

Shop Manual

12V170-1

DIESEL ENGINE

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Category	Komatsu code	Part No.	Q'ty	Container	Main applications, features
Gasket sealant	LG-4	790-129-9020	200 g	Tube	<ul style="list-style-type: none"> • Features: Resistance to water, oil • Used as sealant for flange surface, thread. • Also possible to use as sealant for flanges with large clearance. • Used as sealant for mating surfaces of final drive case, transmission case.
	LG-5	790-129-9080	1 kg	Polyethylene container	<ul style="list-style-type: none"> • Used as sealant for various threads, pipe joints, flanges. • Used as sealant for tapered plugs, elbows, nipples of hydraulic piping.
	LG-6	09940-00011	250 g	Tube	<ul style="list-style-type: none"> • Features: Silicon based, resistance to heat, cold • Used as sealant for flange surface, tread. • Used as sealant for oil pan, final drive case, etc.
	LG-7	09920-00150	150 g	Tube	<ul style="list-style-type: none"> • Features: Silicon based, quick hardening type • Used as sealant for flywheel housing, intake manifold, oil an, thermostat housing, etc.
	Three bond 1211	790-129-9090	100 g	Tube	<ul style="list-style-type: none"> • Used as heat-resisting sealant for repairing engine.
Molybdenum disulphide lubricant	LM-G	09940-00051	60 g	Can	<ul style="list-style-type: none"> • Used as lubricant for sliding portion (to prevent from squeaking).
	LM-P	09940-00040	200 g	Tube	<ul style="list-style-type: none"> • Used to prevent seizure or scuffing of the thread when press fitting or shrink fitting. • Used as lubricant for linkage, bearings, etc.
Grease	G2-LI	SYG2-400LI SYG2-350LI SYG2-400LI-A SYG2-160LI SYGA-160CNLI	Various	Various	<ul style="list-style-type: none"> • General purpose type
	G2-CA	SYG2-400CA SYG2-350CA SYG2-400CA-A SYG2-160CA SYGA-160CNCA	Various	Various	<ul style="list-style-type: none"> • Used for normal temperature, light load bearing at places in contact with water or steam.
	Molybdenum disulphide lubricant	SYG2-400M	400 g (10 per case)	Belows type	<ul style="list-style-type: none"> • Used for places with heavy load

Temperature

Fahrenheit-Centigrade Conversion ; a simple way to convert a Fahrenheit temperature reading into a Centigrade temperature reading or vice versa is to enter the accompanying table in the center or boldface column of figures.

These figures refer to the temperature in either Fahrenheit or Centigrade degrees.

If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.

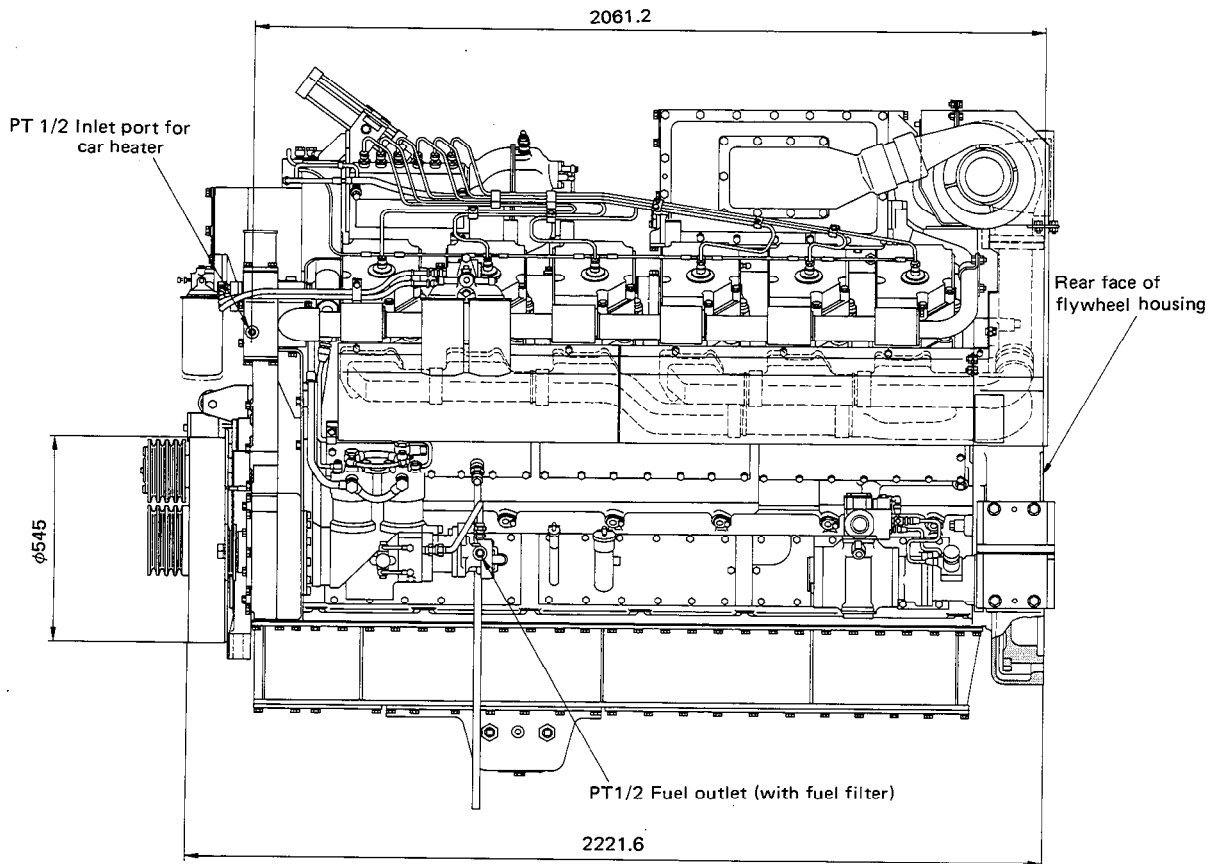
If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

1°C = 33.8°F

°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	85	185.0
-28.3	-19	-2.2	-8.9	16	60.8	10.6	51	123.8	30.0	86	186.8
-27.8	-18	-0.4	-8.3	17	62.6	11.1	52	125.6	30.6	87	188.6
-27.2	-17	1.4	-7.8	18	64.4	11.7	53	127.4	31.1	88	190.4
-26.7	-16	3.2	-7.2	19	66.2	12.2	54	129.2	31.7	89	192.2
-26.1	-15	5.0	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-25.6	-14	6.8	-6.1	21	69.8	13.3	56	132.8	32.8	91	195.8
-25.0	-13	8.6	-5.6	22	71.6	13.9	57	134.6	33.3	92	197.6
-24.4	-12	10.4	-5.0	23	73.4	14.4	58	136.4	33.9	93	199.4
-23.9	-11	12.2	-4.4	24	75.2	15.0	59	138.2	34.4	94	201.2
-23.3	-10	14.0	-3.9	25	77.0	15.6	60	140.0	35.0	95	203.0
-22.8	-9	15.8	-3.3	26	78.8	16.1	61	141.8	35.6	96	204.8
-22.2	-8	17.6	-2.8	27	80.6	16.7	62	143.6	36.1	97	206.6
-21.7	-7	19.4	-2.2	28	82.4	17.2	63	145.4	36.7	98	208.4
-21.1	-6	21.2	-1.7	29	84.2	17.8	64	147.2	37.2	99	210.2
-20.6	-5	23.0	-1.1	30	86.0	18.3	65	149.0	37.8	100	212.0
-20.0	-4	24.8	-0.6	31	87.8	18.9	66	150.8	40.6	105	221.0
-19.4	-3	26.6	0	32	89.6	19.4	67	152.6	43.3	110	230.0
-18.9	-2	28.4	0.6	33	91.4	20.0	68	154.4	46.1	115	239.0
-18.3	-1	30.2	1.1	34	93.2	20.6	69	156.2	48.9	120	248.0
-17.8	0	32.0	1.7	35	95.0	21.1	70	158.0	51.7	125	257.0
-17.2	1	33.8	2.2	36	96.8	21.7	71	159.8	54.4	130	266.0
-16.7	2	35.6	2.8	37	98.6	22.2	72	161.6	57.2	135	275.0
-16.1	3	37.4	3.3	38	100.4	22.8	73	163.4	60.0	140	284.0
-15.6	4	39.2	3.9	39	102.2	23.3	74	165.2	62.7	145	293.0
-15.0	5	41.0	4.4	40	104.0	23.9	75	167.0	65.6	150	302.0
-14.4	6	42.8	5.0	41	105.8	24.4	76	168.8	68.3	155	311.0
-13.9	7	44.6	5.6	42	107.6	25.0	77	170.6	71.1	160	320.0
-13.3	8	46.4	6.1	43	109.4	25.6	78	172.4	73.9	165	329.0
-12.8	9	48.2	6.7	44	111.2	26.1	79	174.2	76.7	170	338.0
-12.2	10	50.0	7.2	45	113.0	26.7	80	176.0	79.4	175	347.0

SA12V170-1 (HD1200M-1)

