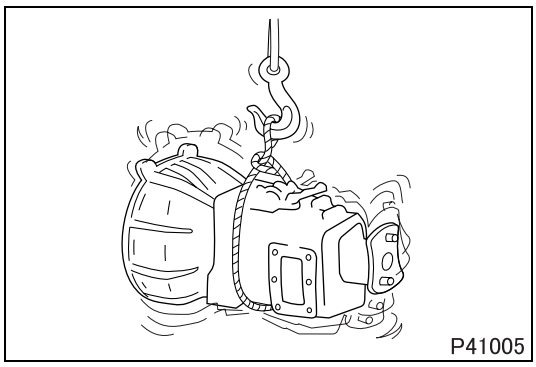


P58091E

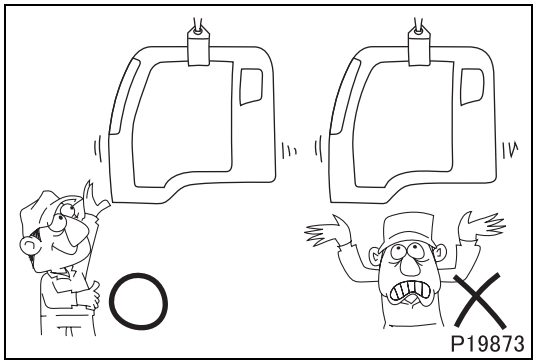
- After manually tilting the cab, be sure to engage the stopper with the lock lever to secure the cab stay in a rigid state.


P19882

- Take extreme care when removing/installing heavy items such as engine, transmission and axle. When lifting heavy items using a cable etc., observe the following precautions.
  - Identify the weight of the item being lifted. Use the cable that is strong enough to support the weight.

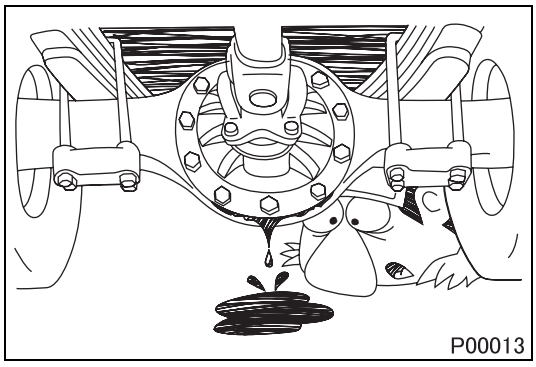


- If lifting eyes are not provided on the item being lifted, tie a cable around the item taking into account the item's center of gravity.

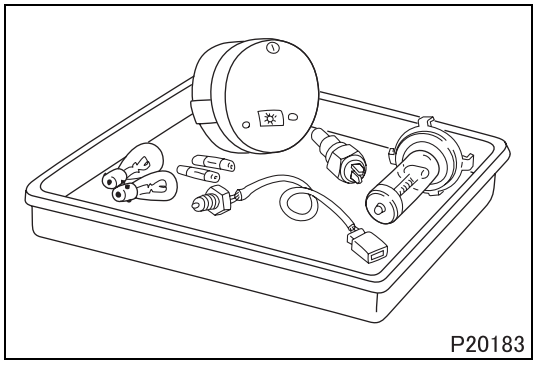


- Do not allow anyone to pass or stay under a lifted item which may possibly fall.

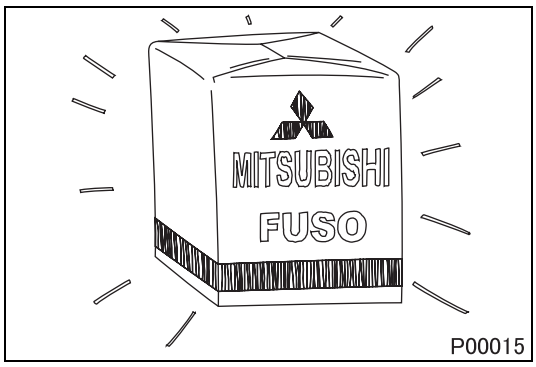
- Never work in shoes that have oily soles.
  When working with a partner or in a group, use pre-arranged signals and pay constant attention to safety. Be careful not to touch switches and levers unintentionally.



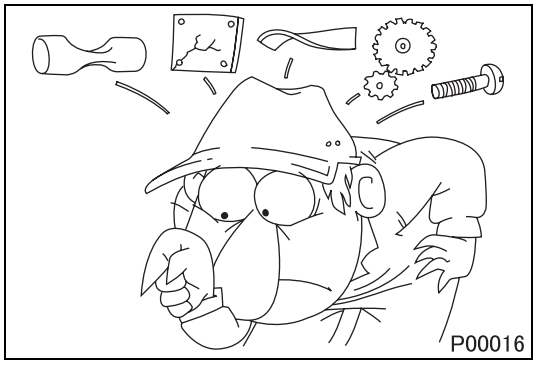
- Inspect for oil leakage etc. before washing the vehicle. If the order is reversed, any oil leakage or fault that may exist could go unnoticed during inspection.



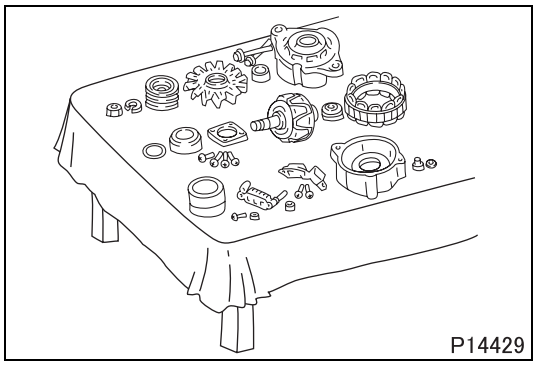
- Prepare replacement parts ready for installation.



- Oil seals, packings, O-rings and other rubber parts, gaskets, and split pins must be replaced with new ones after removal. Use only genuine MITSUBISHI replacement parts.



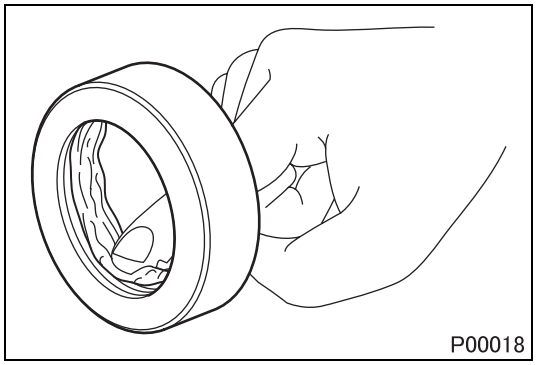
- When disassembling parts, visually check them for wear, cracks, damage, deformation, deterioration, rust, corrosion, defective rotation, fatigue, clogging and any other possible defect.



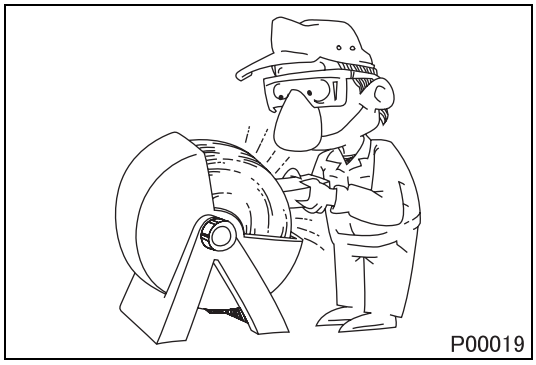
- To facilitate correct reassembly of parts, make alignment marks on them before disassembly and arrange disassembled parts neatly. Make punch marks and other alignment marks where they will not detract from parts' functionality and appearance.
- After removing parts from the vehicle, cover the area to keep it free of dust.

CAUTION ⚠

- **Be careful not to mix up identical parts, similar parts and parts that have left/right alignments.**
- **Keep new replacement parts and original (removed) parts separately.**

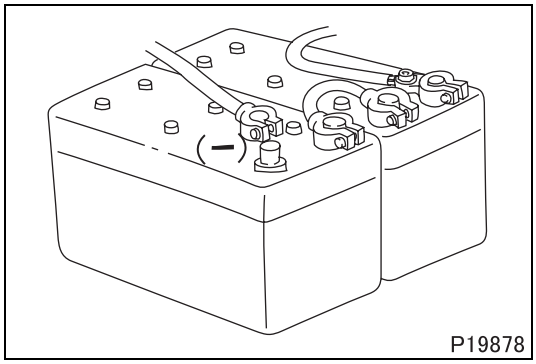


- Apply the specified oil or grease to U-seals, oil seals, dust seals and bearings before reassembly.
- Always use the specified oils and greases when performing inspection or replacement. Immediately wipe away any excess oil or grease with a rag.



- Wear safety goggles when using a grinder or welder. Wear gloves when necessary, and watch out for sharp edges and other items that might wound your hands.

2. Handling of Battery



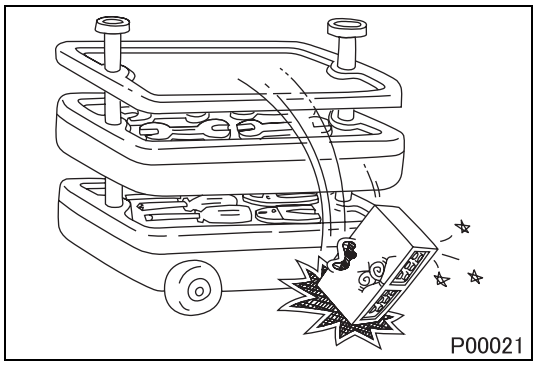
2.1 Handling of battery cable

- Before working on the electrical system, disconnect the (–) battery cable to prevent short circuits.

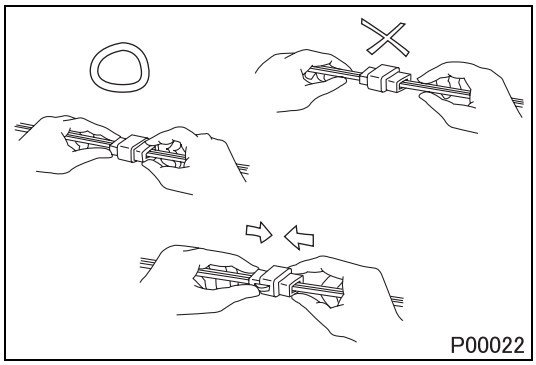
CAUTION ⚠

- **Make sure that the starter switch and lighting switches are OFF before disconnecting or connecting battery cable. (Semiconductor components may otherwise be damaged.)**
- **Disconnect the (–) battery cable, then insulate the (–) terminal of the battery and (–) battery cable with insulating tape or the like.**
- **If the (–) battery cable is not disconnected, battery voltage will remain constantly applied to the B terminal, inviting danger of electric shock.**

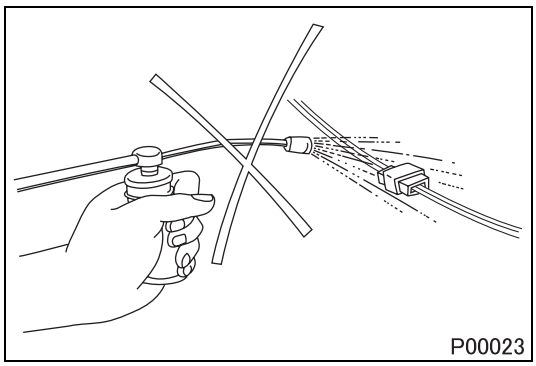
3. Handling of Sensors, Relays and Electronic Control Units



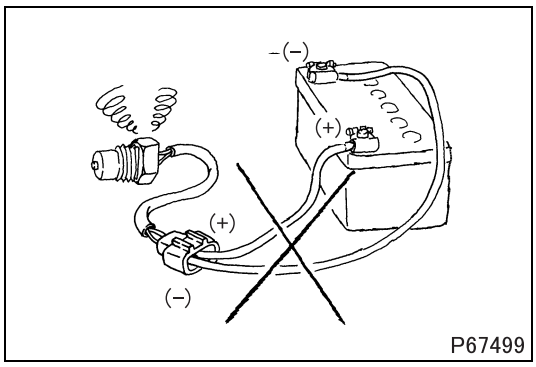
- Carefully handle sensors relays, and other items that are sensitive to shock and heat. Do not remove or paint the cover of any control unit.



- When separating connectors, grasp the connectors themselves rather than the harnesses.
- To separate locking connectors, first push them in the direction of the arrows. To reconnect locking connectors, push them together until they click.

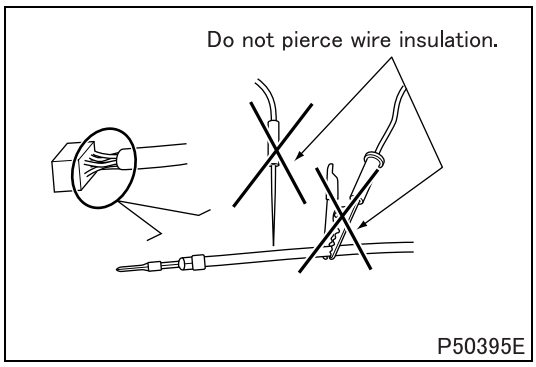


- Before washing the vehicle, cover electrical parts to keep them dry. (Use plastic sheets or equivalent.) Keep water away from harness connectors and sensors and immediately wipe off any water that gets on them.



- When applying a voltage to a part for inspection purposes, check that the (+) and (–) cables are connected properly then gradually increase the voltage from zero. Do not exceed the specified voltage.
  Remember that control units and sensors do not necessarily operate on the battery voltage.

4. Handling Precautions for Electric Circuits



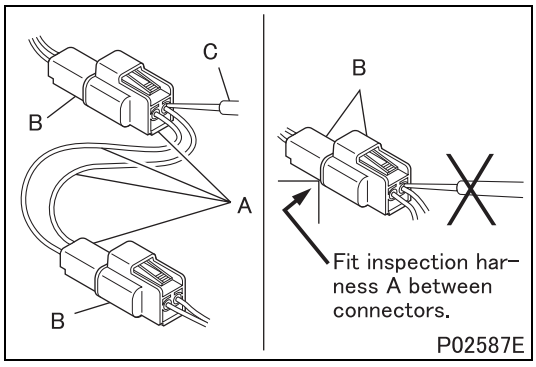
CAUTION ⚠

- **Do not pierce wire insulation with test probes or alligator clips when performing electrical inspections. Doing so can, particularly with the chassis harness, hasten corrosion.**

4.1 Inspection of harnesses

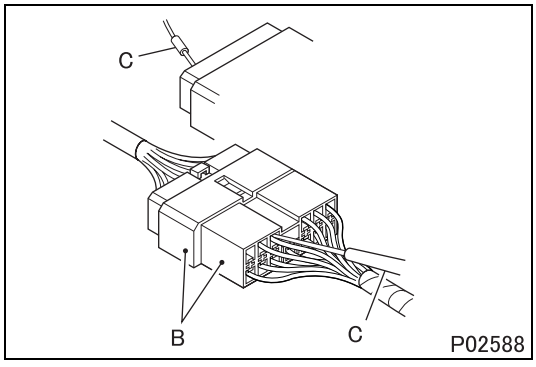
(1) Inspections with connectors fitted together

(1.1) Waterproof connectors



- Connect an inspection harness and connector A between the connectors B of the circuit to be inspected. Perform the inspection by applying a test probe C to the connectors of the inspection harness. Do not insert the test probe C into the wire-entry sides of the waterproof connectors since this would damage their waterproof seals and lead to rust.

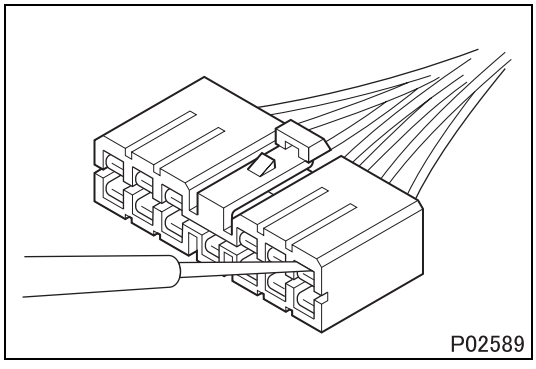
(1.2) Non-waterproof connectors



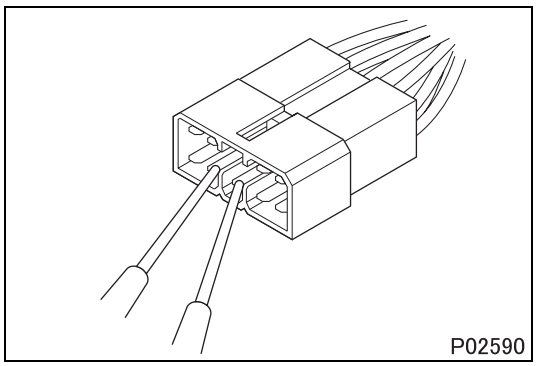
- Perform the inspection by inserting a test probe C into the wire-entry sides of the connectors. An extra-narrow probe is required for control unit connectors, which are smaller than other types of connector. Do not force a regular-size probe into control unit connectors since this would cause damage.

(2) Inspections with connectors separated

(2.1) Inspections on female terminals



- Perform the inspection by carefully inserting a test probe into the terminals. Do not force the test probe into the terminals since this could deform them and cause poor connections.

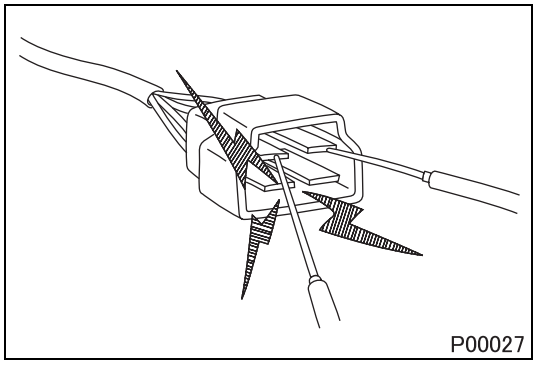

P02590

(2.2) Inspections on male terminals

- Perform the inspection by applying test probes directly to the pins.

CAUTION ⚠

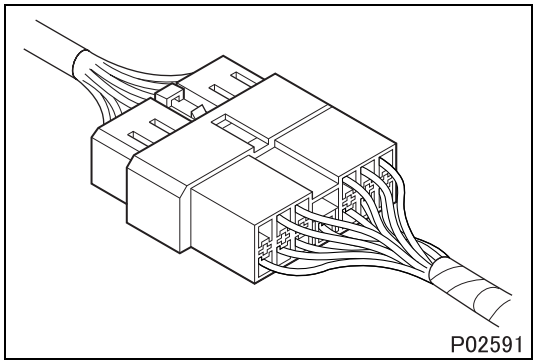
- **Be careful not to short-circuit pins together with the test probes. With control unit connectors, short-circuiting of pins can cause damage to the control unit's internal circuitry.**


P00027

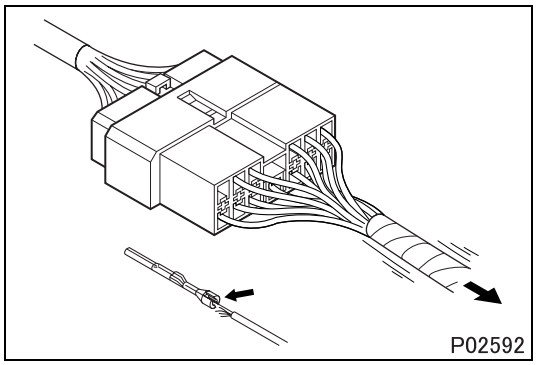
- When using a multimeter to check continuity, do not allow the test probes to touch the wrong terminals.

4.2 Inspection of connectors

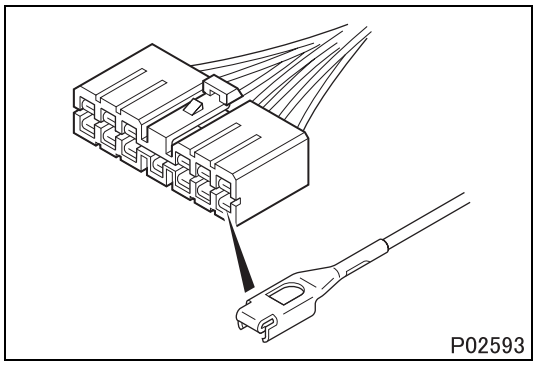
(1) Visual inspection


P02591

- Check that the connectors are fitted together securely.

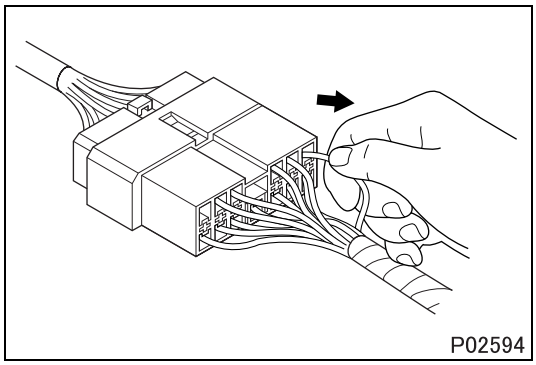

P02592

- Check whether wires have been separated from their terminals due to pulling of the harness.


P02593

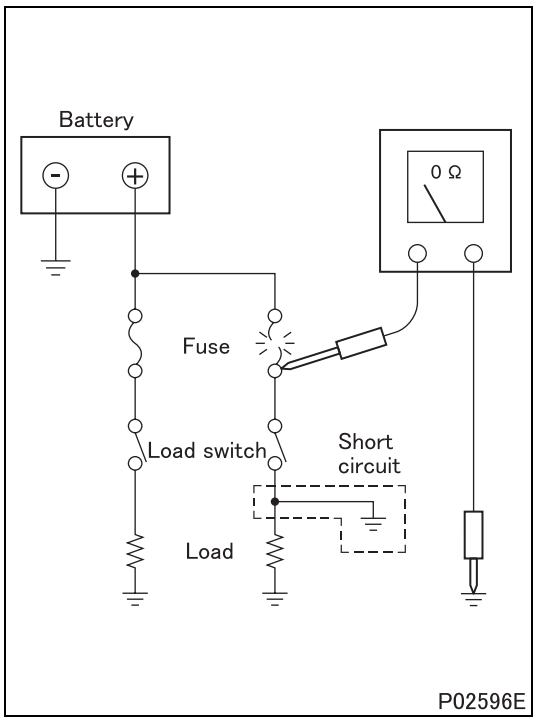
- Check that male and female terminals fit together tightly.

- Check for defective connections caused by loose terminals, by rust on terminals, or by contamination of terminals by foreign substances.


P02594

(2) Checking for loose terminals

- If connector terminal retainers become damaged, male and female terminals may not mate with each other when the connector bodies are fitted together. To check for such terminals, gently pull each wire and see whether any terminals slip out of their connector housings.

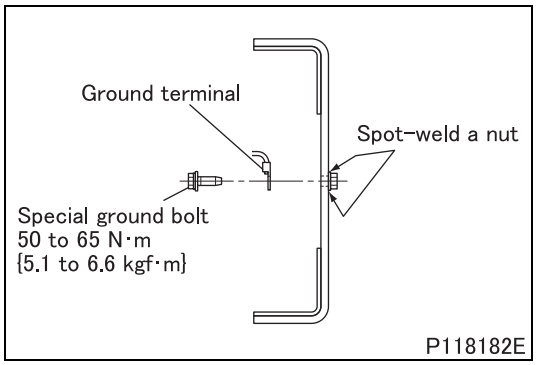


P02596E

4.3 Inspections when a fuse blows

- Remove the fuse, then measure the resistance between ground and the fuse's load side.
  Next, close the switch of each circuit connected to the fuse. If the resistance measurement between any switch and ground is zero, there is a short circuit between the switch and the load. If the resistance measurement is not zero, the circuit is not currently short-circuited; the fuse probably blew due to a momentary short circuit.

- The main causes of short circuits are as follows:
  - Harnesses trapped between chassis parts
  - Harness insulation damage due to friction or heat
  - Moisture in connectors or circuitry
  - Human error (accidental short-circuiting of components)

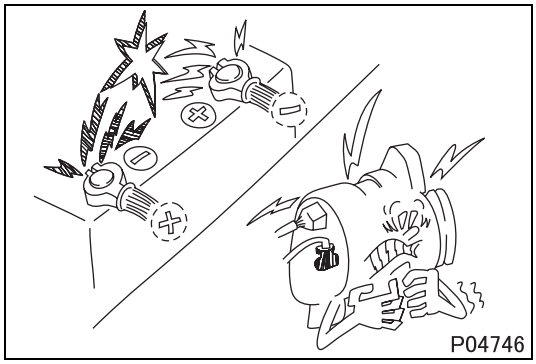


P118182E

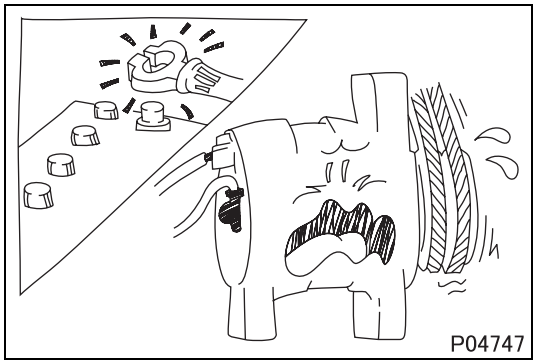
4.4 Inspection of chassis ground

- A special ground bolt is used to tighten a ground terminal. When servicing the ground point, be sure to follow the procedures described below:
  - When reinstalling the ground bolt
    Tighten the ground bolt to the specified torque.
  - When relocating the ground point
    A special ground bolt must be used. Spot-weld a nut to a frame and tighten the ground bolt to the specified torque. Be sure to apply touch-up paint to the welded point.

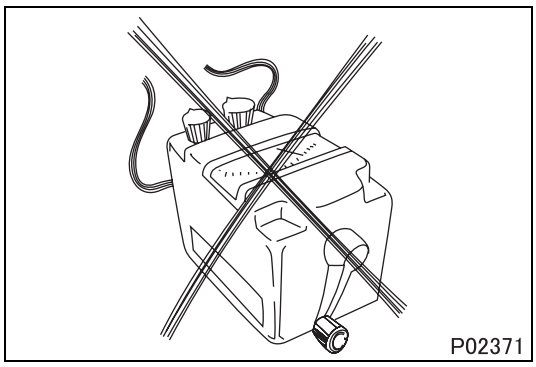
5. Service Precautions for Alternators



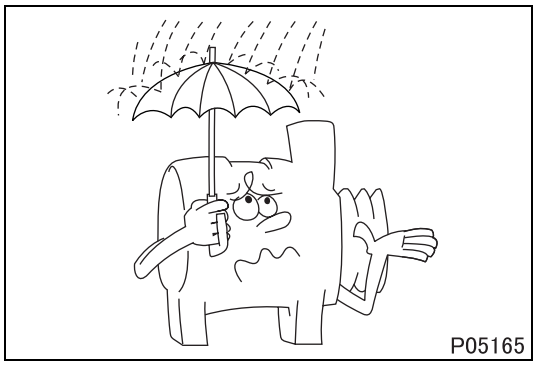
- When servicing alternators, observe the following precautions:
  - Never reverse the polarity of battery connections.
    If the polarity of the battery connections were to be reversed, a large current would flow from the battery to the alternator, damaging the diodes and regulator.



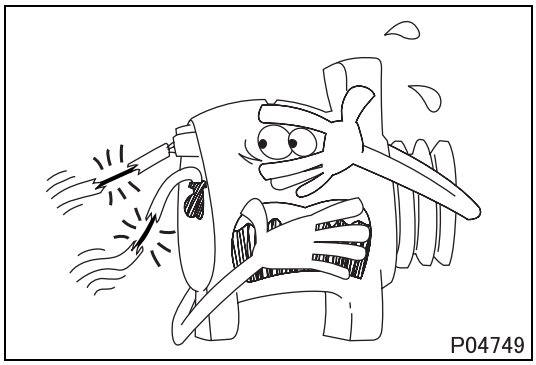
- Never disconnect the battery cables with the engine running.
  Disconnection of the battery cables during engine operation would cause a surge voltage, leading to deterioration of the diodes and regulator.



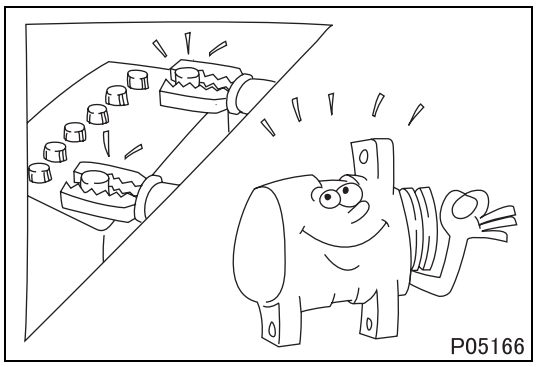
- Never perform inspections using a high-voltage multimeter.
  The use of a high-voltage multimeter could damage the diodes and regulator.



- Keep alternators dry.
  Water on alternators can cause internal short circuits and damage.

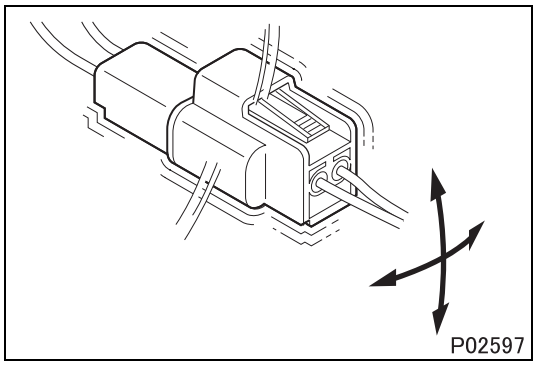


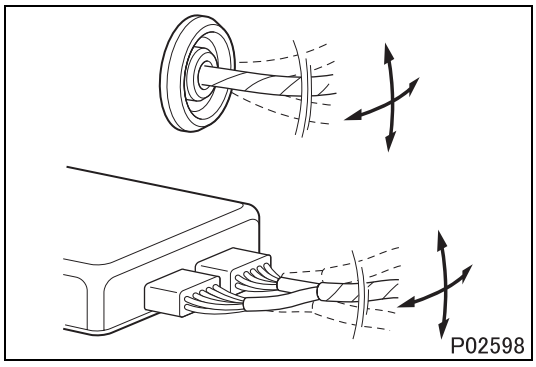
- Never operate an alternator with the B and L terminals short-circuited. Operation with the B and L terminals connected together would damage the diode trio.

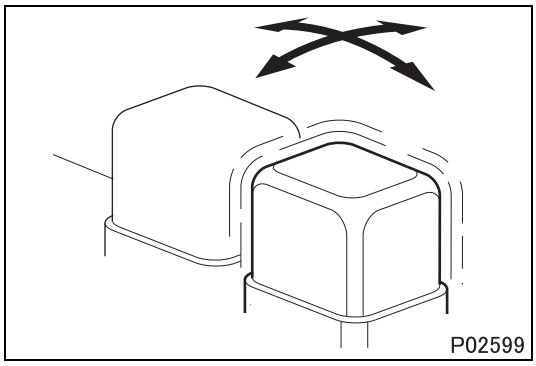


- Disconnect the battery cables before quick-charging the battery with a quick charger.
  Unless the battery cables are disconnected, quick-charging can damage the diodes and regulator.

6. Intermittent Faults





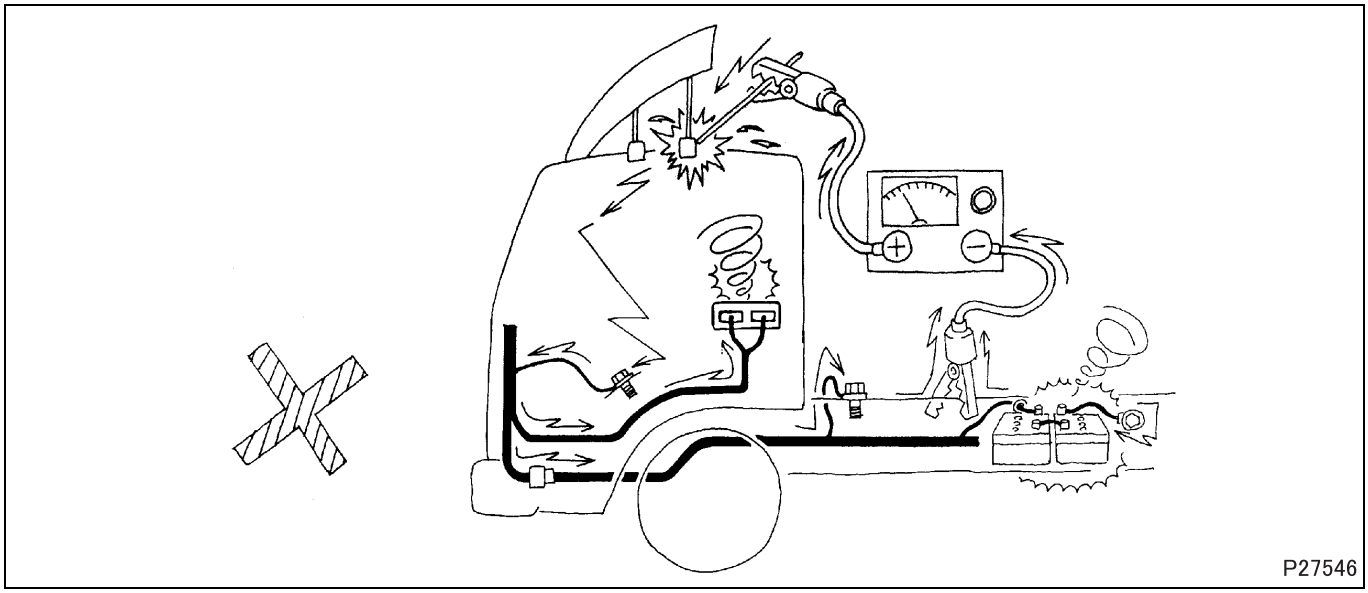


- An intermittent fault typically occurs only under certain operating conditions. Once these conditions have been identified, the cause of the intermittent fault can be ascertained easily. First, ask the customer about the vehicle operating conditions and weather conditions under which the fault occurs. Also ask about the frequency with which the fault occurs and about the fault symptoms. Then, reproduce the fault based on this information.
  In accordance with the conditions under which the fault occurs, determine whether the fault is caused by vibration, heat or other factors. if vibration is a possible factor, see if the fault can be reproduced by performing the following checks on individual connectors and other parts:
  - Gently move connectors up and down and to left and right.
  - Gently move wiring harnesses up and down and to left and right.
  - Gently wiggle sensors and other devices by hand.
  - Gently wiggle wiring harnesses on suspension systems and other moving parts.

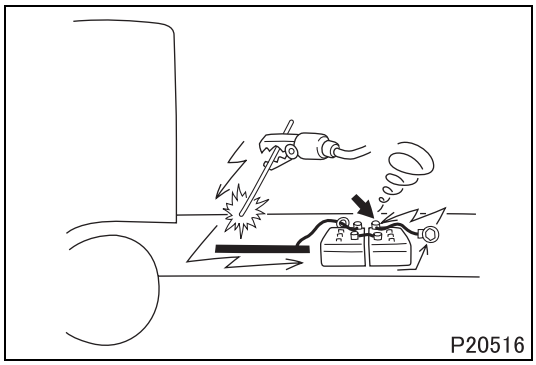
- Connectors and other parts to be checked are those included or given as likely fault locations in inspection procedures corresponding to diagnosis codes and/or fault symptoms.

7. Precautions for Arc Welding

- When arc welding is performed, current from the welder flows to ground via the vehicle's metal parts. Unless appropriate steps are taken, this current can damage control units, other electrical devices and wiring harnesses. And any electrical device near the point on the vehicle to which the (–) cable of the welder is connected, might be largely damaged.



- Current flows backward as shown below.



7.1 From battery (–) cable

To prevent damage to the battery and to electrical devices that are connected directly to the battery, it is essential to disconnect the battery's (–) cable.

7.2 Procedure

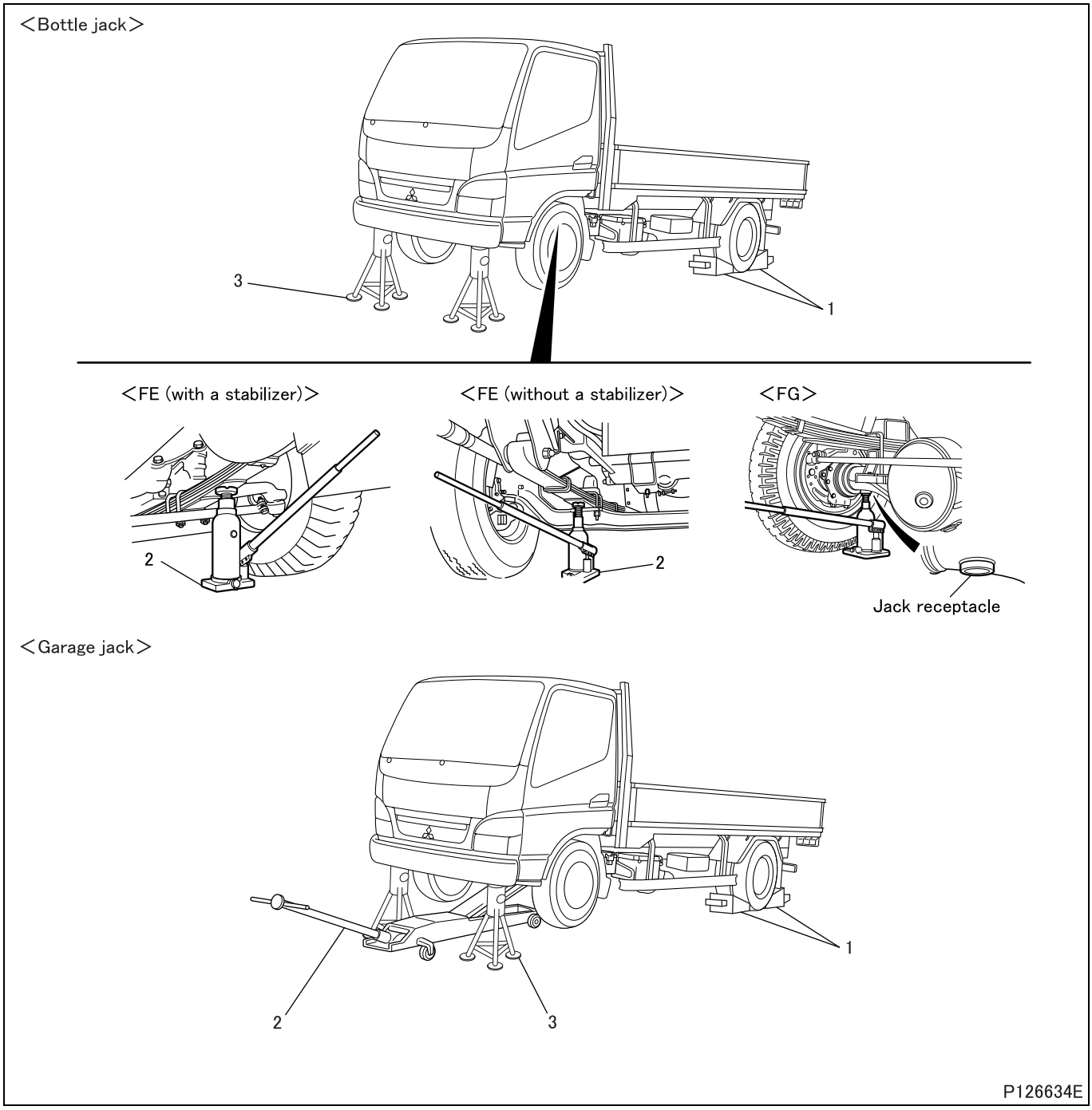
- Turn the starter switch to the LOCK position.
- Disconnect the battery's (–) cable.
- Cover all parts of the vehicle that may be damaged by welding sparks.
- Connect the welder's (–) cable to the vehicle as close as possible to the area being welded. Do not connect the welder's (–) cable to the cab if the frame is being welded, and vice versa.
- Set the welding current in accordance with the part being welded.

8. Precautions When Repainting

- When repainting, cover the following electronic control components with a masking material. If paint get on these components, functional reliability could be deteriorated as a result of the poor connection of connectors, internal circuit failure caused by heat build-up due to poor heat dissipation, erroneous sensor values due to clogged ventilation holes.
  - Engine electronic control unit and other electronic control units
  - Sensors

JACKING UP THE VEHICLE

<Front of Vehicle>



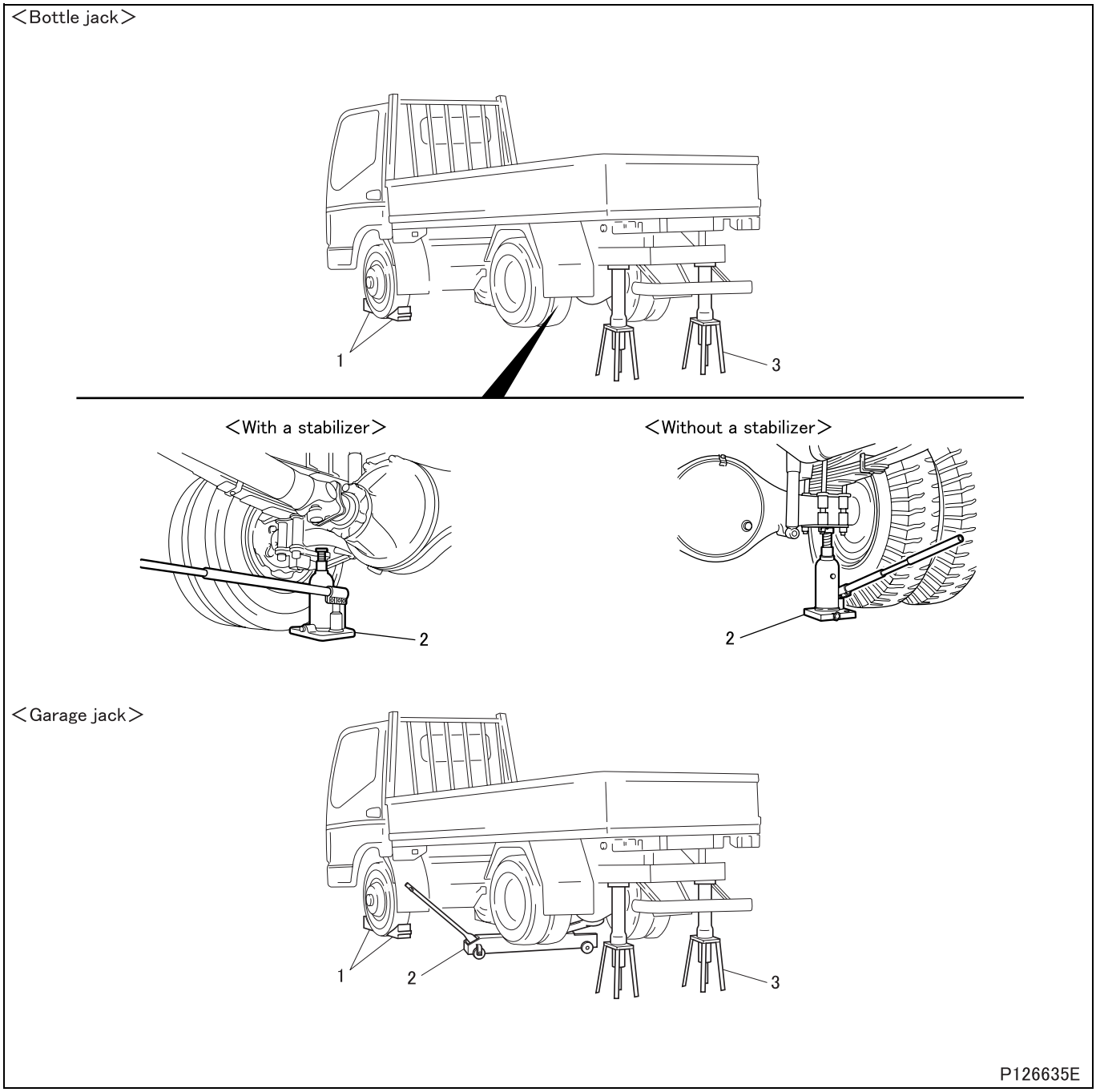
Jacking up procedure

1 Place chocks against the rear wheels.
2 Jack up the front of the vehicle with a bottle jack or garage jack.
3 Support the front of the vehicle frame on jack stands.

WARNING ⚠

- **Chock the wheels firmly to prevent the vehicle from rolling away.**
- **Do not attempt to remove the chocks until the operation is completed.**
- **It is extremely dangerous to support the vehicle with only bottle jack or garage jack. Be sure to additionally support the front of the vehicle frame on jack stands.**
- **Never attempt to remove the bottle jack, garage jack, or jack stands until the operation is completed.**

<Rear of Vehicle>



Jacking up procedure

1 Place chocks against the front wheels.
2 Jack up the rear of the vehicle using a bottle jack or garage jack as illustrated above.
3 Support the vehicle frame on jack stands on both sides.

WARNING ⚠

- **Chock the wheels firmly to prevent the vehicle from rolling away.**
- **Do not attempt to remove the chocks until the operation is completed.**
- **It is extremely dangerous to support the vehicle with only bottle jack or garage jack. Be sure to additionally support the vehicle frame on jack stands on both sides.**
- **Never attempt to remove the bottle jack, garage jack, or jack stands until the operation is completed.**

DIAGNOSIS CODES

1. Diagnosis Codes

- Diagnosis codes indicate the faulty sections of the vehicle.
- A fault can be repaired by reading out the diagnosis code(s) stored in the control unit and performing the remedy for that code(s).
- Diagnosis codes can be displayed in the following two methods. Select either of them according to the system to be diagnosed.
  - Using a Multi-Use Tester
  - Using flashing of a warning lamp on meter cluster
- The table below indicates the systems for which diagnosis codes can be displayed and the methods usable for individual systems.

1.1 Systems and diagnosis code displaying methods

Warning lamp	System	Flashing of warning lamp	Reference Gr
(ABS)	Anti-lock brake system (ABS)	O	35E

1.2 Types of diagnosis codes

(1) Present diagnosis code

- Fault developed in the vehicle after the starter switch is set to ON is indicated by corresponding diagnosis code.
- The fault warning lamp is lit at the same time.

(2) Past diagnosis code

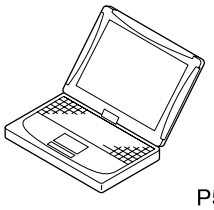
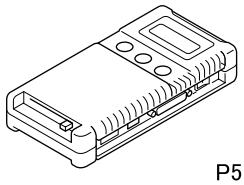
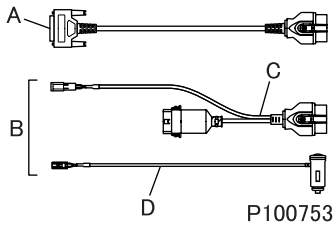
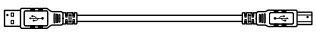
- Past fault developed in the vehicle is indicated by corresponding diagnosis code stored in the memory of the electronic control unit.
- With the vehicle restored to its normal condition or the starter switch turned from OFF to ON after inspection or repair against present diagnosis codes, the present diagnosis code is stored as past diagnosis codes in the memory of the electronic control unit.
- The warning lamp is not lit because the indicated fault is not present one.

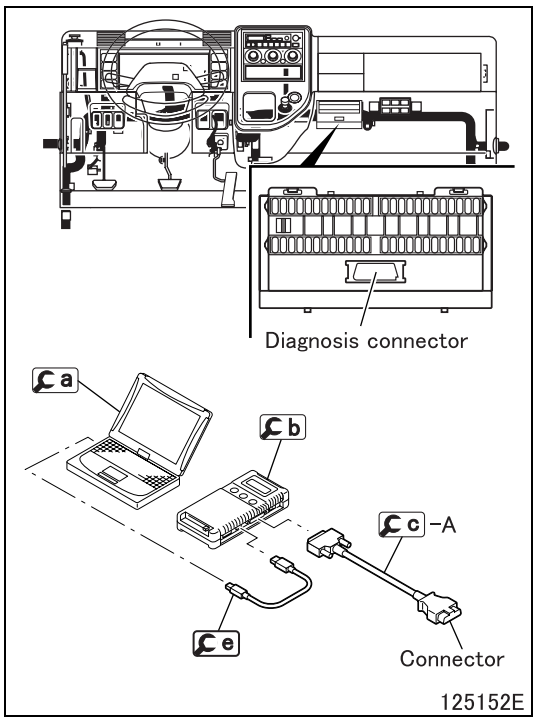
2. Reading and Erasing the Diagnosis Code

2.1 Using a Multi-Use Tester

(1) Connecting a Multi-Use Tester

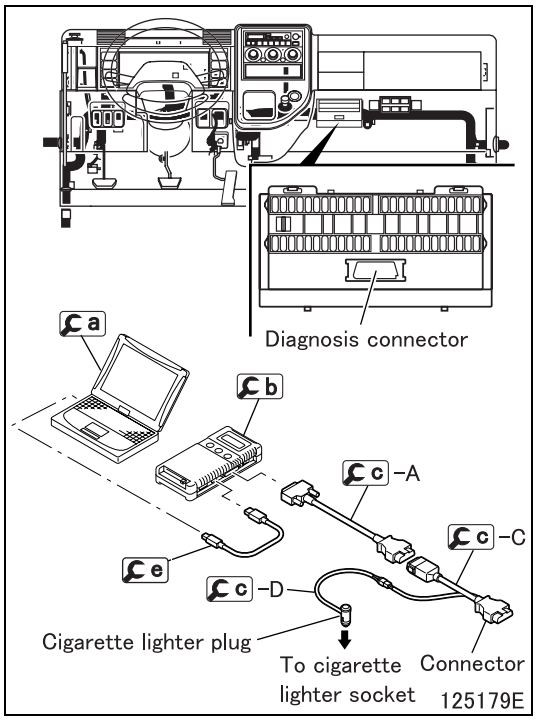
Special tools

Mark	Tool name and shape	Part No.	Application
ca	PC  P57295	FMS-E 12-2 (Multi-Use Tester-III version)	Data transmission between V.C.I. and PC
cb	V.C.I.  P57296	MH062927	Data transmission between electronic control unit and PC
cc	Multi-Use Tester harness E A: For inspection and drive recorder B: For drive recorder C: Driver recorder harness D: Cigar plug harness  P100753	MH063660 A: MH063662 B: MH063663 C: MH063665 D: MH063666	Power supply to V.C.I. and communication with electronic control unit
cd	Multi-Use Tester test harness D (used for extension)  P57299	MH062951	Multi-Use Tester test harness E extension
ce	USB cable  P57300	MH063668	Communication between V.C.I. and PC



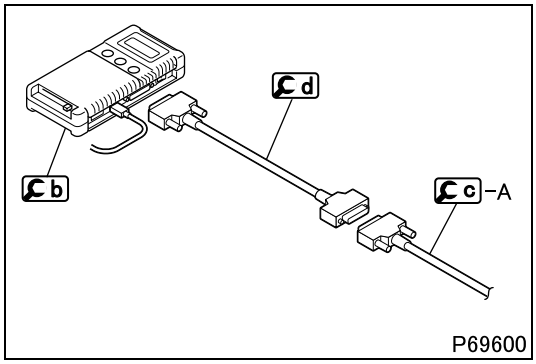
(1.1) To perform system inspection

- Move the starter switch to the LOCK position.
- Connect a, b, c-A and e as illustrated.
- Connect the Diagnosis connector on the vehicle with the connector of c-A.



(1.2) To use drive recorder function

- Move the starter switch to the LOCK position.
- Connect a, b, c-A, c-C, c-D and e as illustrated.
- Connect the Diagnosis connector on the vehicle with the connector of c-C.
- Connect the cigarette lighter plug of c-D with the cigarette lighter socket.



(1.3) To extend the Multi-Use Tester test harness

- Use d to extend the cable if c-A is not long enough such as when using Multi-Use Tester outside the vehicle.

(2) Access of diagnosis code

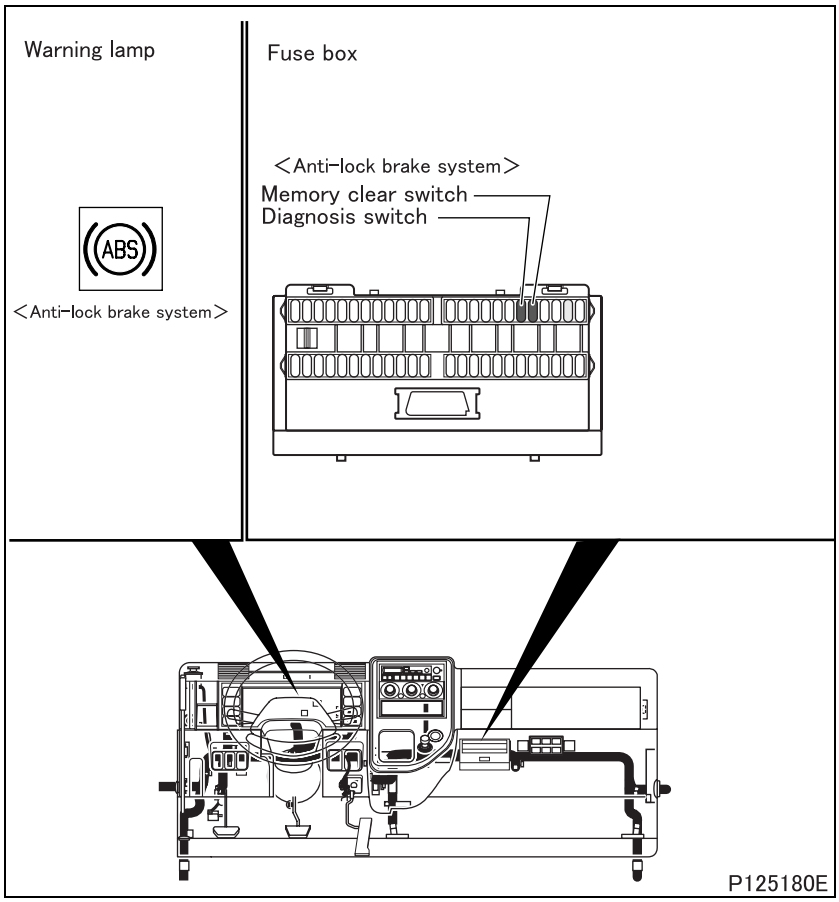
- Set the starter switch to ON.
- Operate the Multi-Use Tester for a display of necessary diagnosis code stored in the memory of the electronic control unit and identify the location of the fault.

(3) Clearing of diagnosis code

- Set the starter switch to ON (the engine not to be started).
- Operate the Multi-Use Tester to delete all the diagnosis codes stored in the memory of the electronic control unit.

2.2 Using flashing of a warning lamp on meter cluster

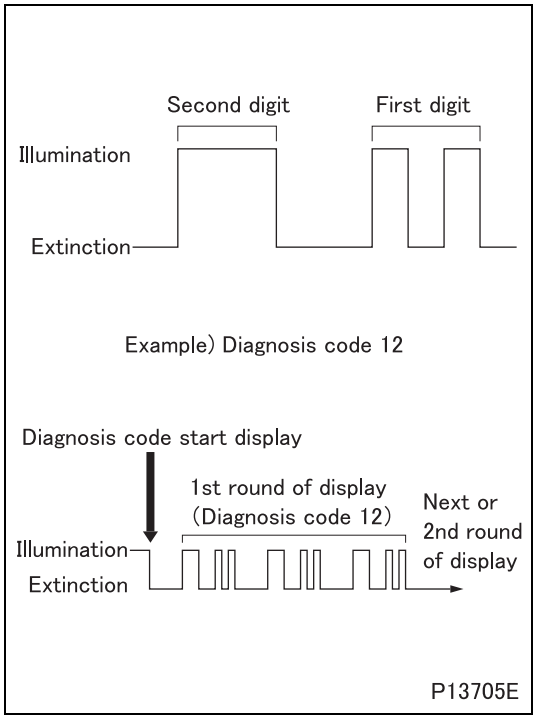
(1) Anti-lock brake system



- Using the diagnosis and memory clear switches, display diagnosis codes.

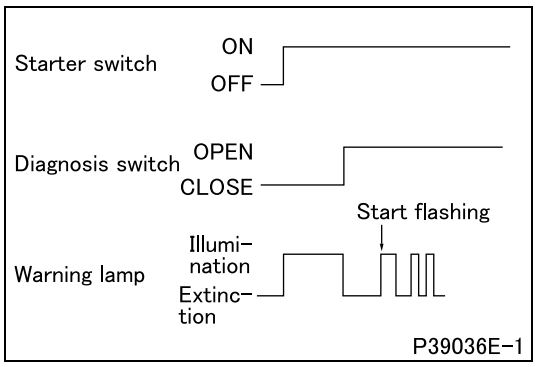
CAUTION ⚠

- **Opening the memory clear switch followed by its reconnection will erase the stored diagnosis codes from the memory. To avoid inadvertently erasing necessary codes, be sure to read well the procedure described below before handling diagnosis codes.**



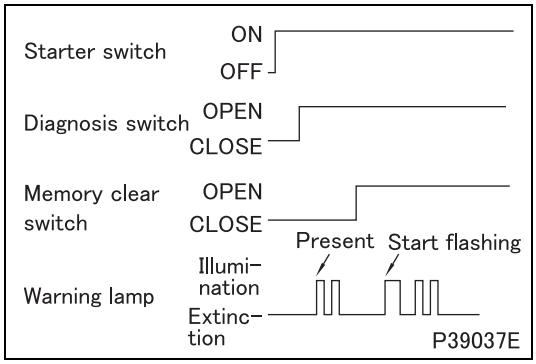
(1.1) Reading diagnosis codes

- To read a diagnosis code, observe how may times the warning lamp flashes and how long each illumination lasts.
- The duration of illumination differs between the first and second digits.
  - Second digit: 1.2 sec.
  - First digit: 0.4 sec.
- A diagnosis code consists of the flashing of second digit and the flashing of first digit in that order. If a diagnosis code has “0” in the second digit, only the first digit will be displayed.
- The diagnosis code 01 will be displayed if the system is normal.
- The same diagnosis code will be displayed 3 times in a row before moving to the display of the next code.
- After the last diagnosis code is displayed, the first code will be displayed again 3 times in a row and then the subsequent codes. This will be repeated.



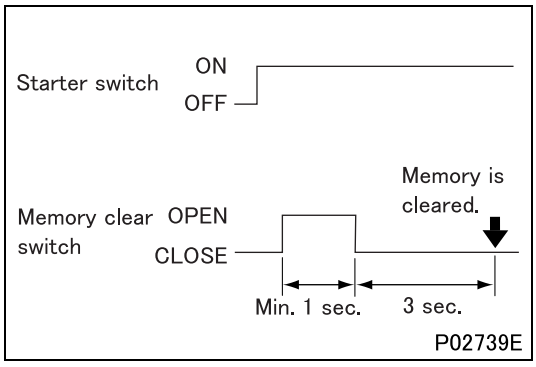
(1.2) Present diagnosis codes

- Turn the starter switch ON.
- Remove the diagnosis switch.
- Diagnosis codes will be displayed by flashing of the warning lamp.
- When the diagnosis switch is connected, electronic control unit will stop (terminate) displaying diagnosis codes.



(1.3) Present and past diagnosis codes

- Turn the starter switch to the ON position.
- Open the diagnosis switch.
- Present diagnosis codes will be displayed by flashing of the warning lamp.
- Open the memory clear switch.
- Present and past diagnosis codes will be displayed by flashing of the warning lamp.
- Turn the starter switch to the OFF position and connect the memory clear switch and diagnosis switch to terminate the diagnosis code displaying mode.



(1.4) Erasing diagnosis codes

- Turn the starter switch to the ON position (do not start the engine).
- Open the memory clear switch and reconnect it; all diagnosis codes stored in electronic control unit memory will be erased.
  To cancel diagnosis code erasure after opening the memory clear switch, turn the starter switch to the OFF position and then reconnect the memory clear switch.

M E M O

TABLE OF STANDARD TIGHTENING TORQUES

1. Tightening Torques

- Tightening torques are roughly classified into the following two categories:

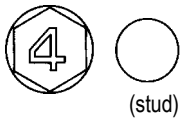
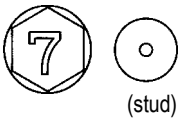
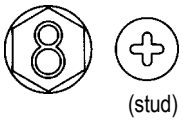
Tightening torque	Definition	Availability of torque specifications in text	How to determine tightening torque
Standard tightening torque	Tightening torque determined according to thread size and material of bolts and nuts	None	Locate a bolt or nut corresponding to actual part in the following standard tightening torque table.
Specified tightening torque	Tightening torque of bolts and nuts other than those defined in “Standard tightening torque”, or that of bolts and nuts not identified in the following tables	Provided	Tightening torque is shown in the text.

- Fasteners used in a location denoted by “wet” should always be tightened in a wet condition (lubricated with engine oil or grease). Any other fasteners than those so specified should be tightened in a dry condition.

2. Table of Standard Tightening Torque

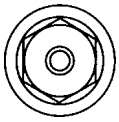
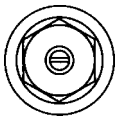
- Threads and bearing surfaces shall be dry (tightened in a dry condition).
- If the mating nut and bolt (or stud bolt) are different in level of strength, tighten them to the torque specified for the bolt.
- Automotive screws refer to coarse screw thread with nominal diameter of 3 to 8 mm or fine screw thread with nominal diameter of 10 mm or larger.

(1) Hexagon head bolts and stud bolts (Unit: N·m {kgf·m})

		Strength					
		4T		7T		8T	
		 (stud)		 (stud)		 (stud)	
		Automotive screw thread	Coarse screw thread	Automotive screw thread	Coarse screw thread	Automotive screw thread	Coarse screw thread
Nominal diameter mm	**M5**	2 to 3 {0.2 to 0.3}	–	4 to 6 {0.4 to 0.6}	–	5 to 7 {0.5 to 0.7}	–
	M6	4 to 6 {0.4 to 0.6}	–	7 to 10 {0.7 to 1.0}	–	8 to 12 {0.8 to 1.2}	–
	M8	9 to 13 {0.9 to 1.3}	–	16 to 24 {1.6 to 2.4}	–	19 to 28 {1.9 to 2.9}	–
	M10	18 to 27 {1.8 to 2.8}	17 to 25 {1.7 to 2.5}	34 to 50 {3.5 to 5.1}	32 to 48 {3.3 to 4.9}	45 to 60 {4.6 to 6.1}	37 to 55 {3.8 to 5.6}
	M12	34 to 50 {3.5 to 5.1}	31 to 45 {3.2 to 4.6}	70 to 90 {7.1 to 9.2}	65 to 85 {6.6 to 8.7}	80 to 105 {8.2 to 11}	75 to 95 {7.6 to 9.7}
	M14	60 to 80 {6.1 to 8.2}	55 to 75 {5.6 to 7.6}	110 to 150 {11 to 15}	100 to 140 {10 to 14}	130 to 170 {13 to 17}	120 to 160 {12 to 16}
	M16	90 to 120 {9.2 to 12}	90 to 110 {9 to 11}	170 to 220 {17 to 22}	160 to 210 {16 to 21}	200 to 260 {20 to 27}	190 to 240 {19 to 24}
	M18	130 to 170 {13 to 17}	120 to 150 {12 to 15}	250 to 330 {25 to 34}	220 to 290 {22 to 30}	290 to 380 {30 to 39}	250 to 340 {25 to 35}
	M20	180 to 240 {18 to 24}	170 to 220 {17 to 22}	340 to 460 {35 to 47}	310 to 410 {32 to 42}	400 to 530 {41 to 54}	360 to 480 {37 to 49}
	M22	250 to 330 {25 to 34}	230 to 300 {23 to 31}	460 to 620 {47 to 63}	420 to 560 {43 to 57}	540 to 720 {55 to 73}	490 to 650 {50 to 66}
	M24	320 to 430 {33 to 44}	290 to 380 {30 to 39}	600 to 810 {61 to 83}	540 to 720 {55 to 73}	700 to 940 {71 to 96}	620 to 830 {63 to 85}

		Strength	
		8.8 (Nut 4T)	8.8 (Nut 6T)
			
		Automotive screw thread	
Nominal diameter mm	**M10**	18 to 27 {1.8 to 2.8}	45 to 60 {4.6 to 6.1}
	M12	34 to 50 {3.5. to 5.1}	80 to 105 {8.2 to 11}
	M14	60 to 80 {6.1 to 8.2}	130 to 170 {13 to 17}

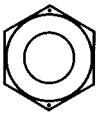
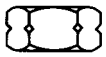
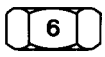
(2) Hexagon flange bolts (Unit: N·m {kgf·m})

		Strength					
		4T		7T		8T	
							
		Automotive screw thread	Coarse screw thread	Automotive screw thread	Coarse screw thread	Automotive screw thread	Coarse screw thread
Nominal diameter mm	**M6**	4 to 6 {0.4 to 0.6}	–	8 to 12 {0.8 to 1.2}	–	10 to 14 {1.0 to 1.4}	–
	M8	10 to 15 {1.0 to 1.5}	–	19 to 28 {1.9 to 2.9}	–	22 to 33 {2.2 to 3.4}	–
	M10	21 to 31 {2.1 to 3.2}	20 to 29 {2.0 to 3.0}	45 to 55 {4.6 to 5.6}	37 to 54 {3.8 to 5.5}	50 to 65 {5.1 to 6.6}	50 to 60 {5.1 to 6.1}
	M12	38 to 56 {3.9 to 5.7}	35 to 51 {3.6 to 5.2}	80 to 105 {8.2 to 11}	70 to 95 {7.1 to 9.7}	90 to 120 {9.2 to 12}	85 to 110 {8.7 to 11}

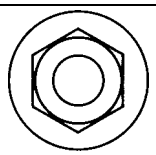
		Strength	
		8.8 (Nut 4T)	8.8
			
		Automotive screw thread	
Nominal diameter mm	**M10**	21 to 31 {2.1 to 3.2}	50 to 65 {5.1 to 6.6}
	M12	38 to 56 {3.9 to 5.7}	90 to 120 {9.2 to 12}

TABLE OF STANDARD TIGHTENING TORQUES

(3) Hexagon nuts (Unit: N·m {kgf·m})

		Strength					
		4T		6T (Bolt 7T)		6T (Bolt 8T)	
							
		Automotive screw thread	Coarse screw thread	Automotive screw thread	Coarse screw thread	Automotive screw thread	Coarse screw thread
Nominal diameter mm	**M5**	2 to 3 {0.2 to 0.3}	–	4 to 6 {0.4 to 0.6}	–	5 to 7 {0.5 to 0.7}	–
	M6	4 to 6 {0.4 to 0.6}	–	7 to 10 {0.7 to 1.0}	–	8 to 12 {0.8 to 1.2}	–
	M8	9 to 13 {0.9 to 1.3}	–	16 to 24 {1.6 to 2.4}	–	19 to 28 {1.9 to 2.9}	–
	M10	18 to 27 {1.8 to 2.8}	17 to 25 {1.7 to 2.5}	34 to 50 {3.5 to 5.1}	32 to 48 {3.3 to 4.9}	45 to 60 {4.6 to 6.1}	37 to 55 {3.8 to 5.6}
	M12	34 to 50 {3.5 to 5.1}	31 to 45 {3.2 to 4.6}	70 to 90 {7.1 to 9.2}	65 to 85 {6.6 to 8.7}	80 to 105 {8.2 to 11}	75 to 95 {7.6 to 9.7}
	M14	60 to 80 {6.1 to 8.2}	55 to 75 {5.6 to 7.6}	110 to 150 {11 to 15}	100 to 140 {10 to 14}	130 to 170 {13 to 17}	120 to 160 {12 to 16}
	M16	90 to 120 {9.2 to 12}	90 to 110 {9 to 11}	170 to 220 {17 to 22}	160 to 210 {16 to 21}	200 to 260 {20 to 27}	190 to 240 {19 to 24}
	M18	130 to 170 {13 to 17}	120 to 150 {12 to 15}	250 to 330 {25 to 34}	220 to 290 {22 to 30}	290 to 380 {30 to 39}	250 to 340 {25 to 35}
	M20	180 to 240 {18 to 24}	170 to 220 {17 to 22}	340 to 460 {35 to 47}	310 to 410 {32 to 42}	400 to 530 {41 to 54}	360 to 480 {37 to 49}
	M22	250 to 330 {25 to 34}	230 to 300 {23 to 31}	460 to 620 {47 to 63}	420 to 560 {43 to 57}	540 to 720 {55 to 73}	490 to 650 {50 to 66}
	M24	320 to 430 {33 to 44}	290 to 380 {30 to 39}	600 to 810 {61 to 83}	540 to 720 {55 to 73}	700 to 940 {71 to 96}	620 to 830 {63 to 85}

(4) Hexagon flange nuts (Unit: N·m {kgf·m})

		Strength	
		4T	
			
		Automotive screw thread	Coarse screw thread
Nominal diameter mm	**M6**	4 to 6 {0.4 to 0.6}	–
	M8	10 to 15 {1.0 to 1.5}	–
	M10	21 to 31 {2.1 to 3.2}	20 to 29 {2.0 to 3.0}
	M12	38 to 56 {3.9 to 5.7}	35 to 51 {3.6 to 5.2}

(5) Tightening torques of general flare nuts (Unit: N·m {kgf·m})

Pipe diameter mm	ϕ4.76	ϕ6.35	ϕ8	ϕ10	ϕ12	ϕ15
Tightening torque	17 {1.7}	25 {2.6}	39 {4.0}	59 {6.0}	88 {9.0}	98 {10}

(6) Tightening torques of nylon tubes for general air piping (DIN) (Unit: N·m {kgf·m})

Nominal diameter × wall thickness mm	6 × 1	10 × 1.25	12 × 1.5	15 × 1.5
Tightening torque	20^{+6}_{0} {$2.0^{+0.6}_{0}$}	34^{+10}_{0} {$3.5^{+1.0}_{0}$}	49^{+10}_{0} {$5.0^{+1.0}_{0}$}	54^{+5}_{0} {$5.5^{+0.5}_{0}$}

(7) Tightening torques of nylon tubes for general air piping (SAE) (Unit: N·m {kgf·m})

Nominal diameter in.	1/4	3/8	1/2	5/8
Tightening torque	13^{+4}_{0} {$1.3^{+0.4}_{0}$}	29^{+5}_{0} {$3.0^{+0.5}_{0}$}	49^{+5}_{0} {$5.0^{+0.5}_{0}$}	64^{+5}_{0} {$6.5^{+0.5}_{0}$}

GROUP 11 ENGINE

SPECIFICATIONS 11-2

STRUCTURE AND OPERATION
1. Exploded View 11-3
2. Valve Mechanism 11-4
3. Cylinder Head Gasket <4D34> 11-5
4. Water Director 11-5
5. Connecting Rod 11-5
6. Piston 11-6
7. Timing Gears 11-6

TROUBLESHOOTING 11-7

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Measuring Compression Pressure 11-8
2. Inspection and Adjustment of Valve Clearances 11-10

ENGINE REMOVAL AND INSTALLATION
<TILT CAB> 11-12
<FIXED CAB> 11-16

CYLINDER HEAD 11-18

PISTON AND CONNECTING ROD, CYLINDER SLEEVE 11-34

FLYWHEEL 11-48

TIMING GEARS 11-52

CAMSHAFT 11-56

CRANKSHAFT AND CRANKCASE 11-60

CAMSHAFT BUSHINGS 11-70

SPECIFICATIONS

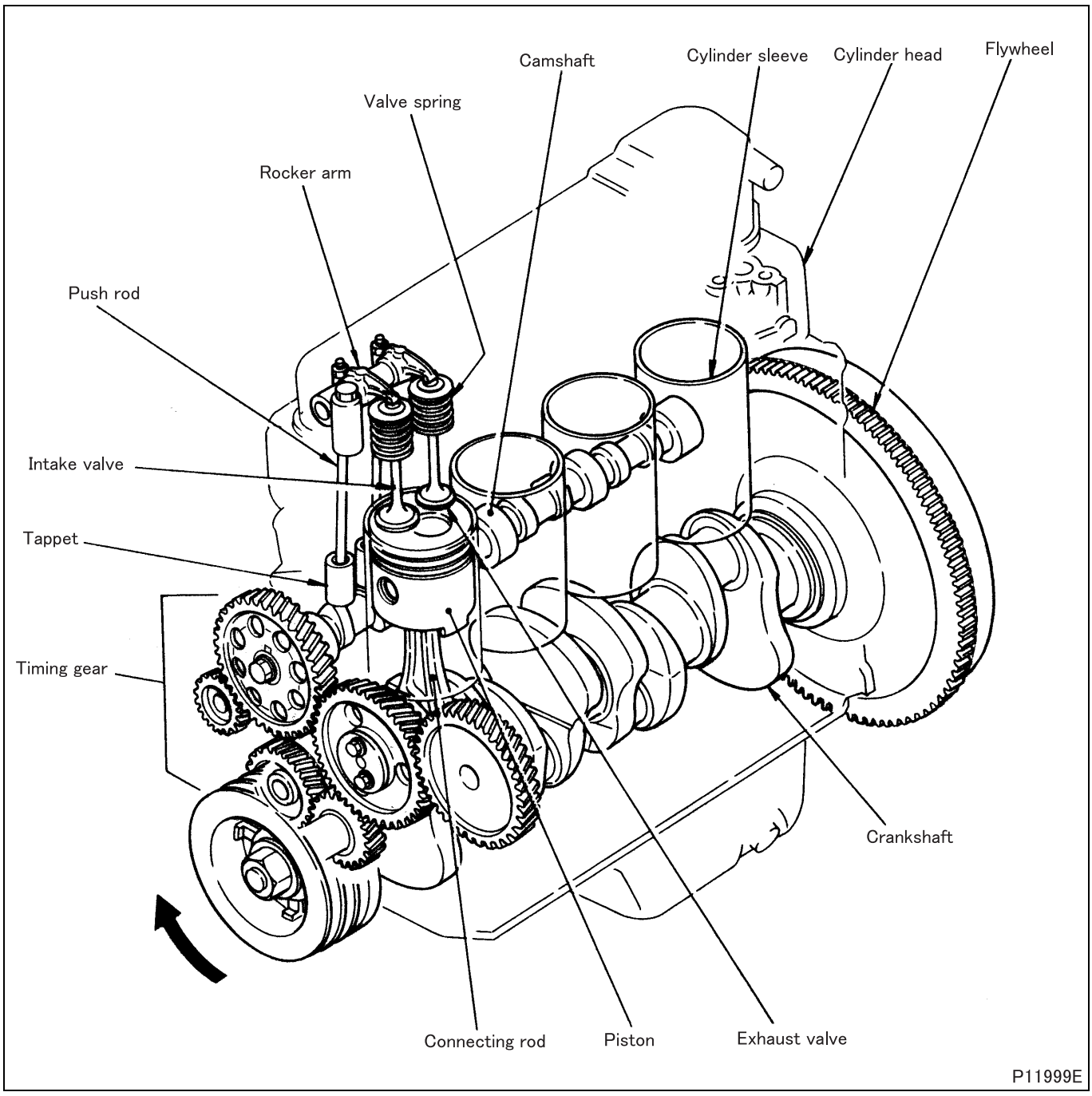
Item		Specifications	
Engine model		4D33	4D34T4
Type		4-cylinder, in-line, water-cooled, 4-cycle diesel engine	
Combustion chamber		Direct injection type	
Valve mechanism		Overhead valves	
Maximum output	kW {PS} /rpm	83 {120} /3200	100 {139} /2900
Maximum torque	N·m {kgf·m} /rpm	304 {31} /1800	373 {38} /1600
Bore × stroke	mm	ϕ108 × 115	ϕ104 × 115
Total displacement	cm^3 {L}	4214 {4.214}	3907 {3.907}
Compression ratio		18	18.5

Remarks

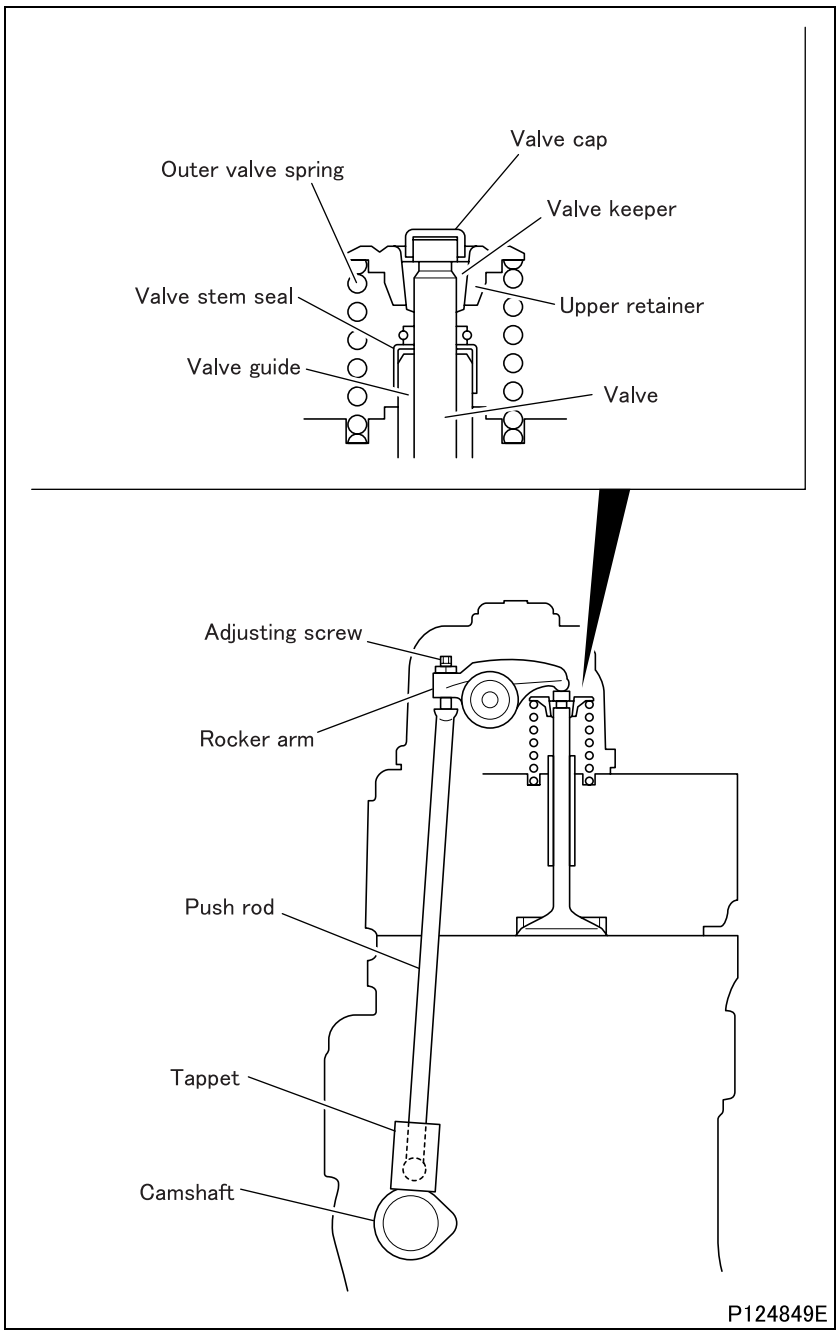
Output and torque represent performance of run-in engine operating under the standard ambient conditions and accessories specified below.

	Standard	Barometric pressure	Temperature of inlet air	Accessories
JIS	JIS D1004, 1976	101.3 kPa {760 mmHg}, dry	15.0°C	Fan, Air cleaner
EEC	EEC 595/2009	99 kPa {743 mmHg}, dry	25.0°C	Fan, Intake and exhaust system of vehicle

1. Exploded View

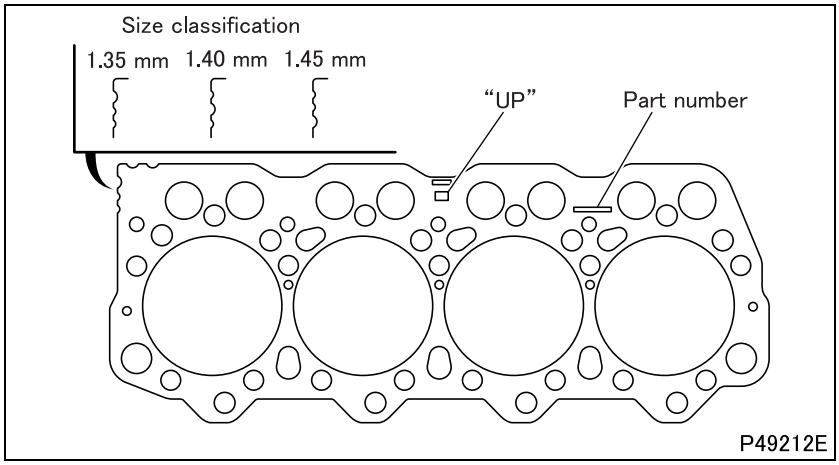


2. Valve Mechanism



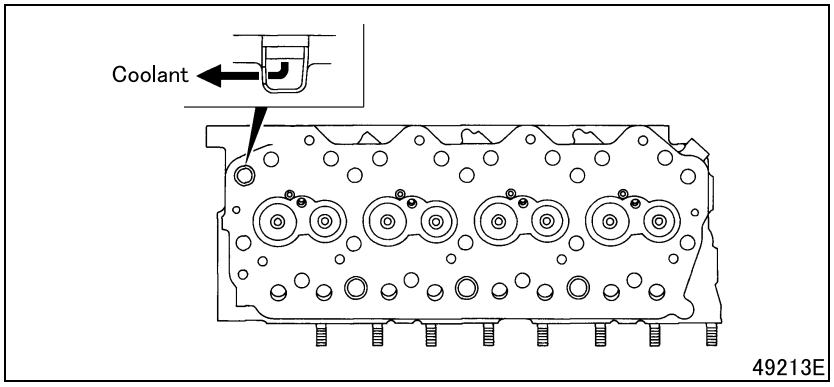
- Each valve has a valve stem seal, which regulates the flow of lubricating oil to the contact surface between the valve and the valve guide.
- The outer valve springs are variable-pitch springs.
- The valve clearance is adjusted using an adjusting screw.

3. Cylinder Head Gasket <4D34>



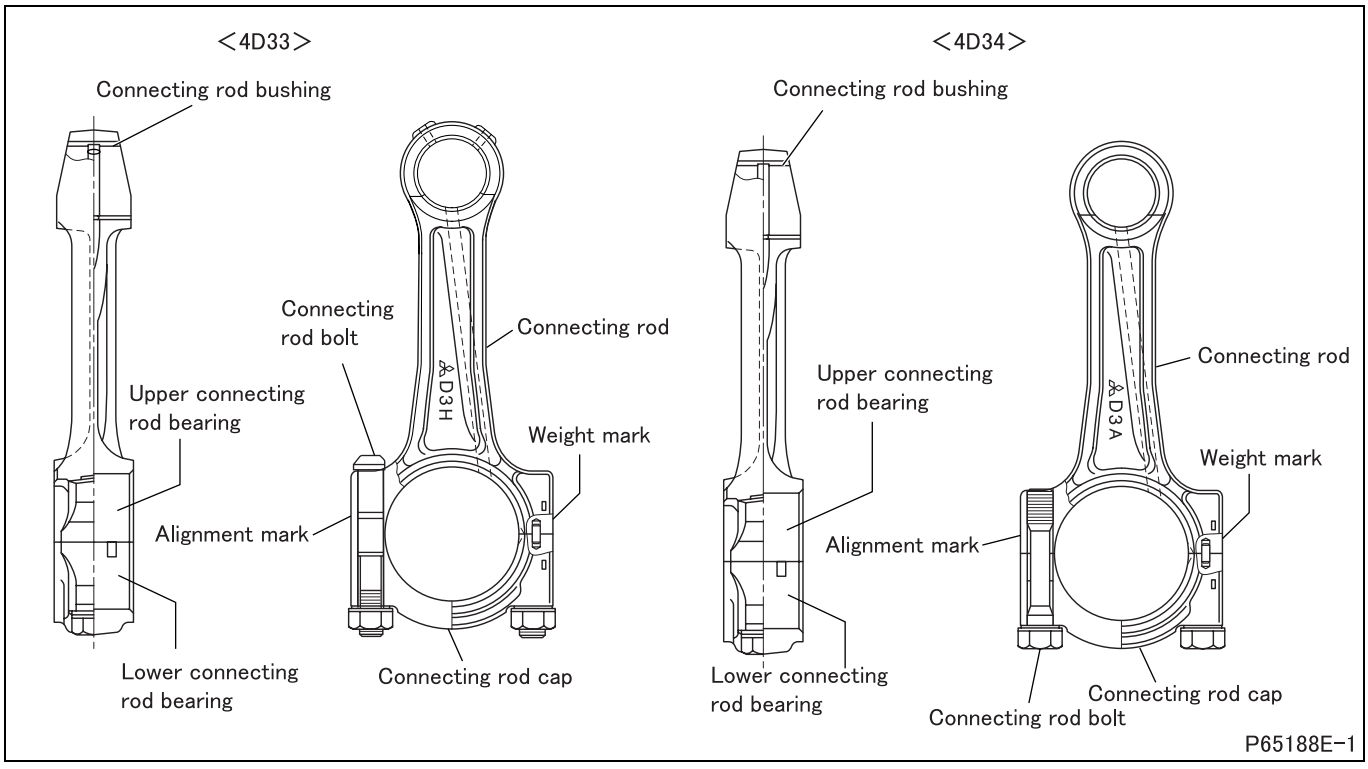
- Select and use a cylinder head gasket of a thickness that can accommodate the piston projection.
- The size (thickness) class of the gasket can be identified by the shape of the notches cut on the edge of each gasket.

4. Water Director

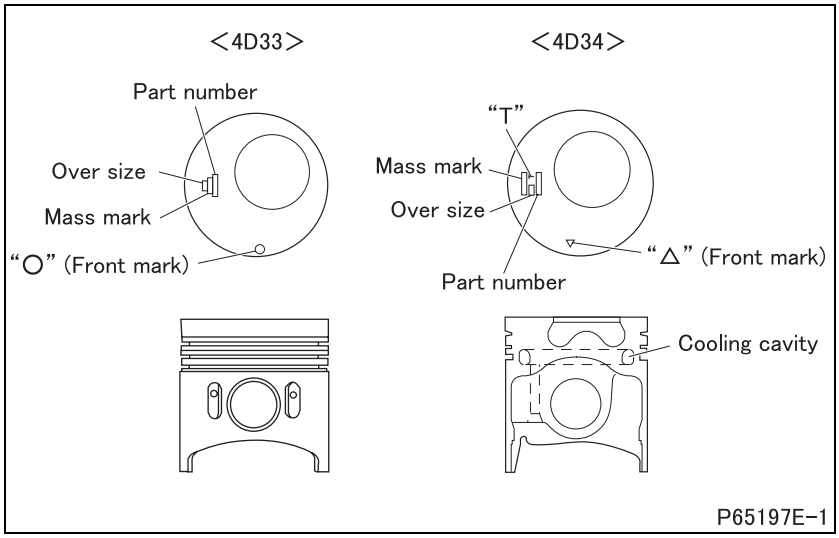


- The water director is attached to the bottom surface of the cylinder head, and is used to direct the flow of the coolant in the right direction.

