




HOW TO READ THIS MANUAL

How This Manual Is Compiled

- This manual is compiled by classifying various systems into certain groups.
- Each group contains specifications; troubleshooting; maintenance service standards;  tightening torque;  lubricant, fluid and sealant;  special tools; and service procedure.
- Page enumeration is independent by every group where first page is always 1.

Group No.	Group denomination	Contents
00	General	General specifications, engine No. and name plate, precautions for maintenance operations, table of standard tightening torques
11	Engine	Engine body
12	Lubrication	Lubrication system
13	Fuel and engine control	Fuel system
14	Cooling	Cooling system
15	Intake and exhaust	Intake and exhaust system, turbocharger, intercooler
21	Clutch	Clutch proper, bearing case
54	Electrical system	Alternator, starter, preheating system, engine start system, automatic stop system
61	Special equipment	Air compressor, pressure governor

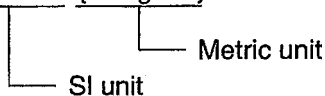
HOW TO READ THIS MANUAL

● Unit

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

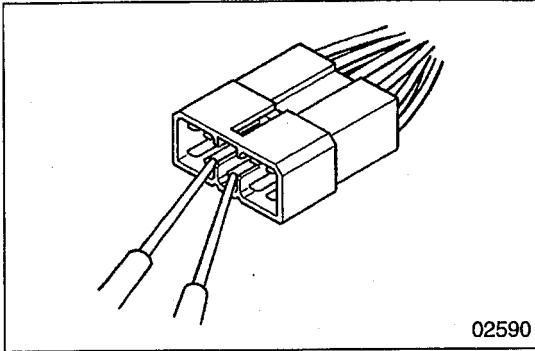
*SI: Le Système International d'Unités

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 }
	Vacuum pressure	kPa {mmHg}
		Pa {mmH ₂ O}
Volume	dm ³ {L}	1 dm ³ {1 L}
Power	kW {PS}	0.7355kW {1 PS}
Heat quantity	J {kcal}	4186.05 J {1 kcal}
Heat flow	W {kcal/h}	1.16279 W {1 kcal/h}
Angle	°	—
Temperature	°C	—
Electric current	A	—
Voltage	V	—
Resistance	Ω	—
Electric power	W	—

Unit	SI unit	Foot-pound unit	Conversion rate
Force	N (Newton)	lbf	1 N = 0.2248 lbf
Moment of force	N · m	ft.lbs	1 N · m = 0.7375 ft.lbs
Pressure	kPa (kilopascal)	psi	1 kPa = 0.145 psi 1 kPa = 0.2953 in. Hg
Volume	L	gal.	1 L = 0.2642 gal. (U.S.) 1 L = 0.220 gal. (Imp.)
	cm ³	oz	1 cm ³ = 0.033814 oz (U.S.) 1 cm ³ = 0.035195 oz (Imp.)
	cm ³	cu.in.	1 cm ³ = 0.061023 cu.in.
Power	kW (kilowatt)	PS	1 kW = 1.3596 PS
Temperature	°C	°F	t°C = (1.8t°C + 32)°F
Mass quantity of matter	kg	lb	1 kg = 2.2046 lb
	g	oz	1 g = 0.035274 oz
Dimension	m	ft.	1 m = 3.2808 ft.
	mm	in.	1 mm = 0.03937 in.

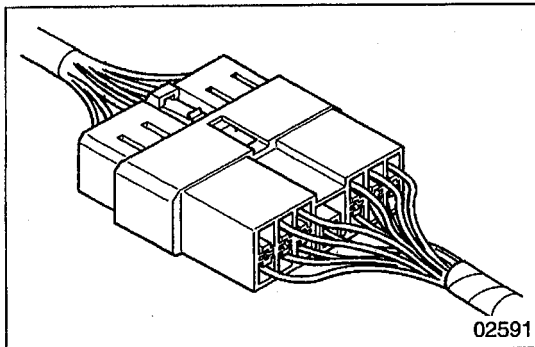


Using male pins
Touch the pins directly using test probes.

CAUTION ⚠

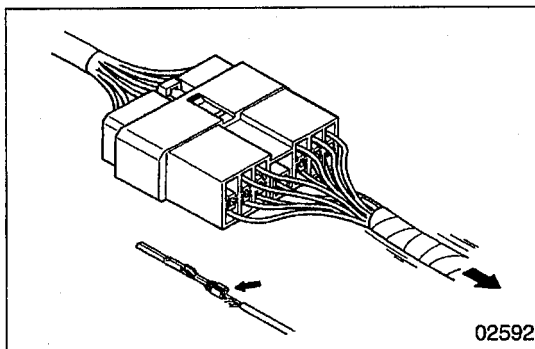
Be sure that you do not short circuit the connector pins when you use the test probe because this could damage the internal circuit of the electronic control unit.

Connector Inspection Procedures

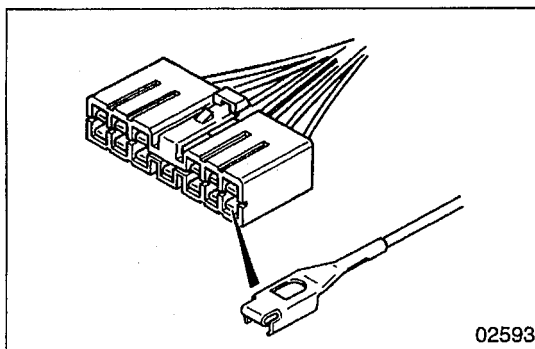


Visual inspection

Check for loose connection and poor engagement.

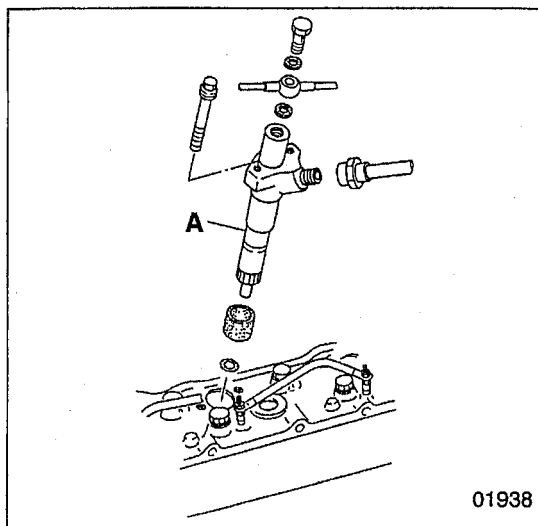


Check if harnesses are broken by pulling gently around the terminals.