- Left side view



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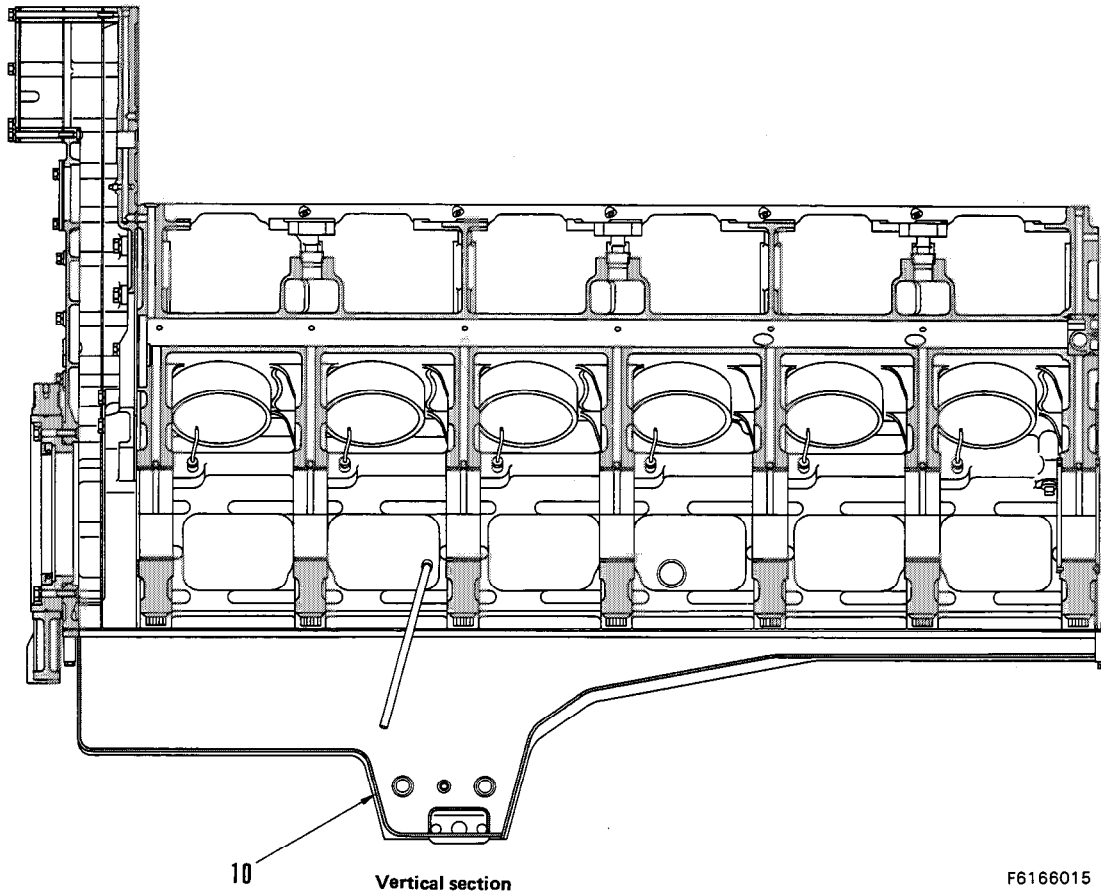
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11 STRUCTURE AND FUNCTION

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★ The illustration given in STRUCTURE AND FUNCTION are representative illustration.
Depending on the machine model, the actual, component may be different from the illustration.

CYLINDER BLOCK



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1. Cylinder block
2. Cylinder liner
3. Crevice seal
4. O-ring
5. O-ring
6. Piston cooling nozzle
7. Main bearing cap
8. Main bearing cap side bolt
9. Main bearing cap bolt
10. Oil pan

Cylinder block

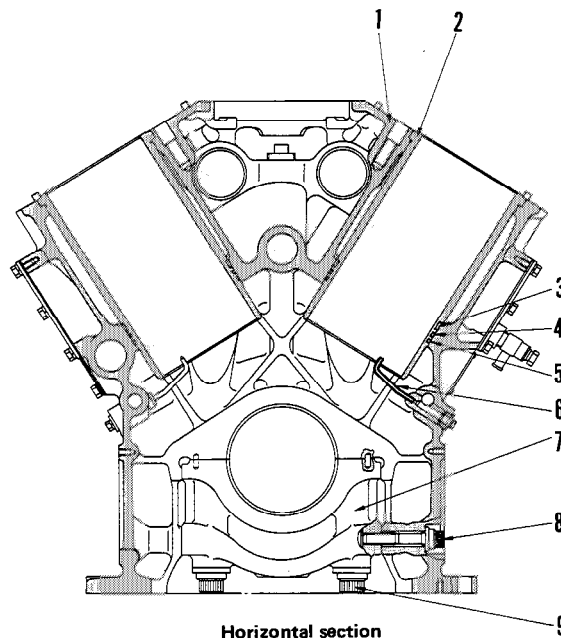
- Crankshaft: Seven bearing
- Camshaft: Seven bearings

Cylinder liner

- Wet type liner, tuffride treatment on bore surface

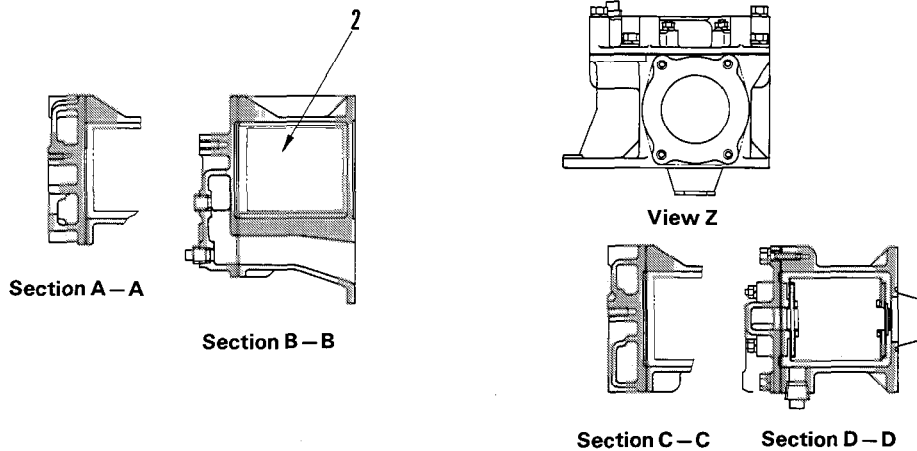
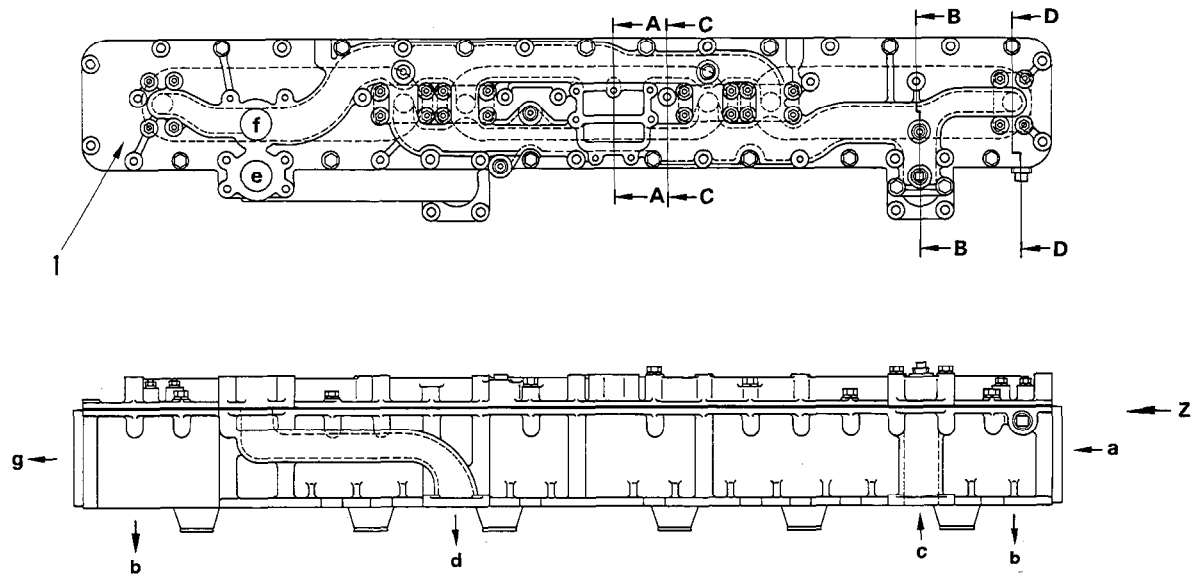
Liner seal

- Top: Clevis seal (Ethylene propylene)
- Middle: O-ring (Ethylene propylene: black)
- Bottom: O-ring (Silicone rubber: red)



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OIL COOLER



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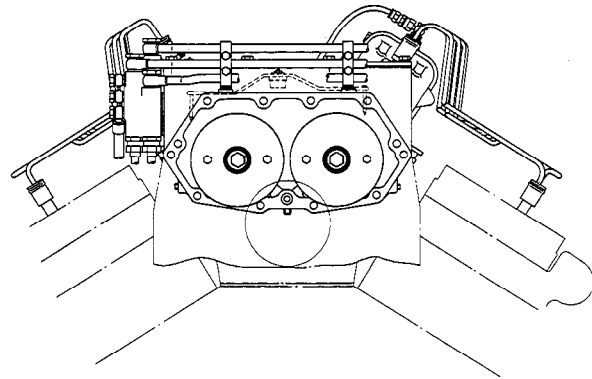
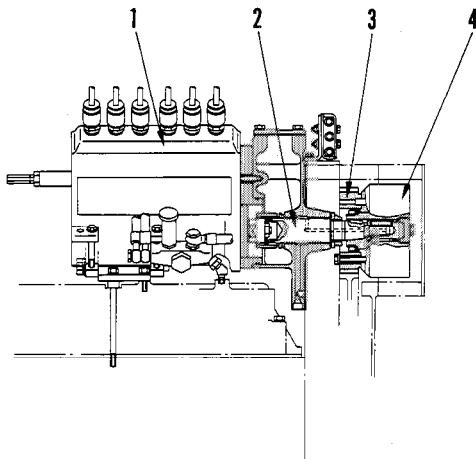
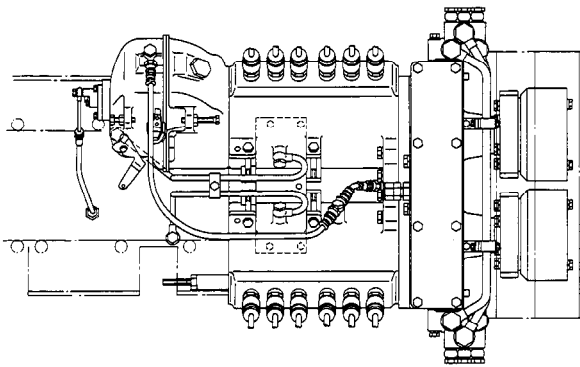
- 1. Cooler cover
- 2. Cooler element

- a. Coolant (from water pump)
- b. Coolant (to engine each component)
- c. Oil (from oil pump)
- d. Oil (to engine each component)
- e. Oil (from oil filter)
- f. Oil (to oil filter)
- g. Coolant (to after cooler)

Oil cooler

- Heat exchanged: Min. 105,600 Kcal/hr.
- Heat-transmitting area: 4.32 m²
(1.44 m² x 3 sets)
- Oil flow capacity: 465 ℓ/min.
- Water flow capacity: 2,000 ℓ/min.

