SHOP MANUAL

KOMATSU

70E, 76E-5 SERIES

DIESEL ENGINE

Printed in Japan 02-05 (01)

HOW TO READ THIS MANUAL

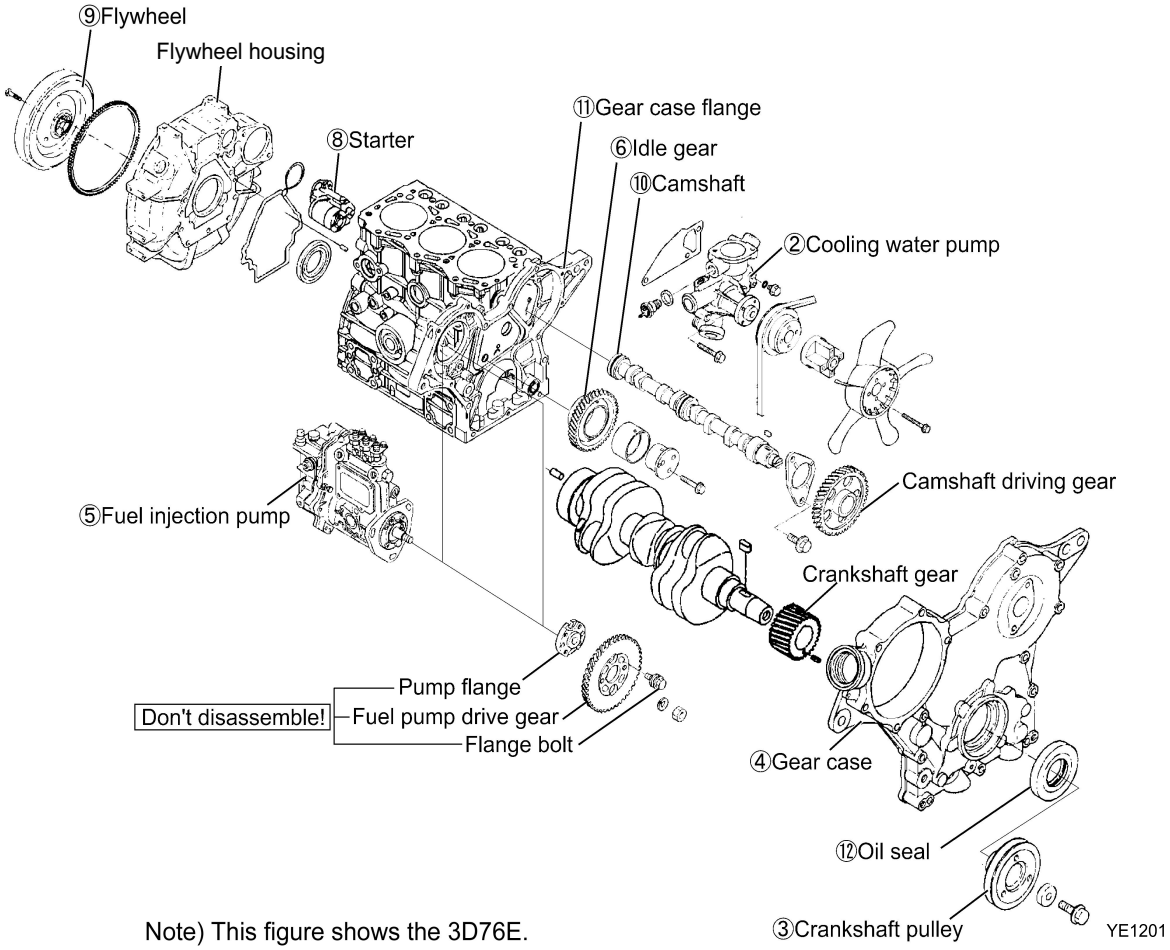
1. Range of Operation Explanation

This manual explains the troubleshooting, installation/removal, replacement, disassemble/reassembly, inspection, adjustment and adjusting operation procedures for the 76E-5 series engines.
Refer to the shop manual for each of the fuel injection pump, governor, starting motor and alternator except for their installation.

2. How to Read the Explanations

- An exploded view, sectional views, a system diagram, etc. are shown at the beginning of each section as required for easy understanding of the mounted states of the components.
- For the removal/installation of each part, the procedure is shown with the procedural step No. in the illustration.
- Precautions and key points for disassembly and reassembly of parts are described as **points**. In the explanation for each point, detailed operation method, information, standard and precautions are described.

Description Example



Note) This figure shows the 3D76E.

The job contents are described in the disassembly procedure for Nos. not shown in the illustration.

- Disassembly procedure
  1) Follow steps (1) to (15) of the cylinder head disassembly procedure.
  2) Remove the cooling water pump.
  3) Remove the crankshaft pulley. (**Point 1**) ← Operation point to be explained on a later page.

- Operation points
  Disassemble: Service point for removal
  Reassemble: Service point for installation
  Disassemble-Reassemble: Service point required in both removal and installation.