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

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

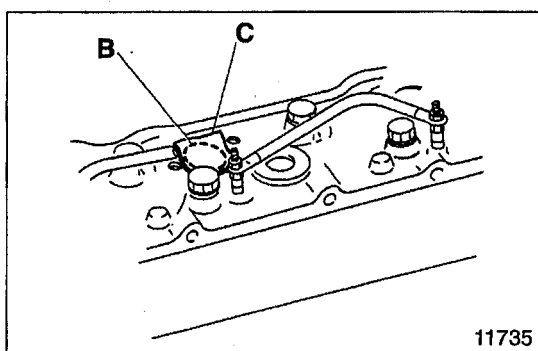


- Remove the injection nozzle **A**.

📖 Gr 13A

CAUTION ⚠

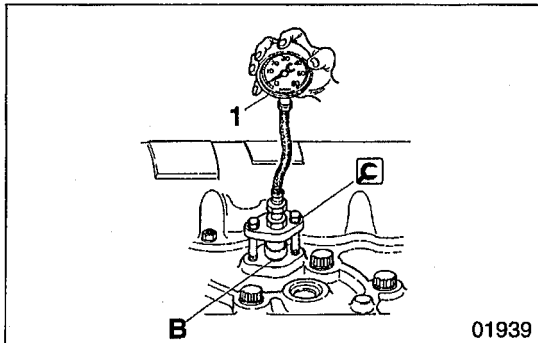
Cover the mounting holes and injection pipes to prevent the entry of dust and dirt.



- Cover the injection nozzle mounting hole **B** with a cloth **C**. Then, turn the engine over with the starter and check that no foreign matter adheres to the cloth.

WARNING ⚠

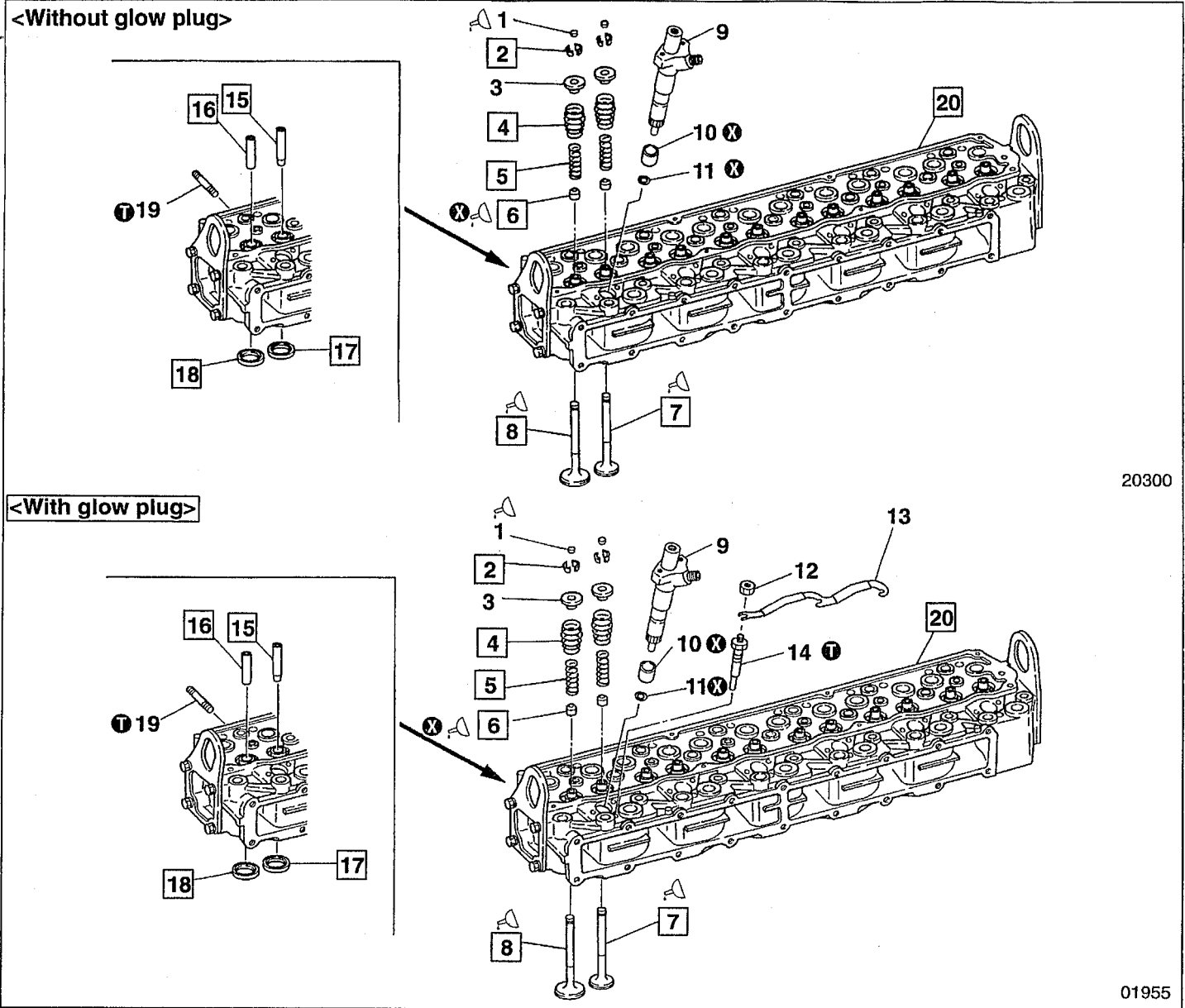
If any cylinder is cracked, coolant, engine oil, and fuel will enter the cylinder through the crack. When the engine is turned over, these substances will spray out of the nozzle mounting hole **B** at a high temperature. For safety, move away from the nozzle mounting hole before turning over the engine.



- Fit the **C** Compression Gauge Adapter onto an injection nozzle mounting hole **B** together with a nozzle gasket. Then, connect the compression gauge **1**.
- Turn the engine over and measure the compression pressure.
- Measure the compression pressure in every cylinder and determine the pressure differences between cylinders.
- If any compression pressure or cylinder-to-cylinder pressure difference exceeds the specified limit, pour a little engine oil into the cylinder via the injection nozzle mounting hole **B** then take the measurement again.
 - If the compression pressure increases, there may be wear or damage on piston rings and inner surfaces of cylinders.
 - If the compression pressure does not increase, valves may be seized or incorrectly seated, or the cylinder head gasket may be defective.

CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head and Valve Mechanism



20300

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● Disassembly sequence

- | | | |
|----------------------|-------------------------------|-----------------------|
| 1 Valve cap | 9 Injection nozzle Gr 13 | 16 Inlet valve guide |
| 2 Valve cotter | 10 Dust seal | 17 Exhaust valve seat |
| 3 Upper retainer | 11 Nozzle tip gasket | 18 Inlet valve seat |
| 4 Outer valve spring | 12 Nut <With glow plug> | 19 Stud |
| 5 Inner valve spring | 13 Connecting plate | 20 Cylinder head |
| 6 Valve stem seal | 14 Glow plug <With glow plug> | |
| 7 Exhaust valve | Gr 54 | |
| 8 Inlet valve | 15 Exhaust valve guide | |

⊗ : Non-reusable part

CAUTION

The injection nozzles 9 and glow plugs 14 project from the bottom surface of cylinder head 20. Take care not to damage them.

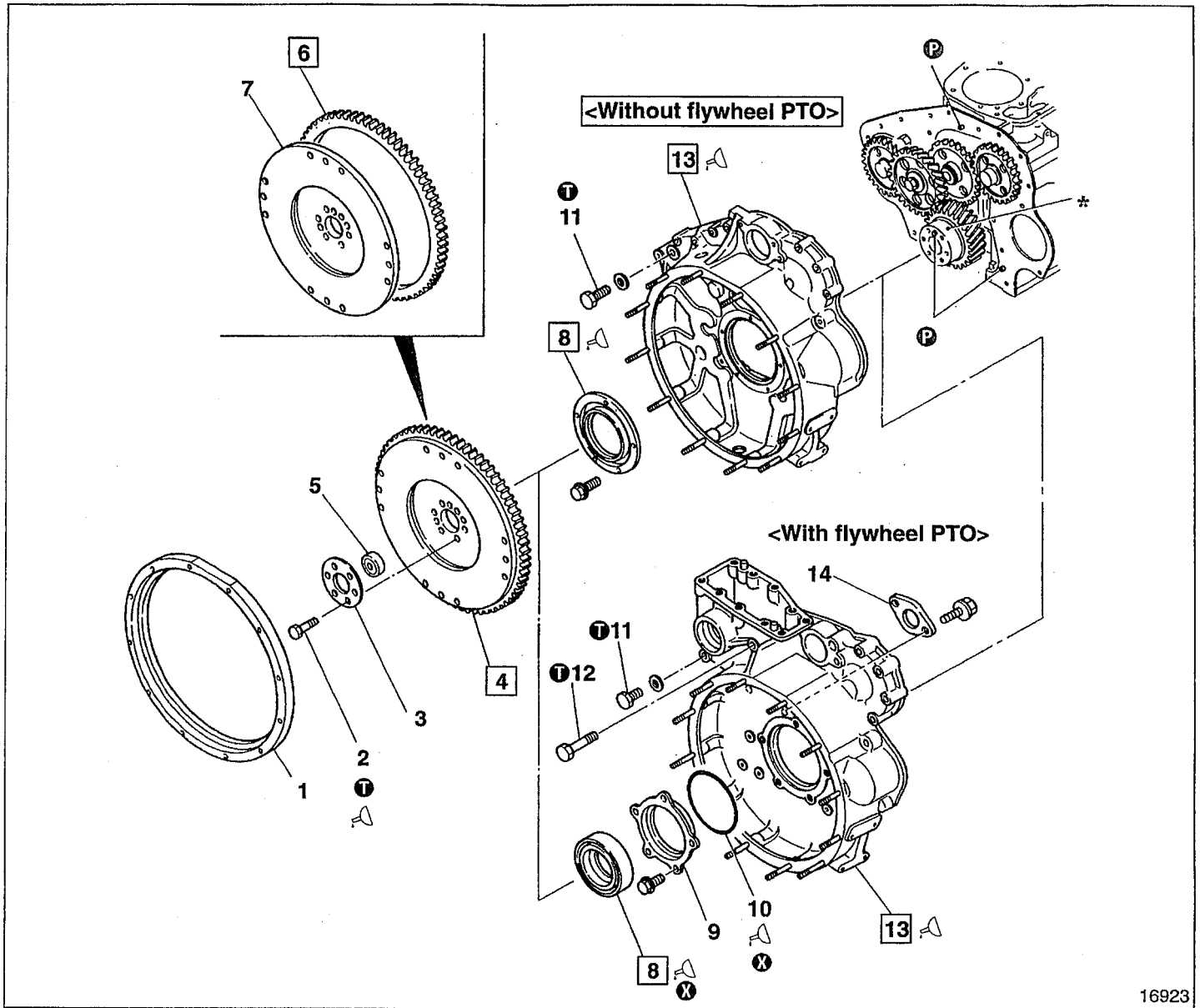
● Assembly sequence

Follow the disassembly sequence in reverse.

NOTE

Any valve stem seal 6 removed from an exhaust valve 7 or inlet valve 8 must be replaced.

FLYWHEEL



16923

● Disassembly sequence

- 1 Spacer
- 2 Bolt
- 3 Washer plate
- 4 Flywheel assembly
- 5 Pilot bearing
- 6 Ring gear
- 7 Flywheel
- 8 Rear oil seal
- 9 Rear oil seal retainer <models with flywheel PTO>

- 10 O-ring <models with flywheel PTO>
- 11 Plug
- 12 Bolt <models with flywheel PTO>
- 13 Flywheel housing
- 14 Thrust plate <models with flywheel PTO>

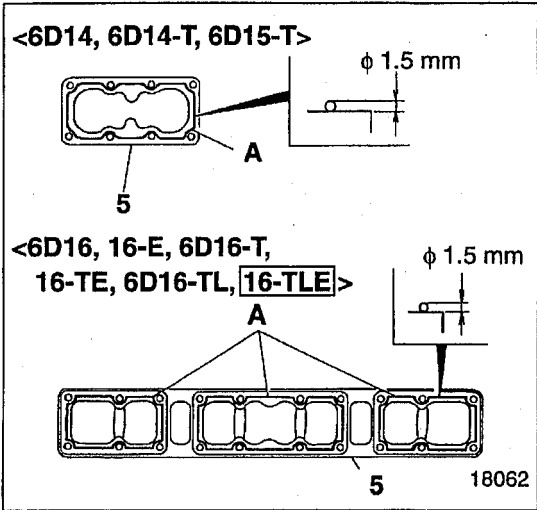
*: Crankshaft P.11-72

P: Locating pin

X: Non-reusable part

● Assembly sequence

Reverse the order of disassembly.

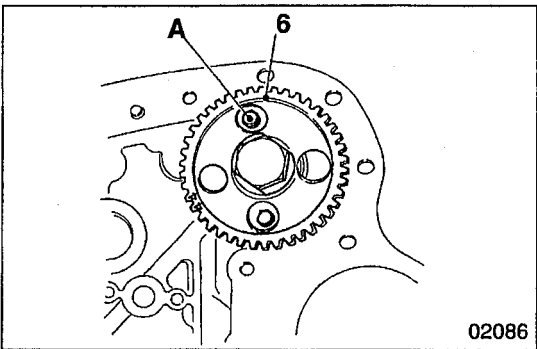


5 Fitting side cover

- Apply an even, unbroken bead of sealant **A** to the side cover **5**.
- Fit the side cover **5** onto the crankcase within **3 minutes** of applying the sealant **A**.