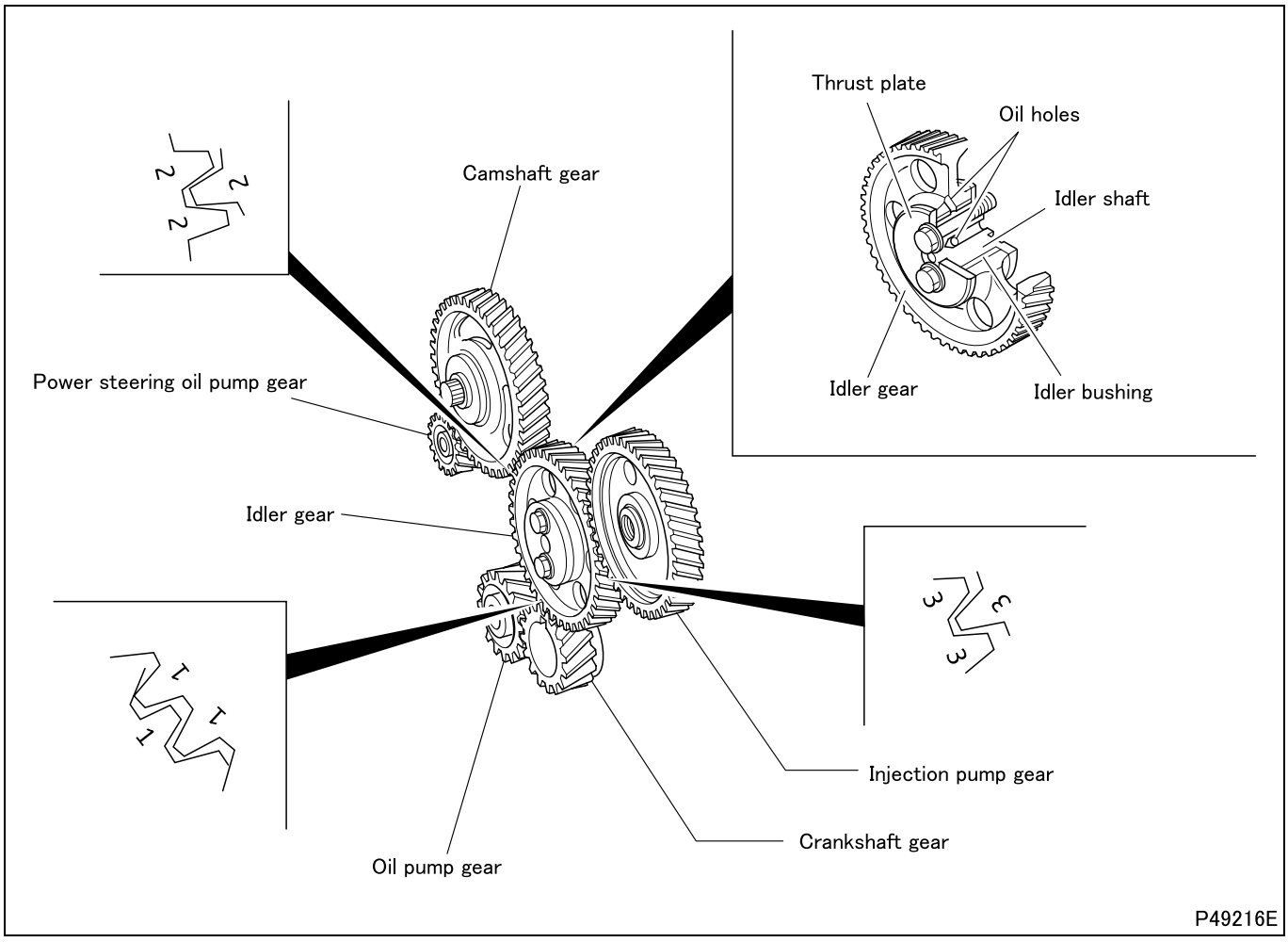
5. Connecting Rod



6. Piston



7. Timing Gears



- Each gear has one or two alignment marks ("1", "2", "3") to facilitate reassembly.

Possible causes \ Symptoms		Low power output	Abnormal engine noise	Reference Gr
Cylinder head and valve mechanism	Incorrect valve clearance	O	O	
	Defective cylinder head gasket	O	O	
	Worn valve and valve seat; carbon deposits	O	O	
	Weakened valve spring	O	O	
	Defective rocker shaft and bracket		O	
	Poor lubrication of rocker shaft bracket		O	
	Worn tappet		O	
Timing gears	Incorrect backlash in timing gears		O	
	Poor lubrication of timing gears and idler shaft		O	
Camshaft	Excessive end play in camshaft		O	
	Worn camshaft		O	
Pistons and connecting rods	Worn/damaged piston ring groove(s)	O	O	
	Worn/damaged piston ring(s)	O	O	
	Worn piston pin and connecting rod small end		O	
Crankshaft	Excessive end play in crankshaft		O	
	Incorrectly fitted crankshaft		O	
	Worn/damaged crankshaft pins and connecting rod bearings		O	
	Worn/damaged crankshaft journals and main bearings		O	
Fuel system	Injection timing faulty	O	O	Gr13
	Defective injection pump	O	O	
	Faulty fuel spray from injection nozzle	O	O	
	Air trapped in fuel system	O		
Cooling system	Malfunctioning cooling system components	O		Gr14
	Loose/damaged V-belts		O	
Intake and exhaust system	Clogged air cleaner	O	O	Gr15
	Clogged muffler	O	O	
Incorrect oil viscosity		O		Gr12
Improper fuel		O		
Incorrectly fitted piping and hoses			O	
Defective/incorrectly fitted alternator and other auxiliaries			O	

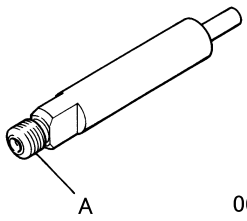
ON-VEHICLE INSPECTION AND ADJUSTMENT

1. Measuring Compression Pressure

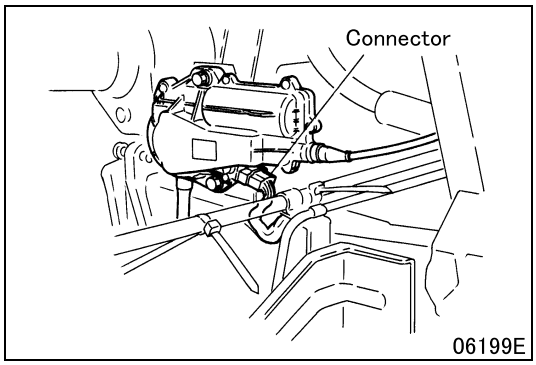
Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	Compression pressure	Each cylinder (at 200 rpm)	2550 kPa {26 kgf/cm^2}	1960 kPa {20 kgf/cm^2}	Inspect
		Cylinder-to-cylinder pressure difference	–	390 kPa {4 kgf/cm^2} or less	Inspect

Special tools (Unit: mm)

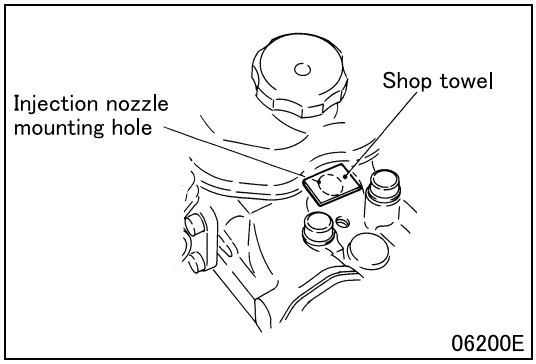
Mark	Tool name and shape	Part No.	Application
Ca	Compression gauge adapter A M14 × 1.5  06197	MH061460	Measuring compression pressure

- A drop in compression pressure can be used as a guide to determine when the engine should be overhauled.
- Measure the compression pressure at regular intervals. Keeping track of its transitions can provide a useful tool for troubleshooting. On new vehicles and vehicles with newly replaced parts, the compression pressure will be somewhat higher depending on the break-in condition of piston rings, valve seats, etc., but this will return to normal as the parts wear down.
- Before the compression measurement, confirm that the engine oil, starter, and battery are in normal condition.
- Place the vehicle in the following conditions.
  - Warm up the engine until the coolant temperature reaches approximately 75 to 85°C.
  - Turn off the lights and auxiliaries.
  - Place the transmission in neutral.
  - Place the steering wheel in the straight-ahead position.



06199E

- Disconnect the connector of the fuel-cut motor so that no injection of fuel takes place when turning over the engine using the starter.

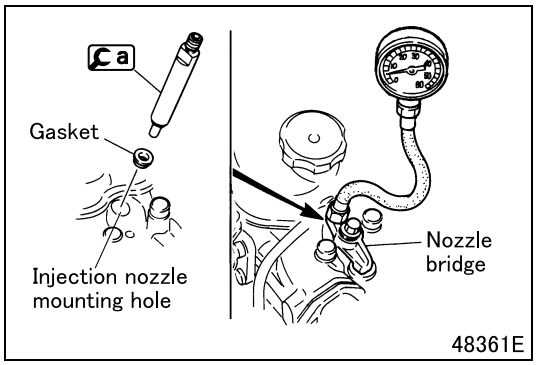


06200E

- Remove all injection nozzles.
- Cover the injection nozzle mounting holes with shop towels.
- After cranking the engine with the starter, check that no foreign substances are deposited on the shop towels.
- If there are deposits (such as engine oil or coolant) on the shop towels, the following may be the cause:
  - Deposits of engine oil alone can mean a defective piston ring seal; the piston rings must be inspected.
  - Deposits of both engine oil and coolant can mean cracks in the cylinders; the crankcase must be replaced.

WARNING ⚠

- **When coolant and engine oil deposits are evident, cranking the engine could be dangerous as these substances, heated to high temperatures, will blow out from the injection nozzle mounting holes. Make sure to stay away from the injection nozzle mounting holes when the engine is being cranked.**



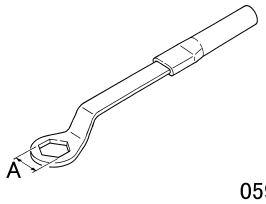
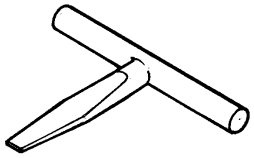
- Attach the gasket and a to one of the injection nozzle mounting holes and fix it in place with the nozzle bridge. Then, connect a compression gauge to a.
- Crank the engine and measure the compression pressure for all the cylinders one after another. Determine the compression pressure difference between the cylinders.
- If the compression pressure is below the limit or the cylinder-to-cylinder pressure differences is not within the limit, pour a small amount of engine oil into the corresponding injection nozzle mounting hole and remeasure the compression pressure.
  - If the compression pressure increases, the piston rings and cylinder surfaces may be badly worn or otherwise damaged.
  - If the compression pressure remains unchanged, there may be seizure in the valves, the valves may be incorrectly seated or the cylinder head gasket may be defective.

2. Inspection and Adjustment of Valve Clearances

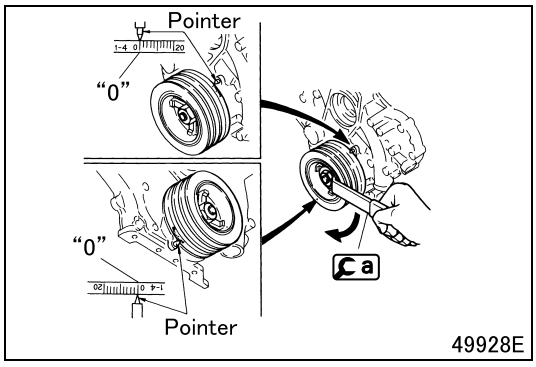
Service standards (Unit: mm)

Location	Maintenance item	Standard value	Limit	Remedy
–	Valve clearance (when cold)	0.4	–	Adjust

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
a	Cranking handle A 36  05999	MH061289	For cranking the engine
b	Slotted screwdriver  06000	MH060008	For adjusting valve clearance (when engine is mounted on vehicle)

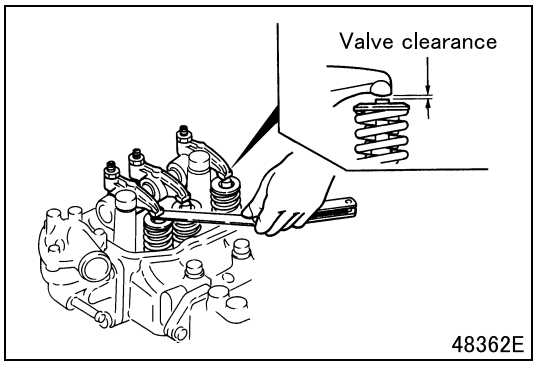
- Valve clearances should be checked and adjusted as follows while the engine is still cold.



49928E

[Inspection]

- Remove the rocker cover.
- Bring the No. 1 or No. 4 cylinder piston to the top dead center (TDC) on the compression stroke according to the following procedure:
  - Rotate the crankshaft pulley in the illustrated direction so that the pointer is aligned with the "0" mark next to the "1" to "4" mark on the inscribed scale on the crankshaft pulley. Either one of the two pointers can be used for this purpose.
  - This will place either the No. 1 or No. 4 cylinder piston at TDC on the compression stroke. The cylinder in which the rocker arms for both the intake and exhaust valves can be pushed down by hand by the valve clearance amounts has its piston at TDC. Rotate the engine by one full turn to switch the TDCs of the No. 1 and No. 4 cylinder pistons.

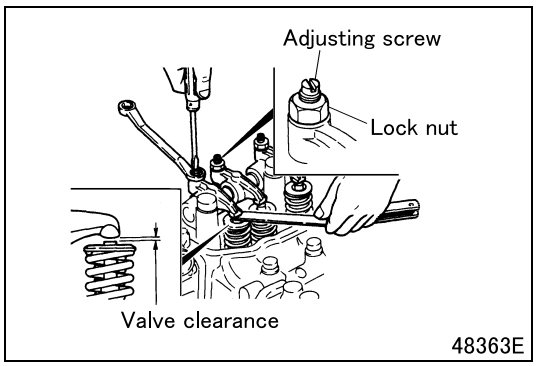


48362E

- With the No. 1 or No. 4 cylinder piston at TDC, measure the clearance of the valves marked with a circle in the table below.
- The feeler gauge must have a slight drag when taking measurements. If the feeler gauge can be moved without any resistance, the measurement will be incorrect.

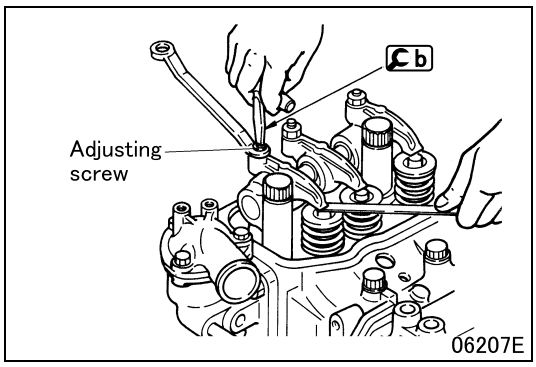
Cylinder No.	1		2		3		4	
Valve	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder piston at TDC on compression stroke	O	O	O	–	–	O	–	–
No. 4 cylinder piston at TDC on compression stroke	–	–	–	O	O	–	O	O

- If the measurements are not within the standard value range, adjust the value clearance via the following procedures.



[Adjustment]

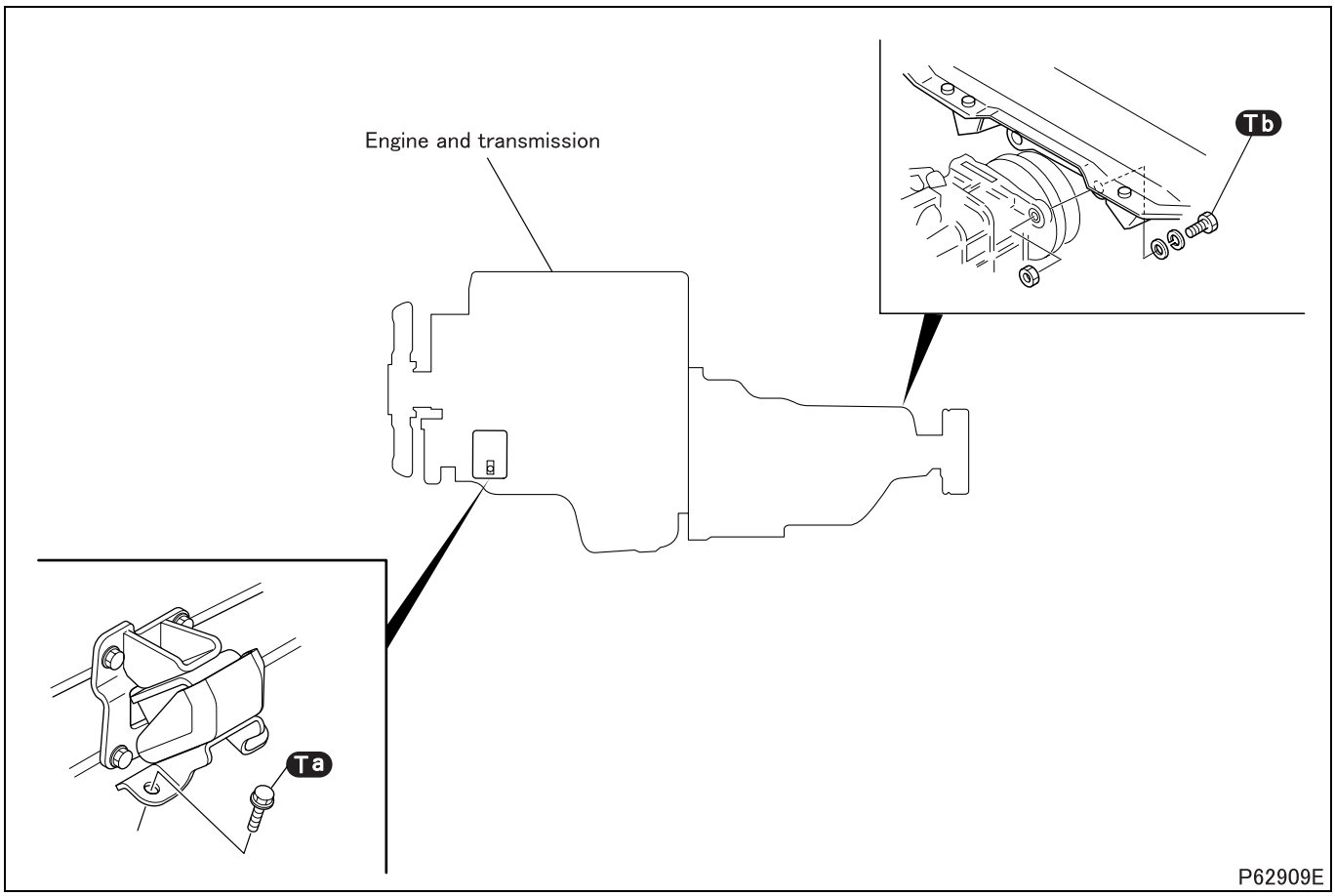
- Adjust the valve clearance by loosening the lock nut and rotating the adjusting screw so that the feeler gauge can only be moved with a slight drag.
- After the adjustment, hold the adjusting screw in position with a screwdriver and tighten the lock nut to the specified torque.
- Recheck the valve clearance with the feeler gauge, and readjust if the measurements are not within the specified value range.



- When carrying out valve clearance adjustment with the engine still mounted on the vehicle, use b to facilitate rotation of the adjusting screw.

ENGINE REMOVAL AND INSTALLATION <TILT CAB>

<FE>



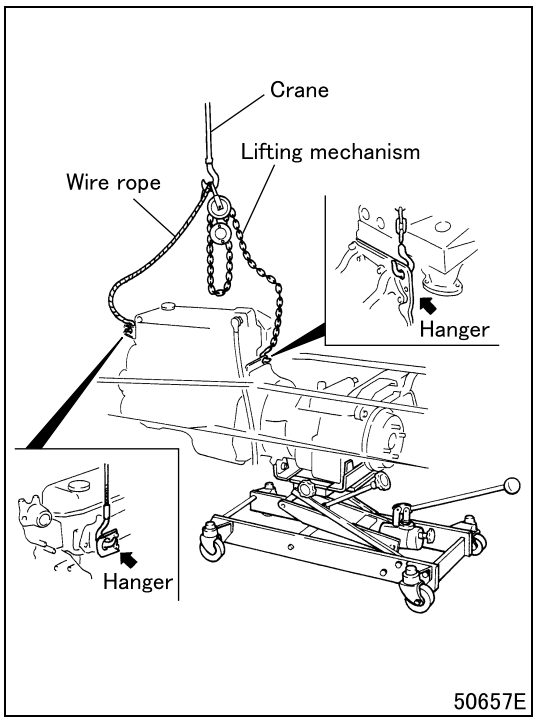
WARNING ⚠

- **Only use hoisting equipment appropriate for the engine weight (approximately 500 kg).**

Tightening torque (Unit: N·m {kgf·m})

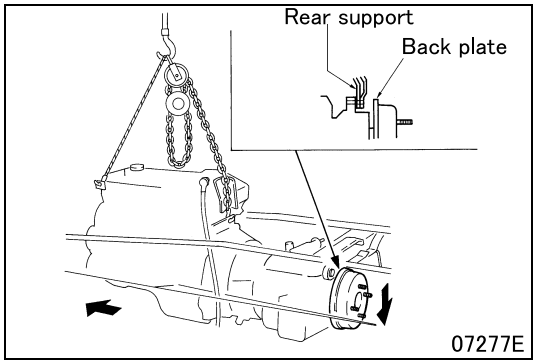
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (front mounting installation)	50 to 65 {5.1 to 6.6}	–
Tb	Bolt (rear mounting installation)	130 to 170 {13 to 17}	–

◆Removal procedure◆

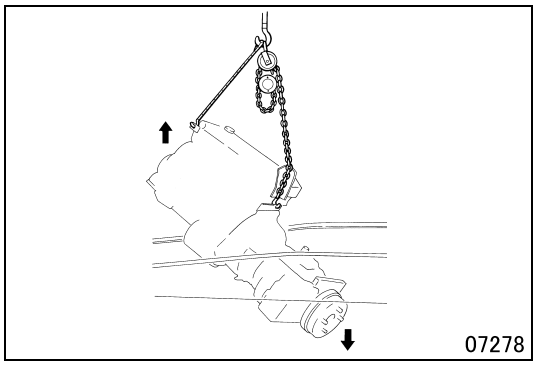


■ **Removal: Engine and transmission**

- Hook the wire rope and lifting mechanism each onto the two hangers on the engine and lift the engine with a crane until they are tight.
- Support the transmission with the transmission jack.
- Check that all wiring and piping have been disconnected from the engine.



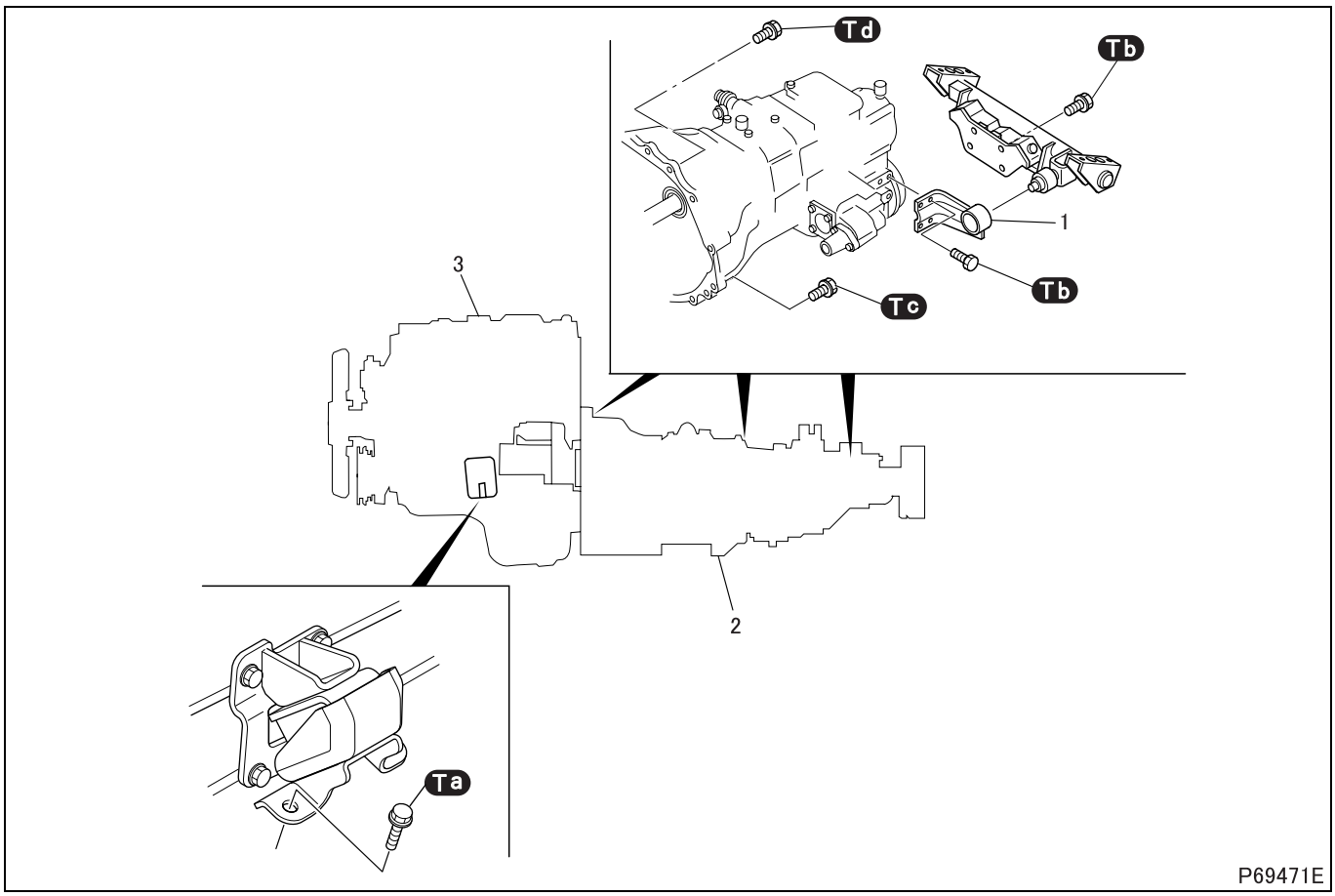
- Taking care not to let the transmission back plate hit the engine rear support, first push down the transmission part of the assembly, and then move the engine and transmission assembly forward.



- Once the transmission is out of the front end of the rear body, turn the engine and transmission assembly 90° to the right so as to prevent the assembly from hitting the frame and cab, and lower it to the right side of the vehicle. Make fine adjustments to the hoisting equipment as necessary.

ENGINE REMOVAL AND INSTALLATION <TILT CAB>

<FG>



● **Removal sequence**

1 Roll stopper
2 Transmission
3 Engine

● **Installation sequence**

Follow the removal sequence in reverse.

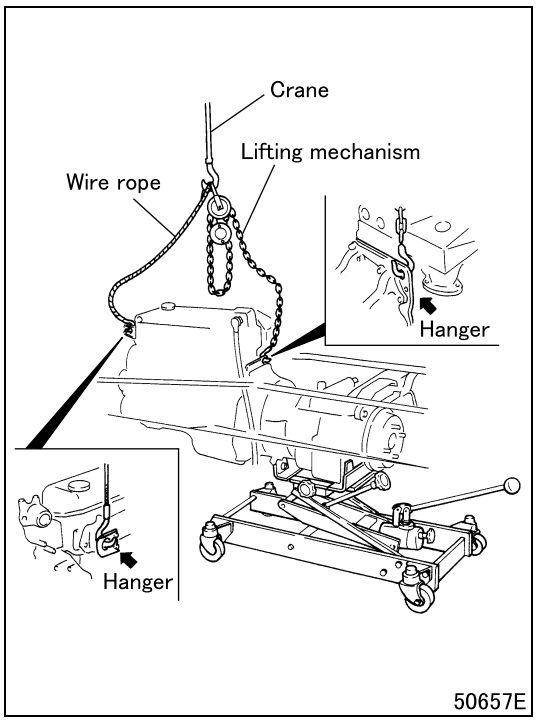
CAUTION ⚠

- **Be careful not to let the engine hit the cab or the rear body when hoisting the engine.**
- **Only use hoisting equipment appropriate for the engine weight (approximately 500 kg).**

Tightening torque (Unit: N·m {kgf·m})

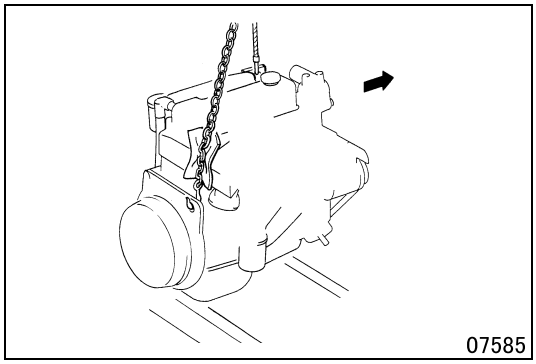
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (front mounting installation)	50 to 65 {5.1 to 6.6}	–
Tb	Bolt (roll stopper bracket installation)	45 to 65 {4.5 to 6.5}	–
	Bolt (rear mounting installation)		
Tc	Bolt (transmission installation)	47 {4.8}	M10 × 1.25
Td	Bolt (transmission installation)	82 {8.4}	M12 × 1.75

◆Removal procedure◆



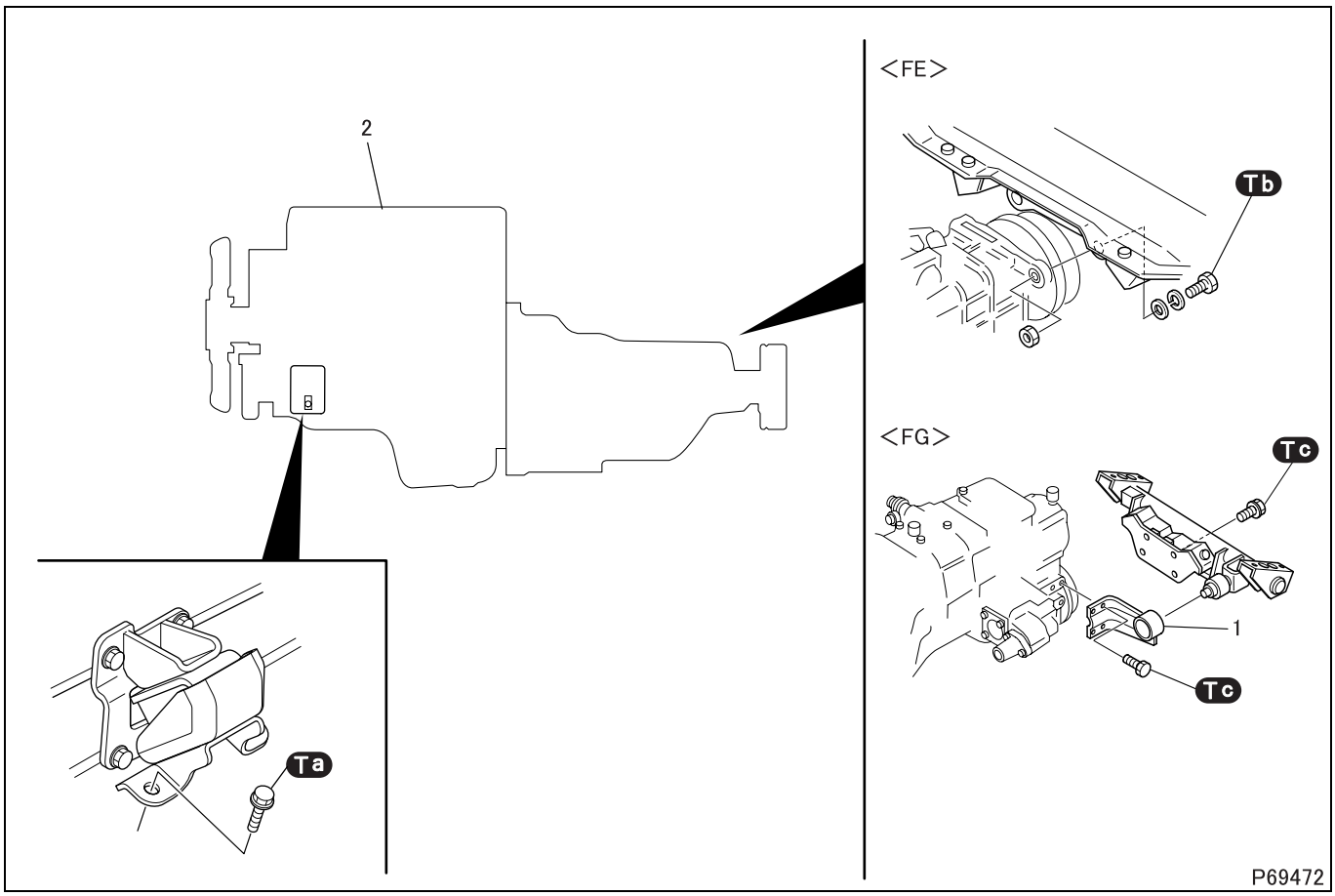
■ **Removal: Engine**

- Hook the wire rope and lifting mechanism each onto the two hangers on the engine and lift the engine with a crane until they are tight.
- Support the transmission with the transmission jack.
- Check that all wiring and piping have been disconnected from the engine.



- Hoist the engine slowly, taking care not to let the engine hit the frame and the cab.
- Once the bottom of the engine is out of the frame, turn the engine by 90° and remove it out of the vehicle.

ENGINE REMOVAL AND INSTALLATION <FIXED CAB>



● **Removal sequence**

1 Roll stopper
2 Engine and transmission

● **Installation sequence**

Follow the removal sequence in reverse.

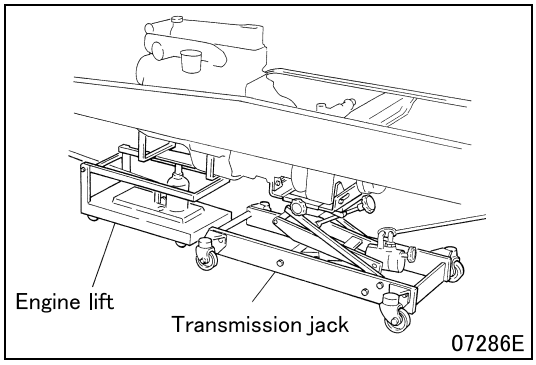
CAUTION ⚠

- **Before removing each part, support the engine and transmission assembly in place using an engine lifter and a transmission jack.**

Tightening torque (Unit: N·m {kgf·m})

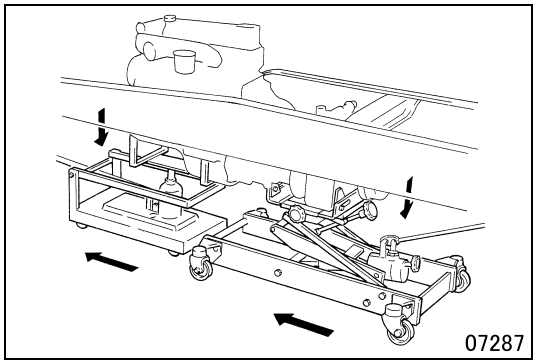
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (front mounting installation)	50 to 65 {5.1 to 6.6}	–
Tb	Bolt (rear mounting installation)	130 to 170 {13 to 17}	–
Tc	Bolt (roll stopper bracket mounting)	45 to 65 {4.5 to 6.5}	–
	Bolt (rear mounting installation)		

◆Removal procedure◆



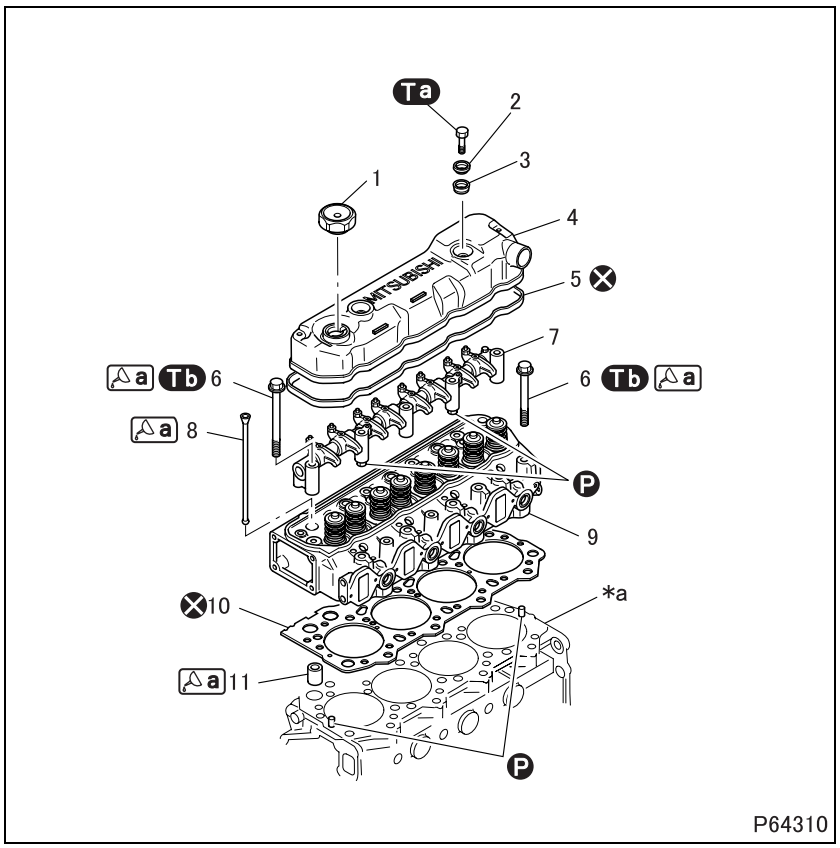
■ **Removal: Engine and transmission**

- Support the engine and transmission with an engine lift and a transmission jack.
- Check that all wiring and piping have been disconnected from the engine.



- Lower the engine and transmission to the greatest extent possible while keeping it horizontally balanced.
- Jack up the vehicle and slide the engine and transmission forward.

CYLINDER HEAD



● **Disassembly sequence**

1 Oil filler cap
2 Plate
3 Insulator
4 Rocker cover
5 Rocker cover gasket
6 Cylinder head bolt
7 Rocker and bracket assembly (See later sections.)
8 Push rod
9 Cylinder head (See later sections.)
10 Cylinder head gasket
11 Tappet

***a**: Crankcase
Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Be careful not to damage the glow plugs and injection nozzles when placing the cylinder head on the worktable, as they protrude out of the bottom of the cylinder head.**
- **The cylinder head bolts are tightened using the torque-turn method. Any cylinder head bolt that has three marks indicating that the bolt has been tightened three times already must be replaced with a new one.**

Service standards (Unit: mm)

Location	Maintenance item	Standard value	Limit	Remedy
8	Push rod run-out	–	0.4	Replace
11, *a	Tappet-to-tappet hole clearance	0.05 to 0.09	0.2	Replace

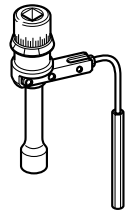
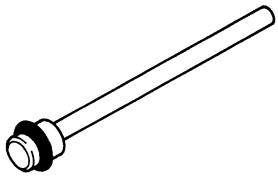
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (rocker cover mounting)	3 to 4 {0.3 to 0.4}	–
Tb	Cylinder head bolt	150 {15} +90°	• Wet • Reusable up to 3 times

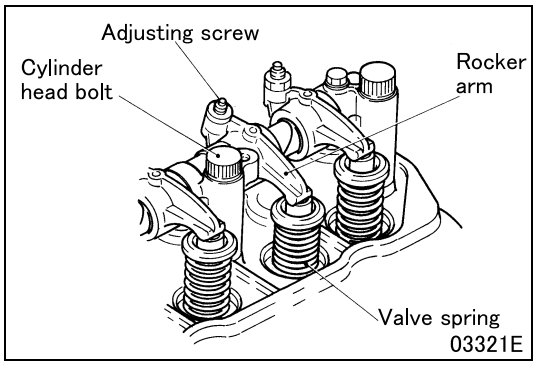
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Threads of cylinder head bolt	Engine oil	As required
	Upper and lower ends of push rod		
	Outer surface of tappet		

Special tools

Mark	Tool name and shape	Part No.	Application
a	Socket wrench  P01984	MH061560	Installation of cylinder head
b	Tappet extractor  03320	MH063329	Removal of tappet

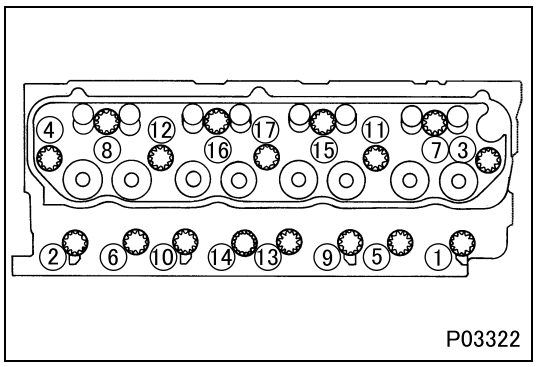
◆Work before removal◆



■ **Preparing for cylinder head removal: Releasing valve spring tension**

- If the rocker arms are pressing down on the valve springs, loosen the adjusting screws on the rocker arms before loosening the cylinder head bolts to prevent any damage by the valve springs' tension.

◆Removal procedure◆



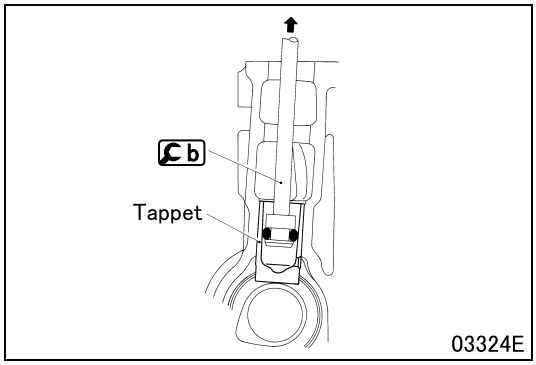
■ **Removal: Cylinder head**

- To remove the cylinder head, first loosen the cylinder head bolts in the order indicated in the illustration.

■ **Removal: Cylinder head gasket**

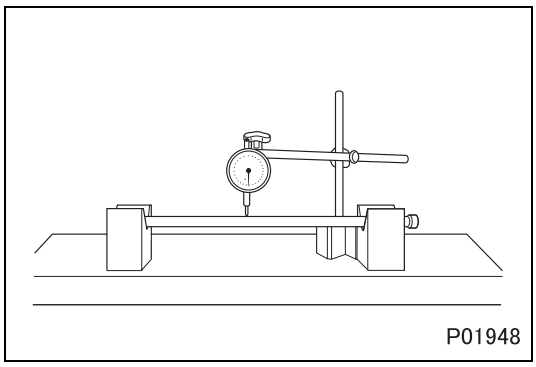
CAUTION ⚠

- **Be careful not to scratch the cylinder head and crankcase when removing the cylinder head gasket.**



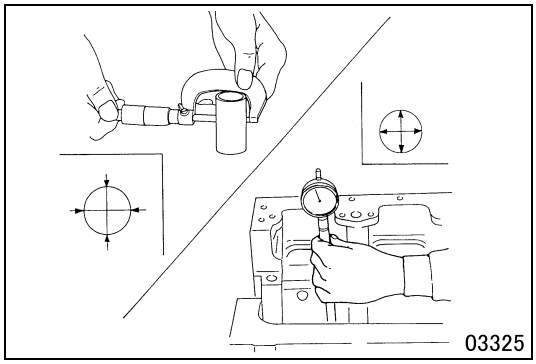
■ **Removal: Tappets**

◆Inspection procedure◆



■ **Inspection: Push rod run-out**

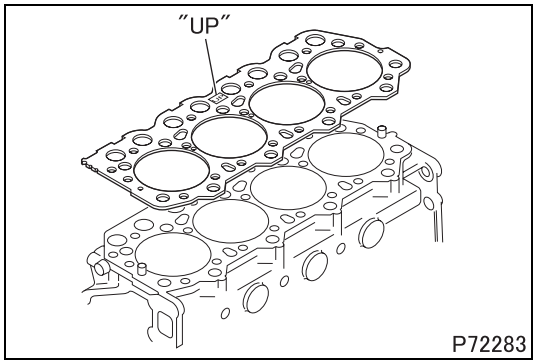
- If the measured values exceed the limit, replace the push rod.



■ **Inspection: Tappet-to-tappet hole clearance**

- If the measured values exceed the limit, replace the defective part(s).

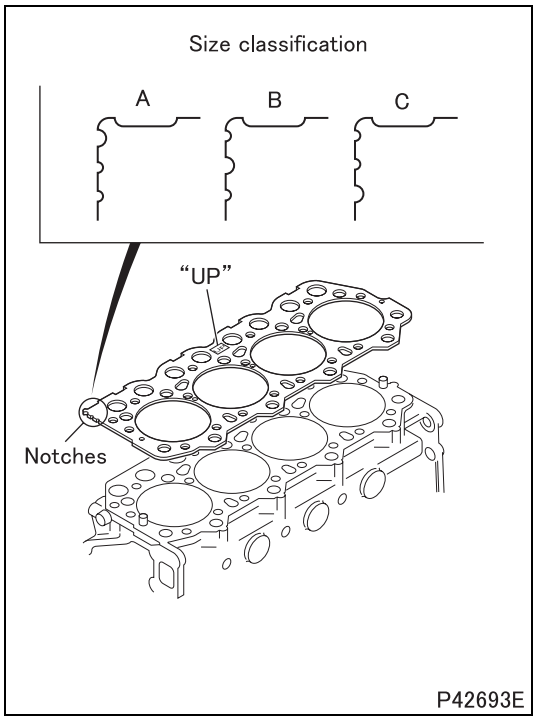
◆Installation procedure◆



■ **Installation: Cylinder head gasket**

<4D33>

- Install the cylinder head gasket on the crank case in the illustrated direction.



<4D34>

- The cylinder head gasket comes in three sizes. Choose the gasket appropriate for the cylinder head by the following procedure.
  - Measure the amount of piston projection for every cylinder. (See the PISTON AND CONNECTING RODS section.)

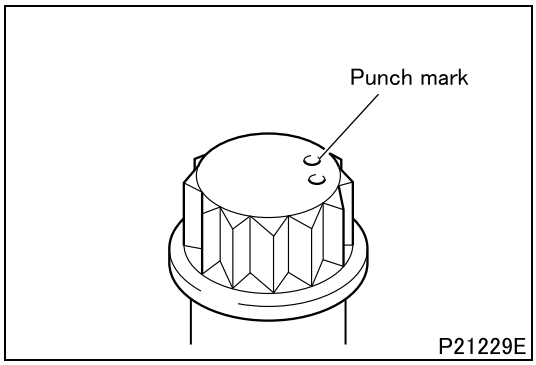
CAUTION ⚠

- **Replacement of the piston or connecting rod alters the piston projection. Always measure the amount of piston projection after either or both of them are replaced.**

- Select a cylinder head gasket with the appropriate thickness for the measured maximum piston projection value from the following table.
  If any of the piston projection measurements is more than 0.05 mm larger than the average value, then use a gasket that is a rank thicker (A→B, B→C).

Piston projection	Cylinder head gasket	
Average value of piston projection	Size	Thickness when tightened
0.466 to 0.526	A	1.35 ± 0.03
0.526 to 0.588	B	1.40 ± 0.03
0.588 to 0.648	C	1.45 ± 0.03

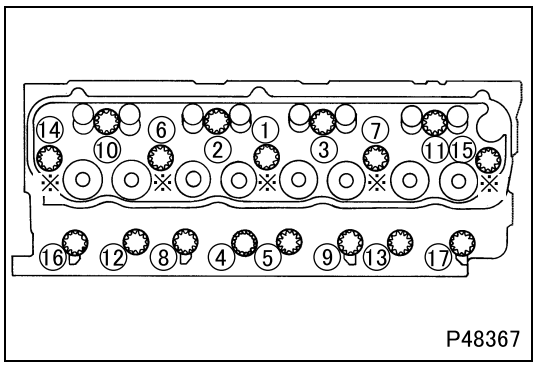
- The size class of the cylinder head gasket can be determined from the shape of the notches cut on the gasket edge.
- Install the cylinder head gasket on the crankcase in the illustrated direction.



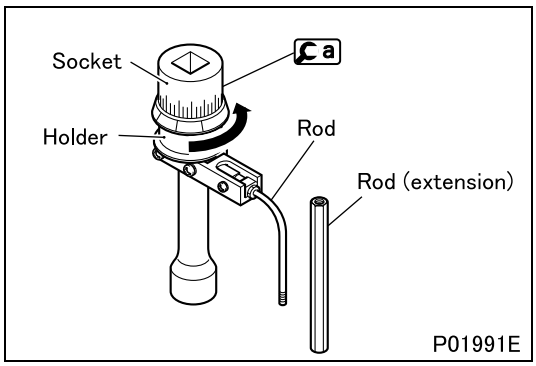
■ **Installation: Cylinder head**

CAUTION ⚠

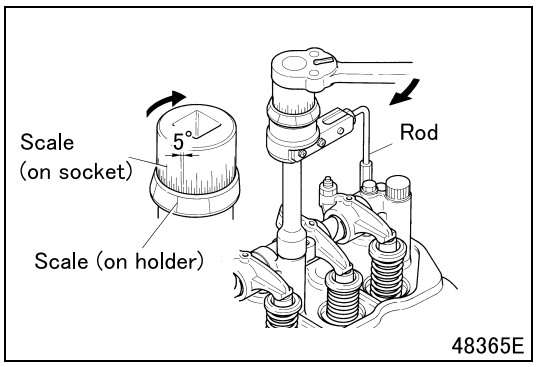
- **Before fitting the cylinder head bolts, check the punch marks on each bolt's head. Do not use the bolt if there are three punch marks.**
- **The punch marks indicate the number of times each bolt has been tightened using the torque-turn tightening method. Any bolt that already has three punch marks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



- Tighten the bolts to half the specified torque (75 N·m {7.5 kgf·m}) in the order indicated in the illustration.
- Tighten these bolts further to the specified torque (150 N·m {15 kgf·m}) in the same order, then completely tighten them by the following procedure.
  ※: Bolts also fastening rocker arm and bracket assembly



- Turn the holder of a counterclockwise to pretension the internal spring.



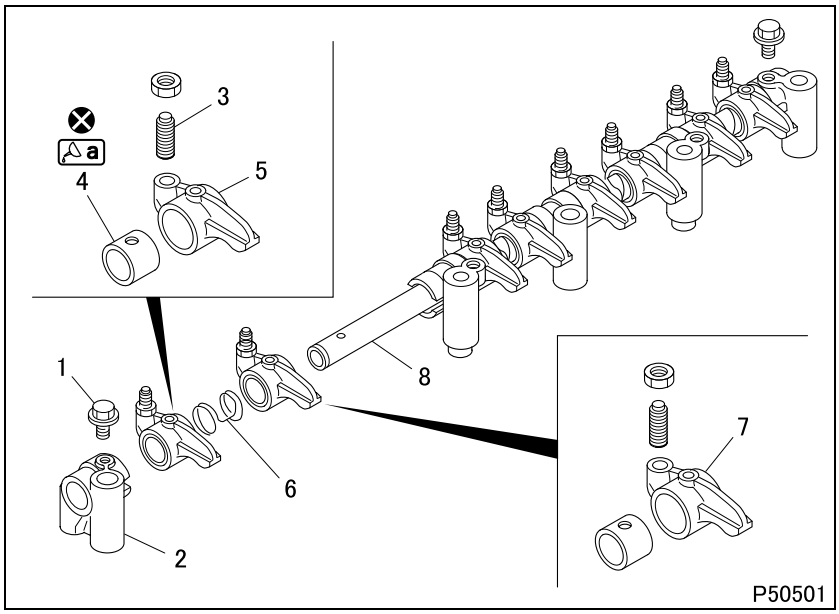
- Fit Ca on the bolt and set it so that the rod (extension) is held pressed by the spring force against a surrounding part such as the rocker shaft bracket or the injection pipe.
- Select a clearly visible mark on the scale on the holder.
- Use this mark as a point of reference and turn the socket clockwise 90° (one graduation on the socket scale represents 5°).
- After tightening each bolt, make a punch mark on the head of the bolt to indicate the number of times that it has been used (bolts may not be used more than three times).

CAUTION ⚠

- **Cylinder head bolts that have been tightened using the torque-turn method must never be additionally tightened after the final angular tightening.**

M E M O

Rocker and Bracket



● **Disassembly sequence**

1 Set bolt
2 Rocker shaft bracket
3 Adjusting screw
4 Rocker bushing
5 Intake valve rocker
6 Rocker shaft spring
7 Exhaust valve rocker
8 Rocker shaft

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

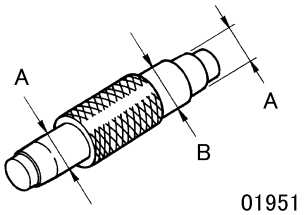
Service standards (Unit: mm)

Location	Maintenance item	Standard value	Limit	Remedy
4, 8	Rocker bushing-to-rocker shaft clearance	0.06 to 0.11	0.2	Replace

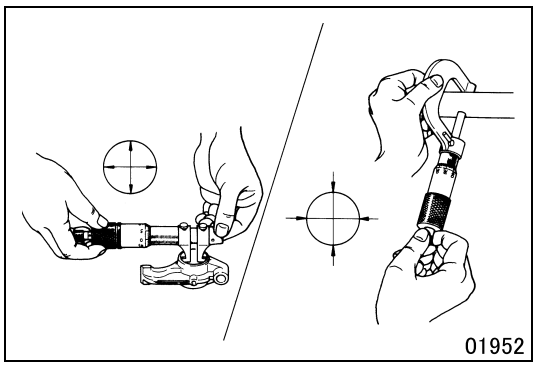
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rocker bushing inside surface	Engine oil	As required

Special tools (Unit: mm)

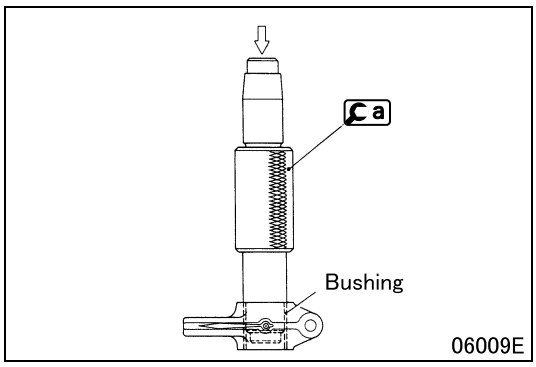
Mark	Tool name and shape	Part No.	Application
Ca	Rocker bushing puller A: φ19, B: φ21 	MH061378	Removal and installation of rocker bushing

◆**Inspection procedure**◆

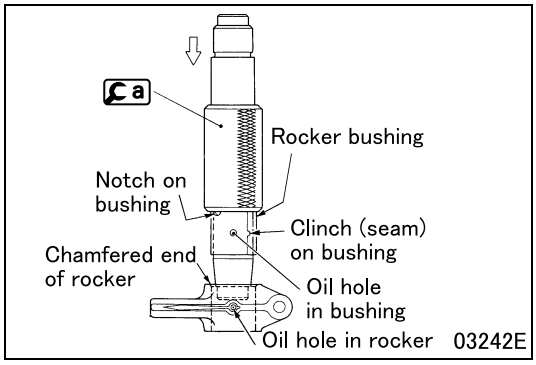


■ **Inspection: Rocker bushing-to-rocker shaft clearance**

- If the difference between the measurements exceeds the limit, replace the bushing.



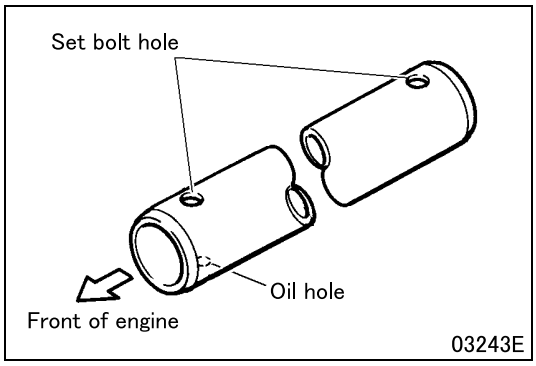
Replacement of rocker bushing
[Removal]



[Installation]

- Assemble the tool and parts as illustrated while aligning the oil hole in the bushing and the oil hole in the rocker.
- Force the bushing into the rocker until a touches the rocker's chamfered end.
- After the installation is completed, measure the clearance between the rocker shaft and the bushing.
- If the measurement is less than the minimum value in the standard value range, ream the rocker bushing.

◆Installation procedure◆

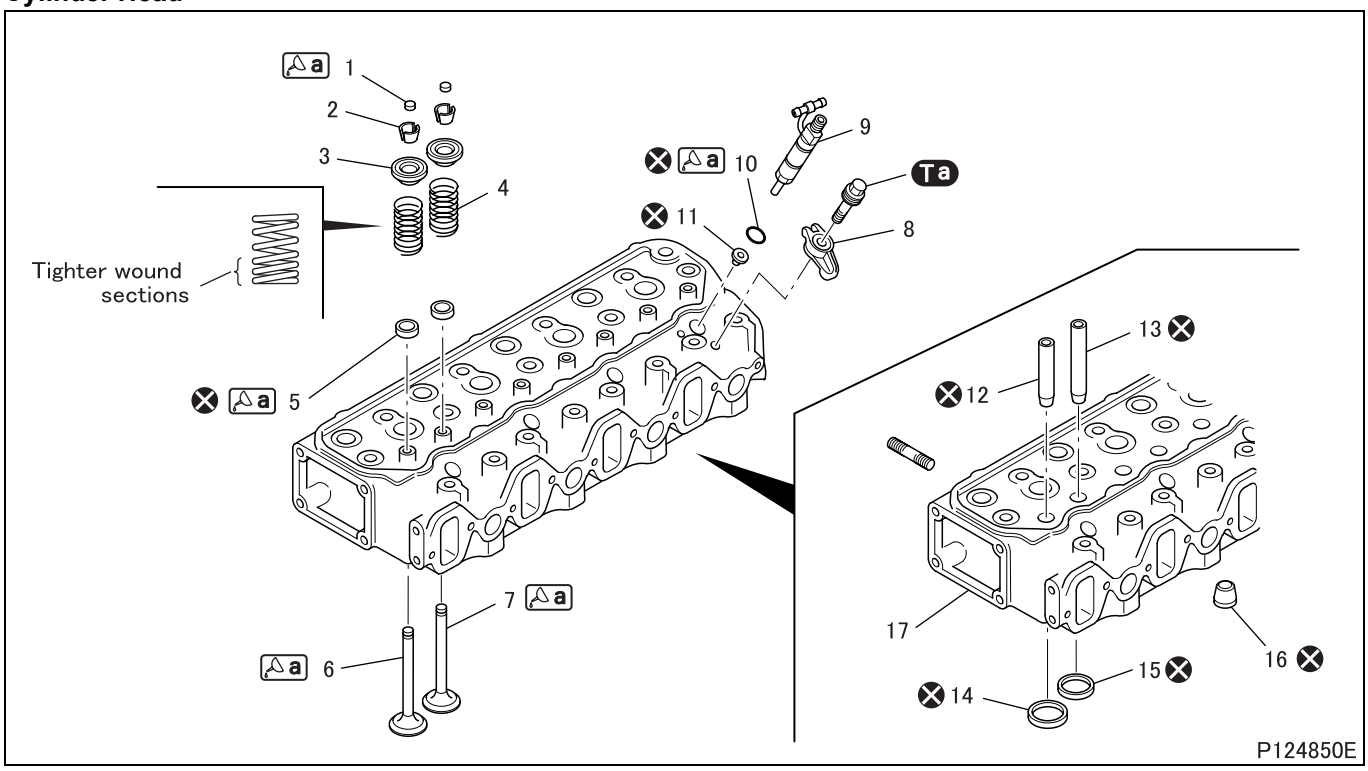


■ Installation: Rocker shaft

- Install the rocker shaft with its ends facing in the illustrated directions.

CYLINDER HEAD

Cylinder Head



● **Disassembly sequence**

1 Valve cap
2 Valve cotter
3 Upper retainer
4 Outer valve spring
5 Valve stem seal
6 Intake valve
7 Exhaust valve
8 Nozzle bridge
9 Injection nozzle (See Gr13.)
10 O-ring
11 Nozzle tip gasket
12 Intake valve guide
13 Exhaust valve guide
14 Intake valve seat
15 Exhaust valve seat
16 Water director
17 Cylinder head

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **When an intake valve or exhaust valve has been removed, make sure to replace the valve stem seal.**

Service standards (Unit: mm)

Location	Maintenance item		Standard value	Limit	Remedy
4	Outer valve spring	Free length	68.3	63.0	Replace
		Installed load (47.80 in installed length)	390 ± 20 N {40 ± 2.0 kgf}	348 N {35.5 kgf}	
		Squareness	–	2.5	
6	Intake valve	Stem outside diameter	8.96 to 8.97	8.85	Replace
		Sinkage from cylinder head bottom surface	1.0 ± 0.25	1.5	Inspect
		Valve margin	1.5	1.2	Reface or replace
		Seat angle	45° ± 15’	–	
6, 12	Intake valve stem-to-valve guide clearance		0.04 to 0.06	0.15	Replace

Location	Maintenance item		Standard value	Limit	Remedy
7	Exhaust valve	Stem outside diameter	8.93 to 8.94	8.85	Replace
		Sinkage from cylinder head bottom surface	1.2 ± 0.25	1.7	Inspect
		Valve margin	1.5	1.2	Reface or replace
		Seat angle	45° ± 15'	–	
7, 13	Exhaust valve stem-to-valve guide clearance		0.07 to 0.1	0.2	Replace
14	Intake valve seat width	4D33	2.0 ± 0.2	2.8	Correct or replace
		4D34	2.8 ± 0.2	3.6	
15	Exhaust valve seat width		2.0 ± 0.2	2.8	Correct or replace
17	Cylinder head	Bottom surface distortion	0.05 or less	0.2	Correct or replace
		Height from top surface to bottom surface	95 ± 0.1	94.6	Replace

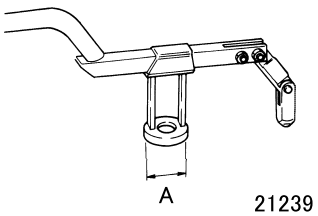
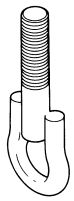
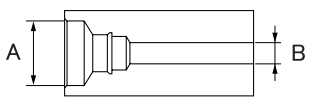
Tightening torque (Unit: N·m {kgf·m})

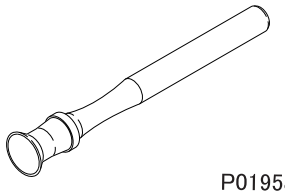
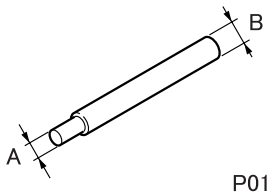
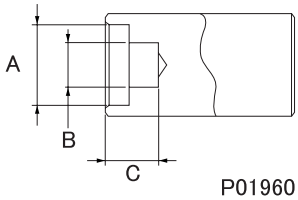
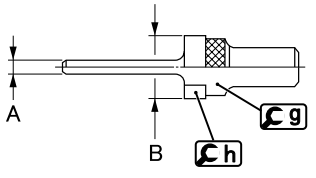
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (nozzle bridge installation)	25 {2.5}	–

Lubricant and/or sealant

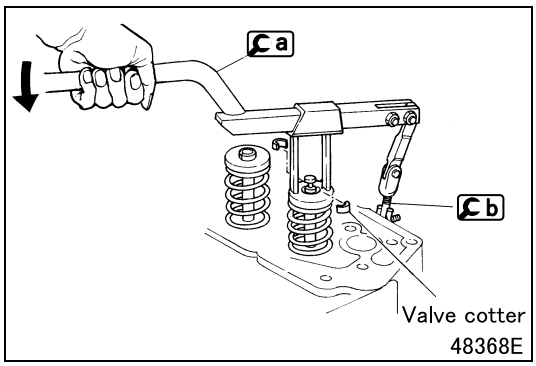
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact surfaces between valve cap and rocker	Engine oil	As required
	Lip of valve stem seal		
	Valve stem		
	O-ring		

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
Ca	Valve lifter A ϕ42  21239	MH061668	Removal and installation of valve cotters
Cb	Valve lifter hook  21240	MH061679	
Cc	Valve stem seal installer A: ϕ28, B: ϕ9  P01957	MH061293	Installation of valve stem seals

<table>
<tr><th>Mark</th><th>Tool name and shape</th><th>Part No.</th><th>Application</th></tr>
<tr><td>d</td><td>Valve lapper
 
P01958</td><td>30091-07500</td><td>Lapping valves and valve guides</td></tr>
<tr><td>e</td><td>Valve guide remover
<table><tr><th>A</th><th>B</th></tr><tr><td>ϕ9</td><td>ϕ13</td></tr></table> 
P01959</td><td>MH061066</td><td>Removal of valve guides</td></tr>
<tr><td>f</td><td>Valve guide installer
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>ϕ28.5</td><td>ϕ15</td><td>ϕ18</td></tr></table> 
P01960</td><td>MH061998</td><td>Installation of valve guides</td></tr>
<tr><td>g</td><td>Caulking tool body
<table><tr><th>A</th></tr><tr><td>ϕ9</td></tr></table></td><td rowspan="2"> 
P01961AE</td><td>MH061067</td><td rowspan="2">Installation of valve seat</td></tr>
<tr><td>h</td><td>Caulking ring
<table><tr><th></th><th>Model</th><th>B</th></tr><tr><td rowspan="2">Intake</td><td>4D33</td><td>ϕ 49</td></tr><tr><td>4D34</td><td>ϕ 47.6</td></tr><tr><td rowspan="2">Exhaust</td><td>4D33</td><td>ϕ 42</td></tr><tr><td>4D34</td><td>ϕ 40.6</td></tr></table></td><td><Intake (4D33)>
MH061695
<Intake (4D34)>
MH061275
<Exhaust (4D33)>
MH061696
<Exhaust (4D34)>
MH061069</td></tr>
</table>

◆Removal procedure◆



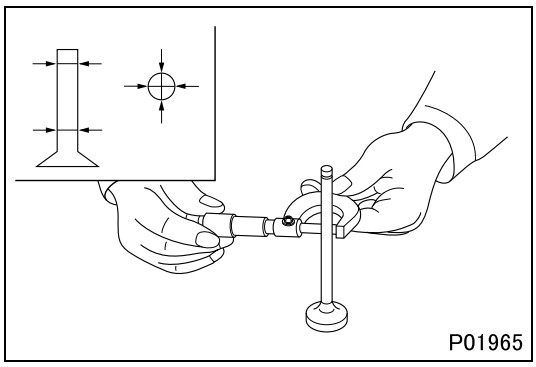
■ **Removal: Valve cotters**

- Remove the valve cotters by evenly compressing the valve springs.

CAUTION ⚠

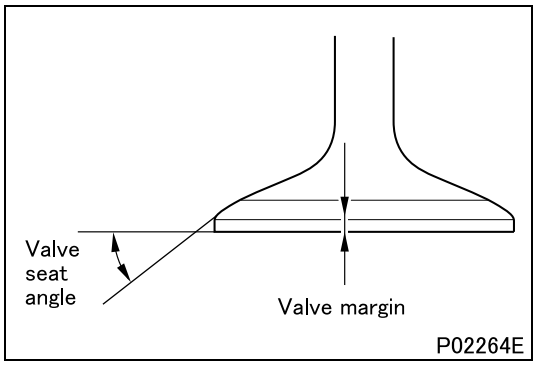
- **Do not compress the valve springs more than necessary, as this may cause the upper retainer to touch the valve stem seal and damage it.**

◆Inspection procedure◆



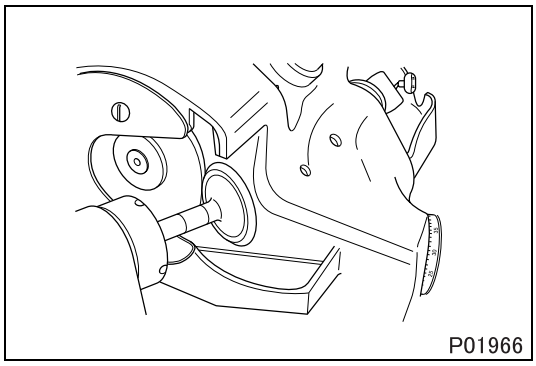
■ Inspection: Valve stem outside diameter

- Replace the valve if the stem's outside diameter is below the limit or is severely worn.
- When the valve has been replaced with a new one, make sure to lap the valve and valve seat.



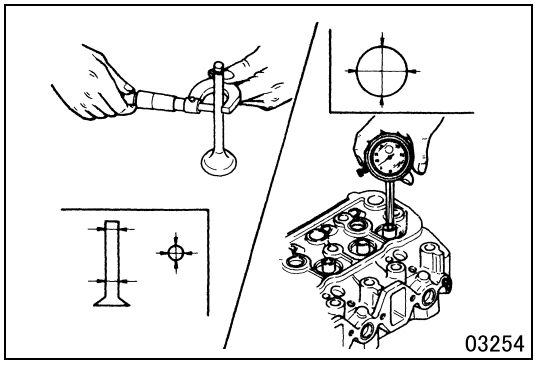
■ Inspection: Valve seat angle and valve margin

- Reface or replace the valve if the valve seat angle or valve margin exceeds the specified limits.



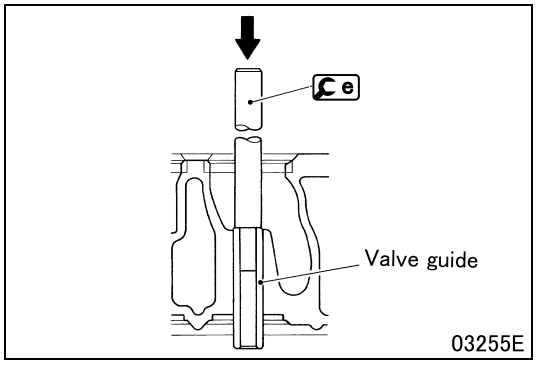
Refacing

- Limit grinding to a necessary minimum.
- If the valve margin is below the limit after grinding, replace the valve.
- After grinding, make sure to lap the valve and valve seat.

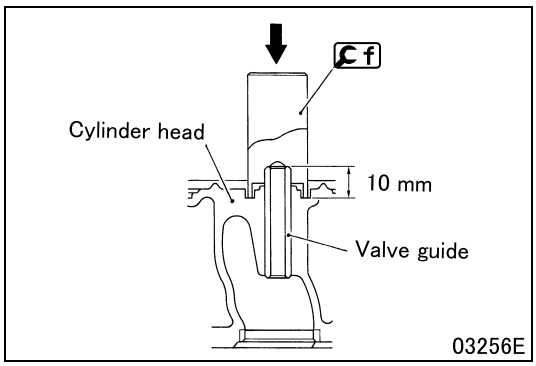


■ Inspection: Valve-to-valve guide clearance

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



Replacement of valve guides
[Removal]

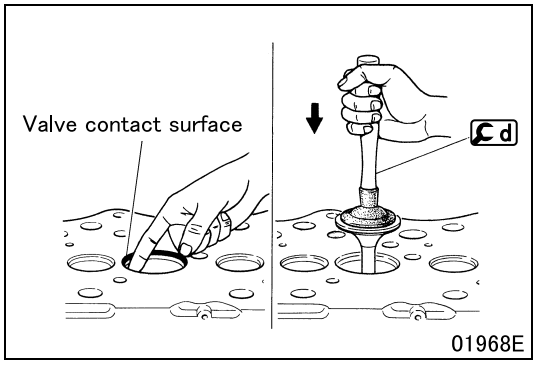


[Installation]

- Install the valve guide until Cf sits snugly on the cylinder head.

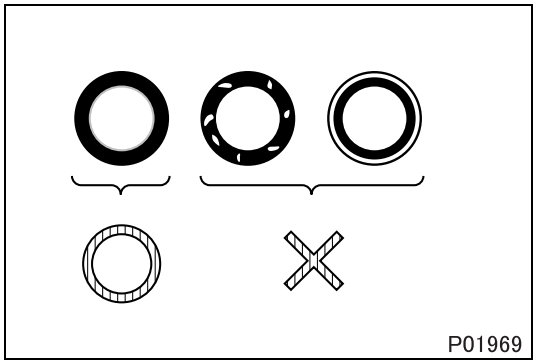
CAUTION ⚠

- **The valve guides must be pressed to a depth of 10 mm. Be sure to use Cf for this operation.**
- **Exhaust valve guides are longer than intake valve guides. Make sure to install the correct type of guide in each location.**



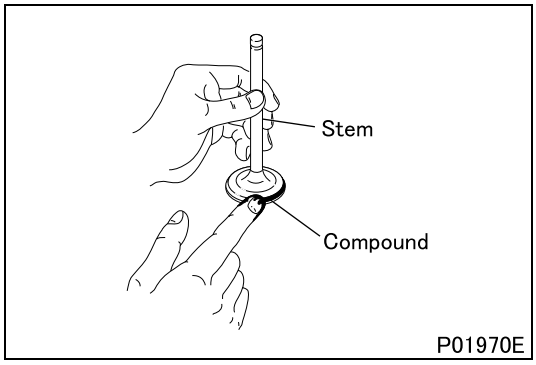
■ Inspection: Contact between valve and valve seat

- Before starting inspection, check that the valve and valve guide are intact.
- Apply an even coat of red lead to the valve contact surface of the valve seat.
- Strike the valve once against the valve seat. Do not rotate the valve during this operation.



- If the red lead deposited on the valve indicates a poor contact pattern, take either of the following corrective actions.

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

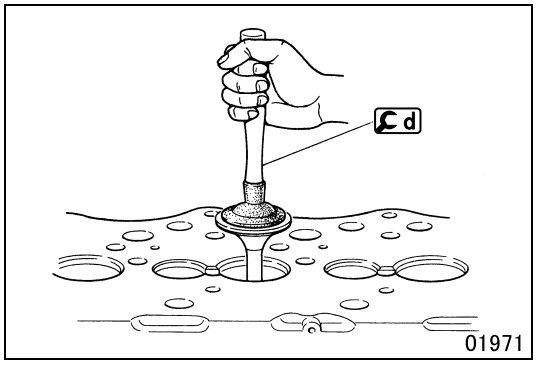


Lapping

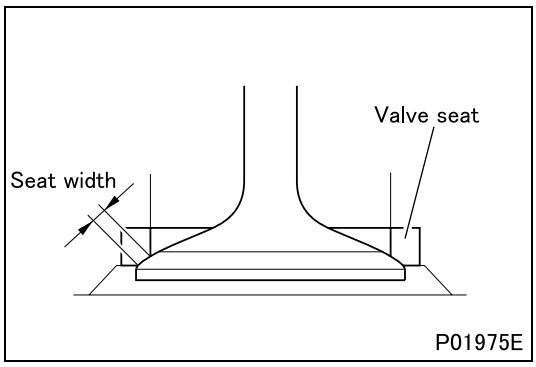
- Apply a thin coat of lapping compound to the seat contact surface of the valve.
- Start with an intermediate-grit compound (120 to 150 grit) and finish with a fine-grit compound (200 grit or more).
- Adding a small amount of engine oil to the lapping compound can facilitate even application.

CAUTION ⚠

- **Do not put any compound on the stem.**



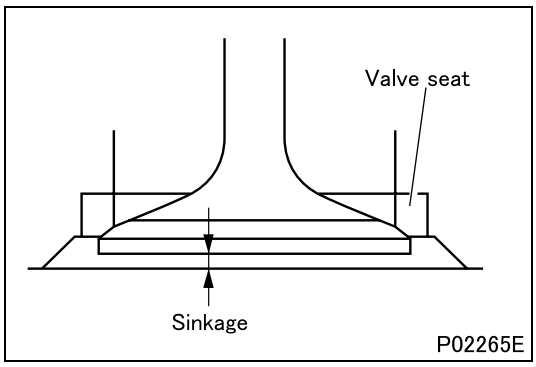
- Strike the valve several times against the valve seat while rotating the valve a little at a time.
- Wash away the compound with diesel fuel.
- Apply engine oil to the valve contact surface of the valve seat and rub in the valve and seat well.
- Inspect the contact pattern of the valve and valve seat again.
- If the contact pattern is still defective, replace the valve seat.



■ **Inspection: Valve seats**

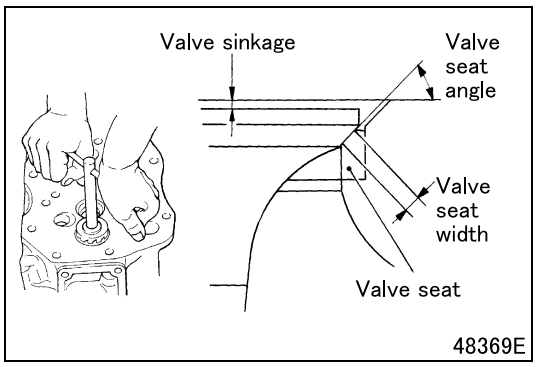
(1) Valve seat width

- If the measurement exceeds the limit, reface or replace the valve seat.
- After refacing or replacing the valve seat, make sure to lap the valve seat and valve.



(2) Valve sinkage from cylinder head bottom surface

- Perform measurement keeping the valve in close contact with the valve seat.
- If the measurement exceeds the limit, adjust or replace the defective part(s).



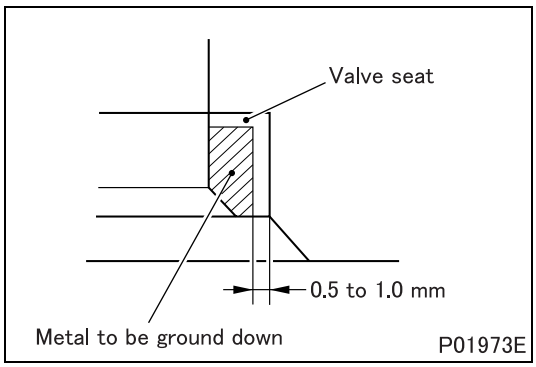
Refacing the valve seat

- Grind the valve seat using a valve seat cutter or valve seat grinder.
- Place a piece of sandpaper of approximately #400 between the cutter and valve seat and grind the valve seat lightly.
- Use a 15° or 75° cutter to cut the valve seat to a width within the standard range.

CAUTION ⚠

- **Make sure that the valve seat refacing does not cause the valve sinkage to exceed the specified limit.**

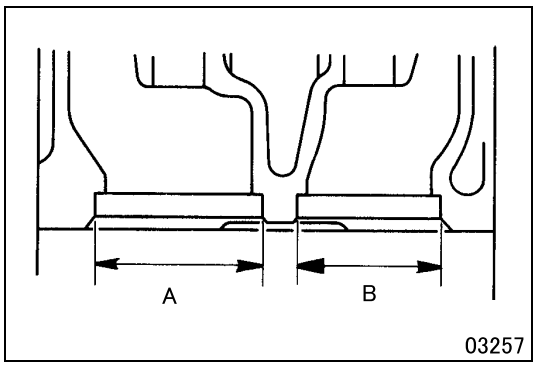
- Lap the valve and valve seat.



Replacement of valve seat

[Removal]

- The valve seats are installed by expansion fitting. To remove a valve seat, grind inside the metal stock to reduce the wall thickness, then remove the valve seat at room temperature.

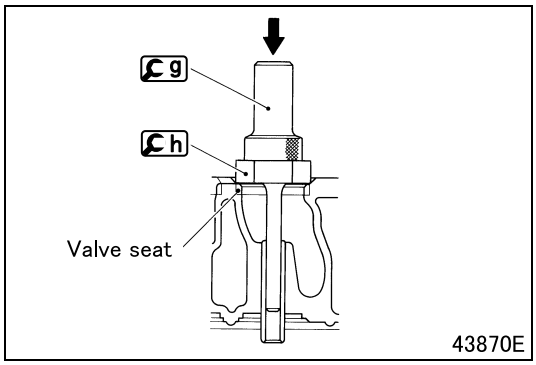


[Installation]

- Check that the diameters of the intake and exhaust valve seat holes A and B in the cylinder head conform with the values shown below.

	4D33	4D34
Intake valve seat hole: A	$\phi 50\ ^{+0.025}_{0}$ mm	$\phi 46\ ^{+0.025}_{0}$ mm
Exhaust valve seat hole: B	$\phi 43\ ^{+0.025}_{0}$ mm	$\phi 39\ ^{+0.025}_{0}$ mm

- Replace the cylinder head if necessary.

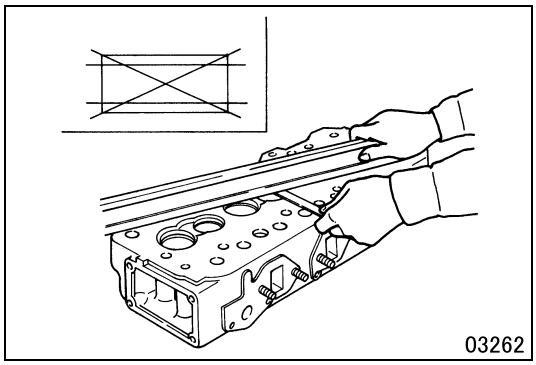


- Chill the valve seat thoroughly by immersing in it in liquid nitrogen.

CAUTION ⚠

- **Handle the chilled valve seats extremely carefully to avoid getting frostbite.**

- Install the valve seat in the cylinder head using g and h.
- Lap the valve seat and valve.



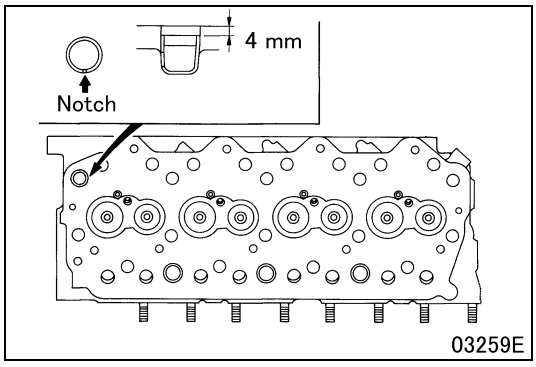
■ Inspection: Cylinder head bottom surface distortion

- If the distortion exceeds the specified limit, rectify it using a surface grinder.

CAUTION ⚠

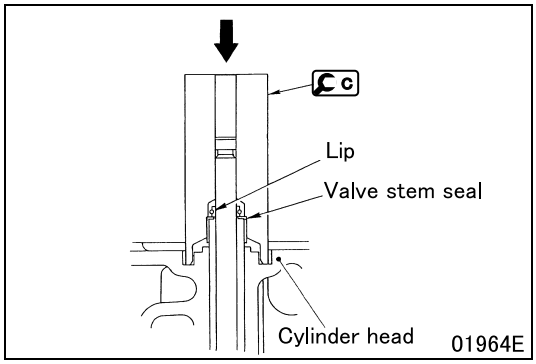
- **Make sure that the height of the cylinder head from the top surface to the bottom surface is not reduced to a value below the specified limit.**

◆Installation procedure◆



■ Installation: Water director

- Install the water director to the specified depth (4 mm) with the notch facing in the illustrated direction.



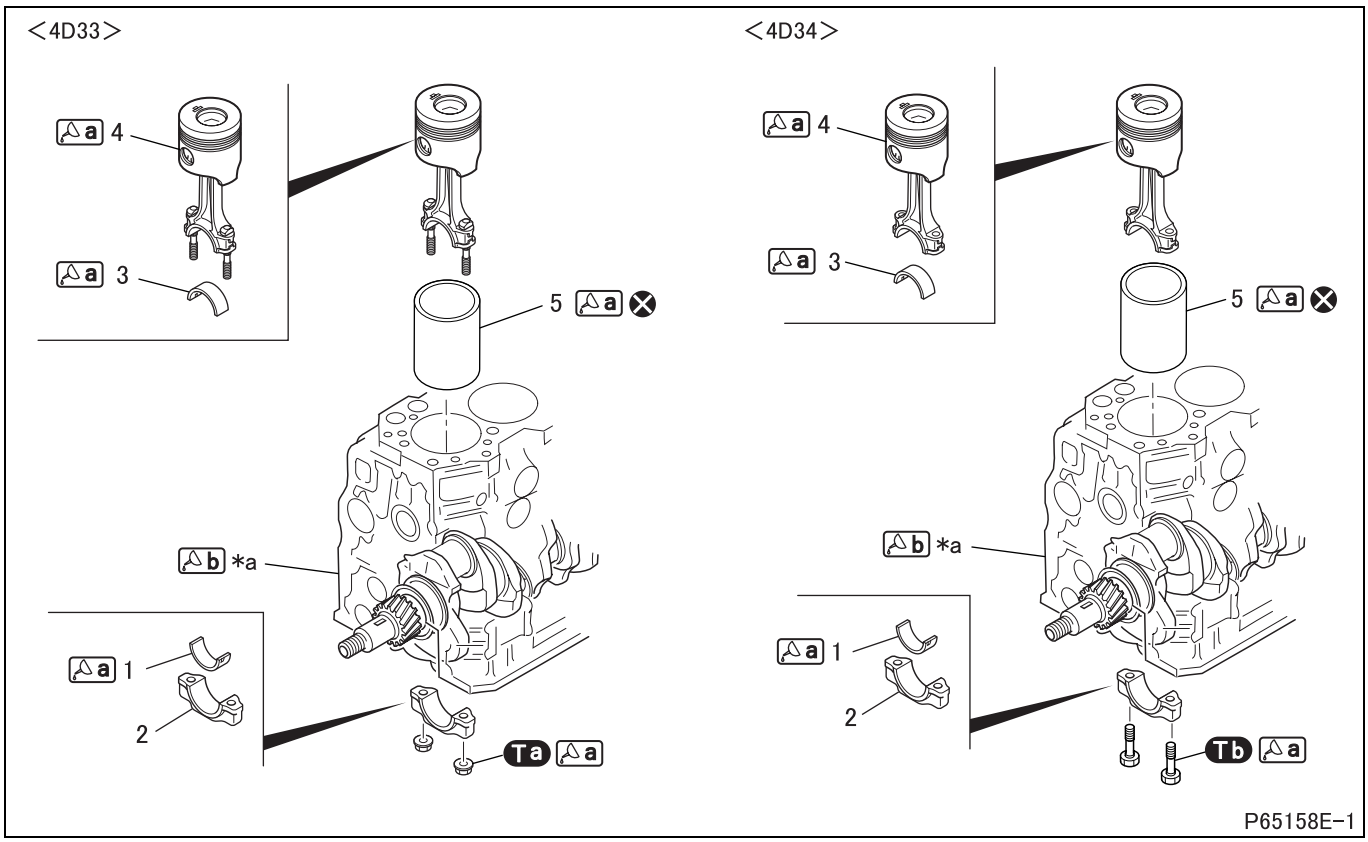
■ Installation: Valve stem seal

- Apply engine oil to the lip of the valve stem seal.
- Install the valve stem seal until c sits snugly on the cylinder head.
- After installing the valve stem seal, check that its spring is not deformed or damaged. Replace the valve stem seal if the spring is defective.