2. INSPECTION AND ADJUSTMENT

(b) Measurement with hydrometer
When using a hydrometer, the measured specific gravity must be corrected according to the temperature at the time of measurement. The specific gravity of battery electrolyte is defined with 20°C as the standard. Since the specific gravity increases or decreases by 0.0007 when the temperature varies by 1°C, correct the value according to the equation below.

$$S20 = St + 0.007(t - 20)$$

- St: Specific gravity at measurement
- t: Electrolyte temperature at measurement
- S20: Converted specific gravity at 20°C

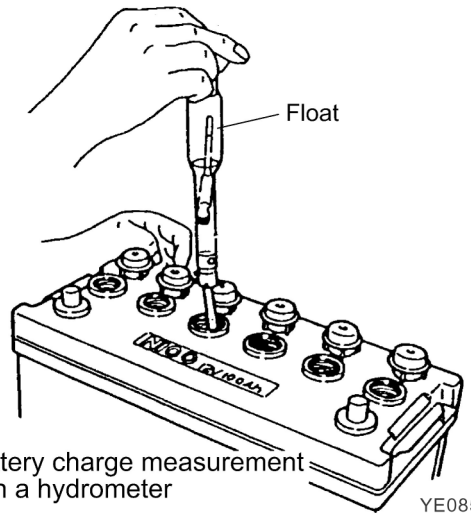
(c) Specific gravity and remaining battery charge

Specific gravity (20°C)	Discharged quantity of electricity (%)	Remaining charge (%)
1.28	0	100
1.26	10	90
1.24	20	80
1.23	25	75

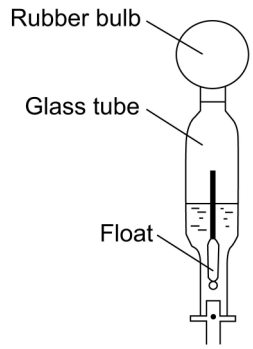
(3) Terminals
Clean if corroded or soiled.

(4) Mounting bracket
Repair or replace it if corroded.
Retighten if loosened.

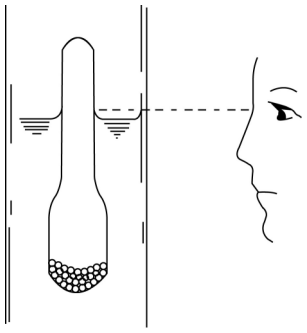
(5) Battery appearance
Replace the battery if cracked or deformed.
Clean with fresh water if contaminated.



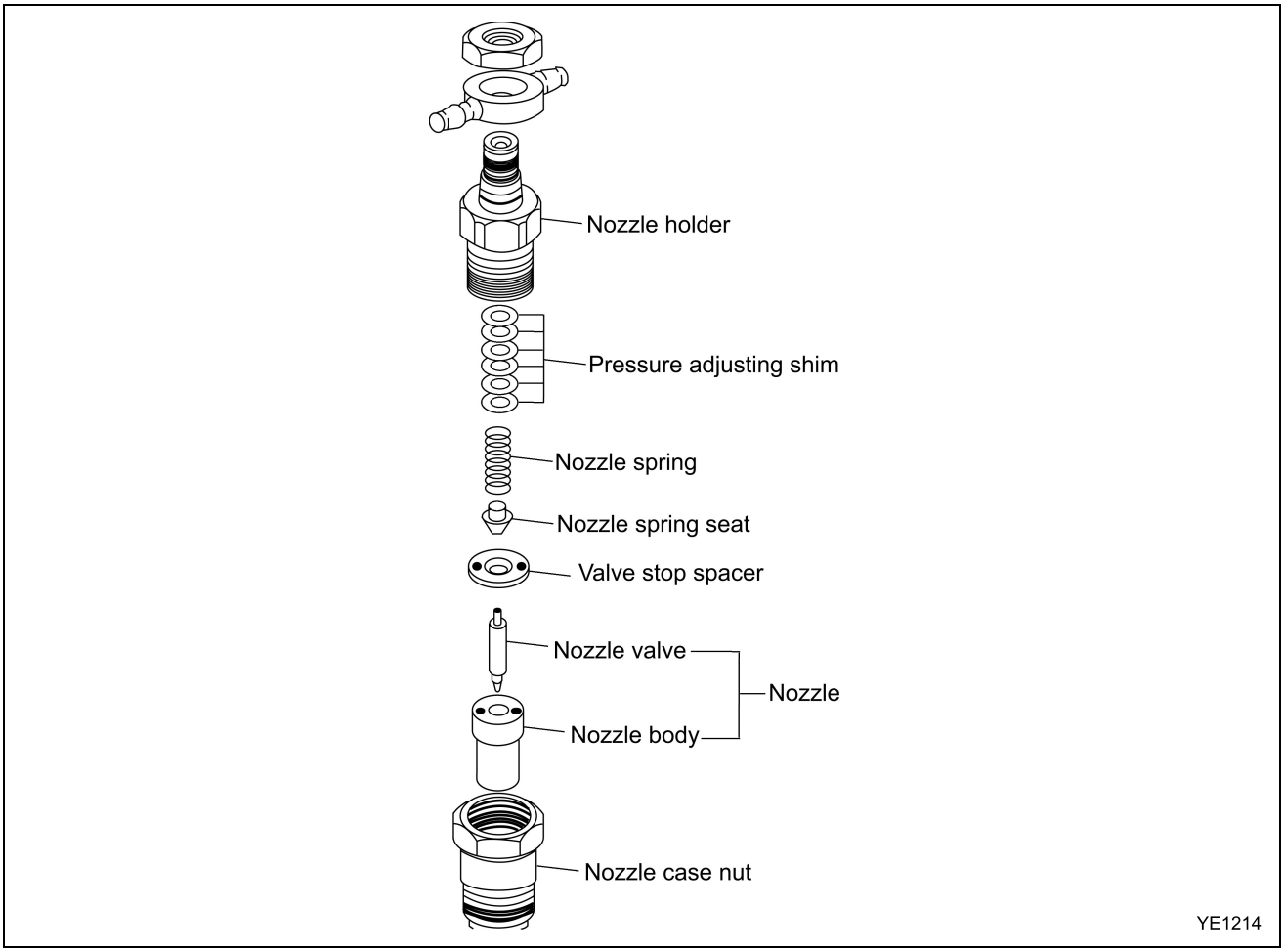
Battery charge measurement with a hydrometer YE0859



