

6D16

diesel engine

Shop Manual

FOREWORD

This Shop Manual is published for the information and guidance of personnel responsible for maintenance of 6D16 diesel engine, 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 service with no wastage.

For more details, please consult your nearest authorized Caterpillar® dealer or distributor.

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.

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HOW TO READ THIS MANUAL

1. Illustration for disassembly and assembly or removal and installation

This shows that the appropriate service procedure is described in the text.

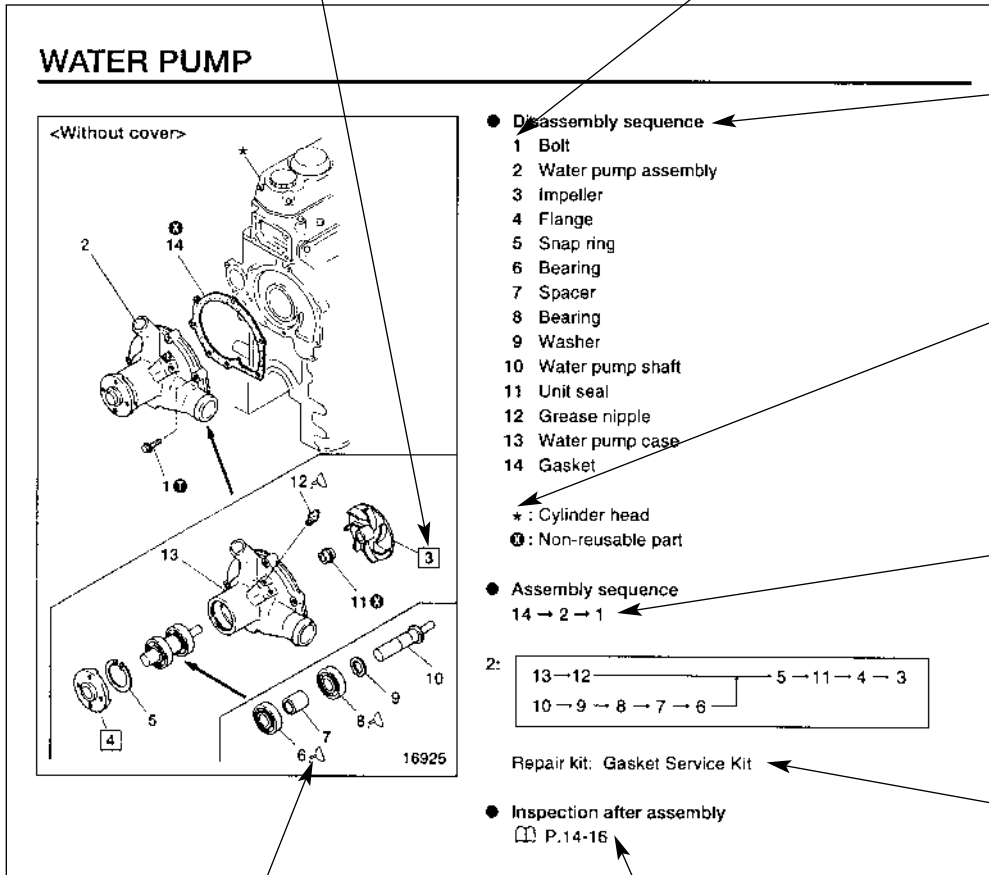
This shows the key No. of the part. In the text, this No. is referred to uniformly throughout.

This shows an example of the disassembly (removal) sequence.

No service procedure is referred to in this section, but the item can be an objective of various procedures.

This is shown when the assembly (installation) sequence is not the reverse of the disassembly (removal) sequence.

This shows that a repair kit is available.



Meaning of symbols

- Ⓢ : shows that the tightening torque is specified.
- 👉 : shows that application of lubricant, fluid or sealant is required.
- 📦 : shows that the part should not be reused.

This shows that the service procedure is described in another section.

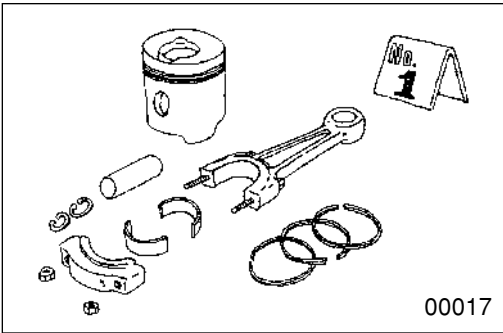
📖 P00-00

: shows reference page within the same group.

📖 Gr00

: shows reference group within the same book.

PRECAUTIONS FOR MAINTENANCE OPERATION



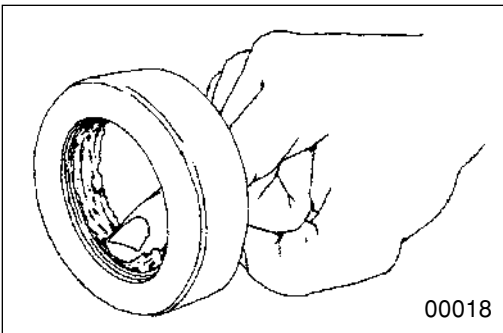
Put alignment marks on part combinations before disassembly and arrange the disassembled parts neatly. This will help avoid mismatching of the parts later.

Put the alignment marks, punch marks, etc. where performance and appearance will not be affected.

Cover the area left open after removal of parts to keep it free from dust.

CAUTION

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

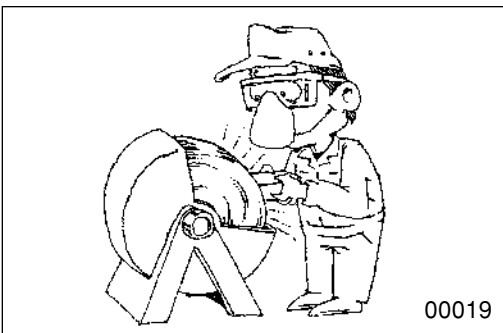


Apply the specified oil or grease to U-packings, oil seals, dust seals and bearings during assembly.

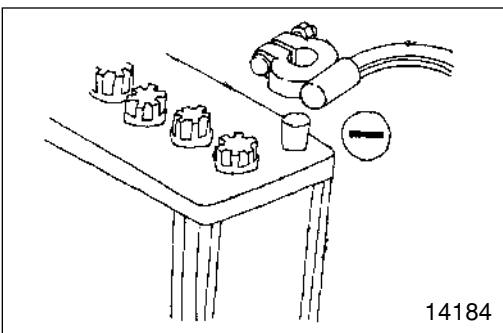
Use only the specified oil, grease, etc. for lubricant, remove the excess immediately after application with a piece of waste, etc.