■ **Installation: Valve cotter**

- To install the valve cotter, follow the removal procedure. (See "■**Removal: Valve cotter**".)

PISTON AND CONNECTING ROD, CYLINDER SLEEVE



- **Disassembly sequence**
  - **1** Lower connecting rod bearing
  - **2** Connecting rod cap
  - **3** Upper connecting rod bearing
  - **4** Piston and connecting rod (See later sections.)
  - **5** Cylinder sleeve <4D34> Cylinder sleeve for correction <4D33>
  - ⊗: Non-reusable parts
  - ***a**: Crankcase

- **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The connecting rod bolts are fastened using the torque-turn method. Any connecting rod bolt that has three marks indicating that it has been tightened three times already must be replaced with a new bolt together with its nut.**
- **The cylinder sleeve for correction is not installed at the first overhaul. The sleeve is used when correction is needed. <4D33>**

Service standards (Unit: mm)

Location	Maintenance item			Standard value	Limit	Remedy
–	Piston projection from crankcase top surface (average value)		4D33	0.57 to 0.83	–	Inspect
			4D34	0.53 to 0.77		
–	Connecting rod end play			0.15 to 0.45	0.6	Inspect
1, 3	Connecting rod bearing	Span when free	4D33	–	Less than 64.5	Replace
			4D34	–	Less than 69.5	
		Oil clearance	4D33	0.035 to 0.094	0.2	
			4D34	0.04 to 0.099	0.2	

Location	Maintenance item		Standard value	Limit	Remedy
4, 5	Piston and connecting rod-to-cylinder sleeve clearance <4D34>		0.115 to 0.525	–	Correct or replace with oversized ones
4, *a	Clearance between piston and connecting rod assembly and crankcase cylinder <4D33>		Basic diameter : 108 0.07 to 0.12	–	Correct, replace with oversized ones or install cylinder sleeve for correction
5	Cylinder sleeve <4D34>	Bore diameter	ϕ102.8 to 103	ϕ103.25	Correct or replace with oversized ones
		Out-of-roundness	0.01 or Less	–	
		Taper	0.03 or Less	–	
5, *a	Crankcase cylinder or cylinder sleeve for correction <4D33>	Bore diameter	ϕ108 to 108.03	ϕ108.25	Correct
		Out-of-roundness	0.01 or Less	–	
		Taper	0.03 or Less	–	
	Interference between cylinder sleeve for correction and crankcase <4D33>		0.21 to 0.27	–	Replace
	Interference between cylinder sleeve and crankcase <4D34>	Standard	0.17 to 0.23	–	Replace with oversized ones
		Oversize	0.19 to 0.21	–	Replace
***a**	Crankcase sleeve hole (when cylinder sleeve for correction is installed) <4D33>	Bore diameter	ϕ111.18 to 111.21	–	Replace
		Out-of-roundness	0.01 or Less	–	
		Taper	0.03 or Less	–	

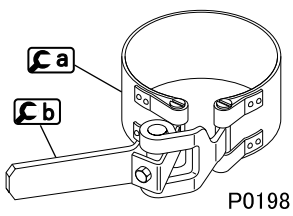
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (connecting rod cap installation)	68.6 {7.0} + 90°	Wet Reusable up to 3 times
Tb	Bolt (connecting rod cap installation)	30 {3.0} + 90° ± 5°	Wet Reusable up to 3 times

Lubricant and/or sealant

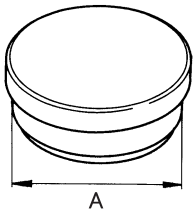
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Nut threads	Engine oil	As required
	Bolt threads		
	Connecting rod bearing inside surface		
	Piston outside surface		
	Cylinder bore surface		
b	Sleeve hole of crankcase	Spindle oil (ISO VG 32)	As required

Special tools

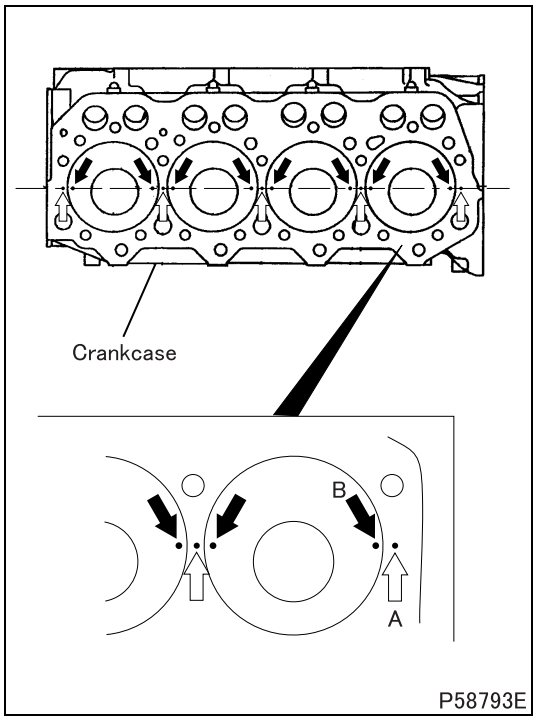
Mark	Tool name and shape		Part No.	Application
a	Piston guide clamp		<4D33> MH062041 <4D34> MH061890	Installation of piston and connecting rod
b	Piston guide lever		MH061658	

PISTON AND CONNECTING ROD, CYLINDER SLEEVE

Special tools

Mark	Tool name and shape	Part No.	Application
C	Cylinder sleeve installer A: 4D33 ϕ107, 4D34 ϕ103  A 03377	<4D33> MH062728 <4D34> MH062228	Installation of cylinder sleeve

◆Inspection before removal◆

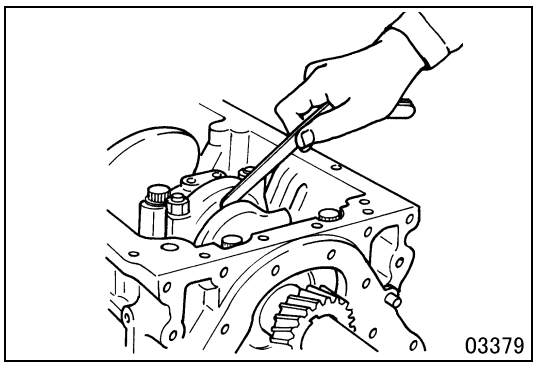


■ **Inspection: Piston projection from crankcase top surface**

CAUTION ⚠

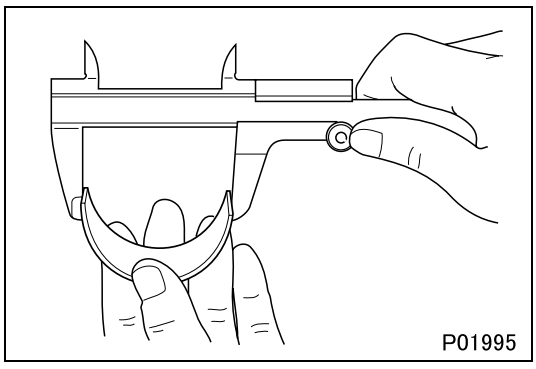
- **The amount of piston projection affects engine performance and must therefore be inspected without fail.**

- Set the piston at the top dead center.
- Mark reference points A (five points in total) on the top surface of the crankcase as shown in the illustration. Using each of the marks as a zero point, measure the amount of piston projection relative to the zero point (height of measurement point B – height of reference point A).
- Make the measurements at the two measurement points B for each cylinder (eight points in total) using the reference point A nearest to each measurement point, and calculate the average value of all the measurements.
- If the average value is out of the standard value range, check the clearances between all relevant parts.
- Select and use a cylinder head gasket that can accommodate the average piston projection (average value of the eight measurements). (See the CYLINDER HEAD section.)



■ **Inspection: Connecting rod end play**

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

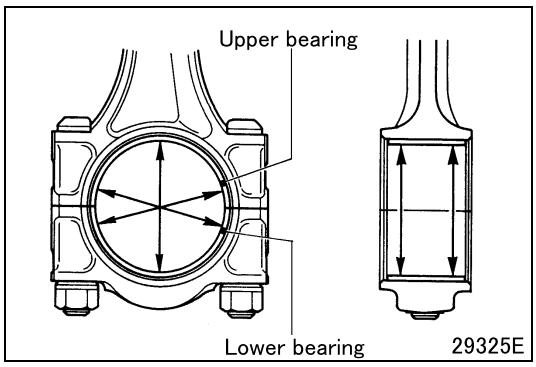


■ **Inspection: Connecting rod bearing span when free**

CAUTION ⚠

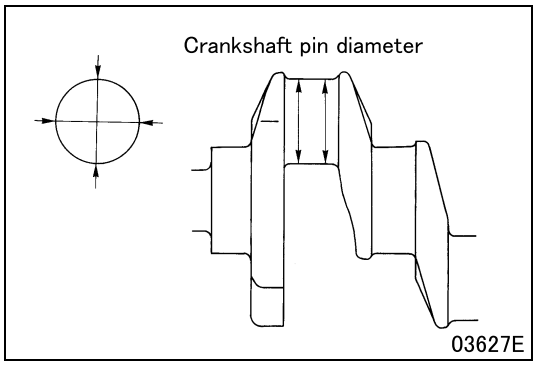
- **Do not attempt to manually expand the bearings.**

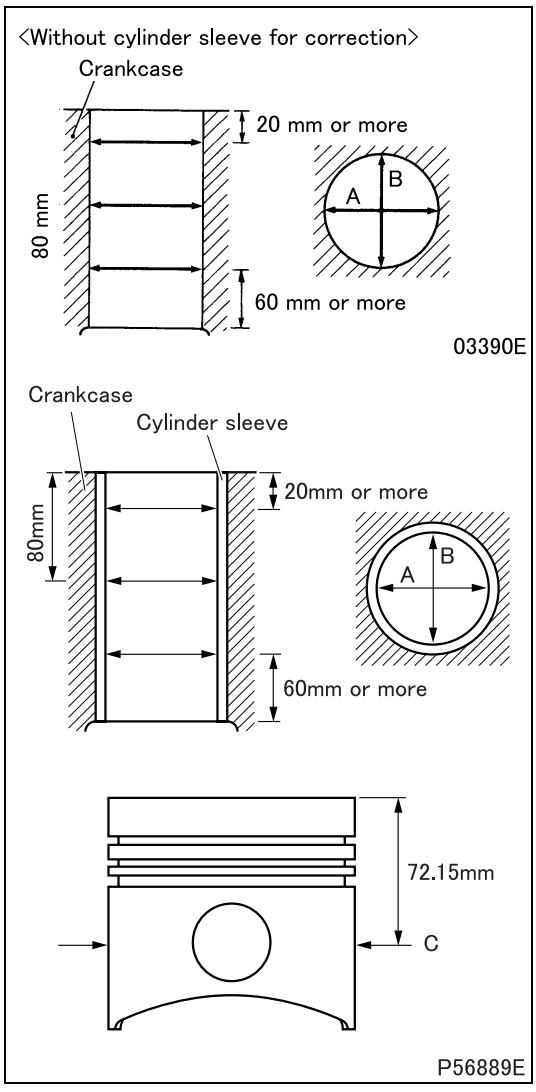
- If a measurement is less than the specified limit, replace both the upper and lower bearings as a matched set.



■ **Inspection: Connecting rod bearing-to-crankshaft clearance (oil clearance)**

- Put the lower bearing and upper bearing on the connecting rod cap and connecting rod, respectively and then tighten the following fasteners to the specified torque:
- Bolt: 69 N·m {7 kgf·m} <4D33>
- Nut: 30 N·m {3 kgf·m} <4D34>
- Measure the inside diameter of the bearing and the diameter of the crankshaft pin.
- If the clearance exceeds the limit, replace the defective part(s).
- If a bearing has to be replaced with an undersized one, machine the crankshaft pin to the specified undersize diameter. (See the CRANKSHAFT section.)





■ **Inspection: Clearance between piston and cylinder sleeve**

[Inspection]

<4D33 (With cylinder sleeve for correction), 4D34>

- Measure the clearance between the inner diameter of cylinder sleeve and outer diameter of the piston part of piston and connection rod.
  - A: Measuring point on the crankcase (in direction of the crankcase axis).
  - B: Measuring point on the crankcase (vertical to the crankcase axis).
  - C: Measuring point on the piston outer diameter (vertical to the piston pin hole).
- If the measured value is higher than the standard value, correct according to one of the following methods, depending on the condition of the parts.

CAUTION ⚠

- **Even if only one cylinder is faulty, correct all the cylinders with oversized ones of the same size.**

  - Replacing the piston with an oversized one.
  - Replacing cylinder sleeve.
- After determining the proper method of correction, correct by following one of the procedures described below.

■ **Inspection: Piston and connecting rod assembly, crankcase**

[Inspection]

<4D33>

- Measure the clearance between the inner diameter of the cylinder part of crankcase and the outer diameter of the piston part of piston and connecting rod assembly.
  - A: Measuring point on the crankcase (in direction of the crankcase axis).

B: Measuring point on the crankcase (vertical to the crankcase axis).
C: Measuring point on the piston outer diameter (vertical to the piston pin hole).

- If the measured value deviates from the standard value, correct according to one of the following methods, depending on the condition of the parts.

CAUTION ⚠

- **Even if only one cylinder is faulty, correct all the cylinders to oversized ones of the same size.**

  - Replace the piston with an oversized one.
  - Install cylinder sleeve for correction
    (When a cylinder sleeve for correction is not already installed)

- After determining the proper method of correction, correct by following one of the procedures described below.

[Correction]

Piston

<When replacing the pistons with oversized ones>

Amount of oversize: 0.5, 1.0 (4D34) mm

- Measure the outer diameter C of the oversized piston to be used.
- Bore each cylinders so that the clearance between the piston and the cylinder sleeves conform to the standard value.

CAUTION ⚠

- **To prevent deformation as a result of the rise in temperature during boring, bore the cylinders in the following order.**
  No. 2 → No. 4 → No. 1 → No. 3

Dimension after boring finish (tolerance ± 0.005) = oversized piston outer dimension C (measured value) + clearance between piston and cylinder (service standards mean value) - 0.02 mm (honing extent).

- Boring is followed by honing to obtain the proper dimensions (tolerance +0.005 to -0.00).
  Dimension after final finish (tolerance ± 0.005) = oversized piston outer dimension C (measured value) + clearance between piston and cylinder (service standards mean value).
  - Honing finished surface coarseness: 3.2 μm or less.
  - Honing cross-hatching angle: 15 to 25° (half angle).
  - Cylinder bore secureness: 0.05 mm.

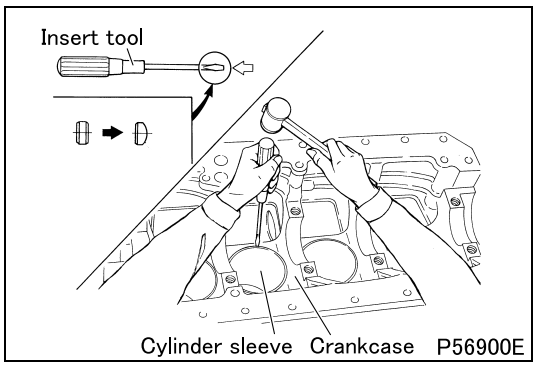
- Check the clearance between the piston and the cylinder.

NOTE

- **Piston rings must be replaced with the corresponding oversized ones.**

Cylinder sleeve

<When replacing the cylinder sleeve>

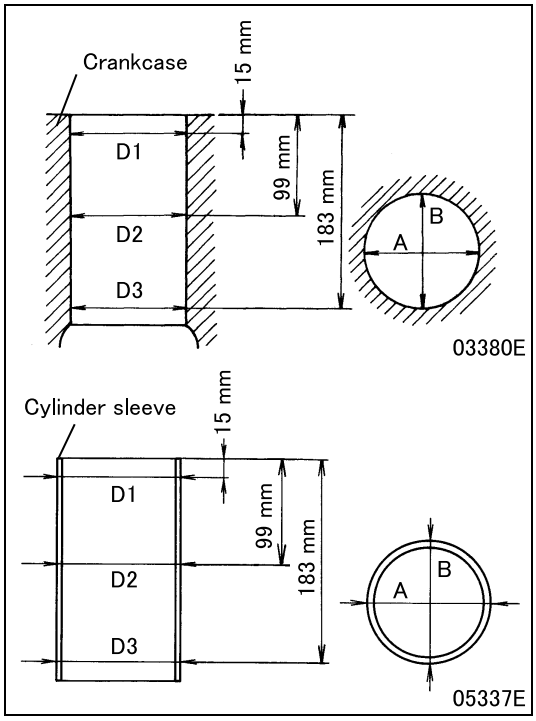


. **[Removal]**

- Mount a boring machine on crankcase and centralize. Centralization should be done at the lower part of cylinder sleeve, which is less unevenly worn.
- Bore until the wall thickness of cylinder sleeve is approximately 0.5 mm.
- Insert tool (Screwdriver, etc. part of which has been altered) into the gap between crankcase and cylinder sleeve, and, tapping the tool lightly, break up and remove the sleeve.

CAUTION ⚠

- **Make sure rounded side of the tip of tool faces crankcase.**



[Inspection]

- Before installing cylinder sleeve, inspect the sleeve hole of crankcase. Bore and correct, if there is a flaw or if there is not enough interference.

CAUTION ⚠

- **When a sleeve hole of crankcase needs boring, remove cylinder sleeves from all of the cylinders and bore the sleeve holes uniformly.**

Inspect interference as follows:

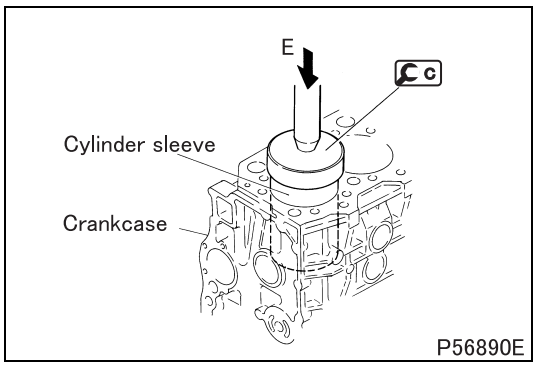
- Measure the inner diameter of the sleeve hole of crankcase and the outer diameter of cylinder sleeve at each of the locations for measurement as illustrated.
- Find the mean value for the vertical directions (D1, D2, D3) and diametrical directions (A, B). Measure the interference.

<When there is sufficient interference>

- Install STD cylinder sleeve.

<When interference is not sufficient>

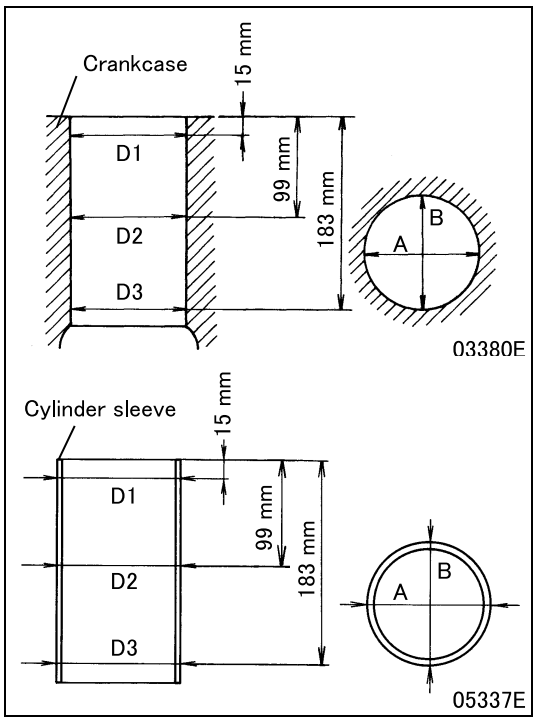
- Install cylinder sleeve which is 0.5 mm oversized in diameter.



[Installation]

<When there is sufficient interference>

- Apply spindle oil (ISO VG 32) to the sleeve hole of crankcase.
- Press-fit cylinder sleeve into crankcase from the chamfered end.
  E: Pressure (press-fitting load: 46.1 to 88.2 kN {4700 to 9000 kgf})
- Align the upper face of cylinder sleeve with the upper face of crankcase, when press-fitting.
- Measure the outer diameter of the standard size piston to be used.
- Bore and hone to make the clearance between the piston and the cylinder sleeve conform to the standard value.
- (See "■ **Inspection: Piston to cylinder sleeve clearance**".)

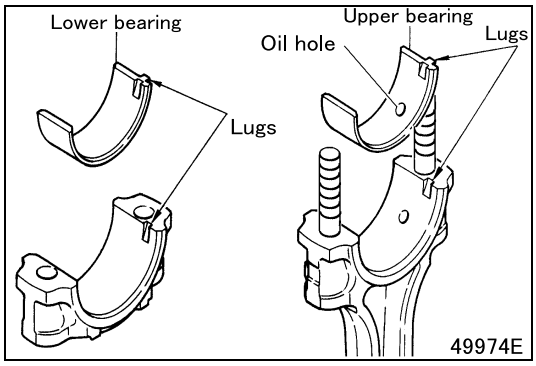


<When interference is not sufficient>

- Measure the interference between the outer diameter of cylinder sleeve and the inner diameter of the cylinder of crankcase.
  Make sure the interference in vertical directions (D1, D2, D3) and diametrical directions (A, B) conform to the mean value.
- Bore and hone the cylinder area until measured value conforms to the standard value. (See "■ **Inspection: Piston to cylinder sleeve clearance**".)
  - Honing finished surface coarseness: 8 μm or less.
  - Honing cross-hatching angle: 15 to 25° (half angle).
  - Cylinder bore secureness: 0.05 mm.

- Press-fit oversized cylinder sleeve.
  See "When there is sufficient interference".

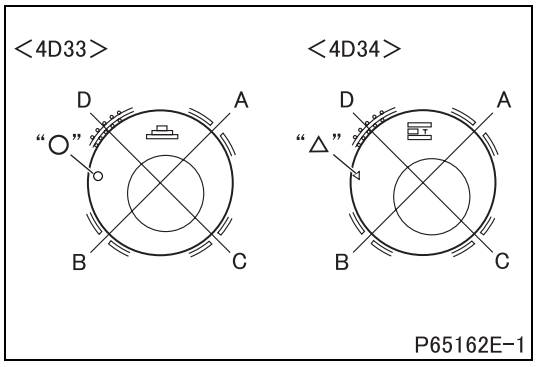
◆Installation procedure◆



■ Installation: Connecting rod bearings

CAUTION ⚠

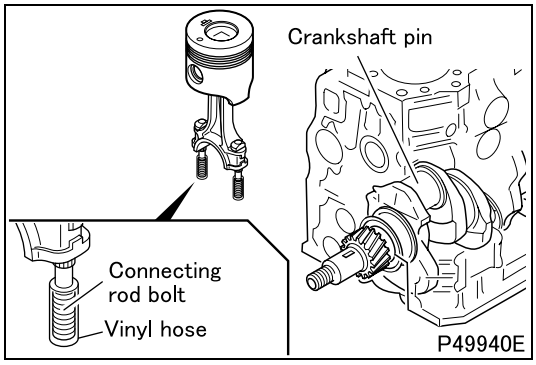
- **Do not reverse the positions of the lower bearing and the upper bearing (with oil hole) when installing, as this may cause seizure in the engine.**



■ Installation: Piston and connecting rod

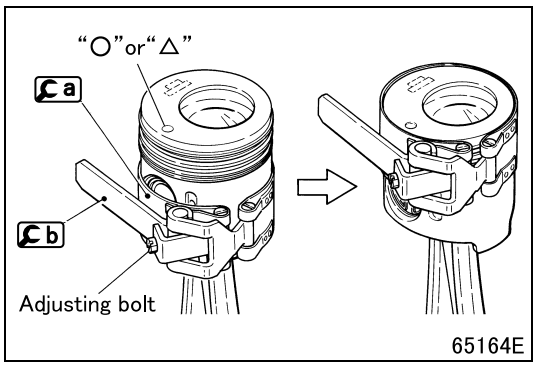
- Check that the piston ring end gaps are in their correct positions.
  A: 1st compression ring gap
  B: 2nd compression ring gap
  C: Oil ring gap
  D: Oil ring expander spring gap

"○": Front mark on piston <4D33>
"△": Front mark on piston <4D34>

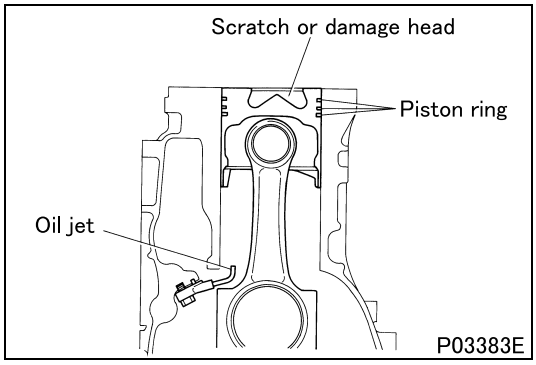


<4D33>

- Cover the connecting rod bolts with vinyl hoses to prevent them from scratching the crankshaft pins and the cylinders in the crankcase.

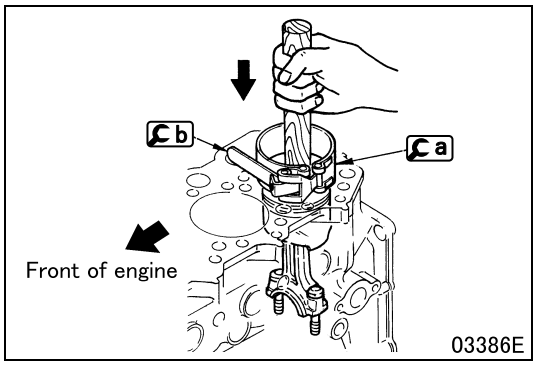


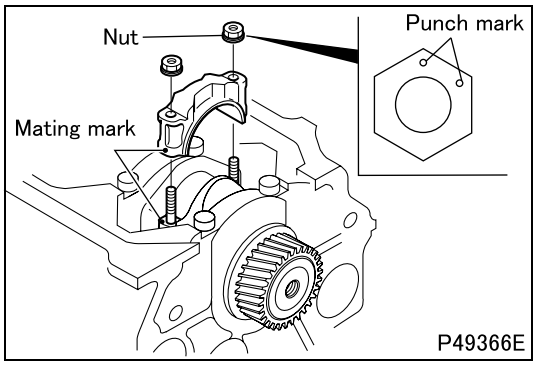
- Face the front mark "○" or "△" of the piston toward the front of the engine.
- Using the adjusting bolt of b, adjust the inside diameter of a such that it matches the piston's skirt diameter.
- Remove the tools from the piston and apply engine oil to the following parts:
  - Outside surface of piston
  - Inside surface of a
  - Cylinder wall surface



CAUTION ⚠

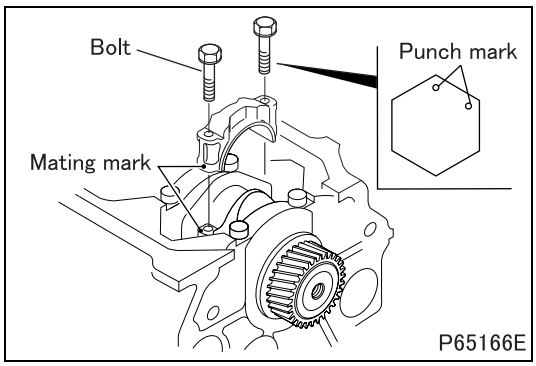
- **Be careful not to scratch or damage head of the piston (a part of the combution chamber).**
- **Make sure that the connecting rod does not hit oil jet.**





<4D33>

- After installing the piston and connecting rod assembly, align the mating marks on the connecting rod and connecting rod cap and tighten the nuts alternately in the following manner.
  - Tighten the nut to a torque of 69 N·m {7.0 kgf·m}.
  - Tighten the nut further by turning it clockwise by 90°.

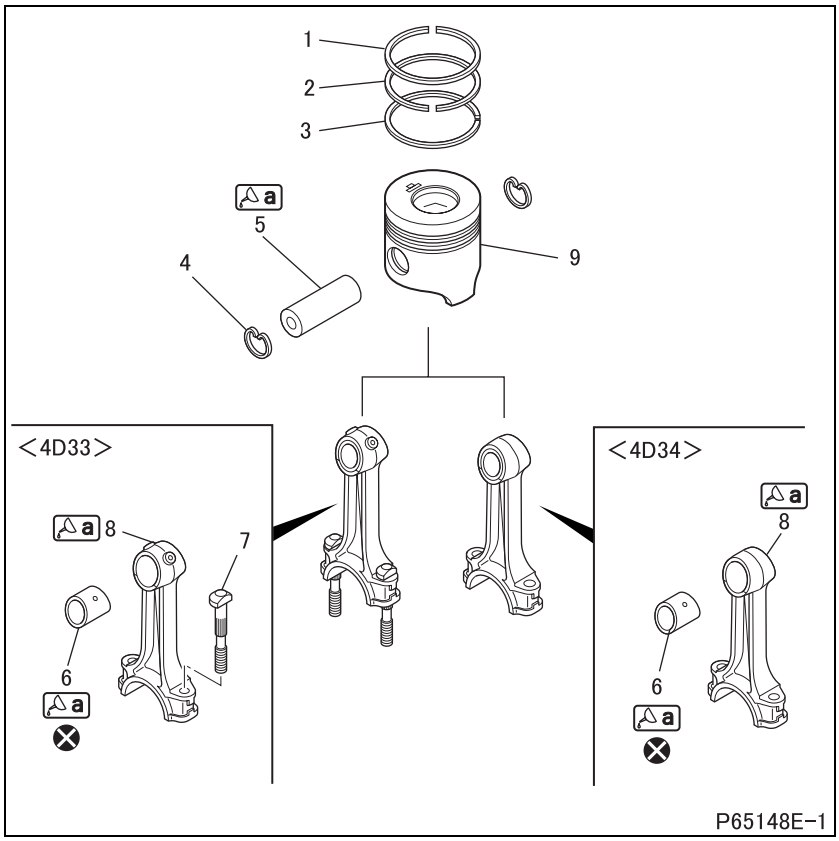


<4D34>

- After installing the piston and connecting rod assembly, align the mating marks in the connecting rod and connecting rod cap and tighten the bolt alternately in the following manner.
  - Tighten the bolt to a torque of 30 N·m {3.0 kgf·m}.
  - Tighten the bolt further by turning it clockwise by 90° ± 5.

PISTON AND CONNECTING ROD, CYLINDER SLEEVE

Piston and Connecting Rod



● **Disassembly sequence**

1 1st compression ring
2 2nd compression ring
3 Oil ring
4 Snap ring
5 Piston pin
6 Connecting rod bushing
7 Connecting bolt <4D33>
8 Connecting rod
9 Piston

⊗: Non-reusable parts

CAUTION ⚠

- **Do not remove the connecting rod bolt unless defects are evident.**

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The connecting bolts are fastened using the torque-turn method. Any connecting rod cap installation nut that has three marks indicating that it has been tightened three times already must be replaced with a new bolt.**

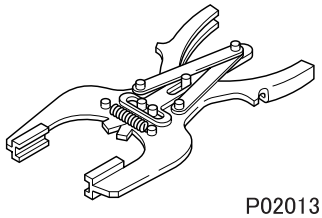
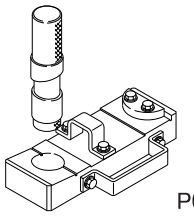
Service standards (Unit: mm)

Location	Maintenance item			Standard value	Limit	Remedy
1 to 3	Piston ring end gap	1st compression ring		0.3 to 0.45	1.5	Replace
		2nd compression ring	4D33	0.3 to 0.45		
			4D34	0.4 to 0.55		
		Oil ring	4D33	0.3 to 0.5		
			4D34	0.25 to 0.45		
1 to 3, 9	Piston ring side clearance in piston groove	1st compression ring	4D33	0.09 to 0.13	0.2	Replace
			4D34	0.04 to 0.13		
		2nd compression ring	4D33	0.04 to 0.06	0.15	
			4D34	0.065 to 0.105		
		Oil ring	4D33	0.04 to 0.06	0.15	
			4D34	0.025 to 0.065		
5, 6	Piston pin-to-connecting rod bushing clearance		4D33	0.023 to 0.054	0.1	Replace
			4D34	0.02 to 0.051		
5, 9	Piston pin-to-piston clearance			0.007 to 0.021	0.05	Replace
8	Connecting rod	Bend		–	0.05	Replace
		Twist		–	0.1	

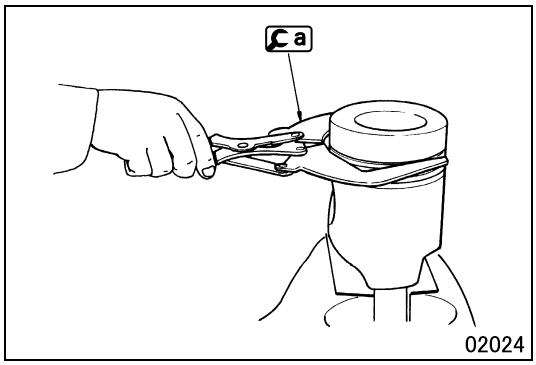
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Piston pin outside surface	Engine oil	As required
	Connecting rod bushing outside surface		
	Connecting rod bolt knurled surface		
	Connecting rod bushing fitting surface of connecting rod		

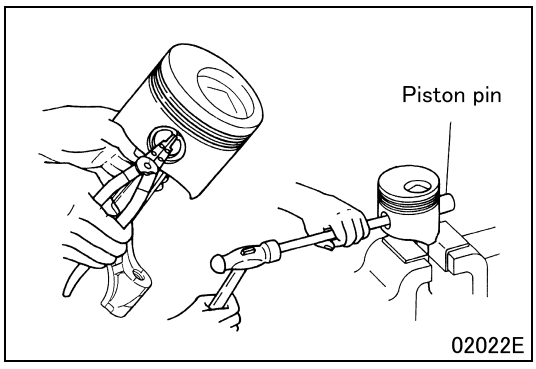
Special tools

Mark	Tool name and shape	Part No.	Application
a	Piston ring tool  P02013	MH060014	Removal and installation of piston rings
b	Connecting rod bushing puller kit  P02015	<4D33> MH061891 <4D34> MH062225	Removal and installation of connecting rod bushings

◆Removal procedure◆



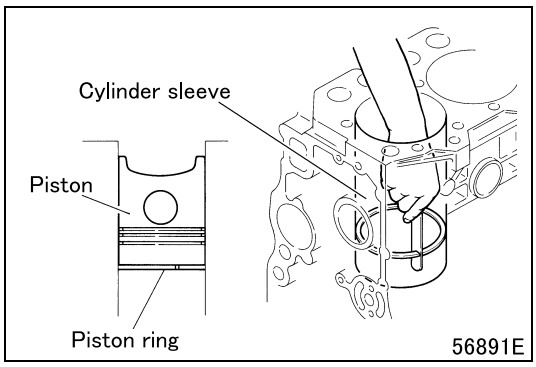
■ **Removal: Piston ring**



■ **Removal: Piston pin**

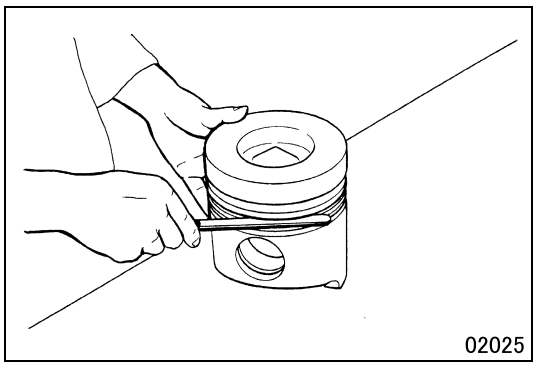
- Remove the piston pin by striking it with a rod and hammer.
- If the piston pin is difficult to remove, first heat the piston in hot water or with a piston heater.

◆Inspection procedure◆



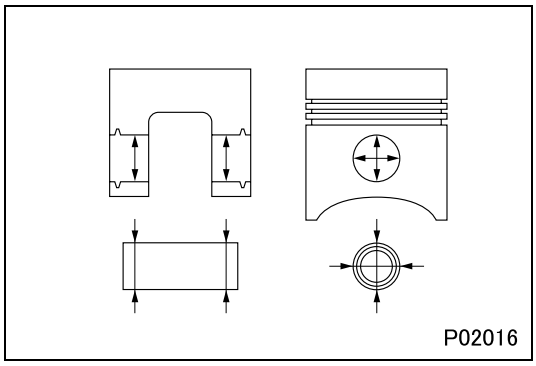
■ Inspection: Piston ring end gap

- Using the crown of a piston, push the piston ring horizontally into a cylinder in the crankcase until it reaches the lower part of the cylinder sleeve, where there is relatively small wear.
- Taking care not to move the piston ring, measure the end gap.
- If any of the rings has a gap exceeding the specified limit, replace all the piston rings as a set.



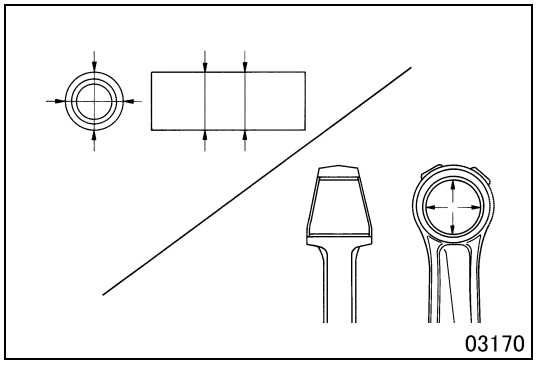
■ Inspection: Piston ring side clearance in piston groove

- Remove any carbon deposits from the ring groove in the piston.
- Measure the side clearance of each ring around the piston's entire periphery.
- If any of the measurements exceeds the specified limit, replace the defective part(s). If any of the piston rings is defective, replace all the rings on the piston as a set.



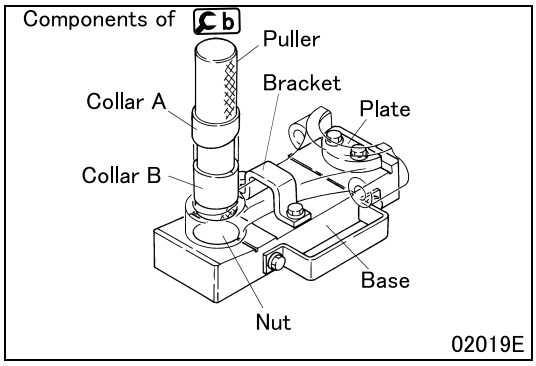
■ Inspection: Piston pin-to-piston clearance

- If any of the measurements exceeds the specified limit, replace the bushing.



■ Inspection: Piston pin-to-connecting rod bushing clearance

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

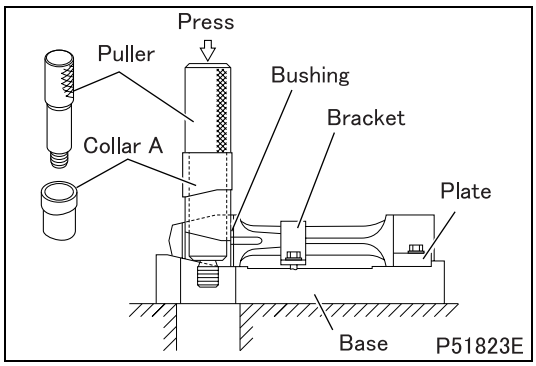


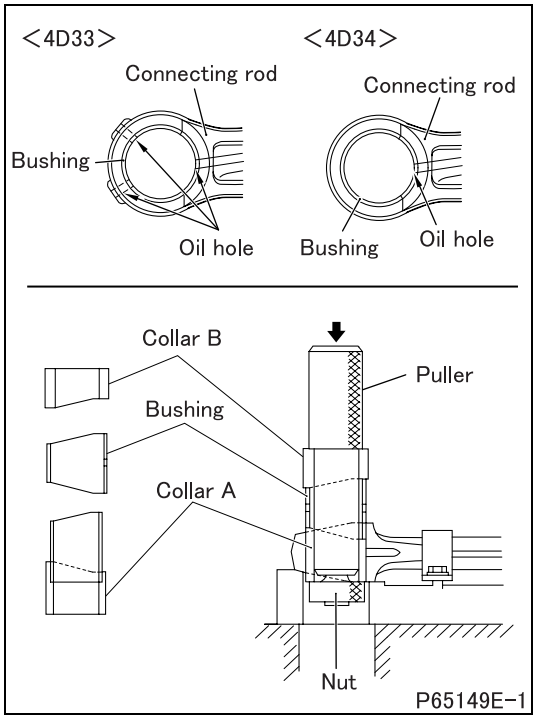
Replacement of connecting rod bushing

- Replace the connecting rod bushing using Cb.

[Removal]

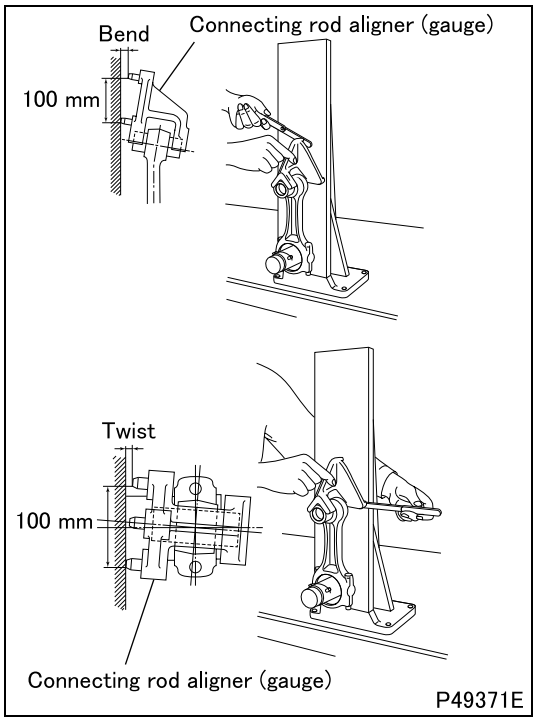
- Remove the upper bearing (if fitted) from the large end of the connecting rod.
- Mount the connecting rod on the base and lock it in position with the bracket and plate.
- Fit collar A over the puller with its ends facing in the illustrated directions. Then, slowly apply a pressure of approximately 49 kN {5000 kgf} to the puller with a press to force out the connecting rod bushing.





[Installation]

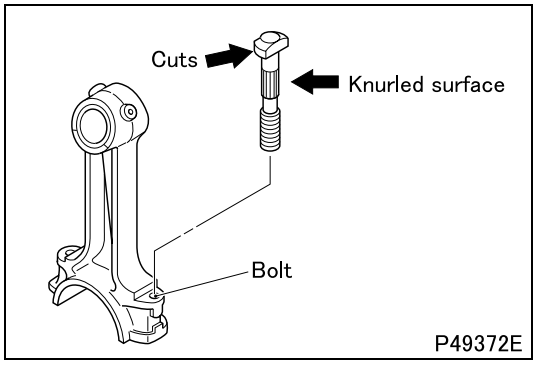
- Apply engine oil to the outside surface of the connecting rod bushing and the bushing fitting surface of the connecting rod.
- Fit collar B, the bushing, and collar A over the puller in the illustrated directions and lock this arrangement together with the nut.
- Align the oil holes in the connecting rod bushing and the connecting rod. Then, use a press to slowly apply a pressure of approximately 49 kN {5000 kgf} to the puller until the bushing is forced into place.
- After press-fitting the connecting rod bushing, measure the clearance between the piston pin and connecting rod bushing.
- If the measurement is less than the standard clearance range, ream the bushing.



■ Inspection: Connecting rod bend and twist

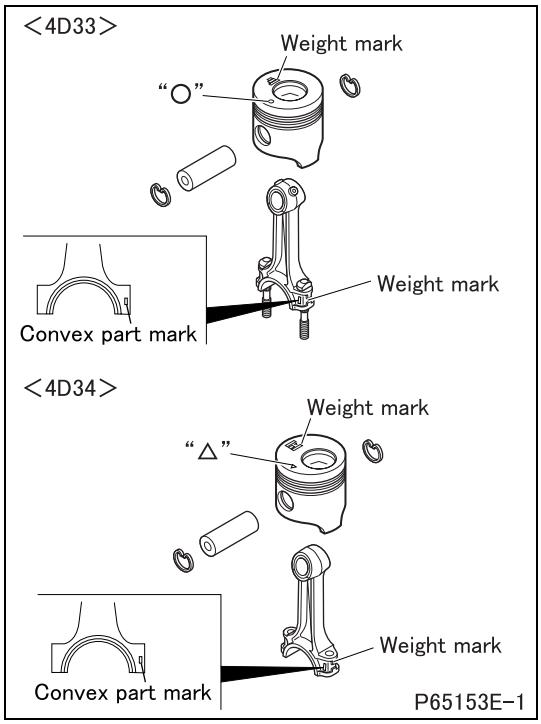
- Mount the connecting rod on the connecting rod aligner. Also mount the connecting rod bearings, piston pin, and connecting rod cap to create the same conditions as are expected when the connecting rod is mounted on a crankshaft. Tighten the nuts of the connecting rod bearing cap to a torque of 69 N·m {7 kgf·m}.
- Measure the extent of bend and twist in the connecting rod.
- If either measurement exceeds the specified limit, replace the connecting rod.

◆Installation procedure◆



■ Installation: Connecting rod bolts <4D33>

- Check that there are no burrs or other defects on the surfaces of the connecting rod bolt holes. Replace the connecting rod if defects are evident.
- Apply engine oil to the knurled surface of the connecting rod bolt. Then, install the bolt by using a press to slowly apply a pressure of approximately 4.9 kN {500 kgf} to it with the cuts of the bolt head facing in the illustrated directions.

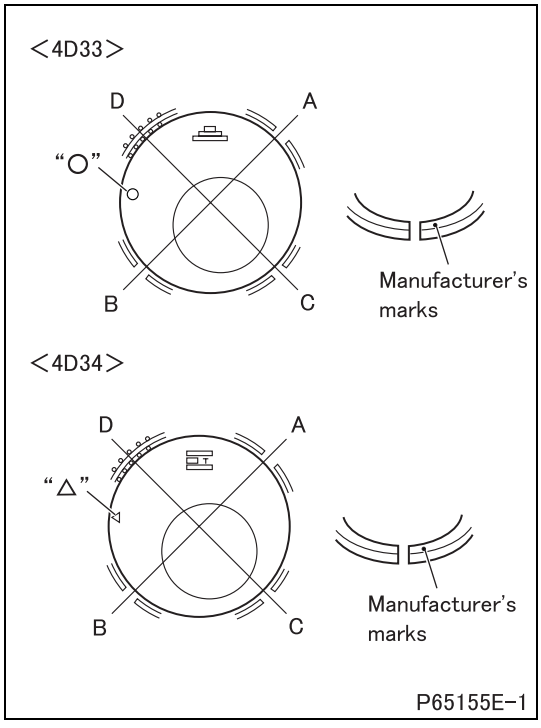


■ Installation: Piston to connecting rod

- If the piston and connecting rods have been replaced, make sure that the weight marks are the same for every cylinder.
- Apply engine oil to the piston pin, and assemble the piston and connecting rod with their marks facing in the illustrated directions.

"○": Front mark <4D33>
"△": Front mark <4D34>

- If the piston pin is difficult to insert, heat the piston in hot water or with a piston heater.



■ Installation: Piston rings

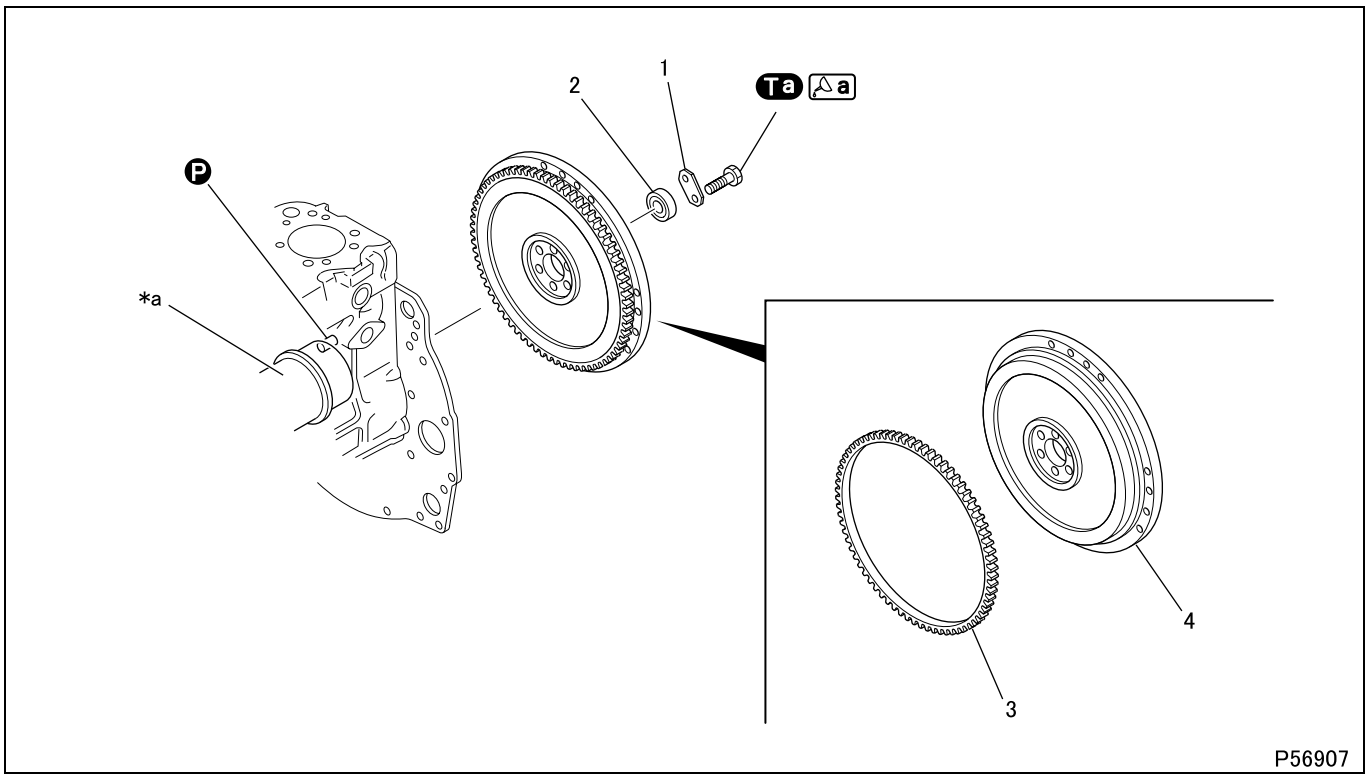
- With the manufacturer's marks (found near the piston ring end gaps) facing up, install the piston rings so that the end gap of each ring is positioned as illustrated.
  - A: 1st compression ring end gap
  - B: 2nd compression ring end gap
  - C: Oil ring end gap
  - D: Oil ring's expander spring end gap

"○": Front mark on piston <4D33>
"△": Front mark on piston <4D34>

The manufacturer's marks are present only on the 1st and 2nd compression rings.

M E M O

FLYWHEEL



● **Disassembly sequence**

1 Plate
2 Bearing
3 Ring gear
4 Flywheel

***a**: Crankshaft
P: Locating pin

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Service standards (Unit: mm)

Location	Maintenance item		Standard value	Limit	Remedy
4	Flywheel	Friction surface runout (when fitted)	–	0.2	Rectify or replace
		Friction surface height	24.5	23.5	
		Friction surface distortion	0.05 or less	0.2	

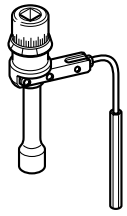
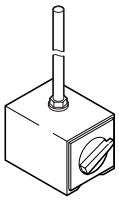
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (flywheel installation)	39 {4.0} + 40°	Wet

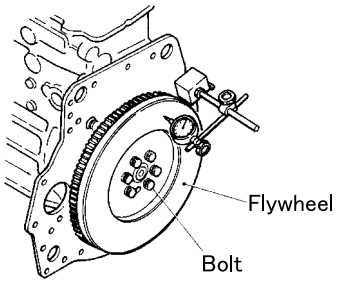
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Bolt threads	Engine oil	As required

Special tools

Mark	Tool name and shape	Part No.	Application
a	Socket wrench  P01984	MH062183	Installation of flywheel
b	Magnet base  P00471	MH062356	

◆Inspection before removal◆



03348E

■ **Inspection: Flywheel runout**

- If the runout exceeds the specified limit, check that the bolts are tightened correctly and that there are no abnormalities on the crankshaft mounting surface. If the runout is still excessive even after necessary steps have been taken according to the check results, rectify or replace the flywheel.

◆Removal procedure◆

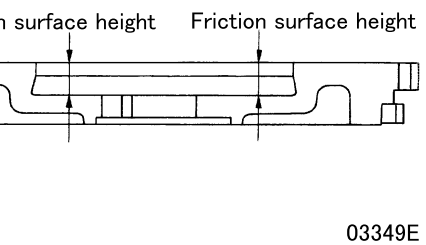
■ **Removal: Ring gear**

- Heat the ring gear evenly with a gas burner or the like until it reaches approximately 200°C, then remove it from the flywheel.

WARNING ⚠

- **You may burn yourself if you touch the heated ring gear.**

◆Inspection procedure◆

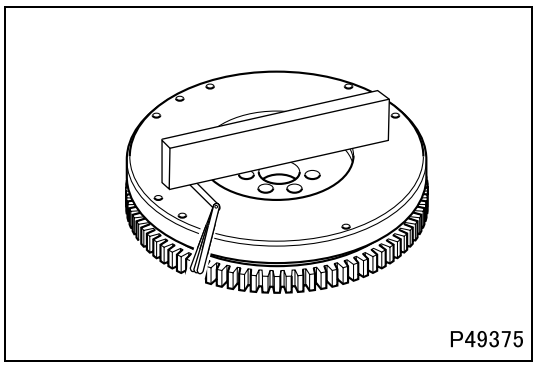


03349E

■ **Inspection: Flywheel**

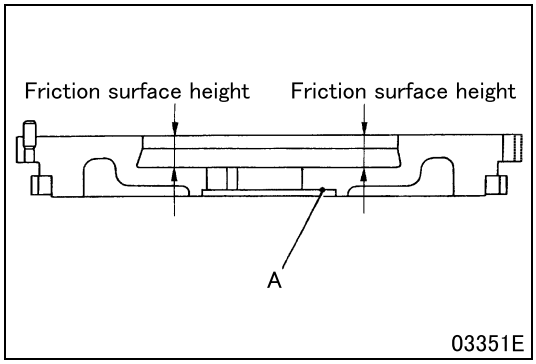
(1) Friction surface height

- If the height is below the specified limit, replace the flywheel.


P49375

(2) Friction surface distortion

- If the measured amount of distortion is above the specified limit, rectify or replace the flywheel.

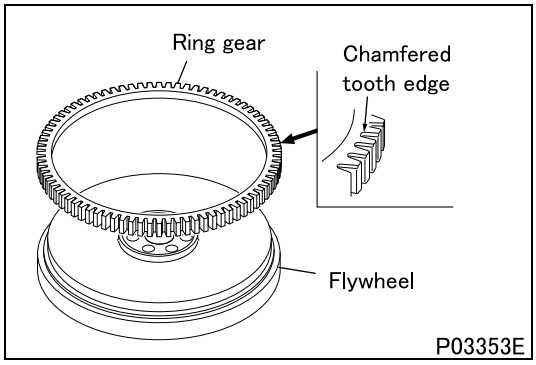


03351E

Rectification of friction surface

- Rectify the friction surface so that its height is not below the specified limit, and it is parallel with surface A with an error not exceeding 0.1 mm.

◆Installation procedure◆



P03353E

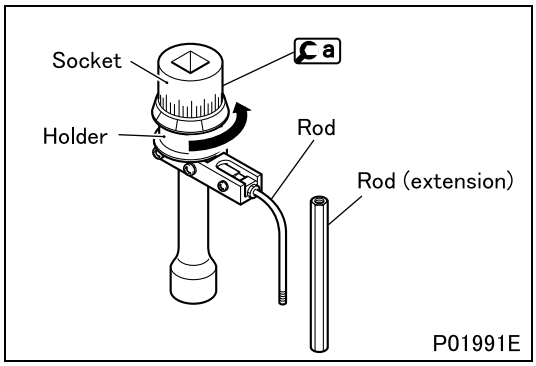
■ Installation: Ring gear

- Heat the ring gear evenly with a gas burner or the like until it reaches approximately 200°C.

WARNING ⚠

- **You may burn yourself if you touch the heated ring gear.**

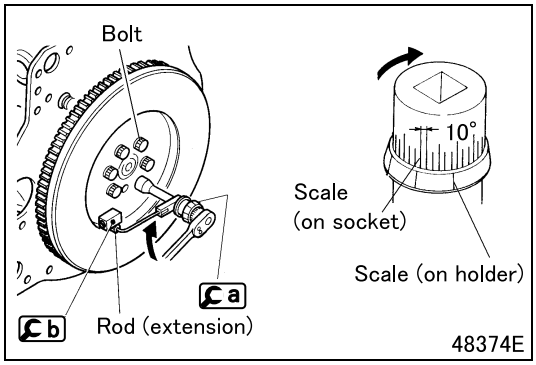
- Fit the ring gear with the side having non-chamfered tooth edges toward the flywheel.



P01991E

■ Installation: Flywheel

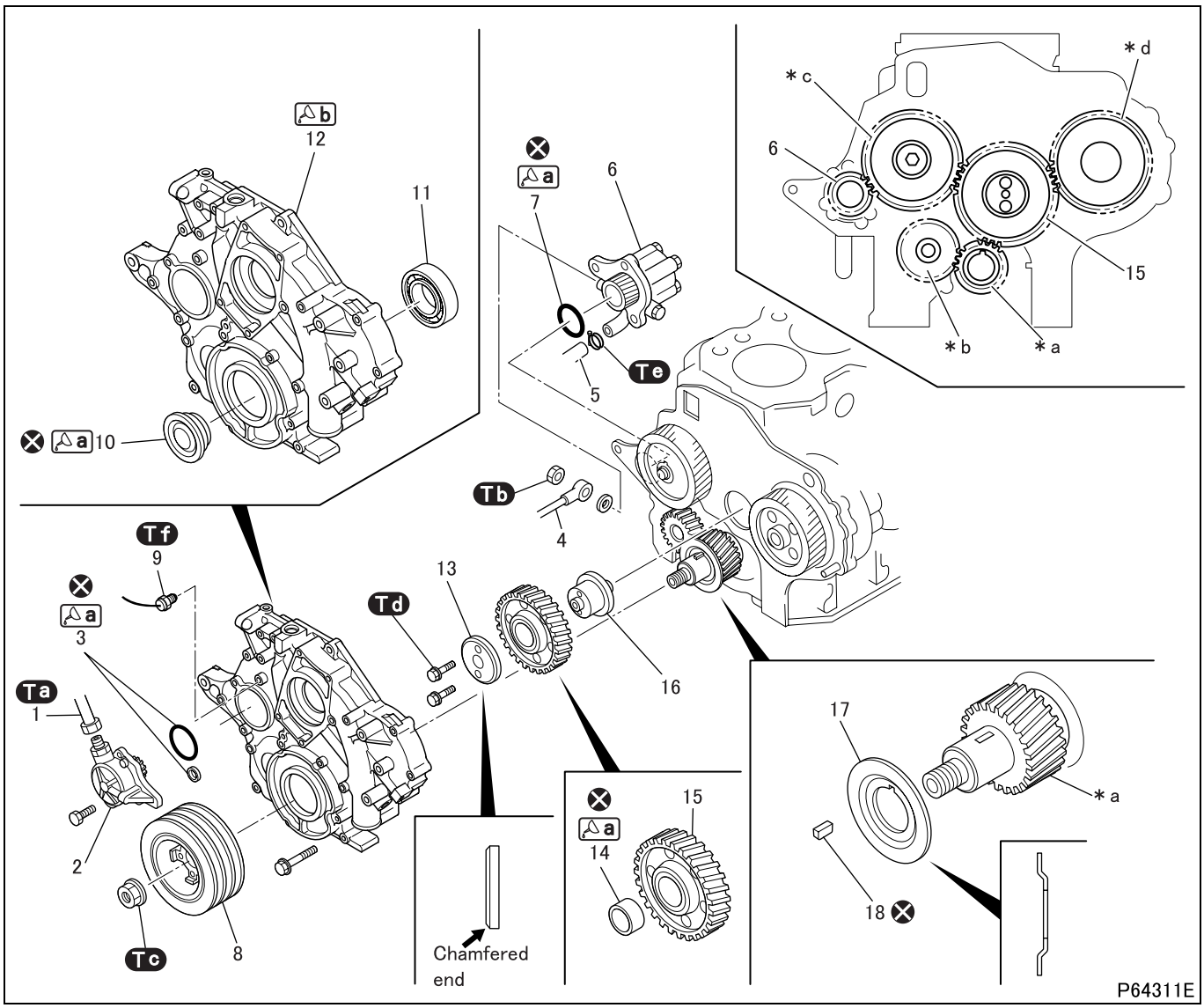
- Tighten all the bolts to 39 N·m {4.0 kgf·m} and then additionally tighten them using the following procedure.
- Rotate the holder of a counterclockwise to pretension the internal spring.



48374E

- Fit a on the bolt and set b so that the rod (extension) is held pressed against it by the spring force.
- Align a scale mark on the socket with a scale mark on the holder. (This point will be the point of reference, or the 0° point.)
- Starting with this point of reference, turn the socket clockwise with a wrench 40° (one graduation on the socket scale represents 10°).

M E M O



● Disassembly sequence

1 Vacuum pipe
2 Vacuum pump (See Gr35.)
3 O-ring
4 Power steering pipe
5 Power steering hose
6 Power steering oil pump (See Gr37.)
7 O-ring
8 Crankshaft pulley
9 Tachometer sensor
10 Front oil seal
11 Bearing
12 Timing gear case
13 Thrust plate
14 Idler gear bushing
15 Idler gear
16 Idler shaft
17 Front oil seal slinger
18 Key

***a**: Crankshaft gear
***b**: Oil pump gear
***c**: Camshaft gear
***d**: Injection pump gear

⊗: Non-reusable parts

CAUTION ⚠

- **Do not remove the front oil seal or bearing unless defects are evident.**

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards (Unit: mm)

Location	Maintenance item		Standard value	Limit	Remedy
–	Backlash between gears	Crankshaft gear and oil pump gear	0.10 to 0.18	0.3	Replace
		Camshaft gear and power steering oil pump gear	0.08 to 0.16	0.3	
		Idler gear and crankshaft gear	0.07 to 0.15	0.3	
		Idler gear and camshaft gear	0.07 to 0.17	0.3	
		Idler gear and injection pump gear	0.07 to 0.17	0.3	
–	Idler gear end play		0.05 to 0.15	0.3	Replace
14, 16	Idler gear bushing-to-idler shaft clearance		0.03 to 0.06	0.1	Replace

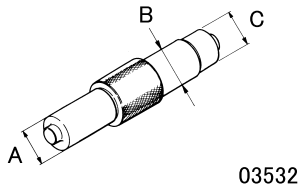
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Vacuum pipe	29.4 {3.0}	–
Tb	Nut (power steering pipe installation)	29.4 to 39.2 {3 to 4}	–
Tc	Nut (crankshaft pulley installation)	590 {60}	–
Td	Bolt (thrust plate installation)	29.4 {3.0}	–
Te	Clamp (power steering hose installation)	2.9 to 3.4 {0.3 to 0.34}	–
Tf	Tachometer sensor	29 ± 4.9 {3.0 ± 0.5}	–

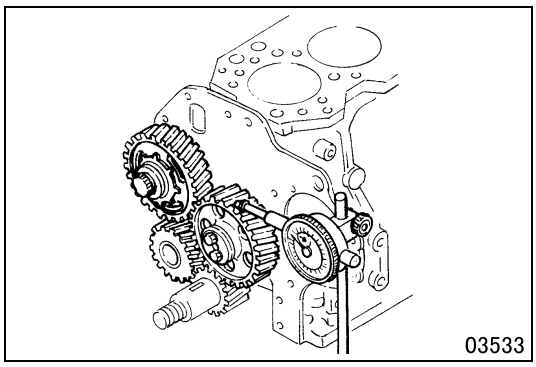
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Front oil seal lip		
	Idler gear bushing inside surface		
b	Timing gear case mounting surface	ThreeBond 1207C	As required

Special tools (Unit: mm)

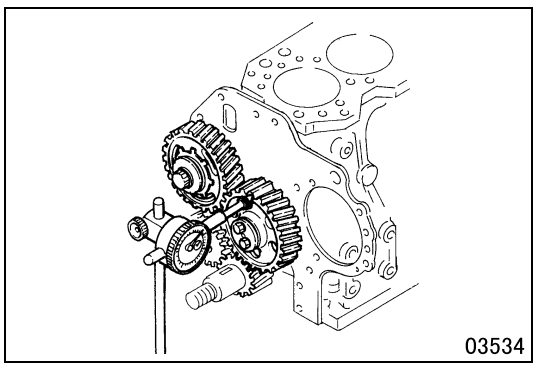
Mark	Tool name and shape	Part No.	Application
Ca	Idler gear bushing puller A: ϕ44.5, B: ϕ49, C: ϕ45 	MH062224	Removal and installation of idler gear bushing

◆Inspection before removal◆



■ **Inspection: Backlash between gears**

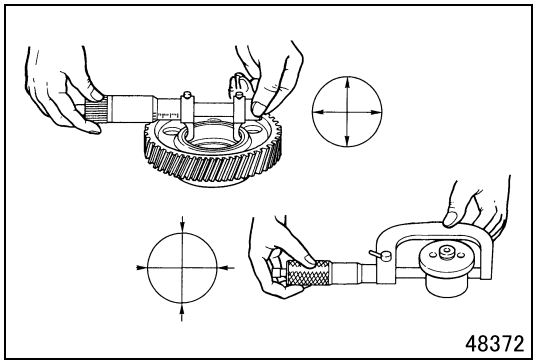
- For each pair of gears, measure the backlash at more than three teeth.
- If any of the measurements exceeds the specified limit, replace the defective part(s).



■ **Inspection: Idler gear end play**

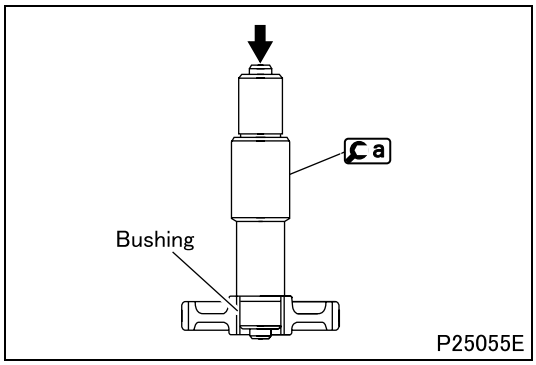
- If the measurement exceeds the specified limit, replace the defective part(s).

◆Inspection procedure◆

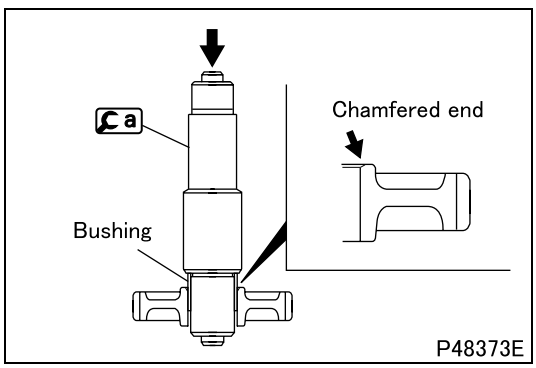


■ **Inspection: Idler gear bushing-to-idler shaft clearance**

- If the measurement exceeds the specified limit, replace the bushing.



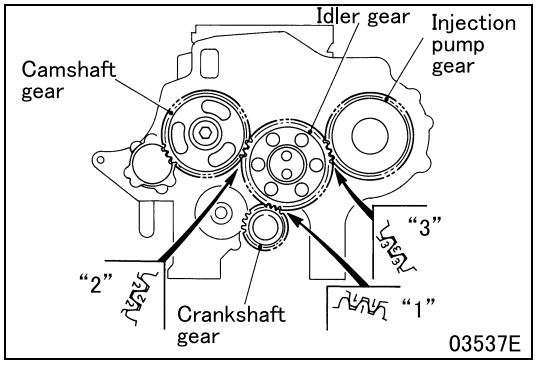
Replacement of idler gear bushing
[Removal]



[Installation]

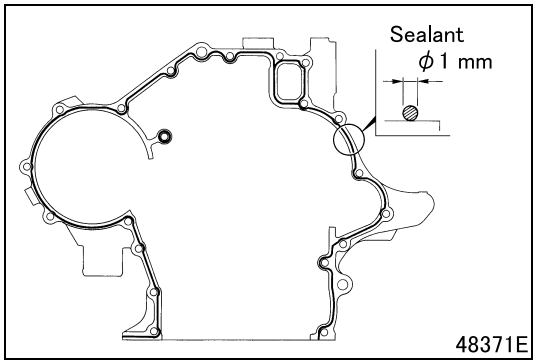
- Place the idler gear with its ends facing as illustrated.
- Press-fit the idler gear bushing until a sits snugly on the chamfered end of the idler gear.
- After press-fitting the bushing, measure the clearance.
- If the measurement is less than the minimum of the standard value range, ream the idler gear bushing until the clearance falls within the standard value range.

◆Installation procedure◆



■ Installation: Idler gear

- Place the No. 1 cylinder piston and the No. 4 cylinder piston at their top dead centers.
- Install the idler gear while aligning the marks "1", "2", and "3" on its teeth with the corresponding marks on the teeth of the other gears.

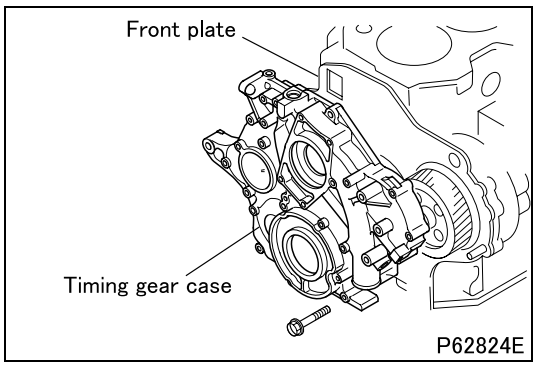


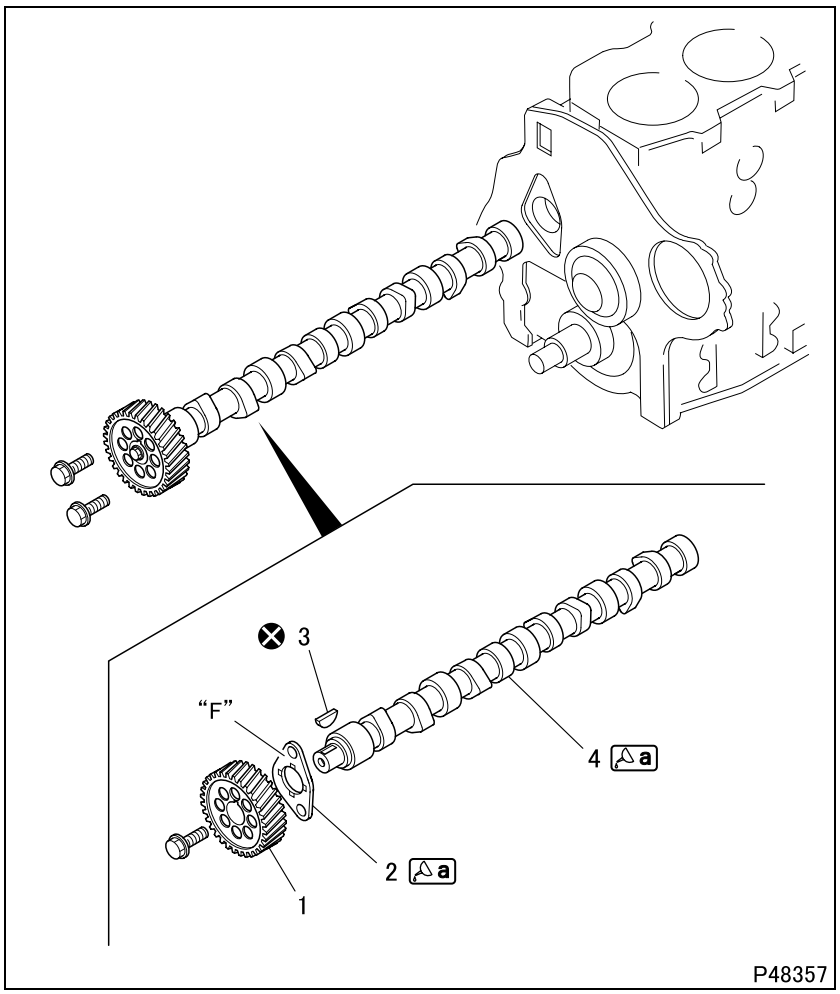
■ Installation: Timing gear case

- Clean off oil and all other foreign substances from the sealant application surface of the timing gear case.
- Apply a bead of sealant to the timing gear case evenly and without any breaks, then mount the case onto the front plate within three minutes. When doing so, make sure that the sealant is not forced out of position.

CAUTION ⚠

- **Do not start the engine less than an hour after installation of the timing gear case.**
- **If the timing gear case mounting bolts are loosened or removed, be sure to reapply sealant.**





● **Disassembly sequence**

1 Camshaft gear
2 Thrust plate
3 Key
4 Camshaft

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

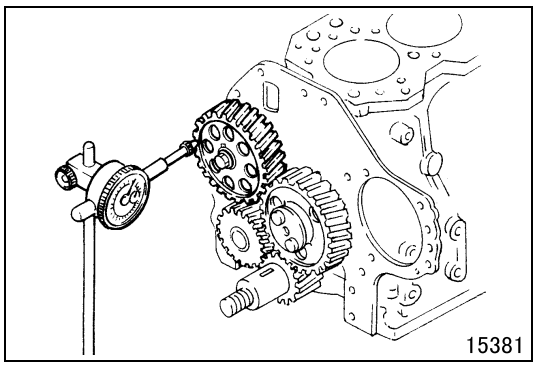
Service standards (Unit: mm)

Location	Maintenance item				Standard value	Limit	Remedy
–	Camshaft end play				0.05 to 0.22	0.3	Replace
1, 4	Camshaft gear and camshaft interference				0.03 to 0.07	–	Reassemble Permitted up to three times
4	Camshaft	Cam lift	Intake	Lobe height: 47.105 Base circle diameter: 39.910	7.195 ± 0.05	6.70	Replace
			Exhaust	Lobe height: 46.979 Base circle diameter: 39.658	7.321 ± 0.05	6.82	
		Bend			0.02 or less	0.05	Replace

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Thrust plate thrust receiving surface	Engine oil	As required
	Camshaft cams and journals		

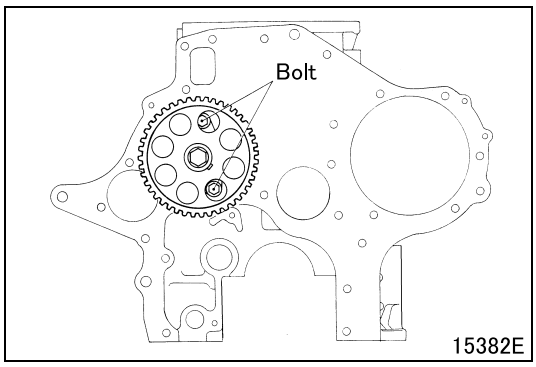
◆Inspection before removal◆



■ **Inspection: Camshaft end play**

- If the measurement is above the specified limit, replace the defective part(s).

◆Removal procedure◆

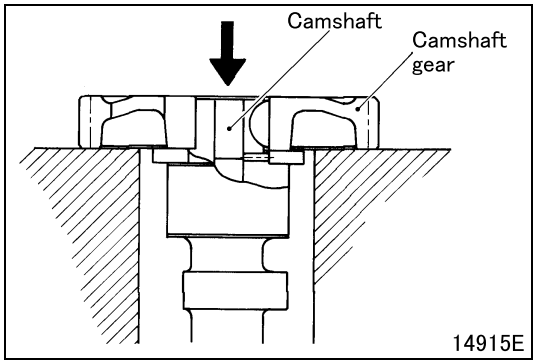


■ **Removal: Camshaft**

- Loosen the thrust plate bolts through the holes in the camshaft gear.

CAUTION ⚠

- **Be careful not to damage the camshaft bushings when removing each camshaft.**



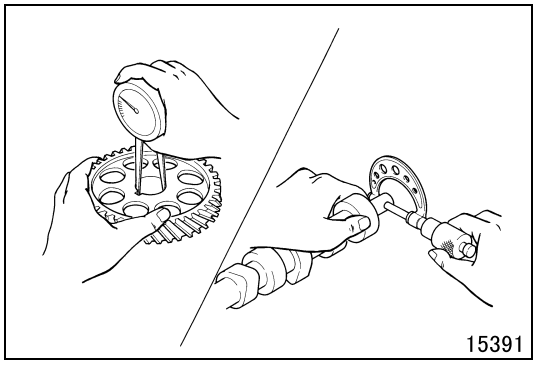
■ **Removal: Camshaft gear**

- The camshaft gear is press-fitted onto the camshaft. Remove the camshaft gear by pushing on the camshaft using a press.

CAUTION ⚠

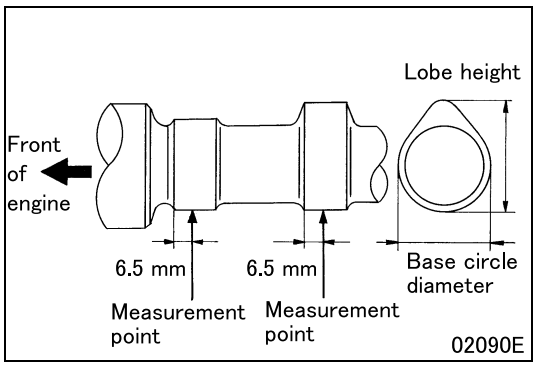
- **Be sure to use a press to remove the camshaft gear. Never use a hammer.**

◆Inspection procedure◆



■ **Inspection: Camshaft gear and camshaft interference**

- If the measurement is not within the standard value range, replace the defective part(s).



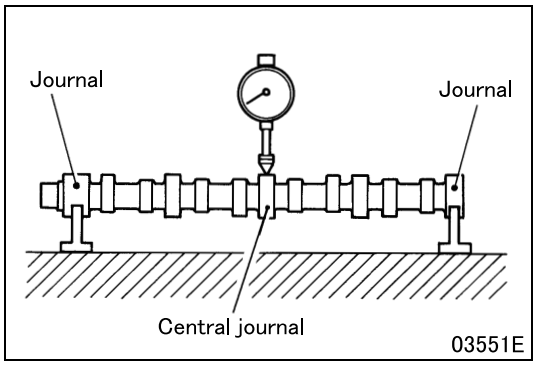
■ **Inspection: Camshaft**

(1) Cam lift

- If the measurement is not up to the specified limit, replace the camshaft.

NOTE

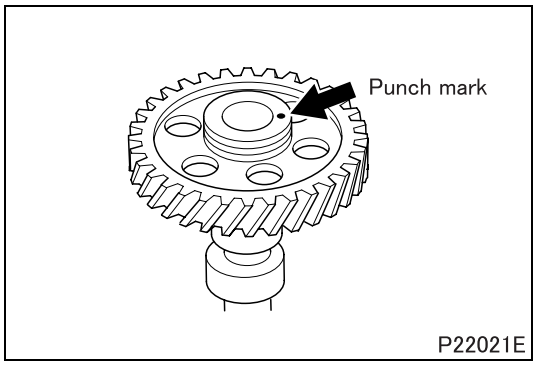
- **Each cam is tapered, so the cam lobe height and base circle diameter should be measured at the measurement points indicated in the illustration.**



(2) Bend

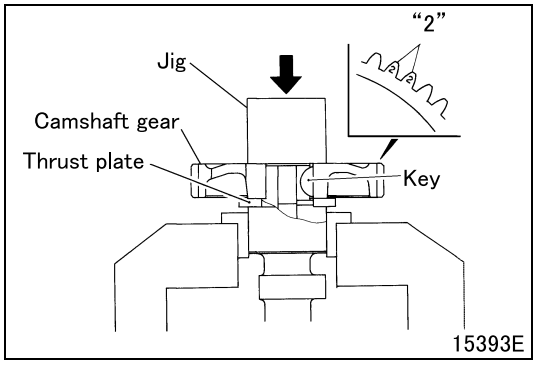
- Place supports under the journals at the ends of the camshaft and measure the bend of the camshaft at the central journal.
- The bend of the camshaft corresponds to one half of the dial gauge pointer indication after one revolution of the camshaft.
- If the measurement exceeds the specified limit, replace the camshaft.

◆Installation procedure◆



■ **Installation: Camshaft gear**

- Before installing the camshaft gear, check the number of punch marks at its center. The camshaft can only be reassembled three times. If there are already three punch marks, replace the camshaft gear and camshaft with new ones.

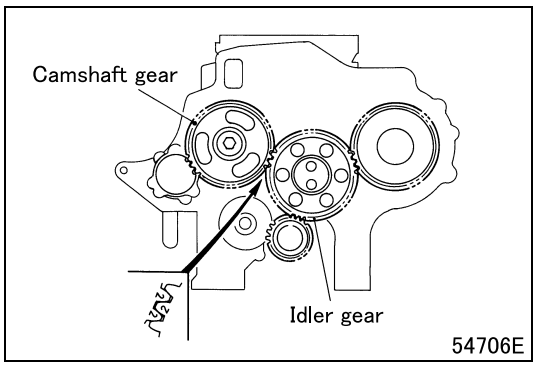


- Install the camshaft gear on the camshaft with the illustrated side facing outward while preventing its rotation on the camshaft by installing the key.

CAUTION ⚠

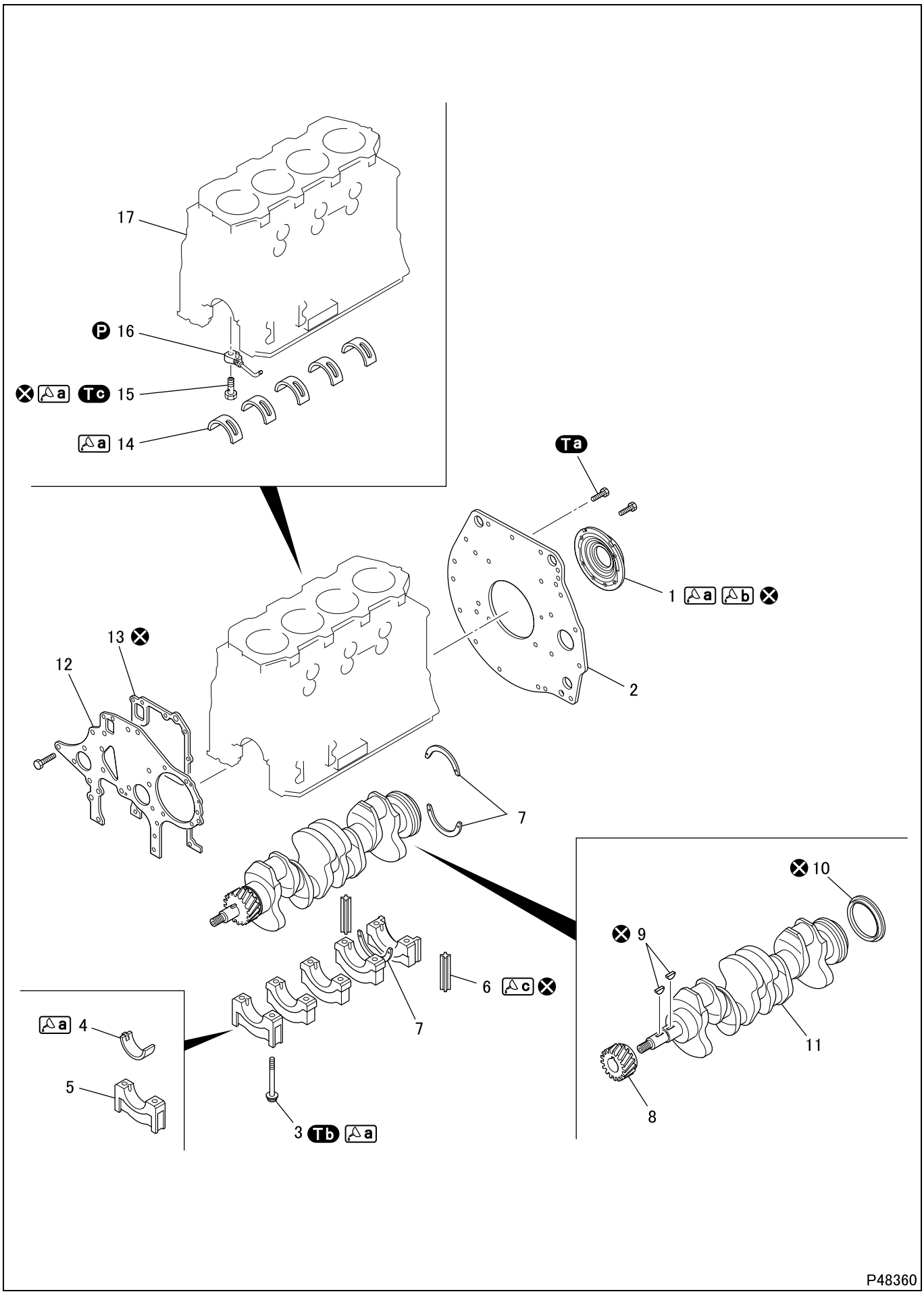
- **Always use the press with the jig applied on the central part of the camshaft gear. Applying it on any other part will damage the camshaft gear.**

- After installing the camshaft gear, make a punch mark on its center to indicate that it has been reassembled.



■ **Installation: Camshaft**

- Place the No. 1 cylinder piston and No. 4 cylinder piston at their top dead centers, and install the camshaft by aligning the mating marks “2” on the camshaft gear and idler gear as shown in the illustration.