Hydrometer structure YE0860


How to read hydrometer YE0861

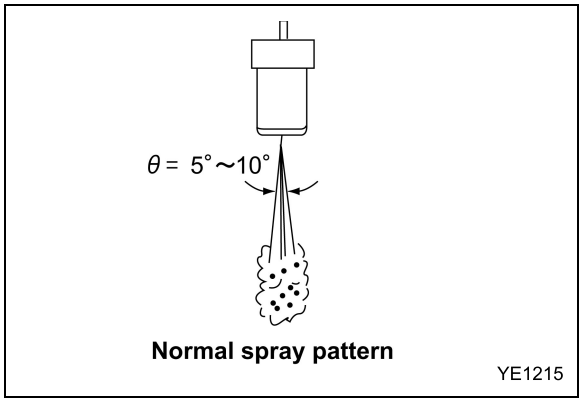
[Informative: Fuel injection valve structure]



(b) Spray pattern inspection
After adjustment to the specified valve opening pressure, use a nozzle tester and check the spray pattern and seat oil-tightness.

Seat oil tightness check

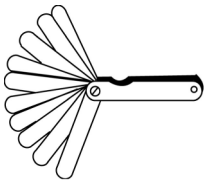
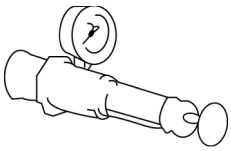
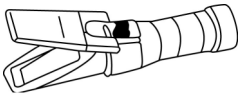
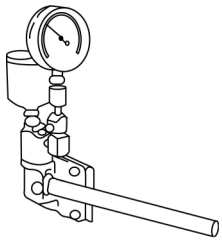
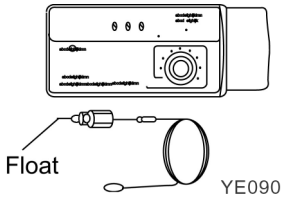
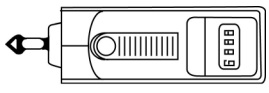
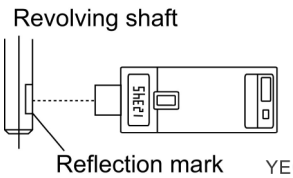
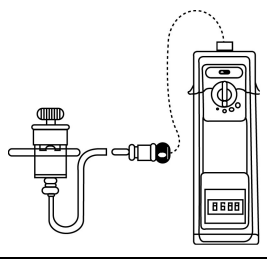
- After injecting a few times, increase the pressure gradually. Hold the pressure for about 5 seconds at a little before the valve opening pressure of 1.96 MPa {20 kg/cm^2}, and check to see that oil does not drip from the tip end of the nozzle.
- If extreme oil leak from the overflow joint exists during injection by the nozzle tester, check after retightening. If much oil is leaking, replace the nozzle assembly.



3.2 Quick Reference Table for Troubleshooting

The following table summarizes the general trouble symptoms and their causes. If any trouble symptom occurs, take corrective action before it becomes a serious problem so as not to shorten the engine service life.

Cause \ Trouble symptom		Starting failure				Insufficient engine output			Poor exhaust color		High knocking sound during combustion	Abnormal engine sound	Uneven combustion sound	Hunting		Large engine vibration	Difficulty in returning to low speed	Excessive fuel consumption	Lubricating oil				Much blow-by gas	Cooling water		Air intake		Exhaust temperature rise	Corrective action
		Engine does not start	Engine starts but stops soon			Insufficient engine output			During work					During idling	During work				Excessive consumption	Dilution by fuel oil	Mixture with water	Low L.O. pressure		Overheat	Low water temperature	Pressure drop	Pressure rise		
			Exhaust smoke			Ordinary	White	Black	White	Black																			
			None	Little	Much																								
Engine system	Improper clearance of intake/exhaust valve	○	○			○						○														○		○	Adjust the clearance. (See 2.2.6(4) in Chapter2.)
	Compression leakage from valve seat					○		○		○		○						○					○			○		○	Lap the valve seat. (See 4.2.6 in Chapter4.)
	Seizure of intake/exhaust valve	○			○	○		○		○		○			○	○				○			○			○			Correct or replace.
	Blowout from cylinder head gasket					○															○			○					Replace the gasket. (See 4.2.2-12) in Chapter4.)
	Seized or broken piston ring	○			○		○		○			○		○		○			○	○			○	○				○	Replace the piston ring. (See 4.4.2-5) & 10) in Chapter4.)
	Worn piston ring, piston or cylinder	○			○		○		○										○	○			○						Perform honing and use oversize parts. (See 4.4.5-1)4) and 4.4.6 in Chapter4.)
	Seized or broken piston ring	○	○									○		○	○	○							○						Repair or replace.
	Improper arrangement of piston ring joints		○				○												○				○						Correct the ring joint positions. (See 4.4.4-point 6 in Chapter4.)
	Reverse assmbly of piston rings						○		○										○				○						Reassemble correctly. (See 4.4.4-point 6 in Chapter4.)
	Worm crankpin and journal bearing					○						○		○	○	○						○							Measure and replace. (See 4.4.5(2) in Chapter4.)
	Loosened connecting rod bolt											○				○						○							Tighten to the specified torque. (See 4.4.4-point 2 in Chapter4.)
	Foreign matter trapped in combustion chamber	○										○							○				○						Disassemble and repair.
	Excessive gear backlash											○																	Adjust gear meshing. (See 4.3.4-point 2 in Chapter4.)
	Worn intake/exhaust valve guide						○												○				○						Measure and replace. (See 4.2.5-(2) and 4.2.7 in Chapter4.)
	Defective governor		○											○	○	○	○												Make adjustment.
	Improper open/close ti ming of intake/exhaust valves	○					○	○	○	○		○																	Adjust the valve clearance. (See 2.2.6-(4) in Chapter2.)