SA12V170-1 (For EG1100-1)

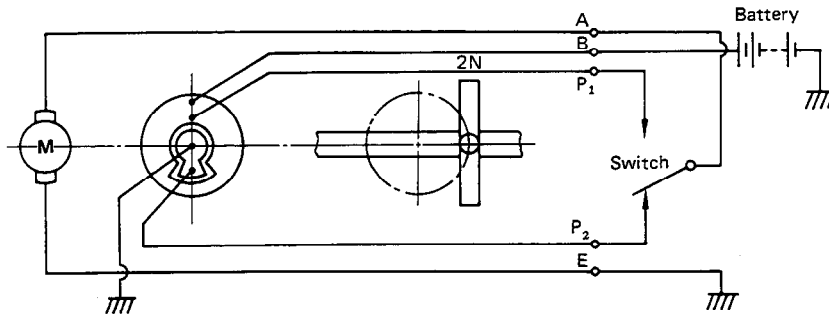


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1. Fuel injection pump
2. Drive shaft
3. Drive gear (No. of teeth: 36)
4. Adapter

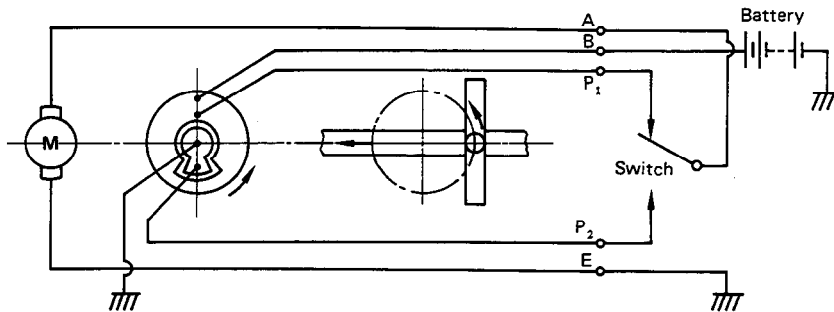
4. When stopped (180°)



A closed circuit is formed when the P₂ auto-stop terminal rides on the minus-side

contactor plate, and the motor comes to a sudden stop. The slider assembly also stops.

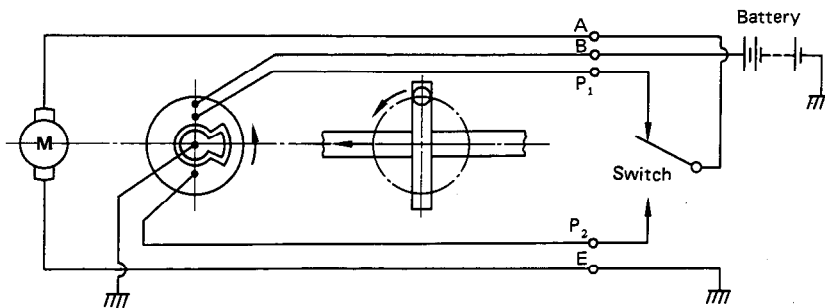
5. When switch is turned (when starting the motor)



When the switch is moved to the P₁ side (starting switch OFF), and electric current flows from the plus contactor plate through the P₁ auto-stop terminal and switch and into the ar-

mature shaft assembly, thereby starting the motor. The slider assembly starts to move in the direction of the arrow at the same time as the roller starts to move.

6. Turning condition (270° in the drawing)

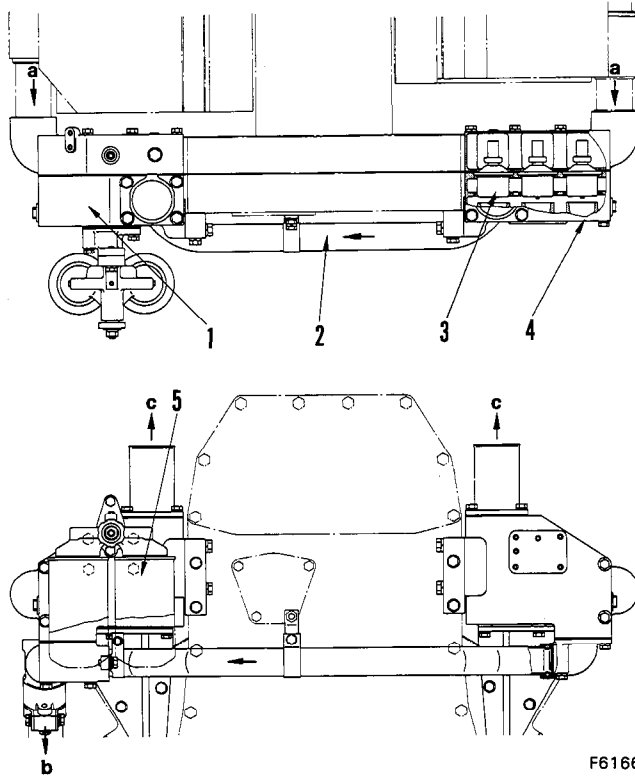


Electric current continues to pass through the armature shaft assembly and the motor continues to turn. The slider assembly also con-

tinues to move in the direction of the arrow. Then the circuit returns to stop condition 1.

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THERMOSTAT

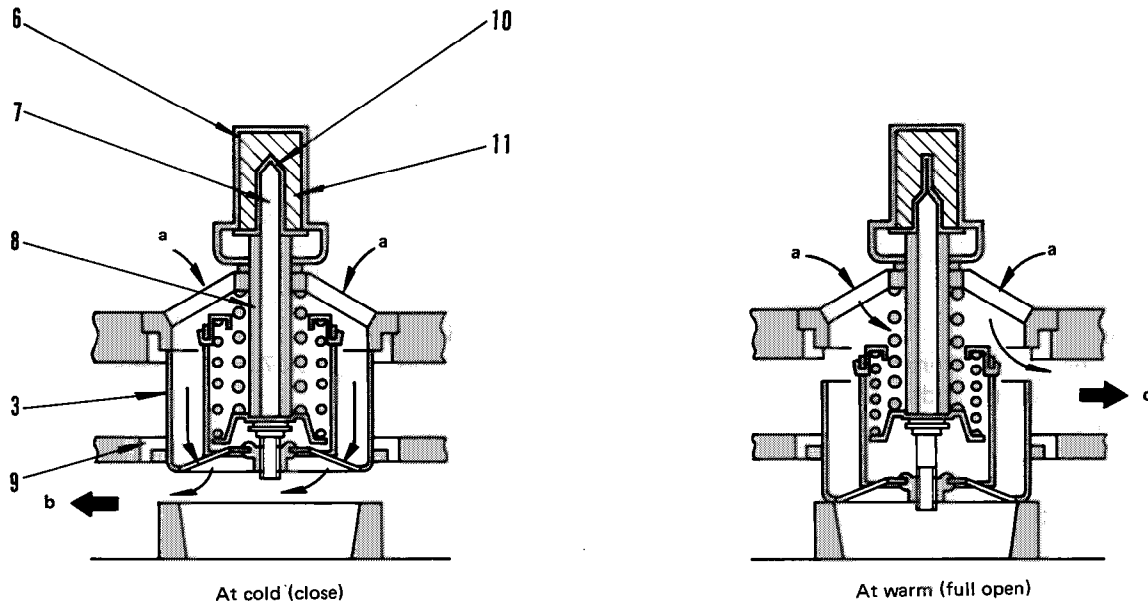


1. Thermostat housing
 2. Water manifold
 3. Thermostat
 4. Thermostat housing
 5. Corrosion resistor
 6. Sensor
 7. Piston
 8. Body
 9. Seal
 10. Sleeve
 11. Wax
- a. From engine each component
 b. To water pump
 c. To radiator

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OPERATION



At cold (close)

At warm (full open)

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Function


- Opening temperature: $76.5 \pm 2^\circ\text{C}$
- Full opening temperature: 90°C
- Valve lift: Min. 10 mm

MEASURING COMPRESSION PRESSURE

⚠ Be careful not to touch any hot places when installing or removing the measuring tools.

★ Raise the temperature of the cooling water to the operating range before measuring.

1. Adjust the valve clearance.
 - ★ For details, see ADJUSTING VALVE CLEARANCE.
2. Remove the nozzle holder assembly of the cylinder to be measured.
 - ★ Be careful not to let dirt or dust get inside.
3. Install adapter **D2** in the mount of the nozzle holder assembly.

 Adapter D2: $26.9 \pm 2.5 \text{ Nm}$
($2.75 \pm 0.25 \text{ kgm}$)

4. Connect compression gauge assembly **D1** to the adapter.

⚠ When measuring the compression pressure, be careful not to touch any hot parts or to get caught in the rotating parts.

5. Place the fuel control lever in the NO INJECTION position. Crank the engine with the starting motor and measure the compression pressure.

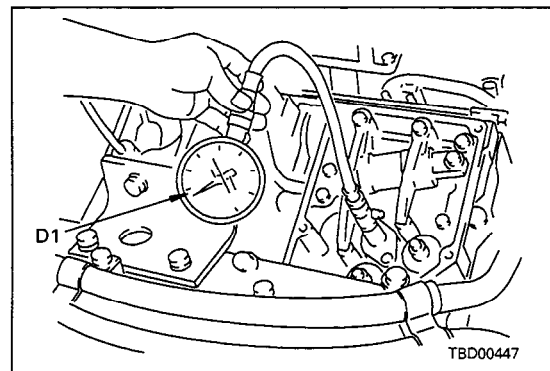
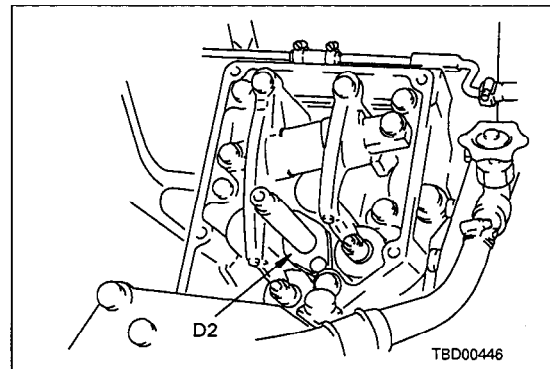
★ Measure the compression pressure at the point where the pressure gauge indicator remains steady.