CAUTION

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



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

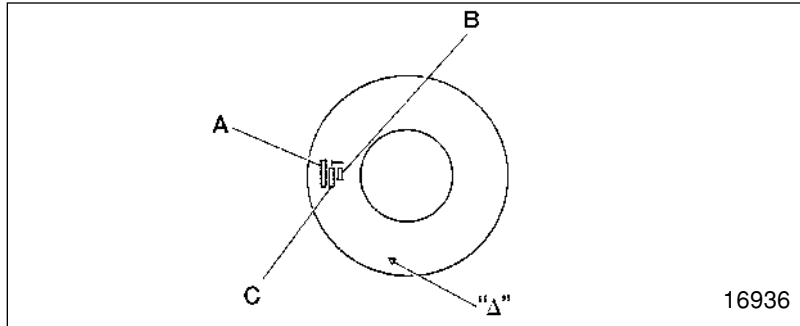


Before carrying out maintenance work on the electric system, disconnect the negative terminals of the batteries to prevent them from short-circuiting and burning-out.

CAUTION

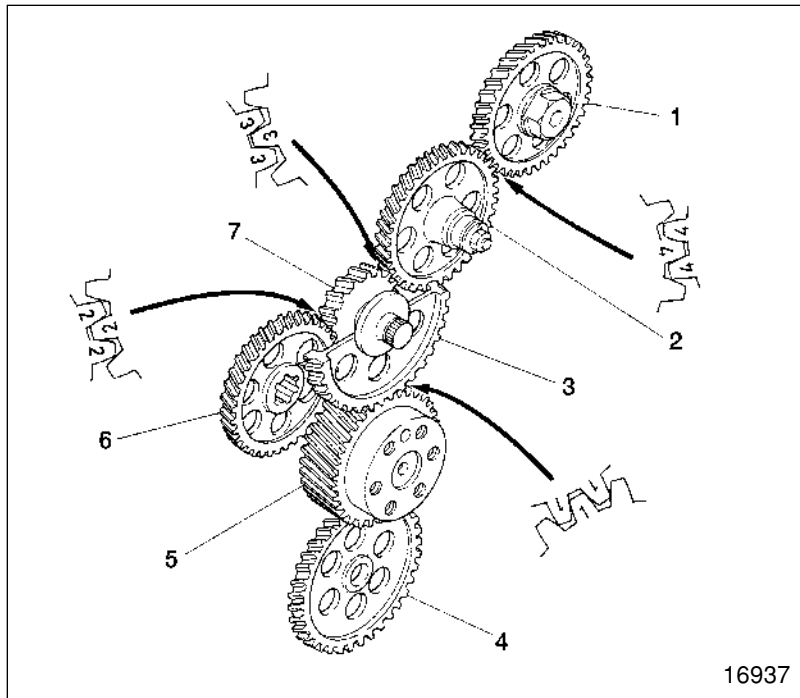
Be sure to turn starter and lighting switches, etc. off before disconnecting or connecting battery terminals, because the semiconductors can be damaged.

Pistons



- A: Part number
- B: Size mark (A, B)
- C: Weight mark
- Δ: Front mark

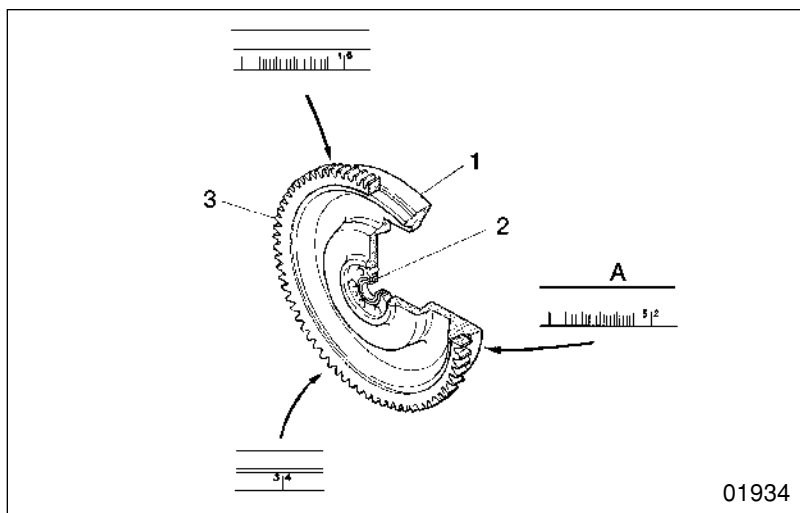
Timing Gears



- 1 Camshaft gear
- 2 No. 2 idler gear
- 3 No. 1 idler gear
- 4 Oil pump gear
- 5 Crankshaft gear
- 6 Air compressor drive gear or injection pump drive gear
- 7 No. 1 idler gear

Each gear is stamped with a timing gear alignment mark ("1", "2", "3", or "4") to facilitate reassembly.

