SHOP MANUAL

KOMATSU

SA6D140-H-1

DIESEL ENGINE

Printed in Japan 04-04(01)

Category	Komatsu code	Part No.	Q'ty	Container	Main applications, featuresr	
Molybdenum disulphide lubricant	LM-G	09940-00051	60 g	Can	• Used as lubricant for sliding portion (to prevent from squeaking).	
	LM-P	09940-00040	200 g	Tube	• Used to prevent seizure or scuffling 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	• General purpose type	
	G2-CA	SYG2-400CA SYG2-350CA SYG2-400CA-A SYG2-160CA SYGA-160CNCA	Various	Various	• Used for normal temperature, light load bearing at places in contact with water or steam.	
	Molybdenum disulphide grease LM-G (G2-M)	SYG2-400M SYG2-400M-A SYGA-16CNM	400 g × 10 400 g × 20 16 kg	Bellows type Bellows type Can	• Used for heavy load portion	
	Hyper White Grease G2-T G0-T (*) *: For use in cold district	SYG2-400T-A SYG2-16CNT SYG0-400T-A (*) SYG0-16CNT (*)	400 g 16 kg	Bellows type Can	• Seizure resistance and heat resistance higher than molybdenum disulfide grease • Since this grease is white, it does not stand out against machine body.	
	Biogrease G2B G2-BT (*) *: For high temperature and large load	SYG2-400B SYGA-16CNB SYG2-400BT (*) SYGA-16CNBT (*)	400 g 16 kg	Bellows type Can	• Since this grease is decomposed by bacteria in short period, it has less effects on microorganisms, animals, and plants.	
Primer	SUNSTAR PAINT PRIMER 580 SUPER	417-926-3910	20 ml	Glass container	Adhesive for cab glass	• Used as primer for cab side (Using limit: 4 months)
	SUNSTAR GLASS PRIMER 580 SUPER		20 ml	Glass container		• Used as primer for glass side (Using limit: 4 months)
Adhesive	SUNSTAR PENGUINE SEAL 580 SUPER "S" or "W"		320 ml	Polyethylene container		• "S" is used for high-temperature season (April - October) and "W" for low-temperature season (November - April) as adhesive for glass. (Using limit: 4 months)
	Sika Japan, Sikaflex 256HV	20Y-54-39850	310 ml	Polyethylene container		• Used as adhesive for glass. (Using limit: 6 months)
Caulking material	SUNSTAR PENGUINE SEAL No. 2505	417-926-3920	320 ml	Polyethylene container		• Used to seal joints of glass parts. (Using limit: 4 months)
	SEKISUI SILICONE SEALANT	20Y-54-55130	333 ml	Polyethylene container		• Used to seal front window. (Using limit: 6 months)

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

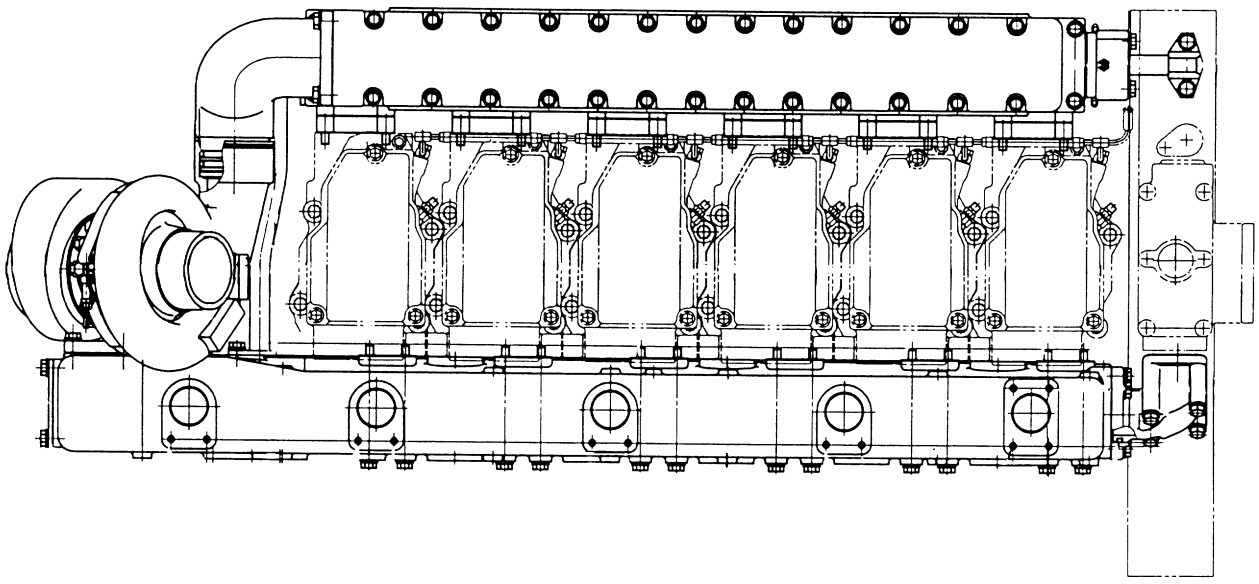
°C		°F	°C		°F	°C		°F	°C		°F
–40.4	**–40**	–40.0	–11.7	**11**	51.8	7.8	**46**	114.8	27.2	**81**	117.8
–37.2	**–35**	–31.0	–11.1	**12**	53.6	8.3	**47**	116.6	27.8	**82**	179.6
–34.4	**–30**	–22.0	–10.6	**13**	55.4	8.9	**48**	118.4	28.3	**83**	181.4
–31.7	**–25**	–13.0	–10.0	**14**	57.2	9.4	**49**	120.2	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	**0**	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

WEIGHT TABLE

Unit: kg

No.	Item	Components	SA6D140-H-1	
1	Turbocharger	Komatsu KTR110G	21	
2	Cylinder head assembly	Cylinder head, valve, rocker arm, valve spring	18.3	
3	Cylinder block assembly	Cylinder block, bearing cap, cylinder liner	340	
4	Front cover		115	
5	Oil pan		27	
6	Oil pan case		85	
7	Flywheel assembly	Flywheel, ring gear	35.5	
8	Flywheel housing		52	
9	Crankshaft assembly	Crankshaft, crankshaft gear	132	
10	Camshaft assembly	Camshaft, camshaft gear, thrust plate	19	
11	Piston and connecting rod assembly	Piston, piston ring, piston pin, connecting rod	10.5 × 6	
12	Oil pump		5.5	
13	Fuel injection pump		29	
14	Water pump		17	
15	Alternator		—	
16	Starting motor	24V, 7.5 kW	18	
17	Air compressor		11	
18	Aftercooler assembly		43	

RIGHT SIDE VIEW



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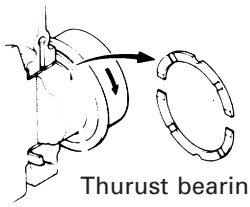
4. FUNCTION AND MATERIAL OF THRUST BEARING



Thurust bearing

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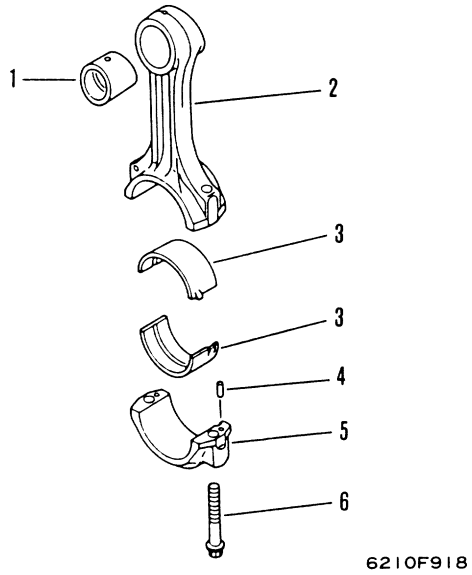
- The crankshaft takes out the engine power through the flywheel on its end and receives load in the axial direction (thrust load) caused by operations of the clutch, etc.
- Accordingly, thrust bearings are installed to both sides of 1 main bearing of the crankshaft.

5. CONNECTING ROD



1. Connecting rod bushing
2. Connecting rod
3. Connecting rod bearing
4. Dowel pin
5. Connecting rod cap
6. Connecting rod bolt

1) Function of connecting rod

- The piston receives the energy of the combustion pressure. The connecting rod receives that energy as reciprocation through the piston pin and transfers it as rotation to the crankshaft.

- The connecting rod receives impulsive compression and buckling loads caused by combustion pressure. Since the engine rotates at high speed, the connecting rod also repeatedly receives tensile loads and bending loads caused by the inertia force of the piston and it. Accordingly, the connecting rod is so designed that it will stand those loads easily.

- For the above reason, the connecting rod is made of special steel having high strength, high fatigue strength in particular, by closed die forging.

★ The connecting rod receives strong and complicated alternating loads. Accordingly, if it has a flaw (a lateral flaw in particular) or a bruise, stress is concentrated on that flaw or a bruise and can cause breakage. Do not make a flaw or a bruise on it.

2) Connecting rod bushing

- The connecting rod bushing is used under the severest condition in the engine. It has high fatigue strength against high surface pressure, fitting performance, and wear resistance.