17
P 16
✕ a Tc 15
a 14
Ta
1 a b ✕
2
13 ✕
12
7
10
✕ 9
11
8
6 c ✕
7
a 4
5
3 Tb a
P48360

● **Disassembly sequence**

1 Rear oil seal
2 Rear plate
3 Main bearing cap bolt
4 Lower main bearing
5 Main bearing cap
6 Side seal
7 Thrust plate
8 Crankshaft gear
9 Key
10 Rear oil seal slinger
11 Crankshaft
12 Front plate
13 Gasket
14 Upper main bearing
15 Check valve
16 Oil jet
17 Crankcase

Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **The main bearing cap bolts are tightened using the torque-turn tightening method. Any bolt that has three punch marks must be replaced.**
- **Do not overtighten the check valve. If it is tightened to a torque exceeding the specification, the check valve may malfunction, resulting in seizures in the engine.**

Service standards (Unit: mm)

Location	Maintenance item			Standard value	Limit	Remedy
–	Crankshaft end play			0.10 to 0.26	0.4	Replace thrust plate
4, 14	Main bearing	Oil clearance		0.04 to 0.09	Less than 0.15	Replace
		Span when free		–	82.5	
11	Crankshaft	Bend		0.02 or less	0.05	Replace
		Pins and journals	Out-of-round-ness	0.01 or less	0.03	Rectify or replace
			Taper	0.006 or less	–	
17	Distortion of crankcase top surface			0.07 or less	0.2	Rectify or replace

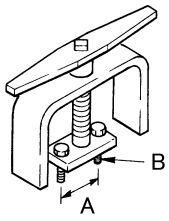
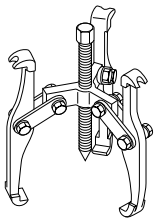
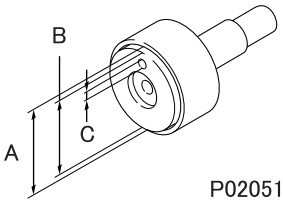
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (rear plate installation)	64 {6.5}	–
Tb	Main bearing cap bolt	59 {6} + 90°	• Wet • Reusable up to 3 times
Tc	Check valve	29 {3.0}	Wet

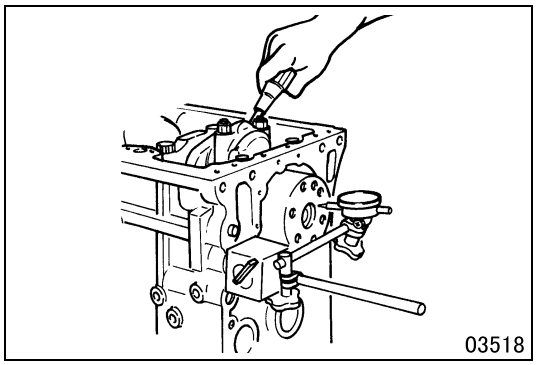
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Rear oil seal lip	Engine oil	As required
	Main bearing cap bolt threads		
	Main bearing inside surface		
	Check valve threads		
b	Crankcase mating surface of rear oil seal	ThreeBond 1217H	As required
c	Side seal tips and grooves	ThreeBond 1207C	As required
	Side seal mounting surfaces of main bearing cap		

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
a	Socket wrench  P01984	MH061560	Installation of main bearing cap
b	Bearing cap extractor A: 60, B: M8 × 1.25  03516	MH061083	Removal of main bearing cap (rear-most cap)
c	Gear puller  P02065	MH061326	Removal of crankshaft gear
d	Rear oil seal slinger installer A: ϕ103, B: ϕ100, C: ϕ15  P02051	MH062677	Installation of rear oil seal slinger

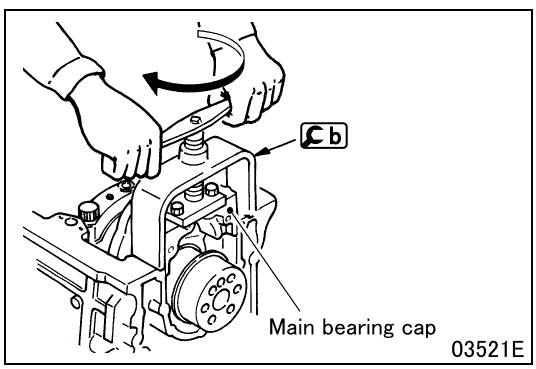
◆Inspection before removal◆


03518

■ **Inspection: Crankshaft end play**

- If the measurement exceeds the specified limit, replace the thrust plates with oversized ones.
- Available oversizes:
  + 0.15 mm, + 0.30 mm, + 0.45 mm
- Replace the crankshaft if the end play is too large to adjust using oversized thrust plates.

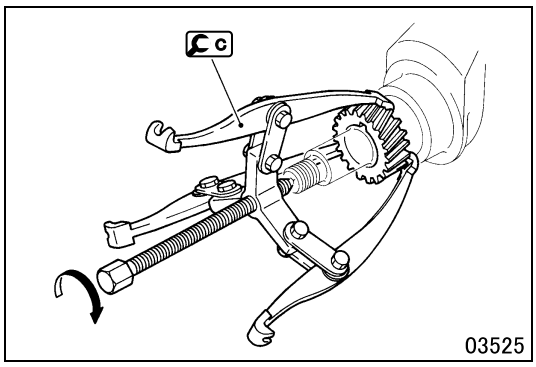
◆Removal procedure◆



03521E

■ **Removal: Main bearing caps**

- Side seals are press-fitted between the rearmost main bearing cap and the crankcase. Use b to remove the rearmost main bearing cap.



■ **Removal: Crankshaft gear**

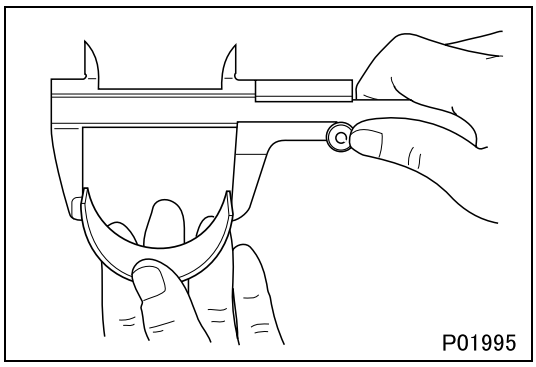
CAUTION ⚠

- **Do not tap off the crankshaft gear as this can damage it.**

■ **Removal: Rear oil seal slinger**

- Taking care not to damage the crankshaft, split the rear oil seal slinger using a chisel or a similar tool.

◆Inspection procedure◆

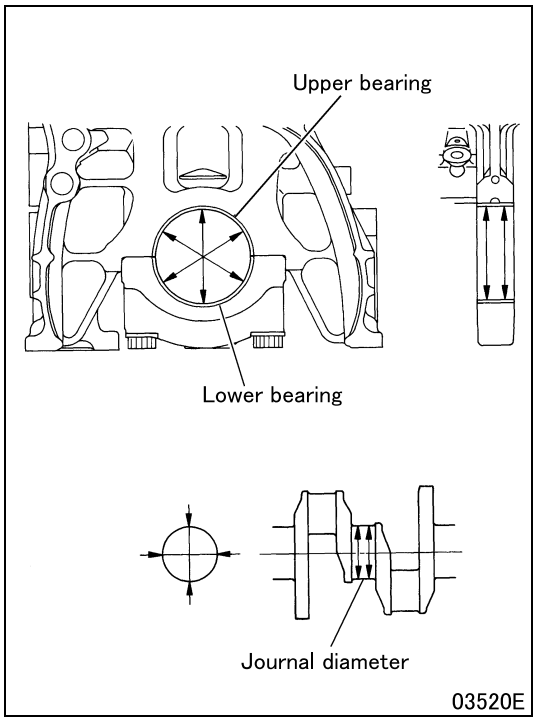


■ **Inspection: Main bearing span when free**

CAUTION ⚠

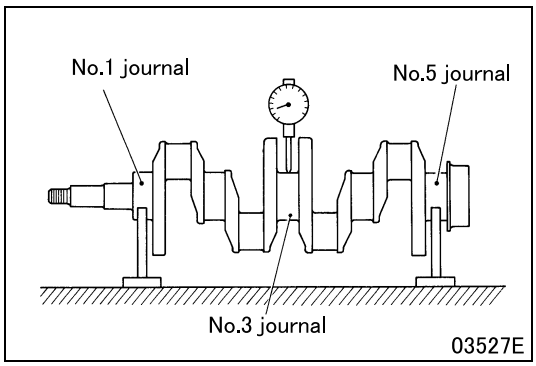
- **Do not attempt to manually expand the bearings.**

- If a measurement is less than the specified limit, replace both the upper and lower bearings as a set.



■ **Inspection: Main bearing-to-crankshaft clearance**

- Fit the upper bearing into the crankcase and the lower bearing into the main bearing cap.
- Tighten the main bearing cap bolts to a torque of 59 N·m {6 kgf·m}.
- Measure the inside diameter of the main bearing and the diameter of the corresponding crankshaft journal. If the difference between the measurements exceeds the specified limit, machine the crankshaft journal to one of the specified undersize dimensions indicated on the next page.



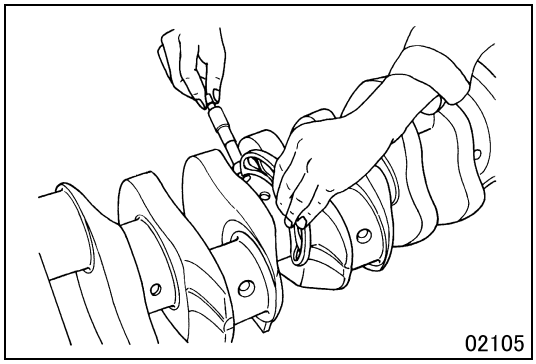
■ **Inspection: Crankshaft**

(1) Bend

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

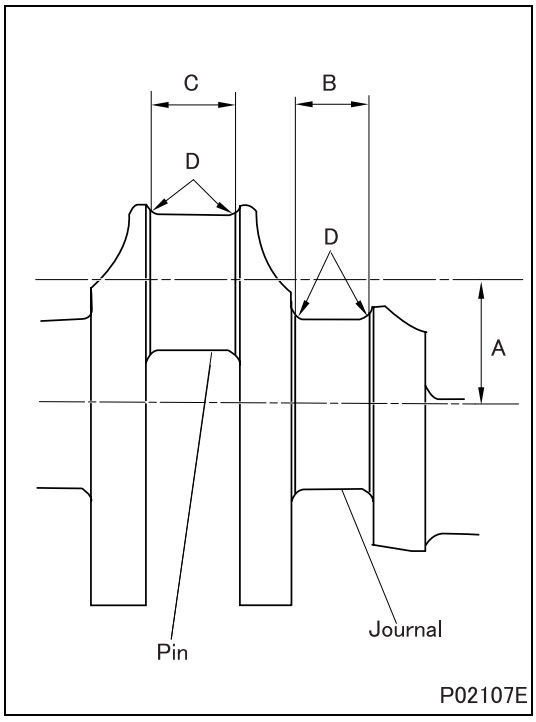
NOTE

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



(2) Out-of-roundness and taper of crankshaft journals and pins

- If any of the measurements exceeds the specified limits, grind the crankshaft journal(s) and/or pin(s) to undersize(s) or replace the crankshaft.



Grinding of crankshaft

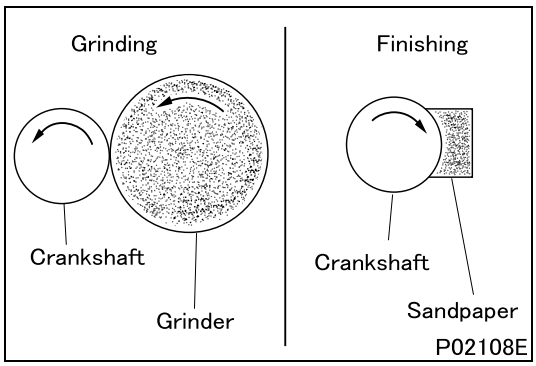
CAUTION ⚠

- **If the crankshaft is ground to an undersize, the main bearings must be replaced with the undersized ones of the corresponding undersize.**

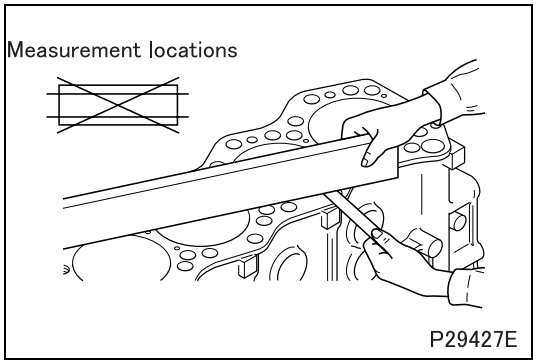
- Do not change the center-to-center distance A between the journal and pin.
  A: 57.5 ± 0.05 mm
- Do not change the journal width B and the pin width C.
  B: 35 mm (32 mm for No. 1 journal)
  C: $41\ ^{+0.2}_{0}$ mm
- Finish the fillets D smoothly.
  D: R4 ± 0.2 mm
- Carry out a magnetic inspection to check for cracks possibly caused by grinding. Also, check that the hardness of the surface has not dropped below Shore hardness number (Hs) 75.
- Replace the crankshaft if defects are evident.

Crankshaft undersize dimensions (Unit: mm)

		Undersizes			
		0.25	0.50	0.75	1.00
Finished journal diameter	No. 1, 2, 4, 5	77.68 to 77.70	77.43 to 77.45	77.18 to 77.20	76.93 to 76.95
	No. 3	77.66 to 77.68	77.41 to 77.43	77.16 to 77.18	76.91 to 76.93
Finished pin diameter	4D33	59.695 to 57.715	59.445 to 59.465	59.195 to 59.215	58.945 to 58.965
	4D34	64.69 to 64.71	64.44 to 64.46	64.19 to 64.21	63.94 to 63.96
Out-of-roundness		0.01 or less			
Taper		0.006 or less			



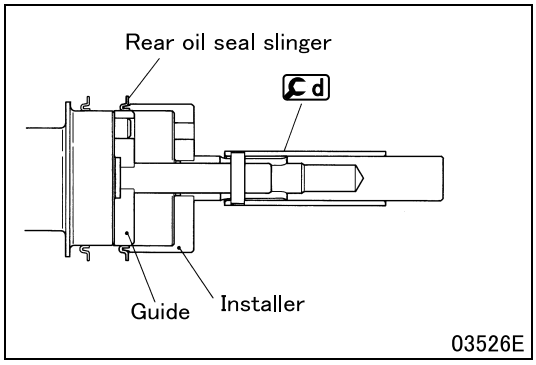
- When grinding, turn both the crankshaft and the grinder counterclockwise as viewed from the crankshaft front end.
- When finishing the crankshaft with whetstone or sandpaper, rotate the crankshaft clockwise.



■ Inspection: Distortion of crankcase top surface

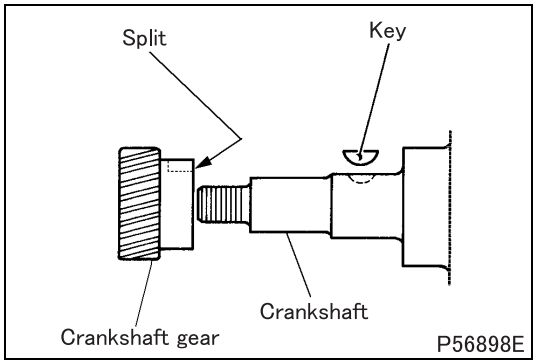
- If the measurement exceeds the specified limit, grind the crankcase top surface with a surface grinder.
- Limit the amount of removed metal to make sure that the amount of piston projection above the crankcase top surface stays within the standard value range.

◆Installation procedure◆



■ Installation: Rear oil seal slinger

- Drive the rear oil seal slinger onto the crankshaft until it touches the guide.



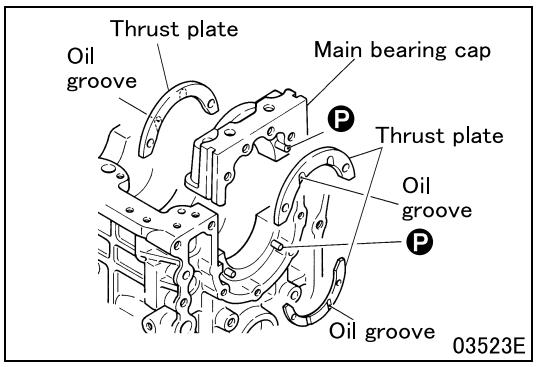
■ Installation: Crankshaft gear

- Heat the crankshaft gear to approximately 100°C with a burner or the like.

CAUTION ⚠

- **Be careful not to get burned.**

- Align the key fitted in the crankshaft with the slot in the crankshaft gear. Drive the gear into position by lightly striking its end face with a plastic hammer.



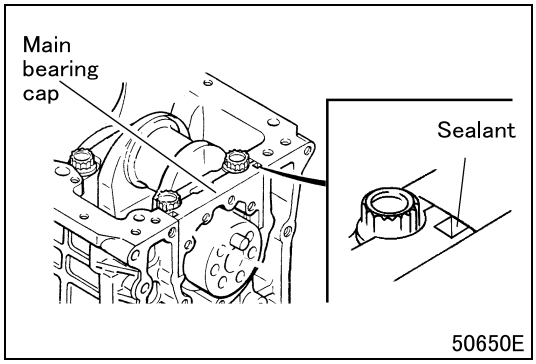
■ **Installation: Thrust plate**

- Install the thrust plates on the rearmost main bearing cap and crankcase with the oil grooves on the inner plates facing inward and those on the outer plates outward as shown in the illustration.
  Ⓟ: Locating pin

CAUTION ⚠

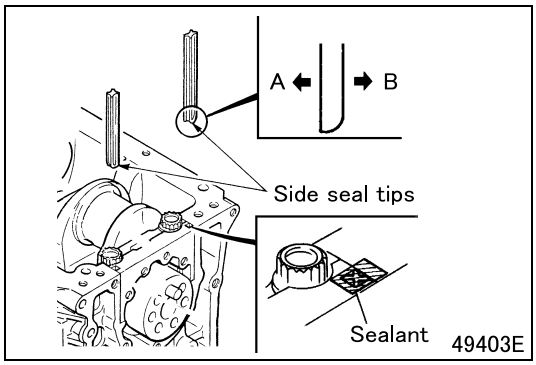
- **Be sure to position the oil grooves as indicated above, otherwise seizures may occur in the engine.**

- Use oversized thrust plates when adjusting the crankshaft end play. The upper and lower thrust plates on the same side must be of the same size. The thrust plates on one side may differ in size from those on the other side.

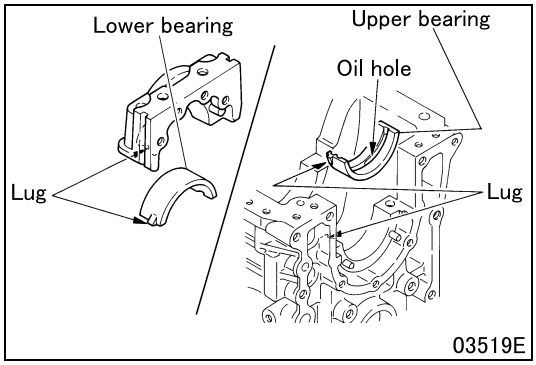


■ **Installation: Side seal**

- Put sealant into each side seal groove in the main bearing cap.



- Apply sealant to the tip of each side seal, and fit the side seal in the hole formed by the groove between the main bearing cap and the crankcase with its sides facing in the illustrated directions.
  A: Crankshaft side
  B: Crankcase side
- After installing each side seal, apply sealant as indicated in the illustration to prevent the engine oil from leaking out.

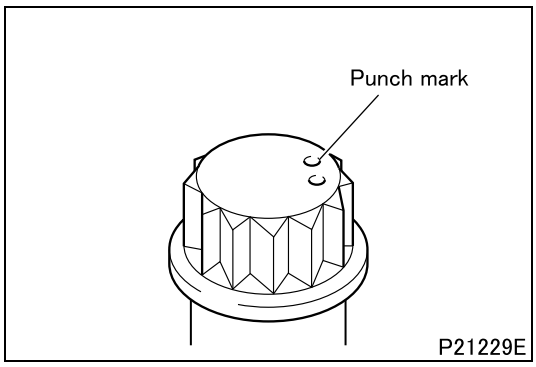


■ **Installation: Main bearing**

- Install the main bearings with their lugs aligned as shown in the illustration. When the crankshaft journals have been ground to an undersize, use undersized main bearings.
  Available main bearing undersizes: 0.25 mm, 0.50 mm, 0.75 mm, 1.00 mm

CAUTION ⚠

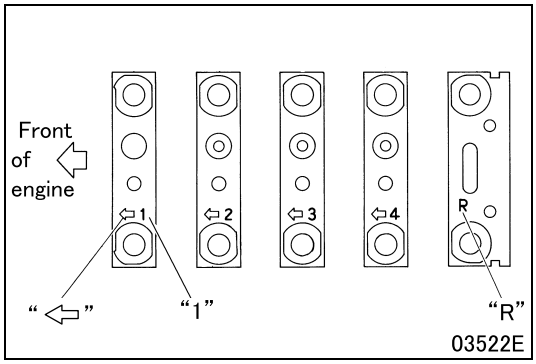
- **The upper main bearing has an oil hole. The lower main bearing has no oil hole. Do not confuse the upper and lower bearings, as this can cause seizure in the engine.**



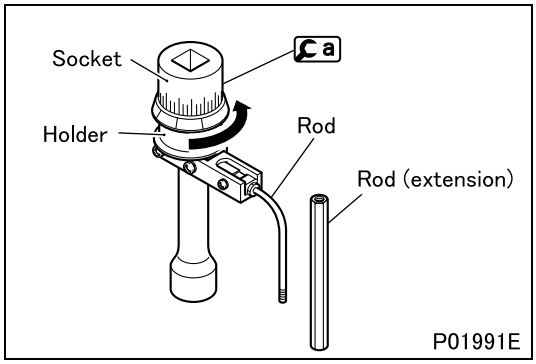
■ **Installation: Main bearing cap**

CAUTION ⚠

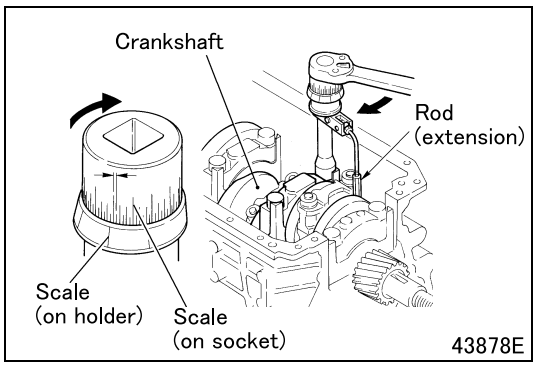
- **Before installing the main bearing cap bolts, check the number of punch marks on the head of each bolt. (A bolt with two or less marks is reusable.)**
- **The number of punch marks corresponds with the number of times the main cap bolt has been tightened using the torque-turn tightening method. Any bolt that has three marks (i.e. that has been used three times) must be replaced.**



- Starting at the front of the engine, fit the main bearing caps in the order of the embossed numbers "1" to "4" with the numbers, letter "R", and front mark "⇦" facing the illustrated direction.



- Apply engine oil on the threads and seat of the main cap bolts. Tighten all the bolts to 59 N·m {6 kgf·m}, then additionally tighten them according to the following procedure.
- Turn the holder of a counterclockwise to pretension the internal spring.

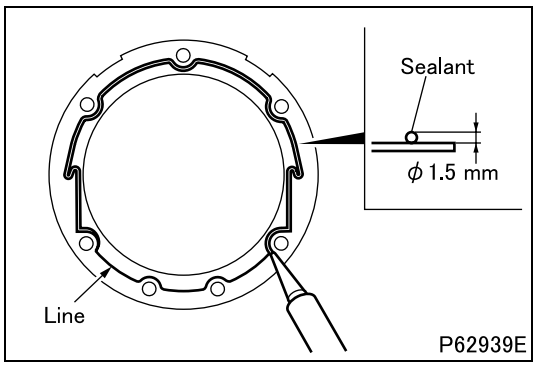


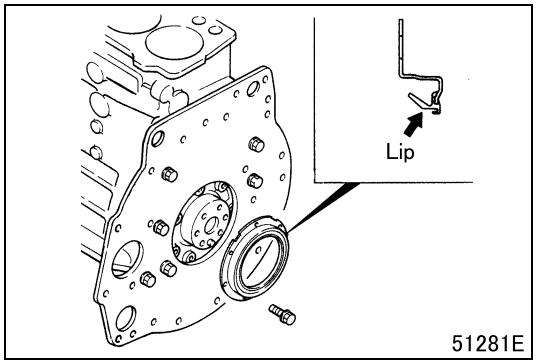
- Fit a on the bolt and set it so that its rod (extension) is held pressed against the crankshaft by the spring force.
- Align a scale mark on the socket with a scale mark on the holder. (This point will be the point of reference, or the 0° point.)
- Starting with this point of reference, turn the socket with a wrench in the illustrated direction until the scale on the socket indicates 90°.
  One graduation on the socket-side scale represents 5°.
- After tightening the bolts using the above torque-turn tightening method, make a punch mark on the head of each bolt to indicate the number of times that it has been used.

CAUTION ⚠

- **The bolts that have been tightened using the torque-turn method must never be additionally tightened after the final angular tightening.**

- After installing the main bearing cap, rotate the crankshaft by hand. If it cannot be rotated smoothly, inspect the main bearing caps for correct installation.





■ **Installation: Rear oil seal**

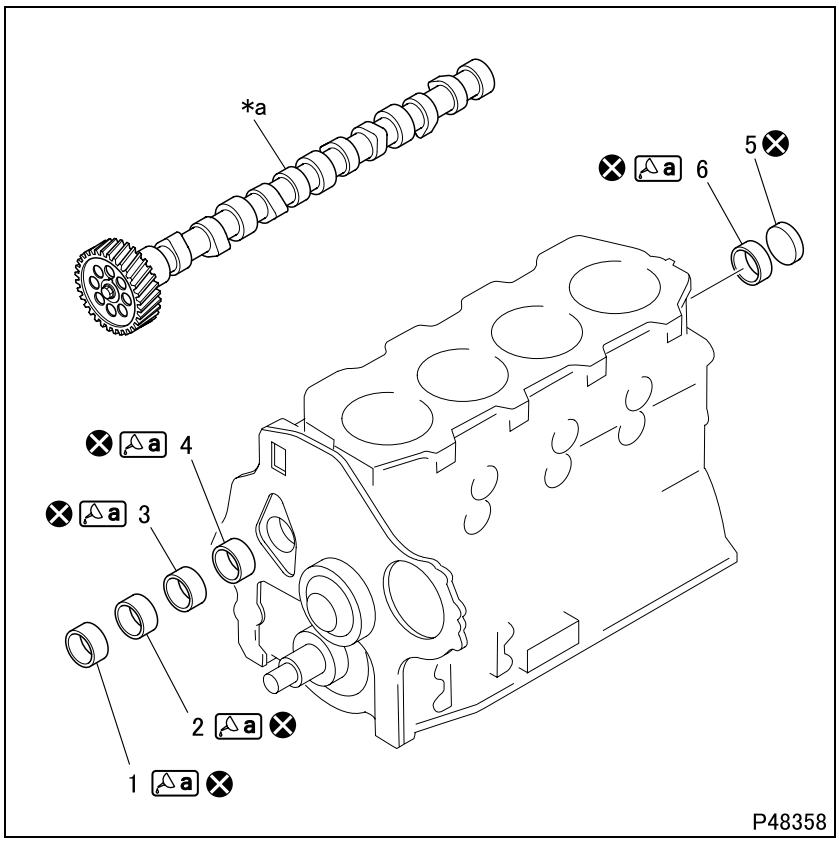
- Apply engine oil to the lip of the rear oil seal.
- Clean the seal surface of the crankshaft.
- Apply a bead of sealant along the line on the rear oil seal evenly without any breaks.
- Install the rear oil seal within three minutes after applying the sealant. Be careful not to let the applied sealant slip out of place during installation.

CAUTION ⚠

- **After fitting the rear oil seal, wait at least an hour before starting the engine.**
- **Apply a new bead of sealant whenever the mounting bolts of the rear oil seal have been loosened.**

M E M O

CAMSHAFT BUSHINGS



● **Disassembly sequence**

1 No. 1 camshaft bushing
2 No. 2 camshaft bushing
3 No. 3 camshaft bushing
4 No. 4 camshaft bushing
5 Sealing cap
6 No. 5 camshaft bushing

***a**: Camshaft
⊗: Non-reusable parts

- Do not remove the camshaft bushings unless defects are evident.

● **Assembly sequence**

Follow the disassembly sequence in reverse.

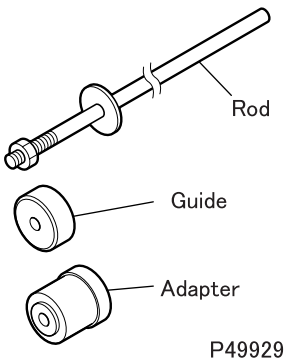
Service standards (Unit: mm)

Location	Maintenance item	Standard value	Limit	Remedy
1 to 4, 6, *a	Camshaft bushing-to-camshaft clearance	0.04 to 0.09	0.15	Rectify or replace

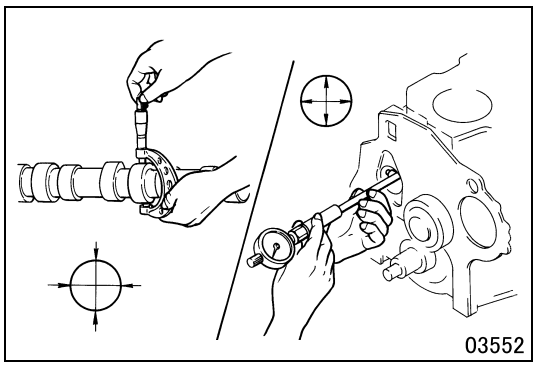
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Camshaft bushing inside surface	Engine oil	As required

Special tools

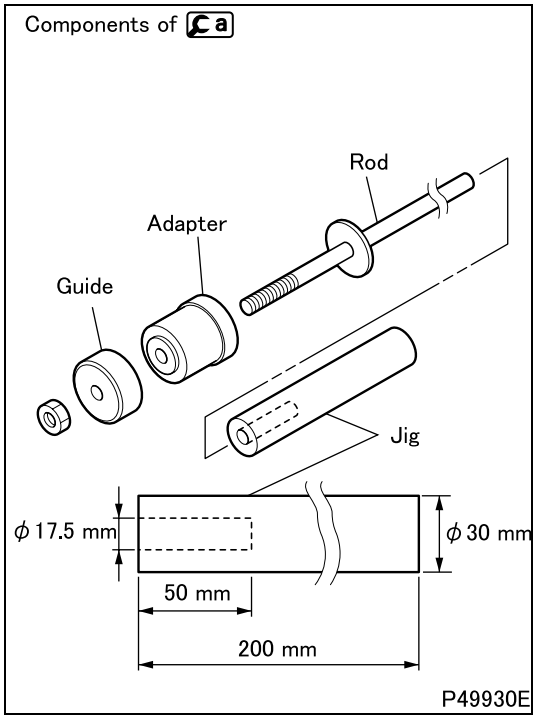
Mark	Tool name and shape	Part No.	Application
a	Camshaft bushing installer and extractor 	MH061276	Removal and installation of camshaft bushings

◆Inspection procedure◆



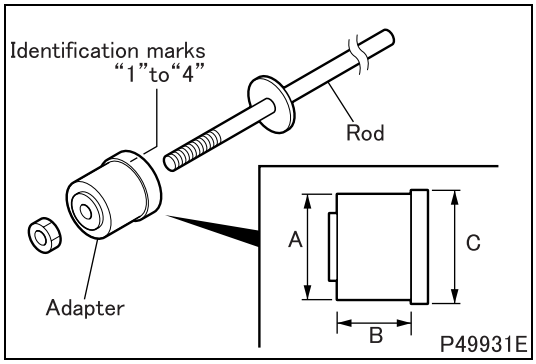
■ Inspection: Camshaft bushing-to-camshaft clearance

- If the measurements exceed the specified limit, replace the bushings.



Replacement of camshaft bushing

- To remove the No. 4 bushing, have an extension like the one indicated in the illustration ready for use with the rod.

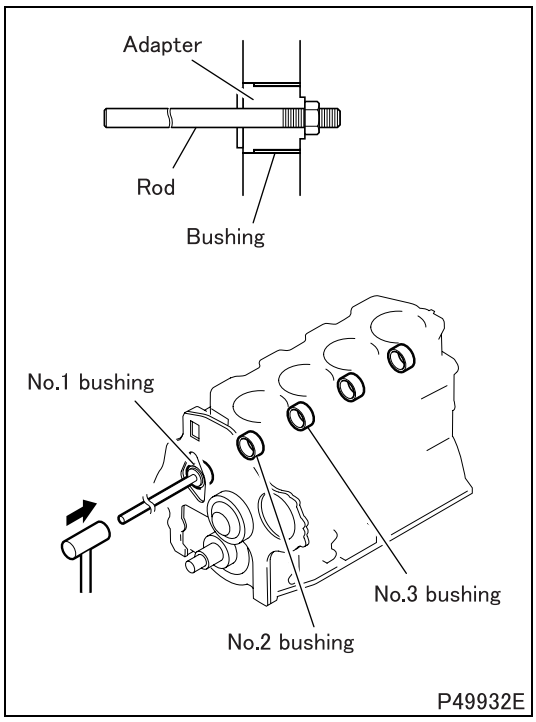


[Removal]

- Attach to the rod the adapter appropriate to each camshaft bushing and use them to remove the camshaft bushing.
  (Unit: mm)

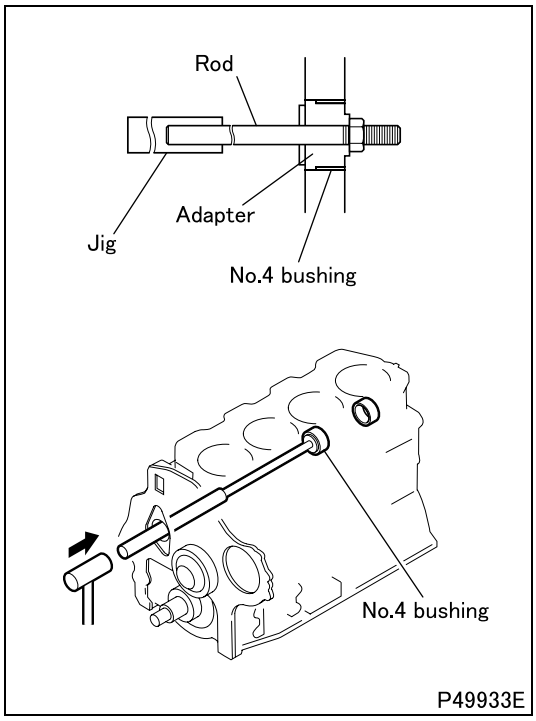
Bushing	Adapter			
	Identification mark	A	B	C
No. 1	"1"	ϕ54.5	41.5	ϕ58.5
No. 2	"2"	ϕ54.5	26.5	ϕ58
No. 3				
No. 4	"3"	ϕ54	26.5	ϕ57.5
No. 5	"4"	ϕ53	30.5	ϕ57

CAMSHAFT BUSHINGS



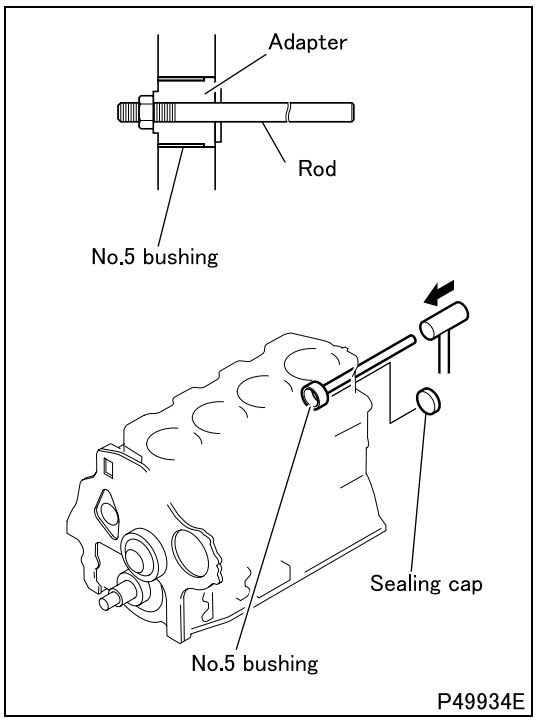
(1) No. 1 to No. 3 camshaft bushings

- Remove the No. 1 to No. 3 camshaft bushings by tapping on them lightly from the front of the engine.



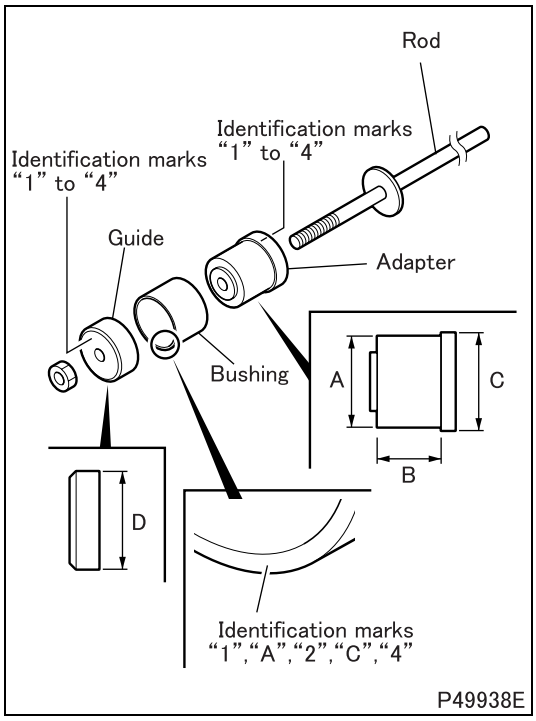
(2) No. 4 camshaft bushing

- Attach an extension jig to the rod. Then, remove the No. 4 bushing by tapping on it lightly from the front of the engine.



(3) No. 5 camshaft bushing

- Remove the sealing cap. Then, remove the No. 5 bushing by tapping on it lightly from the rear of the engine.



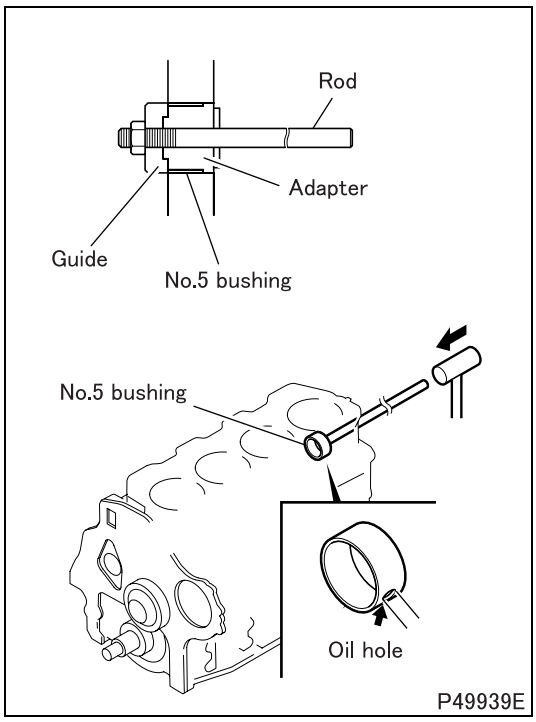
[Installation]

- Attach to the rod an adapter and a guide appropriate to each camshaft bushing and use them together to install the camshaft bushing. Each bushing has a stamped identification mark. Use these marks to identify bushings No.1 to No. 5. If the identification mark is unclear, identify the bushings based on their outside diameters.

(Unit: mm)

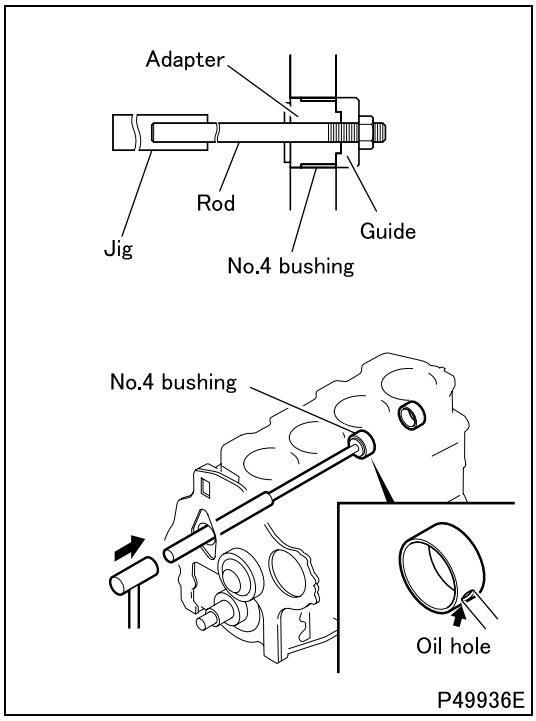
	Bushing		Adapter				Guide	
	Identification mark	Outside diameter	Identification mark	A	B	C	Identification mark	D
No. 1	"1"	ϕ58.5	"1"	ϕ54.5	41.5	ϕ58.5	"1"	ϕ58.5
No. 2	"A"	ϕ58.25	"2"	ϕ54.5	26.5	ϕ58	"2"	ϕ58
No. 3	"2"	ϕ58						
No. 4	"C"	ϕ57.75	"3"	ϕ54	26.5	ϕ57.5	"3"	ϕ57.5
No. 5	"4"	ϕ57	"4"	ϕ53	30.5	ϕ57	"4"	ϕ57

CAMSHAFT BUSHINGS



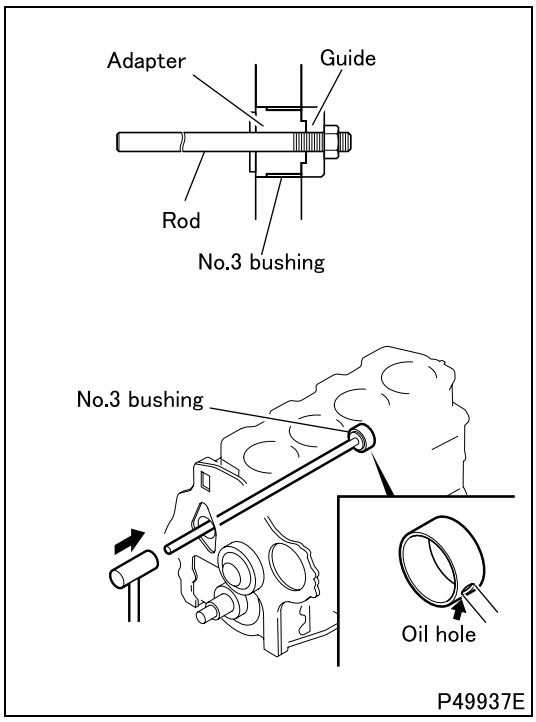
(1) No. 5 camshaft bushing

- Align the oil hole in the No. 5 bushing with the oil hole in the crankcase.
- Install the No. 5 bushing by tapping lightly on it from the rear of the engine until it reaches the illustrated position.



(2) No. 4 camshaft bushing

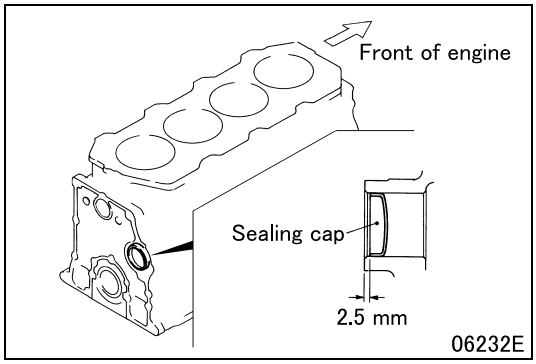
- Align the oil hole in the No. 4 bushing with the oil hole in the crankcase.
- Install the No. 4 bushing by tapping lightly on it from the rear of the engine until it reaches the illustrated position.



(3) No. 3 to No. 1 camshaft bushings

- Align the oil hole in the No. 3 bushing with the oil hole in the crankcase.
- Install the No. 3 bushing by tapping lightly on it from the front of the engine until it reaches the illustrated position.
- Install the No. 1 and No. 2 bushings in the same way.

◆Installation procedure◆



■ Installation: Sealing cap

- Force the sealing cap into the crankcase to the specified depth.

GROUP 12 LUBRICATION

SPECIFICATIONS 12-2

STRUCTURE AND OPERATION
1. Lubrication System 12-3
2. Oil Pump 12-5
3. Oil Cooler and Oil Filter <Spin-on Type> 12-6
4. Oil Cooler and Oil Filter <Replaceable Element Type> 12-8
5. Lubrication of Engine Components 12-10

TROUBLESHOOTING 12-13

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Oil Filter Replacement 12-14
2. Engine Oil Replacement 12-17
3. Oil Pressure Measurement 12-18

OIL PAN AND OIL JETS 12-20

OIL PUMP 12-22

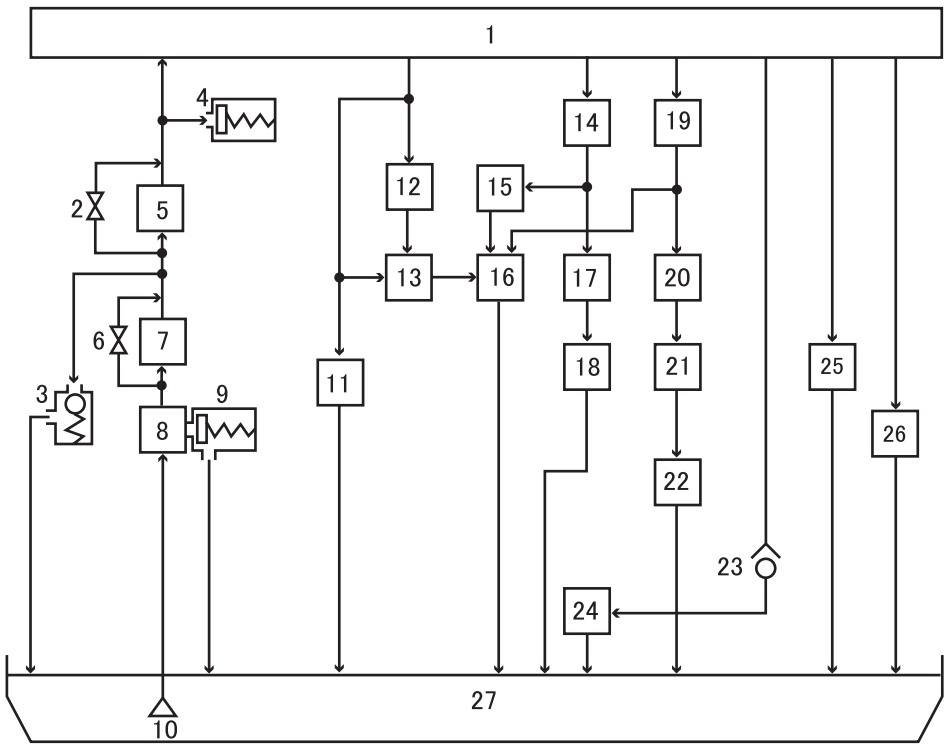
OIL COOLER AND OIL FILTER
<SPIN-ON TYPE> 12-24
<REPLACEABLE ELEMENT TYPE> 12-28

SPECIFICATIONS

Item			Specifications
Method of lubrication			Forced lubrication by oil pump
Oil filter			Replaceable element type or spin-on type
Oil cooler			Shell and plate type (multiple-plate type)
Engine oil	Grade		API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1
	Quantity dm^3 {L}	Oil pan	8 {8}
		Oil filter	1 {1}

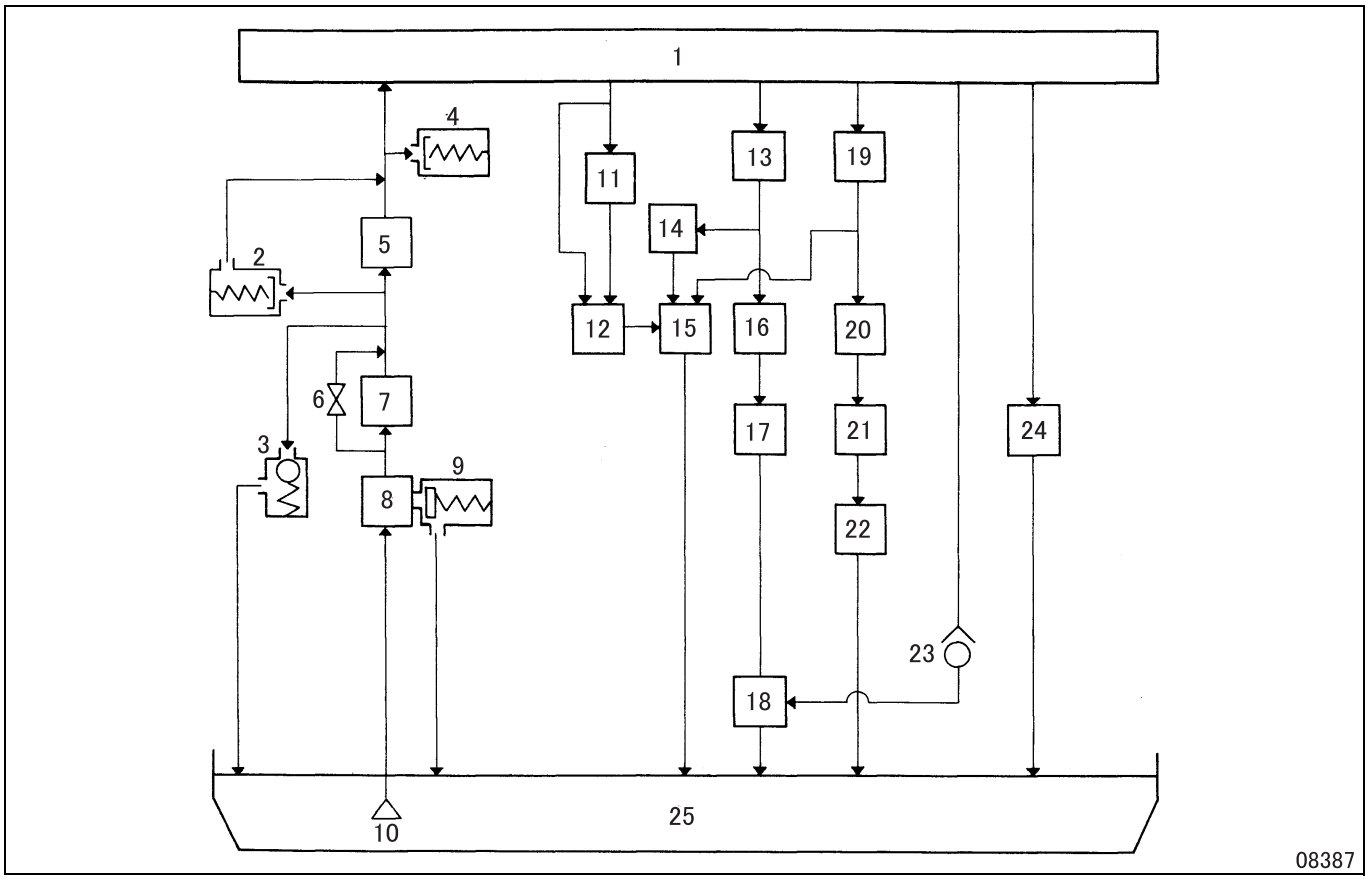
1. Lubrication System

<Spin-on Type>



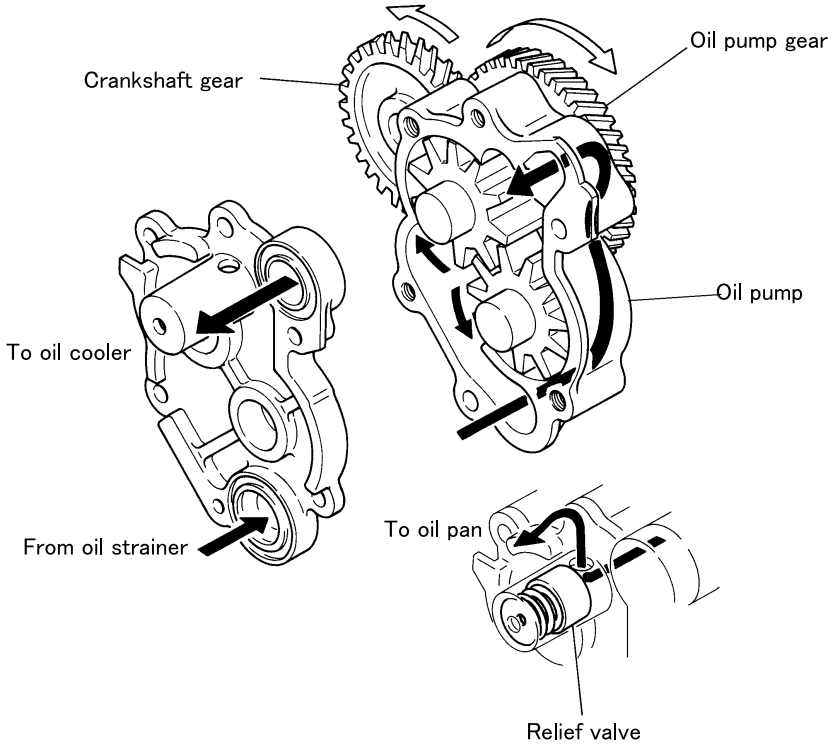
1 Main oil gallery
2 Bypass valve
3 Regulator valve
4 Engine oil pressure switch
5 Full-flow filter element
6 Bypass valve
7 Oil cooler
8 Oil pump
9 Relief valve
10 Oil strainer
11 Injection pump bearing
12 Injection pump
13 Injection pump gear
14 Crankshaft main bearing
15 Idler gear bushing
16 Timing gear
17 Connecting rod bearing
18 Connecting rod bushing
19 Piston
20 Camshaft bushing
21 Rocker bushing
22 Push rod
23 Tappet
24 Check valve for oil jet
25 Turbocharger <4D34>
26 Vacuum pump
27 Oil pan

<Replaceable Element Type>



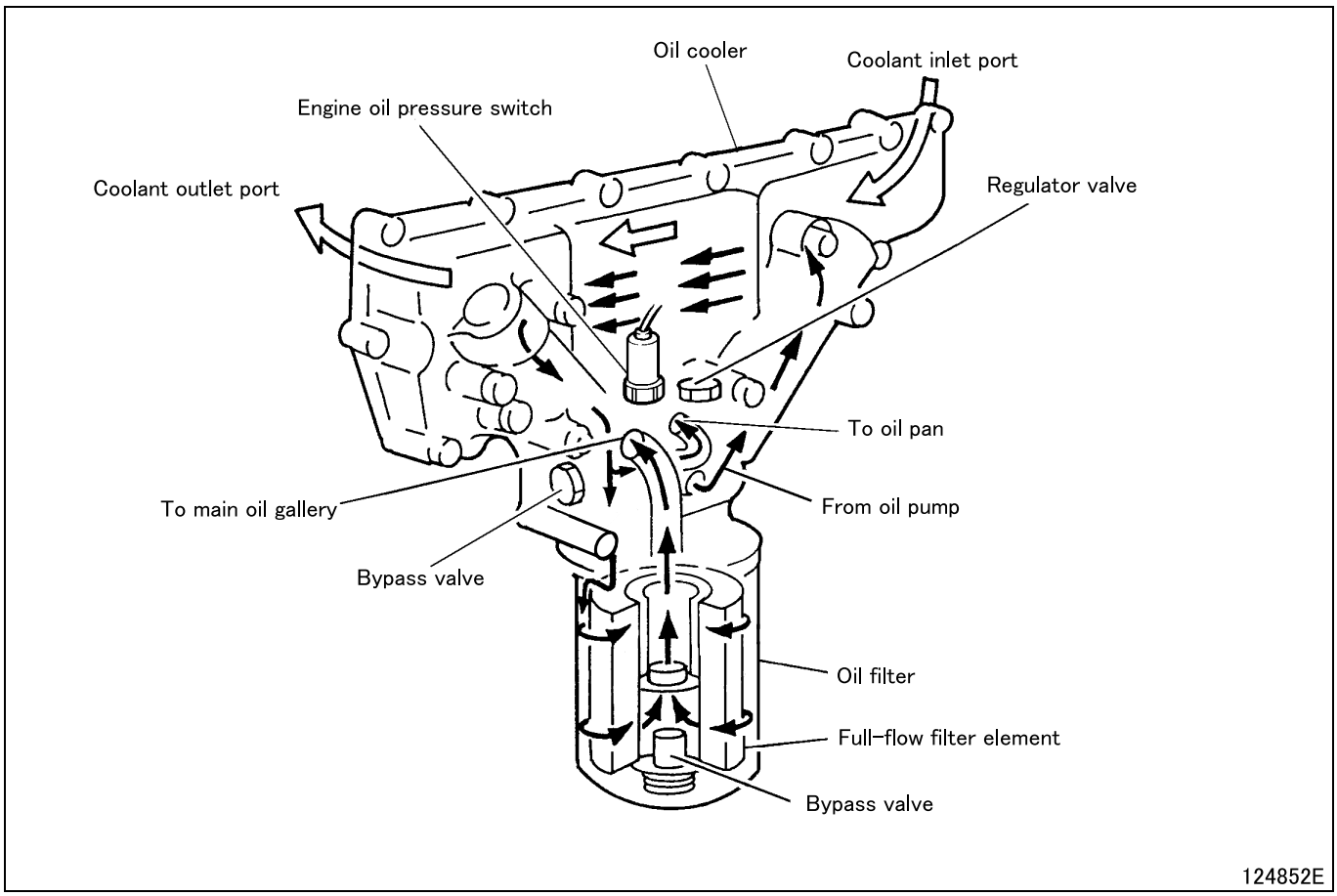
1 Main oil gallery
2 Oil bypass alarm
3 Regulator valve
4 Engine oil pressure switch
5 Oil filter element
6 Bypass valve
7 Oil cooler
8 Oil pump
9 Relief valve
10 Oil strainer
11 Injection pump
12 Automatic timer
13 Main bearing
14 Idler bushing
15 Timing gear
16 Connecting rod bearing
17 Connecting rod bushing
18 Piston
19 Camshaft bushing
20 Rocker bushing
21 Push rod
22 Tappet
23 Check valve for oil jet
24 Vacuum pump
25 Oil pan

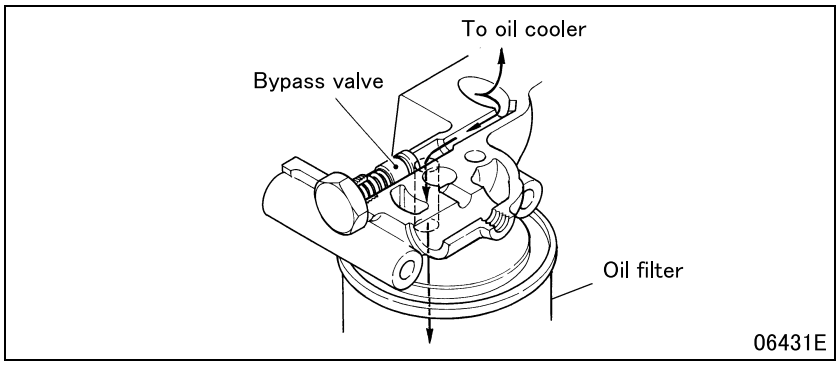
2. Oil Pump



- This engine uses a gear-type oil pump driven by the rotation of the crankshaft transmitted through the engagement of the crankshaft gear and the oil pump gear.
- The oil pump has a relief valve, which prevents excessive pressure from building up inside the lubricating system by allowing part of the engine oil to escape to the oil pan when the oil pressure exceeds a specified level.

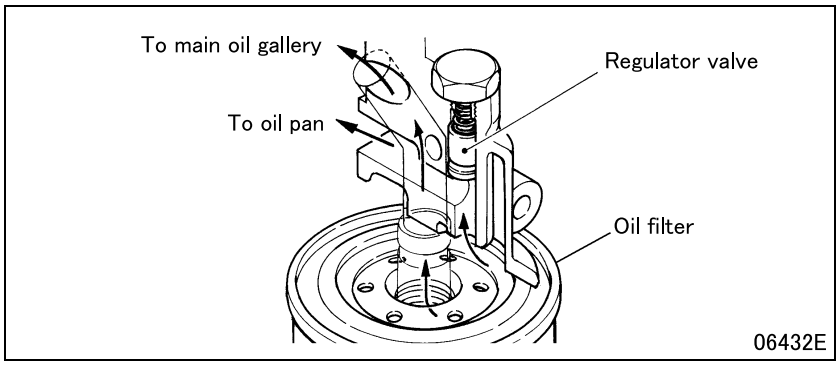
3. Oil Cooler and Oil Filter <Spin-on Type>





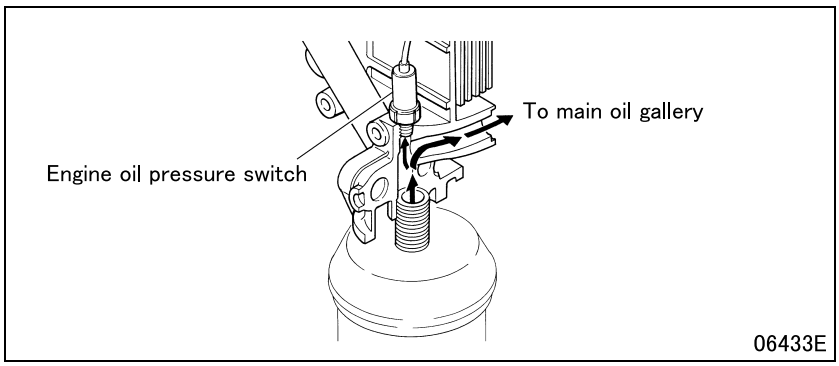
3.1 Bypass valve

- When the engine oil is cool and its viscosity is high, or when the oil cooler element becomes clogged and restricts the flow of the engine oil, the bypass valve opens to let the engine oil bypass the oil cooler and flow directly to the oil filter.



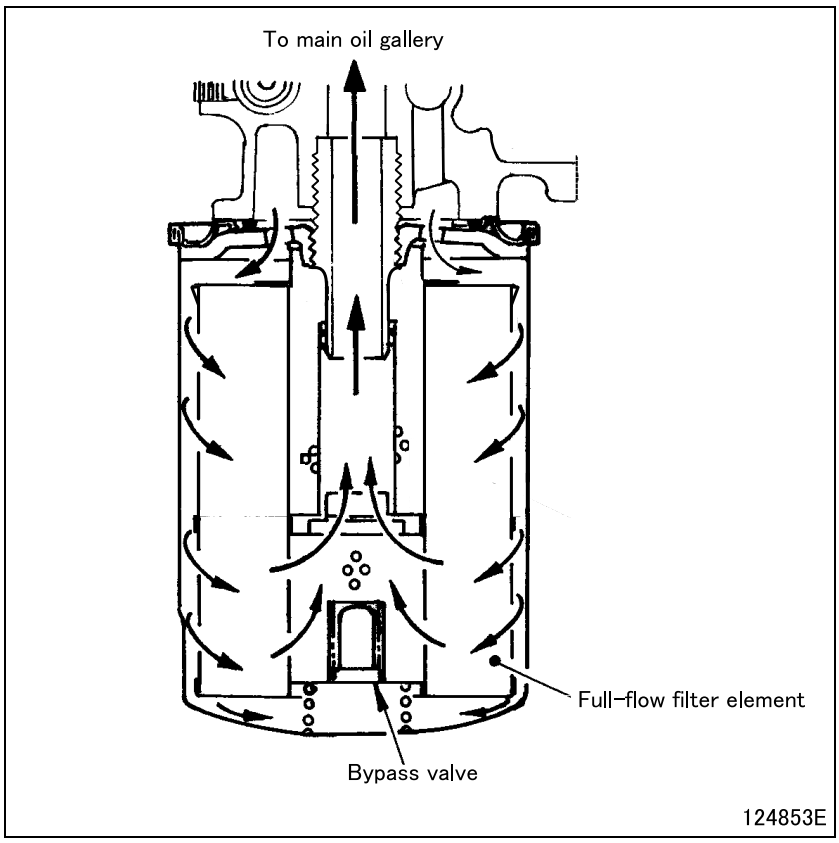
3.2 Regulator valve

- When the oil pressure in the main oil gallery exceeds the specified level, the regulator valve opens to adjust the oil pressure by allowing part of the engine oil to escape to the oil pan.



3.3 Engine oil pressure switch

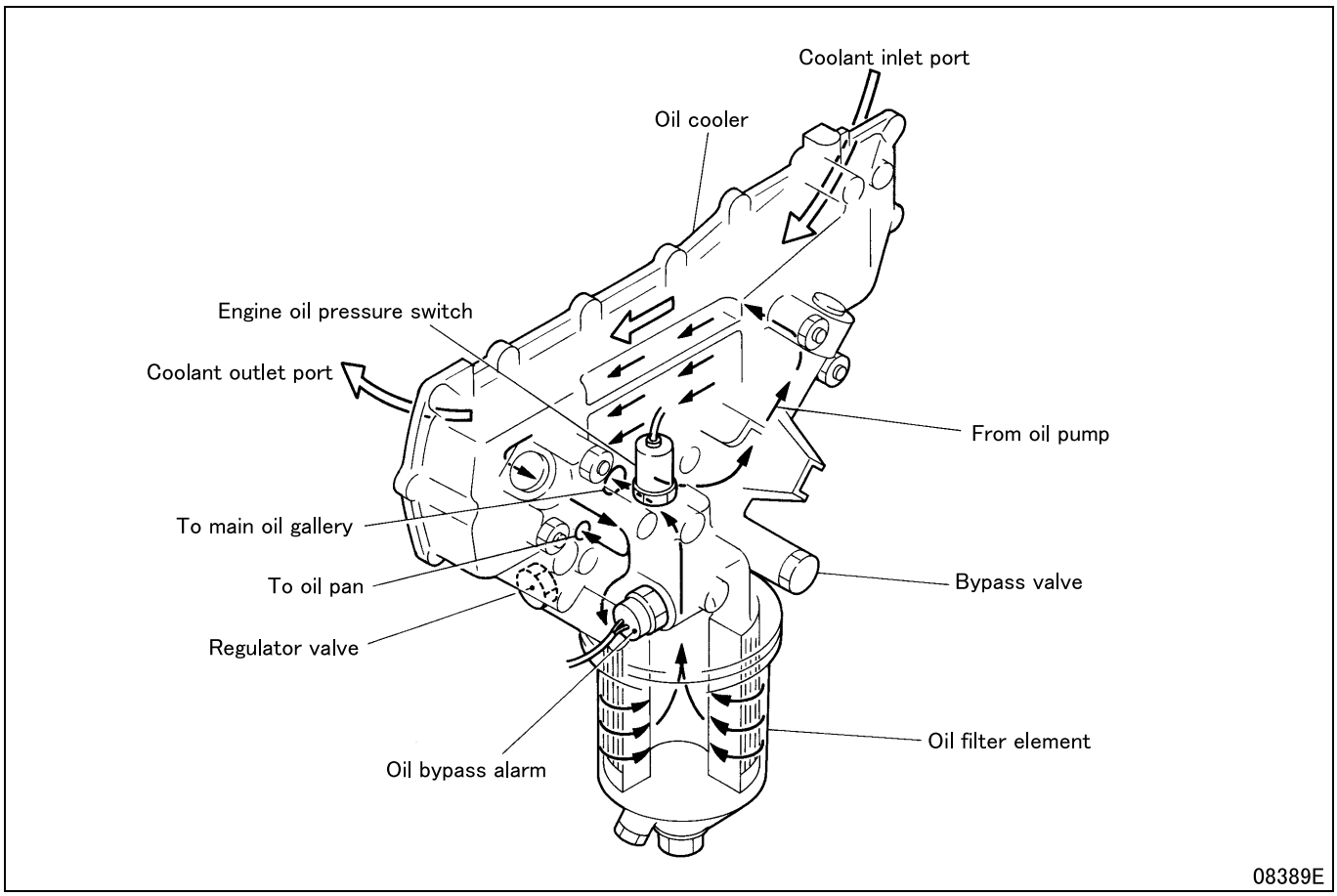
- When the pressure of the engine oil to the main oil gallery drops below the specified level, an electrical contact inside the engine oil pressure switch closes.
- This causes a warning lamp on the meter cluster to illuminate and notify the operator of the excessive pressure drop.

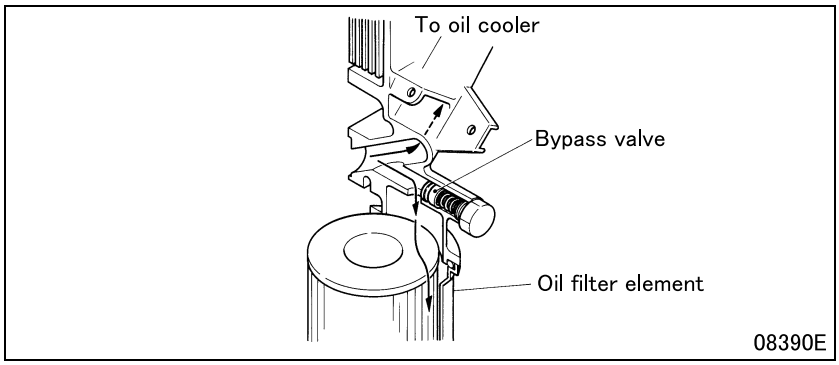


3.4 Oil filter

- This oil filter is a spin-on paper-filter type that incorporates a full-flow filter.
- A bypass valve is installed in the lower part of the oil filter. When the filter elements are clogged, this valve opens to let the engine oil bypass the filter elements and flow directly to the main oil gallery, thereby preventing seizures in the engine.

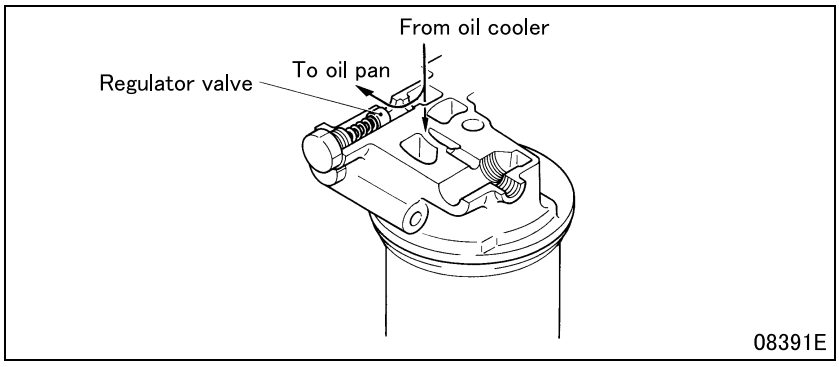
4. Oil Cooler and Oil Filter <Replaceable Element Type>





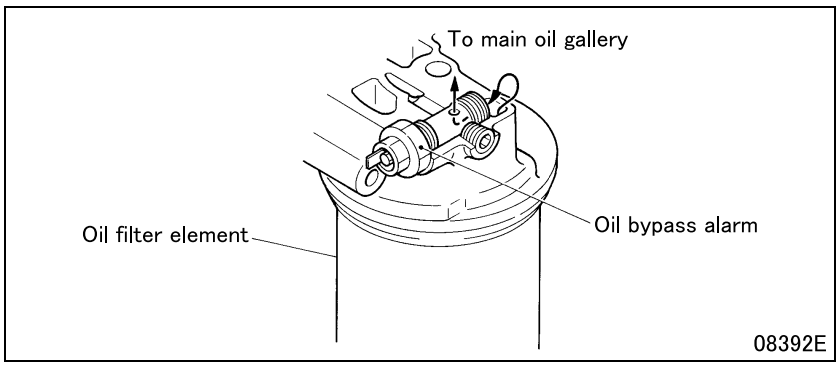
4.1 Bypass valve

- When the viscosity of the engine oil is high at low temperatures, or when oil cooler element is clogged, flow resistance is high, and if this happens, bypass valve opens to let the engine oil return directly to oil filter element without going through the oil cooler.



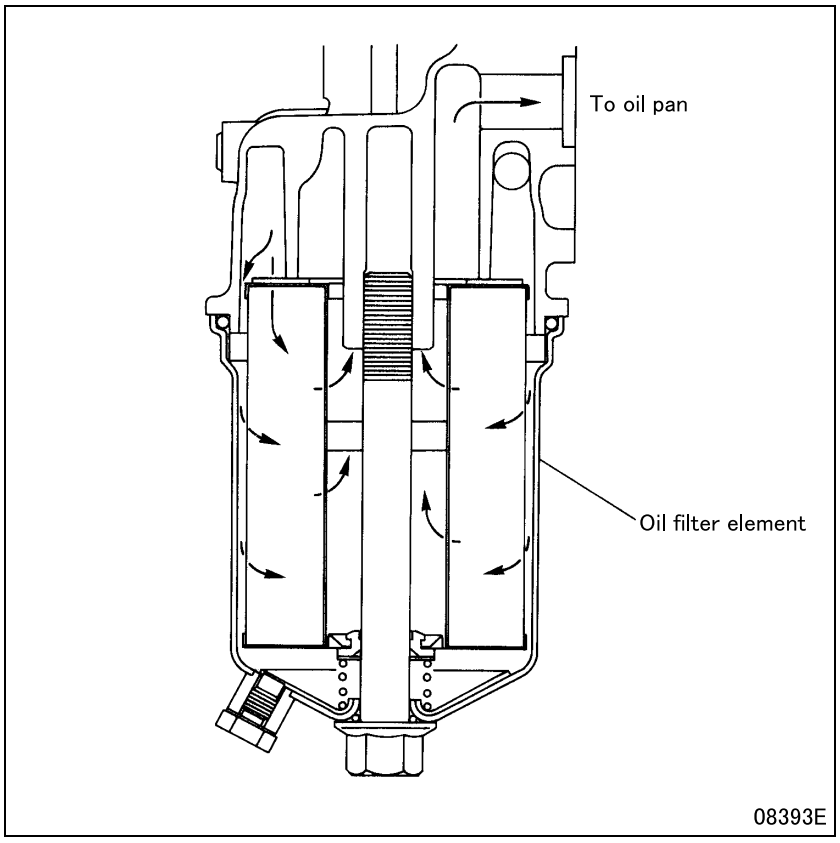
4.2 Regulator valve

- When the oil pressure in the main oil gallery becomes higher than the standard level, regulator valve opens to let part of the engine oil return to oil pan, thereby regulating the oil pressure.



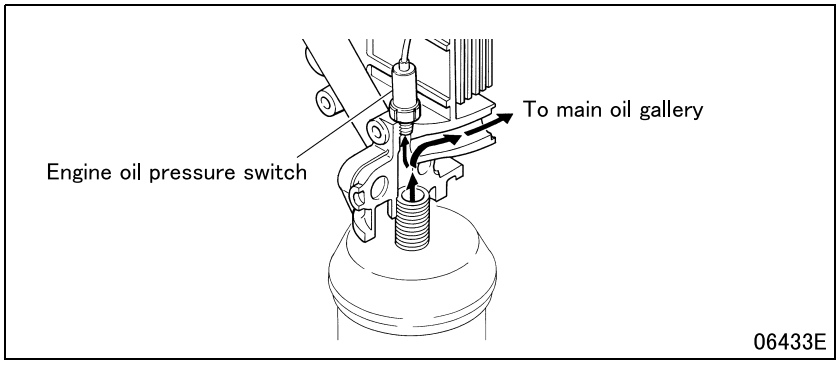
4.3 Oil bypass alarm

- When the difference of the oil pressure between pre-filtering and post-filtering becomes higher than the standard level, the valve inside oil bypass alarm opens to divert the pre-filtered engine oil to main oil gallery. Simultaneously, the built-in electric contact point of the alarm closes.
- This causes a warning lamp on the meter cluster to illuminate and notify the driver that oil filter element is clogged.



4.4 Oil filter element

- This oil filter element is a replaceable element type paper filter.



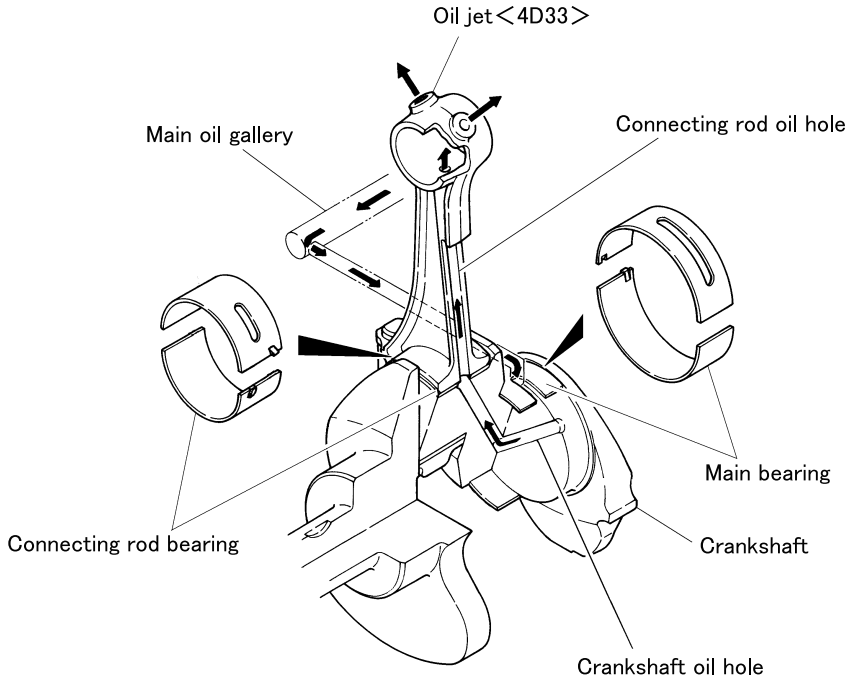
4.5 Engine oil pressure switch

- When the engine oil delivery pressure to main oil gallery becomes lower than the standard pressure level, the built-in electric contact point of engine oil pressure switch closes to light the warning lamp in the meter cluster, warning the driver that the oil pressure is abnormal.

5. Lubrication of Engine Components

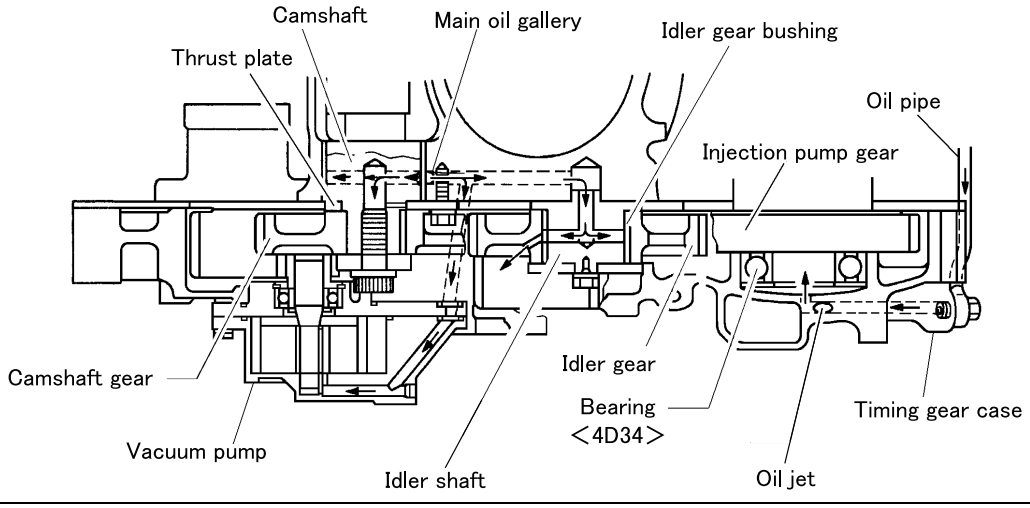
- The engine oil in the main oil gallery lubricates the engine components in the following ways.

5.1 Main bearing and connecting rod bearing

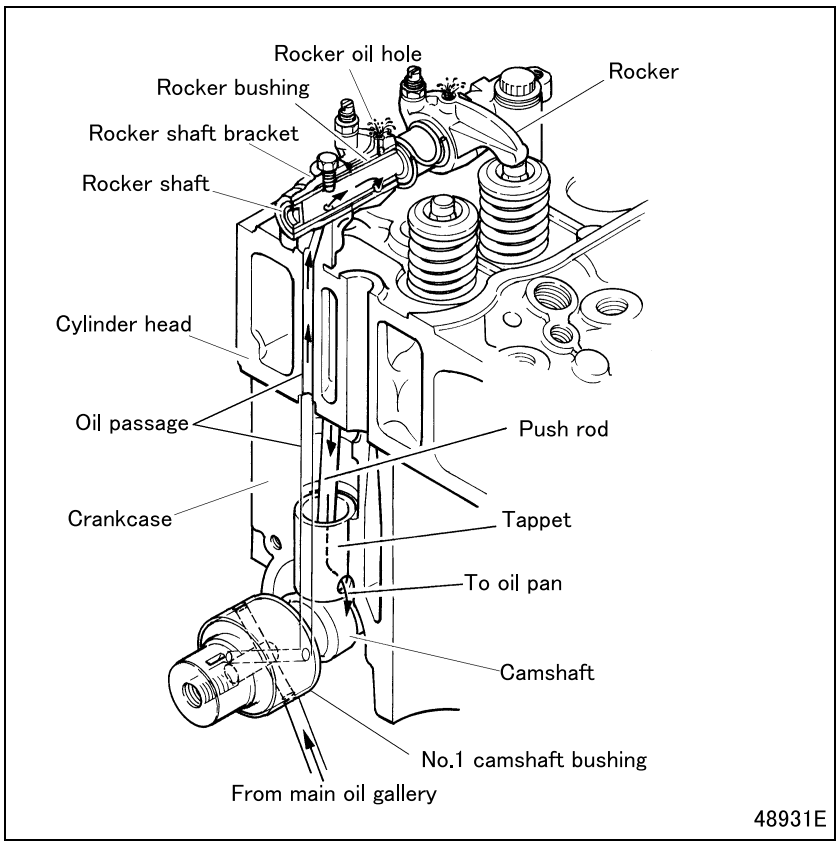


- Engine oil supplied through an oil passage in the crankshaft lubricates the big end (connecting rod bearing) of each connecting rod. Simultaneously, engine oil supplied through an oil passage in the connecting rod lubricates the connecting rod's small end.
- Engine oil is sprayed out of the oil jet at the small end of the connecting rod and cools the piston.

5.2 Timing gears

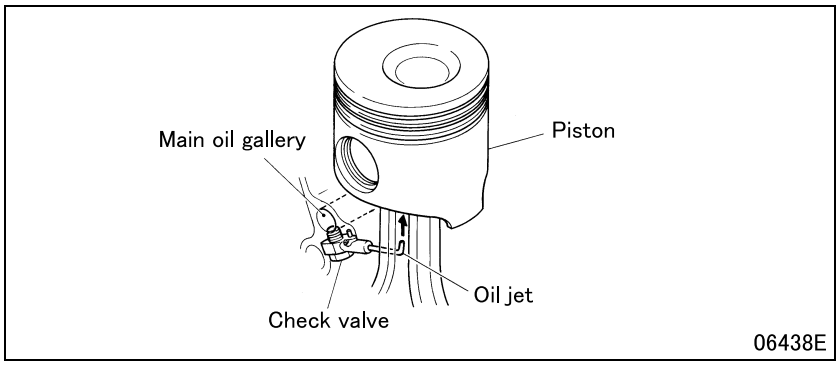


- Engine oil flows through the camshaft and the idler shaft to the timing gear case and lubricates each gear and the vacuum pump. The timing gear case also has an injection pump gear force-feed lubrication oil jet that continuously lubricates the injection pump gears.



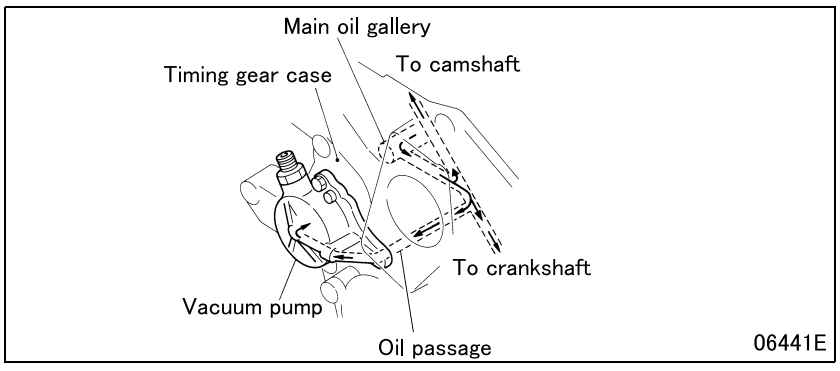
5.3 Valve mechanism

- After lubricating the No.1 camshaft bushing, engine oil flows to the rocker shaft through the oil passages in the crankcase and the cylinder head.
- The engine oil in the rocker shaft flows through the rocker shaft brackets and lubricates the rocker bushings. The engine oil is then sprayed out through the oil hole in each rocker.
- After having lubricated the engine components, the used engine oil returns to the oil pan via the push rod.



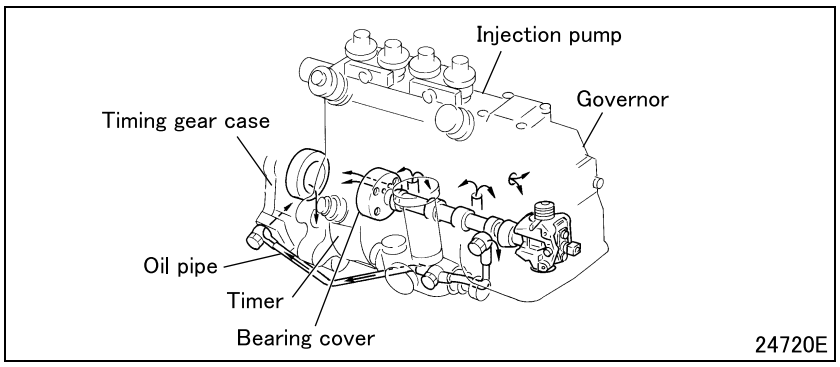
5.4 Check valves and oil jets

- An oil jet is fitted in the lower part of the main oil gallery for each cylinder.
- Engine oil is sprayed out of the oil jet into the piston to cool the piston.
- Each oil jet is fitted with a check valve that opens and closes at predetermined oil pressure levels. At low engine speeds, the check valve closes to maintain the required volume of oil in the lubrication system and prevent reductions in oil pressure.