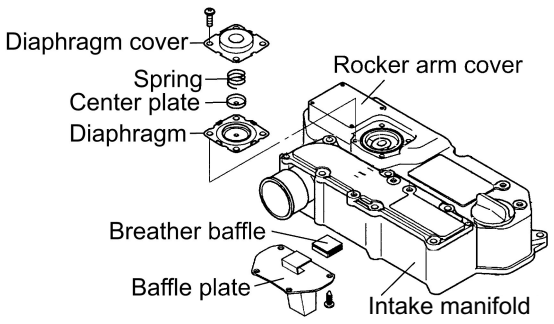
No.	Instrument name		Application	Illustration
11	Thickness gauge		For measuring gaps between ring and ring groove, and shaft joints during assembly	 YE0683
12	Cap tester		For checking water leakage	 YE0684
13	Battery coolant tester		For checking concentration of antifreeze and the battery electrolyte charge status	 YE0685
14	Nozzle tester		For measuring injection spray pattern of fuel injection nozzle and injection pressure	 YE0686
15	Digital thermometer		For measuring temperatures	 YE0901
16	Speed-ometer	Contact type	For measuring revolution by contacting the mortise in the revolving shaft	 YE0688
		Photoelectric type	For measuring revolution by sensing the reflecting mark on the outer periphery of the revolving shaft	 YE0902
		Fuel high-pressure pipe clamp type	For measuring the revolution regardless of the center or periphery of the revolving object.	 YE1153

Point 6

Breather system (A reductor to intake air system of blowby gas)

Emitting blowby gas is harmful to natural environment. Therefore blowby gas reductor is adopted to 76E-5 series engines as breather system.

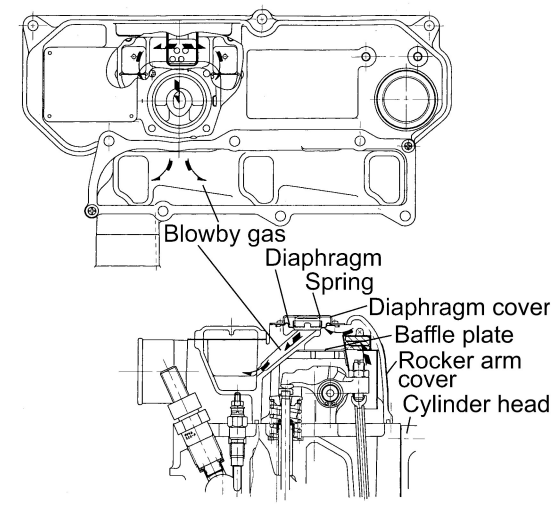
The system of model 3D76E is shown as a representative of that breather system in the right figure. Some of the combustion gas passes through the clearance between the cylinder and the piston, piston ring, and flows to the crankcase. This is said as blowby gas. While it passes into the cylinder head and the rocker arm cover, the blowby gas mixes with splash oil, and becomes oil mist-blowby gas with passing through the baffle plate inside a rocker arm cover. And it passes through a diaphragm ass'y, and an intake manifold, and is reduced in the combustion chamber. Pressure inside a crankcase is controlled by the function of the diaphragm ass'y, and suitable amount of blowby gas is reduced in intake air system.



Breather system componert YE1225

[Disassemble]

When a rocker arm cover is taken off, check whether oil or the like enter the diaphragm space from a small hole on the side of a diaphragm cover or not without disassembling the diaphragm.



Blowby gas flow YE1226

[NOTICE]