- The connecting rod bushing is made of phosphor bronze which is an alloy of copper (Cu), tin (Sn), and phosphorus (P) and which resists high load and has high wear resistance among the bearing materials.

3) Connecting rod bearing

- The connecting rod bearing is used under almost the same condition as the crankshaft main bearing, and the necessary conditions for those bearings are the same.

★ See the section of the crankshaft bearing.

4) Connecting rod bolt

- The connecting rod bolt is used to tighten the connecting rod cap to connect the connecting rod and crankshaft. It receives a tensile load caused by tightening and the high tensile loads repeated by the inertia force of the piston and connecting rod.

★ The connecting rod bolt is the most important bolt in the engine, as well as the cylinder head bolt and main cap bolt, for the above reason. Its stem and thread must be checked carefully for a flaw and damage. It is tightened by plastic-region angle tightening method.

STRUCTURE AND FUNCTION

1. FLYWHEEL

- The flywheel is bolted to the crankshaft and used to transfer the engine power to the chassis and other parts.

- Since the engine power is obtained only during the combustion stroke, the evolutional force is uneven.
  The flywheel has large inertia force to absorb the unevenness of the evolutional force and transfers the power smoothly.

2. RING GEAR

- The ring gear is installed to the end rim of the flywheel by shrink fit. When the engine is started, the pinion gear of the starting motor is engaged with the ring gear to crank the engine.

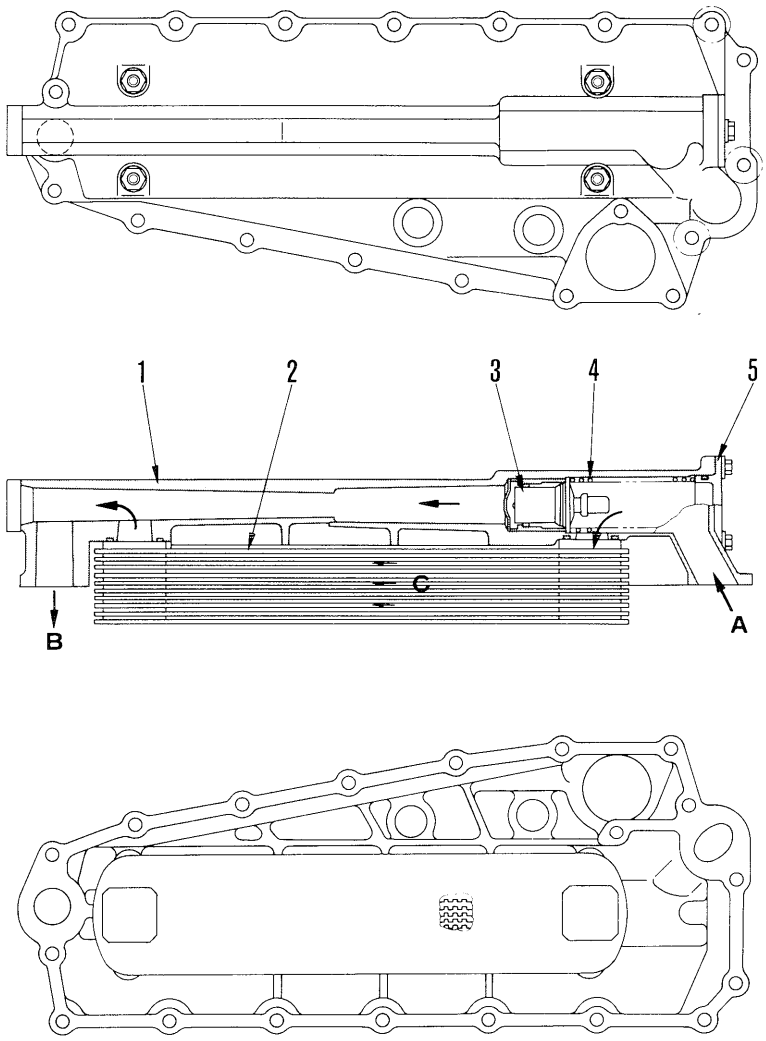
3. FLYWHEEL HOUSING

- The flywheel housing is installed to the rear of the cylinder block to isolate the inside of the engine and protect the flywheel which is a rotating part.

4. REAR SEAL

- The rear seal is installed to the flywheel housing to seal the sliding part of the crankshaft.

OIL COOLER



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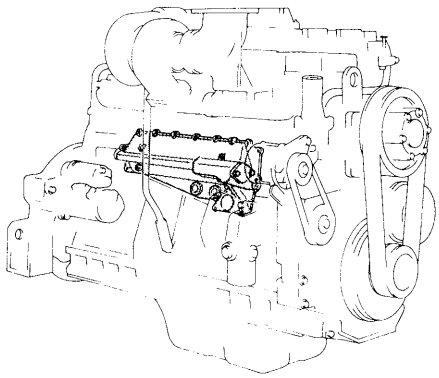
1. Cooler cover
2. Cooler element : 12 cores
3. Thermostat
4. Spring
5. Thermostat cover

A. Oil inlet (From oil pump)
B. Oil outlet (To regulator valve)
C. Cooling water

THERMOSTAT FUNCTION

- Valve cracking temperature: 85 ± 1.5°C
- Full opening temperature: 100°C
- Full opening lift: Min. 8 mm

OIL COOLER



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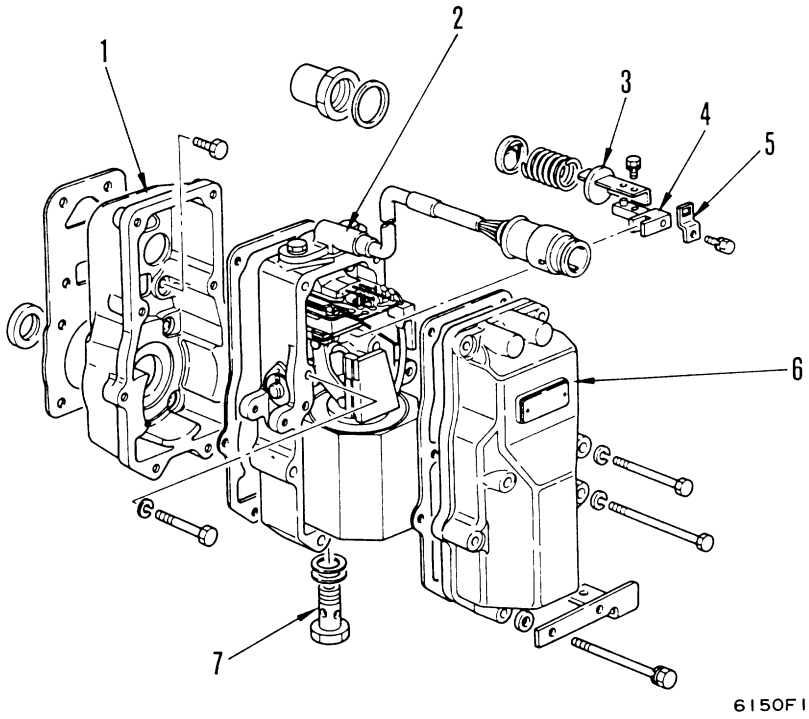
- Effective area: SA6D140-H-1: 0.986 m^2

ELECTRONIC GOVERNOR (RED-III)