CAUTION ⚠

- Ensure that the sealant application surface of the side cover **5** is clean before applying sealant.
- When fitting the side cover **5**, hold it firmly in position to prevent spreading the sealant.
- After fitting the side cover **5**, wait at least an hour before starting the engine.
- Apply a new bead of sealant **A** whenever the mounting bolts of the side cover **5** have been loosened.



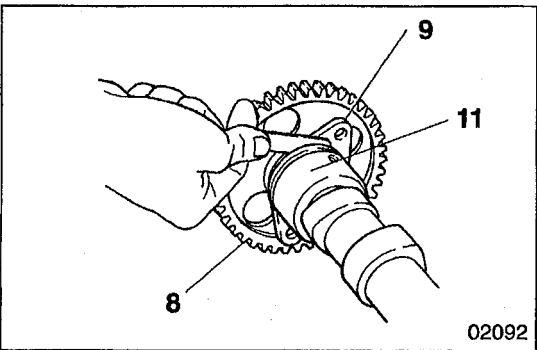
6 Camshaft assembly

[Removal]

- When removing the camshaft assembly **6**, take off the side cover **5** and support the camshaft by hand.
- Remove the bolts **A** from the camshaft gear holes, then slowly remove the camshaft assembly **6**.

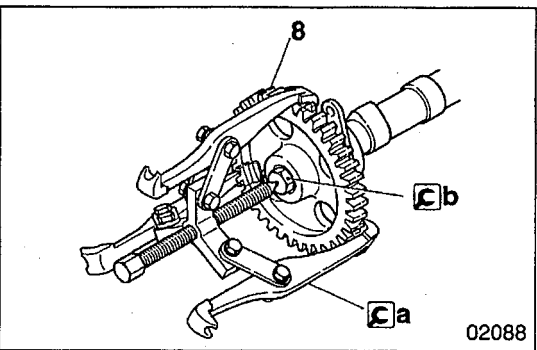
CAUTION ⚠

Take care not to damage the camshaft bushings **12** to **15** when removing the camshaft assembly **6**.



[Installation]

- Before installing the camshaft assembly **6**, measure the end play between the thrust plate **9** and camshaft **11**.
- If the measurement exceeds the specified limit, replace the defective part(s).
- With the alignment marks lined up on the camshaft gear **8** and No. 2 idler gear, fit the camshaft assembly. P.11-54



8 Camshaft gear

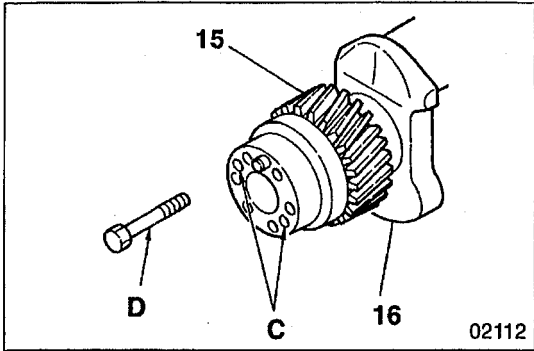
[Removal]

CAUTION ⚠

The camshaft gear **8** must be removed with the appropriate special tools. Do not tap off the camshaft gear since this would damage it.

a: Gear Puller

b: Plug



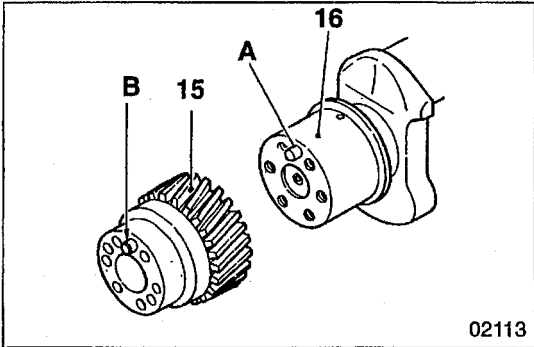
<Models with flywheel PTO>

[Removal]

Screw the flywheel mounting bolts **D** evenly into the threaded removal holes **C** in the crankshaft **16**. Alternatively, remove the crankshaft gear using the Gear Puller.

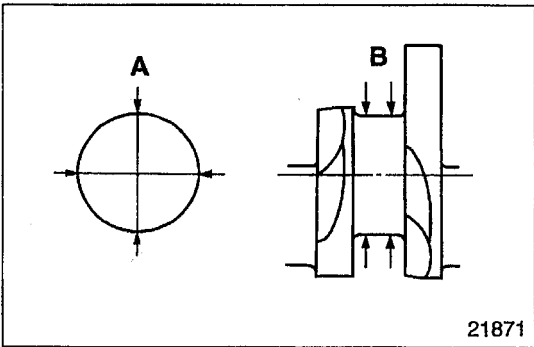
CAUTION

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



[Installation]

- Using a piston heater or the like, heat the crankshaft gear **15** to a temperature of approximately 100°C.
- Align the locating pin **A** on the crankshaft **16** with the dowel pin **B** on the crankshaft gear **15**. Then, drive the gear into position by striking its end face with a plastic mallet.



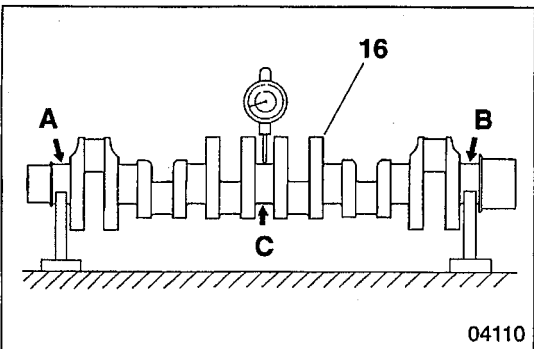
16 Crankshaft

[Inspection]

(1) Roundness and cylindricity of crankshaft journal and pin

If either measurement exceeds the specified limit, replace the crankshaft **16** or grind it to undersize.

- A: Roundness
- B: Cylindricity

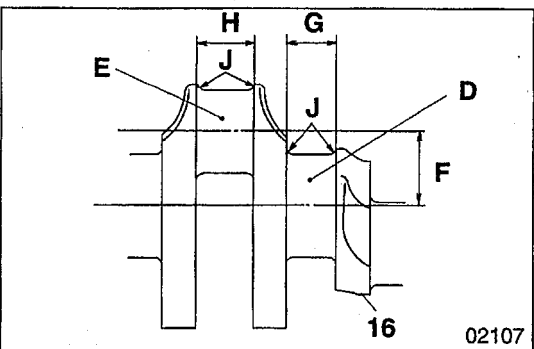


(2) Bend

- Support the crankshaft **16** at its No. 1 journal **A** and No. 7 journal **B**. Measure the extent of bending in the crankshaft at the centre of the No. 4 journal **C**.
- If the measurement exceeds the specified limit, replace the crankshaft.