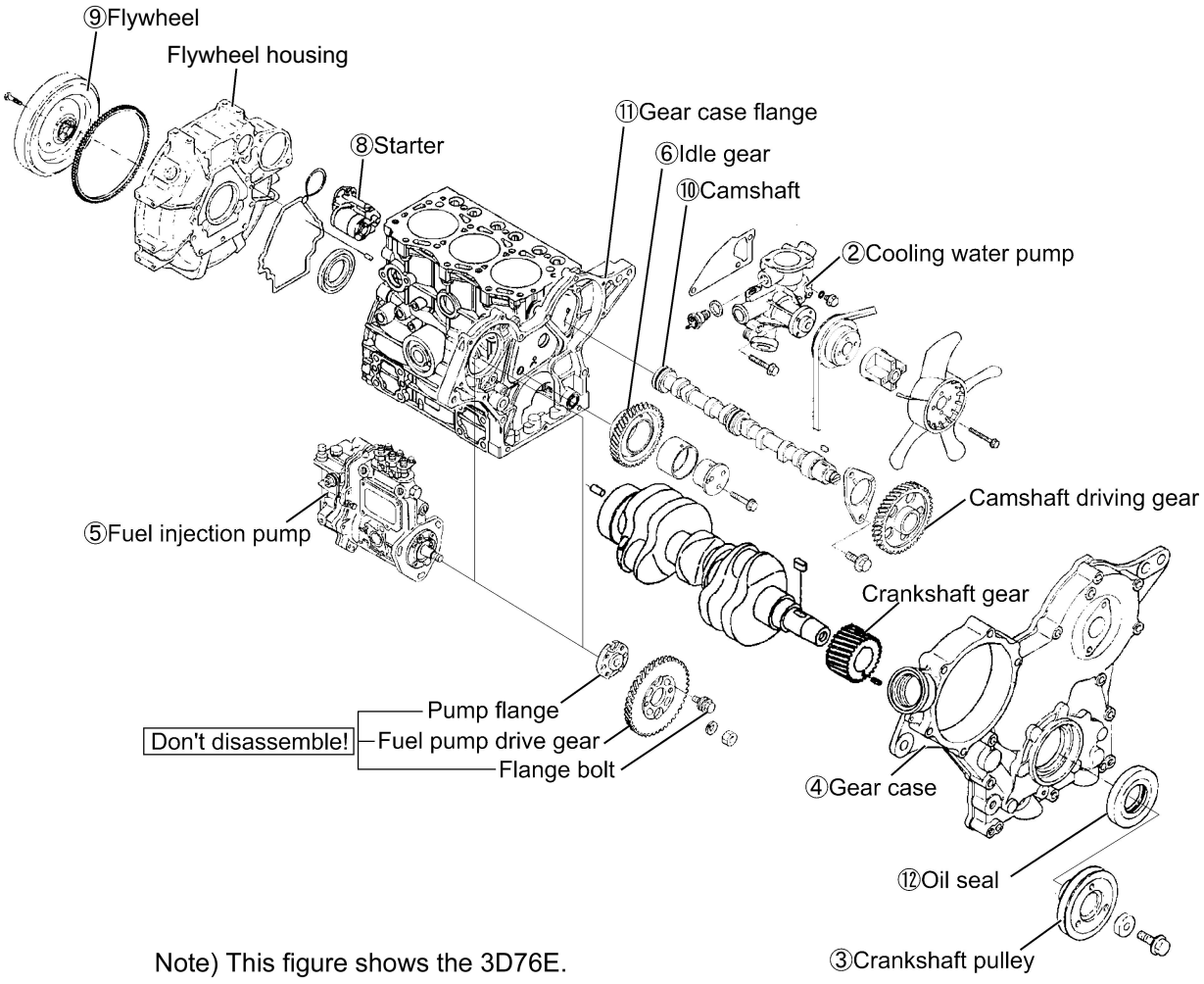
1) When a diaphragm is damaged, pressure control inside the crankcase becomes insufficient, and troubles occur. When the internal pressure of the crankcase decreases too much due to the damage of a spring, much blowby gas containing oil is reduced in intake air system, and it may cause the combustion defect by the early dirt of the intake valve or the urgent rotation of the engine by the oil burning.
   When pressure progresses in the crank case too much due to the wrong operation of the diaphragm and so on, it is considered that oil leakage from the joint of an oil pan, an oil seal and so on will occur. When a diaphragm is damaged, blowby is discharged from the breathing hole on the side of diaphragm cover, and not reduced in the intake manifold. Therefore, be careful of the diaphragm trouble.
2) At lubricating oil replacement or lube oil supply
   The amount of lubricating oil isn't to be beyond the standard upper limit (in the engine horizontality, the upper limit mark of the oil level gauge). Since the blowby gas reductor is adopted, be careful that the amount of oil mist may be inducted in the combustion chamber and the oil hammer sometimes may occur, when the lubricating oil quantity is beyond the upper limit or an engine is operated beyond the allowable maximum angle of an engine.

[Reassembly]

- Replace the diaphragm with new one, when it is damaged.

4.3 Gear Train and Camshaft

4.3.1 Components



4.3.2 Disassembly procedure

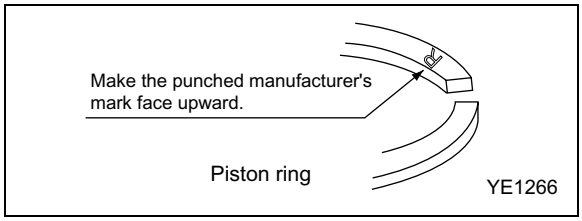
Disassemble in the order of the numbers in the illustration.

1) Perform steps 1) to 12) of the cylinder head disassembly procedure.
2) Remove the cooling water pump.
3) Remove the crankshaft pulley. (See Point 1 of 4.3.4)
4) Remove the gear case cover. (See Point 2 of 4.3.4)
5) Remove the fuel injection pump. (See Point 3 of 4.3.4)
6) Remove the idle gear ass'y. (See Point 4 of 4.3.4)
7) Remove the PTO drive gear. (See Point 5 of 4.3.4)
8) Remove the starting motor.
9) Remove the flywheel. (See Point 6 of 4.3.4)
10) Remove the camshaft ass'y. (See Point 7 of 4.3.4)
11) Remove the gear case. (See Point 8 of 4.3.4)
12) Remove the oil seal from the gear case cover. (See 4.3.6)

Point 6: Piston pin and rings

[Disassemble]

- Using the piston ring replacer (see 4.1.2 (1) No.10 in Chapter 4), remove the piston rings.
- Remove the circlip and remove the piston pin by pushing it out.

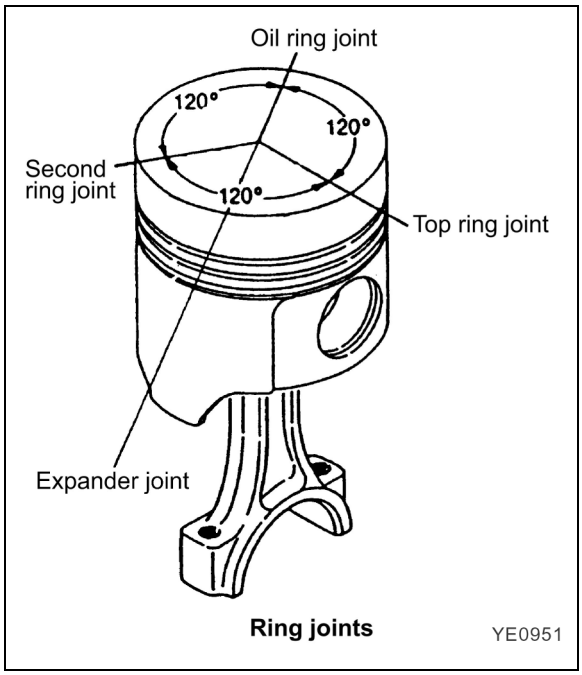


[Reassemble]

- Install each piston ring on the piston, with the punched manufacturer's mark facing upward.