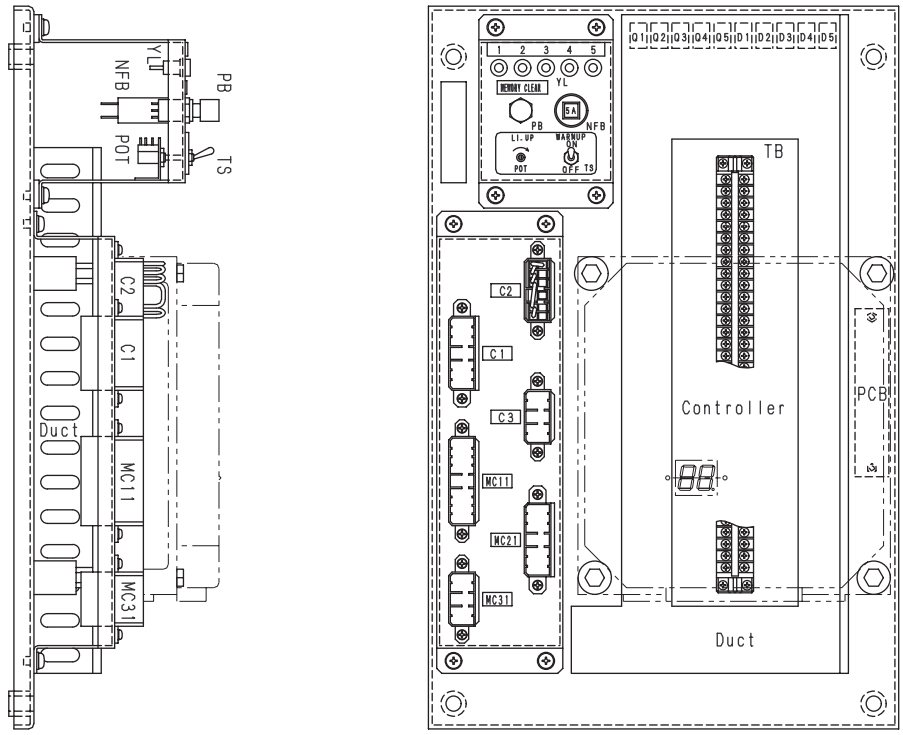
GOVERNOR UNIT



1. Housing
2. Actuator
3. Control rod
4. Connector
5. Copper plate
6. Cover
7. Eyebolt

- The electronic governor roughly consists of the housing and actuator cover.
- The actuator consists of the linear DC motor, link, and control rod position sensor, and is operated by the signals from the control unit.
- The linear DC motor moves the coil assembly vertically according to the signal from the control unit and stops it so that the control rod will be at the target position. (This is performed according to the calculation in the control unit.)
- The movement is further transferred through the link to the connector to move the control rod to the right and left and adjust the fuel injection rate.
- That is, if the coil assembly moves up, the fuel injection rate is increased. If the former moves down, the latter is decreased.
- The copper plate at the connector end is a control rod position sensor. It senses the position of the control rod and feed it back to the linear DC motor.
- The actual fuel injection rate is calculated in the control unit and controlled properly by the above series of operations, depending on the operating condition of the machine.
- The linear DC motor consists of the magnet section to supply a magnetic field, ball section to lead the magnetic field, and coil assembly which moves up and down.
- The principle of operation of the DC motor is based on the Fleming's left-hand rule.
- If a current flows in the coil in the direction of A, the magnetic force acts in the direction C. If the current flows in the direction B, the magnetic force acts in the direction of D. Accordingly, the coil assembly can be moved up and down and the control rod can be stopped at any position by controlling the direction and level of the current flowing in the coil according the feedback from the position sensor.

CONTROL BOX



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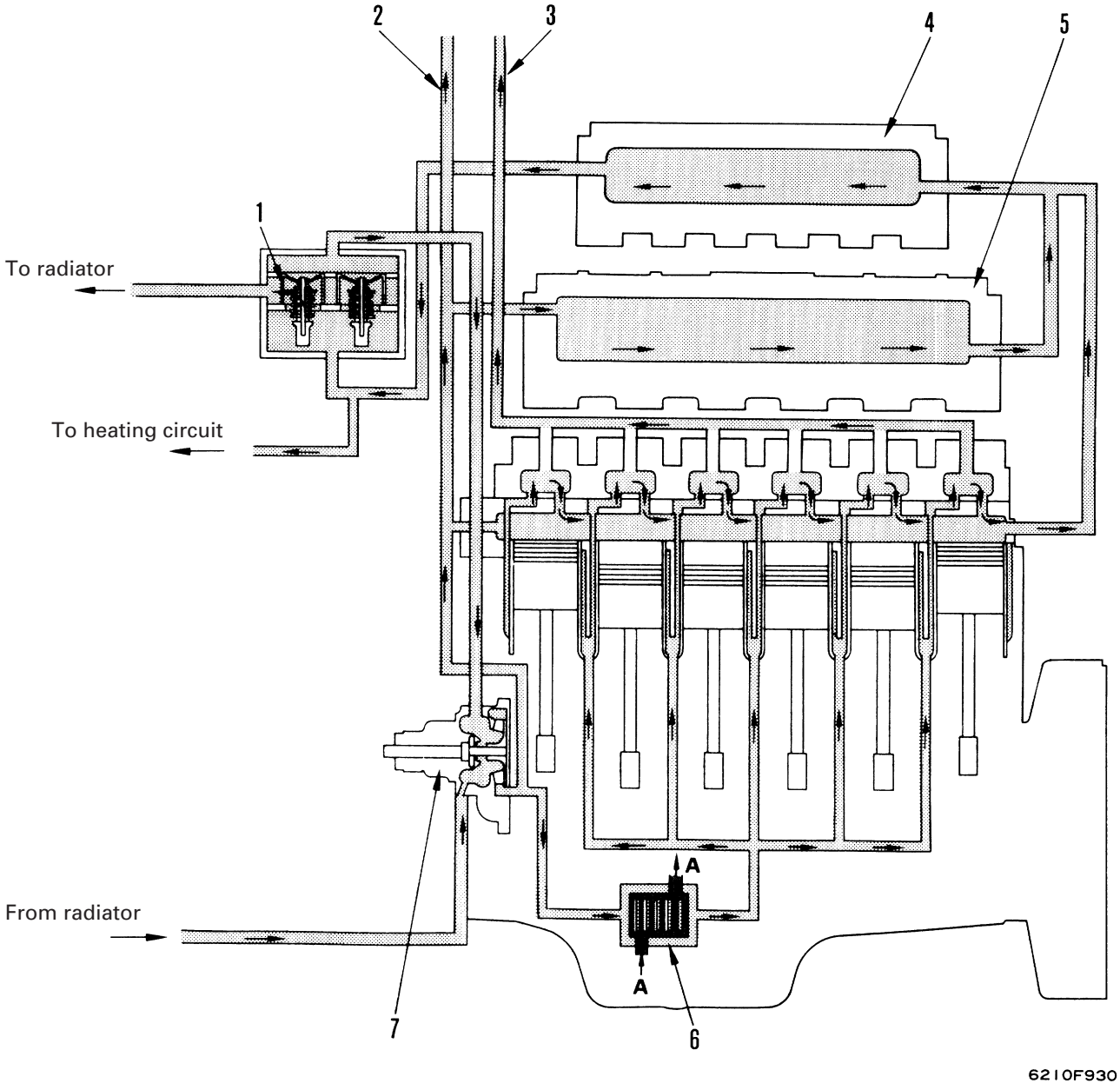
- How to check diagnosis lamps (Green and red)
  A while after the power is turned ON, "0.0" is displayed, if the system is normal. If nothing is displayed at first, the controller may be defective or the power may not be supplied.

- How to check notch lamp (Yellow)
  The notch lamp lights up when the signal (24 V) is input to the notch input line. While the engine is stopped, input the notch signal to see if the lamp lights up. (For the relationship between the notch and input line, see the notch signal specification.)
  If the lamp does not light up, the bulb may be broken or the notch signal may not be input.

COOLING SYSTEM CHART



1. Thermostat
2. After cooler · air bleed
3. Cylinderhead · air bleed
4. Water-cooled exhaust manifold
5. Aftercooler
6. Oil cooler
7. Water pump

A. Oil inlet port, outlet port

MEASURING INTAKE AIR PRESSURE (BOOST PRESSURE)

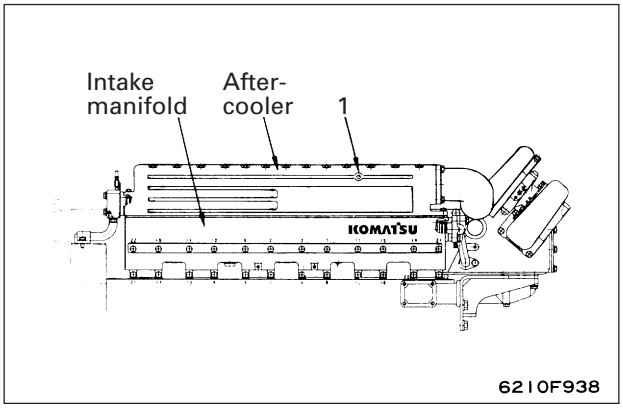
⚠ When removing or installing the plug and pressure gauge, stop the engine.

★ When measuring the intake air pressure, remove all the sand and dirt from the nipple and plug.

1) Remove plug (1).

2) Install the engine pressure measuring tool.

3) Start the engine and measure the intake air pressure “when the engine stalls”.



FUEL INJECTION VOLUME STANDARD (WITH ELECTRONIC GOVERNOR)

Engine	Applicable machine	Fuel injection pump Part No.	Rack Position (mm)	Rack sensor output voltage Vist (V)	Pump speed (rpm)	Fuel injection volume (mm^3/st)		Maximum variance between cylinder
						Service standard	Manufacturer Standard	
SA6D140-H-1	Maintenance disel motor car	6934-71-1113	(13.8) (6.8)	1.24 Approx.2.6	1,000 315	375±5 19±1.5	290 20	±3 ±15

⚠ When carrying out testing and adjusting, or troubleshooting, stop the machine on level ground, fit safety pins, block the wheels, and apply the parking brake.

⚠ When carrying out operations with two or more workers, always use signals, and do not allow any unauthorized person near the machine.

⚠ When checking the water level, if the radiator cap is removed when the engine is hot, boiling water will spurt out and may cause burns, so always wait for the engine to cool down before checking the water level.

⚠ Be extremely careful not to touch any hot parts.

⚠ Be extremely careful not to get caught in the fan or any other rotating parts.

⚠ When removing the plugs or caps from places under hydraulic pressure, water pressure, or air pressure, release the internal pressure first. Fit the measuring tools securely before carrying out any testing, adjusting, or troubleshooting.

★ When using the standard values table for judgement in testing, adjusting, or troubleshooting, it is necessary to be careful of the following points.