⚠ If the fuel control lever is not placed at the NO INJECTION position, fuel will spurt out.

★ If the adapter mount is coated with a small amount of oil, it will reduce the leakage.

★ For details of the standard values for the compression pressure, see TESTING AND ADJUSTING DATA.

★ When measuring the compression pressure, measure the engine speed to confirm that it is within the specified range.



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Pump Assembly Number

6166-71-1510 (103662-3220) (Left bank)
 6166-71-1550 (103664-1300) (Right bank)
 (): Manufacture's part No.

Injection Pump Type	Pump Manufacturer
PES-ZWX	ZEXEL

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
D575A-2	10001 and up	SA12V170-1	10024 - 10096

Injection Timing

Rotating direction	Counter clockwise viewed from drive end
Injection order	1 - 5 - 3 - 6 - 2 - 4
Injection interval	60° ± 30'
Plunger pre-stroke (mm)	3.8 ± 0.05
Delivery valve retraction volume (mm ³ /st)	120

Engine Specification

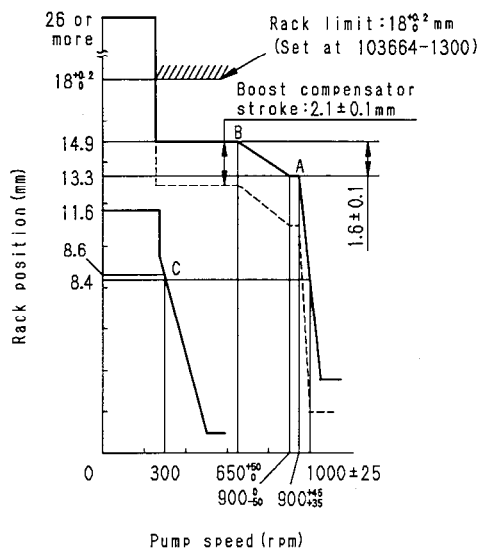
Reted horsepower (kw(HP)/rpm)	854(1,145)/1,800
Maximum torque (Nm(kgm)/rpm)	5,197(530)/1,300
High idling (rpm)	1,950 - 2,050
Low idling (rpm)	600 - 700
Pump tester capacity for Service standard	Motor: 7.5 KW

Calibration Standard

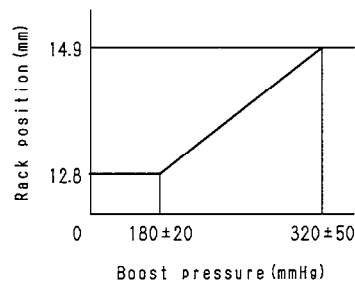
Conditions			Service standard			Manufacturer standard			
<ul style="list-style-type: none"> • Service standard indicates data using calibration test parts. • Manufacture standard is data for factory test parts. 	Nozzle part no.		(105780 - 0050)			(105015 - 6140)			
	Nozzle holder part no.		(105780 - 2090)			(105041 - 7020)			
	Injection pipe (O/D × I/D × length) (mm)		8 × 2.4 × 1,500			8 × 2.4 × 1,400			
	Test oil		ASTM D975 No.2 diesel fuel or equivalent						
	Oil temperature (°C)		43 - 47						
	Nozzle opening pressure (MPa(kg/cm ²))		17.2 (175)			29.4 (300)			
Transfer pump pressure (MPa(kg/cm ²))		0.16 (1.6)			0.16 (1.6)				
Injection volume	Rack point	Rack position (mm)	Pump speed (rpm)	Service standard (cc/100st)			Manufacturer standard (cc/100st)		
				Basis	Allowance	Maximum variance between cylinder	Basis	Allowance	Maximum variance between cylinder
<ul style="list-style-type: none"> • Rack positions B to E are the reference volume when adjusting the injection volume. • Marks ★ are average volumes. 	Basic point	13.3	900		Each cyl.		35.2	Each cyl. 34.7 - 35.7	± 1.4
	B	14.9	650	★			41.8	★ 41.3 - 42.3	—
	C	Approx. 8.6	300	★			8.9	★ 8.4 - 9.4	± 1.2
	D				★			★	
	E					★		★	

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Governor performance (300 - 900 rpm)



Boost compensator performance (500 rpm)



TAE00108

- ★ The values in the table are indicated at standard conditions (Atmospheric temperature 25°C, atmospheric pressure 750 mmHg).
- ★ The values given for dynamometer loads the output and torque are with the fan removed, so they differ from those of the specification.
- ★ Values are standardized under the following conditions: muffler air cleaner installed; alternator idling; and air compressor (if installed) open.
- ★ Dynamometer loads are given for the case of the arm length are 716, 895 and 1,023 mm.
- ★ Fuel used: ASTM D975 No. 1 or No. 2 diesel fuel.
- ★ Lubrication oil used: CLASS-CO SAE30.
- ★ Exhaust temperature column t: (Suction temperature -25°C)

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Output (kW (HP))	Torque (Nm (kgm))	Fuel consumption (sec. / 1000 cc)	Coolant temperature (°C)	Lubrication oil temperature (°C)	Lubrication oil pressure (MPa (kg/cm ²))	Exhaust temperature (°C) t = Intake temp. -25°C
855 - 906 (1146 - 1215)	—	Min. 15.1	70 - 85	80 - 110	0.27 - 0.41 (2.8 - 4.2)	700
—	5197 - 5511 (530 - 562)	—	70 - 85	80 - 110	—	—
—	—	—	70 - 85	80 - 110	0.27 - 0.41 (2.8 - 4.2)	—
—	—	—	70 - 85	Min. 80	0.1 - (1.0 -)	—
890 - 944 (1193 - 1266)	—	Min. 14.5	70 - 85	80 - 110	0.27 - 0.41 (2.8 - 4.2)	700
—	5648 - 6001 (576 - 612)	—	70 - 85	80 - 110	—	—
—	—	—	70 - 85	80 - 110	0.27 - 0.41 (2.8 - 4.2)	—
—	—	—	70 - 85	Min. 80	0.1 - (1.0 -)	—
982 - 1003 (1317 - 1344)	—	Min. 14.6	70 - 85	80 - 110	0.38 - 0.44 (3.9 - 4.5)	Max. 700
—	5138 - 5246 (524 - 535)	—	70 - 85	80 - 110	0.38 - 0.44 (3.9 - 4.5)	Max. 700
—	—	—	70 - 85	80 - 110	Min. 0.15 (Min. 1.5)	Max. 700
—	—	—	70 - 85	Min. 80	Min. 0.15 (Min. 1.5)	Max. 700
879 - 933 (1178 - 1251)	—	Min. 14.6	70 - 85	80 - 110	0.38 - 0.44 (3.9 - 4.5)	Max. 700
—	4726 - 4825 (482 - 492)	—	70 - 85	80 - 110	0.38 - 0.44 (3.9 - 4.5)	Max. 700
—	—	—	70 - 85	80 - 110	0.38 - 0.44 (3.9 - 4.5)	Max. 700
—	—	—	70 - 85	Min. 80	Min. 0.15 (Min. 1.5)	Max. 700

POINTS TO REMEMBER WHEN TROUBLESHOOTING

- ⚠ Stop the machine in a level place, and check that the safety pin, blocks, and parking brake are securely fitted.
- ⚠ When carrying out the operation with two or more workers, keep strictly to the agreed signals, and do not allow any unauthorized person to come near.
- ⚠ If the radiator cap is removed when the engine is hot, hot water may spurt out and cause burns, so wait for the engine to cool down before starting troubleshooting.
- ⚠ Be extremely careful not to touch any hot parts or to get caught in any rotating parts.
- ⚠ When disconnecting wiring, always disconnect the negative (-) terminal of the battery first.
- ⚠ When removing the plug or cap from a location which is under pressure from oil, water, or air, always release the internal pressure first. When installing measuring equipment, be sure to connect it properly.

The aim of troubleshooting is to pinpoint the basic cause of the failure, to carry out repairs swiftly, and to prevent reoccurrence of the failure.

When carrying out troubleshooting, an important point is of course to understand the structure and function. However, a short cut to effective troubleshooting is to ask the operator various questions to form some idea of possible causes of the failure that would produce the reported symptoms.

1. When carrying out troubleshooting, do not hurry to disassemble the components. If components are disassembled immediately any failure occurs:
 - Parts that have no connection with the failure or other unnecessary parts will be disassembled.
 - It will become impossible to find the cause of the failure.

It will also cause a waste of manhours, parts, or oil or grease, and at the same time, will also lose the confidence of the user or operator. For this reason, when carrying out troubleshooting, it is necessary to carry out thorough prior investigation and to carry out troubleshooting in accordance with the fixed procedure.
2. Points to ask user or operator
 - 1) Have any other problems occurred apart from the problem that had been reported?
 - 2) Was there anything strange about the machine before the failure occurred?
 - 3) Did the failure occur suddenly, or were there problems with the machine condition before this?
 - 4) Under what conditions did the failure occur?
 - 5) Had any repairs been carried out before the failure?
When were these repairs carried out?
 - 6) Has the same kind of failure occurred before?
3. Check before troubleshooting
 - 1) Check the oil level.
 - 2) Check for any external leakage of oil from the piping or hydraulic equipment.
 - 3) Check the travel of the control levers.
 - 4) Check the stroke of the control valve spool.
 - 5) Other maintenance items can be checked externally, so check any item that is considered to be necessary.
4. Confirming failure

Confirm the extent of the failure yourself, and judge whether to handle it as a real failure or as a problem with the method of operation, etc.

 - ★ When operating the machine to reenact the troubleshooting symptoms, do not carry out any investigation or measurement that may make the problem worse.
5. Troubleshooting

Use the results of the investigation and inspection in Items 2 - 4 to narrow down the causes of failure, then use the troubleshooting flowchart to locate the position of the failure exactly.