[Reassemble]

- The piston ring joints shall be staggered at by 120° intervals. Do not position the top ring joint vertical to the piston pin. The coil expander joint shall be opposite to the oil ring joint.

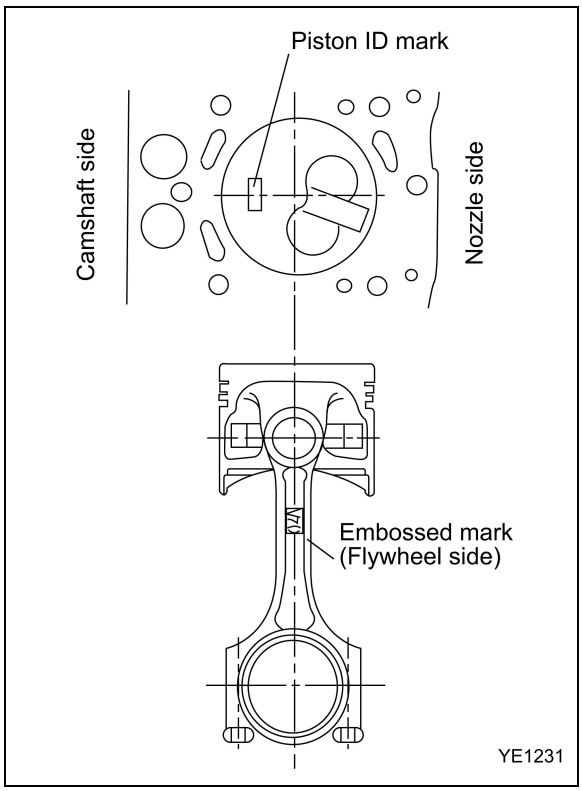


[Reassemble]

- When installing the piston pin to the rod and piston, the punched match mark on the big end of the connecting rod shall be opposite to the size mark on the piston top.

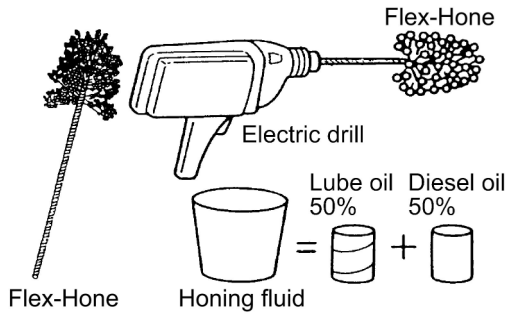
[Reassemble]

- Install the piston in the cylinder block. The embossed mark on the connecting rod shall be on the flywheel side.



4.4.6 Cylinder bore correction

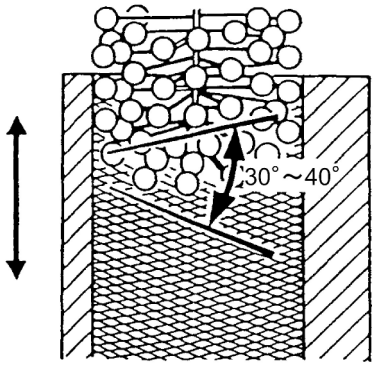
1) Slight uneven worn, flawed, etc. shall be corrected by honing only. If the cylinder is unevenly worn partially, flawed or otherwise damaged and cannot be repaired simply by honing, rebore the cylinder first and then hone. See 4.4.5.(1)(c) for the boring dimension.
2) Items to be prepared for honing
   - Flex-Hone
     (see No.8 of 4.1.2 in Chapter 4)
   - Electric drill
   - Honing fluid
     (50:50 mixture of lube oil and diesel oil)



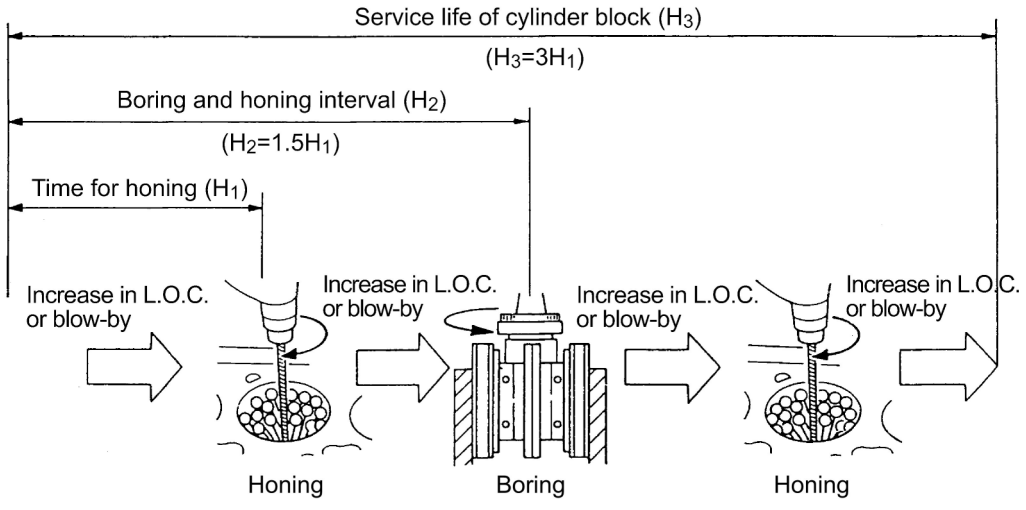
Items to be prepared for honing YE0971

3) Apply the honing fluid to the Flex-Hone and turn the electric drill at 300 to 1,200 rpm. Then insert the Flex-Hone into the cylinder bore while turning it, and move it up and down for about 30 sec. to obtain a honing mark with a cross hatch angle of 30 to 40°.