1. The standard values for the new machines in the standard values table are values given as reference from the standards for new machines and machines shipped from the factory. They should be used as values for estimating wear during operation or as target values when carrying out repairs.
2. The failure judgement standard values in the standard values table are values using estimated values based on the results of various tests and standard values for machines shipped from the factory. Use these values for reference together with the repair and operation history of the machine when judging failures.
3. Do not use this standard values table as a standard for judging claims.

S-3 Engine does not pick up smoothly (follow-up is poor)

★ Check that the monitor panel does not display any abnormality in the governor control system.

General causes why engine does not pick up smoothly

- Insufficient intake of air
- Insufficient supply of fuel
- Improper condition of fuel injection
- Improper fuel used

Legend
◯: Possible causes (judging from Questions and check items)
◎: Most probable causes (judging from Questions and Check items)
△: Possible causes due to length of use (used for a long period)
●: Items to confirm the cause.

			Causes: Clogged air cleaner element	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged injection nozzle, defective spray	Seized injection pump plunger	Worn piston ring, cylinder liner	Seized turbocharger, interference	Improper valve clearance	Clogged air breather hole in fuel tank cap	Clogged, leaking fuel piping	Defective contact of valve and valve seat
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period	△	△	△			△					△
	Replacement of filters has not been carried out according to Operation Manual		◎	◎	◎								
	Non-specified fuel is being used			◎	◎	◎	◎						
	Engine oil must be added more frequently							◎					
	Rust and water are found when fuel tank is drained			◎	◎								
	Dust indicator is red		◎										
	Noise of interference is heard from around turbocharger								◎				
Check items	Engine pick-up suddenly became poor					◯			◎		◯	◯	
	Color of exhaust gas	Blue under light load						◎					
		Black	◎			◎			◎				◯
	Clanging sound is heard from around cylinder head									◎			
	Mud is stuck to fuel tank cap										◎		
	There is leakage from fuel piping											◎	
	High idling speed under no load is normal, but speed suddenly drops when load is applied			◎	◎						◯		
	There is hunting from engine (rotation is irregular)			◯	◎	◯					◯		
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low					◎	◯						
	Blow-by gas is excessive							◎					
Troubleshooting	When air cleaner element is inspected directly, it is found to be clogged		●										
	When fuel filter, strainer are inspected directly, they are found to be clogged			●									
	When feed pump strainer is inspected directly, it is found to be clogged				●								
	Speed does not change when operation of certain cylinders is stopped					●							
	When control rack is pushed, it is found to be heavy, or does not return						●						
	When compression pressure is measured, it is found to be low							●					●
	When turbocharger is rotated by hand, it is found to be heavy								●				
	When valve clearance is checked directly, it is found to be outside standard value									●			
	When fuel cap is inspected directly, it is found to be clogged										●		
	When feed pump is operated, operation is too light or too heavy											●	
		Remedy	Clean	Clean	Clean	Correct	Replace	Replace	Replace	Adjust	Clean	Correct	Replace

S-13 Oil level rises (water, fuel in oil)

★ If there is oil in the cooling water, carry out troubleshooting for “Oil is in cooling water”.

General causes why oil level rises
- Water in oil
- Fuel in oil (diluted, and smells of diesel fuel)
- Entry of oil from other component

Legend
◯ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

		Causes: Broken oil cooler core, O-ring	Defective nozzle holder sleeve	Broken cylinder head, head gasket	Clogged water pump breather hole, defective seal	Worn, damaged rear seal surface	Defective main pump seal	Leakage of fuel inside head cover	Defective part inside injection pump (flange type)	Defective thermostat seat portion	Damaged cylinder liner O-ring, holes made by pitting	Cracks inside cylinder block
Questions	Confirm recent repair history											
	Degree of use of machine — Operated for long period		△		△	△	△				△	
	When engine is first started, drops of water come from muffler		◎									
	Exhaust smoke is white		◎					◯		◯		
	There is oil in radiator cooling water	◎	◯	◯							◯	◯
Check items	Leave radiator cap open. When engine is run at idling, an abnormal number of bubbles appear, or water spurts back			◎							◯	
	Water pump breather hole is clogged with mud				◎							
	When water pump breather hole is cleaned, water comes out				◎							
	Oil level goes down in clutch, TORQFLOW transmission or damper chamber					◎						
	Oil level goes down in hydraulic tank						◎					
	Engine oil smells of diesel fuel							◎	◎	◎		
	Fuel must be added more frequently							◎	◎	◎		
Troubleshooting	Pressure-tightness test of oil cooler shows there is leakage	●										
	Pressure-tightness test of cylinder head shows there is leakage		●									
	When compression pressure is measured, it is found to be low			●								
	Remove water pump and inspect directly				●							
	Remove rear seal and inspect directly					●						
	When main pump is removed, seal is found to be damaged						●					
	Remove head cover and inspect directly							●				
	Remove injection pump and inspect directly								●			
	Defective contact of thermostat seal valve									●		
	Remove oil pan and check directly										●	●
	Remedy	Replace	Replace	Replace	Replace	Correct	Replace	Correct	Replace	Replace	Replace	Replace

ABNORMALITY IN CONTROLLER SYSTEM

90

(Abnormality in computer in controller)

ABNORMALITY IN GOVERNOR SERVO SYSTEM

91

92

Is resistance between (L) (male) (A) ((L) (male) (E)) and (L) (male) (J) ((L) (male) (F)) normal?

- Resistance: 9-10.5 Ω
- Turn power OFF.
- Disconnect (L).

1 YES

NO

Check of whole actuator circuit 2

Is resistance between (A) (female) (1) ((14)) and (2) ((15)) normal?

- Resistance: 9-10.5 Ω
- Turn power OFF.
- Disconnect (A) (Connect (L)).

YES

NO

(Disconnection or short circuit in actuator circuit in injection pump)

Check of injection pump 3

Are resistance between (L) (male) (3) and (2) ((L) (male) (11)) (30.5 - 38.5 Ω) and resistance between (L) (male) (9) and (2) ((L) (male) (11)) (0.75 - 22 Ω) normal?

- Turn power OFF.
- Disconnect (L).

YES

NO

(Disconnection or short circuit in wiring harness)

4 YES

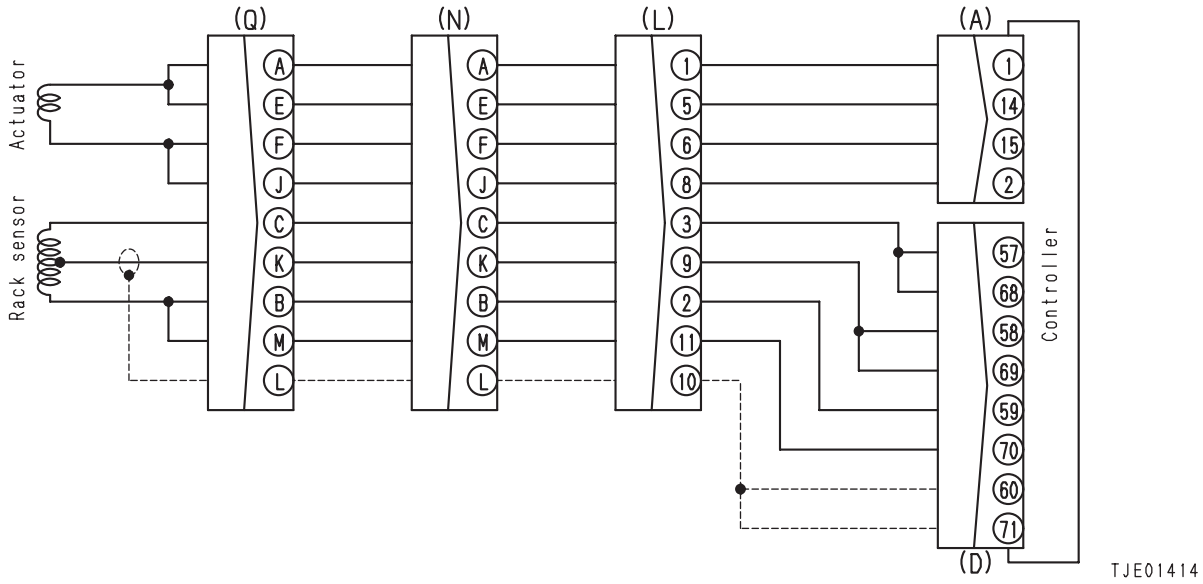
Is rack hitched inside injection pump? (Remove rack cap to check.)

- Turn power OFF.