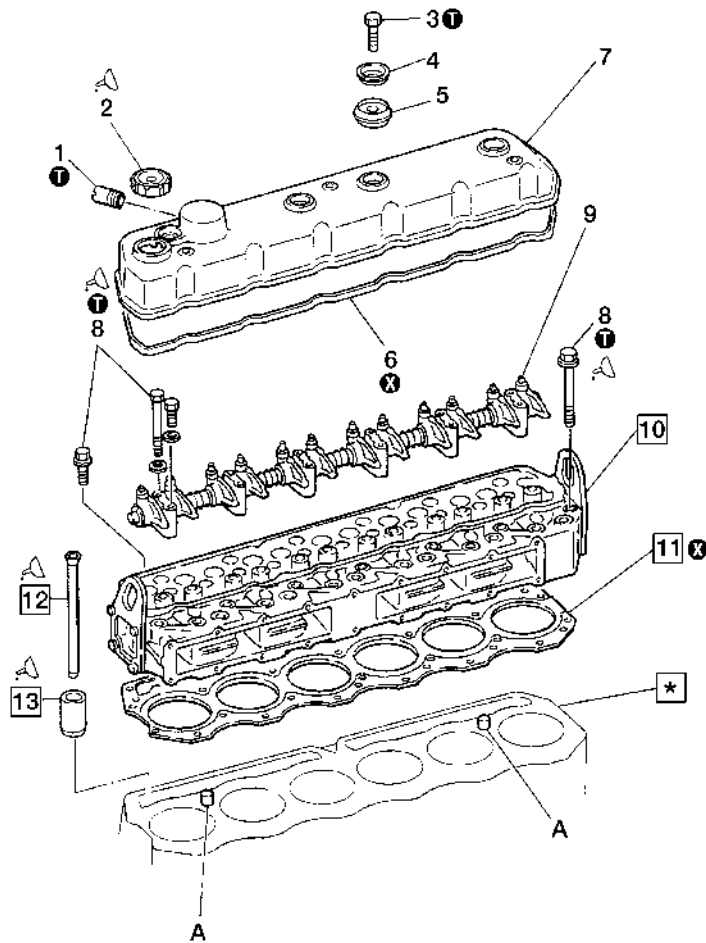
Flywheel



- 1 Flywheel
- 2 Pilot bearing
- 3 Ring gear

A: Angle scale, cylinder number

CYLINDER HEAD AND VALVE MECHANISM



04134

● Disassembly sequence

- | | | |
|-----------------------|-------------------------------------|------------------------|
| 1 Joint | 8 Cylinder head bolt | 12 Push rod |
| 2 Oil filler cap | 9 Rocker and bracket assembly | 13 Tappet |
| 3 Bolt | ⓘ P.11-16 | |
| 4 Plate | 10 Cylinder head and valve assembly | *: Crankcase ⓘ P.11-62 |
| 5 Rubber | ⓘ P.11-20 | A: Locating pin |
| 6 Rocker cover gasket | 11 Cylinder head gasket | ⓧ: Non-reusable part |
| 7 Rocker cover | | |

● Assembly sequence

Follow the disassembly sequence in reverse.

Service standards

Unit: mm (in.)

Location	Maintenance item		Standard value	Limit	Remedy
4	Outer valve spring	Free length	67.0 (2.64)	64.0 (2.52)	Replace
		Installed load [at 47.8 mm (1.88 in.) installed length]	330 N (33.5 kgf) [74.5 lbf]	290 N (29.7 kgf) [65.2 lbf]	Replace
		Squareness	–	2.5 (0.0984)	Replace
5	Inner valve spring	Free length	55.1 (2.17)	52.1 (2.05)	Replace
		Installed load [at 40.5 mm (1.59 in.) installed length]	92 N (94 kgf) [20.7 lbf]	78 N (8.0 kgf) [17.5 lbf]	Replace
		Squareness	–	2.0 (0.0787)	Replace
7	Exhaust valve	Stem outside diameter	$\phi 8.93$ to 8.94 ($\phi 0.3516$ to 0.3520)	$\phi 8.85$ ($\phi 0.348$)	Replace
		Sinkage from cylinder head bottom surface	1.3 to 1.7 (0.0512 to 0.0670)	2.0 (0.0787)	Inspect every location
		Valve margin	1.5 (0.0591)	1.2 (0.0472)	Reface or replace
		Seat angle	45°	–	Correct
8	Inlet valve	Stem outside diameter	$\phi 8.96$ to 8.97 ($\phi 0.3528$ to 0.3531)	$\phi 8.85$ ($\phi 0.348$)	Replace
		Sinkage from cylinder head bottom surface	1.1 to 1.5 (0.0433 to 0.0591)	1.8 (0.0709)	Inspect every location
		Valve margin	1.5 (0.0591)	1.2 (0.0472)	Reface or replace
		Seat angle	45° ± 15'	–	Correct
7, 15	Exhaust valve stem-to valve guide clearance [Basic diameter: 9 mm (0.354 in.)]		0.07 to 0.10 (0.00276 to 0.00394)	0.2 (0.00787)	Replace
8, 16	Inlet valve stem-to-valve guide clearance [Basic diameter: 9 mm (0.354 in.)]		0.04 to 0.06 (0.00157 to 0.00236)	0.15 (0.00591)	Replace
17	Exhaust valve seat width		1.8 to 2.2 (0.0709 to 0.0866)	2.8 (0.110)	Correct or replace
18	Inlet valve seat width		1.8 to 2.2 (0.0709 to 0.0866)	2.8 (0.110)	Correct or replace
20	Cylinder head	Bottom surface distortion	0.08 (0.00315) or less	0.2 (0.00787)	Correct or replace
		Height from top to bottom surface	94.9 to 95.1 (3.736 to 3.744)	94.5 (3.72)	Replace

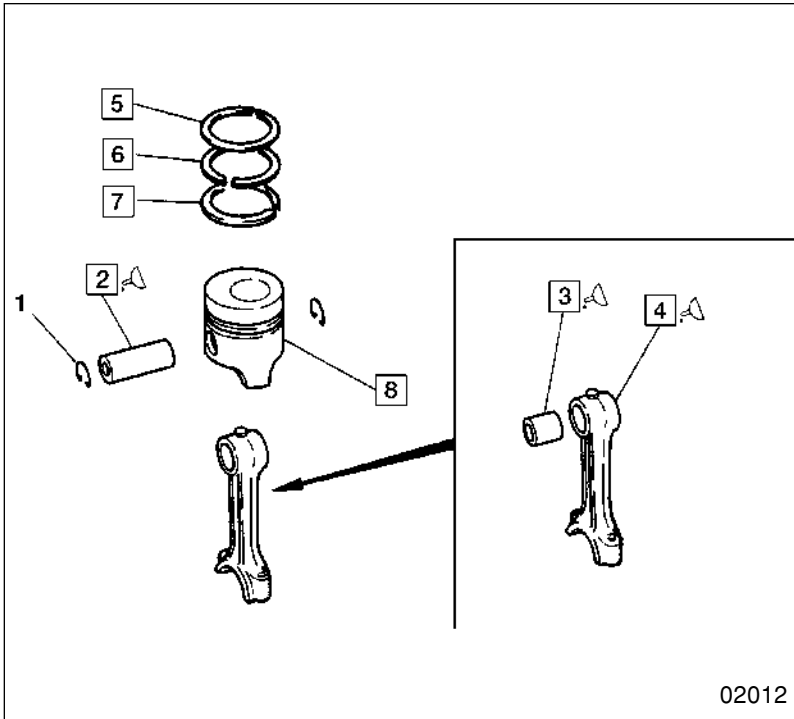
Tightening torques

Unit: N·m (kgf·m) [lbf·ft]

Location	Parts to be tightened	Tightening torque	Remarks
14	Glow plug	15 to 20 (1.5 to 2.0) [11.1 to 14.8]	–
19	Exhaust manifold mounting stud	29 (3) [21.4]	–