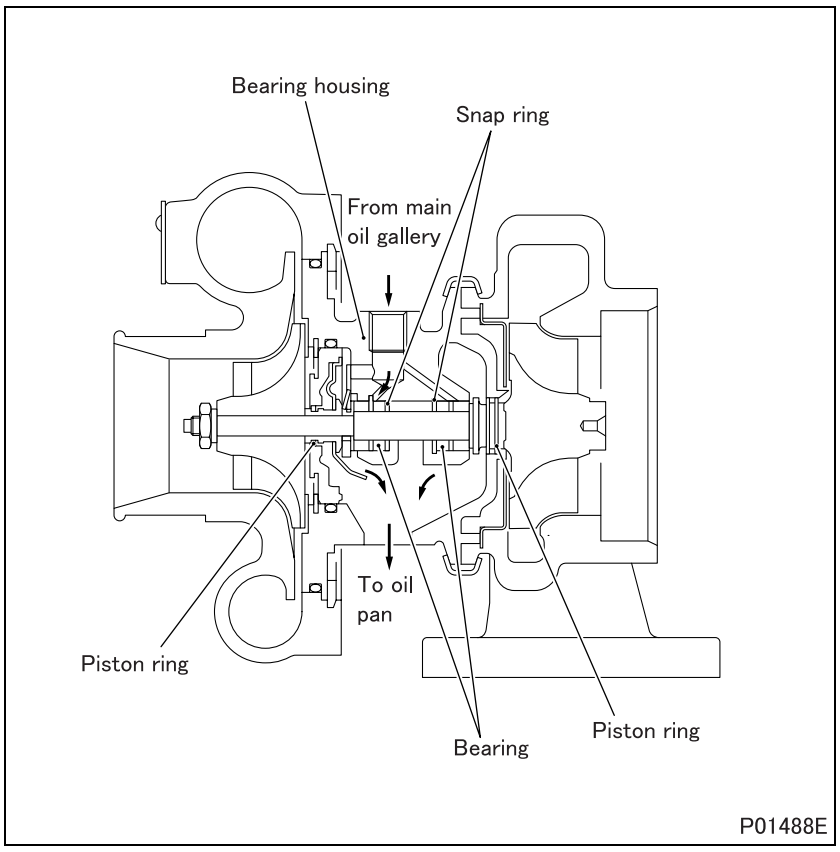
5.5 Vacuum pump

- Engine oil flows to the vacuum pump through the oil passages in the timing gear case to lubricate the pump vanes.
- The used engine oil is discharged from the air discharge port of the vacuum pump along with air and returns to the oil pan.



5.6 Injection pump

- Engine oil that has lubricated injection pump and governor returns to the oil pan through the oil passage of bearing cover.



5.7 Turbocharger

- Engine oil is delivered via the oil pipe from the main oil gallery to bearing housing and lubricates bearing.
- Piston rings fitted on both sides of the turbine wheel shaft act as oil seals.

Possible causes \ Symptoms		Engine is difficult to start	Overheating	Low oil pressure	Excessive oil consumption (oil leakage)	Reference Gr
Oil cooler	Incorrectly mounted element		O	O	O	
	Defective gasket		O	O	O	
	Defective O-ring		O	O	O	
	Clogged element		O	O		
	Damaged element		O	O	O	
	Weakened bypass valve spring		O			
	Weakened regulator valve spring			O		
Oil pump	Malfunctioning oil pump		O	O		
	Interference between oil pump gear and oil pump case and/or cover	O		O		
	Weakened relief valve spring			O		
Oil filter	Incorrect installation				O	
	Clogged element		O	O		
	Defective gasket			O		
Incorrectly mounted and/or clogged oil strainer			O	O		
Defective crankshaft front oil seal					O	Gr11
Defective crankshaft rear oil seal					O	
Incorrectly mounted timing gear case					O	
Defective piston cooling oil jet(s)			O			
Oil working its way up into combustion chamber(s) through piston rings					O	Gr11
Oil working its way down into combustion chamber(s) through valves					O	
Too high oil viscosity		O				
Poor oil quality			O			
Deterioration of oil			O			
Fuel mixed with oil			O			

ON-VEHICLE INSPECTION AND ADJUSTMENT

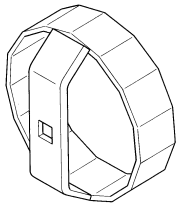
1. Oil Filter Replacement

<Spin-on Type>

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classifioation DH-1)	Approx.1dm^3 {1L}
–	Oil filter gasket		As required

Special tools

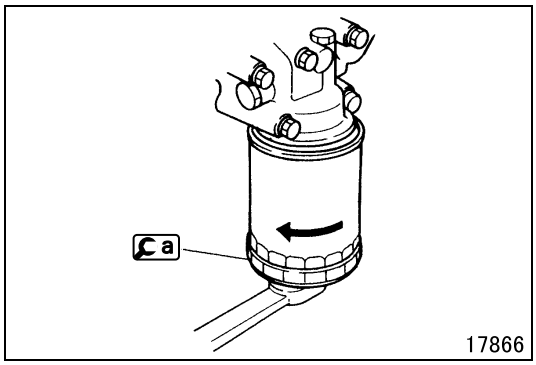
Mark	Tool name and shape	Part No.	Application
ⓒa	Oil filter wrench  04735	MH061590	Removal of oil filter

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**
- **To avoid any risk of burns, take care not to touch the engine oil when the engine is hot.**

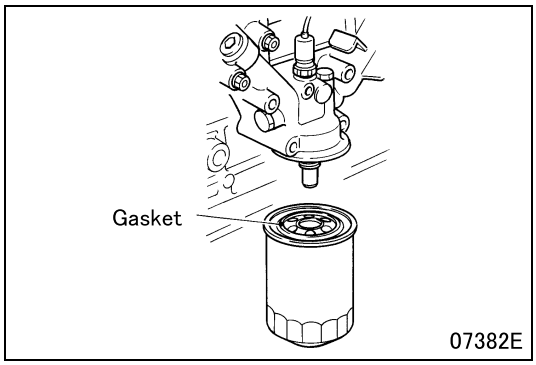
CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Do not reuse the oil filter elements by washing.**



[Removal]

- Remove the drain plug and drain the oil out of the oil filter.



[Installation]

- Clean the oil filter mounting surfaces of the oil cooler.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil cooler. Then, tighten the filter by turning it further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

<Replaceable Element Type>

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug (oil filter)	17 ± 2.5 {1.75 ± 0.25}	–
–	Center bolt (oil filter mounting)	44 ± 5.0 {4.5 ± 0.5}	–

Lubricant and/or sealant

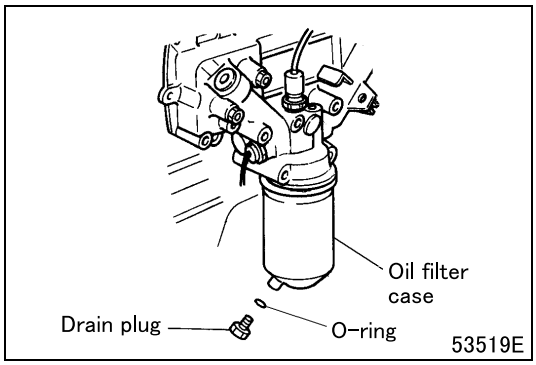
Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 dm^3 {1L}
–	Entire body of O-ring	Engine oil	As required
–	Entire body of gasket	Engine oil	As required

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**
- **To avoid any risk of burns, take care not to touch the engine oil when the engine is hot.**

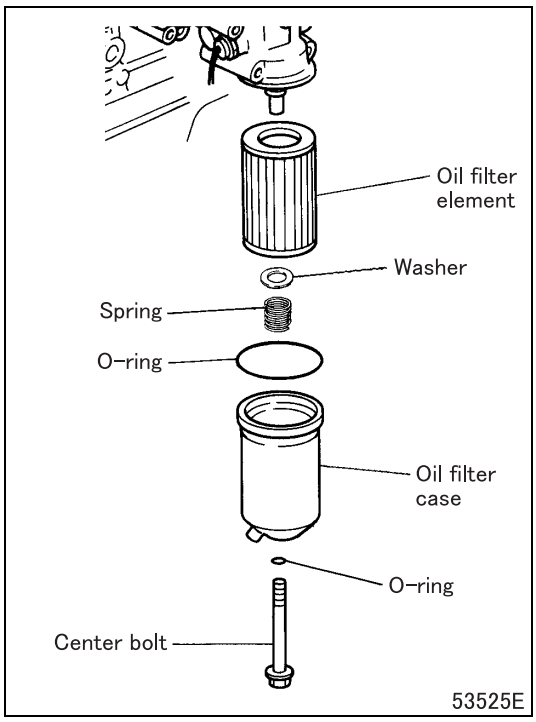
CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil filter. V-belts soiled with oil or grease may easily slip, resulting in deterioreted performance of the cooling system.**
- **Do not reuse the oil filter elements by washing.**



[Removal]

- Loosen oil filter drain plug and O-ring then discharger the engine oil from inside oil filter case.



- Remove center bolt and remove oil filter case, O-ring, oil filter element, washer, sprig and gasket.

[Installation]

- Clean the mounting surface for oil filter case of oil cooler body.
- Assemble parts in the reverse order of disassembly and tighten drain plug and center bolt to the specified torque.

CAUTION ⚠

- **Be sure to use new parts for O-ring, washer and gasket.**

- After installation, let the engine run and check that there is no oil leakage from sealing area of gasket.
- Check the oil level and if it is low, top it up.

2. Engine Oil Replacement

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Drain plug (oil filter) <Replaceable element type>	17 ± 2.5 {1.75 ± 0.25}	–
–	Drain plug (oil pan)	34 to 39 {3.5 to 4.0}	–

Lubricant and/or sealant

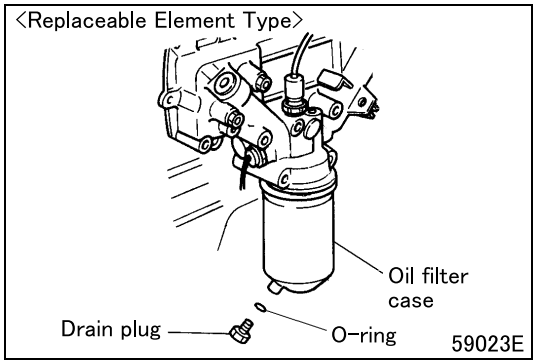
Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Oil filter	Engine oil (API classification CD, CD/SF, CE, CE/SF, CF-4 or JASO classification DH-1)	Approx. 1 dm^3 {1L}
–	Oil pan		Approx. 8 dm^3 {8L}

WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**
- **To avoid any risk of burns, take care not to touch the engine oil when the engine is hot.**

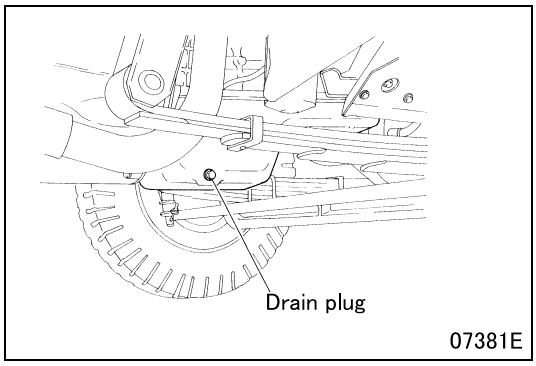
CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt during engine oil replacement. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Do not reuse the oil filter elements by washing.**



[Draining]

- Remove the filler cap.
- Remove the drain plugs of the oil filter or oil pan to drain out the engine oil.



[Refilling]

- Tighten the drain plug to the specified torque, then pour a specified amount of new engine oil into the engine.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

3. Oil Pressure Measurement

Service standards (Unit: mm)

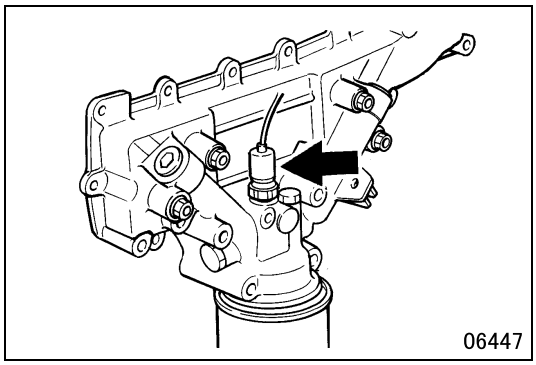
Location	Maintenance item		Standard value	Limit	Remedy
–	Oil pressure (oil temperature at 70 to 90°C)	No-load minimum speed	145 kPa {1.5 kgf/cm^2}	49 kPa {0.5 kgf/cm^2}	Inspect
		No-load maximum speed	295 to 490 kPa {3 to 5 kgf/cm^2}	195 kPa {2 kgf/cm^2}	

Tightening torque (Unit: N·m {kgf·m})

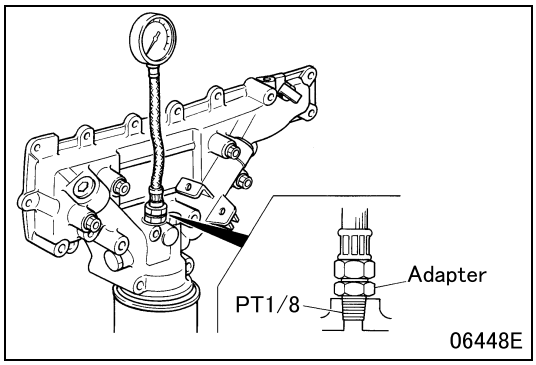
Mark	Parts to be tightened	Tightening torque	Remarks
–	Engine oil pressure switch	7.8 to 15 {0.8 to 1.5}	Sealant With cold engine

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
–	Engine oil pressure switch threads	Teflon tape	3 1/2 turns



- Remove the engine oil pressure switch.



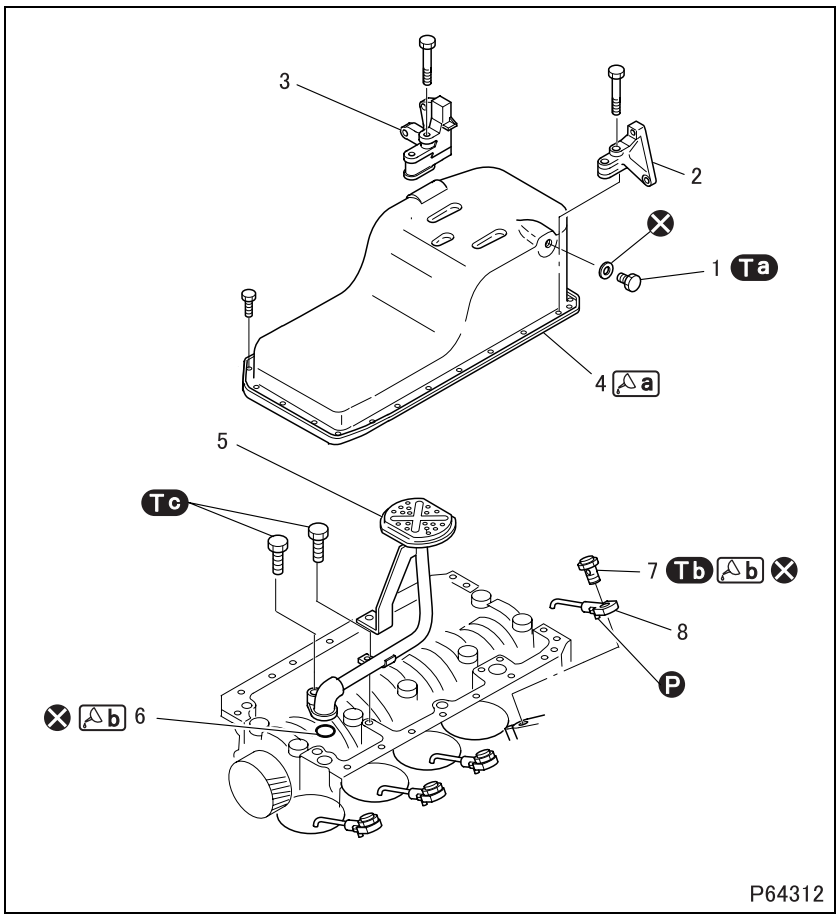
- Using an adapter, connect an oil pressure gauge to the engine oil pressure switch mounting hole.
- Warm up the engine until the oil temperature reaches 70 to 90°C.
- Measure the oil pressure while running the engine at a minimum speed and then at maximum speed, both under no load.
- If the measurements are below the specified limits, overhaul the lubrication system.
- After taking the measurements, fit the oil pressure switch in its mounting hole and tighten it to the specified torque.

CAUTION ⚠

- **Reinstall the oil pressure switch only when the engine is cold.**

M E M O

OIL PAN AND OIL JETS



● **Disassembly sequence**

1 Drain plug
2 Stiffener RH
3 Stiffener LH
4 Oil pan
5 Oil strainer
6 O-ring
7 Check valve
8 Oil jet

Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Make sure to tighten the check valve only to the specified torque. Overtightening it can cause defective operation, resulting in engine seizure.**

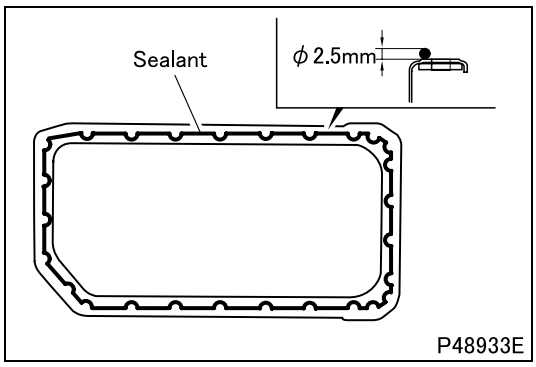
Tightening torque (Unit: N·m {kgf·m})

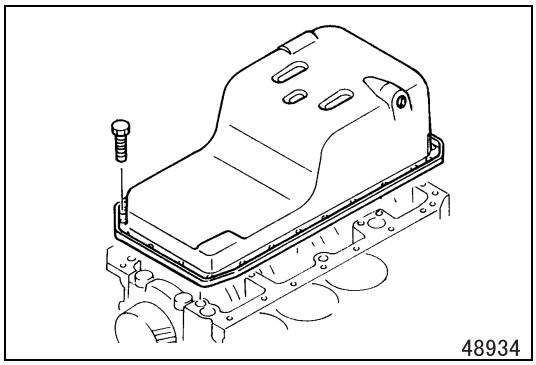
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	34 to 39 {3.5 to 4.0}	–
Tb	Check valve	29 {3.0}	Wet
Tc	Bolt (oil strainer mounting)	23.5 {2.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Crankcase mounting surface of oil pan	ThreeBond 1217H	As required
b	O-ring	Engine oil	As required
	Check valve threads		

◆Installation procedure◆





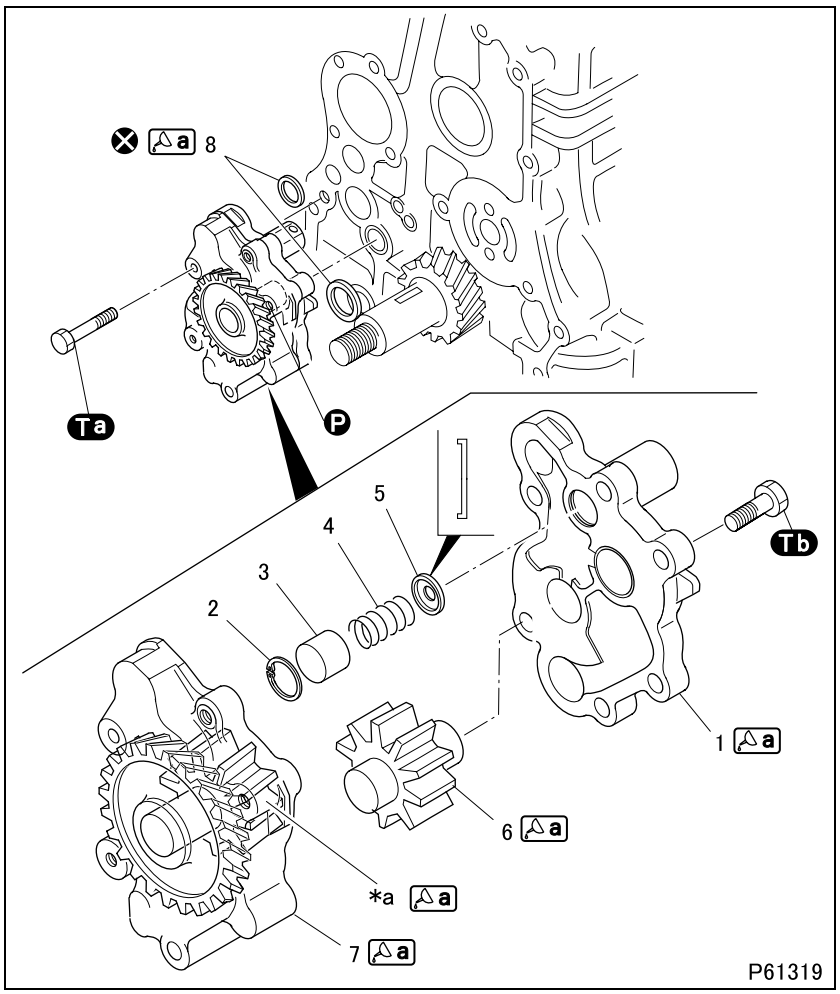
■ **Installation: Oil pan**

- Clean the mating surfaces of each part.
- Apply a bead of sealant to the mating surface of the oil pan evenly and without any breaks.
- Mount the oil pan within three minutes of applying the sealant. Make sure that the sealant stays in place.

CAUTION ⚠

- **Do not start the engine less than an hour after installation.**
- **If the oil pan mounting bolts were loosened or removed, be sure to reapply sealant.**

OIL PUMP



● **Disassembly sequence**

1 Oil pump cover
2 Snap ring
3 Relief valve
4 Relief valve spring
5 Seat
6 Driven gear
7 Gear and case
8 O-ring

***a**: Drive gear
Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly procedure in reverse.

Service standards (Unit: mm)

Location	Maintenance item	Standard value	Limit	Remedy
1, 6	Oil pump cover-to-driven gear shaft clearance	0.04 to 0.07	0.15	Replace
1, *a	Oil pump cover-to-drive gear shaft clearance	0.04 to 0.07	0.15	Replace
3	Relief valve opening pressure	1.1 ± 0.1 MPa {11 ± 1.0 kgf/cm^2}	–	–
4	Load of installed relief valve spring (installed length: 33.4)	217 ± 11 N {22.1 ± 1.1 kgf}	–	Replace
6, 7	Gear and case-to-driven gear shaft clearance	0.04 to 0.07	0.15	Replace
6, 7, *a	Sinkage of each gear from gear and case assembly end surface	0.01 to 0.07	0.18	Replace
	Gear and case-to-tooth tip clearance for each gear	0.10 to 0.19	0.2	Replace

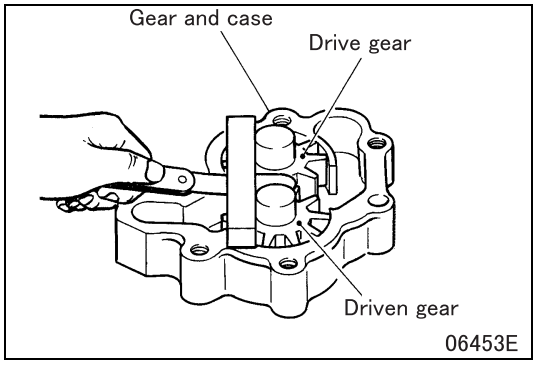
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (oil pump mounting)	28 {2.8}	–
Tb	Bolt (oil pump cover mounting)	9.8 ± 2.0 {1.0 ± 0.2}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Oil pump contact surfaces	Engine oil	As required
	O-ring		

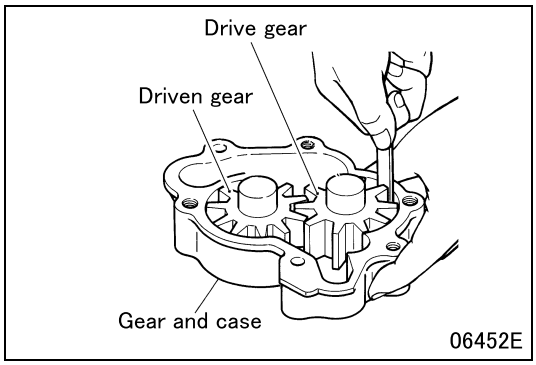
◆Inspection procedure◆



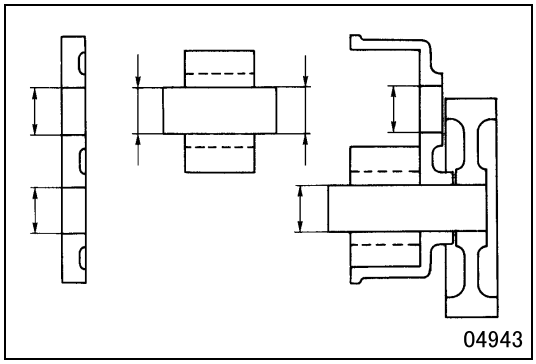
■ **Inspection: Driven gear, drive gear and gear and case**

- Carry out the following inspection. Replace the oil pump if any defects are found.

(1) Sinkage of each gear from gear and case end surface



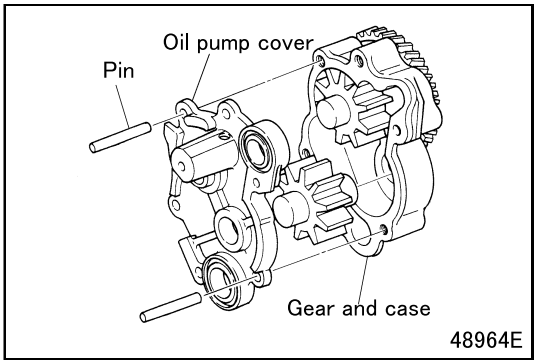
(2) Gear and case-to-tooth tip clearance for each gear



■ **Inspection: Oil pump cover, driven gear, and gear and case**

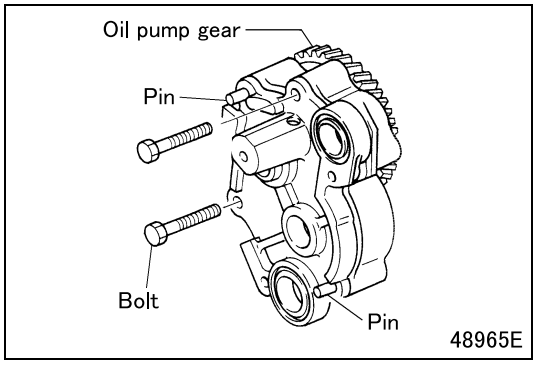
- Measure the clearance between each gear's shaft and the oil pump cover, as well as between each gear's shaft and the gear and case.
- If the measurements are not within the standard value range, replace the defective part(s).

◆Installation procedure◆



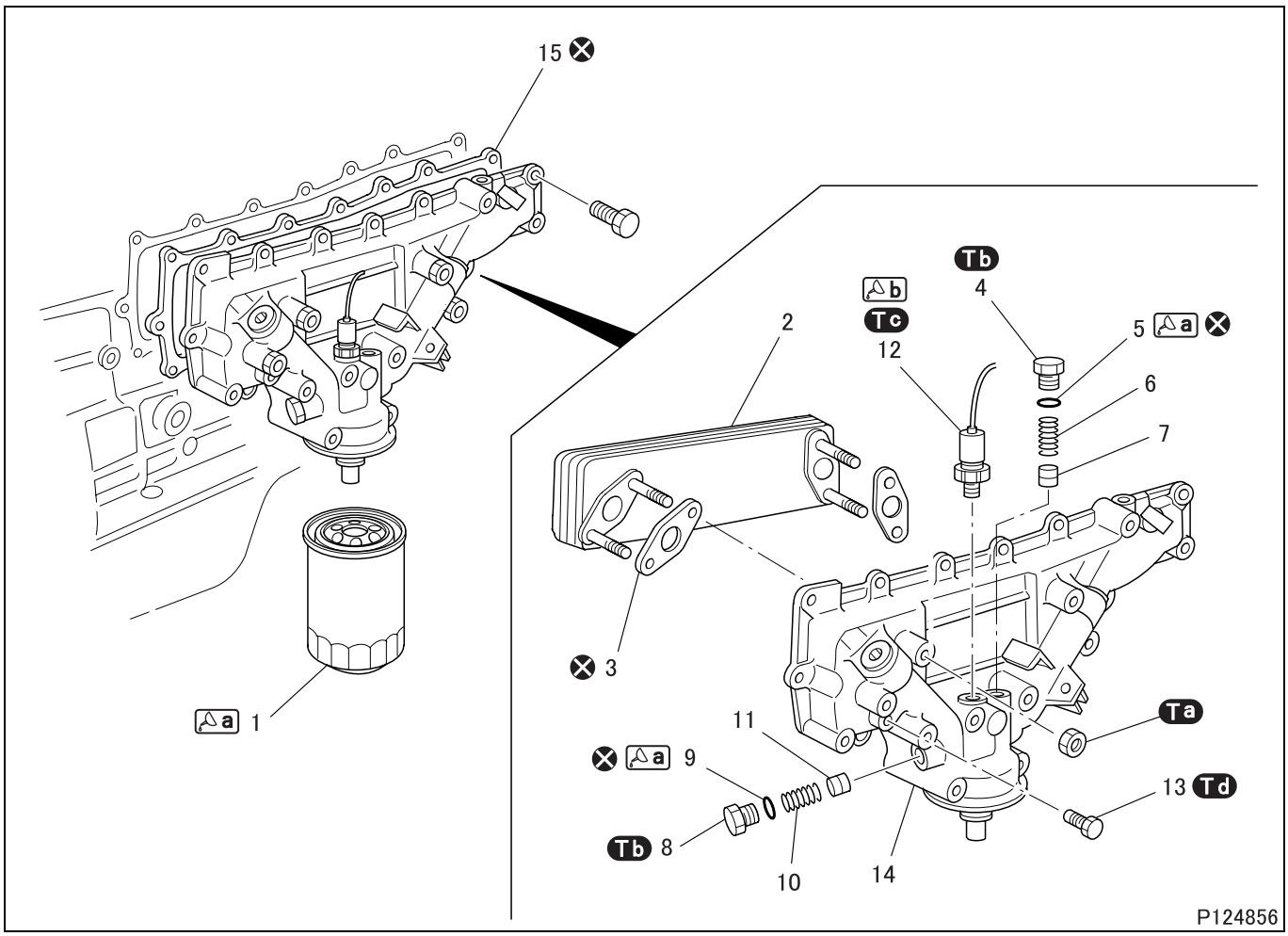
■ **Installation: Oil pump cover**

- Insert a 9 mm-diameter pin into two of the bolt holes (in locations diagonally opposite to each other) to hold the oil pump cover in position on the gear and case.



- Insert bolts into the empty bolt holes and tighten them to the specified torque.
- Remove the two pins and install the bolts in their place.
- After installing all the bolts, turn the oil pump gear by hand and check that it rotates smoothly.
- Disassemble and reassemble the oil pump cover and gear and case if the oil pump gear does not rotate smoothly.

OIL COOLER AND OIL FILTER <SPIN-ON TYPE>



WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**
- **To avoid any risk of burns, take care not to touch the engine oil when the engine is hot.**

CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil cooler and oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Do not reuse the oil filter elements by washing.**

● Removal sequence

1 Oil filter
2 Oil cooler element
3 Gasket
4 Plug
5 O-ring
6 Regulator valve spring
7 Regulator valve
8 Plug
9 O-ring
10 Bypass valve spring
11 Bypass valve
12 Engine oil pressure switch
13 Drain plug
14 Oil cooler body
15 Gasket

⊗: Non-reusable parts

● Installation sequence

Follow the removal sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
2	Air leakage from oil cooler element (air pressure: 980 kPa {10 kgf/cm^2} for 15 seconds)	0 cm^3 {0 mL}	–	Replace
7	Regulator valve opening pressure	590 ± 29 kPa {6.0 ± 0.3 kgf/cm^2}	–	Replace
11	Bypass valve opening pressure	390 ± 29 kPa {4.0 ± 0.3 kgf/cm^2}	–	Replace

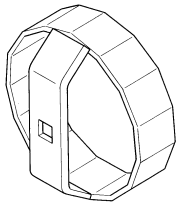
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (oil cooler element mounting)	24.5 ± 5 {2.5 ± 0.5}	–
Tb	Plug (regulator valve spring mounting)	19.5 ± 5 {2.0 ± 0.5}	–
	Plug (bypass valve spring mounting)		
Tc	Engine oil pressure switch	7.8 to 15 {0.8 to 1.5}	Sealant With cold engine
Td	Drain plug (on oil cooler)	25 {2.5}	–

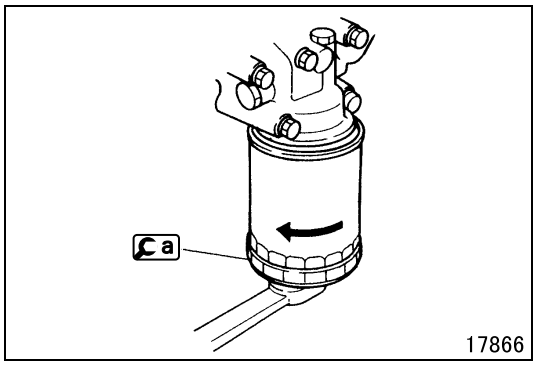
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Oil filter gasket	Engine oil	As required
	O-ring		
b	Engine oil pressure switch threads	Teflon tape	3 1/2 turns

Special tools

Mark	Tool name and shape	Part No.	Application
Ca	Oil filter wrench  04735	MH061590	Removal of oil filter

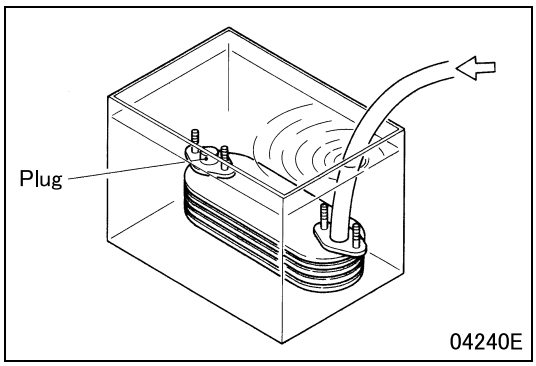
◆Removal procedure◆



■ **Removal: Oil filter**

OIL COOLER AND OIL FILTER <SPIN-ON TYPE>

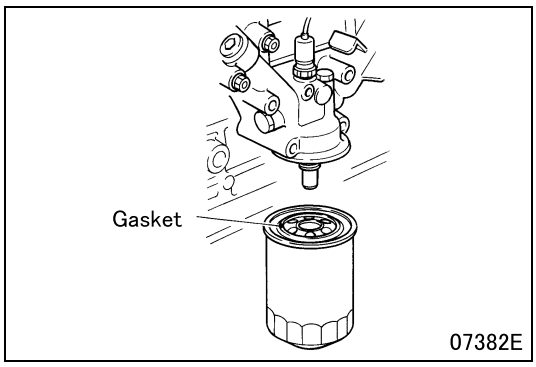
◆Inspection procedure◆



■ Inspection: Oil cooler element

- Plug the outlet of the oil cooler element and connect a hose to the engine oil inlet port. Then, immerse the oil cooler element in a tank of water.
- Apply an air pressure of 980 kPa {10 kgf/cm^2} for 15 seconds through the hose, and check for any air leaks.
- Replace the element if it leaks air.

◆Installation procedure◆

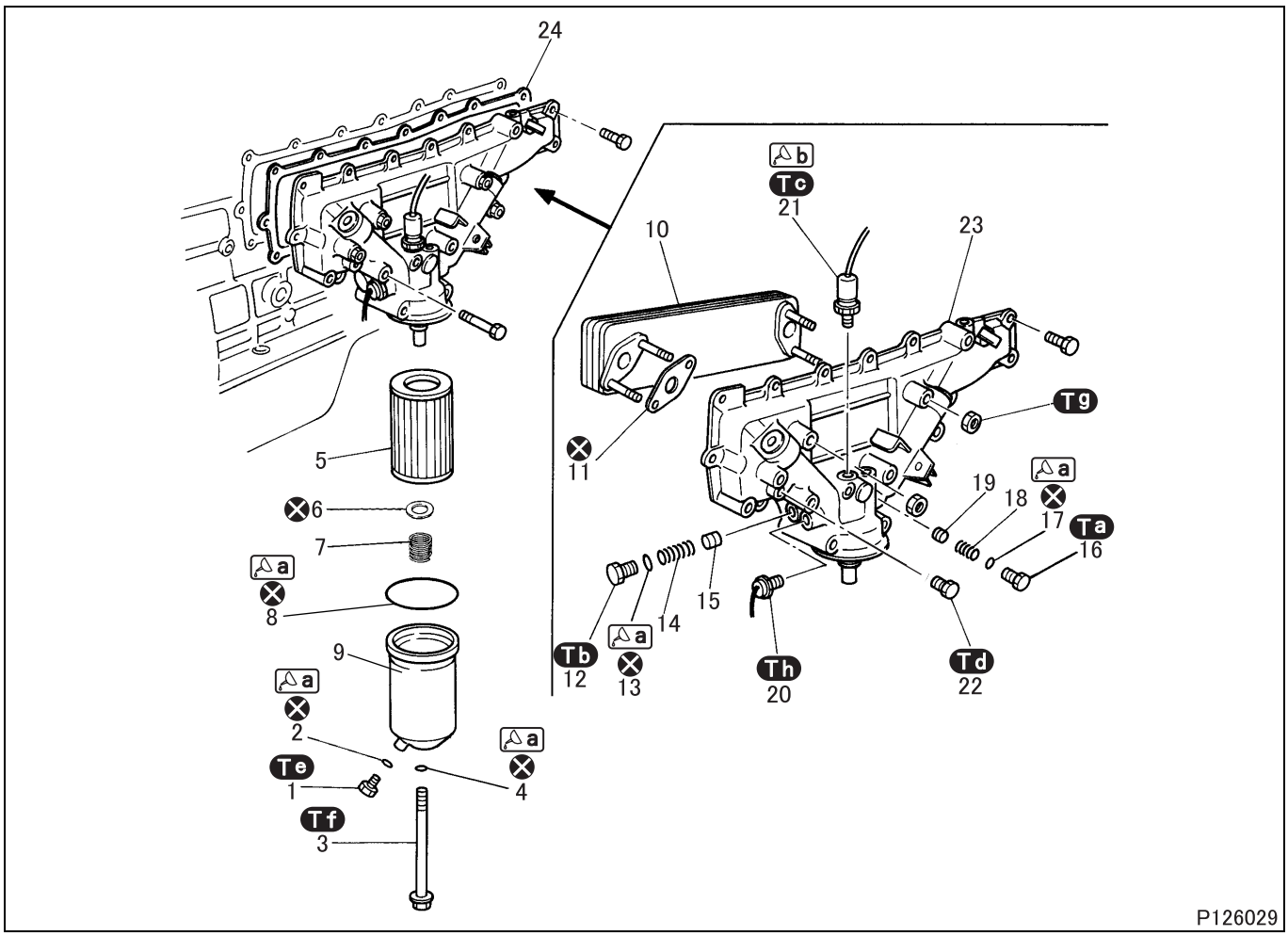


■ Installation: Oil filter

- Clean the oil filter mounting surface of the oil cooler.
- Apply a thin coat of engine oil on the oil filter gasket.
- Screw in the oil filter by hand until the gasket touches the oil cooler. Then, tighten the filter by turning further by three quarters (3/4) of a turn.
- After installing the oil filter, start the engine and check that there are no oil leaks.
- Remove and reinstall the oil filter if it is leaky.
- Stop the engine and check the engine oil level.
- Add engine oil if necessary.

M E M O

OIL COOLER AND OIL FILTER <REPLACEABLE ELEMENT TYPE>



WARNING ⚠

- **Wipe up any spilled engine oil, as it can cause fires.**
- **To avoid any risk of burns, take care not to touch the engine oil when the engine is hot.**

CAUTION ⚠

- **Make sure not to put any engine oil on the V-belt when working on the oil cooler and oil filter. V-belts soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Do not reuse the oil filter elements by washing.**

● **Removal sequence**

1 Drain plug
2 O-ring
3 Center bolt
4 O-ring
5 Oil filter element
6 Washer
7 Spring
8 O-ring
9 Oil filter case
10 Oil cooler element
11 Gasket
12 Plug
13 O-ring
14 Regulator valve spring
15 Regulator valve
16 Plug
17 O-ring
18 Bypass valve spring
19 Bypass valve
20 Oil bypass alarm
21 Engine oil pressure switch
22 Drain plug
23 Oil cooler body
24 Gasket

⊗: Non-reusable parts

● Installation sequence

Follow the removal sequence in reverse.

Service standards

Location	Maintenance item	Standard value	Limit	Remedy
10	Air leakage from oil cooler element (air pressure: 980 kPa {10 kgf/cm^2} for 15 seconds)	0 cm^3 {0 mL}	–	Replace
15	Regulator valve opening pressure	140 ± 20 kPa {1.4 ± 0.2 kgf/cm^2}	–	Replace
19	Bypass valve opening pressure	390 ± 29 kPa {4.0 ± 0.3 kgf/cm^2}	–	Replace
20	Oil bypass alarm (valve opening pressure)	140 ± 20 kPa {1.4 ± 0.2 kgf/cm^2}	–	Replace

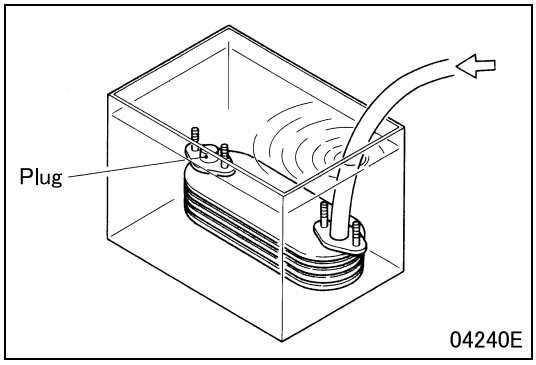
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Plug (bypass valve spring mounting)	19.5 ± 5.0 {2.0 ± 0.5}	–
Tb	Plug (regulator valve spring mounting)	19.5 ± 5.0 {2.0 ± 0.5}	–
Tc	Engine oil pressure switch	7.8 to 15 {0.8 to 1.5}	–
Td	Drain plug (oil cooler)	34 {3.5}	–
Te	Drain plug (oil filter)	17 ± 2.5 {1.75 ± 0.25}	–
Tf	Center bolt (oil filter mounting)	44 ± 5.0 {4.5 ± 0.5}	–
Tg	Nut (oil cooler element mounting)	24.5 ± 5.0 {2.5 ± 0.5}	–
Th	Oil bypass alarm	24.5 ± 4.9 {2.5 ± 0.5}	–

Lubricant and/or sealant

Mark	Points of application	Lubricant and/or sealant	Quantity
a	Oil filter gasket	Engine oil	As required
	O-ring		
b	Engine oil pressure switch threads	Teflon tape	3 1/2 turns

◆Inspection procedure◆



■ Inspection: Oil cooler element

- Plug the outlet of the oil cooler element and connect a hose to the engine oil inlet port. Then, immerse the oil cooler element in a tank of water.
- Apply an air pressure of 980 kPa {10 kgf/cm^2} for 15 seconds through the hose, and check for any air leaks.
- Replace the element if it leaks air.

GROUP 13
FUEL AND ENGINE CONTROL

SPECIFICATIONS 13-2

STRUCTURE AND OPERATION
1. Fuel System (Flow of Fuel) 13-3
2. Engine Control 13-4
3. Fuel Filter 13-5
4. Water Separator 13-6
5. Injection Pump Body 13-8
6. Governor 13-10
7. Feed Pump 13-11
8. Automatic Timer 13-12
9. Injection Nozzle 13-13

TROUBLESHOOTING 13-14

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Inspection and Adjustment of Fuel Injection Timing 13-18
2. Inspecting and Adjusting No-load Minimum and Maximum Speeds 13-21
3. Air-bleeding of Fuel System 13-22
4. Cleaning Gauze Filter 13-23
5. Fuel Filter Replacement 13-24

FUEL TANK 13-26

SPARE FUEL TANK 13-28

FUEL FILTER
<REPLACEABLE ELEMENT TYPE> 13-30
<SPIN-ON TYPE> 13-31

WATER SEPARATOR 13-32

ENGINE CONTROL 13-34

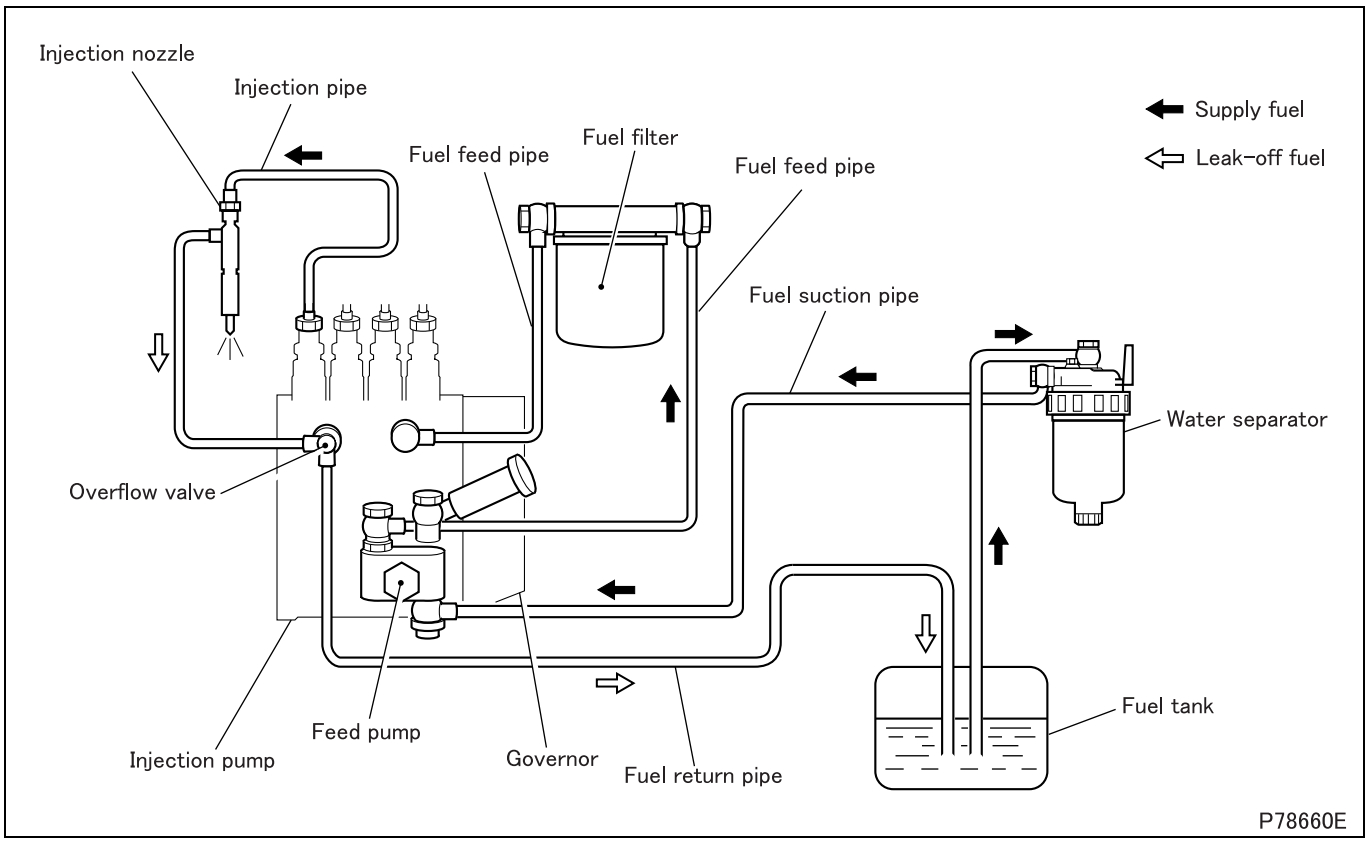
INJECTION PUMP 13-40

INJECTION NOZZLE 13-44

SPECIFICATIONS

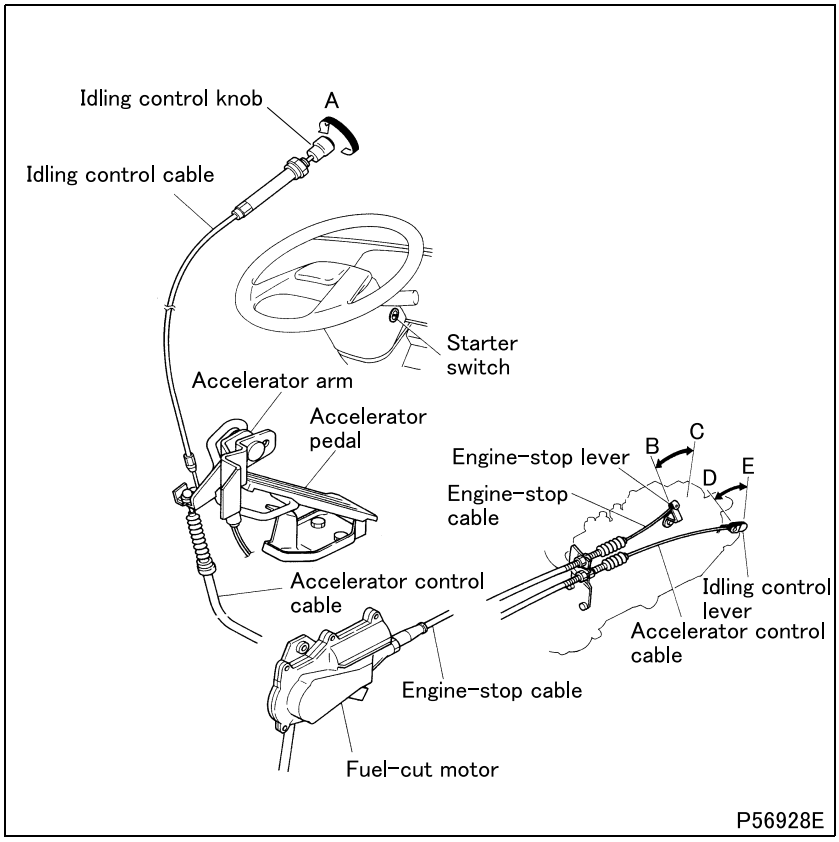
Item			Specifications	
Engine model			4D33	4D34T4
Injection pump	Manufacturer		DENSO	
	Model		NB	
	Governor	Model	R901	
		Type	All speed mechanical governor	
	Timer		Mechanical timer (SBO)	
	Feed pump		KS	
Injection nozzle	Manufacturer		SHANGHAI DENSO	
	Model		Hole type with 2 springs	
	Orifice diameter mm		ϕ0.24	ϕ0.185
Fuel filter	Type		Replaceable element type or spin-on type	Spin-on type

1. Fuel System (Flow of Fuel)



- The feed pump, which is driven by the driveshaft of the injection pump, draws up the fuel from inside the fuel tank and sends it through the fuel filter, where dust and other impurities in the fuel are filtered out.
- The filtered fuel is then sent to the injection pump, where it is pressurized and sprayed out through the injection nozzles into the combustion chamber.
- The leak-off fuel from the injection nozzles returns to the fuel tank through the fuel leak-off hose and fuel return pipe.
- When the internal fuel pressure of the injection pump exceeds the limit, the overflow valve opens to allow part of the fuel to return to the fuel tank.

2. Engine Control



A: Idling revolution rising
B: Engine-stop position
C: Engine start-up position
D: Full-load position
E: Idling position

2.1 Idling control knob

Idling control knob is for making fine adjustment to the idling revolution of the engine. Turning the knob clockwise raises the revolution because it works in the same way as accelerator pedal does when it is pressed down.

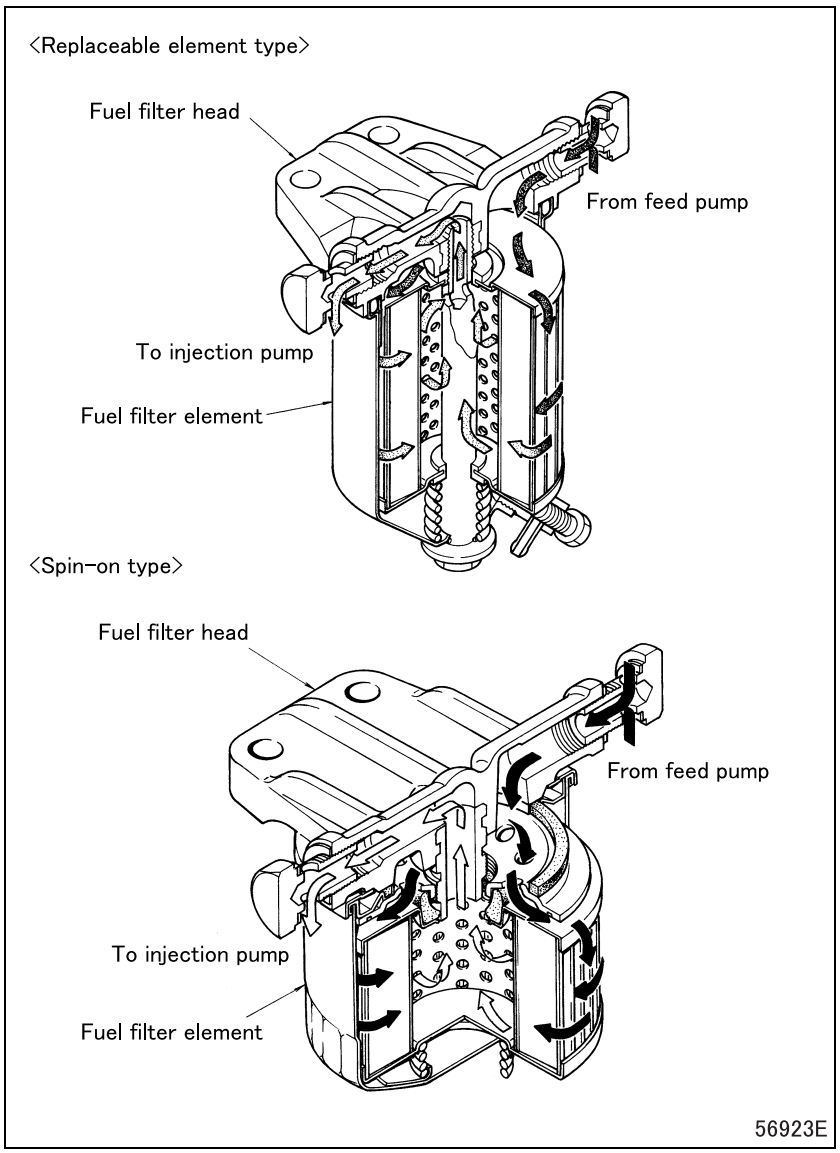
2.2 Fuel-cut motor

Fuel-cut motor is connected to starter switch, and it is activated by the starter switch being turned ON (or to S). This brings engine-stop lever of the governor to engine-stop position (or engine start-up position), and stops (or starts) the engine.

2.3 Accelerator pedal

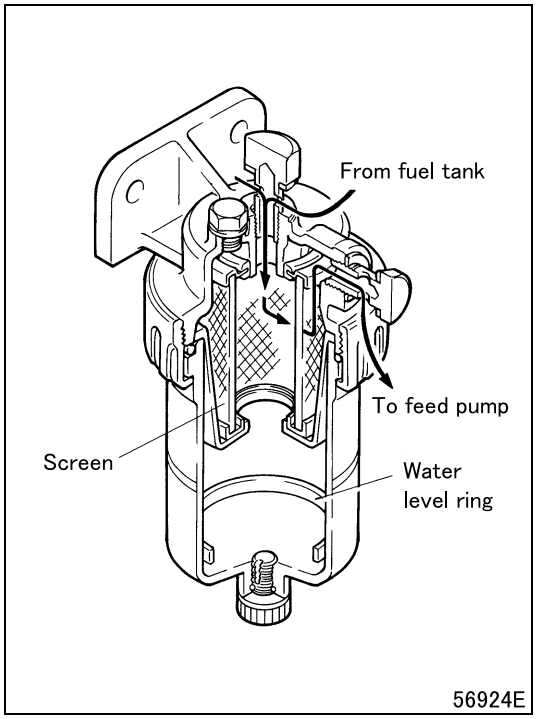
When accelerator pedal is free from foot pressure, the governor return spring forces idling control lever to idling position, restoring the pedal to its original position.

3. Fuel Filter



- Pressurized fuel is delivered from the feed pump of the injection pump to the fuel filter which separates water from the fuel.
- Dirt and other foreign particles are removed from the fuel by fuel filter.

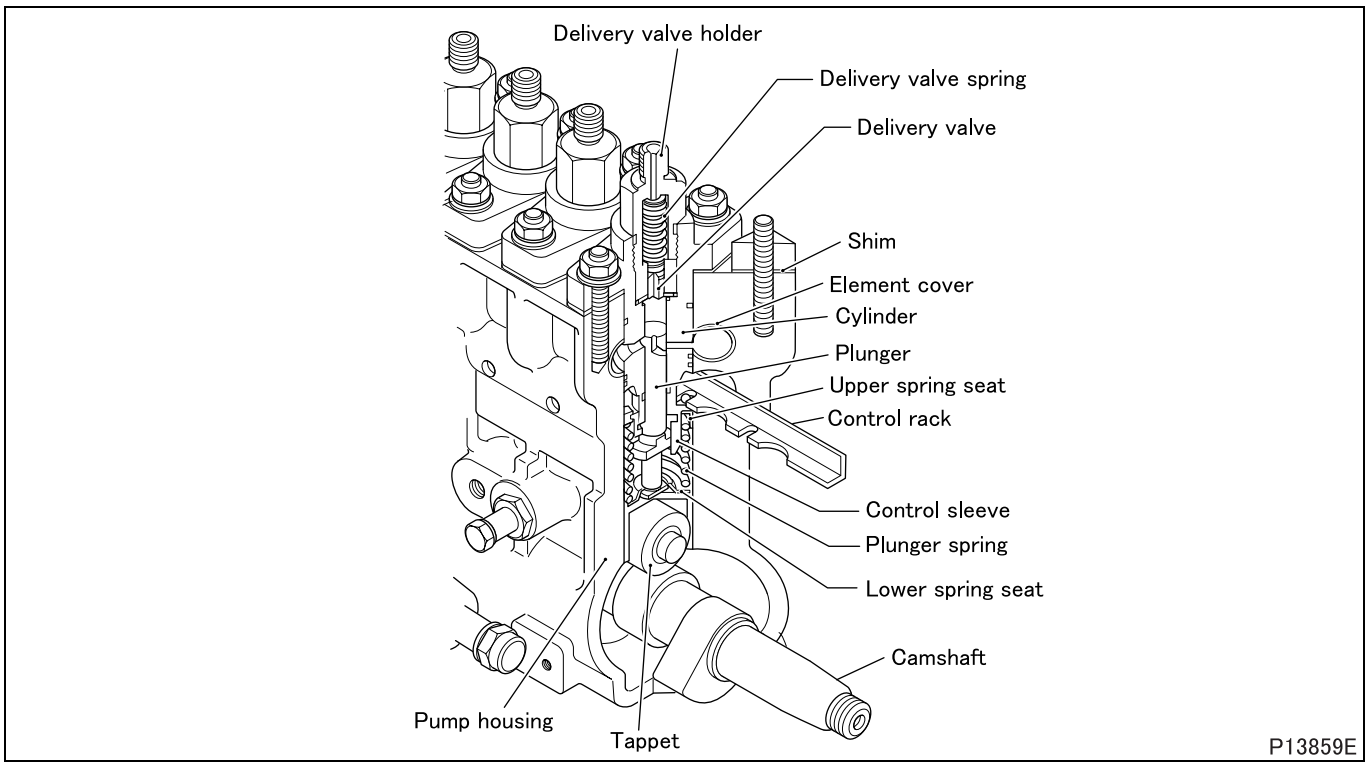
4. Water Separator



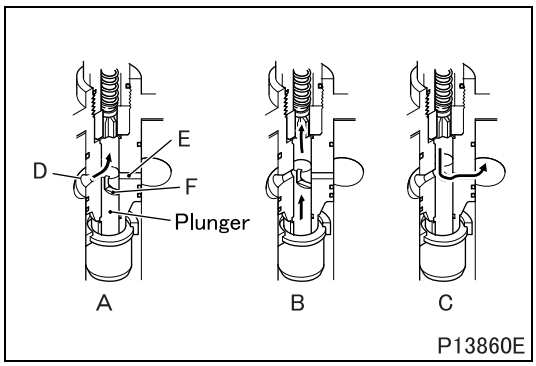
The water separator is installed between the fuel tank and the feed pump. Any water present in the fuel is separated by the baffle plate and the screen assembly.

M E M O

5. Injection Pump Body



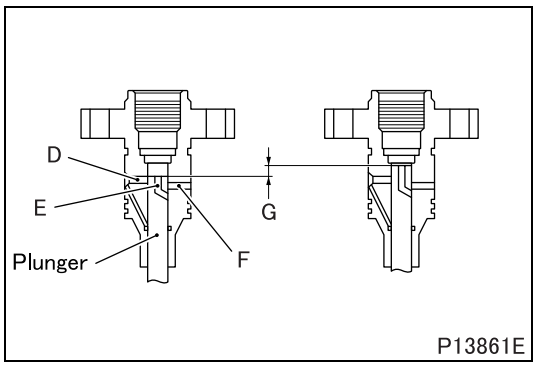
- This injection pump is configured so that the functioning parts can be disassembled and assembled from the top of the pump without removing camshaft.
- The absence of openings on the front and base of pump housing enhances its strength, and that of the bearing. It is suited for high-pressure injection because it is completely sealed.



5.1 Delivery of pressurized fuel

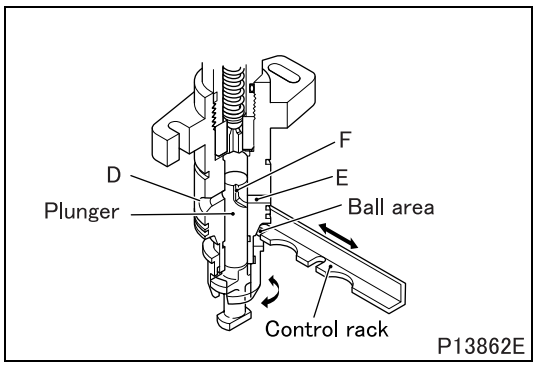
A: Suction
B: Start of pressurized delivery
C: End of pressurized delivery
D: Fuel inlet port
E: Fuel outlet port
F: Lead

- In the upward stroke of plunger, lead meets fuel outlet port, and fuel runs through the vertical slot of the plunger, and is discharged through the fuel outlet port. Pressurized fuel delivery will not occur even if the plunger continues to rise.



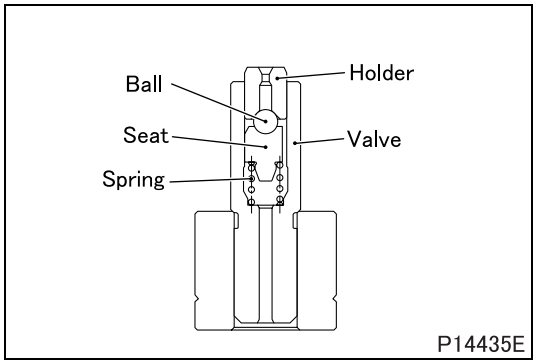
- Stroke of plunger, during which pressurized fuel is delivered, is called the effective stroke.

G: Plunger stroke



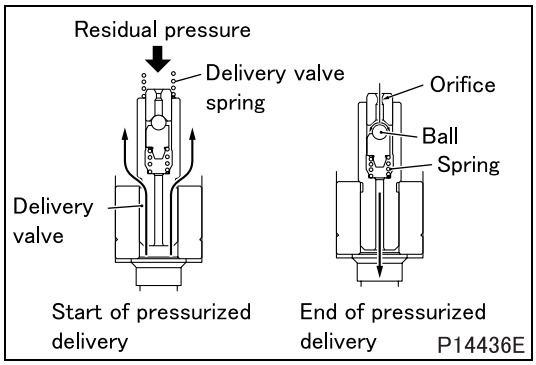
5.2 Fuel injection quantity control mechanism

- The fuel injection quantity can be controlled to cope with the engine load by increasing or decreasing effective stroke. This is accomplished by turning plunger by the required amount, and altering the position at which lead meets fuel inlet port or fuel outlet port during the upward stroke. Ball area at the upper sleeve of each plunger engages the groove of L-shaped control rack.

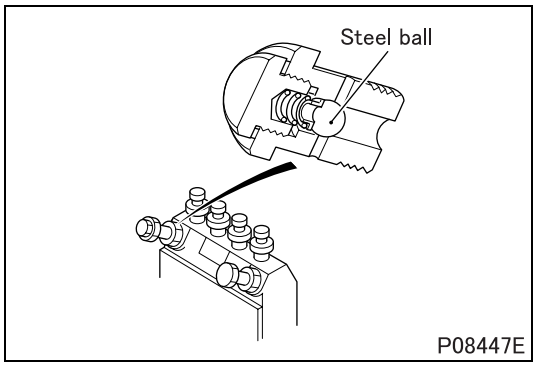


5.3 Delivery valve

- During full revolution, the delivery valve maintains residual pressure in the injection pipe at a fixed level, prevents cavitation, and makes high-pressure injection possible.



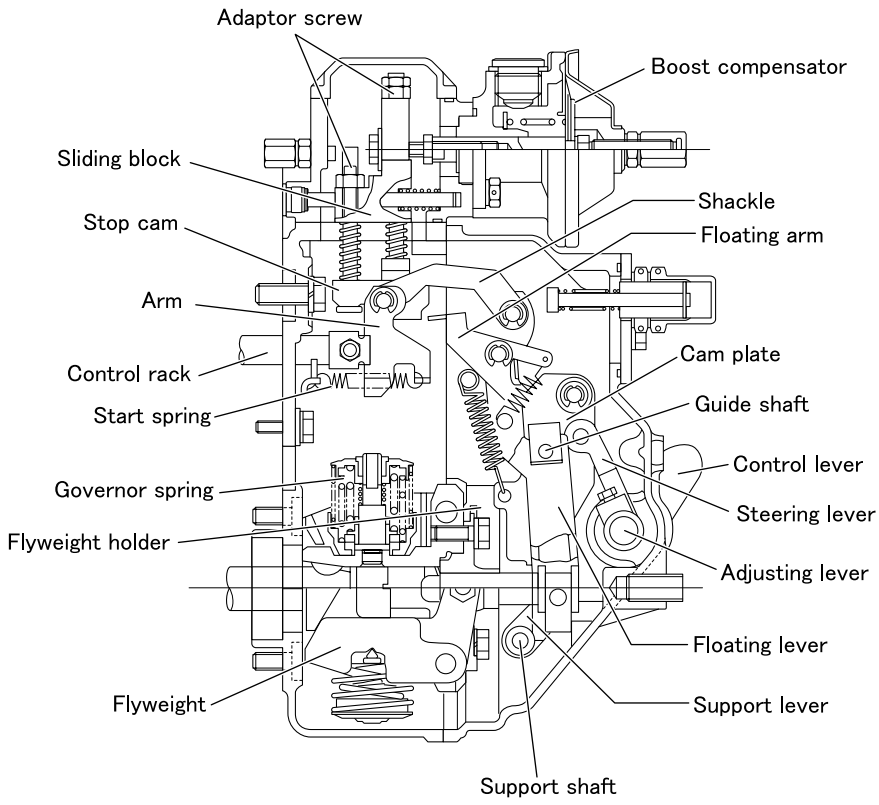
- Start of pressurized delivery
  During the upward stroke of plunger, when the fuel from the plunger overcomes residual pressure in the pipe and the repercussive force of delivery valve spring, delivery valve is pushed upward and the delivery of pressurized fuel starts.
- End of pressurized delivery
  When pressurized delivery from plunger ends, the fuel in the injection pipe is instantaneously returned to the plunger, and delivery valve is closed. Residual fuel is gradually returned through orifice, reducing the pressure in the pipe. When the repercussive force of spring inside the valve matches the pressure inside the pipe, ball closes the orifice, and maintains residual pressure within the pipe at a fixed level.



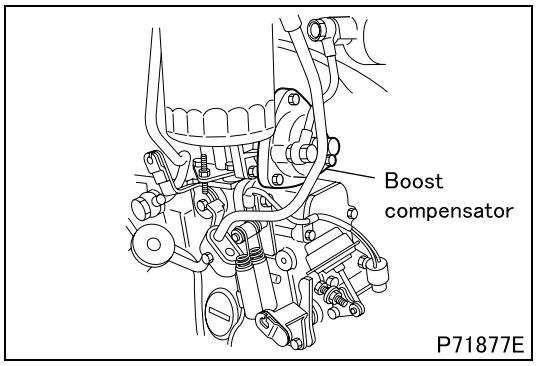
5.4 Overflow valve

- When fuel pressure in the injection pump becomes higher than a certain level, steel ball is pushed up to release fuel from the injection pump into the fuel tank. This stabilizes the fuel temperature, the temperature distribution in the injection pump, and maintains a stable quantity of fuel for injection into the cylinders.

6. Governor



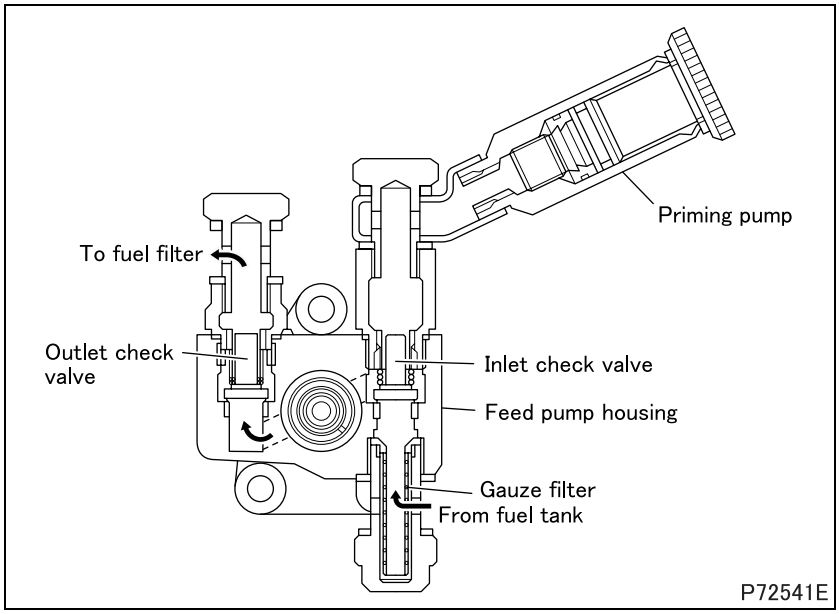
- The governor is a mechanical type that uses centrifugal force generated by flyweights, its characteristics are between those of a minimum/maximum governor and those of an all-speed governor. Since the repercussive force of governor spring does not work directly on control lever when the accelerator pedal is pressed, the repercussive force that is transmitted to the accelerator pedal via the control lever is kept extremely light, making accelerator pedal operation easy.



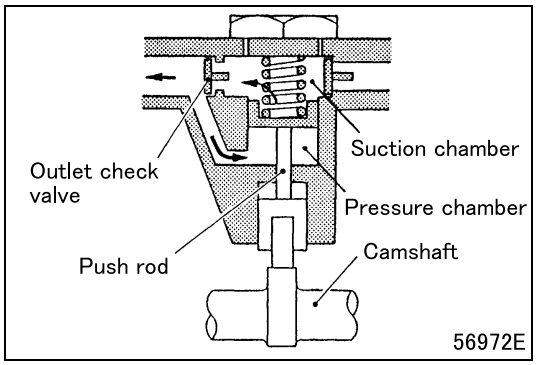
6.1 Boost compensator <4D34>

- Boost compensator is a device that automatically adjusts injection quantity. When, due to turbo operation, the quantity of sucked air delivered to the engine cylinders increases the boost compensator injects the appropriate amount of fuel.

7. Feed Pump

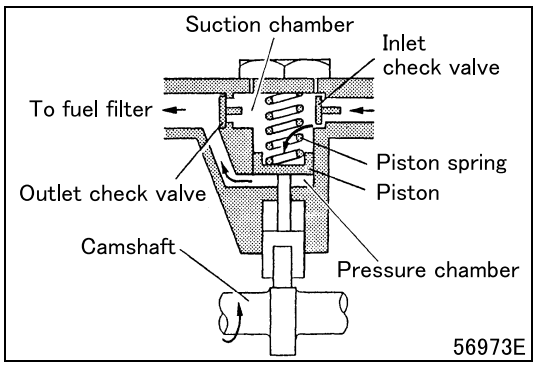


- This feed pump is driven by the camshaft of the injection pump. Priming pump can be manually operated, allowing you to pump fuel when the injection pump is not running, this means it can be used to bleed air from the system.
- Gauze filter removes large particles of dirt and other foreign particles from the fuel pumped from the fuel tank, preventing clogging of the feed pump. The gauze filter must be cleaned with gas oil periodically.



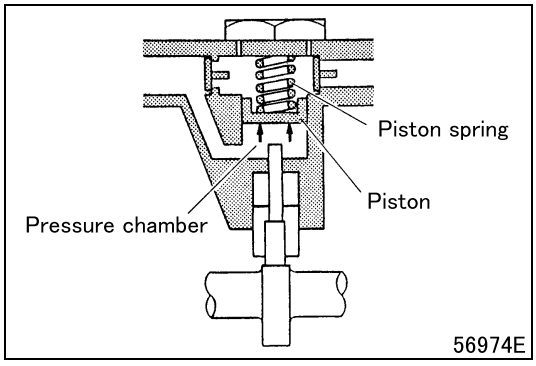
7.1 At suction

- When camshaft of the injection pump pushes up push rod, the fuel inside suction chamber is compressed to open outlet check valve. Most of the fuel pushed out of the chamber is sucked into pressure chamber underneath the piston.



7.2 At delivery of pressurized fuel

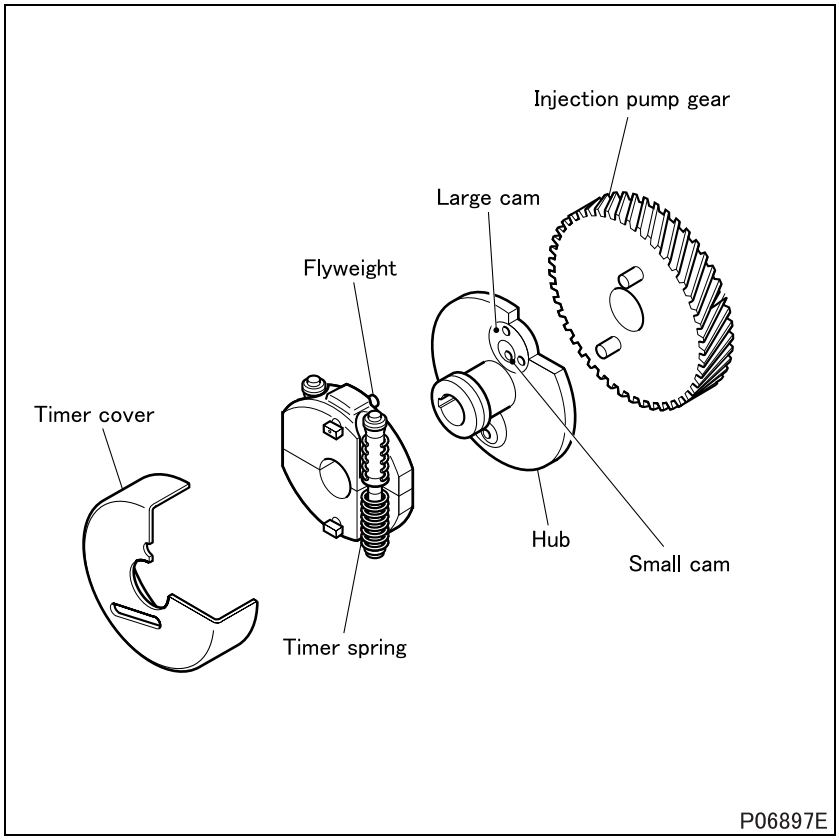
- During the no push-up-cycle of camshaft, piston is pushed back by the repercussive force of piston spring and pushes the fuel in pressure chamber into fuel filter under pressure. Then, outlet check valve closes and inlet check valve opens, sucking fuel into suction chamber.



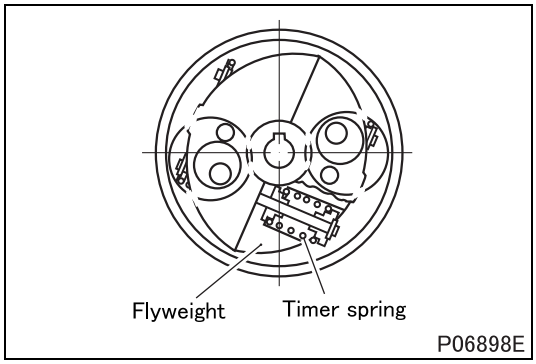
7.3 At engine standstill

- When the pressure in pressure chamber becomes higher than the standard level, piston cannot be returned to its original position by the repercussive force of piston spring, so the pump stops. This controls the fuel pressure inside the fuel filter so that the pressure does not rise above the standard level.

8. Automatic Timer

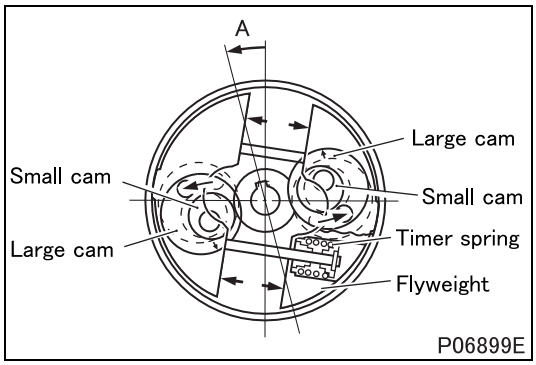


- This is a mechanical automatic timer that automatically changes injection timing in accordance with engine revolution speed. It is mounted on the injection pump camshaft with a round nut, and is driven by the idler gear that engages the injection pump gear.



8.1 At standstill

- Flyweight remains pressed as a result of the installed load of timer spring.

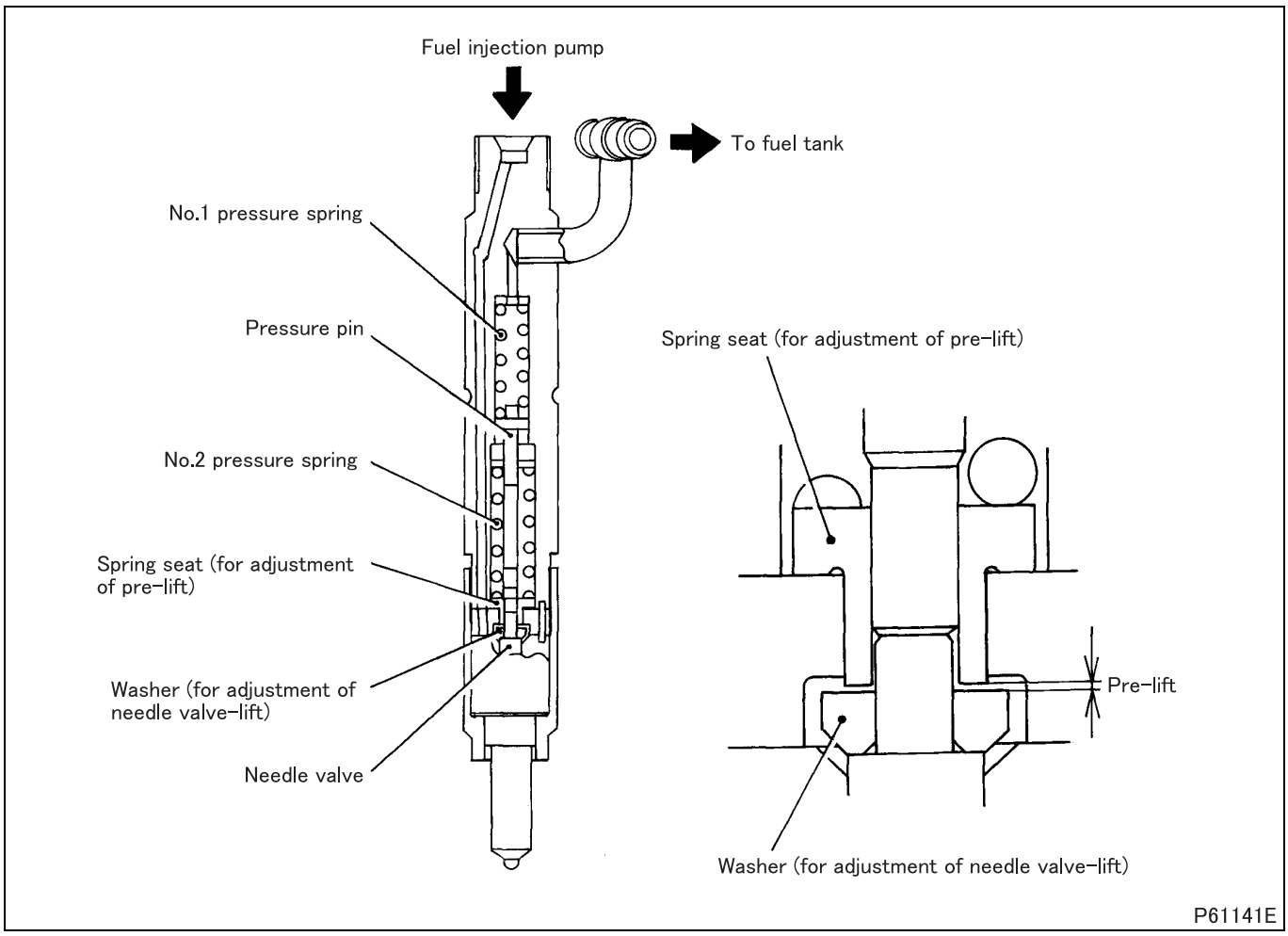


8.2 At operation

- The centrifugal force increases with rising engine revolution, and overcomes the repercussive force of timer spring, enabling flyweight to lift. At this time, small cam and large cam move in the direction of revolution. Since the large cam is installed in a hole in hub, its movement is transmitted to the hub causing advancement.

A: Advancement angle

9. Injection Nozzle



- The nozzle is fitted with a pre-lift (clearance) between washer and spring seat, and the injection opening pressure of the nozzle is determined by the repercussive force of No.1 pressure spring.
- When the pressure of the fuel sent by the injection pump (internal pressure of nozzle) overcomes the force of No.1 pressure spring, the needle valve rises by the amount of the pre-lift. As a result, the force is transmitted in the following order and No.1 pressure spring is lifted.
- When the washer rises by the amount of pre-lift it strikes the spring seat. Then, the repercussive force becomes the combined forces of No.1 pressure spring and No.2 pressure spring, and the rise of the needle valve is momentarily halted.
- When the fuel pressure rises, and the internal nozzle pressure overcomes the combined force of the two springs, the needle valve rises further, resulting in the main fuel spray from the nozzle.
  As a result, the force is transmitted in the following order and No.2 pressure spring is lifted.

Possible causes	Symptoms	Engine does not start	Engine hard to start	Engine knocks	Engine output inconsistent	Engine output does not develop full power	Engine maximum revolution too high	Engine idling unstable	Engine starts but stalls	Engine revolution does not reach specified maximum speed	Engine does not shut off	Accelerator pedal hard to depress	Fuel supply insufficient	Reference Gr
Injection pump body	Plunger stuck	O												
	Control rack stuck	O												
	Delivery valve stuck	O												
	Tappet worn	O												
	Camshaft worn	O												
	Injection timing adjusted incorrectly		O		O	O		O						
	Plunger worn					O		O						
	Delivery valve seated incorrectly					O								
	Injection timing too fast			O										
	Plunger sliding stroke short				O									
	Plunger spring damaged				O			O						
	Control rack not moving smoothly		O		O		O	O						
	Tappet worn, not moving smoothly				O									
	Delivery valve spring damaged				O	O								
	Airtightness incorrect due to delivery valve holder loosened				O	O								
	Delivery valve not moving smoothly				O									
	Control pinion loosened							O						
	Plunger spring setting faulty							O						
	Delivery valve holder tightened excessively							O						
	Injection amount of each cylinder uneven		O					O						
Fuel feed pump	Gauze filter clogged	O						O	O					
	Check valve malfunctioning	O												
	Piston stuck	O												
	Push rod stuck	O												
	Tappet worn	O												
	Check valve not moving smoothly		O		O			O						
	Piston worn		O		O			O						

Possible causes	Symptoms	Engine does not start	Engine hard to start	Engine knocks	Engine output inconsistent	Engine output does not develop full power	Engine maximum revolution too high	Engine idling unstable	Engine starts but stalls	Engine revolution does not reach specified maximum speed	Engine does not shut off	Accelerator pedal hard to depress	Fuel supply insufficient	Reference Gr
Governor	Full-load stopper position short of standard value					O								
	Governor spring weak					O				O				
	Control lever position adjusted incorrectly				O	O				O				
	Flyweight malfunctioning						O							
	Idling spring weak							O						
	Linkage bent							O						
	Linkage friction excessive or linkage too loose							O						
	Round nut loosened							O						
	Idling set bolt adjusted incorrectly							O						
	Control lever not moving smoothly											O		
	Stop mechanism damaged										O			
Automatic timer	Advancement angle faulty					O		O						
Injection nozzle	Needle valve stuck	O												
	Valve opening pressure too low	O								O				
	Injection nozzle clogged	O		O		O		O		O				
	Nozzle airtightness incorrect	O		O		O		O		O				
	Valve opening pressure too high			O										
	Spring broken				O	O								
	Needle valve not moving smoothly				O									
	Valve opening pressure faulty				O									
	Spring fatigued							O						
Fuel filter	Filter clogged	O			O			O	O					
No fuel in fuel tank		O												
Fuel pipe clogged or fuel leaking from connections		O												
Air or water in fuel system		O			O			O	O					
Low-quality fuel being used			O	O		O		O						

Possible causes \ Symptoms		Engine does not start	Engine hard to start	Engine knocks	Engine output inconsistent	Engine output does not develop full power	Engine maximum revolution too high	Engine idling unstable	Engine starts but stalls	Engine revolution does not reach specified maximum speed	Engine does not shut off	Accelerator pedal hard to press	Fuel supply insufficient	Reference Gr
Engine control	Accelerator pedal stopper bolt adjusted incorrectly					O				O				
	Accelerator pedal arm rusted											O		
	Accelerator control cable connection faulty											O		
	Accelerator control cable not operating smoothly											O		
	Engine stop cable damaged										O			
	Engine stop cable adjusted incorrectly										O			
Fuel pipe cracked													O	
Fuel tank airtightness incorrect													O	
Oil viscosity unsuitable			O											Gr12
Valve clearance incorrect			O					O						Gr11
Head gasket faulty			O					O						
Valve and valve seat worn and carbon deposits			O					O						
Valve spring fatigued			O					O						
Piston ring worn or damaged			O					O						
Piston ring groove worn or damaged			O					O						
Piston and cylinder worn			O											
Cooling system malfunctioning			O					O						Gr14
Starter switch faulty			O											Gr54
Multipurpose timing control unit faulty			O											
Fuel-cut motor faulty		O									O			
Engine stop relay faulty		O									O			

M E M O

1. Inspection and Adjustment of Fuel Injection Timing

Service standards (Unit: mm)

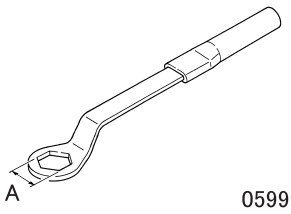
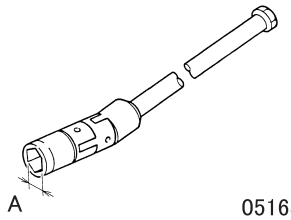
Location	Maintenance item		Standard value	Limit	Remedy
–	Fuel injection timing (BTDC)	4D33	9°	–	Adjust
		4D34	7°	–	Adjust*

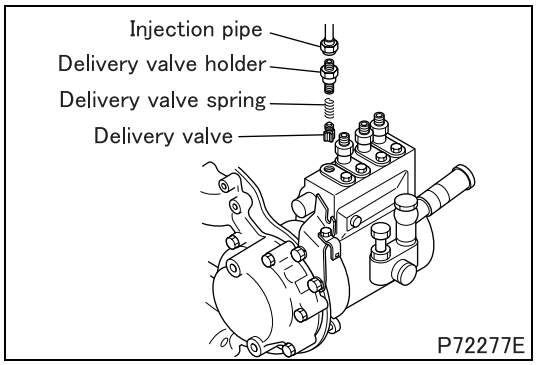
*Have an engine checked and adjusted for the fuel injection timing at the nearest DENSO Service Station, if required.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Injection pipe	25 {2.5}	–
–	Lock plate tightening bolt	7.8 to 11 {0.8 to 1.1}	–
–	Delivery valve holder	44 to 49 {4.5 to 5.0}	–
–	Nut (injection pump mounting)	29 to 39 {3.0 to 4.0}	–

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
Ca	Cranking handle A 36 	MH061289	Cranking of engine
Cb	Universal extension A 14 	MH061099	Inspection and adjustment of fuel injection timing

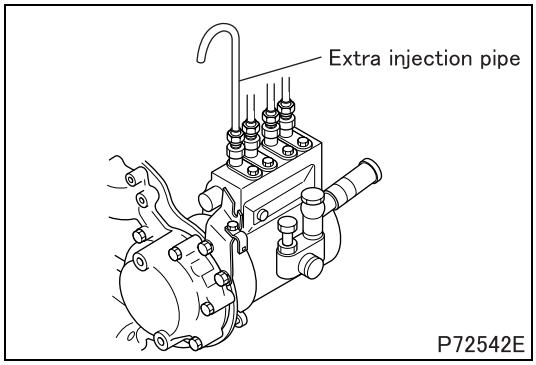


[Work before inspection]

- Remove union nut of the injection pipe, lock plate, delivery valve holder, delivery valve spring and delivery valve from the injection pump of No.1 cylinder.
- After removing these parts, install delivery valve holder.