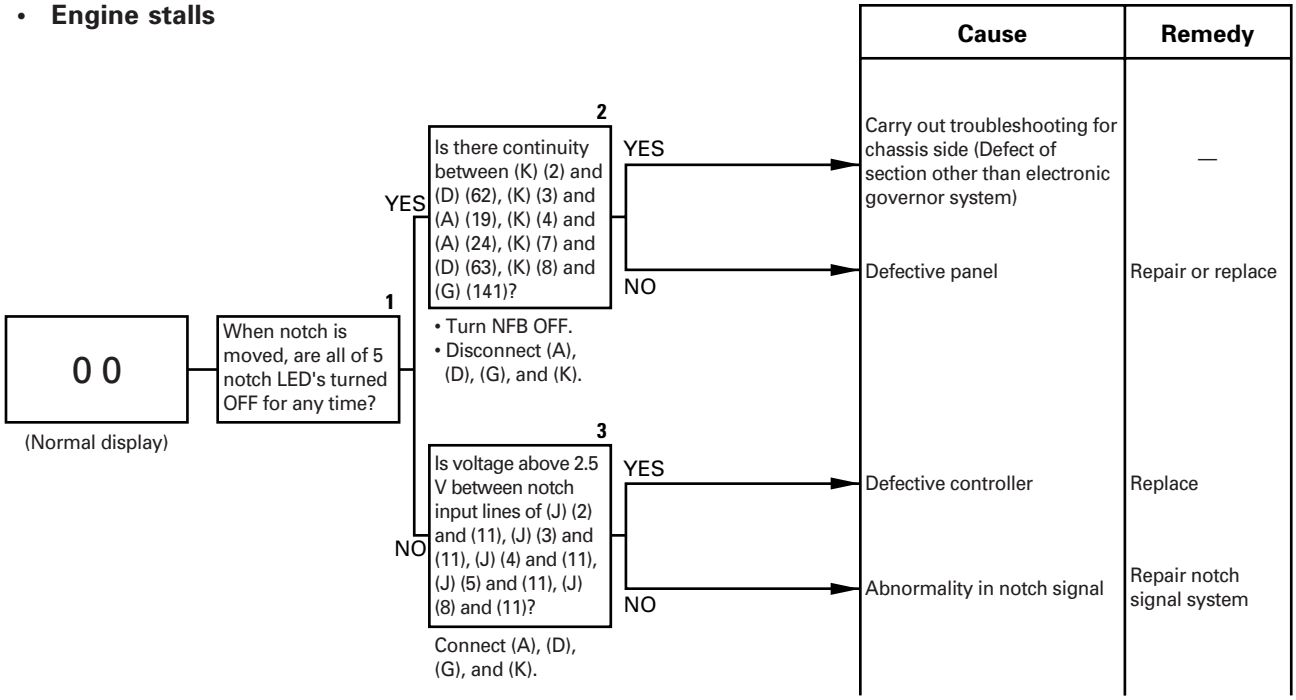
NO

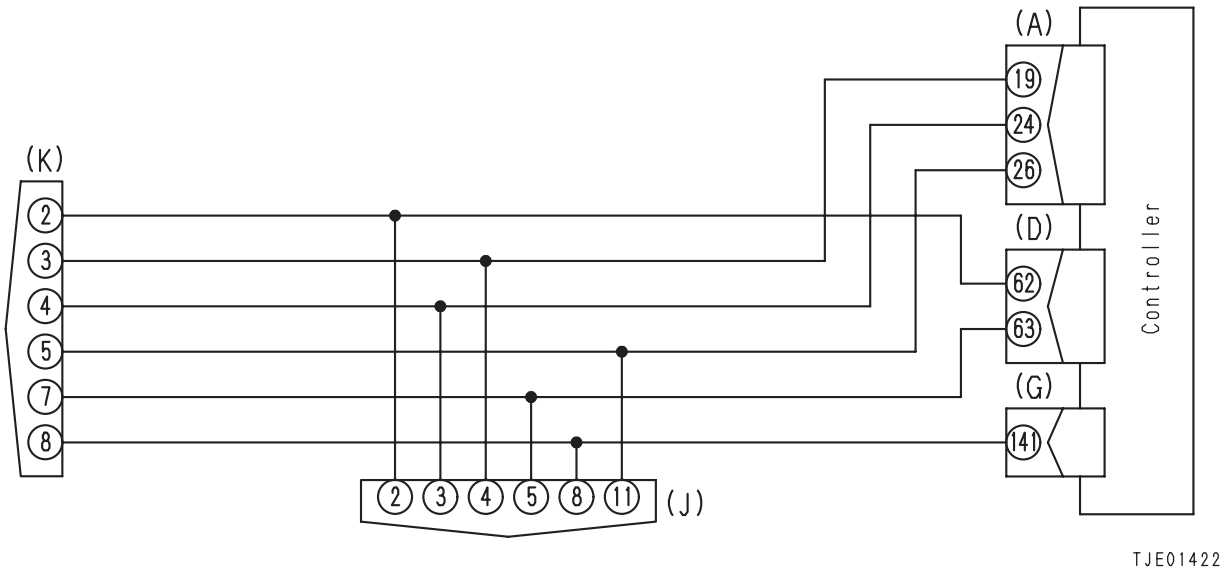
(Disconnection or short circuit in rack sensor in injection pump)

ABNORMALITY IN RACK SENSOR



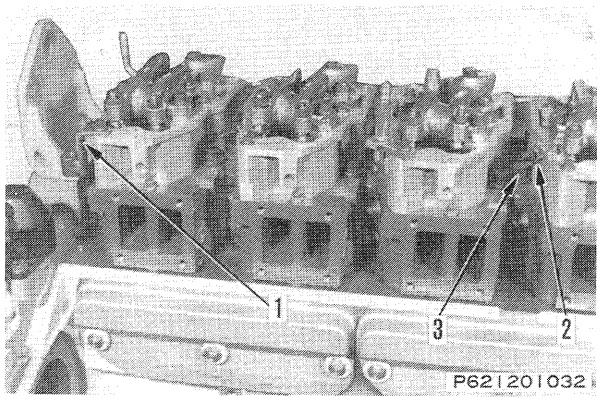
- **Engine stalls**





21. Nozzle holder, inlet connector

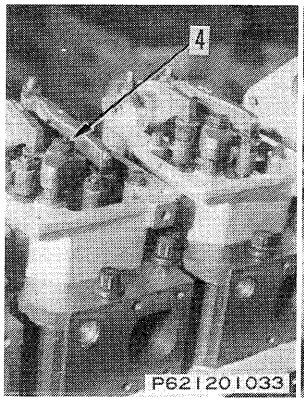
1) Remove compressor pipe bracket (1).
2) Loosen locknut (2), then remove inlet connector (3).

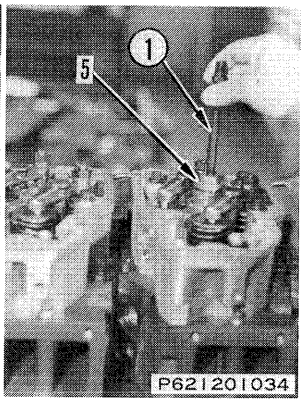


3) Remove mounting bolts (4) and bracket, using bolt ① (Dia. = 10 mm, Pitch = 1.5), remove nozzle holder (5).

★ Mark each nozzle holder with a number before removing. Keep the nozzle holders in a safe place and be careful not to damage them.

★ Check that there is a gasket fitted to the tip of the nozzle holder.

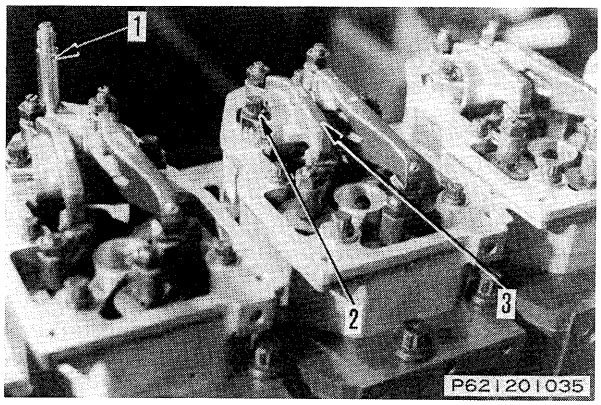




22. Rocker arm

1) Remove turbocharger lubrication tube bracket (1).
2) Remove mounting bolts (2), then remove rocker arm (3).

★ Loosen lock nuts of adjustment screws, then loosen each adjustment screw 2 – 3 turns to avoid excessive pressure being brought to bear on the push rods when installing the rocker arm.



23. Push rod

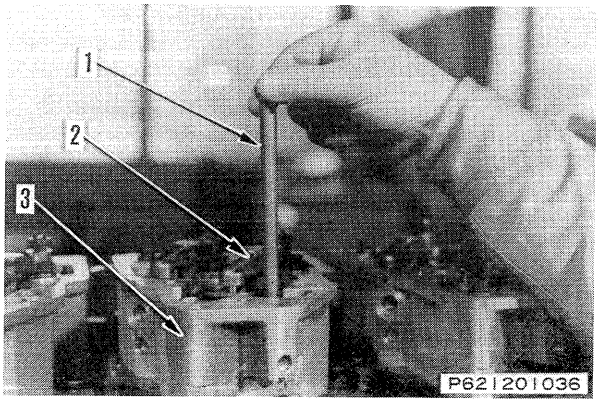
Remove push rod (1).

24. Crosshead

Remove crosshead (2).

25. Rocker arm housing

Remove mounting bolts, then remove rocker arm housing (3).