 - ★ The basic procedure for troubleshooting is as follows.
 - 1) Start from the simple points.
 - 2) Start from the most likely points.
 - 3) Investigate other related parts or information.
6. Measures to remove root cause of failure

Even if the failure is repaired, if the root cause of the failure is not repaired, the same failure will occur again. To prevent this, always investigate why the problem occurred. Then, remove the root cause.

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- Thank you very much for reading the preview of the manual.
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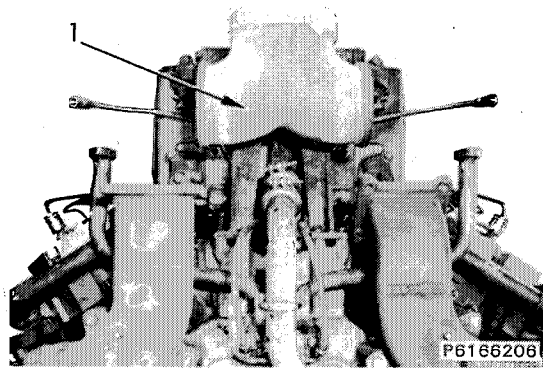


- Please note: If there is no response to CLICKING the link, please download this PDF first and then click on it.

CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL

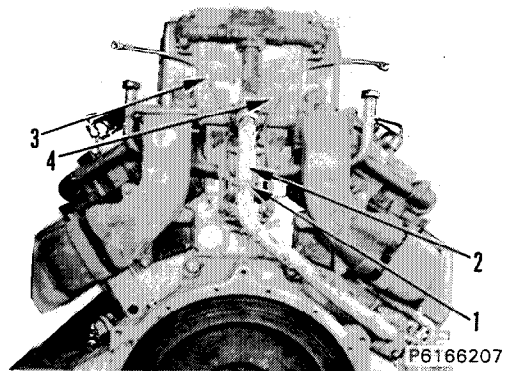
13. Exhaust connector

Dismount the turbocharger exhaust connector (1), then remove bracket.

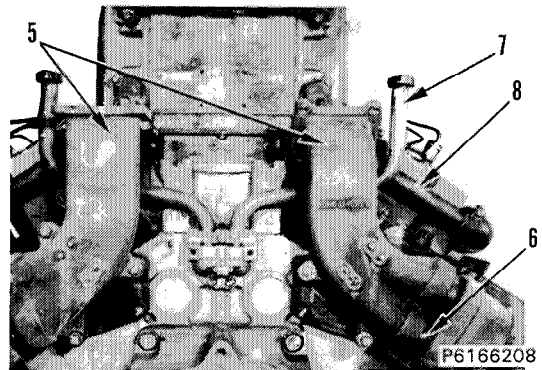


14. Water tube, turbocharger lubrication tube, exhaust tube

- 1) Remove clamp (1) and remove water tube (2).
- 2) Remove clamp and remove turbocharger lubrication tubes (3) and (4).

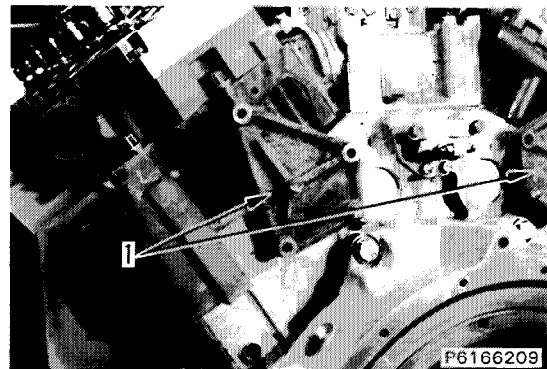


- 3) Remove exhaust tubes (5) and couplings (6).
- 4) Remove turbocharger drain tubes (7).
- 5) Remove water tubes (8).



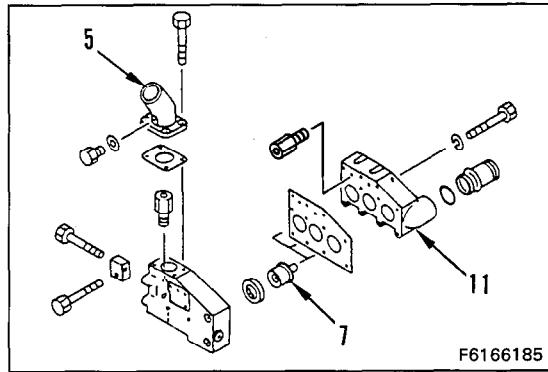
15. Bracket, oil connector, breather

- 1) Remove each bracket (1) for exhaust tube.



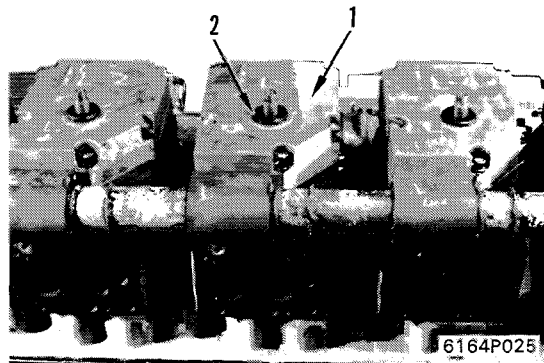
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- 5) Disassemble thermostats as follows.
- i) Remove connector (5).
 - ii) Remove cover (11), then remove 3 thermostats (7).



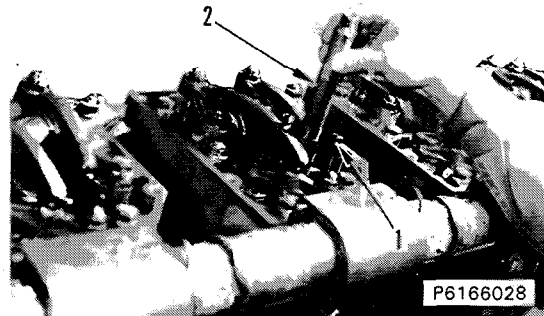
32. Cylinder head covers

- 1) Remove mounting bolts and each head cover (1).
- 2) Remove nozzle seal (2).



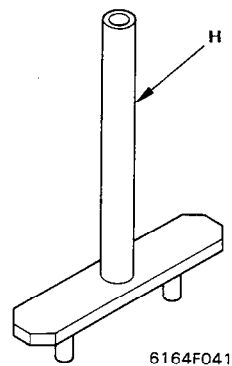
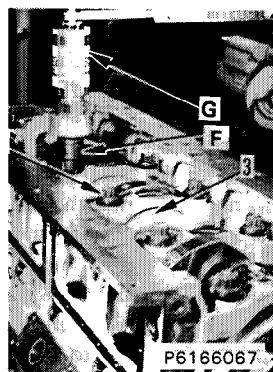
33. Nozzle holders

- Remove mounting bolts (1) and each nozzle holder (2).



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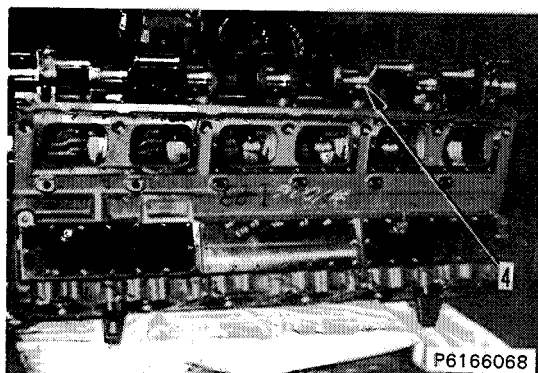
- 3) Using socket (F) and power wrench (G), then remove mounting bolts (2) for main bearing cap (3).
 - 4) Using tool H, insert tool in holes in main bearing cap (3), then remove main bearing cap while shaking the cap with the tool H.
- ★ Check the position of thrust bearing installed the main bearing cap.



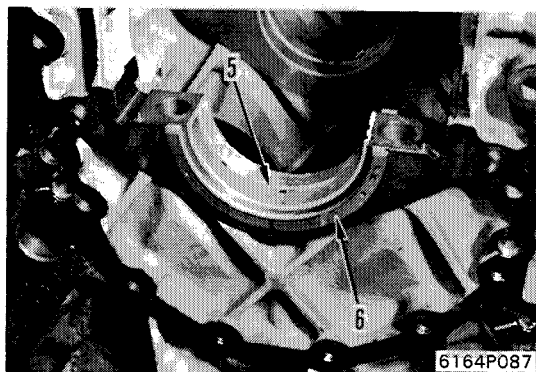
- 5) Lift off crankshaft (4), take care not to let it hit against the cylinder block.



Crankshaft: 419 kg

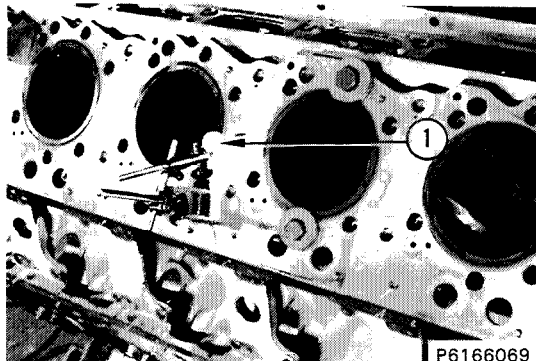
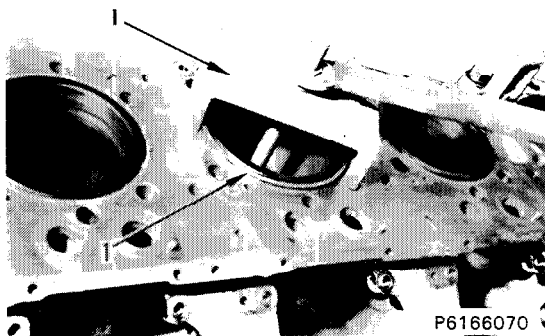


- 6) Remove upper main bearing (5).
- 7) Remove upper thrust bearing (6).