PISTONS, CONNECTING RODS, AND CYLINDER LINERS

Piston and Connecting Rod Assembly



● Disassembly sequence

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

● Assembly sequence

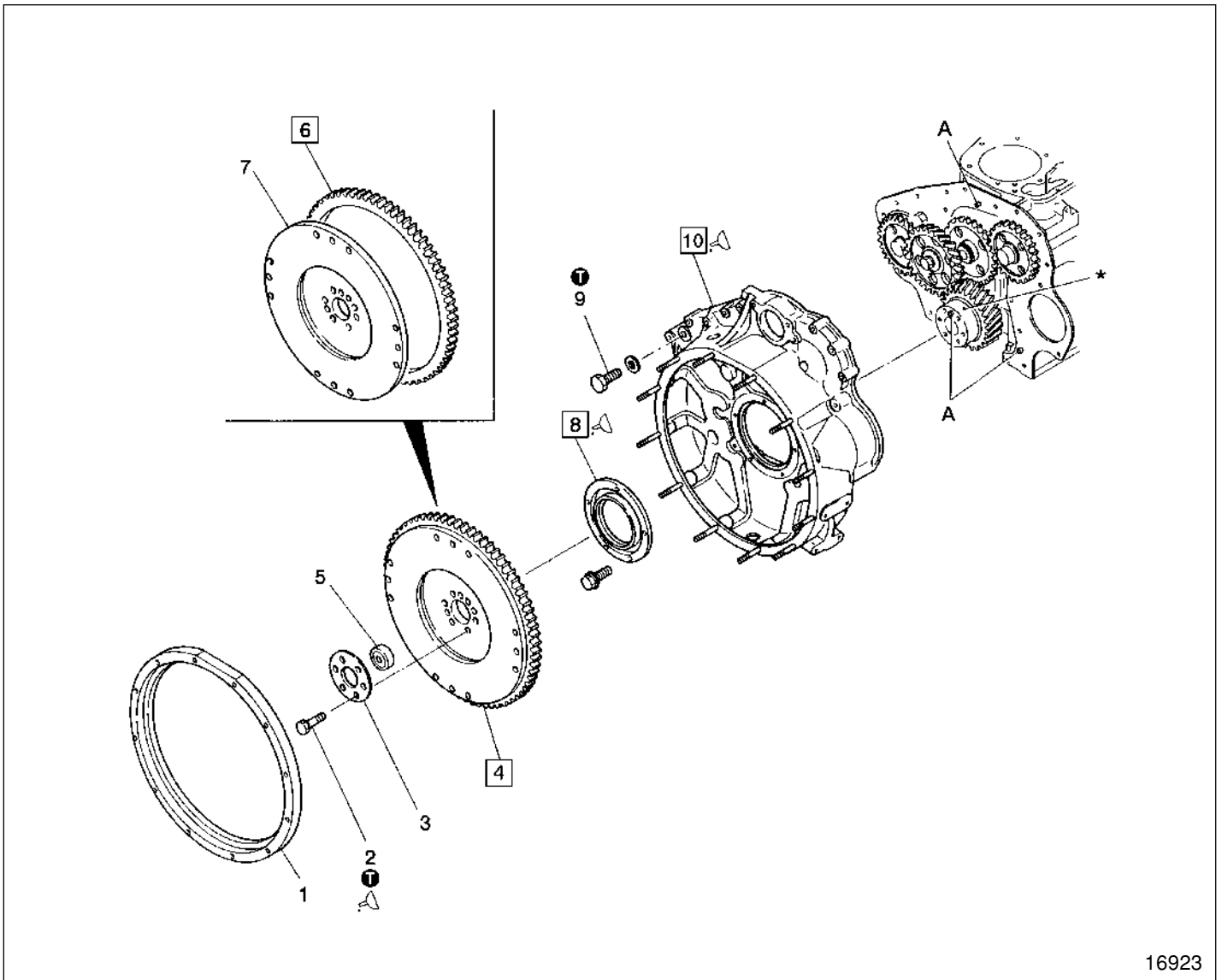
Reverse the order of disassembly.

Service standards

Unit: mm (in.)

Location	Maintenance item	Standard value	Limit	Remedy	
2, 3	Piston pin-to-connecting rod small end bushing clearance [Basic diameter: 38 mm (1.50 in.)]	0.02 to 0.05 (0.000787 to 0.00197)	0.1 (0.00394)	Replace	
2, 8	Piston pin-to-piston clearance [Basic diameter: 38 mm (1.50 in.)]	0.004 to 0.02 (0.000157 to 0.000787)	0.05 (0.00197)	Replace	
4	Connecting rod bend and torsion	—	0.05 (0.00197)	Replace	
5 to 7	Piston ring end gap	1st compression ring	0.35 to 0.55 (0.0138 to 0.0217)	1.5 (0.0591)	Replace
		2nd compression ring	0.35 to 0.55 (0.0138 to 0.0217)	1.5 (0.0591)	Replace
		Oil ring	0.35 to 0.55 (0.0138 to 0.0217)	1.5 (0.0591)	Replace
5 to 8	Piston ring-to-piston ring groove clearance	1st compression ring	0.11 to 0.15 (0.00433 to 0.00591)	0.2 (0.00787)	Replace
		2nd compression ring	0.05 to 0.08 (0.00197 to 0.00315)	0.15 (0.0591)	Replace
		Oil ring	0.03 to 0.06 (0.00118 to 0.00236)	0.15 (0.0591)	Replace