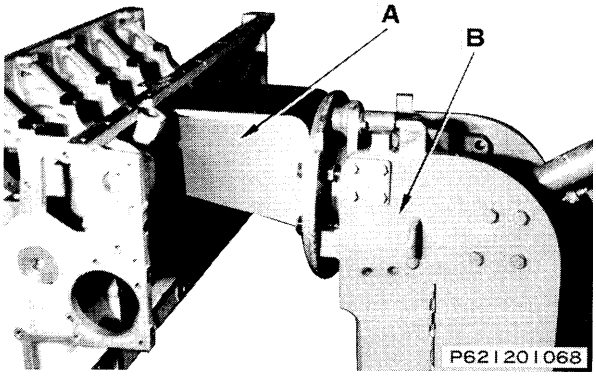
Special tools

	Part No.	Part Name	Q'ty
A	790-901-1260	Adapter	1
B	790-501-2000	Engine overhaul stand	1
C	795-102-2102	Spring pusher	1
D	795-100-1190	Piston ring tool	1
F	795-230-5472	Liner driver	1
G	795-236-1500	Piston holder	1
H	795-502-1121	Gauge	1
I	795-125-1210	Feeler gauge	1

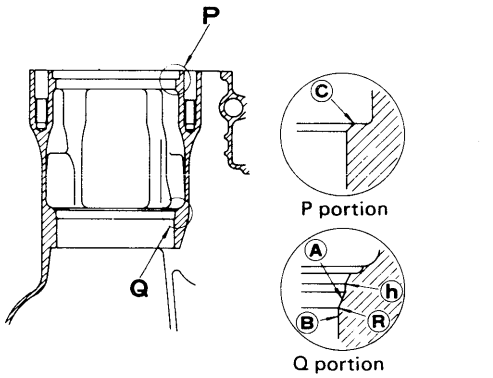
★ Clean all parts, and check for dents, scores or casting defects. Coat the machined surfaces of all parts with engine oil before installing. Check that all the oil and water passages are clear.

Preparatory work

- Install adapter A on cylinder block, set cylinder block on engine overhaul stand B.



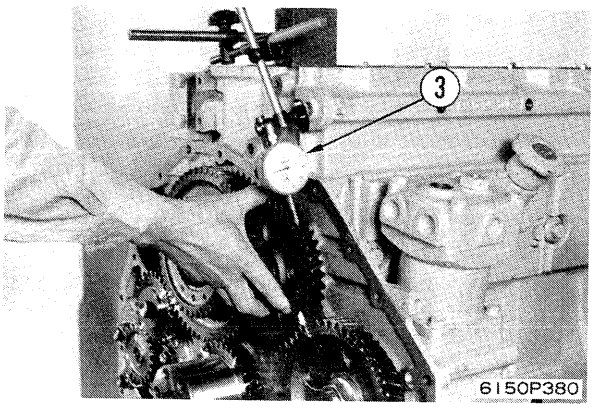
- Prepare the cylinder block before inserting the cylinder liner as follows.
  1) Using sandpaper, remove rust and scale from faces Ⓐ and Ⓑ until machined surface can be seen.
  2) Using No. 60 sandpaper, polish portions Ⓡ and ⓗ to give a smooth finish. If there is a sharp corner formed or any burrs on portion Ⓡ, remove with a scraper or sandpaper. Be particularly careful to finish this surface smoothly to prevent damage to the O-ring.
  3) If there is pitting on face Ⓑ and it cannot be repaired, replace cylinder block.
  4) If there is pitting on face Ⓐ or portion Ⓡ, polish to give a smooth finish.
  5) Inspect counterbore and remove all burrs. Remove all chips and dirt from face Ⓒ. Such dirt will cause defective sealing of the liner, leakage of water, or defective protrusion of the liner.
     ★ If there is any damage, corrosion or pitting in the counterbore, repair it.



★ Measure backlash and end play of each gear using a dial gauge ③.

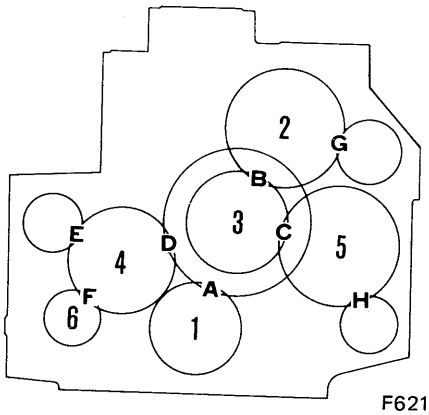
★ Standard backlash for each gear

Position	Range (mm)
A	0.141 – 0.425
B	0.129 – 0.391
C	0.129 – 0.391
D	0.141 – 0.426
E	0.095 – 0.346
F	0.080 – 0.417
G	0.118 – 0.369
H	0.118 – 0.369



★ Standard end play for each gear

Position	Range (mm)
1	0.14 – 0.315
2	0.10 – 0.25
3	0.05 – 0.17
4	0.05 – 0.17
5	0.07 – 0.20
6	0.03 – 0.088



F621201066

9. Gear case cover

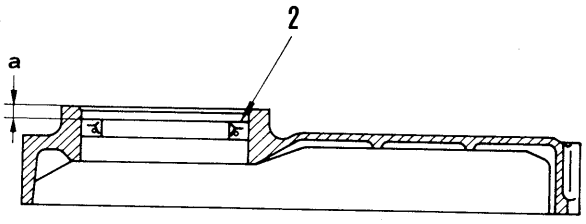
1) Using push tool (outside diameter: 120 mm), press fit oil seal (2) to cover.

★ Press-fitting interference 'a' of oil seal:

$5.0\ ^{+1}_{0}$ mm

Lip of oil seal (50 – 80% of space): Grease (G2-LI)

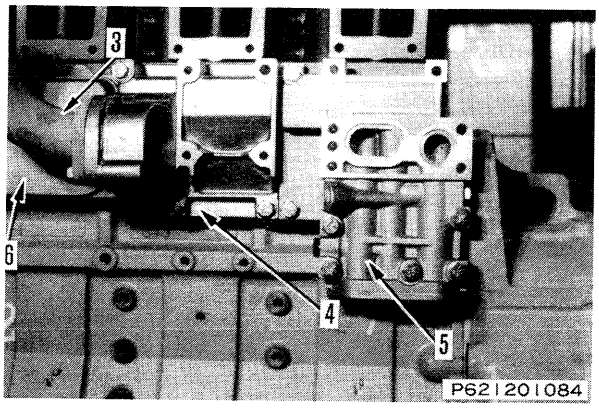
★ When installing the gear case cover, remove the service meter gear box.



6150F311

28. Bracket, cover

1) Fit O-ring and install cover (6).
2) Fit O-ring and install valve adapter (5).
3) Fit O-ring and install fuel filter bracket (4) together with fuel filler (3).

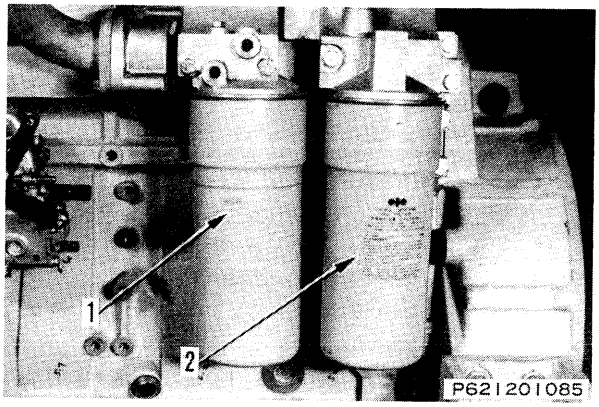


29. Oil filter assembly

Fit O-ring and install oil filter assembly (2).

30. Fuel filter assembly

Install fuel filter assembly (1).

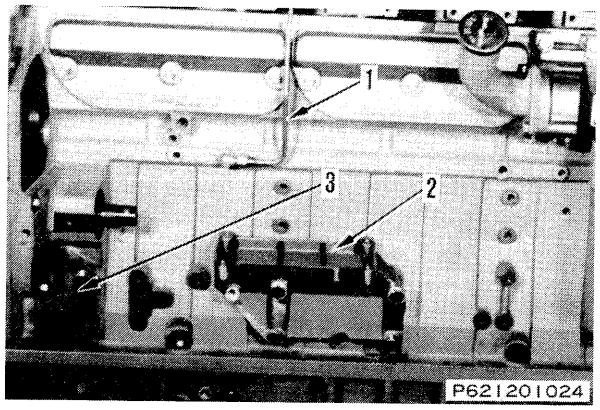


31. PTO case tube, bracket

1) Fit O-ring and install PTO case (3).
2) Install fuel injection pump bracket (2).

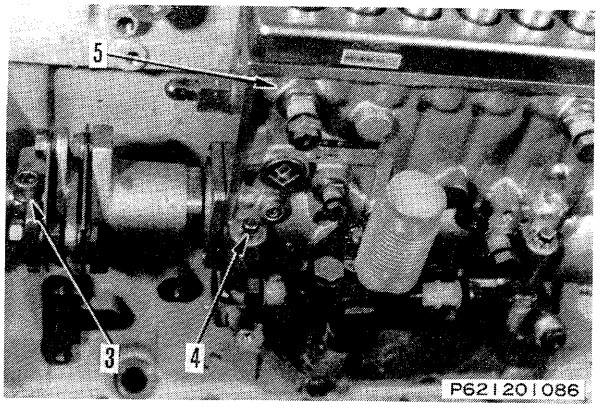
   kgm Bracket mounting bolt: 11.7 ± 0.8 kgm

3) Install turbocharger lubrication tube (1).