59. Cylinder liner

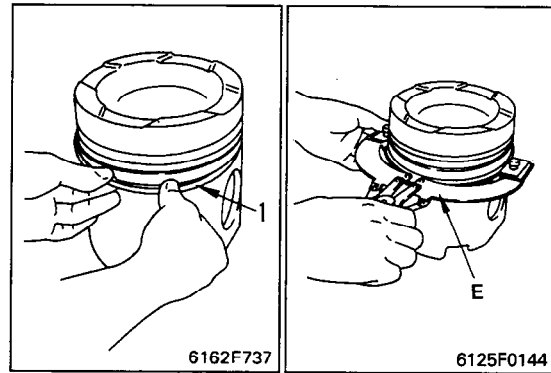
- 1) If necessary, measure the cylinder liner protrusion using dial gauge ① before removing the cylinder liners.
- 2) Pull out cylinder liners (1) using liner puller I.



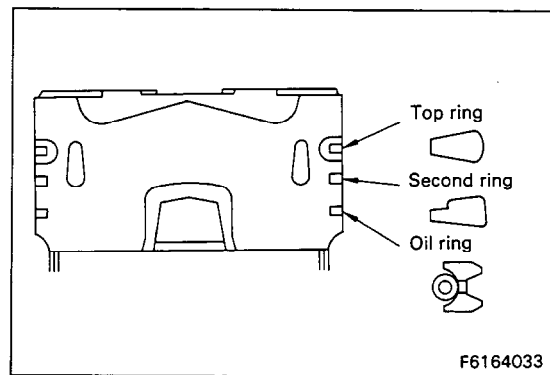
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3. Piston, connecting rod assembly

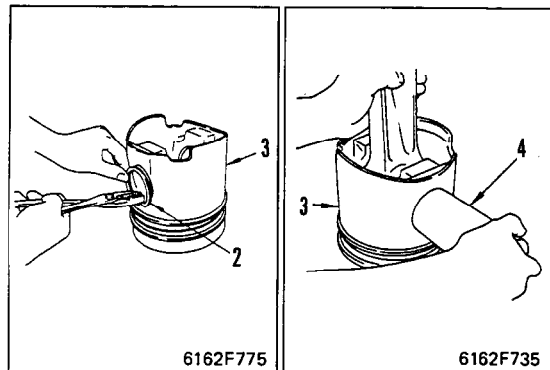
- Assemble piston and connecting rod.
 - i) Fit oil ring expander (1) in oil ring groove.
 - ii) Using piston ring tool E, assemble oil ring, second ring, and top ring in order.
 - ★ Set each ring with the stamped mark facing up, then assemble to the piston.



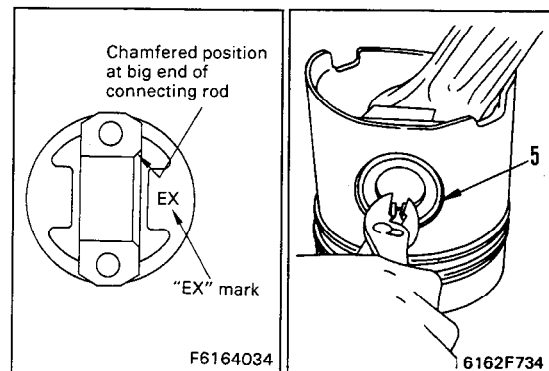
- ★ The end gap of the expander coil must be at 180° to the end gap of the oil ring.
- ★ Assemble each piston ring as shown in the diagram.



- iii) Install snap ring (2) on one side.
- iv) Heat piston (3) at 100°C [212°F] for 5 minutes in a heating furnace.
 - ★ If no heating furnace is available, heat in hot water at 100°C [212°F] for 5 minutes.
 - ★ When heating with hot water, clean the piston completely after setting it in position.
- v) Coat piston bore with engine oil (SAE #30), set chamfered face of connecting rod facing "EX" mark, and insert piston pin (4).



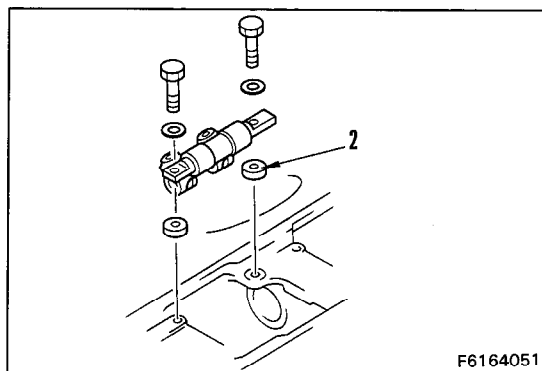
- vi) Install snap ring (5) on opposite side.
 - ★ Turn the snap rings to check that the left and right snap rings are completely fitted in the ring groove.




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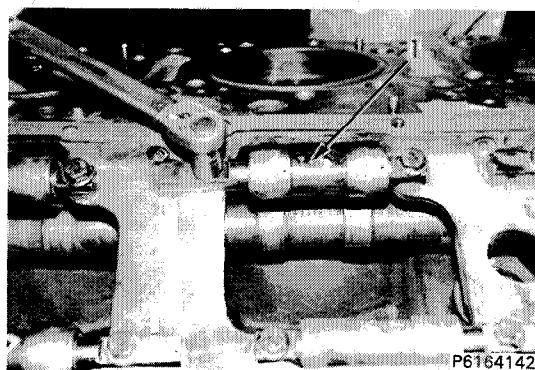
11. Cam follower

- 1) Knock dowel ring (2) into cylinder block.

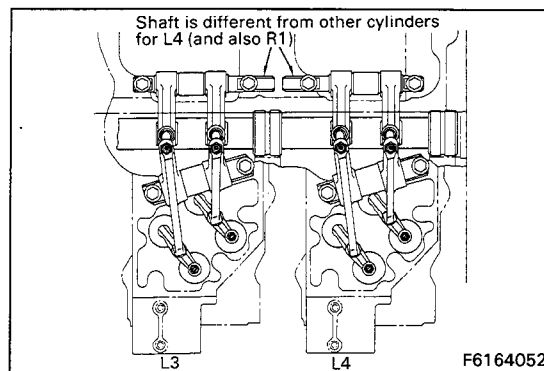


- 2) Install cam follower assembly (1).

 **Mounting bolt:** $97.1 \pm 6.9 \text{ Nm}$
($9.9 \pm 0.7 \text{ kgm}$)

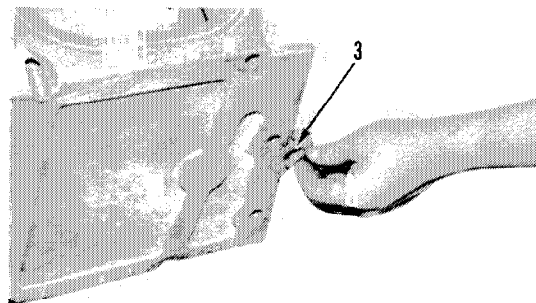


- ★ The position of the shaft mounting hole for the cam followers for R1 and L4 are different from the other cylinders.




12. Intake manifold

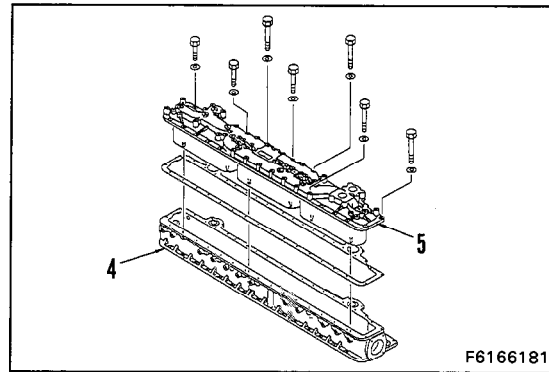
- 1) Assemble grommet (3).



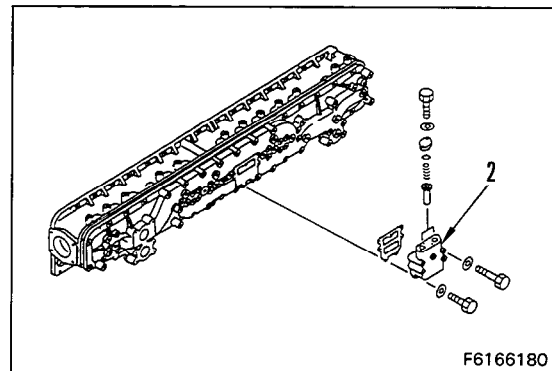
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- ii) Fit gasket to cover and core assembly (5), and install housing (4).

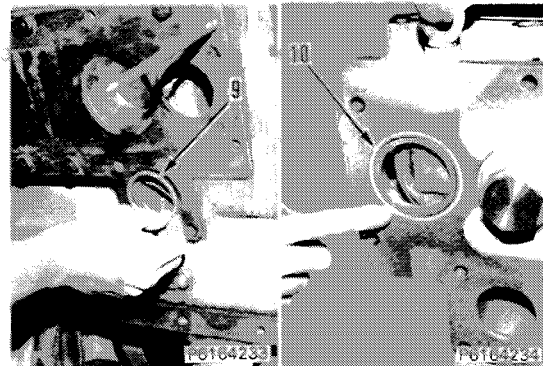
 Mounting bolt: $65.7 \pm 6.8 \text{ Nm}$
($6.7 \pm 0.7 \text{ kgm}$)




- iii) Fit gasket and install by-pass valve (2).

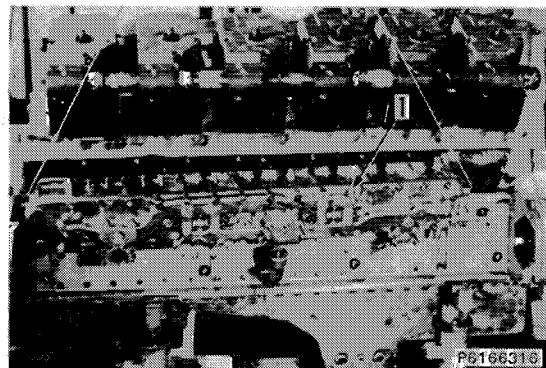


- 1) Install O-ring (9) and washer (10).
 ★ It is easy for the O-ring to fall out, so coat it with gasket sealant (LG-6) when installing.
 ★ Install O-ring (9) to the oil cooler end.