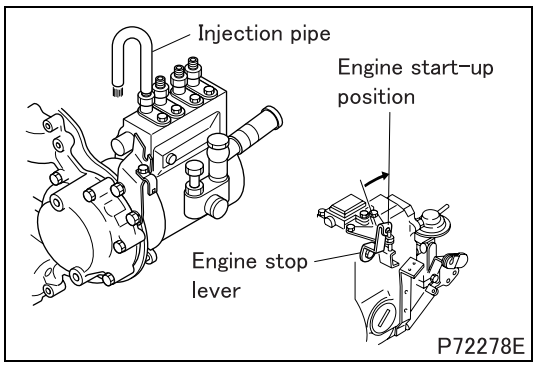
CAUTION ⚠

- **Be sure to keep all the removed parts in gas oil to keep them free from dirt.**



[Inspection]

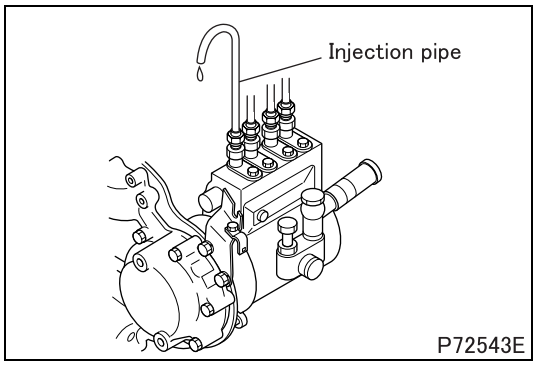
- Mount an extra injection pipe on No.1 cylinder. Direct the free end of the pipe downwards so that fuel discharge can be clearly observed.
- Turn the crankshaft more than 180° in the forward running direction and bring No. 1 cylinder to approximately 30° before top dead center in the compression cycle.



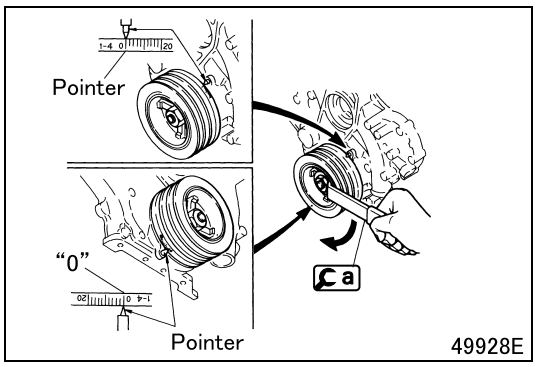
- Turn the engine in the forward running direction slowly while discharging fuel from injection pipe, deliver fuel using priming pump.

NOTE

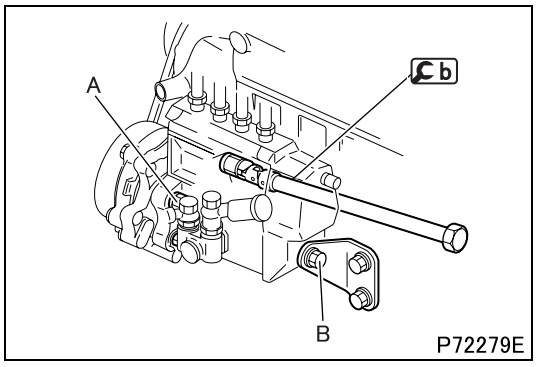
- **Engine stop lever located on top of the governor should be at engine start-up position.**



- When the discharge of fuel from injection pipe becomes intermittent, turn the crankshaft slower, stop turning the crankshaft when the discharge stops completely.



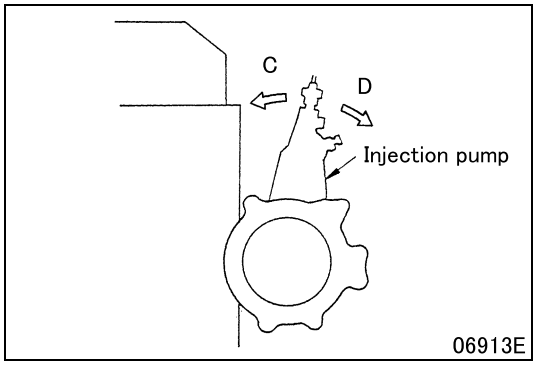
- Make sure that indent on the crankshaft pulley and pointer on the timing gear case show the standard fuel injection timing.



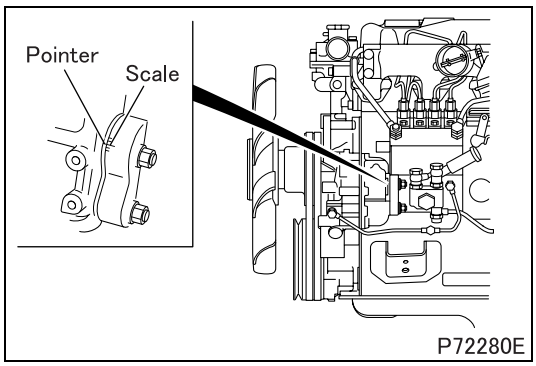
- Adjust fuel injection timing as follows if it does not conform to the standard value.

[Adjustment]

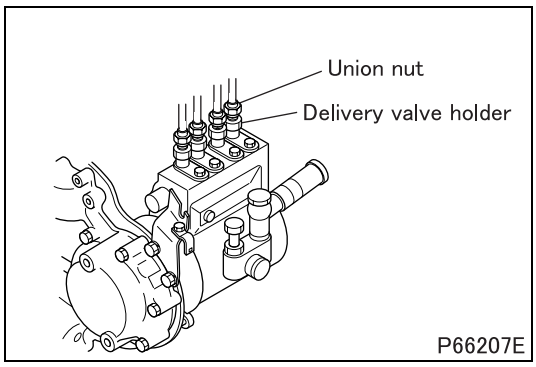
- Loosen injection pump mounting nuts.
  A: 4 points (on flange)
  B: 1 point



- When fuel injection timing is retarded, tilt injection pump towards crankcase side C.
- When fuel injection timing is advanced, tilt injection pump towards D.



- Adjustment of one graduation on indented scale of the timer case flange adjusts fuel injection timing by 7° <4D34>, 9° <4D33>.
- Tighten nuts at specified torque, and remeasure fuel injection timing.



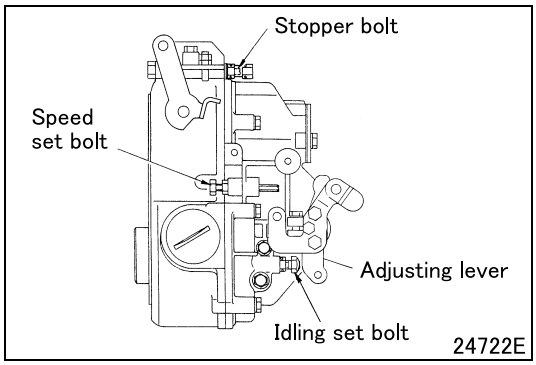
[Work after adjustment]

- After making sure that the fuel injection timing conforms to the standard value, install delivery valve, delivery valve spring and stopper, then tighten delivery valve holder union nut.
- Tighten each part at specified torque.

2. Inspecting and Adjusting No-load Minimum and Maximum Speeds

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
–	No-load minimum speed (idling speed)		650 ± 25 rpm	–	Adjust
–	No-load maximum speed	4D33	3750 ± 50 rpm	–	Adjust
		4D34	3175 ± 25 rpm	–	



[Work before inspection and adjustment]

- Before starting the inspection and adjustment, carry out the following preparatory steps:
- Warm up the engine until the engine coolant temperature is approximately 80 to 95°C;
- turn off all lamps and accessories;
- put the transmission in neutral;
- set the steering wheel at the straight-ahead position.

[Inspection and adjustment]

(1) No-load minimum speed

- Make sure that adjusting lever strikes idling set bolt, and in this state, check and see if the minimum revolution is within the standard value.
- If the minimum revolution deviates from the standard value, adjust using idling set bolt.
- After adjustment increase the revolution from between 2800 rpm to 3400 rpm once, and check the minimum revolution.

(2) No-load maximum speed

- Make sure that adjusting lever strikes full speed set bolt, and in this condition, check and see if the maximum revolution is within the standard value.
- If the maximum revolution deviates from the standard value, adjust using full speed set bolt.

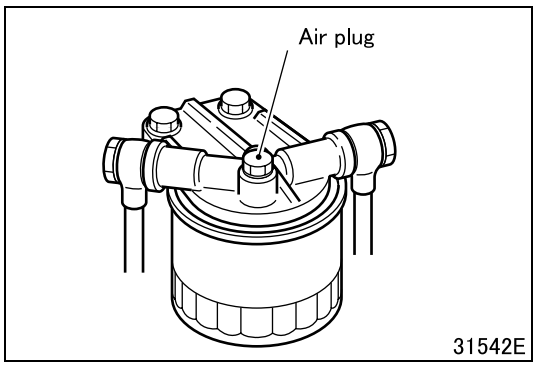
CAUTION ⚠

- **Never change the fixed position of full load stopper bolt.**

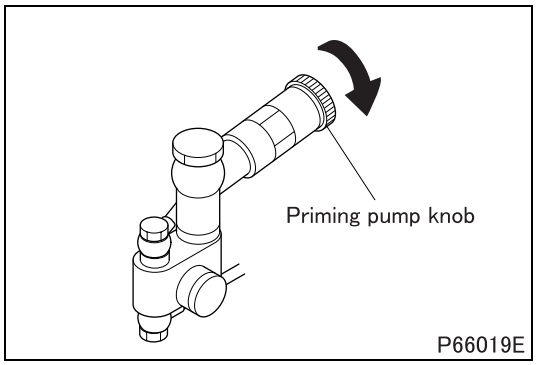
NOTE

- **Ensure that the engine does not stall or hunt when adjusting lever is moved from the full-speed position to the idling position quickly. If performance is faulty, adjust it to within standard values.**

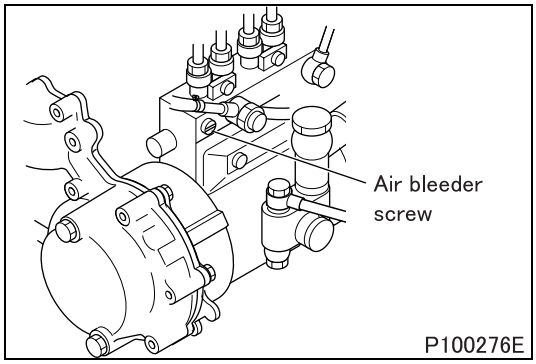
3. Air-bleeding of Fuel System



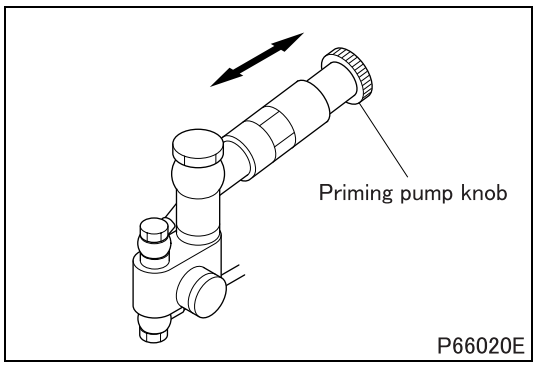
- Loosen the fuel filter air plug.



- Turn the priming pump knob counterclockwise until it pops up.
- Move the priming pump knob up and down to feed fuel through the fuel filter.
- When fuel emerging from the fuel filter air plug no longer contains air bubbles, tighten the air plug securely.



- Then, bleed the fuel injection pump.
- Loosen the air bleeder screw on the pump and move the priming pump knob up and down to feed fuel.
- When fuel emerging from the air bleeder screw no longer contains air bubbles, tighten the air bleeder screw securely.



- Move the priming pump knob up and down five or six more times.
  Then, press the knob down and screw it clockwise to lock it in position.
- Wipe up all spilled fuel, then start the engine.
- Check that no fuel leakage occurs.

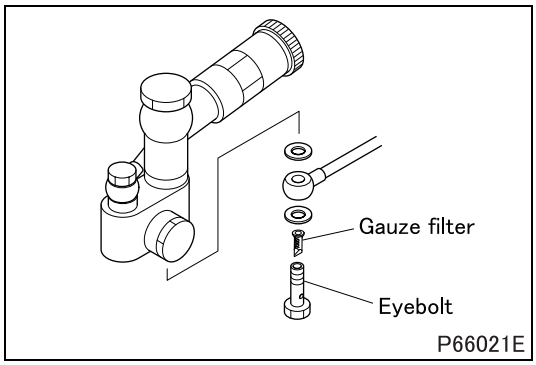
WARNING ⚠

- **Be sure to wipe up all spilled fuel. Unless it is wiped up, it could catch fire.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**

4. Cleaning Gauze Filter

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
–	Eyebolt	15 to 20 {1.5 to 2}	–



- Remove the eyebolt from the suction port side of the fuel feed pump.
- Remove the gauze filter from the eyebolt.
- Clean the gauze filter in diesel fuel.
- Refit the gauze filter and eyebolt in the opposite order to that in which they were removed.
- Bleed all air out of the fuel system.
- Start the engine and check that no fuel leakage occurs.

WARNING ⚠

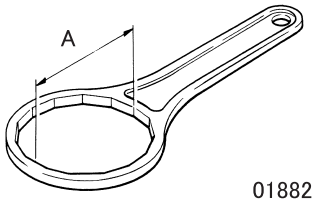
- **To minimize the risk of fire, wipe up any spilled fuel.**
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After refitting the gauze filter, check that no fuel leakage occurs.**

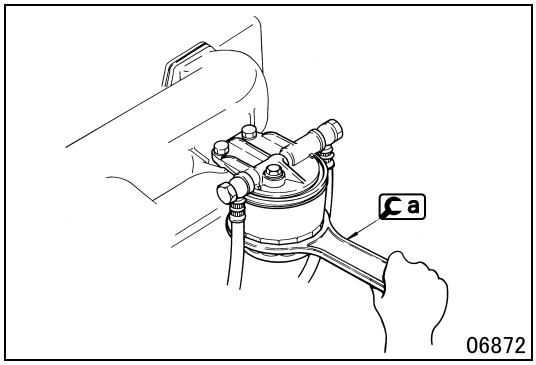
5. Fuel Filter Replacement

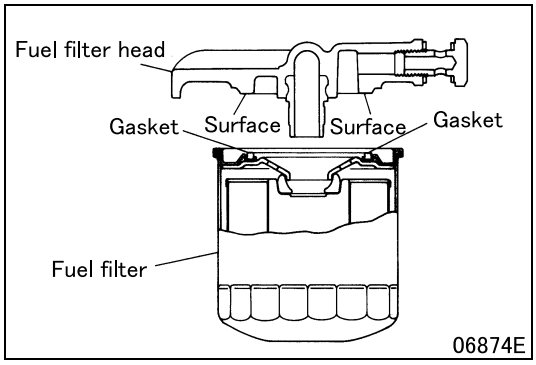
Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
–	Gasket between fuel filter and fuel filter head	Engine oil	As required

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
a	Filter wrench A: 90.2  01882	MH061509	Fuel filter removal





[Removal]

WARNING ⚠

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

[Installation]

WARNING ⚠

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

- To fit the fuel filter, turn it until the gasket touches surface of the fuel filter head. Then, tighten the filter by 1 to 1 1/8 turn. Be sure to turn the filter by hand.
- Bleed all air out of the fuel system. See later sections.

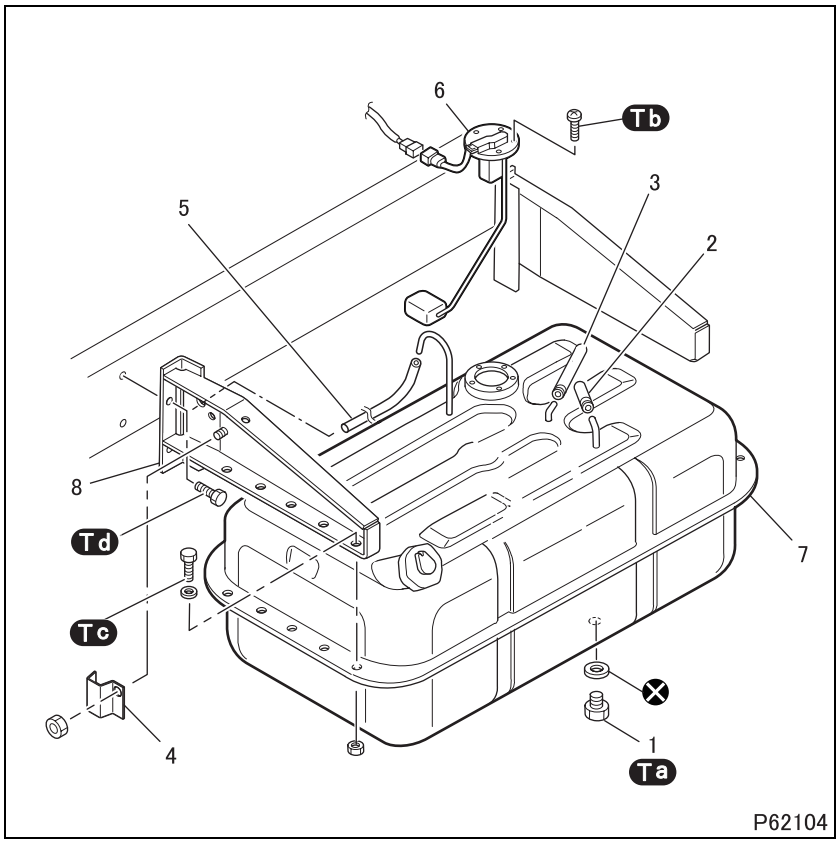
WARNING ⚠

- **After fitting the fuel filter, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.**

M E M O

FUEL TANK

<Two-piece Type>



● **Removal sequence**

1 Drain plug
2 Suction hose
3 Return hose
4 Cover
5 Air vent tube
6 Fuel level sensor
7 Fuel tank
8 Fuel tank bracket

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

DANGER ⚠

- **Do not allow any flames or sources of heat near the fuel tank, as it may explode.**

WARNING ⚠

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

CAUTION ⚠

- **Make sure to install fuel tank bracket to the frame with the specified torque first, then install fuel tank to fuel tank bracket with the specified torque.**

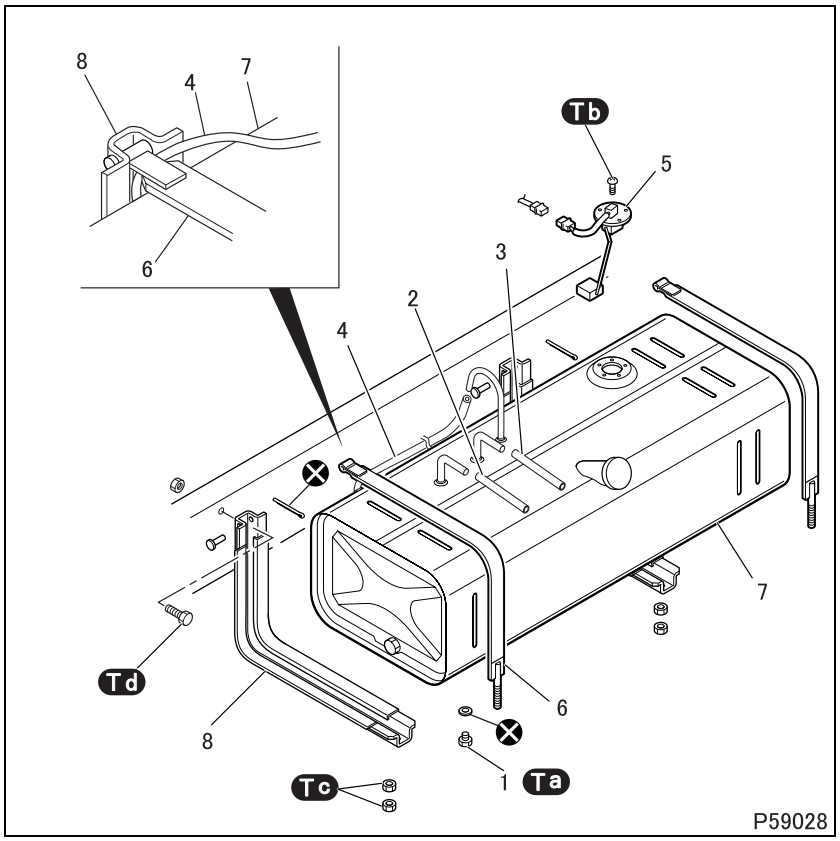
NOTE

- **Insert 35 to 60 mm the air vent tube into the hole of fuel tank bracket on rear side.**

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	15 to 25 {1.5 to 2.5}	–
Tb	Screw (fuel level sensor mounting)	0.98 to 1.47 {0.10 to 0.15}	–
Tc	Bolt (fuel tank mounting)	16 to 24 {1.6 to 2.4}	–
Td	Bolt (fuel tank bracket mounting)	70 to 90 {7.1 to 9.2}	–

<Box Type>



● **Removal sequence**

1 Drain plug
2 Suction hose
3 Return hose
4 Air vent tube
5 Fuel level sensor
6 Fuel tank band
7 Fuel tank
8 Fuel tank bracket

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

DANGER ⚠

- **Do not allow any flames or sources of heat near the fuel tank, as it may explode.**

WARNING ⚠

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

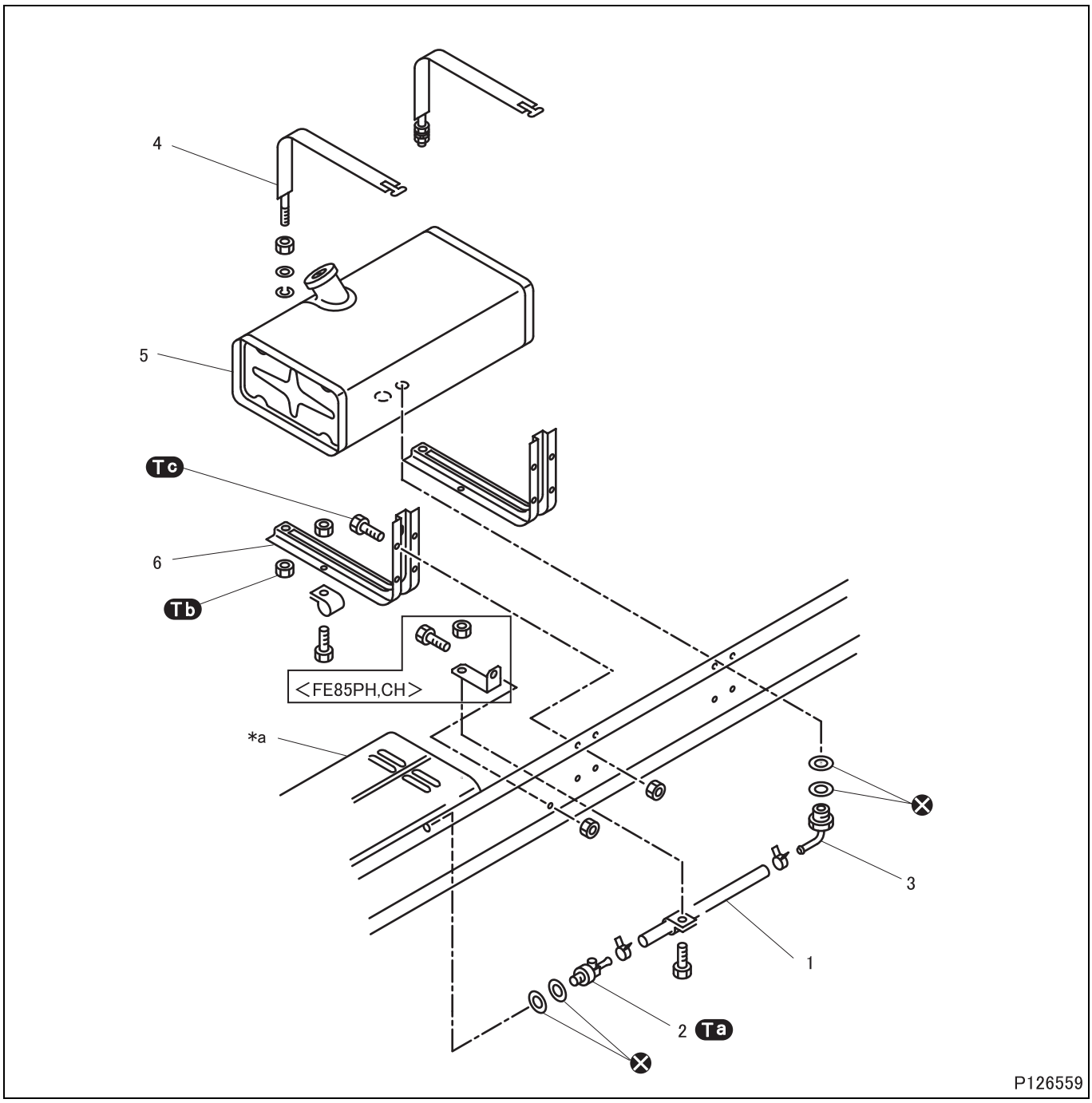
NOTE

Insert the air vent tube into fuel tank bracket as there is no collapse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Drain plug	19.6 ± 4.9 {2.0 ± 0.5}	–
Tb	Screw (fuel level sensor mounting)	0.98 to 1.47 {0.10 to 0.15}	–
Tc	Nut (fuel tank mounting)	3.9 to 7.8 {0.4 to 0.8}	–
Td	Bolt (fuel tank bracket mounting)	70 to 90 {7.1 to 9.2}	–

SPARE FUEL TANK



● **Removal sequence**

1 Fuel hose
2 Fuel cock
3 Connector
4 Fuel tank band
5 Spare fuel tank
6 Fuel tank bracket

***a**: Fuel tank
⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

DANGER ⚠

- **Do not allow any flames or sources of heat near the spare fuel tank, as it may explode.**

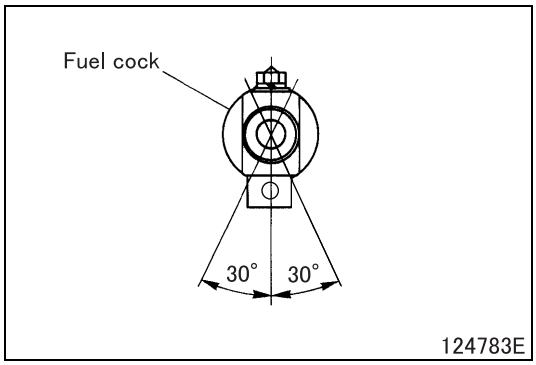
WARNING ⚠

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

Tightening torque (Unit: N·m {kgf·m})

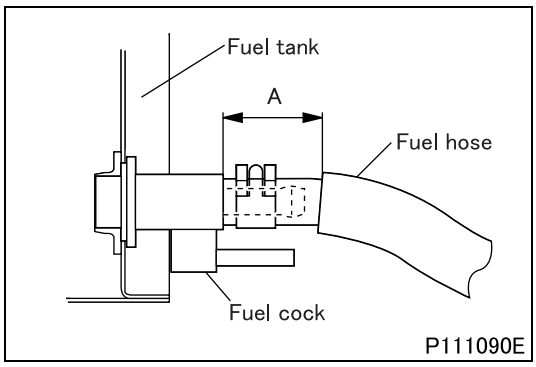
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Fuel cock	15 to 25 {1.5 to 2.5}	–
Tb	Nut (spare fuel tank band mounting)	6.9 to 9.8 {0.7 to 1.0}	–
Tc	Bolt (fuel tank bracket mounting)	70 to 90 {7.1 to 9.2}	–

◆Installation procedure◆



■ Installation: Fuel cock

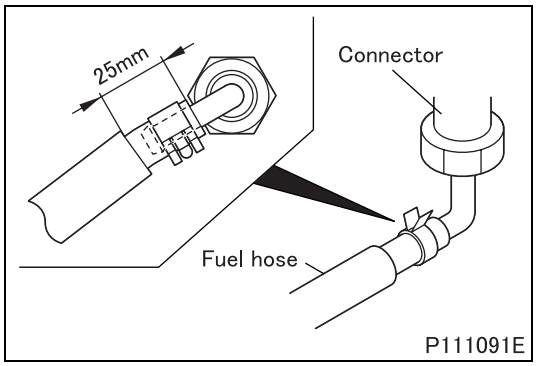
- Install fuel cock so that the cock lever is positioned within the range as illustrated by tightening at specified torque.



■ Installation: Fuel hose

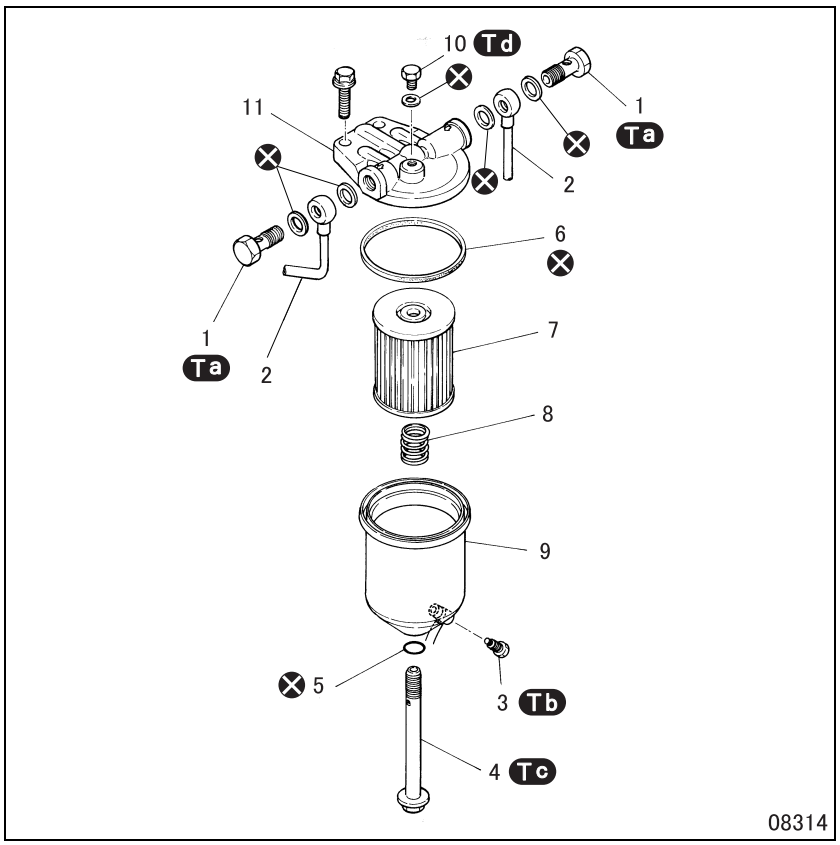
- Install the fuel cock and fuel hose with the dimension shown below.

Model	Dimension A
FE73CE FG83C FE84C FE85CC, CG	30 mm
FE85PH, CH	25 mm



- Install the connector and fuel hose with the dimension shown in the drawing.

FUEL FILTER <REPLACEABLE ELEMENT TYPE>



● **Disassembly sequence**

1 Eyebolt
2 Fuel feed pipe
3 Fuel drain cock
4 Center bolt
5 O-ring
6 Gasket
7 Element
8 Spring
9 Case
10 Air plug
11 Fuel filter head

⊗: Non-reusable parts

● **Assembly sequence**

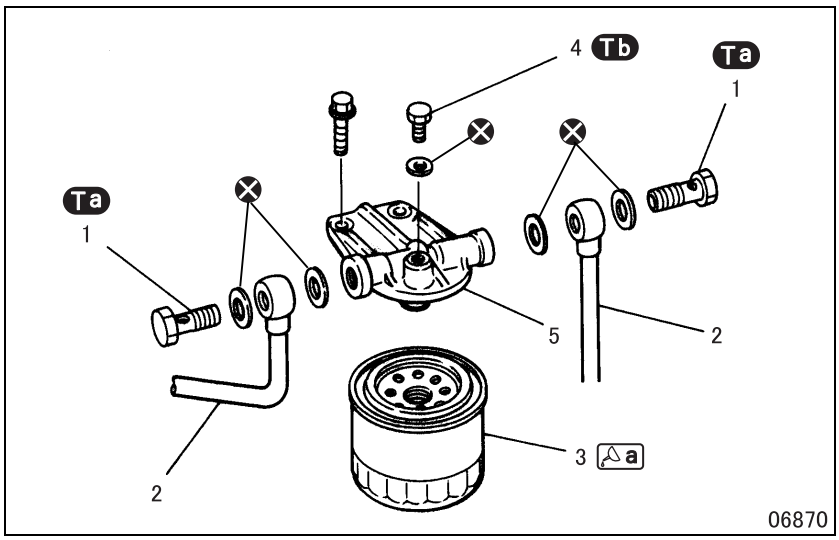
Follow the disassembly sequence in reverse.

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After assembling the water separator, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.**

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eyebolt	25 to 34 {2.5 to 3.5}	–
Tb	Fuel drain cock	9.8 ± 2.0 {1 ± 0.2}	–
Tc	Center bolt	25 ± 4.9 {2.5 ± 0.5}	–
Td	Air plug	9.8 ± 2.0 {1 ± 0.2}	–



● **Disassembly sequence**

1 Eyebolt
2 Fuel feed pipe
3 Fuel filter
4 Air vent plug
5 Fuel filter head

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

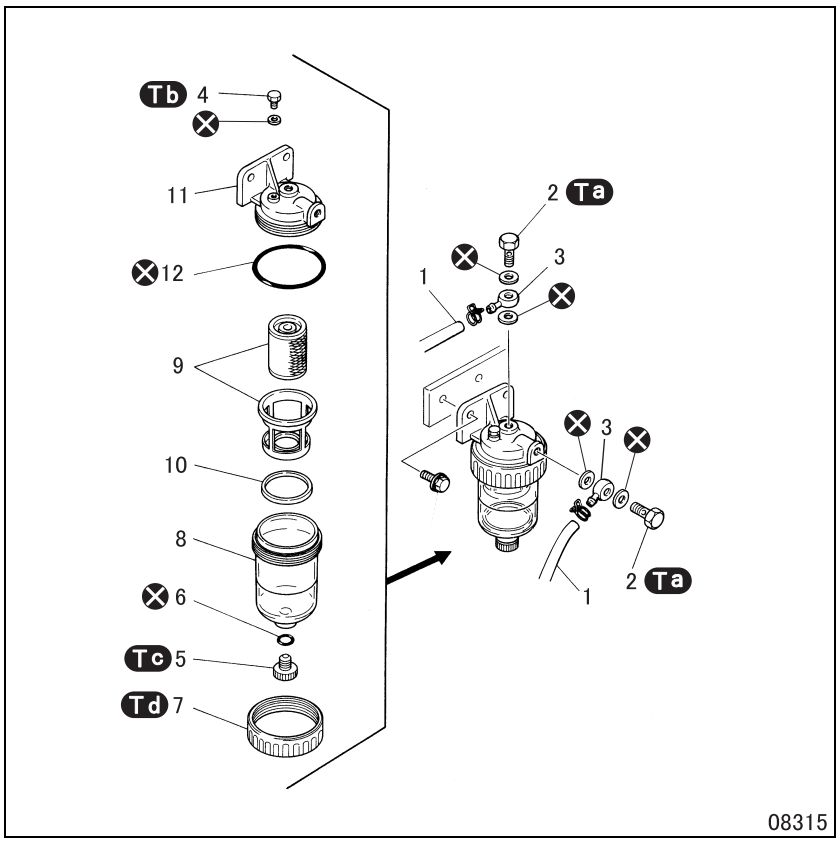
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eyebolt	29.5 {3.0}	–
Tb	Air vent plug	9.8 ± 2.0 {1.0 to 0.2}	–

Lubricant and/or sealant

Location	Points of application	Specified lubricant and/or sealant	Quantity
a	Gasket contact surfaces of fuel filter and fuel filter head	Engine oil	As required

WATER SEPARATOR



● **Disassembly sequence1**

1 Fuel feed hose
2 Eyebolt
3 Connector
4 Air vent plug
5 Drain plug
6 O-ring
7 Ring nut
8 Case
9 Baffle plate and screen
10 Water level ring
11 Head
12 O-ring

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

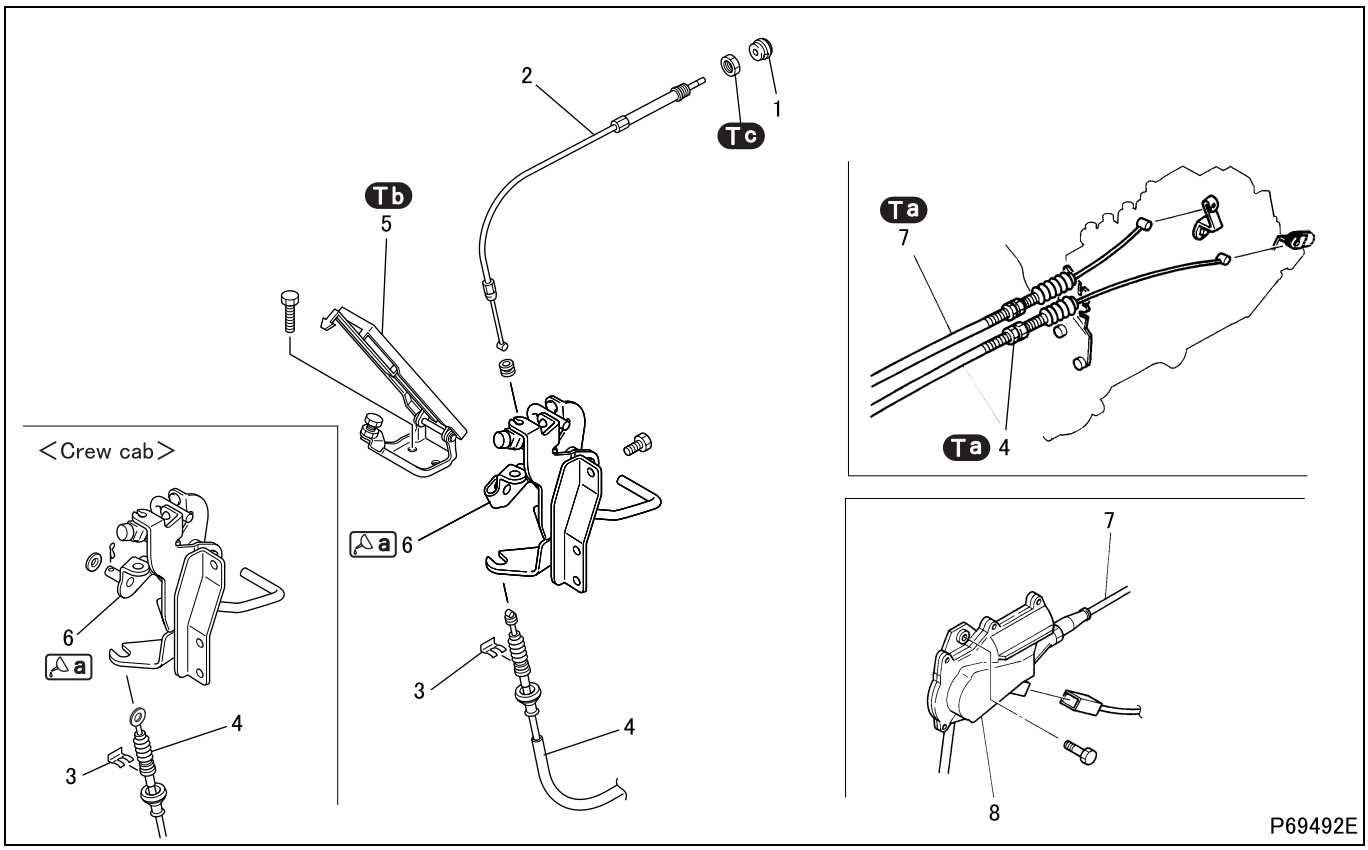
- **Fuel is highly flammable. Keep it away from flames and sources of heat.**
- **After assembling the water separator, start the engine and check that no fuel leakage occurs. Any leaking fuel could cause a fire.**

- Bleed all air out of the fuel system. (See ON-VEHICLE INSPECTION AND ADJUSTMENT.)

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eyebolt	34 {3.5}	–
Tb	Air vent plug	9.8 ± 2 {1 ± 0.2}	–
Tc	Drain plug	3.4 ± 0.5 {0.35 ± 0.05}	–
Td	Ring nut	6.9 ± 1 {0.7± 0.1}	–

M E M O



● **Removal sequence**

1 Knob
2 Idle control cable
3 Clip
4 Accelerator control cable
5 Accelerator pedal (See later section.)
6 Accelerator link (See later section.)
7 Engine stop cable
8 Fuel-cut motor

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **Install the cables taking care that they do not touch the metal edges.**

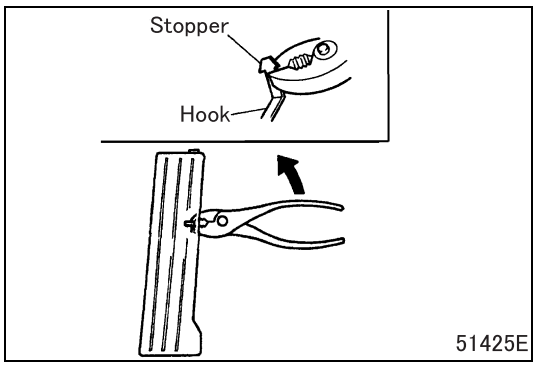
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact surfaces of accelerator control cable and accelerator link	Chassis grease [NLGI No.1 (Li soap)]	As required

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Adjusting nut of accelerator control cable	9.8 to 14.7 {1.0 to 1.5} <M8> 18 to 27 {1.8 to 2.8} <M10>	–
	Adjusting nut of engine stop cable		
Tb	Adjusting nut of stopper bolt	9 to 14 {0.9 to 1.4}	–
Tc	Nut (idle control cable mounting)	2 to 2.5 {0.2 to 0.25}	–

◆Removal procedure◆



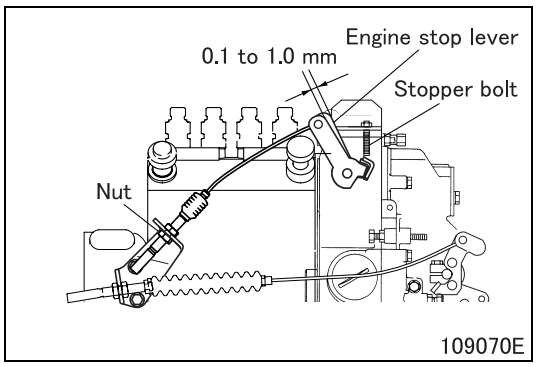
■ **Removal: Accelerator pedal**

- Holding its stopper at the hook with pliers, remove the accelerator pedal while twisting the stopper to approximately 15 degrees.

CAUTION ⚠

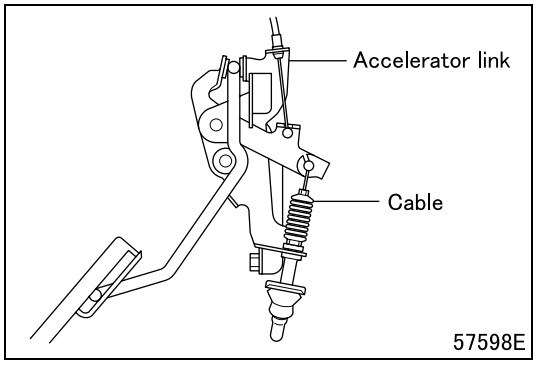
- **Do not pull the stopper too hard. It could be damaged.**

◆Installation procedure◆



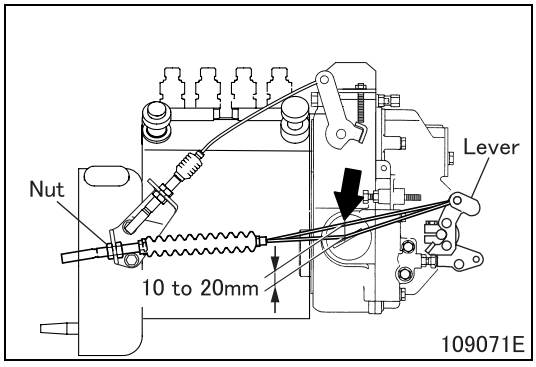
■ **Installation: Engine stop cable**

- With the stop lever pressed against the stopper bolt with the force of 100 to 150 N {10 to 15 kgf}, tighten the engine stop cable without play.
- Adjust the cable tension so that the movement of the stop lever when the lever is released is as shown in the illustration.
- After adjustment, start the engine and confirm that the engine can be stopped by turning the starter switch into the ACC position.

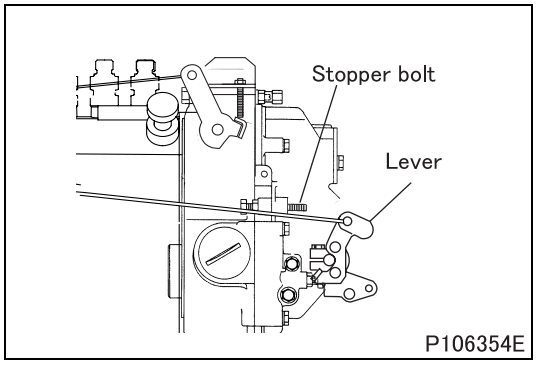


■ **Installation: Accelerator control cable**

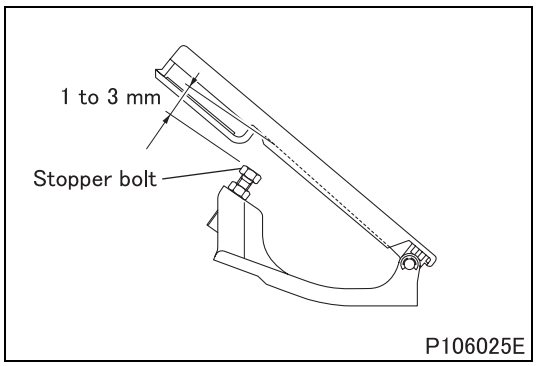
- Connect the accelerator control cable to the accelerator link.



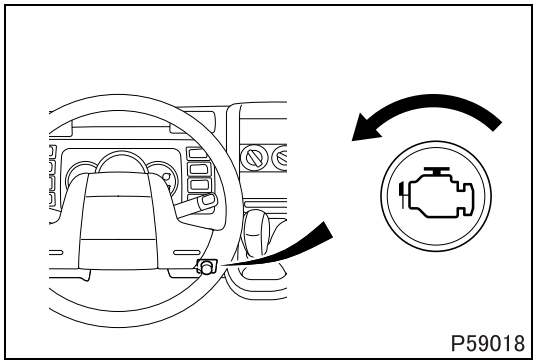
- Without the accelerator pedal depressed, connect the accelerator control cable to the control lever of the injection pump.
- Adjust the tension of the accelerator control cable. The amount of warpage of the cable when the middle of the cable is pressed with the force of 5 to 7 N {0.5 to 0.7 kgf} should be as shown in the illustration.



- Depress the accelerator pedal until the control lever touches the stopper bolt.

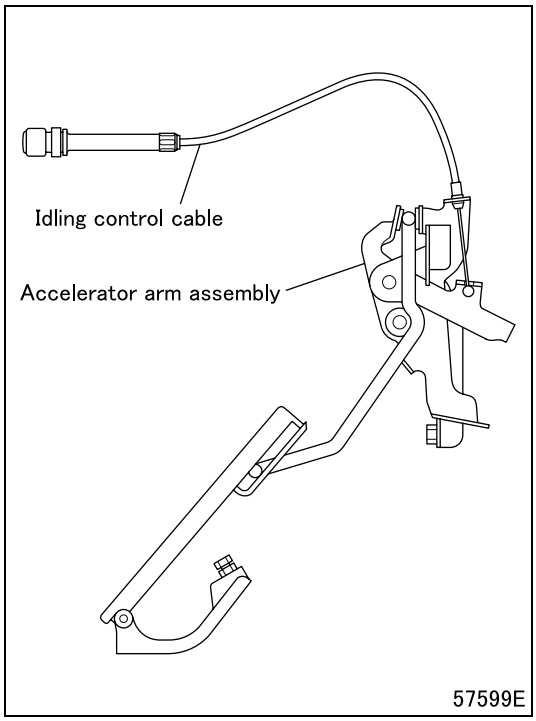


- Adjust the stopper bolt for the specified clearance between the contact surfaces of the accelerator pedal and stopper bolt.



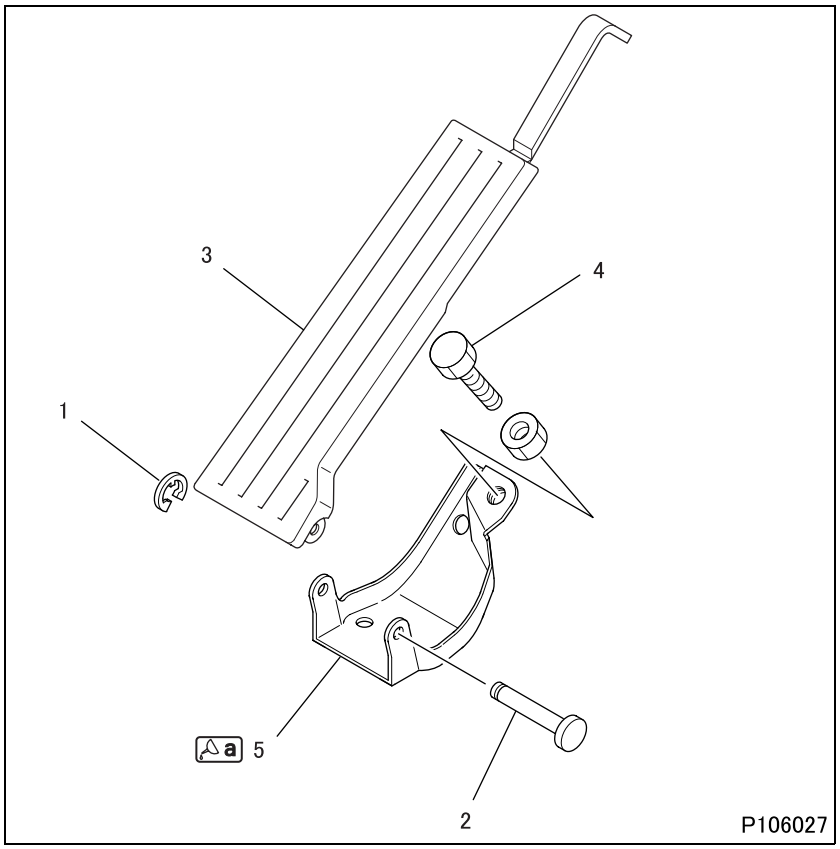
■ **Installation: Idle control cable**

- Turn the knob counterclockwise to a position where the inner cable extends to the full length.



- In this state, connect the idle control cable to the accelerator link.

Accelerator Pedal



● **Disassembly sequence**

1 E-ring
2 Clevis pin
3 Accelerator pedal
4 Stopper bolt
5 Accelerator pedal bracket

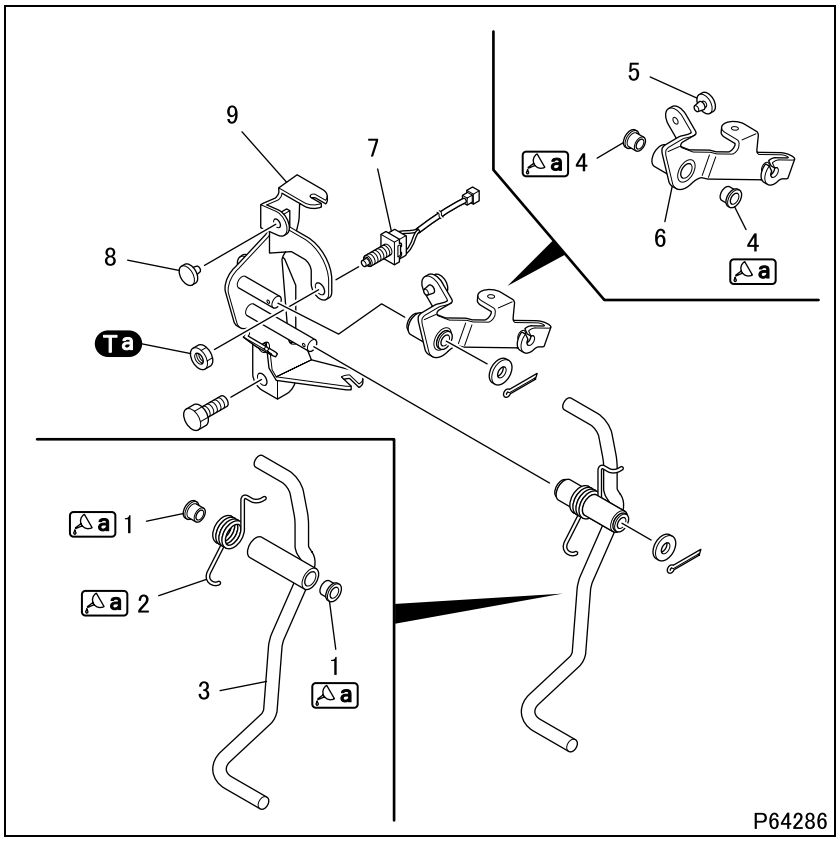
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Contact surfaces of accelerator pedal and bracket	Chassis grease [NLGI No.1 (Li soap)]	As required

Accelerator Link



● **Removal sequence**

1. Bushing
2. Spring
3. Accelerator arm
4. Bushing
5. Rubber stopper
6. Upper lever
7. Accelerator switch (with exhaust brake)
8. Rubber stopper
9. Accelerator link bracket

● **Installation sequence**

Follow the removal sequence in reverse.

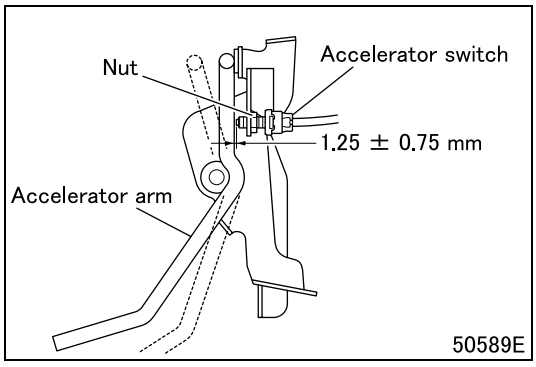
Tightening torque (Unit: N m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (accelerator switch mounting)	9 to 14 {0.9 to 1.4}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Inner surface of bushing	Chassis grease [NLGI No.1 (Li soap)]	As required

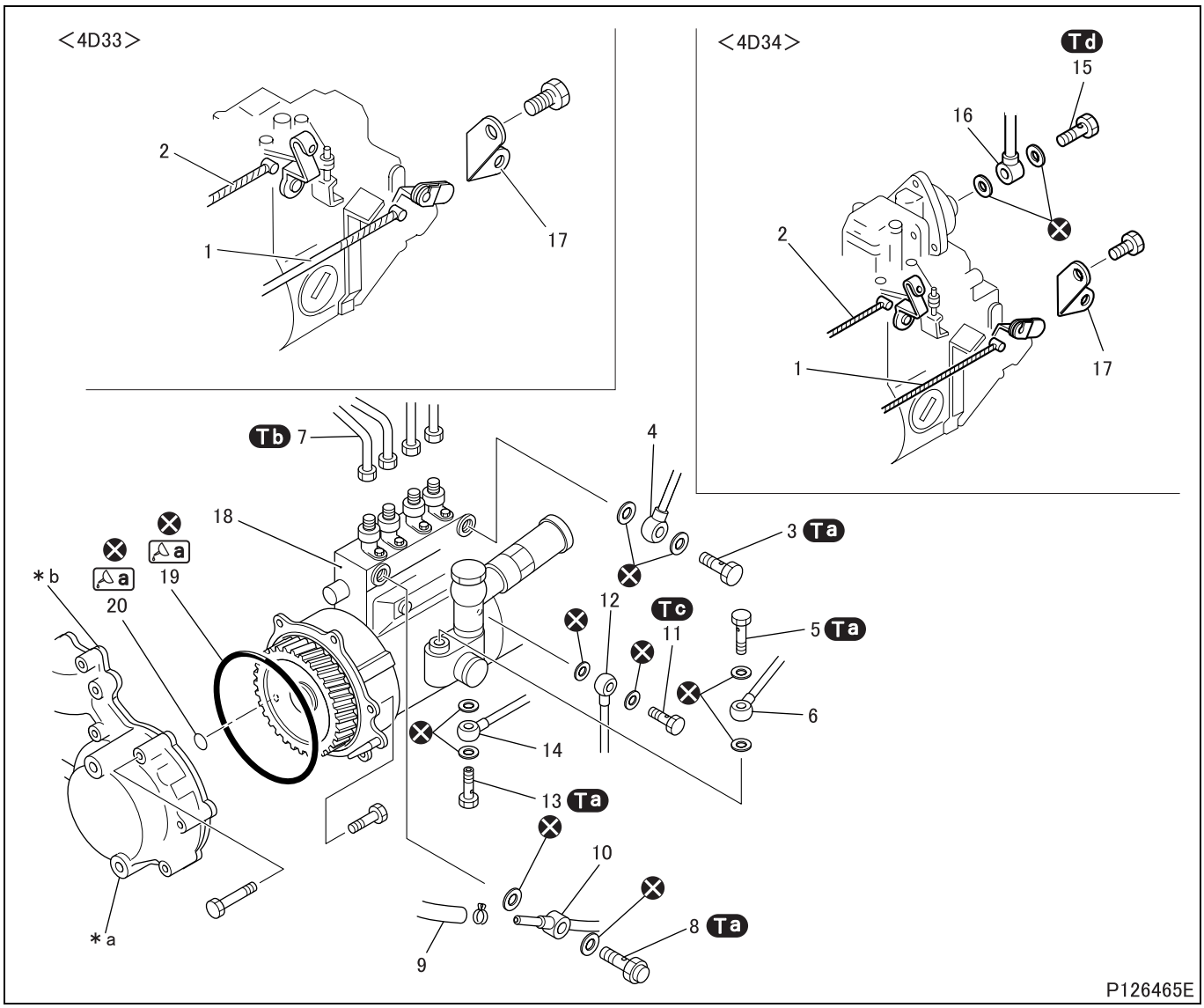
◆Installation procedure◆



■ **Installation: Accelerator switch**

- Screw in and secure the accelerator switch with the nut. Be sure that the clearance between the tip of the threaded part of the switch and the accelerator arm is as shown in the illustration.

M E M O



● **Disassembly sequence**

1 Accelerator control cable
2 Engine stop cable
3 Eyebolt
4 Fuel feed pipe
5 Eyebolt
6 Fuel feed pipe
7 Injection pipe
8 Overflow valve
9 Fuel return hose
10 Fuel return pipe
11 Eyebolt
12 Oil pipe
13 Eyebolt
14 Fuel suction pipe
15 Eyebolt <4D34>
16 Air pipe <4D34>
17 Pump stay
18 Injection pump
19 O-ring
20 O-ring

***a**: Timing gear case
***b**: Front plate
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

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

CAUTION ⚠

- **Be sure to protect all openings by covering them after removal of hoses and pipes because the engine performance is adversely affected if dirt and foreign particles enter injection pump.**
- **Be sure to check that seat surface of injection pipe exhibits no damage or staggers.**
- **Do not hold the control lever when lifting injection pump. Also, do not remove the control lever because removal of the lever might cause poor performance of the pump.**

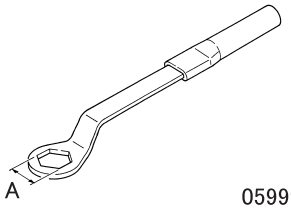
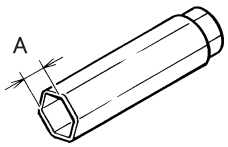
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Eyebolt (fuel feed pipe mounting)	17 {1.75}	–
	Overflow valve		
Tb	Injection pipe	25 {2.5}	–
Tc	Eyebolt (oil pipe mounting)	7.8 to 15 {0.8 to 1.5}	–
Td	Eyebolt (air pipe mounting)	12 to 15 {1.2 to 1.5}	–

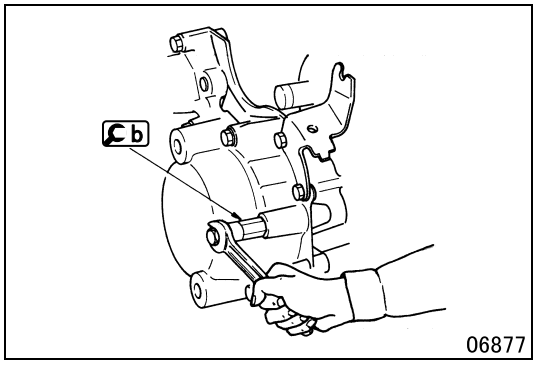
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Entire body of O-ring	Engine oil	As required

Special tools (Unit: mm)

Mark	Tool name and shape	Part No.	Application
a	Cranking handle A: 36  05999	MH061289	Cranking the engine
b	Socket wrench A: 12  06876	31391-14100	Removal and installation of injection pump

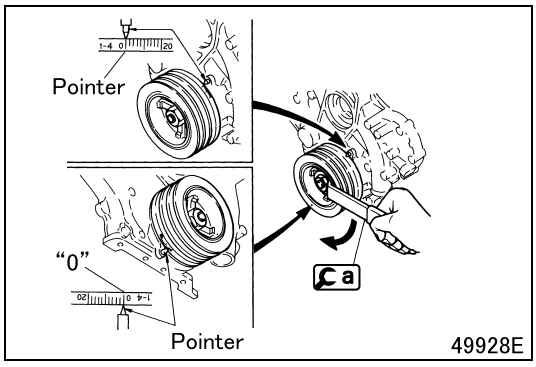
◆Removal procedure◆



06877

■ **Removal: Injection pump**

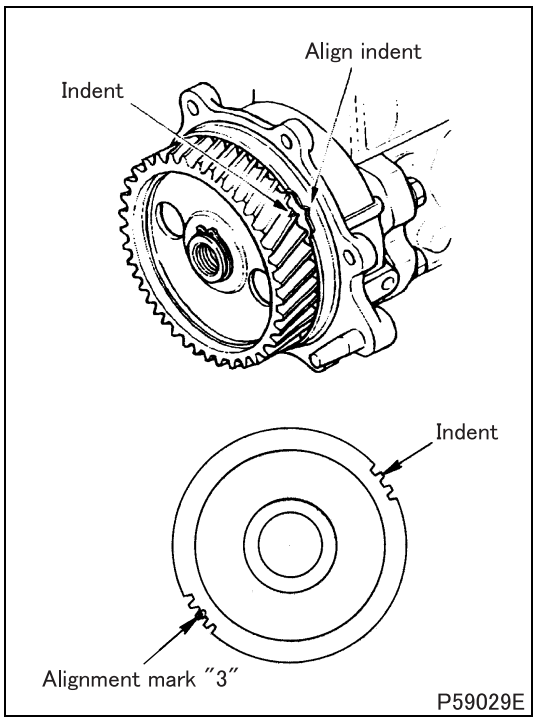
◆Installation procedure◆



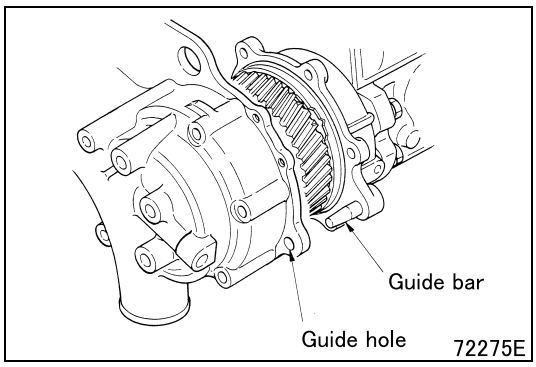
49928E

■ **Installation: Injection pump**

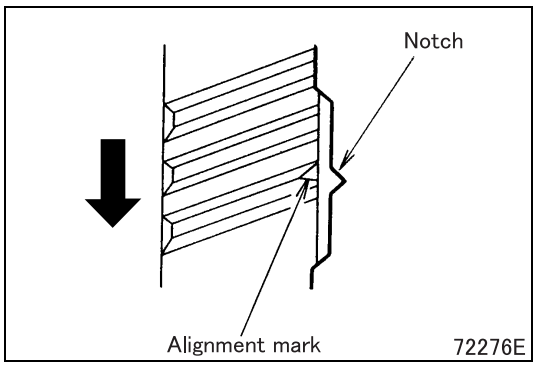
- Remove the rocker cover.
- Position the No. 1 cylinder piston at top dead center (TDC) on compression stroke in the following manner.
- Turn the crank shaft pulley as shown to set "0" on its graduated side marked with "1-4" at the pointer. There are two pointers and either of them may be used.
- Either the No. 1 or No. 4 cylinder piston is now positioned at TDC on compression stroke; if both intake and exhaust rockers can be moved by hand as much as the valve clearance, that is the one that takes the TDC position. Rotating the engine another turn from there makes the No. 1 or No. 4 cylinder piston take the other's TDC position.



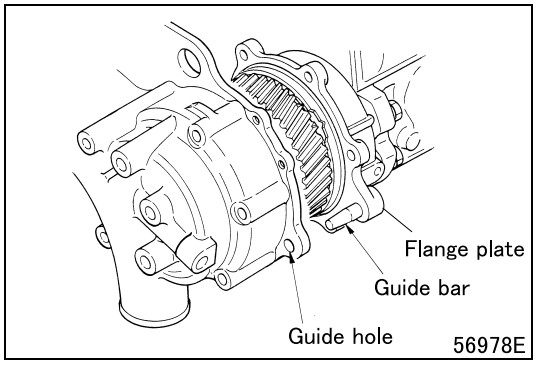
- Align the notch on the flange plate to the alignment mark on the injection pump gear.
- The cut-out area of the gear is almost on the opposite side of alignment mark on gear end face.



- Insert the guide bar of the flange plate into the guide hole in the front plate, then push in the injection pump gear as much as it is just short of engaging with the idler gear.



- Ascertain that the notch in the flange plate meets the alignment mark on the injection pump gear, then push the injection pump into place. The alignment mark on the injection pump gear moves in the arrow direction.

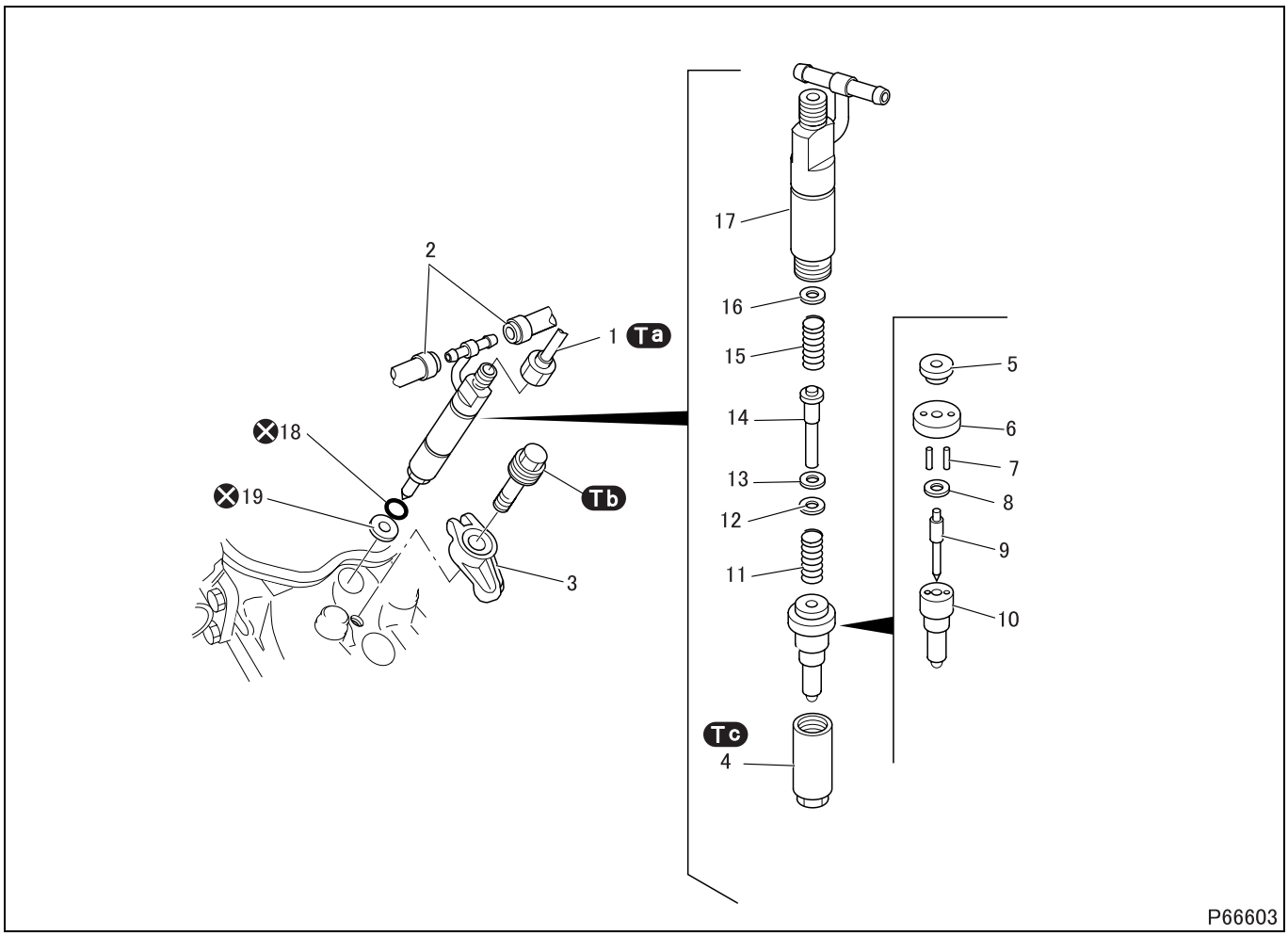


- Pressing the flange plate of the guide bar against the front plate, tighten the bolts.

CAUTION ⚠

- **To ensure the injection pump is installed properly, tighten the bolts with the flange plate pressed firmly against the front plate.**

INJECTION NOZZLE



● **Disassembly sequence**

1 Injection pipe
2 Fuel leak-off pipe
3 Nozzle bridge
4 Retaining nut
5 Spring seat (for pre-lift adjustment)
6 Tip packing
7 Straight pin
8 Washer (for needle valve lift adjustment)
9 Needle valve
10 Nozzle
11 2nd spring
12 Adjusting shim (for adjustment of 2nd valve opening pressure)
13 Spring seat
14 Pressure pin
15 1st spring
16 Adjusting shim (for adjustment of 1st valve opening pressure)
17 Nozzle holder
18 O-ring
19 Nozzle tip gasket

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

WARNING ⚠

- **Fuel is highly flammable. Keep it away from flames and other sources of heat.**
- **Thoroughly wipe up any spilled fuel, otherwise it may catch fire.**

CAUTION ⚠

- **Remove carbon deposits from the injection nozzles before performing disassembly, assembly, and adjustment. Before starting to perform disassembly, check the injection pressure, spray pattern, and absence or presence of fuel leakage. If there is no abnormality, do not perform disassembly.**
- **The needle valve and nozzle of each cylinder's injection nozzle are a set. Do not swap needle valves and nozzles between cylinders.**

Service standards (Unit: mm)

Location	Maintenance item			Standard value	Limit	Remedy
4	Injection pressure	1st valve opening pressure	4D33	16.18 $^{+0.98}_{0}$ MPa {165 $^{+10}_{0}$ kgf/cm^2}	–	Adjust
			4D34	17.7 $^{+0.98}_{0}$ MPa {180 $^{+10}_{0}$ kgf/cm^2}		
		2nd valve opening pressure (cover pressure)		22.06 $^{+0.98}_{0}$ MPa {225 $^{+10}_{0}$ kgf/cm^2}	–	
	Pre-lift			0.08 ± 0.01	–	Adjust
	Full lift (needle valve lift)			0.25 $^{+0.03}_{-0.020}$	–	Adjust

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Union nut (injection pipe)	24.5 {2.5}	–
Tb	Bolt (nozzle bridge installation)	25 {2.6}	–
Tc	Retaining nut	25 to 34 {2.5 to 3.5}	–

Special tools

Mark	Tool name and shape	Part No.	Application
Ca	Nozzle cleaning tool	★105789-0010	Cleaning injection nozzle assembly
Cb	Tool set	✻95093-00040	Disassembly, assembly, and adjustment of injection nozzle
Cc	✻**a** Attachment measure	✻95093-10300	Measurement of pre-lift
Cd	✻**a** Base	✻95093-10230	Assembly of injection nozzle
Ce	Master spring seat	✻95093-10330	Adjustment of 2nd valve opening pressure

★: Bosch part numbers
✻: Denso part numbers
✻**a**: Components of tool set 95093-00040

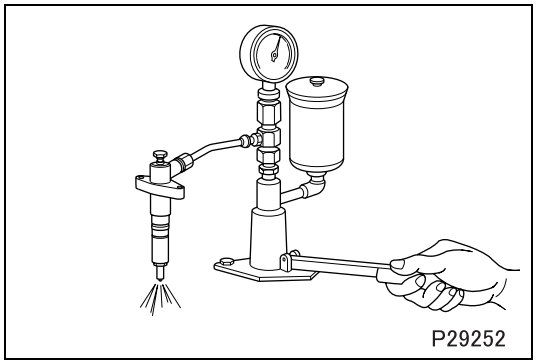
◆Inspection before removal◆

■ Inspection: Injection nozzle

- Fit the injection nozzle assembly onto the nozzle tester to be ready for inspection.

NOTE

- **Before starting inspection, operate the lever of the nozzle tester two or three times to bleed all air out from the nozzle.**

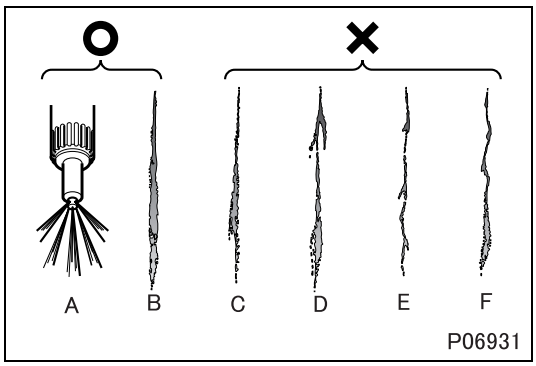


(1) Checking valve opening pressure

- Push down the lever of the nozzle tester at a speed of approximately 1 to 2 seconds per stroke. The pressure gauge indication will gradually rise, then the needle will suddenly deflect. Read the gauge when the sudden deflection starts.
- If the gauge reading deviates from the standard value, disassemble and clean the nozzle then adjust the valve opening pressure by changing the adjusting shim.
- If the gauge reading still deviates from the standard value after adjustment, replace the injection nozzle.

WARNING ⚠

- **Never touch the spray that comes out of the nozzle.**



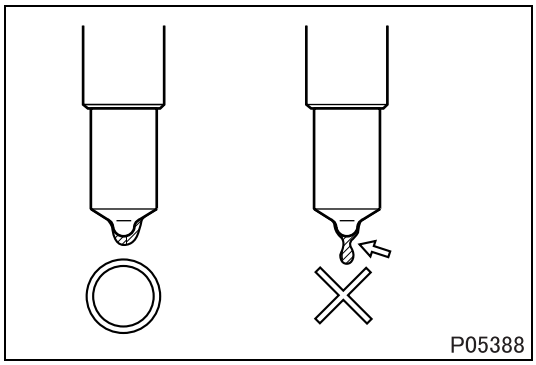
(2) Checking spray pattern

- Pump the lever of the nozzle tester at a rate of 1 to 2 seconds per stroke and maintain a continuous spray.
  - A: Even spray from all five injection orifices <Good>
  - B: Even and symmetrical spray <Good>
  - C: Asymmetrical spray <No good>
  - D: Branched spray <No good>
  - E: Thin spray <No good>
  - F: Irregular spray <No good>

WARNING ⚠

- **Never touch the spray that comes out of the nozzle.**

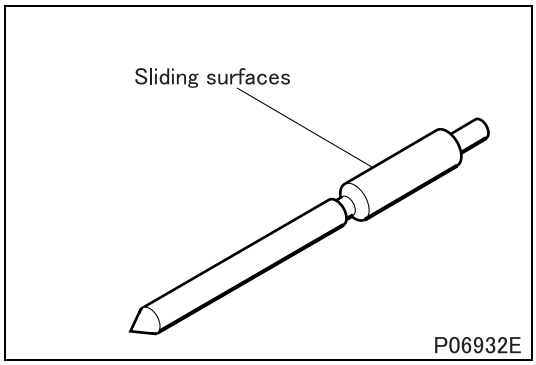
- Check that the nozzle does not dribble after injection.
- If any abnormality is evident, disassemble and clean the injection nozzle then perform another inspection.
- If the injection nozzle still appears defective after disassembly and cleaning, replace the injection nozzle.



(3) Oil tightness and oil leakage

- Keep the nozzle pressure at a level 1960 kPa {20 kgf/cm^2} lower than the specified 1st valve opening pressure. Check that no drops of fuel emerge from the end of the nozzle within a period of 10 seconds.
  - If any abnormality is evident, disassemble and clean the injection nozzle then perform another inspection.
  - If the injection nozzle still appears defective after disassembly and cleaning, replace the injection nozzle.

◆Removal procedure◆

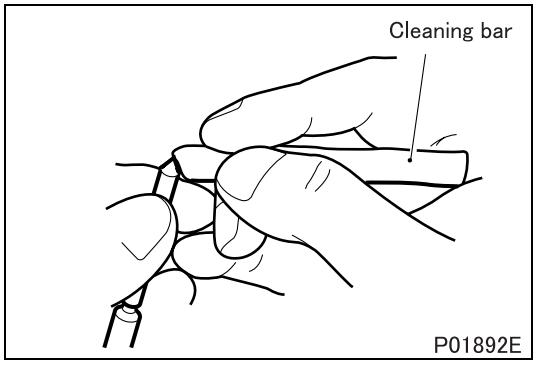


■ Removal: Injection nozzle

CAUTION ⚠

- **Do not touch the sliding surface of the needle valve with your hands. (Should you touch the surface, clean it in kerosene.)**
- **Do not swap removed needle valves and nozzles between cylinders. Keep the needle valve and nozzle for each individual cylinder together.**

◆Cleaning procedure◆

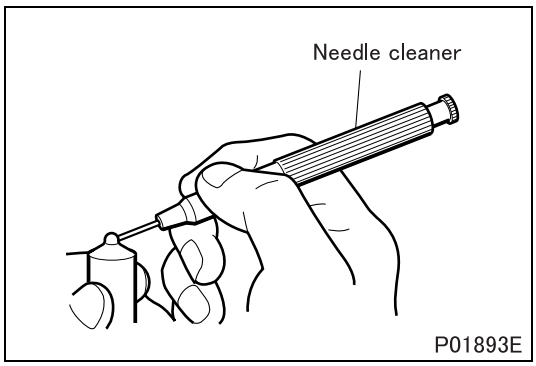


■ Cleaning: Injection nozzle

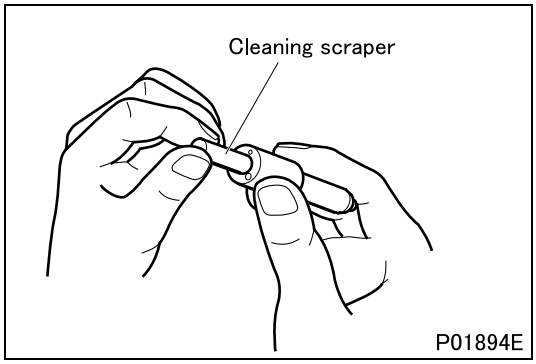
- Wash the needle valve and nozzle in kerosene, then use [a] to remove carbon deposits in the following manner:
  - Remove carbon from the end of the needle valve using the cleaning bar of [a].

CAUTION ⚠

- **Never use a wire brush or any hard metallic object for cleaning.**

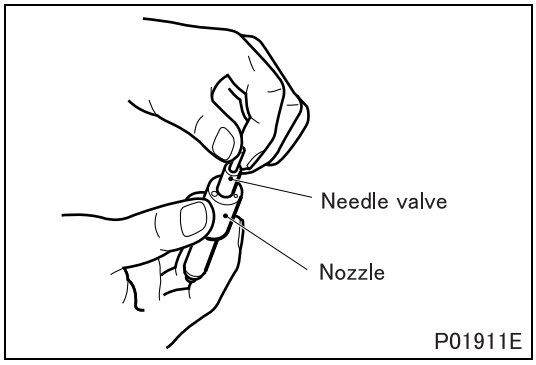


- Insert the needle cleaner of [Ca] into the injection orifice of the nozzle. Rotate it to remove carbon from the orifice.



- Clean the seat of the nozzle using the cleaning scraper of [Ca].
- To remove baked carbon, use the FUSO Carbon Remover.

◆Inspection procedure◆



■ Inspection: Injection nozzle

- Wash the needle valve and nozzle in kerosene, before assembling them together.
- Pull out the needle valve by approximately 1/3 of its length, then check that it slides down under its own weight. (Repeat this test several times, turning the needle valve each time.)
- If the needle valve does not slide down under its own weight, wash it and perform this test again. If the needle valve is still faulty, replace it and the nozzle as a set.

CAUTION ⚠

- **After replacing the nozzle, be sure to readjust the pre-lift such that the valve opening pressure meets the specified standard value.**

◆Adjustment procedure◆

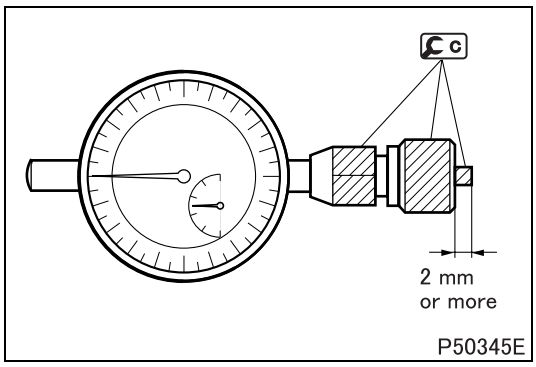
■ Adjustment: Injection nozzle

- Before starting adjustments, wash all parts in clean kerosene to remove all dirt and other foreign matter.
- As you reassemble the parts, make adjustments in the sequence shown below.

CAUTION ⚠

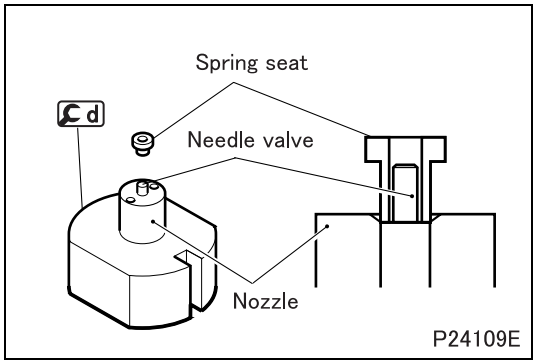
- **Do not touch the sliding surface of the needle valve with your hands.**

Checking full lift of needle valve
↓
Checking pre-lift
↓
Adjusting 2nd valve opening pressure
↓
Adjusting 1st valve opening pressure

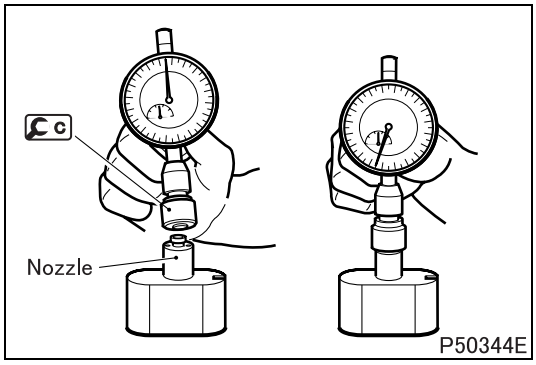


(1) Full lift of needle valve

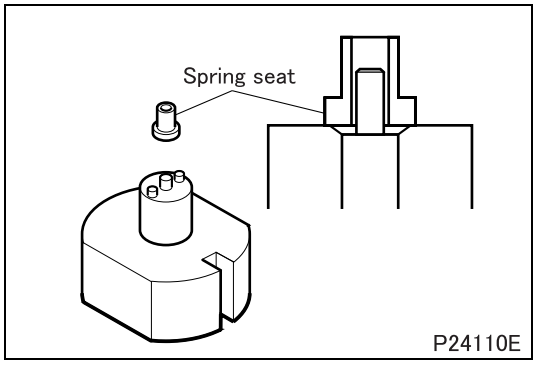
- Attach c to a dial gauge.