32. Fuel injection pump assembly

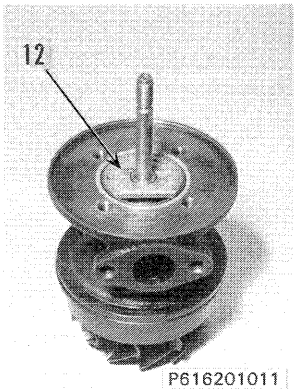
1) Knock key into drive shaft of fuel injection pump.
2) Install 2 coupling bolts (6) of fuel injection pump, then install flange coupling (9) and front laminated coupling (7) to engine drive shaft.
   ★ When doing this, do not tighten coupling connecting bolts (3).

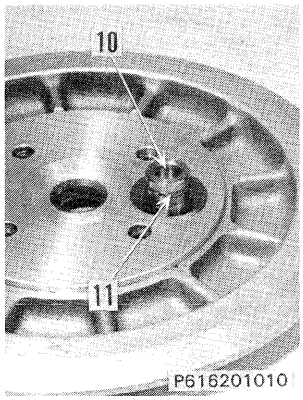


6. Thrust bearing

Install thrust bearing (12) with the dowel pin fitted in position.

★ Before installing the thrust bearing, apply engine oil to both sides of the oil hole.





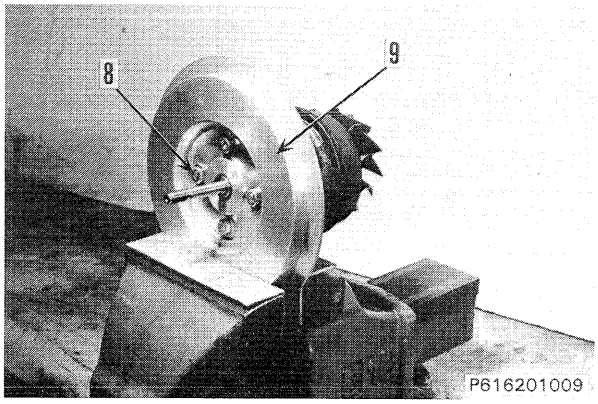
7. Flinger

Fit seal ring (11) into flinger (10).

★ Apply engine oil to the sides of the seal ring.

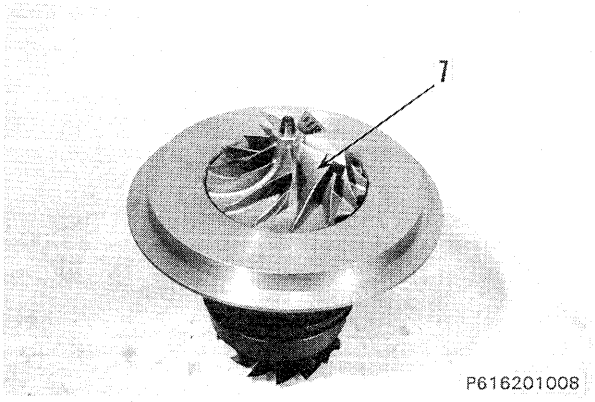
8. Back plate (Diffuser plate)

1) Fit an O-ring to the center housing.
   ★ Apply some grease (G2-LI) to the O-ring.
2) Install flinger into the back plate (9).
   ★ Let the gap of the seal ring on the flinger direct to the oil filler port on the center housing.
3) Install the turbine rotor onto the back plate.
4) Tighten bolts (8) and bend the lock washer.
   kgm Mounting bolt: 3.2 ± 0.2 kgm

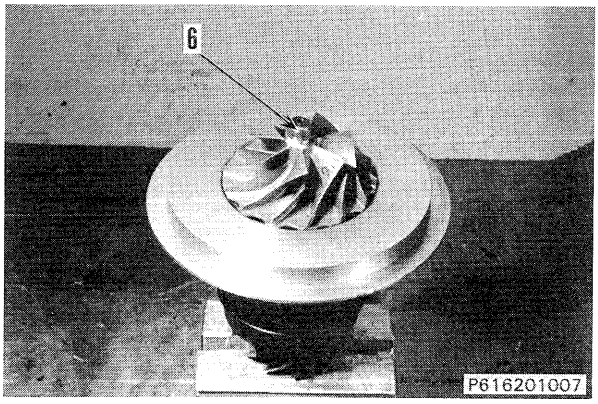


9. Blower impellers

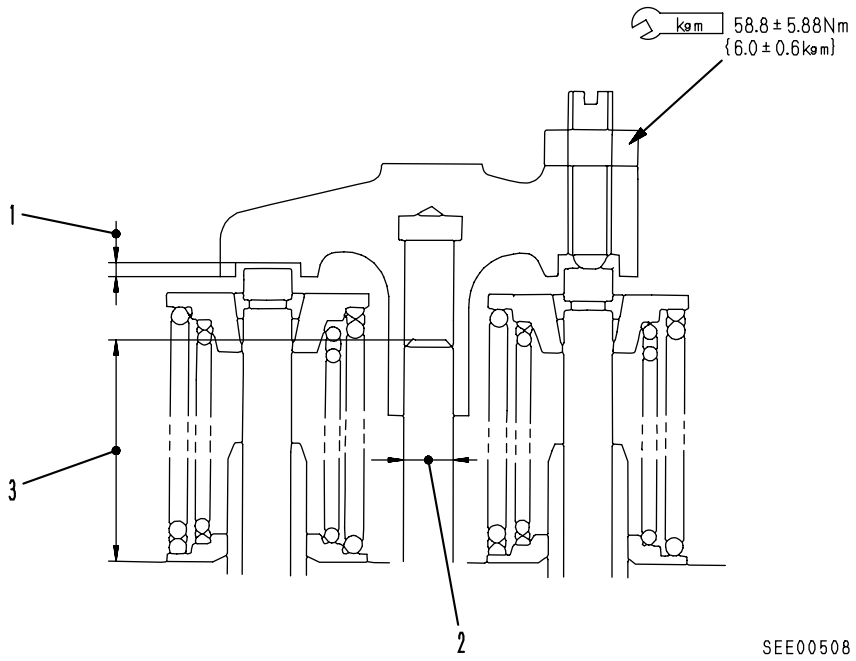
1) Install blower impellers onto the turbine rotor in the following manner.
   i) Immerse blower impellers (7) in the oil that is heated at 140° to 160°C for 5 to 20 minutes.
   ii) Install the blower impellers onto the turbine rotor, aligning the match mark.
      ★ Apply engine oil to the inner face of the blower impeller and install the impeller without using an excessive force.



2) Tighten nut (6).
   ★ When tightening the nut, take care not to allow any of match marks to be out of alignment.
   kgm Nut: 2.9 ± 0.3 kgm



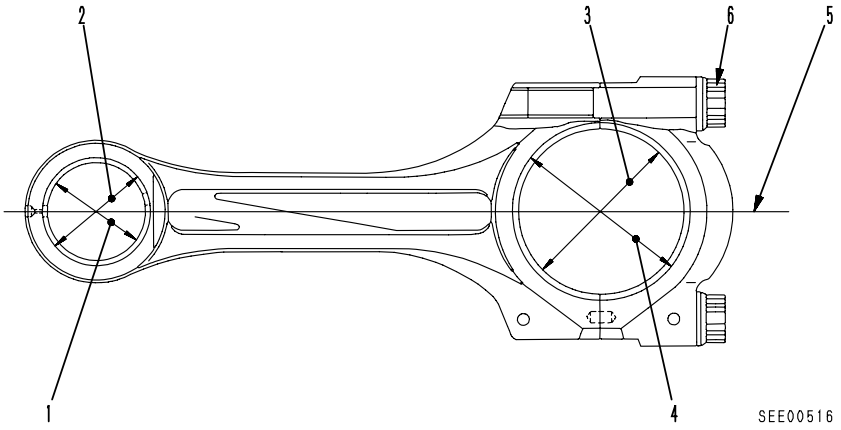
CROSSHEAD AND GUIDE



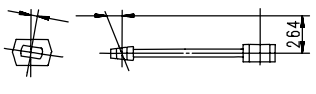
Unit: mm

No.	Check item	Criteria			Remedy
1	Depth of crosshead stem	Standard size	Tolerance	Repair limit	Replace
		3	+0.3 0	3.41	
2	Inside diameter of crosshead	11	+0.06 +0.02	11.17	
	Outside diameter of crosshead guide	11	+0.011 0	10.95	
3	Protrusion of crosshead guide	49.0	±0.25	—	Repair