   [NOTICE]
   1) Avoid faster revolution than 1,200 rpm since it may cause breakdown.
   2) Do not insert or extract the Flex-Hone in stopped state because the cylinder will be damaged.



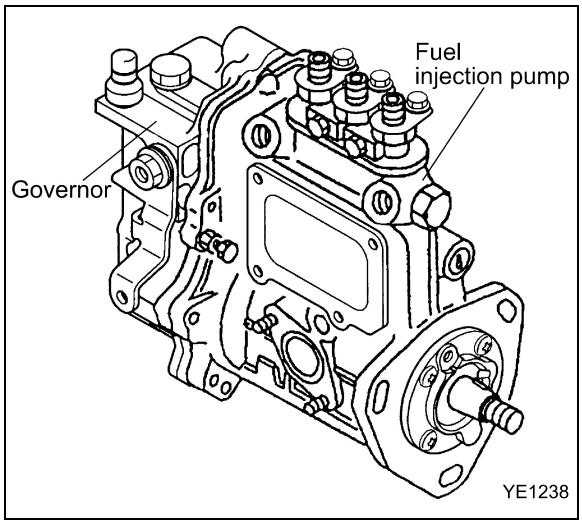
Honing cross hatch YE0972



Study if an oversized piston or piston ring is usable YE0973

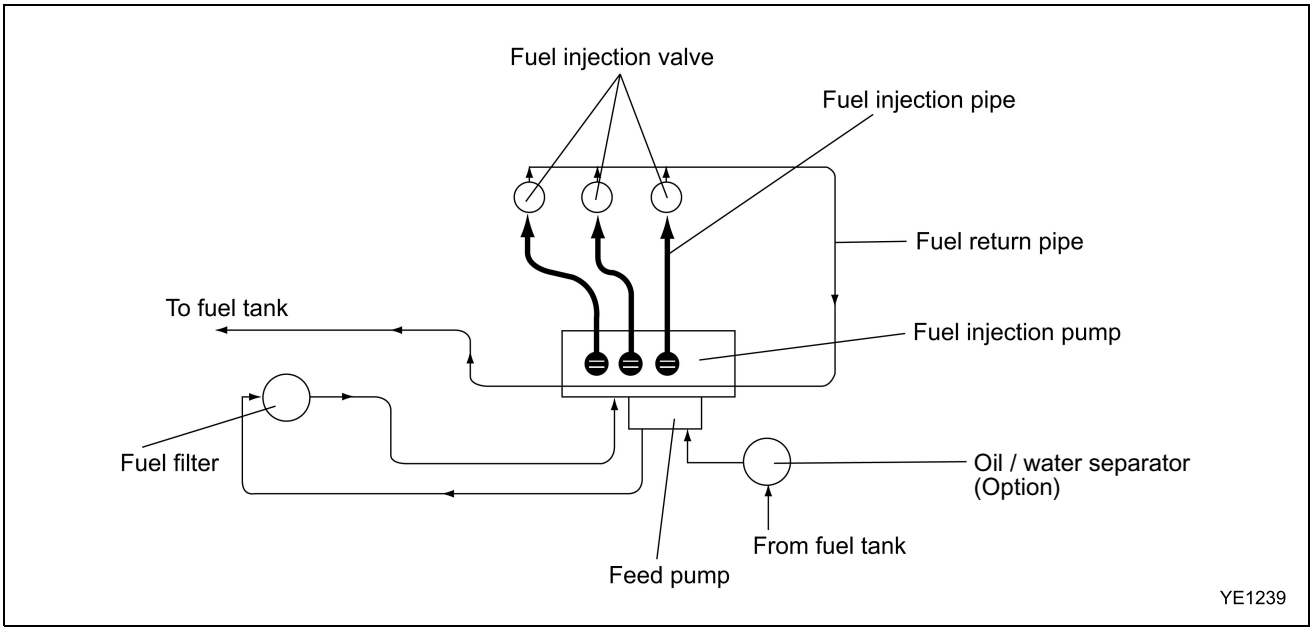
7.1 Introduction

A fuel injection pump is the most important device which adjusts an injection quantity precisely corresponding to the change of engine load.
Therefore, not only a very precise machining should be necessary all parts but also the assembling, adjustment which top-level is excellent in should be necessary.
The careful consideration to avoid dust and rust at the time of disassembly, adjustment, reassembly of the fuel injection pump in the market is necessary.
Fuel injection pumps are inline type.
A cam shaft is driven through the timing gear, and mechanical type fuel feed pump driven by a cam shaft sends fuel to the fuel filter from the fuel tank.
The fuel which passed through the fuel filter is supplied to the storeroom of the pump housing, and the pressure of the fuel rises by the plunger The fuel passes through the fuel high pressure pipe and the fuel is injected to each cylinder from the fuel injection nozzle.