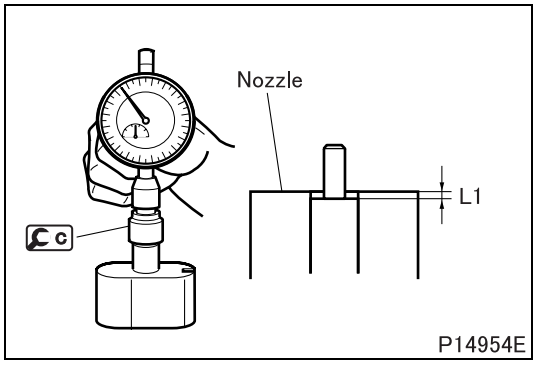
- Mount the nozzle, needle valve, and spring seat (for pre-lift adjustment) on d.



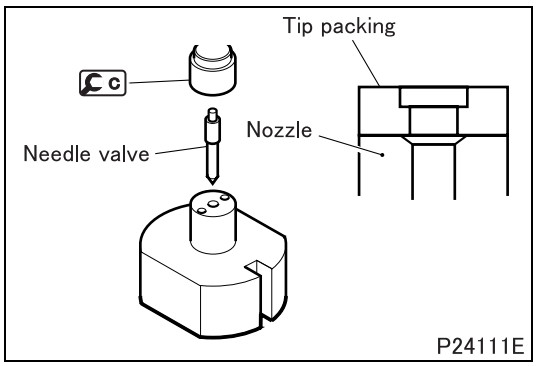
- Mount c on the nozzle.
- Zero the dial gauge.



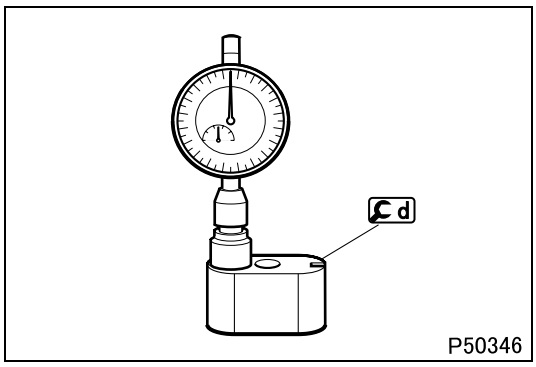
- Remove c. Change the alignment of the spring seat (for pre-lift adjustment), then refit the newly aligned spring seat (for pre-lift adjustment).



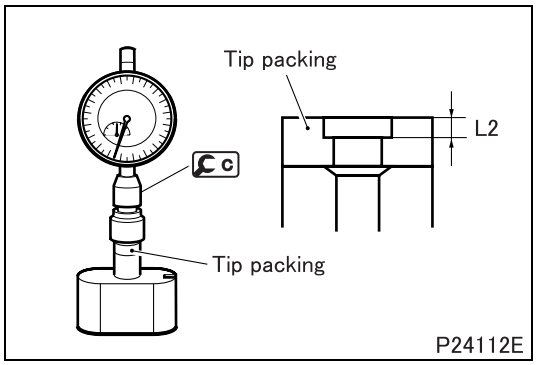
- Mount c on the nozzle again. Read the dial gauge indication. This indication is dimension L1.



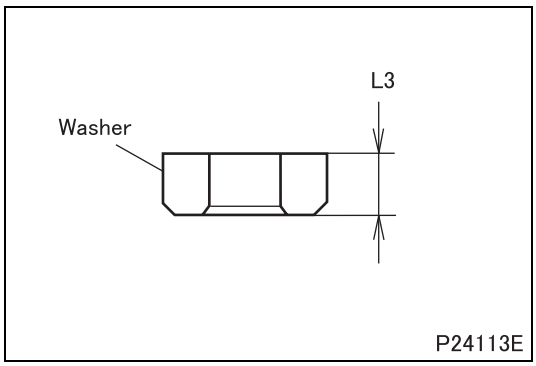
- Remove c and the needle valve. Install the tip packing on the nozzle such that the tip packing is aligned as shown in the drawing.



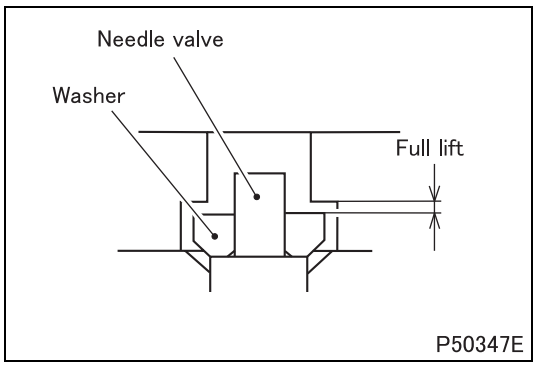
- Zero the dial gauge on d.



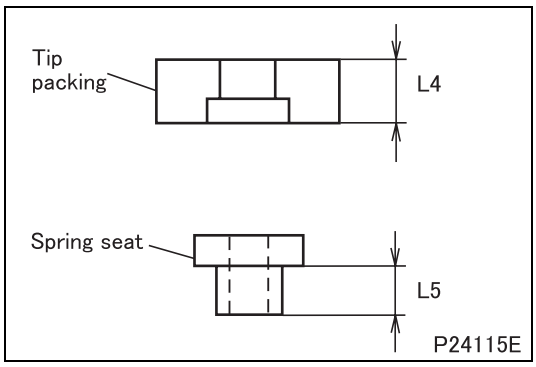
- Fit c on the tip packing. Read the dial gauge indication. This indication is dimension L2.



- Measure the thickness of the washer (for needle valve lift adjustment). This value is dimension L3.

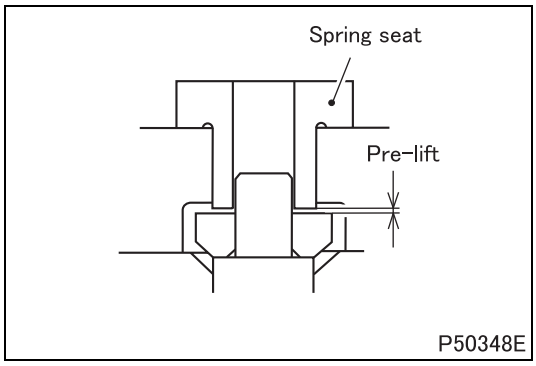


- Use the formula shown below to calculate the full lift of the needle valve from the measured dimensions L1, L2, and L3.
  Full lift = L1 + L2 + L3
- If the calculated value is out of specification, make the necessary adjustment by changing the washer (for needle valve lift adjustment) (for dimension L3).
  Washers are available in five thicknesses: 2.40 mm, 2.425 mm, 2.45 mm, 2.475 mm, and 2.50 mm.

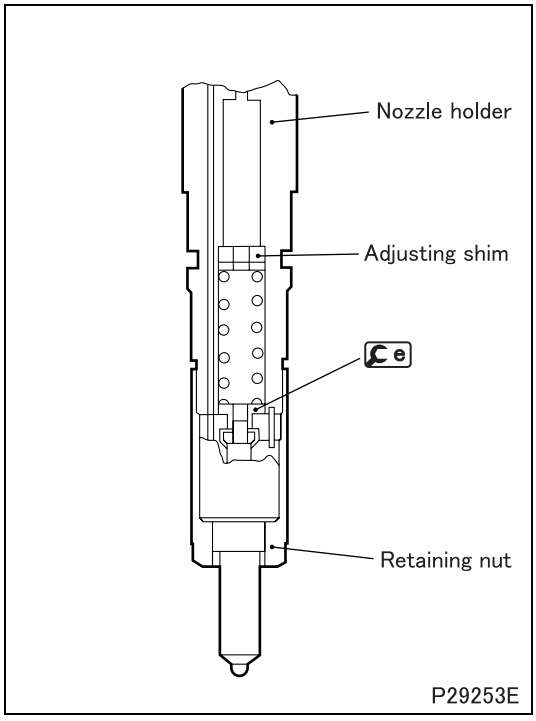


(2) Adjustment of pre-lift

- Measure the thickness of the tip packing. This value is dimension L4.
- Measure dimension L5 of the spring seat (for pre-lift adjustment).



- Using dimensions L4 and L5 and dimensions L1 and L3 [which were measured in part (1)], calculate the pre-lift as follows:
  Pre-lift = L4 - L5 - L3 + L1
- If the calculated value is out of specification, make the necessary adjustment by changing the spring seat (for pre-lift adjustment) (for dimension L5).
  Spring seats are available in 22 thicknesses (from 2.59 mm to 2.80 mm in 0.01 mm increments).



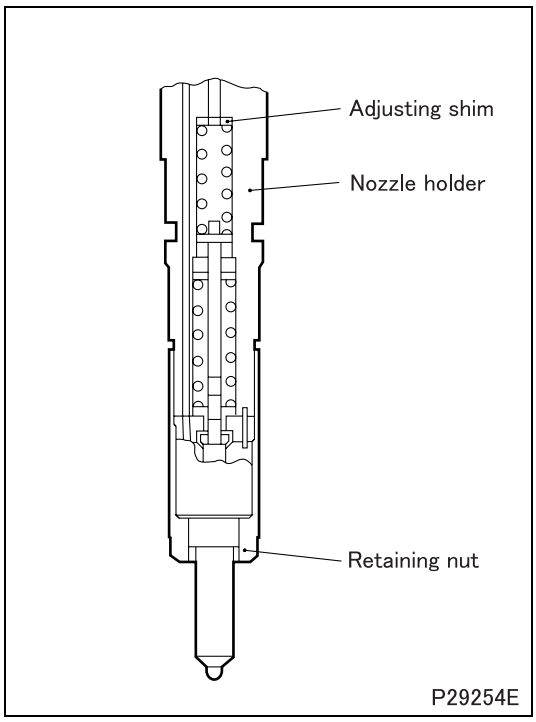
(3) Adjustment of 2nd valve opening pressure

- Mount the parts on the nozzle holder as shown in the drawing. Fit e in place of the spring seat (for pre-lift adjustment).
- Tighten the retaining nut to the specified torque.
- Mount the assembly on a nozzle tester. Measure the 2nd valve opening pressure.

CAUTION ⚠

- **Do not touch the spray that comes out of the nozzle.**

- If the calculated value is out of specification, make the necessary adjustment by changing the adjusting shim (for adjustment of 2nd valve opening pressure).
  Adjusting shims are available in the following thicknesses:
  0.70 mm to 2.15 mm (in 0.05 mm increments (total 30 thicknesses))
  0.975 mm to 1.775 mm (in 0.05 mm increments (total 17 thicknesses))
  A change of 0.025 mm in the thickness of the adjusting shim yields a change of 345 kPa {3.5 kgf/cm^2} in the valve opening pressure.



(4) Adjustment of 1st valve opening pressure

- Mount the parts on the nozzle holder as shown in the drawing.
- Tighten the retaining nut to the specified torque.
- Mount the assembly on a nozzle tester. Measure the 1st valve opening pressure.

CAUTION ⚠

- **Do not touch the spray that comes out of the nozzle.**

- If the calculated value is out of specification, make the necessary adjustment by changing the adjusting shim (for adjustment of 1st valve opening pressure).
  Adjusting shims are available in the following thicknesses:
  0.8 mm to 2.0 mm, 2.05 mm, 2.075 mm to 2.2 mm (in 0.025 mm increments (total 56 thicknesses))
  A change of 0.025 mm in the thickness of the adjusting shim yields a change of 345 kPa {3.5 kgf/cm^2} in the valve opening pressure.

GROUP 14 COOLING

SPECIFICATIONS 14-2

STRUCTURE AND OPERATION
1. Cooling System (Flow of Coolant) 14-3
2. Thermostat 14-4
3. Water Pump 14-4

TROUBLESHOOTING 14-5

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Coolant Replacement and Cleaning of Cooling System 14-6
2. Air Bleeding of Cooling System 14-8
3. Air/Gas Leakage Test 14-8
4. Inspection of Belts 14-9

DISCONNECTION AND CONNECTION
OF HOSES AND PIPES 14-10

RADIATOR 14-12

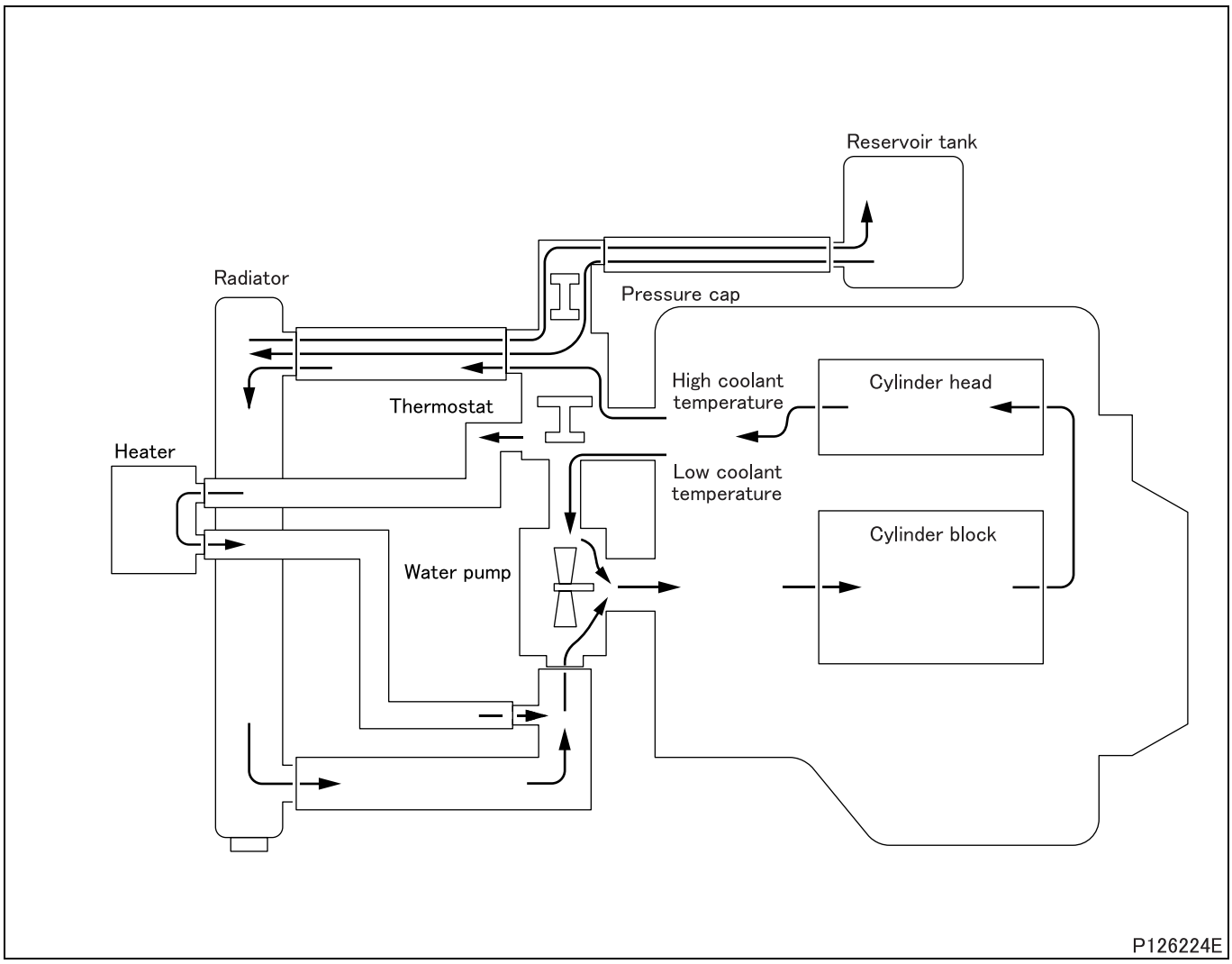
COOLING FAN, BELT AND WATER PUMP 14-16

THERMOSTAT AND PRESSURE CAP 14-20

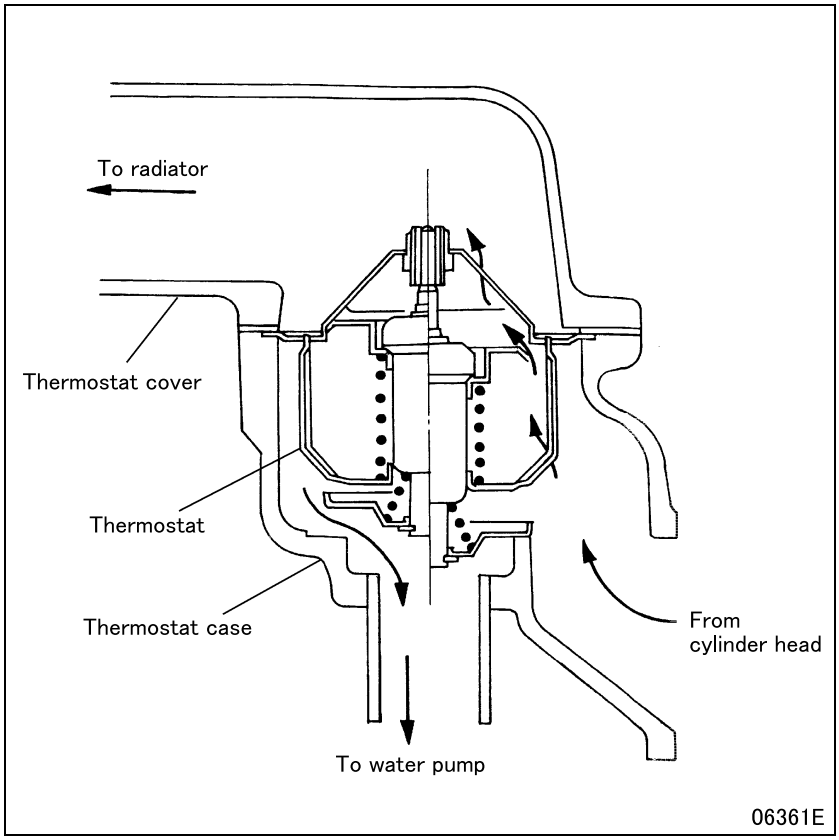
SPECIFICATIONS

Item	Specifications
Cooling system	Forced water circulation system
Water pump	Belt-driven type
Thermostat	Wax pellet, bottom bypass type (with jiggle valve)
Automatic cooling fan coupling	Continuous control type
Radiator	Tube and corrugated fin type
Coolant capacity dm^3{L}	14.5 {14.5}

1. Cooling System (Flow of Coolant)

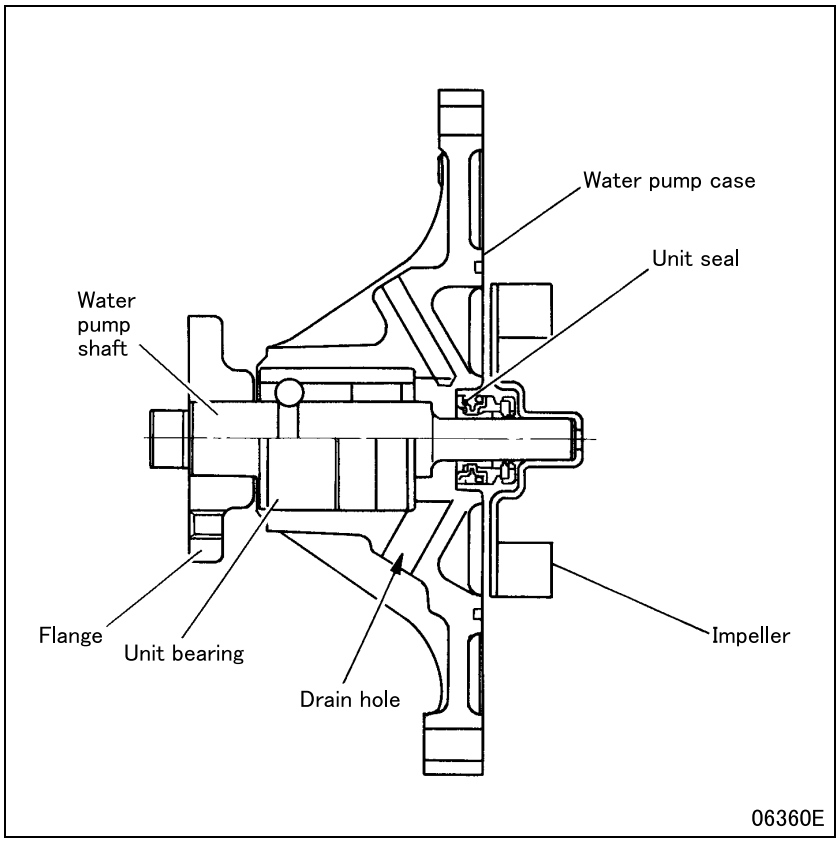


2. Thermostat



- The thermostat is a bottom bypass type that uses a wax-filled pellet as its flow-regulating element. When the wax is heated, it melts from solid to liquid, changing its total volume. This allows the valve to open or close in accordance with the coolant temperature, regulating and adjusting the flow of coolant to the radiator and to the water pump (bypassing the radiator).

3. Water Pump



- The water pump has a drain hole to prevent coolant from entering the unit bearing in case of a defect in the unit seal.

Possible causes \ Symptoms		Overheating (poor cooling)	Overcooling	Abnormal noise	Excessive coolant loss	Reference Gr
Belt	Loose or damaged	O		O		
	Excessive tension			O		
	Oil on belt	O				
Water pump	Incorrectly mounted water pump	O			O	
	Defective gasket	O		O	O	
	Defective unit bearing	O		O		
	Defective impeller	O		O		
	Defective unit seal	O			O	
	Fit of unit bearing on flange and impeller too loose	O		O		
Thermostat	Incorrectly mounted case	O			O	
	Defective gasket	O			O	
	Valve opening temperature too high (valve remains closed)	O				
	Valve opening temperature too low (valve remains open)		O			
	Leakage from coolant temperature sensor	O			O	
Radiator	Clogged core	O				
	Cracked core and/or separation in welds	O			O	
Automatic cooling fan coupling	Defective bearing	O		O		
	Damaged bimetal	O				
	Contaminated bimetal	O	O			
	Silicon oil leakage	O		O		
Oil cooler	Incorrectly mounted oil cooler	O			O	Gr12
	Defective gasket	O			O	
Cylinder head	Incorrectly mounted cylinder head	O			O	Gr11
	Defective gasket	O			O	
Poorly airtight pressure cap		O				
Insufficient coolant amount		O				
Clogged or scaled coolant passage		O				
Incorrectly connected hoses		O			O	
Excessively low exterior temperature			O			

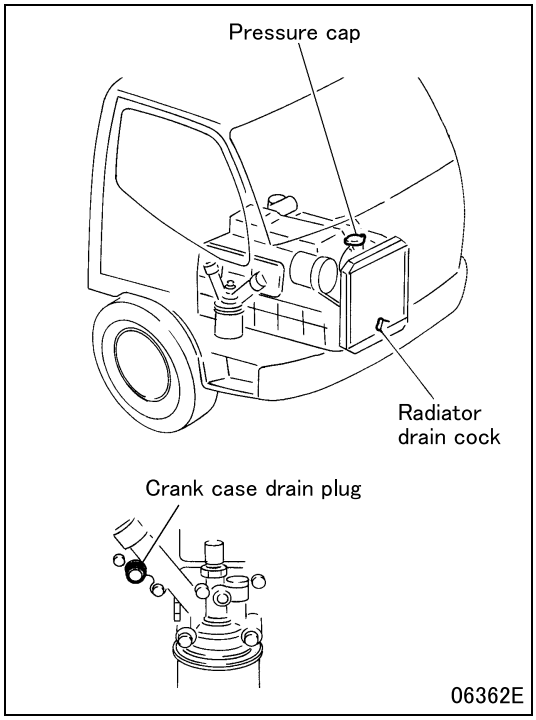
1. Coolant Replacement and Cleaning of Cooling System

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened		Tightening torque	Remarks
–	Radiator drain cock		2 {0.2}	–
–	Crank case drain plug	4D33	25 {2.5}	–
		4D34	34 {3.5}	–

- Using the radiator for extended periods of time without cleaning can increase chance of rust and scale formation, which may cause engine overheating. The cooling system must be cleaned periodically.

1.1 Draining of coolant



- Before draining the coolant, loosen the pressure cap to reduce the pressure in the cooling system. Remember to drain the coolant out of the reservoir tank as well.

WARNING ⚠

- **Drain the coolant only after it has cooled sufficiently to avoid getting scalded.**
- **Opening the pressure cap while the coolant temperature is still high can cause hot coolant to spray out. Cover the pressure cap with a cloth, and loosen it slowly to let the pressure out before opening it fully.**

1.2 Cleaning procedure

- Keep the coolant temperature at approximately 90°C so that the thermostat valve remains open and the coolant continues to circulate in the radiator.
- For the sake of convenience you can raise the coolant temperature quickly by covering the front of the radiator with corrugated cardboard or something similar.
- Set the temperature adjusting lever of the heater controller at maximum so that the coolant can circulate freely in the heater piping area.
- In cases where a great amount of rust has accumulated it is common for the radiator to leak as a result of cleaning. Conduct a thorough check for leakage after cleaning.
- Soft water to be used should have the following properties.

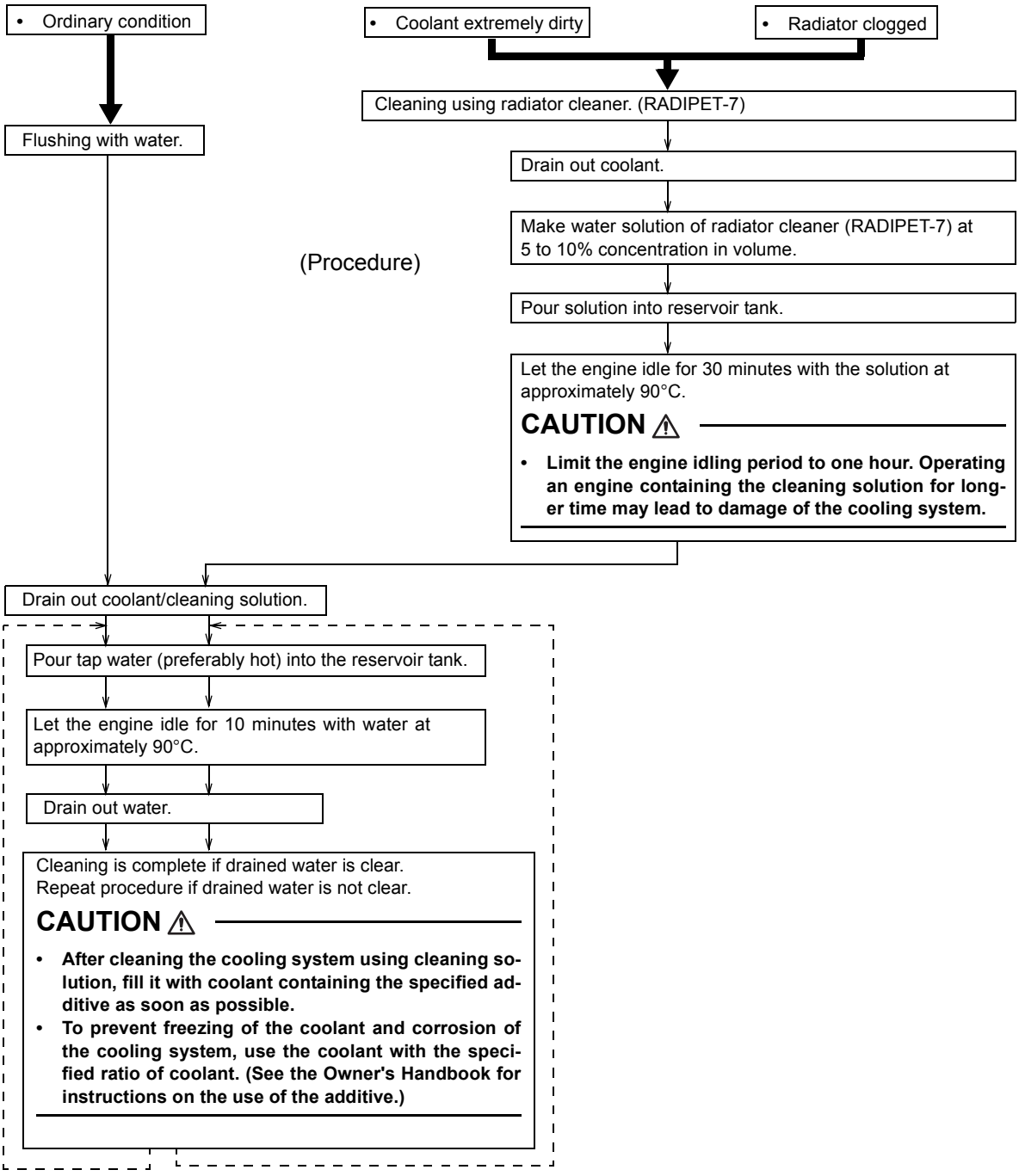
CAUTION ⚠

- **Do not use hard water as it causes scalling and rust.**

Required properties of soft water

Total hardness	300 ppm or less
Sulfate SO_4^-	100 ppm or less
Chloride Cl^-	100 ppm or less
Total dissolved solids	500 ppm or less
pH	6 to 8

- Select an appropriate cleaning method according to the condition of the cooling system as shown below.



WARNING

- **If you accidentally splash coolant or radiator cleaner in your eyes, wash it out immediately with water and seek medical attention.**

CAUTION

- **Coolant is flammable. Keep it away from heat and flames.**

2. Air Bleeding of Cooling System

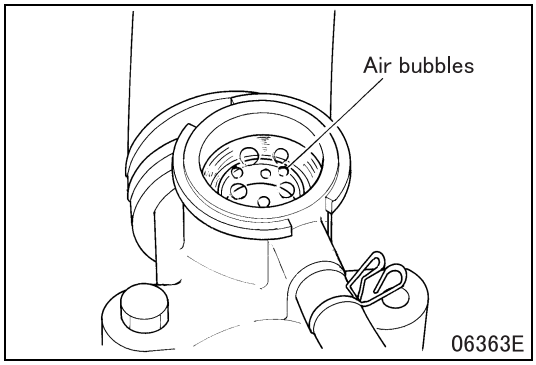
- With the pressure cap removed and the coolant temperature at 90°C, let the engine idle in order to bleed air completely out of the cooling system.
- After air bleeding is completed, refill the reservoir tank with coolant as needed.

3. Air/Gas Leakage Test

- Presence of air or exhaust gas in coolant accelerates corrosion of the cooling system components. To prevent this, carry out air/gas leakage tests in accordance with the following procedure.
- Remove the pressure cap.

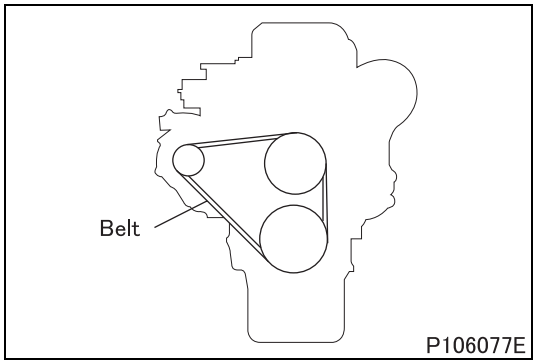
WARNING ⚠

- **If the engine is hot, boiling coolant may spurt out from the filler port when the pressure cap is loosened. To avoid burning yourself, make sure to remove the pressure cap only when the coolant is cold.**

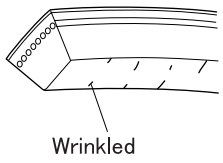
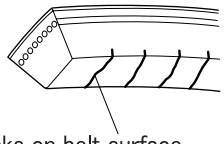
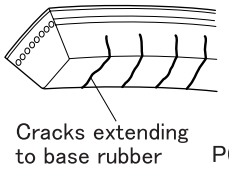
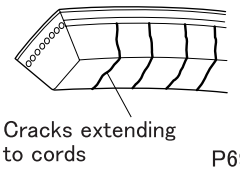
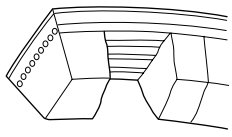


- Run the engine until the coolant temperature rises to approximately 90°C.
- If air bubbles appear continuously through the filler port, there is air or exhaust gas penetrating into the cooling system.
- Presence of air in coolant can be an indication of loose cylinder head bolts, loose water pump mounting bolts, loose hose connections, and/or a damaged hose.
- Presence of exhaust gas in coolant can be an indication of a damaged cylinder head gasket and/or cracks in the cylinder head.

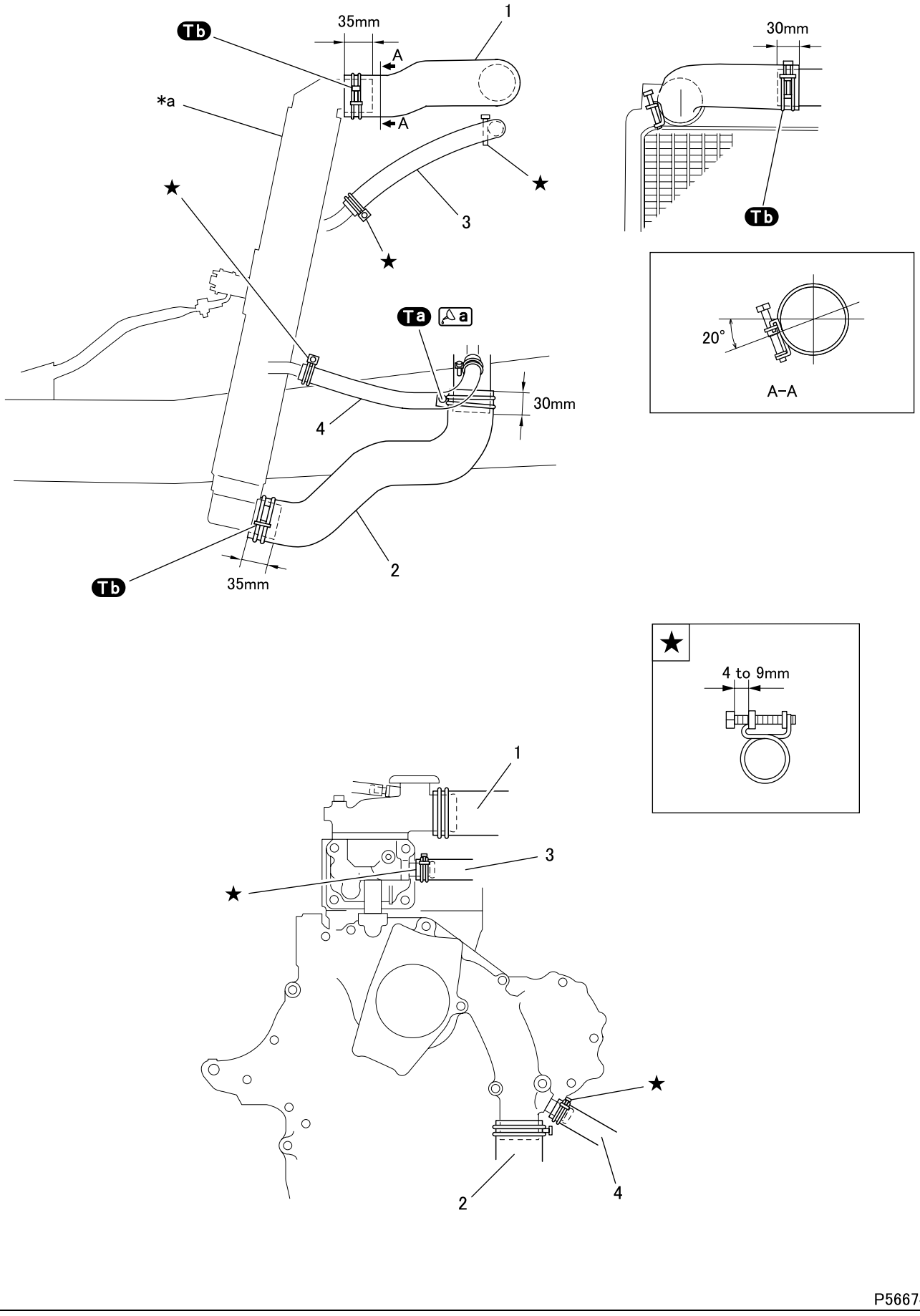
4. Inspection of Belts



- Visually check the belts for possible cracks and damage. Belt replacement time varies depending on the severity of cracks and damage that may be found through the check. Study the table given below for the applicable replacement time.

Belt condition	Remaining service life (reference)
 P69698E	• The driving distance over the which the belt can still be used is at least as long as that over which the belt has been used since the vehicle was new or since the belt was replaced (whichever is more recent).
 P69699E	• The driving distance over the which the belt can still be used is about half of that over which the belt has been used since the vehicle was new or since the belt was replaced (whichever is more recent).
 P69700E	• The driving distance over the which the belt can still be used is about a quarter of that over which the belt has been used since the vehicle was new or since the belt was replaced (whichever is more recent).
 P69701E  P69702	• The belt has reached the end of its service life and must be replaced.

DISCONNECTION AND CONNECTION OF HOSES AND PIPES



● **Removal sequence**

1 Upper radiator hose
2 Lower radiator hose
3 Heater hose
4 Heater hose

***a**: Radiator

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **Install each hose clamp to the angle indicated in the illustration so that sufficient clearance is assured between the hose clamp and its surrounding parts.**

Tightening torque (Unit: N·m {kgf·m})

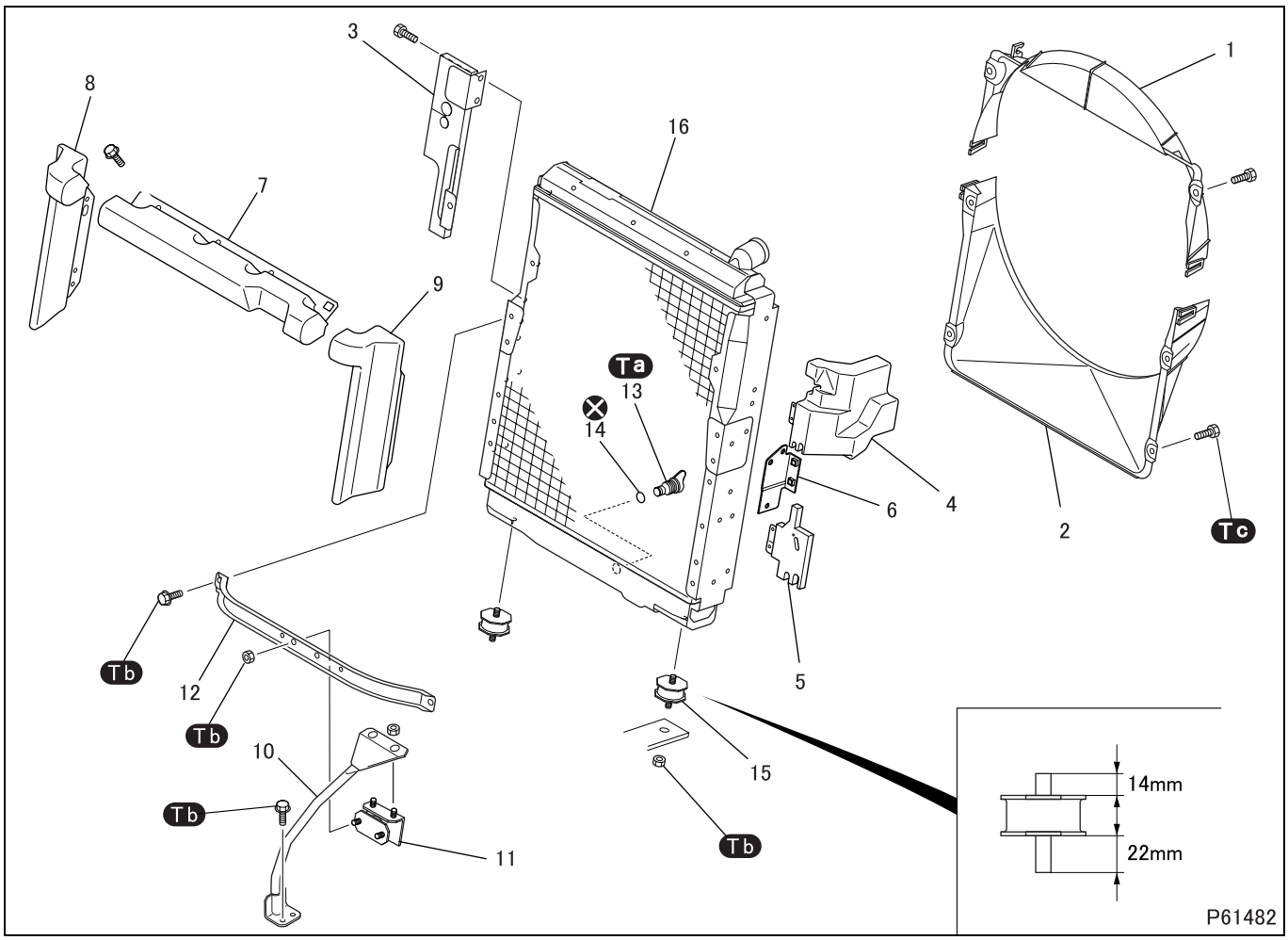
Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	1.5 to 2.0 {0.15 to 0.2}	Wet
Tb	Clamp	3.0 to 4.5 {0.3 to 0.5}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Clamp screw threads	Engine oil	As required

RADIATOR

<FE7>



● **Removal sequence**

1 Upper shroud
2 Lower shroud
3 Baffle plate RH
4 Baffle plate LH
5 Baffle plate LH
6 Baffle plate bracket
7 Baffle plate upper
8 Baffle plate RH
9 Baffle plate LH
10 Support rod
11 Support cushion
12 Upper support
13 Radiator drain cock
14 O-ring
15 Support cushion
16 Radiator

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

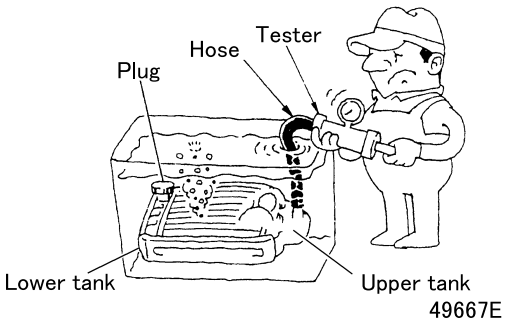
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
16	Air leakage from radiator (air pressure 147 kPa {1.47 kgf/cm^2})	0 cm^3 {0 mL}	–	Repair or replace

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Radiator drain cock	2.5 ± 0.5 {0.25 ± 0.05}	–
Tb	Nut (support cushion mounting)	12 to 15 {1.2 to 1.5}	
	Bolt (support rod mounting)		
	Nut (support cushion mounting)		
Tc	Bolt (lower shroud mounting)	5 to 7 {0.5 to 0.7}	

◆Inspection before removal◆

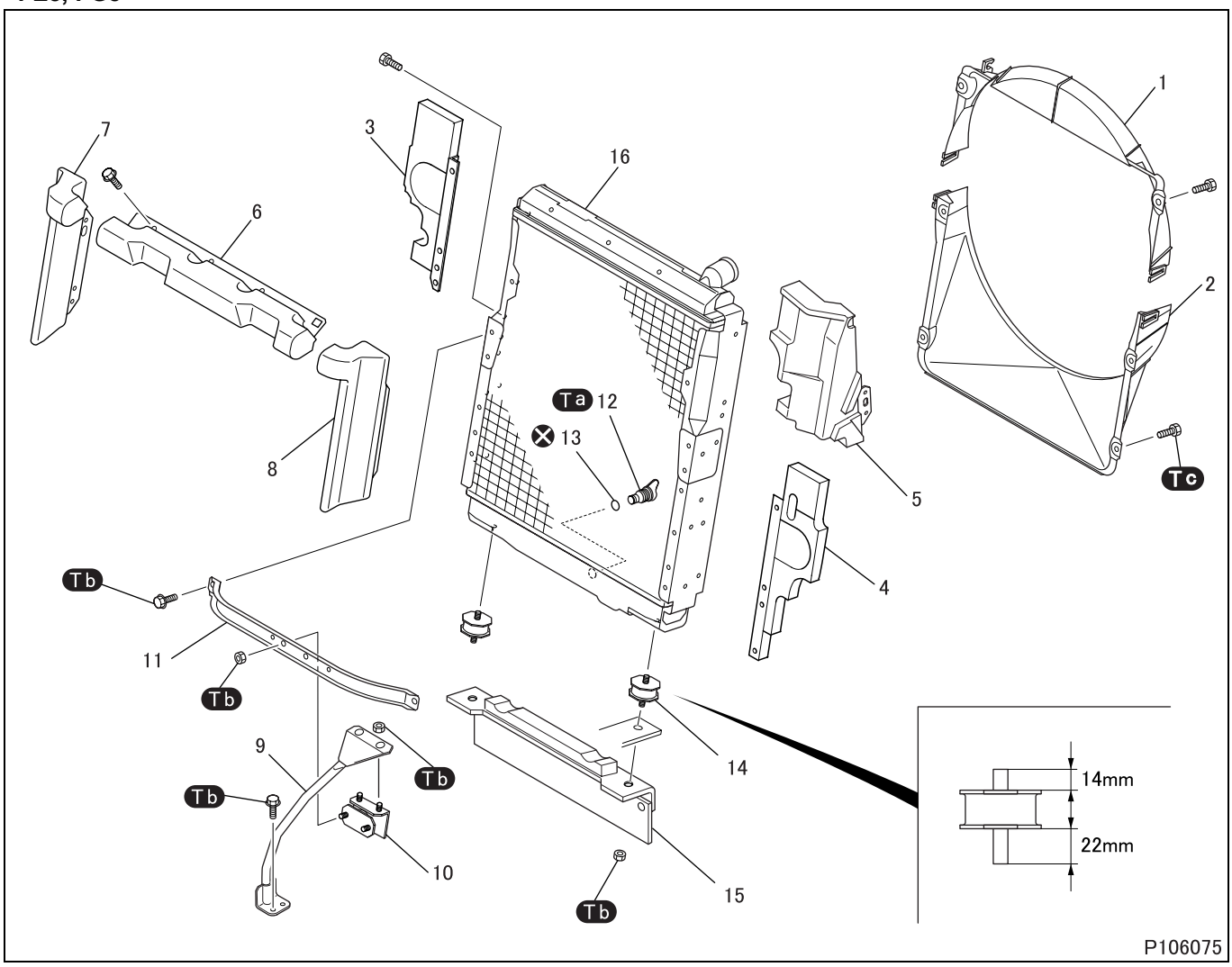


■ Inspection: Radiator air leakage

- Connect a hose and radiator cap tester to the upper tank.
- Plug the lower tank and put the entire radiator into a tank filled with water.
- Use the radiator cap tester to apply an air pressure of 147 kPa {1.47 kgf/cm^2} and check for air leakage.
- If air leakage is found, replace the radiator.

RADIATOR

<FE8, FG8>



● Removal sequence

1 Upper shroud
2 Lower shroud
3 Baffle plate RH
4 Baffle plate LH
5 Baffle plate LH <4D34T>
6 Baffle plate upper
7 Baffle plate RH
8 Baffle plate LH
9 Support rod
10 Support cushion
11 Upper support
12 Radiator drain cock
13 O-ring
14 Support cushion
15 Radiator apron <4D34T>
16 Radiator

⊗: Non-reusable parts

● Installation sequence

Follow the removal sequence in reverse.

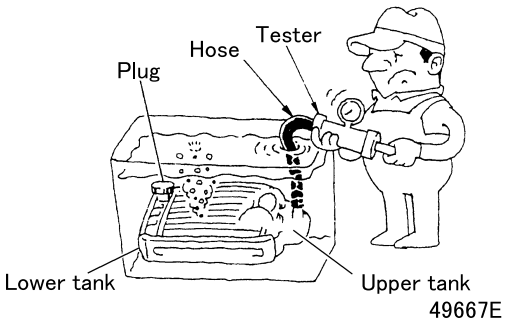
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
16	Air leakage from radiator (air pressure 177 kPa {1.77 kgf/cm^2})	0 cm^3 {0 mL}	–	Repair or replace

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Radiator drain cock	2 {0.2}	–
Tb	Nut (support cushion mounting)	12 to 15 {1.2 to 1.5}	–
	Bolt (support rod mounting)		
	Nut (support cushion mounting)		
Tc	Bolt (lower shroud mounting)	5 to 7 {0.5 to 0.7}	–

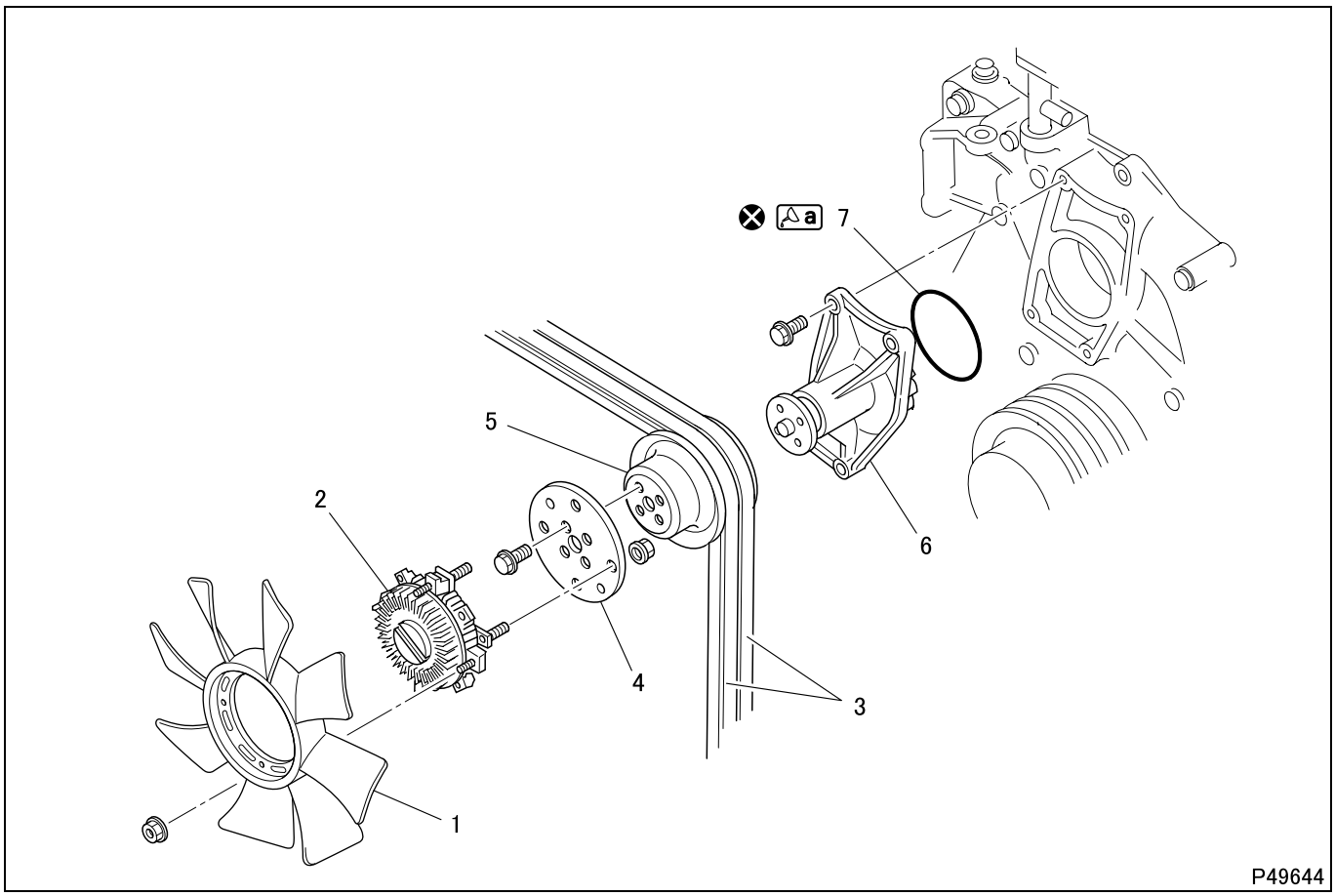
◆Inspection before removal◆



■ Inspection: Radiator air leakage

- Connect a hose and radiator cap tester to the upper tank.
- Plug the lower tank and put the entire radiator into a tank filled with water.
- Use the radiator cap tester to apply an air pressure of 177 kPa {1.77 kgf/cm^2} and check for air leakage.
- If air leakage is found, replace the radiator.

COOLING FAN, BELT AND WATER PUMP



● **Removal sequence**

1 Cooling fan
2 Automatic cooling fan coupling
3 Belt
4 Coupling plate
5 Water pump pulley
6 Water pump
7 O-ring

⊗: Non-reusable parts

● **Installation sequence**

Follow the removal sequence in reverse.

CAUTION ⚠

- **The automatic cooling fan coupling and the water pump cannot be disassembled. It must be replaced if defective.**
- **The water pump pulley is driven by two belts. Always replace the two belts simultaneously to ensure that both belts have the same tension.**
- **Make sure that there is no oil or grease on the belts. Belt soiled with oil or grease may easily slip, resulting in deteriorated performance of the cooling system.**
- **Keep the O-ring free from engine oil. Engine oil will make the O-ring swell, which may cause leakage.**

Service standards (Unit: mm)

Location	Maintenance item		Standard value	Limit	Remedy
3	Belt tension (for one belt)	For fan	12 to 16	–	Adjust
		For air conditioner <with air conditioner>	16 to 20	–	

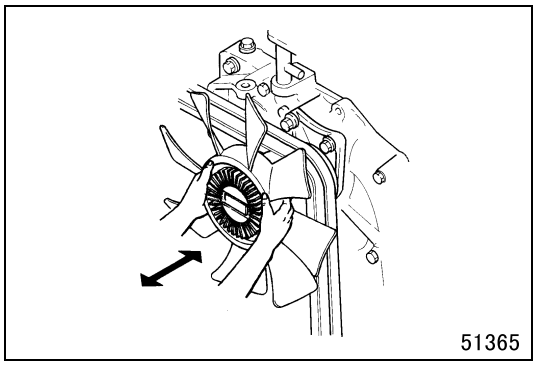
Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Soapy water	As required

Special tools

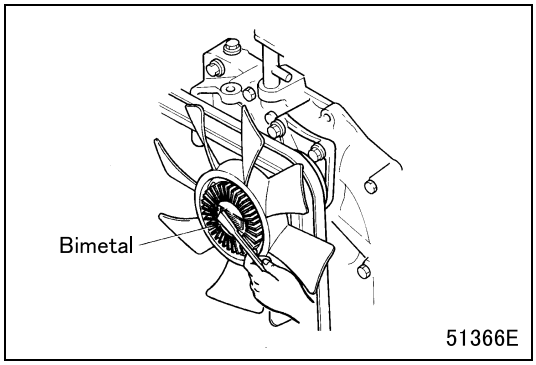
Mark	Tool name and shape	Part No.	Application
a	Belt tension gauge  P03612	MH062345	Measurement of tension of belt

◆Inspection and cleaning procedure◆



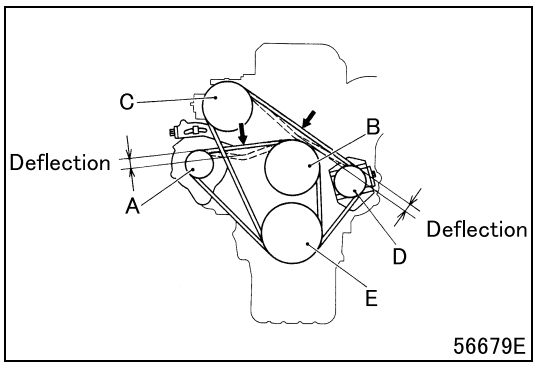
■ Inspection: Automatic cooling fan coupling

- Make an inspection of the following points. Replace the automatic cooling fan coupling if defective.
  Check that:
  - the hydraulic oil sealed inside the coupling is not leaking;
  - the coupling does not make any abnormal noise or rotate unevenly due to defects in the inside bearing when rotated manually; and
  - the automatic cooling fan coupling does not move too much when pushed and pulled in the axial directions when the engine is cold.



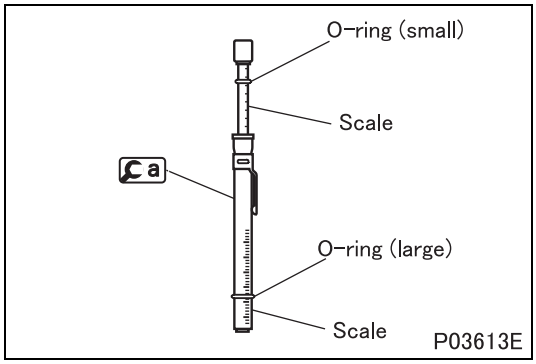
■ Cleaning: Automatic cooling fan coupling

- When removing foreign matter from the bimetal, be careful not to press too hard against the bimetal.

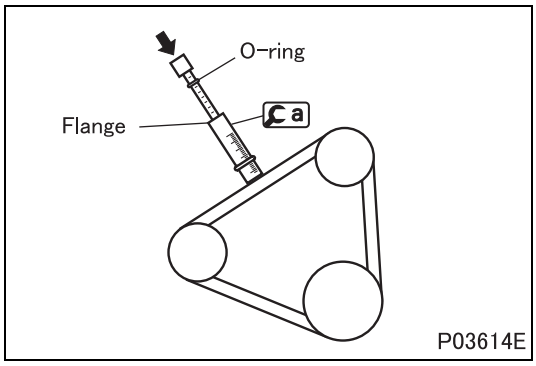


■ **Inspection: Tension of belts**

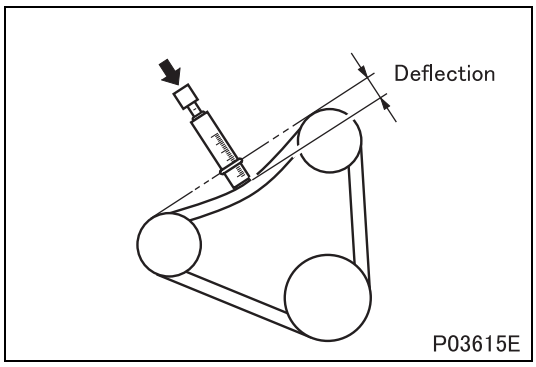
- Press each belt at a central portion between pulleys with a force of approximately 98 N {10 kgf} as shown in the illustration and measure the amount of deflection of the belt.
  - A: Alternator pulley
  - B: Water pump pulley
  - C: Air conditioner compressor pulley <with air conditioner>
  - D: Tension pulley
  - E: Crankshaft pulley



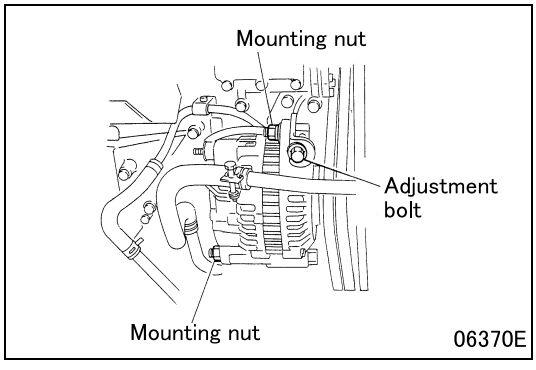
- Place the small O-ring on a at the scale mark corresponding to 98N {10 kgf} (press force).
- Place the large O-ring on a at the scale mark corresponding to the maximum permissible deflection value specified for the belt.



- Place a at a central portion between pulleys of the belt and push the handle (indicated by the arrow in the illustration) until the O-ring touches the flange.



- Measure the amount of deflection of the belt.
- If the measured value deviates from the standard value range, adjust the tension of the belt as follows.



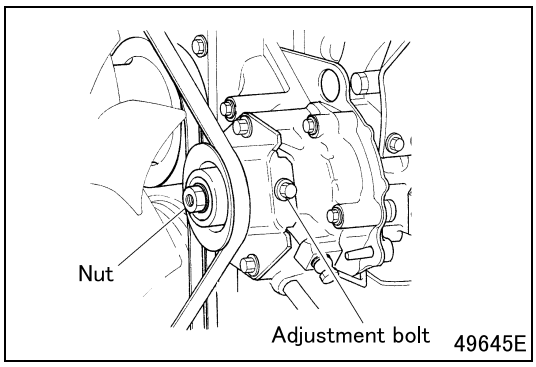
Adjustment of belt

(1) Belt for fan

- Loosen the alternator mounting nuts (2 locations) and adjust the tension of the belt by tightening or loosening the adjustment bolt.
- After the adjustment is completed, retighten the mounting nuts firmly.

CAUTION ⚠

- **Excessive tension in the belt may damage not only the belt itself but also the bearings of the related components.**



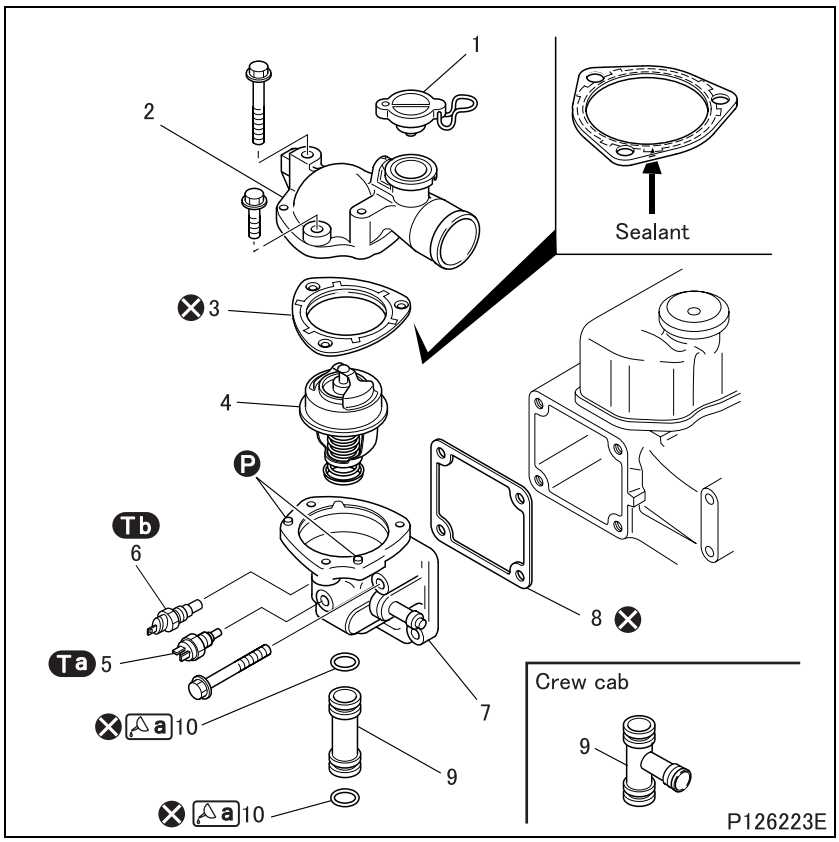
(2) Belt for air conditioner compressor

- Loosen the tension pulley mounting nut, and adjust the tension of the belt by tightening or loosening the adjustment bolt.
- After the adjustment is completed, retighten the tension pulley mounting nut firmly.

CAUTION ⚠

- **Excessive tension in the belt may damage not only the belt itself but also the bearings of the related components.**

THERMOSTAT AND PRESSURE CAP



● **Disassembly sequence**

1 Pressure cap
2 Thermostat cover
3 Gasket
4 Thermostat
5 Water temperature sensor
6 Overheating switch
7 Thermostat case
8 Gasket
9 Bypass pipe
10 O-ring

Ⓟ: Locating pin
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Keep the O-ring free of engine oil. Engine oil will make the O-ring swell, which may cause leakage.**

Service standards (Unit: mm)

Location	Maintenance item		Standard value	Limit	Remedy
1	Pressure cap valve opening pressure		90 ± 15 kPa {0.9 ± 0.15 kgf/cm^2}	–	Replace
4	Thermostat	Valve opening temperature	82 ± 2°C	–	Replace
		Valve lift / temperature	10 or more / 95°C	–	Replace

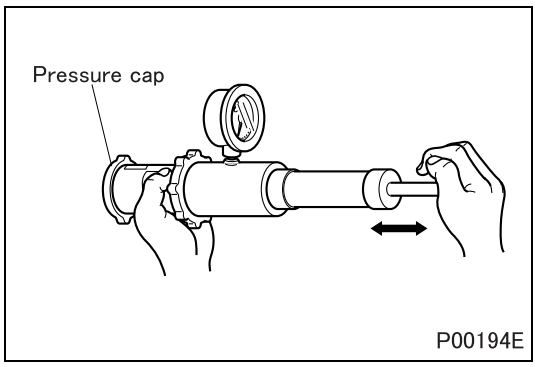
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Water temperature sensor	35 ± 7 {3.5 ± 0.7}	–
Tb	Overheating switch	7.3 ± 1.5 {0.8 ± 0.15}	–

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Soapy water	As required

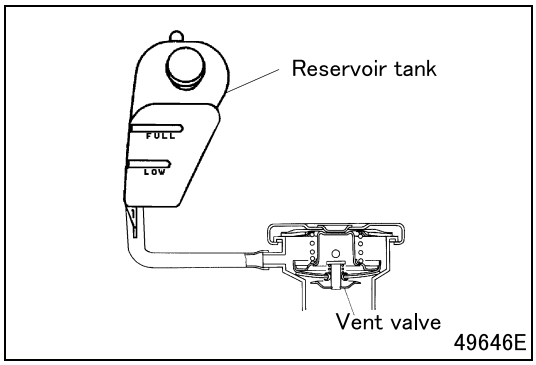
◆Inspection procedure◆



■ Inspection: Pressure cap

(1) Pressure valve opening pressure

- Replace the pressure cap if the measured value deviates from the standard value range.

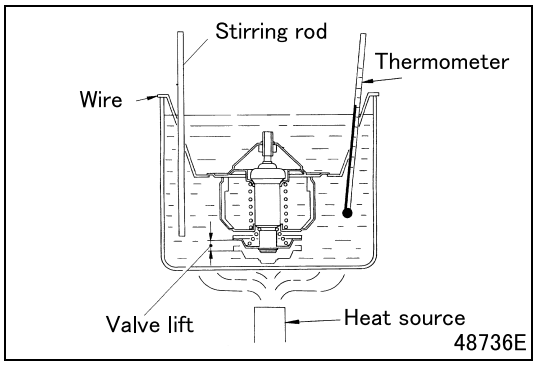


(2) Inspection of vent valve

- Before starting the inspection, check the level of coolant in the reservoir tank.
- Run the engine at full speed. Stop the engine when the level of coolant in the reservoir tank noticeably rises.
- Wait until the coolant temperature drops to the ambient temperature. Then, check if the coolant in the reservoir tank has returned to the same level as that confirmed before the engine was started.
- If the coolant has failed to return to its original level, the vent valve is defective. In this case, replace the pressure cap.

CAUTION ⚠

- **Be aware that removing the pressure cap before the coolant cools down to the ambient temperature will result in loss of vacuum in the radiator, which prevents the coolant from being returned to the reservoir tank.**



■ Inspection: Thermostat

- Stir the water using a stirring rod to maintain an even water temperature in the container, then conduct the tests indicated below.
- If the measured values deviate from the standard value ranges, replace the thermostat.

(1) Valve opening temperature

- Hold the thermostat with wire to keep it away from the heat source.
- Heat the water gradually to the valve opening temperature.
- Maintain this temperature for five minutes and make sure that the valve is completely open.
- Make sure that the valve closes completely when the water temperature drops below 65°C.

(2) Valve lift

- Heat the water to a temperature slightly higher than the valve opening temperature. Maintain this temperature for five minutes and measure the valve lift.

GROUP 15 INTAKE AND EXHAUST

SPECIFICATIONS 15-2

STRUCTURE AND OPERATION
1. Air Cleaner 15-2
2. Turbocharger Assembly 15-3
3. Exhaust Brake System 15-5

TROUBLESHOOTING 15-6

ON-VEHICLE INSPECTION AND ADJUSTMENT
1. Measurement of Turbo Boost Pressure 15-8
2. Inspection and Adjustment of Exhaust Brake System 15-9

AIR DUCT AND AIR CLEANER
<4D33> 15-10
<4D34> 15-18

TURBOCHARGER 15-22

INTERCOOLER 15-28

INTAKE MANIFOLD
<4D33> 15-30
<4D34> 15-31

EXHAUST MANIFOLD
<4D33> 15-32
<4D34> 15-34

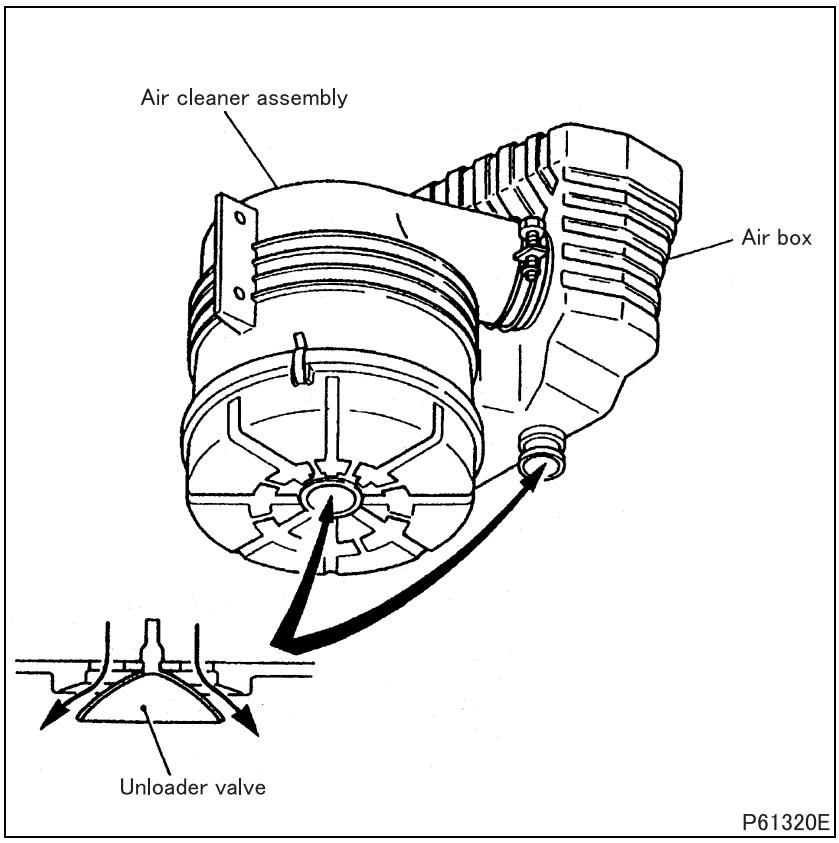
EXHAUST PIPE AND MUFFLER 15-36

SPECIFICATIONS

Item		Specifications
Air cleaner element		Cyclone filter paper type
Turbocharger	Model	TD 05
	Manufacturer	MITSUBISHI HEAVY INDUSTRIES
Intercooler type		Air-cooled, tube and corrugated fin type

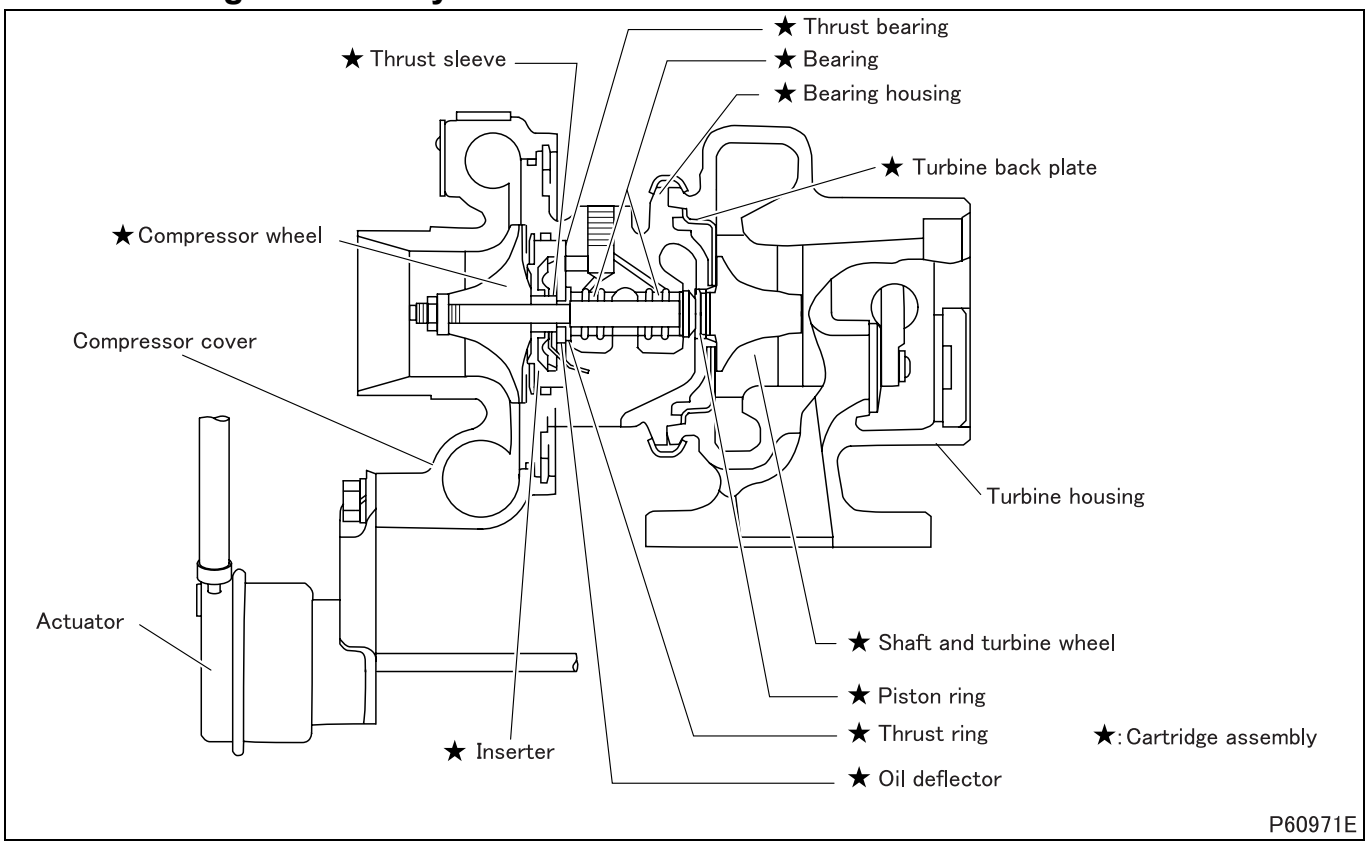
STRUCTURE AND OPERATION

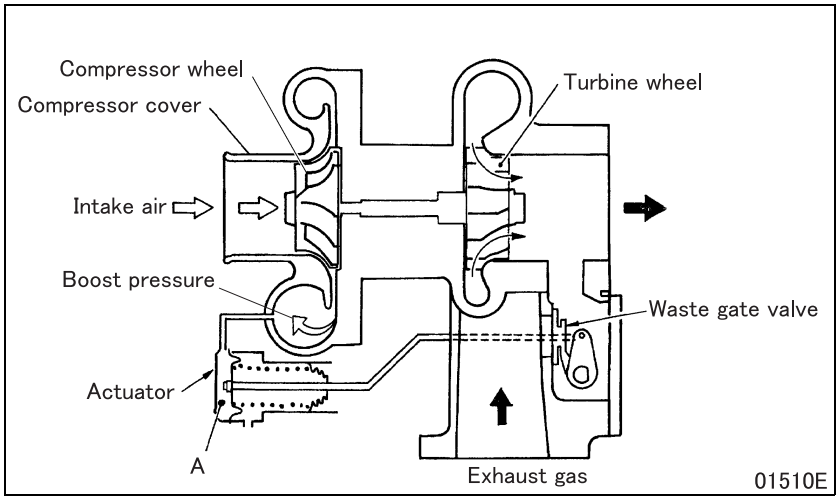
1. Air Cleaner



- The air cleaner is a single or double element type.
- Air box and air cleaner are fitted with unloader valve.
- When the engine slows down below the predetermined speed, the level of vacuum in the air cleaner changes and causes the unloader valve to vibrate. Vibration of the unloader valve allows the air cleaner to automatically discharge any water and dust that has accumulated inside.

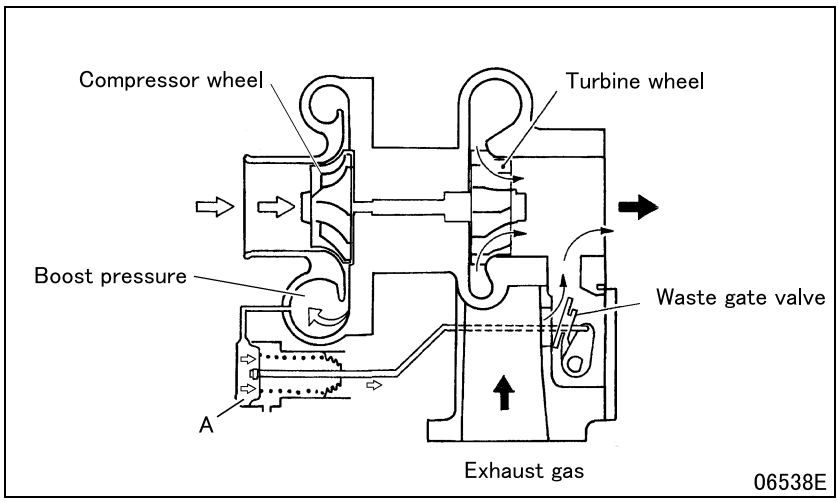
2. Turbocharger Assembly





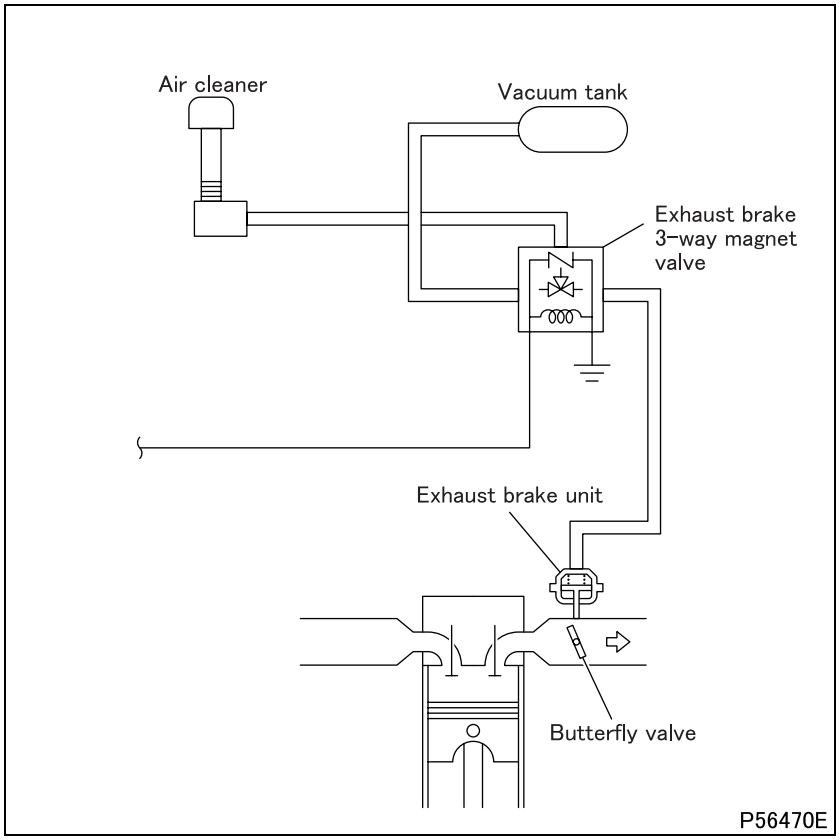
2.1 Waste gate mechanism

- The waste gate mechanism allows excess exhaust gas to escape from the turbocharger by means of an actuator in order to maintain the boost pressure at an appropriate level. This prevents overrunning of the turbocharger and excessive pressure buildups in the intake manifold.
- The boost pressure is led via a rubber hose from the compressor cover to chamber A in the actuator. When the boost pressure in chamber A is less than the predetermined value, the actuator does not function and the waste gate valve remains closed. All exhaust gas then flows toward the turbine wheel.



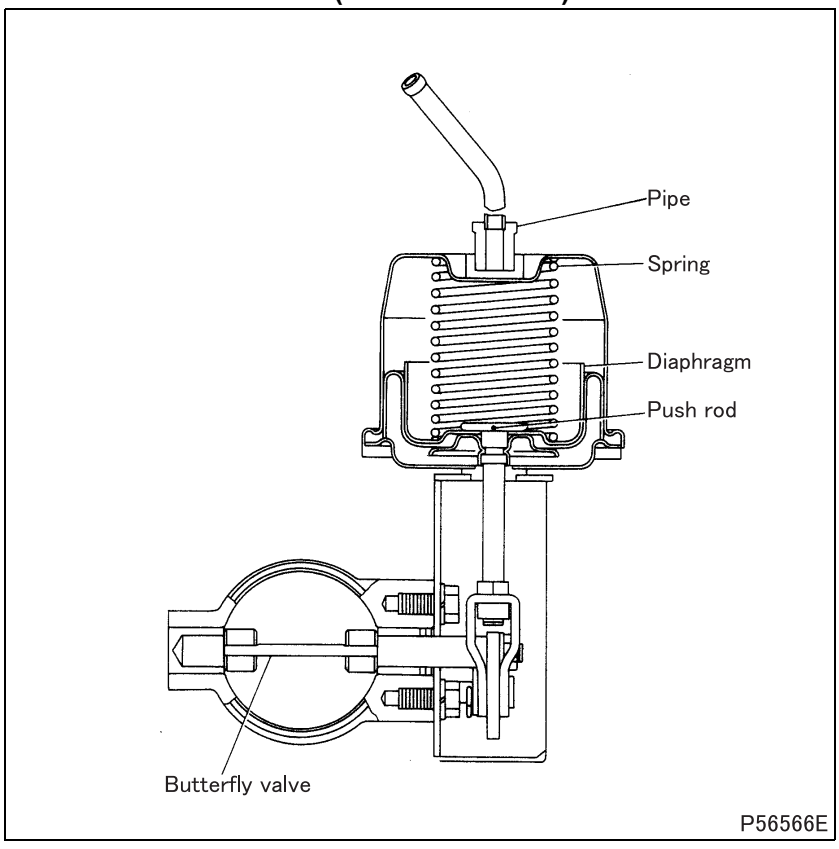
- When the boost pressure in chamber A exceeds the predetermined value, the waste gate valve opens, reducing the amount of exhaust gas flowing toward the turbine wheel. As a result, the speed of the compressor wheel, and thus the boost pressure, are reduced.

3. Exhaust Brake System



- The exhaust brake system provides stopping power by closing the exhaust piping. Specifically, pressure builds up in the blocked exhaust piping, which then is used to resist the pistons as they move to discharge exhaust in the exhaust stroke.
- The exhaust brake system supplements the foot brake. It is equipped with the exhaust brake unit incorporating a butterfly valve. It also uses the intake shutter which reduces intake noise while the exhaust brake system is in operation.
- When the exhaust brake switch is turned ON, the excitation winding within the exhaust brake 3-way magnet valve is magnetized. This closes the atmospheric pressure valve while opening the vacuum valve. Vacuum in the vacuum tank acts on the exhaust brake unit, closing the butterfly valve and bringing the exhaust braking into operation.

3.1 Exhaust brake unit (Power chamber)



Possible causes \ Symptoms			Engine hard to start	Exhaust gas dark	Exhaust gas whitish	Engine output insufficient	Oil consumption excessive	Noise and vibration in intake/exhaust systems	Exhaust brake not effective	Exhaust brake does not disengage	Reference Gr
Air cleaner	Air cleaner element clogged		O	O		O					
Turbocharger	Cartridge assembly	Bearing faulty		O		O		O			
		Carbon deposits on shaft turbine wheel		O		O					
		Shaft and turbine wheel interfering with turbine back plate		O		O					
		Shaft and turbine wheel interfering with turbine housing		O		O					
		Shaft and turbine wheel bent		O		O		O			
		Shaft and turbine wheel broken		O		O		O			
		Compressor wheel interfering with compressor housing		O		O					
		Thrust sleeve and thrust bearing seized		O		O		O			
		Compressor wheel broken		O		O		O			
		Engine oil leaking because piston ring and inserter worn		O	O		O				
		Piston rings installation faulty					O				
		Parts not sliding smoothly because oil lubrication pipe and eyebolt clogged		O		O					
		Oil seal damaged because oil return pipe clogged			O		O				
	Compressor housing installation faulty			O		O	O	O			
	Turbine housing installation faulty					O		O			
Intercooler	Foreign particles on intercooler front core					O					
Actuator	Butterfly valve does not open			O	O	O					
	Butterfly valve opening and closing adjusted incorrectly			O	O	O					
Front pipe, muffler, tailpipe deformed								O			
Front pipe, muffler or tailpipe installation faulty								O			
Valve clearance faulty				O							Gr11
Head gasket faulty				O							
Valve and valve seat worn, and carbon deposits				O							
Valve spring fatigued				O							
Piston rings worn or damaged					O		O				
Piston ring grooves worn or damaged					O		O				
Cooling system malfunctioning				O							Gr14
Engine oil excessive					O						Gr12
Main moving parts seized				O							Gr11
Fuel injection quantity uneven or excessive				O							Gr13
Vacuum system	Insufficient vacuum								O		
	Collapsed piping								O		
Faulty 3-way magnet valve									O	O	Gr54
Exhaust brake unit	Faulty valve								O	O	
	Stuck valve shaft								O	O	
	Faulty valve chamber								O		
Faulty electric system									O	O	Gr54

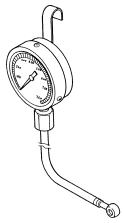
M E M O

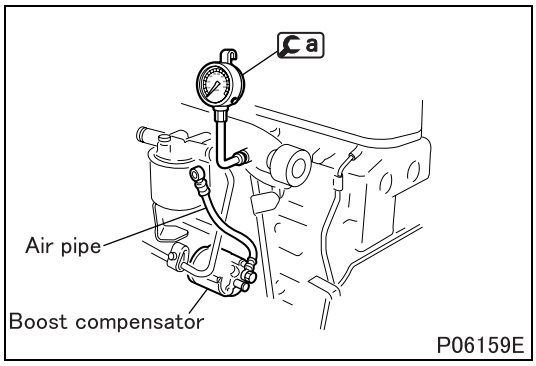
1. Measurement of Turbo Boost Pressure

Service standards

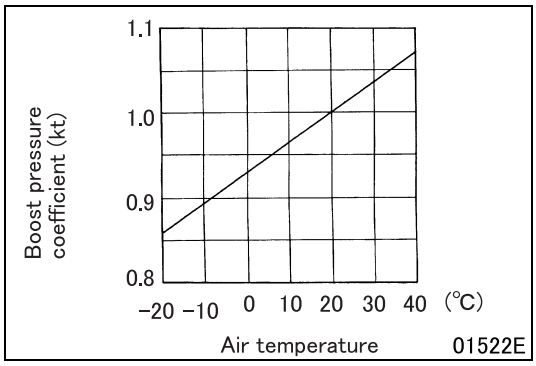
Location	Maintenance item	Standard value	Limit	Remedy
–	Boost pressure (air temperature 20°C, air pressure 100 kPa {760 mmHg})	–	36 kPa {270 mmHg}/ 3700 rpm	Inspect and adjust

Special tools

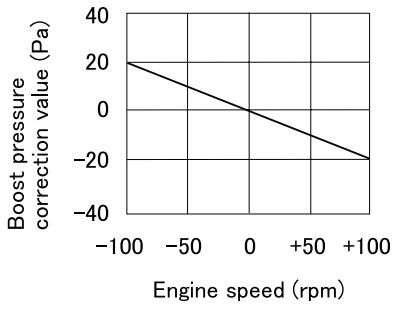
Mark	Tool name and shape	Part No.	Application
ⓒa	Boost pressure gauge  01524	MH061366	Measurement of turbo boost pressure



- Before measuring turbo boost pressure, clean or replace air cleaner element.
- Remove boost compensator air pipe, and attach ⓒa.
- After warming up the engine, measure the boost pressure at no-load maximum engine speed. Also measure the engine speed and the air temperature.