NOTE

With the dial indicator applied to the centre journal, turn the crankshaft **16** through one revolution. One-half of the dial indicator reading represents the extent of bending.



[Rectification]

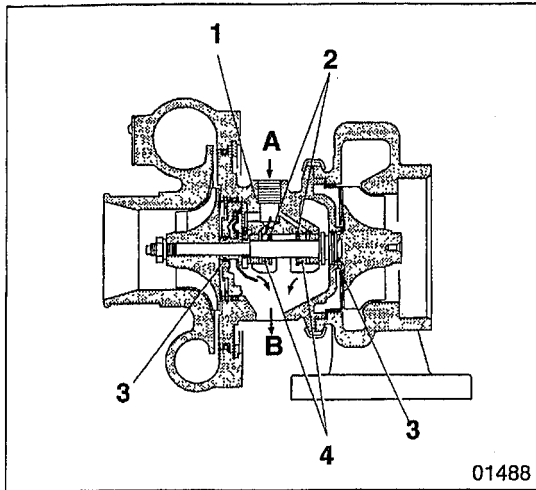
NOTE

If the crankshaft **16** is rectified by grinding, the main bearings **9**, **17** must be replaced with undersized ones.

- Grind such that the centre-to-centre distance **F** between the journal **D** and pin **E** does not change.

F: 57.5 $\begin{matrix} +0.025 \\ -0.075 \end{matrix}$ mm

STRUCTURE AND OPERATION



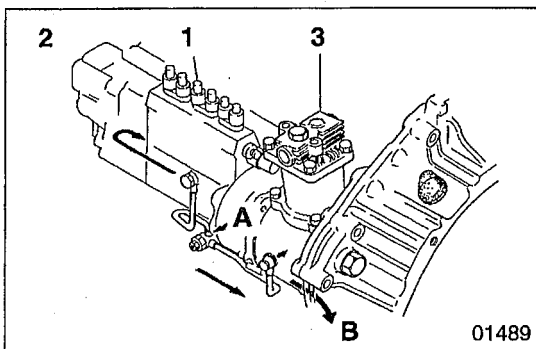
● Turbocharger <6D14-T, 15-T, 16-T, 16-TE, 16-TL, 16-TLE>

- 1 Bearing housing
- 2 Snap ring
- 3 Piston ring
- 4 Bearing

A: From main oil gallery

B: To oil pan

Via an oil pipe, engine oil is delivered from the main oil gallery to the bearing housing 1 to lubricate the inside of the bearing housing. At each end of the turbine wheel shaft, piston ring 3 acts as an oil seal.



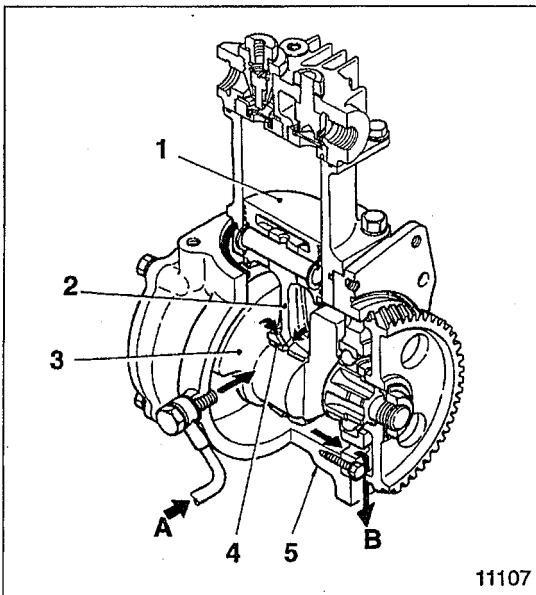
● Injection pump

- 1 Injection pump
- 2 Governor
- 3 Air compressor (or injection pump drive)

A: From main oil gallery.

B: To oil pan

Engine oil that has lubricated injection pump 1 and governor 2 returns to the oil pan via the timer case, air compressor 3 (or injection pump drive), and timing gear train.



● Air compressor

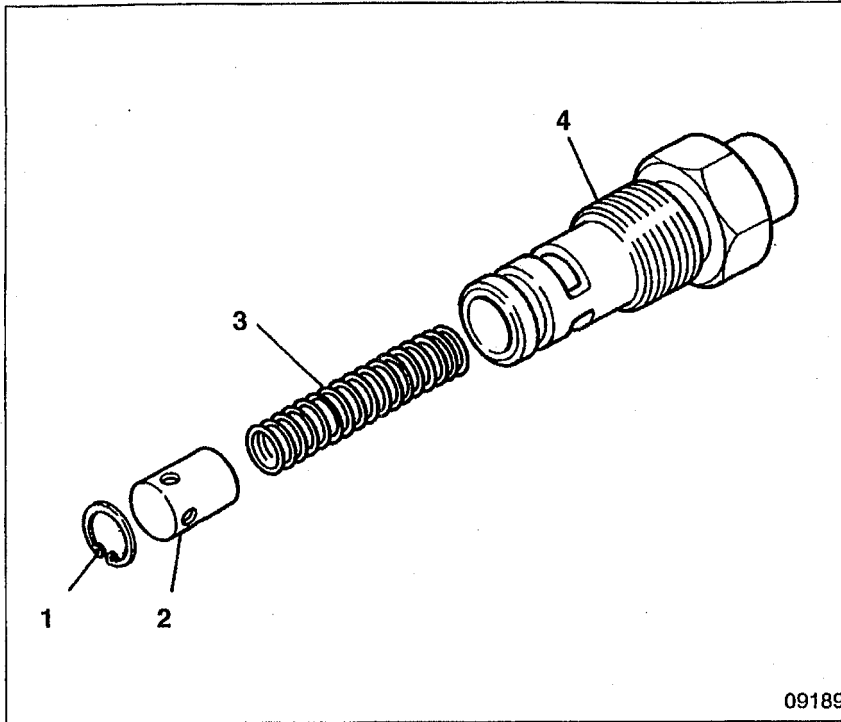
- 1 Piston
- 2 Connecting rod
- 3 Crankshaft
- 4 Connecting rod bushing
- 5 Crankcase

A: From main oil gallery

B: To oil pan

Engine oil from the main oil gallery splashes onto connecting rod 2 and lubricates connecting rod bushing 4. Piston 1 and the connecting rod's small end are lubricated by oil that is splashed onto them by the rotation of the crankshaft 3.