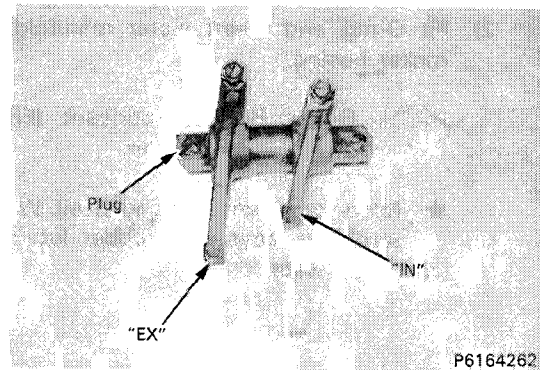
- 2) Using guide bolt, install oil cooler assembly (1).

 Mounting bolt: $65.7 \pm 6.8 \text{ Nm}$
($6.7 \pm 0.7 \text{ kgm}$)



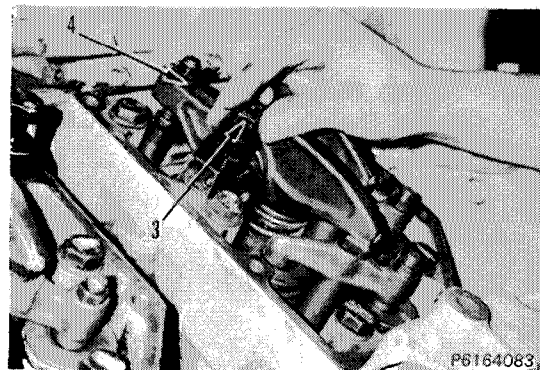
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- iv) Set exhaust rocker arm (long arm) on the left, intake rocker arm (short arm) on the right, and collar in the center, then insert rocker shaft. (See diagram on right)




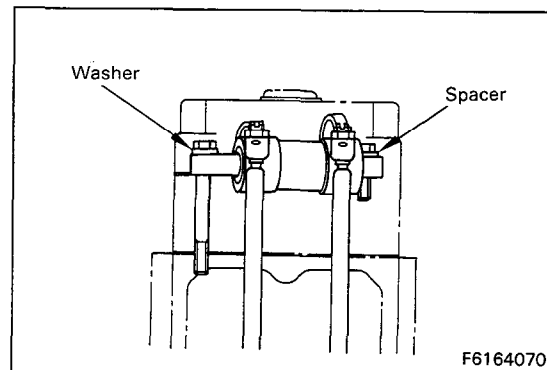
- v) Install rocker arm assembly (4), and tighten bolts (3).

- ★ Check that the ball of the adjustment screw is fitted securely in the ball of the adjustment screw is fitted securely in the socket of the push rod, then install the bolts.



- ★ Install spacer (length: 15 mm) to the short bolt, and a washer to the long bolt.



 Mounting bolt: $98.1 \pm 4.9 \text{ Nm}$
 $(10.0 \pm 0.5 \text{ kgm})$



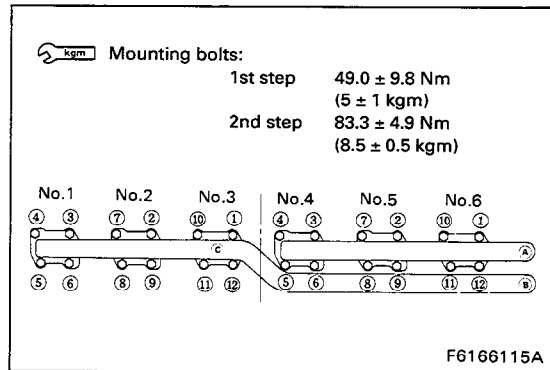
- 1) Using push tool P, insert water manifold (2).
 - 2) Secure with snap ring (1).
 - 3) Adjust valve clearance.
- ★ For details, see TESTING AND ADJUSTING, Adjusting valve clearance.



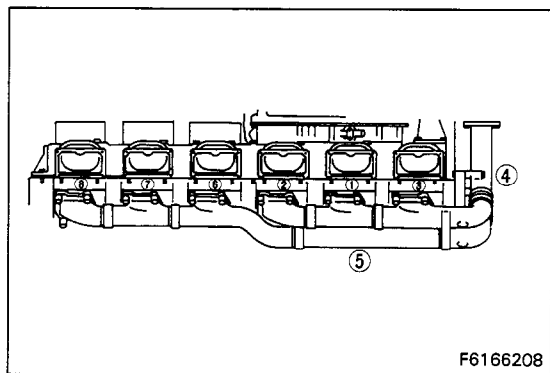
- 4) Fit gasket to left bank exhaust manifold, then tighten (1) — (8) in order.

-  Manifold connection:
Anti-friction compound (LM-P)
-  Mounting bolt:
Anti-friction compound (LM-P)

- ★ After installing manifold, tighten to the specified torque in the tightening order. For the other manifolds, tighten after installing all.

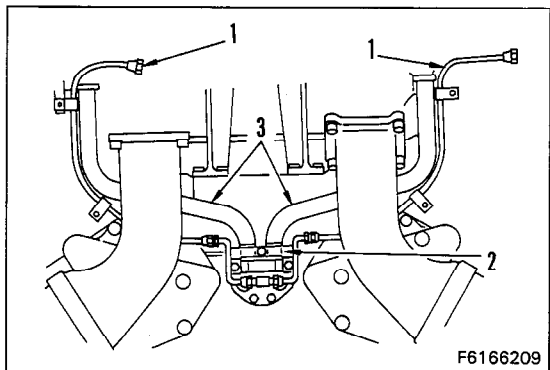


- ★ Heat resistant bolts are used (they have a 660 mark on the head), so be careful to keep the tightening torque.



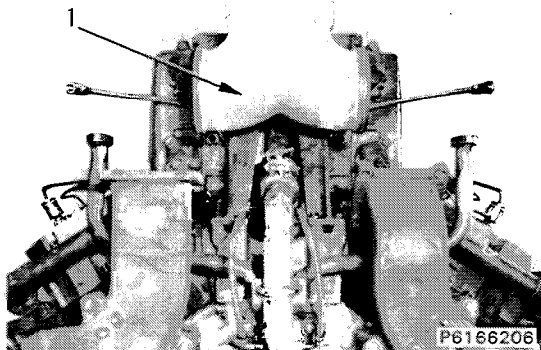
53. Turbocharger lubrication piping, coolant water piping

- 1) Fit O-ring and install tubes (3).
- 2) Install clamp (2).
- 3) Install hoses (1).



54. Exhaust connector

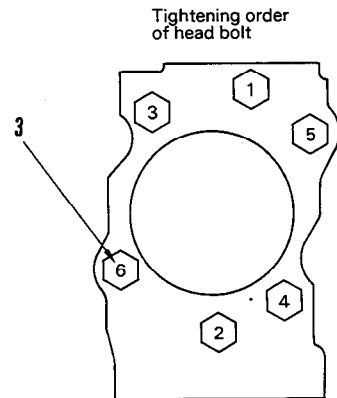
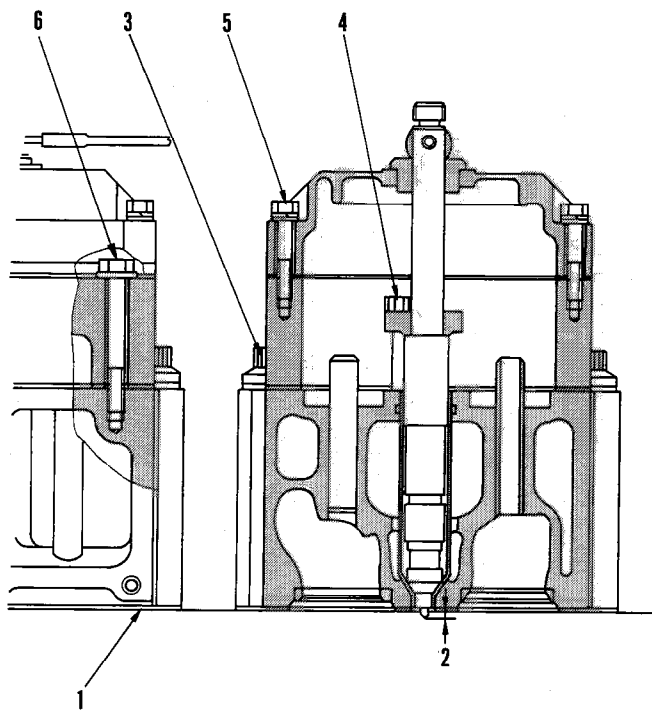
- 1) Install bracket.
- 2) Install seal rings to both sides of the connector.
- 3) Install exhaust connector (1).