FLYWHEEL



16923

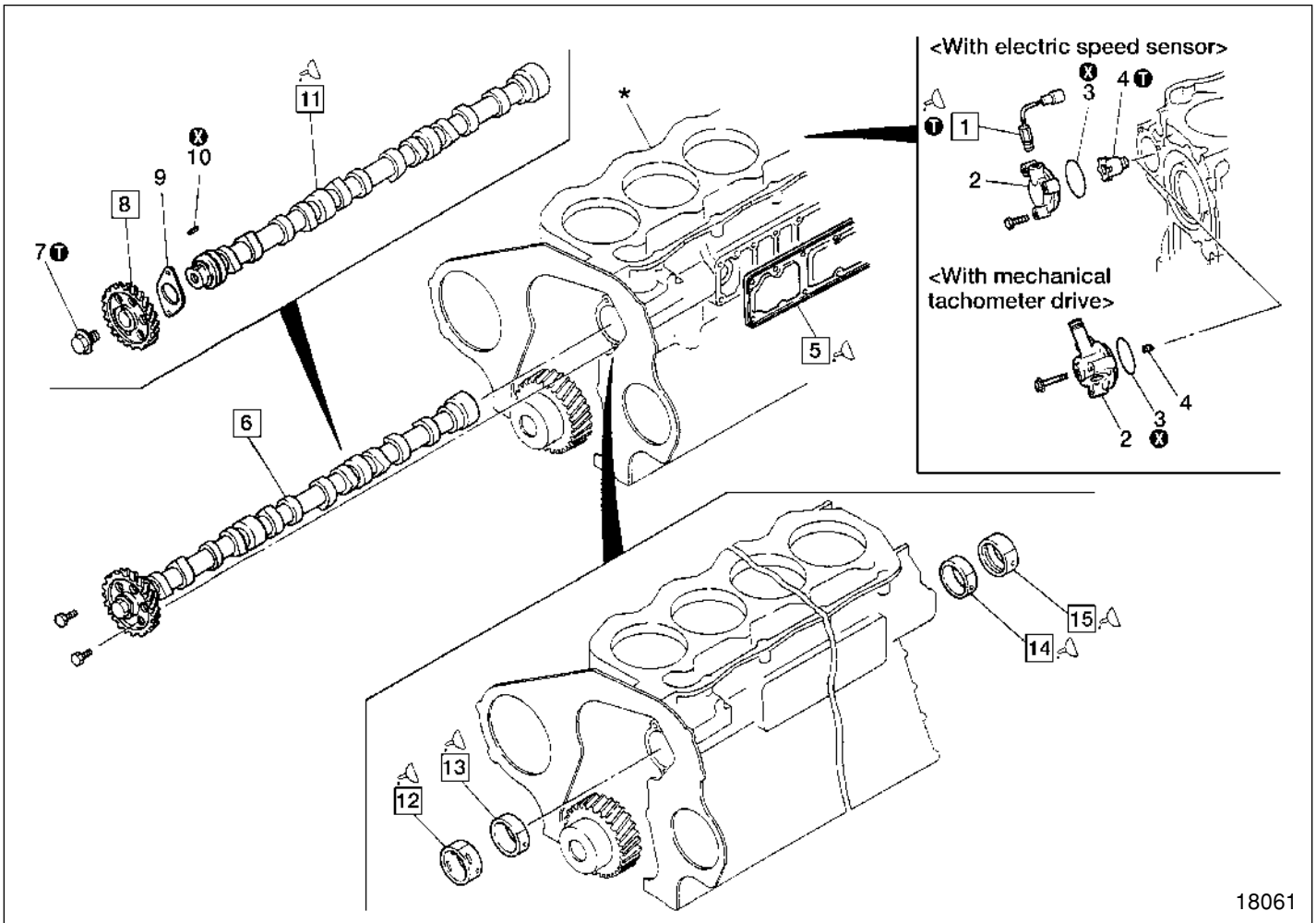
● Disassembly sequence

- | | |
|---------------------|-----------------------|
| 1 Spacer | 8 Rear oil seal |
| 2 Bolt | 9 Plug |
| 3 Washer plate | 10 Flywheel housing |
| 4 Flywheel assembly | |
| 5 Pilot bearing | *: Crankcase P.11-62 |
| 6 Ring gear | A: Locating pin |
| 7 Flywheel | ⊗: Non-reusable part |

● Assembly sequence

Reverse the order of disassembly.

CAMSHAFT



18061

● Pre-disassembly inspection

📖 P.11-56

● Disassembly sequence

- | | |
|---|---------------------------|
| 1 Engine speed sensor
<models with electric speed sensor> | 8 Camshaft gear |
| 2 Adapter <models with electric speed sensor>
Tachometer drive case
<models with mechanical tachometer> | 9 Thrust plate |
| 3 O-ring | 10 Key |
| 4 Pulse rotor <models with electric speed sensor>
Tachometer drive coupling
<models with mechanical tachometer> | 11 Camshaft |
| 5 Side cover | 12 No. 4 camshaft bushing |
| 6 Camshaft assembly | 13 No. 3 camshaft bushing |
| 7 Bolt | 14 No. 2 camshaft bushing |
| | 15 No. 1 camshaft bushing |
- *: Crankcase 📖 P.11-62
 ⓧ: Non-reusable part

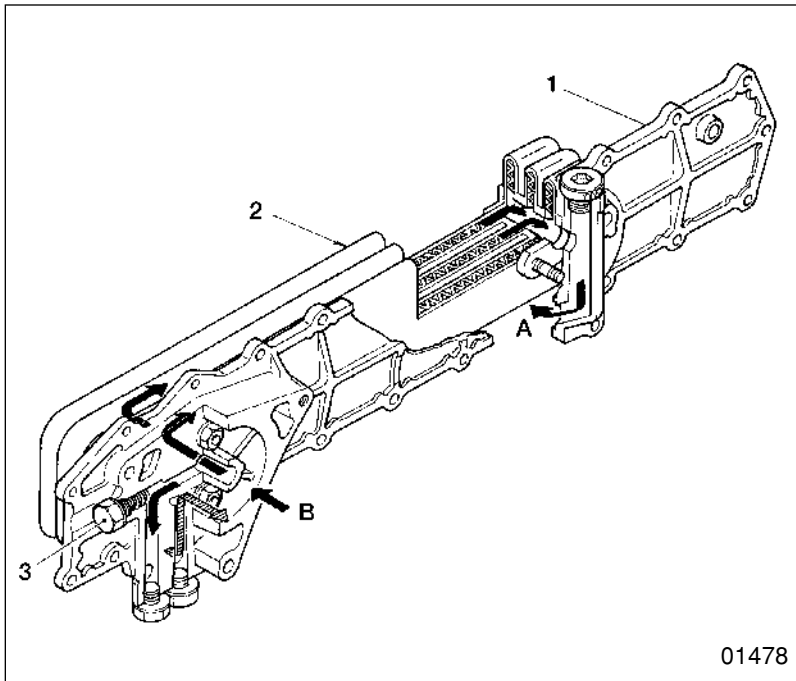
NOTE

- Do not remove the engine speed sensor 1 unless defects are evident.
- Do not remove the camshaft gear 8 unless defects are evident.

● Assembly sequence

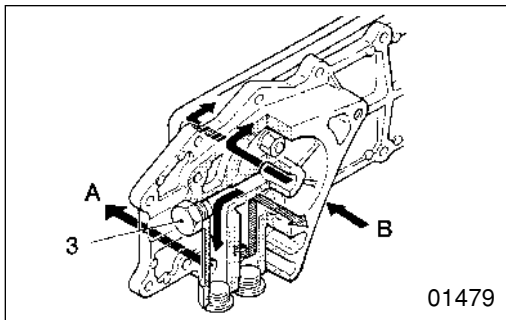
Reverse the order of disassembly.