REGULATOR VALVE



● Disassembly sequence

- 1 Snap ring
- 2 Valve
- 3 Spring
- 4 Body

● Assembly sequence

Reverse the order of disassembly.

[Installation]

📖 P.12-30, 32

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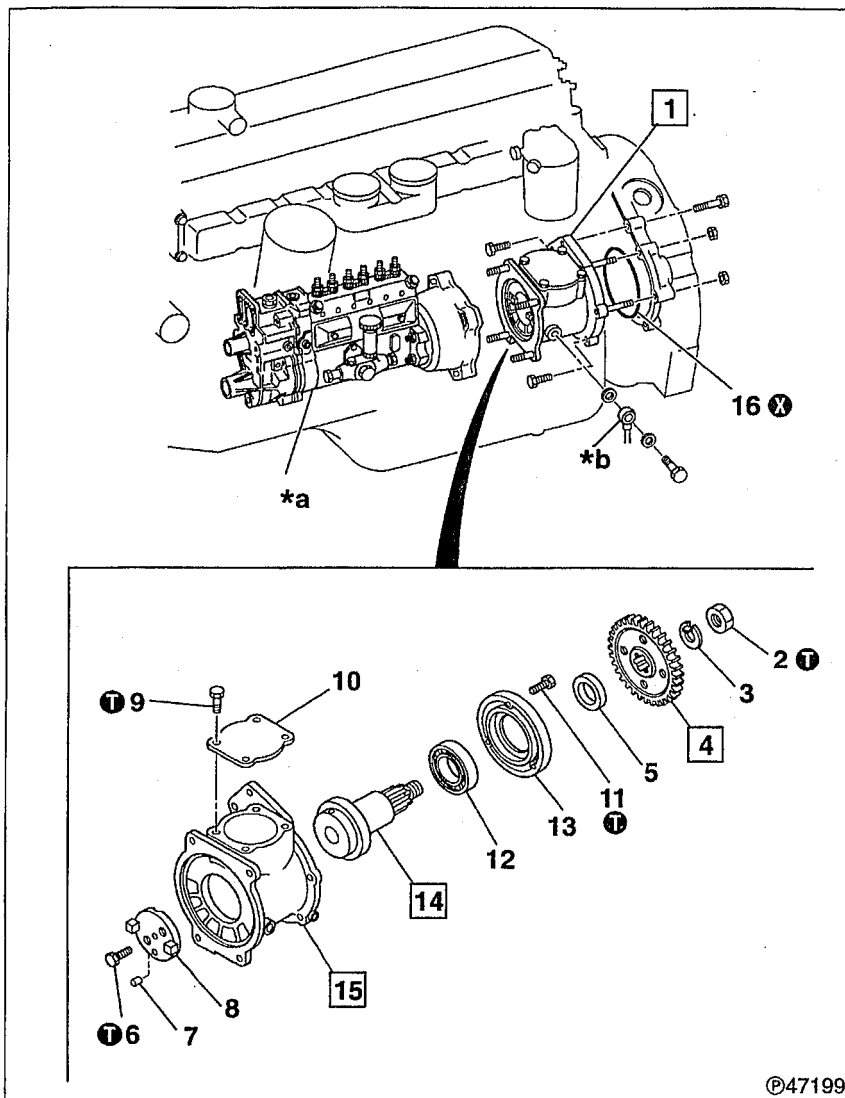
Service standards

Location	Maintenance item	Standard value (Basic diameter in [])	Limit	Remedy
3	Regulator valve spring load (installed length = 48.3 mm)	76 to 80 N {7.8 to 8.2 kgf}	—	—
—	Regulator valve opening pressure	390 ± 29 kPa {4.0 ± 0.3 kgf/cm ² }	—	—

TROUBLESHOOTING

Possible causes		Symptoms															
		Engine will not start	Engine difficult to start	Engine knocks	Unstable engine output	Insufficient engine output	Engine maximum speed too high	Unstable engine idling	Engine stops soon after starting	Engine does not reach maximum speed	Engine will not stop	Accelerator pedal too stiff	Defective fuel supply				
Injection pump proper	Sticky plunger	<input type="radio"/>															
	Sticky control rack	<input type="radio"/>															
	Sticky delivery valve	<input type="radio"/>															
	Worn tappet	<input type="radio"/>															
	Worn camshaft	<input type="radio"/>															
	Poorly adjusted injection timing		<input type="radio"/>		<input type="radio"/>	<input type="radio"/>		<input type="radio"/>									
	Worn plunger					<input type="radio"/>		<input type="radio"/>									
	Defective delivery valve seat					<input type="radio"/>											
	Excessively advanced injection timing			<input type="radio"/>													
	Insufficient plunger slide stroke				<input type="radio"/>												
	Broken plunger spring				<input type="radio"/>				<input type="radio"/>								
	Defective sliding action in control rack		<input type="radio"/>		<input type="radio"/>		<input type="radio"/>	<input type="radio"/>									
	Tappet worn or not sliding correctly				<input type="radio"/>												
	Broken delivery valve spring				<input type="radio"/>	<input type="radio"/>											
	Poor airtightness due to loose delivery valve holder				<input type="radio"/>	<input type="radio"/>											
	Defective delivery valve operation				<input type="radio"/>												
	Loose control pinion								<input type="radio"/>								
	Plunger spring not seating correctly								<input type="radio"/>								
Delivery valve holder too tight								<input type="radio"/>	<input type="radio"/>								
Uneven injection volume to cylinders		<input type="radio"/>						<input type="radio"/>	<input type="radio"/>								
Fuel feed pump	Gauze filter clogged	<input type="radio"/>						<input type="radio"/>	<input type="radio"/>								
	Check valve not operating	<input type="radio"/>															
	Sticky piston	<input type="radio"/>															
	Sticky push rod	<input type="radio"/>															
	Worn tappet	<input type="radio"/>															
	Defective check valve operation		<input type="radio"/>		<input type="radio"/>				<input type="radio"/>								
	Piston worn		<input type="radio"/>		<input type="radio"/>				<input type="radio"/>								

INJECTION PUMP DRIVE <Oldham's Coupling Type>



● Disassembly sequence

- 1 Injection pump drive assembly
- 2 Nut
- 3 Lock washer
- 4 Drive gear
- 5 Collar
- 6 Bolt
- 7 Pin
- 8 Coupling
- 9 Bolt
- 10 Cover
- 11 Bolt
- 12 Bearing
- 13 Bearing holder
- 14 Shaft
- 15 Pump drive case
- 16 O-ring

*a: Injection pump assembly P.13A-32

*b: Oil pipe P.13A-32

● Assembly sequence

Reverse the order of disassembly.