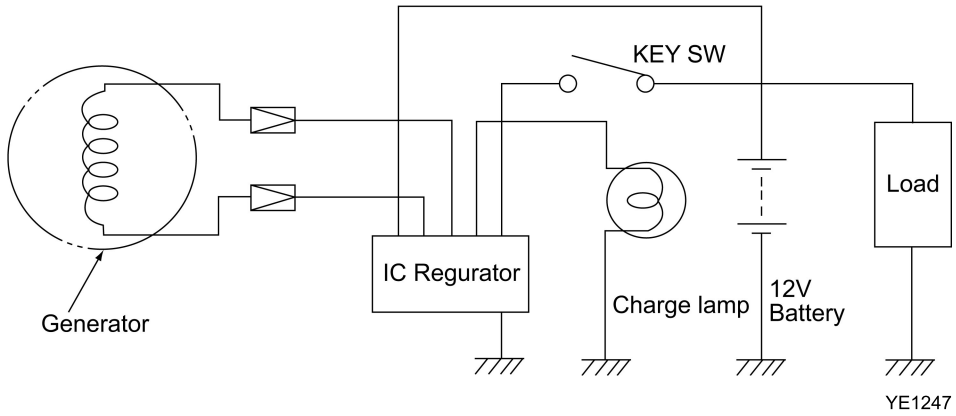
7.2 Fuel Injection Pump

7.2.1 Fuel system diagram



9.1.3 Wiring diagram

Standard circuit composition for output confirmation

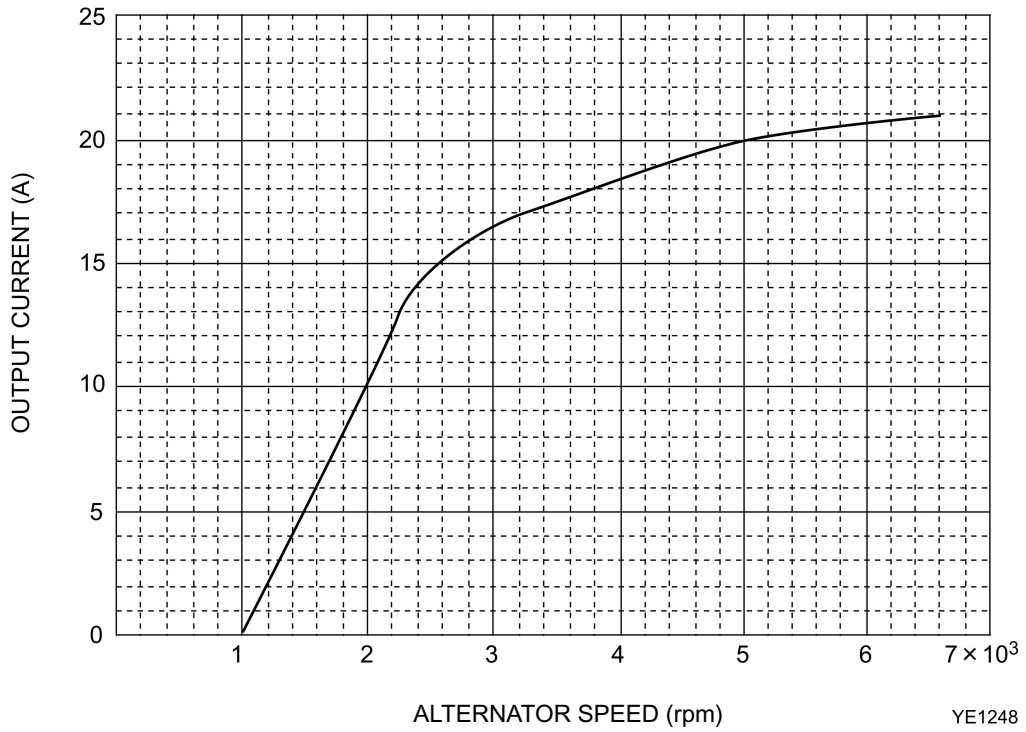


[NOTICE]
1) Do not do mis-connecting and short-circuit of each terminal.
2) Do not remove a battery terminal and a B terminal when rotating.
3) Shut out a battery switch during the alternator stop.

9.1.4 Standard output characteristics

The standard output characteristics of this alternator are shown as the below figure.

STANDARD CHARACTERISTICS (12V)



10.2.2 Starting motor

In the cases listed below the warranty shall not be deemed to apply. Please be sure to read these conditions carefully when planning to use it with other equipment. Also be certain to give appropriate guidance on usage to the user.

(1) Starting performance in the case of using an untested battery
The starting performance of the engine is closely dependent on the battery capacity. This battery capacity is itself affected by the climate and the type of equipment installation. Confer with Komatsu in advance after checking these conditions and fix the battery capacity on the basis of confirmatory tests.

(2) When the resistance of the battery cable exceeds the specified value
The combined total resistance of the battery cable in both directions between the starting motor and battery should be within the value indicated on the wiring diagram. The starting motor will malfunction or break down if the resistance is higher than the specified value.

(3) When the resistance of the starting circuit exceeds the specified value
The combined total resistance of the wiring between the starting motor and key switch (or power relay or safety relay, depending on the application) should be within the value indicated on the wiring diagram. Engine starting will be difficult if the resistance is higher than the specified value. This can also cause welding of the magnet switch at the point of contact and resultant burning of the armature coil.

(4) When there is no safety relay
Over-running (when the electric current flows for too long) is a major cause of starting failure. This burns the armature coil and causes clutch failure. Excessive work and failure of the key switch to return properly are the main causes of over-running. The user must be given sufficient warning about this.
Be sure to use the safety relay to prevent over-running. This safety relay is supplied as an option. Consult Komatsu first when planning to install a safety relay at your own. In the case of failure to consult with Komatsu, our warranty will not be applied to all the electrical equipment.

(5) When there is too much rust due to the entry of water
The water-proofing of the starting motor is equivalent to R2 of JIS D 0203. This guarantees that there will be no damage from the sort of exposure encountered in rain or when water is poured on from a bucket. You should, however, avoid the use of high-pressure washing and steeping in water.

(6) Regarding the heat resistance of the starting motor
The starting motor has heat resistance for an ambient temperature of 80°C and surface temperature of 100°C. Insulators must be installed to prevent overheating when used near high temperature parts such as the exhaust system.

(7) Corrosion of magnet switch contact point by corrosive gas.
When using equipment with a dry clutch, ammonium gas generated by friction is liable to corrode the contact of the magnet switch. Be sure to install a vent in the clutch case.