Oil Cooler



- 1 Oil cooler cover
- 2 Oil cooler element
- 3 Bypass valve

A: To main oil gallery
B: From oil filter

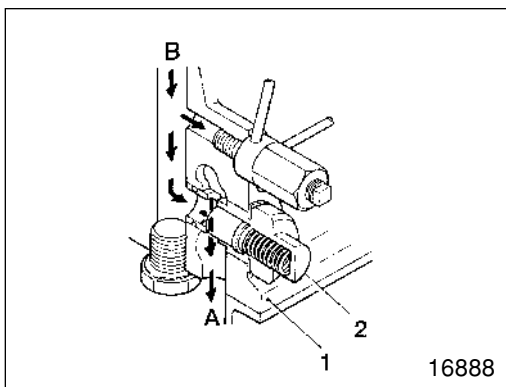


● Bypass valve

When oil viscosity is high at low temperatures or the element is clogged, flow resistance increases. When this happens, bypass valve 3 opens to allow engine oil to return to the main oil gallery without passing through the cooler.

A: To main oil gallery
B: From oil filter

Regulator Valve



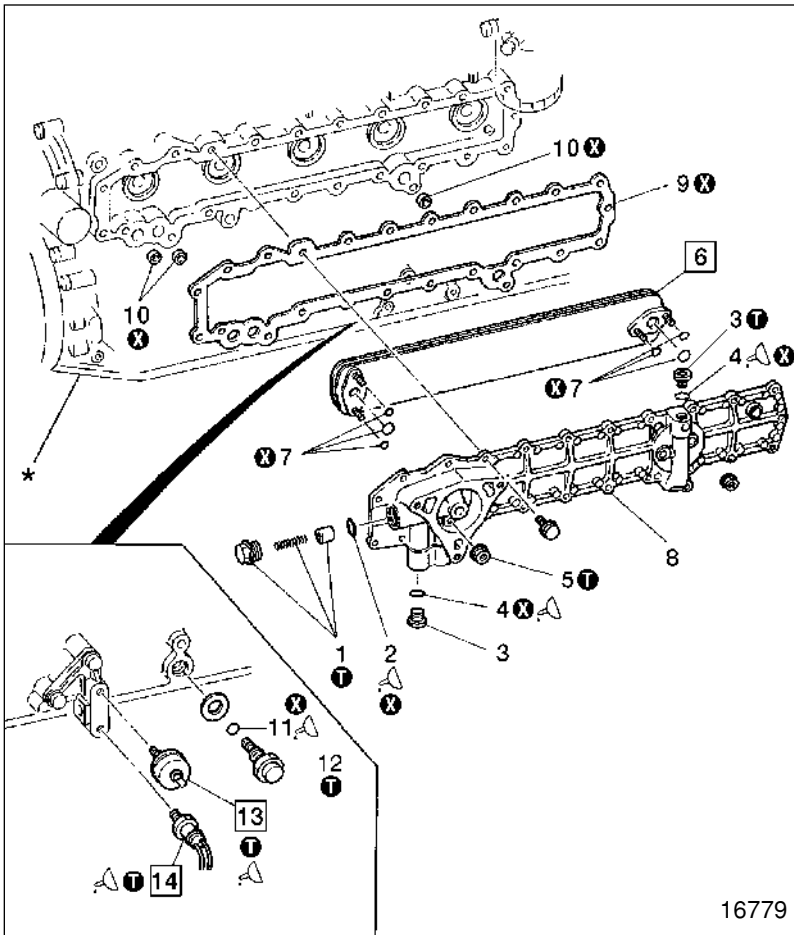
- 1 Crankcase
- 2 Regulator valve

A: To oil pan
B: Main oil gallery

● Regulator valve

When the pressure of oil going to main oil gallery B drops below a specified level, regulator valve 2 opens, allowing some of the oil to return to oil pan A. The oil pressure is thus constantly regulated.

OIL COOLER



● Disassembly sequence

- 1 Bypass valve
- 2 O-ring
- 3 Oil cooler plug
- 4 O-ring
- 5 Nut
- 6 Oil cooler element
- 7 O-ring
- 8 Oil cooler cover
- 9 Gasket
- 10 O-ring
- 11 O-ring
- 12 Regulator valve P.12-24
- 13 Engine oil pressure gauge unit
- 14 Engine oil pressure switch

*: Crankcase assembly Gr 11

⊗: Non-reusable part

● Assembly sequence

Reverse the order of disassembly.

Service standards

Unit: kPa (kgf/cm²) [psi]

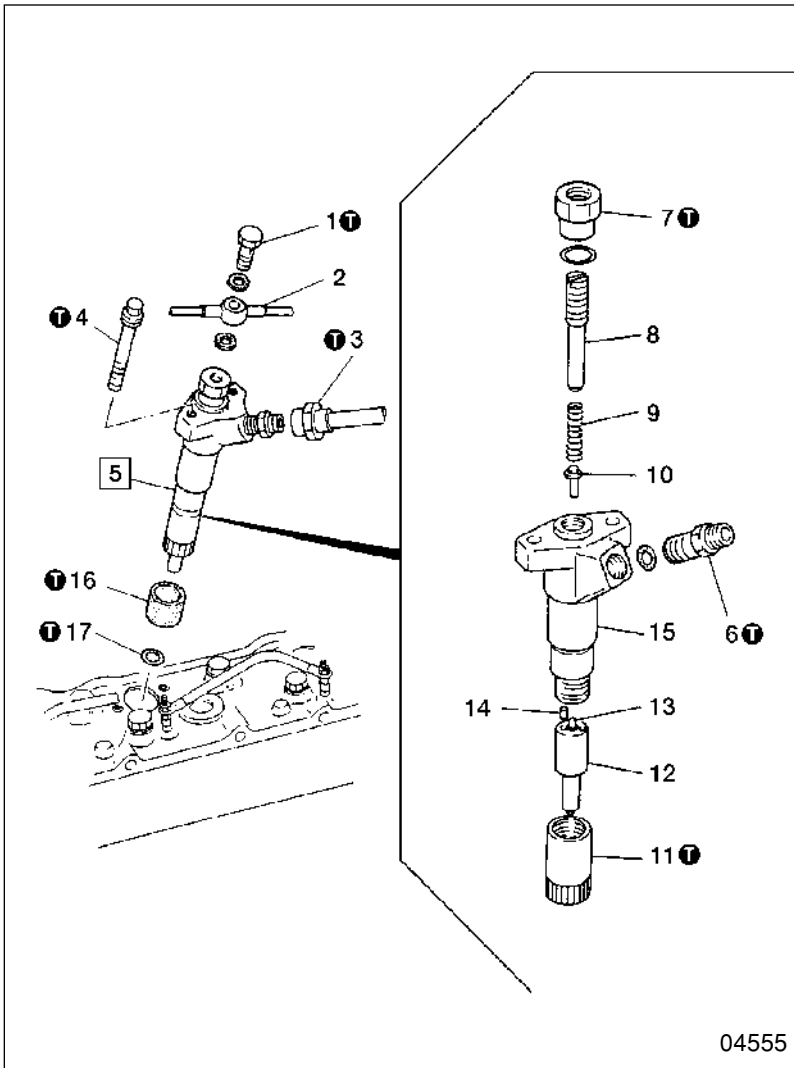
Location	Maintenance item	Standard value	Limit	Remedy
1	Oil cooler bypass valve opening pressure	295 ± 20 (3.0 ± 0.2) [42.8 ± 2.9]	—	—
6	Oil cooler element air leakage (air pressure of 980 kPa (10 kgf/cm ²) [142 psi] for 15 seconds)	0 cc (0 cu.in.)	—	Replace
14	Operating pressure of engine oil pressure switch	19 ± 9.8 (0.5 ± 0.1) [7.11 ± 1.42]	—	Replace