Service standards

Unit: mm

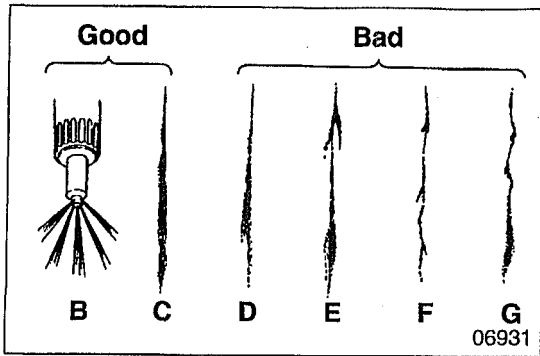
Location	Maintenance item	Standard value	Limit	Remedy
14	Shaft end play	—	0.59	Replace
14, 15	Shaft-to-pump drive case clearance	—	0.12	Replace pump drive case

ⓘ Tightening torques

Unit: N·m {kgf·m}

Location	Parts to be tightened	Tightening torque	Remarks
1	Eyebolt	21 {2.1}	—
2	Nut (drive gear mounting)	167 to 211 {17 to 21.5}	—
6	Bolt (coupling mounting)	30 to 36 {3.1 to 3.7}	—
9	Bolt (cover mounting)	25 to 29 {2.5 to 3}	—
11	Bolt (bearing holder mounting)	5.9 to 6.9 {0.6 to 0.75}	—

INJECTION NOZZLE <1-spring Type>

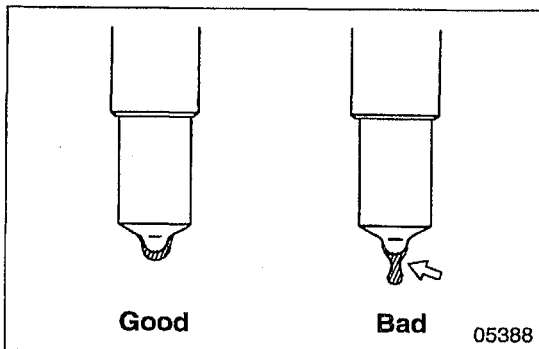


(2) Inspecting spray condition

- Pump the lever on the nozzle tester **A** at a rate of about 1–2 seconds per stroke, and maintain a continuous spray.
- B**: Even spray from all five injection orifices (Good)
- C**: Even and symmetrical spray (Good)
- D**: Asymmetrical spray (Bad)
- E**: Branched spray (Bad)
- F**: Thin spray (Bad)
- G**: Irregular spray (Bad)
- If the spray is unsatisfactory, disassemble and clean the injection nozzle assembly **5**, then inspect the spray again. If the spray is still unsatisfactory, replace the injection nozzle assembly **5**.
- Check that no fuel drips from the nozzle after the spray is complete.

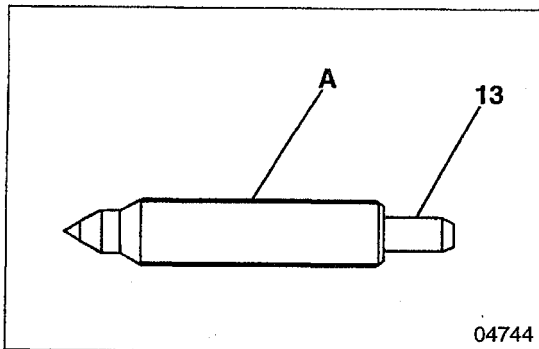
WARNING

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



(3) Inspecting for leaks

- Slowly increase the nozzle pressure to 1.96 MPa {20 kgf/cm²} below the specified valve opening pressure. Maintain this pressure for 10 seconds and check that no fuel drips from the end of the nozzle.
- If the injection nozzle assembly **5** appears defective, disassemble and clean it, then inspect it again. If the injection nozzle assembly **5** still appears defective, it must be replaced.

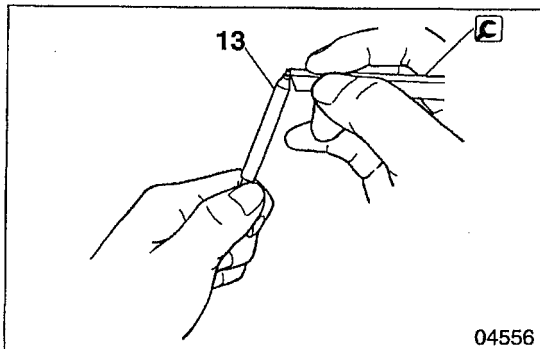


5 Injection nozzle assembly


[Disassembly]


CAUTION

- Do not touch the sliding parts **A** of the needle valve **7**.
- Do not change the needle valve **13** and nozzle **12** combination on each cylinder.



[Cleaning]

Wash the needle valve **13** and nozzle **12** in gas oil, then use the  Cleaning Tool Set to remove any carbon deposits in accordance with the following procedure.

- Remove carbon from the end of the needle valve **13** using the Cleaning Bar of the  Cleaning Tool Set.

CAUTION

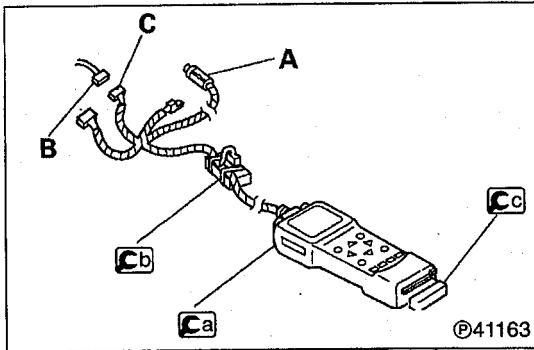
Do not use a wire brush or any hard metallic object for cleaning.

The Multi-Use Tester-II typically draws power from the cigarette lighter. In a vehicle without a cigarette lighter, the power connection of the Multi-Use Tester-II is different depending on the type of the starter switch as follows:

Multi-Use Tester-II power supply connection	With cigarette lighter socket		Without cigarette lighter socket
	Starter switch type A*a	Starter switch type A*b	
Cigarette lighter socket	○	—	—
Battery	—	○	○

*a With starter switch type A, power supply to cigarette lighter continues while engine is being cranked.

*b With starter switch type B, power supply to cigarette lighter is suspended while engine is being cranked.