- Correct the boost pressure at standard conditions. (Since the boost pressure varies depending on the air temperature and engine speed.)
- [Correction for air temperature]
  Identify boost pressure coefficient depending on the air temperature from the graph.



(Difference between the median of the no-load maximum engine speed and the actual engine speed used for boost pressure measurement)

06165E

[Correction for engine speed]

Subtract the engine speed (rpm) actually used for measuring the boost pressure from the median of the no-load maximum engine speed. Identify the boost pressure correction value (Pa) according to the graph.

Median value: 3700 rpm

[Calculation of corrected boost pressure]

Given the measured boost pressure to be P, corrected boost pressure Pb can be calculated from the following equation.

Pb = ktP + Pa

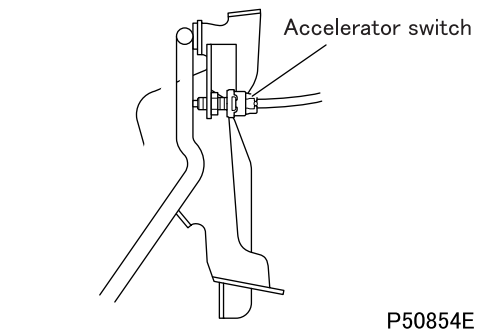
Pb : Corrected boost pressure
P : Measured boost pressure
kt : Boost pressure correcting coefficient depending on air temperature
Pa : Boost pressure correction value

If Pb is lower than the limit, the turbocharger must be inspected and adjusted.

2. Inspection and Adjustment of Exhaust Brake System

[Inspection]

- Set the exhaust brake switch to the “ON” position. Depress the accelerator pedal slowly and check that the exhaust brake operation indicator lamp in the meter cluster goes out when the engine speed reaches a range of 800 to 950 rpm.
- If the lamp fails to go out at the right time, the accelerator switch needs adjustment.



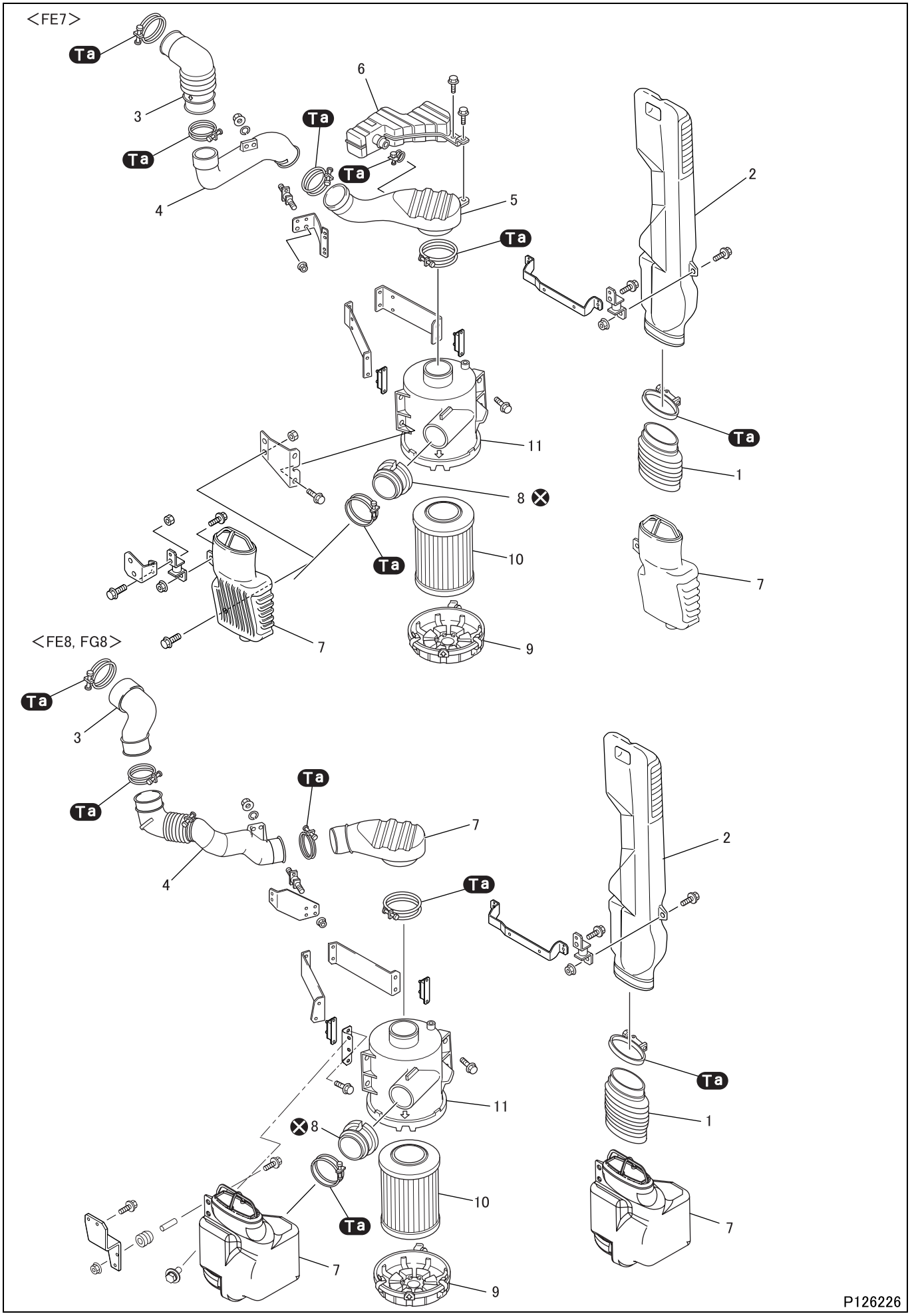
P50854E

[Adjustment]

- If the exhaust indicator lamp goes out before the engine speed reaches 800 rpm, screw the accelerator switch in further.
- If the exhaust indicator lamp goes out after the engine speed exceeds 950 rpm, back up the accelerator switch.

AIR DUCT AND AIR CLEANER <4D33>

<EXCEPT CREW CAB>



● Disassembly sequence

1 Connector
2 Air inlet duct
3 Air duct
4 Air duct
5 Air duct
6 Resonator <FE7>
7 Air box
8 Rubber seal
9 Air cleaner cap
10 Air cleaner element
11 Air cleaner case

⊗: Non-reusable parts

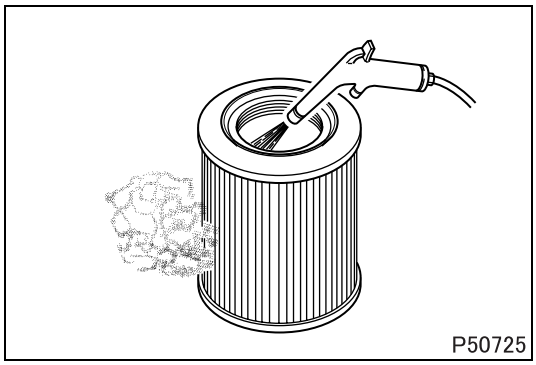
● Assembly sequence

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3 to 3.4 {0.3 to 0.35}	–

◆Cleaning procedure◆


P50725

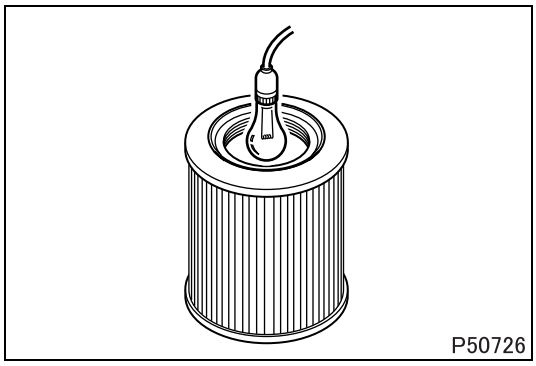
■ Cleaning: Filter element

- Blow a jet of compressed air at a pressure not higher than 685 kPa {7 kgf/cm^2} against the inside surfaces of the element.
- Move the compressed air jet up and down along all pleats of the filter paper element.

CAUTION ⚠

- **For the frequency and timing of cleaning, refer to the relevant instruction manual. More frequent cleaning than necessary could damage the element and cause dust and foreign matter to be sucked into the engine.**
- **Do not strike the element or hit it against another object to remove dust.**
- **Do not blow compressed air against outside surfaces of the element.**

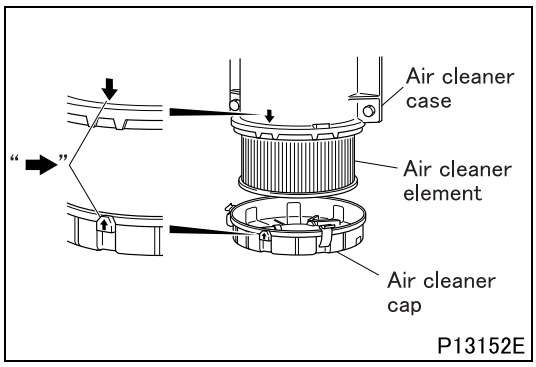
◆Inspection procedure◆


P50726

■ Inspection: Element

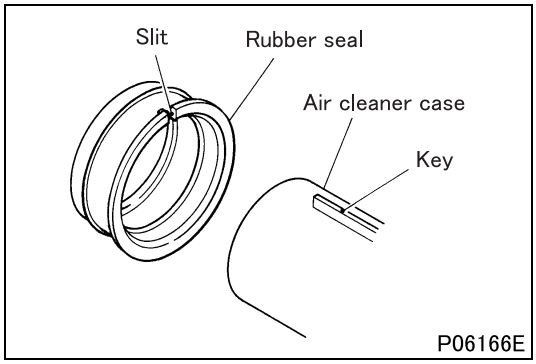
- Shine some electric light inside the element.
- Replace the element if thin spots or broken parts are evident in the filter paper, or if the packing at the top of the element is damaged.
  Also replace the element if the dust on the element is damp with oily smoke or soot, regardless of the replacement schedule.

◆Installation procedure◆



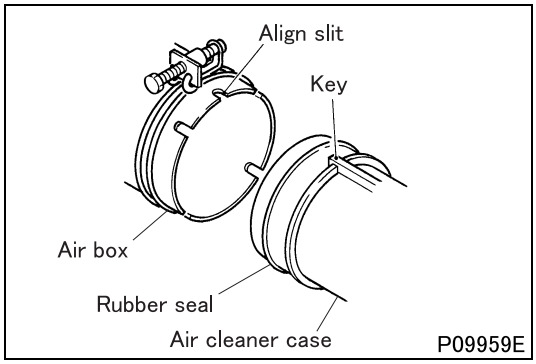
■ **Installation: Air cleaner cap**

➡: Alignment mark



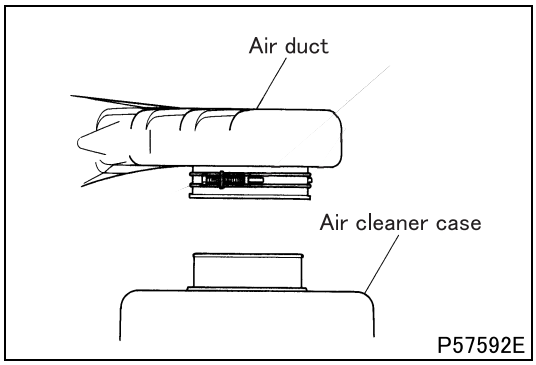
■ **Installation: Rubber seal <FE7>**

Align slit of rubber seal with key of air cleaner case.



■ **Installation: Air box <FE7>**

Align slit of air box with key of air cleaner case.



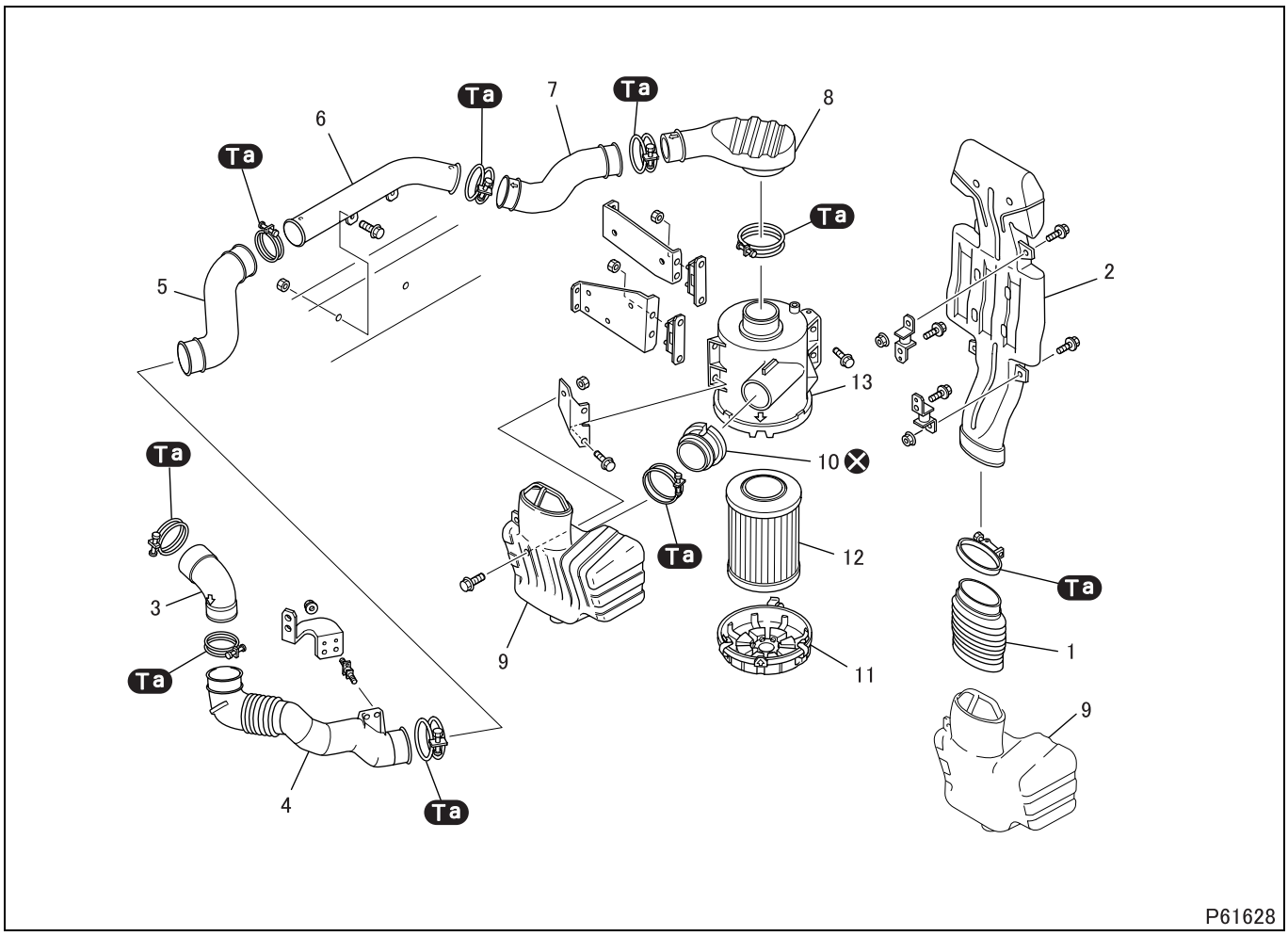
■ **Installation: Clamp and air duct**

- Fit clamp over protrusions of air duct.
- Push air duct in until it hits air cleaner case.

M E M O

AIR DUCT AND AIR CLEANER <4D33>

<CREW CAB>



● **Disassembly sequence**

1 Connector
2 Air inlet duct
3 Air duct
4 Air duct
5 Air hose
6 Air inlet pipe
7 Air hose
8 Air duct
9 Air box
10 Rubber seal
11 Air cleaner cap
12 Air cleaner element
13 Air cleaner case

⊗: Non-reusable parts

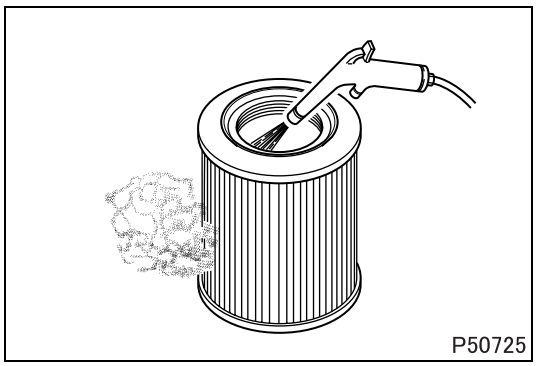
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3.0 to 3.4 {0.3 to 0.35}	–

◆Cleaning procedure◆



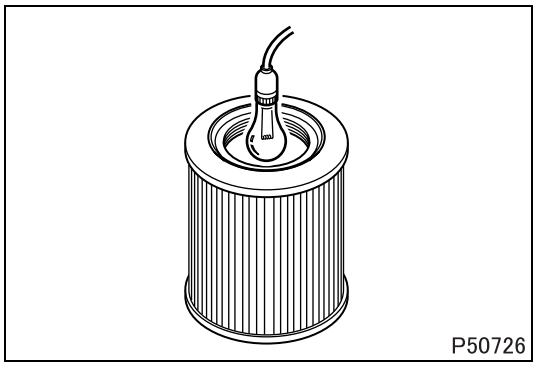
■ Cleaning: Filter element

- Blow a jet of compressed air at a pressure not higher than 685 kPa {7 kgf/cm^2} against the inside surfaces of the element.
- Move the compressed air jet up and down along all pleats of the filter paper element.

CAUTION ⚠

- **For the frequency and timing of cleaning, refer to the relevant instruction manual. More frequent cleaning than necessary could damage the element and cause dust and foreign matter to be sucked into the engine.**
- **Do not strike the element or hit it against another object to remove dust.**
- **Do not blow compressed air against outside surfaces of the element.**

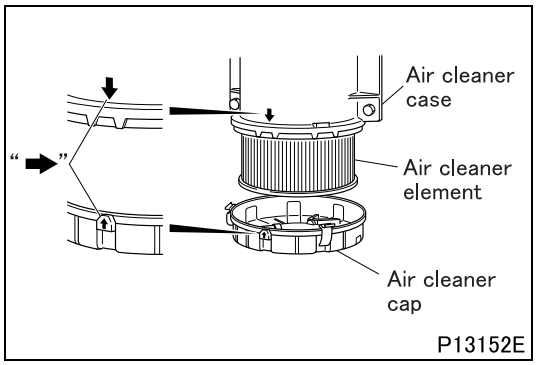
◆Inspection procedure◆



■ Inspection: Element

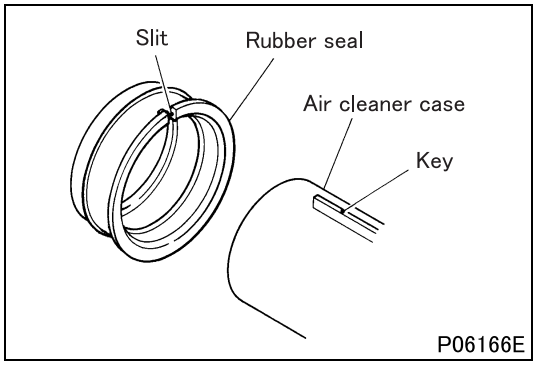
- Shine some electric light inside the element.
- Replace the element if thin spots or broken parts are evident in the filter paper, or if the packing at the top of the element is damaged.
  Also replace the element if the dust on the element is damp with oily smoke or soot, regardless of the replacement schedule.

◆Installation procedure◆



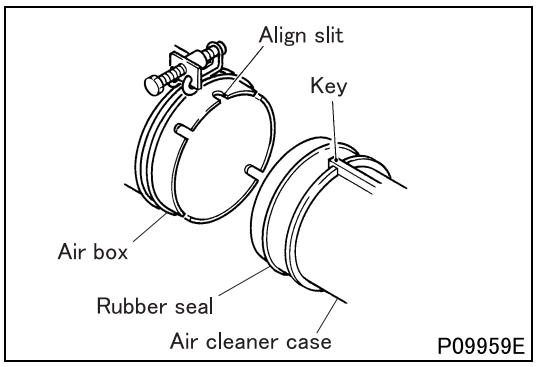
■ Installation: Air cleaner cap

➡: Alignment mark



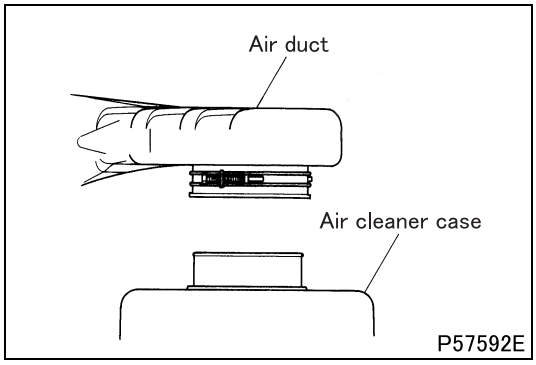
■ Installation: Rubber seal

Align slit of rubber seal with key of air cleaner case.



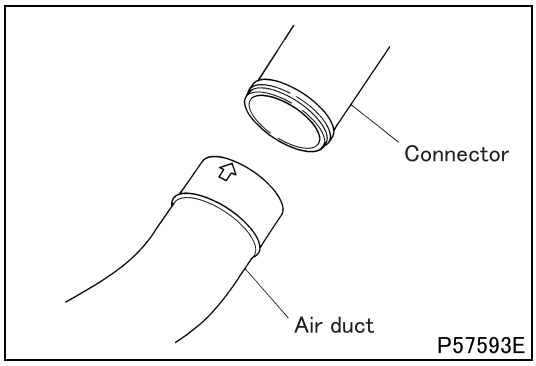
■**Installation: Air box**

Align slit of air box with key of air cleaner case.



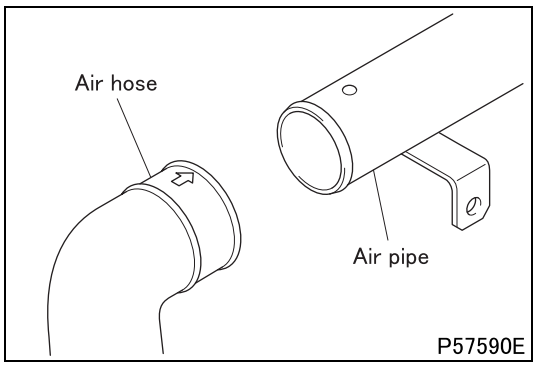
■ **Installation: Clamp and air duct**

- Fit clamp over protrusions of air duct
- Push air duct in until it hits air cleaner case.



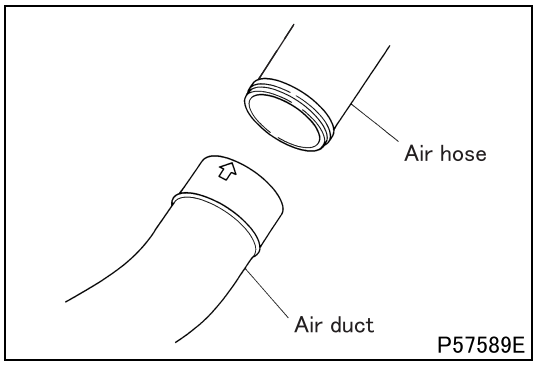
■ **Installation: Air duct**

Align the arrow mark "⇦" on air duct with protrusion on air inlet pipe and push in the air duct.



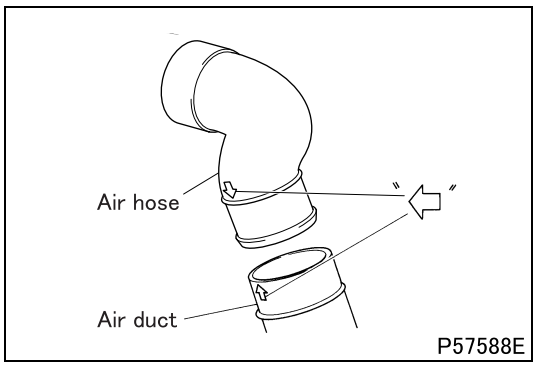
■ **Installation: Connector**

Align painted mark on connector with protrusion on air inlet pipe and push in the connector.



■ **Installation: Air duct**

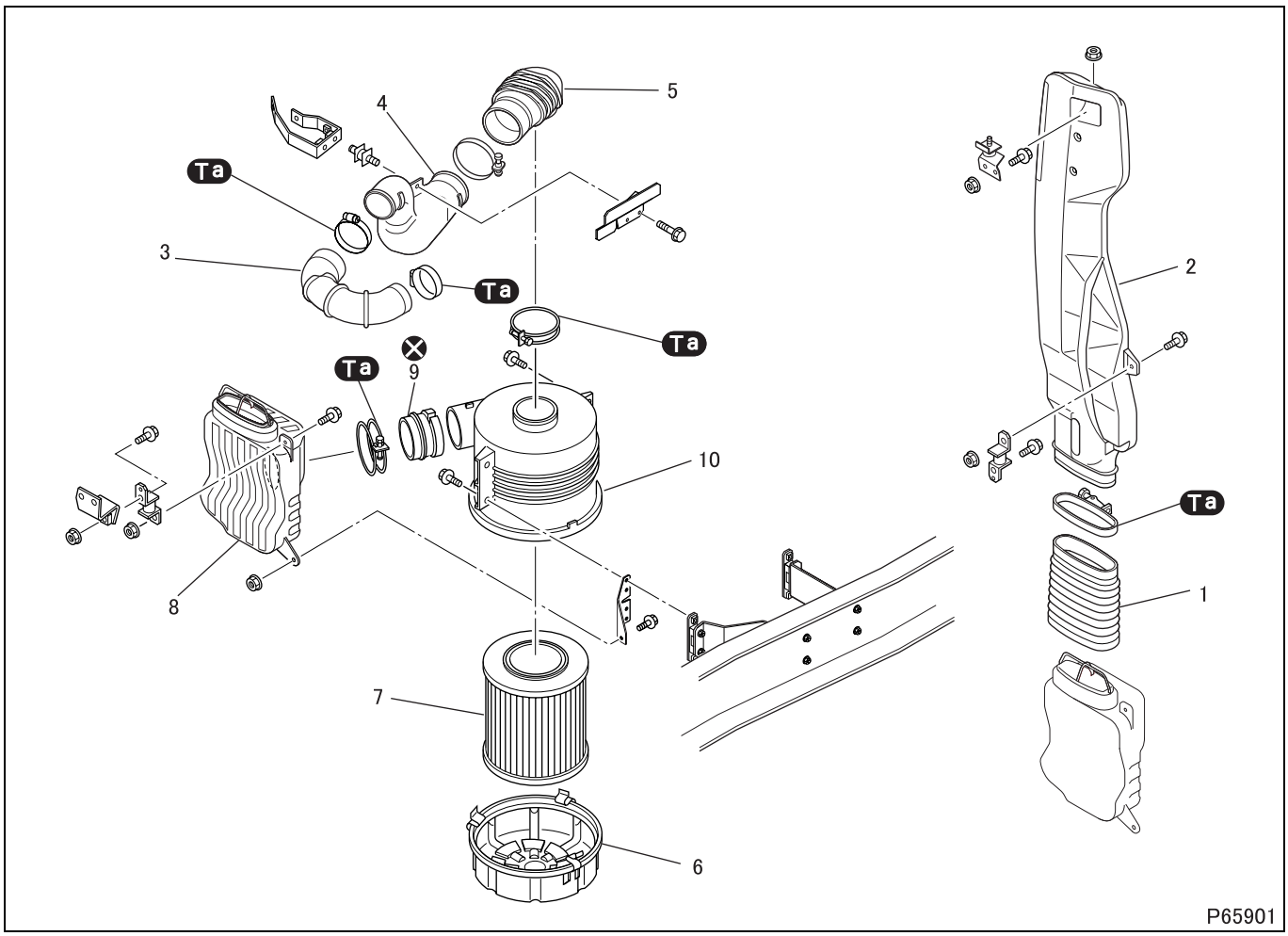
Align the arrow mark "⇦" on air duct with protrusion on air inlet pipe and push in the air duct.



■ **Installation: Air hose**

Align the arrow marks "⇦" on air hose and push it in until it hits stopper.

AIR DUCT AND AIR CLEANER <4D34>



● **Disassembly sequence**

1 Connector
2 Air inlet duct
3 Air hose
4 Air duct
5 Connector
6 Air cleaner cap
7 Air cleaner element
8 Air box
9 Rubber seal
10 Air cleaner case

⊗: Non-reusable parts

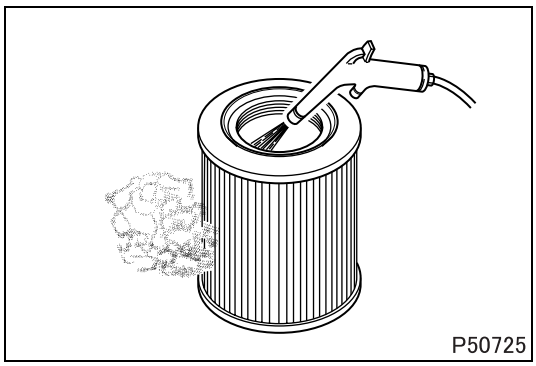
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp	3 to 3.4 {0.3 to 0.35}	–

◆Cleaning procedure◆



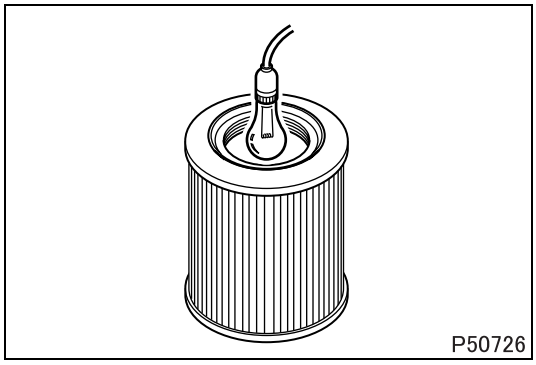
■ **Cleaning: Element**

- Blow a jet of compressed air at a pressure not higher than 685 kPa {7 kgf/cm^2} against the inside surfaces of the element.
- Move the compressed air jet up and down along all pleats of the filter paper element.

CAUTION ⚠

- **For the cleaning interval of the element, refer to the Owner's Handbook. Unnecessarily frequent cleaning may damage the element and can be the cause of dust and foreign objects being trapped in the engine.**
- **Do not strike the element or hit it against another object to remove dust.**
- **Do not blow compressed air against outside surfaces of the element.**

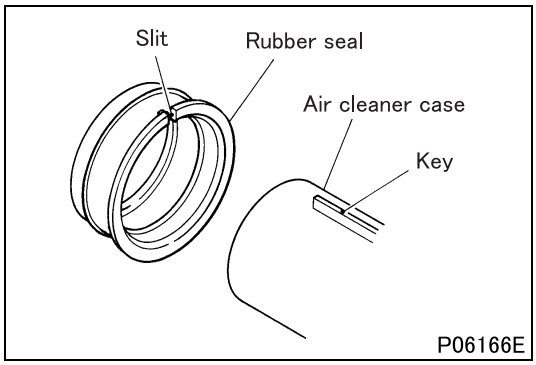
◆Inspection procedure◆



■ **Inspection: Element**

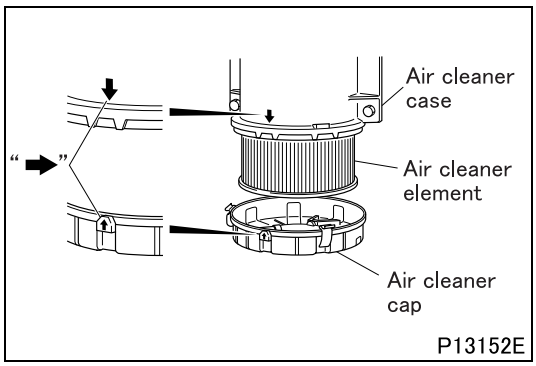
- Shine some electric light inside the element.
- Replace the element if thin spots or broken parts are evident in the filter paper, or if the packing at the top of the element is damaged.
  Also replace the element if the dust on the element is damp with oily smoke or soot, regardless of the replacement schedule.

◆Installation procedure◆



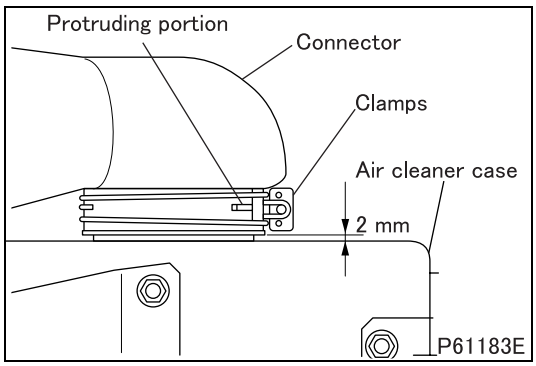
■ **Installation: Rubber seal**

Align slit of rubber seal with key of air cleaner case.



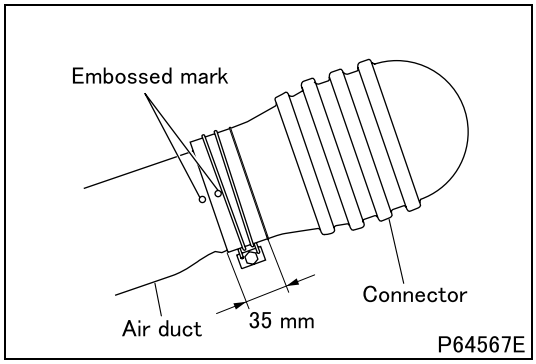
■ **Installation: Air cleaner cap**

➡: Alignment mark



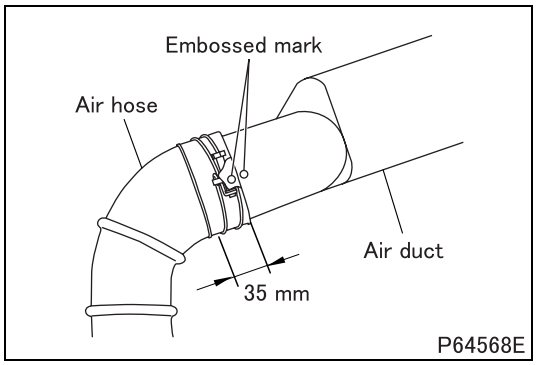
■ **Installation: Connector**

- The protruding portion of the connector is put between clamps.
- This ensures that the space between the connector and the air cleaner case may conform to the dimension shown in the figure.



■ **Installation: Connector**

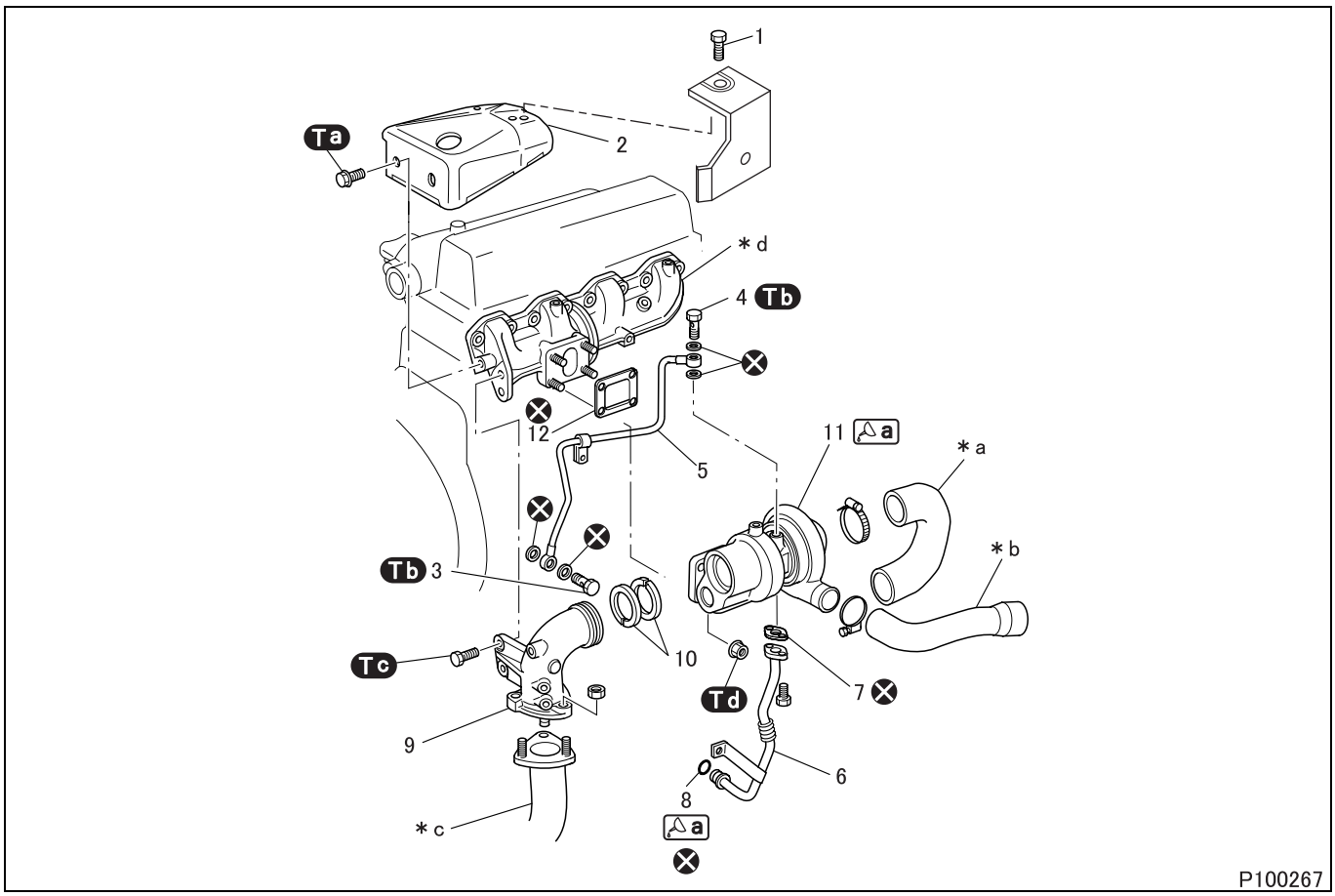
- Align the embossed marks on the connector and the air duct.
- Connect the connector with the air duct with the dimension shown in the drawing.



■ **Installation: Air hose**

- Align the embossed marks on the air hose and the air duct.
- Connect the air hose with the air duct with the dimension shown in the drawing.

M E M O



● **Removal sequence**

1 Insulator <FE7>
2 Insulator
3 Eyebolt
4 Eyebolt
5 Oil pipe
6 Oil return pipe
7 Gasket
8 O-ring
9 Exhaust pipe
10 Seal ring
11 Turbocharger (See later sections.)
12 Gasket

***a**: Air hose
***b**: Air inlet hose
***c**: Front pipe
***d**: Exhaust manifold
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

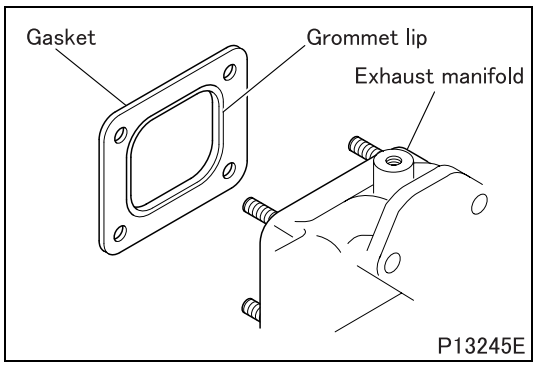
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (insulator mounting)	12 {1.2}	–
Tb	Eyebolt	21.6 {2.2}	–
Tc	Bolt (exhaust pipe mounting)	41 to 54 {4.2 to 5.5}	–
	Nut (turbocharger assembly mounting)		–

Lubricant and/or sealant

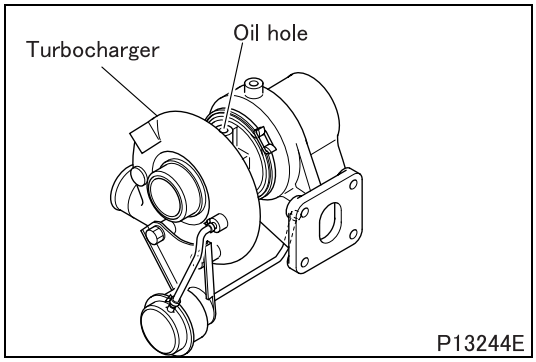
Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	O-ring	Engine oil	As required
	Supply when installing turbocharger assembly		

◆Installation procedure◆



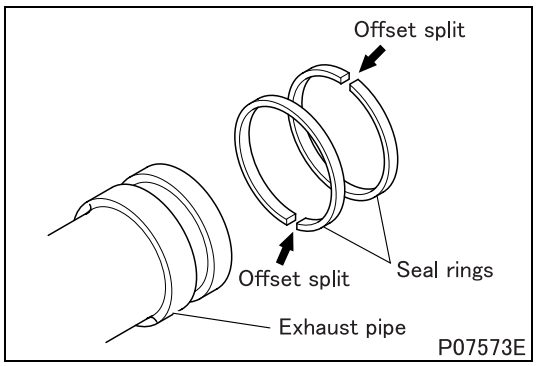
■ Installation: Gasket

- Install gasket to exhaust manifold in the direction as illustrated.



■ Installation: Turbocharger

- When installing the turbocharger, fill adequate amount of engine oil through the oil hole for smooth operation.

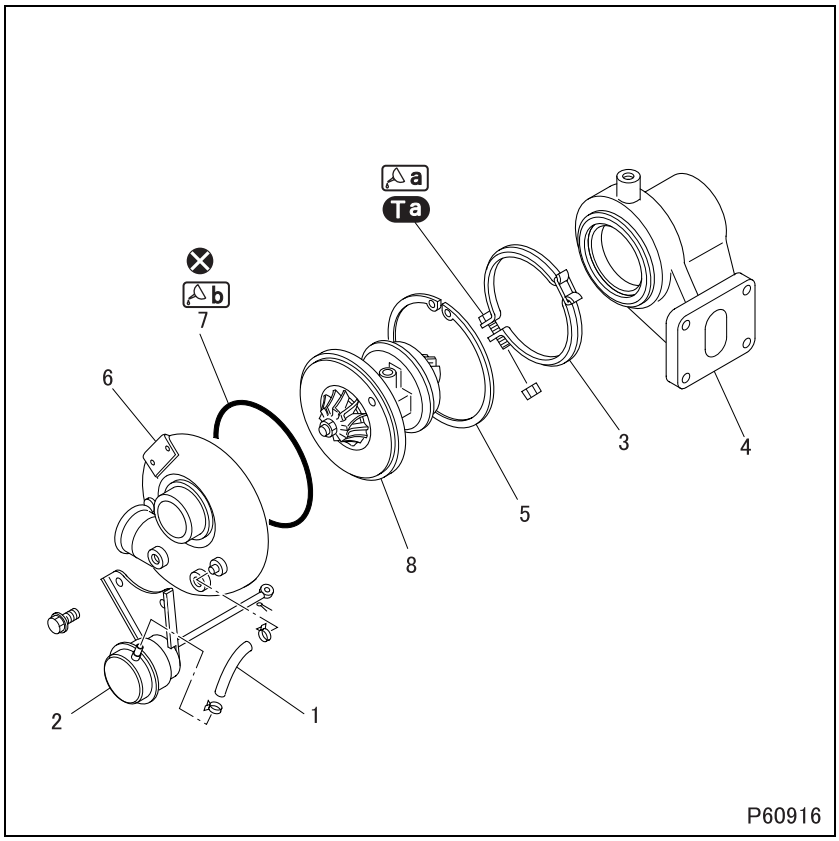


■ Installation: Seal ring

- Offset splits of seal rings at 180°.

TURBOCHARGER

Turbocharger



● **Disassembly sequence**

1 Hose
2 Actuator
3 Coupling
4 Turbine housing
5 Snap ring
6 Compressor cover
7 O-ring
8 Cartridge assembly

⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

CAUTION ⚠

- **Since cartridge assembly is a unit construction, if the turbine wheel or compressor wheel is damaged, or the cartridge assembly does not revolve smoothly, or any other fault is found, replace the assembly as a unit.**

Service standards (Unit: mm)

Location	Maintenance item			Standard value	Limit	Remedy
8	Cartridge assembly	Play in the shaft direction		0.05 to 0.09	0.1	Replace
		Play at right angles to the shaft	Turbine wheel side	0.40 to 0.53	0.58	
			Compressor wheel side	0.55 to 0.66	0.72	

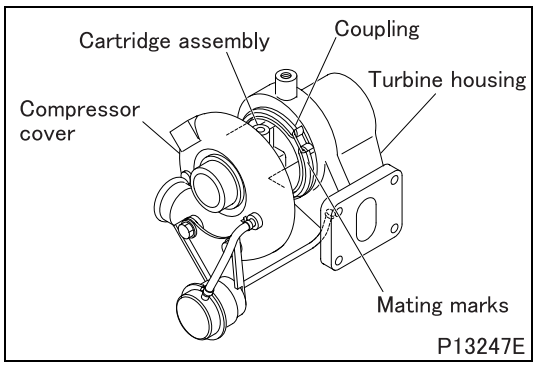
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (tightening of coupling)	3.9 to 4.9 {0.4 to 0.5}	Wet

Lubricant and/or sealant

Mark	Points of application	Specified lubricant and/or sealant	Quantity
a	Thread area of bolt	Molybdenum disulfide grease	As required
b	Periphery of O-ring	Engine oil	As required

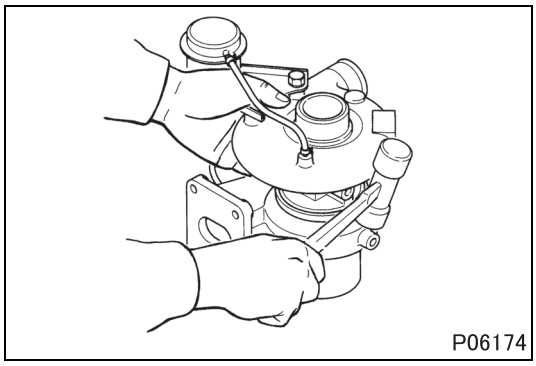
◆Work before removal◆



■ Mating marks

- Draw a line across the coupling, turbine housing, compressor cover, and cartridge assembly. This line will serve as mating marks in the installation procedure.

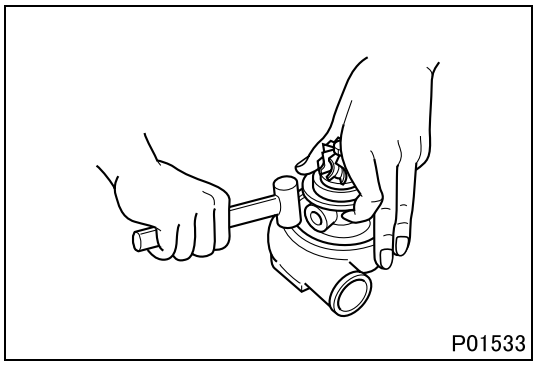
◆Removal procedure◆



■ Removal: Turbine housing

CAUTION ⚠

- **Tap all around the end of the turbine housing with a rubber hammer or a similar tool, being careful not damage the turbine housing**
- **Do not let the blades of the cartridge assembly hit the turbine housing, as they are easily bent.**

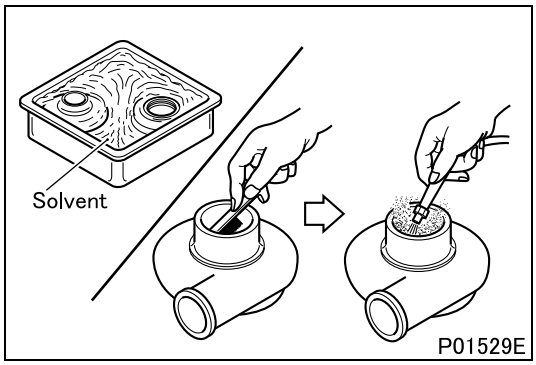


■ Removal: Compressor cover

CAUTION ⚠

- **Tap all around the end of the turbine housing with a rubber hammer or a similar tool, being careful not damage the turbine housing**
- **Do not let the blades of the cartridge assembly hit the turbine housing, as they are easily bent.**

◆Work after disassembly◆



■ Cleaning

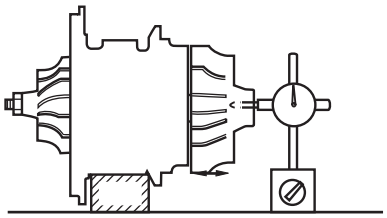
- Before cleaning the parts, carry out a visual inspection for any marks of burns or wear that may become difficult to find after the cleaning. If any defects are evident, replace the part(s).
- Immerse the disassembled parts in an inflammable solvent (add four to nine parts of water to New Hope's Oil Clean). Take out the parts from the solvent and dry them with compressed air.
  If there is any solid matter remaining on the parts, remove them with a plastic scraper or a bristle brush.

CAUTION ⚠

- **Do not immerse the cartridge assembly in the solvent. If doing so, O-rings in the cartridge assembly will swell and may adversely affect to the function of the turbocharger.**

- Reimmerse the parts in the solvent.
- Dry each part with compressed air.

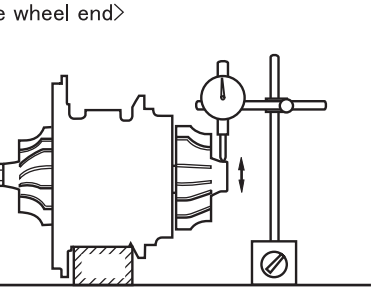
◆Inspection procedure◆


P06175

■ **Inspection: Cartridge assembly**

(1) Play in axial directions

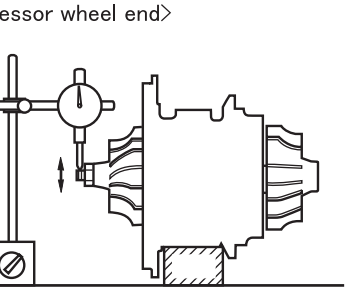
- If the measurement exceeds the specified limit, replace the cartridge assembly.



P06176E

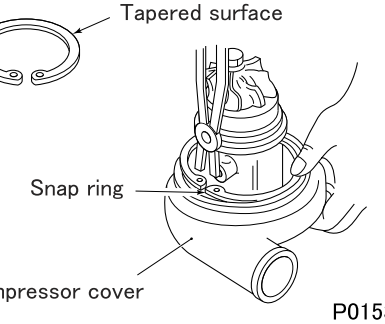
(2) Play in radical directions

- If the measurement exceeds the specified limit, replace the cartridge assembly.



P06177E

◆Installation procedure◆



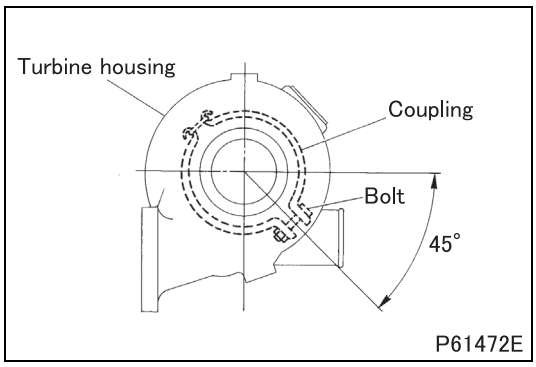
P01532E

■ **Installation: Snap ring**

- Fit the snap ring into the compressor cover with the tapered surface on top.

CAUTION ⚠

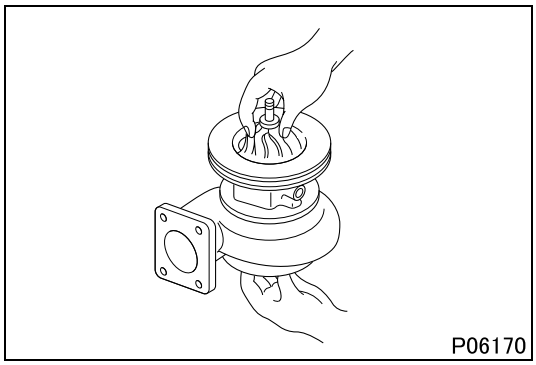
- **Always keep one hand on the snap ring to prevent it from flying off.**



■ **Installation: Coupling**

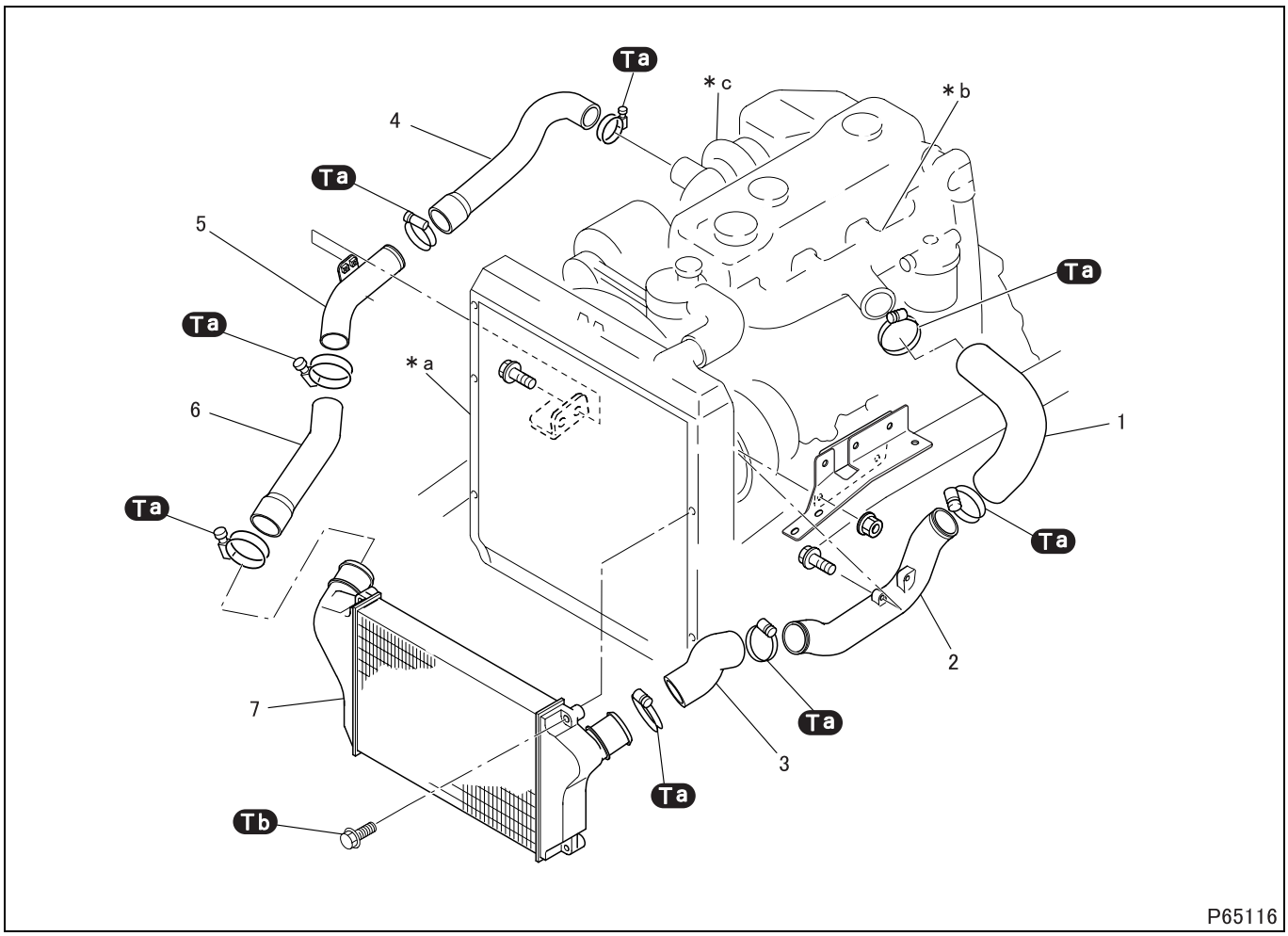
- Install coupling onto turbine housing in the direction as illustrated.

◆Work after installation◆



■ **Inspection: Rotation of cartridge assembly**

- Turn both wheels of the cartridge assembly to check that they rotate smoothly.
- If any abnormality is found, disassemble the cartridge assembly and perform necessary service.



● **Disassembly sequence**

1 Air inlet hose
2 Air inlet pipe
3 Air inlet hose
4 Air inlet hose
5 Air inlet pipe
6 Air inlet hose
7 Intercooler

***a**: Radiator
***b**: Intake manifold
***c**: Turbocharger

● **Assembly sequence**

Follow the disassembly sequence in reverse.

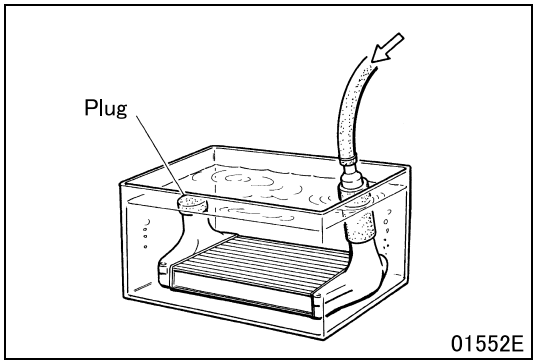
Service standards

Location	Maintenance item	Standard value	Limit	Remedy
7	Air leakage from intercooler (air pressure: 147 kPa {1.5 kgf/cm^2})	0 cm^3 {0 mL}	–	Replace

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Clamp (air inlet hose mounting)	3.9 to 4.9 {0.4 to 0.5}	–
Tb	Bolt (intercooler mounting)	12 to 15 {1.2 to 1.5}	–

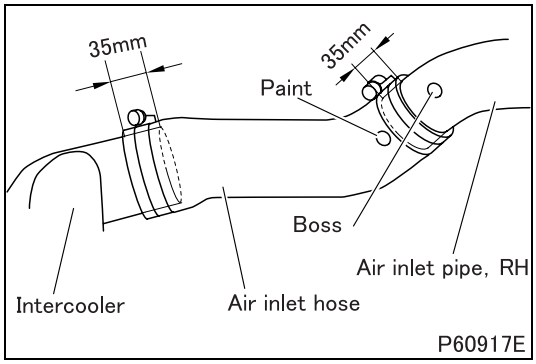
◆Inspection procedure◆



■ **Inspection: Intercooler**

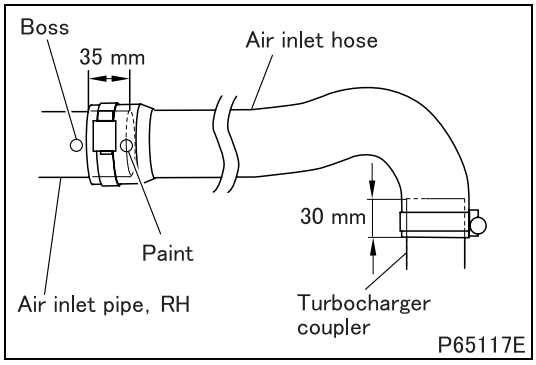
- Plug one of the air ports on the intercooler and connect an air source to the other port. Place the intercooler in a tank of water and apply air pressure at the specified level (200 kPa {2.0 kgf/cm^2) to the intercooler and retain pressure for 30 seconds.
- Replace the intercooler if any air leakage is evident.

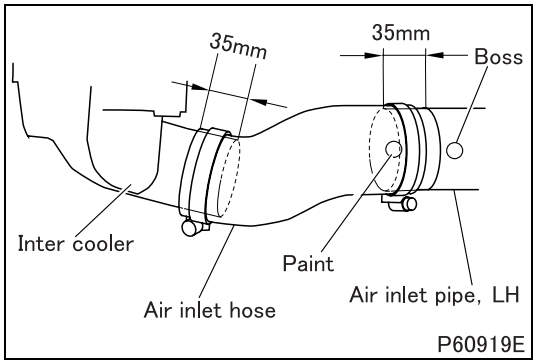
◆Installation procedure◆



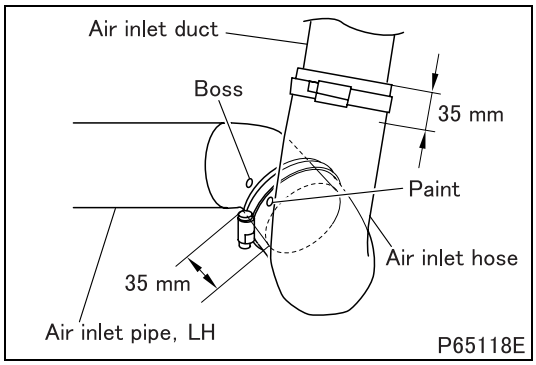
■ **Installation: Air inlet hose**

- Connect the air inlet hose to the RH air inlet pipe with the paint on the hose aligned with the boss on the pipe.
- Connect the air inlet hoses to the intercooler, RH air inlet pipe and turbocharger coupler to the dimensions indicated in the illustrations.

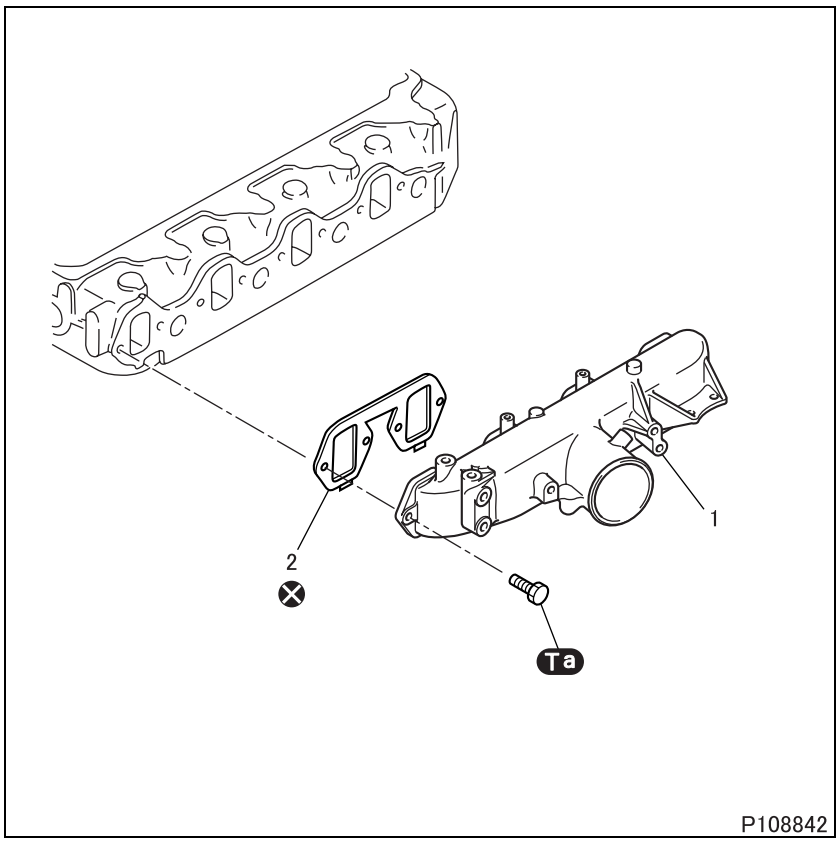




- Connect the air inlet hose to the LH air inlet pipe with the paint on the hose aligned with the boss on the pipe.
- Connect the air inlet hoses to the intercooler, LH air inlet pipe and air inlet duct to the dimensions indicated in the illustrations.



INTAKE MANIFOLD <4D33>



● **Disassembly sequence**

1 Intake manifold
2 Gasket

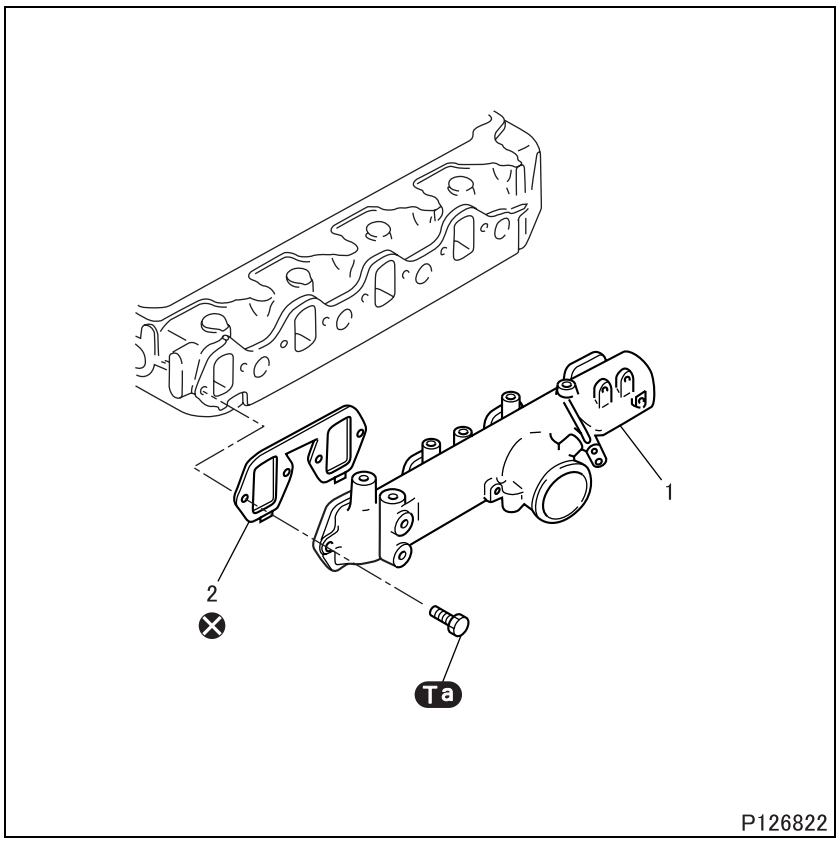
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (intake manifold mounting)	16 to 24 {1.6 to 2.4}	–



● **Disassembly sequence**

1 Intake manifold
2 Gasket

⊗: Non-reusable parts

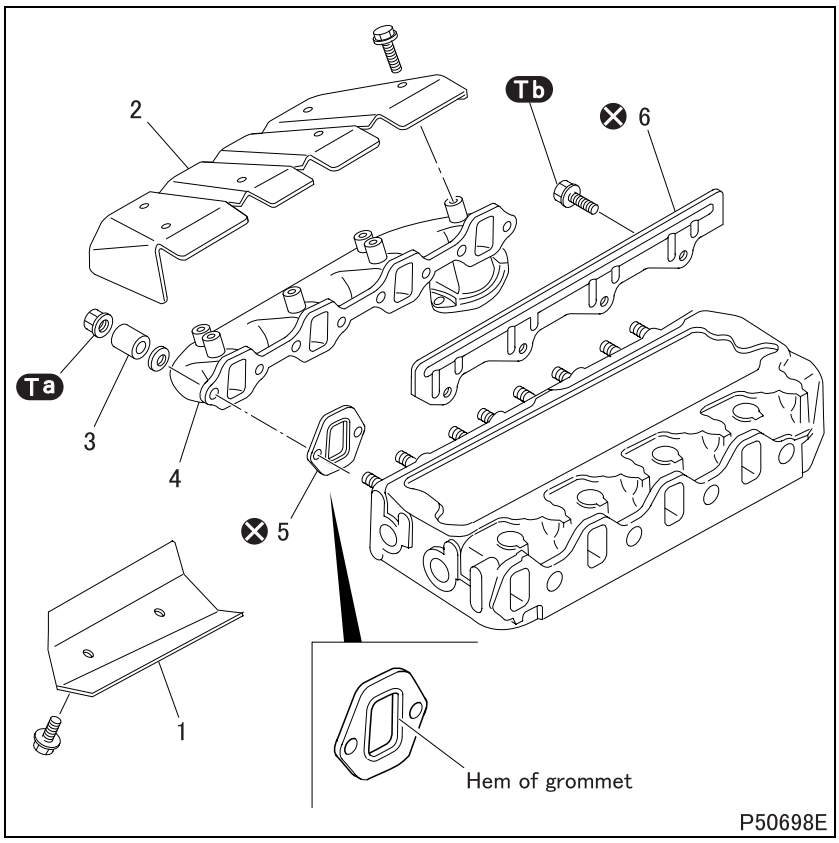
● **Assembly sequence**

Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (intake manifold mounting)	16 to 24 {1.6 to 2.4}	–

EXHAUST MANIFOLD <4D33>



● **Disassembly sequence**

1 Insulator
2 Insulator
3 Distance piece
4 Exhaust manifold
5 Gasket
6 Insulator

⊗: Non-reusable parts

● **Assembly sequence**

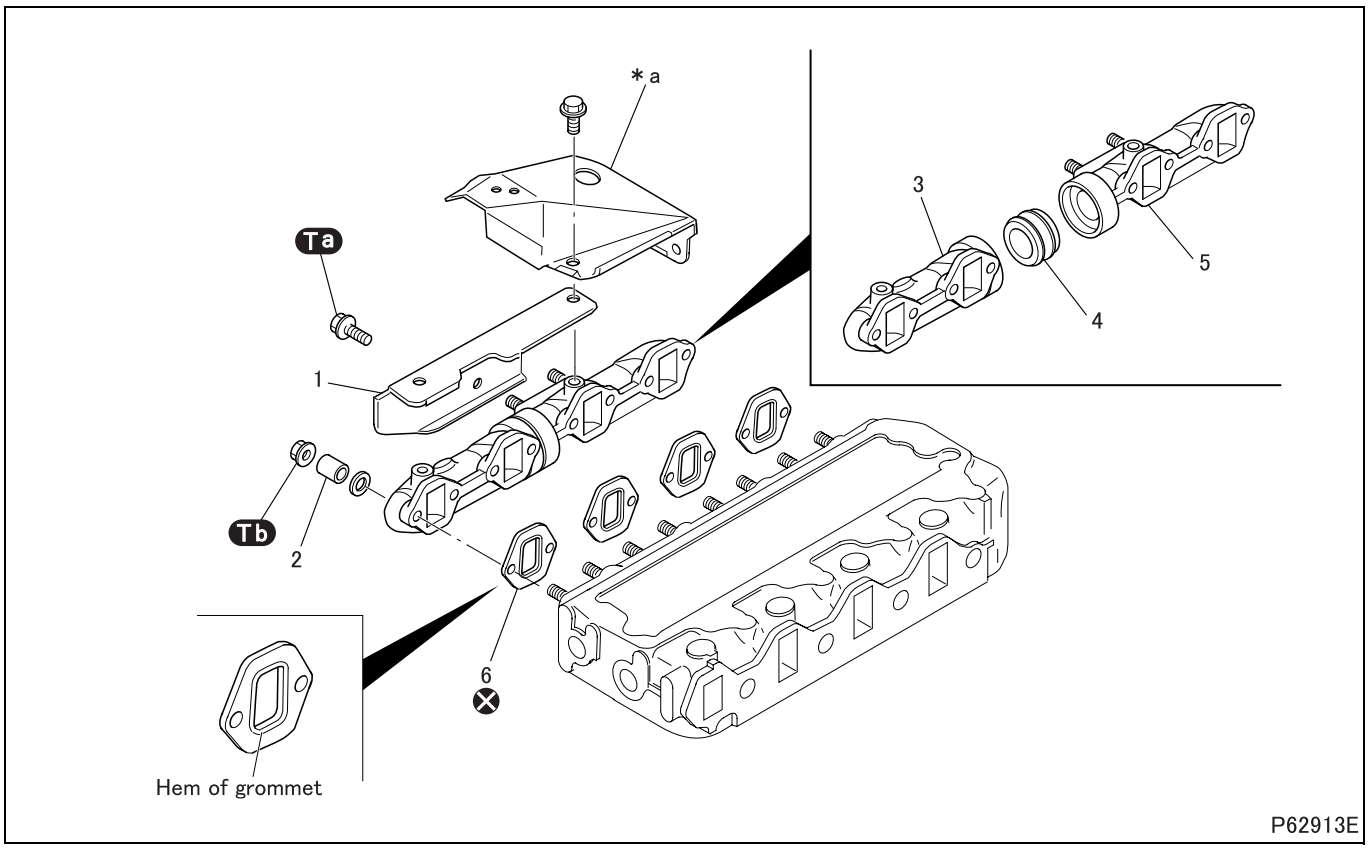
Follow the disassembly sequence in reverse.

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (exhaust manifold mounting)	41 to 54 {4.2 to 5.5}	–
Tb	Bolt (insulator mounting)	12 {1.2}	–

M E M O

EXHAUST MANIFOLD <4D34>



● **Disassembly sequence**

1 Insulator
2 Distance piece
3 Front exhaust manifold
4 Joint
5 Rear exhaust manifold
6 Gasket
***a**: Insulator
⊗: Non-reusable parts

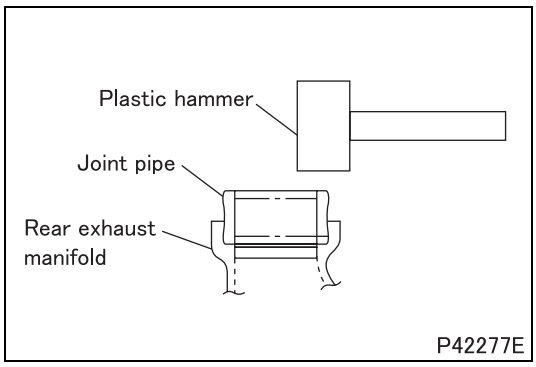
● **Assembly sequence**

Follow the disassembly sequence in reverse.

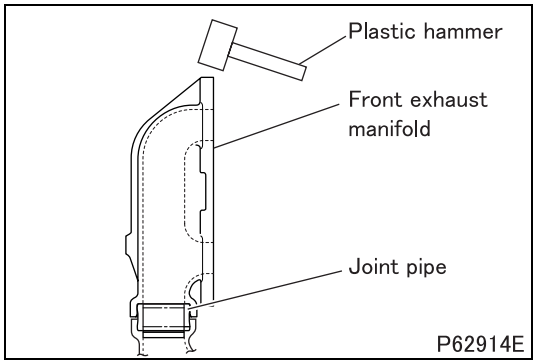
Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (insulator mounting)	12 {1.2}	–
Tb	Nut (front exhaust manifold and rear exhaust manifold mounting)	41 to 54 {4.2 to 5.5}	–

◆Installation procedure◆

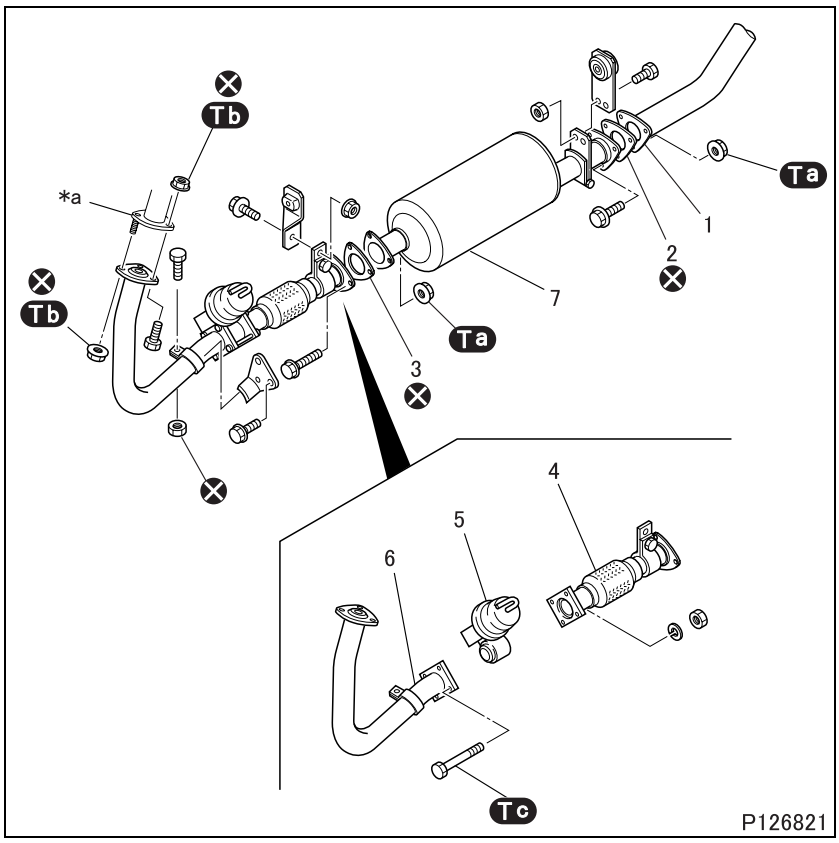


■ **Installation: Joint**



■ **Installation: Front exhaust manifold**

EXHAUST PIPE AND MUFFLER



● **Disassembly sequence**

1 Tail pipe
2 Gasket
3 Gasket
4 Front pipe
5 Exhaust brake unit (See later sections.)
6 Front pipe
7 Muffler

***a**: Exhaust manifold
⊗: Non-reusable parts

● **Assembly sequence**

Follow the disassembly sequence in reverse.

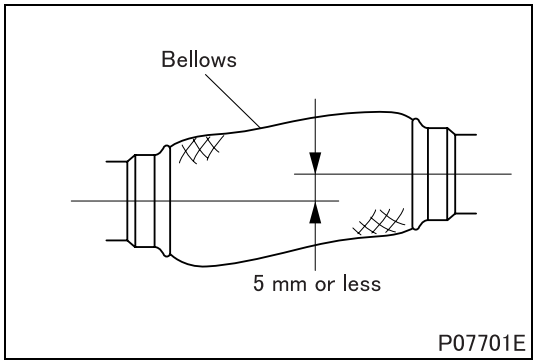
WARNING ⚠

- **Never hit or kick muffler, or the catalyzer in the muffler will be damaged.**
- **A small amount of water sometimes collects inside muffler. Never touch this water, if you do by mistake, wash it off immediately with clean water.**

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Nut (tail pipe mounting)	26 to 33 {2.7 to 3.4}	–
	Nut (muffler mounting)		
Tb	Nut (front pipe mounting)	25 to 30 {2.5 to 3.0}	–
Tc	Bolt (exhaust brake unit mounting)	27 to 29 {2.8 to 3.0}	–

◆Installation procedure◆



■ **Installation: Front pipe**

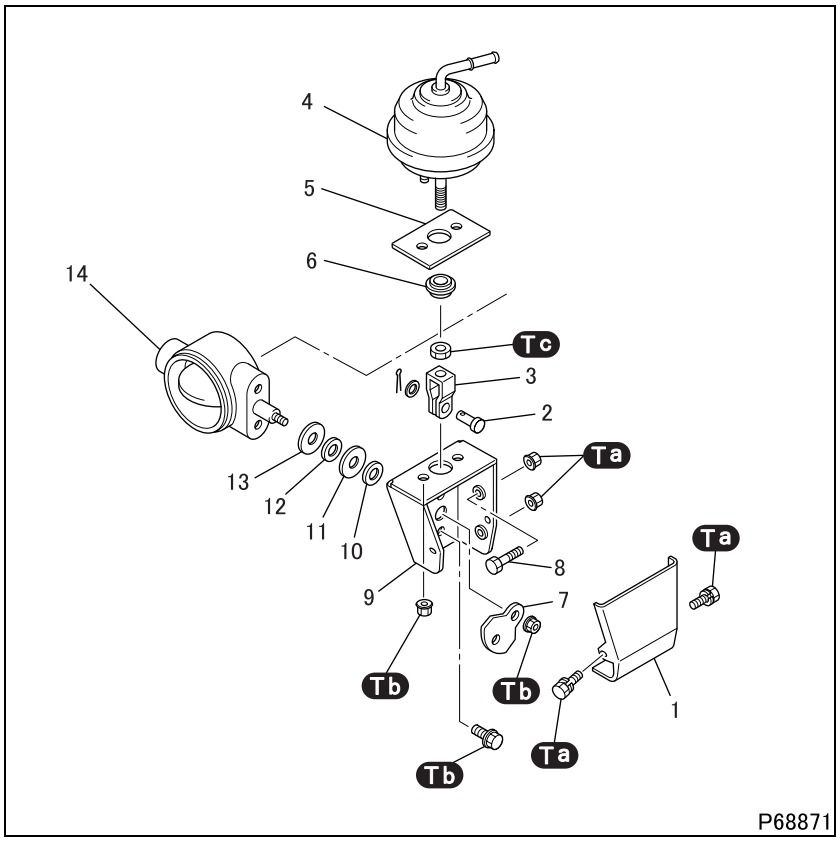
- Install the front pipe so that the amounts of offset in both vertical and horizontal directions between the pipes in front of and behind the bellows are smaller than the dimension indicated in the illustration.

CAUTION ⚠

- **The function of the bellows on the front pipe is to reduce the vehicle noise level. It is not intended for compensating for misalignment that may result from improper installation of the front pipe. Install the front pipe properly to avoid excessive tension or other stress on the bellows.**

M E M O

Exhaust Brake Unit



● Disassembly sequence

1 Cover
2 Clevis pin
3 Clevis
4 Power chamber
5 Gasket
6 Bearing
7 Lever
8 Adjust bolt
9 Bracket
10 Seal ring A
11 Seal ring B
12 Seal ring A
13 Seal ring B
14 Valve

CAUTION ⚠

- **Do not attempt to disassemble the power chamber.**

NOTE

- **For removal and installation procedures of the exhaust brake unit, see Gr15.**

● Assembly sequence

Follow the disassembly sequence in reverse.

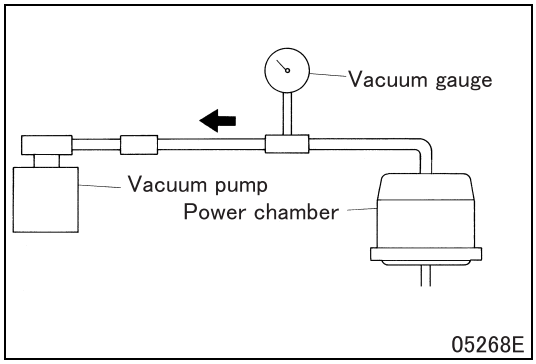
Service standards (Unit: mm)

Location	Maintenance item	Standard value	Limit	Remedy
–	Average of top and bottom clearances between butterfly valve and body with valve fully closed (With power chamber vacuum of 87 to 93 kPa {650 to 700 mmHg} or above)	0.10 to 0.25	–	Replace
4	Air-tightness of power chamber (At 15 sec. after vacuum of 67 kPa {500 mmHg} is achieved in chamber)	63 kPa {475 mmHg} or above	–	Replace

Tightening torque (Unit: N·m {kgf·m})

Mark	Parts to be tightened	Tightening torque	Remarks
Ta	Bolt (cover mounting)	4.9 to 6.9 {0.5 to 0.7}	–
	Nut (bracket mounting)		
Tb	Nut (power chamber mounting)	10.8 to 16.7 {1.1 to 1.7}	–
	Bolt (bracket mounting)		
	Nut (lever mounting)		
Tc	Lock nut (Clevis retention)	9.8 to 15.7 {1.0 to 1.6}	–

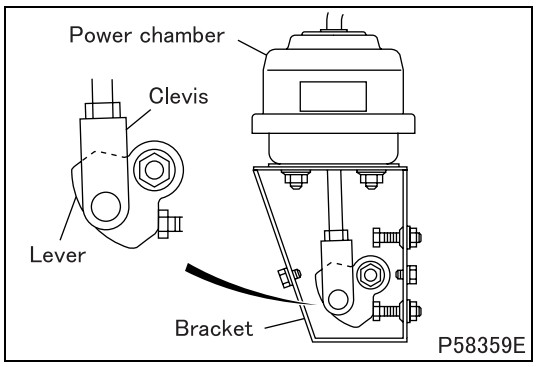
◆Inspection procedure◆



■ **Inspection: Power chamber air-tightness**

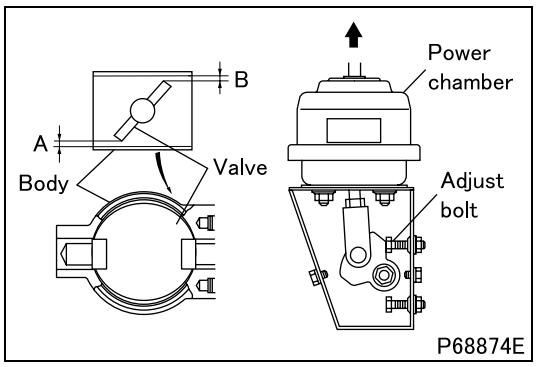
- Connect the components with piping as illustrated. When a vacuum of 67 kPa {500 mmHg} or above is applied to the power chamber, stop the vacuum pump.
- Fifteen seconds later, the reading on the vacuum gauge should conform to the standard value.
- If not, replace the power chamber.

◆Adjustment after installation◆



■ **Adjustment: Clevis**

- Assemble the power chamber onto the bracket. Then, adjust the location of the clevis such that the hole in the clevis is aligned by half with the hole in the lever.

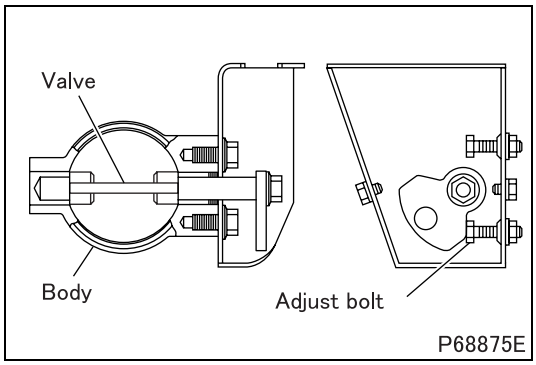


■ **Adjustment: Valve**

(1) Butterfly valve fully-closed position

- Apply a vacuum of 87 to 93 kPa {650 to 700 mmHg} to the power chamber to fully close the butterfly valve. With the valve fully closed, measure the top and bottom clearances B and A between the valve and the body, and obtain the average of the two. The average value should conform to the standard value. Adjust with the adjust bolt as required.

$$\text{Average clearance} = \frac{(A + B)}{2}$$



(2) Valve fully-open position

- Adjust the butterfly valve to the full open position using the adjust bolt.

CANTER

For Gulf Countries 2014 Model

Shop Manual

4D3 diesel engine

MITSUBISHI FUSO TRUCK & BUS CORP.

OCTOBER 2013

262 (H)