ⓘ Tightening torques

Unit: N·m (kgf·m) [lbf·ft]

Location	Parts to be tightened	Tightening torque	Remarks
1	Bypass valve	20 ± 4.9 (2.0 ± 0.5) [14.8 ± 3.6]	—
3	Oil cooler plug	25 ± 4.9 (2.5 ± 0.5) [18.4 ± 3.6]	—
5	Nut (oil cooler element mounting)	20 ± 4.9 (2.0 ± 0.5) [14.8 ± 3.6]	—
12	Regulator valve	105 ± 9.8 (11 ± 1) [77.4 ± 7.2]	—
13	Engine oil pressure gauge unit	15 ± 22 (1.5 ± 2.2) [11.1 ± 16.2]	—
14	Engine oil pressure switch	15 ± 22 (1.5 ± 2.2) [11.1 ± 16.2]	—

INJECTION NOZZLE



04555

● Inspection before disassembly

📖 P.13-29

● Disassembly sequence

- 1 Eyebolt
- 2 Fuel leak-off pipe
- 3 Injection pipe
- 4 Bolt
- 5 Injection nozzle assembly
- 6 Connector
- 7 Cap nut
- 8 Adjusting screw
- 9 Spring
- 10 Push rod
- 11 Retaining nut
- 12 Nozzle
- 13 Needle valve
- 14 Pin
- 15 Nozzle holder
- 16 Dust seal
- 17 Gasket

⊗ : Non-reusable part

Repair kit: Nozzle Service Kit

● Assembly sequence

Reverse the order of disassembly.

WARNING ⚠

To minimize the risk of fire, wipe up any spilled fuel.

CAUTION ⚠

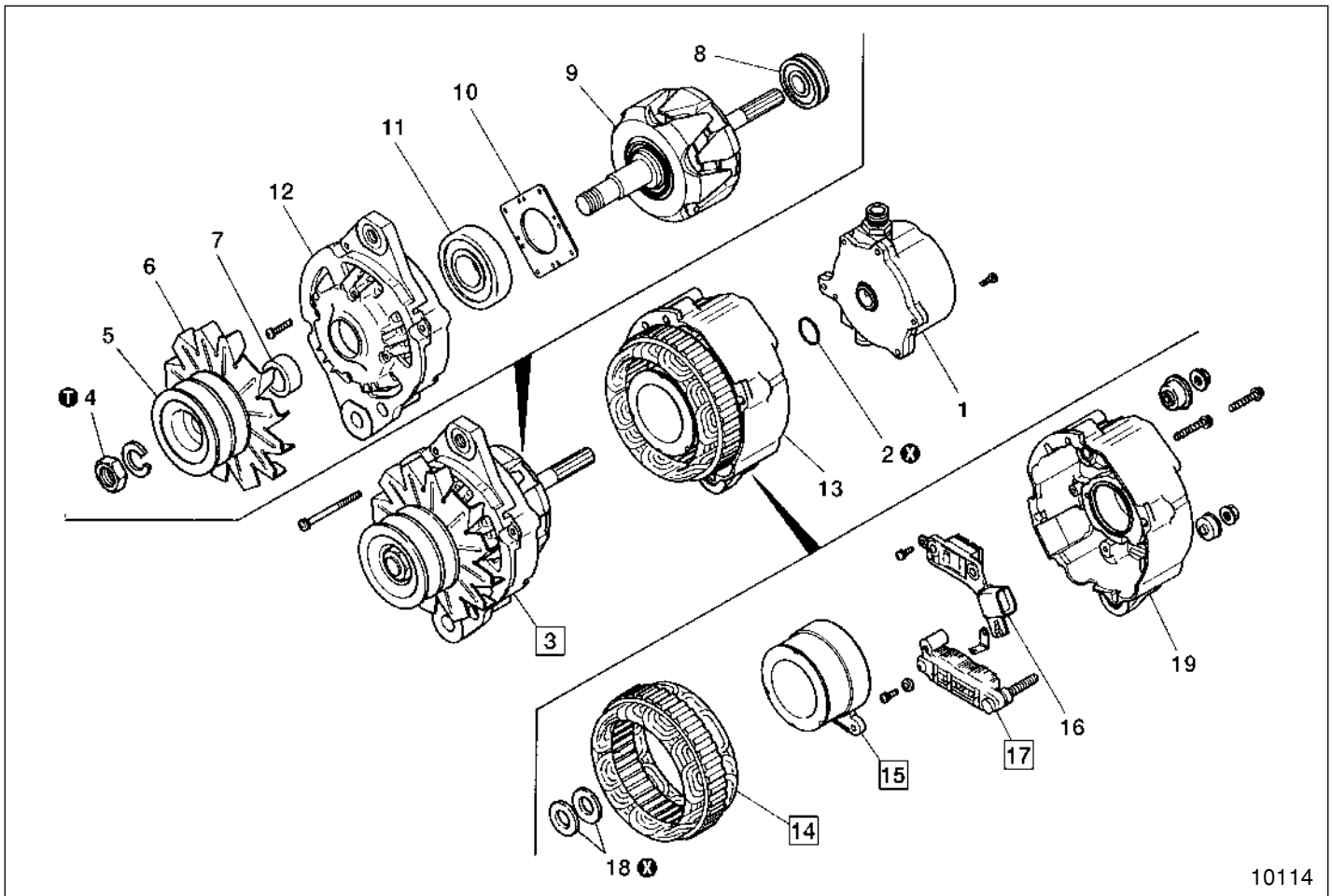
Under no circumstances change the needle valve 13 and nozzle 12 combination used in each injection nozzle assembly 5.