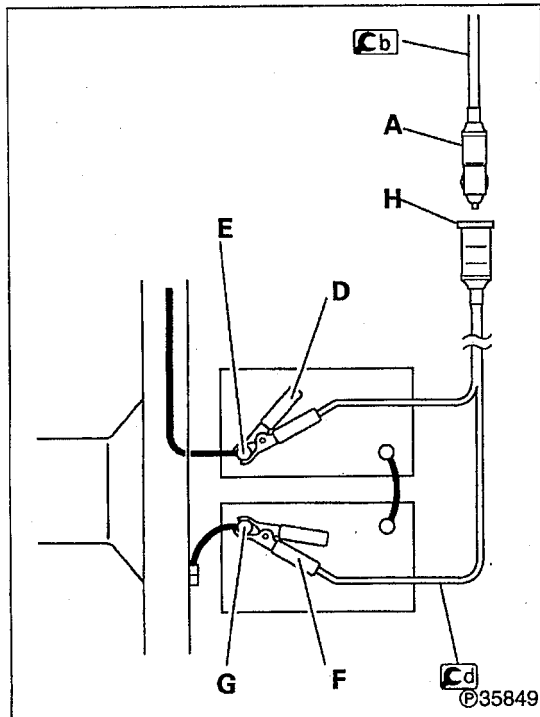


(1) Power supplied to Multi-Use Tester-II from cigarette lighter

- Place the starting switch at the LOCK position.
- Connect the **Ca** Multi-Use Tester-II harness to **Cb** Multi-Use Tester-II and insert the **Cc** read-only memory in the tester.
- Connect the connector **A** to the cigar lighter socket.
- Connect the Multi-Use Tester-II connector **C** (16 pins) to the data link connector **B** (16 pins).

NOTE

For the operating procedures for the Multi-Use Tester-II, refer to the instruction manual for the Multi-Use Tester-II.



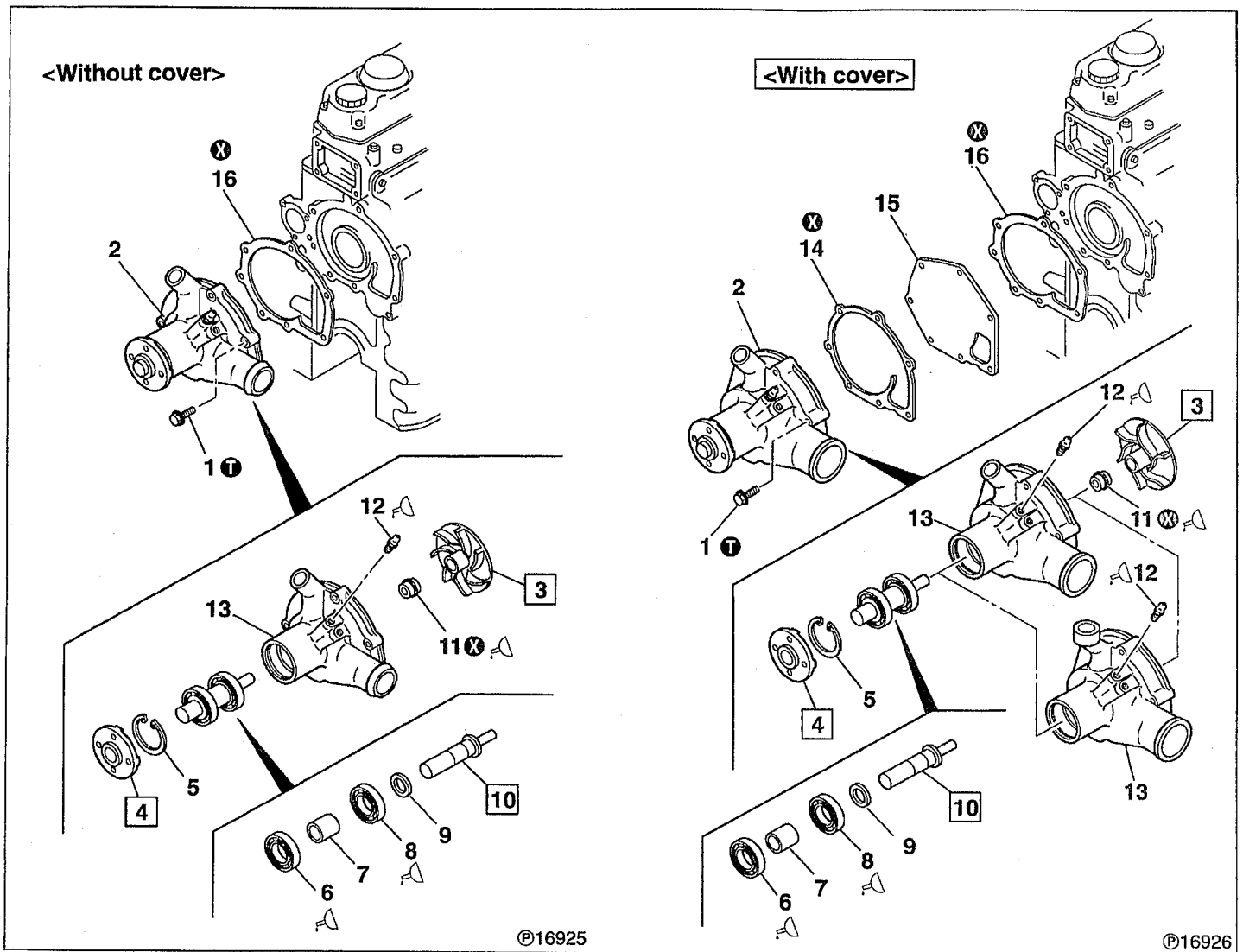
(2) Power supplied to Multi-Use Tester-II from battery

- Place the starter switch in the LOCK position.
- Connect the **Cb** Multi-Use Tester-II harness (for communication) to the **Ca** Multi-Use Tester-II, then insert the **Cc** ROM pack.
- Connect the ⊕ clamp **D** (red) of the **Cd** battery clamp harness to the ⊕ terminal **E** of the battery and the ⊖ clamp **F** (black) to the ⊖ terminal **G** of the battery.
- Fit the connector **A** into the socket **H** of the **Cd** battery clamp harness.
- Fit together the Multi-Use Tester-II connector **B** (16 pins) and connector **C** (16 pins).

NOTE

Connect the ⊕ clamp **D** (red) of the **Cd** battery clamp harness before connecting the ⊖ clamp **F** (black).

WATER PUMP



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©16926

● Disassembly sequence

- 1 Bolt
- 2 Water pump assembly
- 3 Impeller
- 4 Flange
- 5 Snap ring
- 6 Bearing
- 7 Spacer
- 8 Bearing
- 9 Washer

- 10 Water pump shaft
- 11 Unit seal
- 12 Grease nipple
- 13 Water pump case
- 14 Gasket (pump with cover)
- 15 Cover (pump with cover)
- 16 Gasket

⊗ : Non-reusable part

● Assembly sequence

16 → 15 → 14 → 2 → 1

2 : 13 → 12 → 5 → 11 → 4 → 3
 10 → 9 → 8 → 7 → 6

● Inspection after assembly

📖 P.14-16