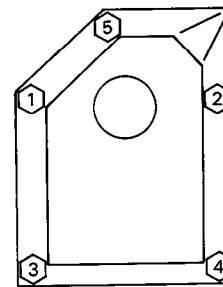
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ENGINE BODY

CYLINDER HEAD



Tightening order of head cover and mounting bolt



F6166057-1

Unit: mm

No.	Check item	Criteria		Remedy	
		Standard	Repair limit		
1	Distortion of cylinder head mounting surface	Max. 0.05	0.1	Repair by grinding or replace	
2	Protrusions of nozzles	Standard: 4.9 — 5.7		Replace nozzles sleeves	
3	Tightening torque of cylinder head mounting bolts (Coat bolt threads and washer with anti-friction compound (LM-P))	Order	Target value (kgm)	Range (kgm)	Tighten in sequence as indicated above.
		1st	7.9	6.4 — 9.4	
		2nd	23.5	22.0 — 25.0	
		3rd	39.0	37.5 — 40.5	
4	Tightening torque of nozzle holder mounting bolt	Target value (kgm)	Range (kgm)		Retighten
		2.75	2.5 — 3.0		
5	Tightening torque of cylinder head cover	3.25	3.0 — 3.5		
6	Tightening torque of rocker arm housing mounting bolt	10.0	9.5 — 10.5		

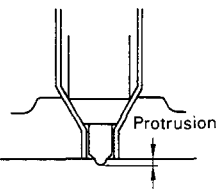
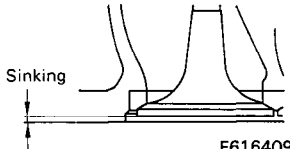
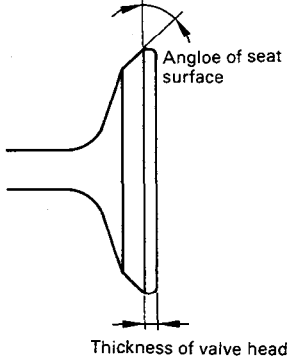
Unit: mm

No.	Check item	Criteria			Remedy		
		Size	Standard size	Tolerance		Repair limit	
2	Outside diameter of No.4 journal	S.T.D.	162.00	-0.040 -0.060	161.94	Replace	
		0.25 US	161.75		161.69		
		0.50 US	161.50		161.44		
		0.75 US	161.25		161.19		
		1.00 US	161.00		160.94		
		No.4 journal roundness			Standard		Repair limit
			0 - 0.010		0.010		
3	Outside diameter of crank pin journal	S.T.D.	124.00	0 -0.020	124.98	Replace	
		0.25 US	123.75		123.73		
		0.50 US	123.50		123.48		
		0.75 US	123.25		123.23		
		1.00 US	123.00		122.98		
		Crank pin journal roundness			Standard		Repair limit
			0 - 0.010		0.10		
Crank pin bearing thickness		3.5 ^{-0.053} -0.040		3.43			
4	End play	Tolerance		Repair limit			
		0.140 - 0.320		0.69			
5	Outside diameter of rear flange	Standard size		Tolerance		Repair limit	
		220		±0.1		219.7	
6	Bend of crankshaft (by indicator)			Tolerance		Repair limit	
		Runout of all main journal		Max. 0.09		0.09	
		Runout of journal adjoin each other		Max. 0.05		0.05	
7	Tightening torque of vibration damper mounting bolt			Target (kgm)		Range (kgm)	
		1st		7.5		5.5 - 9.5	
		2nd		25.0		23 - 27	
		3rd		65.0		63 - 67	

TESTING AND INSPECTING

(1) Cylinder head

Unit: mm

Inspection item	Judgement standards	Remedy						
A. Cracks, leakage from cylinder head	<ul style="list-style-type: none"> • Check for cracks (external color check) • Check for air leakage with air pressure test (3.0 — 3.5 kg/cm², 30 sec.) • Water pressure test (3.5 — 4.0 kg/cm², 10 min.) 	Repair by welding or replace						
B. Distortion of top, bottom surface of cylinder head	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th style="width: 50%;">Tolerance</th> <th style="width: 50%;">Repair limit</th> </tr> </thead> <tbody> <tr> <td>Max. 0.05</td> <td>0.1</td> </tr> </tbody> </table>	Tolerance	Repair limit	Max. 0.05	0.1	Grind to correct		
Tolerance	Repair limit							
Max. 0.05	0.1							
C. Damage to injection nozzle sleeve seat surface, contact width		Machine to repair or replace sleeve						
D. Protrusion of injection nozzle	 <p style="text-align: center;">Permissible range: 4.9 — 5.7</p> <p style="text-align: center;">F6164092</p>	Replace sleeve						
E. Damage to valve seat surface or loosening of seat	<ul style="list-style-type: none"> • Pitting of seat surface • Check contact between valve and seat surface • Airtightness test • Tap cylinder head and check for looseness 	Correct seat surface or replace valve seat						
F. Sinking of valve (both intake and exhaust)	 <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th style="width: 50%;">Standard value</th> <th style="width: 50%;">Repair limit</th> </tr> </thead> <tbody> <tr> <td>0.9 — 1.5</td> <td>2.1</td> </tr> </tbody> </table> <p style="text-align: center;">F6164093</p>	Standard value	Repair limit	0.9 — 1.5	2.1	Replace valve or valve seat		
Standard value	Repair limit							
0.9 — 1.5	2.1							
G. Thickness of valve head	 <ul style="list-style-type: none"> • Thickness of valve head <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th style="width: 50%;">Standard value</th> <th style="width: 50%;">Repair limit</th> </tr> </thead> <tbody> <tr> <td>Intake valve 3.4</td> <td>2.9</td> </tr> <tr> <td>Exhaust valve 3.5</td> <td>3.1</td> </tr> </tbody> </table> • Angle of seat surface <ul style="list-style-type: none"> Intake valve: 30° Exhaust valve: 45° <p style="text-align: center;">F6164094</p>	Standard value	Repair limit	Intake valve 3.4	2.9	Exhaust valve 3.5	3.1	Replace
Standard value	Repair limit							
Intake valve 3.4	2.9							
Exhaust valve 3.5	3.1							

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7. Spot-facing the inside seat of the sleeve

1) Using guide bushing J as the guide, spot-face the seat with sleeve cutter I.

★ Cut the seat little by little while checking the protrusion of the nozzle with the holder for measuring it and a dial guage so that the protrusion of the nozzle will be within the specification.

★ **Rotating speed: 500 to 600 rpm**

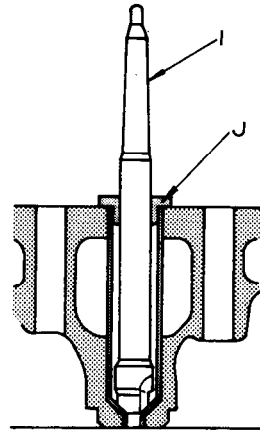
★ **Protrusion of nozzle: 4.9 to 5.7 mm**

2) Remove all the metal chips and dust from the machined surface.

8. Checking the leakage from the seat

• Confirm that fluid does not leak through the sleeve seat in the air pressure test. (There must be no leakage for 30 seconds at an air pressure of 3.0 — 3.5kg/cm²)

★ When carrying out the air pressure test, install a used nozzle holder.



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3. Checking and distinguishing after grinding and correcting

After grinding and correcting, check for scratches on the flat surface around the water and oil holes in the cylinder block top surface.

Remove all burrs completely.

After grinding the top surface, if the cylinder block height **H** exceeds the standard dimension, but is within the repair limit (544.5 — 544.8 mm), always use an oversize head gasket.

★ Thickness of head gasket plate: 2.4 mm
(Standard: 2.0 mm)

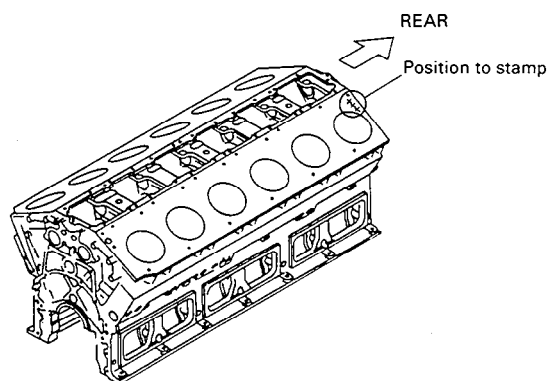
★ To distinguish, the letters "OS" are stamped on the plate.

After correcting, stamp the top surface of the cylinder block according to the content of the correction as shown in the table below.

Table of letters to stamp

	Oversize head gasket	Shim	Stamp
Parts used for correction	—	—	Not needed
	○	—	OS
	—	○	SH
	○	○	WS

(Size of letters: 5 — 10 mm)



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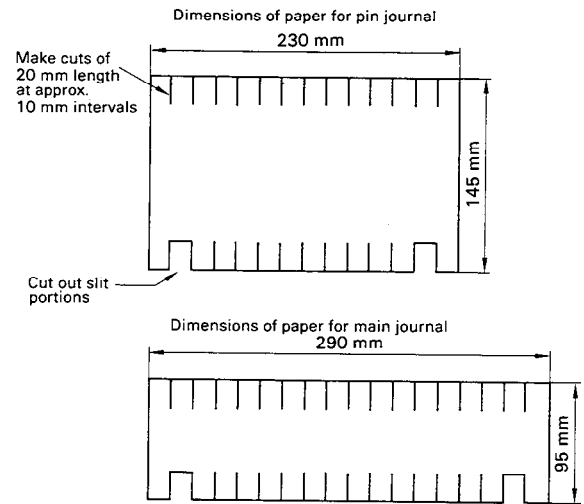
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ii) Cut out a piece of No. 800 paper with the shape shown in the diagram on the right.

iii) Take 2 pieces of paper prepared in Step ii), insert the top and bottom pieces in the slit of the clamp jig. then fix in position with tape.

iv) Fit the journal in the clamp, and fix the ends of the lever with a rubber tube.



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3. Measuring surface roughness

Standard for surface roughness

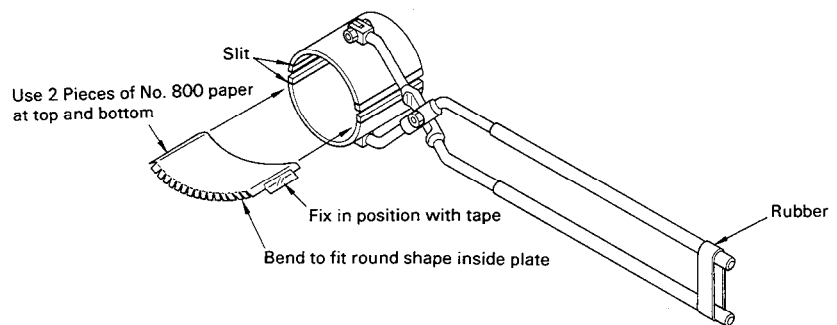
Journal surface, thrust surface: Max. 0.8 S

Using a surface roughness measuring tool, check that the roughness is within the standard. If no measuring tool is available, rub No. 1500 paper extremely lightly in the axial direction, and use a 30-times magnifying glass to inspect the pattern on the paper. If the horizontal lines can be seen to be connected it is within the standard value. If the lines cannot be seen to be connected, the roughness of the journal surface is excessive, so polish it again.

4. Cleaning after correcting surface roughness

After correcting the surface roughness, always brush the oil hole and blow with air.

5. Check that there are no scratches or dents at the journal portion and fillet R portion.



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