CONNECTING ROD



Unit: mm

<table>
<tr><th>No.</th><th>Check item</th><th colspan="5">Criteria</th><th>Remedy</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Inside diameter of bushing at connecting rod small end
(Treat with reamer after press fitting bushing)</td><td>Standard size</td><td colspan="2">Tolerance</td><td>Repair limit</td><td rowspan="2">Replace bushing
(New part is supplied as a semi-finished part)
★1</td></tr>
<tr><td>52</td><td colspan="2">+0.049
+0.030</td><td>52.09</td></tr>
<tr><td rowspan="2">Clearance between bushing at connecting rod small end and piston pin</td><td colspan="3">Standard clearance</td><td colspan="2">Clearance limit</td><td rowspan="2">Replace bushing or piston pin</td></tr>
<tr><td colspan="3">0.030 – 0.055</td><td colspan="2">0.11</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Inside diameter of bushing hole at connecting rod small end</td><td colspan="3">Standard size</td><td colspan="2">Tolerance</td><td rowspan="2">Replace connecting rod</td></tr>
<tr><td colspan="3">57.4</td><td colspan="2">+0.030
0</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Inside diameter of bearing at connecting rod big end</td><td>Standard size</td><td colspan="2">Tolerance</td><td>Repair limit</td><td rowspan="2">Replace bearing
★1</td></tr>
<tr><td>90</td><td colspan="2">+0.042
–0.008</td><td>90.15</td></tr>
<tr><td rowspan="3">4</td><td rowspan="2">Inside diameter of bearing hole at connecting rod big end
(★2 Measure after tightening connecting rod cap bolt with specified torque)</td><td colspan="3">Standard size</td><td colspan="2">Tolerance</td><td rowspan="2">Replace connecting rod</td></tr>
<tr><td colspan="3">95</td><td colspan="2">+0.026
–0.004</td></tr>
<tr><td>Thickness of connecting rod bearing</td><td>Standard size</td><td colspan="2">Tolerance</td><td>Repair limit</td><td>Replace bearing
★1</td></tr>
<tr><td></td><td>2.5</td><td colspan="2">+0.002
–0.008</td><td>—</td><td></td></tr>
<tr><td>5</td><td>Parallelism and twist of connecting rod</td><td colspan="2"> 
Twist Parallelism
SEE00672</td><td>Item</td><td>Standard size</td><td>Repair limit</td><td>Replace connecting rod</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td>Parallelism</td><td>0 – 0.20</td><td>0.25</td><td></td></tr>
<tr><td></td><td></td><td colspan="2"></td><td>Twist</td><td>0 – 0.30</td><td>0.35</td><td></td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Tightening torque of connecting rod cap mounting bolt
(Coat bolt threads and nut seats with engine oil)</td><td>Standard size</td><td colspan="2">Target (Nm{kgm})</td><td colspan="2">Repair (Nm{kgm})</td><td rowspan="3">Retighten</td></tr>
<tr><td>1st step</td><td colspan="2">127.5 {13}</td><td colspan="2">117.7 – 132.4
{12.5 – 13.5}</td></tr>
<tr><td>2nd step</td><td colspan="2">Retighten with 90°</td><td colspan="2">90 – 120°</td></tr>
<tr><td>—</td><td>Weight of connecting rod</td><td colspan="5">Permissible range:
Variation between weights on the machine max. 154 g</td><td>Replace</td></tr>
</table>

★1 Replace at overhaul

★2 Note: The connecting rod bolt can be re-used up to a maximum of 5 times. Each time the bolt is re-used, make a punch mark on the bolt head.

REPLACING VALVE SEAT INSERT

Special tools

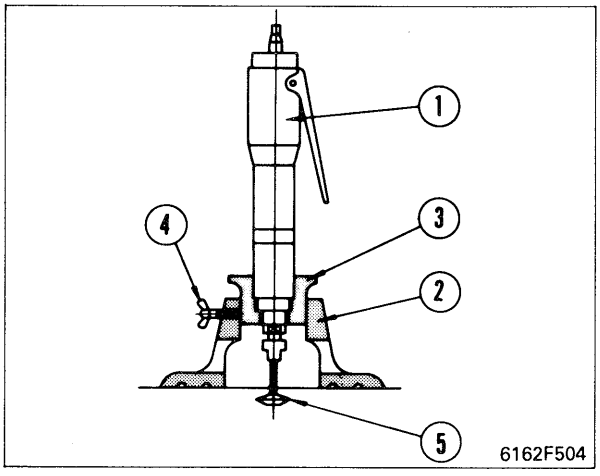
No.		Part No.	Part Name	Q'ty
A		795-100-4800	Puller (valve seat)	1
B	1	795-901-1280	· Plate (for intake valve)	1
	2	795-901-1270	· Plate (for exhaust valve)	1
	1	795-100-3003	Seat cutter (KIT)	1
		795-100-3100	· Body ass'y	1
		795-100-3200	· Micrometer	1
		795-100-3300	· Gauge	1
		795-100-3400	· Tool head	1
		795-100-3601	· Head support	1
	2	795-100-3710	· Cutter (for oversize machining)	1
	3	795-100-3720	· Cutter (for 30°)	1
	4	795-100-3730	· Cutter (for 45°)	1
	5	795-100-4210	· Pilot (10,000 mm)	1
		795-100-4220	· Pilot (10,010 mm)	1
		795-100-4230	· Pilot (10,020 mm)	1
		795-100-4240	· Pilot (10,030 mm)	1

1. Removal of valve seat insert

⚠ When using a grinder to carry out this work, carry out a test run for one minute before starting the operation to check that there is no abnormality.
- If the grindstone has been replaced, carry out the test run for 3 minutes.

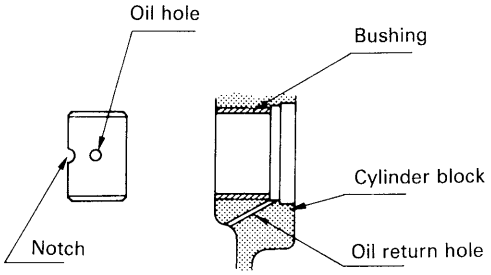
⚠ Check that there is no damage to the grindstone, fit it to the grinder spindle so that there is play, and wear safety glasses when using the grinder.

- **When removing with a valve seat puller**
  1) Install grindstone ⑤ to grinder ①.
  2) Align the groove of the sleeve ③ with holder ②, and insert.
     ★ Adjust the position of the grinder with set screw ④.



- After removing the bushing, remove any burrs or dirt, and clean the mounting hole of the bushing.

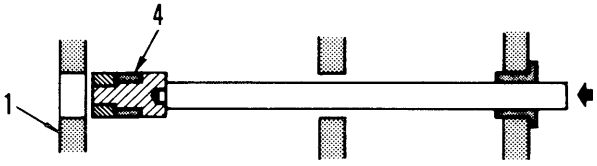
★ **Cam bushing assembly drawing**



6127F242

1. Press fitting No. 3, 4, 5 bushings

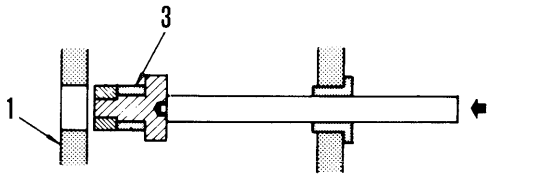
- Assemble bushing (4) to tool **A**, and press fit the bushing until the oil hole of cylinder block (1) matches the oil hole of the bushing.



6202F017

2. Press fitting No. 2, 6 bushings

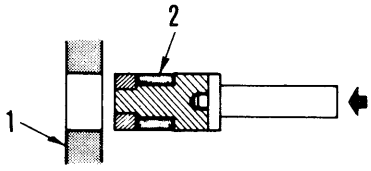
- Assemble bushing (3) to tool **A**, and press fit the bushing until the oil hole of cylinder block (1) matches the oil hole of the bushing.



6162F522

3. Press fitting No. 1, 7 bushings

- Assemble bushing (2) to tool **A**, and press fit the bushing until the oil hole of cylinder block (1) matches the oil hole of the bushing.

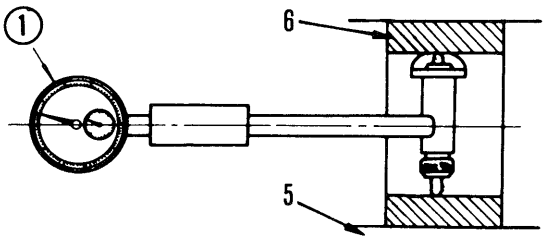


6202F018

- Using inside gauge ①, measure the inside diameter of the bushing.
- Check the clearance between the bushing and shaft, and if the clearance is not within the specified range, or the shaft does not move smoothly, correct the inside diameter of the bushing with a reamer.
  - When the inside diameter of the bushing has been corrected with a reamer, clean all the metal particles from the oil hole and oil groove.

★ Inside diameter cam bushing: ϕ 65 $^{+0.06}_{-0}$

★ Clearance of camshaft journal: 0.016 — 0.096



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3) Machining with boring tool kit
   ★ Apply the following method to a model for which the boring tool kit is prepared as a special tool.

4) Check
   i) Check the main bearing mounting holes for radial runout (misalignment of the main bores) and confirm that the result is in the permissible range.
   ii) Measure the inside diameter of the main bearing mounting holes and confirm that it is in the permissible range.

2. MACHINING MAIN BEARING CAP WIDTH

1) Insert cast iron bushing (6) and pass arbor (7).

2) Install arbor facing tool (8) and cut cap (9) until the tool almost touches the cylinder block surface.

3) Cut the opposite side similarly.
   ★ Take care not to cut the cylinder block.