NOTE

- Clean off any carbon deposits before disassembling, reassembling, or adjusting the injection nozzle assembly 5. Before disassembly, check the pressure and shape of the spray and inspect the assembly for fuel leaks. If no abnormality is apparent, do not commence disassembly.
- When fitting the injection nozzle assembly 5, tighten each of the two bolts 4 a little at a time.

ALTERNATOR <24V-40A (with vacuum pump)>

Alternator Assembly



10114

● Disassembly sequence

- | | |
|-----------------------------------|-----------------------------------|
| 1 Vacuum pump assembly
P.54-22 | 11 Front bearing |
| 2 O-ring | 12 Front bracket |
| 3 Rotor & front bracket assembly | 13 Stator & rear bracket assembly |
| 4 Nut | 14 Stator assembly |
| 5 Pulley | 15 Field coil |
| 6 Fan | 16 Regulator |
| 7 Spacer | 17 Rectifier |
| 8 Rear bearing | 18 Oil seal |
| 9 Rotor assembly | 19 Rear bracket |
| 10 Cover | |

⊗ : Non-reusable part

NOTE

Do not remove parts 8, 11 and 14 unless they are found to be defective.

● Reassembly sequence

13 → 3 → 2 → 1

13:

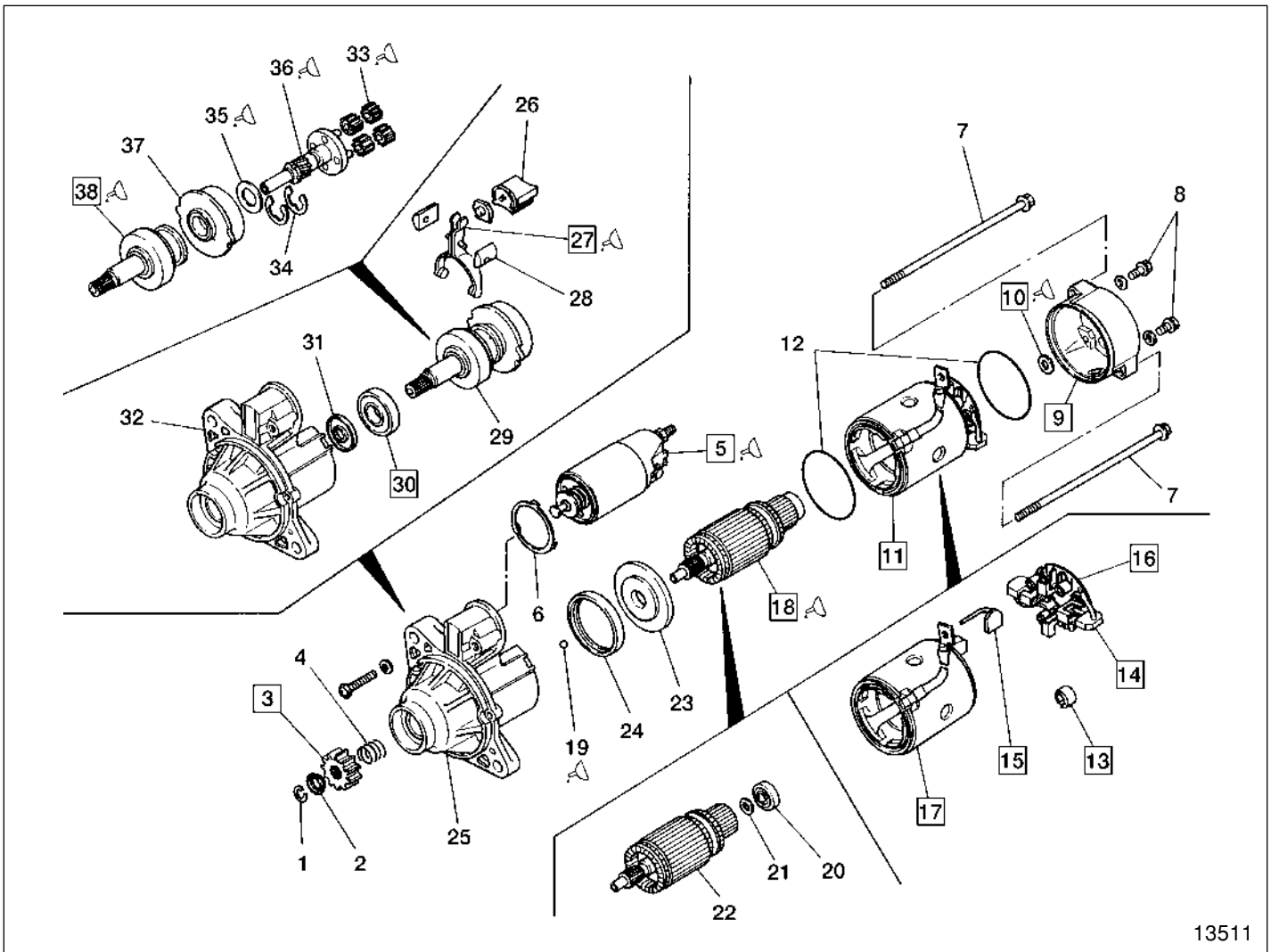
19 → 18	} → 17 → 15 → 14
16	

3:

12 → 11 → 10	} → 7 → 6 → 5 → 4
9 → 8	

STARTER

Starter Assembly



13511

● Disassembly sequence

- | | | |
|---------------------------------|---------------------------|--|
| 1 Stopper ring | 14 Brush ⊖ | 27 Lever |
| 2 Pinion stopper | 15 Brush ⊕ | 28 Bushing |
| 3 Pinion | 16 Brush holder assembly | 29 Gearshaft & overrunning clutch assembly |
| 4 Spring | 17 Yoke assembly | 30 Front bearing |
| 5 Magnet switch | 18 Armature assembly | 31 Dust seal |
| 6 Shim | 19 Ball | 32 Front bracket |
| 7 Bolt | 20 Rear bearing | 33 Planetary gear |
| 8 Screw | 21 Washer | 34 Washer |
| 9 Rear bracket | 22 Armature | 35 Washer |
| 10 Conical washer | 23 Cover | 36 Gearshaft |
| 11 Yoke & brush holder assembly | 24 Rubber packing | 37 Internal gear |
| 12 Rubber packing | 25 Front bracket assembly | 38 Overrunning clutch |
| 13 Brush spring | 26 Rubber packing | |